IxOS

Release 9.39

Platform Reference Guide

KEYSIGHT

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Documentation conventions

The following documentation conventions are used in this guide:

Describing interactions with the UI

You can interact with products by using different input methods: keyboard, mouse, touch, and more. So in most parts of the user documentation, generic verbs have been used that work with any input method. In cases where input-neutral verbs do not work, mouse-specific verbs are used as the first choice, followed by touch-specific verbs as the second choice.

See the following table for examples on how you can interpret the different input methods.

Input-neutral	Mouse	Touch
Select **Modify**.	Click **Modify**.	Tap **Modify**.
Select **Accounts** > **Other accounts** > **Add an account**.	Click **Accounts** > **Other accounts** > **Add an account**.	Tap **Accounts** > **Other accounts** > **Add an account**.
To open the document in Outline view, select **View** > **Outline**.	To open the document in Outline view, click **View** > **Outline**.	To open the document in Outline view, tap **View** > **Outline**.
Select **Protocols**.	Click the **Protocols** tab.	Tap **Protocols**.
-NA-	Double-click the **Client** wizard.	Double-tap the **Client** wizard.
Open the **Packages** context menu.	Right-click **Packages** to open the shortcut menu.	Long tap **Packages** to open the shortcut menu.

Deprecated words

The following words have been replaced with new words, considering the audience profile, our modern approach to voice and style, and our emphasis to use input-neutral terms that support all input methods.

Old usage...	New usage...
shortcut menu, right-click menu	context menu
click, right-click	select
drag and drop	drag

Table of Contents

About This Guide

The information in this section is provided to help you navigate this guide and make better use of its content. A list of related documents is also included.

The Third-Party Software License document is included with the download package.

Purpose

This guide provides information about Ixia hardware theory, features, functions, and options, as well as additional test setup details.

Manual Content

This guide contains the following sections:

Section	Description
About This Guide (this section)	Provides information on this manual, including its purpose, content, and related documentation. Also explains how to contact technical support.
Chapter 1 Platform and Reference Overview	Provides a basic overview of Ixia hardware and theory of operation. Hardware includes descriptions of all supported chassis and load modules.
Chapter 2 Theory of Operation: General	Provides a general overview of the various technologies used in both IxExplorer and in the IxOS.
Chapter 3 Theory of Operation: Protocols	Provides a general overview of the various technologies used in IxNetwork and IxRouter.
Chapter 4 XG12 Chassis	Provides a detailed description of the features and systems of the XG12 chassis.
Chapter 5 XGS12 Chassis Platform	Provides a detailed description of the features and systems of the XGS12 chassis platform.
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Chapter 7 IXIA 400T v2 Chassis	Provides a detailed description of the features and systems of the 400T v2 chassis.
Chapter 8 Metronome	Provides a detailed description of the features and systems of the Ixia Metronome Timing System.
Chapter 9 IXIA Xcellon-Lava Load Modules	Provides a detailed description of the features and capabilities of Xcellon-Lava load module.
Chapter 10 IXIA 10/100/1000 Load	Provides a detailed description of the features and capabilities

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Chapter 12 IXIA 40/100 Gigabit Ethernet Load Modules	Provides a detailed description of the features and capabilities of 40 and 100 Gigabit Ethernet load modules.
Chapter 13 IXIA 10 Gigabit Ethernet Load Modules	Provides a detailed description of the features and capabilities of 10 Gigabit Ethernet load modules.
Chapter 14 IXIA Xcellon-Flex Load Modules	Provides a detailed description of the features and capabilities of Xcellon-Flex load modules.
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Chapter 23 Ixia Novus 10G/5G/2.5G/1G/100M Load Modules	Provides a detailed description of the features and capabilities of Novus 10/1 5-speed load modules.
Chapter 24 Ixia Novus25/10GE8SFP28+100G+50G	Provides a detailed description of the features and capabilities of Novus25/10GE8SFP28+100G+50G load modules.

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Chapter 28 Ixia K400-CFP8 Load Modules	Provides a detailed description of the features and capabilities of K400 CFP8 load modules.
Chapter 29 Ixia K400 QSFP-DD Load Modules	Provides a detailed description of the features and capabilities of K400-QSFP-DD load modules.
Chapter 30 Ixia XMVAEGE Ethernet Load Modules	Provides a detailed description of the features and capabilities of XMVAE Ethernet load module.
Chapter 31 Ixia PerfectStormOne Appliances	Provides a detailed description of the features and capabilities of PerfectStormONE appliances.
Chapter 32 Ixia Novus One Appliance and Novus ONE PLUS Fixed Chassis	Provides a detailed description of the features and capabilities of Novus ONE appliance and Novus ONE PLUS Fixed Chassis.
Chapter 33 Ixia AresONE Fixed Chassis	Provides a detailed description of the features and capabilities of AresONE fixed chassis.
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Appendix E Software Licenses	Provides the copyright and license information of the various open source software that are delivered as part of IxOS.

Related Documentation

The following guides help you learn more about the hardware for IxOS. The guides are available on the CD shipped with the application, as well as on the Ixia Website at www.ixiacom.com.

- *IxExplorer User Guide*: Provides details on the usage of the IxExplorer GUI for operation with an Ixia chassis and Ixia load modules
- *IxServer User Guide*: Provides details on the usage of the IxServer GUI for operation on an Ixia chassis
- *IxOS Tcl Development Guide*: Provides details on the structure and conventions of the IxExplorer Tcl API and provides detailed information on all API commands

Technical Support

You can obtain technical support for any Ixia product by contacting Ixia Technical Support by any of the methods mentioned on the inside cover of this manual. Technical support from Ixia's corporate headquarters is available Monday through Friday from 06:00 to 18:00, UTC (excluding American holidays). Technical support from Ixia's EMEA and India locations is available from Monday through Friday, 08:00 to 17:00 local time (excluding local holidays).

Notes, Cautions, Warnings

Power Cords

Caution:

Power cords that are included in shipments of Ixia equipment meet the approved/recognized standards of the national safety organization(s) of the destination country. Use the power cord provided or a power cord approved by the appropriate agency for use in the country where the unit is being used. The power source should be properly grounded.

Caution:

Les câbles d'alimentation livrés avec les équipements Ixia sont conformes aux/normes reconnues des organismes nationaux de sécurité du pays de destination. Utilisez le câble d'alimentation fourni ou un câble approuvé par l'organisme adéquat du pays dans lequel l'unité est utilisée. La source d'alimentation doit être correctement mise à la terre.

Battery Replacement

Caution:

Danger of explosion if battery is incorrectly replaced. You should not attempt to replace the battery. Return to Ixia Customer Service for replacement with the same or equivalent type of battery. Ixia disposes of used batteries according to the battery manufacturer's instructions.

Remplacement de la batterie

Attention:

Le remplacement incorrect de la batterie peut provoquer une explosion. Vous ne devez en aucun casessayer de remplacer la batterie. Renvoyez le produit au service clients Ixia pour un échange avec le mêmetype de batterie ou un type équivalent. Ixia met les batteries usagées au rebut conformémentaux instructions du fabricant.

Ventilation Requirements

The following caution applies to equipment installed into equipment racks.

Caution:

Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the back or sides of the chassis, and leave approximately two inches of space around the unit for proper ventilation.

Attention:

Flux d'air réduit: installez l'équipement dans un rack de manière à ne pas réduire le flux d'air requis pour le fonctionnement en toute sécurité de l'équipement. N'obstruez ni les côtés ni l'arrière du châssis et laissez environ cinq centimètres (deuxpouces) autour de l'unité pour une ventilation correcte. N'obstruez aucunorifice de ventilation du châssis. Nettoyez régulièrement les grilles d'entrée d'air pour permettre une bonne entrée d'air.

Use End Caps on Open Ports

The metal edges of the SFP port are sharp. To avoid injury, always keep unused SFP ports covered with end caps. When installing a load module into a chassis or removing from a chassis, ensure that end caps are in place on unused ports.

Utilisez des capuchons de protection sur les ports ouverts

Les arêtes métalliques des ports SFP et SFP+ sont VIVES. Pour éviter toute blessure, recouvrez TOUJOURS les ports SFP non utilisés de capuchons. Lorsque vous installez un module de charge dans un châssis ou que vous le retirez, assurez-vous que les ports non utilisés sont bien protégés par des capuchons.

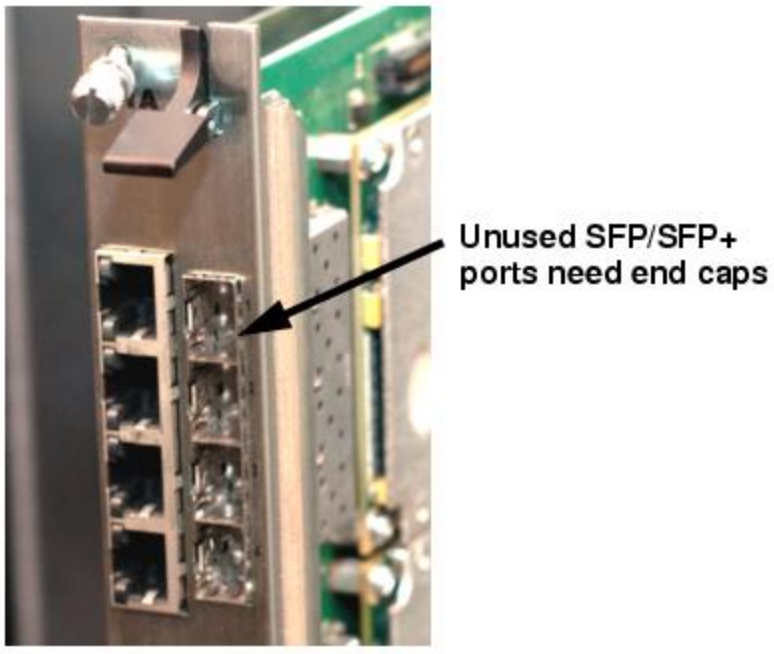
Warning:

To prevent accidental injury to personnel, do not leave unused SFP (or SFP+) ports uncovered. When transceivers are not installed, end caps must be used.

Avertissement:

Pour éviter toute blessure accidentelle de vos employés, ne laissez pas les ports SFP (ou SFP+) découverts. Lorsqu'il n'y a pas d'émetteurs-récepteurs installés, les capuchons doivent être installés.

The following image shows the precautionary measure to be taken while handling unused SFP/SFP+ Ports in the laboratory.



Affected load modules include the following:

- NGY with SFP+ interface, 2/4/8-port, all models
- Dual PHY SFF cards with RJ45 and SFP Gigabit (TXS and STXS)
- Xcellon-Ultra NP, XP, and NG
- LSM1000XMV 4/8/12/16-port
- LSM1000XMS
- ASM1000XMV
- AFM1000SP
- ELM1000ST

Use Ejector Tabs Properly

Ejector tabs on load modules are to be used only to eject a load module from the chassis backplane connector. They are not designed to support the weight of the load module. Ejector tabs can bend or break if used improperly as handles to push, pull, or carry a load module.

Caution:

Do not use ejector tabs as handles to support a load module while installing and seating into the chassis. The ejector tabs are to be used only to eject the module from the chassis backplane connector.

China RoHS Declaration Table Chassis

零件项目(名称) (Component Name)	有毒有害物质或元素(Hazardous Substances or Elements)					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Chromium VI Compounds (Cr6+)	多溴联苯 Poly-brominated Biphenyls (PBB)	多溴二苯醚 Poly-brominated Diphenyl Ethers (PBDE)
印制电路配件 (Printed Circuit Assemblies)	X	O	O	O	O	O
内部线路 (Internal wiring)	X	O	O	O	O	O
底架 (Chassis)	O	O	O	O	O	O
金属外壳 (Metal Enclosure)	O	O	O	O	O	O
螺帽,螺钉(栓),螺旋(钉),垫圈, 紧固件 (Nuts, bolts, screws, washers, Fasteners)	O	O	O	O	O	O
电源供应器 (Power Supply Unit)	O	O	O	O	O	O
风扇 (Fan)	O	O	O	O	O	O
正面(前)面板 (Front panel)	O	O	O	O	O	O

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006标准规定的限量要求以下.
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.

X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006标准规定的限量要求.
X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.

New in Version 9.39

The following new features are added in this release:

- AresONE-800GE OSFP800-M 4-port and 8-port test systems. See AresONE-800GE OSFP800-M Fixed Chassis.
- AresONE-800GE dual interface model 4-port test system. See AresONE-800GE Dual Interface Model-M.

CHAPTER 1

Platform and Reference Overview

The Ixia system is the most comprehensive tool available for testing multilayer 10/100 Mbps Ethernet, Ethernet Gigabit, 10 Gigabit Ethernet, ATM, and Packet over SONET switches, routers, and networks.

The Ixia product family includes chassis, load modules, the Ixia IxExplorer software program, and optional Tcl scripts and related software. A chassis can be configured with any mix of load modules, and multiple chassis can be daisy-chained and synchronized to support very large and complex test environments. The Ixia IxExplorer software provides complete configuration, control, and monitoring of all Ixia resources in the test network, and the Tcl scripts allow to rapidly conduct the most popular industry benchmark tests.

The XGS12-SD chassis is the next generation high performance platform capable of supporting XM form factor load modules. XGS12-SD is a 12-slot chassis with high-speed backplane designed for aggregation across load modules. This flexible platform supports layer 2-7 testing on a massive scale and provides the most comprehensive solution for performance, functional, security, and conformance testing of network equipment and network applications.

The XGS2-SD chassis provides highly flexible and portable chassis that powers load modules and test applications to create an Ixia test system. The chassis platform supports Ixia applications for performance, functional, conformance, and security testing.

You can configure and control the unit directly through connections to a keyboard, mouse, monitor, and printer. Also, the unit can be connected to an Ethernet network, and an administrator can remotely monitor and control it using the IxExplorer software program. Multiple users can access the unit simultaneously, splitting the ports within a chassis and controlling the activity and configuration of all ports and functions.

Front panel displays give immediate indication of link state, transmission or reception of packets, and error conditions.

Ixia produces a number of load modules which provide data transmission and reception capabilities for a variety of Ethernet, ATM, and Packet Over Sonet (POS) speed and technologies. These load modules reside in an Ixia chassis, which provide different numbers of load module slots and power. This chapter introduces the Ixia hardware components. The Ixia chassis and load modules are compared and contrasted.

Ixia Chassis

The following Ixia chassis are currently available for sale:

- XGS12 Chassis Platform: The XGS12 chassis platform is the next generation high performance platform capable of supporting all XM form factor load modules, including full chassis

configurations of the Xcellon load modules. It is a 12-slot chassis platform with highspeed backplane (160 Gbps between each adjacent two cards) designed for aggregation across load modules.

- XGS2 Chassis Platform: The XGS2 chassis platform supports highly flexible and portable chassis that powers load modules and test applications to create an Ixia test system. It is a 2-slot, 3RU modular bench-top test chassis.

The following Ixia chassis are no longer available for sale:

- XG12 Chassis: The XG12 Chassis is the next generation high performance chassis platform capable of supporting next generation load modules. It is a 12 slot chassis with increased power and airflow delivery along with reservations for increased performance to the card. The 12-slot platform allows for higher port density load modules.
- Optixia XM12 Chassis: Capable of holding up to 12 Ixia load modules and equipped with extra power and fans required for high-powered load modules. Supports higher port density. Modules can be inserted and removed from the chassis without shutting the chassis down, and a load module can be removed without impacting the processes of other load modules. An optional Sound Reducer (PN 943-0021) can be installed on the rear of the XM12 chassis, to reduce the fan noise by approximately 10 dB. The XM12 High Performance version (PN OPTIXIAXM12-02) has two 2.0 kW power supply; the standard XM12 version has two 1.6 kW power supply.
- Optixia X16 Chassis: Capable of holding up to 16 Ixia load modules and equipped with extra power and fans required for some high-powered load modules. Modules can be inserted and removed from the chassis without shutting the chassis down, and a load module can be removed without impacting the processes of other load modules.
- IXIA 400T Chassis: Capable of holding up to four Ixia load modules and equipped with extra power and fans required for some high-powered load modules.
- IXIA 1600T Chassis: Capable of holding up to 16 Ixia load modules and equipped with extra power and fans required for some high-powered load modules.
- Ixia 100 Chassis: The IXIA 100 is capable of holding one Ixia load module and includes a built-in GPS or CDMA receiver.
- IXIA 250 Chassis: A portable Field Service Unit (FSU) which includes a single port (either copper 10/100/1000 or fiber 1000) and capable of holding up to two additional Ixia load modules. May optionally be equipped with a built-in CDMA receiver.
- Optixia XL10 Chassis: Capable of holding a combination of high-density Ixia load modules with 24 ports. It supports up to 240 10/100/1000 Mbps ports. It is equipped with redundant power supplies. Modules can be inserted and removed from the chassis without shutting the chassis down, and a load module can be removed without impacting the processes of other load modules. The Optixia XL10 chassis includes sufficient power and airflow to support high-powered load modules.
- Optixia XM2 Chassis: Capable of holding two Ixia load modules and equipped with extra power and fans required for some high-powered load modules. Supports higher port density. Modules can be inserted and removed from the chassis without shutting the chassis down, and a load module can be removed without impacting the processes of other load modules.
- IXIA 400Tv2 Chassis: Ixia 400Tv2 is a portable 4-slot chassis for Ixia standard form factor (SFF) load modules. It supports an integrated test controller that manages all chassis and testing resources.

- XOTN Chassis Unit: The XOTN chassis unit is a part of the XOTN system. This system allows you to use IxNetwork protocols and scalable data plane test capabilities to test Optical Transport Network (OTN) devices.

All Ixia chassis have the ability to hold one or more standard load modules. Ixia load modules provide media dependent and independent ports to Devices Under Test (DUTs). Any of the chassis may be daisy-chained and provide synchronized operations.

Each chassis contains a self-contained computer running Windows XP Professional and includes a 10/100/1000MB network interface and local disk. They may include a floppy drive, a CD-ROM drive, or DVD-ROM drive. A chain of chassis may be controlled through a monitor, keyboard, and mouse directly connected to any of the chassis or remotely through the network interface card. Multiple users may safely share ports in a chassis chain. Several of the high-end load modules consume more power and generate additional heat. Only a limited number of such modules may be used in selected chassis. The basic characteristics of these chassis are compared in the following table. The process of initial chassis configuration is explained in Platform and Reference Overview. Each chassis is further described in its own chapter.

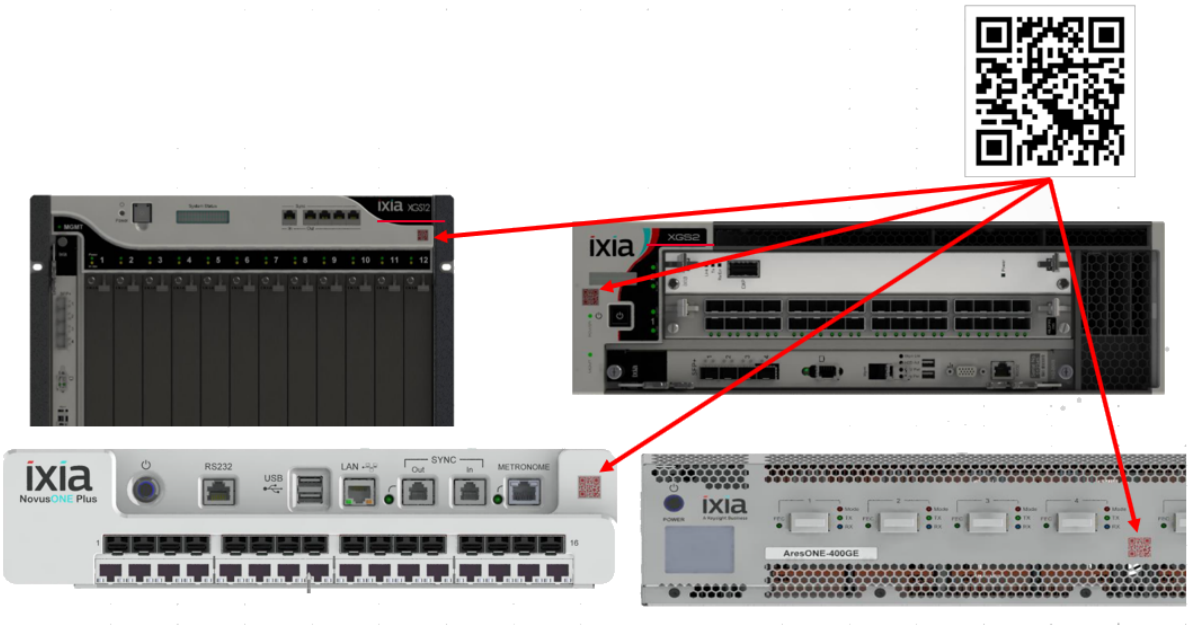
Ixia Chassis Comparison

Chassis	# of Slots	Special Feature	Mounting
XGS12 Chassis Platform	12	The XGS12 chassis platform is the next generation high performance platform capable of supporting all XM form factor load modules, including full chassis configurations of the Xcellon load modules. It is a 12-slot chassis platform with highspeed backplane (160 Gbps between each adjacent two cards) designed for aggregation across load modules.	Rack
XGS2 Chassis Platform	2	The 2-slot XGS2 chassis model - XGS2-SD provides a highly flexible and portable chassis that powers load modules and test applications to create an Ixia test system. The XGS2 platform provides the foundation for a complete benchtop or rackmount test environment. The chassis platform supports Ixia applications for performance, functional, conformance, and security testing.	Desktop/Rack
400Tv2	4	A portable 4-slot chassis for Ixia standard form factor (SFF) load modules.	Desktop/Rack

NOTE Based on power requirements, Ixia chassis do not support all possible mixes of load modules. The Ixia chassis notifies you of conflicts on chassis power-up. Contact Ixia support for configuration verification.

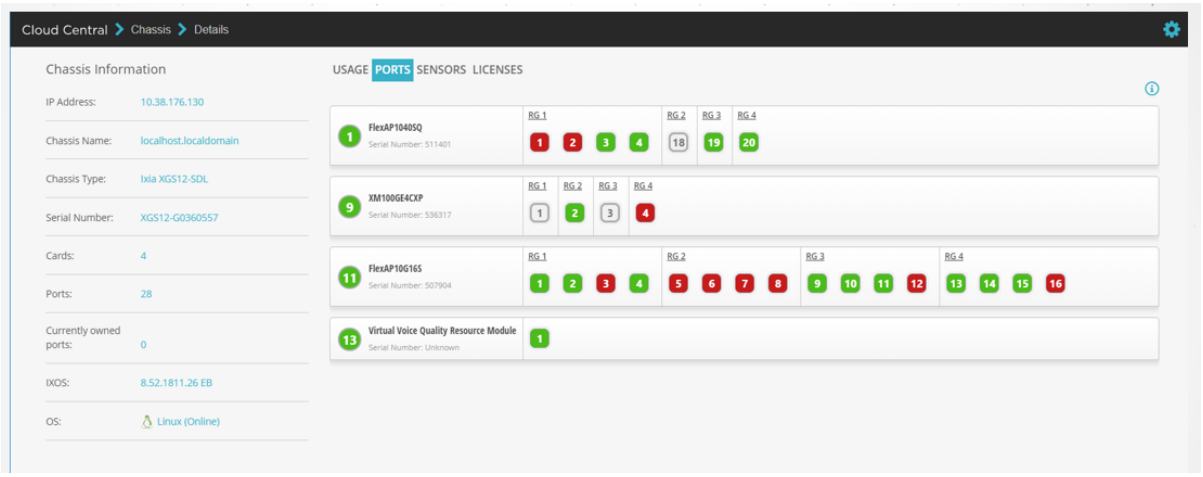
Chassis QRCODE

IxOS 9.00 release onwards, all Ixia chassis will be shipped with QR Code on the front panel.



You can point the phone camera to the chassis QR Code which will take you to the asset portal app (Ixia CloudCentral) to access available chassis details.
For more details about CloudCentral, see https://cloud.central.ixiacom.

After you log on to CloudCentral, you can drill down to the chassis details as shown in the following image:



Chassis Regulatory Standards

The Ixia XGS2 and XGS12 chassis platforms meet the following regulatory testing standards:

Regulatory Testing Standards

Standards	Details	
Safety - US/Canada	UL 60950-1, and CSA C22.2 No. 60950-1-07 - Information Technology Equipment	UL 60950-1, & CSA C22.2 No. 60950-1-07 - Information Technology Equipment

Standards	Details	
Safety - International		IEC 60950-1:2005 (Second Edition); Am1:2009 + Am2:2013 (CB Scheme)
US/Canada	FCC Part 15, Subpart B, Class A, ICES-003	FCC Part 15, Subpart B, Class A, ICES-003
European Directives	Low Voltage: 2006/95/EC EMC: 2004/108/EC	Low Voltage: 2006/95/EC EMC: 2004/108/EC RoHS: 2011/65/EU WEEE: 2002/96/EC
EU Product Family Standards for CE compliance	Safety: • EN 60950-1:2006+A11+A1+A12 EMC: • EN 55022: 2006+A1:2007 • EN 61000-3-2: 2006 • EN 61000-3-3: 1995 + A2: 2005 • EN 55024:1998 A2: 2003	Safety: EN 60950-1:2006+A11+A1+A12 • EMC: EN 55022: 2010 • EN 61000-3-2: 2006, A1: 2009 + A2: 2009 • EN 61000-3-3: 2008 • EN 55024: 2010

Environmental Conditions

The Ixia XG12 chassis and test cards cover a range of temperature and humidity specified as follows:

- Operating temperature range: 41°F to 104°F, (5°C to 40°C)
- Humidity range: 0% to 85% non-condensing

Ixia Load Modules

Ixia offers a number of load modules that provide one to 24 ports of technology and media dependent interfaces to DUTs. The load modules are divided into logical families. Each family of load modules is discussed in details in its own chapter in this manual.

- IXIA Xcellon-Lava Load Modules: Provide testing of high-density data center 40 Gigabit Ethernet (40GbE) and 100 Gigabit Ethernet (100GbE) network equipments.
- IXIA 10/100/1000 Load Modules: Provide either 10 Mbps, 100 Mbps, or 1000 Mbps Ethernet speeds with auto-negotiation (except for Gigabit).
- IXIA Network Processor Load Modules: Provides details about Ixia's Xcellon-Ultra XP and Xcellon-Ultra NP load modules the specifications, features, and functionality. It also provides details on Xcellon-Ultra load module when it operates in IxN2X mode.
- IXIA 40/100 Gigabit Ethernet Load Modules: Provide 40 and 100 Gbps Ethernet with a variety of interfaces.
- IXIA 10 Gigabit Ethernet Load Modules: Provide 10 Gbps Ethernet with a variety of interfaces.

- load modules can operate in multiple modes - 10G MSM, OC-192c Triple Mode and UNIPHY.
- IXIA Xcellon-Flex Load Modules: Deliver high-density, high performance test solutions.
- IXIA Xcellon-Multis Load Modules: Deliver highest density 40G and 100G higher speed Ethernet (HSE) test equipment, providing more flexible test coverage and 4x100GE, 12x40GE. 12x10GE, or dual-rate 40GE/100GE, all in a single-slot load module.
- IXIA Xcellon-Multis Reduced Load Modules: Deliver highest-density 10GE and 40GE higher speed Ethernet (HSE) test equipment, providing more flexible test coverage at upto 320 10GE ports per chassis, with a dual-rate 40GE/10GE and 40GE only capability, all in single-slot load module.
- IXIA PerfectStorm Load Modules: Provides a scalable solution for testing converged multi-play services, application delivery, and network security platforms for both wired and wireless networks.
- IXIA CloudStorm Load Modules: Provides the first multi-terabit application and security test solution, breaking the SSL and DDoS test barriers and achieving over 960Gbps of traffic with strong encryption and ciphers or 2.4 terabit DDoS throughput in a single chassis.
- IXIA K400 CFP8 Load Modules: Provides the first 400GE test system running IEEE 802.3bs RS-544 Forward Error Correction (FEC), PCS/Tx/Rx testing, and layer1 BERT testing with full line-rate layer 2-3 Tx, Rx, and capture capabilities. This load module accelerates development of IEEE 802.3bs-compliant 400GE networking systems..
- IXIA K400 QSFP-DD Load Modules: Provides the first 400GE test system runni ng IEEE 802.3bs RS-544 Forward Error Correction (FEC), PCS/Tx/Rx testing, and layer1 BERT testing with full line-rate layer 2-3 Tx, Rx, and capture capabilities, and interoperability testing. It is capable of 200GE, 100GE and 50GE fan-outs.
- Ixia Novus25/10GE8SFP28 Load Modules: Provides time-sensitive networking (TSN) capabilities, and high-scale control and data plane traffic to validate switched networks.
- IXIA XMVAE Gigabit Ethernet Load Modules: Provide test solutions for complete Layer 2-7 network and application testing functionality in a single test system for Automotive Ethernet switch and ECU testing.
- IXIA PerfectStormONE Appliances: Provides a portable solution in a compact form factor appliance consisting of a single-slot chassis integrated with a load module that is hard-mounted in it.
- IXIA NovusONE Appliance and Novus ONE PLUS Fixed Chassis: Provides a portable solution for complete layer 2 to 7 network and application testing in a compact form-factor appliance.
- IXIA AresONE Appliances: Provides a portable solution for complete layer 2 to 3 network and application testing in a compact form-factor appliance.

Load modules with part numbers that contain -3 or -M are limited in their functionality. Newer boards also may have an `L' before the last number in their part number, signifying the same limited functionality. In general, -3 and -M modules do **not** have the following functions:

- Flows, except where Streams are not supported
- Advanced Streams
- Packet Groups
- Latency
- Sequence Checking

- Data Integrity
- Convert to streams in capture view
- Protocol Server for router testing

`L' modules do **not** have the following functions:

- Advanced Routing functions
- Receive port filtering

Reduced vs. Full Feature

Some load modules are available in a Reduced Features version, which is identified by an `R' before the last number in their part number. The following table illustrates the differences for one family of cards, NGY.

Comparison of Full/Reduced Features, NGY Cards

	Standard	eXtra Performance 8-port	eXtra Performance	Reduced
PCPU	800 MHz	800MHz	1GHz	400MHz
PCPU Memory	512MB	1GB	1GB	128MB
Capture Memory	512MB	350MB	350MB	64MB
Table UDF Entries	1M	1M	1M	32K
UDF Range List	512K	512K	512K	256K
UDF Value List Entries	512K	512K	512K	256K
PGID	1M	1M	1M	64K

Load Module Names

The load module names used within the IxExplorer software differ slightly from the load module names used in Ixia marketing literature. The Load Module to IxExplorer Card Name Map below describes the mapping from load module names to the names in the Ixia price list and those used in IxExplorer. The reverse mapping, alphabetized, is shown in the Load Module to IxExplorer Card Name Map.

NOTE Load modules without a price list column entry are no longer available for purchase.

Load Module to IxExplorer Card Name Map

Family	Load Module	Price List Names	IxExplorer Card Name
10/100 Ethernet	LM100TX8	LM100TX8	10/100 TX8

Family	Load Module	Price List Names	IxExplorer Card Name
	LM100TXS8	LM100TXS8	10/100 TXS8
10/100/1000 Ethernet	ALM1000T8	ALM1000T8	10/100/1000 ALM T8
	Xcellon-Ultra XP-01	Xcellon-Ultra XP	Xcellon-Ultra XP
	Xcellon-Ultra NP-01	Xcellon-Ultra NP	Xcellon-Ultra NP
	Xcellon-Ultra NG-01	Xcellon-Ultra NG	Xcellon-Ultra NG
	ELM1000ST2	ELM1000ST2	10/100/1000 ELM ST2
	LM1000STX2	LM1000STX2	10/100/1000 STX2
	LM1000STX4	LM1000STX4	10/100/1000 STX4
	LM1000STXS2	LM1000STXS2	10/100/1000 STXS2
	LSM1000XMVR12-01	LSM1000XMVR12-01	10/100/1000 LSM XMV1210/100/1000 LSM XMVR12
	LSM1000XMVR8-01	LSM1000XMVR8-01	10/100/1000 LSM XMV810/100/1000 LSM XMVR8
	LSM1000XMVR4-01	LSM1000XMVR4-01	10/100/1000 LSM XMV410/100/1000 LSM XMVR4
	LSM1000XMSP12-01	LSM1000XMSP12-01	10/100/1000 LSM XMSP12
	LSM1000XMVDC4-01	LSM1000XMVDC4-01	10/100/1000 LSM XMVDC4
	LSM1000XMVDC4-NG	LSM1000XMVDC4-NG	10/100/1000 LSM XMVDC4NG
	LSM1000XMVDC8-01	LSM1000XMVDC8-01	10/100/1000 LSM XMVDC8
	LSM1000XMVDC12-01	LSM1000XMVDC12-01	10/100/1000 LSM XMVDC12
	LSM1000XMVDC16-01	LSM1000XMVDC16-01	10/100/1000 LSM XMVDC16
	LSM10/100/1000XMVDC16	LSM10/100/1000XMVDC16	LSM10/100/1000XMVDC16

Family	Load Module	Price List Names	IxExplorer Card Name
	NG	NG	NG
	LM1000GBIC-P1	n/a	GBIC-P1
ATM	LM622MR, LM622MR-512	LM622MR w/ OPTATMMR, LM622MR-512 w/ OPTATMMR	ATM 622 Multi-Rate
		LM622MR w/ OPTPOSMR	ATM/POS 622 Multi-Rate
		LM622MR w/ OPTATMMR+OPTPOSMR	ATM/POS 622 Multi-Rate
OC192	LMOC192cPOS		OC192c POS
	LMOC192cVSR-POS		OC192c VSR POS
	LMOC192cBERT		OC192c BERT
	LMOC192cVSR-BERT		OC192c VSR BERT
	LMOC192cPOS+BERT		OC192c POS/BERT
	LMOC192cVSR-POS+BERT		OC192c VSR POS/BERT
	LMOC192cPOS+WAN		OC192c POS/10GE WAN
	LMOC192cPOS+BERT+WAN		OC192c POS/BERT/10GE WAN
10GE	LM10GELAN		10GE LAN
	LM10GELAN-M		10GE LAN-M
	LM10GEWAN		10GE WAN
	LSM10G1-01	LSM10G1-01	10GE LSM
	LSM10GMS-01	LSM10GMS-01	10GE LSM MACSec
	LM10GEXENPAK		10GE XENPAK
	LM10GEXENPAK-M		10GE XENPAK-M
	LM10GEXENPAK+BERT		10GE XENPAK/BERT
	LM10GEXENPAK-MA+BERT		10GE XENPAK-M/BERT

Family	Load Module	Price List Names	IxExplorer Card Name
	LM10GEXENPAK BERT only		10GE XENPAK BERT
	LSM10GXMR8-01LSM10GXM8XP-01LSM10GXM8S-01LSM10GXMR8S-01 LSM10GXM8GBT-01LSM10GXMR8GBT-01NGY-NP8-01	LSM10GXMR8-01LSM10GXM8XP-01LSM10GXM8S-01LSM10GXMR8S-01 LSM10GXM8GBT-01LSM10GXMR8GBT-01NGY-NP8-01	10GE LSM XM810GE LSM XMR810GE LSM XM8XP10GE LSM XM8S10GE LSM XMR8S 10GE LSM XM8 10GBASE-T10GE LSM XMR8 10GBASE-T NGY-NP8 (10GE LSM XM8-NP)
	LSM10GXMR4-01LSM10GXM4XP-01LSM10GXM4S-01LSM10GXMR4S-01 LSM10GXM4GBT-01LSM10GXMR4GBT-01NGY-NP4-01	LSM10GXMR4-01LSM10GXM4XP-01LSM10GXM4S-01LSM10GXMR4S-01 LSM10GXM4GBT-01LSM10GXMR4GBT-01NGY-NP4-01	10GE LSM XM410GE LSM XMR410GE LSM XM4XP10GE LSM XM4S10GE LSM XMR4S 10GE LSM XM4 10GBASE-T10GE LSM XMR4 10GBASE-T NGY-NP4 (10GE LSM XM4-NP)
	LSM10GXM2XP-01LSM10GXMR2-01LSM10GXM2S-01LSM10GXMR2S-01 LSM10GXM2GBT-01LSM10GXMR2GBT-01NGY-NP2-01	LSM10GXM2XP-01LSM10GXMR2-01LSM10GXM2S-01LSM10GXMR2S-01 LSM10GXM2GBT-01LSM10GXMR2GBT-01NGY-NP2-01	10GE LSM XM2XP10GE LSM XMR210GE LSM XM2S10GE LSM XMR2S 10GE LSM XM2 10GBASE-T10GE LSM XMR2 10GBASE-T NGY-NP2 (10GE LSM XM2-NP)
	MSM10G1-02	MSM10G1-02	10G MSM
	Xcellon-Ultra XP-01	Xcellon-Ultra XP	Xcellon-Ultra XP
	Xcellon-Ultra NP-01	Xcellon-Ultra NP	Xcellon-Ultra NP
	Xcellon-Ultra NG-01	Xcellon-Ultra NG	Xcellon-Ultra NG
40GE	HSE40GETSP1-01	HSE40GETSP1-01	40GE LSM XMV
100GE	HSE100GETSP1-01	HSE100GETSP1-01	100GE LSM XMV
40/100 GE	HSE40GETSP1-01	HSE40GETSP1-01	40GE LSM XMV

Family	Load Module	Price List Names	IxExplorer Card Name
	HSE100GETSP1-01	HSE100GETSP1-01	100GE LSM XMV
	HSE40/100GETSP1-01	HSE40/100GETSP1-01	40/100GE LSM XMV
	HSE40GEQSFP1-01	HSE40GEQSFP1-01	40GE LSM XMV QSFP
Voice Quality	VQM01XM	VQM01XM	Voice Quality Resource Module
Excellon-Flex	FlexAP10G16S		FlexAP10G16S
	FlexFE10G16S		FlexFE10G16S
10GE Ethernet	Xdensity		
Impair Net	EIM10G4S		EIM10G4S
	EIM1G4S		EIM1G4S
Xcellon-Lava	Lava AP40/100GE 2P		Lava AP40/100GE 2P
	Lava AP40/100GE 2P		Lava AP40/100GE 2P
Multis	XM100GE4CXP	XM100GE4CXP	XM100GE4CXP
	XM100GE4CXP+FAN	XM100GE4CXP+FAN	XM100GE4CXP+FAN
	XM40GE12QSFP+FAN	XM40GE12QSFP+FAN	XM40GE12QSFP+FAN
	XM10/40GE12QSFP+FAN	XM10/40GE12QSFP+FAN	XM10/40GE12QSFP+FAN
	XM10/40GE6QSFP+FAN	XM10/40GE6QSFP+FAN	XM10/40GE6QSFP+FAN
	XM100GE4QSFP28	XM100GE4QSFP28	XM100GE4QSFP28
	XM100GE4CFP4	XM100GE4CFP4	XM100GE4CFP4
	XMAVB10/40GE6QSFP+FAN	XMAVB10/40GE6QSFP+FAN	XMAVB10/40GE6QSFP+FAN
	XM100GE4QSFP28+ENH	XM100GE4QSFP28+ENH	XM100GE4QSFP28+ENH
	XM100GE4QSFP28+ENH+	XM100GE4QSFP28+ENH+	XM100GE4QSFP28+ENH+2

Family	Load Module	Price List Names	IxExplorer Card Name
	25G+50G	25G+50G	5G+50G
	XM100GE4CFP4+ENH	XM100GE4CFP4+ENH	XM100GE4CFP4+ENH
	XMR10GE32SFP+FAN	XMR10GE32SFP+FAN	XMR10GE32SFP+FAN
	XMR10GE16SFP+FAN	XMR10GE16SFP+FAN	XMR10GE16SFP+FAN
	XMR40GE12QSFP+	XMR40GE12QSFP+	XMR40GE12QSFP+
	XMR40GE6QSFP+	XMR40GE6QSFP+	XMR40GE6QSFP+
Novus	Novus100GE8Q28+FAN	Novus100GE8Q28+FAN	NOVUS100GE8Q28+FAN
	Novus100GE8Q28+FAN+25G	Novus100GE8Q28+FAN+25G	NOVUS100GE8Q28+FAN+25G
	Novus100GE8Q28+FAN+50G	Novus100GE8Q28+FAN+50G	NOVUS100GE8Q28+FAN+50G
	Novus100GE8Q28+FAN+25G+50G	Novus100GE8Q28+FAN+25G+50G	NOVUS100GE8Q28+FAN+25G+50G
	Novus100GE8Q28+FAN+10G+25G+40G+50G	Novus100GE8Q28+FAN+10G+25G+40G+50G	NOVUS100GE8Q28+FAN+10G+25G+40G+50G
	Novus-NP 10/1GE8DP	Novus-NP 10/1GE8DP	NOVUS-NP10/1GE8DP
	Novus-NP 10/1GE16DP	Novus-NP 10/1GE16DP	NOVUS-NP10/1GE16DP
	Novus10/1GE32S	Novus10/1GE32S	NOVUS10/1GE32S
	Novus10/5/2.5/1/100M16DP	Novus10/5/2.5/1/100M16DP	NOVUS10/5/2.5/1/100M16DP
	Novus10/5/2.5/1/100M8DP	Novus10/5/2.5/1/100M8DP	NOVUS10/5/2.5/1/100M8DP
	Novus10/5/2.5/1/100M16DP-R	Novus10/5/2.5/1/100M16DP-R	NOVUS10/5/2.5/1/100M16DP-R
	Novus10/5/2.5/1/100M8DP-R	Novus10/5/2.5/1/100M8DP-R	NOVUS10/5/2.5/1/100M8DP-R
	Novus10/1GE16DP	Novus10/1GE16DP	NOVUS10/1GE16DP
	Novus10/1GE12DP	Novus10/1GE12DP	Novus10/1GE12DP
	Novus10/1GE8DP	Novus10/1GE8DP	NOVUS10/1GE8DP
	Novus10/1GE4DP	Novus10/1GE4DP	Novus10/1GE4DP

Family	Load Module	Price List Names	IxExplorer Card Name
	Novus-M100GbE8Q28+FAN	Novus-M100GbE8Q28+FAN	NOVUS-M100GbE8Q28+FAN
	Novus-M100GE8Q28+FAN+25G+50G	Novus-M100GE8Q28+FAN+25G+50G	NOVUS-M100GE8Q28+FAN+25G+50G
	Novus-M100GE8Q28+FAN+10G+25G+40G+50G	Novus-M100GE8Q28+FAN+10G+25G+40G+50G	NOVUS-M100GE8Q28+FAN+10G+25G+40G+50G
	Novus-R100GE8Q28+FAN	Novus-R100GE8Q28+FAN	NOVUS-R100GE8Q28+FAN
	Novus-R100GE8Q28+FAN+25G	Novus-R100GE8Q28+FAN+25G	NOVUS-R100GE8Q28+FAN+25G
	Novus-R100GE8Q28+FAN+RU	Novus-R100GE8Q28+FAN+RU	NOVUS-R100GE8Q28+FAN+RU
	Novus-R100GE8Q28+FAN+RU+25G	Novus-R100GE8Q28+FAN+RU+25G	NOVUS-R100GE8Q28+FAN+RU+25G
	Novus-R100GE8Q28+FAN+RU+50G	Novus-R100GE8Q28+FAN+RU+50G	NOVUS-R100GE8Q28+FAN+RU+50G
	Novus-R100GE8Q28+FAN+RU+25G+50G	Novus-R100GE8Q28+FAN+RU+25G+50G	NOVUS-R100GE8Q28+FAN+RU+25G+50G
	Novus-R100GE8Q28+FAN+RU+10G+25G+40G+50G	Novus-R100GE8Q28+FAN+RU+10G+25G+40G+50G	NOVUS-R100GE8Q28+FAN+RU+10G+25G+40G+50G
K400	CFP8-400GE	CFP8-400GE	CFP8-400GE
	CFP8-R400GE	CFP8-R400GE	CFP8-R400GE
	QSFP-DD-400GE	QSFP-DD-400GE	QSFP-DD-400GE
	QSFP-DD-400GE+200G+100G+50G	QSFP-DD-400GE+200G+100G+50G	QSFP-DD-400GE+200G+100G+50G
	QSFP-DD-R400GE	QSFP-DD-R400GE	QSFP-DD-R400GE
	QSFP-DD-R400GE+200G+100G+50G	QSFP-DD-R400GE+200G+100G+50G	QSFP-DD-R400GE+200G+100G+50G

Family	Load Module	Price List Names	IxExplorer Card Name
	UPG-QSFP-DD-R400GE	UPG-QSFP-DD-R400GE	UPG-QSFP-DD-R400GE
	UPG-QSFP-DD-R400GE+200G+100G+50G	UPG-QSFP-DD-R400GE+200G+100G+50G	UPG-QSFP-DD-R400GE+200G+100G+50G
T400	T400GD-8P-QDD	T400GD-8P-QDD	T400GD-8P-QDD
	T400GDR-8P-QDD	T400GDR-8P-QDD	T400GDR-8P-QDD
	T400GD-4P-QDD	T400GD-4P-QDD	T400GD-4P-QDD
	T400GDR-4P-QDD	T400GDR-4P-QDD	T400GDR-4P-QDD

IxExplorer Card Name to Load Module Name Map (Alphabetical)

IxExplorer Card Name	Load Module	Price List Names
10/100 TX8	LM100TX8	LM100TX8
10/100 TXS8	LM100TXS8	LM100TXS8
10/100/1000 ALM T8	ALM1000T8	ALM1000T8
10/100/1000 ELM ST2	ELM1000ST2	ELM1000ST2
10/100/1000 LSM XMSP12	LSM1000XMSP12-01	LSM1000XMSP12-01
10/100/1000 LSM XMVDC4	LSM1000XMVDC4-01	LSM1000XMVDC4-01
10/100/1000 LSM XMVDC4NG	LSM1000XMVDC4-NG	LSM1000XMVDC4-NG
10/100/1000 LSM XMVDC8	LSM1000XMVDC8-01	LSM1000XMVDC8-01
10/100/1000 LSM XMVDC12	LSM1000XMVDC12-01	LSM1000XMVDC12-01
10/100/1000 LSM XMVDC16	LSM1000XMVDC16-01	LSM1000XMVDC16-01
10/100/1000 LSM XMVDC16NG	10/100/1000 LSM XMVDC16NG	10/100/1000 LSM XMVDC16NG
10/100/1000 LSM XMV1210/100/1000 LSM XMVR12	LSM1000XMVR12-01	LSM1000XMVR12-01
10/100/1000 LSM XMV810/100/1000 LSM XMVR8	LSM1000XMVR8-01	LSM1000XMVR8-01
10/100/1000 LSM	LSM1000XMVR4-01	LSM1000XMVR4-01

IxExplorer Card Name	Load Module	Price List Names
XMV410/100/1000 LSM XMVR4		
10/100/1000 STX2	LM1000STX2	LM1000STX2
10/100/1000 STX4	LM1000STX4	LM1000STX4
10/100/1000 STXS2	LM1000STXS2	LM1000STXS2
2.5G MSM	MSM2.5G1-01	MSM2.5G1-01
10G MSM	MSM10G1-02	MSM10G1-02
10GE LAN	LM10GELAN	
10GE LAN-M	LM10GELAN-M	
10GE LSM	LSM10G1-01	LSM10G1-01
10GE LSM MACSec	LSM10GMS-01	LSM10GMS-01
10GE LSM XM810GE LSM XMR810GE LSM XM8XP10GE LSM XM8S10GE LSM XMR8S 10GE LSM XM8 10GBASE-T10GE LSM XMR8 10GBASE-T NGY-NP8	LSM10GXMR8-01LSM10GXM8XP-01LSM10GXM8S-01LSM10GXMR8S-01 LSM10GXM8GBT-01LSM10GXMR8GBT-01 NGY-NP8-01	LSM10GXMR8-01LSM10GXM8XP-01LSM10GXM8S-01LSM10GXMR8S-01 LSM10GXM8GBT-01LSM10GXMR8GBT-01 NGY-NP8-01
10GE LSM XM410GE LSM XMR410GE LSM XM4XP10GE LSM XM4S10GE LSM XMR4S 10GE LSM XM4 10GBASE-T10GE LSM XMR4 10GBASE-T NGY-NP4	LSM10GXMR4-01LSM10GXM4XP-01LSM10GXM4S-01LSM10GXMR4S-01 LSM10GXM4GBT-01LSM10GXMR4GBT-01 NGY-NP4-01	LSM10GXMR4-01LSM10GXM4XP-01LSM10GXM4S-01LSM10GXMR4S-01 LSM10GXM4GBT-01LSM10GXMR4GBT-01 NGY-NP4-01
10GE LSM XM2XP10GE LSM XMR210GE LSM XM2S10GE LSM XMR2S 10GE LSM XM2 10GBASE-T10GE LSM XMR2 10GBASE-TNGY-NP2	LSM10GXM2XP-01LSM10GXMR2-01LSM10GXM2S-01LSM10GXMR2S-01 LSM10GXM2GBT-01LSM10GXMR2GBT-01 NGY-NP2-01	LSM10GXM2XP-01LSM10GXMR2-01LSM10GXM2S-01LSM10GXMR2S-01 LSM10GXM2GBT-01LSM10GXMR2GBT-01 NGY-NP2-01
10GE WAN	LM10GEWAN	LM10GE123F,LM10GE124F

IxExplorer Card Name	Load Module	Price List Names
10GE XENPAK	LM10GEXENPAK	
10GE XENPAK BERT	LM10GEXENPAK BERT only	
10GE XENPAK/BERT	LM10GEXENPAK+BERT	
10GE XENPAK-M	LM10GEXENPAK-M	
10GE XENPAK-M/BERT	LM10GEXENPAK-MA+BERT	
40GE LSM XMV	HSE40GETSP1-01	HSE40GETSP1-01
100GE LSM XMV	HSE100GETSP1-01	HSE100GETSP1-01
40/100GE LSM XMV	HSE40/100GETSP1-01	HSE40/100GETSP1-01
40GE LSM XMV QSFP	HSE40GEQSFP1-01	HSE40GEQSFP1-01
Xcellon-Ultra NP	Xcellon-Ultra NP-01	Xcellon-Ultra NP
Xcellon-Ultra XP	Xcellon-Ultra XP-01	Xcellon-Ultra XP
Xcellon-Ultra NG	Xcellon-Ultra NG-01	Xcellon-Ultra NG
AFM1000SP-01		AFM1000SP-01
ATM 622 Multi-Rate	LM622MR	LM622MR w/OPTATMMR
ATM/POS 622 Multi-Rate		LM622MR w/OPTPOSMR
ATM/POS 622 Multi-Rate		LM622MR w/ OPTATMMR+OPTPOSMR, LM622MR-512 w/ OPTATMMR+OPTPOSMR
GBIC-P1	LM1000GBIC-P1	
OC192c BERT	LMOC192cBERT	
OC192c POS	LMOC192cPOS	
OC192c POS/10GE WAN	LMOC192cPOS+WAN	
OC192c POS/BERT	LMOC192cPOS+BERT	
OC192c POS/BERT/10GE WAN	LMOC192cPOS+BERT+WAN	
OC192c VSR BERT	LMOC192cVSR-BERT	
OC192c VSR POS	LMOC192cVSR-POS	

IxExplorer Card Name	Load Module	Price List Names
OC192c VSR POS/BERT	LMOC192cVSR-POS+BERT	
Voice Quality Resource Module	VQM01XM	VQM01XM
Lava AP40/100GE 2P	Lava AP40/100GE 2P	
Lava AP40/100GE 2P	Lava AP40/100GE 2P	
XM10/40GE6QSFP+FAN	XM10/40GE6QSFP+FAN	XM10/40GE6QSFP+FAN
XM10/40GE12QSFP+FAN	XM10/40GE12QSFP+FAN	XM10/40GE12QSFP+FAN
XM40GE12QSFP+FAN	XM40GE12QSFP+FAN	XM40GE12QSFP+FAN
XM100GE4CFP4	XM100GE4CFP4	XM100GE4CFP4
XM100GE4CFP4+ENH	XM100GE4CFP4+ENH	XM100GE4CFP4+ENH
XM100GE4CXP	XM100GE4CXP	XM100GE4CXP
XM100GE4CXP+FAN	XM100GE4CXP+FAN	XM100GE4CXP+FAN
XM100GE4QSFP28	XM100GE4QSFP28	XM100GE4QSFP28
XM100GE4QSFP28+ENH	XM100GE4QSFP28+ENH	XM100GE4QSFP28+ENH
XM100GE4QSFP28+ENH+25G +50G	XM100GE4QSFP28+ENH+25G +50G	XM100GE4QSFP28+ENH+25G +50G
XMAVB10/40GE6QSFP+FAN	XMAVB10/40GE6QSFP+FAN	XMAVB10/40GE6QSFP+FAN
XMR10GE16SFP+FAN	XMR10GE16SFP+FAN	XMR10GE16SFP+FAN
XMR10GE32SFP+FAN	XMR10GE32SFP+FAN	XMR10GE32SFP+FAN
XMR40GE6QSFP+	XMR40GE6QSFP+	XMR40GE6QSFP+
XMR40GE12QSFP+	XMR40GE12QSFP+	XMR40GE12QSFP+
NOVUS10/1GE8DP	Novus10/1GE8DP	Novus10/1GE8DP
NOVUS10/1GE16DP	Novus10/1GE16DP	Novus10/1GE16DP
NOVUS10/1GE32S	Novus10/1GE32S	Novus10/1GE32S
NOVUS10/5/2.5/1/100M8DP	Novus10/5/2.5/1/100M8DP	Novus10/5/2.5/1/100M8DP
NOVUS10/5/2.5/1/100M16DP	Novus10/5/2.5/1/100M16DP	Novus10/5/2.5/1/100M16DP
NOVUS10/5/2.5/1/100M8DP-R	Novus10/5/2.5/1/100M8DP-R	Novus10/5/2.5/1/100M8DP-R
NOVUS10/5/2.5/1/100M16DP-	Novus10/5/2.5/1/100M16DP-	Novus10/5/2.5/1/100M16DP-

IxExplorer Card Name	Load Module	Price List Names
R	R	R
NOVUS100GE8Q28+FAN	Novus100GE8Q28+FAN	Novus100GE8Q28+FAN
NOVUS100GE8Q28+FAN+25G	Novus100GE8Q28+FAN+25G	Novus100GE8Q28+FAN+25G
NOVUS100GE8Q28+FAN+50G	Novus100GE8Q28+FAN+50G	Novus100GE8Q28+FAN+50G
NOVUS100GE8Q28+FAN+25G +50G	Novus100GE8Q28+FAN+25G +50G	Novus100GE8Q28+FAN+25G +50G
NOVUS100GE8Q28+FAN+10G +25G+40G+50G	Novus100GE8Q28+FAN+10G +25G+40G+50G	Novus100GE8Q28+FAN+10G +25G+40G+50G
NOVUS-M100GbE8Q28+FAN	Novus-M100GbE8Q28+FAN	Novus-M100GbE8Q28+FAN
NOVUS-M100GE8Q28+FAN+25G+50G	Novus-M100GE8Q28+FAN+25G+50G	Novus-M100GE8Q28+FAN+25G+50G
NOVUS-M100GE8Q28+FAN+10G+25G +40G+50G	Novus-M100GE8Q28+FAN+10G+25 G+40G+50G	Novus-M100GE8Q28+FAN+10G+25 G+40G+50G
NOVUS-NP10/1GE8DP	Novus-NP 10/1GE8DP	Novus-NP 10/1GE8DP
NOVUS-NP10/1GE16DP	Novus-NP 10/1GE16DP	Novus-NP 10/1GE16DP
NOVUS-R100GE8Q28+FAN	Novus-R100GE8Q28+FAN	Novus-R100GE8Q28+FAN
NOVUS-R100GE8Q28+FAN+25G	Novus-R100GE8Q28+FAN+25G	Novus-R100GE8Q28+FAN+25G
NOVUS-R100GE8Q28+FAN+RU	Novus-R100GE8Q28+FAN+RU	Novus-R100GE8Q28+FAN+RU
NOVUS-R100GE8Q28+FAN+RU+25G	Novus-R100GE8Q28+FAN+RU+25G	Novus-R100GE8Q28+FAN+RU+25G
NOVUS-R100GE8Q28+FAN+RU+50G	Novus-R100GE8Q28+FAN+RU+50G	Novus-R100GE8Q28+FAN+RU+50G
NOVUS-R100GE8Q28+FAN+RU+25G+50G	Novus-R100GE8Q28+FAN+RU+25G +50G	Novus-R100GE8Q28+FAN+RU+25G +50G
NOVUS-R100GE8Q28+FAN+RU+10G+25G+40G+50G	Novus-R100GE8Q28+FAN+RU+10G +25G+40G+50G	Novus-R100GE8Q28+FAN+RU+10G +25G+40G+50G
CFP8-400GE	CFP8-400GE	CFP8-400GE

IxExplorer Card Name	Load Module	Price List Names
CFP8-R400GE	CFP8-R400GE	CFP8-R400GE
QSFP-DD-400GE	QSFP-DD-400GE	QSFP-DD-400GE
QSFP-DD-400GE+200G+100G+50G	QSFP-DD-400GE+200G+100G+50G	QSFP-DD-400GE+200G+100G+50G
QSFP-DD-R400GE	QSFP-DD-R400GE	QSFP-DD-R400GE
QSFP-DD-R400GE+200G+100G+50G	QSFP-DD-R400GE+200G+100G+50G	QSFP-DD-R400GE+200G+100G+50G
UPG-QSFP-DD-R400GE	UPG-QSFP-DD-R400GE	UPG-QSFP-DD-R400GE
UPG-QSFP-DD-R400GE+200G+100G+50G	UPG-QSFP-DD-R400GE+200G+100G+50G	UPG-QSFP-DD-R400GE+200G+100G+50G
T400GD-8P-QDD	T400GD-8P-QDD	T400GD-8P-QDD
T400GDR-8P-QDD	T400GDR-8P-QDD	T400GDR-8P-QDD
T400GD-4P-QDD	T400GD-4P-QDD	T400GD-4P-QDD
T400GDR-4P-QDD	T400GDR-4P-QDD	T400GDR-4P-QDD

Ixia Load Module Properties

The Ixia load modules, or load modules, support a wide range of features, which are described in the following table.

The full set of supported features per card is described in the spreadsheet *Port Features by Port Type* on the *Ixiacom.com* website, under *Support/User Guides/Spreadsheets*.

Ixia Load Module Feature Descriptions

Feature Category	Feature	Usage
Basic	Local CPU	Each port on the card is supported by an individual CPU for use in protocol server and other sophisticated operations.
	Layer 2/3 Only	The card only supports Layer 2 and 3 control and operation. No protocols except ARP and PING are supported.
	Layer 7 Only	The card only supports Layer 7 usage through the local CPU. This type of card is generally only useful for application testing as in IxLoad and Chariot.
Statistics	Checksum errors	Support generation and checking of special checksums

Feature Category	Feature	Usage
Selection	(IPv4/TCP/UDP)	for IPv4, TCP, and UDP packets.
	Data integrity	Supports data integrity generation and checking.
	Tx Duration	Supports the generation of a transmit duration statistic.
	Per stream stats	Statistics are available for each stream.
Receive Modes	Capture	Received data may be captured to a capture buffer.
	Packet groups	Supports generation of packet group IDs in packets.
	Latency S&Fwd LB to FB	Latency measurement offers the option of measuring the time from last data bit out to first data bit in
	Latency S&Fwd LB to FP	Latency measurement offers the option of measuring the time from last data bit out to first preamble bit in
	Inter-arrival Jitter	Inter-Arrival Time (IAT) compares the time between PGID packet arrivals. In this case, when a packet with a PGID is received, the PGID is examined. If a packet has already been received with the same PGID, then the timestamp of the previous packet is subtracted from the current timestamp. The interval between the timestamps is the jitter, and it is recorded for statistical purposes.
	Delay Variation	Offers the option of measuring variation between latency of consecutive frames.
	MEF Frame Delay	Measurement method: First data bit in to DUT; last data bit out of DUT.
	Forwarding Delay	Measurement method: Last data bit in to DUT; last data bit out of DUT.
	Advanced PG Filter	A set of features which allow packet group matching to ignore or mask: • Group ID • Signature • Filter data
	Round-trip flows	Supports calculation of round-trip flows.
	Data integrity	Supports data integrity generation and checking.

Feature Category	Feature	Usage
	First time stamp	Supports first time stamp operation.
	Tx/Rx Time Stamp Mode	Allows the system to use the time stamp of the last bit of the packet; this is useful when multiple rates are present in the network topology.
	Sequence checking	Supports packet sequence generation and verification.
	Sequence checking per packet ID	When packet groups are used, allows sequence checking generation and verification.
	ISL encapsulation	Receive side of port can accommodate ISL encapsulation on receive side.
	Small packets	Supports the ability to capture packets smaller than a legal packet; captured data may be corrupted when this feature is used.
	Wide packet groups	This feature allows ports, which utilize packet groups, to extend the number of bits in the PGID to 17 bits (or more).
	PRBS Mode	When the Receive Mode is set to PRBS mode, both Wide Packet Groups and Sequence Checking are automatically enabled. In PRBS mode, all latency-related statistics are removed and the following per PGID statistics are added: • PRBS Bits Received • PRBS Errored Bits • PRBS BER
	Split PGIDs	Allows for the creation of split PGID data.
	Latency bins	Latency data may be categorized by latency values for each packet group.
	Time bins	Latency may be measured over time.
	Echo	Ports with this feature may echo all received traffic as transmitted packets.
	Preamble capture	Frame's preamble may be included in the capture buffer.
	Simulate cable disconnect	If this is selected, the port acts as if the cable has been disconnected. The port will neither transmit nor receive.
	Flexible Pattern Offset	Allows to set the Filter/Trigger pattern to a specific

Feature Category	Feature	Usage
		offset.
	Multi Switched-Path	Allows for the detection of loss/duplicate packets.
	Intrinsic Latency Adjustment	Reduces the measured latency by the amount of latency that is induced by the test equipment itself (not the DUT). Retrieves pre-determined latency value for a `known' transceiver, or calculates and stores that value for a `new' transceiver.
	Misdirected Mask	Sets the signature mask used for identifying misdirected packets.
	Rate Monitoring (convergence)	Enables testing convergence times and service interruptions.
	Auto-Detect Instrumentation	On the receive side, automatically detects a specified signature and Instrumentation parameters for Data Integrity, Sequence Checking, or Latency for streams generated with Automatic Instrumentation Offsets using Ixia software applications.
	TSO/LRO	Transmit Segmentation Offload/Large Receive Offload (TSO/LRO) operation mode.
Transmit Modes	Packet streams	Supports the generation of packet streams.
	Packet flows	Supports the generation of packet flows.
	Advanced scheduler	Supports the operation of the advanced scheduler, which allows inter-mixing of multiple packet streams.
	Forced collisions	Supports the insertion of forced collisions.
	Tx Data integrity	Supports data integrity generation and checking.
	Odd preamble	Supports the ability to send a preamble with an odd number of bytes. This is not applicable to boards with dual PHYs (Ethernet/Fiber) when a port is in fiber mode.
	Gap time units	The inter-frame, -burst, and -stream gaps can be programmed in discreet units of time as opposed to indirectly through a percentage of maximums frame rate.
	Gap byte count	Gaps may be expressed as a number of bytes.
	Modifiable preamble	The packet's preamble content may be modified.

Feature Category	Feature	Usage
		On 10GE load modules that support this feature there are two options: modify the 7 rightmost bytes of the 8 byte preamble or modify the inner 6 bytes of the 8 byte preamble.
	Forced minimum IPG	In advanced scheduler mode, a minimum gap may be enforced.
	Increment frame size by N	Frame sizes may be incremented by an arbitrary value between transmitted frames.
	Increment/Decrement DA/SA by N	DA and SA values may be incremented or decremented by an arbitrary value between transmitted frames.
	Random data on even offset only	When random data is generated within a frame's content, the random data may only be placed at even byte boundaries.
	Insert bad TCP checksum	Supports the generation of bad TCP checksums.
	Checksum Override	Overrides IPv4, IPv6 and TCP checksums.
	Frequency offset	The frequency for the card as a whole may be modified a few percent from nominal.
	Echo	The port echoes all received packets.
	Flexible Time Stamp	The position of the time stamp in transmitted packets may be repositioned.
	Protocol Offset	The beginning of the IP (or other) protocol header may be repositioned so as to accommodate leading headers, as in PPP.
	Random IPG	The IPG between packets may be set to a random value.
	Copper RJ45/Fiber SFP	The port has the ability to transmit and receive from either its copper RJ-45 Ethernet or Fiber SFP optic interface.
	Weighted Random Frame Size	The port has the ability to generate packets with random frame sizes. The frame sizes are programmed through a set of frame sizes and weightings.
	Scheduled duration	The duration of the transmit operation may be scheduled for a number of seconds.
	Simulate cable	If this is selected, the port acts as if the cable has been

Feature Category	Feature	Usage
	disconnect	disconnected. The port will neither transmit nor receive.
	Repeatable Random Streams	Allows for repeating randomly generated stream data.
	GRE	An IP transport protocol available for insertion into transmitted streams.
	Stacked VLANs	Allows for sending multiple VLAN IDs in a single packet.
	Tx Ignore Link	Allows for transmission of packets with the link down.
	Protocol Pad	Allows for a data pad to be added before the protocol head field in a frame.
	Dynamic Rate Change	Allow rate change without stopping transmit.
	Dynamic Frame Size Change	Allow frame size change without stopping transmit.
	New Incrementing Frame Size	Allow packets/burst setting in incrementing frame size mode
	Auto-Detect Instrumentation	On the transmit side, automatically configures a specified signature and Instrumentation parameters for Data Integrity, Sequence Checking, Latency, or PRBS for streams generated for Ixia software applications that use Automatic Instrumentation Offsets.
	Intrinsic Latency Adjustment	Reduce the measured latency by the amount of latency that is induced by the test equipment itself (not the DUT). Retrieves pre-determined latency value for a `known' transceiver, or calculates and stores that value for a `new' transceiver.
	PRBS	When the port is in PRBS mode, all latency-related statistics are removed and the following per-PGID statistics are added: • PRBS Bits Received • PRBS Errored Bits • PRBS BER
	TSO/LRO	Transmit Segmentation Offload/Large Receive Offload (TSO/LRO) operation mode.
User Defined Fields (UDF)	Odd offset	UDFs are allowed to start at an odd offset.

Feature Category	Feature	Usage
	Overlap	UDFs may overlap within a 4-octet boundary. Otherwise UDFs must start at least 4 octets apart.
	Cascade	UDFs may continue from previous stream values.
	Cascade from self	UDFs may continue from previous values on the same UDF.
	Split	UDFs may be split into multiple 8-bit and 16-bit counters.
	Bit mask	UDFs output data may be masked with an arbitrary bit mask. Otherwise limitations on the number of changes of bits applies.
	Incr By N	Allows UDFs to increment by an arbitrary value.
	UDF5	The port has a fifth UDF.
	Advanced	The port supports additional UDF features, including: • Nested counters • Linked lists • Step size • Value list • Range list
	IPv4	The port supports UDF - IPv4 type counting.
	Range List	The port supports UDF generated values over a list of value ranges.
	Value List	The port supports UDF generated values from a list of values.
	Nested Counter	The port supports UDF generated values from two nested counters.
	Table	The port supports a UDF that derives values from a table of offsets and values, by packet.
	Chained UDFs	The port supports the ability to chain from a specified UDF.
	Protocol Pad	Allows for a data pad to be added before the protocol head field in a frame.

Feature Category	Feature	Usage
POS/BERT	POS	Supports Packet over SONET operation.
	BERT	Supports Bit Error Rate Testing through the generation and verifications of patterns.
	Channelized BERT	Support channelized BERT testing.
	BERT error insertion	Supports BERT error insertion.
	DCC	Supports additional DCC channel streams.
	SRP	Supports Serial Reuse Protocol passive receive.
	SRP Full	Supports Serial Reuse Protocol active send/receive.
	RPR	Supports Resilient Packet Ring operation.
	FEC	Support Forwarding Error Correction.
	GFP	Supports the Generic Framing Protocol.
	SONET error insertion list	Support the insertion of Sonet errors.
	Multiple DLCIs	Supports the use of more than one DLCI in frame relay testing.
	CJPAT/CRPAT	Supports generated CJPAT and CRPAT frame data patterns.
10 Gigabit Ethernet	OC192	Supports OC192 POS operation.
	WAN	Supports 10 GE WAN operation.
	LAN	Supports 10 GE LAN operation.
	XENPAK	Supports 10GE XENPAK interface.
	LASI	Supports Link Alarm Status Interrupt.
	XFP	Supports an XFP interface.
	SFP	Supports an SFP (small form-factor pluggable) transceiver interface.
	UNIPHY	Supports UNIPHY operation, which allows the same port to operate in LAN, WAN, POS and BERT modes.
	Lane skew	Supports the ability to skew multiple PCS (Physical

Feature Category	Feature	Usage
		Coding Sublayer) lanes.
	Set pause destination address	The destination for pause control packets may be set.
	Link Fault Signalling	Supports the link fault signalling protocol.
	Gap Control Mode	Allows for the selection of the gap control algorithm, as defined by IEEE.
	Pre-Emphasis	Allows for boosting transmit signal.
	MACSec	Supports MACSec functionality. Media Access Control Security (MACsec) is a L2 protocol which authenticates the entire L2 frame (except for the Ethernet CRC) and provides confidentiality for all or some of the MACsec data segment. This protocol is defined in IEEE 802.1AE
Protocol Server	Basic Routing	Supports basic routing protocols, including BGP, IS-IS and OSPF, but none of those in the list for *Advanced Routing.*
	DHCP	Supports the DHCP protocol.
	DHCPv6	Supports the DHCPv6 protocol.
	Advanced Routing (note 1)	Supports advanced routing protocols: • BGP-IPv6 • IGMP (new) with IPMPv3 • ISIS-IPv6 • OSPFv3 • PIM-SM • Layer 2 VPN (LDP) • Layer 3 VPN (BGP) • MLD • RIPng
	ARP	Supports ARP generation and receipt handling.
	Gratuitous ARP	Gratuitous ARP is sent by the host when its IP to MAC mapping changes, so that everybody else on the subnet updates their ARP tables.
	ARP rate control	The rate at which multiple ARP packets are transmitted

Feature Category	Feature	Usage
		may be controlled.
	IGMP rate control	The rate at which multiple IGMP packets are transmitted may be controlled.
	PING	Supports PING generation and receipt.
	FCoE/NPIV	Supports Fibre Channel over Ethernet and N_Port_ID Virtualization.
	PTP	Supports Precision Time Protocol.
	RTP	Supports Real-time Transport Protocol.

NOTE On older, OC192c and 10GE modules, these protocols require that the ports have been upgraded to 128MB of CPU memory.

Card Properties

Details about the card characteristics described in the following table are presented in the chapters about specific load modules.

Card Specifications

Specification	Usage
# ports	The number of ports supported by the card(s).
-3/-M/L Card Available	Whether a limited feature card is available.
L2/L3 Card Available	Whether a Layer 2/3 only card is available.
Layer 7 Card Available	Whether a Layer 7 only card is available.
Data Rate	The choice of data rates offered by the card.
Connector/Frequency-Mode	The connector type used on the card. For optical connections, the light frequency used and whether the fiber is used for singlemode or multimode.
Capture buffer size	The size of each port's capture buffer.
Captured packet size	The range of packet sizes that may be captured on the card.
Streams per port	The number of streams available on each port.
Flows per port	The number of stream flows available on each port. If available, this is always 15,872.
Advanced streams	The number of advanced streams available on each port.

Specification	Usage
Preamble size: min-max	The range of sizes, in bytes, for generated preambles.
Frame size: min-max	The range of sizes, in bytes, for generated frames.
Inter-frame gap: min-max	The gap between frames, expressed as a range of time.
Inter-burst gap: min-max	The gap between bursts of frames, expressed as a range of time.
Inter-stream gap: min-max	The gap between streams, expressed as a range of time. Sometimes expressed as a percentage of the maximum rate.
Latency	The accuracy of latency operations.
Intrinsic Latency Adjustment	Reduce the measured latency by the amount of latency that is induced by the test equipment itself (not the DUT). Retrieves pre-determined latency value for a `known' transceiver, or calculates and stores that value for a `new' transceiver.

Number of captured packets, an important characteristic, cannot be expressed as a simple number. It is dependent on a number of factors as mentioned in the following list:

- Size of the capture buffer
- Size of the captured packet
- Size of the capture slice, set by you
- Memory used by other functions
- Memory overhead per captured packet

The general equation is:

# of captured packets = (size of capture buffer) - (memory used by other functions) (min (captured packet, capture slice) + (per packet overhead)

Maximum number of PGIDs

The maximum number of PGIDs for designated load module families is provided in the following table.

Maximum PGID Summary

Load Module Family	Receive Mode	Maximum Number PDIDs[1] Decimal
LM100TXS8		
	Packet Group	65536
	Packet Group + Sequence	128

Load Module Family	Receive Mode	Maximum Number PDIDs[1] Decimal
	Checking	
	Capture + Sequence Checking	128
	Wide Packet Group	131072
LSM1000XMSP12-01		
	Packet Group	65536
	Packet Group + Sequence Checking	128
	Capture + Sequence Checking	128
	Wide Packet Group	131072
	Wide Packet Group (Reduced Feature)	65536
LSM1000XMV (4, 8, 12, and 16-port)		
	Wide Packet Group	131072
	Wide Packet Group (Reduced Feature)	65536
	Wide Packet Group/Wide Bin Mode (Full Feature)	1048576
ASM1000XMV	Wide Packet Group/Wide Bin Mode	1048576
LSM10G including MSM10G and MSM2.5G		
	Wide Packet Group	2097152
	Wide Packet Group (Reduced Feature)	65536
100GE LSM XMV, 40GE LSM XMV,	Wide Packet Group	1048576

Load Module Family	Receive Mode	Maximum Number PDIDs[1] Decimal
and 40/100GE LSM XMV		
LM10G and LM10GE		
	Packet Group	65536
	Sequence Checking	8192
	Packet Group + Sequence Checking	8192
LMOC-12		
	Packet Group	57344
	Sequence Checking	N/A
LMOC-48		
	Packet Group	65536
	Packet Group + Sequence Checking	512
	Capture + Sequence Checking	512
LMOC-192		
	Packet Group	1024
	Sequence Checking	1024
	Packet Group + Sequence Checking	1024
	Wide Packet Group	131072
LM622MR		
	Packet Group	65536

Load Module Family	Receive Mode	Maximum Number PDIDs[1] Decimal
	Packet Group + Sequence Checking	128
	Capture + Sequence Checking	128
	Wide Packet Group	131072
LavaAP40/100GE		
	Sequence Checking	1048576
	Data Integrity	
	Wide Packet Groups	1048576
	Latency/Jitter	

[1]The maximum number of PGIDs is the maximum hardware PGID that can be supported by a particular load module in a particular mode. If time bin, latency, or other parameters are enabled, the maximum PGID that can be supported is reduced. All modules have a maximum 2048 time bins. All modules that support latency bins have quantity 16 latency bins.

CHAPTER 2

Theory of Operation: General

This chapter discusses the unifying concepts behind the Ixia system. Both the software and hardware structures, and their usage, are discussed. The chapter is divided into the following major sections:

- Ixia Hardware
- IxExplorer Software

Ixia Hardware

This section discusses the range and capabilities of the Ixia hardware, including general discussions of several technologies used by Ixia hardware. This section is divided into the following general areas:

- Chassis Chain (Hardware)
- Chassis
- Load Modules
- Port Hardware
  - Types of Ports
  - Port Transmit Capabilities
  - Port Data Capture Capabilities
  - Port Transmit/Receive Capabilities
  - Port Statistics Capabilities

Chassis Chain (Hardware)

For daisy chain, the Ixia hardware can be structured as a chain of different types of chassis, up to 256 units. For a star topology, the Ixia hardware can be structured as a chain of different types (with restrictions) of chassis, up to 5. The following table describes the chassis available for the two types of chains:

Currently Available Ixia Chassis

Chassis	Number of Load Modules Supported	Daisy chain	Star
XG/XGS	12 high density modules	Yes	Yes

Multiple Ixia chassis are chained together through special Sync-out/Sync-in cables that allow for port-to-port synchronization across locally connected chassis in accordance with the specification mentioned in the Chassis Chain Timing Specification section.

NOTE Windows and Native chassis are not supported in the same chain.

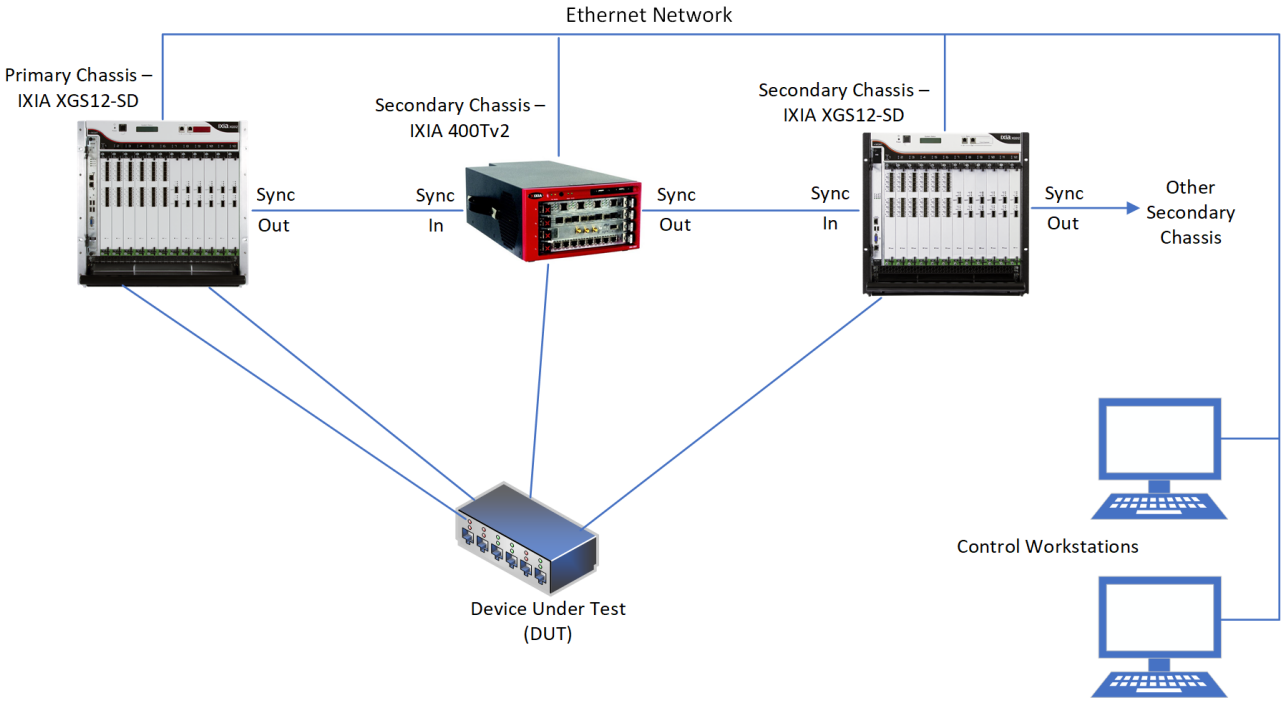
Daisy Chain

There are several rules that must be observed when connecting chassis in daisy chains. If a rule is violated, chassis timing may not meet the specification.

- Sync cable length between two chassis in a chain should be less than or equal to 6 feet.
- In a physical chassis chain, the Optixia chassis must be grouped together, and the non-Optixia chassis must be grouped together; that is, the two types can be on the same chassis chain, but cannot be intermingled. In a virtual chain that consists of several physical chains, each physical chain must obey this rule.
- Sequence numbers must be unique in a chain. Within a chain, there cannot be duplicate sequence numbers. The primary chassis must have the smallest sequence value in the physical chain. The order of sequence numbers must match the order of chassis (up to 99999). The numbers do not have to be sequentially contiguous (1, 2, 3, and so on.) but they must be sequentially increasing in value (1, 5, 8, and so on.)
- Certain load modules must be used in only the first 3 chassis in a chain. These include LM100TXS8, LM100TXS2, LM100TX8, and LM100TX1. If these boards are used in the fourth or later chassis in a chain, the network ports may not operate reliably.

The following figure is a representation of an independent Ixia chassis chain and control network. Chassis are chained together through their sync cables. The first chassis in a chain has a Sync-out connection (but no Sync-in unless it is the AFD1 GPS receiver), and is called the *primary* chassis. All other chassis in the chain are termed *secondary chassis*.

Figure: Ixia Chassis chain and Control Workstation



Star Topology

There are several rules that must be observed connecting chassis in star topology. If a rule is violated, chassis timing may not meet the specification.

- Sync cable length between two chassis in a chain should be less than or equal to 6 feet.
- Only XG/XGS chassis can be the primary chassis of the chain.
- Only Optixia chassis (XG/XGS) can be secondary chassis.

All four sync out ports on the XG12 and XGS12 chassis shall be available for synchronization connection to secondary chassis.

Figure: XG12 chassis sync-out ports

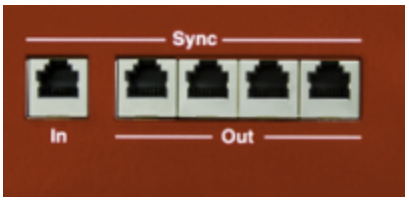


Figure: XGS12 chassis sync-out ports

In current deployment of these chassis, one sync-out port is available, and 3 additional sync-out ports are covered. There shall be a maximum of 5 synchronized chassis per system when deployed in the Star Topology with one secondary chassis connected to each of the 4 sync-out ports on the primary chassis. When there are fewer than 5 chassis, secondary chassis may be connected to any sync-out port on the primary chassis.

You can choose to daisy chain chassis, or use star topology, but cannot combine the two.

Figure: Ixia Daisy Chain and Star Topology

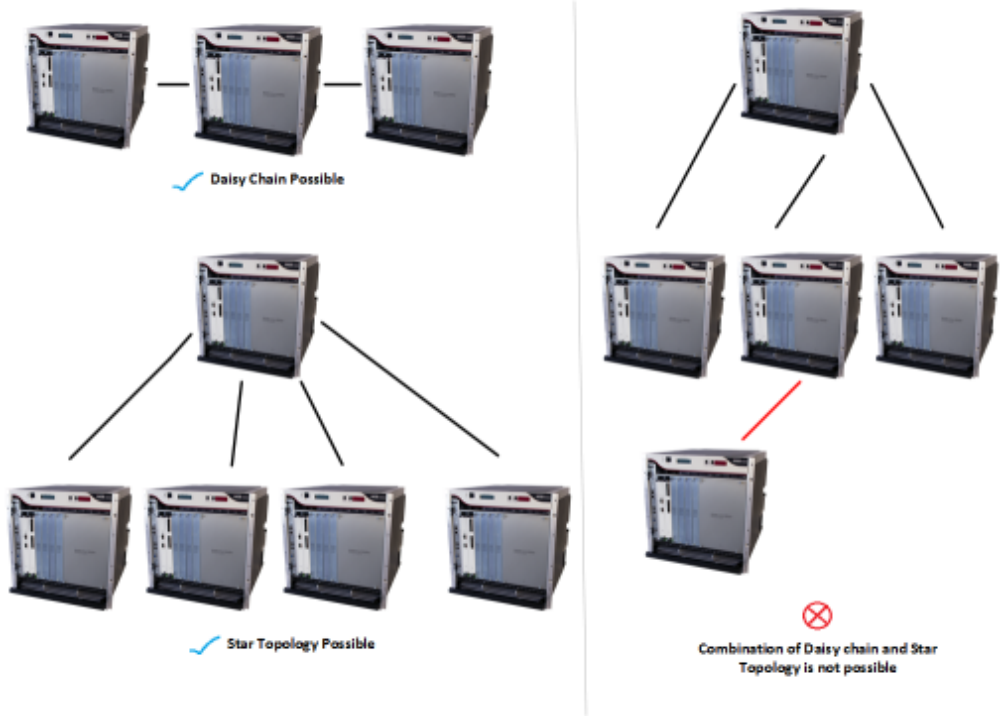
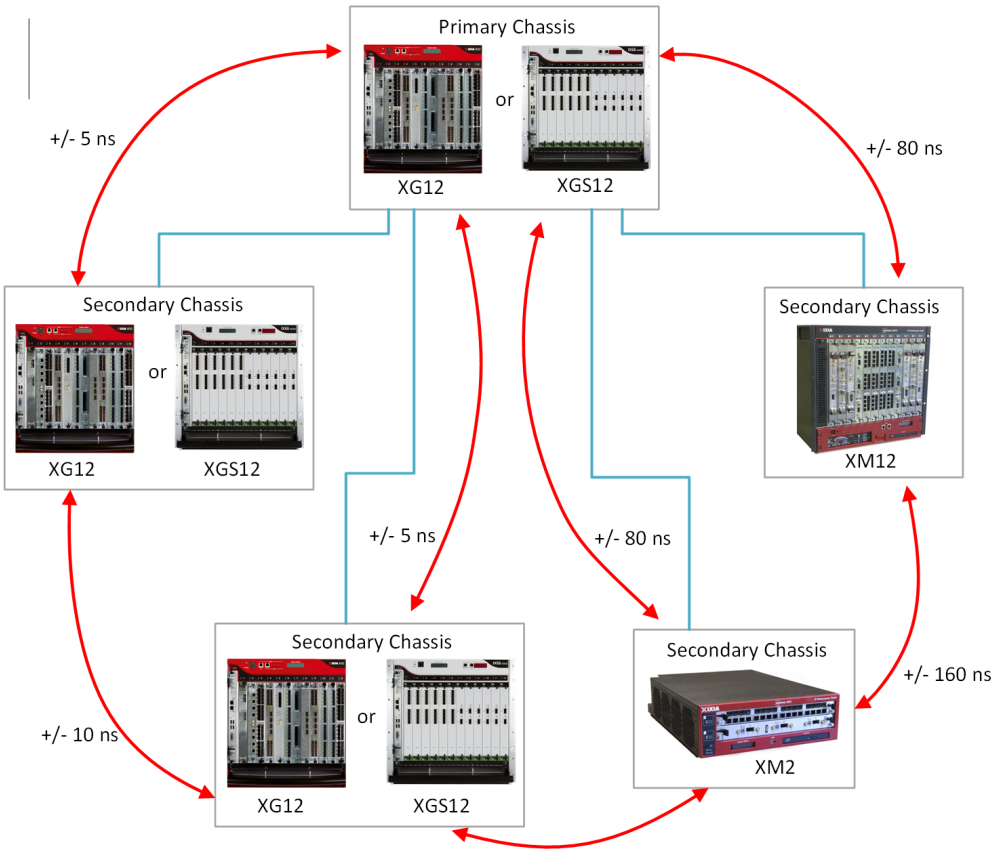


Figure: Ixia Star Topology chassis chain



Multiple, geographically-separated, independent chassis may be synchronized with a high degree of accuracy by using an Ixia chassis. Specific chassis include an integral GPS or CDMA receiver which is used for worldwide chassis synchronization. See Chassis Synchronization for a complete discussion of chassis timing.

NOTE Plugging-in or removing the sync cable while IxServer is starting or running can cause the IxServer to detect the change in the sync-in connection and shut down. If this occurs, restart IxServer, then restart all Ixia applications.

Ports from the chassis are connected to the Device Under Test (DUT) using cables appropriate for the media. Ports from any chassis may be connected to the similar ports on the DUT. It is even possible to connect multiple independent DUTs to different ports on different chassis.

Each chassis is driven by an Intel Pentium-based computer running Windows XP Professional and Ixia-supplied software. Each chassis may be directly connected to a monitor, keyboard, and mouse to create a standalone system, but it is typical to connect all chassis through an Ethernet network and run the IxExplorer client software or Tcl client software on one or more external control PC workstations. IxExplorer client software runs on any Windows 2000/XP based system or Windows Server 2003 (console usage or simultaneous remote terminal access for multiple users). Tcl client software runs on Windows 2000/XP based systems and several Unix-based systems.

Chassis Chain Timing Specification

Depending on the chassis topology, there are different timing skews between chassis.

For daisy chain:

- Chassis timing skew between similar XG/XGS chassis <= +/- 5ns.
- Chassis timing skew between similar chassis (except XG and XGS) <= +/- 40ns.
- Chassis timing skew between different chassis <= +/- 80ns.

Based on the above numbers:

- Maximum latency error between similar XG/XGS chassis due to the chassis <= +/- 5ns.
- Maximum latency error between similar chassis (except XG and XGS) due to the chassis <= +/- 40ns.
- Maximum latency error between different chassis due to the chassis <= +/- 80ns.

For star topology:

- Chassis timing skew between similar XG/XGS chassis one primary and one secondary <= +/- 5ns.
- Chassis timing skew between similar XG/XGS chassis both secondary <= +/- 10ns.
- Chassis timing skew between similar chassis (except XG and XGS) both secondary <= +/- 160ns.
- Chassis timing skew between different chassis (XG primary, XM secondary) <= +/- 80ns.
- Chassis timing skew between different chassis (XG secondary, XM secondary) <= +/- 85ns.

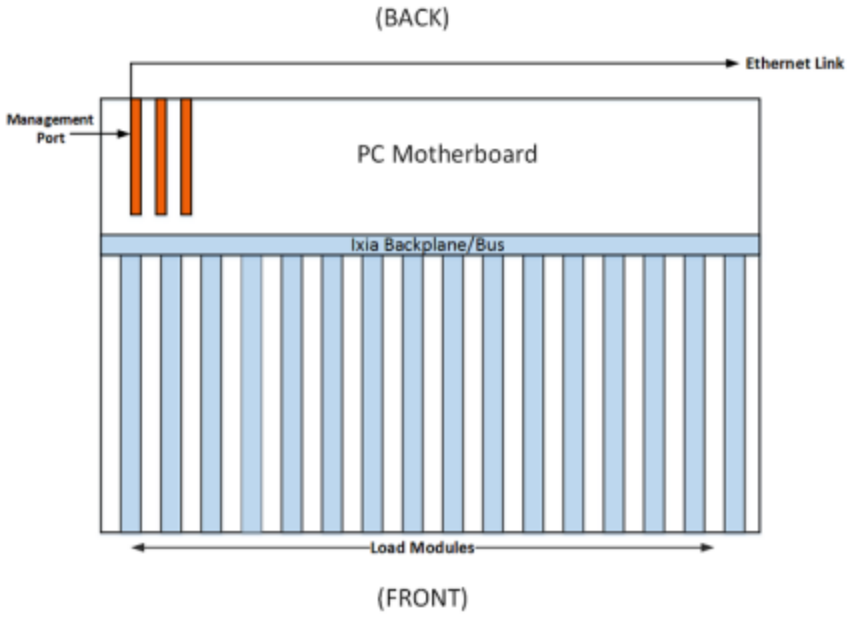
Based on the above numbers:

- Maximum latency error between similar XG/XGS chassis due to the chassis <= +/- 10ns.
- Maximum latency error between similar chassis (except XG and XGS) due to the chassis <= +/- 160ns.
- Maximum latency error between different chassis due to the chassis <= +/- 85ns.

Chassis

Each Ixia chassis can operate as a complete standalone system when connected to a local monitor, keyboard, and mouse. The interior of an Ixia XGS12-SD chassis is shown in the following figure.

Figure: Ixia XGS12-SD Interior View (Top View)



The PC embedded in the chassis system is an Intel-compatible computer system which includes the following components:

- A Pentium processor
- Main memory
- Keyboard interface
- Mouse interface
- Internal connection to the Ixia Backplane
- Video interface capable of 1024 x 768 or greater resolution
- Management Port

The Ixia Backplane is connected to the PC Motherboard, through an Ixia custom PCI interface card, and to the card slots where the Ixia load modules are installed.

Chassis Synchronization

Measurement of unidirectional latency and jitter in the transmission of data from a transmit port to a receive port requires that the relationship between time signatures at each of the ports is known. This

can be accomplished by providing the following signals between chassis:

- Clock (frequency standard): This allows chassis to phase-lock their frequency standards so that a cycle counter on any chassis counts the same number of cycles during the same time interval. Each Ixia port maintains such a counter from a common chassis-wide frequency standard.
- Reset: A means must exist to either discover the fixed offset between their counters, or to simultaneously set the counters to a known value. You may think of this as the *zero reset*.

The use of both **Reset** and **Phase Lock** allow the establishment and maintenance of a fixed time reference between two or more chassis and the ports supported by the chassis.

In test setups where chassis and ports are physically close together, a sync cable is used to connect chassis in a `chassis chain' for synchronization operation.

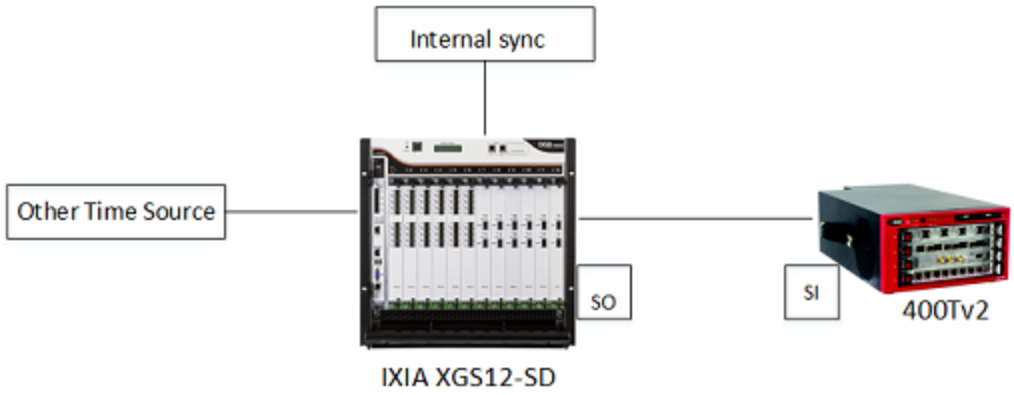
In widely distributed applications, such as monitoring traffic characteristics over a WAN, clock reference and/or reset signals cannot be transmitted between chassis over a physical connection because of unknown delay characteristics. An alternative means is required to satisfy these requirements.

Ixia has facilities that allow for the synchronization of independent Ixia chassis located anywhere in the world by replacing the existing inter-chassis sync cables with a widely available frequency and time standard supplied from an external source. This source provides a reference time used to obtain accurate latency and other measurements in a live global network. When geographically dispersed chassis are connected in this way, the combination is called a *virtual chassis chain*.

Physical Chaining

Independent Ixia 400Tv2, XGS12, or XGS2, chassis may synchronize themselves with other chassis as shown in the following figure. The timing choices are explained in the following table.

Figure: Physical Chaining



Physical Chaining Timing Choices

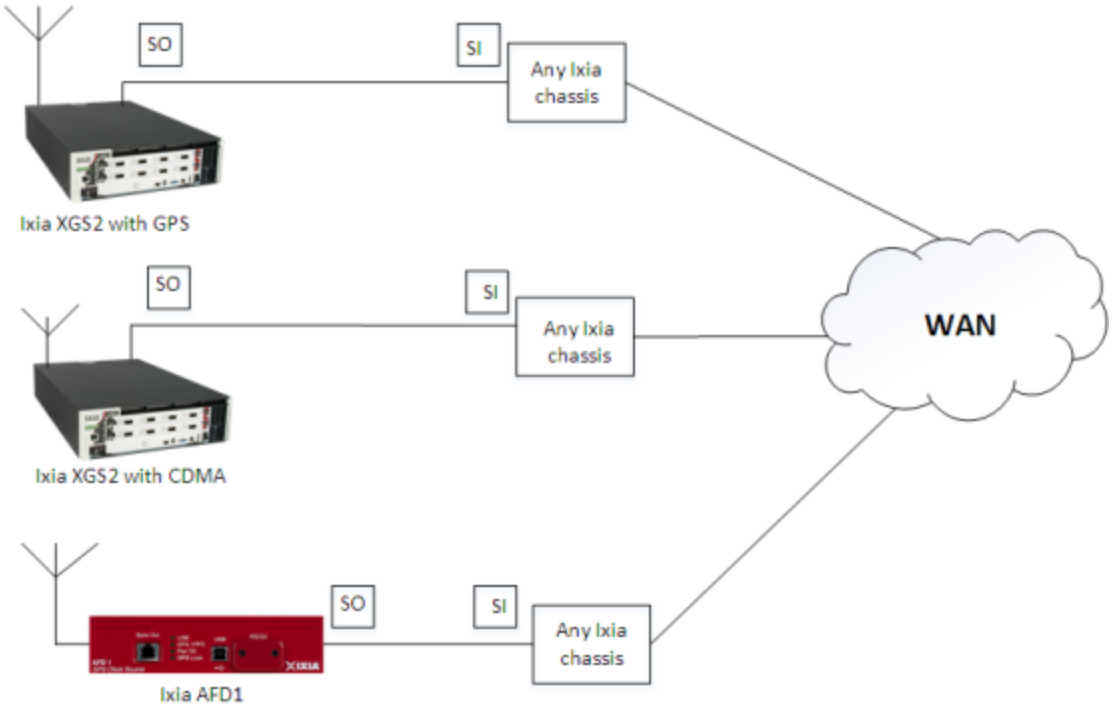
Choice	Usage
Internal Sync (Synchronous)	If a chassis is used in a standalone manner or the primary of a chassis chain, it may generate its own start signal. In general, there is insufficient timing accuracy between timing of primary chassis for measurements over any distance. This is also known as the Synchronous Timing mode.

Choice	Usage
Sync-In (SI)	If a chassis is a secondary one, either directly connected to the primary chassis or further down the chain, it derives its timing from the previous chassis' Sync-Out (SO) signal.

Virtual Chaining

If two chassis are separated by any significant distance, a sync-out/sync-in cable cannot be used to connect them. In this case, an Ixia Auxiliary Function Device (AFD1) is used, one attached to each chassis through sync-out/sync-in cables, as shown in the following figure. The Ixia 100 maintains an accuracy of less than 150 nanoseconds when attached to a GPS antenna, or 100 microseconds when attached to a CDMA receiver, and provides chassis to chassis synchronization.

Figure: Virtual Chaining



To generate traffic for system latency testing, the Ixia 100 can be used alone or in conjunction with another Ixia chassis, or the Ixia AFD1 (GPS receiver) can be used with any other Ixia chassis. The timing features available with these chassis are shown in the following table. A GPS antenna requires external mounting. Refer to Appendix C, GPS Antenna Installation Requirements for more information.

Virtual Chaining Timing Choices

Choice	Usage
GPS	The Ixia 100 or ixia AFD1 requires connection to an external antenna to `capture' multiple GPS satellites. It maintains an accuracy of less than 150 nano-seconds.

Choice	Usage
CDMA	The CDMA cellular network transmits an accurate time signal. CDMA (Code Division Multiple Access) cellular base-stations effectively act as GPS repeaters. The Ixia 100-CDMA receives the CDMA signals passively from an external antenna (you do not need to subscribe to any service) and decodes the embedded GMT time signal. Using this approach, the CDMA chassis can be time-synched to GMT. A CDMA antenna does not require external mounting.

The Sync-Out from a GPS or CDMA chassis is used as primary timing source for a chassis chain at a specific geographic location. Since the Ixia 100 chassis has all other functions provided by the other Ixia chassis, it may also use independent timing when not used to synchronize with other chassis at other locations.

NOTE CDMA reception depends on signal availability and may be impacted by cell location and chassis installation within the selected site. Consult your Ixia representative to determine the best solution for your installation.

Ixia Chassis Connections

A number of LEDs are available on the front panel of the Ixia 100, as described in the following table.

IXIA 100 Front Panel LEDs

LED	Usage
Set Lock	Three LEDs indicate three separate status events: • 1: Indicates that the chassis is armed for a GPS sync event. • 2: Indicates that the antenna is correctly connected. • 3: Indicates that the GPS is tracking satellites.
Time Stamp	Three LEDs indicate the Stratum connection level. The Stratum indicates the accuracy the time stamp. The following list explains the significance of the number of LEDs lit: • 0: Indicates Stratum 4, within 100 us of absolute GMT. • 1: Indicates Stratum 3, within 10 us of absolute GMT. • 2: Indicates Stratum 2, within 1 us of absolute GMT. • 3: Indicates Stratum 1, within 100 ns of absolute GMT.
Shutdown	The chassis is in the process of being shut down.
Power	Power is applied to the chassis.

Similar information is available for the AFD1 GPS receiver in the Time Source tab of the Chassis Properties form (viewable through IxExplorer user interface).

Load Modules

Although each Ixia load module differs in particular capabilities, all modules share a common set of functions. Ixia load modules are generally categorized by network technology. The network

technologies supported, along with names used to reference these technologies and more detailed information on load module differences, are available in the subsequent chapters of this manual.

NOTE A load module can also be referred to as a *card*. The terms *load module* and *card* are used interchangeably in this manual.

The Load Module name prefix is used as the prefix to all load modules for that technology; for example, LM 100 in LM 100 TX. The IxExplorer name is used to label card and port types.

Some load modules are further labelled by the type of connector supported. Thus, a load module's name can be formed from a combination of its basic technology and the connector type. For example, LM 100 TX is the name of the 10/100 load module with RJ-45 connectors.

In addition, less expensive versions of several load modules are available. These are called Type-3 or Type-M modules, signified by an ending of `-3' or `-M' in the load module name and with a `-3'or `-M' suffix in the IxExplorer.

Newer boards also may have an `L' before the last number in their part number, signifying the same limited functionality.

Some load modules can be configured with less than standard amount of memory. Modules configured with such memory have a notation as to the memory upgrade following the module name. For example, LM622MR-512.

Port Hardware

The ports on the Ixia load modules provide high-speed, transmit, capture, and statistics operation. The discussion which follows is broken down into a number of areas:

- Types of Ports: The different types of networking technology supported by Ixia load modules
- Port Transmit Capabilities: Facilities for generating data traffic
  - Streams and Flows: A set of packets, which may be grouped into bursts
  - Bursts and the Inter-Burst Gap (IBG): A number of packets
  - Packets and the Inter-Packet Gap (IPG): Individual frames/packets of data
- Frame Data: The construction of data within a frame/packet
- Port Data Capture Capabilities: Facilities for capturing data received on a port
- Port Statistics Capabilities: Facilities for obtaining statistics on each port

Types of Ports

The types of load module ports that Ixia offers are divided into these broad categories:

- Ethernet
- 10GE
- 40GE and 100GE
- 400GE
- SONET/POS
- ATM
- BERT

Only the currently available Ixia load modules are discussed in this chapter. Subsequent chapters in this manual discuss all supported load modules and their optional features.

Ethernet

Ethernet modules are provided with various feature combinations, as mentioned in the following list:

- Speed combinations: 10 Mbps, 100 Mbps, and 1000 Mbps
- Auto negotiation
- Pause control
- With and without on-board processors, also called Port CPUs (PCPUs). Load modules without processors only allow for very limited routing protocol emulation
- External connections including the following:
  - RJ-45
  - MII
  - RMII - a custom Ixia connector
  - MT-RJ Fibre singlemode and multimode
  - SC multimode
  - GBIC singlemode and multimode

Power Sourcing Equipment (PSE)

A PSE is any equipment that provides the power to a single link Ethernet Network section. The PSE's main functions are to search the link section for a powered device (PD), optionally classify the PD, supply power to the link section (only if a PD is detected), monitor the power on the link section, and remove power when it is no longer requested or required.

There are two power sourcing methods for PoE Alternative A and Alternative B.

PSEs may be placed in two locations with respect to the link segment, either coincident with the DTE/Repeater, or midspan. A PSE that is coincident with the DTE/Repeater is an `Endpoint PSE.' A PSE that is located within a link segment that is distinctly separate from and between the Media Dependent Interfaces (MDIs) is a `Midspan PSE.'

Endpoint PSEs may support either Alternative A, B, or both. Endpoint PSEs can be compatible with 10BASE-T, 100BASE-X, and/or 1000BASE-T.

Midspan PSEs must use Alternative B. Midspan PSEs are limited to operation with 10BASE-T and 100BASE-TX systems. Operation of Midspan PSEs on 1000BASE-T systems is beyond the scope of PoE.

Powered Devices (PD)

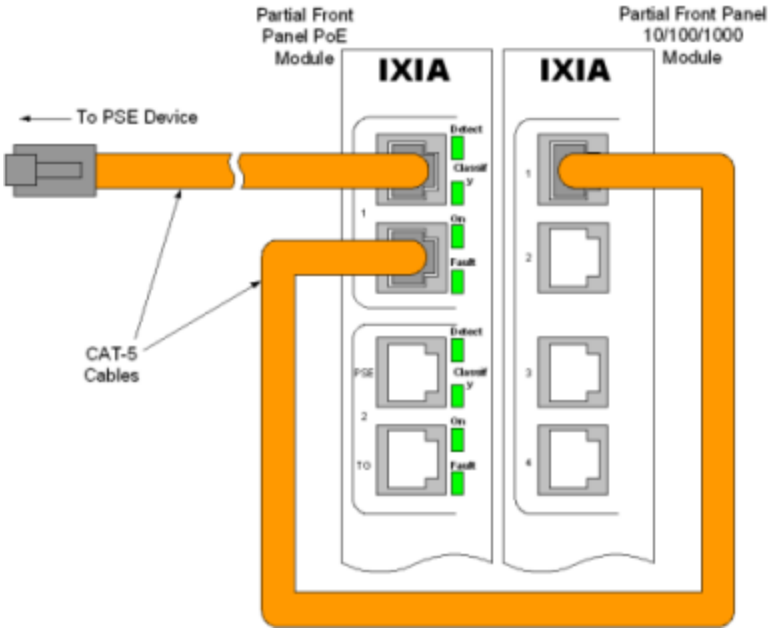
A powered device either draws power or requests power by participating in the PD detection algorithm. A device that is capable of becoming a PD may or may not have the ability to draw power from an alternate power source and, if doing so, may or may not require power from the PSE.

One PoE Load Module emulates up to four PDs. The PoE Load Module (PLM) has eight RJ-45 interfaces four of them used as PD-emulated ports, with each having its own corresponding interface that

connects to a port on any Ixia 10/100/1000 copper-based Ethernet load module (includes all copper-based TXS, and Optixia load modules).

The following figure demonstrates how the PoE modules use an Ethernet card to transmit and receive data streams.

Figure: Data Traffic over PoE Set Up

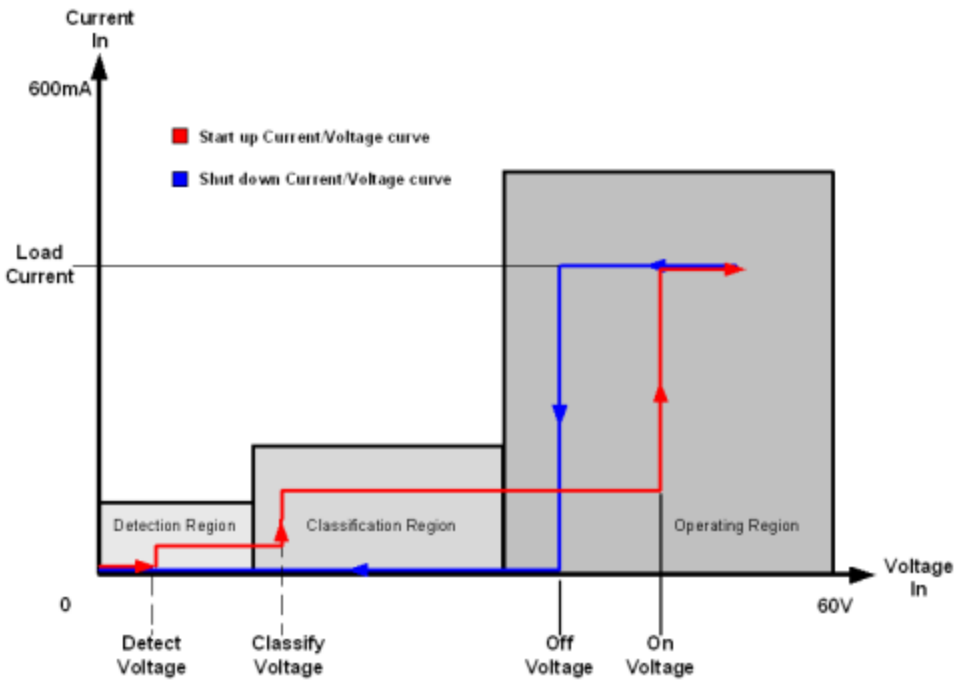


The emulated PD device can `piggy-back' a signal from a different load module along the cable connected to the PSE from which it draws power. In this manner, the emulated PD can mimic a device that generates traffic, such as an IP phone.

Discovery Process

The main purpose for discovery is to prevent damage to existing Ethernet equipment. The Power Sourcing Equipment (PSE) examines the Ethernet cables by applying a small current-limited voltage to the cable and checking for the presence of a 25K ohm resistor in the remote Powered Device (PD). Only if the resistor is present, the full 48V is applied (and this is still current-limited to prevent damage to cables and equipment in fault conditions). The Powered Device must continue to draw a minimum current or the PSE removes the power and the discovery process begins again.

Figure: Discovery Process Voltage



There is also an optional extension to the discovery process where a PD may indicate to the PSE its maximum power requirements, called classification. Once there is power applied to the PD, normal transactions/data transfer occurs. During this period, the PD sends back a *maintain power signature* (MPS) to signal the PSE to continue to provide power.

PoE Acquisition Tests

During the course of testing with the PoE module, it may be necessary to measure the amplitude of the incoming current. The PoE module has the ability to measure amplitude versus time in following two ways:

- Time test: The amount of time that elapses between a *Start* and *Stop* incoming current measurement.
- Amplitude test: The amplitude of the current after a set amount of time from a *Start* incoming current setting.

In both scenarios, a Start trigger is set, indicating when the test should commence based on an incoming current value (in either DC Volts or DC Amps).

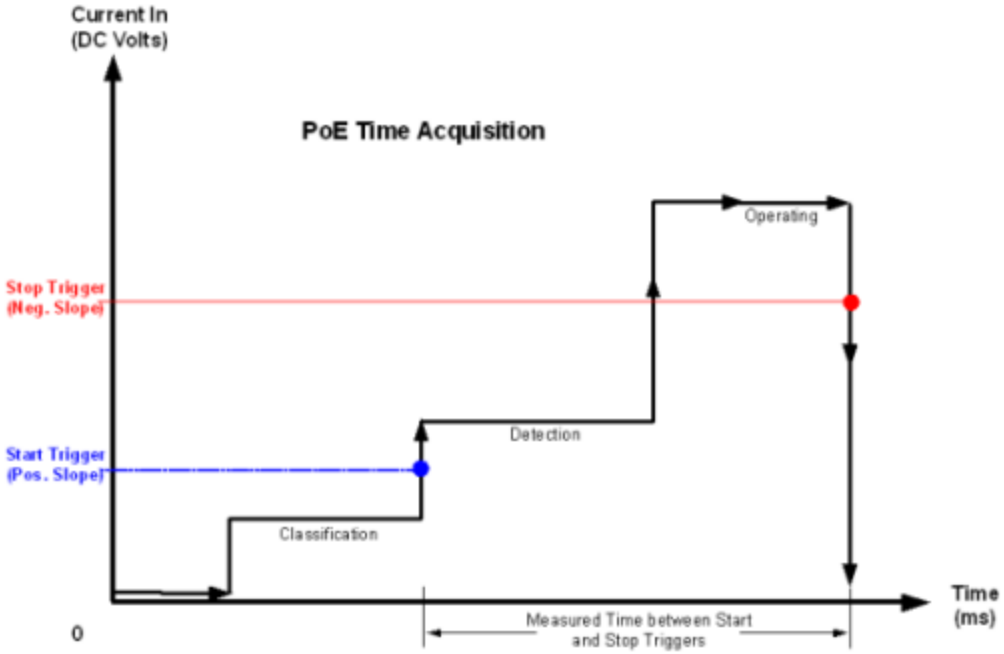
In a Time test, a Stop trigger is also set (in either DC Volts or DC Amps) indicating when the test is over. Once the Stop trigger is reached, the amount of time between the Start and Stop trigger is measured (in microseconds) and the result is reported.

In an amplitude test, an Amplitude Delay time is set (in microseconds), which is the amount of time to wait after the Start trigger is reached before ending the test. The amplitude at the end of the Amplitude Delay time is measured and is reported.

Both Start and Stop triggers must also have a defined Slope type, either positive or negative. A positive slope is equivalent to rising current, while a negative slope is equivalent to decreasing current. A current condition must agree with both the amplitude setting and the Slope type to satisfy the trigger condition.

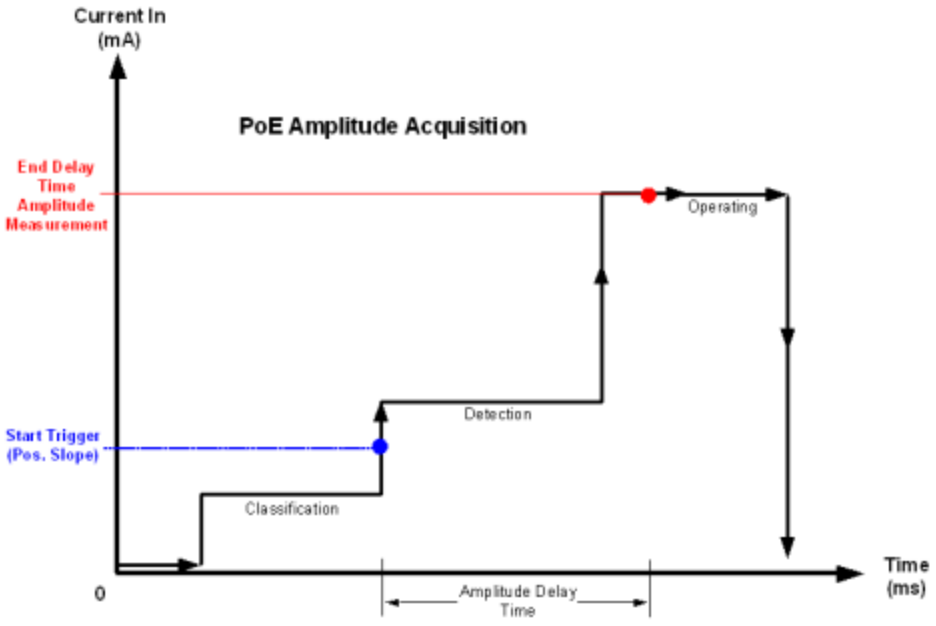
An example of a Time test is shown in the following figure.

Figure: PoE Time Acquisition Example



An example of an Amplitude test is shown in the following figure.

Figure: PoE Amplitude Acquisition Example



10GE

The 10 Gigabit Ethernet (10GE) family of load modules implements five of the seven IEEE 8.2.3ae compliant interfaces that run at 10 Gbit/second. Several of the load modules may also be software

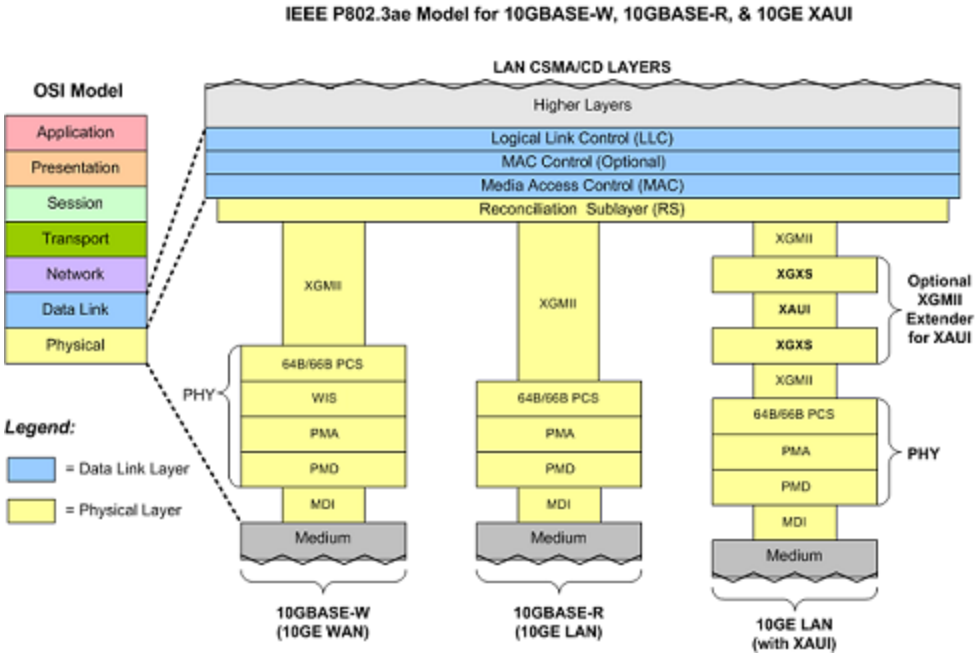
switched to OC192 operation.

The 10 GE load modules are provided with various feature combinations, as mentioned in the following list:

- Interfaces types: LAN, WAN, and XENPAK
- Interface connectors: SC singlemode (LAN and WAN), SC multimode (LAN), LC singlemode/multimode, XFP, and XENPAK
- Reach: Short, long, and extended
- Wavelengths: 850 nm, 1310 nm, 1550 nm

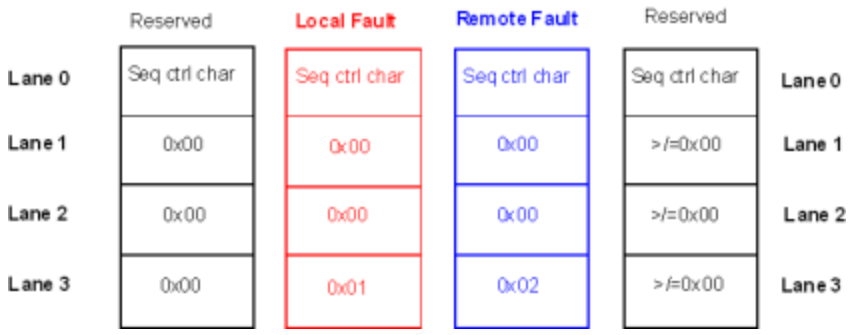
The relationship of the logical structures for the different 10 Gigabit types is shown in the diagram (adapted from the 802.3ae standard) in the following figure.

Figure: IEEE 802.3ae Draft 10 Gigabit Architecture



For 10GE XENPAK module, a Status message contains a 4-byte ordered set with a Sequence control character plus three data characters (in hex), distributed across the four lanes, as shown in the following figure. Four Sequence ordered sets are defined in IEEE 802.3ae, but only two of these Local Fault and Remote Fault are currently in use; the other two are reserved for future use.

Figure: 10GE XENPAK Sequence Ordered Sets



Link Fault Signaling

Link Fault Signaling is defined in Section 46 of the IEEE 802.3ae specification for 10 Gigabit Ethernet. When the feature is enabled, four statistics are added to the list in Statistic View for the port. One is for monitoring the Link Fault State; two for providing a count of the Local Faults and Remote Faults; and the last one is for indicating the state of error insertion, whether or not it is ongoing.

Link Fault Signaling originates with the PHY sending an indication of a local fault condition in the link being used as a path for MAC data. In the typical scenario, the Reconciliation Sublayer (RS) which had been receiving the data receives this Local Fault status, and then send a Remote Fault status to the RS which was sending the data. Upon receipt of this Remote Fault status message, the sending RS terminates transmission of MAC Data, sending only `Idle' control characters until the link fault is resolved.

For the 10GE LAN and LAN-M serial modules, the Physical Coding Sublayer (PCS) of the PHY handles the transition from 64 bits to 66 bit `Blocks.' The 64 bits of data are scrambled, and then a 2-bit synchronization (sync) header is attached before transmission. This process is reversed by the PHY at the receiving end.

Examples of Link Fault Signaling Error Insertion

The examples in this figure are described in the following table:

Cases for Example

Case	Conditions
Case 1	Contiguous Bad Blocks = 2 (the minimum). Contiguous Good Blocks = 2 (the minimum).

Case	Conditions
	Send Type A ordered sets. Loop 1x.
Case 2	Contiguous Bad Blocks = 2 (the minimum). Contiguous Good Blocks = 2 (the minimum). Send Type A ordered sets. Loop continuously.
Case 3	Contiguous Bad Blocks = 2 (the minimum). Contiguous Good Blocks = 2 (the minimum). Send alternate ordered set types. Loop 1x.
Case 4	Contiguous Bad Blocks = 2 (the minimum). Contiguous Good Blocks = 2 (the minimum). Send alternate ordered set types. Loop continuously.

Link Alarm Status Interrupt (LASI)

The link alarm status is an active low output from the XENPAK module that is used to indicate a possible link problem as seen by the transceiver. Control registers are provided so that LASI may be programmed to assert only for specific fault conditions.

Efficient use of XENPAK and its specific registers requires an end-user system to recognize a connected transceiver as being of the XENPAK type. An Organizationally Unique Identifier (OUI) is used as the means of identifying a port as XENPAK, and also to communicate the device in which the XENPAK specific registers are located.

Ixia's XENPAK module allows for setting whether or not LASI monitoring is enabled, what register configurations to use, and the OUI. The XENPAK module can use the following registers:

- Rx Alarm Control (Register 0x9003): It can be programmed to assert only when specific receive path fault condition(s) are present.
- Tx Alarm Control (Register 0x9001): It can be programmed to assert only when specific transmit path fault condition(s) are present.
- LASI Control (Register 0x9002): A LASI control register that allows global masking of the Rx Alarm and Tx Alarm.

You can control the registers by setting a series of sixteen bits for each register. The register bits and their usage are described in the following tables.

Rx Alarm Control

Bits	Description	Default
15 - 11	Reserved	0
10	Vendor Specific	N/A (vendor Setting)
9	WIS Local Fault Enable	1 (when implemented)
8 - 6	Vendor Specific	N/A (vendor Setting)
5	Receive Optical Power Fault Enable	1 (when implemented)
4	PMA/PMD Receiver Local Fault Enable	1 (when implemented)
3	PCS Receive Local Fault Enable	1
2 - 1	Vendor Specific	N/A (vendor Setting)
0	PHY XS Receive Local Fault Enable	1

Tx Alarm Control

Bits	Description	Default
15 - 11	Reserved	0
10	Vendor Specific	N/A (vendor setting)
9	Laser Bias Current Fault Enable	1 (when implemented)
8	Laser Temperature Fault Enable	1 (when implemented)
7	Laser Output Power Fault Enable	1 (when implemented)
6	Transmitter Fault Enable	1
5	Vendor Specific	N/A (vendor setting)
4	PMA/PMD Transmitter Local Fault Enable	1 (when implemented)
3	PCS Transmit Local Fault Enable	1
2 - 1	Vendor Specific	N/A (vendor setting)
0	PHY XS Transmit Local Fault Enable	1

LASI Control

Bits	Description	Default
15 - 8	Reserved	0
7 - 3	Vendor Specific	0 (when implemented)
2	Rx Alarm Enable	0
1	Tx Alarm Enable	0
0	LS Alarm Enable	0

For more detailed information on LASI, see the online document **XENPAK MSA Rev. 3**.

40GE and 100GE

For theoretical information, refer to *40 Gigabit Ethernet and 100 Gigabit Ethernet Technology Overview White Paper*, published by Ethernet Alliance, November, 2008. This white paper may be obtained through the Internet.

http://www.ethernetalliance.org/wp-content/uploads/2011/10/document_files_40G_100G_Tech_overview.pdf

400GE

The 400 Gigabit Ethernet (400GE) family of load modules meets the growing bandwidth requirements of ever-evolving data networks. 400GE addresses the broad range of bandwidth requirements for key application areas such as cloud-scale data centers, Internet exchanges, co-location services, wireless infrastructure, service provider and operator networks, and video distribution infrastructure.

This family of load module is capable of 200GE, 100GE and 50GE fan-outs.

SONET/POS

SONET/POS modules are provided with various feature combinations:

- Different speeds: OC3, OC12, OC48, OC192, Fibre Channel, 2x Fibre Channel, and Gigabit Ethernet.
- Interfaces: SC singlemode and multimode (OC3, OC12, OC192), SC singlemode (OC48), no optical transceiver, SFP LC singlemode (Unframed BERT) and custom interface.
- Reach: long, intermediate and long.
- Wavelengths: 850nm, 1310nm and 1550nm.
- Local processor support. All SONET/POS load modules include a local processor, but the power of the processor and amount of memory varies.
- Variable clocking OC48 only, see Variable Rate Clocking
- Concatenated or channelized SONET operation, see SONET Operation
- Error insertion, see Error Insertion
- BERT: Bit Error Rate Testing both framed and unframed, see BERT

- DCC: Data Communication Channel, see DCC Data Communications Channel.
- RPR: Resilient Packet Ring, see RPR Resilient Packet Ring.
- GFP: Generic Framing Procedure, see GFP Generic Framing Procedure.
- PPP: Point to Point protocol, see PPP Protocol Negotiation.
- HDLC: High-Level Data Link Control, see HDLC.
- Frame Relay: see Frame Relay.
- DSCP: see DSCP Differentiated Services Code Point.

Variable Rate Clocking

The OC48 VAR allows a variation of +/- 100 parts per million (ppm) from the clock source's nominal frequency, through a DC voltage input into the BNC jack marked `DC IN' on the front panel. The frequency may be monitored through the BNC marked `Freq Monitor.'

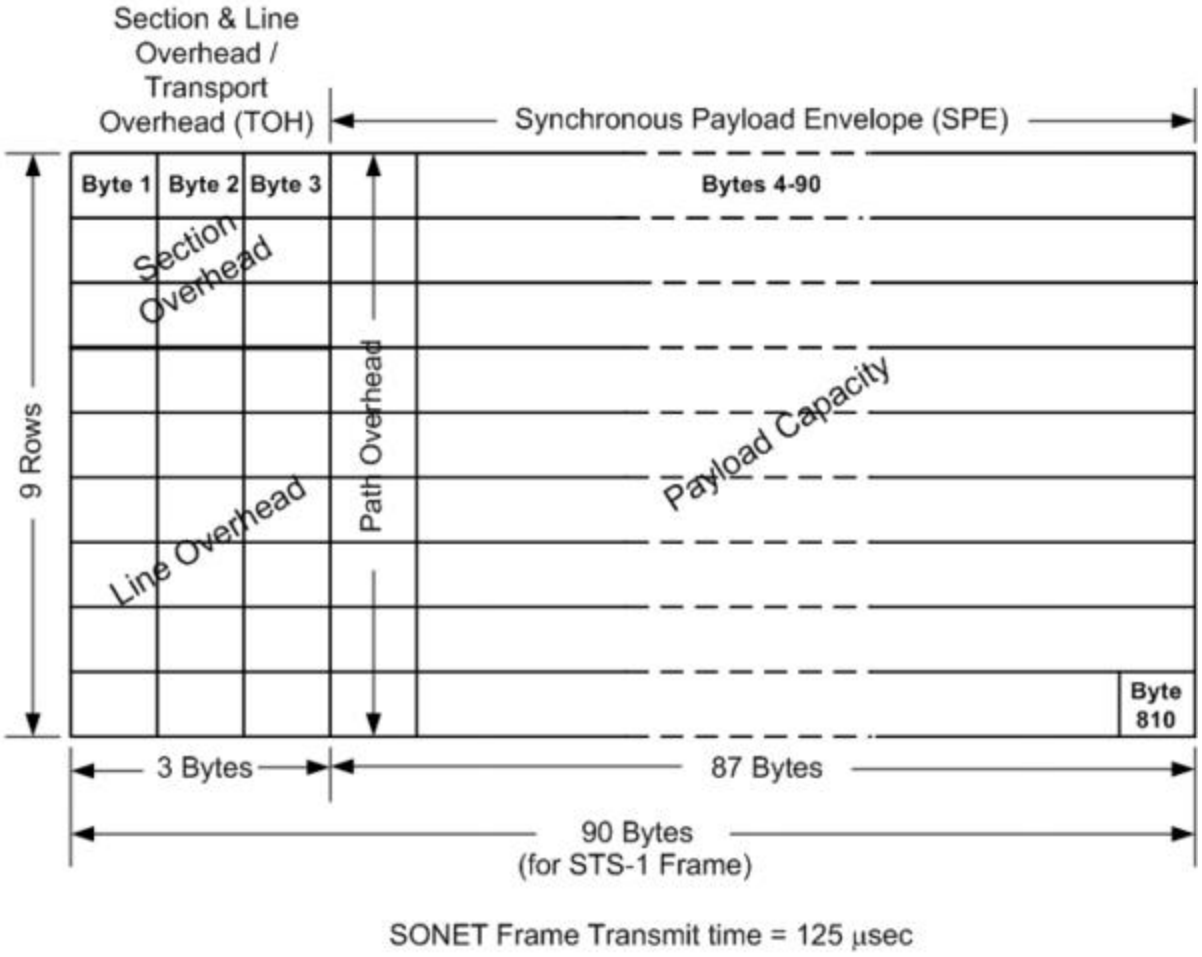
SONET Operation

A Synchronous Optical NETwork/Synchronous Digital Hierarchy (SONET/SDH) frame is based on the Synchronous Transport Signal-1 (STS-1) frame, whose structure is shown in the figure below. Transmission of SONET Frames of this size correspond to the Optical Carrier level 1 (OC-1).

An OC-3c, consists of three OC-1/STS-1 frames multiplexed together at the octet level. OC-12c, OC-48c, and OC-192c, are formed from higher multiples of the basic OC-1 format. The suffix `c' indicates that the basic frames are concatenated to form the larger frame.

Ixia supports both concatenated (with the `c') and channelized (without the `c') interfaces. Concatenated interfaces send and receive data in a single streams of data. Channelized interfaces send and receive data in multiple independent streams.

Figure: Generated Frame Contents SONET STS-1 Frame



The contents of the SONET STS-1 frame are described in the following table.

SONET STS-1 Frame Contents

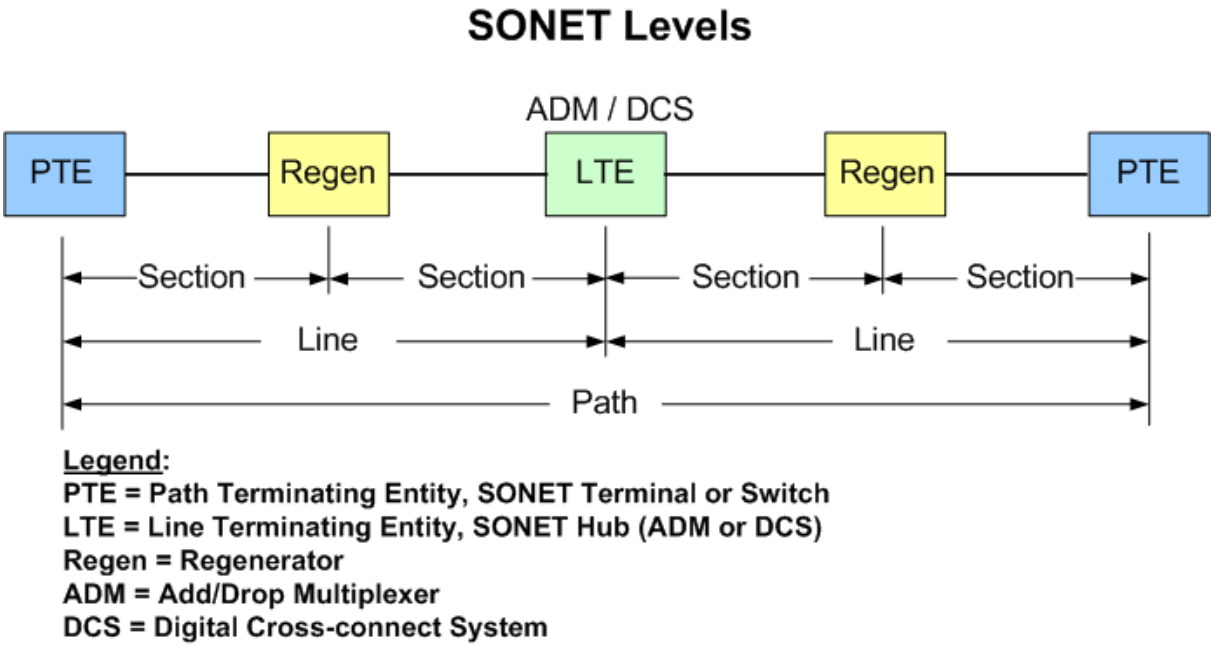
Section	Description
Section Overhead (SOH)	Consists of 9 bytes which include information relating to performance monitoring of the STS-n signal, and framing.
Line Overhead (LOH)	Consists of 18 bytes which include information relating to performance monitoring of the individual STS-1s, protection switching information, and line alarm indication signals.
Transport Overhead (TOH)	Consists of a combination of the Section Overhead and Line Overhead sections of the STS-1 frame.
Path Overhead (POH)	Part of the Synchronous Payload Envelope (SPE), contains information on the contents of the SPE, and handles quality monitoring.
Synchronous	Contains the payload information, the packets which are being transmitted, and includes the Path Overhead bytes.

Section	Description
Payload Envelope (SPE)	
Payload Capacity	Part of the SPE, and contains the packets being transmitted.

The SONET STS-1 frame is transmitted at a rate of 51.84 Mbps, with 49.5 Mbps reserved for the frame payload. A SONET frame is transmitted in 125 microseconds, with the order of transmission of the starting with Row 1, Byte 1 at the upper left of the frame, and proceeding by row from top to bottom, and from left to right.

The section, line, and path overhead elements are related to the manner in which SONET frames are transmitted, as shown in the following figure.

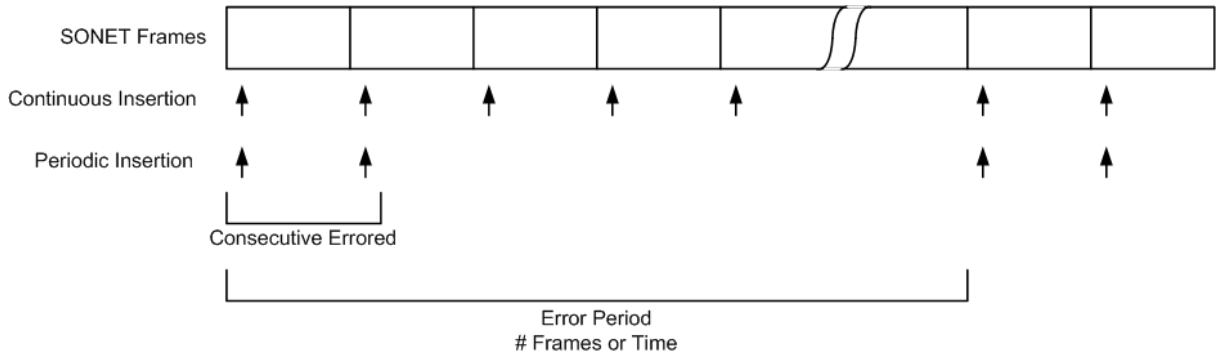
Example Diagram of SONET Levels and Network Elements



Error Insertion

A variety of deliberate errors may be inserted in SONET frames in the section, line or path areas of a frame. The errors which may be inserted vary by particular load module. Errors may be inserted continuously or periodically as shown in the following figure.

Figure: SONET Error Insertion



An error may be inserted in one of two manners:

- Continuous: Each SONET frame receives the error.
- Periodic: A number of errors are inserted in consecutive frames and the pattern is repeated based on a number of frames or a period of time. Predefined periods are available, or you may create your own predefined periods.

Each error may be individually inserted continuously or periodically. Errors may be inserted on a one time basis over a number of frames as well.

DCC Data Communications Channel

The data communication channel is a feature of SONET networks which uses the DCC bytes in the transport overhead of each frame. This is used for control, monitoring and provisioning of SONET connections. Ixia ports treat the DCC as a data stream which `piggy-backs' on the normal SONET stream. The DCC and normal (referred to as the SPE - Synchronous Payload Envelope) streams can be transmitted independently or at the same time.

A number of different techniques are available for transmitting DCC and SPE data, utilizing Ixia streams and flows (see Streams and Flows and advanced stream scheduler (see Advanced Streams).

SRP Spatial Reuse Protocol

The Spatial Reuse Protocol (SRP) was developed by Cisco for use with ring-based media. It derives its name from the spatial reuse properties of the packet handling procedure. This optical transport technology combines the bandwidth-efficient and service-rich capabilities of IP routing with the bandwidth-rich, self-healing capabilities of fiber rings to deliver fundamental cost and functionality advantages over existing solutions. In SRP mode, the usual POS header (PPP, and so forth) is replaced by the SRP header.

SRP networks use two counter-rotating rings. One Ixia port may be used to participate in one of the rings; two may be used to simultaneously participate in both rings. Ixia supports SRP on both OC48 and OC192 interfaces.

In SRP-mode, SRP packets can be captured and analyzed. The IxExplorer capture view displays packet analysis which understands SRP packets. The Ixia hardware also collects specific SRP related statistics and performs filtering based on SRP header contents.

Any of the following SRP packet types may be generated in a data stream, along with normal IPv4 traffic:

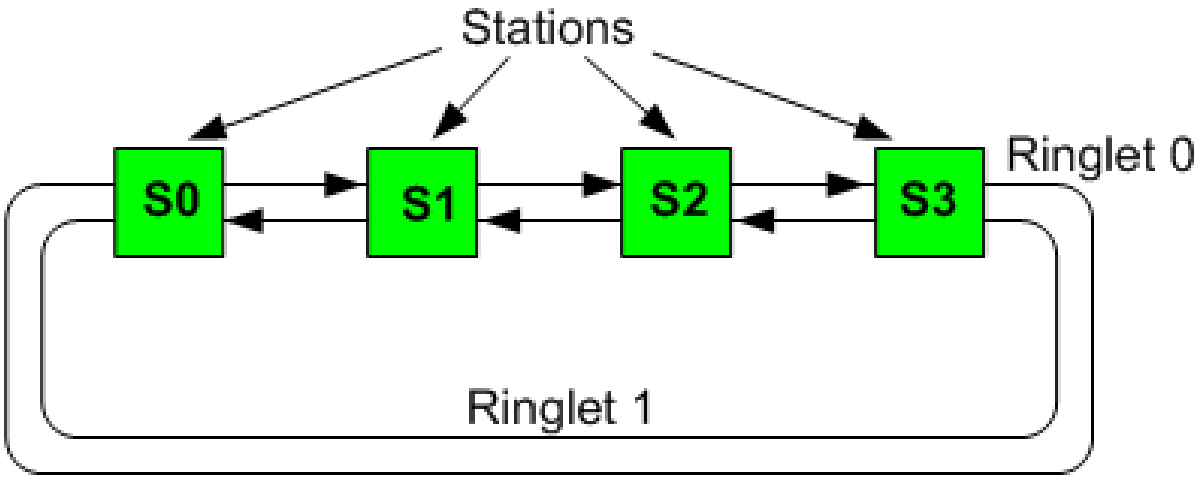
- SRP Discovery
- SRP ARP
- SRP IPS (Intelligent Protection Switching)

RPR Resilient Packet Ring

Ixia's optional Resilient Packet Ring (RPR) implementation is available on the OC-48c and OC-192c POS load modules. RPR is a proposed industry standard for MAC Control on Metropolitan Area Networks (MANs), defined by IEEE P802.17. This feature provides a cost-effective method to optimize the transport of bursty traffic, such as IP, over existing ring topologies.

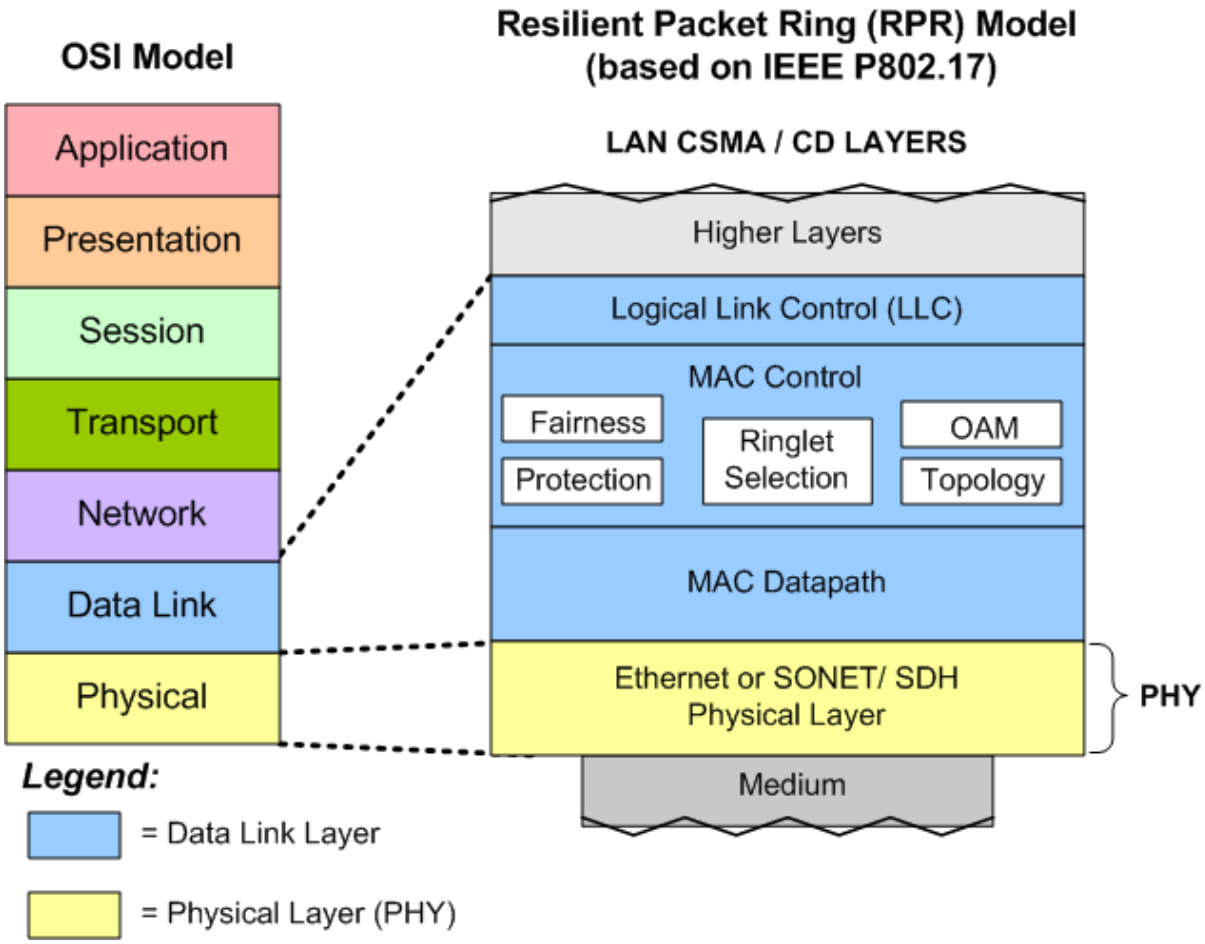
A diagram showing a simplified model of an RPR network is shown in the following figure. It is made up of two, counter-rotating `ringlets,' with nodes called `stations' supporting MAC Clients that exchange data and control information with remote peers on the ring. Up to 255 nodes can be supported on the ring structure.

Figure: RPR Ring Network Diagram



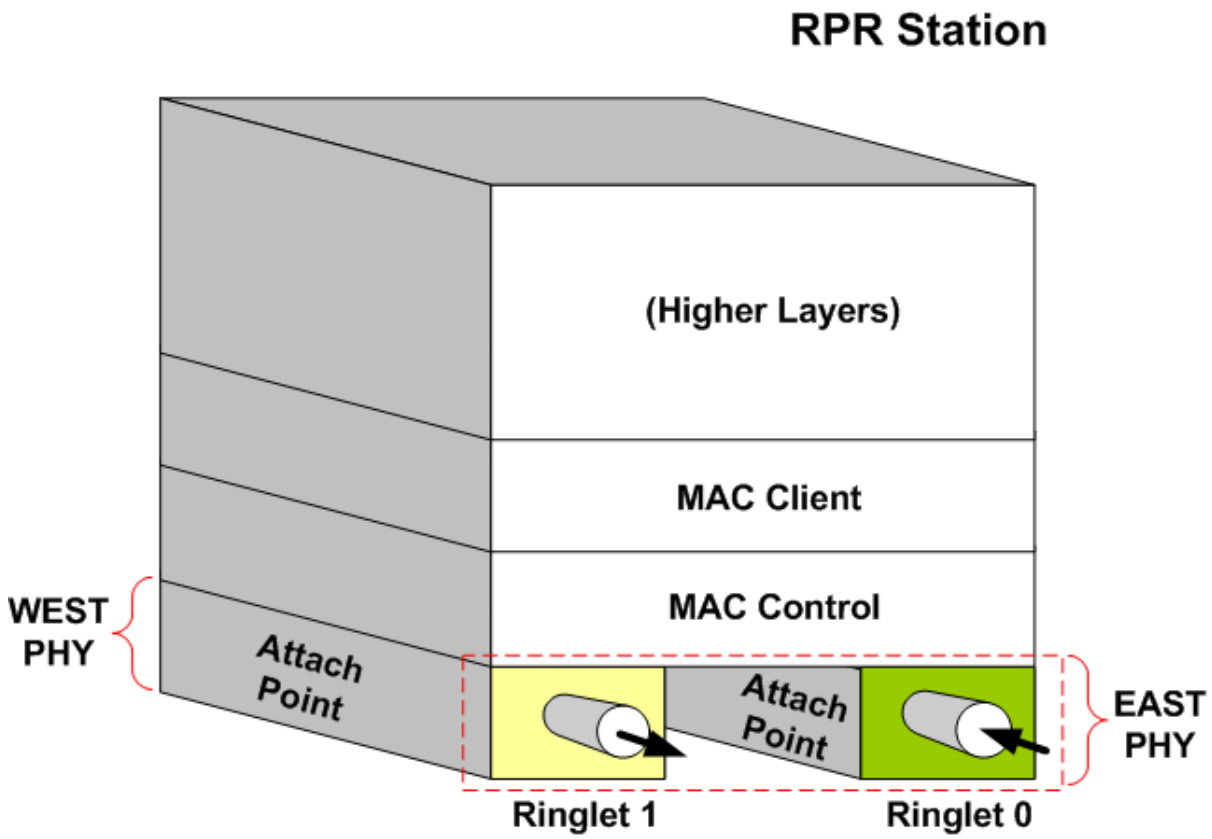
The RPR topology discovery is handled by a MAC sublayer, and a protection function maintains network connectivity in the event of a station or span failure. The structure of the RPR layers, compared to the OSI model, is illustrated in a diagram based on IEEE 802.17, shown in the following figure.

Figure: RPR Layers



A diagram of the layers associated with an RPR Station is shown in the following figure.

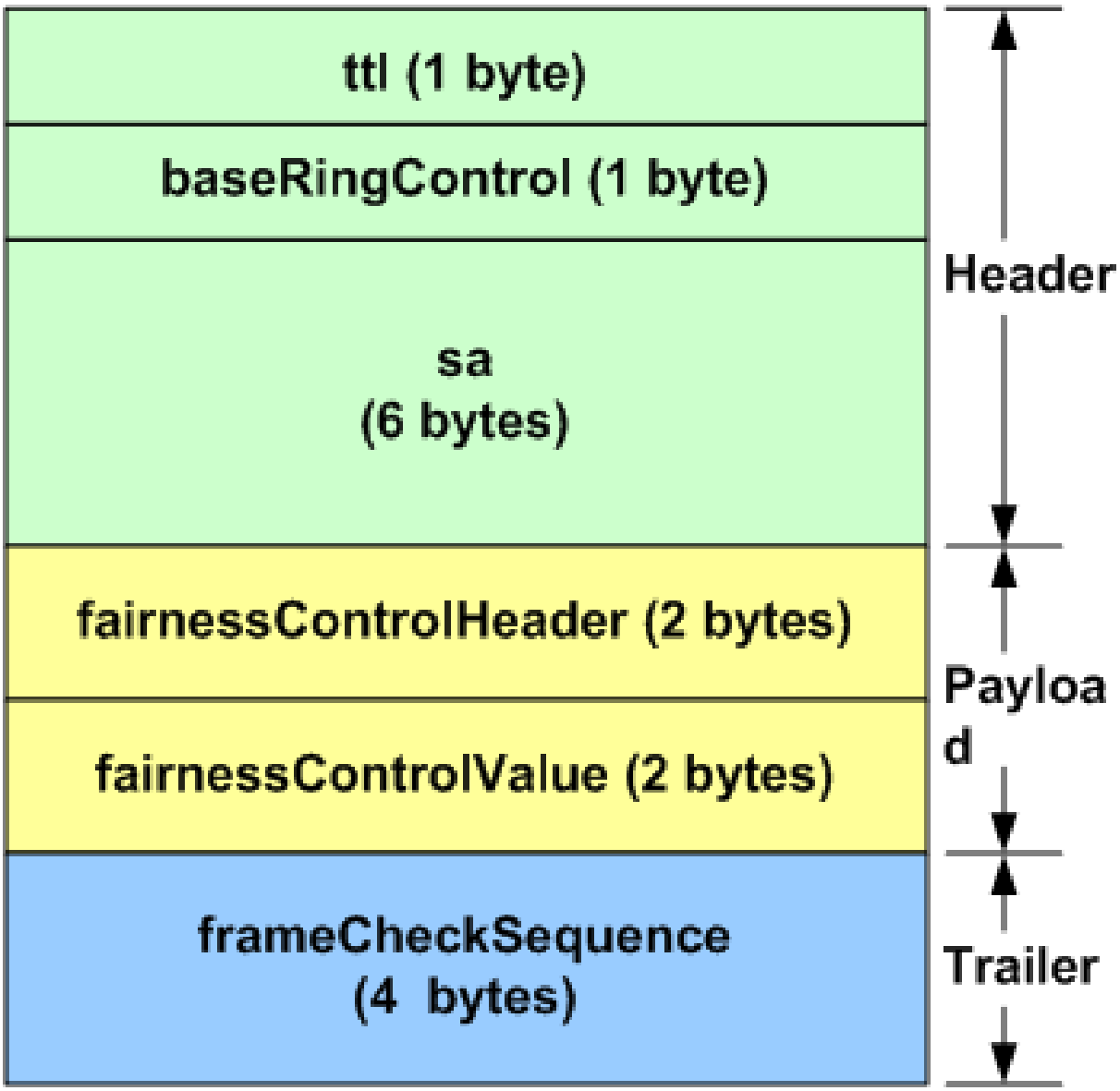
Figure: RPR Layer Diagram



The Ixia implementation allows for the configuration and transmission of the following types of RPR frames:

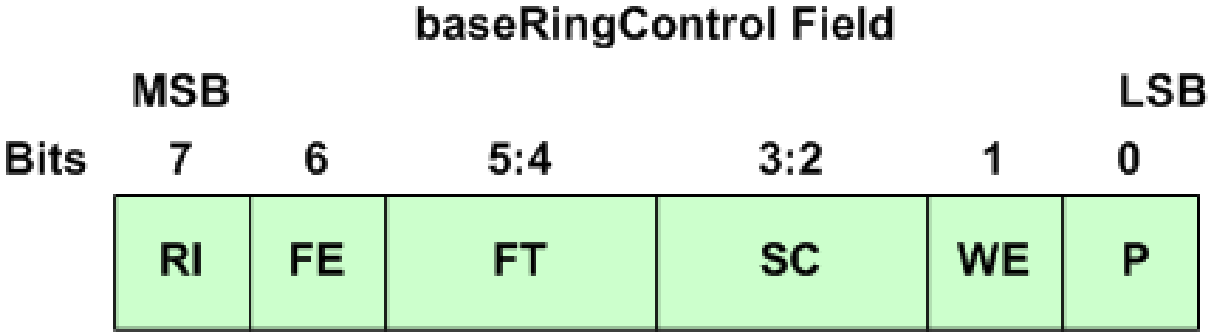
- RPR Fairness Frames: The RPR Fairness Algorithm (FA) is used to manage congestion on the ringlets in an RPR network. Fairness frames are sent periodically to advertise bandwidth usage parameters to other nodes in the network to maintain weighted fair share distributions of bandwidth. The messages are sent in the direction opposite to the data flow, and therefore, on the other ringlet. A diagram of the RPR Fairness Frame, per IEEE 802.17/D2.1, is shown in the following figure.

  Figure: RPR Fairness Frame Format



A diagram of the baseRingControl byte, part of the Ring Control header for all types of RPR frames, is shown in the following figure.

Figure: RPR baseRingControl Byte



- RPR Topology Discovery. Two types of messages are used:

    - RPR Topology Discovery Message: for the discovery of the physical topology.
    - RPR Topology Extended Status Message: for the transmission of additional information from a node concerning bandwidth and other configuration options. This format uses TLV (Type-Length-Value) options, including:
        - Weight
        - Total reserved bandwidth
        - Neighbor address
        - Individual reserved bandwidth
        - Station name
        - Vendor specific data
- RPR Protection Switching Message: used to support automatic, rapid switching of traffic in the presence of a ring failure.
- RPR Operations, Administration and Management (OAM). Three messages are supported:
    - Echo Request and Response messages
    - Flush Frames
    - Vendor specific message

GFP Generic Framing Procedure

GFP provides a generic mechanism to adapt traffic from higher-layer client signals over a transport network. Currently, two modes of client signal adaptation are defined for GFP.

- A PDU-oriented adaptation mode, referred to as Frame-Mapped GFP (GFP-F, for traffic such as IP/PPP or Ethernet MAC).
- A block-code oriented adaptation mode, referred to as Transparent GFP (GFP-T, for traffic such as Fibre Channel or ESCON/SBCON).

In the Frame-Mapped adaptation mode, the Client/GFP adaptation function operates at the data link (or higher) layer of the client signal. Client PDU visibility is required, which is obtained when the client PDUs are received from either the data layer network or a bridge, switch, or router function in a transport network element.

For the Transparent adaptation mode, the Client/GFP adaptation function operates on the coded character stream, rather than on the incoming client PDUs. Processing of the incoming code word space for the client signal is required.

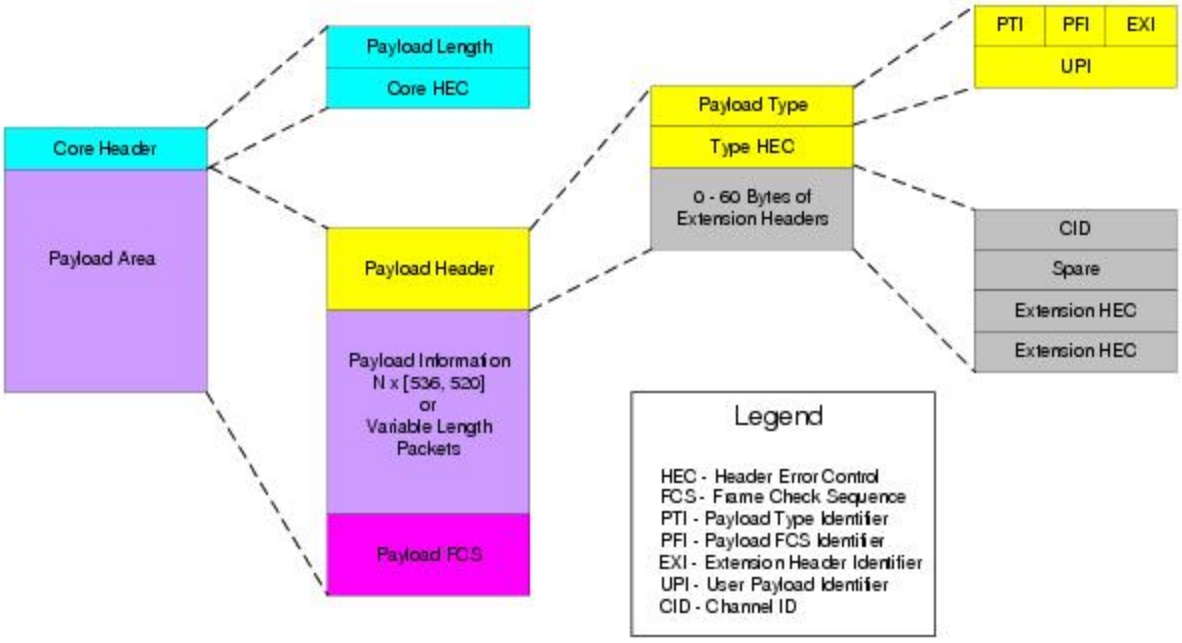
Two kinds of GFP frames are defined: GFP client frames and GFP control frames. GFP also supports a flexible (payload) header extension mechanism to facilitate the adaptation of GFP for use with diverse transport mechanisms.

GFP uses a modified version of the Header Error Check (HEC) algorithm to provide GFP frame delineation. The frame delineation algorithm used in GFP differs from HEC in two basic ways:

- The algorithm uses the PDU Length Indicator field of the GFP Core Header to find the end of the GFP frame.
- HEC field calculation uses a 16-bit polynomial and, consequently, generates a two-octet cHEC field.

A diagram of the format for a GFP frame is shown in the following figure.

Figure: GFP Frame Elements



The sections of the GFP frame are described in the following list:

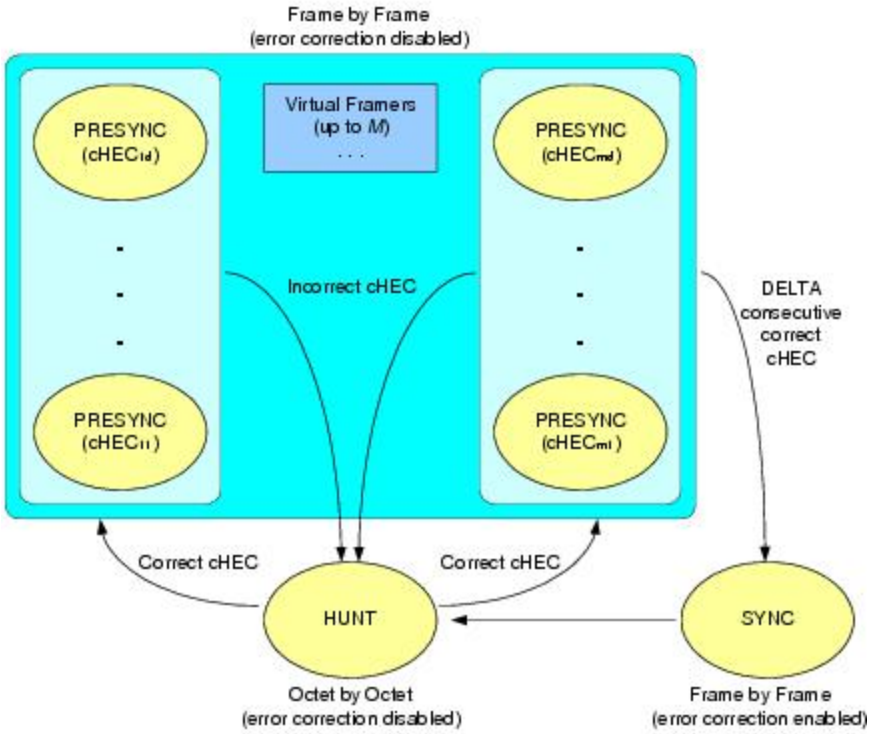
- Payload Length Indicator (PLI): The two-octet PLI field contains a binary number representing the number of octets in the GFP Payload Area. The absolute minimum value of the PLI field in a GFP client frame is 4 octets. PLI values 0-3 are reserved for GFP control frame usage.
- Core Header Error Control (cHEC): The two-octet Core Header Error Control field contains a CRC-16 error control code that protects the integrity of the contents of the Core Header by enabling both single-bit error correction and multi-bit error detection.
- Type Header Error Control (tHEC): The two-octet Type Header Error Control field contains a CRC-16 error control code that protects the integrity of the contents of the Type field by enabling both single-bit error correction and multi-bit error detection.
- Extension Header Error Control (eHEC): The two-octet Extension Header Error Control field contains a CRC-16 error control code that protects the integrity of the contents of the extension headers by enabling both single-bit error correction (optional) and multi-bit error detection.
- Connection Identification (CID): The CID is an 8-bit binary number used to indicate one of 256 communications channels at a GFP termination point.
- Payload: The GFP Payload Area, which consists of all octets in the GFP frame after the GFP Core Header, is used to convey higher layer specific protocol information. This variable length area may include from 4 to 65,535 octets. The GFP Payload Area consists of two common components:
  - A Payload Header and a Payload Information field
  - An optional Payload FCS (pFCS) field

    Practical GFP MTU sizes for the GFP Payload Area are application specific.
- Frame Check Sequence (FCS): The GFP Payload FCS is an optional, four-octet long, frame check sequence. It contains a CRC-32 sequence that protects the contents of the GFP Payload

Information field. A value of 1 in the PFI bit within the Type field identifies the presence of the payload FCS field.

GFP frame delineation is performed based on the correlation between the first two octets of the GFP frame and the embedded two-octet cHEC field. The following figure shows the state diagram for the GFP frame delineation method.

Figure: GFP State Transitions



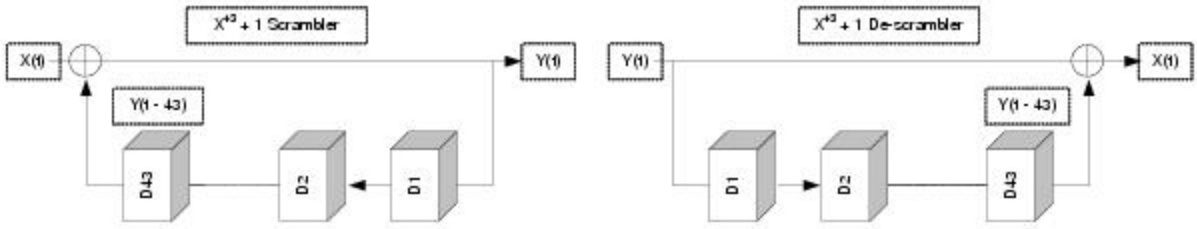
The state diagram works as follows:

1. In the HUNT state, the GFP process performs frame delineation by searching octets for a correctly formatted Core Header over the last received sequence of four octets. Once a correct cHEC match is detected in the candidate Payload Length Indicator (PLI) and cHEC fields, a candidate GFP frame is identified and the receive process enters the PRESYNC state.
2. In the PRESYNC state, the GFP process performs frame delineation by checking frames for a correct cHEC match in the presumed Core Header of the next candidate GFP frame. The PLI field in the Core Header of the preceding GFP frame is used to find the beginning of the next candidate GFP frame. The process repeats until a set number of consecutive correct cHECs are confirmed, at which point the process enters the SYNC state. If an incorrect cHEC is detected, the process returns to the HUNT state.
3. In the SYNC state, the GFP process performs frame delineation by checking for a correct cHEC match on the next candidate GFP frame. The PLI field in the Core Header of the preceding GFP frame is used to find the beginning of the next candidate GFP frame. Frame delineation is lost whenever multiple bit errors are detected in the Core Header by the cHEC. In this case, a GFP Loss of Frame Delineation event is declared, the framing process returns to the HUNT state, and a client Server Signal Failure (SSF) is indicated to the client adaptation process.
4. Idle GFP frames participate in the delineation process and are then discarded.

Robustness against false delineation in the resynchronization process depends on the value of DELTA. A value of DELTA = 1 is suggested. Frame delineation acquisition speed can be improved by the implementation of multiple `virtual framers,' whereby the GFP process remains in the HUNT state and a separate PRESYNC substate is spawned for each candidate GFP frame detected in the incoming octet stream.

Scrambling of the GFP Payload Area is required to provide security against payload information replicating scrambling word (or its inverse) from a frame synchronous scrambler (such as those used in the SDH RS layer or in an OTN OPUk channel). The following figure illustrates the scrambler and descrambler processes.

Figure: GFP Scrambling



All octets in the GFP Payload Area are scrambled using a $x^{43} + 1$ self-synchronous scrambler. Scrambling is done in network bit order.

At the source adaptation process, scrambling is enabled starting at the first transmitted octet after the cHEC field, and is disabled after the last transmitted octet of the GFP frame. When the scrambler or descrambler is disabled, its state is retained. Hence, the scrambler or descrambler state at the beginning of a GFP frame Payload Area is, thus, the last 43 Payload Area bits of the GFP frame transmitted in that channel immediately before the current GFP frame.

The activation of the sink adaptation process descrambler also depends on the present state of the cHEC check algorithm:

- In the HUNT and PRESYNC states, the descrambler is disabled.
- In the SYNC state, the descrambler is enabled only for the octets between the cHEC field and the end of the candidate GFP frame.

CDL Converged Data Link

10GE LAN, 10GE XENPAK, 10GE WAN, and 10GE WAN UNIPHY modules all support the Cisco CDL preamble format.

The Converged Data Link (CDL) specification was developed to provide a standard method of implementing operation, administration, maintenance, and provisioning (OAM&P) in Ethernet packet-based optical networks without using a SONET/SDH layer.

PPP Protocol Negotiation

The Point-to-Point Protocol (PPP) is widely used to establish, configure and monitor peer-to-peer communication links. A PPP session is established in a number of steps, with each step completing before the next one starts. The steps, or layers, are:

1. Physical: a physical layer link is established.
2. Link Control Protocol (LCP): establishes the basic communications parameters for the line, including the Maximum Receive Unit (MRU), type of authentication to be used and type of compression to be used.
3. Link quality determination and authentication. These are optional processes. Quality determination is the responsibility of PPP Link Quality Monitoring (LQM) Protocol. Once initiated, this process may continue throughout the life of the link. Authentication is performed at this stage only. There are multiple protocols which may be employed in this process; the most common of these are PAP and CHAP.
4. Network Control Protocol (NCP): establishes which network protocols (such as IP, OSI, MPLS) are to be carried over the link and the parameters associated with the protocols. The protocols which support this NCP negotiation are called IPCP, OSINLCP, and MPLSCP, respectively.
5. Network traffic and sustaining PPP control. The link has been established and traffic corresponding to previously negotiated network protocols may now flow. Also, PPP control traffic may continue to flow, as may be required by LQM, PPP keepalive operations, and so forth.

All implementations of PPP must support the Link Control Protocol (LCP), which negotiates the fundamental characteristics of the data link and constitutes the first exchange of information over an opening link. Physical link characteristics (media type, transfer rate, and so forth) are not controlled by PPP.

The Ixia PPP implementation supports LCP, IPCP, MPLSCP, and OSINLCP. When PPP is enabled on a given port, LCP and at least one of the NCPs must complete successfully over that port before it is administratively `up' and therefore be ready for general traffic to flow.

Each Ixia POS port implements a subset of the LCP, LQM, and NCP protocols. Each of the protocols is of the same basic format. For any connection, separate negotiations are performed for each direction. Each party sends a *Configure-Request* message to the other, with options and parameters proposing some form of configuration. The receiving party may respond with one of three messages:

- *Configure-Reject*: The receiving party does not recognize or prohibits one or more of the suggested options. It returns the problematic options to the sender.
- *Configure-NAK*: The receiving party understands all of the options, but finds one or more of the associated parameters unacceptable. It returns the problematic options, with alternative parameters, to the sender.
- *Configure-ACK*: The receiving party finds the options and parameters acceptable.

For the *Configure-Reject* and *Configure-NAK* requests, the sending party is expected to reply with an alternative *Configure-Request.*

The Ixia port may be configured to immediately start negotiating after the physical link comes up, or passively wait for the peer to start the negotiation. Ixia ports both sends and responds to PPP keepalive messages called echo requests.

LCP Link Control Protocol Options

The following sections outline the parameters associated with the Link Control Protocol. LCP includes a number of possible command types, which are assigned option numbers in the pertinent RFCs. Note that PPP parameters are typically independently negotiated for each direction on the link.

Numerous RFCs are associated with LCP, but the most important RFCs are RFC 1661 and RFC 1662. The HDLC/PPP header sequence for LCP is FF 03 C0 21.

During the LCP phase of negotiation, the Ixia port makes available the following options:

- Maximum Receive Unit: This LCP parameter (actually the set of Maximum Receive Unit (MRU) and Maximum Transmit Unit (MTU)) determines the maximum allowed size of any frame sent across the link subsequent to LCP completion. To be fully standards-compliant, an implementation must not send a frame of length greater than its MTU + 4 bytes + CRC length. For instance, if the negotiated MTU for a port is 2000 and 32 bit CRC is in use, no frame larger than 2008 bytes should ever be sent out that port. Packets that are larger are expected to be fragmented before transmitting or to be dropped. The Ixia port's MTU is the peer's MRU following LCP negotiation. Strictly speaking, the receiving side can assume that frames received is not greater than the MRU. In practice, however, an implementation should be capable of accepting larger frames. If a peer rejects this option altogether, the negotiated setting defaults to 1,500. Regardless of the negotiated MRU, all implementations must be capable of accepting frames with an information field of at least 1,500 bytes.

  For the transmit direction portion of the negotiation, the peer sends the Ixia port its configuration request. The Ixia port accepts and acknowledges the peer's requested MRU as long as it is less than or equal to the specified user's desired transmit value (but greater than 26). For the receive direction portion of the negotiation, the Ixia port sends a configuration request based on the user's desired value. Generally, the Ixia port accepts what the peer desires (if it acknowledges the request, then the user value is used, or if the peer sends a *Configure-Nak* with another value the Ixia port uses that value as long as it is valid). This approach is used to maximize the probability of successful negotiation.

- Asynchronous Control Character Map: ACCM is only really pertinent to *asynchronous* links. On asynchronous lines, certain characters sent over the wire can have special meaning to one or more receiving entities. For instance, common implementations of the widely used XON/XOFF flow control protocol assign the ASCII DC3 character (0x13) to XOFF. On such a link, an embedded data byte that happens to have the value 0x13 would be misinterpreted by a receiver as an XOFF command, and cause suspension of reception. To avoid this problem, the 0x13 character embedded in the data could be sent through an `escape sequence' which consists of preceding the data character with a dedicated tag character and modifying the data character itself.

  The Asynchronous Control Character Map (ACCM) LCP parameter allows independent designation of each character in the range 0x00 thru 0x1F as a control character. A control character is sent/received with a preceding `control-escape' character (0x7D). When the 0x7D is seen in the received data stream, the 0x7D is dropped and the next character is exclusive-or'd with 0x20 to get the original transmitted character. ACCM negotiation consists of exchanging masks between peers to reach an agreement as to which characters are treated as special control characters on transmission and reception. For example, sending a mask of 0xFFFFFFFF means all characters in the range 0x00 thru 0x1F are sent with escape sequences; a mask of 0 means no special handling, so all characters are arbitrary data.

  Packet over SONET is an octet-synchronous medium. If the link is direct between POS peers, neither side should be generating control-escapes. (Exceptions to this are bytes 0x7D and 0x7E: the former is the special control escape character itself; the latter is the start/end frame marker. Escaping of these two characters is generally handled directly by physical layer hardware). On links in which there is some kind of intermediate asynchronous media, it is

required that whatever device performs the asynchronous to synchronous conversion must also take care of any special character handling, isolating this from any POS port. See RFC 1662, sections 4.1 and 6.

If ACCM negotiation is enabled, the Ixia port advertises an ACCM mask of 0 to its peer in its LCP configuration request. The Ixia port accept whatever the peer puts forth, but does not act on the results. Regardless of the final negotiated settings for receive and transmit ACCM, the Ixia port does not send escape control sequences nor does it expect to receive them. This is the nature of a synchronous PPP medium, such as POS.

- Magic Number: A magic number is a 32-bit value, ideally numerically random, which is placed in certain PPP control packets. Magic numbers aid in detection of looped links. If a received PPP packet that includes a magic number matches a previously transmitted packet, including magic number, the link is probably looped.

  IxExplorer and the Tcl APIs allow global enable/disable of magic number negotiation. If the `Use Magic Number' feature is enabled, the Ixia port does not request magic number of its peer and rejects the option if the peer requests it. If the check box is selected, the port attempts to negotiate magic number. The result of the bi-directional negotiation process is displayed in the fields for transmit and receive: an indication of whether magic number is enabled is written in the field for the corresponding direction.

NCP Network Control Protocols

- IPCP: Internet Protocol Control Protocol Options for IPV4. IPCP includes three command types, which are assigned option numbers in the pertinent RFCs. Note that PPP parameters are typically independently negotiated for each direction on the link.

  The sender of this *Configure-Request* may either include its own IP address, to provide this information to its remote peer, or may send all 0.0.0.0 as an IP address, which requests that the remote peer assign an IP address for the local node. The receiver may refuse the requested IP address and attempt to specify one for the peer to use by using a *Configure-NAK* response to the request with a specification of a different address.

  The Ixia implementation provides minimal configuration of this parameter. You must specify the local IP address of the unit and the peer must provide its own IP address. The Ixia port accepts any IP address the peer wishes to use as long as it is a valid address (for example, not all 0's). The Ixia port expects the peer to accept its address. If, however, the peer specifies a different address for use, the port acknowledges that address but not actually notify you that this has happened. The Ixia port accepts a situation in which local and peer addresses are the same following negotiation.

- IPv6CP: Internet Protocol Control Protocol Options for IPv6. IPv6CP includes three command types, which are assigned option numbers in the pertinent RFCs. Note that PPP parameters are typically independently negotiated for each direction on the link.

  A PPP peer may determine its IPv6 interface address by one or three methods:

  - Generate its own address.
  - Suggest its own address to its peer, but allow the peer to override that value.
  - Require that the peer designate an address.

In any of these cases, the *Configure-Request* must contain a tentative interface-identifier to send to the peer that is both unique to the link and if possible consistently reproducible.

The Ixia PPP implementation of IPv6CP is such that the negotiation mode of the local endpoint may be configured in one of three modes:

- Local may: the local peer may suggest an Interface Identifier (IID), but most allow a *Configure-NAK* with an alternate address to override its setting.
- Local must: the local peer must set the IID, which the peer must accept.
- Peer must: the peer must supply the IID. This is accomplished by sending an all zero tentative IID.

The peer endpoint may be configured in one of three modes:

- Peer may: the remote peer may suggest an IID, but most allow a *Configure-NAK* with an alternate address to override its setting.
- Peer must: the remote peer must set the IID, which the local peer accepts.
- Local must: the local peer must supply the IID.

One IID can be sent in each Configuration-Request. A zero value may be sent, in which case, the peer may send an IID in its response. Either node on the link can provide the valid, non-zero IID values for itself and its peer.

The tentative, or assigned IID in the *Peer - Local Must* case, may be assigned from one of four sources:

- Last Negotiated: the last negotiated interface-identifier.
- MAC Based: an address derived from the port's MAC address.
- IPv6: an IPv6 format address.
- Random: a randomly generated value.

See IPv6 Interface Identifiers as follows for more information.

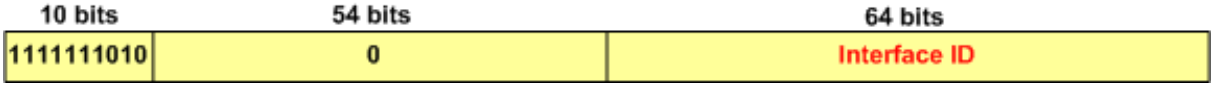
- OSI Network Layer Control Protocol (OSINLCP): A single option is provided for this NCP protocol. If a non-zero value for alignment has been negotiated, subsequent ISO traffic (for example, IS-IS) arrives with or be sent with 1 to 3 zero pads inserted after the protocol header as per RFC 1377.
- MPLS Network Control Protocol (MPLSCP): No options are currently available for this protocol setup.

IPv6 Interface Identifiers (IIDs)

IIDs comprise part of an IPv6 address, as shown in the following figure for a link-local IPv6 address.

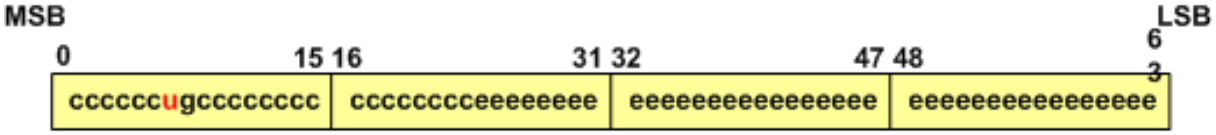
NOTE The IPv6 Interface Identifier is equivalent to EUI-64 Id in the Protocol Interfaces window.

Figure: IPv6 Address Format Link-Local Address



The IPv6 Interface Identifier is derived from the 48-bit IEEE 802 MAC address or the 64-bit IEEE EUI-64 identifier. The EUI-64 is the extended unique identifier formed from the 24-bit company ID assigned by the IEEE Registration Authority, plus a 40-bit company-assigned extension identifier, as shown in the following figure.

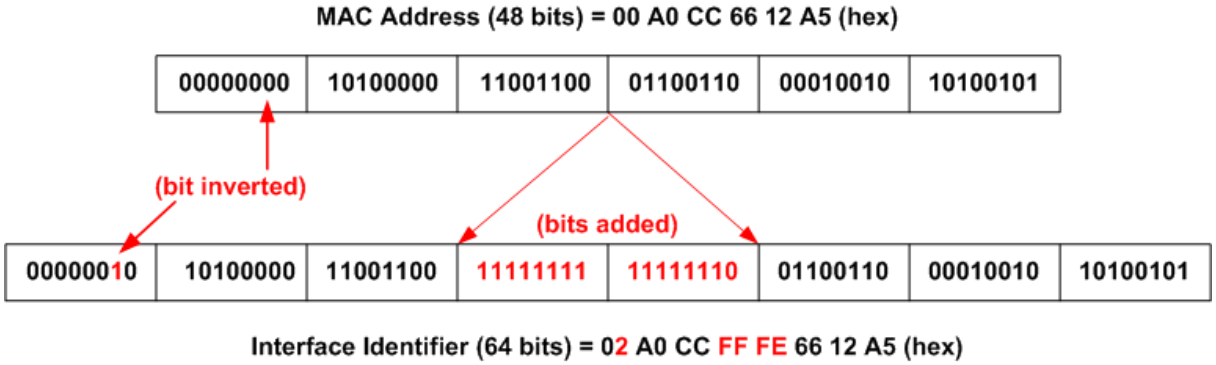
Figure: IEEE EUI-64 Format



Legend:
c = assigned company ID bits
u = universal/local bit
g = group/individual bit
e = company-assigned extension identifier bit

To create the Modified EUI-64 Interface Identifier, the value of the universal/local bit is inverted from `0' (which indicates global scope in the company ID) to `1' (which indicates global scope in the IPv6 Identifier). For Ethernet, the 48-bit MAC address may be encapsulated to form the IPv6 Identifier. In this case, two bytes `FF FE' are inserted between the company ID and the vendor-supplied ID, and the universal/local bit is set to `1' to indicate global scope. An example of an Interface Identifier based on a MAC address is shown in the following figure.

Example Encapsulated MAC in IPv6 Interface Identifier



Retry Parameters

During the process of negotiation, the port uses three Retry parameters. RFC 1661 specifies the interpretation for all of the parameters.

HDLC

Both standard and Cisco proprietary forms of HDLC (High-level Data Link Control) are supported.

Frame Relay

Packets may be wrapped in frame relay headers. The DLCI (Data Link Connection Identifier) may be set to a fixed value or varied algorithmically.

DSCP Differentiated Services Code Point

Differentiated Services (DiffServ) is a model in which traffic is treated by intermediate systems with relative priorities based on the type of services (ToS) field. Defined in RFC 2474 and RFC 2475, the DiffServ standard supersedes the original specification for defining packet priority described in RFC 791. DiffServ increases the number of definable priority levels by reallocating bits of an IP packet for priority marking.

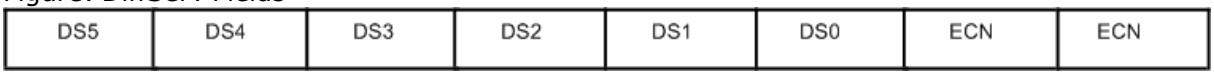
The DiffServ architecture defines the DiffServ (DS) field, which supersedes the ToS field in IPv4 to make Per-Hop Behavior (PHB) decisions about packet classification and traffic conditioning functions, such as metering, marking, shaping, and policing.

Based on DSCP or IP precedence, traffic can be put into a particular service class. Packets within a service class are treated the same way.

The six most significant bits of the DiffServ field are called the Differential Services Code Point (DSCP).

The DiffServ fields in the packet are organized as shown in the following figure. These fields replace the TOS fields in the IP packet header.

Figure: DiffServ Fields



The DiffServ standard utilizes the same precedence bits (the most significant bits are DS5, DS4, and DS3) as TOS for priority setting, but further clarifies the definitions, offering finer granularity through the use of the next three bits in the DSCP. DiffServ reorganizes and renames the precedence levels (still defined by the three most significant bits of the DSCP) into these categories (the levels are explained in greater detail in this document). The following table shows the eight categories.

DSCP Categories

Precedence Level	Description
7	Stays the same (link layer and routing protocol keep alive)
6	Stays the same (used for IP routing protocols)
5	Express Forwarding (EF)
4	Class 4
3	Class 3
2	Class 2
1	Class 1
0	Best Effort

With this system, a device prioritizes traffic by class first. Then it differentiates and prioritizes same-class traffic, taking the drop probability into account.

The DiffServ standard does not specify a precise definition of `low,' `medium,' and `high' drop probability. Not all devices recognize the DiffServ (DS2 and DS1) settings; and even when these settings are recognized, they do not necessarily trigger the same PHB forwarding action at each network node. Each node implements its own response based on how it is configured.

Assured Forwarding (AF) PHB group is a means for a provider DS domain to offer different levels of forwarding assurances for IP packets received from a customer DS domain. Four AF classes are defined, where each AF class is in each DS node allocated a certain amount of forwarding resources (buffer space and bandwidth).

Classes 1 to 4 are referred to as AF classes. The following table illustrates the DSCP coding for specifying the AF class with the probability. Bits DS5, DS4, and DS3 define the class, while bits DS2 and DS1 specify the drop probability. Bit DS0 is always zero.

Drop Precedence for Classes

Drop	Class 1	Class 2	Class 3	Class 4
Low	001010 AF11 DSCP 10	010010 AF21 DSCP 18	011010 AF31 DSCP 26	100010 AF41 DSCP 34
Medium	001100 AF12 DSCP 12	010100 AF 22 DSCP 20	011100 AF32 DSCP 28	100100 AF42 DSCP 36
High	001110 AF13 DSCP 14	010110 AF23 DSCP 22	011110 AF33 DSCP 30	100110 AF43 DSCP 38

ATM

The ATM load module enables high performance testing of routers and broadband aggregation devices such as DSLAMs and PPPoE termination systems.

The ATM module is provided with various feature combinations:

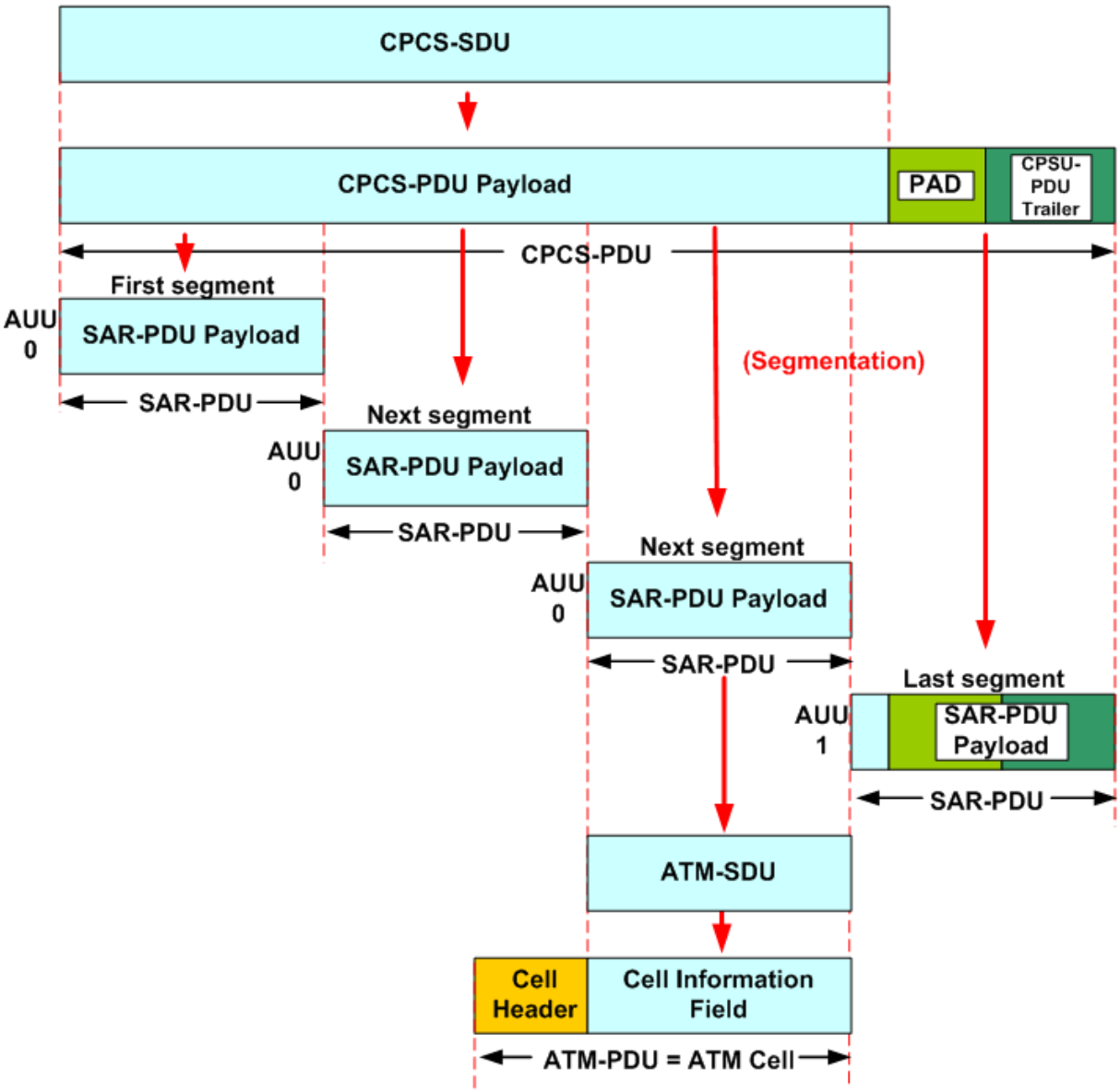
- Interfaces: pluggable PHYs:
  - 1310nm multimode optics with dual -SC connectors
  - SFP socket
- Speeds: OC3 and OC12
- Encapsulations:
  - LLC/SNAP
  - LLC/NLPID
  - LLC Bridged Ethernet
  - LLC Bridged Ethernet without FCS
  - VC Mux Routed

    - VC Mux Bridged Ethernet
    - VC Mux Bridged Ethernet without FCS
- Multiple independent data streams

ATM is a point-to-point, connection-oriented protocol that carries traffic over `virtual connections/circuits' (VCs), in contrast to Ethernet connectionless LAN traffic. ATM traffic is segmented into 53-byte cells (with a 48-byte payload), and allows traffic from different Virtual Circuits to be interleaved (multiplexed). Ixia's ATM module allows up to 4096 transmit streams per port, shared across up to 15 interleaved VCs.

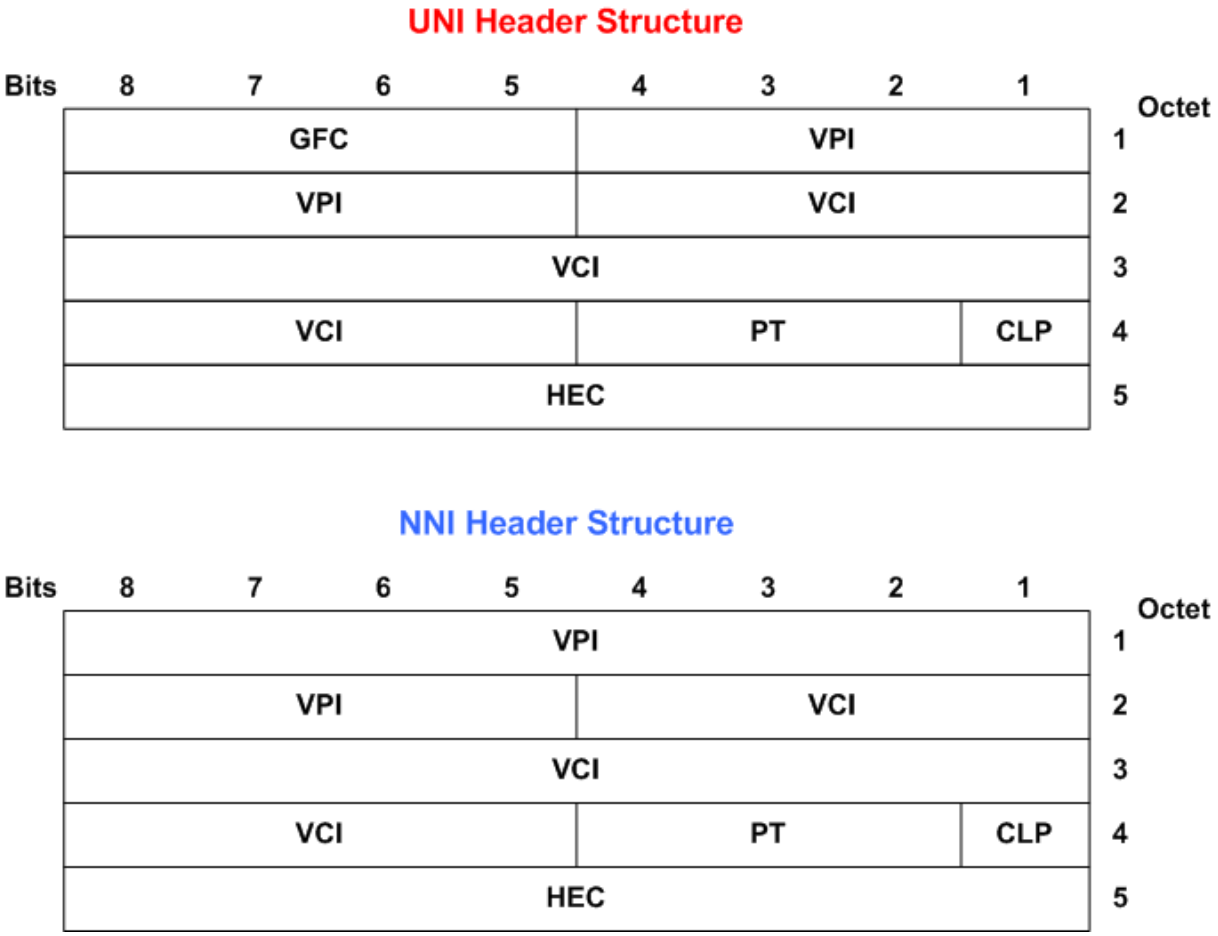
To allow the use of a larger, more convenient payload size, such as that for Ethernet frames, ATM Adaptation Layer 5 (AAL5) was developed. It is defined in ITU-T Recommendation I.363.5, and applies to the Broadband Integrated Services Digital Network (B-ISDN). It maps the ATM layer to higher layers. The Common Part Convergence Sublayer-Service Data Unit (CPSU-SDU) described in this document can be considered an IP or Ethernet packet. The entire CPSU-PDU (CPCS-SDU plus PAD and trailer) is segmented into sections which are sent as the payload of ATM cells, as shown in the following figure, based on ITU-T I.363.5.

Figure: Segmentation into ATM Cells



The Interface Type can be set to UNI (User-to-Network Interface) format or NNI (Network-to-Node Interface aka Network-to-Network Interface) format. The 5-byte ATM cell header is different for each of the two interfaces, as shown in the following figure.

Figure: ATM Cell Header for UNI and NNI

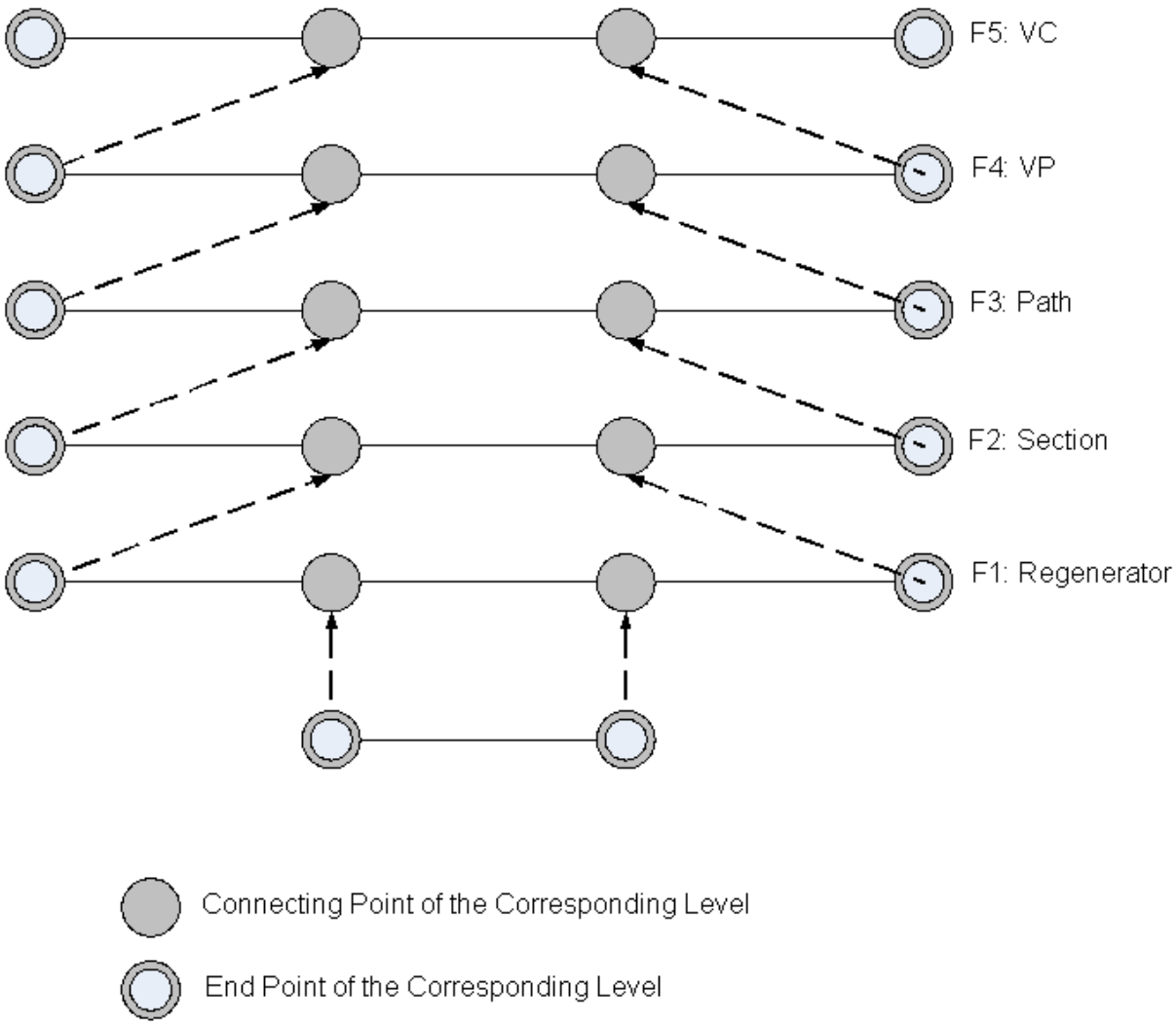


ATM OAM Cells

OAM cells are used for operation, administration, and maintenance of ATM networks. They operate on ATM's physical layer and are not recognized by higher layers. Operation, Administration, and Maintenance (OAM) performs standard loopback (end-to-end or segment) and fault detection and notification Alarm Indication Signal (AIS) and Remote Defect Identification (RDI) for each connection. It also maintains a group of timers for the OAM functions. When there is an OAM state change such as loopback failure, OAM software notifies the connection management software.

The ITU-T considers an ATM network to consist of five flow levels. These levels are illustrated in the following figure.

Figure: Maintenance Levels



The lower three flow levels are specific to the nature of the physical connection. The ITU-T recommendation briefly describes the relationship between the physical layer OAM capabilities and the ATM layer OAM.

From an ATM viewpoint, the most important flows are known as the F4 and F5 flows. The F4 flow is at the virtual path (VP) level. The F5 flow is at the virtual channel (VC) level. When OAM is enabled on an F4 or F5 flow, special OAM cells are inserted into the user traffic.

Four types of OAM cells are defined to support the management of VP/VC connections:

- Fault Management OAM cells. These OAM cells are used to indicate failure conditions. They can be used to indicate a discontinuity in VP/VC connection or may be used to perform checks on connections to isolate problems.
- Performance Management OAM cells. These cells are used to monitor performance (QoS) parameters such as cell block ratio, cell loss ratio and incorrectly inserted cells on VP/VC connections.

- Activation-deactivation OAM cells. These OAM cells are used to activate and deactivate the generation and processing of OAM cells, specifically continuity check (CC) and performance management (PM) cells.
- System management OAM cells. These OAM cells can be used to maintain and control various functions between end-user equipment.Their content is not specified by I.610, and they are limited to end-to-end flows.

The general format of an OAM cell is shown in the following figure.

OAM Cell Format

The header indicates which VCC or VPC an OAM cell belongs to. The cell payload is divided into five fields. The OAM-type and Function-type fields are used to distinguish the type of OAM cell. The Function Specific field contains information pertinent to that cell type. A 10 bit Cyclic Redundancy Check (CRC) is at the end of all OAM cells. This error detection code is used to ensure that management systems do not make erroneous decisions based on corrupted OAM cell information.

Ixia ATM modules allows to configure Fault Management and Activation/Deactivation OAM Cells.

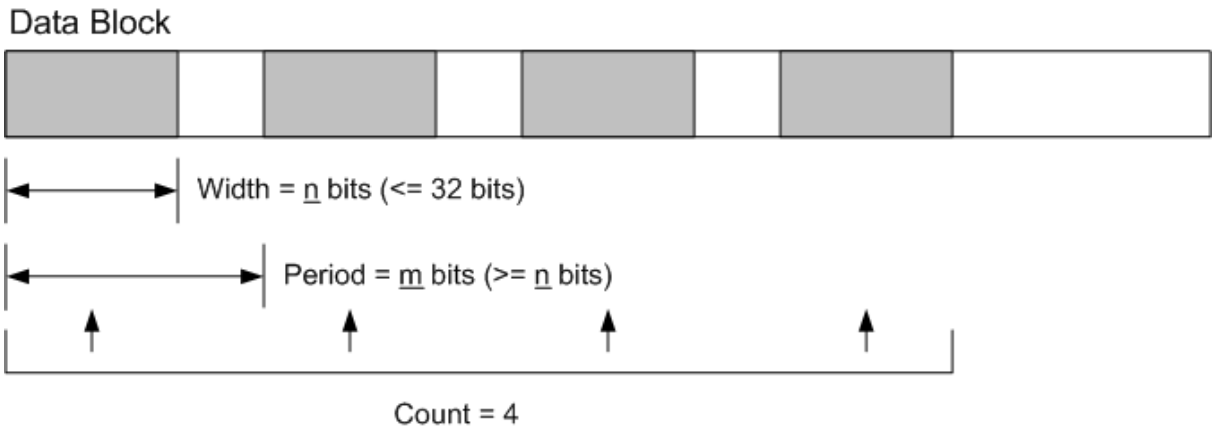
BERT

Bit Error Rate Test (BERT) load modules are packaged as both an option to OC48, POS, 10GE, CFP8 400GE and QSFP-DD 400GE load modules and as BERT-only load modules. As opposed to all other types of testing performed by Ixia hardware and software, BERT tests operate at the physical layer, also referred to as OSI Layer 1. POS frames are constructed using specific pseudo-random patterns, with or without inserted errors. The receive circuitry locks on to the received pattern and checks for errors in those patterns.

Both unframed and framed BERT testing is available. Framed testing can be performed in both concatenated and channelized modes with some load modules.

The patterns inserted within the POS frames are based on the ITU-T O.151 specification. They consist of repeatable, pseudo-random data patterns of different bit-lengths which are designed to test error and jitter conditions. Other constant and user-defined patterns may also be applied. Furthermore, you may control the addition of deliberate errors to the data pattern. The inserted errors are limited to 32-bits in length and may be interspersed with non-errored patterns and repeated for a count. This is illustrated in the following figure. In the figure, an error pattern of *n* bits occurs every *m* bits for a count of 4. This error is inserted at the beginning of each POS data block within a frame.

Figure: BERT Inserted Error Pattern

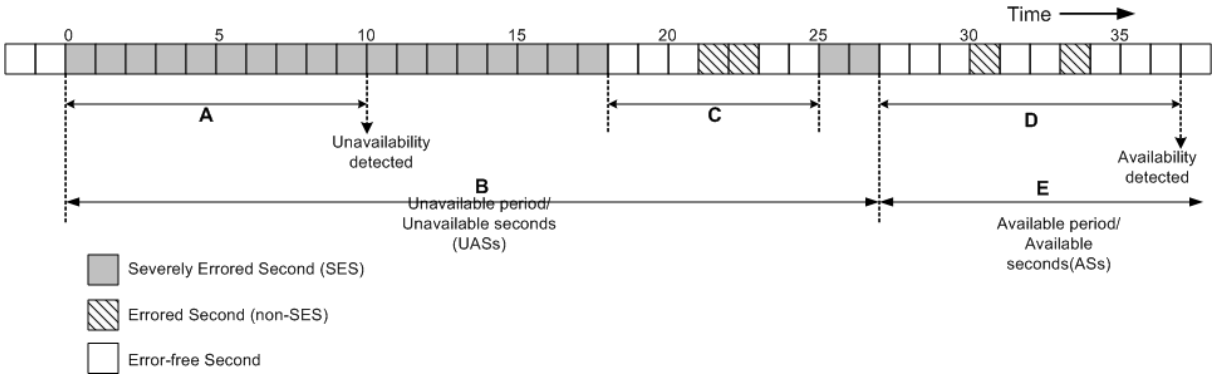


Errors in received BERT traffic are visible through the measured statistics, which are based on readings at one-second intervals. The statistics related to BERT are described in the *Available Statistics* appendix associated with the *Ixia Hardware Guide* and some other manuals.

Available/Unavailable Seconds

Reception of POS signals can be divided into two types of periods, depending on the current state `Available' or `Unavailable,' as shown in the following figure. The seconds occurring during an unavailable period are termed Unavailable Seconds (UAS); those occurring during an available period are termed Available Seconds (AS).

Figure: BERT Unavailable/Available Periods



These periods are defined by the error condition of the data stream. When 10 consecutive SESs (A in the figure) are received, the receiving interface triggers an Unavailable Period. The period remains in the Unavailable state (B in the figure), until a string of 10 consecutive non-SESs is received (D in the figure), and the beginning of the Available state is triggered. The string of consecutive non-SESs in C in the figure was less than 10 seconds, which was insufficient to trigger a change to the Available state.

Port Transmit Capabilities

The Ixia module ports format data to be transmitted in a hierarchy of structures:

- Streams and Flows-A set of related packet bursts
    - Bursts and the Inter-Burst Gap (IBG)-A repetition of packets
        - Packets and the Inter-Packet Gap (IPG)-Individual packets/frames

Timing of transmitted data is performed by the use of inter-stream, -burst, and -packet gaps. Ethernet modules use all three types of gaps, programmed to the resolution of their internal clocks. POS modules gaps are implemented by use of empty frames and the resolution of the gap is limited to a multiple of such frames. ATM modules do not use inter-stream or inter-packet gaps, and instead control the transmission rate through empty frames. The three types of gaps are discussed in:

- Streams and the Inter-Stream Gap (ISG)
- Bursts and the Inter-Burst Gap (IBG)
- Packets and the Inter-Packet Gap (IPG)

The percentage of line rate usage for ports is determined using the following formula:

```
(packet size + 12 byte IPG + requested preamble)/ (packet size + requested IPG +
requested preamble) * 100
```

Streams and Flows

The Ixia system uses sophisticated models for the programming of data to be transmitted. There are two general modes of scheduling data packets for transmission:

- Sequential: The first configured stream in a set of streams is transmitted completely before the next one is sent, and so on, until all of the configured streams have been transmitted. Two types are available:
    - Packet Streams
    - Packet Flows (available on certain modules)
- Interleaved: The individual packets in the streams are multiplexed into a single stream, such that the total packet rate is the sum of the packet rates for each of the streams. One type is available:
    - Advanced Streams (Advanced Stream Scheduler feature)

ATM modules support up to 15 independent stream queues, each of which may contain multiple streams. Up to 4096 total streams may be defined. See Stream Queues.

Packet Streams

This sequential transmission model is supported by the Ixia load modules, where dedicated hardware can be used to generate up to 255 *Packet Streams* `on-the-fly,' with each stream consisting of up to 16 million bursts of up to 16 million packets each. Transmission of the entire set of packet streams may be repeated continuously for an indefinite period, or repeated only for a user-specified count. The variability of the data within the packets is necessarily generated algorithmically by the hardware transmit engine.

NOTE Streams consisting of only one packet are not transmited at wire speed. Also, streams set to random frame size generation does not have accurate IP checksum information. See the *IxExplorer Users Guide*, Chapter 4, *Stream and Flow Control*, for more information on creating streams.

Packet Flows

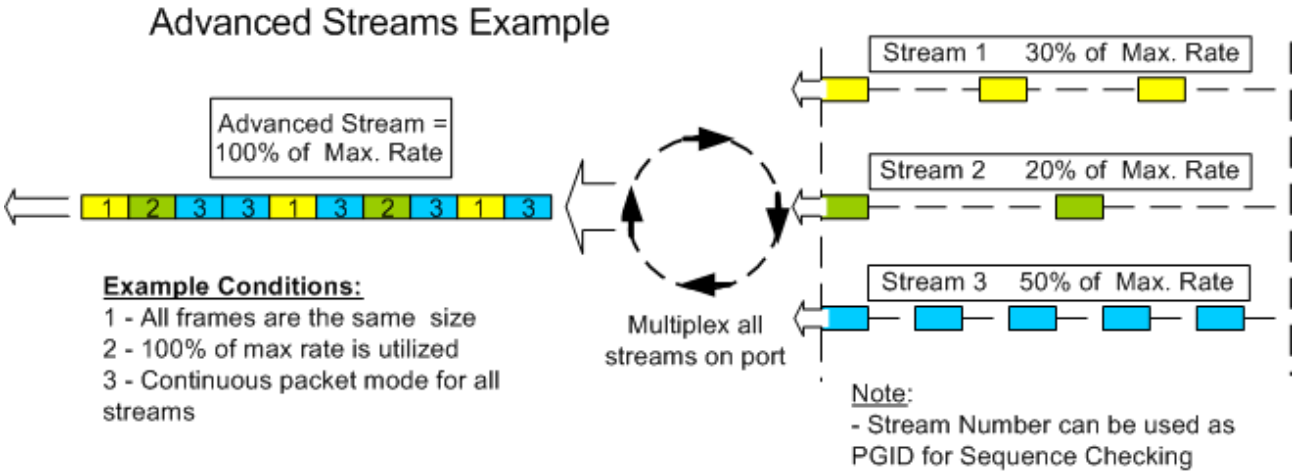
A second sequential data transmission model is supported by software for any Ixia port which supports PacketFlows. An individual packet flow can consist of from 1 to 15,872 packets. For packet flows consisting of only one unique packet each, a maximum of 15,872 individual flows can be transmitted. Because the packets in each of the packet flows is created by the software, including User Defined Fields (UDF) and checksums, and then stored in memory in advance of data transmission, there can be more unique types of packets than is possible with streams. Continuous transmission cannot be selected for flows, but by using a return loop, the flows can be retransmitted for a user-defined count.

Packet streams, which can contain larger amounts of data, are based on only one packet configuration per stream. In contrast, many packet flows can be configured for a single data transmission, where each flow consists of packets with a configuration unique to that flow. Some load modules permit saving/loading of packet flows.

Advanced Streams

A third type of stream configuration is called *Advanced Streams,* which involves interleaving of all defined streams for a port into a single, multiplexed stream. Each stream is assigned a percentage of the maximum rate. The frames of the streams are multiplexed so that each stream's long-term percentage of the total transmitted data rate is as assigned. When the sum of all of the streams is less than 100% of the data rate, idle bytes are automatically inserted into the multiplexed stream, as appropriate.

Example of Advanced Stream Generation



Stream Queues

Stream queues allow standard packet streams to be grouped together. Up to 15 stream queues may be defined, each containing any number of streams so long as the total number of streams in all queues for a port does not exceed 4,096. Each queue is assigned a percentage of the total and traffic is mixed as in advanced streams. Each queue may represent any number of VPI/VCI pairs; the VPI/VCI pairs may also be generated algorithmically.

Basic Stream Operation

When multiple transmit modes are available, the *transmit mode* for each port must be set by you to indicate whether it uses streams, flows, or advanced stream scheduling. The programming of sequential streams or flows is according to the same programming model, with a few exceptions related to continuous bursts of packets. Since the model is identical in both cases, we refer to both streams and flows as `streams' while discussing programming.

There are three basic types of sequential streams:

- Continuous Packet: A continuous stream of packets. The packets are not necessarily identical; their contents may vary significantly. (Not available for packet flows.)
- Continuous Burst: A set of counted packets within a burst; the burst is repeated continuously. (Not available for packet flows.)
- Fixed Count Burst: A fixed number of bursts of packets generated in a stream. This stream has a specified number of packets per burst and a specified number of bursts per stream.

Each non-continuous stream is related to the next stream by one of four modes:

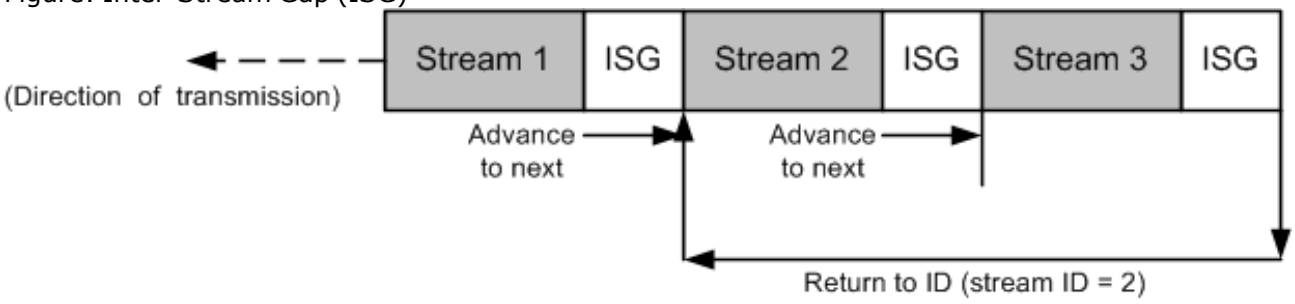
- Stop after this stream: Data transmission stops after the completion of the current stream. (For example, after transmission of a stream consisting of 10 bursts of 100 packets each.)
- Advance to Next: Data transmission continues on to the next stream after the completion of the current stream.
- Return to ID: After the completion of the current stream, a previous stream (designated by its Stream ID) is retransmitted once, and then transmission stops.
- Return to ID for Count: After the completion of the current stream, a previous stream (designated by its Stream ID) is retransmitted for the user-specified number of times (count), and then transmission stops.

If a Continuous Packet or Continuous Burst stream is used, it becomes the last stream to be applied and data transmission continues until a Stop Transmit operation is performed.

Streams and the Inter-Stream Gap (ISG)

A programmable Inter-Stream Gap (ISG) can be applied after each stream, as shown in the following figure.

Figure: Inter-Stream Gap (ISG)



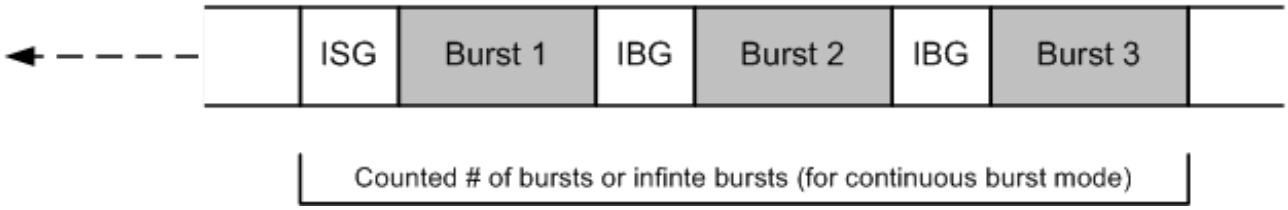
The size and resolution of the Inter-Stream Gaps depends on the particular Ixia module in use. For all modules except 10 Gigabit Ethernet modules, the stream uses the parameters set in the following stream. In 10 Gigabit Ethernet modules, it uses the parameters set in the preceding stream. There

are no ISGs before Advanced Scheduler Streams. For non-Ethernet modules, the ISG is implemented by use of empty frames and the resolution of the ISG is limited to a multiple of such frames.

Bursts and the Inter-Burst Gap (IBG)

Bursts are sets of a specified number of packets, separated by programmed gaps between the sets. For Ethernet modules, Inter-Burst Gaps (IBG) are inserted between the sets. For POS modules, bursts of packets are separated by Burst Gaps. ATM modules do not insert IBGs. The size and resolution of these gaps depends on the type of Ixia load module in use. The placement of Inter-Burst Gaps is shown in the following figure.

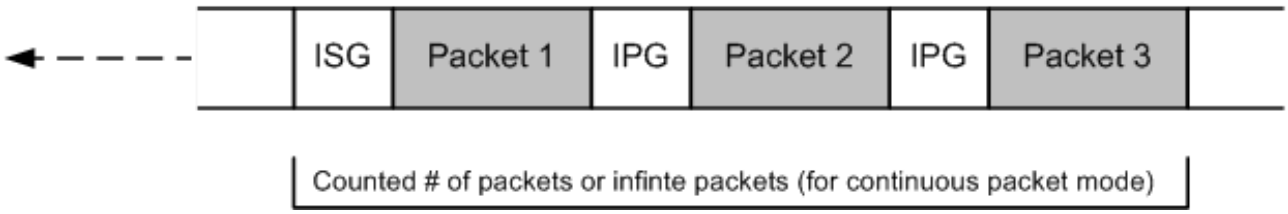
Figure: Inter-Burst Gap (IBG)/Burst Gap



Packets and the Inter-Packet Gap (IPG)

Streams may contain a counted number of frames, or a continuous set of frames when Continuous Packet mode is used. Frames are separated by programmable Inter-Packet Gaps (IPGs), sometimes referred to as Inter-Frame Gaps (IFGs). The size and resolution of the Inter-Packet Gaps depends on the particular Ixia module in use. For non-Ethernet modules, the ISG is implemented by use of empty frames and the resolution of the IPG is limited to a multiple of such frames. ATM modules do not insert IBGs.The placement of Inter-Packet Gaps is shown in the following figure.

Figure: Inter-Packet Gap (IPG)



Frame Data

The contents of every frame and packet are programmable in terms of structure and data content. The programmable fields are:

- Preamble or Header contents
  - Ethernet modules: Preamble Size: The size and resolution depends on the particular Ixia load module used.
  - POS modules: Minimum Flag and Header contents: The minimum number of flag fields to precede the packet within the POS frame and the type of encapsulation/signalling.
  - ATM modules: Header contents.
- Frame size: The size and resolution depends on the particular Ixia load module used.

- Destination and Source MAC Addresses (Ethernet only): Allows the MAC addresses to be set to constants, vary randomly, or increment/decrement using a mask.
- Data generators: Five different data generators are available. These generators are listed as follows, in order of increasing priority (from top to bottom). The values from generators located lower in this list override data from those higher in the list.
  - Protocol-related data: Formatted to correspond to particular data link, transport, and protocol conventions.
    - Data link layer controls for Ethernet allow for Ethernet II/SNAP, 802.3 Raw and 802.3 IPX formatting, with support for VLANs, MPLS, and Cisco-proprietary ISL. VLANs are described in Virtual LANs.
    - Protocol-specific data for formatting IPv4, IPv6, and IPX packets (such as Source and Destination IP addresses), as well as Layer 4 transport protocol headers (TCP/IP, IGMP, and so on) are also supported. IPv4/IPv6 and IPv6/IPv4 tunneling is also supported.
    - IP Source and Destination addresses may be incremented or decremented using a network mask.
  - Data Patterns: Can be one of three types: predefined patterns up to 8K bytes in length, randomly generated data, algorithmically generated data, industry standard (such as CJPAT and CRPAT) or user-specified.
  - User Defined Fields (UDFs): A number of 32-bit counters. For some modules the counters can each be flexibly configured as multiple 8, 16, 24, and 32-bit counters. Each counter may independently increment or decrement using a mask. These are further described in User Defined Fields (UDF).
  - Frame Identity Record (FIR): An identity record stored at the end of the packet. The information is very useful for determining the source of transmitted data found in capture buffers.
  - Frame Check Sequence (FCS): The checksum for a packet may be omitted, formatted correctly, or have deliberate errors inserted. Deliberate errors include incorrect checksum, dribble errors, and alignment errors.

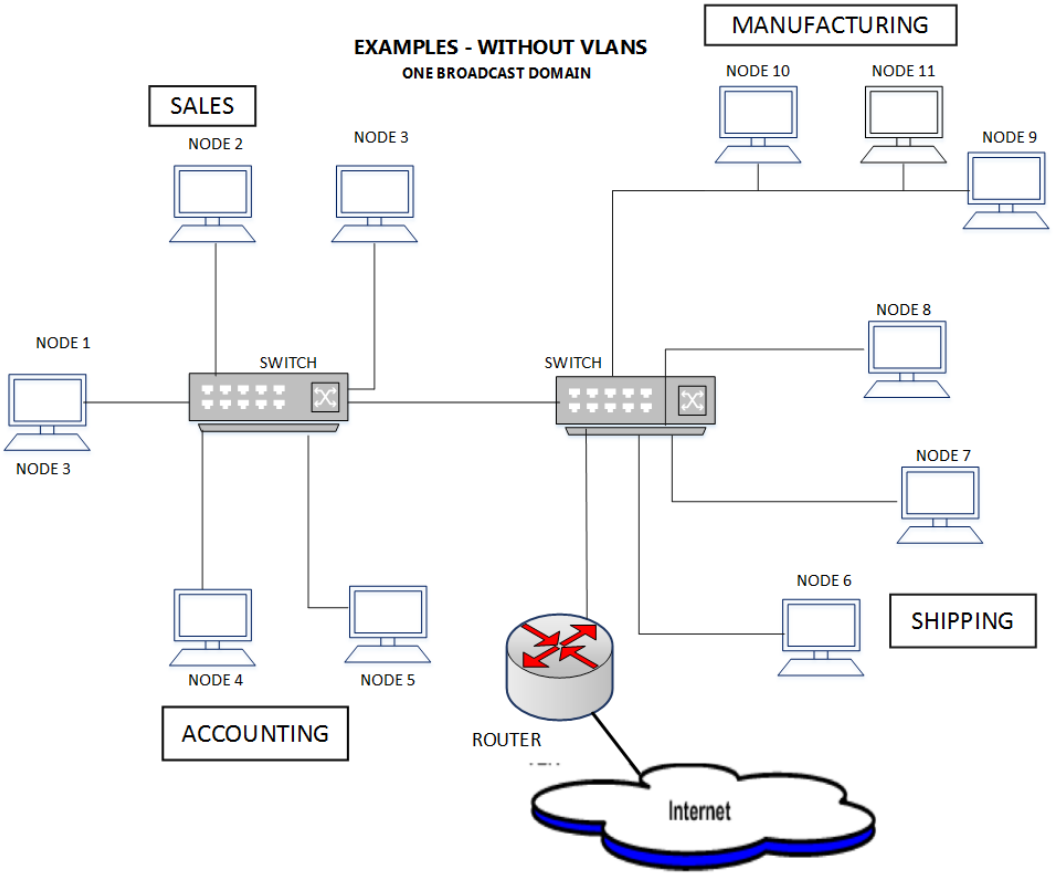
Virtual LANs

Virtual LANs (VLANs) are defined in IEEE 802.1Q, and can be used to create subdomains without the use of IP subnets. The IEEE 802.1Q specification uses the explicit VLAN tagging method and port-based VLAN membership. Explicit tagging involves the insertion of a tag header in the frame by the first switch that the frame encounters. This tag header indicates which VLAN the packet belongs to. A frame can belong to only one VLAN.

VLAN tag headers are inserted into the frames, following the source MAC address. A maximum of 4094 VLANs can be supported, based on the length of the 12-bit VLAN ID. The VID value is used to map the frame into a specific VLAN. VLAN IDs 0 and FFF are reserved. VID = 0 indicates the null VLAN ID, which means that the tag header contains only user priority information.

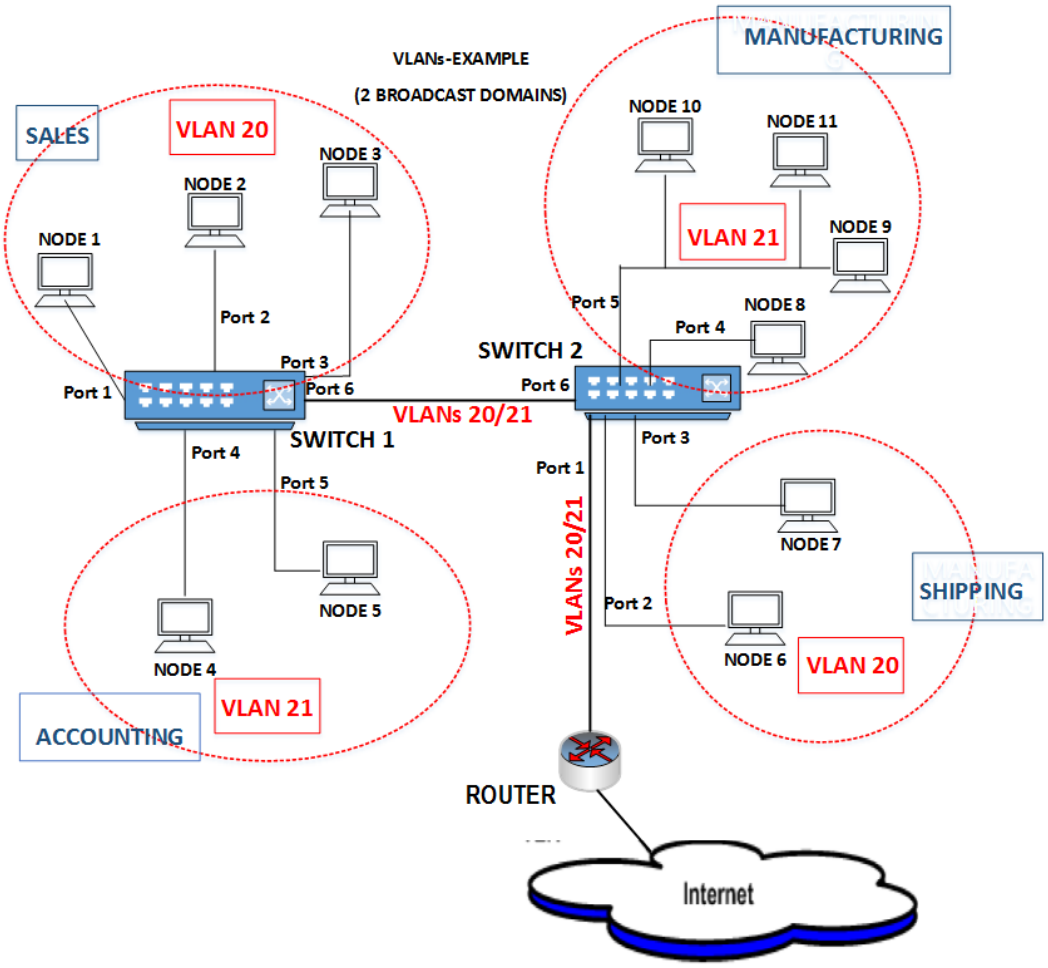
An example of Layer 2 broadcast domain without VLANs is shown in the following figure.

Example of Broadcast Domain Without VLANs



In the example above, a company has four departments (Sales, and so forth) which are in one switched broadcast domain. Broadcasts are flooded to all of the devices in the domain. A router sends/receives Internet traffic. In the figure below, the departments have been grouped into two separate VLANs, cutting down on the amount of broadcast traffic. For example, VLAN 20 contains Ports 1, 2, 3, and 6 on Switch 1, and Ports 1, 2, 3, and 6 on Switch 2. VLAN 21 contains Ports 4, 5, and 6 on Switch 1, and Ports 1, 4, 5, and 6 on Switch 2.

Example of VLANs



With the new network design, switch ports and attached nodes are assigned to VLANs. Frames are tagged with their VLAN ID as they leave the switch, en route to the second switch. The VLAN ID indicates to the second switch which ports to send the frame to. The VLAN tag is removed as the frame exits a port belonging to that VLAN, on its way to the attached node. With VLANs, bandwidth is conserved, and security is improved. Communication between the VLANs is handled by the existing Layer 3 router.

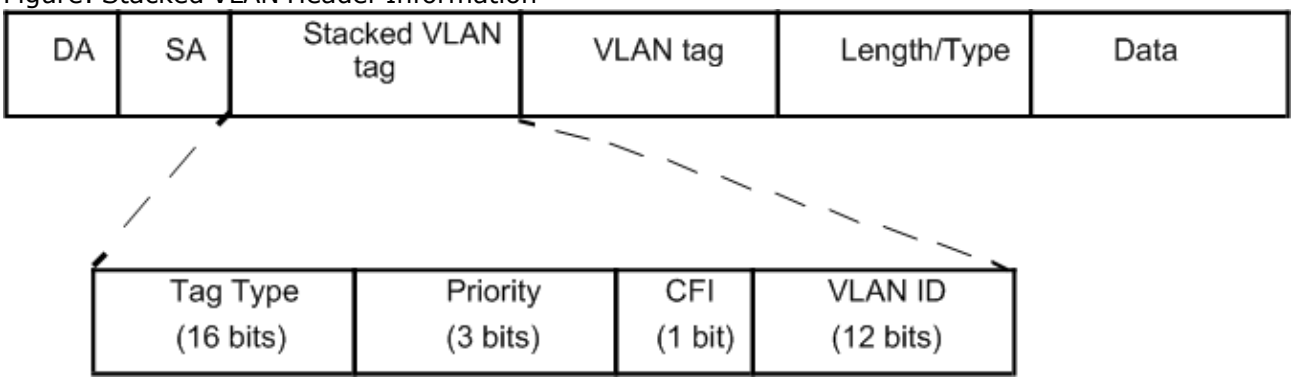
Stacked VLANs (Q in Q)

VLAN Stacking refers to a mechanism where one VLAN (Virtual Local Area Network) may be encapsulated within another VLAN. This allows a carrier to partition the network among several networks, while allowing each network to still utilize VLANs to their full extent. Without VLAN stacking, if one network provisioned an end user into `VLAN 1,' and another network provisioned one of their end users into `VLAN 1,' the two end users would be able to see each other on the network.

VLAN stacking solves this problem by embedding each instance of the 802.1Q VLAN protocol into a second tier of VLANs. The first network is assigned a `Backbone VLAN,' and within that Backbone VLAN a unique instance of 802.1Q VLAN tags may be used to provide that network with up to 4096 VLAN identifiers. The second network is assigned a different Backbone VLAN, within which another unique instance of 802.1Q VLAN tags is available.

The following figure demonstrates an example packet of a stacked VLAN.

Figure: Stacked VLAN Header Information



User Defined Fields (UDF)

Seven different types of UDFs are available, depending on the load module type. The types of UDFs that are supported by particular port types is detailed in Platform and Reference Overview. Not all features supported by a port type are available on all UDFs; whether a particular UDF type is supported on a particular UDF can be ascertained by looking at the UDF with IxExplorer or programatically using the Tcl API. These types are:

- Counter Mode UDF
- Random Mode UDF
- Value List Mode UDF
- Range List Mode UDF
- Nested Counter Mode UDF
- IPv4 Mode UDF
- Table Mode UDF

Some features are common across all UDFs:

- Counter Type: The size of the counter is available in two modes:
  - A single counter with a length of 8, 16, 24 or 32 bits, or
  - A 32-bit value that may be divided into one to four 8 to 32 bit counters in any order. For example, 8x8x8x8 (four 8-bit counters), 8x16 (an 8-bit counter followed by a 16 bit counter), or 24x8 (a 24-bit counter followed by an 8-bit counter). In this case, each of the up to four counters may be independently controlled as described in Counter Mode UDF.
- Offset: The offset from the beginning of the packet to the start of the counter.
- Init val: The initial value given to the counter.
- Cascade: Sets the initial value for the counter, in one of two ways:
  - From the last value for this stream: The counter continues from the last value generated by this UDF for this stream. The first value for the counter is set from the *Init val* setting. This type of cascade is sometimes referred to as *Cascade From Self.*
  - From the last value on the previous cascade stream: The counter continues from the last value generated by the last executed stream using this UDF that is also in this cascade mode. The first value for the first UDF is set from the *Init val* setting. This type of cascade is sometimes referred to as *Cascade From Previous Stream.*

- Masking: The bit masking operation allows certain bits to maintain constant values, while varying other values. In the IxExplorer GUI, a bit mask is represented as a string of characters, one character per counter bit. For example, a possible *Bit Mask* setting for an 8-bit counter might be:

0110XXXX

The `0's and `1's represent fixed values after the mask value, while the `X's are bits which vary as a result of the increment, decrement or random value option.

In the TCL/C++ APIs, the *Bit Mask* value is split into two variables:

- *maskSelect*: Indicates which bits of the counter are fixed in value, and
- *maskval*: Indicates the fixed value for any of the bits set in *maskSelect*.

In all of the UDF figures, the generated counter value is shaded. The parameters are shown in ovals (blue in the online version).

Counter Mode UDF

The counter mode UDF features the ability of a counter (up to four on some load modules) to count up or down or to use random values. Certain bits of the counter may be held at fixed values using a mask. The parameters that affect the counter's operation are shown in the following table.

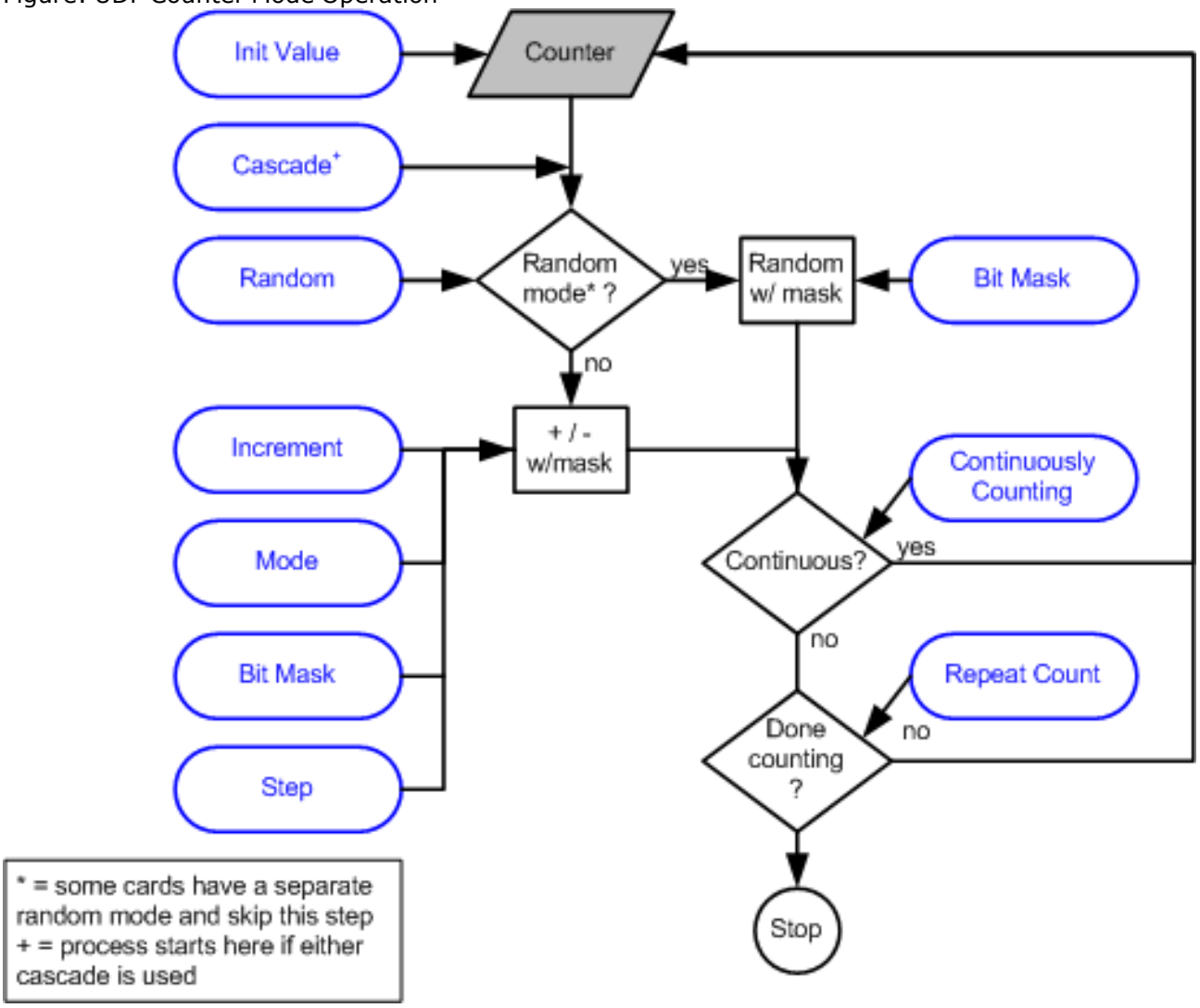
Counter Mode UDF Parameters

IxExplorer Label	Tcl API Variables
Counter Type	countertype
Offset	offset
Init Value	initval
Set from Init ValueContinue from last value for this streamCascade continue	cascadeTypeenableCascade
Random*	random
Continuously Counting	continuousCount
Step	step
Repeat Count	repeat
Mode	updown
Bit Mask	maskvalmaskselect

* some card types include random mode as part of the counter mode and others use them as a separate mode.

In the TCL APIs the value of the *counterMode* variable in the *udf* command should be set to *udfCounterMode (0)*. The operation of counter mode is described in the flowchart shown in the following figure.

Figure: UDF Counter Mode Operation



Random Mode UDF

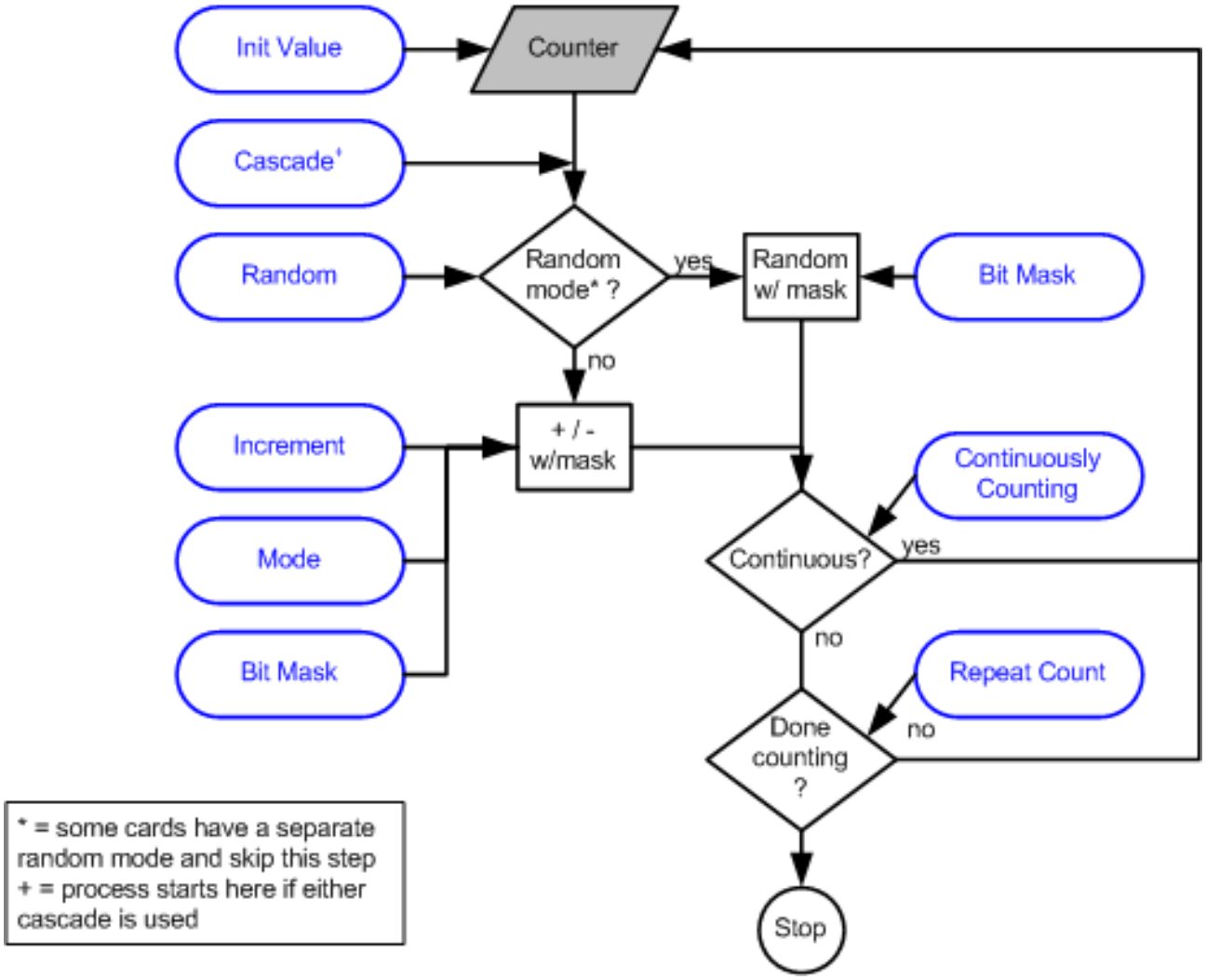
The random mode UDF features a counter whose values are randomly generated, but may be masked. Cascading modes do not apply to random mode UDFs. The parameters that affect the counter's operation are shown in the following table.

Random Mode UDF Parameters

IxExplorer Label	Tcl API Variables
Offset	offset
Bit Mask	maskvalmaskselect

In the TCL APIs the value of the *counterMode* variable in the *udf* command should be set to *udfRandomMode (1)*. The operation of random mode is described in the flowchart shown in the following figure.

Figure: UDF Random Mode Operation



Value List Mode UDF

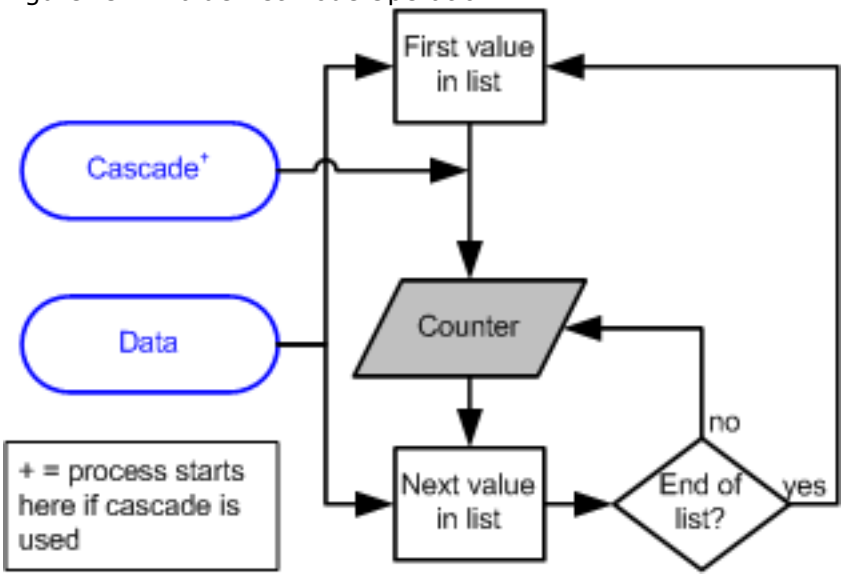
The value list mode UDF features a counter whose values successively retrieved from a table of values. Cascading modes do not apply to value list mode UDFs. The parameters that affect the counter's operation are shown in the following table.

Value List Mode UDF Parameters

IxExplorer Label	Ecl API Variables
Offset	offset
Counter Type	countertype
Data	valueList
Set from Init ValueContinue from last value for this stream	cascadeTypeenableCascade

In the TCL APIs the value of the *counterMode* variable in the *udf* command should be set to *udfValueListMode (2)*. The operation of value list mode is described in the flowchart shown in the following figure.

Figure: UDF Value List Mode Operation



Range List Mode UDF

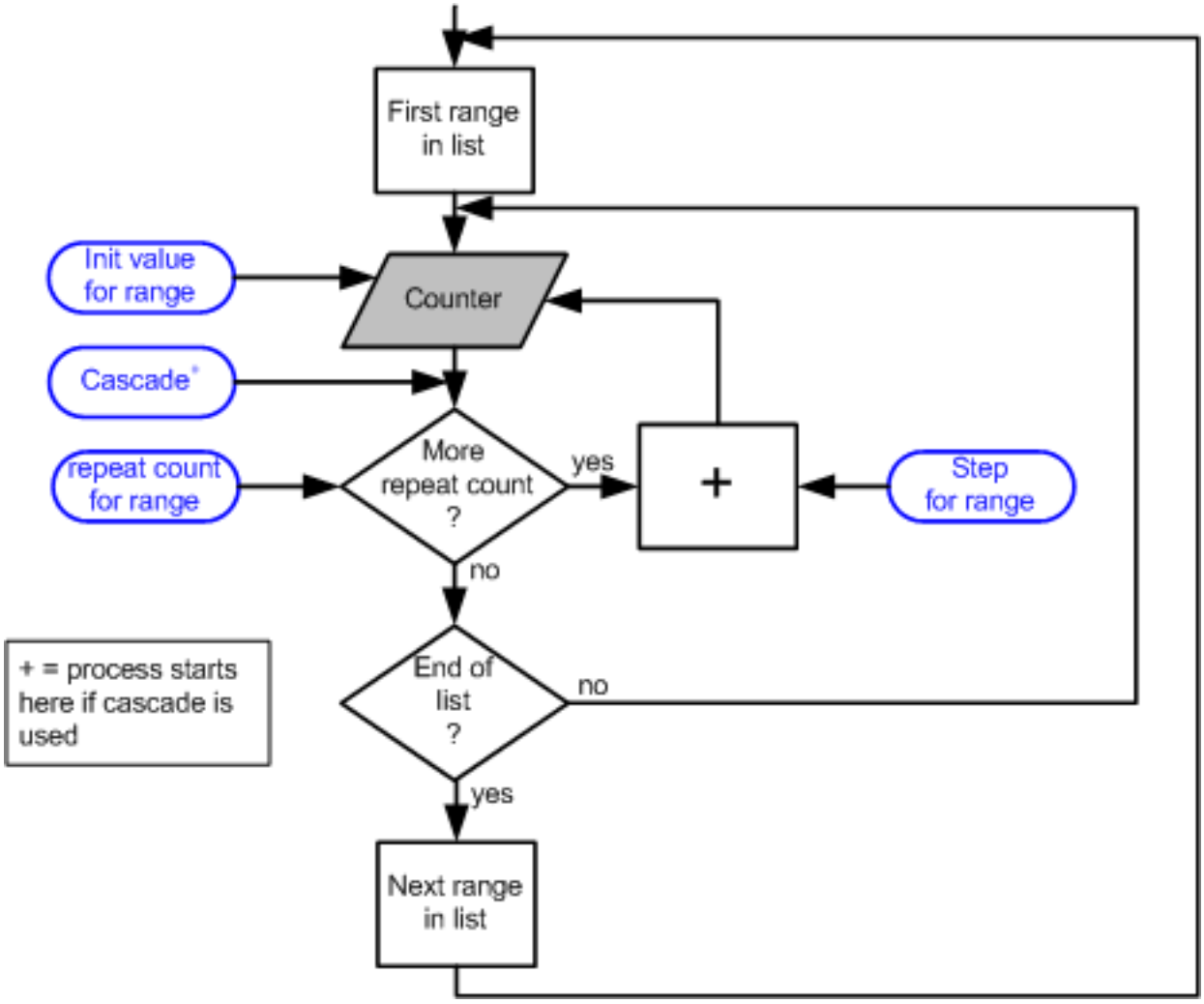
The range list mode UDF features a counter whose values are generated from a list of value ranges. Each range has an initial value, repeat count, and step value. Cascading modes do not apply to range list mode UDFs. The parameters that affect the counter's operation are shown in the following table.

Range List Mode UDF Parameters

IxExplorer Label	Tcl API Variables
Offset	offset
Counter Type	countertype
Init Value	initval
Repeat Count	repeat
Step	step
Set from Init ValueContinue from last value for this stream	cascadeTypeenableCascade

In the TCL APIs the value of the *counterMode* variable in the *udf* command should be set to *udfRangeListMode (4).* The *initval*, *repeat,* and *step* values are added into the *udf* command by the *addRange* sub-command. The operation of range list mode is described in the flowchart shown in the following figure.

Figure: UDF Range List Mode Operation



Nested Counter Mode UDF

The nested counter mode UDF features a counter whose values are generated from three nested loops:

1. A given value may be repeated a number of times.
2. That value is incremented and step 1 is repeated for a count. This is called the *inner loop*.
3. That value is incremented and steps 1 and 2 repeated continuously for a count. This is called the *outer loop*.

The parameters that affect the nested counter's operation are shown in the following table.

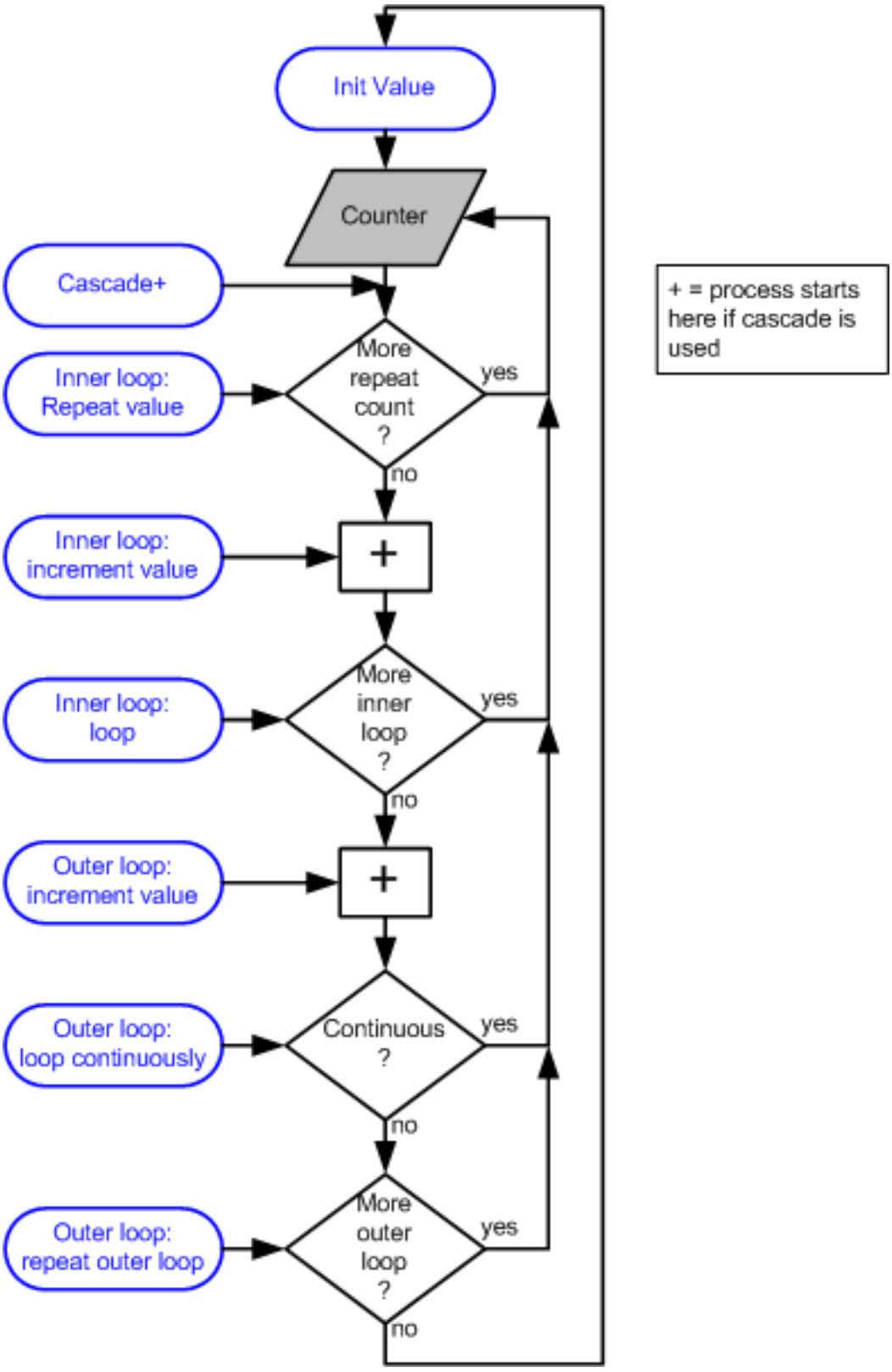
Nested Counter Mode UDF Parameters

IxExplorer Label	Tcl API Variables
Offset	offset
Counter Type	countertype

IxExplorer Label	Tcl API Variables
Init Value	initval
Inner Loop: Repeat value	innerRepeat
Inner Loop: increment value	innerStep
Inner Loop: loop	innerLoop
Outer Loop:increment value	step
Outer Loop: loop continuously	continuousCount
Outer Loop: repeat outer loop	repeat
Set from Init ValueContinue from last value for this stream	cascadeTypeenableCascade

In the TCL APIs the value of the *counterMode* variable in the *udf* command should be set to *udfNestedCouterMode (3).* The operation of range list mode is described in the flowchart shown in the following figure.

Figure: UDF Nested Counter Mode Operation


Init Value
Counter
Cascade+
Inner loop: Repeat value
More repeat count ?
yes
no
Inner loop: increment value
+
Inner loop: loop
More inner loop ?
yes
no
Outer loop: increment value
+
Outer loop: loop continuously
Continuous ?
yes
no
Outer loop: repeat outer loop
More outer loop ?
yes
no
+ = process starts here if cascade is used

IPv4 Mode UDF

The IPv4 counter mode UDF features a counter designed to be used with IPv4 addresses. The process is:

1. A given value may be repeated a number of times. Values with all `1's and `0's in a particular part of the value may be skipped so as to avoid broadcast addresses. The number of low order bits to check for `0's and `1's can be set.
2. That value is incremented and step 1 is repeated continuously or for a count.

The parameters that affect the counter's operation are shown in the following table.

IPv4 Mode UDF parameters

IxExplorer Label	Icl API Variables
Offset	offset
Counter Type	countertype
Init Value	initval
Loop: Repeat value	innerRepeat
Loop: increment by	innerStep
Repeat Loop: Continuously	continuousCount
Repeat Loop: times	repeat
Skip all zeros and ones	enableSkipZerosAndOnes
masked with	skipMaskBits
Set from Init ValueContinue from last value for this stream	cascadeTypeenableCascade

The operation of IPv4 mode is described in the flowchart shown in the following figure.

Figure: UDF IPv4 Mode Operation

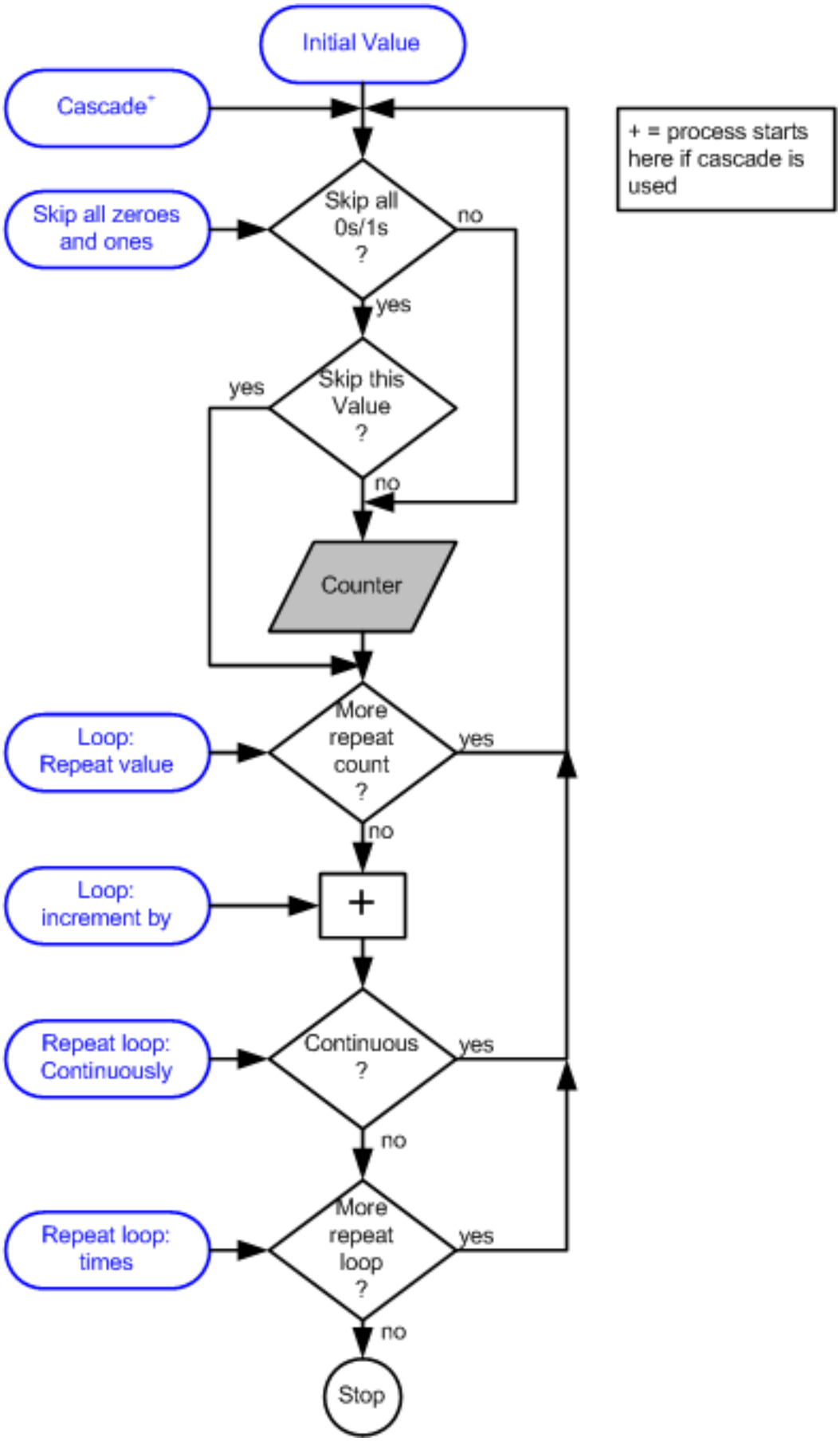
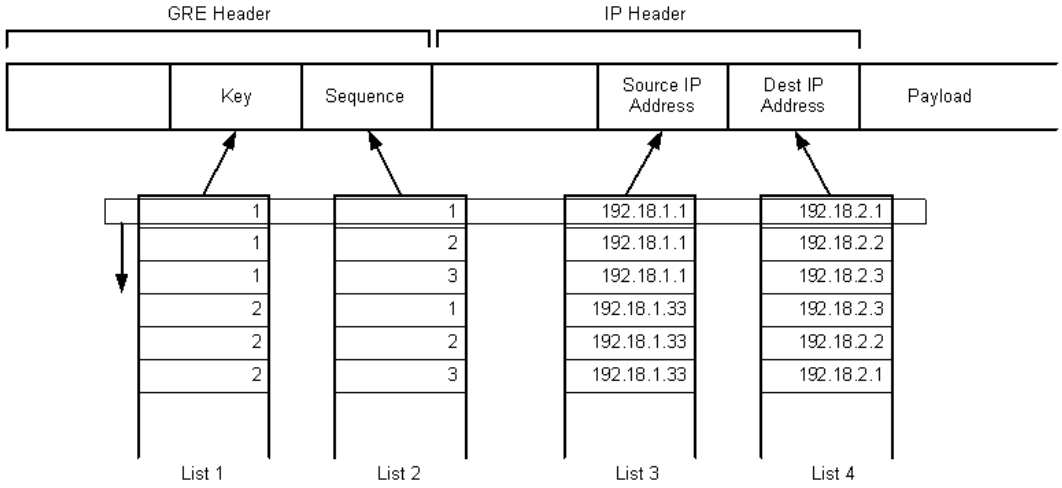

Initial Value
Cascade+
Skip all zeroes and ones
Skip all 0s/1s ?
no
yes
Skip this Value ?
yes
no
Counter
Loop: Repeat value
More repeat count ?
yes
no
Loop: increment by
+
Repeat loop: Continuously
Continuous ?
yes
no
Repeat loop: times
More repeat loop ?
yes
no
Stop
+ = process starts here if cascade is used

Table Mode UDF

Table UDFs allows to specify a number of lists of values to be placed at designated offsets within a stream. Each list consists of an Offset, a Size, and a list of values.

The following figure illustrates the basic operation of the Table UDFs using a GRE encapsulated packet as an example. Four of the fields in the packets need to be modified on a packet by packet basis-the key and sequence GRE fields and the source and destination IP addresses in the IP header. The Table UDF provides a means by which lists are developed for each of these fields and the list is associated with an offset and size within the packet. During stream generation, all lists are applied at the same time in lock step.

Figure: Table UDF Mode



A Table UDF is applied before, and can be combined with, the standard UDF fields already available on ports. By combining these two features you can model multiple flows using the powerful combination of a value list group for flow identity fields and UDFs for protocol related timestamp/sequence fields.

Table Mode UDF has a limitation compared to the other UDFs. Specifically, Table Mode behaves differently when Random Data payload is enabled for the frame.

Most UDFs are attached to the frame after the Random Data is placed in the frame; the UDFs `overlay'on top of the random data. The Table Mode UDF data, however, is put in the frame *before* the random data. As a result, the payload is random only after the Table UDF.

For example, if a frame has a Table UDF that is 1 byte wide starting at offset 100, random data cannot appear in the payload until byte 101. Thus, the first 100 of these frames would have the same `random' data appear within the first 99 bytes of the payload-for all 100 frames. The data would truly appear random starting at byte 101, after the Table UDF insertion.

This is the same limitation currently for random data packets that have PGID or Data Integrity enabled.

The parameters that affect the counter's operation are shown in the following table.

Table Mode UDF Parameters

IxExplorer Label	Tcl API Variables
Offset	offset
Counter Type	countertype
Init Value	initval
Add Column	addColumn
Add Row	addRow
Clear All Columns	clearColumns
Get First Column	getFirstColumn
Get Next Column	getNextColumn
Clear All Rows	clearRows
Get First Row	getFirstRow
Get Next Row	getNextRow
Export to File	export
Import from File	import

Transmit Operations

The transmit operations may be performed across any set of chassis, cards, and ports specified by you. These operations are described in the following table.

Transmit Operations

Operation	Usage
Start Transmit	Starts the transmission operation on all ports included in the present set of ports. If no transmit operation has been performed yet, or if the last operation was *Stop Transmit*, then transmission begins with the first stream configured for each port. If a *Pause Transmit* operation was last performed, then transmission begins at the next packet in the queue for all ports.
Staggered Start Transmit	The same operation is performed as in *Start Transmit*, except that the start operation is artificially staggered across ports. The time interval between the start of transmission on consecutive ports is in the range of 25-30ms.
Stop Transmit	Stops the transmission operation on all ports included in the present set of ports. A subsequent *Start Transmission* or *Step Stream* operation commences from the first stream of each port.
Pause Transmit	Stops the transmission operation on all ports in the present set of ports at the end of transmission of the current packet. A subsequent *Start Transmission* or *Step*

Operation	Usage
	Stream commences at the beginning of the next packet in the queue on each port.
Step Stream	Causes one packet to be transmitted from each of the ports in the present set of ports.

Repeat Last Random Pattern

The 10 GE LSM module transmit engine has the ability to provide repeatable random values in all its random number generators. This feature allows to run tests with random parameters such as frame size, frame data, and UDF values to rerun the tests with the same set of random data if a problem is found. A check box on the Port Properties transmit tab is used to enable/disable, repeating the last seed used on the port. In addition to the check box, there is a read-only window showing the last 32 bit master seed value used in generating seeds for all random number generators on the port.

Port Data Capture Capabilities

Most ports have an extensive buffer which may be used either to capture the packet data `raw' as it is received, or to categorize it into groups known as Port Groups. Each port must be designated to have a *Receive mode* which is either *Capture* or *Packet Groups.* Packet groups are used in measuring latency.

The start of capture buffering may be triggered by a set of matching conditions applied to the incoming data, or all data may be captured. Packets can be filtered, as well. During capture mode operation, the amount of data saved in the capture buffer can be limited to a user-defined `capture slice' portion of each incoming packet, rather than the entire packet.

Each port's Capture trigger and filter conditions are based on:

- For Ethernet Modules:
  - Data link encapsulation type
  - Destination and source MAC addresses
  - Protocol layer type: such as IP, IPv6, and ARP
  - IPv4 and IPv6 source and destination addresses
  - TCP and UDP port numbers
  - VLAN IDs
- For POS Modules:
  - Use of PPP
  - Protocol layer type: such as IP, IPv6, and ARP
  - IPv4 and IPv6 source and destination addresses
  - TCP and UDP port numbers
- For ATM Modules:
  - VPI and VCI combinations
  - Protocol layer type: such as IP, IPv6, and ARP
  - IPv4 and IPv6 source and destination addresses

    - TCP and UDP port numbers
    - ATM OAM cells
- Data pattern match for the packet, and matching errors such as: Bad CRC, Bad Packet, Alignment Error, and Dribble Error
- Packet sizes within a user-specified range

Continuous Versus Trigger Capture

For some load modules, there are more advanced options provided for setting up data capture operations on a port. These options are set in the receive mode dialog for the port. The available options are described in the following list:

- Continuous Capture. Options are as follows:
    - All packets are captured.
    - All packets which match a user-defined Capture Filter condition are captured.
- Trigger Capture:
    - Capture operation starts **before** a packet matching the user-defined Trigger condition is received. Options are:
        - All packets are captured.
        - No packets are captured.
        - All packets which match a user-defined Capture Filter condition are captured.
    - Capture operation starts **after** a packet matching the user-defined Trigger condition is met. Options are:
        - All packets are captured.
        - All packets that match a user-defined Capture Filter condition are captured.
        - All packets that match the user-defined Trigger Capture condition are captured.
    - Trigger Position: The slider bar is used to set the position (% transmitted) in the data stream where the Capture Trigger is first applied to incoming packets.

Port Capture Operations

The data capture operations may be performed across any set of chassis, cards, and ports defined by you. These operations are described in the following table.

Capture Operations

Operation	Usage
Start Capture	Enables data capture on all ports in the set of ports whose receive mode is set to *Capture*. Packets are not actually captured until the user-specified capture trigger condition is satisfied.
Stop Capture	Stops data capture on all ports in the set of ports.
Start Latency	Initiates latency measurements for all ports in the set of ports whose receive mode is set to *Packet Group* operation.

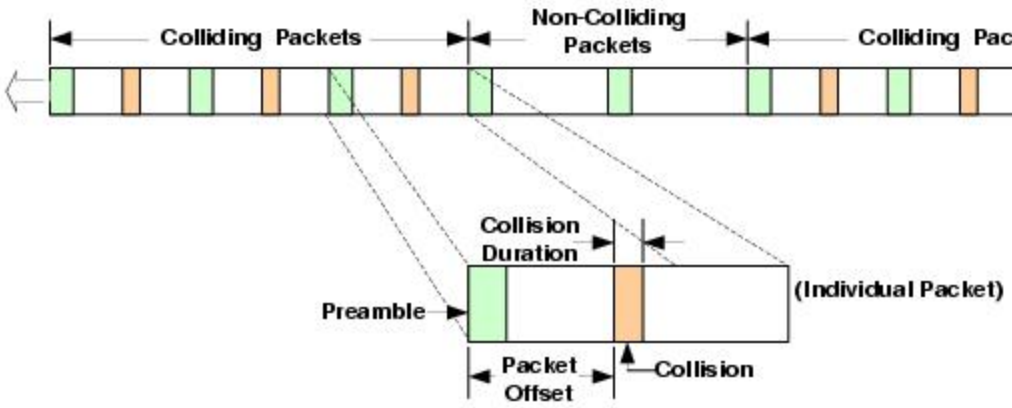
Operation	Usage
Stop Latency	Stops latency measurements on all ports in the set of ports.
Start Collision	Enables generation of forced collisions on received data, for all ports in the set of ports-if this option is selected for the port and enabled. Applies to half-duplex 10/100 Ethernet connections only.
Stop Collision	Stops generation of forced collisions for all ports in the set of ports.

Forced Collision Operation

In addition to normal capture operation, forced collisions can be generated on the receive side of some 10/100/1000 load module ports, but only when the port is in half-duplex mode.

Forced collisions operate by generating `collision' data as information is being received on the incoming port. The `collision' takes the form of a number of nibbles inserted at a user-specified offset within a packet as it is received. A period with a number of consecutive `collisions' is followed by a period with no collisions. This combination of collisions and non-colliding periods can be repeated indefinitely, or repeated for a user-specified number of times. These parameters are shown in the following figure.

Figure: Forced Collisions



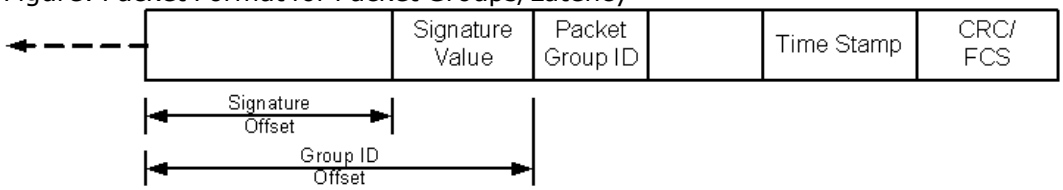
Packet Group Operation

Packet groups are sets of packets which have matching tags, called *Packet Group IDs*. Real-time latency measurements within packet groups depend on coordination between port transmission and port reception. Each transmitted packet must include an inserted 4-byte packet `group signature' field, which triggers the receiving port to look for the packet group ID. This allows the received data to be recognized and categorized into packet groups for latency analysis.

Packet group IDs should be used to group similar packets. For example, packet groups can be used to tag packets connected to individual router ports. Alternatively, packet groups may be used to tag frame sizes. Such groupings allow to measure the latency with respect to different characteristics (for example, router port number or frame size as in the above scenario).

After packet group operation is triggered on the receiving port, the packet group ID-a 2-byte field which immediately follows the signature-is used as an index by the port's receive buffer to store information related to the latency of the packet. When packet group signatures and packet group IDs are included in transmitted data, an additional time stamp is automatically inserted into the packet. The following figure shows the fields within packets which are important for packet grouping and latency analysis.

Figure: Packet Format for Packet Groups/Latency



A special version of packet groups, known as wide packet groups, uses a 4-byte packet group ID, of which only the low order 17 bits are active. A mask may be applied to the matching of the packet group ID. Latency, sequence checking, and first/last timestamps are supported at the same time. Latency over time and data integrity checking are not supported in this mode. Frames must be greater than or equal to 64 bytes.

Split Packet Group Operation

Split PGID allows the 32-bit PGID field used to identify and group packets to be generated from a concatenation of three separate PGID fields. Note that the method for detecting and determining if a packet has a valid signature is no different from standard PGID operation. A valid signature is still required before the concatenated PGID is considered to be valid.

Instead of having one PGID offset value with one mask, you are allowed to enter up to three separate PGID offsets and masks. The split PGID method works with both the standard instrumentation method or the floating instrumentation method, and does not interfere with other features such as time bins and bin by latency.

In addition to having three 16 bit offset values and three 32 bit mask values, the following possibilities are available for the PGID offset:

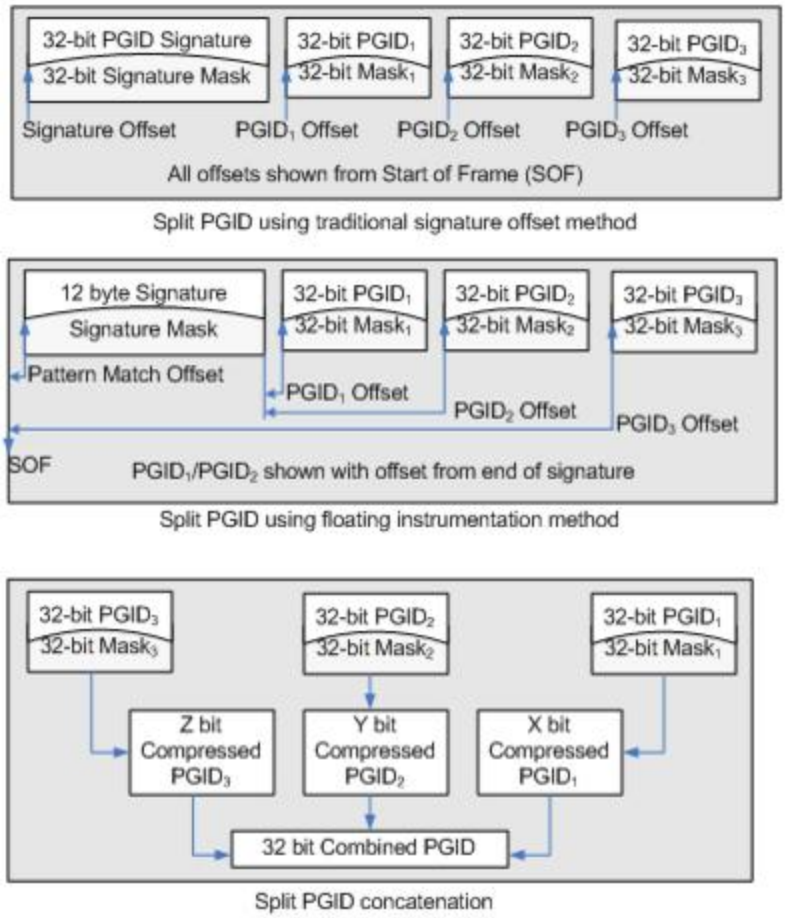
- Offset from Start of Frame (Original starting point for PGIDs)
- Offset from End of Floating Instrumentation Pattern Match
- Offset from Start of IP
- Offset from Start of Protocol

The definition of the mask is also different when in split PGID mode. In the standard PGID mode, the mask is only used to zero out PGID values and not to change the width of the final PGID. In split PGID mode, the mask is used to reduce the overall width of the PGID value for that region. A value of 1 in mask field indicates the bit is discarded (masked out).

The final 32 bit PGID value used is a concatenation of the values extracted based on the offset/mask combinations provided for the three PGID regions. The final 32 bit PGID is generated by concatenating the three regions as follows: PGID3, PGID2, and PGID1. If the concatenation of the three regions is not sufficient to fill the 32 bit value, a padding of 0 is used on the remaining leftmost bits.

The following figure demonstrates the three options when employing split PGIDs.

Figure: Split PGID Scenarios



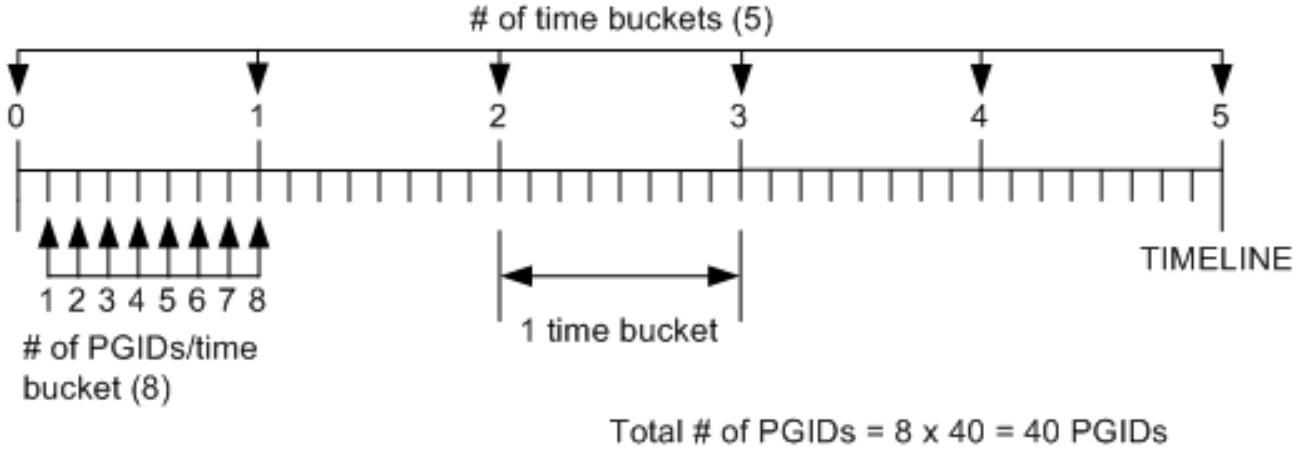
Latency/Jitter Measurements

Latency and Jitter can be measured when packet groups are enabled on a transmitting port and received on a port enabled to receive packet groups. The difference between the received time and the transmitted time held in the packet's time stamp is the measured latency or jitter. The latency is included in a memory cell indexed by the packet group ID. The count of packets received, minimum, maximum, average, and mean latencies are maintained. There are two modes for latency measurement:

- Instantaneous: Latency measured for all received data (continuous). The number of PGID groups available depends on the features being employed on the receive side. The PGID is used as an index into an area of cells and the count/min/max/avg/mean is maintained for each PGID.
- Latency over time: Latency measured for a number of time intervals of equal length, called `time buckets.' The range of cells is divided up over a period of time-for example, for one second intervals over a 30 second period. Each time period (one second in this example) is called a *time bucket*. Within each time bucket, the data for all PGIDs must be stored into a limited number of cells. This is accomplished by grouping a number of PGIDs together. The grouping is called the `# of PGIDs/Time Bucket'. The figure below demonstrates the relationship between the time buckets and PGIDs in an example. The minimum size time bucket

varies by port type, but the size set should be reasonable for the transmission speed of the port-certainly no shorter than 1 microsecond.

Figure: Multiple Latency Time Measurements-Example



The timeline is equally divided into a *# of Time Buckets,* each of which is **one***Time Bucket Duration* in length. A time bucket duration can range anywhere from nanoseconds to hours, depending on the user configuration.

The maximum number of time buckets that can be handled is determined by the number of PGIDs in each bucket.

Four types of timing measurements are available, corresponding to the type of device under test:

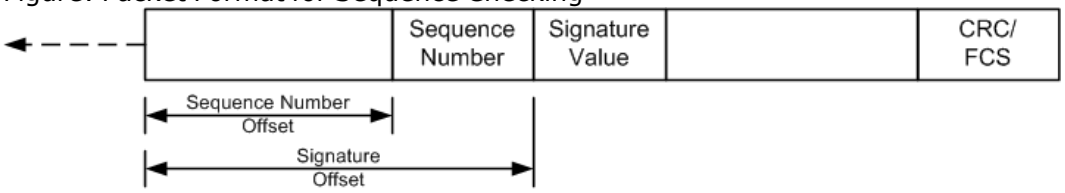
- Cut-Through: For use with switches and other devices that operate using packet header information. The time interval between the first data bit out of the Ixia transmit port and the first data bit received by the Ixia receive port is measured. The first data bit received on Ethernet links (10/100 and Gigabit modules) is the start of the MAC DA field. For Packet over SONET links, the first bit received is the start of the IP header.
- Store and Forward: For use with routers and other devices that operate on the contents of the entire packet. The time interval between the last data bit out of the Ixia transmit port and the first data bit received by the Ixia receive port is measured. The last data bit out is usually the end of the FCS or CRC, and the first data bit received is as described above for Cut Through.NOTE: Store and Forward latency mode is intended to test Store and Forward switching devices, which receive the entire packet before transmitting it to its destination. If Store and Forward latency is used in loopback, back-to-back or without a Store and Forward switch, then either a zero latency or very high latency is reported.
- Store and Forward Preamble (only available on some load modules): As with store and forward, but measured with respect to the preamble to the Ethernet frame. In this case, the time interval between the last data bit out of the Ixia transmit port and the first preamble data bit received by the Ixia receive port is measured. For this measurement, the size of the preamble (in bytes) is considered.
- Inter-Arrival Time (IAT): Compares the time between PGID packet arrivals. In this case, when a packet with a PGID is received, the PGID is examined. If a packet has already been received with the same PGID, then the timestamp of the previous packet is subtracted from the current timestamp. The interval between the timestamps is the jitter, and it is recorded for statistical purposes.

Sequence Checking Operation

A number of ports have the additional ability to insert a sequence number at a user-specified position in each transmitted packet. This sequence number is different and distinct from any IP sequence number within an IP header. On the receiving port, this special sequence number is retrieved and checked, and any out-of-sequence ordering is counted as a sequence error.

As in packet groups (see Packet Group Operation), for sequence checking a signature value is inserted into the packet on the transmit side to signal the receive side to check the packet. In fact, this particular signature value is shared by both the packet group and the sequence checking operations. Both the signature value and sequence number are 4-byte quantities and must start on 4-byte boundaries. These fields are shown in the following figure.

Figure: Packet Format for Sequence Checking



Sequence numbers are integers which start at `0' for each port when transmission is started, and increment by `1' continuously until a Reset Sequence Index operation is performed. Note that multiple sequence errors results when a packet is received out of sequence. For example, if five packets are transmitted in the order 1-2-3-4-5 and received in the order 1-3-2-4-5, three sequence errors are counted:

1. At 1-3, when packet 2 is missed
2. At 1-3-2, when 2 is received after 3
3. At 1-3-2-4, when 4 is received after 2

Switched-Path Duplicate/Gap Checking Mode

This is a mode in sequence checking that allows for detecting duplicate packets, or sequence gaps. IxExplorer stores the largest sequence number received. Any packet that arrives with a lower or equal sequence number is regarded as a duplicated packet. For a flow with no packet reordering, the `reversal errors' matches the number of duplicates received. For a flow with packet reordering, the `reversal errors' gives a count that may be higher than the number of duplicates received.

Data Integrity Checking Operation

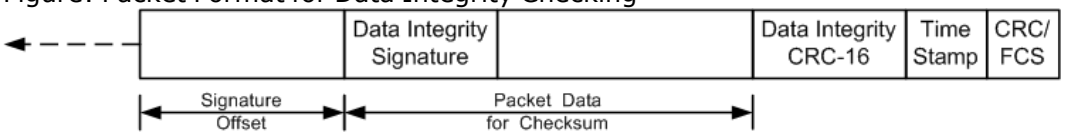
A number of ports also possess the ability to check the integrity of data contained in a received packet, by computing an additional 16-bit CRC checksum.

As with packet groups (see Packet Group Operation) and sequence checking (see Sequence Checking Operation), a signature value is inserted into the packet on the transmitting interface, to serve as a trigger for the receiving port to notice and process the additional checksum. The data integrity operation uses a different signature value from the one shared by packet groups and sequence checking.

The data integrity signature value marks the beginning of the range of packet data over which the 16-bit data integrity checksum is calculated, as shown in the figure below. This packet data ends just before the timestamp and normal CRC/FCS. The CRC-16 checksum value must end on a 4-byte

boundary. There may be 1, 2, or 3 bytes of zeroes (padding) inserted after the CRC-16, but before the Time Stamp, to enforce all boundary conditions.

Figure: Packet Format for Data Integrity Checking



When the Receive Mode for a port is configured to check for data integrity, received packets are matched for the data integrity signature value, and the additional CRC-16 is checked for accuracy. Any mismatches are recorded as data integrity errors.

Automatic Instrumentation Signature

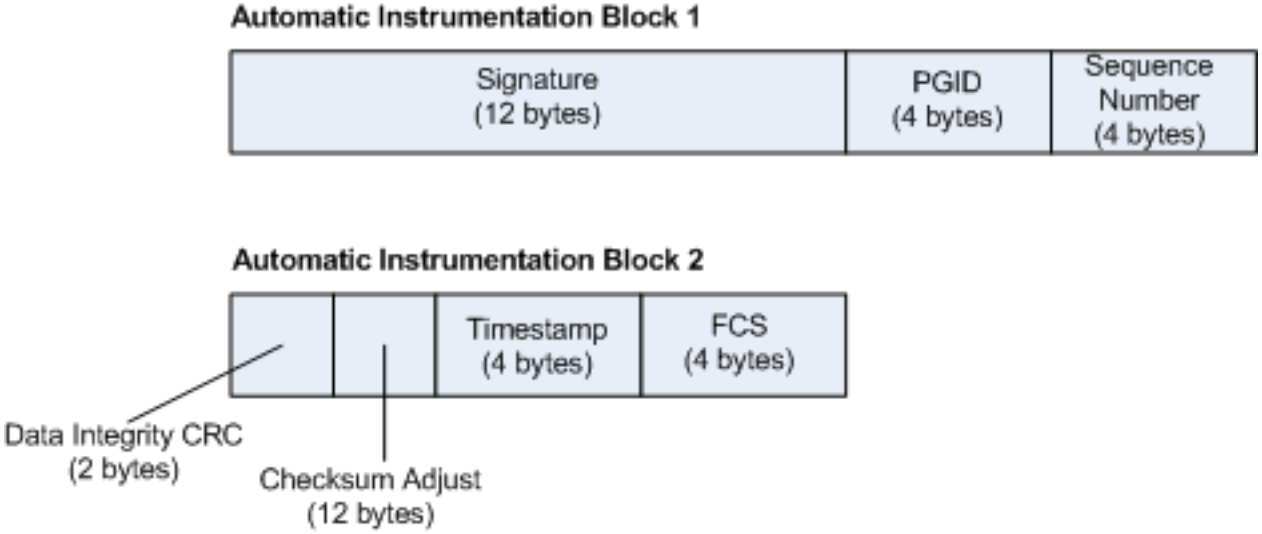
The Automatic Instrumentation Signature feature allows the receive port to look for a signature at a variable offset from the start of frames. The feature supports Sequence Checking, Latency, Data Integrity functionality, with signature and Packet Group ID (when Automatic Instrumentation is enabled, these receive port options are enabled as well).

In normal stream operation, signatures for Data Integrity, Latency, and Sequence Checking are forced to a single, uniform offset location in each frame of the stream. Many of the Ixia software application (that is, IxVPN, IxChariot, and so forth) can generate streams that place a signature at random places within the frames of a single stream. To accurately detect these signatures on the receive side of the chassis, Automatic Instrumentation Signature is used.

Automatic Instrumentation Signature allows the chassis to look for a floating pattern in the frame. Two data blocks are placed in the frame (by some stream generating application). The first is positioned at a variable offset from the start of the frame. The second is positioned at a fixed 12 byte offset from the end of the frame.

The following figure shows the composition of the blocks.

Figure: Automatic Instrumentation Signature Block



The receive port recognizes an instrumented frame by detecting the Signature in the first block. Once a signature match has occurred, the Packet Group ID (PGID) and Sequence Number are extracted from the frame. Data Integrity also starts immediately following the signature.

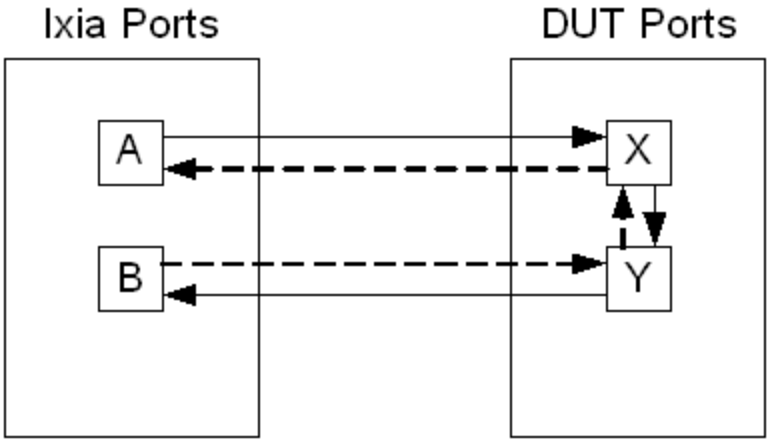
The Checksum Adjust field is reserved for load modules that cannot correctly do checksums on large frames.

Port Transmit/Receive Capabilities

Round Trip TCP Flows

A special capability exists in the Ixia hardware to enable the measurement of round trip times for IP packets sent through a switch or other network device. The normal setup for this measurement is shown in the following figure.

Figure: RoundTrip TCP Flows Setup



In this scenario, Ports A and X are configured on one IP subnet, and Ports B and Y are configured on a different IP subnet. IP packets sent from A have a source address of A and destination address of B. The DUT is configured to route or forward to Y any packets that it receives on X for an address on B-Y's subnet. After being received on Port B, the packet is reconstructed in a modified form as described in the following list, and sent back in the opposite direction along the path to Port A.

When enabled on the Ixia receiving port (in this case, Port B), the Round Trip TCP Flows feature performs several operations on the received IP packet:

- The Source and Destination IP addresses are reversed, and a packet destined for Port A is created using the reversed addresses.
- The frame size, source and destination MAC addresses, and background data pattern are set as specified by you.
- The timestamp is copied to the new packet unmodified.
- The new packet is transmitted to Port Y on the DUT, and should be routed back to Port A by the DUT.

This re-assembly/retransmit process makes it possible to measure the round-trip time for the packet's trip from Port A through the DUT to Port B, and back through the DUT to Port A again. Note that the Packet Groups feature may be used, in addition, for latency measurements on this round trip. For latency testing, the background data set by the Round Trip TCP Flows feature overwrites the

Packet Group Signature Value contained in the packet. It is important that proper programming of the background data pattern be used to insert the appropriate signature value back into the packet.

Port Statistics Capabilities

Each port automatically collects statistics. A wide range of statistics are preprogrammed and available for many types of load modules. Other statistics may be selected or programmed and include:

- User-Defined Statistics: Four counters which can be programmed to increment based on the same conditions as those involved in defining capture triggers and capture filters.
- Quality of Service Types: Separate counts for each of eight Quality of Service values used in IP headers.
- IP/UDP/TCP Checksum Verification Statistics: For hardware checksum verification.
- Data Integrity Statistics: For errors relating to Data Integrity Operation. Refer to Data Integrity Checking Operation.
- Packet Group Statistics: For statistics relating to Latency operations. Refer to Latency/Jitter Measurements.
- Protocol Server Statistics: Protocol-based statistics for a wide range of routing protocols.
- SONET Extended Statistics: Statistics associated with SONET Line, Section and Path characteristics.
- VSR Statistics: Statistics associated with OC192 VSR modules.
- ATM Statistics: Statistics associated with ATM modules.
- BERT Statistics: Statistics associated with BERT error generation and detection.
- Temperature Sensors Statistics: For verifying that temperatures on high-performance 10 Gigabit and OC-192c POS cards are within operational limits.

IxExplorer Software

The IxExplorer software utilizes concepts that match the Ixia hardware hierarchy. The software hierarchy is:

- Chassis Chain (Software): A set of Ixia chassis joined through sync-in/sync-out cables.
  - Chassis: A single Ixia chassis capable of holding different Ixia module cards.
    - Card: An Ixia module card, all of whose ports have the same features.
    - Port: An individual transmit/capture port on a card.
    - Capture View: A view of the capture buffer for the port.
    - Filters, Statistics and Receive Mode: A means of programming capture triggers, filters, and statistics.
    - Packet Streams: A means of programming sets of streams and flows.
    - Statistics: A view of the statistics gathered by the port.
- Global Views:
  - Port Groups: Hold groups of related ports that may be operated on at the same time.
  - Stream Groups: Hold groups of related ports that may be operated on at the same time.

    - Packet Group Statistic Views: Allows the latency data (including Inter-Arrival Time) to be collected from one or more ports that are configured to receive packet groups.
    - Statistic Views: Holds groups of related ports, all of whose statistics can be viewed at one time.
    - Stream Statistic Views: Holds groups of related streams, all of whose statistics can be viewed at one time.
- MII Templates: A means of creating and editing MII templates.
- Layouts: A means of saving open GUI features.
- IxRouter Window: A means of designating interface addresses associated with ports and programming routing protocol simulations on each port. Note that IxRouter must be installed for full use of this window. Without IxRouter, only limited use of ARP and PING are allowed. See *IxRouter User Guide* for more information.

Chassis Chain (Software)

The IxExplorer chassis chain corresponds to the hardware chain. The chain starts with a primary chassis, whose sync-out line is connected to the sync-in line of the next chassis, and so on. Multiple chassis chains may be defined in the IxExplorer and operated independently or at the same time. Various forms of time synchronization may be used to coordinate multiple chassis chains dispersed world-wide into a single `virtual chassis chain'; see Chassis Synchronization.

Chassis

The IxExplorer chassis corresponds to an Ixia 400Tv2, XGS12, XGS2, or other chassis capable of holding Ixia module cards. The name or IP address of each chassis must be input; the type of the chassis is automatically discovered by the software. A chassis may hold any mix of module cards.

Card

The IxExplorer card corresponds to an Ixia load module card. The types of cards loaded in a chassis are automatically discovered and the appropriate number of ports are inserted into the hierarchy. Each port on a card has the same capabilities.

Port

The IxExplorer port corresponds to an individual port on an Ixia module card. Each port is independently programmed in terms of its transmit, capture and statistics capabilities. The IxExplorer software shows four separate views for programming and viewing operations:

- Filters, Statistics and Receive Mode: Sets the trigger and capture conditions for the capture buffer, conditions for the four user-defined statistics, and the receive mode for the port.
- Packet Streams/Flows: Defines the streams within stream regions and the contents of packets.
- Capture View: Shows the data gathered during capture operations. Data is displayed in raw form and interpreted for some protocols.
- Statistics : Shows the live statistics gathered during transmit and capture operation.

Port Properties

A Port Properties dialog allows other port related properties to be programmed:

- Auto-Negotiation: Low level physical controls, such as 10 versus 100 Mbps operation and full duplex versus half duplex.
- Advanced MII controls: Additional low level MII register controls.
- Flow control: Related to pause control operation.
- Collision Backoff Algorithm: Handling of collision situations.
- Forced Collisions: The generation of collision packets on receive ports.
- Transmit mode: The choice of streams or flows for the port.
- SONET Header: For use with Packet Over SONET frames.
- SONET Overhead: For generation of APS (K1/K2), J0/J1 bytes, and Error Insertion.
- PPP: For use with SONET. Includes dialogs for Negotiation, Link Control Protocols, and Network Control Protocols.

Port Groups

Port groups are an IxExplorer convenience. They allow to perform operations, such as start/stop transmit, start/stop capture and clear timestamps, for a wide range of ports all at the same time.

Stream Groups

Stream groups are an IxExplorer convenience. They allow to perform operations, such as start/stop transmit, start/stop capture and clear timestamps, for a group of streams all at the same time.

Packet Group Statistic Views

The Packet Group Statistics View allows the latency data (including Inter-Arrival Time) to be collected from one or more ports that are configured to receive packet groups. Packets representing different types of traffic profiles can be associated with packet group identifiers (PGIDs). The receiving port measures the minimum, maximum, and average latency in real time for each packet belonging to different groups. Measurable latencies include Instantaneous Latency, where each packet is associated with one group ID only, and Latency Over Time, where multiple PGIDs can be placed in `time buckets' with fixed durations.

Statistic Views

Statistic Views are similar to port groups, in that they let you consider a set of ports all at once. When a Statistic View group is selected, all of the statistics for all of the ports are simultaneously viewed. The particular statistics viewed may be independently selected for each Statistic View. Statistic logging and alerts are also provided; see Statistics Logging and Alerts.

Stream Statistic Views

Stream Statistic Views are like Statistic Views, but on a per stream basis rather than per port basis.

MII Templates

Allows for the creation and/or editing of MII template files. Register templates are applied to physical ports through Port Properties dialogs.

Layouts

Allows for the creation of templates for the layout of the IxExplorer GUI. A layout consists of the combined open features in the GUI.

IxRouter Window

The IxRouter window provides the means by which routing protocols are emulated by the Ixia hardware and software. This window includes the interface by which multiple IPv4 and IPv6 interfaces are associated with each port. A growing number of protocols are supported in this window, including ARP, BGP, OSPF, ISIS, RSVP-TE, LDP, RIP, RIPng, and IGMP.

Note that full use of this window requires that IxRouter be installed. For more information on protocols and protocol testing, see *IxRouter User Guide*.

IxExplorer Operation

IxExplorer saves all settings and programming in `saved' named files, which may be retrieved on each invocation. Captured data is lost when the IxExplorer is exited.

All IxExplorer test operations perform on an arbitrary set of ports, as single port or multiple ports may be selected. Any level of the hierarchy may be selected to include all ports below that level. For example, selecting a card includes all ports on that card, or selecting a chassis chain includes all ports on all cards in all chassis in the chassis chain. In addition, port groups may contain ports from any card; the port group may then be used in any testing operations.

The operations that can be performed on any group of ports:

- Start/Stop Capture: When capture is enabled, data for each port that is configured for capture (versus latency) is collected when the trigger is satisfied and to the extent that the filter is satisfied as well.
- Start/Stop Transmit: When transmit is enabled, data is transmitted as programmed to the extent designated by the synchronous stream region.
- Start/Stop Collision: Forced collisions are enabled/disabled for receive ports.
- Start/stop Latency: When latency measurement is enabled, data for each port configured for latency (versus capture) is collected when the trigger is satisfied and to the extent that the filter is satisfied as well.
- Pause/Single-Step Transmit: Transmittal of information may be paused and then single-stepped on a stream-by-stream basis or continued through a start transmit command.
- Interactive streams: This is a special function that allows for interactive variation of frame size and inter-packet gaps. Interactive streams may not be operated across ports that are configured for flows.

Multi-User Operation

IxExplorer provides an optional means of coordinating the sharing of chassis ports among multiple users. If a single user is operating a chassis, multi-user commands are not required at all. As an user, you may perform any operation on any port. Two or more people may also share ports on a chassis without use of IxExplorer multi-user facilities, through some verbal agreement (for example, `You take cards 1-8 and I'll take cards 9-16'). IxExplorer provides no assistance in this instance.

Where more accurate control over port sharing is required, multi-user facilities should be used. IxExplorer's multi-user model is a very simple, advisory model. Each user logs in with an arbitrary name. Each and every user may take ownership of any and all ports. A port owner has the ability to read data and program the port; all other users have read-only access to the port. A port owner may clear ownership of ports, making them available for other users. You may take ownership of a port owned by someone else, with an optional warning message. Any user may clear all ownerships.

IxExplorer provides a further distinction of roles between users. Administrators are privileged users who may take ownership of ports, configure their characteristics, and initiate tests using those ports. Operators are unprivileged users who may only look at chassis, card, and port characteristics and measured data.

NOTE We NEVER support multiple clients simultaneously changing data on one port. The rule is: one port-one owner for each system test. The ownership model should not be used to have one script take ownership of a port and another script take ownership of that same port with the same username because one client may be working with a copy of the port configuration that has been made invalid by another owner.

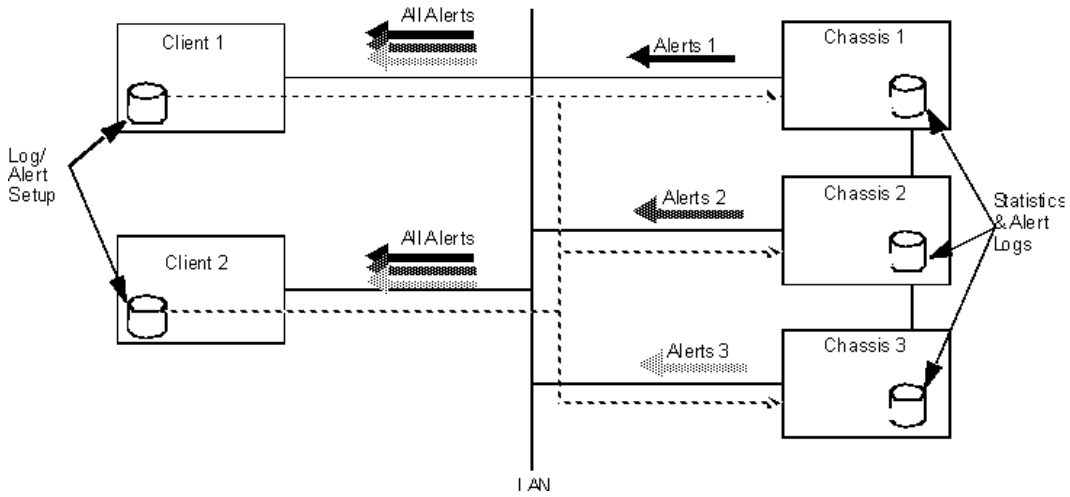
The two basic modes of multi-user operation are referred to as:

- Voluntary: All users are considered administrators and voluntarily login and take or clear ownership of ports. All chassis are initially configured in this mode.
- Secure: Users are characterized as Administrators or Operators. All users must login. Administrators operate in the same manner as all Voluntary mode users. Operators are restricted to viewing data.

Statistics Logging and Alerts

IxExplorer has the ability to centrally log statistics from any port and to signal alert conditions when a particular statistic goes out of a specified, valid range. The following figure shows the basic operation of logging and alerts.

Figure: Statistics Logging and Alerts



The clients (Client 1 and Client 2) run IxExplorer and are connected to all of the chassis (Chassis 1, Chassis 2 and Chassis 3) in the chassis chain. The clients set up conditions under which statistics data is logged and alerts generated. These conditions are transmitted to all of the chassis. Each chassis interprets these conditions and logs statistics data and alert conditions to their local disks.

When a chassis detects an alert condition, it sends signals to **all** of the clients connected to the chassis at the moment. Each client receives alerts from **all** of the chassis, regardless of whether they set up the particular alert condition themselves.

It can take considerable effort to set up one port's statistics logging and alert conditions. It is not necessary to repeat this process for multiple ports that have identical logging and alert behavior. IxExplorer's Port Copy feature may be used to copy these specifications.

It should be noted that logging and alerts continue even after a client has exited IxExplorer.

Statistics Logging

Each client selects particular statistics on particular ports to be logged. The data is logged at the chassis hosting the port. All clients connected to a chassis contribute their desired port-statistics to be logged. All statistics from all clients are logged to the same single file on a chassis.

The log file is ASCII in format and contains a line of text for each port on which statistics have been gathered. Each line contains all of the selected statistics for the port, separated by commas. The contents of the file are easiest to understand and interpret if the same statistics are gathered for all ports.

The statistic values that are logged are the `rolling average' for the value logged. That is, a value at time slot *n* depends on the previous average and the current measured value, as per the following equation:

$Average_n = (Average_{n-1} * (n-1)/n) + (Measurement_n * 1/n)$

The client specifies several parameters that affect the logging of statistics:

- Enable/Disable: Enable or disable all statistics logging specified from this client.
- Log at interval: Specify an interval between logged entries.

- Log during alerts: Log statistics while alert conditions exist.
- File naming: The format and location of logging files on the chassis.

Multiple clients should agree on the log interval and file naming conventions; the chassis uses the settings received from any client that applies changes.

Alerts

Each client sets up anticipated valid ranges for particular statistics on specific ports. All clients connected to a chassis distribute their specific valid ranges to all chassis. Each chassis watches for out of range values on the specified port-statistics and generates alerts for the conditions. **All** alert conditions are sent to **all** connected clients. Alert condition changes may be optionally logged on files at the chassis.

The client indicates how it wants to receive alerts for a particular statistic and port. There are three options:

- Visual: each statistic subject to alerting is displayed as green (in range), red (out of range) or yellow (was previously out of range) in any Statistic View containing the port-statistic.
- Audible: while any out of range condition exists, the client's computer issues a repeating beep-beep. A client may mute all audible alarms at once.
- Both visual and audible.

In addition, the existence of an alert condition for a particular port-statistic may be used to initiate statistics logging for that port, as described in Statistics Logging.

The client specifies several parameters that affect the setup of alert conditions:

- Enable/Disable alerts: Enable or disable all visual and/or audible alerts specified from this client.
- Enable/Disable Alert Logging: Enable or disable the logging of alert change conditions on the chassis.
- File Naming: The format and location of alert files on the chassis.

Multiple clients should agree on the valid range of port-statistics values and file naming conventions; the chassis uses the settings received from any client that applies changes.

Tcl Software Structure

The Tcl software is structured as a number of client-server pieces so that it may operate simultaneously in three different environments:

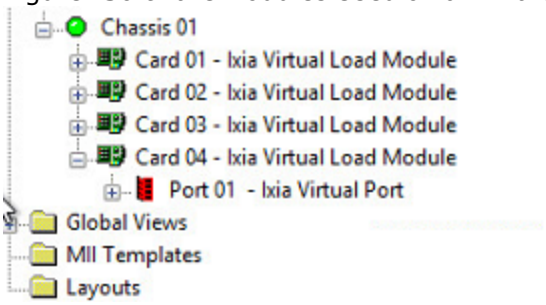
- On the Ixia chassis: The Tcl scripts are executed on the same computer that runs the Ixia hardware.
- On a Windows client: The Tcl scripts are executed on a Windows 2000/XP client.
- On a Unix client: The Tcl scripts are executed on a Unix client.

The following sections describe the components used in each of these scenarios.

Operation on the Ixia Chassis

When the Tcl client software is installed on the Ixia chassis itself three distinct software components are used, as shown in the following figure.

Figure: Software Modules Used on an Ixia Chassis



In this scenario, three components are used as described in the following table.

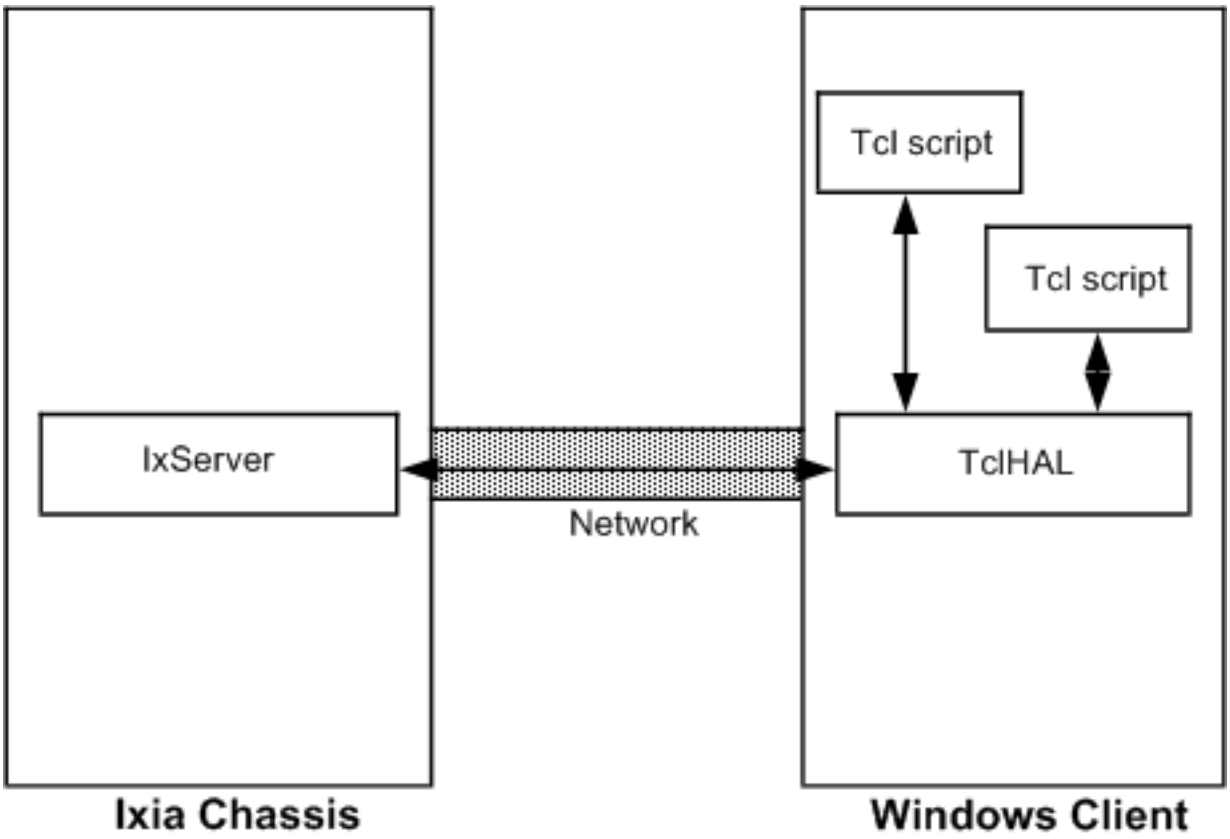
Software Modules Used on an Ixia Chassis

Module	Usage
Tcl scripts	Ixia supplied and user developed Tcl. The Tcl extensions that program the Ixia hardware use the TclHAL layer.
TclHAL	A layer of software, supplied as a DLL (Dynamic Linked Library), that is responsible for interpreting the Tcl commands into C++ functions to be sent to the IxServer software.
IxServer	An independent Windows executable that is responsible for directly controlling the Ixia hardware.

Operation on a Windows Client

When the Tcl client software runs on a Windows client, the same three components are used but in a different configuration, as shown in the following figure.

Figure: Software Modules Used on a Windows Client



In this scenario, three components are used as described in the following table.

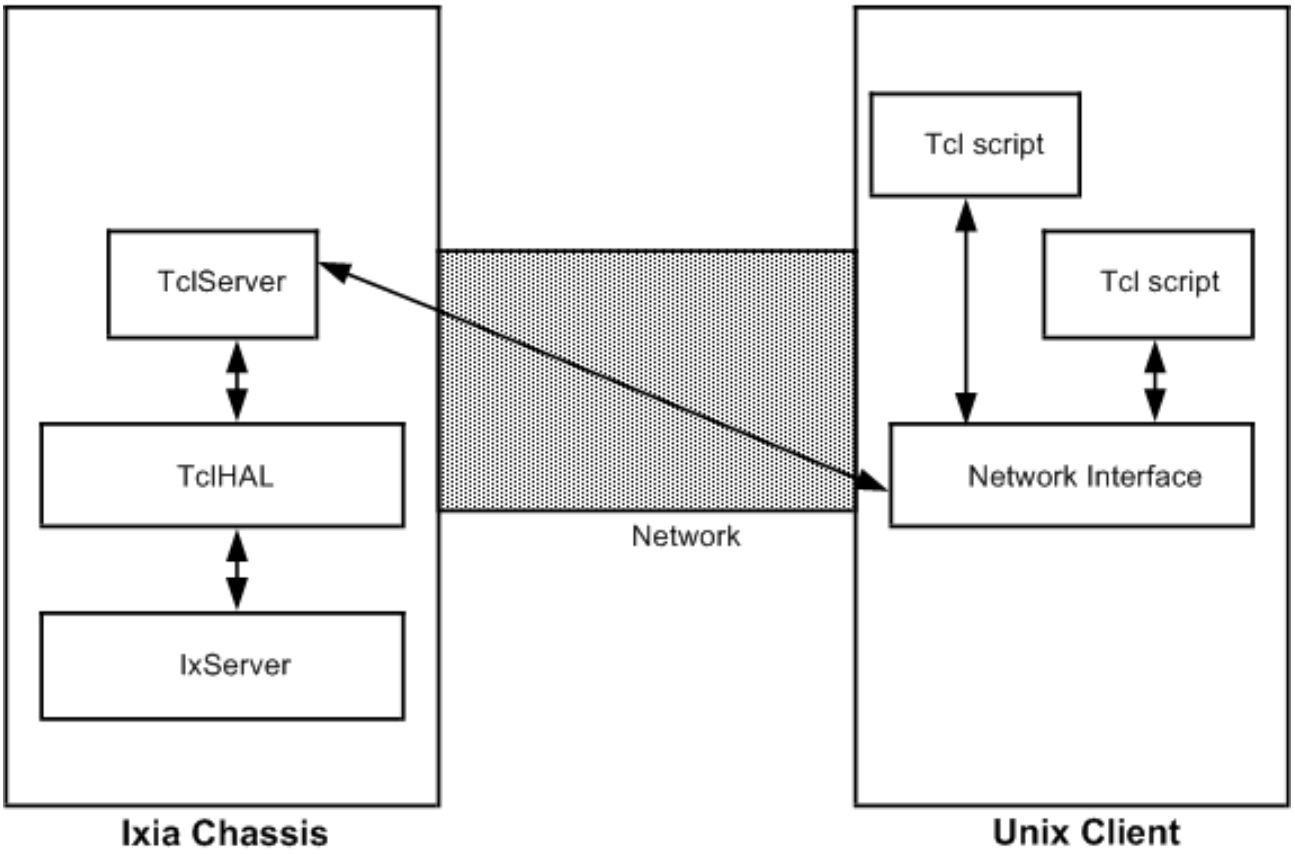
Software Modules Used on a Windows Client

Module	Usage
Tcl scripts	Ixia supplied and user developed tests run on the Windows client using the Tcl software. The Tcl extensions that program the Ixia hardware use the TclHAL layer.
TclHAL	A layer of software, supplied as a DLL (Dynamic Linked Library), that is responsible for interpreting the Tcl commands into C++ functions to be sent to the IxServer over the local network.
IxServer	An independent Windows executable running on the Ixia Chassis that is responsible for directly controlling the Ixia hardware. Its commands are received from clients over the LAN.

Operation on a Unix Client

When the Tcl client software runs on a Unix client, five components are used as shown in the following figure.

Figure: Software Modules Used on a Unix Client



In this scenario, five components are used as described in the following figure.

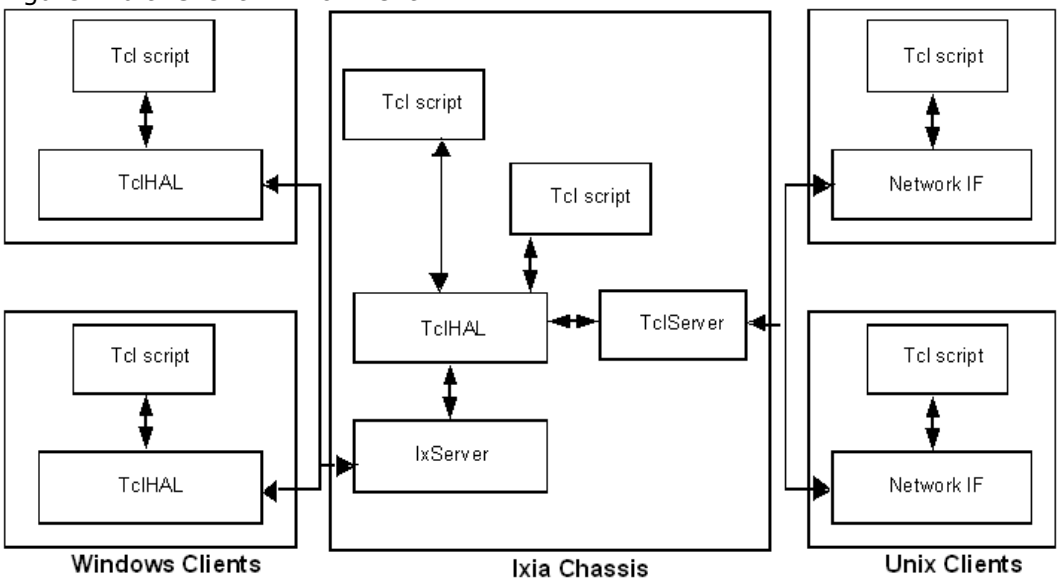
Software Modules Used on a Unix Client

Module	Usage
Tcl scripts	Ixia supplied and user developed tests run on the Windows client using the Tcl software. The Tcl extensions that program the Ixia hardware use the Tcl-DP client software.
Network Interface	This is a layer of software within the TCL system that translates hardware commands into ascii commands, which are sent to the TCL Server on the connected Ixia chassis.
TclServer	This layer receives commands from the Tcl-DP client on Unix client platforms. Commands are translated into calls to the TclHAL layer.
TclHAL	A layer of software, supplied as a DLL (Dynamic Linked Library), that is responsible for interpreting the Tcl commands into C++ functions to be sent to IxServer on the chassis over the network.
IxServer	An independent Windows executable running on the Ixia Chassis that is responsible for directly controlling the Ixia hardware. Its commands are received from clients over the LAN.

Multiple Client Environment

A single Ixia chassis may be used by multiple clients simultaneously. Clients may run from the Ixia chassis, Windows clients, and Unix clients simultaneously, as shown in the following figure.

Figure: Multi-Client Environment



TCL Version Limitations

Note the following limitation with respect to Tcl versions and the use of Wish and Tclsh shells:

1. Tcl 8.0 is no longer supported.
2. Tclsh does not run on any version of Windows, with Ixia software. Under Linux or Solaris, Tclsh runs on any version of Tcl greater than or equal to 8.2.

The use of the Wish shell with Ixia software has been tested for Tcl 8.3 under Windows, Linux, and Solaris. It has not been tested, but should run with any Tcl version greater than or equal to 8.2.

Beginning with the Ixia TCL libraries supplied with IxOS version 3.80, these libraries are compatible with TCL version 8.3 and above. That is, it is not necessary to obtain a new version of the Ixia libraries when TCL 8.4 (or above) is installed on a computer.

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CHAPTER 3

Theory of Operation: Protocols

Protocol Server

Most ports in an Ixia chassis operate a Protocol Server. The Protocol Server includes a complete TCP/IP stack, allowing different forms of high-level DUT testing. The Protocol Server can be configured to test a set of provided Level 2 and Level 3 protocols, which include MAC and IP addressing and IP routing. The Protocol Server for Packet over SONET cards omits all MAC configuration items, since POS does not use a MAC layer. The information gathered by the Protocol Server is used within generated frame data, as well.

The Protocol Server can be accessed through the IxRouter Window. Each protocol must be individually enabled for a selected port in the IxRouter Window.

The protocols supported by the Ixia Protocol Server are described in the following sections in this chapter:

Protocols Supported by Ixia Protocol Server

Address Resolution Protocol (non-POS only) (includes IP to MAC addressing)	See ARP
Internet Gateway Management Protocol	See IGMP
Open Shortest Path First Protocol	See OSPF
Open Shortest Path First Protocol Version 3 (for IPv6)	See OSPFv3
Border Gateway Protocol	See BGP4/BGP+
Routing Information Protocol	See RIP
Routing Information Protocol: Next Generation (for IPV6)	See RIPng
Intermediate System to Intermediate System (Dual Mode)	See ISISv4/v6
Resource ReSerVation Protocol: with Traffic Engineering Extensions	See RSVP-TE
Label Distribution Protocol	See LDP
Multicast Listener Discovery	See MLD
Protocol Independent Multicast: Sparse Mode	See PIM-SM/SSM-v4/v6

Multi-Protocol Label Switching	See MPLS
Bi-Directional Forwarding	See BFD
Connectivity Fault Management	See CFM
Fibre Channel over Ethernet (FCoE), FCoE Initialization Protocol (FIP) and NPIV	See FCoE and NPIV
Precision Time Protocol (PTP)	See Precision Time Protocol (PTP) IEEE 1588v2

There are additional sections on the following topics:

- ATM Interfaces
- Generic Routing Encapsulation (GRE)
- DHCP Protocol
- Ethernet OAM

ARP

The Address Resolution Protocol (ARP) facility controls the manner in which ARP requests are sent. This option is only available on Ethernet load modules. The resulting responses from ARP requests are held in the ARP Table, which is used to set MAC addresses for transmitted data. ARP'ing the Device Under Test (DUT) allows tests and generated frames to be configured with a specific IP address, which at run time is associated with the MAC address of that particular DUT.

IP

The IP table within the ARP window specifies a per-port correspondence between IP addresses, MAC addresses (for Ethernet ports only), and the Default Gateway. IP addresses may be expressed as individual addresses or as a range of addresses.

All ARP requests (for Ethernet) are sent to the Default Gateway address. In most cases, the Default Gateway Address is the address of the DUT. When a gateway separates the Ixia port from the DUT, use the IP address of that gateway as the Default.

IGMP

The Internet Group Management Protocol (IGMP) is used with IPv4 to control the handling of group membership in the Internet. Version 3, specified in RFC 3376, is supported and is interoperable with Versions 1 and 2. Version 1 of the protocol is specified in RFC 1112, and Version 2 is specified in RFC 2236.

IGMP normally works in an environment in which there are a number of IGMP-capable hosts connected to one or more IGMP routers. The routers forward membership information and packets to other IGMP routers and receive group membership information and packets from other IGMP routers.

The Ixia hardware simulates one or more hosts, while the DUTs are assumed to be IGMP routers. The simulation calls for groups of simulated hosts to respond to IGMP router-generated queries and to

automatically generate reports at regular intervals. A number of IGMP groups are randomly shared across a group of hosts.

Version 3 adds the concept of filtering, based on the IP source address, to cut down on the reception of unwanted multicast traffic. This filtering consists of limiting the receipt of packets to only those from specific sources (INCLUDE) or to those from all but specific sources (EXCLUDE). Refer to MLD for information about similar functions for multicast traffic in IPv6 environments.

Compatibility with earlier versions of IGMP is an important part of IGMPv3. The Group Compatibility Modes for an IGMPv3 router are summarized as follows:

- IGMPv3 Compatibility Mode (default): An IGMPv2 and/or IGMPv1 Host is present, but NOT running.
- IGMPv2 Compatibility Mode: An IGMPv2 Host may be present and running. An IGMPv1 Host is present, but NOT running.
- IGMPv1 Compatibility Mode: An IGMPv1 Host is present and running.

OSPF

NOTE See also OSPFv3

Open Shortest Path First (OSPF) is a set of messaging protocols that are used by routers located within a single Autonomous System (AS). The Ixia hardware simulates one or more OSPF routers for the purpose of testing one or more DUT routers configured for OSPF. The OSPF version 2 specification (RFC 2328) details the message exchanges by OSPF routers, as well as the meanings and usage.

OSPF has the following three principal stages:

- The HELLO Protocol
- Database transfer
- HELLO Keepalive

When an OSPF router initializes, it sends out HELLO packets and learns of its neighboring routers by receiving their HELLO packets. If the router is on a Point-to-Point link, or on an Ethernet (transit network) link, these packets are addressed to the *AllSPFRouters* multicast address (224.0.0.5). In these types of networks, there is no need to manually configure any neighbor information for the routers.

Each router that is traversed on the path between neighbors is added to a list contained in the HELLO packet. In this way, each router discovers the shared set of neighbors and creates individual state machines corresponding to each of its neighbors.

If the network type is broadcast, then the process for selecting a Designated Router (DR) and Backup Designated Router (BDR) begins. A Designated Router is used to reduce the number of adjacencies required in a broadcast network. That is, if no Designated Router is used, then each router must pair (form an adjacency) with each of the other routers. In this case, the number of required adjacencies is equal to the square of the number of routers (N^2). If a DR and BDR are used, the number of required adjacencies drops to 2 times the number of routers (2N). Currently, the Ixia ports are unable to simulate a DR or BDR.

Once the routers have initialized their adjacency databases, they synchronize their databases. This process involves one router becoming the master and the other becoming the subordinate. On

Ethernet networks, the DR is always the master; on point-to-point networks, the router with the highest Router ID is the master.

Link State Advertisements (LSAs) are OSPF messages that describe an OSPF router's local environment. The simplest LSA Type is the router-LSA (RouterLinks LSA). Each router is required to generate exactly one of these LSAs to describe its own attached interfaces. If a network that consists of a single OSPF area is being simulated with only point-to-point links and there are no Autonomous System Border Routers (ASBR), then this is the only type of LSA that is sent.

The subordinate asks the master for its LSA (Link State Advertisement) headers, which enables the subordinate to determine the following information:

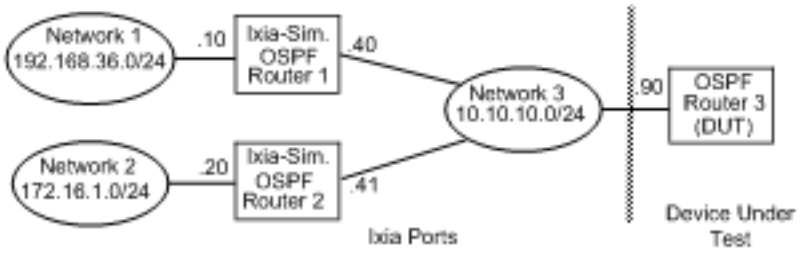
1. The subset of LSAs that the master holds, but that the subordinate does not have, **and**
2. The subset of LSAs that the master and subordinate both have, but which are more recent on the master.

The subordinate router then proceeds to explicitly query the master to send it each LSA from Steps (1) and (2). The subordinate sends an ACK to the master upon receipt of each LSA. The global Link State Database (LSDB) is constructed by each router, based on LSAs from all the other routers in the network.

Once this exchange process is complete, the routers are considered to have reached Full Adjacency, and each runs the link state algorithm to update its IP forwarding tables. The routers continue to exchange periodic HELLO packets, as keepalive messages, until a change occurs (for example, a link goes down or an LSA expires). OSPF routers continue to periodically exchange their LSAs every 30 minutes to ensure that they all hold identical LSDBs.

This section describes the programming of the Ixia hardware related to OSPF testing, as well as the theory of operation and protocol message formats. The Ixia hardware simulates multiple OSPF routers on multiple networks. For example, in the following figure, there are three networks and three routers.

Figure: Sample OSPF Network



The Protocol Server calls for the specification of router-network connections to be specified in a network-centric fashion. One specifies the network in terms of an Area ID and network mask. One specifies the routers in terms of the interface IP address on that network and Router ID, usually the lowest IP address for the router. For the sample OSPF network, in which Router 3 is the DUT, the three networks are specified by their significant characteristics as shown in the following table.

Sample OSPF Network Assignments

Network	Area ID	Network Mask	Router ID	Router Interface IP Address
1	192.168.36.0	255.255.255.0	192.168.36.10	10.0.0.40
2	172.16.0.0	255.255.255.0	172.16.0.20	10.0.0.41
3	10.0.0.0	255.255.0.0	10.0.0.40 10.0.0.41 10.0.0.90	10.0.0.40 10.0.0.41 10.0.0.90

Within this framework, Link State Advertisements (LSAs) may be issued from the perspective of any interface on any router. Any OSPF messages from the DUT Routers may be captured and analyzed in the normal manner.

OSPFv3

Open Shortest Path First Protocol Version 3 supports Internet Protocol version 6 (IPv6), as defined in RFC 2740. The 128-bit IPv6 addressing scheme has been accommodated in OSPF through the use of new LSA types.

Some of the differences between OSPFv2 (for IPv4) and OSPFv3 (for IPv6) are listed as follows:

- Changes to adapt to the IPv6 128-bit address size. No addresses are carried in OSPF packets or basic LSAs, but addresses are carried in certain LSAs.
- OSPFv3 operation is per Link, with the IPv6 concept of `link' replacing the `IP subnet' and `network' terminology of OSPFv2.
- OSPVv3 supports multiple instances of the protocol per link, through `Instance IDs.'
- LSA flooding scope is explicitly defined in the LS Type field of each LSA.
- Authentication is handled by the IPv6 protocol itself, rather than by the OSPF protocol. For this reason, Authentication information has been removed from the packet headers in OSPFv3.

NOTE In OSPFv2, IPv4 addresses were used in many contexts besides IP source and destination addresses. For example, they were assigned as name identifiers for routers (RIDs). This naming convention for RIDs has been retained in OSPFv3.

BGP4/BGP+

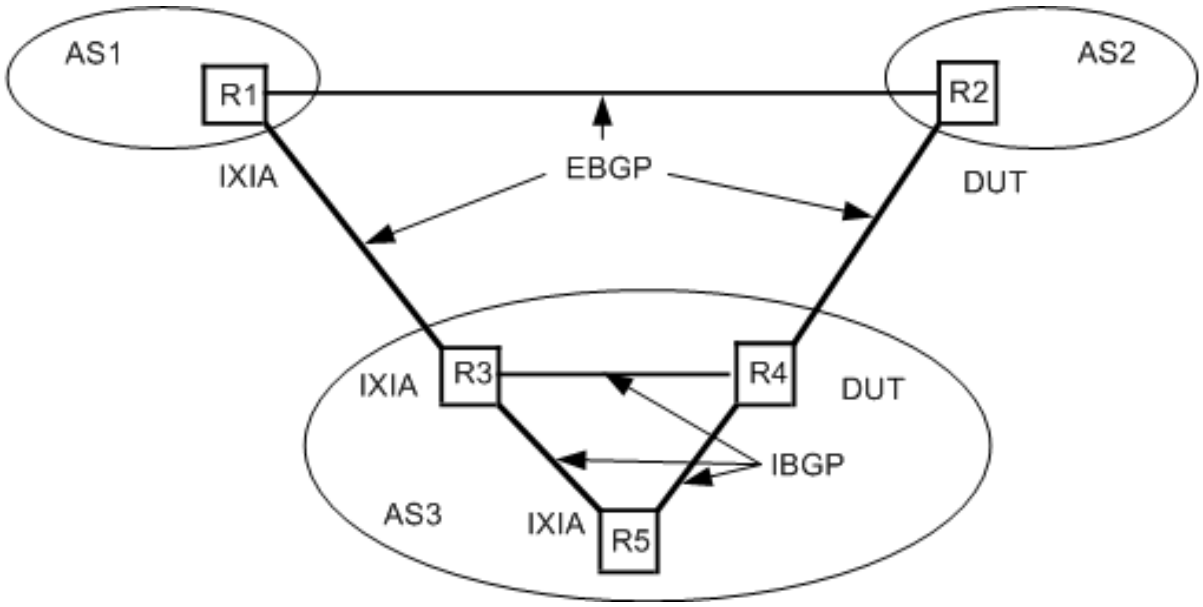
Border Gateway Protocol Version 4 (BGP-4) is the principal protocol used in the Internet backbone and in networks for large organizations. The BGP4 specification (RFC 1771) details the messages exchanged by BGP routers, as well as their meaning and usage. *BGP4 - Inter-Domain Routing in the Internet*, by John W. Stewart III is a descriptive reference on this protocol.

Internal Versus External BGP

The BGP4 protocol is used according to two sets of rules, depending on whether or not the two communicating BGP routers are within the same Autonomous System (AS). An AS is a collection of routers that implement the same routing policy and are typically administered by a single group of

administrators. ASs connected to the Internet are assigned Autonomous System Numbers (ASNs) that are key to inter-domain routing. When BGP is used **between** two ASs, the protocol is referred to as EBGP (External BGP); when BGP is used **within** an AS it is referred to as IBGP (Internal BGP). The following figure depicts the differences in topology between EBGP versus IBGP.

Figure: External BGP Versus Internal BGP



In the figure above, AS1, AS2, and AS3 are distinct Autonomous Systems. The Rns are routers in the various ASs. Routers on the links between ASs `speak' EBGP, while the routers within AS3 `speak' IBGP.

IBGP Extensions

In the original BGP4 specification (RFC 1771), all IBGP routers within an AS are required to establish a full mesh with each other. This leads to a lack of scalability which is solved by the introduction of two additional concepts: *route Reflection* and *Confederations.*

In route reflection, some routers in an AS are assigned the task of re-distributing internal routes to other internal AS routers. To prevent looping within an AS that uses route reflection, two concepts are important: the *originator-id* and *cluster-list* attributesThe originator-id is the identification of the router that originated a particular route. Routers within an AS propagate this information and refuse to send a route back to its originator. Even the use of route reflectors and originator-ids can lead to scalability problems in an AS. The cluster-list concept helps this problem. A cluster consists of a reflecting router and its clients. A Cluster ID is the IP address of the reflecting router if there is one, or a configured number otherwise. A cluster-list is a constructed list, consisting of the cluster IDs of all of the clusters that a route has passed through. Each router refuses to send a route back to a cluster that has seen the route already.

In a confederation, an AS is divided into multiple sub-confederation subsets. Each sub-confederation is defined in terms of its own ASN and a list of routers. Routers within a sub-confederation are expected to fully mesh using IGP. Sub-confederations within a confederation speak a variant of EGP, called EIGP. Additional path attributes are used with a confederation to indicate paths that should not be propagated outside the confederation.

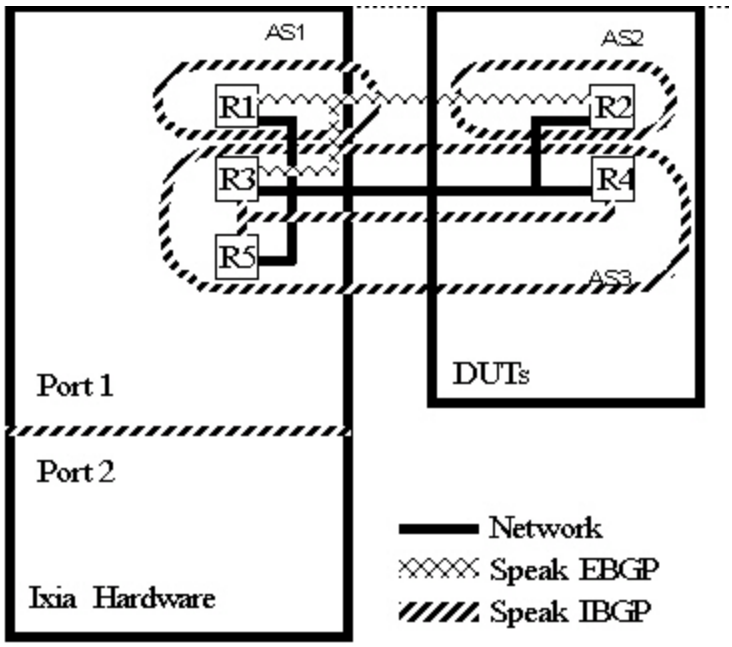
Communities

In deployment of BGP4 into a growing Internet environment, it became necessary to deal with certain routes in different manners not related to the strict routing of packets. The community attribute was invented to allow a route to be `tagged' with multiple numbers, called communities. This is also referred to sometimes as *route coloring.*

BGP Router Test Configuration

The Ixia Protocol server implements an environment in which the Ixia hardware simulates multiple routers which speak IBGP and/or EBGP with one or more DUT routers. For example, in the External BGP Versus Internal BGP figure, the Ixia hardware emulates R1, R3, and R5 while the DUTs are R2 and R4. The following figure depicts the same setup based on the location of the simulated or actual router:

Figure: BGP Interconnection Environment

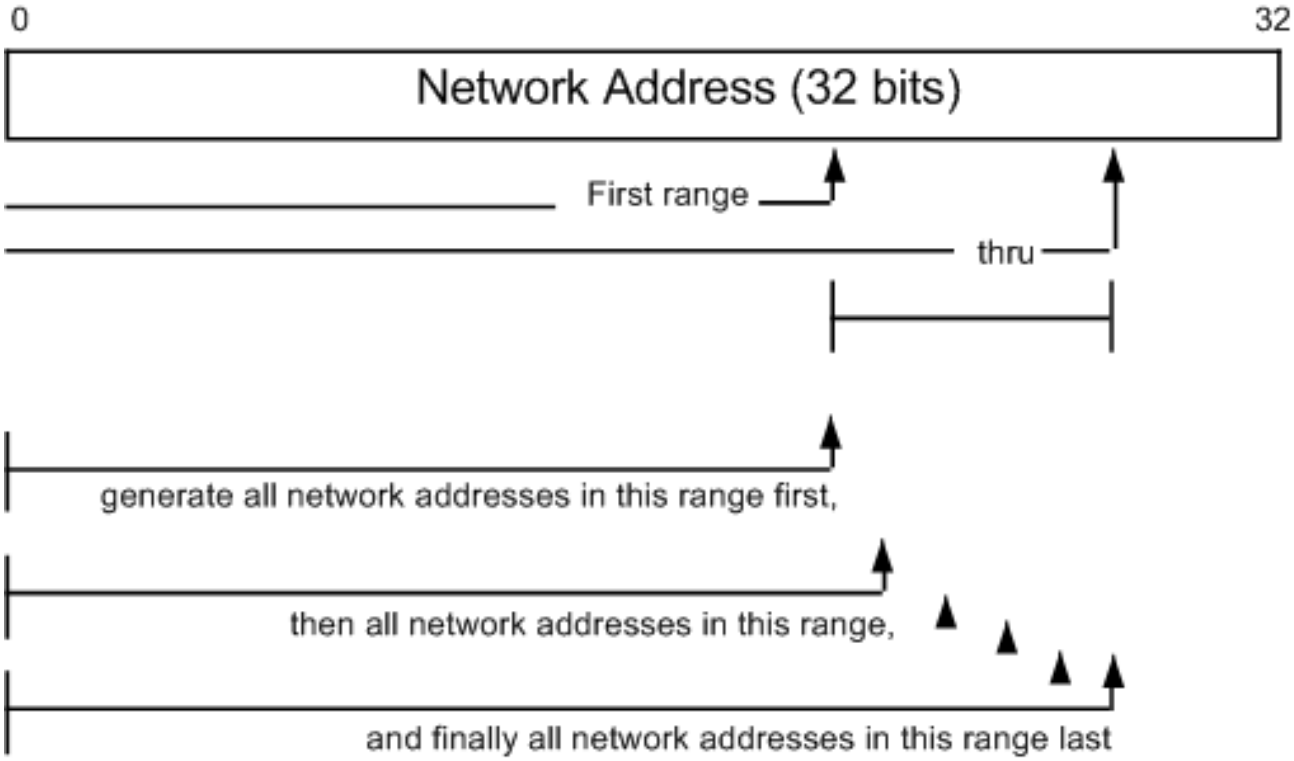


All of the routers are logically connected through appropriate networking hardware. The Ixia hardware is used to simulate three of the routers in two different ASs communicating with two routers being tested.

A single router emulated by the Ixia hardware is specified by a single IP address, and a number of emulated routers may be specified by a range of IP addresses. Each DUT router is identified by its IP address.

Messages may be sent between the emulated routers and the DUT routers when a connection is made and one of the two endpoints sends an OPEN message. Where the emulated routers and the DUT routers send their OPEN messages simultaneously, standard collision handling is applied. Thereafter, the emulated routers send a number of UPDATE messages to the DUT routers. The UPDATE messages contain a number of network address ranges (route ranges), also known as ranges of prefixes. The ranges of generated network addresses is illustrated in the following figure.

Figure: Generation of Network Addresses in BGP UPDATE Messages



A designated number of network addresses are generated with network Mask Width with the *From* through *To* values. The following table shows some examples of generated addresses. Network Addresses are generated by starting with the First Route and *From* mask width up to, but not including 224.0.0.0. (127.*.*.* is also skipped). If the requested number of network addresses has not been generated before 224.0.0.0 is reached, then the next mask length is used with the First Route to generate network addresses.

Examples of Generated BGP Routes (Network Addresses)

First Route	Mask Width From	Mask Width To	Iterator Step	Number of Routes	Generated BGP Routes (Network Addresses)
192.168.36.0	24	26	1	(14,378,756 Max.)	192.168.36.0/24 192.168.37.0/24 192.168.38.0/24 ... 223.255.255.0/24 (224.0.0.0+ skipped) 192.168.36.0/25 192.168.36.128/25 192.168.37.0/25 ...

First Route	Mask Width From	Mask Width To	Iterator Step	Number of Routes	Generated BGP Routes (Network Addresses)
					223.255.255.128/25 (224.0.0.0+ skipped) 192.168.36.0/26 192.168.36.64/26 192.168.36.128/26 ... 223.255.255.192/26
204.197.56.0	24	24	10	4	204.197.56.0/24204.197.66.0/ 24204.197.76.0/24204.197.86.0/ 24

All of the generated network addresses are associated with a set of attributes that describes routing to these generated network addresses and associated features.

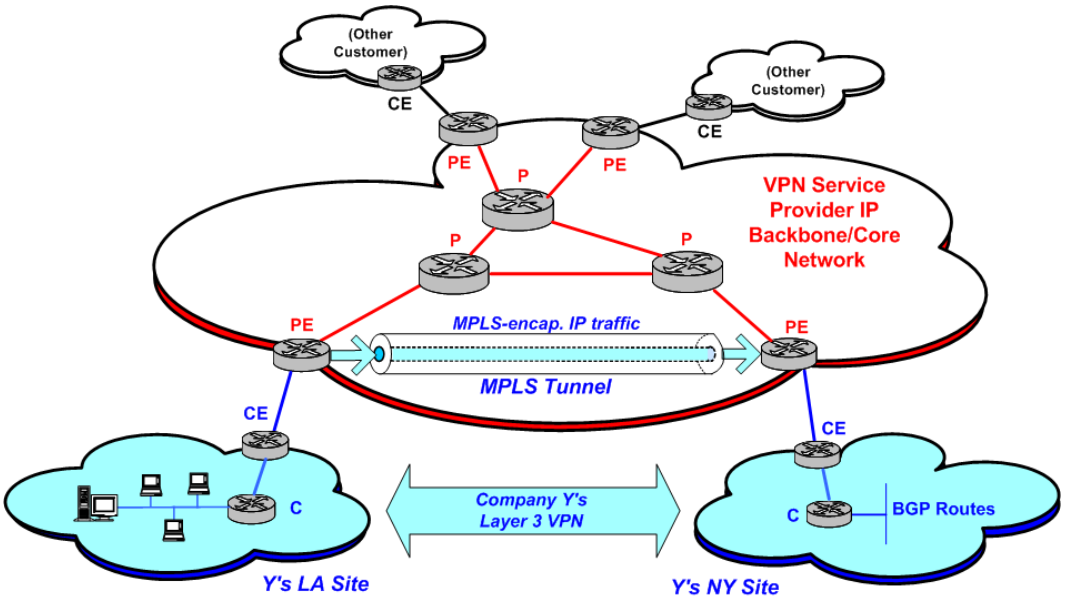
Only one route can be added per UPDATE message, but a variable number of *withdrawn* routes may be packed into each UPDATE message. The packing is randomly chosen across a range of a number of routes. The time interval between UPDATE messages is configurable, in units of milliseconds.

A BGP4 network condition called `flapping' can be emulated by the protocol server on an Ixia port. In the Link flapping emulation, a peer BGP router appears to be going offline and online repeatedly, which is accomplished on the Ixia port by alternate disconnects and reconnects of the TCP/IP stack. In the Route flapping emulation, BGP routes are repeatedly withdrawn, and then re-advertised, in UPDATE messages.

BGP L3 VPNs

L3 Virtual Private Networks (VPNs) over an IP backbone (at Layer 3 of the OSI model), may be provided to the customers of a Service Provider (SP), providing connectivity between two or more sites owned by the customer. L3 VPNs are independent of the Layer 2 protocol. While MPLS handles the packet forwarding in the backbone/core, the BGP protocol provides a means of advertising external routes/network addresses across that backbone between sites. IETF Internet Draft `draft-ietf-ppvpn-rfc2547bis-01.txt,' the proposed successor to RFC 2547, covers the VPN architecture designed for use by private service providers. A simplified example of a BGP L3 VPN topology is shown in the following figure.

Figure: Simplified BGP L3 VPN Diagram

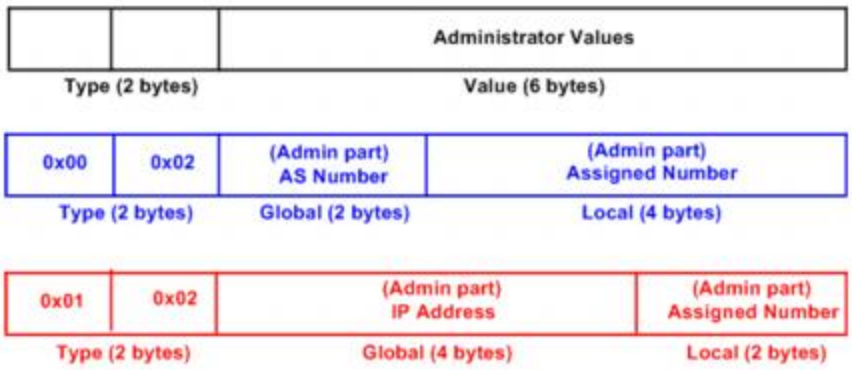


The term *site* refers to a customer/client site, which consists of a group of inter-connected IP devices, usually in one geographic location. A Customer Edge (CE) device, typically a router, connects the site, through a data link connection, to a Provider Edge (PE) router an entry point to the service provider's backbone. The PE-to-CE routing protocols may be static routing, or a dynamic protocol such as eBGP or RIPv2.

Provider (P) network core routers, `transparently' carry the IP traffic across the internal core between CE routers. CEs and Ps are not `VPN-aware' devices. CE devices are considered as belonging to a only one site, but that site may belong to multiple VPNs. A VPN Routing and Forwarding table (VRF) on a PE consists of an IP routing table, a forwarding table, and other information on the set of interfaces in the VPN. The VRF generally describes a VPN site's routing information, and a PE may maintain multiple VRFs, one for each connected customer site. See L3 VPN VRFs for additional information on VRFs.

Layer 3 VPN sites are identified by a Route Target (RT). A route target is based on the mechanism proposed in the IETF draft for the `BGP Extended Communities Attribute.' An 8-byte route target is common to all route ranges that belong to a single L3 site. Route targets are defined for individual VPN route ranges. The formats for Route Targets (RTs) are shown in the following figure.

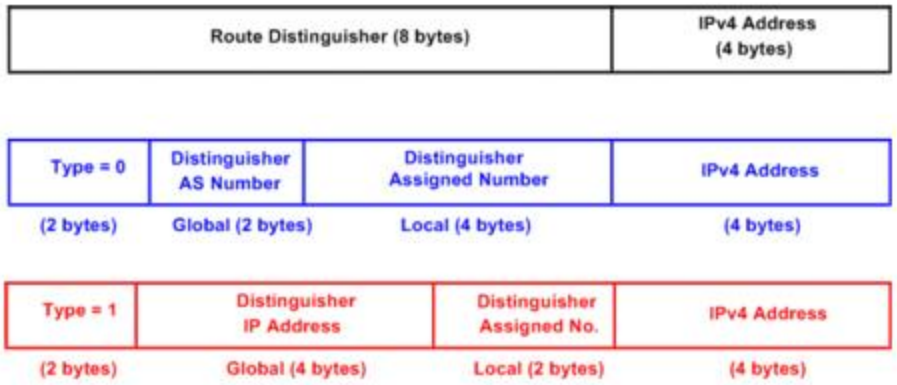
Figure: Route Target Formats (BGP Extended Community Types)



BGP VPN-IPv4 Address Formats

Globally unique 12-byte VPN-IPv4 prefixes are created by a PE router. This includes configuration of the 8-byte VPN Route Distinguishers (RDs). It should be noted that BGP IPv4 routes and VPN -IPv4 routes are considered noncomparable; VPN-IPV4 addresses can be used only within the VPN service provider network.The route distinguishers are used by PE routers to associate routes with the path to a particular CE site router in a VPN. Each route can only have one RD. The formats of the RDs are shown in the following figure.

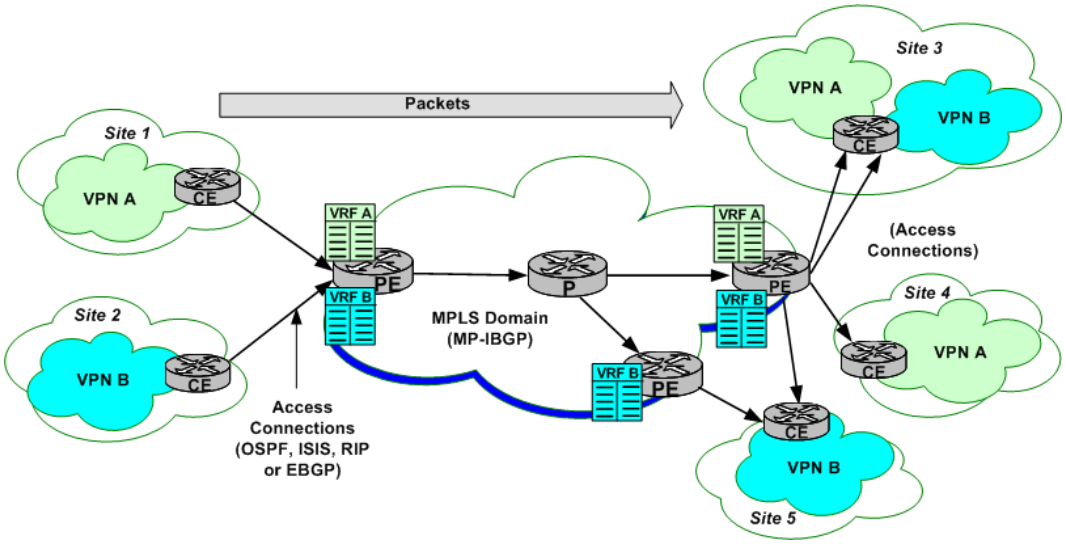
Figure: VPN-IPv4 Address Formats (with Route Distinguishers)



L3 VPN VRFs

For Layer 3 Virtual Private Network (L3 VPN) configurations, the Provider Edge (PE) routers maintain routing tables for each VPN that they participate in, termed VPN Routing and Forwarding tables (VRFs). The VRFs are populated with routes received from both the directly attached and remote Customer Edge (CE) routers. Each entry in the VRF is called a VPN Forwarding Instance (VPI). VRFs and CEs are not required to be configured on a one-to-one basis, although this is the typical situation. An example of the possible relationships between VRFs and CEs is shown in the following figure.

Figure: L3 VPN VRF Example



RIP

The Routing Information Protocol (RIP) is an interior gateway routing protocol (IGP) and uses a Distance Vector Algorithm. It is the oldest and most frequently used of the LAN routing protocols. RIP routers broadcast or multicast to each other on a regular basis and in response to REQUEST packets. RIP routers optionally incorporate routing information received from their neighbors into their own routing table and forward it on to other neighbors.

NOTE For information on **RIPng** (RIP-Next Generation), based on IPv6, see RIPng

As implemented by the Protocol Server, each Ixia port is capable of simulating one or more routers with separate addresses. Routing tables for the simulated routers are configured by you and sent out at regular intervals, with a configurable randomizing factor. Either Version 1 or Version 2 packet formats may be sent through multicast or broadcast (for compatibility with Version 1 routers). Received packets may be filtered for Version 1 or Version 2 compatibility.

The current implementation of the Protocol Server uses Split Horizon with Space Saver as its update mode, which receives, but not process, RIP broadcasts heard from DUT routers. That is, it does **not** incorporate received information into its own table, but rather always broadcast the same routing table. Future versions will offer Split Horizon, Split Horizon with Poison Reverse, and Silent modes of update.

The Protocol Server, however, responds to REQUEST packets that it receives. Two types of requests are processed:

- Request for all routes: The Protocol Server sends the same routing table that it sends at regular intervals back to the requester.
- Request for specific routes: The Protocol Server fills in the requested information in the received packet and send it back to the requester.

RIPng

Routing Information Protocol - Next Generation (RIPng) is specified for use with IPv6 in RFC 2080. Like the IPv4 version of RIP, this routing protocol is based on a Distance Vector algorithm. RIPng routers compare information for various routes through an IPv6 network, especially the information related to the RIPng metric. Due to the limited number of allowed hops, this protocol is used in small- to moderate-sized networks. The valid metric range is from 1 to 15 (hops). The metric values of 16 and above are defined as `infinity' and are considered unreachable.

An RIPng router is assumed to have interfaces to one or more directly-connected networks. Each router maintains a routing table, with one entry for every reachable destination in the RIPng network. Each routing table entry contains a minimum of:

- IPv6 destination prefix(es)
- total metric cost for the path to the destination(s)
- IPv6 address of the next hop router
- a `route change flag'
- timers

As a UDP-based protocol, the RIPng routing process functions on UDP well-known port number 521 (the `RIPng port'), on which datagrams are sent and received. The RIPng port supports the following:

- Receives all communications received from another router's RIPng process.
- Sends all RIPng routing update messages.
- Unsolicited routing update messages specify this port as the source and destination.
- Responses to request messages are sent to the originating UDP port.
- Specific requests need not come from the RIPng port, but the destination on the targeted device must be the RIPng port.

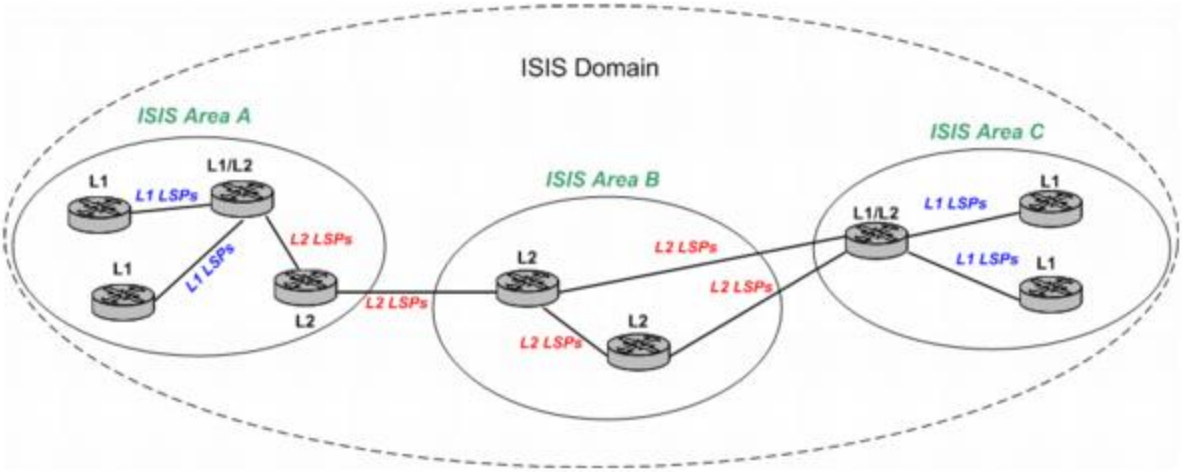
ISISv4/v6

The Intermediate System to Intermediate System (ISIS) routing protocol was originally designed for use with the OSI Connectionless Network Protocol (CLNP) and was defined in ISO DP 10589. It was later extended to include IP routing in IETF RFC 1195. When routing for OSI and IP packets (defined in ISO/IEC 10589:1992(E)) is combined in this way, the protocol is referred to as Integrated ISIS or Dual ISIS. In addition, RFC 2966 extends the distribution of routing prefixes among ISIS routers, and IETF DRAFT draft-ietf-isis-ipv6-05 adds IPv6 routing capability to the protocol.

ISIS Topology

ISIS areas are administrative domains which contain ISIS routers, have one or more private networks, and may share networks with other areas. The example shown in the following figure consists of a theoretical ISIS topology. Note that, as shown in this diagram, all ISIS routers are considered to reside entirely **within** an area, unlike some other protocols such as OSPF, where routers can reside at the edges of areas and domains.

Figure: ISIS Topology



One or more Area IDs are associated with an area. Most areas only require one ID during steady state operation, but up to three IDs may be needed during the process of migrating a router from one area to another. In most cases, the maximum number of area IDs is set to three.

ISIS routers can be divided into three categories, as follows:

- **Level 1 (L1)**: These routers can connect only to L1 or L1/L2 routers within their own area (intra-area). They have no direct connection to any other ISIS area.
- **Level 2 (L2)**: These routers can connect only to other L2 routers outside their area, or to L1/L2 routers within their own area. They are used as backbone routers in the routing domain, to connect ISIS areas.
- **Level 1/2 (L1/L2)**: These routers have separate interfaces which can connect to both L1 routers within their own area and L2 routers in other areas.

Entirely separate routing tables are maintained for Level 1 and Level 2 ISIS information, even within L1/L2 routers. All L1s within an area maintain identical databases. All L2s within a domain maintain identical databases.

ISIS Processing

Many OSI concepts are necessary for describing ISIS. The following terms are important to the following discussion:

- IS - Intermediate System. An ISIS router is an IS.
- ES - End System. A host is an ES. (Note: The Ixia hardware does not currently simulate End Systems.)
- PDU - Protocol Data Unit. PDUs contain messages used for the ISIS protocol. The following PDUs are used in IS-IS communications:
    - IIH - IS-to-IS Hello PDU. This message is multicast over broadcast networks, or unicast on point-to-point links, between ISs to discover neighbors and maintain ISIS state.
    - LSP - Link State PDU. This message holds the significant part of the routing table sent between ISIS routers.
    - SNP - Sequence Number PDU. This message is used to request LSPs and acknowledge receipt of LSPs. Two types are used depending on the network type:
        - CSNP - Complete SNP. In broadcast networks, these are sent by the Designated Router in an area. On point-to-point connections, CSNPs are used for initialization. A CSNP contains a complete description of the LSPs in the sender's database.
        - PSNP - Partial SNP. On broadcast networks, PSNPs are used to request LSPs. On point-to-point connections, PSNPs are used to acknowledge receipt of LSPs. On both types of networks, PSNPs are used to advertise newly learned LSPs or purge LSPs. A PSNP contains a subset of the received records.

ISIS routers maintain knowledge of each other by exchanging Hello PDUs at regular, configured *Hello intervals*. A router is considered down if it does not respond within a separately configured *Dead interval.*

ISIS routers update each other using Link State PDUs (LSPs) at a regular interval of 30 minutes. The LSP header contains the Remaining Lifetime for the LSP, a Sequence Number, and a checksum. Each LSP contains information about a router's connection to local networks, plus a metric related to each network. ISO DP 10589 defines four types of metrics: default, delay, expense, and error.

In a Broadcast/LAN network, the Designated Router sends a Complete Sequence Number PDU (CSNP). In a Point-to-Point network, the receiving router sends a Partial Sequence Number PDU (PSNP).

In the ISIS protocol, for each of the levels (L1 or L2), one of the routers is elected as the Designated IS, based on priority values assigned to each interface as part of Hello PDU processing. The Ixia Protocol Server does not support the role of DR, so to ensure that it is not elected by its ISIS peers each Ixia-simulated ISIS router has a default priority of `0,' indicating its unwillingness to be the Designated IS.

ISIS Addresses

Due to the OSI derivation of the ISIS protocol, each ISIS router has an OSI NET address of 8 to 20 octets in length. The NET address consists of two parts: an Area ID and a System ID. The Area ID has a number of different formats defined in OSI specifications. The System ID may be from 1 to 8 octets in length. The default System ID length defaults to 6 octets and must be the same length for every router in the domain. The System ID is unique within its ISIS **area** for Level 1, or unique within the ISIS routing **domain** for Level 2 or Level 1/2. Two types of network connections are supported: broadcast and point-to-point. In a broadcast network, each interface on an ISIS dual-mode router must have an IP address and mask.

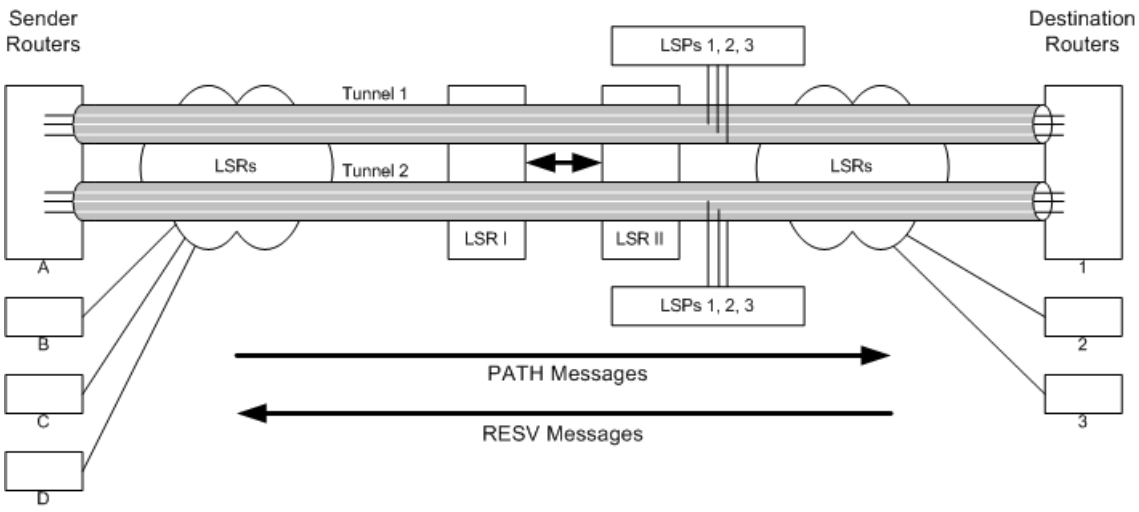
RSVP-TE

The Ixia protocol server implements a part of the Resource Reservation Protocol (RSVP) used for Traffic Engineering (TE). This subset of the RSVP protocol, referred to as RSVP-TE, is used in the process of constructing a path through a sequence of MPLS-enabled label switched routers (LSRs), while reserving necessary bandwidth resources. The use of an internal gateway routing protocol (IGP), such as OSPF, is also required to automatically determine the `next hop' router.

Multi-Protocol Label Switching (MPLS) allows rapid forwarding of packets across a sequence of routers, without time-consuming examination of the packet contents at each hop. Label switching has been used extensively for ATM traffic, where overhead bytes for each `cell,' or packet, of data constitute a large percentage of the overall data transmitted. The addition of a `label' value to the header information in each cell or packet supplies the only forwarding information required to transit the MPLS domain. Based on information in its forwarding table, each LSR replaces (swaps) the incoming label with a new one which directs the packet to the next hop.

The most important output from an RSVP-TE setup session is the set of *MPLSlabels*, which are used by the MPLS-enabled routers along the path to efficiently forward network traffic. The operation of RSVP-TE is shown in the following figure.

Figure: RSVP-TE Overview



Through the use of RSVP-TE message exchanges, the router at the entry to the MPLS domain, also known as an Ingress LSR, initiates the creation of a dynamic `tunneled' pathway to the Egress LSR, the router at the exit side of the MPLS domain. Packets which pass through this `tunnel' are essentially `protected' from the extensive packet processing normally imposed by each router it traverses. Once this special pathway or Label Switched Path (LSP) is established, the router can **forward,** rather than route, packets across the domain, saving considerable processing time at each intermediate LSR (Transit LSR). The resulting tunneled pathway is known as an LSP Tunnel. The traffic flows through an LSP Tunnel are unidirectional. To establish bidirectional traffic through the MPLS domain, a second LSP Tunnel must be created in the opposite direction.

An LSP Tunnel is defined by a Destination Address (the IP address of the Egress LSR), and a Tunnel ID. At a finer level of granularity are LSP IDs. Essentially, these LSP IDs can serve to provide a set of aliases for alternate hop-by-hop paths between a single pair of Ingress and Egress LSRs, and therefore exist within the same LSP Tunnel.

NOTE Note: Ingress LSRs and Egress LSRs are also known as Label Edge Routers (LERs).

Two principal RSVP-TE message types are used to establish LSP Tunnels:

- PATH message. A PATH message is generated by the ingress router and sent toward the egress router. This is termed the *downstream* direction. This PATH message is a request by the sending LSR for the establishment of an LSP to the egress router. Each LSR in the path to the destination router digests the PATH message and does one of three things:
  - If the LSR cannot accommodate the request, it rejects the request by sending a PATH_ ERR message back to the source indicating the nature of the rejection.
  - If the LSR is not the egress router, it sends a PATH message to the next LSR toward the destination router.
  - If the LSR is the egress router, it should respond with a RESV message back to its most recent neighbor.
- RESV message. A RESV message is generated by the egress router and sent over the reverse path that the PATH messages took. This is termed the *upstream* direction.

An additional *HELLO* message is used between neighbor LSRs to ensure that LSRs are alive. This allows for quick tunnel replacement in the case of link or router failure.

A set of labels is passed in the RESV messages sent upstream from the egress to the ingress router. A label is sent from one LSR to its upstream neighbor telling the upstream router which label to use when later sending downstream traffic.

Three scenarios are currently supported to test MPLS/RSVP-TE on a DUT using Ixia equipment:

1. The DUT acts as the Ingress LSR, and the Egress LSR is simulated by an Ixia port.
2. The DUT acts as the Egress LSR, and the Ingress LSR is simulated by an Ixia port.
3. The DUT acts as a Transit/Intermediate LSR, and the Ingress and Egress LSRs are simulated by Ixia ports.

PATH Messages

PATH messages contain a number of objects which define the tunnel to be established. These are shown in the following table.

RSVP-TE PATH Message Objects

Object	Contents	Usage
SESSION		Describes the destination router and associates a tunnel ID with the session.
	tunnel endpoint	The destination router's IP address.
	tunnel ID	A unique LSP tunnel ID.
SENDER_ TEMPLATE		The description of the sender.
	tunnel sender address	The sender router's IP address.
	LSP ID	A unique LSP ID.
LABEL_ REQUEST		Asks all the LSRs to send back label values through RESV messages.
SENDER_ TSPEC andADSPEC		Both of these objects deal with bandwidth and other QoS requirements for the path.
TIME_ VALUES		Timing values related to the refresh of tunnel information.
	refresh interval	The interval between messages.
EXPLICIT_ ROUTE		Allows the sender to request that the LSP tunnel follow a specific path from ingress to egress router. See Explicit_Route for more details.

Object	Contents	Usage
SESSION_ ATTRIBUTE		Other attributes associated with the session: tunnel establishment priorities, session name, and optionally resource affinity.
RSVP_HOP		Describes the immediate upstream router's address to the downstream router.

Explicit_Route

An explicit route is a particular path in the network topology. Typically, the explicit route is determined by a node with the intent of directing traffic along that path. An explicit route is described as a list of groups of nodes along the explicit route. In addition to the ability to identify specific nodes along the path, an explicit route can identify a group of nodes that must be traversed along the path. Each group of nodes is called an *abstract node*. Thus, an explicit route is a specification of a set of abstract nodes to be traversed.

There are three types of objects in an explicit route:

- IPv4 prefix
- IPv6 prefix
- Autonomous system number

Each node has a *loose* bit associated with it. If the bit is not set, the node is considered *strict*. The path between a strict node and its preceding node may only include network nodes from the strict node and its preceding abstract node. The path between a loose node and its preceding node may include other network nodes that are not part of the strict node or its preceding abstract node.

RESV Message

The RESV message contains object that indicate the success of the PATH request and the details of the assigned tunnel. These are shown in the following table.

RSVP-TE RESV Message Objects

Object	Usage
SESSION	Indicates which session is being responded to.
TIME_ VALUES	As in the PATH message but from the downstream LSR to the upstream LSR.
STYLE	The type of reservation assigned by the egress router. This relates to whether individual tunnels are requested for each sender-destination connection or whether some connections may use the same tunnel.
FILTER_ SPEC	The sender router's IP address and the LSP ID.
LABEL	The label value assigned by the downstream router for use by the upstream router.
RECORD_ ROUTE	If requested, the complete route from the destination back to the source. The contents of this object include the IP addresses in either v4 or v6 format of all the

Object	Usage
	LSRs encountered in the formation of the LSP, and optionally the labels used at each step. Each LSR on the upstream path perpends its own address information.
RESV_ CONF	If present, it indicates that the ingress router should send a RESV_CONF message in response to the destination to indicate that the tunnel has been completely established.

Other Messages

Several additional messages are used in RSVP-TE, as explained in the following table.

Additional RSVP-TE Messages

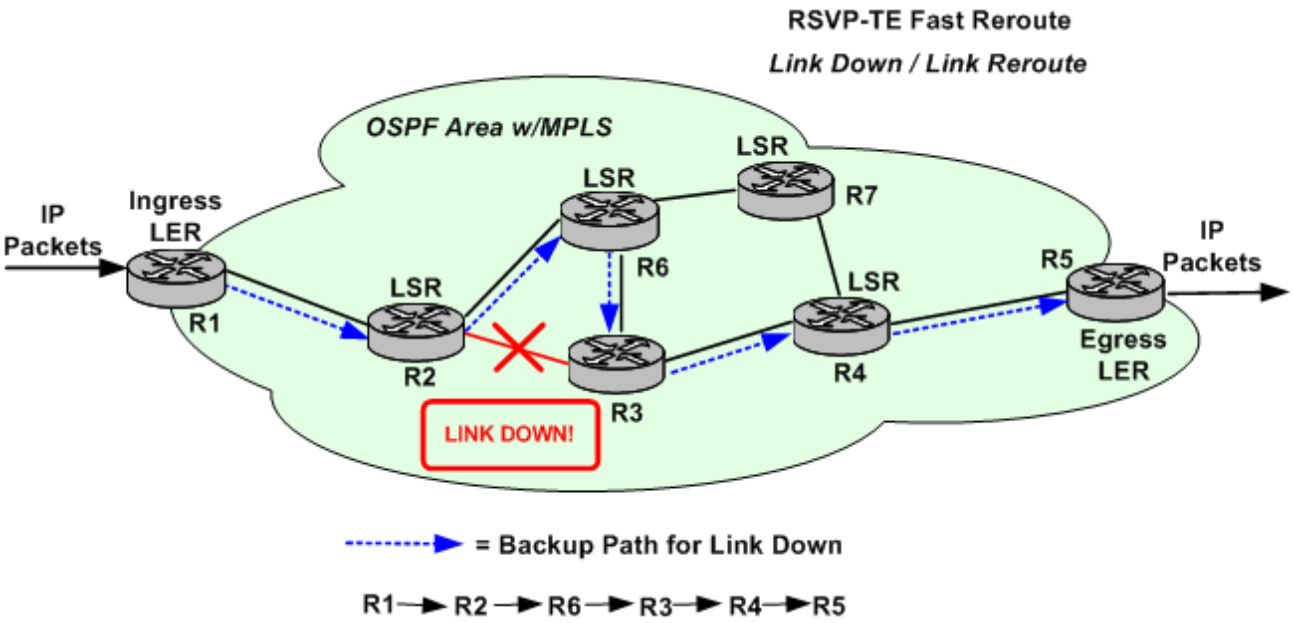
Message	Usage
PATH_ERR	Any LSR may determine that it cannot accommodate the tunnel requested in a PATH message. In this case it sends a PATH_ERR message back to the sender.
PATH_TEAR	When a sender router determines that it wants to tear down a tunnel, it sends a PATH_TEAR message to the destination router.
RESV_ERR	If a router cannot handle a reservation, it sends a RESV_ERR back to the destination router.
RESV_TEAR	When a destination router determines that it wants to tear down a tunnel, it sends a RESV_TEAR message upstream to the source router.
RESV_ CONF	When requested, a sender router responds to the destination router with a RESV_ CONF message to indicate that a complete tunnel has been successfully established.

RSVP-TE Fast Reroute

RSVP-TE Fast Reroute allows to configure backup LSP tunnels to provide local repair/protection ONLY for **explicitly-routed** LSPs/LSP tunnels, termed *protected LSPs* as described in IETF DRAFT draft-ietf-mpls-rsvp-lsp-fastreroute-03.

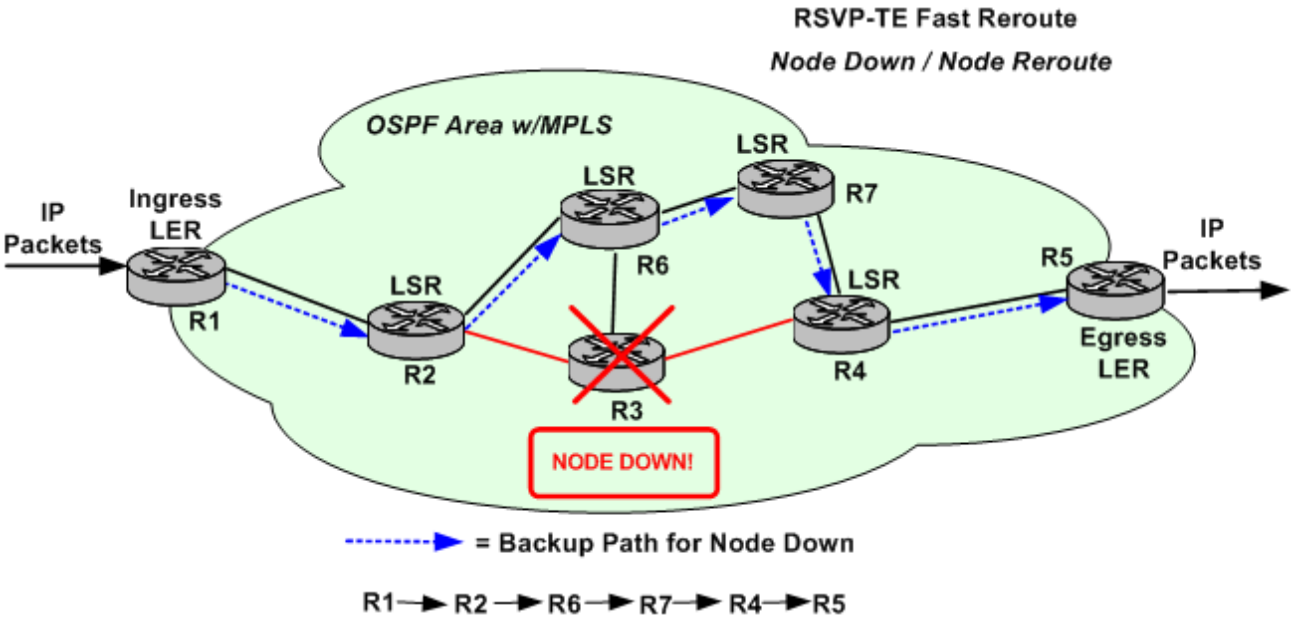
An example diagram of a backup scenario for rerouting around a downed link, using an LSP Detour, is shown in the following figure.

Figure: RSVP-TE Fast Reroute Backup Link (Detour) Example



The following image shows an example diagram for a backup scenario to reroute around a downed node, using an LSP Detour.

Figure: RSVP-TE Fast Reroute Backup Node (Detour) Example



The one-to-one backup method is based on including a DETOUR object in the Path message. The head-end router, the Point of Local Repair (PLR), sets up a separate detour LSP for each LSP it protects. For the Facility backup method, the PLR sets up a tunnel to protect multiple LSPs simultaneously, by using the MPLS label stack.

Ixia Test Model

The Ixia test process is designed so as to fully exercise RSVP functionality in MPLS routers. An Ixia port can simulate any number of LSR routers at the same time. Each router operates in an ingress or egress mode. In the following discussion, LSRs I and II refer to the figure in RSVP-TE Overview.

- Ingress mode: LSRs I and II are termed a neighbor pair, where LSR I is the upstream router being simulated and LSR II is its immediate downstream neighbor. The Ixia port generates the PATH and HELLO messages that LSR I would send. LSR II is the Device Under Test (DUT) and may be an egress router or be connected to other LSRs, as shown in the figure.
- Egress mode: the Ixia port simulates LSR II while LSR I is the DUT. The Ixia port interprets PATH messages that it receives to determine if they are directed for any of the defined destination routers. If that is the case, it responds with appropriate RESV messages.

If requested, HELLO messages are generated and responded to in either mode.

When the Ixia port operates in Ingress mode, it attempts to set up LSP tunnels for each combination of sender router and destination router, using any number of LSP tunnels and any number of LSP IDs for each LSP tunnel. Thus the number of PATH messages that the Ixia port attempts to generate for each refresh interval is:

# of sender routers x # of destination routers x # of LSPs x # of LSP tunnels

The protocol server records all labels and other information that it receives on behalf of its simulated routers and displays those in a convenient format.

LDP

The Label Distribution Protocol (LDP) version 1, defined in RFC 3036, works in conjunction with Multi-Protocol Label Switching (MPLS), to efficiently `tunnel' IP traffic across backbone topologies between Label Switching Routers (LSRs).

MPLS forwards packets based on added labels, so IP routing table lookups are not required along the length of the tunnel. RFC 3031 defines Forwarding Equivalence Classes (FECs) for use with MPLS, for purposes such as Quality of Service (QoS). LDP utilizes this option, assigning an FEC to every Label Switched Path (LSP) it sets up.

The LDP protocol creates peer sessions through a bidirectional exchange of messages, which include label requests and labels. While the initial Hello messages are based on UDP and sent to well-known port `646,' all other messages are based on TCP.

The following global timers can be configured: Hello Hold timer, Hello Interval timer, KeepAlive Hold timer, and KeepAlive Interval timer. The values for these timers can be entered by you, but the final values are negotiated during the Discovery and Session setup processes. When the LDP remote peer has a timeout value which is lower than the one configured for the local LDP router, the lower value is used by both peers.

Virtual Circuit (VC) Ranges of MAC Addresses can be created to simulate Virtual Private LAN Services (VPLS), where L2 PDUs can be carried over VC LSPs, which, in turn, are carried over MPLS. This creates a `bridged,' Ethernet Layer Two Virtual Private Network (Ethernet L2VPN). Refer to IETF DRAFT draft-lasserre-vkompella-ppvpn-vpls-03, which defines the VC Type - Ethernet VPLS, and also discusses the use of MPLS transport tunnels by pseudowires (PWs).

A pseudowire is a logical link through the tunnel, made up of two parallel VC LSPs using the same VC Identifier (VCID), as shown in the following figures.

Figure: LDP VPLS Example

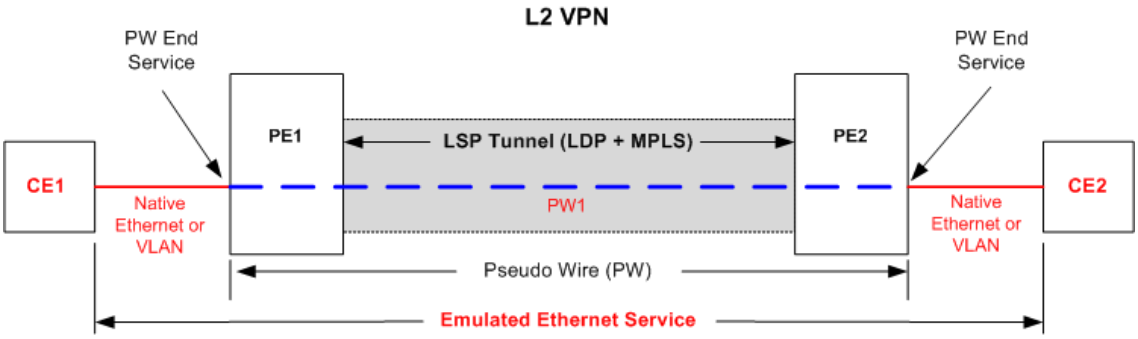
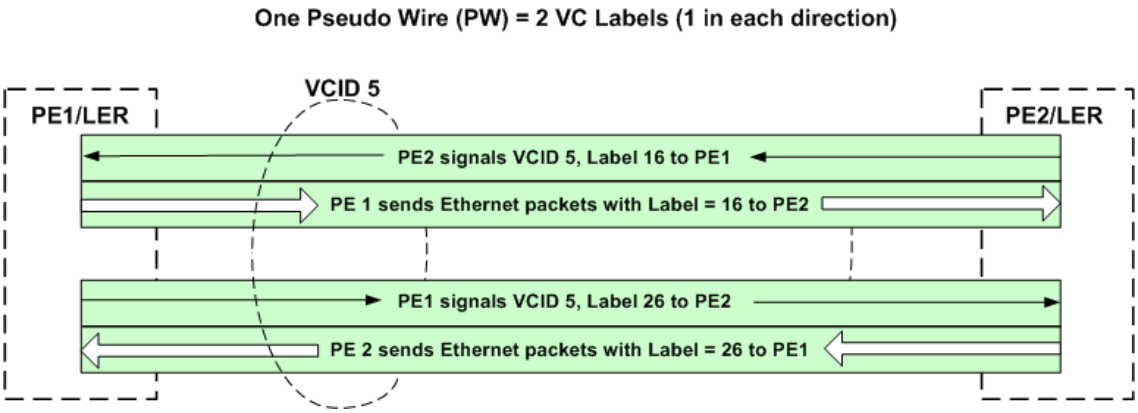


Figure: LDP VPLS Pseudowire Diagram



MLD

The Multicast Listener Discovery (MLD) protocol is integral to the operation of Internet Protocol Version 6 (IPv6). MLDv1 is defined by RFC 2710, while MLDv2 is defined by RFC 3810. The MLD operations are based on operations similar to the Internet Group Management Protocol (IGMP) that supports IPv4. MLDv2 corresponds to IGMPv3. Both versions are supported by the protocol server.

An IPv6 router uses MLD to: (1) discover multicast listeners (nodes) on the directly attached links, and (2) find out which multicast addresses those nodes have interest in. In MLDv2, nodes can indicate interest in listening to packets that are sent to a specific multicast address from a filtered group of source IP addresses. This filtering can be based on `all but' (Excluding) or `only' (Including) certain source addresses. Host nodes can only be multicast `listeners,' while the multicast routers can act as routers or listeners.

PIM-SM/SSM-v4/v6

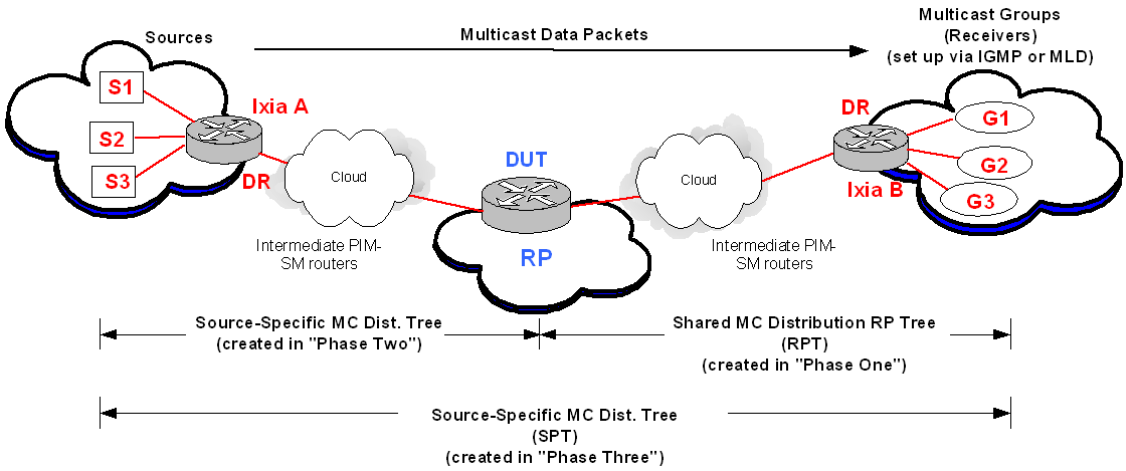
Protocol Independent Multicast - Sparse Mode (PIM-SM) Version 2 protocol is designed for multicast routing, and is defined in RFC 2362. IETF DRAFT draft-ietf-pim-sm-v2-new-06.txt is being designed to obsolete RFC 2362.

There is one Rendezvous Point (RP) per multicast group, and this router serves as the root of a unidirectional *shared* distribution tree whose `leaves' consist of multicast receivers. In addition, PIM-SM can create an optional shortest-path tree for an *individual* source (where the source is the root). The term *upstream* is used to indicate the direction toward the root of the tree; *downstream* indicates the direction away from the root of the tree. The address of the RP can be configured statically by an administrator, or configured through a Bootstrap router (BSR) mechanism.

PIM-SM can use two sources of topology information to populate its routing table, the Multicast Routing Information Base (MRIB): unicast or multicast-capable. In a LAN where there are multiple PIM-SM routers and directly- connected hosts, one of the routers is elected as Designated Router (DR) to act on the behalf of the hosts.

The following diagram shows a simplified PIM-SM test setup using Ixia ports.

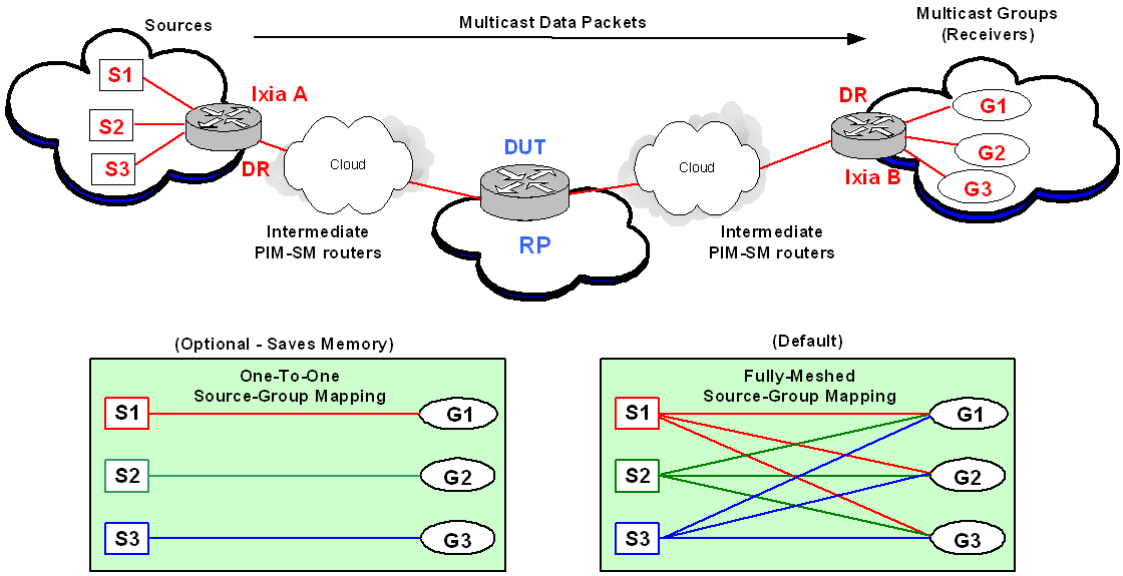
Figure: PIM-SM Diagram



PIM-SM Source-Group Mapping

PIM-SM Source-Group mapping involves the pairing of Sources and Groups. The default method is a fully-meshed mapping of sources to groups, where every source is paired with every group. For a situation where there are `X' number of sources and `Y' number of groups, there will be `X x Y' number of mappings, resulting in a great deal of memory usage for processing. When full-mesh mapping is not desired, the optional `One-To-One' Source-Group Mapping can be used to save memory. In comparison, if a one-to-one type mapping behavior was preferred and only a full-mesh setup was available, you would have to create `N' fully-meshed source-group mapping ranges of size `1' to emulate the one-to-one behavior. An example showing the differences between the two types of mapping is shown in the following figure.

Figure: PIM-SM Source-Group Mapping Example

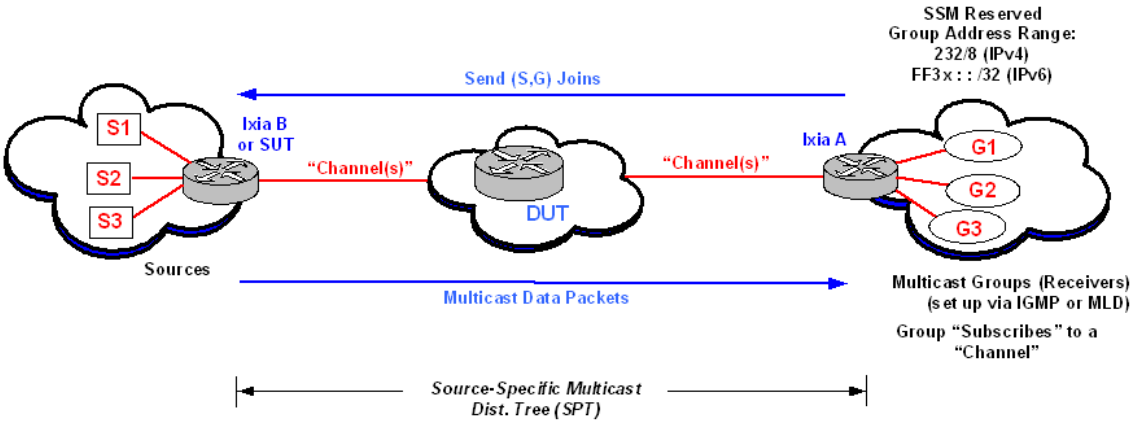


PIM-SSM

Protocol Independent Multicast - Source-Specific Multicast (PIM-SSM) uses a subset of the PIM-SM protocol, described in draft-ietf-ssm-arch-06, Source-Specific Multicast for IP, and in Section 4.8 of draft-ietf-pim-sm-v2-new-11, Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised).

PIM-SSM is useful for broadcast-type applications, where one source sends packets to many host groups. There is no shared distribution tree topology, but there is a shortest-path tree (SPT) established, where the source is the root of the tree. In the case of SSM, the usual PIM-SM multicast terminology is modified, and the term *Channel* is used instead of *Group* and *Subscription* replaces *Join*. A multicast group (G) router that wants to receive packets from a specific Source (S) for its hosts/listeners, will `Subscribe' to `Channel (S,G).' An example of an PIM-SSM topology is shown in the following figure.

Figure: PIM-SSM Topology Example



An existing PIM-SM network can be modified to run SSM by enabling PIM-SSM on the source and destination/group routers. The typical PIM-SM signaling is not used for PIM-SSM, since the role of

Rendezvous Point (RP) router is eliminated. The Subscribe (Join) message travels directly from the Destination router to the Source router, and data packets are transmitted in the opposite direction.

PIM-SSM Addressing

The PIM-SSM protocol uses a restricted addressing scheme, with reserved values for IPv4 SSM addresses defined by the IANA as 232.0.0.0 through 232.255.255.255 (232/8). IPv6 SSM addresses are defined in IETF DRAFT draft-ietf-ssm-arch- 06 and draft-ietf-pim-sm-v2-new-11 as FF3x: : /32. The range of FF3x: : /96 is proposed by RFC 3307, `Allocation Guidelines for IPv6 Multicast Addresses.'

Differences Between PIM-SM and PIM-SSM

Some of the principal differences between PIM-SM and PIM-SSM routers, per draft-ietf-ssm-arch-06, are mentioned in the following list:

- PIM-SSM-only routers must not send (*,G) Join/Prune messages.
- PIM-SSM-only routers must not send (S,G,rpt) Join/Prune messages.
- PIM-SSM-only routers must not send Register messages for packets with SSM destination addresses.
- PIM-SSM-only routers must act in accordance with (*,G) or (S,G,rpt) state by forwarding packets with SSM destination addresses.
- PIM-SSM-only routers acting as RPs must not forward Register messages for packets with SSM destination addresses.

Protocol Elements for PIM-SSM

Protocol elements **required** for PIM-SSM-only routers are mentioned in the following list:

- (S,G) Downstream and Upstream state machines.
- Hello messages, neighbor discovery, and DR election.
- Packet forwarding rules.
- [(S,G) Assert state machine]

Some of the Protocol elements **not required** for PIM-SSM-only routers are mentioned in the following list:

- Register state machine
- (*,G), (S,G,rpt), and (*,*,RP) Downstream and Upstream state machines.
- Keepalive Timer (treated as always running)
- SptBit (treated as always set for an SSM address)

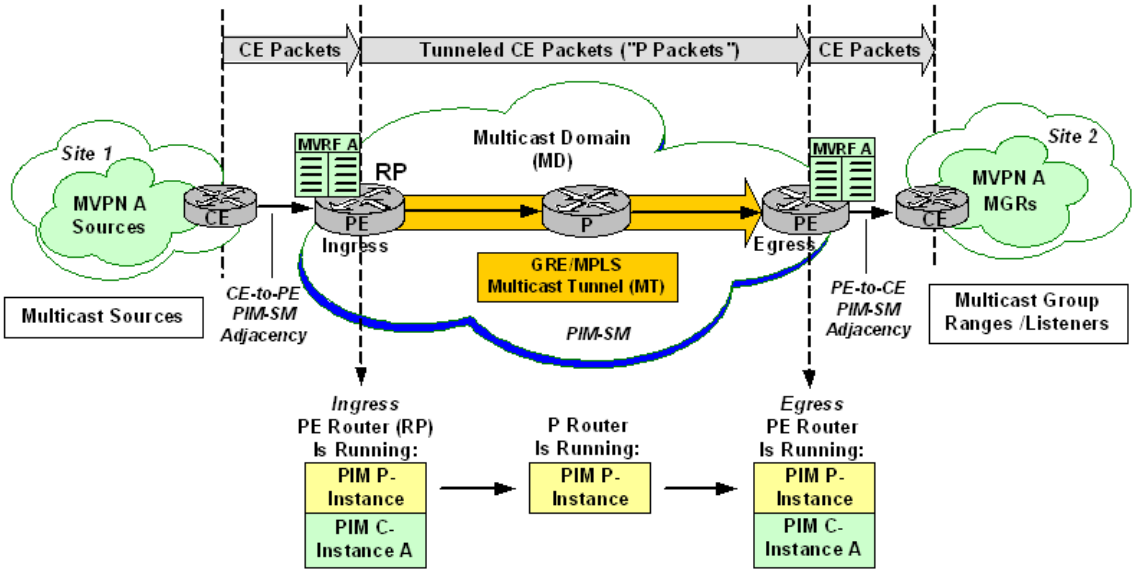
Multicast VPNs

Multicast VPNs (MVPNs) can be created through the use of MP-BGP combined with PIM-SM. Multicast VPNs can be set up by a Service Provider to support scalable, IPv4 multicast traffic solutions, based on IETF draft-rosen-vpn-mcast-07, `Multicast in MPLS/BGP IP VPNs.'

Multicast VRFs (MVRFs) on each PE router contain multicast routing tables. Within a Service Provider's domain, each MVRF is assigned to a Multicast Domain (MD), which is a set of MVRFs that

can send multicast traffic to one another. Multicast packets from CE routers are sent over a (GRE) multicast tunnel to other PE routers in the multicast domain. A simplified example of a Multicast VPN topology, with one MVPN, is shown in the following figure.

Figure: Multicast VPN Topology Example



Each CE and its connected PE set up a PIM-SM adjacency. However, CEs do not set up PIM-SM adjacencies with each other. Separate CE-associated instances of PIM are run by each PE router, and these are called `PIM C-instances.' Each C-instance is MVRF-specific. As each PE can be affiliated with many MVPNs/MVRFs, the router can run many PIM C-instances simultaneously, up to a maximum of one C-instance per MVRF.

PIM Provider-wide instances (`PIM P-instances') are run by each PE router, creating a global PIM adjacency with all of its IGP PIM-SM-enabled neighbors (P routers). P routers cannot set up PIM-SM C-instances.

At startup for the multicast domain's Provider Edge (PE) routers, the default Multicast Distribution Tree (MDT) is set up automatically. Each Multicast Domain is identified by a globally unique Service Provider (P) Group address and a Route Distinguisher. The MD group address is created by using BGP (L3 Site window). It is a valid 4-byte IPv4 multicast address prefix (for example, 239.1.1.1/32). The 12-byte Route Distinguisher is also created through BGP (L3 Site window). This Ixia implementation uses an RD value = 2. One C-Multicast Group Range (MGR) can be configured for each MVRF.

MPLS

Multi-Protocol Label Switching (MPLS) is based on the concept of label switching: and independent and unique `label' is added to each data packet and this label is used to switch and route the packet through the network. The label is simple, essentially a shorthand version of the packet's header information, so network equipment can be optimized around processing the label and forwarding traffic. This concept has been around the data communications industry for years. X.25, Frame Relay, and ATM are examples of label switching technologies.

It is important to understand the differences in the way MPLS and IP routing forward data across a network. Traditional IP packet forwarding uses the IP destination address in the packet's header to

make an independent forwarding decision at each router in the network. These hop-by-hop decisions are based on network layer routing protocols, such as Open Shortest Path First (OPSF) or Border Gateway Protocol (BGP). These routing protocols are designed to find the shortest path through the network, and do not consider other factors, such as latency or traffic congestion.

MPLS creates a connection-based model overlaid onto the traditionally connectionless framework of IP routed networks. This connection-oriented architecture opens the door to a wealth of new possibilities for managing traffic on an IP network. MPLS builds on IP, combining the intelligence of routing, which is fundamental to the operation of the Internet and today's IP networks, with the high performance of switching. Beyond its applicability to IP networking, MPLS is being expanded for more general applications in the form of Generalized MPLS (GMPLS), with applications in optical and Time-Division Multiplexing (TDM) networks.

One of the primary original goals of MPLS, boosting the performance of software-based IP routers, has been superseded as advances in silicon technology have enabled line-rate routing performance implemented in router hardware. In the meantime, additional benefits of MPLS have been realized, notably Virtual Private Network (VPN) services and traffic engineering (TE).

Advantages of MPLS

Some of the advantages of using MPLS are:

- MPLS enables traffic engineering. Explicit traffic routing and engineering help squeeze more data into available bandwidth.
- MPLS supports the delivery of services with Quality of Service (QoS) guarantees. Packets can be marked for high quality, enabling providers to maintain a specified low end-to-end latency for voice and video.
- MPLS reduces router processing requirements, since routers simply forward packets based on fixed labels.

How Does MPLS Work?

MPLS is a technology used for optimizing forwarding through a network. Though MPLS can be applied in many different network environments, this discussion focuses primarily on MPLS in IP packet networks, by far the most common application of MPLS today.

MPLS assigns labels to packets for transport across a network. The labels are contained in an MPLS header inserted into the data packet.

These short, fixed-length labels carry the information that tells each switching node (router) how to process and forward the packets, from source to destination. They have significance only on a local node-to-node connection. As each node forwards the packet, it swaps the current label for the appropriate label to route the packet to the next node. This mechanism enables very-high-speed switching of the packets through the core MPLS network.

MPLS combines the best of both Layer 3 IP routing and Layer 2 switching. In fact, it is sometimes called a `Layer 2-1/2' protocol. While routers require network-level intelligence to determine where to send traffic, switches only send data to the next hop, and so are inherently simpler, faster, and less costly. MPLS relies on traditional IP routing protocols to advertise and establish the network topology. MPLS is then overlaid on top of this topology. MPLS predetermines the path data takes across a network and encodes that information into a label that the network's routers can understand. This is the connection-oriented approach previously discussed. Since route planning

occurs ahead of time and at the edge of the network (where the customer and service provider network meet), MPLS-labeled data requires less router horsepower to traverse the core of the service provider's network.

MPLS Routing

MPLS networks establish Label-Switched Paths (LSPs) for data crossing the network. An LSP is defined by a sequence of labels assigned to nodes on the packet's path from source to destination. LSPs direct packets in one of two ways: hop-by-hop routing or explicit routing.

Hop-by-Hop Routing

In hop-by-hop routing, each MPLS router independently selects the next hop for a given Forwarding Equivalency Class (FEC). A FEC describes a group of packets of the same type; all packets assigned to a FEC receive the same routing treatment. FECs can be based on an IP address route or the service requirements for a packet, such as low latency.

In the case of hop-by-hop routing, MPLS uses the network topology information distributed by traditional Interior Gateway Protocols (IGPs) routing protocols such as OPSF or IS-IS. This process is similar to traditional routing in IP networks, and the LSPs follow the routes the IGPs dictate.

Explicit Routing

In explicit routing, the entire list of nodes traversed by the LSP is specified in advance. The path specified could be optimal or not, but is based on the overall view of the network topology and, potentially, on additional constraints. This is called Constraint-Based Routing. Along the path, resources may be reserved to ensure QoS. This permits traffic engineering to be deployed in the network to optimize use of bandwidth.

Label Information Base

As the network is established and signaled, each MPLS router builds a Label Information Base (LIB), a table that specifies how to forward a packet. This table associates each label with its corresponding FEC and the outbound port to forward the packet to. This LIB is typically established in addition to the routing table and Forwarding Information Base (FIC) that traditional routers maintain.

Connections are signaled and labels are distributed among nodes in an MPLS network using one of several signaling protocols, including Label Distribution Protocol (LDP) and Resource reSerVation Protocol with Tunneling Extensions (RSVPTE). Alternatively, label assignment can be piggybacked onto existing IP routing protocols such as BGP.

The most commonly used MPLS signaling protocol is LDP. LDP defines a set of procedures used by MPLS routers to exchange label and stream mapping information. It is used to establish LSPs, mapping routing information directly to Layer 2 switched paths. It is also commonly used to signal at the edge of the MPLS network, the critical point where non-MPLS traffic enters. Such signaling is required when establishing MPLS VPNs.

RSVP-TE is also used for label distribution, most commonly in the core of networks that require traffic engineering and QoS. A set of extensions to the original RSVP protocol, RSVP-TE provides additional functionality beyond label distribution, such as explicit LSP routing, dynamic rerouting around network failures, preemption of LSPs, and loop detection. RSVP-TE can distribute traffic engineering parameters such as bandwidth reservations and QoS requirements.

Multi-protocol extensions have been defined for BGP, enabling the protocol to also be used to distribute MPLS labels. MPLS labels are piggybacked onto the same BGP messages used to distribute the associated routes. MPLS allows multiple labels (called a label stack) to be carried on a packet. Label stacking enables MPLS nodes to differentiate between types of data flows, and to set up and distribute LSPs accordingly. A common use of label stacking is for establishing tunnels through MPLS networks for VPN applications.

BFD

Bidirectional Forwarding Detection (BFD) is a network protocol used to detect faults between two forwarding engines. It provides low-overhead detection of faults even on physical media that don't support failure detection of any kind, such as ethernet, virtual circuits, tunnels and MPLS LSPs.

BFD establishes a session between two endpoints over a particular link. If more than one link exists between two systems, multiple BFD sessions may be established to monitor each one of them. The session is established with a three-way handshake, and is torn down the same way. Authentication may be enabled on the session. A choice of simple password, MD5 or SHA1 authentication is available.

BFD does not have a discovery mechanism; sessions must be explicitly configured between endpoints. BFD may be used on many different underlying transport mechanisms and layers, and operates independently of all of these. Therefore, it needs to be encapsulated by whatever transport it uses. For example, monitoring MPLS LSPs involves piggybacking session establishment on LSP-Ping packets. Protocols that support some form of adjacency setup, such as OSPF or IS-IS, may also be used to bootstrap a BFD session. These protocols may then use BFD to receive faster notification of failing links than would normally be possible using the protocol's own keepalive mechanism.

A session may operate in one of two modes: asynchronous mode and demand mode. In asynchronous mode, both endpoints periodically send Hello packets to each other. If a number of those packets are not received, the session is considered down.

In demand mode, no Hello packets are exchanged after the session is established; it is assumed that the endpoints have another way to verify connectivity to each other, perhaps on the underlying physical layer. However, either host may still send Hello packets if needed.

Regardless of which mode is in use, either endpoint may also initiate an Echo function. When this function is active, a stream of Echo packets is sent, and the other endpoint then sends these back to the sender through its forwarding plane. This is used to test the forwarding path on the remote system.

CFM

Ethernet CFM is an end-to-end per-service-instance Ethernet layer OAM protocol that includes proactive connectivity monitoring, fault verification, and fault isolation. End to end can be PE to PE or customer edge (CE) to CE. Per service instance means per VLAN.

Being an end-to-end technology is the distinction between CFM and other metro-Ethernet OAM protocols. For example, MPLS, ATM, and SONET OAM help in debugging Ethernet wires but are not always end-to-end. 802.3ah OAM is a single-hop and per-physical-wire protocol. It is not end to end or service aware. Ethernet Local Management Interface (E-LMI) is confined between the uPE and CE and relies on CFM for reporting status of the metro-Ethernet network to the CE.

Troubleshooting carrier networks offering Ethernet Layer 2 services can be difficult. Customers contract with service providers for end-to-end Ethernet service and service providers may subcontract with operators to provide equipment and networks. Compared to enterprise networks, where Ethernet traditionally has been implemented, these constituent networks belong to distinct organizations or departments, are substantially larger and more complex, and have a wider user base. Ethernet CFM provides a competitive advantage to service providers for which the operational management of link uptime and timeliness in isolating and responding to failures is crucial to daily operations.

FCoE and NPIV

IxExplorer provides GUI access to all Ixia platform functionality with full support for stateless FCoE functional and scalability testing. The FCoE and Priority Flow Control (PFC) and FCoE Initialization Protocol (FIP) features allow testing of FCoE switches running both FCoE traffic and traditional Ethernet traffic.

Supported Load Modules

The following Ixia load modules have the Fibre Channel over Ethernet (FCoE) capability:

- GXMR8-01 and GXM8XP-01, including 10GBASE-T versions LSM10GXM(R)8GBT-01
- GXMR4-01 and GXM4XP-01, including 10GBASE-T versions LSM10GXM(R)4GBT-01
- LSM10GXM2XP-01 and GXMR2-01, including 10GBASE-T versions LSM10GXM(R)2GBT-01
- LSM1000XMVDCx-01 load modules. 4-port, 8-port, 12-port, and 16-port
- LSM1000XMVDC4-NG load modules. 4-port

Data Center Mode

FCoE support requires a new port mode, Data Center Mode. You need to switch port mode between Normal Mode and Data Center Mode to use the desired features in each mode.

- Mode switching (to or from Data Center Mode) triggers an FPGA re-download.
- There is no Packet Stream Mode support in Data Center Mode; only Advanced Scheduler Mode is supported.
- Supports 4-Priority traffic mapping for frame size up to 9216-byte. The different frame size support is determined by a sub mode in Data Center Mode. This limitation applies to all frames in Data Center Mode, whether FCoE frame or not.
- Data Center Mode only supports auto instrumentation mode for both TX and RX.
- When the port is in Data Center Mode, both existing Ethernet frames and FCoE frames are generated.

Priority Traffic Generation

The scheduling function is based on the existing Advanced Scheduler. A new parameter called `Priority Group' has been added to each stream. You can map Priority Group to the priority field in the frame. The priority field in the same stream should not change (for example, if the priority is a VLAN priority field, then you cannot configure a UDF to control this field within a stream).

Priority-based Flow Control (PFC)

The Ixia port responds to either IEEE 802.3x pause frame or to IEEE 802.1Qbb Priority-based Flow Control (PFC) frame. The flow control type is determined by the selection made on the Flow Control tab of the Port Properties dialog, in IxExplorer.

IxExplorer Reference

See IxExplorer User Guide, Chapter 6 topic *Frame Data for FCoE Support*, subtopic *Priority-based Flow Control*.

Fibre Channel over Ethernet

When the port is in Data Center Mode, both existing Ethernet frames and FCoE frames are generated.

The Fibre Channel CRC is generated on the fly. This CRC is inserted at offset of Ethernet frame size minus 12 bytes. For example:

Ethernet Frame Size (bytes)	2000	2001	2002	2003
FC-CRC Offset in FCoE Frame (bytes)	1988	1989	1990	1991

The FC-CRC can be set to No Error or to Bad CRC.

Packet View Support

For Fibre Channel frame, there is no Extended Header and Optional Header support. It decodes only FC-2 Frame Header field.

FCoE Initialization Protocol (FIP)

FIP (FCoE Initialization Protocol) has been implemented (in addition to FCoE). It is used to discover and initialize FCoE capable entities connected to an Ethernet cloud.

IxExplorer Reference

See the IxExplorer User Guide, Chapter 6 topic *Frame Data for FCoE Support*.

NPIV Protocol Interface

NPIV stands for N_Port ID Virtualization. These can be used to virtually share a single physical N_ Port. This allows multiple Fibre Channel initiators to occupy a single physical port, easing hardware requirements in SAN design. Up to 256 N_Port_IDs can be assigned to a single N_Port. NPIV interfaces can be configured using the Protocol Interface Wizard.

See the topic *NPIV Protocol Interface*.in IxExplorer User Guide.

Precision Time Protocol (PTP) IEEE 1588v2

Precision Time Protocol (IEEE 1588v2) allows precise synchronization of clocks in measurement and controls systems implemented with technologies such as network communications, local computing and distributed objects. The protocol supports system wide synchronization accuracy in sub-

microseconds range with minimal network and local clock computing resources. The protocol operates in master/subordinate configuration. IEEE1588 deploys Multicast over an Ethernet network, and devices such as routers and switches can sync to the provided timing source.

Supported Load Modules

The following Ixia load modules have the PTP capability:

- LSM1000XMV(R)16, XMV(R)12, XMV(R)8, XMV(R)4
- Xcellon-Ultra XP, NP, and NG

Supported Messages

The following messages are supported between clocks participating in the PTP protocol.

- Event messages
  - Sync
  - Delay Request
- General Messages
  - Announce
  - Follow_up
  - Delay_Response

Supported Features

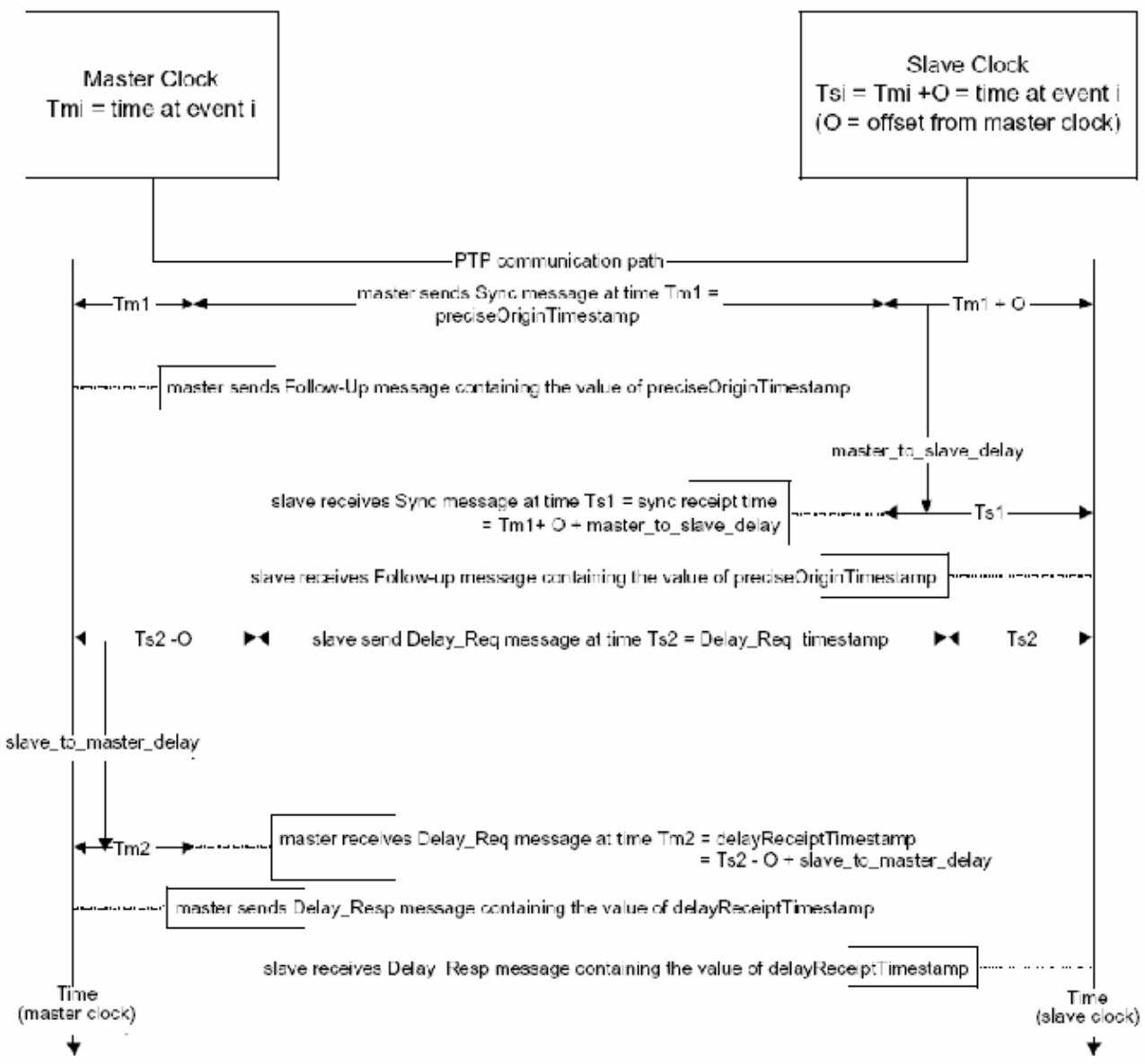
The following PTP features are supported.

- Only one two-step clock is supported on an Ixia port, at this time. One-step clock is not supported.
- Ixia ports can run other (non-PTP) traffic along with PTP traffic. Ixia ports have the ability to throttle transmit based on flow control packets being received.
- IEEE 1588 version 2.2 in IPV4 (multicast) is supported.
- Ports are manually configured in Master or Subordinate mode.
- A histogram reporting Subordinate clock OFFSET from master is provided in the form of plot along with PTP messages transmitted and received.
- Aggregate statistics are displayed in Statistics View in IxExplorer.
- Session/Per Interface stats is displayed in IxNw/Tcl/csv file.
- Per Interface configuration is done in protocol interfaces.
- Ability to compose or decode PTP messages from the IxExplorer user interface.
- Negative testing is supported.
  - Programmable follow-up messages as a percentage of sync messages. See how dropping 10-90% of follow-up messages (while sending 100% of sync messages) affects the DUT.
  - Send follow-up messages with a bad packet.
  - Purposely send data with timestamps that include jitter (to try forcing a sync to fail).
  - Negative testing is done with packet streams/linux.

Local Clock synchronization through PTP to another PTP clock

The local clock of the is synchronized to the 's master clock by minimizing the Offset_from_master value of the current data set. The time and the rate characteristics of the local clock are modified upon receipt of either a sync message or follow-up message. The following figure illustrates the PTP communication path.

Figure: PTP Communication Path



PTP Communication Path

Term	Value
sync_receipt_time = Ts1	Ts1 =Tm1+O+master_to__delay
preciseOriginTimestamp =	Tm1

Term	Value
Tm1	
master_to__delay (computed)	Ts1 Tm1
delay_req_sending_time = Ts2	Ts2
delayReceiptTimestamp = Tm2	Tm2 = Ts2 O + _to_master_delay
_to_master_delay (computed)	Tm2 Ts2
one_way_delay	{(master_to__delay as computed) + (_to_master_delay as computed)}/2
	{(Ts1-Tm1) + (Tm2-Ts2)}/2
	{(O + master_to__delay) +
	O +_to_master_delay)}/2
	{(master_to__delay) + (_to_master_delay)}/2
	master_to__delay if path is symmetrical

1. Offset shall be computed as O= Ts1-Tm1 - one_way_Delay. Offset and One way delay shall be stored.
2. Offset correction shall be applied to the local clock.

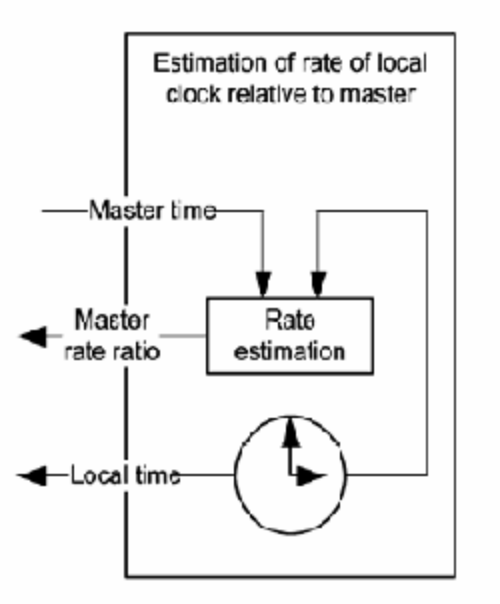
Local clock frequency transfer

In Slave mode of operation, the Ixia port implements a local clock in software (Linux). The frequency of the oscillator is not adjusted but allowed to free-run. The local clock shall be implemented based on time information synchronized from sync/follow_up messages and hardware timestamps associated with these messages. The local clock is associated with a constant and a slope. The rate of a local clock relative to a master clock is illustrated in the figure below in IxExplorer References section.

IxExplorer References

See the IxExplorer User Guide, Chapter 10, Protocol Interfaces, especially topics *Protocol Interfaces Tab*, *PTP Discovered Information*, and *PTP Clock Configuration*.

Figure: Rate of Local Clock Relative to Master



- Clock = K+ Slope*(TS-TS1),
- Slope = (T2-T1)/(TS2-TS1).
- K = T1

Where T1 is the time synchronized from the master and TS1 is the hardware timestamp associated with sync message 1. T2 and TS2 are corresponding parameters associated with sync message 2. T is the time at any point of time.

With a sync message, the parameters K and the slope are updated. The Clock Offset from master is calculated as discussed above and applied to K for correction.

Timestamps are cleared once when PTP is enabled.

In master mode of operation, server provides timestamp to the ports at the instant timestamps are cleared and slope is 1. OFFSET from master is 0.

If a GPS source is interfaced to the chassis, ports emulating the master are configured as Grand Master.

Local clock time format is seconds (32 bits) and nanoseconds (32 bits). The Ixia port supports a 2-step clock.

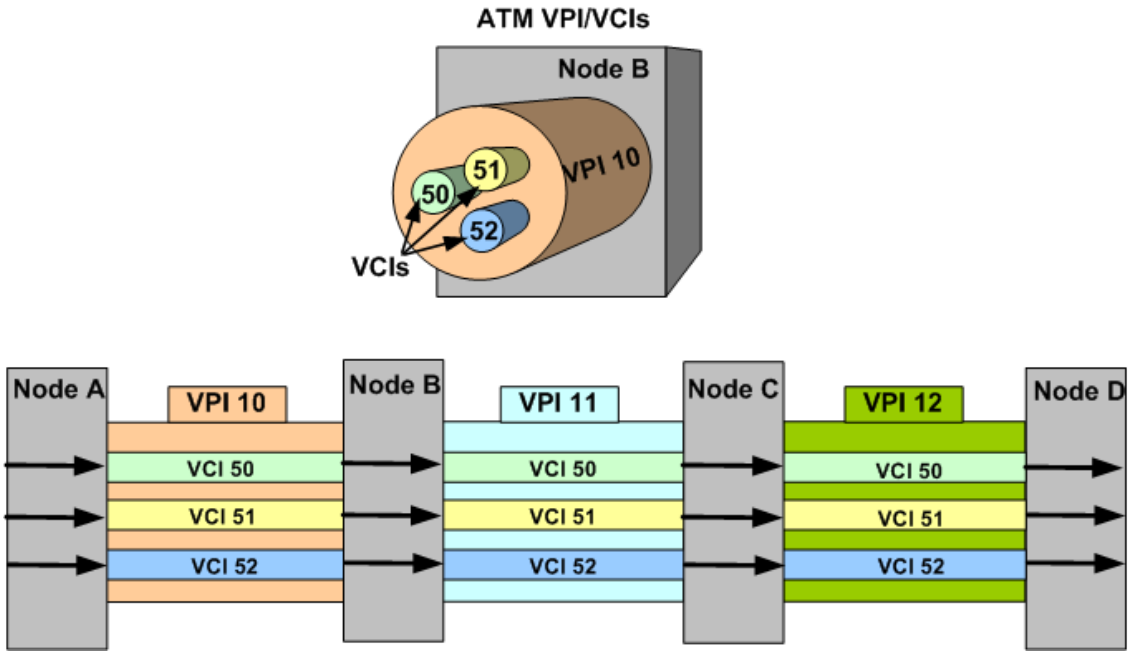
ATM Interfaces

On Asynchronous Transport Mode (ATM) is a Layer 2, connection-oriented, switching protocol, based on L2 Virtual Circuits (VCs). For operation in a connectionless IP routing or bridging environment, the IP PDUs must be encapsulated within the **payload field** of an ATM AAL5 CPCS-PDU (ATM Adaptation Layer 5 Common Part Convergence Sublayer Protocol Data Unit). The ATM CPCS-PDUs are divided into 48-byte segments which receive 5-byte headers to form 53-byte ATM cells.

The ATM cells are then switched across the ATM network, based on the Virtual Port Identifiers (VPIs) and the Virtual Connection Identifiers (VCIs). The relationship between VPIs (identifying one hop

between adjacent nodes) and VCIs (identifying the end-to-end virtual connection) is illustrated in the following figure.

Figure: ATM VPI/VCI Pairs (PVCs)



Bridged ATM' Versus Routed ATM

The ATM AAL5 frames allow for the overlay of the connectionless IP bridging or routing environment over the network of ATM nodes (that have frame handling capability). Each ATM node examines the payload of the AAL5 frame, and forwards the frame to the next node, based on the payload's MAC destination address (for IP bridging) or IP destination address (for IP routing). In effect, the ATM environment functions as a simulated Ethernet or IP network, respectively.

In the case of Label Distribution Protocol (LDP) routing over ATM, the process becomes more complex since MPLS tunnels are created over ATM core networks. For more information on the signaling, session setup, and label distribution for LDP routing over ATM, see the *IxNetwork Users Guide: NetworkProtocols - LDP chapter*.

ATM Encapsulation Types

There are two main types of ATM Multiplexing encapsulations defined by RFC 2684, `Multiprotocol Encapsulation over ATM Adaptation Layer 5.' The ATM AAL5 Frame is described in ATM Frame Formats on page 156. The various encapsulation types and references to diagrams of the encapsulated frame payloads are listed as follows:

- **VC Multiplexing (VC Mux)**: used when only one protocol is to be carried on a single ATM VC. Separate VCs are used if multiple protocols are being transported.
  - Figure: VC Mux IPv4 Routed on page 159:
  - VC Mux IPv6 Routed

    - VC Mux Bridged Ethernet/802.3 (FCS)
    - VC Mux Bridged Ethernet/802.3 (no FCS)
- **Logical Link Control (LLC)**: used for multiplexing multiple protocols over a single ATM virtual connection (VC).
    - LLC Routed AAL 5 Snap
    - LLC Bridged Ethernet (FCS)
    - LLC Bridged Ethernet (no FCS)

NOTE The Protocol Configuration Wizards for BGP, OSPFv2, and ISIS allow configuration on ATM ports, but ***ONLY*** for the VC Mux Bridged Ethernet/802.3 (FCS) encapsulation type.

Encapsulation Types by Protocol

The types of RFC 2684 ATM encapsulations available for each Ixia routing protocol emulation are listed in the following table.

ATM Encapsulations for Protocols

Routing Protocol	ATM Encapsulation Type
BGP	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS) `Routed ATM': • VC Mux IPv4 Routed • VC Mux IPv6 Routed • LLC Routed AAL5 Snap
OSPF (v2 only) NOTE Supported for both Point-to-Point and Point-to-MultiPoint links.	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS)

Routing Protocol	ATM Encapsulation Type
	• LLC Bridged Ethernet (no FCS) `Routed ATM': • VC Mux IPv4 Routed • LLC Routed AAL5 Snap
LDP **Note**: Discovery Mode must be set to Basic, and Advertising Mode must be set to Downstream on Demand (DoD).	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS) `Routed ATM': • VC Mux IPv4 Routed • LLC Routed AAL5 Snap
RSVP-TE	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS)
ISIS	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS)

Routing Protocol	ATM Encapsulation Type
	• LLC Bridged Ethernet (no FCS)
RIP	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS)
RIPng	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS)
IGMP	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS) - (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS)
MLD	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS)- (the default)

Routing Protocol	ATM Encapsulation Type
	• VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS)
PIM-SM	`Bridged ATM': • VC Mux Bridged Ethernet/802.3 (FCS)- (the default) • VC Mux Bridged Ethernet/802.3 (no FCS) • LLC Bridged Ethernet (FCS) • LLC Bridged Ethernet (no FCS)

ATM Frame Formats

The image below shows the format of the Figure: ATM AAL5 CPCS-PDU (ATM AAL5 Frame) below. The formats of the various types of AAL5 CPCS-PDU payloads for these frames are shown in the following diagrams:

- BRIDGED:
  - Figure: VC Mux Bridged Ethernet/802.3 (FCS) on the facing page
  - Figure: VC Mux Bridged Ethernet/802.3 (no FCS) on the facing page
  - Figure: LLC Bridged Ethernet (FCS) on page 158
  - Figure: LLC Bridged Ethernet (no FCS) on page 158
- ROUTED:
  - Figure: VC Mux IPv4 Routed on page 159
  - Figure: VC Mux IPv6 Routed on page 159
  - Figure: LLC Routed AAL5 Snap on page 160

Figure: ATM AAL5 CPCS-PDU (ATM AAL5 Frame)

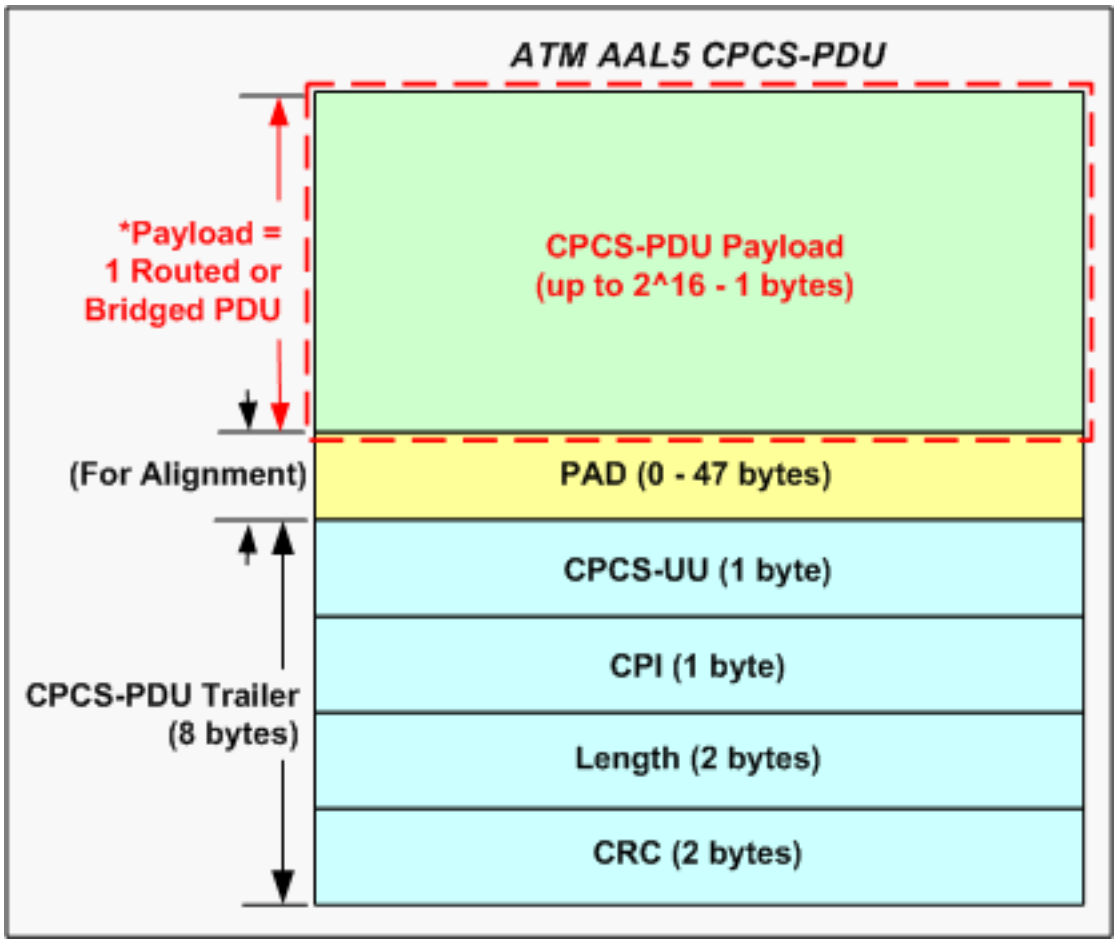


Figure: VC Mux Bridged Ethernet/802.3 (FCS)

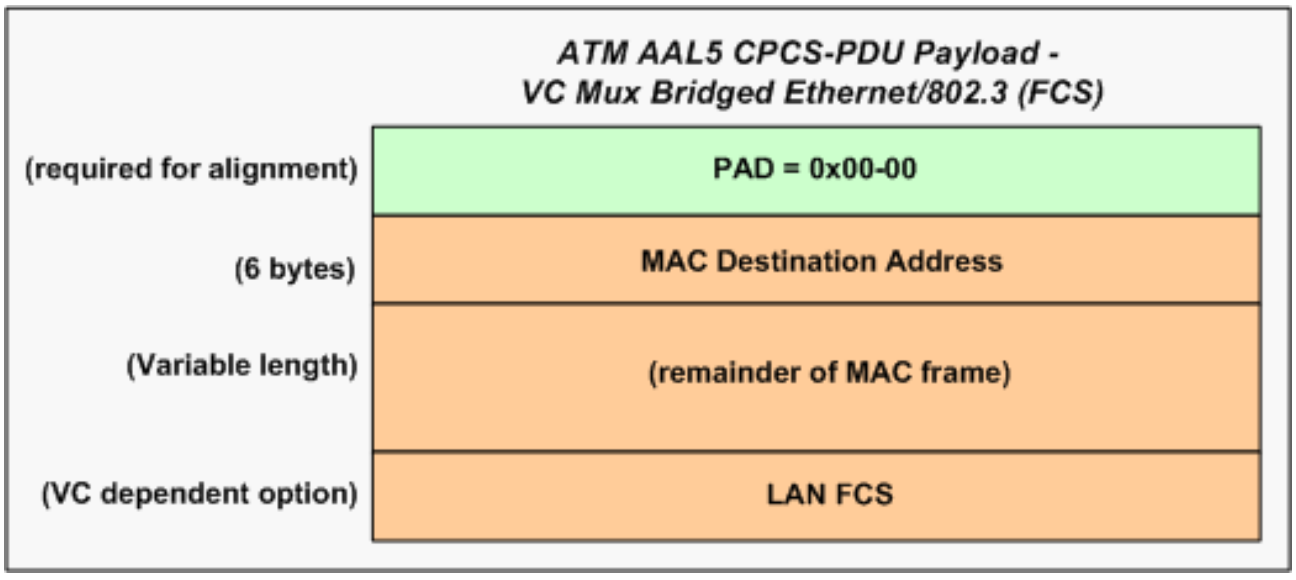


Figure: VC Mux Bridged Ethernet/802.3 (no FCS)

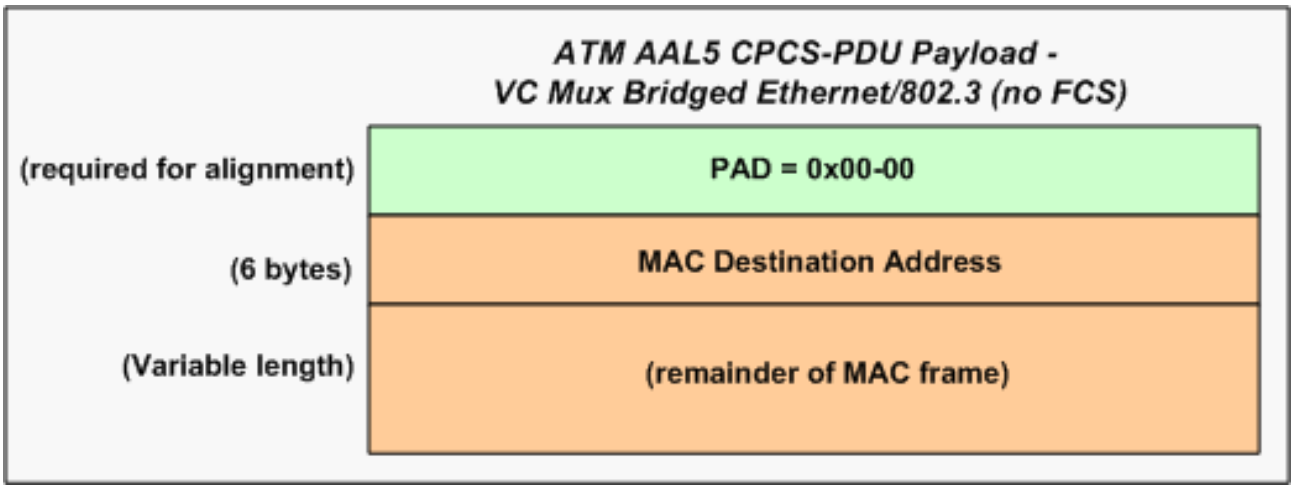


Figure: LLC Bridged Ethernet (FCS)

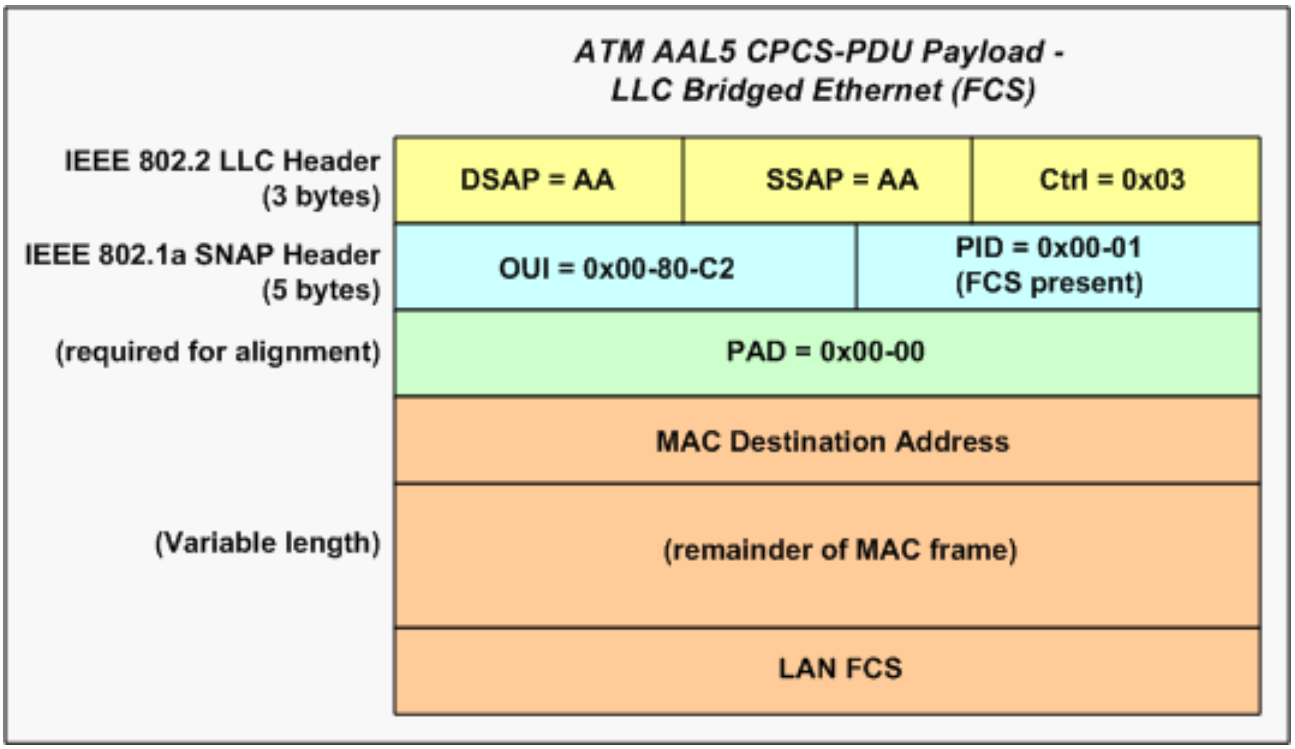


Figure: LLC Bridged Ethernet (no FCS)

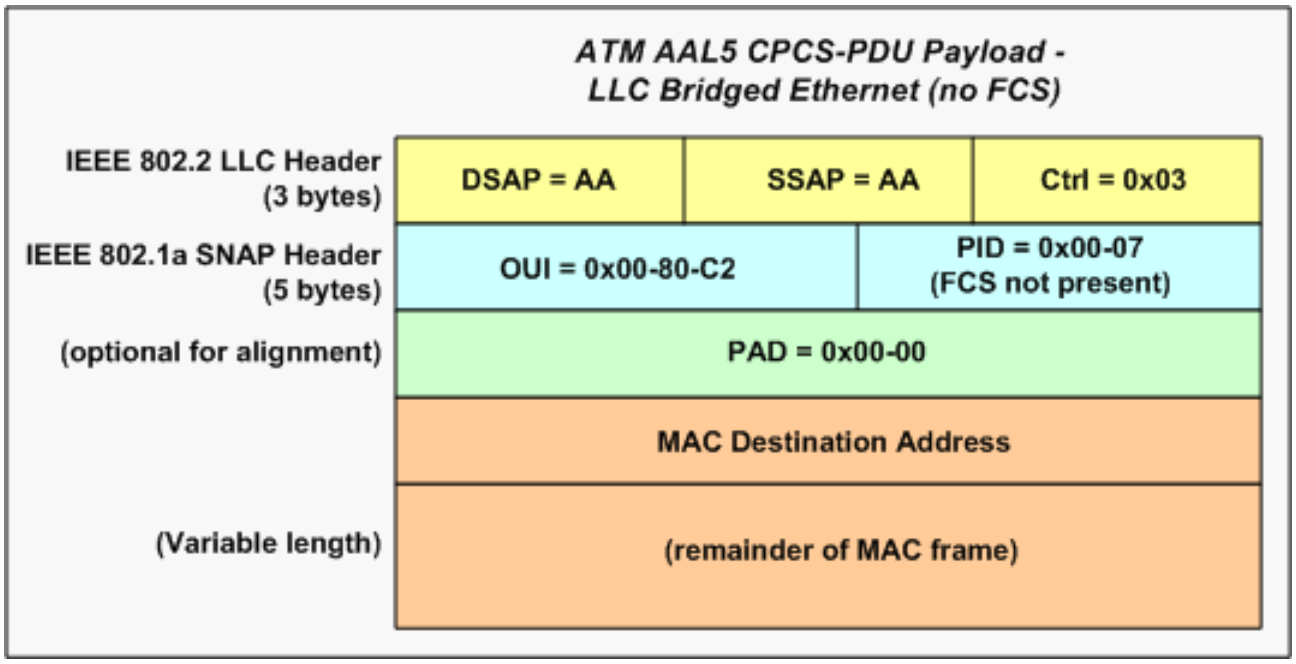


Figure: VC Mux IPv4 Routed

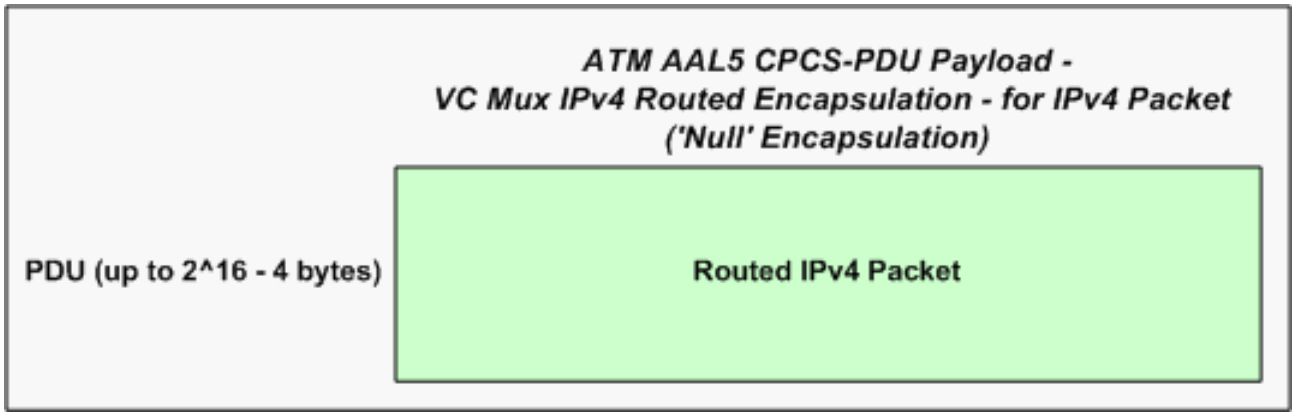


Figure: VC Mux IPv6 Routed

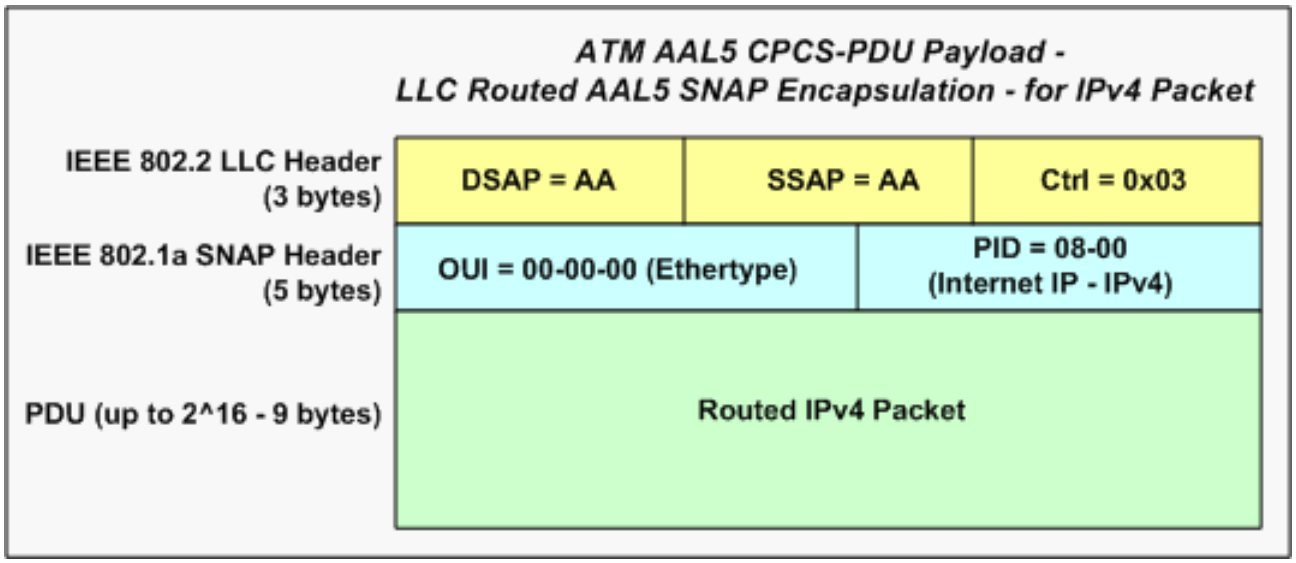
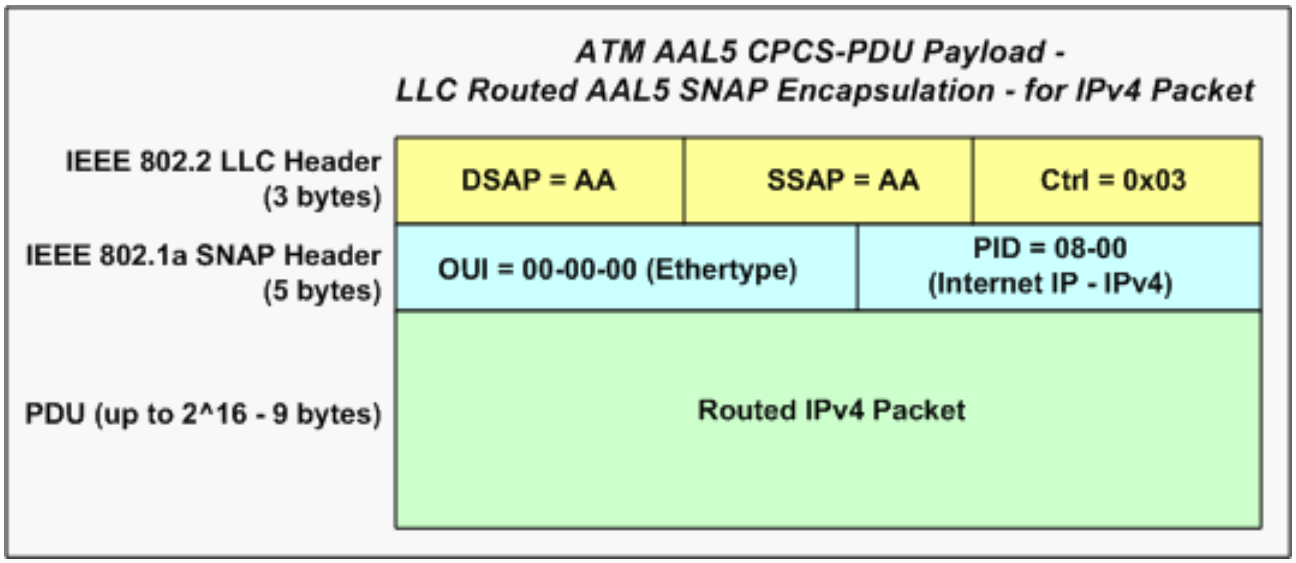


Figure: LLC Routed AAL5 Snap



Generic Routing Encapsulation (GRE)

RFC 2784, `Generic Routing Encapsulation' (GRE), provides a mechanism for encapsulating a payload packet to send that packet over a network of a different type. First, a GRE header is prepended to the payload packet, and the Ethertype for the protocol used in that packet is included in the GRE header. Then, a Delivery header is prepended to the GRE header, which adds a Layer 2 Data Link Layer address plus a Layer 3 Network address (for a network protocol in this implementation, either IPv4 or IPv6). After a GRE-encapsulated payload packet has reached the last router of the GRE `tunnel,' this router removes the GRE header and forwards the payload as a `normal' packet for the native protocol in the network.

This is a relatively simple type of encapsulation and can be used to transparently carry packets for many different protocols, since it is based on Ethertypes. The original specifications for this

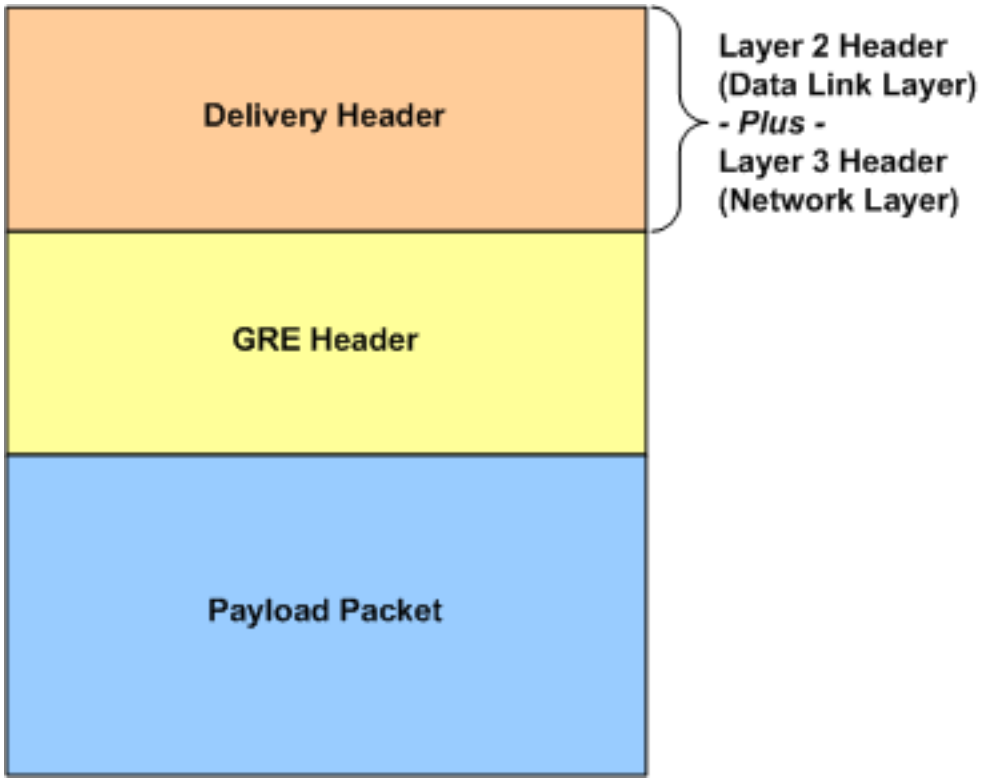
encapsulation were RFC 1701, `Generic Routing Encapsulation (GRE),' published in 1994, and RFC 1702, `Generic Routing Encapsulation over IPv4 Networks,' also published in 1994.

RFC 2890, `Key and Sequence Number Extensions to GRE,' provides optional fields for identifying individual traffic flows within a GRE tunnel through an authentication key value, and for monitoring the sequence of packets within each GRE tunnel.

GRE Packet Format

Both control and data packets can be GRE-encapsulated. The overall format of a GRE-encapsulated packet is shown in the following figure.

Figure: GRE-Encapsulated Packet



GRE Packet Headers

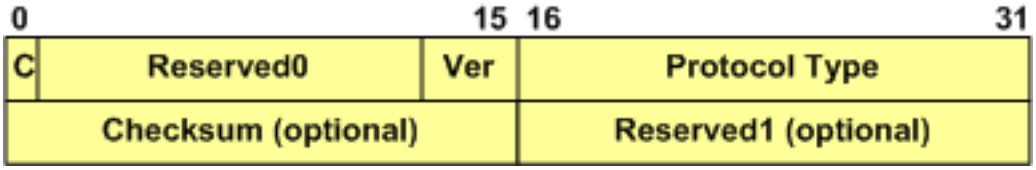
There are two formats for the GRE Packet Headers:

- GRE Header per RFC 2784
- GRE Header per RFC 2890

GRE Header per RFC 2784

The format of a GRE packet header per RFC 2784 is shown in the following figure.

Figure: GRE Packet Header (per RFC 2784)



The fields in the GRE header, per RFC 2784, are described in the following table.

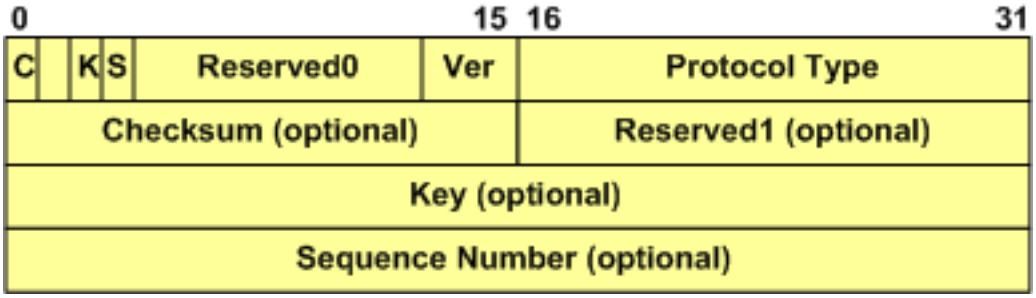
GRE Header Fields (per RFC 2784)

Field	Description
C	The Checksum Present flag bit. If set (= 1), the Checksum and Reserved1 fields are present, and the information in the Checksum field is valid.
Reserved0	(Bits 1 - 12) • Bits 1 - 5 unless the receiver is implementing RFC 1701, the receiver must discard the packet if any of these bits are non-zero. • Bits 6 - 12 reserved for future use.
Ver	The Version Number field. The value must be zero.
Protocol Type	Protocol Type field. The protocol type of the payload packet. These values are defined in RFC 1700, `Assigned Numbers' and by the IANA `ETHER TYPES' document. When the payload is an IPv4 packet, the protocol type must be set to 0x800 (Ethertype for IPv4).
Checksum	(Optional) The IP (one's complement) checksum of all of the 16-bit words in the GRE header and the payload packet. The value of the checksum field = zero for the purpose of computing the checksum. The checksum field is present only if Checksum Present bit is set (= 1).
Reserved1	(Optional) These bits are reserved for future use. This field is present only if the Checksum field is present (that is, the Checksum Present bit = 0). If present, this field must be transmitted as zero.

GRE Header per RFC 2890

The format of a GRE header, with added information per RFC 2890, is shown in the following figure.

Figure: GRE Header (per RFC 2890)



The fields in the GRE header, per RFC 2890, are described in the following table.

GRE Header Fields (per RFC 2890)

Field	Description
C	The Checksum Present flag bit. If set (= 1), the Checksum field and the Reserved1 is present, and the information in the Checksum field is valid.
Reserved0	Bits 1 - 12. For bits 1 - 5, unless the receiver is implementing RFC 1701 the receiver must discard the packet if any of these bits are non-zero. For bits 6 - 12, these bits are reserved for future use.
K	The Key Present flag bit. If set (= 1), the Key field is present. If not set (= 0), this field is not present. (Compatible with RFC 1701)
S	The Sequence Number Present flag bit. If set (= 1), the Sequence Number Present field is present. If not set (= 0), this field is not present. (Compatible with RFC 1701)
Ver	The Version Number field. The value must be zero.
Protocol Type	Protocol Type field. The protocol type of the payload packet. These values are defined in RFC 1700, `Assigned Numbers' and by the IANA `ETHER TYPES' document (located at www.iana.org/assignments/ethernet-numbers). When the payload is an IPv4 packet, the protocol type must be set to 0x800 (Ethertype for IPv4).
Checksum	(Optional) The IP (one's complement) checksum of all of the 16-bit words in the GRE header and the payload packet. The value of the checksum field = zero for the purpose of computing the checksum.

Field	Description
	The checksum field is present only if Checksum Present bit is set (= 1).
Reserved1	(Optional) These bits are reserved for future use. This field is only present if the Checksum field is present (that is, the Checksum Present bit = 0). If present, this field must be transmitted as zero.
Key Present	(Optional) This field is present only if the Key Present bit is set (= 1). A 4-octet number that can be used to identify an individual, logical traffic flow within the GRE tunnel. The encapsulator/sender uses the same key value for all packets within a single flow, for identification by the decapsulator/receiver.
Sequence Number Present	(Optional) This field is present only if the Sequence Number Present bit is set (= 1). A 4-octet number that can be used to identify the order of transmission of the packets, with the goal of providing unreliable, but in-order delivery of packets. The decapsulator/receiver uses the sequence number to monitor the order of the packets as they are received. Out-of-sequence packets should be silently discarded. The sequence number of the first packet = 0. The value range is from 0 to (2 ** 32) -1.

DHCP Protocol

Dynamic Host Configuration Protocol (DHCP) is defined in RFC 2131, and it is based on earlier work with the protocol for BOOTP relay agents, which was specified in RFC 951. A DHCP Server provides permanent storage and dynamic allocation of IPv4 network addresses and other network configuration information. A DHCP Server is a host, and a DHCP Client is also a host. This protocol is designed for allocating IPv4 addresses to hosts, but not to routers.

A Client Identifier (Client ID) is required so that the DHCP Server can match a DHCP client with its `lease.' If the Client does not supply a Client Identifier option, the Client Hardware MAC Address (chaddr) is used by the Server to identify the Client. A lease is the period of time that a DHCP Client may use an IPv4 address that has been allocated by the DHCP Server. This lease period may be extended, and may even be set to `infinity' (0xffffffff hex), to indicate a `permanent' IPv4 address allocation.

DHCP messages are exchanged between client and server using UDP as the transport protocol. The DHCP Server port is UDP Port 67, and the DHCP Client port is UDP Port 68.

DHCPDISCOVER messages are broadcast by the Client on the local subnet, to reach the DHCP Server. Suggested values for a network address and lease period may be included in the Discover message. The Server(s) may respond with a DHCPOFFER message. The Offer message includes available IPv4 network address, plus configuration parameters contained in the DHCP options (TLVs/objects).

NOTE You will not be able to select DHCP-enabled protocol interfaces for use with Ixia protocol emulations, with the exception of IGMP.

DHCPv6 Protocol

The Dynamic Host Control Protocol for Version 6 (DHCPv6) is defined in RFC 3315. DHCPv6 uses UDP packets to exchange messages between servers and clients. The servers provide IPv6 addresses and additional configuration information to clients. A DHCPv6 server listens on a reserved, link-scope multicast address. A client identifies itself to the server by a link-local source address.

The groups of IPv6 addresses managed by the servers and clients are called Identity Associations (IAs), where each IA has a unique identifier. IA_NAs are identity associations of non-temporary (permanent) IPv6 addresses. IA_TAs are identity associations of temporary addresses.

RFC 3633, `IPv6 Prefix Options for Dynamic Host Configuration Protocol (DHCP) Version 6,' adds capability for *automated* allocation of IPv6 prefixes from a delegating router to a requesting router. IA_PDs are identity associations used for delegated IPv6 address prefixes.

The setup for DHCPv6 involves a four-message exchange `handshake.' Maintaining the DHCPv6 client-server relationship, and managing the return or deletion of IPv6 addresses involves three additional messages. These messages are described in the following list:

Message exchange (handshake):

- SOLICIT: Client sends a DHCPv6 SOLICIT message to the all DHCPv6 Agents multicast address to locate suitable servers.
- ADVERTISE: Multiple servers respond to the client's SOLICIT message by sending an ADVERTISE message to the client. The Client receives and stores ADVERTISE messages until the first retransmit timeout for SOLICIT messages, then accepts the message with the highest preference value. Or, the client immediately accepts an ADVERTISE message that has the preference value set to 255.
- REQUEST: Client sends a REQUEST message to the DHCPv6 server that has the highest preference value.
- REPLY: Server responds to the client's REQUEST message with a REPLY message containing the IPv6 address and configuration parameters required by the client.

Additional messages for Maintenance/Return/Deletion of Addresses:

- RENEW: Client sends a RENEW message to the assigned server after the Renew time specified for the IA. The server may respond with a REPLY message.
- REBIND: If the client does not receive a response (REPLY) from the primary (assigned) server, it multicasts a REBIND packet according to the Rebind time specified for the IA. The server(s) may each respond with a REPLY message.
- RELEASE: Client sends a RELEASE message to return one or more IPv6 addresses to the server when it has completed using the IPv6 address(es).

NOTE If the client does not receive any REPLY messages from the server in response to its RENEW or REBIND messages, the client deletes the assigned addresses according to the valid lifetimes of the addresses.

Ethernet OAM

The IEEE Std 802.3ah Operations, Administration, and Maintenance (OAM) sublayer provides mechanisms useful for monitoring link operation such as remote fault indication and remote loopback control. In general, OAM provides network operators the ability to monitor the health of the network and quickly determine the location of failing links or fault conditions.

OAM information is conveyed in Slow Protocol frames called OAM Protocol Data Units (OAM PDUs). OAM PDUs contain the appropriate control and status information used to monitor, test and troubleshoot OAM-enabled links.

The addition of Ethernet OAM support in IxOS involves the following:

- support in stream configuration dialogs to send OAM packets.
- support for a PCPU based state machine that is configured to act as a *passive* mode endpoint and reply to OAM packets.

A list of load modules and the Ethernet OAM statistics they can generate are provided in Ethernet OAM Statistics. Ethernet OAM statistics counters are defined in Description of Statistics.

CHAPTER 4

XG12 Chassis

This chapter provides details about the XG12 chassis its specifications and features.

The XG12 Chassis is the next generation high performance platform capable of supporting all XM form factor load modules, including full chassis configurations of the Xcellon load modules. It is a 12-slot chassis with increased total power capacity available for all load modules and front-to-back airflow delivery along with increased bandwidth from the CPU to the load modules.

The chassis provides improved modularity and access to the major components to reduce downtime of a failed chassis and to reduce the probability of needing to remove a failed chassis from the test environment. The four separate modules that make up the chassis are shown in the following table.

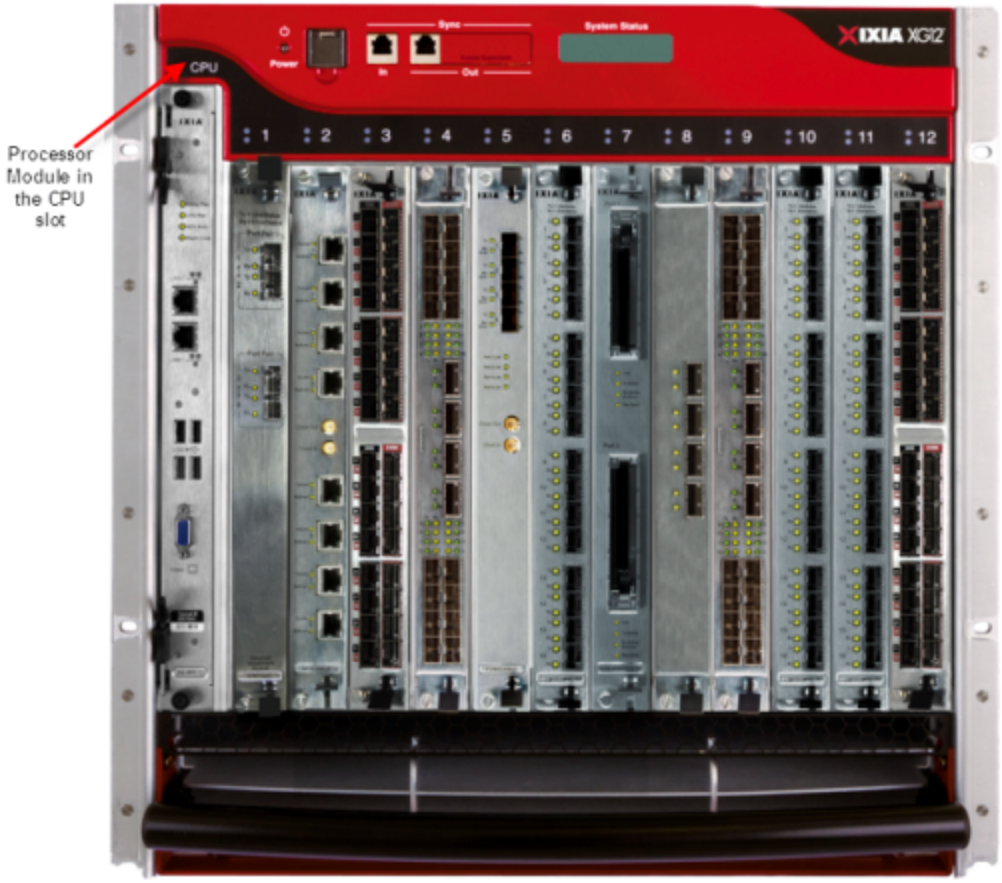
XG12 Part Numbers and Modules

Part Number	Description
941-0017	XG12, 12-Slot Chassis Frame Module
942-0031	XG12, 12-Slot Chassis Fan Module
942-0032	XG12, 12-Slot Chassis Power Supply Module
942-0033	XG12, 12-Slot Chassis Processor Module

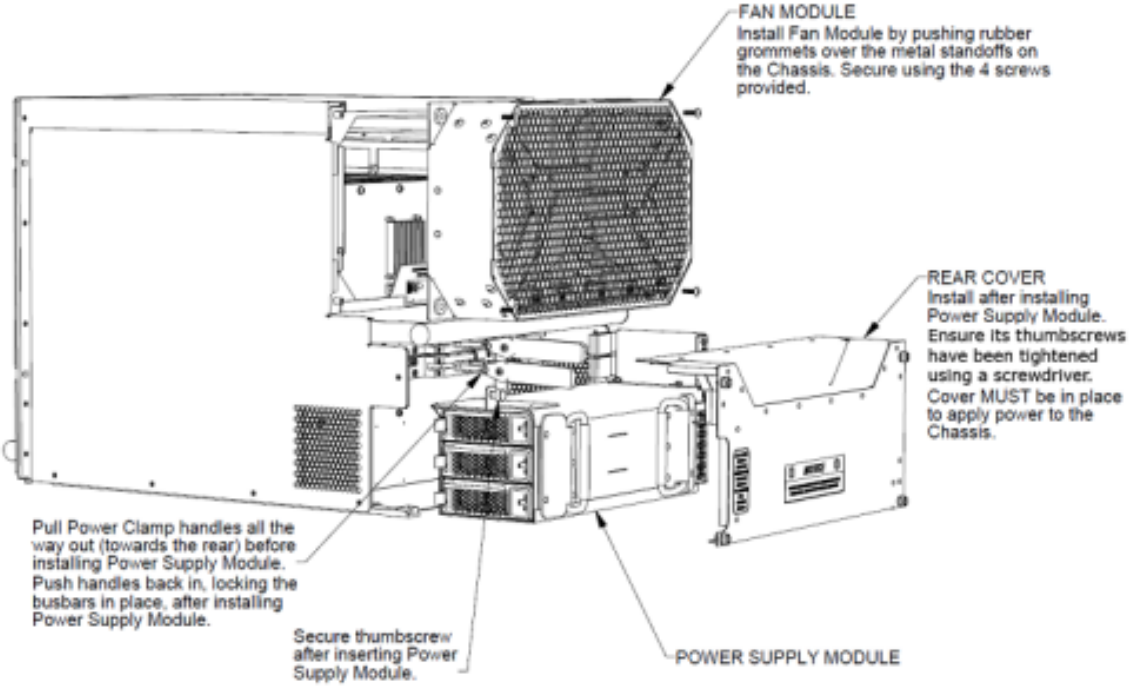
The XG12, shown in the figure below allows the hot-swapping of load modules, without requiring the chassis to be powered down. The Processor module for the XG12 chassis is hot swappable.

The Processor Module is plugged into the front of the chassis. The power supplies and fans are accessible from the rear of the chassis. Each of the modular components is capable of being removed in the field and replaced with minimum downtime.

Figure: XG12 Chassis



The component modules of the XG12 chassis are shown in the following figure:



Specifications

The XG12 chassis specifications are contained in the following tables:

XG12 Processor Module Specifications

Processor Module	Field replaceable and removable processor card module with an Intel 2.26 GHz Core™ 2 Duo processor with 4 GB CPU memory, and 250 GB SATA hard drive
Memory	4GB
Hard Disk Drive	250GB
Operating System	Windows 7
	Caution: Battery replacement: Danger of explosion if battery is incorrectly replaced. You should not attempt to replace the battery. Return to Ixia Customer Service for replacement with the same or equivalent type of battery. Ixia disposes of used batteries according to the battery manufacturer's instructions. **Caution**: Remplacement de la batterie: Le remplacement incorrect de la batterie peut provoquer une explosion. Vous ne devez en aucun casessayer de remplacer la batterie. Renvoyez le produit au service clients Ixia pour un échange avec le mêmetype de batterie ou un type équivalent. Ixia met les batteries usagées au rebut conformémentaux instructions du fabricant.
	NOTE The serial number for the Processor Module is located on module itself. This is used as the overall chassis serial number.

XG12 Chassis Specifications

Size	• 19.0 in. W x 19.21 in. H x 27.2 in. D • 48.26cm W x 48.79cm H x 69.09cm D • 11 rackmount units (11RU)
Load Module Slots	12 (compatible with Ixia XM form factor load modules)
Chassis Power	The chassis requires three single phase, 200-240VAC, 50/60Hz circuits, each capable of providing 3680 watts. These circuits must provide protection against over-currents, short circuits and earth faults for the XG12 chassis. A 20A circuit breaker for each circuit is also required.

	All three power cords must be plugged into their single phase 200-240VAC, 50Hz/60Hz power sources at the same time for correct operation of the chassis. NOTE • The chassis power supplies are interlocked with the rear cover which must be installed for them to be enabled. After removing or installing the rear panel, ensure thumbscrews have been tightened down with a 'Flat Blade' screwdriver. • The load module power is enabled by the Ixia server program. If it is not running, the load modules will not be powered on.
Power Cords	All three power cords are required to operate the XG12 chassis power supplies. Power Cord shipments: • Ixia provides three power cords that are configured and rated to meet the specifications of the target country where the chassis is being installed • For North American customers, the power cords have NEMA L6-20P plugs for attachment to the power source and IEC-60320-C19 connectors that attach to the XG12 chassis • For International shipments, the power cords supplied has plugs suitable for each destination country's power source and IEC-60320-C19 connectors that attach to the XG12 chassis • The XG12 chassis is CE marked and UL certified when using the 200-240VAC power cords supplied with the chassis. However, these certifications for the chassis safety approvals are only valid when the unit is operating from all three 200-240VAC main power sources
Chassis Weights	**Frame**: • 64 lbs. (29.1 kg) empty, component weight • 97 lbs. (44.1 kg) average shipping weight (with filler panels) **Fan module**: • 10.2 lbs. (4.63 kg) component weight • 17.3 lbs. (7.86 kg) average shipping weight **Power Supply module**: • 28 lbs. (12.72 kg) component weight • 35.1 lbs. (15.95 kg) average shipping weight **Processor module**: • 2.7 lbs. (1.23 kg) component weight • 8.5 lbs. (3.86 kg) average shipping weight **Warning**: Total chassis weight, without any load modules installed is 104.9 lbs. (47.6 kg). Do not attempt to lift the fully assembled chassis.

	Avertissement: N'essayez pas de soulever le châssis entièrement assemblé.
Fan Module	Field replaceable chassis fan assembly that is easily installed and removed.
Air flow Clearance	12 inches is required at the rear of the chassis. 24 inches of clearance is preferred.
Power Supply Module	Field replaceable power supply module that is easily installed and removed. There are three 2825W power supplies in the Power Supply Module. Each power supply may be removed or replaced separately.
Timing Sources	Internal clock, synchronized with another Ixia chassis, GPS AFD-1unit, AFD2 IRIG-B unit or with the Timing Distribution Module.
Shipping Vibration	FED-STD-101C, Method 5019.1/5020.1
Operating temperature	41°F to 104°F (5°C to 40°C) NOTE Some high-density/high performance load modules require a lower maximum ambient operating temperature than the standard for the chassis. When a load module that requires the lower maximum operating temperature is installed in an XM chassis, the maximum operating temperature of the chassis is adjusted downward to match the maximum operating temperature of the load module. The operating temperature range specification is specified in the published datasheet for these load modules.
Storage temperature	41°F to 122°F (5°C to 50°C)
Operating Humidity	0% to 85%, non-condensing
Storage Humidity	0% to 85%, non-condensing
Noise	The XG12 chassis running at maximum fan speed capacity may produce noise levels up to 87 dB(A). This is measured per the GR-63-CORE, Issue 1, paragraph 5.6.3 specification. The use of appropriate ear protection is recommended to protect against hearing impairment. Consult local health and safety regulations for recommended maximum exposure levels for noise and ear protection devices. Shown below are the maximum XG12 chassis sound levels measured according to GR-63-CORE, Issue 1, Paragraph 5.6.3. • Front: 83.5 dB(A) • Left Side: 84.2 dB(A)

	• Rear: 86.5 dB(A) • Right Side: 84.4 dB(A)

Warning:

Hearing Protection: The XG12 chassis generates noise levels above 80 dB(A). Ear protection must be worn. The use of appropriate ear protection is recommended to protect against hearing impairment. Consult local health and safety regulations for recommended maximum exposure levels for noise and ear protection devices.

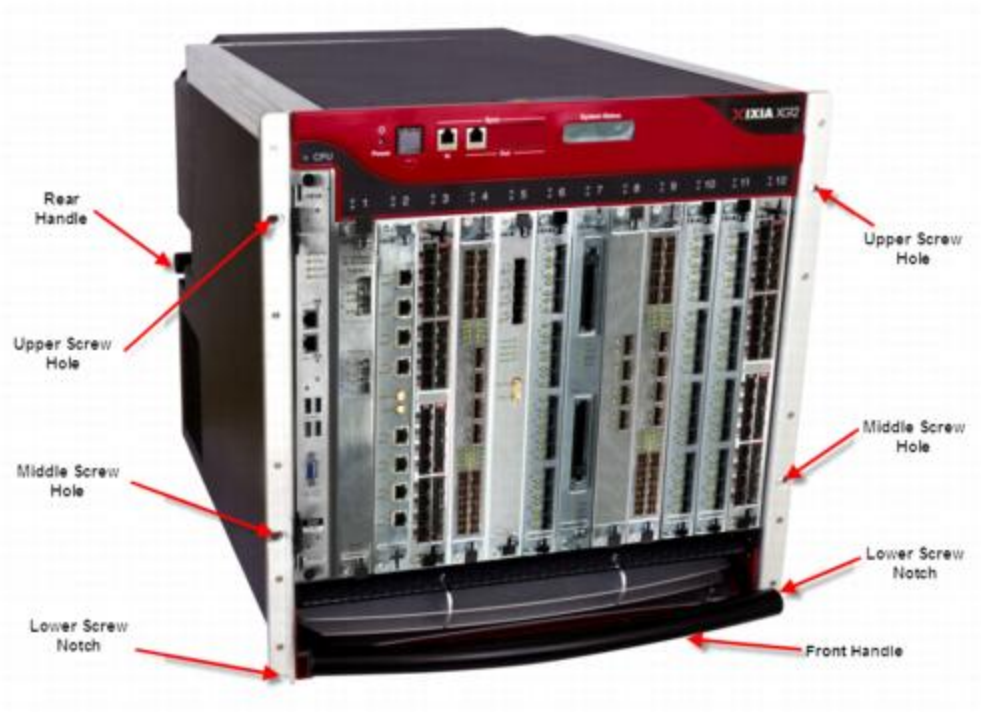
Avertissement:

Produit un niveau sonore de 86.5db (A). Des protections auditives doivent etre portees pour eviter tout risque de perte d'audition. Se referer au manuel IXIA Materiel et Reefrence pour plus d'information sur le chassis XG12 ou XGS12.

XG12 Chassis controls and indicators

Front Panel Switches	On/Off momentary power push button.
Monitor	HD-DB15 Super VGA.
Ethernet	Two RJ-45 10/100/1000Mbps Gigabit Ethernet Management Port.
USB	4 USB dual type A, 4-pin jack connectors
Sync In	Single Sync In jack with a 4-pin RJ11
Sync Out	Single Sync Out jack with a 4-pin RJ11
Front Panel Indicators	See LEDs/LCD Display.
	2 Paired LEDs above each slot position indicating Power and Active status.
	2x16 LCD on front panel indicating chassis information.

Figure: Safety Features



XG12 chassis installation precautions:

- The chassis should be installed in the rack before installing the power supply module, fan module and load modules, thereby reducing the weight of the chassis.
- The two lower bolts used to secure the chassis to a rack can be used to hold the chassis frame in place while securing all of the other bolts (See Figure 6-2).
- Secure the chassis to rack face with all six bolts. Fully depress power supply clamps when installing power supply module.
- Secure the power supply module thumb bolt when installing power supply module.
- Install the rear power supply cover before applying AC power.

  NOTE After removing or installing this cover, ensure that the thumbscrews are tightened down with a screwdriver.

- Do not use the chassis without installing the Fan module.
- Do not use the chassis without installing the Processor module.
- Do not leave unused slots open. Use the filler panels to cover the un-used slots. See Installing Filler Panels for more information.
- Do not block the front air intake.
- A minimum air flow clearance of 12 inches is required. 24 inches of air flow clearance is preferred at the rear of the chassis.
- Operator intervention may be required to power cycle the XG12 chassis or restart a software program in the event the XG12 chassis operation is upset or stopped by electrostatic discharge.

LEDs/LCD Display

The XG12 chassis has front panel LEDs for each load module slot.

XG12 LEDs

Label	Color	Description
Power	Green	When the Power LED is flashing, the board is being detected or initialized. The Power LED is illuminated when the board is powered.
In Use	Amber	The Active LED is illuminated when you have taken ownership of the load module. If you run traffic from IxExplorer, without taking port ownership, the In Use light is not illuminated.

LCD Display

An LCD display is provided on the chassis to indicate the status of the chassis without an external display device (monitor). The LCD operates in two modes:

- Startup: The LCD displays messages from IxServer to indicate the operation of IxServer as it initializes.
- Run: The LCD display provides chassis information. Information displayed includes chassis name, IxOS version, IP address, primary/secondary, and chassis status.

CPU Slot LED Definitions

The specifications of LEDs for the Processor module and the LEDs above the Processor module slot are shown in the following table:

NOTE **ESD Discharge**: Operator intervention may be required to power cycle the unit or restart a software program in the event the unit is upset by electrostatic discharge.

LED Specifications

	LED	Color	Description
On the chassis front face	CPU card Slot LED	Yellow	The backplane is initializing.
		Green	The backplane has initialized
Processor module - front panel	Stdby Pwr LED	Green	5V Stand-by power is available
	CPU Pwr LED	Green	CPU Card power is available
	HDD Act LED		
	Bkpln Link LED	Green	PCIe link to backplane is up
Processor module - Ethernet LEDs for each management port	Link LED	Green	Port has link

	LED	Color	Description
	Act LED		Flashes when port has activity

Supported Modules

The modules that are supported on the XG12 are listed in the following table.

Supported Modules

Family	Module	Function
XM Form Factor (XMFF) load modules	Xcellon-Flex High density 10GbE products	• Xcellon-FlexAP10G16S 10 Gigabit Ethernet LAN Load Module, L2-7 Accelerated Performance, a 1-slot module with 16-ports of SFP+ interfaces • Xcellon-FlexFE10G16S 10 Gigabit Ethernet LAN Load Module, L2-3 Full Emulation Performance, a 1-slot module with 16-ports of SFP+ interfaces
	Xdensity Ultra-high density 10GbE	Xdensity, Ultra-high density, 10-Gigabit Ethernet load module with 32-ports of SFP+ interfaces and L2-3 data plane support
	Xcellon-Flex High density 10GbE and 40 GE products	• Xcellon-FlexAP10/4016SQ 10/40 Gigabit Ethernet Accelerated Performance Load Module, 16-Ports of SFP+ interfaces and 4-ports of QSFP 40 GE interfaces with full performance L1-7 support • Xcellon-FlexFE40G4Q 40 Gigabit Ethernet Full Emulation Load Module, 4-ports of QSFP 40 GE with L1-3 support
	K2 Higher Speed Ethernet product line	• HSE40GETSP1-01, 40-Gigabit Ethernet Load Module, 1-port, 2-slots, with the CFP MSA interface • HSE100GETSP1-01, 100- Gigabit Ethernet Load Module, 1-port, 2-slots, with the CFP MSA interface • HSE40/100GETSP1-01 Dual-Speed, 1-port, 2-slots, with CFP MSA interface • HSE40/100GETSPR1-01, Dual Speed,

Family	Module	Function
		40 and 100-Gigabit Data Plane Ethernet Load Module, 1-port, 2-slots, with the CFP MSA interface • HSE40GEQSFP1-01, 40-Gigabit Ethernet Load Module, 1-port, 1-slot with the QSFP+ pluggable interface for multimode fiber, 850nm, or QSFP+ copper cables
	Xcellon Ultra High Performance Application Test product line	Xcellon-Ultra NP-01, Application Network Processor Load Module, 1-10G XFP port and/or 12-Ports of Dual-PHY (SFP fiber and RJ45 copper) 10/100/1000 Mbps
	NGY High Density 10 Gigabit Ethernet product line	• LSM10GXMR2/4/8-port, reduced performance, load modules with the XFP interface • LSM10GXM2/4/8XP-port, Extra performance, load modules with the XFP interface • LSM10GXM2S/4S/8S-port, Extra performance, load modules with the SFP+ interface • LSM10GXM2S/4S/8S-port, reduced performance, load modules with the SFP+ interface • LSM10GXM2GBT/4GBT/8GBT-port, Extra performance, load modules with the 10GBASE-T interface • LSM10GXM2GBT/4GBT/8GBT-port, reduced performance, load modules with the 10GBASE-T interface
	Fibre Channel load module products	• 4-Port Fibre Channel Load Module, with 2Gbps, 4Gbps, and 8Gbps support, SFP+ interface • 8-Port Fibre Channel Load Module, with 2Gbps, 4Gbps, and 8Gbps support, SFP+ interface
	ImpairNet Load module products	• ImpairNet EIM1G4S Gigabit Ethernet LAN Impairment module, 1-slot with 4-ports of SFP interfaces

Family	Module	Function
		• ImpairNet EIM10G4S 10 Gigabit Ethernet LAN Impairment module, 1-slot with 4-ports of SFP+ interfaces
	Voice Quality module	VQM0001, Resource module, for real time quality of voice measurement. Must purchased with VQM0001-B1, Solution Bundle, Resource module with IXLOAD-PESQ and IXLOAD-AUDIO-CODECS software license
	NGY NP High Density 10GbE Application Test product line	• NGY-NP8-01, 10 Gigabit Application Network Processor Load Module, 8-Port LAN/WAN, SFP+ interface • NGY-NP4-01, 10 Gigabit Application Network Processor Load Module, 4-Port LAN/WAN, SFP+ interface • NGY-NP2-01, 10 Gigabit Application Network Processor Load Module, 2-Port LAN/WAN, SFP+ interface
	High Density Gigabit Ethernet product line	• LSM1000XMVDC 4/8/12/16-port, full performance, load modules with dual-phy SFP fiber and 10/100/1000Mbps RJ45 copper • LSM1000XMVR4/8/12/16-port, reduced performance, load modules with dual-phy SFP fiber and 10/100/1000Mbps RJ45 copper • LSM1000XMSP12-01, Gigabit Ethernet, Load Module, 12-Ports Dual-PHY (SFP fiber and RJ45 copper) 10/100/1000 Mbps
	Xcellon-Lava	• Xcellon-Lava AP40/100GE2P 40/100 Gigabit Ethernet Gigabit Ethernet Accelerated Performance, dual-speed, load module, 2-ports, 1-slot with CFP MSA interfaces and full performance L2-7 support • Xcellon-Lava AP40/100GE2P-NG FUSION 40/100 Gigabit Ethernet Accelerated Performance, dual-speed, load module, 2-ports, 1-slot with CFP MSA interfaces and full performance L2-7 support

Family	Module	Function
		• Xcellon-Lava 40/100GE2RP, 40/100 Gigabit Ethernet Reduced Performance, dual-speed, load module, 2-ports, 1-slot with CFP MSA interfaces and full featured L1-3 data plane support and up to 100 routing protocol emulations per port
	Xcellon-Multis	• Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP load module, 1-slot with 12-ports of 40GE QSFP with L2-7 support. The load module is compatible with the XG12 rackmount chassis (940-0005). It requires purchase of one or more QSFP+ 40GBASE-SR4 optical transceivers (948-0028) and MT 12-fiber MMF cable, 3-meter length (942-0041). NOTE For 10GE fan-out capability the module requires either XM10GE-FAN-OUT 10GE fan-out option for a new module purchase (905-1000), or UPG-XM10GE-FAN-OUT 10GE fan-out UPGRADE option to UPGRADE an existing load module (905-1001). • Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP load module, 1-slot with 6-ports of 40GE QSFP with L2-7 support. The load module is compatible with the XG12 rackmount chassis (940-0005). It requires purchase of one or more QSFP+ 40GBASE-SR4 optical transceivers (948-0028) and MT 12-fiber MMF cable, 3-meter length (942-0041).

Family	Module	Function
		NOTE For 10GE fan-out capability the module requires either XM10GE-FAN-OUT 10GE fan-out option for a new module purchase (905-1000), or UPG-XM10GE-FAN-OUT 10GE fan-out UPGRADE option to UPGRADE an existing load module (905-1001). • Xcellon-Multis XM100GE4CXP 100-Gigabit Ethernet, single rate load module, 1-slot with 4-ports native CXP multimode fiber interfaces, L2-7 support, compatible with XG12 rackmount chassis (940-0005). Requires one or more per port of the following: CXP 100GE pluggable, multimode optical transceiver (948-0030) and MTP-MTP 24-fiber, multimode point-to-point 100GE cable, 3-meter (942-0035), or point-to-point, multimode CXP 100GE Active Optical Cable (AOC), 3-meter [942-0052]. • Xcellon-Multis XM100GE4CXP+FAN 100/40-Gigabit Ethernet, multiple rate load module, 1-slot with 4-ports native 100GE CXP multimode interfaces and up to 12-ports of 40GE via fan-out cables, L2-7 support, compatible with the XG12 rackmount chassis (940-0005). Requires one or more per port of the following 100GE media: CXP 100GE pluggable, multimode optical transceiver (948-0030) and MTP-MTP 24-fiber, multimode point-to-point 100GE cable, 3-meter (942-0035), or point-

Family	Module	Function
		to-point, multimode CXP 100GE Active Optical Cable (AOC), 3-meter [942-0052]. Also requires one or more per port of the following 40GE media: CXP-to-3x40GE QSFP Active Optical Cable (AOC) for 3x40GE fan-out, 3-meter [942-0054], or 5-meter [942-0055], or MTP-to-MTP passive fiber for 3x40GE fan-out, 3-meter (942-0060), 5-meter (942-0061). These cables may be used with QSFP 40GBASE-SR4 transceivers (948-0028). • Xcellon-Multis XM40GE12QSFP+FAN 40-Gigabit Ethernet, load module, 1-slot with 12-ports of 40GE via multimode fan-out AOC cables, with L2-7 support. A quantity of 4 each, 3-meter, multimode CXP-to-3x40GE QSFP fan-out cables (942-0054) are supplied with the load module. The load module is compatible with the XG12 rackmount chassis (940-0005). • Xcellon-Multis XM100GE4CFP4 100-Gigabit Ethernet, 1-slot with 4-ports with the native CFP4 physical interfaces • Xcellon-Multis XM100GE4QSFP28 100-Gigabit Ethernet, 1-slot with 4-ports with the native QSFP28 physical interfaces • Xcellon-Multis XM100GE4QSFP28+ENH, enhanced high density, 4-port 100GE with QSFP28 physical interface • Xcellon-Multis XM100GE4CFP4+ENH, enhanced high density, 4-port 100GE with CFP4 interface
	Xcellon-Multis Reduced	• Xcellon-Multis XMR10GE16SFP+FAN 10-Gigabit Ethernet, Reduced load module, 1-slot with 16-ports of 10GE via multimode fan-out cables, with L2-7 support, full featured L1-3 data plane support and up to 100 protocol emulations per port. This load module

Family	Module	Function
		is compatible with the XG12 rackmount chassis (940-0005). It requires purchase of one or more QSFP+ 40GBASE-SR4 optical transceivers (948-0031) and MT 12-fiber MMF cable, 3-meter length (942-0041)). NOTE For 40GE fan-out capability this module requires XM40GE-FAN-OUT 40GE fan-out option for a new module purchase (905-1002). • Xcellon-Multis XMR10GE32SFP+FAN 10-Gigabit Ethernet, Reduced load module, 1-slot with 32-ports of 10GE via multimode fan-out cables, with L2-7 support, full featured L1-3 data plane support and up to 100 protocol emulations per port. This load module is compatible with the XG12 rackmount chassis (940-0005). It requires purchase of one or more QSFP+ 40GBASE-SR4 optical transceivers (948-0031) and MT 12-fiber MMF cable, 3-meter length (942-0041). NOTE For 40GE fan-out capability this module requires XM40GE-FAN-OUT 40GE fan-out option for a new module purchase (905-1002). • Xcellon-Multis XMR40GE12QSFP+ 40-Gigabit Ethernet QSFP+ Reduced load module, 1-slot with 12-ports of 40GE QSFP+ with L2-7 support, full featured L1-3 data plane support and up to 100 protocol emulations per port. The load module is compatible

Family	Module	Function
		with the XG12 rackmount chassis (940-0005). It requires purchase of one or more QSFP+ 40GBASE-SR4 optical transceivers (948-0031) and MT 12-fiber MMF cable, 3-meter length (942-0041), or QSFP+ 40GE, 40GBASE-LR4, single mode fiber optical transceiver (948-0032). • Xcellon-Multis XMR40GE6QSFP+ 40-Gigabit Ethernet QSFP+ Reduced load module, 1-slot with 6-ports of 40GE QSFP+ with L2-7 support, full featured L1-3 data plane support and up to 100 routing emulations per port.. The load module is compatible with the XG12 rackmount chassis (940-0005). It requires purchase of one or more QSFP+ 40GBASE-SR4 optical transceivers (948-0031) and MT 12-fiber MMF cable, 3-meter length (942-0041), or QSFP+ 40GE, 40GBASE-LR4, single mode fiber optical transceiver (948-0032).
Standard Form Factor (SFF) load modules for XG12 chassis NOTE Requires 944-0007 Adapter Card for XM Chassis installations	Gigabit Ethernet TX, TXS, STX and STXS products	• LM100TX8, 100MB Ethernet Load Module, 8-Port 10/100Mbps, L2-3 data plane support only • LM100TXS8, 10/100Mbps Ethernet Load Module, 8-Port RJ45, 64MB Port CPU memory • LM100TXS2, 10/100Mbps Ethernet Load Module, 2-Port RJ45, 64MB Port CPU memory • LM1000STX4, Gigabit Ethernet Load Module, 4-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps, L2-3 data plane support only • LM1000STX2, Gigabit Ethernet Load Module, 2-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps, L2-3 data plane support only • LM1000STXS2, Gigabit Ethernet Load Module, 2-Port Dual-PHY (RJ45 and SFP) 10/100/1000 MbpsLM1000STXS4-256, Gigabit

Family	Module	Function
		Ethernet Load Module, 4-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps
	10 Gigabit Ethernet LSM products	• LSM10G1-01, 10 Gigabit Ethernet Load Module, 1-Port, Full L2-7 support, requires interface adapter module Interchangeable interface adapter modules for SFP+, 10GBASE-T, XENPAK, X2, and CX4 interfaces for the LSM10G1-01
	Application and Encryption Test product line	• AFM (Auxiliary Function Module): AFM1000SP-0 • ALM (Application Load Module): ALM1000T8 • ELM (Encryption Load Module): ELM1000ST2
	10-Gigabit UNIPHY and MacSec products	• MSM10G1- 10 Gigabit Ethernet OC192 Load Module, 1-port Multi Services Module with an XFP interface, supports 10GE LAN/WAN and optional OC-192c POS • LSM10GMS1-01, 10 Gigabit Ethernet Load Module, 1-Port, LAN/WAN, Full performance and supports 802.1ae Media Access Control Security (MacSec) L2 security, including GCM/AES128
	Packet over SONET and ATM products	• MSM2.5G1-01, OC48 Load Module, 1-Port 2.5G Multi Service Module, Supports POS, Full L2-7 support • LM622MR, Load Module, 2-port ATM/Packet over SONET (POS); Full L2-7 Support. Supports 622 and 155 Mbps data rates • LM622MR-512, Load Module, 2-port ATM/Packet over SONET (POS), Full L2-7 Support. Supports 622 and 155 Mbps data rates, 512MB Port CPU memory • OC3OC12PHY, Dual-SC optical connector, Single-port OC-3/OC-12

Family	Module	Function
		PHY 1310nm Multimode; For the LM622MR or LM622MR-512) load modules

Hot-Swap Procedure

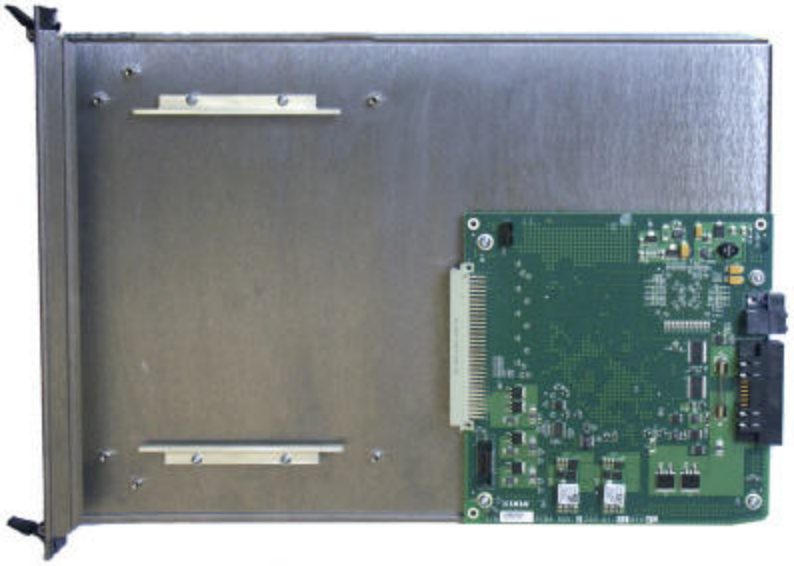
Each XG12 chassis provides the ability of removing and reinstalling a load module without requiring the removal of power from the rest of the chassis. The process of removing/installing a Load Module does not impact either the operation of the OS or remaining load modules installed in the chassis.

The hot-swap procedure is detailed in Appendix D Hot-Swap Procedure.

SFF Adapter Module

The XG12 adapter module allows Ixia Standard Form Factor (SFF) load modules to be adapted into the XG12 chassis. The following figure shows an SFF adapter module.

Figure: SFF Adapter



A SFF load module is inserted into the front of the adapter and connects to the pins in the rear of the adapter. The entire assembly can then be inserted into any XG12 chassis slot.

Once an adapter module is installed in a chassis, SFF load modules can be hot-swapped without removing the SFF load module from the chassis.

The following figure shows an SFF Adapter module with a legacy ATM card.

Figure: SFF Adapter with ATM Module

The table in section Supported Modules identifies the modules that can be used with the SFF Adapter.

Cooling Fan Speed Control

The XG12 chassis automatically monitors and measures the temperature of installed load modules. The XG12 automatically adjusts the fan speed to maintain proper cooling.

Power outage recovery and Automatic booting scenario

The BIOS on the XG12 is set to Power On after a power failure.

The XG12 chassis will start up, boot Windows 7 and automatically login to the Ixia user account. Anything that is in the Startup folder will also launch.

Rack Mount Cautions

Caution:

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (40° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the back or the front of the chassis, and leave approximately 12 inches of space, 24 inches preferred, for the back of the unit for proper ventilation. The air flow clearance should be 12 inches on the front.
3. Mechanical Loading: Mount the chassis so that is it level in the rack and that a hazardous condition is not caused. Please install all six mounting bolts.
4. Circuit Overloading: Consider the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Pay attention to equipment nameplate ratings when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Chassis frame should be screwed down to racks to ensure proper grounding path. In Addition, Pay

special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).

6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Caution:

Si cette unité est installée dans une baie d'équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l'installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l'équipement dans un environnement compatible avec la température ambiante maximale autorisée (40 C) spécifiée pour l'appareil.
2. Circulation d'air réduite: installer l'équipement dans une baie de manière a ce que la circulation d'air requise pour faire fonctionner l'équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l'appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

CHAPTER 5

XGS12 Chassis Platform

This chapter provides details about the XGS12 chassis platform, its specifications and features.

The XGS12 chassis platform models– XGS12-SD, XGS12-SD2, XGS12-SDL, XGS12-SDL2, XGS12-HSL, and XGS12-HSL2 are the next generation chassis capable of supporting XM form factor load modules. The XGS12 chassis are 12-slot chassis with high-speed backplanes designed for aggregation across load modules. These chassis are capable of testing high density, multi-Terabit bandwidth, Carrier class core, edge metro routers and data center switches. This flexible platform supports layer 2-7 testing on a massive scale and provides the most comprehensive solution for performance, functional, security, and conformance testing of network equipment and network applications.

The XGS12 chassis platform has the following features:

- Provides a unified solution for executing a wide array of data, routing, and bridging protocol emulation; and signaling, voice, video, and application testing from layers 2 to 7.
- The XGS12 chassis models provide support for higher speed Ethernet 400GE, 100GE, 50GE, 40GE, 25GE, 10GE, and 10/100/1000 Mbps copper Ethernet and Fibre.
- The XGS12 chassis models support XM, PerfectStorm, and CloudStorm load modules.
- Provides hot-swap capability where load modules can be actively swapped in and out of the test bed without disrupting ongoing test that is using installed modules.
- Has high-speed backplane that supports high bandwidth requirements of large-scale application tests.
- Supports daisy-chaining of Ixia chassis in a single large port count test bed with synchronization accuracy to within 80 nanoseconds. Supported chassis include XGS12-HSL, XGS12-SD, XGS12-SDL, XG12, 400Tv2.
- STAR and Metronome Chassis Synchronization available for the XGS12 with these other Ixia chassis: XGS2-SD, XGS2-SDL, XGS2-HSL, XGS12-SD, XGS12-SDL, XGS12-HSL, XGS12-HSL2, AresONE, and Novus ONE PLUS.
- Has the following highly-serviceable, self-contained and field-replaceable modular components:
  - Processor Module for management and control of load modules, port configurations, and statistics
  - Fan Module for temperature control
  - Power Supply Module with three power supplies

  The XGS12-HSL, XGS12-HSL2, XGS12-SDL, and XGS12-SDL2 models support remote chassis management via a browser.

The following are the four XGS12 chassis bundle models:

XGS12 Chassis Bundle Part Numbers, Components and Application Support

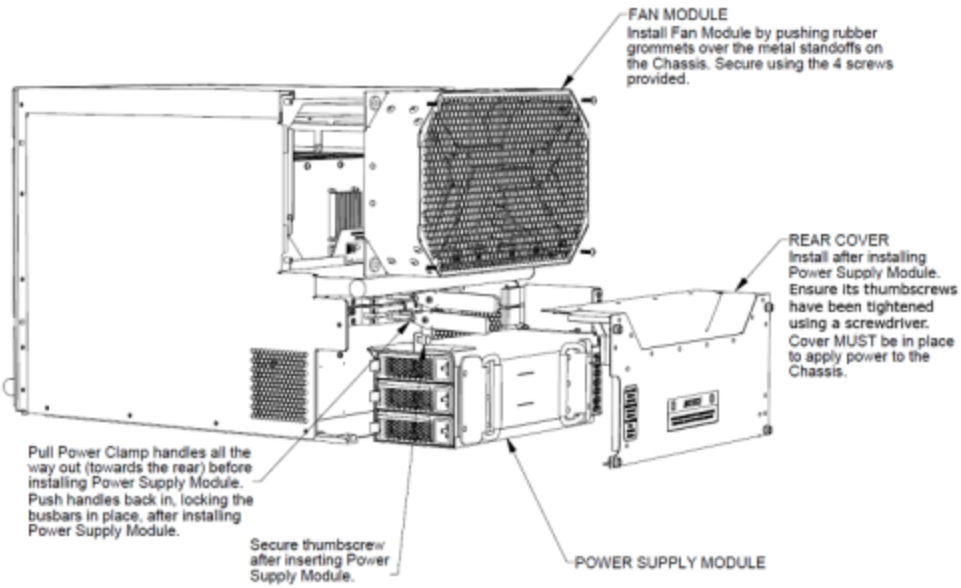
Part Number	Chassis	Components	Application Support
940-0016	XGS12-HSL and XGS12-HSL2	• Chassis frame assembly, w/ STD SYNC • High Performance Processor Module • Fan assembly module • 6000W power supply module • Native IxOS Operating System	• IxLoad • IxNetwork • BreakingPoint • IxExplorer (IxExplorer 9.00 or later for XGS12-HSL2)
940-0011 and 940-0018	XGS12-SD and XGS12-SD2	• Chassis frame assembly, w/ SD SYNC • Standard Processor Module • Fan assembly module • 6000W power supply module • Windows 7 and Windows 10 operating systems	• IxLoad • IxNetwork • IxExplorer (IxExplorer 9.00 or later for XGS12-SD2)
940-0015	XGS12-SDL and XGS12-SDL2	• Chassis frame assembly, w/ SD SYNC • Standard Processor Module • Fan assembly module • 6000W power supply module • Native IxOS Operating System	• IxLoad • IxNetwork • IxExplorer (IxExplorer 9.00 or later for XGS12-SDL2)

All the XGS12 chassis bundles require selection of a free IxOS software version that is ordered separately. For the chassis bundles running Native IxOS operating system, the IxOS software version is 8.13 or later for XGS12-HSL and 8.40 or later for XGS12-SDL. XGS12-SD2, XGS12-SDL2, and XGS12-HSL2 need IxOS 9.00 or later.
The chassis bundles provide improved modularity and access to the major components to reduce downtime in case of failure.

The XGS12-SD, XGS12-SDL, and XGS12-HSL chassis bundles are similar and is shown in the following figure:

The side and front views of the XGS12-SDL2 and XGS12-HSL2 chassis controllers are similar and are shown in the following figures:

The component modules of the XGS12 chassis platform are shown in the following figure:



Specifications

The XGS12 chassis platform model specifications are contained in the following tables.

XGS12-HSL and XGS12-HSL2 Chassis Model Specifications

Size	• 19.0 in. W x 19.21 in. H x 27.2 in. Depth • 48.26 cm W x 48.79 cm H x 69.09 cm Depth • 11 rackmount units (11RU)
Load Module Slots	12 (compatible with Ixia XM form factor load modules)
Chassis Modules and Weights	**Frame**: 97 lbs. (44.1 kg) average shipping weight (with filler panels) **Fan module**: 17.3 lbs. (7.86 kg) average shipping weight **Power Supply module**: 35.1 lbs. (15.95 kg) average shipping weight **Processor module** 15.8 lbs. (7.17 kg) average shipping weight **Warning**: Total chassis weight, without any load modules installed is 112.2 lbs. (50.89 kg). Do not attempt to lift the fully assembled chassis. **Avertissement**: N'essayez pas de soulever le châssis entièrement assemblé.
Chassis Power	3 single-phase, 200-240VAC 50/60Hz power sources rated at 20 Amperes each, are required to supply the chassis. Maximum power consumption per line cord and power supply:

	• 12 Amperes at 200VAC operation • 10 Amperes at 240VAC operation All three power cords must be plugged into their single phase 200-240VAC, 50Hz/60Hz power sources at the same time for correct operation of the chassis. NOTE • The chassis power supplies are interlocked with the rear cover which must be installed for them to be enabled. After removing or installing the rear panel, ensure thumbscrews have been tightened down with a 'Flat Blade' screwdriver. • The load module power is enabled by the Ixia server program. If it is not running, the load modules will not be powered on.
Power Cords	3 power cords are required to operate the XGS12 chassis platform power supplies. Power Cord shipments: Ixia provides three power cords that are configured and rated to meet the specifications of the target country where the chassis is being installed.
Power Supply Module	• Field replaceable power supply module that is easily installed and removed. • There are three 2825W power supplies in the Power Supply Module. • Each power supply may be removed or replaced separately.
Fan Module	Field replaceable chassis fan assembly that is easily installed and removed.
Processor Module	Field-replaceable and removable processor card module with 2 x Intel Sandy Bridge EP, E5-2658 2.1GHz processors; 64GB RAM; dual 400GB solid-state drive hard disk. For HSL2, Intel D-1577 processor; 64GB RAM; 960GB solid-state drive
Operating System	XGS12-HSL Processor Module: Native IxOS XGS12-HSL2 Processor Module: Native IxOS
Timing Sources	Internal or synchronized with another Ixia chassis, or external with the Ixia Metronome Timing System or AFD1 appliance for GPS time sources, or the Ixia AFD2 appliance for BITS and IRIG-B time format input with additional 1PPS input. For the XGS12-HSL chassis, Metronome synchronization is supported with IxOS 8.40 and later. For the XGS12-HSL2 chassis, Metronome synchronization is supported with IxOS 9.00 and later.
Connectors per Processor Module	For HSL: • Monitor HD-DB15 Super VGA • One RJ-45 1000Base-T management port

	• One RJ-45 RS232 serial port • Four SFP+ sockets for future use (for XGS12-HSL only) • Two USB dual type A, 4-pin jack connectors For HSL2: • Monitor HD-DB15 Super VGA • Monitor Display Port 1.1 • One RJ-45 1GBase-T management port • One RJ-45 RS232 serial port • One SFP+ socket for future use • Four USB 3.0 jack connectors
Connectors Chassis Frame	• Sync In: single Sync In jack with a 4-pin RJ11 • Sync Out: four Sync Out jacks, each with a 4-pin RJ11
Industry Certifications	The chassis safety approvals are UL and CE. These certifications are only valid when the unit is operating as specified.
Temperature	Operating: 41° F to 104° F (5° C to 40° C) Storage: 41° F to 122° F (5° C to 50° C)
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing
Noise	All the XGS12 chassis models running at maximum fan speed capacity may produce noise levels up to 87 dB(A). This is measured per the GR-63-CORE, Issue 1, paragraph 5.6.3 specification. The use of appropriate ear protection is recommended to protect against hearing impairment. Consult local health and safety regulations for recommended maximum exposure levels for noise and ear protection devices. NOTE Fan speed is variable and adjusted based on present load and temperatures within the chassis.

XGS12-SD, XGS12-SD2, XGS12-SDL, and XGS12-SDL2 Chassis Model Specifications

Slots	12 (compatible with Ixia XM form factor load modules)
Size	• 19.0 in. Width x 19.21 in. Height x 27.2 in. Depth • 48.26 cm. Width x 48.79 cm. Height x 69.09 cm. Depth • 11 rackmount units (11RU)
Chassis Modules and Weights	**Frame**: 97 lbs. (44.1 kg) average shipping weight (with filler panels) **Fan Module**: 17.3 lbs. (7.86 kg) average shipping weight **Power Supply Module**: 35.1 lbs. (15.95 kg) average shipping weight

	Processor Module (Standard): 6.4 lbs. (2.9 kg) average shipping weight
Chassis Power Requirements	Three, single phase, 200-240VAC 50/60Hz power sources rated at 20 Amperes each, are required to supply the chassis. Maximum power consumption per line cord and power supply: • 12 Amperes at 200VAC operation • 10 Amperes at 240VAC operation
Power Cords	Three power cords are required to operate the XGS12-SD chassis power supplies for normal operating conditions. **Power Cord shipments**: Ixia provides three power cords that are configured and rated to meet the specifications of the target country where the chassis will be installed.
Power Supply Module	• Field-replaceable power supply module that is easily installed and removed • There are three 2825W power supplies in the Power Supply Module • Each power supply may be removed or replaced separately
Fan Module	Field-replaceable chassis fan assembly that is easily installed and removed
Processor Module	**XGS12-SD and XGS12-SDL Processor Module**: Field-replaceable and removable processor card module with an Intel E5 2620 processor with 16GB CPU memory and 1TB SATA hard drive. **XGS12-SD2 and XGS12-SDL2 Processor Module**: Field-replaceable and removable processor card module with an Intel D-1548 processor with 16GB CPU Memory and 960GB solid-state drive.
Chassis Controller Module	• Field-replaceable • USB ports for connecting accessories
Operating System	**XGS12-SD Processor Module**: Windows 7 Professional 32-bit version **XGS12-SD2 Processor Module**: Windows 10 Professional 64-bit version **XGS12-SDL and XGS12-SDL2 Processor Modules**: Native IxOS
Timing Sources	Internal clock, synchronized with another Ixia chassis, or with Ixia GPS AFD-1, AFD2 IRIG-B units. External synchronization is supported on XGS12-SD only. For the XGS12-SDL chassis, it is supported with IxOS 8.40 and later. For the XGS12-SDL2 chassis, it is supported with IxOS 9.00 and later.
Connectors per Processor Module	For SD and SDL: • Monitor HD-DB15 Super VGA • One RJ-45 10/100/1000Mbps Gigabit Ethernet management ports • One RJ-45 RS232 serial port

	• Two USB dual type A, 4-pin jack connectors For SD2 and SDL2: • Monitor HD-DB15 Super VGA • One RJ-45 10/100/1000Mbps Gigabit Ethernet management ports • One RJ-45 RS232 serial port • One SFP+ socket for future use • Four USB 3.0 dual type A jack connectors • Display Port 1.1 (video only) NOTE XGS12-HSL2 has the same interfaces as XGS12-SD2 and XGS12-SDL2.
Connectors: Chassis Frame	Sync In: single Sync In jack with a 4-pin RJ11 Sync Out: four Sync Out jacks, each with a 4-pin RJ11
Switches, LEDs, and LCD Display	• Front panel switches, On/Off momentary power push button • 2x16 character LCD on front panel indicating chassis status information • 2 Paired LEDs above each slot position indicating power, and respective ownership and activity status • LEDs on Processor Module indicating power, hard disk activity, and Ethernet activity on each port
Industry Certifications	The chassis safety approvals are UL and CE. These certifications are only valid when the unit is operating as specified.
Temperature	Operating: 41°F to 104°F (5°C to 40°C) Storage: 41°F to 122°F (5°C to 50°C)
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing
Noise	All the XGS12 chassis models running at maximum fan speed capacity may produce noise levels up to 87 dB(A). This is measured per the GR-63-CORE, Issue 1, and paragraph 5.6.3 specification. The use of appropriate ear protection is recommended to protect against hearing impairment. Consult local health and safety regulations for recommended maximum exposure levels for noise and ear protection devices. NOTE Fan speed is variable and adjusted based on present load and temperatures within the chassis.

XGS12 Chassis Platform Installation Precautions

XGS12-SD, XGS12-SDL, XGS12-HSL, and XGS12-HSL2 chassis installation precautions are as follows:

- The chassis should be installed in the rack before installing the power supply module, fan module and load modules, thereby reducing the weight of the chassis.
- The two lower bolts used to secure the chassis to a rack can be used to hold the chassis frame in place while securing all of the other bolts (See Figure 6-2).
- Secure the chassis to rack face with all six bolts. Fully depress power supply clamps when installing power supply module.
- Secure the power supply module thumb bolt when installing power supply module.
- Install the rear power supply cover before applying AC power.

  NOTE After removing or installing this cover, ensure that the thumbscrews are tightened down with a screwdriver.

- Do not use the chassis without installing the Fan module.
- Do not use the chassis without installing the Processor module.
- Do not leave unused slots open. Use the filler panels to cover the un-used slots. See Installing Filler Panels for more information.
- Do not block the front air intake.
- A minimum air flow clearance of 12 inches is required. 24 inches of air flow clearance is preferred at the rear of the chassis.
- Operator intervention may be required to power cycle the XGS12 chassis platform or restart a software program in the event the XGS12-SD chassis operation is upset or stopped by electrostatic discharge.

LEDs

The XGS12-SD, XGS12-SDL, XGS12-HSL, and XGS12-HSL2 chassis have front panel LEDs for each load module slot.

Color	Status	Description
Green	Power	When the Power LED is flashing, the board is being detected or initialized. The Power LED is illuminated when the board is powered.
Amber	In Use	The Active LED is illuminated when you have taken ownership of the load module. If you run traffic from IxExplorer, without taking port ownership, the In Use light is not illuminated.

LCD Display

An LCD display is provided on the chassis to indicate the status of the chassis without an external display device (monitor). The LCD operates in two modes:

- Startup: The LCD displays messages from IxServer to indicate the operation of IxServer as it initializes.
- Run: The LCD display provides chassis information. Information displayed includes chassis name, IxOS version, IP address, primary/secondary, and chassis status.

CPU Slot LED Definitions

The specifications of LEDs for the Processor module and the LEDs above the Processor module slot are shown in the following table:

NOTE **ESD Discharge**: Operator intervention may be required to power cycle the unit or restart a software program in the event the unit is upset by electrostatic discharge.

		Color	Description
On the chassis front face	MGMT LED	Yellow	The backplane is initializing
		Green	The backplane has initialized
Processor module - front panel	Stdby Pwr LED	Green	5V Stand-by power is available
	CPU Pwr LED	Green	CPU Card power is available
	HDD Act LED	Green	Flashes when HDD has activity
	Bkpln Link LED	Green	PCIe link to backplane is up
Processor module - Ethernet LEDs for each port	Link LED	Green	Port has link Link and Activity LEDs are included for all Ethernet ports.
	Act LED	Green	Flashes when port has activity

Supported Modules

The load modules that are supported on the XGS12 chassis platform are listed in the Product Compatibility Matrix:

XGS12-SD: https://support.ixiacom.com/support-overview/product-support/product-compatibility-matrix

XGS12-SDL and XGS12-SDL2: https://support.ixiacom.com/support-overview/product-support/product-compatibility-matrix

XGS12-HSL and XGS12-HSL2: https://support.ixiacom.com/support-overview/product-support/product-compatibility-matrix

Hot-Swap Procedure

Each XGS12 platforms –XGS12-SD, XGS12-SD2, XGS12-SDL, XGS12-SDL2, XGS12-HSL, and XGS12-HSL2 provide the ability of removing and reinstalling a load module without requiring the

removal of power from the rest of the chassis. The process of removing/installing a Load Module does not impact either the operation of the OS or remaining load modules installed in the chassis.

The hot-swap procedure is detailed in Appendix D Hot-Swap Procedure.

Cooling Fan Speed Control

The XGS12 platforms – XGS12-SD, XGS12-SD2, XGS12-SDL, XGS12-SDL2, XGS12-HSL, and XGS12-HSL2 automatically monitor and measure the temperature of installed load modules. They automatically adjust the fan speed to maintain proper cooling.

Power outage recovery and Automatic booting scenario

The BIOS on the XGS12 platforms – XGS12-SD, XGS12-SD2, XGS12-SDL, XGS12-SDL2, XGS12-HSL, and XGS12-HSL2 is set to Power On after a power failure.

The XGS12-SDL, XGS12-SDL2, XGS12-HSL, and XGS12-HSL2 chassis will start , boot into the Native IxOS operating system, and wait for the user to enter login credentials. At this point, the Ixia Web Platform should also be available for login.

Rack Mount Cautions

Caution:

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, you must install the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (40° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the back or the front of the chassis, and leave approximately 12 inches of space, 24 inches preferred, for the back of the unit for proper ventilation. The air flow clearance should be 12 inches on the front.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused. Please install all six mounting bolts.
4. Circuit Overloading: Consider the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on over-current protection and supply wiring. Pay attention to equipment nameplate ratings when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Chassis frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must be of the same type of cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Attention:

Si cette unité est installée dans une baie d'équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l'installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l'équipement dans un environnement compatible avec la température ambiante maximale autorisée (40 C) spécifiée pour l'appareil.
2. Circulation d'air réduite: installer l'équipement dans une baie de manière a ce que la circulation d'air requise pour faire fonctionner l'équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l'appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

CHAPTER 6

XGS2 Chassis Platform

This chapter provides details about the XGS2 chassis platform, its specifications and features.

The 2-slot XGS2 chassis models - XGS2-SD, XGS2-SD2, XGS2-SDL, XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 provide highly flexible and portable chassis that power load modules and test applications to create an Ixia test system. The XGS2 platform provides the foundation for a complete benchtop or rackmount test environment. The chassis platform supports Ixia applications for performance, functional, conformance, and security testing.

The XGS2 chassis platform has the following features:

- Provides a unified platform for running a wide array of security, data, routing, and bridging protocol emulation; and signaling, voice, video, and application testing.
- Provides extensive load module interface support for Ethernet, impairment, and Fibre Channel from 10Mbps to 100Gbps.
- Can actively swap load modules in and out of the test bed without disrupting the ongoing test that is using installed modules.
- Has a high-speed backplane to support the high bandwidth requirements of large-scale application tests.
- Has highly serviceable modular components consisting of the chassis controller module, fan module, sync module and power supply module.
- Allows you to Daisy-chain the XGS2 with these other Ixia chassis: XGS2-HSL, XGS2-SD, XGS2-SDL, XGS12-SD, XGS2-SDL, XGS12-HSL, XG12, and 400Tv2.
- STAR and Metronome Chassis Synchronization available for the XGS2 with these other Ixia chassis: XGS2-SD, XGS2-SDL, XGS2-SDL2, XGS2-HSL, XGS2-HSL2, XGS12-SD, XGS12-SDL, XGS12-SDL2, XGS12-HSL, XGS12-HSL2, AresONE, and Novus ONE PLUS.
- Has the following highly-serviceable, self-contained and field-replaceable modular components:
  - Chassis Controller Module for management and control of load modules, port configurations, and statistics
  - Fan Module for temperature control
  - Power Supply Module for power supplies
  - Sync Module that allows synchronizing the XGS2 chassis with other Ixia chassis

The following are the four XGS2 chassis models:

XGS2 Chassis Bundle Part Numbers, Components and Application Support

Part Number	Chassis	Components	Application Support
940-0014	XGS2-HSL and XGS2-HSL2	• Chassis frame assembly • High Performance Controller Module • Fan assembly module • 2 Power supplies • Standard Star Topology Sync module	• BreakingPoint • IxLoad • IxNetwork • IxExplorer (IxExplorer 9.00 or later for XGS2-HSL2)
940-0010 and 940-0017	XGS2-SD and XGS2-SD2	• Chassis frame assembly • Standard Performance Controller Module • Fan assembly module • 2 Power supplies • Standard Star Topology Sync module	• IxLoad • IxNetwork • IxExplorer (IxExplorer 9.00 or later for XGS2-SD2)
940-0013	XGS2-SDL and XGS2-SDL2	• Chassis frame assembly • Standard Performance Controller Module • Fan assembly module • 2 Power supplies • Standard Star Topology Sync module	• IxLoad • IxNetwork • IxExplorer (IxExplorer 9.00 or later for XGS2-SDL2)

All the XGS2 chassis bundles require selection of a free IxOS software version that is ordered separately. For the chassis bundles running Native IxOS operating system, the IxOS software version is 8.13 or later for XGS2-HSL, 8.40 or later for XGS2-SDL, and 9.00 or later for XGS2-SD2, XGS2-SDL2, and XGS2-HSL2. The chassis bundles provide improved modularity and access to the major components to reduce downtime in case of failure.

The XGS2-HSL chassis bundle is shown in the following figure:

The XGS2-SD and XGS2-SDL chassis bundles are similar and is shown in the following figure:

The side and front views of the XGS2-SD2, XGS2-SDL2, and XGS2-HSL2 chassis controllers are similar and are shown in the following figures:

Specifications

The XGS2 chassis platform model specifications are contained in the following tables.

XGS2 Chassis Platform Specifications

Slots	2 (compatible with Ixia XM Form Factor load modules)
Size	• 17.5 in. width (19.0 in. with rackmount bracket installed) x 5.1 in. height x 26.5 in. depth • 3 rackmount units (3RU)
Weight	XGS2-HSL weighs 55 lbs. (25 kg) • 71.3 lbs. (32.4 kg) average shipping weight XGS2-SD and XGS2-SDL weighs 53 lbs. (24 kg) • 69.3 lbs. (31.5 kg) average shipping weight
Chassis Power	• Two single phase power supplies rated 20A@110VAC; 60/50 Hz or • Two single phase power supplies rate 10A@220VAC; 60/50 Hz • An additional power supply that can be purchased for redundancy
Timing Source	Internal or synchronized with another Ixia chassis, or external with the Ixia AFD1 appliance for a GPS time sources, or the Ixia AFD2 appliance for BITS and IRIG-B time format input with additional 1PPS input. Metronome synchronization is supported on XGS2-SD chassis only. For the XGS2-HSL chassis, it is supported with IxOS 8.13 and later. For the XGS2-HSL2 chassis, it is supported with IxOS 9.00 and later.
Operating System	• **XGS2-SD Processor Module**: Windows 7 Professional 32-bit version • **XGS2-SD2 Processor Module**: Windows 10 Professional 64-bit version • **XGS2-SDL and XGS2-SDL2 Processor Modules**: Native IxOS • **XGS2-HSL and XGS2-HSL2 Processor Modules**: Native IxOS
Chassis Controller Module	• Field-replaceable • USB ports for connecting accessories
Temperature	• Operating: 41°F to 104°F (5°C to 40°C) • Storage: 41°F to 122°F (5°C to 50°C)
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing
Connectors per Processor Module	For SD, SDL, and HSL: • Video: HD-DB15 Super VGA

	• USB: Two Dual Type A, 4-pin jack connectors • Management: 10/100/1000 Ethernet RJ45 • Serial: One RJ-45 RS-232 port For SD2, SDL2, and HSL2: • Video: HD-DB15 Super VGA • Four USB 3.0 dual type A jack connectors • One SFP+ socket for future use • Management: 10/100/1000 Ethernet RJ45 • Serial: One RJ-45 RS-232 port • Display Port 1.1 (video only) NOTE XGS2-HSL2 has the same interfaces as XGS2-SD2 and XGS2-SDL2.
Switches and Indicators	• Power, Standby, Primary, External Clock • LCD screen with chassis status information • Two paired LEDs next to each slot position indicating slot power and card ownership
Fans	One field-replaceable fan-tray assembly that is easily installed and removed
Noise	XGS2 chassis models running at maximum fan speed capacity may produce noise levels up to 80 dB(A). This is measured per the GR-63- CORE, Issue 1, and paragraph 5.6.3 specification. The use of appropriate ear protection is recommended to protect against hearing impairment. Consult local health and safety regulations for recommended maximum exposure levels for noise and ear protection devices. NOTE Fan speed is variable and adjusted based on present load and temperatures within the chassis.

XGS2 Chassis Platform Installation Precautions

XGS2-SD, XGS2-SD2, XGS2-SDL, XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 chassis installation precautions are as follows:

- Do not use the chassis without the Fan module.
- Do not power the chassis without installing the Processor module.
- Do not leave unused slots open. Use the filler panels to cover the un-used slots. See Installing Filler Panels for more information.
- Do not block the front air intake.
- A minimum air flow clearance of 12 inches is required. 24 inches of air flow clearance is preferred at the rear of the chassis.
- Operator intervention may be required to power cycle the XGS2 chassis platform or restart a software program in the event the XGS2 chassis operation is upset or stopped by electrostatic discharge.

LEDs

The XGS2-SD, XGS2-SD2, XGS2-SDL, XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 chassis have front panel LEDs for each load module slot.

Color	Status	Description
Green	Power	When the Power LED is flashing, the board is being detected or initialized. The Power LED is illuminated when the board is powered.
Amber	In Use	The Active LED is illuminated when you have taken ownership of the load module. If you run traffic from IxExplorer, without taking port ownership, the In Use light is not illuminated.

The XGS2-SD, XGS2-SD2, XGS2-SDL, XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 chassis have a single bi-color rear panel LED for each load module slot.

Color	Status	Description
Nil	Off	No AC input to PSU.
Solid Green	Power	The main output is ON. The Power LED is illuminated when the board is powered.
Blinking Amber	Power Failure	Power supply failure (OCP, OVP, OTP, FAN FAULT).
Blinking Amber	In Standby	The main output is OFF. AC present, Standby ON.

LCD Display

An LCD display is provided on the chassis to indicate the status of the chassis without an external display device (monitor). The LCD operates in two modes:

- Startup: The LCD displays messages from IxServer to indicate the operation of IxServer as it initializes.
- Run: The LCD display provides chassis information. Information displayed includes chassis name, IxOS version, IP address, primary/secondary, and chassis status.

CPU Slot LED Definitions

The specifications of LEDs for the Processor module and the LEDs above the Processor module slot are shown in the following table:

NOTE **ESD Discharge**: Operator intervention may be required to power cycle the unit or restart a software program in the event the unit is upset by electrostatic discharge.

	LED	Color	Description
On the chassis front face	MGMT LED	Yellow	The backplane is initializing
		Green	The backplane has initialized
Processor module - front panel	Stdby Pwr LED	Green	5V Stand-by power is available
	CPU Pwr LED	Green	CPU Card power is available
	HDD Act LED	Green	Flashes when HDD has activity
	Bkpln Link LED	Green	PCIe link to backplane is up
Processor module - Ethernet LEDs for each port	Link LED	Green	Port has linkLink and Activity LEDs are included for all Ethernet ports.
	Act LED	Green	Flashes when port has activity

Supported Modules

The load modules that are supported on the XGS2 chassis platform are listed in the Product Compatibility Matrix:

XGS2-SD and XGS2-SD2: https://support.ixiacom.com/support-overview/product-support/product-compatibility-matrix

XGS2-SDL and XGS2-SDL2: https://support.ixiacom.com/support-overview/product-support/product-compatibility-matrix

XGS2-HSL and XGS2-HSL2: https://support.ixiacom.com/support-overview/product-support/product-compatibility-matrix

Hot-Swap Procedure

The XGS2 chassis platforms provide the ability of removing and reinstalling a load module without requiring the removal of power from the rest of the chassis. The process of removing/installing a Load Module does not impact either the operation of the OS or remaining load modules installed in the chassis.

The hot-swap procedure is detailed in Appendix D Hot-Swap Procedure.

Cooling Fan Speed Control

The XGS2 platforms – XGS2-SD, XGS2-SD2, XGS2-SDL, XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 automatically monitor and measure the temperature of installed load modules. They automatically adjust the fan speed to maintain proper cooling.

Power outage recovery and Automatic booting scenario

The BIOS on the XGS2 platforms – XGS2-SD, XGS2-SD2, XGS2-SDL, XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 is set to Power On after a power failure.

The XGS2-SDL, and XGS2-SDL2, XGS2-HSL, and XGS2-HSL2 chassis will start , boot into the Native IxOS operating system, and wait for the user to enter login credentials. At this point, the Ixia Web Platform should also be available for login.

Rack Mount Cautions

Caution:

If this unit is installed in a network equipment rack, please observe the following precautions:

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1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, you must install the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (40° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the front and back of the chassis, and leave approximately 8 inches of space, on the front and back of the unit for proper ventilation. The air flow clearance should be 8 inches on the front and back of the chassis.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on over-current protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Chassis frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must be of the same type of cord and plug configuration that was shipped with the unit.

CHAPTER 7

IXIA 400T v2 Chassis

This chapter provides details about Ixia 400T v2 chassis, its specifications and features.

The IXIA 400T v2 chassis is shown in the following figure. The IXIA 400T v2 chassis has 4 slots for Ixia Load Modules, but may also be used to support the high-powered load modules, including all OC192 and 10GE modules. The IXIA 400T v2 Chassis is specifically designed to accommodate up to 2 OC192/10GE Load Modules and up to 3 TXS8, TXS4 or SFPS4 Load Modules.

NOTE The Ixia 400T v2 must only be operated in the horizontal position as shown in the following figure.

Figure: Ixia 400T v2 Chassis - Front View

Figure: Ixia 400T v2 Chassis - Rear View

Warning:

In order to prevent accidental injury to personnel, do not leave unused SFP (or SFP+) ports on load modules uncovered. When transceivers are not installed, end caps must be used. For details, see Use End Caps on Open Ports.

Avertissement:

Pour éviter toute blessure accidentelle de vos employés, ne laissez pas les ports SFP (ou SFP+) non utilisés des modules de charge découverts. Lorsqu'il n'y a pas d'émetteurs-récepteurs installés, les capuchons doivent être installés.

Specifications

400T v2 Chassis

The computer specifications are contained in the following table.

IXIA 400T v2 Specifications

CPU	Intel Atom N455 1.66Ghz
	Caution: Battery replacement: Danger of explosion if battery is incorrectly replaced. You should not attempt to replace the battery. Return to Ixia Customer Service for replacement with the same or equivalent type of battery. Ixia disposes of used batteries according to the battery manufacturer's instructions. **Attention**: Remplacement de la batterie: Le remplacement incorrect de la batterie peut provoquer une explosion. Vous ne devez en aucun casessayer de remplacer la batterie. Renvoyez le produit au service clients Ixia pour un échange avec le mêmetype de batterie ou un type équivalent. Ixia met les batteries usagées au rebut conformémentaux instructions du fabricant.
Memory	2 GB
Disk	SATA HDD.250 GB
Operating System	Windows 7 Ultimate
Physical	
Load Module Slots	4
Size	10.25"w x 5.75"h x 18.5"d (26.1cm x 14.6cm x 47cm)
Weight (empty)	13.65lbs (6.2kg)
Avg. Shipping Wt.	19.65lbs (8.9kg)
Shipping Vibration	FED-STD-101C, Method 5019.1/5020.1

Environmental	
Operating Temperature	41°F to 104°F (5°C to 40°C) NOTE Some high-density/high performance load modules may require a lower operating temperature; if this is the case, the operating temperature is specified in the load module datasheet.
Storage	41°F to 122°F (5°C to 50°C)
Humidity	
Operating	0% to 85%, non-condensing
Storage	0% to 85%, non-condensing
Clearance	Rear: 4 in (10 cm); fan openings should be clear of all cables or other obstructions. Sides: 2 in (5 cm) unless rack mounted.
Power	100-240 V 60/50 Hz 4-2 A
	NOTE The CPU monitors each card's power requirements and refrains from applying power to the backplane if the card's required load would cause the total power to exceed 350W.
Front Panel Switches	Momentary Standby Power push button
Back Panel Switches	Power On/Off rocker switch
Front Panel Indicators	Power, Primary, External Clock
Rear Panel Connectors	
Power	Male receptacle (IEC 320-C13)
Keyboard/Mouse	PS/2 6-pin DIN with Y-connector, for external mouse and/or keyboard You **must** use the supplied Y-cable when using the PS/2 mouse.
Monitor	HD-DB15 Super VGA for external monitor
Ethernet	1 RJ-45 10/100/1000Base-T Interface
Com	2 male DB9 Serial Port
USB	4 USB dual type A (2 Front Mounted and 2 Rear Mounted), 4-pin jack connectors

Sync In	4-pin RJ11
Sync Out	4-pin RJ11

Use of Filler Panels

Proper cooling of the cards in the Ixia 400T v2 requires that the Ixia 400T v2 chassis is always mounted in a horizontal position and that the filler panels are installed in the unused slots. High powered cards available for use in the Ixia 400T v2 chassis include all variants of the OC192 load modules, all variants of the 10GE load modules, and all variants of the ALM1000T8. Refer to Installing Filler Panels for instructions on the installation of filler panels.

Rack Mount Cautions

Caution:

If this unit is installed in a Rack Mount, observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (40° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the back or sides of the chassis, and leave approximately two inches of space around the unit for proper ventilation.
3. Mechanical Loading: Mount the equipment in the rack so that a hazardous condition is not caused due to uneven mechanical loading.
4. Circuit Overloading: Consider the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Pay attention to equipment nameplate ratings when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).

Précautions relatives au montage en rack

Attention:

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (40 C) spécifiée pour l’appareil.

2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).

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CHAPTER 8

Metronome

This chapter provides details about Metronome, its specifications and features.

The Ixia Metronome Timing System is a precision test instrument enabling for large scale time synchronized testing within complex networks. Metronome solves the problem of sourcing time from external sources and translating that time into an IXIA proprietary time delivery interface. It recovers time from the actively selected external interface and time synchronizes the Metronome internal clock to the external source, distributes Metronome internal time downstream to IXIA endpoints, and generates aligned IXIA specific triggers to multiple downstream IXIA endpoints.

The following figures show the Metronome hardware:

Figure: Metronome Front Panel

Figure: Metronome Rear Panel

Metronome Extender Chassis

One Metronome Timing System EXTENDER (MTSx) is required for each MTS SyncOut Port that is in use (up to 8 per MTS chassis).

The following figure describes the Metronome Extender chassis:

1. MTSx unit status indicator.
2. **Sync In**:This port connects to a Metronome Sync Out port.
3. Port status indicator.
4. **IN**: This port connects to a XGS2-SD or XGS12-SD out port.
5. **OUT**: This port connects to a XGS2-SD or XGS12-SD in port.

External Time Interfaces in Metronome

Multiple types of external timing sources are accepted through Metronome, like GPS, Sync In (ToD+1PPS), BNC, and PTP (Phase 2).

Rear Panel LEDs

A GPS status LED is present in the rear side of the Metronome chassis for the GPS interface.

Metronome GPS Status LEDs

Color	Description
Solid Green	Indicates that the satellites are acquired and valid time information is being received from the Ublox GPS receiver IC.
Blinking Green	Indicates that a GPS “lock” is being acquired.
Solid Red	Indicates that an antenna fault is detected.

Metronome Specifications

The metronome specifications are contained in the following table.

Feature	Description
Metronome Timing System Part Number	942-0090
Metronome Timing System Extender Part Number	942-0091 NOTE Each timing link requires one MTSx adjacent to each chassis.
Chassis Supported	• XGS12-SD • XGS2-SD
Dimensions	1U - 1.73x17.3x11
Operating Temperature	0° to 40° C
Storage temperature	–40°C to 70°C
Storage humidity	5 to 95% (RH), non-condensing
Input Voltage	100-240Vac
Input Frequency	47-63Hz
Max. Power Consumption	75W
Memory	1x 2GB @ 667MT/s, 64b data width (soDIMM)
Storage	1x 32GB microSD (boot code, application code, libraries)
Power	Worst case power = 2.5W
Cable Lengths Supported – MTSx to MTS	MTS to MTS Extender Distance - 5m / 50m /100m

Feature	Description
	Cable Type - Metronome Sync Cable Product Number - 942-0096, 942-0097, 942-0098 NOTE Ixia sells the cables listed above but you may construct cables of any length up to 200m.
Cable Lengths Supported – Chassis to MTSx	Chassis to MTS Extender Distance - 6 feet Cable Type - Ixia Chassis Sync Cable Product Number - 942-0095

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CHAPTER 9

IXIA Xcellon-Lava Load Modules

This chapter provides specification and feature details of the Xcellon-Lava 40/100 Gigabit Ethernet load modules. This family of load modules consist of the following 3-port cards:

- LavaAP40/100GE 2P
- LavaAP40/100GE 2RP
- LavaAP40/100GE 2P-NG

The Xcellon-Lava 40/100-Gigabit Ethernet load modules belong to the family of Ixia's High Speed Ethernet (HSE) products. These load modules combine the advantages of the Xcellon architecture and provide the highest 40GE and 100GE port densities. Lava load modules can be used for testing layer 1 to layer 7 applications. They are supported by Ixia's test applications, including IxNetwork and IxLoad. These load modules are also supported on Linux chassis.

Xcellon-Lava load modules are used for testing high-density data center 40 Gigabit Ethernet (40GbE) and 100 Gigabit Ethernet (100GbE) network equipments. 40GbE and 100GbE are high-speed computer network standards developed by the IEEE 802.3ba. Lava load modules extends the 802.3 protocol to operating speeds of 40 Gbps and 100 Gbps in order to provide greater bandwidth while maintaining maximum compatibility with the installed base of 802.3 interfaces.

Xcellon-Lava load modules are compatible with Ixia's XG12 and a broad range of Ethernet interfaces, allowing real-world, layer 1 to layer 7 test and measurement in a single chassis.

LavaAP40/100GE 2P-NG load module has capabilities similar to LavaAP40/100GE 2P and includes N2X support.

The Xcellon-Lava load module is shown in the following figure:

Figure: Xcellon-Lava Load Module

LED function table

The LED functions are described in the following tables.

Xcellon-Lava LED Ports

LED Label	Usage
Link	Green if Ethernet link is up (established) or the port is in a forced Link Up state, OFF (no color) if link is down. Link may be down due to no signal or no PCS lock.
Tx Active	Green indicates that Tx is active and frames being sent; red indicates Tx is paused; off indicates Tx is not active.
Rx Active	Green indicates that Rx is active and frames being received; red indicates Rx is paused; off indicates Rx is not active.
Rx/Error	Green indicates valid Rx frames are being received; red indicates error frames being received; off indicates no frames being received.
Pwr Good	Green when power is on, red if power fault occurs.

CFP adapter diagrams

CFP adapter diagrams are as follows:

The CFP-to-QSFP+ Interface adapter module is shown in the following figure:

Figure: CFP-to-QSFP+ Interface adapter

The CFP-to-QSFP+ Dual-Port Interface adapter module is shown in the following figure:

Figure: CFP-to-QSFP+ Dual-Port Interface adapter

The CFP to CXP-Adapter is shown in the following figure:

Figure: CFP-to-CXP-Adapter

CFP-to-QSFP28 Interface Adapter is shown in the following figure:

Figure: CFP-to-QSFP28 Interface Adapter

Part Numbers

The part numbers are shown in the following table.

Part Numbers for Xcellon-Lava Load Module and Supported Adapters

Model Number	Part Number	Description
Lava AP40/100GE 2P	944-1067	This is the dual speed 40GE/100GE Ethernet Lava load module with Accelerated Performance. Each load module consists of 2-ports and 1-slot with CFP MSA interfaces. This load module supports full feature for layer 1 to layer 7 testing.
Lava AP40/100GE 2RP	944-1068	This is the dual speed 40GE/100GE Ethernet Lava load module with data plane support only. It is an economic alternative to the Accelerated Performance load module, perfectly suitable for testing layer 1 to layer 3 applications that does not require routing protocol emulation. Each load module consists of 2-ports and 1-slot with CFP MSA interfaces.
CFP-to-QSFP+ Interface Adapter Module	948-0022	A pluggable unit that converts an Ixia CFP MSA port interface to 1-port of the pluggable 40 GE QSFP+ for multimode fiber or copper cable assemblies or standalone transceivers. The adapter is compatible with the HSE40GETSP1-01, 40-Gigabit Ethernet load module (944-0069), HSE40/100GETSP1-01, 40/100-Gigabit Ethernet, dual-speed, load module (944-0091), HSE40/100GETSPR1-01, 40/100-Gigabit Ethernet, dual-speed, Data Plane Ethernet load module (944-0099), Xcellon-Lava 40/100-Gigabit Ethernet, Accelerated Performance, load module (944-1067) and Xcellon-Lava 40/100-Gigabit Ethernet, Reduced Performance load module (944-1068).
CFP-to-QSFP+ Dual-Port Interface Adapter Module	948-0023	A pluggable, 2-port unit that converts an Ixia Xcellon-Lava CFP MSA port interface to 2-ports of pluggable 40 GE QSFP+ for fiber or copper cable assemblies or standalone transceivers. The adapter is compatible with the Xcellon-Lava 40/100-Gigabit Ethernet, Accelerated Performance, load module (944-1067) and Xcellon-Lava 40/100-Gigabit Ethernet, Reduced Performance, load module (944-1068). Both load modules accept up to two of the Dual Interface Adapter Modules.
CFP-to-CXP Interface Adapter Module	948-0027	A pluggable unit that converts an Ixia CFP MSA port interface to 1-port of the pluggable 100 GE CXP for multimode fiber or copper cable assemblies or standalone transceivers. The adapter is compatible with the HSE100GETSP1-01 100- Gigabit Ethernet load module (944-0070), HSE40/100GETSP1-01, 40/100-Gigabit Ethernet, dual-speed, load module (944-0091), HSE40/100GETSPR1-01, 40/100-Gigabit Ethernet, dual-speed, Data Plane load module (944-0099), Xcellon-Lava 40/100-Gigabit Ethernet, Accelerated Performance, load module (944-1067) and the Xcellon-Lava 40/100-Gigabit Ethernet, Reduced Performance load module (944-1068).
CFP-to-	948-0029	CFP-to-QSFP28 Interface Adapter, 1P, 100GE, SFF-8665.

Model Number	Part Number	Description
QSFP28 Interface Adapter Module		A pluggable unit that converts an Ixia CFP MSA port interface to 1-port of the pluggable 100 GE QSFP28 for multimode fiber or copper cable assemblies or standalone transceivers. The adapter is compatible with the HSE40GETSP1-01, 40-Gigabit Ethernet load module (944-0069), HSE40/100GETSPR1-01, 40/100-Gigabit Ethernet, dual-speed, Data Plane Ethernet load module (944-0099), Xcellon-Lava 40/100-Gigabit Ethernet, Accelerated Performance, load module (944-1067) and Xcellon-Lava 40/100-Gigabit Ethernet, Reduced Performance load module (944-1068).

CFP Adapter usage for Xcellon-Lava Ethernet Load Modules

The CFP Slot #1 specification

Adapter Present	CFP Mode	Speed	Port(s) Available
948-0027	Single	100G/40G	Port 1
	Dual	40G	Not Supported
948-0022	Single	40G	Port #1
	Dual	40G	Port #3
948-0023	Single	40G	Top port: Unavailable Bottom port: Port #1
	Dual	40G	Top port: Port #4 Bottom port: Port #3
948-0029	Single	100G	Port 1

The CFP Slot #2 specification

Adapter Present	CFP Mode	Speed	Port(s) Available
948-0027	Single	100G/40G	Port 2
	Dual	40G	Not Supported
948-0022	Single	40G	Port #2
	Dual	40G	Port #5
948-0023	Single	40G	Top port: Unavailable Bottom port: Port #2
	Dual	40G	Top port: Port #6

Adapter Present	CFP Mode	Speed	Port(s) Available
			Bottom port: Port #5
948-0029	Single	100G	Port 1

CFP Mode

The CFP mode can be of two types:

- **Single Port Operation**: CFP provides one port of 40G or 100G. Speed is selected in a Port Property.
- **Dual Port Operation**: CFP provides two ports of 40G, when using CFP-to-QSFP+ Dual-Port Interface Adapter.

Dual Port Operations has following limitations:

- BERT functionality not available
- Capture buffer is half the capacity of Single Port Operation.
- Max Streams supported = 256
- "No CRC" option not supported
- Value List memory is half that of Single Port Operation
- TX Flow sequence memory is half that of Single Port Operation
- Sequence Checking memory is half that of Single Port Operation
- PPM adjustment is per CFP (pair of QSFP+ ports)
- DCE support not available at this time
- Front panel LEDs not functional

Specifications

The load module specifications are described in the following table:

Xcellon-Lava Ethernet Load Module Specifications

Feature	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
Load Modules	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
Number of ports per module	2-100GE CFP MSA 2-40GE CFP MSA or (4) 40GE QSFP+ [with interface adapter]	2-100GE CFP MSA 2-40GE CFP MSA or (4) 40GE QSFP+ [with interface adapter]
Number of chassis slots per module	1	1
Chassis Support	XG12	XG12
Maximum ports per chassis	XG12: (24) 100GE CFP MSA and (48) 40GE QSFP	XG12: (24) 100GE CFP MSA and (48) 40GE QSFP+

Feature	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
		and (4) 40GE QSFP+
Capture buffer size	1.4 GB	1.4 GB
Streams per port	256. NOTE In packet stream (sequential) or advanced stream (interleaved) mode, each stream definition can generate millions of unique traffic flows. In the Data Center mode, the number of transmit streams is 256.	
Latency	Standard resolution in packet timestamp is 20ns. User selectable high resolution in packet timestamp is 2.5ns	No
Transceiver support	• CFP MSA 1.4, pluggable • SFF-8436 QSFP+, pluggable fiber/copper cables (passive/active) with adapter	
CFP interface adapters	• 1-port, CFP-to-QSFP+ for 40GE • 2-port, CFP-to-QSFP+ for 40GE • 1-port CFP-to-CXP for 100GE operation	
Hardware capture buffer per port	1.4 GB	
Interface protocols	40-Gigabit Ethernet 40GBASE-R and 100-Gigabit Ethernet 100GBASE-R as per IEEE802.3ba-2010 standard	
Layer 2/3 routing protocol emulation	The following protocols are supported in LavaAP40/100GE 2P Full Performance load module: • **MPLS**: RSVP-TE, RSVP-TE P2MP, LDP, PWE, L3 MPLS VPN, 6VP, MPLSTP • **Routing**: RIP, RIPng, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, BGP-4,BGP+ • **VPLS**: 6PE, BGP Auto-Discovery with LDP FEC 129 Support, VPLS-LDP, VPLS-BGP • **IP Multicast**: IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, Multicast VPN, VPNv6 • **Switching**: STP/RSTP, MSTP, PVST+/RPVST+, LACP • **Carrier Ethernet**: Link OAM, CFM, Service OAM, PBT/PBB-TE, SyncE, IEEE 1588v2 PTP • **High-Availability**: BFD	

Feature	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
	The following Host/Client protocols are supported in LavaAP40/100GE2 RP Full Performance load module: • ARP • NDP • ICMP (PING) • IPv4 • IPv6	
Layer 4-7 application traffic testing	This is suppoted only in LavaAP40/100GE 2P Accelerated Performance load module.	
Transmit flows per port (sequential values)	Billions	Billions
Transmit flows per port	1 million	1 million
Trackable receive flows per port	1 million	1 million
Table UDF entries	512K NOTE Comprehensive packet editing function for emulating large numbers of sophisticated flows is supported by Xcellon-Lava load module. Entries of up to 256 bytes, using lists of values can be specified and placed at designated offsets within a stream. Each list consists of an offset, a size and a list of values in a table format.	
Packet flow statistics	Xcellon-Lava load module tracks over 1 million flows.	
Transmit engine	The Xcellon-Lava load module supports wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.	
Receive engine	The Xcellon-Lava load module supports wire-speed packet filtering, capturing, realtime latency and inter-arrival time for each packet group, data Integrity, and sequence checking.	
User Defined Field (UDF) Features	The Xcellon-Lava load module supports the UDF features of fixed, increment or decrement by user-defined step, value list, cascade, random, and chained.	
Filters	The Xcellon-Lava load module uses 48-bit source/destination address, 2x128-bit userdefinable pattern and offset, frame length range, CRC error,	

Feature	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
	data integrity error, sequence checking error (small, big, reverse)	
Error Generation	CRC (good/bad/none), undersize, oversize	
Transmit Line Clock Adjustment	Xcellon-Lava load module has the ability to adjust the parts per million (ppm) line frequency over a range of -100 ppm to +100 ppm.	
Latency measurements	Standard resolution in packet timestamp is 20ns. User selectable high resolution in packet timestamp is 2.5ns	
Layer 1 BERT capability	The Xcellon-Lava load module supports the following BERT features on both 40 GE and 100 GE speeds: • User selected PRBS pattern for each PCS Lane • User can select from a wide range of PRBS data patterns to be transmitted with the ability to invert the patterns • Send single, continuous, and exponentially controlled amounts of error injection • Wide range of statistics, including Pattern Lock, Pattern Transmitted, Pattern Received, Total Number of Bits Sent and Received, Total Number of Errors Sent and Received, Bit Error Ratio (BER), and Number of Mismatched 1's and 0's. • Lane Stats Grouping per lambda for SMF and MMF 40GE and 100GE based on IEEE 802.3ba defined physical medium dependent (PMD).	
40/100 GE Physical Coding Sublayer (PCS) test features	The Xcellon-Lava load module supports IEEE 802.3ba compliant PCS transmit and receive side test capabilities. The supported PCS features are as follows: • **Per PCS lane, transmit lane mapping**: Supports all combination of PCS lane mapping: Default, Increment, Decrement, Random, and Custom. • **Per PCS lane, skew insertion capability**: User selectable from zero up to 3 microseconds of PCS Lane skew insertion on the transmit side. • **Per PCS lane, lane marker, or lane marker and payload error injections**: User selectable ability to inject errors into the PCS Lane Marker and simultaneously into PCS Lane Marker and Payload fields. This includes the ability to inject sync bit errors into the Lane Marker and Payload. User can control the PCS lane, number or errors, period count and manage the repetition of the injected errors. • **Per PCS lane, receive lanes statistics**: PCS Sync Header and Lane Marker Lock, Lane Marker mapping, Relative lane deskew up to 52 microseconds for 40GE and 104 microseconds for 100GE, Sync Header and PCS Lane Marker Error counters, indicators for Loss of Synch Header and Lane Marker, and BIP8 errors.	
IPv4, IPv6, UDP, TCP checksum	Xcellon-Lava load module supports hardware checksum generation and verification.	

Feature	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
Frame length controls	Xcellon-Lava load module supports fixed, random, weighted random, or increment by user-defined step, random, and weighted random.	
Preamble view	Xcellon-Lava load module allows to select to view and edit the preamble contents.	
Link Fault Signaling	Xcellon-Lava load module generates local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner.	
Operating temperature range	41°F to 95°F (5°C to 35°C), ambient air NOTE When an Xcellon-Lava load module is installed in XG12 chassis, the maximum operating temperature of the chassis is 35°C (ambient air).	
Load module dimensions	16.0" (L) x 12.0" (W) x 1.3" (H) 406mm (L) x 305mm (W) x 33mm (H)	
Weight	Module only: 9.8 lbs (4.45 kg) Shipping: 12.0 lbs (5.45 kg)	
ppm Adjust range	+/-100ppm	+/-100ppm
ppm Adjust port/card	Card	Card
Trigger out	No	No
External Clock In (Frequence)	No	No
External Clock Out	No	No
Ambient Operating Temperature Range (C)	5-40	5-40
Timestamp - Resolution	20ns	20ns
Timestamp - High Resolution	No	No
Timestamp - End of Frame Instrumentation	No	No

Feature	LavaAP40/100GE 2P	LavaAP40/100GE 2RP
Timestamp - Floating Intrumentation	No	No
IEEE802.3x Flow control	No	No
WAN	No	No
Streams per port	16	16
Number of streams in Advanced Scheduler Mode (Data Center Mode)	16	16
Transicevier Intrinsic Latency Calibration	No	No
Intrinsic Latency	Yes	Yes
Data Integrity	Yes	Yes
Auto Instrumentation	Yes	Yes
Preamble - Changeable Content	No	No
Preamble - Byte Count Mode	No	No
Preamble - SFD Detect Mode	Yes	Yes
Preamble - Cisco CDL Mode	No	No

The Ixia application support for Lava AP40/100GE 2P and Lava AP40/100GE 2RP is provided in the following table:

Xcellon-Lava Application Support

Lava AP40/100GE 2P	Lava AP40/100GE 2RP
IxExplorer	IxExplorer

Lava AP40/100GE 2P	Lava AP40/100GE 2RP
IxNetwork	IxNetwork
IxAutomate	IxAutomate
TCL API	TCL API

Updated enumerated types in API for LavaAP support in IxN2X

AgtPortSelector ModuleType

- AGT_CARD_TWOPORT_100GBASE_R
- AGT_CARD_TWOPORT_40GBASE_R

AgtPortSelector Personality

Please note that the port speed is selected by the personality

- AGT_PERSONALITY_100GBASE_R
- AGT_PERSONALITY_40GBASE_R

AgtEthernetLinkMode

- AGT_ETHERNET_LINK_40G_FULLDUPLEX,
- AGT_ETHERNET_LINK_100G_FULLDUPLEX

EAgtPluginMediaType

- AGT_PLUGIN_CXP
- AGT_PLUGIN_QSFP
- AGT_PLUGIN_CFP

EAgtPcsStatus

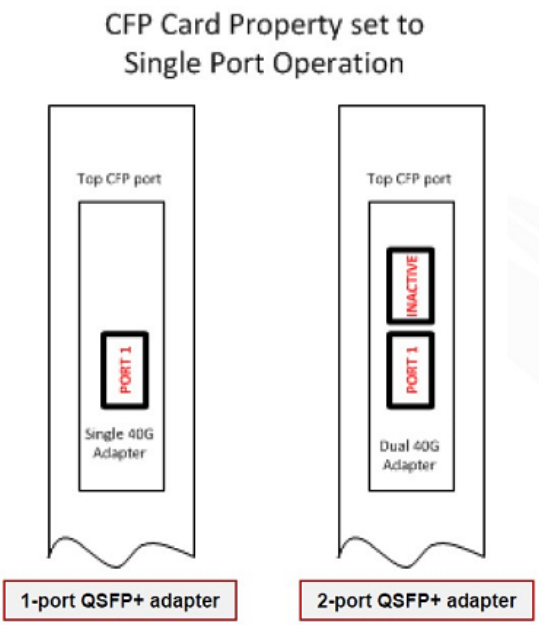
- AGT_PCS_STATUS_SYNC_ERROR
- AGT_PCS_STATUS_ILLEGAL_CODE
- AGT_PCS_STATUS_ILLEGAL_IDLE
- AGT_PCS_STATUS_EXTENDED_ERROR_MASK
- AGT_PCS_STATUS_ALL_ERROR_MASK

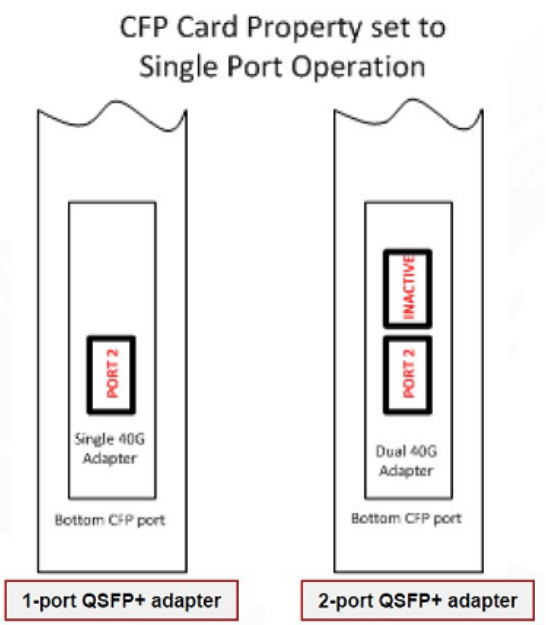
NOTE The Xcellon-Lava AP is a CFP module. CFP-to-CXP and CFP-to-QSFP adaptors are available separately.

2x40 QSFP adaptor

N2X only supports single port mode, even with the dual-port adaptors. In a vertical orientation, it is the bottom port in each adaptor that is supported by N2X and the upper port is inactive.

Figure: Single Port Mode: Single and Dual CFP-to-QSFP+ adapter module configurations


CFP Card Property set to
Single Port Operation
Top CFP port
PORT 1
Single 40G
Adapter
1-port QSFP+ adapter
Top CFP port
INACTIVE
PORT 1
Dual 40G
Adapter
2-port QSFP+ adapter


CFP Card Property set to
Single Port Operation
PORT 2
Single 40G
Adapter
Bottom CFP port
1-port QSFP+ adapter
INACTIVE
PORT 2
Dual 40G
Adapter
Bottom CFP port
2-port QSFP+ adapter

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CHAPTER 10

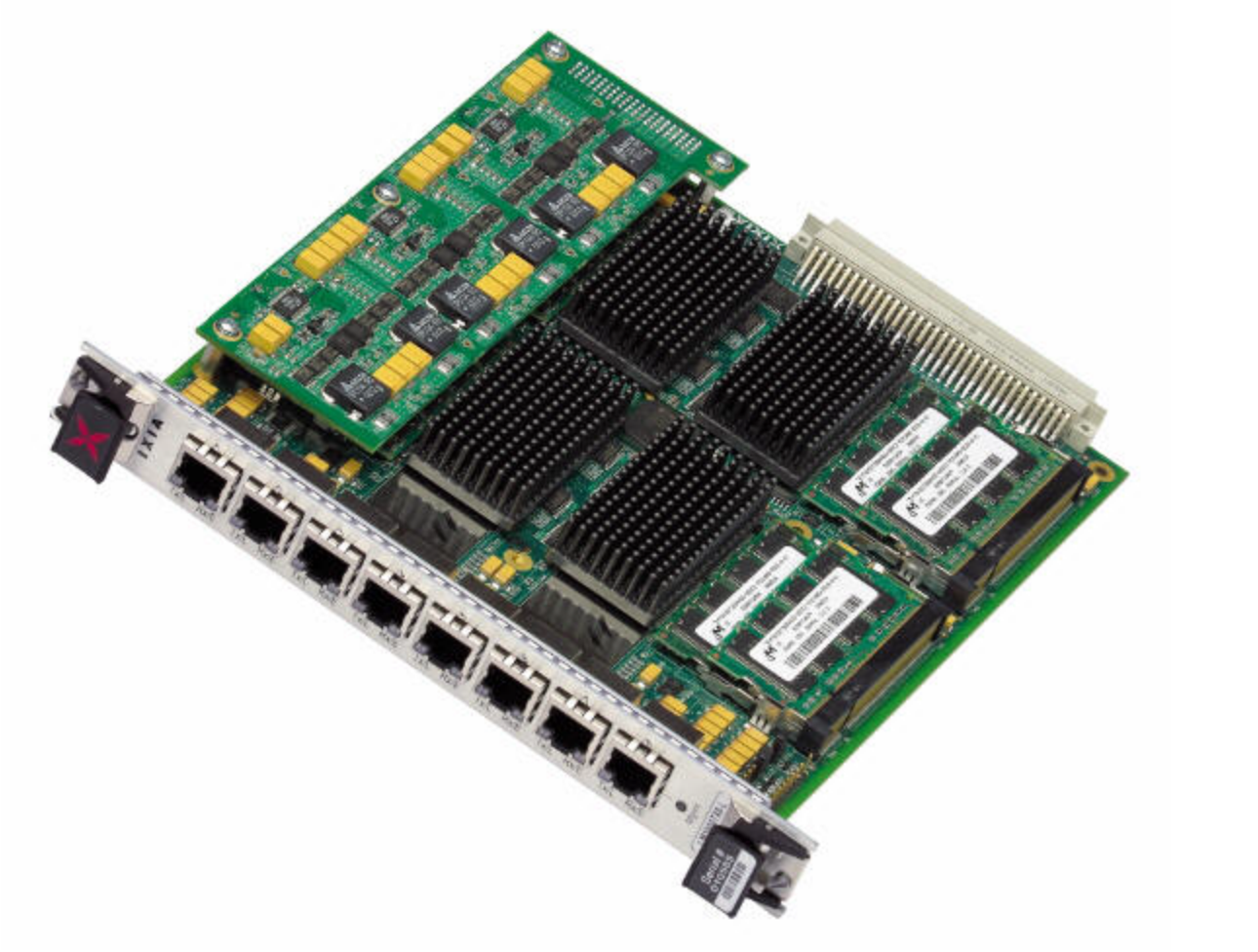
IXIA 10/100/1000 Load Modules

This chapter provides details about Ixia 10/100/1000 family of load modules the specifications and features.

The 10/100/1000 family of load modules implements Ethernet interfaces that run at 10 Mbps, 100 Mbps, or Gigabit (1000 Mbps) speeds. Different numbers of ports and interfaces are available for the different board types. The specifications for these load modules are listed in the table. A representative selection of these load modules are pictured on the pages that follow.

The application load module ALM1000T8 is an 8-port 10/100/1000 Mbps Base T Ethernet copper module which supports the Real World Traffic Suite (includes IxVPN, IxChariot, and IxLoad). This module also supports ARP, PING, and independent Linux SDK applications. The ALM1000T8 load module is shown in the following figure.

Figure: ALM1000T8 Application Load Module



Part Numbers

The part numbers are shown in the following table. Items without a *Price List Names* entry are no longer available.

Part Numbers for 10/100/1000 Modules

Load Module	Price List Names	Description
LSM1000XMVR16-01	LSM1000XMVR16-01	16-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.

Load Module	Price List Names	Description
		NOTE In order to meet the emissions requirements of FCC part 15 Class A the RJ45 cables attached to this module's Ethernet ports must have ferrite beads (Fair-Rite 0431164281 or equivalent) present at both ends of the cable.
LSM1000XMVR12-01	LSM1000XMVR12-01	12-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.
LSM1000XMVR8-01	LSM1000XMVR8-01	8-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.
LSM1000XMVR4-01	LSM1000XMVR4-01	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.
LSM1000XMSP12-01	LSM1000XMSP12-01	12-port Dual-PHY RJ45 10/100/1000 Mbps Gigabit Ethernet and SFP fiber. A 750FL or 750GL PowerPC Processor with

Load Module	Price List Names	Description
		a minimum of 256MB per port of CPU memory and 256KB of layer 2 cache running at 600MHz.
LSM1000XMVDC4-01	LSM1000XMVDC4-01	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC4-NG	LSM1000XMVDC4-NG	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC8-01	LSM1000XMVDC8-01	8-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC12-01	LSM1000XMVDC12-01	12-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC16-01	LSM1000XMVDC16-01	16-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM10/100/1000XMVDC16NG	LSM10/100/1000XMVDC16NG The Part Number of this load	16-port XMVDC16NG load module is Ixia's Fusion-enabled version of the existing LSM XMVDC16 load module. These

Load Module	Price List Names	Description
	module is 944-1072-01.	two load modules are physically similar. The hardware components and application specifications remain unchanged. The key difference is the IxN2X capability to run the load module in IxN2X mode.
LM1000STXS2	LM1000STXS2	2-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module. Does not include SFP transceivers.
LM1000STX2	LM1000STX2	2-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet Load Module. Supports Layer 2-3 stream generation only. No support for routing, Layer 4-7 applications and the Linux SDK. Does not include any SFP transceivers.
LM1000STX4	LM1000STX4	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet Load Module. Supports Layer2-3 stream generation only. No support for routing, Layer 4-7 applications and the Linux SDK. Does not include any SFP transceivers.
ALM1000T8	ALM1000T8	8-port 10/100/1000 Mbps Base T Ethernet copper. Supports Real World Traffic Suite (includes IxVPN, IxChariot and IxLoad), and independent Linux-based SDK applications.
ELM1000ST2	ELM1000ST2	2-port Dual PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet Load Module featuring hardware-based high-speed IPSec encryption for use with IxVPN.
	SFP-LX	1310 nm LX SFP transceiver used with LM1000STX2, LM1000STX4, LM1000STXS2, and LM1000STXS4-256.

Load Module	Price List Names	Description
	SFP-SX	850 nm SX SFP transceiver used with LM1000STX2, LM1000STX4, LM1000STXS2, LM1000STXS4-256, LSM1000XMV(R)4-01, LSM1000XMV(R)8-01, LSM1000XMV(R)12-01, and LSM1000XMV(R)16-01.
LSM1000XMVDC4-NG		4-port LSM1000XMVDC4NG-01,GIGABIT ETHERNET LOAD MODULE

Specifications

The load module specifications are contained in the following tables. The limitations of -3, Layer 2/3, and Layer 7 cards are discussed in the Ixia Load Modules.

10/100/1000 Load Module Specifications Part 1

	ALM1000T8	ELM1000ST2
# ports	8	2
-3 Card Available	N	N
Layer2/Layer3 Card?	N	N
Data Rate	10/100/1000 Mbps	10/100/1000 Mbps
Connector	RJ-45 (copper)	RJ-45 (copper) andSFP (fiber)
Interfaces	1000Base-T100Base-TX10Base-T	1000Base-X1000Base-T100Base-TX10Base-T
Capture buffer size	N/A	N/A
Captured packet size	N/A	N/A
Streams per port	N/A	N/A
Advanced scheduler streams per port	N/A	N/A
Flows per port	N/A	N/A
Preamble size: min-max	N/A	N/A
Frame size: min-max	N/A	N/A
Inter-frame gap: min-max	N/A	N/A

	ALM1000T8	ELM1000ST2
Inter-burst gap: min-max	N/A	N/A
Inter-stream gap:min-max	N/A	N/A
Latency	N/A	N/A

[2]Odd frame sizes can cause diminishment in the actual data rate on this modules.

10/100/1000 Load Module Specifications Part 2

	LM1000STX2, LM1000STX4O, LM1000STX24	LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24
# ports	2 (STX2)4 (STX4) 24 (STX24)	2 (STXS2)4 (STXS4) 4 (XMV(R)4)4 (XMVDC4)8 (XMV(R)8)8 (XMVDC8)12 (XMV(R)12)12 (XMS12/XMSR12)12 (XMSP12)12 (XMVDC12)16 (XMV16/XMVR16)16 (XMVDC16)16 (XMVDC16NG) 24 (STXS24)
-3 Card Available	N	N
Layer2/Layer3 Card?	Y	Y
Data Rate	10/100/1000 Mbps	10/100/1000 Mbps
Connector	Dual: RJ-45 (copper) and SFP (fiber)	Dual: RJ-45 (copper) and SFP (fiber) (1000 Mbps only)
Interfaces	1000Base-X1000Base-T100Base-TX10Base-T	1000Base-X1000Base-T100Base-TX10Base-T LSM1000XMV(R)4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 also have 100Base-FX
Ambient Operating Temperature Range		LSM1000XMVR16-01 41ºF to 86ºF (5ºC to 30ºC)
Capture buffer size	8MB	LSM1000XMV4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 32MB (Packet Group Engine Enabled) 64MB (Packet Group Engine Disabled)

	LM1000STX2, LM1000STX4O, LM1000STX24	**LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24**
		Others:8MB
Captured packet size	12-13k bytes	12-13k bytes
Number of stream in Packet Stream Mode	256	LSM1000XMV4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 4096 Others: 256
Number of streams in Advanced Scheduler Mode (Non Data Center Mode)	Fast: 16 Slow: 240	LSM1000XMV4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 • Fast: 16 • Medium: 240 • Slow: 3584 All others: • Fast: 16 • Slow: 240
Number of streams in Advanced Scheduler Mode (Data Center Mode)	N	(For LSM1000XMVDC4/8/12/16-01 card) Fast: 16Medium: 240
Flows per port	N/A	N/A
Preamble size: min-max (bytes)	2-61 (10/100)8-61 (1000 fiber)6-61 (1000 copper)	2-61 (10/100)8-61 (1000 fiber)6-61 (1000 copper)
Frame size: min-max	12-13k bytes	12-13k bytes For XMVDC: Minimum Frame Size at Line Rate: 48 Minimum Frame Size - may not be at Line Rate: 12 Maximum Frame Size: 2500B

	LM1000STX2, LM1000STX4O, LM1000STX24	**LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24**
Inter-frame gap: min-max	**Basic Scheduler:**10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps **Advanced Scheduler:**10: 6400ns-1717.99s in 800ns steps100: 640ns-171.799s in 80ns steps1000: 64ns-68.719 in 16ns steps	**Basic Scheduler:**10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps **Advanced Scheduler:**10: 6400ns-1717.99s in 800ns steps100: 640ns-171.799s in 80ns steps1000: 64ns-68.719 in 16ns steps
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s
Inter-stream gap:min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps
Normal stream min frame rate	10: 0.00238fps100: 0.0238fps1000: 0.238fps	10: 0.00238fps100: 0.0238fps1000: 0.238fps
Advanced stream min frame rate	10: 0.000582fps100: 0.00582fps1000: 0.0146fps	10: 0.000582fps100: 0.00582fps1000: 0.0146fps
Latency	20ns resolution	20ns resolution
Table UDF feature (based on minimum packet size 64K)	96K (full)32K (reduced)	786K (LSM1000XMV)96K others (full)32K others (reduced)
Max Value List Entries	48K	48K

	LM1000STX2, LM1000STX4O, LM1000STX24	LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24
Max Range List Entries[1]	6K	6K

[1]192k memory is shared between value list entries (at 4 bytes per entry) and range list entries (at 32 bytes per entry).

ALM1000T8

The ALM100T8 has a feature that is non-conformant with the IEEE 802.3 specification. According to the specification, all 4 pairs of signals must be connected in gigabit copper mode for auto-negotiation to function. On the ALM100T8, if auto-negotiation fails using all 4 pairs, auto-negotiation is attempted using only the two pairs used in 10/100 modes. This allows auto-negotiation to succeed even if gigabit mode is enabled for auto-negotiation and a 10/100 only cable is used.

Card LEDs

Each ELM1000ST2, LM1000STX2/4 and LM1000STXS2/4 card incorporates a single LED, as described in the following table.

10/100/1000 Card LEDs for ELM1000ST2, LM1000STX2/4 and LM1000STXS2/4

LED Label	Usage
Trig	The value of the `OR' function of all of the trigger out ports on the board. The LED's color is orange.

The ALM1000T8 has a card-level `mgmt' LED next to Port 8. This LED is not currently used.

Port LEDs

Each port on the ALM1000T8 module incorporates a set of 2 LEDs, as described in the following table. The ALM1000T8 also has a card-level `mgmt' LED next to Port 8; this LED is not currently used.

ALM100T8 Port LEDs

LED Label	Usage
Link/Tx (Upper LED)	Color is used to indicate the link speed: • 1000Mbps Green • 100Mbps Orange • 10Mbps Yellow Flashing indicates transmit activity.

LED Label	Usage
	Off if link is down.
Rx/Error (Lower LED)	Three conditions apply: • Full duplex or master (in 1000 Mbps case): Green with extended pulses off to indicate receive activity. • Half duplex or subordinate (in 1000 Mbps case): Off with extended green pulses to indicate receive activity. • Error: Overrides the other two modes, with extended orange pulses. • No link: Off.

Port LEDs for LSM1000XMV4/8/12/16-01, are described in the following table.

Port LEDs for LSM1000XMV4/8/12/16-01

LED Label	Copper	Fiber
Link/Tx (Upper LED)	Color is used to indicate the link speed: • 1000Mbps Green • 100Mbps Orange • 10Mbps Yellow Flashing indicates transmit activity. Off if link is down.	Green indicates link has been established and flashes during transmit activity.
Rx/Error (Lower LED)	Three conditions apply: • Full duplex or master (in 1000 Mbps case): Green with extended pulses off to indicate receive activity. • Half duplex or subordinate (in 1000 Mbps case): Off with extended pulses to indicate receive activity. • Error: Overrides the other two modes and pulses red. • No link: Off.	Green indicates link has been established and flashes during receive activity. Continuous red indicates a receive error.

Each ELM1000ST2, LM1000STX2, LM1000STX4, LM1000STXS2, and LM1000STXS4-256 port incorporates a set of 6 LEDs, as described in the following table. The LEDs are arranged next to the two connectors associated with each port: Speed, Slave, and RJ45 Link/Tx/Coll are next to the RJ45 connector and Rx/Err, Half, and SFP Link/Tx/Coll are next to the SFP connector.

Port LEDs for ELM1000ST2, LM1000STX2, LM1000STX4, LM1000STXS2, LM1000STXS4, and LM1000STXS4-256

LED Label	Usage
Speed	• Off for 10Mbps.

LED Label	Usage
	• Orange for 100Mbps. • Green for 1000Mbps.
Slave	• On in slave or subordinate mode. • Off otherwise.
RJ45 Link/Tx	• Off if SFP is the active connector. • Steady Orange for no link. • Flashing Orange for link with collision. • Steady Green for link with no transmit. • Flashing green during transmit.
Rx/Err	• Flashes green on data receive. • Steady Red for error.
Half	• Green for half-duplex mode. • Off for full-duplex mode.
SFP Link/Tx/Coll	• Off if RJ45 is the active connector. • Steady Orange for no link. • Flashing Orange for link with collision. • Steady Green for link with no transmit. • Flashing green during transmit.

There is no trigger connector on the ALM100T8.

The ELM1000ST2's triggers are not currently used.

The signals available on the trigger out pins for the LM1000STX4, LM1000STXS4-256, LM1000STXS2, and LM1000STX2 cards is described in the following table.

LM1000STXS4, LM1000STX4, LM1000STXS4-256, LM1000STXS2, and LM1000STX2 Trigger Out Signals

Pin	Signal
1	660ns negative pulse when User Defined Statistic 1 is true.
2	660ns negative pulse when User Defined Statistic 1 is true.
3	660ns negative pulse when User Defined Statistic 1 is true.

Pin	Signal
4	660ns negative pulse when User Defined Statistic 1 is true.
5	Ground
6	Ground

Statistics

Statistics for 10/100/1000 cards, under various modes of operation may be found in Available Statistics.

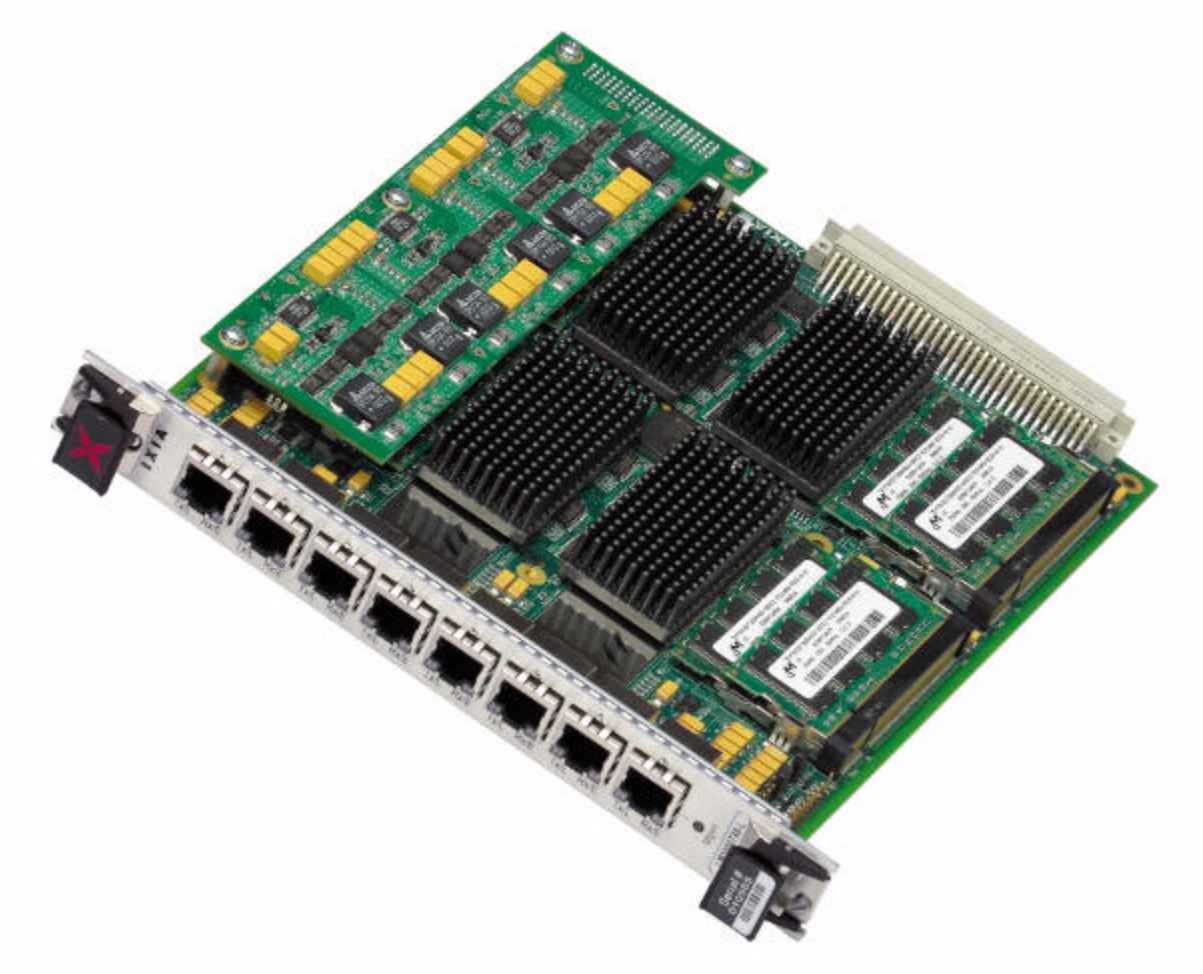
IXIA 10/100/1000 Load Modules

This chapter provides details about Ixia 10/100/1000 family of load modules the specifications and features.

The 10/100/1000 family of load modules implements Ethernet interfaces that run at 10 Mbps, 100 Mbps, or Gigabit (1000 Mbps) speeds. Different numbers of ports and interfaces are available for the different board types. The specifications for these load modules are listed in the table. A representative selection of these load modules are pictured on the pages that follow.

The application load module ALM1000T8 is an 8-port 10/100/1000 Mbps Base T Ethernet copper module which supports the Real World Traffic Suite (includes IxVPN, IxChariot, and IxLoad). This module also supports ARP, PING, and independent Linux SDK applications. The ALM1000T8 load module is shown in the following figure.

Figure: ALM1000T8 Application Load Module



Part Numbers

The part numbers are shown in the following table. Items without a *Price List Names* entry are no longer available.

Part Numbers for 10/100/1000 Modules

Load Module	Price List Names	Description
LSM1000XMVR16-01	LSM1000XMVR16-01	16-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.

Load Module	Price List Names	Description
		NOTE In order to meet the emissions requirements of FCC part 15 Class A the RJ45 cables attached to this module's Ethernet ports must have ferrite beads (Fair-Rite 0431164281 or equivalent) present at both ends of the cable.
LSM1000XMVR12-01	LSM1000XMVR12-01	12-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.
LSM1000XMVR8-01	LSM1000XMVR8-01	8-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.
LSM1000XMVR4-01	LSM1000XMVR4-01	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module, reduced performance, 400MHz PowerPC Processor. 256MB of processor memory per port.
LSM1000XMSP12-01	LSM1000XMSP12-01	12-port Dual-PHY RJ45 10/100/1000 Mbps Gigabit Ethernet and SFP fiber. A 750FL or 750GL PowerPC Processor with

Load Module	Price List Names	Description
		a minimum of 256MB per port of CPU memory and 256KB of layer 2 cache running at 600MHz.
LSM1000XMVDC4-01	LSM1000XMVDC4-01	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC4-NG	LSM1000XMVDC4-NG	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC8-01	LSM1000XMVDC8-01	8-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC12-01	LSM1000XMVDC12-01	12-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM1000XMVDC16-01	LSM1000XMVDC16-01	16-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps. 1GB port CPU memory, full-featured L2-L7 with FCoE enabled; Fiber ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU.
LSM10/100/1000XMVDC16NG	LSM10/100/1000XMVDC16NG The Part Number of this load	16-port XMVDC16NG load module is Ixia's Fusion-enabled version of the existing LSM XMVDC16 load module. These

Load Module	Price List Names	Description
	module is 944-1072-01.	two load modules are physically similar. The hardware components and application specifications remain unchanged. The key difference is the IxN2X capability to run the load module in IxN2X mode.
LM1000STXS2	LM1000STXS2	2-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet load module. Does not include SFP transceivers.
LM1000STX2	LM1000STX2	2-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet Load Module. Supports Layer 2-3 stream generation only. No support for routing, Layer 4-7 applications and the Linux SDK. Does not include any SFP transceivers.
LM1000STX4	LM1000STX4	4-port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet Load Module. Supports Layer2-3 stream generation only. No support for routing, Layer 4-7 applications and the Linux SDK. Does not include any SFP transceivers.
ALM1000T8	ALM1000T8	8-port 10/100/1000 Mbps Base T Ethernet copper. Supports Real World Traffic Suite (includes IxVPN, IxChariot and IxLoad), and independent Linux-based SDK applications.
ELM1000ST2	ELM1000ST2	2-port Dual PHY (RJ45 and SFP) 10/100/1000 Mbps Ethernet Load Module featuring hardware-based high-speed IPSec encryption for use with IxVPN.
	SFP-LX	1310 nm LX SFP transceiver used with LM1000STX2, LM1000STX4, LM1000STXS2, and LM1000STXS4-256.

Load Module	Price List Names	Description
	SFP-SX	850 nm SX SFP transceiver used with LM1000STX2, LM1000STX4, LM1000STXS2, LM1000STXS4-256, LSM1000XMV(R)4-01, LSM1000XMV(R)8-01, LSM1000XMV(R)12-01, and LSM1000XMV(R)16-01.
LSM1000XMVDC4-NG		4-port LSM1000XMVDC4NG-01,GIGABIT ETHERNET LOAD MODULE

Specifications

The load module specifications are contained in the following tables. The limitations of -3, Layer 2/3, and Layer 7 cards are discussed in the Ixia Load Modules.

10/100/1000 Load Module Specifications Part 1

	ALM1000T8	ELM1000ST2
# ports	8	2
-3 Card Available	N	N
Layer2/Layer3 Card?	N	N
Data Rate	10/100/1000 Mbps	10/100/1000 Mbps
Connector	RJ-45 (copper)	RJ-45 (copper) andSFP (fiber)
Interfaces	1000Base-T100Base-TX10Base-T	1000Base-X1000Base-T100Base-TX10Base-T
Capture buffer size	N/A	N/A
Captured packet size	N/A	N/A
Streams per port	N/A	N/A
Advanced scheduler streams per port	N/A	N/A
Flows per port	N/A	N/A
Preamble size: min-max	N/A	N/A
Frame size: min-max	N/A	N/A
Inter-frame gap: min-max	N/A	N/A

	ALM1000T8	ELM1000ST2
Inter-burst gap: min-max	N/A	N/A
Inter-stream gap:min-max	N/A	N/A
Latency	N/A	N/A

[2]Odd frame sizes can cause diminishment in the actual data rate on this modules.

10/100/1000 Load Module Specifications Part 2

	LM1000STX2, LM1000STX4O, LM1000STX24	LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24
# ports	2 (STX2)4 (STX4) 24 (STX24)	2 (STXS2)4 (STXS4) 4 (XMV(R)4)4 (XMVDC4)8 (XMV(R)8)8 (XMVDC8)12 (XMV(R)12)12 (XMS12/XMSR12)12 (XMSP12)12 (XMVDC12)16 (XMV16/XMVR16)16 (XMVDC16)16 (XMVDC16NG) 24 (STXS24)
-3 Card Available	N	N
Layer2/Layer3 Card?	Y	Y
Data Rate	10/100/1000 Mbps	10/100/1000 Mbps
Connector	Dual: RJ-45 (copper) and SFP (fiber)	Dual: RJ-45 (copper) and SFP (fiber) (1000 Mbps only)
Interfaces	1000Base-X1000Base-T100Base-TX10Base-T	1000Base-X1000Base-T100Base-TX10Base-T LSM1000XMV(R)4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 also have 100Base-FX
Ambient Operating Temperature Range		LSM1000XMVR16-01 41ºF to 86ºF (5ºC to 30ºC)
Capture buffer size	8MB	LSM1000XMV4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 32MB (Packet Group Engine Enabled) 64MB (Packet Group Engine Disabled)

	LM1000STX2, LM1000STX4O, LM1000STX24	**LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24**
		Others:8MB
Captured packet size	12-13k bytes	12-13k bytes
Number of stream in Packet Stream Mode	256	LSM1000XMV4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 4096 Others: 256
Number of streams in Advanced Scheduler Mode (Non Data Center Mode)	Fast: 16 Slow: 240	LSM1000XMV4/8/12/16-01 and LSM1000XMVDC4/8/12/16-01 • Fast: 16 • Medium: 240 • Slow: 3584 All others: • Fast: 16 • Slow: 240
Number of streams in Advanced Scheduler Mode (Data Center Mode)	N	(For LSM1000XMVDC4/8/12/16-01 card) Fast: 16Medium: 240
Flows per port	N/A	N/A
Preamble size: min-max (bytes)	2-61 (10/100)8-61 (1000 fiber)6-61 (1000 copper)	2-61 (10/100)8-61 (1000 fiber)6-61 (1000 copper)
Frame size: min-max	12-13k bytes	12-13k bytes For XMVDC: Minimum Frame Size at Line Rate: 48 Minimum Frame Size - may not be at Line Rate: 12 Maximum Frame Size: 2500B

	LM1000STX2, LM1000STX4O, LM1000STX24	**LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24**
Inter-frame gap: min-max	**Basic Scheduler:**10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps **Advanced Scheduler:**10: 6400ns-1717.99s in 800ns steps100: 640ns-171.799s in 80ns steps1000: 64ns-68.719 in 16ns steps	**Basic Scheduler:**10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps **Advanced Scheduler:**10: 6400ns-1717.99s in 800ns steps100: 640ns-171.799s in 80ns steps1000: 64ns-68.719 in 16ns steps
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s
Inter-stream gap:min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-4.29s in 16ns steps
Normal stream min frame rate	10: 0.00238fps100: 0.0238fps1000: 0.238fps	10: 0.00238fps100: 0.0238fps1000: 0.238fps
Advanced stream min frame rate	10: 0.000582fps100: 0.00582fps1000: 0.0146fps	10: 0.000582fps100: 0.00582fps1000: 0.0146fps
Latency	20ns resolution	20ns resolution
Table UDF feature (based on minimum packet size 64K)	96K (full)32K (reduced)	786K (LSM1000XMV)96K others (full)32K others (reduced)
Max Value List Entries	48K	48K

	LM1000STX2, LM1000STX4O, LM1000STX24	LM1000STXS2, LM1000STXS4-256, LSM1000XMSR12-01, LSM1000XMSP12-01, LSM1000XMV4/8/12/16-01, LSM1000XMVR4/8/12/16-01, LSM1000XMVDC4/8/12/16-01O, LM1000STXS24
Max Range List Entries[1]	6K	6K

[1]192k memory is shared between value list entries (at 4 bytes per entry) and range list entries (at 32 bytes per entry).

ALM1000T8

The ALM100T8 has a feature that is non-conformant with the IEEE 802.3 specification. According to the specification, all 4 pairs of signals must be connected in gigabit copper mode for auto-negotiation to function. On the ALM100T8, if auto-negotiation fails using all 4 pairs, auto-negotiation is attempted using only the two pairs used in 10/100 modes. This allows auto-negotiation to succeed even if gigabit mode is enabled for auto-negotiation and a 10/100 only cable is used.

Card LEDs

Each ELM1000ST2, LM1000STX2/4 and LM1000STXS2/4 card incorporates a single LED, as described in the following table.

10/100/1000 Card LEDs for ELM1000ST2, LM1000STX2/4 and LM1000STXS2/4

LED Label	Usage
Trig	The value of the `OR' function of all of the trigger out ports on the board. The LED's color is orange.

The ALM1000T8 has a card-level `mgmt' LED next to Port 8. This LED is not currently used.

Port LEDs

Each port on the ALM1000T8 module incorporates a set of 2 LEDs, as described in the following table. The ALM1000T8 also has a card-level `mgmt' LED next to Port 8; this LED is not currently used.

ALM100T8 Port LEDs

LED Label	Usage
Link/Tx (Upper LED)	Color is used to indicate the link speed: • 1000Mbps Green • 100Mbps Orange • 10Mbps Yellow Flashing indicates transmit activity. Off if link is down.

LED Label	Usage
Rx/Error (Lower LED)	Three conditions apply: • Full duplex or master (in 1000 Mbps case): Green with extended pulses off to indicate receive activity. • Half duplex or subordinate (in 1000 Mbps case): Off with extended green pulses to indicate receive activity. • Error: Overrides the other two modes, with extended orange pulses. • No link: Off.

Port LEDs for LSM1000XMV4/8/12/16-01, are described in the following table.

Port LEDs for LSM1000XMV4/8/12/16-01

LED Label	Copper	Fiber
Link/Tx (Upper LED)	Color is used to indicate the link speed: • 1000Mbps Green • 100Mbps Orange • 10Mbps Yellow Flashing indicates transmit activity. Off if link is down.	Green indicates link has been established and flashes during transmit activity.
Rx/Error (Lower LED)	Three conditions apply: • Full duplex or master (in 1000 Mbps case): Green with extended pulses off to indicate receive activity. • Half duplex or subordinate (in 1000 Mbps case): Off with extended pulses to indicate receive activity. • Error: Overrides the other two modes and pulses red. • No link: Off.	Green indicates link has been established and flashes during receive activity. Continuous red indicates a receive error.

Each ELM1000ST2, LM1000STX2, LM1000STX4, LM1000STXS2, and LM1000STXS4-256 port incorporates a set of 6 LEDs, as described in the following table. The LEDs are arranged next to the two connectors associated with each port: Speed, Slave, and RJ45 Link/Tx/Coll are next to the RJ45 connector and Rx/Err, Half, and SFP Link/Tx/Coll are next to the SFP connector.

Port LEDs for ELM1000ST2, LM1000STX2, LM1000STX4, LM1000STXS2, LM1000STXS4, and LM1000STXS4-256

LED Label	Usage
Speed	• Off for 10Mbps. • Orange for 100Mbps.

LED Label	Usage
	• Green for 1000Mbps.
Slave	• On in slave or subordinate mode. • Off otherwise.
RJ45 Link/Tx	• Off if SFP is the active connector. • Steady Orange for no link. • Flashing Orange for link with collision. • Steady Green for link with no transmit. • Flashing green during transmit.
Rx/Err	• Flashes green on data receive. • Steady Red for error.
Half	• Green for half-duplex mode. • Off for full-duplex mode.
SFP Link/Tx/Coll	• Off if RJ45 is the active connector. • Steady Orange for no link. • Flashing Orange for link with collision. • Steady Green for link with no transmit. • Flashing green during transmit.

There is no trigger connector on the ALM100T8.

The ELM1000ST2's triggers are not currently used.

The signals available on the trigger out pins for the LM1000STX4, LM1000STXS4-256, LM1000STXS2, and LM1000STX2 cards is described in the following table.

LM1000STXS4, LM1000STX4, LM1000STXS4-256, LM1000STXS2, and LM1000STX2 Trigger Out Signals

Pin	Signal
1	660ns negative pulse when User Defined Statistic 1 is true.
2	660ns negative pulse when User Defined Statistic 1 is true.
3	660ns negative pulse when User Defined Statistic 1 is true.
4	660ns negative pulse when User Defined Statistic 1 is true.

Pin	Signal
5	Ground
6	Ground

Statistics

Statistics for 10/100/1000 cards, under various modes of operation may be found in Available Statistics.

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CHAPTER 11

IXIA Network Processor Load Modules

This chapter provides details about Ixia's Xcellon-Ultra XP and Xcellon-Ultra NP load modules the specificatons, features, and functionality. It also provides details on Xcellon-Ultra load module when it operates in IxN2X mode.

Ixia's Gigabit and 10 Gigabit Ethernet Network Processor load modules Xcellon-Ultra XP and Xcellon-Ultra NP. These are Ethernet modules with additional aggregation capability. Each features 12 ports of 10/100/1000Mbps Ethernet configurable in either aggregation mode, stream mode, or as 1 port of 10GE aggregation.

IxN2X capability is added to the regular Xcellon-Ultra load module to use it in IxN2X mode. Xcellon-Ultra XP and NP and Xcellon-Ultra NG load modules share similar physical properties. In addition to the physical properties, Xcellon-Ultra NG supports IxN2X mode.

The Xcellon-Ultra module offers complete Layer 2-7 network and application testing functionality in a single Optixia XM load module. The twelve Gig Ethernet ports may either be used individually or aggregated through a 10 Gigabit Ethernet port. This architecture allows the processing power and resources of up to twelve per-port CPUs to be combined into one physical port, providing the highest Layer 4-7 line-rate performance, unmatched in any other Layer 4-7 test solution. Each test port supports wire-speed Layer 2-3 traffic generation and analysis, high-performance routing/bridging protocol emulation, and true Layer 4-7 application traffic generation and subscriber emulation. Using 12 GbE ports per module, ultra-high density test environments can be created for auto-negotiable 10/100/1000 Mbps Ethernet over copper as well as fiber.

Application Layer Performance Testing

The Gigabit Ethernet Xcellon-Ultra module supports high performance testing of content-aware devices and networks through the Aptixia IxLoad application. IxLoad creates real-world traffic scenarios at the TCP/UDP (Layer 4) and Application (Layer 7) layers, emulating clients and servers for Web (HTTP, SSL), FTP, Email (SMTP, POP3, IMAP), Streaming (RTP, RTSP), Video (MPEG2, MPEG4, IGMP), Voice (SIP, MGCP), and services such as DNS, DHCP, LDAP and Telnet. Each GE XMV port can be independently configured to run different protocols and client/server scenarios.

Real-time Transport Protocol (RTP) Feature

For the Xcellon-Ultra XP and NP modules, the RTP engine built into the FPGA can generate and terminate audio streams (video and data traffic is an option, too). The RTP engine works together with the VoIP Peer signaling protocols present in IxLoad. On a physical port the traffic is a mixture of signaling traffic generated and analyzed by PCPU, RTP traffic generated by CPCU, and RTP traffic generated by hardware.

The RTP feature is selectable from the Port Properties Operation Mode tab in IxExplorer. For details, see the *IxExplorer User Guide*, Chapter 18, topic *Port Properties for Xcellon-Ultra Modules*.

Modes of Operation

The Xcellon-Ultra modules can operate in three different modes providing a flexible, scalable and powerful layer 4-7 performance.

Non-Aggregated (Normal) Mode

In this mode, the twelve 10/100/1000Mbps ports provide L2-L7 XMV functionality. Each port is capable of providing high performance packet generation and application layer testing by employing its own port CPU resources as well as the dedicated hardware stream engine. In this mode the 10GE Aggregation Port is disabled.

Gigabit Aggregated Mode

Gigabit Aggregated Mode allows the twelve PCPUs to be assigned to any of 12 GbE test ports through the switch fabric. Aggregation of the processing power allows application layer testing at line rate regardless of the test objective. A cluster of PCPU's can be assigned to any of the physical ports. Multiple clusters and their assigned physical ports can exist on the same module. Aptixia applications transparently configures the available PCPU resources and make the assignment to the physical port (s) to achieve the test objectives. This mode is exclusive to L4-7 testing and there is no support for hardware stream engine. In this mode the 10GE Aggregation Port is disabled.

10GE Aggregated Mode

In 10GE Aggregated Mode, all of the twelve PCPUs are assigned to the 10GE Aggregation Port through the switch fabric. Aggregation of the processing power allows application layer testing at line rate (10 Gbps). Aptixia applications transparently configure the PCPU resources to achieve the test objectives. This mode is exclusive to L4-7 testing and there is no support for hardware stream engine. In this mode the twelve Gigabit ports are disabled.

Flexible Packet Generation

Each Xcellon-Ultra test port is capable of generating precisely controlled network traffic at up to wire speed of the network interface using Ixia's IxExplorer test application. Up to millions of packet flows can be configured on each port with fully customizable packet header fields. Flexible header control is available for Ethernet, IPv4/v6, IPX, ARP, TCP, UDP, VLANs, QinQ, MPLS, GRE, and many others. Payload contents can also be customized with incrementing/decrementing, fixed, random, or user-defined information. Frame sizes can be fixed, varied according to a pattern, or randomly assigned across a weighted range. Rate control can be flexibly defined in frames per second, bits per second, percentage of line rate, or inter-packet gap time.

Real-Time Latency

Packets representing different traffic profiles can be associated with Packet Group Identifiers (PGIDs). The receiving port measures the minimum, maximum, and average latency in real time for each packet belonging to different groups. Measurable latencies include:

- Instantaneous latency and inter-arrival time where each packet is associated with one group ID
- Latency bins, where PGIDs can be associated with a latency range
- Latency over time, where multiple PGIDs can be placed in `time buckets' with fixed durations
- First and last time stamps, where each PGID can store the timestamps of first and last received packets

Transmit Scheduler

There are two modes of transmission are available - Packet Stream and Advanced Stream Scheduler:

Packet Stream Scheduler

In Packet Stream Scheduler mode, the transmit engine allows configuration of up to 4096 unique sequential stream groupings on each port. Multiple streams can be defined in sequence, each containing multiple packet flows defined by unique characteristics. After transmission of all packets in the first stream, control is passed to the next defined stream in the sequence. After reaching the last stream in the sequence, transmission may either cease, or control may be passed on to any other stream in the sequence. Therefore, multiple streams are cycled through, representing different traffic profiles to simulate real network traffic.

Advanced Stream Scheduler

In Advanced Stream Scheduler mode, the transmission of stream groupings is interleaved per port. For example, assume a port is configured with three streams. If Stream 1 is defined with IP packets at 20% of line rate, Stream 2 is defined with TCP packets at 50% of line rate, and Stream 3 is defined with MPLS packets at 30% of line rate, data on the port is transmitted at an aggregate utilization of 100% with interleaved IP, TCP, and MPLS packets.

Extensive Statistics

- Real-time 64-bit frame counts and rates
- Spreadsheet presentation format for convenient manipulation of statistics counters
- Eight Quality of Service counters (supporting 802.1p, DSCP, and IPv4 TOS measurements)
- Six user-defined statistics that use a trigger condition
- Extended statistics for ARP, ICMP, and DHCP
- Transmit stream statistics for frame counts and rate
- External logging to file for statistics and alerts
- Audible and visual alerts with user-definable thresholds

Data Capture

Each port is equipped with 64 MB of capture memory, capable of storing tens of thousands of packets in real time. The capture buffer can be configured to store packets based on user-defined trigger and filter conditions. Decodes for IPv4, IPv6, UDP, ARP, BGP-4, IS-IS, OSPF, TCP, DHCP, IPX, RIP, IGMP, CISCO ISL, VLAN, and MPLS are provided.

Data Integrity

As packets traverse through networks, IP header contents may change, resulting in the recalculation of packet CRC values. To validate device performance, the data integrity function of Gigabit Ethernet Xcellon-Ultra modules allows packet payload contents to be verified with a unique CRC that is independent of the packet CRC. This ensures that the payload is not disturbed as the device changes header fields.

Sequence and Duplicate Packet Checking

Sequence numbers can be inserted at a user-defined offset in the payload of each transmitted packet. Upon receipt of the packets by the Device Under Test (DUT), out-of sequence errors or duplicated packets are reported in real time at wire-speed rates. You can define a sequence error threshold to distinguish between small versus big errors, and the receive port can measure the amount of small, big, reversed, and total errors. Alternatively, you can use the duplicate packet detection mode to observe that multiple packets with the same sequence number are received and analyzed.

Routing/Bridging Protocol Emulation

Ixia's Gigabit Ethernet Xcellon-Ultra modules support performance and functionality testing using routing/bridging protocol emulation through the Aptixia IxNetwork and Aptixia IxAutomate applications. Protocols supported include IPv4/IPv6 routing (BGP-4, OSPF, IS-IS, and RIP), MPLS (RSVP-TE, LDP, L2 MPLS VPNs, L3 MPLS VPNs, and VPLS), multicast (IGMP, MLD, and PIM-SM), and bridging (STP, RSTP, MSTP). Highly scalable scenarios can be created emulating up to thousands of routers advertising millions of routes per test port. Up to wire-speed Layer 2/3 traffic can be automatically created to target routes and MPLS tunnels.

Part Numbers

The part numbers are shown in the following table.

Part Numbers for Network Processor Modules

Load Module	Price List Name	Description
Xcellon-Ultra XP-01	Xcellon-Ultra XP-01	10 Gigabit Ethernet, Application and Stream Load Module, 1-10G or 12-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps; 800MHz CPU with 1GB of memory per GbE port; On-Board Port Aggregation; GbE Fiber Ports REQUIRE SFP transceivers, options include SFP-LX or SFP-SX; and 10GbE port requires a XFP transceiver, options are either 948-0003 (XFP-850), XFP-1310, or XFP-1550
Xcellon-Ultra NP-01	Xcellon-Ultra NP-01	Same as version above but 1GHz CPU and 2GB of memory.
Xcellon-Ultra NG-	Xcellon-Ultra NG-	Same as above.

Load Module	Price List Name	Description
01	01	
	SFP-SX	850nm SX SFP transceiver
	SFP-LX	SFP Transceiver - 1310nm LX
	XFP-850 (948-0003-01)	XFP 850nm Transceiver
	XFP-1550	XFP 1550nm Transceiver
	XFP-1310	XFP 1310nm Transceiver

Specifications

The load module specifications are contained in the following table. The limitations of -3, Layer 2/3, and Layer 7 cards are discussed in Ixia Load Modules.

Load Module Specifications

	Xcellon-Ultra XP-01 **Xcellon-Ultra NP-01** **Xcellon-Ultra NG-01**
Number of ports	12 GbE (10/100/1000) + 10GbE
Maximum Ports per Chassis	144 GbE + 12 10GbE
Connector	RJ-45 and SFP for GbE ports; XFP for 10GbE port
Interfaces	Port 1 to port 12:1000Base-X100Base-FX1000Base-T (Aggregate, Copper mode)10/100/1000Base-T (Aggregate, Copper mode)100Base-TX10Base-TPort 13: 10GBase-X10G LAN XFP
Port CPU	Xcellon-Ultra XP PowerPC 750GL x12 Port CPU Speed: 800 MHz Port CPU Memory: 1GB Xcellon-Ultra NP PowerPC 750GX x12 Port CPU Speed: 1 GHz Port CPU Memory: 2GB

	Xcellon-Ultra XP-01 **Xcellon-Ultra NP-01** **Xcellon-Ultra NG-01**
	Xcellon-Ultra NG PowerPC 750GX x12 Port CPU Speed: 1 GHz Port CPU Memory: 2GB
Ambient Operating Temperature Range	41ºF to 86ºF (5ºC to 30ºC)
Connection rate (cps)	200K (in aggregated mode)
Layer 2-3 Routing Protocol and Emulation	Yes
Layer 4-7 Application Traffic Testing	Yes
Capture Buffer per Port	32MB (Packet Group Engine Enabled) 64MB (Packet Group Engine Disabled)
Number of Transmit Flows per Port (sequential values)	Bilions
Number of Transmit Flows per Port (arbitrary values)	98K
Number of Trackable Receive Flows per Port (PGIDs)	128K
Number of Stream Definitions per Port	Up to 4K in Packet Stream Mode (sequential) or Advanced Stream (interleaved) modes. Each Stream Definition can generate millions of unique traffic flows.

	Xcellon-Ultra XP-01 **Xcellon-Ultra NP-01** **Xcellon-Ultra NG-01**
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.
Receive Engine	Wire-speed packet filtering, capturing, real-time latency for each packet group, data integrity, and sequence checking.
User Defined Field (UDF) Features	Fixed, increment or decrement by user-defined step, value lists, range lists, cascade, random, and chained. Value list = 48K; Range list = 6K.
Table UDF Feature	Comprehensive packet editing function for emulating large numbers of sophisticated flows. Up to 786K table UDF entries are supported on the XMV12X.
Filters	48-bit source/destination address, 2x128-bit user-definable pattern and offset, frame length range, CRC error, data integrity error, sequence checking error (small, big, reverse)
Data Field (per stream)	Fixed, increment (Byte/Word), decrement (Byte/Word), random, repeating, user-specified up to 13K bytes.
Statistics and Rates: Counter Size: 64-Bit	Link State, Line Speed, Frames Sent, Valid Frames Received, Bytes Sent/Received, Fragments, Undersize, Oversize, CRC Errors, VLAN Tagged Frames, User-Defined Stat 1, User- Defined Stat 2, Capture Trigger (UDS 3), Capture filter (UDS 4), User-Defined Stat 5, User-Defined Stat 6, 8 QoS counters, Data Integrity Frames, Data Integrity Errors, Sequence Checking Frames, Sequence Checking Errors, ARP, and Ping requests and replies.
Error Generation	CRC (Good/Bad/None), Undersize, Oversize
Packet Flow Statistics	Real-time statistics to track up to 128K packet flows on the XMV12X with throughput and latency measurements.
Latency Measurements	20 ns resolution.
IPv4, IPV6, UDP, TCP	Hardware checksum generation.
Frame Length Controls	Fixed, random, weighted random, or increment by user-defined step, random, weighted random.
Applications	Aptixia IxLoad: Layer 4-7 performance testing of content-aware devices and networks. Aptixia IxNetwork: Integrated Layer 2-3 data/control plane performance and functional testing, supporting routing, bridging, MPLS, and multicast protocols.

	Xcellon-Ultra XP-01 **Xcellon-Ultra NP-01** **Xcellon-Ultra NG-01**
	Aptixia IxAutomate: Automation environment providing pre-built tests for Layer 2-7 data and control plane testing. IxExplorer: Layer 2-3 wire-speed traffic generation and analysis. IxChariot: Emulated application performance testing over Layer 4. IxAccess: Broadband access performance testing, including PPPoX and L2TPv2/v3. IxVPN: Performance verification of IPSec devices and networks. Tcl API: Custom user script development for Layer 2-7 testing. Linux Software Development Kit (SDK): Custom user application development. Full TCP/IP connectivity through management interface (Telnet, FTP, and so on.)

Port LEDs

Each Xcellon-Ultra port incorporates a set of two LEDs, as described in the following table. The 1GbE LEDs are used in Normal and 1GbE Aggregate modes. They behave identically in both modes, except that due to switch limitations, the `CRC Error' LED is non-operational in 1GE Aggregate mode (that is, it never indicates error). The 1GE LEDs are disabled (always off) in 10GE Aggregate mode.

1GE Port LEDs for Xcellon-Ultra Modules

LED Label	**Copper**	**Fiber**
1GE Link/Tx (Upper LED)	Color is used to indicate the link speed: • 1000Mbps-Green • 100Mbps-Orange • 10Mbps-Yellow Flashing indicates transmit activity. Off if link is down.	Green indicates link has been established and flashes during transmit activity.No link = off.
1GE Rx/Error (Lower LED)	Three conditions apply: • Full duplex or master (in 1000 Mbps case) green with extended pulses off to indicate receive activity. • Half duplex or subordinate (in 1000 Mbps case) off with extended pulses to indicate receive activity. • Error overrides the other two modes and pulses red (supported only in Normal mode). • No link off.	Green indicates link has been established and flashes during receive activity. Continuous red indicates a receive error (supported only in Normal mode).

10GE LEDs are disabled (always off) in Normal and 1GE Aggregate modes. In 10GE Aggregate mode, the two LEDs behave as described in the following table.

10GE Port LEDS for Xcellon-Ultra Modules

LED Label	Usage
10GE Link/Tx (Upper LED)	Green indicates link has been established. Flashes during transmit activity.No link = off.
10GE Rx/Error (Lower LED)	Green indicates link has been established. Flashes during receive activity.No link = off.

Statistics

Statistics for Xcellon-Ultra cards, under various modes of operation may be found in Available Statistics.

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CHAPTER 12

IXIA 40/100 Gigabit Ethernet Load Modules

This chapter provides details about Ixia's K2 40-Gigabit and 100-Gigabit Ethernet test modules the specifications and features.

Ixia's K2 40-Gigabit and 100-Gigabit Ethernet test modules are the world's first IP network traffic generation and layer 2-7 measurement and analysis test solution. K2 load modules are engineered to meet the needs of product teams developing 40 Gb/s and 100 Gb/s network devices such as routers, switches, and communications devices. K2 modules can measure and analyze the performance of Higher Speed Ethernet (HSE) standard-compliant devices at line rate, and are compatible with Ixia's chassis and broad range of 10 Mbps, 100 Mbps, 1 Gbps, and 10 Gbps interfaces, allowing real-world, full product testing in a single box.

Ixia's 40 Gb/s and 100 Gb/s load modules provide network device developers the ability to test 40 GE and 100 GE hardware electronics at full line-rate operation. Early adopters of the HSE technology can use the Ixia test system to validate their compliance with the new PCS lane operation of the IEEE P802.3ba draft standard.

Ixia's K2 load modules are valuable to developers who are integrating firmware and software into new electronics hardware, or integrating optical transceivers into their network devices and systems. Ixia's HSE modules can be used to validate and benchmark the performance limits of these network devices by employing layer 2 and 3 stress testing, virtual scalability testing, and negative testing. Ixia's HSE load modules ensure that a network device is ready to interoperate with other manufacturers' devices that claim compliance to the IEEE P802.3ba draft standard, and facilitate interoperability testing between different vendors of network devices and equipment.

Figure: 100GE and 40GE LSM XMV Load Modules

Figure: 40GE LSM XMV QSFP Load Module

Key Features

Industry's first commercially available 100 Gb/s Physical Coding Sublayer (PCS) test system:

Provides the ability to check compliance to the IEEE P802.3ba draft standard for both Transmit and Receive sides

Generates and analyzes full 40 Gb/s and 100 Gb/s line rate traffic:

- Tracks and analyzes up to 1 million flows per port for;
  - Real-time latency
  - Inter-arrival time
  - Packet loss
  - Data integrity
  - Sequence checking
  - Packet capture

Ixia's 40 Gb/s and 100 Gb/s load modules are designed for comprehensive layer 2-7 testing with integrated data plane and control plane traffic generation and analysis.

Nomenclature

The LSM HSE family identifying numbers are shown in the following table.

LSM HSE Modules

Load Module	Model Number	Description
40GE LSM XMV1	HSE40GETSP1-01	1-port 40GE, 2-slot, full-featured load module. Supports routing protocols, Linux SDK, and L4-7 applications (requires 40GE CFP MSA transceiver).
100GE LSM XMV1	HSE100GETSP1-01	1-port 100GE, 2-slot, full-featured load module. Supports routing protocols, Linux SDK, and L4-7 applications (requires 100GE CFP MSA transceiver).
40/100GE LSM XMV	HSE40/100GETSP1-01	1-port, 2-slot, dual-speed, full-featured load module with CFP interface
40GE LSM XMV QSFP	HSE40GEQSFP1-01	1-port, 1-slot, full-featured load module with QSFP interface

Specification are given in the following table.

HSE Module Specifications

	HSE40GETSP1HSE100GETSP1HSE40/100GETSP1	HSE40GEQSFP1
Number of ports per module	1	1
Number of chassis slots per module	2	1
Supported transceivers	CFP MSA Pluggable	QSFP Pluggable
Data Rate	40 Gbps100 Gbps	40 Gbps
Port CPU Speed and memory	1GHz/2 GB	1GHz/2 GB
Per-port Capture	1.4 GB	700 MB

	HSE40GETSP1HSE100GETSP1HSE40/100GETSP1	**HSE40GEQSFP1**
buffer		
Interface protocol	40 Gigabit Ethernet per IEEE P802.3ba, Draft 2.0, 100GBASE-R 100 Gigabit Ethernet per IEEE P802.3ba, Draft 2.0,40GBASE-R	40 Gigabit Ethernet per IEEE P802.3ba, Draft 2.0, 100GBASE-R
Ambient Operating Temp. Range	41ºF to 95ºF (5ºC to 35ºC) NOTE Ambient air temperature at the installation site for the system should not exceed 95°F (35°C).	41ºF to 95ºF (5ºC to 35ºC) NOTE Ambient air temperature at the installation site for the system should not exceed 95°F (35°C).
Layer 2/3 routing protocol emulation	Yes	
Layer 4-7 application traffic testing	Yes	
Number of transmit flows per port (sequential)	Billions	
Number of transmit flows per port (arbitrary values)	1 million	
Number of trackable receive flows	1 million	

	HSE40GETSP1HSE100GETSP1HSE40/100GETSP1	**HSE40GEQSFP1**
Captured packet size	49-14,000 bytes	49-14,000 bytes
Number of stream definitions per port	256 In packet stream (sequential) or advanced stream (interleaved) mode, each stream definition can generate millions of unique traffic flows. NOTE In the Data Center mode, the number of transmit streams is 256.	256
Preamble size	8 bytes	8 bytes
Frame size: min-max (bytes)	49-14,000	49-14,000
Inter-frame gap: min-max	1.8ns - 21.99sec	1.8ns - 21.99sec
Inter-burst gap: min-max	1.8ns - 21.99sec	1.8ns - 21.99sec
Inter-stream gap:min-max	1.8ns - 21.99sec	1.8ns - 21.99sec
Normal stream frame rate	0.045 fps - full line rate	0.045 fps - full line rate
Advanced stream min frame rate	0.091fps	0.091fps
Latency measurements	standard resolution as 20ns user selectable high resolution as 2.5ns	20 nanosecond resolution user selectable high resolution as 2.5ns
Table UDF Entries	1million Comprehensive packet editing function for emulating large numbers of sophisticated flows. Entries of up to 256 bytes, using lists of values, can be specified and placed at designated offsets	1 million

	HSE40GETSP1HSE100GETSP1HSE40/100GETSP1	HSE40GEQSFP1
	within a stream. Each list consists of an offset, a size, and a list of values in a table format.	
Max Value List UDF entries	1 million entries for 32-bit and 24-bit, 2 million entries for 8 and 16-bit.	1 million entries for 32-bit and 24-bit, 2 million entries for 8 and 16-bit.
Max Range List UDF entries	N/A	N/A
Packet flow statistics	Track over 1 million flows	
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures	
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, data integrity, and sequence checking	
User defined field features	Fixed, increment, or decrement by user-defined step, value lists, range lists, cascade, random, and chained	
Filters	48-bit source/destination address, 2x128-bit user definable pattern and offset, frame length range, CRC error, data integrity error, sequence checking error (small, big, reverse)	
Data field per stream	Fixed, increment or decrement by user-defined step, value lists, range lists, cascade, random, and chained	
Statistics and rates (counter size: 64 bits)	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), user-defined stat 5, user-defined stat 6, 8 QoS counters, data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and ping requests and replies	
Error generation	CRC (good/bad/none), undersize, oversize	

	HSE40GETSP1HSE100GETSP1HSE40/100GETSP1	HSE40GEQSFP1
MDIO	Ability to calibrate and remove inherent latency from any MSAcompliant 40 Gb/s or 100Gb/s CFP transceiver	
Transmit line clock adjustment	Ability to adjust the parts per million (ppm) line frequency over a range of LAN mode: - 100 to +100 ppm	
Clock In/Out	The load module provides two female SMA coaxial connectors one for clock input and one for clock output to allow the device under test (DUT) to frequency-lock with the load module interface. See Clock In/Out.	
Layer 1 BERT capability	The load module supports the following BERT features on both 40 Gb/s and 100 Gb/s speeds: • User selected PRBS pattern for each PCS Lane • User selects from a wide range of PRBS data patterns to be transmitted (true and complement) • Send single, continuous, and exponentially controlled amounts of error injection • Wide range of statistics, including: Pattern Lock, Pattern Transmitted, Pattern Received, Total Number of Bits Sent and Received, Total Number of Errors Sent and Received, Bit Error Ratio (BER), Number of Mismatched 1's and 0's. • Lane Stats Grouping per lambda for SMF and MMF 40 Gb/s and 100 Gb/s based on IEEE802.3ba defined physical medium dependent (PMD).	
Physical Coding Sublayer (PCS) test features	IEEE P802.3ba compliant PCS transmit and receive side test capabilities.	
Per PCS lane, transmit lane mapping	Supports all combination of PCS lane mapping: Default, Increment, Decrement, Random, and Custom.	
Per PCS lane,	User selectable from zero up to 3 microseconds	

	HSE40GETSP1HSE100GETSP1HSE40/100GETSP1	HSE40GEQSFP1
skew insertion and deskew capability	of skew insertion on transmit side. Ability to measure deskew up to 6 microseconds on receive side.	
IPv4, IPv6, UDP, TCP	Hardware checksum generation, and verification.	
Frame length controls	Fixed, random, weighted random, or increment by user-defined step, random, weighted random.	
Preamble view	Allows to select to view the preamble in Packet View.	
Link Fault Signaling	Ability to select the option to have the transmit port ignore link faults from a remote link partner.	

Port LEDs

Each 40/100GE port incorporates a set of LEDs, as described in the following tables.

40/100GE LSM Port LEDs

LED Label	Usage
Link	Green if Ethernet link is up (established) or the port is in a forced Link Up state, red if link is down. Link may be down due to no signal or no PCS lock.
Tx Active	Green indicates that Tx is active and frames being sent; red indicates Tx is paused; off indicates Tx is not active.
Rx Active	Green indicates that Rx is active and frames being received; red indicates Rx is paused; off indicates Rx is not active.
Rx/Error	Green indicates valid Rx frames are being received; red indicates error frames being received; off indicates no frames being received.
Attention	(Reserved for future use)
Pwr Good	Green when power is on, red if power fault occurs.

Clock In/Out

The load module provides coaxial connectors for clock input and clock output to allow the DUT to frequency-lock with the interface. When running off an external clock, the clock input signal must meet the requirements listed in the following table to ensure proper performance of the load module.

The clock in/out electrical interface parameters are also defined in the following table.

Clock In/Out Electrical Interface Parameters

Parameter		Characteristic
ClockInput	Frequency	161.13 MHz ±100ppm
	Duty cycle	50%
	Jitter	±150ps max. cycle to cycle, >1kHz
	Amplitude	Recommended: 800mV Minimum: 150mV Maximum: 1200mV
	Impedance	50 ohm ± 5%, DC coupled
	Connector	Female SMA
ClockOutput	Frequency	161.13 MHz +/-100ppm (Programmable ppm in Internal Clock Mode)
	Duty cycle	40 to 60%
	Jitter	20ps max cycle to cycle, >1kHz
	Amplitude	0.7Vpp min into 50 ohms, AC coupled output
	Edge rates	200ps to 340ps (20% to 80%) into 50 ohms
	Impedance	50 ohms +/-5%, AC coupled
	Connector	Female SMA

The load module contains a phase-locked loop (PLL) that reduces the jitter of the input clock, either from the internal or external clock source. The bandwidth of the PLL is approximately 1kHz.

Statistics

Statistics for 40/100GE LSM cards, under various modes of operation may be found in 40/100 GE Statistics.

Intrinsic Latency Adjustment

This option, when present and enabled, reduces the measured latency by the amount of latency that is induced by the test equipment itself (not the DUT). For a specific transceiver, the system retrieves its pre-determined latency value and subtracts this from the measured overall latency. For an `unknown' transceiver (not previously measured), it calculates and stores the intrinsic latency value.

On the **General** tab in **Port Properties**, the **Latency Calibration** option is only enabled for cards with transceivers that have not been pre-measured for intrinisic latency by Ixia. The **Latency Calibration** option is grayed-out if any one of the following conditions are present:

- there is no transceiver
- the transceiver is CFP and a value is found for it in the list of precalibrated values

The **Latency Calibration** option is enabled if the transceiver is CFP but no pre-calibrated value is found in the stored list. The **Latency Calibration** option is also enabled for transceivers that you have previously calibrated, so that the calibration measurement may be repeated (if desired).

Selecting the **Latency Calibration** option runs a Tcl script that measures intrinsic latency and stores the value in an .xml file. The .xml file contains the values that you have produced and saved. Each value is identified for a specific transceiver (per manufacturer, model, and serial number). You can run the calibrate process repeatedly with the same transceiver (if desired). Each new measurement overwrites the previous one for that transceiver.

Running the calibration measurement puts the port into a special loopback mode to measure intrinsic latency. When done, the port is put back into default normal mode. Any port configuration you have set before calibrating intrinsic latency, is lost as the port reverts to a default configuration.

The **Enable** check box is grayed out when no value exists in the system for the specific transceiver. If a value exists in the .xml file, then the **Enable** check box is available. Select the check box to enable the intrinsic latency adjustment.

After the intrinsic latency adjustment has been done, you may want to refresh the chassis or close and reopen the Port Properties dialog.

Multilane Distribution Configuration

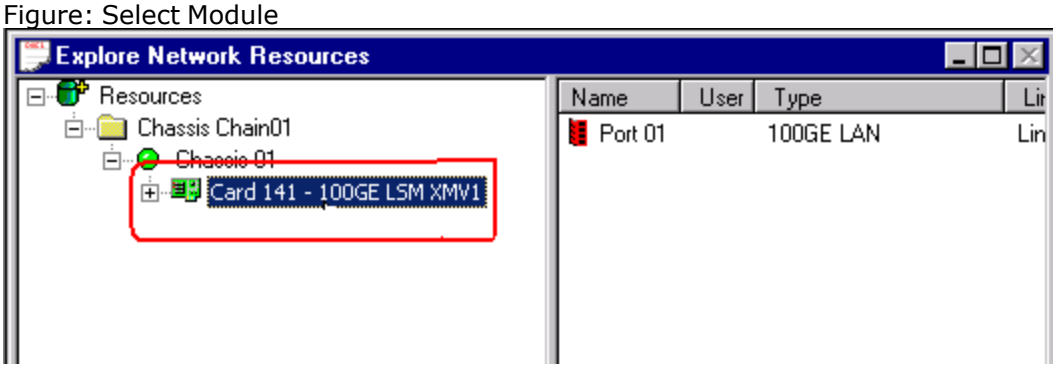
The Tx Lane tab allows to control the PCS (Physical Coding Sublayer) lane configuration and skew. It is part of the Port Properties for the module.

NOTE The other tabs in the Port Properties page are described in the *IxExplorer User Guide*, as are the rest of the controls for the module.

To open the Tx Lane tab:

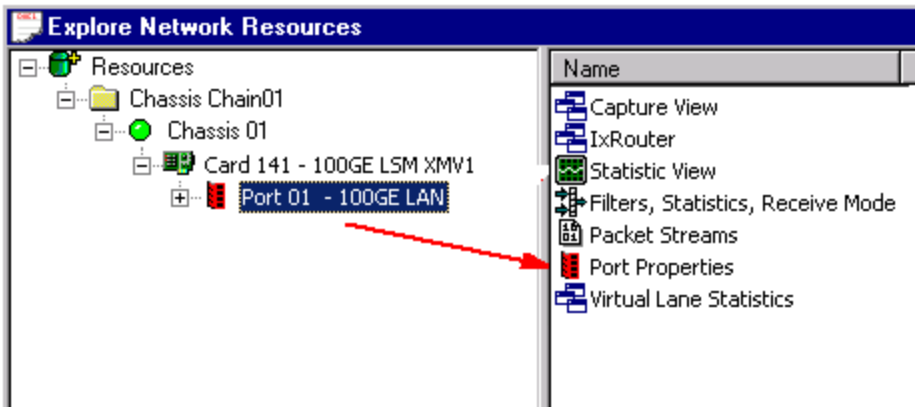
1. Select the 40 or 100GE LSM XMV1 module in the left pane of the IxExplorer window as shown in the following figure.

   Figure: Select Module



2. Expand the node, and select the Port object. In the right window pane, double-click the Port Properties object as shown in the following figure.

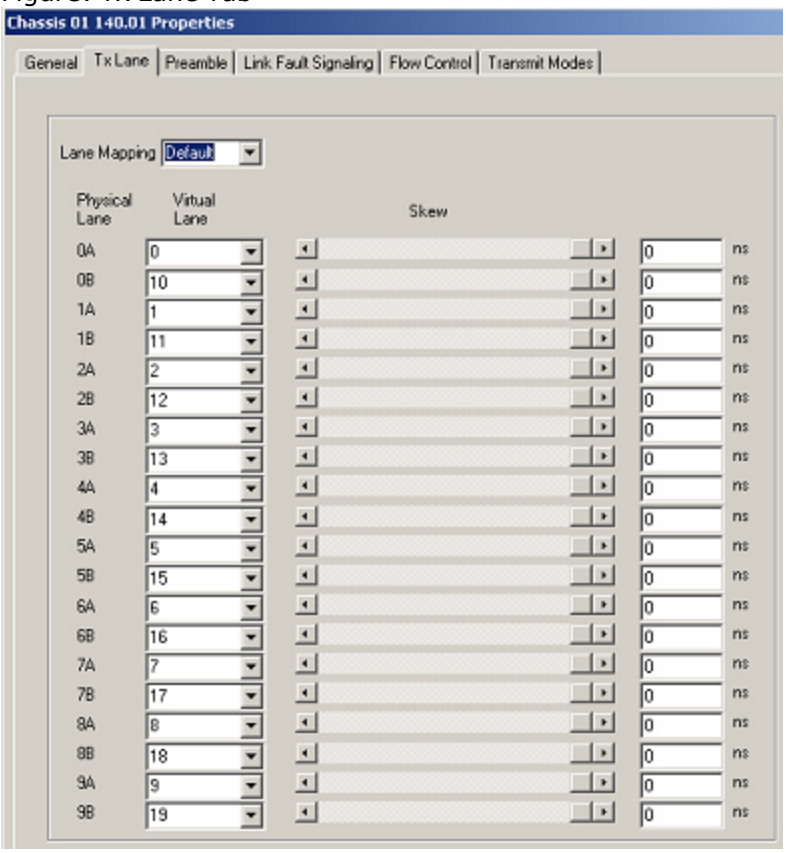
   Figure: Port and Port Properties



3. In the Port Properties dialog, select the Tx Lane tab. Use this tab to control the PCS lane order and the skew for each lane.

   The Tx Lane tab is shown in the following figure.

   Figure: Tx Lane Tab



The following table explains the options in the Tx Lane tab page.

Tx Lane Tab Configuration

Field	Description
Lane Mapping	Allows you to select a PCS lane ordering method. There are four options: • Default: The default ordering method. The default order is each physical port

Field	Description
	corresponds to 2 PCS lanes that are n and n+10, where n = physical lane number. • Increment: Orders the lanes from 0 to 19, straight down the list. • Decrement: Orders the lanes from 19 to 0, straight down the list. • Custom: Allows to put the lanes in any order by manually entering the numbers in the fields. The starting order is the last selected mapping.
Physical Lane	The physical lane identifier. The physical lane is paired with a corresponding PCS lane.
PCS Lane	A number identifier for the PCS lane. The PCS lane is paired with a corresponding physical lane.
Skew	The skew slider is used to set a skew value for the PCS lane, in nanoseconds, on the transmit side. Lane Skew is the ability to independently delay one or more of the 20 PCS lanes. When the slider is moved, the nanoseconds field is correspondingly adjusted. You can also enter a nano second value directly into this field. When the slider is fully pushed to the right, the skew injected into the transmit stream is 0 (minimum). When the slider is pushed all the way to the left. the skew injected into the transmit stream is 3 uS (maximum).

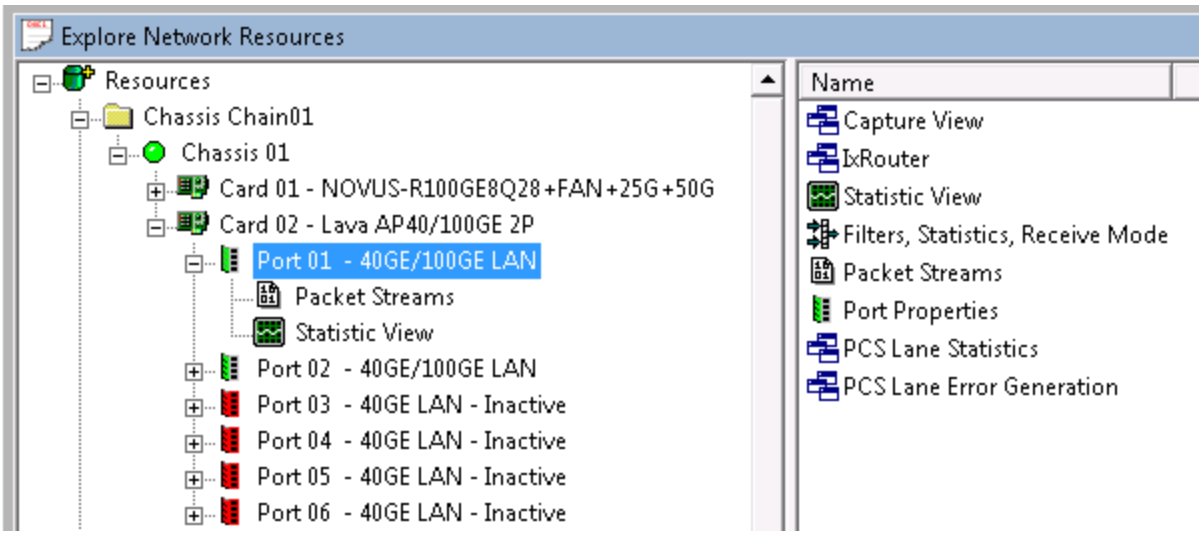
PCS Lane Statistics

The PCS lane statistics table allows to view the statistics for the configured PCS lanes.

To open the PCS lane statistics table:

1. Select the 40 or 100GE LSM XMV1 module in the left pane of the IxExplorer window as shown in the figure.
2. Expand the node, and select the Port object. In the right window pane, double-click the PCS lane statistics object as shown in the following figure.

   Figure: Port and PCS Lane Statistics



3. The PCS lane statistics table opens. Use this table to view the PCS lane statistics for each lane. The statistics are for the **receive** side.

   The PCS lane statistics table is shown in the following figure.

   Figure: PCS Lane Statistics Table

PCS Lanes Statistics - loopback:159.01

	A	B	C	D	E	F	G	H	I	J
1	Physical Lane	Sync Header Lock	PCS Lane Marker Lock	PCS Lane Marker Map	Relative Lane Skew (ns)	Sync Header Error Count	PCS Lane Marker Error Count	BIP-8 Error Count	Lost Sync Header Lock	Lost PCS Lane Marker Lock
2	0A			0		0	0	0		
3	0B			0		0	0	0		
4	1A			0		0	0	0		
5	1B			0		0	0	0		
6	2A			0		0	0	0		
7	2B			0		0	0	0		
8	3A			0		0	0	0		
9	3B			0		0	0	0		
10	4A			0		0	0	0		
11	4B			0		0	0	0		
12	5A			0		0	0	0		
13	5B			0		0	0	0		
14	6A			0		0	0	0		
15	6B			0		0	0	0		
16	7A			0		0	0	0		
17	7B			0		0	0	0		
18	8A			0		0	0	0		
19	8B			0		0	0	0		
20	9A			0		0	0	0		
21	9B			0		0	0	0		

The following table explains the entries in the PCS lane statistics table.

PCS Lane Statistics Data

Field	Description
Physical Lane	The identifier for the Receive physical lane. This is a tag/fixed label to ID each lane.

Field	Description
Sync Header Lock	Indicates if the received PCS lane achieved sync-bit lock. Green indicates success, red failure.
PCS Lane Marker Lock	Indicates if the received PCS lane has achieved alignment marker lock. Green indicates success, red failure.
PCS Lane Marker Map	The PCS lane number identified by the alignment marker. This is only valid when PCS Lane Marker Lock is green.
Relative Lane Skew (ns)	Shows the actual skew in nanoseconds. Skew measurements are valid only when all lanes are locked with 20 unique lane markers. The first PCS Lane markers to arrive have skew of 0. All other lane skews are relative to them.
Sync Header Error Count	The number of synchronization bit errors received.
PCS Lane Marker Error Count	The number of incorrect PCS lane markers received while in PCS lane lock state.
BIP-8 Error Count	Bit interleaved parity error count. It detects the number of BIP-8 errors for a PCS lane.
Lost Sync Header Lock	When lit, indicates the loss of sync header lock since the last statistic was read. If colored gray, there is no error. If colored red, an error has occurred.
Lost PCS Lane Marker Lock	When lit, indicates the loss of PCS lane marker lock since the last statistic was read. If colored gray, there is no error. If colored red, an error has occurred.

CHAPTER 13

IXIA 10 Gigabit Ethernet Load Modules

This chapter provides details about 10 Gigabit Ethernet (10GE) family of load modules the specifications and features.

The 10 Gigabit Ethernet (10GE) family of load modules implements five of the seven IEEE 8.2.3ae compliant interfaces that run at 10Gbit/second. Cards are available which offer the following interfaces:

- 10GE LAN
- 10GE WAN
- XENPAK - with options for XPAK or X2 transceiver use.

The following figure shows an LM10GEXENPAK module.

Figure: LM10GEXENPAK

In addition, two families of multimode card are available which offers combined 10GE LAN/WAN, OC192 POS, BERT, and FEC functionality.

The full details for these families may be found at:

LSM 10GE Family

The Ixia 10 Gigabit Ethernet LAN Service Module (LSM) offers unprecedented scalability, performance, and service testing flexibility. The Ixia 10GE LSM is Ixia's third-generation 10 Gigabit Ethernet solution. It is the industry's first six-port solution, and it offers a broad portfolio of edge/core testing solutions for the most demanding test environments including performance, scalability, and conformance testing of Layer 2-3, Routing Protocols, and high performance Layer 4-7 testing. It supports IPv4 and IPv6 wire-speed traffic generation, advanced analysis and IPv4 and IPv6 routing protocol emulation.

The Ixia 10GE LSM supports a comprehensive portfolio of service testing solutions for the next-generation service provider networks including Metro Ethernet E-LAN and E-LINE services; and MPLS VPNs such as Layer 2 VPNs, Layer 3 RFC 2547 VPNs, and VPLS.

Figure: LSM10GMS-01(MACsec Carrier Card)

Part Numbers

The LSM family part numbers are shown in the following table.

10GE LSM modules

Load Module	Part Number	Description
10GE LSM	LSM10G1-01	1-port 10GE, single slot, full-featured load module. Supports routing protocols, Linux SDK, and L4-7 applications (requires XENPAK or XFP adapter and matching transceiver).
10GE LSM	LSM10GMS-01	1-port 10GE, single slot, full-featured load module.

Load Module	Part Number	Description
MACSec		Supports routing protocols, Linux SDK, and L4-7 applications. Supports MACSec functionality for stream generated traffic. XFP LAN/WAN carrier card is integrated.
10GE LSM XMR810GE LSM XMR8 10GBASE-T	LSM10GXMR8-01LSM10GXMR8GBT-01	NGY 8-port 10GE, 400MHz, 128MB single slot, reduced L2/3 support with limited L3 routing, Linux SDK, and L4-7 applications.Includes 10GBASE-T version.
10GE LSM XM8XP10GE LSM XM8 10GBASE-T	LSM10GXM8XP-01 LSM10GXM8GBT-01	NGY 8-port 10GE, 800MHz, 1GB, Extra Performance. Includes 10GBASE-T version.
10GE LSM XM8S	LSM10GXM8S-01	NGY 8-port 10GE, LAN/WAN, SFP+ interface with 1GB RAM per port. Requires one or more SFP+ transceiver options: 10GBASE-SR, 10GBASE-LR, 10GBASE-LRM, or 10GSFP+Cu.
10GE LSM XMR8S	LSM10GXMR8S-01	Same as 10GE LSM XM8S but reduced L2/3 support with limited L3 routing.
NGY-NP8-01	NGY-NP8-01	10 Gigabit Application Network Processor Load Module, 8-Port LAN/WAN, SFP+ interface.
10GE LSM XMR410GE LSM XMR4 10GBASE-T	LSM10GXMR4-01LSM10GXMR4GBT-01	NGY 4-port 10GE, 400MHz, 128MB, single slot, reduced L2/3 support with limited L3 routing, Linux SDK, and L4-7 applications.Includes 10GBASE-T version.
10GE LSM XM4XP10GE LSM XM4 10GBASE-T	LSM10GXM4XP-01LSM10GXM4GBT-01	NGY 4-port 10GE, 1GHz, 1GB, Extra Performance. Includes 10GBASE-T version.
10GE LSM XM4S	LSM10GXM4S-01	NGY 4-port 10GE, LAN/WAN, SFP+ interface with 1GB RAM per port. Requires one or more SFP+ transceiver options: 10GBASE-SR, 10GBASE-LR, 10GBASE-LRM, or 10GSFP+Cu.
10GE LSM XMR4S	LSM10GXMR4S-01	Same as 10GE LSM XM4S but reduced L2/3 support with limited L3 routing.
NGY-NP4-01	NGY-NP4-01	10 Gigabit Application Network Processor Load Module, 4-Port LAN/WAN, SFP+ interface.
10GE LSM XM2XP10GE	LSM10GXM2XP-01LSM10GXM2GBT-01	NGY 2-port 10GE, 1GHz, 1GB, Extra Performance. Includes 10GBASE-T version.

Load Module	Part Number	Description
LSM XM2 10GBASE-T		
10GE LSM XMR210GE LSM XMR2 10GBASE-T	LSM10GXMR2-01LSM10GXMR2GBT-01	NGY 2-port 10GE, 400MHz, 128MB, single slot, reduced L2/3 support with limited L3 routing, Linux SDK, and L4-7 applications.Includes 10GBASE-T version.
10GE LSM XM2S	LSM10GXM2S-01	NGY 2-port 10GE, LAN/WAN, SFP+ interface with 1GB RAM per port. Requires one or more SFP+ transceivers: 10GBASE-SR, 10GBASE-LR, 10GBASE-LRM, or 10GSFP+Cu.
10GE LSM XMR2S	LSM10GXMR2S-01	Same as 10GE LSM XM2S but reduced L2/3 support with limited L3 routing.
NGY-NP2-01	NGY-NP2-01	10 Gigabit Application Network Processor Load Module, 2-Port LAN/WAN, SFP+ interface.
XENPAK-ADAP-01	948-0007	XENPAK LAN Adapter for LSM10Gx1-xx.
XFP-ADAP-02	948-0002	LAN/WAN Adapter for LSM10Gx1-xx
X2-ADAP-01	948-0008	X2 Carrier
10GBASET-ADAP-01	948-0009	10GBase-T Adapter for LSM10Gx1-xx
SFP-ADAP-01	948-0012	SFP+ Adapter for LSM10G1 and LSMGL1, must be used with an SFP+ transceiver.
SFP+ transceiver 10GBASE-SR	948-0013	10GBASE-SR Accessory, SFP+ Transceiver for 10GE LAN/WAN load modules with pluggable SFP interface, 850nm.
SFP+ transceiver 10GBASE-LR	948-0014	10GBASE-LR Accessory, SFP+ Transceiver for 10GE LAN/WAN load modules with pluggable SFP interface, 1310nm.
SFP+ transceiver 10GBASE-LRM	948-0015	10GBASE-LRM Accessory, SFP+ Transceiver for 10GE LAN load modules with pluggable SFP+ interface, 1300nm, MMF. NOTE LAN mode is not supported.
SFP+ transceiver 10GSFP+Cu	948-0016	10GSFP+Cu Accessory, Direct Attach Cable Transceiver for 10GE LAN/WAN load modules with pluggable SFP+ interface, Copper Wire, 3 meter length.

Load Module	Part Number	Description
10GE LSM XM8NGY	944-1070-01	LSM10GXM8NG-01 10 Gigabit Ethernet Load Module, 8-Port LAN/WAN, XFP interface
10GE LSM XM4NGY	944-1071-01	LSM10GXM4NG-01 10 Gigabit Ethernet Load Module, 4-Port LAN/WAN, XFP
10GE LSM XM2NGY	944-1096-01	LSM10GXM2NG 10 GIGABIT ETHERNET LOAD MODULE, 2-Port LAN/WAN, XFP

10GE LSM Load Module Specifications (except NGY)

	LSM10G1-01	LSM10GMS-01
# ports	1	1
Data Rate	10GB	10GB
Port CPU Speed	1GHz (G1)500MHz (GL1)	1GHz
Port CPU Memory	512MB (G1)128MB (GL1)	512MB
Connector/Frequency-Mode	XFP or XENPAK/X2. See XENPAK Connectors 10GBase-T Adapter, see Removable Carrier Cards Also XFP-CX4 and SFP-CX4	Integrated XFP LAN/WAN carrier card Also XFP-CX4
Ambient Operating Temp. Range	41ºF to 95º(5ºC to 35ºC)	41º to 95º (5ºC to 35ºC)
Capture buffer size	Up to 384 MB	Up to 384 MB
Captured packet size	17-65,535 bytes	17-65,535 bytes
Streams per port	256	256
Advanced streams	256	256
Preamble size: min-max	8	8
Frame size: min-max (bytes)	17-65,535	17-65,535
Inter-frame gap: min-max[3]	4.0ns - 42sec in 3.2ns steps	4.0ns - 42sec in 3.2ns steps
Inter-burst gap: min-max	4.0ns - 42sec in 10.0ns steps	4.0ns - 42sec in 10.0ns steps

	LSM10G1-01	LSM10GMS-01
Inter-stream gap:min-max	4.0ns - 42sec in 10.0ns steps	4.0ns - 42sec in 10.0ns steps
Normal stream frame rate	0.023fps - full line rate	0.023fps - full line rate
Advanced stream min frame rate[4]	Slow: 0.023fpsFast: 1525fps	Slow: 0.023fpsFast: 1525fps
Latency[5]	20ns resolution	20ns resolution The `No CRC' option is not supported.
Table UDF Entries	1M (full)32K (reduced)	1M
Max Value List UDF entries	G1:512K entries GL1:8K entries	512K entries
Max Range List UDF entries	G1:256 entries GL1:16 entries	

[1]The LSM10GMXR3-01 only supports IxNetwork, IxAutomate, and IxExplorer.

[2]Packet gap size also depends on the stream mode selected Fixed or Average.

[3]Streams are divided up into two categories: 224 slow speed streams and 32 fast streams.

[4]Cancel Intrinsic Latency feature measures and/or removes the latency induced by the test equipment (not the DUT). See Intrinsic Latency Adjustment.

Load Module Specifications

Feature	Extra Performance	Reduced Performance
Load Modules	LSM10GXM8XP LSM10GXM4XP LSM10GXM2XP LSM10GXM8S LSM10GXM4S LSM10GXM2S LSM10GXM8GBT LSM10GXM4GBT LSM10GXM2GBT	LSM10GXMR8 LSM10GXMR4 LSM10GXMR2 LSM10GXMR8S LSM10GXMR4S LSM10GXMR2S LSM10GXMR8GBT LSM10GXMR4GBT LSM10GXMR2GBT
Number of ports per module	8/4/2	8/4/2
Line rate	10 Gb/s	10 Gb/s

Feature	Extra Performance	Reduced Performance
Number of chassis slots per module	1	1
Maximum ports per chassis		
Supported transceivers (optical and copper) NOTE The NGY family of load modules can support transceivers that use up to 2.5W of power. Do not use transceivers beyond 2.5W.	XFP, SFP+, RJ-45 10GBASE-T	XFP, SFP+, RJ-45 10GBASE-T
Per-port CPU speed and memory	1 GHz, 1 GB[2]	400 MHz/128 MB
Per-port capture buffer	512 MB	64 MB
Captured packet size	17 bytes absolute minimum frame size64 bytes minimum frame size at line rate	
Frame size	Minimum: 48 bytes Maximum: 16,000 bytes	For LSM10GXMR8, LSM10GXMR4 LSM10GXMR2 Minimum Frame Size at Line Rate: 48 Minimum Frame Size - may not be at Line Rate: 48 Maximum Frame Size: 4Q: 9216 8 + 1Q: P0: 9216B others 2500B
Interface protocols	10 GE LAN/WAN	10 GE LAN/WAN
Layer 2/3 routing protocol emulation	Yes	Yes
Layer 4-7 application traffic testing	Yes	No

Feature	Extra Performance	Reduced Performance
Number of transmit flows per port (sequential values)	Billions	Billions
Number of transmit flow per port (arbitrary values)	1 million	32 K
Number of trackable receive flows	1 million	64K
Number of stream definitions per port	512	512
	In packet stream (sequential) or advanced stream (interleaved) mode, each stream definition can generate millions of unique traffic flows.	
Preamble size: min-max	8	8
Inter-frame gap: min-max	3.2ns - 27.48sec in 3.2ns steps	3.2ns - 27.48sec in 3.2ns steps
Inter-burst gap: min-max	3.2ns - 27.48sec in 3.2ns steps	3.2ns - 27.48sec in 3.2ns steps
Inter-stream gap:min-max	3.2ns - 27.48sec in 3.2ns steps	3.2ns - 27.48sec in 3.2ns steps
Normal stream frame rate	0.023fps - full line rate	0.023fps - full line rate
Advanced stream min. frame rate	Slow: 0.023fpsFast: 1525fps	Slow: 0.023fpsFast: 1525fps
Number of streams in Packet Stream Mode (Non Data Center Mode)	512	512
Number of streams in Advanced Scheduler Mode (Non Data Center Mode)	Fast: 32Slow: 480	Fast: 32Slow: 480
Number of streams in Advanced Scheduler Mode (Data Center Mode)	Fast: 32Slow: 224	Fast: 32Slow: 224
Table UDF	1 million entries	32 K
	Comprehensive packet editing function for emulating large numbers of sophisticated flows. Entries of up to 256 bytes, using lists of values can be specified and placed at designated offsets within a stream. Each list consists of an offset, a size and a list of values in a table format.	

Feature	Extra Performance	Reduced Performance
Max Value List UDF entries	512K entries for 32-bit and 24-bit, 1M entries for 8 and 16-bit.	256K entries for 32-bit and 24-bit, 512K entries for 8 and 16-bit.
Max Range List UDF entries	512 entries	256 entries
Packet flow statistics	Track 1 million flows	Track 64 K flows
Transmit engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures	
Receive engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, data integrity, and sequence checking	
User defined field features	Fixed, increment or decrement by user-defined step, value lists, range lists, cascade, random, and chained.	
Filters	48-bit source/destination address, 2x128-bit user-definable pattern and offset, frame length range, CRC error, data integrity error, sequence checking error (small, big, reverse)	
Data field per stream	Fixed, increment (byte/word), decrement (byte/word), random, repeating, user-specified.	
Statistics and rates (counter size: 64 bits)	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), user-defined stat 5, user-defined stat 6, 8 QoS counters, data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and ping requests and replies.	
Error generation	CRC (good/bad/none), undersize, oversize.	
Latency measurements	20 ns standard 10 ns user-selectable	
Latency self-calibration	Ability to calibrate and remove inherent latency from any MSA-compliant 10GbE XFP transceivers, including unsupported transceivers.	
Transmit line clock adjustment	Ability to adjust the parts per million (ppm) line frequency over a range of: • LAN mode: -105 to +105 ppm[3] • WAN mode: -30 to +30 ppm	

Feature	Extra Performance	Reduced Performance
IPv4, IPv6, UDP, TCP	Hardware checksum generation and verification.	
Frame length controls	Fixed, random, weighted random, or increment by user-defined step, random, weighted random.	
Operating temp. range	41°F to 95°F (5°C to 35°C), ambient air[4]	

[2]The LSM10GXM8XP, LSM10GXM8S, and LSM10GXM8GBT use a high performance 800MHz processor with additional layer 2 cache.

[3]For 10GBASE-T interfaces on NGY the ppm does change the data rate, but does not change the bit period due to phy chip limitations.

Port LEDs

The NGY 10GBASE-T load module has only 2 port LEDs:

- Rx/Error: Same as Rx/Error in the following table
- Tx/Link: Combines the Link and Tx/Pause functions. Solid green = link; blinking green = transmit; red = flow control.

Each 10GB port incorporates a set of LEDs, as described in the following figure.

10GE LSM Port LEDs

LED Label	Usage
Link	Green if Ethernet link is up (established) or the port is in a forced Link Up state, red if link is down. Link may be down due to no signal or no PCS lock.
Tx/Pause	Green while data is transmitted. Red while flow control frames are received. Off if no traffic is passing in either direction. NOTE For NGY load modules LSM10GXM(R)8 and LSM10GXM(R)4: green indicates that Tx is active and frames being sent; red indicates Tx is paused; off indicates Tx is not active.
Rx/Error	Green while data is received. Red on any Ethernet error. Off if no frames are received. NOTE For NGY load modules LSM10GXM(R)8 and LSM10GXM(R)4: green indicates valid Rx frames are being received; red indicates error frames being received; off indicates no frames being received.
LASER ON	Green when the port's laser is turned on. Off otherwise.
Detect	Green when valid plug in module is detected, red otherwise.
Power	Green when power is on, red if power fault occurs.
Option1/2	N/A

LED Label	Usage
Trigger	See Trigger Out Values.

Clock In/Out

The load module provides coaxial connectors for clock input and clock output to allow the DUT to phase-lock with the interface. When running off an external clock, the clock input signal must meet the requirements listed in the following figure to ensure proper performance of the load module.

The clock in/out electrical interface parameters are also defined in the following figure.

Clock In/Out Electrical Interface Parameters

Parameter		Characteristic
ClockInput	Frequency	156.25 MHz ±100ppm
	Duty cycle	50%
	Jitter	±150ps max. cycle to cycle, >1kHz
	Amplitude	Recommended: 800mV Minimum: 150mV Maximum: 1200mV
	Impedance	50 ohm ± 5%, DC coupled
	Connector	Female SMA
ClockOutput	Frequency	156.25MHz +/-105PPM (Programmable PPM in Internal Clock Mode) and variations: 156.25MHz (LAN) or 155.52MHz (WAN) +/-30PPM (Programmable PPM in Internal Clock Mode)
	Duty cycle	40 to 60%
	Jitter	20ps max cycle to cycle, >1kHz
	Amplitude	0.7Vpp min into 50 ohms, AC coupled output
	Edge rates	200ps to 340ps (20% to 80%) into 50 Ohms
	Impedance	50 ohms +/-5%, AC coupled
	Connector	Female SMA

The load module contains a phase-locked loop (PLL) that reduces the jitter of the input clock, either from the internal or external clock source. The bandwidth of the PLL is approximately 1 kHz.

Trigger Out Values

The signals and LEDs available on the trigger out pins for these cards are described in the following table.

10GE LAN Trigger Out Signals

Pin/LED	Value
Trigger Out	Single ended output that pulses high for approximately 1.18s shortly after the Central FPGA is loaded, and following an event defined by UDS1. Voltage output = 3.3V for high, 0V for low.
Trigger LED	Pulses following an event defined by UDS1.

Removable Carrier Cards

The 10GE10G1-01 load modules has removable carrier cards available for use:

- The XENPAK-ADAP-01 carrier card for XENPAK transceivers, shown in the figure - XENPAK-ADAP-01 Carrier Card.
- The XFP-ADAP-02 LAN/WAN carrier card for XFP transceivers (shown being inserted into the LSM load module in the figure - XFP-ADAP-02 Carrier Card.
- X2 carrier card for X2 Transceiver (shown with transceiver installed in the figure - Carrier Card with X2 Transceiver).
- 10GBase-T-ADAP-01 10 Gigabit Ethernet adapter module (shown in the figure - 10GBase-T Adapter Module)

Figure: XENPAK-ADAP-01 Carrier Card

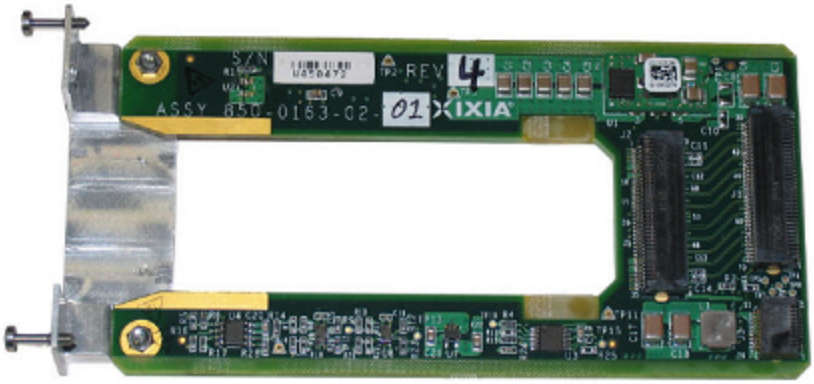


Figure: Carrier Card with X2 Transceiver

Figure: XFP-ADAP-02 Carrier Card

Figure: 10GBase-T Adapter Module

Carrier Card Installation

To install the carrier card, do the following:

1. Insert the card into the opening in the 10GE LSM module.
2. Slide the card along the guide rails until it connects to the load module.
3. Tighten the screws so that the carrier card is firmly in place. Do not over tighten the screws (no more than a quarter turn once flush with the card front).

The carrier card can be installed either before or after the load module is connected to the chassis. It is best not to attach the transceiver to the carrier card until the card is installed in the load module. Load modules should be screwed down in the chassis before removing or installing a carrier card, to prevent from accidentally dislodging a load module from the chassis backplane.

NOTE The carrier cards do not come with the required transceivers. They must be purchased separately.

XENPAK Connector

The LSM10G1-01 load module has XENPAK connector available. See XENPAK Connector above for more information on XENPAK connectors.

These connectors are only applicable when the XENPAK carrier is being used.

Statistics

Statistics for 10GE LSM cards (except NGY), under various modes of operation may be found in Statistics for 10GE LSM Modules (except NGY). Statistics for NGY load modules may be found in Statistics for NGY Modules.

NGY Fault Handling

IEEE Requirements

IEEE 802.3ae, section 46.3.4 defines how a Reconciliation Sublayer (RS) shall respond to Local and Remote Faults. Response to a Local Fault is to immediately cease sending traffic on the transmit data

path (even if doing so truncates a frame) and to send continual Remote Faults. Response to a Remote Fault is to stop sending MAC data (completing any frame that is being transmitted) and to send continual idles.

NGY Operation

NGY load modules have a single statistic for Faults called Link Fault State. This statistic is real-time and indicates the current state of the port's Reconciliation Sublayer (RS) state machine. The possible statistics values are:

- No Fault
- Local Fault
- Remote Fault

Features that force deviation from IEEE spec

NOTE In general, if a NGY port appears to be transmitting according to the Frames Sent statistic, be aware that Link Fault State may override this.

Tx Ignores Rx Link Faults

This feature is enabled through the **Link Fault Signaling** tab of Port Properties. When the feature is enabled, the Fault statistic continues to indicate the RS state of the port; however, the transmit-side response behaves as if no fault was received. That is to say, Remote Faults are not sent as a response to Local Fault and Idles are not forced as a response to Remote Fault, even though Link Fault State indicates the board is in a Fault state.

Transmit Ignores Link Status

This feature is enabled through the Transmit Modes tab of Port Properties. When the feature is enabled, a port is permitted to transmit under conditions that would normally inhibit transmit. For instance, a port that has no link and is not in diagnostic loopback appears in IxExplorer as red color, and is normally not permitted to transmit. Enabling this feature allows transmit. When the feature is enabled, the statistic called Link State indicates `Ignore Link'.

Note that if the port is in Fault, enabling this feature and forcing transmit may result in misleading results. The port shown in the following stat view (See the following figure) is ignoring link (see Link State statistic), is in Remote Fault (see Link Fault State statistic), yet appears to be transmitting (see Frames Sent Rate statistic). The reality is that no frames are actually leaving the port because the port is in Remote Fault. This is because the block that maintains the transmit statistics is located before the block that forces idles as a response to Remote Fault.

Figure: Statistic View for NGY, Ignore Link Status

	A	B
1	Name	loopback:02.01
2	Link State	Ignore Link
3	Line Speed	10GE LAN
4	Frames Sent	164,624,279
5	Frames Sent Rate	14,880,954
6	Valid Frames Received	0
7	Valid Frames Received Rate	0
8	Bytes Sent	10,535,953,80
9	Bytes Sent Rate	952,380,945
10	Bytes Received	0
11	Bytes Received Rate	0
12	Fragments	0
13	Undersize	0
14	Oversize	0
15	CRC Errors	0
16	Link Fault State	Remote Fault
17	Scheduled Transmit Duration	0 : 0: 0.0
18	Bytes Sent / Transmit Duration	21,740,528
19	Bits Sent	84,287,630,43
20	Bits Sent Rate	7,619,047,560
21	Bits Received	0
22	Bits Received Rate	0
23	Central Chip Temperature(C)	45
24	Port Chip Temperature(C)	45
25	Port CPU Status	Ready
26	Port CPU DoD Status	Ready

Intrinsic Latency Adjustment

This option, when present and enabled, reduces the measured latency by the amount of latency that is induced by the test equipment itself (not the DUT). For a specific transceiver, the system retrieves its pre-determined latency value and subtracts this from the measured overall latency. For an `unknown' transceiver (not previously measured), it calculates and stores the intrinsic latency value.

On the **General** tab in **Port Properties**, the **Latency Calibration** option is only enabled for cards with transceivers that have not been pre-measured for intrinisic latency by Ixia. The **Latency Calibration** option is grayed-out if any one of the following conditions are present:

- There is no carrier.
- There is no transceiver.
- The transceiver is XENPAK or X2 and a value is found for it in the list of pre-calibrated values.

The **Latency Calibration** option is enabled if the transceiver is XENPAK or X2 but no pre-calibrated value is found in the stored list. The **Latency Calibration** option is also enabled for transceivers that you have previously calibrated, so that the calibration measurement may be repeated (if desired).

Selecting the **Latency Calibration** option runs a Tcl script that measures intrinsic latency and stores the value in an .xml file. The .xml file contains the values that you have produced and saved. Each value is identified for a specific transceiver (per manufacturer, model, and serial number). You can run the calibrate process repeatedly with the same transceiver (if desired). Each new measurement overwrites the previous one for that transceiver.

Running the calibration measurement puts the port into a special loopback mode to measure intrinsic latency. When done, the port is put back into default normal mode. Any port configuration you have set before calibrating intrinsic latency, is lost as the port reverts to a default configuration.

The **Enable** check box is grayed out when no value exists in the system for the specific transceiver. If a value exists (in the .xml file) then the **Enable** check box is available. Select the check box to enable the intrinsic latency adjustment.

After the intrinsic latency adjustment has been done, you may want to refresh the chassis or close and reopen the Port Properties dialog.

NOTE The LSM10GMS-01 load module always compensates for intrinsic latency it is not optional. Also, this load module does not support the'No CRC' option. Any imported stream with No CRC enabled is Forced Valid to `Bad CRC'.

MDIO

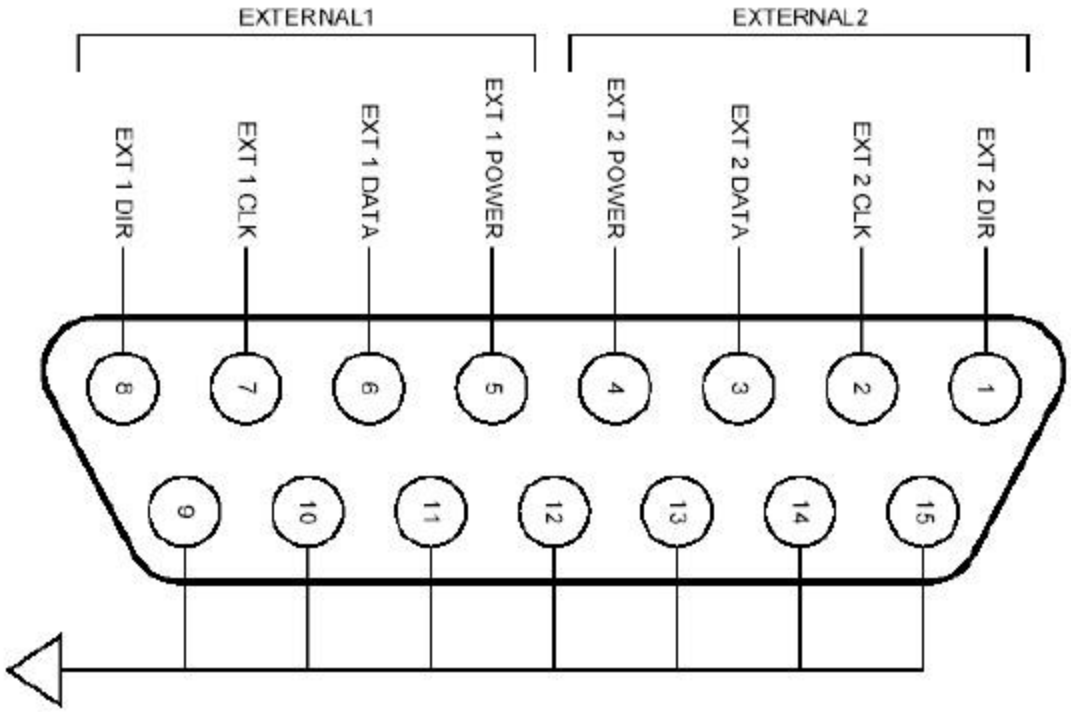
A Management Data Input/Output (MDIO) interface is provided to you. The Ixia Load Module acts as the Station Management entity (STA), and can control one or more MDIO Manageable Devices (MMD) in the users system. Multiple MMDs can be attached to the interface. You can set/read the MDIO control/status registers inside a MMD through a graphical user interface.

The connector used for the MDIO interface is a 15-pin female D-sub and provides with the ability to add up to two external Mii interfaces compliant to either 802.3 clause 22 or 802.3ae clause 45. The connector pin assignments, Mii Interface, signal names, and functional descriptions are listed in the following table.

MDC/MDIO Connector Pin Assignments

Pin No.	Mii Interface	Signal Name	Functional Descriptin
1	External 2	DIR	Data direction control.
2	External 2	MDC	Clock.
3	External 2	MDIO	Bi-directional data.
4	External 2	+5V	+5Vdc supply.
5	External 1	+5V	+5Vdc supply.
6	External 1	MDIO	Bi-directional data.
7	External 1	MDC	Clock.
8	External 1	DIR	Data direction control.
9-15	GND	GND	Ground

Figure: MDC/MDIO D-sub Connector Pin Assignments



NOTE The MDIO on the Ixia XAUI Load Module is 3.3V while the Ixia XENPAK Load Module, when used with the adapter for XAUI, is 1.2V. The reason for the difference is that the XENPAK MSA requires 1.2V for MDIO whereas most XAUI SerDes chips require 3.3V (LVTTL). Therefore, when using the XAUI Load Module to test a XENPAK transceiver or SerDes, which require 1.2V, a level shifter is needed to convert 3.3V to 1.2V.

The MDIO/MDC interface has a clock line (MDC) and bi-directional data line (MDIO) as defined in IEEE 802.3ae. In addition to these, a +5Vdc supply, and data direction control line (DIR) are provided to make interfacing easier for you. The +5Vdc output is intended to power buffers and/or optocouplers at the user-end of the cable. This supply can be turned ON or OFF under software control through the GUI.

The +5Vdc supply is OFF when the chassis is initially powered-up, or following a reset.

Statistics

Statistics for 10GB cards, under various modes of operation may be found in Statistics for 10GE Modules with BERT and Statistics for 10G UNIPHY Modules with BERT.

XENPAK Family

The LM10GE700P3 family is referred to as the XENPAK load modules. Each card accepts a XENPAK transceiver, or with an appropriate carrier card accepts an XPAK or X2 transceiver. Five variants are available, which feature Ethernet and/or BERT modes and full or manufacturing mode.

Part Numbers

The XENPAK family part numbers are shown in the following table.

10GE XENPAK Modules

Load Module	Part Number	Description
Transceivers	XENPAK-LR	XENPAK Transceiver - 1310nm LAN, 10GBASE-LR
	XENPAK-SR	XENPAK Transceiver - 850nm LAN, 10GBASE-SR
	XENPAK-ER	XENPAK Transceiver - 1550nm LAN, 10GBASE-ER
	XENPAK-CX4	XENPAK Transceiver - CX4 Interface (10GBASE-CX4)
Cables	CAB10GE-CX4	CX4-to-CX4 cable, 1 meter
	CX410GE500	CX4 to XENPAK adapter

Specifications

The limitations of -M, Layer 2/3 and Layer 7 cards are discussed in Ixia Load Modules.

10GB Load Module Specifications Part 3

	10GBASE (XENPAK)
# ports	1
-M Card Available	Y
Layer2/Layer3 Card Available?	N
Layer 7 Card Available	N
Data Rate	10GB
Connector/Frequency-Mode	See XENPAK Connectors
Capture buffer size	32MB
Captured packet size	24-65,000 bytes
Streams per port	255, 32 (-M version)
Advanced streams	160
Preamble size: min-max	8
Frame size: min-max	24-65,000
Inter-frame gap: min-max	4.0ns - 42sec in 3.2ns steps
Inter-burst gap: min-max	4.0ns - 42sec in 10.0ns steps
Inter-stream gap:min-max	4.0ns - 42sec in 10.0ns steps
Normal stream frame rate	0.023fps - full line rate

	10GBASE (XENPAK)
Advanced stream min frame rate[1]	Slow: 0.023fpsMed: 95fpsFast: 1525fps
Latency	20ns resolution

[1]Streams are divided up into three categories: 144 slow speed streams, 8 medium streams and 8 fast streams.

The -M load modules includes all of the features of the non-M board with the following exceptions:

- No support for routing protocols
- No real-time latency, but timestamps are included
- 32 streams in packet stream mode
- 16 streams in advanced scheduler mode
- No configurable preamble

When performing sequence checking, no more than 8192 packet group IDs should be used.

Port LEDs

Each 10GB port incorporates a set of LEDs, as described in the following tables.

10GE XENPAK Port LEDs

LED Label	Usage
Link	Green if Ethernet link has been established, red otherwise. Link may be down due to no signal or no PCS lock.
Tx/Pause	Green while data is transmitted. Red while flow control frames are received. Off if no traffic is passing in either direction.
Rx/Error	Green while data is received. Red on any Ethernet error. Off if no frames are received.
Trigger	See below.
LASER ON	Green when the port's laser is turned on. Off otherwise.

Trigger Out Values

Trigger out values depend on the particular board type.

XENPAK Load Modules

The signals and LEDs available on the trigger out pins for these cards are described in the following table.

10GE XENPAK 1-Slot Trigger Out Signals

Pin/LED	Value
Trigger Out A	Low (0V) on Rx Pause Request, high (+5V) otherwise.
Trigger Out B	Low (0V) on User Defined Statistic 1 true, high (+5v) otherwise.
Trigger LED	Pulses each time a Pause Request is detected.

Clock In/Out

The load module provides SMA coaxial connectors for clock input and clock output to allow the DUT to phase-lock with the interface. When running off an external clock, the clock input signal must meet the requirements listed in the following table to ensure proper performance of the load module.

Reference Clock Input Requirements

Parameter	Characteristic
Frequency	156.25 MHz ±100ppm
Jitter	±150ps max. cycle to cycle, >1kHz
Amplitude	0.9 Vpp minimum, into 50 Ω
Duty cycle	40 to 60%
Edge rates (20% to 80%)	600ps maximum, into 50 Ω

The clock in/out electrical interface parameters are defined in the following table.

Clock In/Out Electrical Interface Parameters

Parameter		Characteristic
Clock Input	Connector	Female SMA
	Impedance	50 ohm ± 5%, DC coupled
	Absolute max input	6V (DC plus half AC peak-to-peak
Clock Output	Connector	Female SMA
	Impedance	50 ohm ± 5%, AC coupled
	Amplitude	0.9 Vpp minimum, into 50 Ω. (1.5 Vpp typical)
	Edge rates	200ps to 340ps (20% to 80%) into 50Ω
	Duty cycle	45% to 55%
	Jitter	20ps max cycle to cycle, >1kHz
	Frequency	156.25 MHz ±20ppm (internal clock mode)

The load module contains a phase-locked loop (PLL) that reduces the jitter of the input clock, either from the internal or external clock source. The bandwidth of the PLL is approximately 1kHz.

XENPAK Connectors

Power Sequencing Specification

The Xenpak 2.1 MSA does not specify any particular power sequencing for the various Xenpak power supply rails (3.3V, 5V, and APS).

When Xenpak Power is enabled, power sequencing is as follows:

- The 5V rail comes up first, with a ramp-up time of approximately 2.25 ms.
- The 3.3V and APS rails both start to come up about 500 us after 5V rail is up.
    - The 3.3V supply has a ramp-up time of approximately two milliseconds.
    - The APS supply ramp-up time varies, according to level required by APS Set resistor, but will be no more than two milliseconds. When no Xenpak module is inserted into the Load Module, APS voltage is less than 150 mV.

Reset

Hardware asserts a Reset by bringing Xenpak connector pin 10 low whenever either of the following conditions is true:

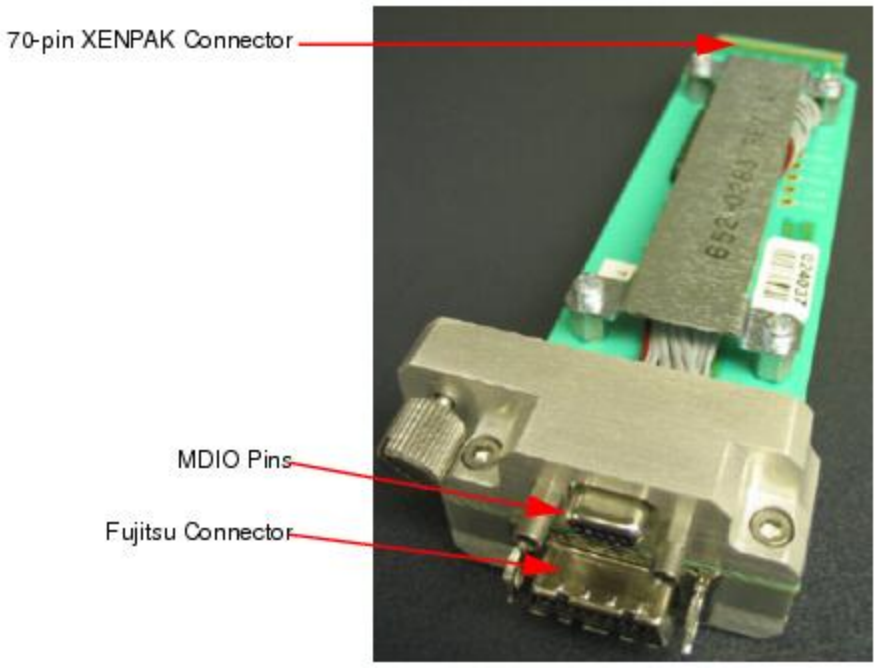
- The Xenpak module is not inserted into the load module; that is, Xenpak pin 14 is high.
- Xenpak power is turned off.

The hardware continues to assert Reset until both of these items are false. Once Xenpak Power is asserted, or if a Xenpak is hot-plugged, the system waits 5 seconds for Xenpak initialization (per MSA 2.1). Reset is then de-asserted, and the system waits an additional 500 ms for any vendor-based reset management to complete initialization. After this final 500 ms delay, the load module assumes the Xenpak module is ready for MII access or to transmit and receive.

XAUI Fujitsu to XENPAK Adapter

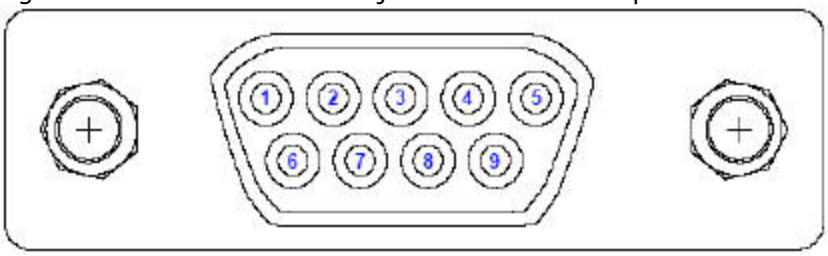
The XAUI Fujitsu to XENPAK Adapter (P/N FXN10GE500) is shown in the figure below.

Figure: XAUI Fujitsu to XENPAK Adapter



The MDIO pins are pictured and described in the following figure and table below.

Figure: MDIO Pins for XAUI Fujitsu to XENPAK Adapter



MDIO Pin Assignments for XAUI Fujitsu to XENPAK Adapter

Pin	Signal
1	PU-5V
2	PU-3.3V
3	PU-APS
4	LASI (GND)
5	RESET
6	TX ON/OFF
7	MDIO
8	MDC

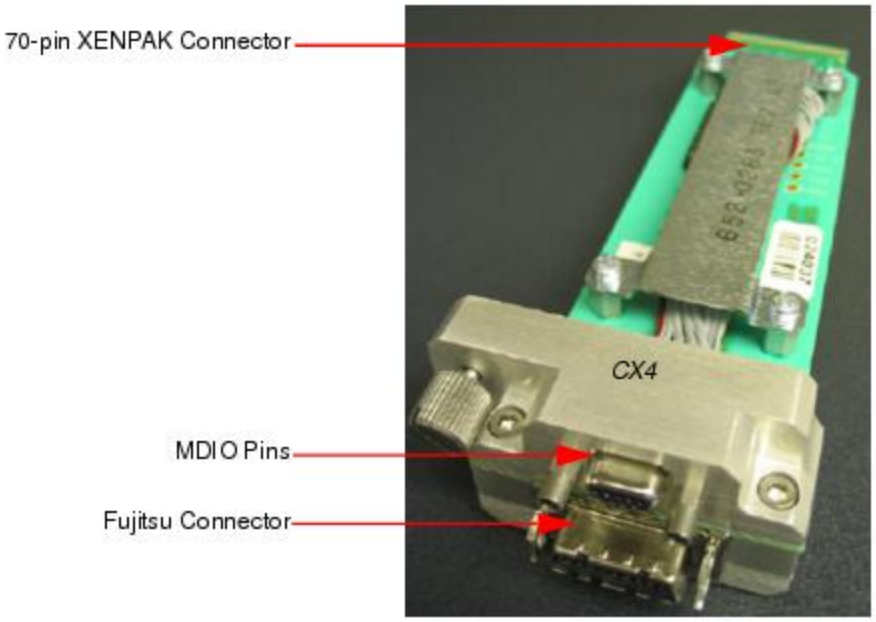
Pin	Signal
9	GND

This MDIO pinout is the same for the CX4 to XENPAK adapter (P/N CX410GE500).

CX4 to XENPAK Adapter

The CX4 to XENPAK Adapter (P/N CX410GE500) is shown in the following figure.

Figure: CX4 to XENPAK Adapter



The MDIO pins are pictured and described in the figure and table.

Statistics

Statistics for 10GB cards, under various modes of operation may be found in Statistics for 10GE Modules with BERT and Statistics for 10G UNIPHY Modules with BERT.

CHAPTER 14

IXIA Xcellon-Flex Load Modules

This chapter provides details about Xcellon-Flex family of load modules specifications and features.

The Xcellon-Flex family of high speed load modules delivers high-density, high-performance test solutions. Xcellon, the architecture behind these load modules, features aggregation of multi-core CPUs and high memory to meet testing needs for high-scale performance.

The Xcellon-Flex family consists of the following load modules:

- 10GbE Accelerated Performance
- 10GbE Full Emulation
- A 10/40 Gigabit Ethernet Accelerated Performance
- A 40 Gigabit Ethernet Full Emulation

The card names are FlexAP10G16S, FlexFE10G16S, FlexAP1040SQ, and FlexFE40QP.

The Accelerated Performance load module provides architecture for layer 2-7 performance testing, providing ultra-high-scale session and protocol emulation per port. The Full Emulation load module is for layer 2-3 mid-range protocol emulation and scale capacity testing for switches and routers. The Xcellon-Flex Combo 10/40GE Accelerated Performance load module provides both 10GE SFP+ and/or 40GE QSFP+ ports in a single chassis slot. It uses aggregation technoloAgy to combine CPU power and memory, and provides ultra-high networking protocol scalability. The 4x40GE Full Emulation load module has a rich layer 2-7 feature set and is well suited for mid-range protocol emulation and scale testing. The load module is ideal for manufacturers of large-port-count, converged data center switches.

The Xcellon-Flex family load module is shown in the following figure:

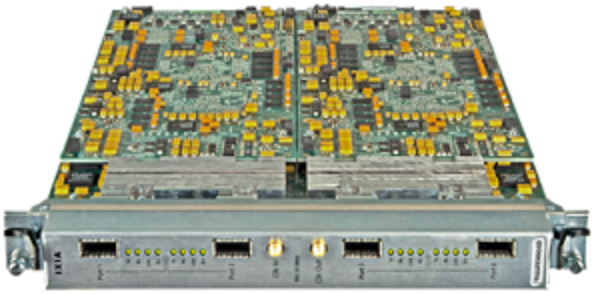
Figure: Xcellon-Flex Module-FlexAP10G16S

The Xcellon-Flex family load module is shown in the following figure:

Figure: Xcellon-Flex Module-FlexFE10G16S

Figure: Xcellon-Flex Module-FlexAP1040SQ

Figure: Xcellon-Flex Module-FlexFE40QP



Part Numbers

The part numbers are shown in the following table.

Part Numbers for Xcellon-Flex Modules

Model Number	Part Number	Description
FlexAP10G16S	944-1060	10 Gigabit Ethernet Accelerated Performance Load Module, 16-Port LAN, SFP+ interface with full performance L2-L7 support.
FlexFE10G16S	944-1061	10 Gigabit Ethernet Full Emulation Load Module, 16-port LAN, SFP+ interface with L2-3 support.
FlexAP1040SQ	944-1062	10/40 Gigabit Ethernet Accelerated Performance Load Module, 16-Ports of SFP+ interfaces and 4-ports of QSFP+ 40GE interfaces with full performance L2-7 support, requires one or more SFP+ transceiver options: 10GBASE-SR/SW (948-0013), or 10GBASE-LR/LW (948-0014).
FlexFE40QP	944-1065	40 Gigabit Ethernet Full Emulation Load Module, 4-ports of QSFP+ 40GE with L2-3 support.

Specifications

The load module specifications are contained in the following table.

Xcellon-Flex Load Module Specifications

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
Load Modules	FlexAP10G16S	FlexFE10G16S	FlexAP1040SQ	FlexFE40QP
Number of ports per module	16	16	4	4
Number of chassis slots per module	1	1	1	1
XGS12-SD Chassis (940-0011)	12 load modules: 192-ports of 10GbE	12 load modules: 192-ports of 10GbE	12 load modules: • 192-ports of 10GbE • 48-ports of 40GbE	12 load modules: 48-ports of 40GbE
XGS12-HSL Chassis (940-0016)	12 load modules: 192-ports of 10GbE	12 load modules: 192-ports of 10GbE	12 load modules: • 192-ports of 10GbE • 48-ports of 40GbE	12 load modules: 48-ports of 40GbE
XGS12-SDL Chassis (940-0015)	12 load modules: 192-ports of 10GbE	12 load modules: 192-ports of 10GbE	12 load modules: • 192-ports of 10GbE • 48-ports of 40GbE	12 load modules: 48-ports of 40GbE
XGS2-SD Chassis (940-0010)	2 load modules: 32-ports of 10GbE	2 load modules: 32-ports of 10GbE	2 load modules: • 32-ports of 10GbE • 8-ports of 40GbE	2 load modules: 8-ports of 40GbE
XGS2-HSL Chassis (940-0014)	2 load modules: 32-ports of 10GbE	2 load modules: 32-ports of 10GbE	2 load modules: • 32-ports of 10GbE • 8-ports of	2 load modules: 8-ports of 40GbE

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
			40GbE	
XGS2-SDL Chassis (940-0013)	2 load modules: 32-ports of 10GbE	2 load modules: 32-ports of 10GbE	2 load modules: • 32-ports of 10GbE • 8-ports of 40GbE	2 load modules: 8-ports of 40GbE
XG12 Chassis (940-0005)	10 load modules: 160-ports of	10 load modules: 160-ports of 10GbE	10 load modules: • 160-ports of 10GbE • 40-ports of 40GbE	10 load modules: 40-ports of 40GbE
Supported transceivers				
Per-port CPU speed and memory				
Capture buffer size	256 MB	64 MB	256MB (10GE), 1GB(40GE)	256 MB
Frame Size	Minimum Frame Size at Line Rate: 48 - No UDF 60 - UDF enabled Minimum Frame Size - may not be at Line Rate: 48 Maximum Frame Size: P0: 9216B others 2500B	Minimum Frame Size at Line Rate: 48 - No UDF 60 - UDF enabled Minimum Frame Size - may not be at Line Rate: 48 Maximum Frame Size: P0: 9216B others 2500B	Minimum Frame Size at Line Rate: 48 - No UDF 60 - UDF enabled Minimum Frame Size - may not be at Line Rate: 48 Maximum Frame Size: P0: 9216B others 2500B	Minimum Frame Size at Line Rate: 60 Minimum Frame Size - may not be at Line Rate: 60 Maximum Frame Size: P0: 9216B others 2500B
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
	16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	**Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	**Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s
Streams per port	512	256	512	256
Table UDF	1 million entries	256 K entries	1 million entries	1 million entries
Advanced scheduler streams per port	512	256	512	256
Latency	20 ns resolution	20 ns resolution	20 ns resolution	2.5 ns resolution
Ambient Operating Temperature Range	5-30	5-30	5-30	5-30
Transceiver Type	SFP+	SFP+	SFP+	QSFP+
Direct Attach Copper	Yes	Yes	No	Yes
LED	2 LED per Port	2 LED per Port	1 LED per Port	4 LED per Port
ppm Adjust range	+/-100ppm	+/-100ppm	+/-100ppm	+/-100ppm
ppm Adjust port/card	Card	Card	Card	Card
10GbE Interface protocols	10GbE LAN	10GbE LAN	IEEE802.3ae 10GE LAN, IEEE802.3ba 40GBASE-R LAN	IEEE802.3ae 10GE LAN, IEEE802.3ba 40GBASE-R LAN
Data Center Protocol Upgrades	FCoE, Priority-based Flow Control (IEEE 802.1Qbb) and LLDP/DCBX support			Priority-based Flow Control (IEEE 802.1Qbb)

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
(optional feature)				
Multi-core processors	Yes	Yes	Yes	Yes
Aggregation capability	Yes	Yes	Yes	No
Layer 2-3 routing protocol emulation	Yes	Yes	Yes	Yes
Layer 4-7 application traffic testing	Yes	No	Yes	Yes
Number of transmit flows per port (sequential values)	Billions	Billions	Billions	Billions
Number of transmit flows per port (arbitrary values)	1 million	32 K		
Number of transmit flows per port (PGID)			1 million	1 million
Trackable receive flows	1 million	64 K	1 million	64 K
Table UDF	1 million entries	256 K entries	1 million entries	1 million entries
Packet flow statistics	Track 1 million flows	Track 64 K flows		
Transmit engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.			Wire-speed packet filtering, capturing, realtime latency

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
				and inter-arrival time for each packet group, data integrity, and sequence checking.
Receive engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, data integrity, and sequence checking			
User defined field features	Fixed, increment or decrement by user defined step, value lists, range lists (supported in all 10 GE mode), cascade, random, and chained			
Filters	48-bit source/destination address, 2x128- bit user-definable pattern and offset, frame length range, CRC error, data integrity error, and sequence checking error (small, big, reverse)			
Data field per stream	Fixed, increment (byte/word), decrement (byte/word), random, repeating, and userspecified			
Error generation	CRC (good/bad/none), undersize, oversize			
Latency self-calibration	Ability to calibrate and remove inherent latency			
Link Fault Signaling	Link state indicator for No Fault, Local Fault, and Remote Fault.	Link state indicator for No Fault, Local Fault, and Remote Fault.	FlexAP1040SQ (10GE and 40GE): Generate local and remote faults with controls for the number of faults and order of faults, and the ability to select the option to have the transmit port ignore link faults from a remote link partner. FlexAP1040SQ (10GE and 40GE): Reports the following PCS	Generate local and remote faults with controls for the number of faults and order of faults, and the ability to select the option to have the transmit port ignore link faults from a remote link partner.

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
			statistics: • Link Fault State - specifies if the link is in Local fault, Remote fault or No fault • Local Fault count number of link transitions from No fault to Local fault • Remote Fault count - number of link transitions from No fault to Remote fault • Local fault ordered-set count number of local fault ordered set (this is bigger than Local Fault count) • Remote fault ordered-set count - number of remote fault ordered set (this is bigger than Remote Fault count)	
Transmit line clock adjustment	Ability to adjust the parts per million (ppm) line frequency over a range of the following • LAN mode: +/-100 ppm			
IPv4, IPv6,	Hardware checksum generation and verification			

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
UDP, TCP				
Frame length controls	Fixed, random, weighted random, or increment by user-defined step			
Operating temperature range	41°F to 86°F (5°C to 30°C), ambient air			
40 GE Physical Coding Sublayer (PCS) test features				IEEE 802.3ba compliant PCS transmit and receive side test capabilities
Per PCS lane, transmit lane mapping				Supports all combinations of PCS lane mapping: Default, Increment, Decrement, Random, and Custom
Per PCS lane, lane marker, or lane marker and payload error injections				Ability to inject errors into the PCS Lane Marker and simultaneously into PCS Lane Marker and Payload fields by the user. This includes the ability to inject sync bit errors into the Lane Marker and Payload. User can control the PCS lane, number or errors, period count and manage the repetition of the injected errors.
Per PCS lane, receive lanes statistics				PCS Sync Header and Lane Marker Lock, Lane Marker mapping, Relative

Feature	Everest 10GE Full Feature	Everest 10GE Reduced Feature	Everest Combo	Everest 40GE Only
				lane skew measurement (up to 104 microseconds), Sync Header and PCS Lane Marker Error counters, indicators for Loss of Synch Header and Lane Marker, BIP8 errors.

Mechanical Specification of FlexAP10G16S/FlexFE10G16S Load Modules

Front Panel

The Front panel of FlexAP10G16S/FlexFE10G16S load module is shown in the following figure:

Figure: Front panel of FlexAP10G16S/FlexFE10G16S

Led Panel

Led panel of FlexAP10G16S/FlexFE10G16S Load Module Specifications

Feature	Specification
LED1	TX
	10GE Link up = Solid Green
	10GE TX Active = Blinking Green
	10GE TX Error = Blinking Red
	Inactive = Off
LED2	RX
	Loopback = Solid Green
	10GE RX Active = Blinking Green

Feature	Specification
	10GE RX Error = Blinking Red
	Link Down = Solid Red
	Port Inactive = Off

When port is in aggregation mode (the PCPU resource is used by other port), TX/RX LEDs are inactive (i.e. off). The aggregation egress port will have normal TX/RX LED operation.

Mechanical Specification of FlexAP1040SQ Load Modules

Front Panel Production 944-1062-02

The Front panel of FlexAP1040SQ load module is shown in the following figure:

Figure: Front panel of FlexAP1040SQ

Led Panel Production 944-1062-02

The Led panel of FlexAP1040SQ load module is shown in the following figure:

Figure: Led panel of FlexAP1040SQ

Led panel of FlexAP1040SQ Load Module Specifications

Feature	Specification
10GE Mode	1 LED/Port where LED number matches port number
Blinking Green	Tx/Rx Activity
Blinking Red	Rx Error
Solid Red	Link down
Solid Green	Link up
Solid Yellow	Loopback
Off	Port is inactive

When port is in aggregation mode (the PCPU resource is used by other port), TX/RX LEDs are inactive (i.e. off). The aggregation egress port will have normal TX/RX LED operation.

Feature	Specification
40GE Mode	LED/Port aligned from top/down defined as follows: • Tx • Rx • Link • Error

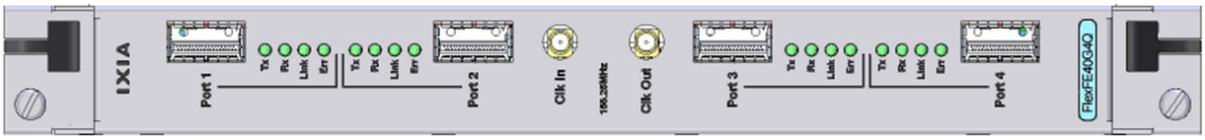
Definition matches the 40G Only definition.

Mechanical Specification of FlexAP40QP4 Load Modules

Front Panel

The Front panel of FlexAP40QP4 load module is shown in the following figure:

Figure: Front panel of FlexAP40QP4



Led Panel

Led panel of FlexAP40QP4 Load Module Specifications

Feature	Specification
	LED/Port aligned from top/down defined as follows: • Tx • Rx • Link • Error
LED1	TX
	10GE TX Active = Blinking Green
	10GE TX Error = Blinking Red
	Inactive = Off
LED2	RX

Feature	Specification
	10GE RX Active = Blinking Green
	10GE RX Error = Blinking Red
	Port Inactive = Off
LED3	Link
	Link up = Solid Green
	Link Down = Solid Red
	Internal Loopback = Solid Yellow
	Line Loopback = Solid Blue
	Port Inactive = Off
LED4	Error
	Remote Faults = Blinking Yellow
	Local Faults = Solid Red
	Port Inactive = Off

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CHAPTER 15

IXIA Xcellon-Multis Load Modules

This chapter provides details about Xcellon-Multis family of load modules-specifications and features.

Xcellon-Multis is a new, next generation, high density, tri-speed, 100/40/50/10GE load module (i.e. NG 100GE) family of products. This load module family comprises the industry's highest density 10GE, 40GE, 50GE and 100GE higher speed Ethernet (HSE) test equipment, providing more flexible test coverage and 100GE, 50GE, 40GE, 10GE, 25GE speeds. Some Multis modules are capable of multi-rates within the same load module.

This is done using cable fan-out technology. Fan-out technology allows a higher speed port to fan-out to several ports of lower speed thus enabling you to have multiple speeds from a single port and higher port densities per chassis.

Xcellon-Multis QSFP load module family comprises the industry's highest- density 10GE, and 40GE higher speed Ethernet (HSE) test equipment, providing more flexible test coverage at 12x40GE ports per load module, with a dual-rate 40GE/10GE capability, all in a single-slot load module. Xcellon-Multis native QSFP28 and CFP4 interface technology comprises high-density 100GE load module. Xcellon-Multis QSFP28 enhanced multi-rate load module allows upto 16 ports of 25GE per blade and 4 ports of 25GE over a 100GE passive copper cable and Active Optical cable. This load module also supports 1x50GE and 2x25GE speeds. The CFP4 enhanced load module is an enhanced high density, native CFP4 4-port load module for 100GE operation.

Xcellon-Multis supports the following:

- 4 x 100GE CXP ports per slot - 2x Xcellon-Lava
- 12 x 40GE QSFP+ ports per slot - 3x Xcellon-Flex
- Upto 32 SFP+ ports per slot
- 40x100GE or 120x40GE ports per XG12 chassis
- 6x40GE QSFP native ports per slot
- 3x10GE and 8x10GE CXP and QSFP ports per slot
- 16x25GE QSFP28 ports per slot
- 8X25GE QSFP28 ports per slot
- 4x50GE QSPF28 ports per slot
- 4x100GE QSFP28 ports per slot.
- 4x100GE CFP4 ports per slot.
- Broad Layer 23 protocol coverage
- Multimode fiber support on some variants

Key Features

The key features of Xcellon-Multis load modules are as follows:

Highest density QSFP module

- Xcellon-Multis QSFP provides upto 12-ports of native QSFP 40GE interfaces in a single chassis slot.
- Up to 120 native QSFP 40GE interfaces are supported in XG12 rackmount chassis.
- With 10GE Fan-out enabled, Xcellon-Multis QSFP supports up to 320-ports of 10GE in the XG12 rackmount chassis.

Highest density QSFP AVB module

- Xcellon-Multis AVB provides upto 6-ports of native QSFP 40GE interfaces in a single chassis slot
- It provides upto 60 native QSFP 40GE interfaces are supported in Ixia's XGS12-SD rack mount chassis
- With 10GE fan-out enabled, Xcellon-Multis AVB can support up to 160-ports of 10GE in the XGS12-SD rack mount chassis

Highest density CXP module

Xcellon-Multis comprises three CXP-based load modules in a single chassis slot.

- 4x100GE only
- 12x40GE and upto 32 ports of 10GE , using fan-out technology
- Multi-rate 4x100GE, 12x40GE, and 32x10GE using fan-out technology

Highest- density QSFP28 and CFP4 modules

- Both Xcellon-Multis QSFP28 and CFP4 provide up to 4-ports of native QSFP28 and CFP4 100GE interfaces respectively in a single chassis slot.
- Support mid-range-to-high-scale protocol testing for L2/3 routing/switching and data center test cases with the Ixia's IxNetwork application.
- Perform multi-vendor interoperability between different QSFP28 and CFP4 optical transceiver solutions, and cable media such as Active Optical Cables.
- Conduct stress tests to ensure error-free network data transmission with long-term stability and high reliability.
- Detect and de-bug data transmission errors using 100Gb/s line rate packet capture and decode tools.
- Provide an excellent test platform for 100GBASE-SR4, 100GBASE-CR4, and 100GBASE-LR4 100GE ASIC designs, FPGAs and hardware switch fabrics at full line rate 100Gb/s.
- Benchmark the data plane and protocol performance of ultra-high-density 100GE network equipment using industry-standard RFC benchmark tests in 100GE test beds with hundreds of 100GE ports in a single test.

Enhanced high-density QSFP28 and CFP4 4-port load modules

- Per native QSFP28 port, supports 4x25GE speed over 100GE passive copper cable media up to 3 meters in length, providing the ability to test the leading-edge data center switches that

support 100GE and 4x25GE over four 25Gb/s SERDES lanes

- Supports 2x25GE speed on QSFP28. The 2x25GE mode is a subset of 4x25GE and has the same capabilities, except that only 2 ports of the port group are activated.
- Supports 1x50GE speed per port (a total of 4 ports of 50GE across a single load module).
- Native CFP4 enhanced high density, 4-port load module for 100GE operation.
- Both QSFP28 and CFP4 enhanced load modules have multi-vendor interoperability between different CFP4 and QSFP28 multimode (100GBASE-SR4), single mode (100GBASE-LR4) and 100GBASE-CR4 optical transceiver solutions, and cable media such as Active Optical Cables.
- Provides an excellent test platform for full line rate 100Gb/s to evaluate the new 100GE ASIC designs, FPGAs, and hardware switch fabrics that use the 4x25Gb/s electrical interface.
- High density – 4-ports of 100GE in a single slot with native QSFP28 physical interfaces supported by the 4x25GE/s electrical interface.
- Provides Reed-Solomon Forward Error Correction and Auto-Negotiation.

Layers 2-7 coverage

- Supports mid-range-to-high-scale protocol testing for L2-3 routing/switching and data center test cases.
- Provides L4-7 capability for all cards.

Same feature set across all speeds

- Provides data plane features for 100/40/10GE testing.
- Provides L23 protocol coverage for 100/40/10GE testing.

Cost Effective

Reduces total cost of ownership with more ports in a single chassis; 120x40GE, or upto 320 10GE ports with fan-out enabled technology.

Load Modules

The Xcellon-Multis family consists of the following models on a single slot card:

- **XM100GE4CXP**: CXP 100GE single rate module that has 4-ports of 100GE CXP, which is the highest density 100GE test module.
- **XM100GE4CXP+FAN**: CXP 100/40GE dual rate module that has 4-ports of 100GE CXP 12-ports of 40GE CXP (using fan-out technology) providing the highest density 40GE test module.
- **XM40GE12QSFP+FAN**: 12-ports of 40GE QSFP+ (using fan-out technology) providing the highest density 40GE test module.
- **XM10/40GE12QSFP+FAN**: 12-ports of 40/10GE QSFP+ (using fan-out technology) providing the highest density 40GE test module with 10GE Fan-out capability.
- **XM10/40GE6QSFP+FAN**: 6-ports of 40/10GE QSFP+ (using fan-out technology) providing the highest density 40GE test module with 10GE Fan-out capability.
- **XM100GE4QSFP28**: 4-ports of 100GE native QSFP28 high density test module.
- **XM100GE4CFP4**: 4-ports of 100GE native CFP4 high density test module.

- **XMAVB10/40GE6QSFP+FAN**: 6-ports of native QSFP interfaces with 10G fan-out capabilities supporting AVB protocols.
- **XM100GE4QSFP28+ENH**: 4-ports of 100GE native QSFP28 high density test module with RS-FEC and Auto Negotiation capabilities. 1x50GE speed per port (a total of 4 ports of 50GE across a single load module) is also supported.
- **XM100GE4CFP4+ENH**: 4-ports of 100GE native CFP4 high density test module with RS-FEC and Auto Negotiation capabilities.

Each of these load modules are described as follows:

XM100GE4CXP

Xcellon-Multis XM100GE4CXP is a 100-Gigabit Ethernet, single rate load module. It has 1-slot with 4-ports native CXP interfaces. It provides L2-7 support and is compatible with XGS12-SD, and XG12 rackmount chassis.

You need to select one or more of the following per port:

- 948-0030 CXP 100GE pluggable
- Optical transceivers
- 942-0035 MTP-MTP 24-fiber multimode fiber cable, or point-to-point CXP Active Optical Cable (AOC)

The XM100GE4CXP load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM100GE4CXP

NOTE Xcellon-Multis load modules have 64KB memory per resource group for stream data. As the value list, frame size and other stream properties become more complex, the maximum number of streams decrease.

XM100GE4CXP+FAN (+10G)

Xcellon-Multis XM100GE4CXP+FAN is a 100/40-Gigabit Ethernet, dual rate load module. It has 1-slot with 4-ports native CXP interfaces and up to 12-ports of 40GE via fan-out cables. The +10G variant supports up to 32 ports of 10GE. It provides L2-7 support and is compatible with XGS12-SD, and XG12 rackmount chassis.

You can select one or more of the available media per port of the following:

- 948-0030 CXP 100GE pluggable, optical transceivers.
- 942-0035 MTP-MTP 24-fiber multimode fiber cable, or point-to-point CXP Active Optical Cable (AOC), or CXP-to-3x40GE QSFP Active Optical Cable (AOC) for 3x40GE fan-out, or MTP-to-MTP

passive fiber for 3x40GE Fan-out. This cable may be used with 948-0028 QSFP 40GBASE-SR4 transceivers. The XM100GE4CXP+FAN load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM100GE4CXP+FAN

XM40GE12QSFP+FAN (+10G)

Xcellon-Multis XM40GE12QSFP+FAN is a 40-Gigabit Ethernet load module. It has 1-slot with 12-ports of 40GE via fan-out cables and provides L2-7 support. The +10G variant supports up to 32 ports of 10GE.

A quantity of 4 each, 3-meter CXP-to-3x40GE QSFP fan-out cables (942-0054) are available with this load module. This is compatible with XGS12-SD, and XG12 rackmount chassis.

The XM40GE12QSFP+FAN load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM40GE12QSFP+FAN

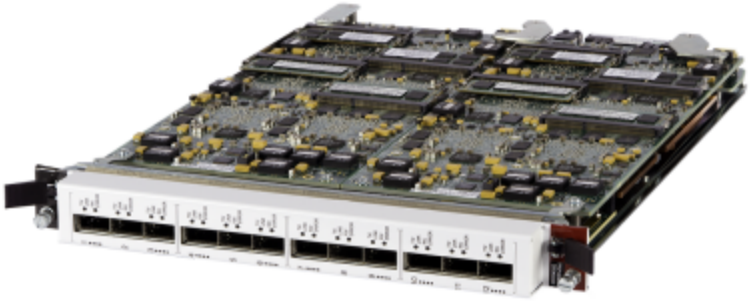
XM10/40GE12QSFP+FAN

Xcellon-Multis XM10/40GE12QSFP+FAN is a 40-Gigabit Ethernet QSFP load module. It has 1-slot with 12-ports of 40GE QSFP with L2-7 support. This load module has 10GE Fan-out capability. The load module is compatible with the XG12 rackmount chassis (940-0005) and XGS12-SD (940-0011).

One or more QSFP+ 40GBASE-SR4 optical transceivers (948-0028) and MT 12-fiber MMF cable, 3-meter length (942-0041) are available with this load module.

The XM10/40GE12QSFP+FAN load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM10/40GE12QSFP+FAN



XM10/40GE6QSFP+FAN

Xcellon-Multis XM10/40GE6QSFP+FAN is a 40-Gigabit Ethernet QSFP load module. It has 1-slot with 6-ports of 40GE QSFP with L2-7 support. This load module has 10GE Fan-out capability and is compatible with the XG12 rackmount chassis (940-0005) and XGS12-SD (940-0011)

One or more QSFP+ 40GBASE-SR4 optical transceivers (948-0028) and MT 12-fiber MMF cable, 3-meter length (942-0041) are available with this load module.

The XM10/40GE6QSFP+FAN load module is shown in the following figure:/

Figure: Xcellon-Multis Module-XM10/40GE6QSFP+FAN

XM100GE4QSFP28

Xcellon-Multis XM100GE4QSFP28 is a 100-Gigabit Ethernet, single rate load module It has 1-slot with 4-ports with the native QSFP28 physical interfaces and provides L2-3 support. This load module is compatible with XGS12-SD Chassis (940-0011) and XG12 rackmount chassis (940-0005).

The XM100GE4QSFP28 load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM100GE4QSFP28

XM100GE4QSFP28+ENH

Xcellon-Multis XM100GE4QSFP28+ENH is an enhanced high density 100-Gigabit Ethernet load module. It has 1-slot with 4-ports with the native QSFP28 physical interfaces, L2-7 support, enhanced for support of Forward Error Correction (RS-FEC) and Auto Negotiation. This load module is compatible with the XGS12-SD rack mount chassis (940-0011) and XG12 rack mount chassis (940-0005).

This is a multi-rate load module and supports testing of 100GE, 50GE, and 25GE speeds.

The XM100GE4QSFP28+ENH load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM100GE4QSFP28+ENH

4x25G options for XM100GE4QSFP28+ENH

4x25G options for XM100GE4QSFP28+ENH is available in two forms:

- Factory Installed
- Field Upgrade

NOTE The 4x25GE speed options do not support Ethernet Forward Error Correction and Auto Negotiation.

4x25GE factory installed

The 4x25GE FACTORY INSTALLED option for the Xcellon-Multis QSFP28 XM100GE4QSFP28+ENH 100GE load module enables 4x25GE capability on all four 100GE QSFP28 ports on the module. The 4x25GE capability is per 100GE port and is ONLY supported over a single 100GE point-to-point QSFP28 cable where each channel of the cable is rated for 25GE per channel operation. This is ONLY supported on the XM100GE4QSFP28+ENH (944-1117) load module.

NOTE The factory installed option is required for new purchases of the 4x25GE capability for the Xcellon-Multis XM100GE4QSFP28+ENH load module with native QSFP28 4x100GE physical interfaces.

4x25GE field upgrade

The 4x25GE FIELD UPGRADE option for the Xcellon-Multis QSFP28 XM100GE4QSFP28+ENH 100GE load module enables 4x25GE capability on all four 100GE QSFP28 ports on the module. The 4x25GE capability is per 100GE port and is ONLY supported over a single 100GE point-to-point QSFP28 cable where each channel of the cable is rated for 25GE per channel operation. This is ONLY supported on the XM100GE4QSFP28+ENH (944-1117) load module.

NOTE The field upgrade option is required on field upgrade purchases of the 4x25GE capability for the Xcellon-Multis XM100GE4QSFP28+ENH load module with native QSFP28 4x100GE physical interfaces.

2x25G option for XM100GE4QSFP28+ENH

2x25G option is also available for XM100GE4QSFP28+ENH. The 2x25GE mode is a subset of 4x25GE and has the same capabilities, except that only 2 ports of the port group are activated.

1x50G option for XM100GE4QSFP28+ENH

1x50GE speed per port (a total of 4 ports of 50GE across a single load module) is available for XM100GE4QSFP28+ENH.

XM100GE4CFP4

Xcellon-Multis XM00GE4CFP4 is a 100-Gigabit Ethernet, single rate load module. It has 1-slot with 4-ports with the native CFP4 physical interfaces and provides L2-3 support. This load module is compatible with XGS12 Chassis (940-0011) and XG12 rackmount chassis (940-0005).

The XM100GE4CFP4 load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM100GE4CFP4

XM100GE4CFP4+ENH

Xcellon-Multis XM00GE4CFP4+ENH is an enhanced high density 100-Gigabit Ethernet load module. It has 1-slot with 4-ports with the native CFP4 physical interfaces and provides L2-7 support, enhanced for support of Forward Error Correction (RS-FEC) and Auto Negotiation. This load module is compatible with XGS12-SD rack mount chassis (940-0011) and XG12 rack mount chassis (940-0005),

The XM100GE4CFP4+ENH load module is shown in the following figure:

Figure: Xcellon-Multis Module-XM100GE4CFP4+ENH

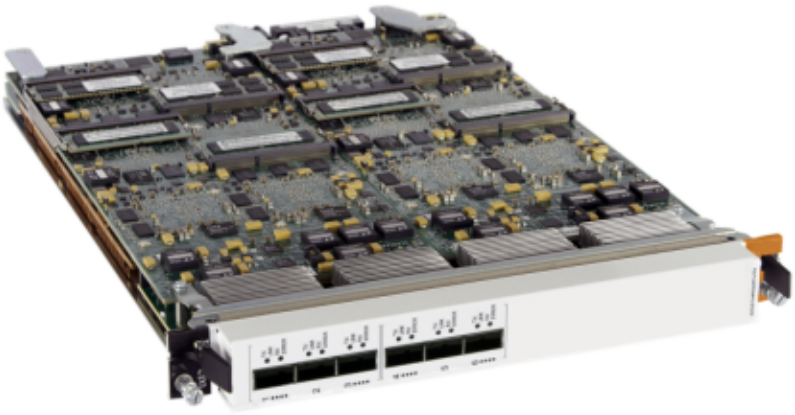
XMAVB10/40GE6QSFP+FAN

XMAVB10/40GE6QSFP+FAN is a 40-Gigabit Ethernet load module. It has 1-slot with 6-ports of 40GE and 16-ports of 10GE via multimode fan-out cables, with full featured L2-7 control and data-plane support. This load module is compatible with the XGS12-SD rack-mount chassis (940-0011). This load module supports AVB protocols.

One or more QSFP+ 40GBASE-SR4 optical transceivers (948-0031) and MT 12-fiber MMF cable, 3-meter length (942-0041) are available with the load module. **Note**: The 10GE Fan-out capability of this load module is provided by a software option, which is delivered using a software activation file.

The XMAVB10/40GE6QSFP+FAN load module is shown in the following figure:

Figure: Xcellon-Multis Module-XMAVB10/40GE6QSFP+FAN



10GE fan-out options for XMAVB10/40GE6QSFP+FAN

The 10G Fan-out options are provided in the same manner as that for Xcellon Multis QSFP family.

AVB Protocols

- Supports MSRP+MVRP and gPTP protocols
- Has 2.5 ns of timestamp resolution and provides highly accurate gPTP measurements
- Facilitates a range of QoS (loss/delay/jitter) testing to verify CBS implementation
- Supports both 1722 and non-1722 encapsulated traffic
- Allows both AVB and Best-Effort traffic to be configured on the same port

NOTE These protocols are supported on Xcellon Multis AVB Load Module family only.

NOTE

- There are limitations on the number of Xcellon-Multis load modules that can be installed into the XG12 chassis. These limitations apply even when Multis load modules are mixed with other Ixia load module types.
- For more information, see Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model section in Xcellon-Multis Load Module Specifications table, and Xcellon-Multis 10GE Fan-out Load Module Specifications table.

Xcellon-Multis Fan-out capability through 10GE license

10G option can be upgraded in the following Xcellon-Multis load modules through license. By default, the ports are in 40GE mode for these load modules.

- XM100GE4CXP+FAN
- XM40GE12QSFP+FAN
- XM10/40GE12QSFP+FAN
- XM10/40GE6QSFP+FAN
- XMAVB10/40GE6QSFP+FAN

Part Numbers

Part Numbers for Xcellon-Multis Load Module and Supported Adapters are provided in the following table.

Part Numbers for Xcellon-Multis Modules

Model Number	Part Number	Description
XM100GE4CXP	944-1100	• 4-ports of 100GE with the CXP physical interface • 100GE only • Does not have 40GE or Fan-out of 40GE
XM100GE4CXP+FAN	944-1101	• 4-ports of 100GE and upto 12 ports of 40GE with CXP physical interface (3x40GE fan-out x 4 ports) • 100GE and 40GE • 40GE Fan-out capable (3x40GE) • Fan-out capable through 10GE license
XM40GE12QSFP+FAN	944-1102	• 12-port 40GE with QSFP physical interface • 40GE only • 100GE speed is disabled on all 4-ports
XM10/40GE12QSFP+FAN	944-1105	• 12-port 40GE with QSFP physical interface • 10GE Fan-out capable (1x10GEx12-ports) • A second 10G mode offers 4x10GE on 8 specific QSFP+ ports, upto 32 ports of 10GE per card. • 1-slot • Fan-out capable through 10GE license
XM10/40GE6QSFP+FAN	944-1109	• 6-port 40GE with QSFP physical interface • 10GE Fan-out capable (1x10GEx6-ports) • A second 10G mode offers 4x10GE on 4 specific QSFP+ ports, upto 16 ports of 10GE per card. • 1-slot • Fan-out capable through 10GE License
XM100GE4QSFP28	944-1116	• 4-port 100GE with QSFP28 physical interface • 1-slot
XM100GE4CFP4	944-1110	• 4-port 100GE with CFP4 physical interface

Model Number	Part Number	Description
		• 1-slot
XMAVB10/40GE6QSFP+FAN	944-1132	• 6-port 40GE with QSFP physical interface • 10GE Fan-out capable (1x10GEx6-ports and 4x10GEx16-ports) • 1-slot • Fan-out capable through 10GE License
XM100GE4QSFP28+ENH	944-1117	• 4-port 100GE or 4-port 50GE with QSFP28 physical interface (with 4x25GE/s host electrical interface) • 1-slot • Provides L2-7 support, enhanced for support of RS-FEC (only for 100G)
	905-1004	• 4x25GE factory installed option for XM100GE4QSFP28+ENH 100GE load module (944-1117) • Enables 4x25GE capability on all four 100GE QSFP28 ports on the module • Supported over a single 100GE point-to-point QSFP28 cable where each channel of the cable is rated for 25GE per channel operation • Does not support 25GE fan-out • Supports 100GE Auto Negotiation and 100GE RS-FEC • Supports 2x25GE speed. The 2x25GE mode is a subset of 4x25GE and has the same capabilities, except that only 2 ports of the port group are activated.
	905-1005	• The 4x25GE field upgrade option for XM100GE4QSFP28+ENH 100GE load module (944-1117) • Enables 4x25GE capability on all four 100GE QSFP28 ports on the module • Supported over a single 100GE point-to-point QSFP28 cable where each channel of the cable is rated for 25GE per channel operation • Supports 100GE Autonegotiation and 100GE RS-FEC • Does not support 25GE fan-out

Model Number	Part Number	Description
		• Supports 2x25GE speed. The 2x25GE mode is a subset of 4x25GE and has the same capabilities, except that only 2 ports of the port group are activated.
XM100GE4CFP4+ENH	944-1111	• 4-port 100GE with CFP4 physical interface • 1-slot • Supports 100GE Autonegotiation and 100GE RS-FEC • Provides L2-7 support

Specifications

The specifications of the Xcellon-Multis load module variants are provided in the following tables.

Specifications of 100GE, 40GE and 100/40GE Multis modules

The load module specifications are contained in the following table.

Xcellon-Multis Load Module Specifications

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
Load Modules	XM100GE4CXP	XM100GE4CXP+FAN	XM40GE12QSFP+FAN	XM100GE4QSFP28	XM100GE4CFP4
Hardware Load Module Specifications					
Slot/Ports	1-slot / 4x100GE ports	1-slot / 4x100GE and 12x40GE ports	1-slot / 12x40GE ports	1-slot / 4x100GE ports	1-slot / 4x100GE ports or 4x50GE ports
Physical Interface	CXP native	• CXP 4x100GE (native) • QSFP 12x40GE (fan-out)	12, via fan-out	• QSFP28 (native) • 4x25GE host electrical interface for the enhanced load module	CFP4 (native)

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
				with 25GE support • 2x25GE support as a subset of 4x25GE with same capabilities for the enhanced load module.	
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model					
XG12 Chassis (940-0005)	10 cards: • 40-ports of 100GE	10 cards: • 40-ports of 100GE • 120-ports of 40GE	10 cards: • 120-ports of 40GE	10 cards: • 40-ports of 100GE • 40-ports of 50GE • QSFP28 enhanced load module supports 160 links of 25GE (i.e. 4x100GE ports with 4x25GE per physical 100GE port). It also supports 2x25GE speed.	
XGS2-SD Chassis (940-0010)	2 cards: • 8-ports of 100GE	2 cards: • 8-ports of 100GE • 24-ports of 40GE	2 cards: • 24-ports of 40GE	2 cards: • 8-ports of 100GE • 8-ports of 50GE	
XGS12-SD Chassis (940-0011)	10 cards: • 40 ports of 100GE	10 cards: • 40 ports of 100G • 120 ports of 40GE	10 cards: • 120 ports of 40GE	10 cards: • 40-ports of 100GE • 40-ports of 50GE • QSFP28 enhanced load module supports 160-links of 25GE (i.e. 4x100GE ports with	

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
				4x25GE per physical 100GE port). It also supports 2x25GE speed.	
XGS12-HSL Chassis (940-0016)	12 load modules: 192-ports of 10GbE	12 load modules: 192-ports of 10GbE	12 load modules: • 192-ports of 10GbE • 48-ports of 40GbE	12 load modules: 48-ports of 40GbE	
XGS12-SDL Chassis (940-0011)	12 load modules: 192-ports of 10GbE	12 load modules: 192-ports of 10GbE	12 load modules: • 192-ports of 10GbE • 48-ports of 40GbE	12 load modules: 48-ports of 40GbE	
XGS2-HSL Chassis (940-0012)	2 load modules: 32-ports of 10GbE	2 load modules: 32-ports of 10GbE	2 load modules: • 32-ports of 10GbE • 8-ports of 40GbE	2 load modules: 8-ports of 40GbE	
XGS2-SDL Chassis (940-0013)	2 load modules: 32-ports of 10GbE	2 load modules: 32-ports of 10GbE	2 load modules: • 32-ports of 10GbE • 8-ports of 40GbE	2 load modules: 8-ports of 40GbE	
CPU and Memory	Multicore processors with 4GB of memory per processor				
IEEE802.3ba-2010 Interface Protocols	100GBASE-SR10	100GBASE-SR10 40GBASE-SR4	40GBASE-SR4	• IEEE 802.3 100GBASE-R • IEEE 802.3 25GBASE-R • IEEE 802.3bj • IEEE	• IEEE 802.3 100GBASE-R • IEEE 802.3bj • IEEE P802.3 bm

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
				P802.3bm	
Transceiver Support	Pluggable CXP, 12-lane, MMF for 100GE operation	Pluggable CXP, 12-lane, MMF for 100GE operation QSFP+ MSA	QSFP+ MSA	• 100GBASE-LR4 QSFP28 for single mode fiber • 100GBASE-SR4 QSFP28 for multimode fiber	• 100GBASE-LR4 CFP4 for single mode fiber • 100GBASE-SR4 CFP4 for multimode fiber
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air			• 41°F to 95°F (5°C to 35°C), ambient air • 0% to 85%, non-condensing	
Load Module Dimensions	16.0" (L) x 12.0" (W) x 1.3" (H) 406mm (L) x 305mm (W) x 33mm (H)			• 16.1” (L) x 1.3” (W) x 12.0” • (H) 409mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights				• Module only: 13.15 lbs. (5.96 kg) • Shipping: 16.95 lbs. (7.69 kg)	
Transmit Feature Specifications					
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures				
Max. Streams per Port	100GE: 128	100GE: 128 40GE: 32 / fan-out link	40GE: 32 / fan-out link	• 100GE and 50GE: 128 • QSFP28 enhanced load module 25G support: 16	
Max. Streams per Port in Data	Supported	Supported	Supported	• 100GE and 50GE: 128 • QSFP28 enhanced load module 25G support: 16	

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
Center Ethernet					
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s				
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler				
Minimum Frame Size	100GE: • 60 bytes (line rate) • 49 bytes (< line rate)	100GE: • 60 bytes (line rate) • 49 bytes (< line rate) 40GE: • 64 bytes (line rate) • 49 bytes (< line rate)	40GE: • 64 bytes (line rate) • 49 bytes (< line rate)	100GE, 50GE and 25GE: • 60 bytes (line rate) • 49 bytes (< line rate)	
Maximum Frame Size	14,000 bytes				
Maximum Fame Size in Data Center Ethernet	9,216 bytes				
Priority Flow Control	8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths 1 queue supporting up to 9,216 byte frame lengths				
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian				

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.				
Value Lists (max.)	4 million / UDF	100GE: 4 million / UDF 40GE: 1 million / UDF	40GE: 1 million / UDF	• 100 GE and 50GE: 4 million / UDF • QSFP28 enhanced load module 25G support: 1 million / UDF	
Sequence (max.)	256K / UDF	100GE: 256K / UDF 40GE: 64K / UDF	40GE: 64K / UDF	• 100 GE and 50GE: 256K / UDF • QSFP28 enhanced load module 25G support: 64K / UDF	
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum				
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP				
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics. Reports the following PCS statistics: • Link Fault State - specifies if the link is in Local fault, Remote fault or No fault • Local Fault count - number of link transitions from No fault to Local fault • Remote Fault count - number of link transitions from No fault to Remote fault • PCS Local faults count - number of local fault ordered sets • PCS Remote faults count - number of remote fault ordered sets			Reports, no fault, remote fault, and local fault port statistics. Generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner.	
Latency Measurement Resolution	100GE: 2.5 nanoseconds	100GE: 2.5 nanoseconds 40GE: 2.5 nanoseconds	40GE: 2.5 nanoseconds	100GE, 50GE, 2x25GE, and 4x25GE: 2.5 nanoseconds	

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
Intrinsic Latency Compensation	Removes inherent latency error from 40GE or 100GE port electronics			Removes inherent latency error from 100GE, 40GE port electronics	Removes inherent latency error from 100GE port electronics
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm per resource group				
Receive Feature Specifications					
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability				
Trackable Receive Flows per Port	100GE: 512K	100GE: 512K 40GE: 128K	40GE: 128K	• 100GE and 50GE: 512K • QSFP28 enhanced load module 25G support: 128K	
Minimum Frame Size	• 64 bytes at line rate • > 49 bytes not a line rate			100GE, 50GE, and 25GE: • 60 bytes and greater at full line rate • 49 bytes at less than full line rate	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available				
Hardware Capture Buffer per Port or Resource Group	100GE: 2GB	100GE: 2GB 40GE: 2GB per 1, user-selected link of the 3x40GE fan-out link resource group	40GE: 2GB per 1, user-selected link of the 3x40GE fan-out link resource group	100GE and 50GE: 2GB	
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received,				

Feature	Xcellon-Multis (100 GE only)	Xcellon-Multis (100/40GE combo)	Xcellon-Multis (40GE only)	Xcellon-Multis QSFP28 (100 GE only)	Xcellon-Multis CFP4 (100 GE only)
	fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies				
PCS Lanes Port Statistics	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set NOTE These statistics are available only for 100G and 40G.				
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 time bins latency/jitter, MEF jitter, and inter-arrival time				
L2/3 Routing, Bridging, and Timing	**Routing:** RIP, RIPng, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, BGP/BGP+ **MPLS:** RSVP-TE, RSVP-TE P2MP, LDP, mLDP, BGP RFC 3107, MPLS-TP, MPLS OAM **MPLS VPN:** L2VPN PW, L3VPN/6VPE, 6PE , VPLS-LDP, VPLS-BGP, VPLS-BGP AD and LDP FEC 129, Inter-AS VPN Option A, B, and C, Seamless MPLS, Carrier Supporting Carrier (CsC), GRE mVPN, NG MVP (mLDP and RSVP-TE P2MP), EVPN/PBB-EVPN **High-Availability:** BFD, Graceful Restart, MPLS Ping/TraceRoute, LSP BFD, VCCV BFD, Real-time dynamic label swap for convergence time measurement up to millisecond accuracy **IP Multicast:** IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, multicast VPN **Switching:** STP/RSTP, MSTP, PVST+/RPVST+, LACP, LLDP, Protocols over LACP Bundle **Carrier Ethernet:** Link OAM, CFM, Service OAM, PBT/PBB-TE, SyncE, PTP (1588v2), E-LMI				
Data Center Ethernet	Priority Class-Based Flow Control (IEEE802.1Qbb), FCoE/ FIP, LLDP/DCBX, VNTAG/VIC, OpenFlow, FabricPath, TRILL, SPBM, VEPA, VXLAN				
Broadband Access	**Broadband:** ANCP, PPPoX, DHCPv4 client/server, DHCPv6 client/server, L2TPv2, Radius Attributes for L2TP, Dual-Stack PPPoX, AMT **Authentication:** 802.1x, WebAuth, Cisco NAC				

Specifications of Multis Modules with 10GE Fan-out capability

The load module specifications for the modules with 10GE Fan-out capability are contained in the following table.

Xcellon-Multis 10GE Fan-out Load Module Specifications

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
Load Modules	XM100GE4CXP+FAN+10GE	XM10/40GE12QSFP+FAN	XM10/40GE6QSFP+FAN	XMAVB10/40GE6QSFP+FAN
Hardware Load Module Specifications				
Slot/Ports	1-slot / 4x100GE and 12x40GE ports	1-slot: • 12x40GE QSFP native ports • 10GE fan-out; - 12x10GE ports (1x10GE/port)	1-slot: • 6x40GE QSFP native ports • 10GE fan-out; - 6x10GE ports (1x10GE/port)	1-slot: • 6x40GE QSFP native ports • 10GE fan-out; - 6x10GE ports (1x10GE/port) - 16x10GE ports (4x10GE/port)
Physical Interface	CXP 4x100GE (native) QSFP 12x40GE (fan-out)	QSFP 12x40GE (native) 10GE: LC connector (fiber), or SFP+ connector (copper)	QSFP 6x40GE (native) 10GE: LC connector (fiber), or SFP+ connector (copper)	QSFP 6x40GE (native) 10GE: LC connector (fiber), or SFP+ connector (copper)
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model				
XG12 Chassis (940-0005)	12 cards: • 48-ports of 100GE • 144-ports of 40GE	10 cards: • 120-ports of 40GE • 120-ports of 10GE (1x10GE mode)	10 cards: • 60-ports of 40GE • 60-ports of 10GE (1x10GE mode)	
XGS12-SD				10 cards:

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
Chassis (940-0011)				• 60-ports of 40GE • 60-ports of 10GE (1x10GE mode) • 160-ports of 10GE (4x10GE mode)
XGS2-SD Chassis (940-0010)	2 cards: • 8-ports of 100GE • 4-ports of 40GE	2 cards: • 24-ports of 40GE • 24-ports of 10GE (1x10GE mode)	2 cards: • 12-ports of 40GE • 12-ports of 10GE (1x10GE mode)	2 cards: • 12-ports of 40GE • 12-ports of 10GE (1x10GE mode) • 32-ports of 10GE (4x10GE mode)
CPU and Memory	Multicore processors with 4GB of memory per processor			
IEEE802.3 ba-2010 Interface Protocols	100GBASE-SR10 40GBASE-SR4	40GBASE-SR4, 40GBASE-LR4 (802.3ba-2010) 10GBASE-SR (802.3ae-2002)		
Transceiver Support	Pluggable CXP, 12-lane, MMF for 100GE operation QSFP+ MSA	QSFP: • 40GBASE-SR4 (multimode 850nm) • 40GBASE-LR4 (single mode 1310nm)		
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air	41°F to 95°F (5°C to 35°C), ambient air 0% to 85%, non-condensing		
Load Module Dimensions	16.0" (L) x 1.3" (W) x 12.0" (H) 409mm (L) x 33mm (W) x 305mm (H)	16.8” (L) x 1.3” (W) x 12.0” (H) 427mm (L) x 33mm (W) x 305mm (H)		
Load	Module only: 13.0	12-port model:	6 port model:	

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
Module Weights	lbs. (5.90 kg) Shipping: 16.8 lbs. (7.62 kg)	• Module only: 12.5 lbs. (5.67 kg) • Shipping: 16.2 lbs. (7.35 kg)	• Module only: 9.3 lbs. (4.22 kg) • Shipping: 13.1 lbs. (5.94 kg)	
Transmit Feature Specifications				
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures			
Max. Streams per Port	100GE: 128 40GE: 32 / fan-out link	40GE: 32 10GE 12x10 mode: 32 (1x10GE fan-out/port)		40GE: 32 10GE 6x10 mode: 32 (1x10GE fan-out/port) 10GE 16x10 mode: 16 (4x10GE fan-out/port)
Max. Streams per Port in Data Center Ethernet	Supported	40GE: 32 10GE 12x10 mode: 32 (1x10GE fan-out/port)		40GE: 32 10GE 6x10 mode: 32 (1x10GE fan-out/port) 10GE 16x10 mode: 16 (4x10GE fan-out/port)
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s			
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler			
Minimum Frame Size	100GE: • 60 bytes (line rate) • 49 bytes (<	40GE: • 64 bytes (line rate) • 49 bytes (<	40GE: • 64 bytes (line rate) • 49 bytes (< line rate) 10GE:	

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
	line rate) 40GE: • 64 bytes (line rate) • 49 bytes (< line rate)	line rate) 10GE: • 64 bytes (line rate) • 49 bytes (< line rate)	• 64 bytes (line rate) • 49 bytes (< line rate)	
Maximum Frame Size	14,000 bytes			
Maximum Fame Size in Data Center Ethernet	9,216 bytes			
Priority Flow Control	8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths 1 queue supporting up to 9,216 byte frame lengths			
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian			
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.			
Value Lists (max.)	100GE: 4 million / UDF 40GE: 1 million / UDF	40GE: 1 million / UDF 10GE: • 1million / UDF(1x10GE mode) • 512K / UDF (4x10GE mode)		
Sequence (max.)	100GE: 256K / UDF 40GE: 64K / UDF	40GE: 128K / UDF 10GE: • 128K / UDF (1x10GE mode) • 64K / UDF (4x10GE mode)		
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum			

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP			
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics. Reports the following PCS statistics: • Link Fault State - specifies if the link is in Local fault, Remote fault or No fault • Local Fault count - number of link transitions from No fault to Local fault • Remote Fault count - number of link transitions from No fault to Remote fault • PCS Local Faults count - number of local fault ordered set • PCS Remote Faults count - number of remote fault ordered set			
Latency Measurement Resolution	100GE: 2.5 nanoseconds 40GE: 2.5 nanoseconds	40GE and 10 GE: 2.5 nanoseconds		
Intrinsic Latency Compensation	Removes inherent latency error from 40GE or 100GE port electronics	Removes inherent latency error from 40GE or 10GE port electronics		
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm per resource group			
Receive Feature Specifications				
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability			
Trackable Receive Flows per Port	100GE: 512K 40GE: 128K	40GE: 128K 10GE: • 128K (1x10GE mode) • 64K (4x10GE mode)		
Minimum Frame Size	64 bytes at line rate ≥ 49 bytes not a line rate			

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available			
Hardware Capture Buffer per Port or Resource Group	100GE: 2GB 40GE: 2GB per 1, user-selected link of the 3x40GE fan-out link resource group	40GE: 2GB per 1, user-selected port/resource group 10GE: • 1x10GE mode: 2GB per 1 user-selected link of the 1x10GE fan-out link resource group • 4x10GE: 256MB/port for all ports in the fan-out of the resource group		
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies			
Latency / Jitter Measurements	Cut-through, store & forward, forwarding delay, up to 16 time bins latency/jitter, MEF jitter, and inter-arrival time			
Protocol Support				
L2/3 Routing, Bridging, Routing, Timing and Carrier Ethernet	**Routing:** RIP, RIPng, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, BGP/BGP+ **MPLS:** RSVP-TE, RSVP-TE P2MP, LDP, mLDP, BGP RFC 3107, MPLS-TP, MPLS OAM **MPLS VPN:** L2VPN PW, L3VPN/6VPE, 6PE , VPLS-LDP, VPLS-BGP, VPLS-BGP AD and LDP FEC 129, Inter-AS VPN Option A, B, and C, Seamless MPLS, Carrier Supporting Carrier (CsC), GRE mVPN, NG MVP (mLDP and RSVP-TE P2MP), EVPN/PBB-EVPN **High-Availability:** BFD, Graceful Restart, MPLS Ping/TraceRoute, LSP BFD, VCCV BFD, Real-time dynamic label swap for convergence time measurement up to millisecond accuracy **IP Multicast:** IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, multicast VPN **Switching:** STP/RSTP, MSTP, PVST+/RPVST+, LACP, LLDP, Protocols over LACP Bundle **Carrier Ethernet:** Link OAM, CFM, Service OAM, PBT/PBB-TE, SyncE, PTP (1588v2), E-LMI			

Feature	Xcellon-Multis (CXP 10 GE Fan-out upgrade)	Xcellon-Multis (12-port QSFP 10/40GE Fan-out)	Xcellon-Multis (6-port QSFP 10/40GE Fan-out)	Xcellon-Multis AVB (6-port QSFP 10/40GE Fan-out)
Data Center Ethernet	Priority Class-Based Flow Control (IEEE802.1Qbb), FCoE/ FIP, LLDP/DCBX, VNTAG/VIC, OpenFlow, FabricPath, TRILL, SPBM, VEPA, VXLAN			
Broadband Access	**Broadband:** ANCP, PPPoX, DHCPv4 client/server, DHCPv6 client/server, L2TPv2, Radius Attributes for L2TP, Dual-Stack PPPoX, AMT **Authentication:** 802.1x, WebAuth, Cisco NAC			
Audio video bridging				MSRP + MVRP, gPTP

Application Support

The Ixia application support for Xcellon-Multis load modules is provided in the following table:

Xcellon-Multis Application Support

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Layer 2-3 wire-speed traffic generation and analysis and Layer 1 BERT and IEEE 802.3ba HSE PCS Lanes testing.
Tcl API	Custom user script development for layer 1-7 testing.

Mechanical Specifications

Front Panel

The Front panel of Xcellon-Multis load modules is shown in the following figure:

Figure: Front panel of Xcellon-Multis XM100GE4CXP

Figure: Front panel of Xcellon-Multis XM10/40GE12QSFP+FAN

Figure: Front panel of Xcellon-Multis XM10/40GE6QSFP+FAN

LED Panel

The LED panel specifications for Multis CXP module are provided in the following table.

LED panel Specifications for Multis Load Module

Speed Mode	MODE LED	TX LED	RX LED
100G	Off	Link Up=Green Link Down=Red TX Active-Blinking Green	RX Active (errors)=Blinking Red RX Active=Blinking Green
40G	Green	Link Up (all ports)=Green Link Up (partial)=Yellow Link Down (all ports)=Red TX Active-Blinking Green	RX Active (errors)(any)=Blinking Red RX Active (any)=Blinking Green
10G	Yellow	Link Up (all ports)=Green Link Up (partial)=Yellow Link Down (all ports)=Red TX Active-Blinking Green	RX Active (errors)(any)=Blinking Red RX Active (any)=Blinking Green
25G	Blue	Link Up (all ports)=Green Link Up (partial)=Yellow Link Down (all	RX Active (errors)(any)=Blinking Red RX Active (any)=Blinking Green

Speed Mode	MODE LED	TX LED	RX LED
		ports)=Red TX Active-Blinking Green	
	Red	Faulty Card	Faulty Card

For 10/40GE QSFP modules, there are 2 LEDs per port. They operate the same way in 40GE and 10 GE modes.So the number of LEDs are:

- 12x2 = 24 LEDs on front pannel for 12-port QSFP card
- 6x2 = 12 LEDs for 6-port QSFP card

LED panel Specifications of XM10/40GE12QSFP+FAN, XM10/40GE6QSFP+FAN, and XMAVB10/40GE6QSFP+FAN Load Modules

LED 1: Bi-Color Tx Status LED		LED 2: Bi-Color Rx Status LED	
Ports Inactive/No Power	Off	Ports Inactive/No Power	Off
Link Down	Solid Red	Rx Active with Errors	Blinking Red
Link Up	Solid Green	Rx Active	Blinking Green
Tx Active	Blinking Green		
Partial Link up	Solid Yellow		

Fan-out Capability

The 3x40GE fan-out is a new capability that provides up to 12 independent 40GE QSFP+ links or generic 40GE fiber links. There are up to three 40GE QSFP+ fiber-based links provided via a cable per 100GE CXP physical port, using all of the 4-ports of 100GE CXP on the Multis load module.

Fan-out Cable Options

The Xcellon-Multis cable options are described in the following sections.

100GE CXP-to-3x40GE QSFP+ AOC fiber fan-out cables

CXP-to-3x40GE QSFP Active Optical Cable (AOC) cables are used with Xcellon-Multis XM100GE4CXP+FAN 100/40GE (944-1101) and XM40GE12QSFP+FAN 40GE (944-1102) load modules.

100GE CXP-to-3x40GE QSFP+ AOC fiber fan-out cables have the following features:

- Active Optical Cable (AOC)
- Multi-mode fiber (MMF), 850nm
- 942-0053 - 1 meter

- 942-0054 - 3 meter
- 942-0055 - 5 meter

The 100GE CXP-to-3x40GE QSFP+ AOC fiber fan-out cable is shown in the following figure:

Figure: 100GE CXP-to-3x40GE QSFP+ AOC fiber fan-out cable

MT-MT 3x40GE passive fiber fan-out cables

The MT-MT 3x40GE passive fiber fan-out cables requires 1 each CXP 100GE pluggable optical transceiver (948-0030). This combination is compatible with Xcellon-Multis XM100GE4CXP+FAN 100/40GE (944-1101) and XM40GE12QSFP+FAN 40GE load modules.

The MT-MT 3x40GE passive fiber fan-out cables have the following features:

- Multi-mode frequency (MMF), 850nm
- F-F key-up compatible with CXP & QSFP optical transceivers
- 942-0060 - 3 meter
- 942-0061 - 5 meter
- Transceivers are sold separately

The MT-MT 3x40GE passive fiber fan-out cable is shown in the following figure:

Figure: MT-MT 3x40GE passive fiber fan-out cable

CXP point-to-point AOC Cable (no fan-out)

The CXP point-to-point AOC cable has the following features:

- Active Optical Cable (AOC)
- Multi-mode frequency (MMF), 850nm
- 942-0052 - 3 meter

The CXP point-to-point AOC cable is shown in the following figure:

Figure: CXP point-to-point AOC cable

MT-to-4x10GE LC fan-out, MMF

MT-to-4x10GE LC fan-out, MMF, 3-meter cable requires QSFP 40GBASE-SR4, pluggable, transceiver, 850nm, MMF (948-0031). The cables and transceiver are compatible with Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105), and the Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109).

MT-to-4x10GE LC fan-out, MMF, 5-meter cable requires QSFP 40GBASE-SR4, pluggable, transceiver, 850nm, MMF (948-0031). The cables and transceiver are compatible with Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105), and the Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109).

The MT-MT 4x10GE passive fiber fan-out cable is shown in the following figure:

Figure: MT-MT 4x10GE passive fiber fan-out cable

QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC)

QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) is a passive copper, fan-out, cable that is 3-meter in length. This cable is compatible with the load modules Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).

The load modules must have the 10GE fan-out option enabled to use this cable. This requires 905-1000 XM10GE-FAN-OUT 10GE fan-out option for NEW purchases of Xcellon-Multis load modules, or the 905-1001 UPG-XM10GE-FAN-OUT 10GE fan-out option UPGRADE for existing Xcellon-Multis load modules.

The QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) cable is shown in the following figure:

Figure: QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) cable

QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC)

QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC) is a passive copper, point-to-point cable that is 3-meter in length. This cable is compatible with the load modules Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).

The QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC) is shown in the following figure:

Figure: QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC)

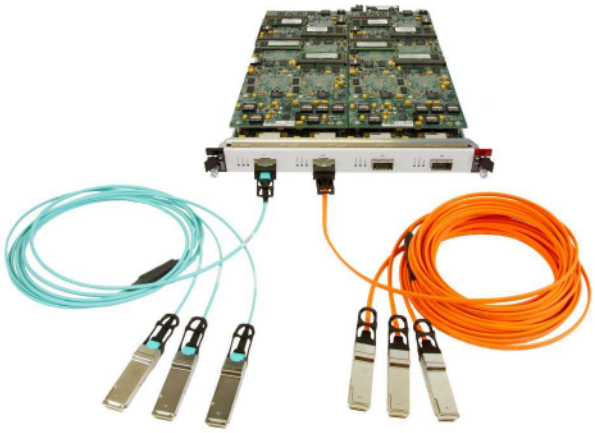
Features

The 100GE fan-out capability has the following features:

- Each 100GE port and transceiver combination has the ability to fan-out to three 40GE QSFP+ links using a fiber fan-out cable media type, or a pluggable transceiver used with a fiber-only fan-out cable.
- Each 100GE port, when in the 3x40GE fan-out configuration, supports one-user for all three 40GE links.
- Each 100GE port with a transceiver that uses a fan-out cable to produce 3x40GE links will equally divide and allocate the data and control plane resources of the 100GE port to each 40GE link.
- There are 32 transmit streams for each of 40GE link in a 3x40GE fan-out configuration and at least 64K Rx PGID capacity per link.
- There is one LED per 100GE CXP port that indicates that the port is in fan-out mode.
- PCS lanes and Link Fault Signaling port counter support supports link troubleshooting for the entire port.

The Xcellon-Multis load module with CXP-to-3x40GE fan-out fiber cables for a 100GE CXP port with a 100GE transceiver installed, is shown in the following figure.

Figure: Xcellon-Multis load module with CXP-to-3x40GE fan-out



Benefits

Due to the enormous growth in Internet users and devices, the total bandwidth requirements of a single switch or router has reached multiple terabits. Devices that scale up to hundreds of 40GE and 100GE ports, instead of dozens, are needed to match such huge bandwidth requirements.

Xcellon-Multis family of load modules allows Higher Speed Ethernet testing using cable fan-out technology. This allows higher ports speeds to fan-out to several ports (links) of another speed. It also has the following benefits:

- 100GE/40GE fan-out technology separates a phyiscal interface into multiple interfaces.
- The same features for 100GE and 40GE can be used from a single port or a group of ports.
- The same features for 100GE and 40GE all able to be used from a single port or a group of ports.
- Enables higher port densities per chassis - 2x the 100GE capacity and 3x the 40GE capacity.
- A simple fan-out cable allows you to have 3 ports of 40GE QSFP at a lower cost than a new, full load module.
- Multis provide an efficient way to have 100GE using the native physical port of CXP, and then have in the same port of the same card 3x40GE QSFP interfaces. A second card with 40GE QSFP naïve interface is not needed. This saves a slot in your chassis.
- The fan-out technology allows the user to have 100GE/40GE port all emanating from a single card. Compared to traditional Ixia cards, this saves power because you do not have to have two or three different cards in the chassis to perform 100GE/40GE tests.
- Every chassis in the lab produces less heat output to be cooled with less total number of load module installed in the chassis. Multis reduces the number of load modules in the chassis by being:
    - High port density
    - Providing Fan-out technology

Transceivers and Cables

The Xcellon-Multis family supports optical transceivers and fiber cables for each of the physical interfaces that are supported.

The following are the two types of 3x40GE fan-out cables:

- Active Optical cable (AOC): CXP to (3) QSFP+, fiber, active, fan-out cable.
- Fiber fan-out cable: MTP to (3) MTP QSFP+, fiber, passive, fan-out cable.

Active Optical Cable

The following tables list the specifications of the AOC cable.

CXP to 3-QSFP+ 40GE AOC fan-out

CXP AOC part number	Cable length	Cards/Adapters to Interoperate with
ICD120GVP2420-05	5.0 m	MK, 4x40GE, K2
1110251303	3.0 m	MK, 4x40GE, K2
1110251305	5.0 m	MK, 4x40GE, K2
1110251307	7.0 m	MK, 4x40GE
1110251310	10.0 m	MK, 4x40GE

CXP 100GE Active Optical Cable

CXP AOC part number	Cable length	Cards/Adapters to Interoperate with
FCBGD10CD1C03/ICD120GVP2410-03	5.0 m	MK, K2
FCBGD10CD1C05/ICD120GVP2410-05	3.0 m	MK
FCBGD10CD1C10/ICD120GVP2410-10	5.0 m	MK
FCBGD10CD1C20/ICD120GVP2410-20	7.0 m	MK

Fibre Fan-out Cable

The following table lists the specifications of the fibre fan-out cable.

MTP to (3) MTP QSFP+, fiber, passive, fan-out

MTP Fan-out part number	Cable length	Cards/Adapters/Optics to Interoperate with
Custom	1.0 m	QSFP optic, MK, 4x40GE, Combo
Custom	3.0 m	QSFP optic, MK, 4x40GE, Combo
Custom	5.0 m	QSFP optic, MK, 4x40GE, Combo
Custom	10.0 m	QSFP optic, MK, 4x40GE, Combo

Cables used by Multis CXP, QSFP, and QSFP28

The following table lists the cables used by Multis CXP, QSFP, and QSFP28 load modules.

Cables used by Multis CXP, QSFP, and QSFP28

Part number	Media Type	Cable length	Cards on which supported
1-2231368-2	Q28-CR4	5.0 m	QSFP28 Enhanced
2231368-5	Q28-CR4	5.0 m	QSFP28 Enhanced
2231368-8	Q28-CR4	3.0 m	QSFP28 Enhanced
2231368-1	Q28-CR4	1.0 m	QSFP28 Enhanced
MFA1A00-E003	AOC QSFP28	3.0 m	QSFP28 Enhanced
MCP1600-C002	Passive Copper Cable	2.0 m	QSFP28 Enhanced
IXIA 942-0064	MMF Fiber	3.0 m	Multis CXP
MB-752024-135-071-343-010M-116	MMF Fiber	10.0 m	Multis CXP
942-0054-01	MMF Fiber	3.0 m	Multis CXP, Multis QSFP
942-0069-01	Copper	3.0 m	Multis QSFP

Transceivers

QSFP Transceiver

QSFP+ 40GE, 40GBASE-SR4 ia an optical, pluggable, MMF, 850nm transceiver is compatible with the load modules Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105), and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).

The QSFP+ 40GE, 40GBASE-SR4 transceiver is shown in the following figure:

Figure: QSFP+ 40GE, 40GBASE-SR4 transceiver

QSFP+ 40GE, 40GBASE-LR4, optical, pluggable, SMF, 1310nm transceiver is compatible with the load modules Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105), and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).

The QSFP+ 40GE, 40GBASE-LR4 transceiver is shown in the following figure:

Figure: QSFP+ 40GE, 40GBASE-LR4 transceiver

CXP

CXP is useful in the clustering and high-speed computing areas. It is about one-fourth the size of a CFP transceiver providing higher density network interfaces. It is an excellent low cost 100GE system for Multimode fiber cables.

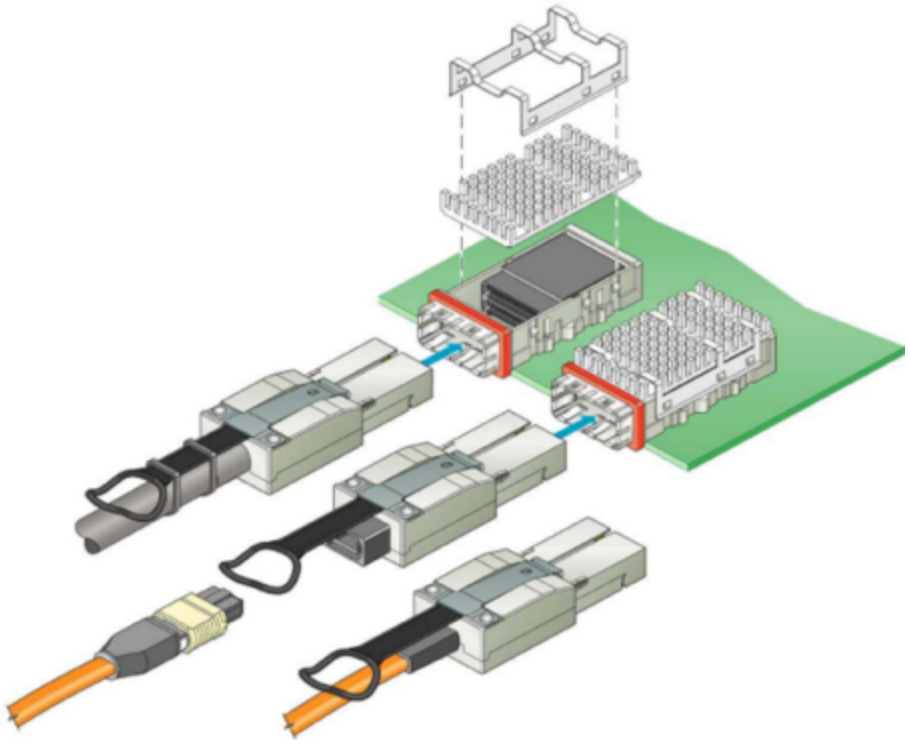
CXP is a copper connector system. It provides twelve 10 Gbps links suitable for 100 Gigabit Ethernet, three 40 Gigabit Ethernet channels, or twelve 10 Gigabit Ethernet channels or a single Infiniband 12× QDR link.CXP components are low cost, field proven and available in volume.

The following are the CXP formats:

- Pluggable transceiver
- Active Optical Cable

The following figure shows the CXP Active Copper, Optical (pluggable), Active Optical:

Figure: CXP Active Copper, Optical (pluggable), Active Optical



QSFP

The Quad (4-channel) Small Form-factor Pluggable (often abbreviated as QSFP or QSFP+) is a compact, hot-pluggable transceiver used for data communications applications. It interfaces a network device (switch, router, media converter or similar device) to a fiber optic cable.

The QSFP specification supports Ethernet, Fibre Channel, InfiniBand and SONET/SDH standards with different data rate options. QSFP+ transceivers are designed to support Serial Attached SCSI, 40G Ethernet, 20G/40G Infiniband, and other communications standards. QSFP modules increase the port-density by 3x-4x compared to CFP modules.

The following figures show the QSFP+ Pluggable and Cable modules:

Figure: QSFP+ Pluggable module

Figure: QSFP+ Cable module

CHAPTER 16

IXIA Xcellon-Multis Reduced Load Modules

This chapter provides details about Xcellon-Multis Reduced family of load modules-specifications and features.

Ixia's Xcellon-Multis Reduced load module family comprises the industry's highest-density 10GE and 40GE higher speed Ethernet (HSE) test equipment, providing more flexible test coverage at upto 320 10GE ports per chassis, with a dual-rate 40GE/10GE and 40 GE only capability, all in a single-slot load module. Xcellon-Multis provides 10GE fan-out technology that allows a higher-speed port to fan-out to several ports of a lower speed.

The Xcellon-Multis Reduced load modules provide high-density, cost-effective, and flexible 10GE and 40GE capability for testing next-generation multi-terabit networks. You can use them with Ixia applications to quickly and accurately assess the performance and reliability of network solutions before they are deployed.

For more information on Xcellon-Multis family of load modules, see IXIA Xcellon-Multis Load Modules.

Key Features

The key features of Xcellon-Multis Reduced load modules are as follows:

Highest- density test module in the industry

- Xcellon-Multis Reduced offers up to 32-ports of 10GE or 12-ports of 40GE interfaces in a single chassis slot
- Up to 320 native 10GE interfaces are supported in Ixia's XG12 rackmount chassis
- With 40GE fan-out enabled, Xcellon-Multis Reduced can support up to 120-ports of 40GE in the XG12 rackmount chassis
- Xcellon-Multis also offers a 40GE only version

Fan-out technology

- Provides high-density interfaces over multiple speeds; 10GE and 40GE
- Increases interface flexibility by allowing 10GE and 40GE in mixed speed tests
- Facilitates a wide range of interoperability testing

Multi-personality

- Multi-speed 10GE and 40GE support
- Support for multiple interface types: QSFP+, SFP+ (LC), and MT fiber cable interfaces
- Support for QSFP-to-1x10GE or 4x10GE LC connector interfaces for fiber

- Support for 10GE SFP+ Direct Attach Cable (DAC) 1x10GE or 4x10GE fan-out over passive copper
- 40GBASE-SR4 (multimode) and 40GBASE-LR4 (single mode) optical transceivers
- Facilitates a wide range of 10GE and 40GE interoperability testing.

Layers 2-7 coverage

- Supports low-range protocol testing for L2-3 routing/switching and data center test cases.
- Provides L4-7 capability for all Xcellon-Multis Reduced load modules.

Same feature set across all speeds

- Provides exactly the same data plane features for 10GE and 40GE testing.
- Provides exactly the same L23 protocol coverage for 10GE and 40GE testing.

Highest ROI of any test and measurement load module

- Density
- Versatility - multiple speeds, multiple interfaces
- Balanced performance and scale
- Greater test case coverage
- Industry-standard fan-out technology

Cost-effective

- Reduces total cost of ownership with more ports in a single chassis; 320x10GE or 120x10GE, or 120x40GE ports.

Load Modules

The Xcellon-Multis Reduced family consists of the following models on a single slot card:

- XMR10GE32SFP+FAN: A 32-port module for 10GE operation that can also support 12 ports of 40GE
- XMR10GE16SFP+FAN: A 16-port module for 10GE operation that can also support 6 ports of 40GE
- 40GE fan-out enablement options for XMR10GE32SFP+FAN and XMR10GE16SFP+FAN:
  - XM40GE-FAN-OUT 40GE fan-out option for a new module purchase
  - UPG-XM40GE-FAN-OUT 40GE fan-out field upgrade option for existing load modules
- XMR40GE12QSFP+: A 12-port module for 40GE operation only
- XMR40GE6QSFP+: A 6-port module for 40GE operation only

Each of these load modules are described as follows:

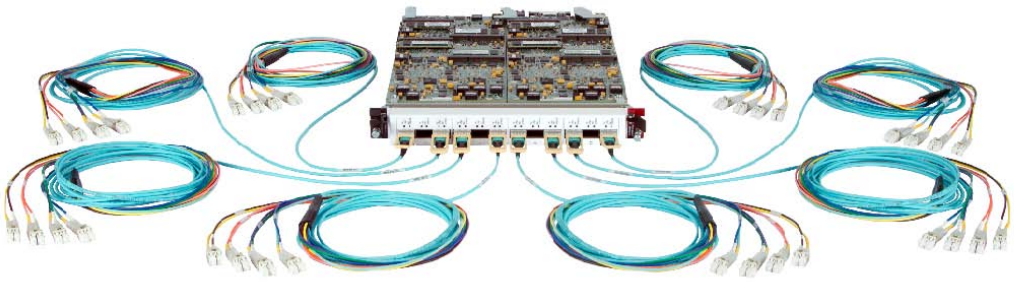
XMR10GE32SFP+FAN

Xcellon-Multis XMR10GE32SFP is a 10-Gigabit Ethernet load module. It takes up 1-slot with 32-ports 10GE via multimode fan-out cables. The following components are available along with the load module:

- 8 each, 3 meter multimode MT-to-4x10GE LC fan-out cables (942-0067)
- 8 each, QSFP+ 40GBASE-SR4 optical transceivers (942-0067)

The XMR10GE32SFP+FAN load module is shown in the following figure:

Figure: Xcellon-Multis Reduced Module-XMR10GE32SFP+FAN



XMR10GE16SFP +FAN

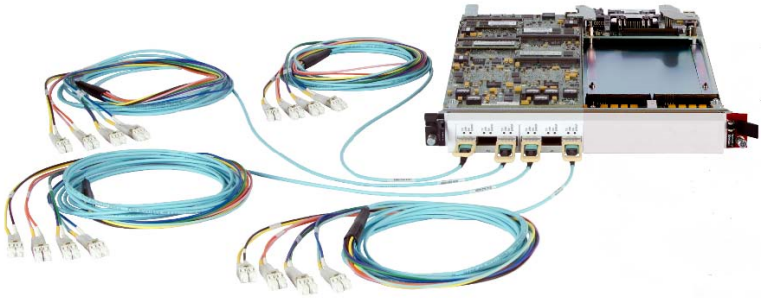
Xcellon-Multis XMR10GE16SFP+FAN is a 10-Gigabit Ethernet load module. It has 1-slot with 16-ports 10GE via multimode fan-out cables. It provides L2-7 support and is compatible with XG12 rackmount chassis.

The following components are available along with the load module:

- 4 each, 3-meter, multimode MT-to-4x10GE LC fan-out cables (942-0067)
- 4 each, QSFP+ 40GBASE-SR4 optical transceivers (948-0031).

The XMR10GE16SFP+FAN load module is shown in the following figure:

Figure: Xcellon-Multis Reduced Module-XMR10GE16SFP+FAN



40GE Fan-out options

The following fan-out options are available for XMR10GE32SFP+FAN and XMR10GE16SFP+FAN:

- XM40GE-FAN-OUT 40GE FACTORY INSTALLED fan-out option - This enables 40GE QSFP+ capability and is required on new purchases of the 40GE capability for XMR10GE32SFP+FAN and XMR10GE16SFP+FAN.
- UPG-XM40GE 40GE FIELD UPGRADE fan-out option - This enables 40GE QSFP+ capability and is required on upgrade purchases of the 40GE capability for XMR10GE32SFP+FAN and XMR10GE16SFP+FAN.

XMR40GE12QSFP+

Xcellon-Multis XMR40GE12QSFP+ is a 40-Gigabit Ethernet QSFP+ Reduced load module. It takes up 1-slot with 12-ports of 40GE QSFP+ only. It provides L2-7 support, full featured L1-3 data plane support and up to 100 protocol emulations per port. The load module is compatible with XG12 rackmount chassis.

The following components are required along with the load module:

- One or more QSFP+ 40GBASE-SR4 optical transceivers (948-0031) and MT 12-fiber MMF cable
- 3-meter length (942-0041), or QSFP+ 40GE, 40GBASE-LR4, single mode fiber optical transceiver (948-0032).

The XMR40GE12QSFP+ load module is shown in the following figure:

Figure: Xcellon-Multis Reduced Module-XMR40GE12QSFP+

XMR40GE6QSFP+

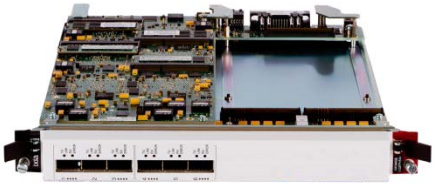
Xcellon-Multis XMR40GE6QSFP+ is a 40-Gigabit Ethernet QSFP+ Reduced load module. It has 1-slot with 6-ports of 40GE QSFP+ only. It provides L2-7 support, full featured L1-3 data plane support and up to 100 protocol emulations per port. The load module is compatible with the XG12 rackmount chassis (940-0005).

The following components are required along with the load module:

- One or more XMR40GE6QSFP+ optical transceivers (948-0031) and MT 12-fiber MMF cable
- 3-meter length (942-0041), or QSFP+ 40GE, 40GBASE-LR4, single mode fiber optical transceiver (948-0032).

The XMR40GE6QSFP+ load module is shown in the following figure:

Figure: Xcellon-Multis Reduced Module-XMR40GE6QSFP+



Part Numbers

Part Numbers for Xcellon-Multis Reduced Load Modules are provided in the following table.

Part Numbers for Xcellon-Multis Modules

Model Number	Part Number	Description
XMR10GE32SFP+FAN	947-5053	32-ports of 10GE via multimode fan-out cables.
	944-1107	UPG-XM40GE 40GE FIELD UPGRADE option for enabling 40GE QSFP+ capability on upgrade purchases.
		XM40GE-FAN-OUT 40GE FACTORY INSTALLED fan-out option for enabling 40GE QSFP+ capability on new purchases.
XMR10GE16SFP+FAN	947-5054	16-ports of 10GE via multimode fan-out cables.
	944-1108	UPG-XM40GE 40GE FIELD UPGRADE option for enabling 40GE QSFP+ capability on upgrade purchases.
		XM40GE-FAN-OUT 40GE FACTORY INSTALLED fan-out option for enabling 40GE QSFP+ capability on new purchases.
XMR40GE12QSFP+	944-1114	• 12-port 40GE with QSFP+ • 40GE only • 1 slot
XMR40GE6QSFP+	944-1115	• 6-port 40GE with QSFP+ • 40GE only • 1-slot

Specifications

Specifications of XMR10GE32SFP+FAN and XMR10GE16SFP+FAN modules

The load module specifications are contained in the following table.

Xcellon-Multis Reduced Load Module Specifications

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
Part Number	947-5053	947-5054
Hardware Load Module Specifications		
Slot/Ports	1 slot: • 32x10GE SFP+ ports (via fan-out) • 40GE fan-out (optional);	1 slot: • 16x10GE SFP+ ports (via fan-out) • 40GE fan-out (optional);

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
	- 12x40GE ports (1x10GE/port)	- 6x10GE ports (1x10GE/port)
Physical Interface	QSFP 12x40GE (native) 10GE: LC connector (fiber), or SFP+ connector (copper)	QSFP 6x40GE (native) 10GE: LC connector (fiber), or SFP+ connector (copper)
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model		
XG12 Chassis (940-0005)	10 cards: • 320-ports of 10GE (4x10GE mode) • 120-ports of 10GE (1x10GE mode) • 120-ports of 40GE (optional)	10 cards: • 160-ports of 10GE (4x10GE mode) • 60-ports of 10GE (1x10GE mode) • 120-ports of 40GE (optional)
XGS2-SD Chassis (940-0010)	2 cards: • 64-ports of 10GE (4x10GE mode) • 24-ports of 10GE (1x10GE mode) • 24-ports of 40GE (optional)	2 cards: • 32-ports of 10GE (4x10GE mode) • 12-ports of 10GE (1x10GE mode) • 12-ports of 40GE (optional)
XGS12-HSL Chassis (940-0016)	12 cards: • 768-ports of 10GE (4x10GE mode) • 288-ports of 10GE (1x10GE mode) • 288-ports of 40GE (optional)	12 cards: • 384-ports of 10GE (4x10GE mode) • 144-ports of 10GE (1x10GE mode) • 144-ports of 40GE (optional)
XGS12-SDL Chassis (940-0015)	12 cards: • 768-ports of 10GE (4x10GE mode) • 288-ports of 10GE (1x10GE mode) • 288-ports of 40GE (optional)	12 cards: • 384-ports of 10GE (4x10GE mode) • 144-ports of 10GE (1x10GE mode) • 144-ports of 40GE (optional)
XGS2-HSL Chassis (940-0014)	2 cards: • 64-ports of 10GE (4x10GE mode) • 24-ports of 10GE (1x10GE mode) • 24-ports of 40GE (optional)	2 cards: • 32-ports of 10GE (4x10GE mode) • 12-ports of 10GE (1x10GE mode) • 12-ports of 40GE (optional)

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
XGS2-SDL Chassis (940-0013)	2 cards: • 64-ports of 10GE (4x10GE mode) • 24-ports of 10GE (1x10GE mode) • 24-ports of 40GE (optional)	2 cards: • 32-ports of 10GE (4x10GE mode) • 12-ports of 10GE (1x10GE mode) • 12-ports of 40GE (optional)
CPU and Memory	Multicore processors with 4GB of memory per processor	
IEEE Interface Protocols	10GBASE-SR (802.3ae-2002), 40GBASE-SR4, 40GBASE-LR4 (802.3ba-2010)	
Transceiver Support	QSFP: • 40GBASE-SR4 (multimode 850nm) • 40GBASE-LR4 (single mode 1310nm)	
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air 0% to 85%, non-condensing	
Load Module Dimensions	16.8" (L) x 1.3" (W) x 12.0" (H) 427mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights	12-port model: • Module only: 12.5 lbs. (5.67 kg) • Shipping: 16.2 lbs. (7.35 kg) 6 port model: • Module only: 9.3 lbs. (4.22 kg) • Shipping: 13.1 lbs. (5.94 kg)	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures	
Max. Streams per Port	10GE 32x10 mode: 16 (4x10GE fan-out/port) 10GE 12x10 mode: 32 (1x10GE fan-out/port) 40GE: 32	
Max. Streams per Port in Data Center Ethernet	10GE 32x10 mode: 16 (4x10GE fan-out/port) 10GE 12x10 mode: 32 (1x10GE fan-out/port) 40GE: 32	

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler	
Minimum Frame Size	10GE: • 60 bytes (line rate) • 49 bytes (< line rate) 40GE: • 64 bytes (line rate) • 49 bytes (< line rate)	10GE: • 60 bytes (line rate) • 49 bytes (< line rate) 40GE: • 64 bytes (line rate) • 49 bytes (< line rate)
Maximum Frame Size	14,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority Flow Control	8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths 1 queue supporting up to 9,216 byte frame length	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian	
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.	
Value Lists (max.)	40GE: 1 million / UDF 10GE: • 1million / UDF(1x10GE mode) • 512K / UDF (4x10GE mode)	
Sequence (max.)	40GE: 128K / UDF 10GE: • 128K / UDF (1x10GE mode) • 64K / UDF (4x10GE mode)	40GE: 128K / UDF 10GE: • 128K / UDF (1x10GE mode) • 64K / UDF (4x10GE mode)

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP	
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics.	
Latency Measurement Resolution	40GE and 10GE: 2.5 nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency error from port electronics	
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm per resource group	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability	
Trackable Receive Flows per Port	10GE: • 128K (1x10GE mode) • 64K (4x10GE mode) 40GE: 128K (optional)	
Minimum Frame Size	64 bytes at line rate $\geq$ 49 bytes not a line rate	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available	
Hardware Capture Buffer per Port or Resource Group	10GE: • 1x10GE mode: 2GB per 1 user-selected link of the 1x10GE fan-out link resource group • 4x10GE: 256MB/port for all ports in the fan-out of the resource group 40GE: 2GB per 1, user-selected port/resource group (optional)	
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-	

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
	defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
PCS Lanes Port Statistics	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set	
Latency / Jitter Measurements	Cut-through, store & forward, forwarding delay, up to 16 time bins latency/jitter, MEF jitter, and inter-arrival time	
L2/3 Routing, Bridging, and Timing	**Routing:** RIP, RIPng, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, BGP/BGP+ **MPLS:** RSVP-TE, RSVP-TE P2MP, LDP, mLDP, BGP RFC 3107, MPLS-TP, MPLS OAM **MPLS VPN:** L2VPN PW, L3VPN/6VPE, 6PE , VPLS-LDP, VPLS-BGP, VPLS-BGP AD and LDP FEC 129, Inter-AS VPN Option A, B, and C, Seamless MPLS, Carrier Supporting Carrier (CsC), GRE mVPN, NG MVP (mLDP and RSVP-TE P2MP), EVPN/PBB-EVPN **High-Availability:** BFD, Graceful Restart, MPLS Ping/TraceRoute, LSP BFD, VCCV BFD, Real-time dynamic label swap for convergence time measurement up to millisecond accuracy **IP Multicast:** IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, multicast VPN **Switching:** STP/RSTP, MSTP, PVST+/RPVST+, LACP, LLDP, Protocols over LACP Bundle **Carrier Ethernet:** Link OAM, CFM, Service OAM, PBT/PBB-TE, SyncE, PTP (1588v2), E-LMI	
Data Center Ethernet	Priority Class-Based Flow Control (IEEE802.1Qbb), FCoE/ FIP, LLDP/DCBX, VNTAG/VIC, OpenFlow, FabricPath, TRILL, SPBM, VEPA, VXLAN	
Broadband Access	**Broadband:** ANCP, PPPoX, DHCPv4 client/server, DHCPv6 client/server, L2TPv2, Radius Attributes for L2TP, Dual-Stack PPPoX, AMT **Authentication:** 802.1x, WebAuth, Cisco NAC	
Layer 2-7 Protocol Support (32x10GE Fan-out mode)		
L2/3 routing, bridging and timing	**Routing**: RIP, RIPng, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, BGP/BGP+ **MPLS**: RSVP-TE, RSVP-TE P2MP, LDP, mLDP **MPLS VPN**: L3VPN/6VPE, 6PE , VPLS-LDP, VPLS-BGP, VPLS-BGP AD and LDP FEC 129, NG mVPN (mLDP and RSVP-TE P2MP), PWE3 **High-Availability**: BFD **IP Multicast**: IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, multicast VPN **Switching**: STP/RSTP, MSTP, PVST/PVST+/RPVST+	

Model	XMR10GE32SFP+FAN BUNDLE	XMR10GE16SFP+FAN BUNDLE
	Carrier Ethernet: Link OAM, CFM/ Y.1731, PBB-TE, SyncE, PTP (1588v2), E-LMI	
Data center Ethernet	FCoE, DCBX, VNTAG/VIC, OpenFlow, FabricPath, TRILL, SPBM, VEPA, VXLAN, DHCPv4 over VXLAN over IPv4, DHCPv6 over VXLAN over IPv4, IPv4 over VXLAN over IPv4, IPv6 over VXLAN over IPv4, IGMP over VXLAN over IPv4, MLD over VXLAN over IPv4	
Broadband access	DHCPv4 client/server, DHCPv6 client/server	

Specifications of Multis Reduced Modules with 40GE only capability

The load module specifications for the modules with 40GE only capability are contained in the following table.

Xcellon-Multis Reduced 40GE Load Module Specifications

Model Name	XMR40GE12QSFP+	SMR40GE6QSFP+
Part Number	944-1114	944-1115
Hardware Load Module Specifications		
Slot/Ports	1-slot 12x40GE ports (1x10GE/port)	1-slot: 6x10GE ports (1x10GE/port)
Physical Interface	QSFP 12x40GE (native)	QSFP 6x40GE (native)
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model		
XG12 Chassis (940-0005)	10 cards: • 120-ports of 40GE	10 cards: • 60-ports of 40GE
XGS2-SD Chassis (940-0010)	2 cards: • 24-ports of 40GE	2 cards: • 12-ports of 40GE
CPU and Memory	Multicore processors with 4GB of memory per processor	
IEEE Interface Protocols	40GBASE-SR4, 40GBASE-LR4 (802.3ba-2010)	
Transceiver Support	QSFP: • 40GBASE-SR4 (multimode 850nm) • 40GBASE-LR4 (single mode 1310nm)[viii]	

Model Name	XMR40GE12QSFP+	SMR40GE6QSFP+
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air 0% to 85%, non-condensing	
Load Module Dimensions	16.8" (L) x 1.3" (W) x 12.0" (H) 427mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights	12-port model: • Module only: 12.5 lbs. (5.67 kg) • Shipping: 16.2 lbs. (7.35 kg) 6 port model: • Module only: 9.3 lbs. (4.22 kg) • Shipping: 13.1 lbs. (5.94 kg)	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures	
Max. Streams per Port	40GE: 32	
Max. Streams per Port in Data Center Ethernet	40GE: 32	
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler	
Minimum Frame Size	40GE: • 64 bytes (line rate) • 49 bytes (< line rate)	
Maximum Frame Size	14,000 bytes	
Maximum Fame Size in Data	9,216 bytes	

Model Name	XMR40GE12QSFP+	SMR40GE6QSFP+
Center Ethernet		
Priority Flow Control	8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths 1 queue supporting up to 9,216 byte frame lengths	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian	
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.	
Value Lists (max.)	40GE: 1 million / UDF	
Sequence (max.)	40GE: 128K / UDF	
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP	
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics.	
Latency Measurement Resolution	40GE: 2.5 nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency error from port electronics	
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm per resource group	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability	
Trackable Receive Flows per Port	40GE: 128K (optional)	
Minimum Frame	64 bytes at line rate	

Model Name	XMR40GE12QSFP+	SMR40GE6QSFP+
Size	≥ 49 bytes not a line rate	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available	
Hardware Capture Buffer per Port or Resource Group	40GE: 2GB per 1, user-selected port/resource group	
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
PCS lanes port statistics (40GE mode only)	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set	
Latency / Jitter Measurements	Cut-through, store & forward, forwarding delay, up to 16 time bins latency/jitter, MEF jitter, and inter-arrival time	
Layer 2-7 Protocol Support (40GE mode)		
L2/3 Routing, Bridging, and Timing	**Routing:** RIP, RIPng, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, BGP/BGP+ **MPLS:** RSVP-TE, RSVP-TE P2MP, LDP, mLDP, BGP RFC 3107, MPLS-TP, MPLS OAM **MPLS VPN:** L2VPN PW, L3VPN/6VPE, 6PE , VPLS-LDP, VPLS-BGP, VPLS-BGP AD and LDP FEC 129, Inter-AS VPN Option A, B, and C, Seamless MPLS, Carrier Supporting Carrier (CsC), GRE mVPN, NG MVP (mLDP and RSVP-TE P2MP), EVPN/PBB-EVPN **High-Availability:** BFD, Graceful Restart, MPLS Ping/TraceRoute, LSP BFD, VCCV BFD, Real-time dynamic label swap for convergence time measurement up to millisecond accuracy **IP Multicast:** IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, multicast VPN **Switching:** STP/RSTP, MSTP, PVST+/RPVST+, LACP, LLDP, Protocols over LACP Bundle **Carrier Ethernet:** Link OAM, CFM, Service OAM, PBT/PBB-TE, SyncE, PTP (1588v2), E-LMI	
Data Center Ethernet	Priority Class-Based Flow Control (IEEE802.1Qbb), FCoE/ FIP, LLDP/DCBX, VNTAG/VIC, OpenFlow, FabricPath, TRILL, SPBM, VEPA, VXLAN	

Model Name	XMR40GE12QSFP+	SMR40GE6QSFP+
Broadband Access	**Broadband:** ANCP, PPPoX, DHCPv4 client/server, DHCPv6 client/server, L2TPv2, Radius Attributes for L2TP, Dual-Stack PPPoX, AMT **Authentication:** 802.1x, WebAuth, Cisco NAC	

Application Support

The Ixia application support for Xcellon-Multis Reduced load modules is provided in the following table:

Xcellon-Multis Reduced Load Module Application Support

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Layer 2-3 wire-speed traffic generation and analysis.
Tcl API	Custom user script development for layer 1-7 testing.

Fan-out Capability

The following are the new fan-out capabilities of the Multis Reduced load module:

- 32x10GE fan-out - This is a new capability that provides up to 32 independent 10GE QSFP+ links or generic 10GE fiber links.
- 16x10GE fan-out - This is a new capability that provides up to 16 independent 10GE QSFP+ links or generic 10GE fiber links.

There are up to four 10GE links provided via a cable per physical port. For XMR10GE32SFP+FAN, we use 8 of the 12 ports which equals 32x10GE SFP+ports. For more information, see XMR10GE32SFP+FAN. For XMR10GE16SFP+FAN, we use 4 of the 6 ports which equals 16x10GE SFP+ports. For more information, see XMR10GE16SFP +FAN.

Transceivers

The Xcellon-Multis Reduced family supports optical transceivers and fiber cables for the physical interfaces that are supported.

QSFP+ 40GE, 40GBASE-SR4 Transceiver

QSFP+ 40GE, 40GBASE-SR4 ia an optical, pluggable, MMF, 850nm transceiver is compatible with the following load modules:

- Xcellon-Multis XMR10GE32SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105)
- Xcellon-Multis XMR10GE16SFP+FAN 40-Gigabit Ethernet QSFP (944-1109)

The QSFP+ 40GE, 40GBASE-SR4 transceiver is shown in the following figure:

Figure: QSFP+ 40GE, 40GBASE-SR4 transceiver

QSFP+ 40GE, 40GBASE-LR4 Transceiver

QSFP+ 40GE, 40GBASE-LR4, optical, pluggable, SMF, 1310nm transceiver is compatible with the load modules Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105), and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).

The QSFP+ 40GE, 40GBASE-LR4 transceiver is shown in the following figure:

Figure: QSFP+ 40GE, 40GBASE-LR4 transceiver

Fan-out Cable Options

The Xcellon-Multis Reduced load module cable options are described in the following sections.

QSFP+ 40GBASE-SR4 40GE active optical parallel fiber cable

The QSFP+ 40GBASE-SR4 40GE active optical parallel fiber cable assembly has the following features:

- OM3 Multimode Fiber (MMF) 850nm
- 3-meter length

This cable is compatible with the following load modules:

- Xcellon-Multis XMR10GE32SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105)
- Xcellon-Multis XMR10GE16SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109)

The QSFP+ 40GBASE-SR4 40GE active optical parallel fiber cable is shown in the following figure:

Figure: QSFP+ 40GBASE-SR4 40GE active optical parallel fiber cable

MT-to-4x10GE LC fan-out, MMF 3-meter

MT-to-4x10GE LC fan-out, MMF, 3-meter cable requires QSFP 40GBASE-SR4, pluggable, transceiver, 850nm, MMF (948-0031). The cables and transceiver are compatible with the following load modules:

- Xcellon-Multis XMR10GE32SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105)
- Xcellon-Multis XMR10GE16SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109).

The MT-MT 4x10GE passive fiber fan-out cable is shown in the following figure:

Figure: MT-MT 4x10GE passive fiber fan-out cable

MT-to-4x10GE LC fan-out, MMF 5-meter

MT-to-4x10GE LC fan-out, MMF, 5-meter cable requires QSFP 40GBASE-SR4, pluggable, transceiver, 850nm, MMF (948-0031). The cables and transceiver are compatible with the following load modules:

- Xcellon-Multis XMR10GE32SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105)
- Xcellon-Multis XMR10GE16SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109).

The MT-MT 4x10GE SFP+ direct attach cable is shown in the following figure:

Figure: MT-MT 4x10GE passive fiber fan-out cable

QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC)

QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) is a passive copper, fan-out, cable that is 3-meter in length. This cable is compatible with the following load modules:

- Xcellon-Multis XMR10GE32SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105)
- Xcellon-Multis XMR10GE16SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109).

NOTE The load modules must have the 10GE fan-out option enabled to use this cable. This requires 905-1000 XM10GE-FAN-OUT 10GE fan-out option for NEW purchases of Xcellon-Multis load modules, or the 905-1001 UPG-XM10GE-FAN-OUT 10GE fan-out option UPGRADE for existing Xcellon-Multis load modules.

The QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) cable is shown in the following figure:

Figure: QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) cable

QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC)

QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC) is a passive copper, point-to-point cable that is 3-meter in length. This cable is compatible with the following load modules:

- Xcellon-Multis XMR10GE32SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1105)
- Xcellon-Multis XMR10GE16SFP+FAN 40-Gigabit Ethernet QSFP load module (944-1109).

The QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC) is shown in the following figure:

Figure: QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC)

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CHAPTER 17

IXIA Novus QSFP28 Load Modules

This chapter provides details about Novus 5-speed family of load modules and their specifications and features.

Novus is a 5-speed, high density, 8-port or 4-port, native QSFP28 100/50/40/25/10GbE load module. This load module family supports the test needs of both high-density, multi-rate switch/router makers and the organizations implementing the network equipment. Novus supports 8 native QSFP28 100/40GbE, 16 ports of 50 GbE and 32 ports of 25/10GbE per load module, and enables interoperability and functional testing, as well as high-port count performance testing. Its native QSFP28 100GbE/40GbE interfaces with 10GbE and 25GbE speed and fan-out cable support, that provides a more efficient and flexible set of 100/50/40/25/10GbE test use cases.

Key Features

The key features of Novus load module are as follows:

- Supports multi-vendor interoperability 100GbE, 50GbE , 40GbE, 25GbE and 10GbE testing between speeds that run over these QSFP28 optical transceivers, Active Optical Cables and passive copper Direct Attach Cable media:
- 100GBASE-SR4, 100GBASE-LR4 and 100GASE-CR4
- 50GBASE-SR2 and 50GBASE-CR2
- 40GBASE-SR4, 40GBASE-LR4 and 40GBASE-CR4
- 25GBASE-SR and 25GBASE-CR
- 10GBASE-SR, 10GBASE-LR and 10GSFP+Cu(Through fanout)
- Supports mid-range protocol testing for L2/3 routing/switching and data center test cases with the Ixia’s IxNetwork application
- Supports traffic and protocol scale and benchmark performance stress tests to ensure error-free network data transmission with long-term stability and high reliability at full 100GbE, 50GbE, 40Gbe, 25GbE, and 10GbE line rate
- Provides 100Gb/s, 50Gb/s, 40Gb/s, 25Gb/s and 10Gb/s line rate packet capture and decode tools to detect and de-bug data transmission errors
- Provides an excellent test platform for full line rate 100Gb/s to evaluate the new 100GbE ASIC designs, FPGAs, and hardware switch fabrics that use the 4x25Gb/s, 1x40Gb/s and 4x10Gb/s electrical interface
- Supports benchmarking of the data plane and protocol emulation performance and scale of ultra-high-density 100/50/40/25/10GbE-capable network equipment using industry-standard RFC benchmark tests in test beds with hundreds of 100GbE and/or 50GbE and/or 40GbE and/or 25GbE ports and/or 10GbE in a single test

- 25GbE speed support (requires purchase of the 25GbE load module option):
- Support for independent 25GbE virtual and physical fan-out configurations including: 4x25GbE
- Up to 4x25GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- 50GbE speed support (requires purchase of the 50GbE load module option):
- Support for independent 50GbE virtual and physical fan-out configurations including: 2x50GbE
- Up to 2x50GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- 40/10GbE speed support (requires purchase of the 40/10GbE load module option):
- Support for independent 40/10GbE virtual and physical fan-out configurations including: 1x40GbE and 4x10GbE
- Up to 1x40GbE/4x10GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- Ethernet Forward Error Correction on 100GbE, 50GbE and 25GbE, auto-negotiation, and link training on 100GbE, 50GbE , 40GbE, and 25GbE
- Provides a broad range of application support including: IxExplorer, IxNetwork, and the related Tcl and automation APIs.

Load Modules

The Novus family consists of the following models on a single slot card:

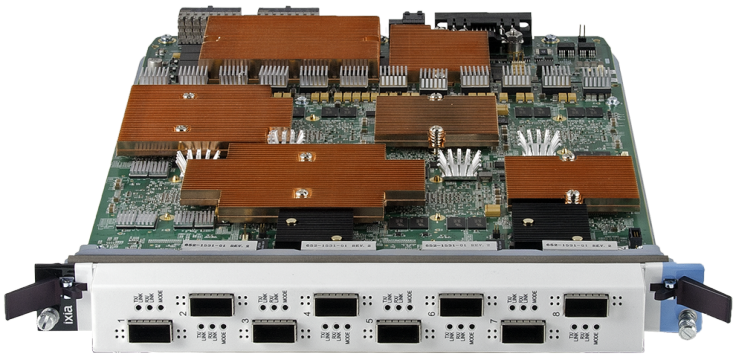
- Novus100GE4Q28+FAN
- Novus100GE4Q28+FAN+25G
- Novus100GE4Q28+FAN+50G
- Novus100GE4Q28+FAN+25G+50G
- Novus100GE4Q28+FAN+10G+25G+40G+50G
- Novus100GE8Q28+FAN
- Novus100GE8Q28+FAN+25G
- Novus100GE8Q28+FAN+50G
- Novus100GE8Q28+FAN+25G+50G
- Novus100GE8Q28+FAN+10G+25G+40G+50G

The load module is described as follows:

Novus100GE8Q28+FAN

Novus100GE8Q28+FAN is a 100 Gigabit Ethernet full-featured load module. It has 1-slot with 8-ports with the native QSFP28 physical interface. It provides L2-3 support and is compatible with the XGS2-SD 2-slot standard performance chassis (940-0010), XGS12-SD rack mount chassis (940-0011), XGS2-HSL, 2-slot high performance chassis (940-0014), and the XGS12-HSL, 12-slot high speed rackmount chassis (940-0016).

The Novus100GE8Q28+FAN load module is shown in the following figure:



Novus100GE4Q28+FAN

Novus100GE4Q28+FAN is a 4-port enablement on the NOVUS100GE8Q28+FAN load module. It has 1-slot with 4-ports with the native QSFP28 physical interface. It provides L2-3 support and is compatible with the XGS2-SD 2-slot, 3RU standard performance chassis (940-0010), XGS12-SD 12-slot, 11RU rack mount chassis (940-0011), XGS2-SDL, 2-slot, 3RU standard performance rack-mountable chassis bundle (940-0013), XGS2-HSL 2-slot, 3RU high performance chassis (940-0014), XGS12-SDL 12-slot, 11RU standard performance rack-mountable chassis bundle (940-0015), and the XGS12-HSL, 12-slot 11RU high speed rackmount chassis (940-0016).

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2x50GbE/4x25GbE options for Novus100GE8Q28+FAN and Novus100GE4Q28+FAN

2x50GbE/4x25GbE options for Novus100GE8Q28+FAN and Novus100GE4Q28+FAN are available in two forms:

- Factory Installed
- Field Upgrade

2x50GbE/4x25GbE factory installed

The 2x50GbE/4x25GbE Fan-Out FACTORY INSTALLED option for the Novus100GE8Q28+FAN/Novus100GE4Q28+FAN load module enables 2x50GbE/4x25GbE capability on all eight 100GbE QSFP28 ports on the module. The 2x50GbE/4x25GbE capability is per 100GE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE and 50GbE per channel operation. This is ONLY supported on the Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules.

NOTE The factory installed option is required for new purchases of the 2x50GbE/4x25GbE capability for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load modules with native QSFP28 8x100GbE physical interfaces.

2x50GbE/4x25GbE field upgrade

The 2x50GbE/4x25GbE Fan-Out FIELD UPGRADE option for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load module enables 2x50GbE/4x25GbE capability on all eight 100GbE

QSFP28 ports on the module. The 2x50GbE/4x25GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE and 50GbE per channel operation. This is ONLY supported on the Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules.

NOTE The field upgrade option is required on field upgrade purchases of the 2x50GbE/4x25GbE capability for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load modules with native QSFP28 8x100GbE physical interfaces. Please provide the serial number of the desired load module at the time of placement of order, to install the option.

1x40GbE/4x10GbE options for Novus100GE8Q28+FAN and Novus100GE4Q28+FAN

1x40GbE/4x10GbE options for Novus100GE8Q28+FAN and Novus100GE4Q28+FAN are available in two forms:

- Factory Installed
- Field Upgrade

1x40GbE/4x10GbE factory installed

The 1x40GbE/4x10GbE Fan-Out FACTORY INSTALLED option for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load modules enables 1x40GbE/4x10GbE capability on all eight 100GbE QSFP28 ports on the module. The 1x40GbE/4x10GbE capability is per 100GE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 40GbE and 10GbE per channel operation. This is ONLY supported on the Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules.

NOTE The factory installed option is required for new purchases of the 1x40GbE/4x10GbE capability for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load modules with native QSFP28 8x100GbE physical interfaces.

1x40GbE/4x10GbE field upgrade

The 1x40GbE/4x10GbE Fan-Out FIELD UPGRADE option for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load modules enables 1x40GbE/4x10GbE capability on all eight 100GbE QSFP28 ports on the module. The 1x40GbE/4x10GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 40GbE and 10GbE per channel operation. This is ONLY supported on the Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules.

NOTE The field upgrade option is required on field upgrade purchases of the 1x40GbE/4x10GbE capability for the Novus100GE8Q28+FAN and Novus100GE4Q28+FAN load modules with native QSFP28 8x100GbE physical interfaces. Please provide the serial number of the desired load module at the time of placement of order, to install the option .

Novus 2x50GbE/4x25GbE and 1x40GbE/4x10GbEcapability through 25GbE, 50GbE and 40/10GbE license

2x50GbE/4x25GbE and 1x40GbE/4x10GbE options can be upgraded in the following Novus load module through license. By default, the ports are in 100GbE mode for the following load modules:

- Novus100GE8Q28+FAN (944-1140)
- Novus100GE4Q28+FAN (944-1165)

Part Numbers

Part Numbers for Novus Load Module and Supported Adapters are provided in the following table.

Model Number	Part Number	Description
Novus100GE8Q28+FAN	944-1140	• 8-ports of 100GbE with the QSFP28 physical interface • 100GbE only
Novus100GE4Q28+FAN	944-1165	4-ports of 100GbE with the QSFP28 physical interface.
	905-1096	Field Upgrade from Novus100GE4Q28+FAN 4-port full scale and performance load module (944-1165) to Novus100GE8Q28+FAN 8-port, QSFP28 100GE full scale and performance load module (944-1140).
Novus100GE8Q28+FAN and Novus100GE4Q28+FAN	905-1007	• 4x25GbE factory installed option for Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules • Enables 4x25GbE capability on all eight 100GbE QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE per channel operation • Supports Auto Negotiation and RS-FEC for 100GbE and 25GbE
	905-1008	• The 4x25GbE field upgrade option for Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules • Enables 4x25GbE capability on all eight 100GbE QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE per channel operation • Supports Auto Negotiation and RS-FEC for 100GbE

Model Number	Part Number	Description
		and 25GbE
	905-1011	• 2x50GbE factory installed option for Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules • Enables 2x50GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbEpoint-to-point QSFP28 cable • Supports Auto Negotiation, BASE-R FEC and RS-FEC for 50GbE
	905-1012	• 2x50GbE field upgrade option for Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules • Enables 2x50GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation, BASE-R FEC and RS-FEC for 50GbE
	905-1025	• 1x40GbE/4x10GbE factory installed option for Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules • Enables 1x40GbE/4x10GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation
	905-1026	• 1x40GbE/4x10GbE field upgrade option for Novus100GE8Q28+FAN (944-1140) and Novus100GE4Q28+FAN (944-1165) load modules • Enables 1x40GbE/4x10GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation

Specifications

The load module specifications are contained in the following table.

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
Hardware Load Module Specifications		
Slot / Number of Ports	1-slot / 8x100GE native QSFP28, 16x50GbE, 8x40GbE, ports, 32x25GbE ports to 32x10GbE ports via fan-out media.	1-slot / 4x100GE native QSFP28, 8x50GbE, 4x40GbE, ports, 16x25GbE ports to 16x10GbE ports via fan-out media.
Physical Interface	8-ports of Native QSFP28	NOVUS100GE4Q28+FAN is an 8-port hardware load module with 4-ports enabled.
Supported Port Speeds	• 100GbE/port: 100GbE-capable fiber and passive copper cable media • 4x25GbE/port: 25GbE-capable fiber and passive copper point-point and fan-out cable media • 2x50GbE/port: 50GbE-capable fiber and passive copper point-to-point and fan-out cable media • 1x40GbE/4x10GbE per port: 40/10GbE-capable fiber and passive copper point-to-point and fan-out cable media	
CPU and Memory	Multicore processor with 2GB of CPU memory per port	
IEEE Interface Protocols	• IEEE 802.3ae • IEEE 802.3bj • IEEE 802.3bm • IEEEP802.3by (draft specification 3.2)	
25G Consortium specification	25GbE: Compatible with version 1.5 50GbE: Compatible with version 1.5	
Advanced Layer 1 support	10GbE: • Independent fan-out ports with physical fan-out media for up to 4x10GbE per QSFP28 port 25GbE: • Auto-negotiation (AN), Clause 73 for passive copper DAC • Link Training(LT) for 25GE copper DAC media (Clause 93, 110) • Ethernet Forward Error Correction : BASE-R, Clause 74 and RS FEC, Clause 108 • FEC statistics: FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability • Independent fan-out ports with physical fan-out media for up to 4x25GE per QSFP28 port	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
	40GbE: • Auto-negotiation (AN) (based on Clause 73) • Link training (LT) for 40GbE copper DAC media (clause 93) • Ability to independently turn ON/OFF AN with Link training or to allow IEEE defaults to automatically manage the interoperability 50GbE: • Auto-negotiation (AN) (based on Clause 73) • Link training (LT) for 50GbE copper DAC media (clause 93) • Ethernet Forward Correction : BASE-R based on Clause 74 and RS-FEC based on Clause 91 • FEC statistics: FEC Corrected and Uncorrected Counts • Ability to independently turn ON/OFF AN with Link training or FEC or to allow IEEE defaults to automatically manage the interoperability • Independent fan-out ports with physical fan-out media for up to 2x50GbE per QSFP28 port 100GbE: • Auto-negotiation (AN, Clause 73 for copper DAC) • Link training for 100GbE copper cable media (Clause 93) • Ethernet Forward Error Correction (RS-FEC , Clause 91) • FEC statistics: RS-FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with and Link Training, or FEC, or to allow IEEE defaults to automatically manage the interoperability. AN needs to be turned on to enable Link Training	
Transceiver Support	• 100GBASE-SR4, 100GBASE-LR4, 40GBASE-SR4, 40GBASE-LR4, and 4x25GBASE-SR QSFP28 for multimode fiber ▪ Pluggable transceiver ▪ 25GbE/50GbE speed support requires a point-to-point or a fan-out cable ▪ Active Optical Cable (AOC) This transceiver supports the 25GbE and 50GbE speeds (PN 905-1007, 905-1008, 905-1011, 905-1012) on the Novus100GE8Q28+FAN load module	
Cable Media	• 100GBASE-SR4 multimode fiber Active Optical Cable (AOC) and MT-MT 12-fiber point-to-point cables for QSFP28 • 100GBASE-CR4, passive, copper Direct Attached Cable (DAC) up to 5 meters in length; note: requires RS-FEC to be enabled • 40GBASE-SR4 multimode fiber Active Optical Cable (AOC) and MT-MT 12-fiber point-to-point cables for QSFP28	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
	• 40GBASE-CR4, passive, copper Direct Attached Cable (DAC) up to 3 meters in length • 25GBASE-SR multimode fiber Optical Cable (AOC) and MT-MT 12-fiber point-to-point cable for QSFP28, 3 meter length is available • 25GBASE-SR multimode fiber MT-to-4xLC fan-out cable for QSFP28, 3 meter and 5 meter lengths are available • 25GBASE-CR passive, copper Direct Attached Cable (DAC) point-point, up to 5 meters in length; Note: Requires BASE-R FEC Clause 74 to be enabled • 25GBASE-CR passive, copper Direct Attached Cable (DAC) QSFP28-to-4xSFP28 fan-out media, up to 5 meters in length; Note: Requires BASE-R FEC Clause 74 to be enabled NOTE When operating in 25GbE/50GbE mode, the only supported Direct Attached Copper (DAC) cables are the ones that respect the compliance code for CA-L, CA-S or CA-N cable assembly type. If cables without compliance code are used, link will not be established on IXIA equipment side.	
Cables	• 942-0067: MT-to-4x10GbE LC fan-out, MMF, 3-meter cable for 10GbE and 25GbE fan-out. For 4x25GbE fan-out it requires a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GbE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 942-0068: MT-to-4x10GbE LC fan-out, MMF, 5-meter cable for 10GbE and 25GbE fan-out. For 4x25GbE fan-out it requires a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GbE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 942-0088: QSFP28 passive, copper, Direct Attach Cable (DAC), 3-meter length for Xcellon-Multis XM100GE4QSFP28+ENH 100GE load module (944-1117) and the Novus100GE8Q28+FAN, 8-port, QSFP28 100GbE load module (944-1140). • 942-0092: QSFP28 Active Optical Cable (AOC), multimode fiber, 850nm, 3-meter length. Compatible with the Xcellon-Lava CFP-to-QSFP28 interface adapter (948-0029), Xcellon-Multis XM100GE4QSFP28+ENH 100-Gigabit Ethernet, Enhanced load module (944-1117) and the Novus100GE8Q28+FAN, 8-port, QSFP28 100GbE load module (944-1140). • 942-0093: QSFP28-to-QSFP28 passive copper, Direct Attached Cable (DAC), 1-meter long. • 942-0071: QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC), passive copper, point-to-point cable, 3-meter length. This cable is compatible with these load modules: Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
	1109). • 942-0069: QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) passive copper, fan-out, 3-meter length. This cable is compatible with these load modules: Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109). NOTE: The load modules must have the 10GE fan-out option enabled to use this cable. REQUIRES: 905-1000 XM10GE-FAN-OUT 10GE fan-out option for NEW purchases of Xcellon-Multis load modules, or the 905- 1001 UPG-XM10GE-FAN-OUT 10GE fan-out option UPGRADE for existing Xcellon-Multis load modules.	
Load Module Dimensions	17.3” (L) x 1.3” (W) x 12.0” (H) 440mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights	Module only: 11.8 lbs. (5.35 kg) Shipping: 18.6 lbs. (8.44 kg)	
Temperature	Operating: 41°F to 95°F (5°C to 35°C) Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing	
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model		
XGS12-SD Chassis (940-0011)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE	12 load modules: • Rackmount chassis • 48-ports of 100GbE • 96-ports of 50GbE • 192-ports of 25GbE • 48-ports of 40GbE • 192-ports of 10GbE
XGS12-HSL Chassis (940-0016)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE	12 load modules: • Rackmount chassis • 48-ports of 100GbE • 96-ports of 50GbE • 192-ports of 25GbE • 48-ports of 40GbE • 192-ports of 10GbE
XGS2-SD Chassis	2 load modules:	2 load modules:

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
(940-0010)	• Desktop chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE	• Desktop chassis • 8-ports of 100GbE • 16-ports of 50GbE • 32-ports of 25GbE • 8-ports of 40GbE • 32 ports of 10GbE
XGS2-HSL Chassis (940-0014)	2 load modules: • Rackmount chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE	2 load modules: • Rackmount chassis • 8-ports of 100GbE • 16-ports of 50GbE • 32-ports of 25GbE • 8-ports of 40GbE • 32 ports of 10GbE
XGS12-SDL Chassis (940-0011)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE	12 load modules: • Rackmount chassis • 48-ports of 100GbE • 96-ports of 50GbE • 192-ports of 25GbE • 48-ports of 40GbE • 192-ports of 10GbE
XGS2-SDL Chassis (940-0013)	2 load modules: • Rackmount chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE	2 load modules: • Rackmount chassis • 8-ports of 100GbE • 16-ports of 50GbE • 32-ports of 25GbE • 8-ports of 40GbE • 32 ports of 10GbE
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures	
Max. Streams per Port	• 100GbE: 64 • 50GbE: 16 • 25GbE: 16	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
	• 40GbE: 64 • 10GbE: 16 For High Stream Mode: • 100GbE: 128 • 50GbE: 64 • 25GbE: 64 • 40GbE: 128 • 10GbE: 64	
Max. Streams per Port in Data Center Ethernet	• 100GbE: 64 • 50GbE: 16 • 25GbE: 16 • 40GbE: 64 • 10GbE: 16 For High Stream Mode: • 100GbE: 128 • 50GbE: 64 • 25GbE: 64 • 40GbE: 128 • 10GbE: 64	
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler	
Minimum Frame Size	60 bytes at full line rate	
Maximum Frame Size	14,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths For High Stream Mode: • 1 queue supporting up to 9,216 byte frame lengths	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian	
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available. UDF 1-10 supports Value Lists. For High Stream Mode, UDF 1-5 supports Value Lists.	
Value Lists (max.)	1M/UDF For High Stream Mode, the values are: • 100GbE and 40GbE: 2M/UDF • 50GbE: 1M/UDF • 25GbE and 10GbE: 512K/UDF	
Sequence (max.)	• 100GbE: 8K / UDF • 50GbE: 4K / UDF • 25GbE: 2K/UDF • 40GbE: 8K/UDF • 10GbE: 2K/UDF	
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP	
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics; generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner.	
Latency Measurement Resolution	2.5 nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm across all ports on the load module.	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability	
Trackable Receive Flows per Port	100GbE/40GbE: • 32k PGIDs limited statistics (regardless of TxRxSynch mode) • 8k PGIDs full statistics is non-TxRxSynch mode • 4k PGID full statistics in TxRxSynch mode 50GbE: • 16k PGIDs limited statistics (regardless of TxRxSynch mode) • 8k PGIDs full statistics is non-TxRxSynch mode • 4k PGID full statistics in TxRxSynch mode 25GbE/10GbE: • 8k PGIDs limited statistics (regardless of TxRxSynch mode) • 4k PGIDs full statistics is non-TxRxSynch mode • 2k PGID full statistics in TxRxSynch mode	
Limited Stats Capability	Supports a higher number of PGID/flows, but each with reduced measurements • Latency stats are Average only ◦ Min/Max latency are not included • Basic Sequence check is a flag (yes/no) to indicate if a sequence error occurred during transmission • There are no small/big/reverse sequence error counts	
Minimum Frame Size	64 bytes at full line rate into the capture buffer	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.	
Hardware Capture Buffer per Port or Resource Group	By Default, there are two 512 MB capture buffers on the card. You can select the port or resource group each capture buffer may be assigned for capture. Only one capture buffer may be assigned to a single Resource Group, that is 4x25 GbE or 4x10 GbE mode or 2x50 GbE mode. If you turn on **Capture Extended Mode**, all 8 ports will support capture. To turn on this mode, refer to the *IxServer Guide*.	

Feature	Novus100GE8Q28+FAN	Novus100GE4Q28+FAN
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies, FEC statistics: RS-FEC Corrected and Uncorrected Codeword Counts.	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.	
Receive-side PCS Lanes Port Statistics Counters	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set.	
100GE Physical Coding Sublayer (PCS) Receive-Side Statistics and Indicators	IEEE 802.3ba-compliant PCS transmit and receive side test capabilities include: Per PCS lane, receive lanes statistics - PCS Sync Header and Lane Marker Lock, Lane Marker mapping, Relative lane deskew up to 104 microseconds for 100GE, Sync Header and PCS Lane Marker Error counters, indicators for Loss of Synch Header and Lane Marker, and BIP8 errors.	
Layer 2-3 Protocol Support		
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, Seamless BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP	
Software Defined Network	OpenFlow, Segment Routing MPLS (ISIS, OSPFv2, OSPFv3, BGP), Segment Routing IPv6 (ISIS, L3VPN, EVPN), BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE, BGP FlowSpec, BGP SR TE Policy, Netconf, BIER, eCPRI, Flex-Algo (ISIS, OSPFv2)	
MPLS	RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS/VPWS, L3VPN/6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN	
Broadband and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP/MLD, 802.1x, Bonded GRE HG	
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, Sync-E ESMC, IEEE 1588v2 (PTP), NTP	
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA	
L2 Security	MACsec	

Application Support

The Ixia application support Novus load modules is provided in the following table:

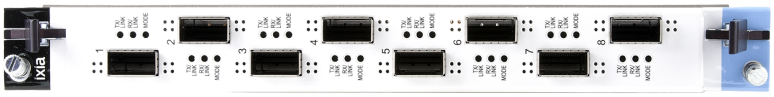
Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides layer 2-3 wire-speed traffic generation and analysis and IEEE 802.3ba HSE PCS Lanes testing. **Note**: Not all Ixia loads modules support Layer 1 BERT and/or the complete set of PCS Lanes test capabilities.
Tcl API	Allows custom user script development for layer 1-3 testing.

Mechanical Specifications

Front Panel

The front panel of Novus load modules is shown in the following figure:

Figure: Front panel of Novus100GE8Q28+FAN



LED Panel

There are 3 tricolor LEDs per port. The LED panel specifications for Novus are provided in the following table.

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
100GbE	Port Inactive/No Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Mode=Off Card Fault=Solid Red
50GbE	Link Up (1 link) = Solid Yellow Link Down = Solid Red Link Up (all) = Solid Green Tx Axctive = Blinking Green	Port Inactive/No Power = Off Rx Active with Errors = Blinking Red Rx Active = Blinking Green	Mode = Solid White Card Fault = Solid Red
25GbE	Link Up (1,2, or 3 links) =Solid	Port Inactive/No Power=Off	Mode=Solid Blue

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
	Yellow Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Card Fault=Solid Red
40GbE	Link Down = Solid Red Link Up (1 link) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Green Card Fault = Solid Red
10GbE	Link Down = Solid Red Link Up (1,2 or 3 links) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Yellow Card Fault = Solid Red

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CHAPTER 18

IXIA Novus-R QSFP28 Load Modules

This chapter provides details about Novus-R family of load modules and their specifications and features.

Novus-R is a next generation, high density, 8-port, native QSFP28 100/25GE load module. This load module family supports the test needs of both high-density, multi-rate switch/router makers and the organizations implementing the network equipment. Novus-R supports 8 native QSFP28 100/40GbE, 16 ports of 50 GbE and 32 ports of 25/10GbE per load module, and enables interoperability and functional testing, as well as high-port count performance testing. Its native QSFP28 100GE/40GbE interfaces with 10GbE and 25GbE speed and fan-out cable support, that provides a more efficient and flexible set of 100/50/40/25/10GbE test use cases. It is field upgradeable to the full feature compliant Novus100GE8Q28+FAN load module.

For more information on Novus family of load modules, see Novus Load Modules.

Key Features

The key features of Novus-R load module are as follows:

- Supports multi-vendor interoperability 100GbE, 50GbE , 40GbE, 25GbE and 10GbE testing between speeds that run over these QSFP28 optical transceivers, Active Optical Cables and 100GBASE-CR4 passive copper Direct Attach Cable media:
- 100GBASE-SR4, 100GBASE-LR4 and 100GASE-CR4
- 50GBASE-SR2 and 50GBASE-CR2
- 40GBASE-SR4, 40GBASE-LR4 and 40GBASE-CR4
- 25GBASE-SR and 25GBASE-CR
- 10GBASE-SR, 10GBASE-LR and 10GSFP+Cu(Through fanout)
- Supports limited host protocols and data center test cases with the Ixia’s IxNetwork application
- Provides 100Gb/s, 50Gb/s, 40Gb/s, 25Gb/s and 10Gb/s line rate packet capture and decode tools to detect and de-bug data transmission errors
- Provides an excellent test platform for full line rate 100Gb/s to evaluate the new 100GbE ASIC designs, FPGAs, and hardware switch fabrics that use the 4x25Gb/s, 1x40Gb/s and 4x10Gb/s electrical interface
- Supports benchmarking of the data plane and protocol emulation performance and scale of ultra-high-density 00/50/40/25/10GbE-capable network equipment using industry-standard RFC benchmark tests in test beds with hundreds of 100GbE and/or 50GbE and/or 40GbE and/or 25GbE ports and/or 10GbE in a single test
- 25GbE speed support (requires purchase of the 25GbE load module option):

- Support for independent 25GE virtual and physical fan-out configurations including: 4x25GbE
- Up to 4x25GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- 50GbE speed support (requires purchase of the 50GbE load module option):
- Support for independent 50GbE virtual and physical fan-out configurations including: 2x50GbE
- Up to 2x50GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- 40/10GbE speed support (requires purchase of the 40/10GbE load module option):
- Support for independent 40/10GbE virtual and physical fan-out configurations including: 1x40GbE and 4x10GbE
- Up to 1x40GbE/4x10GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- Ethernet Forward Error Correction on 100GbE, 50GbE and 25GbE, auto-negotiation, and link training on 100GbE, 50GbE , 40GbE, and 25GbE
- Provides a broad range of application support including: IxExplorer, IxNetwork, and the related Tcl and automation APIs.
- It is field upgradeable to the full feature compliant Novus100GE8Q28+FAN load module

Load Modules

The Novus-R family consists of the following model on a single slot card:

- Novus-R100GE8Q28+FAN
- Novus-R100GE8Q28+FAN+25G
- Novus-R100GE8Q28+FAN+RU
- Novus-R100GE8Q28+FAN+RU+25G
- Novus-R100GE8Q28+FAN+RU+50G
- Novus-R100GE8Q28+FAN+RU+25G+50G
- Novus-R100GE8Q28+FAN+RU+10G+25G+40G+50G

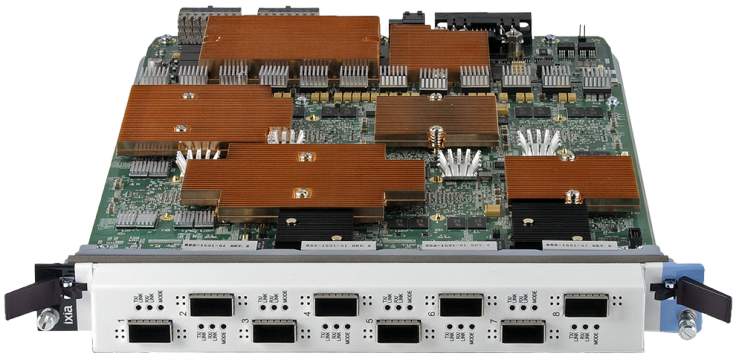
The load module is described as follows:

Novus-R100GE8Q28+FAN

Novus-R100GE8Q28+FAN is a 100 Gigabit Ethernet reduced feature load module. It is field upgradeable to the full feature compliant Novus100GE8Q28+FAN load module. It has 1-slot with 8-ports with the native QSFP28 physical interface. It provides L2-3 support and is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

The Novus-R100GE8Q28+FAN load module is shown in the following figure:

Figure: Novus Module-Novus-R100GE8Q28+FAN



2x50GbE/4x25GbE options for Novus-R100GE8Q28+FAN

2x50GbE/4x25GbE options for Novus-R100GE8Q28+FAN is available in two forms:

- Factory Installed
- Field Upgrade

2x50GbE/4x25GbE factory installed

The 2x50GbE/4x25GbE Fan-Out FACTORY INSTALLED option for the Novus-R100GE8Q28+FAN load module enables 2x50GbE/4x25GbE capability on all eight 100GE QSFP28 ports on the module. The 2x50GbE/4x25GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE and 50GbE per channel operation. This is supported on the Novus100GE8Q28+FAN (944-1140) and Novus-R100GE8Q28+FAN (944-1147) load modules.

NOTE The factory installed option is required for new purchases of the 2x50GbE/4x25GbE capability for the Novus-R100GE8Q28+FAN load module with native QSFP28 8x100GE physical interfaces.

2x50GbE/4x25GbE field upgrade

The 2x50GbE/4x25GbE Fan-Out FIELD UPGRADE option for the Novus-R100GE8Q28+FAN load module enables 2x50GbE/4x25GbE capability on all eight 100GE QSFP28 ports on the module. The 2x50GbE/4x25GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE and 50GbE per channel operation. This is supported on the Novus100GE8Q28+FAN (944-1140) and Novus-R100GE8Q28+FAN (944-1147) load modules.

NOTE The field upgrade option is required on field upgrade purchases of the 2x50GbE/4x25GbE capability for the Novus-R100GE8Q28+FAN load module with native QSFP28 8x100GE physical interfaces. Please provide the serial number of the desired load module at the time of placement of order, to install the option .

1x40GbE/4x10GbE options for Novus-R100GE8Q28+FAN

1x40GbE/4x10GbE options for Novus-R100GE8Q28+FAN is available in two forms:

- Factory Installed
- Field Upgrade

1x40GbE/4x10GbE factory installed

The 1x40GbE/4x10GbE Fan-Out FACTORY INSTALLED option for the Novus-R100GE8Q28+FAN load module enables 1x40GbE/4x10GbE capability on all eight 100GbE QSFP28 ports on the module. The 1x40GbE/4x10GbE capability is per 100GE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 40GbE and 10GbE per channel operation. This is ONLY supported on the Novus-R100GE8Q28+FAN (944-1147) load module.

NOTE The factory installed option is required for new purchases of the 1x40GbE/4x10GbE capability for the Novus-R100GE8Q28+FAN load module with native QSFP28 8x100GbE physical interfaces.

1x40GbE/4x10GbE field upgrade

The 1x40GbE/4x10GbE Fan-Out FIELD UPGRADE option for the Novus-R100GE8Q28+FAN load module enables 1x40GbE/4x10GbE capability on all eight 100GbE QSFP28 ports on the module. The 1x40GbE/4x10GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 40GbE and 10GbE per channel operation. This is ONLY supported on the Novus-R100GE8Q28+FAN (944-1147) load module.

NOTE The field upgrade option is required on field upgrade purchases of the 1x40GbE/4x10GbE capability for the Novus-R100GE8Q28+FAN load module with native QSFP28 8x100GbE physical interfaces. Please provide the serial number of the desired load module at the time of placement of order, to install the option .

Novus 2x50GbE/4x25GbE and 1x40GbE/4x10GbEcapability through 25GbE, 50GbE and 40/10GbE license

2x50GbE/4x25GbE and 1x40GbE/4x10GbE options can be upgraded in the following Novus-R load module through license. By default, the ports are in 100GbE mode for this load module.

- Novus-R100GE8Q28+FAN (944-1147)

Novus-R UPG field upgrade

The following Novus-R load module can be upgraded to enhance the data plane feature set and to add full support for all IxNetwork L23 protocol emulations equal to that of the full featured Novus QSFP28 8x100GE load module (944-1140).

- Novus-R100GE8Q28+FAN (944-1147)

After the upgrade is complete, the load module is named Novus-R100GE8Q28+FAN+RU instead of Novus100GE8Q28+FAN.

NOTE For the Novus-R upgrade purchase, please provide the serial number of the desired load module at the time of placement of order, to install the option .

Part Numbers

Part Numbers for Novus-R Load Module and Supported Adapters are provided in the following table.

Part Numbers for Novus Modules

Model Number	Part Number	Description
Novus-R100GE8Q28+FAN	944-1147	• Reduced load module • 8-ports of 100GbE with the QSFP28 physical interface • 100GbE only
	905-1007	• 4x25GbE factory installed option for Novus100GE8Q28+FAN load module (944-1140) and Novus-R100GE8Q28+FAN load module (944-1147) • Enables 4x25GbE capability on all eight 100GbE QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE per channel operation • Supports 100GbE Auto Negotiation and 100GbE RS-FEC • Support 25GbE Auto Negotiation and 25GbE FC-FEC
	905-1008	• The 4x25GbE field upgrade option for Novus100GE8Q28+FAN load module (944-1140) and Novus-R100GE8Q28+FAN load module (944-1147) • Enables 4x25GbE capability on all eight 100GbE QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE per channel operation • Supports 100GbE Auto Negotiation and 100GbE RS-FEC • Support 25GbE Auto Negotiation and 25GbE FC-FEC
	905-1011	• 2x50GbE factory installed option for Novus100GE8Q28+FAN load module (944-1140) • Enables 2x50GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbEpoint-to-point QSFP28 cable • Supports Auto Negotiation, BASE-R FEC and RS-FEC for 50GbE
	905-1012	• 2x50GbE field upgrade option for Novus100GE8Q28+FAN load module (944-1140) • Enables 2x50GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbEpoint-to-point QSFP28 cable

Model Number	Part Number	Description
		• Supports Auto Negotiation, BASE-R FEC and RS-FEC for 50GbE
	905-1013	• The Novus-R-UPG field upgrade option for Novus-R100GE8Q28+FAN load module (944-1147) • Enhances data plane feature set • Adds full support for all IxNetwork L23 protocol emulations equal to that of Novus QSFP28 8x100GE load module (944-1140)
	905-1025	• 1x40GbE/4x10GbE factory installed option for Novus100GE8Q28+FAN load module (944-1140) • Enables 1x40GbE/4x10GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation
	905-1026	• 1x40GbE/4x10GbE field upgrade option for Novus100GE8Q28+FAN load module (944-1140) • Enables 1x40GbE/4x10GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation

Specifications

The load module specifications are contained in the following table.

Novus Load Module Specifications

Feature	Novus-R100GE8Q28+FAN
Hardware Load Module Specifications	
Slot / Number of Ports	1-slot / 8x100GE native QSFP28, 16x50GbE, 8x40GbE, ports, 32x25GbE ports to 32x10GbE ports via fan-out media.
Physical Interface	Native QSFP28
Supported Port Speeds	• 100GbE/port: 100GE-capable fiber and copper cable media • 4x25GbE/port: 25GbE-capable fiber and copper point-point and fan-out cable media

Feature	Novus-R100GE8Q28+FAN
	• 2x50GbE/port: 50GbE-capable fiber and passive copper point-to-point and fan-out cable media • 1x40GbE/4x10GbE per port: 40/10GbE-capable fiber and passive copper point-to-point and fan-out cable media
CPU and Memory	Multicore processor with 2GB of CPU memory per port
IEEE Interface Protocols	• IEEE 802.3ae • IEEE 802.3bj • IEEE 802.3bm • IEEEP802.3by (draft specification 3.2)
25G Consortium specification	25GbE: Compatible with version 1.5 50GbE: Compatible with version 1.5
Advanced Layer 1 support	100GbE: • Auto-negotiation (AN, Clause 73 for copper DAC) • Link training for 100GE copper cable media (Clause 73) • Ethernet Forward Error Correction (RS-FEC , Clause 91) • FEC statistics: RS-FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with and Link Training, or FEC, or to allow IEEE defaults to automatically manage the interoperability. AN needs to be turned on to enable Link Training 50GbE: • Auto-negotiation (AN) (based on Clause 73) • Link training (LT) for 50GbE copper DAC media (clause 93) • Ethernet Forward Correction : BASE-R based on Clause 74 and RS-FEC based on Clause 91 • FEC statistics: FEC Corrected and Uncorrected Counts • Ability to independently turn ON/OFF AN with Link training or FEC or to allow IEEE defaults to automatically manage the interoperability • Independent fan-out ports with physical fan-out media for up to 2x50GbE per QSFP28 port 40GbE: • Auto-negotiation (AN) (based on Clause 73) • Link training (LT) for 40GbE copper DAC media (clause 93) • Ability to independently turn ON/OFF AN with Link training or to allow IEEE defaults to automatically manage the interoperability 25GbE:

Feature	Novus-R100GE8Q28+FAN
	• Auto-negotiation (AN, Clause 73 for copper DAC) • Link training for 25GbE copper DAC media (Clause 93, 110) • Ethernet Forward Error Correction (BASE-R, Clause 74) • FEC statistics: FC-FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with and Link Training, or FEC, or to allow IEEE defaults to automatically manage the interoperability • Independent fan-out ports with physical fan-out media for up to 4x25GbE per QSFP28 port 10GbE: • Independent fan-out ports with physical fan-out media for up to 4x10GbE per QSFP28 port
Transceiver Support	• 100GBASE-SR4, 100GBASE-LR4, 40GBASE-SR4, 40GBASE-LR4 and 4x25GBASE-SR QSFP28 for multimode fiber ▪ Pluggable transceiver ▪ 25GbE speed support requires a point-to-point or a fan-out cable NOTE This transceiver supports the 25GbE and 50GbE speeds (PN 905-1007, 905-1008, 905-1011, 905-1012) on the Novus100GE8Q28+FAN load module • 100GBASE-LR4 QSFP28 for single-mode fiber ▪ Pluggable transceiver
Cable Media	• 100GBASE-SR4 multimode fiber Active Optical Cable (AOC) and MT-MT 12-fiber point-to-point cables for QSFP28 • 100GBASE-CR4, passive, copper Direct Attached Cable (DAC) up to 5 meters in length; note: requires RS-FEC to be enabled 40GBASE-SR4 multimode fiber Active Optical Cable (AOC) and MT-MT 12-fiber point-to-point cables for QSFP28 • 40GBASE-CR4, passive, copper Direct Attached Cable (DAC) up to 3 meters in length • 25GBASE-SR multimode fiber Optical Cable (AOC) and MT-MT 12-fiber point-to-point cable for QSFP28, 3 meter length is available • 25GBASE-SR multimode fiber MT-to-4xLC fan-out cable for QSFP28, 3 meter and 5 meter lengths are available • 25GBASE-CR passive, copper Direct Attached Cable (DAC) point-point, up to 5 meters in length; note: requires BASE-R FEC Clause 74 to be enabled • 25GBASE-CR passive, copper Direct Attached Cable (DAC) QSFP28-to-4xSFP28 fan-out media, up to 5 meters in length; note: requires BASE-R FEC Clause 74 to be enabled

Feature	Novus-R100GE8Q28+FAN
	NOTE When operating in 25GbE/50GbE mode, the only supported Direct Attached Copper (DAC) cables are the ones that respect the compliance code for CA-L, CA-S or CA-N cable assembly type. If cables without compliance code are used, link will not be established on IXIA equipment side.
Cables	• 942-0067: MT-to-4x10GE LC fan-out, MMF, 3-meter cable for 10GE and 25GE fan-out. For 4x25GE fan-out it requires a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 942-0068: MT-to-4x10GE LC fan-out, MMF, 5-meter cable for 10GE and 25GE fan-out. For 4x25GE fan-out it REQUIRES a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 942-0088: QSFP28 passive, copper, Direct Attach Cable (DAC), 3-meter length for Xcellon-Multis XM100GE4QSFP28+ENH 100GE load module (944-1117) and the Novus100GE8Q28+FAN, 8-port, QSFP28 100GE load module (944-1140). • 942-0092: QSFP28 Active Optical Cable (AOC), multimode fiber, 850nm, 3-meter length. Compatible with the Xcellon-Lava CFP-to-QSFP28 interface adapter (948-0029), Xcellon-Multis XM100GE4QSFP28+ENH 100-Gigabit Ethernet, Enhanced load module (944-1117) and the Novus100GE8Q28+FAN, 8-port, QSFP28 100GE load module (944-1140). • 942-0093: QSFP28-to-QSFP28 passive copper, Direct Attached Cable (DAC), 1-meter long • 942-0069: QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) passive copper, fan-out, 3-meter length. This cable is compatible with these load modules: Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109). NOTE: The load modules must have the 10GE fan-out option enabled to use this cable. REQUIRES: 905-1000 XM10GE-FAN-OUT 10GE fan-out option for NEW purchases of Xcellon-Multis load modules, or the 905- 1001 UPG-XM10GE-FAN-OUT 10GE fan-out option UPGRADE for existing Xcellon-Multis load modules. • 942-0071: QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC), passive copper, point-to-point cable, 3-meter length. This cable is compatible with these load modules: Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).
Load Module Dimensions	17.3” (L) x 1.3” (W) x 12.0” (H) 440mm (L) x 33mm (W) x 305mm (H)

Feature	Novus-R100GE8Q28+FAN
Load Module Weights	Module only: 11.8 lbs. (5.35 kg) Shipping: 18.6 lbs. (8.44 kg)
Temperature	Operating: 41°F to 95°F (5°C to 35°C) Storage: 41°F to 122°F (5°C to 50°C)
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model	
XGS12-SD Chassis (940-0011)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE
XGS2-SD Chassis (940-0010)	2 load modules: • Desktop chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE
XGS2-HSL Chassis (940-0014)	2 load modules: • Desktop chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE
XGS12-HSL Chassis (940-0016)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE

Feature	Novus-R100GE8Q28+FAN
	• 96-ports of 40GbE • 384-ports of 10GbE
XGS2-SDL Chassis (940-0013)	2 load modules: • Desktop chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE
XGS12-SDL Chassis (940-0011)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE
Transmit Feature Specifications	
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures
Max. Streams per Port	• 100GbE: 64 • 50GbE: 16 • 25GbE: 16 • 40GbE: 64 • 10GbE: 16 For High Stream Mode: • 100GbE: 128 • 50GbE: 64 • 25GbE: 64 • 40GbE: 128 • 10GbE: 64
Max. Streams per Port in Data Center Ethernet	• 100GbE: 64 • 50GbE: 16 • 25GbE: 16

Feature	Novus-R100GE8Q28+FAN
	• 40GbE: 64 • 10GbE: 16 For High Stream Mode: • 100GbE: 128 • 50GbE: 64 • 25GbE: 64 • 40GbE: 128 • 10GbE: 64
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler
Minimum Frame Size	60 bytes at full line rate
Maximum Frame Size	14,000 bytes
Maximum Fame Size in Data Center Ethernet	9,216 bytes
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths For High Stream Mode: • 1 queue supporting up to 9,216 byte frame lengths
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available. For High Stream Mode, UDF 1-5 supports Value Lists.
Value Lists (max.)	1M / UDF

Feature	Novus-R100GE8Q28+FAN
	For High Stream Mode, the values are: • 100GbE and 40GbE: 64K/UDF • 50GbE: 32K/UDF • 25GbE and 10GbE: 32K/UDF
Sequence (max.)	• 100GbE: 8K / UDF • 50GbE: 4K / UDF • 25GbE: 2K/UDF • 40GbE: 8K/UDF • 10GbE: 2K/UDF
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics; generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner.
Latency Measurement Resolution	2.5 nanoseconds
Intrinsic Latency Compensation	Removes inherent latency
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm across all 100GbE ports on the load module.
Receive Feature Specifications	
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability
Trackable Receive Flows per Port	100GbE/40GbE: • 32K limited statistics mode • 4K full statistics mode 50GbE: • 16k PGIDs limited statistics (regardless of TxRxSynch mode)

Feature	Novus-R100GE8Q28+FAN
	• 8k PGIDs full statistics is non-TxRxSynch mode • 4k PGID full statistics in TxRxSynch mode 25GbE/10GbE: • 8K limited statistics mode • 2K full statistics mode
Limited Stats Capability	Supports a higher number of PGID/flows, but each with reduced measurements • Latency stats are Average only ◦ Min/Max latency are not included • Basic Sequence check is a flag (yes/no) to indicate if a sequence error occurred during transmission • There are no small/big/reverse sequence error counts
Minimum Frame Size	64 bytes at full line rate into the capture buffer
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.
Hardware Capture Buffer per Port or Resource Group	By Default, there are two 512 MB capture buffers on the card. You can select the port or resource group each capture buffer may be assigned for capture. Only one capture buffer may be assigned to a single Resource Group, that is 4x25 GbE or 4x10 GbE mode or 2x50 GbE mode. If you turn on **Capture Extended Mode**, all 8 ports will support capture. To turn on this mode, refer to the *IxServer Guide*.
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies, FEC statistics: RS-FEC Corrected and Uncorrected Codeword Counts.
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.
Receive-side PCS Lanes Port Statistics Counters	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set.
100GE Physical Coding Sublayer (PCS) Receive-Side Statistics	IEEE 802.3ba-compliant PCS transmit and receive side test capabilities include: Per PCS lane, receive lanes statistics - PCS Sync Header and Lane Marker Lock, Lane Marker mapping, Relative lane deskew up to 104 microseconds for 100GE, Sync Header and PCS Lane Marker Error counters, indicators for Loss of

Feature	Novus-R100GE8Q28+FAN
and Indicators	Synch Header and Lane Marker, and BIP8 errors.

Product Description	Novus-R100GE8Q28+FAN
Routing and Switching	Only supported with Novus-R upgrade option (905-1013).
Software Defined Network	Only supported with Novus-R upgrade option (905-1013).
MPLS	Only supported with Novus-R upgrade option (905-1013).
Broadband and Authentication	IPv4/IPv4, DHCP, PPPoE, L2TP, IGMP, MLD, 802.1x.
Industrial Ethernet	Only supported with Novus-R upgrade option (905-1013).
Data Center Ethernet	FCoE/FIP, Priority Flow Control IEEE 802.1Qbb (PFC), and LLDP/DCBX.

Application Support

The Ixia application support Novus load modules is provided in the following table:

Novus-R Application Support

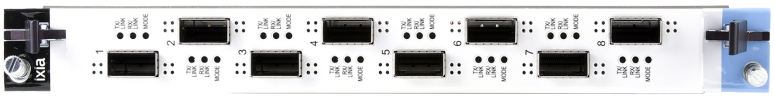
Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides layer 2-3 wire-speed traffic generation and analysis and IEEE 802.3ba HSE PCS Lanes testing. **Note**: Not all Ixia loads modules support Layer 1 BERT and/or the complete set of PCS Lanes test capabilities.
Tcl API	Allows custom user script development for layer 1-3 testing.

Mechanical Specifications

Front Panel

The front panel of Novus-R load module is shown in the following figure:

Figure: Front panel of Novus-R100GE8Q28+FAN



LED Panel

There are 3 tricolor LEDs per port. The LED panel specifications for Novus-R are provided in the following table.

LED panel Specifications for Novus-R Load Module

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
100GbE	Port Inactive/No Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Mode=Off Card Fault=Solid Red
50GbE	Link Up (1 link) = Solid Yellow Link Down = Solid Red Link Up (all) = Solid Green Tx Axctive = Blinking Green	Port Inactive/No Power = Off Rx Active with Errors = Blinking Red Rx Active = Blinking Green	50GbE Speed Mode = Solid White Card Fault = Solid Red
25GbE	Link Up (1,2, or 3 links) =Solid Yellow Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	25GbE Speed Mode=Solid Blue Card Fault=Solid Red
40GbE	Link Down = Solid Red Link Up (1 link) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Green Card Fault = Solid Red
10GbE	Link Down = Solid Red Link Up (1,2 or 3 links) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Yellow Card Fault = Solid Red

CHAPTER 19

IXIA Novus-M QSFP28 Load Modules

This chapter provides details about Novus-M family of load modules and their specifications and features.

Novus-M is a next Generation, high density, 8-port, native QSFP28 100/50/40/25/10GbE load module. This load module family supports the test needs of both high-density, multi-rate switch/router makers and the organizations implementing the network equipment. Novus-M supports 8 native QSFP28 100/40GbE, 16 ports of 50 GbE and 32 ports of 25/10GbE per load module, and enables interoperability and functional testing, as well as high-port count performance testing. Its native QSFP28 100GbE/40GbE interfaces with 10GbE and 25GbE speed and fan-out cable support, that provides a more efficient and flexible set of 100/50/40/25/10GbE test use cases.

For more information on Novus family of load modules, see Novus Load Modules.

Key Features

The key features of Novus-M load module are as follows:

- Supports multi-vendor interoperability 100GbE, 50GbE and 25GbE testing between speeds that run over these QSFP28 optical transceivers, Active Optical Cables and 100GBASE-CR4 passive copper Direct Attach Cable media:
- 100GBASE-SR4, 100GBASE-LR4 and 100GASE-CR4
- 50GBASE-SR2 and 50GBASE-CR2
- 40GBASE-SR4, 40GBASE-LR4 and 40GBASE-CR4
- 25GBASE-SR and 25GBASE-CR
- 10GBASE-SR, 10GBASE-LR and 10GSFP+Cu(Through fanout)
- Supports L2/3 protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases using Ixia's IxNetwork application
- Supports medium host protocols and data center test cases with the Ixia's IxNetwork application
- Provides 100Gb/s, 50Gb/s, 40Gb/s, 25Gb/s and 10Gb/s line rate packet capture and decode tools to detect and de-bug data transmission errors
- Provides an excellent test platform for full line rate 100Gb/s to evaluate the new 100GbE ASIC designs, FPGAs, and hardware switch fabrics that use the 4x25Gb/s, 1x40Gb/s and 4x10Gb/s electrical interface
- Supports benchmarking of the data plane and protocol emulation performance and scale of ultra-high-density 100/50/40/25/10GbE-capable network equipment using industry-standard

RFC benchmark tests in test beds with hundreds of 100GbE and/or 50GbE and/or 40GbE and/or 25GbE ports and/or 10GbE in a single test

- 25GbE speed support (requires purchase of the 25GbE load module option):
- Support for independent 25GbE virtual and physical fan-out configurations including: 4x25GbE
- Up to 4x25GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- 50GbE speed support (requires purchase of the 50GbE load module option):
- Support for independent 50GbE virtual and physical fan-out configurations including: 2x50GbE
- Up to 2x50GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- 40/10GbE speed support (requires purchase of the 40/10GbE load module option):
- Support for independent 40/10GbE virtual and physical fan-out configurations including: 1x40GbE and 4x10GbE
- Up to 1x40GbE/4x10GbE links over single point-to-point 100GbE cable media (MT-MT, AOC, or DAC media)
- Ethernet Forward Error Correction on 100GbE, 50GbE and 25GbE, auto-negotiation, auto-negotiation, and link training on 100GbE, 50GbE , 40GbE, and 25GbE
- Provides a broad ranGbE of application support including: IxExplorer, IxNetwork, and the related Tcl and automation APIs.

Load Modules

The Novus-M family consists of the following models on a single slot card:

- Novus-M100GbE8Q28+FAN
- Novus-M100GE8Q28+FAN+25G+50G
- Novus-M100GE8Q28+FAN+10G+25G+40G+50G

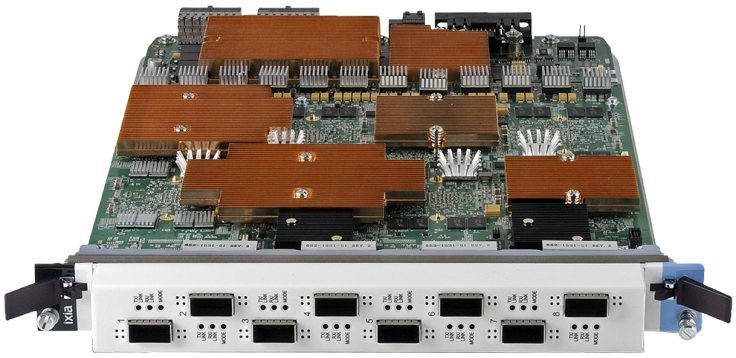
The load module is described as follows:

Novus-M100GbE8Q28+FAN

Novus-M100GbE8Q28+FAN is a 100 Gigabit Ethernet reduced feature load module. It has 1-slot with 8-ports with the native QSFP28 physical interface. It provides L2-3 support with complete protocol coverage, and mid-range scale and performance protocol emulation for routing, switching and access protocols. and is compatible with the XGS12-SD 12-slot, standard performance rack mount chassis bundle (940-0011), XGS2-SD 2-slot, 3RU standard performance chassis bundle (940-0010), XGS2-HSL 2-slot, 3RU high-speed performance chassis bundle (940-0014), and XGS12-HSL 12-slot, high-speed performance rackmount chassis bundle (940-0016).

The Novus-M100GbE8Q28+FAN load module is shown in the following figure:

Figure: Novus Module-Novus-M100GbE8Q28+FAN



2x50GbE/4x25GbE options for Novus-M100GbE8Q28+FAN

2x50GbE/4x25GbE options for Novus-M100GbE8Q28+FAN is available in two forms:

- Factory Installed
- Field Upgrade

2x50GbE/4x25GbE Factory Installed

The 2x50GbE/4x25GbE Fan-Out FACTORY INSTALLED option for the Novus-M100GbE8Q28+FAN load module enables 2x50GbE/4x25GbE capability on all eight 100GbE QSFP28 ports on the module. The 2x50GbE/4x25GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 2x50GbE/4x25GbE per channel operation. This is supported on the Novus-M100GbE8Q28+FAN (944-1156) load module.

NOTE The factory installed option is required for new purchases of the 2x50GbE/4x25GbE capability for the Novus-M100GbE8Q28+FAN load module with native QSFP28 8x100GbE physical interfaces.

2x50GbE/4x25GbE Field Upgrade

The 2x50GbE/4x25GbE Fan-Out FIELD UPGRADE option for the Novus-M100GbE8Q28+FAN load module enables 2x50GbE/4x25GbE capability on all eight 100GbE QSFP28 ports on the module. The 2x50GbE/4x25GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE and 50GbE per channel operation. This is supported on the Novus-M100GbE8Q28+FAN (944-1156) load module.

NOTE The field upgrade option is required on field upgrade purchases of the 2x50GbE/4x25GbE capability for the Novus-M100GbE8Q28+FAN load module with native QSFP28 8x100GbE physical interfaces. Please provide the serial number of the desired load module at the time of placement of order, to install the option .

1x40GbE/4x10GbE options for Novus-M100GE8Q28+FAN

1x40GbE/4x10GbE options for Novus-M100GE8Q28+FAN is available in two forms:

- Factory Installed
- Field Upgrade

1x40GbE/4x10GbE factory installed

The 1x40GbE/4x10GbE Fan-Out FACTORY INSTALLED option for the Novus-M100GE8Q28+FAN load module enables 1x40GbE/4x10GbE capability on all eight 100GbE QSFP28 ports on the module. The 1x40GbE/4x10GbE capability is per 100GE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 40GbE and 10GbE per channel operation. This is ONLY supported on the Novus-M100GE8Q28+FAN (944-1156) load module.

NOTE The factory installed option is required for new purchases of the 1x40GbE/4x10GbE capability for the Novus-M100GE8Q28+FAN load module with native QSFP28 8x100GbE physical interfaces.

1x40GbE/4x10GbE field upgrade

The 1x40GbE/4x10GbE Fan-Out FIELD UPGRADE option for the Novus-M100GE8Q28+FAN load module enables 1x40GbE/4x10GbE capability on all eight 100GbE QSFP28 ports on the module. The 1x40GbE/4x10GbE capability is per 100GbE port and is ONLY supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 40GbE and 10GbE per channel operation. This is ONLY supported on the Novus-M100GE8Q28+FAN (944-1156) load module.

NOTE The field upgrade option is required on field upgrade purchases of the 1x40GbE/4x10GbE capability for the Novus-M100GE8Q28+FAN load module with native QSFP28 8x100GbE physical interfaces. Please provide the serial number of the desired load module at the time of placement of order, to install the option .

Novus 2x50GbE/4x25GbE and 1x40GbE/4x10GbEcapability through 25GbE, 50GbE and 40/10GbE license

2x50GbE/4x25GbE and 1x40GbE/4x10GbE options can be upgraded in the following Novus-M load module through license. By default, the ports are in 100GbE mode for this load module.

- Novus-M100GE8Q28+FAN (944-1156)

Part Numbers

Part Numbers for Novus-M Load Module and Supported Adapters are provided in the following table.

Part Numbers for Novus-M Load Modules

Model Number	Part Number	Description
Novus-M100GbE8Q28+FAN	944-1156	• 8-ports of 100GbE with the QSFP28 physical interface • 100GbE only
	905-1007	• 4x25GbE factory installed option for Novus100GbE8Q28+FAN load module (944-1140) and Novus-R100GbE8Q28+FAN load module (944-1147)

Model Number	Part Number	Description
		• Enables 4x25GbE capability on all eight 100GbE QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE per channel operation • Supports 100GbE Auto Negotiation and 100GbE RS-FEC • Support 25GbE Auto Negotiation and 25GbE FC-FEC
	905-1008	• The 4x25GbE field upgrade option for Novus100GbE8Q28+FAN load module (944-1140) and Novus-R100GbE8Q28+FAN load module (944-1147) • Enables 4x25GbE capability on all eight 100GbE QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable where each channel of the cable is rated for 25GbE per channel operation • Supports 100GbE Auto Negotiation and 100GbE RS-FEC • Support 25GbE Auto Negotiation and 25GbE FC-FEC
	905-1011	• 2x50GbE factory installed option for Novus100GE8Q28+FAN load module (944-1140) • Enables 2x50GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbEpoint-to-point QSFP28 cable • Supports Auto Negotiation, BASE-R FEC and RS-FEC for 50GbE
	905-1012	• 2x50GbE field upgrade option for Novus100GE8Q28+FAN load module (944-1140) • Enables 2x50GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbEpoint-to-point QSFP28 cable • Supports Auto Negotiation, BASE-R FEC and RS-FEC for 50GbE
	905-1025	• 1x40GbE/4x10GbE factory installed option for Novus100GE8Q28+FAN load module (944-1140)

Model Number	Part Number	Description
		• Enables 1x40GbE/4x10GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation
	905-1026	• 1x40GbE/4x10GbE field upgrade option for Novus100GE8Q28+FAN load module (944-1140) • Enables 1x40GbE/4x10GbE capability on all eight 100G QSFP28 ports on the module • Supported over a single 100GbE point-to-point QSFP28 cable • Supports Auto Negotiation

Specifications

The load module specifications are contained in the following table.

Novus-M Load Module Specifications

Feature	Novus-M100GbE8Q28+FAN
Hardware Load Module Specifications	
Slot / Number of Ports	1-slot / 8x100GE native QSFP28, 16x50GbE, 8x40GbE, ports, 32x25GbE ports to 32x10GbE ports via fan-out media.
Physical Interface	8-ports of Native QSFP28.
Supported Port Speeds	• 100GbE/port: 100GbE-capable fiber and passive copper cable media • 4x25GbE/port: 25GbE-capable fiber and passive copper point-point and fan-out cable media • 2x50GbE/port: 50GbE-capable fiber and passive copper point-to-point and fan-out cable media • 1x40GbE/4x10GbE per port: 40/10GbE-capable fiber and passive copper point-to-point and fan-out cable media
CPU and Memory	Multicore processor with 2GB of CPU memory per port.
IEEE Interface Protocols	• IEEE 802.3ae • IEEE 802.3bj

Feature	Novus-M100GbE8Q28+FAN
	• IEEE 802.3bm • IEEEP802.3by (draft specification 3.2)
25G Consortium specification	25GbE: Compatible with version 1.5 50GbE: Compatible with version 1.5
Advanced Layer 1 support	100GbE: • Auto-negotiation (AN, Clause 73 for copper DAC) • Link training for 100GbE copper cable media (Clause 73) • Ethernet Forward Error Correction (RS-FEC , Clause 91) • FEC statistics: RS-FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability 50GbE: • Auto-negotiation (AN) (based on Clause 73) • Link training (LT) for 50GbE copper DAC media (clause 93) • Ethernet Forward Correction : BASE-R based on Clause 74 and RS-FEC based on Clause 91 • FEC statistics: FEC Corrected and Uncorrected Counts • Ability to independently turn ON/OFF AN with Link training or FEC or to allow IEEE defaults to automatically manage the interoperability • Independent fan-out ports with physical fan-out media for up to 2x50GbE per QSFP28 port 40GbE: • Auto-negotiation (AN) (based on Clause 73) • Link training (LT) for 40GbE copper DAC media (clause 93) • Ability to independently turn ON/OFF AN with Link training or to allow IEEE defaults to automatically manage the interoperability 25GbE: • Auto-negotiation (AN, Clause 73 for copper DAC) • Link training (LT) for 25GbE copper DAC media (Clause 93, 110) Note: Clause 72 link training patterns are not supported • Ethernet Forward Error Correction (BASE-R, Clause 74) • FEC statistics: FC-FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with and Link Training, or FEC, or to allow IEEE defaults to automatically manage the interoperability • Independent fan-out ports with physical fan-out media for up to 4x25GbE per QSFP28 port 10GbE:

Feature	Novus-M100GbE8Q28+FAN
	• Independent fan-out ports with physical fan-out media for up to 4x10GbE per QSFP28 port
Transceiver Support	• 100GBASE-SR4, 100GBASE-LR4, 40GBASE-SR4, 40GBASE-LR4, and 4x25GBASE-SR QSFP28 for multimode fiber ▪ Pluggable transceiver ▪ 25GbE speed support requires a point-to-point or a fan-out cable NOTE ▪ This transceiver supports the 25GbE and 50GbE speeds (PN 905-1007, 905-1008, 905-1011, 905-1012) on the Novus100GE8Q28+FAN load module • 100GBASE-LR4 QSFP28 for single-mode fiber ▪ Pluggable transceiver
Cable Media	• 100GBASE-SR4 multimode fiber Active Optical Cable (AOC) and MT-MT 12-fiber point-to-point cables for QSFP28 • 100GBASE-CR4, passive, copper Direct Attached Cable (DAC) up to 5 meters in length; note: requires RS-FEC to be enabled • 40GBASE-SR4 multimode fiber Active Optical Cable (AOC) and MT-MT 12-fiber point-to-point cables for QSFP28 • 40GBASE-CR4, passive, copper Direct Attached Cable (DAC) up to 3 meters in length • 25GBASE-SR multimode fiber Optical Cable (AOC) and MT-MT 12-fiber point-to-point cable for QSFP28, 3 meter length is available • 25GBASE-SR multimode fiber MT-to-4xLC fan-out cable for QSFP28, 3 meter and 5 meter lengths are available • 25GBASE-CR passive, copper Direct Attached Cable (DAC) point-point, up to 5 meters in length; note: requires BASE-R FEC Clause 74 to be enabled • 25GBASE-CR passive, copper Direct Attached Cable (DAC) QSFP28-to-4xSFP28 fan-out media, up to 5 meters in length; Note: requires BASE-R FEC Clause 74 to be enabled NOTE When operating in 25GbE/50GbE mode, the only supported Direct Attached Copper (DAC) cables are the ones that respect the compliance code for CA-L, CA-S or CA-N cable assembly type. If cables without compliance code are used, link will not be established on IXIA equipment side.
Cables and Transceivers	• QSFP28 100GBASE-SR4 100GbE pluggable optical transceiver, MMF (multimode), 850nm, 100m reach • QSFP28 100GBASE-LR4 100GbE pluggable optical transceiver, SMF (single mode fiber), 1310nm, 10km reach • 942-0067: MT-to-4x10GbE LC fan-out, MMF, 3-meter cable for 10GbE

Feature	Novus-M100GbE8Q28+FAN
	and 25GbE fan-out. For 4x25GbE fan-out it requires a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GbE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 942-0068: MT-to-4x10GbE LC fan-out, MMF, 5-meter cable for 10GbE and 25GbE fan-out. For 4x25GbE fan-out it REQUIRES a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GbE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 942-0088: QSFP28 passive, copper, Direct Attach Cable (DAC), 3-meter length for Xcellon-Multis XM100GbE4QSFP28+ENH 100GbE load module (944-1117) and the Novus100GbE8Q28+FAN, 8-port, QSFP28 100GbE load module (944-1140). • 942-0092: QSFP28 Active Optical Cable (AOC), multimode fiber, 850nm, 3-meter length. Compatible with the Xcellon-Lava CFP-to-QSFP28 interface adapter (948-0029), Xcellon-Multis XM100GbE4QSFP28+ENH 100-Gigabit Ethernet, Enhanced load module (944-1117) and the Novus100GbE8Q28+FAN, 8-port, QSFP28 100GbE load module (944-1140). • 942-0093: QSFP28-to-QSFP28 passive copper, Direct Attached Cable (DAC), 1-meter long. • 942-0069: QSFP-to-4x10GE SFP+ Direct Attach Cable (DAC) passive copper, fan-out, 3-meter length. This cable is compatible with these load modules: Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109). NOTE: The load modules must have the 10GE fan-out option enabled to use this cable. REQUIRES: 905-1000 XM10GE-FAN-OUT 10GE fan-out option for NEW purchases of Xcellon-Multis load modules, or the 905- 1001 UPG-XM10GE-FAN-OUT 10GE fan-out option UPGRADE for existing Xcellon-Multis load modules. • 942-0071: QSFP-to-QSFP 40GE 40GBASE-CR4 Direct Attach Cable (DAC), passive copper, point-to-point cable, 3-meter length. This cable is compatible with these load modules: Xcellon-Multis XM10/40GE12QSFP+FAN 40-Gigabit Ethernet QSFP (944-1105) and Xcellon-Multis XM10/40GE6QSFP+FAN 40-Gigabit Ethernet QSFP (944-1109).
Load Module Dimensions	17.3” (L) x 1.3” (W) x 12.0” (H) 440mm (L) x 33mm (W) x 305mm (H)
Load Module Weights	Module only: 11.8 lbs. (5.35 kg) Shipping: 18.6 lbs. (8.44 kg)
Temperature	Operating: 41°F to 95°F (5°C to 35°C) Storage: 41°F to 122°F (5°C to 50°C)
Humidity	Operating: 0% to 85%, non-condensing

Feature	Novus-M100GbE8Q28+FAN
	Storage: 0% to 85%, non-condensing
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model	
XGS12-SD Chassis (940-0011)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE
XGS12-HSL Chassis (940-0016)	12 load modules: • Rackmount chassis • 96-ports of 100GbE • 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384 ports of 10GbE
XGS2-SD Chassis (940-0010)	2 load modules: • Desktop chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE
XGS2-HSL Chassis (940-0014)	2 load modules: • Desktop chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE
XGS12-SDL Chassis (940-0011)	12 load modules: • Rackmount chassis • 96-ports of 100GbE

Feature	Novus-M100GbE8Q28+FAN
	• 192-ports of 50GbE • 384-ports of 25GbE • 96-ports of 40GbE • 384-ports of 10GbE
XGS2-SDL Chassis (940-0013)	2 load modules: • Rackmount chassis • 16-ports of 100GbE • 32-ports of 50GbE • 64-ports of 25GbE • 16-ports of 40GbE • 64 ports of 10GbE
Transmit Feature Specifications	
Transmit Engine	Wire-speed packet Generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.
Max. Streams per Port	• 100GbE: 64 • 50GbE: 16 • 25GbE: 16 • 40GbE: 64 • 10GbE: 16 For High Stream Mode: • 100GbE: 128 • 50GbE: 64 • 25GbE: 64 • 40GbE: 128 • 10GbE: 64
Max. Streams per Port in Data Center Ethernet	• 100GbE: 64 • 50GbE: 16 • 25GbE: 16 • 40GbE: 64 • 10GbE: 16 For High Stream Mode: • 100GbE: 128 • 50GbE: 64 • 25GbE: 64

Feature	Novus-M100GbE8Q28+FAN
	• 40GbE: 128 • 10GbE: 64
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler
Minimum Frame Size	60 bytes at full line rate
Maximum Frame Size	14,000 bytes
Maximum Fame Size in Data Center Ethernet	9,216 bytes
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths For High Stream Mode: • 1 queue supporting up to 9,216 byte frame lengths
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian .
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available. For High Stream Mode, UDF 1-5 supports Value Lists.
Value Lists (max.)	1M / UDF For High Stream Mode, the values are: • 100GbE and 40GbE: 64K/UDF • 50GbE: 32K/UDF • 25GbE and 10GbE: 32K/UDF
Sequence (max.)	• 100GbE: 8K / UDF • 50GbE: 4K / UDF

Feature	Novus-M100GbE8Q28+FAN
	• 25GbE: 2K/UDF • 40GbE: 8K/UDF • 10GbE: 2K/UDF
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum.
Hardware Checksum Generation	Checksum Generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP .
Link Fault Signaling	Reports port statistics; Generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner.
Latency Measurement Resolution	2.5 nanoseconds.
Intrinsic Latency Compensation	Removes inherent latency
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm across all 100GbE ports on the load module.
Receive Feature Specifications	
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability.
Trackable Receive Flows per Port	100GbE/40GbE: • 32K limited statistics mode • 4K full statistics mode 50GbE: • 16k PGIDs limited statistics (regardless of TxRxSynch mode) • 8k PGIDs full statistics is non-TxRxSynch mode • 4k PGID full statistics in TxRxSynch mode 25GbE/10GbE: • 8K limited statistics mode • 2K full statistics mode
Limited Stats Capability	Supports a higher number of PGID/flows, but each with reduced measurements • Latency stats are Average only

Feature	Novus-M100GbE8Q28+FAN
	◦ Min/Max latency are not included • Basic Sequence check is a flag (yes/no) to indicate if a sequence error occurred during transmission • There are no small/big/reverse sequence error counts
Minimum Frame Size	64 bytes at full line rate into the capture buffer
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.
Hardware Capture Buffer per Port or Resource Group	By Default, there are two 512 MB capture buffers on the card. You can select the port or resource group each capture buffer may be assigned for capture. Only one capture buffer may be assigned to a single Resource Group, that is 4x25 GbE or 4x10 GbE mode or 2x50 GbE mode. If you turn on **Capture Extended Mode**, all 8 ports will support capture. To turn on this mode, refer to the *IxServer Guide*.
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagGbEd frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies, FEC statistics: RS-FEC Corrected and Uncorrected Block Counts, FEC Corrected Error Bits, FEC Sync.
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.
Receive-side PCS Lanes Port Statistics Counters	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set.
100GbE Physical Coding Sublayer (PCS) Receive-Side Statistics and Indicators	IEEE 802.3ba-compliant PCS transmit and receive side test capabilities include: Per PCS lane, receive lanes statistics - PCS Sync Header and Lane Marker Lock, Lane Marker mapping, Relative lane deskew up to 104 microseconds for 100GbE, Sync Header and PCS Lane Marker Error counters, indicators for Loss of Synch Header and Lane Marker, and BIP8 errors.
Layer 2-3 Protocol Support	
Routing and Switching	BGP-4, BGP+, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, RIP, RIPng, BFD, IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, STP/RSTP, MSTP, PVST+/RPVST+, Link Aggregation (LACP), LLDP
Software	VXLAN, EVPN VXLAN, OpenFlow, ISIS Segment Routing, OSPF Segment

Feature	Novus-M100GbE8Q28+FAN
Defined Network	Routing, BGP Segment Routing, BGP Link State (BGP-LS), PCEP, OVSDB
Basic	IPv4/IPv6, DHCP, PPPoE, L2TP, IGMP, MLD, 802.1x
MPLS	RSVP-TE, RSVP-TE P2MP, LDP/LDPv6, mLDP, PWE, VPLS-LDP, VPLS-BGP, BGP auto-discovery with LDP FEC 129 support, L3 MPLS VPN/6VPE, 6PE, BGP RT-Constraint, BGP Labeled unicast, L3 Inter-AS VPN Options (A, B, C), MPLS-TP, MPLS OAM, Multicast VPN (GRE, mLDP, RSVP-TE P2MP), EVPN, PBB-EVPN
Broadband and Authentication	PPPoX, DHCPv4, DHCPv6, L2TPv2, Radius attributes for L2TP, ANCP, IPv6 Autoconfiguration (SLAAC), IGMPv1/v2/v3, MLDv1/v2, 802.1x
Industrial Ethernet	Link OAM IEEE 802.3ah, CFM IEEE 802.1ag, Service OAM ITUT-Y.1731, PBT/PBB-TE, Sync-E ESMC, PTP IEEE 1588 with G.8265.1 Telecom Profile, ELMI
Data Center Ethernet	FCoE/FIP, Priority Flow Control IEEE 802.1Qbb (PFC), LLDP/DCBX

Product Description	Novus-M100GbE8Q28+FAN
Routing and Switching	Only supported with Novus-R upgrade option (905-1013).
Software Defined Network	Only supported with Novus-R upgrade option (905-1013).
MPLS	Only supported with Novus-R upgrade option (905-1013).
Broadband and Authentication	IPv4/IPv4, DHCP, PPPoE, L2TP, IGMP, MLD, 802.1x.
Industrial Ethernet	Only supported with Novus-R upgrade option (905-1013).
Data Center Ethernet	FCoE/FIP, Priority Flow Control IEEE 802.1Qbb (PFC), and LLDP/DCBX.

Application Support

The Ixia application support Novus load modules is provided in the following table:

Novus-M Application Support

Application	Support
IxNetwork	Provides wire-rate traffic Generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.

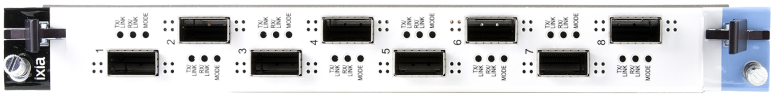
Application	Support
IxExplorer	Provides layer 2-3 wire-speed traffic Generation and analysis and IEEE 802.3ba HSE PCS Lanes testing. NOTE Not all Ixia loads modules support Layer 1 BERT and/or the complete set of PCS Lanes test capabilities.
Tcl API	Allows custom user script development for layer 1-3 testing.

Mechanical Specifications

Front Panel

The front panel of Novus-M load module is shown in the following figure:

Figure: Front panel of Novus-M100GbE8Q28+FAN



LED Panel

There are 3 tricolor LEDs per port. The LED panel specifications for Novus-M are provided in the following table:

LED panel Specifications for Novus-M Load Module

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
100GbE	Port Inactive/No Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Mode=Off Card Fault=Solid Red
50GbE	Link Up (1 link) = Solid Yellow Link Down = Solid Red Link Up (all) = Solid Green Tx Axctive = Blinking Green	Port Inactive/No Power = Off Rx Active with Errors = Blinking Red Rx Active = Blinking Green	50GbE Speed Mode = Solid White Card Fault = Solid Red
25GbE	Link Up (1,2, or 3 links) =Solid Yellow Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	25GbE Speed Mode=Solid Blue Card Fault=Solid Red

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
40GbE	Link Down = Solid Red Link Up (1 link) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Green Card Fault = Solid Red
10GbE	Link Down = Solid Red Link Up (1,2 or 3 links) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Yellow Card Fault = Solid Red

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CHAPTER 20

IXIA Novus 10GE/1GE/100M Ethernet Load Modules

This chapter provides details about Novus 10/1 family of load modules and its specifications and features.

Novus 10/1 is a new, tri-speed, high density, multi-rate ethernet load module with up to 16 Dual-PHY ports per module. This load module family supports complete Layer 2-7 (L2-7) network and application testing in a single system. It provides support for Dual-PHY (SFP+ and 10GBase-T RJ45), and enables up to line-rate L2/3 traffic generation and analysis, high-performance routing/bridging protocol emulation, and true L4-7 application traffic generation and subscriber emulation. All these features are available within one load module. It allows ultra-high-density test environments for 10GE/1GE/100M Ethernet over copper and fiber and supports up to 192 10GE/1GE/100M Ethernet test ports in a single 12-slot Ixia chassis.

For more information on Novus family of load modules, see Novus Load Modules.

Key Features

The key features of Novus 10/1 load module are as follows:

- Provides support for testing SFP+ and 10GBase-T RJ-45 copper ports at different speeds simultaneously on the same load module
- Allows industry-standard RFC test and protocol emulation in large test bed with hundreds of 10GE, 1GE, and/or 100M ports in a single test. This helps to benchmark data plane, performance, and scale of ultra-high-density network equipment.
- 10GE, 1GE, and 100M line-rate hardware packet capture and decode tools to detect and debug data transmission errors
- Provides a broad range of application support including: IxExplorer, IxNetwork, IxLoad, and the related Tcl and automation APIs
- Adds IxLoad L4-7 including Voice, Video and Access protocols
- Has a flexible 4:1 CPU and memory aggregation, for high-scale protocol emulation and performance
- Uses flexible custom packet generation
- Provides real-time latency with latency resolution of up to 2.5ns
- Enables extensive port and traffic flow statistics
- Allows advanced sequence checking with duplicate packet detection
- Provides support for BroadR-Reach transceivers, to test BroadR-Reach enabled Automotive Ethernet switch, for SGMII 100Mbps.
- Provides support for 1000 Base T1 using Marvell Transceivers for SGMII 1G.

Load Modules

The Novus 10/1 family is available in the following three models:

- Novus10/1GE16DP
- Novus10/1GE8DP
- Novus1GE16DP

The load modules are described as follows:

Novus10/1GE16DP

Novus10/1GE16DP is a full-featured 16-port, Dual-PHY (RJ45 and SFP+) 10GE/1GE/100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

Novus10/1GE8DP

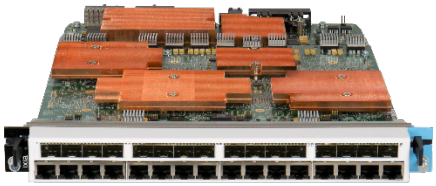
Novus10/1GE8DP is a full-featured 8-port, Dual-PHY (RJ45 and SFP+) 10GE and 1GE load module designed for high-density switch testing. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

Novus1GE16DP

Novus1GE16DP is a full-featured 16-port, Dual-PHY (RJ45 and SFP+) 1GE and 100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

The Novus10/1GE16DP load module is shown in the following figure:

Figure: Novus Module-Novus10/1GE16DP



Novus10/1GE8DP Field Upgrade

The following Novus 10/1, 8 port load module can be upgraded to support evolving test needs, by a software field-upgrade to a full 16-port Novus10/1GE16DP load module.

- Novus10/1GE8DP (944-1143)

NOTE For the additional 8-port upgrade purchase, please provide the serial number of the desired load module at the time of placement of order, to install the option.

Part Numbers

Part Numbers for Novus 10GE/1GE/100M Load Modules and Supported Adapters are provided in the following table.

Part Numbers for Novus 10GE/1GE/100M Modules

Model Number	Part Number	Description
Novus10/1GE16DP 10G/1G/100M	944-1142	• Dual-PHY with 16-ports each of the SFP+ • 1-slot • 10GBASE-T RJ45 physical interfaces • L2-7 support
Novus10/1GE8DP 10G/1G/100M	944-1143	• Dual-PHY with 8-ports each of the SFP+ • 1-slot • 10GBASE-T RJ45 physical interfaces • L2-7 support
Novus1GE16DP 1G/100M	944-1146	• Dual-PHY with 16-ports each of the SFP+ • 1-slot • 1000BASE-T RJ45 physical interfaces • L2-7 support NOTE This is the Novus10/1GE16DP, 16-port load module (944-1142) enabled for ONLY 1GE/100Mbps operation on all 16-ports.

Specifications

The load module specifications are contained in the following table.

Novus 10GE/1GE/100M Load Module Specifications

Feature	Novus10/1GE16DP 10G/1G/100M	Novus10/1GE8DP 10G/1G/100M	Novus1GE16DP 1G/100M
Hardware Load Module Specifications			
Slot / Number of Ports	1-slot with 16x10/1G Dual-PHY SFP+/10GBASE-T ports	1-slot with 8x10/1G Dual-PHY SFP+/10GBASE-T ports	1-slot with 16x10/1G Dual-PHY SFP+/100BASE-T ports
Physical Interfaces	16-ports of Dual-PHY SFP+/10GBASE-T RJ-45	8-ports of Dual-PHY SFP+/10GBASE-T RJ-45	16-ports of SFP+/100BASE-T RJ-45

Feature	Novus10/1GE16DP 10G/1G/100M	Novus10/1GE8DP 10G/1G/100M	Novus1GE16DP 1G/100M
Supported Port Speeds	• 10G/port and 1G/port: 10G and 1G-capable fiber and copper cable media • 100M/port: 100M capable fiber and copper media		• 1G/port: 1G-capable fiber and copper cable media • 100M/port: 100M capable fiber and copper media
CPU and Memory	Multicore processor with 2GB of CPU memory per port		
Cable Media	• CAT5e • CAT6 • CAT6A		
Load Module Dimensions	• 17.3” (L) x 1.3” (W) x 12.0” (H) • 440mm (L) x 33mm (W) x 305mm (H)		
Load Module Weights	• Module only: 12.9 lbs (5.85 kg) • Shipping: 19.7 lbs (8.94 kg)		
Temperature	• Operating: 41°F to 104°F (5°C to 40°C) • Storage: 41°F to 122°F (5°C to 50°C)		
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing		
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model			
XGS12-SD Chassis (940-0011)	12 load modules: • 192-ports of 10GE • 192-ports of 1GE • 192-ports of 100ME	12 load modules: • 96-ports of 10GE • 96-ports of 1GE • 96-ports of 100ME	12 load modules: • 192-ports of 1GE • 192-ports of 100ME
XGS12-HSL Chassis (940-0016)	12 load modules: • 192-ports of 10GE • 192-ports of 1GE • 192-ports of 100ME	12 load modules: • 96-ports of 10GE • 96-ports of 1GE • 96-ports of 100ME	12 load modules: • 192-ports of 1GE • 192-ports of 100ME
XGS2-SD Chassis (940-0010)	2 load modules: • 32-ports of 10GE	2 load modules: • 16-ports of 10GE	2 load modules: • 32-ports of 1GE

Feature	Novus10/1GE16DP 10G/1G/100M	Novus10/1GE8DP 10G/1G/100M	Novus1GE16DP 1G/100M
	• 32-ports of 1GE • 32-ports of 100ME	• 16-ports of 1GE • 16-ports of 100ME	• 32-ports of 100ME
XGS2-HSL Chassis (940-0014)	2 load modules: • 32-ports of 10GE • 32-ports of 1GE • 32-ports of 100ME	2 load modules: • 16-ports of 10GE • 16-ports of 1GE • 16-ports of 100ME	2 load modules: • 32-ports of 1GE • 32-ports of 100ME
XGS12-SDL Chassis (940-0011)	12 load modules: • 192-ports of 10GE • 192-ports of 1GE • 192-ports of 100ME	12 load modules: • 96-ports of 10GE • 96-ports of 1GE • 96-ports of 100ME	12 load modules: • 192-ports of 1GE • 192-ports of 100ME
XGS2-SDL Chassis (940-0013)	2 load modules: • 32-ports of 10GE • 32-ports of 1GE • 32-ports of 100ME	2 load modules: • 16-ports of 10GE • 16-ports of 1GE • 16-ports of 100ME	2 load modules: • 32-ports of 1GE • 32-ports of 100ME
Transmit Feature Specifications			
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.		
Max. Streams per Port	512		
Max. Streams per Port in Data Center Ethernet	256		
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s		
Stream Controls	Rate and frame size change on the fly, sequential, and advanced stream scheduler.		
Minimum Frame Size	10GE: • 49 bytes at full line rate without UDF60 bytes at full line rate with UDF		

Feature	Novus10/1GE16DP 10G/1G/100M	Novus10/1GE8DP 10G/1G/100M	Novus1GE16DP 1G/100M
	1GE and 100ME: • 49 bytes at less than full line rate		
Maximum Frame Size	16,384 bytes		
Maximum Fame Size in Data Center Ethernet	9,216 bytes		
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths		
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian		
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.		
Value Lists (max.)	2M across 5 User Defined Fields		
Sequence (max.)	512		
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum.		
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP .		
Link Fault Signaling	10GE: Reports no fault port statistics; ability to select the option to have the transmit port ignore link faults from a remote link partner		Not Applicable
Latency Measurement Resolution	2.5 nanoseconds		
Transmit line clock adjustment	Ability to adjust the parts-per-million line frequency over a range of -100 ppm to +100 ppm across all ports on the load module.		
Receive Feature Specifications			
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time		

Feature	Novus10/1GE16DP 10G/1G/100M	Novus10/1GE8DP 10G/1G/100M	Novus1GE16DP 1G/100M
	for each packet group, with data integrity, sequence, and advanced sequence checking capability.		
Trackable Receive Flows per Port	• 1M without Tx/Rx Sync and sequence checking • 512k with Tx/Rx Sync and sequence checking		
Minimum Frame Size	• 64 bytes at full line rate into the capture buffer • 49 bytes at less than full line rate		
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.		
Hardware Capture Buffer per Port or Resource Group	512MB per port		
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies.		
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.		
Layer 2-3 Protocol Support			
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP.		
Software Defined Network	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE.		
MPLS	RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS, L3VPN/6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN.		
Broadband and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP/MLD, IPTV, 802.1x, WebAuth, EAPoUDP, Cisco NAC.		
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, TWAMP, Sync-E ESMC, IEEE 1588v2 (PTP), gPTP (IEEE 802.1AS), MSRP (IEEE 802.1 Qat), IEEE 1722.		

Feature	Novus10/1GE16DP 10G/1G/100M	Novus10/1GE8DP 10G/1G/100M	Novus1GE16DP 1G/100M
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA.		
Layer 4-7 Application Traffic Testing Support			
Data	HTTP, HTTPS, TCP Session, FTP, DNS, Mail (SMTP, POP3, and IMAP),TFTP, AppReplay, AppLibrary.		
Video	RTSP, IPTV, VoD, Adobe Flash Client, Apple HLS Client, Microsoft Silverlight Client, Adobe HDS Client, DASH Client; includes Video Quality VQMON and TCP Video Quality.		
Voice	Advanced VoIP SIP & RTP, Audio & Video Codecs, VoLTE, MSRP, Telepresence, SMS, T.38; includes: Voice Quality and Video Quality for conversational video traffic.		
Storage	iSCSI, CIFSv1, CIFSv2 (SMB2), SMB3, NFSv3 Client, NFSv4 Client, NFS4.1 Client, Cloud Storage Client.		
Access	IPv4, IPv6, VLAN, Emulated Routers, DNS, DHCP.		

Application Support

The Ixia application support for Novus 10GE/1GE/100M load modules is provided in the following table:

Novus 10GE/1GE/100M Application Support

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides layer 2-3 wire-speed traffic generation and analysis test application.
Tcl API	Allows custom user script development for layer 2-7 testing.
IxLoad	Provides a scalable L4-7 solution for testing converged multiplay services, application delivery platforms, and security devices and systems. IxLoad ensures quality of experience (QoE) through emulation of data, access, storage, voice and video subscribers, and associated protocols.

Mechanical Specifications

Front Panel

The front panel of one of the Novus 10GE/1GE/100M load module is shown in the following figure:

Figure: Front panel of Novus10/1GE16DP

LED Panel

There are 2 bicolor LEDs per port for the SFP+ (10G) variant. The LED panel specifications for Novus SFP+ (10G) are provided in the following table.

LED panel Specifications for Novus SFP+ (10G) Load Module

Speed Mode	LED1: TX LED	LED2: RX LED
10GE	Port Inactive/No Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green

Transceivers and Cables

The Novus 10/1 family supports optical transceivers and fiber cables for each of the physical interfaces that are supported:

- **988-0011**: This is an SFP+10GBASE-SR/SW and 1000BASE-SX optical, dual-rate, 850nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 3 meter, multi-mode fiber LC-LC cable is included with this transceiver.

- **988-0012**: This is an SFP+10GBASE-LR/LW and 1000BASE-LX optical, dual-rate, 1310nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 10 ft, single-mode fiber LC-LC cable is included with this transceiver.

- **988-0013**: This is an SFP+10GBASE-SR/SW, Accessory, 850nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).

- **988-0014**: This is an SFP+10GBASE-LR/LW, Accessory, 1310nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0015**: This is an SFP+10GBASE-LRM, Accessory, 1310nm transceiver, for multimode fiber, with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).

NOTE SFP+10GBASE-LRM does not support the 10GbE WAN mode in any of the load modules listed above.

- **988-0016**: This is an SFP+10GSFP+Cu, Accessory, passive, copper Direct Attach Cable Assembly, with pluggable SFP+ interface. It is compatible with NGY 10GE SFP+ modules, Xdenisty modules, and Xcellon-Flex 10GE SFP+ FE and AP modules.
- **SFP-LX**: This is a 1310nm LX, SFP 1 Gigabit Ethernet Transceiver.
- **SFP-SX**: This is a 850nm SX, SFP 1 Gigabit Transceiver.

CHAPTER 21

IXIA Novus-NP 10GE/1GE/100M Ethernet Load Modules

This chapter provides details about Novus-NP 10/1 family of load modules and their specifications and features.

Novus-NP 10/1 combines the architecture of Novus load modules with Ixia's NP (network processor) technology. It is a high density, with up to 16 Dual-PHY ports per module, multi-rate ethernet load module. This load module family supports complete Layer 2-7 (L2-7) network and application testing in a single system. It provides support for Dual-PHY (SFP+ and 10GBase-T RJ45), and enables up to line-rate L2/3 traffic generation and analysis, high-performance routing/bridging protocol emulation, and true L4-7 application traffic generation and subscriber emulation. All these features are available within one load module. It allows ultra-high-density test environments for 10GE/1GE/100M Ethernet over copper and fiber and supports up to 192 10GE/1GE/100M Ethernet test ports in a single 12-slot Ixia chassis.

For more information on Novus family of load modules, see Novus Load Modules.

Key Features

The key features of Novus-NP 10/1 load module are as follows:

- Allows high-performance layer 4-7 testing using Ixia’s IxLoad application: up to 40G application throughput per load module
- Provides ultra-high scale and performance for emulating L2/3 protocols to validate performance and scalability of L2/3 routing/switching and data center test cases using Ixia’s IxNetwork application
- Supports full line-rate traffic generation to evaluate ASIC designs, FPGAs, and hardware switch fabrics
- Provides support for testing SFP+ and 10GBase-T RJ-45 copper ports at different speeds simultaneously on the same load module
- Allows industry-standard RFC test and protocol emulation in large test bed with hundreds of 10G, 1G, and/or 100M ports in a single test. This helps to benchmark data plane, performance, and scale of ultra-high-density network equipment.
- 10G, 1G, and 100M line-rate hardware packet capture and decode tools to detect and debug data transmission errors
- Provides a broad range of application support including: IxExplorer, IxNetwork, IxLoad, and the related Tcl and automation APIs
- Adds IxLoad L4-7 including Voice, Video and Access protocols

- Has a flexible 4:1 CPU and memory aggregation, for high-scale protocol emulation and performance
- Uses flexible custom packet generation
- Provides real-time latency with latency resolution of up to 2.5ns
- Enables extensive port and traffic flow statistics
- Allows advanced sequence checking with duplicate packet detection
- Provides support for BroadR-Reach transceivers, to test BroadR-Reach enabled Automotive Ethernet switch, for SGMII 100Mbps.
- Provides support for 1000 Base T1 using Marvell Transceivers for SGMII 1G.

Load Modules

The Novus-NP 10/1 family are available in the following two models:

- Novus-NP 10/1GE8DP
- Novus-NP 10/1GE16DP

The load modules are described as follows:

Novus-NP 10/1GE8DP

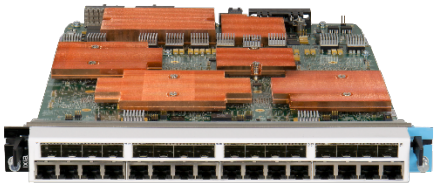
Novus-NP 10/1GE8DP is a full-featured 8-port, Dual-PHY (RJ45 and SFP+) 10GE and 1GE load module designed for high-density switch testing. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

Novus-NP 10/1GE16DP

Novus-NP10/1GE16DP is a full-featured 16-port, Dual-PHY (RJ45 and SFP+) 1GE and 100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

The Novus-NP 10/1GE16DP load module is shown in the following figure:

Figure: Novus Module-Novus-NP 10/1GE16DP



Novus-NP 10/1GE8DP Field Upgrade

The following Novus-NP 10/1, 8 port load module can be upgraded to support evolving test needs, by a software field-upgrade to a full 16-port Novus-NP 10/1GE16DP load module by a 905-1006 field

upgrade:

- Novus-NP 10/1GE8DP (944-1163)

NOTE For the additional 8-port upgrade purchase, please provide the serial number of the desired load module at the time of placement of order, to install the option.

Part Numbers

Part Numbers for Novus-NP 10G/1G/100M Load Modules and Supported Adapters are provided in the following table.

Part Numbers for Novus-NP 10G/1G/100M Modules

Model Number	Part Number	Description
Novus-NP 10/1GE16DP 10G/1G/100M	944-1162	• Dual-PHY with 16-ports each of the SFP+ • 1-slot • 10GBASE-T RJ45 physical interfaces • L2-7 support
Novus-NP 10/1GE8DP 10G/1G/100M	944-1163	• Dual-PHY with 8-ports each of the SFP+ • 1-slot • 10GBASE-T RJ45 physical interfaces • L2-7 support

Specifications

The load module specifications are contained in the following table:

Novus-NP 10G/1G/100M Load Module Specifications

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
Hardware Load Module Specifications		
Slot / Number of Ports	1-slot with 16x10/1G Dual-PHY SFP+/10GBASE-T ports	1-slot with 8x10/1G Dual-PHY SFP+/10GBASE-T ports
Physical Interfaces	16-ports of Dual-PHY SFP+/10GBASE-T RJ-45	8-ports of Dual-PHY SFP+/10GBASE-T RJ-45
Supported Port Speeds	• 10G/port and 1G/port: 10G and 1G-capable fiber and copper cable media • 100M/port: 100M capable fiber and copper media	
CPU and	Multicore processor with 2GB of CPU memory per port	

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
Memory		
Cable Media	• CAT5e • CAT6 • CAT6A	
Cables and Transceivers	• 988-0011: SFP+10GBASE-SR/SW and 1000BASE-SX Dual-Rate pluggable optical transceiver for 10/1 Gigabit Ethernet LAN/WAN load modules with pluggable SFP+ interface, 850nm. Compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm and Firestorm load modules and appliances. Note: Multi-mode fiber LC-LC, 3 meter cable included. • 988-0012: SFP+10GBASE-LR/LW and 1000BASE-LX Dual-Rate pluggable optical transceiver for 10/1 Gigabit Ethernet LAN/WAN load modules with pluggable SFP+ interface, 1310nm, 10km reach. Compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm and Firestorm load modules and appliances. Note: Single-mode fiber LC-LC, 10 ft cable included. • 948-0014: SFP+10GBASE-LR/LW, Accessory, SFP+ Transceiver for 10 Gigabit Ethernet LAN/WAN load modules with pluggable SFP+ interface, 1310nm; Operates with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01). • 942-0068: MT-to-4x10GE LC fan-out, MMF, 5-meter cable for 10GE and 25GE fan-out. For 4x25GE fan-out it REQUIRES a 100GBASE-SR4 QSFP28 100GBASE-SR4 100GE pluggable transceiver, 850nm, MMF (QSFP28-SR4-XCVR). • 948-0015: SFP+10GBASE-LRM, Accessory, SFP+ Transceiver for 10 Gigabit Ethernet LAN/WAN load modules with pluggable SFP+ interface, For multimode fiber, 1310nm; Operates with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01); NOTE: SFP+10GBASE-LRM does not support the 10GbE WAN mode in any of the load modules listed above. • 948-0016: SFP+10GSFP+Cu, Accessory, passive, copper Direct Attach Cable Assembly for 10 Gigabit Ethernet LAN/WAN load modules with pluggable SFP+ interface, 3 meter length; NGY 10GE SFP+ modules, Xdenisty modules, and Xcellon-Flex 10GE SFP+ FE and AP modules. • SFP-LX: SFP 1 Gigabit Ethernet Transceiver - 1310nm LX • SFP-SX: SFP 1 Gigabit Transceiver - 850nm SX	

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
	• SFP-FX-100M-XCVR: SFP 100BASE-FX 100M pluggable optical transceiver, MMF (multimode), 1310nm, 2km reach	
Load Module Dimensions	• 17.3” (L) x 1.3” (W) x 12.0” (H) • 440mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights	• Module only: 12.9 lbs (5.85 kg) • Shipping: 19.7 lbs (8.94 kg)	
Temperature	• Operating: 41°F to 104°F (5°C to 40°C) • Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing	
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model		
XGS12-SD Chassis (940-0011)	12 load modules: • 192-ports of 10GbE • 192-ports of 1GbE • 192-ports of 100MbE	12 load modules: • 96-ports of 10GbE • 96-ports of 1GbE • 96-ports of 100MbE
XGS12-HSL Chassis (940-0016)	12 load modules: • 192-ports of 10GbE • 192-ports of 1GbE • 192-ports of 100MbE	12 load modules: • 96-ports of 10GbE • 96-ports of 1GbE • 96-ports of 100MbE
XGS2-SD Chassis (940-0010)	2 load modules: • 32-ports of 10GbE • 32-ports of 1GbE • 32-ports of 100MbE	2 load modules: • 16-ports of 10GbE • 16-ports of 1GbE • 16-ports of 100MbE
XGS2-HSL Chassis (940-0014)	2 load modules: • 32-ports of 10GbE • 32-ports of 1GbE • 32-ports of 100MbE	2 load modules: • 16-ports of 10GbE • 16-ports of 1GbE • 16-ports of 100MbE
XGS12-SDL Chassis (940-0011)	12 load modules: • 192-ports of 10GbE • 192-ports of 1GbE • 192-ports of 100MbE	12 load modules: • 96-ports of 10GbE • 96-ports of 1GbE • 96-ports of 100MbE

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
XGS2-SDL Chassis (940-0013)	2 load modules: • 32-ports of 10GbE • 32-ports of 1GbE • 32-ports of 100MbE	2 load modules: • 16-ports of 10GbE • 16-ports of 1GbE • 16-ports of 100MbE
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.	
Max. Streams per Port	512	
Max. Streams per Port in Data Center Ethernet	256	
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	
Stream Controls	Rate and frame size change on the fly, sequential, and advanced stream scheduler.	
Minimum Frame Size	10GbE: • 49 bytes at full line rate without UDF60 bytes at full line rate with UDF 1GbE and 100MbE: • 49 bytes at less than full line rate	
Maximum Frame Size	16,384 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian	

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.	
Value Lists (max.)	2M across 5 User Defined Fields	
Sequence (max.)	512	
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum.	
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP .	
Link Fault Signaling	10GE: Reports no fault port statistics; ability to select the option to have the transmit port ignore link faults from a remote link partner	
Latency Measurement Resolution	2.5 nanoseconds	
Transmit line clock adjustment	Ability to adjust the parts-per-million line frequency over a range of -100 ppm to +100 ppm across all ports on the load module.	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence, and advanced sequence checking capability.	
Trackable Receive Flows per Port	• 1M without Tx/Rx Sync and sequence checking • 512k with Tx/Rx Sync and sequence checking	
Minimum Frame Size	• 64 bytes at full line rate into the capture buffer • 49 bytes at less than full line rate	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.	
Hardware Capture Buffer per Port or Resource Group	512MB per port	

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies.	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.	
Layer 2-3 Protocol Support		
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP.	
Software Defined Network	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE.	
MPLS	RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS, L3VPN/6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN.	
Broadband and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP/MLD, IPTV, 802.1x, WebAuth, EAPoUDP, Cisco NAC.	
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, TWAMP, Sync-E ESMC, IEEE 1588v2 (PTP), gPTP (IEEE 802.1AS), MSRP (IEEE 802.1 Qat), IEEE 1722.	
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA.	
Layer 4-7 Application Traffic Testing Support		
Data	HTTP, HTTPS, TCP Session, FTP, DNS, Mail (SMTP, POP3, and IMAP),TFTP, AppReplay, AppLibrary.	
Video	RTSP, IPTV, VoD, Adobe Flash Client, Apple HLS Client, Microsoft Silverlight Client, Adobe HDS Client, DASH Client; includes Video Quality VQMON and TCP Video Quality.	
Voice	Advanced VoIP SIP & RTP, Audio & Video Codecs, VoLTE, MSRP, Telepresence, SMS, T.38; includes: Voice Quality and Video Quality for conversational video traffic.	
Storage	iSCSI, CIFSv1, CIFSv2 (SMB2), SMB3, NFSv3 Client, NFSv4 Client, NFS4.1 Client, Cloud Storage Client.	

Feature	Novus-NP 10/1GE16DP 10G/1G/100M	Novus-NP 10/1GE8DP 10G/1G/100M
Access	IPv4, IPv6, VLAN, Emulated Routers, DNS, DHCP.	

Application Support

The Ixia application support for Novus-NP 10G/1G/100M load modules is provided in the following table:

Novus-NP 10G/1G/100M Application Support

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides layer 2-3 wire-speed traffic generation and analysis test application.
Tcl API	Allows custom user script development for layer 2-7 testing.
IxLoad	Provides a scalable L4-7 solution for testing converged multiplay services, application delivery platforms, and security devices and systems. IxLoad ensures quality of experience (QoE) through emulation of data, access, storage, voice and video subscribers, and associated protocols.

Mechanical Specifications

Front Panel

The front panel of one of the Novus 10G/1G/100M load module is shown in the following figure:

Figure: Front panel of Novus-NP 10/1GE16DP

LED Panel

There are 2 bicolor LEDs per port for the SFP+ (10G) variant. The LED panel specifications for Novus SFP+ (10G) are provided in the following table.

LED panel Specifications for Novus-NP Load Module

Speed Mode	LED1: TX LED	LED2: RX LED
10GE	Port Inactive/No Power=Off Link Down (all)=Solid Red	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red

Speed Mode	LED1: TX LED	LED2: RX LED
	Link Up (all)=Solid Green Tx Active=Blinking Green	Rx Active=Blinking Green

Transceivers and Cables

The Novus 10/1 family supports optical transceivers and fiber cables for each of the physical interfaces that are supported:

- **988-0011**: This is an SFP+10GBASE-SR/SW and 1000BASE-SX optical, dual-rate, 850nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 3 meter, multi-mode fiber LC-LC cable is included with this transceiver.

- **988-0012**: This is an SFP+10GBASE-LR/LW and 1000BASE-LX optical, dual-rate, 1310nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 10 ft, single-mode fiber LC-LC cable is included with this transceiver.

- **988-0013**: This is an SFP+10GBASE-SR/SW, Accessory, 850nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0014**: This is an SFP+10GBASE-LR/LW, Accessory, 1310nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0015**: This is an SFP+10GBASE-LRM, Accessory, 1310nm transceiver, for multimode fiber, with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).

NOTE SFP+10GBASE-LRM does not support the 10GbE WAN mode in any of the load modules listed above.

- **988-0016**: This is an SFP+10GSFP+Cu, Accessory, passive, copper Direct Attach Cable Assembly, with pluggable SFP+ interface. It is compatible with NGY 10GE SFP+ modules, Xdenisty modules, and Xcellon-Flex 10GE SFP+ FE and AP modules.
- **SFP-LX**: This is a 1310nm LX, SFP 1 Gigabit Ethernet Transceiver.
- **SFP-SX**: This is a 850nm SX, SFP 1 Gigabit Transceiver.

CHAPTER 22

IXIA Novus-32P 10GE/1GE/100M Ethernet Load Modules

This chapter provides details about Novus-32P 10/1 family of load modules and their specifications and features.

Novus-32P 10/1 is a tri-speed, high density, with up to 32 ports per module, multi-rate ethernet load module. This load module family supports complete Layer 2-3 (L2-3) network and application testing in a single system. It provides support for SFP+ ports, and enables up to line-rate L2/3 traffic generation and analysis, and high-performance routing/bridging protocol emulation. All these features are available within one load module. It allows ultra-high-density test environments for 10GE/1GE/100M Ethernet and supports up to 384 10GE/1GE/100M Ethernet test ports in a single 12-slot Ixia chassis.

For more information on Novus family of load modules, see Novus Load Modules.

Key Features

The key features of Novus-32P 10/1 load module are as follows:

- Provides ultra-high scale and performance for emulating L2/3 protocols to validate performance and scalability of L2/3 routing/switching and data center test cases using Ixia's IxNetwork application
- Supports full line-rate traffic generation to evaluate ASIC designs, FPGAs, and hardware switch fabrics
- Allows industry-standard RFC test and protocol emulation in large test bed with hundreds of 10G, 1G, and/or 100M ports in a single test. This helps to benchmark data plane, performance, and scale of ultra-high-density network equipment.
- 10G, 1G, and 100M line-rate hardware packet capture and decode tools to detect and debug data transmission errors
- Provides a broad range of application support including: IxExplorer, IxNetwork, and the related Tcl and automation APIs
- Has a flexible 4:1 CPU and memory aggregation, for high-scale protocol emulation and performance
- Uses flexible custom packet generation
- Provides real-time latency with latency resolution of up to 2.5ns
- Enables extensive port and traffic flow statistics
- Allows advanced sequence checking with duplicate packet detection

- Provides support for BroadR-Reach transceivers, to test BroadR-Reach enabled Automotive Ethernet switch, for SGMII 100Mbps.
- Provides support for 1000 Base T1 using Marvell Transceivers for SGMII 1G.

Load Modules

The Novus-32P 10/1 family is available in the following model:

- Novus10/1GE32S

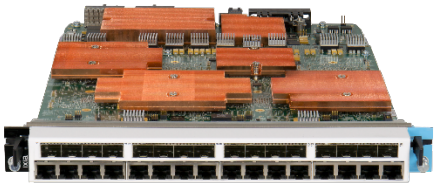
The load module is described as follows:

Novus10/1GE32S

Novus10/1GE32S is a 32-port, SFP+ 10GE/1GE/100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

The Novus10/1GE32S load module is shown in the following figure:

Figure: Novus Module-Novus10/1GE32S



Part Numbers

Part Numbers for Novus-32P 10G/1G/100M Load Modules and Supported Adapters are provided in the following table.

Part Numbers for Novus-32P 10G/1G/100M Modules

Model Number	Part Number	Description
Novus10/1GE32S 10G/1G/100M	944-1141	• 32-ports of SFP+ • 1-slot • L2-3 support

Specifications

The load module specifications are contained in the following table.

Novus-32P 10G/1G/100M Load Module Specifications

Feature	Novus 10/1GE32S 10G/1G/100M
Hardware Load Module Specifications	
Slot / Number of Ports	1-slot with 32x10/1G SFP+ ports
Physical Interfaces	32-ports of SFP+
Supported Port Speeds	10G, 1G, 100M
CPU and Memory	Multicore processor with 2GB of CPU memory per port
Cable Media	• CAT5e • CAT6 • CAT6A
Load Module Dimensions	• 16.4” (L) x 1.3” (W) x 12.0” (H) • 417mm (L) x 33mm (W) x 305mm (H)
Load Module Weights	• Module only: 11.4 lbs (5.15 kg) • Shipping: 18.2 lbs (8.26 kg)
Temperature	• Operating: 41°F to 95°F (5°C to 35°C) • Storage: 41°F to 122°F (5°C to 50°C)
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model	
XGS12-SD Chassis (940-0011)	12 load modules: • 384-ports of 10GbE • 384-ports of 1GbE • 384-ports of 100MbE
XGS12-HSL Chassis (940-0016)	12 load modules: • 384-ports of 10GbE • 384-ports of 1GbE • 384-ports of 100MbE
XGS2-SD Chassis (940-0010)	2 load modules: • 64-ports of 10GbE

Feature	Novus 10/1GE32S 10G/1G/100M
	• 64-ports of 1GbE • 64-ports of 100MbE
XGS2-HSL Chassis (940-0014)	2 load modules: • 64-ports of 10GbE • 64-ports of 1GbE • 64-ports of 100MbE
XGS12-SDL Chassis (940-0011)	12 load modules: • 384-ports of 10GbE • 384-ports of 1GbE • 384-ports of 100MbE
XGS2-SDL Chassis (940-0013)	2 load modules: • 64-ports of 10GbE • 64-ports of 1GbE • 64-ports of 100MbE
Transmit Feature Specifications	
	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.
Max. Streams per Port	512
Max. Streams per Port in Data Center Ethernet	256
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s
Stream Controls	Rate and frame size change on the fly, sequential, and advanced stream scheduler.
Minimum Frame Size	10GbE: • 49 bytes at full line rate without UDF60 bytes at full line rate with UDF 1GbE and 100MbE:

Feature	Novus 10/1GE32S 10G/1G/100M
	• 49 bytes at less than full line rate
Maximum Frame Size	16,384 bytes
Maximum Fame Size in Data Center Ethernet	9,216 bytes
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.
Value Lists (max.)	2M across 5 User Defined Fields
Sequence (max.)	512
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum.
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP .
Link Fault Signaling	10GE: Reports no fault port statistics; ability to select the option to have the transmit port ignore link faults from a remote link partner
Latency Measurement Resolution	2.5 nanoseconds
Transmit line clock adjustment	Ability to adjust the parts-per-million line frequency over a range of -100 ppm to +100 ppm across all ports on the load module.
Receive Feature Specifications	
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence, and advanced sequence checking capability.
Trackable	• 1M without Tx/Rx Sync and sequence checking

Feature	Novus 10/1GE32S 10G/1G/100M
Receive Flows per Port	• 512k with Tx/Rx Sync and sequence checking
Minimum Frame Size	• 64 bytes at full line rate into the capture buffer • 49 bytes at less than full line rate
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.
Hardware Capture Buffer per Port or Resource Group	512MB per port
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies.
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.
Layer 2-3 Protocol Support	
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP.
Software Defined Network	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE.
MPLS	RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS, L3VPN/6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN.
Broadband and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP/MLD, IPTV, 802.1x, WebAuth, EAPoUDP, Cisco NAC.
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, TWAMP, Sync-E ESMC, IEEE 1588v2 (PTP), gPTP (IEEE 802.1AS), MSRP (IEEE 802.1 Qat), IEEE 1722.
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA.

Application Support

The Ixia application support for Novus-32P 10G/1G/100M load modules is provided in the following table:

Novus-32P 10G/1G/100M Application Support

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides layer 2-3 wire-speed traffic generation and analysis test application.
Tcl API	Allows custom user script development for layer 2-7 testing.

Mechanical Specifications

Front Panel

The front panel of one of the Novus-32P 10G/1G/100M load module is shown in the following figure:

Figure: Front panel of Novus-32P Novus10/1GE32S

LED Panel

There are 2 bicolor LEDs per port for the SFP+ (10G) variant. The LED panel specifications for Novus-32P SFP+ (10G) are provided in the following table.

LED panel Specifications for Novus-32P Load Module

Speed Mode	LED1: TX LED	LED2: RX LED
10GE	Port Inactive/No Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green

Transceivers and Cables

The Novus-32P 10/1 family supports optical transceivers and fiber cables for each of the physical interfaces that are supported:

- **988-0011**: This is an SFP+10GBASE-SR/SW and 1000BASE-SX optical, dual-rate, 850nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 3 meter, multi-mode fiber LC-LC cable is included with this transceiver.

- **988-0012**: This is an SFP+10GBASE-LR/LW and 1000BASE-LX optical, dual-rate, 1310nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 10 ft, single-mode fiber LC-LC cable is included with this transceiver.

- **988-0013**: This is an SFP+10GBASE-SR/SW, Accessory, 850nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0014**: This is an SFP+10GBASE-LR/LW, Accessory, 1310nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0015**: This is an SFP+10GBASE-LRM, Accessory, 1310nm transceiver, for multimode fiber, with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).

NOTE SFP+10GBASE-LRM does not support the 10GbE WAN mode in any of the load modules listed above.

- **988-0016**: This is an SFP+10GSFP+Cu, Accessory, passive, copper Direct Attach Cable Assembly, with pluggable SFP+ interface. It is compatible with NGY 10GE SFP+ modules, Xdenisty modules, and Xcellon-Flex 10GE SFP+ FE and AP modules.
- **SFP-LX**: This is a 1310nm LX, SFP 1 Gigabit Ethernet Transceiver.
- **SFP-SX**: This is a 850nm SX, SFP 1 Gigabit Transceiver.
- **SFP-FX-100M-XCVR**: This is a SFP 100BASE-FX 100M pluggable optical transceiver with MMF (multimode), 1310nm, and a 2km reach.

CHAPTER 23

IXIA Novus 10GbE/5GbE/2.5GbE/1GbE/100M Ethernet Load Modules

This chapter provides details about the Novus10/5/2.5/1/100M16DP 5-speed family of load modules and its specifications and features.

Novus10/5/2.5/1/100M16DP is a five-speed, high density, multi-rate ethernet load module with up to 16 Dual-PHY ports per module. This load module family supports complete Layer 2-7 (L2-7) network and application testing in a single system. It provides support for Dual-PHY (SFP+ and 10GBase-T RJ45), and enables up to line-rate L2/3 traffic generation and analysis, high-performance routing/bridging protocol emulation, and true L4-7 application traffic generation and subscriber emulation. All these features are available within one load module. It allows ultra-high-density test environments for 10GbE/5GbE/2.5GbE/1GbE/100M Ethernet over copper and fiber and supports up to 192 10GbE/1GbE/100M Ethernet test ports in a single 12-slot Ixia chassis.

For more information on Novus family of load modules, see Novus Load Modules.

Key Features

The key features of Novus10/5/2.5/1/100M16DP 5-speed family of load modules are as follows:

- Has 10GbE, 5GbE, 2.5GbE, 1GbE, and 100M line-rate hardware packet capture and decode tools to detect and debug data transmission errors.
- The presence of both full and reduced feature versions allow flexibility to choose the required performance level
- Full line-rate traffic generation allows to evaluate ASIC designs, FPGAs, and hardware switch fabrics.
- Capable of ultra-high scale and performance for emulating L2/3 protocols to validate performance and scalability of routing/switching and data center test cases using Ixia’s IxNetwork application
- Provides support for testing SFP+ and 10GBase-T RJ-45 copper ports at different speeds simultaneously on the same load module
- Allows industry-standard RFC test and protocol emulation in large test bed with hundreds of 10GbE, 5GbE, 2.5GbE, 1GbE and/or 100M ports in a single test. This helps to benchmark data plane, performance, and scale of ultra-high-density network equipment.
- 10GbE, 1GbE, and 100M line-rate hardware packet capture and decode tools to detect and debug data transmission errors.
- Provides a broad range of application support including: IxExplorer, IxNetwork, IxLoad, and the related Tcl and automation APIs.

- Adds IxLoad L4-7 including Voice, Video, and Access protocols.
- Has a flexible 4:1 CPU and memory aggregation, for high-scale protocol emulation and performance.
- Uses flexible custom packet generation
- Provides real-time latency with latency resolution of up to 2.5ns
- Enables extensive port and traffic flow statistics
- Allows advanced sequence checking with duplicate packet detection
- Provides support for BroadR-Reach transceivers, to test BroadR-Reach enabled Automotive Ethernet switch, for SGMII 100Mbps.
- Provides support for 1000 Base T1 using Marvell Transceivers for SGMII 1G.

Load Modules

The Novus Novus10/5/2.5/1/100M16DP 5-speed family is available in the following four models:

- Novus10/5/2.5/1/100M16DP
- Novus10/5/2.5/1/100M8DP
- Novus10/5/2.5/1/100M16DP-R
- Novus10/5/2.5/1/100M8DP-R

The load modules are described as follows:

Novus10/5/2.5/1/100M16DP

Novus10/5/2.5/1/100M16DP is a 5-speed, full-featured 16-port, Dual-PHY (RJ45 and SFP+) 10GE/5GE/2/5GE/1GE/100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

Novus10/5/2.5/1/100M8DP

Novus10/5/2.5/1/100M8DP is a 5-speed, full-featured 8-port, Dual-PHY (RJ45 and SFP+) 10GE/5GE/2/5GE/1GE/100M load module designed for high-density switch testing. It is compatible with the XGS12-SD rack mount chassis (940-0011), and the XGS2-SD 2-slot standard performance chassis (940-0010).

Novus10/5/2.5/1/100M16DP-R

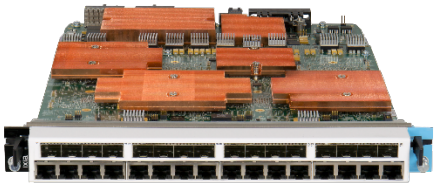
Novus10/5/2.5/1/100M16DP-R is a 5-speed, reduced-featured 16-port, Dual-PHY (RJ45 and SFP+) 10GE/5GE/2/5GE/1GE/100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

Novus10/5/2.5/1/100M8DP-R:

Novus10/5/2.5/1/100M8DP-R is a 5-speed, reduced-featured 8-port, Dual-PHY (RJ45 and SFP+) 10GE/5GE/2/5GE/1GE/100M load module designed for high-density requirements. It is compatible with the XGS12-SD rack mount chassis (940-0011), XGS12-HSL, 12-slot high speed rackmount chassis (940-0016), XGS2-SD 2-slot standard performance chassis (940-0010), and the XGS2-HSL, 2-slot high performance chassis (940-0014).

The Novus10/5/2.5/1/100M16DP load module is shown in the following figure:

Figure: Novus Module-Novus10/5/2.5/1/100M16DP



Novus10/5/2.5/1/100M8DP Field Upgrade

The following Novus 10/1, 8 port 5-speed load module can be upgraded to support evolving test needs, by a software field-upgrade to a full 16-port 5-speed 10/5/2.5/1/100M16DP load module.

- Novus10/5/2.5/1/100M8DP (944-1149)

NOTE For the additional 8-port upgrade purchase, please provide the serial number of the desired load module at the time of placement of order, to install the option.

Part Numbers

Part Numbers for Novus 10GbE/5GbE/2.5GbE/1GbE/100M Load Modules and Supported Adapters are provided in the following table.

Part Numbers for Novus 10GbE/5GbE/2.5GbE/1GbE/100M Modules

Model Number	Part Number	Description
Novus10/5/2.5/1/100M16DP	944-1148	• Dual-PHY with 16-ports each of the SFP+ • 1-slot • 10GBASE-T RJ45 physical interfaces • L2-7 support
Novus10/5/2.5/1/100M8DP	944-1149	• Dual-PHY with 8-ports each of the SFP+ • 1-slot • 10GBASE-T RJ45 physical interfaces • L2-7 support

Model Number	Part Number	Description
Novus10/5/2.5/1/100M16DP-R	944-1154	• Dual-PHY with 16-ports each of the SFP+ • 1-slot • 1000BASE-T RJ45 physical interfaces • L2-3 support
Novus10/5/2.5/1/100M8DP-R	944-1155	• Dual-PHY with 8-ports each of the SFP+ • 1-slot • 1000BASE-T RJ45 physical interfaces • L2-3 support

Specifications

The load module specifications are contained in the following table.

Novus 10GbE/5GbE/2.5GbE/1GbE/100M Load Module Specifications

Feature	Novus 10/5/2.5/1/100M16DP	Novus 10/5/2.5/1/100M8DP	Novus 10/5/2.5/1/100M16DP-R	Novus 10/5/2.5/1/100M8DP-R
Hardware Load Module Specifications				
Slot / Number of Ports	1-slot with 16x10/1GbE	1-slot with 8x10/1GbE	1-slot with 16x10/1GbE	1-slot with 8x10/1GbE
Physical Interfaces	SFP+ and 10GBASE-T RJ-45			
Supported Port Speeds	• 10GbE, 1GbE, and 100Mbps speed support on the fiber and copper RJ45 ports • 5GbE, 2.5GbE speed support on the copper RJ45 ports			
CPU and Memory	Multicore processor with 2GB of CPU memory per port			
Cable Media	• CAT5e twisted pair • CAT6 twisted pair • CAT6A twisted pair			

Feature	Novus 10/5/2.5/1/100M16DP	Novus 10/5/2.5/1/100M8DP	Novus 10/5/2.5/1/100M16DP-R	Novus 10/5/2.5/1/100M8DP-R
Load Module Dimensions	• 17.3” (L) x 1.3” (W) x 12.0” (H) • 440mm (L) x 33mm (W) x 305mm (H)			
Load Module Weights	• Module only: 12.9 lbs (5.85 kg) • Shipping: 19.7 lbs (8.94 kg)			
Temperature	• Operating: 41°F to 104°F (5°C to 40°C) • Storage: 41°F to 122°F (5°C to 50°C)			
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing			
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model				
XGS12-SD Rackmount Chassis (940-0011)	12 load modules: • 192-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 96-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 192-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 96-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support
XGS12-HSL Rackmount Chassis (940-0016)	12 load modules: • 192-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 96-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 192-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 96-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support
XGS2-SD Rackmount Chassis (940-0010)	2 load modules: • 32-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	2 load modules: • 16-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	2 load modules: • 32-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	2 load modules: • 16-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support
XGS2-HSL	2 load modules:	2 load modules:	2 load modules:	2 load modules:

Feature	Novus 10/5/2.5/1/100M16DP	Novus 10/5/2.5/1/100M8DP	Novus 10/5/2.5/1/100M16DP-R	Novus 10/5/2.5/1/100M8DP-R
Rackmount Chassis (940-0014)	• 32-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	• 16-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	• 32-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	• 16-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support
XGS12-SDL Chassis (940-0011)	12 load modules: • 192-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 96-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 192-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	12 load modules: • 96-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support
XGS2-SDL Chassis (940-0013)	2 load modules: • 32-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	2 load modules: • 16-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	2 load modules: • 32-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support	2 load modules: • 16-ports with 10/5/2.5/1/100M Dual-PHY, 5-speed support
Transmit Feature Specifications				
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.			
Max. Streams per Port	512			
Max. Streams per Port in Data Center Ethernet	256			
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**:			

Feature	Novus 10/5/2.5/1/100 M16DP	Novus 10/5/2.5/1/100M8DP	Novus 10/5/2.5/1/100 M16DP-R	Novus 10/5/2.5/1/100 M8DP-R
	10: 0.419s 100: 0.0419s 1000: 0.0167s			
Stream Controls	Rate and frame size change on the fly, sequential, and advanced stream scheduler.			
Minimum Frame Size	10GbE, 5GbE, and 2.5GbE: • 49 bytes at full line rate without UDF • 60 bytes at full line rate with UDF 1GbE and 100Mbps: • 49 bytes at full line rate			
Maximum Frame Size	16,384 bytes			
Maximum Fame Size in Data Center Ethernet	9,216 bytes			
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths			
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian			
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available.			
Value Lists (max.)	2M total entries across 5 User Defined Fields			
Sequence (max.)	512K maximum PGIDs per port			
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum.			
Hardware	Checksum generation and verification for IPv4, IP over IP, ICMP/GRE/TCP/UDP,			

Feature	Novus 10/5/2.5/1/100 M16DP	Novus 10/5/2.5/1/100M8DP	Novus 10/5/2.5/1/100 M16DP-R	Novus 10/5/2.5/1/100 M8DP-R
Checksum Generation	L2TP, GTP .			
Link Fault Signaling	10GE: Reports no fault port statistics; ability to select the option to have the transmit port ignore link faults from a remote link partner.			
Latency Measurement Resolution	2.5 nanoseconds			
Transmit line clock adjustment	Ability to adjust the parts-per-million line frequency over a range of -100 ppm to +100 ppm across all ports on the load module.			
Receive Feature Specifications				
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence, and advanced sequence checking capability.			
Trackable Receive Flows per Port	• 1M without Tx/Rx Sync and sequence checking • 512k with Tx/Rx Sync and sequence checking			
Minimum Frame Size	• 64 bytes at full line rate into the capture buffer • 49 bytes at less than full line rate			
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.			
Hardware Capture Buffer per Port or Resource Group	512MB per port			
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity			

Feature	Novus 10/5/2.5/1/100M16DP	Novus 10/5/2.5/1/100M8DP	Novus 10/5/2.5/1/100M16DP-R	Novus 10/5/2.5/1/100M8DP-R
	frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies.			
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, up to 16 Latency bins / jitter, MEF frame delay, and inter-arrival time.			
Layer 2-3 Protocol Support				
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP.			
Software Defined Network	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE.			
MPLS	RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS, L3VPN/6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN.			
Broadband and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP/MLD, IPTV, 802.1x, WebAuth, EAPoUDP, Cisco NAC.			
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, TWAMP, Sync-E ESMC, IEEE 1588v2 (PTP), gPTP (IEEE 802.1AS), MSRP (IEEE 802.1 Qat), IEEE 1722.			
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA.			
Layer 4-7 Application Traffic Testing Support				
Data	HTTP, HTTPS, TCP Session, FTP, DNS, Mail (SMTP, POP3, and IMAP),TFTP, AppReplay, AppLibrary.			
Video	RTSP, IPTV, VoD, Adobe Flash Client, Apple HLS Client, Microsoft Silverlight Client, Adobe HDS Client, DASH Client; includes Video Quality VQMON and TCP Video Quality.			
Voice	Advanced VoIP SIP & RTP, Audio & Video Codecs, VoLTE, MSRP, Telepresence, SMS, T.38; includes: Voice Quality and Video Quality for conversational video traffic.			
Storage	iSCSI, CIFSv1, CIFSv2 (SMB2), SMB3, NFSv3 Client, NFSv4 Client, NFS4.1 Client, Cloud Storage Client.			

Feature	Novus 10/5/2.5/1/100 M16DP	Novus 10/5/2.5/1/100 M8DP	Novus 10/5/2.5/1/100 M16DP-R	Novus 10/5/2.5/1/100 M8DP-R
Access	IPv4, IPv6, VLAN, Emulated Routers, DNS, DHCP.			

Application Support

The Ixia application support for Novus 10GE/5GE/2.5GE/1GE/100M load modules is provided in the following table:

Novus 10GE/5GE/2.5GE/1GE/100M Application Support

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides layer 2-3 wire-speed traffic generation and analysis test application.
Tcl API	Allows custom user script development for layer 2-7 testing.
IxLoad	Provides a scalable L4-7 solution for testing converged multiplay services, application delivery platforms, and security devices and systems. IxLoad ensures quality of experience (QoE) through emulation of data, access, storage, voice and video subscribers, and associated protocols.

Mechanical Specifications

Front Panel

The front panel of one of the Novus 10GbE/5GbE/2.5GbE/1GbE/100M load module is shown in the following figure:

Figure: Front panel of Novus 10GbE/5GbE/2.5GbE/1GbE/100M

LED Panel

There are 2 bicolor LEDs per port for the SFP+ (10G) 5-speed variant. The LED panel specifications for Novus SFP+ (10G) 5-speed are provided in the following table.

LED panel Specifications for Novus SFP+ (10G) 5-Speed Load Module

Speed Mode	LED1: TX LED	LED2: RX LED
10GbE	Port Inactive/No Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green

Transceivers and Cables

The Novus10/5/2.5/1/100M16DP 5-speed family supports optical transceivers and fiber cables for each of the physical interfaces that are supported:

- **988-0011**: This is an SFP+10GBASE-SR/SW and 1000BASE-SX optical, dual-rate, 850nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 3 meter, multi-mode fiber LC-LC cable is included with this transceiver.

- **988-0012**: This is an SFP+10GBASE-LR/LW and 1000BASE-LX optical, dual-rate, 1310nm transceiver with pluggable SFP+ interface. It is compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules, and appliances.

NOTE A 10 ft, single-mode fiber LC-LC cable is included with this transceiver.

- **988-0013**: This is an SFP+10GBASE-SR/SW, Accessory, 850nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0014**: This is an SFP+10GBASE-LR/LW, Accessory, 1310nm transceiver with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).
- **988-0015**: This is an SFP+10GBASE-LRM, Accessory, 1310nm transceiver, for multimode fiber, with pluggable SFP+ interface. It is compatible with 944-0050 (LSM10GXM4S-01), 944-0051 (LSM10GXM8S-01), 944-0052 (LSM10GXMR4S-01), 944-0053 (LSM10GXMR8S-01), 944-0054 (LSM10GXM2S-01), 944-0055 (LSM10GXMR2S-01); and 944-0022 (LSM10G1-01) with 948-0012 (SFP+ADAP-01); or 944-0024 (LSM10GL1-01) with 948-0012 (SFP+ADAP-01).

NOTE SFP+10GBASE-LRM does not support the 10GE WAN mode in any of the load modules listed above.

- **988-0016**: This is an SFP+10GSFP+Cu, Accessory, passive, copper Direct Attach Cable Assembly, with pluggable SFP+ interface. It is compatible with NGY 10GE SFP+ modules, Xdenisty modules, and Xcellon-Flex 10GE SFP+ FE and AP modules.
- **SFP-LX**: This is a 1310nm LX, SFP 1 Gigabit Ethernet Transceiver.

- **SFP-SX**: This is a 850nm SX, SFP 1 Gigabit Transceiver.
- **SFP-FX-100M-XCVR**: This is a 1310nm SX, SFP 100BASE-FX 100M pluggable optical transceiver, with a 2 km reach.

CHAPTER 24

IXIA Novus25/10GE8SFP28+100G+50G Load Module

This chapter provides details about Novus25/10GE8SFP28+100G+50G load module and its specifications and features.

Novus25/10GE8SFP28+100G+50G is a high density, 8-port, SFP28 100/50/25/10GE load module. This load module provides time-sensitive networking (TSN) capabilities, and high-scale control and data plane traffic to validate switched networks. Novus supports 8x100GE SFP28 ports with QSA56 adaptors , 8x50GE SFP28 ports with QSA56 adaptors, 8x25GE SFP28 ports with QSA56 adaptors and 8x10GE SFP28 ports with QSA56 adaptors. It enables multi-vendor interoperability of testing between different speeds over copper, multimode and single-mode fiber interconnect media.

Key Features

The key features of Novus25/10GE8SFP28+100G+50G load module are as follows:

- Supports multi-vendor interoperability of 100GE, 50GE, 25GE, and 10GE testing between different speeds that run over these optics and media: pluggable optical transceivers, active optical cables (AOC), and passive copper direct attach cable (DAC) media.
- Supports 8x25GE, 8x10GE interface speed across all of the ports of the load module with the pluggable QSA56 adaptors. The adaptors are included with the load module.
- Provides optional, dual-speed 8x100GE and 8x50GE QSFP28 speed support across all of the ports of the load module for multimode 100GBASE-SR4, single mode 100GBASE-LR4, 100GBASE-CR4 passive copper, multimode 50GBASE-SR, single mode 50GBASE-LR and 50GBASE-CR2 passive copper.
- Provides ability to read and write SFP28 or QSFP28 transceiver registers and to export the transceiver register information to a csv file.
- Provides line-rate hardware packet capture and decode tools to detect and de-bug data transmission errors.
- Provides an excellent test platform for full line rate 100GE and 50GE speed support over QSFP28 and 25Gb/s or 10Gb/s over SFP28 to evaluate hardware switch fabrics with NRZ encoding.
- Supports benchmarking of the data plane and protocol emulation performance and scale of ultra-high- density 100/50/25/10GE-capable network equipment; uses industry-standard RFC benchmark tests in large test beds with hundreds of ports in a single test
- Supports advanced features such as: Ethernet Forward Error Correction both RS-FEC and FC_ FEC, auto-negotiation, and link training on 100GE, 50GE, and 25GE speeds.
- Provides medium to high-scale L2-3 protocol emulation to validate performance and scalability of L2-3 routing/switching and data center test cases using Keysight's IxNetwork application.

- Supports TSN Frame preemption (802.1Qbu / 802.13br), Time aware shaper (802.1Qbv) and a variety of 1588v2 profiles.
- Provides a broad range of application support including: IxExplorer, IxNetwork, and the related Tcl and automation APIs.

Load Modules

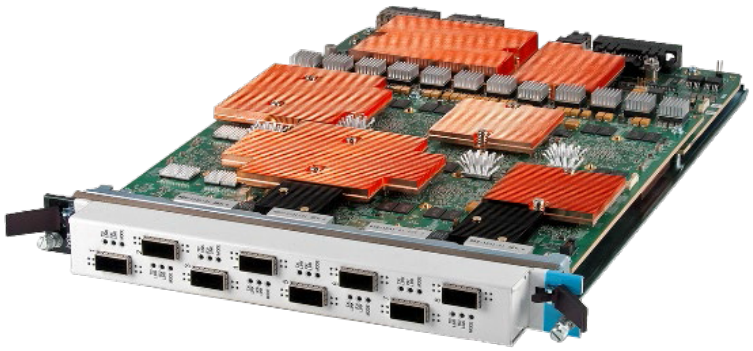
The Novus25/10GE8SFP28+100G+50G load module is described as follows:

Novus25/10GE8SFP28+100G+50G

Novus25/10GE8SFP28+100G+50G is an 8-port, SFP28 10/25 Gigabit Ethernet full-featured load module. It has 1-slot with 8-ports adaptor based SFP28 physical interface. It provides L2-3 support with complete protocol coverage. It is compatible with the following chassis:

- XGS2-SD 2-slot, 3RU standard performance rack-mountable chassis bundle (940- 0010)
- XGS12-SD 12-slot, 11RU standard performance rack-mountable chassis bundle (940-0011)
- XGS2-SDL 2-slot, 3RU standard performance rack-mountable chassis bundle (940-0013)
- XGS12-SDL 12-slot, 11RU standard performance rack-mountable chassis bundle (940-0015)
- XGS2-HSL 2-slot, 3RU high performance rack-mountable chassis bundle (940-0014)
- XGS12-HSL 12-slot, 11RU high performance rack-mountable chassis bundle (940-0016)

The Novus25/10GE8SFP28+100G+50G load module is shown in the following figure:



Speed options

100GE and 50GE factory installed

The 100GE and 50GE FACTORY INSTALLED speed option is available for new purchases of Novus25/10GE8SFP28+100G+50G (944-1164), 8-port, SFP28 10GE/25GE load module.

This option enables the 1x100GE and 1x50GE speeds per port on all ports of this load module.

100GE and 50GE field upgrade

The 100GE and 50GE FIELD UPGRADE speed option is available for field upgrade purchases of Novus25/10GE8SFP28+100G+50G (944-1164), 8-port, SFP28 10GE/25GE load module.

This option enables the 1x100GE and 1x50GE speeds per port on all ports of this load module.

TSN enablement option

TSN factory installed

Novus25/10GE8SFP28+100G+50G (944-1164) load module has a factory installed option for enabling TSN capability for 10G and 25G. This requires 930-2120 IxNetwork, optional software, AVB/TSN protocols emulation.

NOTE

- The factory installed option is required for new purchases of the Novus25/10GE8SFP28+100G+50G load module with 8-port adaptor based SFP28 physical interface.
- This option enables support for Frame preemption (802.1Qbu and 802.3br) on 25G link speeds only.

TSN field upgrade

Novus25/10GE8SFP28+100G+50G (944-1164) load module has a field upgrade option for enabling TSN capability for 10G and 25G. This requires 930-2120 IxNetwork, optional software, AVB/TSN protocols emulation.

NOTE This option enables support for Frame preemption (802.1Qbu and 802.3br) on 25G link speeds only.

Specifications

The load module specifications are contained in the following table.

Feature	Novus25/10GE8SFP28+100G+50G
Part number	944-1164
Hardware Load Module Specifications	
Slot / Number of Ports	1-slot load module with: • 8x100GE native QSFP28 ports (requires 905-1063 or 905-1064 option) • 8x50GE native QSFP28 ports (requires 905-1063 or 905-1064 option) • 8x25GE SFP28 ports with QSA56 adaptors • 8x10GE SFP28 ports with QSA56 adaptors
Physical Interface	8-ports of native QSFP28 + 8 each QSA56 adaptors to support native SFP28 pluggable optics and copper DACs
Supported Port Speeds	• 25GE/port: 25GE-capable fiber and passive copper cable media • 10GE/port: 10GE-capable fiber and passive copper cable media • Optional 100GE/50GE port speed using 100GE and/or 50GE-capable fiber and passive copper cable media
Number of users	Up to 8-users per load module
CPU and	Multicore processor with 2GB of CPU memory per port for 100/50/25/10GE

Feature	Novus25/10GE8SFP28+100G+50G
Memory	speed modes
IEEE Interface Protocols	• IEEE 802.3 100GBASE-R LAN • IEEE P802.3bj • IEEE P802.3bm • IEEE P802.3by • IEEE 802.3ba • IEEE 802.3ae
Advanced Layer 1 support	100GE: • Auto-negotiation (AN), Clause 73 for passive copper DAC • Link training for 100GE copper cable media, Clause 73 • Ethernet Forward Error Correction RS-FEC, Clause 91 • FEC statistics: RS-FEC Corrected and Uncorrected Codeword Counts • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability 50GE: • Auto-negotiation (AN) (based on Clause 73) for passive copper DAC. Compatible with 25G/50G Consortium v 1.6 (uses 25G CID) • Link training (LT) for 50GE copper cable media (Clause 93, 110) NOTE Clause 72 link training patterns are not supported • Ethernet Forward Correction : ◦ FC-FEC, Clause 74 for BASE-R PHYs ◦ RS-FEC, Clause 91 for 50GBASE-R PHYs ◦ FEC statistics: - RS-FEC Corrected and Uncorrected Codeword Count - FC-FEC Corrected and Uncorrected Block Count - FC-FEC Corrected Error Bits • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability 25GE: • Auto-negotiation (AN), Clause 73 for passive copper DAC. Compatible with 25G/50G Consortium v 1.6 (uses 25G CID) • Link training (LT) for 50GE copper cable media (Clause 93, 110) NOTE Clause 72 link training patterns are not supported • Ethernet Forward Error Correction: ◦ FC-FEC, Clause 74 for BASE-R PHYs

Feature	Novus25/10GE8SFP28+100G+50G
	◦ RS-FEC, Clause 108 for 25GBASE-R PHYs ◦ FEC statistics: - RS-FEC corrected and uncorrected codeword count - FC-FEC corrected and uncorrected block count - FC-FEC corrected error bits • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability 10GE: • Independent SFP28 ports with 10GE speed support
Transceiver Support	100GE: requires 100/50GE speed option • 100GBASE-SR4 and 4x25GBASE-SR QSFP28 for multimode fiber • Pluggable transceiver: 100GBASE-SR4 QSFP28 for multimode fiber • Pluggable transceiver: 100GBASE-LR4 QSFP28 for single-mode fiber • Pluggable transceiver: 100G PSM4 QSFP28 for single mode fiber • 100GE support requires a point-to-point cable 50GE: requires the 100/50GE speed option • Pluggable transceiver: 50GBASE-SR2 multimode fiber Active Optical Cable (AOC) media, 850nm, 3-meter length • Pluggable transceiver: 100GBASE-SR4 QSFP28 for multimode fiber • Pluggable transceiver: 100GBASE-LR4 QSFP28 for single-mode fiber 25/10GE • Pluggable transceiver: 25/10GE SFP28-LR for single mode fiber • 25/10GE support requires an LC-duplex single mode fiber cable • Pluggable transceiver: 25/10GE SFP28-SR for multimode fiber • 25/10GE support requires an LC-duplex multimode fiber cable
Transceiver Register Management Support	• Read and write SFP28 or QSFP28 transceiver registers • Ability to export transceiver register information to a csv file
Cable Media	• 100GBASE-SR4 multimode fiber AOC and MT-MT 12-fiber point-to-point cables for QSFP28 • 100GBASE-CR4, passive, copper DAC up to 5 meters in length Note: Requires RS-FEC to be enabled • 50GBASE-CR2 passive, copper DAC, point-to-point, up to 3 meters in length Note: Requires BASE-R FEC Clause 74 or RS-FEC Clause 91 to be enabled • 50GBASE-SR2 multimode fiber Active Optical Cable (AOC) media, 850nm,

Feature	Novus25/10GE8SFP28+100G+50G
	3-meter length • 25GBASE-SR requires an LC-duplex multimode fiber, point-to-point cable • 25GBASE-LR requires an LC-duplex single mode fiber, point-to-point cable • 25GBASE-CR requires a passive copper DAC point-point, up to 3 meters in length Note: Requires BASE-R FEC Clause 74 or RS-FEC Clause 91 to be enabled per IEEE 802.3by standard • 10GBASE-SR requires a LC-duplex multimode fiber, point-to-point cable • 10GBASE-LR requires a LC-duplex single mode fiber, point-to-point cable • This card supports passive copper CA-N cables for up to 2 meters in length with RS-FEC turned ON or FC-FEC turned ON or No-FEC turned at all
Load Module Dimensions	17.3” (L) x 1.3” (W) x 12.0” (H) 440 mm (L) x 33 mm (W) x 305 mm (H)
Load Module Weights	Module only: 11.8 lbs. (5.35 kg) Shipping: 19.24 lbs. (8.73 kg) includes eight QSA56 adaptors
Temperature (Ambient Air)	Operating: 41°F to 95°F (5°C to 35°C) Storage: 41°F to 122°F (5°C to 50°C)
Humidity (Ambient Air)	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model	
12 slot rack-mount chassis (XGS12-SD/HSL)	12 load modules per chassis: • 96-ports of 100GE, 50GE, 25GE and 10GE in a single 12-slot, chassis
2-slot rack-mount chassis (XGS2- SD/HSL)	2 load modules per chassis: • 16-ports of 100GE, 50GE, 25GE, and 10GE in a single 2-slot, chassis
Transmit Feature Specifications	
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures
Max. Streams per Port	• 100GE: 64 • 50GE: 64 • 25GE: 64

Feature	Novus25/10GE8SFP28+100G+50G
	• 10GE: 64 For High Stream Mode: • 100GE: 128
Max. Streams per Port in Data Center Ethernet	• 100GE: 64 • 50GE: 64 • 25GE: 64 • 10GE: 64 For High Stream Mode: • 100GE: 128
Stream Controls	Rate and frame size change on the fly, sequential and advanced stream scheduler
Minimum Frame Size	60 bytes at full line rate 49 bytes at less than full line rate
Maximum Frame Size	14,000 bytes
Maximum Fame Size in Data Center Ethernet	9,216 bytes
Priority Flow Control	• 8 line-rate-capable queues with each supporting up to 2,500 byte frame lengths • 1 queue supporting up to 9,216 byte frame lengths For High Stream Mode: • 1 queue supporting up to 9,216 byte frame lengths
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs, uniform, repeatable random, IMIX, and Quad Gaussian
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations. Up to ten, 32-bit wide UDFs are available. For High Stream Mode, UDF 1-5 supports Value Lists.
Value Lists (max.)	1M / UDF For High Stream Mode, the values are: • 100GE: 2M/UDF
Sequence (max.)	• 100GE: 8K/UDF • 50G:8K/UDF • 25GE: 8K/UDF

Feature	Novus25/10GE8SFP28+100G+50G
	• 10GE: 8K/UDF
Error Generation	Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum
Hardware Checksum Generation	Checksum generation and verification for IPv4, IP over IP, IGMP/GRE/TCP/UDP, L2TP, GTP
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics; generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner.
Latency Measurement Resolution	2.5 nanoseconds
Intrinsic Latency Compensation	Removes inherent latency error from the 100GE port electronics
Transmit line clock adjustment	Ability to adjust the parts per million line frequency over a range of -100 ppm to +100 ppm across all ports on the load module.
Receive Feature Specifications	
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability
Trackable Receive Flows per Port	100GE/50GE/25GE/10GE: • 32k Limited Statistics Mode • 4k Full Statistics mode
Minimum Frame Size	• 60 bytes at full line rate • 64 bytes at full line rate into the capture buffer • 49 bytes at less than full line rate
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.
Hardware Capture Buffer per Port or Resource Group	There are two 512MB hardware capture buffers on the card; user can select which port and/or resource group each capture buffer may be assigned for capture purposes.

Feature	Novus25/10GE8SFP28+100G+50G
Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, VLAN tagged frames, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), 8 QoS counters, data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies, FEC statistics: RS-FEC Corrected and Uncorrected Block Counts, FEC Corrected Error Bits, FEC Sync.
Latency / Jitter Measurements	Cut-through, store & forward, forwarding delay, up to 16 time bins latency/jitter, MEF jitter, and inter-arrival time.
100GE Receive-side PCS Lanes Port Statistics Counters	PCS Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, Out Of Order SOF, Out Of Order EOF, Out Of Order Data, Out Of Order Ordered Set.
100GE Physical Coding Sublayer (PCS) Receive-side Statistics and Indicators	IEEE 802.3ba-compliant PCS transmit and receive side test capabilities include: Per PCS lane, receive lanes statistics - PCS Sync Header and Lane Marker Lock, Lane Marker mapping, Relative lane deskew up to 104 microseconds for 100GE, Sync Header and PCS Lane Marker Error counters, indicators for Loss of Synch Header and Lane Marker, and BIP8 errors.
Time Sensitive Networking (TSN)	Support for Time Synchronization (802.1AS, 802.1AS 2020), Stream Reservation (802.1Qat), Credit Based Shaper (802.1Qav), Time Aware Shaper (802.1Qbv) – 10/25GE only, Frame Preemption (802.3br, 802.1Qbu) – 10/25GE only, Redundancy (802.1CB), Filtering & Policing (802.1Qci) – 10/25GE only, Configuration Management (802.1Qcc) – 10/25GE only. Support for Avnu Automotive, Avnu Industrial & TSN Conformance package on 10/25GE.
Layer 2-3 Protocol Support	
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP
Software Defined Network	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE, BGP FlowSpec, BGP SR TE Policy
MPLS	RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS/VPWS, L3VPN/6VPE, 6PE, BGP RFC3107, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN, Multicast VPN Rosen Draft, NG Multicast VPN
Broadband and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6 Autoconfiguration (SLAAC), IGMP/MLD, 802.1x, Bonded GRE HG
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, Sync-E ESMC, IEEE 1588v2 (PTP)

Feature	Novus25/10GE8SFP28+100G+50G
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA
5G RAN Transport	eCPRI, TSN, Static MACsec, 1588v2 (PTP)

Application Support

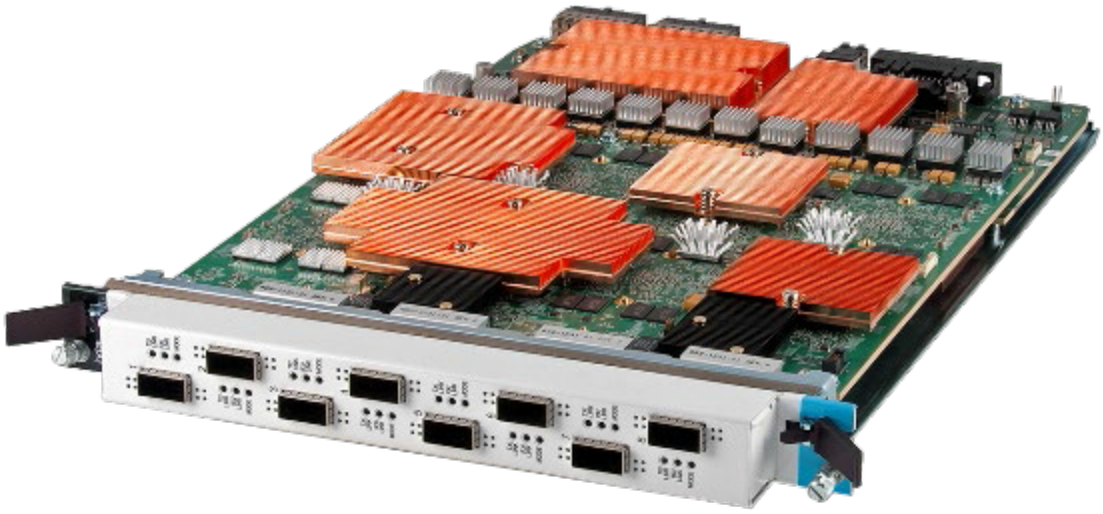
The Ixia application support for Novus25/10GE8SFP28+100G+50G load module is provided in the following table:

Application	Support
IxNetwork	Provides wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Provides Layer 2-3 wire-speed traffic generation and analysis with HSE PCS Lanes Rx-side testing. NOTE Not all Ixia loads modules support Layer 1 BERT and/or the complete set of Tx PCS Lanes test capabilities.
Tcl API	Allows custom user script development for layer 1-3 testing.

Mechanical Specifications

Front Panel

The front panel of the Novus25/10GE8SFP28+100G+50G load module is shown in the following figure:



LED Panel

There are 3 tricolor LEDs per port. The LED panel specifications for Novus25/10GE8SFP28+100G+50G are provided in the following table.

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
100GE	Link Down = Solid Red Link Up (1,2 or 3 links) = Solid Yellow Link Up (all) = Solid Green TX Active = Blink Green	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Yellow Card Fault = Solid Red
50GE	Link Up (1,2, or 3 links) =Solid Yellow Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Mode=Solid Blue Card Fault=Solid Red
25GE	Link Up (1,2, or 3 links) =Solid Yellow Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Port Inactive/No Power=Off Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Mode=Solid Blue Card Fault=Solid Red
10GE	Link Down = Solid Red Link Up (1,2 or 3 links) = Solid Yellow	Rx Active with Error = Blinking Red Rx Active = Blinking Green	Mode = Solid Yellow Card Fault = Solid

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
	Link Up (all) = Solid Green TX Active = Blink Green		Red

CHAPTER 25

IXIA PerfectStorm Load Modules

This chapter provides details about PerfectStorm 10GE, 40GE and 100GE family of load modules specifications and features.

Ixia's PerfectStorm family of load modules is a scalable solution for testing converged multi-play services, application delivery, and network security platforms for both wired and wireless networks.

The PerfectStorm product family consists of a new next generation XGS12 chassis platform, an XGS integrated system controller for both IxLoad and BreakingPoint and load modules 8x10GE, 2x40GE and 1x100GE.The PerfectStorm10GE, 40GE, and 100GE load modules have two variants, fusion (IxLoad and BreakingPoint) and non-fusion (IxLoad only). The key feature of PerfectStorm 10GE/40GE/100GE NG cards is the fusion between IxLoad and BreakingPoint applications.

PerfectStorm supports the following:

- both IxLoad and BreakingPoint software applications; BPS runs on the fusion variants of the load module
- native 40GE QSFP+ and 100GE CXP interfaces
- line-rate application performance per interface
- hardware-based acceleration for SSL and IPsec performance

Key Features

The key features of PerfectStorm load modules are as follows:

Unified Applications and Security Test Platform

PerfectStorm is a unified applications and security test platform, with support for BreakingPoint and IxLoad software.

Networking Interfaces per Blade

- 8 x 10GE
- 2 x 40GE
- 1 x 100GE

Blended Application Traffic

PerfectStorm Fusion can create blended application traffic and current security attacks with a very high count of concurrent wired and wireless users from a single 11u chassis.

Massive Scale Real-World Traffic Conditions

PerfectStorm tests and validates IT systems under controlled real-world scenarios that model your own unique environments.It understands actual performance, system limitations, and real security posture in a better way, to right size data centers and eliminate incidents in production.It generates stateful applications and malicious traffic that simulate millions of real-world end-user environments to test and validate infrastructure, a single device, or an entire system. This includes complex data, video, voice, storage, and network application workloads.

Real Attacks

- 6,000+ live security attacks, 35,000+ pieces of live malware found in enterprise, core, and mobile networks, 180+ evasions
- DDoS and botnet simulation and custom attacks
- Research and frequent updatesHardware-based Acceleration

Multi-user Environment

PerfectStorm's multi-user environment leverages the per port user ownership model for all ports on the test modules installed into the chassis.

High-performing Business Applications

PerfectStorm ensures high-performing, and more available and secure business applications.

Disaster Recovery

PerfectStorm validates disaster recovery and business continuity.

Reduced Legal Exposure

PerfectStorm provides reduced legal exposure due to data loss by validating security using the industry's most up to date application and threat intelligence.

Platform Support

PerfectStorm is equipped with powerful multi-core, multi-threaded network processors, to satisfy the testing needs of equipment manufacturers having higher-density 10GE and 40GE equipments. As service providers and large enterprises prepare to deploy these equipments in their own networks, they must test and verify performance and functionality prior to deployment.

PerfectStorm's single, integrated system equipped with 12 PerfectStorm blades allows control of application traffic to nearly a terabit, up to 720 million concurrent connections, and new TCP connection rates of up to 24 Million. The hardware-based acceleration supports massive encryption levels. The system uses inline field programmable gate arrays (FPGAs) for enhanced accuracy pertaining to latency measurements with a resolution of 10ns.

PerfectStorm is compatible with XGS12, which is a 12-slot Chassis platform. The Chassis platform architecture supports easy setup and management of high scale, multi-user system. The XGS12 chassis platform includes a pluggable system controller for chassis management and web-based UI.

For more information on XGS12, see XGS12 Chassis Platform.

Load Modules

PerfectStorm load module comprises a two board set, the Main Board and the PHY Card. The Main Board contains the backplane interface, processors and FPGAs. The card occupies one slot in the XGS12 chassis platform and consumes no more than 400W of power.

The PerfectStorm family consists of the following models:

- PerfectStorm 10GE 8-port (SFP+)
- PerfectStorm Fusion 10GE 8-port (SFP+)
- PerfectStorm 40GE 2-port (QSFP+)
- PerfectStorm Fusion 40GE 2-port (QSFP+)
- PerfectStorm 100GE1 1-port (CXP)
- PerfectStorm 100GE1NG 1-port (CXP)

Each of these load modules are described as follows:

PS10GE8

PerfectStorm PS10GE8 is a 8 port 10-Gigabit Ethernet, load module with SFP+ interface. Each 10GE port uses of 1/8th of the network processor and memory resources available on the load module, allowing delivery of application traffic at wire-speeds for each port.It supports only IxLoad software and is compatible with XGS12 chassis platform.

The PS10GE8 load module is shown in the following figure:

Figure: PerfectStorm Module-PS10GE8

PS10GE8NG

PerfectStorm PS10GE8NG is a 8 port 10-Gigabit Ethernet, fusion load module with SFP+ interface. This mode provides extra flexibility to allocate all available NP resources and memory available on a single module while using a single 10 GE interface to transmit or receive the traffic. Ixia test applications transparently configure the allocation of NP resources to achieve the maximum performance.It supports IxLoad and BreakingPoint software and is compatible with XGS12 chassis platform.The PS10GE8NG load module is shown in the following figure:

Figure: PerfectStorm Module-PS10GE8NG

PS40GE2

PerfectStorm PS40GE2 is a 2 port 40-Gigabit Ethernet, load module with QSFP+ interface. Each 40GE port uses of ½ of the network processor and memory resources available on the load module, allowing delivery of application traffic at wire-speeds for each port. It supports only IxLoad software and is compatible with XGS12 chassis platform.

The PS40GE2 load module is shown in the following figure:

Figure: PerfectStorm Module-PS40GE2

PS40GE2NG

PerfectStorm PS40GE2NG is a 2 port 40-Gigabit Ethernet, fusion load module with QSFP+ interface. This mode provides extra flexibility to allocate all network processor and memory resources available on a load module to a single 40GE port. Ixia test applications transparently configure the allocation of NP resources to achieve the maximum performance. It supports IxLoad and BreakingPoint software and is compatible with XGS12 chassis platform.

The PS40GE2NG load module is shown in the following figure:

Figure: PerfectStorm Module-PS40GE2NG

PS100GE1

PerfectStorm PS100GE1 is a 1-port 100-Gigabit Ethernet load Module with CXP interface. This supports upto 2-ports of 40GE OR 8-ports of 10GE via Fan-out cables. It requires one CXP 100GE pluggable, multimode optical transceiver (948-0030) and a point-to-point, multimode CXP 100GE Active Optical Cable (AOC) (942-0052), or alternatively, one PerfectStorm 100G transceiver and cable bundle to enable support for the native 100G and all the fan-out options (942-0073).

The PS100GE1 load module is shown in the following figure:

Figure: PerfectStorm Module-PS100GE1

PS100GE1NG

PerfectStorm PS100GE1NG is a 1-port 100-Gigabit Ethernet fusion load Module with CXP interface. This supports upto 2-ports of 40GE or 8-ports of 10GE via optional Fan-out cables. It requires BreakingPoint Application and Threat Intelligence (ATI) (909-0856), one CXP 100GE pluggable, multimode optical transceiver (948-0030) and a point-to-point, multimode CXP 100GE Active Optical Cable (AOC) (942-0052), or alternatively, one PerfectStorm 100G transceiver and cable bundle to enable support for the native 100G and all the fan-out options (942-0073).

The PS100GE1NG load module is shown in the following figure:

Figure: PerfectStorm Module-PS100GE1NG

Part Numbers

Part Numbers for PerfectStorm Load Modules and supported adapters are provided in the following table.

Part Numbers for PerfectStorm Modules

Model Number	Part Number	Description
PS10GE8NG	944-1200	• 8-ports of 10GE with the SFP+ physical interface. • SSL and IPsec hardware acceleration.
PS10GE8	944-1204	• 8-ports of 10GE with the SFP+ physical interface. • SSL and IPsec hardware acceleration.
PS40GE2NG	944-1201	• 2-ports of 40GE with the SFP+ physical

Model Number	Part Number	Description
		interface. • SSL and IPsec hardware acceleration.
PS40GE2	944-1205	• 2-ports of 40GE with the SFP+ physical interface. • SSL and IPsec hardware acceleration.
PS100GE1NG	944-1202	• 1-port 100GE CXP interface. • SSL and IPsec hardware acceleration.
PS100GE1	944-1206	• 1-port 100GE CXP interface. • SSL and IPsec hardware acceleration.

Specifications

The load module specifications are contained in the following table.

PerfectStorm Load Module Specifications

Feature	PerfectStorm 10GE	PerfectStorm Fusion 10GE	PerfectStorm 40GE	PerfectStorm Fusion 40GE	PerfectStorm 100GE	PerfectStorm Fusion 100G
Load Modules	PS10GE8	PS10GE8NG	PS40GE2	PS40GE2NG	PS100GE1	PS100GE1NG
Hardware, Load Module Specifications						
Number of Ports	8	8	2	2	1	1
Physical Interface	8-port, 10GE SFP+	8-port, 10GE SFP+	2-port, 40GE QSFP+	2-port, 40GE QSFP+	1-port, 100GE CXP	1-port, 100GE CXP
Transceiver Support (pluggable transceivers)	10GBASE-SR/SW (850 nm) 10GBASE-LR/LW (1310 nm)	10GBASE-SR/SW (850 nm) 10GBASE-LR/LW (1310 nm)	QSFP+, 40GBASE-SR4	QSFP+, 40GBASE-SR4	CXP 100GBASE-SR10	CXP 100GBASE-SR10
Memory	64GB	64GB	64GB	64GB	64GB	64GB
Hardware Encryption Offload	Yes	Yes	Yes	Yes	Yes	Yes

Feature	PerfectStorm 10GE	PerfectStorm Fusion 10GE	PerfectStorm 40GE	PerfectStorm Fusion 40GE	PerfectStorm 100GE	PerfectStorm Fusion 100G
Hardware-Based Traffic Capture	N/A	N/A	N/A	N/A	N/A	2GB per 100GbE interface 1GB per 40GbE interface 256 MB per 10GbE interface
FPGA Offload	Yes	Yes	Yes	Yes	Yes	Yes
IPv4, IPv6, UDP, TCP	Hardware checksum generation					
MTU(IP)	8900B	8900B	8900B	8900B	8900B	8900B
Load Module Dimensions	16" (L) x 12.00" (W) x 1.3" (H) 406 mm (L) x 305 mm (W) x 33 mm (H)					
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air					
Chassis Capacity						
Cards per Chassis	12	12	12	12	12	12
Port Density per XGS12 Chassis	144-port, 10GE SFP+	144-port, 10GE SFP+	24-port, 40GE QSFP+	24-port, 40GE QSFP+	12-port, 100GE CXP	12-port, 100GE CXP
Chassis Compatibility	XGS12 , XGS2	XGS12 , XGS2	XGS12 , XGS2	XGS12 , XGS2	XGS12 , XGS2	XGS12 , XGS2
XGS12 Chassis Bundles	XGS12 (940-0007)		XGS12 (940-0007)			

Transceiver and Cable Support

The transceiver and cable support for PerfectStorm load modules is provided in the following table:

PerfectStorm Transceiver and Cable Support

Hardware	Transceiver/Cable Part Number	Description
• PerfectStorm PS10GE8 • PerfectStorm Fusion PS10GE8NG	988-0011	SFP+, 10Gb/1Gb SR optical Xcvr, 850nm (cable included)
	988-0012	SFP+, 10Gb/1Gb LR optical Xcvr, 1310nm
• PerfectStorm PS40GE2 • PerfectStorm Fusion PS40GE2NG	948-0028	QSFP+ 40GBASE-SR4 optical transceivers
	942-0041	MT 12-fiber MMF cable, 3-meter length
• PerfectStorm PS100GE1 • PerfectStorm Fusion PS100GE1NG	948-0030	CXP 100GbE pluggable, multimode optical transceiver
	942-0035	MT cable, 24-filer, Multimode fiber, Key Up/Down, 3 meter length
	942-0052	Point-to-point, multimode CXP 100GbE Active Optical Cable (AOC)
	942-0072	CXP-to-2x40GbE QSFP Active Optical Cable (AOC), 850nm, 3 meter cable to support the fan-out option
	942-0073	PerfectStorm Transceiver and Cable bundle containing the following: • (942-0035) MT cable, 24-filer, Multimode fiber, Key Up/Down, 3 meter, • (942-0052) Multis, CXP-to-CXP 100GE Active Optical Cable, point-to-point (AOC), 3M, • (942-0064) MT-to-8x10GE LC fan-out, MMF, 3-meter cable, • (942-0072) PerfectStorm, CXP-to-2x40G QSFP Active Optical Cable (AOC), 850NM,3-METER, • (948-0030) Multis, CXP,100GE,MMF,850NM,pluggable transceiver

Hardware	Transceiver/Cable Part Number	Description
	942-0074	CXP-to-2x40GbE QSFP Active Optical Cable (AOC), 850nm, 5 meter cable to support the fan-out option
	942-0064	MT-to-8x10GbE LC fan-out, MMF, 3-meter cable to support the fan-out option
	942-0068	MT-to-4x10GbE LC fan-out, MMF, 5-meter cable to support the fan-out option

Application Support

The Ixia application support for PerfectStorm load modules is provided in the following table:

PerfectStorm Application Support

Hardware	Application Support
PerfectStorm PS10GE8	IxOS, IxLoad, TCL API
PerfectStorm Fusion PS10GE8NG	IxOS, IxLoad, BreakingPoint, TCL API
PerfectStorm PS40GE2	IxOS, IxLoad, TCL API
PerfectStorm Fusion PS40GE2NG	IxOS, IxLoad, BreakingPoint, TCL API
PerfectStorm PS100GE1	IxOS, IxLoad, TCL API
PerfectStorm Fusion PS100GE1NG	IxOS, IxLoad, BreakingPoint, TCL API

Mechanical Specifications

Front Panel

The Front panel of the 8x10GE, 2x40GE, and 1x100GE PerfectStorm load modules are shown in the following figures (applies to Fusion and non-Fusion versions):

Figure: Front panel of 8x10GE PerfectStorm PS10GE8

Figure: Front panel of 8x10GE Fusion PerfectStorm PS10GE8NG

Figure: Front panel of 2x40GE PerfectStorm PS40GE2

Figure: Front panel of 2x40GE Fusion PerfectStorm PS40GE2NG

Figure: Front panel of 1x100GE Fusion PerfectStorm PS100GE1NG

Figure: Front panel of 1x100GE PerfectStorm PS100GE1

LED Panel

The LED panel specifications are provided in the following table.

LED panel specifications of PS10GE8(NG) and PS40GE2(NG) Load Modules

Feature	Specification
Link	• OFF indicates link is down • Solid Green indicates link is up
Tx	• Off indicates Tx is inactive • Blinking Green indicates Tx is active
Rx/Err	• Off indicates Rx is inactive • Blinking Red indicates Rx is active with errors • Blinking Green indicates Rx is active

CHAPTER 26

IXIA CloudStorm Load Modules

This chapter provides details about CloudStorm 100GE load modules specifications and features.

Ixia's CloudStorm family of load modules is the first multi-terabit application and security test solution. It breaks the SSL and DDoS test barriers, achieving over 960Gbps of traffic with strong encryption and ciphers or 2.4 terabit DDoS throughput in a single chassis.

Each CloudStorm load module supports two native QSFP28 100GE interfaces with an innovative architecture that allows concurrent emulation of complex applications, unprecedented SSL encrypted applications, and a large volume of DDoS traffic to validate your network infrastructure is high performing and secure.

The CloudStorm product family consists of 100GE load modules that have two variants, fusion (IxLoad and BreakingPoint) and non-fusion (IxLoad only). A key feature of CloudStorm 100GE load modules is the fusion between IxLoad and BreakingPoint applications—the industry-leading test solutions for application delivery and security resiliency testing.

CloudStorm supports the following:

- BreakingPoint software application which runs on the fusion variant of the load module and IxLoad which runs on the non-fusion variant
- QSFP28 interfaces
- hardware-based SSL acceleration delivering 4X encryption performance

Key Features

The key features of CloudStorm load modules are as follows:

Massive Scale Real-World Traffic Conditions

CloudStorm delivers 3X-application and 4X-SSL-emulation scale over any other test system. It helps NEMs shortening their development cycles, and enterprises and data center operators find the right balance between mitigating security risks and delivering high end-user application performance.

SSL Acceleration

CloudStorm provides hardware-based SSL acceleration to deliver 80G of encrypted traffic with strong encryption and chiphers.

Multi-user Environment

CloudStorm's multi-user environment leverages the per port user ownership model for all ports on the test modules installed into the chassis.

Emulate Multi-terbit DDoS

CloudStorm emulates multi-terbit DDoS and botnet attacks to future-proof security solutions.

Unified Application and Security Test Platform

CloudStorm provides a unified application and security test platform with layers 2-7 capabilities and support for BreakingPoint and IxLoad software.

Platform Support

CloudStorm provides cloud-grade L4-7 application performance with fully integrated L2/3 stateless traffic support. It exercises the systems under test in real world conditions, helping the customers to easily identify the performance and interoperability issues. The modular architecture of the solution allows linear performance scaling to multi terabit, by populating an Ixia's XGS12-HSL chassis with multiple CloudStorm load modules—up to 12.

CloudStorm is compatible with XGS12-HSL, a 12-slot chassis platform and XGS2-HSL, a 2-slot chassis platform. The Chassis platform architecture supports easy setup and management of high scale, multi-user system.

For more information on XGS12 and XGS2, see the following:

- XGS12 Chassis Platform
- XGS2 Chassis Platform

Load Modules

Each CloudStorm load module supports two native QSFP28 100GE interfaces with an innovative architecture that allows concurrent emulation of complex applications, unprecedented SSL encrypted applications, and a large volume of DDoS traffic to validate your network infrastructure is high performing and secure.

The dual-port capabilities of CloudStorm enable 100GE inline devices like firewalls to be tested with a single card. The CloudStorm load module also includes a mission control center CPU (MCC) equipped with dedicated memory and a solid-state drive (SSD) to accelerate boot time and reduce test configuration time.

The CloudStorm family consists of the following models:

- CloudStorm 100GE 2-port QSFP28
- CloudStorm Fusion 100GE 2-port QSFP28

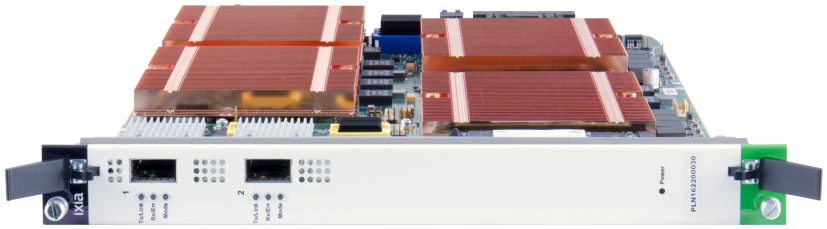
Each of these load modules are described as follows:

CS100GE2Q28

CloudStorm CS100GE2Q28 is a 2 port 100-Gigabit Ethernet, load module with QSFP28 interface. It provides support for native QSFP28 100GE pluggable multi-mode optical transceiver or single-mode optical transceiver. It is compatible only with XGS12-HSL and XGS2-HSL chassis. This load module supports only IxLoad software application.

The CS100GE2Q28 load module is shown in the following figure:

Figure: CloudStorm Module-CS100GE2Q28

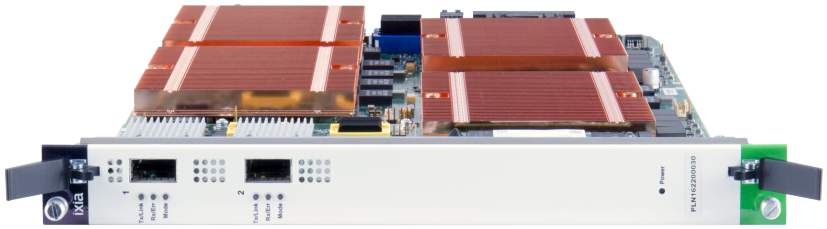


CS100GE2Q28NG

CloudStorm CS100GE2Q28NG is a 2 port 100-Gigabit Ethernet, fusion load module with QSFP28 interface. It provides support for native QSFP28 100GE pluggable multi-mode optical transceiver or single-mode optical transceiver. It is compatible only with XGS12-HSL and XGS2-HSL chassis. This load module supports both IxLoad and BreakingPoint software applications.

The CS100GE2Q28NG load module is shown in the following figure:

Figure: CloudStorm Module-CS100GE2Q28NG



Part Numbers

Part Numbers for CloudStorm Load Modules and supported adapters are provided in the following table.

Part Numbers for CloudStorm Modules

Model Number	Part Number	Description
CS100GE2Q28	944-1232	2-ports of 100GE with the QSFP28 physical interface.
CS100GE2Q28NG	944-1231	2-ports of 100GE with the QSFP28 physical interface.

Specifications

The load module specifications are contained in the following table.

CloudStorm Load Module Specifications

Feature	CloudStorm 100GE	CloudStorm Fusion 100G
Load Modules	CS100GE2Q28	CS100GE2Q28NG
Hardware, Load Module Specifications		
Physical Interfaces	2-port, 100GE QSFP28	

Feature	CloudStorm 100GE	CloudStorm Fusion 100G
Transceiver Support	QSFP28 SR4 and LR4 (pluggable transceivers)	
Memory	128GB	128GB
Hardware Encryption Offload	Yes	Yes
Hardware-Based Traffic Capture (for BreakingPoint)	N/A	2GB per 100GB interface
Capture Memory (for IxLoad)	Maximum between 2GB or 2 Million packets, per interface	Maximum between 2GB or 2 Million packets, per interface
FPGA Offload	Yes	Yes
IPv4, IPv6, UDP, TCP	Hardware checksum generation	
Load Module Dimensions	16.4" (L) x 12.0" (W) x 1.3" (H) 417mm (L) x 305mm (W) x 33mm (H)	
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air	
Chassis Capacity		
Cards per Chassis	• 12 on XGS12-HSL • 2 on XGS2-HSL	
Port Density	• XGS12-HSL: 24-ports, 100GE QSFP28 • XGS2-HSL: 4-ports, 100GE QSFP28	
XGS12 and XGS2 Chassis Bundles	• XGS12-HSL (940-0016) • XGS2-HSL (940-0014)	• XGS12-HSL (940-0016) • XGS2-HSL (940-0014)

Transceiver and Cable Support

The transceiver and cable support for CloudStorm load modules is provided in the following table:

CloudStorm Transceiver and Cable Support

Hardware	Transceiver/Cable Part Number	Description
• CloudStorm CS100GE2Q28 • CloudStorm Fusion CS100GE2Q28NG	QSFP28-SR4-XCVR	QSFP28 100GBASE-SR4 100GE pluggable optical transceiver, MMF (multimode), 850 nm, 100 m reach
	QSFP28-LR4-XCVR	QSFP28 100GBASE-LR4 100GE pluggable optical transceiver, SMF (single mode fiber),

Hardware	Transceiver/Cable Part Number	Description
		1310 nm, 10 km reach
	942-0088	QSFP28 passive, copper, Direct Attach Cable (DAC), 3 meter length
	942-0092	QSFP28 Active Optical Cable (AOC), multimode fiber, 850 nm, 3 meter length

Application Support

The Ixia application support for CloudStorm load modules is provided in the following table:

CloudStorm Application Support

Hardware	Application Support
CloudStorm CS100GE2Q28	IxOS, IxLoad, TCL API
CloudStorm Fusion CS100GE2Q28NG	IxOS, IxLoad, BreakingPoint, TCL API

Mechanical Specifications

Front Panel

The Front panel of the CloudStorm load module is shown in the following figures (applies to Fusion and non-Fusion versions):

Figure: Front panel of 100GE Fusion CloudStorm CS100GE2Q28NG

Figure: Front panel of 100GE CloudStorm CS100GE2Q28

LED Panel

There are 3 tricolor LEDs per port. The LED panel specifications for CloudStorm are provided in the following table.

LED panel Specifications for CloudStorm Load Module

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
100GE	Port Inactive/No	Port Inactive/No Power=Off	Mode=Off

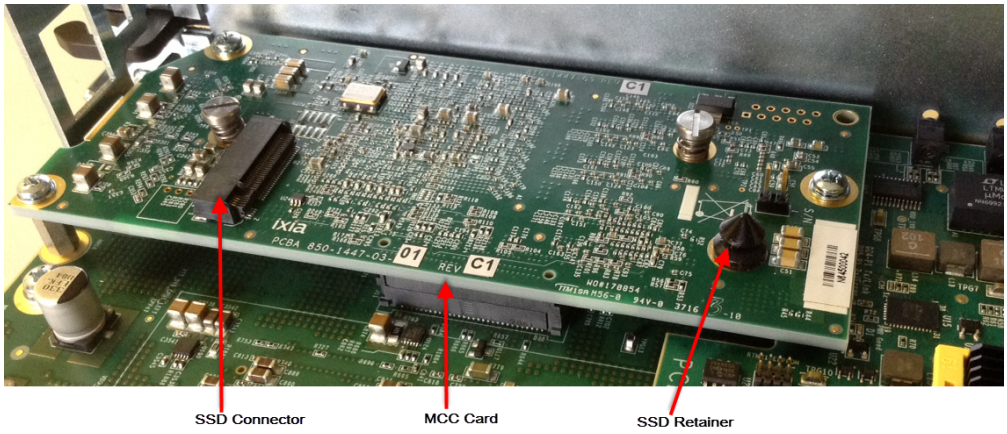
Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
	Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Card Fault=Solid Red

Remove and Insert SSD on CloudStorm

You can remove the Solid State Drive (SSD) on the CloudStorm load module and insert it back when needed.

To remove the SSD: Bend the top of the retainer away from the SSD card. The SSD will spring upward. Now pull the SSD card straight out.

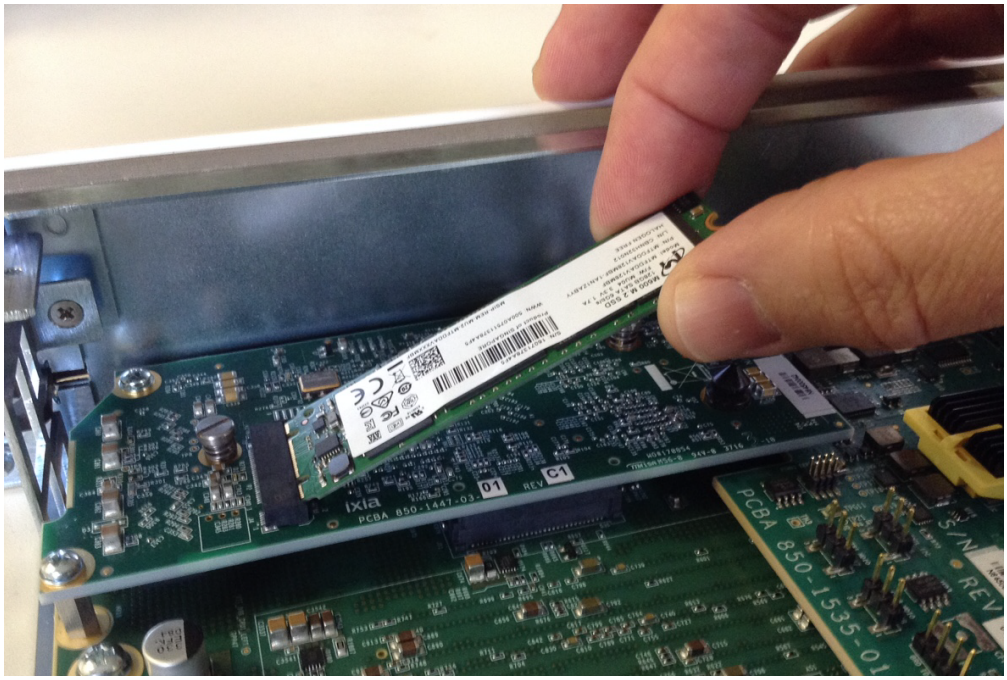
The SSD edge connector on the MCC card is shown in the following figure.



To insert SSD, do the following:

1. Align SSD edge connector with SSD connector on the MCC card.

2. Insert SSD edge connector and push SSD downward towards the MCC card.



3. With your finger, bend the top of the retainer away from the SSD card and push the SSD downward until it hits the retainer. Now release the retainer. If the SSD card is properly seated, the top of the retainer will capture the SSD card.

4. The SSD card is now properly placed on the MCC card.

CHAPTER 27

IXIA Data Center Storage Load Modules

This chapter provides details about Data Center Storage (DCS) load modules, their specifications, and features.

Keysight's Data Center Storage 100GE Test Load Module generates realistic RoCEv2 traffic at line-rate in a controlled and repetitive manner. It enables users to characterize the performance and latency impacts of various storage workloads and tune switching fabric parameters to overcome network congestion.The Data Center Storage Load Modules have 2 QSFP28 ports that can fanout to 8 x 25GE ports.

Driven by IxLoad – the test application for measuring the quality of experience (QoE) of real-time, business-critical applications with converged multiplay service emulations – the Data Center Storage 100GE Test Load Module is a unique platform for validating RoCEv2 implementations and parameter settings of converged data center switches.

Compared to homegrown or open source test solutions on commercial compute servers, the Keysight RoCEv2 test solution brings higher efficiency through high scalability, high density, simplified and unified management, easier configurability, and lower maintenance while providing comprehensive and replicable testing.

Key Features

The key features of Data Center Storage load modules are as follows:

- Provides data center performance for RoCE and HTTP traffic with full congestion control mechanism support for exercising the systems under test (SUT) in realworld conditions, enabling users to easily identify performance and interoperability issues.
- The modular architecture of the solution allows linear performance scaling to multi terabits by populating a Keysight XGS12-HSL or XGS12-SDL chassis with up to 12 Data Center Storage Test load modules.

Load Module

DCS100GE2Q28ALL is a 2 port load module with QSFP28 interface. It provides support for native QSFP28 100GBASE-SR4 pluggable optical transceivers (QSFP28-SR4-XCRV). Each of the 100GE QSFP28 ports can operate through a fan-out cable as 4 x 25GE SFP28 ports. The Data Center Storage Test Load Module is multiuser. The ports are independent and can be used in a single or multiple concurrent test sessions. It is compatible only with Keysight XGS12-HSL or XGS12-SDL chassis. This load module supports only IxLoad software application.

The DCS100GE2Q28ALL load module is shown in the following figure:

Part Numbers

Part Numbers for the DCS Load Module is provided in the following table.

Model Number	Part Number	Description
DCS100GE2Q28ALL	957-5110	2-ports of 100GE with the QSFP28 physical interface.

Specifications

The load module specifications are contained in the following table.

Feature	DCS100GE2Q28ALL
Hardware, Load Module Specifications	
Physical Interfaces	2-port, 100GE QSFP28
Transceiver Support	QSFP28 SR4 and LR4 (pluggable transceivers)
Memory	128GB
Hardware Encryption Offload	Yes
Hardware-Based Traffic Capture (for BreakingPoint)	N/A
Capture Memory (for IxLoad)	Maximum between 2GB or 2 Million packets, per interface
FPGA Offload	Yes
IPv4, IPv6, UDP, TCP	Hardware checksum generation
Load Module Dimensions	16.4" (L) x 12.0" (W) x 1.3" (H) 417mm (L) x 305mm (W) x 33mm (H)
Load Module Weights	• Module only: 10.2 lbs. (4.6 kg) • Shipping: 19.9 lbs. (9.0 kg)

Feature	DCS100GE2Q28ALL
Operating Temperature Range	41°F to 95°F (5°C to 35°C), ambient air
Chassis Capacity	
Cards per Chassis	• 12 on XGS12-HSL or XGS12-SDL • 2 on XGS2-HSL or XGS2-SDL
Port Density	• XGS12-HSL/SDL: 24-ports, 100GE QSFP28 • XGS12-HSL/SDL: 96-ports, 25GE QSFP28 • XGS2-HSL/SDL: 4-ports, 100GE QSFP28 • XGS2-HSL/SDL: 16-ports, 25GE QSFP28
XGS12 and XGS2 Chassis Bundles	• XGS2-SDL (940-0013) • XGS2-HSL (940-0014) • XGS12-SDL (940-0015) • XGS12-HSL (940-0016)

DCS Load Module, IxLoad Performance

The performance numbers in a back-to-back scenario using a single DCS load module are provided in the following table:

Performance Metric	DCS100GE2Q28ALL Support	XGS12 Chassis with 12 Load Modules
HTTP Throughput	100 Gbps	1.2 Tbps
RoCEv2 Throughput	100 Gbps	1.2 Tbps
Number of Q-Pairs	8k	96k
Latency	<100ns	

Transceiver and Cable Support

The transceiver and cable support for the DCS load module is provided in the following table:

Transceiver/Cable Part Number	Description
QSFP28-SR4-XCVR	QSFP28 100GBASE-SR4 100GE pluggable optical transceiver, MMF (multimode), 850 nm, 100 m reach
QSFP28-LR4-XCVR	QSFP28 100GBASE-LR4 100GE pluggable optical transceiver, SMF (single mode fiber), 1310 nm, 10 km reach
942-0088	QSFP28 passive, copper, Direct Attach Cable (DAC), 3 meter length
942-0092	QSFP28 Active Optical Cable (AOC), multimode fiber, 850 nm, 3 meter length

Application Support

The Keysight application support for DCS load modules is provided in the following table:

Hardware	Application Support
DCS100GE2Q28ALL	IxOS, IxLoad, TCL API, REST API

IxLoad Application Support	DCS100GE2Q28ALL
Application Delivery	• RoCEv2 • HTTP

Mechanical Specifications

Front Panel

The front panel of the DCS load module is shown in the following figure:

LED Panel

There are 3 tricolor LEDs per port. The LED panel specifications for DCS are provided in the following table.

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
25GE	Port Inactive/No	Port Inactive/No Power=Off	Mode=Off

Speed Mode	LED1: TX LED	LED2: RX LED	LED3: MODE LED
	Power=Off Link Down (all)=Solid Red Link Up (all)=Solid Green Tx Active=Blinking Green	Rx Active with Errors=Blinking Red Rx Active=Blinking Green	Card Fault=Solid Red

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CHAPTER 28

IXIA K400 CFP8 Load Modules

This chapter provides details about K400 CFP8 family of load modules and their specifications and features.

K400 CFP8 is a 1-port, 400GE load module. It provides FEC error injection, PCS/Tx/Rx testing, and layer1 BERT testing with full line-rate layer 2-3 Tx, Rx, and capture capabilities. This load module accelerates development of IEEE 802.3bs-compliant 400GE networking systems.

These load modules are available in two different models:

- Full feature and scale CFP8-400GE
- Reduced feature and scale CFP8-R400GE

Both models enable full line-rate traffic generation transmit, receive, and capture functionality from 64B to 16,000B frame lengths. This facilitates stress testing, hardware/ASIC bring-up, optics and cable qualification, interoperability, and functional test and Layer 2/3 routing protocol emulation as required.

Key Features

The key features of K400 CFP8 load module are as follows:

- Supports line-rate 400Gbps packet generation, capture, and analysis of received traffic to detect and debug data transmission errors.
- Supports line-rate per-port and per-flow statistics.
- Provides high latency measurement resolution at 0.625ns.
- Provides RS-544 (KP4) Forward Error Correction (FEC) support.
- Provides native 28Gb/s SERDES with NRZ encoding support that is IEEE 802.3bs compliant.
- Supports FEC error injection with a comprehensive set of FEC corrected and uncorrected statistics, including Bit Error Rate statistics for pre- and post-FEC operations.
- Injects packet errors: CRCs, runts, giants, checksum errors, and out of sequence.
- Supports standard Ixia instrumentation including timestamp, sequence number and flow identification, and data integrity.
- Supports layer 1 BERT: 16 independent lanes of 28Gb/s PRBS pattern generation, error checking, and statistics.
- Supports 400G PCS lanes Transmit, error injection testing and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion

- Supports mid-to-high-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases using the Ixia's IxNetwork application.
- Provides an excellent test platform for full line-rate 400Gb/s to evaluate the new 400GE ASIC designs, FPGAs, and hardware switch fabrics that use the new 16x28Gb/s electrical interface with NRZ encoding.
- Supports benchmarking of networking devices and equipment using industry-standard RFC benchmark tests at line-rate 400GE.
- Provides application support including: IxExplorer, IxNetwork, and related Tcl and automation APIs.

Load Modules

The K400 CFP8 family consists of the following models on a single slot card:

- CFP8-400GE
- CFP8-R400GE

The load modules are described as follows:

CFP8-400GE

CFP8-400GE is a 1-port 400 Gigabit Ethernet full-featured load module. It has 2 slots with the native CFP8 physical interface and supports enterprise and data center switch and router testing. It provides L2-3 support and is compatible with the XGS12-HSL rack mount chassis (940-0016) and 2-slot high performance chassis XGS2-HSL chassis (940-0014).

The CFP8-400GE load module is shown in the following figure:

Figure: K400 Module-CFP8-400GE

CFP8-R400GE

CFP8-R400GE is a 1-port 400 Gigabit Ethernet reduced load module that that scales down the L2-3 feature set and L2-3 networking protocol scaling, while increasing affordability. It has 2 slots with the native CFP8 physical interface and supports hardware, ASIC, cable/optics qualification, and interoperability testing. It provides L2-3 support and is compatible with the XGS12-HSL rack mount chassis (940-0016) and 2-slot high performance chassis XGS2-HSL chassis (940-0014).

The CFP8-R400GE load module is shown in the following figure:

Figure: K400 Module-CFP8-R400GE

Part Numbers

Part Numbers for K400 CFP8 Load Module and Supported Adapters are provided in the following table.

Part Numbers for K400 CFP8 Modules

Model Number	Part Number	Description
CFP8-400GE	944-1150	• 2-slots, 1-port of 400GE with the native CFP8 physical interface • Full-featured model • 400GE only
	944-1151	• 2-slots, 1-port of 400GE with the native CFP8 physical interface • Reduced-featured model • 400GE only

Specifications

The load module specifications are contained in the following table.

K400 Load Module Specifications

Feature	CFP8-400GE FULL FEATURE	CFP8-R400GE REDUCED FEATURE
Hardware Load Module Specifications		
Slot / Number of Ports	2-slot, 1-port 400GE.	
Physical Interface	Native CFP8 physical port	
Supported Port Speeds	400GE over 400GE-capable fiber media	
CPU and Memory	Multicore processor with 4GB of CPU memory per port	

Feature	CFP8-400GE FULL FEATURE	CFP8-R400GE REDUCED FEATURE
IEEE Interface Protocols	IEEE P802.3bs 400 GbE, 400GBASE-R	
Advanced Layer1 support	400GE: • KP4 (RS-544) Ethernet Forward Error Correction, Clause 119 • Pre- and post-FEC statistics: Comprehensive per-port and per-lane statistics • FEC error injection • PCS lanes Tx and Rx test and statistics • Classical Layer 1 BERT test and statistics	
Transceiver Support	Capable of support for 400GBASE-SR16, 400GBASE-LR8 10 km and 400GBASE-FR8 2 km optical transceivers.	
Cable Media	400GBASE capable multimode fiber and single mode fiber cables that are compatible the optical receptacle on the CFP8 transceiver.	
Load Module Dimensions	• 17.3” (L) x 1.3” (W) x 12.0” (H) • 440mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights	• Module only: 11.8 lbs. (5.35 kg) • Shipping: 18.6 lbs. (8.44 kg)	
Temperature	• Operating: 41°F to 95°F (5°C to 35°C) • Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing	
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model		
XGS12-HSL Chassis (940-0016)	6 load modules: • 12-slot rackmount chassis • 6-ports of 400GE	
XGS2-HSL Chassis (940-0014)	1 load modules: • 2-slot rackmount chassis • 1-port of 400GE	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	

Feature	CFP8-400GE FULL FEATURE	CFP8-R400GE REDUCED FEATURE
Max. Streams per Port	400GE: 128	400GE: 32
Max. Streams per Port in Data Center Ethernet	400GE: 128	400GE: 32
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler	
Minimum Frame Size	400GE: • 64 bytes at full line rate • 56 bytes at less than full line rate	
Maximum Frame Size	16,000 bytes	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K), uniform, repeatable random, IMIX, and Quad Gaussian	
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (max.)	400GE: 1M / UDF	
Sequence (max.)	400GE: 32K / UDF	
Error Generation	• FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific error rates • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical Coding Sublayer	• PCS lane skew injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
L1 Bert	Classical, line rate, un-encapsulated transmit and receive of various PRBS	

Feature	CFP8-400GE FULL FEATURE	CFP8-R400GE REDUCED FEATURE
	patterns, controls over the patterns that help to produce BER statistics	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum. Support for protocol verification for control plane traffic	
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics; generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner	
Latency Measurement Resolution	400GE: 0.625 nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency error from the 400GE port electronics	
Transmit/Receive loopback	Internal loopback support	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability	
Trackable Receive Flows per Port	400GE : 32K with the full statistics	
Minimum Frame Size	400GE: • 64 bytes at full line rate • 49 bytes at less than full line rate	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	256KB	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies.	
FEC Statistics	• FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected	

Feature	CFP8-400GE FULL FEATURE	CFP8-R400GE REDUCED FEATURE
	Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis • FEC per lane statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate	
Latency / Jitter Measurements	Cut-through, store & forward, forwarding delay, up to 16 time bins latency/jitter, MEF jitter, and inter-arrival time.	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF.	
400GE Physical Coding Sublayer (PCS) Receive-Side Statistics and Indicators	IEEE 802.3bs-compliant PCS transmit and receive capabilities include: Receive - Per PCS lane receive lanes statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count.	
Layer 2-3 Protocol Support		
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, EIGRP/EIGRPv6, RIP/RIPng, BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP, PVST+/RPVST+, Link Aggregation (LACP), LISP	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2000 host/access sessions
Software Defined Network	OpenFlow, Segment Routing, BGP Link State (BGP-LS), PCEP, VXLAN, EVPN VXLAN, OVSDB, GENEVE, BGP FlowSpec, BGP SR TE Policy	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2000 host/access sessions
MPLS	RSVP-TE, RSVP-TE P2MP, LDP/LDPv6, mLDP, PWE, VPLS-LDP, VPLS-BGP, BGP auto-discovery with LDP FEC 129 support, L3 MPLS VPN/6VPE, 6PE, BGP RT-Constraint, BGP Labeled unicast, L3 Inter-AS VPN Options (A, B, C), MPLS-TP, MPLS OAM, Multicast VPN (GRE, mLDP, RSVP-TE P2MP), EVPN, PBB-EVPN	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2000 host/access sessions
Broadband and	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IPv6	Complete protocol

Feature	CFP8-400GE FULL FEATURE	CFP8-R400GE REDUCED FEATURE
Authentication	Autoconfiguration (SLAAC), IGMP/MLD, 802.1x	coverage with reduced session scale: • 100 routing and switching sessions • 2000 host/access sessions
Industrial Ethernet	Link OAM (IEEE 802.3ah), CFM/Y.1731, PBB/PBB-TE, ELMI, Sync-E ESMC, IEEE 1588v2 (PTP)	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2000 host/access sessions
Data Center Ethernet	DCBX/LLDP, FCoE/FIP, PFC (IEEE 802.1Qbb), TRILL, Cisco FabricPath, SPBM, VEPA	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2000 host/access sessions

Application Support

The Ixia application support K400 CFP8 load modules is provided in the following table:

CFP8-400GE/CFP8-R400GE Application Support

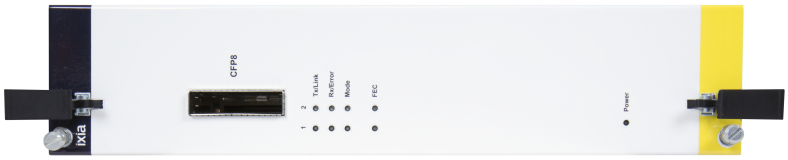
Application	Support
IxNetwork	Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx testing with statistics, and Layer 1 BERT test and reporting capability.
Tcl API	Allows custom user script development for layer 1-3 testing.

Mechanical Specifications

Front Panel

The front panel of K400 CFP8 load modules is shown in the following figure:

Figure: Front panel of K400 CFP8-400GE



LED Panel

The LED panel specifications for K400 CFP8 are provided in the following table.

LED panel Specifications for K400 CFP8 Load Module

Speed Mode	MODE LED	TX STATUS	RX STATUS	FEC
400G	Solid Red - Card fault	Solid Red - Link down	Off - Port is inactive	Blinking Red - Uncorrectable FEC errors
	Solid Purple - 400G speed mode	Blinking Red - Tx active while Link is down (transmitting while ignoring link status or pulling physical link while transmitting)	Blinking Red - Rx active with errors	Blinking Green - Corrrectable FEC errors
		Solid Green - Link up	Blinking Green - Rx active with no errors received	Solid Green - No errors
		Blinking Green - Tx is active		Off - Link down
		Solid Yellow - Loopback		

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CHAPTER 29

IXIA K400 QSFP-DD Load Modules

This chapter provides details about K400 QSFP-DD family of load modules and their specifications and features.

K400 QSFP-DD is a 1-port 400GE load module capable of 200GE, 100GE and 50GE fan-outs. This load module has a 50 Gbps PAM-4 electrical interface and validates performance, scalability and interoperability. It provides FEC error injection, PCS/Tx/Rx testing, and layer1 BERT testing with full line-rate layer 2-3 Tx, Rx, and capture capabilities. This load module accelerates development of IEEE 802.3bs-compliant 400GE networking systems.

These load modules are available in the following different models:

- Full feature and scale QSFP-DD-400GE
- Reduced feature and scale QSFP-DD-R400GE

The following options are available for these models:

- FIELD UPGRADE option that upgrades the reduced performance QSFP-DD-R400GE
- Fan-out speed modes

All the models enable full line-rate traffic generation transmit, receive, and capture functionality from 64B to 16,000B frame lengths. This facilitates stress testing, hardware/ASIC bring-up, optics and cable qualification, interoperability, and functional test and Layer 2/3 routing protocol emulation as required.

Key Features

The key features of QSPF-DD load module are as follows:

- Supports line-rate 400/200/100/50Gbps packet generation, capture, and analysis of received traffic to detect and debug data transmission errors.
- Supports line-rate per-port and per-flow statistics.
- Provides the following high latency measurement resolution for different speed modes:
  - 400G: 0.625ns
  - 200G: 1.25ns
  - 100G: 2.5ns
  - 50G: 2.5ns
- Provides RS-544 (KP4) Forward Error Correction (FEC) support.
- Provides native 56Gb/s SERDES with PAM4 encoding support that is IEEE P802.3bs and IEEE P802.3cd compliant.

- Supports FEC error injection with a comprehensive set of FEC corrected and uncorrected statistics, including Bit Error Rate statistics for pre- and post-FEC operations.
- Injects packet errors: CRCs, runts, giants, checksum errors, and out of sequence.
- Supports standard instrumentation including timestamp, sequence number and flow identification, and data integrity.
- Supports layer 1 BERT: 8 independent lanes of 56Gb/s PRBS pattern generation, error checking, and statistics.
- Supports PCS lanes Transmit on all speed modes, error injection testing and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion
- Supports mid-to-high-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases using Ixia's IxNetwork application.
- Provides an excellent test platform for full line-rate 400/200/100/50Gb/s to evaluate the new ASIC designs for all the speed modes, FPGAs, and hardware switch fabrics that use the new 8x56Gb/s electrical interface with PAM4 encoding.
- Supports benchmarking of networking devices and equipment using industry-standard RFC benchmark tests at line-rate 400/200/100/50GE.
- Provides application support including: IxExplorer, IxNetwork, and related Tcl and automation APIs.

Load Modules

The K400 QSFP-DD family consists of the following models on a single slot card:

- QSFP-DD-400GE
- QSFP-DD-400GE+200G+100G+50G (fan-out speed modes)
- QSFP-DD-R400GE
- QSFP-DD-R400GE+200G+100G+50G (fan-out speed modes)
- UPG-QSFP-DD-R400GE
- UPG-QSFP-DD-R400GE+200G+100G+50G (fan-out speed modes)

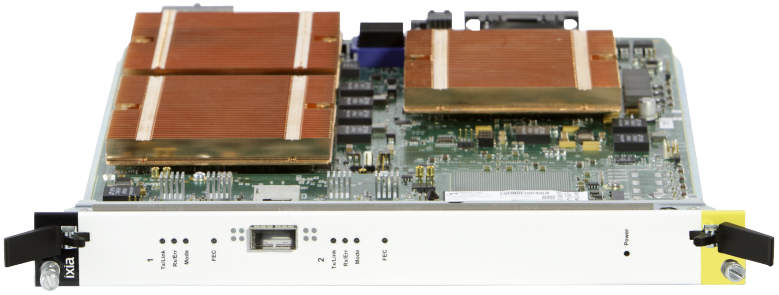
The load modules are described as follows:

QSFP-DD-400GE

QSFP-DD-400GE is a 1-port full-featured load module. It has 1-slot with the QSFP-DD physical interface and supports enterprise and data center switch and router testing. It provides L2-3 support and is compatible with the XGS12-HSL rack mount chassis (940-0016) and 2-slot high performance chassis XGS2-HSL chassis (940-0014).

The QSFP-DD-400GE load module is shown in the following figure:

Figure: K400 Module-QSFP-DD-400GE

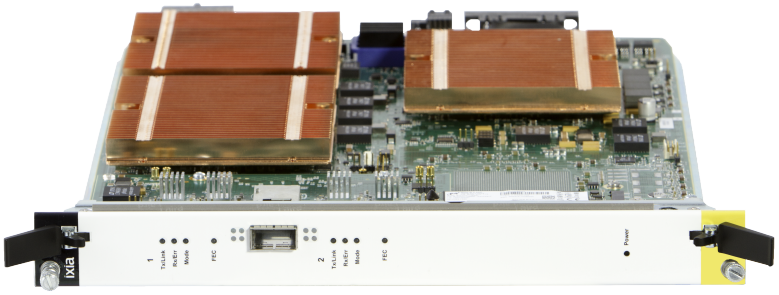


QSFP-DD-R400GE

QSFP-DD-R400GE is a 1-port 400 Gigabit Ethernet reduced load module that scales down the L2-3 feature set and L2-3 networking protocol scaling, while increasing affordability. It has 1-slot with the QSFP-DD physical interface and supports hardware, ASIC, cable/optics qualification, and interoperability testing. It provides L2-3 support and reduced protocol emulation scale and is compatible with the XGS12-HSL rack mount chassis (940-0016) and 2-slot high performance chassis XGS2-HSL chassis (940-0014).

The QSFP-DD-R400GE load module is shown in the following figure:

Figure: K400 Module-QSFP-DD-R400GE



Fan-out options for QSFP-DD

The Fan-out options for QSFP-DD are available in two forms:

- Factory Installed
- Field Upgrade

1x200GE/2x100GE/4x50GE factory installed

The 200GE/100GE/50GE Fan-Out FACTORY INSTALLED option for the QSFP-DD load module enables 1x200GE/2x100GE/4x50GE capability on the single port of the module. This is supported on QSFP-DD-400GE (944-1152) and the QSFP-DD-R400GE (944-1153) 1-port load modules.

NOTE The factory installed option is required for new purchases to enable 200GE, 100GE and 50GE speeds on the QSFP-DD-400GE or QSFP-DD-R400GE load modules.

1x200GE/2x100GE/4x50GE field upgrade

The 200GE/100GE/50GE Fan-Out FIELD UPGRADE option for the QSFP-DD load module enables 1x200GE/2x100GE/4x50GE capability on the single port of the module. This is supported on QSFP-DD-400GE (944-1152) and the QSFP-DD-R400GE (944-1153) 1-port load modules.

NOTE The field upgrade option is required on field upgrade purchases to enable 200GE, 100GE and 50GE speeds on the QSFP-DD-400GE or QSFP-DD-R400GE load modules. Please provide the serial number of the desired load module at the time of placement of order, to install the option .

Link Behavior of the 50GE Fan-Out mode

When a QSFP-DD or QSFP56 transceiver is connected to the load module, the 4x50GE speed mode is not fully independent.
The first two ports of 50GE in the GUI are sourced by the clock recovered from the first 50GE port. Therefore, if the DUT connected to the first port is disabled, no clock can be recovered and both of the local 50GE ports shows link down. This indicates that the second 50GE port has a dependency on the first port.
The same logic holds for the third and fourth port of the 50GE fan-out mode.

Part Numbers

Part Numbers for QSFP-DD Load Module and Supported Adapters are provided in the following table.

Part Numbers for QSFP-DD Modules

Model Number	Part Number	Description
QSFP-DD-400GE	944-1152	• 1-port of 400GE with the native QSFP-DD physical interface • Full-featured model • Capable of 200/100/50GE fan-outs
	944-1153	• 1-port of 400GE with the native QSFP-DD physical interface • Reduced-featured model • Capable of 200/100/50GE fan-outs
UPG-QSFP-DD-R400GE	905-1032	FIELD UPGRADE option that upgrades the reduced performance QSFP-DD-R400GE 1-port, 1-slot, L2-3 load module to have the following: • an increased number of transmit streams • higher L23 IxNetwork protocol emulation of the QSFP-DD-400GE full feature, load module (944-1152) model • Capable of 200/100/50GE fan-outs
QSFP-DD-	905-1023	• 200GE/100GE/50GE Fan-out FACTORY

Model Number	Part Number	Description
400GE+200G+100G+50G		INSTALLED option • Enables the following speeds on QSFP-400GE 1-port load module: ▪ 1x200GE ▪ 2x100GE ▪ 4x50GE
	905-1024	• 200GE/100GE/50GE Fan-out FIELD UPGRADE option • Enables the following speeds on QSFP-400GE 1-port load module: ▪ 1x200GE ▪ 2x100GE ▪ 4x50GE

Specifications

The load module specifications are contained in the following table.

QSFP-DD Load Module Specifications

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
Hardware Load Module Specifications		
Slot / Number of Ports	• 1-slot, 1-port 400GE • 1 port of 200GE • 2 ports of 100GE • 4 ports of 50GE	
Physical Interface	Native QSFP28 DD physical port	
Supported Port Speeds	• 400GE/port: 400GE-capable fiber and passive copper cable media • 200/100/50GE port capable with a purchasable option	
CPU and Memory	Multicore processor with 4GB of CPU memory per port	
IEEE Interface Protocols	• IEEE P802.3bs 200GE & 400GE, 400GBASE-R • IEEE P802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet	
Advanced Layer1 support	• Pre- and post-FEC statistics: Comprehensive per-port and per-lane statistics	

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
	• FEC error injection • PCS lanes Tx and Rx test and statistics • Classical Layer 1 BERT test and statistics	
Transceiver Support	Capable of support for 400GBASE-DR8, 400GBASE-FR8 and 400GBASE-LR8 when they are available in the QSFP-DD form factor. Other configurations may be supported, consult factory.	
Cable Media	400GBASE-CR8, passive, copper Direct Attached Cable (DAC) up to 3 meters in length.	
Load Module Dimensions	• 16.4” (L) x 1.3” (W) x 12.0” (H) • 417mm (L) x 33mm (W) x 305mm (H)	
Load Module Weights	• Module only: 11.8 lbs. (5.35 kg) • Shipping: 18.6 lbs. (8.44 kg)	
Temperature	• Operating: 41°F to 95°F (5°C to 35°C) • Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing	
Chassis Capacity: Maximum Number of Cards and Ports per Chassis Model		
XGS12-HSL Chassis (940-0016)	12 load modules: • Rackmount chassis • 12-ports of 400GE/200GE • 24-ports of 100GE • 48-ports of 50GE	
XGS2-HSL Chassis (940-0014)	2 load modules: • Rackmount chassis • 2-ports of 400GE/200GE • 4-ports of 100GE • 8-ports of 50GE	
XGS12-SDL Chassis (940-0015)	12 load modules: • 12-slot rackmount chassis • 12-ports of 400GE/200GE • 24-ports of 100GE • 48-ports of 50GE	

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
XGS2-SDL Chassis (940-0013)	2 load modules: • 2-slot rackmount chassis • 2-ports of 400GE/200GE • 4-ports of 100GE • 8-ports of 50GE	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. Streams per Port	• 400GE: 128 • 200GE: 128 • 100GE: 32 • 50GE: 16	• 400GE: 32 • 200GE: 32 • 100GE: 16 • 50GE: 8
Max. Streams per Port in Data Center Ethernet	• 400GE: 128 • 200GE: 128 • 100GE: 32 • 50GE: 16	• 400GE: 32 • 200GE: 32 • 100GE: 16 • 50GE: 8
Inter-burst gap: min-max	10: 6400ns-429s in 800ns steps100: 640ns-42.9s in 80ns steps1000: 64ns-16.7ms in 16ns steps **Advanced Scheduler**: 10: 0.419s 100: 0.0419s 1000: 0.0167s	
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler	
Minimum Frame Size	At line rate • 400GE: 60 Bytes • 200GE: 60 Bytes • 100GE: 64 Bytes • 50GE: 64 Bytes At less than full line rate • 56 Bytes for all speed modes	
Maximum Frame Size	• 400GE: 16000 Bytes	

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
	• 200GE: 16000 Bytes • 100GE: 14000 Bytes • 50GE: 14000 Bytes	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K), uniform, repeatable random, IMIX, and Quad Gaussian	
User defined fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (max.)	• 400GE: 1M / UDF • 200GE: 1M / UDF • 100GE: 1M / UDF • 50GE: 512K / UDF	
Sequence (max.)	• 400GE: 32K / UDF • 200GE: 32K / UDF • 100GE: 8K / UDF • 50GE: 2K / UDF	
Error Generation	• FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific error rates • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical Coding Sublayer	• PCS lane skew injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
L1 Bert	Classical, line rate, un-encapsulated transmit and receive of various PRBS patterns, controls over the patterns that help to produce BER statistics	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum. Support for protocol verification for control plane traffic	
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics; generate local and remote faults with controls for the number of faults and order of faults, plus the ability to select the option to have the transmit port ignore link faults from a remote link partner	
Latency Measurement	• 400GE: 0.625 nanoseconds • 200GE: 1.25 nanoseconds	

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
Resolution	• 100GE: 2.5 nanoseconds • 50GE: 2.5 nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency error from the 400GE port electronics	
Transmit/Receive loopback	Internal loopback support	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency and inter-arrival time for each packet group, with data integrity, sequence and advanced sequence checking capability	
Trackable Receive Flows per Port	Maximum PGID without SQ Checking (No Tx/Rx Sync) • 400G/200G: 32K • 100G: 32k Min / 8k Full • 50G: 16k Min / 8k Full Maximum PGID with SQ Checking (No Tx/Rx Sync) • 400G/200G: 32K • 100G: 32k Min / 8k Full • 50G: 16k Min / 8k Full Maximum PGID without SQ Checking (With Tx/Rx Sync) • 400G/200G: 32K • 100G: 32k Min / 8k Full • 50G: 16k Min / 8k Full Maximum PGID with SQ Checking (With Tx/Rx Sync) • 400G/200G: 32K • 100G: 32k Min / 8k Full • 50G: 16k Min / 8k Full	
Limited Stats Capability	Supports a higher number of PGID/flows, but each with reduced measurements • Latency stats are Average only ◦ Min/Max latency are not included • Basic Sequence check is a flag (yes/no) to indicate if a sequence error occurred during transmission • There are no small/big/reverse sequence error counts	
Minimum Frame	At line rate	

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
Size	• 400GE: 60 Bytes • 200GE: 60 Bytes • 100GE: 64 Bytes • 50GE: 64 Bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns with offsets capability for start of: frame, IP, or protocol. Up to 6 UDS counters are available.	
Hardware Capture Buffer	• 400GE: 256KB • 200GE: 256KB • 100GE: 1MB • 50GE: 1MB	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence and advanced sequence checking frames, sequence checking errors, ARP, and PING requests and replies.	
FEC Statistics	• FEC port statistics: Total Bit Errors, Max Corrected Symbols, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis • FEC per lane statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate	
Latency / Jitter Measurements	Cut-through, store & forward, forwarding delay, up to 8 time bins latency/jitter/DV, MEF jitter, and inter-arrival time.	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, Illegal SOF, PCS Out Of Order SOF, PCS Out Of Order EOF, PCS Out Of Order Data and PCS Out Of Order Ordered Set..	
Physical Coding Sublayer (PCS) Receive-Side Statistics and Indicators	IEEE 802.3bs-compliant PCS transmit and receive capabilities include: Receive Per PCS lane receive lanes statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count	
Layer 2-3 Protocol Support		
Routing and Switching	BGP-4, BGP+, OSPFv2/v3, ISISv4/v6, EIGRP, EIGRPv6, RIP, RIPng, BFD, IGMPv1/v2/v3, MLDv1/v2, PIM-SM/SSM, PIM-BSR, STP/RSTP, MSTP, PVST+/RPVST+, Link Aggregation (LACP), LLDP	Complete protocol coverage with reduced session scale: 100 routing & switching sessions 2000

Feature	QSFP-DD-400GE FULL FEATURE	QSFP-DD-R400GE REDUCED FEATURE
		host/access sessions
Software Defined Network	VXLAN, EVPN VXLAN, OpenFlow, ISIS Segment Routing, OSPF Segment Routing, BGP Segment Routing, BGP Link State (BGP-LS), PCEP, OVSDB	Complete protocol coverage with reduced session scale: • 100 routing & switching sessions • 2000 host/access sessions
Basic	IPv4/IPv6, DHCP, PPPoE, L2TP, IGMP, MLD, 802.1x	
MPLS	RSVP-TE, RSVP-TE P2MP, LDP/LDPv6, mLDP, PWE, VPLS-LDP, VPLS-BGP, BGP auto-discovery with LDP FEC 129 support, L3 MPLS VPN/6VPE, 6PE, BGP RT-Constraint, BGP Labeled BGP Labeled unicast, L3 Inter-AS VPN Options (A, B, C), MPLS-TP, MPLS OAM, Multicast VPN (GRE, mLDP, RSVP-TE P2MP), EVPN, PBB-EVPN	Complete protocol coverage with reduced session scale: • 100 routing & switching sessions • 2000 host/access sessions
Broadband and Authentication	PPPoX, DHCPv4, DHCPv6, L2TPv2, Radius attributes for L2TP, ANCP, IPv6 Autoconfiguration (SLAAC), IGMPv1/v2/v3, MLDv1/v2, 802.1x	Complete protocol coverage with reduced session scale: • 100 routing & switching sessions • 2000 host/access sessions
Industrial Ethernet	Link OAM IEEE 802.3ah, CFM IEEE 802.1ag, Service OAM ITUT-Y.1731, PBT/PBB-TE, Sync-E ESMC, ELMI	Complete protocol coverage with reduced session scale: • 100 routing & switching sessions • 2000 host/access sessions
Data Center Ethernet	Priority Flow Control IEEE 802.1Qbb (PFC), LLDP/DCBX	Complete protocol coverage with reduced session scale: • 100 routing & switching sessions • 2000 host/access sessions

Application Support

The Ixia application support QSFP-DD load modules is provided in the following table:

QSFP-DD-400GE / QSFP-DD-R400GE Application Support

Application	Support
IxNetwork	Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer	Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics, and Layer 1 BERT test and reporting capability.
Tcl API	Allows custom user script development for layer 1-3 testing.

Transceiver Support

The transceiver supported by QSFP-DD load modules is provided in the following table:

QSFP-DD Transceiver Support

Model	Description
QSFP-DD-1M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 1-meter length. This cable is compatible with the following load modules: • QSFP-DD-400GE 1-port, full performance 400GE • QSFP-DD-R400GE 1-port, reduced-featured 400GE • QSFP-DD-400GE+200G+100G+50G 1-port, full performance fan-out speed modes • QSFP-DD-R400GE+200G+100G+50G 1-port, reduced-featured fan-out speed modes
QSFP-DD-2M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2-meter length. This cable is compatible with the following load modules: • QSFP-DD-400GE 1-port, full performance 400GE • QSFP-DD-R400GE 1-port, reduced-featured 400GE • QSFP-DD-400GE+200G+100G+50G 1-port, full performance fan-out speed modes • QSFP-DD-R400GE+200G+100G+50G 1-port, reduced-featured fan-out speed modes
QSFP-	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC),

Model	Description
DD-5M-CBL	point-to-point cable, 5-meter length. This cable is compatible with the following load modules: • QSFP-DD-400GE 1-port, full performance 400GE • QSFP-DD-R400GE 1-port, reduced-featured 400GE • QSFP-DD-400GE+200G+100G+50G 1-port, full performance fan-out speed modes • QSFP-DD-R400GE+200G+100G+50G 1-port, reduced-featured fan-out speed modes

Mechanical Specifications

Front Panel

The front panel of QSFP-DD load modules is shown in the following figure:

Figure: Front panel of QSFP-DD

LED Panel

The LED panel specifications for QSFP-DD are provided in the following table.

LED panel Specifications for QSFP-DD Load Module

MODE LED	TX STATUS	RX STATUS	FEC
Solid Red - Card fault	Solid Red - Link down	Blinking Red - RX active with errors	Blinking Red - Uncorrectable FEC errors
Solid Purple - 400GE speed mode	Solid Green - Link up	Blinking Green - RX active with no errors received	Blinking Green - Corrrectable FEC errors
Solid Cyan - 200GE speed mode	Blinking Green - TX is active on at least one fan-out port	Off - Port is inactive	Solid Green - No errors
Solid White - 50GE speed mode	Solid Yellow - At least one link (but not all) is up (2x100GE, 4x50GE)		Off - FEC not enabled
Off - 100GE speed mode			

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CHAPTER 30

IXIA XMVAE GE Load Modules

This chapter provides details about Ixia's XMVAE-Gigabit Ethernet test modules the specifications and features.

Ixia's XMVAE Gigabit Ethernet test modules provide complete Layer 2-7 network and application testing functionality in a single test system for Automotive Ethernet switch and ECU testing. Ixia test system supports Automotive Ethernet specific interface for 10/100/1000 Mbps Ethernet speeds for testing Automotive Ethernet network components in next-generation vehicles and smart cars.

The XMVAE load modules include support for BroadR-Reach transceivers for testing BroadR-Reach enabled Automotive Ethernet switch and ECU functionality. Each test port on the module has the following:

- Auto-negotiable /100/1000 Mbps Ethernet over copper
- Gigabit Fiber and 100Base-FX Ethernet over fiber
- A powerful RISC processor running Linux
- A full, test-optimized TCP/IP stack

The XMVAE architecture provides unprecedented performance and flexibility for testing the following:

- BroadR-Reach enabled Automotive switches
- ADAS/Infotainment ECUs
- Media and wireless access devices
- Gateways and AUTOSAR IP/Ethernet applications for Automotive use

The XMVAE load module supports the following:

- Wire-speed Layer 2-3 traffic generation and analysis
- High performance IPv4/IPv6 protocol emulations
- Ethernet ECU behavior emulation and true Layer 4-7 application traffic generation on each test port

Ixia's XMVAE Gigabit Ethernet modules comprise an 8 and a 16 port full-performance configuration, providing scalability and affordability for a diverse range of test requirements. With 12 slots per XGS12-SD high performance chassis, up to 96/192 Ethernet ECU ports can be simulated in a single test system to create high density automotive network test environments.

Key Features

The key features of XMVAE load modules are as follows:

Flexible Packet Generation

- Each Ixia GE XMVAE test port is capable of generating precisely-controlled network traffic at up to wire speed using Ixia's IxExplorer test application.
- Millions of packet flows can be configured on each port with fully customizable packet header fields. Flexible header control is available for Ethernet, IPv4/v6, IPX, ARP, TCP, UDP, VLANs, QinQ, and many others protocols.
- Payload contents can also be customized with incrementing/decrementing, fixed, random, or user-defined information.
- Frame sizes can be fixed, varied according to a pattern, or randomly assigned across a weighted range.
- Rate control can be flexibly defined in frames per second, bits per second, percentage of line rate, or inter-packet gap time.

Real-time Latency

Packets representing different traffic profiles can be associated with packet group identifiers (PGIDs). The receiving port measures the minimum, maximum, and average latency in real time for each packet belonging to different groups. Measurable latencies include:

- Instantaneous latency and inter-arrival time where each packet is associated with one group ID
- Latency bins, where PGIDs can be associated with a latency range
- Latency over time, where multiple PGIDs can be placed in "time buckets" with fixed durations
- First and last time stamps, where each PGID can store the timestamps of first and last received packets

Transmit Scheduler

There are two modes of transmission available - Packet Stream and Advanced Stream Scheduler.

In **Packet Stream Scheduler** mode, the transmit engine allows configuration of up to 256 unique sequential stream groupings on each port. Multiple streams can be defined in sequence, each containing multiple packet flows defined by unique characteristics. After transmission of all packets in the first stream, control is passed to the next defined stream in the sequence. After reaching the last stream in the sequence, transmission may either cease, or control may be passed on to any other stream in the sequence. Therefore, multiple streams are cycled through, representing different traffic profiles to simulate real network traffic. In **Advanced Stream Scheduler** mode, the transmission of stream groupings is interleaved per port. For example, assume a port is configured with three streams. If Stream 1 is defined with IP packets at 20% of line rate, Stream 2 is defined with TCP packets at 50% of line rate, and Stream 3 is defined with MPLS packets at 30% of line rate, data on the port will be transmitted at an aggregate utilization of 100% with interleaved IP, TCP, and MPLS packets.

Extensive Statistics

- Real-time 64-bit frame counts and rates
- Spreadsheet presentation format for convenient manipulation of statistics counters
- Eight quality of service counters (supporting 802.1p, DSCP, and IPv4 TOS measurements)
- Six user-defined statistics that use a trigger condition

- Extended statistics for ARP, ICMP, and DHCP
- Transmit stream statistics for frame counts and rate
- External logging to file for statistics and alerts
- Audible and visual alerts with user-definable thresholds

Data Capture

Each port of the load module is equipped with 64 MB of capture memory, capable of storing tens of thousands of packets in real time. The capture buffer can be configured to store packets based on user-defined trigger and filter conditions. Decodes for VLAN, IPv4, IPv6, ARP, ICMP, DHCP, IGMP, UDP, TCP and various other protocols are provided.

Data Integrity

As packets traverse through networks, IP header contents may change resulting in the recalculation of packet CRC values. To validate device performance, the data integrity function of XMVAE Gigabit Ethernet modules allows packet payload contents to be verified with a unique CRC that is independent of the packet CRC. This ensures that the payload is not disturbed as the device changes header fields.

Sequence and Duplicate Packet Checking

Sequence numbers can be inserted at a user-defined offset in the payload of each transmitted packet. Upon receipt of the packets by the device under test (DUT), out-of-sequence errors or duplicated packets are reported in real time at wire-speed rates. The user can define a sequence error threshold to distinguish between small versus big errors, and the receive port can measure the amount of small, big, reversed, and total errors. Alternatively, the user can use the duplicate packet detection mode to observe that multiple packets with the same sequence number are received and analyzed.

L2-3 Protocol Emulation

Ixia's XMVAE Gigabit Ethernet modules support performance and functionality testing using routing/bridging protocol emulation via the IxNetwork and IxAutomate applications. Protocols supported include: VLAN, STP/RSTP, MSTP, PVST+/RPVST+, MSRP, link aggregation (LACP), ESMC, PTP, PPPoX, DHCPv4 client/server, DHCPv6 client/server, 802.1x, WebAuth. IxNetwork offers the customization and flexibility to test hundreds of switches and ECUs. IxNetwork can customize millions of traffic flows to stress data plane performance. Powerful GUI wizards and grid controls allow users to create sophisticated traffic flows with ease. Its enhanced real-time analysis and statistics are capable of reporting comprehensive protocol status and detailed per-flow traffic performance metrics.

AVB Testing

Ixia’s XMVAE Gigabit Ethernet modules support functional and performance testing of MSRP and gPTP protocols. You can send both 1722 encapsulated and VLAN encapsulated traffic at line rate for the AVB reserved streams. Clock hierarchy can be established using gPTP BMCA algorithm and synchronization of various clocks can be measured using the in-built Stratum-3 clock that has 20 ns of timestamp resolution. This load module’s capability to measure the latency, latency variation, loss and sequence errors allows extensive performance evaluation of various algorithms such as strict

priority queuing, Weighted Round-Robin, Weighted Fair Queuing and Credit Based Shaper implementations.

ECU Testing

Ixia’s XMVAE Gigabit Ethernet load modules can connect to the BroadR-Reach interface in ECUs using PHY media converters. The load module can be used to load the Automotive Ethernet network with traffic and test ECU functionality. IxNetwork’s powerful Traffic Template can be used to generate custom ECU protocols and load the desired traffic that can be sent at any rate up to the wire-speed. Various bench marking tests like RFC 2544 can be run to fully qualify the embedded switches in the ECUs.

Application Layer Performance Testing

Ixia's XMVAE Gigabit Ethernet modules support performance testing of content-aware devices and networks via the IxLoad application. IxLoad creates real-world traffic scenarios at the TCP/UDP (Layer 4) and application (Layer 7) layers, emulating clients and servers for web (HTTP, SSL), P2P, FTP, email (SMTP, POP3, IMAP), streaming (RTP, RTSP), video (MPEG2, MPEG4, IGMP and RSTP), voice (SIP, H.323, H.248, SCCP and MGCP), and infrastructure services such as DNS, DHCP, LDAP, AAA, and Telnet. Security platforms can be tested with integrated L2/L3 authentication mechanisms such as 802.1x and NAC, as well generated malicious traffic to test for security. Each 1GbE XMVAE port can be independently configured to run different protocols and client/server scenarios.

Tcl API

Ixia's XMVAE Gigabit Ethernet modules are supported by a comprehensive Tcl application programming interface (API). This API allows users to develop custom scripts and integrate the modules into automated test environments.

Load Modules

The XMVAE family consists of the following models:

- An 8-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps load module
- A 16-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps load module

Each of these load modules are described as follows:

LSM1000XMVAE8

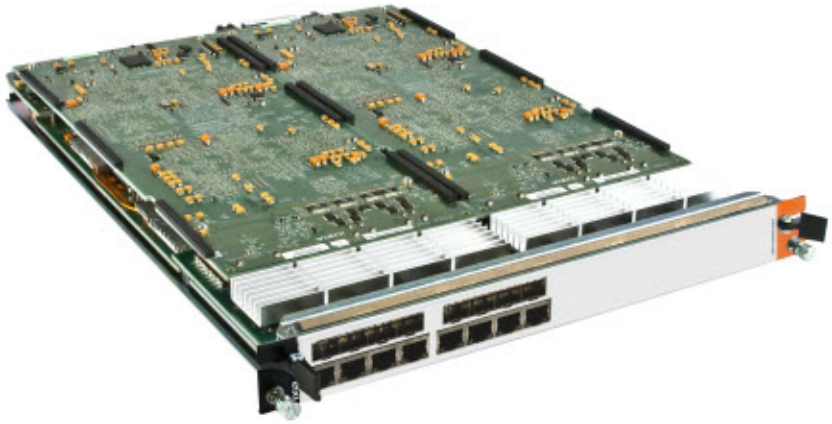
LSM1000XMVAE8 Gigabit Ethernet is an 8-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps load module. It provides complete L2-7 support and is compatible with the XGS12-SD rack mount chassis (940-0011).

It requires the following:

- Separate BroadR-Reach transceivers
- SFP transceivers- SFP-LX, SFP-SX, and SFP-CU,required by Fiber ports

The LSM1000XMVAE8 load module is shown in the following figure:

Figure: LSM1000XMVAE8



LSM1000XMVAE16

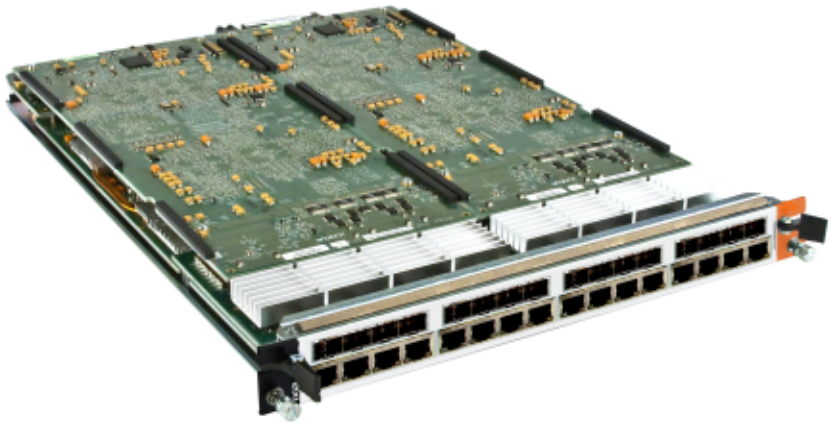
LSM1000XMVAE16 Gigabit Ethernet is a 16-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps load module. It provides complete L2-7 support and is compatible with the XGS12-SD rack mount chassis (940-0011).

It requires the following:

- Separate BroadR-Reach transceivers
- SFP transceivers- SFP-LX, SFP-SX, and SFP-CU,required by Fiber ports

The LSM1000XMVAE16 load module is shown in the following figure:

Figure: LSM1000XMVAE16



Part Numbers

Part Numbers for XMVAE Load Module and Supported Adapters are provided in the following table.

Part Numbers for XMVAE Modules

Model Number	Part Number	Description
LSM1000XMVAE8	944-1130	• 8-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps

Model Number	Part Number	Description
		• Full featured L2-L7 with BroadR-Reach enabled (requires separate BroadR-Reach transceivers) • Fiber Ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU
LSM1000XMVAE16	944-1131	• 16-Port Dual-PHY (RJ45 and SFP) 10/100/1000 Mbps • Fiber Ports require SFP transceivers, options include SFP-LX, SFP-SX, and SFP-CU • Full featured L2-L7 with BroadR-Reach enabled (requires separate BroadR-Reach transceivers)

Specifications

The load module specifications are provided in the following table:

XMVAE Load Module Specifications

Feature	Details
Load module	LSM1000XMVAE8 LSM1000XMVAE16
Connector type	SFP, can connect to BroadR-Reach transceivers or BroadR-Reach media converters, or 1GE copper or fiber transceivers.
Maximum ports per chassis	192 ports in XGS12-SD Rack mount
Connection speed	Auto-negotiable 10/100/1000 Mbps Ethernet over copper and Gigabit Fiber and100Base-FX Ethernet over Fiber
Port CPU/memory per port	800MHz /1GB
Number of ports per model	16/8
Layer 2-3 switching/routing protocol testing	Yes
Layer 4–7 application traffic testing	Yes
AUTOSAR IP/Ethernet bus compatibility tests	Yes

Feature	Details
AUTOSAR IP/Ethernet stack functionality tests	Yes
IEEE Audio/Video Bridging tests for AVB bridge and end points	Yes
802.1AS/gPTP timing and sync tests	Yes
Capture buffer per port	64 MB
Number of transmit flows per port (sequential values)	Billions
Number of transmit flows per port (arbitrary values)	98 K
Number of track-able receive flows per port	512 K
Number of stream definitions per port	4096
Transmit engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity signature, and packet group signatures.
Receive engine	Wire-speed packet filtering, capturing, real-time latency for each packet group, data integrity, and sequence checking.
Statistics and rates (counter size: 64-Bit)	Link State, Line Speed, Frames Sent, Valid Frames Received, Bytes Sent/Received, Fragments, Undersize, Oversize, CRC Errors, VLAN Tagged Frames, 8 QoS counters, Data Integrity Frames, Data Integrity Errors, Sequence Checking Frames, Sequence Checking Errors, ARP, and Ping requests and replies.
Error generation	CRC (Good/Bad/None), Undersize, Oversize.
Packet flow statistics	Real-time statistics to track up to 128K packet flows with throughput and latency measurements.
Latency measurements	20ns resolution

Feature	Details
IPv4, IPv6, UDP, TCP	Hardware checksum generation
Frame length controls	Fixed, random, weighted random, or increment by user-defined step, random, weighted random.

Application Support

The Ixia application support for XMVAE load modules is provided in the following table:

XMVAE Application Support

Application	Support
IxExplorer	A full-featured layer 2-3 wire-speed Ethernet traffic generation and analysis test application with full support for stateless protocol functional and scalability testing. IxExplorer is included with the purchase of all Ixia chassis.
IxNetwork	IxNetwork provides wire-rate traffic generation with service modeling that builds realistic, dynamically-controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for switching, routing, ARP, ICMP, DHCP, IPv4, IPv6, multicast, timing and AVB protocols.
IxLoad	Provides a scalable solution for testing converged multiplay services and application delivery platforms. IxLoad emulates data, voice, and video subscribers and associated protocols for performance testing as well as the ability to generate malicious traffic to test for security.
IxANVL	Provides industry standard AUTOSAR IP/Ethernet bus compatibility, standards compliance, interoperability, ECU configuration and functionality tests for Automotive Ethernet switches and ECUs.

Mechanical Specifications

LED Panel

Each LSM1000XMVAE8 and LSM1000XMVAE16 port incorporates a set of 2 LEDs, as described in the following table.

Port LEDs for LSM1000XMVAE8 and LSM1000XMVAE16

LED Label	Copper	Fiber
Link/Tx (Upper LED)	Color is used to indicate the link speed: • 1000Mbps Green • 100Mbps Orange • 10Mbps Yellow	Green indicates link has been established and flashes during transmit activity.

LED Label	Copper	Fiber
	Flashing indicates transmit activity. Off if link is down.	
Rx/Error (Lower LED)	Three conditions apply: • Full duplex or master (in 1000 Mbps case): Green with extended pulses off to indicate receive activity. • Half duplex or subordinate (in 1000 Mbps case): Off with extended pulses to indicate receive activity. • Error: Overrides the other two modes and pulses red. • No link: Off.	Green indicates link has been established and flashes during receive activity. Continuous red indicates a receive error.

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CHAPTER 31

IXIA PerfectStormONE Appliances

This chapter provides details about PerfectStormONE 10GE and 40GE family of appliances-specifications and features.

The PerfectStormONE appliance provides the platform to seamlessly unify the IxLoad and BreakingPoint software applications into a single and more powerful system, and at the same time provides a portable solution in a compact form factor appliance. Due to the compact form factor and reduced power requirements, you can use the appliance when you need high performance, but have space and power availability constraints in the lab. The single appliance allows control of up to 80Gbps of blended application traffic, 60 million concurrent connections, and new TCP connection rates of up to 2 million/sec. The hardware-based acceleration supports massive encryption levels with up to 40Gbps encrypted throughput per system.

PerfectStormONE's unique combination of portability, performance, and cost-effectiveness allows you to perform enterprise-scale performance and security testing anywhere, at any time, using the exact application, attack, and load behavior needed to optimize and harden your IT infrastructure.

The PerfectStormONE 10GE and 40GE appliances have two variants, fusion (supports IxLoad and BreakingPoint) and standard (supports IxLoad only).

PerfectStormONE supports the following:

- both IxLoad and BreakingPoint software applications; BPS runs on the fusion variants of the appliance
- native 40GE QSFP+ and 10GE SFP+ interfaces
- native 40GE QSFP+ interfaces with 4 x 10GE fan-out option
- compact form factor and reduced power requirements
- line-rate application performance per interface
- hardware-based acceleration for SSL and IPsec performance
- software licensing upgrades enable affordable 4Gbps performance now with easy expansion for future needs of up to 80Gbps

Key Features

The key features of PerfectStormONE appliances are as follows:

Unified Applications and Security Test Platform

PerfectStormONE is a unified applications and security test platform, with support for BreakingPoint and IxLoad software.

Flexible Modes

- PerfectStormONE 10GE and 40GE variants can operate in both Aggregated and Non-Aggregated modes. For more information, see PerfectStormONE 10GE and PerfectStormONE 40GE.
- PerfectStormONE 10GE appliance can operate either in 1GE mode or 10GE mode using SFP+ interfaces.
- PerfectStormONE 40GE appliance can connect to 10GE devices using 40GE to 4x10GE fan-out cables. In fan-out mode, the appliance provides access to 8x10GE SFP+ interfaces.

Blended Application Traffic

PerfectStormONE Fusion can create blended application traffic and current security attacks with a very high count of concurrent wired and wireless users from a single chassis less than 2u.

Massive Scale Real-World Traffic Conditions

PerfectStormONE tests and validates IT systems under controlled real-world scenarios that model your own unique environments.It understands actual performance, system limitations, and real security posture in a better way, to right size data centers and eliminate incidents in production.It generates stateful applications and malicious traffic that simulate millions of real-world end-user environments to test and validate infrastructure, a single device, or an entire system. This includes complex data, video, voice, storage, and network application workloads.

Real Attacks

- 6,000+ live security attacks, 35,000+ pieces of live malware found in enterprise, core, and mobile networks, 180+ evasions
- DDoS and botnet simulation and custom attacks
- Research and frequent updatesHardware-based Acceleration

PerfectStormONE provides hardware-based acceleration for SSL and IPsec.

Multi-user Environment

PerfectStormONE's multi-user environment leverages the per port user ownership model for all ports on the test modules installed into the appliance.

High-performing Business Applications

PerfectStormONE ensures high-performing, and more available and secure business applications.

Disaster Recovery

PerfectStormONE validates disaster recovery and business continuity.

Reduced Legal Exposure

PerfectStormONE provides reduced legal exposure due to data loss by validating security using the industry's most up to date application and threat intelligence.

PerfectStormONE Appliances

PerfectStormONE appliances can generate stateful applications and malicious traffic, simulating millions of real-world end-user environments to test and validate infrastructure, a single device, or an entire system.PerfectStormONE's unique combination of portability, performance, and cost-effectiveness allows you to perform enterprise-scale performance and security testing anywhere, at any time, using the exact application, attack, and load behavior needed to optimize and harden your IT infrastructure.

PerfectStormONE's unified architecture platform in the form of a compact form-factor appliance provides portability. It also provides the flexibility to license the port count and their operating speed. PerfectStormONE appliance comprises the variants provided in the following table.

PerfectStormONE 10GE and 40GE appliances:

	Standard	**Fusion**
10GE	PerfectStormONE 1GE/10GE 8-port SFP+	PerfectStormONE Fusion 1GE/10GE 8-port (SFP+)
	PerfectStormONE 1GE/10 GE 4-port SFP+	PerfectStormONE Fusion, 1GE/10GE 4-port SFP+
	PerfectStormONE 1GE/10GE 2-port SFP+	PerfectStormONE Fusion, 1GE/10GE 2-port SFP+
	PerfectStormONE , 1GE 8-port SFP+	PerfectStormONE Fusion, 1GE, 8-port SFP+
	PerfectStormONE , 1GE 4-port SFP+	PerfectStormONE Fusion, 1GE, 4-port SFP+
40GE	PerfectStormONE 40GE 2-port QSFP+	PerfectStormONE Fusion 40GE 2-port QSFP+

PerfectStormONE 10GE

The PerfectStormONE 10GE appliance consist of 8-port 1GE/10GE SFP+ interfaces, and is licensed as five variants, each one available in both standard (enables support for IxLoad) and Fusion (enables support for both IxLoad and BreakingPoint) as provided in the table above.You can upgrade your appliance from any of the variants to another using an activation code.These variants can operate in three different flexible modes as follows:

- **Non-Aggregated Mode**: In this mode,
  - Each 10GE port uses of 1/8th of the network processor and memory resources available on the appliance
  - Delivery of application traffic happens at wire-speeds for each port, with up to 80Gbps.
- **10GE Aggregated Mode**: In this mode,
  - There is an extra flexibility of allocating all available NP resources and memory available on an appliance while using a single 10GE interface to transmit/receive the traffic.
  - Ixia test applications transparently configure the allocation of NP resources to achieve the maximum performance.
- **1GE or 10GE mode**: In this mode,

- The PerfectStorm ONE 10GE appliance can operate either in 1GE mode or 10GE mode, using SFP+ interfaces.

PerfectStormONE 40GE

The PerfectStormONE 40GE appliances consist of 2-port 40GE QSFP+ interfaces, and is available in two variants as provided in the table above. Both the variants support the following:

- 8 x 10GE SFP+ via fan-out cable (MT-to-4x10GE LC fan-out, MMF, 3-meter or 5-meter cables)
- QSFP+ 40GE optical transceiver, MMF, 850nm (948-0031)

These variants can also operate in three different flexible modes as follows:

- **Non-Aggregated Mode**: In this mode,
  - Each 40GE port uses of ½ of the network processor and memory resources available on the load module
  - Delivery of application traffic happens at wire-speeds for each port, with up to 80 Gbps per module.
- **40GE Aggregated Mode**: In this mode,
  - There is extra flexibility to allocate all network processor and memory resources available on a load module to a single 40GE port, doubling the performance the performance achieved per 40GE port.
  - Ixia test applications transparently configure the allocation of NP resources to achieve the maximum performance.
- **40GE QSFP+ to 4x10GE SFP+ Mode**: In this mode,
  - There is an additional flexibility of connecting to 10GE devices using 40GE to 4 x 10GE fan-out cables.
  - In fan-out mode, the appliance provides access to 8 x 10GE SFP+ interfaces.

PerfectStormONE appliances are described as follows:

PS10GE8

PerfectStormONE PS10GE8 is a 8 port 10-Gigabit Ethernet, appliance with SFP+ interface.It supports only IxLoad software.

The PS10GE8 appliance is shown in the following figure:

Figure: PerfectStormONE appliance-PS10GE8

PS10GE8NG

PerfectStormONE PS10GE8NG is a 8 port 10-Gigabit Ethernet, fusion appliance with SFP+ interface.It supports IxLoad and BreakingPoint software.The PS10GE8NG appliance is shown in the following figure:

Figure: PerfectStormONE appliance-PS10GE8NG

PS40GE2

PerfectStormONE PS40GE2 is a 2 port 40-Gigabit Ethernet, appliance with QSFP+ interface.It supports only IxLoad software.

The PS40GE2 appliance is shown in the following figure:

Figure: PerfectStormONE appliance-PS40GE2

PS40GE2NG

PerfectStormONE PS40GE2NG is a 2 port 40-Gigabit Ethernet, fusion appliance with QSFP+ interface.It supports IxLoad and BreakingPoint software.

The PS40GE2NG appliance is shown in the following figure:

Figure: PerfectStormONE appliance-PS40GE2NG

Part Numbers

Part Numbers for PerfectStormONE appliances are provided in the following table.

Model Number	Part Number	Description
PSO10GE8	941-0037-01	• 8-ports of 10GE with the SFP+ appliance. • SSL and IPsec hardware acceleration. • Supports IxLoad
PSO10GE8NG	941-0027-01	• 8-ports of 10GE with the SFP+ appliance. • SSL and IPsec hardware acceleration.

Model Number	Part Number	Description
		• Supports IxLoad and BPS
PSO10GE4	941-0038-01	• 4-ports of 10GE with the SFP+ appliance. • SSL and IPsec hardware acceleration. • Supports IxLoad
PSO10GE4NG	941-0031-01	• 4-ports of 10GE with the SFP+ appliance. • SSL and IPsec hardware acceleration. • Supports IxLoad and BPS
PSO10GE2	941-0039-01	• 2-ports of 10GE with the SFP+ appliance. • SSL and IPsec hardware acceleration. • Supports IxLoad
PSO10GE2NG	941-0032-01	• 2-ports of 10GE with the SFP+ appliance. • SSL and IPsec hardware acceleration. • Supports IxLoad and BPS
PSO1GE8	941-0044-01	• 8-ports of 1GE with the SFP+ appliance. • Supports IxLoad
PSO1GE8NG	941-0033-01	• 8-ports of 1GE with the SFP+ appliance. • Supports IxLoad and BPS
PSO1GE4	941-0045-01	• 4-ports of 1GE with the SFP+ appliance. • Supports IxLoad
PSO1GE4NG	941-0034-01	• 4-ports of 1GE with the SFP+ appliance. • Supports IxLoad and BPS
PS40GE2	941-0036-01	• 2-ports of 40GE with the QSFP+ appliance.

Model Number	Part Number	Description
		• SSL and IPsec hardware acceleration. • Supports IxLoad
PS40GE2NG	941-0028-01	• 2-ports of 40GE with the QSFP+ appliance. • SSL and IPsec hardware acceleration. • Supports IxLoad and BPS

Specifications

The appliance specifications are contained in the following table.

PerfectStormONE Appliance Specifications

Feature	PerfectStormONE 10GE Standard/PerfectStormONE 10GE Fusion	PerfectStormONE 40GE Standard/PerfectStormONE 40GE Fusion
Hardware, Appliance Specifications		
Number of Ports	8	2
Physical Interface	8-port, 10GE SFP+	2-port, 40GE QSFP+ (native) 8-port, 10GE SFP+ via fan-out cable
1GE Support	Yes	No
Transceiver Support (pluggable transceivers)	• 10GBASE-SR/SW (850 nm) • 10GBASE-LR/LW (1310 nm)	QSFP+, 40GBASE-SR4 (pluggable transcievers)
Memory	64GB + 16GB on system controller	64GB + 16GB on system controller
Operating System	Native Linux with Windows 7 Virtual Machine for IxOS	Native Linux with Windows 7 Virtual Machine for IxOS
Hardware Encryption Offload	Yes / Yes	Yes / Yes
Hardware-Based Traffic Capture	256MB per 10GE interface (available in BreakingPoint). This is applicable for Fusion variants only	• 1GB per 40GE interface • 256 MB per 10GE interface This is available in BreakingPoint and applicable for Fusion variants only

Feature	PerfectStormONE 10GE Standard/PerfectStormONE 10GE Fusion	PerfectStormONE 40GE Standard/PerfectStormONE 40GE Fusion
FPGA Offload	Yes	Yes
IPv4, IPv6, UDP, TCP	Hardware checksum generation	Hardware checksum generation
Appliance Dimensions	17.1 x 13.23 x 3.12 inches	17.1 x 13.23 x 3.12 inches
Appliance Weight	21 lbs (9.52 Kg)	21 lbs (9.52 Kg)
Temperature Range	• Operating: 41°F to 104°F (5°C to 40°C), ambient air • Storage: 41°F to 122°F (5°C to 50°C), ambient air	• Operating: 41°F to 104°F (5°C to 40°C), ambient air • Storage: 41°F to 122°F (5°C to 50°C), ambient air
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing
RU	Chassis <2U With Rack Mount Shelf 2U	Chassis <2U With Rack Mount Shelf 2U
Power	600W, 90 to 264 VAC. The main 750W power supply output provides 12V@62.5A and has a standby voltage of 12V@3A. At a cold start the power supply inrush current is 38A; the carrier board and backplane 12V power rails support 70A.	600W, 90 to 264 VAC. The main 750W power supply output provides 12V@62.5A and has a standby voltage of 12V@3A. At a cold start the power supply inrush current is 38A; the carrier board and backplane 12V power rails support 70A.
Shipping Vibration	1.5G rms	1.5G rms
Integrated System Controller		
CPU	Quad-Core, Intel Processor	Quad-Core, Intel Processor
HDD	1 TB, Enterprise Class, High MTBF	1 TB, Enterprise Class, High MTBF
Rack Mount (included with Appliance)		
Rack Mount Dimensions	19.0 x 17.15 x 3.46 inches	2U rackmount, 19.0 x 17.15 x 3.46 inches
Rack Mount	4.1 lbs	4.1 lbs

Feature	PerfectStormONE 10GE Standard/PerfectStormONE 10GE Fusion	PerfectStormONE 40GE Standard/PerfectStormONE 40GE Fusion
Weight		

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Ixia application support for PerfectStormONE appliances is provided in the following table:

PerfectStormONE Application Support

Hardware	Application Support
• PerfectStormONE 10GE Standard • PerfectStormONE 40GE Standard	IxOS, IxLoad, TCL API
• PerfectStormONE 10GE Fusion • PerfectStormONE 40GE Fusion	IxOS, IxLoad, BreakingPoint, TCL API

Transceiver and Cable Support

The transceivers and cables supported by PerfectStormONE appliances are provided in the following table:

PerfectStormONE Transceiver and Cable Support

Applicances	Transceiver/Cable Part number	Description
• PerfectStormONE 10GE Standard • PerfectStormONE 10GE Fusion	988-0011	SFP+, 10Gb/1Gb SR optical Xcvr, 850nm (cable included)
	988-0012	SFP+, 10Gb/1Gb LR optical Xcvr, 1310nm
• PerfectStormONE 40GE Standard • PerfectStormONE 40GE Fusion	948-0028	QSFP+ 40GBASE-SR4 optical transceivers (incompatible with fan-out)
	948-0031	QSFP+ 40GBASE-SR4 optical transceivers (required for fan-out)
	948-0041	MT 12-fiber MMF cable, 3-meter length

Applicances	Transceiver/Cable Part number	Description
	948-0067	MT-to-4x10GE LC fan-out, MMF, 3-meter
	948-0068	MT-to-4x10GE LC fan-out, MMF, 5-meter

Mechanical Specifications

Controls and Indicators

The PerfectStormONE appliance controls and indicators are provided in the following table:

Controls and Indicators of PerfectStormONE appliances

Feature	Specification
Ethernet	One RJ-45 10/100/1000-BaseT management port
Serial	One RJ-45 RS232 serial port
USB	2 USB dual type A, 4-pin jack connectors

Front Panel

The Front panel of the 8x10GE and 2x40GE PerfectStormONE appliances are shown in the following figures (applies to Fusion and non-Fusion versions):

Figure: Front panel of 8x10GE PerfectStormONE

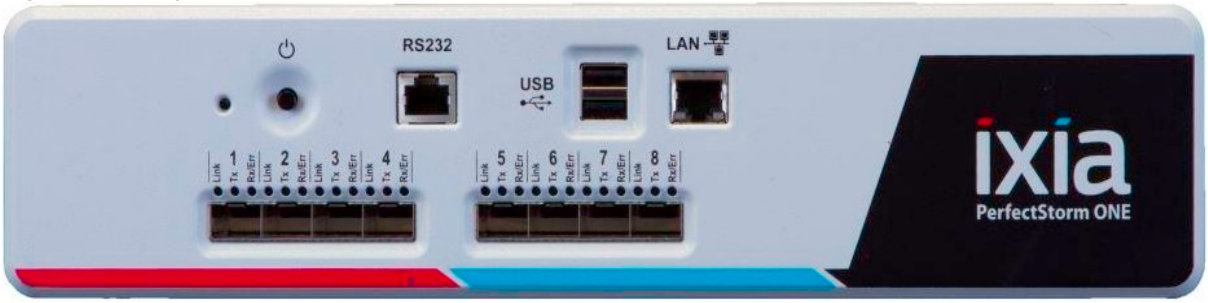
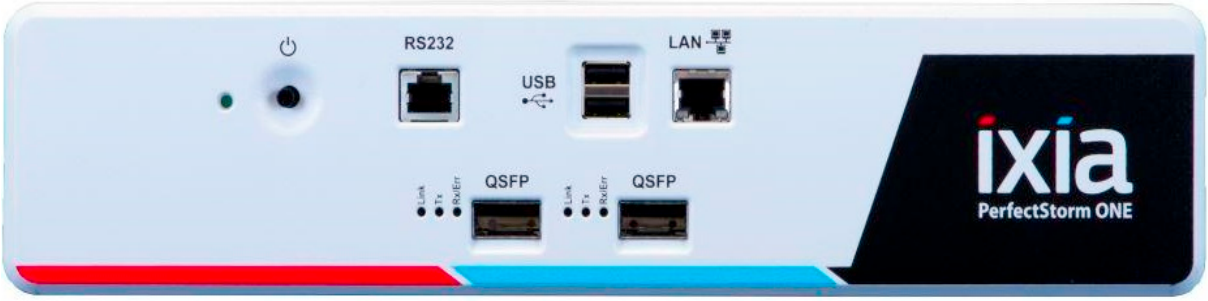


Figure: Front panel of 2x40GE PerfectStormONE



The front panel switches and indicators are provided in the following table:

Front panel specifications of PerfectStormONE appliances

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Indicators	Power LED • Green indicates that the system is ON and all power supplies are operational. • Off indicates that the system is OFF, or one or more power supplies are not operational.

LED Panel

The LED panel specifications are provided in the following table.

LED panel specifications of PerfectStormONE appliances

Feature	Specification
Link	• OFF indicates link is down • Solid Green indicates link is up
Tx	• Off indicates Tx is inactive • Blinking Green indicates Tx is active
Rx/Err	• Off indicates Rx is inactive • Blinking Red indicates Rx is active with errors • Blinking Green indicates Rx is active

Cooling Fan Speed Control

The PerfectStormONE appliance automatically monitors and measures the temperature of installed appliances. The appliance automatically adjusts the fan speed to maintain proper cooling.

Power outage recovery and Automatic booting scenario

The BIOS on PerfectStormONE is set to Power On after a power failure.

The PerfectStormONE appliance will start up, boot Windows 7 and automatically login to the Ixia user account. Anything that is in the Startup folder will also launch.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the appliance (40° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the appliance, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the appliance so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d'équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l'installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l'équipement dans un environnement compatible avec la température ambiante maximale autorisée (40 C) spécifiée pour l'appareil.
2. Circulation d'air réduite: installer l'équipement dans une baie de manière a ce que la circulation d'air requise pour faire fonctionner l'équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l'appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

NOTE For instructions on rack mounting and administration of the PerfectStormONE appliance, see the *PerfectStormONE Getting Started Guide*.

CHAPTER 32

IXIA Novus ONE Appliance and Novus ONE PLUS Fixed Chassis

This chapter provides details about the specification and features of the Novus ONE appliance and Novus ONE PLUS fixed chassis

The Novus ONE appliance provides the platform for complete layer 2 to 7 network and application testing in a compact form-factor. It provides unique combination of portability, performance - up to 16 Dual-PHY ports per appliance, allows user to create cost-effective test environments for 10GE/1GE/100M Ethernet over copper and fiber media.

The Novus ONE appliances have the following variants:

- 16-port, Dual-PHY (RJ45 and SFP+) 10GE/1GE/100M appliance
- 12-port, Dual-PHY (RJ45 and SFP+) 10GE/1GE/100M appliance
- 8-port, Dual-PHY (RJ45 and SFP+) 10GE/1GE/100M appliance
- 4-port, Dual-PHY (RJ45 and SFP+) 10GE/1GE/100M appliance

In addition to Novus ONE feature set, Novus ONE PLUS adds timing source support and optional 2.5GBASE-T/5GBASE-T features. Novus ONE PLUS is available in 3-Speed and 5-Speed models:

- 16-port, 10GE/1GE/100M
- 8-port, 10GE/1GE/100M
- 4-port, 10GE/1GE/100M
- 16-port, 10GE/5GE/2.5GE/1GE/100M
- 8-port, 10GE/5GE/2.5GE/1GE/100M
- 4-port, 10GE/5GE/2.5GE/1GE/100M

Both Novus ONE and Nouvs ONE PLUS support software field-upgrade to higher number of ports.

Key Features

- Full line-rate traffic generation to evaluate ASIC designs, FPGAs, and hardware switch fabrics.
- High scale and performance for emulating L2/3 protocols to validate performance and scalability of routing/switching and data center test cases using the Ixia’s IxNetwork application.
- Support for testing SFP+ and 10GBase-T RJ-45 copper ports at different speeds simultaneously.

- Industry-standard RFC tests and protocol emulation on 10G, 1G, and/or 100M ports in a single test—to benchmark data-plane and performance and scale of network equipment.
- 10G, 1G, and 100M line-rate packet capture and decode tools to detect and debug data transmission errors.
- Application support for IxExplorer, IxNetwork, and IxLoad applications and related Tcl and automation APIs.
- Flexible 4:1 CPU and memory aggregation, for high-scale protocol emulation and performance.
- Real-time latency with latency resolution of up to 2.5 ns.
- Extensive port and traffic flow statistics.
- Provides support for BroadR-Reach transceivers, to test BroadR-Reach enabled Automotive Ethernet switch, for SGMII 100Mbps.
- Provides support for 1000 Base T1 using Marvell Transceivers for SGMII 1G.
- Novus ONE PLUS provides synchronization ports and can act as external timing source or provide timing source to other units.

Novus ONE PLUS

Novus ONE PLUS use Ixia's next-generation architecture designed to meet high-throughput testing needs. Due to its compact form-factor and reduced power requirements, Novus ONE PLUS is a great option for providing high performance testing for users constrained by the space and power availability in their lab.

Part Numbers

Part Numbers for Novus ONE appliances are provided in the following table.

Model Number	Part Number	Description
Novus10/1GE16DP	941-0060	• 16-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance. • 1-slot Dual-PHY with 16-ports each of the SFP+ and 10GBASE-T RJ45 physical interfaces. • Supports layer 2-7
Novus10/1GE8DP	941-0061	• 8-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance. • 1-slot Dual-PHY with 8-ports each of the SFP+ and 10GBASE-T RJ45 physical interfaces. • Supports layer 2-7
Novus10/1GE4DP	941-0062	• 4-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance. • 1-slot Dual-PHY with 4-ports each of the SFP+ and 10GBASE-T RJ45 physical interfaces. • Supports layer 2-7

Model Number	Part Number	Description
Novus10/1GE12DP	905-1037	• 12-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance. • 1-slot Dual-PHY with 12-ports each of the SFP+ and 10GBASE-T RJ45 physical interfaces. • Supports layer 2-7

Part Numbers for Novus ONE PLUS fixed chassis are provided in the following table.

Model Number	Part Number	Description
Novus10/1GE16DP	941-0063	16-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance.
Novus10/1GE8DP	941-0064	8-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance.
Novus10/1GE4DP	941-0065	4-port SFP+/10GBASE-T Dual-PHY 10GE/1GE/100M appliance.
NOVUS10/5/2.5/1GE16DP	941-0066	16-port SFP+/10GBASE-T Dual-PHY 10/5/2.5/1GE/100M appliance.
NOVUS10/5/2.5/1GE8DP	941-0067	8-port SFP+/10GBASE-T Dual-PHY 10/5/2.5/1GE/100M appliance.
NOVUS10/5/2.5/1GE4DP	941-0068	4-port SFP+/10GBASE-T Dual-PHY 10/5/2.5/1GE/100M appliance.

Specifications

Novus ONE feature set is identical to Novus 10G/1G/100M Ethernet Load Modules. Additionally, it has a 4 port variant. See Chapter 34 for the detail specification.

Novus ONE PLUS feature set is identical to full feature of Novus 10G/5G/2.5G/1G/100M Ethernet Load Modules. Additionally, it has a 4 port variant. The 5G/2.5G support is optional. See Chapter 37 for the detail specification.

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

IxOS 8.52 EA supports Nouvs ONE PLUS and AresOne only.The Ixia application support for Novus ONE and Novus ONE PLUS is provided in the following table:

Novus ONE and Novus ONE PLUS Application Support

Hardware	Application Support
NovusONE	IxExplorer, IxLoad, IxNetwork, TCL API
Novus ONE PLUS	IxExplorer, IxNetwork, TCL API

Transceiver and Cable Support

Transceiver and cable support for Novus ONE is similar to Novus 10G/1G/100M Ethernet Load Modules. See Chapter 34 for detail information. Transceiver and cable support for Novus ONE PLUS is similar to full feature of Novus 10G/5G/2.5G/1G/100M Ethernet Load Modules. See Chapter 37 for detail information.

Mechanical Specifications

Front Panel

The Front panel of the Novus ONE appliance is shown in the following figure:

Figure: Front panel of Novus ONE

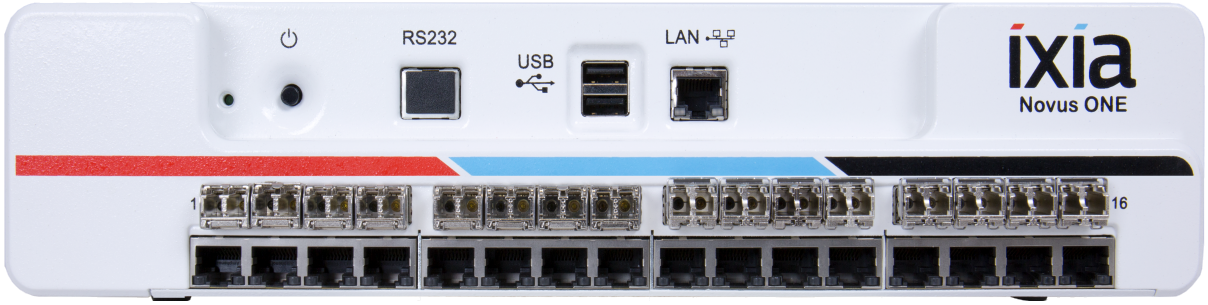
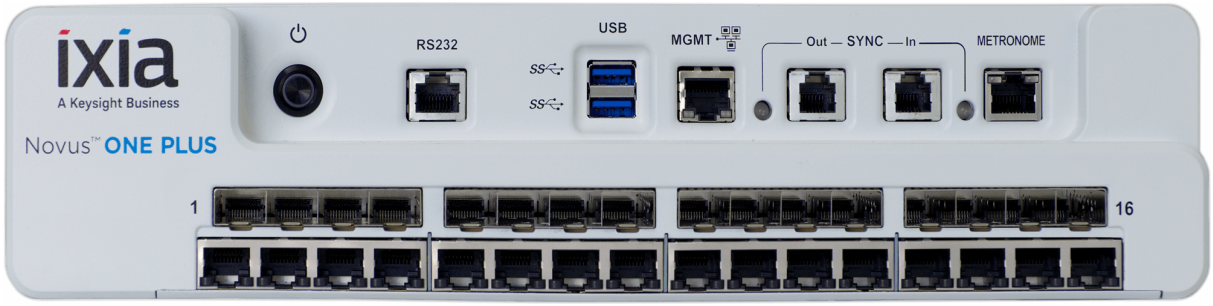


Figure: Front panel of Novus ONE PLUS



The front panel switches and indicators are provided in the following table:

Front panel specifications of Novus ONE appliance and Novus ONE PLUS fixed chassis

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Indicators	Power LED • Green indicates that the system is ON and all power supplies are operational. • Off indicates that the system is OFF, or one or more power supplies are not operational.
RS232	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
USB	Indicates that the connection is enables, and glows solid with USB activity.
LAN	100/1G/10G management port for connection to your network.
Sync In (available only in Novus ONE PLUS)	4-pin RJ11
Sync Out (available only in Novus ONE PLUS)	4-pin RJ11

LED Panel

The LED panel specifications are provided in the following table.

LED panel specifications of Novus ONE appliance

Feature	Specification
Link	• OFF indicates link is down • Solid Green indicates link is up
Tx	• Off indicates Tx is inactive • Blinking Green indicates Tx is active
Rx/Err	• Off indicates Rx is inactive • Blinking Red indicates Rx is active with errors • Blinking Green indicates Rx is active

Cooling Fan Speed Control

The Novus ONE PLUS automatically monitors and measures the temperature of installed appliances. The unit automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the appliance (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the appliance, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the appliance so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.
2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de

protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.

5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d’alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l’unité.

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CHAPTER 33

IXIA AresONE Fixed Chassis

This chapter provides details about AresONE 400GE fixed chassis, its specifications and features.

AresONE-400GE product family is the most compact high-port-density 400GE test solution for accelerating performance and benchmark testing of your high density 3.23-12.8Tbps networking devices. AresONE is the industry's most compact 8-port and 4-port 400GE test solution. Due to the compact form factor and reduced power requirements, you can use the device when you need high performance, but have space and power availability constraints in the lab.
This 2 rack-unit device has four times the density of any other test solution and supports QSFP-DD pluggable interfaces. It runs IxNetwork, the industry's most powerful L2-3 protocol test software.

AresONE is a fixed chassis. The field replaceability of parts and capability to sync to other chassis differentiates it from an appliance. See Chassis Synchronization.
This chassis is available in the following models:

- Full-feature performance and scale
- Reduced-feature performance and scale
- Upgrades from 4-port to 8-port for all 4-port models and from reduced to full performance for all models
- 2x200GE, 4x100GE, and 8x50GE fan-out speed test capabilities provided by field and factory upgrade

The AresONE models enable full line-rate traffic generation functionality for transmit, receive, and capture. This facilitates RFC benchmark testing, stress testing, and hardware/ASIC bring-up in high-port-count test beds. It can be used for optics and cable qualification, interoperability, and functional test.

AresONE supports the following:

- IxNetwork software application
- Native QSFP-DD interface
- Native OSFP interface
- Compact form factor and reduced power requirements
- Line-rate with per-port and per-flow statistics

Key Features

The key features of AresONE fixed chassis are as follows:

- Provides line-rate 400Gbps packet generation, capture, and analysis of received traffic to detect and debug data transmission errors for multiple speeds, 2x200GE, 4x100GE, and

8x50GE.

- Provides multi-rate speed option that includes 2x200GE, 4x100GE, and 8x50GE speed modes and fan-out support; these speed modes are compliant with IEEE 802.3cd draft specification.
- Requires lesser rack space, power and better cooling at 400GE port density.
- Supports new IxNetwork protocol bundles that provide easy and flexible pricing designed for appliances.
- Provides support for all reduced and 4-port models to be upgraded via one or more options to an 8-port full performance mode.
- Supports line-rate, at all speeds with per-port and per-flow statistics.
- Provides high-latency measurement resolution at 0.625ns at the 400GE speed and 1.25ns at 200GE.
- Provides RS-544 (KP4) Forward Error Correction (FEC) support for all speeds (400/200/100/50GE)
- Provides an excellent test platform for full line-rate 400/200/100/50 Gb/s to evaluate 400GE ASIC designs, FPGAs, and hardware switch fabrics that use the new 8x56Gb/s electrical interface with PAM4 encoding that is IEEE P802.3bs and IEEE 802.3cd compliant
- Provides auto-negotiation and link training support
- Supports 400GE and 2x200GE FEC symbol error injection with a comprehensive set of FEC corrected and uncorrected statistics, and Bit Error Rate (BER) statistics for pre- and post-FEC analysis
- Provides Inject packet errors: CRCs, runts, giants, alignments, checksum errors, and out of sequence
- Supports Keysight instrumentation including floating timestamp, sequence number and flow identification, and data integrity
- Supports 400G PCS lanes Transmit, error injection testing and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion
- Supports +/- 100 PPM line frequency adjustment
- Provides mid-to-high-range layer 2-3 networking protocol emulation to validate performance and scalability of layer 2-3 routing/switching and data center test cases using Keysight’s IxNetwork protocol emulation application
- Supports RFC benchmarking of networking devices and equipment using industry-standard RFC benchmark tests at line-rate 400/200/100/50GE speeds
- Supports Native IxOS
- Provides backward compatibility with existing chassis and software with IxExplorer and IxNetwork
- Supports IxExplorer, IxNetwork, and related Tcl and automation APIs

AresONE Variants

AresONE fixed chassis comprises the variants described as follows:

T400GD-8P-QDD

T400GD-8P-QDD is an 8- port, high density, full performance model with native QSFP-DD 400GE physical interfaces and layer 1-3 support.

T400GDR-8P-QDD

T400GDR-8P-QDD is a reduced-performance model in a 2RU device designed for high-density hardware, ASIC, cable/optics qualification, RFC benchmark, and interoperability testing for high-port-count testing. The QSFP-DD-R400GE scales down the layer 2-3 feature set and layer 2-3 networking protocol scaling, without compromising routing protocol coverage, while increasing affordability.

T400GD-4P-QDD

T400GD-4P-QDD is a 4- port, high density, full performance model with native QSFP-DD 400GE physical interfaces with layer 1-3 support.

T400GDR-4P-QDD

T400GDR-4P-QDD is a reduced-performance model in a 2RU device designed for high-density hardware, ASIC, cable/optics qualification, RFC benchmark, and interoperability testing for high-port-count testing. The QSFP-DD-R400GE scales down the layer 2-3 feature set and layer 2-3 networking protocol scaling, without compromising routing protocol coverage, while increasing affordability.

T400GD-8P-OSFP

T400GD-8P-OSFP is an 8- port, high density, full performance model with native native OSFP 400GE physical interfaces and layer 1-3 support.

T400GDR-8P-OSFP

T400GDR-8P-OSFP is a reduced-performance model in a 2RU device designed for high-density hardware, ASIC, cable/optics qualification, RFC benchmark, and interoperability testing for high-port-count testing. The OSFP-R400GE scales down the layer 2-3 feature set and layer 2-3 networking protocol scaling, without compromising routing protocol coverage, while increasing affordability.

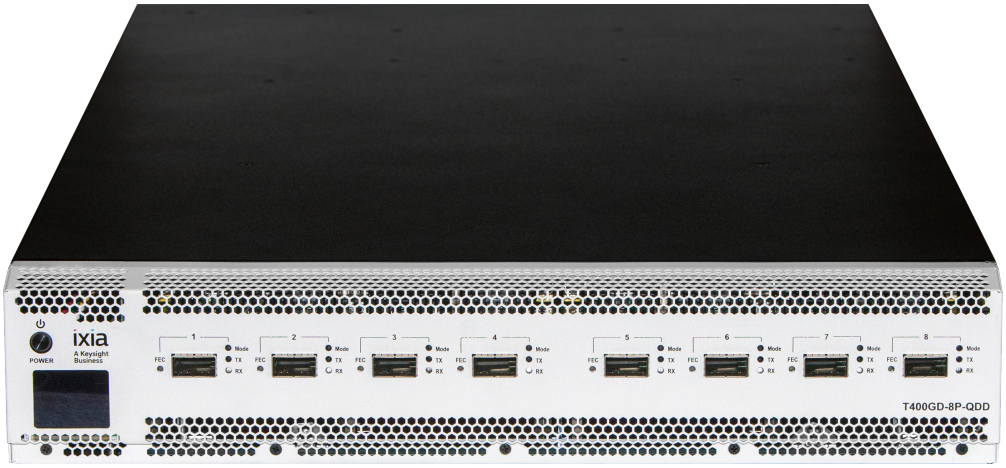
T400GD-4P-OSFP

T400GD-4P-OSFP is a 4- port, high density, full performance model with native OSFP 400GE physical interfaces with layer 1-3 support.

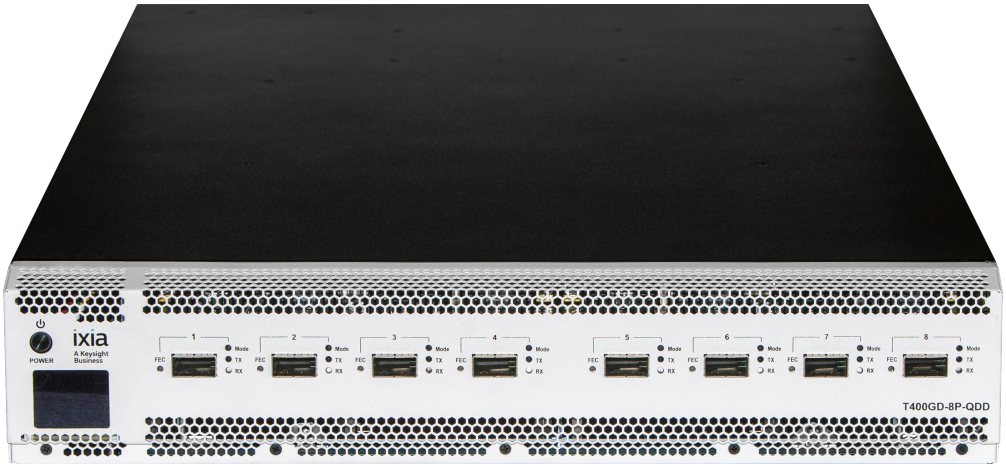
T400GDR-4P-OSFP

T400GDR-4P-OSFP is a reduced-performance model in a 2RU device designed for high-density hardware, ASIC, cable/optics qualification, RFC benchmark, and interoperability testing for high-port-count testing. The OSFP-R400GE scales down the layer 2-3 feature set and layer 2-3 networking protocol scaling, without compromising routing protocol coverage, while increasing affordability.

The 8-port full performance and reduced QDD and OSFP models are similar and shown in the following figure:



The 4-port full performance and reduced QDD and OSFP models are similar and shown in the following figure:



2x200GE, 4x100GE, 8x50GE Fan-Out Options

The T400GD and T400GDR Fan-Out options for the QDD and OSFP models are available in two forms:

- Factory Installed
- Field Upgrade

2x200GE, 4x100GE, 8x50GE Factory Installed

2x200GE, 4x100GE, 8x50GE FAN-OUT FACTORY INSTALLED for the T400GD/T400GDR 8 and 4-port, full and reduced, fixed chassis systems. One option is required for each system for all 8x400GE ports (905-1044). This is applicable on new purchases to enable the 2x200GE, 4x100GE and 8x50GE fan-out speeds per port.

2x200GE, 4x100GE, 8x50GE Field Upgrade

2x200GE, 4x100GE, 8x50GE FAN-OUT FIELD UPGRADE for the T400GD/T400GDR 8-port and 4-port, full and reduced, fixed chassis systems. One option is required for each fixed chassis system for all 8x400GE ports (905-1045). This is applicable on field upgrade purchases to enable the 2x200GE, 4x100GE and 8x50GE fan-out speeds.

NOTE Fully Qualified Port Name (FQPN) format is supported for AresONE 400GE High Density load module. This format uniquely identifies the port. It is the concatenation of path and port ID. The FQPN port number indicates the front panel port ID and the fan-out ID. For example, port 1.1 indicates front panel port 1 and fan out 1.

Part Numbers

Part Numbers for AresONE fixed chassis are provided in the following table.

Model Number	Part Number	Description
T400GD-8P-QDD	944-1170	• 8-ports of 400GE with the native QSFP-DD physical interface. • Full performance • Supports layer 1-3
T400GDR-8P-QDD	944-1171	• 8-ports of 400GE with the QSFP-DD physical interface. • Reduced performance • Supports layer 1-3
T400GD-4P-QDD	944-1172	• 4-ports of 400GE with the QSFP-DD physical interface. • Full performance • Supports layer 1-3
T400GDR-4P-QDD	944-1173	• 4-ports of 400GE with the QSFP-DD physical interface. • Reduced performance • Supports layer 1-3
T400GD-8P-OSFP	944-1174	• 8-ports of 400GE with the native OSFP physical interface. • Full performance • Supports layer 1-3
T400GDR-8P-OSFP	944-1175	• 8-ports of 400GE with the OSFP physical interface.

Model Number	Part Number	Description
		• Reduced performance • Supports layer 1-3
T400GD-4P-OSFP	944-1176	• 4-ports of 400GE with the OSFP physical interface. • Full performance • Supports layer 1-3
T400GDR-4P-OSFP	944-1177	• 4-ports of 400GE with the OSFP physical interface. • Reduced performance • Supports layer 1-3
• T400GD-8P-QDD+200G+100G+50G • T400GDR-8P-QDD+200G+100G+50G • T400GDR-4P-QDD+200G+100G+50G • T400GD-4P-QDD+200G+100G+50G	905-1044	• 2x200GE, 4x100GE, 8x50GE fan-out speeds per port • Fan-out factory installed • Both full and reduced performance models • Required on new purchases
• T400GD-8P-OFP+200G+100G+50G • T400GDR-8P-OSFP+200G+100G+50G • T400GDR-4P-OSFP+200G+100G+50G • T400GD-4P-OSFP+200G+100G+50G	905-1045	• 2x200GE, 4x100GE, 8x50GE fan-out speeds per port • Fan-out field upgrade • Both full and reduced performance models • Required on field upgrade purchases

Specifications

The hardware specifications for the AresONE QDD and OSFP models are contained in the following tables.

AresONE 400GE QDD Specifications

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
Hardware Appliance Specifications		
RU/ Number of Ports	2 RU 8-port and 4-port fixed chassis	
Physical Interfaces	Native QSFP-DD physical port	
Supported Port Speeds	400GE/port: 400GE-capable fiber and passive copper cable media 2x200, 4x100, 8x50GE capable with the purchase of a factory or a field upgrade speed option	
CPU and Memory	Multicore processor with 2GB of CPU memory per port	
IEEE Interface Protocols for 400GE	IEEE P802.3bs 200GE and 400GE, 400GBASE-R IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet	
Layer 1 support	400GE native ports and 200/100/50GE speed option: • KP4 (RS-544) Ethernet Forward Error Correction, Clause 119 • Auto-negotiation and link training support • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400GE and 200GE speeds) • PCS lanes Tx and Rx test and statistics • Layer 1 classical BERT	
Optical Transceiver Support	Capable of support for 400GBASE-DR4, 400GBASE-FR4, and 400GBASE-LR8 optical transceivers when available that are compliant to the QSFP-DD MSA.	
Copper Cable Media	400GBASE-CR8, passive, copper Direct Attached Cable (DAC) up to 3 meters in length.	
Fixed Chassis System Dimensions	• 30.3” (L) x 17.3” (W) x 3.46” (H) • 770mm (L) x 438.2mm (W) x 88mm (H)	
Fixed Chassis System Weights	• Hardware only: 74.6 lbs. (33.84 kg) • Shipping: 94.5 lbs. (42.86 kg)	
Fixed Chassis System Electrical Power	• Operates on 100-240VAC, 50/60Hz • 200-240VAC is single phase • Requires (3) power sources when running 100-120VAC, 9A for each	

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
	power supply. • AresONE fixed chassis is shipped with (3) 100-125VAC power cords. • AresONE can use (3) power sources when running 200-240VAC, 7A for each power supply. NOTE The power specifications are preliminary and for initial planning purpose.	
Temperature	Operating: 41°F to 95°F (5°C to 35°C) Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing	
Chassis Capacity: Maximum number of chassis and ports per model		
T400GD-8P-QDD (944-1170) T400GDR-8P-QDD (944-1171)	8-port fixed chassis systems: • 8-port, 2RU fixed chassis with built-in star topology synchronization ports to connect up to 5 additional fixed chassis systems • Total single synchronized system capacity is 48-ports of 400GE in a single configuration • Consult factory for port count requirements beyond 48-ports in a single configuration	
T400GD-4P-QDD (944-1172) T400GDR-4P-QDD (944-1173)	4-port fixed chassis systems: • 4-port, 2RU fixed chassis with built-in star topology synchronization ports to connect up to 5 additional fixed chassis systems • Total single system capacity is 24-ports of 400GE in a single configuration • Consult factory for port count requirements beyond 24-ports in a single configuration	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. Streams per Port and Speed (Including in Data Center Ethernet)	400GE: 128 2x200GE: 128 4x100GE: 32 8x50GE: 16	400GE: 32 2x200GE: 32 4x100GE: 16 8x50GE: 8

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler support	
Minimum Frame Size	400GE and 200GE • 60 bytes at full line rate • 56 bytes at less than full line rate 100GE and 50 GE • 64 bytes at full line rate • 56 bytes at less than full line rate	
Maximum Frame Size	16,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority Flow Control	400GE/200GE • 4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths 100GE/50GE • 4 line-rate-capable queues, each supporting up to 2,500-byte frame lengths • 1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K in 400/200/100GE and 8K in 50GE), uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (Max.) per port	• 400GE: 1M / UDF • 2x200GE: 1M / UDF • 4x100GE: 1M / UDF • 8x50GE: 512K / UDF	
Sequence (Max.)	• 400GE: 32K / UDF • 2x200GE: 16K / UDF	

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
	• 4x100GE: 8K / UDF • 8x50GE: 4K / UDF	
Error Generation (FEC and standard layer 2-3 Ethernet)	400GE FEC and 2x200GE FEC • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 400/200GE • No FEC error insertion and related statistics for 4x100GE and 8x50GE 400GE, 2x200GE, 4x100GE, 8x50GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical Coding Sublayer	• PCS lane marker error injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic	
Link Fault Signaling	• Reports, no fault, remote fault, and local fault port statistics • Generate local and remote faults with controls for the number of faults and order of faults • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway	
Latency Measurement Resolution	400GE: 0.625 nanoseconds 2x200GE: 1.25 nanoseconds 4x100GE: 2.5ns nanoseconds 8x50GE: 2.5ns nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 100 ppm on all the ports of a 400GE fixed chassis system	
Transmit/Receive Loopback	Internal loopback support	

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable Receive Flows per Port without Sequence Checking and with Tx/Rx Synch	400GE: 32K full statistics 2x200GE: 32K full statistics 4x100GE: 4K full statistics and 32K with minimum statistics 8x50GE: 4K full statistics and 16K with minimum statistic	
Trackable Receive Flows per Port with and without Sequence checking and no Tx/RX synch	400GE: 32K full statistics 2x200GE: 32K full statistics 4x100GE: 8K full statistics and 32K with minimum statistics 8x50GE: 8K full statistics and 16K with minimum statistics	
Minimum Frame Size	400GE and 2x200GE: 60 bytes 4x100GE and 8x50GE: 64 bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	400GE: 1MB 2x200GE, 4x100GE and 8x50GE: 1MB NOTE There is a hardware capture buffer per a fan-out resource group that may be assigned to one port of the fanout resource group	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
FEC Statistics	400GE and 2x200GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate	

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
	4x100GE and 8x50GE • Corrected and uncorrectable codewords NOTE This is a minimum specification; consult factory for more information.	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
400GE Physical Coding Sublayer (PCS) ReceiveSide Statistics and Indicators	Per-lane PCS receive capabilities include: • Receive – per-lane PCS receive statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive – per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	
Layer 2-3 Protocol Support		
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, EIGRP, BFD, IGMP/MLD/PIM-SM/SSM, LACP/Protocol over LACP, STP/RSTP/MSTP/PVST, GRE and Protocol over GRE, CFM/Y.1731, Link-OAM, PBB-TE, ELMI, 1588v2/SyncE ESMC, Y.1564QT, TWAMP, NTP, LISP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Software Defined Network	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, Segment Routing, BGP-LS, PCEP, BGP SR-TE Policy, BGP FlowSpec, OVSDB, Netconf, BIER, OpenFlow; GRE and Protocol over GRE, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Basic	Included with IxNetwork: IPv4/IPv6, DHCP, PPPoE, L2TP, IGMP, MLD, 802.1x	

Feature	T400GD-8P-QDD and T400GD-4P-QDD FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-QDD and T400GDR-4P-QDD REDUCED FEATURE 8-PORT and 4-PORT
MPLS and VPN	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD, RSVP-TE/P2MP, LDP/mLDP/LDPv6, L3VPN/6VPE, NGmVPN, PIM-SM/SSM/mVPN, MPLS-TP, MPLS OAM, GRE and Protocol over GRE, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Broadband Access and Authentication	PPPoX/L2TP, DHCPv4/v6, ANCP, IGMP/MLD/IPTV, 802.1x, GRE/Protocol over GRE, LACP/Protocol over LACP, Session Aware Traffic, Service over MPLS, Broadband Control Plane QT, Asymmetric Data Performance QT; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Data Center Ethernet	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, OVSDB, DCBX, FCoE, Fabric Path, SPBM, VEPA, TRILL, FCoE QT, IxCloudPerf QT, RFC7747 BGP Convergence QT, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

AresONE 400GE OSFP Specifications

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
Hardware Appliance Specifications		
RU/ Number of Ports	2 RU 8-port and 4-port fixed chassis	
Physical Interfaces	Native OSFP physical ports	

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
Supported Port Speeds	400GE/port: 400GE-capable fiber and passive copper cable media 2x200, 4x100, 8x50GE capable with the purchase of a factory or a field upgrade speed option	
CPU and Memory	Multicore processor with 2GB of CPU memory per port	
IEEE Interface Protocols for 400GE	IEEE 802.3bs 200GE and 400GE, 400GBASE-R IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet	
Layer 1 support	400GE native ports and 200/100/50GE speed option: • KP4 (RS-544) Ethernet Forward Error Correction, Clause 119 • Auto-negotiation and link training support • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400GE and 200GE speeds) • PCS lanes Tx and Rx test and statistics • Layer 1 classical BERT	
Optical Transceiver Support	Capable of support for 400GBASE-DR4, 400GBASE-FR4, and 400GBASE-LR8 optical transceivers when available that are compliant to the OSFP MSA 2.0.	
Copper Cable Media	400GBASE-CR8, passive, copper Direct Attached Cable (DAC) up to 3 meters in length.	
Fixed Chassis System Dimensions	• 30.9” (L) x 17.3” (W) x 3.5” (H) • 785mm (L) x 43mm (W) x 88mm (H)	
Fixed Chassis System Weights	• Hardware only: 74.6 lbs. (33.84 kg) • Shipping: 94.5 lbs. (42.86 kg)	
Fixed Chassis System Shipment Dimensions	• 41.5” (L) x 25.4” (W) x 14.25” (H) • 1054mm (L) x 645mm (W) x 362mm (H)	
Fixed Chassis System Electrical Power	• Operates on 100-240VAC, 50/60Hz • 200-240VAC is single phase • Requires (3) power sources when running 100-120VAC, 9A for each power supply. • AresONE fixed chassis is shipped with (3) 100-125VAC power cords. • AresONE can use (3) power sources when running 200-240VAC, 7A for each power supply.	

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
	NOTE The power specifications are preliminary and for initial planning purpose.	
Temperature	Operating: 41°F to 95°F (5°C to 35°C) Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing	
Chassis Capacity: Maximum number of chassis and ports per model		
T400GD-8P-OSFP (944-1174) T400GDR-8P-OSFP (944-1175)	8-port fixed chassis systems: • 8-port, 2RU fixed chassis with built-in star topology synchronization ports to connect up to 5 additional fixed chassis systems • Total single synchronized system capacity is 48-ports of 400GE in a single configuration • Consult factory for port count requirements beyond 48-ports in a single configuration	
T400GD-4P-OSFP (944-1176) T400GDR-4P-OSFP (944-1177)	4-port fixed chassis systems: • 4-port, 2RU fixed chassis with built-in star topology synchronization ports to connect up to 5 additional fixed chassis systems • Total single system capacity is 24-ports of 400GE in a single configuration • Consult factory for port count requirements beyond 24-ports in a single configuration	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. Streams per Port and Speed (Including in Data Center Ethernet)	400GE: 128 2x200GE: 128 4x100GE: 32 8x50GE: 16	400GE: 32 2x200GE: 32 4x100GE: 16 8x50GE: 8
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler support	
Minimum Frame Size	400GE and 200GE • 60 bytes at full line rate	

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
	• 56 bytes at less than full line rate 100GE and 50 GE • 64 bytes at full line rate • 56 bytes at less than full line rate	
Maximum Frame Size	16,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority Flow Control	400GE/200GE • 4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths 100GE/50GE • 4 line-rate-capable queues, each supporting up to 2,500-byte frame lengths • 1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K in 400/200/100GE and 8K in 50GE), uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (Max.) per port	• 400GE: 1M / UDF • 2x200GE: 1M / UDF • 4x100GE: 1M / UDF • 8x50GE: 512K / UDF	
Sequence (Max.)	• 400GE: 32K / UDF • 2x200GE: 16K / UDF • 4x100GE: 8K / UDF • 8x50GE: 4K / UDF	
Error Generation (FEC and standard layer 2-3 Ethernet)	400GE FEC and 2x200GE FEC • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates	

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
	(BER) for 400/200GE • No FEC error insertion and related statistics for 4x100GE and 8x50GE 400GE, 2x200GE, 4x100GE, 8x50GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical Coding Sublayer	• PCS lane marker error injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic	
Link Fault Signaling	• Reports, no fault, remote fault, and local fault port statistics • Generate local and remote faults with controls for the number of faults and order of faults • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway	
Latency Measurement Resolution	400GE: 0.625 nanoseconds 2x200GE: 1.25 nanoseconds 4x100GE: 2.5ns nanoseconds 8x50GE: 2.5ns nanoseconds	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 100 ppm on all the ports of a 400GE fixed chassis system	
Transmit/Receive Loopback	Internal loopback support	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable Receive	400GE: 32K full statistics	

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
Flows per Port without Sequence Checking and with Tx/Rx Synch	2x200GE: 32K full statistics 4x100GE: 4K full statistics and 32K with minimum statistics 8x50GE: 4K full statistics and 16K with minimum statistic	
Trackable Receive Flows per Port with and without Sequence checking and no Tx/RX synch	400GE: 32K full statistics 2x200GE: 32K full statistics 4x100GE: 8K full statistics and 32K with minimum statistics 8x50GE: 8K full statistics and 16K with minimum statistics	
Minimum Frame Size	400GE and 2x200GE: 60 bytes 4x100GE and 8x50GE: 64 bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	400GE: 1MB 2x200GE, 4x100GE and 8x50GE: 1MB NOTE There is a hardware capture buffer per a fan-out resource group that may be assigned to one port of the fanout resource group	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
FEC Statistics	400GE and 2x200GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate 4x100GE and 8x50GE • Corrected and uncorrectable codewords NOTE This is a minimum specification; consult factory for more information.	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
400GE Physical Coding Sublayer (PCS) ReceiveSide Statistics and Indicators	Per-lane PCS receive capabilities include: • Receive – per-lane PCS receive statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive – per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	
Layer 2-3 Protocol Support		
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, EIGRP, BFD, IGMP/MLD/PIM-SM/SSM, LACP/Protocol over LACP, STP/RSTP/MSTP/PVST, GRE and Protocol over GRE, CFM/Y.1731, Link-OAM, PBB-TE, ELMI, 1588v2/SyncE ESMC, Y.1564QT, TWAMP, NTP, LISP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Software Defined Network	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, Segment Routing, BGP-LS, PCEP, BGP SR-TE Policy, BGP FlowSpec, OVSDB, Netconf, BIER, OpenFlow; GRE and Protocol over GRE, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Basic	Included with IxNetwork: IPv4/IPv6, DHCP, PPPoE, L2TP, IGMP, MLD, 802.1x	
MPLS and VPN	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD, RSVP-TE/P2MP, LDP/mLDP/LDPv6, L3VPN/6VPE, NGmVPN, PIM-SM/SSM/mVPN, MPLS-TP, MPLS OAM, GRE and Protocol over GRE, LACP/Protocol over LACP;	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions

Feature	T400GD-8P-OSFP and T400GD-4P-OSFP FULL FEATURE 8-PORT and 4-PORT	T400GDR-8P-OSFP and T400GDR-4P-OSFP REDUCED FEATURE 8-PORT and 4-PORT
	REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	
Broadband Access and Authentication	PPPoX/L2TP, DHCPv4/v6, ANCP, IGMP/MLD/IPTV, 802.1x, GRE/Protocol over GRE, LACP/Protocol over LACP, Session Aware Traffic, Service over MPLS, Broadband Control Plane QT, Asymmetric Data Performance QT; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Data Center Ethernet	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, OVSDB, DCBX, FCoE, Fabric Path, SPBM, VEPA, TRILL, FCoE QT, IxCloudPerf QT, RFC7747 BGP Convergence QT, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions

Application Support

The Keysight application support for AresONE appliances is provided in the following table:

AresONE Application Support

Hardware	Application Support
T400GD-8P-QDD T400GD-4P-QDD	IxExplorer, IxNetwork, TCL API
T400GDR-8P-OSFP T400GDR-4P-OSFP	IxExplorer, IxNetwork, TCL API

Transceiver and Cable Support

The transceivers and cables supported by AresONE fixed chassis are provided in the following table:

AresONE Transceiver and Cable Support

Transceiver/Cable	Description	Compatibility
QSFP-DD-1M-CBL	QSFP-DD-to-QSFP-DD 400GE	

Transceiver/Cable	Description	Compatibility
	400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 1-meter length	• T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173)
QSFP-DD-2M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2-meter length	• T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173)
QSFP-DD-2-5M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2.5-meter length.	• T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173)
OSFP-1M-CBL	OSFP-to-OSFP 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 1-meter length.	• T400GD-8P-OSFP 8-port full (944-1174) • T400GDR-8P-OSFP 8-port reduced (944-1175) • T400GD-4P-OSFP 4-port full (944-1176) • T400GDR-4P-OSFP 4-port reduced (944-1177)

Status Icons

AresONE includes a full-color graphics display which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

Status Icons for AresONE fixed chassis

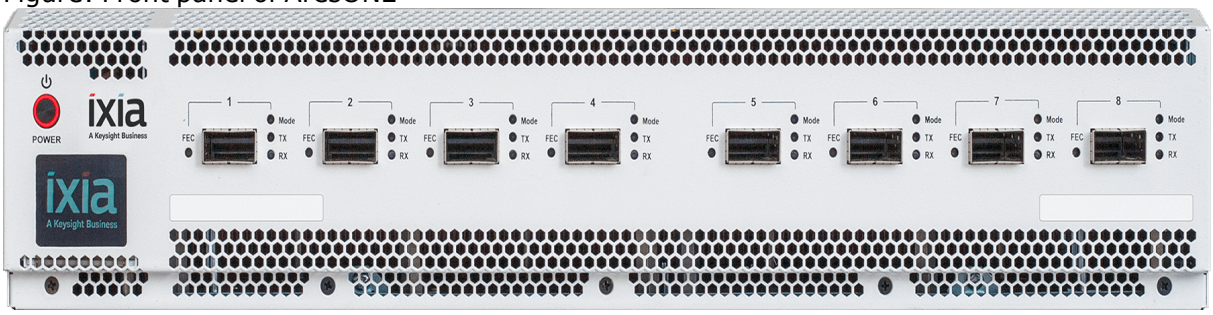
Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The Front panel of the AresONE fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):

Figure: Front panel of AresONE



Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Front panel Switch and LED specifications of AresONE fixed chassis

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

LED panel Specifications for AresONE

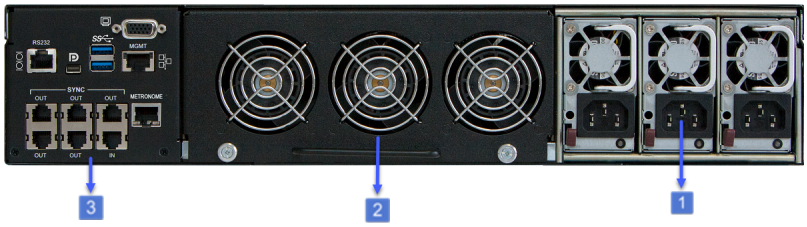
MODE LED	TX STATUS	RX STATUS	FEC
• Solid Red - Card fault • Solid Purple -	• Solid Red - Link down • Solid Green -	• Blinking Red - RX active with errors • Blinking Green -	• Solid Red - Uncorrectable FEC errors

MODE LED	TX STATUS	RX STATUS	FEC
400GE speed mode	Link up • Blinking Green - TX is active	RX active with no errors received • Off - Port is inactive	• Blinking Green - Correctable FEC errors • Solid Green - No errors • Off - FEC not enabled

Rear Panel

The Rear panel of the AresONE fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):

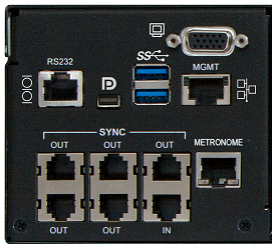
Figure: Rear panel of AresONE



1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Utility / Sync / Mgmt ports	Sync connectors

Rear Panel Ports

The Rear Panel MGMT Port LED specifications are provided in the following table.



Rear panel Port Information for AresONE fixed chassis

Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	Reserved for future use

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are provided in the following table.

LED panel Specifications for AresONE

Position	Indicator	Color	Description
Left	Link Speed	Solid Green	Linked at 10G
		Solid Yellow	Linked at 1G
		Off	Linked at 100M or Link Down
Right	Link/Activity	Solid Green	Link Up, no activity
		Blinking Green	Link Up, actively transmitting or receiving
		Off	Link Down

Power Supply LEDs

The power supply LEDs indicate the following:

Power Supply LED specifications for AresONE

State	Description
Off	No AC power
Solid Amber	Power Supply Critical Failure, system shutdown (eg. over temperature, over Current, fan fail)
Blinking Amber	Power Supply Warning (eg. high temperature, high current, slow fan)
Solid Green	AC Powered and Output Active (Normal Operation)
Blinking Green	AC Powered and System inactive or in sleep state (Appliance Plugged in but Powered Down)

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE has five sync out ports, an AresONE acting as primary chassis can sync five more AresONE fixed chassis or XGS chassis.

The following image shows the back of a primary chassis where its sync out ports are connected to secondary chassis by sync cables.

The following image shows a secondary chassis that has sync cables connected to the sync-in port.

NOTE

- AresONE can also act as a secondary chassis to an XGS-HSL or XGS-SDL chassis acting as primary chassis.
- AresONE can only co-exist with Native IxOS chassis in sync topology.
- AresONE supports only Star topology and not Daisy chaining.

Cooling Fan Speed Control

The AresONE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.

5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d'équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l'installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l'équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l'appareil.
2. Circulation d'air réduite: installer l'équipement dans une baie de manière a ce que la circulation d'air requise pour faire fonctionner l'équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l'appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

NOTE For instructions on rack mounting and administration of the AresONE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

CHAPTER 34

IXIA AresONE High Performance Fixed Chassis

This chapter provides details about AresONE 400GE High Performance fixed chassis, its specifications, and features.

AresONE 400GE High Performance fixed chassis provides high-scale 400 GE traffic generation, network protocol emulation, and performance test solution available for 400/200/100/50 GE QSFP-DD interfaces. It delivers massive protocol scale on every fan-out port for unparalleled traffic generation performance and receive-side measurement scale over its supported 8x200 GE, 16x100 GE, and 32x50 GE ports. It is the only test solution that does not lose transmit stream capability, receive-side measurement tracking, and measurement capability because of fan-out to 2x200 GE and 4x100 GE.

AresONE 400GE High Performance fixed chassis facilitates high-scale mixed protocol tests, large system-under-test (SUT) scenarios, and fail-over and convergence testing at large subscriber scales. The solution accommodates testing of pre-designed full-scale networks with multi-service protocol configurations.

Following are the highlights of AresONE 400GE High Performance fixed chassis:

- It validates high protocol scale devices for performance and scalability with AresONE multi-speed 400/200/100/50 GE test capabilities and Keysight's IxNetwork Layer 2/3 test application.
- It allows you to run test on massive scale, even in 400 GE to 2x200 GE, 4x100 GE fan-out mode with no reduction in number of transmit streams and receive-side tracking per flow with full line-rate traffic and multi-protocol test scenarios
- It simplifies testing transceivers and cables during test bed.
- It relies on proven IxNetwork test solution for validating mission-critical network infrastructure and IxSuiteStore for Layer 1 BERT and PCS lanes Tx/Rx test capability.

AresONE offers a factory and a field-upgrade Ethernet speed option that provides 2x200 GE, 4x100 GE, and 8x50 GE test capabilities.

Key Features

The key features of AresONE 400GE High Performance fixed chassis are as follows:

- Provides line-rate 400 Gbps packet generation, capture, and analysis of received traffic to detect and debug data transmission errors for multiple speeds, including 2x200 GE, 4x100 GE, and 8x50 GE.

- Provides multi-rate speed option that includes 2x200 GE, 4x100 GE, and 8x50 GE speed modes with fan-out support. These speed modes are compliant with the IEEE 802.3cd specification.
- Supports new IxNetwork protocol bundles that provide easy and flexible pricing designed for fixed chassis systems.
- Supports IxSuiteStore 400 GE Transceiver and PCS Testing suite, the industry's first fully automated IEEE 802.3bs-based test suite that enables validation of 400 GE implementations. This includes testing of physical coding sublayer (PCS) lanes, BER, KP4 FEC bit-error distribution with error insertion and link stability.
- Provides support for all reduced and 2-port models to be upgraded through one or more options to an 4-port full performance mode.
- Supports line-rate at all speeds with per-port and per-flow statistics.
- Provides high-latency measurement resolution at 0.625 ns at the 400 GE speed and 1.25 ns at 200 GE.
- Provides RS-544 (KP4) Forward Error Correction (FEC) support for all speeds (400/200/100/50GE).
- Provides an excellent test platform for full line-rate 400/200/100/50 Gb/s with high stream count requirements to evaluate 400GE ASIC designs, FPGAs, and hardware switch and router fabrics that use the new 8x56 Gb/s electrical interface with PAM4 encoding that is IEEE 802.3bs and IEEE 802.3cd compliant.
- Provides auto-negotiation (AN) and link training (LT) support.

NOTE With AN and LT turned on, 50 GE fan-out operation becomes 4x50 GE per port. With AN and LT turned off, the 50 GE operation becomes 8x50 GE per port.

- Supports 400 GE and 2x200 GE FEC ssymbol error injection and FEC symbol error distribution analysis with a comprehensive set of FEC corrected and uncorrected count and rate statistics. Provides bit error rate (BER) statistics for pre- and post-FEC analysis.
- Supports Keysight instrumentation, including floating timestamp, sequence number and flow identification, and data integrity.
- Provides Inject packet errors: CRCs, runts, giants, alignments, checksum errors, and out of sequence.
- Supports 400G PCS lanes transmit, error injection testing and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion.
- Supports Layer 1 BERT capability with per-lane and per-port BER statistics and has the ability to send PRBS patterns and inject bit errors per lane under user control.
- Supports +/- 100 PPM line frequency adjustment.
- Allows you to inject packet errors: CRCs, runts, giants, alignments, checksum errors, and out of sequence.
- Provides ultra-high-range layer 2-3 networking protocol emulation to validate performance and scalability of layer 2-3 routing/switching and data center test cases using Keysight's IxNetwork protocol emulation application.
- Supports RFC benchmarking of networking devices and equipment by using industry-standard RFC benchmark tests at line-rate 400/200/100/50 GE speeds.
- Supports Native IxOS.

- Provides backward compatibility with existing chassis and software with IxExplorer and IxNetwork.
- Supports IxExplorer, IxNetwork, and related Tcl and automation APIs.

AresONE High Performance Fixed Chassis Variants

AresONE-400GE High Performance fixed chassis comprises the variants described as follows:

T400GP-4P-QDD

T400GP-4P-QDD is a 4-port, high performance model with native QSFP-DD 400GE physical interfaces and layer 1-3 support.

T400GP-2P-QDD

T400GP-2P-QDD is a 2- port, high performance model with native QSFP-DD 400GE physical interfaces and layer 1-3 support. 2 ports are activated in the hardware using the EEPROM option.

2x200GE, 4x100GE, 8x50GE Fan-Out Options

The fan-out options for the T400GP-4P-QDD and T400GP-2P-QDD models are available in two forms:

- Factory Installed
- Field Upgrade

2x200GE, 4x100GE, 8x50GE Factory Installed

2x200 GE, 4x100 GE, 8x50 GE FAN-OUT FACTORY INSTALLED for the T400GP 4-port and 2-port fixed chassis systems. One option is required for each system for all 8x400 GE ports (905-1044). This is applicable on new purchases to enable the 2x200 GE, 4x100 GE and 8x50 GE fan-out speeds per port.

2x200GE, 4x100GE, 8x50GE Field Upgrade

2x200 GE, 4x100 GE, 8x50 GE FAN-OUT FIELD UPGRADE for the T400GP 4-port and 2-port fixed chassis systems. One option is required for each fixed chassis system for all 8x400 GE ports (905-1045). This is applicable on field upgrade purchases to enable the 2x200 GE, 4x100 GE and 8x50 GE fan-out speeds.

NOTE 4x100GE_MACSEC/2x200GE_MACSEC/1x400GE_MACSEC FAN-OUT FIELD UPGRADE is available for T400GP 8-port fixed chassis systems. One option is required for each fixed chassis system for all 8x400GE ports (905-1045). This is applicable on field upgrade purchases to turn on the 4x100GE_ MACSEC/2x200GE_MACSEC/1x400GE_MACSEC fan-out speed.

NOTE Fully Qualified Port Name (FQPN) format is supported for AresONE 400GE High Performance load module. This format uniquely identifies the port. It is the concatenation of path and port ID. The FQPN port number indicates the front panel port ID and the fan-out ID. For example, port 1.1 indicates front panel port 1 and fan out 1.

Part Numbers

Part Numbers for AresONE High Performance fixed chassis are provided in the following table:

Model Number	Part Number	Description
T400GP-4P-QDD	944-1178	• 4-ports of 400 GE with the native QSFP-DD physical interface. • High performance • Supports layer 1-3
T400GP-4P-QDD+200G+100G+50G	905-1044	• 2x200 GE, 4x100 GE, 8x50 GE fan-out speeds per port • Fan-out factory installed • Both full and reduced performance models • Required on new purchases
T400GP-4P-QDD+200G+100G+50G	905-1045	• 2x200GE, 4x100GE, 8x50GE fan-out speeds per port • Fan-out field upgrade • Both full and reduced performance models • Required on field upgrade purchases

Model Number	Part Number	Description
T400GP-2P-QDD+200G+100G+50G	944-1179	• 2-ports of 400 GE with the native QSFP-DD physical interface. • High performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE fan-out speeds per port

Specifications

The hardware specifications for the AresONE High Performance QDD models are contained in the following tables:

Feature	T400GP-4P-QDD	T400GP-2P-QDD
Hardware Fixed Chassis Specifications		
RU/ Number of Ports	2 RU, 4-port fixed chassis system	2 RU, 2-port fixed chassis system
Physical Interfaces	Native QSFP-DD physical port	
Supported Port Speeds	• 400 GE/port: 400 GE-capable fiber and passive copper cable media • 2x200, 4x100, 4x50 GE, 8x50 GE with the purchase of a factory or a field upgrade speed option	
CPU and Memory	Multicore processor with up to 8 GB of CPU memory per port depending on the speed mode set on the port.	
IEEE Interface Protocols for 400GE	• IEEE 802.3bs 200 GE and 400 GE, 400GBASE-R • IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet	
Layer 1 support	400GE native ports and 200/100/50 GE speed option: • KP4 (RS-544, 514) Ethernet Forward Error Correction, Clause 119 • Auto-negotiation (AN) and link training (LT) support ▪ All speeds support AN and LT for 1x400 GE, 2x200 GE, 4x100 GE, and 4x50 GE speed modes ▪ 8x50 GE speed mode does not support AN and LT • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400 GE & 200 GE speeds only) • FEC symbol error density distribution analysis • Pre-FEC BER and FLR measurements • Extensive FEC BER and rate related statistics	

Feature	T400GP-4P-QDD	T400GP-2P-QDD
	• PCS lanes Tx and Rx BER test and statistics • Layer 1 BERT testing with PRBS patterns	
Optical Transceiver Support	Capable of support for all QSFP-DD MSA compliant optical transceivers up to Power Class 7 with 14 watts of power consumption such as: 400GBASE-DR4, 400GBASE-FR4, 400GBASE-LR8, and 400GBASE-SR8 other optical transceiver types, such as QSFP56 and AOCs.	
Copper Cable Media	400GBASE-CR8, passive, copper Direct Attached Cable (DAC) up to 3 meters in length.	
Fixed Chassis System Dimensions	• 30.3” (L) x 17.3” (W) x 3.46” (H) • 770mm (L) x 438.2mm (W) x 88mm (H)	
Fixed Chassis System Weights	• Hardware only: 74.6 lbs. (33.84 kg) • Shipping: 94.5 lbs. (42.86 kg) NOTE Shipping weight is approximate. It includes rackmount slides, power cords, sync cables, and packaging.	
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120 VAC, 9 A for each power supply. AresONE fixed chassis is shipped with (3) 100-125 VAC power cords. • Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply. NOTE The power specifications are preliminary and for initial planning purpose.	
Temperature	• Operating: 41°F to 95°F (5°C to 35°C) • Storage: 41°F to 122°F (5°C to 50°C)	
Humidity	• Operating: 0 % to 85 %, non-condensing • Storage: 0 % to 85 %, non-condensing	
Regulatory Compliance Specifications	IEC 60950-1, UL 60950-1, CSA C22.2 No.60950-1, CE (LVD, EMC, RoHS), EN/IEC 55032, EN/IEC 55024, CFR 47, FCC Part 15B, ICES-003, AS/NZ CISPR 32/24, KN32/35	
Chassis Capacity: Maximum number of chassis and ports per model		
T400GP-4P-QDD (944-1178)] T400GP-2P-QDD	4-port fixed chassis system: • 4-port, 2RU fixed chassis with built-in star topology synchronization ports to	2-port fixed chassis system: • 2-port, 2RU fixed chassis with built-in star topology synchronization ports to

Feature	T400GP-4P-QDD	T400GP-2P-QDD
(944-1179)]	connect up to 5 additional fixed chassis systems • Total single system capacity is 24-ports of 400GE in a single configuration with support for the following total port counts: ▪ 8 x 200 GE ▪ 16 x 100 GE ▪ 16 x 50 GE with AN and LT ▪ 32 x 50 GE without AN and LT • Consult factory for port count requirements beyond 24-ports of 400 GE physical ports in a single configuration	connect up to 5 additional fixed chassis systems • Total single system capacity is 12-ports of 400GE in a single configuration with support for the following total port counts: ▪ 4 x 200 GE ▪ 8 x 100 GE ▪ 8 x 50 GE with AN and LT ▪ 16 x 50 GE without AN and LT • Consult factory for port count requirements beyond 12-ports of 400 GE physical ports in a single configuration
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. Streams per Port and Speed (Including in Data Center Ethernet)	• 400 GE: 512 • 2x200 GE: 512 • 4x100 GE: 512 • 8x50 GE: 256	
Stream Controls	• Rate and frame size change on the fly • Advanced and Sequential stream scheduler support	
Minimum Frame Size	400 GE and 200 GE • 60 bytes at full line rate • 56 bytes at less than full line rate 100 GE and 50 GE • 60 bytes at full line rate • 56 bytes at less than full line rate	
Maximum Frame Size	16,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority Flow	400GE/200GE	

Feature	T400GP-4P-QDD	T400GP-2P-QDD
Control	• 4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths 100GE/50GE • 4 line-rate-capable queues, each supporting up to 2,500-byte frame lengths • 1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K in 400/200/100 GE and 8 K in 50 GE), uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (Max.) per port	• 400 GE: 1M/UDF • 2x200 GE: 1M/UDF • 4x100 GE: 1M/UDF • 8x50 GE: 512K/UDF	
Sequence (Max.)	• 400 GE: 1M/UDF • 2x200 GE: 1M/UDF • 4x100 GE: 1M/UDF • 8x50 GE: 512K/UDF	
Error Generation (FEC and standard layer 2-3 Ethernet)	400 GE and 2x200 GE FEC • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 400/200 GE. • No FEC error insertion and related statistics for 4x100 GE and 8x50 GE. 400 GE, 2x200 GE, 4x100 GE, 8x50 GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum.	
Physical Coding Sublayer	• PCS lane marker error injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for	

Feature	T400GP-4P-QDD	T400GP-2P-QDD
	control plane traffic	
Link Fault Signaling	• Reports, no fault, remote fault, and local fault port statistics • Generate local and remote faults with controls for the number of faults and order of faults • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway	
Latency Measurement Resolution	400 GE: 0.625 ns 2x200 GE: 1.25 ns 4x100 GE: 2.5 ns 8x50 GE: 2.5 ns	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 100 ppm on all the ports of a 400 GE fixed chassis system	
Transmit/Receive Loopback	• Internal loopback support • Line loopback support	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable Receive Flows per Port	Without sequence checking and with Tx/Rx synch. • 400/200/100 GE: 1 M • 50 GE: 512 K With and without sequence checking and no Tx/RX synch. • 400/200/100 GE: 1 M • 50 GE: 512 K	
Minimum Frame Size	400 GE and 2x200 GE: 60 bytes 4x100 GE and 8x50 GE: 64 bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	400 GE: 1 GB per physical port 2x200 GE port fan-out:r 1 GB for each 200 GE port 4x100 GE port fan-out: 1 GB for each 100 GE port	

Feature	T400GP-4P-QDD	T400GP-2P-QDD
	8x50GE port fan-out: 512 MB for each 50 GE port	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
FEC Statistics	400 GE and 2x200 GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate 4x100 GE and 8x50 GE • Corrected and uncorrectable codewords NOTE This is a minimum specification; consult factory for more information.	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
400GE Physical Coding Sublayer (PCS) ReceiveSide Statistics and Indicators	Per-lane PCS receive capabilities include: • Receive – per-lane PCS receive statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive – per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	
Layer 2-3 Protocol Support		
Basic	IxNetwork Base, RFC2544/2889/3918 QuickTest	
Routing, Switching, and Carrier Ethernet	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, EIGRP, BFD, Seamless BFD, IGMP/MLD, PIM-SM/SSM, STP/RSTP/MSTP/PVST, LACP/Protocol over LACP, GRE and Protocol over GRE, LISP, CFM/Y.1731, Link-OAM, PBB-TE, ELMI, 1588v2/SyncE ESMC, Y.1564QT, TWAMP, NTP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE	
Software Defined Network	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, Segment Routing (MPLS and IPv6), BGP-LS, PCEP, BGP SR-TE Policy, BGP FlowSpec, OVSDB, Netconf, BIER, OpenFlow; GRE and Protocol over GRE, LACP/Protocol over LACP, eCPRI; REQUIRES: 930-2201	

Feature	T400GP-4P-QDD	T400GP-2P-QDD
	IxNetwork Basic package for AresONE	
MPLS and VPN	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, EIGRP, BFD, RSVP-TE P2P/P2MP, LDP/LDPv6/mLDP, LDP L2VPN (PWE/VPLS), BGP VPLS/VPWS, L3VPN/6VPE, BGP RFC3107, PIM-SM/SSM, Multicast VPN, MPLS-TP, MPLS OAM, EVPN/PBB-EVPN; REQUIRES: 930-2201 IxNetwork Basic package for AresONE	
Broadband Access and Authentication	PPPoX/L2TPv2, DHCPv4/DHCPv6, ANCP, IGMP/MLD, IPv6 Autoconfiguration (SLAAC), 802.1x, Bonded GRE HG, GRE/Protocol over GRE, LACP/Protocol over LACP, Session Aware Traffic, Service over MPLS, Broadband Control Plane QT, Asymmetric Data Performance QT; REQUIRES: 930-2201 IxNetwork Basic package for AresONE	
Data Center Ethernet	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, OVSDB, DCBX, FCoE, Fabric Path, SPBM, VEPA, TRILL, FCoE QT, IxCloudPerf QT, RFC7747 BGP Convergence QT, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE	

Application Support

The Keysight application support for AresONE High Performance fixed chassis is provided in the following table:

Hardware	Application Support
• T400GP-4P-QDD • T400GP-2P-QDD	IxExplorer, IxNetwork, TCL API , IxSuiteStore

Transceiver and Cable Support

The transceivers and cables supported by AresONE High Performance fixed chassis are provided in the following table:

AresONE Transceiver and Cable Support

Transceiver/Cable	Description	Compatibility
QSFP-DD-1M-CBL	QSFP-DD-to-QSFP-DD 400 GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 1 meter length	• K400 QSFP-DD-400GE (944-1152) • K400 QSFP-DD-R400GE (944-1153) • T400GD-8P-QDD 8-port full (944-

Transceiver/Cable	Description	Compatibility
		1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173) • T400GP-4P-QDD (944-1178) • T400GP-2P-QDD (944-1179)
QSFP-DD-2M-CBL	QSFP-DD-to-QSFP-DD 400 GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2 meter length	• K400 QSFP-DD-400GE (944-1152) • K400 QSFP-DD-R400GE (944-1153) • T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173) • T400GP-4P-QDD (944-

Transceiver/Cable	Description	Compatibility
		1178) • T400GP-2P-QDD (944-1179)
QSFP-DD-2-5M-CBL	QSFP-DD-to-QSFP-DD 400 GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2.5 meter length.	• K400 QSFP-DD-400GE (944-1152) • K400 QSFP-DD-R400GE (944-1153) • T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173) • T400GP-4P-QDD (944-1178) • T400GP-2P-QDD (944-1179)
QSFP-DD-DR4-CBL	MT-to-4x100 GE LC fan-out, SMF, 3-meter cable for 100 GE fan-out (942-0138)	• K400 QSFP-DD-400GE (944-1152) • K400 QSFP-DD-R400GE (944-1153) • T400GD-8P-QDD 8-port full (944-1170)

Transceiver/Cable	Description	Compatibility
		• T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173) • T400GP-4P-QDD (944-1178) • T400GP-2P-QDD (944-1179)
QSFP-DD-SR8-CBL	MT-to-8x50 GE LC fan-out, MMF, MPO16, 3-meter cable for 400 GE 8x50 GE fan-out (942-0125).	• K400 QSFP-DD-400GE (944-1152) • K400 QSFP-DD-R400GE (944-1153) • T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173) • T400GP-4P-QDD (944-1178)

Transceiver/Cable	Description	Compatibility
		• T400GP-2P-QDD (944-1179)
QSFP-DD-MPO16-CBL	MT-to-MT, MPO16, OM4, MMF, 3 meter cable for 400 GE QSFP-DD-SR8-XCVR (942-0124)	• K400 QSFP-DD-400GE (944-1152) • K400 QSFP-DD-R400GE (944-1153) • T400GD-8P-QDD 8-port full (944-1170) • T400GDR-8P-QDD 8-port reduced (944-1171) • T400GD-4P-QDD 4-port full (944-1172) • T400GDR-4P-QDD 4-port reduced (944-1173) • T400GP-4P-QDD (944-1178) • T400GP-2P-QDD (944-1179)

Status Icons

AresONE includes a full-color graphics display, which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The Front panel of the AresONE High Performance fixed chassis is shown in the following image (applies to 4-port and 2-port variants):

Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

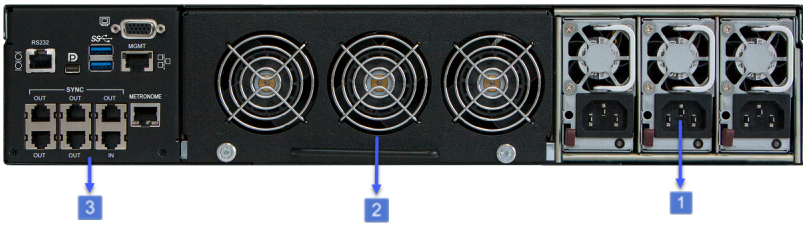
Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table:

MODE LED	TX STATUS	RX STATUS	FEC
• Solid Red - Card fault • Solid Purple - 400 GE speed mode	• Solid Red - Link down • Solid Green - Link up • Blinking Green - TX is active	• Blinking Red - RX active with errors • Blinking Green - RX active with no errors received • Off - Port is inactive	• Solid Red - Uncorrectable FEC errors • Blinking Green - Correctable FEC errors • Solid Green - No errors • Off - FEC not enabled

Rear Panel

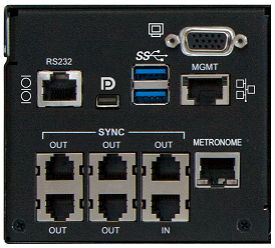
The Rear panel of the AresONE High Performance fixed chassis is shown in the following image (applies to 4-port and 2-port variants):



1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 2 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Utility / Sync / Mgmt ports	Sync connectors

Rear Panel Ports

The Rear Panel MGMT Port LED specifications are provided in the following table:



Rear panel Port Information for AresONE High Performance fixed chassis

Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management

Port Label	Description	Additional Information
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	Reserved for future use

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are provided in the following table.

Position	Indicator	Color	Description
Left	Link Speed	Solid Green	Linked at 10 G
		Solid Yellow	Linked at 1 G
		Off	Linked at 100 M or Link Down
Right	Link/Activity	Solid Green	Link Up, no activity
		Blinking Green	Link Up, actively transmitting or receiving
		Off	Link Down

Power Supply LEDs

The power supply LEDs indicate the following:

State	Description
Off	No AC power
Solid Amber	Power Supply Critical Failure, system shutdown (for example, over temperature, over Current, fan fail)
Blinking Amber	Power Supply Warning (for example, high temperature, high current, slow fan)
Solid Green	AC Powered and Output Active (Normal Operation)

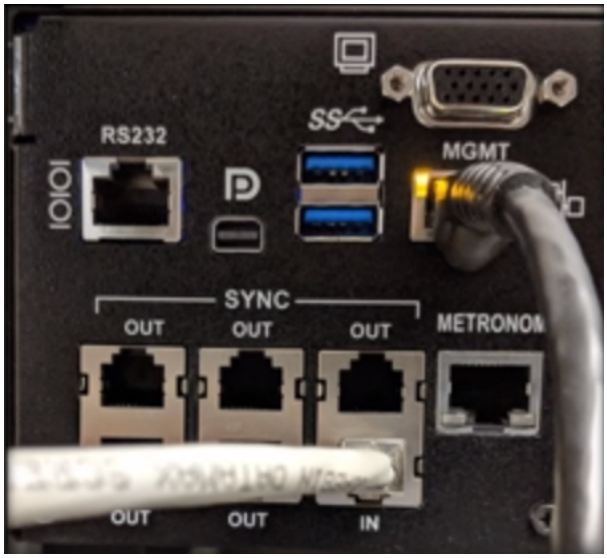
State	Description
Blinking Green	AC Powered and System inactive or in sleep state (Appliance Plugged in but Powered Down)

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE High Performance fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Because AresONE has five sync out ports, an AresONE acting as primary chassis can sync five more AresONE fixed chassis or XGS chassis.

The following image shows the back of a primary chassis where its sync out ports are connected to the secondary chassis by sync cables:

The following image shows a secondary chassis that has sync cables connected to the sync-in port:



NOTE

- AresONE can also act as a secondary chassis to an XGS-HSL or XGS-SDL chassis acting as primary chassis.
- AresONE can only co-exist with Native IxOS chassis in sync topology.
- AresONE supports only Star topology and not Daisy chaining.

Cooling Fan Speed Control

The AresONE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.
2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de

préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.

3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

NOTE For instructions on rack mounting and administration of the AresONE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

CHAPTER 35

IXIA AresONE-S-400GE QSFP-DD High-Density Fixed Chassis

This chapter provides details about AresONE-S-400GE fixed chassis, its specifications and features.

AresONE-S doubles the density of AresONE in the same 2RU fixed chassis form factor. It provides 6.4Tbps traffic generation capability, stackable to build higher throughput test beds and hence a test platform that can grow with your needs.
AresONE-S front panel ports support native 400G Ethernet. It enables testing 4 speeds in the same platform with each port capable of the following speeds:
PAM4 speeds: 1x400GE, 2x200GE, 4x100GE, 8x50GE

NRZ Speeds: 2x100, 4x50GE, 2x40GE, 8x25GE, 8x10GE

AresONE-S-400GE test system is a fixed chassis. The field replaceability of parts and capability to sync to other chassis differentiates it from an appliance. See Chassis Synchronization.
This fixed chassis is available in the following models:

- Full performance and scale
- Reduced performance and scale
- Upgrades from 8-port to 16-port for all 16-port models and from reduced to full performance for all models
- Upgrades from 4-port to 8-port for all 8-port models and from reduced to full performance for all models
- 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speed test capabilities provided by field and factory upgrade
- 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speed test capabilities provided by field and factory upgrade

Key Features

The key features of AresONE-S-400GE fixed chassis are as follows:

- Provides line-rate 400 Gbps packet generation, capture, and analysis of received traffic to detect and debug data transmission errors for multiple speeds
- Provides the following multi-rate 4-speed options:
  - PAM4 Speeds: 2x200, 4x100, 8x50GE (optional)
  - NRZ speeds: 2x100, 4x50, 2x40, 8x25, 8x10GE (optional)
  - 1x400GE PAM4 is the default, per port speed on the hardware chassis

- Supports IxNetwork protocol bundles that provide easy and flexible pricing designed for fixed chassis systems
- Supports IxSuiteStore, the industry's first fully automated IEEE 802.3bs-based test suite that enables automated validation of 400GE implementations, includes testing of physical coding sublayer (PCS) lanes, bit error rate (BER), KP4 FEC bit-error distribution with error insertion and link stability
- Supports field upgradability from reduced to full performance, incremental port density and add-on speed options
- Provides bundles for easy ordering
- Supports line-rate, at all speeds with per-port and per-flow statistics
- Provides high-latency measurement resolution at 0.625 ns at the 400GE speed and 1.25 ns at 200GE
- Supports RS-544 (KP4) Forward Error Correction (FEC) support for all PAM4 speeds (400/200/100/50GE)
- Supports RS-FEC and FC-FEC as applicable per industry standards for the NRZ speeds
- Provides auto-negotiation and link training support
- Supports 400GE and 2x200GE FEC symbol error injection and FEC symbol error density distribution; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis are provided to name a few
- Provides Keysight instrumentation including floating timestamp, sequence number, flow identification, and data integrity
- Supports 400GE PCS lanes Transmit, error injection testing and receive measurement:
    - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion
- Provides layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBS patterns and inject bit errors per lane under user control
- Supports +/- 100 PPM line frequency adjustment
- Provides inject packet errors: CRCs, runts, giants, alignments, checksum errors, and out of sequence
- Supports mid-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases using Keysight's IxNetwork protocol emulation application
- Supports RFC benchmarking of networking devices and equipment using industry-standard RFC benchmark tests at line-rate 400/200/100/50GE speeds
- Supported with Native IxOS software
- Application support: Provides backward compatibility with existing chassis and software with IxExplorer and IxNetwork
- Supports IxExplorer, IxNetwork, and related Tcl and automation APIs

AresONE-S-400GE Variants

AresONE-S-400GE fixed chassis comprises the following full- and reduced-performance variants:

16-port fixed chassis

- S400GD-16H-16P-QDD+FAN
- S400GDR-16H-16P-QDD+FAN

8-ports enabled on the 16-port chassis

- S400GD-16H-8P-QDD+FAN
- S400GDR-16H-8P-QDD+FAN

8-port fixed chassis

- S400GD-8H-8P-QDD+FAN
- S400GDR-8H-8P-QDD+FAN

4-ports enabled on the 8-port chassis

- S400GD-8H-4P-QDD+FAN
- S400GDR-8H-4P-QDD+FAN

Field Upgrade

AresONE-S offers flexibility for upgrade based on need. In addition to being field upgradable from reduced to full performance, you can also field-upgrade from the following options:

- An 8-port option to 16 ports and add on PAM4 and NRZ speeds.
- A 4-port option to 8 ports and add on PAM4 and NRZ speeds.

S400GD-16H-16P-QDD+FAN

S400GD-16P-QDD is a 16- port, high density, full performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support.

S400GDR-16H-16P-QDD+FAN

S400GDR-16P-QDD is a 16-port, high density, reduced performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support.

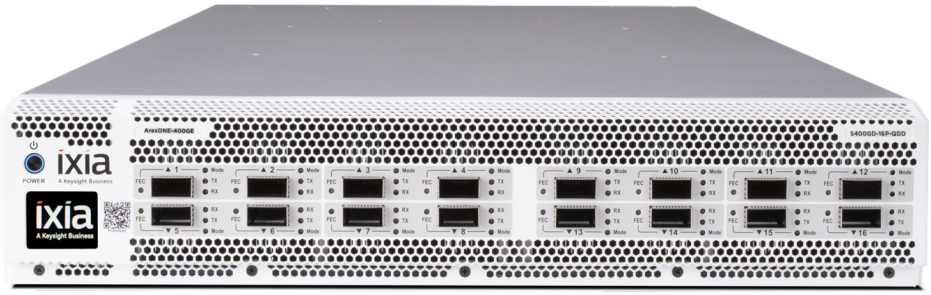
S400GD-16H-8P-QDD+FAN

S400GD-8H-4P-QDD is an 8-port, high density, full performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support. In this model 8 ports are enabled on the 16-port chassis.

S400GDR-16H-8P-QDD+FAN

S400GD-8PHW-4P-QDD is an 8-port, high density, reduced performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support. In this model 8 ports are enabled on the 16-port chassis.

The 16-port and 8-port full performance and reduced performance QDD models are similar and shown in the following figure:



S400GD-8H-8P-QDD+FAN

S400GD-8H-8P-QDD is an 8- port, high density, full performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support.

S400GDR-8H-8P-QDD+FAN

S400GDR-8H-8P-QDD is an 8-port, high density, reduced performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support.

S400GD-8H-4P-QDD+FAN

S400GD-8H-4P-QDD is a 4-port, high density, full performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support. In this model 4 ports are enabled on the 8-port chassis.

S400GDR-8H-4P-QDD+FAN

S400GD-8H-4P-QDD is a 4-port, high density, reduced performance model with native QSFP-DD 400GE (PAM4) physical interfaces and layer 1-3 support. In this model 4 ports are enabled on the 8-port chassis.

The 8-port and 4-port full performance and reduced performance QDD models are similar and shown in the following figure:

NOTE Fully Qualified Port Name (FQPN) format is supported for AresONE-S load module. This format uniquely identifies the port. It is the concatenation of path and port ID. The FQPN port number indicates the front panel port ID and the fan-out ID. For example, port 1.1 indicates front panel port 1 and fan out 1.

Part Numbers

Part Numbers for AresONE-S-400GE 16-port fixed chassis are provided in the following table.

Model Number	Part Number	Description
S400GD-16H-16P-QDD+FAN	944-1186	• High Density, 16-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces • Full performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port
S400GDR-16H-16P-QDD+FAN	944-1187	• High Density, 16-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port
S400GD-16H-8P-QDD+FAN	944-1300	• High Density, 8-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces • Full performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port
S400GDR-16H-8P-QDD+FAN	944-1301	• High Density, 8-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port

Model Number	Part Number	Description
S400GD-8H-8P-QDD+FAN	944-1302	• High Density, 8-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces. • Full performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port
S400GDR-8H-8P-QDD+FAN	944-1303	• High Density, 8-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces. • Reduced performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port
S400GD-8H-4P-QDD+FAN	944-1304	• High Density, 4-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces. • Full performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port
S400GDR-8H-4P-QDD+FAN	944-1305	• High Density, 4-port, fixed chassis model with native QSFP-DD 400GE (PAM4) physical interfaces. • Reduced performance • Supports layer 1-3 • 2x200GE, 4x100GE, 8x50GE (PAM4) fan-out speeds per port • 2x100GE, 2x40GE, 4x50GE, 8x25GE, 8x10GE (NRZ) fan-out speeds per port

Specifications

The hardware specifications for the AresONE-S-400G fixed chassis is contained in the following table.

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
Part Number	944-1186/ 944-1300/ 944-1302/ 944-1304	944-1187/ 944-1301/ 944-1303/ 944-1305
Hardware Fixed Chassis System Specifications		
RU/ Number of Ports	2 RU 16-port fixed chassis system / 8-ports enabled on 16-port chassis and 2 RU 8-port fixed chassis system / 4-ports enabled on 8-port chassis	
Physical Interfaces	Native QSFP-DD physical port	
Supported Port Speeds	Default 1x400GE/port (PAM4): 400GE-capable fiber and passive copper cable media	
	Optional fan-out speeds available with the purchase of a factory or a field upgrade speed option or bundle options: • PAM4: 2x200, 4x100, 8x50GE • NRZ: 2x100, 4x50, 2x40, 8x25GE, 8x10GE	
CPU and Memory	Multicore processor with 2GB of CPU memory per port	
Number of users	16-port enabled chassis supports 8 simultaneous users 8-port enabled, 16-port hardware chassis supports 4 simultaneous users	
IEEE Interface Protocols for 400GE	IEEE P802.3bs 200GE and 400GE, 400GBASE- IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet	
IEEE Interface Protocols for 100GE and lower NRZ speeds	• IEEE 802.3 100GBASE-R LAN • IEEE P802.3bj • IEEE P802.3bm • IEEE P802.3by • IEEE 802.3ba • IEEE 802.3ae • 25G/50G Consortium specification v1.6	
Layer 1 support	PAM4, 400GE native ports and 200/100/50GE speed option: • KP4 (RS-544,514) Ethernet Forward Error Correction, Clause 119	

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
	• Auto-negotiation (AN) and link training (LT) support • Speeds modes: 1x400GE, 2x200GE, 4x100GE, and 8x50GE NOTE The previous 8x50GE Half-port density mode is no longer supported from the 9.18 release and higher. In the 9.18 SW this feature is removed as the Full-port density mode with AN and LT is enabled and is the recommended mode to use. Half-port density mode: • Speed modes: 4x100GE Half Density High Stream, 8x50GE Half Density High Stream • Ports 1, 3, 6, 8 and 9, 11, 14, 16 are active for the 4x100GE Half Density and 8x50GE Half Density modes in PAM4 with AN and LT enabled on each port • Only needed for copper DAC support—Copper DACs require AN and LT to be enabled • Up to 8 users will have one port each of 4x100GE Half Density and 8x50GE Half Density from each port resource group on the 16-port hardware chassis Full-port density mode: • All ports in all port resource groups are in the 8x50GE PAM4 fan-out speed • AN and LT are disabled on all active ports in all resource groups • Up to 8 users will have two ports each of 8x50GE per port in each port resource group on the 16-port hardware chassis • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400GE and 200GE speeds only) • FEC Codeword error distribution statistics support for all PAM4 speeds except for the Full port density mode of the 8x50GE fan-out speed • PCS lanes Tx and Rx test and statistics • Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support NRZ, 100/50/40/25/10GE speed option: • 2x100GE, 4x50GE, 2x40GE, 8x25GE, and 8x10GE speed support • RS(528,514) Clause 91, BASE-R FEC Cause 74 Forward Correction, Clause 91 for applicable speeds • Auto-negotiation and link training support for all 100/50/25GE speeds • Correctable and uncorrectable FEC statistics per-port for applicable	

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
	speeds • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability • Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS15, PRBS-20, PRBS-23, and PRBS-31 pattern support NRZ Half-port density mode: • Speed modes: 8x25GE Half Density and 8x10GE Half Density • Ports 1, 3, 6, 8 and 9, 11, 14, 16 are active for the 8x25GE Half Density and 8x10GE Half Density modes in NRZ with AN and LT enabled on each port • Up to 8 users will have one port each of 8x25GE Half Density and 8x10GE Half Density from each port resource group on the 16-port hardware chassis	
QSFP-DD Optical Transceiver Support	Support for all QSFP-DD MSA compliant optical transceivers up to Power Class 7 with 14 watts of power consumption such as: 400GBASE-DR4, 400GBASE-FR4, 400GBASE-LR8, and 400GBASE-SR8 other optical transceiver types (e.g. QSFP56), and AOCs.	
QSFP-DD Passive Copper Cable Media	400GBASE-CR8, passive, copper Direct Attached Cable (DAC) up to 3 meters in length. Both point-to-point and fan-out cables are supported.	
Fixed Chassis System Dimensions	• 30.3” (L) x 17.3” (W) x 3.46” (H) • 770 mm (L) x 438.2 mm (W) x 88 mm (H)	
Fixed Chassis System Weights	• Hardware only: 65 lbs. (29.5 kg) • Shipping: 99.2 lbs. (45 kg)	
Fixed Chassis System Electrical Power	• Operates on 100-240VAC, 50/60Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120 VAC, 9A for each power supply. • AresONE-S fixed chassis is shipped with (3) 100-125 VAC power cords. • AresONE-S can use (2) power sources when running 200-240VAC, 7A for each power supply. NOTE The power specifications are preliminary and for initial planning purpose.	

<table>
<tr><th>Feature</th><th>S400GD-16H-16P-QDD+FAN/
S400GD-16H-8P-QDD+FAN/
S400GD-8H-8P-QDD+FAN/
S400GD-8H-4P-QDD+FAN</th><th>S400GDR-16H-16P-QDD+FAN/
S400GDR-16H-8P-QDD+FAN/
S400GDR-8H-8P-QDD+FAN/
S400GDR-8H-4P-QDD+FAN</th></tr>
<tr><td>Temperature</td><td colspan="2">Operating: 41°F to 95°F (5°C to 35°C)
Storage: 41°F to 122°F (5°C to 50°C)</td></tr>
<tr><td>Humidity</td><td colspan="2">Operating: 0% to 85%, non-condensing
Storage: 0% to 85%, non-condensing</td></tr>
<tr><td>Regulatory Compliance Specifications</td><td colspan="2">IEC 60950-1, UL 60950-1, CSA C22.2 No.60950-1, CE (LVD, EMC, RoHS), EN/IEC 55032, EN/IEC 55024, CFR 47, FCC Part 15B, ICES-003, AS/NZ CISPR 32/24, KN32/35</td></tr>
<tr><td colspan="3">Chassis Synchronization Extendibility</td></tr>
<tr><td>Maximum Number of Chassis in Single Test Topology</td><td colspan="2">Each chassis has built-in star topology synchronization ports to connect to 5 additional compatible chassis systems</td></tr>
<tr><td colspan="3">Transmit Feature Specifications</td></tr>
<tr><td>Transmit Engine</td><td colspan="2">Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures</td></tr>
<tr><td>Max. Streams per Port and Speed (Including in Data Center Ethernet)</td><td colspan="2">
<table>
<tr><td></td><td colspan="2">Full Cards:
S400GD-16H-16P-QDD+FAN
S400GD-16H-8P-QDD+FAN
S400GD-8H-8P-QDD+FAN
S400GD-8H-4P-QDD+FAN</td><td colspan="2">Reduced Cards:
S400GDR-16H-16P-QDD+FAN
S400GDR-16H-8P-QDD+FAN
S400GDR-8H-8P-QDD+FAN
S400GDR-8H-4P-QDD+FAN</td></tr>
<tr><td>Speed Mode</td><td>Ports/RG</td><td>Stream Count</td><td>Ports/RG</td><td>Stream Count</td></tr>
<tr><td>400G PAM4</td><td>2</td><td>256</td><td>2</td><td>128</td></tr>
<tr><td>200G PAM4</td><td>4</td><td>256</td><td>4</td><td>128</td></tr>
<tr><td>100G PAM4 Half Density High Stream</td><td>4</td><td>128</td><td>4</td><td>64</td></tr>
<tr><td>100G PAM4</td><td>8</td><td>32</td><td>8</td><td>16</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Feature</th><th colspan="3">S400GD-16H-16P-QDD+FAN/
S400GD-16H-8P-QDD+FAN/
S400GD-8H-8P-QDD+FAN/
S400GD-8H-4P-QDD+FAN</th><th colspan="2">S400GDR-16H-16P-QDD+FAN/
S400GDR-16H-8P-QDD+FAN/
S400GDR-8H-8P-QDD+FAN/
S400GDR-8H-4P-QDD+FAN</th></tr>
<tr><td></td><td colspan="5"><table>
<tr><td>100G NRZ</td><td>4</td><td>128</td><td>4</td><td>64</td></tr>
<tr><td>40G NRZ</td><td>4</td><td>128</td><td>4</td><td>64</td></tr>
<tr><td>50G PAM4 Half Density High Stream</td><td>8</td><td>64</td><td>8</td><td>32</td></tr>
<tr><td>50G PAM4</td><td>16</td><td>16</td><td>16</td><td>16</td></tr>
<tr><td>50G NRZ</td><td>8</td><td>64</td><td>8</td><td>32</td></tr>
<tr><td>25G NRZ Half Density High Stream</td><td>8</td><td>64</td><td>8</td><td>32</td></tr>
<tr><td>25G NRZ</td><td>16</td><td>16</td><td>16</td><td>16</td></tr>
<tr><td>10G NRZ Half Density High Stream</td><td>8</td><td>64</td><td>8</td><td>32</td></tr>
<tr><td>10G NRZ</td><td>16</td><td>16</td><td>16</td><td>16</td></tr>
</table></td></tr>
<tr><td>Stream Controls</td><td colspan="5">• Rate and frame size change on the fly
• Advanced stream scheduler support
• Optional sequential stream scheduler support</td></tr>
<tr><td>Minimum Frame Size</td><td colspan="5">400GE and 200GE
• 64 bytes at full line rate
• 60 bytes at less than full line rate
100GE and below
• 64 bytes</td></tr>
<tr><td>Maximum Frame Size</td><td colspan="5">400GE and 200GE: 16,000 bytes
100GE and below: 14,000 bytes</td></tr>
<tr><td>Maximum Fame Size in Data Center Ethernet</td><td colspan="5">9,216 bytes</td></tr>
<tr><td>Priority Flow Control</td><td colspan="5">4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths</td></tr>
</table>

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K in 400/200/100GE and 8K in 50GE and below), uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (Max.) per port	• 400GE: 64K /port /UDF • 200GE: 32K /port /UDF • 100GE: 64K /4 ports /UDF • 50GE: 32K /4 ports /UDF • 40GE: 64K /4 ports /UDF • 25GE: 16K /4 ports /UDF • 10GE: 16K /4 ports /UDF	
Sequence (Max.)	• 400GE: 32K • 200GE: 32K • 100GE: 8K • 50GE: 4K • 40GE: 4K • 25GE: 4K • 10GE: 4K	
Error Generation (FEC and standard layer 2-3 Ethernet)	400GE FEC and 2x200GE FEC • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 400/200GE • No FEC error insertion and related statistics for 4x100GE and 8x50GE 400GE, 2x200GE, 4x100GE, 8x50GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical Coding Sublayer	• PCS lane marker error injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
Hardware Checksum	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane	

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
Generation	traffic	
Link Fault Signaling	• Reports, no fault, remote fault, and local fault port statistics • Generate local and remote faults with controls for the number of faults and order of faults • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway	
Latency Measurement Resolution	• 400GE: 0.625 ns • 200GE: 1.25 ns • 100GE: 2.5 ns • 50GE: 2.5 ns • 40GE: 2.5 ns • 25GE: 2.5 ns • 10GE: 2.5 ns	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 100 ppm on all the ports of a 400GE fixed chassis system	
Transmit/Receive Loopback	Internal loopback support	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable Receive Flows per Port without Sequence Checking and with Tx/Rx Synch	• 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics • 50GE: 4K full statistics and 16K with minimum statistic • 40GE: 4K full statistics and 16K with minimum statistic • 25GE: 2K full statistics and 8K with minimum statistic • 10GE: 2K full statistics and 8K with minimum statistic	
Trackable Receive Flows per Port with	• 400GE: 32K full statistics • 200GE: 32K full statistics	

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
and without Sequence checking and no Tx/RX synch	• 100GE: 8K full statistics and 32K with minimum statistics • 50GE: 8K full statistics and 16K with minimum statistic • 40GE: 8K full statistics and 16K with minimum statistic • 25GE: 4K full statistics and 8K with minimum statistic • 10GE: 4K full statistics and 8K with minimum statistic	
Minimum Frame Size	64Bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	1 MB per front panel port Fan-out modes: 1MB per resource group in fan-out	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
FEC Statistics	PAM4 400GE, 2x200GE, 4x100GE and Full-port density 8x50GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate NRZ speeds: 2x100, 4x50, and 8x25GE2 • 100GE FEC statistics • Ethernet Forward Error Correction RS-FEC, Clause 91 • FEC statistics: ◦ RS-FEC Corrected and uncorrectable codewords • 50GE FEC statistics • FC-FEC, Clause 74 for BASE-R PHYs • RS-FEC, 50GE FEC statistics: ◦ RS-FEC Corrected and Uncorrected Codeword Count ◦ FC-FEC Corrected and Uncorrected Block Count ◦ FC-FEC Corrected Error Bits	

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
	• 25GE FEC statistics • FC-FEC, Clause 74 for BASE-R PHYs • RS-FEC, Clause 108 for 25GBASE-R PHYs • FEC statistics: ◦ RS-FEC corrected and uncorrected codeword count ◦ FC-FEC corrected and uncorrected block count ◦ FC-FEC corrected error bits NOTE This is a minimum specification; consult factory for more information.	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
400GE Physical Coding Sublayer (PCS) ReceiveSide Statistics and Indicators	Per-lane PCS receive capabilities include: • Receive – per-lane PCS receive statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive – per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	
Layer 2-3 Protocol Support		
Basic	IxNetwork Base, RFC2544/2889/3918 QuickTest	
Routing and Switching	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, EIGRP, BFD, IGMP/MLD/PIM-SM/SSM, LACP/Protocol over LACP, STP/RSTP/MSTP/PVST, GRE and Protocol over GRE, CFM/Y.1731, Link-OAM, PBB-TE, ELMI, 1588v2/SyncE ESMC, Y.1564QT, TWAMP, NTP, LISP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Software Defined Network	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN,	Complete protocol coverage with reduced session scale:

Feature	S400GD-16H-16P-QDD+FAN/ S400GD-16H-8P-QDD+FAN/ S400GD-8H-8P-QDD+FAN/ S400GD-8H-4P-QDD+FAN	S400GDR-16H-16P-QDD+FAN/ S400GDR-16H-8P-QDD+FAN/ S400GDR-8H-8P-QDD+FAN/ S400GDR-8H-4P-QDD+FAN
	VXLAN, GENEVE, Segment Routing, BGP-LS, PCEP, BGP SR-TE Policy, BGP FlowSpec, OVSDB, Netconf, BIER, OpenFlow; GRE and Protocol over GRE, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	• 100 routing and switching sessions • 2,000 host/access sessions
MPLS and VPN	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD, RSVP-TE/P2MP, LDP/mLDP/LDPv6, L3VPN/6VPE, NGmVPN, PIM-SM/SSM/mVPN, MPLS-TP, MPLS OAM, GRE and Protocol over GRE, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Broadband Access and Authentication	PPPoX/L2TP, DHCPv4/v6, ANCP, IGMP/MLD/IPTV, 802.1x, GRE/Protocol over GRE, LACP/Protocol over LACP, Session Aware Traffic, Service over MPLS, Broadband Control Plane QT, Asymmetric Data Performance QT; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions
Data Center Ethernet	BGP4/BGP4+, OSPFv2/v3, ISISv4/v6, RIP/RIPng, BFD; EVPN, VXLAN, GENEVE, OVSDB, DCBX, FCoE, Fabric Path, SPBM, VEPA, TRILL, FCoE QT, IxCloudPerf QT, RFC7747 BGP Convergence QT, LACP/Protocol over LACP; REQUIRES: 930-2201 IxNetwork Basic package for AresONE.	Complete protocol coverage with reduced session scale: • 100 routing and switching sessions • 2,000 host/access sessions

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE-S fixed chassis is provided in the following table:

QSFP-DD-400GE / QSFP-DD-R400GE
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics. and reporting capability
IxNetwork: Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxSuiteStore: Test suite for functional validation of PCS lanes BER, KP4 FEC bit-error distribution with error insertion and link stability based on IEEE 802.3bs specification (at 400GE speed only)
Tcl API: Custom user script development for Layer 1-3 testing

Transceiver and Cable Support

The transceivers and cables supported by AresONE-S fixed chassis are provided in the following table:

Transceiver/Cable	Description	Compatibility
Passive Copper Point-to-Point Cables		
QSFP-DD-1M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 1-meter length (942-0106).	This copper DAC is compatible with all AresONE-S variants.
QSFP-DD-2M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2-meter length (942-0109).	This copper DAC is compatible with all AresONE-S variants. .
QSFP-DD-2-5M-CBL	QSFP-DD-to-QSFP-DD 400GE 400GBASE-R passive copper, Direct Attach Cable (DAC), point-to-point cable, 2.5-meter length (942-0108).	This copper DAC is compatible with all AresONE-S variants.
Passive Copper Fan-Out Cables		
QSFPDD4XQ56-1-5M-CBL	QSFP-DD-to-4xQSFP-DD 400GBASE-R Direct Attached Copper cable (DAC), for 400GE to 4x100GE PAM4 fan-	This Direct Attached Copper (DAC) cable is compatible with all all AresONE-S variants. Note: This fanout cable supports PAM4

Transceiver/Cable	Description	Compatibility
	out, 1.5 meter length (942-0140).	signaling only.
QSFPDD2XQ56-2-5M-CBL	QSFP-DD-to-2xQSFP-DD 400GBASE-R Direct Attached Copper cable (DAC), for 400GE to 2x200GE PAM4 fan-out, 2.5 meter length (942-0141).	This Direct Attached Copper (DAC) cable is compatible with all AresONE-S variants. Note: This fanout cable supports PAM4 signaling only.
Optical Transceivers		
QSFP-DD-DR4-XCVR	QSFP-DD 400GE 400GBASE-DR4 pluggable optical transceiver, SMF (singlemode), 1310 nm, 500 m reach (948-0050).	This optical transceiver is compatible with all AresONE-S variants.
QSFP-DD-FR4-XCVR	QSFP-DD 400GE 400GBASE-FR4 pluggable optical transceiver, SMF (singlemode), 1310 nm, 2 km reach (948-0052).	This optical transceiver is compatible with all AresONE-S variants.
QSFP-DD-LR4-XCVR	QSFP-DD 400GE 400GBASE-LR4 pluggable optical transceiver, SMF (singlemode), 1310 nm, 10 km reach (948-0054).	This optical transceiver is compatible with all AresONE-S variants.
QSFP-DD-SR8-XCVR	QSFP-DD 400GE 400GBASE-SR8 pluggable optical transceiver, MMF (multimode), 850 nm, 100 m reach (948-0051).	This optical transceiver is compatible with all AresONE-S variants.
QSFP-DD-LR8-XCVR	QSFP-DD 400GE 400GBASE-LR8 pluggable optical transceiver, SMF (singlemode), 1310 nm, 10 km reach (948-0053).	This optical transceiver is compatible with all AresONE-S variants.
Optical Transceiver Point-to-Point Cables		
QSFP-DD-MPO16-CBL	MT-to-MT, MPO16, OM4, MMF, 3-meter cable for 400GE QSFP-DDSR8-XCVR (942-0124). REQUIRES QSFP-DD-SR8-XCVR pluggable optical	This cable and transceiver are compatible with all AresONE-S variants.

Transceiver/Cable	Description	Compatibility
	transceiver, 850 nm, MMF (Multimode Fiber), 100 m reach (948- 0051).	
Optical Transceiver Fan-Out Cables		
QSFP-DD-DR4-CBL	MT-to-4x100GE LC fan-out, SMF, 3-meter cable for 100GE fan-out (942-0138). REQUIRES QSFP-DD-DR4-XCVR pluggable optical transceiver, 1310 nm, SMF (Single Mode Fiber), 500 m reach (948-0050).	This cable and transceiver are compatible with all AresONE-S variants.
QSFP-DD-SR8-CBL	MT-to-8x50GE LC fan-out, MMF, MPO16, 3-meter cable for 400GE 8x50GE fan-out (942-0125). REQUIRES QSFP-DD-SR8-XCVR pluggable optical transceiver, 850 nm, MMF (Multimode Fiber), 100 m reach (948-0051).	This cable and transceiver are compatible with all AresONE-S variants.

Status Icons

AresONE-S includes a full-color graphics display which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

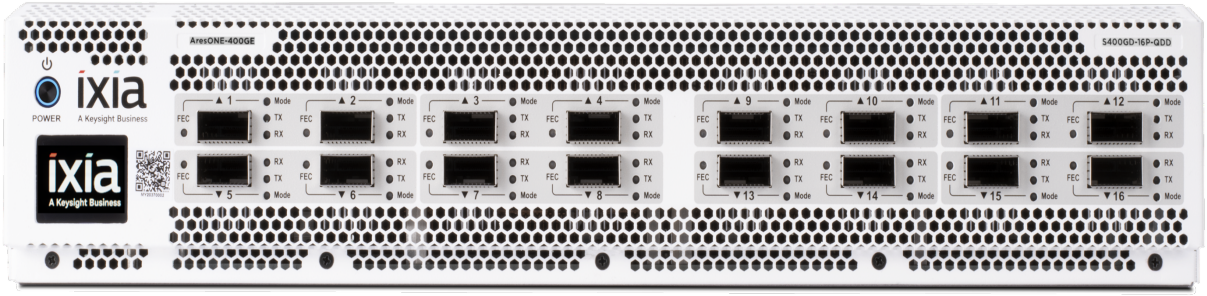
Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A

Icon Name	Icon Image	Icon State	Description
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

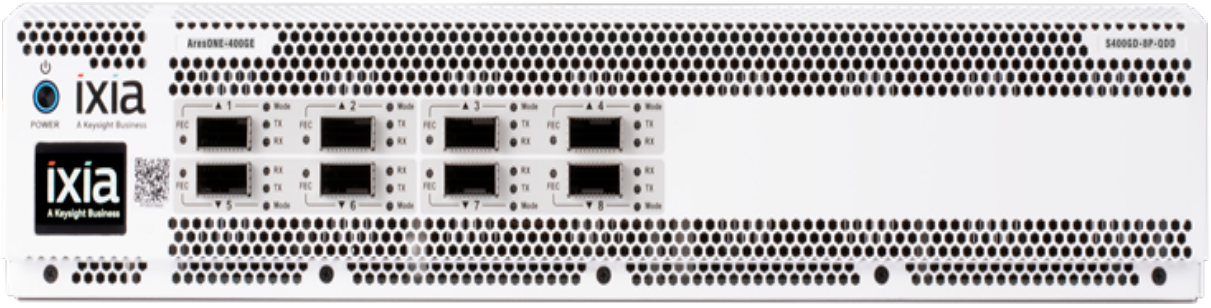
Mechanical Specifications

Front Panel

The front panel of the AresONE-S 400GE 16-port fixed chassis is shown in the following figure (applies to 16-port and 8-port variants):



The front panel of the AresONE-S 8-port fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):



Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

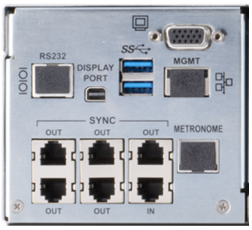
MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4 • Solid Red – Card fault • Solid Yellow – NRZ • Off – No power to the card or port	• Solid Red – All links down • Solid Green – All inks up • Solid Yellow – Some links up • Blinking (Red, Green or Yellow)– TX is active	Application Mode: • Blinking Red – RX active with errors • Blinking Green – RX active with no errors received • Off – Port is inactive BERT Mode: • Blinking Green – PRBS locked all lanes • Blinking Yellow – PRBS locked on some lanes • Blinking Red – PRBS not locked on any lane • Off – Port is inactive	• Blinking Red – Uncorrectable FEC errors • Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

Rear Panel

The Rear panel of the AresONE-S 400GE fixed chassis is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12,

Port Label	Description	Additional Information
		XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE-S fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE-S has five sync out ports, an AresONE-S acting as primary chassis can sync five more AresONE-S fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE-S fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.

4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d'équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l'installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l'équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l'appareil.
2. Circulation d'air réduite: installer l'équipement dans une baie de manière a ce que la circulation d'air requise pour faire fonctionner l'équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l'appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

NOTE For instructions on rack mounting and administration of the AresONE-S fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

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CHAPTER 36

IXIA AresONE 800GE QSFP-DD Fixed Chassis

This chapter provides details about AresONE 800GE fixed chassis, its specifications and features.

AresONE 800GE 4-port model matches the port density and 3.2 Tbps traffic generation capability of AresONE 400 platforms. and is also stackable to build higher-throughput and port-count testbeds. This provides a future-proof test platform that can grow with the user needs.

AresONE 800GE enables testing multiple Ethernet speeds in the same platform with each port capable of the following speeds:

- Bulti-in PAM4 signaling-based speeds: 2x400GE, 4x200GE, 8x100GE, and 1x800GE

AresONE 800G offers flexibility for upgrades based on need. Users can field-upgrade from the 2-port configuration to the 4-port configuration at any time.

Key Features

The key features of AresONE 800GE QSFP-DD fixed chassis are as follows:

- Provides line-rate 800 Gbps packet generation per QSFP-DD front panel port , for analysis and capture of received traffic to detect and debug data transmission errors for multiple speeds by using PAM4 signaling and 112 Gb/s electrical lane speeds
- Provides the following multi-rate 4-speed options:
  - PAM4 Speeds: 2x400, 4x200, 8x100GE, 1x800GE
- Provides line-rate, at all speeds with per-port and per-flow statistics
- Supports Keysight instrumentation, including floating timestamp, sequence number, flow identification, and data integrity (that is, for the entire packet)
- Supports high-latency measurement resolution at 0.3125 ns at the 800GE speed and 0.625 ns at 400GE
- Supports IxNetwork protocol bundles that provide easy and flexible pricing designed for fixed chassis systemst
- Provides RS-544 (KP4) Forward Error Correction (FEC) support for all PAM4 speeds, 800/400/200 and 100GE over 112 Gb/s electrical lanes
- Supports 2x400GE and 4x200GE FEC symbol error injection and FEC symbol error density distribution analysis; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis is provided
- Supports 2x400GE,4x200GE, and 8x100GE PCS lanes Transmit, error injection testing and receive measurement

    - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion; see details in Specification Table in this datasheet, as capabilities may vary per Ethernet speed
- Supports +/- 50 PPM line frequency adjustment per IEEE 802.3ck
- Provides inject packet errors: CRCs, runts, giants, alignments, checksum errors, and out of sequence
- Provides IxNetwork, Native IxOS, and IxExplorerapplication support with related Tcl automation
- Provides Layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBSQ patterns PRBS-13Q and PRBS-31Q

AresONE 800GE Variants

AresONE 800GE QSFP-DD fixed chassis is available in 4-port and 2-port with full- and reduced-performance model selections:.
4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-4P-QDD, High Density, 4-port, full performance fixed chassis model with native QSFP-DD800 physical interfaces and L1-3 support. Chassis includes the 2x400GE, 4x200GE, 8x100GE, and 1x800GE speed support.
- AresONE 800GER-4P-QDD, High Density, 4-port, reduced performance fixed chassis model with native QSFP-DD800 physical interfaces and L1-3 support. Chassis includes the 2x400GE, 4x200GE, 8x100GE, and 1x800GE speed support.

2-ports enabled on the 4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-2P-QDD, High Density, 2-port, full performance fixed chassis model with native QSFP-DD800 physical interfaces and L1-3 support. Chassis includes the 2x400GE, 4x200GE, 8x100GE, and 1x800GE speed support.
- AresONE 800GER-2P-QDD, High Density, 2-port, reduced performance fixed chassis model with native QSFP-DD800 physical interfaces and L1-3 support. Chassis includes the 2x400GE, 4x200GE, 8x100GE, and 1x800GE speed support.

800GE-4P-QDD

800GE-4P-QDD is a 4- port, high density, full performance model with native QSFP-DD800 physical interfaces and layer 1-3 support.

800GER-4P-QDD

800GER-4P-QDD is a 4-port, high density, reduced performance model with native QSFP-DD800 physical interfaces and layer 1-3 support.

800GE-2P-QDD

800GE-2P-QDD is a 2-port, high density, full performance model with native QSFP-DD800 physical interfaces and layer 1-3 support. In this model 2 ports are enabled on the 4-port chassis.

800GER-2P-QDD

800GER-2P-QDD is an 2-port, high density, reduced performance model with native QSFP-DD800 physical interfaces and layer 1-3 support. In this model 2 ports are enabled on the 4-port chassis.

The 4-port and 2-port full performance and reduced performance QDD models are similar and shown in the following figure:

Part Numbers

Part Numbers for AresONE 800GE QSFP-DD fixed chassis are provided in the following table.

Model Number	Part Number	Description
800GE-4P-QDD	944-1192	• 4-port, fixed chassis model with native QSFP-DD800 physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE, and 1x800GE per port (PAM4)
800GER-4P-QDD	944-1193	• 4-port, fixed chassis model with native QSFP-DD800 physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE, and 1x800GE per port (PAM4)
800GE-2P-QDD	944-1190	• 2-port, fixed chassis model with native QSFP-DD800 physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE, and 1x800GE per port (PAM4)
800GER-2P-QDD	944-1191	• 2-port, fixed chassis model with native QSFP-DD800 physical interfaces • Reduced performance

Model Number	Part Number	Description
		• Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE, and 1x800GE per port (PAM4)

Specifications

The hardware specifications for the AresONE 800GE QSFP-DD fixed chassis are contained in the following table.

Feature	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port / 4-Port
Part Number	944-1190 / 944-1192	944-1191 / 944-1193
Hardware Fixed Chassis System Specifications		
RU/ Number of Ports	2 RU 2-ports enabled on 4-port hardware chassis or all 4-ports enabled	
Physical Interfaces	Native QSFP-DD800 physical front panel pluggable ports	
Supported Port Speeds	Default speeds 2x400GE, 4x200GE, 8x100GE, and 1x800GE per port (PAM4): • Optical transceiver and fiber cable interconnect support	
CPU and Memory	Multicore processor with 4 GB of CPU memory per QSFP-DD front panel port	
Number of users	4-port hardware chassis: Supports up to 4 users, one user per physical front panel port 2-port enabled on 4-port hardware chassis: Supports up to 2 users, one user per physical front panel port	
Interface Protocols Specifications for 800GE/112Gb/s electrical lane support	IEEE 802.3ck Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling Ethernet Technology Consortium v1.1 specification	
Layer 1 support	PAM4 800/400/200/100GE speeds: • KP4 (RS-544,514) Ethernet Forward Error Correction, Clause 119 • FEC Correctable and uncorrectable statistics per-port • FEC symbol error injection (400GE and 200GE speeds only) • FEC Codeword error distribution statistics	

Feature	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port / 4-Port
	• PCS lanes Tx and Rx test and statistics • Layer 1 BERT with PRBS-13Q and PRBS-31Q pattern generation support	
QSFP-DD Optical Transceiver Support	Support for QSFP-DD800 MSA compliant optical transceivers up to Power Class 8 with more than 14 watts of power consumption such as: 800GBASE-DR4, 800GBASE-2xFR4, and other optical transceivers and AOCs. • For transceivers that consume more than 14 watts of power, please consult the factory for additional information before using these optics in the system. • Please consult the factory for specific transceiver support information. • See Transceiver and Cable Support section for current support of optical transceiver for this product.	
QSFP-DD800 Active Electrical Cable (AEC) Support	Active Electrical Cable support; please consult the factory for specific support information.	
Fixed Chassis System Dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)	
Fixed Chassis System Weights	• Hardware only: 58.4 lbs. (26.5 kg) • Shipping: 113 lbs. (51.5 kg) 1 NOTE Approximate (includes rackmount slides, power cords, sync cables, and packaging)	
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120VAC, 9 Amps for each power supply. AresONE fixed chassis is shipped with (3 each) 100-125 VAC power cords. • Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply.	
Temperature (Ambient Air)	• Operating: 41 °F to 95 °F (5 °C to 35 °C) • Storage: 41 °F to 122 °F (5 °C to 50 °C)	
Humidity (Ambient Air)	• Operating: 0 % to 85 %, non-condensing • Storage: 0 % to 85 %, non-condensing	
Regulatory Compliance	IEC 62368-1, UL 62368-1, CSA C22.2 No.62368-1-14, CISPR 32, EN/IEC 55032, EN/IEC 61000, 47 CFR FCC Part 15B, CAN ICES-003(A)/NMB-003	

Feature	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port / 4-Port
Specifications	(A), AS/NZ CISPR 32/24, KN32/35, EN/IEC 63000	
Chassis Synchronization Extendibility		
Maximum Number of Chassis in Single Test Topology	• Each chassis has built-in star topology synchronization ports to connect to five additional compatible chassis systems • The Metronome Timing System (942-0090) is used for synchronizing a total of six or more chassis at one time. Consult factory for port count requirements beyond five chassis in a single configuration	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. Streams per Port and Speed	• 1x800GE: 64 (per FPP) • 2x400GE: 64 (per fan-out) • 4x200GE: 64 (per fan-out) • 8x100GE: 32 (per fan-out)	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler support • Optional sequential stream scheduler support (must be ordered as a factory installed option-no field upgrade is available)	
Minimum Frame Size	800GE, 400GE, 200GE and 100GE: • 64 bytes at full line rate • 60 bytes at less than full line rate	
Maximum Frame Size	800GE, 400GE, 200GE and 100GE: 14,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority Flow Control	4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K in 400/200/100GE and 8K in 50GE and below), uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields	Fixed, increment or decrement by user-defined step, sequence, value list,	

Feature	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port / 4-Port
(UDF)	and random configurations; up to 10, 32-bit-wide UDFs are available	
Value Lists (Max.) per port	• 1x800GE: 64K / port /UDF • 2x400GE: 64K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 64K / 4-ports /UDF	
Sequence (Max.)	• 800GE: 32K / port /UDF • 400GE: 32K /port /UDF • 200GE: 32K /port /UDF • 100GE: 8K /ports /UDF	
Error Generation (FEC and Standard Keysight L2/3 Ethernet in PAM4 Mode Only)	800GE and 2x400GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 800/400GE • No FEC error insertion and related statistics for 8x100GE	
	800GE, 2x400GE, 4x200GE, 8x100GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical Coding Sublayer	• PCS lane marker error injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic.	
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics. Generate local and remote faults with controls for the number of faults and order of faults. Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway.	

Feature	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port / 4-Port
Latency Measurement Resolution	• 800GE: 0.3125 ns • 400GE: 0.625 ns • 200GE: 1.25 ns • 100GE: 2.5 ns	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds.	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 50 ppm on all the ports of the 800GE fixed chassis system.	
Transmit/Receive Loopback	Internal loopback support.	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable Receive Flows per Port without Sequence Checking and with Tx/Rx Synch	• 800GE: 32K full statistics • 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics	
Trackable Receive Flows per Port with and without Sequence checking and no Tx/RX synch	• 800GE: 32K full statistics • 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 8K full statistics and 32K with minimum statistics	
Minimum Frame Size	64Bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	1 MB per front panel QSFP-DD port and for fan-out modes on that port.	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames,	

Feature	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port / 4-Port
	data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies. PAM4 800GE, 2x400GE, 4x200GE, 8x100GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis. • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
400GE Physical Coding Sublayer (PCS) ReceiveSide Statistics and Indicators	Per-lane PCS receive capabilities include: • Receive—per-lane PCS receive statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew,Lane Marker Error Count • Receive—per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE 800GE QSFP-DD fixed chassis is provided in the following table:

AresONE 800GE Full and Reduced Performance
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics and reporting capability.
Tcl API: Custom user script development for Layer 1-3 testing

Transceiver and Cable Support

The transceivers and cables supported by AresONE 800GE QSFP-DD fixed chassis are provided in the following table:

Transceiver/Cable	Description	Compatibility
QSFP-DD 800GE Optical Transceiver		
QSFPDD800-DR8-XCVR	QSFPDD800-DR8-XCVR, 800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0068). CMIS 4.0 compliant. Compatible with cables: QSFPDD800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter.	This transceiver is compatible the G800GE chassis: QSFP-DD (941-0084) and the QSFP-DD-COAX (941-0085), and with all models of AresONE 800GE QSFP-DD fixed chassis: 800GE-2P-QDD (944-1190), 800GER-2P-QDD (944-1191), 800GE-4P-QDD (944-1192), 800GER-4P-QDD (944-1193), 800GE-8P-QDD (944-1194) and 800GER-8P-QDD (944-1195).
Optical transceiver point-to-point cable		
QSFPDD800-DR8-CBL	QSFPDD800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0144) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.	
Optical transceiver fan-out cable		
QSFPDD800-DR8-FO-CBL	QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0125) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.	

Status Icons

AresONE 800GE QSFP-DD includes a full-color graphics display which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

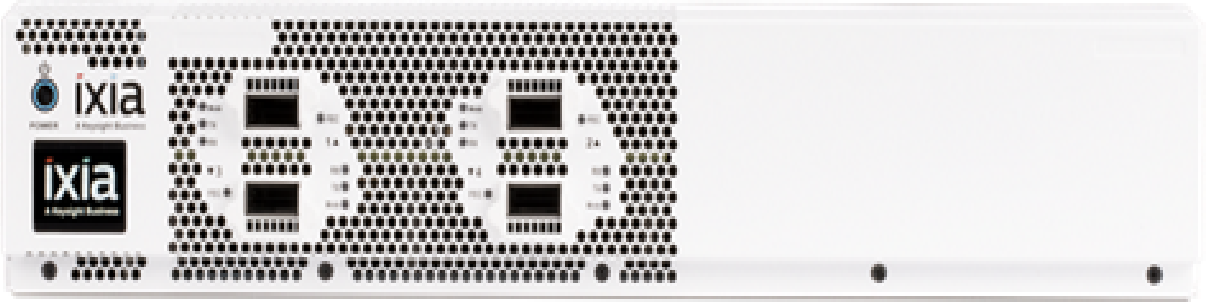
Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error

Icon Name	Icon Image	Icon State	Description
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The front panel of the AresONE 800GE QSFP-DD fixed chassis is shown in the following figure (applies to 4-port and 2-port variants):



Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

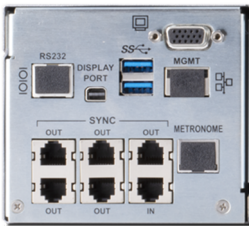
MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4 • Solid Red – Card fault • Off – No power to the card or port	• Solid Red – All links down • Solid Green – All inks up • Solid Yellow – Some links up • Blinking (Red, Green or Yellow)– TX is active	Application Mode: • Blinking Red – RX active with errors • Blinking Green – RX active with no errors received • Off – Port is inactive	• Blinking Red – Uncorrectable FEC errors • Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

Rear Panel

The Rear panel of the AresONE 800GE QSFP-DD fixed chassis is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE 800GE QSFP-DD fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE 800GE has five sync out ports, an AresONE 800GE acting as primary chassis can sync five more AresONE 800GE fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE 800GE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.

2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d’alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l’unité.

NOTE For instructions on rack mounting and administration of the AresONE 800GE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

CHAPTER 37

IXIA AresONE 800GE QDD-C Fixed Chassis

This chapter provides details about AresONE 800GE QDD-C fixed chassis, its specifications and features.

AresONE 800GE QDD-C matches the port density and 3.2 Tbps traffic generation capability of AresONE 400GE platforms. and the 800GE 4-port and 8-port models are also stackable to build higher-throughput and port-count testbeds with up to 6.4Tbps in a single chassis. This provides a future-proof test platform that can grow with the user needs.

AresONE 800GE QDD-C enables testing multiple Ethernet speeds in the same platform with each port capable of the following speeds:

- Bulti-in PAM4 signaling-based speeds: 2x400GE, 4x200GE, and 8x100GE
- 1x800GE speed as a separate purchasable option with the initial order from the factory or later with a field upgrade

AresONE 800G QDD-C offers flexibility for upgrades based on need. Users can field-upgrade from the 2-port configuration to the 4-port configuration, 4-port to the 8-port configuration, and provide add-on of the 1x800GE speed field option at any time.

Key Features

The key features of AresONE 800GE QDD-C fixed chassis are as follows:

- Provides line-rate 800 Gbps packet generation per QSFP-DD front panel port , for analysis and capture of received traffic to detect and debug data transmission errors for multiple speeds by using PAM4 signaling over 112 Gb/s electrical lane speeds
- Provides the following multi-rate fan-out speed options:
  - PAM4 Speeds: 2x400, 4x200, 8x100GE (default, built-in speeds)
  - 1x800GE PAM4 is purchased option in a factory or field upgrade
- Provides line-rate, at all speeds with per-port and per-flow statistics
- Supports Keysight instrumentation, including floating timestamp, sequence number, flow identification, and data integrity (that is, for the entire packet)
- Supports high-latency measurement resolution at 0.3125 ns at the 800GE speed and 0.625 ns at 400GE
- Provides RS-544 (KP4) Forward Error Correction (FEC) support for all PAM4 speeds, 800/400/200 and 100GE over 112 Gb/s electrical lanes. Interleaved FEC is also supported.
- Provides inject packet errors: CRCs, runts, giants, alignments, checksum errors, and out of sequence

- Provides up to 25 watts of power and cooling support for QSFP-DD800 MSA compatible optical transceivers and active optical cables
- Provides support for active electrical cables and passive copper direct attached cables
- Provides interconnect media support with CMIS 5.0 and C-CMIS 1.0 support with IxExplorer GUI and Tcl automation support
- Supports 2x400GE and 4x200GE FEC symbol error injection and FEC symbol error density distribution analysis; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis is provided
- Supports 2x400GE, and 4x200GE PCS lanes Transmit, error injection testing and receive measurement
  - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion; see details in Specification Table in this datasheet, as capabilities may vary per Ethernet speed
- Supports +/- 50 PPM line frequency adjustment per IEEE 802.3ck
- Provides Layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBSQ patterns PRBS-13Q and PRBS-31Q
- Provides Native IxOS and IxExplorer application support with related Tcl automation
- Provides IxNetwork support for the following:
  - RFC benchmarking of networking devices and equipment by using industry-standard RFC benchmark tests at line-rate 800/400/200 and 100GE speeds
  - Mid-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases by using Keysight's IxNetwork protocol emulation application
  - IxNetwork protocol bundles that provide easy ordering and bundled packages designed for fixed chassis systems

AresONE 800GE QDD-C Variants

AresONE 800GE QDD-C fixed chassis is available in 8-port, 4-port, and 2-port with full- performance and reduced-performance model selections:
8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8P-QDD-C
- AresONE 800GER-8P-QDD-C

4-ports enabled on the 8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8PHW-4P-QDD-C
- AresONE 800GER-8PHW-4P-QDD-C

4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-4P-QDD-C
- AresONE 800GER-4P-QDD-C

2-ports enabled on the 4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-2P-QDD-C
- AresONE 800GER-2P-QDD-C

800GE-8P-QDD-C

800GE-8P-QDD-C is a 8-port, high density, full performance model with native QSFP-DD800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support . The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8P-QDD-C

800GER-8P-QDD-C is a 8-port, high density, reduced performance model with native QSFP-DD800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-8PHW-4P-QDD-C

800GE-4P-QDD-C is a 4-port, high density, full performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8PHW-4P-QDD-C

800GER-4P-QDD is a 4-port, high density, reduced performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-4P-QDD-C

800GE-4P-QDD-C is a 4-port, high density, full performance model with native QSFP-DD800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-4P-QDD-C

800GER-4P-QDD is a 4-port, high density, reduced performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-2P-QDD-C

800GE-4P-QDD-C is a 2-port, high density, full performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled

on the 4-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-2P-QDD-C

800GER-4P-QDD is a 2-port, high density, reduced performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis.The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

The 8-port full performance and reduced performance QDD-C models are similar and shown in the following figure:

The 4-port full performance and reduced performance QDD-C models are similar and shown in the following figure:

Part Numbers

Part Numbers for AresONE 800GE QDD-C fixed chassis are provided in the following table.

Model Number	Part Number	Description
800GE-8P-QDD-C	944-1194	• 8-port, fixed chassis model with native QSFP-DD800 physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-8P-QDD-C	944-1195	• 8-port, fixed chassis model with native QSFP-DD800 physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)

Model Number	Part Number	Description
800GE-8PHW-4P-QDD	944-1196	• 4-port, fixed chassis model with PHY chip and native QSFP-DD800 physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-8PHW-4P-QDD	944-1197	• 4-port, fixed chassis model with PHY chip and native QSFP-DD800 physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GE-4P-QDD-C	944-1402	• 4-port, fixed chassis model with native QSFP-DD800 physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-4P-QDD-C	944-1403	• 4-port, fixed chassis model with native QSFP-DD800 physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GE-2P-QDD-C	944-1400	• 2-port, fixed chassis model with native QSFP-DD800 physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-2P-QDD-C	944-1401	• 2-port, fixed chassis model with native QSFP-DD800 physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)

Specifications

The hardware specifications for the AresONE 800GE QDD-C fixed chassis are contained in the following table.

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
Part Number	944-1196 / 944-1194	944-1197 / 944-1195	944-1400/944-1402	944-1401/944-1403
Hardware Fixed Chassis System Specifications				
RU/ Number of Ports	2 RU 8-port hardware chassis or 4-ports enabled		2 RU 4-port har-port hardware chassis or 2-ports enabled	
Physical Interfaces	Native QSFP-DD800 physical front panel pluggable ports			
Supported Port Speeds	Default speeds 2x400GE, 4x200GE, 8x100GE per port (PAM4) 1x800GE speed as a separate purchasable option with the initial order from the factory or later with a field upgrade • Optical transceiver and fiber cable interconnect support			
CPU and Memory	Multicore processor with 4 GB of CPU memory per QSFP-DD front panel port			
Number of users	8-port hardware chassis: Supports up to 8 users, one user per physical front panel port 4-port enabled on 8-port hardware chassis: Supports up to 4 users, one user per physical front panel port		4-port hardware chassis: Supports up to 4 users, one user per physical front panel port 2-port enabled on 4-port hardware chassis: Supports up to 2 users, one user per physical front panel port	
Interface Protocols Specifications for 800GE/112Gb/s electrical lane support	IEEE 802.3ck Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling Ethernet Technology Consortium v1.1 specification			
Layer 1 support	PAM4 800/400/200/100GE speeds:			

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
	• KP4 (RS-544,514) Ethernet Forward Error Correction, Clause 119 • FEC Correctable and uncorrectable statistics per-port • FEC symbol error injection (400GE and 200GE speeds only) • FEC Codeword error distribution statistics • Interleaved FEC support • PCS lanes Tx and Rx test and statistics • Layer 1 BERT with PRBS-13Q and PRBS-31Q pattern generation support			
QSFP-DD Optical Transceiver Support	Support for QSFP-DD800 MSA compliant optical transceivers up to Power Class 8 with more than 14 watts of power consumption such as: 800GBASE-DR4, 800GBASE-2xFR4, and other optical transceivers and AOCs. • For transceivers that consume more than 14 watts of power, please consult the factory for additional information before using these optics in the system. • Please consult the factory for specific transceiver support information. • See Transceiver and Cable Support section for current support of optical transceiver for this product.			
QSFP-DD800 Active Electrical Cable (AEC) Support	Active Electrical Cable support; please consult the factory for specific support information.			
Fixed Chassis System Dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)			
Fixed Chassis System Weights	• Hardware only: 58.4 lbs. (26.5 kg) • Shipping: 113 lbs. (51.5 kg) 1 NOTE Approximate (includes rackmount slides, power cords, sync cables, and packaging)			
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120VAC, 9 Amps for each power supply. AresONE fixed chassis is shipped with (3 each) 100-125 VAC power cords.			

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
	• Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply.			
Temperature (Ambient Air)	• Operating: 41 °F to 95 °F (5 °C to 35 °C) • Storage: 41 °F to 122 °F (5 °C to 50 °C)			
Humidity (Ambient Air)	• Operating: 0 % to 85 %, non-condensing • Storage: 0 % to 85 %, non-condensing			
Regulatory Compliance Specifications	IEC 62368-1, UL 62368-1, CSA C22.2 No.62368-1-14, CISPR 32, EN/IEC 55032, EN/IEC 61000, 47 CFR FCC Part 15B, CAN ICES-003(A)/NMB-003(A), AS/NZ CISPR 32/24, KN32/35, EN/IEC 63000			
Chassis Synchronization Extendibility				
Maximum Number of Chassis in Single Test Topology	• Each chassis has built-in star topology synchronization ports to connect to five additional compatible chassis systems • The Metronome Timing System (942-0090) is used for synchronizing a total of six or more chassis at one time. Consult factory for port count requirements beyond five chassis in a single configuration			
Transmit Feature Specifications				
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures			
Max. Streams per Port and Speed	• 1x800GE: 64 (per FPP) • 2x400GE: 64 (per fan-out) • 4x200GE: 64 (per fan-out) • 8x100GE: 32 (per fan-out)	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)	• 1x800GE: 64 (per FPP) • 2x400GE: 64 (per fan-out) • 4x200GE: 64 (per fan-out) • 8x100GE: 32 (per fan-out)	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler support			

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
	• Optional sequential stream scheduler support (must be ordered as a factory installed option-no field upgrade is available)			
Minimum Frame Size	800GE, 400GE, 200GE and 100GE: • 64 bytes at full line rate • 60 bytes at less than full line rate			
Maximum Frame Size	800GE, 400GE, 200GE and 100GE: 14,000 bytes			
Maximum Fame Size in Data Center Ethernet	9,216 bytes			
Priority Flow Control	4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths			
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 16K in 400/200/100GE and 8K in 50GE and below), uniform, repeatable random, IMIX, and Quad Gaussian			
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available			
Value Lists (Max.) per port	• 1x800GE: 64K / port /UDF • 2x400GE: 64K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 64K / 4-ports /UDF			
Sequence (Max.)	• 800GE: 32K / port /UDF • 400GE: 32K /port /UDF • 200GE: 32K /port /UDF • 100GE: 8K /ports /UDF			
Error Generation (FEC and Standard Keysight L2/3 Ethernet in PAM4 Mode Only)	800GE and 2x400GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 800/400GE • No FEC error insertion and related statistics for 8x100GE			

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
	800GE, 2x400GE, 4x200GE, 8x100GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum			
Physical Coding Sublayer	• PCS lane marker error injection • PCS lane re-mapping • PCS lane marker error injection • PCS bit error generation			
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic.			
Link Fault Signaling	Reports, no fault, remote fault, and local fault port statistics. Generate local and remote faults with controls for the number of faults and order of faults. Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway.			
Latency Measurement Resolution	• 800GE: 0.3125 ns • 400GE: 0.625 ns • 200GE: 1.25 ns • 100GE: 2.5 ns			
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds.			
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 50 ppm on all the ports of the 800GE fixed chassis system.			
Transmit/Receive Loopback	Internal loopback support.			
Receive Feature Specifications				
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability			
Trackable Receive	• 800GE: 32K full statistics			

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
Flows per Port without Sequence Checking and with Tx/Rx Synch	• 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics			
Trackable Receive Flows per Port with and without Sequence checking and no Tx/RX synch	• 800GE: 32K full statistics • 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 8K full statistics and 32K with minimum statistics			
Minimum Frame Size	64 bytes			
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.			
Hardware Capture Buffer	1 MB per front panel QSFP-DD port and for fan-out modes on that port.			
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies. PAM4 800GE, 2x400GE, 4x200GE, 8x100GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis. • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate			
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time			
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF			

Feature	AresONE 800GE QSFP-DD Full Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Reduced Performance 4-Port / 8-Port	AresONE 800GE QSFP-DD Full Performance 2-Port / 4-Port	AresONE 800GE QSFP-DD Reduced Performance 2-Port /4-Port
400GE Physical Coding Sublayer (PCS) ReceiveSide Statistics and Indicators	Per-lane PCS receive capabilities include: • Receive—per-lane PCS receive statistics; Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew,Lane Marker Error Count • Receive—per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate			

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE 800GE QDD-C fixed chassis is provided in the following table:

AresONE 800GE QDD-C Full and Reduced Performance
IxNetwork: Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics and reporting capability.
Tcl API: Custom user script development for Layer 1-3 testing

Transceiver and Cable Support

The transceivers and cables supported by AresONE 800GE QDD-C fixed chassis are provided in the following table:

Transceiver/Cable	Description	Compatibility
QSFP-DD 800GE Optical Transceiver		
QSFPDD800-DR8-XCVR	QSFPDD800-DR8-XCVR,	This transceiver is compatible the

Transceiver/Cable	Description	Compatibility
	800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0068). CMIS 4.0 compliant. Compatible with cables: QSFPDD800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter.	G800GE chassis: QSFP-DD (941-0084) and the QSFP-DD-COAX (941-0085), and with all models of AresONE 800GE QSFP-DD fixed chassis: 800GE-2P-QDD (944-1190), 800GER-2P-QDD (944-1191), 800GE-4P-QDD (944-1192), 800GER-4P-QDD (944-1193), 800GE-8P-QDD (944-1194) and 800GER-8P-QDD (944-1195).
Optical transceiver point-to-point cable		
QSFPDD800-DR8-CBL	QSFPDD800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0144) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.	
Optical transceiver fan-out cable		
QSFPDD800-DR8-FO-CBL	QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0125) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.	

Status Icons

AresONE 800GE QDD-C includes a full-color graphics display which includes a series of colored icons indicating the system health.

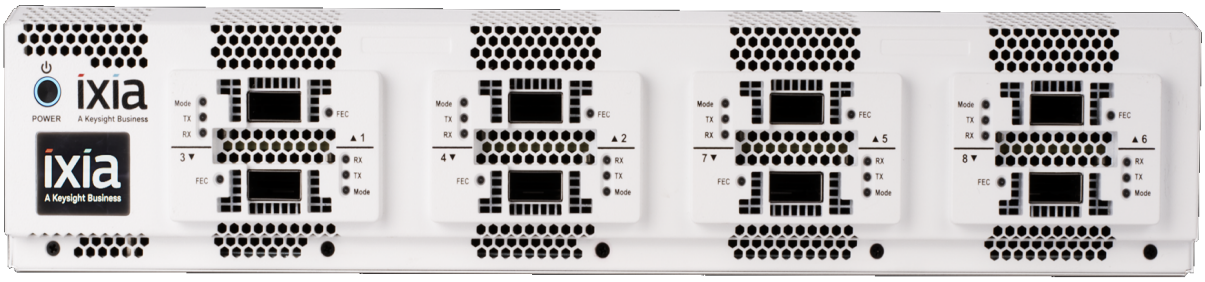
The description of the icons are provided in the following table.

Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The front panel of the AresONE 800GE 8-port QDD-C fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):



The front panel of the AresONE 800GE 4-port QDD-C fixed chassis is shown in the following figure (applies to 4-port and 2-port variants):

Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4 • Solid Red – Card fault • Off – No power to the card or port	• Solid Red – All links down • Solid Green – All inks up • Solid Yellow – Some links up • Blinking (Red, Green or Yellow)– TX is active	Application Mode: • Blinking Red – RX active with errors • Blinking Green – RX active with no errors received • Off – Port is inactive	• Blinking Red – Uncorrectable FEC errors • Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

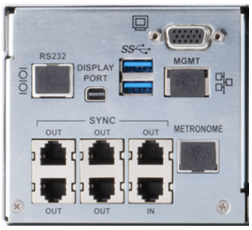
Rear Panel

The Rear panel of the AresONE 800GE 8-port and 4-port QDD-C fixed chassis is similar and is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow

3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE 800GE QDD-C fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE 800GE has five sync out ports, an AresONE 800GE acting as primary chassis can sync five more AresONE 800GE fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE 800GE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.

2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d’alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l’unité.

NOTE For instructions on rack mounting and administration of the AresONE 800GE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

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CHAPTER 38

IXIA AresONE 800GE OSFP800-C Fixed Chassis

This chapter provides details about AresONE 800GE OSFP800-C fixed chassis, its specifications and features. AresONE 800GE OSFP800-C 8-port, 4-port and 2-port models enable L1–L3 testing in a single platform. It supports 6.4 Tbps of line-rate traffic per 8-port chassis with option to synchronize multiple chassis to test 51.2 Tbps bandwidth and beyond switching platforms. It provides one platform for 1x800GE, 2x400GE, 4x200GE, and 8x100GE with PAM4 signaling, extensive KP4 FEC stats and analysis, and L1 BERT, for 106.25 Gb/s electrical lane

signaling test.

AresONE 800GE OSFP800-C enables testing multiple Ethernet speeds in the same platform with each port capable of the following speeds:

- Bulti-in PAM4 signaling-based speeds: 2x400GE, 4x200GE, and 8x100GE
- 1x800GE speed as a separate purchasable option with the initial order from the factory or later with a field upgrade

AresONE 800G OSFP800-C offers flexibility for upgrades based on need. Users can field-upgrade from the 2-port configuration to the 4-port configuration, 4-port to the 8-port configuration, and provide add-on of the 1x800GE speed field option at any time.

Key Features

The key features of AresONE 800GE- OSFP800-C fixed chassis are as follows:

- Provides line-rate 800 Gbps packet generation per OSFP800-C front panel port , for analysis and capture of received traffic to detect and debug data transmission errors for multiple Ethernet speeds when using PAM4 signaling over 112 Gb/s electrical lanes.
- Provides the following multi-rate fan-out speed options to configure fan-out speeds with PAM4 signalling:
  - PAM4 Speeds: 2x400, 4x200, 8x100GE (default, built-in speeds)
  - 1x800GE PAM4 is purchased option in a factory or field upgrade
- Provides line-rate, at all speeds with per-port and per-flow statistics
- Supports Keysight instrumentation, including floating timestamp, sequence number, flow identification, and data integrity (that is, for the entire packet)
- Supports high-latency measurement resolution at 0.3125 ns at the 800GE speed and 0.625 ns at 400GE
- Provides RS-544 (KP4) Forward Error Correction (FEC) support for all PAM4 speeds, 800/400/200 and 100GE over 106.25 Gb/s electrical lanes. Interleaved FEC is also supported.

- Provides inject packet errors: CRCs, runts, giants, checksum errors, and out of sequence
- Provides up to 25 watts of power and cooling support for OSFP MSA compatible optical transceivers, active optical cables, and other interconnect media.
- Provides support for passive copper direct attached cables (DAC) up to 1.5 meters in length
- Provides auto-negotiation and Link Training support for passive, copper direct attached cables (DAC) up to 1.5 meters in length for: 1x800GE, 2x400GE, 4x200GE and 8x100GE speeds per port
- Provides support for active electrical cables (AEC) and linear amplified copper cables (ACC).
- Provides overall optical and copper interconnect media support with CMIS 5.0 and C-CMIS 1.0 support with IxExplorer GUI and Tcl automation support
- Supports Digital Optical Monitoring (DOM) that Automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application
- Supports 1x800GE, 2x400GE and 4x200GE FEC symbol error injection and FEC symbol error density distribution analysis; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis is provided
- Supports 2x400GE, and 4x200GE PCS lanes Transmit, error injection testing and receive measurement
    - Per-lane controls and status, FEC and error monitoring, error insertion, lane mapping and skew insertion; see details in Specification Table in this datasheet, as capabilities may vary per Ethernet speed
- Supports +/- 50 PPM line frequency adjustment per IEEE 802.3ck
- Provides Layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBSQ patterns PRBS-13Q and PRBS-31Q. Additional test, pattern controls, and pattern detection are included. This capability is provided with IxExplorer application.
- Provides Native IxOS and IxExplorer application support with related Tcl automation
- Provides IxNetwork support for the following:
    - RFC benchmarking of networking devices and equipment by using industry-standard RFC benchmark tests at line-rate 800/400/200 and 100GE speeds
    - Mid-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases by using Keysight’s IxNetwork protocol emulation application
    - IxNetwork protocol bundles that provide easy ordering and bundled packages designed for all AresONE 800GE fixed chassis systems

AresONE 800GE OSFP800-C Variants

AresONE 800GE OSFP800-C fixed chassis is available in 8-port, 4-port, and 2-port with full-performance and reduced-performance model selections:
8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8P-OSFP-C

- AresONE 800GER-8P-OSFP-C

4-ports enabled on the 8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8PHW-4P-OSFP-C
- AresONE 800GER-8PHW-4P-OSFP-C

4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-4P-OSFP-C
- AresONE 800GER-4P-OSFP-C

2-ports enabled on the 4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-2P-OSFP-C
- AresONE 800GER-2P-OSFP-C

800GE-8P-OSFP-C

800GE-8P-OSFP-C is a 8-port, high density, full performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support . The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8P-OSFP-C

800GER-8P-OSFP-C is a 8-port, high density, reduced performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-8PHW-4P-OSFP-C

800GE-4P-OAFP-C is a 4-port, high density, full performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8PHW-4P-OSFP-C

800GER-4P-OSFP-C is a 4-port, high density, reduced performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-4P-OSFP-C

800GE-4P-OSFP-C is a 4-port, high density, full performance model with native OSFP800 800GE physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-4P-OSFP-C

800GER-4P-OSFP-C is a 4-port, high density, reduced performance model with native OSFP800 800GE physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-2P-OSFP-C

800GE-4P-OSFP-C is a 2-port, high density, full performance model with native OSFP800 800GE physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-2P-OSFP-C

800GER-4P-OSFP-C is a 2-port, high density, reduced performance model with native OSFP800 800GE physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis. The chassis supports 2x400GE, 4x200GE, and 8x100GE Ethernet speeds. It also includes factory installed or field upgrade 1x800GE speed support.

The 8-port full performance and reduced performance OSFP800-C models are similar and shown in the following figure:

The 4-port full performance and reduced performance OSFP800-C models are similar and shown in the following figure:

Part Numbers

Part Numbers for AresONE 800GE OSFP800-C fixed chassis are provided in the following table.

Model Number	Part Number	Description
800GE-8P-OSFP-C	944-1408	• High density, 8-port, fixed chassis model with native OSFP800 800GE (PAM4) physical interfaces

Model Number	Part Number	Description
		• Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-8P-OSFP-C	944-1409	• High density, 8-port, fixed chassis model with native OSFP800 800GE (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GE-8PHW-4P-OSFP-C	944-1410	• 4-port, fixed chassis model with PHY chip and native OSFP800 800GE (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-8PHW-4P-OSFP-C	944-1411	• 4-port, fixed chassis model with PHY chip and native OSFP800 800GE (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GE-4P-OSFP-C	944-1406	• 4-port, fixed chassis model with native OSFP800 800GE (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-4P-OSFP-C	944-1407	• 4-port, fixed chassis model with native OSFP800 800GE (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE

Model Number	Part Number	Description
		(PAM4)
800GE-2P-OSFP-C	944-1404	• 2-port, fixed chassis model with native OSFP800 800GE (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)
800GER-2P-OSFP-C	944-1405	• 2-port, fixed chassis model with native OSFP800 800GE (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Default speeds 2x400GE, 4x200GE, 8x100GE (PAM4)

Specifications

The hardware specifications for the AresONE 800GE OSFP800-C fixed chassis are contained in the following table.

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
Part numbers	944-1404 / 944-1406 / 944-1410 / 944-1408	944-1407 / 944-1407 / 944-1411 / 944-1409
Hardware fixed chassis system specifications		
RU / number of ports	2 RU / 2-ports enabled on 4-port hardware chassis, or all 4-ports enabled, and 4-ports enabled on 8-port hardware chassis, or all 8-ports enabled	
Physical interfaces	Native OSFP800 physical front panel pluggable ports	
Supported per port speeds	Default speeds 2x400GE, 4x200GE, and 8x100GE per port (PAM4): • Optical transceiver and fiber cable interconnect support • Copper cable interconnect support Optional speed: • PAM4: 1x800GE • Requires purchase of a factory or a field upgrade speed option	
CPU and memory	Multicore processor with 4 GB of CPU memory per OSFP800 front panel port	

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
Number of users	• 8-port hardware chassis: Supports up to 8 users, one user per physical front panel port • 4-port enabled 8-port hardware chassis: Supports up to 4 users, one user per physical front panel port • 4-port hardware chassis: Supports up to 4 users, one user per physical front panel port • 2-port enabled 4-port hardware chassis: Supports up to 2 users, one user per physical front panel port	
Interface protocols specifications for 800GE/112Gb/s electrical lane support	IEEE 802.3ck Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling Ethernet Technology Consortium 800 Gigabit Ethernet (GbE) v1.1 specification	
Layer 1 support	PAM4, 400/200/100GE speeds: KP4 (RS-544, 514) Ethernet Forward Error Correction, IEEE 802.3 Clause 119: • FEC Correctable and uncorrectable statistics per-port • FEC symbol error injection (800GE, 400GE and 200GE speeds) • FEC Codeword symbol error correction distribution statistics • Interleaved FEC support • Pre-FEC BER and Frame Lose Ratio (FLR) measurements • PCS lanes Tx lane map and skew insertion (400GE and 200GE speeds only) • PCS Rx per lane and port statistics • Layer 1 BERT with PRBS-13Q and PRBS-31Q pattern generation support and Rx-side statistics and analysis. Additional test, pattern controls and pattern detection are included.	
OSFP800 optical transceiver support	Support for OSFP800 MSA compliant optical transceivers up to Power Class 8 with more than 14 watts of power consumption such as: 800GBASE-DR8, 800GBASE-2xFR4, 800GBASE-SR8 and many other optical transceivers and AOCs. • For transceivers that consume more than 14 watts of power, all AresONE 800GE OSFP800-C chassis support up to 25 • watts of power and cooling per port for MSA compliant optical transceivers • You need to consult the factory for additional transceiver support information from various manufacturers	

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
	• See Transceiver and Cable Support section for current support of optical transceiver for this product.	
OSFP800 Passive copper cable support	• Passive copper cable support up to 1.5 meters in length • Auto-negotiation and Link Training support for passive, copper direct attached cables (DAC) up to 1.5 meters in length for: 1x800GE, 2x400GE, 4x200GE and 8x100GE speeds per port	
Common Management Interface Specification (CMIS)	• Support for the CMIS 4.0 and 5.0 specifications including read/write access to all CMIS pages and registers via the IxExplorer GUI and Tcl test automation programming interface. • CMIS will operate with optical and copper interconnect media to the extent they are supported by the interconnect manufacturer	
Digital Optical Monitoring (DOM)	Automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application.	
Fixed chassis system dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)	
Fixed chassis system weights	• Hardware only: 57.4 lbs (26 kg) • Shipping: 112 lbs (50.8 kg)	
Fixed chassis system electrical power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120VAC, 9 Amps for each power supply. AresONE fixed chassis is shipped with (3 each) 100-125 VAC power cords. • Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply	
Temperature (ambient air)	• Operating: 41 °F to 86 °F (5 °C to 30 °C) • Storage: 41 °F to 122 °F (5 °C to 50 °C)	
Safety	• EN 62368-1 / IEC 62368-1 • UL 62368-1 / CSA C22.2 No. 62368-1-19	
Emissions and Immunity	• FCC Part 15B, Class A	

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
	• ICES-003 • EN 55032/35 • AS/NZS CISPR 32 • KS C 9832/35	
Regulatory Approvals	• CE (Europe) • CSA (USA, Canada) • RCM (Australia, New Zealand) • UKCA (United Kingdom) • KCC (Korea)	
Environmental	• RoHS Directive 2011/65/EU; Annex II, Directive (EU) 2015/863 • WEEE Directive 2012/19/EU • China RoHS • Russia RoHS	
Chassis synchronization extendibility		
Maximum number of chassis in single test topology	• Each chassis has built-in star topology synchronization ports to connect to five additional compatible chassis systems • The Metronome Timing System (942-0090) is used for synchronizing a total of six or more chassis at one time. You need to consult factory for port count requirements beyond five chassis in a single configuration	
Transmit feature specifications		
Transmit engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. streams per port and speed	• 1x800GE: 64 (per FPP) • 2x400GE: 64 (per fan-out) • 4x200GE: 64 (per fan-out) • 8x100GE: 32 (per fan-out)	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)
Stream controls	• Rate and frame size change on the fly • Advanced stream scheduler support • Optional sequential stream scheduler support (must be ordered as a factory installed option-no field upgrade is available)	

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
Minimum frame size	800GE, 400GE, 200GE and 100GE: • 64 bytes at full line rate • 60 bytes at less than full line rate	
Maximum frame size	800GE, 400GE, 200GE and 100GE: 14,000 bytes	
Maximum frame size in data center Ethernet	9,216 bytes	
Priority flow control	4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths	
Frame length controls	Fixed, increment by user-defined step, weighted pairs (up to 14K in 400/200/100GE, uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value lists (max.) per port	• 1x800GE: 64K / port /UDF • 2x400GE: 64K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 64K / 4-ports /UDF	
Sequence (max.)	• 800GE: 32K / port /UDF • 400GE: 32K /port /UDF • 200GE: 32K /port /UDF • 100GE: 8K /ports /UDF	
Error generation (FEC and standard Keysight L2/3 Ethernet in PAM4 mode only)	1x800GE, 2x400GE, and 4x200GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 800/400GE • No FEC error insertion and related statistics for 8x100GE 1x800GE, 2x400GE, 4x200GE, 8x100GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical coding sublayer	2x400GE and 4x200GE: • PCS Transmit lane marker re-mapping • PCS lane skew insertion	

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
Hardware checksum generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic	
Link fault signaling	Reports, no fault, remote fault, and local fault port statistics. Generate local and remote faults with controls for the number of faults and order of faults. Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway.	
Latency measurement resolution	• 800GE: 0.3125 ns • 400GE: 0.625 ns • 200GE: 1.25 ns • 100GE: 2.5 ns	
Intrinsic latency compensation	Removes inherent latency error from the port electronics for all speeds	
Transmit line clock adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 105 ppm on all the ports of the 800GE fixed chassis system	
Transmit/receive loopback	Internal loopback	
Receive feature specifications		
Receive engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable receive flows per port without Sequence checking and with Tx/Rx sync	• 800GE: 32K full statistics • 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics	
Trackable receive flows per Port with and without Sequence checking and no Tx/RX sync	• 800GE: 32K full statistics • 400GE: 32K full statistics • 200GE: 32K full statistics • 100GE: 8K full statistics and 32K with minimum statistics	
Minimum frame size	64 Bytes	
Filters (user-defined statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame	

Feature	AresONE 800GE OSFP800-C Full Performance 2-port / 4-port / 8-port	AresONE 800GE OSFP800-C Reduced Performance 2-port / 4-port / 8-port
Hardware capture buffer	1 MB per front panel OSFP800 port and for fan-out modes on that port	
Standard statistics and rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
Latency / jitter measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS lanes port statistics counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
PCS receive-side statistics and indicators	Per-lane PCS receive capabilities include: • Receive — per-lane PCS receive statistics, Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive — per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	
Advanced Rx Eye Histogram Analysis	Advanced Rx Eye Histogram Analysis Option provides in-depth, user-selected, per lane PAM4 signal shape analysis, SER statistics, comparison of signal quality between lanes and an array of eye measurements. This version of the feature is only for the AresONE 800GE OSFP-C and QSFP-DD800-C chassis models. Support of this feature REQUIRES the purchase of the 905-1107 Factory Installed option, or the 905-1108 Field Upgrade option.	

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE 800GE OSFP800-C fixed chassis is provided in the following table:

AresONE 800GE OSFP800-C Full and Reduced Performance
IxNetwork: Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast,

AresONE 800GE OSFP800-C Full and Reduced Performance
broadband, authentication, Carrier Ethernet, and data center Ethernet protocols.
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics and reporting capability.
Tcl API: Custom user script development for Layer 1-3 testing using the IxExplorer features.

Transceiver and Cable Support

The transceivers and cables supported by AresONE 800GE OSFP800-C fixed chassis are provided in the following table:

Transceiver/Cable	Description
OSFP800 800GE Optical Transceiver	
OSFP800-DR8-XCVR	OSFP800-DR8-XCVR, 800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0071). CMIS 4.0 compliant. Compatible with cables: OSFP800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and OSFP800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter. This transceiver is compatible with all models of the G800GE OSFP and OSFP-COAX chassis products: G800GE OSFP, 800GE, 2-port (941-0082), and G800GE OSFP-COAX, 800GE, 1-port OSFP, 1-port electrical coax breakout (941-0083).
OSFP800 800GE fiber cable	
OSFP800-DR8-CBL	OSFP800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0146) for OSFPDR8 800GE optical transceiver, part number OSFP800-DR8-XCVR.
Optical transceiver fan-out cable	
OSFP800-DR8-FO-CBL	QSFP800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0147) for OSFP-DR8 800GE optical transceiver, part number OSFP800-DR8-XCVR.

Status Icons

AresONE 800GE OSFP800-C includes a full-color graphics display which includes a series of colored icons indicating the system health.

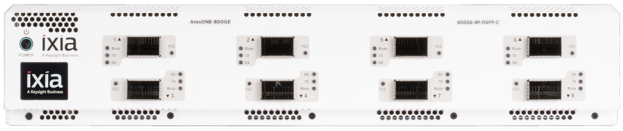
The description of the icons are provided in the following table.

Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The front panel of the AresONE 800GE 8-port OSFP800-C fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):



The front panel of the AresONE 800GE 4-port OSFP800-C fixed chassis is shown in the following figure (applies to 4-port and 2-port variants):

Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4	• Solid Red – All links down	Application Mode: • Blinking	• Blinking Red – Uncorrectable FEC errors

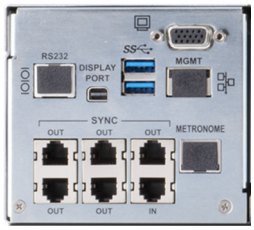
MODE LED	TX STATUS	RX STATUS	FEC
• Solid Red – Card fault • Off – No power to the card or port	• Solid Green – All inks up • Solid Yellow – Some links up • Blinking (Red, Green or Yellow)– TX is active	Red – RX active with errors • Blinking Green – RX active with no errors received • Off – Port is inactive	• Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

Rear Panel

The Rear panel of the AresONE 800GE 8-port and 4-port OSFP800-C fixed chassis is similar and is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE 800GE OSFP800-C fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE 800GE has five sync out ports, an AresONE 800GE acting as primary chassis can sync five more AresONE 800GE fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE 800GE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.

2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d’alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l’unité.

NOTE For instructions on rack mounting and administration of the AresONE 800GE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

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CHAPTER 39

IXIA AresONE 800GE QSFP-DD800-M Fixed Chassis

This chapter provides details about AresONE 800GE QSFP-DD800-M fixed chassis, its specifications and features.

AresONE 800GE 4-port and 8-port models provide up to 6.4Tbps of test traffic bandwidth and measurement. They are stackable to build higher-throughput and port-count testbeds, up to 64-ports of line-rate 800GE traffic generation and performance measurement in a single configuration. This provides an expandable test platform that can grow with the user test bandwidth needs.

AresONE 800GE QSFP-DD800-M enables testing multiple Ethernet speeds in the same platform with each port capable of the following speeds:

- Built-in PAM4 signaling speeds based on 106.25 Gb/s host electrical lanes: 2x400GE, 4x200GE, and 8x100GE per port
- Built-in PAM4 signaling speeds based on 53.125 Gb/s host electrical lanes: 1x400GE, 2x200GE, 4x100GE and 8x50GE per port
- Optional NRZ signaling based on 26 Gb/s and 10Gb/s host electrical lanes: 1x200GE, 2x100GE, 4x50GE, 2x40GE, 8x25GE, and 8x10GE per port
- 1x800GE speed as a separate purchasable option with the initial order from the factory or later with a field upgrade

Key Features

The key features of AresONE 800GE QSFP-DD800-M fixed chassis are as follows:

- Provides line-rate 800GE, 400GE and 100GE packet generation per QSFP-DD800 front panel port, for analysis and capture of received traffic to detect and debug data transmission errors for multiple Ethernet speeds when using PAM4 signaling over 106.25 Gb/s, and 53.125Gb/s as the built in speeds.
- Provides Built-in multi-rate fan-out speeds to configure the fan-out speeds with PAM4 signaling:
  - 800GE PAM4 speeds: 2x400, 4x200, 8x100GE (default, built-in speeds)
  - 400GE PAM4 speeds: 1x400, 2x200, 4x100 and 8x50GE (default, built-in speeds)
  - 1x800GE PAM4 is a purchased speed option in a factory or field upgrade
- Supports 100GE speeds with the optional NRZ signaling over 26Gb/s and 10Gb/s electrical lanes as required with a factory or a field upgrade
  - 1x200GE, 2x100GE, 4x50GE, 2x40GE, 8x25GE, and 8x10GE are available
- Provides Line-rate, at all speeds with per-port and per-flow statistics

- Supports Keysight instrumentation, including floating timestamp, sequence number, flow identification, and data integrity (that is, for the entire packet)
- Supports High-latency measurement resolution at 0.625 ns at the 800GE and at 400GE
- Supports RS-544 (KP4) Forward Error Correction (FEC) for all PAM4 speeds, 800/400/200 and 100GE over 106.25 Gb/s electrical lanes and 400/200/100 and 50GE over 53.125 Gb/s electrical lanes
- Supports RS-FEC and FC-FEC for all NRZ speeds over 26Gb/s electrical lanes
- Supports FEC error injection and analysis for 800GE, 400GE and 200GE PAM4 speeds
  - FEC symbol error injection and FEC symbol error density distribution analysis; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis is provided
- Provides 400GE, and 200GE PAM4, PCS lanes Transmit, and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, lane mapping and skew insertion; see Specifications for details
- Provides 100GE, and 40GE NRZ, PCS lanes Transmit, and receive measurement:
  - Per-lane controls and status, PCS error injection and lane mapping; see Specifications for details
- Provides inject packet errors: CRCs, runts, giants, checksum errors, and out of sequence
- Provides up to 25 watts of power and cooling support for QSFP-DD800 MSA compatible optical transceivers, active optical cables, and other interconnect media
- Supports passive, copper direct attached cables (DAC) up to 2.0 meters in length
- Supports auto-negotiation and Link Training for passive, copper direct attached cables (DAC):
  - Up to 2.0 meters in length for: 1x800GE, 2x400GE, 4x200GE and 8x100GE PAM4 speeds over 106.25 Gb/s electrical lanes per port
  - Up to 3.0 meters in length for: 1x400GE, 2x200GE, 4x100GE and 8x50GE PAM4 speeds over 53.125Gb/s electrical lanes per port
  - Up to 5.0 meters in length for: 1x200GE, 2x100GE, 1x100GE, 4x50GE, 2x50GE,- and 8x25GE NRZ speeds over 26Gb/s electrical lanes per port
- Supports active electrical cables (AEC) and linear amplified copper cables (ACC). You need to consult the factory for support of specific cable lengths as it may vary between different manufacturers
- Provides overall optical and copper interconnect media support with CMIS 5.0 and C-CMIS 1.0 support with IxExplorer GUI and Tcl automation support
- Supports Digital Optical Monitoring (DOM) that automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application
- Supports +/- 105 ppm line frequency adjustment that can be adjusted per front panel port for 800GE PAM4 speed mode
- Provides Layer 1 BERT support
  - 800GE PAM4 speed mode: Layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBSQ patterns PRBS-13Q and PRBS-31Q. Additional test,

pattern controls, and pattern detection are included.

- 400GE PAM4 speed mode: Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support
- o 100GE NRZ speed mode: Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support
- This capability is only provided with IxExplorer application

- Provides IxNetwork application support
  - Support for RFC benchmarking of networking devices and equipment by using industry-standard RFC benchmark tests at line-rate from 10GE to 800GE PAM4 and NRZ speeds
  - Mid-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases by using Keysight's IxNetwork protocol emulation application
  - IxNetwork protocol bundles that provide easy ordering and bundled packages specifically designed for AresONE 800GE fixed chassis systems
- Provides Native IxOS and IxExplorer application support with related Tcl automation

AresONE 800GE QSFP-DD800-M Variants

AresONE 800GE QSFP-DD800-M fixed chassis is available in 8-port, 4-port, and 2-port with full-performance and reduced-performance model selections:
8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8P-QDD-M
- AresONE 800GER-8P-QDD-M

4-ports enabled on the 8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8PHW-4P-QDD-M
- AresONE 800GER-8PHW-4P-QDD-M

4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-4P-QDD-M
- AresONE 800GER-4P-QDD-M

2-ports enabled on the 4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-2P-QDD-M
- AresONE 800GER-2P-QDD-M

800GE-8P-QDD-M

800GE-8P-QDD-M is a 8-port, full performance model with native QSFP-DD800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support . The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8P-QDD-M

800GER-8P-QDD-M is a 8-port, reduced performance model with native QSFP-DD800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-8PHW-4P-QDD-M

800GE-4P-QDD-M is a 4-port, full performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8PHW-4P-QDD-M

800GER-4P-QDD is a 4-port, reduced performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-4P-QDD-M

800GE-4P-QDD-M is a 4-port, full performance model with native QSFP-DD800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-4P-QDD-M

800GER-4P-QDD is a 4-port, reduced performance model with native QSFP-DD800 800GE(PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-2P-QDD-M

800GE-2P-QDD-M is a 2-port, full performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-2P-QDD-M

800GER-2P-QDD is a 2-port, reduced performance model with native QSFP-DD800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

The 8-port full performance and reduced performance QSFP-DD800-M models are similar and shown in the following figure:

The 4-port full performance and reduced performance QSFP-DD800-M models are similar and shown in the following figure:

Part Numbers

Part Numbers for AresONE 800GE QSFP-DD800-M fixed chassis are provided in the following table.

Model Number	Part Number	Description
800GE-8P-QDD-M	944-1427	• 8-port, fixed chassis model with native QSFP-DD800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-8P-QDD-M	944-1428	• 8-port, fixed chassis model with native QSFP-DD800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3

Model Number	Part Number	Description
		• Optical transceiver and copper DAC support
800GE-8PHW-4P-QDD-M	944-1429	• 4-port, fixed chassis model with PHY chip and native QSFP-DD800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-8PHW-4P-QDD-M	944-1430	• 4-port, fixed chassis model with PHY chip and native QSFP-DD800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GE-4P-QDD-M	944-1425	• 4-port, fixed chassis model with native QSFP-DD800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-4P-QDD-M	944-1426	• 4-port, fixed chassis model with native QSFP-DD800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GE-2P-QDD-M	944-1423	• 2-port, fixed chassis model with native QSFP-DD800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-2P-QDD-M	944-1424	• 2-port, fixed chassis model with native QSFP-DD800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support

Specifications

The hardware specifications for the AresONE 800GE QDD-M fixed chassis are contained in the following table.

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
Part Number	944-1423 / 944-1425 / 944-1427 / 944-1429	944-1424 / 944-1426 / 944-1428 / 944-1430
Hardware Fixed Chassis System Specifications		
RU/ Number of Ports	2 RU / 2-ports enabled on 4-port hardware chassis, or all 4-ports enabled, and 4-ports enabled on 8-port hardware chassis, or all 8-ports enabled	
Physical Interfaces	Native QSFP-DD800 physical front panel pluggable ports	
Supported Port Speeds	Default speeds included with the chassis: • 2x400GE, 4x200GE, and 8x100GE per port, PAM4 over 106Gb/s electrical lanes • 1x400GE, 2x200GE, 4x100GE, and 8x50GE, PAM4 over 53Gb/s electrical lanes • Optical transceiver and fiber cable interconnect support for all speeds • Copper cable interconnect support for all speeds Optional speeds: • PAM4: 1x800GE over 106Gb/s electrical lanes • NRZ: 1x200GE, 2x100GE, 4x50GE, and 8x25GE over 26Gb/s electrical lanes, and 2x40GE and 8x10GE over 10Gb/s electrical lanes • Requires purchase of a factory or a field upgrade NRZ speed option.	
CPU and Memory	Multicore processor with 4 GB of CPU memory per QSFP-DD800 front panel port	
Number of users	1 user per physical front panel port. The user owns all the fan-out ports on the front panel port.	
Interface protocols specifications for 800GE/106Gb/s electrical lane support	IEEE 802.3ck Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling Ethernet Technology Consortium 800 Gigabit Ethernet (GbE) v1.1 specification	
Interface protocols specifications for 400GE and 100GE for 53Gb/s and 26Gb/s electrical lane support	IEEE 802.3bs 200GE and 400GE, 400GBASE-R IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet IEEE 802.3 100GBASE-R LAN, IEEE P802.3bj, IEEE P802.3bm, IEEE P802.3by, IEEE 802.3ba, IEEE 802.3ae	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
Layer 1 support 800GE PAM4 speeds for 106Gb/s electrical lanes	PAM4, 800/400/200/100GE speeds: KP4 (RS-544, 514) Ethernet Forward Error Correction, IEEE 802.3 Clause 119: • FEC Correctable and uncorrectable statistics per-port • FEC symbol error injection (800GE, 400GE and 200GE speeds only) • FEC Codeword symbol error correction distribution statistics • Interleave FEC for PAM4 100GE(ck) applications over 106Gb/s electrical lanes • Pre-FEC BER and Frame Lose Ratio (FLR) measurements • PCS lanes Tx lane map and skew insertion (400GE and 200GE speeds only) • PCS Rx per lane and port statistics • Layer 1 BERT with PRBS-13Q and PRBS-31Q pattern generation support and Rx-side statistics and analysis. Additional test, pattern controls and pattern detection are included.	
Layer 1 support 400GE PAM4 speeds for 53Gb/s electrical lanes	PAM4, 400GE native ports and 200/100/50GE speed option: • KP4 (RS-544,514) Ethernet Forward Error Correction, Clause 119 • All speeds support AN and LT for 1x400GE, 2x200GE, 4x100GE, and 8x50GE speed modes • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400GE and 200GE speeds only) • FEC Codeword error distribution statistics support for all PAM4 speeds • PCS lanes Tx and Rx test and statistics • Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support	
Layer 1 support 100GE NRZ speeds for 26Gb/s electrical lanes	NRZ, 200/100/50/25GE speed option: • 1x200, 2x100, 4x50, 8x25GE speed support • RS (528,514) Clause 91, BASE-R FEC Cause 74 Forward Error Correction, Clause 91 for applicable speeds • Auto-negotiation and link training support for all 100/50/25GE speeds • Correctable and uncorrectable FEC statistics per-port for applicable speeds • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability ◦ Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
Layer 1 support 100GE NRZ speeds for 10Gb/s electrical lanes	NRZ, 40/10GE speed option: • 2x40GE and 8x10GE speed support ◦ Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support	
QSFP-DD800 and QSFP-DD optical transceiver support (800GE and 400GE-rated transceivers)	Support for QSFP-DD800 and QSFP-DD MSA compliant optical transceivers up to Power Class 8 with more than 14 watts of power consumption such as: 800GBASE-DR8, 800GBASE-2xFR4, 800GBASE-SR8, 400GBASE-DR4 and 400G-ZR coherent optics plus many other optical transceivers and AOCs. For transceivers that consume more than 14 watts of power, all AresONE 800GE QSFP-DD800-C and AresONE QSFP-DD800-M chassis support up to 25 watts of power and cooling per port for MSA compliant optical transceivers that are rated for 800GE and 400GE operation. Please consult the factory for additional transceiver support information from various manufacturers. • See Transceiver and Cable Support section for current support of optical transceiver for this product.	
QSFP28/QSFP+ Optical Transceiver Support	Support for QSFP28/QSFP+ compliant optical transceivers up to Power Class 7 with 5 watts of power consumption such as: QSFP28-SR4, QSFP28-LR4, QSFP28-PSM4, QSFP-PLR4 and others. Please consult the factory for specific transceiver support information.	
SFP56/SFP28 Optical Transceiver Support	SFP56-SR, SFP56-DR, SFP56-FR, and SFP56-LR optical transceivers are supported for 1x50GE PAM4 Ethernet speeds for per port operation using the required Ixia, QSA28 adapter for enabling SFP56 interfaces on each physical port (948-0072). SFP28-SR and SFP28-LR optical transceivers are supported for 1x25GE and 1x10GE NRZ Ethernet speeds for per port operation using the required Ixia, QSA28 adapter for enabling SFP28 interfaces on each physical port (948-0072).	
QSFP-DD800 and QSFP-DD Active Electrical Cable support (800GE and 400GE-rated cables)	Active Electrical Cable (AEC) and Active Copper Cable (ACC) support; please consult the factory for specific support information	
QSFP-DD800, QSFP-DD, and QSFP28 passive copper cable	• QSFP-DD800 passive copper cable support for up to 2.0 meters in length • QSFP-DD passive copper cables support for up to 3.0 meters in length • QSFP28 passive copper cables support for up to 5.0 meters in length	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
support (800GE and 400GE-rated cables)	• Auto-negotiation and Link Training support for passive, copper direct attached cables (DAC) for all supported Ethernet speeds per port Please consult the factory for support of passive copper cable lengths that are longer than those stated above	
QSFP28/QSFP+ Passive Copper Cable Media	100GBASE-CR4, 50GBASE-CR2, and 25GBASE-CR passive, copper Direct Attached Cable (DAC) up to 5 meters in length dependent upon technology type. Both point-to-point and fan-out cables are supported. Please consult the factory for longer lengths and information on Active Electrical Cable information.	
Fixed Chassis System Dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)	
Common Management Interface Specification (CMIS)	• Support for the CMIS 4.0 and 5.0 specifications including read/write access to all CMIS pages and registers • Support for C-CMIS 1.0 (Coherent CMIS) • CMIS will operate with optical and copper interconnect media to the extent they are supported by the interconnect manufacturer • CMIS is exposed through the IxExplorer application and Tcl test automation support	
Digital Optical Monitoring (DOM)	Automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application.	
Fixed Chassis System Dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)	
Fixed Chassis System Weights	• Hardware only: 58.4 lbs. (26.5 kg) • Shipping: 113 lbs. (51.5 kg) 1 NOTE Approximate (includes rackmount slides, power cords, sync cables, and packaging)	
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120VAC, 9 Amps for each power supply. AresONE fixed chassis is shipped with (3 each)	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
	100-125 VAC power cords. • Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply (note, all three supplies must be installed when operating).	
Temperature (Ambient Air)	• Operating: 41 °F to 95 °F (5 °C to 35 °C) • Storage: 41 °F to 122 °F (5 °C to 50 °C)	
Humidity (Ambient Air)	• Operating: 0 % to 85 %, non-condensing • Storage: 0 % to 85 %, non-condensing	
Regulatory Compliance Specifications	IEC 62368-1, UL 62368-1, CSA C22.2 No.62368-1-14, CISPR 32, EN/IEC 55032, EN/IEC 61000, 47 CFR FCC Part 15B, CAN ICES-003(A)/NMB-003 (A), AS/NZ CISPR 32/24, KN32/35, EN/IEC 63000	
Chassis Synchronization Extendibility		
Maximum Number of Chassis in Single Test Topology	• Each chassis has built-in star topology synchronization ports to connect to five additional compatible chassis systems • The Metronome Timing System (942-0090) is used for synchronizing a total of six or more chassis at one time. Consult factory for port count requirements beyond five chassis in a single configuration	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. streams per port and 800GE PAM4 speeds	• 1x800GE: 64 (per FPP) • 2x400GE: 64 (per fan-out) • 4x200GE: 64 (per fan-out) • 8x100GE: 32 (per fan-out)	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)
Max. streams per port and 400GE PAM4 speeds	• 1x400GE: 256 (per FPP) • 2x200GE: 256 (per fan-out) • 4x100GE: 128 (per fan-out) • 8x50GE: 64 (per fan-	• 1x400GE: 128 (per FPP) • 2x200GE: 128 (per fan-out) • 4x100GE: 64 (per fan-out) • 8x50GE: 32 (per fan-out)

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
	out)	
Max. Streams per port and 100GE NRZ speeds	• 1x100GE: 128 (per FPP) • 2x50GE: 64 (per fan-out) • 1x40GE: 128 (per FPP) • 4x25GE: 64 (per fan-out) • 4x10GE: 64 (per fan-out)	• 1x100GE: 128 (per FPP) • 2x50GE: 32 (per fan-out) • 1x40GE: 64 (per FPP) • 4x25GE: 32 (per fan-out) • 4x10GE: 32 (per fan-out)
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler support • Optional sequential stream scheduler support (must be ordered as a factory installed option-no field upgrade is available)	
Minimum Frame Size	800GE, 400GE, 200GE and 100GE PAM4 speeds: • 64 bytes at full line rate • 61 bytes at less than full line rate (approximately 90% utilization) • 400GE, 200GE, 100GE and 50GE PAM4 speeds: • 64 bytes at full line rate • 60 bytes at less than full line rate • 100GE, 50GE, 40GE, 25GE, and 10GE NRZ speeds: • 64 bytes at full line rate	
Maximum frame size 800GE PAM4 speeds	800GE, 400GE, 200GE and 100GE PAM4 speeds: 14,000 bytes 1x400GE and 2x200GE PAM4 200GE: 16,000 bytes	
Maximum frame size 400GE PAM4 and 100GE NRZ speeds	1x400GE and 2x200GE PAM4: 16,000 bytes 100GE PAM4 and NRZ plus below speeds: 14,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority flow control	4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
(4:1) for 800GE,400GE PAM4 and 100GE NRZ speeds	1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Priority flow control (8:1) for 100GE NRZ speeds	8 line-rate-capable queues, each supporting up to 2,500-byte frame lengths 1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 14K in 400/200/100GE uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value lists (max.) per port for 800GE PAM4 speeds	• 1x800GE: 64K / port /UDF • 2x400GE: 64K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 64K / 4-ports /UDF	
Value lists (max.) per port for 400GE PAM4 speeds	• 1x400GE: 64K / port /UDF • 2x200GE: 32K /port /UDF • 4x100GE: 64K / 4-ports /UDF • 8x50GE: 32K / 4-ports /UDF	
Value lists (max.) per port for 100GE NRZ speeds	• 1x100GE: 64K /4 ports /UDF • 2x50GE: 32K /4 ports /UDF • 40GE: 64K /4 ports /UDF • 25GE: 16K /4 ports /UDF • 10GE: 16K /4 ports /UDF	
Sequence (max.) for 800GE PAM4 speeds	• 1x800GE: 32K / port /UDF • 2x400GE: 32K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 8K / 4-ports /UDF	
Sequence (max.) for 400GE PAM4 speeds	• 1x400GE: 32K / port /UDF • 2x200GE: 32K / port /UDF • 4x100GE: 8K / port /UDF • 8x50GE: 4K / port /UDF	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
Sequence (max.) for 100GE NRZ speeds	• 1x100GE: 8K / port /UDF • 2x50GE: 4K / port /UDF • 40GE: 4K / port /UDF • 25GE: 4K / port /UDF • 10GE: 4K / port /UDF	
Error generation (FEC and standard Keysight L2/3 Ethernet in 800GE PAM4 mode only)	1x800GE, 2x400GE, and 4x200GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 800/400/200GE • No FEC error insertion and related statistics for 8x100GE 1x800GE, 2x400GE, 4x200GE, 8x100GE L2/3 Ethernet: Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Error generation (FEC and standard Keysight L2/3 Ethernet in 400GE PAM4 mode only)	400GE and 2x200GE FEC: FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 400/200GE No FEC error insertion and related statistics for 4x100GE and 8x50GE	
Error generation (FEC and standard Keysight L2/3 Ethernet in 100GE NRZ mode only)	No FEC error insertion for all NRZ speeds Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical coding sublayer for 800GE and 400GE PAM4 Ethernet speeds	800GE: 2x400GE and 4x200GE, and 400GE: 1x400GE and 2x200GE PCS Transmit lane marker re-mapping PCS lane skew insertion	
Physical coding sublayer for 100GE NRZ Ethernet speeds	100GE: 1x100GE and 1x40GE PCS Transmit lane marker re-mapping	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic	
Link Fault Signaling fro all speeds	• Reports, no fault, remote fault, and local fault port statistics.	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
	• Generate local and remote faults with controls for the number of faults and order of faults. • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway.	
Latency measurement resolution for 800GE and 400GE PAM4 Ethernet speeds	800GE and 400GE: 0.625 ns 200GE: 1.25 ns 100GE and 50GE: 2.5 ns	
Latency measurement resolution for 100GE NRZ Ethernet speeds	2.5 nanoseconds for all NRZ speeds	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds.	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 105 ppm on all the ports of the 800GE fixed chassis system.	
Transmit/Receive Loopback	Internal loopback.	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable receive flows per port without Sequence checking and with Tx/Rx synch for 800GE PAM4 Ethernet speeds	800GE, 400GE, 200GE: 32K full statistics 100GE: 4K full statistics and 32K with minimum statistics	
Trackable receive flows per Port with and without Sequence checking and no Tx/RX synch	800GE, 400GE, 200GE: 32K full statistics 100GE: 8K full statistics and 32K with minimum statistics	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
for 800GE PAM4 Ethernet speeds		
Trackable receive flows per port with and without Sequence Checking with Tx/Rx Synch for 400GE PAM4 and 100GE NRZ Ethernet speeds	400GE and 200GE: 32K full statistics 100GE: 4K full statistics and 32K with minimum statistics 50GE, 40GE, 25GE, 10GE: 4K full statistics and 16K with minimum statistic	
Trackable receive flows per port with and without Sequence Checking and no Tx/RX Synch for 400GE PAM4 and 100GE NRZ Ethernet speeds	400GE and 200GE: 32K full statistics 100GE: 4K full statistics and 32K with minimum statistics 50GE, 40GE, 25GE, 10GE: 8K full statistics and 16K with minimum statistic	
Minimum Frame Size for all speeds	64 Bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	1 MB per front panel QSFP-DD800 port and for fan-out modes on that port.	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
FEC Statistics for 800GE and 400GE PAM4 Ethernet Speeds	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
FEC Statistics 100GE NRZ Ethernet speeds	100GE NRZ speeds: • 100GE FEC statistics: RS-FEC Corrected and uncorrectable codewords	

Feature	AresONE 800GE QSFP-DD800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE QSFP-DD800-M Reduced Performance 2-Port / 4-Port / 8-Port
	50GE and 25GE FEC statistics: • RS-FEC corrected and uncorrected codeword count • FC-FEC corrected and uncorrected block count • FC-FEC corrected error bits	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
PCS receive-side statistics and indicators for 800GE and 400GE PAM4 Ethernet speeds	Per-lane PCS receive capabilities include: • Receive — per-lane PCS receive statistics, Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive — per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE 800GE QSFP-DD800-M fixed chassis is provided in the following table:

AresONE 800GE QSFP-DD800-M Full and Reduced Performance
IxNetwork: Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols. Included with IxNetwork are test automation tools based on TCL, Python, and the Rest/RestPy.
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics and reporting capability.
Tcl API: Custom user script development for Layer 1-3 testing using the IxExplorer features.

Transceiver and Cable Support

The transceivers and cables supported by AresONE 800GE QSFP-DD800-M fixed chassis are provided in the following table:

Transceiver/Cable	Description
QSFP-DD800 800GE Optical Transceiver	
QSFPDD800-DR8-XCVR	Ixia, QSFPDD800-DR8-XCVR, 800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0068). CMIS 4.0 compliant. Compatible with Ixia cables: QSFPDD800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter. This transceiver is compatible with all models of AresONE 800GE QSFP-DD800 and QSFP-DD800-C fixed chassis. It is compatible with all models of the G800GE and G800GE-02 QSFP-DD800 and QSFP-DD800-COAX chassis.
QSFP-DD800 800GE optical transceiver	
QSFPDD800-DR8-CBL	Ixia, QSFPDD800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0144) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.
Optical transceiver fan-out cable	
QSFPDD800-DR8-FO-CBL	Ixia, QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0145) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.
Passive copper Direct Attached Cable (DAC)	
QSFPDD800-1M-CBL	Ixia, QSFPDD800-1M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1-meter length (942-0153). This copper DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP800-C, fixed chassis models: 800GE-2P-QDD-C (944-1400), 800GER-2P-QDD-C (944-1401), 800GE-4P-QDD-C (944-1402), 800GER-4P-QDD-C (944-1403), 800GE-8P-QDD-C (944-1194), 800GER-8P-QDD-C (944-1195), 800GE-8PHW-4P-QDD-C (944-1196), 800GER-8PHW-4P-QDD-C (944-1197).
QSFPDD800-1-6M-CBL	Ixia, QSFPDD800-1-6M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1.6-meter length (942-0154). This copper DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP800-C, fixed chassis models: 800GE-2P-QDD-C (944-1400), 800GER-2P-QDD-C (944-1401), 800GE-4P-QDD-C (944-1402), 800GER-4P-QDD-C (944-1403), 800GE-8P-QDD-C (944-1194), 800GER-8P-QDD-C (944-1195), 800GE-8PHW-4P-QDD-C (944-1196),

Transceiver/Cable	Description
	800GER-8PHW-4P-QDD-C (944-1197).

Status Icons

AresONE 800GE QSFP-DD800-M includes a full-color graphics display which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error

Icon Name	Icon Image	Icon State	Description
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The front panel of the AresONE 800GE 8-port QSFP-DD800-M fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):

The front panel of the AresONE 800GE 4-port QSFP-DD800-M fixed chassis is shown in the following figure (applies to 4-port and 2-port variants):

Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate

Feature	Specification
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4 • Solid Red – Card fault • Solid Yellow – NRZ • Off – No power to the card or port	• Solid Red – All links down • Solid Green – All inks up • Solid Yellow – Some links up • Blinking (Red, Green or Yellow)– TX is active	Application Mode: • Blinking Red – RX active with errors • Blinking Green – RX active with no errors received • Off – Port is inactive BERT Mode: • Blinking Green – PRBS locked all lanes • Blinking Yellow – PRBS locked on some lanes • Blinking Red – PRBS not locked on	• Blinking Red – Uncorrectable FEC errors • Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

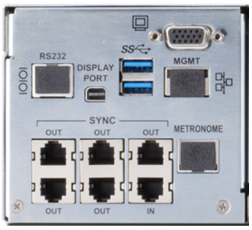
MODE LED	TX STATUS	RX STATUS	FEC
		any lane • Off – Port is inactive	

Rear Panel

The Rear panel of the AresONE 800GE QSFP-DD800-M 8-port and 4-port fixed chassis is similar and is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control

Port Label	Description	Additional Information
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE 800GE QDD-M fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE 800GE has five sync out ports, an AresONE 800GE acting as primary chassis can sync five more AresONE 800GE fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE 800GE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d'équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l'installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l'équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l'appareil.
2. Circulation d'air réduite: installer l'équipement dans une baie de manière a ce que la circulation d'air requise pour faire fonctionner l'équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l'appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l'unité pour une ventilation adéquate. L'espace laisse libre pour la circulation de l'air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l'appareil de manière a s'assurer qu'il soit droit dans la baie afin d'éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l'équipement au circuit d'alimentation et aux conséquences qu'une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d'alimentation. Prendre des précautions d'usage en prêtant attention aux normes figurant sur la plaque d'identification de l'équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l'équipement monté en baie. L'appareil doit etre vissé sur la baie afin d'assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d'alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l'unité.

NOTE For instructions on rack mounting and administration of the AresONE 800GE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

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CHAPTER 40

AresONE 800GE OSFP800-M Fixed Chassis

This chapter provides details about AresONE 800GE OSFP800-M fixed chassis, its specifications and features.

AresONE 800GE 4-port and 8-port models provide up to 6.4Tbps of test traffic bandwidth and measurement. They are stackable to build higher-throughput and port-count testbeds, up to 64-ports of line-rate 800GE traffic generation and performance measurement in a single configuration. This provides an expandable test platform that can grow with the user test bandwidth needs.

AresONE 800GE OSFP800-M enables testing multiple Ethernet speeds in the same platform with each port capable of the following speeds:

- Built-in PAM4 signaling speeds based on 106.25 Gb/s host electrical lanes: 2x400GE, 4x200GE, and 8x100GE per port
- Built-in PAM4 signaling speeds based on 53.125 Gb/s host electrical lanes: 1x400GE, 2x200GE, 4x100GE and 8x50GE per port
- Optional NRZ signaling based on 26 Gb/s and 10Gb/s host electrical lanes: 1x200GE, 2x100GE, 4x50GE, 2x40GE, 8x25GE, and 8x10GE per port
- 1x800GE speed as a separate purchasable option with the initial order from the factory or later with a field upgrade

Key Features

The key features of AresONE 800GE OSFP800-M fixed chassis are as follows:

- Provides line-rate 800GE, 400GE and 100GE packet generation per OSFP800 front panel port, for analysis and capture of received traffic to detect and debug data transmission errors for multiple Ethernet speeds when using PAM4 signaling over 106.25 Gb/s, and 53.125Gb/s as the built in speeds.
- Provides Built-in multi-rate fan-out speeds to configure the fan-out speeds with PAM4 signaling:
  - 800GE PAM4 speeds: 2x400, 4x200, 8x100GE (default, built-in speeds)
  - 400GE PAM4 speeds: 1x400, 2x200, 4x100 and 8x50GE (default, built-in speeds)
  - 1x800GE PAM4 is a purchased speed option in a factory or field upgrade
- Supports 100GE speeds with the optional NRZ signaling over 26Gb/s and 10Gb/s electrical lanes as required with a factory or a field upgrade
  - 1x200GE, 2x100GE, 4x50GE, 2x40GE, 8x25GE, and 8x10GE are available
- Provides Line-rate, at all speeds with per-port and per-flow statistics

- Supports Keysight instrumentation, including floating timestamp, sequence number, flow identification, and data integrity (that is, for the entire packet)
- Supports High-latency measurement resolution at 0.625 ns at the 800GE and at 400GE
- Supports RS-544 (KP4) Forward Error Correction (FEC) for all PAM4 speeds, 800/400/200 and 100GE over 106.25 Gb/s electrical lanes and 400/200/100 and 50GE over 53.125 Gb/s electrical lanes
- Supports RS-FEC and FC-FEC for all NRZ speeds over 26Gb/s electrical lanes
- Supports FEC error injection and analysis for 800GE, 400GE and 200GE PAM4 speeds
  - FEC symbol error injection and FEC symbol error density distribution analysis; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis is provided
- Provides 400GE, and 200GE PAM4, PCS lanes Transmit, and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, lane mapping and skew insertion; see Specifications for details
- Provides 100GE, and 40GE NRZ, PCS lanes Transmit, and receive measurement:
  - Per-lane controls and status, PCS error injection and lane mapping; see Specifications for details
- Provides inject packet errors: CRCs, runts, giants, checksum errors, and out of sequence
- Provides up to 20 watts of power and cooling support for OSFP800 MSA compatible optical transceivers, active optical cables, and other interconnect media
- Supports passive, copper direct attached cables (DAC) up to 2.0 meters in length
- Supports auto-negotiation and Link Training for passive, copper direct attached cables (DAC):
  - Up to 2.0 meters in length for: 1x800GE, 2x400GE, 4x200GE and 8x100GE PAM4 speeds over 106.25 Gb/s electrical lanes per port
  - Up to 3.0 meters in length for: 1x400GE, 2x200GE, 4x100GE and 8x50GE PAM4 speeds over 53.125Gb/s electrical lanes per port
  - Up to 5.0 meters in length for: 1x200GE, 2x100GE, 1x100GE, 4x50GE, and 8x25GE NRZ speeds over 26Gb/s electrical lanes per port
- Supports active electrical cables (AEC) and linear amplified copper cables (ACC). You need to consult the factory for support of specific cable lengths as it may vary between different manufacturers
- Provides overall optical and copper interconnect media support with CMIS 5.0 and C-CMIS 1.0 support with IxExplorer GUI and Tcl automation support
- Supports Digital Optical Monitoring (DOM) that automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application
- Supports +/- 105 ppm line frequency adjustment that can be adjusted per front panel port for 800GE PAM4 speed mode
- Provides Layer 1 BERT support
  - 106Gb/s lane mode: Layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBSQ patterns PRBS-13Q and PRBS-31Q. Additional test pattern controls,

per lane clock ppm adjustment, and pattern detection are included.
    - 53Gb/s mode: Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support
    - 26Gb/s and 10Gb/s lane mode: Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support
    - The BERT capability is only provided with IxExplorer application
- Provides IxNetwork application support
    - Support for RFC benchmarking of networking devices and equipment by using industry-standard RFC benchmark tests at line-rate from 10GE to 800GE PAM4 and NRZ speeds
    - Mid-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases by using Keysight's IxNetwork protocol emulation application
    - IxNetwork protocol bundles that provide easy ordering and bundled packages specifically designed for AresONE 800GE fixed chassis systems
- Provides Native IxOS and IxExplorer application support with related Tcl automation

AresONE 800GE OSFP800-M Variants

AresONE 800GE OSFP800-M fixed chassis is available in 8-port, 4-port, and 2-port with full-performance and reduced-performance model selections:
8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8P-OSFP-M
- AresONE 800GER-8P-OSFP-M

4-ports enabled on the 8-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-8PHW-4P-OSFP-M
- AresONE 800GER-8PHW-4P-OSFP-M

4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-4P-OSFP-M
- AresONE 800GER-4P-OSFP-M

2-ports enabled on the 4-port hardware chassis—Full and Reduced Performance models

- AresONE 800GE-2P-OSFP-M
- AresONE 800GER-2P-OSFP-M

800GE-8P-OSFP-M

800GE-8P-OSFP-M is a 8-port, full performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support . The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8P-OSFP-M

800GER-8P-OSFP-M is a 8-port, reduced performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-8PHW-4P-OSFP-M

800GE-8PHW-4P-OSFP-M is a 4-port, full performance model with native OSFP800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-8PHW-4P-OSFP-M

800GER-8PHW-4P-OSFP-M is a 4-port, reduced performance model with native OSFP800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 4 ports are enabled on the 8-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-4P-OSFP-M

800GE-4P-OSFP-M is a 4-port, full performance model with native OSFP800 800GE (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-4P-OSFP-M

800GER-4P-OSFP-M is a 4-port, reduced performance model with native OSFP800 800GE(PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GE-2P-OSFP-M

800GE-2P-OSFP-M is a 2-port, full performance model with native OSFP800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

800GER-2P-OSFP-M

800GER-2P-OSFP-M is a 2-port, reduced performance model with native OSFP800 (PAM4) physical interfaces, layer 1-3, optical transceiver, and copper DAC support. Here 2 ports are enabled on the 4-port chassis. The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

The 8-port full performance and reduced performance OSFP800-M models are similar and shown in the following figure:

The 4-port full performance and reduced performance OSFP800-M models are similar and shown in the following figure:

Part Numbers

Part Numbers for AresONE 800GE OSFP800-M fixed chassis are provided in the following table.

Model Number	Part Number	Description
800GE-8P-OSFP-M	944-1419	• 8-port, fixed chassis model with native OSFP800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-8P-OSFP-M	944-1420	• 8-port, fixed chassis model with native OSFP800 (PAM4) physical interfaces

Model Number	Part Number	Description
		• Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GE-8PHW-4P-OSFP-M	944-1421	• 4-port, fixed chassis model with PHY chip and native OSFP800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-8PHW-4P-OSFP-M	944-1422	• 4-port, fixed chassis model with PHY chip and native OSFP800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GE-4P-OSFP-M	944-1417	• 4-port, fixed chassis model with native OSFP800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-4P-OSFP-M	944-1418	• 4-port, fixed chassis model with native OSFP800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GE-2P-OSFP-M	944-1415	• 2-port, fixed chassis model with native OSFP800 (PAM4) physical interfaces • Full performance • Supports layer 1-3 • Optical transceiver and copper DAC support
800GER-2P-OSFP-M	944-1416	• 2-port, fixed chassis model with native OSFP800 (PAM4) physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and copper DAC support

Specifications

The hardware specifications for the AresONE 800GE OSFP-M fixed chassis are contained in the following table.

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
Part Number	944-1415 / 944-1417 / 944-1419 / 944-1421	944-1416 / 944-1418 / 944-1420 / 944-1422
Hardware Fixed Chassis System Specifications		
RU/ Number of Ports	2 RU / 2-ports enabled on 4-port hardware chassis, or all 4-ports enabled, and 4-ports enabled on 8-port hardware chassis, or all 8-ports enabled	
Physical Interfaces	Native OSFP800 physical front panel pluggable ports	
Supported Port Speeds	Default speeds included with the chassis: • 2x400GE, 4x200GE, and 8x100GE per port, PAM4 over 106Gb/s electrical lanes • 1x400GE, 2x200GE, 4x100GE, and 8x50GE, PAM4 over 53Gb/s electrical lanes • Optical transceiver and fiber cable interconnect support for all speeds • Copper cable interconnect support for all speeds Optional speeds: • PAM4: 1x800GE over 106Gb/s electrical lanes • NRZ: 1x200GE, 2x100GE, 4x50GE, and 8x25GE over 26Gb/s electrical lanes, and 2x40GE and 8x10GE over 10Gb/s electrical lanes • Requires purchase of a factory or a field upgrade NRZ speed option.	
CPU and Memory	Multicore processor with 4 GB of CPU memory per OSFP800 front panel port	
Number of users	1 user per physical front panel port. The user owns all the fan-out ports on the front panel port.	
Interface protocols specifications for 800GE/106Gb/s electrical lane support	IEEE 802.3ck Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling Ethernet Technology Consortium 800 Gigabit Ethernet (GbE) v1.1 specification	
Interface protocols specifications for 400GE and 100GE	IEEE 802.3bs 200GE and 400GE IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
for 53Gb/s and 26Gb/s, and 10Gb/s electrical lane support	IEEE 802.3 100GBASE-R LAN, IEEE P802.3bj, IEEE P802.3bm, IEEE P802.3by, IEEE 802.3ba, IEEE 802.3ae	
Layer 1 support 800GE PAM4 speeds for 106Gb/s electrical lanes	PAM4, 800/400/200/100GE speeds: KP4 (RS-544, 514) Ethernet Forward Error Correction, IEEE 802.3 Clause 119: • FEC Correctable and uncorrectable statistics per-port • FEC symbol error injection (800GE, 400GE and 200GE speeds only) • FEC Codeword symbol error correction distribution statistics • Interleave FEC(RS-FEC-Int) for PAM4 100GE(ck) 100BASE-CR1 applications over 106Gb/s electrical lanes • Pre-FEC BER and Frame Lose Ratio (FLR) measurements • PCS lanes Tx lane map and skew insertion (400GE and 200GE speeds only) • PCS Rx per lane and port statistics • Layer 1 BERT with PRBS-13Q and PRBS-31Q pattern generation support and Rx-side statistics and analysis. Additional test, pattern controls and pattern detection are included.	
Layer 1 support 400GE PAM4 speeds for 53Gb/s electrical lanes	PAM4, 400GE native ports and 200/100/50GE speed option: • KP4 (RS-544,514) Ethernet Forward Error Correction, Clause 119 • All speeds support AN and LT for 1x400GE, 2x200GE, 4x100GE, and 8x50GE speed modes • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400GE and 200GE speeds only) • FEC Codeword error distribution statistics support for all PAM4 speeds • PCS lanes Tx and Rx test and statistics • Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support	
Layer 1 support 100GE NRZ speeds for 26Gb/s electrical lanes	NRZ, 100/50/25GE speed option: • 2x100, 4x50, 8x25GE speed support • RS (528,514) Clause 91, BASE-R FEC Cause 74 Forward Error Correction, Clause 91 for applicable speeds • Auto-negotiation and link training support for all 100/50/25GE speeds • Correctable and uncorrectable FEC statistics per-port for applicable speeds	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
	• Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability ◦ Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support	
Layer 1 support 100GE NRZ speeds for 10Gb/s electrical lanes	NRZ 40/10GE speed option: • 2x40GE and 8x10GE speed support ◦ Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support	
OSFP800 optical transceiver support (800GE and 400GE-rated transceivers)	Support for OSFP800 specification compliant optical transceivers up to 20 watts of consumption (Power Class 8) such as: 800GBASE-DR8, 800GBASE-2xFR4, 800GBASE-SR8, 400GBASE-DR4, 400G-ZR, and 400ZR+ coherent optics plus many other MSA compliant optical transceivers and AOCs. Please consult the factory for additional transceiver support information from various manufacturers. • See Transceiver and Cable Support section for current support of optical transceiver for this product.	
OSFP800 Active Electrical Cable support (800GE and 400GE-rated cables)	Active Electrical Cable (AEC) and Active Copper Cable (ACC) support. Please consult the factory for specific support information.	
OSFP800, passive copper cable support (800GE and 400GE-rated cables)	• OSFP800 passive copper cable support for up to 2.0 meters in length • OSFP800-to-QSFP800 conversion cable support for up to 2.0 meters in length • Auto-negotiation and Link Training support for passive copper direct attached cables (DAC) for all supported Ethernet speeds per port	
Common Management Interface Specification (CMIS)	• Support for the CMIS 4.0 and 5.0 specifications including read/write access to all CMIS pages and registers • Support for C-CMIS 1.0 (Coherent CMIS) • CMIS will operate with optical and copper interconnect media to the extent they are supported by the interconnect manufacturer	
Digital Optical Monitoring (DOM)	Automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application.	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
400G-ZR/ZR+ Coherent Optics Transceiver support	• CMIS 5.0 and C-CMIS 1.0 (Coherent CMIS) provide Read/Write access to all management pages and Versatile Diagnostics Monitoring (VDM) registers via IxExplorer GUI and Tcl test automation programming interface • Coherent optics up to 20 watts of power consumption are supported on the manufacturers that have been qualified by Keysight. Please consult your Keysight Sales Representative for additional information.	
Fixed Chassis System Dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)	
Fixed Chassis System Weights	• Hardware only: 58.4 lbs. (26.5 kg) • Shipping: 113 lbs. (51.5 kg) NOTE Approximate (includes rackmount slides, power cords, sync cables, and packaging)	
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120VAC, 9 Amps for each power supply. AresONE fixed chassis is shipped with (3 each) 100-125 VAC power cords. • Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply (note, all three supplies must be installed when operating).	
Temperature (Ambient Air)	• Operating: 41 °F to 86 °F (5 °C to 30 °C) • Storage: 41 °F to 122 °F (5 °C to 50 °C)	
Humidity (Ambient Air)	• Operating: 0 % to 85 %, non-condensing • Storage: 0 % to 85 %, non-condensing	
Safety	• EN 62368-1 / IEC 62368-1+A11, BS EN IEC 62368-1+A11 • UL 62368-1 / CSA C22.2 No. 62368-1:19	
Emissions and immunity	• FCC Part 15B, Class A • ICES-003(A)/NMB-003(A) • EN 55032 Class A, EN 55035, EN 61000-3-2, EN 61000-3-3 • AS/NZS CISPR 32 Class A • KS C 9832 Class A, KS C 9835, KS C 9610-3-2, KS C 9610-3-3 • VCCI – CISPR 32 Class A	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
Regulatory approvals	• UL (USA, Canada) • CE (Europe) • UKCA (United Kingdom) • RCM (Australia, New Zealand) • KCC (Korea) • VCCI (Japan)	
Environmental	• RoHS Directive 2011/65/EU, Directive (EU) 2015/863 • WEEE Directive 2012/19/EU • China RoHS	
Chassis Synchronization Extendibility		
Maximum Number of Chassis in Single Test Topology	• Each chassis has built-in star topology synchronization ports to connect to five additional compatible chassis systems • The Metronome Timing System (942-0090) is used for synchronizing a total of six or more chassis at one time. Consult factory for port count requirements beyond five chassis in a single configuration	
Transmit Feature Specifications		
Transmit Engine	Wire-speed packet generation with timestamps, sequence numbers, data integrity, and packet group signatures	
Max. streams per port and 800GE PAM4 speeds	• 1x800GE: 64 (per FPP) • 2x400GE: 64 (per fan-out) • 4x200GE: 64 (per fan-out) • 8x100GE: 32 (per fan-out)	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)
Max. streams per port and 400GE PAM4 speeds	• 1x400GE: 256 (per FPP) • 2x200GE: 256 (per fan-out) • 4x100GE: 128 (per fan-out) • 8x50GE: 64 (per fan-out)	• 1x400GE: 128 (per FPP) • 2x200GE: 128 (per fan-out) • 4x100GE: 64 (per fan-out) • 8x50GE: 32 (per fan-out)

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
Max. Streams per port and NRZ speeds	• 1x200GE: 256 (FPP) 2x100GE: 128 (per fan-out) • 4x50GE: 64 (per fan-out) • 2x40GE: 128 (per fan-out) • 8x25GE: 64 (per fan-out) • 8x10GE: 64 (per fan-out)	• 1x200GE: 128 (FPP) • 2x100GE: 128 (per fan-out) • 4x50GE: 32 (per fan-out) • 2x40GE: 64 (per fan-out) • 8x25GE: 32 (per fan-out) • 8x10GE: 32 (per fan-out)
Stream Controls	• Rate and frame size change on the fly • Advanced stream scheduler support • Optional sequential stream scheduler support (must be ordered as a factory installed option-no field upgrade is available)	
Minimum Frame Size	800GE, 400GE, 200GE and 100GE PAM4 speeds: • 64 bytes at full line rate • 61 bytes at less than full line rate (approximately 90% utilization) • 400GE, 200GE, 100GE and 50GE PAM4 speeds: • 64 bytes at full line rate • 60 bytes at less than full line rate • 100GE, 50GE, 40GE, 25GE, and 10GE NRZ speeds: • 64 bytes at full line rate	
Maximum frame size for all speeds	14,000 bytes	
Maximum Fame Size in Data Center Ethernet	9,216 bytes	
Priority flow control (4:1) for 800GE,400GE PAM4 and 100GE NRZ speeds	4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths 1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Priority flow control (8:1) for 100GE	8 line-rate-capable queues, each supporting up to 2,500-byte frame lengths	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
NRZ speeds	1 line-rate-capable queue, non-blocking supporting up to 9,216-byte frame length	
Frame Length Controls	Fixed, increment by user-defined step, weighted pairs (up to 14K in 400/200/100GE uniform, repeatable random, IMIX, and Quad Gaussian	
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available	
Value lists (max.) per port for 800GE PAM4 speeds	• 1x800GE: 64K / port /UDF • 2x400GE: 64K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 64K / 4-ports /UDF	
Value lists (max.) per port for 400GE PAM4 speeds	• 1x400GE: 64K / port /UDF • 2x200GE: 32K /port /UDF • 4x100GE: 64K / 4-ports /UDF • 8x50GE: 32K / 4-ports /UDF	
Value lists (max.) per port for NRZ speeds	• 1x200GE: 32K/port/UDF • 2x100GE: 64K /4 ports /UDF • 4x50GE: 32K /4 ports /UDF • 2x40GE: 64K /4 ports /UDF • 8x25GE: 16K /4 ports /UDF • 8x10GE: 16K /4 ports /UDF	
Sequence (max.) for 800GE PAM4 speeds	• 1x800GE: 32K / port /UDF • 2x400GE: 32K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 8K / 4-ports /UDF	
Sequence (max.) for 400GE PAM4 speeds	• 1x400GE: 32K / port /UDF • 2x200GE: 32K / port /UDF • 4x100GE: 8K / port /UDF • 8x50GE: 4K / port /UDF	
Sequence (max.) for NRZ speeds	• 1x200GE: 32K/port/UDF • 2x100GE: 64K /4 ports /UDF • 4x50GE: 32K /4 ports /UDF	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
	• 2x40GE: 64K /4 ports /UDF • 8x25GE: 16K /4 ports /UDF • 8x10GE: 16K /4 ports /UDF	
Error generation (FEC and standard Keysight L2/3 Ethernet in 800GE PAM4 mode only)	1x800GE, 2x400GE, and 4x200GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 800/400/200GE • No FEC error insertion and related statistics for 8x100GE 1x800GE, 2x400GE, 4x200GE, 8x100GE L2/3 Ethernet: Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Error generation (FEC and standard Keysight L2/3 Ethernet in 400GE PAM4 mode only)	400GE and 2x200GE FEC: FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 400/200GE No FEC error insertion and related statistics for 4x100GE and 8x50GE	
Error generation (FEC and standard Keysight L2/3 Ethernet in 100GE NRZ mode only)	No FEC error insertion for all NRZ speeds Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum	
Physical coding sublayer for 800GE and 400GE PAM4 Ethernet speeds	800GE: 2x400GE and 4x200GE, and 400GE: 1x400GE and 2x200GE PCS Transmit lane marker re-mapping PCS lane skew insertion	
Physical coding sublayer for NRZ Ethernet speeds	100GE: 1x100GE and 2x40GE PCS Transmit lane marker re-mapping	
Hardware Checksum Generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic	
Link Fault Signaling fro all speeds	• Reports, no fault, remote fault, and local fault port statistics. • Generate local and remote faults with controls for the number of faults and order of faults. • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway.	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
Latency measurement resolution for 800GE and 400GE PAM4 Ethernet speeds	800GE and 400GE: 0.625 ns 200GE: 1.25 ns 100GE and 50GE: 2.5 ns	
Latency measurement resolution for 100GE NRZ Ethernet speeds	2.5 nanoseconds for all NRZ speeds	
Intrinsic Latency Compensation	Removes inherent latency error from the port electronics for all speeds.	
Transmit Line Clock Adjustment	Ability to adjust the parts-per-million (ppm) line frequency over a range of +/- 105 ppm on all the ports of the 800GE fixed chassis system.	
Transmit/Receive Loopback	Internal loopback.	
Receive Feature Specifications		
Receive Engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability	
Trackable receive flows per port without Sequence checking and with Tx/Rx synch for 800GE PAM4 Ethernet speeds	800GE, 400GE, 200GE: 32K full statistics 100GE: 4K full statistics and 32K with minimum statistics	
Trackable receive flows per Port with and without Sequence checking and no Tx/RX synch for 800GE PAM4 Ethernet speeds	800GE, 400GE, 200GE: 32K full statistics 100GE: 8K full statistics and 32K with minimum statistics	
Trackable receive flows per port with	400GE and 200GE: 32K full statistics 100GE: 4K full statistics and 32K with minimum statistics	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
and without Sequence Checking with Tx/Rx Synch for 400GE PAM4 and 100GE NRZ Ethernet speeds	50GE, 40GE, 25GE, 10GE: 4K full statistics and 16K with minimum statistic	
Trackable receive flows per port with and without Sequence Checking and no Tx/RX Synch for 400GE PAM4 and 100GE NRZ Ethernet speeds	400GE and 200GE: 32K full statistics 100GE: 4K full statistics and 32K with minimum statistics 50GE, 40GE, 25GE, 10GE: 8K full statistics and 16K with minimum statistic	
Minimum Frame Size for all speeds	64 Bytes	
Filters (User-Defined Statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame.	
Hardware Capture Buffer	1 MB per front panel OSFP800 port and for fan-out modes on that port.	
Standard Statistics and Rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies	
FEC Statistics for 800GE and 400GE PAM4 Ethernet Speeds	800GE and 400GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis. • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate	
FEC Statistics 100GE NRZ Ethernet speeds	100GE NRZ speeds: • 100GE FEC statistics: RS-FEC Corrected and uncorrectable codewords 50GE and 25GE FEC statistics:	

Feature	AresONE 800GE OSFP800-M Full Performance 2-Port / 4-Port / 8-Port	AresONE 800GE OSFP800-M Reduced Performance 2-Port / 4-Port / 8-Port
	• RS-FEC corrected and uncorrected codeword count • FC-FEC corrected and uncorrected block count • FC-FEC corrected error bits	
Latency / Jitter Measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time	
Receive-side PCS Lanes Port Statistics Counters	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF	
PCS receive-side statistics and indicators for 800GE and 400GE PAM4 Ethernet speeds	Per-lane PCS receive capabilities include: • Receive — per-lane PCS receive statistics, Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive — per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate	

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE 800GE OSFP800-M fixed chassis is provided in the following table:

AresONE 800GE OSFP800-M Full and Reduced Performance
IxNetwork: Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols. Included with IxNetwork are test automation tools based on TCL, Python, and the Rest/RestPy.
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics and reporting capability.
Tcl API: Custom user script development for Layer 1-3 testing using the IxExplorer features.

Transceiver and Cable Support

The transceivers and cables supported by AresONE 800GE OSFP800-M fixed chassis are provided in the following table:

Transceiver/Cable	Description
OSFP800 800GE Optical Transceiver	
OSFP800-DR8-XCVR	Keysight, OSFP800-DR8-XCVR, 800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0071). CMIS 4.0 compliant. Compatible with Ixia cables: OSFP800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and OSFP800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter. This transceiver is compatible with all AresONE 800GE OSFP800-C and OSFP800-M fixed chassis models, and with the G800GE-02 800GE OSFP800 and OSFP800-COAX chassis models.
OSFP800 800GE fiber point-to-point cable	
OSFP800-DR8-CBL	Keysight, OSFP800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0146) for OSFP-DR8 800GE optical transceiver, part number OSFP800-DR8-XCVR.
OSFP800 Optical transceiver fan-out cable	
OSFP800-DR8-FO-CBL	Keysight, QSFP800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0147) for OSFP-DR8 800GE optical transceiver, part number OSFP800-DR8-XCVR.
OSFP800 Passive copper Direct Attached Cable (DAC)	
OSFP800-1M-CBL	Keysight, OSFP800 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1-meter length (942-0158). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-C and OSFP800-M, fixed chassis models.
OSFP800-1-5M-CBL	Keysight, OSFP800 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1.5-meter length (942-0159). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-C and OSFP800-M, fixed chassis models.
OSFP800-2M-CBL	Keysight, OSFP800-2M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable (DAC), 25 AWG, 2-meter length (942-0164). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-M, fixed chassis models.
Passive copper conversion Direct Attached Cables (DAC) – OSFP800-to-QSFP-DD800	

Transceiver/Cable	Description
Q800G-O800G-1M-CBL	Keysight, QSFPDD800-to-OSFP800-CBL 800GE 800GBASE-R passive copper, conversion Direct Attach Cable (DAC), 26 AWG, 1-meter length (942-0155). This copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP-DD800-C, AresONE 800GE QSFP-DD800-M, AresONE 800GE OSFP800-C, AresONE 800GE OSFP800-M fixed chassis models.
Q800G-O800G-1-5M-CBL	Keysight, QSFPDD800-to-OSFP800-CBL 800GE 800GBASE-R passive copper, conversion Direct Attach Cable (DAC), 26 AWG, 1.5-meter length (942-0156). This copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP-DD800-C, AresONE 800GE QSFP-DD800-M, AresONE 800GE OSFP800-C, AresONE 800GE OSFP800-M fixed chassis models.
Q800G-O800G-2M-CBL	Keysight, QSFPDD800-to-OSFP800-CBL 800GE 800GBASE-R passive copper, conversion Direct Attach Cable (DAC), 26 AWG, 2-meter length (942-0162). This copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP-DD800-M, and AresONE 800GE OSFP800-M fixed chassis models.

Status Icons

AresONE 800GE OSFP800-M includes a full-color graphics display which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

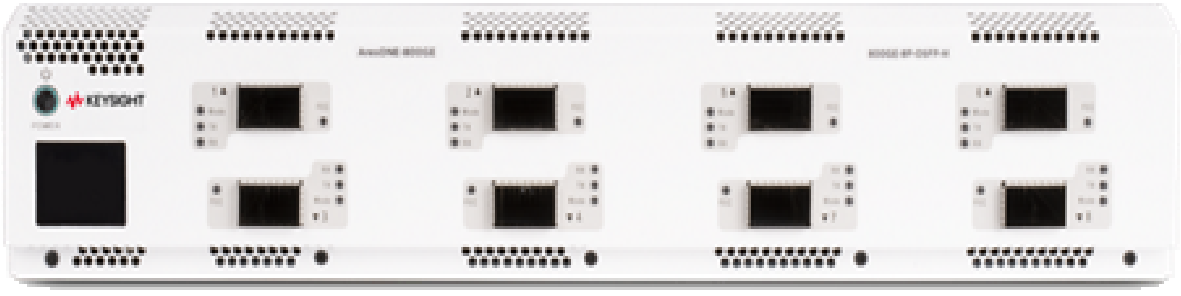
Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits

Icon Name	Icon Image	Icon State	Description
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The front panel of the AresONE 800GE 8-port OSFP800-M fixed chassis is shown in the following figure (applies to 8-port and 4-port variants):



Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4 • Solid Red – Card fault • Solid Yellow – NRZ • Off – No power to the card or port	• Solid Red – All links down • Solid Green – All inks up • Solid Yellow – Some links up • Blinking (Red, Green or Yellow)– TX is active	Application Mode: • Blinking Red – RX active with errors • Blinking Green – RX active with no errors received • Off – Port is inactive BERT Mode: • Blinking Green – PRBS locked all lanes • Blinking Yellow – PRBS locked on	• Blinking Red – Uncorrectable FEC errors • Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

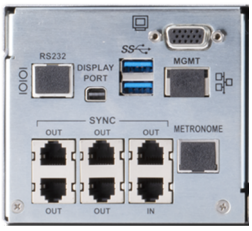
MODE LED	TX STATUS	RX STATUS	FEC
		some lanes • Blinking Red – PRBS not locked on any lane • Off – Port is inactive	

Rear Panel

The Rear panel of the AresONE 800GE OSFP800-M 8-port and 4-port fixed chassis is similar and is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow
3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE 800GE OSFP-M fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE 800GE has five sync out ports, an AresONE 800GE acting as primary chassis can sync five more AresONE 800GE fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE 800GE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.
2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de

protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.

5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d’alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l’unité.

NOTE For instructions on rack mounting and administration of the AresONE 800GE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

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CHAPTER 41

AresONE 800GE Dual Interface Model-M

This chapter provides details about AresONE 800GE Dual Interface Model-M, its specifications and features.

The Dual Interface Model-M is the first integrated Layer 1 through 3 test platform that supports both the QSFP-DD800 and OSFP800 front panel interfaces in the same fixed chassis. Dual Interface Model with 2-ports of QSFP-DD800 and 2-ports of OSFP800 supports all the features of other AresONE 800GE-M platforms with dedicated front panel interfaces. Both PAM4 and NRZ signaling support is available on the Dual Interface Model. Now, AresONE 800GE Dual Interface Model-M is the latest innovation to the AresONE high-speed Ethernet family.

AresONE 800GE Dual Interface Model-M enables testing of multiple Ethernet speeds in the same platform with each port capable of the following speeds:

- Built-in PAM4 signaling speeds based on 106.25 Gb/s host electrical lanes: 2x400GE, 4x200GE, and 8x100GE per port
- Built-in PAM4 signaling speeds based on 53.125 Gb/s host electrical lanes: 1x400GE, 2x200GE, 4x100GE and 8x50GE per port
- Optional NRZ signaling based on 26Gb/s and 10Gb/s host electrical lanes: 1x200GE, 2x100GE, 4x50GE, 2x40GE, 8x25GE and 8x10GE per port
- 1x800GE is a separate purchasable option with the initial order from the factory or later with a field upgrade

Key Features

The key features of AresONE 800GE Dual Interface Model-M are as follows:

- Provides line-rate 10GE to 800GE, packet generation per QSFP-DD800 or OSFP800 front panel port, for analysis and capture of received traffic to detect and debug data transmission errors for multiple Ethernet speeds when using PAM4 signaling over 106.25 Gb/s, and 53.125Gb/s as the built in speeds.
- Provides Built-in multi-rate fan-out speeds to configure the fan-out speeds with PAM4 signaling:
  - 800GE PAM4 speeds: 2x400, 4x200, 8x100GE (default, built-in speeds)
  - 400GE PAM4 speeds: 1x400, 2x200, 4x100 and 8x50GE (default, built-in speeds)
  - 1x800GE PAM4 is a purchased speed option in a factory or field upgrade
- Supports 100GE-related speeds with the optional NRZ signaling over 26Gb/s and 10Gb/s electrical lanes as required with a factory or a field upgrade
  - 1x200GE, 2x100GE, 4x50GE, 2x40GE, 8x25GE, and 8x10GE are available

- Provides Line-rate, at all speeds with per-port and per-flow statistics
- Supports Keysight instrumentation, including floating timestamp, sequence number, flow identification, and data integrity (that is, for the entire packet)
- Supports High-latency measurement resolution at 0.625 ns at the 800GE and at 400GE
- Supports RS-544 (KP4) Forward Error Correction (FEC) for all PAM4 speeds, 800/400/200 and 100GE over 106.25 Gb/s electrical lanes and 400/200/100 and 50GE over 53.125 Gb/s electrical lanes
  - RS-FEC-Int for 100GBASE-R1 per IEEE802.3 Clause 161 is also supported on PAM4 signaling
- Supports RS-FEC and FC-FEC for all NRZ speeds over 26Gb/s electrical lanes
- Supports FEC error injection and analysis for 800GE, 400GE and 200GE PAM4 speeds
  - FEC symbol error injection and FEC symbol error density distribution analysis; comprehensive set of FEC corrected and uncorrected counts, rates, and statistics; BER per lane and per port, and pre-FEC BER, frame loss ratio (FLR) analysis is provided
- Provides 400GE, and 200GE PAM4, PCS lanes Transmit, and receive measurement:
  - Per-lane controls and status, FEC and error monitoring, lane mapping and skew insertion; see Specifications for details
- Provides 100GE, and 40GE NRZ, PCS lanes Transmit, and receive measurement:
  - Per-lane controls and status, PCS error injection and lane mapping; see Specifications for details
- Provides inject packet errors: CRCs, runts, giants, checksum errors, and out of sequence
- Provides up to 20 watts of power and cooling support for QSFP-DD800 and OSFP800 MSA and specification compatible optical transceivers, active optical cables, and other interconnect media
- Supports active and passive copper direct attached cables (DAC) up to 2.0 meters in lengthl
- Supports auto-negotiation and Link Training for passive, copper direct attached cables (DAC):
  - Up to 2.0 meters in length for: 1x800GE, 2x400GE, 4x200GE and 8x100GE PAM4 speeds over 106.25 Gb/s electrical lanes per port
  - Up to 3.0 meters in length for: 1x400GE, 2x200GE, 4x100GE and 8x50GE PAM4 speeds over 53.125Gb/s electrical lanes per port
  - Up to 5.0 meters in length for: 1x200GE, 2x100GE, 1x100GE, 4x50GE, and 8x25GE NRZ speeds over 26Gb/s electrical lanes per port
- Supports active electrical cables (AEC) and linear amplified copper cables (ACC). You need to consult the factory for support of specific cable lengths as it may vary between different manufacturers
- Provides overall optical and copper interconnect media support with CMIS 5.0 and C-CMIS 1.0 support with IxExplorer GUI and Tcl automation support
- Supports Digital Optical Monitoring (DOM) that automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application

- Supports +/- 105 ppm line frequency adjustment that can be adjusted per front panel port for 800GE PAM4 speed mode
- Provides Layer 1 BERT support
  - 106Gb/s lane mode: Layer 1 BERT capability with per-lane and per-port BER statistics, ability to send PRBSQ patterns PRBS-13Q and PRBS-31Q. Additional test pattern controls, per lane clock ppm adjustment, and pattern detection are included.
  - 53Gb/s mode: Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support
  - 26Gb/s and 10Gb/s lane mode: Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support
  - The BERT capability is only provided with IxExplorer application
- Provides IxNetwork application support
  - Support for RFC benchmarking of networking devices and equipment by using industry-standard RFC benchmark tests at line-rate from 10GE to 800GE PAM4 and NRZ speeds
  - Mid-range L2/3 networking protocol emulation to validate performance and scalability of L2/3 routing/switching and data center test cases by using Keysight's IxNetwork protocol emulation application
  - IxNetwork protocol bundles that provide easy ordering and bundled packages specifically designed for AresONE 800GE fixed chassis systems
- Provides Native IxOS and IxExplorer application support with related Tcl automation

AresONE 800GE Dual Interface Model-M Variant

AresONE 800GE Dual Interface Model-M is available as a 4-port variant with reduced-performance:

- AresONE 800GER-4P-QDD-OSFP-M

800GER-4P-QDD-OSFP-M

800GER-4P-QDD-OSFP-M is a 4-port, reduced performance model with native QSFP-DD800 and OSFP800 physical interfaces, layer 1-3, optical transceiver, and copper DAC support . The chassis supports Ethernet speeds 2x400GE, 4x200GE, and 8x100GE based on 106.25 Gb/s electrical lanes and Ethernet speeds 1x400GE, 2x200GE, 4x100GE, and 8x50GE based on 53.125 Gb/s electrical lanes. It also includes factory installed or field upgrade 1x800GE speed support.

The 4-port reduced performance Dual Interface-M model is shown in the following figure:

Part Numbers

Part Number for AresONE 800GE Dual Interface Model-M is provided in the following table.

Model Number	Part Number	Description
800GER-4P-QDD-OSFP-M	944-1412	• 4-port, dual interface model with native QSFP-DD800 and OSFP800 physical interfaces • Reduced performance • Supports layer 1-3 • Optical transceiver and fiber cable interconnect support for all speeds • Copper cable interconnect support for all speeds

Specifications

The hardware specifications for the AresONE 800GE Dual Interface Model-M are contained in the following table.

Feature	**AresONE 800GE Dual Interface Model -M Reduced performance, 4-port**
Hardware Specifications	
Rack Unit (RU)/Number of ports	2 RU / 2-ports of QSFP-DD800 and 2-ports of OSFP800 for a total of -ports
Physical interfaces	Native QSFP-DD800 and OSFP800 physical front panel pluggable ports
Supported per port speeds	Default speeds included with the chassis: • 2x400GE, 4x200GE, and 8x100GE per port, PAM4 over 106Gb/s electrical lanes • 1x400GE, 2x200GE, 4x100GE, and 8x50GE, PAM4 over 53Gb/s electrical lanes • Optical transceiver and fiber cable interconnect support for all speeds • Copper cable interconnect support for all speeds Optional speeds: • PAM4: 1x800GE over 106Gb/s electrical lanes • NRZ: 1x200GE, 2x100GE, 4x50GE, and 8x25GE, over 26Gb/s electrical lanes, and 2x40GE and 8x10GE over 10Gb/s electrical lanes • Requires purchase of a factory or a field upgrade NRZ speed option.

CPU and Memory	Multicore processor with 4 GB of CPU memory per OSFP800 front panel port
Number of users	1 user per physical front panel port. The user owns all the fan-out ports on the front panel port.
Interface protocols specifications for 800GE/106Gb/s electrical lane support	IEEE 802.3ck Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling Ethernet Technology Consortium 800 Gigabit Ethernet (GbE) v1.1 specification
Interface protocols specifications for 400GE and 100GE for 53Gb/s, 26Gb/s, and 10Gb/s electrical lane support	IEEE 802.3bs 200GE and 400GE IEEE 802.3cd 50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet IEEE 802.3 100GBASE-R LAN, IEEE P802.3bj, IEEE P802.3bm, IEEE P802.3by, IEEE 802.3ba, IEEE 802.3ae
Layer 1 support 800GE PAM4 speeds for 106Gb/s electrical lanes	PAM4, 800/400/200/100GE speeds: KP4 (RS-544, 514) Ethernet Forward Error Correction, IEEE 802.3 Clause 119: • FEC Correctable and uncorrectable statistics per-port • FEC symbol error injection (800GE, 400GE and 200GE speeds only) • FEC Codeword symbol error correction distribution statistics • Interleave FEC (RS-FEC-Int) for PAM4 100GE(ck) 100BASE-CR1 applications over 106Gb/s electrical lanes • Pre-FEC BER and Frame Lose Ratio (FLR) measurements • PCS lanes Tx lane map and skew insertion (400GE and 200GE speeds only) • PCS Rx per lane and port statistics • Layer 1 BERT with PRBS-13Q and PRBS-31Q pattern generation support and Rx-side statistics and analysis. Additional test, pattern controls, per lane clock ppm adjustment and pattern detection are included.
Layer 1 support 400GE PAM4 speeds for 53Gb/s electrical lanes	PAM4, 400GE native ports and 200/100/50GE speeds: • KP4 (RS-544,514) Ethernet Forward Error Correction, Clause 119 • All speeds support AN and LT for 1x400GE, 2x200GE, 4x100GE, and 8x50GE speed modes • Correctable and uncorrectable FEC statistics per-port • FEC symbol error injection (400GE and 200GE speeds only) • FEC Codeword error distribution statistics support for all PAM4 speeds

	• PCS lanes Tx and Rx test and statistics • Layer 1 BERT with PRBS-7Q, PRBS-9Q, PRBS-11Q, PRBS-13Q, PRBS-15Q, PRBS-20Q, PRBS-23Q, and PRBS-31Q pattern support
Layer 1 support NRZ speeds for 26Gb/s electrical lanes	NRZ, 100/50/25GE included in the NRZ speed option: • 2x100, 4x50, and 8x25GE speed support • RS (528,514) Clause 91, BASE-R FEC Cause 74 Forward Error Correction, Clause 91 for applicable speeds • Auto-negotiation and link training support for all 100/50/25GE speeds • Correctable and uncorrectable FEC statistics per-port for applicable speeds • Ability to independently turn ON or OFF AN with Link training, or FEC, or to allow IEEE defaults to automatically manage the interoperability • Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support
Layer 1 support 100GE NRZ speeds for 10Gb/s electrical lanes	• NRZ, 40/10GE included in the NRZ speed option: 2x40GE and 8x10GE speed support • Layer 1 BERT with PRBS-7, PRBS-9, PRBS-11, PRBS-13, PRBS-15, PRBS-20, PRBS-23, and PRBS-31 pattern support
QSFP-DD800 and OSFP800 optical transceiver support (800GE and 400GE-rated transceivers)	• Support for QSFP-DD800 and OSFP800 MSA or specification compliant optical transceivers up to 20 watts of consumption (Power Class 8) such as: 800GBASE-DR8, 800GBASE-2xFR4, 800GBASE-SR8, 400GBASE-DR4, 400G-ZR and 400ZR+ coherent optics plus many other MSA compliant optical transceivers, AEC's, ACC's and AOCs. • Please consult the factory for additional transceiver support information from various manufacturers
QSFP-DD800 and OSFP800 Active Electrical Cable support (800GE and 400GE-rated cables)	Active Electrical Cable (AEC) and Active Copper Cable (ACC) support; please consult the factory for specific support information
QSFP-DD800 and OSFP800, passive copper cable support (800GE and 400GE-rated cables)	• QSFP-DD800 and OSFP800 passive copper cable support for up to 2.0 meters in length • OSFP800-to-QSFP-DD800 conversion cable support for up to 2.0 meters in length • Auto-negotiation and Link Training support for passive copper direct attached cables (DAC) for all supported

	Ethernet speeds per port
Common Management Interface Specification (CMIS)	• Support for the CMIS 4.0 and 5.0 specifications including read/write access to all CMIS pages and registers • Support for C-CMIS 1.0 (Coherent CMIS) • CMIS will operate with optical and copper interconnect media to the extent they are supported by the interconnect manufacturer • CMIS is exposed through the IxExplorer application and Tcl test automation support
Digital Optical Monitoring (DOM)	Automatically provides information from the interconnect device plugged into the test port, along with the device status, electrical power, temperatures, power class, laser power and various LOL and LOS threshold and alarm monitoring information. The DOM also provides feedback when alarms and thresholds are exceeded. This capability is provided with the IxExplorer application.
400G-ZR/ZR+ Coherent Optics Transceiver support	• CMIS 5.0 and C-CMIS 1.0 (Coherent CMIS) provide Read/Write access to all management pages and Versatile Diagnostics Monitoring (VDM) registers via IxExplorer GUI and Tcl test automation programming interface • Coherent optics up to 20 watts of power consumption are supported on the manufacturers that have been qualified by Keysight. Please consult your Keysight Sales Representative for additional information.
Fixed Chassis System Dimensions	• 30.6” (L) x 17.3” (W) x 3.46” (H) • 778 mm (L) x 440 mm (W) x 88 mm (H)
Fixed Chassis System Weights	• Hardware only: 58.4 lbs. (26.5 kg) • Shipping: 113 lbs. (51.5 kg) 1 1 Approximate (includes rackmount slides, power cords, sync cables, and packaging)
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires (3) power sources when running 100-120VAC, 9 Amps for each power supply. AresONE fixed chassis is shipped with (3 each) 100-125 VAC power cords. Note all three power supplies must be installed when operating the unit. • Requires (2) power sources when running 200-240 VAC, 7 Amps for each power supply (note, all three power supplies must be installed when operating the unit). For 200-240 VAC power cords, order part number 942-0110 from the

	Ordering Section of this datasheet. The kit is provided at no charge with the purchase of an AresONE fixed chassis when 200-240 VAC is required.
Temperature (ambient air)	• Operating: 41 °F to 86 °F (5 °C to 30 °C) • Storage: 41 °F to 122 °F (5 °C to 50 °C)
Humidity (ambient air)	• Operating: 0 % to 85 %, non-condensing • Storage: 0 % to 85 %, non-condensing
Safety	• EN 62368-1 / IEC 62368-1+A11, BS EN IEC 62368-1+A11 • UL 62368-1 / CSA C22.2 No. 62368-1:19
Emissions and immunity	• FCC Part 15B, Class A • ICES-003(A)/NMB-003(A) • EN 55032 Class A, EN 55035, EN 61000-3-2, EN 61000-3-3 • AS/NZS CISPR 32 Class A • KS C 9832 Class A, KS C 9835, KS C 9610-3-2, KS C 9610-3-3 • VCCI – CISPR 32 Class A
Regulatory approvals	• UL (USA, Canada) • CE (Europe) • UKCA (United Kingdom) • RCM (Australia, New Zealand) • KCC (Korea) • VCCI (Japan)
Environmental	• RoHS Directive 2011/65/EU, Directive (EU) 2015/863 • WEEE Directive 2012/19/EU • China RoHS
Chassis synchronization extendibility	
Maximum number of chassis in single test topology	• Each chassis has built-in star topology synchronization ports to connect to five additional compatible chassis systems • The Metronome Timing System (942-0090) is used for synchronizing a total of eight or more chassis at one time. Consult factory for port count requirements beyond five chassis in a single configuration
Transmit feature specifications	
Transmit engine	Wire-speed packet generation with timestamps, sequence

	numbers, data integrity, and packet group signatures
Max. streams per port and 800GE PAM4 speeds	• 1x800GE: 32 (FPP) • 2x400GE: 32 (per fan-out) • 4x200GE: 32 (per fan-out) • 8x100GE: 16 (per fan-out)
Max. streams per port and 400GE PAM4 speeds	• 1x400GE: 128 (per FPP) • 2x200GE: 128 (per fan-out) • 4x100GE: 64 (per fan-out) • 8x50GE: 32 (per fan-out)
Max. Streams per port and NRZ speeds	• 1x200GE: 128 (per FPP) • 2x100GE: 128 (per fan-out) • 4x50GE: 32 (per fan-out) • 2x40GE: 64 (per fan-out) • 8x25GE: 32 (per fan-out) • 8x10GE: 32 (per fan-out)
Stream controls	• Rate and frame size change on the fly • Advanced stream scheduler support • Optional sequential stream scheduler support (must be ordered as a factory installed option-no field upgrade is available)
Minimum frame size	800GE, 400GE, 200GE and 100GE PAM4 speeds: • 64 bytes at full line rate • 61 bytes at less than full line rate (approximately 90% utilization) • 400GE, 200GE, 100GE and 50GE PAM4 speeds: • 64 bytes at full line rate • 60 bytes at less than full line rate • 100GE, 50GE, 40GE, 25GE, and 10GE NRZ speeds: • 64 bytes at full line rate
Maximum frame size for all speeds	14,000 bytes
Maximum frame size in data center Ethernet	9,216 bytes
Priority flow control (4:1) for 800GE,400GE PAM4 and 100GE NRZ speeds	• 4 line-rate-capable queues, each supporting up to 9,216-byte frame lengths • 1 line-rate-capable queue, non-blocking supporting up to

	9,216-byte frame length
Frame length controls	Fixed, increment by user-defined step, weighted pairs (up to 14K in 400/200/100GE, uniform, repeatable random, IMIX, and Quad Gaussian
User-Defined Fields (UDF)	Fixed, increment or decrement by user-defined step, sequence, value list, and random configurations; up to 10, 32-bit-wide UDFs are available
Value lists (max.) per port for 800GE PAM4 speeds	• 1x800GE: 64K / port /UDF • 2x400GE: 64K / port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 64K / 4-ports /UDF
Value lists (max.) per port for 400GE PAM4 speeds	• 1x400GE: 64K /port /UDF • 2x200GE: 32K /port /UDF • 4x100GE: 64K /4 ports /UDF • 8x50GE: 32K /4 ports /UDF
Value lists (max.) per port for NRZ speeds	• 1x200GE: 32K/port/UDF • 2x100GE: 64K /4 ports /UDF • 4x50GE: 32K /4 ports /UDF • 2x40GE: 64K /4 ports /UDF • 8x25GE: 16K /4 ports /UDF • 8x10GE: 16K /4 ports /UDF
Sequence (max.) for 800GE PAM4 speeds	• 1x800GE: 32K / port /UDF • 2x400GE: 32K /port /UDF • 4x200GE: 32K /port /UDF • 8x100GE: 8K / 4-ports /UDF
Sequence (max.) for 400GE PAM4 speeds	• 1x400GE: 32K / port /UDF • 2x200GE: 32K / port /UDF • 4x100GE: 8K / port /UDF • 8x50GE: 4K / port /UDF
Sequence (max.) for NRZ speeds	• 1x200GE: 32K/port/UDF • 2x100GE: 8K / port /UDF • 4x50GE: 4K / port /UDF • 2x40GE: 4K / port /UDF • 8x25GE: 4K / port /UDF • 8x10GE: 4K / port /UDF

Error generation (FEC and standard Keysight L2/3 Ethernet in 800GE PAM4 mode only)	1x800GE, 2x400GE, and 4x200GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 800/400/200GE • No FEC error insertion and related statistics for 8x100GE 1x800GE, 2x400GE, 4x200GE, 8x100GE L2/3 Ethernet: • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum
Error generation (FEC and standard Keysight L2/3 Ethernet in 400GE PAM4 mode only)	400GE and 2x200GE FEC: • FEC symbol error-injection allows the user to inject FEC symbol errors using various weighted methods to achieve specific bit error rates (BER) for 400/200GE • No FEC error insertion and related statistics for 4x100GE and 8x50GE
Error generation (FEC and standard Keysight L2/3 Ethernet in 100GE NRZ mode only)	• No FEC error insertion for all NRZ speeds • Generate good CRC or force bad CRC, undersize and oversize standard Ethernet frame lengths, and bad checksum
Physical coding sublayer for 800GE and 400GE PAM4 Ethernet speeds	800GE: 2x400GE and 4x200GE, and 400GE: 1x400GE and 2x200GE • PCS Transmit lane marker re-mapping • PCS lane skew insertion
Physical coding sublayer for NRZ Ethernet speeds	100GE: 1x100GE and 2x40GE: • PCS Transmit lane marker re-mapping
Hardware checksum generation	Checksum generation for IPv4, IP over IP, ICMP/GRE/TCP/UDP, L2TP, GTP, and multilayer checksum; support for protocol verification for control plane traffic
Link fault signaling for all speeds	• Reports, no fault, remote fault, and local fault port statistics • Generate local and remote faults with controls for the number of faults and order of faults • Option to have the transmit port ignore link faults from a remote link partner and send traffic anyway
Latency measurement resolution for 800GE and 400GE PAM4 Ethernet speeds	• 800GE and 400GE: 0.625 ns • 200GE: 1.25 ns • 100GE and 50GE: 2.5 ns
Latency measurement resolution for 100GE NRZ	• 2.5 ns for all NRZ speeds

Ethernet speeds	
Intrinsic latency compensation	Removes inherent latency error from the port electronics for all speeds
Transmit line clock adjustment	Ability to adjust the parts-per-million (ppm) line frequency: +/- 105 ppm on all the ports of the fixed chassis system for all speeds Ability to adjust the clock ppm over a range of +/- 105 ppm in the BERT mode on a per lane basis
Transmit/receive loopback	Internal loopback
Receive feature specifications	
Receive engine	Wire-speed packet filtering, capturing, real-time latency, and inter-arrival time for each packet group, with data integrity, and sequence checking capability
Trackable receive flows per port without Sequence checking and with Tx/Rx synch for 800GE PAM4 Ethernet speeds	• 800GE, 400GE, 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics
Trackable receive flows per Port with and without Sequence checking and no Tx/RX synch for 800GE PAM4 Ethernet speeds	• 800GE, 400GE, 200GE: 32K full statistics • 100GE: 8K full statistics and 32K with minimum statistics
Trackable receive flows per port with and without Sequence Checking with Tx/Rx Synch for 400GE PAM4 and 100GE NRZ Ethernet speeds	• 400GE and 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics • 50GE, 40GE, 25GE, 10GE: 4K full statistics and 16K with minimum statistics
Trackable receive flows per port with and without Sequence Checking and no Tx/RX Synch for 400GE PAM4 and 100GE NRZ Ethernet speeds	• 400GE and 200GE: 32K full statistics • 100GE: 4K full statistics and 32K with minimum statistics • 50GE, 40GE, 25GE, 10GE: 8K full statistics and 16K with minimum statistics
Minimum frame size for all speeds	64 Bytes
Filters (user-defined statistics, UDS)	2 SA/DA pattern matchers, 2x16-byte user-definable patterns. 6 UDS counters are available with offsets for start of frame
Hardware capture buffer	1 MB per front panel OSFP800 port and for fan-out modes on that

	port
Standard statistics and rates	Link state, line speed, frames sent, valid frames received, bytes sent/received, fragments, undersize, oversize, CRC errors, 6 user-defined stats, capture trigger (UDS 3), capture filter (UDS 4), data integrity frames, data integrity errors, sequence checking frames, sequence checking errors, ARP, and PING requests and replies
FEC Statistics for 800GE and 400GE PAM4 Ethernet Speeds	800GE and 400GE: • FEC port statistics: Total Bit Errors, Max Symbol Errors, Corrected Codewords, Total Codewords, Uncorrectable Codewords, Frame Loss Ratio, Pre-FEC Bit Error Rate, and Codeword error distribution analysis. • FEC per lane Rx statistics: FEC Symbol Error Count, Corrected Bits Count, Symbol Error Rate, Corrected Bit Rate
FEC Statistics 100GE NRZ Ethernet speeds	100GE NRZ speeds: • 100GE FEC statistics: ◦ RS-FEC Corrected and uncorrectable codewords 50GE and 25GE FEC statistics: • RS-FEC corrected and uncorrected codeword count • FC-FEC corrected and uncorrected block count • FC-FEC corrected error bits
Latency / jitter measurements	Cut-through, store and forward, forwarding delay, latency/jitter, MEF jitter, and inter-arrival time
Receive-side PCS lanes port statistics counters for all speeds	PCS: Sync Errors, Illegal Codes, Remote Faults, Local Faults, Illegal Ordered Set, Illegal Idle, and Illegal SOF
PCS receive-side statistics and indicators for 800GE and 400GE PAM4 Ethernet speeds	Per-lane PCS receive capabilities include: • Receive — per-lane PCS receive statistics, Physical Lane assignments, Lane Marker Lock, Lane Market Map, Relative Lane Skew, Lane Marker Error Count • Receive — per-lane FEC receive statistics; FEC Symbol Error Count, FEC Corrected Bits Count, FEC Symbol Error Rate, FEC Corrected Bit Rate

NOTE In the unlikely event that the unit stops working and does not automatically restore the previous session due to an ESD event, the unit must be manually restarted.

Application Support

The Keysight application support for AresONE 800GE Dual Interface Model-M is provided in the following table:

AresONE 800GE Dual Interface Model-M Reduced Performance
IxNetwork: Wire-rate traffic generation with service modeling that builds realistic, dynamically controllable data-plane traffic. IxNetwork offers the industry's best test solution for functional and performance testing by using comprehensive emulation for routing, switching, MPLS, IP multicast, broadband, authentication, Carrier Ethernet, and data center Ethernet protocols. Included with IxNetwork are test automation tools based on TCL, Python, and the Rest/RestPy.
IxExplorer: Layer 1-3 wire-speed traffic generation, capture, and analysis with Forward Error Correction and error injection with statistics, PCS Lanes Tx/Rx with statistics and reporting capability.
Tcl API: Custom user script development for Layer 1-3 testing using the IxExplorer features.

Transceiver and Cable Support

The transceivers and cables supported by AresONE 800GE Dual Interface Model-M are provided in the following table:

Transceiver/Cable	Description
800GE optical transceivers	
OSFP800-DR8-XCVR	Keysight, OSFP800-DR8-XCVR, 800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0071). CMIS 4.0 compliant. Compatible with Ixia cables: OSFP800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and OSFP800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter. This transceiver is compatible with all AresONE 800GE OSFP800-C and OSFP800-M fixed chassis models, and with the G800GE-02 800GE OSFP800 and OSFP800-COAX chassis models.
QSFPDD800-DR8-XCVR	Keysight, QSFPDD800-DR8-XCVR, 800GBASE-DR8, Single Mode Fiber, 500-meter reach with FEC, 1310nm center wavelength, 100G Lambda, optical transceiver (948-0068). CMIS 4.0 or higher version compliant. Compatible with Ixia cables: QSFPDD800-DR8-CBL MPO16 APC-APC, SMF, 3-meter and QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, SMF, MPO16-to-8x100GE LC, 3-meter. This transceiver is compatible with all models of AresONE 800GE QSFP-DD800-C, QSFP-DD800-C, QSFP-DD800-M and QSFP-DD800-M fixed chassis. It is compatible with all models of the G800GE QSFP-DD800 and QSFP-DD800-COAX and G800GE-02 QSFP-DD800 and QSFP-DD800-COAX chassis.

Transceiver/Cable	Description
800GE fiber point-to-point cable	
OSFP800-DR8-CBL	Keysight, OSFP800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0146) for OSFP-DR8 800GE optical transceiver, part number OSFP800-DR8-XCVR.
QSFPDD800-DR8-CBL	Ixia, QSFPDD800-DR8-CBL, point-to-point, MPO16, APC-APC, Single Mode Fiber (SMF) cable, 2-meter length (942-0144) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.
Optical transceiver fan-out cable	
OSFP800-DR8-FO-CBL	Keysight, QSFP800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0147) for OSFP-DR8 800GE optical transceiver, part number OSFP800-DR8-XCVR.
QSFPDD800-DR8-FO-CBL	Ixia, QSFPDD800-DR8-FO-CBL, fan-out, MPO16, APC-UPC, Single Mode Fiber (SMF) cable, MPO16-to-8x100GE LC, 2-meter length (942-0145) for QSFPDD-DR8 800GE optical transceiver, part number QSFPDD800-DR8-XCVR.
OSFP800 Passive copper Direct Attached Cable (DAC)	
OSFP800-1M-CBL	Keysight, OSFP800 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1-meter length (942-0158). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-C and OSFP800-M, fixed chassis models.
OSFP800-1-5M-CBL	Keysight, OSFP800 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1.5-meter length (942-0159). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-C and OSFP800-M, fixed chassis models.
OSFP800-2M-CBL	Keysight, OSFP800-2M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable (DAC), 25 AWG, 2-meter length (942-0164). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-M, fixed chassis models.
Passive copper conversion Direct Attached Cables (DAC) – OSFP800-to-QSFP-DD800	
Q800G-O800G-1M-CBL	Keysight, QSFPDD800-to-OSFP800-CBL 800GE 800GBASE-R passive copper, conversion Direct Attach Cable (DAC), 26 AWG, 1-meter length (942-0155). This copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP-DD800-C, AresONE 800GE QSFP-DD800-M, AresONE 800GE OSFP800-C, AresONE 800GE OSFP800-M fixed chassis models.
QSFPDD800-1M-CBL	Keysight, QSFPDD800-1M-CBL 800GE 800GBASE-R passive copper,

Transceiver/Cable	Description
	Direct Attach Cable, 28 AWG, 1-meter length (942-0153). This copper DAC is a single point-to-point cable and is compatible with all models of AresONE 800GE QSFP-DD800-C, QSFP-DD800-C, QSFP-DD800-M and QSFP-DD800-M fixed chassis. It is compatible with all models of the G800GE-02 QSFP-DD800 and QSFP-DD800-COAX chassis.
OSFP800-1-5M-CBL	Keysight, OSFP800 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1.5-meter length (942-0159). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-C and OSFP800-M, fixed chassis models.
QSFPDD800-1-6M-CBL	Keysight, QSFPDD800-1-6M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable, 28 AWG, 1.6-meter length (942-0154). This copper DAC is a single point-to-point cable and is compatible with all models of AresONE 800GE QSFP-DD800-C, QSFP-DD800-C, QSFP-DD800-M and QSFP-DD800-M fixed chassis. It is compatible with all models of the G800GE-02 QSFP-DD800 and QSFP-DD800-COAX chassis.
OSFP800-2M-CBL	Keysight, OSFP800-2M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable (DAC), 25 AWG, 2-meter length (942-0164). This passive copper conversion DAC is a single point-to-point cable and is compatible with all AresONE 800GE OSFP800-M, fixed chassis models.
QSFPDD800-2M-CBL	Keysight, QSFPDD800-2M-CBL 800GE 800GBASE-R passive copper, Direct Attach Cable (DAC), 26 AWG, 2-meter length (942-0163). This passive copper DAC is a single point-to-point cable and is compatible with all AresONE 800GE QSFP-DD800-M, fixed chassis models.

Status Icons

AresONE 800GE Dual Interface Model-M includes a full-color graphics display which includes a series of colored icons indicating the system health.

The description of the icons are provided in the following table.

Icon Name	Icon Image	Icon State	Description
Alert		Grey	All systems are OK
		Green	Not Applicable (N/A)
		Yellow	An error occurred
		Red	N/A

Icon Name	Icon Image	Icon State	Description
Power		Grey	Power information not available
		Green	Power is OK
		Yellow	N/A
		Red	Power statistics unavailable or have exceeded limits
Server		Grey	IxServer has not started
		Green	IxServer is running and in the READY state
		Yellow	IxServer is running and in the BOOTING state
		Red	IxServer is stopped, or exited with an error
Network		Grey	Network is disconnected
		Green	Network is connected and has an IP address
		Yellow	Network is connected and acquiring an IP address
		Red	Network error
Management		Grey	No active management sessions
		Green	N/A
		Yellow	At least one management session is active
		Red	N/A

Mechanical Specifications

Front Panel

The front panel of the AresONE 800GE Dual Interface Model-M is shown in the following figure (applies to 4-port variant):

Front Panel Switch and Power LED

The front panel switches and indicators are provided in the following table:

Feature	Specification
Front Panel Switches	On/Off momentary power push button: • Short press (0.5-2 seconds) - Graceful system shutdown - allow up to 30 seconds before power-off. • Long press (4 seconds) - Force Power Shutdown - immediate
Front Panel Power LED	Off - Indicates Powered Off, No Standby Power
	Blinking Blue - Indicates Powered Off, Standby power connected
	Solid Blue - Indicates Powered On

Front Panel Port LEDs

Each port has four LEDs to indicate link state and activity. The LED panel specifications are provided in the following table.

MODE LED	TX STATUS	RX STATUS	FEC
• Solid Green – PAM4 • Solid Red – Card fault • Solid Yellow – NRZ • Off – No power to the card or port	• Solid Red – All links down • Solid Green – All inks up • Solid Yellow – Some links up • Blinking	Application Mode: • Blinking Red – RX active with errors • Blinking Green – RX active with no errors received	• Blinking Red – Uncorrectable FEC errors • Blinking Green – Correctable FEC errors • Solid Green – No errors • Off - FEC not enabled

MODE LED	TX STATUS	RX STATUS	FEC
	(Red, Green or Yellow)– TX is active	• Off – Port is inactive BERT Mode: • Blinking Green – PRBS locked all lanes • Blinking Yellow – PRBS locked on some lanes • Blinking Red – PRBS not locked on any lane • Off – Port is inactive	

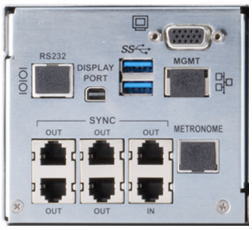
Rear Panel

The Rear panel of the AresONE 800GE Dual Interface Model-M 4-port variant is shown in the following figure:

1	Field replaceable power supplies	Mandatory to have all 3 power supplies plugged in for both 4 port and 8 port. See Fixed Chassis System Electrical Power.
2	Field replaceable fans	Front to back airflow

3	Rear Panel ports	Utility/Sync/MGMT ports

Rear Panel Ports



Port Label	Description	Additional Information
RS232	Serial Console Port	Serial console access for system management. Terminal settings: 115200 N-8-1, No Parity, No Flow Control
	Mini Display Port (mDP)	Digital Video / Monitor output for system management.
	USB 3.0 Ports	Keyboard, Mouse or other peripheral for system management
	VGA	Analog Video / Monitor output for system management
	Management Network Interface	100/1G/10G management port for connection to your network
SYNC OUT / IN	Sync Connectors	For synchronization with up to 5 additional XGS12, XGS2 or AresONE systems using a Star topology. NOTE Daisy chaining topology with AresONE systems using both Sync In and Out is not supported)
METRONOME	Metronome Sync Connector	For metronome synchronization

Rear Panel MGMT Port LEDs

The Rear Panel MGMT Port LED specifications are same as that for AresONE. See AresONE Rear Panel MGMT Port LEDs.

Power Supply LEDs

The power supply LED specifications are same as that for AresONE. See AresONE Power Supply LEDs.

Chassis Synchronization

There is an increased need of chassis synchronization to run mixed speed port tests with the AresONE 800GE OSFP-M fixed chassis.
This ability to sync with other chassis differentiates it from an appliance.
Since AresONE 800GE has five sync out ports, an AresONE 800GE acting as primary chassis can sync five more AresONE 800GE fixed chassis or XGS chassis.

For more details, see AresONE Chassis Synchronization.

Cooling Fan Speed Control

The AresONE 800GE fixed chassis automatically monitors and measures the temperature of installed units. The fixed chassis automatically adjusts the fan speed to maintain proper cooling.

Rack Mount Cautions

If this unit is installed in a network equipment rack, please observe the following precautions:

1. Elevated Operating Ambient Temperature: If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient temperature. Therefore, consider installing the equipment in an environment that is compatible with the maximum allowable ambient temperature specified for the chassis (35° C).
2. Reduced Air Flow: Install the equipment in a rack so that the amount of air flow required for safe operation of the equipment is not reduced. Do not block the sides of the chassis, and leave approximately 8 inches of space, on either sides of the unit for proper ventilation. The air flow clearance should be 8 inches on either sides.
3. Mechanical Loading: Mount the chassis so that it is level in the rack and that a hazardous condition is not caused.
4. Circuit Overloading: Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.
5. Reliable Earthing: Maintain reliable earthing (grounding) of rack-mounted equipment. Appliance frame should be screwed down to racks to ensure proper grounding path. In addition, pay special attention to supply connections other than direct connections to the branch circuit (such as use of power strips).
6. Replacement of the power supply cord must of the same type cord and plug configuration that was shipped with the unit.

Précautions relatives au montage en rack

Si cette unité est installée dans une baie d’équipement réseau, observer les précautions suivantes:

1. Température ambiante élevée: si installée dans un assemblage de baie fermé ou contenant plusieurs unités, la température ambiante de l’installation peut etre plus élevée que la température ambiante de la pièce. En conséquence, penser a installer l’équipement dans un environnement compatible avec la température ambiante maximale autorisée (35 C) spécifiée pour l’appareil.

2. Circulation d’air réduite: installer l’équipement dans une baie de manière a ce que la circulation d’air requise pour faire fonctionner l’équipment en toute sécurité ne soit pas réduite. Ne pas bloquer les côtés de l’appareil, et laisser approximativement un espace de 12 pouces, de préférence 24 pouces, de chaque côté de l’unité pour une ventilation adéquate. L’espace laisse libre pour la circulation de l’air doit être de 12 pouces de chaque côté.
3. Montage mécanique: monter l’appareil de manière a s’assurer qu’il soit droit dans la baie afin d’éviter de créer une condition dangereuse
4. Un soin particulier doit etre apporté au branchement de l’équipement au circuit d’alimentation et aux conséquences qu’une charge excessive des circuits pourrait avoir sur le système de protection contre les surcharges et sur le cablâge d’alimentation. Prendre des précautions d’usage en prêtant attention aux normes figurant sur la plaque d’identification de l’équipement.
5. Mise a la terre fiable: maintenir une mise a la terre fiable de l’équipement monté en baie. L’appareil doit etre vissé sur la baie afin d’assurer une mise a la terre correcte. De plus, faire particulièrement attention aux alimentations en courant autres que celles provenant de connections directes au circuit de dérivation (par exemple utilisation de prises multiples).
6. Le remplacement du cordon d’alimentation doit comporter le même type de cordon et le même type de prise que ceux livrés avec l’unité.

NOTE For instructions on rack mounting and administration of the AresONE 800GE fixed chassis, see the *AresONE Native IxOS Getting Started Guide*.

CHAPTER 42

XAir XM Module

Ixia's new XAir is the next generation hardware for LTE UE emulation. It delivers the unparalleled LTE performance in the smallest footprint providing the industry highest UE density. This module will allow LTE Advanced feature support. The XM/XG platform can easily expand to support additional sectors.

With the XAir module, complex subscriber modeling can be achieved with the following parameters:

- 1000 UEs per sector
- Voice (VoLTE), Video and Data Traffic Support
- QoE analysis and scoring of each traffic stream
- Mobility over multiple sectors
- Channel Modeling per UE

Each XAir board supports one sector, with 1 Gbps Ethernet ports connected to the IxLoad Xcellon NP or IxCatapult m500/p250 chassis. It also supports up to 4 CPRI interfaces to an eNB or to Ixia's Remote Radio Head r10 units that cover all FDD & TDD frequency bands.

Key Features

- Highest density LTE UE emulation starting at 1000 connected active UEs per board
- Board has its own high accuracy 10MHz clock for eNB synchronization
- Based on Ixia's NP technology for line-rate traffic through a large number of connections
- Fully compatible with the Ixia XM/XG chassis and load modules for seamless testing with other Ixia hardware and test applications.

Specifications

XAir Module Specifications

Hardware Specification	
Number of Ports	3x 1 Gbps Ethernet ports, 1x 10 Gbps Ethernet port, 4x Optical SFP+ CPRI ports, 1x Serial port, SMA Clock In/Out and Analog Out
Physical	
Form Factor	1U Module for insertion into Ixia XM/XG chassis
Height	12.00" (304.8mm)
Width	1.28" (32.5mm)
Depth	15.95" (405.1mm)
Gross Weight	7.5 lbs (3.4kg)
Power Consumption	184 Watts

CHAPTER 43

XAir2 LTE Module

The XAir2 LTE load module supports LTE UE simulation at the 3GPP LTE UU interface. The XAir2 module provides a rich array testing capabilities for all layers of 3GPP LTE User Equipment including the PHY, MAC, RLC, PDCP, RRC and NAS protocols. In conjunction with the Ixia PerfectStorm 10G Load Module and IxLoad, the XAir2 provides a complete evolved Node-B (eNB) test environment in a single powerful, intuitive, and easy to use system. Application layer traffic such as VoLTE, HTTP, FTP and streaming video can be generated on 1 or 1000s of simulated UEs. These simulated UEs can support the latest LTE Advanced PRO functionality for increased throughput such as multiple carrier aggregation (FDD and TDD).

XAir2 provides all of the key features and capabilities provided by the previous generation XAir XM module. In addition, the XAir2 module provides support for an increased number of carriers, increased throughput and the latest of LTE-Advanced and LTE-Advanced PRO PHY and MAC functionality.

Key Features

The XAir2 LTE load module features continue to be significantly enhanced with a steady stream of frequent and new software releases. New features and enhancements to existing features as defined in the 3GPP Release 10, Release 11,12 and 13 3GPP specifications. Not all of the features listed below will be available in the initial release. For a detailed description of available features, please consult Ixia representative.

- 4 Primary Carriers
- FDD and TDD duplex, selectable on each carrier
- LTE-Advanced Carrier Aggregation (2CA through 5CA)
- 4 CPRI Ports supporting CPRI line rates 3,5 and 7 (2457.6 to 9830.4 Mbit/s)
- SISO, 2x2 and 4x4 MIMO antenna configurations
- Transmission Modes ranging from TM1 to TM9
- Up to 256QAM Downlink and 64QAM Uplink
- Built-in high accuracy Stratum 1 10MHz clock
- LTE Advanced PRO Licensed Assisted Access (LAA)
- 1000s of simulated UEs
- Mobility validation with Handover and ReEstablishment scenarios
- Standard and Custom Channel Modeling features
- Support for simulated UE Categories 1-7 and 9-12
- Application support for IxLoad Voice, Video and Data protocols including VoLTE, HTTP, FTP

- Tcl and automation APIs
- Supports the Ixia Wideband Radio with support for all bands in the range of 400 MHz to 6 GHz

Part Numbers

Part Numbers for XAir2 LTE Load Module and Supported Adapters are provided in the following table.

Part Numbers for XAir2 LTE Module

Model Number	Part Number	Description
XAir2	960-0518	• 3GPP LTE UE Simulation Module • 1-slot • CPRI and 10GE interfaces • IxLoad Application Test Support

Specifications

The load module specifications are contained in the following table.

XAir2 LTE Load Module Specifications

Feature	NOVUS-R100GE8Q28+FAN
Hardware Load Module Specifications	
Chassis Slots Used	1 slot
Physical Interfaces per module	16
Number of CPRI Ports	4
Number of 10G Ethernet Ports	1
CPU and Memory	Multicore processor with 32GB Memory
Load Module Dimensions	17.3” (L) x 1.3” (W) x 12.0” (H) 440mm (L) x 33mm (W) x 305mm (H)
Load Module Weights	Module only: 12.9 lbs (5.85 kg) Shipping: 19.7 lbs (8.94 kg)
Temperature	Operating: 41°F to 104°F (5°C to 40°C)

Feature	NOVUS-R100GE8Q28+FAN
	Storage: 41°F to 122°F (5°C to 50°C)
Humidity	Operating: 0% to 85%, non-condensing Storage: 0% to 85%, non-condensing
Chassis Capacity: Maximum Number of XAir2 Cards per Chassis Model	
XGS12-SD Chassis (940-0011)	12 load modules, 48 carriers
XGS2-SD Chassis (940-0010)	2 load modules, 8 carriers
LTE PHY Features	
Number of carriers	4 carriers per XAir2 module
Bandwidths	5,10,15,20 MHz
CPRI line rate options	3,5 and 7 (2457.6, 4915.2, 9830.4 Mbit/s)
Bands	Supports all 3GPP defined LTE bands in the 400MHz to 6000 MHz range
Duplex	FDD, TDD
Physical Antenna Configurations	1x1, 2x2
Transmission Modes	TM1, TM2, TM3, TM4
Carrier Aggregation	2CA and 3CA Downlink in all R12 supported combinations of FDD and TDD
Channel Modeling	Custom channel modeling and pre-defined DL channel models based on 3GPP TS 36.101 (AWGN, EPA5Hz, EVA5Hz, EVA70Hz, ETU70Hz, ETU300Hz, HST)
Layer 4-7 Application Traffic Testing Support	
Data	UDP, HTTP, HTTPS, TCP Session, FTP
Video	RTSP, IPTV, VoD
Voice	Advanced VoIP SIP & RTP, Audio & Video Codecs, VoLTE, MSRP, SMS, includes: Voice Quality and Video Quality for conversational video traffic
Access	IPv4, IPv6

Application Support

The Ixia application support for the XAir2 load module is provided in the following table:

XAir2 LTE Load Module Application Support

Application	Support
Tcl API	Allows custom user script development for layer 2-7 testing.
IxLoad	Provides a scalable L4-7 solution for simulating a broad variety of traffic mixes commonly found on LTE User Equipment devices including Voice, Video and Data.

Additional Specifications

Front Panel

There are a total of 16 SFP+ transceiver ports on the XAir2 front panel with 8 labeled CPRI 1-8 and 8 more labeled Port 1-8. Not all ports are currently used on the XAir2 LTE product with the remaining unused ports available for possible future expansion features. The ports currently supported are CPRI 1, CPRI 2, CPRI 5, CPRI 6 and Port 4.

The front panel of the XAir2 LTE load module is shown in the following figure:

Figure: Front panel of XAir2 Load Module

LED Panel

The XAir2 LTE card has 16 multi-color LEDs visible on the front panel. Each LED is located directly below or directly above a SFP+ transceiver port. These LEDs provide you with a visible status related to the operation of each of the XAir2 ports. Not all SFP+ ports are currently used on the XAir2 module as described above. Therefore, the LEDs associated with ports that are not used are off. A description of the LEDs for the ports that are active on the XAir2 module are described in the table below.

LED panel Specifications for XAir2 LTE Load Module

SFP+ Port Label	Active Port Numbers	Description	
		LED Color	Meaning
CPRI	1, 2, 5, 6	Off	No test actively running
		Red	Test running, no CPRI sync
		Blue	Test running, CPRI Hyperframe sync but no LTE radio frame alignment
		Yellow	Test running, CPRI Hyperframe sync and Radio Frame alignment successful, but no BCH sync
		Green	Test running and BCH is being decoded
PORT	4	Off	No Link or no test actively running
		Yellow	Test running, No Link Status on 10GE
		Green	Test running, 10GE Link Status

NOTE If more than one carrier is configured to utilize the same CPRI port, it is possible that one carrier is indicating Yellow (Radio Frame Alignment) and the second carrier is indicating Green (BCH decoded). In this case, the LED color will be Yellow, indicating that at least one of the carriers is not successfully decoding BCH. An example of this scenarios is where the radio is being used to support 2 independent 2x2 MIMO carriers (primary carriers or a primary and secondary carrier). The radio has a single CPRI connection supporting both carriers in this configuration. This would be different than the radio supporting a single 4x4 carrier.

Transceivers and Cables

The XAir2 LTE load module supports optical transceivers and fiber cables for each of the physical interfaces that are enabled for the product. The following SFP+ transceivers are supported and qualified on the specified SFP+ port.

Transceivers and Cables for XAir2 LTE Load Module

SFP+ Port Label	Active Port Numbers	Ixia Part Number	Description
CPRI	1, 2, 5, 6	988-0012	Optical Singlemode, LC-LC 1310nm transceiver with pluggable SFP+ interface and 3m LC-LC singlemode optical cable. This provides the direct CPRI connection to the Ixia 6 GHz Wideband Radio.

SFP+ Port Label	Active Port Numbers	Ixia Part Number	Description
			NOTE This SFP+ transceiver is also compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules and appliances.
PORT	4	988-0011	Optical Multimode, LC-LC 850nm transceiver with pluggable SFP+ interface and 3m LC-LC multimode optical cable. This SFP+ and cable provides the connectivity between the PerfectStorm L4-7 IxLoad application module and the XAir2 LTE module through the 10 Gigabit Ethernet Switch provided with the Ixia LTE Access XGS Connection Kit. NOTE This SFP+ transceiver is also compatible with all 10/1 Gigabit Ethernet Novus, PerfectStorm, and Firestorm load modules and appliances.
		955-8123	Optical Multimode, LC-LC 850nm transceiver with pluggable SFP+ interface and 3m LC-LC multimode optical cable. This SFP+ and cable provides the connectivity between the PerfectStorm L4-7 IxLoad application module and the XAir2 LTE module through the 10 Gigabit Ethernet Switch provided with the Ixia LTE Access XGS Connection Kit.

Additional Hardware Required with XAir2 LTE

General Information

The complete XAir2 LTE Access UE Simulation solution requires several other hardware and software components. The additional hardware items are listed in the table below.

Additional Hardware Required with the XAir2 LTE Module

Category	Options	Ixia Part Number
Chassis	XGS12-SD, 12-slot chassis bundle with Standard Processor Module	940-0011
	XGS2-SD, 2-slot chassis bundle with Standard Processor Module	940-0010
Connection Kit	LTE Access XGS Connection Kit. One connection kit is required for every chassis with an XAir2 module present	949-1035

Category	Options	Ixia Part Number
Radio	LTE Access 6GHz Wideband Radio	949-1034
Radio Connection Enclosure	LTE Access Radio Connection Enclosure (RCE) Standard 700 MHz-2700MHz	949-1026
	LTE Access Radio Connection Enclosure (RCE) High Band 1000MHz-3900MHz	949-1029

Radio

The XAir2 Module is connected to the Device Under Test (DUT), typically an evolved-NodeB (eNB) through a Radio Frequency (RF) connection provided by the Ixia 6GHz Wideband Radio. The specifications for this radio are provided in the table below.

Figure: Ixia 6GHz Wideband Radio

LTE Access 6GHz Wideband Radio

Feature	XAir2 Specification
Physical Dimensions	
General	19” Rack Mount
Height	1U
Depth	<500mm
Weight	<12kg
Mounting	Tool-less Rack Mount Kit (included)
Environmental	
Operating Temperature	+5C to +50C
Humidity	0% to 85%, non-condensing
Power	
Mains Power	100 – 240 VAC, 50-60 Hz
Front Panel Interfaces	

Feature	XAir2 Specification
Receiver inputs	4 SMA connectors, female
Transmitter outputs	4 SMA connectors, female
Status LED	16 multi colour LEDs
Rear Panel Interfaces	
Mains input	IEC-C14
CPRI	Duplex LC
Ethernet	RJ45 NOTE The Ethernet Port is designed for compatibility with an Ethernet cable meeting the requirements for Category 5e or Category 6, however the Ethernet port is not used in the Ixia IxLoad LTE Access solution and no Ethernet cable is required.
RF Specifications	
Frequency Range	400MHx – 5925MHz
Bandwidths Supported	5MHz, 10MHz, 15MHz, 20MHz
Display status indication	
Sys Clk	• Green Flashing = Not locked • Green=Locked
SFP1 status (Only SFP 1 on Radio 0 is externally accessible)	• Off=SFP not present • Orange = Initializing • Green = Link active
AxC TX (TX baseband configuration status)	• Orange = Awaiting config • Green = Configured for data
AxC RX	• Orange = Awaiting config

Feature	XAir2 Specification
(RX baseband configuration status)	• Green = Configured for data
RF TX ports	Green = Active
RF RX ports	Green = Active
STS (CPRI link embedded Ethernet status)	• CPRI link embedded Ethernet status: • Orange = Initialising • Flashing Green = Network discovery • Green = configured to network

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CHAPTER 44

IXIA XAir3 Appliance

This chapter provides details about XAir3, its specifications, and features. XAir3 provides 5G NR user equipment (UE) emulation that enables a powerful Layer 1 to 7 test solution.

Key Features

The key features of XAir3 Appliance are as follows:

- Full-featured 5G NR UE emulation within all FR1 Sub6 GHz bands with 100 MHz Bandwidth.
- Designed for 5G
- Initially NSA, software upgradable to SA
- Uses current gen 4G UE Emulation system as LTE Anchor
- Baseband + lower Mac-layer functions
- Support for both sub 6GHz and mmWave
- Support for 2x2, 4x4 MIMO
- Support for aggregated carriers
- eCPRI at 25GbE

Part Numbers

Part Numbers for XAir3 Appliance is provided in the following table.

Part Numbers for XAir3 Appliance

Model Number	Part Number	Description
XAir3	960-0889	XAir3 appliance for 5G NR UE emulation

Specifications

The appliance specifications are contained in the following table.

XAir3 Appliance Specifications

Feature	XAir3
XAir3 Baseband Fixed Chassis System Specifications	
Fixed Chassis System Dimensions	30.3” (L) x 17.3” (W) x 3.46” (H) • 770mm (L) x 438.2mm (W) x 88mm (H)
Fixed Chassis System Weights	• Hardware only: 74.6 lbs (33.84 Kg) • Shipping: 94.5 lbs (42.86 Kg) approximately NOTE Shipping weight includes weight of slides, power cords, sync cables, and packaging materials.
Fixed Chassis System Electrical Power	• Operates on 100-240 VAC, 50/60 Hz • 200-240 VAC is single phase • Requires three power sources when running 100-120 VAC, 9 Amps for each power supply. XAir3 fixed chassis is shipped with three 100-125 VAC power cords. • Requires two power sources when running 200-240 VAC, 7 Amps for each power supply. For 200-240 VAC power cords, order part number 942-0110. Contact Ixia Support for ordering. The kit is provided free with the purchase of a XAir3 fixed chassis when 200-240 VAC is required. NOTE Power specifications are preliminary and are for reference for initial facility planning purposes.
Temperature	• Operating: 41°F to 95°F (5°C to 35°C) • Storage: 41°F to 122°F (5°C to 50°C)
Humidity	• Operating: 0% to 85%, non-condensing • Storage: 0% to 85%, non-condensing

Appendix A: Available Statistics

This appendix covers the available statistics for the following different card types:

- Statistics for 10/100 TXS Modules. These cards include the following:
  - 10/100 TX8 (LM100TX8)
  - 10/100 TXS8 (LM100TXS8)
- Statistics for 10/100/1000 TXS, 10/100/1000 XMS(R)12, 1000 SFPS4, and 1000STXS24 Cards. These cards include the following:
  - 10/100/1000 STXS2, STXS4, STXS24 (LM1000STXS2/4)
  - 10/100/1000 XMS12, XMSR12 (LSM1000XMSR12)
- Statistics for 10/100/1000 LSM XMV(R)4/8/12/16, and 10/100/1000 ASM XMV12X Cards. These cards include the following:
  - 10/100/1000 XMV4/8/12/16, XMVR4/8/12/16 (LSM1000XMV4/8/12/16, LSM1000XMVR4/8/12/16)
  - 10/100/1000 ASM XMV12X
- Statistics for 2.5G MSM POS modules. These cards include the following:
  - 2.5 Gigabit MSM POS OC-48c modules (MSM2.5G1-01)
- Statistics for OC192c Modules with BERT, Statistics for OC192c Modules with SRP and DCC, and Statistics for OC192c Modules with RPR and DCC. These cards include the following:
  - OC192c with optional BERT and 10 Gigabit Ethernet. (LMOC192cPOS+BERT, LMOC192cPOS+BERT+WAN)
  - OC192c VSR. Note that all VSR cards have available all of the VSR statistics listed in the **VSR** section of **Table B-6 on page B-25.** (LMOC192cVSR-POS, LMOC192cVSR-BERT, LMOC192cVSR-POS+BERT)
- Statistics for 10GE Modules with BERT. These cards include the following:
  - 10 Gigabit Ethernet with optional BERT. (LM10GELAN, LM10GELAN-M, LM10GEWAN, LM10GEXENPAK+BERT, LM10GEXENPAK-M+BERT, LM10GEXENPAK BERT only)
- Statistics for 10G UNIPHY Modules with BERT. These cards include the following:
  - 10 Gigabit UNIPHY with optional LAN/WAN, POS and BERT. (LM10G)
- Statistics for 10GE LSM Modules (except NGY). These cards include the following:
  - 10 Gigabit LSM modules using XFP, XENPAK, or X2 carrier cards. (LSM10G1-01)
  - 10 Gigabit LSM modules supporting MACSec. (LSM10GMS-01). See also MACSec statistics.
  - 10 Gigabit LSM XM3 (LSM10GXM3)
  - NGY LSM10GXM(R)8(XP)(S)-01, LSM10GXM(R)4(XP)(S)-01,LSM10GXM2XP-01, LSM10GXMR2(S)-01, LSM10GXM2S-01, including 10GBASE-T versions LSM10GXM (R)2/4/8GBT-01
- Statistics for NGY Modules. These cards include the following:

    - NGY LSM10GXM(R)8(XP)(S)-01, LSM10GXM(R)4(XP)(S)-01,LSM10GXM2XP-01, LSM10GXMR2(S)-01, LSM10GXM2S-01, including 10GBASE-T versions LSM10GXM (R)2/4/8GBT-01
- Statistics for 10G MSM modules. These cards include the following:
    - 10 Gigabit Ethernet MSM modules. (MSM10G1)
- Statistics for ATM Modules. These include the following:
    - ATM 622 Multi-Rate (LM622MR, LM622MR-512)
- Statistics for IxNetwork. These statistics are common to all cards that support IxNetwork.
- ALM, ELM and CPM Statistics. These include the following:
    - ALM1000T8 and ELM1000ST2 load modules
- 40/100 GE Statistics. These include the following:
    - 40GE LSM XMV1 and 100GE LSM XMV1 load modules
    - Lava 40/100GE load modules

Table Organization

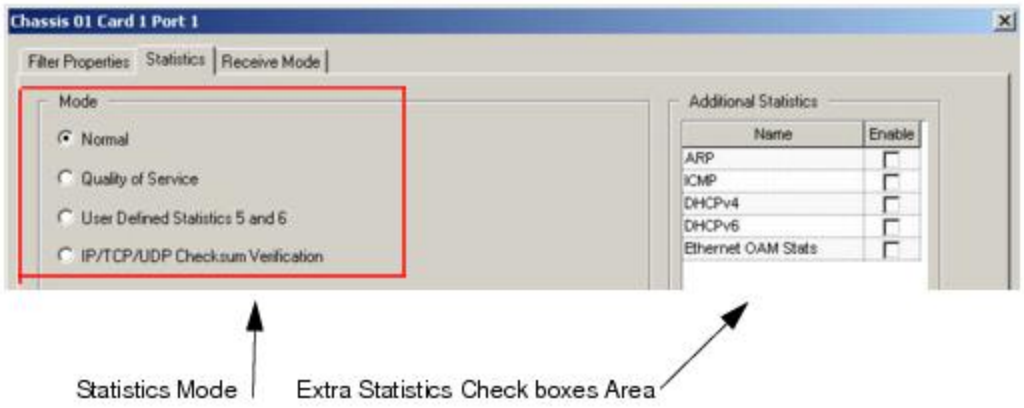
Each of the following tables details the statistics available for that set of cards. Available statistics are controlled by three sets of controls.

IxExplorer

Statistics Modes

From the IxExplorer pane, select a port and select **Filter, Statistics, Receive Mode** from the right-hand pane. Select the tab at the top labelled **Statistics**. This is shown here for a Gigabit module with the statistics modes highlighted. The choices here are mutually exclusive. In most cases, when one is selected new statistics are available at the expense of others.

Figure: Statistics Mode Selection



Extra Statistics Check Boxes

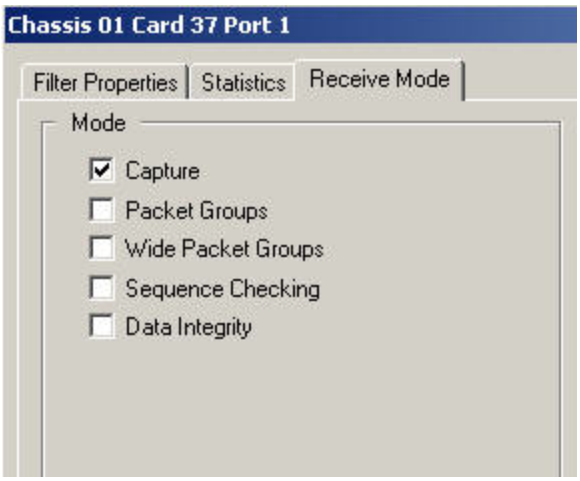
Additional statistics are selected through a set of check boxes located on the same **Statistics** tab, in the **Additional Statistics** section. These statistics are always in addition to those in the **Statistics**

Mode section.

Receive Mode

From the IxExplorer pane, select a port and select **Filter, Statistics, Receive Mode** from the right-hand pane. Select the tab at the top labelled **Receive Mode**. This is shown here for a 10GE LAN module. The check boxes generally result in additional statistics.

Figure: Receive Mode Selection



Key to Tables

The following table lists the headings that appear in the tables in this appendix and their correspondence to IxExplorer dialogs and selections.

Key for Statistics Table

Heading Item	IxExplorer Dialog	IxExplorer Label
Statistics Mode		
UDS 5&6	Statistics	User Defined Statistics 5 and 6
QoS	Statistics	Quality of Service
Normal	Statistics	Normal
Checksum Errors	Statistics	IP/TCP/UDP Checksum Verification
Data Integrity	Statistics	Data Integrity
Extra Statistics Check boxes		
IxRouter	Statistics	IxRouter Stats
ARP STATS	Statistics	ARP Stats
ICMP STATS	Statistics	ICMP Stats

Heading Item	IxExplorer Dialog	IxExplorer Label
BGP STATS	Statistics	BGP Stats
OSPF STATS	Statistics	OSPF Stats
ISIS STATS	Statistics	ISIS Stats
RSVP-TE STATS	Statistics	RSVP-TE Stats
LDP STATS	Statistics	LDP Stats
POS Ext	Statistics	POS Extended Stats
DHCPv4	Statistics	DHCPv4 Stats
DHCPv6	Statistics	DHCPv6 Stats
Temp Sensors	Statistics	Temperature Sensor Stats
OAM Stats	Statistics	Ethernet OAM Stats
PTP Stats	Statistics	Ptp Stats
Receive Mode		
Rx Capture	Receive Mode	Capture
Rx Seq Checking	Receive Mode	Sequence Checking
Rx Data Integrity	Receive Mode	Data Integrity
Rx Packet Group	Receive Mode	Packet Group
Rx Mode Bert	Receive Mode	Mode Bert
Rx Mode ISL	Receive Mode	Mode ISL
Rx Bert Channelized	Receive Mode	Bert Channelized
Rx Mode Echo	Receive Mode	Mode Echo
Rx Mode DCC	Receive Mode	Mode DCC
Rx Wide Packet Group	Receive Mode	Wide Packet Groups
Rx Mode PRBS	Receive Mode	PRBS
Rx Rate Monitoring	Receive Mode	Rate Monitoring
Rx Per Flow Error Stats	Receive Mode	Per PGID Checksum Error Stats

TCL Development

Statistics Mode

The statistics mode is controlled by the use of the Tcl stat mode command. The following table lists the available choices and their correspondence to IxExplorer choice.

Tcl Stat Mode Options

Option	IxExplorer Choice
statNormal (0) (default)	Normal
statQos (1)	Quality of Service
statStreamTrigger (2)	User Defined Statistics 5 and 6
statModeChecksumErrors (3)	IP/TC@/UDP Checksum Verification
statModeDataIntegrity (4)	Data Integrity

Access to Statistics

Most statistics are accessed through the use of `stat` command. VSR statistics are access through the use of the `vsrStat` command.

Receive Mode

The receive mode is controlled through the use of the port receiveMode option. The choices available are or'd together and list the bits available to control the receive mode.

Tcl Port Receive Options

Option	IxExplorer Choice
portCapture (1)	Capture
portPacketGroup (2)	Packet Groups
portRxTcpSessions (4)	Does not affect statistics.
portRxTcpRoundTrip (8)	Does not affect statistics.
portRxDataIntegrity (16)	Data Integrity
portRxFirstTimeStamp (32)	Does not affect statistics.
portRxSequenceChecking (64)	Sequence Checking
portRxModeBert (128)	BERT Mode
portRxModeBertChannelized (128)	Channelized BERT Mode
portRxModeIsl	ISL Mode
portRxModeEcho	Echo Mode

Option	IxExplorer Choice
portRxModeDcc	DCC Mode
portRxModeWidePacketGroup	Wide Packet Groups
portRxModePrbs	PRBS Mode
portRxModeRateMonitoring	Rate Monitoring
portRxModePerFlowErrorStats	Per PGID Checksum Error Stats

C++ Development

Statistics Mode

The statistics mode is controlled by the use of the stat.mode member.Key for Statistics Table on page 783 lists the available choices and their correspondence to IxExplorer choices and the labels used in the tables in this appendix.

C++ Stat Members

Member Value	IxExplorer Choice
statNormal (0) (default)	Normal
statQos (1)	Quality of Service
statStreamTrigger (2)	User Defined Statistics 5 and 6
statModeChecksumErrors (3)	IP/TCP/UDP Checksum Verification
statModeDataIntegrity (4)	Data Integrity

Access to Statistics

Most statistics are accessed through the use of `TCLStatistics` class. VSR statistics are accessed through the use of the `TCLvsrStat` class.

Receive Mode

The receive mode is controlled through the use of the port.receiveMode member. The choices available are or'd together and list the bits available to control the receive mode.

Tcl Port Receive Options

Member Value	IxExplorer Choice
portCapture (1)	Capture
portPacketGroup (2)	Packet Groups
portRxTcpSessions (4)	Does not affect statistics

Member Value	IxExplorer Choice
portRxTcpRoundTrip (8)	Does not affect statistics
portRxDataIntegrity (16)	Data Integrity
portRxFirstTimeStamp (32)	Does not affect statistics
portRxSequenceChecking (64)	Sequence Checking
portRxModeBert (128)	BERT Mode
portRxModeBertChannelized (128)	Channelized BERT Mode
portRxModeIsl	ISL Mode
portRxModeEcho	Echo Mode
portRxModeDcc	DCC Mode
portRxModeWidePacketGroup	Wide Packet Groups
portRxModePrbs	PRBS Mode
portRxModeRateMonitoring	Rate Monitoring
portRxModePerFlowErrorStats	Per PGID Checksum Error Stats

Description of Statistics

The table below lists all of the available statistics, along with an explanation of those statistics.The following three columns are used:

- Counter: the name of the statistics as it appears in IxExplorer. These are organized by general category, as used in the remaining tables in this appendix.
- Interpretation: the description of the statistics.
- Internal Baseame: the internal *basename* used to describe the statistics in the TCL and C++ API. The base name is used to form other names:
  - TCL *stat* command options: the *basename* is the name of the option.
  - TCL *stat* command get sub-command *counterType* argument : the *counterType* name needed to fetch a particular statistic is formed by prepending the letters *stat* to the *basename*, while capitalizing the first letter of the statistic. For example, for *basename* alignmentErrors, the *counterType* name is *statAlignmentErrors.*
  - C++ *statistic* class members: the *basename* is the name of the member.
  - C++ *statistic* command *get* method *counterType* argument: the *counterType* name needed to fetch a particular statistic is formed by prepending the letters *stat* to the *basename*, while capitalizing the first letter of the statistic. For example, for *basename* alignmentErrors, the *counterType* name is *statAlignmentError*

Statistics Counters

Counter	Interpretation	Internal Basename
Opix Power Supply 1 Status	The status of the #1 (left most) power supply.	Not available.
Opix Power Supply 2 Status	The status of the #2 power supply.	Not available.
Opix Power Supply 3 Status	The status of the #3 power supply.	Not available.
Opix Power Supply 4 Status	The status of the #4 power supply.	Not available.
Opix Power Supply 1 Current	The current of the #1 power supply. This should be within 3 amps of other installed power supplies.	Not available.
Opix Power Supply 2 Current	The current of the #2 power supply. This should be within 3 amps of other installed power supplies.	Not available.
Opix Power Supply 3 Current	The current of the #3 power supply. This should be within 3 amps of other installed power supplies.	Not available.
Opix Power Supply 4 Current	The current of the #4 power supply. This should be within 3 amps of other installed power supplies.	Not available.
Opix Fan Bank 1 Status	The status of the #1 bank of fans, located	Not available.

Counter	Interpretation	Internal Basename
	in the fan tray.	
Opix Fan Bank 2 Status	The status of the #2 bank of fans, located in the fan tray.	Not available.
Opix Fan Bank 3 Status	The status of the #3 bank of fans, located in the fan tray.	Not available.
Opix Fan Bank 4 Status	The status of the #4 bank of fans, located in the fan tray.	Not available.
5V Power Status	Indicates that the 5VDC bus A rail is on and valid.	Not available.
3.3V Power Status	Indicates that the 3.3VDC bus A rail is on and valid.	Not available.
3.3V/5V Power Status	Indicates that either the bus A 5VDC or 3.3VDC rail had an overcurrent event and shut down.	Not available.
LM Other Power Output	Indicates that power is good for the miscellaneous power supplies.	Not available.
LM 48V Power Output	Indicates that the -48VDC input is on.	Not available.
LM Temperature 1 Status	LM 83 programmable interrupt - over temperature alarm.	Not available.
LM Temperature 2 Status	LM 83 critical temperature alarm.	Not available.

Counter	Interpretation	Internal Basename
LM Bus B 5V Power Status	Indicates that the 5VDC bus B rail is on and valid.	Not available.
LM Bus B 3.3V Power Status	Indicates that the 3.3VDC bus B rail is on and valid.	Not available.
LM Bus B 3.3V/5V Power Status	Indicates that either the bus B 5VDC or 3.3VDC rail had an overcurrent event and shut down.	Not available.
LM Temperature Central FPGA	Nominal board temperature in area 3.	Not available.
LM Temperature LM83	Nominal board temperature in area 1.	Not available.
LM Temperature LM87	Nominal board temperature in area 2.	Not available.
LM -48VDC Status	Indicates that the -48VDC input is in the valid input range.	Not available.
LM System V1	Dependent on each Optixia Load Module. Monitors one of several system buses.	Not available.
LM SMBUS 3.3V	Measures the SM bus. This value should be 3.3VDC =/- 10%.	Not available.
LM System V2	Dependent on each Optixia Load Module. Monitors one of	Not available.

Counter	Interpretation	Internal Basename
	several system buses.	
LM System V3	Dependent on each Optixia Load Module. Monitors one of several system buses.	Not available.
LM System V4	Dependent on each Optixia Load Module. Monitors one of several system buses.	Not available.
LM System V5	Dependent on each Optixia Load Module. Monitors one of several system buses.	Not available.
LM System V6	Dependent on each Optixia Load Module. Monitors one of several system buses.	Not available.
LM System V7	Dependent on each Optixia Load Module. Monitors one of several system buses.	Not available.
User Configurable		
User Defined Stats 1 and 2 & Rate	Counters that increment each time the statistics conditions are met. The user-defined statistics conditions are set up in the Capture Filter window.	userDefinedStat1userDefinedStat2

Counter	Interpretation	Internal Basename
Capture Trigger (UDS3) & Rate	A counter that increments each time the capture trigger conditions are met, as defined in the Capture Filter window.	captureTrigger
Capture Filter (UDS4) & Rate	A counter that increments each time the capture filter conditions are met, as defined in the Capture Filter window.	captureFilter
User Defined Stats 5 and 6 & Rate	Counters that increment each time the statistics conditions are met. The user-defined statistics conditions are set up in the Capture Filter window. (N/A to OC192 modules.)	streamTrigger1streamTrigger2
States		
Link State	`Up' when a link is established with another device, `Loopback' when the port has loopback enabled, `Down' when there is no connection to another device. (See note 2 in Notes.)	link
Line Speed	`10,' `100,' or `1000' (denoting Mbps) and OC-12, OC-3 or OC-48 for POS modules. (See	lineSpeed

Counter	Interpretation	Internal Basename
	note 6 in Notes)	
Duplex Mode	`Half' or `Full.'	duplexMode
Transmit State	Not shown in IxExplorer. The current transmit state of the port. See the *stat* command in the *Tcl Development Guide* and *C++ Development Guide.*	transmitState
Capture State	Not shown in IxExplorer. The current capture state of the port. See the *stat* command in the *Tcl Development Guide* and *C++ Development Guide.*	captureState
Pause State	Not shown in IxExplorer. The current pause state of the port. See the *stat* command in the *Tcl Development Guide* and *C++ Development Guide.*	pauseState
Common		
Frames Sent & Rate	A counter that increments only when a frame is successfully transmitted. This counter does not count collision attempts.	framesSent
Valid Frames Received & Rate	The valid frame size is from 64 bytes to	framesReceived

Counter	Interpretation	Internal Basename
	1518 bytes inclusive of FCS, exclusive of preamble and SFD and must be an integer number of octets. This 32 bit counter only counts frames with good FCS. VLAN tagged frames that are greater than 1518 but less than 1522 bytes in size are also counted by this counter.	
Bytes Sent & Rate	A counter that counts the total number of bytes transmitted.	bytesSent
Bytes Received & Rate	A counter that counts the total number of bytes received.	bytesReceived
Bits Sent & Rate	A counter that counts the total number of bits transmitted.	bitsSent
Bits Received & Rate	A counter that counts the total number of bits received.	bitsReceived
Scheduled Transmit Time	The scheduled transmit time associated with the port.	scheduledTransmitTime
CPU Status	The status of the port's CPU.	portCpuStatus
CPU DoD Status	The status of the port's DoD process. The table of values are available in the	portCpuDodStatus

Counter	Interpretation	Internal Basename
	Tcl Development Guide.	
Port CPU Status	The state of the port's CPU. The table of values are available in the *Tcl Development Guide*.	portCpuStatus
Port CPU DoD Status	The state of the DOD (software download on demand) process.	portCpuDodStatus
Pcpu Fpga Temperature (C)	Temperature of the port CPU FPGA chip.	pcpuFpgaTemperature
PCS		
PCS Sync Errors	The number of 64B/66B blocks received with a sync header that does not have a valid value of either 01 (data) or 10 (control).	pcsSyncErrorsReceived
PCS Illegal Codes	The number of 64B/66B control blocks received with a block type field that is not among one of the following valid types of 64B/66B Block Formats: 0x1E, 0x78, 0x4B, 0x87, 0x99, 0xAA, 0xB4, 0xCC, 0xD2, 0xE1, 0xFF.	pcsIllegalCodesReceived
PCS Remote Faults	The number of Remote Fault sequence ordered sets received by the test port.	pcsRemoteFaultsReceived

Counter	Interpretation	Internal Basename
PCS Local Faults	The number of Local Fault sequence ordered sets received by the test port.	pcsLocalFaultsReceived
PCS Illegal Ordered Set	The number of 64B/66B control blocks received with a block type field of 0x4B for Ordered Sets, and the remainder of the block does not match that of valid ordered set codes (for local fault or remote fault).	pcsIllegalOrderedSetReceived
PCS Illegal Idle	The number of 64B/66B control blocks received with a block type field of 0x1E, and the remainder of the block does not contain all valid idle control codes.	pcsIllegalIdleReceived
PCS Illegal SOF	The number of 64B/66B control blocks received with a block type field of 0x78 for a Start code, and the remainder of the block does not match that of a valid preamble (0x55_55_55_55_55_55_D5). If the port has programmable preamble mode enabled, the remainder of the block is allowed to have any value, and so no blocks will be counted as Illegal	pcsIllegalSofReceived

Counter	Interpretation	Internal Basename
	SOF.	
PCS Out of Order SOF	The number of SOF control blocks received while in the middle of a frame. In other words, a 64B/66B SOF control block was received (block type field = 0x78) to start a frame, possibly followed by additional Data blocks, followed by another SOF block prior to having received an EOF control block to terminate the frame.	pcsOutOfOrderSofReceived
PCS Out of Order EOF	The number of EOF control blocks received while not in the middle of a frame. In other words, an EOF control block was received without having received an SOF control block to start the frame.	pcsOutOfOrderEofReceived
PCS Out of Order Data	The number of Data blocks received while not in the middle of a frame. In other words, a Data block was received without having received an SOF control block to start the frame.	pcsOutOfOrderDataReceived
PCS Out of Order Ordered Set	The number of	pcsOutOfOrderOrderedSetReceived

Counter	Interpretation	Internal Basename
	Ordered Set blocks received while in the middle of a frame. In other words, a 64B/66B SOF control block was received (block type field = 0x78) to start a frame, possibly followed by additional Data blocks, followed by an ordered set block prior to having received an EOF control block to terminate the frame.	
Transmit		
Transmit Neighbor Solicitations	The number of Neighbor Solicitation packets transmitted during the neighbor discovery process for IPv6 protocol.	txNeighborSolicits
Transmit Neighbor Advertisements	The number of Neighbor Advertisements packets transmitted during the neighbor discovery process for IPv6 protocol.	txNeighborAdvertisements
Receive Neighbor Solicitations	The number of Neighbor Solicitation packets received during the neighbor discovery process for IPv6 protocol.	rxNeighborSolicits
Receive Neighbor Advertisements	The number of Neighbor Advertisements	rxNeighborAdvertisements

Counter	Interpretation	Internal Basename
	packets received during the neighbor discovery process for IPv6 protocol.	
Tx Fpga Temperature (C)	Temperature of the Transmit FPGA chip.	txFpgaTemperature
Rx Fpga Temperature (C)	Temperature of the Receive FPGA chip.	rxFpgaTemperature
FEC		
FEC Total Bit Errors	Total number of bit errors in the received codewords.	fecTotalBitErrors
FEC Max Symbol Errors	Maximum number of symbol errors in the received FEC codewords. An uncorrectable codeword will return a value of 16.	fecMaxSymbolErrors
FEC Corrected Codewords	Number of FEC codewords that were successfully corrected.	fecCorrectedCodewords
FEC Total Codewords	Total number of FEC codewords received.	fecTotalCodewords
FEC Frame Loss Ratio	The IEEE definition for Frame Loss Ratio (FLR) is the ratio of 64 byte frames lost to 64 byte frames transmitted with minimum inter-packet gap. The FEC Frame Loss Ratio is a way to derive the end-to-	fecFrameLossRatio

Counter	Interpretation	Internal Basename
	end FLR by performing the following computation: • 400GE/200GE: FEC Frame Loss Ratio = (2 x FEC Uncorrectable Events) / FEC Total Codewords • 100GE/50GE: FEC Frame Loss Ratio = FEC Uncorrectable Codewords / FEC Total Codewords	
pre FEC Bit Error Rate	Ratio of errored bits received (0 instead of 1 or 1 instead of 0) to total bits before FEC was applied.	preFecBer
FEC Codewords with n Errors (n=0-15)	Number of FEC codewords with n symbol errors received.	fecMaxSymbolErrorsBin0 … fecMaxSymbolErrorsBin15
FEC Uncorrectable Codewords	Number of FEC codewords with errors that could not be corrected.	fecUncorrectableCodewords
FEC Transcoding Uncorrectable Events	Number of FEC uncorrectable codeword events when both FEC engines are active. Per IEEE 802.3bs, a 400GBASE-R or a 200GBASE-R PCS	fecTranscodingUncorrectableErrors

Counter	Interpretation	Internal Basename
	has two FEC engines. If either FEC engine or both FEC engines detect an uncorrectable codeword at the same time, that counts as one event. In 100GBASE-R and 50GBASE-R modes, only one FEC engine is instantiated, and the 'FEC Uncorrectable Codewords' statistic is enough to count the FEC uncorrectable codeword events.	
L1 Bits Sent	Number of bits sent on the line; it adds packet overhead bytes (preamble + minimum frame gap) to the bytes sent, and multiplies by 8.	l1BitsSent
L1 Bits Received	Number of bits received on the line; it includes the packet overhead bytes (preamble + minimum frame gap) to the bytes received, and multiplies by 8.	l1BitsReceived
L1 Line Rate Transmit (%)	Transmit line rate utilization percentage.	l1LineRatePercentTx
L1 Line Rate Receive (%)	Receive line rate utilization percentage.	l1LineRatePercentRx

Counter	Interpretation	Internal Basename
Transmit Arp Gratuitous	Number of Gratuitous Arp packets sent by the port.	Not available.
Transmit Arp	Transmit ARP requests on a group of ports simultaneously using the protocol server.	
Transceiver Temperature (C)	Monitored temperature from transceiver module. When present, it will be used to control system fans to ensure optics are adequately cooled. If modules exceed their upper temperature threshold, they will be taken out of high power mode.	Not available.
Transceiver Interrupt Asserted	Status of the interrupt pin being asserted (or not asserted) by the transceiver.	Not available.
PGID Overflow	Number of packets that were dropped by the packet group engine.	pgidOverflowCount
Quality of Service		
Quality of Service 0 - 7 & Rate	Counters which increment each time a frame with that particular QoS setting is received. (N/A to OC192-3)	qualityOfService0qualityOfService1...
Framer Stats		

Counter	Interpretation	Internal Basename
Framer CRC Errors	CRC errors detected by the POS framer.	framerFCSErrors
Framer Abort	POS frames aborted by the Framer.	framerAbort
Framer Min Length & Rate	POS frames received with less than the minimum length.	framerMinLength
Framer Max Length & Rate	POS frames received with more than the maximum length.	framerMaxLength
Extended Framer Stats		
Framer Frames Sent	Reserved for future use.	framerFramesTx
Framer Frames Received	Reserved for future use.	framerFramesRx
Checksum Stats		
IP Packets Received	The number of IP packets received.	ipPackets
UDP Packets Received	The number of UDP packets received.	udpPackets
TCP Packets Received	The number of TCP packets received.	tcpPackets
IP Checksum Errors	The number of IP checksum errors detected.	ipChecksumErrors
UDP Checksum Errors	The number of UDP checksum errors detected.	udpChecksumErrors
TCP Checksum Errors	The number of TCP checksum errors	tcpChecksumErrors

Counter	Interpretation	Internal Basename
	detected.	
Data Integrity		
Data Integrity Frames	The number of data integrity frames received.	dataIntegrityFrames
Data Integrity Errors	The number of data integrity errors detected.	dataIntegrityErrors
Transmit Duration (Cleared on Start Tx)	Transmit duration, in nanoseconds. Cleared on Start Transmit.	transmitDuration
Sequence Checking		
Sequence Frames	The number of sequence checking frames received.	sequenceFrames
Sequence Errors	The number of sequence checking errors detected.	sequenceErrors
Small Sequence Errors	The number of times when the current sequence number minus the previous sequence number is less than or equal to the error threshold and not negative, or when the current sequence number is equal to the previous sequence number.	smallSequenceErrors
Big Sequence Errors	The number of times when the current sequence number minus the previous	bigSequenceErrors

Counter	Interpretation	Internal Basename
	sequence number is greater than the error threshold.	
Reverse Sequence Errors	The number of times when the current sequence number is less than the previous sequence number.	reverseSequenceErrors
Total Sequence Errors	The sum of the small, bug and reverse sequence errors.	totalSequenceErrors
Packet Group Mode		
Packets Skipped In Packet Group Mode	The number of packets which were not assigned to a packet group. This can occur if the packet contains the anticipated packet group signature, but is too short to hold the group ID.	packetsSkippedInPacketGroupMode
IxRouter Stats		
General		
IxRouter Server Transmit	Packets transmitted by the protocol handler.	protocolServerTx
IxRouter Receive	Packets received by the protocol handler.	protocolServerRx
VLAN Dropped Frames	The number of VLAN frames dropped by the IxRouter.	protocolServerVlan DroppedFrames

Counter	Interpretation	Internal Basename
ARP		
ProtocolServer Transmit	Packets transmitted by the protocol handler.	protocolServerTx
ProtocolServer Receive	Packets received by the protocol handler.	protocolServerRx
Transmit Arp Reply	Number of ARP replies generated.	txArpReply
Transmit Arp Request	Number of ARP requests generated.	txArpRequest
Receive Arp Reply	Number of ARP replies received.	rxArpReply
Receive Arp Request	Number of ARP requests received.	rxArpRequest
ICMP		
Receive Ping Reply	Number of Ping replies received. (N/A to OC192-3)	rxPingReply
Receive Ping Request	Number of Ping requests generated. (N/A to OC192-3)	rxPingRequest
Transmit Ping Reply	Number of Ping replies generated. (N/A to OC192-3)	txPingReply
Transmit Ping Request	Number of Ping requests received. (N/A to OC192-3)	txPingRequest
Asynchronous Frames Sent	The number of frames sent as a result of user request	asynchronousFramesSent

Counter	Interpretation	Internal Basename
Scheduled Frames Sent	The number of frames originating from the stream engine.	scheduledFramesSent
Port CPU Frames Sent	The number of frames originating from the port's CPU as opposed to the stream engine.	portCPUFramesSent
DHCPv4		
DHCPv4 Discovered Messages Sent	The number of Discovered messages sent	dhcpV4DiscoveredMessagesSent
DHCPv4 Offers Received	The number of Offer messages received.	dhcpV4OffersReceived
DHCPv4 Requests Sent	The number or Request messages sent.	dhcpV4RequestsSent
DHCPv4 ACKs Received	The number or ACK messages received.	dhcpV4AcksReceived
DHCPv4 NACKs Received	The number of NACK messages received	dhcpV4NacksReceived
DHCPv4 Releases Sent	The number of Release messages sent.	dhcpV4ReleasesSent
DHCPv4 Enabled Interfaces	The number of enabled interfaces.	dhcpV4EnabledInterfaces
DHCPv4 Addresses Learned	The number of address learned.	dhcpV4AddressesLearned
DHCPv6		

Counter	Interpretation	Internal Basename
DHCPv6 Solicits Sent	The number of DHCPv6 Solicits Sent	dhcpV6SolicitsSent
DHCPv6 Advertisements Received	The number of DHCPv6 Advertisements Received.	dhcpV6AdvertisementsReceived
DHCPv6 Requests Sent	The number of DHCPv6 Requests Sent.	dhcpV6RequestsSent
DHCPv6 Declines Received	The number of DHCPv6 Declines Received.	dhcpV6DeclinesSent
DHCPv6 Replies Received	The number of DHCPv6 Replies Received.	dhcpV6RepliesReceived
DHCPv6 Releases Sent	The number of DHCPv6 Releases Sent.	dhcpV6ReleasesSent
DHCPv6 Enabled Interfaces	The number of DHCPv6 Enabled Interfaces.	dhcpV6EnabledInterfaces
DHCPv6 Addresses Learned	The number of DHCPv6 Addresses Learned.	dhcpV6AddressesLearned
Ethernet OAM Stats		
EOAM Information PDUs Sent	The number of OAM Information PDUs Sent	ethernetOAMInformationPDUs Sent
EOAM Information PDUs Received	The number of OAM Information PDUs Received	ethernetOAMInformationPDUs Received
EOAM Event	The number of OAM	ethernetOAMEventNotification PDUsReceived

Counter	Interpretation	Internal Basename
Notification PDUs Received	Event Notification PDUs Received	
EOAM Loopback Control PDUs Received	The number of OAM Loopback Control PDUs Received	ethernetOAMLoopbackControl PDUsReceived
EOAM Organization PDUs Received	The number of OAM Organization PDUs Received	ethernetOAMOrgPDUsReceived
EOAM Variable Request PDUs Received	The number of OAM Variable Request PDUs Received	ethernetOAMVariableRequest PDUsReceived
EOAM Variable Response PDUs Received	The number of OAM Variable Response PDUs Received	ethernetOAMVariableResponse PDUsReceived
EOAM Unsupported PDUs Received	The number of OAM Unsupported PDUs Received	ethernetOAMUnsupportedPDUs Received
BGP		
BGP Sessions Configured	The number of BGP4 sessions that were configured.	bgpTotalSessions
BGP Sessions Established	The number of configured BGP4 sessions that established adjacencies.	bgpTotalSessionsEstablished
IGMP		
Received IGMP Frames	The number of IGMP frames received by all logical hosts after being internally broadcast (For newer IGMPv3 emulation).	rxIgmpFrames

Counter	Interpretation	Internal Basename
Transmitted IGMP Frames	The number of IGMP frames transmitted. (For newer IGMPv3 emulation).	txIgmpFrames
ISIS		
ISIS L1 Sessions Configured	The total number of level 1 configured sessions.	isisSessionsConfiguredL1
ISIS L2 Sessions Configured	The total number of level 2 configured sessions.	isisSessionsConfiguredL2
ISIS L1 Sessions Up	The total number of level 1 configured sessions that are fully up.	isisSessionsUpL1
ISIS L2 Sessions Up	The total number of level 2 configured sessions that are fully up.	isisSessionsUpL2
MLD		
MLD Frames Received	The number of MLD frames received by all logical hosts after being internally broadcast.	rxMldFrames
MLD Frames Transmitted	The number of MLD frames transmitted.	txMldFrames
OSPF		
OSPF Total Sessions	The number of OSPF sessions that were configured.	ospfTotalSessions
OSPF Neighbors	The number of OSPF	ospfFullNeighbors

Counter	Interpretation	Internal Basename
in Full State	neighbors that are fully up.	
OSPFv3		
OSPFv3 Sessions Configured	The number of OSPFv3 sessions that were configured.	ospfV3SessionsConfigured
OSPFv3 Neighbors in Full State	The number of OSPFv3 neighbors that are fully up.	ospfV3SessionsUp
PIM-SM		
PIM-SM Routers Configured	The number of configured PIM-SM routers.	pimsmRoutersConfigured
PIM-SM Routers Running	The number of PIM-SM routers in the run state.	pimsmRoutersRunning
PIM-SM Learned Neighbors	The number of learned PIM-SM neighbors.	pimsmNeighborsLearned
RSVP		
RSVP Ingress LSPs Configured	The number of ingress LSPs configured.	rsvpIngressLSPsConfigured
RSVP Ingress LSPs Up	The number of ingress LSPs configured and running.	rsvpIngressLSPsUp
RSVP Egress LSPs Up	The number of egress LSPs configured and running.	rsvpEgressLSPsUp

Counter	Interpretation	Internal Basename
LDP		
LDP Sessions Configured	The number of LDP sessions configured for targeted peers.	ldpSessionsConfigured
LDP Sessions Up	The number of LDP sessions configured and running with targeted peers.	ldpSessionsUp
LDP Basic Sessions Up	The number of LDP sessions up for broadcast peers.	ldpBasicSessionsUp
Ethernet		
Fragments & Rate	A counter that counts the number of frames less than 64 bytes in size with a bad FCS.	fragments
Undersize & Rate	A counter that counts the number of frames less than 64 bytes in size with a good FCS.	undersize
Oversize & Rate	A counter that counts the number of frames greater than 1518 bytes in size. The following modules count oversize packets with both good and bad FCSs: 10/100 TX, and 10/100 MII. All other modules include oversize packets with a good FCSs only.	oversize
CRC Errors & Rate	A counter that counts all valid size frames that have CRC errors.	fcsErrors

Counter	Interpretation	Internal Basename
Vlan Tagged Frames & Rate	A counter that counts the number of VLAN tagged frames.	vlanTaggedFramesReceived
Line Errors & Rate	A counter that counts the number of 4B/5B (100Mbps) or 8B/10B (Gigabit) symbol errors.	symbolErrors
Flow Control Frames & Rate	A counter that counts the number of PAUSE frames received. This counter only increments when Flow Control is enabled for that port (using the port properties dialog).	flowControlFrames
10/100		
Alignment Errors & Rate	A counter that counts all frames that are **not** an integer multiple of 8 bits and have an invalid FCS. The frame is truncated to the nearest octet and then the FCS is validated. If the FCS is bad, then this frame is counted as an alignment error.	alignmentErrors
Dribble Errors & Rate	A counter that counts all frames that are **not** an integer multiple of 8 bits and have a valid FCS. The frame is truncated to the nearest octet and	dribbleErrors

Counter	Interpretation	Internal Basename
	then the FCS is validated. If the FCS is good, then this frame is counted as a dribble bit error.	
Collisions & Rate	A counter that counts all occurrences (only one count per frame or fragment) of the Collision Detect signal from the physical layer controller that are not late collisions.	collisions
Late Collisions & Rate	A counter that counts all collisions that occur after the 512th bit time (preamble included) or after the 56th byte.	lateCollisions
Collision Frames & Rate	A counter that counts the number of frames that were retransmitted due to one or more collisions.	collisionFrames
Excessive Collision Frames & Rate	A counter that counts the number of frames that were attempted to be sent but had 16 or more consecutive collisions.	excessiveCollisionFrames
Gigabit		
Oversize and CRC Errors & Rate	A counter that counts the number of frames greater than 1518 bytes in size with a bad FCS.	oversizeAndCrcErrors

Counter	Interpretation	Internal Basename
Line Error Frames & Rate	A counter that counts the number of frames received that contain symbol errors.	symbolErrorFrames
Byte Alignment Error & Rate	A counter that counts the number of times that a comma character is detected to be out of alignment.	synchErrorFrames
POS		
Section LOS	`OK' or `ALARM' during loss of signal. (See note 3 in Notes.)	sectionLossOfSignal
Section LOF	`OK' or `ALARM' during loss of frame. (See note 3 in Notes.)	sectionLossOfFrame
Section BIP(B1) & Rate	The number of section bit interleaved parity errors.	sectionBip
Line AIS	`OK' or `ALARM' during a line alarm indication signal condition. (See note 3 in Notes.)	lineAis
Line RDI	`OK' or `ALARM' during a remote defect indication. (See note 3 in Notes.)	lineRdi
Line REI(FEBE) & Rate	A count of the number of remote error indicate	lineRei

Counter	Interpretation	Internal Basename
	conditions.	
Line BIP(B2) & Rate	The number of line bit interleaved parity errors.	lineBip
Path AIS	`OK' or 'ALARM' during a path alarm indication signal condition. (See note 3 in Notes.)	pathAis
Path RDI	`OK' or `ALARM' during a path remote defect indication. (See note 3 in Notes.)	pathRdi
Path REI(FEBE) & Rate	A count of the number of path remote error indicate conditions.	pathRei
Path BIP(B3) & Rate	The number of path bit interleaved parity errors.	pathBip
Path LOP	`OK' or `ALARM' during a loss of pointer condition. (See note 3 in Notes.)	pathLossOfPointer
Path PLM(C2)	Either `OK' or `ALARM' along with the current received path signal label byte. `ALARM' occurs when a path signal label mismatch occurs. (See note 5 in Notes.)	pathPlm
Section BIP	A count of the	sectionBipErroredSecs

Counter	Interpretation	Internal Basename
Errored Seconds	number of seconds during which (at any point during the second) at least one section layer BIP was detected.	
Section BIP Severely Errored Seconds	A count of the number of seconds during which K or more Section layer BIP errors were detected, where K = 2,392 for OC-48 (per ANSI T1.231-1997).	sectionBipSeverlyErroredSecs
Section LOS Seconds	A count of the number of seconds during which (at any point during the second) at least one section layer LOS defect was present.	sectionLossOfSignalSecs
Line BIP Errored Seconds	A count of the seconds during which (at any point during the second) at least one Line layer BIP was detected.	lineBipErroredSecs
Line REI Errored Seconds	A count of the seconds during which at least one line BIP error was reported by the far end.	lineReiErroredSecs
Line AIS Alarmed Seconds	A count of the seconds during which (at any point during the second) at least one Line layer AIS defect was present.	lineAisAlarmSecs
Line RDI	A count of the	lineRdiUnavailableSec

Counter	Interpretation	Internal Basename
Unavailable Seconds	seconds during which the line is considered unavailable at the far end.	
Path BIP Errored Seconds	A count of the seconds during which (at any point during the second) at least one Path BIP error was detected.	pathBipErroredSecs
Path REI Errored Seconds	A count of the seconds during which (at any point during the second) at least one STS Path error was reported by the far end.	pathReiErroredSecs
Path AIS Alarmed Seconds	A count of the seconds during which (at any point during the second) an AIS defect was present)	pathAisAlarmSec
Path AIS Unavailable Seconds	A count of the seconds during which the STS path was considered unavailable.	pathAisUnavailableSecs
Path RDI Unavailable Seconds	A count of the seconds during which the STS path was considered unavailable at the far end.	pathRdiUnavailableSec
Input Signal Strength (dB)	(OC-192) This statistic monitors the receive optical input power. (See note 8 in Notes)	inputSignalStrength

Counter	Interpretation	Internal Basename
POS K1 Byte	Monitors the k1 status byte in SONET Headers.	posK1byte
POS K2 Byte	Monitors the k1 status byte in SONET Headers.	posK2byte
SRP		
SRP Data Frames Received	The number of data frames received. IPv4 frames fall in this category.	srpDataFramesReceived
SRP Discovery Frames Received	The number of discovery type frames received.	srpDiscoveryFramesReceived
SRP IPS Frames Received	The number of IPS type frames received.	srpIpsFramesReceived
SRP Header Parity Errors	The number of SRP frames received with SRP header parity error. This includes all frame types.	srpParityErrors
SRP Usage Frames Received	The number of usage frames received with good CRC, good header parity, and only those that match the MAC address set for the SRP's port. Bad CRC frames, frames with header errors or those with other MAC addresses are received but not counted.	srpUsageFramesReceived

Counter	Interpretation	Internal Basename
SRP Usage Frames Sent	The number of usage frames sent.These are sent periodically to keep the link alive.	srpUsageFramesSent
SRP Usage Status	If the number of consecutive timeouts exceeds the Keep Alive threshold, this status changes to FAIL. Otherwise shows OK.	srpUsageStatus
SRP Usage Timeouts	The number of times a usage frame was not received within the time period.	srpUsageTimeouts
RPR		
RPR Discovery Frames Received	The number of RPR discovery frames received.	rprDiscoveryFramesReceived
RPR Data Frames Received	The number of RPR encapsulated data frames received.	rprDataFramesReceived
RPR Fairness Frames Received	The number of RPR fairness frames received.	rprFairnessFramesReceived
RPR Fairness Frames Sent	The number of RPR fairness frames sent.	rprFairnessFramesSent
RPR Timeout Events	The number of timeouts that occurred waiting for RPR fairness frames.	rprFairnessTimeouts
RPR Header CRC Errors	The number of RPR frames received with header CRC errors.	rprHeaderCrcErrors

Counter	Interpretation	Internal Basename
RPR OAM Frames Received	The number of RPR OAM frames received.	rprOamFramesReceived
RPR Payload CRC Errors	The number of RPR frames received with payload CRC errors.	rprPayloadCrcErrors
RPR Protection Frames Received	The number of RPR protection frames received.	rprProtectionFramesReceived
RPR Idle Frames Received	The number or RPR idle frames received.	rprIdleFramesReceived
GFP		
GFP Idle Frames	The number of GFP idle frames received.	gfpIdleFrames
GFP Sync State	The GFP sync state.	gfpSyncState
GFP SYNC/HUNT Transitions	The number of Sync/Hunt state transition frames received.	gfpSyncHuntTransitions
GFP eHEC Errors	Number of GFP extension header HEC errors detected.	gfpeHecErrors
GFP Payload FCS Errors	Number of payload FCS errors detected.	gfpPayloadFcsErrors
GFP Receive Bandwidth	The measured receive GFP bandwidth, in Mbps.	gfpRxBandwidth
GFP tHEC Errors	Number of GFP type header HEC errors detected.	gfptHecErrors

Counter	Interpretation	Internal Basename
BERT		
BERT Status	For BERT: The status of the connection. `Locked' when the receiving interface locks onto the data pattern. (See note 1 in Notes)	bertStatus
BERT Bits Sent	For BERT, it is the total number of bits sent.	bertBitsSent
BERT Bits Received	For BERT, it is the total number of bits received.	bertBitsReceived
BERT Bit Errors Sent	For BERT, it is the total number of bit errors sent.	bertBitErrorsSent
BERT Bit Errors Received	For BERT, it is the total number of bit errors received.	bertBitErrorsReceived
BERT Bit Error Ratio	For BERT, it is the ratio of the number of errored bits compared to the total number of bits transmitted.	bertBitErrorRatio
BERT Errored Blocks	For BERT (EB) Number of blocks containing at least one errored second.	bertErroredBlocks
BERT Errored Seconds	For BERT (ES) Number of seconds containing at least one errored block or a defect.	bertErroredSeconds

Counter	Interpretation	Internal Basename
BERT Errored Second Ratio	For BERT (ESR) the ratio of Errored Seconds (ES) to the total seconds.	bertErroredSecondRatio
BERT Severely Errored Seconds	For BERT (SES) Number of seconds with 30% or more of the errored blocks or a defect.	bertSeverelyErroredSeconds
BERT Severely Errored Second Ratio	For BERT (SESR) the ratio of Severely Errored Seconds (SESs) to the total seconds in available time.	bertSeverelyErroredSecondsRatio
BERT Error Free Seconds	For BERT (EFS) Number of seconds with no errored blocks or defects.	bertErrorFreeSeconds
BERT Available Seconds	For BERT (AS) Number of seconds which have occurred during Available Periods.	bertAvailableSeconds
BERT Unavailable Seconds	For BERT (UAS) Number of seconds which have occurred during Unavailable Periods.	bertUnavailableSeconds
BERT Block Error State	For BERT Available Period or Unavailable Period, determined according to the running count and calculation of seconds in various error conditions. A min. of 10 non-SESs	bertBlockErrorState

Counter	Interpretation	Internal Basename
	must pass for the state to change from Unavailable to Available. A min. of 10 SESs must pass for the state to change from Available to Unavailable. See note 4 in Notes.)	
BERT Background Block Errors	For BERT (BBE) The number of errored blocks not occurring as part of a Severely Errored Second.	bertBackgroundBlockErrors
BERT Background Block Error Ratio	For BERT (BBER) the ratio of Background Block Errors (BBEs) to the total number of blocks in available time.	bertBackgroundBlockErrorRatio
BERT Elapsed Test Time	For BERT the elapsed test time, expressed in seconds.	bertElapsedTestTime
BERT Number Mismatched Zeros	The number of expected zeroes received as ones.	bertNumberMismatchedZeros
BERT Mismatched Zeros Ratio	The ratio of the number of expected zeroes received as ones to all bits.	bertismatchedZerosRatio
BERT Number Mismatched Ones	The number of expected ones received as zeroes.	bertNumberMismatchedOnes
BERT Mismatched Ones Ratio	The ratio of the number of expected ones received as zeroes to all bits.	bertMismatchedOnesRatio

Counter	Interpretation	Internal Basename
Service Disruption	A service disruption is the period of time during which the service is unavailable while switching rings. The SONET spec calls for this to be less than 50 ms.	
Last Service Disruption Time (ms)	The length of the last service disruption that occurred, expressed in milliseconds.	bertLastServiceDisruptionTime
Min Service Disruption Time (ms)	The shortest service disruption that occurred, expressed in milliseconds.	bertMinServiceDisruptionTime
Max Service Disruption Time (ms)	The longest service disruption that occurred, expressed in milliseconds.	bertMaxServiceDisruptionTime
Cumulative Service Disruption Time (ms)	The total service disruption time encountered, expressed in milliseconds.	bertServiceDisruptionCumulative
DCC		
DCC Bytes Received	The number of DCC bytes received.	dccBytesReceived
DCC Bytes Sent	The number of DCC bytes sent.	dccBytesSent
DCC CRC Receive Errors	The number of DCC CRC errors received.	dccCrcErrorsReceived
DCC Frames Received	The number of DCC frames received.	dccFramesReceived

Counter	Interpretation	Internal Basename
DCC Frames Sent	The number of DCC frames sent.	dccFramesSent
DCC Framing Errors Received	The number of DCC framing errors received.	dccFramingErrorsReceived
Link Fault Signalling		
Insertion State	The current state of link fault insertion. 0 = not inserting, 1 = inserting.	insertionState
Link Fault State	The current state of link fault detection on a port. 0 = no fault, 1 = local fault, 2 = remote fault.	linkFaultState
Local Faults	The number of local faults detected.	localFaults
Remote Faults	The number of remote faults detected.	remoteFaults
Scheduled Transmit Duration	The scheduled transmit time associated with the port.	scheduledTransmitTime
Bytes Sent/Transmit Duration	Total number of bytes sent per unit of Transmit Duration.	Not available
CDL	Converged Data Layer	
CDL Error Frames Received	The number of CDL error frames received.	cdlErrorFramesReceived

Counter	Interpretation	Internal Basename
CDL Good Frames Received	The number of good CDL frames received.	cdlGoodFramesReceived.
FEC	Forwarding Error Correction	
FEC Corrected 0s Count	Number of 0 errors (1s changed to 0s) that have been corrected.	fecCorrected0sCount
FEC Corrected 1s Count	Number of 1 errors (0s changed to 1s) that have been corrected.	fecCorrected1sCount
FEC Corrected Bits Count	Number of flipped bits errors (0s changed to 1s and vice versa) that have been corrected.	fecCorrectedBitsCount
FEC Corrected Bytes Count	Number of bytes that have had errors corrected.	fecCorrectedBytesCount
FEC Uncorrectable Subrow Count	Number of subrows that have had uncorrectable errors.	fecUncorrectableSubrowCount
OC192		
Temperature		
DMA Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the DMA chip.	dMATemperature
Capture Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the Capture chip.	captureTemperature

Counter	Interpretation	Internal Basename
Latency Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the Latency chip.	latencyTemperature
Background Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the Background chip.	backgroundTemperature
Overlay Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the Overlay chip.	overlayTemperature
Front End Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the Front End Chip.	frontEndTemperature
Scheduler Chip Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature of the Scheduler Chip.	scheduleTemperature
Plm Internal Chip Temperature 1 (C)	(OC-192 - Temperature Sensors Stats) Internal temperature of temperature measuring device #1.	plmDevice1InternalTemperature
Plm Internal Chip Temperature 2 (C)	(OC-192 - Temperature Sensors Stats) Internal temperature of temperature measuring device #2.	plmDevice2InternalTemperature

Counter	Interpretation	Internal Basename
Plm Internal Chip Temperature 3 (C)	(OC-192 - Temperature Sensors Stats) Internal temperature of temperature measuring device #3.	plmDevice3InternalTemperature
Fom Port Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature for one of the sensors on the Fiber optic module (Fom).	fobPort1FpgaTemperaturefobPort2FpgaTemperature
Fom Board Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature for one of the sensors on the Fiber optic module (Fom).	fobBoardTemperature
Fom Internal Temperature (C)	(OC-192 - Temperature Sensors Stats) Temperature for one of the sensors on the Fiber optic module (Fom).	fobDevice1InternalTemperature
VSR	The statistics in this sub-section relate to all VSR channels. See **VSR per Channel** statistics for further per-channel statistics.	
Rx Channel Protection Disabled	The status of the channel protection on the receiving interface.	rxChannelProtectionDisabled[8]
Rx Channel Skew Error	The status of the channel skew error detection on the	rxChannelSkewError[8]

Counter	Interpretation	Internal Basename
	receiving interface.	
RX Channel Skew First	The channel number of the earliest channel to arrive on the receiving interface. If more than one channel arrives at the same time, Channel #1 has the highest priority and so on.	rxChannelSkewFirst[8]
Rx Channel Skew Last	The channel number of the latest channel to arrive on the receiving interface. If more than one channel arrives at the same time, Channel #1 has the highest priority, and so on.	rxChannelSkewLast[8]
Rx Channel Skew Max	This counter increments every time the channel skew is equal to or greater than the maximum channel skew.	rxChannelSkewMax[8]
Rx Channel Swapped	Indicates one or more channel swap errors.	rxChannelSwapped[8]
Rx Code Word Violation Error	Indicates one or more 8b/10b code word violation errors.	rxCodeWordViolationError[8]
Rx CRC Corrected Errors	The number of corrected CRC block errors accumulated on the receiving interface.	rxCrcCorrectedErrorCounter[8]

Counter	Interpretation	Internal Basename
Rx CRC Correction Disabled	Indicates the status of the CRC correction on the receiving interface.	rxCrcCorrectionDisabled[8]
Rx CRC Error	Indicates one or more detected CRC errors.	rxCrcError[8]
Rx CRC Uncorrected Errors	The number of uncorrected CRC block errors accumulated on the receiving interface.	rxCrcUnCorrectedErrorCounter[8]
Rx Hardware Error	The number of hardware errors detected on the receive side.	rxHardwareError[8]
Rx Loss Of Synchronization Counter	Indicates the number of times that a protection channels was in the loss of synchronization state.	rxLossOfSynchronizationCounter[8]
Rx Multi-loss Of Synchronization Counter	Indicates the number of times that two or more data or protection channels were in the Loss of Synchronization state.	rxMultiLossOfSynchronizationCounter[8]
Rx Multi-loss Of Synchronization Status	Indicates that two or more data or protection channels are in the Loss of Synchronization state.	rxMultiLossOfSynchronizationStatus[8]
Rx Out of Frame Counter	Indicates the number of frame errors for	rxOutOfFrameCounter[8]

Counter	Interpretation	Internal Basename
	the receiving interface.	
Rx Out of Frame Status	Indicates one or more out of frame errors for the receiving interface.	rxOutOfFrameStatus[8]
Rx Section BIP Error Counter	The number of Section BIP errors detected on the receiving interface.	rxSectionBipErrorCounter[8]
Tx Hardware Error Counter	The number of hardware errors detected on the transmit side.	txHardwareError[8]
Tx Out Of Frame Counter	The number of out of frame errors detected on the transmit side.	txOutOfFrameCounter[8]
Tx Out of Frame Status	Indicates one or more out of frame errors for the transmit interface.	txOutOfFrameStatus[8]
Tx Section BIP Error Counter	The number of Section Bit Interleaved Parity (BIP) errors which have been detected on the transmit interface.	txSectionBipErrorCounter[8]
VSR per Channel	The statistics in this sub-section relate to a specific VSR channel.	
Rx Code Word Violation Counter	This per-channel statistic indicates the number of codeword	rxCodeWordViolationCounter[9]

Counter	Interpretation	Internal Basename
	violations detected on the receiving channel interface. Codeword violations include running disparity errors, undefined codewords, and any control characters besides K28.5.	
Rx CRC Error Counter	This per-channel statistic indicates the number of corrected and uncorrected errors on the receive interface.	rxCrcErrorCounter[9]
Rx Loss Of Synchronization Status	This per-channel statistic indicates the loss of synchronization status of the receiving interface.	rxLossOfSynchronization[9]
Rx Out of Frame Status	This per-channel statistic indicates the out of frame status of the receiving interface for a particular channel.	rxOutOfFrame[9]
10 Gig		
LSM		
Local Ordered Sets Sent	The number of local ordered sets sent. Ordered sets are part of Link Fault Signaling, and can be configured in the *Link Fault Signaling* tab.	localOrderedSetsSent

Counter	Interpretation	Internal Basename
Local Ordered Sets Received	The number of local ordered sets received. Ordered sets are part of Link Fault Signaling, and can be configured in the *Link Fault Signaling* tab.	localOrderedSetsReceived
Remote Ordered Sets Sent	The number of remote ordered sets sent.Ordered sets are part of Link Fault Signaling, and can be configured in the *Link Fault Signaling* tab.	remoteOrderedSetsSent
Remote Ordered Sets Received	The number of remote ordered sets received.Ordered sets are part of Link Fault Signaling, and can be configured in the *Link Fault Signaling* tab.	remoteOrderedSetsReceived
Custom Ordered Sets Sent	The number of custom ordered sets sent.Ordered sets are part of Link Fault Signaling, and can be configured in the *Link Fault Signaling* tab.	customOrderedSetsSent
Custom Ordered Sets Received	The number of custom ordered sets received.Ordered sets are part of Link Fault Signaling, and can be configured in the *Link Fault Signaling* tab.	customOrderedSetsReceived
Frames Received with Coding	The number of frames received with	codingErrorFramesReceived

Counter	Interpretation	Internal Basename
Errors	coding errors.	
Frames Received with /E/ error Character	The number of frames received with DUT labeled errors received.	eErrorCharacterFramesReceived
Dropped Frames	The number of dropped frames.	droppedFrames
Pause Frame		
Pause Acknowledge	The number of clocks for which transmit has been paused.	pauseAcknowledge
Pause End Frames	The number of pause frames received with a quanta of 0.	pauseEndFrames
Pause Overwrite	The number of pause frames received while transmit was paused with a quanta not equal to 0.	pauseOverwrite
Temperature		
Lan Transmit FPGA Temperature	For the 10Gig LAN board, the temperature at the transmit FPGA.	10GigLanTxFpgaTemperature
Lan Receive FPGA Temperature	For the 10Gig LAN board, the temperature at the receive FPGA.	10GigLanRxFpgaTemperature
ATM and ATM/POS		
ATM AAL5 Bytes Received	The number of AAL5 bytes received.	atmAal5BytesReceived

Counter	Interpretation	Internal Basename
ATM AAL5 Bytes Sent	The number of AAL5 bytes sent.	atmAal5BytesSent
ATM AAL5 CRC Error Frames	The number of AAL5 frames received with CRC errors.	atmAal5CrcErrorFrames
ATM AAL5 Frames Received	The number of AAL5 frames received.	atmAal5FramesReceived
ATM AAL5 Frames Sent	The number of AAL5 frames sent.	atmAal5FramesSent
ATM AAL5 Length Error Frames	The number of AAL5 frames received with length errors.	atmAal5LengthErrorFrames
ATM AAL5 Timeout Error Frames	The number of AAL5 frames received with timeout errors.	atmAal5TimeoutErrorFrames
ATM Cells Received	The number of ATM cells received.	atmCellsReceived
ATM Cells Sent	The number of ATM cells sent.	atmCellsSent
ATM Corrected HCS Error Count	The number of AAL5 frames received with HCS errors that were corrected.	atmCorrectedHcsErrorCount
ATM Idle Cell Count	The number of idle ATM cells sent.	atmIdleCellCount
ATM Scheduled Cells Sent	The number of scheduled (non-idle) ATM cells sent.	atmScheduledCellsSent
ATM Uncorrected HCS Error Count	The number of AAL5 frames received with HCS errors that were not corrected.	atmUncorrectedHcsErrorCount

Counter	Interpretation	Internal Basename
ATM Unregistered Cells	The number of unregistered ATM cells that were received.	atmUnregisteredCellsReceived
OAM Tx Cells	Number of ATM OAM cells transmitted.	atmOamTxCells
OAM Tx Bytes	Number of ATM OAM bytes transmitted.	atmOamTxBytes
OAM Tx Fault Management AIS	Number of ATM OAM Fault Management AIS cells transmitted.	atmOamTxFaultMgmtAIS
OAM Tx Fault Management RDI	Number of ATM OAM Fault Management RDI cells transmitted.	atmOamTxFaultMgmtRDI
OAM Tx Fault Management CC	Number of ATM OAM Fault Management CC cells transmitted.	atmOamTxFaultMgmtCC
OAM Tx Fault Management LB	Number of ATM OAM Fault Management LB cells transmitted.	atmOamTxFaultMgmtLB
OAM Tx Fault ActDeact CC	Number of ATM OAM ActDeact cells transmitted.	atmOamTxActDeactCC
OAM Rx Good Cells	Number of ATM OAM good cells received.	atmOamRxGoodCells
OAM Rx Bytes	Number of ATM OAM bytes received.	atmOamRxBytes
OAM Rx Fault Management AIS	Number of ATM OAM Fault Management AIS cells received.	atmOamRxFaultMgmtAIS

Counter	Interpretation	Internal Basename
OAM Rx Fault Management RDI	Number of ATM OAM Fault Management RDI cells received.	atmOamRxFaultMgmtRDI
OAM Rx Fault Management CC	Number of ATM OAM Fault Management CC cells received.	atmOamRxFaultMgmtCC
OAM Rx Fault Management LB	Number of ATM OAM Fault Management LB cells received.	atmOamRxFaultMgmtLB
OAM Rx Bad Cells	Number or ATM OAM bad cells received.	atmOamRxBadCells
OAM Rx ActDeact CC	Number of ATM OAM ActDeact cells transmitted.	atmOamRxActDeactCC
Ethernet CRC	The Ethernet CRC, representing AAL5 CRCs.	ethernetCrc

Notes

Notes for Statistics Counters

NOTE	Choices Displayed for Statistic
1	Locked - All Ones
	Locked - Inverted Alternating One/Zero
	Locked - Inverted User Defined Pattern
	Locked - Inverted 2^31 Linear Feedback Shift Reg
	Locked - Inverted 2^11 Linear Feedback Shift Reg
	Locked - Inverted 2^15 Linear Feedback Shift Reg
	Locked - Inverted 2^20 Linear Feedback Shift Reg
	Locked - Inverted 2^23 Linear Feedback Shift Reg
	Locked - All Zero

NOTE	Choices Displayed for Statistic
	Locked - Alternating One/Zero
	Locked - User Defined Pattern
	Locked - 2^11 Linear Feedback Shift Reg
	Locked - 2^15 Linear Feedback Shift Reg
	Locked - 2^20 Linear Feedback Shift Reg
	Locked - 2^23 Linear Feedback Shift Reg
	Not Locked
2	Demo Mode
	Link Up
	Link Down
	Loopback
	WriteMii
	Restart AutoNegotiate
	End RestartAutoNegotiate
	AutoNegotiate
	WriteMii Failed
	No Transceiver
	Invalid PHY Address
	Read LinkPartner
	No LinkPartner
	FPGA Download Failed
	No GBIC Module
	Fifo Reset
	Fifo Reset Compete
	PPP Off
	PPP Up

NOTE	Choices Displayed for Statistic
	PPP Down
	PPP Init
	PPP WaitForOpen
	PPP AutoNegotiate
	PPP Close
	PPP Connect
	Loss of Frame
	Loss of Signal
	StateMachine Failure
	PPP RestartNegotiation
	PPP RestartNegotiation Init
	PPP RestartNegotiation WaitForOpen
	PPP RestartNegotiation WaitForClose
	PPP RestartNegotiation Finish
	LP Boot Failed
	PPP Disabled - LOF
	Ignore Link
	Temperature Alarm
	PPP Closing
	PPP LCP Negotiate
	PPP Authenticate
	PPP NCP Negotiate
3	OK
	Alarm
	`_'
	Defect

NOTE	Choices Displayed for Statistic
4	Unavailable Period
	Available Period
5	OK
	OK (%)
	Alarm (%)
	`-'
6	OC-3c
	OC-12c
	OC-48c
	OC-192c
	10GE WAN
	10 Mbps
	100 Mbps
	1000 Mbps
7	Full
	Half
8	Loss of Signal
	[-] %d.%d
8	The statistics in this section must be accessed using the *vsrStat* command in TCL and the *TCLvsrStat* class in C++.
9	The statistics in this section must be accessed using the *vsrStat* command in TCL and the *TCLvsrStat* class in C++. In addition, the desired channel must be set with the *getChannel* sub-command (TCL) or method (C++).

Statistics for 10/100 TXS Modules

Statistics for 10/100 TXS Modules

	Normal							Qos				StreamTrigger						
	Capture	PacketGroup	RxTcpRoundTrip	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxFirstTimeStamp	RxModeWidePacketGroup	Capture	PacketGroup	RxTcpRoundTrip	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup
Capture																		
Type: User Configurable																		
UserDefinedStat1	X	X	X	X	X	X	X					X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X					X	X	X	X	X	X	X
CaptureTrigger	X	X	X		X		X					X	X	X		X		X
CaptureFilter	X	X	X		X		X					X	X	X		X		X
StreamTrigger 1												X	X			X		X
StreamTrigger 2												X	X			X		X
Type: States																		
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal							**Qos**				**StreamTrigger**						
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																			
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
PortCpuDodStatus	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Type: Transmit Duration																			
TransmitDuration	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Type: Quality of Service																			
QualityOfService0								X	X	X	X								
Type: Checksum Stats																			
IpPackets																			
UdpPackets																			
TcpPackets																			

	Normal							**Qos**				**StreamTrigger**						
IpChecksumErrors																		
UdpChecksumErrors																		
TcpChecksumErrors																		
Type: Data Integrity																		
DataIntegrityFrames				X											X			
DataIntegrityErrors				X											X			
Type: Sequence Checking																		
SequenceFrames						X											X	
SequenceErrors						X											X	
Type: Ethernet																		
Fragments	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oversize	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx	X	X	X		X		X							X				
FlowControlFrames	X	X	X		X		X	X	X	X	X	X	X	X		X		X

	Normal							**Qos**				**StreamTrigger**						
Type: 10/100																		
AlignmentErrors	X	X	X		X		X							X				
DribbleErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Collisions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LateCollisions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CollisionFrames	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ExcessiveCollisionFrames	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: 10/100 + Gigabit																		
SymbolErrors																		
OversizeAndCrcErrors	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X

Statistics for 10/100 TXS Modules

	ModeChecksumErrors						**ModeDataIntegrity**					
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup
Capture												
Type: User Configurable												
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X

	ModeChecksumErrors						ModeDataIntegrity					
UserDefinedStat2			X		X		X	X	X	X	X	X
CaptureTrigger	X	X		X		X	X	X		X		X
CaptureFilter	X	X		X		X	X	X		X		X
StreamTrigger1												
StreamTrigger2												
Type: States												
Link	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X	X	X
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common												
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuDodStatus	X	X	X	X	X	X	X	X	X	X	X	X
Type: Transmit Duration												
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service												

	ModeChecksumErrors						**ModeDataIntegrity**					
QualityOfService0												
Type: Checksum Stats												
IpPackets	X	X		X		X						
UdpPackets	X	X		X		X						
TcpPackets	X	X		X		X						
IpChecksumErrors	X	X		X		X						
UdpChecksumErrors	X	X		X		X						
TcpChecksumErrors	X	X		X		X						
Type: Data Integrity												
DataIntegrityFrames			X						X			
DataIntegrityErrors			X						X			
Type: Sequence Checking												
SequenceFrames					X						X	
SequenceErrors					X						X	
Type: Ethernet												
Fragments	X	X	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X	X	X
Oversize	X	X	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx							X	X		X		X
FlowControlFrames							X	X		X		X
Type: 10/100												
AlignmentErrors							X	X		X		X
DribbleErrors	X	X	X	X	X	X	X	X	X	X	X	X
Collisions	X	X	X	X	X	X	X	X	X	X	X	X
LateCollisions	X	X	X	X	X	X	X	X	X	X	X	X

	ModeChecksumErrors						ModeDataIntegrity					
CollisionFrames	X	X	X	X	X	X	X	X	X	X	X	X
ExcessiveCollisionFrames	X	X	X	X	X	X	X	X	X	X	X	X
Type: 10/100 + Gigabit												
SymbolErrors												
OversizeAndCrcErrors	X	X	X	X	X	X	X	X	X	X	X	X

Statistics for 10/100/1000 TXS, 10/100/1000 XMS(R)12, 1000 SFPS4, and 1000STXS24 Cards

Statistics for 10/100/1000 TXS, 10/100/1000 XMS(R)12, 1000 SFPS4, and 1000STXS24 Cards

Statistics Mode	Normal					QoS			StreamTrigger				
	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup
Type: User Configurable													
UserDefinedStat 1	X	X	X	X	X				X	X	X	X	X
UserDefinedStat 2	X	X	X	X	X				X	X	X	X	X
CaptureTrigger	X		X		X				X		X	X	X
CaptureFilter	X		X		X				X		X	X	X

Statistics Mode	Normal					QoS			StreamTrigger				
StreamTrigger1									X				X
StreamTrigger2									X				X
Type: States													
Link	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X	X	X	X
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common													
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X				X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X				X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus					X		X	X					X
PortCpuDodStatus					X		X	X					X

Statistics Mode	Normal					QoS			StreamTrigger				
Type: Transmit Duration													
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service													
QualityOfService0						X	X	X					
Type: Checksum Stats													
IPv4Packets													
UdpPackets													
TcpPackets													
IPv4ChecksumErrors													
UdpChecksumErrors													
TcpChecksumErrors													
Type: Data Integrity													
DataIntegrityFrames			X								X		

Statistics Mode	Normal					QoS			StreamTrigger				
DataIntegrityErrors			X								X		
Type: Sequence Checking													
SequenceFrames				X								X	
SequenceErrors				X								X	
Type: Ethernet													
Fragments	X	X	X	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X	X	X	X
Oversiz	X	X	X	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx	X	X			X					X			
FlowControlFrames	X	X			X	X	X	X	X	X			X
Type: 10/100													
AlignmentErrors					X								
DribbleErrors					X		X	X					X
Collisions					X		X	X					X
LateCollisions					X		X	X					X
CollisionFrames					X		X	X					X

Statistics Mode	Normal					QoS			StreamTrigger				
ExcessiveCollisionFrames					X		X	X					X
Type: Gigabit													
SymbolErrorFrames	X	X	X	X					X	X	X	X	
SynchErrorFrames	X	X				X			X	X			
Type: 10/100 + Gigabit													
SymbolErrors	X	X								X			
OversizeAndCrcErrors	X	X	X	X	X	X	X	X	X	X	X	X	X

Statistics for 10/100/1000 TXS, 10/100/1000 XMS(R)12, 1000 SFPS4, and 1000STXS24 Cards

Statistics Mode	ModeChecksum Errors					ModeData Integrity				
	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup
Type: User Configurable										
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X

Statistics Mode	ModeChecksum Errors					ModeData Integrity				
UserDefinedStat2		X	X	X		X	X	X	X	X
CaptureTrigger	X		X	X	X	X			X	X
CaptureFilter	X		X	X	X	X			X	X
StreamTrigger1										
StreamTrigger2										
Type: States										
Link	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X
TransmitState	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X
Type: Common										
FramesSent	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X

Statistics Mode	ModeChecksum Errors					ModeData Integrity				
PortCpuStatus					X					X
PortCpuDodStatus					X					X
Type: Transmit Duration										
TransmitDuration	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service										
QualityOfService0										
Type: Checksum Stats										
IPv4Packets	X	X								
UdpPackets	X	X								
TcpPackets	X	X								
IPv4ChecksumErrors	X	X								
UdpChecksumErrors	X	X								
TcpChecksumErrors	X	X								
Type: Data Integrity										
DataIntegrityFrames			X					X		
DataIntegrityErrors			X					X		
Type: Sequence Checking										
SequenceFrames				X					X	

Statistics Mode	ModeChecksum Errors					ModeData Integrity				
SequenceErrors				X					X	
Type: Ethernet										
Fragments	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X
Oversiz	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx		X				X	X			X
FlowControlFrames		X				X	X			X
Type: 10/100										
AlignmentErrors										X
DribbleErrors					X					X
Collisions					X					X
LateCollisions					X					X
CollisionFrames					X					X
ExcessiveCollisionFrames					X					X
Type: Gigabit										
SymbolErrorFrames		X	X	X		X	X	X	X	
SynchErrorFrames		X				X	X			
Type: 10/100 + Gigabit										

Statistics Mode	ModeChecksum Errors					ModeData Integrity				
SymbolErrors		X				X	X			
OversizeAndCrcErrors	X	X	X	X	X	X	X	X	X	X

Statistics for 10/100/1000 LSM XMV(R)4/8/12/16, and 10/100/1000 ASM XMV12X Cards

Statistics for 10/100/1000 LSM XMV(R)4/8/12/16, and 10/100/1000 ASM XMV12X Cards

Statistics Mode	Normal					QoS			StreamTrigger					ModeData Integrity				
Receive Mode	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup
Type: User Configurable																		
UserDefinedStat1	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
CaptureTrigger	X		X		X				X		X	X	X	X			X	X
CaptureFilter	X		X		X				X		X	X	X	X			X	X
StreamTrigger1									X				X					
StreamTrigger2									X				X					
Type: States																		
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Statistics Mode	Normal					QoS			StreamTrigger					ModeData Integrity				
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																		
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus					X		X	X					X					X
PortCpuDodStatus					X		X	X					X					X
Type: Transmit Duration																		
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																		
QualityOfService0						X	X	X										
Type: Checksum Stats																		
IPv4Packets	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
UdpPackets	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TcpPackets	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Statistics Mode	Normal					QoS			StreamTrigger					ModeData Integrity				
IPv4Checksum Errors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
UdpChecksumErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TcpChecksumErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Data Integrity																		
DataIntegrityFrames			X								X					X		
DataIntegrityErrors			X								X					X		
Type: Sequence Checking																		
SequenceFrames				X								X					X	
SequenceErrors				X								X					X	
Type: Ethernet																		
Fragments	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oversize	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx	X	X			X					X				X	X			X
FlowControlFrames	X	X			X	X	X	X	X	X			X	X	X			X
Type: 10/100																		
AlignmentErrors					X													X
DribbleErrors					X		X	X					X					X
Collisions					X		X	X					X					X

Statistics Mode	Normal					QoS			StreamTrigger					ModeData Integrity				
LateCollisions					X		X	X					X					X
CollisionFrames					X		X	X					X					X
ExcessiveCollisionFrames					X		X	X					X					X
Type: Gigabit																		
SymbolErrorFrames	X	X	X	X					X	X	X	X		X	X	X	X	
SynchErrorFrames	X	X				X			X	X				X	X			
Type: 10/100 + Gigabit																		
SymbolErrors	X	X								X				X	X			
OversizeAndCrcErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Statistics for Gigabit Modules

Statistics for Gigabit Modules

	Normal							Qos				StreamTrigger						
	Capture	PacketGroup	RxTcpRoundTrip	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxFirstTimeStamp	RxModeWidePacketGroup	Capture	PacketGroup	RxTcpRoundTrip	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup
Type: User Configurable																		
UserDefinedStat1	X	X	X	X	X	X	X					X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X					X	X	X	X	X	X	X

	Normal							**Qos**				**StreamTrigger**						
CaptureTrigger	X		X	X			X					X		X	X		X	X
CaptureFilter	X		X	X			X					X		X	X		X	X
StreamTrigger 1												X						X
StreamTrigger 2												X						X
Type: States																		
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																		
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X					X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X					X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus							X		X	X	X							X
PortCpuDodStatus							X		X	X	X							X

	Normal							Qos				StreamTrigger						
Type: Transmit Duration																		
TransmitDuration	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X
Type: Quality of Service																		
QualityOfService0								X	X	X	X							
Type: Checksum Stats																		
IpPackets																		
UdpPackets																		
TcpPackets																		
IpChecksumErrors																		
UdpChecksumErrors																		
TcpChecksumErrors																		
Type: Data Integrity																		
DataIntegrityFrames				X											X			
DataIntegrityErrors				X											X			
Type: Sequence Checking																		

	Normal							Qos				StreamTrigger						
SequenceFrames						X											X	
SequenceErrors						X											X	
Type: Ethernet																		
Fragments	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oversize	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx	X	X	X		X		X						X	X		X		
FlowControlFrames	X	X	X		X		X	X	X	X	X	X	X	X		X		X
Type: 10/100																		
AlignmentErrors			X				X							X				
DribbleErrors			X				X		X	X	X			X				X
Collisions			X				X		X	X	X			X				X
LateCollisions			X				X		X	X	X			X				X
CollisionFrames			X				X		X	X	X			X				X
ExcessiveCollisionFrames			X				X		X	X	X			X				X
Type: Gigabit																		
SymbolErrorFrames	X	X		X	X	X						X	X		X	X	X	
	X	X			X			X				X	X			X		

	Normal							**Qos**				**StreamTrigger**						
SynchErrorFrames																		
Type: 10/100 + Gigabit																		
SymbolErrors	X	X			X								X			X		
OversizeAndCrcErrors	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X

Statistics for Gigabit Modules

	ModeChecksumErrors						**ModeDataIntegrity**					
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeWidePacketGroup
Type: User Configurable												
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X
CaptureTrigger	X		X		X	X	X				X	X
CaptureFilter	X		X		X	X	X				X	X
StreamTrigger1												
StreamTrigger2												
Type: States												
Link	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode	X	X	X	X	X	X	X	X	X	X	X	X

	ModeChecksumErrors						ModeDataIntegrity					
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common												
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus						X						X
PortCpuDodStatus						X						X
Type: Transmit Duration												
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service												
QualityOfService0												
Type: Checksum Stats												
IpPackets	X					X						
UdpPackets	X					X						
TcpPackets	X					X						
IpChecksumErrors	X					X						
UdpChecksumErrors	X					X						
TcpChecksumErrors	X					X						

	ModeChecksumErrors						**ModeDataIntegrity**					
Type: Data Integrity												
DataIntegrityFrames			X						X			
DataIntegrityErrors			X						X			
Type: Sequence Checking												
SequenceFrames					X						X	
SequenceErrors					X						X	
Type: Ethernet												
Fragments	X	X	X	X	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X	X	X	X	X
Oversize	X	X	X	X	X	X	X	X	X	X	X	X
VlanTaggedFramesRx		X		X			X	X		X		X
FlowControlFrames		X		X			X	X		X		X
Type: 10/100												
AlignmentErrors												X
DribbleErrors						X						X
Collisions						X						X
LateCollisions						X						X
CollisionFrames						X						X
ExcessiveCollisionFrames						X						X
Type: Gigabit												
SymbolErrorFrames		X	X	X	X		X	X	X	X	X	
SynchErrorFrames		X		X			X	X		X		
Type: 10/100 + Gigabit												
SymbolErrors		X		X			X	X		X		

	ModeChecksumErrors						ModeDataIntegrity					
OversizeAndCrcErrors	X	X	X	X	X	X	X	X	X	X	X	X

Statistics for OC192c Modules with SRP and DCC

Statistics for OC192c Modules with SRP and DCC

	Normal								Qos				StreamTrigger							
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																				
UserDefinedStat 1	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
UserDefinedStat 2	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
CaptureTrigger	X												X							
CaptureFilter	X												X							
StreamTrigger1													X	X			X	X	X	X
StreamTrigger2													X	X			X	X	X	X
Type: States																				
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal								**Qos**				**StreamTrigger**							
DuplexMode				X												X				
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																				
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
PortCpuDodStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
Type: Transmit Duration																				
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of																				

	Normal								**Qos**				**StreamTrigger**							
Service																				
QualityOfService0									X	X	X	X								
Type: Checksum Stats																				
IpPackets																				
UdpPackets																				
TcpPackets																				
IpChecksumErrors																				
UdpChecksumErrors																				
TcpChecksumErrors																				
Type: Data Integrity																				
DataIntegrityFrames			X												X					
DataIntegrityErrors			X												X					
Type: Sequence Checking																				
SequenceFrames					X						X						X			
SequenceErrors					X						X						X			
Type: Ethernet																				
Fragments				X												X				

	Normal								**Qos**				**StreamTrigger**							
Undersize				X												X				
Oversize				X												X				
VlanTaggedFramesRx				X												X				
FlowControlFrames				X												X				
Type: Gigabit																				
SymbolErrorFrames				X												X				
SynchErrorFrames				X												X				
Type: 10/100 + Gigabit																				
SymbolErrors				X												X				
OversizeAndCrcErrors				X												X				
Type: POS																				
SectionLossOfSignal																				
SectionLossOfFrame																				
SectionBip																				
LineAis																				

	Normal								Qos				StreamTrigger							
LineRdi																				
LineRei																				
LineBip																				
PathAis																				
PathRdi																				
PathRei																				
PathBip																				
PathLossOfPointer																				
PathPlm																				
SectionBipErroredSecs									X	X	X	X								
SectionBipSeverlyErroredSecs									X	X	X	X								
SectionLossOfSignalSecs									X	X	X	X								
LineBipErroredSecs									X	X	X	X								
LineReiErroredSecs									X	X	X	X								
LineAisAlarmSecs									X	X	X	X								
LineRdiUnavailableSecs									X	X	X	X								
PathBipErroredS									X	X	X	X								

	Normal								Qos				StreamTrigger							
ecs																				
PathReiErroredSecs									X	X	X	X								
PathAisAlarmSecs									X	X	X	X								
PathAisUnavailableSecs									X	X	X	X								
PathRdiUnavailableSecs									X	X	X	X								
InputSignalStrength	X	X	X		X	X	X	X					X	X	X		X	X	X	X
PosK1Byte	X	X	X		X	X	X	X					X	X	X		X	X	X	X
PosK2Byte	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpDataFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpDiscoveryFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpIpsFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpParityErrors	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpUsageFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpUsageStatus	X	X	X		X	X	X	X					X	X	X		X	X	X	X

	Normal								Qos				StreamTrigger							
SrpUsageTimeouts	X	X	X		X	X	X	X					X	X	X		X	X	X	X
Type: DCC																				
DccBytesReceived						X	X					X						X	X	
DccBytesSent																				
DccCrcErrorsReceived						X	X					X						X	X	
DccFramesReceived						X	X					X						X	X	
DccFramesSent																				
DccFramingErrorsReceived																				
Type: OC192 - Temperature																				
DMATemperature																				
CaptureTemperature																				
LatencyTemperature																				
BackgroundTemperature																				
OverlayTemperature																				

	Normal								Qos				StreamTrigger							
FrontEndTemperature																				
SchedulerTemperature																				
PlmDevice1InternalTemperature																				
PlmDevice2InternalTemperature																				
PlmDevice3InternalTemperature																				
FobPort1FpgaTemperature																				
FobPort2FpgaTemperature																				
FobBoardTemperature																				
FobDevice1InternalTemperature																				

Statistics for OC192c Modules with SRP and DCC

	ModeChecksumErrors						**ModeDataIntegrity**								**Add'l**	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X						X			
CaptureFilter	X						X						X			
StreamTrigger1																
StreamTrigger2																
Type: States																
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X		X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X		X	X		
Type: Transmit Duration																
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																
QualityOfService0																
Type: Checksum Stats																
IpPackets	X					X										
UdpPackets	X					X										
TcpPackets	X					X										
IpChecksumErrors	X					X										
UdpChecksumErrors	X					X										
TcpChecksumErrors	X					X										
Type: Data Integrity																
DataIntegrityFrames			X						X							
DataIntegrityErrors			X						X							
Type: Sequence Checking																
SequenceFrames					X						X					
SequenceErrors					X						X					
Type: Ethernet																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
Fragments				X						X						
Undersize				X						X						
Oversize				X						X						
VlanTaggedFramesRx				X						X						
FlowControlFrames				X						X						
Type: Gigabit																
SymbolErrorFrames				X						X						
SynchErrorFrames				X						X						
Type: 10/100 + Gigabit																
SymbolErrors				X						X						
OversizeAndCrcErrors				X						X						
Type: POS																
SectionLossOfSignal															X	
SectionLossOfFrame															X	
SectionBip															X	
LineAis															X	
LineRdi															X	
LineRei															X	
LineBip															X	
PathAis															X	
PathRdi															X	
PathRei															X	
PathBip															X	

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PathLossOfPointer															X	
PathPlm															X	
SectionBipErroredSecs	X	X	X		X	X										
SectionBipSeverlyErroredSecs	X	X	X		X	X										
SectionLossOfSignalSecs	X	X	X		X	X										
LineBipErroredSecs	X	X	X		X	X										
LineReiErroredSecs	X	X	X		X	X										
LineAisAlarmSecs	X	X	X		X	X										
LineRdiUnavailableSecs	X	X	X		X	X										
PathBipErroredSecs	X	X	X		X	X										
PathReiErroredSecs	X	X	X		X	X										
PathAisAlarmSecs	X	X	X		X	X										
PathAisUnavailableSecs	X	X	X		X	X										
PathRdiUnavailableSecs	X	X	X		X	X										
InputSignalStrength							X	X	X		X	X	X	X		
PosK1Byte							X	X	X		X	X	X	X		
PosK2Byte							X	X	X		X	X	X	X		
SrpDataFramesReceived							X	X	X		X	X	X	X		
							X	X	X		X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
SrpDiscoveryFrames Received																
SrpIpsFramesReceiv ed							X	X	X		X	X	X	X		
SrpParityErrors							X	X	X		X	X	X	X		
SrpUsageFramesRec eived							X	X	X		X	X	X	X		
SrpUsageStatus							X	X	X		X	X	X	X		
SrpUsageTimeouts							X	X	X		X	X	X	X		
Type: DCC																
DccBytesReceived						X						X	X			
DccBytesSent																
DccCrcErrorsReceive d						X						X	X			
DccFramesReceived						X						X	X			
DccFramesSent																
DccFramingErrorsRe ceived																
Type: OC192 - Temperature																
DMATemperature																X
CaptureTemperature																X
LatencyTemperature																X
BackgroundTempera ture																
OverlayTemperature																X

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
FrontEndTemperature																X
SchedulerTemperature																X
PlmDevice1InternalTemperature																X
PlmDevice2InternalTemperature																X
PlmDevice3InternalTemperature																X
FobPort1FpgaTemperature																X
FobPort2FpgaTemperature																
FobBoardTemperature																X
FobDevice1InternalTemperature																X

Statistics for OC192c Modules with RPR and DCC

Statistics for OC192c Modules with RPR and DCC

	Normal								Qos				StreamTrigger							
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	Capture	RxModeWidePacketGroup	Capture	PacketGroup	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																				
UserDefinedStat1	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
CaptureTrigger	X												X							
CaptureFilter	X												X							
StreamTrigger1													X	X			X	X	X	X
StreamTrigger2													X	X			X	X	X	X
Type: States																				
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X												X				
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal								Qos				StreamTrigger							
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																				
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
PortCpuDodStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
Type: Transmit Duration																				
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																				
QualityOfService0									X	X	X	X								
Type: Checksum Stats																				
IpPackets																				

	Normal								Qos				StreamTrigger							
UdpPackets																				
TcpPackets																				
IpChecksumErrors																				
UdpChecksumErrors																				
TcpChecksumErrors																				
Type: Data Integrity																				
DataIntegrityFrames			X												X					
DataIntegrityErrors			X												X					
Type: Sequence Checking																				
SequenceFrames					X						X						X			
SequenceErrors					X						X						X			
Type: Ethernet																				
Fragments				X												X				
Undersize				X												X				
Oversize				X												X				
VlanTaggedFramesRx				X												X				

	Normal								Qos				StreamTrigger							
FlowControlFrames				X												X				
Type: Gigabit																				
SymbolErrorFrames				X												X				
SynchErrorFrames				X												X				
Type: 10/100 + Gigabit																				
SymbolErrors				X												X				
OversizeAndCrcErrors				X												X				
Type: POS																				
SectionLossOfSignal																				
SectionLossOfFrame																				
SectionBip																				
LineAis																				
LineRdi																				
LineRei																				
LineBip																				
PathAis																				
PathRdi																				
PathRei																				

	Normal								Qos				StreamTrigger							
PathBip																				
PathLossOfPointer																				
PathPlm																				
SectionBipErroredSecs									X	X	X	X								
SectionBipSeverlyErroredSecs									X	X	X	X								
SectionLossOfSignalSecs									X	X	X	X								
LineBipErroredSecs									X	X	X	X								
LineReiErroredSecs									X	X	X	X								
LineAisAlarmSecs									X	X	X	X								
LineRdiUnavailableSecs									X	X	X	X								
PathBipErroredSecs									X	X	X	X								
PathReiErroredSecs									X	X	X	X								
PathAisAlarmSecs									X	X	X	X								
PathAisUnavailableSecs									X	X	X	X								

	Normal								Qos				StreamTrigger							
PathRdiUnavailableSecs									X	X	X	X								
InputSignalStrength	X	X	X		X	X	X	X					X	X	X		X	X	X	X
PosK1Byte																				
PosK2Byte																				
SrpDataFramesReceived																				
SrpDiscoveryFramesReceived																				
SrpIpsFramesReceived																				
SrpParityErrors																				
SrpUsageFramesReceived																				
SrpUsageStatus																				
SrpUsageTimeouts																				
Type: DCC																				
DccBytesReceived						X	X					X						X	X	
DccBytesSent																				
DccCrcErrorsReceived						X	X					X						X	X	
DccFramesReceiv						X	X					X						X	X	

	Normal								Qos				StreamTrigger							
ed																				
DccFramesSent																				
DccFramingErrorsReceived																				
Type: OC192 - Temperature																				
DMATemperature																				
CaptureTemperature																				
LatencyTemperature																				
BackgroundTemperature																				
OverlayTemperature																				
FrontEndTemperature																				
SchedulerTemperature																				
PlmDevice1InternalTemperature																				
PlmDevice2InternalTemperature																				
PlmDevice3Internal|Temperature																				

	Normal								Qos				StreamTrigger							
FobPort1FpgaTemperature																				
FobPort2FpgaTemperature																				
FobBoardTemperature																				
FobDevice1InternalTemperature																				
Type: RPR																				
RprDiscoveryFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprDataFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprFairnessFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprFairnessFramesSent	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprFairnessTimeouts	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprHeaderCrcErrors	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprOamFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprPayloadCrcErrors	X	X	X		X	X	X	X					X	X	X		X	X	X	X

	Normal								Qos				StreamTrigger							
RprProtectionFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X

Statistics for OC192c Modules with RPR and DCC

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X						X			
CaptureFilter	X						X						X			
StreamTrigger1																
StreamTrigger2																
Type: States																
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X		X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X		X	X		
Type: Transmit Duration																
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																
QualityOfService0																
Type: Checksum Stats																
IpPackets	X					X										
UdpPackets	X					X										
TcpPackets	X					X										
IpChecksumErrors	X					X										
UdpChecksumErrors	X					X										
TcpChecksumErrors	X					X										
Type: Data Integrity																
DataIntegrityFrames			X						X							
DataIntegrityErrors			X						X							
Type: Sequence Checking																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
SequenceFrames					X						X					
SequenceErrors					X						X					
Type: Ethernet																
Fragments				X						X						
Undersize				X						X						
Oversize				X						X						
VlanTaggedFramesRx				X						X						
FlowControlFrames				X						X						
Type: Gigabit																
SymbolErrorFrames				X						X						
SynchErrorFrames				X						X						
Type: 10/100 + Gigabit																
SymbolErrors				X						X						
OversizeAndCrcErrors				X						X						
Type: POS																
SectionLossOfSignal															X	
SectionLossOfFrame															X	
SectionBip															X	
LineAis															X	
LineRdi															X	
LineRei															X	
LineBip															X	
PathAis															X	

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PathRdi															X	
PathRei															X	
PathBip															X	
PathLossOfPointer															X	
PathPlm															X	
SectionBipErroredSecs	X	X	X		X	X										
SectionBipSeverlyErroredSecs	X	X	X		X	X										
SectionLossOfSignalSecs	X	X	X		X	X										
LineBipErroredSecs	X	X	X		X	X										
LineReiErroredSecs	X	X	X		X	X										
LineAisAlarmSecs	X	X	X		X	X										
LineRdiUnavailableSecs	X	X	X		X	X										
PathBipErroredSecs	X	X	X		X	X										
PathReiErroredSecs	X	X	X		X	X										
PathAisAlarmSecs	X	X	X		X	X										
PathAisUnavailableSecs	X	X	X		X	X										
PathRdiUnavailableSecs	X	X	X		X	X										
InputSignalStrength							X	X	X		X	X	X	X		
PosK1Byte																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PosK2Byte																
SrpDataFramesReceived																
SrpDiscoveryFramesReceived																
SrpIpsFramesReceived																
SrpParityErrors																
SrpUsageFramesReceived																
SrpUsageStatus																
SrpUsageTimeouts																
Type: DCC																
DccBytesReceived						X						X	X			
DccBytesSent																
DccCrcErrorsReceived						X						X	X			
DccFramesReceived						X						X	X			
DccFramesSent																
DccFramingErrorsReceived																
Type: OC192 - Temperature																
DMATemperature																X
CaptureTemperature																X
LatencyTemperature																X

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
BackgroundTemperature																
OverlayTemperature																X
FrontEndTemperature																X
SchedulerTemperature																X
PlmDevice1InternalTemperature																X
PlmDevice2InternalTemperature																X
PlmDevice3Internal|Temperature																X
FobPort1FpgaTemperature																X
FobPort2FpgaTemperature																
FobBoardTemperature																X
FobDevice1InternalTemperature																X
Type: RPR																
RprDiscoveryFramesReceived							X	X	X		X	X	X	X		
RprDataFramesRecei							X	X	X		X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
ved																
RprFairnessFramesReceived							X	X	X		X	X	X	X		
RprFairnessFramesSent							X	X	X		X	X	X	X		
RprFairnessTimeouts							X	X	X		X	X	X	X		
RprHeaderCrcErrors							X	X	X		X	X	X	X		
RprOamFramesReceived							X	X	X		X	X	X	X		
RprPayloadCrcErrors							X	X	X		X	X	X	X		
RprProtectionFramesReceived							X	X	X		X	X	X	X		

Statistics for 2.5G MSM POS modules

Statistics for 2.5G MSM POS modules

	Normal									Qos							StreamTrigger								
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																										
UserDefinedStat1	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X
UserDefinedStat2	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X

	Normal									Qos								StreamTrigger								
CaptureTrigger	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
CaptureFilter	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
StreamTrigger 1	X	X	X		X				X	X	X	X	X				X	X	X	X		X		X	X	X
StreamTrigger 2	X	X	X		X				X	X	X	X	X				X	X	X	X		X		X	X	X
Type: States																										
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X																X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																										
FramesSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X

	Normal									Qos								StreamTrigger								
FramesReceived	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
BytesSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
BytesReceived	X	X	X	X	X		X	X	X										X	X	X	X	X		X	X	X
FcsErrors	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
BitsReceived	X	X	X	X	X		X	X	X										X	X	X	X	X		X	X	X
BitsSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
PortCpuStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
PortCpuDodStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
Type: Transmit Duration																										
TransmitDuration	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Type: Quality of Service																										
QualityOfService0										X	X	X	X	X	X	X	X									
Type: Checksum Stats																										

	Normal									Qos								StreamTrigger								
IpPackets																										
UdpPackets																										
TcpPackets																										
IpChecksumErrors																										
UdpChecksumErrors																										
TcpChecksumErrors																										
Type: Data Integrity																										
DataIntegrityFrames			X									X								X						
DataIntegrityErrors			X									X								X						
Type: SequenceChecking																										
SequenceFrames					X								X								X					
SequenceErrors					X								X								X					
Type: Ethernet																										
Fragments				X			X							X	X					X			X			
Undersize				X			X							X	X					X			X			

	Normal									Qos								StreamTrigger								
Oversize				X			X							X	X						X			X		
VlanTaggedFramesRx				X			X							X	X						X			X		
FlowControlFrames				X			X							X	X						X			X		
Type: Gigabit																										
SymbolErrorFrames				X																	X					
SynchErrorFrames				X																	X					
Type: 10/100 + Gigabit																										
SymbolErrors				X																	X					
OversizeAndCrcErrors				X			X							X	X						X			X		
Type: POS																										
SectionLossOfSignal						X																X				
SectionLossOfFrame																										
SectionBip																										
LineAis																										
LineRdi																										

	Normal									Qos								StreamTrigger								
LineRei																										
LineBip																										
PathAis																										
PathRdi																										
PathRei																										
PathBip																										
PathLossOfPointer																										
PathPlm																										
SectionBipErroredSecs																X										
SectionBipSeverlyErroredSecs																X										
SectionLossOfSignalSecs																X										
LineBipErroredSecs																X										
LineReiErroredSecs																X										
LineAisAlarmSecs																X										
LineRdiUnavailableSecs																X										
PathBipErroredSecs																X										

	Normal									Qos								StreamTrigger								
PathReiErroredSecs																X										
PathAisAlarmSecs																X										
PathAisUnavailableSecs																X										
PathRdiUnavailableSecs																X										
InputSignalStrength							X	X						X	X									X	X	
PosK1Byte	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
PosK2Byte	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
SrpDataFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
SrpDiscoveryFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
SrpIpsFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
SrpParityErrors	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
SrpUsageFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X

	Normal									**Qos**								**StreamTrigger**								
SrpUsageStatus	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
SrpUsageTimeouts	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
Type: DCC																										
DccBytesReceived								X								X									X	
DccBytesSent																										
DccCrcErrorsReceived								X								X									X	
DccFramesReceived								X								X									X	
DccFramesSent																										
DccFramingErrorsReceived																										
Type: BERT																										
BertStatus						X																	X			
BertBitsSent						X																	X			
BertBitsReceived						X																	X			
BertBitErrorsSent						X																	X			

	Normal									Qos								StreamTrigger								
BertBitErrorsReceived						X																		X			
BertErroredBlocks						X																		X			
BertErroredSeconds						X																		X			
BertSeverelyErroredSeconds						X																		X			
BertErrorFreeSeconds						X																		X			
BertAvailableSeconds						X																		X			
BertUnavailableSeconds						X																		X			
BertBlockErrorState						X																		X			
BertBackgroundBlockErrors						X																		X			
BertBitErrorRatio						X																		X			
BertErroredSecondRatio						X																		X			
BertSeverlyErroredSecondRatio						X																		X			

	Normal									Qos								StreamTrigger								
BertBackgroundBlockErrorRatio						X																	X			
BertNumberMismatchedOnes						X																	X			
BertMismatchedOnesRatio						X																	X			
BertNumberMismatchedZeros						X																	X			
BertMismatchedZerosRatio						X																	X			
BertElapsedTestTime						X																	X			
BertUnframedOutputSignalStrength																										
BertUnframedDetectedLineRate																										
BertDeskewPatternLock																										
BertRxDeskewErroredFrames																										
BertRxDeskewErrorFreeFra																										

	Normal									Qos								StreamTrigger								
mes																										
BertRxDeskewLossOfFrame																										
BertTimeSinceLastError																										
BertTriggerCount																										
BertTxDeskewBitErrors																										
BertTxDeskewErroredFrames																										
BertTxDeskewErrorFreeFrames																										
Type: Service Disruption																										
BertLastServiceDisruptionTime						X																X				
BertMinServiceDisruptionTime						X																X				
BertMaxServiceDisruptionTime						X																X				
BertServiceDi						X																X				

	Normal									Qos								StreamTrigger								
sruptionCumulative																										
Type: OC192 - Temperature																										
DMATemperature																										
CaptureTemperature																										
LatencyTemperature																										
BackgroundTemperature																										
OverlayTemperature																										
FrontEndTemperature																										
SchedulerTemperature																										
PlmDevice1InternalTemperature																										
PlmDevice2InternalTemperature																										
PlmDevice3InternalTemperature																										

	Normal									Qos								StreamTrigger								
FobPort1FpgaTemperature																										
FobPort2FpgaTemperature																										
FobBoardTemperature																										
FobDevice1InternalTemperature																										
Type: 10 Gig																										
PauseAcknowledge							X						X	X									X			
PauseEndFrames							X						X	X									X			
PauseOverwrite							X						X	X									X			
10GigLanTxFpgaTemperature																										
10GigLanRxFpgaTemperature																										
CodingErrorFramesReceived																										
EErrorCharacterFramesReceived																										

	Normal									Qos								StreamTrigger								
DroppedFrames																											
Type: Link Fault Signaling																											
LinkFaultState							X								X									X			
LocalFaults							X								X									X			
RemoteFaults							X								X									X			
Type: RPR																											
RprDiscoveryFramesReceived								X																	X		
RprDataFramesReceived								X																	X		
RprFairnessFramesReceived								X																	X		
RprFairnessFramesSent								X																	X		
RprFairnessTimeouts								X																	X		
RprHeaderCrcErrors								X																	X		
RprOamFram								X																	X		

	Normal									Qos								StreamTrigger								
esReceived																										
RprPayloadCrcErrors								X																	X	
RprProtectionFramesReceived								X																	X	

Statistics for 2.5G MSM POS modules

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																		
UserDefinedStat1	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2				X				X	X	X	X	X	X	X	X	X		
CaptureTrigger	X						X	X	X	X		X				X		
CaptureFilter	X							X	X	X		X				X		
StreamTrigger1								X	X	X		X				X		
StreamTrigger2								X	X	X		X				X		
Type: States																		
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X							X							

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																		
FramesSent				X			X	X	X	X	X	X	X	X	X	X		
FramesReceived				X			X	X	X	X	X	X	X	X	X	X		
BytesSent				X			X	X	X	X	X	X	X	X	X	X		
BytesReceived				X			X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X		X	X	X	X		X			X	X		
PortCpuDodStatus	X	X	X		X		X	X	X	X		X			X	X		
Type: Transmit Duration																		
TransmitDuration	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																		
QualityOfService0																		
Type: Checksum Stats																		
IpPackets	X	X	X		X		X											
UdpPackets	X	X	X		X		X											
TcpPackets	X	X	X		X		X											
IpChecksumErrors	X	X	X		X		X											
UdpChecksumErrors	X	X	X		X		X											
TcpChecksumErrors	X	X	X		X		X											

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
Type: Data Integrity																		
DataIntegrityFrames										X								
DataIntegrityErrors										X								
Type: Sequence Checking																		
SequenceFrames												X						
SequenceErrors												X						
Type: Ethernet																		
Fragments				X							X		X	X				
Undersize				X							X		X	X				
Oversize				X							X		X	X				
VlanTaggedFramesRx				X							X		X	X				
FlowControlFrames				X							X		X	X				
Type: Gigabit																		
SymbolErrorFrames				X							X							
SynchErrorFrames				X							X							
Type: 10/100 + Gigabit																		
SymbolErrors				X							X							
OversizeAndCrcErrors				X							X		X	X				
Type: POS																		
SectionLossOfSignal						X											X	
SectionLossOfFrame																	X	

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
SectionBip																	X	
LineAis																	X	
LineRdi																	X	
LineRei																	X	
LineBip																	X	
PathAis																	X	
PathRdi																	X	
PathRei																	X	
PathBip																	X	
PathLossOfPointer																	X	
PathPlm																	X	
SectionBipErroredSecs							X										X	
SectionBipSeverlyErroredSecs							X										X	
SectionLossOfSignalSecs							X										X	
LineBipErroredSecs							X										X	
LineReiErroredSecs							X										X	
LineAisAlarmSecs							X										X	
LineRdiUnavailableSecs							X										X	
PathBipErroredSecs							X										X	
PathReiErroredSecs							X										X	
PathAisAlarmSecs							X										X	

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
PathAisUnavailableSecs							X										X	
PathRdiUnavailableSecs							X										X	
InputSignalStrength													X	X	X			
PosK1Byte								X	X	X		X				X		
PosK2Byte								X	X	X		X				X		
SrpDataFramesReceived								X	X	X		X				X		
SrpDiscoveryFramesReceived								X	X	X		X				X		
SrpIpsFramesReceived								X	X	X		X				X		
SrpParityErrors								X	X	X		X				X		
SrpUsageFramesReceived								X	X	X		X				X		
SrpUsageStatus								X	X	X		X				X		
SrpUsageTimeouts								X	X	X		X				X		
Type: DCC																		
DccBytesReceived							X								X			
DccBytesSent																		
DccCrcErrorsReceived							X								X			
DccFramesReceived							X								X			
DccFramesSent																		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
DccFramingErrorsReceived																		
Type: BERT																		
BertStatus						X												
BertBitsSent						X												
BertBitsReceived						X												
BertBitErrorsSent						X												
BertBitErrorsReceived						X												
BertErroredBlocks						X												
BertErroredSeconds						X												
BertSeverelyErroredSeconds						X												
BertErrorFreeSeconds						X												
BertAvailableSeconds						X												
BertUnavailableSeconds						X												
BertBlockErrorState						X												
BertBackgroundBlockErrors						X												
BertBitErrorRatio						X												
BertErroredSecondRatio						X												

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
BertSeverlyErroredSecondRatio						X												
BertBackgroundBlockErrorRatio						X												
BertNumberMismatchedOnes						X												
BertMismatchedOnesRatio						X												
BertNumberMismatchedZeros						X												
BertMismatchedZerosRatio						X												
BertElapsedTestTime						X												
BertUnframedOutputSignalStrength																		
BertUnframedDetectedLineRate																		
BertDeskewPatternLock																		
BertRxDeskewErroredFrames																		
BertRxDeskewErrorFreeFrames																		
BertRxDeskewLoss																		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
OfFrame																		
BertTimeSinceLastError																		
BertTriggerCount																		
BertTxDeskewBitErrors																		
BertTxDeskewErroredFrames																		
BertTxDeskewErrorFreeFrames																		
Type: Service Disruption																		
BertLastServiceDisruptionTime						X												
BertMinServiceDisruptionTime						X												
BertMaxServiceDisruptionTime						X												
BertServiceDisruptionCumulative						X												
Type: OC192 - Temperature																		
DMATemperature																		X
CaptureTemperature																		X
LatencyTemperatur																		X

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
e																		
BackgroundTemperature																		X
OverlayTemperature																		X
FrontEndTemperature																		X
SchedulerTemperature																		
PlmDevice1InternalTemperature																		
PlmDevice2InternalTemperature																		
PlmDevice3InternalTemperature																		
FobPort1FpgaTemperature																		
FobPort2FpgaTemperature																		
FobBoardTemperature																		
FobDevice1InternalTemperature																		
Type: 10 Gig																		
PauseAcknowledge													X	X				

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
PauseEndFrames													X	X				
PauseOverwrite													X	X				
10GigLanTxFpgaTemperature																		
10GigLanRxFpgaTemperature																		
CodingErrorFramesReceived																		
EErrorCharacterFramesReceived																		
DroppedFrames																		
Type: Link Fault Signaling																		
LinkFaultState														X				
LocalFaults														X				
RemoteFaults														X				
Type: RPR																		
RprDiscoveryFramesReceived															X			
RprDataFramesReceived															X			
RprFairnessFramesReceived															X			
RprFairnessFramesSent															X			
															X			

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
RprFairnessTimeouts																		
RprHeaderCrcErrors															X			
RprOamFramesReceived															X			
RprPayloadCrcErrors															X			
RprProtectionFramesReceived															X			

Statistics for OC192c Modules with BERT

Statistics for OC192c Modules with BERT

	Normal										Qos								StreamTrigger									
	Capture	PacketGroup	RxTcpRoundTrip	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxTcpRoundTrip	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																												
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	X	X	X	X
CaptureTrigger	X		X																X		X							

	Normal										Qos								StreamTrigger									
CaptureFilter	X		X																X		X							
StreamTrigger1																			X	X				X	X	X	X	X
StreamTrigger2																			X	X				X	X	X	X	X
Type: States																												
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode			X		X								X								X		X					
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																												
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal										**Qos**								**StreamTrigger**									
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X		X		X			X	X	X	X	X	X			X	X	X	X		X		X			X	X
PortCpuDodStatus	X	X		X		X			X	X	X	X	X	X			X	X	X	X		X		X			X	X
Type: Transmit Duration																												
TransmitDuration	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Type: Quality of Service																												
QualityOfService0											X	X	X	X	X	X	X	X										
Type: Checksum Stats																												
IpPackets																												

	Normal										Qos								StreamTrigger									
UdpPackets																												
TcpPackets																												
IpChecksumErrors																												
UdpChecksumErrors																												
TcpChecksumErrors																												
Type: Data Integrity																												
DataIntegrityFrames				X																	X							
DataIntegrityErrors				X																	X							
Type: Sequence Checking																												
SequenceFrames						X							X										X					
SequenceErrors						X							X										X					
Type: Ethernet																												
Fragments			X		X							X								X		X						
Undersize			X		X							X								X		X						

	Normal										Qos								StreamTrigger									
Oversize			X		X								X								X		X					
VlanTagged FramesRx			X		X																X		X					
FlowControl Frames			X		X								X								X		X					
Type: 10/100																												
AlignmentErrors			X																		X							
DribbleErrors			X										X								X							
Collisions			X										X								X							
LateCollisions			X										X								X							
CollisionFrames			X										X								X							
ExcessiveCollisionFrames			X										X								X							
Type: Gigabit																												
SymbolErrorFrames					X																		X					
SynchErrorFrames					X																		X					

	Normal										Qos								StreamTrigger									
Type: 10/100 + Gigabit																												
SymbolErrors					X																		X					
OversizeAndCrcErrors					X								X										X					
Type: POS																												
SectionLossOfSignal																												
SectionLossOfFrame																												
SectionBip																												
LineAis																												
LineRdi																												
LineRei																												
LineBip																												
PathAis																												
PathRdi																												
PathRei																												
PathBip																												
PathLossOfPointer																												
PathPlm																												
SectionBipErroredSecs									X								X										X	

	Normal										Qos										StreamTrigger									
SectionBipSeverlyErroredSecs									X								X													X	
SectionLossOfSignalSecs									X								X													X	
LineBipErroredSecs									X								X													X	
LineReiErroredSecs									X								X													X	
LineAisAlarmSecs									X								X													X	
LineRdiUnavailableSecs									X								X													X	
PathBipErroredSecs									X								X													X	
PathReiErroredSecs									X								X													X	
PathAisAlarmSecs									X								X													X	
PathAisUnavailableSecs									X								X													X	
PathRdiUnavailableSecs									X								X													X	

	Normal										Qos								StreamTrigger									
InputSignalStrength	X	X		X		X	X	X		X	X	X		X	X	X		X	X	X		X		X	X	X		X
PosK1Byte																												
PosK2Byte																												
SrpDataFramesReceived																												
SrpDiscoveryFramesReceived																												
SrpIpsFramesReceived																												
SrpParityErrors																												
SrpUsageFramesReceived																												
SrpUsageStatus																												
SrpUsageTimeouts																												
Type: DCC																												
DccBytesReceived									X								X										X	
DccBytesSent																												
DccCrcError									X								X										X	

	Normal										Qos								StreamTrigger									
sReceived																												
DccFrames Received									X								X										X	
DccFrames Sent																												
DccFraming ErrorsReceived																												
Type: OC192 - Temperature																												
DMATemperature																												
CaptureTemperature																												
LatencyTemperature																												
Background Temperature																												
OverlayTemperature																												
FrontEndTemperature																												
SchedulerTemperature																												

	Normal										**Qos**								**StreamTrigger**									
PlmDevice1 InternalTemperature																												
PlmDevice2 InternalTemperature																												
PlmDevice3 InternalTemperature																												
FobPort1FpgaTemperature																												
FobPort2FpgaTemperature																												
FobBoardTemperature																												
FobDevice1 InternalTemperature																												

Statistics for OC192c Modules with BERT

	ModeChecksumErrors								**ModeDataIntegrity**									**Add'l**	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats

	ModeChecksumErrors								ModeDataIntegrity									Add'l	
Type: User Configurable																			
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X				X	X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X	X	X							X			
CaptureFilter	X							X	X							X			
StreamTrigger1																			
StreamTrigger2																			
Type: States																			
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X				X				X							
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																			
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

	ModeChecksumErrors								ModeDataIntegrity									Add'l	
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X		X	X	X	X	X		X			X	X		
PortCpuDodStatus	X	X	X		X		X	X	X	X	X		X			X	X		
Type: Transmit Duration																			
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																			
QualityOfService0																			
Type: Checksum Stats																			
IpPackets	X					X	X	X											
UdpPackets	X					X	X	X											
TcpPackets	X					X	X	X											
IpChecksumErrors	X					X	X	X											
UdpChecksumErrors	X					X	X	X											

	ModeChecksumErrors								ModeDataIntegrity									Add'l	
TcpChecksumErrors	X					X	X	X											
Type: Data Integrity																			
DataIntegrityFrames			X								X								
DataIntegrityErrors			X								X								
Type: Sequence Checking																			
SequenceFrames					X								X						
SequenceErrors					X								X						
Type: Ethernet																			
Fragments				X				X				X							
Undersize				X				X				X							
Oversize				X				X				X							
VlanTaggedFramesRx				X								X							
FlowControlFrames				X								X							
Type: 10/100																			
AlignmentErrors																			
DribbleErrors								X											

	ModeChecksumErrors								ModeDataIntegrity									Add'l	
Collisions								X											
LateCollisions								X											
CollisionFrames								X											
ExcessiveCollisionFrames								X											
Type: Gigabit																			
SymbolErrorFrames				X								X							
SynchErrorFrames				X								X							
Type: 10/100 + Gigabit																			
SymbolErrors				X								X							
OversizeAndCrcErrors				X				X				X							
Type: POS																			
SectionLossOfSignal																		X	
SectionLossOfFrame																		X	
SectionBip																		X	
LineAis																		X	
LineRdi																		X	
LineRei																		X	
LineBip																		X	

	ModeChecksumErrors								ModeDataIntegrity									Add'l	
PathAis																		X	
PathRdi																		X	
PathRei																		X	
PathBip																		X	
PathLossOfPointer																		X	
PathPlm																		X	
SectionBipErroredSecs	X	X	X		X	X	X									X			
SectionBipSeverlyErroredSecs	X	X	X		X	X	X									X			
SectionLossOfSignalSecs	X	X	X		X	X	X									X			
LineBipErroredSecs	X	X	X		X	X	X									X			
LineReiErroredSecs	X	X	X		X	X	X									X			
LineAisAlarmSecs	X	X	X		X	X	X									X			
LineRdiUnavailableSecs	X	X	X		X	X	X									X			
PathBipErroredSecs	X	X	X		X	X	X									X			
PathReiErroredSecs	X	X	X		X	X	X									X			
PathAisAlarmSecs	X	X	X		X	X	X									X			

	ModeChecksumErrors								**ModeDataIntegrity**									**Add'l**	
PathAisUnavailableSecs	X	X	X		X	X	X									X			
PathRdiUnavailableSecs	X	X	X		X	X	X									X			
InputSignalStrength									X	X	X		X	X	X		X		
PosK1Byte																			
PosK2Byte																			
SrpDataFramesReceived																			
SrpDiscoveryFramesReceived																			
SrpIpsFramesReceived																			
SrpParityErrors																			
SrpUsageFramesReceived																			
SrpUsageStatus																			
SrpUsageTimeouts																			
Type: DCC																			
DccBytesReceived							X									X			
DccBytesSent																			

	ModeChecksumErrors								ModeDataIntegrity										Add'l	
DccCrcErrorsReceived							X									X				
DccFramesReceived							X									X				
DccFramesSent																				
DccFramingErrorsReceived																				
Type: OC192 - Temperature																				
DMATemperature																				X
CaptureTemperature																				X
LatencyTemperature																				X
BackgroundTemperature																				
OverlayTemperature																				X
FrontEndTemperature																				X
SchedulerTemperature																				X
PlmDevice1InternalTemperature																				X
PlmDevice2Intern																				X

	ModeChecksumErrors								ModeDataIntegrity									Add'l	
alTemperature																			
PlmDevice3InternalTemperature																			X
FobPort1FpgaTemperature																			X
FobPort2FpgaTemperature																			
FobBoardTemperature																			X
FobDevice1InternalTemperature																			X

Statistics for OC192c Modules with SRP and DCC

Statistics for OC192c Modules with SRP and DCC

	Normal								Qos				StreamTrigger							
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																				
UserDefinedStat1	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
CaptureTrigger	X												X							

	Normal								**Qos**				**StreamTrigger**							
CaptureFilter	X												X							
StreamTrigger1													X	X			X	X	X	X
StreamTrigger2													X	X			X	X	X	X
Type: States																				
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X												X				
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																				
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X

	Normal								**Qos**				**StreamTrigger**							
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
PortCpuDodStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
Type: Transmit Duration																				
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																				
QualityOfService0									X	X	X	X								
Type: Checksum Stats																				
IpPackets																				
UdpPackets																				
TcpPackets																				
IpChecksumErrors																				
UdpChecksumErrors																				
TcpChecksumErrors																				
Type: Data Integrity																				
DataIntegrityFra			X												X					

	Normal								**Qos**				**StreamTrigger**							
mes																				
DataIntegrityErrors			X												X					
Type: Sequence Checking																				
SequenceFrames					X						X						X			
SequenceErrors					X						X						X			
Type: Ethernet																				
Fragments				X												X				
Undersize				X												X				
Oversize				X												X				
VlanTaggedFramesRx				X												X				
FlowControlFrames				X												X				
Type: Gigabit																				
SymbolErrorFrames				X												X				
SynchErrorFrames				X												X				
Type: 10/100 + Gigabit																				
SymbolErrors				X												X				

	Normal								Qos				StreamTrigger							
OversizeAndCrcErrors				X												X				
Type: POS																				
SectionLossOfSignal																				
SectionLossOfFrame																				
SectionBip																				
LineAis																				
LineRdi																				
LineRei																				
LineBip																				
PathAis																				
PathRdi																				
PathRei																				
PathBip																				
PathLossOfPointer																				
PathPlm																				
SectionBipErroredSecs									X	X	X	X								
SectionBipSeverlyErroredSecs									X	X	X	X								
SectionLossOfSignalSecs									X	X	X	X								
									X	X	X	X								

	Normal								Qos				StreamTrigger							
LineBipErroredSecs																				
LineReiErroredSecs									X	X	X	X								
LineAisAlarmSecs									X	X	X	X								
LineRdiUnavailableSecs									X	X	X	X								
PathBipErroredSecs									X	X	X	X								
PathReiErroredSecs									X	X	X	X								
PathAisAlarmSecs									X	X	X	X								
PathAisUnavailableSecs									X	X	X	X								
PathRdiUnavailableSecs									X	X	X	X								
InputSignalStrength	X	X	X		X	X	X	X					X	X	X		X	X	X	X
PosK1Byte	X	X	X		X	X	X	X					X	X	X		X	X	X	X
PosK2Byte	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpDataFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
	X	X	X		X	X	X	X					X	X	X		X	X	X	X

	Normal								Qos				StreamTrigger							
SrpDiscoveryFramesReceived																				
SrpIpsFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpParityErrors	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpUsageFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpUsageStatus	X	X	X		X	X	X	X					X	X	X		X	X	X	X
SrpUsageTimeouts	X	X	X		X	X	X	X					X	X	X		X	X	X	X
Type: DCC																				
DccBytesReceived						X	X					X						X	X	
DccBytesSent																				
DccCrcErrorsReceived						X	X					X						X	X	
DccFramesReceived						X	X					X						X	X	
DccFramesSent																				
DccFramingErrorsReceived																				
Type: OC192 - Temperature																				
DMATemperature																				

	Normal								Qos				StreamTrigger							
CaptureTemperature																				
LatencyTemperature																				
BackgroundTemperature																				
OverlayTemperature																				
FrontEndTemperature																				
SchedulerTemperature																				
PlmDevice1InternalTemperature																				
PlmDevice2InternalTemperature																				
PlmDevice3InternalTemperature																				
FobPort1FpgaTemperature																				
FobPort2FpgaTemperature																				
FobBoardTemperature																				
FobDevice1Inter																				

	Normal								**Qos**				**StreamTrigger**							
nalTemperature																				

Statistics for OC192c Modules with SRP and DCC

	ModeChecksumErrors						**ModeDataIntegrity**								**Add'l**	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X						X			
CaptureFilter	X						X						X			
StreamTrigger1																
StreamTrigger2																
Type: States																
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X		X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X		X	X		
Type: Transmit Duration																
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																
QualityOfService0																
Type: Checksum Stats																
IpPackets	X					X										
UdpPackets	X					X										
TcpPackets	X					X										
IpChecksumErrors	X					X										
UdpChecksumErrors	X					X										
TcpChecksumErrors	X					X										
Type: Data Integrity																
DataIntegrityFrames			X						X							
DataIntegrityErrors			X						X							
Type: Sequence Checking																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
SequenceFrames					X						X					
SequenceErrors					X						X					
Type: Ethernet																
Fragments				X						X						
Undersize				X						X						
Oversize				X						X						
VlanTaggedFramesRx				X						X						
FlowControlFrames				X						X						
Type: Gigabit																
SymbolErrorFrames				X						X						
SynchErrorFrames				X						X						
Type: 10/100 + Gigabit																
SymbolErrors				X						X						
OversizeAndCrcErrors				X						X						
Type: POS																
SectionLossOfSignal															X	
SectionLossOfFrame															X	
SectionBip															X	
LineAis															X	
LineRdi															X	
LineRei															X	
LineBip															X	
PathAis															X	

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PathRdi															X	
PathRei															X	
PathBip															X	
PathLossOfPointer															X	
PathPlm															X	
SectionBipErroredSecs	X	X	X		X	X										
SectionBipSeverlyErroredSecs	X	X	X		X	X										
SectionLossOfSignalSecs	X	X	X		X	X										
LineBipErroredSecs	X	X	X		X	X										
LineReiErroredSecs	X	X	X		X	X										
LineAisAlarmSecs	X	X	X		X	X										
LineRdiUnavailableSecs	X	X	X		X	X										
PathBipErroredSecs	X	X	X		X	X										
PathReiErroredSecs	X	X	X		X	X										
PathAisAlarmSecs	X	X	X		X	X										
PathAisUnavailableSecs	X	X	X		X	X										
PathRdiUnavailableSecs	X	X	X		X	X										
InputSignalStrength							X	X	X		X	X	X	X		
PosK1Byte							X	X	X		X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PosK2Byte							X	X	X		X	X	X	X		
SrpDataFramesReceived							X	X	X		X	X	X	X		
SrpDiscoveryFramesReceived							X	X	X		X	X	X	X		
SrpIpsFramesReceived							X	X	X		X	X	X	X		
SrpParityErrors							X	X	X		X	X	X	X		
SrpUsageFramesReceived							X	X	X		X	X	X	X		
SrpUsageStatus							X	X	X		X	X	X	X		
SrpUsageTimeouts							X	X	X		X	X	X	X		
Type: DCC																
DccBytesReceived						X						X	X			
DccBytesSent																
DccCrcErrorsReceived						X						X	X			
DccFramesReceived						X						X	X			
DccFramesSent																
DccFramingErrorsReceived																
Type: OC192 - Temperature																
DMATemperature																X
CaptureTemperature																X
LatencyTemperature																X

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
BackgroundTemperature																
OverlayTemperature																X
FrontEndTemperature																X
SchedulerTemperature																X
PlmDevice1InternalTemperature																X
PlmDevice2InternalTemperature																X
PlmDevice3InternalTemperature																X
FobPort1FpgaTemperature																X
FobPort2FpgaTemperature																
FobBoardTemperature																X
FobDevice1InternalTemperature																X

Statistics for OC192c Modules with RPR and DCC

Statistics for OC192c Modules with RPR and DCC

	Normal								Qos				StreamTrigger							
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	Capture	RxModeWidePacketGroup	Capture	PacketGroup	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																				
UserDefinedStat1	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
CaptureTrigger	X												X							
CaptureFilter	X												X							
StreamTrigger1													X	X			X	X	X	X
StreamTrigger2													X	X			X	X	X	X
Type: States																				
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X												X				
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal								**Qos**				**StreamTrigger**							
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																				
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
PortCpuDodStatus	X	X	X		X		X	X	X	X	X	X	X	X	X		X		X	X
Type: Transmit Duration																				
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																				
QualityOfService0									X	X	X	X								
Type: Checksum Stats																				
IpPackets																				

	Normal								**Qos**				**StreamTrigger**							
UdpPackets																				
TcpPackets																				
IpChecksumErrors																				
UdpChecksumErrors																				
TcpChecksumErrors																				
Type: Data Integrity																				
DataIntegrityFrames			X												X					
DataIntegrityErrors			X												X					
Type: Sequence Checking																				
SequenceFrames					X						X						X			
SequenceErrors					X						X						X			
Type: Ethernet																				
Fragments				X												X				
Undersize				X												X				
Oversize				X												X				
VlanTaggedFramesRx				X												X				

	Normal								Qos				StreamTrigger							
FlowControlFrames				X												X				
Type: Gigabit																				
SymbolErrorFrames				X												X				
SynchErrorFrames				X												X				
Type: 10/100 + Gigabit																				
SymbolErrors				X												X				
OversizeAndCrcErrors				X												X				
Type: POS																				
SectionLossOfSignal																				
SectionLossOfFrame																				
SectionBip																				
LineAis																				
LineRdi																				
LineRei																				
LineBip																				
PathAis																				
PathRdi																				
PathRei																				

	Normal								Qos				StreamTrigger							
PathBip																				
PathLossOfPointer																				
PathPlm																				
SectionBipErroredSecs									X	X	X	X								
SectionBipSeverlyErroredSecs									X	X	X	X								
SectionLossOfSignalSecs									X	X	X	X								
LineBipErroredSecs									X	X	X	X								
LineReiErroredSecs									X	X	X	X								
LineAisAlarmSecs									X	X	X	X								
LineRdiUnavailableSecs									X	X	X	X								
PathBipErroredSecs									X	X	X	X								
PathReiErroredSecs									X	X	X	X								
PathAisAlarmSecs									X	X	X	X								
PathAisUnavailableSecs									X	X	X	X								

	Normal								Qos				StreamTrigger							
PathRdiUnavailableSecs									X	X	X	X								
InputSignalStrength	X	X	X		X	X	X	X					X	X	X		X	X	X	X
PosK1Byte																				
PosK2Byte																				
SrpDataFramesReceived																				
SrpDiscoveryFramesReceived																				
SrpIpsFramesReceived																				
SrpParityErrors																				
SrpUsageFramesReceived																				
SrpUsageStatus																				
SrpUsageTimeouts																				
Type: DCC																				
DccBytesReceived						X	X					X						X	X	
DccBytesSent																				
DccCrcErrorsReceived						X	X					X						X	X	
DccFramesReceiv						X	X					X						X	X	

	Normal								Qos				StreamTrigger							
ed																				
DccFramesSent																				
DccFramingErrorsReceived																				
Type: OC192 - Temperature																				
DMATemperature																				
CaptureTemperature																				
LatencyTemperature																				
BackgroundTemperature																				
OverlayTemperature																				
FrontEndTemperature																				
SchedulerTemperature																				
PlmDevice1InternalTemperature																				
PlmDevice2InternalTemperature																				
PlmDevice3Internal|Temperature																				

	Normal								Qos				StreamTrigger							
FobPort1FpgaTemperature																				
FobPort2FpgaTemperature																				
FobBoardTemperature																				
FobDevice1InternalTemperature																				
Type: RPR																				
RprDiscoveryFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprDataFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprFairnessFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprFairnessFramesSent	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprFairnessTimeouts	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprHeaderCrcErrors	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprOamFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X
RprPayloadCrcErrors	X	X	X		X	X	X	X					X	X	X		X	X	X	X

	Normal								**Qos**				**StreamTrigger**							
RprProtectionFramesReceived	X	X	X		X	X	X	X					X	X	X		X	X	X	X

Statistics for OC192c Modules with RPR and DCC

	ModeChecksumErrors						**ModeDataIntegrity**								**Add'l**	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X						X			
CaptureFilter	X						X						X			
StreamTrigger1																
StreamTrigger2																
Type: States																
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X		X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X		X	X		
Type: Transmit Duration																
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																
QualityOfService0																
Type: Checksum Stats																
IpPackets	X					X										
UdpPackets	X					X										
TcpPackets	X					X										
IpChecksumErrors	X					X										
UdpChecksumErrors	X					X										
TcpChecksumErrors	X					X										
Type: Data Integrity																
DataIntegrityFrames			X						X							
DataIntegrityErrors			X						X							
Type: Sequence Checking																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
SequenceFrames					X						X					
SequenceErrors					X						X					
Type: Ethernet																
Fragments				X						X						
Undersize				X						X						
Oversize				X						X						
VlanTaggedFramesRx				X						X						
FlowControlFrames				X						X						
Type: Gigabit																
SymbolErrorFrames				X						X						
SynchErrorFrames				X						X						
Type: 10/100 + Gigabit																
SymbolErrors				X						X						
OversizeAndCrcErrors				X						X						
Type: POS																
SectionLossOfSignal															X	
SectionLossOfFrame															X	
SectionBip															X	
LineAis															X	
LineRdi															X	
LineRei															X	
LineBip															X	
PathAis															X	

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PathRdi															X	
PathRei															X	
PathBip															X	
PathLossOfPointer															X	
PathPlm															X	
SectionBipErroredSecs	X	X	X		X	X										
SectionBipSeverlyErroredSecs	X	X	X		X	X										
SectionLossOfSignalSecs	X	X	X		X	X										
LineBipErroredSecs	X	X	X		X	X										
LineReiErroredSecs	X	X	X		X	X										
LineAisAlarmSecs	X	X	X		X	X										
LineRdiUnavailableSecs	X	X	X		X	X										
PathBipErroredSecs	X	X	X		X	X										
PathReiErroredSecs	X	X	X		X	X										
PathAisAlarmSecs	X	X	X		X	X										
PathAisUnavailableSecs	X	X	X		X	X										
PathRdiUnavailableSecs	X	X	X		X	X										
InputSignalStrength							X	X	X		X	X	X	X		
PosK1Byte																

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
PosK2Byte																
SrpDataFramesReceived																
SrpDiscoveryFramesReceived																
SrpIpsFramesReceived																
SrpParityErrors																
SrpUsageFramesReceived																
SrpUsageStatus																
SrpUsageTimeouts																
Type: DCC																
DccBytesReceived						X						X	X			
DccBytesSent																
DccCrcErrorsReceived						X						X	X			
DccFramesReceived						X						X	X			
DccFramesSent																
DccFramingErrorsReceived																
Type: OC192 - Temperature																
DMATemperature																X
CaptureTemperature																X
LatencyTemperature																X

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
BackgroundTemperature																
OverlayTemperature																X
FrontEndTemperature																X
SchedulerTemperature																X
PlmDevice1InternalTemperature																X
PlmDevice2InternalTemperature																X
PlmDevice3Internal|Temperature																X
FobPort1FpgaTemperature																X
FobPort2FpgaTemperature																
FobBoardTemperature																X
FobDevice1InternalTemperature																X
Type: RPR																
RprDiscoveryFramesReceived							X	X	X		X	X	X	X		
RprDataFramesRecei							X	X	X		X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity								Add'l	
ved																
RprFairnessFramesReceived							X	X	X		X	X	X	X		
RprFairnessFramesSent							X	X	X		X	X	X	X		
RprFairnessTimeouts							X	X	X		X	X	X	X		
RprHeaderCrcErrors							X	X	X		X	X	X	X		
RprOamFramesReceived							X	X	X		X	X	X	X		
RprPayloadCrcErrors							X	X	X		X	X	X	X		
RprProtectionFramesReceived							X	X	X		X	X	X	X		

Statistics for OC192c Modules with BERT

Statistics for 10GE Modules with BERT

	Normal									Qos							StreamTrigger								
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																									
UserDefinedStat1	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X

	Normal									**Qos**							**StreamTrigger**								
CaptureTrigger	X																X								
CaptureFilter	X																X								
StreamTrigger1																	X	X			X	X	X	X	X
StreamTrigger2																	X	X			X	X	X	X	X
Type: States																									
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X																X					
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																									
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal									Qos							StreamTrigger								
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X		X			X	X	X	X	X			X	X	X	X	X		X			X	X
PortCpuDodStatus	X	X	X		X			X	X	X	X	X			X	X	X	X	X		X			X	X
Type: Transmit Duration																									
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																									
QualityOfService0										X	X	X	X	X	X	X									
Type: Checksum Stats																									

	Normal									**Qos**							**StreamTrigger**								
IpPackets																									
UdpPackets																									
TcpPackets																									
IpChecksumErrors																									
UdpChecksumErrors																									
TcpChecksumErrors																									
Type: Data Integrity																									
DataIntegrityFrames			X																X						
DataIntegrityErrors			X																X						
Type: Sequence Checking																									
SequenceFrames					X							X									X				
SequenceErrors					X							X									X				
Type: Ethernet																									
Fragments	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X		X	X	X	X		X
Undersize	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X		X	X	X	X		X

	Normal									**Qos**							**StreamTrigger**								
Oversize	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X		X	X	X	X		X
VlanTaggedFramesRx	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X		X	X	X	X		X
FlowControlFrames	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X		X	X	X	X		X
Type: Gigabit																									
SymbolErrorFrames				X																X					
SynchErrorFrames				X																X					
Type: 10/100 + Gigabit																									
SymbolErrors				X																X					
OversizeAndCrcErrors	X	X		X	X	X	X		X	X	X	X	X	X		X	X	X		X	X	X	X		X
Type: POS																									
SectionLossOfSignal																									
SectionLossOfFrame																									
SectionBip																									
LineAis																									
LineRdi																									

	Normal									Qos							StreamTrigger								
LineRei																									
LineBip																									
PathAis																									
PathRdi																									
PathRei																									
PathBip																									
PathLossOfPointer																									
PathPlm																									
SectionBipErroredSecs															X										
SectionBipSeverlyErroredSecs															X										
SectionLossOfSignalSecs															X										
LineBipErroredSecs															X										
LineReiErroredSecs															X										
LineAisAlarmSecs															X										
LineRdiUnavailableSecs															X										
PathBipErroredSecs															X										

	Normal									Qos							StreamTrigger								
PathReiErroredSecs															X										
PathAisAlarmSecs															X										
PathAisUnavailableSecs															X										
PathRdiUnavailableSecs															X										
InputSignalStrength	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X
PosK1Byte			X					X											X					X	
PosK2Byte			X					X											X					X	
SrpDataFramesReceived			X					X											X					X	
SrpDiscoveryFramesReceived			X					X											X					X	
SrpIpsFramesReceived			X					X											X					X	
SrpParityErrors			X					X											X					X	
SrpUsageFramesReceived			X					X											X					X	

	Normal									Qos								StreamTrigger							
SrpUsageStatus			X					X												X					X	
SrpUsageTimeouts			X					X												X					X	
Type: DCC																										
DccBytesReceived								X						X											X	
DccBytesSent																										
DccCrcErrorsReceived								X						X											X	
DccFramesReceived								X						X											X	
DccFramesSent																										
DccFramingErrorsReceived																										
Type: OC192 - Temperature																										
DMATemperature																										
CaptureTemperature																										
LatencyTemperature																										

	Normal									Qos							StreamTrigger								
BackgroundTemperature																									
OverlayTemperature																									
FrontEndTemperature																									
SchedulerTemperature																									
PlmDevice1InternalTemperature																									
PlmDevice2InternalTemperature																									
PlmDevice3InternalTemperature																									
FobPort1FpgaTemperature																									
FobPort2FpgaTemperature																									
FobBoardTemperature																									
FobDevice1InternalTemperature																									
Type: 10 Gig																									

	Normal									Qos							StreamTrigger								
PauseAcknowledge	X	X			X	X	X		X	X	X	X	X	X		X	X	X			X	X	X		X
PauseEndFrames	X	X			X	X	X		X	X	X	X	X	X		X	X	X			X	X	X		X
PauseOverwrite	X	X			X	X	X		X	X	X	X	X	X		X	X	X			X	X	X		X
10GigLanTxFpgaTemperature																									
10GigLanRxFpgaTemperature																									
CodingErrorFramesReceived																									
EErrorCharacterFramesReceived																									
DroppedFrames																									
Type: Link Fault Signaling																									
LinkFaultState	X	X			X		X		X	X	X	X		X		X	X	X			X		X		X
LocalFaults	X	X			X		X		X	X	X	X		X		X	X	X			X		X		X
RemoteFaults	X	X			X		X		X	X	X	X		X		X	X	X			X		X		X

	Normal									Qos								StreamTrigger								

Statistics for 10GE Modules with BERT

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																	
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X							X			
CaptureFilter	X						X							X			
StreamTrigger1																	
StreamTrigger2																	
Type: States																	
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X							
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																	
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X			X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X			X	X		
Type: Transmit Duration																	
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																	
QualityOfService0																	
Type: Checksum Stats																	
IpPackets	X					X											
UdpPackets	X					X											
TcpPackets	X					X											
IpChecksumErrors	X					X											
UdpChecksumErrors	X					X											
TcpChecksumErrors	X					X											
Type: Data Integrity																	
DataIntegrityFrames			X						X								

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
DataIntegrityErrors			X						X								
Type: Sequence Checking																	
SequenceFrames					X						X						
SequenceErrors					X						X						
Type: Ethernet																	
Fragments				X			X	X		X	X	X	X		X		
Undersize				X			X	X		X	X	X	X		X		
Oversize				X			X	X		X	X	X	X		X		
VlanTaggedFrames Rx				X			X	X		X	X	X	X		X		
FlowControlFrames				X			X	X		X	X	X	X		X		
Type: Gigabit																	
SymbolErrorFrames				X						X							
SynchErrorFrames				X						X							
Type: 10/100 + Gigabit																	
SymbolErrors				X						X							
OversizeAndCrcErrors				X			X	X		X	X	X	X		X		
Type: POS																	
SectionLossOfSignal																X	
SectionLossOfFrame																X	

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
SectionBip																X	
LineAis																X	
LineRdi																X	
LineRei																X	
LineBip																X	
PathAis																X	
PathRdi																X	
PathRei																X	
PathBip																X	
PathLossOfPointer																X	
PathPlm																X	
SectionBipErroredSecs	X	X	X		X	X											
SectionBipSeverlyErroredSecs	X	X	X		X	X											
SectionLossOfSignalSecs	X	X	X		X	X											
LineBipErroredSecs	X	X	X		X	X											
LineReiErroredSecs	X	X	X		X	X											
LineAisAlarmSecs	X	X	X		X	X											
LineRdiUnavailableSecs	X	X	X		X	X											
PathBipErroredSecs	X	X	X		X	X											
PathReiErroredSecs	X	X	X		X	X											

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
PathAisAlarmSecs	X	X	X		X	X											
PathAisUnavailableSecs	X	X	X		X	X											
PathRdiUnavailableSecs	X	X	X		X	X											
InputSignalStrength							X	X	X		X	X	X	X	X		
PosK1Byte									X					X			
PosK2Byte									X					X			
SrpDataFramesReceived									X					X			
SrpDiscoveryFramesReceived									X					X			
SrpIpsFramesReceived									X					X			
SrpParityErrors									X					X			
SrpUsageFramesReceived									X					X			
SrpUsageStatus									X					X			
SrpUsageTimeouts									X					X			
Type: DCC																	
DccBytesReceived						X								X			
DccBytesSent																	
DccCrcErrorsReceived						X								X			

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
DccFramesReceived						X								X			
DccFramesSent																	
DccFramingErrorsReceived																	
Type: OC192 - Temperature																	
DMATemperature																	X
CaptureTemperature																	X
LatencyTemperature																	X
BackgroundTemperature																	
OverlayTemperature																	X
FrontEndTemperature																	X
SchedulerTemperature																	X
PlmDevice1InternalTemperature																	X
PlmDevice2InternalTemperature																	X
PlmDevice3InternalTemperature																	X

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
FobPort1FpgaTemperature																	X
FobPort2FpgaTemperature																	
FobBoardTemperature																	X
FobDevice1InternalTemperature																	X
Type: 10 Gig																	
PauseAcknowledge							X	X			X	X	X		X		
PauseEndFrames							X	X			X	X	X		X		
PauseOverwrite							X	X			X	X	X		X		
10GigLanTxFpgaTemperature																	
10GigLanRxFpgaTemperature																	
CodingErrorFramesReceived																	
EErrorCharacterFramesReceived																	
DroppedFrames																	
Type: Link Fault Signaling																	
LinkFaultState							X	X			X		X		X		
LocalFaults							X	X			X		X		X		
RemoteFaults							X	X			X		X		X		

Statistics for 10G UNIPHY Modules with BERT

Statistics for 10G UNIPHY Modules with BERT

	Normal									Qos							StreamTrigger								
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																									
UserDefinedStat1	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
CaptureTrigger	X																X								
CaptureFilter	X																X								
StreamTrigger1																	X	X			X	X	X	X	X
StreamTrigger2																	X	X			X	X	X	X	X
Type: States																									
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

	Normal									**Qos**							**StreamTrigger**								
DuplexMode				X																X					
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																									
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X		X			X	X	X	X	X			X	X	X	X	X		X			X	X

	Normal									**Qos**							**StreamTrigger**								
PortCpuDodStatus	X	X	X		X			X	X	X	X	X			X	X	X	X	X		X			X	X
Type: Transmit Duration																									
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																									
QualityOfService0										X	X	X	X	X	X	X									
Type: Checksum Stats																									
IpPackets																									
UdpPackets																									
TcpPackets																									
IpChecksumErrors																									
UdpChecksumErrors																									
TcpChecksumErrors																									
Type: Data Integrity																									
DataIntegrityFrames			X																X						
DataIntegrity			X																X						

	Normal									Qos							StreamTrigger								
Errors																									
Type: Sequence Checking																									
SequenceFrames					X							X									X				
SequenceErrors					X							X									X				
Type: Ethernet																									
Fragments				X		X	X			X	X	X	X	X		X				X		X	X		
Undersize				X		X	X			X	X	X	X	X		X				X		X	X		
Oversize				X		X	X			X	X	X	X	X		X				X		X	X		
VlanTaggedFramesRx				X		X	X			X	X	X	X	X		X				X		X	X		
FlowControlFrames				X		X	X			X	X	X	X	X		X				X		X	X		
Type: Gigabit																									
SymbolErrorFrames				X																X					
SynchErrorFrames				X																X					
Type: 10/100 + Gigabit																									

	Normal									Qos							StreamTrigger								
SymbolErrors				X																X					
OversizeAndCrcErrors				X		X	X			X	X	X	X	X		X				X		X	X		
Type: POS																									
SectionLossOfSignal																									
SectionLossOfFrame																									
SectionBip																									
LineAis																									
LineRdi																									
LineRei																									
LineBip																									
PathAis																									
PathRdi																									
PathRei																									
PathBip																									
PathLossOfPointer																									
PathPlm																									
SectionBipErroredSecs															X										
SectionBipSeverlyErroredSecs															X										

	Normal									Qos							StreamTrigger								
SectionLossOfSignalSecs															X										
LineBipErroredSecs															X										
LineReiErroredSecs															X										
LineAisAlarmSecs															X										
LineRdiUnavailableSecs															X										
PathBipErroredSecs															X										
PathReiErroredSecs															X										
PathAisAlarmSecs															X										
PathAisUnavailableSecs															X										
PathRdiUnavailableSecs															X										
InputSignalStrength	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X
PosK1Byte																									
PosK2Byte																									
SrpDataFram																									

	Normal									Qos							StreamTrigger								
esReceived																									
SrpDiscoveryFramesReceived																									
SrpIpsFramesReceived																									
SrpParityErrors																									
SrpUsageFramesReceived																									
SrpUsageStatus																									
SrpUsageTimeouts																									
Type: DCC																									
DccBytesReceived								X							X									X	
DccBytesSent																									
DccCrcErrorsReceived								X							X									X	
DccFramesReceived								X							X									X	
DccFramesSent																									
DccFramingE																									

	Normal									Qos							StreamTrigger								
rrorsReceived																									
Type: OC192 - Temperature																									
DMATemperature																									
CaptureTemperature																									
LatencyTemperature																									
BackgroundTemperature																									
OverlayTemperature																									
FrontEndTemperature																									
SchedulerTemperature																									
PlmDevice1InternalTemperature																									
PlmDevice2InternalTemperature																									
PlmDevice3InternalTemperature																									

	Normal									Qos							StreamTrigger								
FobPort1FpgaTemperature																									
FobPort2FpgaTemperature																									
FobBoardTemperature																									
FobDevice1InternalTemperature																									
Type: 10 Gig																									
PauseAcknowledge						X	X			X	X	X	X	X		X						X	X		
PauseEndFrames						X	X			X	X	X	X	X		X						X	X		
PauseOverwrite						X	X			X	X	X	X	X		X						X	X		
10GigLanTxFpgaTemperature																									
10GigLanRxFpgaTemperature																									
CodingErrorFramesReceived																									
EErrorCharacterFramesRec																									

	Normal									Qos							StreamTrigger								
eived																									
DroppedFrames																									
Type: Link Fault Signaling																									
LinkFaultState							X			X	X	X		X		X							X		
LocalFaults							X			X	X	X		X		X							X		
RemoteFaults							X			X	X	X		X		X							X		
Type: RPR																									
RprDiscoveryFramesReceived	X	X	X		X			X	X								X	X	X		X			X	X
RprDataFramesReceived	X	X	X		X			X	X								X	X	X		X			X	X
RprFairnessFramesReceived	X	X	X		X			X	X								X	X	X		X			X	X
RprFairnessFramesSent	X	X	X		X			X	X								X	X	X		X			X	X
RprFairnessTimeouts	X	X	X		X			X	X								X	X	X		X			X	X
RprHeaderCrcErrors	X	X	X		X			X	X								X	X	X		X			X	X

	Normal									Qos							StreamTrigger								
RprOamFramesReceived	X	X	X		X			X	X								X	X	X		X			X	X
RprPayloadCrcErrors	X	X	X		X			X	X								X	X	X		X			X	X
RprProtectionFramesReceived	X	X	X		X			X	X								X	X	X		X			X	X

Statistics for 10G UNIPHY Modules with BERT

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																	
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X										
CaptureFilter	X						X										
StreamTrigger1																	
StreamTrigger2																	
Type: States																	
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X							

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																	
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X			X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X			X	X		
Type: Transmit Duration																	
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																	
QualityOfService0																	
Type: Checksum Stats																	
IpPackets	X					X											
UdpPackets	X					X											
TcpPackets	X					X											
IpChecksumErrors	X					X											
UdpChecksumErrors	X					X											
TcpChecksumErrors	X					X											

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
Type: Data Integrity																	
DataIntegrityFrames			X						X								
DataIntegrityErrors			X						X								
Type: Sequence Checking																	
SequenceFrames					X						X						
SequenceErrors					X						X						
Type: Ethernet																	
Fragments				X						X		X	X				
Undersize				X						X		X	X				
Oversize				X						X		X	X				
VlanTaggedFrames Rx				X						X		X	X				
FlowControlFrames				X						X		X	X				
Type: Gigabit																	
SymbolErrorFrames				X						X							
SynchErrorFrames				X						X							
Type: 10/100 + Gigabit																	
SymbolErrors				X						X							
OversizeAndCrcErrors				X						X		X	X				
Type: POS																	

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
SectionLossOfSignal																X	
SectionLossOfFrame																X	
SectionBip																X	
LineAis																X	
LineRdi																X	
LineRei																X	
LineBip																X	
PathAis																X	
PathRdi																X	
PathRei																X	
PathBip																X	
PathLossOfPointer																X	
PathPlm																X	
SectionBipErroredSecs	X	X	X		X	X											
SectionBipSeverlyErroredSecs	X	X	X		X	X											
SectionLossOfSignalSecs	X	X	X		X	X											
LineBipErroredSecs	X	X	X		X	X											
LineReiErroredSecs	X	X	X		X	X											
LineAisAlarmSecs	X	X	X		X	X											
LineRdiUnavailableSecs	X	X	X		X	X											

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
PathBipErroredSecs	X	X	X		X	X											
PathReiErroredSecs	X	X	X		X	X											
PathAisAlarmSecs	X	X	X		X	X											
PathAisUnavailableSecs	X	X	X		X	X											
PathRdiUnavailableSecs	X	X	X		X	X											
InputSignalStrength							X	X	X		X	X	X	X	X		
PosK1Byte																	
PosK2Byte																	
SrpDataFramesReceived																	
SrpDiscoveryFramesReceived																	
SrpIpsFramesReceived																	
SrpParityErrors																	
SrpUsageFramesReceived																	
SrpUsageStatus																	
SrpUsageTimeouts																	
Type: DCC																	
DccBytesReceived						X								X			
DccBytesSent																	

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
DccCrcErrorsReceived						X								X			
DccFramesReceived						X								X			
DccFramesSent																	
DccFramingErrorsReceived																	
Type: OC192 - Temperature																	
DMATemperature																	X
CaptureTemperature																	X
LatencyTemperature																	X
BackgroundTemperature																	
OverlayTemperature																	X
FrontEndTemperature																	X
SchedulerTemperature																	X
PlmDevice1InternalTemperature																	X
PlmDevice2InternalTemperature																	X

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
PlmDevice3InternalTemperature																	X
FobPort1FpgaTemperature																	X
FobPort2FpgaTemperature																	
FobBoardTemperature																	X
FobDevice1InternalTemperature																	X
Type: 10 Gig																	
PauseAcknowledge												X	X				
PauseEndFrames												X	X				
PauseOverwrite												X	X				
10GigLanTxFpgaTemperature																	
10GigLanRxFpgaTemperature																	
CodingErrorFramesReceived																	
EErrorCharacterFramesReceived																	
DroppedFrames																	
Type: Link Fault Signaling																	
LinkFaultState													X				

	ModeChecksumErrors						ModeDataIntegrity									Add'l	
LocalFaults													X				
RemoteFaults													X				
Type: RPR																	
RprDiscoveryFramesReceived							X	X	X		X			X	X		
RprDataFramesReceived							X	X	X		X			X	X		
RprFairnessFramesReceived							X	X	X		X			X	X		
RprFairnessFramesSent							X	X	X		X			X	X		
RprFairnessTimeouts							X	X	X		X			X	X		
RprHeaderCrcErrors							X	X	X		X			X	X		
RprOamFramesReceived							X	X	X		X			X	X		
RprPayloadCrcErrors							X	X	X		X			X	X		
RprProtectionFramesReceived							X	X	X		X			X	X		

Statistics for 10GE LSM Modules (except NGY)

Statistics for 10GE LSM Modules (except NGY)

Statistics Mode	Normal									Qos								StreamTrigger								
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																										
UserDefined Stat1	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
UserDefined Stat2	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
CaptureTrigger	X	X							X	X	X						X	X	X							X
CaptureFilter	X	X							X	X	X						X	X	X							X
StreamTrigger1	X	X	X		X				X	X	X	X	X				X	X	X	X		X	X	X	X	X
StreamTrigger2	X	X	X		X				X	X	X	X	X				X	X	X	X		X	X	X	X	X
Type: States																										
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Statistics Mode	Normal									Qos								StreamTrigger								
DuplexMode				X																	X					
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																											
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Statistics Mode	Normal									Qos								StreamTrigger								
PortCpuStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
PortCpuDodStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
Type: Transmit Duration																										
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Quality of Service																										
QualityOfService0										X	X	X	X	X	X	X	X									
Type: Checksum Stats																										
IpPackets																										
UdpPackets																										
TcpPackets																										
IpChecksumErrors																										
UdpChecksumErrors																										
TcpChecksumErrors																										
Type: Data Integrity																										

Statistics Mode	Normal									Qos								StreamTrigger							
DataIntegrityFrames			X									X								X						
DataIntegrityErrors			X									X								X						
Type: Sequence Checking																										
SequenceFrames					X								X									X				
SequenceErrors					X								X									X				
Type: Ethernet																										
Fragments	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
Undersize	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
Oversize	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
VlanTaggedFramesRx	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
FlowControlFrames	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
Type: Gigabit																										
SymbolErrorFrames				X																	X					

Statistics Mode	Normal									Qos								StreamTrigger								
SynchErrorFrames				X																	X					
Type: 10/100 + Gigabit																										
SymbolErrors				X																	X					
OversizeAndCrcErrors	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
Type: POS																										
SectionLossOfSignal																										
SectionLossOfFrame																										
SectionBip																										
LineAis																										
LineRdi																										
LineRei																										
LineBip																										
PathAis																										
PathRdi																										
PathRei																										
PathBip																										
PathLossOfPointer																										
PathPlm																										

Statistics Mode	Normal									Qos								StreamTrigger								
SectionBipErroredSecs																X										
SectionBipSeverlyErroredSecs																X										
SectionLossOfSignalSecs																X										
LineBipErroredSecs																X										
LineReiErroredSecs																X										
LineAisAlarmSecs																X										
LineRdiUnavailableSecs																X										
PathBipErroredSecs																X										
PathReiErroredSecs																X										
PathAisAlarmSecs																X										
PathAisUnavailableSecs																X										
PathRdiUnav																X										

Statistics Mode	Normal									Qos								StreamTrigger								
ailableSecs																										
InputSignalStrength	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X
PosK1Byte																										
PosK2Byte																										
SrpDataFramesReceived																										
SrpDiscoveryFramesReceived																										
SrpIpsFramesReceived																										
SrpParityErrors																										
SrpUsageFramesReceived																										
SrpUsageStatus																										
SrpUsageTimeouts																										
Type: DCC																										
DccBytesReceived								X								X								X	
DccBytesSen																										

Statistics Mode	Normal									Qos								StreamTrigger								
t																										
DccCrcErrorsReceived								X								X									X	
DccFramesReceived								X								X									X	
DccFramesSent																										
DccFramingErrorsReceived																										
Type: OC192 - Temperature																										
DMATemperature																										
CaptureTemperature																										
LatencyTemperature																										
BackgroundTemperature																										
OverlayTemperature																										
FrontEndTemperature																										

Statistics Mode	Normal									Qos								StreamTrigger								
SchedulerTemperature																										
PlmDevice1InternalTemperature																										
PlmDevice2InternalTemperature																										
PlmDevice3InternalTemperature																										
FobPort1FpgaTemperature																										
FobPort2FpgaTemperature																										
FobBoardTemperature																										
FobDevice1InternalTemperature																										
Type: 10 Gig																										
PauseAcknowledge	X	X	X		X	X	X		X	X	X	X	X	X	X		X	X	X	X		X	X	X		X
PauseEndFrames	X	X	X		X	X	X		X	X	X	X	X	X	X		X	X	X	X		X	X	X		X

Statistics Mode	Normal									Qos								StreamTrigger							
PauseOverwrite	X	X	X		X	X	X		X	X	X	X	X	X	X		X	X	X	X		X	X	X		X
10GigLanTxFpgaTemperature																										
10GigLanRxFpgaTemperature																										
CodingErrorFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
EErrorCharacterFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
DroppedFrames	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
Type: Link Fault Signaling																										
LinkFaultState	X	X	X		X		X		X	X	X	X	X		X		X	X	X	X		X		X		X
LocalFaults	X	X	X		X		X		X	X	X	X	X		X		X	X	X	X		X		X		X
RemoteFaults	X	X	X		X		X		X	X	X	X	X		X		X	X	X	X		X		X		X
Type: RPR																										
RprDiscoveryFramesRec								X																	X	

Statistics Mode	Normal									Qos								StreamTrigger								
eived																										
RprDataFramesReceived								X																	X	
RprFairnessFramesReceived								X																	X	
RprFairnessFramesSent								X																	X	
RprFairnessTimeouts								X																	X	
RprHeaderCrcErrors								X																	X	
RprOamFramesReceived								X																	X	
RprPayloadCrcErrors								X																	X	
RprProtectionFramesReceived								X																	X	
Type: Ordered Sets																										
LocalOrderedSetsSent	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
LocalOrdered	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X

Statistics Mode	Normal									Qos								StreamTrigger								
SetsReceived																										
RemoteOrderedSetsSent	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
RemoteOrderedSetsReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
CustomOrderedSetsSent	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
CustomOrderedSetsReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X

Statistics for 10GE LSM Modules (except NGY)

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats	TemperatureSensorsStats
Type: User Configurable																	
UserDefinedStat1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2		X	X	X	X		X	X	X	X	X	X	X	X	X		
CaptureTrigger	X					X	X	X							X		
CaptureFilter	X						X	X							X		

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
StreamTrigger1							X	X	X		X				X		
StreamTrigger2							X	X	X		X				X		
Type: States																	
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X						X							
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																	
FramesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FramesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BytesReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X	X	X	X	X		X			X	X		
PortCpuDodStatus	X	X	X		X	X	X	X	X		X			X	X		
Type: Transmit Duration																	
TransmitDuration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																	
QualityOfService0																	
Type: Checksum Stats																	

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
IpPackets	X					X											
UdpPackets	X					X											
TcpPackets	X					X											
IpChecksumErrors	X					X											
UdpChecksumErrors	X					X											
TcpChecksumErrors	X					X											
Type: Data Integrity																	
DataIntegrityFrames			X						X								
DataIntegrityErrors			X						X								
Type: Sequence Checking																	
SequenceFrames					X						X						
SequenceErrors					X						X						
Type: Ethernet																	
Fragments				X			X	X	X	X	X	X	X		X		
Undersize				X			X	X	X	X	X	X	X		X		
Oversize				X			X	X	X	X	X	X	X		X		
VlanTaggedFramesRx				X			X	X	X	X	X	X	X		X		
FlowControlFrames				X			X	X	X	X	X	X	X		X		
Type: Gigabit																	
SymbolErrorFrames				X						X							

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
SynchErrorFrames				X						X							
Type: 10/100 + Gigabit																	
SymbolErrors				X						X							
OversizeAndCrcErrors				X			X	X	X	X	X	X	X		X		
Type: POS																	
SectionLossOfSignal																X	
SectionLossOfFrame																X	
SectionBip																X	
LineAis																X	
LineRdi																X	
LineRei																X	
LineBip																X	
PathAis																X	
PathRdi																X	
PathRei																X	
PathBip																X	
PathLossOfPointer																X	
PathPlm																X	
SectionBipErroredSecs	X	X	X		X	X											
SectionBipSeverlyErroredSecs	X	X	X		X	X											

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
SectionLossOfSignalSecs	X	X	X		X	X											
LineBipErroredSecs	X	X	X		X	X											
LineReiErroredSecs	X	X	X		X	X											
LineAisAlarmSecs	X	X	X		X	X											
LineRdiUnavailableSecs	X	X	X		X	X											
PathBipErroredSecs	X	X	X		X	X											
PathReiErroredSecs	X	X	X		X	X											
PathAisAlarmSecs	X	X	X		X	X											
PathAisUnavailableSecs	X	X	X		X	X											
PathRdiUnavailableSecs	X	X	X		X	X											
InputSignalStrength							X	X	X		X	X	X	X	X		
PosK1Byte																	
PosK2Byte																	
SrpDataFramesReceived																	
SrpDiscoveryFramesReceived																	
SrpIpsFramesReceived																	

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
SrpParityErrors																	
SrpUsageFramesReceived																	
SrpUsageStatus																	
SrpUsageTimeouts																	
Type: DCC																	
DccBytesReceived						X								X			
DccBytesSent																	
DccCrcErrorsReceived						X								X			
DccFramesReceived						X								X			
DccFramesSent																	
DccFramingErrorsReceived																	
Type: OC192 - Temperature																	
DMATemperature																	X
CaptureTemperature																	X
LatencyTemperature																	X
BackgroundTemperature																	X
OverlayTemperature																	X

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
FrontEndTemperature																	X
SchedulerTemperature																	
PlmDevice1InternalTemperature																	
PlmDevice2InternalTemperature																	
PlmDevice3InternalTemperature																	
FobPort1FpgaTemperature																	
FobPort2FpgaTemperature																	
FobBoardTemperature																	
FobDevice1InternalTemperature																	
Type: 10 Gig																	
PauseAcknowledge							X	X	X		X	X	X		X		
PauseEndFrames							X	X	X		X	X	X		X		
PauseOverwrite							X	X	X		X	X	X		X		
10GigLanTxFpgaTemperature																	
10GigLanRxFpgaTe																	

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
mperature																	
CodingErrorFrames Received							X	X	X		X				X		
EErrorCharacterFramesReceived							X	X	X		X				X		
DroppedFrames							X	X	X		X				X		
Type: Link Fault Signaling																	
LinkFaultState							X	X	X		X		X		X		
LocalFaults							X	X	X		X		X		X		
RemoteFaults							X	X	X		X		X		X		
Type: RPR																	
RprDiscoveryFramesReceived														X			
RprDataFramesReceived														X			
RprFairnessFrames Received														X			
RprFairnessFrames Sent														X			
RprFairnessTimeouts														X			
RprHeaderCrcErrors														X			
RprOamFramesReceived														X			

Statistics Mode	ModeChecksumErrors						ModeDataIntegrity									Add'l	
RprPayloadCrcErrors														X			
RprProtectionFramesReceived														X			
Type: Ordered Sets																	
LocalOrderedSetsSent							X	X	X		X				X		
LocalOrderedSetsReceived							X	X	X		X				X		
RemoteOrderedSetsSent							X	X	X		X				X		
RemoteOrderedSetsReceived							X	X	X		X				X		
CustomOrderedSetsSent							X	X	X		X				X		
CustomOrderedSetsReceived							X	X	X		X				X		

Statistics for NGY Modules

Statistics for NGY Modules

Statistics Mode	Normal				Qos			
Receive Mode	Capture	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	Capture	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup

Statistics Mode	Normal				Qos			
Type: User Configurable								
UserDefinedStat1	X	X	X	X	X	X	X	X
UserDefinedStat2	X	X	X	X	X	X	X	X
UserDefinedStatByteCount1	X	X	X	X	X	X	X	X
UserDefinedStatByteCount2	X	X	X	X	X	X	X	X
CaptureTrigger	X			X	X			X
CaptureFilter	X			X	X			X
StreamTrigger1	X	X	X	X	X	X	X	X
StreamTrigger2	X	X	X	X	X	X	X	X
Type: States								
Link	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X
DuplexMode								
TransmitState	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X
Type: Common								
FramesSent	X	X	X	X	X	X	X	X
FramesReceived	X	X	X	X	X	X	X	X
BytesSent	X	X	X	X	X	X	X	X
BytesReceived	X	X	X	X	X	X	X	X
FcsErrors	X	X	X	X	X	X	X	X
BitsReceived	X	X	X	X	X	X	X	X
BitsSent	X	X	X	X	X	X	X	X
PortCpuStatus	X	X	X	X	X	X	X	X
PortCpuDodStatus	X	X	X	X	X	X	X	X

Statistics Mode	Normal				Qos			
Type: Transmit Duration								
TransmitDuration	X	X	X	X	X	X	X	X
Type: Quality of Service								
QualityOfService0					X	X	X	X
Type: Checksum Stats								
IPv4Packets	X	X	X	X	X	X	X	X
UdpPackets	X	X	X	X	X	X	X	X
TcpPackets	X	X	X	X	X	X	X	X
IPv4ChecksumErrors	X	X	X	X	X	X	X	X
UdpChecksumErrors	X	X	X	X	X	X	X	X
TcpChecksumErrors	X	X	X	X	X	X	X	X
Type: Data Integrity								
DataIntegrityFrames		X				X		
DataIntegrityErrors		X				X		
Type: Sequence Checking								
SequenceFrames			X				X	
SequenceErrors			X				X	
Type: Ethernet								
Fragments	X	X	X	X	X	X	X	X
Undersize	X	X	X	X	X	X	X	X
Oversize	X	X	X	X	X	X	X	X
VlanTaggedFramesRx	X	X	X	X	X	X	X	X
FlowControlFrames	X	X	X	X	X	X	X	X
Type: Gigabit								
SymbolErrorFrames								
SynchErrorFrames								

Statistics Mode	Normal				Qos			
Type: 10/100 + Gigabit								
SymbolErrors								
OversizeAndCrcErrors	X	X	X	X	X	X	X	X
Type: POS								
SectionLossOfSignal								
SectionLossOfFrame								
SectionBip								
LineAis								
LineRdi								
LineRei								
LineBip								
PathAis								
PathRdi								
PathRei								
PathBip								
PathLossOfPointer								
PathPlm								
SectionBipErroredSecs								
SectionBipSeverlyErroredSecs								
SectionLossOfSignalSecs								
LineBipErroredSecs								
LineReiErroredSecs								
LineAisAlarmSecs								
LineRdiUnavailableSecs								
PathBipErroredSecs								
PathReiErroredSecs								

Statistics Mode	Normal				Qos			
PathAisAlarmSecs								
PathAisUnavailableSecs								
PathRdiUnavailableSecs								
InputSignalStrength	X	X	X	X	X	X	X	X
PosK1Byte								
PosK2Byte								
SrpDataFramesReceived								
SrpDiscoveryFramesReceived								
SrpIpsFramesReceived								
SrpParityErrors								
SrpUsageFramesReceived								
SrpUsageStatus								
SrpUsageTimeouts								
Type: DCC								
DccBytesReceived								
DccBytesSent								
DccCrcErrorsReceived								
DccFramesReceived								
DccFramesSent								
DccFramingErrorsReceived								
Type: OC192 - Temperature								
DMATemperature								
CaptureTemperature								
LatencyTemperature								
BackgroundTemperature								
OverlayTemperature								

Statistics Mode	Normal				Qos			
FrontEndTemperature								
SchedulerTemperature								
PlmDevice1InternalTemperature								
PlmDevice2InternalTemperature								
PlmDevice3InternalTemperature								
FobPort1FpgaTemperature								
FobPort2FpgaTemperature								
FobBoardTemperature								
FobDevice1InternalTemperature								
Type: 10 Gig								
PauseAcknowledge	X	X	X	X	X	X	X	X
PauseEndFrames	X	X	X	X	X	X	X	X
PauseOverwrite	X	X	X	X	X	X	X	X
10GigLanTxFpgaTemperature								
10GigLanRxFpgaTemperature								
DroppedFrames	X	X	X	X	X	X	X	X
Type: Link Fault Signaling								
LinkFaultState	X	X	X	X	X	X	X	X
Type: RPR								
RprDiscoveryFramesReceived								
RprDataFramesReceived								
RprFairnessFramesReceived								
RprFairnessFramesSent								
RprFairnessTimeouts								
RprHeaderCrcErrors								
RprOamFramesReceived								

Statistics Mode	Normal				Qos			
RprPayloadCrcErrors								
RprProtectionFramesReceived								
Type: Ordered Sets								
LocalOrderedSetsSent	X	X	X	X	X	X	X	X
LocalOrderedSetsReceived	X	X	X	X	X	X	X	X
RemoteOrderedSetsSent	X	X	X	X	X	X	X	X
RemoteOrderedSetsReceived	X	X	X	X	X	X	X	X
CustomOrderedSetsSent	X	X	X	X	X	X	X	X
CustomOrderedSetsReceived	X	X	X	X	X	X	X	X

Statistics for 10G MSM modules

Statistics for 10G MSM modules

	Normal									Qos								StreamTrigger								
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																										
UserDefinedStat1	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X
UserDefinedStat2	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X
CaptureTrigger	X	X							X	X	X						X	X	X							X
CaptureFilter	X	X							X	X	X						X	X	X							X

	Normal									**Qos**								**StreamTrigger**								
StreamTrigger 1	X	X	X		X				X	X	X	X	X				X	X	X	X		X		X	X	X
StreamTrigger 2	X	X	X		X				X	X	X	X	X				X	X	X	X		X		X	X	X
Type: States																										
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X																X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																										
FramesSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
FramesReceived	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
BytesSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X

	Normal									Qos								StreamTrigger								
BytesReceived	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X
FcsErrors	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
BitsReceived	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X		X	X	X
BitsSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
PortCpuStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
PortCpuDodStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
Type: Transmit Duration																										
TransmitDuration	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Type: Quality of Service																										
QualityOfService0										X	X	X	X	X	X	X	X									
Type: Checksum Stats																										
IpPackets																										
UdpPackets																										
TcpPackets																										

	Normal									Qos								StreamTrigger								
IpChecksumErrors																										
UdpChecksumErrors																										
TcpChecksumErrors																										
Type: Data Integrity																										
DataIntegrityFrames			X									X							X							
DataIntegrityErrors			X									X							X							
Type: SequenceChecking																										
SequenceFrames					X								X								X					
SequenceErrors					X								X								X					
Type: Ethernet																										
Fragments	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X	
Undersize	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X	
Oversize	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X	

	Normal									Qos								StreamTrigger								
VlanTaggedFramesRx	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X
FlowControlFrames	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X
Type: Gigabit																										
SymbolErrorFrames				X																X						
SynchErrorFrames				X																X						
Type: 10/100 + Gigabit																										
SymbolErrors				X																X						
OversizeAndCrcErrors	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	X	X	X	X		X		X
Type: POS																										
SectionLossOfSignal						X																X				
SectionLossOfFrame																										
SectionBip																										
LineAis																										
LineRdi																										
LineRei																										
LineBip																										
PathAis																										
PathRdi																										

	Normal									Qos								StreamTrigger								
PathRei																										
PathBip																										
PathLossOfPointer																										
PathPlm																										
SectionBipErroredSecs																X										
SectionBipSeverlyErroredSecs																X										
SectionLossOfSignalSecs																X										
LineBipErroredSecs																X										
LineReiErroredSecs																X										
LineAisAlarmSecs																X										
LineRdiUnavailableSecs																X										
PathBipErroredSecs																X										
PathReiErroredSecs																X										
PathAisAlarmSecs																X										

	Normal									Qos								StreamTrigger								
PathAisUnavailableSecs																X										
PathRdiUnavailableSecs																X										
InputSignalStrength	X	X	X		X		X	X	X	X	X	X	X	X	X		X	X	X	X		X		X	X	X
PosK1Byte																										
PosK2Byte																										
SrpDataFramesReceived																										
SrpDiscoveryFramesReceived																										
SrpIpsFramesReceived																										
SrpParityErrors																										
SrpUsageFramesReceived																										
SrpUsageStatus																										
SrpUsageTimeouts																										
Type: DCC																										
DccBytesReceived								X								X								X		

	Normal									Qos								StreamTrigger								
DccBytesSent																										
DccCrcErrorsReceived								X								X									X	
DccFramesReceived								X								X									X	
DccFramesSent																										
DccFramingErrorsReceived																										
Type: BERT																										
BertStatus						X																X				
BertBitsSent						X																X				
BertBitsReceived						X																X				
BertBitErrorsSent						X																X				
BertBitErrorsReceived						X																X				
BertErroredBlocks						X																X				
BertErroredSeconds						X																X				
BertSeverelyE						X																X				

	Normal									Qos								StreamTrigger								
rroredSeconds																										
BertErrorFreeSeconds						X																		X		
BertAvailableSeconds						X																		X		
BertUnavailableSeconds						X																		X		
BertBlockErrorState						X																		X		
BertBackgroundBlockErrors						X																		X		
BertBitErrorRatio						X																		X		
BertErroredSecondRatio						X																		X		
BertSeverlyErroredSecondRatio						X																		X		
BertBackgroundBlockErrorRatio						X																		X		
BertNumberMismatchedOnes						X																		X		
BertMismatchedOnesRatio						X																		X		

	Normal									Qos								StreamTrigger								
BertNumberMismatchedZeros						X																		X			
BertMismatchedZerosRatio						X																		X			
BertElapsedTestTime						X																		X			
BertUnframedOutputSignalStrength																											
BertUnframedDetectedLineRate																											
BertDeskewPatternLock																											
BertRxDeskewErroredFrames																											
BertRxDeskewErrorFreeFrames																											
BertRxDeskewLossOfFrame																											
BertTimeSinceLastError																											
BertTriggerCount																											

	Normal									Qos								StreamTrigger								
BertTxDeskewBitErrors																										
BertTxDeskewErroredFrames																										
BertTxDeskewErrorFreeFrames																										
Type: Service Disruption																										
BertLastServiceDisruptionTime						X																X				
BertMinServiceDisruptionTime						X																X				
BertMaxServiceDisruptionTime						X																X				
BertServiceDisruptionCumulative						X																X				
Type: OC192 - Temperature																										
DMATemperature																										
CaptureTemperature																										

	Normal									Qos								StreamTrigger								
LatencyTemperature																										
BackgroundTemperature																										
OverlayTemperature																										
FrontEndTemperature																										
SchedulerTemperature																										
PlmDevice1InternalTemperature																										
PlmDevice2InternalTemperature																										
PlmDevice3InternalTemperature																										
FobPort1FpgaTemperature																										
FobPort2FpgaTemperature																										
FobBoardTemperature																										
FobDevice1InternalTempera																										

	Normal									Qos								StreamTrigger								
ture																										
Type: 10 Gig																										
PauseAcknowledge	X	X	X		X		X		X	X	X	X	X	X	X		X	X	X	X		X		X		X
PauseEndFrames	X	X	X		X		X		X	X	X	X	X	X	X		X	X	X	X		X		X		X
PauseOverwrite	X	X	X		X		X		X	X	X	X	X	X	X		X	X	X	X		X		X		X
10GigLanTxFpgaTemperature																										
10GigLanRxFpgaTemperature																										
CodingErrorFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
EErrorCharacterFramesReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
DroppedFrames	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
Type: Link Fault Signaling																										
LinkFaultState	X	X	X		X		X		X	X	X	X	X		X		X	X	X	X		X		X		X
LocalFaults	X	X	X		X		X		X	X	X	X	X		X		X	X	X	X		X		X		X

	Normal									Qos								StreamTrigger								
RemoteFaults	X	X	X		X		X		X	X	X	X	X		X		X	X	X	X		X		X		X
Type: RPR																										
RprDiscoveryFramesReceived								X																	X	
RprDataFramesReceived								X																	X	
RprFairnessFramesReceived								X																	X	
RprFairnessFramesSent								X																	X	
RprFairnessTimeouts								X																	X	
RprHeaderCrcErrors								X																	X	
RprOamFramesReceived								X																	X	
RprPayloadCrcErrors								X																	X	
RprProtectionFramesReceived								X																	X	
Type: Ordered Sets																										

	Normal									**Qos**								**StreamTrigger**								
LocalOrderedSetsSent																										
LocalOrderedSetsReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
RemoteOrderedSetsSent																										
RemoteOrderedSetsReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X
CustomOrderedSetsSent																										
CustomOrderedSetsReceived	X	X	X		X				X	X	X	X	X				X	X	X	X		X				X

Statistics for 10G MSM modules

	ModeChecksumErrors							**ModeDataIntegrity**									**Add'l**	
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	TemperatureSensorsStats	PoSExtendedStats
Type: User Configurable																		
UserDefinedStat1	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
UserDefinedStat2				X				X	X	X	X	X	X	X	X	X		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
CaptureTrigger	X						X	X	X							X		
CaptureFilter	X							X	X							X		
StreamTrigger1								X	X	X		X				X		
StreamTrigger2								X	X	X		X				X		
Type: States																		
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DuplexMode				X							X							
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Type: Common																		
FramesSent				X			X	X	X	X	X	X	X	X	X	X		
FramesReceived				X			X	X	X	X	X	X	X	X	X	X		
BytesSent				X			X	X	X	X	X	X	X	X	X	X		
BytesReceived				X			X	X	X	X	X	X	X	X	X	X		
FcsErrors	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
BitsReceived	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
BitsSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
PortCpuStatus	X	X	X		X		X	X	X	X		X			X	X		
PortCpuDodStatus	X	X	X		X		X	X	X	X		X			X	X		
Type: Transmit Duration																		
TransmitDuration	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
Type: Quality of Service																		
QualityOfService0																		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
Type: Checksum Stats																		
IpPackets	X	X	X		X		X											
UdpPackets	X	X	X		X		X											
TcpPackets	X	X	X		X		X											
IpChecksumErrors	X	X	X		X		X											
UdpChecksumErrors	X	X	X		X		X											
TcpChecksumErrors	X	X	X		X		X											
Type: Data Integrity																		
DataIntegrityFrames										X								
DataIntegrityErrors										X								
Type: Sequence Checking																		
SequenceFrames												X						
SequenceErrors												X						
Type: Ethernet																		
Fragments				X				X	X	X	X	X	X	X		X		
Undersize				X				X	X	X	X	X	X	X		X		
Oversize				X				X	X	X	X	X	X	X		X		
VlanTaggedFrames Rx				X				X	X	X	X	X	X	X		X		
FlowControlFrames				X				X	X	X	X	X	X	X		X		
Type: Gigabit																		
SymbolErrorFrames				X							X							
SynchErrorFrames				X							X							

	ModeChecksumErrors							**ModeDataIntegrity**									**Add'l**	
Type: 10/100 + Gigabit																		
SymbolErrors				X							X							
OversizeAndCrcErrors				X				X	X	X	X	X	X	X		X		
Type: POS																		
SectionLossOfSignal						X												
SectionLossOfFrame																		
SectionBip																		
LineAis																		
LineRdi																		
LineRei																		
LineBip																		
PathAis																		
PathRdi																		
PathRei																		
PathBip																		
PathLossOfPointer																		
PathPlm																		
SectionBipErroredSecs							X											
SectionBipSeverlyErroredSecs							X											
SectionLossOfSignalSecs							X											

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
LineBipErroredSecs							X											
LineReiErroredSecs							X											
LineAisAlarmSecs							X											
LineRdiUnavailableSecs							X											
PathBipErroredSecs							X											
PathReiErroredSecs							X											
PathAisAlarmSecs							X											
PathAisUnavailableSecs							X											
PathRdiUnavailableSecs							X											
InputSignalStrength								X	X	X		X	X	X	X	X		
PosK1Byte																		
PosK2Byte																		
SrpDataFramesReceived																		
SrpDiscoveryFramesReceived																		
SrpIpsFramesReceived																		
SrpParityErrors																		
SrpUsageFramesReceived																		
SrpUsageStatus																		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
SrpUsageTimeouts																		
Type: DCC																		
DccBytesReceived							X								X			
DccBytesSent																		
DccCrcErrorsReceived							X								X			
DccFramesReceived							X								X			
DccFramesSent																		
DccFramingErrorsReceived																		
Type: BERT																		
BertStatus						X												
BertBitsSent						X												
BertBitsReceived						X												
BertBitErrorsSent						X												
BertBitErrorsReceived						X												
BertErroredBlocks						X												
BertErroredSeconds						X												
BertSeverelyErroredSeconds						X												
BertErrorFreeSeconds						X												
BertAvailableSeconds						X												

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
BertUnavailableSeconds						X												
BertBlockErrorState						X												
BertBackgroundBlockErrors						X												
BertBitErrorRatio						X												
BertErroredSecondRatio						X												
BertSeverlyErroredSecondRatio						X												
BertBackgroundBlockErrorRatio						X												
BertNumberMismatchedOnes						X												
BertMismatchedOnesRatio						X												
BertNumberMismatchedZeros						X												
BertMismatchedZerosRatio						X												
BertElapsedTestTime						X												
BertUnframedOutputSignalStrength																		
BertUnframedDetec																		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
tedLineRate																		
BertDeskewPatternLock																		
BertRxDeskewErroredFrames																		
BertRxDeskewErrorFreeFrames																		
BertRxDeskewLossOfFrame																		
BertTimeSinceLastError																		
BertTriggerCount																		
BertTxDeskewBitErrors																		
BertTxDeskewErroredFrames																		
BertTxDeskewErrorFreeFrames																		
Type: Service Disruption																		
BertLastServiceDisruptionTime						X												
BertMinServiceDisruptionTime						X												
BertMaxServiceDisruptionTime						X												

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
BertServiceDisruptionCumulative						X												
Type: OC192 - Temperature																		
DMATemperature																	X	
CaptureTemperature																	X	
LatencyTemperature																	X	
BackgroundTemperature																	X	
OverlayTemperature																	X	
FrontEndTemperature																	X	
SchedulerTemperature																		
PlmDevice1InternalTemperature																		
PlmDevice2InternalTemperature																		
PlmDevice3InternalTemperature																		
FobPort1FpgaTemperature																		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
FobPort2FpgaTemperature																		
FobBoardTemperature																		
FobDevice1InternalTemperature																		
Type: 10 Gig																		
PauseAcknowledge								X	X	X		X	X	X		X		
PauseEndFrames								X	X	X		X	X	X		X		
PauseOverwrite								X	X	X		X	X	X		X		
10GigLanTxFpgaTemperature																		
10GigLanRxFpgaTemperature																		
CodingErrorFramesReceived								X	X	X		X				X		
EErrorCharacterFramesReceived								X	X	X		X				X		
DroppedFrames								X	X	X		X				X		
Type: Link Fault Signaling																		
LinkFaultState								X	X	X		X		X		X		
LocalFaults								X	X	X		X		X		X		
RemoteFaults								X	X	X		X		X		X		
Type: RPR																		
RprDiscoveryFramesReceived															X			

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
RprDataFramesReceived															X			
RprFairnessFramesReceived															X			
RprFairnessFramesSent															X			
RprFairnessTimeouts															X			
RprHeaderCrcErrors															X			
RprOamFramesReceived															X			
RprPayloadCrcErrors															X			
RprProtectionFramesReceived															X			
Type: Ordered Sets																		
LocalOrderedSetsSent																		
LocalOrderedSetsReceived								X	X	X		X				X		
RemoteOrderedSetsSent																		
RemoteOrderedSetsReceived								X	X	X		X				X		

	ModeChecksumErrors							ModeDataIntegrity									Add'l	
CustomOrderedSets Sent																		
CustomOrderedSets Received								X	X	X		X				X		

Statistics for ATM Modules

Statistics for ATM Modules

	Normal									Qos								StreamTrigger							
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup
Type: User Configurable																									
UserDefinedStat1	X	X	X	X	X		X	X	X								X	X	X	X	X	X		X	X	X
UserDefinedStat2	X	X	X	X	X		X	X	X								X	X	X	X	X	X		X	X	X
CaptureTrigger	X								X								X	X								X
CaptureFilter	X								X								X	X								X
StreamTrigger 1									X								X	X	X	X		X		X	X	X
StreamTrigger 2									X								X	X	X	X		X		X	X	X

	Normal									**Qos**								**StreamTrigger**								
Type: States																										
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DuplexMode				X																	X					
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Type: Common																										
FramesSent				X			X	X	X					X	X	X	X				X			X	X	X
FramesReceived				X			X	X	X					X	X	X	X				X			X	X	X
BytesSent				X			X	X	X					X	X	X	X				X			X	X	X
BytesReceived				X			X	X	X								X				X			X	X	X
FcsErrors	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
BitsReceived																										

	Normal									Qos								StreamTrigger								
	X	X	X	X	X		X	X	X								X	X	X	X	X	X		X	X	X
BitsSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
PortCpuStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
PortCpuDodStatus	X	X	X		X			X	X	X	X	X	X			X	X	X	X	X		X			X	X
Type: Transmit Duration																										
TransmitDuration	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Type: Quality of Service																										
QualityOfService0										X	X	X	X	X	X	X	X									
Type: Checksum Stats																										
IpPackets																										
UdpPackets																										
TcpPackets																										
IpChecksumErrors																										
UdpChecksumErrors																										
TcpChecksum																										

	Normal									Qos								StreamTrigger								
Errors																										
Type: Data Integrity																										
DataIntegrity Frames																										
DataIntegrity Errors																										
Type: Sequence Checking																										
SequenceFrames					X																					
SequenceErrors					X																					
Type: Ethernet																										
Fragments				X			X		X					X	X		X				X			X		X
Undersize				X			X		X					X	X		X				X			X		X
Oversize				X			X		X					X	X		X				X			X		X
VlanTaggedFramesRx				X			X		X					X	X		X				X			X		X
FlowControlFrames				X			X		X					X	X		X				X			X		X
Type: Gigabit																										

	Normal									Qos								StreamTrigger								
SymbolErrorFrames				X																	X					
SynchErrorFrames				X																	X					
Type: 10/100 + Gigabit																										
SymbolErrors				X																	X					
OversizeAndCrcErrors				X			X		X					X	X		X				X			X		X
Type: POS																										
SectionLossOfSignal						X																	X			
SectionLossOfFrame																										
SectionBip																										
LineAis																										
LineRdi																										
LineRei																										
LineBip																										
PathAis																										
PathRdi																										
PathRei																										
PathBip																										
PathLossOfPointer																										

	Normal									Qos								StreamTrigger								
PathPlm																										
SectionBipErroredSecs																X										
SectionBipSeverlyErroredSecs																X										
SectionLossOfSignalSecs																X										
LineBipErroredSecs																X										
LineReiErroredSecs																X										
LineAisAlarmSecs																X										
LineRdiUnavailableSecs																X										
PathBipErroredSecs																X										
PathReiErroredSecs																X										
PathAisAlarmSecs																X										
PathAisUnavailableSecs																X										
PathRdiUnavailableSecs																X										

	Normal									Qos								StreamTrigger								
InputSignalStrength							X	X	X					X	X		X							X	X	X
PosK1Byte																										
PosK2Byte																										
SrpDataFramesReceived																										
SrpDiscoveryFramesReceived																										
SrpIpsFramesReceived																										
SrpParityErrors																										
SrpUsageFramesReceived																										
SrpUsageStatus																										
SrpUsageTimeouts																										
Type: DCC																										
DccBytesReceived								X								X									X	
DccBytesSent																										
DccCrcErrorsReceived								X								X									X	

	Normal									Qos								StreamTrigger								
DccFramesReceived								X								X									X	
DccFramesSent																										
DccFramingErrorsReceived																										
Type: BERT																										
BertStatus						X																X				
BertBitsSent						X																X				
BertBitsReceived						X																X				
BertBitErrorsSent						X																X				
BertBitErrorsReceived						X																X				
BertErroredBlocks						X																X				
BertErroredSeconds						X																X				
BertSeverelyErroredSeconds						X																X				
BertErrorFreeSeconds						X																X				

	Normal									Qos								StreamTrigger								
BertAvailableSeconds						X																		X			
BertUnavailableSeconds						X																		X			
BertBlockErrorState						X																		X			
BertBackgroundBlockErrors						X																		X			
BertBitErrorRatio						X																		X			
BertErroredSecondRatio						X																		X			
BertSeverlyErroredSecondRatio						X																		X			
BertBackgroundBlockErrorRatio						X																		X			
BertNumberMismatchedOnes						X																		X			
BertMismatchedOnesRatio						X																		X			
BertNumberMismatchedZeros						X																		X			

	Normal									Qos								StreamTrigger								
BertMismatchedZerosRatio						X																		X			
BertElapsedTestTime						X																		X			
BertUnframedOutputSignalStrength																											
BertUnframedDetectedLineRate																											
BertDeskewPatternLock																											
BertRxDeskewErroredFrames																											
BertRxDeskewErrorFreeFrames																											
BertRxDeskewLossOfFrame																											
BertTimeSinceLastError																											
BertTriggerCount																											
BertTxDeskewBitErrors																											

	Normal									Qos								StreamTrigger								
BertTxDeskewErroredFrames																											
BertTxDeskewErrorFreeFrames																											
Type: Service Disruption																											
BertLastServiceDisruptionTime						X																	X				
BertMinServiceDisruptionTime						X																	X				
BertMaxServiceDisruptionTime						X																	X				
BertServiceDisruptionCumulative						X																	X				
Type: 10 Gig																											
PauseAcknowledge							X		X					X	X		X							X		X	
PauseEndFrames							X		X					X	X		X							X		X	
PauseOverwrite							X		X					X	X		X							X		X	
10GigLanTxFpgaTemperatur																											

	Normal									Qos								StreamTrigger								
e																										
10GigLanRxFpgaTemperature																										
CodingErrorFramesReceived									X								X									X
EErrorCharacterFramesReceived									X								X									X
DroppedFrames									X								X									X
Type: ATM																										
AtmAal5BytesReceived	X	X	X		X					X	X	X	X					X	X	X		X				
AtmAal5BytesSent	X	X	X		X					X	X	X	X					X	X	X		X				
AtmAal5CrcErrorFrames																										
AtmAal5FramesReceived	X	X	X		X					X	X	X	X					X	X	X		X				
AtmAal5FramesSent	X	X	X		X					X	X	X	X					X	X	X		X				
AtmAal5LengthErrorFrames																										
AtmAal5TimeoutErrorFram																										

	Normal									Qos								StreamTrigger								
es																											
AtmCellsReceived	X	X	X		X					X	X	X	X					X	X	X		X				
AtmCellsSent	X	X	X		X					X	X	X	X					X	X	X		X				
AtmCorrectedHcsErrorCount	X	X	X		X					X	X	X	X					X	X	X		X				
AtmIdleCellCount	X	X	X		X					X	X	X	X					X	X	X		X				
AtmScheduledCellsSent	X	X	X		X					X	X	X	X					X	X	X		X				
AtmUncorrectedHcsErrorCount	X	X	X		X					X	X	X	X					X	X	X		X				
AtmUnregisteredCellsReceived	X	X	X		X					X	X	X	X					X	X	X		X				
EthernetCrc	X	X	X		X					X	X	X	X					X	X	X		X				
Type: Link Fault Signaling																										
LinkFaultState							X		X						X		X						X		X	
LocalFaults							X		X						X		X						X		X	
RemoteFaults																										

	Normal									Qos								StreamTrigger								
							X		X						X		X							X		X
Type: RPR																										
RprDiscoveryFramesReceived								X																X		
RprDataFramesReceived								X																X		
RprFairnessFramesReceived								X																X		
RprFairnessFramesSent								X																X		
RprFairnessTimeouts								X																X		
RprHeaderCrcErrors								X																X		
RprOamFramesReceived								X																X		
RprPayloadCrcErrors								X																X		
RprProtectionFramesReceived								X																X		
Type: Ordered Sets																										
LocalOrderedSetsSent									X								X									X

	Normal									Qos								StreamTrigger								
LocalOrderedSetsReceived									X								X									X
RemoteOrderedSetsSent									X								X									X
RemoteOrderedSetsReceived									X								X									X
CustomOrderedSetsSent									X								X									X
CustomOrderedSetsReceived									X								X									X

Statistics for ATM Modules

	ModeChecksumErrors							ModeDataIntegrity									Add'l
	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeDcc	Capture	PacketGroup	RxDataIntegrity	RxFirstTimeStamp	RxSequenceChecking	RxModeBert	RxModeBertChannelized	RxModeDcc	RxModeWidePacketGroup	PoSExtendedStats
Type: User Configurable																	
UserDefinedStat1	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
UserDefinedStat2				X				X	X	X	X	X	X	X	X	X	
CaptureTrigger	X						X	X								X	
CaptureFilter	X							X								X	

	ModeChecksumErrors							ModeDataIntegrity									Add'l
StreamTrigger1																X	
StreamTrigger2																X	
Type: States																	
Link	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
LineSpeed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
DuplexMode				X							X						
TransmitState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
CaptureState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
PauseState	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Type: Common																	
FramesSent				X			X				X		X	X	X	X	
FramesReceived				X			X				X		X	X	X	X	
BytesSent				X			X				X		X	X	X	X	
BytesReceived				X			X				X		X	X	X	X	
FcsErrors	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
BitsReceived	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
BitsSent	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
PortCpuStatus	X	X	X		X		X	X	X	X		X			X	X	
PortCpuDodStatus	X	X	X		X		X	X	X	X		X			X	X	
Type: Transmit Duration																	
TransmitDuration	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
Type: Quality of Service																	
QualityOfService0																	
Type: Checksum Stats																	

	ModeChecksumErrors							ModeDataIntegrity									Add'l
IpPackets	X	X	X		X		X										
UdpPackets	X	X	X		X		X										
TcpPackets	X	X	X		X		X										
IpChecksumErrors	X	X	X		X		X										
UdpChecksumErrors	X	X	X		X		X										
TcpChecksumErrors	X	X	X		X		X										
Type: Data Integrity																	
DataIntegrityFrames										X							
DataIntegrityErrors										X							
Type: Sequence Checking																	
SequenceFrames												X					
SequenceErrors												X					
Type: Ethernet																	
Fragments				X							X		X	X		X	
Undersize				X							X		X	X		X	
Oversize				X							X		X	X		X	
VlanTaggedFramesRx				X							X		X	X		X	
FlowControlFrames				X							X		X	X		X	
Type: Gigabit																	
SymbolErrorFrames				X							X						
SynchErrorFrames				X							X						
Type: 10/100 + Gigabit																	
SymbolErrors				X							X						

	ModeChecksumErrors							ModeDataIntegrity									Add'l
OversizeAndCrcErrors				X							X		X	X		X	
Type: POS																	
SectionLossOfSignal						X											X
SectionLossOfFrame																	X
SectionBip																	X
LineAis																	X
LineRdi																	X
LineRei																	X
LineBip																	X
PathAis																	X
PathRdi																	X
PathRei																	X
PathBip																	X
PathLossOfPointer																	X
PathPlm																	X
SectionBipErroredSecs							X										
SectionBipSeverlyErroredSecs							X										
SectionLossOfSignalSecs							X										
LineBipErroredSecs							X										
LineReiErroredSecs							X										
LineAisAlarmSecs							X										

	ModeChecksumErrors							ModeDataIntegrity									Add'l
LineRdiUnavailableSecs							X										
PathBipErroredSecs							X										
PathReiErroredSecs							X										
PathAisAlarmSecs							X										
PathAisUnavailableSecs							X										
PathRdiUnavailableSecs							X										
InputSignalStrength													X	X	X	X	
PosK1Byte																	
PosK2Byte																	
SrpDataFramesReceived																	
SrpDiscoveryFramesReceived																	
SrpIpsFramesReceived																	
SrpParityErrors																	
SrpUsageFramesReceived																	
SrpUsageStatus																	
SrpUsageTimeouts																	
Type: DCC																	
DccBytesReceived							X								X		

	ModeChecksumErrors							ModeDataIntegrity									Add'l
DccBytesSent																	
DccCrcErrorsReceived							X								X		
DccFramesReceived							X								X		
DccFramesSent																	
DccFramingErrorsReceived																	
Type: BERT																	
BertStatus						X											
BertBitsSent						X											
BertBitsReceived						X											
BertBitErrorsSent						X											
BertBitErrorsReceived						X											
BertErroredBlocks						X											
BertErroredSeconds						X											
BertSeverelyErroredSeconds						X											
BertErrorFreeSeconds						X											
BertAvailableSeconds						X											
BertUnavailableSeconds						X											
BertBlockErrorState						X											

	ModeChecksumErrors							ModeDataIntegrity									Add'l
BertBackgroundBlockErrors						X											
BertBitErrorRatio						X											
BertErroredSecondRatio						X											
BertSeverlyErroredSecondRatio						X											
BertBackgroundBlockErrorRatio						X											
BertNumberMismatchedOnes						X											
BertMismatchedOnesRatio						X											
BertNumberMismatchedZeros						X											
BertMismatchedZerosRatio						X											
BertElapsedTestTime						X											
BertUnframedOutputSignalStrength																	
BertUnframedDetectedLineRate																	
BertDeskewPatternLock																	

	ModeChecksumErrors							ModeDataIntegrity									Add'l
BertRxDeskewErroredFrames																	
BertRxDeskewErrorFreeFrames																	
BertRxDeskewLossOfFrame																	
BertTimeSinceLastError																	
BertTriggerCount																	
BertTxDeskewBitErrors																	
BertTxDeskewErroredFrames																	
BertTxDeskewErrorFreeFrames																	
Type: Service Disruption																	
BertLastServiceDisruptionTime						X											
BertMinServiceDisruptionTime						X											
BertMaxServiceDisruptionTime						X											
BertServiceDisruptionCumulative						X											

	ModeChecksumErrors							ModeDataIntegrity									Add'l
Type: 10 Gig																	
PauseAcknowledge													X	X		X	
PauseEndFrames													X	X		X	
PauseOverwrite													X	X		X	
10GigLanTxFpgaTemperature																	
10GigLanRxFpgaTemperature																	
CodingErrorFramesReceived																X	
EErrorCharacterFramesReceived																X	
DroppedFrames																X	
Type: ATM																	
AtmAal5BytesReceived	X	X	X		X			X	X	X		X					
AtmAal5BytesSent	X	X	X		X			X	X	X		X					
AtmAal5CrcErrorFrames																	
AtmAal5FramesReceived	X	X	X		X			X	X	X		X					
AtmAal5FramesSent	X	X	X		X			X	X	X		X					
AtmAal5LengthErrorFrames																	

	ModeChecksumErrors							ModeDataIntegrity									Add'l
AtmAal5TimeoutErrorFrames																	
AtmCellsReceived	X	X	X		X			X	X	X		X					
AtmCellsSent	X	X	X		X			X	X	X		X					
AtmCorrectedHcsErrorCount	X	X	X		X			X	X	X		X					
AtmIdleCellCount	X	X	X		X			X	X	X		X					
AtmScheduledCellsSent	X	X	X		X			X	X	X		X					
AtmUncorrectedHcsErrorCount	X	X	X		X			X	X	X		X					
AtmUnregisteredCellsReceived	X	X	X		X			X	X	X		X					
EthernetCrc	X	X	X		X			X	X	X		X					
Type: Link Fault Signaling																	
LinkFaultState														X		X	
LocalFaults														X		X	
RemoteFaults														X		X	
Type: RPR																	
RprDiscoveryFramesReceived															X		
RprDataFramesReceived															X		
RprFairnessFramesReceived															X		

	ModeChecksumErrors							ModeDataIntegrity									Add'l
RprFairnessFramesSent															X		
RprFairnessTimeouts															X		
RprHeaderCrcErrors															X		
RprOamFramesReceived															X		
RprPayloadCrcErrors															X		
RprProtectionFramesReceived															X		
Type: Ordered Sets																	
LocalOrderedSetsSent																X	
LocalOrderedSetsReceived																X	
RemoteOrderedSetsSent																X	
RemoteOrderedSetsReceived																X	
CustomOrderedSetsSent																X	
CustomOrderedSetsReceived																X	

Statistics for PoE Modules

Statistics for PoE Modules

Type: PoE	
PoeStatus	X
PoeInputVoltage	X
PoeInputCurrent	X
PoeInputPower	X
PoeActiveInput	X
PoeTemperature	X
PoeAutocalibration	X

Statistics for 10/100/1000 AFM

	Single Mode
Type: AFM	
bytesFromApplication	X
packetsFromApplication	X
monitorBytesFromPort2	X
monitorBytesFromPort3	X
monitorPacketsFromPort2	X
monitorPacketsFromPort3	X

Statistics for IxNetwork

	Additional Modes		
	ProtocolServerStats	**ArpStats**	**IcmpStats**
Type: Protocol Server - General			
ProtocolServerTx	X		
ProtocolServerRx	X		

	Additional Modes		
	ProtocolServerStats	**ArpStats**	**IcmpStats**
TxArpReply		X	
TxArpRequest		X	
TxPingReply			X
TxPingRequest			X
RxArpReply		X	
RxArpRequest		X	
RxPingReply			X
RxPingRequest			X
ProtocolServerVlanDroppedFrames	X		
ScheduledFramesSent			
AsynchronousFramesSent			
PortCPUFramesSent			

Ethernet OAM Statistics

Ethernet OAM statistics are capable of being generated for the load modules listed in the following table.

Ethernet OAM Statistics

Load Module	**Ethernet OAM Stats**							
	OAM Information PDUs Sent	OAM Information PDUs Received	OAM Event Notification PDUs Received	OAM Event Notification PDUs Received	OAM Organization PDUs Received	OAM Variable Request PDUs Received	OAM Variable Response PDUs Received	OAM Unsupported PDUs Received
10/100/1000 (S)TX(S)2,	X	X	X	X	X	X	X	X

Load Module	Ethernet OAM Stats							
4, 24								
1000 SFP(S)4	X	X	X	X	X	X	X	X
10/100/1000 XMS(R)12	X	X	X	X	X	X	X	X
10/100/1000 LSM XMV (R)4, 16	X	X	X	X	X	X	X	X
10/100/1000 ASM XMV12	X	X	X	X	X	X	X	X
10GE LSM (XM3, XMR3, XL6) in LAN mode	X	X	X	X	X	X	X	X
10GE LSM (XM8, XMR8, XM4, XMR4) in LAN mode	X	X	X	X	X	X	X	X
10GE LSM (XFP, XENPAK, X2, 10GBase-T) in LAN mode	X	X	X	X	X	X	X	X
10G MSM in LAN mode	X	X	X	X	X	X	X	X
10GE LSM MACSec LAN mode	X	X	X	X	X	X	X	X

MACsec Statistics

MACsec statistics can be generated for the LSM10GMS load module and are listed in the following table. For details, see *IEEE standard 802.1 AE-2006, Media Access Control (MAC) Security*.

MACsec Statistics

Statistic Type	Name	Description
MACSec Valid Frames Sent	macSecValidFramesSent	32-bit stat counter that indicates the total number valid MACSEC packets transmitted
MACSec Valid Bytes Sent	macSecValidBytesSent	64-bit stat counter that indicates the total numbre valid MACSEC bytes transmitted
MACSec Frames With Unknown Key Sent	macSecFramesWithUnknownKeySent	32-bit stat counter that indicates the total number of transmit packets for which no key was found
MACSec Valid	macSecValidFramesReceived	32-bit stat counter that

Statistic Type	Name	Description
Frames Received		indicates the total number valid MACSEC packets received
MACSec Valid Bytes Received	macSecValidBytesReceived	64-bit stat counter that indicates the total numbre valid MACSEC bytes received
MACSec Frames With Unknown Key Received	macSecFramesWithUnknownKeyReceived	32-bit stat counter that indicates the total number of receive packets for which no key was found
MACSec Frames With Bad Hash Received	macSecFramesWithBadHashReceived	32-bit stat counter that indicates the total number of receive packets with a bad ICV

FCoE Statistics

FCoE statistics can be generated for the NGY LSM10GXM family of load modules and are listed in the following table.

FCoE Statistics

Statistic Type	Name
FCoE Fabric Login sent	fcoeFlogiSent
FCoE Fabric Login Link Service Accept received	fcoeFlogiLsAccReceived
FCOE Port Login sent	fcoePlogiSent
FCOE Port Login Link Service Accept received	fcoePlogiLsAccReceived
FCOE Port Login Requests received	fcoePlogiRequestsReceived
FCoE Fabric Logout sent	fcoeFlogoSent
FCOE Port Logout sent	fcoePlogoSent
FCOE Port Logout received	fcoePlogoReceived
FCoE Discovery sent.	fcoeFdiscSent
FCoE Discovery Link Service Accept received	fcoeFdiscLsAccReceived
FCoE Name Server Registration sent	fcoeNSRegSent
FCoE Name Server Registration successful	fcoeNSRegSuccessful

Statistic Type	Name
FCoE Nx Ports Enabled	fcoeNxPortsEnabled
FCoE Nx Port IDs Acquired	fcoeNxPortIdsAcquired
FCoE Rx Shared Stat 1	fcoeRxSharedStat1
FCoE Rx Shared Stat 2	fcoeRxSharedStat2

fcoeRxSharedStat1 and fcoeRxSharedStat2

Select the statistic to be assigned to these two counters from these options:

statFcoeInvalidDelimiter
statFcoeInvalidFrames
statFcoeInvalidSize
statFcoeNormalSizeBadFccRc
statFcoeNormalSizeGoodFccRc
statFcoeUndersizeBadFccRc
statFcoeUndersizeGoodFccRc
statFcoeValidFrames

FIP Statistics

FIP statistics can be generated for any load module capable of FCoE and are listed in the following table.

FIP Statistics

Statistic Type	Name
Number of FIP Discovery Solicitations that have been sent.	FipDiscoverySolicitationsSent
Number of FIP Discovery Advertisements that have been received.	FipDiscoveryAdvertisementsReceived
Number of FIP Keep Alives that have been sent.	FipKeepAlivesSent
Number of FIP Clear Virtual Links that have been received.	FipClearVirtualLinksReceived

ALM, ELM and CPM Statistics

Statistics generated for ALM1000T8 and ELM1000ST2 load modules are listed in the following table.

Statistics for 10/100/1000 ALM T8, ELM ST2, and CPM T8

	Common	Additional Statistics			
		ArpStats	DHCPv4Stats	DHCPv6Stats	TempSensors Stats
Link State	X				
Line Speed	X				
Duplex Mode	X				
Frames Sent	X				
Valid Frames Received	X				
Bytes Sent	X				
Bytes Received	X				
Fragments	X				
Undersize	X				
Oversize and Good CRCs	X				
CRC Errors	X				
Alignment Errors	X				
Dribble Errors	X				
Collisions	X				
Late Collisons	X				
Collision Frames	X				
Excessive Collision Frames	X				
Oversize and CRC Errors	X				
ProtocolServer Transmit	X				
ProtocolServer	X				

	Common	Additional Statistics			
		ArpStats	DHCPv4Stats	DHCPv6Stats	TempSensors Stats
Receive					
Transmit ARP Reply		X			
Transmit ARP Request		X			
Transmit Ping Reply	X				
Transmit Ping Request	X				
Receive ARP Reply		X			
Receive ARP Request		X			
Receive Ping Reply	X				
Receive Ping Request	X				
Bits Sent	X				
Bits Received	X				
Central Chip Temperature (C)					X
Port Chip Temperature (C)					X[1]
Port CPU Status	X				
Port CPU DoD Status	X				
DHCPv4 Discovered Messages Sent			X		

	Common	Additional Statistics			
		ArpStats	DHCPv4Stats	DHCPv6Stats	TempSensors Stats
DHCPv4 Offers Received			X		
DHCPv4 Requests Sent			X		
DHCPv4 ACKs Received			X		
DHCPv4 NACKs Received			X		
DHCPv4 Releases Sent			X		
DHCPv4 Enabled Interfaces			X		
DHCPv4 Addresses Learned			X		
DHCPv6 Solicits Sent				X	
DHCPv6 Advertisements Received				X	
DHCPv6 Requests Sent				X	
DHCPv6 Declines Sent				X	
DHCPv6 Replies Received				X	
DHCPv6 Releases Sent				X	
DHCPv6 Enabled Interfaces				X	
DHCPv6 Addresses Learned				X	

[1]Not ELM (ALM and CPM only)

40/100 GE Statistics

Statistics for 40/100GE LSM Modules

Statistics Mode	**Normal**				**Qos**				
	Capture	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	Capture	RxDataIntegrity	RxSequenceChecking	RxModeWidePacketGroup	TemperatureSensorsStats
Type: User Configurable									
UserDefinedStat1	X	X	X	X	X	X	X	X	
UserDefinedStat2	X	X	X	X	X	X	X	X	
UserDefinedStatByteCount1 (supported only on Lava AP40/100GE 2P	X	X	X	X	X	X	X	X	
UserDefinedStatByteCount2 (supported only on Lava AP40/100GE 2P	X	X	X	X	X	X	X	X	
CaptureTrigger	X	X	X	X	X	X	X	X	
CaptureFilter	X	X	X	X	X	X	X	X	
StreamTrigger1	X	X	X	X	X	X	X	X	
StreamTrigger2	X	X	X	X	X	X	X	X	
UserDefinedStat5	X	X	X	X	X	X	X	X	
UserDefinedStat6	X	X	X	X	X	X	X	X	
Type: States									
Link	X	X	X	X	X	X	X	X	
LineSpeed	X	X	X	X	X	X	X	X	
TransmitState	X	X	X	X	X	X	X	X	

Statistics Mode	Normal				Qos				
CaptureState	X	X	X	X	X	X	X	X	
PauseState	X	X	X	X	X	X	X	X	
Type: Common									
FramesSent	X	X	X	X	X	X	X	X	
FramesReceived	X	X	X	X	X	X	X	X	
BytesSent	X	X	X	X	X	X	X	X	
BytesReceived	X	X	X	X	X	X	X	X	
FcsErrors	X	X	X	X	X	X	X	X	
BitsReceived	X	X	X	X	X	X	X	X	
BitsSent	X	X	X	X	X	X	X	X	
PortCpuStatus	X	X	X	X	X	X	X	X	
PortCpuDodStatus	X	X	X	X	X	X	X	X	
ScheduledTransmitTime	X	X	X	X	X	X	X	X	
Type: Transmit Duration									
TransmitDuration	X	X	X	X	X	X	X	X	
Type: Quality of Service									
QualityOfService 0-7					X	X	X	X	
Type: Checksum Stats									
IPv4Packets	X	X	X	X	X	X	X	X	
UdpPackets	X	X	X	X	X	X	X	X	
TcpPackets	X	X	X	X	X	X	X	X	
IPv4ChecksumErrors	X	X	X	X	X	X	X	X	
UdpChecksumErrors	X	X	X	X	X	X	X	X	
TcpChecksumErrors	X	X	X	X	X	X	X	X	
Type: Data Integrity									
DataIntegrityFrames		X				X			

Statistics Mode	Normal				Qos				
DataIntegrityErrors		X				X			
Type: Sequence Checking									
SequenceFrames			X				X		
SequenceErrors			X				X		
ReverseSequenceErrors			X				X		
SmallSequenceErrors			X				X		
TotalSequenceErrors			X				X		
BigSequenceErrors			X				X		
Type: Ethernet									
Fragments	X	X	X	X	X	X	X	X	
Undersize	X	X	X	X	X	X	X	X	
Oversize	X	X	X	X	X	X	X	X	
VlanTaggedFramesRx	X	X	X	X	X	X	X	X	
FlowControlFrames	X	X	X	X	X	X	X	X	
Type: Temperature									
PCPU FPGA Temperature									X
Capture1 Fpga Temperature									X
Capture2 Fpga Temperature									X
Tx1 Fpga Temperature									X
Tx2 Fpga Temperature									X
Latency1 Fpga Temperature									X
Latency2 Fpga Temperature									X
TxSchedulerOverlay Temperature									X
TxFmx Fpga Temperature									X
RxFmx Fpga Temperature									X
Type: Pause									

Statistics Mode	Normal				Qos				
PauseEndFrames									
PauseOverwrite	X	X	X	X	X	X	X	X	
Type: Gigabit									
Oversize and CRC Errors	X	X	X	X	X	X	X	X	
Type: POS									
Input Signal Strength	X	X	X	X	X	X	X	X	
Type: ARP									
TxArpReply	X	X	X	X	X	X	X	X	
TxArpRequest	X	X	X	X	X	X	X	X	
RxArpReply	X	X	X	X	X	X	X	X	
RxArpRequest	X	X	X	X	X	X	X	X	
Type: ICMP									
TxPingReply	X	X	X	X	X	X	X	X	
TxPingRequest	X	X	X	X	X	X	X	X	
RxPingReply	X	X	X	X	X	X	X	X	
RxPingRequest	X	X	X	X	X	X	X	X	
ScheduledFramesSent	X	X	X	X	X	X	X	X	
AsynchronousFramesSent	X	X	X	X	X	X	X	X	
PortCPUFramesSent	X	X	X	X	X	X	X	X	
Type: Protocol Server-General									
ProtocolServerTx	X	X	X	X	X	X	X	X	
ProtocolServerRx	X	X	X	X	X	X	X	X	
ProtocolServerVlanDroppedFrames	X	X	X	X	X	X	X	X	
Type: Link Fault Signaling									
LinkFaultState	X	X	X	X	X	X	X	X	

Statistics Mode	Normal				Qos				
LocalFaults	X	X	X	X	X	X	X	X	
RemoteFaults	X	X	X	X	X	X	X	X	
Type: LSM									
codingErrorFramesReceived	X	X	X	X	X	X	X	X	
eErrorCharacterFramesReceived	X	X	X	X	X	X	X	X	
Type: PCS									
PcsSyncErrorsReceived	X	X	X	X	X	X	X	X	
PcsIllegalCodesReceived	X	X	X	X	X	X	X	X	
PcsRemoteFaultsReceived	X	X	X	X	X	X	X	X	
PcsLocalFaultsReceived	X	X	X	X	X	X	X	X	
PcsIllegalOrderedSetReceived	X	X	X	X	X	X	X	X	
PcsIllegalIdleReceived	X	X	X	X	X	X	X	X	
PcsIllegalSofReceived	X	X	X	X	X	X	X	X	
PcsOutOfOrderSof Received	X	X	X	X	X	X	X	X	
PcsOutOfOrderEof Received	X	X	X	X	X	X	X	X	
PcsOutOfOrderData Received	X	X	X	X	X	X	X	X	
PcsOutOfOrderOrderedSetReceived	X	X	X	X	X	X	X	X	
TotalFrames	X	X	X	X	X	X	X	X	
ReadTimeStamp	X	X	X	X	X	X	X	X	
Type: Latency/Jitter									
MinLatency	X	X	X	X	X	X	X	X	
MaxLatency	X	X	X	X	X	X	X	X	
MaxminInterval	X	X	X	X	X	X	X	X	
AverageLatency	X	X	X	X	X	X	X	X	
TotalByteCount	X	X	X	X	X	X	X	X	

Statistics Mode	Normal				Qos				
BitRate	X	X	X	X	X	X	X	X	
ByteRate	X	X	X	X	X	X	X	X	
FrameRate	X	X	X	X	X	X	X	X	
FirstTimeStamp	X	X	X	X	X	X	X	X	
LastTimeStamp	X	X	X	X	X	X	X	X	

Appendix B: GPS Antenna Installation Requirements

Ixia GPS equipped systems used to provide local Stratum 1 timing signals requires the installation of a GPS antenna kit (942-0003 or 942-0005, where the facility or environment prevent the window mount antenna from functioning). This section describes the installation method we recommend for an IXIA GPS Antenna. This section also provides a scheme for installation of lightning protection for an installed antenna. In order to ensure that all of the following criteria in this manual can be met, we recommend a site survey.

This is not an installation manual and should not be used in place of building codes for electronic installations applicable to specific sites.

Ce manuel n'est pas un manuel d'installation et ne doit pas être utilisé à la place des normes de construction pour les installations électroniques qui s'appliquent à des sites spécifiques.

This appendix has the following sections:

Roof Mount Antenna

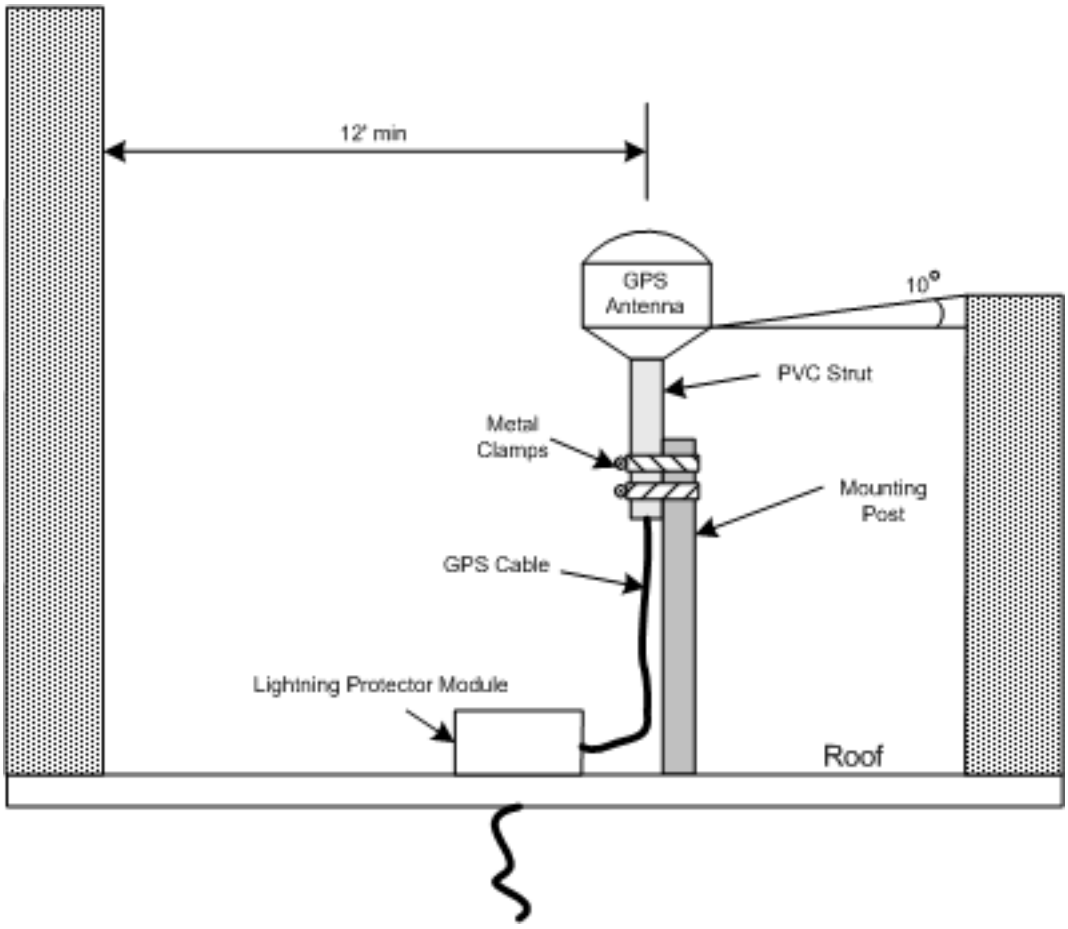
The general location requirements for installation of the GPS antenna and conduit are:

GPS Location Requirements

1.	Ideally, a roof area with an unobstructed 360-degree view of the sky above the horizon. At the minimum, a 180-degree view of the sky is required.
2.	Mounted away from and above a plane from items such as elevators, air conditions and other machinery.
3.	Should have the best view of the horizon that is possible. No obstructions should be within a ten-degree angle from the horizontal.
4.	There should be adequate space available on the roof to install two antennas with an absolute minimum of 10 feet between antennas.
5.	The antenna should be 12 feet away from metallic objects.
6.	Sufficient access to the roof for installation of the GPS conduit/mast and antenna.
7.	Permission to run a 2-inch PVC conduit from the GPS antenna on the roof to the building entrance point.
8.	The coax cable must be connected to the lightning protector (supplied) in the most direct fashion possible, and the lightning protector must be grounded. We recommend that this ground be interconnected to the antenna's tower ground. NOTE It is very important that the lightning protector be grounded to a low impedance (low R and low L) ground system.

One possible installation is shown in the following figure.

Figure: GPS Installation Requirements



The following items are included as part of the Ixia package:

- The GPS Antenna
- GPS Cables (1 long and 1 short)
- Lightning Protector
- The PVC Strut
- Two metal clamps

The placement and construction illustrate many of the recommendations found in this section.

Conduit

We recommend the coax from the GPS antenna to the Ixia unit to be installed in a secure conduit from the point directly above the chassis to the GPS antenna. The conduit serves two purposes:

1. It protects the coax cable.
2. It provides a rigid mast on which the GPS can be mounted.

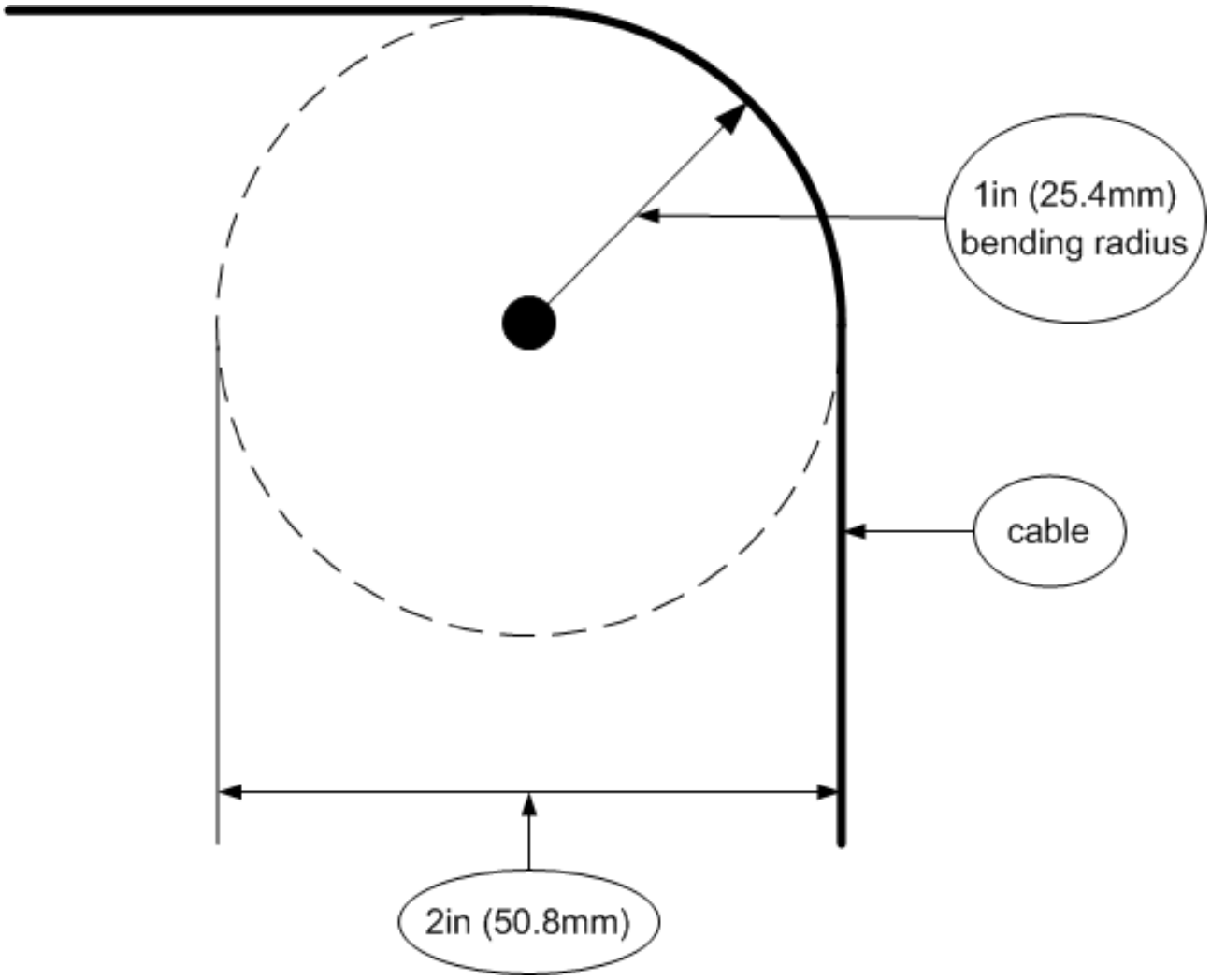
Conduit Type

The GPS conduit should be 2-inch PVC. Installation of the coaxial cable is uncomplicated within the pipe. There should be no more than four 90-degree bends between pull boxes.

Coaxial Bending Radius

The coaxial cable should be run as straight as possible to meet the manufacturer phase stability. The coaxial cable may have a greater than 1in (25.4 mm) bending radius.

Figure: Coaxial Bending Radius



In order to go around a corner a conduit that has less than the required bending radius, it would be necessary to use either a junction box with an accessible elbow installed at each 90-degree turn or two 45-degree elbow connected with a piece of straight pipe. A 2-inch conduit only requires one 90-degree elbow to make the correct bending radius around a 90-degree turn.

Lightning Protection

Lightning protection for the installation is required. The lightning protector must be correctly grounded to function properly. It must be connected to a low impedance (low R and low L) ground system. We recommend that this ground be interconnected to the tower ground and power ground to form one system.

NOTE When attaching to the grounding stud (M8), use a maximum of 88.5 lbf-in. (10 N-m) of torque.

The earth ground electrode should be driven in at least 8 ft. (2.44m) into the earth. A #6 grounding wire should be used.

GPS Mast Location Requirements

Preferred Location

The preferred mounting location for the GPS antenna is an unobstructed 360-degree view of the sky above the horizon. The specific requirements are:

GPS Mast Preferred Location Requirements

1.	Optimal view of the sky.
2.	Not the highest point of the building so as to reduce the possibility of lightning strikes.
3.	Located at least 12 ft. from any large metal objects.
4.	Located at least 10 ft. from any other GPS antenna.
5.	Located within 30 ft. of where the coax cable enters the building.
6.	The GPS antenna mast should be mounted at least 4 feet higher than the highest horizontal **reflective surface** such as roof top mounted AC units.

Requirements if Preferred Location is Not Available

If an unobstructed 360-degree view of the sky is not available then the following requirements should be met:

GPS Mast Location Requirements if a Preferred Location is not Available

1.	300-degree azimuth view of the sky.
2.	No vertical obstructions to obscure the view of the antenna from the horizon for more than 10 degrees.
3.	No high-power radar signal beamed directly at the unit; this may damage the pre-amplifier in the antenna.
4.	No harmonics from a high-power, broad band transmitter within a few megahertz of the carrier frequency (1.575 GHz) should be present. This may jam the GPS receiver.

Window Mount Antenna

The GPS chassis kit includes a window mount antenna. This antenna is capable of operation in areas with a relatively unrestricted view of the sky, and low background interference from other radiators.

Mounting

Mount the antenna on the metal frame of the window. The antenna should be no lower than the lower edge of the glass. A 180-degree view of the sky is preferred, with no buildings adjacent to the window.

In the absence of a metal window frame, a nine centimeter square metal plact can be used to mount the antenna in a position above the window sill.

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Appendix C: Hot-Swap Procedure

Each Optixia chassis provides the ability of removing and reinstalling a Load Module without requiring the removal of power from the rest of the chassis. The process of removing/installing a Load Module does not impact either the operation of the OS or load modules installed in the chassis. The following features are part of the installation/removal process:

- Remove Notification sent to you through IxServer and IxExplorer
- No impact on tests operating on other cards
- Safe power application/removal from the card interface

Legacy modules installed in the SFF adapter module can also be hot-swapped.

NOTE The following guidelines should be applied when hot-swapping modules:

- Modules can be hot-swapped in and out of a chassis without impacting server operation only if they are not currently being used to run a test.
- Do not add or remove more than one module at a time.
- Do not add or remove modules during IxServer start up wait until LCD display shows `Server OK.'
- `In Use' LED indicates the module is currently owned by an application. This is to warn of hot-swapping conflicts.

Load Module Hot-Swap Insertion

The process of insertion of a Load Module causes the slot location to apply power to the Load Module and determine that there is no immediate fault condition. The presence of a Load Module in a slot is flagged to IxServer. Upon recognition of a Load Module's presence, IxServer determines if the Load Module is a supported type. All supported types shall be loaded automatically. In all cases, once IxServer has determined the presence of a Load Module in a slot, IxExplorer represents the Load Module as present and advertises the type. For unsupported Load Modules, the module type is shown and is indicated as unsupported in the IxExplorer GUI as long as it resides in a slot.

To insert a load module:

1. Carefully slide the load module along the chassis slot runners until it selects into place. Ensure that it is firmly connected to the backplane.
2. Secure the holding screws. Be careful not to over tighten the screws.

NOTE You should not hot-swap more than one load module at a time into a powered Optixia chassis.

Load Module Hot-Swap Removal

The removal of a load module does not impact the operation of other Load Modules in the chassis with respect to power or independent operation. In the event that an application is using the Load Module, the application operations for that Load Module are terminated and a message is sent to you. In the event that inter-board operations are enabled, the other Load Modules interfacing the removed Load

Module are notified of its absence and are instructed to terminate operations to the removed Load Module.

To remove a load module:

1. Loosen the holding screws.
2. Disconnect the load module from the backplane and remove it from the chassis. Be sure to use correct ESD handling procedures at all times.

NOTE You should not hot-swap more than one load module at a time into a powered Optixia chassis.

NOTE In the event of indications of inadequate power, remove load modules starting from the low-number slots (slot 1, 2, 3), then working upward toward the higher-numbered slots, until the problem is solved.

Appendix D: TCP/UDP Port Assignments on Ixia Chassis

Applicability

The information in this bulletin applies to all Ixia chassis.

Ports Used in Ixia Chassis

The following table lists the TCP and UDP ports on Ixia Chassis that are used by Ixia applications running on Client machines such as Ixia Application Controllers:

Ixia Hardware Chassis — Inbound Firewall Rules

Source IP	Destination IP	Ixia Application (Source)	Protocol	Src Port	Dst Port
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	21
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	22
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	23
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, ILU, Automation	TCP	ANY	80
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	111
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	135
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, ILU, Automation	TCP	ANY	443
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	445
IP address of Client	IP address of Ixia	IxN, IxL, IxE,	TCP	ANY	1024

Source IP	Destination IP	Ixia Application (Source)	Protocol	Src Port	Dst Port
Machine running Ixia applications	Hardware Chassis	Automation			
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	1080
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	2048
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	2049
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	2050-2111
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	2782
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	2809 - 2825
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	3222
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	4500
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, ILU, Automation	TCP	ANY	4501-4502
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	4555
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	4900
IP address of Client	IP address of Ixia	IxN, IxL, IxE,	TCP	ANY	5286

Source IP	Destination IP	Ixia Application (Source)	Protocol	Src Port	Dst Port
Machine running Ixia applications	Hardware Chassis	Automation			
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	5326
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	6001
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	6101
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, Automation	TCP	ANY	7768
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxL, Automation	TCP	ANY	8021
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxL, Automation	TCP	ANY	8085
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, Automation	TCP	ANY	8881
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, ILU, Automation	TCP	ANY	8890
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	9101-9102
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	9613-9676
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	17668-17777
IP address of Client	IP address of Ixia	IxN, IxL, IxE,	TCP	ANY	21653

Source IP	Destination IP	Ixia Application (Source)	Protocol	Src Port	Dst Port
Machine running Ixia applications	Hardware Chassis	Automation			
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	23123-23380
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, ILU, Automation	TCP	ANY	27000-27009
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	TCP	ANY	38096
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	67
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	68
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	111
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	123
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	135
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	445
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	797-800
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	1024

Source IP	Destination IP	Ixia Application (Source)	Protocol	Src Port	Dst Port
IP address of Client Machine running Ixia applications	IP address of Ixia Hardware Chassis	IxN, IxL, IxE, Automation	UDP	ANY	2049

NOTE While installing IxNetwork in lab environments, the firewall may need to be configured to allow traffic flow among network segments. Keep the following ports open for IxNetwork use:

- 1080
- 7768
- 7769
- 21653
- Ports that are used in IxNetwork command line as TCl port, Rest port, and SDM port, like:
  IxNetwork.exe -tclPort 8009 -sdmPort 9009 -restPort 11009

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Appendix E: Software Licenses

IxOS contains certain third-party software that is delivered as part of the product. A list of such third party software that is licensed to Ixia, is identified and provided in a separate PDF document.

For details about the third-party software licenses, see the IxOS_Third_Party_Software_Licenses document on the support website https://support.ixiacom.com/ixos-software-downloads-documentation.

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