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JDSU

COMMUNICATIONS TEST & MEASUREMENT SOLUTIONS

ONT-503/-506/-512

Optical Network Tester 40/43 Gb/s Test Solution

February 2008 edition

InfoVision AWARD FINALIST

2007 FROST & SULLIVAN Global Communications Test & Measurement Company of the Year Award

The first all-in-one telecom box

Key Features

- **40/43 Gb/s optical and electrical interfaces in a single instrument**
- **SDH STM-256 and SONET OC-768 concatenated and fully structured signals**
- **OTM0.3 with PRBS or SDH/SONET client**
- **Unframed 39.813 Gb/s and 43.018 Gb/s BER testing**
- **Alarm, error, overhead, and pointer generation and analysis**
- **Jitter/ Wander generation and analysis for 40/43 Gb/s**

Optical transport networking

New 40/43 Gb/s networks will allow operators to further enhance transport capacity in the optical network, extend distances between systems, and improve its flexibility and responsiveness in setting up new high-bandwidth services as well as lowering operating costs for these services.

Market drivers

High-end core routers with 40 Gb/s short reach interfaces are becoming an important market driver, reducing the number of interconnecting fibers within the central office. Big benefits are the lower cost, space and power consumption. In long-haul networks, a key to 40 Gb/s migration is the ability to utilize the existing line system. In metro-regional networks, e.g. city-hoppers applications, 40 Gb/s can also be used very cost effectively.

Challenges

New, high bit rate networks create enormous challenges for equipment vendors not only because they push the boundaries of physics, but also because every network component must be perfectly designed, installed and tuned. The point at which networks are installed, turned up and commissioned will prove critical. A new generation of test equipment capable of meeting the demands of 40/43 Gb/s systems will be required at each stage of network design, system verification and validation, network installation, maintenance, and troubleshooting.

Optical transport test solution

The JDSU ONT-5xx enables evaluation and characterization of 40/43 Gb/s electrical/ optical devices. The ONT supports unframed BER testing, and framed SDH/SONET/OTN functional testing including jitter/ wander generation and analysis. The modular concept starts with 3 slots for 40 Gb/s optical framed and unframed. Further modules can be added to enable electrical interfaces and jitter/ wander applications. In addition, the programmable hardware architecture allows to add a payload module for the combined OTN with SDH/SONET client testing and to assure the future-proof for further applications.

ONT-503 mainframe

Highlights

- 3 slots to cover multiple ports/applications
- Large 15" TFT touchscreen
- Interchangeable plug-in modules for most flexible use
- Linux operating system
- Easy test automation with full featured driver support

The ONT-503 is a 3-slot mainframe test solution with true multi-port operation for interactive and automated applications.

'Plug-in' modules allow for easy upgrade in the field and exchange of interfaces among ONT-503 mainframes as well as between ONT-506 and ONT-512 mainframes.

As part of the ONT-5xx family, the ONT-503 supports all modules available for the family and uses the same software concept as the ONT-506. Therefore, developed scripts can be used and training times for users are minimized.

General specifications

Power supply (nominal range of use)

AC line voltage	100 to 240 V
AC line frequency	50/60 Hz, ± 5%
Power consumption (fully equipped)	max. 350 VA
Safety class to IEC 61010-1	class I

Ambient temperature

Nominal range of use	+5 to +40 °C/ 41 to 104 °F
Storage	–20 to +45 °C/ –4 to +113 °F
Transport	–40 to +70 °C/ –40 to 158 °F
Dimensions, including handle/bumpers (w × h × d)	360 × 392 × 185 mm, 14.1 × 15.4 × 7.3 in
Weight (without modules)	approx. 10 kg/ 21.5 lb

Clock and synchronization

Internal master clock accuracy	± 2.0 ppm (exceeds T1.101 stratum 3/3E accuracy)

External synchronization

Connector, unbalanced	75 Ω, BNC jack
Clock source	DS1, E1, 1544 kHz, 2048 kHz, 1 MHz, 5 MHz, 10 MHz
Connector, balanced	110 Ω, Bantam jack
Clock source	DS1, E1, 1544 kHz, 2048 kHz

From RX

Each module may use its received signal clock information as reference for its transmitter.

Clock output

Connector, unbalanced	75 Ω, BNC jack

Instrument operation

The ONT-503, which uses the Linux operating system, supports three types of operation:

- Local GUI via built-in touchscreen
- Customer script controlled for test automation
- Remote operation via LAN

Touchscreen display

Large color TFT	15"
Resolution	1024 × 768 (XGA)

Interfaces, storage, data transfer

The ONT-503 uses a Pentium PC as internal controller allowing to run Linux applications as well.

Interfaces	Ethernet (RJ45), USB, external keyboard, mouse, VGA, DVI

CD R/W/DVD-ROM drive for data transfer and software update.
PC Pentium M, 1.8 GHz, 1 GB RAM

Hard drive for data/setup storage	≥ 40 GB

Remote control for test automation

The ONT-503 is controlled remotely via SCPI commands sent by the customer's program using an Ethernet TCP/IP connection.

Modules are addressed independently and in parallel and may be shared among multiple users.

Universal driver libraries facilitate automation with specific support for individual applications.

Scripting support via Tcl/Tk and C libraries and LabWindows drivers.

The interactive GUI also works in parallel to remote control, so that it is very easy to develop automated scripts.

ONT-506 mainframe

Highlights

- 6 slots to cover multiple ports/applications
- Large 15" TFT screen
- Plug-in modules
- Linux operating system
- Driver support

The ONT-506 is a 6-slot mainframe test solution with true multi-port operation for local and remote controlled applications.

'Plug-in' modules allow for easy upgrades in the field and exchange of interfaces among ONT-506 mainframes as well as between the ONT-506 and ONT-512 mainframes.

General specifications

Power supply (nominal range of use)

AC line voltage	100 to 240 V
AC line frequency	50/60 Hz, ± 5%
Power consumption (fully equipped)	max. 650 VA
Safety class to IEC 61010-1	class I

Ambient temperature

Nominal range of use	+5 to +40 °C/41 to 104 °F
Storage	–20 to +45 °C/–4 to +113 °F
Transport	–40 to +70 °C/–40 to 158 °F
Dimensions, including handle/bumpers (w × h × d)	450 × 335 × 435 mm, 17.7 × 13.2 × 17.1 in
Weight (without modules)	approx. 17 kg/ 37.5 lb

Clock and synchronization

Internal master clock accuracy	± 2.0 ppm (exceeds T1.101 stratum 3/3E accuracy)

External synchronization

Connector	75 Ω, unbalanced, BNC jack
Clock source	DS1, E1, 1544 kHz, 2048 kHz, 8 kHz, 1MHz, 5 MHz, 10 MHz
Connector	110 Ω, balanced, bantam jack
Clock source	DS1, E1, 1544 kHz, 2048 kHz

From RX

Each module may use its received signal clock information as reference for its transmitter.

Clock outputs

Connector	75 Ω, unbalanced, BNC jack
Connector	110 Ω, balanced, bantam jack

Instrument operation

The ONT-506, which uses the Linux operating system, supports three types of operation:

- Local GUI via built-in touchscreen
- Remote control, for test automation
- Remote operation via LAN

Touchscreen display

Large color TFT	15"
Resolution	1024 × 768 (XGA)

Interfaces, storage, data transfer

The ONT-506 uses a Pentium PC as internal controller allowing to run Linux applications as well.

Interfaces	Ethernet (RJ45), USB, external keyboard, mouse, VGA

CD R/W/DVD-ROM drive for data transfer and software update.
PC Pentium M, 1.8 GHz, 512 MB RAM

Hard drive for data/setup storage	≥ 40 GB

Remote control for test automation

The ONT-506 is controlled remotely via SCPI commands sent by the customer's program using an Ethernet TCP/IP connection.
Modules are addressed independently and in parallel and may be shared among multiple users.
Universal driver libraries facilitate automation with specific support for individual applications.
Scripting support via Tcl/Tk and C libraries and LabWindows drivers.
The interactive GUI also works in parallel to remote control, so that it is very easy to develop automated scripts.

ONT-512 mainframe

Highlights

- 12 slots to cover multiple ports/applications
- Rack-mount chassis
- Plug-in modules
- Linux operating system
- Driver support

The ONT-512 is a 12-slot mainframe test solution with true multi-port operation for local and remote control.

'Plug-in' modules allow for easy upgrades in the field and exchange of interfaces among ONT-512 mainframes as well as between the ONT-512 and ONT-506 mainframes.

General specifications

Power supply (nominal range of use)

AC line voltage	100 to 240 V
AC line frequency	50/60 Hz, ± 5%
Power consumption (fully equipped)	max. 1000 VA
Safety class to IEC 61010-1	class I

Ambient temperature

Nominal range of use	+5 to +40 °C/ 41 to 104 °F
Storage	–25 to +45 °C/–13 to +113 °F
Transport	–40 to +70 °C/–40 to 158 °F
Dimensions (w × h × d)	464 × 327 × 523 in mm 18.2 × 12.9 × 20.6 in 7.5 rack unit height is required in a 19'' rack for stacking
Weight (without modules)	approx. 17 kg/ 37.5 lb

Clock and synchronization

Internal master clock accuracy	± 2.0 ppm (exceeds T1.101 stratum 3/3E accuracy)

External synchronization

Connector	75 Ω, unbalanced, BNC jack
Clock source	DS1, E1, 1544 kHz, 2048 kHz, 8 kHz, 1MHz, 5 MHz, 10 MHz
Connector	110 Ω, balanced, bantam jack
Clock source	DS1, E1, 1544 kHz, 2048 kHz

From RX

Each module may use its received signal clock information as reference for its transmitter.

Clock outputs

Connector	75 Ω, unbalanced, BNC jack
Connector	110 Ω, balanced, bantam jack

Instrument operation

The ONT-512, which uses the Linux operating system, supports three types of operation:

- Local by connecting screen/ mouse/ keyboard
- Remote control for test automation
- Remote operation via LAN

Interfaces, storage, data transfer

The ONT-512 uses a Pentium PC as internal controller allowing to run Linux applications as well.

Interfaces	Ethernet (RJ45), USB, external keyboard, mouse, VGA

CD R/W/DVD ROM drive for data transfer and software update.
PC Pentium M, 1.8 GHz, 512 MB RAM

Hard drive for data/setup storage	≥ 40 GB

Remote control for test automation

The ONT-512 is controlled remotely via SCPI commands sent by the customer's program using an Ethernet TCP/IP connection.
Modules are addressed independently and in parallel and may be shared among multiple users.
Universal driver libraries facilitate automation with specific support for individual applications.
Scripting support via Tcl/Tk and C-libraries and LabWindows drivers.
Remote operation may be used as a parallel monitor, while the ONT-512 is controlled remotely for test automation.

Figure 1:
40G SDH/SONET (BN 3061/91.51)
– Unframed testing at 39.813 Gb/s
– Framed testing of SDH and SONET at 39.813 Gb/s

Figure 2:

40G SDH/SONET (BN 3061/91.51) and 43G OTN (BN 3061/91.52)
– Unframed testing at 39.813 Gbps and 43.018 Gb/s
– Framed testing of SDH and SONET at 39.813 Gb/s
– Framed testing of OTM0.3 at 43.018 Gb/s

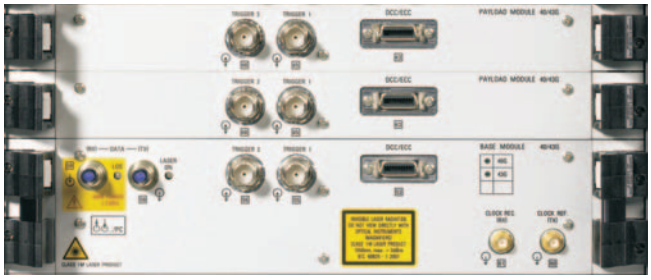


Figure 3:

40G SDH/SONET Jitter (BN 3061/91.61)
– Unframed testing at 39.813 Gb/s
– Framed testing of SDH and SONET at 39.813 Gb/s
– Jitter testing at 39.813 Gb/s
– Wander testing at 39.813 Gb/s (optional with BN 3061/93.93)

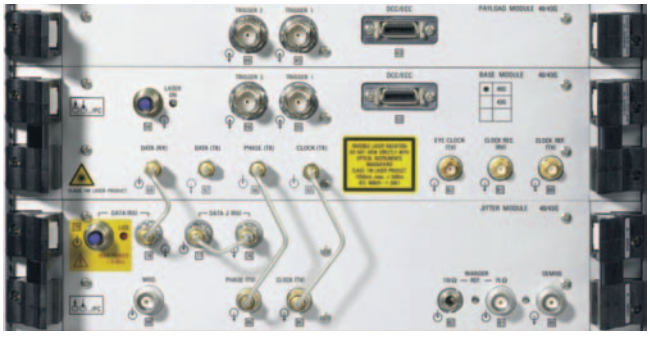
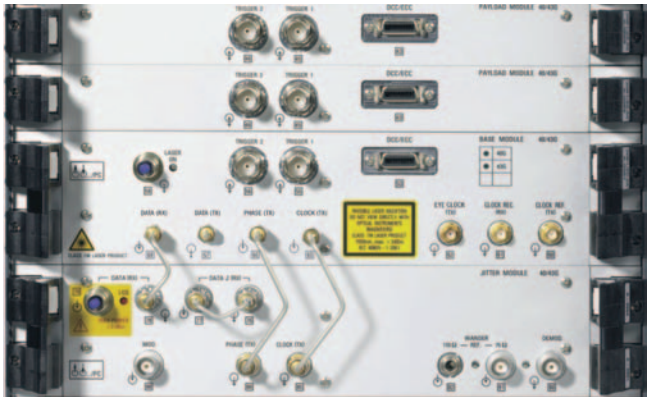


Figure 4:

40G SDH/SONET Jitter (BN 3061/91.61) and
43G Jitter (BN 3061/91.62) and 43G OTN (BN 3061/91.52)
– Unframed testing at 39.813 Gb/s and 43.018 Gb/s
– Framed testing of SDH and SONET at 39.813 Gb/s
– Framed testing of OTM0.3 at 43.018 Gb/s
– Jitter testing at 39.813 Gb/s and 43.018 Gb/s
– Wander testing at 39.813Gb/s and 43.018 Gb/s (optional with BN 3061/93.93)



40/43G Solutions

Physical layer

40G General

Interface

Line rate	39.813 Gb/s
Line code	scrambled NRZ

Clock generator

Internal accuracy	± 2 ppm
Offset range	± 50 ppm
Offset step size	0.1 ppm

Synchronization to external reference signals:

- From received signal
- From mainframe see clock and synchronization of the ONT-503/506/512 mainframe

40G Standard optical

Optical interface

The interface is in accordance with ITU-T G.693 more specific VSR2000-3R3 and VSR2000-3R5

Generator

Wavelength	1530 to 1565 nm
Output level	0 dBm to +3 dBm

Generator reference clock output
Via 50 Ω SMA connector, with clocking at line rate/64

Receiver

Wavelength	1530 to 1565 nm
Sensitivity	–6 dBm to +3 dBm
Offset pulling range	± 50 ppm

Displays the current optical input level and the min/max values with timestamp.
Displays the current signal offset and the min/max values with timestamp.

Recovered clock output
Via 50 Ω SMA connector, with clocking at line rate/64

40G Standard electrical (in preparation)

Electrical interface

Impedance	AC coupled 50 Ω
Connector type	PC 2.92 mm (SMA compatible)

Generator

Line code	scrambled NRZ
Output level	>200 mVpp

Generator reference clock output
Via 50 Ω SMA connector, with clocking at line rate/64

Receiver

Line code	scrambled NRZ
Input level	200 to 600 mVpp

Displays the current optical input level and the min/max values with timestamp.
Displays the current signal offset and the min/max values with timestamp.

Recovered clock output
Via 50 Ω SMA connector, with clocking at line rate/64

40G Jitter

Optical interface

The interface is in accordance with ITU-T G.693

Generator

Wavelength	1530 to 1565 nm
Output level	0 dBm to +3 dBm

Generator reference clock output
Via 50 Ω SMA connector, with clocking at line rate/64

Receiver

Wavelength	1530 - 1565 nm
Sensitivity	–5 dBm to +3 dBm
Sensitivity for jitter measurement	–2 dBm to +2 dBm
Offset pulling range	± 50 ppm
Offset permitted for jitter measurement	± 20 ppm

Displays the current optical input level and the min/max values with timestamp.
Displays the current signal offset and the min/max values with timestamp.

Recovered clock output
Via 50 Ω SMA connector, with clocking at line rate/64

Eye clock interface

Clock	9.953 GHz
Connector type	SMA

Electrical interfaces

Impedance	AC coupled 50 Ω
Connector type	PC 2.92 mm (SMA compatible)

Generator data signal

Line code	scrambled NRZ
Output level	>200 mVpp

Generator clock signal

Output level	>200 mVpp

Receiver data signal for digital measurement

Line code	scrambled NRZ
Input level	200 to 600 mVpp

43G General

Interface

Line Rate	43.018 Gb/s
Line code	scrambled NRZ

Clock generator

Internal accuracy	± 2 ppm
Offset range	± 50 ppm
Offset step size	0.1 ppm

Synchronization to external reference signals:

- From received signal
- From mainframe, see clock and synchronization of the ONT-503/506/512 mainframe

43G Standard optical

Optical interface

The interface is in accordance with ITU-T G.693 more specific VSR2000-3R3F and VSR2000-3R5F

Generator

Wavelength	1530 to 1565 nm
Output level	0 dBm to +3 dBm

Reference clock output

Via 50 Ω SMA connector, with clocking at line rate/64

Receiver

Wavelength	1530 to 1565 nm
Sensitivity	–6 dBm to +3 dBm
Offset pulling range	± 50 ppm

Displays the current optical input level and the min/max values with timestamp.
Displays the current signal offset and the min/max values with timestamp.

Recovered clock output

Via 50 Ω SMA connector, with clocking at line rate/64

43G Standard electrical (in preparation)

Electrical interfaces

Impedance	AC coupled 50 Ω
Connector type	PC 2.92 mm (SMA compatible)

Generator

Line code	scrambled NRZ
Output level	>200 mVpp

Generator reference clock output
Via 50 Ω SMA connector, with clocking at line rate/64

Receiver

Line code	scrambled NRZ
Input level	200 to 600 mVpp

Displays the current optical input level and the min/max values with timestamp.
Displays the current signal offset and the min/max values with timestamp.

Recovered clock output
Via 50 Ω SMA connector, with clocking at line rate/64

43G Jitter

Optical interface

The interface is in accordance with ITU-T G.693

Generator

Wavelength	1530 to 1565 nm
Output level	0 dBm to +3 dBm

Reference clock output

Via 50 Ω SMA connector, with clocking at line rate/64

Receiver

Wavelength	1530 to 1565 nm
Sensitivity	–5 dBm to +3 dBm
Sensitivity for jitter measurement	–2 dBm to +2 dBm
Offset pulling range	± 50 ppm
Offset permitted for jitter measurement	± 20 ppm

Displays the current optical input level and the min/max values with timestamp.

Displays the current signal offset and the min/max values with timestamp.

Recovered clock output
Via 50 Ω SMA connector, with clocking at line rate/64

Eye clock interface

Clock	10.75 GHz
Connector type	SMA

Electrical interfaces

Impedance	AC coupled 50 Ω
Connector type	PC 2.92 mm (SMA compatible)

Generator data signal

Line code	Scrambled NRZ
Output level	>200 mVpp

Generator clock signal

Output level	>200 mVpp

Receiver data signal for digital measurement

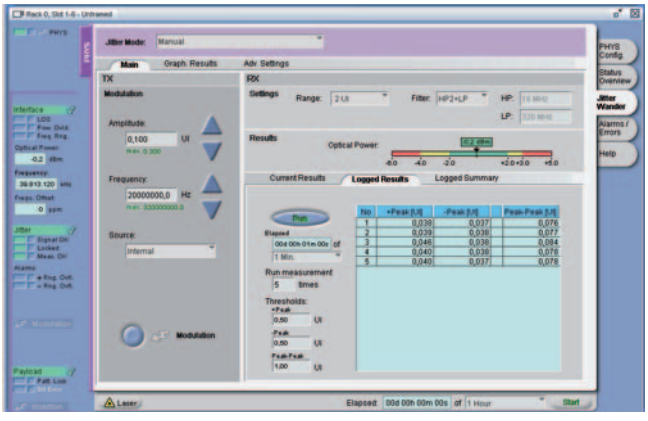
Line code	Scrambled NRZ
Input level	200 to 600 mVpp

40/43G Jitter

Standards

Jitter is generated and analyzed in accordance with the following standards:

- ITU-T Recommendation O.172
- ITU-T Recommendation O.173
- ITU-T Recommendation G.825
- ITU-T Recommendation G.8251



Jitter generator

Built-in modulation generator

Jitter modulation signal	Sine wave, 10 Hz to 320 MHz
Jitter amplitude	Up to 12800 UIpp
Step width	0.001 UI

Generation accuracy (16 MHz to 320 MHz) 40 mUIpp

External modulation input

Connector type	BNC, 50 Ω
Modulation frequency	0.1 Hz to 320 MHz
Input voltage range	0 to 632 mVpp (0 dBm)

Jitter analyzer

Measuring ranges/resolution

Peak-Peak I	0 to 2 UIpp/1 mUIpp
Peak-Peak II	1 to 8 UIpp/1 mUIpp
Peak-Peak III	4 to 40 UIpp/10 mUIpp
Peak-Peak IV	20 to 800 UIpp/100 mUIpp
Peak-Peak V	400 to 14000 UIpp/1 UIpp
RMS I	0 to 1 UI/0.1 mUI
RMS II	0.5 to 4 UI/0.1 mUI
RMS III	2 to 20 UI/1 mUI
RMS IV	10 to 400 UI/10 mUI
RMS V	200 to 7000 UI/100 mUI

Measurement accuracy (fixed error in 2 UI range)

20/80 kHz to 320 MHz	150 mUIpp
16 MHz to 320 MHz	50 mUIpp

Built-in filters

High-pass filters	20 kHz, 80 kHz, 16 MHz
Low-pass filter	320 MHz

Demodulator output

Connector type	BNC, 50 Ω

Jitter application

Supports all manual and automatic measurements for jitter evaluations.

Jitter measuring modes

Current values (continuous measurement): Peak-Peak, positive peak, negative peak, RMS

Maximum values (gated measurement): Peak-Peak, positive peak, negative peak

Logged values (repetitive measurements): Peak-Peak, positive peak, negative peak

Phase hits

The instrument detects when the programmable threshold for positive and negative jitter values is exceeded and the result indicates how often the threshold was exceeded.

Jitter versus time

This function is used to record variations of jitter with time and allows the positive and negative peak values, peak-to-peak values, and RMS values to be displayed versus time. Duration is up to 99 days.

Automatic jitter measurements

Maximum tolerable jitter (MTJ)

The jitter module automatically determines the maximum jitter amplitude tolerated by the DUT at selected jitter frequencies. The maximum permissible jitter amplitude can be precisely determined using a successive method. The module determines the exact limit value. Several error sources are selectable. Standard tolerance masks are available and can be edited.

Fast maximum tolerable jitter (Fast-MTJ)

This extremely fast measurement tests the device under test for conformance to the standard tolerance mask limits for maximum tolerable jitter. The editable frequency/amplitude values are set sequentially and the test pattern is monitored for the permitted threshold by the receiver. The result of each measurement is shown in a table as a status message.

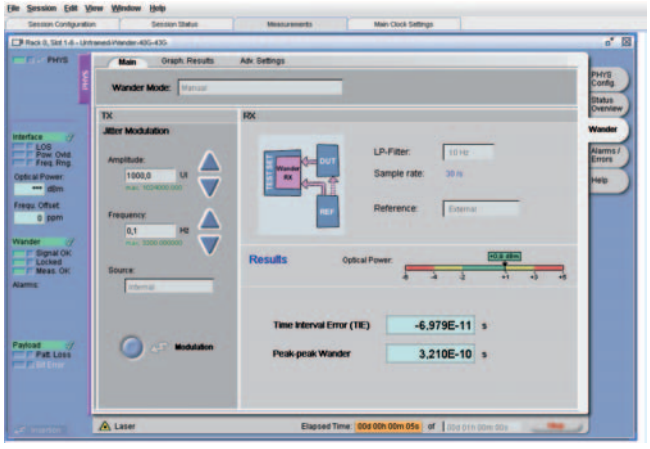
Selective jitter transfer function (JTF)

The JTF shows the ratio of the jitter amplitude at the output of the device under test (DUT) and at the input at various frequencies. Standard tolerance masks are available and can be edited.

40/43G Wander

Fully complies with or exceeds the requirements of ITU-T O.172.

This software option is only available in conjunction with 40G SDH/SONET jitter and the 43G jitter option which enables wander generation and analysis at the different bit rates.



Wander generator

Modulation signal	sine wave
Amplitude range	0.1 to 1024000 UI
Amplitude step width	0.1 UI
Frequency range	10 µHz to 10 Hz
Frequency step width	1 µHz

Wander analyzer

Four different sampling rates are available for detailed analysis versus time:
Sampling rate – Low-pass filter

1/s – 0.1 Hz, 30/s – 10 Hz (O.172), 60/s – 20 Hz, 1000/s – 100 Hz (O.172)

Wander reference signal input

Balanced	Bantam 110 Ω
Clock signal	1.544, 2.048 MHz
Data signal	1.544, 2.048 Mb/s
Unbalanced	BNC 75 Ω
Clock signal	1.544, 2.048, 5, 10 MHz
Data signal	1.544, 2.048 Mb/s

Wander measuring modes

Time interval error (TIE) numerical and graphical, peak-peak wander numerical.
TIE values are recorded and available for MTIE/TDEV evaluations and frequency offset and drift rate measurements with graphs and built-in masks that comply with Telcordia GR-253, GR-1244, ANSI T1.101, ETSI ETS 300 462, EN 302 084, ITU-T O.172, and G.810 to G.813 recommendations.

Automatic wander measurements

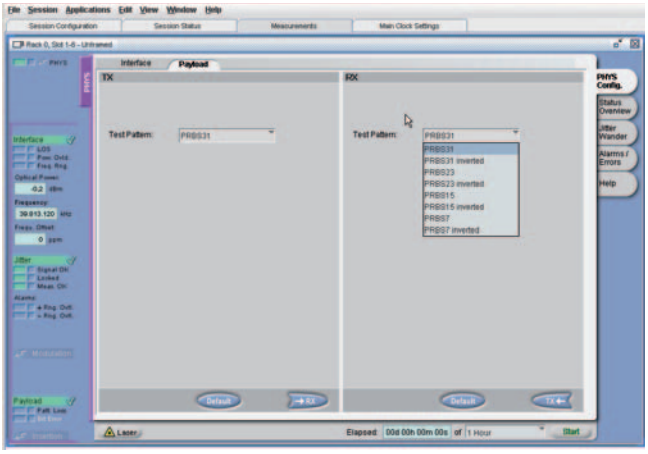
Maximum tolerable wander (MTW)

This application tests the DUT for conformance to the standard tolerance mask limits for wander tolerance and is available in connection with the wander generator.

The device under test is subjected to wander at several amplitudes and frequencies and the output signal is monitored for different error sources. The measurement point is then marked as “Pass” (no alarms or errors detected) or “Fail” (alarms or errors detected).

Unframed application

Unframed testing
With the possibility to generate and analyze unframed test signals the application space for testing with ONT family can be extended to earlier testing phases in the optical component area but also for verification of real transparent signals.



Generator

Test pattern	PRBS: 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{7}-1, 2^{31}-1 inv., 2^{23}-1 inv., 2^{15}-1 inv., 2^{7}-1 inv. (conforming to ITU-T O.150)

Error insertion

Type	Bit errors
Trigger	Single, rates from 1 x 10^{-3} to 1 x 10^{-12} with mantissa equal 1

Alarm insertion

Type	LOS
Trigger	Continuous

Analyzer

Analysis of test pattern	PRBS: 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{7}-1, 2^{31} -1 inv., 2^{23}-1 inv., 2^{15}-1 inv., 2^{7} -1 inv. (conforming to ITU-T O.150)

Error measurement

Type	Bit errors

Alarm detection

Type	LOS, Pattern Loss
Resolution	100 ms

Result display of errors and alarms

Numerical display

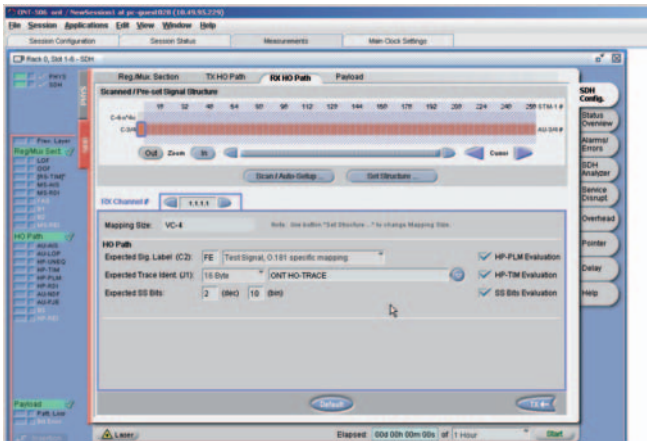
Count, ratio and duration are displayed for each error
Duration is displayed for each alarm

Tabular display

Display of all results with time stamps

Criteria	Start, stop, duration, count

40G SDH/SONET



SDH/SONET application

SDH/SONET testing

Generation/evaluation of STM-256 signal according to ITU-T G.707
Generation/evaluation of OC-768 signal according to ANSI T1.105

Mapping

SDH	VC-4-256c, VC-4-64c, VC-4-16c, VC-4-4c, VC-4, AU-3/VC-3
SONET	STS-768c SPE, STS-192c SPE, STS-48c SPE, STS-12c SPE, STS-3c SPE, STS-1 SPE

Generator modes

- Free definable foreground
- All channels identical
- Background selectable mapping, depending on foreground channel with definable path overhead and Null pattern as payload

Auto signal structure

Receiver analyses the signal structure (mapping, payload, traces) automatically for easy configuration of the test channel.

Generator

Test pattern	PRBS: 2^{31}-1, 2^{23}-1, 2^{31}-1 inv., 2^{23}-1 inv. (conforming to ITU-T O.150)
Programmable word	Length 32 bits

Error insertion

Types

SDH	Random, FAS, B1, B2, B3, MS-REI, HP-REI, Bit errors
SONET	Random, FAS, B1, B2, B3, REI-L, REI-P, Bit errors
Trigger	Single, rates

Error	Min rate	Max rate	Stepping	Mapping
Random	1.00^{-10}	1.00^{-03}	expo-nential	–
FAS	1.00^{-12}	1.00^{-03}	0.1	–
B1	1.00^{-12}	1.61^{-06}	0.1	–
B2	1.00^{-12}	1.00^{-03}	0.1	–
MS-REI, REI-L	1.00^{-12}	1.00^{-03}	0.1	–
B3	1.00^{-12}	1.61^{-06}	0.1	STM-VC-4-256c, STS-1-768cSPE
B3	1.00^{-12}	1.00^{-03}	0.1	STM-VC-3, STS-1-SPE
HP-REI, REI-P	1.00^{-12}	1.61^{-06}	0.1	STM-VC-4-256c, STS-1-768cSPE
HP-REI, REI-P	1.00^{-12}	1.00^{-03}	0.1	STM-AU-3/VC-3, STS-1-SPE
Bit error	1.00^{-12}	1.00^{-03}	expo-nential	–

Burst error once and continuous M errored frames followed by N error-free frames. All errors except random and bit errors
N, M = 1 to 8000000 or 125 µs to 1000 s

Alarm generation

Type:

SDH	LOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-UNEQ, HP-TIM, HP-PLM, HP-RDI, HP-RDI-C, HP-RDI-S, HP-RDI-P
SONET	LOF, AIS-L, RDI-L, TIM-L, AIS-P, LOP-P, UNEQ-P, TIM-P, PLM-P, RDI-P, RDI-P-C, RDI-P-S, RDI-P-P, PDI-P
Trigger	LOS, TIMs on/off
	All others on/off or burst
	Burst once and continuous
	M frames with alarm ON, N frames with alarm OFF
	N, M = 1 to 800000 or 125 µs to 1000 s

Overhead generator

The stimulus of different overhead byte pattern is an important part of verification and interoperability testing. Network elements (NE) should respond in the defined manner and any responses then conveyed by a different overhead byte.

Statically programmable bytes
- A1-A2 unscrambled
- RSOH/SOH all bytes except B1
- MSOH/LOH all bytes except B2, H1...H3
- POH all bytes except B3

Display of overhead on the GUI.

Trace identifier
J0, J1 programmable 1 byte, 16 bytes with CRC or 64 byte sequence

Generation of pointer actions

Generation of pointer actions at the AU/STS level

- New pointer value setting with or without NDF
- Offset simulation in ppms
- Single, periodical and alternating pointer increment/decrement
- Pointer sequences with different types
- SS-bits definable

Analyzer

Test pattern	PRBS: 2^{31}-1, 2^{23}-1, 2^{31}-1 inv., 2^{23}-1 inv. (conforming to ITU-T O.150)
Programmable word	Length 32 bits
"Traffic" mode ignores LSS alarm and TSE that allows analysis of live traffic without trouble indication	

Error measurements

SDH	FAS, B1, B2, B3, MS-REI, HP-REI, Bit errors
SONET	FAS, B1, B2, B3, REI-L, REI-P, Bit errors

Alarm detections

SDH	OOF, LOF, MS-AIS, MS-RDI, RS-TIM, AU-AIS, AU-LOP, HP-TIM, HP-UNEQ, HP-PLM, HP-RDI, Pattern Loss
SONET	OOF, LOF, AIS-L, RDI-L, TIM-L, AIS-P, LOP-P, TIM-P, UNEQ-P, PLM-P, RDI-P, PDI-P, PLM-P, ERDI-P-Payload, ERDI-P-Server, ERDI-P-Connect, Pattern Loss
Resolution	100 ms

Result display of errors and alarms

Numerical display
Count, ratio and duration are displayed for each error
Duration is displayed for each alarm

Tabular display
Display of all results with time stamps
Criteria start, stop, duration, count

Graphical display
Display of all events as bar graphs versus time. Cursors allow easy identification and zooming (in and out) on results. Filters enable event selection.
Time axis second, minute, hour

Overhead analyzer

Display of Overhead on the GUI.

Message evaluation (TIM/PLM)

- J0, J1 1 byte, 16 bytes with CRC or 64 byte sequence
- J0, J1 clear text display
- TIM evaluation: exception value editable as criterion for TIM
- C2 signal label clear text selection
- PLM Evaluation : exception value editable as criterion for PLM

Service disruption test

To analyze service disruption times, the ONT-5xx generates a highspeed event list as a result of all detected events.

Sensor to trigger service disruption test, selectable

Errors

SDH	FAS, B1, B2, MS-REI, B3, HP-REI, bit errors/pattern loss
SONET	FAS, B1, B2, REI-L, B3, REI-P, bit errors/patt. loss

Alarms

SDH	LOS, LOF, OOF, MS-AIS, MS-RDI, AU-AIS, AU-LOP , HP-UNEQ, HP-PLM, HP-RDI,
SONET	LOS, LOF, SEF, AIS-L, RDI-L, AIS-P, LOP-P, UNEQ-P, PLM-P, PDI-P, RDI-P
Event sample resolution	100 µs
Separation time	0.1 ms to 100000 ms

Separation time starts at the end of the last event. Separation time is used to determine if the following event is a continuation of the same disruption (event occurs within separation time) or the start of the next disruption (event occurs after separation time has elapsed).

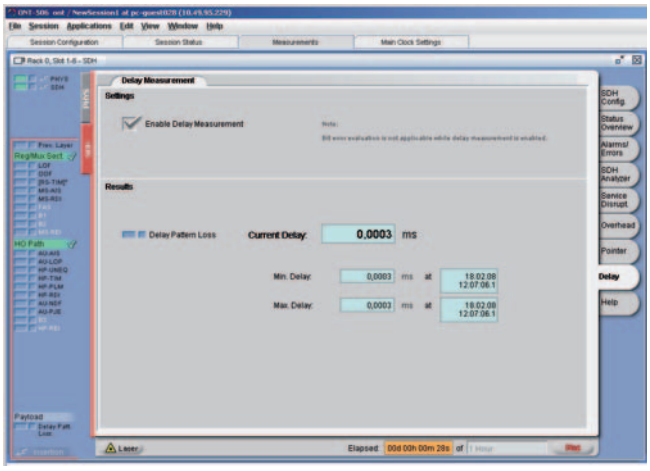
Result display of disruptions

Numerical display
Total Number of disruptions, begin timestamp of first disruption, end timestamp of last disruption,
Shortest disruption time (with timestamp)
Longest disruption time (with timestamp)

Average disruption time
The threshold to identify a violation of allowed service disruption time can be set in the range of 0 ms to 100000 ms

Tabular display
Service disruption events with start/stop times and duration.
Three logging modes available (no logging; disruption events only; disruption and causing sensor events)

Transfer delay analysis



Transfer delay measurements by special payload pattern in the range of 0 to 40s.
Transfer delay can be measured even between different ports within the same mainframe.

Numerical display
Current transfer delay with accuracy of 1 µs and resolution 100 ns
Minimum transfer delay (with timestamp)
Maximum transfer delay (with timestamp)

Pointer analysis
AU/STS Pointer

Numerical display
Value, count of increments, decrements, NDF.

Tabular display
Display of all events with time stamps
Criteria start, stop, duration, count

Performance monitoring

For SDH

Performance monitoring G.826

EB, BBE, ES, EFS, SES, and UAS are evaluated. Pass/fail assessments based on line length allocation of 0.1 to 100%.
The SES and UAS thresholds are user-programmable. In-service measurement (ISM) of the near end and the far end of a selected path, as well as out-of-service (OOS) measurements, are supported.

Performance monitoring G.828 and G.829
The G.828 defines error performance parameters for international synchronous paths.

EB, BBE, ES, EFS, SES, and UAS are evaluated. Pass/fail assessments are based on a line length allocation of 0.1 to 100%.The SES and UAS thresholds are user-programmable. The SEP can be switched off for assessment. G.829 defines error performance events and block structures for SDH multiplex and regenerator sections.

For SONET

Evaluation of ES, EFS, SES, UAS and SEFS (GR 253, T1.231) ESA, ESB

Byte capture SOH/TOH

To analyze the SOH/TOH functions, it is necessary to capture individual bytes vs. time, allowing detection of errors or short term changes with frame level resolution. The capture function is started by a selectable trigger.

Values for one/two selected bytes are stored and can be accessed subsequently in a table of values.

Particularly in capturing the APS sequences, bytes K1 and K2 are displayed in clear text.

Selectable bytes for SOH/TOH	all bytes
Captured parameters	byte value, number of frames and correspondent time
Storage depth of one byte or K1/K2 combination	
post trigger	up to 256 value changes
pre trigger	up to 256 value changes
Trigger conditions	pre, post, center
Trigger events	user defined byte value, bit mask (compare, not compare, don't care)

43G OTN

OTN application

OTN testing

The OTN application runs on the Interface module and the payload board and allows generation and analysis of an OTM0.3 signal.

Detailed parameters can be manipulated and evaluated in different OTN levels. Its payload supports both framed SDH/SONET and unframed clients.

The test set provides signal analysis and manipulation (alarm, error, overhead), Forward Error Correction (FEC) generation and analysis as well as FEC error testing. In addition to this, the full analysis capabilities of SDH and SONET are available for OTN client analysis.

Generator

OPU3 mapping of client signals:

- CBR40G with SDH/SONET client (optional, BN 3061/91.52)
  - STM-256/STS-768 signal internally generated.
  - Generation see chapter 40G SDH/SONET application (page 27).
- PRBS test signal
  - PRBS 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{7}-1, 2^{31}-1 inv., 2^{23}-1 inv., 2^{15}-1 inv., 2^{7}-1 inv. (conforming to ITU-T O.150)
  - Digital word 32 bit free programmable
- Null client
- OTN multiplexing (optional, see page 33)

All clients can be mapped bit-synchronous or asynchronous.

Client offset – stuffing

The asynchronous SONET and SDH client offset can be adjusted within the ± 65 ppm range and the stuffing rate of the client can thus be manipulated.

Overhead

Overhead bytes (frame alignment/OTU/ODU/OPU)

- All bytes statically programmable except MFAS, SM BIP, PM BIP, TCM1...6 BIP
- Additional possibilities for SM TTI, PM TTI, TCM1...6 TTI (Trail Trace Identifier):
  Sequence consisting of the SAPI (16 bytes) and DAPI (16 bytes) and the operator specified (32 bytes).
- User designed payload structure identifier (PSI) and payload type identifier clear text
- One OH byte can be selected for a freely defined sequence of 16/32/64/128/256 bytes
- FTFL free definable forward/backward (FW/BW) fault indication and operator identifier

Error insertion

Type	Random, FAS, MFAS
	SM BIP-8, SM BEI, PM BIP-8, PM BEI
	TCMi BIP-8, TCMi BEI (i = 1 to 6)
	Bit errors (only available with PRBS test signal)
Trigger	Single , rate, burst , burst continuous
Burst error	M frames errors, N frames error free,
	M and N = 0 to 2^{31}

Rate

Error name	Min rate	Max rate	Stepping
Random	1.0^{-10}	1.0^{-03}	exponential
Bit	1.0^{-12}	1.0^{-03}	exponential
FAS	4.9^{-12}	1.0^{-03}	0.1
MFAS	3.0^{-11}	1.0^{-03}	0.1
SM BIP	1.0^{-12}	6.6^{-05}	0.1
SM BEI	1.0^{-12}	6.6^{-05}	0.1
PM BIP	1.0^{-12}	6.6^{-05}	0.1
PM BEI	1.0^{-12}	6.6^{-05}	0.1
TCMi BIP	1.0^{-12}	6.6^{-05}	0.1
TCMi BEI	1.0^{-12}	6.6^{-05}	0.1

BIP masks

The position and number of bit errors in the bytes can be selected.
Valid for SM BIP, PM BIP, TCMi BIP (i = 1 to 6)

BEI value

To stress the BEI evaluation of the DUT receiver the BEIs can be set to values 0 to 15
Valid for SM BEI, PM BEI, TCMi BEI (i = 1 to 6)

Alarm generation

Type	LOF, OOF, LOM, OOM
	OTU-AIS, ODU-AIS, ODU-OCI, ODU-LCK, SM BDI,
	SM IAE, SM BIAE, PM-BDI, PM-TM
	FW-SD, FW-SF, BW-SD, BW-SF
	TCMi-LTC, TCMi-BDI, TCMi-BIAE, TCMi-TIM (i = 1 to 6)

Trigger

Continuously	all alarms
Burst once/ Burst continuous	all errors except LOF, OOF, OOM, SD, SF, TIMs
Burst alarms	M frames with alarm, N frames no alarm,
	M = 1 to 2^{31}
	N = 0 to 2^{31}

OTU FEC

The FEC generation can be switched on and off. Using the OTU FEC field, FEC according to the Reed-Solomon (255,239) algorithm is performed on the generated frame. With data blocks consisting of 239 data bytes and 16 FEC field bytes, up to 16 byte errors can be detected or 8 byte errors be corrected.

FEC error insertion modes

- FECcorrectable, FECuncorrectable
- FECstress: This extremely helpful function allows maximum stress tests within a short time frame.
  The maximum possible number of errors that the device under test (DUT) should still be able to correct is inserted into the OTU frame.

FECadvanced

FECadvanced allows the user to define a detailed position for error insertion in the OTU frame. Correction capability testing below and above the correction limit can be performed.

Selectable parameters: row, subrow, errored bytes per subrow, start position in subrow, byte error mask

Analyzer

OPU-3 mapping of client signals:

- CBR40G with SDH/SONET client (optional, BN 3061/91.52)
  - STM-256/STS-768 signal.
  - Analysis see chapter 40G SDH/SONET applications (page 18).
- PRBS test signal
  - PRBS 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{7}-1, 2^{31}-1 inv., 2^{23}-1 inv. 2^{15}-1 inv., 2^{7}-1 inv., (conforming to ITU-T O.150)
  - Digital word 32 bit free programmable
- Null client
- OTN multiplexing (optional, see page 33)

All clients can be de-mapped bit-synchronous and asynchronous

Stuffing of the payload

Display of payload offset in ppm

Stuffing counts

Positive, negative, sum count, duration of effected seconds

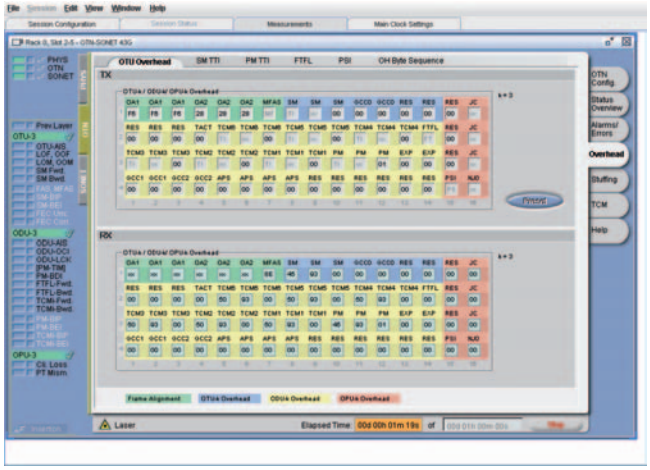
Overhead

Overhead evaluation (frame alignment/OTU/ODU/OPU)

- Display of the complete overhead
- SM TTI, PM TTI, TCM1…6 TTI display of the 64 byte ASCII sequence of SAPI, DAPI and Operator field
- One sequence of up to 256 bytes can be captured and displayed for a selectable OH byte
- Display payload structure identifier (PSI) bytes and payload type identifier (PT) clear text
- Editable PT expectation value as mismatch criterion
- FTFL forward/backward (FW/BW) fault indication and operator identifier fields

Trace references

- Set of SAPI and DAPI expectation values in traces SM TTI, PM TTI, TCM1…6 TTI
- Select evaluation type of the received signal: SAPI or DAPI or SAPI/DAPI



Error measurement

Validation of data for error measurement occurs after frame alignment, descrambling, and FEC computation and correction (if enabled).

Alarm detection

Types	LOF, OOF, LOM, OOM
	OTU-AIS, ODU-AIS, ODU-OCI, ODU-LCK, SM BDI, SM IAE, SM
	BIAE, SM TIM, PM-BDI, PM TIM
	FW-SD, FW-SF, BW-SD, BW-SF
	TCMi-LTC, TCMi-BDI, TCMi-IAE, TCMi-BIAE, TCMi-TIM (i = 1 to 6)
	CL-LOSS (Client signal Loss of synchronization)
	PT-MISM

Error detection

Types	FAS, MFAS, SM BIP, SM BEI, PM BIP, PM BEI
	TCMi BIP, TCMi BEI (i = 1 to 6)
	Bit error (only available for PRBS/digital word testing signal)
Resolution	100 ms

Result display of errors and alarms

Numerical display

Count, ratio and duration are displayed for each error

Duration is displayed for each alarm

Tabular display

Display of all results with time stamps

Criteria: start, stop, duration, count

Graphical display

Display of all events as bar graphs versus time. Cursors allow easy identification and zooming (in and out) on results. Filters enable event selection.

Time axis: second, minute, hour

OTU FEC

The FEC analysis and correction can be switched on and off. Using the OTU FEC field, FEC according to the Reed-Solomon (255,239) algorithm is performed on the received frame. With data blocks consisting of 239 data bytes and 16 FEC field bytes, up to 16 byte errors can be detected or 8 byte errors be corrected.

Error detection

Type	FECcorrectable bit, FECcorrectable code word, FECuncorrectable code word

Result display of errors

Numerical display

Count, ratio and duration are displayed for each error

Tabular display

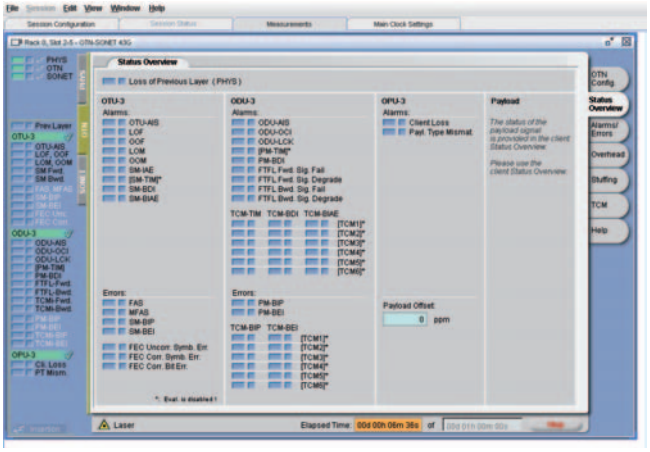
Display of all results with time stamps

Criteria: start, stop, duration, count

Graphical display

Display of all events as bar graphs versus time. Cursors allow easy identification and zooming (in and out) on results. Filters enable event selection.

Time axis: second, minute, hour



Service disruption test

To analyze service disruption times, the ONT-5xx generates a highspeed event list as a result of all detected events.

Sensor to trigger service disruption test, selectable:

Errors

Types	MFAS, SM-BEI, PM-BIP, PM-BEI, payload errors
Event sample resolution	100 µs

Alarms

Types	LOS, LOM, OOM, SM-IAE, SM-BDI, SM-BIAE, ODU-AIS, ODU-OCI, ODU-LCK, PM-BDI
Separation time	0.1 ms to 100000 ms

Separation time starts at the end of the last event. Separation time is used to determine if the following event is a continuation of the same disruption (event occurs within separation time) or the start of the next disruption (event occurs after separation time has elapsed).

Result display of disruptions

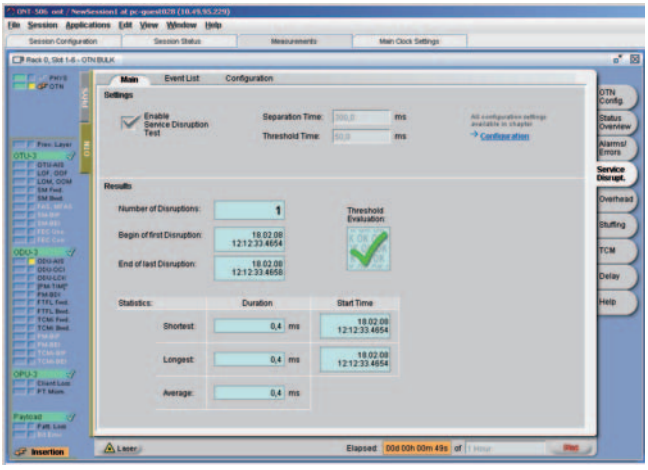
Numerical display
Total Number of disruptions, begin timestamp of first disruption, end timestamp of last disruption,

Shortest disruption time (with timestamp)
Longest disruption time (with timestamp)

Average disruption time
The threshold to identify a violation of allowed service disruption time can be set in the range of 0 ms to 100000 ms

Tabular display:
Service disruption events with start/stop times and duration.

Three logging modes available (no logging; disruption events only; disruption and causing sensor events)



Transfer delay analysis

Transfer delay measurements by special payload pattern in the range of 0 to 40 s.

Transfer delay can be measured even between different ports within the same mainframe.

Numerical display
Current transfer delay with accuracy of 1 µs and resolution 100 ns

Minimum transfer delay (with timestamp)
Maximum transfer delay (with timestamp)

OTN-Multiplexing (in preparation)

As OTN moving forward from a point to point technology to a network technology additional features getting implemented. In special OTN-Multiplexing is to mention as such a feature. The ONT-503/-506/-512 will support ODU2 multiplexing in ODU3.

This multiplexing structure consists of

- one full structured ODU2 (feature equal to ODU3)
  - with a full feature SDH/SONET client or
  - PRBS bulk client and
- 3 lightweight ODU2s conforming streams with a Null client, which can be passed to a lower rate physical interface by a DUT.

Further details will be published with the availability.

Ordering information

40/43G solution

SDH/SONET Application

For ONT-506/512

BN 3061/91.51	**40G SDH/SONET** STM-256, OC-768, unframed 40G 3 slots
BN 3061/91.54 (in preparation)	**40G SDH/SONET electrical** STM-256, OC-768, unframed 40G 3 slots

For ONT-503

BN 3075/91.51	**40G SDH/SONET** STM-256, OC-768, unframed 40G 2 slots

OTN Application

BN 3061/91.52	**43G OTN** OTM.03, unframed 43G, SDH/SONET bulk-client 1 slot in addition Requires one of the following: 40G SDH/SONET BN 3061/91.51 or BN 3075/91.51 or 43G Jitter BN 3061/91.62
BN 3061/91.53	**43G OTN bulk** OTM.03 unframed 43G, Bulk-client Software option Requires one of the following: 40G SDH/SONET BN 3061/91.51 or BN 3075/91.51 or 43G Jitter BN 3061/91.62
BN 3061/93.14 (in preparation)	**43G OTN Multiplexing** ODU2 in ODU3 with SDH/SONET or bulk client Requires BN 3061/91.52

Jitter/Wander Application

BN 3061/91.61	**40G SDH/SONET Jitter** STM-256, OC-768, unframed 40G 5 slots
BN 3061/91.62	**43G Jitter** Unframed jitter at 43G No additional slot required Requires the following: 40G SDH/SONET Jitter BN 3061/91.61 OTN framed signals require: 43G OTN BN 3061/91.52
BN 3061/93.93	**Wander 40/43G** Software option Requires the following: 40G SDH/SONET Jitter BN 3061/91.61 and optional 43G Jitter BN 3061/91.62

Optical Connectors

One type of optical connector must be selected and will be delivered from BN 2060/00.xy for every digital module except Ethernet as listed below.

Measuring adapter

BN 2060/00.51	FC, FC-PC, FC-APC
BN 2060/00.58	SC, SC-PC, SC-APC
BN 2060/00.32	ST type (AT&T)
BN 2060/00.51	DIN 47256
BN 2060/00.53	E 2000 (Diamond)
BN 2060/00.59	LC, F-3000 (PC-APC)

Optical attenuators

BN 2239/90.30	FC-PC, 10 dB, 1310/1550 nm
BN 2239/90.38	SC, 10 dB, 1310/1550 nm

JDSU offers a wide range of optical power meters, sources and attenuators. Contact your local sales representative for details.

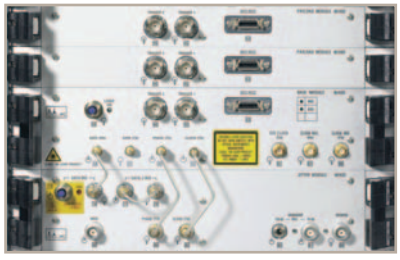
Notes:

Design and conformance testing of NextGeneration transport networks

Multi-application and multi-port configuration

40/43G solution
- SONET/SDH, OTN (optional)
- Unframed testing

40/43G jitter/wander solution
- SONET/SDH, OTN (optional)
- High-accurate jitter evaluation according to new O.172 Appendices VII + VIII
- Wander (optional)



2.5G/10G (-B) modules
- SONET/SDH (PoS optional)
- Multi-Channel SONET/SDH (optional)
- Jitter/wander for version -B (optional)

OTN 2.5/2.7G (-B) module
- OTN/SONET/SDH (PoS optional)
- Multi-Channel SONET/SDH (optional)

OTN 10/10.7G (-B) module
- OTN/SONET/SDH (PoS optional)
- Multi-Channel SONET/SDH (optional)
- Jitter/wander for version -B (optional)

Multi-channel extension module
- Adds Multi-Channel SONET/SDH to 2.5/10G, OTN and NewGen modules

Module-E 10G
- 9.9 to 11.3 Gb/s
- 10G LAN/WAN/FC/SDH/SONET, OTN and overclocked
- Electrical interfaces 10G

Ethernet modules up to 1 Gb/s
- Optical and electrical interfaces
- Ethernet MAC
- Ethernet link

NewGen solution 2.5G (-B)/10G
- Ethernet over SONET/SDH (EoS)
- Ethernet MAC
- LCAS, GFP, differential delay
- SONET/SDH (PoS optional)
- Multi-Channel SONET/SDH (optional)
- GFP-T (optional)

- Jitter/wander for version 2.5G-B (optional)

DSn/PDH modules
- Unframed, framed and muxed DSn and PDH signals
- Single and dual ports

Differential interface module
- Differential interfaces for XFP/SFP jitter testing

2.5G-B, 2.5/2.7G-B jitter module (155 Mb/s to 2.7 Gb/s)
- High-accurate jitter evaluation according to new O.172 Appendices VII + VIII
- Adds jitter to 2.5G modules
- Adds jitter to NewGen module 2.5G
- Adds jitter to OTN module 2.5/2.7G
- Wander (optional)

10G-B, 10/ 10.7G-B jitter module
- High-accurate jitter evaluation according to new O.172 Appendices VII + VIII
- Adds jitter to 10G modules
- Adds jitter to OTN module 10/10.7G
- Wander (optional)

ONT-503
- 3 slots to take any combination of modules
- 15" TFT display

ONT-506
- 6 slots to take any combination of modules
- 15" TFT display

ONT-512
- 12 slots to take any combination of modules
- Rack mount
- Multi-port load testing with high port count

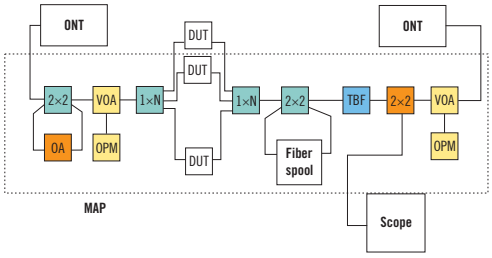
Related products

Multiple Application Platform (MAP)

With over 20 unique modules, MAP enables users to manipulate and control optical transmission signals (independent of rate or format) and enables testing of transmission quality as a function of parameters such as Average Power, OSNR and Polarization state. Optical switches and optical splitter modules may be added to enable automation interfaces for multiple devices and/or multiple signal sources.

The modular platform is available in 3 or 8 slot chassis with GPIB or RS-232 interfaces. ActiveX and LabView drivers are also provided. Rack mount kits and a reverse mount system enable clean factory test integration and rear fiber exit when needed.

2×2: optical switch (cross)
OA: optical amplifier
OPM: optical power meter
VOA: variable optical attenuator
1×N: 1:N switch
TBF: tunable bandpass filter



OLA-55M Optical Level Controller

The OLA-55M contains both attenuator and power level function making test set-up simple and eliminating the need to connect several instruments, cables and couplers.

See OLA-55M data sheet for details.

Handheld Fiber Inspection Microscope

Many light transmission problems occur as a result of improper fiber connectors. The Fiber Microscope reflects details of scratches and any contamination of connector end surfaces. The light weight microscope is equipped with universal push-pull adapter.

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