# NetBlazer V2 Series
# High-speed portable field testers

## SMARTER TESTING FOR ALL THINGS 64K TO 100G

NetBlazer 100G

EXFO TFv
Test Function Virtualization

EXFO Connect
Compatible

iSAM

iOptics

OpticalRF™

Feature(s) of this product is/are protected by US patent 9,432,206 and equivalents in other countries.

The NetBlazer V2 Series is the industry's most complete and portable 64K to 100G test solution. Optimize your field technicians' tasks with simultaneous coverage of legacy and high-speed network interfaces.

## KEY FEATURES AND BENEFITS

### Platform highlights

Windows 10 IoT (bring your own device, install what you want)

Custom-designed platform with 128 GB of onboard memory, including a micro SD card interface (massively expand the memory)

Built-in connectivity—choose between Gigabit interface, WiFi, Bluetooth, and 3G or 4G LTE via USB dongle

Lightweight and portable solution with an ultra-bright, 8-in multitouch screen

### High speed interfaces

Pluggable CFP4 and QSFP28 optics to facilitate the testing of next-generation 100G networks

Pluggable QSFP+ interface for 40GE and OTU3

iOptics—an intelligent pluggable optics test application that quickly validates the sanity of an optical device using minimal configuration

### Transport testing

OTU1, OTU1e/1f, OTU2, OTU2e/2f, OTU3, OTU3e1/e2, OTU4

Advanced OTN features: single- and multi-stage mapping, Ethernet over OTN, ODU0, ODUflex

SONET and SDH testing from STS-1e/3e and STM-0e/1e to OC-192 and STM-64

DSn testing DS1, DS3 and dual DS1/DS3 RX

Plesiochronous digital hierarchy (PDH) testing: E1, E3 and E4

ISDN PRI for DS1 or E1

Round-trip delay on all interfaces and payload mappings

Service disruption measurements on all interfaces and mappings

Overhead monitoring and modification for all time slots

Pointer adjustment

### Ethernet/Fibre Channel testing

Dual-port or quad-port testing up to 10G

Port testing available at 100G

iSAM: ultra-simple ITU-T Y.1564 and RFC 6349 service activation methodology

10M to 100G multisession transmission control protocol (TCP) testing with bidirectional RFC 6349

Power-over-Ethernet validation within cable test

EtherSAM (Y.1564), RFC 2544, traffic generation and monitoring, EtherBERT, Through Mode, Smart Loopback and second-port loopback tool

Packet synchronization, including IEEE 1588v2 PTP and SyncE

Carrier Ethernet OAM, including ITU-T Y.1731, IEEE 802.1ag, IEEE 802.3ah link OAM

Packet capture and advanced filtering up to 100G

Fibre Channel 1x, 2x, 4x, 8x, 10x and 16x support

### Fronthaul/FTTA/C-RAN testing

Dual port and Quad Port CPRI testing up to 10.1G

CPRI layer-2 link validation for BBU or RRH from 1.2G to 10.1G

OBSAI layer-2 link validation for BBU or RRH from 1.5G to 6.1G

CPRI/OBSAI framed and unframed BER with pseudo-random bit sequence (PRBS) patterns and latency measurements

BBU emulation allowing RF level validation of RRHs , RET status and control and remote SFP identification

Wander time error testing

### RF spectrum analysis

Real-time high-resolution RF spectrum analysis over CPRI

## COMPATIBLE PLATFORM

**Platform**
FTB-1 Pro

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# CHOOSE THE RIGHT NETBLAZER FOR YOU

| | | | | | NetBlazer 100G | |
| NETBLAZER V2 MODULES | FTB-870V2 | FTB-880V2 | FTB-870Q | FTB-880Q | FTB-890 | FTB-890NGE |
|---|---|---|---|---|---|---|
| DSn/PDH (DS1/E1) | • | • | • | • | | • |
| ISDN PRI | • | • | • | • | | • |
| DSn/PDH (DS3, E3 and E4) | | • | | • | | • |
| OTN (OTU1/OTU2) | • | • | • | • | • | • |
| OTN (OTU3/OTU4) | | | | | • | • |
| Single- and multi-stage mapping (ODUMUX) | • | • | • | • | • | • |
| Ethernet over OTN | • | • | • | • | • | • |
| ODU0 and ODUflex | • | • | • | • | • | • |
| SONET/SDH (up to 10G) | • | • | • | • | • | • |
| SONET/SDH (electrical) | | • | | • | • | • |
| Fibre Channel (1x, 2x, 4x, 8x and 10x) | • | • | • | • | • | • |
| Fibre Channel (16x) | | | | | • | • |
| 1588 PTP/SyncE | • | • | • | • | • | • |
| Wander | | • | | • | | • |
| Carrier Ethernet OAM | • | • | • | • | • | • |
| RFC 6349 (up to 10G TCP) | • | • | • | • | • | • |
| RFC 6349 (up to 100G TCP) | | | | | • | • |
| CPRI (1.2G up to 10.1G) | • | • | • | • | • | • |
| Dual-port Ethernet and CPRI testing | • | • | • | • | | |
| Quad-port Ethernet and CPRI testing | | | • | • | | |
| OBSAI (1.5G, 3.1G and 6.1G) | • | • | • | • | • | • |
| OpticalRF™ and BBU emulation | • | • | • | • | | • |
| Simultaneous transport/Ethernet testing | | | • | • | | |
| iOptics | • | • | • | • | • | • |

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# TEST SPEEDS UP TO 100G

**FTB-890 NetBlazer**

The FTB-890 NetBlazer is the entry-level 10M-to-100G tester that covers a wide range of technologies including Ethernet, OTN, SONET/SDH, CPRI and Fibre Channel.

**FTB-890NGE NetBlazer**

The FTB-890NGE NetBlazer is the most comprehensive all-in-one tester, including testing for legacy networks at 64K all the way up to next-generation networks at speeds of 100G.

# TEST SPEEDS UP TO 10G

**FTB-880v2 NetBlazer**

The FTB-880v2 NetBlazer is the field technician's go-to solution covering all things 10G. Fully loaded Ethernet testing includes iSAM and RFC 6349 with GigE and 10 GigE dual ports, OTN, SONET/SDH, DSn/PDH, ISDN PRI, fiber-to-the-antenna (FTTA), Fibre Channel and packet synchronization.

**FTB-880Q NetBlazer**

Double up everything the FTB-880v2 NetBlazer has to offer, and you get the FTB-880Q NetBlazer. The FTB-880Q is designed for maximum field-technician efficiency through accelerated processes running up to four simultaneous tests, as well as completely independent tests with zero restrictions. The FTB-880Q (and the FTB-870Q) are the only handheld testers offering quad-port GigE and 10 GigE.

# STREAMLINED FOR EASE OF USE
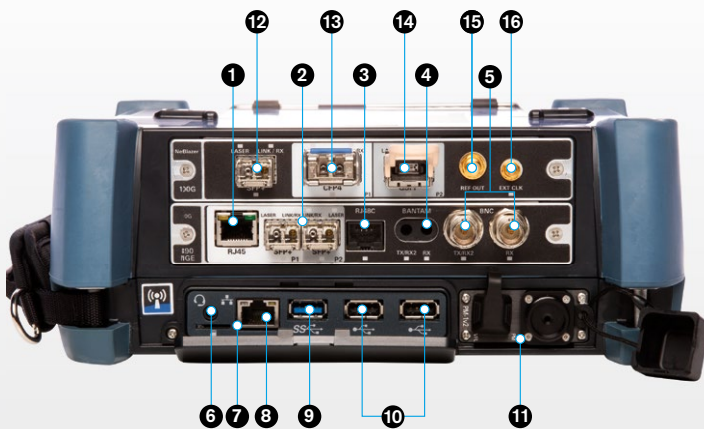
**1 ETHERNET**
10/100/1000 BASE-T

**2 OPTICAL 10G**
CPRI 1.2 to 10.1G
OBSAI 1.5G to 6.1G
OC-192/STM-64,
OC-48/STM-16,
OC-12/STM-4,
OC-3/STM-1,
OC-1/STM-0, OTU1, OTU2,
OTU1e, OTU2e, OTU1f,
OTU2f, 10GE LAN/WAN,
Ethernet 10/100/1000
BASE-T, 100M/1G optical,
FC 1x, 2x, 4x, 8x, 10x,
RF spectrum over CPRI

**3 DSn/PDH**
EXT CLK
Wander

**4 DSn/PDH**
RX2: DS1
EXT CLK

**5 Electrical**
SONET/SDH
DSn/PDH
RX2: DS1/DS3
EXT CLK
Wander

**6** Mic/headset jack

**7** Micro SD card slot

**8** 1 GigE port

**9** One USB 3.0 port

**10** Two USB 2.0 ports

**11** Power meter and VFL

**12 OPTICAL 10G**
Ethernet up to 10 Gbit/s
CPRI 1.2 to 10.1G
OBSAI 1.5G to 6.1G
OC-192/STM-64,
OC-48/STM-16,
OC-12/STM-4,
OC-3/STM-1,
OC-1/STM-0, OTU1, OTU2,
OTU1e, OTU2e, OTU1f,
OTU2f, 10GE LAN/WAN,
Ethernet 10/100/1000
BASE-T, 100M/1G optical,
FC 1x, 2x, 4x, 8x, 10x, 16x

**13 HIGH SPEED**
CFP4 interface
supporting OTU4, 100GE

**14 HIGH SPEED**
QSFP28/QSFP+ interface
supporting OTU4, OTU3,
OTU3e1/e2, 100GE, 40GE

**15 REF CLOCK OUT**
SMA interface

**16 EXT CLK**
SMB interface

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# THE ULTRA-PORTABLE CHOICE FOR MULTISERVICE TESTING

The ongoing transition towards a converged network infrastructure for legacy DSn/PDH, ISDN, SONET/SDH, OTN, Fibre Channel, CPRI, OBSAI and packet-based, high-speed Ethernet services requires a test tool that is capable of covering a wide range of interfaces and rates without sacrificing portability, speed or cost. Leveraging the powerful, intelligent FTB-1 Pro handheld platform, the NetBlazer V2 Series streamlines processes and empowers field technicians to test and validate DSn/PDH, ISDN, SONET/SDH, OTN, Fibre Channel, CPRI and Ethernet circuits efficiently.

## Powerful and fast

The NetBlazer V2 Series is a fully integrated DSn/PDH, ISDN, SONET/SDH, OTN, Fibre Channel, CPRI, OBSAI and high-speed Ethernet handheld tester. It features an 8-inch multitouch screen and unprecedented configuration simplicity. Multiple platform connectivity options including WiFi, Bluetooth, Gigabit Ethernet and USB ports, make it accessible in any environment.

### DSN/PDH, ISDN, SONET/SDH, OTN, FIBRE CHANNEL, CPRI, OBSAI AND CARRIER ETHERNET UP TO 100G

**Key Testing Benefits**

- Up to 10G SONET/SDH
- OTN bit-error-rate (BER) testing with configurable threshold settings
- GCC 0/1/2 BERT test capability on OTN BERT
- Advanced OTN features: single- and multi-stage mapping, Ethernet over OTN, ODU0, ODUflex, intrusive OTN through mode
- Coupled, Decoupled and Through mode testing
- Error and alarm insertion and monitoring
- Overhead monitoring and manipulation
- High-order and low-order mappings
- Tandem connection monitoring (TCM)
- Pointer manipulation, including pointer sequence testing as per Telcordia GR-253, ANSI T1.105-03 and ITU-T G.783
- Performance monitoring as per ITU-T G.821, G.826, G.828, G.829, M.2100 and M.2101
- Frequency analysis and offset generation
- Automatic protection switching
- Service-disruption-time measurements
- Round-trip delay measurements
- DS1/DS3 and E1/E3/E4 testing
- Dual DS1/DS3 receiver (Rx) support
- DS1/DS3 autodetection of line code, framing and pattern
- DS1 loop codes and NI/CSU emulation
- DS1 automated multipattern BER
- DS1/DS0 monitoring, including ABCD signaling bits
- DS1 FDL and DS3 FEAC
- Fractional T1/E1 testing
- ISDN PRI for DS1 or E1 interfaces
- External clock support

- 10BASE-T to 100 GigE testing
- Quad-port testing (8XXQ module only)
- Dual-port testing
- 10M-to-100G TCP throughput testing as per RFC 6349
- SAM: ultra-simple ITU-T Y.1564 combined with RFC 6349
- EtherSAM, RFC 2544, traffic generation and monitoring, and EtherBERT
- Up to 10 frame sizes in a single RFC 2544 test run
- 1588 PTP supporting G.8265.1 and G.8275.1 profiles and SyncE
- Through mode and Smart Loopback
- Cable testing, including power over Ethernet
- Full line-rate packet capture and advanced filtering from 10M to 100G
- IPv6 testing
- VLANs, including E-VLAN, S-VLAN and C-VLAN
- VLAN scan
- Multiprotocol label switching (MPLS)
- Asymmetrical testing with dual test set (EtherSAM, RFC 2544, iSAM and RFC 6349)
- Carrier Ethernet OAM (MEF, IEEE 802.1ag, ITU-T Y.1731 and ITU-T G.8113.1 MPLS-TP) and link OAM (IEEE 802.3ah)
- Fibre Channel 1x, 2x, 4x, 8x, 10x, 16x
- Framed CPRI BBU and RRH layer-2 link validation from 1.2 Gbit/s to 10.1 Gbit/s
- Unframed and framed CPRI BER from 1.2 Gbit/s to 10.1 Gbit/s with SDT and RTD
- Framed OBSAI BBU and RRH layer-2 link validation from 1.5 Gbit/s to 6.1 Gbit/s
- iOptics intelligent pluggable optics test that quickly validates the sanity of an optical device
- OpticalRF™ real-time high-resolution RF spectrum over CPRI
- BBU emulation enabling RF level validation of RRHs, RET status and control and remote SFP identification
- Wander timer error testing

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# KEY OTN, SONET/SDH AND DSn/PDH FEATURES

## Simplified BER testing

The NetBlazer V2 Series provides the ability to preconfigure bit-error-rate (BER) thresholds that are user-defined prior to running the test. This allows for a simple pass/fail verdict at the conclusion of the test, leaving no room for misinterpretation of the test results.
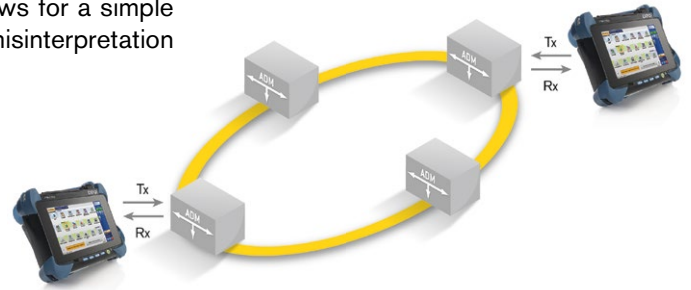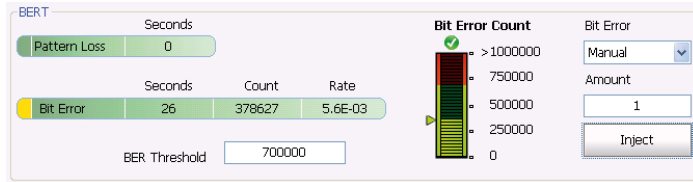


# MULTISERVICE

## Decoupled mode

The decoupled mode enables the user to independently configure the Tx and Rx ports of the NetBlazer V2 Series module. This makes it possible to test the mapping and demapping functionality of a network element or at cross-connect points in the network.



## Through mode

This mode is required for in-service monitoring of the network. The NetBlazer V2 Series can be inserted in-line on a specific link to monitor and analyze the errors and alarms in a non-intrusive manner.

## Complete overhead monitoring

The NetBlazer V2 Series offers access to all SONET/SDH or OTN overhead (OH) bytes. Furthermore, by selecting any given OH byte, the user can retrieve additional detailed information about that byte without having to switch pages.
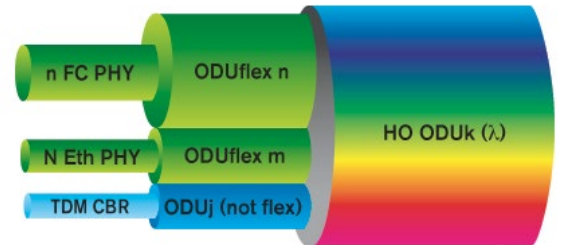


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### OTN GCC BERT

This NetBlazer V2 Series feature enables the user to run a BERT test on GCC channels. The test set supports BERT on GCC0/1/2 channels individually, two channels simultaneously or all channels simultaneously.

### ODUflex

The fixed OTN rates, including OTU2 (10 Gbit/s), OTU3 (43 Gbit/s) and OTU4 (112 Gbit/s), among many other OTN rates, provide an efficient transport mechanism for constant bit rate (CBR) clients such as SONET/SDH, Ethernet and Fibre Channel. On the other side, ODUflex provides the ability to create a container that is appropriately sized for the data rate of the client, offering a single manageable entity across the OTN that can be permanently fixed for CBR clients, or adjusted based on connectivity demand in the network using the generic framing procedure (GFP). ODUflex uses 1.25 Gbit/s tributary time slots (ODTUGk) to create the variable container in which a client signal is mapped and then transported. Using ODUflex in carrier networks brings significant benefits, including higher efficiency for network configuration and bandwidth allocation and also provides a future-proof solution for transporting any client signal at any rate, when needed.



### Ethernet and SONET/SDH mapping over OTN

EXFO's solution offers 10G/40G/100G Ethernet and SONET mapping capability over OTU3/OTU4 through EoOTN or SONET/SDH software options. This key testing capability allows the validation of the operation of high-speed transponder functionalities, such as mapping and demapping capabilities as well as client signal timing transparency. It also provides the 40 GigE-specific transcoding capability that must be qualified to ensure that the 40 GigE-frame is properly transcoded from 64B/66B to 1024B/1027B, and properly mapped into the OTU3 (43G) standard frame.

Customers can now map Ethernet clients or SONET/SDH over OTN with different traffic characteristics, run end-to-end BER tests across OTN and measure the ratio of bit errors to the number of bits sent. In this testing configuration, the module provides complete analysis of the OTN transport layers, including OTU/ODU/OPU and GMP statistics to ensure proper recovery of the client signal at the received end and complete SONET/SDH analysis. The EoOTN testing capability also validates the Ethernet traffic transmission with 100% throughput, and ensures that latency does not impact service providers' service-level agreements (SLAs) with their customers.

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## KEY ISDN FEATURES

The NetBlazer V2 Series lets you test and troubleshoot North American or European ISDN PRI configurations, and offers best-in-class ISDN PRI testing by allowing field technicians to call one or all 23 DS1 or 31 E1 PRI channels. Once connected, the user can go channel by channel to perform a BER test on individual or all channels, as well as talk and listen via a headset.
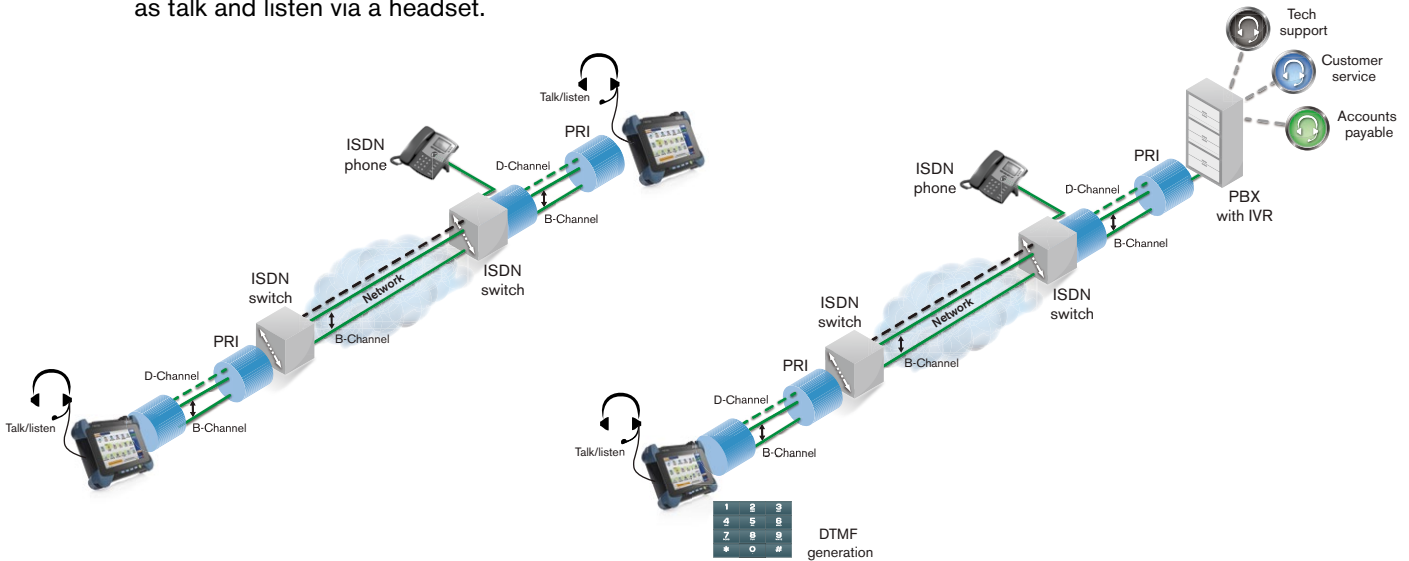


### Talk? Listen? Inject DTMF?

With one click, field technicians can talk and listen with simplicity—no need for a clumsy butt set. The FTB-1 Pro platform enables the use of a lightweight talk/listen headset, which can be controlled via software to inject dual-tone multifrequency (DTMF) tones, and control volume and microphone levels.
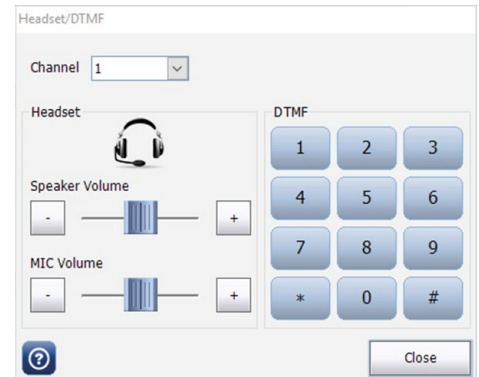


### Who's calling? What type of calls?

As calls come in or leave the ISDN primary rate interface, the summary results screen shows a crystal-clear analysis with its own unique call-monitoring grid. In a single glance, users can see all call information: types of calls and statistics such as idle, voice, 3.1 kHz, ringing, alerts, bit error, and pass or fail.
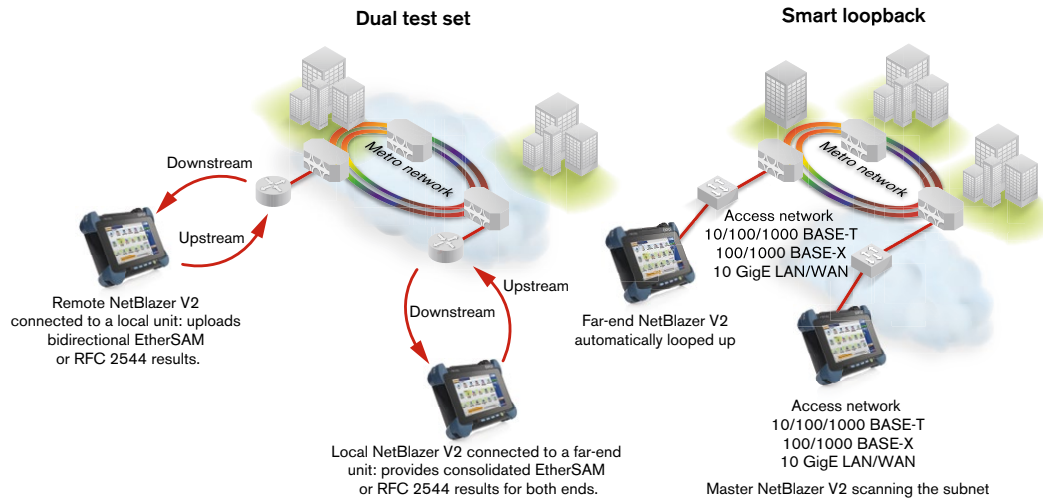


### Centralized control

With the NetBlazer V2 Series, field technicians have complete control at their fingertips at all times. Whether that applies to a phone book, headset activation, DTMF injection, error injection, report generation, or save and load configurations, all utilities are just a tap of a finger away from activation.
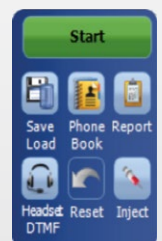


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# KEY ETHERNET FEATURES

## Intelligent network discovery mode

Using the NetBlazer V2 Series, you can single-handedly scan the network and connect to any available EXFO datacom remote tester. Simply select the unit to be tested and choose whether you want traffic to be looped back via Smart Loopback or dual test set mode for bidirectional EtherSAM, RFC 6349 or RFC 2544 results. As such, you no longer need an additional technician at the far end to relay critical information—the NetBlazer V2 Series takes care of everything.



**Dual test set**

Downstream

Upstream

Remote NetBlazer V2 connected to a local unit: uploads bidirectional EtherSAM or RFC 2544 results.

Upstream

Downstream

Local NetBlazer V2 connected to a far-end unit: provides consolidated EtherSAM or RFC 2544 results for both ends.

**Smart loopback**

Access network
10/100/1000 BASE-T
100/1000 BASE-X
10 GigE LAN/WAN

Far-end NetBlazer V2 automatically looped up

Access network
10/100/1000 BASE-T
100/1000 BASE-X
10 GigE LAN/WAN

Master NetBlazer V2 scanning the subnet

## Smart loopback flexibility

The smart loopback functionality has been enhanced to offer five distinct loopback modes. Whether you are looking to pinpoint loopback traffic from a user-datagram-protocol (UDP) or TCP layer, or all the way down to a completely promiscuous mode (transparent loopback mode), the NetBlazer V2 Series has the flexibility to adjust to all unique loopback situations.

## Dual-port and through mode testing

With dual-port testing, one technician can use a single NetBlazer V2 Series module to launch either EtherSAM or RFC 2544, and obtain bidirectional results using only one module. With traffic generation and monitoring, and EtherBERT tests, the technician can set up two distinct tests, one on port 1 and the other on port 2. Both ports can also be bound to different interfaces (e.g., 10BASE-T electrical on port 1 and 10 GigE on port 2).

## VLAN/MPLS

Today's networks are expected to deliver high performance. To meet such high expectations, 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 NetBlazer V2 Series supports virtual-local-area-network (VLAN) tags, Q-in-Q VLAN tags and multiprotocol label switching (MPLS).



**EXFO**
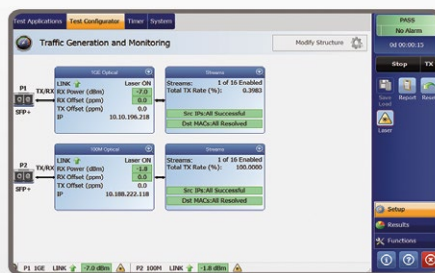
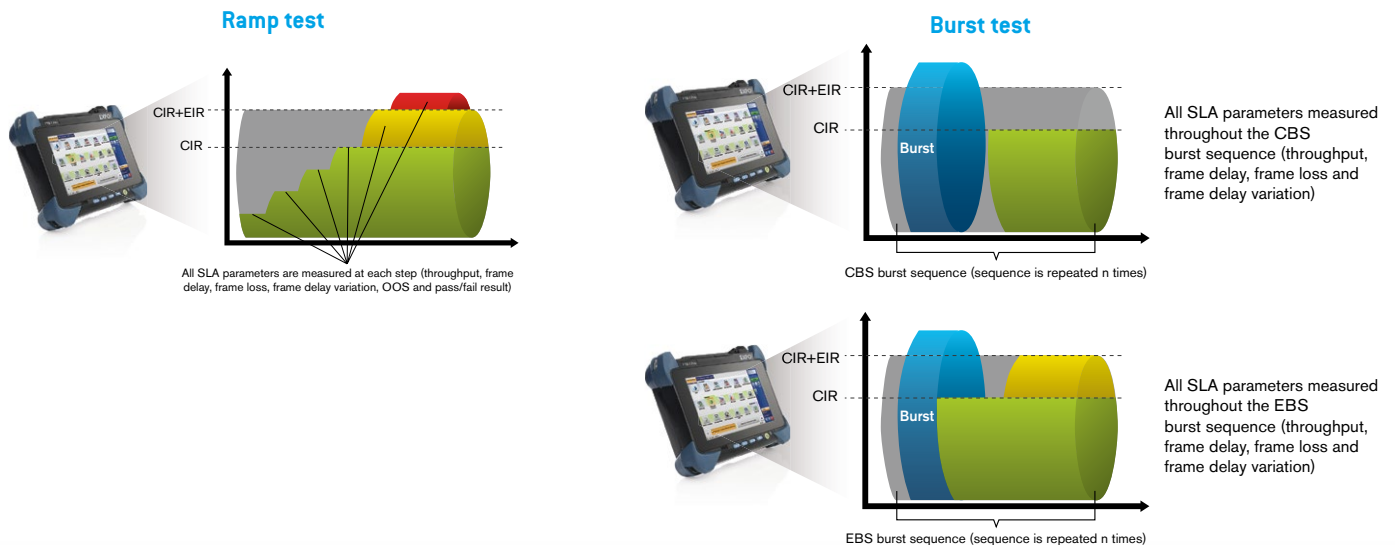## EtherSAM: THE NEW STANDARD IN ETHERNET TESTING

RFC 2544 used to be the most widespread Ethernet testing methodology. However, it was designed for network-device testing in the lab, not service testing in the field. ITU-T Y.1564, the new standard for turning up and troubleshooting Carrier Ethernet services, has a number of advantages over RFC 2544, including validation of critical service-level agreement (SLA) criteria, such as packet jitter and quality-of-service (QoS) measurements. This methodology is also significantly faster, thereby saving time and resources while optimizing QoS.

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.

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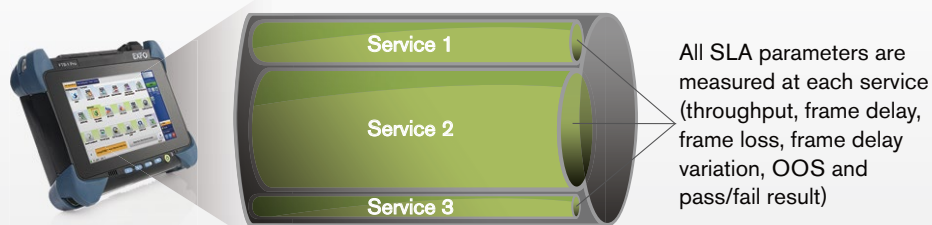
### Service configuration test

The service configuration test involves sequentially testing each service to validate that it is properly provisioned and that all specific key performance indicators (KPIs) or SLA parameters have been met. A ramp test and burst test are performed to verify the committed information rate (CIR), excess information rate (EIR), committed burst size (CBS) and excess burst size (EBS).



**Ramp test**

CIR+EIR
CIR

All SLA parameters are measured at each step (throughput, frame delay, frame loss, frame delay variation, OOS and pass/fail result)

**Burst test**

CIR+EIR
CIR
Burst

All SLA parameters measured throughout the CBS burst sequence (throughput, frame delay, frame loss and frame delay variation)

CBS burst sequence (sequence is repeated n times)

CIR+EIR
CIR
Burst

All SLA parameters measured throughout the EBS burst sequence (throughput, frame delay, frame loss and frame delay variation)

EBS burst sequence (sequence is repeated n times)

### Service performance test

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



Service 1

Service 2

Service 3

All SLA parameters are measured at each service (throughput, frame delay, frame loss, frame delay variation, OOS and pass/fail result)

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## EtherSAM BIDIRECTIONAL RESULTS

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



**Round-trip results only**

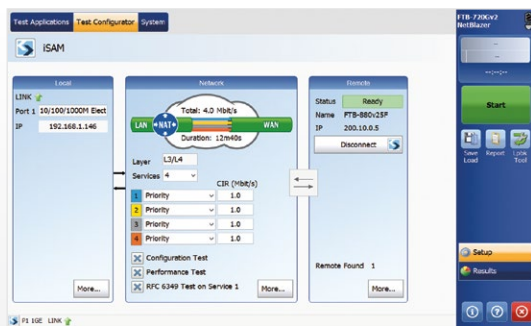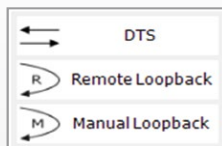**The only effective way to test burst**
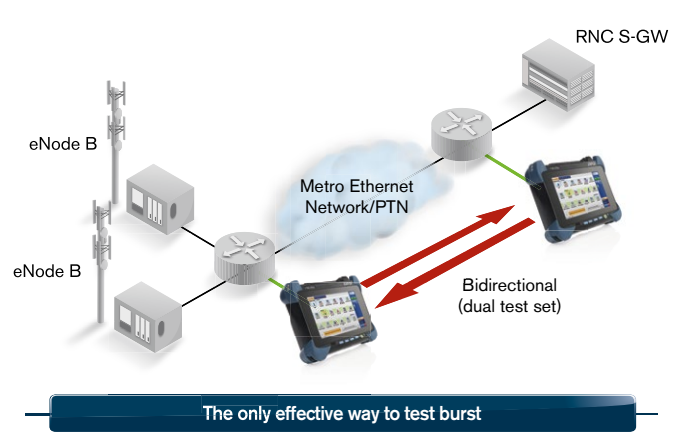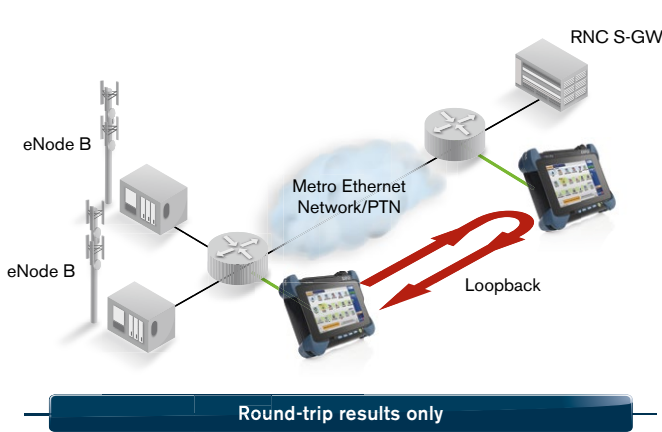
## iSAM

With iSAM, which includes Y.1564 (EtherSAM) and optional 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.



*One-page setup*

*Multiple modes of connection*

*One-page results*

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## DUAL PORT

The dual-port testing feature enables technicians to use a single NetBlazer module to launch two simultaneous tests (one on port 1 and the other on port 2), including rates from 10M to 100G. Having a separate set of statistics for alarms and errors provides the capability to inject errors independently. This feature helps technicians reduce testing time during new link implementations.



## CABLE TEST WITH POWER OVER ETHERNET (PoE)

The cable test helps field technicians quickly and efficiently detect cable issues. Using this feature with the NetBlazer V2 Series, technicians can troubleshoot any cabling or installation issue by checking the cable's actual pin-out, wire map, cable length, distance-to-fault and propagation delay. With the addition of PoE, technicians can check for the following: presence of power, the power-supply equipment type, power class rating, voltage, current and power in watts. Whether a technician needs to validate a basic component such as a PoE-powered VoIP phone, or an actual PoE-powered small cell, the NetBlazer V2 Series fits the bill for basic to critical devices.



Small cell unit

NetBlazer V2 with cable test to diagnose the issue

VoIP

Power sourcing equipment

VoIP multimedia phone

Speed dome camera

Network camera

Wireless router

**EXFO**

## TRAFFIC GENERATION AND MONITORING

The NetBlazer V2 Series surpasses the multistream offerings of typical handheld Ethernet testing devices. Up to 64 streams of traffic (available on 870Q or 880Q modules) can be configured by a technician in order to test just about any frame format: Ethernet II, 802.3 SNAP, IPv4, IPv6, three levels of VLANs, MPLS, UDP and TCP. Each stream has an analog visual gauge and user-definable pass/fail thresholds that instantly show whether the test traffic is in or out of the expected ranges of the SLA.
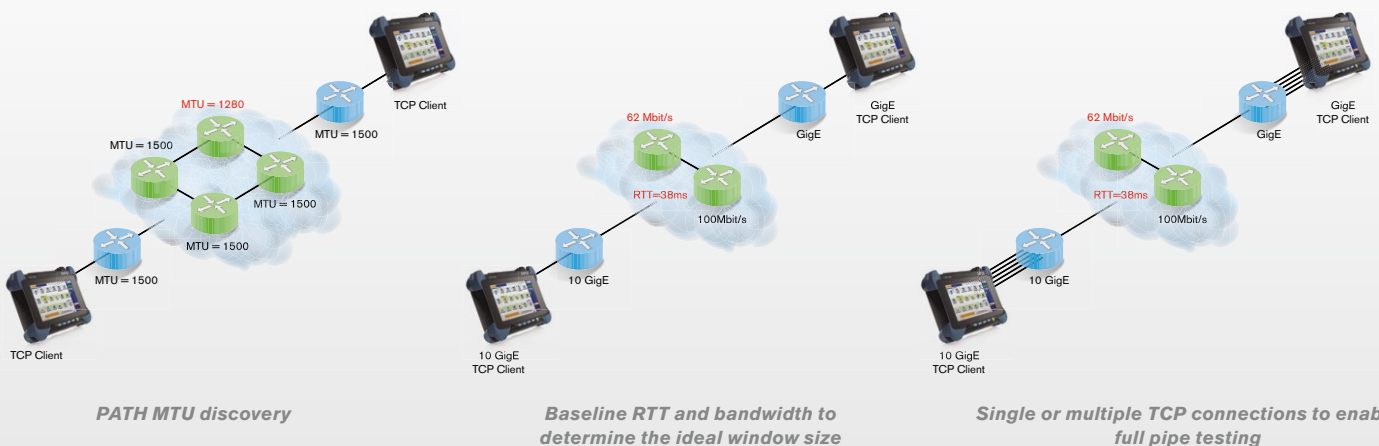
### Layer-2 Transparency Testing

The NetBlazer V2 Series uses a new virtual frame display that allows field technicians to easily configure multiple streams and their parameters, including the ability to modify the source medium-access-control (MAC) address and EtherType. This makes it possible to test layer-2 protocols such as Cisco discovery protocol (CDP), VLAN trunking protocol (VTP) and link layer discovery protocol (LLDP). For added simplification, there are also predefined factory configurations capable of automatically loading up to ten layer-2 protocols simultaneously.



Visual frame display

← Up to 16 streams

Voice/video/data services
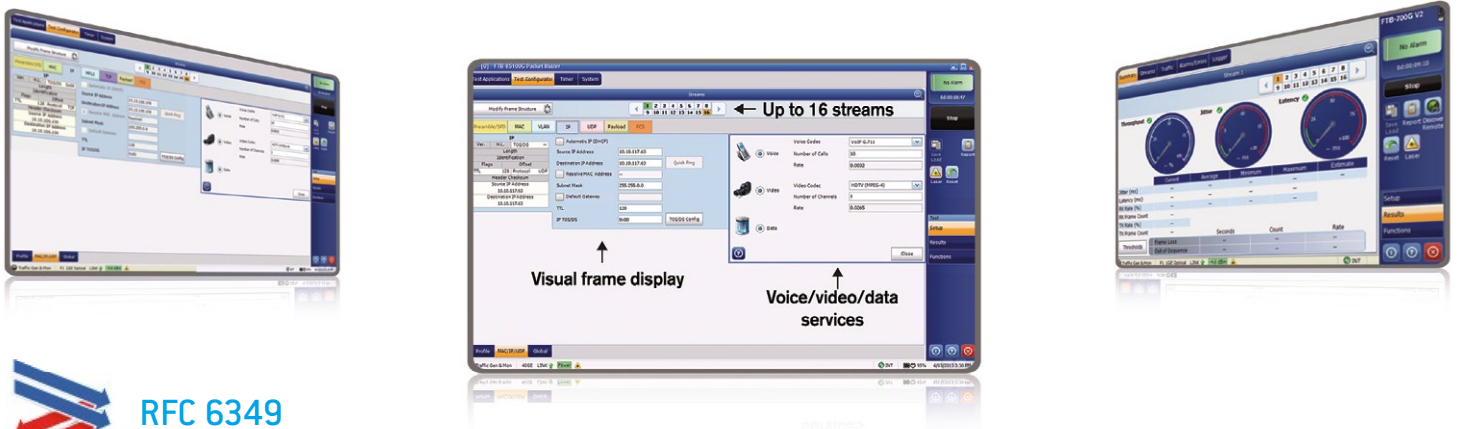
## RFC 6349

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 and streaming video. 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 following steps that 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 second step is aimed at determining 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 to resolve any potential discrepancies occurring between the service provider network and the customer premises equipment.



*PATH MTU discovery*

*Baseline RTT and bandwidth to determine the ideal window size*

*Single or multiple TCP connections to enable full pipe testing*

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## DUAL TEST SET – NETWORK ADDRESS TRANSLATION

Bidirectional testing between a private and public network is a hassle because of extensive network configurations, so service providers are limiting their tests at the demarcation point that is located only in the public network. However, Business Ethernet customers are continually complaining of network problems that are impossible for service providers to pinpoint if they don't or can't look beyond the public/private demarcation point.
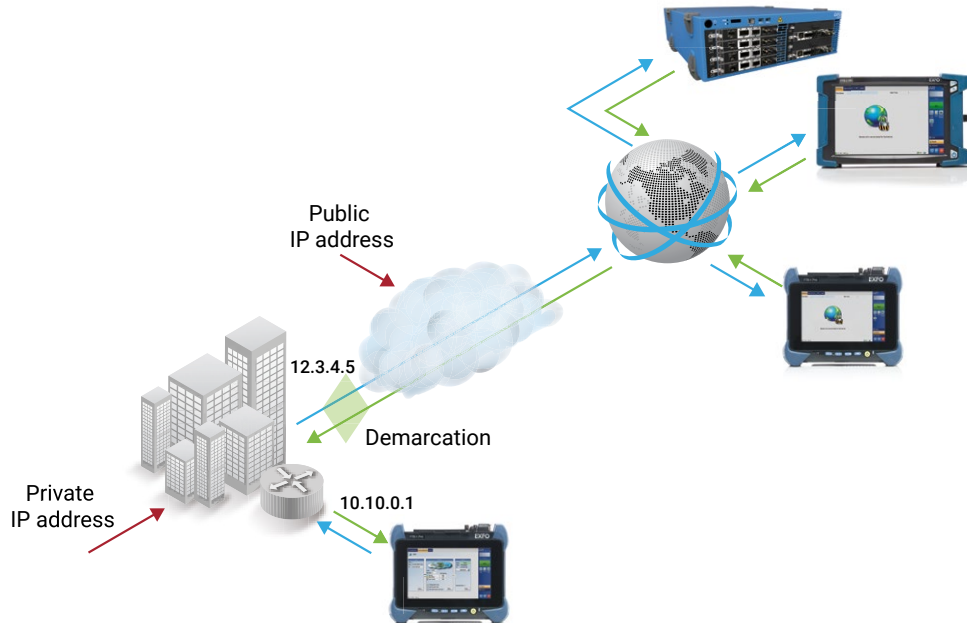


**Why stop at the demarcation point when you can troubleshoot Business Ethernet service issues directly from inside the customer's network?**

Only EXFO offers end-to-end bidirectional testing from within private networks using our patent-pending Dual Test Set Network Address Translation (DTS-NAT) capability. DTS-NAT enables a router to act as an agent between the internet (public network) and a local (private) network. With the easy-to-use dual test set feature, the NetBlazer V2 Series can connect to a remote EXFO test unit located anywhere on the network without any port forwarding or the help of a high-level technician.

EXFO's DTS-NAT feature is truly unique in that it enables service providers to pinpoint issues all the way into customers' networks— when stopping at the demarcation point simply isn't enough to locate difficult network issues. Testing from within the private network will provide you with accurate data to handle serious disputes, meet your customers' service expectations and ultimately reduce churn.

The DTS-NAT feature delivers:

› One-of-a-kind automated discovery of NAT-enabled networks

› Fully bidirectional testing through:

  › EtherSAM–layer 2/layer 3, as per ITU-T Y.1564

  › Layer 4 TCP, as per RFC 6349

  › iSAM–intelligent service activation methodology (compliant with both Y.1564 and RFC 6349)

› Up to eight simultaneous tests using the LTB-8

## CARRIER ETHERNET OAM

Ever since the introduction of metro Ethernet networks, there has been a need to ensure "*five nines*" level of availability, and reliability, as well as a 50 millisecond recovery time from failures. As per PDH, time-division multiplexing (TDM) and SONET/SDH, operations, administration and maintenance (OAM) has become a crucial network component that has enabled the same quality for carrier-class Ethernet.

The NetBlazer V2 Series offers a new application that validates the mechanics of the service operation, administration and maintenance (S-OAM) tools, covering ITU-T Y.1731, IEEE 802.1ag, IEEE 802.3ah, ITU-T G.8113.1 (MPLS-TP) and MEF modes. The features of this application include continuity check generation and monitoring, loopback testing, frame loss, synthetic loss and frame delay. There is also an S-OAM link trace and responder.



Carrier Ethernet OAM
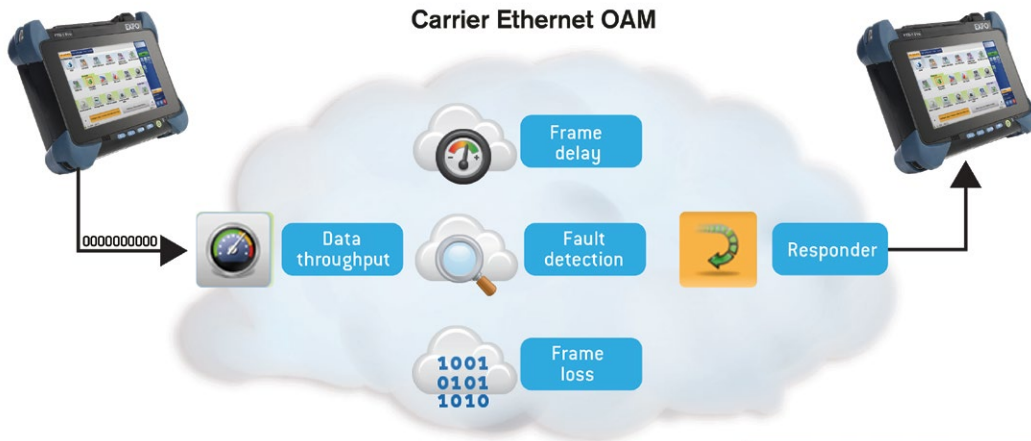
## PACKET CAPTURE

The capturing power of EXFO's NetBlazer V2 Series extends far beyond basic capabilities. The NetBlazer V2 Series 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.
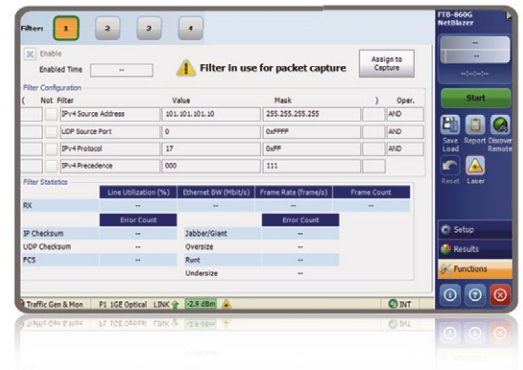
## ADVANCED TRAFFIC FILTERING

In some cases, troubleshooting only concerns a particular traffic flow. The advanced traffic-filtering capability of the NetBlazer V2 Series allows you to restrict traffic by using up to four matching 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.

## iOptics

The intelligent Pluggable Optics (iOptics) test application is a first-alert test that can be used in field or lab environments to efficiently evaluate the proper operation of an optical device with minimal user configuration required. This test application performs that validation using several sub-tests in addition to monitoring an optical device's power consumption and temperature; it reports a global and individual verdict for each sub-test and monitoring task. The test application also automatically collects the device manufacturing information enabling the user to determine whether or not the desired device has been tested.

SFP/SFP+          CFP4          QSFP+/
                                QSFP28

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# FRONTHAUL/FTTA/C-RAN TESTING

With the NetBlazer V2 modules, field technicians can carry out a variety of FTTA tests. For instance, when installing an RRH, it is critical that all equipment be verified before the riggers have finished the construction phase. The NetBlazer V2 Series CPRI/OBSAI 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 the NetBlazer V2 Series enabled with the layer-2 CPRI/OBSAI protocol, technicians can easily connect to the RRH without having to climb the cell tower. Regardless of whether the cell site's BBU is connected to the RRH, the NetBlazer V2 is always ready to validate a CPRI/OBSAI-enabled BBU. Once connected to the RRH, the NetBlazer V2 is able to supply the field technician with a complete analysis of vital CPRI/OBSAI statistics.

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 NetBlazer V2 Series to validate the RRH in order to validate the CPRI/OBSAI link with the BBU.

Moving closer toward CPRI/OBSAI-enabled infrastructures, a significant challenge arises as a result of human error occurring between the RRH and the BBU; faulty configurations, bad wiring and incorrect SFPs can lead to problems when trying to initialize the CPRI start-up sequence between the BBU and RRH. The NetBlazer V2 Series test suite better equips field technicians to decipher and solve these basic yet very costly human errors.

Finally, using the NetBlazer V2 Series modules, field technicians can perform an unframed and framed layer-2 CPRI/OBSAI BER test. The NetBlazer V2 Series modules are able to validate that the fiber from the BBU 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.
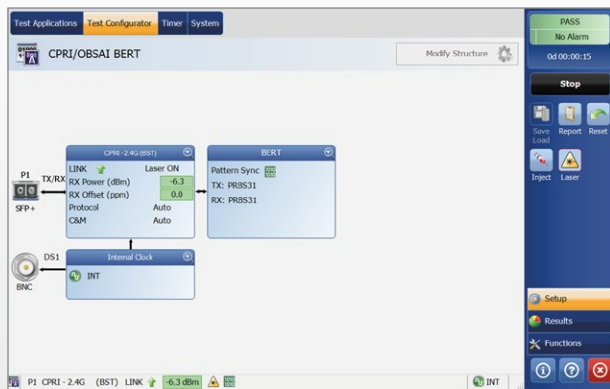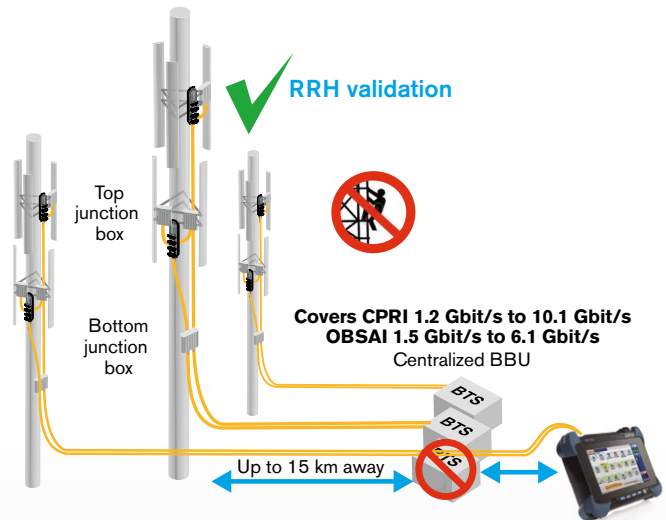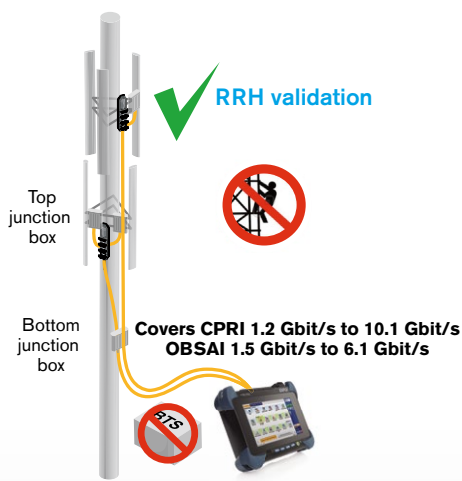


*Framed CPRI/OBSAI test*
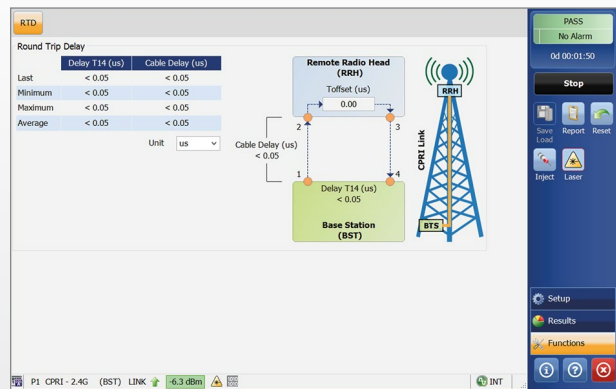
*CPRI/OBSAI round-trip delay*

## RF SPECTRUM ANALYSIS OVER CPRI

Most of today's modern mobile installations interconnect baseband units (BBUs) and far-end remote radio heads (RRHs) with fiber optic cables. This new network configuration, known as fronthaul, provides many advantages. RRHs can now be physically separated from BBUs. However, with this new mobile installation, analog RF signals can only be accessed at RRHs, which are often placed in hard-to-reach locations, such as tower tops or rooftops.

The NetBlazer V2 Series offers a new application that eliminates dangerous and difficult climbs by providing access to RF signals through the digital CPRI link available at the BBU site (at the bottom of the tower or at the BBU hotel located kilometers away). The digital link uses the CPRI protocol to carry RF signals in digital format (IQ data). By accessing the RF signal at the BBU location, costs associated with truck rolls and tower climbs are reduced. In addition, time to resolution of complex RF issues is accelerated by multiple user collaboration via remote access capabilities to EXFO's OpticalRF application from any smart device or laptop.
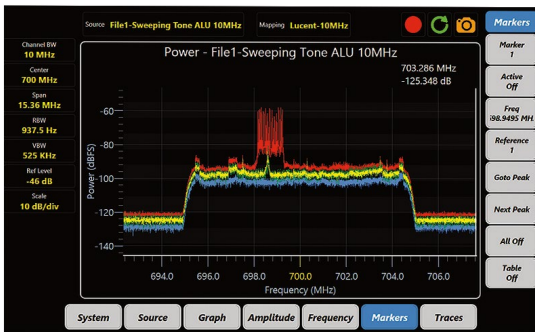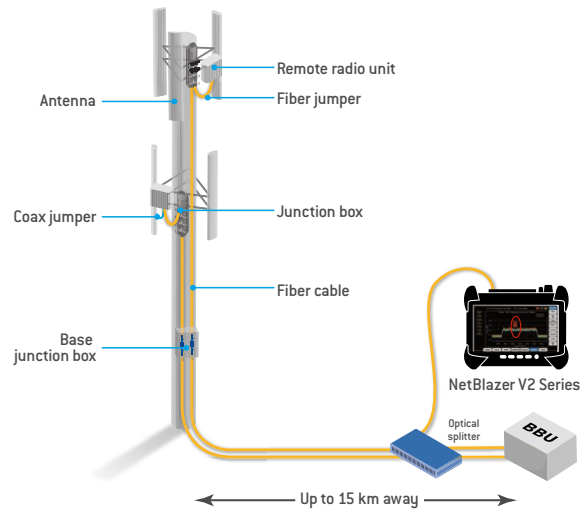


## REAL-TIME HIGH-RESOLUTION RF SPECTRUM ANALYSIS OVER CPRI

OpticalRF on the NetBlazer V2 modules provides the most powerful real-time high-resolution RF spectrum analysis over CPRI. It automatically scans for the correct CPRI rate option and configures it to get an active link.

OpticalRF is an easy-to-use solution that quickly identifies issues, such as external RF interference, internal PIM and external PIM. It detects RF interference even when the BBUs are kilometers away at more convenient locations, such as in a centralized radio access network (C-RAN) architecture.

## RF INTERFERENCE ANALYSIS WITH MULTI-ANTENNA DISPLAY

OpticalRF provides the ability to display multiple antenna carriers (AxC) at the same time. Multiple antenna carriers can be displayed either in a side-by-side or overlaid view. PIM detection combined with a pass or fail verdict facilitates the ability to visualize diversity imbalances or passive intermodulation (PIM).



*Dual AxC overlay display*



*Dual AxC side-by-side display*

# BASEBAND UNIT (BBU) EMULATION

EXFO's BBU emulation feature enables mobile contractors, technicians and engineers to ensure that cell sites are installed correctly the first time, prior to handing them over to the mobile network operator (MNO) for integration. The solution is designed for simple one-click operation with clear pass/fail verdicts, enabling problems to be isolated quickly and successful test reports to be generated, creating a birth certificate for the cell site.
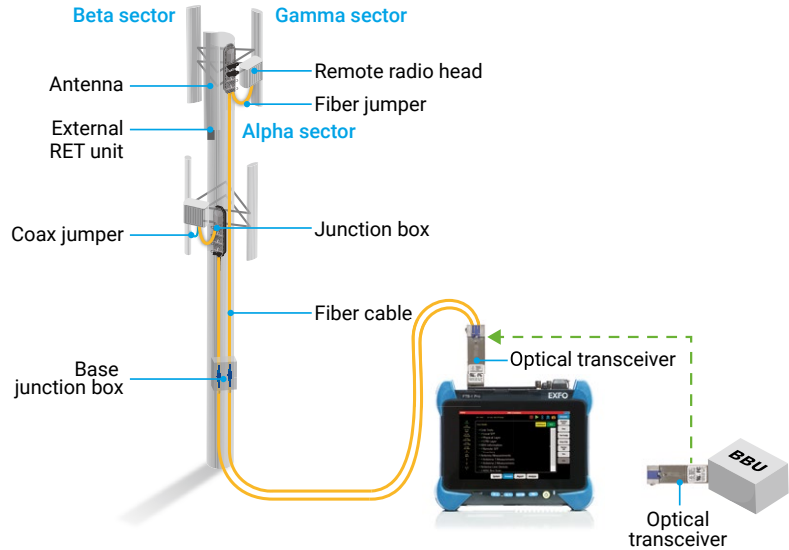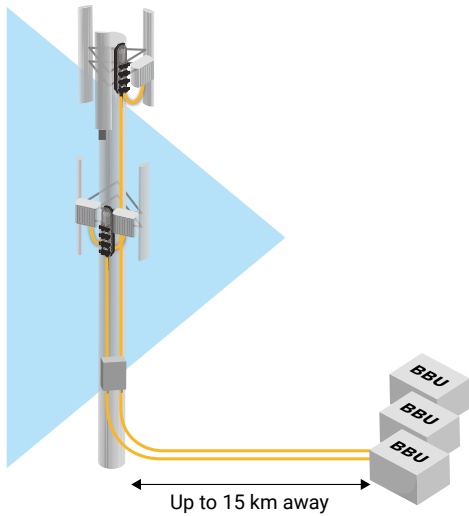


*RRH validation*

EXFO's BBU emulation solution includes:

> CPRI layer-2 link tests

> RRH configuration and information

> Local and remote SFP identification

> AISG bus scan

> Voltage standing wave ratio (VSWR) and receive signal strength indicator (RSSI)

> PIM testing

> RRH physical cell identification (PCI)

> Antenna remote electrical tilt (RET)

> Orthogonal channel noise simulation (OCNS)

> Over-the-air (OTA) LTE transmission



*BBU emulation turn-up*
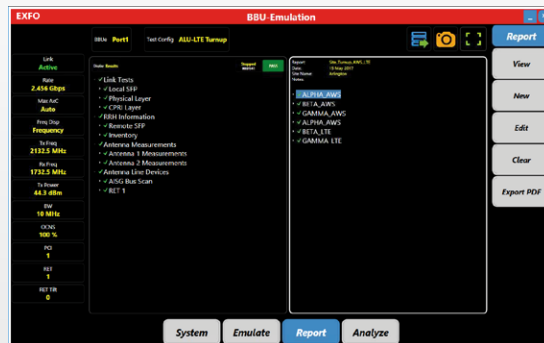


*BBU emulation site report*

EXFO

## WANDER

MNOs face continuous pressure related to the synchronization of their multiple network elements. Typical deployments involve not only a primary reference time clock and a telecom grand master clock, but also several telecom boundary clocks (T-BC) and telecom time secondary clocks (T-TSC) that feed network elements directly connected to the radio equipment (RE) at the cell towers. A time error budget is defined for different reference points of the network.

With 5G technology soon to be widely deployed, time constraints are even higher. MNOs must—more than ever—validate that their reference clocks at multiple points of the network are compliant to standardized time error thresholds and expected time error budgets.
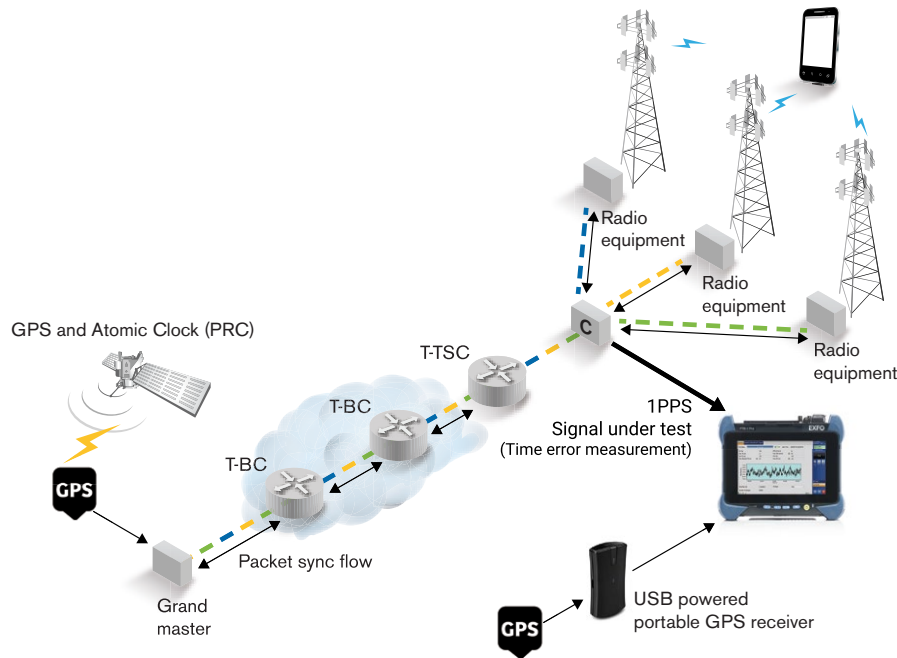


Wander delivers all the test results that MNOs require in order to diligently evaluate the reference signal/clock during turn-up or troubleshooting at cell tower locations. Wander performs multiple time error measurements such as Maximum Absolute Time Error (Max |TE|), dynamic Time Error (dTE), constant Timer Error (cTE), Maximum Time Interval Error (MTIE), Time Deviation (TDEV). Wander automatically evaluates if the signal under test meets different standardized masks such as the MTIE mask defined by ITU G.8271.1, G8261, G.8282, G.811, G.812, G.813 and others. Signals under evaluation can be 1PPS, Ethernet-SyncE at various rates (e.g., 2 MHz). Verdicts are presented to the user based on several different criteria. Wander also allows users to zoom into time error graphical results of tests that last up to five days. Synchronization experts can easily identify the most important events during their time error measurements.
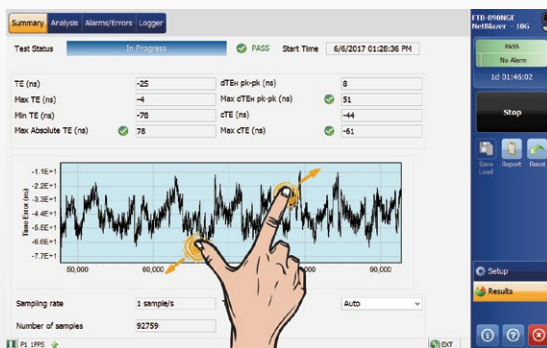


*Wander results/multitouch pinch-to-zoom*



*Wander analysis*

EXFO
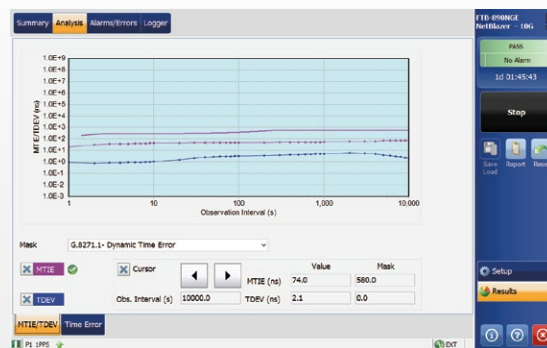
# EFFICIENTLY ASSESSING THE PERFORMANCE OF FIBRE CHANNEL SERVICES

The NetBlazer V2 Series modules provide comprehensive testing capabilities for Fibre Channel (FC) network deployments, supporting multiple FC interfaces.

## 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 NetBlazer V2 Series modules provide full wire-speed traffic generation at the FC2 layer, which allows for BER testing for link integrity measurements. The NetBlazer V2 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.

Therefore, it is critical for service providers to properly characterize network latency when offering FC services. The NetBlazer V2 Series modules estimate buffer-to-buffer credit value requirements from the performed latency measurement.

### 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 NetBlazer V2 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 NetBlazer V2 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 for automatic detection of port/fabric login, login status (successful login, in progress, failure and logout) and response to remote buffer-to-buffer advertised credit.

## 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 |
| 16X | 14.025 | 1600 |

**End-to-end networking**
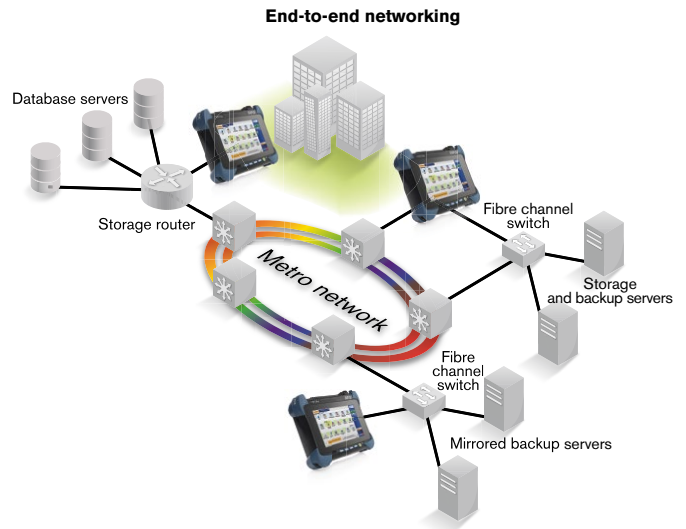


*Thanks to end-to-end network testing capabilities, EXFO's NetBlazer V2 Series enables fast deployment and configuration of FC networks. Communication between the transport network, interconnection devices and end nodes can be validated with features such as BER testing, latency measurement, buffer-to-buffer credit estimation and port login capabilities.*

EXFO

## 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 a 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 | C⚫nnect

### 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.

## EXpert TEST TOOLS ON THE FTB-1 PRO PLATFORM

EXpert Test Tools is a series of platform-based software testing tools that enhance the value of the FTB-1 Pro platform, providing additional testing capabilities without the need for additional modules or units.

| EXpert TEST TOOLS | |
|---|---|
| **EXpert VoIP TEST TOOLS** | The EXpert VoIP Tools generate a voice-over-IP call directly from the test platform to validate performance during service turn-up and troubleshooting. <br> • Supports a wide range of signaling protocols, including SIP, SCCP, H.248/Megaco and H.323 <br> • Supports mean-opinion-score (MOS) and R-factor quality metrics <br> • Simplifies testing with configurable pass/fail thresholds and RTP metrics |
| **EXpert IP TEST TOOLS** | The EXpert IP Tools integrate six commonly used datacom test tools into one platform-based application to ensure that field technicians are prepared for a wide range of testing needs. <br> • Rapidly performs debugging sequences with VLAN scan and LAN discovery <br> • Validates end-to-end ping and traceroute <br> • Verifies FTP performance and HTTP availability |
| **EXpert IPTV TEST TOOLS** | This powerful IPTV quality-assessment solution enables set-top box emulation and passive monitoring of IPTV streams, allowing for quick and easy pass/fail verification of IPTV installations. <br> • Real-time video preview <br> • Analyzes up to 10 video streams <br> • Comprehensive QoS and quality-of-experience (QoE) metrics, including MOS score |



**EXFO**

## ELECTRICAL ETHERNET INTERFACES

One port: 10/100 BASE-T half/full duplex, 1000BASE-T full duplex
Automatic or manual detection of straight/crossover cable

| Electrical interface | 10BASE-T | 100BASE-TX | 1000BASE-T |
|---|---|---|---|
| Tx bit rate | 10 Mbit/s | 125 Mbit/s | 1 Gbit/s |
| Tx accuracy (uncertainty) (ppm) | ±4.6 | ±4.6 | ±4.6 |
| Rx bit rate | 10 Mbit/s | 125 Mbit/s | 1 Gbit/s |
| Rx measurement accuracy (uncertainty) (ppm) | | ±4.6 | ±4.6 |
| Duplex mode | Half and full duplex | Half and full duplex | Full duplex |
| Jitter compliance | IEEE 802.3 | IEEE 802.3 | IEEE 802.3 |
| Connector | RJ45 | RJ45 | RJ45 |
| Maximum reach (m) | 100 | 100 | 100 |

## DSN/PDH AND SONET/SDH ELECTRICAL INTERFACES

| Electrical interface | DS1 | E1/2M | | E3/34M | DS3/45M | | STS-1e/STM-0e/52M | E4/140M | STS-3e/STM-1e/155M | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tx pulse amplitude | 2.4 to 3.6 V | 3.0 V | 2.37 V | 1.0 ±0.1 V | 0.36 to 0.85 V | | | 1.0 ±0.1 Vpp | 0.5 V | |
| Tx pulse mask | GR-499 Figure 9-5 | G.703 Figure 15 | G.703 Figure 15 | G.703 Figure 17 | DS-3 GR-499 Figure 9-8 | 45M G.703 Figure 14 | GR-253 Figure 4-10/4-11 | G.703 Figure 18/19 | STS-3e GR-253 Figure 4-12, 4-13, 4-14 | STM-1e/ 155M G.703 Figure 22 and 23 |
| Tx LBO preamplification | 0-133 ft 133-266 ft 266-399 ft 399-533 ft 533-655 ft | | | | 0 to 225 ft 225 to 450 ft | | 0 to 225 ft 225 to 450 ft | | 0 to 225 ft | |
| Cable simulation | −22.5 dB −15.0 dB −7.5 dB 0 dB | | | | 450 to 900 (927) ft | | 450 to 900 (927) ft | | | |
| Rx level sensitivity | For 772 kHz: TERM: ≤26 dB (cable loss only) at 0 dBdsx Tx DSX-MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Bridge: ≤6 dB (cable loss only) | For 1024 kHz: TERM: ≤6 dB (cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Bridge: ≤6 dB (cable loss only) | For 1024 kHz: TERM: ≤6 dB (cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Bridge: ≤6 dB (cable loss only) | For 17.184 MHz: TERM: ≤12 dB (coaxial cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) | For 22.368 MHz: TERM: ≤10 dB (cable loss only) DSX-MON: ≤26.5 dB (21.5 dB resistive loss + cable loss ≤ 5 dB) | | For 25.92 MHz: TERM: ≤10 dB (cable loss only) MON: ≤25 dB (20 dB resistive loss + cable loss ≤ 5 dB) | For 70 MHz: TERM: ≤12 dB (coaxial cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) | For 78 MHz: TERM: ≤12.7 dB (coaxial cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) | |
| Transmit bit rate | 1.544 Mbit/s ±4.6 ppm | 2.048 Mbit/s ±4.6 ppm | 2.048 Mbit/s ±4.6 ppm | 34.368 Mbit/s ±4.6 ppm | 44.736 Mbit/s ±4.6 ppm | | 51.84 Mbit/s ±4.6 ppm | 139.264 Mbit/s ±4.6 ppm | 155.52 Mbit/s ±4.6 ppm | |
| Frequency offset generation | 1.544 Mbit/s ±140 ppm | 2.048 Mbit/s ±70 ppm | 2.048 Mbit/s ±70 ppm | 34.368 Mbit/s ±50 ppm | 44.736 Mbit/s ±50 ppm | | 51.84 Mbit/s ±50 ppm | 139.264 Mbit/s ±50 ppm | 155.52 Mbit/s ±50 ppm | |
| Receive bit rate | 1.544 Mbit/s ±140 ppm | 2.048 Mbit/s ±100 ppm | 2.048 Mbit/s ±100 ppm | 34.368 Mbit/s ±100 ppm | 44.736 Mbit/s ±100 ppm | | 51.84 Mbit/s ±100 ppm | 139.264 Mbit/s ±100 ppm | 155.52 Mbit/s ±100 ppm | |
| Measurement accuracy (uncertainty) Frequency (ppm) Electrical power (dB) | ±4.6 ±1.5 | ±4.6 ±1.5 | ±4.6 ±1.5 | ±4.6 ±1.5 | ±4.6 ±1.5 | | ±4.6 ±1.5 | ±4.6 ±1.5 | ±4.6 ±1.5 | |
| Peak-to-peak voltage | ±10 % down to 500 mVpp | ±10 % down to 500 mVpp | ±10 % down to 500 mVpp | ±10 % down to 500 mVpp | ±10 % down to 200 mVpp | | ±10 % down to 200 mVpp | ±10 % down to 200 mVpp | ±10 % down to 200 mVpp | |
| Intrinsic jitter (Tx) | ANSI T1.403 section 6.3 GR-499 section 7.3 | G.823 section 5.1 | G.823 section 5.1 | G.823 section 5.1 G.751 section 2.3 | GR-499 section 7.3 (categories I and II) | | GR-253 section 5.6.2.2 (category II) | G.823 section 5.1 G.751 section 3.3 | G.825 section 5.1 GR-253 section 5.6.2.2 | |
| Input jitter tolerance | AT&T PUB 62411 GR-499 section 7.3 | G.823 section 7.1 | G.823 section 7.1 | G.823 section 7.1 | GR-499 section 7.3 (categories I and II) | | GR-253 section 5.6.2.3 (Category II) | G.823 section 7.1 G.751 section 3.3 | G.825 section 5.2 GR-253 section 5.6.2.3 | |
| Line coding | AMI and B8ZS | AMI and HDB3 | AMI and HDB3 | HDB3 | B3ZS | | B3ZS | CMI | CMI | |
| Input impedance (resistive termination) | 100 Ω ±5 %, balanced | 120 Ω ±5 %, balanced | 75 Ω ±5 %, unbalanced | 75 Ω ±5 %, unbalanced | 75 Ω ±5 %, unbalanced | | 75 Ω ±5 %, unbalanced | 75 Ω ±10 %, unbalanced | 75 Ω ±5 %, unbalanced | |
| Connector type | BANTAM and RJ48C | BANTAM and RJ48C | BNC | BNC | BNC | | BNC | BNC | BNC | |

EXFO

| SONET AND DSn FUNCTIONAL SPECIFICATIONS | | SDH AND PDH FUNCTIONAL SPECIFICATIONS | |
|---|---|---|---|
| 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 |
| Electrical interfaces | DS1, DS3, STS-1e, STS-3e | Electrical interfaces [a] | 1.5M (DS1), 2M (E1), 34M (E3), 45M (DS3), 140M (E4), STM-0e, STM-1e |
| DS1 framing | Unframed, SF, ESF, SLC-96 | 2M (E1) framing | Unframed, PCM30, PCM31, PCM30 CRC-4, PCM31 CRC-4 |
| DS3 framing | Unframed, M13, C-bit parity | 8M (E2), 34M (E3), 140M (E4) framing | Unframed (not applicable to E2), framed |
| Clocking | Internal, loop-timed, external (BITS) | Clocking | Internal, loop-timed, external (MTS/SETS), 2 MHz |
| **Mappings** | | | |
| VT1.5 | Bulk, DS1 | AU-3-TU-11, AU-4-TU-11 | Bulk, 1.5M, |
| VT2 | Bulk, E1 | AU-3 -TU-12, AU-4-TU-12 | Bulk, 1.5M, 2M |
| STS-1 SPE | Bulk, DS3 | AU-3-Bulk, 34M, 45M, TU-3-AU-4 | Bulk, 34M, 45M |
| STS-3c | Bulk | AU-4 | Bulk, 140M |
| 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** | | | |
| DS1 | Framing bit, BPV, CRC-6, bit error, EXZ | E1 (2M) | Bit error, FAS, CV, CRC-4, E-bit |
| DS3 | BPV, C-bit, F-bit, P-bit, FEBE, bit error, EXZ | E2 (8M), E3 (34M), E4 (140M) | Bit error, FAS, CV (not applicable to E2) |
| STS-1e, STS-3e | Section BIP (B1), line BIP (B2), path BIP (B3), BIP-2, REI-L, REI-P, REI-V, BPV, FAS, CV, bit error | STM-0e, STM-1e | RS-BIP (B1), MS-BIP (B2), HP-BIP (B3), MS-REI, HP-REI, LP-BIP-2, LP-REI, CV, FAS, bit error |
| 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** | | | |
| DS1 | Framing bit, BPV, CRC-6, EXZ, bit error | E1 (2M) | Bit error, FAS, CV, CRC-4, E-bit |
| DS3 | BPV, C-bit, F-bit, P-bit, FEBE, bit error, EXZ | E2 (8M), E3 (34M), E4 (140M) | Bit error, FAS, CV (not applicable to E2) |
| STS-1e, STS-3e | Section BIP (B1), line BIP (B2), path BIP (B3), BIP-2, REI-L, REI-P, REI-V, BPV, FAS, CV, bit error | STM-0e, STM-1e | RS-BIP (B1), MS-BIP (B2), HP-BIP (B3), MS-REI, HP-REI, LP-BIP-2, LP-REI, CV, FAS, bit error |
| 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** | | | |
| DS1 | LOS, RAI, AIS, OOF, pattern loss | E1 (2M) | LOS, LOS Mframe, LOF, AIS, TS16 AIS, RAI, RAI Mframe, pattern loss |
| DS3 | LOS, RDI, AIS, OOF, DS3 idle, pattern loss | E2 (8M), E3 (34M), E4 (140M) | LOS, LOF, RAI, AIS, pattern loss |
| STS-1e, STS-3e, 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-0e, STM-1e, 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** | | | |
| DS1 | LOS, LOC, RAI, AIS, OOF, pattern loss | E1 (2M) | LOS, LOS Mframe, LOC, LOF, AIS, TS16 AIS, RAI, RAI Mframe, pattern loss |
| DS3 | LOS, LOC, RDI, AIS, OOF, DS3 idle, pattern loss | E2 (8M), E3 (34M), E4 (140M) | LOS, LOC, LOF, RAI, AIS, pattern loss |
| STS-1e, STS-3e, 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-0e, STM-1e, 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 alarm on all supported interfaces* | | |
| **Patterns** | | | |
| DS0 | 2E9-1, 2E11-1, 2E20-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 3-in-24, 32 bit programmable (inverted or non-inverted), bit errors | E0 (64K) | 2E9-1, 2E11-1, 2E20-1, 1100, 1010, 1111, 0000 1-in-8, 1-in-16, 3-in-24, 32 bit programmable (inverted or non-inverted), bit errors |
| DS1 | 2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, QRSS, 1-in-8, 1-in-16, 3-in-24, 32 bit programmable (inverted or non-inverted), T1-DALY, 55-octet, bit errors, multipattern | E1 (2M) | 2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 3-in-24, 32 bit programmable (inverted or non-inverted), bit errors |
| DS3 | 2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 2-in-8, 1-in-16, 3-in-24, 32 bit programmable (inverted or non-inverted), bit errors | E3 (34M), E4 (140M) | 2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, 1-in-8, 1-in-16, 3-in-24 [b], 32 bit programmable (inverted or non-inverted), bit errors |
| 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* | | |

**Notes**

a.  1.5M (DS1) and 45M (DS3) interfaces described under SONET and DSn column.

b.  Not supported for E4 (140M).

EXFO

## FEATURES

### HIGH SPEED KEY FEATURES

| | |
|---|---|
| Detailed compliance testing | › IEEE 802.3bm standard (2010)<br>› CFP MSA CFP4 Hardware Specification Revision 1.1 18 Mar 2015<br>› CFP MSA Management Interface Specification Version 2.4 (R06b)<br>› ITU-T G.709, G.798 and G.872 |
| Multi-interface support | › Pluggable, MSA-compliant 4 x 10G QSFP+ transceivers<br>› Pluggable, MSA-compliant 4 x 25G CFP4 and QSFP28 transceivers<br>› External timing reference (DS1/E1/2 MHz) |
| Robust physical-layer validation | › 40G/100G XLAUI/CAUI lane error generation and monitoring<br>› PCS lane mapping and monitoring capability<br>› Per-lane skew generation and measurement<br>› PCS error generation and monitoring per lane<br>› Full MDIO/I2C read/write access |
| PRBS patterns per lane | Allows users to configure different PRBS patterns on different CAUI/XLAUI lanes in 40G/100G, and on physical lanes in OTU3/OTU4 diagram |
| Per-wavelength power measurement | Allows users to measure the received optical power per wavelength in the used parallel CFP4 and QSFP+/QSFP28 transceivers |
| iOptics | › Optical-device I/O interface quick check<br>› Optical Tx power-level range test<br>› Optical Rx signal-presence and power-level range test<br>› BERT (Bit Error Rate Test) at nominal rates and standard offset<br>› Excessive skew test<br>› Temperature and power/current consumption monitoring |
| 100G and 40G MPLS | › Generates and analyzes streams with up to two layers of labels. |
| Advanced filtering | › Ability to configure up to 10 filters, each with four fields that can be combined with AND/OR/NOT operations; a mask is also provided for each field value with IPv4 and IPv6 capabilities |
| Packet capture | › Ethernet packet capture up to 4 Mbits<br>› Configurable triggers including errors and header fields<br>› Data capture in packet capture (PCAP) format; read through Wireshark |
| 40G/100G OTN testing | › OTU4 (112 Gbit/s), OTU3 (43 Gbit/s), OTU3e1 (44.57 Gbit/s) and OTU3e2 (44.58 Gbit/s) unframed and framed BER tests<br>› FEC testing: error insertion and monitoring<br>› OTL 3.4 and 4.4: alarm and error generation and monitoring<br>› OTL lane mapping, and skew generation and measurement<br>› Single- and multi-stage mapping<br>› Ethernet over OTN<br>› Support to ODU0 and ODUflex<br>› OTN through and OTN intrusive through mode testing<br>› Multiplexing/demultiplexing of ODU13, ODU23, ODU123, ODU03, ODU013, ODU0123, ODU04, ODU014, ODU134, ODU24, ODU234, ODU34, ODU14, ODU01234, ODU0124, ODU12, ODU024, ODU034, ODU1e4, ODUflex24, ODU2e4 and ODU124, ODU1234 with PRBS pattern and GigE and 10 GigE client mappings into OPU payloads. ODUflex at ODU2, ODU3 and ODU4 rates with full flexibility to configure the required bandwidth based on (n x 1.25) Gbit/s tributary time slots with a PRBS pattern into the ODUflex payload; 40 GigE client mapping into ODU3 into ODU4<br>› OTU, ODU, OPU overhead manipulation and monitoring<br>› OTU, ODU (including ODU TCM), OPU layer alarm/error generation and analysis<br>› OTU, ODU (including ODU TCM) trace messages<br>› Round-trip delay (RTD) measurement<br>› OTN SDT measurement<br>› Performance monitoring: G.821, M.2100<br>› Frequency analysis and offset generation |

**EXFO**

## OTN TEST FEATURES

| | | |
|---|---|---|
| **OTN** | Standards compliance | ITU-T G.709, ITU G.798, ITU G.872 |
| | Interfaces | OTU1 (2.6660 Gbit/s), OTU2 (10.7092 Gbit/s), OTU1e (11.0491 Gbit/s), OTU2e (11.0957 Gbit/s), OTU1f (11.2701 Gbit/s), OTU2f (11.3176 Gbit/s), OTU3 (43.018 Gbit/s), OTU3e1 (44.571 Gbit/s), OTU3e2 (44.583 Gbit/s), OTU4 (111.81 Gbit/s) |
| **OTU Layer** | Errors | OTU-FAS, OTU-MFAS, OTU-BEI, OTU-BIP-8 |
| | Alarms | LOF, OOF, LOM, OOM, OTU-AIS, OTU-TIM, OTU-BDI, OTU-IAE, OTU-BIAE |
| | Traces | 64-byte trail trace identifier (TTI), as defined in ITU-T G.709 |
| **ODU TCM Layer** | Errors | TCMi-BIP-8, TCMi-BEI (i = 1 to 6) |
| | Alarms | TCMi-LTC, TCMi-TIM, TCMi-BDI, TCMi-IAE, TCMi-BIAE |
| | Traces | 64-byte trail trace identifier (TTI), as defined in ITU-T G.709 |
| **ODU Layer** | Errors | ODU-BIP-8, ODU-BEI |
| | Alarms | ODU-AIS, ODU-OCI, ODU-LCK, ODU-TIM, ODU-BDI, ODU-FSF, ODU-BSF, ODU-FSD, ODU-BSD |
| | Traces | Generates 64-byte trail trace identifier (TTI), as defined in ITU-T G.709 |
| | FTFL [b] | As defined in ITU-T G.709 |
| **OPU Layer** | Alarms | OPU-PLM, OPU-AIS, OPU-CSF |
| | Payload-type (PT) label | Generates and displays received PT value |
| **Forward error correction (FEC)** | Errors | FEC-correctable (codeword), FEC-uncorrectable (codeword), FEC-correctable (symbol), FEC-correctable (bit), and FEC-stress (codeword) |
| **Pattern** | Patterns | 2E-9, 2E-15, 2E-20, 2E-23, 2E-31, NULL, 32-bit programmable (inverted or noninverted) |
| | Error | Bit error |
| | Alarm | Pattern loss |

## ADDITIONAL OTN FUNCTIONS

| | |
|---|---|
| Frequency measurements | Supports clock frequency measurements (i.e., received frequency and deviation of the input signal clock from nominal frequency), displayed in ppm. 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 |
| M.2100 | ES, SES, UAS |

| | |
|---|---|
| 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 supported on all interfaces and mappings. Measurements: last RTD time, minimum, maximum, average, measurement count (number of successful RTD tests) and failed measurement count. |
| Through mode | Performs through mode analysis of any incoming OTN signal transparently. |
| Intrusive through mode | This mode allows the insertion of OTN alarms and errors into an incoming OTN signal |

**EXFO**

## ETHERNET TEST FEATURES

| | |
|---|---|
| EtherSAM (ITU-T Y.1564) | Perform service configuration and service performance tests as per ITU-T Y.1564 including EBS, CBS and EMIX. Tests can be performed using 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; with the RFC 6349 option enabled, 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 between one to ten sizes |
| 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 |
| RFC 6349 Interop with BV-3100 | RFC 6349 can be tested through the network using the Netblazer V2 and the BV3100 verifier. Including the ability to use interop mode through NAT-enabled networks. |
| 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. Also includes the ability to generate fixed, random and frame size sweep, as well as MAC flooding. |
| Carrier Ethernet OAM | Supports four S-OAM modes, MEF, Y.1731, G.8113.1 (MPLS-TP) and 802.1ag. CCM generation and monitoring, loopback, test, frame loss, synthetic loss and frame delay. Alarm generation: AIS, RDI, LCK, CSF(C-LOS, C-RDI, C-FDI, C-DCI). Alarm monitoring: RDI, AIS, LCK, CSF, loss of continuity, mismerge, unexpected MEP, unexpected MEG/MD level, unexpected period supports S-OAM responder, S-OAM link trace, ping and trace route, filters and packet capture. |
| Packet capture and filters | Ability to perform 10BASE-T all the way up to 100 GigE full line-rate packet capture and decode. Configuration of capture filters and triggers as well as capture slicing parameters. |
| Through mode | Sectionalize traffic between a service provider's network and customer premise equipment up to 100G |
| 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. |
| Error measurement (BERT) | Bit error, bit mismatch 0, bit mismatch 1. |
| Traffic Scan | Discover up to three levels of VLAN tagged traffic (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 layers of VLAN (including IEEE 802.1ad and Q-in-Q tagged VLAN). |
| VLAN preservation | Validates that CE-VLAN tags classes of service (CoS), and that ID is passed transparently through the network. |
| MPLS | Generate and analyze streams with up to two layers of MPLS labels. |
| Cable testing | The cable test application provides test functions to diagnose UTP cables transmitting Ethernet over twisted pair. It verifies connectivity errors and evaluates cabling performance. The cable test can optionally simulate a PoE powered device to verify if a PoE-powered device to verify whether PoE power-sourcing equipment is capable of delivering adequate power prior to connection of a powered device. |
| PoE | Applicable rates: 10M to 1000M electrical, meets 802.3at (802.3 Section 33) unloaded and loaded testing, identification of cable pairs carrying power and polarity, voltage/current/power measurement on each pair, and user-configurable power class (0 to 4). |
| Service disruption time (SDT) | Includes statistics such as longest, shortest, last, average, count, total and pass/fail thresholds. |
| IPv6 testing | Performs the following tests up to 100G over IPv6, EtherSAM, RFC 2544, BERT, traffic generation and monitoring, through mode, intelligent auto discovery, ping and traceroute. |
| 10 GigE WAN testing | Includes WAN interface sublayer, J0/J1 trace and C2 label generation, J0/J1 trace and C2 label 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, TCP throughput test for undisputable SLA reinforcement for Ethernet services. |
| One-way delay | Measurement of the one-way frame delay at up to 10G as part of EtherSAM (Y.1564) and RFC 2544. |
| 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 | Inject or monitor pause frames, including frame counts of pause, abort frames and total, last, maximum and minimum pause time. |
| Batch configuration | Ability to automatically set a specific source IP address, subnet mask, default gateway, DHCP, destination MAC address or destination IP address to one or all EtherSAM services or traffic generation streams. |
| Dual port | Dual-port testing with EtherSAM (ITU-T Y.1564), RFC 2544, EtherBERT and traffic generation and monitoring when using 10/100/1000 BASE-T, 100BASE-X, GigE and 10 GigE. |
| FEC monitoring | Enable Ethernet FEC capabilities with alarms and error monitoring. |
| EoE/PBB-TE | Validates EoE and PBB-TE encapsulations. |

**EXFO**

## FIBRE CHANNEL TEST FEATURES

### TESTING 1x, 2x, 4x, 8x, 10x, 16x

| | |
|---|---|
| BERT | Framed FC2 |
| Patterns (BERT) | PRBS 2E31-1, 2E23-1, 2E20-1, 2E15-1, 2E11-1, 2E9-1, one user-defined pattern and 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 (10x only) |
| Buffer-to-buffer credit testing | Buffer-to-buffer credity estimation based on latency |
| Latency | Round-trip latency |

## DSN/PDH AND 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. |
| Dual DSn receivers | Supports two DS1 or DS3 receivers, allowing users to simultaneously monitor two directions of a circuit under test in parallel, resulting in quick isolation of the source of errors. |
| 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 | Analysis |
|---|---|
| › Pointer increment and decrement | › Pointer increments |
| › Pointer jump with or without NDF | › Pointer decrements |
| › Pointer value | › Pointer jumps (NDF, no NDF) |
| | › Pointer value and cumulative offset |

| | |
|---|---|
| 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 NetBlazer transmitter back to its receiver after crossing a far-end loopback. Measurements are provided on all supported NetBlazer interfaces and mappings. Measurements: last, minimum, maximum, average; measurement count: number 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] | Tandem connection monitoring (TCM) is used to monitor the performance of a subsection of a SONET/SDH path routed via different network providers. The NetBlazer 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 |
| Pointer sequence testing | Perform pointer sequence testing as per G.783, GR253 and T1.105-3 standards. |
| M13 mux/demux | Ability to multiplex/demultiplex a DS1 signal into/from a DS3 signal. (Note: E1 to DS3 mux/demux available with G.747 software option.) |
| DS1 FDL | Support for DS1 Facility Data Link testing. |
| DS1 loopcodes | Support for generation of DS1 in-band loopcodes with the availability of up to 10 pairs of user-defined loopcodes. |
| NI/CSU loopback emulation | Ability to respond to DS1 in-band/out-of-band loopcodes. |
| DS3 FEAC | Support for DS3 far-end alarms and loopback code words. |
| DS1/DS3 autodetection | Ability to automatically detect DS1/DS3 line coding, framing and test pattern. |
| DS1 multipattern | BER test that includes five automated patterns: all ones, 1-in-8, 2-in-8, 3-in-2, QRSS |
| DS1 signaling bits | Ability to monitor the ABCD signaling bits for all 24 DS0 channels |
| Through mode | Perform Through mode analysis of any incoming electrical (DSn, PDH, SONET, SDH) and optical line (OC-1/STM-0, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, OC-192/STM-64) transparently. |

**Note**

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

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## ISDN PRIMARY RATE INTERFACE TEST FEATURES

| | | | |
|---|---|---|---|
| Supported interfaces | DS1: bantam or RJ48C (SF or ESF)<br>E1: bantam, RJ48C or BNC (PCM31 with or without CRC-4) | Headset support | Talk/listen through a selectable connected voice or 3.1 kHz B-channel |
| Supported switch types | DS1: national ISDN, Nortel DMS and AT&T 4/5ESS<br>E1: Euro ISDN, Euro VN6 and Q.SIG | D-channel control | D-channel timeslot configuration<br>Rate (64K or 56K)<br>HDLC mode (Normal or Inverted) |
| Emulation modes | Terminal equipment (TE)<br>Network termination (NT) | Statistics | Call status, CRV, incoming or outgoing calls, call duration<br>BERT (bit error count and rate) with graphical BERT meter on a per B-channel (data) basis<br>Performance monitoring statistics: UAS, EFS, ES and SES<br>Active calls (data, voice, 3.1 kHz)<br>Total call count (connected, cleared, failed/rejected, placed)<br>Frequency (Rx, offset, max +/max − offset) |
| Call types/rates | Data (56K or 64K), voice or 3.1 kHz (audio) | Alarms | DS1: LOS, frequency, LOC, AIS, OOF, RAI, D-channel down<br>E1: LOS, frequency, LOC, AIS, LOF, RAI, D-channel down<br>Pattern loss (per B-channel injection) |
| BER test | Configurable test pattern<br>Provides simultaneous BER testing on multiple B-channels configured with data traffic | Errors | DS1: BPV, EXZ, framing bit, CRC-6, D-channel FCS<br>E1: CV, FAS, CRC-4, E-bit, D-channel FCS<br>Bit error (per B-channel injection) |
| Call setting | Calling party (numbering type, numbering plan and number up to 30 digits)<br>Called party (number type, numbering plan and number up to 30 digits)<br>Network (network transit selection code of up to four digits, and operator system access: None, Principal or Alternate)<br>› All parameters are configurable on a per-call basis<br>› Highlights missing calls or called party numbers | ISDN logger | Logs layer-2 (Q.921) and layer-3 (Q.931) messages<br>Filter: All, layer 2 or layer 3<br>Information: ID, time, message type, direction, channel number, called number, call type, cause values/definition, status and progress |
| Call control | Call origination<br>› Establishment of calls prior to starting the test<br>› Automatically initiate single, multiple or all configured calls upon starting a test<br>Call reception<br>› Auto-Answer mode, Auto-Reject or prompt<br>Call release<br>› Hang up individual or all channels | Pass/fail verdict | BERT, call establishment and termination |
| DTMF injection | Generate DTMF tones for all standard digits, including 0-9, # and * as per Q.23/G.224<br>Available for one of the connected voice or 3.1 kHz B-channel | Phone book | Easy access to phone book to manage names and associated numbers.<br>Save/load functions to update the phone book and import/export to exchange the phone book with other NetBlazer |

## SYNCHRONIZATION INTERFACES

| | External Clock DS1/1.5M | External Clock E1/2M | External Clock E1/2M | Trigger 2 MHz |
|---|---|---|---|---|
| Tx pulse amplitude | 2.4 to 3.6 V | 3.0 V | 2.37 V | 0.75 to 1.5 V |
| Tx pulse mask | GR-499 Figure 9-5 | G.703 Figure 15 | G.703 Figure 15 | G.703 Figure 20 |
| Tx LBO preamplification | Typical power dBdsx<br>+0.6 dBdsx (0 to 133 ft)<br>+1.2 dBdsx (133 to 266 ft)<br>+1.8 dBdsx (266 to 399 ft)<br>+2.4 dBdsx (399 to 533 ft)<br>+3.0 dBdsx (533 to 655 ft) | | | |
| Rx-level sensitivity | TERM: ≤6 dB (cable loss only)<br>(at 772 kHz for T1)<br>DSX-MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Bridge: ≤6 dB (cable loss only) | TERM: ≤6 dB (cable loss only)<br>MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Bridge: ≤6 dB (cable loss only) | TERM: ≤6 dB (cable loss only)<br>MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Bridge: ≤6 dB (cable loss only) | ≤6 dB (cable loss only) |
| Transmission bit rate | 1.544 Mbit/s ± 4.6 ppm | 2.048 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 | 2.048 Mbit/s ± 50 ppm | |
| Intrinsic jitter (Tx) | ANSI T1.403 section 6.3<br>GR-499 section 7.3 | G.823 section 6.1 | G.823 section 6.1 | G.703 table 11 |
| Input jitter tolerance | AT&T PUB 62411<br>GR-499 section 7.3 | G.823 section 7.2<br>G.813 | G.823 section 7.2<br>G.813 | G.823 section 7.1<br>G.751 section 3.3 |
| Line coding | AMI and B8ZS | AMI and HDB3 | AMI and HDB3 | |
| Input impedance (resistive termination) | 75 Ω ± 5 %, unbalanced | 75 Ω ± 5 %, unbalanced | 75 Ω ± 5 %, unbalanced | 75 Ω ± 5 %, unbalanced |
| Connector type | BNC a | BNC a | BNC | BNC |

## WANDER REFERENCE INTERFACES

| | 1 PPS | 2 MHz | 10 MHz |
|---|---|---|---|
| Connector type | BNC, RJ48C | BNC, RJ48C | BNC, RJ48C |

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## EXFO OPTICALRF™: RF SPECTRUM MEASUREMENTS OVER CPRI

| | |
|---|---|
| Application | Real-time RF spectrum analysis using digitized RF data (IQ data) in the CPRI link |
| CPRI rate support | • CPRI rate options from 2 to 8 (1.2 Gbit/s to 10.1 Gbit/s)<br>• Automatic CPRI rate scan<br>• Hardware-ready for CPRI rate option 9 (12.1 Gbit/s) |
| Air technology support | LTE, W-CDMA, CDMA, UMTS |
| Radio support | Ericsson, Alcatel-Lucent/Nokia, Huawei |
| Viewer options | • Power spectrum<br>• Waterfall<br>• Power spectrum persistence |
| RF spectrum settings | • Antenna carrier (AxC) selection<br>• Resolution bandwidth (59 Hz to 30 KHz)<br>• Video bandwidth (170 KHz to 8 MHz)<br>• Persistence delay<br>• Min./max./average hold<br>• Decay adjustments for all traces<br>• Zoom for all views<br>• Center frequency and frequency span adjustments<br>• Reference level adjustment<br>• Up to five markers, with table for power, frequency, delta power and delta frequency<br>• Snapshot and video recording capability<br>• dB, dBm, and dBFS adjustments |
| Graph settings | • Crosshair or normal cursor<br>• Channel bandwidth barriers<br>• Grid on/off |
| Interface support | Optical (CWDM, DWDM) SFP interface for both multimode and singlemode fibers |
| Protocol support | CPRI version 7.0 and lower |
| Recording | Up to 270 seconds of real-time RF recording available, depending upon channel bandwidth setting. Saved file is playable on any EXFO OpticalRF-enabled test solution. |
| Remote control and collaboration | The unit can be remotely controlled via a wired or wireless internet connection. |
| Test solutions supported | FTB-870v2, FTB-880v2, FTB-870Q, FTB-880Q, FTB-720Gv2, FTB-730Gv2, FTB-740Gv2 and FTB-890NGE |

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## ADDITIONAL FEATURES

| | |
|---|---|
| CPRI/OBSAI layer-2 protocol testing | Supports BBU and RRH emulation modes by supporting start-up sequence states, autodetection of protocols, negotiated parameters for control and maintenance. |
| CPRI BER testing | Includes unframed and framed BER measurment, bit error injection, round-trip delay measurement, and pass/fail verdicts for 1.2 to 10.1 Gbit/s rates. |
| CPRI/OBSAI SDT | Measurements in ms for the longest, shortest, last, average, total and count of disruptions. |
| CPRI DUAL PORT | Provides two simultaneous ports of CPRI BBU or RRH layer-2 link validation with rates from 1.2 to 10.1G Gbit/s. |
| 1588 PTP | Validates 1588 PTP packet network synchronization services, supports G.8265.1 and G.8275.1 profiles, emulates PTP clients, generates and analyzes messages between master/clients, clock quality level and IPDV |
| SyncE | Validates SyncE frequency, ESMC messages and clock quality levels. |
| Power measurement | Supports power measurement at all times, displayed in dBm (dBdsx for DS1 and DS3), for optical and electrical interfaces. |
| Power-up and restore | In the event of power failure to the unit, the active test configuration and test logger are saved and restored upon boot-up. |
| Save and load configuration | Store and load test configurations to/from a non-volatile USB memory stick or internal flash. |
| Pass/fail analysis | Provides a pass/fail outcome with user-adjustable thresholds, based on bit error rate and/or service disruption time. |
| Alarm hierarchy | Alarms are displayed according to a hierarchy based on root cause. Secondary effects are not displayed. This hierarchy serves to facilitate alarm analysis. |
| Report generation | Generate test reports with customizable selections, company logos and clear pass/fail color-coded analysis, in both HTML and PDF formats, and save them directly on the unit, on a USB stick or via EXFO Connect. |
| Event logger | Log test results with absolute or relative time and date, details and duration of events, color-coded events and pass/fail outcome. |
| Remote control | Remote control via VNC or Remote desktop. |
| Remote loopback | Detects other NetBlazer/PowerBlazer units and sets them to Smart Loopback mode. |
| Dual test set | Detects and connects to other NetBlazer/Power Blazer units to perform bidirectional EtherSAM, RFC 6349 and RFC 2544 testing. |
| Second port loopback tool | Enables any Ethernet test (e.g., EtherSAM, RFC 2544, traffic generation and monitoring, or BERT) to run directly to itself using one self-contained unit with second port loopback. |
| IP tools | Performs ping and traceroute functions. |
| Smart loopback | Return Ethernet traffic to the local unit by swapping packet overhead up to layer 4. |
| Test timer | Select a predefined duration or enter start and stop times. |

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## GENERAL SPECIFICATIONS

| MODULE VERSIONS | FTB-880V2 | FTB-870V2 | FTB-880Q | FTB-870Q |
|---|---|---|---|---|
| Size (H x W x D) | 210 mm x 254 mm x 55 mm (8 ¼ in x 10 in x 2 ³⁄₁₆ in) | | 210 mm x 254 mm x 76 mm (8 ¼ in x 10 in x 3 in) | |
| Weight | 0.91 kg (2 lb) | 0.85 kg (1.85 lb) | 2.1 kg (4.65 lb) | 1.84 kg (4.06 lb) |
| Operating temperature | 0 °C to 50 °C (32 °F to 122 °F) up to 2000 m (6561 ft) | | | |
| Relative humidity | 0 % to 95 %, non-condensing | | | |
| Battery duration | Over two hours | | Over one hour | |
| Battery charging time | Two hours | | | |
| Languages | English, Spanish, Chinese, Japanese and Korean | | | |

| MODULE VERSIONS | FTB-890 | FTB-890NGE |
|---|---|---|
| Size (H x W x D) | 210 mm x 254 mm x 76 mm (8 1/4 in x 10 in x  3 in) | |
| Weight | 1.85 kg (4.08 lb) | 2.2 kg (4.85 lb) |
| Operating temperature | 0 °C to 40 °C (32 °F to 104 °F) up to 2000 m (6561 ft) | |
| Relative humidity | 0 % to 95 % non-condensing | |
| Battery duration | Over one hour | |
| Battery charging time | Two hours | |
| Languages | English, Spanish, Chinese, Japanese and Korean | |

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