

100G and Beyond

# HIGH-SPEED PRODUCT PORTFOLIO

MORE SPEED. MORE SYNERGY. MORE SERVICES.

40G

100G

400G

EXFO

An aerial, black and white photograph of a dense urban landscape, likely New York City. The image shows a vast expanse of skyscrapers and buildings, with a large body of water (the Hudson River) visible in the background. The perspective is from a high vantage point, looking down on the city. The text is overlaid on the bottom left of the image.

THE FUTURE IS HIGH-SPEED  
—STAY AHEAD OF THE CURVE



# DELIVERING PROVEN 40G/100G TEST SOLUTIONS

In today's increasingly competitive market, worldwide carriers and network operators are striving to deliver the bandwidth required for residential, mobile and enterprise services, and consequently upgrading to 40G/100G. To achieve this transition in a simple, cost-effective way—and to tackle challenges such as measuring in-band optical signal-to-noise ratio (OSNR) and pinpointing high PMD on fiber networks, or to enable multirate services up to 100G over optical transport networks—they are turning to EXFO's unique and powerful test expertise.

From network construction and fiber characterization to commissioning and troubleshooting, EXFO brings innovation to 40G/100G lab and field testing:

- › Optical spectrum analysis (OSA)
- › Chromatic dispersion (CD)
- › Polarization mode dispersion (PMD)
- › Transport protocols: SONET/SDH, optical transport network (OTN), etc.
- › Multirate Ethernet from 10M to 100G, including 40/100 Gigabit Ethernet
- › Advanced modulation formats

Discover our 40G/100G product portfolio, and get the tools you need to **accelerate time-to-market, save costs, and deliver high-speed services.**



# 10M-TO-100G MULTISERVICE TEST MODULE

## FTB-88100NGE POWER BLAZER

### THE CHALLENGE

Carriers are actively deploying 100G to address the growing demand for bandwidth, but they are also facing multiple challenges. In addition to supporting legacy and packet-based services on a single network, they need to reduce time-to-service and increase revenues without compromising quality. What's more, 40G/100G technology, with its related multilane transmission approach and new C form-factor pluggable (CFP) optics, is extremely complex.

### THE SOLUTION

EXFO's FTB-88100NGE Power Blazer is future-proof, and gives carriers peace of mind knowing that module can be easily adapted to meet future requirements up to 100G. Meanwhile, these carriers can instantly leverage its flexible configuration to enable any testing capability in line with their current needs, and at a competitive price. Additional rates and interfaces can be easily enabled in the field via a simple software key, providing maximum flexibility with minimum downtime, eliminating the need for multiple test units.

### DELIVERING MULTISERVICE TESTING UP TO 100G IN A SINGLE, RUGGED SOLUTION BUILT AND READY FOR THE FIELD

Future-proof product supporting any test, anywhere, at any rate:

- › Complete validation of quality-of-service (QoS) metrics for a wide range of services: Ethernet, SONET/SDH and OTN for full compliancy with service-level agreements (SLAs); done right the first time, 100% of the time
- › iOptics, an intelligent pluggable optics test application for field and lab environments used to efficiently evaluate the proper operation of transceivers, from SFP to CFP2/4 and QSFP, QSFP+ and QSFP28, using minimal user configuration
- › Offers operational savings and flexibility via FTB OnDemand time-based licenses, which are part of EXFO TFv—Test Function Virtualization
- › Field-ready with a portable platform, user-friendly graphical user interface (GUI), battery power operation, full connectivity, remote management capability and integrated optical tools



# STILL TESTING ONLY 10G, BUT WANT TO GET READY FOR 100G?

## INDUSTRY'S ONLY 10M-TO-100G FIELD-TESTING SOLUTION IN A SINGLE, POWERFUL, COMPACT PLATFORM

### THE CHALLENGE/APPLICATION

100G is fast becoming a must for carriers and data centers. Meanwhile, 10G testing still predominates in the field. So, how do carriers continue to test 10G while ensuring that they are ready for 100G?

Most service providers are still predominantly testing 10G, but want to set the stage for 100G. With more and more services becoming delay-sensitive, providers want to maximize the return on investment (ROI) of existing fiber installations while reducing network latency. They also need to be able to support both legacy and next-generation technologies on the same network using the same hardware.

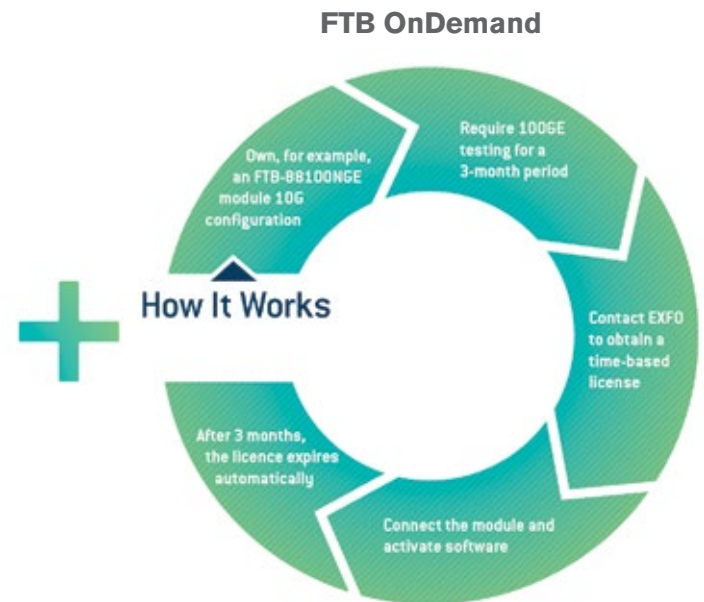
### THE SOLUTION

The FTB-88100NGE Power Blazer module on the FTB-2 Pro Platform is the industry's only solution enabling customers to test 10G networks today while delivering the capabilities needed to respond to 100G needs tomorrow.

FTB-88100G POWER BLAZER  
ON THE FTB-2 PRO PLATFORM



- ✓ ALL RATES: 10M, 10G, 40G, 100G
- ✓ MULTISERVICE: SONET/SDH, OTN, ETHERNET
- ✓ INDUSTRY'S SMALLEST SINGLE PLATFORM FOR HIGH-SPEED DEPLOYMENTS
- ✓ 50% LIGHTER THAN OTHER SOLUTIONS
- ✓ 50% SMALLER THAN OTHER SOLUTIONS
- ✓ 50% LESS MODULES NEEDED TO MATCH OTHER OFFERING—NO ADDITIONAL MODULES NEEDED



FTB OnDemand time-based licenses allow carriers to test specific high-speed features associated with a specific module for a specific period of time, providing a barrier-free entry to 100G capabilities. Ready when you're ready.

# STREAMLINE NETWORK OPERATIONS



**EXFO TFv**  
Test Function Virtualization

## TESTING REQUIREMENTS TAILORED TO YOUR NEEDS

EXFO TFv—Test Function Virtualization is the industry's first suite of defined offerings that focuses on test function virtualization. EXFO TFv offers all the benefits of virtualization through seamless enablement of test functions on any EXFO test asset, at any time.

EXFO TFv offers two options: FTB Anywhere and FTB OnDemand.

- › FTB Anywhere: Floating test licenses shared by all your technicians—anywhere, anytime.
- › FTB OnDemand: Time-based licenses that give service providers immense flexibility to perform a specific test on a specific module for a specific period of time.

**OPTIMIZE TEST  
ASSET INVESTMENTS**

# EXFO CONNECT—MAKE YOUR DATA MEAN BUSINESS

EXFO | Connect

With EXFO Connect, all data related to tests and test equipment can be easily brought together to enhance business decisions and make processes more efficient.





# 40G/100G INTEGRATED TEST MODULE

## FTB-88100G POWER BLAZER



### A TURNKEY SOLUTION DESIGNED TO ADDRESS 40G/100G FIELD COMMISSIONING AND TURN-UP

A true, compact 40G/100G field-testing solution:

- › Complete validation of QoS metrics for a wide range of services: 40GE/100GE OC-768/STM-256 and OTU3/e1/e2/4 for full compliancy with SLAs; accelerates service turn-up while ensuring the job is always done right the first time
- › iOptics, an intelligent pluggable optics test application for field and lab environments used to efficiently evaluate the proper operation of transceivers, from SFP to CFP2/4 and QSFP, QSFP+ and QSFP28, using minimal user configuration
- › Operational flexibility based on EXFO Connect test equipment and data management (TEM and TDM) cloud-based services
- › Field-ready with a portable platform, user-friendly GUI, battery power operation, full connectivity, remote management capability, and integrated optical tools



EXFO | Connect



EXFO TFv  
Test Function Virtualization

# ETHERSAM (Y.1564) IN THE FIELD

## APPLICATION CONTEXT

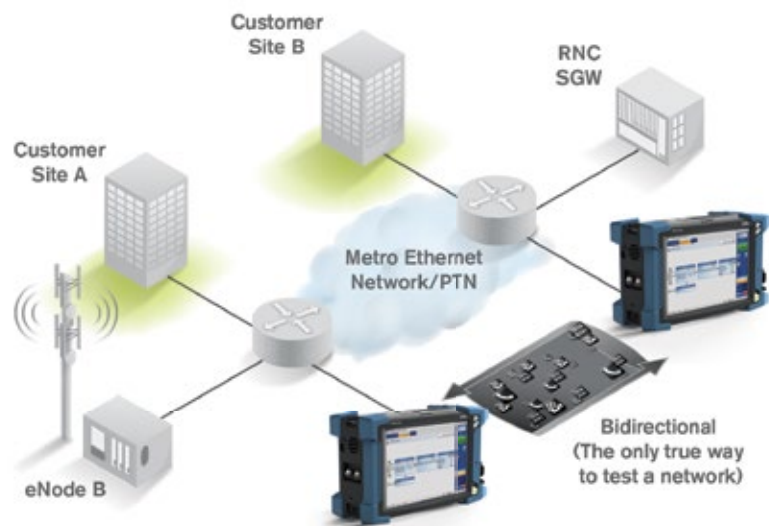
In response to the ever-increasing demand for bandwidth and Ethernet's ascension as the transport technology of choice, most carriers have now made the shift from 10 Gigabit Ethernet (GE) to 100GE. Network focus has shifted from purely moving data to providing entertainment and new applications in the interconnected world. Ethernet-based mobile backhaul, business and wholesale services need to carry a variety of applications, namely voice, video, e-mail, online trading and others. These applications place new requirements on network performance and the methodologies used to validate Ethernet service performance up to 100G.

## THE APPLICATION

When turning up new high-speed services, and even in the case of troubleshooting, mobile backhaul and other Ethernet-based services mainly carrying voice, data or high-definition video use streaming applications that need to be validated to ensure expected performance.

Carriers are now validating their SLAs all the way up to 100G using the ITU-T Y.1564 methodology test. These SLAs specify the key forwarding characteristics and the minimum performance guaranteed for each characteristic. To optimize test time, EtherSAM (ITU-T Y.1564) can be combined with a dual-test-set configuration to perform a bidirectional test qualifying both directions simultaneously. EXFO supports the latest addition to EtherSAM (Y.1564), including dual-test-set (DTS) configuration enabling quick QoS and key-performance-indicator (KPI) results, such as committed information rate (CIR), excess information rate (EIR), and discarded traffic based on the SLA in the field.

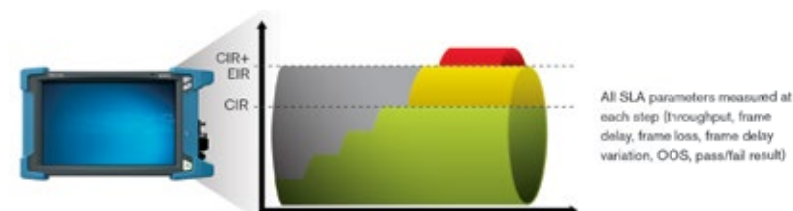
## EtherSAM (Y.1564) Bidirectional Field Test



## Phase 1: Service Configuration Test (Ramp Test)

**Objective:** Validate the network configuration of each defined service (rate limiting, traffic shaping, quality of service).

**Methodology:** For each service, a ramp test is used to gradually reach and exceed the CIR; all KPIs are measured against a threshold.



## Phase 2: Service Performance Test

**Objective:** Validate the quality of service of each defined service and prove SLA conformance.

**Methodology:** All services are generated to their CIR at once, and all KPIs are measured for all services.



# IDENTIFYING WHERE AND WHY NETWORK FAILURES ARE OCCURRING

## APPLICATION CONTEXT

Troubleshooting high-speed Ethernet services.

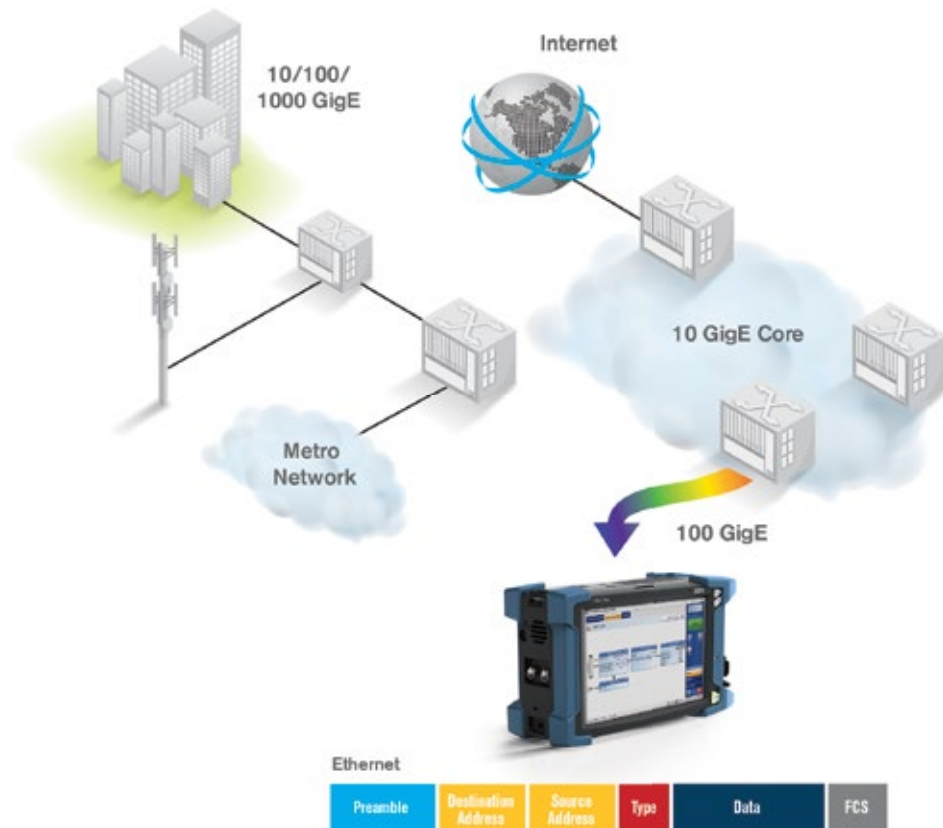
## THE APPLICATION

High-speed networks are becoming more and more complex. With these networks, it is necessary to perform a number of complex procedures in order to identify where and why failures are occurring. Network engineers usually have very little information about each event, and must investigate various probable causes of failure. The difficulty of these tasks is compounded by the pressure of time constraint for investigation, and the risk that customers will be affected.

In order to ensure the proper deployment and optimal performance of 100G Ethernet networks, it is imperative that carriers use the right troubleshooting tools.

For quick and optimal identification of failures, a packet filtering and capture function can be extremely useful. In most troubleshooting cases, the traffic of interest needs to be isolated from any other traffic that takes up memory without providing any useful information. EXFO's Ethernet capture and filtering tool has the capability needed to filter Ethernet traffic in such a way that only a specific profile type is captured, thus maximizing efficient use of available memory. Furthermore, it provides an innovative capability that limits capture to a specific number of bytes starting from the first bit of the Ethernet frame. This enables network engineers to limit capture to the first few bytes of the header, or add more bytes in order to include higher-layer information.

## 40G/100G Ethernet Data Capture



## THE SOLUTION

EXFO's FTB-88XXX Power Blazers and FTB-85100G Packet Blazer high-speed solutions offer a complete Ethernet capture functionality that can help identify critical data issues—and this all the way up to 100G Ethernet. This functionality is designed to quickly pinpoint issues in the field and speed up the troubleshooting process to ensure fast service recovery.



◀ FTB-85100G  
PACKET BLAZER



FTB-8830NGE  
POWER BLAZER ▶



◀ FTB-88100G  
POWER BLAZER

# 100G MULTISERVICE TEST MODULE FTB-890/890NGE NETBLAZER

## THE CHALLENGE

A surge in connected devices is transforming the telecommunications landscape. To deliver high-performance networks and to ensure the best possible quality of experience to their customers, communication service providers need to keep pace.

In the field, this means technicians have to test and validate multiple, complex technologies on a daily basis to ensure that these networks are properly deployed. There is huge pressure on field teams to become experts on all the latest technology and service specifications.

Now, more than ever, technicians need test solutions that are agile, intelligent and easy to use to quickly, accurately and efficiently validate the performance of critical networks.

◀ FTB-890/890NGE NETBLAZER



## THE SOLUTION

Leveraging the powerful FTB-1 Pro test platform, the FTB-890 and FTB-890NGE NetBlazer V2 modules streamline processes and empower field technicians to test and validate: DS<sub>n</sub>/PDH, ISDN, SONET/SDH, OTN, Fibre Channel, common public radio interface (CPRI), and packet-based high-speed Ethernet services—and also analyze radio frequency (RF) interference over CPRI—without sacrificing portability, speed or cost.

Testing traffic speeds from 64K to 100G, the ultra-versatile FTB-890 and FTB-890NGE offer a complete suite of testing capabilities that scales with existing and future testing requirements. These NetBlazer V2 modules address the transformation of metro networks driven by the surge in demand for high-capacity video, voice and other services, as well as the specific testing requirements of data center interconnects (DCIs).

## SIMULTANEOUS COVERAGE OF LEGACY AND HIGH-SPEED NETWORK INTERFACES—SMARTER, SIMPLER, FASTER

- › Optimized field tasks: a complete, all-in-one handheld tester for DS<sub>n</sub>/PDH, ISDN, SONET/SDH, OTN, Fibre Channel (1x to 16x) and 10M-to-100G Ethernet
- › iSAM intelligent service activation methodology: based on ITU-T Y.1564 and RFC 6349 standards to simplify and speed up deployment of advanced metro networks and DCIs
- › Pluggable CFP4, QSFP+ and QSFP28 optics: facilitate testing of next-generation 100G networks



# 100G MULTISERVICE TEST MODULE FTBx-88200NGE FOR LAB AND FIELD



## THE CHALLENGE

With 100G mass deployments now rolling out, network equipment manufacturers are ramping up their 100G stations in the lab and on the production floor. Today's NEMs need to be able to validate and test remotely, automatically, with the most flexible solutions. In addition, NEMs are looking to improve efficiency to reduce testing time from days to hours and deliver solutions to market faster.

In addition, 100G field deployment has arrived. Carriers and carrier labs have been faced with the issue of addressing the growing bandwidth for some time, but there are challenges, including rapidly changing CFP and QSFP technologies, which can be complex.

As well, often, both labs and field need to use the same equipment.

◀ FTBx-88200NGE POWER BLAZER

## THE SOLUTION

The FTBx-88200NGE supports the latest CFP4 and QSFP28 transceiver interfaces, along with SFP, SFP+. This addresses data center and carrier needs to deploy 100G circuits more cost effectively. EXFO's FTBx-88200NGE is the first test solution that offers integrated CFP4 and QSFP28 interfaces that are ready for the 100G network evolution. Moreover, through the industry's first and only iOptics solution, transceivers can be tested and validated quickly and easily.

The FTBx-88200NGE offers a full suite of Ethernet and OTN test capabilities, including advanced lab test options, making it the perfect test solution to help NEMs develop and test their next-generation high speed network equipment.



## SCALABLE AND UNIQUELY AGILE

- › Maximize valuable shelf space while minimizing costs: NEMs can also benefit from EXFO's LTB-8 platform—a highly scalable, highly compact platform offering the industry's best 100G port density
- › Lab managers can simultaneously test 8 x 100G modules with the 8-slot configuration
- › Unique Multilink application: a multi-user interface that offers remote access to multi-modules, multi-platform across multiple locations
- › Transition from the lab to the field: thanks to the compact size and versatility of EXFO's FTB-2 Pro portable platform, the FTBx-88200NGE can be moved from the LTB-8 and slotted to the FTB-2 Pro, ready to take testing from the lab to the field

LTB-8 RACKMOUNT  
PLATFORM ▶



# 40G/100G MULTISERVICE TEST MODULE

## FTB-85100G PACKET BLAZER



### THE CHALLENGE

100G CFP optical module manufacturers and network equipment manufacturers (NEMs) are continuously enhancing their 100G capabilities to reduce network costs and improve efficiency. To this end, manufacturers are looking to in-depth testing capabilities for the development and qualification of their 100G CFPs, transponders, muxponders, switches, etc. These challenges are in addition to their ongoing efforts to speed up time-to-market without compromising quality.

◀ FTB-85100G PACKET BLAZER

## THE SOLUTION

EXFO's FTB/IQS-85100G Packet Blazer delivers in-depth 40G/100G testing capabilities covering a wide range of technologies. Developed with a focus on NEM testing needs, the module offers extensive OTN (ITU-T G.709) testing capabilities, including 40G/100G Ethernet mapping over OTN using GMP for transponder qualification, ODU multiplexing for 40G/100G muxponder qualification and multichannel OTN capabilities with support for 80 simultaneous testing channels. These features are in addition to its full suite of CFP Health Check capabilities dedicated to qualifying the stability and reliability of every CFP used.

## PURPOSELY-BUILT FOR THOROUGH TESTING, PORTABILITY, TRUE RUGGEDNESS AND EASE OF USE

- › In-depth OTN (ITU-T G.709) testing capabilities: 40G/100G Ethernet client mappings into OTN, ODU multiplexing, FEC testing, etc.
- › Complete validation of QoS metrics for 40GE/100GE (IEEE 802.3ba) services: real-life traffic simulation, shaping and analysis, and advanced traffic filtering and capture for troubleshooting purposes
- › iOptics, an intelligent pluggable optics test application for field and lab environments used to efficiently evaluate the proper operation of transceivers, from SFP to CFP2/4 and QSFP, QSFP+ and QSFP28, using minimal user configuration
- › Operational flexibility with multi-user remote management access and complete automation testing capabilities using standard commands for programmable instruments (SCPI)
- › Consistent user experience: simple, standard GUI featured on the FTB/IQS-85100G lab modules and on the FTB/IQS-88100 Series field modules





# 40G/100G DEDICATED TEST MODULE IQS-88100G POWER BLAZER

## THE CHALLENGE

With 100G mass deployments now rolling out, NEMs are ramping up their 100G production lines and stations. Today's NEMs need to be able to validate 100% of the capacity of their manufactured circuits, and do so at a competitive price. In addition, NEMs are looking to reduce testing time from days to hours for significant time savings that translate into direct cost savings.

◀ IQS-88100G POWER BLAZER

## THE SOLUTION

EXFO's IQS-88100G Power Blazer module offers competitively priced 40G/100G testing interfaces for production stations. When needed, four IQS-88100G modules can be housed in EXFO's IQS-610 rackmount platform for port density. The IQS-88100G module can also be configured through software options in order to meet NEMs' production testing needs, which include unframed and framed bit-error-rate (BER) testing capabilities. This, of course, is in addition to its supported automation capabilities for repeatable testing and cost savings.

## INSTALL, VALIDATE AND TROUBLESHOOT NETWORKS UP TO 100G WITH THIS TURNKEY CENTRAL-OFFICE TEST SOLUTION

- › Software-configurable module to address Ethernet and OTN technologies
- › Basic BER testing capabilities with full analysis
- › Multi-user access, full-automation testing capabilities, and customized test reports
- › Rackmount platforms supporting the port density required
- › Professional services to assist with automation and scripting needs

# 400G LAB TESTING

## TKS-600-400G KIT

# 400G



### APPLICATION CONTEXT

With 100G mass deployments ramping up, industry and optical system manufacturers are already shifting their focus and research and development (R&D) efforts to 400G technology. To achieve 400G on the client side, many NEMs have decided to multiplex four 100G client interfaces. Nonetheless, these NEMs still need to fill the 400G pipe with traffic at full capacity, and validate its throughput and other QoS metrics.

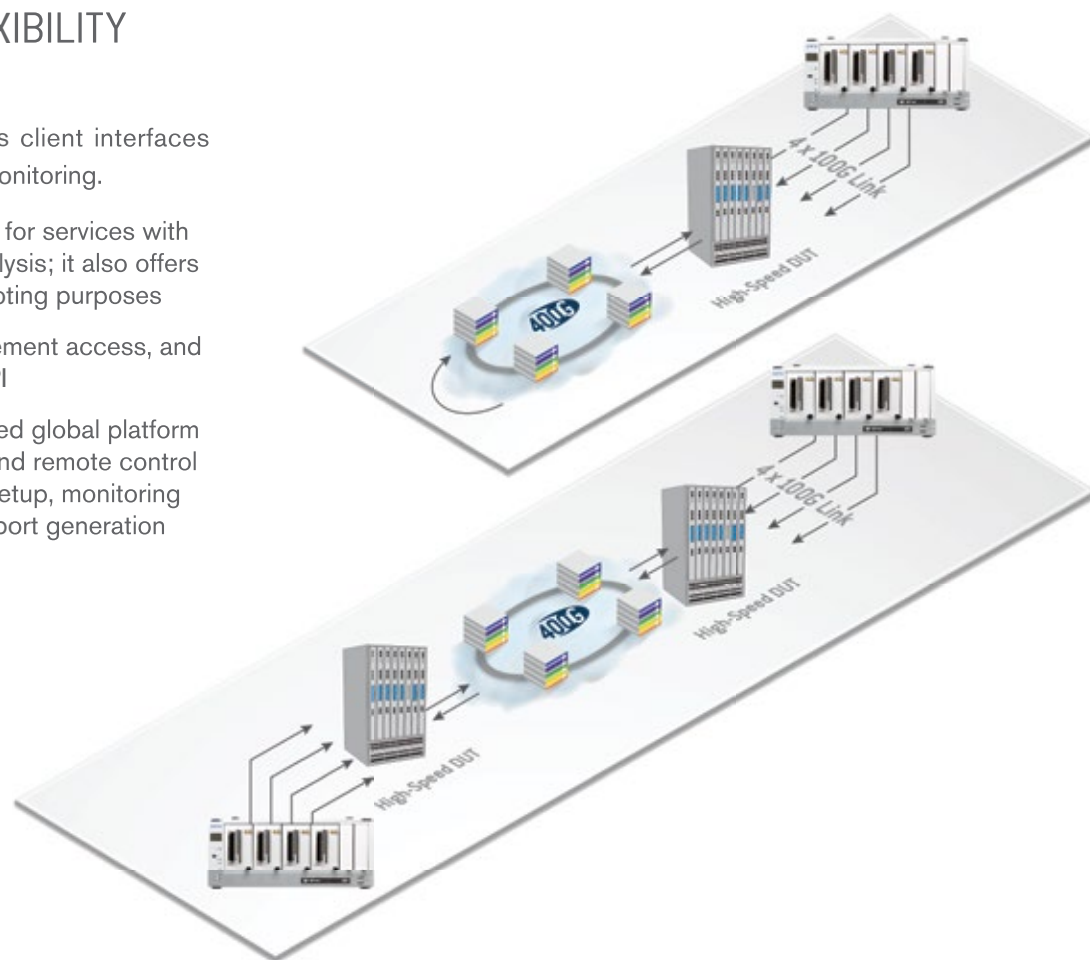
### THE SOLUTION

EXFO's TKS-600-400G kit houses four IQS-88100G Power Blazer modules, each configured to 100GE and running simultaneously to generate and monitor 400 Gbit/s traffic. This competitively priced solution gives NEMs the flexibility to fill the 400G data pipe while monitoring key parameters such as Ethernet throughput, line utilization and Ethernet frame statistics. In addition, the TK-600-400G supports automated testing capabilities using SCPI commands, which reduces testing time from days to hours for significant time savings that translate into direct cost savings.

## 100G MULTIPLEXING WITH THE FLEXIBILITY TO FILL THE 400G DATA PIPE

Offering the capability to configure four 100 Gbit/s client interfaces simultaneously with full traffic profiling, shaping and monitoring.

- › Qualifies 400G implementations and validates KPIs for services with complete real-life traffic simulation, shaping and analysis; it also offers advanced traffic filtering and capture for troubleshooting purposes
- › Operational flexibility with multi-user remote management access, and complete automation testing capabilities using SCPI
- › As a complement to the 400G test kit, the web-based global platform viewer (GPV) application offers a centralized view and remote control of all four IQS-88100G Power Blazer modules for setup, monitoring and troubleshooting purposes, in addition to test-report generation



UP TO

100G



# 100G COMMISSIONING, TURN-UP AND TROUBLESHOOTING INDUSTRY'S ONLY SINGLE-PLATFORM SOLUTION

## FTB-500 WITH FTB-5240S-P AND FTB-88100NGE

### FTB-500 PLATFORM

- › One GigE port and three USB 2.0 ports
- › Inspection probe with automatic pass/fail analysis (ConnectorMax)
- › Optional power meter and visual fault locator (VFL)
- › 6.5-inch TFT outdoor-enhanced LCD display
- › Rechargeable Li-ion batteries providing up to 8 hours of operation as per Telcordia (Bellcore) TR-NWT-00138
- › Remote desktop and VNC
- › Wireless networking (mobile, Wi-Fi, etc.)

### FTB-5240S-P

- › Highly accurate, easy-to-use OSA for CWDM/DWDM network analysis
- › Compliant with recommendation ITU-T G.697

#### Intuitive and Powerful

- › No 1 handheld OSA (Frost & Sullivan)
- › Portable spectral characterization of DWDM networks
- › DWM-Aware: automatic expert settings on a per-channel basis
- › One-button operation for easy setup
- › Flexibility to analyze WDM, EDFA, drift, spectral transmittance, DFB and FP lasers

#### Next-Generation-Ready

- › IEC and in-band OSNR capability
- › First third-party 40G/100G Pol-Mux OSNR option on the market
- › Compliant with 40G/100G and ROADM networks
- › Suitable for all channel spacings

### FTB-88100NGE

- › 10M-to-100G compact multiservice field-test solution addressing 100G converged networks
- › Unprecedented field-testing simplicity requiring minimal training for new users
- › FTB cloud-based services: software upgrade manager, asset and test data management, and floating licenses for OPEX reduction
- › Cost-effective, field-scalable and future-proof solution with FLEX offering: simply point and click to enable any software option—anywhere, anytime
- › OTU1 to OTU4 and OC-3/STM-1 to OC-768/STM-256 bit-error-rate (BERT) testing with pass/fail status
- › 10M-to-100G Ethernet turn-up: EtherSAM (Y.1564), RFC 2544 and EtherBERT with KPIs, including throughput, frame loss, packet jitter, latency and out-of-sequence
- › iOptics transceiver validation



# DWDM TURN-UP AND COMMISSIONING

## FTB-5240S-P/BP

### THE CHALLENGE

Turning up and operating dense wavelength-division multiplexing (DWDM) networks requires an assessment of the signal quality of each channel based on an optical signal-to-noise ratio (OSNR) measurement. However, ROADM and 40G/100G networks present a unique challenge, given that traditional OSNR measurements can produce incorrect results due to the fact that the noise level between the channels is no longer directly correlated with the noise level at the channel wavelength.

### THE SOLUTION

Integrated into the FTB-5240S-P/BP modules, WDM-Aware technology delivers accurate and consistent OSNR measurements:

- › In-band OSNR for noncoherent 40G and ROADM networks
- › Pol-Mux OSNR for coherent 40G/100G and ROADM networks

Some highlights of EXFO's OSA portfolio are as follows:

- › The single best tool for ensuring successful CWDM/DWDM network turn-up
- › Best tool for troubleshooting WDM network failures
- › In-service PMD assessment with WDM Investigator option
- › Intuitive user interface
- › Advanced impairment analysis with WDM Investigator option (crosstalk, nonlinear effects, etc.)

**WDM AWARE™**  
POL-MUX TECHNOLOGY



**EXFO TFv**  
Test Function Virtualization

# 40G/100G OPTICAL SPECTRUM ANALYZER

## IQS-5240S/BP

### THE CHALLENGE

Today's systems and networks are reliant upon new technologies such as reconfigurable add-drop multiplexers (ROADM), and transmit at speeds reaching up to 40G and 100G. In such challenging technological environments, getting reliable in-band OSNR values is key, and the IQS-5240S/BP does exactly that, thanks to EXFO's polarization-resolved optical spectrum (PROS) OSNR measurement approach.



### THE SOLUTION

The IEC 61280-2-9 subsystem test procedure defines OSNR measurement as the power ratio between the peak power and the noise at half the distance between the peaks. Using this method, the noise level at the channel (or peak power) wavelength is interpolated from the noise level between the channels.

However, this method may lead to incorrect results in ROADM or 40 Gbit/s systems, because the noise level between the peaks is no longer directly correlated with the noise level at the channel wavelength. For instance, closely spaced 40G signals require in-band OSNR measurement, because the power level between the channels is higher than the actual noise due to channel overlap.

The built-in, polarization-resolved optical spectrum method featured in EXFO's IQS-5240S-P and IQS-5240BP OSAs enables you to achieve accurate in-band OSNR measurements of ROADM or 40 Gbit/s systems both automatically and directly.

# SINGLE-ENDED DISPERSION ANALYZER

## FTB-5700

### AUTOMATED CD/PMD TESTING WITH ONE EASY-TO-USE MODULE

#### THE CHALLENGE

Increasing market pressure is pushing network operators to reduce costs (both CAPEX and OPEX), and to find ways to do more with less: less engineers and technicians, less truck rolls, less human intervention and less time—while meeting performance standards.



#### THE SOLUTION

Leveraging over 15 years of CD and PMD testing leadership and close collaboration with tier-1 customers, EXFO was in a unique position to design a dispersion test solution that addresses today's reality—the FTB-5700, ratified by the EIA/TIA.

- › Approximately half the cost of traditional dispersion analyzers
- › Single-ended testing on up to 120 km, with reports finalized in the field for faster job completion
- › Immediately accurate results, significant manpower reduction, and about 66% OPEX and time-to-service reduction
- › One module, one connection, one test, one technician: zero setup, zero data interpretation
- › Optimized for point-to-point and mesh networks: compact configuration for metro applications
- › Compliant with next-generation network standards: EIA/TIA FOTP 175B (CD), EIA/TIA FOTP 243 (PMD) and ITU G.650.3

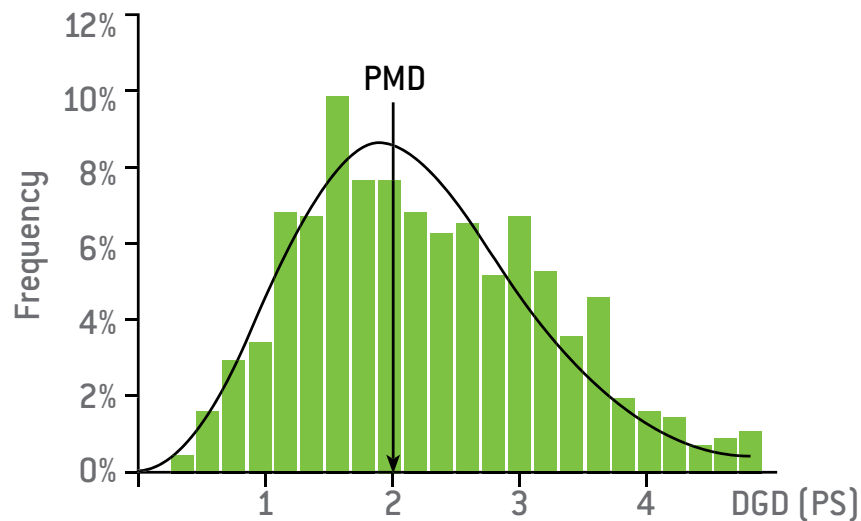
# PMD COMPENSATION FAILURES IN 100G COHERENT SYSTEMS

## REDUCE OCCURRENCES WITH THE FTB-5500B

### APPLICATION CONTEXT

One of the touted benefits of coherent systems is that they can compensate for PMD, but just how valid is this claim? Each wavelength has a different instantaneous PMD (referred to as differential group delay, or DGD) that is uncorrelated with the next wavelength and which changes over time. The average of all these DGDs at individual wavelengths is what we refer to as PMD. Coherent systems feature digital-signal-processing (DSP) technology that tracks and compensates for the variations in DGD on a per-wavelength basis in real time. However, DSPs can only compensate for a limited range of DGD, and have a limited reaction time to changes in DGD.

Because DGD changes over time, very high DGD values could exceed the compensation range of the DSP. Similarly, DGD changes very rapidly sometimes, and much faster than the DSP is capable of tracking, which leads to loss of PMD compensation. In addition, sudden changes in the state of polarization can lead to a complete loss of signal. When this occurs, the DSP tries to resynchronize and rediscover the level of PMD to be compensated for. Although it usually does this very quickly, during the process many bits will have gone by uncompensated for, potentially generating a lot of errors.



EVEN WITH LOW PMD, HIGH DGD VALUES CAN OCCUR AND LEAD TO PMD COMPENSATION FAILURE

## THE SOLUTIONS

There is a greater chance of exceeding the PMD tolerance range if the PMD of the fiber is high. Likewise, rapid changes in PMD or the state of polarizations usually occur when fiber PMD is high. As such, testing the PMD of coherent systems with an instrument such as the FTB-5500B is imperative in order to identify fibers with high PMD levels. Doing so makes it possible to reduce the risk of network failures by using a fiber with lower PMD, or by replacing the high-PMD section with the help of a tool such as the FTB-5600 Distributed PMD Analyzer. In particular, aerial sections, bridge sections and the sections that follow these areas are very prone to exhibiting high PMD. Furthermore, PMD testing is also required in coherent systems, because system vendors often ask service providers to supply the fiber's PMD value when a new coherent network is deployed.



# PMD ANALYZER FTB-5500B

## ADVANCED PMD TESTING, AT LIGHTNING-FAST SPEEDS

### THE CHALLENGE

PMD has been known for a long time as a significant danger to both legacy and newly deployed networks. However, with the advent of 10G, 40G and 100G systems, concern and awareness for PMD keeps growing.

### THE SOLUTION

EXFO's FTB-5500B PMD Analyzer helps you get ahead in the field. Whether you need to verify the capacity of legacy fiber or maintain a network, this FTB-5500B test module is fast, reliable and ready to go.

- › Dynamic range of more than 50 dB
- › PMD range of 0 ps to 115 ps
- › Tests through EDFAs
- › Combines with the FLS-5800 light source, which is designed for both PMD and chromatic dispersion (CD) testing

MATCH YOUR DISPERSION  
TESTING APPROACH  
TO YOUR NEEDS

# CHROMATIC DISPERSION ANALYZER—FTB-5800

FAST, ACCURATE CD TESTING  
IN THE CO AND IN THE FIELD

## THE CHALLENGE

Much like PMD, chromatic dispersion (CD) is a physical phenomenon whose effect increases with higher transmission speeds. At 40 Gbit/s and 100 Gbit/s, it becomes critical to accurately characterize CD and implement appropriate compensation.

## THE SOLUTION

EXFO's FTB-5800 uses the approved phase-shift method to measure CD in DWDM, long-haul and ultra-long-haul networks and systems. Housed in the expert FTB-500 Platform, it offers speed, accuracy and high performance for all your CD test needs in the central office (CO) and in the field.

- › Tests through EDFAs
- › No communication between source and receiver
- › Personalized data management for clear, customized report generation

# DISTRIBUTED PMD ANALYZER—FTB-5600

THE FIRST DISTRIBUTED PMD  
ANALYZER ON THE MARKET

## THE CHALLENGE

At higher bit rates such as 10 Gbit/s, 40 Gbit/s and 100 Gbit/s, polarization mode dispersion (PMD) can be quality-limitative, as it increases with faster transmission. Traditionally, two options were available to address this situation: trying to find another fiber fit for high-speed transmission, or replacing the whole link. While the former option offers no guarantee, since other fibers installed around the same time will likely display similar PMD, the latter option, although effective, can be extremely costly.

## THE SOLUTION

The FTB-5600 Distributed PMD Analyzer adds a third option to the mix: replacing only the faulty sections of the link. The first instrument of its kind on the market, the FTB-5600 delivers a clearer, more detailed picture of a link's PMD, one that performs a paradigm shift from "effective but costly" to "cost-effective."

- › Performs single-ended, section-by-section measurement of a link's PMD
- › Simulates the impact of replacing a high-PMD section on the link's total PMD



FUTURE-PROOF THE CHARACTERIZATION  
OF ANY OPTICAL SIGNAL

# OPTICAL SAMPLING OSCILLOSCOPES PSO-100 SERIES

## DISTORTION-FREE CHARACTERIZATION AT 40G, 100G AND BEYOND

### THE CHALLENGE

Thanks to advanced modulation schemes, ultra-high network speeds can be achieved using existing DWDM channel spacing while maintaining resilience to chromatic and polarization dispersion phenomena. However, full characterization of such ultra high-speed encoding represents a significant challenge.

### THE SOLUTION

EXFO's PSO-100 Series delivers such capabilities for applications ranging from high-speed transceiver compliance testing to line card/system design and characterization to new modulation scheme research.

- › Distortion-free signal recovery thanks to 500 GHz bandwidth
- › Bit rate and modulation format-independent
- › No trigger needed
- › Polarization-independent
- › Ultra-low timing jitter:  $\leq 50$  fs (typical)

# OPTICAL MODULATION ANALYZER—PSO-200

## ALL-OPTICAL SAMPLING— NO BOUNDARIES

### THE CHALLENGE

Due to new advanced modulation schemes that enable transmission of high-speed optical signals over fiber, research centers and NEMs (and ultimately carriers) need new test instruments to properly characterize these signals.

### THE SOLUTION

The PSO-200 uses optical sampling that allows for complete characterization of random or repetitive digital signals up to 100 GBd—perfect for applications such as manufacturing testing of phase-modulated transmitters, including 100G DP-QPSK, as well as design and optimization of the system band on phase and amplitude modulation schemes at rates of up to 1 Tbit/s and beyond.

- › All-optical design providing the effective bandwidth to properly characterize waveforms and signals up to 1 Tbit/s and beyond
- › Compatible with dual-polarization transmission
- › Fully integrated with the smallest form factor in the industry
- › Includes all the required tools for testing of transmitters in manufacturing, such as EVM, BER and masks
- › Single pass/fail criterion for transmitter compliance testing using time-resolved EVM



# 100G/200G/400G COHERENT TRANSMITTER TESTING AND OPTIMIZATION

## A KEY CONSIDERATION FOR LABS AND MANUFACTURING

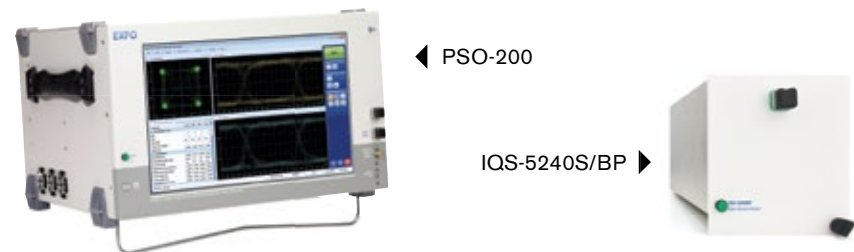
### APPLICATION CONTEXT

Coherent transmitter testing and optimization in lab and manufacturing is critical in order to achieve the system performances expected with such high-speed transmission technology. One of the inherent challenges of such testing and optimization is that most transmitter problems can only be seen with a highly accurate modulation analyzer providing distortion-free signal recovery. This is all the more true in the case of new Nyquist filtering or raised cosine shaping applied to 200G and 400G signals.

There are over a dozen different adjustment points in a coherent transmitter, and each of them can have a serious impact on transmission quality. For this reason, signal parameters such as IQ imbalance, IQ offset, skew and BER must be accurately tested. However, these measurements involve complex calculations. In addition, deep knowledge of transmitter design is often required for proper evaluation of the results analysis.

EXFO's expertise has been integrated into both the PSO-200 Optical Modulation Analyzer and the IQS-5240S/BP Optical Spectrum Analyzers, providing simple, accurate and reliable instruments with the features required by R&D engineers, as well as the simplicity and integration required for manufacturing.

### THE SOLUTIONS



◀ PSO-200

IQS-5240S/BP ▶

# FACE THE MASSIVE TRAFFIC SURGE HEAD-ON

- > Cost-effective, scalable and future-proof solutions
- > Comprehensive and fully integrated test solutions covering OTN, Ethernet and SONET/SDH technologies
- > 100G multiservice field-service solutions addressing the commissioning, turn-up and troubleshooting of next-generation networks
- > From lab to deployment and design to development, we've got you covered
- > Industry's first Pol-Mux OSA for DWDM networks

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[www.EXFO.com/high-speed](http://www.EXFO.com/high-speed)

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