Acterna ONT-50

Optical Network Tester

A number of factors are responsible for driving the evolution of fiber networks. DWDM for example has been a great enabler of increased bandwidth while at the same time, packet over SONET/SDH (PoS) has alleviated the constraining aspects of Time Domain Multiplexing (TDM) line rates for IP packets. And Optical Transport Network (OTN) G.709 Digital Wrapper (DW) technologies will soon provide intelligent multiwave networks. In continuing this evolution, Virtual Concatenation (VC) will address the needs of operators to leverage from and optimize widely deployed SONET/SDH networks. As a result, companies will increasingly require advanced testing solutions that enable them to support these technological developments.

The Acterna ONT-50 Optical Network Tester delivers a complete solution for:

- reducing the network installation time of DWDM systems
- simulating and troubleshooting IP traffic conditions,
- simplifying the provisioning of OTN G.709 systems and early test new technologies including Virtual Concatenation and Ethernet.

The ONT-50 is a flexible, four-slot, mainframe test solution with field upgradeable modules and multiuser, multi-application functionality for testing these networks.

With its multiport structure and flexible hardware and software architecture design, carriers can rest assured that whatever new technologies emerge, the ONT-50 is able to grow with their needs.

Highlights

- **Offers multiport SONET/SDH testing up to 10 Gbps**
- **Provides complete testing solution for OTN FEC technology and DWDM testing (optical and digital)**
- **Early adapter for New SONET/SDH technology and Ethernet**
- **Offers unique dual port OSA and Q-factor analysis**
- **Enables multiuser remote use through innovative web browser interface**
- **Supports multiple users with multiple applications simultaneously**

Edition March 03

ACTERNA™
The Keepers of Communications

ONT-50 configuration guide

ONT-50 mainframe			BN 3070/01	
Digital modules		Slots required		
	Module 2.5G	1	BN 3070/90.18	☐
	1-port 10G 1550 nm	1	BN 3070/90.01	☐
	Module 10G 1310 nm	1	BN 3070/90.15	☐
	OTN module 2.5/2.7G FEC	1	BN 3070/90.17	☐
	OTN module 10/10.7G FEC	2	BN 3070/90.30	☐
	OTN module 10/10.7G version 2	2	BN 3070/90.32	☐
	NewGen module 2.5G	1	BN 3070/90.40	☐
	Ethernet module 1G	1	in preparation	☐
	Jitter module 10/10.7G	1	BN 3070/90.91	☐
Optical modules		Slots required		
	OSA-160 single port	2	BN 3070/91.01	☐
	OSA-161 single port with channel isolator	2	BN 3070/91.12	☐
	OSA-201 dual port with channel isolator	2	BN 3070/91.14	☐
	OAM-200 Optical amplifier (C-band)	1	BN 3070/92.20	☐
	OQM-200 Q-factor meter 10G	1	BN 3070/92.01	☐
	OQM-201 Q-factor meter 10.7G	1	BN 3070/92.02	☐
Select software option				
	PoS book		BN 3070/93.03	☐
	PMD software		BN 3070/91.10	☐
	Long-term monitoring software (OSA)		BN 2264/90.10	☐
	Wander 10/10.7G		BN 3070/93.91	☐

Application capability of the digital modules

	SDH	SONET	OTN	PoS	EoS	MAC	Jitter with 90.91
Module 2.5G	●	●		●			
1-port 10G 1550 nm	●	●		●			
Module 10G 1310 nm	●	●		●			
OTN module 2.5/2.7G FEC	●	●	●	●			
OTN module 10/10.7G FEC	●	●	●	●			
OTN module 10/10.7G version 2	●	●	●	●			●
NewGen module 2.5G	●	●		●	●		
Ethernet module 1G						●	

ONT-50 mainframe

The ONT-50 is a four-slot mainframe test solution with field upgradeable modules and can be equipped with digital test modules for SONET/SDH/OTN, PoS and New SONET/SDH analysis. Optical test modules for Q-factor and optical spectral analysis (OSA) are also available as well as a range of additional modules for simultaneous multi-application and multi-port measurements.

General specifications

Power supply (nominal range of use)

AC line voltage	100 to 240 V
AC line frequency	50/60 Hz
Power consumption (max configuration)	max. 400 VA
Safety class to IEC 61010-1	class I

Ambient temperature

Nominal range of use	+5 to +40°C/ 41 to 104°F
Storage and transport range	20 to +60°C/ 4 to 140°F
Dimensions (w × h × d)	approx. 13.8 × 12.7 × 8.3 in approx. 350 × 323 × 211 mm
Weight (includes protective cover without modules)	approx. 22 lb/10 kg

Clock and synchronization of digital test modules

Internal master clock accuracy: ±4.6 ppm (meets T1.101 stratum 3/3E accuracy)

External synchronization

- 50/75 Ω, unbalanced, BNC jack:
  - Reference clock: 1 MHz, 1.544 MHz, 2.048 MHz, 5 MHz, 10 MHz
  - Reference clock accuracy: ± 50 ppm
- 100/120 Ω, balanced, Bantam jack
  - E1 (HDB3) 2.048 Mbps, DS1 (B8ZS/AMI scrambled) 1.544 Mbps
  - Bit rate accuracy: ±50 ppm
- Receive signal

Clock outputs

50 Ω, unbalanced, BNC jack, TTL level

- 1.544 MHz clock
- 2.048 MHz clock

Instrument operation

Interfaces

Parallel port, serial port, universal serial bus (for future use), PCMCIA port, floppy disk drive, Ethernet (RJ-45), VGA connector

Save, load, export and import

Current instrument settings and measurement results can be saved on internal HD, and loaded again later. Alternatively the settings/results can be exported to floppy disk or via remote LAN for further processing (report documentation and printouts) and imported onto the same or another ONT-50.

Screen copy print

Printing of screen picture via ONT-50 parallel port.

Touchscreen display

Color TFT screen	12.1-in, 65 536 colors
Resolution	800 × 600 pixels (SVGA standard)

The touchscreen allows for simple point and shoot operation.

Multiuser remote via LAN (remote operation)

In LAN environments, the ONT-50 can be operated interactively via TCP/IP and a standard browser. The ONT-50's multiuser capability offers flexible use of the instrument, allowing several users to access the modules of a single unit. The user interface can be displayed simultaneously on local terminals and in parallel on the ONT. Multiple ONTs can also be operated simultaneously from a single PC.

Remote control for test automation

The ONT-50 can be controlled via SCPI commands sent by the customer's program. Possible interfaces are LAN, RS.232 or GPIB (by external RS.232/GPIB converter).

Digital test modules

All the optical interfaces are intended for single mode fibers for which Acterna offers a complete line of optical test adapters. Test adapters for the individual modules are listed in the order information section of this datasheet. All optical interface options include the required number of test adapters.

Module 2.5G

Hardware option – 1 slot

The module 2.5G supports SDH (STM-0 to STM-16) and SONET (OC-1 to OC-48) interfaces with non-concatenated and concatenated sub-rate mappings down to STS-1/VC3-AU3. It also provides signal analysis and manipulation (alarm, error, overhead and pointers), and bit error rate (BER) testing in the corresponding output signals.

General

Line rates	2.488 Gbps, 622 Mbps, 155 Mbps, 52 Mbps
Line code	scrambled NRZ

Clock generator

Internal, accuracy	±4.6 ppm
Offset	±50 ppm

Synchronization from external signal according to clock specifications of the mainframe

Optical interface

The interface meets the requirements of ITU-T G.957/GR.253

Generator

Wavelength	1310 nm and 1550 nm switchable
Output level	2 to +3 dBm

Receiver

Wavelength	1260 to 1360 nm, 1430 to 1580 nm
Sensitivity all rates	–8 to –28 dBm
Sensitivity 52M, 155M	–8 to typ. –34 dBm
Max. input power (destructive power)	+3 dBm
Measurement optical power	–8 to –34 dBm

Electrical interfaces (in preparation)

Impedance	AC coupled 50 Ω
Connector type	SMA

Generator data signal

Bit rates	52M to 2.488 Gbps
Line code	scrambled NRZ
Output level	> 200 mVpp

Generator clock signal

Bit rates	52M to 2.488 GHz
Eye clock	$f_{clock}/4$
Output level	> 200 mVpp

Receiver data signal

Bit rates	52M to 2.488 Gbps
Line code	scrambled NRZ
Input level	200 to 1000 mVpp

Receiver clock signal

Rec. clock	$f_{clock}/4$
Output level	> 200 mVpp

1-port 10G – 1550 nm and Module 10G – 1310 nm

Hardware option – 1 slot

The 1-port 10G - 1550 nm and module 10G - 1310 nm support SDH (STM-64) and SONET (OC-192) interfaces with non-concatenated and concatenated sub-rate mappings down to STS-1/VC3-AU3. They also provide signal analysis and manipulation (alarm, error, overhead and pointers), and BER testing in the corresponding output signals.

General

Line rate	9.953 Gbps
Line code	scrambled NRZ

Clock generator

Internal, accuracy	±4.6 ppm
Offset	±20 ppm

Synchronization from external signal: according to clock specifications of the mainframe

Optical interfaces

The interface meets the requirements of ITU-T G.691/GR.253

Generator

Wavelength	1550 nm or 1310 nm
Output level 1550 nm	–2 to +3 dBm
Output level 1310 nm	–2 to 0 dBm

Receiver 1550 nm

Wavelength range m	1530 to 1565 nm
Sensivity	–3 to –14 dBm
Max. input power (destructive power)	+2 dBm
Measuring optical input power	–14 to 0 dBm

Receiver 1310 nm

Wavelength range m	1290 to 1330 nm
Sensitivity	–3 to –12 dBm
Max. input power (destructive power)	0 dBm
Measuring optical input power	–14 to 0 dBm

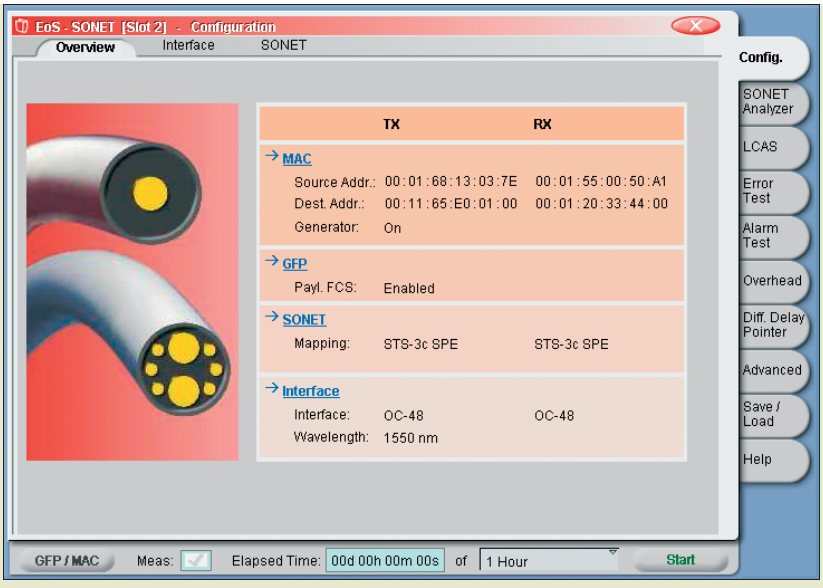
NewGen module 2.5G

Hardware option – 1 slot

The NewGen module 2.5G supports SDH (STM-0 to STM-16) and SONET (OC-1 to OC-48) interfaces and Virtual Concatenation (VC) mappings. It also provides signal analysis and generation of Ethernet MAC frames mapped in Generic Frame Procedure (GFP), Virtual Concatenation, and Link Capacity Adjustment Scheme (LCAS) emulation and analysis. For detailed interface specification please refer to Module 2.5G section.

Ethernet module 1G

see page 12



OTN module 2.5/2.7G FEC

Hardware option – 1 slot

The OTN module 2.5/2.7G FEC supports SDH (STM-0 to STM-16), SONET (OC-1 to OC-48) and OTU-1 (2.7 Gbps) interfaces with non-concatenated and concatenated sub-rate mappings down to STS-1/VC3-AU3. It also provides signal analysis and manipulation (alarms, errors, overheads), and BER testing in the corresponding output signals.

General

Line rates	2.666 Gbps, 2.488 Gbps, 622 Mbps, 155 Mbps, 52 Mbps
Line code	scrambled NRZ

Clock generator

Internal, accuracy	±4.6 ppm
Offset	±50 ppm

Synchronization from external signal according to clock specifications of the mainframe

Optical interfaces

The interface meets the requirements of ITU-T G.959.1/G.957/GR.253

Generator

Wavelength	1310 nm and 1550 nm switchable
Output level	–2 to +3 dBm

Receiver

Wavelength	1260 to 1360 nm, 1430 to 1580 nm
Sensitivity all rates	–8 to typ. –28 dBm
Sensitivity 52M, 155M	–8 to typ. –34 dBm (typ.)
Max. input power (destructive power)	+3 dBm
Measurement optical power	–8 to –34 dBm

Electrical interfaces (in preparation)

Impedance	AC coupled 50 Ω
Connector type	SMA

Generator data signal

Bit rates	52M to 2.666 Gbps
Line code	scrambled NRZ
Output level	> 200 mVpp

Generator clock signal

Bit rates	52M to 2.666 GHz
Eye clock	$f_{clock}/4$
Output level	> 200 mVpp

Receiver data signal

Bit rates	52M to 2.666 Gbps
Line code	scrambled NRZ
Input level	200 to 1000 mVpp

Receiver clock signal

Rec. clock	$f_{clock}/4$
Output level	> 200 mVpp

OTN module 10/10.7G FEC

Hardware option – 2 slots

The OTN module 10/10.7G FEC supports STM-64 and OC-192 and OTU-2 (10.7 Gbps) interfaces with non-concatenated and concatenated sub-rate mappings down to STS-1/VC3-AU3. It also provides signal analysis and manipulation (alarms, errors, overheads), and BER testing in the corresponding output signals.

General

Line rate	10.709 Gbps, 9.953 Gbps
Line code	scrambled NRZ

Clock generator

Internal, accuracy	±4.6 ppm
Offset	±20 ppm

Synchronization from external signal: according to clock specifications of the mainframe

Optical interfaces

The interface meets the requirements of ITU-T G.691/GR.253

Generator

Wavelength	1550 nm
Output level 1550 nm	–2 to +3 dBm

Receiver

Wavelength range m	1530 to 1565 nm
Sensivity	–3 to –14 dBm
Max. input power (destructive power)	+2 dBm
Measuring optical input power	–14 to 0 dBm

Electrical interfaces (in preparation)

only with BN 3070/90.32

Impedance	AC coupled 50 Ω
Connector type	SMA

Generator data signal

Bit rates	9.953 Gbps, 10.709 Gbps
Line code	scrambled NRZ
Output level	> 200 mVpp

Generator clock signal

Bit rates	9.953 GHz, 10.709 GHz
Output level	> 200 mVpp

Receiver data signal

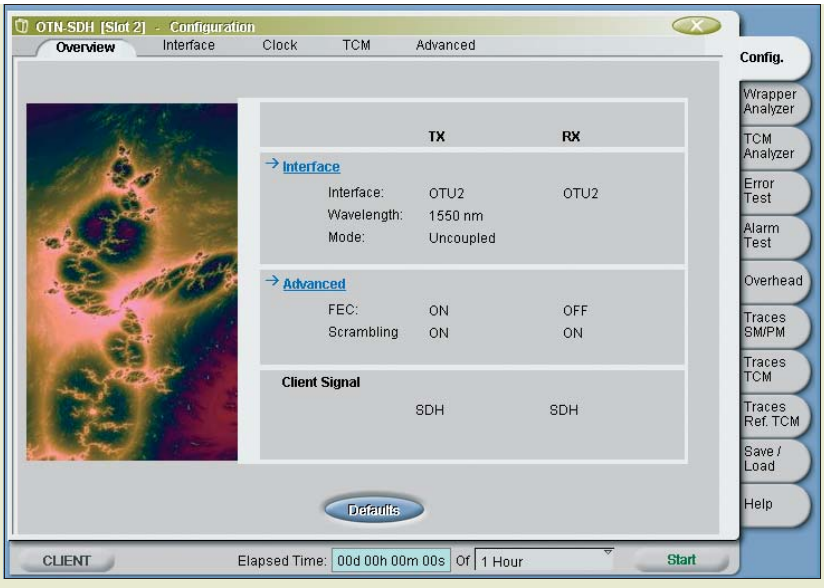
Bit rates	9.953 Gbps, 10.709 Gbps
Line code	scrambled NRZ
Input level	100 to 600 mVpp

Eye clock signal

Bit rates	622 MHz , 669 MHz
Output level	sinusoidal > 200 mVpp

Jitter module 10/10.7G

see page 13



SDH Expert Book

Software built-in

The SDH expert book is an application that runs on the OC-48/STM-16, OC-192/STM-64 modules and additionally as a client inside the OTN 2.7 and 10.7G structure. It is a complete test set for extended SDH testing that also enables users to perform in-depth analyses such as performance measurements, pointer analysis, overhead analysis and generation.

Signal structure

SDH mappings (dependent on hardware module)

AU-3: VC-3, VC-11, VC-12 (bulk filled)

AU-4: VC-4, VC4-4c/16c/64c, VC-3, , VC11, VC12 (bulk filled)

Fill patterns

$2^{31}-1$ (non-inv, non-ITU), $2^{31}-1$ (inv, ITU),

$2^{23}-1$ (non-inv, non-ITU), $2^{23}-1$ (inv, ITU),

16 bit user definable word

Background channels

Identically structured and filled

Through mode

The received signal is looped through the ONT-50 and re-transmitted (coupled receiver and transmitter). The received signal can be monitored and the transmitted signal manipulated.

Error injection single rate	B1, B2, FAS, MS-REI, random 1E-5 to 1E-10 random
Alarm injection	LOS, LOF, MS-AIS, MS-RDI, AU-AIS, AU-LOP

Measurement types

Error insertion

Error types	bit errors, random, B1, B2, B3, MS-REI, HP-REI, BIP2, LP-REI
Triggering	
all errors	single
additonally bit errors ratio	1E-2 to 1E-9
additonally random ratio	1E-5 to 1E-10

Error measurement

All errors count, ratio, seconds

Alarm generation

LOS, LOF

MS-AIS, MS-RDI, AU-LOP, AU-AIS, HP-RDI, HP-UNEQU, LOM, LP-AIS, LP-RDI, RFI, LP-LOP, LP-UNEQU

Triggering	on/off

Alarm detection

LOS, OOF, LOF

MS-AIS, MS-RDI, AU-LOP, AU-AIS, HP-RDI, HP-UNEQU, LOM, LP-AIS, LP-RDI, RFI, LP-LOP, LP-UNEQU

Pattern loss

Resolution	100 ms

Pointer generation

- AU and TU pointer increment, decrement, new value
- Pointer sequences G.783 with programmable spacing
- Set new value and correspondent container offset
- Trigger inc/dec single, periodical, alternating

Pointer analysis

- AU and TU Pointer New value
- Count increments, decrements, NDF

Message evaluation

- J0, J1, J2
  programmable 16 and 64 byte ASCII sequence
  Expectation value editable – criterion for TIM
- C2, V5
  signal label clear text selection
  Expectation value editable – criterion for PLM
- J0, J1, J2, C2, V5
  clear text display

SOH and POH evaluation

- Manipulation and analysis of all accessible SOH/POH overhead bytes (including K1/K2, C2, V5, J0/J1/J2)
- SOH and POH-HP and POH-LP display
- K1, K2 and S1 are shown in clear text

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, the far end of a selected path as well as out-of-service (OOS) measurements are possible.

Performance monitoring G.828 and G.829

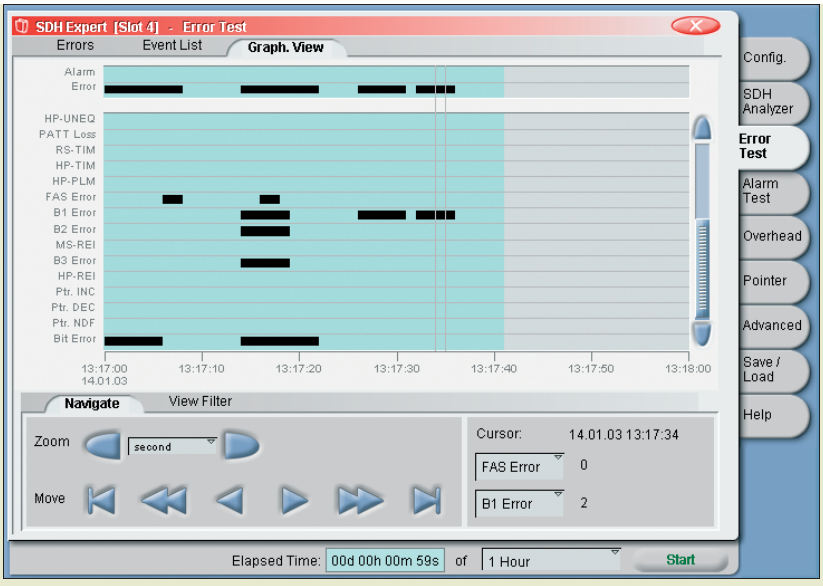
The G.828 defines error performance parameters for international synchronous paths.
EB, BBE, ES, EFS, SES, and UAS are evaluated.
PASS/FAIL assessments are based on a line length allocation of 0.1 to 100%.
The SES and UAS thresholds are user-programmable.
The SEP can be switched off for assessment.
G.829 defines error performance events and block structures for SDH multiplex and regenerator sections.

Service disruption measurement

In synchronous networks, a defined maximum switch over time is necessary to ensure minimal disruption to traffic should a fault occur.
When activated, the ONT-50 will generate a high speed event list, that tracks the service disruptions of a valid signal as a result of Automatic Protection Switching (APS). The list shows start and stop times as well as event duration. The shortest, longest and last disruptions are displayed as summary results.

Criteria for signal disruption

Alarms	OOF, LOF, MS-AIS, MS-RDI, AU-AIS HP-RDI, AU-LOP in preparation: LOM, LP-RDI, LP-LOP
Errors	FAS, B1, B2, MS-REI, B3, HP-REI , bit errors in preparation: BIP2, LP-REI
Event resolution	frame based 125 µsec



Result display of errors and alarms

Numerical display

The count, ratio and duration are displayed for each error.

Tabular display

Display of all results with time stamps
Criteria start, stop, duration and count.

Graphical display

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

Time axis	second, minute, hour

Measurement interval

The application can be started and stopped manually or automatically with the use of a timer. Measurement stop intervals are 1 min, 15 min, 1 h, 24 h, 72 h, 96 h or user definable.

SONET Expert Book

Software built-in

The SONET expert book is an application that runs on the OC-48/STM-16, OC-192/STM-64 modules and additionally as a client inside the OTN 2.7 and 10.7G structure. It is a complete test set for extended SONET testing that also enables users to perform in-depth analyses including performance measurements, pointer analysis, overhead analysis and generation.

Signal structure

SONET mappings (dependent on hardware module)
STS-1/3c/12c/48c/192c (bulk filled)
VT1.5, VT2 (bulk filled)

Fill patterns

2^{31}–1 (non-inv, non-ITU), 2^{31}–1 (inv, ITU),
2^{23}–1 (non-inv, non-ITU), 2^{23}–1 (inv, ITU),
16 bit user definable word

Background channels

Identically structured and filled

Through mode

The received signal is looped through the ONT-50 and re-transmitted (coupled receiver and transmitter). The received signal can be monitored and the transmitted signal manipulated.

Error injection single rate	B1, B2, FAS, REI-L, random 1E-5 to 1E-10 random
Alarm injection	LOS, LOF, AIS-L, RDI-L, AIS-P, LOP-P

Measurement types

Error insertion

Error types	bit errors, random, B1, B2, B3, REI-L, REI-P, BIP-V, REI-V
Triggering	
all errors	single
additonally bit errors ratio	1E-2 to 1E-9
additonally random ratio	1E-5 to 1E-10

Error measurement

All errors	count, ratio, seconds

Alarm generation

LOS, LOF
AIS-L, RDI-L, LOP-P, AIS-P, RDI-P, UNEQU-P
LOM, AIS-V, RDI-V, RFI, LOP-V, UNEQU-V, PDI-V

Triggering	on/off

Alarm detection

LOS, OOF, LOF
AIS-L, RDI-L, LOP-P, AIS-P, RDI-P, UNEQU-P,
LOM, AIS-V, RDI-V, RFI, LOP-V, UNEQU-V, PDI-V
Pattern loss

Resolution	100 ms

Pointer generation

- STS and VT pointer
- Increment, decrement, new value
- Pointer sequences G.783 with programmable spacing
- Set new value and correspondent container offset
- Trigger inc/dec single, periodical, alternating

Pointer analysis

- STS and VT pointer
- New value
- Count increments, decrements, NDF

Message evaluation

- J0, J1, J2
  programmable 16 and 64 byte ASCII sequence
  Expectation value editable – criterion for TIM
- C2, V5
  signal label clear text selection
  Expectation value editable - criterion for PLM
- J0, J1, J2, C2, V5
  clear text display

TOH and POH evaluation

- Manipulation and analysis of all accessible TOH/POH overhead bytes (including K1/K2, C2, V5, J0/J1/J2)
- TOH and POH display
- K1, K2 and S1 are shown in clear text

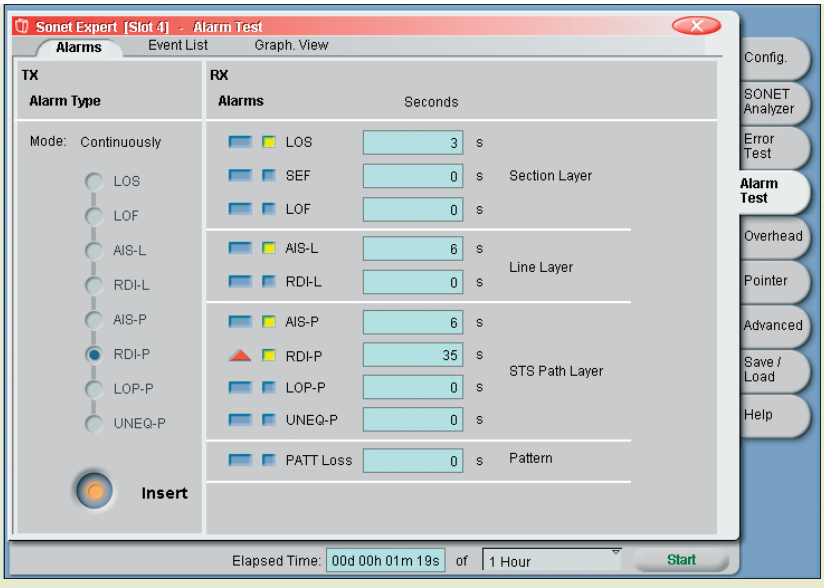
Performance monitoring

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

Service disruption measurement

In synchronous networks, a defined maximum switch over time is necessary to ensure minimal disruption to traffic should a fault occur.
When activated, the ONT-50 will generate a high speed event list, that tracks the service disruptions of a valid signal as a result of Automatic Protection Switching (APS). The list shows start and stop times as well as event duration. The shortest, longest and last disruptions are displayed as summary results.
Criteria for signal disruption

Alarms	SEF, LOF, AIS-L, RDI-L, AIS-P, RDI-P, LOP-P in preparation: LOM, RDI-V, LOP-V
Errors	FAS, B1, B2, REI-L, B3, REI-P, bit errors in preparation: BIP-V, REI-V
Event resolution	frame based 125 µs



Result display of errors and alarms

Numerical display

The 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 on the results. Filters enable event selection.
Time axis second, minute, hour

Measurement interval

The application can be started and stopped manually and automatically with the use of a timer. Measurement stop intervals are 1 min, 15 min, 1 h, 24 h, 72 h, 96 h or user definable.

IP/PoSDH and IP/PoSONET Book

Software option

The combined IP/PoSDH and IP/PoSONET book enables applications to run on the OC-48/STM-16, OC-192/STM-64 modules and is a complete test set for extended packet over SONET/SDH testing.
It allows the user to check the physical layer (SONET/SDH) as well as traffic in IP networks with HDLC/PPP framing.

SONET/SDH measurement types

Errors, alarms, pointer overheads, traces

As defined in SDH expert book and SONET expert book

Signal structure

SDH and SONET mappings

As defined in SDH expert book and SONET expert book

Fill patterns

– HDLC/PPP like framing (RFC 1662)
– CISCO HDLC

IP/PoS measurement types

Traffic parameters on transmit side

Frame size, frame rate
Sustained bandwidth
Utilization

Traffic analysis on receive side

Frame rate, total frames received, analyzed test frames
Link bandwidth, link utilization
Average delay, delay variation

Error insertion

Error types	FCS error, invalid frame, lost packets
Triggering	single

Error measurement

All errors count, ratio, duration

Alarm detection

Red, Yellow, LPAC duration	
Resolution	100 ms

Results

Results are displayed in count and ratio and the summary result provides clear GO/NOGO indication.

OTN Book

Software built in

The OTN book is an application that runs on the OTN module 2.5/2.7G (OTU1) and 10/10.7G (OTU-2) and allows generation and analysis of OTN signals. Detailed parameters can be manipulated and evaluated in different OTN levels. Its payload supports both framed SONET/SDH and unframed clients. The test set provides signal analysis and manipulation (alarm, error, overhead), Forward Error Correction (FEC) generation and analysis as well as in depth FEC error testing. In addition to this, the full analysis capabilities of the SDH and SONET expert books are available for OTN client analysis.

OTN OTU1 and OTU2 generation unit

Content of overhead bytes

(frame alignment/OTU/ODU/OPU)

– All bytes statically programmable except MFAS, SM BIP-8, PM BIP-8, TCM1...6 BIP-8
– Additional possibilities for SM TTI, PM TTI, TCM1...6 TTI (Trail Trace Identifier): Sequence consisting of the SAPI (16 bytes), DAPI (16 bytes) and the operator specific field (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

OPU client signals

– OC-192/STM-64 signal internally generated, bit-synchronous or asynchronous mapping.
– Generation see chapter SDH and SONET expert book.
– PRBS $2^{31}-1$ inv./non-inv., PRBS $2^{23}-1$ inv./non-inv.
– Digital word 16 bit free programmable
– Null client

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.

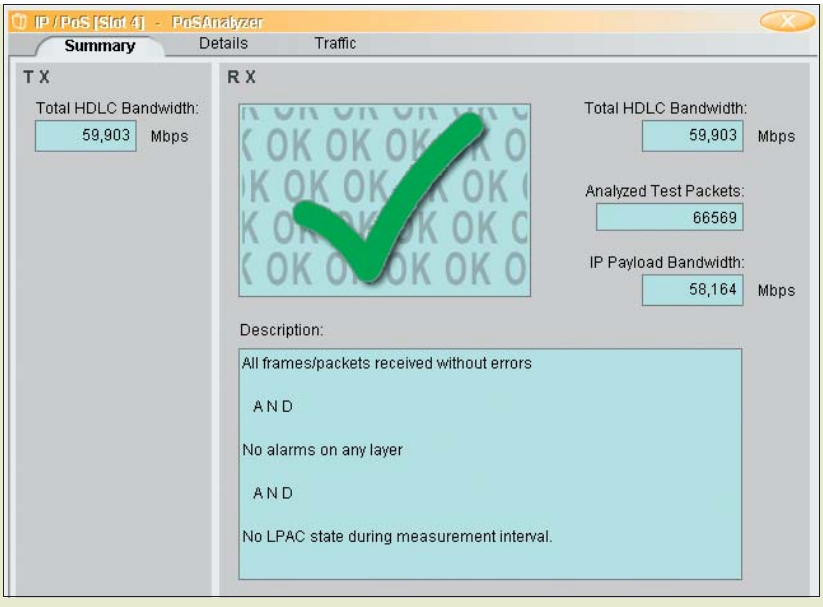
The OTU FEC field

This field contains the FEC values calculated according to the Reed-Solomon (255,239) algorithm.

Error insertion

Error types

Random, FAS, MFAS, FEC
SM BIP-8, SM BEI, PM BIP-8, PM BEI
FECuncorr., FEC corr., FECstress, FECadv.
TCMi BIP-8, TCMi BEI (i = 1 to 6)



Triggering

Single	all errors except FEC
Ratio	random 1E-3 to 1E-10
Burst once	all errors except random, FECstress
Burst continuous	all errors except random
Burst error	M frames errors, N frames non-errored, M and N = 0 to 2E9

BIP masks

The position and number of bit errors in the bytes can be selected.
Valid for SM BIP8, PM BIP8, TCMi BIP8 (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)

FEC error insertion modes

FECcorrectable, FECuncorrectable

FECstress

This extremely helpful function allows maximum stress tests within short timeframes.
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

Alarm generation

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

Triggering

Continuously	all alarms
Burst once and Burst continuous	all errors except LOS, LOF, OOF, OOM, SD, SF
Burst alarms	M frames with alarm, N frames no alarm, M and N = 0 to 2E9

Through mode

The received signal is looped through the ONT-50 and retransmitted without termination of alarms and errors. All alarms, errors and traces of the received signal can be monitored on the client signal and on the wrapper level. The intrusive manipulation of the transmitted signal (alarm and error insertion as well as manipulation of the traces and specific OH bytes) is planned for a future release.

OTN OTU1 and OTU2 analyzer unit
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 can be displayed for a selectable OH byte up to 256 values
- 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

OPU client signals

- OC-192/STM-64 signal mapped bit-synchronous or asynchronous.
  Analysis see chapter SDH and SONET expert book.
- Validation for payload bit error measurement at:
  PRBS 2^{31}–1 inv./non-inv.,
  PRBS 2^{23}–1 inv./non-inv.
- Digital word 16 bit free programmable
- Null client

The OTU FEC

The FEC procedure 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 and 8 byte errors be corrected.

Error measurement

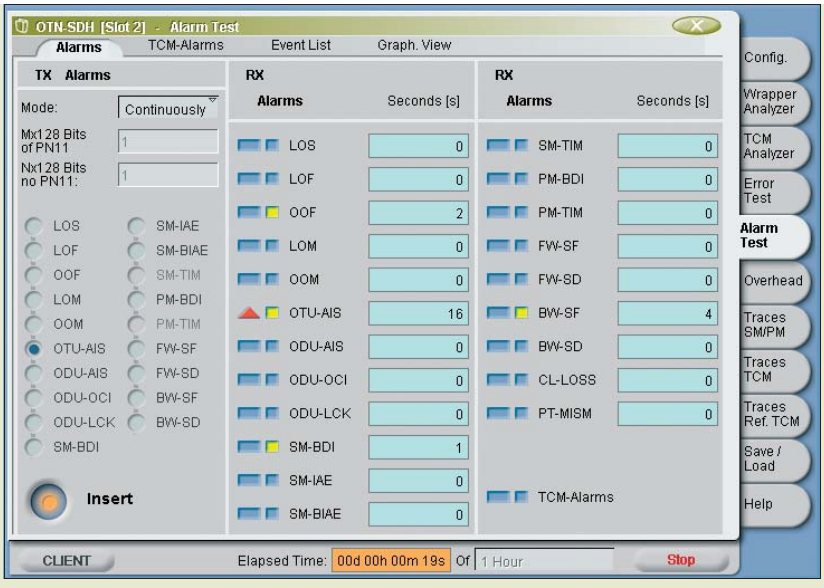
Validation of data for error measurement occurs after frame alignment, descrambling, and FEC computation and correction.

Error types

FAS, MFAS,
SM BIP-8, SM BEI, PM BIP-8, PM BEI
FECcorr., FECuncorr.
TCMi BIP-8, TCMi BEI (i = 1 to 6)

Alarm detection

From each alarm the duration will be displayed.
LOS, 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-BDI, TCMi-IAE, TCMi-TIM (i = 1 to 6)
CL-LOSS (Client signal Loss of synchronization)
PT-MISM



Result display of errors and alarms

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

Stuffing of the payload

Display of payload offset	ppm

Stuffing counts

Positive, negative, sum	count, duration

Ethernet over SONET/SDH Book

Hardware and software option

The NewGen Module 2.5G (SONET/SDH) supports line interface rates of 52 Mbps, 155 Mbps, 622 Mbps and 2.488 Gbps for SONET/SDH signals.

The **EoS** software book includes all the associated topics addressed by the New SONET/SDH technology including, Virtual Concatenation (VC), the Link Capacity Adjustment Scheme (LCAS), the Generic Frame Procedure (GFP) and the generation and analysis of Ethernet frames. For each of the technologies, the New SONET/SDH book allows a detailed analysis of the most important parameters and functions.

General SONET/SDH analysis

All line interface related parameters – for example optical parameters, and transport layer related functions – are similar to those specified in the SONET/SDH expert book.

Virtual Concatenation – VC

Virtual concatenation implementation is in accordance with ITU-T G.707, G.783 and ANSI T1.105-2001 recommendations. One higher order (HO) Virtual Concatenation Group (VCG) is supported.

Group size:

– 1 to 7 members of VC-4/STS-3c and

– 1 to 21 members of VC-3/STS-1

Path layer overhead generation and analysis is supported for every member of the VCG. Functionality is comparable to the SONET/SDH expert book.

Generation

Sequence numbers

With LCAS disabled, transmitted sequence numbers (TxSQ) can be user programable per member. With LCAS enabled, sequence numbers are automatically assigned in accordance with LCAS rules.

Differential delay

Differential delay emulation capability is provided. Distribution of differential delay within the group is arbitrary within the range supported.

Maximum differential delay	100 ms

Manipulation of H4 byte (per member)

Out of Multiframe 1	OOM1
Out of Multiframe 2	OOM2

Evaluation

Sequence numbers

With LCAS disabled, expected sequence numbers are user programmable per member (ExSQ). With LCAS enabled, sequence number acceptance is in accordance with LCAS protocol rules and no ExSQ is required. SQM defect is only valid with LCAS disabled.

Sequence number related results per member

Accepted sequence number	AcSQ
Sequence number mismatch defect	SQM

Differential delay

With differential delay compensation and measurement of differential delay, measurement is on a per member basis. LOA defect detection is supported.

Maximum differential delay	100 ms
Loss of alignment detection	LOA

Analysis of H4 byte

Analysis of the following defects (per member):

Loss of Multiframe	LOM
Out of Multiframe 1	OOM1
Out of Multiframe 2	OOM2

Link Capacity Adjustment Scheme – LCAS

LCAS implementation in accordance with ITU-T G.7042, G.707 and ANSI T1.105-2001.

ONT-50 supports LCAS source and sink protocol emulation as well as the generation and analysis of relevant LCAS control packet information. In a monitor configuration, the instrument analyzes the relevant LCAS information transported in the H4 byte.

LCAS protocol emulation

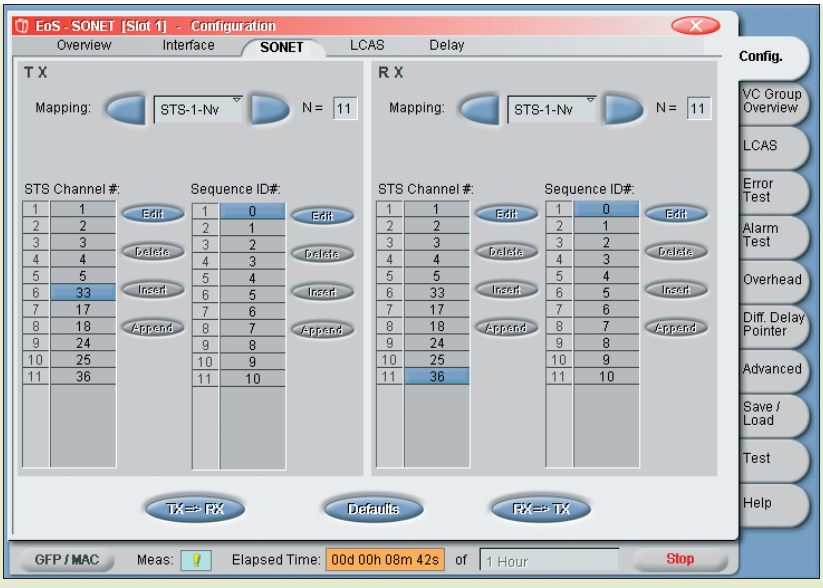
An LCAS source state machine is implemented for every member of the Tx VCG. An LCAS sink state machine is implemented for every member of the Rx VCG. The ONT-50 provides state machine control as well as state machine monitoring capabilities. LCAS protocol emulation can be disabled. With LCAS disabled, FIXED control packets are generated (all H4 byte information zero except sequence number and multiframe indicators).

Source state machine control (per member)

Direct command	ADD, REMOVE
Overwrite received member status	OK, FAIL, AUTO
Force re-sequence acknowledge	RS-Ack

Sink state machine control (per member)

Direct command	ADD, REMOVE
Overwrite generated member status	FAIL, AUTO



Source state machine monitoring (per member)

Machine state	IDLE, ADD, NORM, DNU, REMOVE
Transmitted control word	ADD, NORM, EOS, IDLE, DNU
Transmitted member status	OK, FAIL
Received member status	OK, FAIL
Transmitted sequence number	

Sink state machine monitoring (per member)

Sink monitoring information is analyzed after differential delay compensation.

Machine state	IDLE, FAIL, OK
Received control word	ADD, NORM, EOS, IDLE, DNU, FIXED
Received sequence number	

Group wide monitoring

Transmitted re-sequence acknowledge	Count
Received re-sequence acknowledge	Count
Selected return information member number	0-20

LCAS defects and alarms

Source

Loss of transport capacity	TxLOC
Loss of partial transport capacity	TxLOPC
Loss of total transport capacity	TxLOTC

Sink

Loss of transport capacity	RxLOC
Loss of partial transport capacity	RxLOPC
Loss of total transport capacity	RxLOTC
Failure of protocol excessive CRC errors	FOP_CRC

Generic Frame Procedure – GFP

The GFP functionality included in the EoS book provides Ethernet MAC framing/deframing and mapping/de-mapping of GFP to SONET/SDH virtual concatenation. Implementation is in accordance with ITU-T G.7041, G.707 and ANSI T1.105.02-2001 recommendations – frame mapped Ethernet.
GFP defect/alarm and error insertion and analysis is provided. On Rx, filtering based on type header fields is performed. GFP bandwidth and utilization measurements are also carried out.
Features supported:

- Core header processing
- Payload type header processing
- Rate adaptation (idle frame handling)
- Payload scrambling (scrambler can be disabled)
- Payload FCS (can be disabled)
- Frame based Ethernet MAC frame encapsulation
- Client signal fail alarm generation and reporting

Frame transmission:

GFP traffic profile setting

Constant frame rate traffic profile. User settable frame size and bandwidth.

GFP frame size	72 - 32767 byte
GFP bandwidth	0 - 1 Gbps

Manipulation of payload header

The Payload Type Header is formatted in the following way:

PFI	0 corresponding to FCS off 1 corresponding to FCS on
EXI	Null extension header
UPI	clear text selection acc. to ITU-T G.7041

Client data signal frame

Default UPI is frame mapped Ethernet	01_{hex}

Client management signal frame

Default UPI is Client signal fail	01_{hex}

The following errors and alarms can be inserted in the **Core Header** and the **Payload Header.**

Error insertion (single error)

Error insertion Core Header

Core header single-bit error	cH_SNGL
Core header multiple-bit error	cH_MULT

Error insertion Payload Type Header

Type header single-bit error	tH_SNGL
Type header multiple-bit error	tH_MULT

Error insertion in payload

GFP Payload FCS single-bit error	GFP Payl. FCS

Alarm insertion

Loss of Frame Delineation	LFD
Client signal fail	CSF
CSF frame period	500 ms

Frame reception

GFP receive filtering is based on payload type header fields. Only error free frames matching the filter criteria are forwarded to MAC layer processing. Core header and payload header error detection as well as error correction are supported.

Frame delineation

Programmable frame with user settable delta:

Delta	1-8

Error detection

Core header errors (count and ratio)

Core header single-bit error	cH_SNGL

Payload Type Header errors (count and ratio)

Type header single-bit error	tH_SNGL
Type header multiple-bit error	tH_MULT

Payload errors (count and ratio)

GFP Payload FCS error	GFP Payl. FCS

Alarm detection

Loss of Frame Delineation	LFD
Client signal fail	CSF

Bandwidth and utilization measurements:

Tx traffic parameters

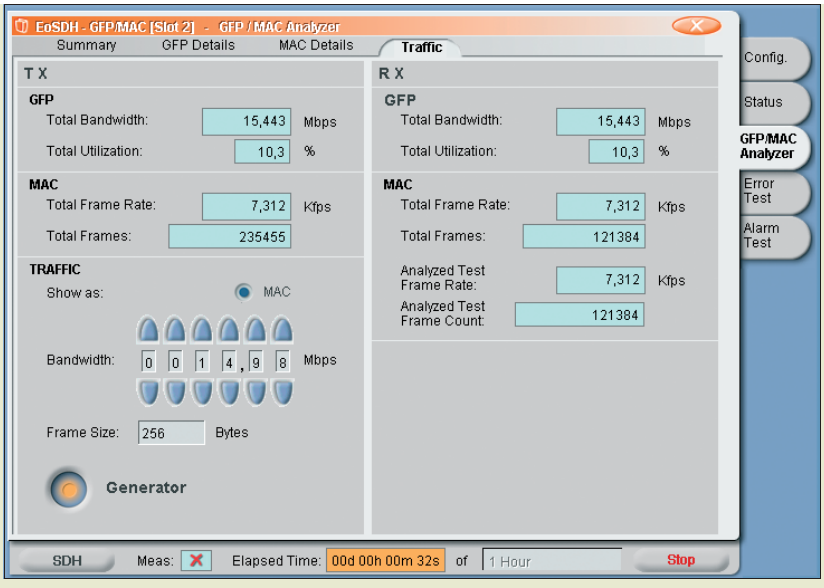
Tx total GFP bandwidth	0 – 1 Gbps
Tx total GFP utilization	0 – 100%

Rx traffic parameters

Rx total GFP bandwidth	0 – 1 Gbps
Rx total GFP utilization	0 – 100%

Ethernet MAC Layer

The EoS book supports the following Ethernet frame formats:
Ethernet II frames (ISO/IEC 8802-3), IEEE 802.3 frames, IEEE 802.2 (LLC) frames, SNAP frames and VLAN tagged frames.



Frame transmission

MAC traffic profile setting

Constant frame rate traffic profile. User settable frame size and bandwidth.

MAC frame size	64 - 1518 byte without VLAN Tag 64 - 1522 byte with VLAN Tag
MAC bandwidth	0 - 1 Gbps

Tx MAC frame rate measurement

Tx total frame count
Tx total frame rate

MAC frame error insertion

Single error insertion is supported for the following errors:
Jabber frame, Runt frame, Too long frame,
FCS errrored frame, In Range Length error.
Note: In Range Length error is only supported for IEEE 802.3 frames.

Frame reception

MAC receive filtering is based on source address and destination address information. Only error free frames matching the filter criteria are forwarded to network performance evaluation.

MAC frame error measurements

Errors detected (count and ratio)

Jabber frame, Runt frame, Too long frame, FCS errrored frame, In Range Length error, Errored frame.
Note: In Range Length error is only supported for IEEE 802.3 frames.

Rx MAC frame rate measurement

Rx total frame count
Rx total frame rate

Network Performance

The EoS book supports network performance measurements based on GFP mapped Ethernet frames. Acterna test frame information is carried in user frame payload. Receiver evaluates the test frame information for network performance parameter measurement.

Error insertion (singe error)

Lost frame

Network performance parameters measured

Analyzed test frames	count, rate
Lost frames	count, rate
Average frame transfer delay	0 to 42.9 s
Current average frame transfer delay	0 to 42.9 s
Frame transfer delay variation	0 to 42.9 s
Current frame transfer delay variation	0 to 42.9 s

Network performance related defects

Loss of Performance Assessment Capability	LPAC

Ethernet Module 1G

The **Ethernet Module 1G** provides effient diagnosis and testing of Ethernet based network elements with 1GE interfaces, and is also essential for verifying the correct interworking of NewSONET/SDH network elements with Ethernet. In addition to this, the module also enables end to end testing for connectivity and Ethernet transparency.

Interface specifications

Supports 4 ports of optical 1GE on an Ethernet module.
The following physical interfaces related to IEEE 802.3 are supported:

- 1000 BASE – SX
- 1000 BASE – LX

Support of the various physical interfaces is provided via Small Form Factor Pluggable (SFPs) which are optional. Interface supports full duplex mode.

Data rate	1000 Mbps
Coding scheme	8B/10B
Connectors	LC

Transmitter

Clock accuracy	±4.6 ppm
Offset	±100 ppm
Offset resolution	0.1 ppm

Receiver

Offset	±200 ppm

TX reference clock output

Nominal frequency	125 MHz
Pulling range	±100 ppm
Signal level	≥400 mVpp
Impedance	AC coupled 50 Ω
Connector type	SMA

RX recovered clock output

Nominal frequency	125 MHz
Pulling range	±200 ppm
Signal level	≥400 mVpp
Impedance	AC coupled 50 Ω
Connector type	SMA

Ethernet MAC book

Auto-negotiation

To establish a link betweeen two Ethernet users the Ethernet module provides “Auto-negotiation”.
The following modes are available:

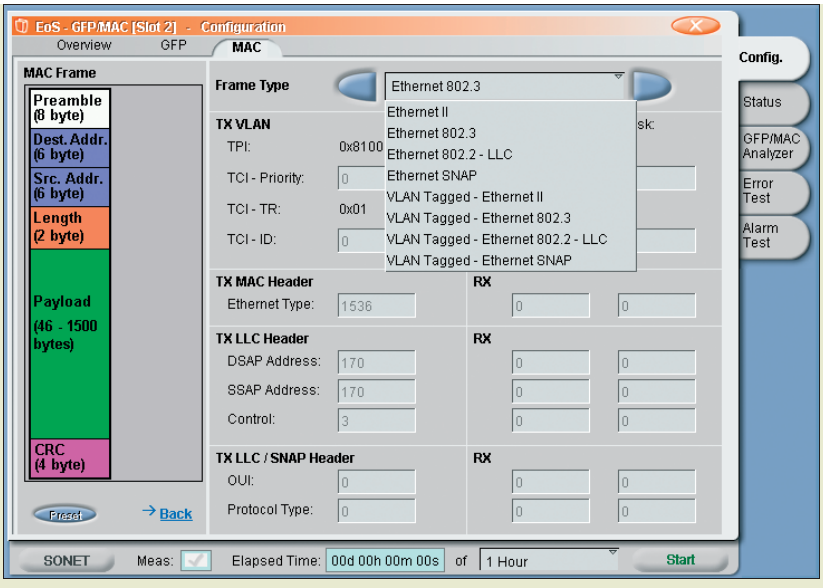
- Auto-negotiation on/off
- Manual restart of auto-negotiation process
- Ignore link status – If auto-negotiation is disabled the ONT-50 module (RX) ignores the status of the link

Auto-negotiation capabilitiy insertion

Specific user defined capabilities displayed during auto-negotiation:
Flow control capabilities, Remote fault encoding

Auto-negotiation results

The following status information is provided:
Auto-negotiation in progress, Auto-negotiation fail
The Ethernet module 1G indicates the following capabilities displayed by the link partner:
Flow control capabilities
Remote fault encoding



Link error generation

Types	Invalid code group, running disparity
Triggering	single, continuous

Link status monitoring

Loss of signal, loss of synchronization, link down

Link error monitoring

Evaluation count and ratio:
Invalid code group, running disparity error, error propagation received (/V/ ordered set received)
Evaluation count:
Loss of synchronization event

Link bandwidth and utilization measurement

RX total link bandwidth	0 to 1000 Mbps
RX total link utilization	0 to 100%
TX total link bandwidth	0 to 1000 Mbps
TX total link utilization	0 to 100%

Ethernet MAC frame generation and analysis

The following Ethernet frame formats are supported:
Ethernet II frames (ISO/IEC 8802-3), IEEE 802.3 frames, IEEE 802.2 (LLC) frames, SNAP frames and VLAN tagged frames.

Frame transmission

MAC traffic profile setting

Constant frame rate traffic profile. User settable frame size and bandwidth.

MAC frame size	64 – 1518 byte without VLAN Tag 64 – 1522 byte with VLAN Tag
MAC bandwidth	0 – 1 Gbps

Tx MAC frame rate measurement:

Tx total frame count
Tx total frame rate

MAC frame error insertion:

Single error insertion is supported for the following errors:
Jabber, Runt, Oversized, FCS errrored, in range length error
Note: In Range Length error is only supported for IEEE 802.3 frames.

Frame reception:

MAC receive filtering is based on source address and destination address information. Only error free frames matching the filter criteria are forwarded for network performance evaluation.

MAC frame error measurements:

Errors detected (count and ratio):
Jabber, Runt, Oversized, FCS errrored, in range length error, Errored (aggregated)
Note: In Range Length error is only supported for IEEE 802.3 frames.

Rx MAC frame rate measurement:

Rx total frame count
Rx total frame rate

Network Performance

The MAC book supports network performance measurements based on Acterna test frames carried in the user frame payload Ethernet frames. The receiver evaluates the test frame information for network performance parameter measurement.

Error insertion

Lost frame (single error)

Network performance parameters measured

Analyzed test frames	count, rate
Lost frames	count, rate
Average frame transfer delay	0 to 42.9sec
Current average frame transfer delay	0 to 42.9sec
Frame transfer delay variation	0 to 42.9sec
Current frame transfer delay variation	0 to 42.9sec

Network performance related defects

Loss of Performance Assessment Capability LPAC

Jitter module 10/10.7G

Hardware option

Together with OTN module 10/10.7G, the jitter module provides jitter functions on bit rates of 10 and 10.7 Gbps.
The jitter/wander book displays specific generation and measurement details.
With an additional software option, the module also enables wander generation and analysis.

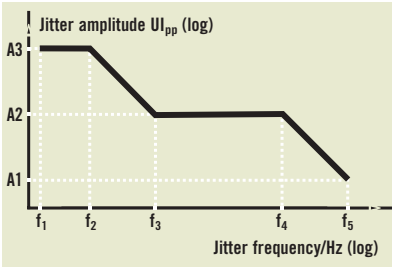
Jitter generator 10/10.7 Gbps

In accordance with
– Telcordia GR-253, GR-499
– ANSI T1.101, T1.105.03
– ITU-T G.783, G.825, O.172, G.8251

Bit rate	9.953 and 10.709 Gbps
Offset	t.b.d.
Modulation source	internal or external
Jitter modulation signal	sine wave

Built-in modulation generator (sine wave)

or external	10 Hz to 80 MHz
Jitter amplitude	up to 3200 Uipp
Step width	0.001 UI



Amplitude in UIpp			Frequency in Hz				
A1	A2	A3	f1	f2	f3	f4	f5
0.5	20	3200	10	12.5	2k	2M	80M

Modulator input

BNC, 75 Ω	
Modulation frequency	10 Hz to 80 MHz
Nominal input voltage range	0 to 2 Vpp

Generation accuracy conform to O.172

Jitter meter 10/10.7 Gbps

In accordance with
- Telcordia GR-253, GR-499
- ANSI T1.101, T1.105.03
- ITU-T G.783, G.825, O.172, G.8251

Bit rate	9.953 and 10.709 Gbps
Offset permitted	t.b.d.

Measuring ranges/resolution

Peak-Peak I	0 to 4 UIpp / 1 mUIpp
Peak-Peak II	2 to 40 UIpp / 10 mUIpp
Peak-Peak III	20 to 3200 UIpp / 100 mUIpp
RMS I	0 to 2 UIpp / 1 mUIpp
RMS II	0 to 20 UIpp / 10 mUIpp
RMS III	0 to 1600 UIpp / 100 mUIpp

Built-in filters

as per Telcordia GR-253, ANSI T1.105.03, ITU-T O.172, G.825, G.8251

High-pass filters	10k, 12k, 20k, 50k, 4 MHz
Low-pass filter range I	80 MHz
Low-pass filter range II and III	10 kHz
Demodulator output	BNC, 75 Ω

Wander generator/analyzer 10/10.7 Gbps

This software option is only available in conjunction with jitter module 10/10.7G.
Enables wander generation and analysis in accordance with:
- Telcordia GR-253, GR-499
- ANSI T1.101, T1.102, T1.105.03
- ITU-T G.825, O.172

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

Wander generator 10/10.7 Gbps (optional)

Modulation shape	sine wave
Amplitude range	0.1 to 320.000 UI
Amplitude step width	0.1 UI
Frequency range	10 µHz to 10 Hz
Frequency step width	1 µHz

Wander analyzer 10/10.7 Gbps (optional)

Other sampling rates in addition to the 30/s rate are available for detailed analysis versus time:

Sampling rate – Low-pass filter	
1/s – 0,1 Hz	
30/s – 10 Hz	
1000/s – 100 Hz	
Measurement accuracy	as per O.172

Reference signal input

Balanced Bantam	110 Ω
Clock signal	1.544; 2.048 MHz
Bit rate	1.544; 2.048 Mbps
Unbalanced BNC	75 Ω
Clock signal	1.544k; 2.048k, 5M, 10 MHz
Bit rate	1.544; 2.048 Mbps

Jitter/Wander book

Jitter software built in, Wander software option

The jitter/wander book is an application that runs on the jitter module 10/10.7G and includes all the manual and automatic measurements for jitter and wander (optional) evaluations.

Jitter generation

Refer to jitter module 10/10.7G

Jitter measuring modes

Current values (continuous measurement or displayed in graphical form)
Peak-Peak, positive peak, negative peak

Maximum values (gated measurement)
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 or peak-to-peak values to be displayed versus time. Duration is up to 99 days.

RMS measurement

GR-253, GR-499, T1.105.03
ITU-T G.783
The RMS value is measured on-line and displayed in UI.
Peak jitter and RMS values can be displayed simultaneously and a graph versus time is available for long-term analysis. An RMS filter preset is also available.

Automatic jitter measurements

Selective Jitter Transfer Function (JTF)

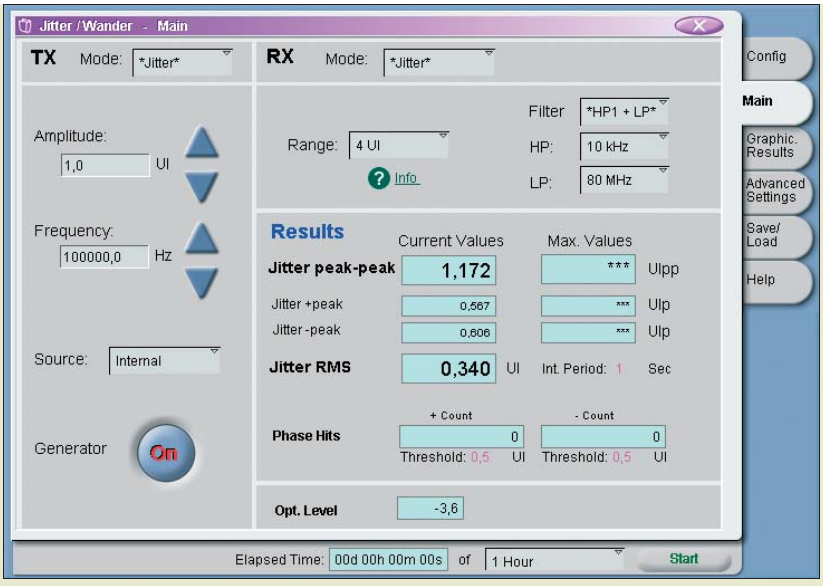
(In accordance with Telcordia GR-253, ANSI T1.105.03,ITU-T G.783 and G.8251)
The JTF shows the ratio of the jitter amplitude at the output of the device under test (DUT) and at the input at various frequencies. Standard tolerance masks are available and can be edited.

Maximum Tolerable Jitter (MTJ)

(In accordance with Telcordia GR-253, ANSI T1.105.03,ITU-T G.825, G.783 and G.8251)
The jtter module 10/10.7G 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. Standard tolerance masks are available and can be edited.

Wander generation (optional)

refer to jitter module 10/10.7G



Wander measuring modes (optional)
Time Interval Error (TIE)
(In accordance with ITU-T O.172)
TIE values are recorded and available for subsequent off-line MTIE/TDEV evaluations.
TIE value results are analyzed in accordance 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.

Maximum Tolerable Wander (MTW) (optional)
ITU-T G.823, G.825
This application tests the DUT for conformance to the standard tolerance mask limits for wander tolerance.

Optical test modules

OQM-200/OQM-201

Hardware option
The OQM-200/-201 optical Q-factor meter is the first instrument to provide in-service measurement of signal quality independent of transmitted data format. The Q-factor meter can be used to quickly optimize DWDM systems during installation, maintenance and troubleshooting. The module offers unrivalled test speed and requires less than 30 seconds to determine Q-factors in the range from 4 to 13 (estimation of a theoretical bit error rate in the range of 10^{-4} to 10^{-40} possible). For monitoring reasons, the Q-factor can be recorded for up to 3 days.
Two versions of the OQM are available to support different input bit rates. Each bit rate requires a dedicated external filter that is supplied with the modules.

Supported data rates OQM-200

OC-12/STM-4	622 Mbps
1 GE (Gigabit Ethernet)	1,250 Gbps
OC-48/STM-16	2,488 Gbps
OC-192/STM-64 and 10 GE(WAN)	9,953 Gbps

Supported data rates OQM-201

Data rate ranges	622M ±8%, 1.25G ±8%, 2.5G ±8%, 10G ±8%
Data rates in particular	
OC-12/STM-4	622 Mbps
1 GE (Gigabit Ethernet)	1.250 Gbps
OC-48/STM-16	2.488 Gbps
G.709 OTU-1	2.666 Gbps
OC-192/STM-64 and 10 GE(WAN)	9.953 Gbps
10 GE (LAN)	10.312 Gbps
G.975	10.664 Gbps
G.709 OTU-2	10.709 Gbps

Operating modes

Scanning mode	single/continuous
Optimize	real time mode
Long-term monitoring	

Optical input port

Fiber type	single-mode
Interface	universal
Optical return loss	> 30 dB

Measurement ranges

Wavelength range	1280 to 1620 nm
Q-factor range	4 to 13
estimated BER range	10^{-4} to 10^{-40}
Max. optical input power	0 dBm
Dynamic range	–14 to –5 dBm

Optical power meter (integrated)

Power range typ.	–28 to –4 dBm

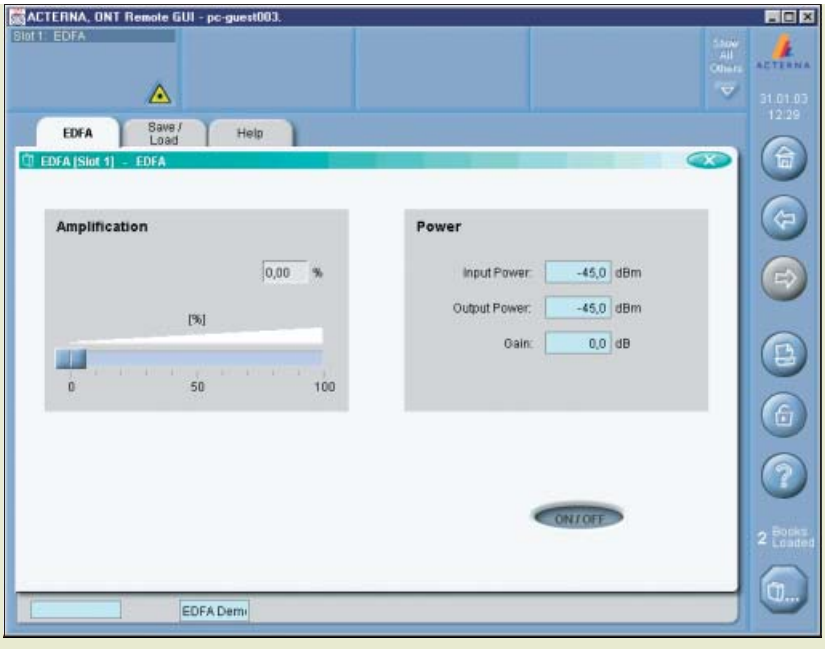
Measurement time (independent of data-rates)

for Q-factor range 4 to 13	typ. < 30 sec (without synchr.)

OAM-200

Hardware option
The OAM-200 Optical Amplifier Module is an economical, compact one slot module that provides pure C-band amplification. Delivering small signal gain up to 24 dB and saturated output up to 15 dBm, it is the ideal tool for narrow band or single channel amplification.

Application
For system verification testing and troubleshouting particulary in DWDM systems, it is occasionally necessary to isolate specific channels out of the entire wavelength spectrum in order to verify the signal performance on the digital layer. With the OAM-200, the power level of the channel can be adjusted to the receiver power dynamic range of the following BER tester or Q-factor meter.



Specifications

Operating wavelength range	1529 nm to 1562 nm
Small signal gain	up to 24 dB
Saturated output power	up to 15 dBm
PDL	0.3 dB
Optical return loss	30 dB

OSA-160/161, OSA-200/201

Hardware option

The OSA-160/161 and OSA-200/201 modules are the first in a new family of DWDM spectrum analyzers for the Acterna ONT Optical Network Tester platform.

As the first dual-port DWDM analyzer, the OSA-201 enables simultaneous measurement at two different points within DWDM systems. A standard single-port (OSA-160/161) is available as well as a patented dual-port version. The OSA modules offer high test speed and internal wavelength calibration without the need for recalibration of wavelength and relative optical power.

Graphical and tabular display formats can be selected for use during installation of multichannel DWDM systems in the wavelength range 1280 to 1650 nm. Built-in test functions allow automatic PASS/FAIL evaluation based on predetermined limits. An optional filter function is available for extracting specific signals up to a line rate of 10.7 Gbps. This filter function can be used to further qualify optical signals using Q-factor meters or BER testers.

Specifications

Operating modes

Full-spectrum graphic display

Functions	zoom/move, cursor/marker, channel-grid, multitrace, summary
FOX	one button automode for evaluation of DWDM signal with PASS/FAIL indication
Sweep modes	realtime, continuous, averaging
Graph mode	Display of up to 4 traces with trace comparison and min/max Hold
Table Mode	Simultaneously visible channels up to 22 channels
Display parameters	channel no, wavelength, power, OSNR, statistics (Min, Max), label, channel status, history, pass/fail

Summary: WDM system evaluation mode

Evaluation of DWDM signals against customers' predefined parameters with indication of PASS/FAIL result.

Channel isolator (OSA-161/-201)

Channel isolator output for further signal analysis with BERT, Q-factor etc.

Wavelength range	1280 to 1650 nm
Data rates	up to 10.7 Gbps
Spectral filter bandwidth	typ. 200 pm
Insertion loss (input signal to channel isolator output)	typ. 8 dB
Tracking mode	Auto wavelength control

Network component testing

EDFA test for evaluation of optical amplifiers

Display parameters	input/output noise (ASE), noise figure, gain per channel

Additional specifications

Optical ports (physical contact interfaces)

Input ports	2 x SM/1 x SM
Output port (ch-drop optional)	1 x SM
Interface	Universal
Optical return loss	typ. 35 dB
Maximum total safe power	+23 dBm

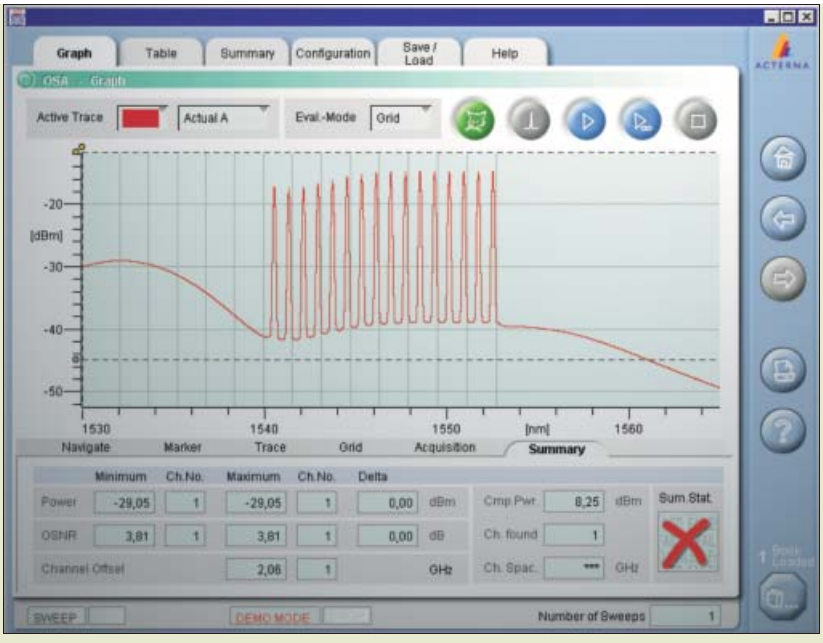
Spectral measurement ranges

Number of optical channels	256
Wavelength range	1280 to 1650 nm
Wavelength calibration [1]	internal, online
Wavelength accuracy [7]	±20 pm
Readout resolution	0.001 nm
Resolution bandwidth (FWHM) [2]	typ. 75 pm
Man. settable	0.1/0.2/0.3/0.4/0.5/1.0/2.0 nm

Power measurement ranges

Dynamic range (per ch power) [3]	−75 to +20 dBm
Noise floor RMS (with averaging) [2]	−75 dBm
Absolute accuracy [2,5]	±0.4 dB
Linearity [4]	±0.05 dB
Readout resolution	0.01 dB
Scanning time (1280 to 1650 nm) [6]	<1.5 sec
Optical rejection ratio [2]	
at ±25 GHz (±0.2 nm)	>35 dBc
at ±50 GHz (±0.4 nm)	>40 dBc
PDL [2]	±0.1 dB
Flatness [2]	±0.2 dB
Level reproducibility	±0.05 dB

[1] Built in, physical constant wavelength calibrator, needs no recalibration
[2] 18 to 28°C, 1520 to 1570 nm
[3] Max. power per channel +15 dBm, max total power +20 dBm
[4] −45 to +10 dBm, at 23°C
[5] At −10 dBm
[6] Full span 370 nm, 37000 measurement samples, incl. WDM-table analysis
[7] at 1550 nm, at 23°C



Long-term monitoring test application software

External PC software option

The long-term performance of DWDM systems is essential, particularly in supporting the growing number of channels, faster transmission speeds per channel, and smaller spacing between channels. It is becoming increasingly important to monitor both the channel power and channel wavelength of optical system parameters. Digital signals as well as OSNR must also be monitored.

The ONT's long-term monitoring test application software is Windows® based and can be run on an external laptop for long-term measurements of optical parameters during system commissioning and normal transmission operations. Once configured, specified test sequences can be launched. Channels to be monitored, reference values for the optical parameters, the corresponding limit values, and the wait between individual measurements must all be specified.

Results are shown in realtime for the complete system and are illustrated by bar graphs. Here, the parameter of interest (λ, P or OSNR) can be selected and the threshold violations in individual channels displayed – including those affecting hidden parameters.

Behavior versus time (drift) can also be displayed on a per channel basis by preselecting the channel and desired parameter. If a limit value is exceeded during measurement (FAIL condition), the entire spectrum is recorded to allow detailed analysis.

Specifications

Configurable measurement parameters for test sequence

Optical parameters	channel configuration up to 255 channels (ITU-T G. 692 grid allowed for) Reference values for power and OSNR Limit values for λ, power and OSNR
Other parameters	Limit values for Q-factor
Measurement interval settings	between 40 s and 999 hrs
Resolution of spectrum recorded when limit values violated	1 nm, 0.1 nm
Average measurement duration per test sequence	
Without spectrum recording	15 s
With spectrum recording	25 s
File size	
DWDM data (32 channels)	5.6 kByte (1st measurement) 2.5 kByte (further measurements)
Spectrum data	10 kbyte (per spectrum recorded)

PMD Test Kit for OSA-160/161/201

Hardware and software option

Product features

- Measurement capability based on the OSA-160/161/201 module
- Uses Fixed Analyzer Method (in accordance with ANSI/FIA/EIA FOTP-113 or IEC TS 61941)
- Upgradeable on any OSA-160/161/201
- Easy to use
- Rugged design for field applications

Applications

The OSA-160/161/201 can be used in the qualification of legacy and new fibers for high speed transmission.

Fibers deployed for telecommunication purposes may have significant Polarization Mode Dispersion (PMD) values. If certain limits of PMD are exceeded, the bit error ratio rapidly increases. The maximum PMD values permitted for various bit rates are shown in table 1.

The PMD Test Kit (available as an option for the OSA-160/161/201 module) is designed to qualify fibers for high speed transmission such as 10 Gbps or 40 Gbps. The kit contains analysis software, broadband light source and variable polarizer.

Specifications

The Acterna PMD solution – developed specifically for portable field applications – is based on the Fixed Analyzer Method (FOTP-113) which is equivalent to the Interferometric Method (ANSI/TIA/EIA FOTP-124) and provides comparable results.

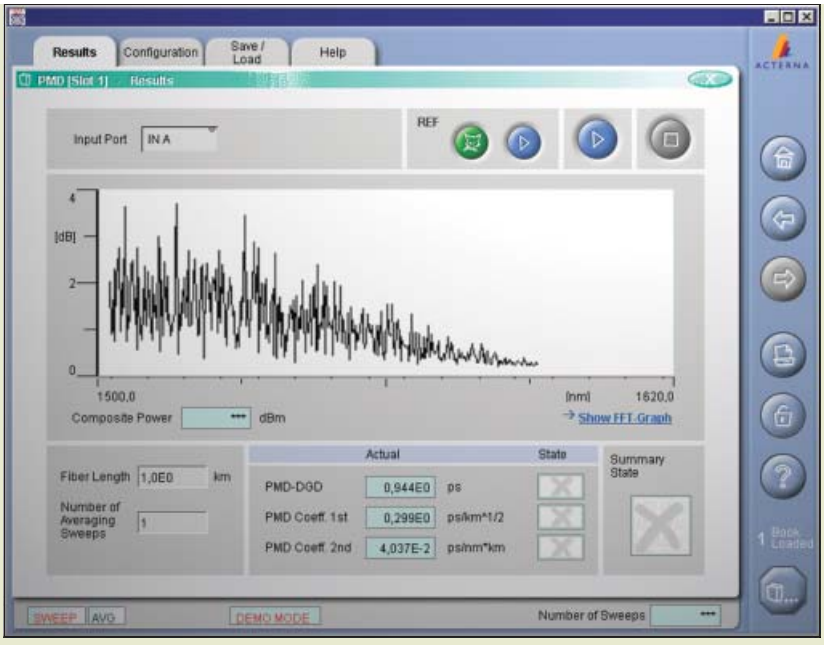
The PMD solution test kit consists of a polarized light source (OBS-15), a polarizer (OVP-15) and evaluation software that can be run on the ONT mainframe.

Existing ONT-50s equipped with OSA-160/161/201 modules can be upgraded to include the PMD evaluation software.

PMD Test Kit performance

Main specifications

Measurement range	0.1 to 50 ps
Dynamic range	up to 35 dB (optional up to 40 dB with ASE light source: on request)
Fiber length to be measured	up to 140 km (up to 160 km with ASE light source: on request)
Selectable settings for mode coupling	strong (for ordinary fibers) weak (for polarization maintaining fibers and most PMD standards)
Measurement time	approx. 4 seconds



OBS-15 (broadband handheld light source)

Main specifications

Output level (for back reflection $<4\%$)	>0 dBm
Spectral power density between $\lambda_1 = 1520$ nm and $\lambda_2 = 1620$ nm	>-42 dBm/0.1 nm
Applicable fiber	SMF 9/125 µm (PC)
Optical connector (Interchangeable adapter system)	FC, SC, DIN, etc.

Power supply

Battery operation	NiMH, type AA (rechargeable, exchangeable, 2 pieces)
Operating time	approx. 3.5 h
AC operation (by means of SNT-92 AC/DC adapter/charger)	

Adapter/Charger

Nominal range of use	100 to 240 V, 50/60 Hz

Ambient temperature conditions

Nominal range of use	−10 to +40°C/14 to 104°F
Storage and transport	−25 to +45°C/−12 to 114°F
Dimensions (w×h×d)	approx. 3.7×1.8×7.7 in approx. 95×49×185 mm

OVP-15 (Polarizer)

Applicable fiber	SMF 9/125 µm (PC)
Optical connector (Interchangeable adapter system)	2×FC, SC, DIN, etc.
Max. allowable input power	+23 dBm

Ambient temperature conditions

Nominal range of use	−5 to +45°C/23 to 114°F
Storage and transport	−20 to +45°C/−4 to 114°F
Dimensions (w×h×d)	approx. 3.7×1.9×7.7 in approx. 95×49×185 mm

Bit rate Gbps	Max. PMD (ps)	PMD coeff. of fiber for 400 km length (ps/$\sqrt{\text{km}}$)
2.5	40	<2.0
10	10	<0.5
40	2.5	<0.125

table 1 Maximum allowed PMD values for digital signal transmission

Ordering information

ONT-50 Optical Network Tester **BN 3070/01**

(mainframe with four free configurable slots available and color TFT display touchscreen)
A minimum of one module must be ordered and a maximum of four slots can be fitted. The mainframe can be equipped with a combination of modules.
One type of optical connector must be selected from BN 2060/00.xy as listed below.

Optical connectors

Measuring adapter	
FC, FC-PC, FC-APC (NTT)	BN 2060/00.51
SC, SC-PC, SC-APC (NTT)	BN 2060/00.58
ST Type (AT&T)	BN 2060/00.32
Optical test adapters:	
ST type (AT&T)	BN 2060/00.32
HMS-10/A, HFS-13/A (Diamond)	BN 2060/00.34
HMS-10, HFS-13 (Diamond)	BN 2060/00.35
"Keyed Biconic", Twist-Proof (AT&T)	BN 2060/00.37
D4 (NEC)	BN 2060/00.40
DIN 47256	BN 2060/00.50
FC, FC-PC (NTT)	BN 2060/00.51
E 2000 (Diamond)	BN 2060/00.53
SC, SC-PC (NTT)	BN 2060/00.58

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

Optical attenuators

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

Digital modules

Module 2.5G **BN 3070/90.18**
OC-48/12/3 & STM-16/4/1, 1310/1550 nm
SDH, SONET
1 slot

1-port 10G 1550 nm **BN 3070/90.01**
OC-192 & STM-64
SDH, SONET
1 slot

Module 10G 1310 nm **BN 3070/90.15**
OC-192 & STM-64
SDH, SONET
1 slot

OTN Module 2.5/2.7G FEC **BN 3070/90.17**
OC-48/12/3 & STM-16/4/1 & OTN1, 1310/1550 nm,
SDH, SONET, OTN
1 slot

OTN Module 10/10.7G FEC **BN 3070/90.30**
OC-192 & STM-64 & OTU2, 1550 nm,
SDH, SONET, OTN
1 slot

OTN Module 10/10.7G FEC version 2 **BN 3070/90.32**
OC-192 & STM-64 & OTU2, 1550 nm,
Electrical interfaces
1 slot

NewGen Module 2.5G **BN 3070/90.40**
OC-48/12/3 & STM-16/4/1, 1310/1550 nm,
SDH, SONET, EOS
1 slot

Ethernet Module 1G **BN 3070.xx.yy**
4 ports 1000BASE-SX/LX
SFPs are not included
1 slot

Jitter module 10/10.7G **BN 3070/90.91**
TX built-in BN 3070/90.32
RX 1 slot

Optical modules

OSA-160 single port DWDM analyzer*

2 slots BN 3070/91.01

OSA-160 single port DWDM analyzer with drop*

2 slots BN 3070/91.xx

OSA-200 dual port DWDM analyzer with drop*

2 slots BN 3070/91.04

OQM-200 Optical Q-factor meter 10G*

1 slot BN 3070/92.01

OQM-201 Optical Q-factor meter 10.7G

1 slot BN 3070/92.02

PMD Test Kit ***BN 3070/91.11***

including the following seven items:

PMD evaluation software for OSA-160/200 module running on ONT-50

OBS-15 Optical Broadband Source BN 2267/01

One adapter must be selected 2060/00.xx

OVP-15 Optical Variable Polarizer BN 2271/01

Two adapters must be selected 2060/00.xx

NiMH batteries (2 items) for OBS-15 (Mignon AA-Size) BN 2237/90.02

SNT-92 AC/DC adapter/charger for OBS-15 BN 2267/90.01

Cleaning tape for optical connectors BN 2229/90.07

MT-2 Bag (for 2 optical handhelds and measuring accessories) BN 2126/01

Calibration report for OBS-15 BN 2267/90.02

Accessories

Carrying case for ONT-50 with rollers BN 3070/92.45

Soft carrying case for ONT-50 BN 3070/92.46

Calibration report

Calibration is carried out in accordance with quality management system certified to ISO 9001

ONT-50 and modules BN 3070/94.01

Software options

IP/PoS book BN 3070/93.03

PMD software BN 3070/91.10

Long-term monitoring software BN 2264/90.10

Wander 10/10.7G BN 3070/93.91

Related products

OLA-15 Variable Optical Attenuator *BN 2239/01*

The OLA-15 can be used to line up optical links, when line interruptions are simulated for bit error testing. The device is also useful for measuring the sensitivity of optical receivers. With a wide variable attenuation range as well as highly accurate and reproducible attenuation settings, the OLA-15 is an ideal complementary tool for the ONT.

Calibrated at	1310 nm and 1550 nm
Attenuation range	3 to 60 dB
Resolution	0.05 dB

See OLA-15 data sheet for details.

GPIB-RS232 Converter GPIB-232CV-A

It is recommended that the National Instruments GPIB/RS-232 Converter be used for controlling the ONT-50 via GPIB. Ordering is country-specific. Go to www.ni.com for further details.

Handheld Fiber Inspection Microscope FM-C320/FM-C400

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.

Magnification FM-C320	320
FM-C400	400
Power supply	3 “AAA” batteries
FM-C320	BN WO-FM-C320
FM-C400	BN WO-FM-C400

FM-C320/FM-C400

GPIB-232CV-A

OLA-15

Acterna Advantage[SM] – adding value with global services and solutions
From basic instrument support for your field technicians to management of complex, company-wide initiatives, Acterna s service professionals are committed to helping you maximize your return on investment. Whatever your needs – product support, system management, education services, or consulting – we offer programs that will give you the competitive edge.
To learn more about how Acterna Advantage can help your business be more successful, visit the services section on your local web page at http://www.acterna.com/.

Acterna is the world's largest provider of test and management solutions for optical transport, access, and cable networks, and the second largest communications test company overall. Focused entirely on providing equipment, software, systems, and services, Acterna helps customers develop, install, manufacture, and maintain optical transport, access, cable, data/IP, and wireless networks.

Worldwide Headquarters

12410 Milestone Center Drive
Germantown, Maryland
20876-7100
USA

Acterna is present in more than 80 countries. To find your local sales office go to:
www.acterna.com

Regional Sales Headquarters

North America
12410 Milestone Center Drive
Germantown, Maryland
20876-7100
USA
Toll Free: 1 866 ACTERNA
Toll Free: 1 866 228 3762
Tel: +1 301 353 1560 x 2850
Fax: +1 301 353 9216

Latin America
13450 West Sunrise Blvd.,
suite 170
33323 Sunrise
FL - USA
Tel: +1 954 838 9008
Fax: +1 954 838 8838

Asia Pacific
42 Clarendon Street
PO Box 141
South Melbourne
Victoria 3205
Australia
Tel: +61 3 9690 6700
Fax: +61 3 9690 6750

Western Europe
Arbachtalstraße 6
72800 Eningen u.A.
Germany
Tel: +49 7121 86 2222
Fax: +49 7121 86 1222

Eastern Europe, Middle East & Africa
Elisabethstraße 36
2500 Baden
Austria
Tel: +43 2252 85521 0
Fax: +43 2252 80727

Prospect Mira, 25,
stroenie 5
RF 129090 Moscow
Russia
Tel: +7 095 937 88 04
Fax: +7 095 775 26 05

ACTERNA™
The Keepers of Communications

ONT-50/DS/OPT/03-03/AE-PDF