FTB/IQS-88100NGE/88100G Power Blazer Series

HIGH-SPEED COMPACT MULTISERVICE TEST SOLUTION

EXFO TFv
Test Function Virtualization

EXFO Connect Compatible

EtherSAM

iSAM

COMPLETE IPv6 TESTING

CFP2 READY

CFP Health Check

Turnkey compact field-test solution for deploying and troubleshooting networks up to 100G.

KEY FEATURES AND BENEFITS

- 10M-to-100G compact multiservice field-test solution addressing testing, troubleshooting and performance-assessment requirements of next-gen networks
- Comprehensive and fully integrated test solution covering OTN, Ethernet and SONET/SDH technologies
- Cost-effective, scalable and future-proof module with 10M-to-100G flexible offering, as well as CFP and CFP2 transceiver coverage—no hardware upgrade, no return to factory required
- Unprecedented testing simplicity requiring minimal training for new users and maintaining a consistent experience from the lab to the field
- Packet synchronization turn-up and troubleshooting (SyncE/1588 PTP)
- True wire-speed, stateful TCP throughput based on RFC 6349 for undisputable SLA enforcement of Ethernet services
- FTTA framed and unframed CPRI testing, including CPRI service disruption tests (CPRI SDTs)
- 10G dual-port Ethernet capabilities for simultaneous and bidirectional traffic generation and analysis at 100% wire speed at any packet size
- iSAM ultra-simple ITU-T Y.1564 and RFC 6349 service activation methodology
- Efficiently assesses Fibre Channel networks with best-in-class coverage via 1x, 2x, 4x, 8x and 10x interfaces
- FTB Ecosystem and EXFO Connect-compatible with software upgrade manager, as well as automated cloud-based asset and test data management capabilities
- OTN, SONET/SDH, FC and Ethernet bit-error-rate testing (BERT) with real-time pass/fail status, quick action buttons, clear results and assorted notifications
- 100% line-rate testing of IP traffic at up to 100G and faster Ethernet service activation with EtherSAM (ITU-T Y.1564) service configuration and performance tests, complemented by Remote Discovery, Smart Loopback and Dual Test Set capabilities
- Housed in the FTB-2 Pro, FTB-500 or IQS-600 platforms, and complemented with integrated optical tools, battery operation, power-up and restore, remote access, GPS capabilities and test reports
- Offers EXFO TFv—Test Function Virtualization, including FTB Anywhere floating licenses and FTB OnDemand time-based licenses

* A complete list of all the best-in-class test modules supporting this functionality is available on our FTB OnDemand Web page.

COMPLEMENTARY PRODUCTS

Platforms
FTB-500/FTB-2 Pro

Optical Spectrum Analyzers
FTB-5240S/BP

Integrated Qualification System
IQS-600

HIGH-SPEED NETWORK ROLLOUT CHALLENGES

Compact, Steel-Toed and Field-Ready

Rising to the multiservice field-testing challenges of today and offering the scalability to cover the unforeseeable future, EXFO's FTB/IQS-88100NGE (10M to 100G) and FTB/IQS-88100G (40G/100G) Power Blazer test modules have been designed to specifically address high-speed applications. Housing the FTB/IQS-88100NGE in EXFO's FTB-2 Pro or IQS-600 platforms provides the most compact 10M-to-100G testing solution on the market and supports a wide range of technologies, including legacy TDM and new packet-based services. This EXFO innovation sets a new benchmark: 10M-to-100G Ethernet, OTU1 to OTU4 (including standard and overclocked rates) and OC-1/STM-0 to OC-768/STM-256—all in one compact, powerful solution. Furthermore, both the FTB/IQS-88100NGE and the FTB/IQS-88100G are EXFO Connect-ready, which means that both technicians and managers can reap the benefits of EXFO's FTB cloud-based services.

A GAME CHANGER FOR HIGH-SPEED SERVICE DEPLOYMENT

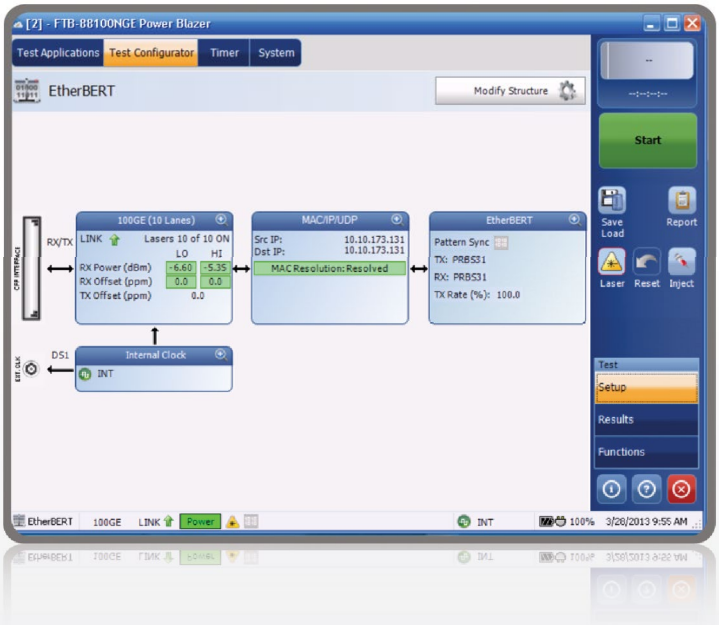
The FTB/IQS-88100NGE Power Blazer introduces new OPEX and CAPEX saving factors, as its FLEX configuration capitalizes on EXFO's flexible platform architecture to enable any testing capability from 10M to 100G—anywhere, anytime with a simple point-and-click to enable software options. This flexibility guarantees a cost-effective, future-proof offering and ensures immediate access to testing capabilities and faster service provisioning, while avoiding unnecessary costs related to shipping back test equipment.

In addition, because the FTB/IQS-88100NGE and the FTB/IQS-88100G are housed in the FTB-2 Pro compact platform, they provide you with the added benefits of EXFO's FTB Ecosystem—including EXFO Connect automated, cloud-based asset and test data management, in addition to EXFO's Update Manager software utility, allowing you to streamline test operations from build-out to maintenance.

POWERFUL, YET SIMPLE

Regardless of the fact that high-speed technologies and next-generation networks are becoming more and more complex, the FTB/IQS-88100NGE and FTB/IQS-88100G Power Blazer modules address all field-testing needs up to 100 Gbit/s without sacrificing simplicity. Thanks to EXFO's highly intuitive graphical user interface (GUI), streamlined procedures and predefined configurations, these modules require minimal to no training for new users. Furthermore, with unmatched connectivity via Wi-Fi, Bluetooth, Gigabit Ethernet or USB ports, the FTB-2 Pro Windows-based platform is accessible in any environment and at any time, reducing unnecessary tier-2 technician dispatching and truck rolls to remote sites.

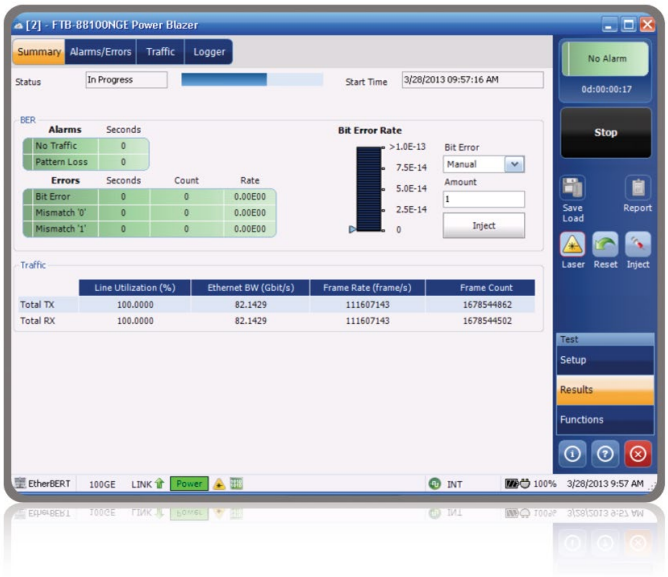
In addition, the FTB-500 and IQS-600 platforms allow you to customize your testing solution. Combine the FTB/IQS-88100NGE and the FTB/IQS-88100G Power Blazer modules with any EXFO optical module for fiber characterization and optical signal-to-noise ratio (OSNR) qualification, and run them simultaneously to speed up testing and accelerate time-to-service.

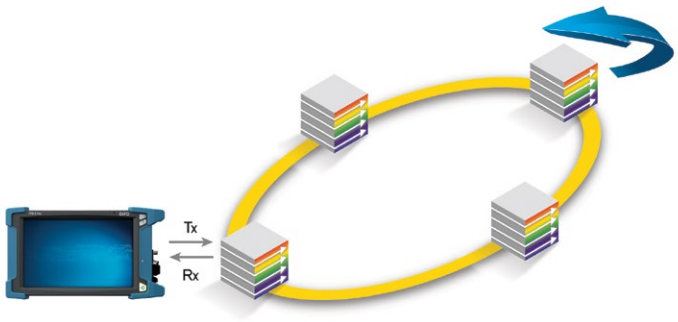


SIMPLIFIED BER TESTING

With the FTB/IQS-88100NGE Power Blazer, you can preconfigure OTN (from OTU1 to OTU4, including standard and overclocked rates), Ethernet (from 10M to 100G), and SONET/SDH (from OC-3/STM-1 to OC-768/STM-256) BER test parameters prior to arrival at the test site, and then load them from the Favorites menu with one click. The same flexibility is available on the FTB/IQS-88100G for supported 40G/100G rates, allowing for simple BER testing with no risk of misconfiguration between two remote sites.

Furthermore, the preconfigured Favorites can be copied from one platform to another or even sent to technicians out in the field via e-mail, where they can load them using the USB port on their platform. Once the BER test has started, the FTB/IQS-88100NGE and FTB/IQS-88100G provide clear results, assorted notifications and real-time pass/fail status via text or icons. Clicking on the pass/fail indicator maximizes this important status to full screen, providing instant, easily understood notification, whether a given unit is in your hand or across the room.





ETHERNET PERFORMANCE ASSESSMENT

The FTB/IQS-88100NGE and FTB/IQS-88100G offer an automated RFC 2544 test suite for all supported Ethernet interfaces on both modules at all frame sizes and at full line rate, delivering repeatable test results and error-free circuit certification at 100% utilization.

RFC 2544 is complemented by five Smart Loopback modes. So, whether you are looking to pinpoint loopback traffic from a user-datagram protocol (UDP) or transmission-control-protocol (TCP) layer, or all the way down to a completely promiscuous mode (Transparent Loopback), the FTB/IQS-88100NGE and FTB/IQS-88100G can adjust to all loopback situations where the remote unit will return traffic to the local unit by swapping packet overhead up to layer 4 of the OSI stack. The Ethernet performance assessment capabilities of the FTB/IQS-88100NGE and FTB/IQS-88100G also include test reports with detailed throughput, frame loss, back-to-back and latency measurements, and clear histograms for future reference regarding specific SLAs.

EtherSAM: ITU-T Y.1564 Ethernet Service Activation

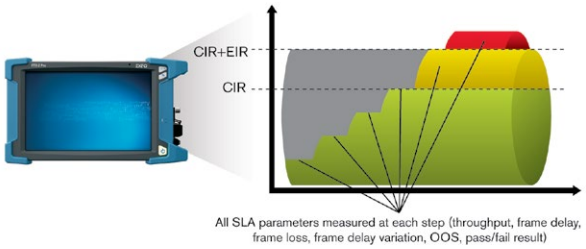
With more and more Ethernet services being activated today, the new ITU-T Y.1564 standard addresses the growing demand for turning up and troubleshooting Carrier Ethernet services. Supported on the FTB/IQS-88100NGE Power Blazer module for 10M-to-100G Ethernet client services, this new methodology brings numerous advantages, including validation of critical SLA criteria such as packet jitter and quality-of-service (QoS) measurements, as well as faster time-to-service. EXFO's EtherSAM test suite—based on the ITU-T Y.1564 Ethernet service activation methodology—provides comprehensive field testing for mobile backhaul and commercial services. EtherSAM can simulate all types of services that will run on the network and simultaneously qualify all key SLA parameters for each of these services.

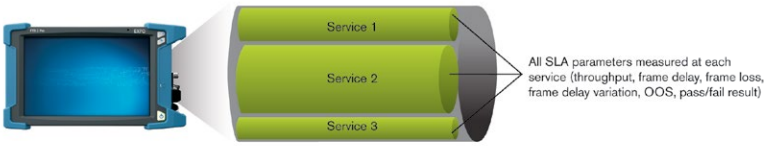
Moreover, it validates the QoS mechanisms provisioned in the network to prioritize the different service types, resulting in better troubleshooting, more accurate validation and much faster deployment. EtherSAM is comprised of two phases: the service configuration test and the service performance test.

- **Service Configuration Test**
  The service configuration test consists of sequentially testing each service. It validates that the service is properly provisioned and that all specific KPIs or SLA parameters are met.

- **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.

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





iSAM

With iSAM, which includes Y.1564 (EtherSAM) and RFC 6349, the focus is on minimalism and simplicity, making both tests as simple as possible for all users. This is in sharp contrast with the current situation in the test and measurement market today. One key aspect of iSAM's simplicity lies in its efficiency: it only requires a limited number of steps to set up, run and receive valid test results.

The core objective of iSAM is to remove friction between the user and the testing solution. The end goal is to enable field technicians of any skill level to set up and run an iSAM test, and all of this is done within a one-page setup.

The innovation does not stop there. iSAM also takes the lead in delivering the latest test and measurement standards. iSAM has achieved an industry first by introducing actual Metro Ethernet Forum (MEF) standards and thresholds to guarantee that service providers, mobile network operators and multisystem operators are able to test against the latest MEF 23.1 standard.

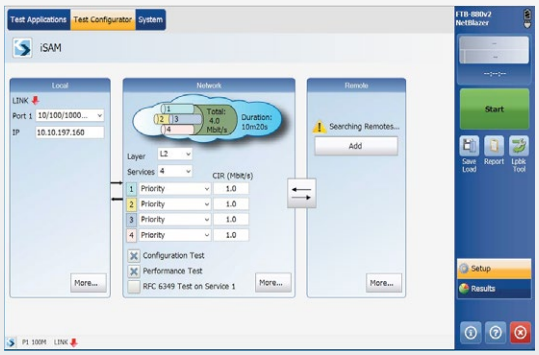


Figure 1. One-page setup

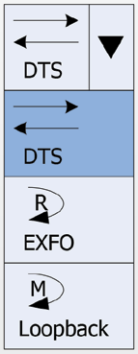


Figure 2. Multiple modes of connection

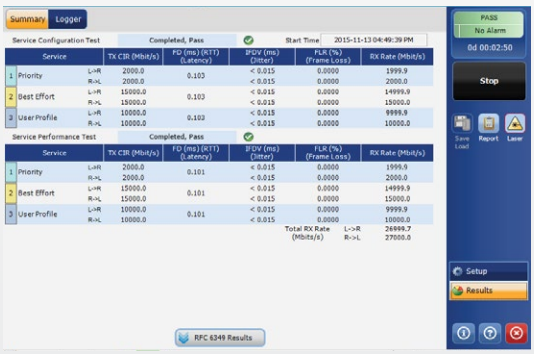


Figure 3. One-page results

DUAL TEST SET

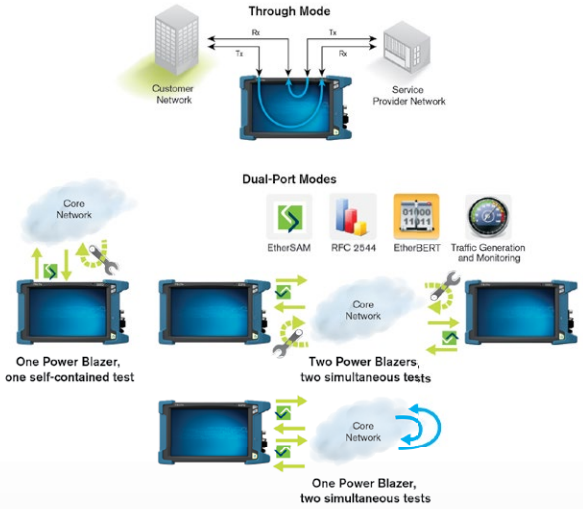
Whether the customer is using RFC 2544, RFC 6349 or Y.1564 (EtherSAM) for service activation, these tests can be executed in Dual Test Set mode. In this case, two 40G/100G test sets, one designated as local and the other as remote, are used to communicate and independently run tests per direction. The Dual Test Set approach is a more accurate test scenario. In this case, two units perform an asymmetrical SLA measurement, providing test results per direction. This scenario's main strength is that it quickly pinpoints which direction has not been configured properly or is at fault, while providing performance metrics for each direction.

Results from both directions are displayed on the local unit to ensure that the entire test routine can be completed by a single person in control of a single unit, thus resulting in shorter test time and reduced manpower. This flexibility also guarantees that different units can be set as a remote unit. The most interesting scenario is a centralized unit that is always configured as a remote unit with fixed addresses. The carrier can simply dispatch a single test person to a test site, following which the tester can quickly discover and execute service turn-up and burn-in quickly and efficiently without requiring an extra worker in the central office.

The Dual Test Set approach also provides the capability to segment the network and quickly pinpoint in which direction issues occur. This is especially important in cases where the bandwidth differs between the upstream and downstream directions. In such instances, using a loopback tool will always yield the same results, because the measurement will be affected by the lowest throughput, and the test results will not reflect that one direction has higher performance than the other. The same scenario will occur if a network misconfiguration is present in only one direction of the service. Depending on the error, the problem will not be identified with round-trip measurements. This often results in customer complaints and additional truck rolls. With the Dual Test Set approach, both directions are independently analyzed at the same time, and pass/fail results are provided per direction, yielding the highest level of confidence in service testing.

DUAL-PORT AND THROUGH MODE TESTING

With dual-port testing, one technician can use a single Power Blazer module to launch either EtherSAM, RFC 6349 or RFC 2544 and obtain bidirectional results with just one module. With traffic generation, monitoring and EtherBERT tests, the technician can set up two distinct tests: one on port 1, and another on port 2. Both ports can also be set to different interfaces and rates (e.g., 10BASE-T electrical on port 1 and 10 GigE on port 2).



ETHERNET TRAFFIC GENERATION AND MONITORING

Data services carried over 40G/100G networks are making a significant shift toward supporting a variety of applications. Multiservice offerings such as triple-play services have fuelled the need for QoS testing to ensure the condition and reliability of each service, and qualify SLA parameters. The FTB/IQS-88100NGE and FTB/IQS-88100G Power Blazer, with their supported traffic generation and monitoring application, allow service providers to simultaneously simulate and qualify different applications. Up to 16 streams can be configured 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. In addition, the FTB/IQS-8830NGE Power Blazer now supports monitoring of multiple VLAN streams through the Traffic Scan functionality. Traffic simulation also includes traffic shaping with burst and ramp capabilities. In the same line, a MAC flooding capability is available for switch-addressable memory testing, where the range of MAC addresses can be cycled, forcing the switch to learn every single one. The FTB/IQS-88100NGE and FTB/IQS-88100G also offer the flexibility to define one configuration profile and apply it to as many streams as required. From there, it is just a matter of tweaking them to each stream. The FTB/IQS-88100NGE and FTB/IQS-88100G also simultaneously measure throughput, latency, packet jitter (RFC 3393), frame loss and out-of-sequence errors in all streams, yielding fast and in-depth qualification of all SLA criteria. Results are displayed in tabular format and on analog visual gauges to ensure that test outcomes are quickly and easily interpreted.

CARRIER ETHERNET OAM

Metro Ethernet networks with carrier-class Ethernet services demand performance measurements for proper system maintenance. Ethernet service operations, administration and management (OAM) covers the end-to-end measurements and standards needed for systems maintenance. OAM utilizes a variety of protocols for installing, monitoring and troubleshooting networks, including network discovery, link monitoring, remote fault detection, and remote loopback. This in turn simplifies Ethernet service deployments as Ethernet moves to mass deployment. Carrier Ethernet OAM is also a mechanism for monitoring and validating SLAs that eliminates finger-pointing between carriers. Most service providers are focusing today on implementing connectivity fault management and performance monitoring OAM protocols, including Ethernet (ITU-T Y.1731, IEEE 802.1ag, MEF and Link OAM [802.3ah]) and MPLS-TP (ITU-T G.8113.1) OAMs.

VLAN/MPLS

To meet the high performance expectations for today's networks, service providers must rely on various mechanisms such as Ethernet tagging, encapsulation and labeling. Thanks to these additions, service providers can enhance security, scalability, reliability and performance. The FTB/IQS-88100NGE supports virtual local area network (VLAN) tags, Traffic Scan, Q-in-Q VLAN tags, VLAN preservation and multiprotocol label switching (MPLS).

RFC 6349

The Internet Engineering Task Force (IETF) ratified RFC 6349 as a new method for validating an end-to-end TCP service. This new TCP throughput test methodology provides a repeatable standards-based test that validates TCP applications such as web browsing, file transfer, business applications, streaming video and more. After running the RFC 6349 test, service providers will have all the metrics needed to optimize TCP performance from within their networks or customer premises equipment.

The RFC 6349 test is important, because it includes the steps that follow to help locate and diagnose TCP issues correctly. The first step consists of finding the maximum transmission unit (MTU) size. This ensures that the network is not fragmenting the traffic. The aim of the second step is to determine the baseline round-trip delay, which means letting the technician know that this latency value is the best-case scenario that the network under test can deliver. The third step uses either single or multiple TCP connections to fill the pipe and then report back the actual TCP throughput. Once the test is complete, all TCP metrics are clearly laid out. If changes are required to optimize the TCP performance, the technician will have all the values needed to rectify the situation. In the end, the RFC 6349 test helps resolve any potential discrepancies that could occur between the service provider network and the customer-premises equipment.

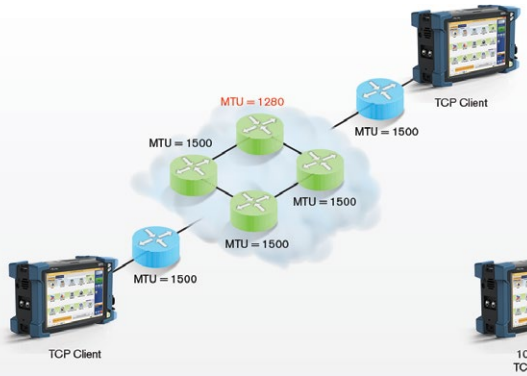


Figure 4. PATH MTU discovery

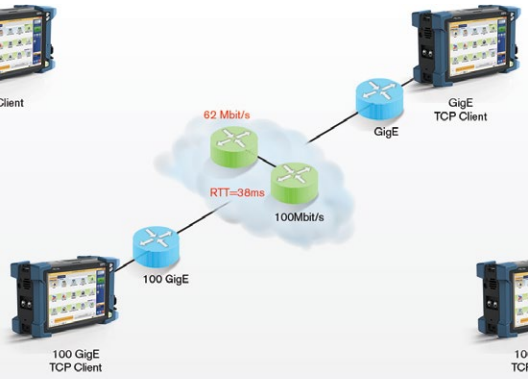


Figure 5. Baseline round-trip time (RTT) and bandwidth to determine ideal window size

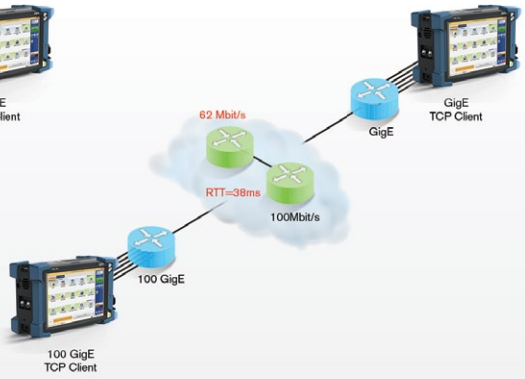


Figure 6. Single or multiple TCP connections to enable full pipe testing

FTTA TESTING

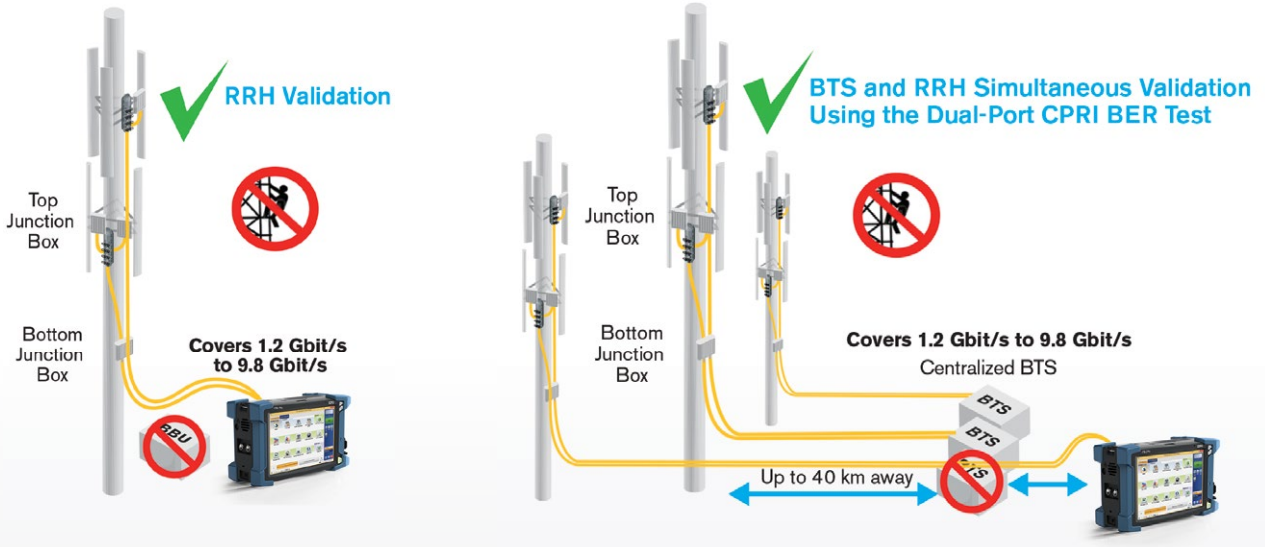
With the Power Blazer Series modules, field technicians can carry out a variety of FTTA tests. For instance, when installing a remote radio head (RRH), it is critical that all equipment be verified before the riggers have finished the construction phase. The Power Blazer Series' CPRI protocol feature verifies that the RRH is fully operational and that the correct small form-factor pluggable (SFP) transceivers are installed and connected correctly.

Using these multiservice test modules enabled with the layer-2 CPRI protocol, technicians can easily connect to the RRH without having to climb the cell tower. Regardless of whether the cell site's base station (BTS) is connected to the RRH, these multiservice test modules are always ready to emulate a CPRI-enabled BTS. Once connected to the RRH, these modules are able to supply the field technician with a complete analysis of vital CPRI statistics that includes the following: optical power levels, protocol version, frequency and frequency offset, hyperframe and code word counts, the negotiated Ethernet or HDLC control and maintenance channels.

Having this information readily accessible enables field technicians to ensure that the RRH is working at the correct, specified line rate, and that it is timed and fully transmitting continuous frames from the top to the bottom of the tower. In addition, the reverse verification can be made by using the Power Blazer Series to emulate the RRH in order to validate the CPRI link with the BTS.

Moving closer towards CPRI-enabled infrastructures, a significant challenge arises as a result of human error occurring between the RRH and the BTS; faulty configurations, bad wiring and incorrect SFPs can lead to problems when trying to initialize the CPRI start-up sequence between the BTS and RRH. The Power Blazer Series test suite better equips field technicians to decipher and solve these basic yet very costly human errors.

In addition to performing CPRI service disruption (CPRI SDT), field technicians can perform an unframed and framed layer-2 CPRI BER test from 1.2 Gbit/s all the way up to 9.8 Gbit/s. These modules are able to validate that the fiber from the BTS located at the base of the tower or kilometers away in a Cloud-RAN environment is running with the expected latency and is error-free.



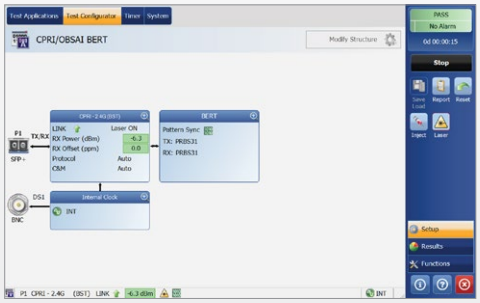


Figure 7. Framed CPRI BER Test

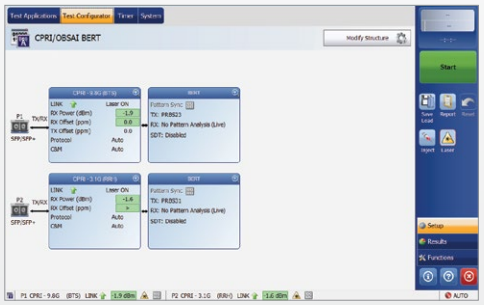


Figure 8. Dual Port CPRI BER test

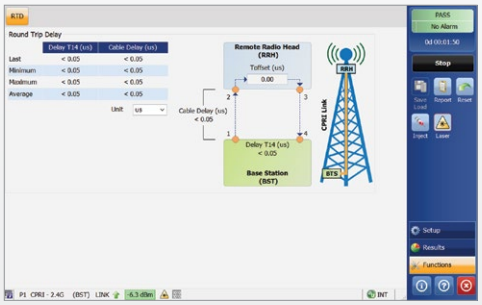


Figure 9. CPRI Round-Trip Delay

SIMPLIFIED ERROR INJECTION

The FTB/IQS-88100NGE and FTB/IQS-88100G Power Blazer modules enable error and alarm injection with a single click from any screen, allowing you to ensure circuit continuity prior to starting a test. This capability applies to single optical channels when addressing testing interfaces from 10M to 100G on the FTB/IQS-88100NGE and 40G/100G on the FTB/IQS-88100G, and extends to four or ten optical channels for 40G and 100G when using parallel CFPs. Furthermore, this functionality can be preprogrammed for any type of error, not just bit errors. In addition, alarm injection can be selected per lane, and not necessarily on all lanes simultaneously.

COMPLETE OVERHEAD MANIPULATION AND MONITORING

EXFO's FTB/IQS-88100NGE and FTB/IQS-88100G modules allow for complete OTN and SONET/SDH overhead manipulation and monitoring for advanced testing and troubleshooting. Furthermore, and consistent with this module's simplified testing approach, the overhead manipulation and monitoring capability is categorized under the Functions menu in the GUI, and is separate from the default setup and results pages. The Functions category offers various 40G/100G testing capabilities required by tier-2 engineers for advanced field troubleshooting.

DELAY MEASUREMENT

Today, carriers have an opportunity to turn optical networks into a competitive advantage by guaranteeing low-latency traffic transmission for delay-sensitive applications, including video, cloud computing and financial trading applications. With this in mind, the FTB/IQS-88100NGE and FTB/IQS-88100G Power Blazer modules enable OTN, SONET/SDH and Ethernet delay measurements across all supported testing interfaces. This enables carriers to solidify their competitive advantage when building low-latency optical transport networks and guarantee speed of service to their end-customers.

This functionality measures the time required for a bit to travel from the transmitter of the FTB/IQS-88100NGE or the FTB/IQS-88100G and back to the receiver after crossing a far-end loopback, thereby providing complete delay results, including delay measurement and minimum/maximum/average delay statistics.

EFFICIENTLY ASSESSING THE PERFORMANCE OF FIBRE CHANNEL SERVICES

The Power Blazer Series modules provide comprehensive testing capabilities for Fibre Channel (FC) network deployments, supporting multiple FC interfaces.

COMPLETE SUITE OF FIBRE CHANNEL INTERFACES		
Interface	**Signal Rate (Gbit/s)**	**Data Rate (Mbit/s)**
1x	1.0	100
2x	2.1	200
4x	4.2	400
8x	8.5	800
10x	10.5	1200

APPLICATIONS

Since most storage area networks (SANs) cover large distances, and because FC has stringent performance requirements, it is imperative to test at each phase of network deployment to ensure appropriate service levels. EXFO's Power Blazer Series modules provide full wire-speed traffic generation at the FC2 layer, which allows for BER testing for link integrity measurements. The Power Blazer Series also supports latency, buffer-to-buffer credit measurements for optimization, as well as login capabilities.

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 the processing time inside each piece of network equipment. Latency is the total accumulation of delays between two endpoints. Some applications, such as VoIP, video and storage area networks, are very sensitive to excess latency.

It is therefore critical for service providers to properly characterize network latency when offering FC services. The Power Blazer Series modules estimate buffer-to-buffer credit value requirements from the performed latency measurement.

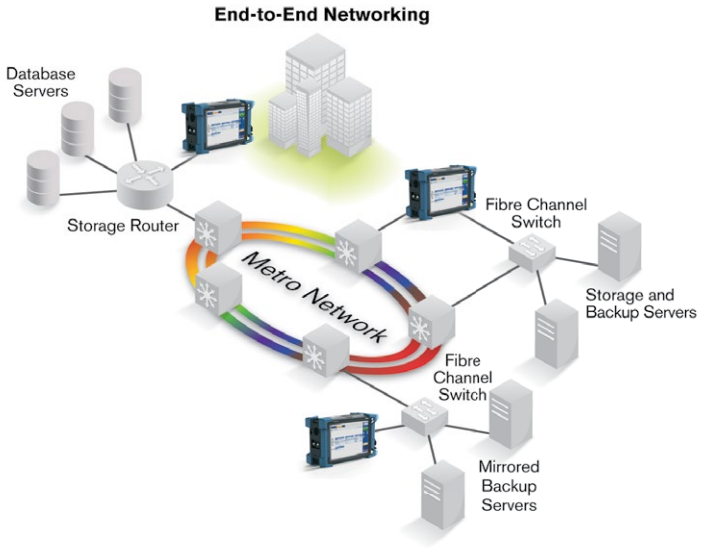


Figure 10. Thanks to end-to-end network testing capabilities, EXFO's Power Blazer enables fast deployment and configuration of FC networks. Communication between the transport network, interconnection devices and end nodes can be validated with features such as BER testing, latency measurement, buffer-to-buffer credit estimation and port login capabilities.

Buffer-to-Buffer Credit Estimation

In order to regulate traffic flow and congestion, FC 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 is a crucial configuration parameter for optimal network performance. Usually, network administrators calculate the value by taking the traveled distance and the data rate into consideration; however, since latency issues are not considered, poor accuracy is to be expected. The Power Blazer Series 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 can then be used by network administrators to optimize the network configuration.

Login Testing

Most new-generation transport devices (xWDM or SONET/SDH mux) supporting FC are no longer fully transparent; they also have increased built-in intelligence, acting more as FC switches. With switch fabric login ability, the Power Blazer Series modules support connections to a remote location through a fabric or semitransparent network.

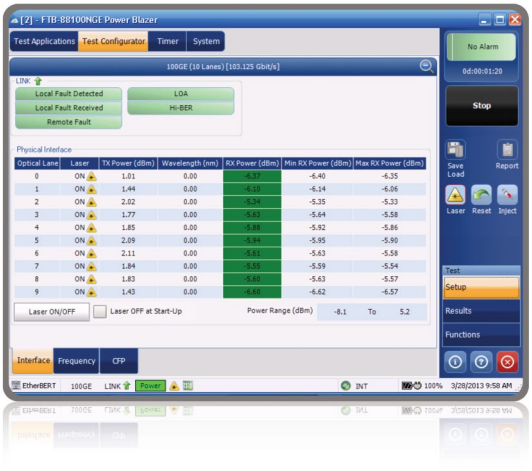
The login process not only permits the unit to connect through a fabric, but it also exchanges some of the basic port characteristics (such as buffer-to-buffer credit and class of service) in order to efficiently transport the traffic through the network.

The login feature allows automatic detection of port/fabric login, login status (successful login, in progress, failure and logout) and response to remote buffer-to-buffer advertised credit.

RAPID DIAGNOSTIC TEST TOOLS

Per-Wavelength Laser Control and Power Measurements

Verifying the power level may seem obvious, but it is a vital step often omitted due to lack of convenience or test equipment. The built-in power-measurement capability of the FTB/IQS-88100NGE and FTB/IQS-88100G enables you to accurately test per-channel ingress and egress levels without risking damage to expensive 40G/100G circuit packs caused by high power, or signal degradation resulting from low power on any of the transmitted optical channels.

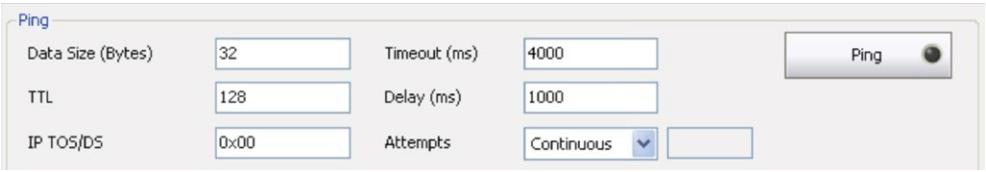


Per-Lane Frequency and Offset Measurements

Along with optical power measurements, frequency accuracy verification is a good sanity check to determine network health prior to BER testing during 40G/100G network commissioning. The FTB/IQS-88100NGE and FTB/IQS-88100G Power Blazer modules offer per-lane frequency and frequency offset testing capabilities to verify that the NE's clock recovery circuitry is operating accurately.

IP Connectivity Tools

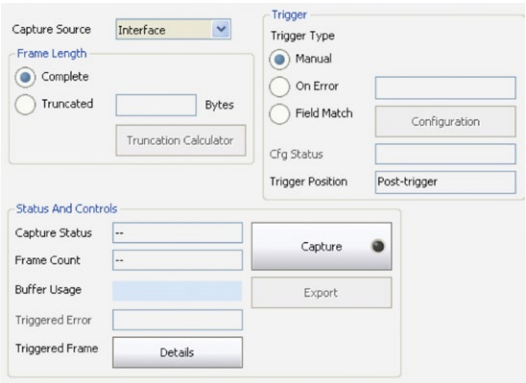
As part of the IP connectivity tools, the ping tool is used to verify that the user can reach a specific address within or outside of a subnetwork. The traceroute tool is a modified version of the ping tool and is used to determine the route or the number of hops that are required to reach a destination host. These basic tools, which are supported on the FTB/IQS-88100NGE and FTB/IQS-88100G Power Blazer modules, are essential when testing through 40G/100G routed networks. The results of these tests can pinpoint critical configuration issues within the network.



ADVANCED TROUBLESHOOTING TOOLS

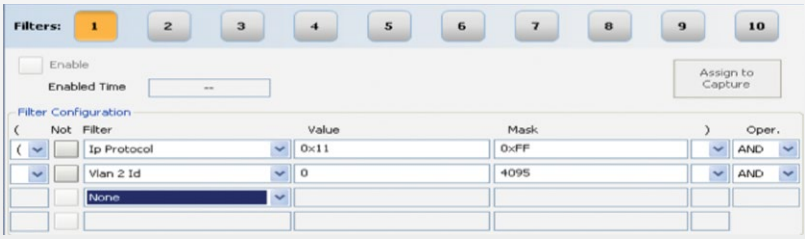
Capturing

The capturing power of EXFO's FTB/IQS-88100NGE and FTB/IQS-88100G extends far beyond basic capabilities. The module adds extra features and functionalities to boost test cycle efficiency and provide more value. Its packet capture tool offers comprehensive filtering, triggering and truncation methods to target specific traffic and quickly pinpoint issues in the lab and in the field.



Advanced Traffic Filtering

In some cases, troubleshooting only concerns a particular traffic flow. The advanced traffic-filtering capability of the FTB/IQS-88100NGE and FTB/IQS-88100G allows you to restrict traffic by using up to four trigger fields and operands (and, or, not). A complete set of triggers is available, such as MAC, IP and TCP/UDP fields, as well as VLAN and MPLS fields.



CFP Health Check

The FTB/IQS-88100NGE and FTB/IQS-88100G also offer 40G/100G CFP Health Check testing capabilities. Unlike the single wavelength transceiver used in legacy 2.5G and 10G networks, each CFP parallel optical channel must be monitored for transmitted and received power levels to avoid damaging expensive 100G circuits and equipment. Moreover, each parallel lane must be monitored for frequency and frequency offset to ensure proper clock and timing recovery.

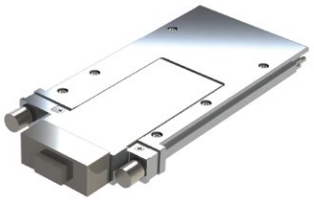
CFP Health Check

The CFP information page now provides detailed information on the module, no longer requiring the removal of the CFP to read the CFP module details. Complete management data input/output (MDIO) read/write access has also been given, allowing advanced network engineers to verify the management interface in the CFP through a registered access, as per the CFP multi-source agreement (MSA). For example, access to the MDIO allows the user to read the CFP operational temperature as needed for troubleshooting purposes.

The FTB/IQS-88100NGE and FTB/IQS-88100G also include a 100G automated stress-test application that covers transmission tolerance tests like static skew measurement, crosstalk, electrical amplitude and pattern dependency. Essentially, all manual interventions have been removed, thus simplifying the CFP qualification process. In short, this tool enables carriers to ensure the optimal performance of 100G networks during evaluation and deployments.

CFP2—THE SECOND-GENERATION HIGH-SPEED TRANSCEIVERS

In today's competitive market, service providers strive to meet their bandwidth requirements by upgrading their networks to higher speeds. Taking this into consideration, network element manufacturers (NEM) have shifted their 100G development to leverage the second-generation high-speed transceivers known as CFP2s. These new CFP2 transceivers have the significant advantages of being 50% smaller in form factor and saving more than 50% on power consumption when compared to first-generation transceivers (CFP). They also enable higher port density on high-speed transmission, switching and routing systems required for 100G mass deployments.



EXFO's FTB/IQS-88100NGE/88100G Power Blazer modules offer 100G testing capabilities for CFP2 transceivers thanks to the new FTB-85970 CFP-to-CFP2 adapter, which requires no additional high-speed modules. This CFP-to-CFP2 adapter provides the flexibility needed to support the industry's different implementations of 100G transceivers, including 4 x 25G and 10 x 10G. Customers can therefore have full access to 100G testing capabilities on their lab unit using both CFP and CFP2 transceivers at a fraction of the cost of upgrading their full fleet of test units to dedicated CFP2-based modules. This unique offering on the market ensures a maximum ROI and eliminates the need for multiple test modules.

EXFO TFv
Test Function Virtualization

EXFO TFv

EXFO TFv—Test Function Virtualization is a cloud-based suite of defined offerings for service providers who are looking to scale their testing requirements to their specific needs. Under the EXFO TFv umbrella are FTB Anywhere floating licenses, and the newly launched FTB OnDemand time-based software licenses.

FTB Anywhere: Floating Test Licenses

FTB Anywhere is an EXFO Connect-enabled offering that allows FTB platform users to share floating test licenses and get the required functionality—anywhere, anytime. In short, the customer owns the software licenses and can share them between FTB platforms.

FTB OnDemand: Time-Based Software Licenses

FTB OnDemand allows customers to activate time-based software licenses covering a wide range of test functionalities (e.g., 100G testing) to match their exact needs. FTB OnDemand enables users to obtain a license for specific test for a specific module for a specific period of time. FTB OnDemand is available for a number of best-in-class EXFO test modules. For a complete list of all the available modules, visit our FTB OnDemand Web page.

EXFO Connect

AUTOMATED ASSET MANAGEMENT. PUSH TEST DATA IN THE CLOUD. GET CONNECTED.

EXFO Connect pushes and stores test equipment and test data content automatically in the cloud, allowing you to streamline test operation from build-out to maintenance.

EXFO

40G/100G ETHERNET FUNCTIONAL SPECIFICATIONS (CONT'D)

The following section provides detailed information about all 40G and 100G Ethernet functional specifications.

40G/100G ETHERNET (IEEE 802.3ba)	
Standards compliance	IEEE 802.3ba
Line rates	103.125 Gbit/s and 41.25 Gbit/s
Framing	Framed and unframed
Power measurement	Optical channel power measurement with color indicators
Frequency measurement	Clock frequency measurements displayed in Hz
EtherSAM (ITU-T Y.1564)	Performs service configuration and service performance tests as per ITU-T Y.1564, including excess burst size (EBS) and committed burst size (CBS), and can be performed using Remote Loopback or Dual Test Set mode for bidirectional results, including VLAN preservation for monitoring and analysis of VLAN priority CoS and ID
iSAM	Simplified ITU-T Y.1564 test that performs service configuration and service performance tests using Remote Loopback or Dual Test Set mode for bidirectional results; an additional, completely automated RFC 6349 test can be run in conjunction with the EtherSAM (Y.1564) tests, or on its own to perform layer-4 TCP testing, with the inclusion of discovering the maximum transmission unit (MTU) and round-trip time (RTT), as well as the actual and ideal TCP throughput of the circuit under test
RFC 2544	Throughput, back-to-back, frame loss and latency measurements according to RFC 2544; frame size: RFC-defined or user-configurable
Dual Test Set	Complementing RFC 2544, RFC 6349 and EtherSAM (ITU-T Y.1564) for bidirectional measurements, including one-way latency
Intelligent autodiscovery	Offers intelligent autodiscovery of other EXFO modules, allowing a single user to perform end-to-end testing
Smart Loopback	Traffic return to the local unit by swapping packet overhead up to layer 4 of the OSI stack
BERT	Unframed and framed layer 2, with or without VLAN Q-in-Q
Layer-2/3/4 header	IP, MAC, UDP source/destination addresses
Patterns	PRBS 2E9-1, PRBS 2E11-1, PRBS 2E15-1, PRBS 2E20-1, PRBS 2E23-1, PRBS 2E31-1 and user-configurable pattern
Traffic generation and monitoring	Traffic generation and shaping of up to 16 streams of Ethernet and IP traffic, including the simultaneous monitoring of throughput, frame loss, packet jitter, latency and out-of-sequence frames, including MAC flooding for source and destination MAC addresses
Frame size	Fixed (from 64 to 16 000 bytes), Random and Sweep (from 64 to 16 000 bytes)
Framing	IEEE 802.3 SNAP and Ethernet II frame format testing
IFG	Tx minimum IFG value of 8, 9, 10, 11, 12
Rx frame-size analysis	< 64, 64, 65-127, 128-255, 256-511, 512-1023, 1024-1518 and > 1518
Rx rate	Line utilization (%), Ethernet BW (Mbit/s), frame rate (frame/s) and frame count
Traffic Scan	Discover multiple levels of VLAN channels (C-/S-/E-VLAN) including their ID and priority, as well as the total VLAN tagged frame count and associated bandwidth
VLAN stacking	Capability to generate one stream with up to three layers of VLAN (including IEEE 802.1ad Q-in-Q tagged VLAN)
VLAN preservation	Monitoring and analysis of VLAN information presentation including VLAN priority CoS and ID
RFC 6349	Performs TCP testing with single or multiple TCP connections from 10BASE-T up to 100G; discovers the MTU, RTT, actual and ideal TCP throughput
40GE/100GE MPLS testing	Generates and analyzes streams with up to two layers of labels
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
Packet jitter statistics	Delay variation statistics (ms): minimum, maximum, last, average and jitter measurement estimate (RFC 3393)
Rx valid frame count	Multicast, broadcast, unicast, non-unicast and total valid count
IP error analysis	IP checksum
Ethernet alarms	Link down, local fault detected, local fault received, remote fault, LOA, Hi-BER, invalid mapping
Per-lane alarms	LOS, LOC-lane, frequency, excessive skew, LOBL, LOAML
Ethernet errors	FCS, jabber, runt, undersize, oversize
Per-lane errors	Block error, invalid marker, PCS BIP-8
Higher-layer error analysis	UDP checksum
Error Injection mode	Manual, rate and continuous (maximum rate)
Traffic filtering	Incoming traffic analysis and statistics according to a set of up to 10 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 source/destination port; VLAN filtering can be applied to any of the stacked VLAN layers
Advanced filtering	Capability to enhance the filters with up to four fields each, which can be combined with AND/OR/NOT operations; a mask is also provided for each field value to allow for wildcards; complete statistics are gathered for each defined filter
Data capture	Full-line-rate data capture and decoding at up to 100G; configuration of detailed capture filters and triggers, as well as capture slicing parameters
IP tools	Ping and traceroute functions
IPv6 testing	Performs the following tests up to 100G over IPv6, EtherSAM, RFC 2544, BERT, traffic generation and monitoring, intelligent autodiscovery, ping and traceroute
Service disruption time (SDT)	Service disruption time measurements based on No Traffic mode, with statistics including longest disruption time, shortest, last, average, count, total, and pass/fail thresholds
Pass/fail verdict	Provides a pass/fail outcome with user-adjustable thresholds, based on bit error rate and/or service disruption time

ETHERNET TEST FEATURES

EtherSAM (ITU-T Y.1564)	Performs service configuration and service performance tests as per ITU-T Y.1564 including EBS, CBS, EMIX and VLAN preservation; use remote loopback or dual test set mode for bidirectional results
iSAM	Simplified ITU-T Y.1564 test that performs service configuration and service performance tests using Remote Loopback or Dual Test Set mode for bidirectional results; an additional, completely automated RFC 6349 test can be run in conjunction with the EtherSAM (Y.1564) tests, or on its own to perform layer-4 TCP testing, with the inclusion of discovering the maximum transmission unit (MTU) and round-trip time (RTT), as well as the actual and ideal TCP throughput of the circuit under test
RFC 2544	Throughput, back-to-back, frame loss and latency measurements according to RFC 2544; frame size: RFC-defined sizes, user-configurable between one to seven sizes
Dual Test Set mode	Complementing RFC 2544, RFC 6349 and EtherSAM (ITU-T Y.1564), for bidirectional measurements, including one-way latency
Intelligent autodiscovery	Offers intelligent autodiscovery of other EXFO modules, allowing single user to perform end-to-end testing
10 GigE dual-port test	10 GigE dual-port testing including: EtherSAM (ITU-T Y.1564), iSAM, RFC 2544, and traffic generation and monitoring when using 100BASE-X, GigE and 10 GigE
Traffic generation and monitoring	Traffic generation and shaping of up to 16 streams of Ethernet and IP traffic, including the simultaneous monitoring of throughput, frame loss, packet jitter, latency and out-of-sequence frames, including MAC flooding for source and destination MAC addresses
Through mode	Sectionalizes traffic between a service provider's network and customer premises equipment
BER testing	Up 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 and one user pattern; capability to invert patterns
Frame size	Fixed (from 64 to 16 000 bytes), random and sweep (from 64 to 16 000 bytes)
10 GigE LAN patterns	Seed A, seed B, PRBS 32 unscrambled
Error measurement (BERT)	Bit error, bit mismatch 0, bit mismatch 1
Traffic Scan	Discover multiple levels of VLAN channels (C-/S-/E-VLAN) including their ID and priority, as well as the total VLAN tagged frame count and associated bandwidth
VLAN stacking	Generates up to three levels of VLAN (including IEEE 802.1ad and Q-in-Q tagged VLAN
VLAN preservation	Validates that the CE-VLAN tags and ID, which are part of classes of service (CoS), are passed transparently
MPLS	Generates and analyzes streams with up to two layers of MPLS labels
Service disruption time (SDT)	Service disruption time measurements based on No Traffic mode, with statistics including longest disruption time, shortest, last, average, count, total, and pass/fail thresholds
IPv6 testing	Performs the following tests up to 10G over IPv6, EtherSAM, RFC 2544, BERT, traffic generation and monitoring, Through mode, intelligent autodiscovery, ping and traceroute
10 GigE WAN testing	Includes the WAN interface sublayer, J0/J1 trace and C2 label generation and monitoring
10 GigE WAN alarm monitoring	Includes SEF, LOF, AIS-L, RDI-L, AIS-P, RDI-P, LCD-P, LOP-P, PLM-P, UNEQ-P, ERDI-P, WIS link down, B1, B2, B3, REI-L, REI-P
TCP throughput	True wire-speed, stateful TCP throughput test based on RFC 6349 for undisputable SLA enforcement of Ethernet services
RFC 6349	Performs TCP testing with single or multiple TCP connections from 10BASE-T up to 100G; discovers the MTU, RTT, actual and ideal TCP throughput
Error measurement	Jabber/giant, runt, undersize, oversize, FCS, symbol, alignment, collision, late collision, excessive collision, IP checksum, UDP checksum, TCP checksum and 10G block error
Alarm detection	LOS, link down, pattern loss, frequency, LOC, 10G local/remote fault
Flow control statistics	Injects or monitors pause frames, including frame counts of pause, abort frames and total, last, maximum and minimum pause time

ETHERNET TEST FEATURES (CONT'D)	
1588 PTP	Validates 1588 PTP packet network synchronization services, emulates PTP clients, and generates and analyzes messages between master/clients, clock quality level and IPDV
G.8275.1	1588 PTP precision-time-protocol profile for phase and time synchronization with network full-timing support
SyncE	Validates SyncE frequency, ESMC messages and clock quality levels
Carrier Ethernet OAM	Fault-management and performance-monitoring Ethernet and MPLS-TP OAM protocols, including Y.1731, 802.1ag, MEF, Link OAM (802.3ah), and G.8113.1 OAMs; addresses metro Ethernet networks; supports continuity check, loopback, link trace, test, frame delay, frame loss and synthetic loss functions, and AIS, CSF, RDI, and LCK alarm generation and monitoring
Traffic filtering	Incoming traffic analysis and statistics according to a set of up to 10 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 source/destination port; VLAN filtering can be applied to any of the stacked VLAN layers
Advanced filtering	Ability to enhance the filters with up to four fields each, which can be combined with and/or/not operations; a mask is also provided for each field value to allow for wild cards; complete statistics are gathered for each defined filter
Data capture	Full line-rate data capture and decoding at up to 10G; configuration of detailed capture filters and triggers, as well as capture slicing parameters
IP tools	Performs ping and traceroute functions
Smart Loopback	Return Ethernet traffic to the local unit by swapping packet overhead up to layer 4
Cable testing	Category 5 cable (or better), 100 UTP/STP cable, ≤120 meters
Pass/fail verdict	Provides a pass/fail outcome with user-adjustable thresholds, based on bit error rate and/or service disruption time
FTTA	
CPRI layer-2 protocol testing	Supports BTS and RRH emulation modes by supporting start-up sequence states, autodetection of protocols, negotiated parameters for control and maintenance, Ethernet and HDLC channels, hyperframe and codeword counts, injection, and monitoring of layer-1 alarms and frequency
CPRI SDT	Measurements in milliseconds (ms) for the longest, shortest, last, average, total and count of disruptions
CPRI RTD	Determine the CPRI protocol round-trip delay measurement
CPRI dual port	Provides two simultaneous ports of CPRI BBU or RRH emulation with rates from 1.2 to 9.8 Gbit/s

SONET/SDH FUNCTIONAL SPECIFICATIONS

SONET		SDH	
Optical interfaces	OC-1, OC-3, OC-12, OC-48, OC-192	Optical interfaces	STM-0, STM-1, STM-4, STM-16, STM-64
Available wavelengths (nm)	1310, 1550	Available wavelengths (nm)	1310, 1550
Clocking	Internal, loop-timed, external building integrated timing supply (BITS)	Clocking	Internal, loop-timed, external (MTS/SETS), 2 MHz
Mappings			
VT1.5	Bulk	AU-3-TU-11, AU-4-TU-11	Bulk
VT2	Bulk	AU-3 -TU-12, AU-4-TU-12	Bulk
STS-1 SPE	Bulk	AU-3, AU-4-TU-3	Bulk
STS-3c	Bulk	AU-4	Bulk
STS-12c/48c/192c, SPE	Bulk	AU-4-4c/16c/64c	Bulk
SONET overhead analysis and manipulation	A1, A2, J0, E1, F1, D1-D12, K1, K2, S1, M0, M1, E2, J1, C2, G1, F2, H4, Z3, Z4, Z5, N1, N2, Z6, Z7	SDH overhead analysis and manipulation	A1, A2, J0, E1, F1, D1-D12, K1, K2, S1, M0, M1, G1, F2, F3, K3, N1, N2, K4, E2, J1, C2, H4
Error insertion			
OC-1, OC-3, OC-12, OC-48, OC-192	Section BIP (B1), line BIP (B2), path BIP (B3), BIP-2, REI-L, REI-P, REI-V, FAS, bit error	STM-0, STM-1, STM-4, STM-16, STM-64	RS-BIP (B1), MS-BIP (B2), HP-BIP (B3), MS-REI, HP-REI, LP-BIP-2, LP-REI, FAS, bit error
Error measurement			
OC-1, OC-3, OC-12, OC-48, OC-192	Section BIP (B1), line BIP (B2), path BIP (B3), BIP-2, REI-L, REI-P, REI-V, FAS, bit error	STM-0, STM-1, STM-4, STM-16, STM-64	RS-BIP (B1), MS-BIP (B2), HP-BIP (B3), MS-REI, HP-REI, LP-BIP-2, LP-REI, FAS, bit error
Alarm insertion			
OC-1, OC-3, OC-12, OC-48, OC-192	LOS, LOF-S, SEF, AIS-L, RDI-L, AIS-P, LOP-P, LOM, PDI-P, RDI-P, ERDI-PCD, ERDI-PPD, ERDI-PSD, UNEQ-P, AIS-V, LOP-V, RDI-V, ERDI-VCD, ERDI-VPD, ERDI-VSD, RFI-V, UNEQ-V, pattern loss	STM-0, STM-1, STM-4, STM-16, STM-64	LOS, LOF, OOF, MS-AIS, MS-RDI, AU-AIS, AU-LOP, H4-LOM, HP-ERDI-CD, HP-ERDI-PD, HP-ERDI-SD, LP-ERDI-CD, LP-ERDI-PD, LP-ERDI-SD, HP-UNEQ, TU-AIS, LP-RFI, LP-RDI, LP-RFI, LP-UNEQ, pattern loss
Alarm detection			
OC-1, OC-3, OC-12, OC-48, OC-192	LOS, LOC, LOF-S, SEF, TIM-S, AIS-L, RDI-L, AIS-P, LOP-P, LOM, PDI-P, RDI-P, ERDI-PCD, ERDI-PPD, ERDI-PSD, PLM-P, UNEQ-P, TIM-P, AIS-V, LOP-V, RDI-V, ERDI-VCD, ERDI-VPD, ERDI-VSD, RFI-V, UNEQ-V, TIM-V, PLM-V, pattern loss	STM-0, STM-1, STM-4, STM-16, STM-64	LOS, RS-LOF, LOC, RS-OOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, H4-LOM, HP-RDI, HP-ERDI-CD, HP-ERDI-PD, HP-ERDI-SD, LP-ERDI-CD, LP-ERDI-PD, LP-ERDI-SD, HP-PLM, HP-UNEQ, HP-TIM, TU-AIS, LP-RFI, LP-RDI, LP-RFI, LP-UNEQ, LP-TIM, LP-PLM, pattern loss
Frequency alarms on all supported interfaces			
Patterns			
VT1.5/2	2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 32 bit programmable (inverted or non-inverted), bit errors	TU-11/12/3	2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 32 bit programmable (inverted or non-inverted), bit errors
STS-1, STS-3c/ 12c/48c/192c	2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 32 bit programmable (inverted or non-inverted), bit errors	AU-3/AU-4/AU-4-4c/ 16c/64c	2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 32 bit programmable (inverted or non-inverted), bit errors
Pattern loss, and bit-error generation and analysis supported on all patterns			

SONET/SDH TEST FEATURES

Frequency measurements	Supports clock frequency measurements (i.e., received frequency and deviation of the input signal clock from nominal frequency), displayed in ppm, for optical and electrical interfaces; measurements are performed using a local oscillator
Frequency offset generation	Supports offsetting the clock of the transmitted signal on a selected interface to exercise clock recovery circuitry on network elements
Performance monitoring	The following ITU-T recommendations, and corresponding performance-monitoring parameters, are supported: **ITU-T recommendation** — **Performance-monitoring statistics** G.821 — ES, EFS, EC, SES, UAS, ESR, SESR, DM G.826 — ES, EFS, EB, SES, BBE, UAS, ESR, SESR, BBER G.828 — ES, EFS, EB, SES, BBE, SEP, UAS, ESR, SESR, BBER, SEPI G.829 — ES, EFS, EB, SES, BBE, UAS, ESR, SESR, BBER M.2100 — ES, SES, UAS M.2101 — ES, SES, BBE, UAS
Pointer adjustment and analysis	Generation and analysis of HO/AU and LO/TU pointer adjustments as per GR-253, and ITU-T G.707 **Generation** › Pointer increment and decrement › Pointer jump with or without NDF › Pointer value **Analysis** › Pointer increments › Pointer decrements › Pointer jumps (NDF, no NDF) › Pointer value and cumulative offset
Pointer sequence testing	Performs pointer sequence testing as per the G.783, GR253 and T1.105-3 standards
Service-disruption-time (SDT) measurements	The service-disruption-time test tool measures the time during which there is a disruption of service due to the network switching from the active channels to the backup channels Measurements: last disruption, shortest disruption, longest disruption, average disruption, total disruption, and service disruption count
Round-trip delay (RTD) measurements	The round-trip delay test tool measures the time required for a bit to travel from the transmitter back to its receiver after crossing a far-end loopback. Measurements are provided on all supported interfaces and mappings Measurements: last, minimum, maximum, average; measurement count: no. of successful RTD tests and failed measurement count
APS message control and monitoring	Ability to monitor and set up automatic protection-switching messages (K1/K2 byte of SONET/SDH overhead)
Synchronization status	Ability to monitor and set up synchronization status messages (S1 byte of SONET/SDH overhead)
Signal label control and monitoring	Ability to monitor and set up payload signal labels (C2, V5 byte of SONET overhead)
Tandem connection monitoring (TCM) [a, b]	Tandem connection monitoring (TCM) is used to monitor the performance of a subsection of a SONET/SDH path routed via different network providers; the Power Blazer supports transmitting and receiving alarms and errors on a TCM link; also, transmission and monitoring of the tandem connection (TC) trace can be generated to verify the connection between TCM equipment Error generation: TC-IEC, TC-BIP, TC-REI, TC-OEI Error analysis: TC-IEC, TC-REI, TC-OEI, TC-VIOL (non-standardized alarm) Alarm generation: TC-RDI, TC-UNEQ, TC-ODI, TC-LTC, TC-IAIS Alarm analysis: TC-TIM, TC-RDI, TC-UNEQ, TC-ODI, TC-LTC, TC-IAIS
Through mode	Performs Through mode analysis of any incoming optical line (OC-1/STM-0, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, OC-192/STM-64) transparently

FIBRE CHANNEL FUNCTIONAL SPECIFICATIONS

Testing 1x, 2x, 4x, 8x, 10x	
BERT	Framed FC2
Patterns (BERT)	PRBS 2E31-1, 2E23-1, 2E20-1, 2E15-1, 2E11-1, 2E9-1, one user-defined pattern and the capability to invert patterns
Error insertion	Bit error, amount and rate
Error measurement	Bit error, symbol error, oversize error, CRC error, undersize error and block error (10x only)
Alarm detection	LOS, pattern loss, link down, local and remote fault
Buffer-to-buffer credit testing	Buffer-to-buffer credit estimation based on latency
Latency	Round-trip latency

Notes

a. HOP and LOP supported as per ITU G.707 option 2.

b. SONET/SDH rates up to 10G.

ELECTRICAL INTERFACES

The following section provides detailed information on all supported electrical interfaces.

SYNCHRONIZATION INTERFACES

	External Clock DS1/1.5M	External Clock E1/2M	2 MHz
Tx pulse amplitude (V)	2.4 to 3.6	2.37	0.75 to 1.5
Tx pulse mask	GR-499 figure 9.5	G.703 figure 15	G.703 figure 20
Tx LBO pre-amplification (typical) (dBdsx)	0.6 for 0 to 40.5 m (0 to 133 ft) 1.2 for 40.5 to 81.1 m (133 to 266 ft) 1.8 for 81.1 to 121.6 m (266 to 399 ft) 2.4 for 121.6 to 162.5 m (399 to 533 ft) 3 for 162.5 to 200 m (533 to 655 ft)		
Rx-level sensitivity	TERM: ≤6 dB (cable loss only) at 772 kHz for T1 DSX-MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)	TERM: ≤6 dB (cable loss only) MON: ≤26 dB (resistive loss + cable loss ≤ 6 dB)	≤6 dB (cable loss only)
Transmission bit rate	1.544 Mbit/s ± 4.6 ppm	2.048 Mbit/s ± 4.6 ppm	
Reception bit rate	1.544 Mbit/s ± 50 ppm	2.048 Mbit/s ± 50 ppm	
Intrinsic jitter (Tx)	ANSI T1.403 section 6.3 GR-499 section 7.3	G.823 section 6.1	G.703 table 11
Input jitter tolerance	AT&T PUB 62411 GR-499 SECTION 7.3	G.823 section 7.2 G.813	
Line coding	AMI and B8ZS	AMI and HDB3	
Input impedance (resistive termination)	75 Ω ± 5 %, unbalanced	75 Ω ± 5 %, unbalanced	75 Ω ± 5 %, unbalanced
Connector type [a]	SMB	SMB	SMB

REF-OUT INTERFACE

Tx pulse amplitude	400 ± 200 mVpp
Transmission frequency	155 MHz to 3.5 GHz
Output configuration	AC-coupled
Load impedance	50 Ω
Maximum cable length	1 m
Connector type	SMA

MECHANICAL AND ENVIRONMENTAL SPECIFICATIONS

FTB-88100NGE/88100G Modules			IQS-88100NGE/88100G Modules
Size (H x W x D)		96 mm x 51 mm x 288 mm (3 ¾ in x 2 in x 11 $^{5}/_{16}$ in)	125 mm x 74 mm x 282 mm (4 $^{15}/_{16}$ in x 2 $^{15}/_{16}$ in x 11 $^{1}/_{8}$ in)
Weight		1.1 kg (2.4 lb)	1.2 kg (2.6 lb)
Temperature	operating storage	0 °C to 40 °C (32 °F to 104 °F) –40 °C to 60 °C (–40 °F to 140 °F)	0 °C to 40 °C (32 °F to 104 °F) –40 °C to 60 °C (–40 °F to 140 °F)
FTB-85970 CFP-to-CFP2 Adapter			
Size (H x W x D)		82 mm x 17 mm x 163 mm (3 ½ in x $^{11}/_{16}$ in x 6 $^{7}/_{16}$ in)	
Weight		0.2 kg (0.4 lb)	
Temperature	operating storage	0 °C to 40 °C (32 °F to 104 °F) –40 °C to 70 °C (–40 °F to 158 °F)	

Note

a. An SMB-to-BNC adapter is available.

ORDERING INFORMATION

FTB-88100NGE-XX-XX-XX-XX-XX-XX-XX-XX
IQS-88100NGE-XX-XX-XX-XX-XX-XX-XX-XX

Ethernet Rate Options
GigE Bundle = 10/100/1000 BASE-T, 100BASE-FX (optical), 1000BASE-X (optical)
10GigE = 10G_LAN and 10G_WAN
40GE = Ethernet optical rate of 41.25 Gbit/s
100GE = Ethernet optical rate of 103.125 Gbit/s

SONET/SDH Rate Options [a]
2.5G Bundle = 52M (OC-1/STM-0), 155M (OC-3/STM-1), 622M (OC-12/STM-4), 2488M (OC-48/STM-16)
9953M = 9953M (OC-192/STM-64)
40G = 39.81G (OC-768/STM-256)

Fibre Channel Rate Options
00 = No Fibre Channel option
FC1X = 1x Fibre Channel interface [b]
FC2X = 2x Fibre Channel interface [b]
FC4X = 4x Fibre Channel interface [b]
FC8X = 8x Fibre Channel interface [c]
FC10X = 10x Fibre Channel interface [c]

OTN Rate Options
OTU1 = OTN optical rate of 2.666 Gbit/s
OTU2 = OTN optical rate 10.709 Gbit/s
OTU2-1e-2e = OTN optical rates of 11.049/11.096 Gbit/s
OTU2-1f-2f = OTN optical rates of 11.270/11.318 Gbit/s
OTU3 = OTN optical rate of 43.018 Gbit/s
OTU3-e1-e2 = OTN optical rates of 44.57 Gbit/s and 44.58 Gbit/s
OTU4 = OTN optical rate of 111.81 Gbit/s

CPRI Rate Options [c]
CPRI-1.2G = Enables CPRI 1.2G
CPRI-4.9G = Enables CPRI 4.9G
CPRI-6.1G = Enables CPRI 6.1G
CPRI-9.8G = Enables CPRI 9.8G
CPRI_ALLRATES = Enables all CPRI rates
DP-CPRI = Enables two CPRI ports

Example: FTB-88100NGE-100GE-40G-FC10X-OTU3-SONET-SDH-EoOTN-ETH-CAPTURE

Ethernet Options
00 = No Ethernet option
ADV-FILTERS = Advanced filtering [d, j]
DUAL-PORT = 10 GigE Dual Port testing [d]
ETH-CAPTURE = Full-line-rate packet capture [d, j]
ETH-OAM = Enables four OAM modes, including Y.1731, 802.1ag, MEF and G.8113.1 [d]
LINK-OAM = Enables 802.3ah Link OAM [d]
TST-OAM = Enables OAM testing within EtherSAM
IPV6 = Internet protocol version 6 [d]
IPV6_40-100GE = 40GE and 100GE IPv6 internet protocol version 6 [j]
ETH-THRU = Through mode capability [d]
MPLS = Enables MPLS [d]
MPLS_40-100GE = Enables 40GE and 100GE MPLS tags [j]
1588PTP = Generates and analyzes 1588 PTP [d]
G82751 = Enables ITU-T G.8275.1 profile
SyncE = Generates and analyzes SyncE protocol [d]
RFC6349 = Enables TCP testing as per RFC 6349 [d]
RFC6349_40-100GE = 40GE and 100GE enables TCP testing as per RFC 6349 [j]
iSAM = Enables simplified ITU-T Y.1564 test [d, j]
Cable_Test = Cable test e
TCP-THPUT = Enables TCP throughput measurements [e]
TRAFFIC-SCAN = Discover and monitor VLAN [d, j]

OTN Options
00 = No OTN option
EoOTN = Ethernet mapping over OTN f
ODUMUX = Single and multistage ODU multiplexing f
ODU0 = ODU0 (1.25 Gbit/s) mapping g
ODUflex = ODUflex functionality [g]
OTN-INTR-THRU = OTN intrusive Through mode [k]

SONET/SDH Options and Mapping
00 = Without SONET/SDH software option
SONET = SONET-BASE and mapping [h]
SDH = SDH-BASE and mapping [h]
SONET-SDH = SONET and SDH combo software [h]
SONETSDH-INTR-THRU = SONET/SDH intrusive Through mode [l]
TCM = Tandem connection monitoring [i]

Notes

a. Requires SONET, SDH or SONET-SDH option.
b. Requires purchase of SFP.
c. Requires purchase of SFP+.
d. Requires GigE bundle and/or 10 GigE.
e. Requires GigE bundle.
f. Requires enabling OTU2 and/or OTU3, and/or OTU4 rates.
g. Requires enabling ODUMUX OTN option.
h. Requires enabling OTU3 and/or 40G SONET/SDH rates.
i. Requires enabling 2.5G bundle or 9953M rate, with SONET or SDH or SONET-SDH.
j. Requires 40GE and 100GE.
k. Requires enabling OTU3 rate.
l. Requires 40G SONET, SDH or SONET-SDH option.

ORDERING INFORMATION

FTB-88100G-XX-XX-XX-XX-XX-XX
IQS-88100G-XX-XX-XX-XX-XX-XX

Ethernet Rate Options
40GE = Ethernet optical rate of 41.25 Gbit/s
100GE = Ethernet optical rate of 103.125 Gbit/s

SONET/SDH Rate Options [a]
40G = 39.81G (OC-768/STM-256)

OTN Rate Options
OTU3 = OTN optical rate of 43.018 Gbit/s
OTU3-e1-e2 = OTN optical rates of 44.57 Gbit/s and 44.58 Gbit/s
OTU4 = OTN optical rate of 111.81 Gbit/s

Ethernet Options
00 = No Ethernet option
ADV-FILTERS = Advanced filtering [f]
ETH-CAPTURE = Full-line-rate packet capture [f]
IPV6_40-100GE = 40GE and 100GE IPv6 internet protocol version 6 [f]
iSAM = Intelligent service activation methodology based on ITU-T Y.1564 [f]
MPLS_40-100GE = Enables 40GE and 100GE MPLS tags [f]
RFC6349_40-100GE = 40GE and 100GE enables TCP testing as per RFC 6349 [f]
TRAFFIC-SCAN = Discover and monitor VLAN traffic flows on a live signal

OTN Options
00 = No OTN option
EoOTN = Ethernet mapping over OTN [b]
ODUMUX = Single and multistage ODU multiplexing [b]
ODU0 = ODU0 (1.25 Gbit/s) mapping [c]
ODUflex = ODUflex functionality [c]
OTN-INTR-THRU = OTN intrusive Through mode [g]

SONET/SDH Options and Mapping
SONET = SONET-BASE and mapping [d]
SDH = SDH-BASE and mapping [d]
SONET-SDH = SONET and SDH combo software [d]
SONETSDH-INTR-THRU = SONET/SDH intrusive Through mode [a]
TCM = Tandem connection monitoring [e]

Example: IQS-88100G-100GE-40G-OTU3-SONET-SDH-EoOTN-ETH-CAPTURE

Notes

a. Requires SONET, SDH or SONET-SDH option.
b. Requires enabling OTU3 and/or OTU4 rates.
c. Requires enabling ODUMUX OTN option.
d. Requires enabling OTU3 and/or 40G SONET/SDH rates.
e. Requires enabling 2.5G bundle or 9953M rate, with SONET or SDH or SONET-SDH.
f. Requires 40GE and 100GE.
g. Requires enabling OTU3 rate.

40G/100G PLUGGABLE TRANSCEIVERS (CFPs)

FTB-85953 = 100GBASE-LR10 dual-rate (100GE/OTU4) CFP (10 x 10G WDM, 2 km)
CFP-85954= 40 Gbit/s Ethernet and OTN CFP (4 x 10G WDM, 10 km)
FTB-85955 = 100GBASE-LR4 dual-rate (100GE/OTU4) CFP (4 x 28G WDM, 10 km), low power
FTB-85958 = 100GBASE-LR4 dual-rate (100GE/OTU4) CFP (4 x 28G WDM, 10 km)
CFP-85961 = 100GBASE-SR10 dual-rate (100GE/OTU4) CFP (10 x 10G) MMF, 100 m reach)
CFP-85962 = 100GBASE-LR4 dual-rate (100GE/OTU4) CFP (4 x 28G WDM, 10 km)
CFP-85963 = 40GBASE-SR4 dual-rate CFP (4 x 10G LAN-WDM, MMF, 850 nm, 100 m reach) MPO
CFP-85964 = 40GBASE-FR multirate (OC-768/STM-256, OTU3, OTU-3e1-e2) serial CFP (1550 nm, 2 km) LC

100G PLUGGABLE TRANSCEIVERS (CFP2s)

FTB-85970 = CFP-to-CFP2 adapter supporting 4 x 25G and 10 x 10G CFP2 transceiver implementations
CFP2-85974 = 100GBASE-SR10 dual-rate (100GE/OTU4) CFP2 (10 x 10G MMF, 100 m reach)
CFP2-85975 = 100GBASE-LR4 dual-rate (100GE/OTU4) CFP2 (4 x 28G LAN-WDM, 10 km reach)
CFP2-85978 = 100GBASE-LR4 dual-rate (100GE/OTU4) CFP2 (4 x 28G LAN-WDM, 10 km reach)

ACCESSORIES

TJ-MP24-LB = MPO-24 loopback multimode 24 fiber 50/125 µm CXP pin out
TJ-MP24-MP24-5M = MPO-24 to MPO-24 multimode fiber ribbon, 5 m

SFP MULTIRATE OPTICAL TRANSCEIVERS

FTB-8590 = SFP module GigE/FC/2FC, CPRI/OBSAI 2.45/3.07 Gbit/s at 850 nm, MM, <500 m reach
FTB-8690 = Multirate SFP supporting: GigE, 850 nm, LC connector, MMF, < 500 m reach
FTB-8190 = SFP module; rates: 155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE/FC/2FC, CPRI/OBSAI 2.45/3.07 Gbit/s at 1310 nm, LC connector, 15 km reach
FTB-8191 = SFP module; rates: 155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE/FC/2FC; CPRI/OBSAI 2.45/3.07 Gbit/s at 1310 nm, LC connector, 40 km reach
FTB-8192 = Multirate optical transceiver; rates: 155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE, 1550 nm, LC connector, SMF, 80 km reach
FTB-8193 = Multirate SFP supporting: 155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE, 1550 nm, LC connector, SMF, 40 km reach
FTB-85912 = SFP modules: GigE/FC/2FC/4FC at 850 nm, < 500 m reach
FTB-85913 = SFP modules: GigE/FC/2FC/4FC at 1310 nm, 4 km reach
FTB-85914 = SFP modules: GigE/FC/2FC/4FC at 1310 nm, 30 km reach
FTB-85915 = SFP modules: GigE/FC/2FC/4FC at 1550 nm, < 50 km reach
FTB-85919 = SFP copper, multirate 10/100/1000 BASE-T, Cat5 UTP 100 m reach

100M SFP SINGLE-RATE OPTICAL TRANSCEIVERS

FTB-85910 = Single-rate SFP supporting: 100BASE-FX, 1310 nm, LC connector, SMF, 2 km reach
FTB-85911 = Single-rate SFP supporting: 100BASE-FX, 1310 nm, LC connector, SMF, 15 km reach

1000M SFP BIDIRECTIONAL OPTICAL TRANSCEIVERS

FTB-8596 = Bidirectional SFP supporting: 1000BASE-BX10, 1490TX/1310RX, 10 km reach (should be paired and sold with the FTB-8597)
FTB-8597 = Bidirectional SFP supporting: 1000BASE-BX10, 1310TX/1490RX, 10 km reach (should be paired and sold with the FTB-8596)
FTB-8598 = Bidirectional SFP supporting: 1000BASE-BX40, 1310TX/1490/1550RX, 40 km reach (should be paired and sold with the FTB-8599)
FTB-8599 = Bidirectional SFP supporting: 1000BASE-BX40, 1550TX/1310RX, 40 km reach (should be paired and sold with the FTB-8598)

1000M SFP COPPER TRANSCEIVERS

SFP-85919 = SFP copper, multirate 10/100/1000 BASE-T, Cat5 UTP, 100 m reach

10G SFP+ MULTIRATE OPTICAL TRANSCEIVERS

SFP-8600 = SFP+ modules: CPRI 1.228 to 9.83 Gbit/s at 1310 nm, LC connector, 1.4 km reach
SFP-8601 = SFP+ 10G (1.25 Gbit/s to 10.3125 Gbit/s) CWDM at 1471 nm, LC SMF, 10 km reach
SFP-8602 = SFP+ 10G (1.25 Gbit/s to 10.3125 Gbit/s) CWDM at 1511 nm, LC SMF, 10 km reach
FTB-8690 = Multirate SFP+ supporting: 10 GigE LAN/WAN (9.95 to 10.3 Gbit/s), 850 nm, LC connector, MMF, 300 m reach (not rated for SONET/SDH)
FTB-8691 = SFP+ modules: 10 GigE at 1310 nm, 10 km reach
FTB-8693 = Multirate SFP+ supporting: Sonet/SDH, 10 GigE LAN/WAN, OTU2, OTU1e/2e (8.5, 9.95 to 11.3 Gbit/s), 1310 nm, LC connector, SMF, 10 km reach
FTB-8694 = Multirate SFP+ supporting: Sonet/SDH, 10 GigE LAN/WAN (9.95 to 11.1 Gbit/s), 1550 nm, LC connector, SMF, 40 km reach
FTB-8695 = Multirate SFP+ supporting: Sonet/SDH, 10 GigE LAN/WAN, OTU2, OTU1e/2e (9.95 to 11.1 Gbit/s), 1550 nm, LC connector, SMF, 80 km reach

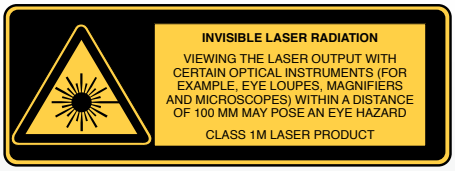
10G XFP MULTIRATE OPTICAL TRANSCEIVERS

FTB-81900 = Multirate XFP supporting: 10/10.7/10 GigE LAN-WAN, 1310 nm, LC connector, SMF, 10 km reach
FTB-81901 = Multirate XFP supporting: 10/10.7/10 GigE LAN-WAN, 1550 nm, LC connector, SMF, 40 km reach
FTB-81902 = Multirate XFP supporting: 10/10.7/10 GigE LAN-WAN, 1550 nm, LC connector, SMF, 80 km reach

10 GigE XFP OPTICAL TRANSCEIVERS

FTB-85900 = Single-rate XFP supporting: 10GBASE-SR/-SW, 850 nm, 10 GigE LAN/WAN, LC connector, MMF, < 500 m reach
FTB-85901 = Single-rate XFP supporting: 10GBASE-LR/-LW, 1310 nm, 10 GigE LAN/WAN, LC connector, SMF, 10 km reach
FTB-85902 = Single-rate XFP supporting: 10GBASE-ER/-EW, 1550 nm, 10 GigE LAN/WAN, LC connector, SMF, 40 km reach

LASER SAFETY



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