IQS-8525/8535 Packet Blazer

FIBRE CHANNEL AND ETHERNET TEST MODULES

COMPLETE IPv6 TESTING

EtherSAM

FROST & SULLIVAN
2011 BEST PRACTICES AWARD
GLOBAL GIGABIT ETHERNET TEST EQUIPMENT GROWTH EXCELLENCE AWARD

SPEC SHEET

Fully integrated test solution for performance and functionality assessment of Fibre Channel and Ethernet equipment

KEY FEATURES

- Fibre Channel traffic generation and BER testing
- Full line rate for 10x, 4x, 2x and 1x interfaces
- FC-0, FC-1 and FC-2 logical layer configuration for Fibre Channel port definition, testing and performance analysis
- Ethernet LAN/WAN traffic generation and BER testing
- Round-trip latency measurement and buffer-to-buffer credit estimation
- Full line rate from 10 Gbit/s to 10 Mbit/s
- Ethernet service performance validation through BER testing, RFC 2544 testing and bidirectional RFC 2544 testing (dual test set configuration) to assess meshed topologies
- True wire-speed, stateful TCP throughput test for undisputable SLA reinforcement for Ethernet services
- Complete bidirectional EtherSAM (ITU-T Y.1564) test suite. EtherSAM is the new standard for turning up and troubleshooting mobile backhaul and business Ethernet services

PLATFORM COMPATIBILITY

Integrated Qualification System
IQS-600

EXFO

INTEGRATED FIBRE CHANNEL AND ETHERNET TESTING

Up to 10 Gbit/s Multiservice Datacom Testing to Address Manufacturing, R&D and Software Verification Needs

EXFO's IQS-8525/8535 Packet Blazer test modules deliver Fibre Channel testing at speeds of up to 10 Gbit/s (1200 MB/s) and bring FC-0, FC-1 and FC-2 logical layer Fibre Channel testing to services carried via transport protocols such as DWDM, SONET/SDH and dark fiber. They provide valuable timing information as well as buffer credit estimation for Fibre Channel network deployment. These test modules support the full range of Fibre Channel interfaces (1x, 2x, 4x and 10x), offering flexibility to both manufacturing and software verification groups.

The IQS-8525/8535 Packet Blazer modules are housed in the IQS-600 Integrated Qualification System. Shown here is the IQS-8535 model.

The IQS-8525/8535 modules also provide the option to enable EXFO's full test suite for Ethernet services at up to 10 Gbit/s, including Ethernet BER and RFC 2544 testing with VLAN support. They support a wide range of Ethernet interfaces, from 10 Mbit/s electrical to 10 Gbit/s optical.

The integration of Fibre Channel and Ethernet service testing at multiple rates brings the versatility, flexibility and affordability required by R&D, software verification and manufacturing groups.

KEY FEATURES

Fibre Channel
Simultaneous traffic generation and analysis at wire speed for 10x (IQS-8535 only), 4x, 2x and 1x Fibre Channel rates
BER testing of Fibre Channel circuits
Fully integrated FC-0, FC-1 and FC-2 logical layer testing, enabling fabric and port login (F-port and N-port login)
Round-trip latency measurements for assessing the capability of a link
Buffer-to-buffer credit estimation for optimal configuration of Fibre Channel nodes
Ethernet
Simultaneous traffic generation and analysis at wire speed for 10 Gbit/s LAN/WAN (IQS-8535 only), 1 Gbit/s optical, 100 Mbit/s optical, 1 Gbit/s electrical, 100 Mbit/s electrical and 10 Mbit/s electrical Ethernet rates
EtherBERT™ for bit-error-rate testing of 10, 100, 1000 Mbit/s and 10 Gbit/s Ethernet circuits
Complete carrier Ethernet services testing portfolio: PBB-TE (MAC-in-MAC), MPLS and IPv4/IPv6
RFC 2544 (throughput, latency, frame loss and back-to-back) for Ethernet service performance assessment
Bidirectional RFC 2544 testing for meshed network topologies
Q-in-Q capability for up to three layers of stacked VLANs
Broad set of remote control commands using SCPI
Remote access through Visual Guardian Lite software, Remote Desktop, VNC and WebVNC
Easy-to-use interface for configurable screens, customization of test routines, and real-time and historical performance reporting

EFFICIENTLY ASSESSING PERFORMANCE OF FIBRE CHANNEL SERVICES

IQS-8525/8535 Packet Blazer modules provide comprehensive testing capabilities for Fibre Channel network deployments, supporting multiple Fibre Channel interfaces.

INTERFACE	RATE (GBIT/S)	RATE (MB/S)
1x	1.0625	100
2x	2.125	200
4x	4.25	400
10x (IQS-8535 only)	10.51875	1200

Applications

Since most storage area networks (SANs) cover large distances and Fibre Channel has stringent performance requirements, it is imperative to verify that the network equipment meets performance requirements at each phase of network deployment to ensure appropriate service levels. EXFO's IQS-8525/8535 modules provide wire-speed traffic generation at FC-0, FC-1 and FC-2 logical layers, allowing BER testing for link integrity measurements. In addition, latency, buffer-to-buffer credit measurements for optimization as well as login capabilities are supported.

Bit-Error-Rate Testing (BERT)

Bit-error-rate testing is commonly used in R&D, software verification and manufacturing to ensure proper functionality and reliability of the data path in the network equipment and on the fiber. BERT uses a pseudo-random binary sequence (PRBS) encapsulated into a Fibre Channel frame, making it possible to go from a frame-based error measurement to a bit-error-rate measurement.

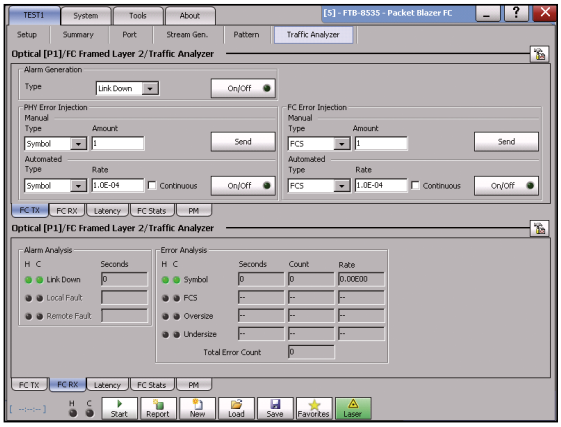
Latency

Transmission of frames in a network is not instantaneous and is subject to multiple delays caused by the propagation delay in the fiber and by processing time inside each piece of network equipment. Latency is the total accumulation of delays between two end points. Some applications such as transaction processing and storage area networks are very sensitive to latency.

It is therefore critical to properly characterize the network equipment's latency when offering Fibre Channel services. From the latency measurement that they perform, the IQS-8525/8535 modules estimate buffer-to-buffer credit value requirements.

Buffer-to-Buffer Credit Estimation

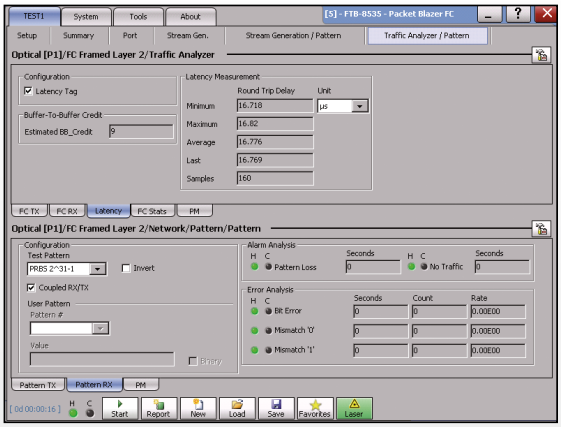
In order to regulate traffic flow and congestion, Fibre Channel ports use "buffers" to temporarily store frames. The number of frames a port can store is referred to as a "buffer credit". Each time a frame is received by a port, an acknowledgement frame is sent. The buffer-to-buffer credit threshold refers to the amount of frames a port can transmit without receiving a single acknowledgement.



This crucial configuration parameter has a strong impact on latency and needs to be carefully selected for optimal equipment and network performance. The value is commonly calculated by taking into account latency in the network equipment, the data rate and the travel delay on the fiber. The IQS-8525/8535 modules are capable of estimating buffer credit values with respect to latency by calculating the distance according to the round-trip latency time. This value is critical when testing network equipment to ensure compliance with any network configuration, whether the latency is large or small.

Login Testing

Most new-generation transport devices (xWDM or SONET/SDH mux) supporting Fibre Channel are no longer fully transparent; they also have increased built-in intelligence, acting more as Fibre Channel switches. With switch fabric login ability, the IQS-8525/8535 Packet Blazer modules support connections to a remote location through a fabric or semi-transparent networks.



The login process not only permits the unit to connect through Fibre Channel switch, but it also exchanges some of the basic port characteristics (such as buffer-to-buffer credit and class of service) in order to efficiently transport the traffic through the network. The login feature allows automatic detection of port/fabric login (often referred to as N-port and F-port login), login status (successful login, in progress, failure and logout) and response to remote buffer-to-buffer advertised credit.

ETHERNET PERFORMANCE VALIDATION AND RELIABILITY

EXFO's IQS-8525/8535 Packet Blazers offer a wide range of Ethernet test functions aimed at performance validation and reliability testing, supporting multiple Ethernet interfaces, both optical and electrical.

ELECTRICAL	OPTICAL
10 Mbit/s	100 Mbit/s
100 Mbit/s	1000 Mbit/s (GigE)
1000 Mbit/s (GigE)	10 Gbit/s (10 GigE)–IQS-8130NGE only

Applications

The IQS-8525/8535 Packet Blazer modules deliver the features required to perform common Ethernet service testing, namely BER and RFC 2544 testing.

BER Testing

Because the transparent transport of Ethernet services over physical media is becoming common, Ethernet is increasingly carried across a variety of layer 1 media over longer distances. This creates a growing need for the certification of Ethernet transport on a bit-per-bit basis, which can be done using bit-error-rate testing (BERT). BERT uses a pseudo-random binary sequence (PRBS) encapsulated into an Ethernet frame, making it possible to go from a frame-based error measurement to a bit-error-rate measurement.

This provides the bit-per-bit error count accuracy required for the acceptance testing of physical-medium transport systems. In addition to BER testing, the IQS-8525/8535 Packet Blazer modules also provide service disruption time (SDT) measurements.

RFC 2544 Testing

RFC 2544 is a test methodology commonly used by network operators to validate the performance of their switched Ethernet network and define SLA and QoS parameters with their customers. As such, it is critical that network equipment manufacturers perform RFC 2544 testing to ensure optimal results of their equipment.

The IQS-8525/8535 Packet Blazer modules come with a complete set of RFC 2544 test capabilities, including:

- Throughput testing
- Burst (back-to-back) testing
- Frame loss analysis
- Latency measurement

Dual Test Set

RFC 2544 is optimal for traditional network testing, but is less relevant in today's meshed networks where ingress and egress data can likely take different paths. EXFO's dual test set capability—using two end ports and two test sets—allows for concurrent bidirectional RFC 2544 testing through the direct control of only one test set (two test sets are required for local/remote testing, also known as head-to-head testing). This brings better visibility to each test direction (local to remote, remote to local) than by viewing round-trip results.

IP Test Tools

The IQS-8525/8535 Packet Blazer modules provide tools to execute connectivity tests at the IP layer: ping and traceroute.

Ping

This tool sends a ping command to a specific destination IP address configured by the client in order to determine if the client is reachable within a given delay. When reached, the destination IP replies to this ping request and statistics are collected by the local module from these replies. Results collected include the response delay for each ping request, round-trip time measurement and a count of frames sent and received. The user has the ability to configure the parameters of the ping test.

Traceroute

This tool lists all client-configured routers identified between the local and the destination IP address, within a given delay. When link routers respond to the ping command, the route and statistics are collected by the local module from these replies. Results collected include the IP address of routers in the link and the response delay, round-trip time measurement and a count of frames sent and received. The user also has the ability to configure the parameters of the traceroute.

Ethernet QoS Measurements

Data services are making a significant shift toward supporting a variety of applications on the same network. Multiservice offerings such as triple-play services have fuelled the need for QoS testing to ensure the condition and reliability of each service. The IQS-8525/8535 Packet Blazer allows simultaneous simulation and qualification of different applications through its multistream application. The user has the capability to configure up to ten streams with different Ethernet and IP QoS parameters such as VLAN ID (802.1Q), VLAN Priority (802.1p), VLAN stacking (802.1ad Q-in-Q), ToS and DSCP. Specific stream profiles to transmit VoIP, video and data can be selected for each stream. Throughput, latency, frame loss and packet jitter (RFC 3393) measurements are also available simultaneously for each stream, allowing fast and in-depth qualification of performance criteria.

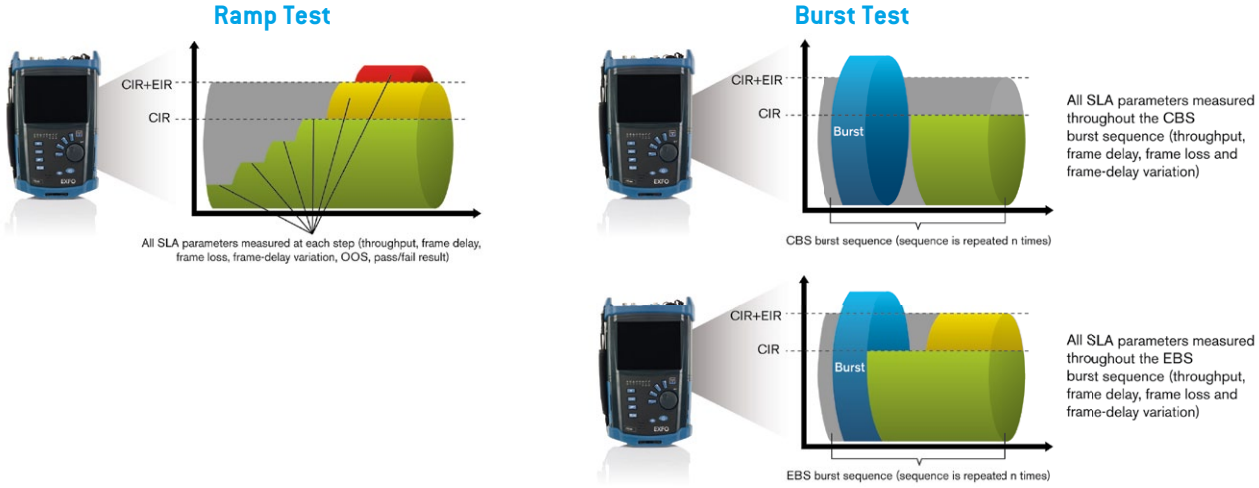
ETHERSAM: THE NEW STANDARD IN ETHERNET TESTING

ITU-T Y.1564 is the new standard for turning up and troubleshooting Carrier Ethernet services. This methodology is completely adapted to today's Ethernet services especially mobile backhaul and commercial services. Up to now, RFC 2544 has been the most widely used methodology. However, it was designed for network device testing in the lab, not for services testing in the field. ITU-T Y.1564 is the first testing standard developed for the field. It has a number of advantages over the RFC 2544 including validation of critical SLA criteria such as packet jitter and QoS measurements. This methodology is also significantly faster, therefore saving time and resources while optimizing QoS.

Contrary to other methodologies, EtherSAM supports new multiservice offerings. It can simulate all types of services that will run on the network and simultaneously qualify all key SLA parameters for each of these services. Moreover, it validates the QoS mechanisms provisioned in the network to prioritize the different service types, resulting in more accurate validation and much faster deployment and troubleshooting. EtherSAM is comprised of two phases, the service configuration test and the service performance test.

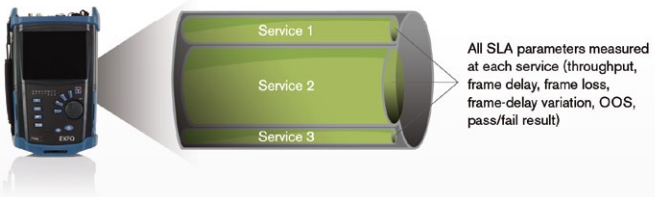
Service Configuration Test

The service configuration test consists in sequentially testing each service. It validates that the service is properly provisioned and that all specific KPIs or SLA parameters are met. A ramp test and a burst test are performed to verify the committed information rare (CIR), excess information rate (EIR), committed burst size (CBS) and excess burst size (EBS).



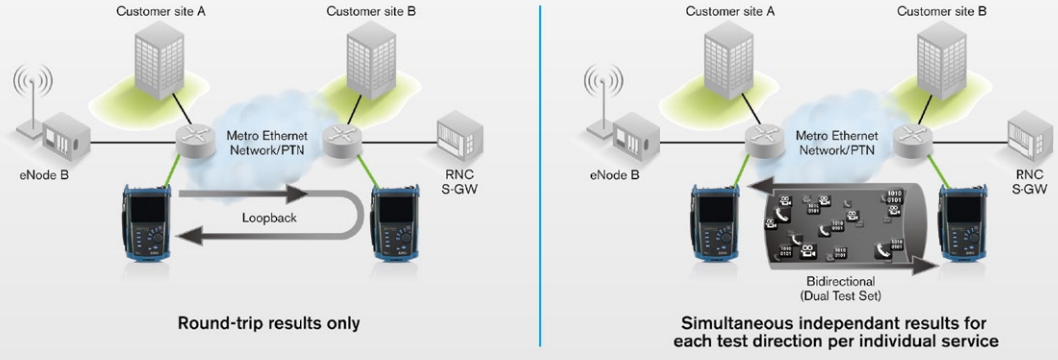
Service Performance Test

Once the configuration of each individual service is validated, the service performance test simultaneously validates the quality of all the services over time.



EtherSAM Bidirectional Results

EXFO's EtherSAM approach proves even more powerful as it executes the complete ITU-T Y.1564 test with bidirectional measurements. Key SLA parameters are measured independently in each test direction, thus providing 100 % first-time-right service activation–that is the highest level of confidence in service testing.



ETHERNET PERFORMANCE VALIDATION AND RELIABILITY (CONTINUED)

MPLS, MPLS-TP and PBB-TE: Carrier Ethernet Transport Solution Testing

As technologically-sophisticated business and residential consumers continue to drive demand for premium, high-bandwidth data services such as voice and video, service providers worldwide are evolving their transport infrastructures to support these bandwidth and quality intensive services. No longer is an all-IP core sufficient – providers must now expand their IP convergence to the edge/metro network, in a cost-effective, quality-assured manner. Ethernet has long been accepted as an inexpensive, scalable data networking solution in LAN environments. The stringent quality of service expectations require solutions that tap into the cost-effectiveness of Ethernet without sacrificing the benefits of connection-oriented (albeit it costly) time-division multiplexing (TDM) solutions such as SONET/SDH.

Ethernet tunneling technologies such as Provider Backbone Bridge-Traffic Engineering or PBB-TE (also referred to as PBT) and transport MPLS address these requirements. These technologies enable connection-oriented Ethernet, providing carriers with a means of offering scalable, reliable and resilient Ethernet services. The PBB-TE and MPLS options on the IQS-8525/8535 Packet Blazer offer service providers a comprehensive field tool to efficiently qualify Ethernet services from end-to-end, validating metro and core tunneling technologies.

TCP Throughput

The Internet protocol (IP) and transmission control protocol (TCP) together form the essence of TCP/IP networking. While IP deals with the delivery of packets, TCP provides the integrity and assurance that the data packets transmitted by one host are reliably received at the destination. Applications such as hypertext transfer protocol (HTTP), e-mail or file transfer protocol (FTP) depend on TCP as their delivery assurance mechanism within networks.

Customers deploying such applications expect not only physical and link level SLAs from their service providers, but assurance that their TCP traffic requirements will be supported across the network. The TCP throughput feature on the Packet Blazer™ offers Ethernet service providers the capability of measuring and validating that the services offered to their customers support the TCP traffic performance they expect.

Ethernet Advanced Troubleshooting

The IQS-8525/8535 provides a number of advanced features essential for in-depth troubleshooting in the event of network failures or impairments. The advanced filtering option allows the user to configure up to ten filters each with up to four operands, which will be applied to the received Ethernet traffic. Detailed statistics are available for each configured filter providing the user with critical information required to pinpoint specific problems. Additionally, the IQS-8525/8535 supports a traffic scan feature that allows quick identification and monitoring of VLAN and MPLS flows on the network. This can help clearly identify top bandwidth users.

The IQS-8525/8535 also supports full-line-rate data capture and decode. This key troubleshooting tool enables field technicians to easily identify complex network issues. The comprehensive capture feature includes the capability to configure capture filters and triggers to quickly zero-in on network events.

POWERFUL AUTOMATED TEST SCRIPTING

Automation and scripting, traditionally found in manufacturing applications, is gaining momentum in system verification testing and manufacturing environments to facilitate repeatability and improve quality and efficiency. EXFO is committed to addressing manufacturing and system verification test (SVT) needs with its automation features.

The IQS-8525/8535 Packet Blazer modules include a wide range of SCPI commands (standard commands for programmable instrumentation), which are powerful enough to provide repeatable testing of complex configurations, yet simple enough to create a 10 gigabit BERT in as little as six commands. As with all IQS-8500 series modules, the IQS-8525/8535 offer an intuitive macro recorder enabling users to easily record test actions and automatically create test scripts in VB.Net.

Flexible Remote Access

Through their optional Visual Guardian Lite management software, the IQS-8525/8535 Packet Blazer modules support remote testing, monitoring and data analysis via standard Ethernet with the same familiar user interface. In addition, users can remotely access the IQS-600 platform with a simple Web browser, a VNC client or through Remote Desktop to control any module housed in the platform.

Part of EXFO's Layer 0/1/2/3/4 Unified Testing Solution

EXFO's IQS-600 platform can house a mix of optical test modules, SONET/SDH and OTN modules, as well as datacom modules (Ethernet and Fibre Channel). This makes the IQS-600 the industry's first truly integrated and unified testing platform. This multilayer, multitechnology modular test platform simplifies upgrades and is the ideal solution for system verification, manufacturing and R&D testing environments.

FIBRE CHANNEL INTERFACES

FC-1X/2X/4X

Wavelength (nm)	850	**1310**	**1310**	**1550**
Tx level (dBm)	–9 to –2.5	–8.4 to –3	0 to 5	1 to 5
Rx level sensitivity (dBm)	–15 at FC-4 –18 at FC-2 –20 at FC-1	–18 at FC-4 –21 at FC-2 –22 at FC-1	–18 at FC-4 –21 at FC-2 –22 at FC-1	–16.5 at FC-4 –20.5 at FC-2 –22 at FC-1
Maximum reach (FC-1)	500 m on 50/125 µm MMF 300 m on 62.5/125 µm MMF	4 km	30 km	40 km
Transmission bit rate (Gbit/s)	1.06/2.125/4.25	1.06/2.125/4.25	1.06/2.125/4.25	1.06/2.125/4.25
Reception bit rate (Gbit/s)	1.06/2.125/4.25	1.06/2.125/4.25	1.06/2.125/4.25	1.06/2.125/4.25
Tx operational wavelength range (nm)	830 to 860	1260 to 1350	1285 to 1345	1544.5 to 1557.5
Measurement accuracy (uncertainty) Frequency (ppm) Optical power (dB)	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2
Maximum Rx before damage (dBm)	3	3	3	3
Jitter compliance	ANSI FC-PI-2	ANSI FC-PI-2	ANSI FC-PI-2	ANSI FC-PI-2
FC classification	ANSI FC-PI-2	ANSI FC-PI-2	ANSI FC-PI-2	ANSI FC-PI-2
Laser type	VCSEL	Fabry-Perot	DFB	DFB
Eye safety	Class 1	Class 1	Class 1	Class 1
Connector	LC	LC	LC	LC
Transceiver type	SFP	SFP	SFP	SFP

FC-10X

Wavelength (nm)	850	**1310**	**1310**	**1550**	**1550**
Tx level (dBm)	–5 to –1	0.5 max	–6 to –1	–1 to 2	0 to 4
Rx level sensitivity (dBm)	–11.1	–12.6	–14.4	–16	–23
Maximum reach (FC-1)	300 m on 50/125 µm MMF	10 km	10 km	40 km	80 km
Transmission bit rate (Gbit/s)	10.5	10.5	10.5	10.5	10.5
Reception bit rate (Gbit/s)	10.5	10.5	10.5	10.5	10.5
Tx operational wavelength range (nm)	840 to 860	1260 to 1355	1290 to 1330	1530 to 1565	1530 to 1565
Measurement accuracy (uncertainty) Frequency (ppm) Optical power (dB)	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2
Maximum Rx before damage (dBm)	6	6	6	2	4
Jitter compliance	ANSI FC-PI-3	ANSI FC-PI-3	ANSI FC-PI-3	ANSI FC-PI-3	ANSI FC-PI-3
FC classification	ANSI FC-PI-3	ANSI FC-PI-3	ANSI FC-PI-3	ANSI FC-PI-3	ANSI FC-PI-3
Laser type	VCSEL	DFB	DFB	EML	EML
Eye safety	Class 1	Class 1	Class 1	Class 1	
Connector	LC	LC	LC	LC	
Transceiver type	XFP	XFP	XFP	XFP	XFP

FIBRE CHANNEL FUNCTIONAL SPECIFICATIONS

TESTING (1X, 2X, 4X AND 10X)

BERT	Unframed, framed FC-1, framed FC-2.
Patterns (BERT)	PRBS 2E31-1, 2E23-1, 2E20-1, 2E15-1, 2E11-1, 2E9-1 CSPAT, CRPAT, CJTPAT, and 10 user-defined 32-bit patterns.
Error insertion	Bit error, symbol error, oversize error, CRC error, undersize error and block error (10x only).
Error measurement	Bit error, symbol error, oversize error and block error, performance management (G.821 and G.826).
Alarm insertion	LOS, pattern loss, link down, local and remote fault (10x only).
Alarm detection	LOS, pattern loss, link down, local and remote fault (10x only).
Buffer-to-buffer credit testing	Buffer-to-buffer credit estimation based on latency.
Latency	Round-trip latency measurement.

ADDITIONNAL TEST AND MEASUREMENT FUNCTIONS (1X, 2X, 4X AND 10X)

Power measurement	Support optical power measurement, displayed in dBm.
Frequency measurement	Supports clock frequency measurements (i.e., received frequency and deviation of the input signal clock from nominal frequency).
Frequency offset measurement	Range: ±120 ppm Resolution: 1 ppm Accuracy (uncertainty): ±4.6 ppm

ELECTRICAL INTERFACES

	10Base-T	100Base-T	1000Base-T
Tx bit rate	10 Mbit/s	125 Mbit/s	1.25 Gbit/s
Tx accuracy (uncertainty) (ppm)	±100	±100	±100
Rx bit rate	10 Mbit/s	125 Mbit/s	1 Gbit/s
Rx measurement accuracy (uncertainty) (ppm)	±4.6	±4.6	±4.6
Duplex mode	Half and full duplex	Half and full duplex	Full duplex
Jitter compliance	IEEE 802.3	IEEE 802.3	IEEE 802.3
Connector	RJ-45	RJ-45	RJ-45
Maximum reach (m)	100	100	100

100 Mbit/s AND GigE OPTICAL INTERFACES

	100Base-FX	100Base-LX	1000Base-SX	1000Base-LX	1000Base-ZX
Wavelength (nm)	1310	1310	850	1310	1550
Tx level (dBm)	–20 to –15	–15 to –8	–9 to –3	–9.5 to –3	0 to 5
Rx level sensitivity (dBm)	–31	–28	–20	–22	–22
Maximum reach	2 km	15 km	550 m	10 km	80 km
Tx bit rate (Gbit/s)	0.125	0.125	1.25	1.25	1.25
Rx bit rate (Gbit/s)	0.125	0.125	1.25	1.25	1.25
Tx operational wavelength range (nm)	1280 to 1380	1261 to 1360	830 to 860	1270 to 1360	1540 to 1570
Measurement accuracy (uncertainty) Frequency (ppm) Optical power (dB)	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2
Maximum Rx before damage (dBm)	3	3	6	6	6
Jitter compliance	ANSI X3.166	IEEE 802.3	IEEE 802.3	IEEE 802.3	–
Ethernet classification	ANSI X3.166	IEEE 802.3	IEEE 802.3	IEEE 802.3	–
Laser type	LED	FP	VCSEL	FP	DFB
Eye safety	Class 1	Class 1	Class 1	Class 1	Class 1
Connector	LC	LC	LC	LC	LC
Transceiver type	SFP	SFP	SFP	SFP	SFP

FIBRE CHANNEL FUNCTIONAL SPECIFICATIONS (CONT'D)

10 GigE OPTICAL INTERFACES

	10GBase-SW	10GBase-SR	10GBase-LW	10GBase-LR	10GBase-EW	10GBase-ER
Wavelength (nm)	850 Multimode	850 Multimode	1310 Singlemode	1310 Singlemode	1550 Singlemode	1550 Singlemode
Tx level (802.3ae-compliant) (dBm)	–7.3 to –1	–7.3 to –1	–8.2 to 0.5	–8.2 to 0.5	–4.7 to 4.0	–4.7 to 4.0
Rx operating range (dBm)	–9.9 to –1.0	–9.9 to –1.0	–14.4 to 0.5	–14.4 to 0.5	–15.8 to –1.0	–15.8 to –1.0
Tx bit rate (Gbit/s)	9.95328 ± 4.6 ppm [a]	10.3125 ± 4.6 ppm [a]	9.95328 ± 4.6 ppm [a]	10.3125 ± 4.6 ppm [a]	9.95328 ± 4.6 ppm [a]	10.3125 ± 4.6 ppm [a]
Rx bit rate (Gbit/s)	9.95328 ± 135 ppm	10.3125 ± 135 ppm	9.95328 ± 135 ppm	10.3125 ± 135 ppm	9.95328 ± 135 ppm	10.3125 ± 135 ppm
Tx operational wavelength range (802.3ae-compliant) (nm)	840 to 860	840 to 860	1260 to 1355	1260 to 1355	1530 to 1565	1530 to 1565
Measurement accuracy (uncertainty) Frequency (ppm) Optical power (dB)	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2	 ±4.6 ±2
Maximum Rx before damage (dBm)	0	0	1.5	1.5	4.0	4.0
Jitter compliance	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae
Ethernet classification	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae	IEEE 802.3ae
Laser type	VCSEL	VCSEL	DFB	DFB	EML	EML
Eye safety	Class 1 laser; complies with 21 CFR 1040.10 and IEC 60825-1	Class 1 laser; complies with 21 CFR 1040.10 and IEC 60825-1	Class 1 laser; complies with 21 CFR 1040.10 and IEC 60825-1	Class 1 laser; complies with 21 CFR 1040.10 and IEC 60825-1	Class 1 laser; complies with 21 CFR 1040.10 and IEC 60825-1	Class 1 laser; complies with 21 CFR 1040.10 and IEC 60825-1
Connector	Duplex LC	Duplex LC	Duplex LC	Duplex LC	Duplex LC	Duplex LC
Transceiver type (compliant with XFP MSA)	XFP	XFP	XFP	XFP	XFP	XFP

ETHERNET FUNCTIONAL SPECIFICATIONS

TESTING (10 Mbit/s TO GigE)

EtherSAM (ITU-T Y.1564)	Capability to perform the service configuration test, including the ramp and burst tests, and service performance test as per ITU-T Y.1564. Tests can be performed to loopback or dual test set mode for bidirectional results.
RFC 2544	Throughput, back-to-back, frame loss and latency measurements according to RFC 2544. Frame size: RFC-defined sizes, user-configurable.
BERT	Unframed, framed layer 1 to layer 4 supported with or without VLAN Q-in-Q.
Patterns (BERT)	PRBS 2E9-1, PRBS 2E11-1, PRBS 2E15-1, PRBS 2E20-1, PRBS 2E23-1, PRBS 2E31-1, CRPAT, CSPAT, CJTPAT, Short CRTPAT, Long CRTPAT and up to 10 user patterns. Capability to invert patterns.
Error insertion (BERT)	FCS, bit and symbol.
Error measurement	Jabber/giant, runt, undersize, oversize, FCS, symbol, idle, carrier sense, alignment, collision, late collision, excessive collision, UDP and IP header checksum.
Error measurement (BERT)	Bit error, symbol error, idle error, bit mismatch 0, bit mismatch 1, performance monitoring (G.821 and G.826).
Alarm insertion (BERT)	LOS, pattern loss.
Alarm detection	LOS, link down, pattern loss, no traffic.
Service disruption time measurement (BERT)	Defect or No Traffic mode. Disruption time statistics include shortest, longest, last, average, total and count.
VLAN stacking	Capability to generate one stream with up to three layers of VLAN (including IEEE 802.1ad Q-in-Q tagged VLAN).
Flow control statistics	Pause time, last pause time, max. pause time, min. pause time, paused frames, abort frames, frames Tx, frames Rx.
Advanced auto-negotiation	Capability to auto-negotiate the rate, duplex and flow control capabilities with another Ethernet port. Configurable auto-negociation parameters. Display of link partner capabilities. Fault injection: offline, link failure, auto-negotiation error.
Multistream generation	Capability to transmit up to ten streams. Configuration parameters are packet size, transmission mode (N-Frames, Burst, N-Burst, Ramp, N-Ramp and Continuous), MAC source/destination address, VLAN ID, VLAN priority, IP source/destination address, ToS field, DSCP field, TTL, UDP/TCP source/destination port and payload. Selectable pre-defined stream profiles for VoIP, Video and data streams. VoIP codecs (G.711, G.723.1, G.729), video (MPEG-2 SDTV, MPEG-2 HDTV, MPEG-4 HDTV). (Available with Frame-Analyzer software option.)
Traffic filtering	Capability to analyze the incoming traffic and provide statistics according to a set of up to ten configurable filters. Filters can be configured for MAC source/destination address, VLAN ID, VLAN priority, IP source/destination address, ToS field, DSCP field, TCP source/destination port and UDP/TCP source/destination port. VLAN filtering can be applied to any of the stacked VLAN layers. (Available with Frame-Analyzer software option.)
Multistream analysis	Capability to analyze packet jitter, latency, throughput, frame loss and out-of-sequence per-stream statistics. (Available with Frame-Analyzer software option.)

Note

a. When clocking is in internal mode.

ETHERNET FUNCTIONAL SPECIFICATIONS (CONT'D)

TESTING (10 Mbit/s TO GigE) (CONT'D)

Ethernet statistics	Multicast, broadcast, unicast, N-unicast, pause frame, frame size distribution, bandwidth, utilization, frame rate, frame loss, out-of-sequence frames and in-sequence frames. (Available with Frame-Analyzer software option.)
Packet jitter statistics	Delay variation statistics (ms)—min., max., last, average and jitter measurement estimate. (Available with Frame-Analyzer software option.)
PBB-TE	Capability to generate and analyze streams with PBB-TE data traffic including configuration of B-MAC (source and destination), B-VLAN and I-tag (as per 802.1ah) and to filter received traffic by any of these fields.
MPLS	Capability to generate and analyze streams with up to two layers of MPLS labels and to filter received traffic by MPLS label or COS.
IPv6	Capability to perform BERT, RFC 2544, traffic generation and analysis and Smart Loopback tests over IPv6. Ping, traceroute, neighbor discovery and stateless auto-configuration.
Advanced filtering [a]	Capability to enhance the filters with up to four fields each, which can be combined with AND/OR/NOT operations.
Data capture [a]	Capability to perform up to 1G full-line-rate data capture and decode. Capability to configure detailed capture filters and triggers as well as capture slicing parameters.
Traffic scan [a]	Capability to scan incoming live traffic and auto-discover all VLAN/VLAN Priority and MPLS ID/COS flows. Capability to provide statistics for each flow including frame count and bandwidth.

A mask is also provided for each field value to allow for wildcards. Complete statistics are gathered for each defined filter.

ADDITIONAL TEST AND MEASUREMENT FUNCTIONS (10 Mbit/s TO GigE)

Power measurement	Supports optical power measurement, displayed in dBm.
Frequency generation and measurement	Supports clock frequency generation and measurements (i.e., received frequency and deviation of the input signal clock from nominal frequency). Frequency offset generation: Range: ±50 ppm Resolution: 1 ppm Accuracy (uncertainty): ±4.6 ppm Frequency offset measurement: Range: ±135 ppm Resolution: ±1 ppm Accuracy (uncertainty): ±4.6 ppm
Dual test set	Performs end-to-end, bidirectional performance testing (as required by leading standards bodies)—remote IQS-8525/8535 (or other EXFO Ethernet test module) controlled via the LAN connection under test.
DHCP client	Capability to connect to a DHCP server to obtain its IP address and subnet mask for connecting on to the network.
Smart Loopback	Capability to return traffic to the local unit by swapping packet overhead up to layer 4 of the OSI stack.
TCP throughput measurements [a]	Capability to evaluate TCP throughput and to provide performance results and statistics: window size with corresponding throughput, number of transmitted and re-transmitted segments, round-trip time.
IP tools	Capability to perform ping and traceroute functions.

Note

a. Available as a software option.

ETHERNET FUNCTIONAL SPECIFICATIONS (CONT'D)

TESTING (10 GigE)

EtherSAM (ITU-T Y.1564)	Capability to perform the service configuration test, including the ramp and burst tests, and service performance test as per ITU-T Y.1564. Tests can be performed to loopback or dual test set mode for bidirectional results.
RFC 2544	Throughput, back-to-back, frame loss and latency measurements according to RFC 2544. Frame size: RFC-defined sizes, user-configurable.
Patterns (BERT)	PRBS 2E9-1, PRBS 2E11-1, PRBS 2E15-1, PRBS 2E20-1, PRBS 2E23-1, PRBS 2E31-1, CRPAT, CSPAT, CJTPAT, Short CRTPAT, Long CRTPAT and up to 10 user patterns. Capability to invert patterns.
Error insertion (BERT)	FCS, bit and symbol.
Error measurement	Jabber/giant, runt, undersize, oversize, FCS, symbol, idle, carrier sense, alignment, collision, late collision, excessive collision, UDP and IP header checksum.
Error measurement (BERT)	Bit error, symbol error, idle error, bit mismatch 0, bit mismatch 1, performance monitoring (G.821 and G.826).
Alarm insertion (BERT)	LOS, pattern loss.
Alarm detection	LOS, link down, pattern loss, no traffic.
Service disruption time measurement (BERT)	Defect or No Traffic mode. Disruption time statistics include shortest, longest, last, average, total and count.
VLAN stacking	Capability to generate one stream with up to three layers of VLAN (including IEEE 802.1ad Q-in-Q tagged VLAN).
Flow control statistics	Pause time, last pause time, max. pause time, min. pause time, paused frames, abort frames, frames Tx, frames Rx.
Multistream generation	Capability to transmit up to ten streams. Configuration parameters are packet size, transmission mode (N-Frames, Burst, N-Burst, Ramp, N-Ramp and Continuous), MAC source/destination address, VLAN ID, VLAN priority, IP source/destination address, ToS field, DSCP field, TTL, UDP/TCP source/destination port and payload. Selectable pre-defined stream profiles for VoIP, Video and data streams. VoIP codecs (G.711, G.723.1, G.729), video (MPEG-2 SDTV, MPEG-2 HDTV, MPEG-4 HDTV). (Available with Frame-Analyzer software option.)
Traffic filtering	Capability to analyze the incoming traffic and provide statistics according to a set of up to ten configurable filters. Filters can be configured for MAC source/destination address, VLAN ID, VLAN priority, IP source/destination address, ToS field, DSCP field, TCP source/destination port and UDP/TCP source/destination port. VLAN filtering can be applied to any of the stacked VLAN layers. (Available with Frame-Analyzer software option.)
Multistream analysis	Capability to analyze packet jitter, latency, throughput, frame loss and out-of-sequence per-stream statistics. (Available with Frame-Analyzer software option.)
Ethernet statistics	Multicast, broadcast, unicast, N-unicast, pause frame, frame size distribution, bandwidth, utilization, frame rate, frame loss, out-of-sequence frames and in-sequence frames. (Available with Frame-Analyzer software option.)
Packet jitter statistics	Delay variation statistics (ms)—min., max., last, average and jitter measurement estimate. (Available with Frame-Analyzer software option.)
PBB-TE	Capability to generate and analyze streams with PBB-TE data traffic including configuration of B-MAC (source and destination), B-VLAN and I-tag (as per 802.1ah) and to filter received traffic by any of these fields.
MPLS	Capability to generate and analyze streams with up to two layers of MPLS labels and to filter received traffic by MPLS label or COS.
IPv6	Capability to perform BERT, RFC 2544, traffic generation and analysis and Smart Loopback tests over IPv6. Ping, traceroute, neighbor discovery and stateless auto-configuration.
Advanced filtering [a]	Capability to enhance the filters with up to four fields each, which can be combined with AND/OR/NOT operations.
Data capture [a]	Capability to perform up to 1G full-line-rate data capture and decode. Capability to configure detailed capture filters and triggers as well as capture slicing parameters.
Traffic scan [a]	Capability to scan incoming live traffic and auto-discover all VLAN/VLAN Priority and MPLS ID/COS flows. Capability to provide statistics for each flow including frame count and bandwidth.

ADDITIONAL TEST AND MEASUREMENT FUNCTIONS (10 GigE)

Power measurement	Supports optical power measurement, displayed in dBm.
Frequency generation and measurement	Supports clock frequency generation and measurements (i.e., received frequency and deviation of the input signal clock from nominal frequency). Frequency offset generation: Range: ±50 ppm Resolution: 1 ppm Accuracy (uncertainty): ±4.6 ppm Frequency offset measurement: Range: ±135 ppm Resolution: ±1 ppm Accuracy (uncertainty): ±4.6 ppm
Signal label control and monitoring	Ability to configure and monitor J0 Trace, J1 Trace and payload signal label C2 (WAN).
Dual test set	Performs end-to-end, bidirectional performance testing (as required by leading standards bodies)—remote IQS-8525/8535 (or other EXFO Ethernet test module) controlled via the LAN connection under test.
DHCP client	Capability to connect to a DHCP server to obtain its IP address and subnet mask for connecting on to the network.
Smart Loopback	Capability to return traffic to the local unit by swapping packet overhead up to layer 4 of the OSI stack.
IP tools	Capability to perform ping and traceroute functions.

Note

a. Available as a software option.

ADDITIONAL FEATURES

Expert mode	Ability to set thresholds in RFC 2544 and BERT mode to provide a pass/fail status.
Scripting	The built-in Visual Basic .NET scripting engine and embedded macrorecorder provide a simple means of automating test cases and routines. Embedded scripting routines provide a powerful means of creating advanced test scripts.
Event logger	Supports logging of test results, and the ability to print, export (to a file), or export the information contained in the logging tool.
Power up and restore	In the event of a unit power failure, the active test configuration and results are saved and restored upon bootup.
Save and load configuration	Ability to store and load test configurations to/from non-volatile memory.
Configurable test views	Allows users to customize their test views; i.e., to dynamically insert or remove test tabs/windows, in addition to creating new test windows, so as to accurately match their testing needs.
Configurable test timer	Allows a user to set a specific start, stop and duration for. tests.
Test favorites	Capability to select and load from predefined or user-modified test conditions.
Report generation	Ability to generate test reports in the following user-selectable formats: .pdf, .html, .txt and .csv.
Graph	Allows to graphically display the test statistics of the performance (RFC 2544).
Remote control	Remote control through Visual Guardian Lite software or VNC.

MODEL SPECIFICATIONS

		IQS-8525	IQS-8535
Fibre Channel Rate Options			
FC10x	Fibre Channel 10x rate	Not available	Available
FC4x	Fibre Channel 4x rate	Available	Available
FC1x-FC2x	Fibre Channel 1x and 2x rates	Available	Available
Ethernet Rate Options			
10GigE	Ethernet 10 GigE LAN and WAN	Not available	Available
GigE	Ethernet 10/100/1000 Base-T and optical GigE	Available	Available
100optical	100 Mbit/s optical Ethernet	Available	Available

GENERAL SPECIFICATIONS

Size (H x W x D)	125 mm x 74 mm x 282 mm	(4 $^{15}/_{16}$ in x 2 $^{15}/_{16}$ in x 11 $^{1}/_{8}$ in)
Weight (without transceiver)	0.9 kg (2.0 lb)	(2.0 lb)
Temperature operating storing	 0 °C to 40 °C −40 °C to 60 °C	 (32 °F to 104 °F) (−40 °F to 140 °F)

ORDERING INFORMATION

IQS-85XX-XX-XX-XX-XX-XX-XX

Model
IQS-8525 = Fibre Channel and Ethernet test module
IQS-8535 = Fibre Channel and Ethernet test module

Ethernet Rate Options
00 = without rate option
LAN/WAN 10GigE = Ethernet 10GigE LAN and WAN [a]
10M/100M/1000M = Ethernet 10/100/1000 Base-T and optical GigE
100M-0-AP = 100 Mbit/s optical Ethernet [b]

Fibre Channel Rate Options
FC1x, 2x = Fibre Channel 1x and 2x testing
FC4x = Fibre Channel 4x testing
FC10x = Fibre Channel 10x testing [a]
FC-BUNDLE = Fibre Channel 1x, 2x, 4x and 10x testing [a]

Transceivers SFP Test Port
00 = SFP test port
IQS-85910 = 100Base-FX (1310 nm) MM, LC connectors; optical SFP transceiver module c
IQS-85911 = 100Base-LX (1310 nm) SM, LC connectors; optical SFP transceiver module c
IQS-85912 = SFP modules GigE/FC/2FC/4FC at 850 nm, MMF, <500 m
IQS-85913 = SFP modules GigE/FC/2FC/4FC at 1310 nm, MMF, <4 km
IQS-85914 = SFP modules GigE/FC/2FC/4FC at 1310 nm, MMF, <30 km
IQS-85915 = SFP modules GigE/FC/2FC/4FC at 1550 nm, MMF, <40 km

Options
Frame-Analyzer = Multiple stream generation and analysis
PBB-TE = PBB-TE testing
MPLS = MPLS testing
Adv_filtering = Advanced filtering capabilities
IPv6 = IPv6 testing capabilities
TCP-THPUT = TCP Throughput measurement [b]
Data_Capture = Data capture and decode capabilities
TRAFFIC-SCAN = VLAN/MPLS traffic scan

Transceivers XFP Test Port [a]
IQS-85900 = 10GBase-SR/-SW (850 nm, LAN/WAN PHY) LC connectors; optical XFP transceiver module
IQS-85901 = 10GBase-LR/-LW (1310 nm, LAN/WAN PHY) LC connectors; optical XFP transceiver module
IQS-85902 = 10GBase-ER/-EW (1550 nm, LAN/WAN PHY) LC connectors; optical XFP transceiver module

Example: IQS-8535-10M/100M/1000M-FC10x-85912-85901

Notes

a. Available with the IQS-8535 only.

b. Available only if the 10M/100M/1000M option is selected.

c. Available with the 100M-0-AP option only.

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