

Agilent Technologies

**OmniBER OTN
Communications
Performance Analyzers**

J7232A & J7230B
Technical Data Sheet



Powerful SONET/SDH testers, ideal for testing next generation SONET/ SDH devices and modules.



Agilent Technologies

Key Features

- ITU-T G.7041 GFP (Generic Framing Procedure) compliance testing (GFP-T and GFP-F)
- ITU-T X.86 LAPS (Link Access Procedure for SDH) compliance testing
- ITU-T G.707 Virtual Concatenation with 256ms delay generation and measurement
- High order (STS-3c, STS-1, VC-4, VC-3) and low order (TU, VT) virtual concatenation
- Ethernet Payload Structures
- Full range of standard, concatenated and mixed mappings
- Unframed/framed testing at all rates
- Powerful overhead testing
- Alarm stress test
- Sequence generation and capture
- SONET/SDH entire overhead capture
- Transmit and receive output triggers for error and alarm events
- All standard error and alarm measurements, plus:
 - optical power, frequency
 - service disruption time, pointer movements
- Simultaneous all-channel testing
- GPIB, LAN and RS-232 remote control
- Universal Instrument Drivers
- Broad range of graphical results tools
- Comprehensive on-line help
- 2 year calibration cycle

Product Overview

Introduction

Agilent Technologies' new OmniBER OTN J7232A and J7230B are not only powerful SONET/SDH testers, they are ideal for testing next generation SONET/SDH devices and modules. The OmniBER OTN J7232A supports all line rates from 1.5 Mb/s to 2.488 Gb/s whereas the OmniBER OTN J7230B supports all line rates from 1.5 Mb/s to 10 Gb/s plus the OTU-2 line rate of 10.7 Gb/s. Each product provides a rich feature set tailored for design and verification of Next Generation SONET/SDH test applications helping you get your new products to market fast.

OmniBER OTN's extensive capabilities help you to ensure that your new products meet the stringent requirements set out in the latest standards. With its ability to verify Ethernet encapsulation into SONET/SDH via Generic Framing Procedure (GFP), Link Access Procedure for SDH (LAPS) and Virtual Concatenation to ITU-T G.7041, X.86 and G.707 respectively, you can be confident that your designs comply and will interoperate in a multi-vendor environment.

What's more, Agilent's all-channel monitoring technology lets you simultaneously monitor all STS/AU channels (up to 192 with the J7230B) in a received SONET or SDH line signal, continuously, for fast problem resolution and efficient verification of next generation transmission systems.

A comprehensive on-line help system is accessible at the touch of a button, while context sensitive help is provided automatically as you navigate through the user interface. You can also extend the help available by adding your own documentation.

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SmartTest

The front panel Smart Test key provides fast access to the test set's extensive measurement capability. With only a few key presses you can quickly access:

- SignalWizard
- Virtual concatenation measurement overview
- Optical Power measurement
- Frequency measurement
- Trouble scan
- Overhead monitor
- Pointer graph

Signal Wizard

Signal Wizard is a unique test tool that has been specifically designed to meet the challenges associated with testing the new generation of SONET/SDH transmission systems - systems that combine grooming, switching and multiplexing in a single unit. With one key press, Signal Wizard automatically:

- Simultaneously monitors the line signal and all STS/AU channels (up to 192) for errors, alarms and pointer activity.
- Shows which channels are unequipped and the type of service being carried by equipped channels.
- Provides Path Trace message listing and search tools (including sub-string searches) to assist in identifying path routing errors within the network

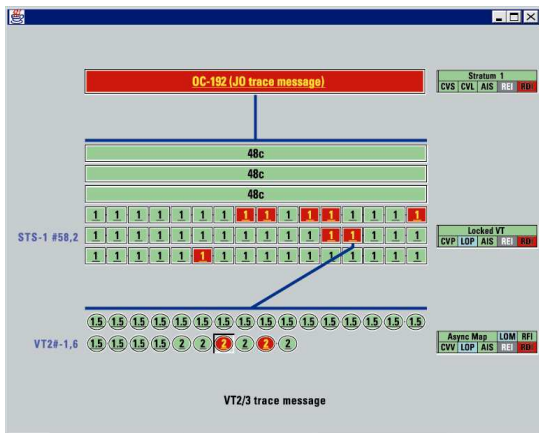


Figure 1.
Error and alarm status clearly presented for each detected STS/AU channel, and for all VT/TU channels in a selected STS/AU.

GFP Testing (ITU-T G.7041)

The OmniBER OTN allows structured test signals to be generated in order to fully test Ethernet over SONET/SDH encapsulation to ITU-T G.7041. This verifies that designs are compliant to standards and ensures multi-vendor interoperability.

- Generate and receive Framed (GFP-F) and Transparent (GFP-T) payloads
- Generate and detect correctable and uncorrectable Header Error Control (HEC) errors
- Generate and detect Loss of Client Signal (LOCS) and Loss of Client Character Synchronization (LOCCS)
- Access to GFP overhead including extended header for linear (CID) and null topologies
- Ethernet MAC Payload mapping with adjustable data rate from 1Mb/s to 1Gb/s (GbE)
- User specified number of superblocks for GFP-T

LAPS Testing (ITU-T X.86)

Prove standards compliance and ensure interoperability with OmniBER OTN's ability to generate and analyze Ethernet mapped into SONET/SDH via LAPS encapsulation as defined in ITU-T X.86.

- Generate and receive LAPS encapsulated Ethernet
- Error generation includes the ability to inject undersized frames and invalid control sequence errors

- Ability to inject and detect erroneous frame alarms and link loss
- User programmable header fields allows other HDLC-based encapsulations such as Cisco HDLC to be generated and received
- Configurable Ethernet MAC payload up to 1GbE

Ethernet MAC Testing

OmniBER OTN provides the capability to test Ethernet MAC payloads, which have been encapsulated using GFP or LAPS.

- User definable Ethernet overhead
- Adjustable data rate from 1Mb/s to 1Gb/s
- Ethernet MAC Error generation and detection
- PRBS generation within Ethernet MAC payload

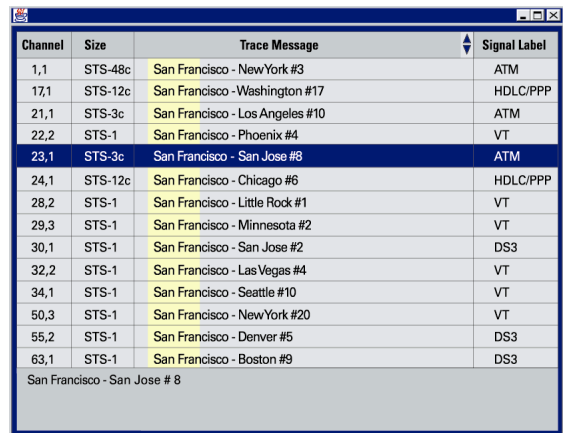


Figure 2.
Clear tabular display of J1 or J2 path trace messages, or those identified based on a sub-string search.

SONET/SDH Virtual Concatenation

Verify virtual concatenation of high and low order payloads with delay generation across the full ITU-T G.707 256ms range. Realistic traffic with full Ethernet payload mapped via GFP or LAPS.

- High order concatenation of STS-3c/STS-1/AU-4/AU-3
- Low order concatenation of VT2/VT1.5/ TU-3/TU-12/TU-11
- Flexibility to specify which members form the group and add delay to each member
- Group overview simultaneously monitors all group members
- Discovery function automatically detects virtual concatenation members
- Fine delay adjustment to see exactly when input buffers fail
- Coarse delay adjustment allows performance under transients to be verified.
- Full alarm and error generation and detection

SONET/SDH testing

SONET/SDH capability allows comprehensive testing of synchronous networks with the following interface rates: 2.5 G/s, 622 Mb/s, 155 Mb/s and 52 Mb/s. Supported functionality includes:

- Framed/unframed testing at all rates
- SONET/SDH error and alarm generation and detection
- Setup and monitor all overhead bytes
- Alarm stress testing with 'p', 'n', and 'm' sequences
- Overhead sequence generation and capture
- Entire overhead capture (no payload capture)
- Transmit and receive error and alarm event trigger outputs
- Through mode test capability
 - Transparent through mode
 - Overhead overwrite - add errors/alarms

- Service disruption test
- Setup and monitoring for linear and ring APS/MSP messages
- Active APS test
- Setup and monitoring for J0, J1 and J2 trace messages
- Tandem connection monitoring testing to the SDH standards (both N1 and N2)
- Burst and periodic sequence pointer adjustment control
- Drop-Insert of DCC channels
- External drop-Insert of asynchronous mapped payloads
- Performance analysis G.826, G.828, G.821, M.2101, M.2101.1, M.2110, M.2120

Contiguous Concatenations enhancement

Enhancement of contiguous concatenations allows you to test the breadth of GR-253/ G.707.

- STS-3c, 6c, 9c, 12c, 24c and 48c
- AU-3, AU-4, AU-4-2c, AU-4-3c, AU-4-4c, AU-4-8c, AU-4-16c
- PRBS within the concatenated payloads
- Support of GFP/LAPS as the concatenated payloads

Mixed mappings

Support for mixed mappings now allows convenient setup of complex structures resulting in reduced test times

- Two convenient configuration modes
 - Preset (simple background selection)
 - Mixed mappings (mixed background selection)
- Configure any combination of valid positions
- Any channel can be set as Foreground
- Foreground channel can be virtually concatenated
- Background channels can be either
 - Equipped
 - Unequipped
 - AIS

DSn/PDH testing

The DSn/PDH test capability allows comprehensive testing of DSn/PDH signals and networks with the following interfaces: DS1 (1.5 Mb/s), DS3 (45 Mb/s), 2 Mb/s, 8 Mb/s, 34 Mb/s and 140 Mb/s. Supported functionality includes:

- Unframed, framed, and structured (mux/demux) testing
- Error and alarm generation and detection
- 56 kb/s, n x 56 kb/s, 64 kb/s and n x 64 kb/s testing
- Drop-Insert DSn/PDH to/from SONET/SDH
- Drop-Insert DS1/2Mb/s to/from DSn/PDH
- DS1 loop codes and DS3 FEAC messages
- PDH spare-bits control and monitoring
- Performance analysis G.826, G.828, G.821, M.2101, M.2101.1, M.2110, M.2120

Additional measurements

- Optical power
- Line frequency
- Pointer measurements
- Service disruption
- Virtual concatenation differential delay measurement

Instrument Tour

Figure 3.

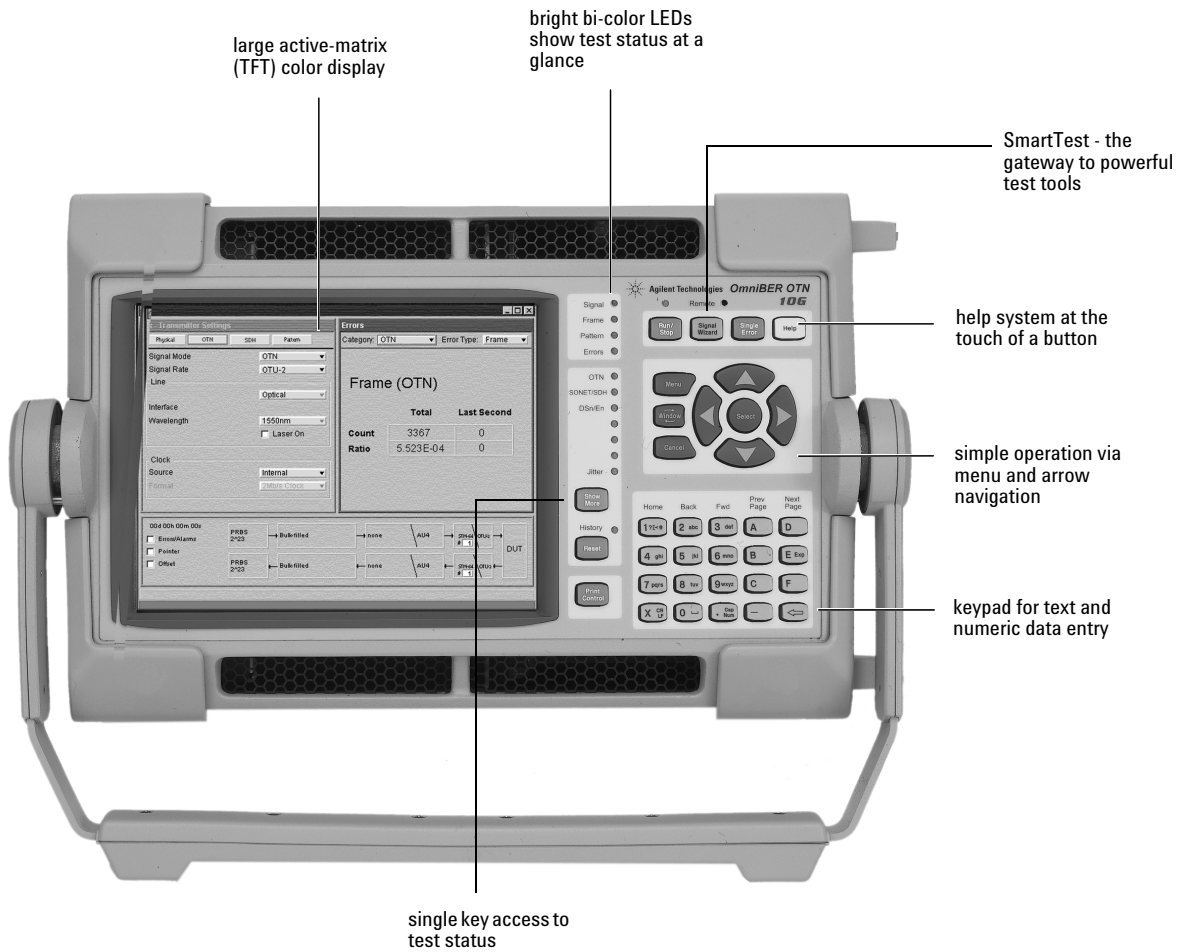
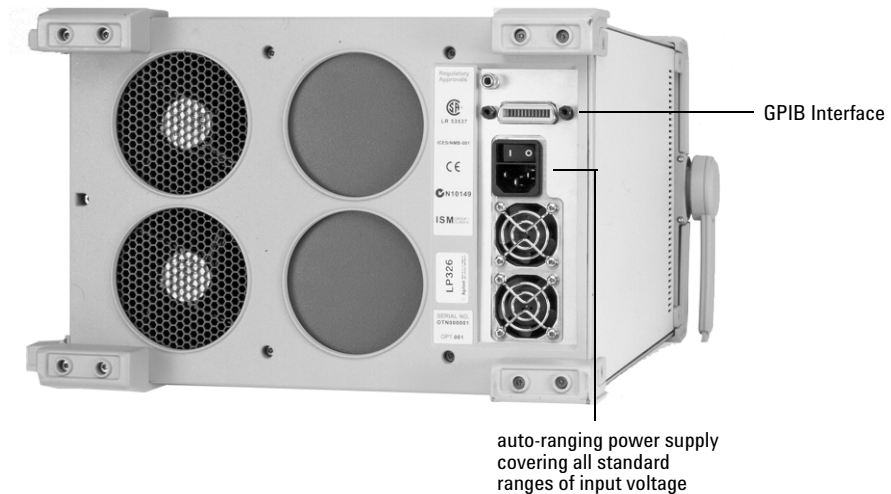


Figure 4.



Instrument Tour (continued)

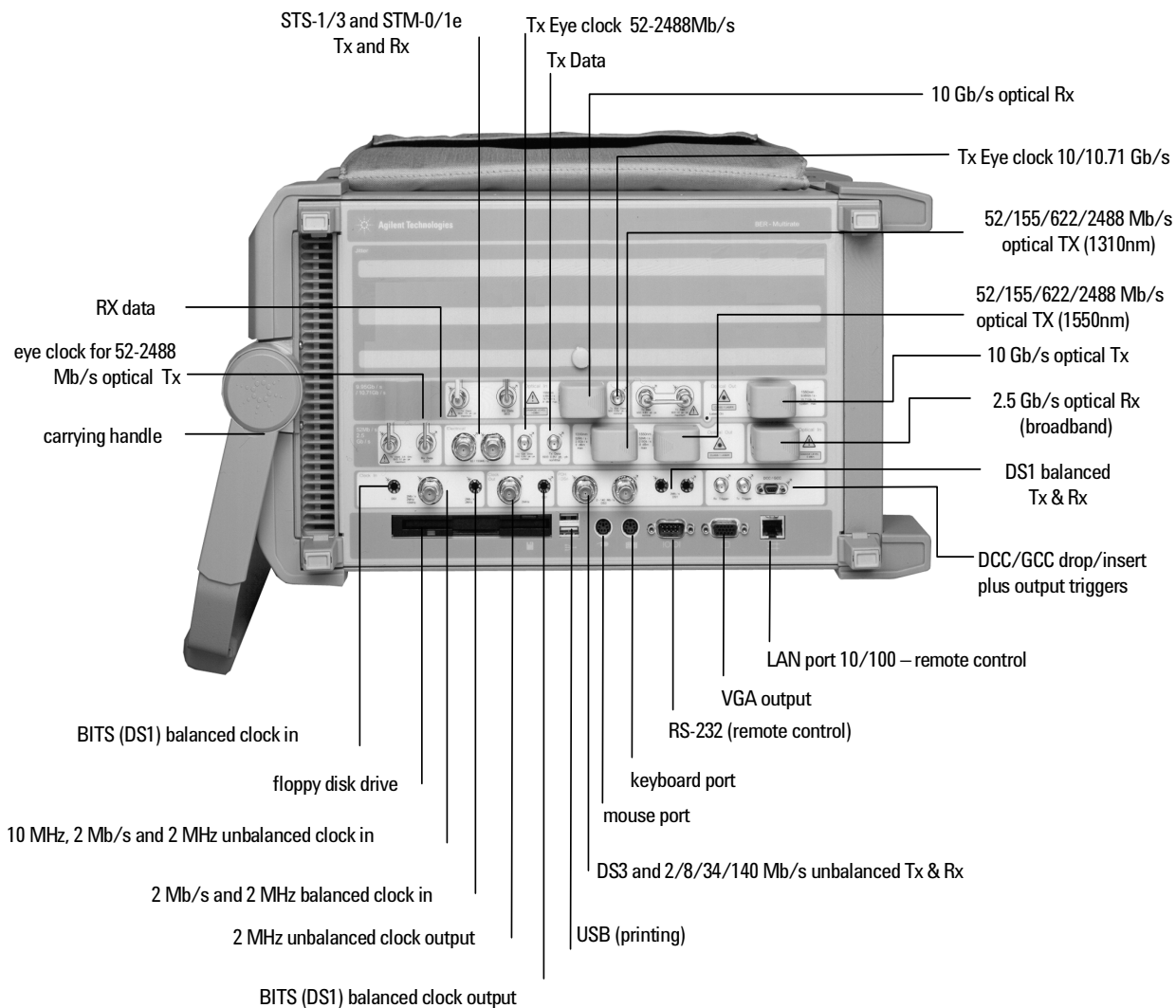


Figure 5.

Technical specifications

OmnibER OTN J7232A & J7230B

The following specification provides details on the OmnibER OTN transmission test set, including all standard options. Where required, contact your Agilent sales representative for information regarding availability of these enhanced testing products.

Test interfaces (rates, wavelengths, connectors, line codes)

Optical	Line Rates
(Option 108 and 112 only available on J7230B)	Framed: OTU2 OC-1/3/12/48/192 STM-0/1/4/16/64 Unframed: 10.71/9.95/2.48 Gb/s 622/155/52 Mb/s
	Wavelength (≤ 2.5 Gb/s) Option 104 - 1310 nm Option 105 - 1550 nm Option 106 - 1310/1550 nm
	Wavelength (10 Gb/s) Option 108 - 1550 nm Wavelength (10/10.71 Gb/s) Option 112 - 1550 nm
	Connectors Option 609 - FC/ PC Option 610 - SC Option 611 - ST
SONET/SDH Electrical	Line Rates STS-1/3 (STM-0/1e)
	Connectors STS-1/3 (STM-0/1e) - BNC (75 Ω, unbalanced)
	Line Code STS-3/STM-1e - CMI STS-1/STM-0e - B3ZS
PDH/DSn Electrical	Line Rates DS1, DS3; 2/8/34/140 Mb/s
	Connectors DS1- Bantam (100 Ω, balanced) DS3 - BNC (75 Ω, unbalanced) 2 Mb/s - BNC (75 Ω, unbalanced); 3-pin Siemens (120 Ω, balanced) 8/34/140 Mb/s - BNC (75 Ω, unbalanced)
	Line Code DS1 - B8ZS, AMI DS3 - B3ZS 2/8/34 Mb/s - HDB3 140 Mb/s - CMI

Optical transmitters

	52Mb/s - 2.5Gb/s	10Gb/s & 10.71Gb/s
Line Code	NRZ	NRZ
Wavelength		
1310nm	1280-1335nm	-
1550nm	1500-1580nm	1530-1565nm
Output Power		
1310nm	-2.5 to +2.0dBm	-
1550nm	-2.5 to +2.0dBm	-1.0 to +2.0dBm
Spectral Width (-20dB)	<1.0nm	<1.0nm
Extinction Ratio	>8.2dB	>8.2dB
Pulse Mask	Meets ITU-T G.957 (6/1999) and Telcordia GR-253-CORE issue 3 (9/2000)	
Fiber Type	Single mode	Single mode
Laser Safety	See "Regulatory Standards" section for details	

Optical receivers

	52Mb/s - 2.5Gb/s	10Gb/s & 10.71Gb/s
Line Code	NRZ	NRZ
Wavelength ⁽²⁾	1310/ 1550nm	1310/ 1550nm
Fiber Type	Single mode	Single mode
Damage Input Power	>0dBm	>+2dBm
Operating Range ⁽³⁾	-28dBm to -9dBm	-16dBm to -8dBm

Notes:

- 52-2488 Mb/s: For BER = 1×10^{-10} (input signal extinction ratio ≥ 8.2 dB).
10.71 Gb/s: For BER = 1×10^{-12} (input signal extinction ratio ≥ 8.2 dB).
- Specification nominal however the receiver is a broadband device and operates over the 1290 - 1565nm range.
- Typical specification.

SONET/SDH Electrical interfaces (supplied with options 104, 105 and 106)

STS-1/3 and STM-0/1e

Transmitter	Meets Telcordia GR-253-CORE Issue 3 and ITU-T G.703 for level and pulse shape. Level: STS-1: STS-1 (HI), STSX-1 (450 ft), STS-1 (900 ft), STM-0e: ± 1.1 Vpk, $\pm 10\%$. STS-3/STM-1e: ± 0.5 Vpk, $\pm 10\%$.
Receiver	Input mode: terminated or monitor. Monitor gain: 20 dB or 26 dB. Equalization: STS-1/STM-0e: Selectable off/on. When enabled, automatic equalization provided for 450 to 900 ft of cable loss. STS-3/STM-1e: Automatic for cable loss to 12 dB at half the bit rate. Jitter tolerance: Meets Telcordia GR-253-CORE Issue 3 and ITU-T G.825.

DSn/PDH Electrical interfaces (requires option 012)

DS1/3

Transmitter	Meets ANSI T1.102-1993. Level: DS1: DSX-1, DS1-LO. DS3: DS3-HI, DSX-3, DS3-900'.
Receiver	Meets ANSI T1.102-1993. Input mode: terminated or monitor. Monitor gain: DS1: 20 dB, 26 dB, 30 dB. DS3: 20 dB, 26 dB. Equalization: DS1: Automatic equalizes for DS1-HI, DSX-1, and DS1-LO levels in both terminated and monitor modes. DS3: Selectable off/on. When enabled, automatically equalizes for DS3-HI, DSX-3, and DS3-900' levels in both terminated and monitor modes. Jitter tolerance: Meets Telcordia GR-499 Category II and ITU-T G.824.

2/8/34/140 Mb/s

Transmitter	Meets ITU-T G.703. Level: Meets ITU-T G.703 for all rates.
Receiver	Meets ITU-T G.703 and G.772. Input mode: terminated or monitor. Monitor gain: 2/8 Mb/s: 20 dB, 26 dB, 30 dB. 34/140 Mb/s: 20 dB, 26 dB. Equalization: Meets ITU-T G.703. Jitter tolerance: Meets ITU-T G.823.

Clock synchronization (inputs, outputs, line frequency offset)

Clock references	Internal: ± 4.5 ppm Includes setting accuracy, stability over temperature and aging. External Clock Inputs: BITS (1.5 Mb/s): Bantam (100 Ω balanced). MTS (2 MHz and 2 Mb/s): BNC (75 Ω unbalanced) and Bantam (120 Ω balanced) Loop-timed: Transmitter timed by a clock recovered from the receiver.
Frequency offset	Offsets the transmitted line signal relative to the selected clock reference. Offset: ± 100 ppm in 0.1 ppm step. Offset accuracy: 0.02 ppm Note: For 10Gb/s and 10.71Gb/s operation the total of external clock reference offset and transmitter line rate offset must not exceed ± 90 ppm. For all other rates the combined offsets must not exceed ± 120 ppm.
Clock outputs	Output clocks generated relative to the selected transmit reference clock. BITS (1.5Mb/s): Bantam (100 Ω balanced). MTS (2 MHz): BNC (75 Ω unbalanced).
Eye clock outputs	Clock outputs that are frequency locked to the transmitted optical line signal. Rate: 52/155/622 Mb/s and 2.5 Gb/s: Output line rate divided by four. 10 Gb/s: Output line rate divided by sixteen (622 MHz nominal). 10.71 Gb/s: Output line rate divided by sixteen (669 MHz nominal) Level: Nominal ECL, ac coupled. Impedance: Drives nominal 50 Ω inputs. Connector: SMA.

Signal Structures, Mappings and Payloads

OTN mappings

Synchronous and asynchronous mapping of 10 Gb/s SONET/SDH structured payloads is supported plus test signal and null client mappings as per ITU-T G.709. For SONET/SDH payloads, both synchronous and asynchronous mappings are supported. In asynchronous mode, the payload offset and line rate offset can be applied to the transmitted signal and measured by the instrument receiver.

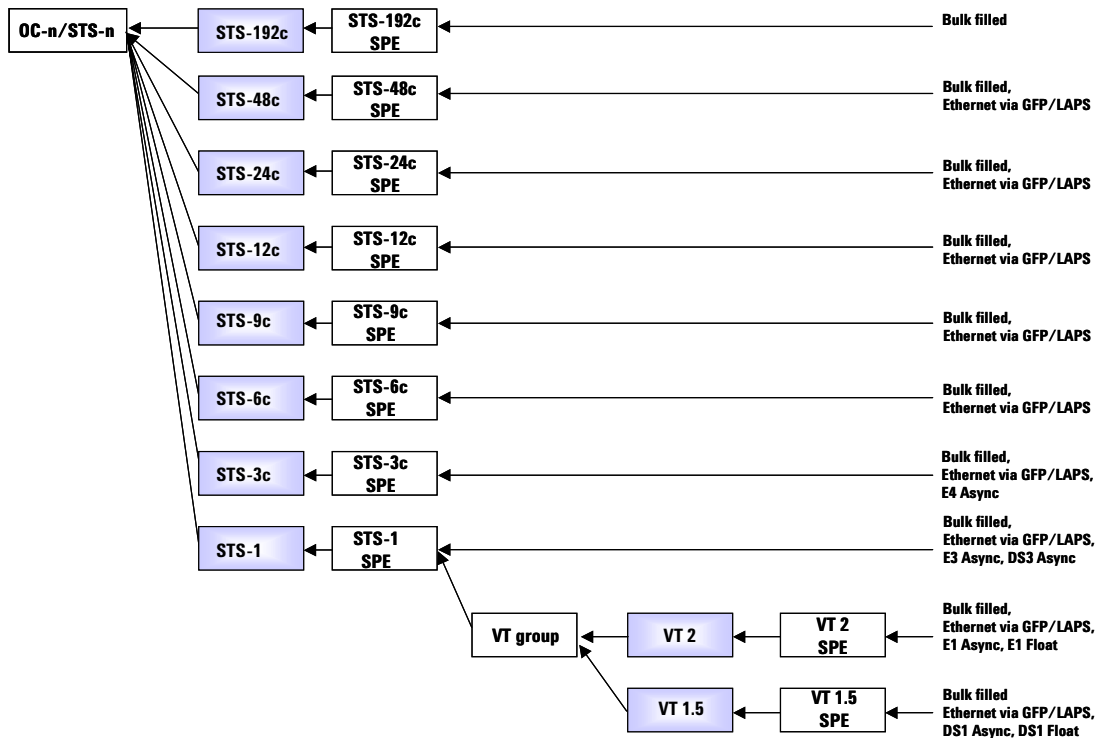
SONET mappings

Bulk STS-1, STS-Nc, VT mappings and DSn/En service payload testing supplied as standard with the product. Ethernet mappings support GFP (Framed and transparent) and LAPS within virtually concatenated STS-3c-xv, STS-1-xv, VT2-xv, VT1.5-xv or STS-1, 3c, 6c, 9c, 12c, 24c, and 48c.

Virtual Concatenation mappings

Mapping	No. of Members	Payloads
STS-3c-Xv	X=1 to 16	Bulk Filled or GFP/LAPS with Ethernet frame
STS-1-Xv	X=1 to 48	Bulk Filled or GFP/LAPS with Ethernet frame
VT2-Xv into single STS-1	X=1 to 21	Bulk Filled or GFP/LAPS with Ethernet frame
VT1.5-Xv into single STS-1	X=1 to 28	Bulk Filled or GFP/LAPS with Ethernet frame

Figure 6.
SONET Mappings Supported

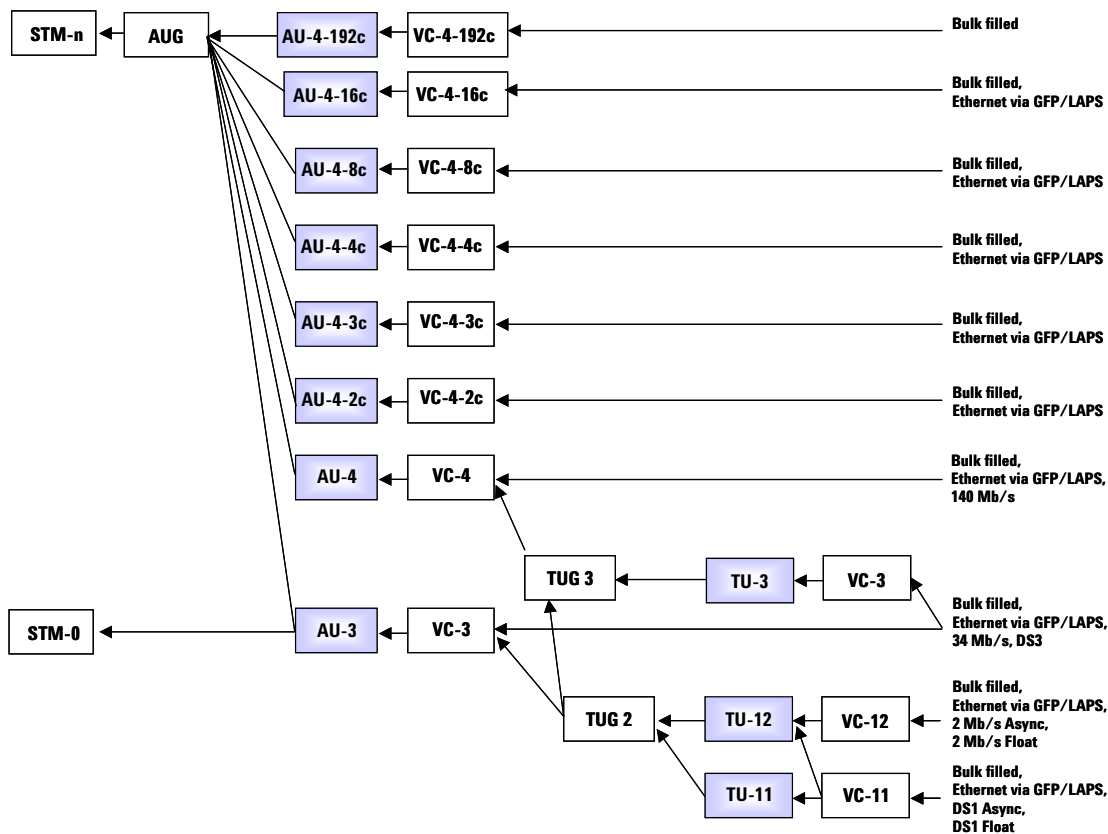


SDH mappings

Bulk AU-3, AU-4, AU-4-Nc, TU mappings and DSn/En service mappings supplied as standard with the product. Ethernet mappings support GFP (Framed and transparent) and LAP-S within virtually concatenated AU-4-xv, AU-3-xv, TU-3-xv, TU-12-xv, TU-11-xv or AU-3, AU-4, AU-4-2c, AU-4-3c, AU-4-8c.

Virtual Concatenation mappings		
Mapping	No. of Members	Payloads
AU-4-Xv	X=1 to 16	Bulk Filled or GFP/LAPS with Ethernet frame
AU-3-Xv	X=1 to 48	Bulk Filled or GFP/LAPS with Ethernet frame
TU-3-Xv via TUG-3	X=1 to 48	Bulk Filled or GFP/LAPS with Ethernet frame
VC-12-Xv into single VC-4	X=1 to 63	Bulk Filled or GFP/LAPS with Ethernet frame
VC-12-Xv into single VC-3	X=1 to 21	Bulk Filled or GFP/LAPS with Ethernet frame
VC-11-Xv into single VC-4	X=1 to 64	Bulk Filled or GFP/LAPS with Ethernet frame
VC-11-Xv into single VC-3	X=1 to 28	Bulk Filled or GFP/LAPS with Ethernet frame

Figure 7.
SDH Mappings Supported

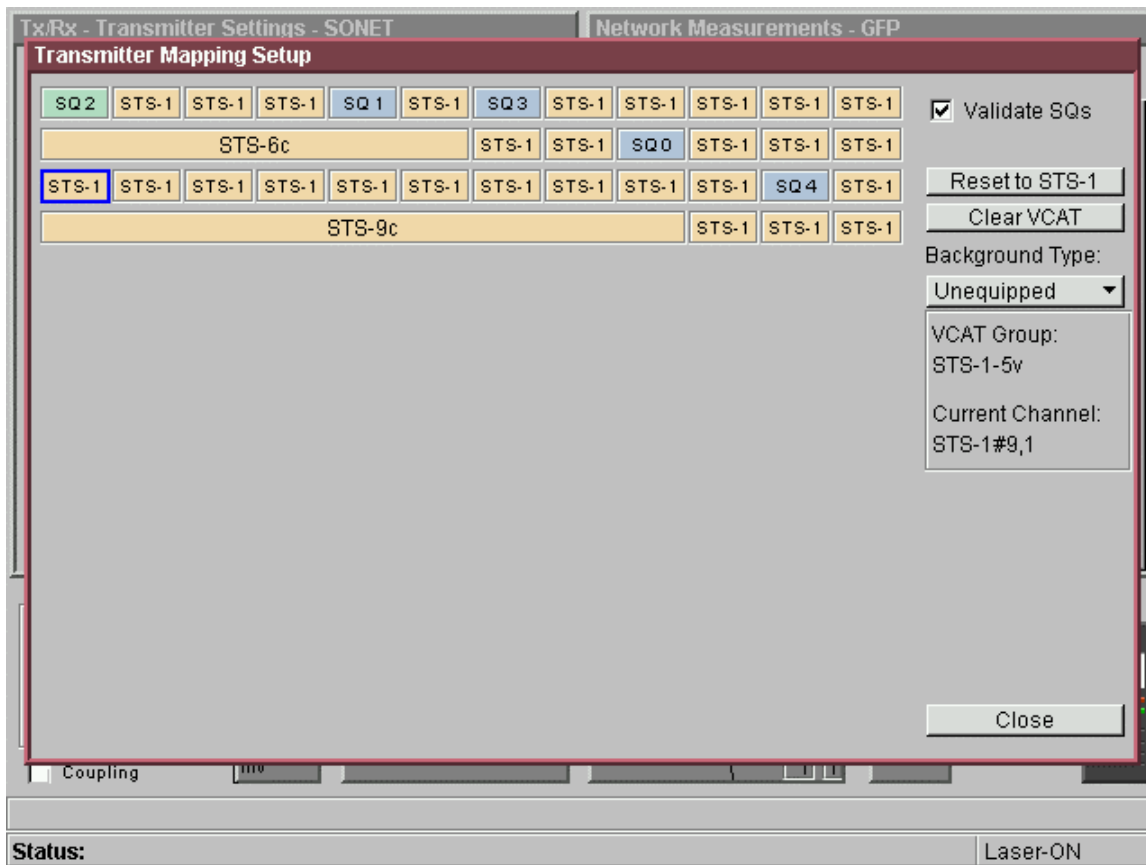


Mixed mappings generation (requires option 325)

The OmniBER OTN can easily generate a SONET/SDH test signal containing any valid combination of supported STS/AU containers. An example is shown in Figure 8 below:

With a mixed mapping configuration, one channel is selected as the foreground/test channel on the instrument transmitter. This test channel can be a virtually concatenated signal. The background channels can be defined as equipped, unequipped or AIS-P/AU-AIS.

Figure 8.
Example Setup of SONET Mixed Mapping



DSn/PDH frame formats and channel structures

Supports generation and analysis of framed, channel structured (mux/demux) and unframed test signals.

Signal	Framing	Channel structures
DS1	SF (D4), ESF, SLC-96, no frame, bit	56 kb/s, 64 kb/s, n x 56 kb/s, n x 64 kb/s
DS3	M13, C-bit	DS1, 2 Mb/s, 56 kb/s, 64 kb/s, n x 56 kb/s, n x 64 kb/s
2 Mb/s	PCM30, PCM30CRC, PCM31, PCM31CRC	64 kb/s, n x 64 kb/s
8 Mb/s	ITU-T G.742	2 Mb/s, 64 kb/s, n x 64 kb/s
34 Mb/s	ITU-T G.751	8 Mb/s, 2 Mb/s, 64 kb/s, n x 64 kb/s
140 Mb/s	ITU-T G.751	34 Mb/s, 8 Mb/s, 2 Mb/s, 64 kb/s, n x 64 kb/s

Test patterns

PRBS	2 ⁹ -1, 2 ¹¹ -1 ⁽¹⁾ , 2 ¹⁵ -1, 2 ²⁰ -1 ⁽¹⁾ , QRSS ⁽²⁾ , 2 ²³ -1. Polarity control: Inverted, non-inverted.
Word	All 1s, All 0s, 1010, 1000, 16-bit word, Incremental Byte ⁽³⁾ . Note: Word not available in unframed mode
Agilent Test Set Frame ⁽³⁾	Test frame transmitted within Ethernet frame providing CRC and sequence error measurements when used in conjunction with J2127A fitted with Ethernet test interface option.
Additional DS1 patterns	3-in-24, 1-in-8, 2-in-8, 55-octet (Daly).

Notes:

1. Not provided for GFP payloads.
2. Non-inverted only. Provided for DSn signals (including 56/64 kb/s channel testing) and VT1.5 bulk payloads.
3. Provided for GFP payloads only

Measurements

Error measurements

Measurement control	Manual, single, timed start.
Basic results	Error count, error ratio. Provided for the total measurement period and the most recent (last) measurement second.
GFP - Framed	Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, payload FCS, header mismatch.
GFP - Transparent	Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, uncorrectable superblock errors, correctable superblock errors, 10B_ERR errors, payload FCS, header mismatch.
LAPS	Invalid control sequence, undersize frames, FCS, header mismatch.
Ethernet MAC	FCS, length/type mismatch, runt frames, jumbo frames, header mismatch.
SONET	Transport O/H: Frame (A1,A2), CV-S (B1), CV-L (B2), REI-L (CV-LFE) Path O/H: CV-P (B3), REI-P (CV-PFE) VT: CV-V(V5), CV-VFE(REI-V). Bulk payload: Bit. Virtual Concatenation: All errors and alarms can be applied to selected member of virtually concatenated group. Signal: BPV (STS-1 and STS-3 interfaces).
SDH	Section O/H: Frame (A1A2), B1 BIP, B2 BIP, MS-REI Path O/H: B3 BIP, HP-REI LO-path: B3 (VC-3), BIP-2; LP-REI Tandem path: (VC-3/4 and VC-4-Nc): IEC, TC-REI, OEI, TC-ERR (VC-11/12): TC-REI, OEI, N2-BIP, TC-ERR Bulk payload: Bit. Virtual Concatenation: All errors and alarms can be applied to selected member of virtually concatenated group. Signal: Code (STM-0e and STM-1e interfaces).
DSn	DS1: BPV, frame, CRC6, bit. DS3: BPV, frame, P-bit, CP-bit, FEFE, bit.
PDH (En)	2 Mb/s: Code, frame, CRC4, E-bit, bit. 8Mb/s and 34 Mb/s: Code, frame, bit. 140 Mb/s: Frame, bit.
Performance analysis SONET, SDH, DSn and PDH	G.826, G.828, G.821, M.2100, M.2101, M2101.1, M.2110, M.2120.

Alarm detection and measurement	
Results	Alarm seconds provided for all supported alarms.
Alarm LEDs	<p>Front panel LEDs: Red/green: Signal, frame (all levels of framing), errors (any error type), pattern. Red: SONET/SDH (any SONET/SDH alarm), DS_n/PDH (any DS_n or PDH alarm), history (any error/alarm event earlier in measurement period). Virtual LEDs (accesses via front panel 'Show More' key): Graphical alarm display showing status information (including history) for all supported alarm types.</p>
SONET	<p>Physical: LOS Transport O/H: LOF, SEF, AIS-L, RDI-L, K1/K2 change. Path O/H: AIS-P, AIS-C, LOP-P, LOP-C, RDI-P, RDI-P-P, RDI-P-C, RDI-P-S, PDI-P, UNEQ-P, STS pointer change VT path: H4-LOM, P1P2 Loss, LOP-V, AIS-V, UNEQ-V, RDI-V, RDI-V-P, RDI-V-S, RDI-V-C, RFI-V, VT pointer adjustment. Virtual Concatenation: OOM1, OOM2, LOM, SQM Payload: Pattern loss. Other: Clock loss, power loss.</p>
SDH	<p>Physical: LOS. Section O/H: LOF, OOF, MS-AIS, MS-RDI, K1/K2 change. Path O/H: AU-AIS, AU-AIS-C, AU-LOP, AU-LOP-C, HP-RDI, HP-RDI-P, HP-RDI-C, HP-RDI-S, HP-UNEQ, AU pointer change LO-path: H4-LOM, TU-AIS, TU-LOP, LP-UNEQ, LP-RDI, LP-RFI, TU pointer change Tandem path: (VC-3/4 & VC-4-Nc): TC-OOM, VC-AIS, TC-IAIS, TC-RDI, ODI, TC-UNEQ (VC-11/12): TC-RDI, ODI, TC-IAIS, TC-OOM, TC-UNEQ. Virtual Concatenation: OOM1, OOM2, LOM, SQM Payload: Pattern loss Other: Clock loss, power loss</p>
GFP	Loss of Client Signal (LOCS), Loss of Client Character Synchronization (LOCCS), GFP link loss (no valid GFP frames)
LAPS	Erroneous Frame Alarm and Link Loss Alarm
DS_n	<p>DS1: LOS, LOF, AIS, RAI, excess zeros, pattern loss. DS3: LOS, LOF, LOMF, AIS, RAI, idle, DS3 framing mismatch, DS2 LOF, excess zeros, pattern loss.</p>
PDH (En)	<p>2 Mb/s: LOS, LOF, LOMF, AIS, RDI, RDI (MF), minor alarm, pattern loss. 8 / 34 / 140 Mb/s: LOS, LOF, AIS, RDI, minor alarm, pattern loss.</p>

Additional measurements	
Optical power	<p>Supported for all optical receive rates. Ranges: 10/10.71 Gb/s: -3dBm to -25 dBm. 52Mb/s, 155Mb/s, 622Mb/s, 2.5 Gb/s: -3 dBm to -28 dBm. Accuracy: 10/10.71 Gb/s: ± 1.5 dB. 2.5 Gb/s: ± 2 dB. 622 Mb/s and below: ± 1 dB. Resolution: 0.1 dB.</p>
Line frequency	<p>Supported for all optical and electrical receive rates. Results: Frequency (Hz), Offset (Hz and ppm). Accuracy: ± 4.5 ppm Resolution: Frequency: 1 Hz (up to 622 Mb/s), 0.1 kHz (2.5 Gb/s and 10 Gb/s). Offset: 0.1 ppm.</p>
Pointer measurements	<p>Supported for both STS/AU and VT/TU pointers Results: Pointer value, increment count, decrement count, increment seconds, decrement seconds, NDF seconds, missing NDF seconds, SPE/VC offset (in ppm).</p>
Virtual Concatenation	<p>Measurement of differential delay with reference to earliest arriving member to a maximum of 256ms. VCAT Measurement Overview - a group alarm indication graphically displays active errors and alarms and in which member of the group the condition is present.</p>
GFP	Data rate, bandwidth utilization, valid frames, invalid frames, valid idles frames, total frames, payload bytes, non idle bytes, all bytes, total superblocks, valid superblocks, invalid superblocks.
LAPS	Data rate, bandwidth utilization, valid frames, invalid frames, total frames, rate adaptation octets, payload bytes, all bytes, flag bytes.
Ethernet MAC	Data rate, frame size, valid frames, invalid frames, total frames, runt frames, jumbo frames, MAC bytes.
Service disruption	<p>Measures the duration of an error burst detected in the received test pattern (not available for word patterns). Supported for all SONET/SDH mappings (including concatenated) and DS_n/PDH signals. Results: Longest burst, shortest burst, last burst. Range: 50 μs to 2 s. Accuracy: ± 100 μs plus the sum of the applicable re-framing times. Resolution: 50 μs. Re-framing time (maximum): SONET/SDH: 250 μs STS/AU Pointer: 500 μs H4 multiframe (VT/TU): 1000 μs VT/TU Pointer: 2000 μs</p>

Signal Wizard (all-channel testing)

Line rates	<p>OTN: OTU2 SONET: OC-1/3/12/48/192, STS-1/3 SDH: STM-0/1/4/16/64c, STM-0/1e</p>
Channel sizes	<p>Supports detection and simultaneous monitoring of any 'mix' of the following channel types: OTN: OPU2 SONET: STS-1, STS-Nc (where N = 3, 12, 48, 192). SDH: AU-3, AU-4, AU-4-Nc (where N = 4, 16, 64). Note: SignalWizard will identify STS/AU channels of any size (for example STS-24c, AU-4-8c). However, error and alarm results will only be provided for the channel types identified above.</p>
Signal monitoring	<p>Monitors the line signal for:</p> <ul style="list-style-type: none"> CV-S (B1), CV-L (B2), CV-LFE (MS-REI) errors. LOS, LOF, DOF, AIS-L (MS-AIS), RDI-L (MS-RDI). Signal power/level. Synchronization status (S1) message. J0 section trace message. <p>Simultaneously monitors each STS/AU channel for:</p> <ul style="list-style-type: none"> CV-P (B3), CV-PFE (HP-REI) errors. AIS-P (AU-AIS), LOP-P (AU-LOP), RDI-P (HP-RDI) alarms. Payload mapping type (C2 signal label). Pointer activity. J1 path trace message. <p>Simultaneous monitor of all VT/TU channels in selected STS/AU for:</p> <ul style="list-style-type: none"> CV-V (BIP-2), CV-VFE (LP-REI) errors. AIS-V (TU-AIS), LOP-V (TU-LOP), RFI-V (LP-RFI), RDI-V (LP-RDI) alarms. Payload mapping type (V5 signal label). Pointer activity. J2 path trace message.
STS/AU channel viewer display	<p>Results clearly presented on a colour-coded graphical display showing:</p> <ul style="list-style-type: none"> Line rate and power/level of the received signal. Status (including history) for each line/section error and alarm. Text decode of synchronization status (S1) and J0 section trace. For each STS/AU channels: <ul style="list-style-type: none"> Channel size and channel traffic information (equipped/unequipped and channels carrying VT/TU payloads). Aggregated error/alarm status (including history) and pointer activity. For a selected STS/AU channel: <ul style="list-style-type: none"> Status indicators (including history) for each channel error/alarm. Pointer activity. The payload mapping being carried (C2 signal label decode). J1 path trace message. For each VT/TU channel in a selected STS/AU: <ul style="list-style-type: none"> Channel size and traffic information (equipped/unequipped). Aggregated error/alarm status (including history) and pointer activity. For a selected VT/TU channel: <ul style="list-style-type: none"> Status (including history) for each channel error and alarm. The payload mapping being carried (V5 signal label decode). Pointer activity. J2 path trace message.

Path routing test facilities	<p>Overview of received path trace messages:</p> <ul style="list-style-type: none"> Tabular display showing the J1 path trace message associated with each STS/AU channel in the received line signal. Tabular display showing the J2 path trace message associated with each VT/TU channel in a selected STS/AU. <p>Search for specified path trace message:</p> <ul style="list-style-type: none"> Identifies channel that is carrying a user-specified path trace message. For J1 messages, the search is performed on all STS/AU channels in received signal. The J2 message search is performed on: <ul style="list-style-type: none"> All VT/TU channels in a selected STS/AU channel. All VT/TU channels in all STS/AU channels. Search can be performed using any sub-string contained in the target path trace message. Search results report up to 25 matches.
Channel traffic overview	<p>Tabular display that lists for each STS/AU channel in the received signal:</p> <ul style="list-style-type: none"> Channel number. Channel size/type. The payload mapping being carried. J1 path trace message. <p>Tabular display that lists for each VT/TU channel in a selected STS/AU:</p> <ul style="list-style-type: none"> Channel number. Channel size/type. The payload mapping being carried. J2 path trace message.

Error and alarm generation

Error generation

OTN	<p>Physical: Entire frame ⁽¹⁾ OTU2: Frame (OA1,OA2), MFAS, BIP-8, BEI, correctable FEC errors, uncorrectable FEC blocks ODU2: BIP-8, BEI Payload: Bit Error control: Single, error all ⁽³⁾, M.P x 10⁻ⁿ (where M.P = 0.1 to 9.9 in 0.1 steps; n = 3 to 9)⁽⁴⁾,</p>
SONET	<p>Physical: Entire frame ⁽¹⁾ Transport O/H: Frame (A1A2), CV-S (B1), CV-L (B2), REI-L (CV-LFE) ⁽²⁾ Path O/H: CV-P (B3), REI-P (CV-PFE) Bulk payload: Bit. Additional error add capability provided by: Signal: BPV (STS-1). VT path: CV-V (V5), CV-VFE (REI-V). DSn/En payload: See DSn and PDH (En) error add for details. Error Control: Single, error all ⁽³⁾, M.P x 10⁻ⁿ (where M.P = 0.1 to 9.9 in 0.1 steps; n = 3 to 9)⁽⁴⁾, N-in-4⁽⁵⁾, N-in-T⁽⁶⁾.</p>
SDH	<p>Physical: Entire frame ⁽¹⁾ Section O/H: Frame (A1A2), B1 BIP, B2 BIP, MS-REI. ⁽²⁾ Path O/H: B3 BIP, HP-REI Tandem path (VC-3/4 and VC-4-Nc): IEC, TC-REI, OEI. Bulk payload: Bit. Additional error add capability provided by: Signal: Code (STM-0e). LO-path: B3 (VC-3), BIP-2 (VC-1/2); LP-REI. Tandem path (VC-11/12): TC-REI, TC-OEI, N2-BIP. PDH/DSn payload: See PDH and DSn error add for details. Error Control: Single, Error All ⁽³⁾, M.P x 10⁻ⁿ (where M.P = 0.1 to 9.9 in 0.1 steps; n = 3 to 9)⁽⁴⁾, N-in-4⁽⁵⁾, N-in-T⁽⁶⁾⁽⁷⁾</p>
GFP - Framed	Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, payload FCS.
GFP - Transparent	Correctable core HEC, uncorrectable core HEC, correctable type HEC, uncorrectable type HEC, correctable extension HEC, uncorrectable extension HEC, uncorrectable superblock errors, correctable superblock errors (pre scrambler), superblock errors (post scrambler), 10B_ERR errors, payload FCS.
LAPS	Undersize Frames <=7bytes, undersize frames <=5bytes, FCS, Invalid Control Sequence
Ethernet MAC	Jumbo Frame, Runt Frame, FCS
DSn	<p>DS1: BPV⁽⁸⁾, excess zeros⁽⁹⁾, frame, CRC6, bit. DS3: BPV⁽⁸⁾, excess zeros⁽⁹⁾, frame, MFAS, P-bit, CP-bit, FEBE, bit. Error Control: Single, M.P x 10⁻ⁿ (where M.P = 0.1 to 9.9 in 0.1 steps, and n = 3 to 9)⁽⁴⁾, N-in-4⁽¹⁰⁾, N-in-6⁽¹¹⁾</p>
PDH (En)	<p>2 Mb/s: Code⁽⁸⁾, frame, CRC4, E-bit, bit. 8 Mb/s and 34 Mb/s: Code⁽⁸⁾, frame, bit. 140 Mb/s: frame, bit. Error Control: Single, M.P x 10⁻ⁿ (where M.P = 0.1 to 9.9 in 0.1 steps, and n = 3 to 9)⁽⁴⁾, N-in-4⁽¹⁰⁾.</p>

Notes:
1. Errors added after scrambling (and also after FEC calculation for OTN) to simulate transmission errors.

- For OC-192/STM-64, supports both the 'M1 only' and 'M0+M1' options of the standards.
- Not supported for data, frame, MFAS BPV/code, FEÇ block or bit.
- The maximum error rate for any error type is 1 x 10⁻³ or the maximum error rate supported by the error type (its saturation value), whichever is the lower.
- Supported for frame (A1A2) errors. N = 1 to 4.
- SONET: B2 errors only. N errors transmitted during time T (T = 10 ms to 1000 s in decade steps; N = 0 to 640 x n errors, where n is the hierarchical level of the STS-n/OC-n signal).
- SDH: B2 errors only. N errors transmitted during time T (T = 10 ms to 1000 s in decade steps; N = 0 to 640 errors for STM-0, and 0 to 1920 x n errors for all other line rates, where n is the hierarchical level of the STM-n signal).
- Not available when signal is a mapped payload in SONET/SDH or a channel within a higher rate DSn/PDH signal.
- Single burst of 3 to 16 zeros (user selectable) transmitted without line coding.
- Supported for DS3 frame, DS3 MFAS and PDH frame errors. N = 1 to 4.
- Supported for DS1 frame errors. N = 1 to 6.

Alarm generation

Alarm control	<p>On/Off/Single/Stress On/Off: The alarm is turned on or off Single: A single instance of the selected alarm is generated as per ITU-T /Telcordia recommendations Stress test: Performed using a 'p', 'n' and 'm' sequence. With alarm initial condition ON (OFF), the alarm is toggled OFF (ON) for 'p' frames followed by a continuous repeat of 'n' frames ON (OFF) then 'm' frames OFF (ON). The values of p, n and m can be changed hitlessly during testing. Note: Single and stress test only available for SONET and SDH alarm testing, excluding VT/TU alarms</p>
OTN	<p>Physical: LOS OTU2: LOF, OOF, OOM, AIS, IAE, BDI ODU2: AIS, OCI, LCK, BDI</p>
SONET	<p>Physical: LOS. Transport O/H: LOF, SEF, AIS-L, RDI-L. Path O/H: AIS-P, LOP-P, RDI-P, RDI-P-P, RDI-P-S, RDI-P-C, UNEQ-P. VT path: H4-LOM, AIS-V, LOP-V, RDI-V, RDI-V-P, RDI-V-S, RDI-V-C, RFI-V, UNEQ-V.</p>
SDH	<p>Physical: LOS. Section O/H: LOF, OOF, MS-AIS, MS-RDI. Path O/H: AU-AIS, AU-LOP, HP-RDI, HP-RDI-P, HP-RDI-C, HP-RDI-S, HP-UNEQ. Tandem path: (VC-3/4 and VC-4-Nc): TC-OOM, VC-AIS, TC-IAIS, TC-RDI, ODI, TC-UNEQ. LO-path: H4-LOM, TU-AIS, TU-LOP, LP-RDI, LP-RFI, LP-UNEQ. Tandem path (VC-11/12): TC-RDI, TC-ODI, VC-AIS, TC-UNEQ.</p>
Virtual Concatenation	OOM1, OOM2, LOM, SQM - applied to selected member of group AIS-P, RDI-P, LOP-P, UNEQ-P, AIS-V, RDI-V, LOP-V, UNEQ-V applied to all SONET members. HP-AIS, HP-RDI, AU-LOP, HP-UNEQ, TU-AIS, LP-RDI, TU-LOP, LP-UNEQ - applied to all SDH members.
GFP - Framed and Transparent	Loss of Client Signal (LOCS), Loss of Client Character Synchronization (LOCCS) with configurable time interval between 100 and 1000ms.
LAPS	Erroneous frame - abort, - inverted FCS, link loss.
DSn	<p>DS1: LOS, LOF, AIS, RAI. DS3: LOS, LOF, AIS, RAI, idle.</p>
PDH (En)	<p>2 Mb/s: LOS, LOF, LOMF, AIS, RDI, RDI (MF), minor alarm. 8 /34/140 Mb/s: LOS, LOF, AIS, RDI, minor alarm.</p>

Overhead testing

OTN overhead testing

Overhead Setup	Overhead bytes are user programmable in hexadecimal. Trace identifier messages are settable in ASCII. Restrictions: SM BIP-8 and PM BIP-8 are calculated values. Control of these bytes is achieved using the instrument error generation feature. No access to JC, NJO or PJO.
Overhead Monitor	Displays all received OTU, ODU and OPU overhead bytes in hexadecimal format. Values are updated approximately every second.
Overhead Sequence Generation	A single overhead channel can be chosen to have a sequence of hexadecimal values inserted. 256 different elements for the sequence can be defined, each element being the appropriate number of bytes for the selected overhead channel. Each element can be transmitted for a variable number of frames (1-65535). This sequence can be transmitted as a single run or repeated indefinitely. Sequence Channels: 6 Bytes: FAS 4 Bytes: APS/PCC 2 Bytes: GCC0-2, EXP 1 Byte: MFAS, TCM ACT, FTFL, RES, PM bytes 1 and 3, SM bytes 1 and 3, TCM 1-6 bytes 1 and 3, OPU2 bytes (excluding JC, NJO and PJO when in async mode) For TCM1-6, bytes 1 and 3 can be sequenced, the BIP-8 is calculated. Overhead sequences will be automatically synchronized to the MFAS if the number of frames in the sequence is a multiple or sub-multiple of 256 (e.g. 64, 128 or 512 frames).
Overhead Sequence Capture	A single overhead channel can be selected for capture. 256 unique values of the selected channel are displayed along with the number of frames (1-65535) for which each value has persisted. Sequence Channels: 6 Bytes: FAS (OA1, OA2) 4 Bytes: APC/PCC 2 Bytes: GCC0, TCM TOS, EXP, GCC1, GCC2 1 Byte: MFAS, TCM ACT, FTFL, RES, PM bytes 1 and 3, SM bytes 1 and 3, TCM 1-6 bytes 1 and 3, OPU2 bytes (not JC, NJO, PJO in async mode) Trigger value: User definable Capture is triggered when user defined value is <ul style="list-style-type: none"> Equal to the received value in the selected channel or NOT equal to the received value in the selected channel Trigger Mask: Trigger mask value settable by user. Only bits corresponding to a '1' in the mask value are used to detect trigger. Trigger Selection: <ul style="list-style-type: none"> Manual. 256 values following the manual capture are displayed. Pre trigger capture. Up to 256 values up to and including the trigger point are displayed. Capture is triggered as soon as possible after the capture is started, even if 256 values have not been captured. Post trigger capture. Up to 256 values including and following the trigger point are displayed. The captured data is updated every second after the capture has triggered. Centred capture. Up to 128 values before the trigger point and up to 128 values including and following the trigger point are displayed.

Frame Capture	Four complete optical channel frames including overhead, payload and FEC blocks can be captured for display and analysis. Frame Capture Triggers: Trigger Selection: <ul style="list-style-type: none"> Manual - Four frames after the manual trigger are captured. Pre-trigger - Four frames up to and including the trigger frame are captured. Post-trigger - The trigger frame plus three following frames are captured. Centered - Two frames before the trigger frame, the trigger frame and the next frame are captured. Capture Triggers: Frame capture can be triggered on receive triggers as detailed in "Event Trigger Outputs".
Trail Trace Identifiers	Text based set-up and monitoring of the SM and PM TTI message

SONET/SDH overhead testing

Overhead setup	All TOH/SOH, STS-path/HO-path, and VT-path/LO-path overhead bytes user programmable in hexadecimal. Restrictions: B1, B2, B3, H1 (SS-bits programmable), H2, H3, V1 to V4, V5 (bits 5-7 programmable).
Overhead monitor	Displays all TOH/SOH overhead bytes in a selected STS-3/STM-1 group, plus all STS-path/HO-path and VT path/LO-path overhead bytes. Byte values are presented in hexadecimal.
Overhead Sequence Generation	A single overhead channel can be chosen to have a sequence of hexadecimal values inserted. 256 different elements for the sequence can be defined, each element being the appropriate number of bytes for the selected overhead channel. Each element can be transmitted for a variable number of frames (1-65535). Sequence transmitted as a single run or repeated indefinitely. Sequence Channels: 9 Bytes: D4-D12 6 Bytes: A1,A2 for STM-1 to 64 and STS-3 to 192 3 Bytes: D1-D3 2 Bytes: A1,A2 for STM-0 or STS-1, M0-M1 (STM-64 only), K1-K2, H1-H2 1 Byte: J0, E1, F1, Z0, J1, C2, G1, F2, H4, F3, K3, N1, H3

<p>Overhead Sequence Capture</p>	<p>A single overhead channel can be selected for capture. 256 unique values of the selected channel are displayed along with the number of frames (1-65535) for which each value has persisted.</p> <p>Sequence Channels: 9 Bytes: D4-D12 6 Bytes: A1,A2 for STM-1 to 64 and STS-3 to 192 3 Bytes: D1-D3 2 Bytes: A1,A2 for STM-0 or STS-1, M0-M1 (STM-64 only), K1-K2, H1-H2 1 Byte: J0, E1, F1, S1, M1, Z0, J1, C2, G1, F2, H4, F3, K3, N1, H3</p> <p>Trigger value: User definable Capture is triggered when user defined value is</p> <ul style="list-style-type: none"> Equal to the received value in the selected channel or NOT equal to the received value in the selected channel <p>Trigger Mask: Trigger mask value settable by user. Only bits corresponding to a '1' in the mask value are used to detect trigger.</p> <p>Trigger Selection:</p> <ul style="list-style-type: none"> Manual. 256 values following the manual capture displayed. Pre trigger capture. Up to 256 values up to and including the trigger point are displayed. Capture is triggered as soon as possible after the capture is started, even if 256 values have not been captured. Post trigger capture. Up to 256 values including and following the trigger point are displayed. The captured data is updated every second after the capture has triggered. Centred capture. Up to 128 values before, the trigger point and up to 128 values including and following the trigger point are displayed.
<p>Entire Overhead Capture</p>	<p>6 complete frames of overhead are captured.</p> <p>Overhead selection:</p> <ul style="list-style-type: none"> SOH+LOH / RSOH+MSOH or STS/POH <p>Trigger selection:</p> <ul style="list-style-type: none"> Manual - 6 frames after the manual trigger are captured Pre-trigger - 6 frames up to and including trigger captured Post-trigger - Trigger plus 5 following frames captured Centred - 3 frames before the trigger frame, the trigger frame and the next 2 frames are captured <p>Capture Triggers: Entire overhead capture can be triggered on receive triggers as detailed in "Event Trigger Outputs"</p>
<p>APS/MSP messages (K1K2)</p>	<p>Text-based setup and monitoring of APS/MSP messages.</p> <p>Linear: Messages comply with Telcordia GR-253-CORE Issue 3 and ITU-T G.783.</p> <p>Ring: Messages comply with Telcordia GR-1230 and ITU-T G.841</p>
<p>Active APS Test</p>	<p>NOTE: Only available for linear architecture. The ACTIVE APS message test gives real-time K1/K2 response to provide switching keep-alive capability. The instrument will not initiate any K1/K2 changes, but will respond to change requests that appear on the input K1/K2 byte values. K1/K2 response is sent (response time:10ms) if received value persists for 3 frames.</p> <p>Operating Modes:</p> <ul style="list-style-type: none"> Unidirectional Bidirectional <p>Emulation response time:10ms</p>

<p>Trace messages (J0, J1, J2, TC-APId)</p>	<p>Text-based setup and monitoring of all trace messages (J0, J1, J2, TC-APId (VC-3/4, VC-4-Nc), TC-APId (VC-11/12)).</p> <p>Message formats: J0/J1/J2: Selectable as 16-byte or 64-byte format. TC-APId (SDH only): 16-byte format.</p>
<p>Synchronization status message (S1)</p>	<p>Text-based setup and monitoring of Synchronization Status messages. Messages comply with Telcordia GR-253-CORE Issue 3 and ITU-T G.707 (04/00 draft).</p>
<p>Signal labels (C2, V5)</p>	<p>Text-based setup and monitoring of payload signal labels (both STS path/HO-path and VT path/LO-path). Labels comply with Telcordia GR-253-CORE Issue 3 and ITU-T G.707 (04/00 draft).</p>

GFP overhead testing

<p>Overhead setup</p>	<p>User programmable PTI, PFI, EXI (linear and NULL), CID (linear only), UPI</p>
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LAPS overhead testing

<p>Overhead setup</p>	<p>User programmable SAPI, Address, Control, FCS length (16/32 bit), scrambler (ON/OFF), Rate adaptation octet (Enable/Disable). Custom mode allows other HDLC encapsulations such as HDLC/PPP to be simulated using an Ethernet payload.</p>
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Ethernet overhead testing

<p>Overhead setup</p>	<p>User programmable destination address, source address, VLAN (tagged/untagged), User priority (VLAN tagged), VLAN No. (VLAN tagged), Length/Type field, requested data rate.</p>
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SONET/SDH pointer adjustment control

The following pointer adjustment controls are provided as standard for STS-Nc/AU-4-Nc and STS/AU payload pointers.

<p>New pointer</p>	<p>Transmits a new pointer address with or without a new data flag (NDF). Supports setting of any valid pointer value.</p>
<p>Burst</p>	<p>Single burst of adjustments transmitted in a selected pointer.</p> <p>Adjustment polarity: Incrementing, decrementing, alternating.</p> <p>Burst size: STS/AU and STS-Nc/AU-4-Nc: 1 to 10. VT/TU: 1 to 5.</p> <p>Separation of adjustments in burst: STS/AU and STS-Nc/AU-4-Nc: 4 frames (500µs). VT/TU: 4 multiframe (2 ms).</p>
<p>Periodic sequence</p>	<p>Periodic sequence of pointer adjustments created by generating a frequency offset between the line and SPE/VC clocks.</p> <p>Clock control: User selectable as either: 1. SPE/VC clock offset, line clock locked to reference. 2. Line clock offset, SPE/VC clock locked to reference.</p> <p>Offset: User selectable in the range ± 100 ppm. Setting resolution: 0.1 ppm. Accuracy: 0.02 ppm.</p>

Virtual Concatenation Delay Generation

Delay Generation	Up to 256ms can be added to any or all members of the virtual concatenated. Full delay generation to ITU-T G.707.
Delay Control	Delay can be entered in microseconds to 2 decimal places with On/Off control provided. Also for each member selected it is possible to increment/decrement the pointer to hitlessly vary delay.

Event triggers outputs - OTN/SONET/SDH

OTN transmit triggers	<p>Source: LOS - available with alarm stress 'Pulse' mode OTU2: LOF, OOF, LOM, OOM, AIS, IAE, BDI, ODU2: AIS, OCI, LCK, BDI, Format: Level</p> <p>Source: Start of frame, entire frame error add, frame error (OA1,OA2), MFAS OTU2: BIP8, BEI ODU2: SM BIP8, SM BEI, FEC Block error, bit Format: Pulse</p>
OTN receive triggers	<p>Source: OTU2: LOF, OOF, AIS, IAE, BDI ODU2: AIS, OCI, LCK, BDI Format: Level</p> <p>Source: Start of frame, frame error (OA1,OA2), MFAS OTU2: BIP8, BEI ODU2: BIP8, BEI FEC Block error Format: Pulse</p> <p>Note: All of the above triggers are selectable for frame capture</p>
SONET transmit triggers	<p>Alarms Physical: LOS Transport O/H: LOF, SEF, AIS-L, RDI-L Path O/H: AIS-P, AIS-C, LOP-P, LOP-C, RDI-P, UNEQ-P, Virtual Concatenation: OOM1, OOM2, LOM, SQM Format: Level</p> <p>Errors/Events Transport O/H: Start of frame, entire frame error add, frame error (A1,A2), CV-S(B1), CV-L(B2), REI-L (CV-LFE) Path O/H: CV-P(B3), REI-P (CV-PFE) Payload: Bit Format: Pulse</p>
SONET receive triggers	<p>Alarms Physical: LOS Transport O/H: LOF, SEF, AIS-L, RDI-L, K1/K2 change Path O/H: LOP-P*, LOP-C*, AIS-P*, AIS-C*, RDI-P, UNEQ-P Virtual Concatenation: OOM1, OOM2, LOM, LOA, SQM Format: Level</p> <p>Errors/Events Transport O/H: Start of frame, frame error, CV-S(B1), CV-L(B2), REI-L(CV-LFE), STS pointer change Path O/H: CV-P(B3), REI-P (CV-PFE) Format: Pulse</p> <p>Note: TOH event triggers are selectable for TOH frame capture. STS event triggers are selectable for STS-Path capture. * Trigger not available for Entire Overhead Capture</p>

SDH transmit triggers	<p>Alarms Physical: LOS Section O/H: LOF, OOF, MS-AIS, MS-RDI, Path O/H: AU-AIS, AU-AIS-C, AU-LOP, AU-LOP-C, HP-RDI, HP-UNEQ Tandem path: TC-OOM, VC-AIS, TC-IAIS, TC-RDI, ODI, TC-UNEQ Virtual Concatenation: OOM1, OOM2, LOM, SQM Format: Level</p> <p>Errors/Events Section O/H: Start of frame, entire frame error add, frame error (A1,A2), B1 BIP, B2 BIP, MS-REI Path O/H: B3 BIP, HP-REI Tandem Path: IEC, TC-REI, OEI Payload: bit Format: Pulse</p>
SDH receive triggers	<p>Alarms Physical: LOS Section O/H: LOF, OOF, MS-AIS, MS-RDI, K1/K2 change Path O/H: AU-AIS*, AU-AIS-C*, AU-LOP*, AU-LOP-C*, HP-RDI, HP-UNEQ Tandem Path: TC-OOM, VC-AIS, TC-IAIS, TC-RDI, ODI, TC-UNEQ Virtual Concatenation: OOM1, OOM2, LOM, LOA, SQM Format: Level</p> <p>Errors/Events Section O/H: Start of frame, frame error (A1,A2), B1 BIP, B2 BIP, MS-REI, AU-3/4 pointer change Path O/H: B3 BIP, HP-REI Tandem Path: IEC, TC-REI, OEI, TC-ERR Format: Pulse</p> <p>Note: RSOH and MSOH event triggers are selectable for RSOH+MSOH frame capture. POH event triggers are selectable for POH capture. * Trigger not available for Entire Overhead Capture</p>

Trigger output port for OTN/SONET/SDH

Connectors	SMA, TTL, 50ohm
Output level	Logic '1' = 4V typical Logic '0' = 0V typical
Pulse Width	100ns Nominal

GCC/DCC drop/insert

Supports the drop and insert of DCC channels from SONET/SDH or GCC channels from OTN signals

Connector	9-pin miniature D-type.
Rates	D1-D3 DCC channel: 192 kb/s. D4-D12 DCC channel: 576 kb/s. GCC0, 1, 2 channels: 1.3124 Mb/s
Signal type	Unipolar differential type designed to be similar to TIA/EIA-422-B and ITU Recommendation V.11 with reduced common-mode voltage range due to reduced supply voltage of 3.3V.
Input termination	100Ω differential.
Input sensitivity	200mV over a common-mode input voltage range from -0.3V to 5.5V.
Output voltage swing	>0.95V (1.5V typical)
DC Levels	Logic '1' = 2.3V typical, 1.85V min Logic '0' = 0.8V typical, 1.05V max
Order of transmission	Most significant bit (MSB) transmitted first (for both data input and data output).

GCC/DCC drop/insert connector pin-out

Pin number	RS-449/422 signal
1	Rx data output (+)
2	Rx clock output (+)
3	Signal ground
4	Tx clock output (+)
5	Tx data input (+)
6	Rx data output (-)
7	Rx clock output (-)
8	Tx clock output (-)
9	Tx data input (-)

Payload drop/insert capabilities

DSn/PDH to/from SONET	Supports the external drop/insert of asynchronous mapped DSn/PDH payloads. Drop/insert is performed via the instrument's DSn/PDH electrical test ports. Supported rates: DS1, E1 (2Mb/s), DS3.
DSn/PDH to/from SDH	Supports the external drop/insert of asynchronous mapped DSn/PDH payloads. Drop/insert performed via the instrument's DSn/PDH electrical test ports. Supported rates: DS1, 2 Mb/s, 34 Mb/s, DS3, 140 Mb/s.
DSn/PDH to/from DSn/PDH	Supports the external drop/insert of a DS1 or 2 Mb/s channel to/from a higher-rate DSn/PDH signal. Drop-insert performed via the instrument's DSn/PDH electrical test ports. Supported rates: DS1 to/from DS3; 2 Mb/s ⁽¹⁾ to/from 8/34/140 Mb/s or DS3.
Voice drop	Allows the traffic in a selected 56 kb/s or 64 kb/s timeslot carried within a DS1 or 2 Mb/s signal to be dropped to an internal speaker. The DS1 or 2 Mb/s signal can be at the primary signal rate or carried within a higher-rate line signal (SONET/SDH or DS3/PDH). Coding: A-law (2 Mb/s), μ-law (DS1).

Note: 2 Mb/s drop/insert to/from an 8/34/140 Mb/s signal is performed via the 120Ω balanced test ports (3-pin Siemens connectors)

Thru-mode testing

OTN	Rate: OTU2 Transparent: Receive signal passes unaltered through test set. All receiver test facilities are available.
SONET/SDH	Rates: SONET: OC-1, OC-12, OC-48, STS-1, STS-3. SDH: STM-0c, STM-4c, STM-16c, STM-0e, STM-1e. Transparent: Receive signal passes unaltered through test set. All receiver test facilities are available. Overhead Overwrite: Error and alarm events down to high order path level as detailed in sections "Error Generation" and "Alarm Generation" DCC drop/insert Trace messages (J0, J1) Labels (S1, C2) APS Messages (K1, K2) Entire frame error add A1/A2 error add
Virtual Concatenation	Receive signal passes unaltered through the test set. All receiver test functions, including differential delay measurement, are available
GFP	Receive signal passes unaltered through the test set. All receiver test functions are available.
Ethernet	Receive signal passes unaltered through the test set. All receiver test functions are available.
DSn	Receive signal passes unaltered through test set. All receiver test facilities are available. Rates: DS1, DS3.

DSn/PDH testing

DS1 loopcodes and DS3 FEAC messages

DS1 loopcodes	<p>Transmits and monitors in-band and out-of-band DS1 loopcodes.</p> <p>In-band: Line, payload, network, user (selectable from 3 to 8 bits).</p> <p>Transmit: Selected code transmitted for 8 seconds (nominal).</p> <p>Monitor: Indicates the detection of a selected loop-up and loop-down code. Displays the last valid loopcode received.</p> <p>Out-of-band: Line, payload, network, universal, user (1111111 0xxxxx0).</p> <p>Transmit: Selected code transmitted either continuously or in a burst of n-messages (where n is selectable in the range 1 to 15).</p> <p>Monitor: Displays in decode form the two most recently received loopcodes (current and previous).</p>
DS3 FEAC messages	<p>Applies to DS3 C-bit framed signals. Transmits and monitors loopback and alarm/status codes as per ANSI T1.107-1995.</p> <p>Loopback code transmit: Transmits any user selected loopback code as a single burst of 'N loopback codes' and 'M messages' (where N and M are selectable in the range 1 to 15).</p> <p>Alarm/status code transmit: Transmits any ANSI T1.107-1995 message or any user specified code (0xxxxx0 1111111), either continuously or in a single burst (selectable in the range 1 to 15).</p> <p>Monitor: Displays in decoded form the two most recently received FEAC messages (current and previous).</p>

PDH spare-bits testing

Supports user-programming and monitoring of PDH frame spare-bits.

2 Mb/s (non-CRC framing)	Si-bit (timeslot 0, bit 1); Sa4 to Sa8 (NFAS timeslot); timeslot 16 (MFAS) bits 5, 7 and 8 (PCM30 framing).
2 Mb/s (CRC framing)	E-bits (Si-bit in frames 13 and 15); 8-bit pattern in each NFAS Sa-bit (Sa4 to Sa8); timeslot 16 (MFAS) bits 5, 7 and 8 (PCM30CRC framing).
8/34/140 Mb/s	8 Mb/s and 34 Mb/s: FAS bit 12. 140 Mb/s: FAS bits 14 to 16.

Signaling-bits testing

2 Mb/s	<p>Framing formats: PCM30, PCM30CRC (CAS).</p> <p>Transmit: User-programmed value transmitted in ABCD signaling-bits associated with all 30-channels.</p> <p>Monitor: Displays ABCD signaling-bits associated with all 30-channels.</p>
DS1	<p>Frame formats: SF (D4), ESF, SLC-96</p> <p>Channel type: 56 kb/s structured timeslots.</p> <p>Transmit: User-programmed value transmitted in AB or ABCD signaling-bits associated with all 24-channels.</p> <p>Monitor: Displays AB or ABCD signaling-bits associated with all 24-channels.</p>

Additional features

Help facilities	<p>On-line user documentation: Accessed via front panel key.</p> <p>Context-sensitive help: Provided for each control-field on a dedicated line of the instrument's display. The displayed help information automatically tracks the cursor.</p> <p>User-help documentation: Supports the installation (from floppy disk) of up to 1.44 Mbytes of user-authored help files in the instrument's non-volatile memory. This help information is available in addition to that provided as standard.</p>
Stored configurations	Provides storage for five instrument configurations (one factory-default configuration plus four user configurations) in non-volatile memory. Additional instrument configurations can be saved to and recalled from the floppy disk.
Graphical results	<p>The following graphical results are available for display during a measurement:</p> <p>STS/AU pointer: Line graph of STS/AU pointer address versus time.</p> <p>Additional graphical result capability provided by</p> <p>Errors: Bar graph for each supported error types versus time.</p> <p>Alarms: Line graph for each supported alarm type versus time.</p> <p>VT/TU pointer: Line graph of VT/TU pointer address versus time.</p> <p>Time resolution: 1-second.</p> <p>Storage: Up to 10 sets (or 10 Mbytes in total) of graphical results can be saved in the instrument's non-volatile memory.</p>
Result logging	<p>Supports logging of results during a measurement to a printer, to a file in the instrument's non-volatile memory or to floppy disk.</p> <p>Logged information: Instrument settings, time and date, period-results, end-of-measurement results (the results logged are user selectable).</p> <p>Logging period: 10-minutes, 1-hour, 24-hours, user-defined (in ranges 10 to 99-minutes; 1 to 99-hours).</p>
Printing	Supports printing of logged results and screen dumps via USB port.
Beep-on-error	<p>Audible beep emitted on detection of any valid error-type.</p> <p>Control: Off/on (with user controlled volume).</p>

General specifications	
Display	8.4" VGA display (TFT active matrix).
Floppy disk	1.44 Mb IBM-compatible. Supported facilities include: Stored configurations: Save and recall of instrument configurations. Logged results: Saving the results generated during measurement logging. Results saved in Windows®-compatible 'plain text' format. Screen dumps: Saving the current instrument display in Windows-compatible .BMP format. User-help files: Downloading user-help files to the instrument. Graphical results. Save and recall of the instrument's graphical results. Results saved in Windows-compatible CSV (comma separated variable) format for importing in to spreadsheets and other PC applications.
Remote control interfaces	LAN (10/100BaseT), RS-232, GP-IB.
Peripheral interfaces	PS/2 keyboard; PS/2 mouse 2 x USB (for printer).
Remote graphical user interface	A Java™ application connected remotely via LAN or modem. Compatible with PC-based Windows® operating systems.
Firmware upgrades	Downloaded to the test set from a PC via LAN or RS-232 interface.
AC power	Voltage range: 90 to 260 Vac nominal (auto-ranging). Frequency range: 47 to 63 Hz. Power: 250 VA.
Environmental	Operating temperature: 10 to 40 oC (50 to 104 oF) Storage temperature: -20 to 70 oC (-4 to 158 oF). Humidity: 15% to 90% relative humidity at 40°C (104 oF).
Dimensions (height x width x depth)	Maximum dimensions including handle: 300 mm x 365 mm x 450 mm (11.75" x 14.5" x 17.75").
Weight	18 kg (39.7 lbs) up to 2.5 Gb/s 19.5 kg (43 lbs) up to 10.71 Gb/s
Warranty	1-year as standard. Extended warranty period to 3-years available. Extended warranty period to 5-years available.
Calibration cycle	2-years.

Regulatory standards	
EMC	Complies with: <ul style="list-style-type: none"> EMC Directive 89/336/EEC. Australian EMC Framework Act 1992. ICES/NMB-001. Meets: <ul style="list-style-type: none"> EN 55011:1991 Group 1, Class A. EN 50082-1:1992.
Electrical safety	Complies with: <ul style="list-style-type: none"> Low Voltage Directive 73/23/EEC. Meets: <ul style="list-style-type: none"> EN 61010-1:1993. IEC 61010-1 (2001 - 02). CSA C22.2 No. 1010.1-92.
Laser safety	Meets: <ul style="list-style-type: none"> EN 60825-1:1994 Class I. IEC 60825-1 (1993) Class I. 21 CFR Chapter 1 1040-2 Class 1.

The OmniBER OTN is
Class 1 laser product
EN60825-1: (1994)
IEC60825-1: (1993)

Class 1 laser product
FDA 23 CER CH.1 1040.10: (1994)



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Agilent Technologies manufactures the OmniBER OTN family under a quality system approved to the international standard ISO 9001 plus TickIT (BSI Registration Certificate No FM 10987).

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Product literature

You'll find ordering details for the OmniBER OTN J7232A and J7230B in the product configuration guides at www.agilent.com/comms/otn

Related products

OmniBER OTN Family

The OmniBER OTN family is the industry's most comprehensive solution for testing ITU-T G.709 optical channel and SONET/SDH devices. Equipped with all standard telecom rates from 1.5 Mb/s to 10 Gb/s, 2.66 Gb/s (OTU-1), and 10.71 Gb/s (OTU-2) optical channel, the OmniBER OTN keeps you at the cutting-edge of next generation transport applications. For more information refer to publication no. 5988-6646EN, or www.agilent.com/comms/otn

OmniBER XM Network Simulator

The Agilent OmniBER XM network simulator offers fast and thorough system verification test (SVT) to accelerate the time to market of next-generation SONET/SDH network equipment. With multi-channel, multi-port, multi-rate and multi-user capability, the OmniBER XM can generate (in terminate or intrusive-thru mode) realistic network signals using mixed payloads, with errors and alarms, on up to 192 STS-1/AU-3 channels or up to 1344 VT1.5/TU-11 channels simultaneously. This replicates real network conditions to truly stress-test network elements, and increases the effectiveness of verification test. The OmniBER XM also simultaneously measures each channel for errors, alarms, APS switching durations, and correct connectivity, reducing test times and uncovering all performance issues. For more information, refer to www.agilent.com/find/omniberxm

RouterTester 900

The RouterTester 900 E7880A Traffic Generation and Analysis application excels for testing layer 2 and 3 devices that are used in enterprise, metro/edge and core networks. Combined with the new 10/100 Ethernet and GbE PacketTest Cards, this flexible "packet blaster" offers a cost-effective solution for performing Ethernet traffic testing on switches, routers, next generation SONET/SDH Multi-Service Provisioning Platforms and many other devices. For more information refer to publication no 5988-9860EN.

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