# FTB-8120/8130
## Transport Blazer

NETWORK TESTING – TRANSPORT AND DATACOM


## Fully integrated test solution supporting next-generation SONET/SDH and optical transport network (OTN) test functions

- DS0/E0 to OC-192/STM-64/OTU2 testing in a single module
- Supports SONET, SDH, DSn, PDH, next-generation SONET/SDH and OTN testing
- Ethernet-over-SONET/SDH (EoS) testing via GFP, VCAT and LCAS software options
- OTN forward error correction (FEC) and optical channel data unit (ODU) multiplex testing capabilities as per ITU-T G.709
- Offers ODU0 (1.25 Gbit/s) container with Gigabit Ethernet and SONET/SDH client signals for qualifying newly and efficiently mapped transport and datacom services over OTN
- Supports circuit and packet ODUflex testing capabilities for OTN bandwidth optimization
- SmartMode signal structure discovery for rates of up to 10 Gbit/s, with real-time simultaneous monitoring of all discovered STS/AU and user selected VT/TU channels
- Intuitive, feature-rich user interface with automated test scripting and multi-user remote management capabilities

## Platform Compatibility

- FTB-500 Platform
- FTB-200 Compact Platform

EXFO | Assessing Next-Gen Networks

# The Next Step in SONET/SDH Testing

The increased demand for data and video services continues to drive the need for more cost-effective networks. Technologies such as next-generation SONET/SDH are becoming more important to service providers as they offer an economical means of introducing new revenue-generating, Ethernet-based transport services on existing SONET/SDH infrastructures. In addition, implementation of OTN (ITU-T G.709) will also help reduce the cost of operating DWDM networks by achieving higher transmission quality with longer optical links through the use of forward error correction (FEC).

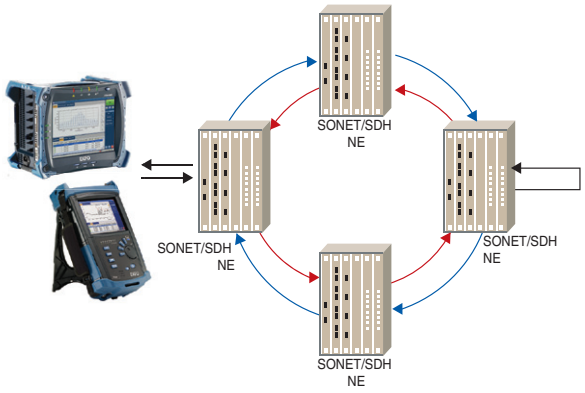
This opportunity creates the need for test solutions that can help ensure proper deployment, operation and maintenance of standard SONET/SDH, OTN and new Ethernet-based transport networks.

EXFO's FTB-8120 (2.5/2.7 Gbit/s) and FTB-8130 (10/11.3 Gbit/s) Transport Blazer test modules provide advanced DSn/PDH, SONET/SDH, next-generation SONET/SDH and OTN test functions in a single unit, eliminating the need for multiple purpose-built test platforms when commissioning or troubleshooting SONET/SDH, OTN and new data-aware SONET/SDH circuits.

## SONET/SDH Service Turn-Up and Troubleshooting

The FTB-8120/8130 Transport Blazer modules offer a wide range of SONET/SDH test functions, allowing users to perform tests ranging from simple bit error rate (BER) testing to advanced characterization and troubleshooting procedures. These functions include:

- Mixed and bulk payload generation and analysis from 64 kbit/s to 10 Gbit/s
- High-order mappings: STS-1/3c/12c/48c/192c and AU-3/AU-4/AU-4-4c/16c/64c
- Low-order mappings: VT1.5/2/6, TU-11/12/2/3
- Unframed optical signal testing at 10 Gbit/s rate
- Section/RS, Line/MS, high-order and low-order path overhead manipulation and monitoring
- Section/RS, Line/MS, high-order and low-order path alarm/error generation and monitoring
- High-order and low-order pointer generation and monitoring
- K1/K2 OH byte capture
- Tandem connection monitoring
- Performance monitoring: G.821, G.826, G.828, G.829, M.2100, M.2101
- Frequency analysis and power measurement
- Frequency offset generation
- Payload block and replace
- Automatic protection switching and service disruption time measurements
- Round-trip delay measurements
- DS1/DS3 auto detection of line code, framing and test pattern
- Dual DS1/DS3 receiver testing
- Independent transmitter and receiver testing
- Through mode analysis
- Intrusive through mode
- Programmable error/alarm injection
- DS1 FDL
- DS1 loopcodes and NI/CSU loopback emulation
- Fractional T1/E1 testing
- DS3 FEAC




*Housed in the FTB-500 or FTB-200 platform, the FTB-8120/8130 modules offer the solution for field circuit turn-up and troubleshooting.*

## Optical Transport Network Testing

OTN as per ITU-T G.709 has recently introduced two new concepts: ODU0 and ODUflex. ODU0 is a new virtual container of 1.25 Gbit/s bandwidth specifically defined for efficiently mapping Gigabit Ethernet services over OTN. As for ODUflex, it is the most efficient sub-wavelength bandwidth management capability for transport line rates of 10 Gbit/s, 40 Gbit/s and upcoming 100 Gbit/s. ODUflex allows providers to interconnect routers in ways that enable efficient bandwidth growth in steps of 1.25 Gbit/s, eliminating the need to allocate a full fixed-rate ODU container to each connection and allowing service providers to transport efficiently and seamlessly across lower-cost optical infrastructures.

With OTN deployments rapidly increasing, so does the need for smaller field-oriented OTN test equipment. The FTB-8120/8130 Transport Blazer modules offer OTN test capabilities for verifying compliancy with ITU-T G.709 standards. The tests include:

- OTU1 (2.7 Gbit/s) and OTU2 (10.7 Gbit/s) bit rates
- ODU0 (1.25 Gbit/s) container with Gigabit Ethernet and SONET/SDH client signals mapping
- ODUflex with Ethernet client signal mapping
- Over-clocked OTU2 rates: OTU1e (11.0491 Gbit/s), OTU2e (11.0957 Gbit/s), OTU1f (11.2701 Gbit/s) and OTU2f (11.3176 Gbit/s)
- Unframed optical signal testing at 10.7 Gbit/s, 11.0491 Gbit/s, 11.0957 Gbit/s, 11.2701 Gbit/s and 11.3176 Gbit/s rates
- Synchronous mapping of SONET/SDH signals within OTN as well as synchronous and asynchronous demapping
- Forward error correction (FEC) testing
- Service disruption time (SDT) measurements
- Round-trip delay (RDT) measurements
- OTU, ODU, OPU overhead manipulation and monitoring
- OTU, ODU (including ODU TCM), OPU layer alarms/errors generation and analysis
- OTU, ODU (including ODU TCM) trace messages
- Mux/demux of ODU1/ODU2 testing–generation of four ODU1 into a single ODU2 structure and transporting it over a single wavelength
- ODU multiplexing alarm-generation and analysis
- Through mode analysis
- Intrusive Through mode
- EoOTN testing using internally generated 10 GigE LAN and mapping onto OTU1e and OTU2e rates
- 10 GigE LAN mapping into OTU2 using GFP-F


*Transport Blazer modules support G.709 testing in the FTB-200 Compact Platform or the FTB-500 Platform.*

# Scalable, High-Performance Testing

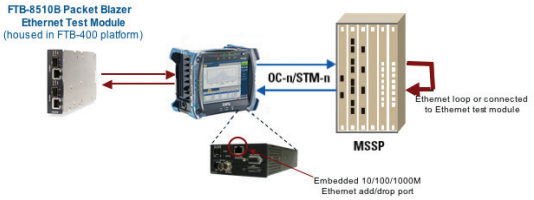
## Next-Gen SONET/SDH Testing

Available next-generation SONET/SDH test functionalities include generic framing procedure (GFP), virtual concatenation (VCAT) and link capacity adjustment scheme (LCAS). These options are available on the FTB-8120NG/8130NG modules when installed in the FTB-500 platform.

| GFP | VCAT | LCAS |
|---|---|---|
| ▬ Generation and analysis of frame types (client management/client data)<br>▬ Alarm/error generation and monitoring<br>▬ Overhead manipulation and monitoring<br>▬ Transmission and reception statistics monitoring<br>▬ Supported over contiguous or VCAT containers | ▬ High-order and low-order VCAT support<br>▬ Simultaneous manipulation and monitoring of each member<br>▬ Alarm/error generation and monitoring<br>▬ Sequence-indicator manipulation and processing<br>▬ Group-summary monitoring<br>▬ Differential delay analysis and insertion | ▬ Emulation and analysis of LCAS protocol (Automatic and Manual modes)<br>▬ Source and sink state machines control and monitoring<br>▬ Real-time generation and monitoring of LCAS control fields<br>▬ Real-time insertion and monitoring of LCAS alarms/errors |

## Ethernet Add/Drop Interface

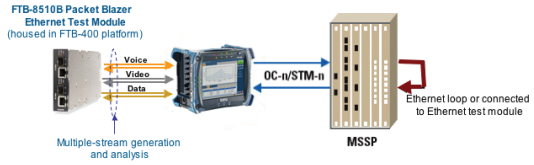
In addition to its internal PRBS generator, each FTB-8120NG and FTB-8130NG Transport Blazer module includes one 10/100/1000M Ethernet (RJ-45 interface) and one Gigabit Ethernet (SFP) interface. These interfaces can be used to interconnect with an FTB-8510B Packet Blazer Ethernet test module or an external Ethernet device (e.g., switch, router, etc.), delivering the industry's first data-integrated next-generation SONET/SDH test solution for advanced Ethernet-over-SONET/SDH service emulation and analysis–ideal for lab or field test applications.




*The FTB-8120NG/8130NG module's embedded 10/100/1000M Ethernet and Gigabit Ethernet interfaces allow users to extract and insert Ethernet payload to/from a GFP-mapped OC-n/STM-n line, providing a powerful test solution for Ethernet-over-SONET/SDH service validation.*

## Multiservice QoS Testing

Next-generation SONET/SDH networks are being deployed to transport a mix of services, such as voice, video and data access services. Used in conjunction with the FTB-8510B Packet Blazer Ethernet Test Module, EXFO's FTB-8120NG/8130NG Transport Blazer test modules allow for the generation and analysis of multiple Ethernet test streams over a GFP-enabled SONET/SDH link. Each stream's quality-of-service setting is user-configurable (via IP TOS, Diffserv, Ethernet 802.1 priority bits), providing a means of prequalifying delivery of multiple services over their multiservice provisioning platforms (MSPPs) and corresponding next-generation SONET/SDH networks.

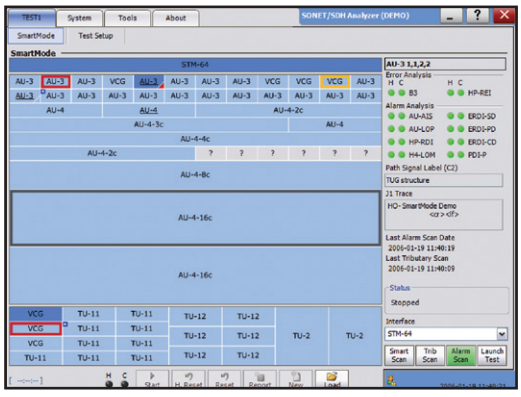



*Combining the FTB-8510B's Ethernet multiple-streaming capabilities and the FTB-8120NG/8130NG embedded Ethernet interfaces creates a powerful solution for testing multiple services over SONET/SDH.*

## SmartMode: Real-time Signal Structure Discovery and Monitoring

EXFO's FTB-8120/8130 Transport Blazer supports a unique feature called SmartMode. This provides users with full visibility of all high-order (STS/AU) and low-order (VT/TU) mixed mappings within the incoming SONET/SDH and OTN test signal.

SmartMode automatically discovers the signal structure of the OC-n/STM-n line including mixed mappings and virtual concatenation (VCAT) members. In addition to this in-depth multichannel visibility, SmartMode performs real-time monitoring of all discovered high-order paths and user selected low-order paths simultaneously, providing users with the industry's most powerful SONET/SDH multichannel monitoring and troubleshooting solution. Real-time monitoring allows users to easily isolate network faults, saving valuable time and minimizing service disruption. SmartMode also provides one-touch test case start, allowing users to quickly configure a desired test path.



*FTB-8120/8130 SmartMode: multichannel signal discovery with real-time alarm scan (shown in the FTB-500 user interface).*

# Unsurpassed Configuration and Operational Flexibility

## Multiplatform Support and Versatility

EXFO's Transport Blazer series offers four hardware configurations:

- FTB-8120 supports SONET/SDH and OTN test functions to 2.7 Gbit/s
- FTB-8130 supports SONET/SDH and OTN test functions to 11.3 Gbit/s
- FTB-8120NG supports next-generation SONET/SDH and OTN test functions to 2.7 Gbit/s
- FTB-8130NG supports next-generation SONET/SDH and OTN test functions to 11.3 Gbit/s

*FTB-8130NG with next-generation SONET/SDH and OTN hardware including optical and electrical Ethernet add/drop interfaces.*

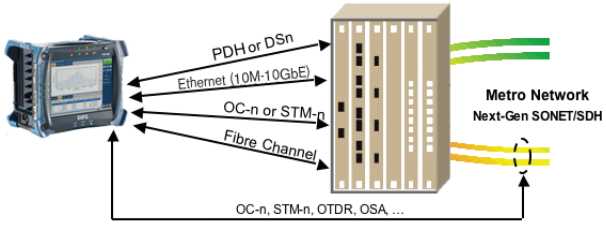
*FTB-8130 module with SONET/SDH and OTN test functions.*

The FTB-8120/8120NG and FTB-8130/8130NG Transport Blazer modules share a unique architecture that allows them to be supported and interchangeable on the FTB-500 Platform and the FTB-200 Compact Platform. This cross-platform support provides users with added flexibility by enabling them to select the appropriate platform that suits their testing needs. EXFO is the first and only test solution provider to offer this versatility, delivering single to multi-application test solutions with the same hardware module, which in turn dramatically reduces capital expenditures.

*FTB-8120/8130 modules supported on the FTB-200 and FTB-500 platforms.*

Once inserted into the FTB-200, the FTB-8120/FTB-8120NG or FTB-8130/FTB-8130NG Transport Blazer modules deliver DSn/PDH, SONET/SDH and OTN test functions in a small, lightweight platform, ideal for field technicians' installation and commissioning needs. When combined with the FTB-200's optional integrated high-precision power meter, visual fault locator and fiber scope, this solution provides all the critical test tools required for day-to-day activities, eliminating the need to carry and manage multiple test sets.

Using the FTB-500 platform provides users with an all-in-one solution supporting a mix of SONET/SDH, OTN, Ethernet, Fibre Channel and optical-layer test modules, making it the industry's first truly integrated network testing platform. This modularity enables users to upgrade their systems in the field according to their testing needs. This multitechnology test platform is the ideal solution for field, central office and lab applications.




*With its modular, multislot design, the FTB-500 platform enables users to configure and upgrade their systems in the field according to their testing needs, minimizing capital expenditures.*

## Product Option Flexibility

The Transport Blazer series provides customers with the flexibility to purchase SONET/SDH-only configurations and upgrade to next-generation SONET/SDH and/or OTN test functions to meet evolving needs. This avoids having to perform complete hardware and/or platform retrofits, therefore significantly decreasing capital and training expenses.

In addition, with the FTB-8120NG and FTB-8130NG Transport Blazer modules, users can purchase one or more next-generation options (e.g., GFP, VCAT, LCAS) and/or OTN options (OTU1, OTU2) to customize their configuration as new needs arise. At any point, additional next-generation options are available via simple field upgrades.

## Remote Management

Through the optional Visual Guardian Lite™ management software, the FTB-8120/FTB-8120NG and FTB-8130/FTB-8130NG Transport Blazer modules allow users to perform remote testing and data analysis, as well as remote monitoring via standard Ethernet.

## Automated Test Scripting

The FTB-8120/8120NG and FTB-8130/8130NG Transport Blazer modules come with a built-in macro recorder allowing users to easily record their test actions and automatically create test scripts. This also allows them to build standard test routines that can be easily accessed and run by field technicians with little or no manual intervention.

# Electrical Interfaces

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

| | | DS1 | E1/2M | | E2/8M | 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 | 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 16 | G.703 Figure 17 | DS-3 GR-499 Figure 9-8 / 45-M 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 4-14/22, 23 |
| Tx LBO Preamplification | | Power dBdsx<br>+0.6 dBdsx (0-133 ft)<br>+1.2 dBdsx (133-266 ft)<br>+1.8 dBdsx (266-399 ft)<br>+2.4 dBdsx (399-533 ft)<br>+3.0 dBdsx (533-655 ft) | | | | | 0 to 225 ft<br>225 to 450 ft | 0 to 225 ft<br>255 to 450 ft | | 0 to 225 ft |
| Cable Simulation | | Power dBdsx<br>−22.5 dBdsx<br>−15.0 dBdsx<br>−7.5 dBdsx<br>0 dBdsx | | | | | 450 to 900 (927) ft | 450 to 900 (927) ft | | |
| Rx Level Sensitivity | | For 772 kHz:<br>TERM: ≤26 dB (cable loss only) at 0 dBdsx Tx<br>DSX-MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Bridge: ≤6 dB (cable loss only)<br>Note: measurement units = dBdsx | For 1024 kHz:<br>TERM: ≤6 dB (cable loss only)<br>MON: ≤25 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Bridge: ≤6 dB (cable loss only)<br>Note: measurement units = dBm | For 1024 kHz:<br>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)<br>Note: measurement units = dBm | For 4224 kHz:<br>TERM: ≤6 dB (cable loss only)<br>MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Note: measurement units = dBm | For 17.184 MHz:<br>TERM: ≤12 dB (coaxial cable loss only)<br>MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Note: measurement units = dBm | For 22.368 MHz:<br>TERM: ≤10 dB (cable loss only)<br>DSX-MON: ≤26.5 dB (21.5 dB resistive loss + cable loss ≤ 5 dB)<br>Note: measurement units = dBm | For 25.92 MHz:<br>TERM: ≤10 dB (cable loss only)<br>MON: ≤25 dB (20 dB resistive loss + cable loss ≤ 5 dB)<br>Note: measurement units = dBm | For 70 MHz:<br>TERM: ≤12 dB (coaxial cable loss only)<br>MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Note: measurement units = dBm | For 78 MHz:<br>TERM: ≤12.7 dB (coaxial cable loss only)<br>MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB)<br>Note: measurement units = dBm |
| Transmit Bit Rate | | 1.544 Mbit/s ± 4.6 ppm | 2.048 Mbit/s ± 4.6 ppm | 2.048 Mbit/s ± 4.6 ppm | 8.448 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 |
| Receive Bit Rate | | 1.544 Mbit/s ± 140 ppm | 2.048 Mbit/s ± 100 ppm | 2.048 Mbit/s ± 100 ppm | 8.448 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)<br>Electrical Power (dB) | ±4.6<br>DSX range: ±1.0<br>DSX-MON range: ±2.0 | ±4.6<br>Normal: ±1.0<br>Monitor: ±2.0 | ±4.6<br>Normal: ±1.0<br>Monitor: ±2.0 | ± 4.6<br>Normal: ±1.0<br>Monitor: ±2.0 | ±4.6<br>Normal: ±1.0<br>Monitor: ±2.0 | ±4.6<br>DSX range: ±1.0<br>DSX-MON range: ±2.0 | ±4.6<br>DSX range: ±1.0<br>DSX-MON range: ±2.0 | ±4.6<br>Normal: ±1.0<br>Monitor: ±2.0 | ±4.6<br>Normal: ±1.0<br>Monitor: ±2.0 |
| Peak-to-Peak Voltage | | ±10 % down to 500 mVpp | ±10 % down to 500 mVpp | ±10 % down to 500 mVpp | ±10 % down to 400 mVpp | ±10 % down to 200 mVpp | ±10 % down to 200 mVpp | ±10 % down to 200 mVpp | ±10 % down to 200 mVpp | ±10 % down to 200 mVpp |
| Frequency Offset Generation | | 1.544 Mbit/s ± 140 ppm | 2.048 Mbit/s ± 70 ppm | 2.048 Mbit/s ± 70 ppm | 8.448 Mbit/s ± 50 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 |
| Intrinsic Jitter (Tx) | | ANSI T1.403 section 6.3<br>GR-499 section 7.3 | G.823 section 5.1 | G.823 section 5.1 | G.823 section 5.1 | G.823 section 5.1<br>G.751 section 2.3 | GR-449 section 7.3 (categories I and II) | GR-253 section 5.6.2.2 (category II) | G.823 section 5.1 | G.825 section 5.1<br>GR-253 section 5.6.2.2 |
| Input Jitter Tolerance | | AT&T PUB 62411<br>GR-499 section 7.3 | G.823 section 7.1 | G.823 section 7.1 | G.823 section 7.1 | G.823 section 7.1 | GR-449 section 7.3 (categories I and II) | GR-253 section 5.6.2.2 (category II) | G.823 section 7.1<br>G.751 section 3.3 | G.825 section 5.2<br>GR-253 section 5.6.2.3 |
| Line Coding | | AMI and B8ZS | AMI and HDB3 | AMI and HDB3 | HDB3 | HDB3 | B3ZS | B3ZS | CMI | CMI |
| Input Impedance (Resistive Termination) | | 100 ohms ± 5 %, balanced | 120 ohms ± 5 %, balanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 10 %, unbalanced | 75 ohms ± 5 %, unbalanced |
| Connector Type | | BANTAM and RJ-48C | BANTAM and RJ-48C | BNC | BNC | BNC | BNC | BNC | BNC | BNC |

## 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 (0-133 ft)<br>+1.2 dBdsx (133-266 ft)<br>+1.8 dBdsx (266-399 ft)<br>+2.4 dBdsx (399-533 ft)<br>+3.0 dBdsx (533-655 ft) | | | |
| Rx Level Sensivity | 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 (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<br>section 6.1 | G.823<br>section 6.1 | G.703<br>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 | |
| Line Coding | AMI and B8ZS | AMI and HDB3 | AMI and HDB3 | |
| Input Impedance (Resistive Termination) | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced | 75 ohms ± 5 %, unbalanced |
| Connector Type | BNC [a] | BNC [a] | BNC | BNC |

**Note**

a. Adaptation cable required for BANTAM.

# Electrical Interfaces

## ETHERNET ADD/DROP INTERFACE

| | |
|---|---|
| **10/100/1000 Base-T (Add/Drop)** | |
| Compliance | 10 Mbit/s: IEEE 802.3 section 14<br>100 Mbit/s: IEEE 802.3 section 25<br>1000 Mbit/s: IEEE 802.3 section 40 |
| Connector | RJ-45 Ethernet |
| **Gigabit Ethernet (Add/Drop)** | |
| Interface/connector | SFP/Dual LC |
| Compliance | 1000 Mbit/s: IEEE 802.3 Section 40 [a] |
| Wavelength/Max Tx level | 850, 1310 nm/–3 dBm<br>1550 nm/+5 dBm |

## REF-OUT INTERFACE

| Parameter | Value | | | | | |
|---|---|---|---|---|---|---|
| Tx pulse amplitude | 600 ± 150 mVpp | | | | | |
| Transmission frequency | | | | | | |
| | SONET/SDH | OTU2 | OTU1e | OTU2e | OTU1f | OTU2f |
| Clock divider = 16 | 622.08 MHz | 669.33 MHz | 690.57 MHz | 693.48 MHz | 704.38 MHz | 707.35 MHz |
| Clock divider = 32 | 311.04 MHz | 334.66 MHz | 345.29 MHz | 346.74 MHz | 352.19 MHz | 353.68 MHz |
| Clock divider = 64 | 155.52 MHz | 167.33 MHz | 172.64 MHz | 173.37 MHz | 176.10 MHz | 176.84 MHz |
| Output configuration | AC coupled | | | | | |
| Load impedance | 50 ohms | | | | | |
| Maximum cable length | 3 meters | | | | | |
| Connector Type | SMA | | | | | |

# SONET/SDH/OTN Optical Interfaces

The following section provides detailed information on all supported SONET/SDH/OTN optical interfaces.

| | | OC-3/STM-1 | | | | OC-12/STM-4 | | | | OC-48/STM-16/OTU1 | | | | OC-192/STM-64/OTU2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15 km; 1310 nm | 40 km; 1310 nm | 40 km; 1550 nm | 80 km; 1550 nm | 15 km; 1310 nm | 40 km; 1310 nm | 40 km; 1550 nm | 80 km; 1550 nm | 15 km; 1310 nm | 40 km; 1310 nm | 40 km; 1550 nm | 80 km; 1550 nm | 10 km; 1310 nm | 40 km; 1550 nm | 80 km; 1550 nm |
| Level Tx | | –5 to 0 dBm | –2 to 3 dBm | –5 to 0 dBm | –2 to 3 dBm | –5 to 0 dBm | –2 to 3 dBm | –5 to 0 dBm | –2 to 3 dBm | –5 to 0 dBm | –2 to 3 dBm | –5 to 0 dBm | –2 to 3 dBm | –6 to –1 dBm | –1 to 2 dBm | 0 to 4 dBm |
| Rx operating range | | –23 to –10 dBm | –30 to –15 dBm | –23 to –10 dBm | –30 to –15 dBm | –22 to 0 dBm | –27 to –9 dBm | –22 to 0 dBm | –29 to –9 dBm | –18 to 0 dBm | –27 to –9 dBm | –18 to 0 dBm | –28 to –9 dBm | –11 to –1 dBm | –14 to –1 dBm | –24 to –9 dBm |
| Transmit bit rate | | 155.52 Mbit/s ± 4.6 ppm | | | | 622.08 Mbit/s ± 4.6 ppm | | | | 2.48832 Gbit/s ± 4.6 ppm<br>2.66606 Gbit/s ± 4.6 ppm (OTU1) | | | | 9.95328 Gbit/s ± 4.6 ppm (OC-192/STM-64)<br>10.70922 Gbit/s ± 4.6 ppm (OTU2)<br>11.0491 Gbit/s ± 4.6 ppm (OTU1e)<br>11.0957 Gbit/s ± 4.6 ppm (OTU2e)<br>11.2701 Gbit/s ± 4.6 ppm (OTU1f)<br>11.3176 Gbit/s ± 4.6 ppm (OTU2f) | 9.95328 Gbit/s ± 4.6 ppm<br>10.70922 Gbit/s ± 4.6 ppm (OTU2) | |
| Receive bit rate | | 155.52 Mbit/s ± 100 ppm | | | | 622.08 Mbit/s ± 100 ppm | | | | 2.48832 Gbit/s ± 100 ppm<br>2.66606 Gbit/s ± 100 ppm (OTU1) | | | | 9.95328 Gbit/s ± 100 ppm (OC-192/STM-64)<br>10.70922 Gbit/s ± 100 ppm (OTU2)<br>11.0491 Gbit/s ± 120 ppm (OTU1e)<br>11.0957 Gbit/s ± 120 ppm (OTU2e)<br>11.2701 Gbit/s ± 120 ppm (OTU1f)<br>11.3176 Gbit/s ± 120 ppm (OTU2f) | 9.95328 Gbit/s ± 100 ppm<br>10.70922 Gbit/s ± 100 ppm (OTU2) | |
| Operational wavelength range | | 1261 to 1360 nm | 1263 to 1360 nm | 1430 to 1580 nm | 1480 to 1580 nm | 1270 to 1360 nm | 1280 to 1335 nm | 1430 to 1580 nm | 1480 to 1580 nm | 1260 to 1360 nm | 1280 to 1335 nm | 1430 to 1580 nm | 1500 to 1580 nm | 1290 to 1330 nm | 1530 to 1565 nm | 1530 to 1565 nm |
| Spectral width | | 1 nm (–20 dB) | | | | 1 nm (–20 dB) | | | | 1 nm (–20 dB) | | | | 1 nm (–20 dB) | | |
| Frequency offset generation | | ± 50 ppm | | | | ± 50 ppm | | | | ± 50 ppm | | | | ± 50 ppm [b] | | |
| Measurement accuracy (uncertainty) | Frequency<br>Optical power | ± 4.6 ppm<br>± 2 dB | | | | ± 4.6 ppm<br>± 2 dB | | | | ± 4.6 ppm<br>± 2 dB | | | | ± 4.6 ppm<br>± 2 dB | | |
| Maximum Rx before damage [c] | | 3 dBm | | | | 3 dBm | | | | 3 dBm | | | | 3 dBm | | |
| Jitter compliance | | GR-253 (SONET)<br>G.958 (SDH) | | | | GR-253 (SONET)<br>G.958 (SDH) | | | | GR-253 (SONET)<br>G.958 (SDH)<br>G.8251 (OTN) | | | | GR-253 (SONET)<br>G.825 (SDH)<br>G.8251 (OTN) | | |
| Line coding | | NRZ | | | | NRZ | | | | NRZ | | | | NRZ | | |
| Eye safety | | SFP/XFP transceivers comply with IEC 60825 and 21 CFR 1040.10 (except for deviations pursuant to Laser Notice No. 50, dated July 2001), for Class 1 or 1M lasers. | | | | | | | | | | | | | | |
| Connector [d] | | Dual LC | | | | Dual LC | | | | Dual LC | | | | Dual LC | | |
| Transceiver type [e] | | SFP | | | | SFP | | | | SFP | | | | XFP | | |

**NOTES**

a. SFP/XFP transceivers comply with IEC 60825 and 21 CFR 1040.10 (except for deviations pursuant to Laser Notice 50, dated July, 2001), for Class 1 or 1M lasers.

b. For OTU1e, OTU2e, OTU1f and OTU2f rates, the frequency offset generation is ±115 ppm.

c. In order not to exceed the maximum receiver power level before damage, an attenuator must be used.

d. External adaptors can be used for other types of connectors. For example FC/PC.

e. SFP/XFP compliance: The FTB-8120/8130 selected SFP/XFP shall meet the requirements stated in the “Small Form-Factor Pluggable (SFP) Transceiver Multisource Agreement (MSA)”. The FTB-8120/8130 selected SFP/XFP shall meet the requirements stated in the “Specification for Diagnostic Monitoring Interface for Optical Xcvrs”.

# SONET/SDH Functional Specifications

| SONET AND DSn | | SDH AND PDH | |
|---|---|---|---|
| **Optical interfaces** | OC-3, OC-12, OC-48, OC-192 | **Optical interfaces** | 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), 8M (E2), 34M (E3), 45M (DS3), 140M (E4), STM-0e, STM-1e |
| DS1 framing | Unframed, SF, ESF | 2M framing | Unframed, PCM30, PCM31, PCM30 CRC-4, PCM31 CRC-4 |
| DS3 framing | Unframed, M13, C-bit parity | 8M, 34M, 140M framing | Unframed, framed |
| Clocking | Internal, loop-timed, external (BITS), inter-module | Clocking | Internal, loop-timed, external (MTS/SETS), 2 MHz, inter-module |
| **Mappings** [b] | | **Mappings** [b] | |
| VT1.5 | Bulk, DS1, GFP [c] | TU-11-AU-3, TU-11-AU-4 | Bulk, 1.5M, GFP [c] |
| VT2 | Bulk, E1, GFP [c] | TU-12-AU-3, TU-12-AU-4 | Bulk, 1.5M, 2M, GFP [c] |
| VT6 | Bulk, GFP [c] | TU-3-AU-4 | Bulk, 34M, 45M, GFP [c] |
| STS-1 SPE | Bulk, DS3, GFP [c] | TU-2-AU-3, TU-2-AU-4 | Bulk, GFP [c] |
| STS-3c | Bulk, E4, GFP [c] | AU-4 | Bulk, 140M, GFP [c] |
| STS-12c/48c/192c, SPE | Bulk, GFP [c] | AU-4-4c/16c/64c | Bulk, GFP [c] |
| SONET overhead analysis and manipulation | A1, A2, J0, E1, F1, D1-D12, K1, K2, S1, M0, 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, G1, F2, F3, K3, N1, N2, K4, E2, J1, C2, H4 |
| **Error insertion** | | **Error insertion** | |
| DS1 | Framing bit, BPV, CRC-6, bit error | E1 (2M) | Bit error, FAS, CV, CRC-4, E-bit |
| DS3 | BPV, C-bit, F-bit, P-bit, FEBE, bit error | E2 (8M), E3 (34M), E4 (140M) | Bit error, FAS, CV |
| STS-1e, STS-3e | Section BIP (B1), line BIP (B2), path BIP (B3), BIP-2, REI-L, REI-P, REI-V, BPV, FAS, 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-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-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** | | **Error measurement** | |
| DS1 | Framing bit, BPV, CRC-6, excess zeros, bit error | E1 (2M) | Bit error, FAS, CV, CRC-4, E-bit |
| DS3 | BPV, C-bit, F-bit, P-bit, FEBE, bit error | E2 (8M), E3 (34M), E4 (140M) | Bit error, FAS, CV |
| STS-1e, STS-3e | Section BIP (B1), line BIP (B2), path BIP (B3), BIP-2, REI-L, REI-P, REI-V, BPV, FAS, 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-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-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, CV, FAS, bit error |
| **Alarm insertion** | | **Alarm insertion** | |
| DS1 | LOS, RAI, AIS, OOF, pattern loss | E1 (2M) | LOS, LOS Mframe, LOS CRC 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-3, OC-12, OC-48, OC-192 | LOS, LOF, 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-1, STM-4, STM-16, STM-64 | LOS, LOF, OOF, MS-AIS, MS-RDI, AU-AIS, AU-LOP, H4-LOM, HP-PDI, ERDI-PSD, ERDI-PCD, ERDI-PPD, HP-UNEQ, TU-AIS, LP-RFI, LP-RDI, ERDI-VCD, ERDI-VPD, ERDI-VSD, LP-RFI, LP-UNEQ, pattern loss |
| **Alarm detection** | | **Alarm detection** | |
| DS1 | LOS, loss of clock (LOC), RAI, AIS, OOF, pattern loss | E1 (2M) | LOS, LOS Mframe, LOS CRC 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-3, OC-12, OC-48, OC-192 | LOS, LOC, LOF, SEF, TIM-S, AIS-L, RDI-L, AIS-P, LOP-P, LOM, PDI-P, RDI-P, ERDI-PCD, ERDI-PPD, ERDI-PSD, PLM/SLM-P, UNEQ-P, TIM-P, AIS-V, LOP-V, RDI-V, ERDI-VCD, ERDI-VCD, ERDI-VPD, ERDI-VSD, RFI-V, UNEQ-V, TIM-V, PLM/SLM-V, pattern loss | STM-0e, STM-1e, STM-1, STM-4, STM-16, STM-64 | LOS, LOF, LOC, OOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, H4-LOM, HP-RDI, ERDI-PSD, ERDI-PCD, ERDI-PPD, HP-PLM/SLM, HP-UNEQ, HP-TIM, TU-AIS, LP-RFI, LP-RDI, ERDI-VPD, ERDI-VSD, LP-RFI, LP-UNEQ, LP-TIM, LP-PLM/SLM, pattern loss |
| *Frequency alarm on all supported interfaces.* | | | |
| **Patterns** | | **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 | 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, QRSS, 1-in-8, 1-in-16, 3-in-24, 32 bit programmable (inverted or non-inverted), bit errors | E2 (8M), 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 [d], 32 bit programmable (inverted or non-inverted), bit errors |
| VT1.5/2/6 | 2E9-1, 2E11-1, 2E15-1, 2E20-1, 2E23-1, 2E31-1, 1100, 1010, 1111, 0000, QRSS, 1-in-8, 1-in-16, 32 bit programmable (inverted or non-inverted), bit errors | TU-11/12/2/3 | 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. VCAT mappings are also available. Please refer to the VCAT section of this document for details.

c. GFP supported only with purchase of GFP-F option.

d. Not supported for E4 (140M).

# SONET/SDH Functional Specifications (Cont'd)

| NEXT-GENERATION SONET | | NEXT-GENERATION SDH | |
|---|---|---|---|
| **Generic framing procedure (GFP)** | | **Generic framing procedure (GFP)** | |
| Standards compliance | As per ITU-T G.7041, and ANSI T1.105.02 | Standards compliance | As per ITU-T G.7041, G.707, and ANSI T1.105.02 |
| Payload | PRBS pattern; Ethernet | Payload | PRBS pattern; Ethernet |
| Ethernet add/drop | Ability to add/drop Ethernet payload to/from GFP mapped OC-n/OTU signal | Ethernet add/drop | Ability to add/drop Ethernet payload to/from GFP mapped STM-n/OTU signal |
| Error insertion | Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, payload FCS | Error insertion | Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, payload FCS |
| Error monitoring | Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, payload FCS | Error monitoring | Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, payload FCS |
| Alarm insertion | Loss of client signal (LOCS) and loss of client character, synchronization (LOCCS) with configurable time interval between 10 and 1200 ms, loss of frame delineation (LFD), client forward defect indication (FDI), client reverse defect indication (RDI) and client defect clear indication (DCI) | Alarm insertion | Loss of client signal (LOCS) and loss of client character, synchronization (LOCCS) with configurable time interval between 10 and 1200 ms, loss of frame delineation (LFD), client forward defect indication (FDI), client reverse defect indication (RDI) and client defect clear indication (DCI) |
| Alarm monitoring | Loss of client signal (LOCS), loss of client character synchronization (LOCCS), loss of frame delineation (LFD), client forward defect indication (FDI), client reverse defect indication (RDI) and client defect clear indication (DCI) | Alarm monitoring | Loss of client signal (LOCS), loss of client character synchronization (LOCCS), loss of frame delineation (LFD), client forward defect indication (FDI), client reverse defect indication (RDI) and client defect clear indication (DCI) |
| Statistics | Transmit: client data frames (including payload bytes), client management frames, total frames, idle frames, GFP bandwidth usage (%), GFP mapping efficiency (%)<br>Receive: client data frames (including payload bytes), client management frames, total frames, idle (control) frames, reserved (control) frames, invalid frames, discarded frames, EXI mismatches, UPI mismatches, CID mismatches, GFP bandwidth usage (%), GFP mapping efficiency (%) | Statistics | Transmit: client data frames (including payload bytes), client management frames, total frames, idle frames, GFP bandwidth usage (%), GFP mapping efficiency (%)<br>Receive: client data frames (including payload bytes), client management frames, total frames, idle (control) frames, reserved (control) frames, invalid frames, discarded frames, EXI mismatches, UPI mismatches, CID mismatches, GFP bandwidth usage (%), GFP mapping efficiency (%) |
| Header manipulation | PTI, PFI, EXI, UPI, CID and spare (extension header) fields | Header manipulation | PTI, PFI, EXI, UPI, CID and spare (extension header) fields |
| Header monitoring | PLI, PTI, PFI, EXI, UPI, CID, spare (extension header) fields, cHEC, tHEC, eHEC | Header monitoring | PLI, PTI, PFI, EXI, UPI, CID, spare (extension header) fields, cHEC, tHEC, eHEC |
| **Virtual concatenation (VCAT)** | | **Virtual concatenation (VCAT)** | |
| Standards compliance | Supports high-order and low-order virtual concatenation as per ANSI T1.105 | Standards compliance | Supports high-order and low-order virtual concatenation as per ITU G.707 |
| Mappings | High-order<br>STS-1-Xv (X = 1 to 21)<br>STS-3-Xv (X = 1 to 7)<br>Low-order<br>VT1.5-Xv (X = 1 to 64)<br>VT-2-Xv (X = 1 to 64) | Mappings | High-order<br>VC-3-Xv (X = 1 to 21)<br>VC-4-Xv (X = 1 to 7)<br>Low-order<br>VC-11-Xv (X = 1 to 64)<br>VC-12-Xv (X = 1 to 64)<br>VC-3-Xv in AU-4 (X = 1 to 21) |
| Alarm insertion | LOM, OOM1, OOM2, SQM<br>VCAT and Path alarms can be generated independently on any member of a VCG | Alarm insertion | LOM, OOM1, OOM2, SQM<br>VCAT and Path alarms can be generated independently on any member of a VCG |
| Alarm monitoring | LOM, OOM1, OOM2, SQM, LOA | Alarm monitoring | LOM, OOM1, OOM2, SQM, LOA |
| Differential delay | Analysis<br>Range: 0 to 256 ms<br>Display: numerical and graphical<br>Insertion<br>Range: 0 to 256 ms | Differential delay | Analysis<br>Range: 0 to 256 ms<br>Display: numerical and graphical<br>Insertion<br>Range: 0 to 256 ms |
| Sequence number manipulation and processing | Sequence range: 0 to 63<br>Sequence number monitoring: current AcSQ (accepted SQ) monitored against the ExSQ (expected SQ); SQM alarm raised on mismatch | Sequence number manipulation and processing | Sequence range: 0 to 63<br>Sequence number monitoring: current AcSQ (accepted SQ) monitored against the ExSQ (expected SQ); SQM alarm raised on mismatch |

# SONET/SDH Functional Specifications (Cont'd)

## NEXT-GENERATION SONET/SDH (CONT'D)

**Link capacity adjustment scheme (LCAS)**

| | |
|---|---|
| Standards compliance | As per ITU G.7042; supported for both low-order and high-order VCAT groups |
| Test functions | ▬ Emulation of source and sink state machines<br>▬ Automatic and manual control of source and sink state machines<br>▬ Independent overwrite capability at the source and sink for each member<br>▬ Automatic SQ management |
| Source state machine control | ▬ Add/remove member(s)<br>▬ Configure: RS-ACK timeout, remote DUT, PLCT threshold<br>▬ Statistics count: received RS-ACK, unexpected RS-ACK<br>▬ Error/alarm generation: CRC errors, group ID (GID) mismatch<br>▬ Error/alarm monitoring: loss of partial transport capacity, loss of total transport capacity, failure of protocol transmission, CRC errors, unexpected member status |
| Sink state machine control | ▬ Add/remove member(s)<br>▬ Configure Hold-Off and Wait-to-Restore timers, PLCR threshold<br>▬ Toggle RS-ACK<br>▬ Statistics count: transmitted RS-ACK<br>▬ Error/alarm generation: CRC errors, group ID (GID) mismatch<br>▬ Error/alarm monitoring: loss of partial transport capacity, loss of total transport capacity, failure of protocol reception, CRC errors, unexpected member status |

## ADDITIONAL TEST AND MEASUREMENT FUNCTIONS

| | |
|---|---|
| Power measurements | Supports power measurements, displayed in dBm (dBdsx for DS1), for optical and electrical interfaces. |
| Frequency measurements | Supports clock frequency measurements (i.e., received frequency and deviation of the input signal clock from nominal frequency), displayed in ppm and bit/s (bps), for optical and electrical interfaces. |
| 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 on the FTB-8120/8130.<br>**ITU-T recommendation** — **Performance monitoring statistics**<br>G.821 — ES, EFS, EC, SES, UAS, ESR, SESR, DM<br>G.826 — ES, EFS, EB, SES, BBE, UAS, ERS, SESR, BBER<br>G.828 — ES, EFS, EB, SES, BBE, SEP, UAS, ESR, SESR, BBER, SEPI<br>G.829 — ES, EFS, EB, SES, BBE, UAS, ESR, SESR, BBER<br>M.2100 — ES, SES, UAS, ESR, SESR<br>M.2101 — ES, SES, BBE, UAS, ESR, SESR, BBER |
| Pointer adjustment and analysis | Generation and analysis of HO/AU and LO/TU pointer adjustments as per GR-253, and ITU-T G.707<br>**Generation**<br>• Pointer increment and decrement<br>• Pointer jump with or without NDF<br>• Pointer value<br>**Analysis**<br>• Pointer increments<br>• Pointer decrements<br>• Pointer jumps (NDF, no NDF)<br>• Pointer value and cumulative offset |
| Programmable error/alarm injection | Ability to inject errors/alarms in the following modes: Manual, Constant Rate, Burst, Periodic Burst and Continuous. |
| 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.<br>User-selectable triggers: all supported alarms and errors.<br>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 FTB-8120/8130 transmitter back to its receiver after crossing a far-end loopback.<br>Measurements are supported on all supported FTB-8120/8130 interfaces and mappings.<br>Measurements: last RTD time, minimum, maximum, average, measurement count (no. of successful RTD tests), 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). |
| Through mode | Ability to perform Through mode analysis of any incoming electrical (DSn, PDH) and optical line (OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, OC-192/STM-64, OTU1, OTU2, OTU1e and OTU2e) either transparently or intrusively. |
| 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 auto detection | Ability to automatically detect DS1/DS3 line coding, framing and test pattern. |
| Tandem connection monitoring (TCM) [a] | Tandem connection monitoring (TCM), Option 2 [b], is used to monitor the performance of a subsection of a SONET/SDH path routed via different network providers. The FTB-8120/8130 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.<br>Error generation: TC-IEC, TC-BIP, TC-REI, OEI<br>Error analysis: TC-IEC, TC-REI, OEI, TC-VIOL<br>Alarm generation: TC-RDI, TC-UNEQ, ODI, TC-LTC, TC-IAIS<br>Alarm analysis: TC-TIM, TC-RDI, TC-UNEQ, ODI, TC-LTC, TC-IAIS |
| Payload block and replace | Ability to terminate and analyze a specific high-order path element and replace it with a PRBS pattern on the TX side. |
| K1/K2 OH byte capture | Ability to capture K1/K2 OH byte value transitions. |

**NOTES**

a. HOP and LOP supported.

b. G.707 option 2.

# SONET/SDH Functional Specifications (Cont'd)

## ADDITIONAL FEATURES

| | |
|---|---|
| Scripting | The built-in scripting engine and embedded macro-recorder provide a simple means of automating test cases and routines. Embedded scripting routines provide a powerful means of creating advanced test scripts. |
| Reports | Supports generation of test reports in .html, .csv, .txt, .pdf formats.<br>Contents of reports are customizable by the user. |
| Power-up and restore | In the event of a power failure to the unit, the active test configuration and test logger are saved and restored upon bootup. |
| Store and load configurations | Ability to store and load test configurations to/from non-volatile memory. |
| 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. |
| Configurable test views | This allows users to customize their test views; i.e., to dynamically insert or remove test tabs/windows, in addition to creating new test windows, so as to accurately match their testing needs. |
| Configurable test timer | Provides the ability for a user to set pre-defined test start and stop times. |
| Remote control | Available with Windows-based remote management software known as Visual Guardian Lite (optional software package). This allows users to remotely monitor and control the FTB-8120/8130 modules via standard Ethernet connection. |

# OTN Functional Specifications

| | |
|---|---|
| **OTN** | |
| Standards compliance | ITU-T G.709, ITU G.798, ITU G.872 |
| Interfaces | OTU1 (2.7 Gbit/s), OTU2 (10.7 Gbit/s), OTU1e (11.0491 Gbit/s), OTU2e (11.0957 Gbit/s), OTU1f (11.2701 Gbit/s), OTU2f (11.3176 Gbit/s) |
| Client types [a] | All supported SONET/SDH mappings (including next-generation GFP, VCAT, LCAS), NULL, PRBS (2E31-1), ODU1 into OTU2 multiplexing |
| **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-bytes 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-bytes 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-bytes Trail Trace Identifier (TTI) as defined in ITU-T G.709 |
| FTFL [b] | As defined in ITU-T G.709 |
| **ODU0** | |
| Muxing | ODU0 into ODU1, ODU0 into ODU2 |
| Client types | Pattern, OC-3/STM-1, OC-12/STM-4, GigE using GFP-T |
| GFP-T errors | SB Correctable, SB Uncorrectable, 10B_ERR |
| **ODU Multiplexing [c]** | |
| Alarms | OPU-MSIM, ODU-LOFLOM |
| **ODUflex** | |
| Muxing | ODUflex into ODU2 |
| Client types | Ethernet using GFP-F or pattern for constant bit rate (CBR) |
| **OPU Layer** | |
| Alarm | OPU-PLM, OPU-CSF, OPU-AIS |
| Payload type (PT) label | Generates and displays received PT value |
| GMP errors | Cm CRC-8, CnD CRC-5 |
| **Forward Error Correction (FEC)** | |
| Errors | FEC-Correctable (Codeword), FEC-Uncorrectable (Codeword), FEC-Correctable (Symbol), FEC-Correctable (Bit), and FEC-Stress (Codeword) |
| **Ethernet over OTN (EoOTN) [d]** | |
| Mapping | Direct mapping into OTU1e or OTU2e; or using GFP-F into OTU2; or using GFP-T into ODU0; or using GFP-F into ODUflex |
| BERT | Framed layer 2 supported with or without VLAN |
| Pattern | PRBS 2E9-1, PRBS 2E11-1, PRBS 2E15-1, PRBS 2E20-1, PRBS 2E23-1, PRBS 2E31-1 and up to 10 user patterns<br>Capability to invert patterns |
| Error insertion | FCS, 64B/66B block (10 GigE), symbol (GigE), bit |
| Error measurement | Jabber/giant, runt, undersize, oversize, FCS, 64B/66B block (10 GigE), symbol (GigE), idle (GigE), false carrier (GigE) |
| Error measurement (BERT) | Bit error, bit mismatch 0, bit mismatch 1 |
| Alarm insertion | Link down, local fault, remote fault, pattern loss |
| Alarm detection | Link down, local fault, remote fault, pattern loss |
| VLAN | Capability to generate one stream with one layer of VLAN |
| Ethernet statistics | Multicast, broadcast, unicast, N-unicast, frame size distribution, bandwidth, utilization, frame rate |

## ADDITIONAL FUNCTION

| | |
|---|---|
| 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.<br>User-selectable triggers: all supported alarms and errors.<br>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 FTB-8120/8130 transmitter back to its receiver after crossing a far-end loopback.<br>Measurements are supported on all supported FTB-8120/8130 interfaces and mappings.<br>Measurements: last RTD time, minimum, maximum, average, measurement count (no. of successful RTD tests), failed measurement count. |

**Notes**
a. Available with ODUMUX option.
b. Fault type and fault location.
c. Available on the FTB-8130 and FTB-8130NG only.
d. Available on the FTB-8130NG only.

# Additional Specifications

| FTB-8120 | FTB-8120NG | FTB-8130 | FTB-8130NG |
|---|---|---|---|
| SONET/SDH 2.5 Gbit/s and OTN 2.7 Gbit/s | Next-generation SONET/SDH 2.5 Gbit/s and OTN 2.7 Gbit/s | SONET/SDH 10 Gbit/s and OTN 10.7 Gbit/s | Next-generation SONET/SDH 10 Gbit/s and OTN 10.7 Gbit/s |
| Analyzer module supporting up to 2.5/2.7 Gbit/s optical rates, as well as electrical DSn/PDH interfaces | Analyzer module supporting up to 2.5/2.7 Gbit/s optical rates, as well as as well as electrical DSn/PDH interfaces | Analyzer module supporting up to 10/10.7 Gbit/s optical rates,as well as electrical DSn/PDH interfaces | Analyzer module supporting up to 10/10.7 Gbit/s optical rates, as well as electrical DSn/PDH interfaces |
| **Test Interfaces** | | | |
| OTN: OTU1 (2.7 Gbit/s) | OTN: OTU1 (2.7 Gbit/s) | OTN: OTU1 (2.7 Gbit/s), OTU2 (10.7 Gbit/s)<br>OTU1e (11.0491 Gbit/s), OTU2e (11.0957 Gbit/s)<br>OTU1f (11.2701 Gbit/s), OTU2f (11.3176 Gbit/s) | OTN: OTU1 (2.7 Gbit/s), OTU2 (10.7 Gbit/s)<br>OTU1e (11.0491 Gbit/s), OTU2e (11.0957 Gbit/s)<br>OTU1f (11.2701 Gbit/s), OTU2f (11.3176 Gbit/s) |
| SONET: STS-1e, STS-3e, OC-3, OC-12, OC-48 | SONET: STS-1e, STS-3e, OC-3, OC-12, OC-48 | SONET: STS-1e, STS-3e, OC-3, OC-12, OC-48, OC-192 | SONET: STS-1e, STS-3e, OC-3, OC-12, OC-48, OC-192 |
| SDH: STM-0e, STM-1e, STM-0, STM-4, STM-16 | SDH: STM-0e, STM-1e, STM-0, STM-4, STM-16 | SDH: STM-0e, STM-1e, STM-0, STM-4, STM-16, STM-64 | SDH: STM-0e, STM-1e, STM-0, STM-4, STM-16, STM-64 |
| DSn: DS1, DS3, Dual DS1 Rx, Dual DS3 Rx | DSn: DS1, DS3, Dual DS1 Rx, Dual DS3 Rx | DSn: DS1, DS3, Dual DS1 Rx, Dual DS3 Rx | DSn: DS1, DS3, Dual DS1 Rx, Dual DS3 Rx |
| PDH: E1, E2, E3, E4 | PDH: E1, E2, E3, E4 | PDH: E1, E2, E3, E4 | PDH: E1, E2, E3, E4 |
| | Ethernet: 10/100/1000M and GigE (for EoS testing) | | Ethernet: 10/100/1000M and GigE (for EoS testing) |

## GENERAL SPECIFICATIONS

| | FTB-8120NG | FTB-8130NG |
|---|---|---|
| Weight (without transceiver) | 0.9 kg (2.0 lb) | 0.9 kg (2.0 lb) |
| Size (H x W x D) | 96 mm x 51 mm x 288 mm (3 3/4 in x 2 in x 11 3/8 in) | 96 mm x 51 mm x 288 mm (3 3/4 in x 2 in x 11 3/8 in) |
| Temperature | | |
| operating | 0 °C to 40 °C (32 °F to 104 °F) | 0 °C to 40 °C (32 °F to 104 °F) |
| storage | –40 °C to 60 °C (–40 °F to 140 °F) | –40 °C to 60 °C (–40 °F to 140 °F) |

## ORDERING INFORMATION

**FTB-81XX-XX-XX-XX-XX-XX-XX-XX**

**Model**
See models listed above

**Test options**
SONET = SONET-BASE-SW
SDH = SDH-BASE-SW
SONET-SDH = Software option for combined SONET/SDH functionality

**Rate options** [a]
155 = 155 Mbit/s (OC-3/STM-1)
622 = 622 Mbit/s (OC-12/STM-4)
2.5G = 2.5/2.7 Gbit/s (OC-48/STM-16, OTU1)
10G = 10/10.7 Gbit/s (OC-192/STM-64, OTU2) [b]

All rate enablers are included as standard for FTB-8130 and FTB-8130NG modules.

**Transceivers SFP telecom** [a]
FTB-8190 = Multirate (155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE/FC/2FC) optical SFP transceiver module with LC connector; 1310 nm; 15 km reach
FTB-8191 = Multirate (155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE/FC/2FC) optical SFP transceiver module with LC connector; 1310 nm; 40 km reach
FTB-8192 = Multirate (155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE/FC/2FC) optical SFP transceiver module with LC connector; 1550 nm; 80 km reach
FTB-8193 = Multirate (155/622 Mbit/s, 2.5/2.7 Gbit/s, GigE/FC/2FC) optical SFP transceiver module with LC connector; 1550 nm; 40 km reach

**10 Gbit/s transceivers XFP telecom** [a, b]
FTB-81900 = Multirate (10-11.3 Gbit/s) optical XFP transceiver module with LC connector; 1310 nm; 10 km reach
FTB-81901 = Multirate (10/10.7 Gbit/s) optical XFP transceiver module with LC connector; 1550 nm; 40 km reach
FTB-81902 = Multirate (10/10.7 Gbit/s) optical XFP transceiver module with LC connector; 1550 nm; 80 km reach

**Optical Ethernet transceivers SFP datacom** [a, c, d]
FTB-8590 = GigE/FC/2FC optical SFP transceiver module with LC connector; 850 nm; MMF, < 500 m reach
FTB-8591 = GigE/FC/2FC optical SFP transceiver module with LC connector; 1310 nm; 10 km reach
FTB-8592 = GigE/FC/2FC optical SFP transceiver module with LC connector; 1550 nm; 90 km reach

**Next-generation options** [a, e]
00 = Without next-generation software
HO-VCAT = High-order virtual concatenation
LO-VCAT = Low-order virtual concatenation
LCAS = Link capacity adjustement scheme [f]
GFP-F = Generic framing procedure–framed
EoS = Ethernet-over-SONET/SDH [d, g]

**Options** [a]
G.747 [h]
DS1-FDL
DS3-FEAC
DUAL-RX
SMART_MODE
TCM = Tandem connection monitoring
OTU1 = OTN optical rate 2.7 Gbit/s
OTU2 = OTN optical rate 10.7 Gbit/s [b]
ODUMUX = ODU MUX functionality [b, i]
ODU0 = ODU0 mapping [j]
ODUflex = ODUflex functionality [k]
INTR-THRU-MODE = SONET/SDH intrusive Through mode
OTN-INTR-THRU = OTN intrusive Through mode [j]
OTU2-1e-2e = OTN optical rates 11.0491 Gbit/s and 11.0957 Gbit/s [b]
OTU2-1f-2f = OTN optical rates 11.2701 Gbit/s and 11.3176 Gbit/s [b]
OTU2-GFP-F = 10 GigE LAN over GFP-F into OTU2 [b]
EoOTN = Ethernet-over-OTN functionality [l]

**Notes**
a. Multiple options can be purchased to suit the required application.
b. Applies only to FTB-8130 and FTB-8130NG models.
c. Enables Ethernet add/drop interface. This option is only applicable for FTB-8120NG and FTB-8130NG modules.
d. Ethernet SFP transceiver must be purchased with the EoS software option.
e. These options are available for FTB-8120NG and FTB-8130NG modules.
f. Must be combined with the HO-VCAT or LO-VCAT option.
g. Must be combined with the GFP-F option.
h. Enables E1/2M in DS3/45M analysis, as per ITU-T G.747 recommendation.
i. Must be combined with the OTU1 and OTU2 options.
j. Must be combined with the OTU1 or OTU2 option.
k. Applicable for FTB-8130NG modules only and must be combined with the OTU2 option.
l. Applicable for FTB-8120NG and FTB-8130NG modules only and must be combined with the OTU2-1e-2e or OTU2-GFP-F or ODU0 option.

Example: FTB-8130NG-SONET-SDH-10G-FTB-8192-FTB-8592-OTU1-HO-VCAT

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