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OmniBER OTN 10G J7230A communications performance analyzer

Technical specifications

Effective 1st March 2003



G.709

Agilent Technologies

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Table of Contents

Introduction ***4***
- Summary of capability 4
- SmartTest 5
- Signal Wizard 5
- OTN testing (ITU-T G.709) 6
- SONET/SDH testing 6
- Modes of Operation 7
- DSn/PDH testing 8
- Additional measurements 8
- Instrument Tour 9

OmniBER OTN (J7230A) Technical Specifications ***11***
- Test interfaces (rates, wavelengths, connectors, line codes) 11
- Optical transmitters 13
- Optical receivers 13
- SONET/SDH Electrical interfaces (Supplied with J7230A-104, 105 and 106) 14
- DSn/PDH Electrical interfaces (requires J7230A-012) 14
- Clock Synchronization (inputs, outputs, line frequency offset) 15

Signal Structures, Mappings and Payloads ***16***
- OTN mappings 16
- SONET mappings 16
- SDH mappings 17
- Mixed Mappings Generation (requires J7230A-510) 18
- DSn/PDH frame formats and channel structures (requires J7230A-012) 19
- Test patterns 19

Measurements ***20***
- Error measurements 20
- Alarm detection and measurement 21
- Additional measurements 22
- SignalWizard (all-channel testing) 23
- SignalWizard (continued) 24

Error and Alarm Generation ***25***
- Error generation 25
- Error generation (continued) 26
- Alarm generation 27

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Table of Contents (contd)

OTN, SONET and SDH Overhead Testing ***28***
OTN Overhead Testing 28
SONET/SDH overhead testing 30
SONET/SDH pointer adjustment control 32
Event Triggers Outputs - OTN/SONET/SDH 33
Trigger Output Port for OTN/SONET/SDH 35
GCC/DCC Drop/Insert 36

Payload Drop/Insert capabilities *(requires J7230A-012)* ***37***

Thru-mode testing ***38***

DSn/PDH Testing *(requires J7230A-012)* ***39***
DS1 loopcodes and DS3 FEAC messages 39
PDH spare-bits testing 39
Signaling-bits testing 39

General features ***40***

General specifications ***41***

Regulatory standards ***42***

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Introduction

Agilent Technologies' new OmniBER OTN is not only a powerful SONET/SDH tester, it's ideal for testing devices and modules for the ITU-T G.709 optical transport network (OTN) too. Equipped with all line rates from 1.5 Mb/s to 10 Gb/s, 10.71 Gb/s (OTU2) and 2.66 Gb/s (OTU1), plus a rich feature set tailored for design and verification applications, OmniBER OTN will help you get your new products to market fast.

OmniBER OTN's extensive capabilities will help you to ensure that your new products meet the stringent requirements set out in the latest standards. What's more, Agilent's all-channel monitoring technology lets you simultaneously monitor all STS/AU channels (up to 192) in a received SONET or SDH line signal, continuously, for fast problem resolution and efficient verification of new 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.

Summary of capability

Model	Optical Interface Rates	Electrical Interface Rates
OmniBER OTN	OTU2 / 1 OC-1 / 3 / 12 / 48 / 192 STM-0 / 1 / 4 / 16 / 64	STS-1 / 3, STM-0 / 1, DS1 (1.5 Mb/s), DS3 (45 Mb/s), 2 / 8 / 34 / 140 Mb/s

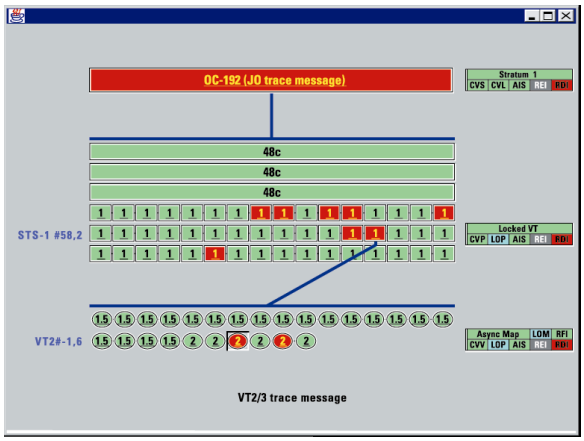
- ITU-T G.709 OTU2 (10.71 Gb/s) testing – *Optional*
- ITU-T G.709 OTU1 (2.66 Gb/s) testing – *Optional*
- Global test coverage (SONET and SDH)
- Unframed/framed testing at all rates
- Fully integrated all-rate testing: 52 Mb/s to 10.71 Gb/s optical and 1.5 to 140 Mb/s electrical
- Full range of standard and concatenated mappings
- STS-6c, 9c and 24c and AU4- 2c, 3c and 8c – *Optional*
- Generation of mixed mappings – *Optional*
- Powerful overhead testing
- Alarm stress test
- Sequence generation and capture
- SONET/SDH entire overhead capture
- OTN frame capture – *Optional*
- Transmit and receive output triggers for error and alarm events
- All standard error and alarm measurements, plus optical power, line frequency, service disruption time and 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

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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
- Optical Power measurement
- Frequency measurement
- Trouble scan
- Overhead monitor
- Pointer graph

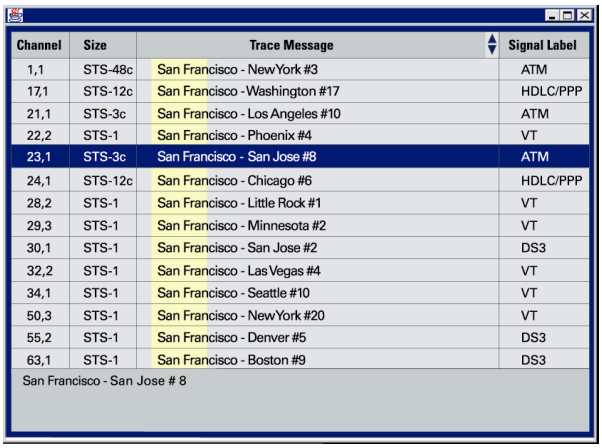


Error and alarm status clearly presented for each detected STS/AU channel, and for all VT/TU channels in a selected STS/AU.

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 two simple key presses, Signal Wizard automatically:-

- Discovers the STS/AU channel structure of a valid OC-n/STM-n signal, including any 'mix' of standard and concatenated channels.
- 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.



Channel	Size	Trace Message	Signal Label
1,1	STS-48c	San Francisco - NewYork #3	ATM
17,1	STS-12c	San Francisco - Washington #17	HDLC/PPP
21,1	STS-3c	San Francisco - Los Angeles #10	ATM
22,2	STS-1	San Francisco - Phoenix #4	VT
23,1	STS-3c	San Francisco - San Jose #8	ATM
24,1	STS-12c	San Francisco - Chicago #6	HDLC/PPP
28,2	STS-1	San Francisco - Little Rock #1	VT
29,3	STS-1	San Francisco - Minnesota #2	VT
30,1	STS-1	San Francisco - San Jose #2	DS3
32,2	STS-1	San Francisco - Las Vegas #4	VT
34,1	STS-1	San Francisco - Seattle #10	VT
50,3	STS-1	San Francisco - NewYork #20	VT
55,2	STS-1	San Francisco - Denver #5	DS3
63,1	STS-1	San Francisco - Boston #9	DS3

San Francisco - San Jose # 8

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

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OTN testing (ITU-T G.709)

The OTN test capability allows detailed testing of OTU2 (10.71 Gb/s) and OTU1 (2.66 Gb/s) signals with mapped SONET/SDH payload or test signal mapping.

- Framed/unframed testing at 10.71 and 2.66 Gb/s
- OTN error and alarm generation and detection
- Add correctable and uncorrectable FEC errors
- Measure correctable FEC errors and uncorrectable blocks
- Setup and monitor for all overhead bytes
- Alarm stress testing with 'p', 'n' and 'm' sequences
- Overhead sequence generation and capture
- Frame capture (overhead, payload and FEC blocks)
- Transmit and receive error and alarm event trigger outputs
- Synchronous and asynchronous mapping of SONET/SDH
- Drop-Insert of GCC channels

SONET/SDH testing

The SONET/SDH test capability allows comprehensive testing of synchronous networks with the following interface rates: 10 Gb/s, 2.5 G/s, 622 Mb/s, 155 Mb/s and 52 Mb/s. Supported functionality includes:

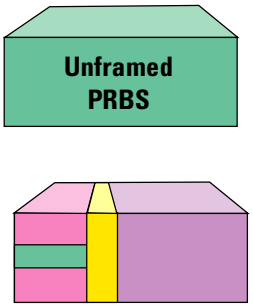
- Framed/unframed testing at all rates
- SONET/SDH error and alarm generation and detection
- Mixed mappings generation
- Setup and monitor for all overhead bytes
- Alarm stress testing with 'p', 'n' and 'm' sequences
- Overhead sequence generation and capture
- Entire overhead capture (no payload capture)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

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Modes of Operation

The OmniBER OTN has different modes of operation as illustrated in the following diagrams.

SONET/SDH (all rates)



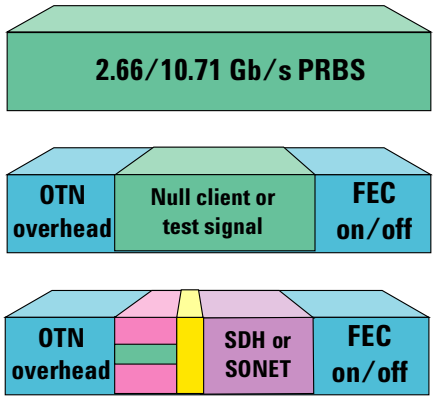
For SDH and SONET rates, the instrument operates in either unframed or framed mode.

In unframed mode, the instrument tests using a prbs at any standard line rate from 52Mb/s to 10Gb/s.

Alternatively, with framed mode selected, the OmniBER OTN generates and measures framed and structured signals conforming to Telcordia GR-253 or ITU-T G.707.

When testing OTN equipment, the following modes of operation can be used in the OmniBER OTN.

OTU1 & 2



In unframed mode, the instrument tests using a prbs at either 2.66 or 10.71 Gb/s.

Alternatively, with framed mode selected, the OmniBER OTN generates and measures framed and structured signals conforming to ITU-T G.709.

The payload mapped into the OTUk signal can be easily selected from the following choices:

- Test signal
- Null Client
- SONET/SDH synchronous
- SONET/SDH asynchronous

With framed OTUk signals, the instrument can also enable/disable FEC checking independently on the transmitter and receiver.

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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
- Round trip delay

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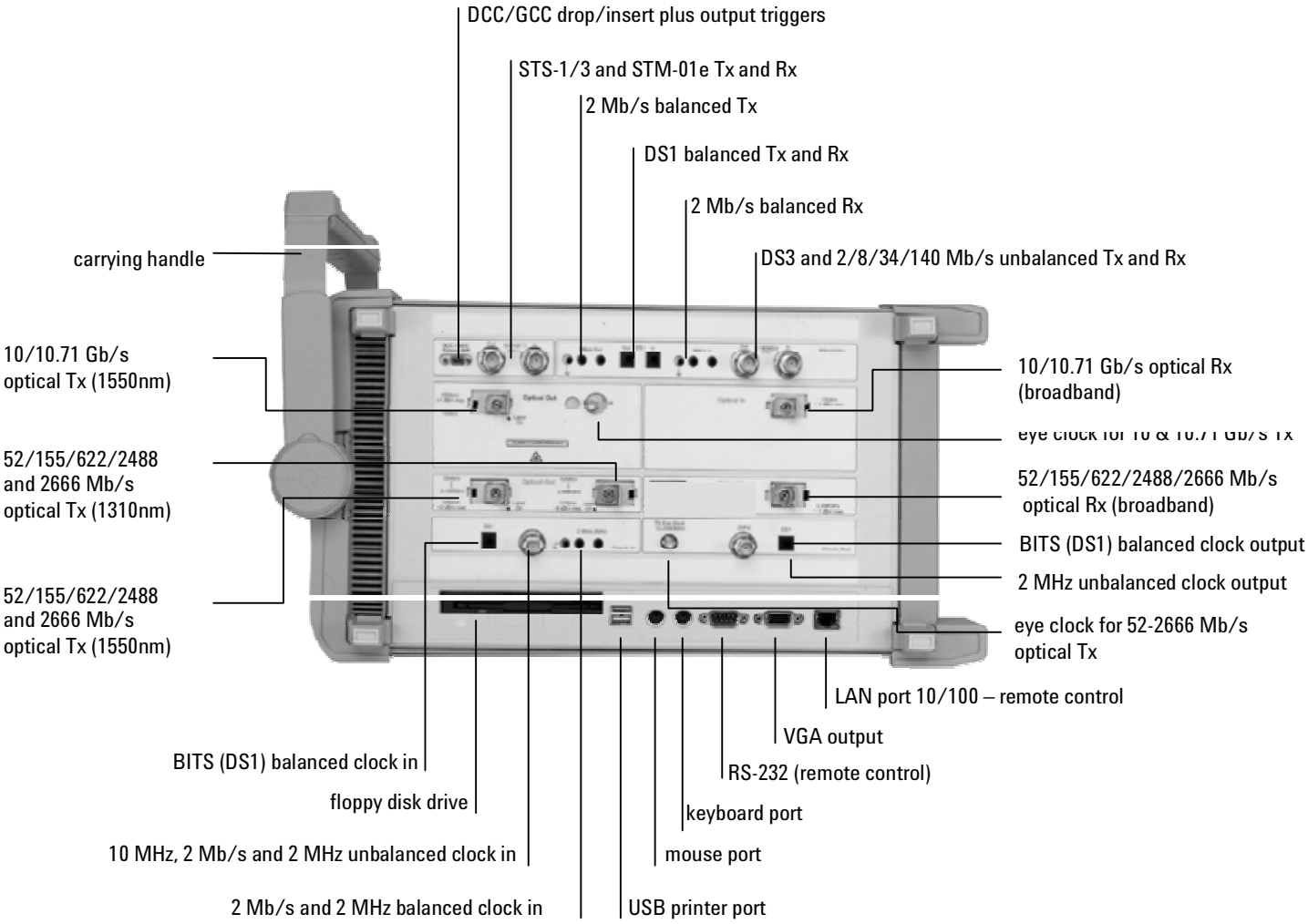
Instrument Tour





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Instrument Tour (continued)



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OmniBER OTN (J7230A) Technical Specifications

The following specification provides details on the OmniBER OTN (J7230A) transmission test set, including all standard options.

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

Optical	Line rates	
	Framed	OTU2/1 OC-1/3/12/48/192 STM-0/1/4/16/64
	Unframed	10.71/9.95/2.66/2.48 Gb/s 622/155/52 Mb/s
	Wavelength (≤ 2.5 Gb/s)	
	J7230A-104	1310 nm
	J7230A-105	1550 nm
	J7230A-106	1310/1550 nm
	Wavelength (10 Gb/s)	
	J7230A-108	1550 nm
	Wavelength (10/10.71 Gb/s)	
	J7230A-110	1550 nm
	Connectors	
	J7230A-609	FC/PC
	J7230A-610	SC
	J7230A-611	ST
	Line code	NRZ
SONET/SDH Electrical Supplied with J7230A-104, J7230A-105 and J7230A-106	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

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PDH/DSn Electrical (Requires J7230A-012)	Line rates	DS1, DS3; 2/8/34/140 Mb/s
	Connectors DS1 DS3 2 Mb/s 8/34/140 Mb/s	 Bantam (100 Ω, balanced) BNC (75 Ω, unbalanced) BNC (75 Ω, unbalanced); 3-pin Siemens (120 Ω, balanced) BNC (75 Ω, unbalanced)
	Line Code DS1 DS3 2/8/34 Mb/s 140 Mb/s	 B8ZS, AMI B3ZS HDB3 CMI

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Optical transmitters

	52Mb/s – 2.66Gb/s	10Gb/s	10.71Gb/s
Line Code	NRZ	NRZ	NRZ
Wavelength			
1310nm	1260-1360nm	-	-
1550nm	1500-1580nm	1530-1565nm	1530-1565nm
Output Power			
1310nm	-5 to 0dBm (-2.5dBm typical)	-	-
1550nm	-2 to +3dBm (0.5dBm typical)	-5 to –1dBm	-5 to –1dBm
Spectral Width (-20dB)	<1.0nm	<1.0nm	<1.0nm
Extinction Ratio	>8.2dB	>8.2dB	>8.2dB
Pulse Mask	Meets ITU-T G.957 (6/1999) and Telcordia GR-253-CORE issue 3 (9/2000) Note: For 10/10.71 Gb/s a scaled OC-48/STM-16 mask used		
Fiber Type	Single mode	Single mode	Single mode
Laser Safety	See "Regulatory Standards" section for details		

Optical receivers

	52Mb/s & 155Mb/s	622Mb/s	2.5Gb/s & 2.66Gb/s	10Gb/s	10.71Gb/s
Line Code	NRZ	NRZ	NRZ	NRZ	NRZ
Wavelength	1200-1600nm	1200-1600nm	1200-1600nm	1310nm or 1550nm nom	1310nm or 1550nm nom
Min. Sensitivity(1)	<-34dBm	<-28dBm	<-28dBm @2.5 Gb/s <-26dBm @2.66 Gb/s	<-14dBm @1550nm <-11dBm @1310nm	<-14dBm @1550nm <-11dBm @1310nm
Max. Input Power(1)	>-10dBm	>-9dBm	>-9dBm	>-1dBm	>-1dBm
Damage Input Power	>+3dBm	>+3dBm	>+3dBm	>+3dBm	>+3dBm
Fiber Type	Multi mode	Multi mode	Multi mode	Single mode	Single mode

Notes:
1. 52-2488 Mb/s: For BER = 1 x 10^{-10} (input signal extinction ratio >= 8.2 dB).
2. 10 & 10.71 Gb/s: For BER = 1 x 10^{-12} (input signal extinction ratio >= 8.2 dB).

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SONET/SDH Electrical interfaces (supplied with J7230A-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, ± 10%. STS-3/STM-1e: ± 0.5 Vpk, ± 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 J7230A-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.

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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 3-pin Siemens (120 Ω balanced) 10 MHz: BNC (75 Ω unbalanced) **Loop-timed**: Transmitter timed by a clock recovered from the receiver.
Frequency offset	Offsets the transmitted line signal relative to the selected clock reference. **All rates up to and including 2.66Gb/s:** ± 100 ppm in 0.1 ppm step. **10 & 10.71Gb/s:** ± 90 ppm in 0.1 ppm step **Offset accuracy:** 0.02 ppm **Note:** For 10 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 (100Ω balanced). MTS (2 MHz): BNC (75Ω unbalanced).
Eye clock outputs	Clock outputs that are frequency locked to the transmitted optical line signal. **Rate**: 52/155/622 Mb/s, 2.5 Gb/s and 2.66 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.

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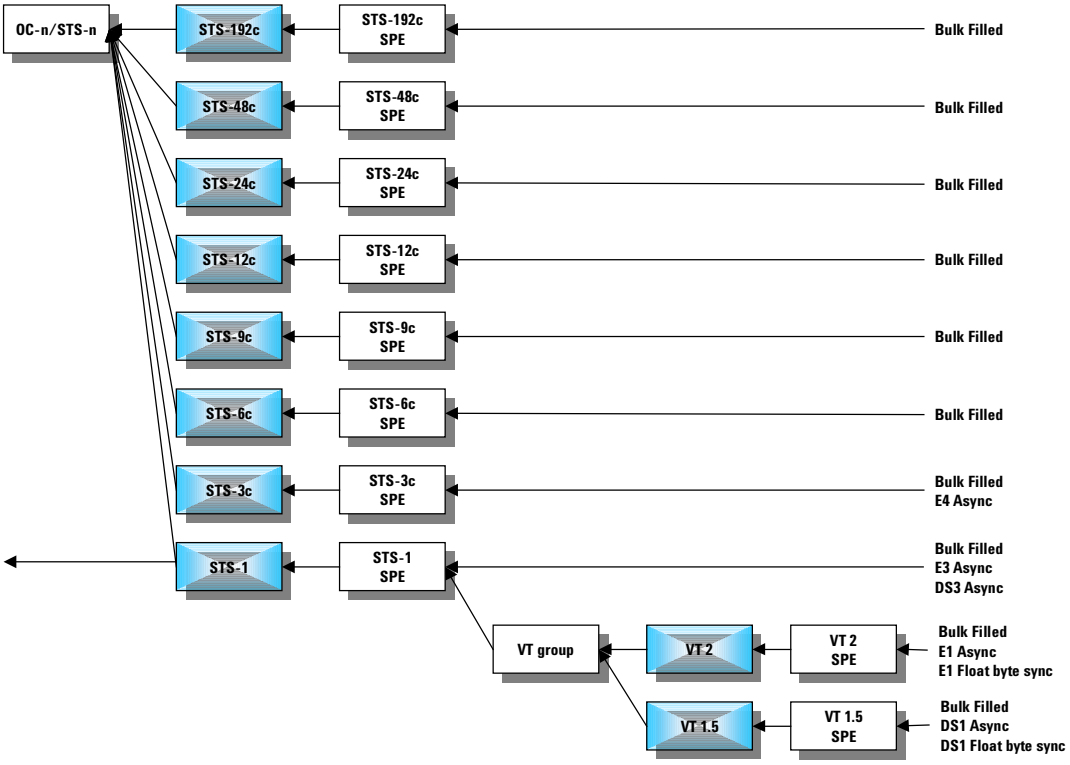
Signal Structures, Mappings and Payloads

OTN mappings

Synchronous and asynchronous mapping of 10 and 2.5 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

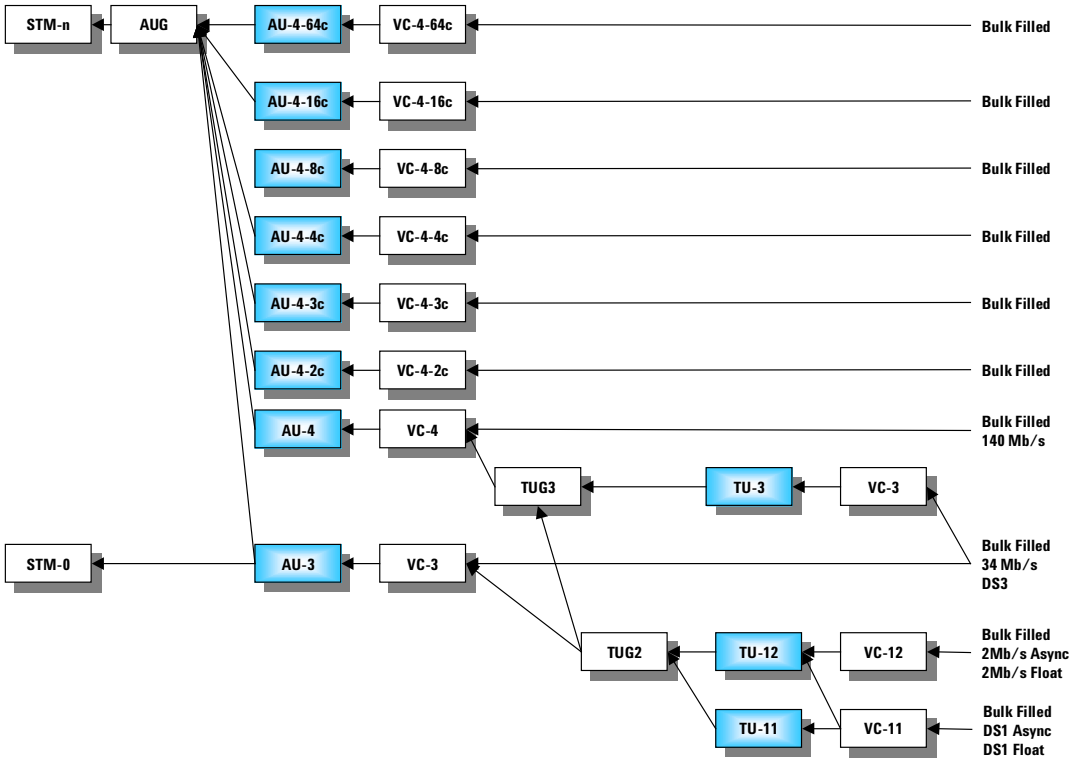
Bulk VT, STS-1, STS-3c, 12c, 48c and 192c mappings supplied as standard.
STS-6c, 9c and 24c mappings supplied with J7230A-510
DSn/En service payload testing supplied with the J7230A-012.



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SDH mappings

Bulk TU, C-3, C-4, C-4-4c, 16c and 64c mappings supplied as standard.
VC-4-2c, 3c and 8c mappings supplied with J7230A-510
DSn/En service payload testing supplied with the J7230A-012.

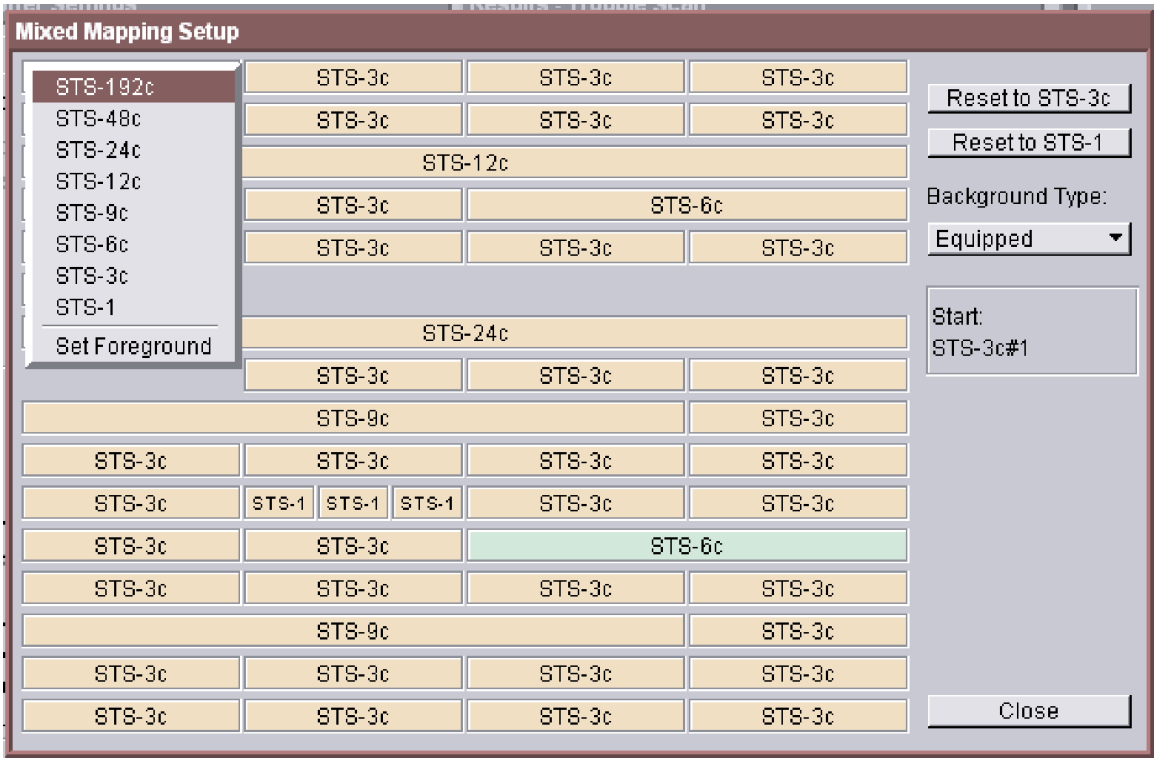


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Mixed Mappings Generation (requires J7230A-510)

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

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



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DSn/PDH frame formats and channel structures (requires J7230A-012)

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), $2^{23}-1$, $2^{31}-1$ (3). **Polarity control**: Inverted, non-inverted.
Word	All 1s, All 0s, 1010, 1000, 16-bit word. Note: Word not available in unframed mode
Additional DS1 patterns (requires J7230A-012)	3-in-24, 1-in-8, 2-in-8, 55-octet (Daly).

Notes:
1. Not provided for OTU2 or STS-192c/C-4-64c bulk payloads.
2. Non-inverted only. Provided for DSn signals (including 56/64 kb/s channel testing) and VT1.5 bulk payloads by J7230A-012.
3. Not available for unscrambled OTU2 or unframed 10.71Gb/s test signals

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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.
OTN (requires J7230A-111 for OTU1 measurements, J7230A-112 for OTU2 measurements)	**OTU1/2:** Frame (OA1,OA2), MFAS, SM BIP-8, SM BEI, corrected FEC errors, uncorrectable FEC blocks **ODU1/2:** PM BIP-8, PM BEI **Payload:** Bit
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. **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 **Tandem path** (VC-3/4 and VC-4-Nc): IEC, TC-REI, OEI, TC-ERR **LO-path**: B3 (VC-3), BIP-2; LP-REI **Tandem path** (VC-11/12): TC-REI,OEI,N2-BIP, TC-ERR **Bulk payload**: Bit. **Signal**: Code (STM-0e and STM-1e interfaces).
DSn (requires J7230A-012)	**DS1**: BPV, frame, CRC6, bit. **DS3**: BPV, frame, P-bit, CP-bit, FEBE, bit.
PDH (En) (requires J7230A-012)	**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.

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Alarm detection and measurement

Results	Alarm seconds provided for all supported alarms.
Alarm LEDs	**Front panel LEDs**: **Red/green:** Signal, frame (all levels of framing), errors (any error type), pattern. **Red:** OTN (any OTN alarm), SONET/SDH (any SONET/SDH alarm), DSn/PDH (any DSn 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.
OTN	**Physical:** LOS **OTU1/OTU2:** LOF, OOF, OOM, LOM, AIS, IAE, BDI **ODU1/ODU2:** AIS, OCI, LCK, BDI **Payload:** Pattern loss **Other:** Clock loss, power loss
SONET	**Physical**: LOS **Transport O/H**: LOF, SEF, J0-TIM, AIS-L, RDI-L, K1/K2 change. **Path O/H**: J1-TIM, AIS-P, AIS-C, LOP-P, LOP-C, RDI-P, RDI-P-P, RDI-P-C, RDI-P-S, UNEQ-P, STS pointer change, PDI-P **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. **Payload**: Pattern loss. **Other**: Clock loss, power loss.
SDH	**Physical**: LOS. **Section O/H**: LOF, OOF, J0-TIM, MS-AIS, MS-RDI, K1/K2 change. **Path O/H**: J1-TIM, 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 and 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. **Payload**: Pattern loss **Other**: Clock loss, power loss
DSn (requires J7230A-012)	**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.
PDH (En) (requires J7230A-012)	**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.

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Additional measurements

Optical power	Supported for all optical receive rates. **Ranges**: 10/10.71 Gb/s: -1dBm to –19 dBm. 2.5/2.66 Gb/s: 0 dBm to –28 dBm. 622 Mb/s and below: 0 dBm to –30 dBm. **Accuracy**: 10/10.71 Gb/s: ± 1.5 dB. 2.5/2.66 Gb/s: ± 2 dB. 622 Mb/s and below: ± 1 dB. **Resolution**: 0.1 dB.
Line frequency	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, 2.66 and 10 Gb/s). Offset: 0.1 ppm.
Pointer measurements	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).
Service disruption	Measures the duration of an error burst detected in the received test pattern (not available for word patterns). Supported for OTN (with test signal mapping and SONET/SDH payload) and all SONET/SDH mappings (including concatenated) and DSn/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)**: OTN: 25µs SONET/SDH: 250 µs STS/AU Pointer: 500 µs H4 multiframe (VT/TU): 1000 µs VT/TU Pointer: 2000 µs
Round trip delay	*Round trip delay measurement. Supported for all DSn and PDH signals, both as a line signal and as a mapped payload in SONET/SDH.* ***Range**: 0 to 1999.999 ms.* ***Resolution**: 1 µs.*

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SignalWizard (all-channel testing)

Line rates	**OTN:** OTU1/2 **SONET:** OC-1/3/12/48/192, STS-1/3 **SDH:** STM-0/1/4/16/64o, STM-0/1e
Channel sizes	Supports detection and simultaneous monitoring of any 'mix' of the following channel types: **OTN:** OPU1/2 **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.

Signal discovery and monitoring	▪ For OTU2 signals the decoded value of the PT (payload type) byte is displayed. If the payload type is null or prbs test signal the instrument receiver is set to the appropriate test pattern. If the payload type is async or sync OC-192/STM-64, SignalWizard will determine the SONET/SDH signal structure as detailed below
	▪ Discovers the STS/AU channel structure of a received signal.
	▪ Monitors the line signal for:
	  ▪ CV-S (B1), CV-L (B2), CV-LFE (MS-REI) errors.
	  ▪ LOS, LOF, OOF, AIS-L (MS-AIS), RDI-L (MS-RDI).
	  ▪ Signal power/level.
	  ▪ Synchronization status (S1) message.
	  ▪ J0 section trace message.
	▪ Simultaneously monitors each STS/AU channel for:
	  ▪ 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.
	▪ Discovery and simultaneous monitor of all VT/TU channels in a selected STS/AU for:
	  ▪ 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.

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SignalWizard (continued)

STS/AU channel viewer display	Results are clearly presented on a colour-coded graphical display that shows:
	▪ Line rate and power/level of the received signal.
	▪ Status indicators (including history) for each line/section error and alarm.
	▪ Text decode of synchronization status (S1) and J0 section trace.
	▪ For each STS/AU channels:
	  ▪ 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:
	  ▪ 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:
	  ▪ Channel size and channel traffic information (equipped/unequipped).
	  ▪ Aggregated error/alarm status (including history) and pointer activity.
	▪ For a selected VT/TU channel:
	  ▪ Status indicators (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	Overview of received path trace messages:
	▪ 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.
	Search for specified path trace message:
	▪ 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.
	▪ J2 message search is performed on:
	  ▪ 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	Tabular display that lists for each STS/AU channel in the received signal: ▪ Channel number. ▪ Channel size/type. ▪ The payload mapping being carried. ▪ J1 path trace message. Tabular display that lists for each VT/TU channel in a selected STS/AU: ▪ Channel number. ▪ Channel size/type. ▪ The payload mapping being carried. ▪ J2 path trace message.

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Error and Alarm Generation

Error generation

OTN	**Physical:** Entire frame [1] **OTU1/OTU2:** Frame (OA1,OA2), MFAS, BIP-8, BEI, correctable FEC errors, uncorrectable FEC blocks **ODU1/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],
SONET	**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) **VT path**: CV-V (V5), CV-VFE (REI-V). **Signal**: BPV (STS-1). **DSn/En payload**: See DSn and PDH (En) error add for details. **Bulk 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], N-in-4[5], N-in-T[6].
SDH	**Physical**: Entire frame [1] **Section O/H**: Frame (A1A2), B1 BIP, B2 BIP , MS-REI.[2] **Path O/H**: B3 BIP, HP-REI **LO-path**: B3 (VC-3), BIP-2 (VC-1/2); LP-REI. **Tandem path** (VC-3/4 and VC-4-Nc): IEC, TC-REI, OEI. (VC-11/12): TC-REI, TC-OEI, N2-BIP. **PDH/DSn payload**: See PDH and DSn error add for details. **Bulk 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], N-in-4 [5], N-in-T [6][7]

Notes:

1. Errors added after scrambling (and also after FEC calculation for OTN) to simulate transmission errors
2. For OC-192/STM-64, supports both the 'M1 only' and 'M0+M1' options of the standards.
3. Not supported for data, frame, MFAS BPV/code, FEC block or bit.
4. 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.
5. Supported for frame (A1A2) errors. N = 1 to 4.
6. 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).
7. 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).

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Error generation (continued)

DSn (requires J7230A-012)	**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]
PDH (En) (requires J7230A-012)	**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].

8. Not available when signal is a mapped payload in SONET/SDH or a channel within a higher rate DSn/PDH signal.
9. Single burst of 3 to 16 zeros (user selectable) transmitted without line coding.
10. Supported for DS3 frame, DS3 MFAS and PDH frame errors. N = 1 to 4.
11. Supported for DS1 frame errors. N = 1 to 6.

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Alarm generation

Alarm control	On/Off/Stress **On/Off:** The alarm is turned on or off **Stress sequence:** 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. **Pulse:** The alarm condition can be transmitted for a user defined number of consecutive frames. **Single:** OOF only – A single instance of OOF generated as per ITU-T /Telcordia recommendations **Note:** Stess testing available for OTN, SONET and SDH alarm testing, excluding VT/TU alarms. LOS stress test only available at 10/10.71 Gb/s
OTN	**Physical:** LOS **OTU1 & 2:** LOF, OOF, OOM, AIS, IAE, BDI **ODU1 & 2:** AIS, OCI, LCK, BDI
SONET	**Physical**: LOS. **Transport O/H**: LOF, SEF, J0-TIM, AIS-L, RDI-L. **Path O/H**: J1-TIM, 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.
SDH	**Physical**: LOS. **Section O/H**: LOF, OOF, J0-TIM, MS-AIS, MS-RDI. **Path O/H**: J1-TIM, AU-AIS, AU-LOP, HP-RDI, HP-RDI-P, HP-RDI-C, HP, RDI-S, HP-UNEQ. **LO-path**: H4-LOM, TU-AIS, TU-LOP, LP-RDI, LP-RFI, LP-UNEQ. **Tandem path:** (VC-3/4 and VC-4-Nc): TC-OOM, VC-AIS, TC-IAIS, TC-RDI, ODI, TC-UNEQ. (VC-11/12): TC-RDI, TC-ODI, VC-AIS, TC-UNEQ.
DSn (requires J7230A-012)	**DS1**: LOS, LOF, AIS, RAI. **DS3**: LOS, LOF, AIS, RAI, idle.
PDH (En) (requires J7230A-012)	**2 Mb/s**: LOS, LOF, LOMF, AIS, RDI, RDI (MF), minor alarm. **8 /34/140 Mb/s**: LOS, LOF, AIS, RDI, minor alarm.

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OTN, SONET and SDH 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 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).

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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 excluding JC, NJO , PJO **Trigger value:** User definable Capture is triggered when user defined value is • 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:** • 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: • 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 • Centred – 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 setup and monitoring of the SM and PM TTI message

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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-1group, plus all STS-path/HO-path and VT path/LO-path overhead bytes. Received 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). This sequence can be 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
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:** 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 **Trigger value:** User definable Capture is triggered when user defined value is • 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:** • 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.

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Entire Overhead Capture	6 complete frames of overhead are captured. **Overhead selection:** • SOH+LOH / RSOH+MSOH or • STS/POH **Trigger selection:** • Manual – 6 frames after the manual trigger are captured • Pre-trigger – 6 frames up to and including the trigger frame are captured • Post-trigger – The trigger frame plus 5 following frames are captured • Centred – 3 frames before the trigger frame, the trigger frame and the next 2 frames are captured **Capture Triggers:** Entire overhead capture can be triggered on receive triggers as detailed in "Event Trigger Outputs"
APS/MSP messages (K1K2)	Text-based setup and monitoring of APS/MSP messages. **Linear**: Messages comply with Telcordia GR-253-CORE Issue 3 and ITU-T G.783. **Ring**: Messages comply with Telcordia GR-1230 and ITU-T G.841.
Active APS Test	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. The K1/K2 response is sent if the received value persists for 3 frames. **NOTE:** Only available when 1:N architecture is selected **Operating Modes**: • Unidirectional • Bidirectional Emulation response time: 10ms
Trace messages (J0, J1, J2, TC-APId)	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)*. **Message formats**: J0/J1/J2: Selectable as 16-byte or 64-byte format. TC-APId (SDH only): 16-byte format. **Trace Identifier Mismatch Alarm (TIM)**: Generation and detection of J0 and J1 TIM
Synchronization status message (S1)	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).
Signal labels (C2, V5)	Text-based setup and monitoring of payload signal labels (both STS path/HO-path and VT path/LO-path). Signal labels comply with Telcordia GR-253-CORE Issue 3 and ITU-T G.707 (04/00 draft).

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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.

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

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Event Triggers Outputs - OTN/SONET/SDH

OTN transmit triggers	**Source:** LOS – available with alarm stress 'Pulse' mode **OTU1/2:** LOF, OOF, LOM, OOM, AIS, IAE, BDI, **ODU1/2:** AIS, OCI, LCK, BDI, **Format:** Level **Source:** Start of frame, entire frame error add, frame error (OA1,OA2), MFAS **OTU1/2:** BIP8, BEI **ODU1/2:** SM BIP8, SM BEI, FEC Block error, bit **Format:** Pulse
OTN receive triggers	**Source:** **OTU1/2:** LOF, OOF, AIS, IAE, BDI **ODU1/2:** AIS, OCI, LCK, BDI **Format:** Level **Source:** Start of frame, frame error (OA1,OA2), MFAS **OTU1/2**: BIP8, BEI **ODU1/2:** BIP8, BEI FEC Block error, bit **Format:** Pulse ***Note:*** *All of the above triggers are selectable for frame capture*
SONET transmit triggers	**Physical:** LOS – available with alarm stress 'Pulse' mode **Transport O/H:** LOF, SEF, AIS-L, RDI-L **Path O/H:** AIS-P, AIS-C, LOP-P, LOP-C, RDI-P, UNEQ-P, **Format:** Level **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
SONET receive triggers	**Transport O/H:** LOF*, SEF*, AIS-L, RDI-L **Path O/H:** LOP-P**, LOP-C**, AIS-P**, AIS-C**, RDI-P, UNEQ-P, PDI-P **Format:** Level **Transport O/H:** Start of frame, frame error, CV-S(B1), CV-L(B2), REI-L (CV-LFE), STS pointer change, K1/K2 change **Path O/H:** CV-P(B3), REI-P (CV-PFE) **Payload:** Bit **Format:** Pulse ***Note:*** *TOH event triggers are selectable for TOH frame capture.* *STS event triggers are selectable for STS-Path capture.* * *Trigger not available at OC-48 rate* ** *Trigger not available for Entire Overhead Capture*

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SDH transmit triggers	**Physical:** LOS – available with alarm stress 'Pulse' mode **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 **Format:** Level **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
SDH receive triggers	**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 **Format:** Level **Section O/H:** Start of frame, frame error (A1,A2), B1 BIP, B2 BIP, MS-REI, , AU-3/4 pointer change, K1/K2 change **Path O/H:** B3 BIP, HP-REI **Tandem Path:** IEC, TC-REI, OEI, TC-ERR **Payload:** Bit **Format:** Pulse ***Note:*** *RSOH and MSOH event triggers are selectable for RSOH+MSOH frame capture.* *POH event triggers are selectable for POH capture.* * *Trigger not available at STM-16 rate* ** *Trigger not available for Entire Overhead Capture*

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Trigger Output Port for OTN/SONET/SDH

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Connector	9-pin micro D-type.
Accessory cable	An accessory adapter cable is supplied with every instrument. This cable converts the output from the 9-pin miniature D-type to two 50 Ohm BNC (m) connectors for Tx and Rx output triggers.
Output level (alarms)	Logic '1' = 2.3V typical, 1.85V min Logic '0' = 0.8V typical, 1.05V max
Pulse width (errors)	10us Nominal
Trigger position	The trigger level/pulse is output as soon as the alarm/error condition is set/detected, that is when the relevant byte is transmitted/received and not at the start/end of the frame.
Trigger output delay	Transmitter: The trigger output level/pulse will always be output *before* the data on the output. Maximum lead time 25us Receiver: The trigger output level/pulse will always be output *after* the data on the receiver input. Maximum delay time 25us

Connector: Uses DCC/GCC port*		
Pin No.	Input/Output	Triggers
1	O	Tx Trigger (+)
2	O	Rx Trigger (+)
3	O	GND
4	O	Fixed level
5	I	Not used
6	O	Tx Trigger (-)
7	O	Rx Trigger (-)
8	O	Fixed level
9	I	Not used
* An adapter cable (micro D-type to dual BNC) is supplied as standard with the instrument		

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GCC/DCC Drop/Insert

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

Connector	9-pin micro 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 per channel at OTU2 rate, 326.7 kb/s per channel at OTU1 rate
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	100 Ω 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 (-)

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Payload Drop/Insert capabilities (requires J7230A-012)

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 120 Ω balanced test ports (3-pin Siemens connectors)	

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Thru-mode testing

OTN	**Rates:** OTU1/2 **Transparent:** Receive signal passes unaltered through test set. All receiver test facilities are available.
SONET/SDH	**Rates**: **SONET:** OC-1, OC-3, OC-12, OC-48, OC-192, STS-1*, STS-3*. **SDH:** STM-0o, STM-1o, STM-4o, STM-16o, STM-64o, STM-0e*, STM-1e*. **Requires option 104 or 105 or 106* **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
DSn (requires J7230A-012)	Receive signal passes unaltered through test set. All receiver test facilities are available. **Rates**: DS1, DS3.

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DSn/PDH Testing (requires J7230A-012)

DS1 loopcodes and DS3 FEAC messages

DS1 loopcodes	Transmits and monitors both in-band and out-of-band DS1 loopcodes. **In-band:** Line, payload, network, user (selectable in range 3 to 8 bits). Transmit: Selected code transmitted for 8 seconds (nominal). Monitor: Indicates the detection of a selected loop-up and loop-down code. Displays the last valid loopcode received. **Out-of-band:** Line, payload, network, universal, user (11111111 0xxxxxx0). Transmit: Selected code transmitted either continuously or in a burst of n-messages (where n is selectable in the range 1 to 15). Monitor: Displays in decode form the two most recently received loopcodes (current and previous).
DS3 FEAC messages	Applies to DS3 C-bit framed signals. Transmits and monitors loopback and alarm/status codes as per ANSI T1.107-1995. **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). **Alarm/status code transmit**: Transmits any ANSI T1.107-1995 message or any user specified code (0xxxxxx0 11111111), either continuously or in a single burst (selectable in the range 1 to 15). **Monitor:** Displays in decoded form the two most recently received FEAC messages (current and previous).

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

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General features

Help facilities	**On-line user documentation**: Accessed via front panel key. **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. **User-help documention**: 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.
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	The following graphical results are available for display during a measurement: **STS/AU pointer**: Line graph of STS/AU pointer value vs time. **Optical Power:** Line graph of optical power vs time **Errors**: Bar graph for each supported error types vs time. **Alarms**: Line graph for each supported alarm type vs time. **VT/TU pointer**: Line graph of VT/TU pointer address vs time. **Time resolution**: 1-second. **Storage**: Up to 10 sets (or 10 Mbytes in total) of graphical results can be saved in the instrument's non-volatile memory.
Result logging	Supports logging of results during a measurement to a printer, to a file in the instrument's non-volatile memory or to floppy disk. **Logged information**: Instrument settings, time and date, period-results, end-of-measurement results (the results logged are user selectable). **Logging period**: 10-minutes, 1-hour, 24-hours, user-defined (in ranges 10 to 99-minutes; 1 to 99-hours).
Printing	Supports printing of logged results and screen dumps via USB port.
Beep-on-error	Audible beep emitted on detection of any valid error-type. **Control**: Off/on (with user controlled volume).

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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**: Option 004: 0 to 40 °C (32 to 104 °F) Option 005; 0 to 45 °C (32 to 113 °F) **Storage temperature**: -40 to 70 °C (-40 to 158 °F). **Humidity**: 15% to 90% relative humidity at 40 °C (104 °F).
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	15.2 kg (33.5 lbs) (covers all rates 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.

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Regulatory standards

EMC	Complies with: ▪ EMC Directive 89/336/EEC. ▪ Australian EMC Framework Act 1992. ▪ ICES/NMB-001. Meets: ▪ EN 55011:1991 Group 1, Class A. ▪ EN 50082-1:1992.
Electrical safety	Complies with: ▪ Low Voltage Directive 73/23/EEC. Meets: ▪ EN 61010-1:1993. ▪ IEC 61010-1 (2001 – 02). ▪ CSA C22.2 No. 1010.1-92.
Laser safety	Meets: ▪ EN 60825-1:1994 Class I. ▪ IEC 60825-1 (1993) Class I. ▪ 21 CFR Chapter 1 1040-2 Class 1.

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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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