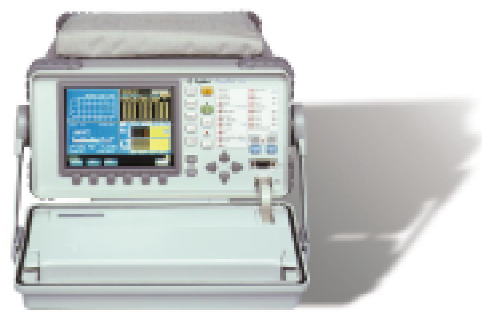
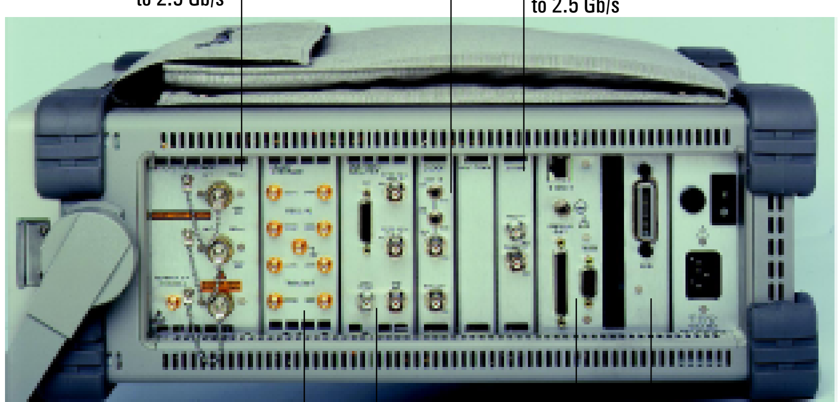
Agilent Technologies *OmniBER 725* communications performance analyzer specifications (J1409-90053)

The OmniBER 725 combines the best in class SDH and SONET jitter capability at all rates up to 2.5 Gb/s with the ability to interface the test set electrically to SDH/SONET modules and components. This combined with the ability to test the entire 2.5 Gb/s signal using 'raw' PRBS generation or the entire payload capacity using concatenated payloads means that the OmniBER 725 is the fastest and most accurate way to qualify SDH/SONET devices.



This document applies to the J1408A for bit error testing and J1409A for BER and jitter testing.

Side view



Summary of capabilities

Best-in-class jitter performance

The OmniBER 725 communications performance analyzer offers extensive measurement capability at 2.5 Gb/s, 622 Mb/s, 155 Mb/s and 52 Mb/s rates to manufacturers building components and modules for SDH/SONET network equipment. The analyzer provides optical and binary interfaces for applications where access to electrical clock and data signals is required. Plus, it provides a range of bit error ratio (BER) and jitter measurements, to ITU-T/ Bellcore standards, to thoroughly verify the error and jitter performance of modules before their integration into operational systems.

Jitter capability to ITU-T 0.171/0.172 is available from 2.5 Gb/s through 622/155/ 52 Mb/s. Jitter generation and measurement can be performed on both optical and electrical clock signals. Automatic jitter tolerance and automatic narrowband jitter transfer testing is available to ITU-T G.958 for SDH network elements and NL-GR-253 for SONET. Full jitter and wander generation to ITU-T G.825 is supported at all rates, plus SDH/SONET line rate jitter to ITU-T G.958/ GR.253 with RMS and peak-to-peak jitter measurements.

In addition, the analyzer provides ITU-T G.707/GR.253 mapping support including concatenated payloads at STM-1/OC-3c, STM-4c/OC-12c and STM-16c/OC-48c. Optical 1310nm and 1550nm interfaces are also supported.

Differential and single-ended electrical interfaces

Differential interfaces are commonly used because of their superior signal to noise performance. The OmniBER 725 provides the flexibility to interface to differential components and modules. This potentially reduces the test time by at least half when compared to testers providing only single ended test signals. Not only is the test time dramatically reduced, the test is more realistic as it tests both halves of the signal simultaneously and means that nothing is left to interpretation.

Raw (unframed) PRBS generation and analysis

To test the entire signal payload and overhead area with one simple and fast test, the OmniBER 725 allows the SONET/SDH frame structure to be turned off. In this mode, the analyzer can generate a raw PRBS pattern to quickly and accurately characterize the BER and jitter performance of the device under test.

Payload concatenation

To rigorously test fiber optic transmitter and receiver modules, the OmniBER 725 is equipped with concatenated payloads.

Full overhead access

The analyzer provides ITU-T G.707/GR.253 mapping support including concatenated payloads at STM-1/OC-3c, STM-4c/OC-12c and STM-16c/OC-48c. Full transmit and receive access to overhead and section trace messages.

SmartTest

The front panel SmartTest key offers a simple shortcut to the extensive capabilities of the OmniBER 725 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:

- Optical power measurement
- Line frequency measurement
- Error and alarm summary results
- Jitter measurement.

Large color display

The color VGA display on the OmniBER 725 analyzer operates in single- or multi-window mode. In multi-window mode, four windows are displayed 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 a VGA projector for training purposes.

Other features of the OmniBER 725

- Troublescan automatically scans for all possible error and alarm conditions
- Payload offset test
- SDH/SONET error and alarm generation/detection
- 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.826, M.2101, M.2110, M.2120
- Graphical results storage

Interface specifications

Optical interfaces

Wavelength Option 104 Option 105 Option 106	 1310 nm 1550 nm 1310/1550 nm
Rates	2.5 Gb/s, 622 Mb/s 155 Mb/s 52 Mb/s
Connectors	FC/PC (standard) SC (option 610) ST (option 611) ***Notes:*** *Optical interfaces on the OmniBER 725 use a customer exchangeable connector system.*

Optical transmitters

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

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

Optical receiver

Line code	NRZ
Wavelength	1280 to 1335 nm and 1500 to 1580 nm
Sensitivity	STM-16: –28 dBm STM-4/1/0: –28 dBm, typically –34 dBm
Max input power	–8 dBm
Fiber pigtail	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. *The optical receiver operates over the range 1200 to 1600 nm. Sensitivity and maximum input power specifications are valid in defined wavelength ranges.*

Electrical Transmitter

Level	800 mV $\pm$ 200 mV with 50 ohm termination load			
Output Impendance	50 ohm ac			
	2.5 Gb/s	622 Mb/s	155 Mb/s	52 Mb/s
Rise time, fall time	$<$ 120 ps	$<$ 480 ps	$<$ 1920 ps	$<$ 2000 ps
Overshoot	Typically $<$ 15%			
Clock polarity control	Normal or inverted			
Connector	SMA			

The clock and data transmit signals remain active whenever an optical signal is selected.

Electrical Receiver

Level (minimum)	200 mV			
Level(maximum)	1.2 V			
	2.5 Gb/s	622 Mb/s	155 Mb/s	52 Mb/s
Clock to Data Max Skew	$\pm$ 100 ps	$\pm$ 400 ps	$\pm$ 1600 ps	$\pm$ 4800 ps
Termination	50 ohm ac			
Data polarity control	Normal or inverted			
Connector	SMA			

Protected monitor point input (on optical modules)

622 Mb/s, 155 Mb/s and 52 Mb/s.
Line code: NRZ.
Level: Nominal 1 V peak-to-peak into 50 ohms.
Connector: SMA female.

Coded Electrical line rates/interfaces

STM-1e (CMI), STM-0e (B3ZS).
Connector: BNC, 75 ohm nominal unbalanced.
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.

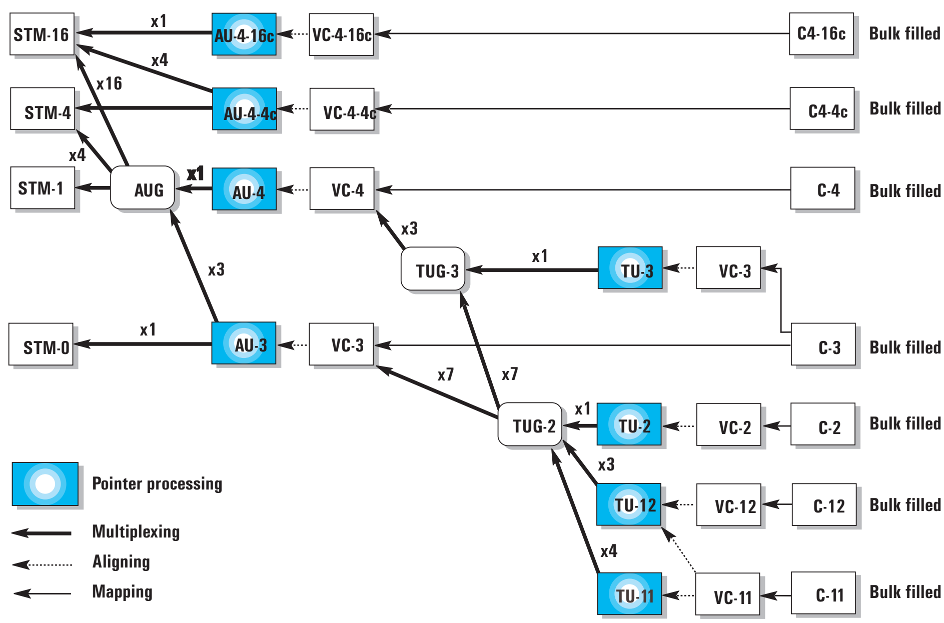


Figure 1: ITU-T G.707 mapping structure (SDH payload mapping)

Transmit signals	Provision to transmit the following SDH signals: STM-16, STM-4, STM-1, STM-0.
Receive signals	Provision to transmit the following SDH signals: STM-16, STM-4, STM-1, STM-0.
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 (10 MHz, 2M); 3 pin Siemens 120 ohm balanced (2M, BITS, 64 kb/s); Bantam 100 ohm balanced (1.5 M).
Clock trigger	**Divided clock output:** 51.840 MHz for STM-16/STM-4/STM-1, 8.65 MHz for STM-0. **Connector:** BNC, ECL 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.

SDH multiplexing structure (includes AU-4 and AU-3 mappings to ITU-T G.707).

STM-16: VC-4-16c, VC-4-4c (concatenated payloads).
STM-4: VC-4-4c (concatenated payloads).
VC-4→STM-N.
VC-3→TU-3→VC-4→ STM-N.
VC-3→AU-3→STM-N.
TU-2:
TU-2→TU-3→VC-4→STM-N (TU-2-Nc concatenated payloads).
TU-2→VC-3→AU-3→STM-N (TU-2-Nc concatenated payloads).
VC-12→TU-12→VC-4→STM-N.
VC-12→TU-12→VC-3→AU-3→STM-N.
VC-11→TU-12→VC-4→STM-N.
VC-11→TU-11→VC-4→STM-N.
VC-11→TU-11→VC-3→AU-3→STM-N.

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.

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 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.

SDH tributary scan

Automatically test BER on each SDH tributary for error free operation. Receiver 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*

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

- Periodic Single
- Periodic Burst
- Periodic Phase Transient Burst
- Alternating Single
- Alternating Double
- Regular with Added
- 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 userdefined or predefined 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.
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. **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 sixteen 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, when in SDH mode. Not available in unframed mode. **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.
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, M.2101, M.2110, M.2120.
AlarmScan/alarm and 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

Ten 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.

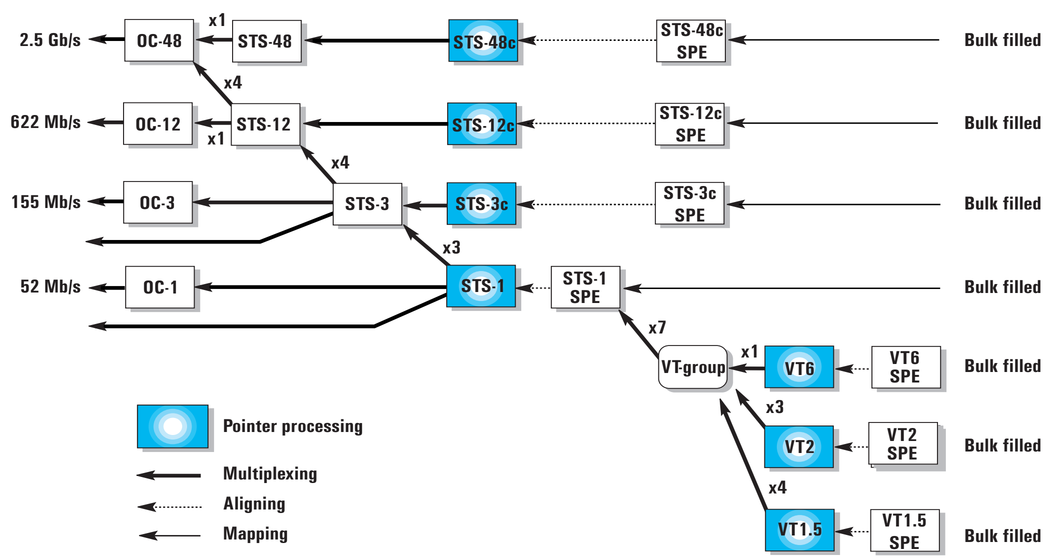


Figure 2: Bellcore GR-253 mapping structure (SONET payload mapping)

Transmit signals	Provision to transmit the following SONET signals: OC-48, OC-12, OC-3, OC-1, STS-1, STS-3, STS-12, STS-48.
Receive signals	Provision to transmit the following SONET signals: OC-48, OC-12, OC-3, OC-1, STS-1, STS-3, STS-12, STS-48.
Clock reference	**Internal:** $\pm$ 0.5 ppm; stability: $\pm$ 3 ppm; Ageing: $\pm$ 1 ppm. **Loop-timed:** Clock recovered from receiver's SONET input. **External reference:** 1.5 M (BITS), 64 kb/s, 10 MHz, **Connector:** BNC 75 ohm unbalanced (10 MHz); Bantam, 100 ohm balanced (BITS, 64 kb/s).
Clock trigger	**Divided clock output:** 51.840 MHz for OC-48/OC-12/OC-3/STS-3, 8.65 MHz for OC-1/STS-1. **Connector:** BNC, ECL 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	$\pm$ 999 ppm in 0.1 ppm steps; offset accuracy $\pm$ 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.
SONET tributary scan	Automatically test BER on each SONET tributary for error free operation. Receiver 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, $\geq 10^{-3}$,$\geq 10^{-6}$.
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.

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

- Periodic single
- Periodic burst
- Periodic phase transient burst
- Alternating single
- Alternating double
- Periodic with added
- 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.

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.
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.
Optical stress test	Payload is overwritten with a block of zeros or ones after scrambling to stress timing recovery circuits, when in SDH mode. Not available in unframed mode. **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 VTs 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.
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.

Frequency measurement	**OC-48:** Frequency displayed in kHz with a 0.1 kHz resolution. Offset in ppm/kHz $\leq$ **OC-12:** Frequency displayed in Hz with a 1 Hz resolution. Offset in ppm/Hz. **Accuracy:** $\pm$ 1 Hz $\pm$ (internal clock error[1]) $\times$ 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.

Interfaces	Binary and optical
Transmit signals	2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s,
Receive signals	2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s,
Terminology	Unframed SDH and unframed SONET Provides raw test pattern without a SONET or SDH frame structure. Enables testing of the entire signal bandwidth.
Clock reference	**Internal:** ± 0.5 ppm; stability: ± 3 ppm; Ageing: ± 1 ppm. **Loop-timed:** Clock recovered from receiver's SONET input. **External reference:** 2M (MTS) 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:** 51.840 MHz for STM-16/OC-48/STM-4/OC-12/STM-1/OC-3/STS-3, 8.65 MHz for OC-1/STS-1. **Connector:** BNC, ECL ac coupled, 50 ohm.
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.
Test patterns	2^9 -1, 2^{11}-1, 2^{15}-1, 2^{23}-1 (inverted or non-inverted), 1010.
Alarm generation	LOS, Pattern Sync Loss.

Error generation	**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]

Error detection Bit errors (error count, error ratio).

Jitter generation Refer to jitter section of this document.

Jitter measurement Refer to jitter section of this document.

Optical power measurement
Accuracy: ± 2 dB; Range: –10 dBm to –30 dBm.
Wavelength: 1310 nm or 1550 nm.
Resolution: 0.1 dBm.

Frequency measurement
2.5 Gb/s: Frequency displayed in kHz with a 0.1 kHz resolution.
Offset in ppm/kHz
≤ **622 Mb/s:** 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.*

Jitter

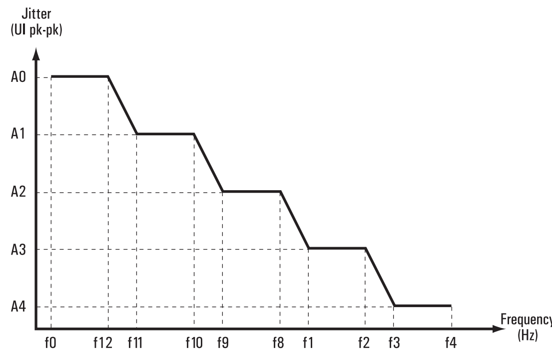
(J1409A only)

1. Jitter generation

Jitter generation interfaces	Optical, binary, coded electrical. When in binary mode both clock and data signals have jitter added.
Jitter generation rates	2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s.
Wander generation interfaces	Optical, binary, coded electrical. When in binary mode both clock and data signals have wander added.
Wander generation rates	2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s.
External jitter modulation input	**Input range:** 20 UI: SDH/SONET rates. 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.172 for SDH jitter generation. Exceeds the network equipment requirements of 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, Bellcore GR-253.
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), 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.

ITU-T 0.172
SDH jitter
generation requirements

ITU-T 0.172 jitter amplitude versus modulation frequency:



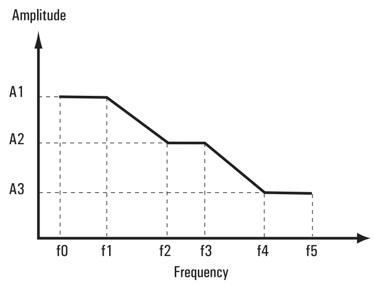
ITU-T O.172 SDH jitter amplitude versus modulation frequency:

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 725 exceeds above requirements of ITU-T O.172*

Bellcore GR-253-CORE SONET jitter tolerance

Bellcore GR-253 jitter amplitude versus modulation frequency:

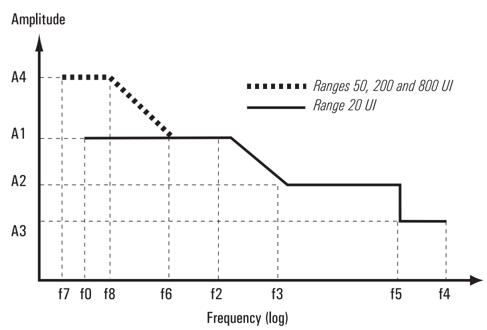


Bellcore GR-253 jitter amplitude versus modulation frequency table

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

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

Jitter generation modulation range

Range (UI)	Line Rate (Mb/s)	Min (UI) (UI)	Max (UI) Range	Amplitude Resolution	Modulation Frequency
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

[1] *Refer to f4 in SDH/SONET 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:

SDH/SONET generator intrinsic jitter:

Bit Rate (kb/s)	Y (UI) 1010 Data Pattern	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:

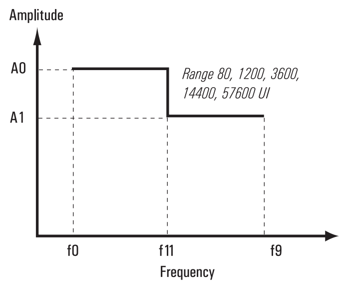
Additional frequency response term Z[1]	
1 to 5 MHz	± 2%
5 to 10 MHz	± 3%
10 to 20 MHz	± 5%

1 *Applies to SDH/SONET generation only.*

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)
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	10 μHz	0.125 Hz
1200	0.5	1200	0.5		
3600	0.5	3600	0.5		
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.

3. Jitter measurement

Jitter measurement interfaces Optical, binary (clock), coded electrical.

Jitter measurement rates 2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s.

Wander measurement interfaces Optical, binary (clock), coded electrical.

Wander measurement rates 2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 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]
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	500 m	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

Jitter measurement bandwidth

		Jitter measurement bandwidth			
Rate	Range (UI)	F_L (Hz)	F_{min} (Hz)	F_{max}	F_U
155 Mb/s	1.6	10	500	1.3 MHz	2.6 MHz
155 Mb/s	16	10	200	100 kHz	150 kHz
622 Mb/s	1.6	10	1000	5 MHz	5 MHz
622 Mb/s	16	10	500	1040 kHz	1.3 MHz
2.5 Gb/s	1.6	10	5000	20 MHz	20 MHz
2.5 Gb/s	64	10	2000	2.8 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.172 (SDH); 12 kHz HP filter.

	HP1 (Hz)	HP2 (kHz)	LP (kHz)	HP rms (kHz)
155 Mb/s	500	65	1300	12
622 Mb/s	1000	250	5000	12
2.5 Gb/s	5000	1000	20000	12

Extended range jitter measurement bandwidth

		Jitter measurement bandwidth[1]			
Rate	Range (UI)	F_L (Hz)	F_{min} (Hz)	F_{max}	F_U
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

The peak-to-peak accuracy for SDH/SONET rates is specified as ± 5% of reading ± W ± Z as is the convention in ITU-T recommendation O.172 where W represents the intrinsic jitter (as per ITU-T O.171/O.172) for a given data pattern and receiver range, and where Z represents the frequency response term of the receiver. The typical rms accuracy for SDH/SONET rates is specified as ± 5% of reading ± W ± Z.

SDH/SONET system intrinsic term W:

Bit rate (kb/s)	Range	Data pattern			
		System		Receiver only[1]	
		STM-n[2]c with PRBS[3] scrambled payload		STM-nc with PRBS scrambled payload	
		W[4,5,6]		W[4,5,6]	
		UI p-p	UI rms[1]	UI p-p	UI rms
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
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
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
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

1 *Typical specification only.*
2 *Variable n corresponds to the line bit rate, STM-1, 4 or 16.*
3 *The PRBS used will be of length ($2^{23}-1$).*
4 *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.*
5 *Intrinsic limits for a calibrated OmniBER 725 transmitter and receiver pair.*
6 *Unframed optical operation may result in degradation of W term due to baseline offset and retiming issues with some unscrambled patterns. The W term is therefore typical when using unscrambled signals with low timing content.*

SDH/SONET receiver frequency inaccuracy term Z:

Bit rate (kb/s)	Additional frequency response error[1,2]
51840	± 2% of reading from 100 Hz to 300 kHz ± 3% of reading from 300 kHz to 400 kHz
155520	± 2% of reading from 500 Hz to 300 kHz ± 3% of reading from 300 kHz to 1 MHz ± 5% of reading from 1 MHz to 1.3 MHz
622080	± 2% of reading from 1000 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 5 MHz
248830	± 2% of reading from 5000 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 10 MHz ± 15% 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.*

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), elapsed 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).

4. Jitter transfer

Jitter measurement — **Optical, binary (clock), coded electrical.**

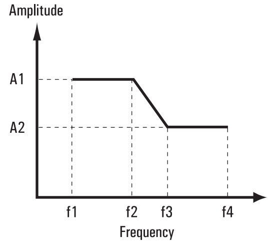
Jitter transfer rates — 2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 Mb/s.

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.
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.

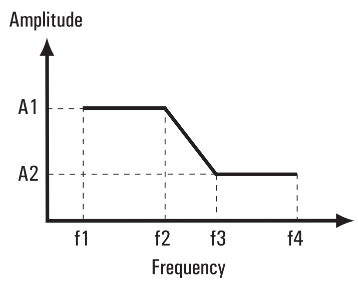
Generated jitter amplitude versus modulation frequency:



SDH jitter transfer input masks:

Rate (Mb/s)	Mask	F1 (Hz)	F2 (Hz)	F3 (kHz)	F4 (kHz)	A1 (UI)	A2 (UI)
155	G.958, Type A	500	6.5 k	65	1300	1.5	0.15
	G.958, Type B	500	1.2 k	12	1300	1.5	0.15
622	G.958, Type A	1 k	25 k	250	5000	1.5	0.15
	G.958, Type B	500	1.2 k	12	5000	1.5	0.15
2488	G.958, Type A	5 k	100 k	1000	20000	1.5	0.15
	G.958, Type B	500	1.2 k	12	20000	1.5	0.15

Generated jitter amplitude versus modulation frequency:

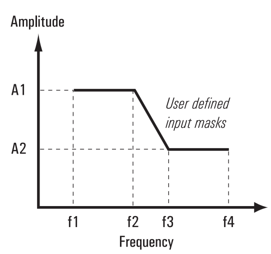


SONET jitter transfer input masks:

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 52 Mb/s	1.3 MHz 400 kHz

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

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]

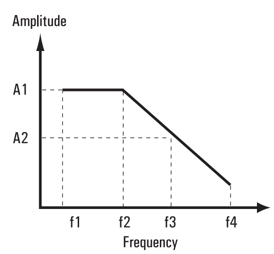
Rx Jitter (UI)	Accuracy[2] (dB)
> 0.3	0.04
0.3 to 0.1	0.15
0.1 to 0.03	0.25
0.03 to 0.01	0.5
0.01 to 0.003	1
0.003 to 0.001	3

[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.

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)
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: *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.

5. Wander measurement

Wander generation interfaces

Optical, binary (clock), coded electrical.

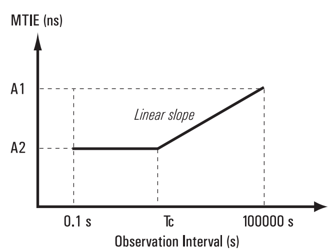
Wander measurement rates

2.5 Gb/s, 622 Mb/s, 155 Mb/s, 52 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.

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	Logging of instrument results 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.
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).

Printers

The OmniBER 725 can print to an external printer or the in-lid printer (option 602)

		OmniBER 725 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

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

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.

OmniBER 725 is a
Class 1 laser product
EN60825-1: 1994

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

CE

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Agilent Technologies manufactures the OmniBER 725 analyzer under a quality system approved to the international standard ISO 9001 plus TickIT (BSI Registration Certificate No FM 10987).