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OmniBER 718 communications performance analyzer

Technical specification



SDH:
STM-16, STM-4, STM-1, STM-0

SONET:
OC-48, OC-12, OC-3, OC-1, STS-3, STS-1

PDH/T-carrier:
2 Mb/s, 8 Mb/s, 34 Mb/s, 140 Mb/s, DS1, DS3

Jitter:
DS1 to STM-16c/OC-48c

ATM:
DS1 to STM-16c/OC-48c

POS:
STM-0/STS-1 to STM-16/OC-48

Agilent Technologies

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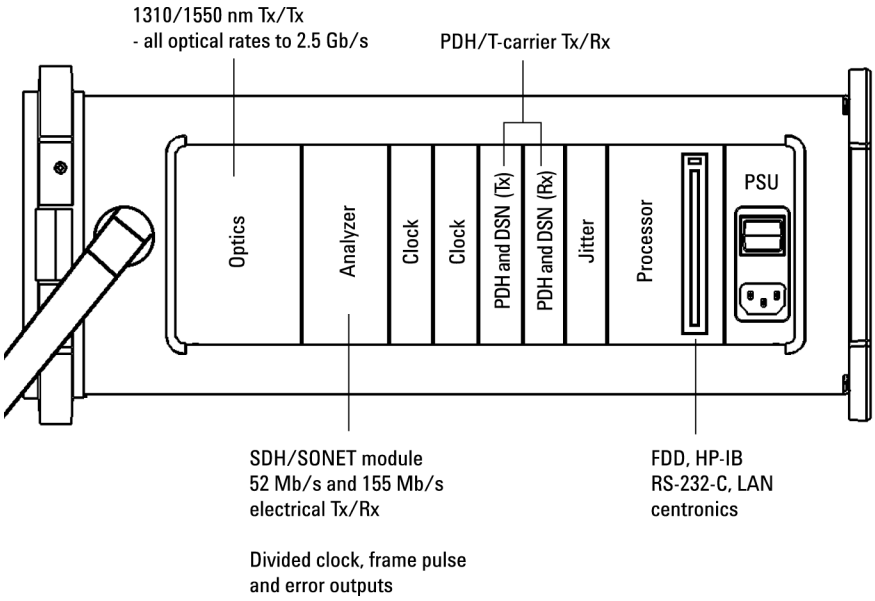
Agilent Technologies OmniBER 718 communications performance analyzer

The Agilent Technologies OmniBER 718 communications performance analyzer offers a single box field portable multi-rate SDH/SONET tester up to 2.5 Gb/s (STM-16/OC-48). The analyzer is ideally suited to installation, maintenance, commissioning, system verification and manufacture of SDH/SONET transport networks and network equipment.

POS and ATM devices can also be tested up to 2.5 Gb/s by simply adding the appropriate payload mapping options. The latest enhancements to the OmniBER 718 analyzer include a choice of instrument variants for multi-rate testing. This new choice allows you to buy the SDH only or SDH/SONET test configuration you need today and upgrade in the future as your testing needs move to higher rates.



Side view



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Summary of capabilities

Model	SDH/SONET rates	Optional PDH/T-carrier
37718A	2.5 Gb/s, 622, 155, 52 Mb/s	2, 8, 34, 140 Mb/s DS1 (1.5 Mb/s), DS3 (45 Mb/s)
37718B	622, 155, 52 Mb/s	2, 8, 34, 140 Mb/s DS1 (1.5 Mb/s), DS3 (45 Mb/s)
37718C	155, 52 Mb/s	2, 8, 34, 140 Mb/s DS1 (1.5 Mb/s), DS3 (45 Mb/s)

Other enhancements added to the latest OmniBER 718 analyzer include:

- Smartsetup autodiscover wizard simultaneously displays all J1 trace identifiers.
- Smartsetup lets you quickly and easily explore right down into the payload of selected SDH/SONET tributaries.
- Full SDH and SONET jitter measurement and generation including DS1 and DS3.
- Real-time analysis of key performance indices MTIE, TDEV, MRTIE
- User-definable jitter tolerance and transfer masks.
- SDH-only or dual standard SONET/SDH configurations available.
- Electrical-only configuration available 155/52 Mb/s testing.
- 2 Mb/s mapped into DS3.
- A telephone jack socket enables talk/listen on 64 kb/s channels carried in higher rate signals.
- ATM payloads available.
- POS payloads available.

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Main features

Smartsetup

Not only is the OmniBER 718 analyzer rugged and portable, its easy-to-use **Smartsetup** and **Smart Tests** simplify and speed up the installation and maintenance of SDH/SONET/ATM networks.

The OmniBER 718 analyzer lets you start testing with just ***two key presses!*** With the analyzer connected to any signal, simply press the **Smart Test** key on the front panel, select **Smartsetup** and the instrument's autodiscover wizard automatically identifies the line rate and payload structure of the unknown input signal. The analyzer also automatically displays all of the J1 trace identifiers, that is 48 J1 identifiers in an OC-48 signal, or 16 in an STM-16 signal. With the signal structure now identified it's a simple process, using the cursor control keys, to select a channel of interest and to explore right down into the payload.

Smart Tests

The front panel Smart Test key offers a simple shortcut to the extensive capabilities of the OmniBER 718 analyzer. The Smart Tests are grouped together in functional blocks so you don't need to be an instrument 'expert' to get tests up and running quickly. Test capability that is accessed with only a couple of key presses include:

- Protection switch time measurement
- Optical power measurement
- Line frequency measurement
- Error and alarm summary results.

Large color display

The color VGA display on the OmniBER 718 analyzer operates in single- or multi-window mode. In multi-window mode, four windows are diplayed allowing simultaneous viewing of transmitter settings, receiver settings, graphical results and text results summary.

A VGA output is provided on the analyzer's front panel for connection to VGA projector for training purposes.

Protection switch time measurement

Service disruption measurement couldn't be simpler than with the OmniBER 718 analyzer. Using dedicated hardware, the analyzer measures the length of the error burst associated with a protection switch. Unlike the old method of correlating bit errors with time, the unique implementation in the analyzer is accurate to 50 μs with a resolution of 1 μs. Service disruption is also available on ATM signals.

SDH/SONET ring testing

Configuring SDH/SONET rings and verifying their functionality is a complex and time-consuming process. Using the comprehensive thru mode capability of the OmniBER 718 analyzer can help to speed up the task and ensure that the advantages of the SDH/SONET ring configuration will be delivered when problems arise on the live network.

The three different thru modes of operation available are:

- **Transparent:** The SDH/SONET signal is monitored and normal measurements made. The line signal is passed through unaltered without recalculation of BIPs.

- **AU-n/STS Payload overwrite:** Select an AU-n/STS SPE channel and overwrite with an internally generated payload. BIPs are recalculated and all other AU-n/STS SPEs are retransmitted unaltered. Standard transmit test functions are enabled so that it is possible to add errors, alarms, pointer adjustments etc.

- **TU-n/VT payload overwrite:** Select a TU-n/VT channel and overwrite with an internally generated payload. All other are retransmitted unaltered. Standard transmit test functions are enabled so that it is possible to add errors, alarms and pointer adjustments.

Concatenated payloads

Concatenated payloads are vital for the rapid and accurate testing of high bandwidth paths before they are brought into service. The OmniBER 718 analyzer provides concatenated payload testing at all levels of a SDH/SONET/ATM signal. As well as providing concatenated payloads at the line rate e.g. OC-48c, the analyzer lets you test SDH/SONET structures containing concatenated payloads from lower levels of the SDH/SONET hierarchy e.g. STM-4c/STS-12c carried in STM-16/OC-48.

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Remote control for manufacturing

Every OmniBER 718 analyzer is shipped with a set of Universal Instrument Drivers (UIDs) on CD-ROM. UIDs provide a suite of graphical function panels which make programming the analyzer easy and fast! There is no need to know about SCPI commands – the SCPI commands are generated automatically by setting switches on a graphical function panel.

UIDs are supported in the following environments:

- HP VEE
- Labview
- LabWindows/CVI
- Visual Basic
- C++

and on the following operating systems:

- Windows 95
- Windows NT
- HP-UX
- Sun Solaris.

Remote control for remote in-service monitoring

The Distributed Network Analyzer (DNA) software (E4540A) allows control of an OmniBER 718 analyzer from a remote PC via modem or LAN. Changes made on the virtual front panel on the PC are seen in real time at the remote site. Key presses made on the instrument at the remote site are seen in real time on the PC – ideal for remote troubleshooting by a centralized expert!

For long-term monitoring applications it is also possible to dial in to a remote OmniBER 718 analyzer, download/update results and disconnect. Disconnect and re-connect at any time without interrupting test progress.

PDH and T-carrier testing

The PDH/T-carrier test module provides comprehensive test capability for 2, 8, 34, 140 Mb/s, DS1(1.5 Mb/s) and DS3 (45 Mb/s) interfaces. For DS3 testing FEAC code generation and monitor capability is included. At DS1 both in-band and out-of-band loop code generation and monitor is also available.

The test module also provides mapped payload testing capability for SDH/SONET testing

Other supported functionality includes:

- Unframed, framed and structured (mux/demux) testing
- Error and alarm generation and measurement
- 56 kb/s, n × 56 kb/s, 64 kb/s and n × 64 kb/s testing
- DS1 add/drop from DS3 (requires option 002)
- 2 Mb/s add/drop from 8/34/140 Mb/s
- DS1/DS3 and 2/34 Mb/s add/drop from SDH/SONET
- Telephone handset connector for talk/listen capability.

Testing of 2 Mb/s mapped into DS3 is also available if required (option 014).

Jitter Testing

The OmniBER 718 can optionally perform jitter generation and measurement at all installed interface rates from 2.5 Gb/s to 1.5 Mb/s. The jitter capability in the OmniBER 718 lets you ensure that your network equipment complies with all relevant ITU-T and Bellcore jitter recommendations. Jitter test applications covered by the OmniBER 718 are:

- Output jitter measurement
- Auto jitter tolerance
- Auto jitter transfer
- Pointer jitter measurement
- Mapping jitter measurement

As well as the standard ITU-T and Bellcore masks, user definable jitter masks are included to let you specify the exact points you need to test your network equipment.

Wander analysis software

The wander analyzer software provides the real-time calculation of the MTIE, TDEV and MRTIE wander performance indices. The software is windows compatible.

What's more, the OmniBER 718 meets the latest ITU-T O.172 recommendation for test equipment.

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Other features of the OmniBER 718

SDH/SONET

- Troublescan automatically scans for all possible error and alarm conditions
- Payload offset test
- SDH/SONET error and alarm generation/detection
- SDH/SONET tributary scan
- SDH/SONET pointer adjustments to ITU-T G.783/Bellcore GR-253-CORE
- Graphical pointer location graph
- Access to SDH/SONET overhead
- Overhead sequence generation and capture
- Text decode of APS messages for transmit and receive
- Optical stress test
- Drop/insert of DCC channels
- Optical power measurement
- Line frequency measurement
- Line frequency offset
- Choice of clock reference: Internal, recovered, external 64 kb/s, 2 M (MTS), 1.5 M (BITS), 10 MHz.
- Performance analysis to ITU-T G.821, G.826, M.2101, M.2110, M.2120
- Graphical results storage.
- Transmit and receive can be independently configured.

PDH/T-carrier (optional)

- Troublescan automatically scans for all possible error and alarm conditions
- Alarm scan
- Error and alarm generation/detection
- Choice of clock reference: Internal, recovered, external 64 kb/s, 2 M (MTS), 1.5 M (BITS), 10 MHz.
- Line frequency offset
- Signaling bits generation/detection
- Performance analysis to ITU-T G.821, G.826, M.2100, M.2110, M.2120
- Graphical results storage.
- Transmit and receive can be independently configured.

ATM (optional)

- ATM payloads up to 2.5 Gb/s.
- Comprehensive jitter test with ATM payloads.
- Fast, accurate measurements of protection switch times of ATM circuits.

POS (optional)

- POS payloads at all synchronous rates to 2.5 Gb/s.
- Channelized testing.
- PPP/HDLC and Cisco HDLC coverage.
- Verify HDLC stuffing.
- Continuity and throughput testing.
- Stress testing using traffic profiles - IP datagram size and inter-packet gap size fully configurable.
- Comprehensive jitter test with POS payloads.
- Service disruption measurement with POS payloads.

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SDH

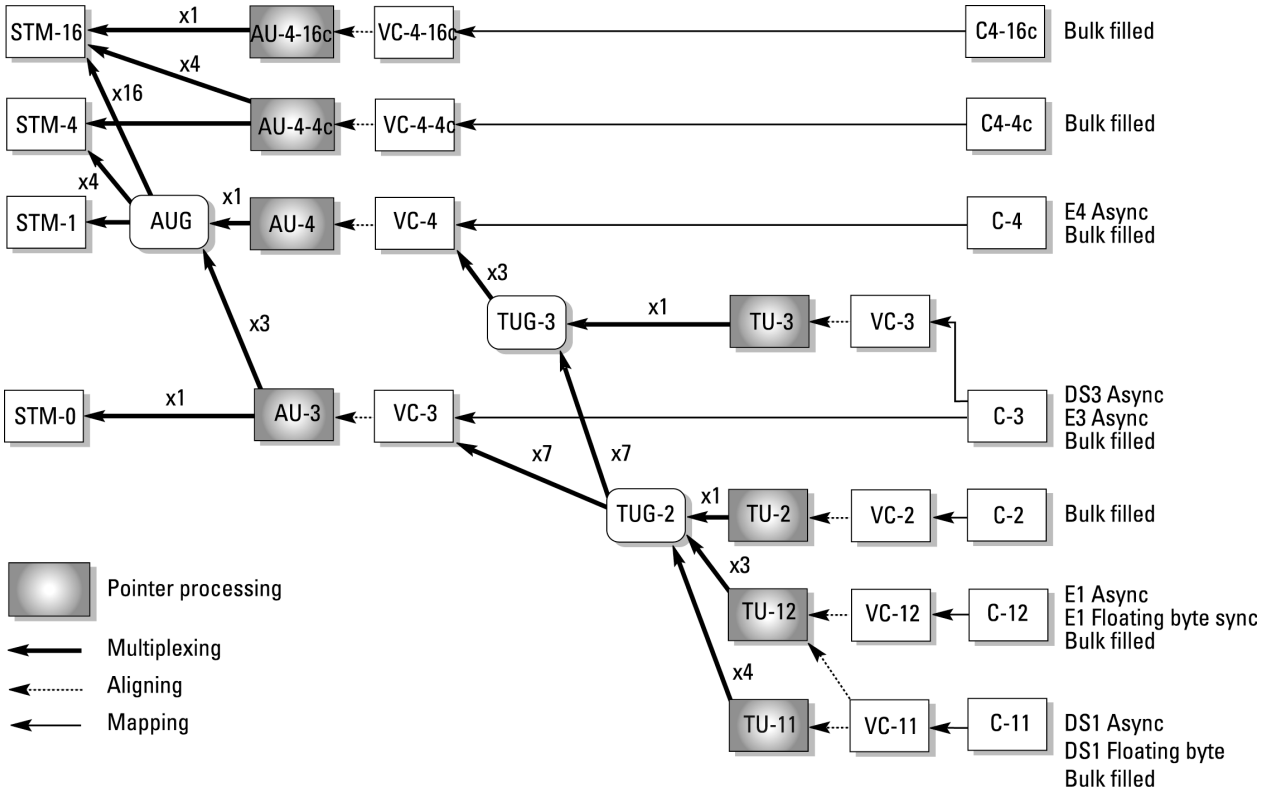


Figure 1: ITU-T G.707 mapping structure (SDH payload mapping)

Optical interfaces

	37718A	37718B	37718C
Wavelength Option 104 Option 105 Option 106	 1310 nm 1550 nm 1310/1550 nm	 1310 nm 1550 nm 1310/1550 nm	 1310 nm 1550 nm 1310/1550 nm
Rates	2.5 Gb/s, 622/155/52 Mb/s	622/155/52 Mb/s	155/52 Mb/s
Connectors	FC/PC (standard) SC (option 610) ST (option 611) ***Notes:*** *Optical interfaces on the 37718A use a customer exchangeable connector system. On 37718B and 37718C models, a fixed connector system is used (supports removal for cleaning).*		

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Optical transmitters

The following specifications cover both 1310 and 1550 nm transmitters unless otherwise stated.

	37718A	37718B and 37718C
Line code	NRZ	NRZ
Wavelength 1310 nm 1550 nm	 1280 to 1330 nm Typical: 1310 nm 1530 to 1570 nm Typical: 1550 nm	 1280 to 1335 nm Typical: 1310 nm 1480 to 1580 nm Typical: 1550 nm
Power	1 dBm ± 2 dB	–3 to +2 dBm
Spectral width	≤ 0.3 nm at –3 dB ≤ 1.0 nm at –20 dB	≤ 1.0 nm at –20 dB
Extinction ratio	> 10 dB	> 10 dB
Pulse mask	Meets ITU-T G.957 and Bellcore GR-253-CORE	
Fiber pigtail	Single mode	Single mode
Laser safety	Class 1 as defined by IEC825-1 and FDA 21 CFR, chapter 1, subchapter J.	

Optical receiver

	37718A	37718B and 37718C
Line code	NRZ	NRZ
Wavelength **Sensitivity**	1280 to 1335 nm and 1500 to 1580 nm STM-16: –28 dBm STM-4/1/0: –28 dBm, typically –34 dBm	1200 to 1600 nm STM-4: –28 dBm STM-1/0: –28 dBm, typically –34 dBm
Max input power	–8 dBm	–3 dBm
Fiber pigtail	Multi-mode	Multi-mode

Notes:

1. *Sensitivity and maximum input power specifications are valid in the 0 to +45 °C temperature range.*
2. *Sensitivity and maximum input power specifications are measured at 10^{-10} error rate using a $2^{23} - 1$ test pattern.*
3. *37718A: The optical receiver operates over the range 1200 to 1600 nm. Sensitivity and maximum input power specifications are valid in defined wavelength ranges.*

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Protected monitor point input (on optical modules)	52 Mb/s, 155 Mb/s and 622 Mb/s . **Line code:** NRZ. **Level:** Nominal 1 V peak-to-peak into 50 ohms. **Connector:** SMA female.
Electrical line rates/interfaces	STM-1e (CMI) to ITU-T G.703, STM-0e (B3ZS). **Input mode:** Terminate or monitor mode to ITU-T G.772. **Monitor gain:** 20 dB or 26 dB. **STM-1e equalization:** Automatic for cable loss up to 12 dB at half the bit rate. **STM-0e operating level:** STM-0 HI: 1.1V peak nominal with cable equalization upto 450 ft. STM-0 900ft: As STM-0 HI with added cable equalization for 450 ft to 900 ft. **Connector:** BNC, 75 ohm nominal unbalanced.
Clock reference	**Internal:** ± 0.5 ppm; stability: ± 3 ppm; ageing: ± 1 ppm. **Loop-timed:** Clock recovered from receiver's SDH input. **External reference:** 2M (MTS), 1.5 M(BITS), 64 kb/s, 10 MHz. **Connector:** BNC, 75 ohm nominal unbalanced, 3 pin Siemens 120 ohm balanced.
Clock trigger	**Divided clock output (37718A)** 51.840 MHz for STM-16/STM-4/STM-1 8.65 MHz for STM-0. **Divided clock output (37718B/C)** 51.840 MHz for STM-16/STM-4/STM-1/STM-0 **Connector:** BNC, ECL to –2 V, ac coupled, 50 ohm.
Clock output	2 MHz reference clock output. 2.048 MHz ± 100 ppm (synchronized to clock reference). **Connector:** BNC, 75 ohm nominal unbalanced.
Trigger/error output	60 μsec (nominal) pulse on B1, B2, B3 error, Tx/Rx frame (TTL level, termination can be 75 ohm or 10 kohm). **Connector:** BNC, 75 ohm unbalanced.
Clock offset	± 999 ppm in 0.1 ppm steps. Offset accuracy up to 100 ppm ± 0.02 ppm. Offset accuracy 100 to 999 ppm ± 0.2 ppm. Offsets the transmitted STM-n line frequency versus the selected clock reference.
SDH payload structure	See Figure 1 "SDH payload mapping" for details of payload mapping. Verifies the payload mapping/demapping functions used to ensure a payload is carried through the SDH network, so that it is delivered correctly at its destination, as per the recommendations in ITU-T O.181. SDH multiplexing structure (includes AU-4 and AU-3 mappings to ITU-T G.707). **STM-16:** bulk filled VC-4-16c, VC-4-4c (concatenated payloads). **STM-4:** bulk filled VC-4-4c (concatenated payloads). **140Mb/s:** VC-4→STM-N (bulk filled, unframed, framed, structured). **34Mb/s:** VC-3→TU-3→VC-4→ STM-N (bulk filled, unframed, framed, structured). VC-3→AU-3→STM-N (bulk filled, unframed, framed, structured).

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DS3:
VC-3→TU-3→VC-4→STM-N (bulk filled, unframed, framed, structured).
VC-3→AU-3→STM-N (bulk filled, unframed, framed, structured).
TU-2:
TU-2→TU-3→VC-4→STM-N (bulk filled TU-2-Nc concatenated payloads).
TU-2→VC-3→AU-3→STM-N (bulk filled TU-2-Nc concatenated payloads).
2 Mb/s (async/FI byte sync):
VC-12→TU-12→VC-4→STM-N (bulk filled, unframed, framed, structured).
VC-12→TU-12→VC-3→AU-3→STM-N (bulk filled, unframed, framed, structured).
DS1:
VC-11→TU-12→VC-4→STM-N (unframed, framed, structured).
VC-11→TU-11→VC-4→STM-N (unframed, framed, structured).
VC-11→TU-11→VC-3→AU-3→STM-N (unframed, framed, structured).

The foreground VC-4/VC-3 test signal can be mapped into any one or all channels. The background channels can be identical to the foreground or filled with a different structure.

Notes:
1. *Option 012 (PDH/T-carrier testing) is required for 2/34/140Mb/s/DS1/DS3 mappings.*
2. *STM-16 mappings only available on 37718A fitted with optical interface option (option 104, 105 or 106).*
3. *STM-4 mappings only available on 37718A or 37718B fitted with optical interface option (option 104, 105 or 106).*

Mixed payloads generation With TU-3 or TU-11or TU-12 as foreground signal the background structure can be configured to be any valid combination of TU-3 or TU-11 or TU-12.

Payload offset ±100 ppm in 1 ppm steps, linearity 0.5 ppm.
The line rate of the PDH signal, within the SDH container, is offset with respect to the container in which it is carried. Required for mapping jitter tests.

Payload test pattern 2^9–1, 2^{11}–1, 2^{15}–1, 2^{23}–1 (inverted or non-inverted), all ones, all zeros, 1010, 1000, 16 bit user word.
DS1 only: QRSS (2^{20}–1; 14 zero limited), Daly (55-octet) 1-in-8, 2-in-8.

PDH/DSn drop/insert Requires option 012 (T -carrier testing).
2/34/140 Mb/s, DS3 dropped and/or inserted into STM-n line signal (supported for asynchronous mappings only). In addition, DS1 drop/insert is available with option 002.

SDH tributary scan Automatically test BER on each SDH tributary for error free operation. Rx setup is used to determine tributary structure and test pattern. (At STM-16/STM-4 the foreground STM-1 will be scanned).
Alarms: Pattern loss.
User selectable BER threshold: Off, >0, $\geq 10^{-3}$,$\geq 10^{-6}$.

SDH error add Data (whole frame)[1], frame (A1,A2)[1], B1, B2, MS-REI, HP B3, HP-REI, AU4-IEC, LP BIP-2, LP-REI, bit[1].

Control: Single, error all, M.P x 10^{-n} (where M.P = 0.1 to 9.9 in 0.1 steps and n = 3 to 9[2]).

1. *No "Error All" selection available.*
2. *Max Error Rate depends on the Error Type*

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SDH alarm generation

LOS, LOF, OOF, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-RDI, HP-unequipped, TU-AIS, LP-RDI, TU-LOP, LP-unequipped, H4 LOM.
Control: On/off.

SDH pointer adjustments

Frequency offset: Offset the VC-n,TU-n relative to the line rate. In the AU pointer mode the 87:3 sequence is generated. Frequency offset control (±100 ppm in 0.1 ppm steps).
ITU-T G.783 sequences: Initialisation sequence and cool down period

1. Periodic Single,
2. Periodic Burst,
3. Periodic Phase Transient Burst,
4. Alternating Single,
5. Alternating Double,
6. Regular with Added,
7. Regular with Missing.

Programmable interval between regular adjustments.
Regular: Interval between regular adjustments can be programmed as follows:
10 ms < T <100 ms in 10 ms steps.
100 ms < T < 1 s in 100 ms steps.
1 s, 2 s, 5 s or 10 s.
Single burst: Incrementing burst, decrementing burst, alternating.
Burst size: 1 to 10 adjustments (AU and TU-3),1 to 5 adjustments (TU-2 and TU-12).
Adjustments within the burst are separated by the minimum legal limit (4 frames/multiframes).
New pointer: New pointer address transmitted with or without a NDF. VC-n payload moves to the user programmed address immediately.

SDH overhead setup

RSOH: All bytes (hex/binary) user settable except B1.
J0: 16 (15 +1 CRC) byte user defined or pre-defined trace identifier.
MSOH: All bytes (hex/binary) user settable except B2, H1, H2 and H3. (The SS bits in H1 col1 are settable), APS/MSP messages (K1K2) synchronization status messages (S1).
VC-4/VC-3 POH: All bytes (hex/binary) user settable except B3.
J1: 64 or 15 byte user defined or pre-defined trace identifier.
TU-2/TU-12/TU-11 POH: V5, J2, N2, K4 (hex/binary) user settable.
J2: 16 (15 + 1 CRC) byte user defined or pre- defined trace identifier.

SDH overhead monitor

RSOH, MSOH, VC-4/VC-3 POH, TU-2/TU-12/TU-11 LPOH all bytes (hex/binary).
Text decodes provided for regenerator section trace identifier(J0), synchronization status (S1), ASP/MSP messages (K1K2), path trace identifiers (J1, J2), signal label (C2), low order path signal label (V5).

APS/MSP messages

Linear (ITU-T G.783) or ring architecture (ITU-T G.841) textual based protection switching messages can be transmitted and decoded.

For linear topologies APS messages can be active or passive. In passive, static messages can be generated and received. The active APS selection gives relative response to provide switch keep-alive capability by responding to change requests that appear on the K1/K2 byte values.

SDH overhead sequence generation

Sequence of up to 5 values transmitted in a selected overhead channel. The transmit duration for each value is user programmable in range 0 to 64000 frames.

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Overhead channel:
RSOH: A1-A2 (6 bytes), D1-D3 (3 bytes), J0, Z0 ,E1, F1
MSOH: D4-D12 (9 bytes), K1K2 (2 bytes), S1, M1, Z1, Z2, E2
HPOH: J1, C2, G1, F2, H4, F3, K3, N1.

SDH overhead sequence capture

A single overhead channel can be selected to be captured. The display can be triggered manually or on a user-defined value. The first 16 values including the trigger are displayed along with the number of frames for which the pattern has persisted, each value being the width of the channel under test.
Overhead channel:
RSOH: A1-A2 (6 bytes), D1-D3 (3 bytes), J0, Z0 , E1, F1.
MSOH: H1H2 (2bytes), D4-D12 (9 bytes), K1K2 (2 bytes), S1, M0, M1, Z1, Z2, E2.
HPOH: J1, C2, G1, F2, H4, F3, K3, N1.

SDH overhead BER

2^9–1 PRBS transmitted and analyzed in a single 64 kb/s overhead channel. Single bit errors can be inserted in the transmitted test pattern.
Overhead channel:
RSOH: D1 to D3 (single byte), J0, E1, F1.
MSOH: D4 to D12 (single byte), K1, K2, S1, M1, M0, E2.
HPOH: J1, C2, G1, F2, H4, F3, K3, N1.
Results: Error count, error ratio, error free seconds, % error free seconds, pattern loss seconds

Optical stress test

Payload is overwritten with a block of zeros or ones after scrambling to stress timing recovery circuits.
Range:
2 to 85 bytes – STM-0.
2 to 259 bytes – STM-1.
2 to 1042 bytes – STM-4.
2 to 4174 bytes – STM-16.
CID test: Consecutive 1s digital test to ITU-T G,958 Appendix 1.

DCC add-drop

D1-D3 (192 kb/s), D4-D12 (576 kb/s)
Serial add-drop of DCC channels via RS-449 (15-pin D-type connector).

SDH thru mode

STM-16, STM-4, STM-1, STM-0 through mode
Transparent mode: Signal passes through unaltered. BIPs are not recalculated.
Overhead overwrite: The test features associated with the SOH/POH can be enabled to alter one single or multi-byte overhead channel ie, errors and alarms, overhead sequences, stress sest, APS/MSP messages, DCC insert, overhead BER. In this mode the B1,B2 BIPs are recalculated.
AU-4/AU-3 payload overwrite: Overwrite the complete selected AU-4/AU-3 with the internally generated payload. Enables the other AU-4/AU-3s to be looped while a new payload is inserted. The test features associated with the VC-4/VC-3 and/or the POH are enabled, ie, errors and alarms, adjust pointer, overhead sequences, stress test, overhead BER.
TU-3/TU-12 payload overwrite: Overwrite the complete selected TU with the internally generated payload. Enables the other TUs to be looped while a new payload is inserted. The test features associated with the VC-n and/or the POH are enabled, ie, errors and alarms, adjust pointer.

SDH alarm detection

LOS, OOF, LOF, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-RDI, H4-LOM, TU-AIS, TU-LOP, TU-RDI, pattern loss, clock loss, K1/K2 change, power loss, pointer adjust.

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SDH error measurements

Measurement control: Manual, single, timed start, power loss.
Error: Frame (A1A2), B1, B2, MS-REI, B3, HP-REI, HP-IEC, LP-REI, LP-BIP-2, bit.
Basic results: Error count, error ratio, elapsed time.
Performance analysis: ITU-T G.826, G.821, M.2101, M.2110, M.2120.

Service Disruption test
Note: *Requires Option 012*

Measures error burst length for measurement of service disruption during protection switching times to ITU-T G.783 (linear architecture)/G.841 (ring network topology).
Accuracy: 50 μs. for unframed signals
NOTE: It is recommended that unframed signals are used to measure service disruption as frame sync times will affect the measurement.
Results: longest burst length, shortest burst length, last burst length.
Resolution: 1 μs.

Start Condition: Any error.

Stop Condition: Error burst assumed complete when between 200 – 300ms have elapsed witout any errors being received.

Measurement Period: Elapsed time between the first bit error received and the last error received when the Start and Stop Conditions have been met.

NOTE: Option 350 is required for the following service disruption and AIS functionality.
OmniBER now provides timestamping of the first 10 service disruption events and the first 10 AIS duration measurements.

Service disruption has been extended to cover the following SDH and SONET tributaries.
- ❑ STS-48c
- ❑ STS-12c
- ❑ STS-3c
- ❑ STS-1

Service disruption measurement parameters

Display resolution: 1 μs

Measurement accuracy: 50 μs or better (for unframed signals)

Pattern: All current supported PRBS patterns (2^9–1, 2^{11}–1, 2^{15}–1, 2^{20}–1, 2^{23}–1) normal or inverted.
Bulk fitted.
POS
ATM (Using ITU-T 0.191 test cell)

Start condition: Single PRBS bit error.

Stop condition: Error burst assumed complete when >200ms has elapsed without any errors being received.

Measurement period: The elapsed time between the first bit error received and the last error received once the start and stop conditions have been met.

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AIS duration measurement parameters	**Display resolution:** 1 μs **Measurement accuracy:** 125 μs (1 frame) **Start condition:** Detection of an all ones pattern in the H1 and H2 bytes, present for three consecutive super-frames (i.e. detection of AIS-P/AU-AIS). **Stop condition:** The absence of all ones in the H1 and H2 bytes.
AlarmScan/ alarm & BIP scan	Automatically scans the SDH network hierarchy for alarms and BIP errors or alarms only with a graphical display of the network hierarchy's status including identification of unequipped channels. **Alarms:** LOP, HP AIS, HP RDI, H4 LOM, TU LOP, LP AIS,LP RDI **BIP Errors:** Lowest level BIP errors ie, B3 or BIP-2
TroubleScan	Scans all possible error and alarm sources simultaneously. Non-zero error counts are displayed in large characters, up to a maximum of four different error counts.
Pointer location graph	**Graphical display:** Shows the variation with time of the AU-n and TU-n pointer location. Up to four days of pointer location activity can be monitored. **Implied VC offset:** Calculated from the total +ve and –ve pointer movements since start of the measurement period.
Pointer results	AU and TU justifications (pointer value, positive count, positive seconds, negative count, negative seconds, NDF seconds, missing NDF seconds, implied AU-TUoffset).
Optical power measurement	**Accuracy:** ± 2 dB; Range: –10 dBm to –30 dBm. **Wavelength:** 1310 nm or 1550 nm. **Resolution:** 0.1 dBm.
Frequency measurement	**STM-16:** Frequency displayed in kHz with a 0.1 kHz resolution. Offset in ppm/kHz ≤ **STM-4:** Frequency displayed in Hz with a 1 Hz resolution. Offset in ppm/Hz. **Accuracy:** ± 1 Hz ± (internal clock error[1]) × frequency. [1] *See 'clock reference' for details on internal clock error.*
Stored measurement graphics	10 internal SMG stores (increases with floppy disc drive – number of stores limited only by free disc space). **Bar chart:** Results versus time periods with up to 1 second resolution. **Alarm chart:** Alarms versus time periods with up to 1 second resolution. **Resolution:** 1 sec, 1 min, 15 min, 60 min. **SDH bar graphs:** Frame (A1A2), B1, B2, MS REI, B3, HP REI, HP IEC, LP REI, LP BIP, bit. **SDH alarms:** LOS, LOF, OOF, AU LOP, AU NDF, AU missing NDF, MS AIS, MS RDI, K1K2 change, HP AIS, HP RDI, H4 LOM, TU LOP, TU NDF, TU missing NDF, LP AIS, LP RDI, pattern sync loss, power loss.
Tandem connection monitoring	**Selection:** High order (N1), low order (N2), OFF. **Alarm generation:** TC-LOM, TC-IAIS, TC-RDI, TC-ODI. **Error generation:** TC-REI, TC-IEC, OEI, TC-BIP **APID generation:** 16 byte (15 user byte + 1 CRC) user-definable message. **Alarm detection:** TC-LOM, TC-IAIS, TC-RDI, ODI. **Error detection:** TC-REI, TC-IEC, OEI, TC-BIP. **APID detection:** Access point identifier is captured and dis-layed in text.

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SONET Optical interfaces
(Option 002)

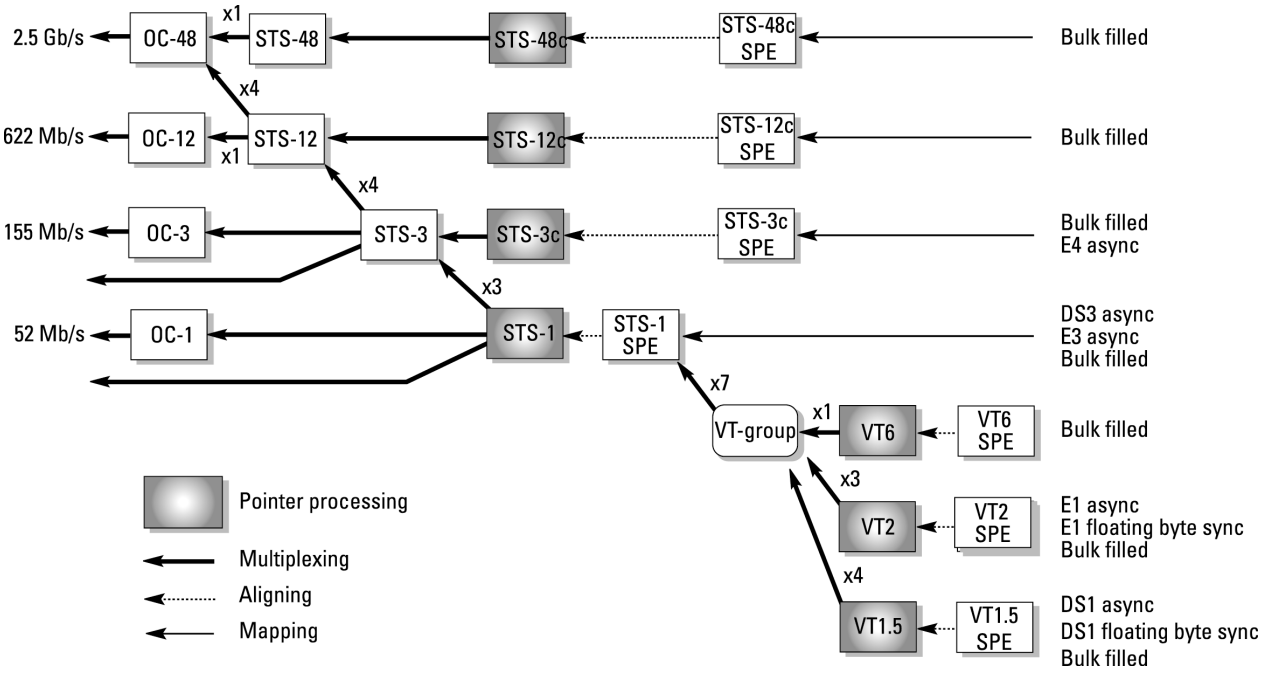


Figure 2: Bellcore GR-253 mapping structure (SONET payload mapping)

Optical interfaces

	37718A	37718B	37718C
Wavelength Option 104 Option 105 Option 106	 1310 nm 1550 nm 1310/1550 nm	 1310 nm 1550 nm 1310/1550 nm	 1310 nm 1550 nm 1310/1550 nm
Rates	OC-48/12/3/1	OC-12/3/1	OC-3/1
Connectors	FC/PC (standard) SC (option 610) ST (option 611) ***Notes:*** *Optical interfaces on the 37718A use a customer exchangeable connector system. On 37718B and 37718C models, a fixed optical connector system is used (supports removal for cleaning).*		

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Optical transmitters

The following specifications cover both 1310 and 1550 nm transmitters unless otherwise stated.

	37718A	37718B and 37718C
Line code	NRZ	NRZ
Wavelength 1310 nm 1550 nm	 1280 to 1330 nm Typical: 1310 nm 1530 to 1570 nm Typical: 1550 nm	 1280 to 1335 nm Typical: 1310 nm 1480 to 1580 nm Typical: 1550 nm
Power	1 dBm to ± 2 dB	–3 to + 2 dBm
Spectral width	≤ 0.3 nm at –3 dB ≤ 1.0 nm at –20 dB	≤ 1.0 nm at –20 dB
Extinction ratio	> 10 dB	> 10 dB
Pulse mask	Meets Bellcore GR-253-CORE and ITU-T G.957	
Fiber pigtail	Single mode	Single mode
Laser safety	Class 1 as defined by IEC825-1 and FDA 21 CFR, chapter 1, subchapter J.	

Optical receiver

	37718A	37718B and 37718C
Line code	NRZ	NRZ
Wavelength **Sensitivity**	1280 to 1335 nm and 1500 to 1580 nm OC-48: –28 dBm OC-12/3/1: –28 dBm, typically –34 dBm	1200 to 1600 nm OC-12: –28 dBm OC-3/1: –28 dBm, typically –34 dBm
Max input power	–8 dBm	–3 dBm
Fiber pigtail	Multi-mode	Multi-mode

Notes:

1. *Sensitivity and maximum input power specifications are valid in the 0 to +40 °C temperature range.*
2. *Sensitivity and maximum input power specifications are measured at 10^{-10} error rate using a $2^{23} - 1$ test pattern.*
3. *37718A: The optical receiver operates over the range 1200 to 1600 nm. Sensitivity and maximum input power specifications are valid in defined wavelength ranges.*

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Protected monitor point input

52 Mb/s, 155 Mb/s and 622 Mb/s (not available on 37718C).
Line code: NRZ.
Level: Nominal 1 V peak-to-peak into 50 ohms.
Connector: SMA female.

Electrical line rates/interfaces

STS-3 (CMI), STS-1 (B3ZS)
Input mode: Terminate or monitor mode.
Monitor gain: 20 dB or 26 dB
Equalization:
STS-3: Automatic for cable loss up to 12 dB at half the bit rate.
STS-1: Automatic covering range LO, x-connect and HI.
STS-1 operating level:
STS-1 HI: 1.1V peak nominal with cable equalization up to 450 ft.
STS-1 900ft: As STS-1 HI with added cable equalization for 450ft to 900 ft.
Connector: BNC, 75 ohm unbalanced.
Option 620: WECO 560 connector replaces BNC.

Clock reference

Internal: ± 0.5 ppm; stability: ± 3 ppm; Ageing: ± 1 ppm.
Loop-timed: Clock recovered from receiver's SONET input.
External reference: BITS (1.5 Mb/s), 64 kb/s, 10 MHz.
Connector: Bantam, 100 ohm balanced (BITS, 64 kb/s);
BNC, 75 ohm unbalanced (10 MHz).

Clock trigger

Divided clock output (37718A)
51.840 MHz for OC-48/OC-12/OC-3/STS-3
8.65 MHz for OC-1/STS-1
Divided clock output (37718B/C)
51.840 MHz for OC-48/OC-12/OC-3/STS-3/OC-1/STS-1
Connector: BNC, ECL to –2 V, ac coupled, 50 ohm.

Trigger/error output

60 μsec (nominal) pulse on B1, B2, B3 error, Tx/Rx frame (TTL level, termination can be 75 ohm or 10 kohm).
Connector: BNC, 75 ohm unbalanced.

Clock offset

± 999 ppm in 0.1 ppm steps; offset accuracy ± 0.02 ppm
Offsets the transmitted OC/STS-n line frequency relative to the selected clock reference.

SONET payload structure

See Figure 2 for details of SONET payload mapping.

The foreground STS-n test signal can be mapped into any select channel in the SONET line signal. Background channels can be set to the same as to the foreground or filled with an unequipped signal structure.

Notes:

1. *Option 012 (T-carrier testing) is required for DS1/DS3/E1/E3/E4 mappings.*
2. *OC-48 mappings only available on 37718A fitted with optical interface option (option 104, 105 or 106).*
3. *OC-12 mappings only available on 37718A or 37718B fitted with optical interface option (option 104, 105 or 106).*

Payload offset

± 100 ppm in 1 ppm steps, linearity 0.5 ppm.
The mapped DSn/En signal is offset with respect to the SPE in which it is carried.

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Payload test pattern

2^9–1, 2^{11}–1, 2^{15}–1, 2^{23}–1 (inverted or non-inverted), all ones, all zeros, 1010, 1000, 16 bit user word.
DS1 only: QRSS (2^{20}–1; 14 zero limited), Daly (55-octet) 1-in-8, 2-in-8.

PDH/DSn drop/insert

Requires option 012 (PDH/T -carrier testing).
DS3, DS1, E3, E1 dropped from and/or inserted into OC-N/STS-N line signal (supported for asynchronous mappings only).

SONET tributary scan

Automatically test BER on each SONET tributary for error free operation. Rx setup is used to determine tributary structure and test pattern. (At OC-48/OC-12 the foreground STS-3 will be scanned).
Alarms: Pattern loss.
User selectable BER threshold: Off, >0, $\geq 10^{-3}$,$\geq 10^{-6}$.

SONET error add

Data (whole frame)[1], frame (A1,A2)[1], CV-S (B1), CV-L (B2), REI-L (M0), REI-L (M1), CV-P (B3), REI-P (G1), STS IEC, CV-V (V5), REI-V (V5), bit[1].

Control: Single, error all, M.P x 10^{-n} (where M.P = 0.1 to 9.9 in 0.1 steps and n = 3 to 9)[2].
N-in-T[3], where N is the number of errors transmitted in time T,
T = 10 ms to 10000s in decade steps.
N = 0 to 640 (STS-1), 1920 (STS-3), 7680 (STS-12), 30720 (STS-48).

1. *No "error all" selection available.*
2. *Max error rate depends on the error type.*
3. *CV-L (B2) errors only.*

SONET alarm generation

LOS, LOF, OOF, AIS-L, RDI-L, AIS-P, RDI-P, LOP-P, UNEQ-P, AIS-V, LOP-V, RDI-V, UNEQ-V, H4 LOM.
Control: On/off.

SONET pointer adjustments

Frequency offset: Offset the SPE/VT relative to the line rate. In the SPE/VT pointer mode the 87:3 sequence is generated. Frequency offset control (±100 ppm in 0.1 ppm steps).
Bellcore GR-253,ANSI T1.105.03 sequences: Initialisation sequence and cool down period

1. Periodic single,
2. Periodic burst,
3. Periodic phase transient burst,
4. Alternating single,
5. Alternating double,
6. Periodic with added,
7. Periodic with cancelled.

Programmable interval between regular adjustments.
Regular: Interval between regular adjustments can be programmed as follows:
10 ms < T < 100 ms in 10 ms steps
100 ms < T < 1 s in 100 ms steps
1 s, 2 s, 5 s or 10 s
Single burst: Incrementing burst, decrementing burst, alternating.
Burst size: 1 to 10 adjustments (SPE). 1 to 5 adjustments (VT).
Adjustments within the burst are separated by the minimum legal limit (4 frames/multiframes).
New pointer: New pointer address transmitted with or without a NDF. SPE/VT payload moves to the user programmed address immediately.

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SONET overhead setup	**TOH:** All bytes user settable except B1 B2, H1, H2 and H3. The size bits in H1 are settable. J0: User byte; 16 byte section trace message. S1: Clear text setup of synchronization status message. **STS POH:** All bytes user settable except B3. J1: 64 or 16 byte path trace message. C2: Clear text setup of signal label. **VT POH:** V5, J2, Z6, Z7 user settable. J2: User byte; 16 byte VT path trace message.. V5 (VT signal label): Clear text setup of VT path signal label.
SONET overhead monitor	**SOH, LOH, STS POH, VT POH all bytes** (hex/binary) Text decodes provided for section trace (J0), synchronization status (S1), ASP/MSP messages (K1K2), STS and VT path trace messages (J1, J2), STS and VT signal labels (C2, V5).
APS messages	Clear text setup and decode of protection switching messages. Supports both linear (Bellcore GR-253) and ring (Bellcore GR-1230) messages. For linear topologies APS messages can be active or passive. In passive, static messages can be generated and received. The active APS selection gives relative response to provide switch keep-alive capability by responding to change requests that appear on the K1/K2 byte values.
SONET overhead sequence generation	Sequence of up to 5 values transmitted in a selected overhead channel. The transmit duration for each value is user programmable in range 0 to 64000 frames. **Overhead channel:** **SOH:** A1-A2 (6 bytes), D1-D3 (3 bytes), J0, Z0 ,E1, F1, media dependent bytes (row 2 col 2; row 2, col 3; row 3 col 2; row 3, col 3). **LOH:** D4-D12 (9 bytes), K1K2 (2 bytes), S1, M0, M1, Z1, Z2, E2. **POH:** J1, C2, G1, F2, H4, Z3, Z4, N1.
SONET overhead sequence capture	A selected overhead channel can be selected for capture. The capture can be triggered manually or on a user-defined receive value. The first 16 different receive values including the trigger are displayed along with the number of frames for which the value has persisted. **Overhead channel:** **SOH:** A1-A2 (6 bytes), D1-D3 (3 bytes), J0, Z0 , E1, F1, media dependent bytes (row 2 col 2; row 2, col 3; row 3 col 2; row 3, col 3). **LOH:** H1H2 (2bytes), D4-D12 (9 bytes), K1K2 (2 bytes), S1, M0, M1, Z1, Z2 E2 **POH:** J1, C2, G1, F2, H4, Z3, Z4, N1.
SONET overhead BER	2^9–1 PRBS transmitted and analyzed in a single 64 kb/s overhead channel. Single bit errors can be inserted in the transmitted test pattern. **Overhead channel:** **SOH:** D1-D3 (single byte), J0, Z0, E1, F1, media dependent bytes (row 2 col 2; row 2, col 3; row 3 col 2; row 3, col 3). **LOH:** D4-D12 (single byte), K1, K2, S1, M1, M0, E2. **POH:** J1, C2, G1, F2, H4, Z3, Z4, N1. **Results:** Error count, error ratio, error free seconds, % error free seconds, pattern loss seconds.

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Optical stress test

Payload is overwritten with a block of zeros or ones after scrambling to stress timing recovery circuits.
Range:
2 to 85 bytes – OC-1.
2 to 259 bytes – OC-3.
2 to 1042 bytes – OC-12.
2 to 4174 bytes – OC-48.

DCC add-drop

D1-D3 (192 kb/s), D4-D12 (576 kb/s)
Serial add-drop of DCC channels via RS-449 (15-pin D-type connector).

SONET thru mode

OC-48, OC-12, OC-3, OC-1, STS-3, STS-1 through mode:
Transparent mode: Signal passes through unaltered. BIPs are not recalculated.

Overhead overwrite: The test features associated with the TOH/POH can be enabled to alter one single or multi-byte overhead channel (ie, errors and alarms, overhead sequences, stress test, APS/MSP messages, DCC insert, overhead BER) In this mode the parity bytes are recalculated.

STS payload overwrite: Overwrite a selected STS SPE channel with an internally generated payload. All other SPEs are retransmitted unaltered. All standard transmit test functions are enabled (errors and alarms, pointer adjustments, overhead sequences, stress test, overhead BER).

VT payload overwrite: Overwrite a selected VT with an internally generated payload. All other VT s and SPEs are retransmitted unaltered. All standard transmit test functions are enabled (errors and alarms; pointer adjustments).

SONET alarm detection

LOS, OOF, LOF, AIS-L, RDI-L, LOP-P, AIS-P, RDI-P, H4-LOM, LOP-V, AIS-V, RDI-V, pattern loss, clock loss, K1/K2 change, power loss, pointer adjust.

SONET error measurements

Measurement control: Manual, single, timed start.
Error: Frame (A1,A2), CV-S(B1), CV-L(B2), CV-LFE(REI-L), CV-P(B3), CV-PFE(REI-P), CV IEC (STS path IEC), CV-V(V5), CV-VFE(REI-V), bit.
Basic results: Error count, error ratio, alarm seconds.
Performance analysis: G.826, G.821, M2101, M.2110, M.2120.

Protection switch times
Note: *Requires Option 012*

The 'service disruption' test measures protection switching time by measuring the duration of the error burst caused by a protection switching event (patent pending technique used with DSn signals).
Accuracy: < 50 μs.
Results: longest burst length, shortest burst length, last burst length.
Resolution: 1 μs.

NOTE: Option 350 is required for the following service disruption and AIS functionality.
OmniBER now provides timestamping of the first 10 service disruption events and the first 10 AIS duration measurements.

Service disruption has been extended to cover the following SDH and SONET tributaries.
- ❑ AU-4-16c
- ❑ AU-4-4c
- ❑ AU-4
- ❑ AU-3

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Service disruption measurement parameters	**Display resolution**: 1 μs **Measurement accuracy:** 50 μs or better (for unframed signals) **Pattern:** All current supported PRBS patterns (2^9–1, 2^{11}–1, 2^{15}–1, 2^{20}–1, 2^{23}–1) normal or inverted. Bulk fitted. POS ATM (Using ITU-T 0.191 test cell) **Start condition:** Single PRBS bit error. **Stop condition:** Error burst assumed complete when >200ms has elapsed without any errors being received. **Measurement period:** The elapsed time between the first bit error received and the last error received once the start and stop conditions have been met.
AIS duration measurement parameters	**Display resolution:** 1 μs **Measurement accuracy:** 125 μs (1 frame) **Start condition:** Detection of an all ones pattern in the H1 and H2 bytes, present for three consecutive super-frames (i.e. detection of AIS-P/AU-AIS). **Stop condition:** The absence of all ones in the H1 and H2 bytes.
AlarmScan	Automatically identifies the payload structure then scans each STS/VT channel for alarms and BIP errors. Graphically displays the status of each STS/VT channel. **Alarms:** **STS-SPE:** LOP-P, AIS-P, RDI-P. **VT :** AIS-P, RDI-P, H4 LOM, LOP-V, AIS-V, RDI-V. **BIP errors:** B3 or V5 BIP-2 associated with each STS/VT channel.
TroubleScan	Scans all possible error and alarm sources simultaneously. Non-zero error counts are displayed in large characters, up to a maximum of four different error counts.
Pointer location graph	**Graphical display:** Shows the variation with time of the STS SPE and VT pointer location. Up to four days of pointer location activity can be monitored. **Implied SPE/VT offset:** Calculated from the total +ve and –ve pointer movements since start of the measurement period.
Pointer results	SPE and VT iustifications (pointer value, positive count, positive seconds, negative count, negative seconds, NDF seconds, missing NDF seconds, implied SPE/VT offset).
Optical power measurement	**Accuracy:** ± 2 dB; Range: –10 dBm to –30 dBm. **Wavelength:** 1310 nm or 1550 nm. **Resolution:** 0.1 dBm.

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Frequency measurement

OC-48: Frequency displayed in kHz with a 0.1 kHz resolution. Offset in ppm/kHz
≤ **OC-12:** Frequency displayed in Hz with a 1 Hz resolution. Offset in ppm/Hz.
Accuracy: ± 1 Hz ± (internal clock error[1]) × frequency.
[1] *See 'clock reference' for details on internal clock error.*

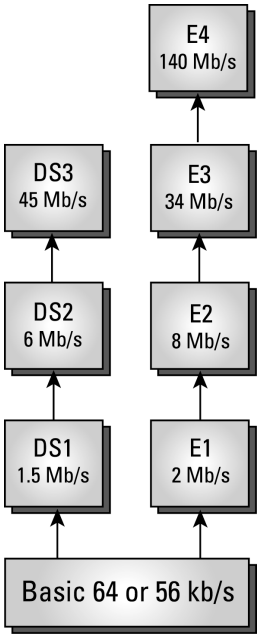
Stored measurement graphics

10 internal SMG stores (increases with floppy disc drive - number of stores limited only by free disc space).
Bar chart: Results versus time periods with up to 1 second resolution.
Alarm chart: Alarms versus time periods with up to 1 second resolution.

Resolution: 1sec, 1min, 15min, 60min
SONET bar graphs: Frame (A1A2), CV-S (B1), CV-L (B2), CV-LFE (REI-L), CV-P (B3), CV-LFE (REI-P), CV-IEC (STS path IEC), CV-V (V5), CV-VFE (REI-V), bit.
SONET alarms: LOS, LOF, OOF, LOP-P, NDF, missing NDF, AIS-L, RDI-L, K1K2 change, AIS-P, RDI-P, H4 LOM, LOP-V, VT NDF, VT missing NDF,AIS-V, RDI-V, pattern sync loss, power loss.

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PDH/T-carrier testing
(Option 012)



Adds PDH and T-carrier test capability. Testing can be performed directly at PDH/DSn physical interfaces or on SDH/SONET mapped payload signals.

Line rates

2/8/34/140 Mb/s, DS1 (1.5 Mb/s), DS3 (45 Mb/s) interfaces
2 Mb/s: HDB3/AMI; 75 ohm unbalanced (BNC), 120 ohm balanced*.
8 Mb/s: HDB3; 75 ohm unbalanced (BNC)
34 Mb/s: HDB3; 75 ohm unbalanced (BNC).
140 Mb/s: CMI; 75 ohm unbalanced (BNC).
DS1: B8ZS/AMI; 100 ohm balanced*.
DS3: B3ZS; 75 ohm unbalanced (BNC),
3-pin Siemens connector if ordered with option 001, or
WECO Bantam connector if ordered with option 002.
Input level: Terminate or monitor mode (to ITU-T G.772 specified signals).
Monitor gain:
2/8 Mb/s, DS1: 20, 26 dB or 30 dB.
34/140 Mb/s, DS3: 20 or 26 dB.
Equalization: Automatically adapts to the range of signal levels specified in the ITU-T and ANSI standards.
2/8/34/140 Mb/s: As per ITU-T G.703.
DS1: DSX-1 (ANSI T1.102-1993) to DS1-LO (DSX-1 with 655ft of ABAM cable).
DS3: DS3-HI through DSX-3 (ANSI T1.102-1993) to DS3-900'.
Output level:
DS1: DSX-1 (ANSI T1.102-1993), DS1-LO.
DS3: DS3-HI, DSX-3 (ANSI T1.102-1993), DS3-900.
2 Mb/s: ITU-T G.703.
8 Mb/s: ITU-T G.703.
34 Mb/s: ITU-T G.703.
140 Mb/s: ITU-T G.703.

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Clock references

Internal: ± 0.5ppm @ 25C [± 4.5 ppm (includes ageing, stability, setting accuracy)].
DS1 only: ± 0.7ppm @ 25C [± 4.7 ppm (includes ageing, stability setting accuracy)].
Loop-timed: Clock recovered from receiver.
External reference: 64 kb/s, 1.5 M (BITS), 2 M (MTS), 10 MHz.
Connector: Bantam, 100 ohm balanced (BITS, 64 kb/s);
BNC, 75 ohm unbalanced (10 MHz).

Line rate offset

± 100 ppm in 1ppm steps.
Offsets the transmitted PDH/DSn line frequency relative to the selected clock reference.

Frame format

Framed, structured (mux/demux), unframed

	Framing	Channel structure
DS1	SF (D4), ESF, SLC-96 (ANSI T1-403-1989, TR-TSY-000499, ITU-T G.704)	56/64 kb/s, n × 56/64 kb/s
DS3	M13 (ANSI T1-107-1995), C-bit (ANSI T1-107a-1990)	DS1, 56/64 kb/s, n × 64 kb/s Option 014: E1 (ITU-T G.747)
2 Mb/s	PCM30, PCM30CRC, PCM31, PCM31CRC (ITU-T G.704, G.732, G.706)	64 kb/s, n × 64 kb/s
8 Mb/s	ITU-T G.742	2 Mb/s 64 kb/s, n × 64 kb/s
34 Mb/s	ITU-T G.751	2/8 Mb/s, 64 kb/s, n × 64 kb/s
140 Mb/s	ITU-T G.751	2/8/34 Mb/s, 64 kb/s, n × 64 kb/s

Test pattern

PRBS: $2^9 - 1$, $2^{11} - 1$, $2^{15} - 1$, QRSS (14 zero limit – DS1 only), $2^{20} - 1$, $2^{23} - 1$.
Word: All 1s, all 0s, 1010, 1000, 16-bit word (frame aligned).
DS1 only: 3-in-24, 1-in 8, 2-in-8, Daly (55 octet).
Live traffic: Externally generated.
The test pattern can be inserted/measured at the line rate or at any level within the multiplexing structure, inlcuding in a selected 64/56 kb/s or n × 64/56 kb/s timeslot.

Error add

2 Mb/s: Bit, FAS, code, CRC4, REBE
8/34 Mb/s: Bit, FAS, code.
140 Mb/s: Bit, FAS.
DS1: Bit, FAS (frame alignment signal), BPV/Code, CRC6, EXZ (excess zeros).
DS3: Bit, FAS, MFAS (multi-frame alignment signal), FAS+MFAS, BPV/Code, C-bit, P-bit, FEBE, EXZ.

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Control:

Single	Selected error type transmitted when “single error” key is pressed.
Rate	1.0×10^{-3}, 1.1×10^{-3}, $M.P \times 10^{-n}$ (n = 4 to 9; M.P = 1.0 to 9.9 in 0.1 steps)[1]
Burst	Single burst of n-errors. EXZ: n = 3 to 16 DS1 FAS: n = 1 to 6 DS3 FAS and MFAS: n = 1 to 4 PDH FAS: n = 1 to 4
[1] *Maximum error rate is 2.1×10^{-4} for:* – *DS1 CRC6 errors* – *DS3 FEBE, P-bit and C-bit errors*	

Alarm generation

2 Mb/s: LOS, LOF, AIS, RAI, RAI (MF), CASMFL,minor alarm (via spare bits).
8/34 Mb/s: LOS, LOF, AIS, RAI.
140 Mb/s: LOF, AIS, RAI.
DS1: LOS, OOF, AIS, RAI (yellow).
DS3: LOS, OOF, AIS, Idle, RAI (X-bit), FEAC codes (Loopback and alarm/status codes).
Control: On/off.

Spare bits generation

User-selected value transmitted in spare bits of PDH frame.
2 Mb/s: Si bits (international bits): Timeslot 0 bit1 in both FAS and NFAS frames.
2 Mb/s: E bits: CRC4 frames 13 and 15: timeslot bit 1.
2 Mb/s: Sa bit (national bits): NFAS timeslot bits 4 to 8.
2 Mb/s: Sa bit sequences: 8 bit sequence transmitted in any selected NFAS Sa bit.
2 Mb/s: CAS multiframe: MFAS timeslot bits 5,7 and 8.
8 Mb/s: FAS bit 12.
34 Mb/s: FAS bit 12.
140 Mb/s: FAS bits 14 to 16.

Signaling bits generation/monitor

2 Mb/s: PCM30 and PCM30CRC frame formats.
Transmit: User selected value transmitted in ABCD signal bits associated with all channels.
Monitor: Simultaneously displays received ABCD signaling associated with all 30 channels.
DS1:
Transmit: User selected value transmitted in ABCD signal bits of test channel.
Monitoring: Displays signaling bits associated with all DS0 channels
(ABCD format for ESF; AB format for SF (D4) and SLC-96).
SLC-96 can display one of three states; 0,1 or alternating.

FEAC codes

DS3 C-bit frame format. Transmits and monitors loopback and alarm/status codes as per ANSI T1.107-1995.
Transmit: Use-selected loopback or alarm/status code tranmitted for controlled duration.
Loopback codes: A single burst of N loopback codes and M messages transmitted (where N and M are selectable in the range 1 to 15).
Alarm/status codes: Any ANSI T1.107-1995 message or any 0xxxxxx0 11111111 message may be transmitted, either in a single burst (selectable in the range 1 to 15) or continuously.
Monitor: Displays in decoded form the two most recently received FEAC messages (current and previous messages.)

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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 range 1 to15). Monitor: Displays in decode form the two most recently received loopcodes (current and previous).
TroubleScan	Scans all possible error and alarm sources simultaneously. Non-zero error counts are displayed in large characters, up to a maximum of 4 different error counts.
PDH/DSn alarm scan	Continuously scans a received signal for alarms at the interface rate or within any sub-channel. Results presented graphically.
Error and alarm measurements	**Measurement control:** Manual, single, timed start. **Errors:** **2 Mb/s:** Bit, code, frame error, CRC, REBE. **8/34 Mb/s:** Bit, code, frame error. **140 Mb/s:** Bit, frame error. **DS1:** Bit, BPV/code, frame error, CRC6. **DS3:** Bit, BPV/code, frame error, P-bit, C-bit, FEBE. **Alarms:** **2 Mb/s:** LOS, pattern loss, AIS, LOF, RAI, RAI(MF), CASMFL. **8/34 Mb/s:** LOS, pattern loss, AIS, LOF, RAI. **140 Mb/s:** LOS, pattern loss, AIS, LOF, RAI. **DS1:** LOS, pattern loss, AIS, OOF, multiframe loss, RAI (yellow), EXZ, idle. **DS3:** LOS, pattern loss, AIS, OOF, multiframe loss, RAI (x-bit), EXZ, idle. **Basic results:** Error count, error ratio, alarm seconds.
Performance analysis	ITU-T G.821 (bit), G.826, M.2100, M.2110, M.2120.
Additional measurements	Line frequency (Hz and ppm offset), delay (En signals only).
Thru mode	DS1 and DS3 only. Received signal is retransmitted either unchanged or with a selected error rate injected across the entire DSn frame. All standard DSn received functions are available. **Error rate:** 1.1×10^{-3} to 1.0×10^{-9} (in 0.1 steps).
DS1, 2 Mb/s add-drop	DS1 inserted and extracted from a DS3 signal (requires option 002). 100 ohm balanced (WECO Bantam). 2 Mb/s inserted and extracted from a 8/34/140 Mb/s signal. 75 ohm unbalanced (BNC). DS1 (requires option 002), DS3, 8/34 Mb/s dropped from and/or inserted into an SDH/SONET line signal. Not for DS1 async mapping.
Handset connector	Supports adding and dropping of a selected 64 kb/s voice channel (carried in a PDH/DSn signal) to an external handset. **Connector:** RJ411. **Coding:** μ-law (DSn), A-law (En).

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Jitter (Option 200)

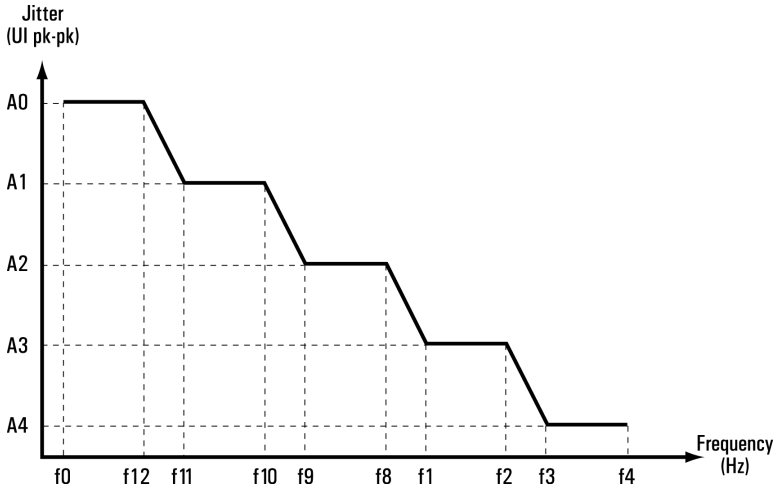
1. Jitter generation

Jitter generation rates/interfaces	**SDH/SONET:** 2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s. **PDH/T-carrier:** 140 Mb/s, 34 Mb/s, 8 Mb/s, 2 Mb/s, DS1 (1.5 Mb/s), DS3 (45 Mb/s).
Wander generation rates/interfaces	**SDH/SONET:** 2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s. **PDH/T-carrier:** 2 Mb/s, DS1 (1.5 Mb/s).
External jitter modulation input	Used for external modulation. **Input range:** 10 UI: 2/8/34/140 Mb/s. 20 UI: SDH/SONET rates, DS1, DS3. Jitter Tx display provides a numerical indication of the level of externally applied modulation. **Signal:** Sinusoidal but can be used with other signal formats. **Max Input Level:** ± 5 V peak. **Connector:** BNC, 75 ohm nominal unbalanced.
ITU-T/Bellcore GR-253 jitter generation specifications	Meets the test equipment requirements of ITU-T O.171 for PDH/T-carrier jitter generation and ITU-T 0.172 for SDH jitter generation. Exceeds the network equipment requirements of ITU-T G.823 for PDH jitter generation and ITU-T G.825/ITU-T G.958 for SDH jitter generation. Exceeds the network equipment requirements of Bellcore GR-253 for SONET jitter generation.
Fixed jitter tolerance masks	**Spot mode, swept mode or auto jitter tolerance** ITU-T G.825, ITU-T G.958 type A and type B, ITU-T G.823 low Q and high Q, Bellcore GR-253 and Bellcore GR-499-CORE.
Automatic jitter tolerance	**Onset of errors and BER penalty methods** **User defined:** No of frequency points (3 to 55), delay time (0.1 to 99.9s), dwell time (0.1 to 99.9s), bit error threshold (1 to 10^6). **Masks:** ITU-T G.825, G.958 (type A and type B), G.823 (low Q and high Q), Bellcore GR-253.
User-programmable masks	Provides the ability to create, edit and title up to 5 user input jitter masks. Each mask can be defined with up to 55 frequency and amplitude points.

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ITU-T O.171/O.172 PDH/T-carrier/SDH jitter generation requirements

ITU-T O.171/O.172 jitter amplitude versus modulation frequency:



ITU-T O.171 PDH jitter amplitude versus modulation frequency:

Bit Rate (kb/s)	A0 (UI)	A1 (UI)	A2 (UI)	A3 (UI)	A4 (UI)	f0 (μHz)	f12 (Hz)	f11 (Hz)	f10 (Hz)	f9 (Hz)	f8 (Hz)	f1 (Hz)	f2 (Hz)	f3 (kHz)	f4 (kHz)
1544	–	–	–	10	0.5	–	–	–	–	–	–	2	400	8	40
2048	40	–	20	10	0.5	12	–	–	–	–	5	10	900	18	100
8448	200	–	20	10	0.5	12	–	–	–	–	10	20	400	8.5	400
34368	1000	–	20	10	0.5	–	–	–	–	–	50	100	1.0k	20	800
44736	–	–	–	10	0.5	–	–	–	–	–	–	2	5.0k	100	400
139264	–	–	–	10	0.5	–	–	–	–	–	50	100	500	10	3500

ITU-T O.172 SDH jitter amplitude versus modulation frequency:

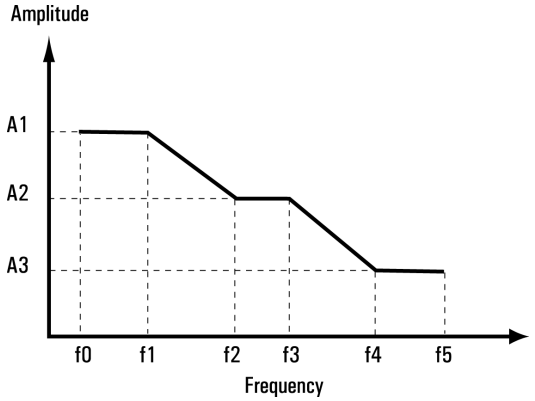
Bit Rate (kb/s)	A0 (UI)	A1 (UI)	A2 (UI)	A3 (UI)	A4 (UI)	f0 (μHz)	f12 (μHz)	f11 (mHz)	f10 (mHz)	f9 (Hz)	f8 (Hz)	f1 (Hz)	f2 (kHz)	f3 (kHz)	f4 (kHz)
51840	–	–	20	2	0.2	–	–	–	–	10	30	300	2.0	20	400
155520e	3600	400	50	2	0.1	12	178	1.6	15.6	0.125	19.3	500	3.25	65	1300
155520	3600	400	50	2	0.2	12	178	1.6	15.6	0.125	19.3	500	6.5	65	1300
622080	14400	1600	200	2	0.2	12	178	1.6	15.6	0.125	9.65	1k	25	250	5000
2488320	57600	6400	800	2	0.2	12	178	1.6	15.6	0.125	12.1	5k	100	1000	20000

Note: *OmniBER 718 exceeds above requirements of ITU-T O.171/O.172*

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Bellcore GR-253-CORE SONET jitter tolerance

Bellcore GR-253 jitter amplitude versus modulation frequency:

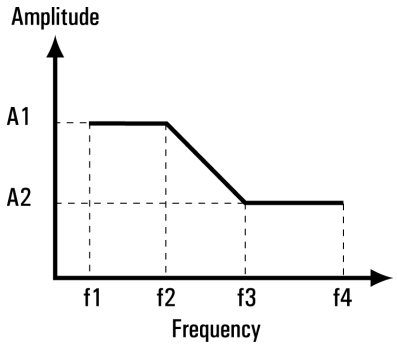


Bellcore GR-253 jitter amplitude versus modulation frequency table

Bit Rate (kb/s)	A1 (UI)	A2 (UI)	A3 (UI)	f0 (Hz)	f1 (Hz)	f2 (Hz)	f3 (kHz)	f4 (kHz)	f5 (kHz)
51840	15	1.5	0.15	10	30	300	2	20	400
155520	15	1.5	0.15	10	30	300	6.5	65	1300
622080	15	1.5	0.15	10	30	300	25	250	5000
2488320	15	1.5	0.15	10	600	6000	100	1000	20000

Bellcore GR-499-CORE T-carrier jitter tolerance

Bellcore GR-499 jitter amplitude versus modulation frequency:



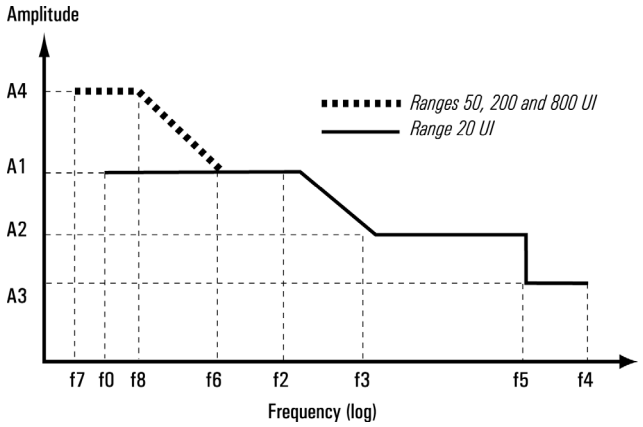
Bellcore GR-499 jitter amplitude versus modulation frequency:

Bit Rate kb/s)	A4 (UI)	A2 (UI)	f1 (Hz)	f2 (Hz)	f3 (Hz)	f4 (kHz)
1544, Cat 1	5	0.1	10	500	8k	40
1544, Cat 2	10	0.3	10	192.9	6.43 k	40
44736, Cat 1	5	0.1	10	2.3 k	60 k	300
44736, Cat 2	10	0.3	10	669	22.3	300

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SDH/SONET generated jitter amplitude versus modulation frequency

SDH/SONET generated jitter amplitude versus modulation frequency:

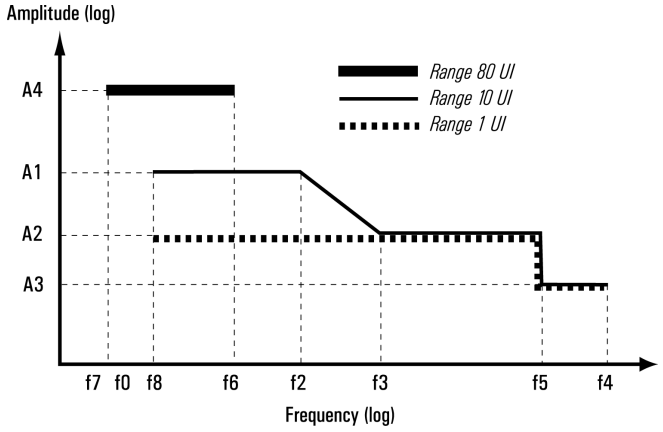


SDH/SONET generated jitter amplitude versus modulation frequency:

Bit Rate (kb/s)	A4 (UI)	A1 (UI)	A2 (UI)	A3 (UI)	f7 (Hz)	f0 (Hz)	f8 (Hz)	f6 (Hz)	f2 (kHz)	f3 (kHz)	f5 (kHz)	f4 (kHz)
51840	20	20	1.0	0.6	0.1	2	–	200	2	10	100	400
155520	50	20	1.0	0.6	0.1	2	30	500	5	50	1000	1300
622080	200	20	1.0	0.6	0.1	2	30	1000	25	250	1000	5000
2488320	800	20	1.0	0.6	0.1	2	30	5000	100	1000	5000	20000

PDH/T-carrier generated jitter amplitude versus modulation frequency

PDH/T-carrier generated jitter amplitude versus modulation frequency:



PDH/T-carrier generated jitter amplitude versus frequency:

Bit Rate (kb/s)	A4 (UI)	A1 (UI)	A2 (UI)	A3 (UI)	f7 (Hz)	f0 (Hz)	f6 (Hz)	f2 (kHz)	f3 (kHz)	f5 (kHz)	f4 (kHz)
1544	80	20	1.0	0.6	0.1	2	100	1.0	10	30	42
2048	80	10	1.0	0.6	0.1	2	100	13	25	50	102
8448	80	10	1.0	0.6	0.1	2	100	50	100	200	430
34368	80	10	1.0	0.6	0.1	2	100	100	200	400	840
44736	80	20	1.0	0.6	0.1	2	100	10	200	300	430
139264	80	10	1.0	0.6	0.1	2	100	5	10	2000	3500

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Jitter generation modulation range

Range (UI)	Line Rate (Mb/s)	Min (UI)	Max (UI)	Amplitude Resolution (UI)	Modulation Frequency Range
20	52, 155, 622, 2488	0.01	20.0	0.01	2 Hz to f4[1]
20 *(low freq)*	52	0.5	20.0	0.5	0.1 to 200
50	155	0.5	50.0	0.5	0.1 to 500 Hz
200	622	0.5	200.0	0.5	0.1 to 1000 Hz
800	2488	0.5	800.0	0.5	0.1 to 5000 Hz
10	2, 8, 34, 140	0.01	10.0	0.01	2 Hz to f4[1]
20	1.5, 45	0.01	20.0	0.01	2 Hz to f4[1]
80	1.5, 2, 8, 34, 45, 140	0.5	80.0	0.5	0.1 to 100 Hz

[1] Refer to f4 in SDH/SONET and PDH/T-carrier jitter generation vs frequency amplitude table.

Jitter modulation frequency resolution

Modulation Frequency	Mimimum Resolution
< 10 kHz	1 Hz
10 to 99.99 kHz	10 Hz
100 to 999.99 kHz	100 Hz
1 to 20 MHz	1000 Hz

Jitter modulation accuracy

Jitter frequency:

±1% above 3 Hz.
±3% between 3 Hz and 1 Hz.
±10% below 1 Hz.

Jitter amplitude:

±5% ±X ±Y ±Z
where X is given by the following table:

Amplitude accuracy:

Range	X (UI)
10	0.01
20	0.01
50	0.5
80	1.0
200	1.0
800	2.0

and where Y is given by the following tables:

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PDH generator intrinsic jitter:

Bit Rate (kb/s)		Y (UI) All 1s Data Pattern	Y (UI) PRBS[1] Data Pattern
1544		0.02	0.02
2048		0.02	0.02
8448		0.02	0.02
34368		0.03	0.03
44736		0.03	0.03
139264	< 10 kHz	0.04	0.04
	> 10 kHz	0.02	0.02

SDH/SONET generator intrinsic jitter:

Bit Rate (kb/s)	Y (UI) 1010 Data Pattern	Y (UI) PRBS Data Pattern[1] (payload)
51840 electrical	0.02	0.03 (STM-0/STS-1)
155520 electrical	0.02	0.03 (STM-1/STS-3c)
155520 optical	0.02	0.03 (STM-1/OC-3c)
622280	0.02	0.03 (STM-4c/OC-12c)
2488320	0.02	0.04(STM-16c/OC-48c)

[1] *The payload is PRBS length (2^{23}–1) scrambled.*

[2] *SDH/SONET intrinsic jitter generation is specified over the HP1-LP filter bandwidth.*

and where Z is given by the following table:

Additional frequency response term Z[1]	
1 to 5 MHz	± 2%
5 to 10 MHz	± 3%
10 to 20 MHz	± 5%

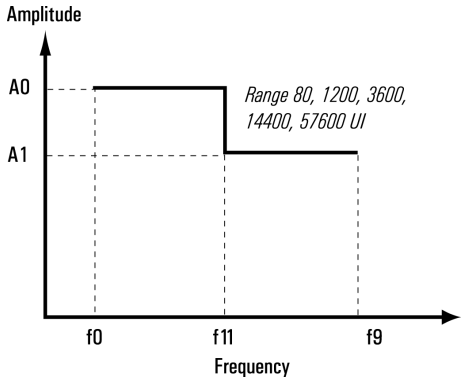
[1] *Applies to SDH/SONET generation only.*

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2. Wander generation

Generated wander amplitude versus modulation frequency

Generated wander amplitude versus modulation frequency:



Generated wander amplitude versus modulation frequency

Bit Rate (kb/s)	A0 (UI)	A1 (UI)	f0 (μHz)	f11 (mHz)	f9 (Hz)
1544	80	80	10	0.125	–
2048	80	80	10	0.125	–
51840	1200	140	10	1.6	0.125
155520	3600	400	10	1.6	0.125
622080	14400	1600	10	1.6	0.125
2488320	57600	6400	10	1.6	0.125

Wander generation modulation range

Range	Min (UI)	Max (UI)	Amplitude Resolution (UI)	Modulation Frequency Min	Modulation Frequency Max
80	0.5	80	0.5		
1200	0.5	1200	0.5		
3600	0.5	3600	0.5	10 μHz	0.125 Hz
14400	0.5	14400	0.5		
57600	2	57600	2		

Wander modulation accuracy

Wander frequency:
±1%.
Wander amplitude:
±5% ±X ±Y
where X is amplitude accuracy and Y the generator intrinsic jitter as give in the table below:

Range	X (UI)	Y (UI)
80	1.0	0.1
1200	0.5	0.1
3600	0.5	0.1
14400	0.5	0.1
57600	1.0	0.1

Fixed wander tolerance masks

Spot mode: ITU-T G.825.

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3. Jitter measurement

Jitter measurement rates/interfaces

SDH/SONET: 2.5 Gb/s, 622/155/52 Mb/s.
PDH/T-carrier: 140 /34/8/2 Mb/s, DS1 (1.5 Mb/s), DS3 (45 Mb/s).

Wander measurement rates/interfaces

SDH/SONET: 2.5 Gb/s, 622/155/52 Mb/s.
PDH/T-carrier: 140 /34/8/2 Mb/s, DS1 (1.5 Mb/s), DS3 (45 Mb/s).

Optical sensitivity

–12 to –20 dBm for 2.5 Gb/s, –10 to –22 dBm for 52, 155, 622 Mb/s.

Jitter measurement ranges

These ranges cover the measurements required in ITU-T O.171 Table 3 and ITU-T O.172 Table 5.

Range (UI)	Rate	Max UI_{p-p}	Max UI_{rms}[1]
1.6	All rates	1.6	0.8
16	All rates to 622 Mb/s	16	8
64	2.5 Gb/s	64	32

Extended jitter measurement peak-peak ranges

Range (UI)	Rate	Max UI_{p-p}	Max UI_{rms}[1]
256	All rates to 139 Mb/s	256	128
64	155/52 Mb/s	64	32
256	622 Mb/s	256	128
1024	2.5 Gb/s	1024	512

[1]The rms range is linked to the selection for peak-peak jitter measurement.

Jitter receiver results resolution

Range (UI)	Resolution UI_{p-p}	Resolution UI_{rms}
1.6	1 m	1 m
16	5 m	1 m
64	10 m	1 m
256	50 m	5 m
1024	200 m	20 m

Jitter hit threshold

Range (UI)	Min UI_{p-p}	Max UI_{p-p}	Resolution UI_{p-p}
1.6	50 m	1.6	10 m
16	500m	16.0	100 m
64	1.0	64.0	200 m
256	5.0	256.0	1.0
1024	10.0	1024.0	5.0

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Jitter measurement bandwidth

		Jitter measurement bandwidth			
Rate	**Range (UI)**	**F_L (Hz)**	**F_{min} (Hz)**	**F_{max}**	**F_U**
1.5 Mb/s 1.5 Mb/s	1.6 16	2 2	10 10	40 kHz 7.0 kHz	80 kHz 8.27 kHz
2 Mb/s 2 Mb/s	1.6 16	2 2	20 20	100 kHz 10 kHz	150 kHz 12.5 kHz
8 Mb/s 8 Mb/s	1.6 16	2 2	20 20	400 kHz 20 kHz	500 kHz 25 kHz
34 Mb/s 34 Mb/s	1.6 16	2 2	100 100	800 kHz 64 kHz	1300 kHz 80 kHz
45 Mb/s 45 Mb/s	1.6 16	2 2	10 10	400 kHz 80 kHz	800 kHz 100 kHz
52 Mb/s 52 Mb/s	1.6 16	10 10	100 100	400 kHz 80 kHz	800 kHz 100 kHz
139 Mb/s 139 Mb/s	1.6 16	2 2	200 200	3.5 MHz 100 kHz	6.25 MHz 150 kHz
155 Mb/s 155 Mb/s	1.6 16	10 10	500 200	1.3 MHz 100 kHz	2.6 MHz 150 kHz
622 Mb/s 622 Mb/s	1.6 16	10 10	1000 500	5 MHz 1040 kHz	5 MHz 1.3 MHz
2.5 Gb/s 2.5 Gb/s	1.6 64	10 10	5000 2000	20 MHz 2.8 MHz	20 MHz 3.5 MHz

[1] Measurement accuracy is specified between F_{min} and F_{max} bandwidth.
F_L = lower3 dB point. F_U = upper 3 dB point.

Measurement filters

LP, HP1 and HP2 filters to ITU-T O.171 (PDH)/O.172 (SDH); 12 kHz HP filter.

	HP1 (Hz)	**HP2 (kHz)**	**LP (kHz)**	**HP rms (kHz)**
1.5 Mb/s	10	8	40	12
2 Mb/s	20	18	100	12
8 Mb/s	20	80	400	12
34 Mb/s	100	10	800	12
45 Mb/s	10	30	400	12
52 Mb/s	100	20	400	12
140 Mb/s	200	10	3500	12
155 Mb/s	500	65	1300	12
622 Mb/s	1000	250	5000	12
2.5 Gb/s	5000	1000	20000	12

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Extended range jitter measurement bandwidth

		Jitter measurement bandwidth[1]			
Rate	Range (UI)	F_L (Hz)	F_{min} (Hz)	F_{max}	F_U
1.5 Mb/s	256	0.15	1	200 Hz	250 Hz
2 Mb/s	256	0.15	1	200 Hz	250 Hz
8 Mb/s	256	0.15	1	200 Hz	625 Hz
34 Mb/s	256	0.15	1	2 kHz	2.5 kHz
45 Mb/s	256	0.15	1	5 kHz	6.25 kHz
52 Mb/s	64	0.15	1	20 kHz	25 kHz
139 Mb/s	256	0.15	1	5 kHz	6.25 kHz
155 Mb/s	64	0.15	1	20 kHz	25 kHz
622 Mb/s	256	0.15	1	20 kHz	25 kHz
2.5 Gb/s	1024	0.15	1	20 kHz	25 kHz

[1] Measurement accuracy is specified between F_{min} and F_{max}

F_L = lower3 dB point. F_U = upper 3 dB point.

Note: *No selectable filters are provided for extended jitter measurement operation.*

SDH/SONET jitter measurement accuracy (as per ITU-T O.171/O.172)

The peak-to-peak accuracy for SDH/SONET rates is specified as ±R% of reading ±W, where W represents the intrinsic jitter for a given data pattern and receiver range and where R represents the frequency response term of the receiver. The typical rms accuracy for SDH/SONET rates is specified as ±R% of reading ±W.
SDH/SONET system intrinsic term W:

Bit Rate (kb/s)	Range	Data Pattern					
		System		Receiver only[1]		Receiver only with option 210[7]	
		STM-n^2-c with PRBS[3] scrambled payload		STM-n^2-c with PRBS[3] scrambled payload		STM-n^2-c with PRBS[3] scrambled payload	
		$W^{4,5}$		W^4		$W^{4,6}$	
		UI p-p	UI rms[1]	UI p-p	UI rms	UI p-p	UI rms[1]
51840	1.6 16 64	0.07 0.1 3	0.005 0.03 1	0.035 0.07 2	0.004 0.015 0.7	0.035 0.07[1] 2[1]	0.004 0.015 0.7
155520	1.6 16 64	0.05 0.1 3	0.005 0.03 1	0.035 0.07 2	0.004 0.015 0.4	0.035 0.07[1] 2[1]	0.004 0.015 0.4
622080	1.6 16 256	0.07 0.1 12	0.005 0.03 4	0.05 0.07 8	0.004 0.015 1.6	0.035 0.07[1] 8[1]	0.004 0.015 0.6
2488320	1.6 64 1024	0.07 0.15 50	0.005 0.06 15	0.05 0.1 24	0.004 0.03 8	0.035 0.1[1] 24[1]	0.004 0.03 8

[1] Typical specification only
[2] Variable n corresponds to the line bit rate, STM-1, 4 or 16.
[3] The PRBS used will be (2^{23}-1).
[4] W is specified for filter bandwidth HP1 to LP inserted in peak-to-peak measurements and filter rms in rms measurements. For extended range operation W is specified with no filtering.
[5] Intrinsic limits for a calibrated OmniBER 718 transmitter and receiver pair.
[6] Option 210 specification for the receiver intrinsic only, using the 1.6UI range, from +20°C to +45°C and –12 to –20dbm input power.
[7] Instruments with option 210 fitted must be returned to factory for calibration. OmniBER calibration is recommended once every two years.

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SDH/SONET receiver frequency inaccuracy term R:

Bit Rate (kb/s)	Additional frequency response error[1,2]
51840	± 7% of reading from 100 Hz to 300 kHz ± 8% of reading from 300 kHz to 400 kHz
155520	7% of reading from 500 Hz to 300 kHz ± 8% of reading from 300 kHz to 1 MHz ± 10% of reading from 1 MHz to 1.3 MHz
622080	± 7% of reading from 1000 Hz to 300 kHz ± 8% of reading from 300 kHz to 1 MHz ± 10% of reading from 1 MHz to 3 MHz ± 15% of reading from 3 MHz to 5 MHz
2488320	± 7% of reading from 5000 Hz to 300 kHz ± 8% of reading from 300 kHz to 1 MHz ± 10% of reading from 1 MHz to 3 MHz ± 15% of reading from 3 MHz to 10 MHz ± 20% of reading from 10 MHz to 20 MHz

1 This is with respect to calibrated value at 100 kHz. At 100 kHz Z = 0.
2 The frequency response term will only apply over the bandwidth F_{min} to F_{max} in an associated receiver range.

PDH/T-carrier jitter measurement accuracy (ITU-T O.171/O.172)

The peak-to-peak accuracy for PDH/T-carrier rates is specified as ± 5% of reading ± W ± Z where W represents the intrinsic jitter for a given data pattern and receiver range, and where Z represents the frequency response term of the receiver. The typical rms accuracy for PDH/T-carrier rates is specified as ± 5% of reading ± W ± Z.
PDH/T-carrier system intrinsic term W:

Bit Rate (kb/s)	Range	Data Pattern							
		System				Receiver only[1]			
		PRBS[2] W[3,4]		All 1s input W[3,4]		PRBS W[3,4]		All 1s input W[3,4]	
		UI p-p	UI rms[1]	UI p-p	UI rms[1]	UI p-p	UI rms	UI p-p	UI rms
1544	1.6 16 256	0.02 0.1 10	0.004 0.03 3	0.02 0.07 10	0.002 0.03 3	0.01 0.07 4	0.002 0.015 1.4	0.005 0.05 4	0.002 0.015 1.4
2048[5]	1.6 16 256	0.02 0.1 10	0.004 0.03 3	0.02 0.07 10	0.002 0.03 3	0.01 0.07 4	0.002 0.015 1.4	0.005 0.05 4	0.002 0.015 1.4
8448[5]	1.6 16 256	0.02 0.1 10	0.004 0.03 3	0.02 0.07 10	0.002 0.03 3	0.02 0.07 4	0.004 0.015 1.4	0.01 0.05 4	0.002 0.015 1.4
34368	1.6 16 256	0.03 0.1 10	0.004 0.03 3	0.03 0.07 10	0.003 0.03 3	0.02 0.07 4	0.004 0.015 1.4	0.01 0.05 4	0.002 0.015 1.4
44736	1.6 16 256	0.03 0.1 10	0.004 0.03 3	0.03 0.07 10	0.003 0.03 3	0.02 0.07 4	0.004 0.015 1.4	0.01 0.05 4	0.002 0.015 1.4
139264	1.6 16 256	0.04 0.1 10	0.004 0.03 3	0.04 0.07 10	0.004 0.03 3	0.02 0.07 4	0.004 0.015 1.4	0.01 0.05 4	0.002 0.015 1.4

1 Typical specification only
2 The PRBS pattern type 2^{15}–1 for 2048 and 8448 kbit/s, and 2^{23}–1 for 34368 and 139264 kbit/s as given in ITU-T recommendation O.171.
3 W is specified for the supplementary filter HP1 inserted in peak-peak measurements and filter rms in rms measurements. For extended range operation W is specified with no filtering.
4 Intrinsic limits for a calibrated OmniBER 718 transmitter and receiver pair.
5 Specified only for HDB3 encoding, the performance is not specified for AMI encoding.

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PDH/T-carrier receiver frequency inaccuracy term Z:

Bit Rate (kb/s)	Additional frequency response error[1,2]
1544	± 4% of reading from 10 Hz to 1 kHz ± 2% of reading from 1 kHz to 40 kHz
2048	± 2% of reading from 20 Hz to 100 kHz
8448	± 2% of reading from 20 Hz to 300 kHz ± 3% of reading from 300 kHz to 400 kHz
34368	± 2% of reading from 100 Hz to 300 kHz ± 3% of reading from 300 kHz to 800 kHz
44736	± 4% of reading from 10 Hz to 200 kHz ± 2% of reading from 200 kHz to 300 kHz ± 3% of reading from 300 kHz to 400 kHz
139264	± 2% of reading from 200 Hz to 300 kHz ± 3% of reading from 300 kHz to 1 MHz ± 5% of reading from 1 MHz to 3 MHz ± 10% of reading from 3 MHz to 3.5 MHz

1 *With respect to calibrated value at 1 kHz. At 1 kHz Z = 0.*
2 *The frequency response term will only apply over the bandwidth F_{min} to F_{max} in an associated receiver range.*

Demodulated jitter output

The output has gain dependent on range and is after the supplementary filter selection.

Demodulated output gain:

Range (UI p-p)	Gain (mV/UI p-p)
1.6	1000
16	100
64	25
256	6
1024	1.5

Connector: BNC, 75 ohm nominal unbalanced.

Jitter measurement results

Amplitude: +ve peak, –ve peak, peak-peak, rms, filters (indicates filters in use), lapsed time
Hits: Jitter hit count, jitter hit seconds, jitter hit free seconds, elapsed time.

Jitter stored measurement graphs

Bar graph: Hit count.
Alarms: Unlock, out-of-range, LOS (STM-1e only), LOL (STM-N optical only).

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4. Jitter transfer

Jitter transfer rates

SDH/SONET: 2.5 Gb/s, 622/155/52 Mb/s.
PDH/T-carrier: 140/45/34/8/2/1.5 Mb/s.

Jitter transfer function

An automatic jitter transfer function is available when both transmitter and receiver are configured to the same rate. The rates available are shown above.

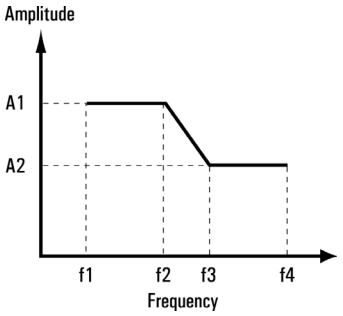
Automatic jitter transfer function

Masks: ITU-T G.825, G.958: type A and type B, ITU-T G.823 low Q and high Q.
User defined: No of frequency points (1 to 55), delay time (5 to 30 s), dwell time (5 to 30 s).

Fixed jitter transfer input masks

ITU-T G.958: type A and type B, Bellcore GR-253.
ITU-T G.823 low Q and high Q.

Generated jitter amplitude versus modulation frequency:

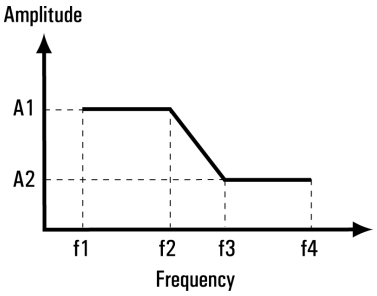


PDH/SDH jitter transfer input masks:

Rate (Mb/s)	Mask	F1 (Hz)	F2 (Hz)	F3 (kHz)	F4 (kHz)	A1 (UI)	A2 (UI)
1.5	G.824 GR-499, Cat 1 GR-499, Cat 2	10 10 10	120 500 192.9	6 8 6.43	40 40 40	5 5 10	0.1 0.1 0.3
2	G.823, High Q G.823, Low Q	20 20	93 2.4 k	0.700 18	100 100	1.5 1.5	0.2 0.2
8	G.823, High Q G.823, Low Q	20 20	400 10.7	3 80	400 400	1.5 1.5	0.2 0.2
34	G.823	100	1 k	10	800	1.5	0.15
45	G.824 GR-499, Cat 1 GR-499, Cat 2	10 10 10	600 2.3k 669	30 60 22.3	400 300 300	5 5 10	0.1 0.1 0.3
139	G.823	200	500	10	3500	1.5	0.075
155	G.958, Type A G.958, Type B	500 500	6.5 k 1.2 k	65 12	1300 1300	1.5 1.5	0.15 0.15
622	G.958, Type A G.958, Type B	1 k 500	25 k 1.2 k	250 12	5000 5000	1.5 1.5	0.15 0.15
2488	G.958, Type A G.958, Type B	5 k 500	100 k 1.2 k	1000 12	20000 20000	1.5 1.5	0.15 0.15

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Generated jitter amplitude versus modulation frequency:

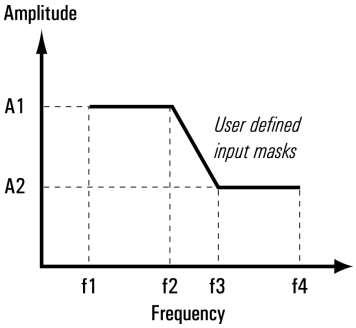


SONET jitter transfer input masks:

Rate (Mb/s)	Mask	F1 (Hz)	F2 (Hz)	F3 (Hz)	F4 (Hz)	A1 (UI)	A2 (UI)
52	GR-253-CORE(1) GR-253-CORE(2)	10 500	30 2k	300 20k	500 400k	15 1.5	1.5 0.15
155	GR-253-CORE(1) GR-253-CORE(2)	10 500	30 6.5k	300 65k	500 1300k	15 1.5	1.5 0.15
622	GR-253-CORE(1) GR-253-CORE(2)	10 1k	30 25k	300 250k	1k 5000k	15 1.5	1.5 0.15
2488	GR-253-CORE(1) GR-253-CORE(2)	10 10k	600 100k	6k 1000k	10k 20000k	15 1.5	1.5 0.15

User selectable jitter transfer input masks

User defined:
f1, f2, f3, f4 (Note f1<f2<f3<f4); $f1_{min}$=10 Hz; $f4_{max}$ rate dependent, see table below:



Rate	f4 max
2.5 Gb/s	20 MHz
622 Mb/s	5 MHz
155 Mb/s	1.3 MHz
140 Mb/s	3.5 MHz
52 Mb/s	400 kHz
45 Mb/s	400 kHz
34 Mb/s	800 kHz
8 Mb/s	400 kHz
2 Mb/s	100 kHz
1.5 Mb/s	40 kHz

A1,A2 ($A1_{max}$ = max value instrument can generate at f2;
$A2_{max}$ = max value instrument can generate at f4)

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Jitter transfer receiver

A narrowband filtering technique will be used when performing a jitter transfer measurement.
Measurement bandwidth: 10 Hz.
Dynamic range: +5 dB to –40 dB.
Stability: 0.02 dB.
Calibration: 0.01 dB.

Jitter transfer accuracy[1]

Rx Jitter (UI)	Accuracy[2] (dB)
> 0.3	0.04
0.3 to 0.1	0.15
0.1 to 0.03	0.25
0.03 to 0.01	0.5
0.01 to 0.003	1
0.003 to 0.001	3

[1] Specified for a minimum dwell time of 20 s and a minimum delay time of 10 s.

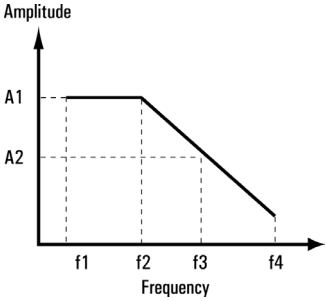
[2] Nominal

Jitter transfer results

The jitter transfer results can be displayed in tabular or graphical form.

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Jitter transfer pass masks



ITU-T G.958: type A and type B, Bellcore GR-253.
ITU-T G.823 low Q and high Q.

Rate (Mb/s)	Mask	F1 (Hz)	F2 (Hz)	F3 (Hz)	F4 (kHz)	A1 (dB)	A2 (dB)
1.5	G.824 GR-499, Cat 1 GR-499, Cat 2 GR-253-CORE	10 10 10 10	350 350 9.65 40	2.5 k 2.5 k – –	15 k 15 k 40 k 15 k	0.5 0.1 0.1 0.1	– – – –
2	G.823[1], High Q G.8231, Low Q	20 20	40 70	400 700	100 100	0.5 0.5	–19.5 –19.5
8	G.823[2], High Q G.823[2], Low Q	20 20	100 8 k	1 k 80 k	400 400	0.5 0.5	–19.5 –19.5
34	G.823[2]	100	300	3 k	800	0.5	–19.5
45	G.824 GR-499, Cat 1 GR-499, Cat 2 GR-253-CORE	10 10 10 10	500 10 k 59.6 k 40	2.5 k – – –	15 k 15 k 300 k 15 k	0.1 0.1 0.1 0.1	– – – –
52	GR-253-CORE	10	40 k	–	400 k	0.1	–
155	G.958, Type A GR-253-CORE	500	130 k	Note 2	–	0.1	–
	G.958, Type B	500	30 k	Note 2	–	0.1	–
622	G.958, Type A GR-253-CORE	1 k	500 k	Note 2	–	0.1	–
	G.958, Type B	1 k	30 k	Note 2	–	0.1	–
2488	G.958, Type A GR-253-CORE	5 k	2000 k	Note 2	–	0.1	–
	G.958, Type B	5 k	30 k	Note 2	–	0.1	–

[1] Actual values from ITU-T G.742.
[2] Actual values from ITU-T G.751.

Note 1: *There is no mask defined for 139 Mb/s. In this case, the display will show the result without the pass threshold.*
Note 2: *The mask shows threshold falling off by 20 dB per decade after F2.*

An offset in the range –2 dB to +2 dB in steps of 0.01 dB can be added to the selected pass mask.

Jitter transfer graph results

The result is plotted on a graph of gain versus frequency. The pass mask is displayed on the graph as well as the results.

Jitter transfer text results

Point number, frequency, mask value, result, pass/fail indication.

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5. Wander measurement

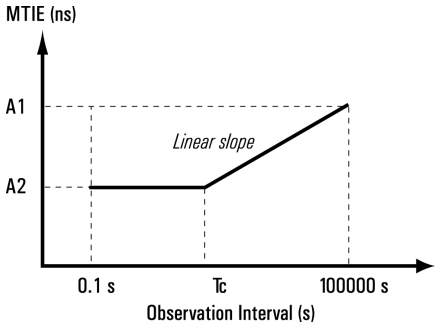
Wander measurement rates

SDH/SONET: 2.5 Gb/s, 622/155/52 Mb/s.
PDH/T-carrier: 140/45/34/8/2/1.5 Mb/s.

Wander timing reference

Wander measurement can only be performed on a locked synchronous system where one clock reference is used. For wander measurement on a PDH/T-carrier tributary, the PDH/T-carrier source must be locked to a clock reference which is available to the instrument.

Sinusoidal wander receive range MTIE:



Sinusoidal wander receive range MTIE:

A1 ns)	A2 (ns)	Tc	Resolution (ns)
10^{10}	10^{5}	3.14	0.1

Wander measurement bandwidth

All rates: 10 μHz to 10 Hz.

Wander sampling rate

Maximum sampling rate is 50 Hz.

Wander measurement accuracy

3% max ± 2.5 ns.

Wander results

Amplitude: +ve Peak, –ve peak, peak-peak, peak-peak (15 mins), peak-peak (24 hours), estimated bit slips (2 Mb/s only), estimated frame slips (2 Mb/s) , time interval error, implied frequency offset.

Graphical wander

Sliding bar graph presenting wander results in a graphical format (2 Mb/s only).

Wander stored measurement graphs

Bar graph: +ve bit slips, –ve bit slips, frame slips.

Wander slew rate limit

Should not exceed 100000 ns/s. The slew rate limit is equivalent to a maximum fixed frequency offset of ± 100 ppm.

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6. Wander Analysis Software (E4547A)

Description	The Wander analyzer software provides the ***real-time*** calculation of the MTIE, TDEV and MRTIE wander performance indices. The software is Windows compatible.
Measurement Rates	**SONET:** OC-48, OC-12, OC-3, OC-1. **SDH:** STM-16, STM-4, STM-1, STM-0. **PDH/T-Carrier:** 140 Mb/s, 45 Mb/s (DS3), 34 Mb/s, 8 Mb/s, 2 Mb/s, 1.5 Mb/s (DS1).
Results	TIE, MTIE, MRTIE, TDEV, frequency offset and drift.
Standards Compliance	Complies with all relevant ITU-T, Bellcore, ETSI, ANSI standards. **ITU-T:** G.811, G.812, G.813, G.823, G.824. **Bellcore:** GR-253-CORE, GR-1244-CORE. **ANSI:** T1.101. **ETSI:** ETS 300 462, ETS 302 084.
User Defined Pass Mask	In addition to providing all relevant masks from the Standards bodies, the software provides the ability to quickly and easily generate additional user defined pass masks.
Software Controls	Software provides user control of Cursor, Markers, Zoom In/Out, TIE Value and Transient search.
Minimum PC Requirements	**Processor:** 166 MHz Pentium MMX. **Memory:** 64M (Windows NT). **Comm Port:** RS-232 connection to OmniBER.

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ATM (Option 300)

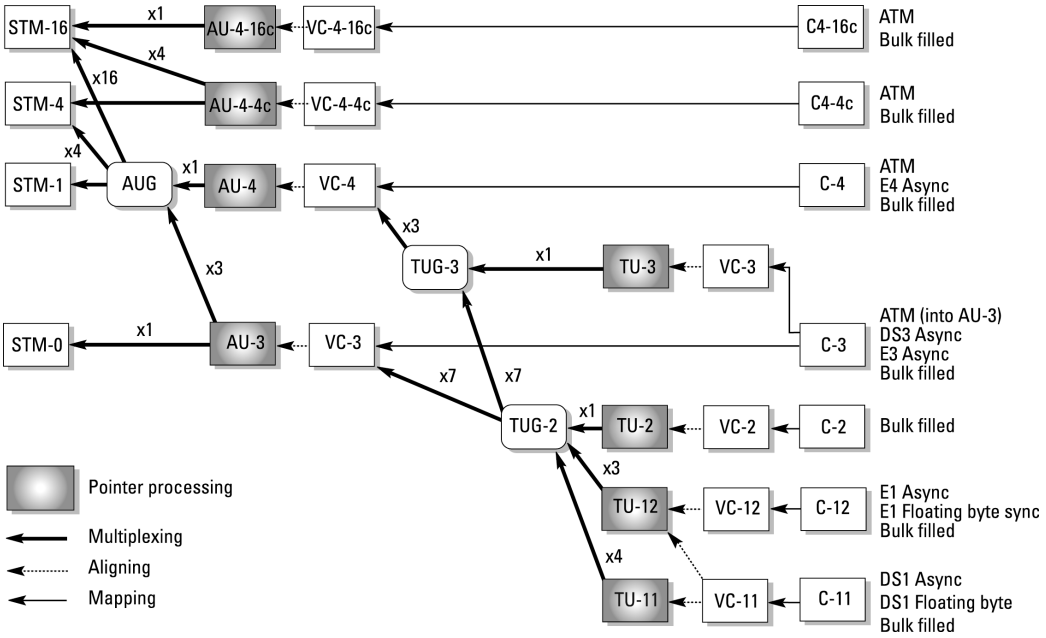


Figure 1: ITU-T G.707 mapping structure (SDH payload mapping)

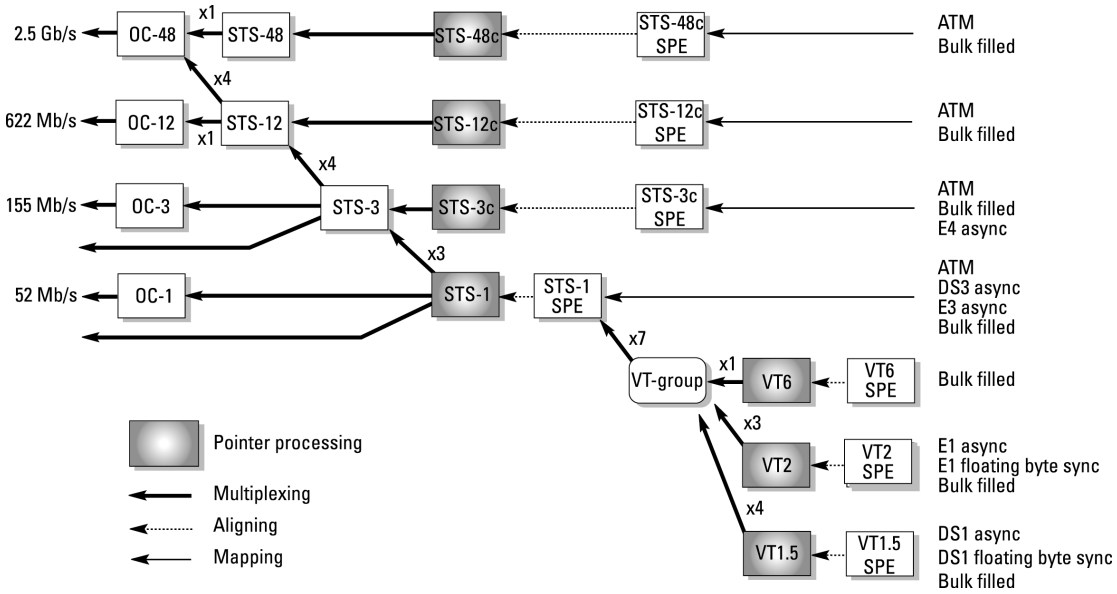


Figure 2: Bellcore GR-253 mapping structure (SONET payload mapping)

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Physical interfaces

Specifications for the PDH and SDH/SONET interfaces can be found in the SDH/SONET and PDH/T-carrier specifications.

ATM physical layer structure

An ATM signal can be mapped into the following physical layers;

SDH(bulk filled):
VC-3 (into AU-3);
VC-4;
VC-4-4c (concatenated payload);
VC-4-16c (concatenated payload).

SONET (bulk filled):
STS-1 full SPE;
STS-3c full SPE;
STS-12c full SPE;
STS-48c full SPE.

PDH/T-Carrier:
2M (AMI,HDB3);
34 M (HDB3);
DS1 (AMI,B8ZS);
DS3 direct mapping (B3ZS);
DS3 PLCP mapping (B3ZS).

Note: *For PDH/T-carrier ATM test, option 012 must be ordered.*

SDH/SONET mappings:
All ATM mappings can be multiplexed into the selected line-rate as defined in Figures 1 and 2.

ATM framing structure

STS-1, STS-3c, STS-12c and STS-48c: As per Bellcore GR-253.
VC-4,VC-4-4c and VC-16c: As per ITU-T G.707.
34 Mb/s: As per ITU-T G.832.
2 Mb/s: PCM30, PCM30CRC.
DS3 (45 Mb/s): C-bit parity framing.
DS1 (1.5 Mb/s): ESF.

Cell scrambling

On/off, conforms to ITU-T I.432.

DS3 PLCP mappings

Direct/PLCP. PLCP per Annex A of T1E1.2/95-003 and ITU-T Rec. G.804

Error add

SDH/SONET physical layers: See SDH/SONET specifications.
2 Mb/s: See PDH/T-carrier specifications.
34 Mb/s Code, EM-BIP.
DS1: See PDH/T-carrier specifications.
DS3: See PDH/T-carrier specifications.
DS3 PLCP: BIP.

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Error add ratios

Single	Selected error type transmitted when "single error" key is pressed.
Rate	1.0×10^{-3}, 1.1×10^{-3}, $M.P \times 10^{-n}$ (n = 4 to 9; M.P = 1.0 to 9.9 in 0.1 steps)[1]
[1] Maximum error rate is 2.1×10^{-4} for: *– 34 M EM-BIP*	

For other error ratios refer to PDH/SDH/SONET specifications.

Alarm generation

SDH/SONET physical layers: See SDH/SONET spec.
2 Mb/s: See PDH/T-carrier specifications.
34 Mb/s: LOS, LOF, AIS, RDI.
DS1: See PDH/T-carrier specifications.
DS3: See PDH/T-carrier specifications.
DS3 PLCP: RAI.

Thru mode

SDH/SONET only: Thru mode passes the received signal unchanged to the transmit port. Payload overwrite and overhead channel overwrite operate with ATM payload in the same manner as PRBS.

ATM transmitter

ATM cell stream

Physical layer as per ITU-T I.432, ATM layer as per ITU-T I.361.

Cell streams

1 foreground, 7 background, fill cells.

A single ATM cell stream is set up as the foreground test signal. The remaining bandwidth is then filled with background cells and idle or unassigned cells.

Cell stream header

The following are settable for the foreground and all background cell streams:
UNI/NNI, GFC, VPI, VCI, PTI, CLP.

Foreground cell distribution

Service type: Constant bit rate (CBR) with settable peak cell rate (PCR) and cell delay variation tolerance (CDVT), [variable bit rate (VBR) with settable PCR, CDVT sustained cell rate (SCR) and maximum burst size (MBS)] VBR (settable PCR, SCR, MBS and CDVT), single cell or burst of cells.

SCR: Sustainable cell rate (VBR only) 0 to maximum value (step size 1 cell/s).
PCR: Peak cell rate 0 to maximum value (step size 1 cell/s).
CDVT: Cell delay variation tolerance 10 μs to 100 ms, step size 10 μs.
MBS: Maximum burst size, 1 to 2047 (VBR and single only).

Traffic is generated according to ITU-T O.191 enhanced traffic generator.

Rate synchronization

The transmit cell rates for both foreground and background traffic are synchronized to the selected timing source. Adding jitter, wander or line frequency offset does not affect the transmitted cell rate.

Foreground cell payload

Test cell as per ITU-T O.191.
Cross cell (2^{15} –1 and 2^{23} –1).
User byte.

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Background cell distribution	CBR with settable PCR.
Background cell payload	User byte.
Fill cell payload	Idle, unassigned.
Error Add	**Type:** Single HEC, double HEC, bit, lost cell, misinserted cell, errored cell. **Stream:** For foreground cells or all cells (HEC only). **Rate :** Off, 1^{-n} where n is 3 to 9, user programmable 1.1E–3 to 1.0E–9. **Burst size:** HEC errors, all cells: Selectable between 1 and 8. Lost, misinserted, errored: Selectable between 1 and 999. Single error add: A single error (or burst) of selected type is added when single key is pressed. Only when rate is off.
Transmit OAM	**OAM alarm type :** VP-RDI, VP-AIS, VP-CC, VC-RDI, VC-AIS, VC-CC (all end-to-end).

ATM receiver

ATM Physical layer structure	An ATM signal can be demapped from the following physical layers : **SDH (bulk filled):** VC-3 (into AU-3); VC-4; VC-4-4c (concatenated payload); VC-4-16c (concatenated payload). **SONET(bulk filled):** STS-1 full SPE; STS-3c full SPE; STS-12c full SPE; STS-48c full SPE. **PDH/T-Carrier:** 2 M (AMI, HDB3); 34 M (HDB3); DS1 (AMI, B8ZS); DS3 direct mapping (B3ZS); DS3 PLCP mapping (B3ZS).
Framing	As for transmitter.
Cell descrambling	On/Off (conforms to ITU-T I.432).
Header error correction	On/off.
Interface	UNI/NNI.
Cell selected for test	All user cells, VP, VC, expert mode (all bits selectable).

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Cell stream filter Selectable GFC, VPI, VCI, user data cells (ITU-T I.610).

Cell payload Test cell, cross cell $2^{15}-1$ and $2^{23}-1$, user byte, live traffic.

Policing Policing algorithm as defined in ITU-T I.371 is applied to measure cells that do not conform to tariffed parameters. Parameters are set up on receiver page.

Service type :
CBR (policing via PCR & CDVT);
VBR (policing via PCR, CDVT, SCR and MBS);
OFF;

SCR: 1 cell/s up to max. value. Format of SCR is cells/s *VBR only*;
PCR: 1 cell/s up to max value. Format of PCR is cells/s. *PCR* > *SCR*;
CDVT: Cell delay variation tolerance. 10 μs to 100 ms, step size 10 μs;
MBS: Maximum burst size 1-2047 cells.

Measurements

Physical layer alarms Signal loss, power.

SDH/SONET: See SDH/SONET specifications.
2 Mb/s: See PDH/T-carrier specifications.
34 Mb/s: AIS, LOF, RDI.
DS1: See PDH/T-carrier specifications.
DS3: See PDH/T-carrier specifications.
PLCP alarms: OOF, RAI.

Physical layer errors/events

SDH/SONET: See SDH/SONET specs.
2 Mb/s errors: See PDH/T-carrier specifications.
34 Mb/s errors: Code, EM BIP, REI, trail trace.
DS1 errors: See PDH/T-carrier specifications.
DS3 errors: See PDH/T-carrier specifications.
PLCP errors: BIP.

ATM alarms

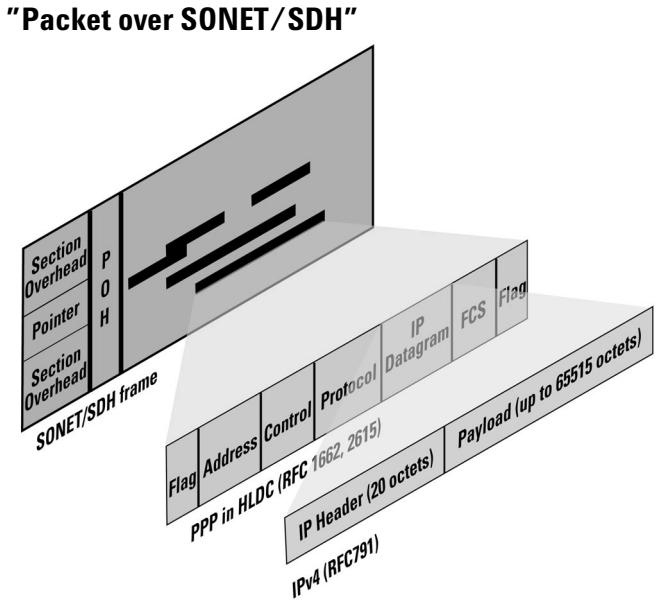
Alarm seconds are calculated for each of the following alarms:
LCD (loss of cell delineation as defined in ITU-T I.432);
SCNR (selected cell not received; no cells of selected type received for 1s);
VP AIS (alarm indication signal as defined in ITU-T I.610);
VP RDI (remote defect indication as defined in ITU-T I.610);
VP LOC (loss of continuity as defined in ITU-T I.610);
Congestion experienced (as defined in ITU-T I.361);
VC AIS (alarm indication signal as defined in ITU-T I.610);
VC RDI (remote defect indication as defined in ITU-T I.610);
VC LOC (loss of continuity as defined in ITU-T I.610);
Test cell sync loss (LPAC as defined in ITU-T O.191);
Pattern loss.

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ATM errors/events	Corrected HEC errors; Non corrected HEC errors; Received cells CLP0 (high priority); Received cells CLP1 (low priority); Received cells CLP0+1; Errored cells; Lost cells; Misinserted cells; Mean cell transfer delay; Peak-to-peak 2-point CDV; Bit error; Non-conforming cells.
ATM LEDs	VP alarm (VP AIS, VP RDI or VC LOC); VC alarm (VP AIS, VP RDI or VC LOC); LCD; Selected cell not Rx; Pattern loss (pattern loss or test call sync loss); Error.
ATM service disruption measurement	Service disruption can be measured on an ATM signal (using ITU-T O.191 test cell patent pending). The disruption period is the time from a received error free test cell to the occurrence of the next error-free test cell after an impairment has been detected. The measurement is recorded only if 200 ms of no errors occur after the disruption period.
ATM jitter measurement	Comprehensive jitter capability is available with ATM payloads. Please see the Jitter specifications for full details of the OmniBER's jitter capability.

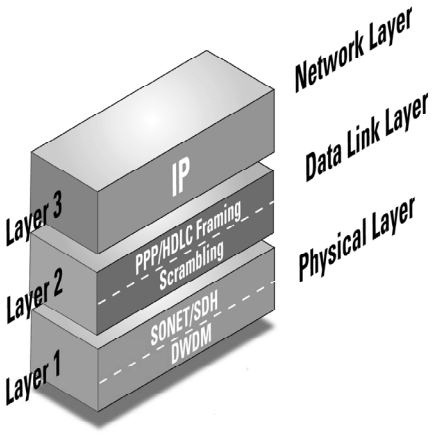
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POS (Option 310)



POS protocol stack

Packet over SONET/SDH (POS) maps IP packets into the SONET/SDH frame payload using Point-to-Point (PPP) encapsulation and High Level Data Link Control (HDLC) framing.



POS transmitter

Physical Layer

Interface Rates

SONET	SDH	Rate
OC-48	STM-16	2.5 Gb/s
OC-12	STM-4	622 Mb/s
OC-3	STM-1o/e	155 Mb/s
OC-1/STS-1	STM-0o/e	52 Mb/s

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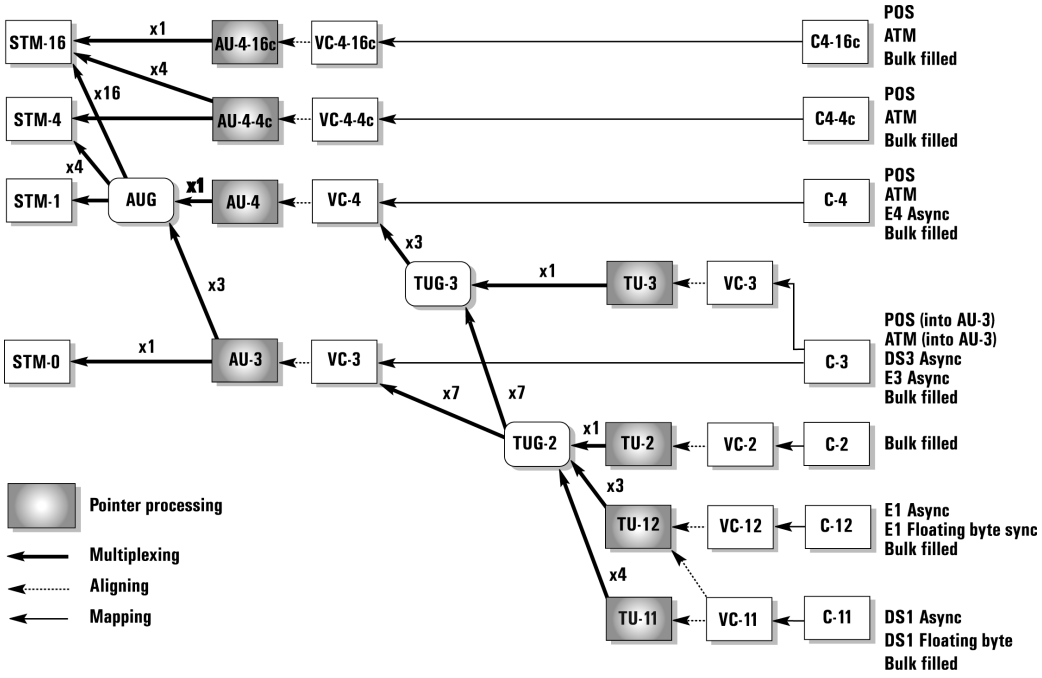


Figure 1: ITU-T G.707 mapping structure (SDH payload mapping)

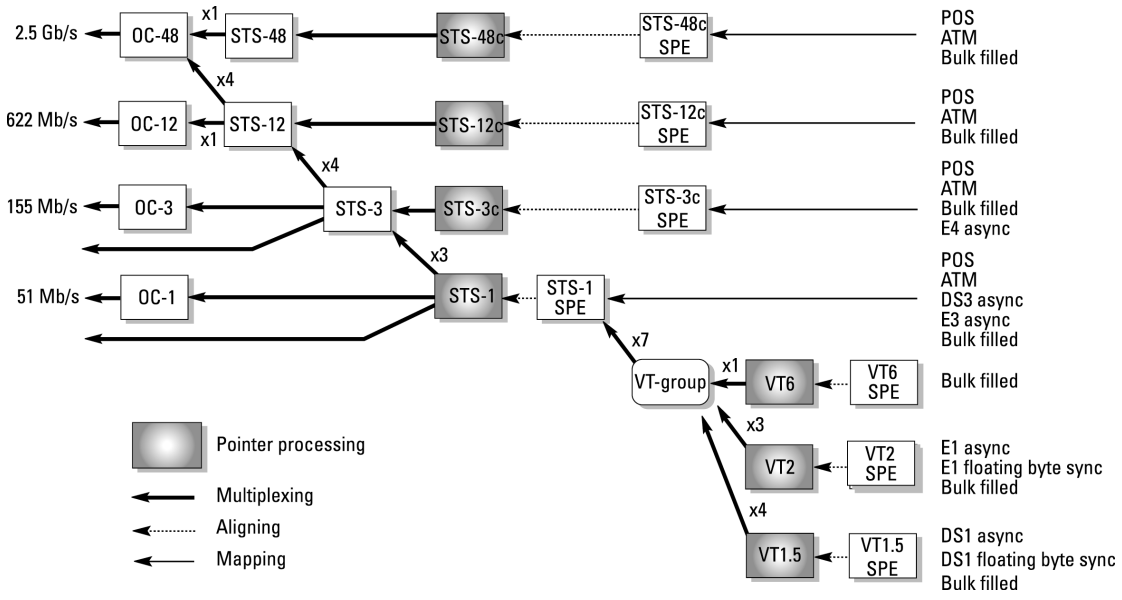


Figure 2: Bellcore GR-253 mapping structure (SONET payload mapping)

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POS payload mappings

All POS mappings can be multiplexed into the selected line rate as defined in figure 1 and figure 2

Overhead

Path signal label (C2):
Set to 0x16 to indicate PPP with x^{43}+1 scrambling
Set to 0xCF to indicate PPP without x^{43}+1 scrambling.
Multiframe indicator (H4): Set to 0.

Data Link Layer

PPP encapsulation

As per RFC1661

Protocol	Information	Padding
16 bits	Variable	Not supported

Framing

PPP encapsulated packets are mapped to frames. Two framing formats are supported:

PPP in HDLC framing (as per RFC 1662);
Cisco HDLC.

The frame structure is common to both formats as shown below:

	Flag	Address	Control	Protocol	IP Datagram	Padding	FCS	Flag
	8 bits	8 bits	8 bits	16 bits	variable		16/32 bits	8 bits
PPP in HDLC	7E	FF	03	0021				7E
Cisco HDLC	7E	0F	00	0800				7E

Flag

Inter-frame gap is configurable (1 to 2^{30}–1 octets, step size 1 octet).

Frame check sequence (FCS)

Calculated over all bits of the address, control, protocol and information fields (FCS, flags and stuffing octets not included). As defined by RFC 1662.
CRC-16 (not available at 2.5 Gb/s);
CRC-32 (all rates).

Scrambling

off: (provided for backwards compatibility with RFC 1619).
on: scrambling is performed during insertion into SONET/SDH using an x^{43}+1 polynominal.

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IP Layer

IP packet stream

Both the IP datagram size and the inter-packet gap are settable.

IP datagram size

User selectable: User, random or 7,4,1 distribution
User: settable between 20 and 65535 octets, step size 1 octect. This is the size of the entire datagram, including the 20 octet header, before any HDLC octect stuffing. When the size is set to 20, only a header is transmitted.
Random: The IP datagram size is varied randomly between minimum and maximum limits. The minimum datagram size is settable between 20 and 63 octets. The maximum datagram size can be set to one of the following values: 127, 511, 1023, 8191, 65535. There is an approximately equal probability of finding datagram sizes between min. and max. values.
7,4,1 distribution: Emulates traffic patterns by sending a repeating sequence of 12 packets in which 7 have size 40 octets, 4 have size 552 octets, and 1 has size 1500 octets.

Inter-packet gap size

User selectable: User or random.
User: Settable between 1 to 2^{30}–1 octets. Step size 1 octet.
Random: The inter packet gap is varied randomly between minimum and maximum limits. The minimum gap size is 1 octet. The maximum gap size can be set to one of the following values: 4, 32, 1024, 2^{20}, 2^{30}–1. There is an equal probability of finding inter-packet gap sizes between min and maxvalues.

Hitless re-configuration

Changing packet size or inter-packet gap size will not affect the contents of the POS frames. If a long packet is in progress, it will complete before the new size takes effect.
If a long inter-packet gap is in progress it will be terminated when the gap size is changed, and the new packet will begin immediately.

Note: At very low packet rates there may be a noticeable delay between changing a packet size, and the first occurrence of the new packet size. This is due to buffering of packet data (approximately 50 bytes) within the transmitter.

IP header

Version: 0100 (version 4).
Header length (specified in 32 bit words): 5 (fixed) i.e. no header options.
Type of service: User definable, 0 → 0xFF.
Total length: User definable (see IP datagram size above).
Identification: 0 (fixed).
Flags: User definable.
Fragment offset: 0 (fixed).
Time to live: User definable, 0 → 255 (default 64).
Protocol: User definable, 0 → 255 (default 6 – TCP).
Header checksum: automatically calculated.
Source address: settable in dotted decimal notation.
Destination address: settable in dotted decimal notation.
Options: Not supported.

IP payload data

2^{23}–1 PRBS (inverted/normal), all ones, all zeros, 0xAA55 pattern,
16 and 32 bit user defined word (Hex or Binary).

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Test Functions

Alarm generation HDLC frame loss: Asserted by transmitting a value 0x81, the logical inverse of 0x7E flag in all octets.

Error add HDLC FCS (CRC-16 or CRC-32) errors: single, 10^{-3}.
IP header checksum errors: single, 10^{-3}.
IP payload bit errors: single, 10^{-3} to 10^{-9}.

POS receiver

Physical Layer

Interface rates As for transmitter.

POS payload mappings As for transmitter.

Data Link Layer

PPP encapsulation As per RFC1661

Framing User selectable between:

PPP in HDLC framing (as per RFC 1662);
Cisco HDLC.

Flag Minimum inter-frame gap is one flag sequence.

Frame check sequence (FCS) User selectable between:
CRC-16 (not available at 2.5 Gb/s);
CRC-32 (all rates).

Descrambling off, on (default).

MPLS The receiver automatically handles any number (from 0 upwards) of 4-octet MPLS Shim headers. MPLS shims are silently removed and the IP datagram is processed as usual. MPLS unicast and multicast protocol fields (0x281, 0x283, 0x8847, 0x8848) handled by receiver.

IP Layer

IP header The receiver can support variable length IP header options.

IP payload data 2^{23}–1 PRBS (inverted/normal), all ones, all zeros, 0xAA55 pattern,
16 and 32 bit user word (Hex or Binary), live traffic.

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Measurements

Physical layer alarms

Power loss.
SDH/SONET : See SDH/SONET specifications.

Physical layer errors/events

SDH/SONET : See SDH/SONET specifications.

POS alarms/LEDs

HDLC link loss
IP not Rx
Pattern loss.

POS errors

HDLC FCS errors (count and ratio): The number of HDLC frames received with the FCS in error.
IP header errors (count and ratio): The number of IP datagrams received with an error in the header, where any of the following will be counted as an IP header error:
– header length shorter than 20 octets
– header checksum error
– error in MPLS formatting
IP payload bit errors (count and ratio): The number of errors in the IP payload.

Any of above will cause the red 'error' LED to light.

POS events

Transmit packet rate (packets/s).
HDLC Frame (count, frames/s).
IP datagrams (count and rate).

Service disruption

Service disruption can be measured with POS payloads.
The disruption period is the time from the end of a received error-free packet to the occurence of the next error-free word. The measurement is recorded only if 200 ms of no bit errors occur after the disruption period.

General

Thru mode

The transmitter can be configured to retransmit the signal being input to the receiver.
The following modes are available with POS payloads:
Transparent mode: signal unaltered.
Overhead overwrite: The test features associated with the TOH/POH can be enabled to overwrite one single or multi-byte overhead channel.
STS overwrite: Overwrites the complete SPE with internal payload. This enables the TOH to be looped while a new payload is inserted.
AU-4/AU-3 overwrite : Overwrites the complete AU-4/AU-3 with internal payload. This enables the TOH and background AU-4/AU-3's to be looped while a new payload is inserted.

Jitter

Comprehensive jitter capability is available with POS payloads. Please see the Jitter specifications for full details of the OmniBER's jitter capability.

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General

Disk drive

Configurations	Save/recall of instrument configurations to/from floppy disk drive (in addition to the 5 internal stored settings).
Graphics	Save/recall of stored measurements graphics (SMG) to/from floppy disk drive. Extends internal event based storage from 10,000 events to 310,000 events.
Logging	Direction of logging output to floppy disk drive.
PC results format	Save SMG (stored measurement graphics) results in a CSV (comma separated variable) PC compatible format for importing to PC spreadsheets etc.
Screen dumps	Save screen dumps to disk in Windows-compatible .BMP format.
Disk management	Instrument provides the following disk drive features: Copying of instrument measurement graphics files to/from internal instrument storage to/from floppy disk drive. Copying of stored measurement graphics files from internal instrument storage to floppy disk drive. Deleting files or directories from floppy disk drive. Renaming of files. Labeling of floppy disks. Formatting of floppy disks.
Firmware upgrades	Allows the upgrading of instrument firmware from the floppy disk drive.

Graphics/logging

Max test result stores	10 internal SMG stores (stored graphics and data) (increases with floppy disk drive – number of stores limited only by free disk space).
Graphic display or printout	Bar chart (results versus time periods with up to 1 second resolution) for current or stored measurement period.
Storage capacity	10,000 events (increases to 310,000 events with floppy disk drive).
Bar resolution	1 second or 1, 15, 60 minutes.
PDH/DSn bar graphs	**PDH:** Bit, code, frame, CRC, REBE plus all PDH alarms. **DS1/DS3:** Bit, BPV, frame, CRC6, P-bit, C-bit, FEBE plus all DSn alarms.
SONET/SDH bar graphs	Frame errors (A1A2), B1, B2, MS FEBE, B3, HP FEBE, HP IEC, LP BIP, LP FEBE bit errors.
POS bar graphs	HDLC FCS, IP header, IP payload errors. HDLC link loss, IP not Rx, PSL alarms.
Printing/logging	Results, time, date and instrument control settings to internal/external printer or floppy disk drive. **Print/logging period:** 10 minutes, 1 hour, 24 hours, user-defined (10 to 99 minutes, or 1 to 99 hours).

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Printers

The OmniBER 718 can print to an external printer or the in-lid printer (option 602)

		OmniBER 718 Option 602	External Printer
Results logging	Logging of instrument results to printer.		
Graphics logging	Logging of instrument graphics results to printer.		
Screen dump	Full-width printing of instrument screen to printer at press of a key.		–
Environmental	Printer operating temperature:	5 to 35°C	n/a
	Printer storage temperature:	–15 to +50°C	n/a
	Printer humidity range:	30% to 85% RH	n/a

Remote control/printer interface (option 601)

Capability

RS-232-C printer/remote-control interface.

HP-IB printer/remote-control interface.

Parallel printer interface.

LAN remote control interface.

General

Preset facility

Complete instrument configurations can be saved in non-volatile memory. Four independent configurations can be saved. Each store has a user-programmable name (disk drive increases storage – number of stores only limited by free disk space).

Supply

90 to 260 Vac nominal;
47 to 63 Hz, 450 VA nominal.

Dimensions

7.5 (H) × 13.40 (W) × 18.5 in (D) (× 20.10 in (D) with lid fitted).
190 (H) × 340 (W) × 470 mm (D) (× 510 mm (D) with lid fitted)

Weight

16 kg (typical); 35 lb.

Internal clock error

Basic accuracy: < 0.5 ppm at 77 °F (25 °C).
Temperature stability: < 3 ppm over operating temperature range.
Ageing rate: < 1 ppm per year.

Environmental

Operating temperature: 32 to 113°F (0 to 45 °C).
Storage temperature: 68 to 168 °F (–20 to + 70 °C).
Humidity range: 15% to 95% RH.

"This instrument is designed for use in installation category II and pollution degree two per IEC 61010.0 – 1 and 60664 respectively."

CE mark

ESD/Electrical fast transients/radiated susceptibility: Meets EN50082-1 (1992).
Radiation emissions/conducted emissions: Meets EN55011 (1991).

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Regulatory standards

Product safety	EN 61010-1 (1993); IEC 1010-1 (1990) +A1 (1992) +A2 (1995); CSA C-22.2 No 1010.1-92.
EMC compatibility	**Immunity:** EN 50082-1 (1992); **Emmissions:** EN 55011 (1991), Group 1 Class A.
Laser safety standards	21 CFR CH.1 1040; EN 60825-1 (1994).

Accessories

Optical accessories	**E4545A:** 3 m fiber optic cable (FC/PC connectors) **E4546A:** FC/PC 15 dB attenuator.
Optical coupler	**15744B:** In-lid optical coupler. **15744C:** In-pouch optical coupler.
Carrying cases	**15910B:** Soft, vinyl carrying case. **15772C:** Hard, robust transit case.
Rack mount kit	**15989A:** Rack mount kit. **15990A:** Connector access panel (see publication number 5968-2793E).
Warranty	1-year warranty as standard.
Calibration certificate	**Option UK6:** Commercial calibration certificate with test data.
Graphics printer paper	**9270-1360:** Printer paper.
Telephone handset	**15722A:** Telephone handset for option 012.

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Agilent Technologies manufactures the OmniBER 718 analyzer under a quality system approved to the international standard ISO 9001 plus TickIT (BSI Registration Certificate No FM 10987).

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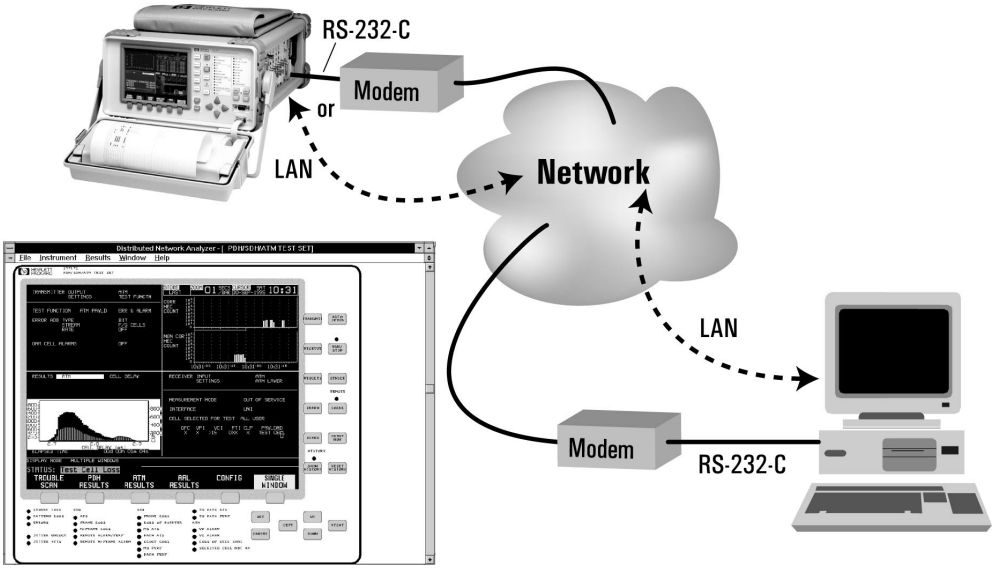
Distributed network analyzer (DNA) features

Use E4540A DNA software to pin-point elusive network faults and identify links with poor performance. The DNA software's long-term testing and automatic results logging capability let you easily monitor the quality of service you provide to key customers.

Monitor the network to identify performance and signal degradation. Interactively control analyzers for faster problem resolution.

Create and run your own customized test sequences effectively.

Transfer results to other Windows®-based applications and provide detailed quality-of-service information for managers and customers.



Distributed/remote testing

E4540A distributed network

PC/laptop/MS Windows® software (Windows 3.1, Windows NT or Windows 95) that allows control of the 377xx family of analyzers via a virtual instrument display. Allows remote user to store and recall instrument configurations, create and run test sequences, transfer test results to other Windows-based applications and provide quality-of-service information for managers and customers.

Option 0A9: License to use up to 10 copies.
Option UAT: License to use unlimited copies.

For full details of centralized testing using the OmniBER 718 analyzer and other telecom testers from Agilent Technologies, please ask your local Agilent representative for brochure 5988-5256EN (distributed network analyzer software).

Also order an RS-232-C or LAN remote control interface (option 601).

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The OmniBER 718 is a
Class 1 laser product
EN60825-1: (1994)

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



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