FTB-8120/8130 Transport Blazer

NEXT-GENERATION SONET/SDH TEST MODULES

EXFO Connect Compatible

FROST & SULLIVAN 2011 BEST PRACTICES AWARD
GLOBAL SONET/SDH & OTN TEST EQUIPMENT GROWTH LEADERSHIP OF THE YEAR AWARD

SPEC SHEET

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

KEY FEATURES

- 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
- Multichannel SDT measurements and real-time error/alarm monitoring for SONET/SDH and OTN
- 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
- EXFO Connect-compatible: automated asset management; data goes through the cloud and into a dynamic database

COMPLEMENTARY PRODUCTS

Platform
FTB-500

Compact Platform
FTB-200

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).

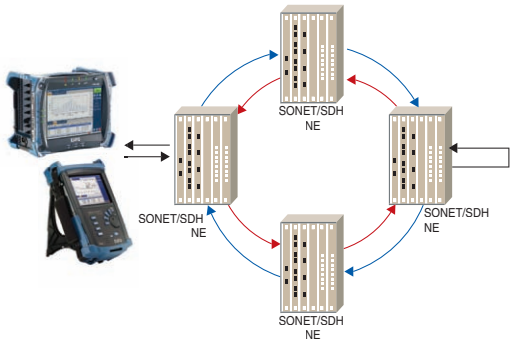
This opportunity creates the need for test solutions that can help ensure proper deployment, operation and maintenance of standard SONET/SDH, OTN and new Ethernet-based transport networks.

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
- Frequencyanaly sisandpo wer measurement
- Frequency offset generation
- Payload block and replace
- Automatic protection switching and service disruption time measurements
- Multichannel SDT measurements and real-time error/alarm monitoring for all STS-1/AU-4 channels
- 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
- Multichannel SDT measurements and real-time error/alarm monitoring for all ODU0 channels
- 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

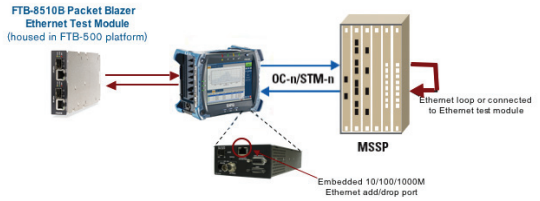
Next-Gen SONET/SDH Testing

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

Ethernet Add/Drop Interface

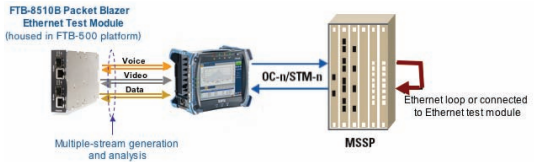
In addition to its internal PRBS generator, each FTB-8120NG and FTB-8130NG Transport Blazer module includes one 10/100/1000M Ethernet (RJ-45 interface) and one Gigabit Ethernet (SFP) interface. These interfaces can be used to interconnect with an FTB-8510B Packet Blazer Ethernet test module or an external 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.

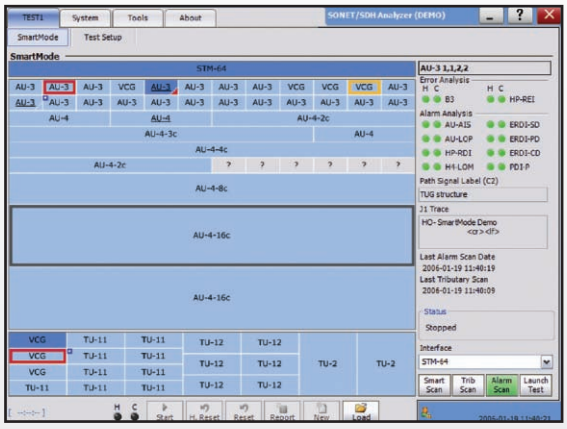


Combining the FTB-8510B's Ethernet multiple-streaming capabilities and the FTB-8120NG/8130NG embedded Ethernet interfaces creates a powerful solution for testing multiple services over SONET/SDH.

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

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.

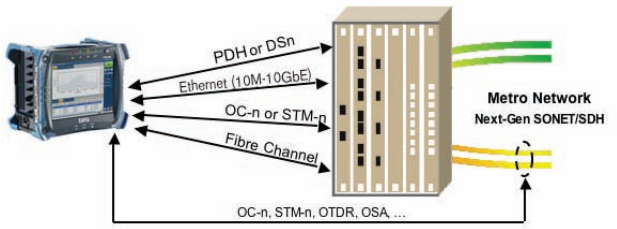
Once inserted into the FTB-200, the FTB-8120/FTB-8120NG or FTB-8130/FTB-8130NG Transport Blazer modules deliver DSn/PDH, SONET/SDH and OTN test functions in a small, lightweight platform, ideal for field technicians' installation and commissioning needs. When combined with the FTB-200's optional integrated 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.

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

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

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



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.

EXFO Connect

EXFO Connect

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

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

EXPERT TEST TOOLS ON THE FTB-200 PLATFORM

EXpert Test Tools is a series of platform-based software testing tools that enhance the value of the FTB-200 platform, providing additional testing capabilities without the need for additional modules or units.

EXpert TEST TOOLS

EXpert VoIP TEST TOOLS

EXpert VoIP generates a voice-over-IP call directly from the test platform to validate performance during service turn-up and troubleshooting.

› Supports a wide range of signaling protocols, including SIP, SCCP, H.248/Megaco and H.323

› Supports MOS and R-factor quality metrics

› Simplifies testing with configurable pass/fail thresholds and RTP metrics

EXpert IP TEST TOOLS

EXpert IP integrates 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.

› Rapidly performs debugging sequences with VLAN scan and LAN discovery

› Validates end-to-end ping and traceroute

› 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 quick and easy pass/fail verification of IPTV installations.

› Real-time video preview

› Analyzes up to 10 video streams

› Comprehensive QoS and QoE metrics including MOS score

ELECTRICAL INTERFACES

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

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	G.253 Figure 4-10/4-11	GR-703 Figure 18/19	STM-3e GR-253 Figure 4-12/ 4-13/4-14	STM-1e/155M G.703 Figure 22-23
Tx LBO preamplification		Power dBdsx +0.6 dBdsx (0-133 ft) +1.2 dBdsx (133-266 ft) +1.8 dBdsx (266-399 ft) +2.4 dBdsx (399-533 ft) +3.0 dBdsx (533-655 ft)					0 to 225 ft 255 to 450 ft		0 to 225 ft 255 to 450 ft		0 to 225 ft	
Cable simulation		Power dBdsx −22.5 dBdsx −15.0 dBdsx −7.5 dBdsx 0 dBdsx					450 to 900 (927) ft		450 to 900 (927) ft			
Rx level sensitivity (dynamic range)		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) Note: measurement units = dBdsx (Vref = 6 Vpp)	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) Note: measurement units = dBm	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) Note: measurement units = dBm	For 4224 kHz: TERM: ≤6 dB (cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Note: measurement units = dBm	For 17.184 MHz: TERM: ≤12 dB (coaxial cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Note: measurement units = dBm	For 22.368 MHz: TERM: ≤10 dB (cable loss only) DSX-MON: ≤26.5 dB (21.5 dB resistive loss + cable loss ≤ 5 dB) Note: measurement units = dBm (Vref = 1.21 Vpp)		For 25.92 MHz: TERM: ≤10 dB (cable loss only) MON: ≤25 dB (20 dB resistive loss + cable loss ≤ 5 dB) Note: measurement units = dBm	For 70 MHz: TERM: ≤12 dB (coaxial cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Note: measurement units = dBm	For 78 MHz: TERM: ≤12.7 dB (coaxial cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) 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	±4.6 ppm	±4.6 ppm	±4.6 ppm	±4.6 ppm	±4.6 ppm	±4.6 ppm		±4.6 ppm	±4.6 ppm	±4.6 ppm	
	Electrical power	Normal: ±1.0 dB Monitor: ±2.0 dB	Normal: ±1.0 dB Monitor: ±2.0 dB	Normal: ±1.0 dB Monitor: ±2.0 dB	Normal: ±1.0 dB Monitor: ±2.0 dB	Normal: ±1.0 dB Monitor: ±2.0 dB	DSX range: ±1.0 dB DSX-MON range: ±2.0 dB		DSX range: ±1.0 dB DSX-MON range: ±2.0 dB	Normal: ±1.0 dB Monitor: ±2.0 dB	Normal: ±1.0 dB Monitor: ±2.0 dB	
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 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 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 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	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 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	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	

SYNCHRONISATION 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 +0.6 dBdsx (0-133 ft) +1.2 dBdsx (133-266 ft) +1.8 dBdsx (266-399 ft) +2.4 dBdsx (399-533 ft) +3.0 dBdsx (533-655 ft)			
Rx level sensivity (dynamic range)	TERM: ≤6 dB (cable loss only) (at 772 kHz for T1) DSX-MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Bridge: ≤6 dB (cable loss only)	TERM: ≤6 dB (cable loss only) MON: ≤26 dB (20 dB resistive loss + cable loss ≤ 6 dB) Bridge: ≤6 dB (cable loss only)	TERM: ≤6 dB (cable loss only) MON: ≤26 dB (resistive loss + cable loss ≤ 6 dB) 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 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 GR-499 SECTION 7.3	G.823 section 7.2 G.813	G.823 section 7.2 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 (CONT'D)

ETHERNET ADD/DROP INTERFACE

10/100/1000 Base-T (Add/Drop)	Compliance	10 Mbit/s: IEEE 802.3 section 14 100 Mbit/s: IEEE 802.3 section 25 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 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 AND OTN OPTICAL INTERFACES

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

SONET/SDH AND OTN OPTICAL INTERFACES

		OC-3/STM-1				OC-12/STM-4				E2/8M				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
Tx level		–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 2.66606 Gbit/s ± 4.6 ppm (OTU1)				9.95328 Gbit/s ± 4.6 ppm (OC-192/STM-64) 10.70922 Gbit/s ± 4.6 ppm (OTU2) 11.0491 Gbit/s ± 4.6 ppm (OTU1e) 11.0957 Gbit/s ± 4.6 ppm (OTU2e) 11.2701 Gbit/s ± 4.6 ppm (OTU1f) 11.3176 Gbit/s ± 4.6 ppm (OTU2f)	9.95328 Gbit/s ± 4.6 ppm (OTU2) 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 2.66606 Gbit/s ± 100 ppm (OTU1)				9.95328 Gbit/s ± 100 ppm (OC-192/STM-64) 10.70922 Gbit/s ± 100 ppm (OTU2) 11.0491 Gbit/s ± 120 ppm (OTU1e) 11.0957 Gbit/s ± 120 ppm (OTU2e) 11.2701 Gbit/s ± 120 ppm (OTU1f) 11.3176 Gbit/s ± 120 ppm (OTU2f)	9.95328 Gbit/s ± 100 ppm 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	±4.6 ppm				±4.6 ppm				±4.6 ppm				±4.6 ppm		
	Optical power	±2 dB				±2 dB				±2 dB				±2 dB		
Maximum Rx before damage [c]		3 dBm				3 dBm				3 dBm				3 dBm		
Jitter compliance		GR-253 (SONET) G.958 (SDH)				GR-253 (SONET) G.958 (SDH)				GR-253 (SONET) G.958 (SDH) G.8251 (OTN)				GR-253 (SONET) G.825 (SDH) 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				SFP		

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, CV, 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, 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, 1-in-8, 1-in-16, 3-in-24 [d], 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, and loss of frame delineation (LFD)	Alarm insertion	Loss of client signal (LOCS) and loss of client character synchronization (LOCCS) with configurable time interval between 10 and 1200 ms, and 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) and loss of frame delineation (LFD)	Alarm monitoring	Loss of client signal (LOCS), loss of client character synchronization (LOCCS) and 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 (%) 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 (%) 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 STS-1-Xv (X = 1 to 21) STS-3-Xv (X = 1 to 7) Low-order VT1.5-Xv (X = 1 to 64) VT-2-Xv (X = 1 to 64)	Mappings	High-order VC-3-Xv (X = 1 to 21) VC-4-Xv (X = 1 to 7) Low-order VC-11-Xv (X = 1 to 64) VC-12-Xv (X = 1 to 64) VC-3-Xv in AU-4 (X = 1 to 21)
Alarm insertion	LOM, OOM1, OOM2, SQM VCAT and Path alarms can be generated independently on any member of a VCG	Alarm insertion	LOM, OOM1, OOM2, SQM 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 Range: 0 to 256 ms Display: numerical and graphical Insertion Range: 0 to 256 ms	Differential delay	Analysis Range: 0 to 256 ms Display: numerical and graphical Insertion Range: 0 to 256 ms
Sequence number manipulation and processing	Sequence range: 0 to 63 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 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 › Automatic and manual control of source and sink state machines › Independent overwrite capability at the source and sink for each member › Automatic SQ management
Source state machine control	› Add/remove member(s) › Configure: RS-ACK timeout, remote DUT, PLCT threshold › Statistics count: received RS-ACK, unexpected RS-ACK › Error/alarm generation: CRC errors, group ID (GID) mismatch › 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) › Configure Hold-Off and Wait-to-Restore timers, PLCR threshold › Toggle RS-ACK › Statistics count: transmitted RS-ACK › Error/alarm generation: CRC errors, group ID (GID) mismatch › 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 b/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. **ITU-T recommendation** — **Performance monitoring statistics** G.821 — ES, EFS, EC, SES, UAS, ESR, SESR, DM G.826 — ES, EFS, EB, SES, BBE, UAS, ERS, 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, ESR, SESR 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 **Generation** › Pointer increment and decrement › Pointer jump with or without NDF › Pointer value **Analysis** › Pointer increments › Pointer decrements › Pointer jumps (NDF, no NDF) › Pointer value and cumulative offset
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. User-selectable triggers: all supported alarms and errors. 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. Measurements are supported on all supported FTB-8120/8130 interfaces and mappings. Measurements: last RTD time, minimum, maximum, average, measurement count (no. of successful RTD tests), failed measurement count.
Multichannel testing	Ability to monitor in real-time errors and alarms, and to perform simultaneous SDT measurements for all STS-1/AU-4 channels; a user-defined threshold can also be applied to the SDT measurements for simple pass/fail results for each channel.
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 for-end alarms and loopback codewords.
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. Error generation: TC-IEC, TC-BIP, TC-REI, OEI Alarm generation: TC-RDI, TC-UNEQ, ODI, TC-LTC, TC-IAIS Error analysis: TC-IEC, TC-REI, OEI, TC-VIOL 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. 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 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) [c]	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. 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. User-selectable triggers: all supported alarms and errors. 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-8120NGE/8130NGE transmitter back to its receiver after crossing a far-end loopback. Measurements are supported on all supported FTB-8120NGE/8130NGE interfaces and mappings. Measurements: last RTD time, minimum, maximum, average, measurement count (no. of successful RTD tests), failed measurement count.
Multichannel testing	Ability to monitor in real-time errors and alarms, and to perform simultaneous SDT measurements for all ODU0 channels; a user-defined threshold can also be applied to the SDT measurements for simple pass/fail results for each channel.

Notes

a. Available with ODUMUX option.
b. Fault type and fault location.
c. Available on the FTB-8130 anf 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 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) OTU1e (11.0491 Gbit/s), OTU2e (11.0957 Gbit/s) OTU1f (11.2701 Gbit/s), OTU2f (11.3176 Gbit/s)	OTN: 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)
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 ¾ in x 2 in x 11 3/8 in)	96 mm x 51 mm x 288 mm (3 ¾ in x 2 in x 11 ⅜ 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-XX

Model
See models listed in previous page

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

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

Options [a]
G.747 [g]
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, h]
ODU0 = ODU0 mapping [i]
ODUflex = ODUflex functionality [j]
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 [k]
MULTI-CH-SDT = Multichannel SDT measurements

Optical Ethernet transceivers SFP datacom [a, e, l]
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

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

Notes

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

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