Acterna ANT-10G

Advanced Network Tester – SDH version

Powerful tester for SDH networks

Over the last few years, there has been a dramatic increase in global communications services. The Internet continues to be an area of rapid growth. As a response to the increasing demand for bandwidth, two different technologies have simultaneously developed. One is the time-division multiplexing (TDM) of synchronous channels to achieve higher bit rates. The other is dense wavelength division multiplexing (DWDM), which is the optical multiplexing of a large number of synchronous systems, all of which are then carried by a single fiber. The goal of each technology is the same, however – to make the best possible use of available fiber capacity.

So whether it's TDM or DWDM, Acterna partners with systems manufacturers and network operators to define new standards of quality and technical excellence while guaranteeing maximum ease of use for testers and technicians. The result is the Acterna Advanced Network Tester ANT-10G – SDH version.

Highlights

- **Easy-to-use, compact and comprehensive test kit for STM-64/OC-192 including jitter and wander testing**
- **Customizable test functionality, including BERT, performance and pointer analysis and synchronization problems**
- **Pinpoint troubleshooting of in-service networks**
- **Suitable for the lab or the field**
- **Optional components address all network testing needs**

ACTERNA™
The Keepers of Communications

10 Gbps in a portable test solution
The ANT-10G – SDH version is a part of the ANT-20se family. It is equally at home in the labs or in the field and it is the best tool for conformance and functional tests in production, installation and acceptance. It can even pinpoint troubleshoot in-service networks.

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With its high degree of measurement flexibility, the ANT-10G enables testers to investigate all major quality parameters using a variety of tests, ranging from simple bit error rate tests (BERTs) and performance and pointer analysis, to even complex synchronization problems. The ANT-10G can also be customized to meet user needs.

It can resolve signal structures right up to STM-64/OC-192 level and analyze them down to 64 kbps. Access to all standardized mapping structures is possible, including mixed structures, for example DS1 in STM-1 or E1 in STS-1. The ANT-10G also allows testing of all currently used concatenated signal structures up to STM-64c/OC-192c.

Comprehensive options package
In addition to its wide-ranging mainframe functionality, the ANT-10G – SDH version supports one of the largest ranges of configurable options available on the market today.
These include:
- STM-64 and OC-192 optical and electrical interface in a portable instrument
- 1310 nm, 1550 nm or 1310/1550 nm switchable optical interface
- Jitter and Wander testing at 10 Gbps
- OTN 10.7G FEC solution in preparation
- Tributaries: STM-1 with all standard mappings, and STM-4c, STM-16c, STM-64c, STS-3c SPE, STM-12c, STM-48c, STM-192c
- Access to all SOH/TOH bytes
- Errors, alarms, pointers
- Internal and external simulation and analysis of overhead bytes
- BERT and V.11 interface for DCC
- High output power 0 dBm
- Receiver with optical power level display

Please see opposite for detailed information about the many configuration options available for the ANT-10G – SDH version.

Configuration Guide ANT-10G

* This option must be ordered with the mainframe as a subsequent upgrade is not possible

** Please note that the options STM-16/OC-48 or ATM comprehensive are mutually exclusive to Wander generator at 10 Gbps or Jitter/Wander up to 155/622 Mbps.

Specifications ANT-10G (Mainframe)

The ANT-10G Mainframe includes:

- Mainframe, touchscreen
- STM-64 with mappings STM-1, VC-4-4c, VC-4-16c and VC-4-64c BERT
- OC-192 with mappings STS-3c, STS-12c, STS-48c and STS-192c SPE
- Mappings for STM-1: DS1, E1, DS3, E3, E4
- Electrical interfaces STM-1, E1, E3, E4
- Extended overhead analysis
- Two optical adapters to be selected
- Ethernet and USB interface

Generator STM-64

The transmitter of the optical interface meets the specification of ITU-T G.691 (Table 5A, 5B) Application code: S-64.2b, S-64.3b, S-64.5b and I-64.2r, I-64.2, I-64.3, I-64.5, S-64.3a, S-64.5a with additional optical attenuator 1 to 3 dB and Telcordia GR-1377 (Table 4-4, 4-5, 4-6).
Parameter: SR-2, LR-2 (a and c), IR-2, IR-3.

Optical interface

Wavelengths	1310 nm, 1550 nm or 1310/1550 nm switchable
Output level at 1310 nm	0 dBm ±1 dB
Output level at 1550 nm	0 dBm ±1 dB
Line code	scrambled NRZ

Clock generator

Internal, accuracy	±2 ppm
Offset	±50 ppm
Synchronization from external signal	

Generation of STM-64 signal

compliant to ITU-T G.707
One test channel STM-1 with standard mappings or STM-4c bulk or STM-16c bulk, others unequipped or same as test channel.
Additionally generation of OC-192 signal compliant to GR-253 one test channel STS-3c or STS-12c or STS-48c SPE BERT, others unequipped or same as test channel.

Contents of STM-64 overhead bytes

For all bytes except B1, B2, H1 to H3	statically programmable
For bytes E1, E2, F1, D1 to D3 and D4 to D12	test pattern external data via V.11
For bytes K1, K2	external data via V.11
For J0 byte	16 byte sequence ASCII with CRC

Byte sequence

m in n in p for bytes of first 16 STM-1 SOH m times (1 to 200,000,000) byte A followed by n times (1 to 2,000,000,000) byte B sequence repetition p (1 to 65 000).

Error insertion

Error types B1, B2, MS-REI	single and rate
Burst errors: m anomalies in n periods	m = 1 to 4.8 x 10^6 and n = 2 to 8001 frames or 0.2 s to 600 s

Alarm generation

Alarm types

LOS, LOF, MS-AIS, MS-RDI, RS-TIM	on/off

Dynamic alarms

m alarms in n frames LOF, MS-AIS, MS-RDI	m = 1 to n –1, n_{max} = 8000 or active = 0 to 60 s, passive = 0 to 600 s

Frame trigger [100]

Output voltage (open circuit)	CMOS
Connector/impedance	BNC/approx. 50 Ω

Analyzer STM-64

The receiver of the optical interface meets the specification of Telcordia GR-1377 (Table 4-4, 4-5) Parameter: SR-2, IR-2, IR-3 and ITU-T G.691 (Table 5A, 5B) Application code: S-64.2b, S-64.3b, S-64.5b, I-64.2r, I-64.2, I-64.3, I-64.5.

Optical interface

Wavelengths	1260 to 1360 nm and 1520 to 1580 nm
Sensitivity at 1310 nm	–12 to 0 dBm
Sensitivity at 1550 nm	–15 to 0 dBm
Line code	scrambled NRZ
Offset range	±500 ppm

Demultiplexing of STM-64 signal

compliant to ITU-T G.707
Evaluation of one selectable channel STM-1 down to the mapped tributary or STM-4c SPE or STM-16c.
Additionally demultiplexing of OC-192 signal compliant to Telcordia GR-253 Evaluation to one selectable channel STM-4c or STM-16c.

Generator unit PDH/SDH

Digital outputs

Interfaces to ITU-T recommendation G.703 75 Ω unbalanced output, adapter jack selectable from Versacon 9 adapter system.

Bit rates and line codes

2048, 8448 and 34368 kbps	HDB3, CMI
139264 and 155520 kbps	CMI

120 Ω balanced output, Lemosa jack

Bit rate and line codes

2048 kbps	HDB3, CMI
Bit rate offset	±500 ppm
Step size	0.001 ppm

Clock

– *Internal clock generation*
  at all of the bit rates listed above
  Clock stability ±2 ppm
– *Synchronization to external signals*
  via 75 Ω unbalanced input, BNC jack:
  Reference clock 2048 kHz and 1544 kHz
  2048 kbps (HDB3), 1544 kbps (B8ZS) or Receive signal
– *Clock outputs*
  Clock output at frequency of generator signal, approx. 400 mV (when terminated into 75 Ω), BNC jack
  2048 kHz reference clock output via trigger output

STM-1 output signal

Generation of a STM-1 signal conforming to ITU-T Recommendation G.707.

– *Mappings*
  Content of the selected container:
  Framed or unframed PDH/DSn test pattern
  PDH multiplex signal (with 64k/140M Mux/Demux chain option)
  External PDH/DSn signal (with D&I option)
  Test pattern without stuffing bits (bulk signal to O.181)
  Content of non-selected containers framed PRBS 2^{11} –1

STM-1 mappings

C12 mapping (2 Mbps in STM-1, AU-3/AU-4)

Modes	asynchronous, byte synchronous (floating)

C3 mapping (34 Mbps in STM-1, AU-3/AU-4)
C4 mapping (140 Mbps in STM-1 and STS-3c)
C11 mapping (1.5 Mbps in STM-1, AU-3/AU-4, TU11/TU12)
C3 mapping (45 Mbps in STM-1, AU-3/AU-4)
C2 mapping (6 Mbps unframed/Bulk in STM-1)

Generation of pointer actions (figure 2)

Generation of pointer actions at the AU and TU levels simultaneously.

– Pointer sequences to G.783 with programmable spacing
– Pointer increment/decrement (continuously repeated)
– Single pointer
– Pointer value setting with or without NDF
  Trigger types: Single or continuous repeat

Content of SOH and POH bytes

The content of all bytes with the exception of B1, B2, B3 and H1 to H4 is programmable with any byte or a user defined byte-sequence p in m in n (p frames in m frames and the entire sequence repeated n times) can be inserted.

Bytes E1, E2, F1, F2, and byte groups D1 to D3 and D4 to D12:

– Transmission of a PRBS test pattern with bit error insertion (see test patterns)
– Insertion of an external data signal via V.11 interface (also for K1, K2 and K3)

Trace identifier

J0, J1, J2	programmable 16 byte ASCII sequence with CRC
J1, J2, additionally	programmable 64 byte ASCII sequence
H4 byte	4 or 48 byte sequence

Error insertion

Error types B1, B2, B3, BIP2 parity errors, frame alignment signal errors, MS-REI, HP-REI, LP-REI, bit errors in test pattern, code errors (single errors)

Triggering

Single error or error ratio	2×10^{-3} to 1×10^{-10}
for B1, B3, HP-REI, LP-REI	2×10^{-4} to 1×10^{-10}
for bit errors	1×10^{-2} to 1×10^{-9}
Step size for mantissa and exponent	1
Burst error: m anomalies in n periods	
For FAS, B1, B2, B3, MS-REI, HP-REI	m = 1 to 4.8×10^6 and n = 2 to 8001 frames or 0.2 s to 600 s

Alarm generation

– *Dynamic*
  Alarm types LOF, MS-AIS, MS-RDI, AU-LOP, AU-AIS, HP-UNEQ, HP-RDI, HP-RDIEP, HP-RDIES, HP-RDIEC, TU-LOP, TU-AIS, LP-UNEQ, LP-RDI, LP-RDIEP, LP-RDIES, LP-RDIEC, LP-RFI

m alarms in n frames	m = 1 to n–1, n_{max} = 8000
or	
t1 alarm active, t2 alarm passive	t1 = 0 to 60 s, t2 = 0 to 600s

– Static (on/off)
  Alarm types LOS, LOF, MS-AIS, RS-TIM, MS-RDI, AU-LOP, AU-AIS, HP-UNEQU, HP-PLM, HP-TIM, HP-RDI, HP-RDIEP, HP-RDIES, HP-RDIEC, TU-LOP, TU-AIS, LP-UNEQ, LP-PLM, LP-TIM, LP-RDI, LP-RDIEP, LP-RDIES, LP-RDIEC, LP-RFI

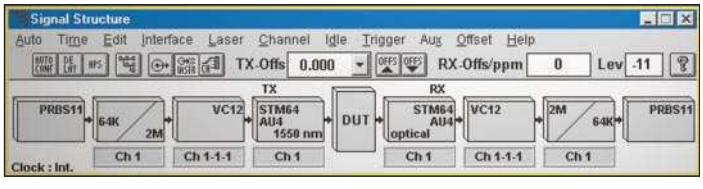


figure 1 Signal structure

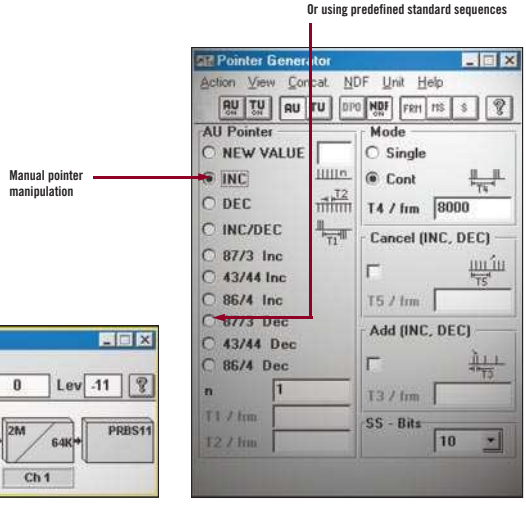


figure 2 Pointer actions

PDH output signals

Signal structures for all bit rates:

- Unframed test pattern
- Framed test pattern (to ITU-T O.150); CRC-4 selectable for 2 Mbps
- *Error insertion*

Error types	bit errors, FAS errors, code errors (single errors)
Trigger types: Single error or error rate	1 x 10^{-2} to 1 x 10^{-9}
Step size for mantissa and exponent	1

- *Alarm generation, dynamic*

Alarm types	LOF, RDI
m alarms in n frames	m = 1 to n–1, n_{max} = 1000

- *Alarm generation, static (on/off)*

Alarm types	LOS, LOF, AIS, RDI

Test patterns

- Pseudo-random bit sequences

  PRBS: 2^1 –1, 2^{15}–1, 2^{20}–1, 2^{23}–1, 2^{11}–1 inv., 2^{15}–1 inv., 2^{20}–1 inv., 2^{23}–1 inv.
- Programmable word

Length	16 bits

Receiver unit PDH/SDH

Digital inputs

Interfaces to ITU-T Recommendation G.703.

75 Ω unbalanced input; adapter jack selectable from Versacon 9 adapter system

Bit rates and line codes.

2048, 8448 and 34,368 kbps	HDB3, CMI
139,264 and 155,520 kbps	CMI

120 Ω balanced input, Lemosa jack

Bit rate and line codes

2048 kbps	HDB3, CMI
Clock recovery pulling range	+500 ppm

Selectable input gain

CMI coded	15 to 23 dB
B3ZS, B8ZS, HDB3, AMI coded	15 to 26 dB

Selectable adaptive equalizers for 1544, 2048, 34,368, 44,736, 51,840, 139,264 and 155 520 kbps

Monitor input for STM-1 and STM-4 NRZ signals

Trigger output

75 Ω BNC connector, HCMOS signal level

Pulse output for received bit errors, transmit frame trigger, transmit pattern trigger or 2048 kHz reference clock

Concatenated mappings

OC-12c/STM-4c BERT

Contiguous concatenation signal structure to ANSI T1.105.02 and G.707.

Error measurement to O.150

Test pattern	PRBS-31, IPRBS-31, PRBS-23, IPRBS-23, PRBS-20, PRBS-15, IPRBS-15

- *Programmable word*

Length	16 bits

- *Error insertion*

Bit errors in test pattern, single error or error ratio	1 x 10^{-2} to 1 x 10^{-9}

- *Error measurement and alarm detection*

  Bit errors and AIS in test pattern

OC-48c/STM-16c BERT

Contiguous concatenation signal structure to ANSI T1.105.02 and G.707.

Error measurement to O.150

Test pattern	PRBS-31, IPRBS-31, PRBS-23, IPRBS-23

- *Programmable word*

Length	16 bits

- *Error insertion*

Bit errors in test pattern, single error or error ratio	1 x 10^{-3} to 1 x 10^{-9}

- *Alarm generation*

  AU-AIS, AIS-C1...AIS-C16, AU-LOP, LOP-C1...LOP-C16
- *Error measurement and alarm detection*

  AU-AIS, AU-LOP

  Bit errors
- *Automatic Protection Switching*

  Sensor: MS-AIS, AU-AIS

OC-192c/STM-64c BERT

Contiguous concatenation signal structure to ANSI T1.105.02 and G.707.

Error measurement to O.150

Test pattern	PRBS-31, IPRBS-31

- *Programmable word*

Length	16 bits

- *Error insertion*

Bit errors in test pattern, single error or error ratio	1 x 10^{-3} to 1 x 10^{-9}
Alarm generation	AU-AIS, AU-LOP

- *Error measurement and alarm detection*

  AU-AIS, AU-LOP

  Bit errors

Automatic modes

Autoconfiguration

The Autoconfiguration routine automatically sets the ANT-10G to the input signal. ANT-10G searches at the electrical and optical interfaces for the presence of standard PDH and STM-N signals (G.703, G.707, O.151, O.181) and the payload contents in channel 1.

Automatic SCAN function

The SCAN function permits sequential testing of all C11 or C12 channels via AU-3 or AU-4 in a SDH signal. The ANT-10G receiver checks for alarms in the receive signal, the SDH structure and all channels, and for synchronization of the selected test pattern in all channels. The results (OK/not OK) for each channel are entered in a matrix. The generator runs simultaneously and can be used to stimulate the device under test.

Automatic TROUBLE SCAN function (figure 3)

The TROUBLE SCAN function permits sequential testing of all C11 or C12 channels via AU-3 or AU-4 in a SDH signal. The ANT-10G receiver checks for alarms in the receive signal, the SDH structure and all channels. The results (OK/not OK) for each channel are entered in a matrix.

A detailed alarm history can be displayed by selecting a channel from the matrix.

The alarm status of individual channels can be displayed following the measurement. Only the receive channels are altered during a TROUBLE SCAN.

AutoScan function (figure 4)

This automatic AutoScan function enables you to rapidly check the signal structure, the mapping used and the payload – even with mixed mapped signals. The ANT-10G receiver analyzes the incoming received signal and provides a clear overview of all the signals present in the composite receive signal.

The variable scan depth setting enables even complex signal structures to be resolved and displayed clearly. Even Trace Identifiers are evaluated. All the displayed results can be printed out.

Automatic SEARCH function

Channel shifts in the payload may occur when measuring complex network elements, depending on the configuration of the device under test. The SEARCH function permits rapid automatic location of the test channel (C11 or C12 with defined PRBS) in the payload of a SDH signal. The ANT-10G receiver checks for alarms in the receive signal, the SDH structure and all channels, and for synchronization of the selected test pattern in all channels. The results (OK/not OK) for each channel are entered in a matrix. An OK result indicates that the corresponding channel contains the signal searched for. Only the receive channels are altered during a SEARCH.

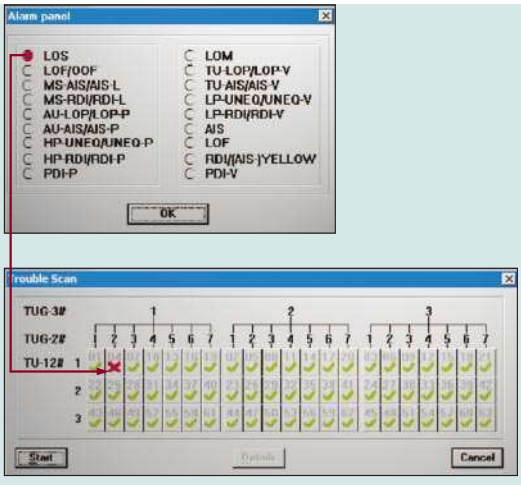


figure 3 TROUBLE SCAN

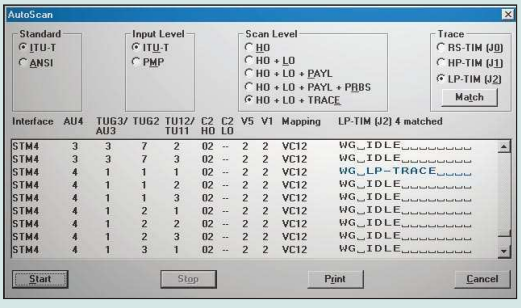


figure 4 AutoScan

Measurement types

Error measurements

Error types	B1, B2, B3, BIP2 parity errors, MS-REI, HP-REI, LP-REI, bit errors in test pattern, code errors

G.821

Evaluation of PDH and SDH systems to ITU-T recommendation

ES, EFS, SES, DM and UAS are evaluated. Pass/fail assessment based on line length allocation of 0.1 to 100%. The SES and DM thresholds are user-settable. Evaluation for higher bit rates (up to 140 Mbps) is obtained using a multiplex factor as per G.821, Annex D.

Measurements can be made using the following events:

PDH systems	bit errors, FAS2, FAS8, FAS34, FAS140, CRC and E-bit errors
SDH systems	payload bit errors (PDH and bulk), overhead bytes E1, E2, F2, D1 to D3, D4 to D12

G.826

Evaluation to ITU-T recommendation

EB, BBE, ES, EFS, SES and UAS are evaluated.

Pass/fail assessment based on line length allocation of 0.1 to 100%.

The SES and UAS thresholds are user-settable.

In-service measurement (ISM)

Simultaneous in-service measurement of near end and far end of a selected path:

- Near end: B1, B2, HP-B3, LP-B3, BIP2, FAS at 140/34/8 or 2 Mbps, CRC-4
- Far end: HP-REI, LP-REI, E-bit at 2 Mbps

Out-of-service measurement (OOS)

Out of service measurement using bit errors in the test pattern (for PDH and SDH).

G.828 and G.829

Evaluation of SDH systems to ITU-T recommendation (figure 5)

The G.828 defines error performance parameters and objectives for synchronous paths.

ES, EFS, SES, BBE, SEP and UAS are evaluated.

Pass/fail assessment based on line length allocation of 0.1 to 100%.

The SES and UAS thresholds are user-settable. The SEP can be switched off for assessment.

The recommendation G.829 defines error performance events and block structures for SDH multiplex and regenerator sections.

M.2100

Evaluation of PDH and SDH systems to ITU-T recommendation

This recommendation describes requirements during line-up and maintenance (in-service).

ES, EFS, SES and UAS are evaluated.

Pass/fail assessment based on line length allocation of 0.1 to 100%.

The UAS and BISO (bringing into service objectives) thresholds are user-settable.

ISM simultaneously for near end and far end of a selected path

PDH systems, near end	bit errors, FAS2, FAS8, FAS34, FAS140, CRC-4
PDH systems, far end	E-bit at 2 Mbps
SDH systems	payload bit errors (PDH and bulk), overhead bytes E1, E2, F2, D1 to D3, D4 to D12

This operating mode enables application of the "Bringing into Service" procedures as per ITU-T Rec. M.2110 and the determination of "Performance Information" as per ITU-T Rec. M.2120.

M.2101

Evaluation of SDH systems to ITU-T recommendation (Revision 09/99)

This recommendation describes requirements during line-up and maintenance (in-service).

ES, EFS, BBE, SEP, SES and UAS are evaluated according to the newest Revision of M.2101.

Pass/fail assessment based on line length allocation of 0.1 to 100%.

The UAS and BISO (bringing into service objectives) thresholds are user-settable.

ISM simultaneously for near end and far end of a selected path or Multiplex Section:

Evaluated anomalies	payload bit errors (TSE), B1, B2, B3 and BIP2, MS-REI, HP-REI, LP-REI

This operating mode allows application of the "Bringing into Service" procedures as per ITU-T "Performance Information" as per ITU-T Rec. M.2120.

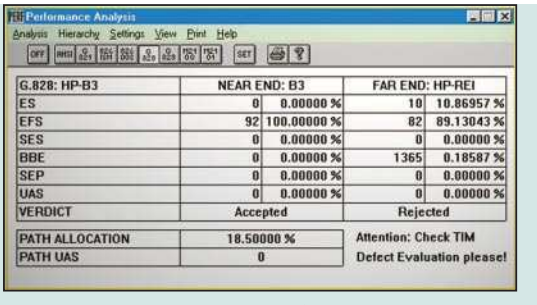


figure 5 Performance analysis to ITU-T G.828/G.829

Analysis of AU and TU pointer actions (figure 6)

Display of
- Number of pointer operations:
  Increment, decrement, sum (increment +decrement),
  Difference (increment –decrement)
- Pointer value

Clock frequency measurement

The deviation of the input signal clock frequency from the nominal frequency is displayed in ppm.

Delay measurement

A delay measurement is used to line-up satellite hops, to test the maximum permitted latency in storage exchanges and cross-connect systems and to check the loop circuits of regenerators. The ANT-10G measures the time taken for the test pattern to be transmitted from the generator back to the receiver via the path under test. The measurement is made on the test patterns in the selected channel, in the containers (bulk or PDH) for SDH or in the selected channel at the lowest hierarchy level of PDH multiplex systems. To avoid ambiguities in the measurement, two measurement times are provided.

Measurement range	
Bit rates from 8 to 155 Mbps	1 ms to 1 s
Bit rate 2 Mbps	10 ms to 5 s
Bit rate 64 kbps	100 ms to 16 s

Alarm detection

All alarms are evaluated and displayed in parallel

Alarm types LOS, OOF, LOF, MS-AIS, MS-RDI, RS-TIM, LTI, AU-AIS, AU-LOP, AU-NDF, HP-RDI, HP-UNEQ, HP-TIM, HP-PLM, AIS, RDI, LSS, TU-NDF, TU-LOP, TU-AIS, LP-UNEQ, LP-RDI, LP-RDIEP, LP-RDIES, LP-RDIEC, LP-RFI

Measurement interval

Variable	1 second to 99 days
Measurement start	manual or automatic timer (user setting)
Measurement stop	manual or automatic timer (user setting)

Memory for errors, pointer operations and alarms

Resolution of error events and pointers	1 s
Alarm resolution	100 ms

SOH and POH evaluation

- Display of complete SOH and POH, e.g. interpretation of APS information in K1 and K2

For the bytes E1, E2, F1, F2 and byte groups D1 to D3 and D4 to D12:
- BERT using test pattern from the generator unit
  Output of the data signal via the V.11 interface (also for K1, K2 and K3)

For the trace identifier
- J0 display of 16 byte ASCII sequence
- J1, J2 display of 16 or 64 byte ASCII sequence

Ring testing – APS time measurement (figure 7)

In synchronous networks, a defined maximum switch-over time is necessary for the traffic in case of a fault. To verify compliance with this requirement, the ANT-10G measures the switch-over time with 1 ms resolution. The result can be printed.

Criteria for the time measurement	TU-AIS, MS-AIS, AU-AIS, bit error
Max. measurable switch-over time	2 s
Resolution	1 ms
Allowable error rate for user signal	$<2 \times 10^{-4}$

Ring testing – Byte capture SOH and POH

To analyze the SOH/POH functions, individual bytes vs. time needs to be captured, allowing detection of errors or short-term changes with frame level precision.

The capture function is started by a selectable trigger. Values for a selected byte are stored and can be accessed subsequently in a table of values. Particularly in capturing the APS sequences, the bytes (K1, K2) are displayed as an abbreviation of the standard commands.

The function also allows recording of the N1 or N2 bytes for evaluation of "Tandem Connection" information.

H4 sequences can also be analyzed very easily. The results can be printed or exported.

Capture bytes for STM-0/1, el. and opt	all SOH/POH bytes
STM-N el. and opt	all SOH/POH bytes, channel 1 except A1, A2, B1
Storage depth for a byte	266
K1, K2	200
Trigger events	MS-AIS, AU-AIS, MS-RDI, AU-LOP, editable value in trigger byte
Capture resolution	frame precision

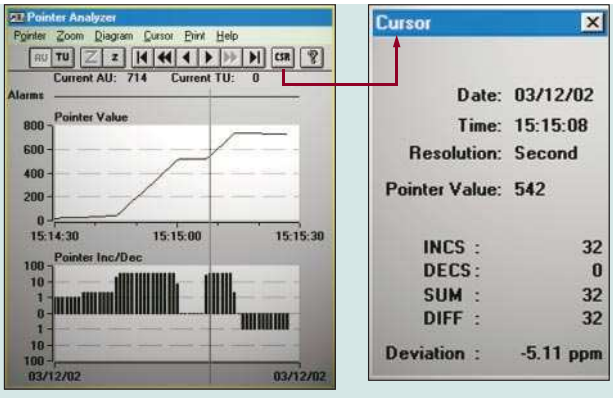


figure 6 Graphic pointers. Display showing additional evaluation of cursor position

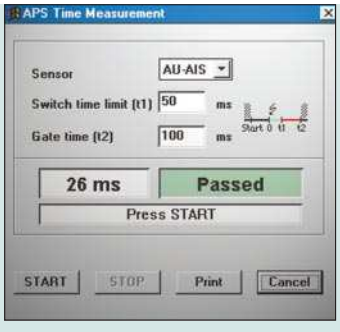


figure 7 APS time measurement

Tandem connection monitoring (TCM) (figure 8)

TCM is a method used to monitor the performance of an SDH path subsection path via the N1/N2 bytes. This is particularly useful when the path is routed via different network providers. If errors occur on an end-to-end connection, you can use TCM to determine which subnetwork the errors occurred in.
The ANT-10G helps to monitor the content of the N1/N2 bytes and provides users with easy interpretation of the detailed events.

Capture TCM frames	all N1/N2 bytes, TC-IEC, TC-AIS, TC-REI, TC-OEI
Trigger events	Start of TCM frame (TCM FAS word)
Storage depth	266 bytes (3.5 TCM frames)
On-line monitoring of alarms and trace identifier.	
Display of actual and history values	TC-UNEQ, LTC, TC-AIS, TC-RDI, TC-ODI, TC-REI, TC-OEI
On-line display of TCM access point identifier	
TCM error measurement	
Error types	TC-IEC, TC-DIFF, TC-REI, TC-OEI

TCM Byte Sequencer and Editor

This serves to test a sequential TCM process (tandem connection monitoring) in the N1/N2 bytes. A sequence of 76 bytes simulating a TCM frame (equivalent frame) is generated. Individual values can be edited as binary or hexadecimal values to simulate various events for TCM evaluations.
Additionally, major events may be simulated, line alarm, errors and trace identifier.

Alarms	TC-ODI,TC-AIS, TC-RDI
Errors	TC-OEI, TC-IEC
Trace	TC-APID

Result display and instrument operation

Numerical display

Display of absolute and relative values for all error types

Intermediate results	every 1 s to 99 min

Graphical display (histogram) (figure 9)

Display of errors, pointer operations/values and alarms as bargraphs vs. time units

Units, time axis	seconds, minutes, 15 minutes, hours, days

Tabular display

Display of all alarm and error events with time stamp

Result printout

ANT-10G supports a variety of dot-matrix, inkjet and laser printers. (Windows Print Manager)

Printer interfaces

Serial	V.24/RS232
Parallel	Centronics/EPP/IEEE P 1284

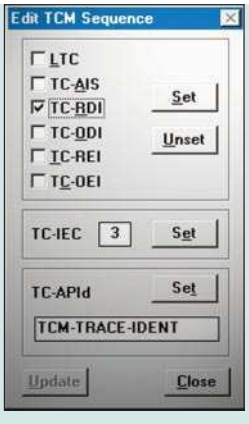
Result export

Results are stored in a database and can be processed using standard PC software.

Instrument operation

ANT-10G is operated using the standard Microsoft® Windows™ graphical user interface.
Operation is menu-controlled using the trackball or touchscreen. A mouse can also be connected if desired.

– *Application selection and storage*
ANT-10G includes an applications library to which customer-specific applications can be added.
All applications are stored internally on the built-in hard disk drive and can be copied to any other ANT-10G via floppy disk or super disk.
Easy-to-use filter functions allow quick selection of the desired application.



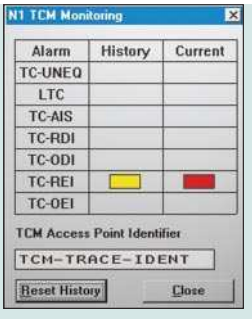


figure 8 TCM monitor and editor

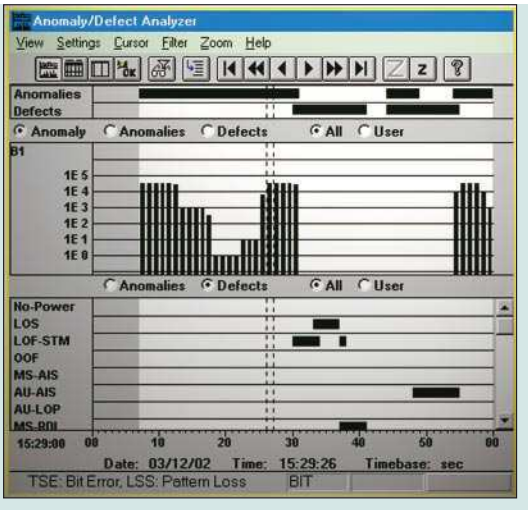


figure 9 Histogram results and display

Touchscreen Display

Color TFT screen	10.4-in, 256 colors
Resolution	640 x 480 pixels (VGA standard)

The touchscreen provides very easy point and shoot operation.

Built-in PC

ANT-10G uses a Pentium PC as internal controller so that standard PC applications can also be run on the instrument.

RAM capacity	64 MB
LS 120 drive	3.5-in, 120 MB
Hard disk drive	6 GB

USB interface, 10/100 Mbit Ethernet interface are included

Keyboard

Full keyboard for text input, extended PC applications and future requirements. The keyboard is protected by a fold back cover.
An additional connector is provided for a standard PC keyboard.

External display connector

Simultaneous display with built-in screen

Interface	VGA standard

PCMCIA interface

Type	PCMCIA 2.1 types I, II and III

The PCMCIA interface provides access to GPIB, LANs, etc., via adapter cards.

Power outage function

In the event of an AC line power failure during a measurement, ANT-10G saves all data. As soon as the AC line voltage is reestablished, the measurement is resumed. Previous results are retained and the time of the power failure is recorded along with other events.

General specifications

– *Power supply*	
AC line voltage, automatic switching	100 to 127 V and 220 to 240 V
AC line frequency	50/60 Hz
Power consumption (all options fitted)	max. 230 VA
Safety class to IEC 1010-1	class I
– *Ambient temperature*	
Nominal range of use	+5 to +40°C
Storage and transport range	–20 to –70°C
– *Dimensions*	
(w x h x d)	approx. 12.6 x 13.8 x 11 in (approx. 320 x 350 x 280 mm)
– *Weight*	approx. 33 lb/(15 kg)

Options

Electrical interfaces at 9953 Mbps
Electrical interfaces at 10 Gbps* for 3060/35 ***BN3060/91.48***
Electrical interfaces at 10 Gbps* for 3060/41, /42 ***BN3060/91.54***

This option must be ordered with the mainframe as a subsequent upgrade is not possible.

Generator unit

Output level (peak-peak)	400 to 600 mV
Connector/impedance	SMA/50 Ω

Receiver unit

Input level (peak-peak)	100 to 600 mV
Connector/impedance	SMA/50 Ω

Clock

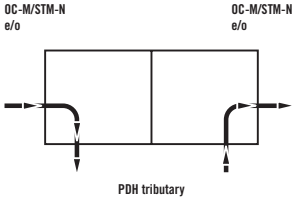
Frequency	9953.28 MHz
Tx output level (peak-peak)	≥ 450 mV
Rx output level (peak-peak)	≥ 470 mV
Connector/impedance	SMA/50 Ω

Drop and Insert ***BN 3060/90.10***

This option provides the following functions:

1. Generator and receiver operate independently

as mapper and demapper. The PDH signal from a selected channel is dropped from the receive signal and output to a connector. An external or internal PDH signal is inserted into the transmit signal.



2. Through mode with jitter injection, error insertion and overwriting of SOH bytes

available for all bit rates up to 10 Gbps.
The received signal is looped through the ANT-10G and retransmitted (generator and receiver coupled).
The looped-through synchronous signal can be manipulated if required:

- Overwriting bytes in the SOH (except B1, B2, H1 to H3)
- Overwriting of B3 byte at 10 Gbps
- Anomaly insertion
- Defect generation by programming the SOH
- Jitter injection (jitter options required)

64k/140M MUX/DEMUX chain ***BN 3060/90.11***

This option provides n x 64 kbps to 140 Mbps multiplex and demultiplex functions. The output signal is fed to the electrical interface and is available as payload in mappings (for STM-0 mappings please select the option "Add SONET").
Alarms and errors can be generated and analyzed.

M13 MUX/DEMUX chain ***BN 3060/90.12***

M13 multiplexers are used in North America in hybrid networks and synchronous system cross-connects.
This option provides n x DS0 to DS3 multiplex and demultiplex functions.
The output signal is fed to the electrical interface and is available as payload in mappings (requires option "Add SONET").
Alarms and errors can be generated and analyzed.

Add SONET ***BN 3060/90.03***

VT1.5 SPE mapping

DS1 in STS-1 and 1.5 Mbps in STM-0 Modes
asynchronous, byte synchronous (floating)
Error insertion and measurement
Additional error types BIP-V, REI-V

– *Alarm generation, dynamic*

Alarm types	LOP-V, AIS-V, LOM, UNEQ-V, RDI-V, RDIEVP, RDIEVS, RDIEVC, RFI-V, PDI-V
m alarms in n frames	m = 1 to n –1, n_{max} = 8000
or	
t1 alarm active, t2 alarm passive	t1 = 0 to 60 s, t2 = 0 to 600s

– *Alarm generation, static (on/off) and evaluation*

Alarm types	LOP-V, AIS-V, LOM, UNEQ-V, PLM-V, TIM-V, RDI-V, RDIEVP, RDIEVS, RDIEVC, RFI-V
Alarm detection only	NDF-V

VT6 SPE mapping

6 Mbps unframed/Bulk in STS-1

STS-1 SPE mapping

DS3 in STS-1 and 45 Mbps in STM-0

VT2 SPE and STM-0 mapping

E1 in STS-1 and 2 Mbps in STM-0
Modes asynchronous, byte synchronous (floating)
Error insertion and alarm generation as for VT1.5 SPE mapping.

BERT (1.5/6/45 Mbps)

Signal structure and interfaces for generator and receiver
Framed and unframed test patterns (6 Mbps unframed)
Additional test pattern QRSS20
Additionally, for unbalanced digital signal input/output

Bit rate, line code	1,544 kbps, 6,312 kbps, B8ZS, AMI
Bit rate, line code	44,736 kbps, B3ZS

Additionally, for balanced digital signal input/output

Bit rate, code	1,544 kbps, B8ZS

Optical options

All the optical interfaces are intended for single-mode fibers. Acterna offers a complete line of optical test adapters. Select one test adapter each for the generator and receiver from the ordering information in this data sheet.
In addition to 10 Gbps, ANT-10G provides all optical interfaces from STM-0/OC-1 to STM-16/OC-48. This includes SDH and SONET signal generation, error and alarm insertion, and SOH/TOH manipulation.

Optical modules up to 155 Mbps

Optical STM-0/1, OC-1/3, 1310 nm	*BN 3060/91.01*
Optical STM-0/1, OC-1/3, 1310 and 1550 nm	*BN 3060/91.02*
Bit rate of TX and RX signal	155,520 kbps
additionally, for STS-1/STM-0 mappings	51,840 kbps
Line code	scrambled NRZ

Generator unit

The generator meets the requirements of ITU-T Rec. G.957, Tables 2 and 3 (Telcordia GR-253, ANSI T1.105.06).
Classes L1.1, L1.2 and L1.3 (LR-1, LR-2, LR-3) are covered.
There are two options for adapting to the required wavelength:

Wavelength	1310 nm, 1310 and 1550 nm (switchable in the instrument)
Output level	0 dBm +2/–3 dB
with 1310 and1550 nm option	0 dBm +2/–3.5 dB

Receiver unit

The receiver unit meets the specifications of ITU-T Rec. G.957 (Telcordia GR-253, ANSI T1.105.06) and fulfills classes S1.1 and S1.2 (IR-1, IR-2).

Wavelength range	1100 to 1580 nm
Input sensitivity	–28 to –8 dBm (–34 to –8 dBm typ.)
Display of optical input level	
Resolution	1 dB

155 Mbps electrical interface for connecting the ANT-10G to STM-1/STS-3 monitor points

Line code	scrambled NRZ
Input voltage (peak-peak)	0.2 to 1 V
Unbalanced input	
Connector/impedance	SMA/50 Ω

Optical modules up to 622 Mbps

Optical STM-0/1/4, OC-1/3/12, 1310 nm	*BN 3060/91.11*
Optical STM-0/1/4, OC-1/3/12, 1310 and1550 nm	*BN 3060/91.12*
Bit rate of TX and RX signal	155,520 kbps, 622,080 kbps
additionally, for STS-1/STM-0 mappings	51,840 kbps
Line code	scrambled NRZ

Generator unit

The generator meets the requirements of ITU-T Rec. G.957, Tables 2 and 3 (Telcordia GR-253, ANSI T1.105.06).
Classes L1.1, L1.2, L1.3, L4.1, L4.2 and L4.3 (LR-1, LR-2, LR-3) are covered.
There are two options for adapting to the required wavelength:

Wavelength	1310 nm, 1310 and 1550 nm (switchable in the instrument)
Output level	0 dBm +2/–3 dB
with 1310 and 1550 nm option	0 dBm +2/–3.5 dB

– *Generation of STM-4 TX signal*
In instruments with STM-1 mappings the STM-4 TX signal consists of:
– Four identical STM-1 tributary signals (AU-4), or
– One internally generated STM-1 tributary signal with the other three tributaries filled with UNEQ.
– *Generation of OC-12 TX signal*
In instruments with STS-1 mappings the OC-12 TX signal consists of:
– One internally generated STS-1 tributary signal with the other 11 tributaries filled with UNEQ or
– One internally generated STS-3c tributary signal with the other three tributaries filled with UNEQ.
with STS-3c mapping option or ATM Basic Option BN 3060/90.50
– *Contents of the STM-4/OC-12 overhead bytes*
For all bytes except B1, B2 and H1 to H3:
The content of each byte is statically programmable or a user defined byte-sequence p in m in n (p frames in m frames and the entire sequence repeated n times) can be inserted.
For the E1, E2, F1 bytes and the DCC channels D1 to D3 and D4 to D12:
– Transmission of a test pattern with bit error insertion (see mainframe for pattern selection)
– Insertion of an external data signal (via the V.11 interface)
For the K1, K2, N1, N2 bytes
– Insertion of the data signal via the V.11 interface
For the J0 bytes
– Transmission of a 16-byte sequence, with CRC
– *Error insertion*

Error types	B1 and B2 parity error
additionally, for STM-4	MS-REI
for OC-12	REI-L
Triggering	
Single errors or error ratio	2×10^{-3} to 1×10^{-10}
for B1 parity errors	2×10^{-4} to 1×10^{-10}
Burst error: m anomalies in n periods	
For FAS, B1, B2, B3, REI-L, REI-P	m = 1 to 4.8 x 106 and n = 2 to 8001 frames or 0.2 s to 600 s

– *Alarm generation, dynamic*

Alarm types for STM-4	LOF, MS-AIS, MS-RDI
for OC-12	LOF, AIS-L, RDI-L
m alarms in n frames	m = 1 ton–1, n_{max} = 8000
or	
t1 alarm active, t2 alarm passive	t1 = 0 to 60 s, t2 = 0 to 600 s

– *Alarm generation, static (on/off)*

Alarm type	LOS, LOF
additionally, for STM-4	MS-AIS, MS-RDI, RS-TIM
for OC-12	AIS-L, RDI-L, TIM-L
Insertion on/off	

The receiver unit meets the specifications of ITU-T Rec. G.957 (Telcordia GR-253, ANSI T1.105.06) and fulfills classes S1.1, S1.2, S4.1, S4.2, L4.1, L4.2 and L4.3 (IR-1, IR-2, LR-1, LR-2, LR-3).

Wavelength range	1100 to 1580 nm
Input sensitivity, STM-1/4, OC-1/3/12	–8 to –28 dBm (–8 to –34 dBm typ.)
Display of optical input level	
Resolution	1 dB

The ANT-10G demultiplexes one selectable STM-1 or STS-3c/STS-1 tributary from the STM-4 or OC-12/OC-3 RX signal and feeds it to the internal processor for evaluation.
– *Measurement types*

Error measurements	
Error types	B1 parity error, B2 parity error of all STM-1/STS-1/STS-3c signals, MS-REI/REI-L
Alarm detection	
Alarm types	LOS, LOF, OOF, LTI
additionally, for STM-4	MS-AIS, MS-RDI, RS-TIM
for OC-12	AIS-L, RDI-L, TIM-L

– *Overhead evaluation*
– Display of the complete overhead of a selectable STM-1/STS-1/STS-3c signal
For the E1, E2, F1 bytes and the DCC channels D1 to D3 and D4 to D12:
– BERT using a test pattern from the generator unit
– Output of the data signal via the V.11 interface
For the K1, K2, N1, N2 bytes:
– Data signal output via the V.11 interface
For the J0 byte:
– Display of 15-byte sequences in ASCII.
– *155/622 Mbps electrical interface*
For connecting the ANT-10G to STM-1/OC-3 and STM-4/OC-12 monitor points

Line code	scrambled NRZ
Input voltage (peak-peak)	0.2 to 1 V
Coaxial input	
Connector/impedance	SMA/50 Ω

Concatenated mappings

Option OC-12c/STM-4c

Virtual concatenation — *BN 3060/90.92*

Only in conjunction with BN 3060/90.90 or BN 3060/90.91

- *Signal structure*
  STM-4 to ITU-T G.707
  Virtual concatenation with 4 AU-4 pointers
- *Generation of pointer actions*
  Manipulations on pointer #1 as in basic data sheet
  Setting of delta values for pointers #2, #3, #4
- *Pointer analysis*
  For pointer #1 — as in basic data sheet
  Delta values (maximum, minimum) — +40 for pointers #2, #3, #4
- *POH generation/analysis*
  POH #1 — as in basic data sheet
  POH #2, #3, #4 — static setting of all bytes except B3
  Automatic B3 generation for VC-4 #1, #2, #3, #4

Option OC-12c/STM-4c ATM-Testing — *BN 3060/90.91*

Only in conjuction with BN 3060/90.50 and BN 3060/91.11 or BN 3060/91.12
Please see heading “ATM options” for further details.

Optical modules 2488 Mbps

Optical STM-16, OC-48, 1310 nm — *BN 3060/91.51*
Optical STM-16, OC-48, 1550 nm — *BN 3060/91.50*
Optical STM-16, OC-48, 1310/1550 nm switchable — *BN 3060/91.52*

One 2.5 Gbps module can be fitted in the extension slot of the ANT-10G.
The optical interfaces meet the specifications of ITU-T Recommendation G.957 (Table 4) and Telcordia TA-NWT-000253 I.6 (Table 4-9, 4-10). Classes S-16.2, L-16.2, L-16.3 (ITU-T) or IR-2, LR-2, LR-3 (Telcordia) are fulfilled at 1550 nm; classes S-16.1, L-16.1 (G.957) or IR-1, LR-1 (Telcordia) are fulfilled at 1310 nm.

Generator

- *Optical interfaces*
  Wavelengths — 1310 nm, 1550 nm or 1310/1550 nm switchable
  Output level at 1310 nm and 1550 nm — 0 dBm +0/–2 dB
  Line code — scrambled NRZ
- *Electrical interfaces*
  Line code — scrambled NRZ
  Output voltage (peak-peak) — ≥40.6 V
  Connector/impedance — SMA/50 Ω
- *Clock generator*
  Internal, accuracy — ±2 ppm
  Offset — ±50 ppm
  Synchronization from external signal as for mainframe
- *Generation of STM-16 TX signal*
  In instruments with STM-1 mappings
  The STM-16 signal consists of one or more internally generated tributaries plus several tributaries filled with UNEQ (or non-specific UNEQ)
- 16 identical STM-1
- One STM-1 tributary and 15 x UNEQ/non specific
- 4 identical STM-4c (Option BN 3060/90.90 required)
- One STM-4c tributary (Option BN 3060/90.90 required) and 3 x UNEQ/non specific
- *Generation of OC-48 TX signal*
  In instruments with STS-1/STS-3c mappings
  The OC-48 signal consists of one or more internally generated tributaries plus several tributaries filled with UNEQ (or non-specific UNEQ)
- 48 identical STS-1
- One STS-1 tributary and 47 x UNEQ/non specific
- 16 identical STS-3c (Option BN 3060/90.02 required)
- One STS-3c tributary (Option BN 3060/90.02 required) and 15 x UNEQ/non specific
- 4 identical STS-12c (Option BN 3060/90.90 required)
- One STS-12c tributary (Option BN 3060/90.90 required) and 3 x UNEQ/non specific
- *Contents of STM-16/OC-48 overhead bytes*
  For all bytes except B1, B2 and H1 through to H3:
- The contents of the bytes in all SOH/TOH are statically programmable
  For the bytes E1, E2, F1 and the DCC channels D1 to D3 and D4 to D12:
- Transmission of a test pattern and bit error insertion (see mainframe for pattern selection)
- Insertion of an externally-generated data signal (via V.11 interface)
  For the K1, K2, N1, N2 bytes:
- Insertion of an external data signal via the V.11 interface
  For the J0 byte:

– Transmission of a 16-bit sequence with CRC
– *Error insertion*

Error types	B1, B2 parity errors
Single error or error rate B1	1 x 10^{-10} to 2 x 10^{-5}
B2	1 x 10^{-10} to 2 x 10^{-3}
additionally, for STM-16	MS-REI
for OC-48	REI-L
Single error or error rate	1 x 10^{-10} to 2 x 10^{-3}

– *Alarm generation, dynamic*

Alarm types for STM-16	LOF, MS-AIS, MS-RDI
for OC-48	LOF, AIS-L, RDI-L
m alarms in n frames	m = 1 to n-1, n_{max} = 8000
or	
t1 alarm active, t2 alarm passive	t1 = 0 to 60s, t2 = 0 to 600 s

– *Alarm generation, static (on/off)*

Alarm types	LOS, LOF
additionally, for STM-16	MS-AIS, MS-RDI
for OC-48	AIS-L, RDI-L

Receiver

– *Optical interfaces*

Wavelength	1260 to 1580 nm
Line code	scrambled NRZ
Sensitivity	–28 to –8 dBm
Input overload	> –8 dBm
Display of optical input level	
Range	–30 to –8 dBm
Resolution	1 dB

– *Electrical interfaces*

Line code	scrambled NRZ
Input voltage (peak-peak)	0.3 to 1 V
Connector/impedance	SMA/50 Ω

A selectable STM-1, STS-1 or STS-3c channel is fed to the internal evaluation circuits by demultiplexing from the input signal.

– *Error measurement*

Error types	B1 parity error, MS-REI, B2 parity sum error over all STM-1/STS-1/STS-3c channels
Evaluation (bit/block errors)	error rate, count
Error event resolution	1 s

– *Alarm detection*

Alarm types	LOS, LOF, OOF
additionally, for STM-16	MS-AIS, MS-RDI, RS-TIM
for OC-48	AIS-L, RDI-L, TIM-L
Alarm event resolution	100 ms

– *SOH/TOH evaluation*

Display of complete overhead

For the bytes E1, E2, F1 and the DCC channels D1 to D3 and D4 to D12:

– BERT using test pattern from generator unit
– Output of the data signal via the V.11 interface

For the K1, K2, N1, N2 bytes

– Data signal output via the V.11 interface

For the J0 byte

– Display of 15-byte sequences in ASCII format

DWDM laser

Optical STM-64, OC-192, 15xy nm *BN 3060/91.49*

Special DWDM lasers to G.692

Lasers with precisely defined wavelengths in the 1550 nm range are used specifically for DWDM applications. The ANT-10G can be fitted with a selected laser source conforming to ITU-T G.692 for such applications.

Further options

Optical power splitter (90%/10%) *BN 3060/91.05*

The optical power splitter is built into the ANT-10G. Three optical test adapters are required to operate it, please indicate your choice.

The optical power splitter provides an optical monitor point. The input signal is passed through to the output transparently.

Light energy forwarded	approx. 90% (–0.45 dB)
Light energy coupled out	approx. 10% (–10 dB)

The optical power splitter operates in the following ranges:

Wavelengths	1260 to 1360 nm and 1500 to 1600 nm

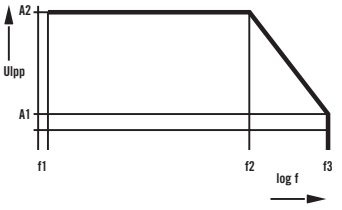
Jitter and wander options

As an alternative to the STM-16/OC-48 option, jitter applications up to 622 Mbps or wander at 10 Gbit are possible with the ANT-10G. The modules are optimized for compliance with the latest standard (O.172) and assure reliable jitter and wander measurements, useful when analyzing pointer jitter in 10 Gbps systems, for example. ANT-10G is particularly adept at wander analysis. The graphical MTIE wander analyses require no external computing resources and allow rapid verification of the synchronicity of a SDH network. Jitter/wander components are available for all built-in bit rates up to 622 Mbps and for 10 Gbps.

Standards

Jitter generation and jitter/wander analysis are in accordance with:

- Telcordia GR-253, GR-499, GR-1244
- ANSI T1.101, T1.102, T1.105.03,T1.403, T1.404, T1.105.09
- ITU-T G.783, G.823, G.824, G.825, O.171, O.172
- ETSI ETS 300 462-1 to -6, ETS 300 417-1-1, EN 302 084



Clock rate/kHz	A1	A2	f1/Hz	f2/Hz	f3/Hz
1544				625	80
2048				1560	200
6312				940	120
8448				6250	800
34,368	0.5	64	0.1	27 k	3500
44,736				35 k	4500
51,840				27 k	3500
139,264				39 k	5000
155,520				39 k	5000
622,080*	1.0	256		20 k	5000

**Requires option BN3060/91.31*

O.172 Jitter/Wander up to 155 Mbps	*BN 3060/91.30*

Jitter generator

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

Bit rates

Generates jitter at all bit rates included in the mainframe configuration up to 155520 kbps.

TX signals	all test patterns and frame structures included in the mainframe configuration
Built-in modulation generator (sinewave)	0.1 Hz to 5 MHz
External modulation	0 Hz to 5 MHz
Jitter amplitude	up to 64 UI
– *Modulator input*	
75 Ω, BNC socket	
Voltage required	0 to 2 Vpp
– *Error limits*	as per O.172

Jitter analyzer

Jitter measurement at all bit rates included in the mainframe configuration up to 155520 kbps.

– *Built-in filters*	
High-pass filters	0.1, 2, 4, 10, 20, 40, 100, 200, 400, 500, 700 Hz, 1, 3, 8, 10, 12, 18, 20, 30, 65, 80, 250 kHz
Low-pass filters	40, 60, 100, 400, 800, 1300, 3500, 5000 kHz
Filter characteristics	as per O.172
– *Measurement ranges*	
Peak-peak	
Range I, resolution	0 to 1.6 Ulpp, 1 mUlpp
Range II, resolution	0 to 20 Ulpp, 10 mUlpp
Range III, resolution	0 to 200 Ulpp, 100 mUlpp
RMS	
Range I, resolution	0 to 0.8 Ulpp, 1 mUlpp
Range II, resolution	0 to 10 Ulpp, 10 mUlpp
Range III, resolution	0 to 100 Ulpp, 100 mUlpp
Measurement accuracy	as per O.172
– *Demodulator output*	
75 Ω, BNC socket	
Range I (0 to 1.6 Ulpp)	1 V/Ulpp
Range II (0 to 20 Ulpp)	0.1 V/Ulpp
Range III (0 to 200 Ulpp)	0.01 V/Ulpp

Wander generator

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

Bit rates

Wander generation at all implemented bit rates up to 155 Mbps according to the equipment level of the instrument.

Amplitude range	up to 200,000 UI
Frequency range	10 µHz to 10 Hz
Accuracy	as per O.172
Resolution	1 µHz

Wander analyzer

Fully complies with or exceeds the requirements of ITU-T O.172.
For all bit rates up to 155 Mbps according to the equipment level of the instrument.
Other sampling rates in addition to the 30/s rate are available for detailed analysis versus time.

Sampling rate – low-pass filter – test duration	1/s – 0.1Hz – 99 days; 30/s – 10 Hz – 99 h 60/s – 20 Hz – 99 h; 300/s – 100 Hz – 5000 s
Amplitude range	±1 ns to ±1 µs
Measurement accuracy	as per O.172

Accessory: "Standard Frequency Source" for wander applications, please see end of section.

O.172 Jitter/Wander up to 622 Mbps — *BN 3060/91.31*

Jitter generator

Jitter modulation of STM-4 TX signals.

Built-in modulation generator (sinewave)	0.1 Hz to 5 MHz
External modulation	0 Hz to 5 MHz
Jitter amplitude	up to 256 UI

Jitter modulation of externally-generated signals in Through mode

Externally-generated signals can be jittered in Through mode when the D&I option is included.

This applies to all bit rates included in the mainframe configuration at the appropriate electrical and optical interfaces.

Built-in modulation generator (sinewave)	0.1 Hz to 5 MHz
External modulation	0 Hz to 5 MHz
Jitter amplitude	as for jitter generator in UIpp

Jitter analyzer

– *Measurement range*

Peak-peak	
Range I, resolution	0 to 6.4 UIpp, 1 mUIpp
Range II, resolution	0 to 80 UIpp, 10 mUIpp
Range III, resolution	0 to 800 UIpp, 100 mUIpp
RMS	
Range I, resolution	0 to 3.2 UIpp, 1 mUIpp
Range II, resolution	0 to 40 UIpp, 10 mUIpp
Range III, resolution	0 to 400 UIpp, 100 mUIpp
Measurement accuracy	as per O.172

– *Demodulator output*

75 Ω, BNC socket	
Range I (0 to 6.4 UIpp)	0.25 V/UIpp
Range II (0 to 80 UIpp)	0.025 V/UIpp
Range III (0 to 800 UIpp)	0.0025 V/UIpp

Wander generator

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

Bit rates

Wander generation at all implemented bit rates up to 622 Mbps according to the equipment level of the instrument.

Amplitude range	up to 200,000 UI
Frequency range	10 µHz to 10 Hz
Accuracy	as per O.172
Resolution	1 µHz

Wander analyzer

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

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

Sampling rate – low-pass filter – test duration	1/s – 0.1Hz – 99 days; 30/s – 10 Hz – 99 h 60/s – 20 Hz – 99 h; 300/s – 100 Hz – 5000 s
Amplitude range	±1 ns to ±1 µs
Measurement accuracy	as per O.172

– *Reference signal input*

Frequencies	1.544, 2.048, 5, 10 MHz
Bit rates	1.544, 2.048 Mbps
Balanced 110 Ω connector	Bantam
Clock input voltage (sine or square wave)	1.0 to 6.5 Vpp
HDB3/B8ZS input voltage	±3 V ±10%
Coaxial 75 Ω connector	BNC
Clock input voltage (sine or square wave)	1.0 to 5 Vpp
HDB3/B8ZS input voltage	±2.37 V ±10%

Accessory: “Standard Frequency Source” for wander applications, see end of section.

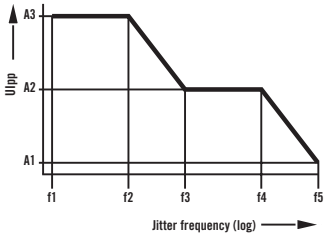
0.172 Jitter/Wander at 9953 Mbps

Jitter at 9953 Mbps ***BN 3060/91.60***
Wander analyzer at 9953 Mbps ***BN 3060/91.61***
Wander generator at 9953 Mbps ***BN 3060/91.62***

Jitter generator

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

Bit rate	9,953,280 kbps
Maximum offset	±50 ppm
Built-in modulation generator	sine wave
or external	0.1 Hz to 80 MHz
Jitter amplitude	up to 3200 UIpp



Amplitude in UIpp			Frequency in Hz				
A1	A2	A3	f_1	f_2	f_3	f_4	f_5
0.5	20	3200	0.1	12.5	2 k	2 M	80 M

– *Modulator input*

75 Ω, BNC socket	
Modulation frequency	0.1 Hz to 80 MHz
Input voltage range	0 to 2.0 Vpp
Error limits	as per ITU-T O.172

Jitter analyzer

Bit rate	9,953,280 kbps

– *Measurement ranges*

Peak-peak	
Range I, resolution	0 to 4 UIpp, 1 mUIpp
Range II, resolution	0 to 40 UIpp, 10 mUIpp
Range III, resolution	0 to 3200 UIpp, 100 mUIpp
RMS	
Range I, resolution	0 to 2 UIpp, 1 mUIpp
Range II, resolution	0 to 20 UIpp, 10 mUIpp
Range III, resolution	0 to 1600 UIpp, 100 mUIpp
Measurement accuracy	as per O.172

– *Built-in filters*

as per ITU-T O.172, G.825, G.813, Telcordia GR-1377, ANSI T1.101, T1.105.03

High-pass filters	10kHz, 12kHz, 20kHz, 50kHz and 4MHz
Low-pass filters	10kHz, 80MHz

The high-pass filters can be switched off.

Frequency range without high-pass filter	
Measurement range I	100 Hz
Measurement range II	10 Hz
Measurement range III	10 Hz

– *Demodulator output*

75 Ω, BNC socket	
Output voltage	
Measurement range I (0 to 4 UIpp)	0.5 V/UIpp
Measurement range II (0 to 40 UIpp)	50 mV/UIpp
Measurement range III (0 to 3200 UIpp)	0.625 mV/UIpp

Wander generator

Requires option BN 3035/90.81 or BN 3060/91.30 or BN 3060/91.31
Fully complies with or exceeds the requirements of ITU-T O.172.

Bit rate	9,953,280 kbps
Amplitude range	0.1 UI to 320,000 UI
Frequency range	10 µHz to 10 Hz
Accuracy	as per O.172
Resolution	1 µHz

Wander analyzer

Fully complies with or exceeds the requirements of ITU-T O.172.
Other sampling rates in addition to the 30/s rate are available for detailed analysis versus time:

Sampling rate – low-pass filter – test duration	1/s – 0.1Hz – 99 days; 30/s – 10 Hz – 99 h 60/s – 20 Hz – 99 h; 300/s – 100 Hz – 5000 s
Amplitude range	±1 ns to ±1 µs
Measurement accuracy	as per O.172

– *Reference signal input*

Frequencies	1.544, 2.048, 5, 10 MHz
Bit rates	1.544, 2.048 Mbps
Balanced 110 Ω connector	
Clock input voltage	
(sine or square wave)	0.65 to 6.5 Vpp
HDB3/B8ZS input voltage	±3 V ±10%
Coaxial 75 Ω connector	
Clock input voltage	
(sine or square wave)	0.5 to 5 Vpp
HDB3/B8ZS input voltage	±2.37 V ±10%

For “Standard Frequency Source” accessory for wander applications, see end of section

Jitter analysis

Current values (continuous measurement)	
Peak jitter value	in UIpp
Positive peak value	in UI+p
Negative peak value	in UI–p
Maximum value (gated measurement)	
Maximum peak jitter value	in UIpp
Maximum positive peak value	in UI+p
Maximum negative peak value	in UI–p
Result averaging (switchable)	1 to 5 s

The ANT-10G retains phase synchronicity even when pointer jitter occurs (phase tolerance to O.172).

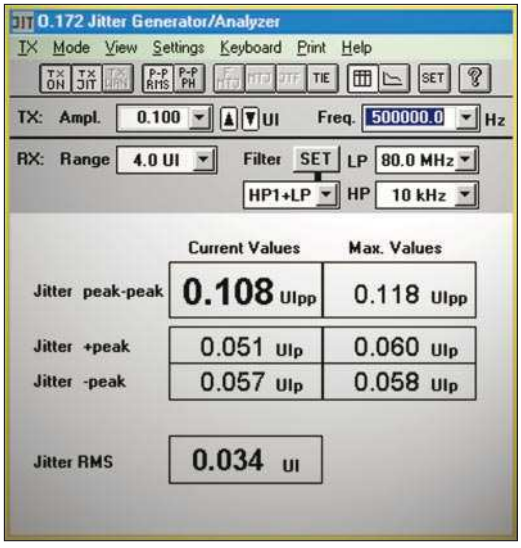


figure 10 Jitter peak to peak/RMS measurement

– *Phase hits*
The instrument detects when the programmable threshold for positive and negative jitter values is exceeded. The result indicates how often this threshold was exceeded. Setting range for positive and negative thresholds (depending on measurement range) 0.1 up to the half measurement range.

Jitter versus time (figure 11)

This function is used to record variations of jitter with time.
It allows the positive and negative peak values or peak-to-peak values to be displayed versus time. Measured values have one second resolution. Measurement duration is up to 99 days. By simultaneously evaluating alarms and errors, corellations between events can be quickly identified.

Clock jitter measurement

The ANT-10G can also measure the jitter on the clock signals (square-wave) at standard bit rates. All built-in bit rates with electrical interfaces up to 155 Mbps can be measured (requires option BN 3060/91.30 or 3060/91.31).

RMS measurement

T1.105.03, GR-253, GR-499, G.958 (or G.783 rev.)
The RMS value is measured on-line and displayed in UI. The peak jitter and RMS values can be displayed simultaneously; a graph versus time is available for long-term analysis. An RMS filter preset is available.

Wander analysis

Time interval error (TIE)

To O.172	numerical and graphical
Sampling rates	please see under O.172 wander analyzer

MTIE is additionally determined as a continually updated numerical value.
To prevent data loss or premature termination of long term measurements, the ANT-10G checks the remaining space on the hard disk before the start of the measurement. If necessary, the selected measurement time can be adjusted.
The TIE values are recorded and are then available for subsequent offline MTIE/TDEV evaluations. The values are also saved in .csv format for documentation or further analysis.

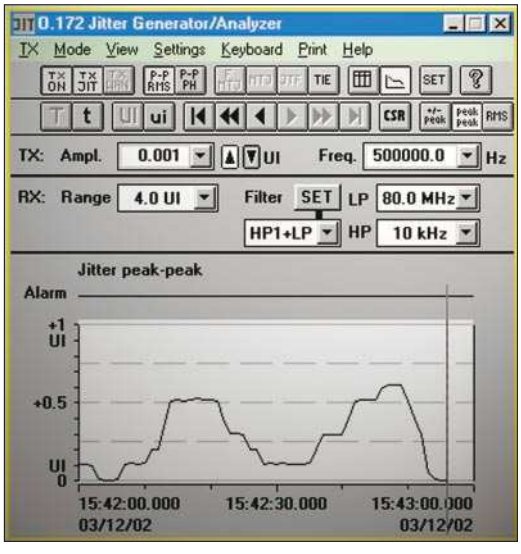


figure 11 Jitter versus time display

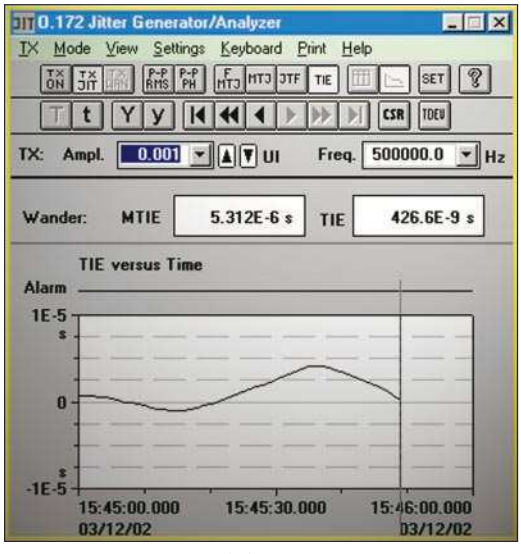


figure 12 On-line wander testing (TIE)

MTIE/TDEV Off-line analysis evaluation

This software provides extended off-line statistical analysis facilities for the results of wander measurements. TIE values results obtained using the ANT-10G are analyzed according to ANSI T1.101, Telcordia GR-1244, ETSI ETS 300 462, EN 302 084, ITU-T O.172, G.810 to G.813.

Network synchronization quality is presented graphically using the MTIE (maximum time interval error) and TDEV (time deviation) parameters. To ensure correct assessment, the tolerance masks for PRC (primary reference clock), SSU (synchronization supply unit), SEC (synchronous equipment clock) or PDH can be superimposed. The results and masks can be printed out with additional user-defined comments.

This software allows several TIE results to be displayed simultaneously. Decisive details during long term measurements disappear in the multitude of results. An effective zoom function is available for detailed wander characteristic analysis.

Result printout and export

The results can be printed out and stored internally or on floppy disk. The file format allows further processing using standard PC software.

Frequency offset and frequency drift rate (ANSI T1.101)

To ensure reliable operation when a clock source is in holdover mode, the frequency characteristics must not exceed specific deviation limits relative to an absolute reference source. To verify this data, the ANT-10G determines the following over the selected measurement interval:

Frequency offset	in ppm
Frequency drift rate	in ppm/s

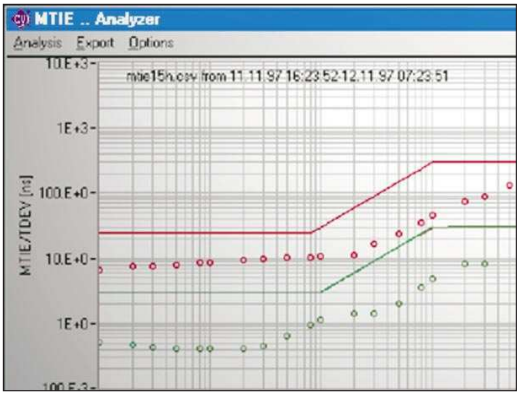


figure 13 Display of MTIE/TDEV results and comparison against masks

MRTIE – relative MTIE (G.823 and EN 302 084)

If the reference is unavailable (too far away) when analyzing the wander of asynchronous signals, the MTIE analysis may have a superimposed frequency offset. This offset depends on the difference between the signal and local reference clocks. The MRTIE measurement subtracts the frequency offset from the result so that the "actual" wander characteristic is shown.

Accessory for wander analysis

Standard frequency source please see end of section.

Automatic measurements

The following automatic measurements can be run for all standard bit rates and interfaces included in the mainframe configuration (electrical/optical) up to 10 Gbps.

Automatic determination of selective jitter transfer function, JTF

Telcordia GR-499, GR-253, ANSI T1.105.03, ITU-T G.958.

The jitter transfer function indicates the ratio of the jitter amplitude at the output of the device under test to that at the input at various frequencies. This determines whether the device under test reduces or amplifies input jitter and at which frequencies. After a calibration measurement to minimize intrinsic errors, the ANT-10G outputs a preselected jitter amplitude at various frequencies and measures selectively the jitter amplitude at the output of the device under test. The ratio of the amplitudes in dB is the jitter transfer function. The preselected amplitudes correspond to the mask for maximum permitted input jitter. The jitter frequencies and amplitudes can also be edited. Calibration values can be saved and used again for other measurements.

Additional measurement mode

– Transfer MTJ results:
  An MTJ measurement is first performed. The measured amplitude values can then be used automatically as generator values for the JTF measurement. The results can be displayed in tabular and graphical form.
  The graphical display includes the standard tolerance masks specified in T1.105.03 and GR-253 or G.735 to G.739, G.751, G.758. The distance of the measurement points from the tolerance masks indicates the degree to which the device under test meets the requirements of the standard.
  Tolerance mask violations during the measurement are indicated in the numerical table.

Freely programmable tolerance masks

The existing tolerance masks for the ANT-10G can be altered as required to suit requirements that do not conform to specific standards. The new values selected for jitter frequency and jitter gain/loss are stored when the application is saved.

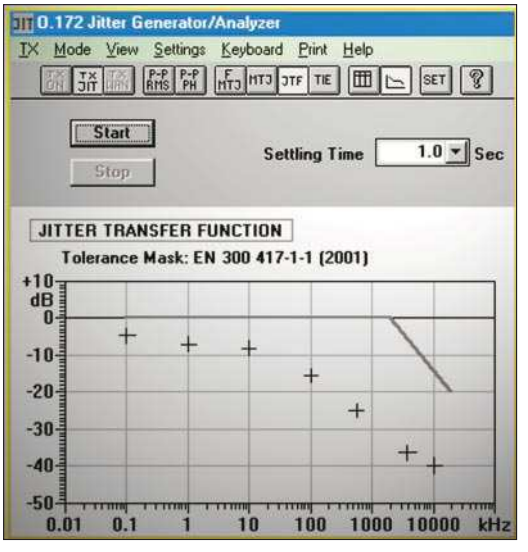


figure 14 Jitter transfer testing results

Automatic limit testing of maximum tolerable jitter (fast maximum tolerable jitter F-MTJ)

ANSI T1.403, T1.404, T1.105.03, Telcordia GR-253, GR-499, ITU-T G.823, G.824, G.825, G.958.

This extremely fast measurement tests the device for conformance to the standard tolerance mask limits for maximum tolerable jitter.

Jitter frequencies	up to 10 fixed frequencies corresponding to standard tolerance mask
Detection criteria	TSE (bit error), code error, B2, B3, REI, RDI
Error threshold	0 to 999,999 errors
Settling time	0.1 to 99.9 s

The editable frequency/amplitude values are set sequentially and the test pattern monitored for the permitted bit error count by the receiver.

The result of each measurement is shown in a table as the status message "OK" or "FAILED".

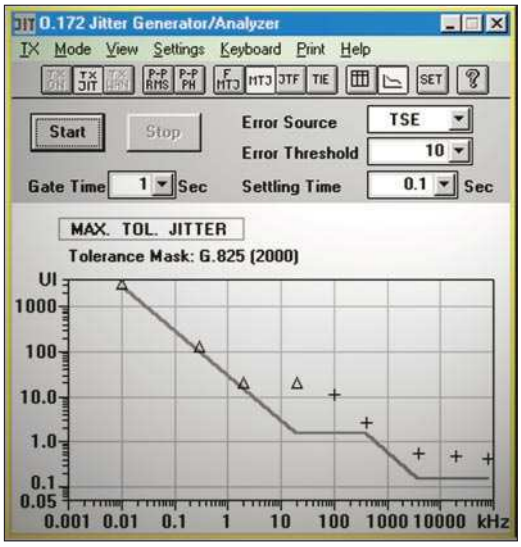


figure 15 Maximum tolerable jitter testing

Automatic determination of maximum tolerable jitter, MTJ

ANSI T1.403, T1.404, T1.105.03, Telcordia GR-253, GR-499, ITU-T G.823, G.824, G.825, G.958.

The ANT-10G automatically determines the maximum jitter amplitude tolerated by the device under test at each jitter frequency.

Jitter frequencies	20 freely selectable frequencies
Detection criteria	TSE (bit error), code error, B2, B3, REI, RDI
Error threshold	0 to 999,999 errors
Settling time	0.1 to 99.9 s
Gating time	1 to 999 s

The maximum permissible jitter amplitude is determined precisely and quickly using a successive method. The ANT-10G determines the exact limit value.

The method is derived from a great deal of experience in the performance of jitter tolerance tests and is recognized by leading systems manufacturers.

The frequency/amplitude result pairs can be displayed in tabular and graphical form.

The graphical display includes the standard tolerance masks. The distance of the measurement points from the tolerance masks indicates the degree to which the device under test meets the requirements of the standard.

Tolerance mask violations during the measurement are indicated in the numerical table.

– *Freely programmable tolerance masks*
  The existing tolerance masks for the ANT-10G can be altered as required to suit requirements that do not conform to specific standards.
  The new values selected for jitter frequency and amplitude are stored when the application is saved.

Automatic pointer sequences for analyzing combined jitter

(available with CATS test sequencer option)

Among other things, T1.105.03 defines various pointer sequence scenarios for testing combined jitter (mapping and pointer jitter) at network elements. These sequences are normally selected manually and the jitter measured. ANT-10G allows simple automation of these sequences. The entire sequence is started and the maximum pointer jitter determined with a single key press. This saves considerable time spent in setting up the test and executing the measurement.

Automatic limit testing of maximum tolerable wander, MTW

ITU-T G.823, G.824.

The ANT-10G tests the device for conformance to the standard tolerance mask limits for maximum tolerable wander.

Measurement points	up to 10 frequency/amplitude values
Detection criteria	TSE (bit error), alarms
Frequency range	10 µHz to 10 Hz, step 1 µHz
Amplitude range	0.1 to 200,000UI, step 0.1 UI

The result of each measurement is shown in a table with an "OK" or "FAILED" message.

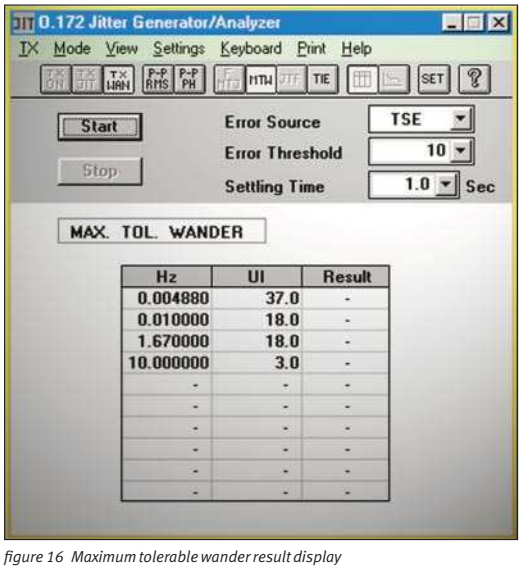


figure 16 Maximum tolerable wander result display

Accessory

Acterna TSR-37 *DA 3700/00*

Rubidium timing signal reference

The TSR-37 is a powerful reference source to quickly measure and test the synchronization quality of PDH/SDH/SONET digital networks. MTIE and TDEV measurements for up to 1000 seconds can be easily performed without a GPS reference. Coupled with the optional GPS-FC, the range of observation time can be largely extended to meet specific requirements.

Provides the reference clock for wander analysis using the ANT-10G.

– PDH/SDH/SONET wander measurement source
– Accuracy at 25°C: +5 x 10^{-11} without GPS; <1 x 10^{-11} with GPS
– 12 outputs, framed and unframed:
  5 MHz, 10 MHz, 2.048 kHz, 1.544 kHz, E1, T1
– Compact, robust and lightweight
– External autocalibration input
– Input for GPS or Cesium reference

Please see Acterna TSR-37 data sheet for details.

ATM options

With its ATM options, the ANT-10G enables commissioning tests on newly installed ATM links. The major error and delay related performance parameters can be quickly and reliably verified in this manner. Using the flexible cell generator, policing functions can be easily checked. Bit error analyses and alarm flow diagnostics allow a fast assessment of whether links are working properly.

ATM cells can be generated for all bit rates up to STM-4c/ OC-12c.

ATM Basic **BN 3060/90.50**

General

Adjustable test channel from 0 to 150 Mbps

In ATM network elements, user channels are monitored with the UPC (usage parameter control). The sensors of the control instance can be quickly checked if the bandwidth of a test channel exceeds the set threshold in the network element. For all measurements, the test channel in the ANT-10G is set on-line. Settings are made directly with a control (figure 18) which shows the bandwidth in Mbps, Cells/s or percent. This makes it easy to simulate CBR (constant bit rate) sources. For each interface, the load setting has a range from 0.01 percent to 100 percent. This corresponds to the load conditions which can occur in the real world.

Load profiles

A test channel can be generated with typical load profiles in order to stress network elements or simulate source profiles. In burst mode, for example, the burst load, burst length and burst period parameters can be used to simulate a video signal whose key figures correspond to a real-life signal.

Background load generator

To make a real-time measurement under loaded conditions, additional background load can be simulated to supplement the test channel (foreground traffic). The ATM channels are defined using an editor. The user specifies the repetition rate of the load cell and a sequence of empty cells. Load channels can be transmitted continuously as a sequence. The load generator can also be used separately with the test channel switched off. In this case, the channels and profiles can be user-specified.

Determining cell delay variation

The ANT-10G includes very powerful tools for measuring delay parameters. Once a precise measurement has been made, subsequent measurements usually require only a low-resolution display to enable rapid pass/fail assessment. Delay values are displayed by the ATM Traffic analyzer as a histogram with a minimum class width equal to 160 ns (maximum 335 ms). As a result, delay fluctuations are shown graphically with the same resolution. An adjustable offset can be used to maintain measurement accuracy even if the delay values are high, for example over international links.

F4/F5 OAM alarm flow

In accordance with I.610 and the ATM forum standard, the status of ATM paths and channels is transmitted in the OAM cell stream (fault management). The ANT-10G generates the alarms VP-AIS, VC-AIS or VP-RDI, VC-RDI for the foreground channel. The receiver simultaneously detects alarms and error messages in the channel and path.

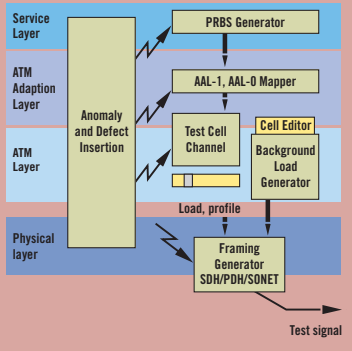


figure 17 ATM-BERT generator configuration

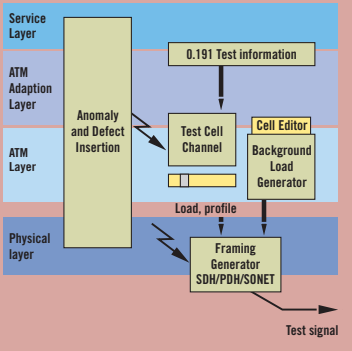


figure 18 Generator configuration for performance measurement

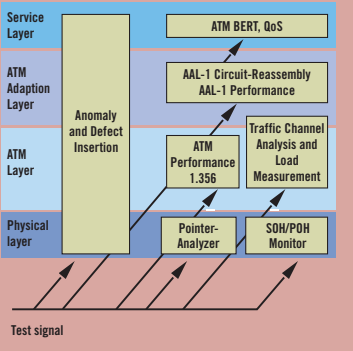


figure 19 Analyzers in the ANT-10G – a hierarchical overview

The ATM module comprises

- Generation and analysis of ATM cell streams
- ATM layer cell transfer performance as per ITU-T I.356, O.191
- AAL-1 segmentation/reassembly for circuit emulation
- STM-1/STS-3c with C4 ATM mapping, ITU-T G.707, ANSI T1.105/107
- F4/F5 fault management OAM flow for AIS and RDI as per ITU-T I.610, ATM forum UNI 3.1

Generator unit

Bit rates of the framed cell streams	155.520 Mbps
Cell scrambler $X^{43}+1$ (ITU-T)	can be switched on and off

Test cell channel

Adjustable from	0 to 149.760 Mbps
Header setting	editor
Load setting in	Mbps, Cells/sec, %

Test cells, payload pattern

AAL-0, pseudo-random bit sequences (PRBS)	$2^{11}-1$, $2^{15}-1$, $2^{23}-1$
AAL-1, pseudo-random bit sequences (PRBS)	$2^{11}-1$, $2^{15}-1$, $2^{23}-1$
Programmable word, length	16 bits
Test pattern for ATM performance analysis, with sequence number	3 bytes
Time stamp	4 bytes
Error correction	CRC-16

Load profiles

Equidistant, setting range	1 to 10,000 cell times
Constant Bit Rate (CBR), setting range	0.01% to 100%
Variable Bit Rate (VBR), settings	
Peak cell rate	1% to 100%
Mean cell rate	1% to 100%
Burst size	1 to 1,023 cell times
Burst period	2 to 32,767 cell times

Error insertion

Physical layer as with ANT-10G basic instrument ATM layer, AAL:
Correctable and non-correctable header errors

- AAL-0, cell payload bit errors
- AAL-1, sequence number errors
- AAL-1, SAR-PDU bit errors
- AAL-1 SNP, CRC errors
- AAL-1 SNP, parity errors

Triggering: single errors, error ratio, n errors in m cells

Alarm generation

Physical layer as with basic instrument, also

loss of cell delineation	LCD

ATM layer (for selected test cell channel)

OAM F4/F5 fault flow	VP AIS, VP RDI, VP AIS+VC AIS, VC AIS, VC RDI, VP RDI+VC RDI

Background load generator

For programming user-defined cell sequences. The sequences can be transmitted at a selectable repetition rate.

Editor	200 ATM channels
Header	user-selectable
Payload	1 filler byte, user-selectable

Circuit emulation

(for selected test cell channel)
Generation of an asynchronous channel: 1544, 2048, 6312, 8448, 34,368, 44,736 kbps, 2048 kbps with PCM30 frame structure

ATM channel segmentation	AAL-1, ITU-T I.363

Receiver unit

Bit rates of framed cell streams	155.520 Mbps
Cell scrambler $X^{43}+1$ (ITU-T)	can be switched on and off

Measurement types

Error measurement (anomalies), statistics

Detection of the following error types:
Correctable and non-correctable header errors

- AAL-0, cell payload bit errors
- AAL-1, sequence number errors
- AAL-1, SAR-PDU bit errors
- AAL-1 SNP, CRC errors
- AAL-1 SNP, parity errors

ATM performance analysis

- Cell error ratio
- Cell loss ratio
- Cell misinsertion rate
- Mean cell transfer delay
- 2-point cell delay variation
  measured between minimum and maximum cell transfer delay values
- Cell transfer delay histogram

Number of classes	128
Minimum class width	160 ns
Maximum class width	335 ms
Settable offset	0 to 167 ms
Offset step width	2.5 µs

Alarm detection (defects)

Physical layer as with ANT-10G basic instrument, also

Loss of Cell Delineation	LCD

ATM layer (for selected test cell channel)

OAM F4/F5 fault flow	VP AIS, VP RDI, VC AIS, VC RDI

User channel analysis

Concurrent X-Y chart (load vs. time) for:

- All user cells
- Average cell rate of a selected cell channel
- Peak cell rate of a selected cell channel

Display units: Mbps, Cells/s, %
Channel utilization histogram:

- All user cells (“assigned cells”)
- A selected cell channel (“user cells”)

Cell distribution of a selected cell channel with classification by:

- User cells
- F5 OAM flow
- F4 OAM flow
- User cells with CLP=1

Circuit reassembly

(for selected test cell channel)

Reassembly	AAL-1, ITU-T I.363
Error measurement on an asynchronous channel	1544, 2048, 6312, 8448, 34,368, 44,736 kbps, 2048 kbps with PCM30 frame structure

ATM Comprehensive **BN 3060/90.51**
includes the function of ATM BASIC BN 3060/90.50 and broadband analyzer generator module (BAG)

Selection of ready-to-run applications and graphics-supported test settings
The graphical method for making test settings is unique. The way that the ANT-10G is connected to the device under test, ensures that the protocol layers and settings included in the test, or the ATM services to be tested can be quickly and easily seen. Users can select from a range of predefined test setups or customize their own. Predefined ATM channels can be selected from a database or new channels added. Additionally, all characteristics and parameters for each channel are also stored, for example: traffic type, circuit type, header, traffic contract, traffic source. An editor program is provided for defining the test circuits.

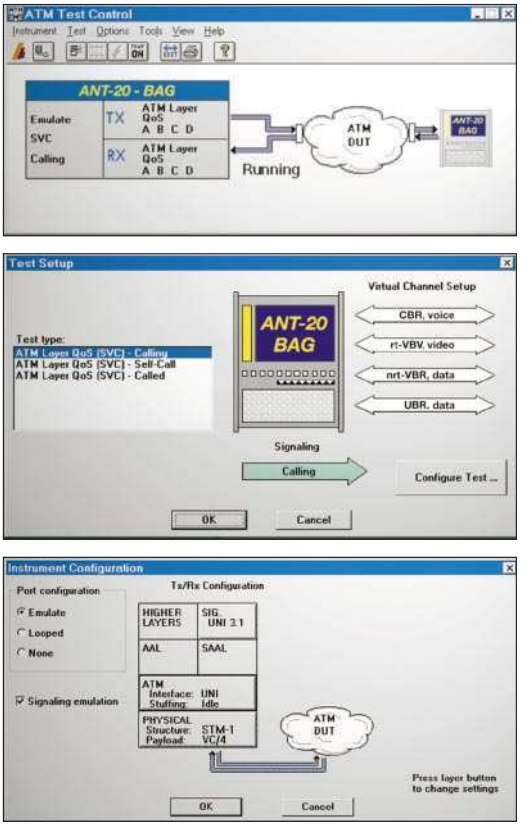


figure 20 The ATM Test Control windows make operation simple

Direct testing of all contract parameters
Some of the main tasks facing measurement services are determining whether users are keeping to traffic contracts and how they are doing so, and establishing how the network handles such contracts. These questions can only be answered by means of a test that enables all the major service parameters to be set and measured.

For such applications, the Broadband module includes an editor that permits all the contract parameters for the various ATM services to be set for the first time. For terminal emulation, all contract characteristics and of the traffic model used for the test can be defined with the Channel Editor.

After starting the measurement, the ANT-10G generates test traffic using the selected parameters. This allows direct demonstration of the way that the ATM network handles the user traffic and whether the agreed network resources were in fact available.

The source parameters can be varied on-line during the measurement. This makes it possible to detect policing errors or incorrect network access threshold settings quickly and easily.

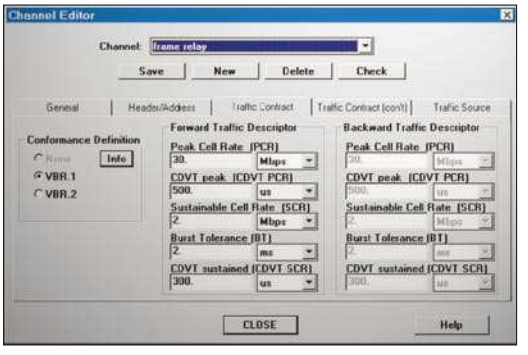


figure 21 Channel Editor: setting the traffic descriptor

ATM QoS test with four different SVCs
The ANT-10G with BAG can perform SVC and PVC tests on up to four circuits simultaneously. Multi-channel services, such as those used for multimedia applications, can thus be simulated.

Any channel type can be selected from the database or newly defined for each channel.

Realtime measurements conform to the ITU-T O.191 standard which defines the test cell format and the test algorithm. Important source parameters can be regulated online during the test. The results are clearly displayed, with graphics elements used to indicate defects or highlight status information.

Signaling analysis

Sequence errors in the signaling protocol adversely affect correct management of ATM services. They can be detected by recording and displaying all channel states and changes of state in chronological order with timestamp information. The ANT-10G constantly monitors the states of the SVCs being tested. The protocol can thus be checked for correctness and any errors detected rapidly. The connection set up time is measured for all test channels.

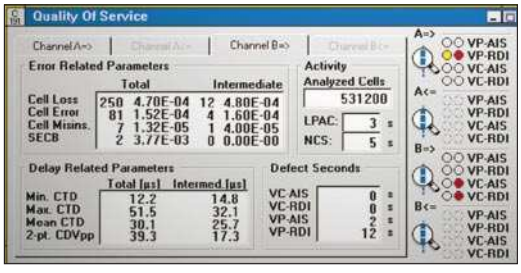


figure 22 ATM test results for a realtime measurement on channel A

Traffic management and contract optimization

Traffic shaping (single/dual leaky bucket) can be switched on for each ATM channel, even on-line during the measurement. In addition, the following are displayed per channel with soft LEDs:

– Non conforming cells (NCC)
– Dropped cells (DC)

Using this information it is possible to check whether the UPC (usage parameter control) functions of the network are working and are implemented in compliance with the standard. At the same time, the degree of utilization of the traffic contracts can be determined. Using the facilities for simulating all relevant source parameters with up to four competing channels, it is possible to optimize the contract parameters in the network.M

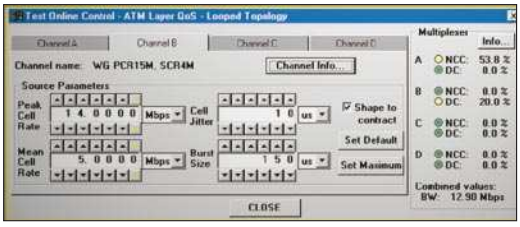


figure 23 Soft-LED indication of multiplex results

Professional record of results

The ANT-10G generates a professional record of instrument settings and test results that can be output from a standard printer.

The record can be used for various purposes, for example:

– Guarantee documentation
– Acceptance documentation
– Installation record
– Evidence of adherence to contract, and so on.

In other words, the ANT-10G handles the entire process from measurement through to producing a permanent record of the results

Broadband analyzer/generator

The module includes software test functions for
- ATM test controller
- ATM test results
- ATM channel explorer
- STM-1/STS-3c with C4/SPE ATM mapping to ITU-T G.707, I.432 and ANSI T1.105/107

ATM test controller

Instrument port configurations

Emulation	SVCs, PVCs
Looped signal	PVCs

Test cell channels

– 4 test channels settable from	0 to 149.760 Mbps
Header setting	via editor
Load setting in	kbps, Mbps, cells/s
Test cell format	to ITU-T O.191

ATM service categories

Switched circuits and permanent circuits for:

Constant bit rate	CBR
Real-time variable bit rate	rt-VBR
Non real-time variable bit rate	nrt-VBR
Deterministic bit rate	DBR
Statistical bit rate	SBR
Unspecified bit rate	UBR

Signaling emulation

Terminal emulation at the UNI as per ITU-T and ATM forum recommendations

Protocol types	UNI 3.0, UNI 3.1, Q.2931, Q.2961
Test types	Self-call, 2 SVCs, Calling, 4 SVCs, Called, 4 SVCs

ATM channel editor

Traffic contract:

Direction type	unidirectional, bidirectional symmetrical, bidirectional asymmetrical

Traffic descriptor:

Peak cell rate	PCR
Cell delay variation tolerance peak	CDVT peak
Sustainable cell rate	SCR
Burst tolerance	BT
Cell delay variation tolerance sustained	CDVT sustained
Source parameters	Cell clumping, burst size, mean cell rate, peak cell rate

On-line channel settings

Peak cell rate
Cell clumping
Mean cell rate
Burst size

Traffic management

User-selectable shaping

CBR	Single leaky bucket
DBR	Single leaky bucket
rt-VBR	Dual leaky bucket
nrt-VBR	Dual leaky bucket
SBR	Dual leaky bucket
UBR	Dual leaky bucket

Error insertion

Correctable and uncorrectable header errors
Cell loss
Cell error
Cell misinsertion
Severely errored cell blocks

Alarm generation

ATM layer alarms (for all test channels):

OAM F4/F5 fault flow	VP AIS, VP RDI, VC AIS, VC RDI

ATM test results

Measurement modes

ISM	In-service measurement
OOS	Out-of-service measurement

Receiver status (ISM, OOS)

Signal load, bandwidth
Correctable and uncorrectable header errors

Errored seconds	LCD, physical layer defects

ATM Quality of service (QoS) for 4 SVCs or 4 PVCs

Cell error ratio
Cell loss ratio
Cell misinsertion rate
Mean cell transfer delay
Maximum cell transfer delay
Minimum cell transfer delay
2-point cell delay variation
Severely errored cell block ratio

Errored seconds	VP AIS, VP RDI, VC AIS, VC RDI
Activity	Analyzed cells, not connected seconds
	(SVCs), Loss of performance assessments capability seconds

Alarm detection, defects (ISM, OOS)

ATM layer alarms (for selected test cell channel):

OAM F4/F5 fault flow	VP AIS, VP RDI, VC AIS, VC RDI

Signaling analysis

Channel set-up time
Channel status with interpretation and timestamp
Representation of ATM QoS for the SVC after clearing down the circuit.

ATM channel explorer (ISM, OOS)

Channel search:
Automatic determination of up to 1000 ATM channels with indication of:

Channel number	VPI, VCI
Explicit forward congestion	
Indication bandwidth (%)	CI-BW
CLP = 1 bandwidth (%)	CLP1-BW
Average bandwidth	AvBW
Current bandwidth	CuBW

Aging (switchable function)
Sorts out inactive channels from the activity list.
AAL analysis
Automatic determination of AAL type for 1000 ATM channels.
Graphic display of distribution.
Trouble scan
Automatic determination of VC AIS, VC RDI, VP AIS and VP RDI in up to 1000 ATM channels.

Add ATM SDH — *BN 3060/90.52*

The ATM mapping options provide further frame structures for interfaces conforming to ITU-T G.804/832/707.
Corresponding physical layer measurement functions are offered by the mapping options for the interfaces. These include error and alarm insertion, error measurement and alarm detection.
The following ATM mappings are included:

E4 (140 Mbps) ATM mapping

Bit rate	139,264 kbps

E3 (34 Mbps) ATM mapping

Bit rate	34,368 kbps

E1 (2 Mbps) ATM mapping

Bit rate	2,048 kbps

STM-1/VC12 ATM mapping

Bit rate	155,520 kbps

STM-1/VC-3 ATM mapping

Bit rate	155,520 kbps

Add ATM SONET — BN 3060/90.53

The ATM mapping options provide further frame structures for interfaces conforming to ANSI T1.105/107. Corresponding physical layer measurement functions are offered by the mapping options for the interfaces. These include error and alarm insertion, error measurement and alarm detection.
The following ATM mappings are included:

STS-1/STS-3 ATM mapping

Bit rate
STS-1 — 51,840 kbps

DS3 (45 Mbps) ATM mapping and STS-1 DS3 ATM mapping

PLCP-based mapping
HEC-based mapping
Bit rate — 44,736 kbps

DS1 (1.5 Mbps) ATM mapping

Bit rate — 1,544 kbps

STM-4c/OC-12c ATM testing — BN 3060/90.91

Only in conjunction with BN 3060/90.50 and BN 3060/91.11 or BN 3035/91.12.
Signal structure (TC sublayer) contiguous concatenation to T1.646, I.432 and af-phy-0046.000
Cell scrambler $X^{43}+1$ (ITU-T) — can be switched off
Test cell channel
Adjustable from — 0 to 149.760 Mbps
Header setting — editor
Load setting in — Mbps, Cells/sec, %
Test cells, pay load pattern
AAL-0, pseudorandom bit sequences (PRBS) — $2^{11}-1$, $2^{15}-1$, $2^{23}-1$
AAL-1, pseudorandom bit sequences (PRBS) — $2^{11}-1$, $2^{15}-1$, $2^{23}-1$
Programmable word length — 16 bits
Test cells for ATM performance analysis
Sequence number — 3 bytes
Timestamp — 4 bytes
Error checking — CRC-16
Load profiles
Equidistant, setting range — 4 to 40,000 cell times +1
Constant bit rate (CBR), setting range — 0.01 to 25%
Variable bit rate (VBR), settings
Peak cell rate — 1 to 25%
Mean cell rate — 1 to 25%
Burst size — 4 to 4,092 cell times
Burst period — 8 to 131,068 cell times
Error insertion
Physical layer like basic ANT-10G instrument
ATM layer, AAL:
- Correctable and non-correctable header errors
- AAL-0, cell payload bit error
- AAL-1, sequence number error
- AAL-1, SAR-PDU bit error
- AAL-1 SNP, CRC error
- AAL-1 SNP, parity error
- Resolution
  Single error, error ratio, n errors in m cells

Alarm generation
Loss of cell delineation — LCD
ATM layer (for any selected cell channel)
OAM F4/F5 fault flow
VP AIS, VP RDI, VP AIS+VC AIS, VC AIS, VC RDI, VP RDI+VC RDI
Background load generator
1 channel can be switched ON/OFF
Residual bandwidth — up to 599.040 Mbps
Header is freely definable
Circuit emulation
Generation of asynchronous channels:
1.544, 2.048, 6.312, 8.448, 34.368, 44.736 kbps,
2.048 kbps with PCM30 frame structure
ATM channel segmentation — AAL-1, ITU-T I.363
Error measurement, anomalies, statistics
Detection of following error types:
- Correctable and non-correctable header errors
- AAL-0, cell payload bit error
- AAL-1, sequence number error
- AAL-1, SAR-PDU bit error
- AAL-1 SNP, CRC error
- AAL-1 SNP, parity error

ATM performance analysis
- Cell error ratio
- Cell loss ratio
- Cell misinsertion rate
- Mean cell transfer delay
- 2-point cell delay variation
  Measured between greatest and smallest value of cell transfer delay
- Cell transfer delay histogram
  Number of classes — 128
  Min. class width — 160 ns
  Max. class width — 335 ms
  Adjustable offset — 0 to 167 ms
  Offset steps — 2.5 ms

Alarm detection, defects (ISM, OoS)
Loss of cell delineation — LCD
ATM layer (for any selected cell channel)
OAM F4/F5 fault flow — VP AIS, VP RDI, VC AIS, VC RDI
Traffic channel analysis
Time chart simultaneously for
- All traffic cells
- Average cell rate of any selected cell channel
- Peak cell rate of any selected cell channel
- Display in — Mbps, Cells/s, %
  Channel utilization histogram
- All assigned cells
- One selected cell channel (user cells)
  Cell distribution in traffic channel
  Classification of one selected cell channel by
- User cells
- F5 OAM flow
- F4 OAM flow
- User cells with CLP = 1

Circuit reassembly
Reassembly — AAL-1, ITU-T I.363
Error measurement on asynchronous channels
1.544, 2.048, 6.312, 8.448, 34.368, 44.736 kbps,
2.048 kbps with PCM30 frame structure

AUTO/Remote

ANT-10G applications in the remote controlled production environment

V.24/RS232 remote control interface	***BN 3035/91.01***
Remote control of instrument functions using SCPI command structure.	
Interface	V.24/RS232

GPIB (PCMCIA) remote control interface	***BN 3035/92.10***
Remote control of instrument functions using SCPI command structure. A GPIB adapter card for the ANT-10G PCMCIA interface is supplied with this option.	
Interface	GPIB

TCP/IP remote control interface	***BN 3035/92.11***
Remote control of instrument functions using SCPI command structure.	
Interface	10/100 Mbps Ethernet

LabWindows driver	***BN 3038/95.99***
Simplifies creation of remote-control programs for automated testing using LabWindows. The drivers can be used with options BN 3035/91.01 and BN 3035/92.10.	

Simplified test automation (figure 24) Computer aided test sequencer (CATS) and test case library

The test sequencer is the ideal tool for rapid, simple adaptation and automatic performance of complete test sequences on the ANT-10G (CATS = computer aided test sequence). This saves time where repetitive tests are required in the production, installation and monitoring of SDH, SONET and ATM network elements. The comprehensive test case library includes solutions for various applications, such as BERTs, alarm sensor tests, jitter, offset and pointer tests and monitoring ATM Quality of Service (QoS) parameters.

Once created, test sequences are started with a single mouse click. A report in ASCII format for documentation purposes is compiled during the measurement. All test cases are predefined and ready to run. They can also be easily customized.

More information is found in the data sheet “Test Automation and Remote Control”.

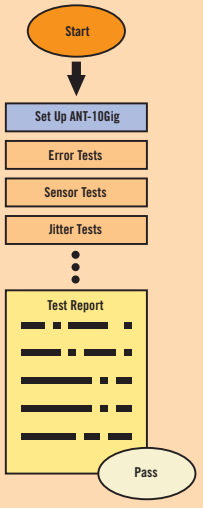


figure 24 Automatic test sequences with the ANT-10G

Remote operation — *BN 3035/95.30*

These options enable operation of the ANT-10G from a Windows® PC. The complete ANT-10G user interface is transferred to the PC screen via modem or LAN link. This means that all the functions of the instrument can be used from any remote location. The results are simply transferred to the controlling PC for further processing. Applications include troubleshooting networks or centralized operation of test instrumentation and devices in the production and system test environment.

Remote operation via the included Ethernet interface and remote operation via modem

Provides remote operation via a PCMCIA or external modem (V.24) which must be purchased separately.

Calibration — *BN 3060/94.01*

Calibration report

Calibration is carried out in accordance with a quality management system certified to ISO 9001. Recommended confirmation interval 24 months
Information via Internet
http://www.ant-20.acterna.com

Ordering information

ANT-10G SDH version

Includes
Mainframe, touchscreen
STM-64/OC-192 combined with STM-4c, STM-16c and STM-64c, STS-12c SPE, STS-48c SPE, STS-192c SPE
Mappings for STM-1: DS1, E1, DS3, E3, E4
Electrical interfaces: STM-1, E1, E3, E4
APS, TCM analysis, OH capture, OH sequencing
Two optical adapters to be selected

1550 nm	BN 3060/35
1310 nm	BN 3060/41
1310/1550 nm	BN 3060/42

Options

Electrical interfaces at 9953 Mbps	
Electrical interfaces at 10 Gbps* for 3060/35	BN 3060/91.48
Electrical interfaces at 10 Gbps* for 3060/41, /42	BN 3060/91.54
Please order with the mainframe as a subsequent upgrade is not possible.	
Add SONET	BN 3060/90.03
STM-0 mappings	
STM-0 and VT2 SPE (2 Mbps)	
STM-0 and VT1.5 SPE g (1.5 Mbps)	
VT6 SPE (6 Mbps)	
STM-0 and STS-1 SPE (34/45 Mbps)	
BERT (1.5/6/45 Mbps)	
Add BERT SONET only	BN 3060/90.34
(interfaces 1.5/6/45 Mbps)	
Drop and Insert	BN 3060/90.10
PDH 64k/140M MUX/DEMUX chain	BN 3060/90.11
M13 MUX/DEMUX chain	BN 3060/90.12

Optical interfaces

Include two optical adapters – please select.
The following options BN 3060/91.01 to /91.12 are alternatives.

Optical STM-0/1, OC-1/3, 1310 nm	BN 3060/91.01
Optical STM-0/1, OC-1/3, 1310 and 1550 nm	BN 3060/91.02
Optical STM-0/1/4, OC-1/3/12, 1310 nm	BN 3060/91.11
Optical STM-0/1/4, OC-1/3/12, 1310 and 1550 nm	BN 3060/91.12

The options BN 3060/91.50 to /91.53 are alternatives.

Optical STM-16/OC-48, 1310 nm	BN 3060/91.51
Optical STM-16/OC-48, 1550 nm	BN 3060/91.50
Optical STM-16/OC-48, 1310/1550 nm	switchable BN 3060/91.52

STM-4c/OC-12c options

STM-4c/OC-12c ATM Testing	BN 3060/90.91
	Requires optical module BN 3060/91.11
	or /91.12 and ATM BASIC BN 3060/90.50
STM-4c/OC-12c virtual concatenation	BN 3060/90.92
	Requires BN 3060/90.90 or /90.91

Optical packages

Include optical interfaces from 52 Mbps to 2488 Mbps and four optical adapters – please select.

Optics STM-0/1/4/16, OC-1/3/12/48, 1310 nm	BN 3060/91.17
Optics STM-0/1/4/16, OC-1/3/12/48, 1550 nm	BN 3060/91.18
Optics STM-0/1/4/16, OC-1/3/12/48, 1310 and 1550 nm	BN 3060/91.19
Optics STM-0/1/4, OC-1/3/12, 1310 nm	
Optics STM-16, OC-48, 1550 nm	BN 3060/91.20
Optical Attenuator (plug-in)	BN 2060/00.61
SC-PC, 1310 nm, 15 dB	
Optical Power Splitter (90%/10%)	***BN 3060/91.05***

– Includes three optical adapters – please select.

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.

O.172 Jitter and Wander

O.172 Jitter/Wander packet up to 155 Mbps	BN 3060/91.30
Includes MTIE/TDEV offline analysis	
Mutually exclusive to STM-16/OC-48 and ATM comprehensive	
O.172 Jitter/Wander packet up to 622 Mbps	BN 3060/91.31
Includes MTIE/TDEV offline analysis	
Mutually exclusive to STM-16/OC-48 and ATM comprehensive	
O.172 Jitter at 9953 Mbps	BN 3060/91.60
O.172 Wander analyzer at 9953 Mbps	BN 3060/91.61
Includes MTIE/TDEV offline analysis	
Requires jitter at 9953 Gbps	BN 3060/91.60
O.172 Wander generator	BN 3060/91.62
Requires jitter at 9953 Gbps	BN 3060/91.60
and either jitter generator at 155 Mbps	BN 3035/90.81 or BN 3060/91.30 or BN 3060/91.31
Mutually exclusive to STM-16/OC-48 and ATM comprehensive	

ATM Functions

ATM basic for STM-1/STS-3c	BN 3060/90.50
ATM comprehensive	BN 3060/90.51
Includes ATM basic and BAG	
Add ATM SONET	BN 3060/90.53
Requires ATM module BN 3060/90.50 or BN 3060/90.51	
STS-1 (51 Mbps) ATM mapping	
DS3 (45 Mbps) ATM mapping	
DS1 (1.5 Mbps) ATM mapping	
Add ATM SDH	BN 3060/90.52
Requires ATM module BN 3060/90.50 or BN 3060/90.51	
E4 (140 Mbps) ATM mapping	
E3 (34 Mbps) ATM mapping	
E1 (2 Mbps) ATM mapping	
VC-12 ATM mapping in STM-1 (AU-3/AU-4)	
VC-3 ATM mapping in STM-1 (AU-3/AU-4)	
OC-12c/STM-4c ATM Testing	BN 3060/90.91
Requires optical module BN 3060/91.11 or /91.12	

Test automation

Test sequencer CATS BASIC	BN 3035/95.90
Test sequencer CATS PROFESSIONAL	BN 3035/95.95

Remote control interfaces

V.24/RS232 remote control interface	BN 3035/91.01
GPIB remote control interface	BN 3035/92.10
TCP/IP remote control interface	BN 3035/92.11
LabWindows CVI driver	BN 3038/95.99
Remote operation	BN 3035/95.30

Accessories

Transport case for ANT-10G	BN 3035/92.03
External keyboard (UK/US)	BN 3035/92.04
Decoupler (–20 dB, 1.6/5.6 jack plug)	BN 3903/63
TKD-1 probe, 48 to 8500 kbps	BN 822/01
TSR-37 rubidium timing source reference	DA 3700/00
Calibration report	BN 3060/94.01

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

Training courses

Location: 72800 Eningen u.A., Germany
Information about availability and other locations available on request.

“SDH/SONET troubleshooting”	BN 3035/89.01
“Synchronization”	BN 3035/89.02
“Solving Jitter Problems”	BN 3035/89.03
“SDH/SONET Quality of Service”	BN 3035/89.04
“Optimizing Your SDH/SONET Network”	BN 3035/89.05

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.

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Note: Specifications, terms and conditions are subject to change without notice.

ANT10GSDH/DS/OPT/04-02/AE/ACT00093