SUNRISE TELECOM

STT® ONE

OTN and Next-Generation SDH/SONET Testing

Data Sheet

The STT ONE is part of a family of test modules for the STT Platform

The STT Optical Network Expert (ONE) is a powerful and versatile test module for the Scalable Test Toolkit (STT) for testing emerging technologies such as OTN (ITU-T G.709) and Next-Generation SDH/SONET, as well as traditional SDH/SONET, offering service providers a complete solution for today's metro and core networks. By integrating OTN and EoS (VCAT, GFP, and LCAS) testing into a single, compact unit, the STT ONE module is extremely cost effective because it eliminates the need for multiple instruments.

FEATURES

- OTN, EoS, SDH, SONET in one instrument
- Dual wavelength optical transmitters up to 2.66 Gbps
- Advanced differential delay measurement, generation, and payload reassembly
- Fully independent or can be combined with other test modules to enhance application
- Ethernet traffic generation over SDH/SONET without extra equipment
- Auto-configuration and tributary scan

BENEFITS

- All-in-one test solution
- Single, compact unit
- Extremely cost-effective
- Eliminates the need for multiple instruments
- Intuitive user-friendly GUI

TEST FEATURES

The STT ONE allows the user to perform routine and advanced testing on transport and access networks, legacy and next generation networks with a single test set. Its price to performance ratio makes this product ideal.

Optical Transport Network (OTN)

STT ONE provides Forward Error Correction (FEC), verifies conformance to ITU-T G.709 and a wide range of network performance standards, including end-to-end connectivity at OTU1 (2.66 Gbps) and OTU2 (10.7 Gbps) bit rates, and complete asynchronous/synchronous mapping of SDH/SONET client signals.

- Conforms to ITU-T G.709
- OTU1 (2.66 Gbps) and OTU2 (10.7 Gbps) interfaces
- Synchronous and Asynchronous mapping of SDH
- OTN/SDH, OTN/SONET muxtest
- Error performance analysis per ITU-T G.8201 and M.2401
- OTU, ODU, OPU error injection & alarm generation
- OTU, ODU, and OPU bytes control and decode

Next-Generation SDH/SONET

With the growth of IP services and the increasing need to leverage existing SDH/SONET networks, service providers must routinely monitor and test NGN to ensure packet-based traffic is properly delivered across the network. STT ONE offers a complete solution for NGN.

In additon, high and low order virtual concatenation capabilities help verify end-to-end connectivity. Its differential delay detection and generation functions help measure the delay in the existing network and stress the far end payload assembly circuitry by inserting a delay on each member.

Virtual Concatenation (VCAT)

- Conforms to ITU-T G.707, Telcordia GR-253 & ANSI T1.105-2001
- SDH/SONET error performance analysis per ITU-T G.821, G.828, G.829, M.2101, M.2110, M.2120, and Telcordia GR-253
- Virtual Concatenation Testing, VC-4-X-v, VC-3-X-v, VC-12-X-v, VC-11-X-v / STS-3-X-v, STS-1-X-v, VT1.5-X-v, VT2-X-v
- Differential delay generation, measurement, and payload reassembly up to 256 ms
- Path overhead bytes control and decode on each member
- Error injection/alarm generation on each member

Generic Framing Procedure (GFP)
- Conforms to ITU-T G.7041 and ANSI T1.105-2001
- GFP-F support
- GFP header control, error injection, and error detection

Ethernet over SDH/SONET (EoS)
- Ethernet frames generation via GFP-F
- Layer 2, Layer 3 testing including VLAN and MPLS tags
- Ethernet statistics

Link Capacity Adjustment Scheme (LCAS)
- Conforms to ITU-T G.7042 and ANSI T1.105-2001
- LCAS protocol emulation
- Emulation of Source and Sink state machines (per member)
- Generation and capture of member status information

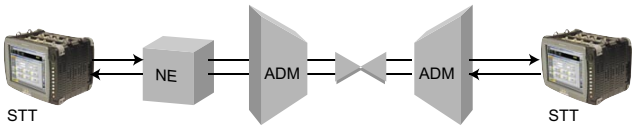
Traditional SDH/SONET
- 52 Mbps to 2.5 Gbps testing
- Mapping/demapping of contiguously concatenated payloads
- SDH/SONET errors/alarms detection and generation
- SDH/SONET overhead control and decode
- Pointer monitoring and adjustment
- APS timing measurement

APPLICATIONS

STT ONE allows the user to perform testing on transport and access networks, legacy and next generation networks with a single product.

Out-of-Service Testing

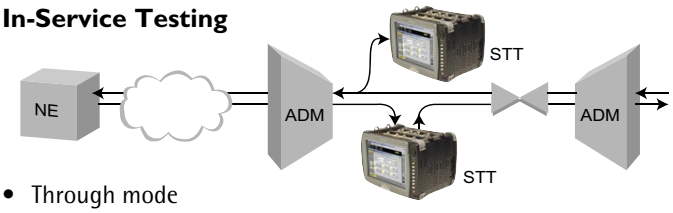
OTN/SDH/SONET



- End-to-end error free transmission verification
- Bringing into service measurements and error performance analysis conforming to ITU-T and Telcordia standards
- SDH/SONET network routing verification

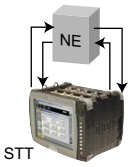
EoS (VCAT, GFP, and LCAS)
- End-to-end Ethernet over SDH/SONET tests
- Verification of path connectivity
- Stressing far end payload assembly structure by generating additional differential delay to each VCG member

In-Service Testing



- Through mode
- In-service monitoring through protected monitoring points or optical splitters
- Overhead bytes monitoring and decoding
- Pointer monitoring
- LCAS protocol monitoring
- VCAT and LCAS interaction monitoring

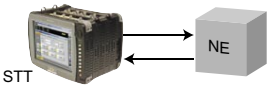
Mux Test



OTN
- OTN/SDH, OTN/SONET Mux/demux testing
- Asynchronous/synchronous mapping/demapping of SDH/SONET client signals into OTU1/2

EoS
- Verification of proper mapping of Ethernet frames into GFP cells
- Testing GFP behavior
- Compatible with STT Ethernet module or SunSet MTT with -28 or -29 module

Network Element Verification



OTN/SDH/SONET
- Error injection, alarm generation to verify NE remote indication
- FEC error generation to verify NE Forward Error Correction capabilities
- Frequency offset to stress clock recovery of NE
- SDH/SONET Pointer Test Sequences generation to test NE response to problems with sync

VCAT/GFP/LCAS
- VCAT bandwidth availability verification
- VCAT differential delay generation to stress NE payload assembly circuitry
- LCAS state machines generation to verify NE response by increasing or decreasing bandwidth

ABOUT STT PLATFORM

The Scalable Test Toolkit is an advanced, modular, and flexible testing solution that addresses Layer 1 through Layer 7 requirements, from fiber optics to Quality of Service. Designed to meet the challenges of designing, installing, maintaining, and troubleshooting core, metro, and access networks, the STT combines an innovative test platform with revolutionary test features, supporting a complete suite of capabilities and technologies for the converging global communications market.

All STT modules are equipped with a unique standalone feature and can operate at 100% of their capabilities outside of the platform, maximizing test resources.

- STT NAM. Traditional transport testing from 1.5 Mbps to 10 Gbps. Advanced features include tributary scan, pointer test sequences, APS/service disruption, VF, Pulse mask analysis, and DSn Jitter measurements.
- STT FAM. Fiber physical layer testing. OTDR, optical power meter, laser source, ORL, and visual fault locator.
- STT DTM. Measures Polarization Mode Dispersion (PMD) and Chromatic Dispersion (CD).
- STT xWDM. OSA for the O, E, S, C and L bands. Channel drop and tunable laser for the C and L bands.
- STT Ethernet. Ethernet testing for Layers 1, 2, and 3, from 10 Mbps to 10 GigE LAN/WAN and Fibre Channel. Advanced test features include MPLS, VLAN stacking, and packet capture and decode up to Layer 7.
- STT MSA. Advanced protocol and service analysis, simulation, and troubleshooting of PSTN, VoIP, and 3G wireless.

SPECIFICATIONS

TEST INTERFACES

OTN

10.7G Optical (OTU-2)

Port/Connector
- Universal interface with FC/SC (STT-6953)
- SCAPC 9 degrees (STT-6955-SC9DEG)

Mode: Single
Line coding: NRZ
Complies to ITU-T G.709 and ITU-T G.959.1

Transmitter

Clock source
- Internal
  - Bit rate: 10.709225 Gbps ± 4.5 ppm
  - Frequency offset: ± 50 ppm with 1, 0.1, 0.01, or 0.001 ppm resolution
- Receive: Recovered from received signal
- External: Synchronization to external 2.048 Mbps or 2.048 MHz (SDH), 1.544 Mbps or 1.544 MHz (SONET)

Output power range
- 1310 nm/1550 nm Short Reach: -4 to -1 dBm
- 1550 nm Intermediate Reach: -1 to +2 dBm
- 1550 nm Long Reach: 0 to +2 dBm
- Laser Safety: IEC825-1, Class 1, 21 CFR 1040.10 and 1040.11

Receiver

Frequency recovery range: 10.709225 Gbps ± 50 ppm (OTN OTU-2)
Complies to ITU-T G.709 and ITU-T G.959.1
Wavelength: 1290 to 1600 nm
Input power range
- 1310 nm Short Reach, PIN detector: -15 to 0 dBm
- 1550 nm Short Reach, PIN detector: -15 to 0 dBm
- 1550 nm Intermediate/Long Reach, APD detector: -23 to -5 dBm

Maximum input power: +7 dBm

2.66G Optical (OTU-1)

Port/Connector
- Universal interface with FC/SC (STT-6953)
- SCAPC 9 degrees (STT-6955-SC9DEG)

Mode: Single
Line coding: NRZ
Complies to ITU-T G.709 and ITU-T G.959.1

Transmitter

Clock source
- Internal
  - Bit rate: 2.666057 Gbps ± 4.5 ppm
  - Frequency offset: ± 50 ppm with 1, 0.1, 0.01, or 0.001 ppm resolution
- Receive: Recovered from received signal
- External: Synchronization to external 2.048 Mbps or 2.048 MHz (SDH), 1.544 Mbps or 1.544 MHz (SONET)

Output power range
- 1310 nm Short Reach: -10 to -3 dBm
- 1310 nm/1550 nm Long Reach: -2 to +3 dBm
- Laser Safety: IEC825-1, Class 1, 21 CFR 1040.10 and 1040.11

Receiver

Frequency recovery range: 2.666057 Gbps ± 50 ppm
Complies to ITU-T G.709 and ITU-T G.959.1
Wavelength: 1280 to 1580 nm
Range: -27 to -9 dBm
Maximum input power: -4 dBm

Clock Output

Connector: 50Ω SMA
Signal: 1v peak to peak
Frequency
- 10.7G: 669.324 MHz
- 2.66G: 166.628 MHz

SDH/SONET

10G Optical (STM-64/OC-192)

Port/Connector
- Universal interface with FC/SC (STT-6953)
- SCAPC 9 degrees (STT-6955-SC9DEG)

Mode: Single and multi-mode compatible
Line coding: NRZ
Complies to ITU-T G.691 (SDH) and Telcordia GR-253 (SONET)

Transmitter

Clock source
- Internal
  - Bit rate: 9.95328 Gbps ± 4.5 ppm
  - Frequency offset: ± 50 ppm with 1, 0.1, 0.01, or 0.001 ppm resolution
- Receive: Recovered from received signal
- External: Synchronization to external 2.048 Mbps or 2.048 MHz (SDH), 1.544 Mbps or 1.544 MHz (SONET), 64k + 8k codirectional

Output power range
- 1310 nm/1550 nm Short Reach: -4 to -1 dBm
- 1550 nm Intermediate Reach: -1 to +2 dBm
- 1550 nm Long Reach: 0 to +2 dBm
- Laser Safety: IEC825-1, Class 1, 21 CFR 1040.10 and 1040.11

Receiver

Frequency recovery range: 9.95328 Gbps ± 50 ppm
Complies to ITU-T G.691 and Telcordia GR-253
Wavelength: 1290 to 1600 nm
Input power range
- 1310 nm/1550 nm Short Reach, PIN detector: -15 to 0 dBm
- 1550 nm Intermediate/Long Reach, APD detector: -23 to -5 dBm

Maximum input power: +7 dBm

52/155/622M/2.5G Optical (STM-0/1/4/16 / OC-1/3/12/48)

Port/Connector
- Universal interface with FC/SC (STT-6953)
- SCAPC 9 degrees (STT-6955-SC9DEG)

Mode: Single and multi-mode compatible
Line coding: NRZ
Complies to ITU-T G.957 and Telcordia GR-253

Transmitter

Clock source
- Internal
  - Bit rates
    - 2.48832 Gbps ± 4.5 ppm
    - 622.080 Mbps ± 4.5 ppm
    - 155.520 Mbps ± 4.5 ppm
    - 51.840 Mbps ± 4.5 ppm
  - Frequency offset: ± 50 ppm with 1, 0.1, 0.01, or 0.001 ppm resolution
- Receive: Recovered from received signal
- External: Synchronization to external 2.048 Mbps or 2.048 MHz (SDH), 1.544 Mbps or 1.544 MHz (SONET), 64k + 8k codirectional

Output power range
- 1310 nm Short Reach: -10 to -3 dBm
- 1310 nm Long Reach: -2 to +3 dBm
- 1550 nm Long Reach: -2 to +3 dBm
- Laser Safety: IEC825-1, Class 1, 21 CFR 1040.10 and 1040.11

Receiver

Frequency recovery range
- 2.48832 Gbps ± 50 ppm
- 622.080 Mbps ± 50 ppm
- 155.520 Mbps ± 50 ppm
- 51.840 Mbps ± 50 ppm

Wavelength: 1280 to 1580 nm
Range: -27 to -9 dBm
Maximum input power: -4 dBm

155M Electrical (STM-1/STS-3)

Port/Connector: 75Ω unbalanced BNC (f)
Line coding: CMI
Complies to ITU-T G.707 & Telcordia GR-253 (September 2000 issue)

Transmitter

Clock source
- Internal
  - Bit rate: 155.520 Mbps ± 4.5 ppm
  - Frequency offset: ± 50 ppm with 1, 0.1, 0.01, or 0.001 ppm resolution
- Receive: Recovered from received signal
- External: Synchronization to external 2.048 Mbps or 2.048 MHz (SDH), 1.544 Mbps or 1.544 MHz (SONET), 64k + 8k codirectional

Pulse shape: Conforms to ITU-T G.703
Framing: Conforms to GR-253 and ITU-T G.707

Receiver

Frequency recovery range: 155.520 Mbps ± 50 ppm
Input sensitivity
- Terminate: 12.7 dB cable loss
- Monitor: 0 to -12.7 dB (20 dB resistive loss plus 12.7 dB cable loss)

Jitter tolerance: Conforms to ITU-T G.825

52M Electrical (STM-0/STS-1)

Port/Connector: 75Ω unbalanced BNC (f)
Line coding: B3ZS
Complies to Telcordia GR-253 (September 2000 issue) & ITU-T G.703

Transmitter

Clock source
- Internal
  - Bit rate: 51.840 Mbps ± 4.5 ppm
  - Frequency offset: ± 50 ppm in with 1, 0.1, 0.01, or 0.001 ppm resolution
- Receive: Recovered from received signal
- External: Synchronization to external 2.048 Mbps or 2.048 MHz (SDH), 1.544 Mbps or 1.544 MHz (SONET), 64k + 8k codirectional

Pulse shape: Conforms to GR-253 and ITU-R F.750-3
Framing: Conforms to GR-253 and ITU-T G.707

Receiver

Frequency recovery range: 51.840 Mbps ± 50 ppm
Input sensitivity: -26 dB from STX-1 (-20 dB plus 6 dB cable loss)
Jitter tolerance: Conforms to ITU-T G.825

Clock Output

Connector: 50Ω SMA
Signal: 1v peak to peak
Frequency
- 10G: 622.080 MHz
- 2.5G, 622M: 155.520 MHz
- 155M/52M: 19.44 MHz

TEST FEATURES

Application Modes

Standards

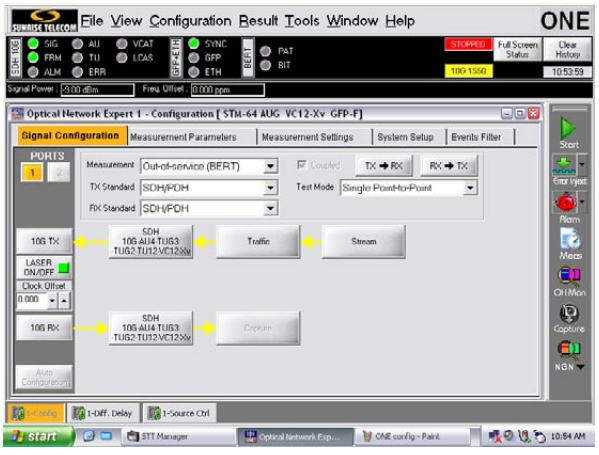
OTN, NGN SDH/SONET, Legacy SDH/PDH or SONET/T-Carrier

Measurement Modes

Out-of-service (BERT) or In-service (Live)

Tx & Rx

Coupled: Tx & Rx are coupled together & have the same configuration
Independent: Tx & Rx may be configured independently



Test Modes

Single Point-to-Point
Tx and Rx are set to the same rate

Through Mode Operation (all interface rates)
Line through
- Passes entire signal through with no manipulation of overhead or injection of errors or alarms
- Overhead can be monitored; alarms and errors measured

Payload through
- Passes payload through
- Passes path overhead through
- SOH errors/alarms insertion/generation possible
- SOH overhead control possible (except pointers)

OTN Mux Test
The test pattern is generated on SDH/SONET or OTN Tx, and the BERT is measured on the OTN or SDH/SONET Rx.

OTN

Frame/Payloads
Frame and mapping structure conforms to ITU-T G.709
Synchronous and asynchronous mapping of SDH/SONET payloads and PRBS test signals

Test Patterns
PRBS: 2^{31}-1, 2^{23}-1, 2^{20}-1, 2^{15}-1
Fixed: All 1s, All 0s, Alt 1010, 1-4
User: 10 programmable 16-bit user patterns. Pattern names up to 10 characters.
Test pattern inversion

Error Injection
OTU-1/2: FAS (OA1, OA2), MFAS, SM-BIP-8, SM-BEI, correctable FEC errors, uncorrectable FEC errors
ODU-1/2: PM-BIP-8, PM-BEI
TCM1-6: BIP-8, BEI
Burst: 1 to 9999
Rate: $1x10^{-9}$ to $2x10^{-3}$ (depending on configuration)

Alarm Generation
LOS
OTU-1/2: LOF, OOF, OOM, AIS, SM-TIM, SM-IAE, SM-BDI
ODU-1/2: AIS, OCI, LCK, PM-TIM, PM-BDI
OPU-1/2: PLM
TCM1-6: OCI, AIS, LCK, TIM, BDI, IAE, LTC

Measurements
Errors
- OTU-1/2: FAS (OA1, OA2), MFAS, SM-BIP-8, SM-BEI, correctable FEC errors, uncorrectable FEC errors
- ODU-1/2: PM-BIP-8, PM-BEI
- TCM1-6: BIP-8, BEI
- Payload Bit Errors

Alarms
- LOS
- OTU-1/2: LOF, OOF, OOM, AIS, SM-TIM, SM-IAE, SM-BDI
- ODU-1/2: AIS, OCI, LCK, BDI, PM-TIM, PM-BDI
- OPU: PLM
- TCM1-6: OCI, AIS, LCK, TIM, BDI, IAE, LTC

Error performance analysis: ITU-T G.8201, M.2401

Overhead Features
Overhead Monitor
- Hex display of all bytes (OTU, ODU, and OPU)
- Text decode of all applicable bytes
  - TTI [SM (OTU), PM (ODU), TCM1-6], FTFL, APS/PCC, PSI
  - Conforms to ITU-T G.709

Overhead Programming
- Hex input for all bytes except framing (FAS and MFAS), parity (BIP8, BEI) and justification (JC)
- Trail Trace Identifier (TTI) Generation
  - SM (OTU), PM (ODU), TCM1-6: SAPI/DAPI 16 bytes E.164 ASCII sequence
  - Operation bytes: 32 bytes HEX or E.164 ASCII sequence
- Automatic Protection Switching (APS)/Protection Communcation Channel (PCC) bytes control & decode per ITU-T G.709 and G.873
- Fault Type Fault Locator (FTFL) control and decode. Forward and backward field structure per ITU-T G.709
- Payload Structure Identifier
  - Payload type generation/decode: Hex mode or text mode
  - Conforms to ITU-T G.709, PT decode requires locking to MF #1

Overhead Sequence Generation
- Bytes: TTI (SM, PM, TCM1-6) (1 to 64 bytes), GC0 (2 bytes), GCC1 (2 bytes), GCC2 (2 bytes), APS/PCC (4 bytes), or any single overhead byte
- Generates up to 256 elements, where each element (value) can be transmitted in up to 65536 consecutive frames

Overhead Sequence Capture
- OA1/OA2 (6 bytes), TTI (SM, PM, TCM1-6) (1 to 64 bytes), GC0 (2 bytes), GCC1 (2 bytes), GCC2 (2 bytes), APS/PCC (4 bytes), or any single overhead byte
- Captures up to 4096 elements, where each element (value) can be detected in up to 65536 consecutive frames

GCC0, GCC1, or GCC2 Drop and Insert
GCC0, GCC1, or GCC2 BER Testing

SDH

Payloads
VC4-64c Bulk, VC4-16c Bulk, VC4-4c Bulk, VC4 Bulk, VC3 Bulk, VC12 Bulk, VC11 Bulk

Test Patterns
PRBS: 2^{31}-1 (2.5/10G), 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1, 2^{9}-1
Fixed: All 1s, All 0s, Alt 1010, 1-4
User: 10 programmable 16-bit user patterns. Pattern names up to 10 characters.
Test pattern inversion

Error Injection
Code (52Me, 155Me), Bit, FAS (except at 10 Gbps), B1, B2, B3, LP-BIP, MS-REI, HP-REI, LP-REI
Burst: 1 to 8000
Rate: $1x10^{-9}$ to $2x10^{-3}$ (depending on configuration)

Alarm Generation
RS: LOS, LOF, RS-TIM
AU: AU-LOP, AU-AIS
MS: MS-AIS, MS-RDI
HP: HP-AIS, HP-UNEQ, HP-TIM, HP-RDI, HP-ERDI (Payload, Server, Connectivity)
TU: TU-LOP, TU-AIS, TU-LOM
LP: LP-UNEQ, LP-TIM, LP-RDI, LP-ERDI (Payload, Server, Connectivity)

Measurements
Errors: Bit, B1, B2, B3, BIP-2, MS REI, HP/LP REI
Alarms: LOS, LOF, OOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-AIS, HP-PLM, HP-ERDI (Payload, Server, Connectivity), HP-TIM, HP-UNEQ, TU-LOM, TU AIS, TU-LOP, LP-PLM, LP-ERDI (Payload, Server, Connectivity), LP-TIM, LP-UNEQ
Error performance analysis: ITU-T G.821, G.826, G.828, G.829, M.2101, M.2110, M.2120

Overhead Features
Overhead Monitor
- Hex display of all bytes (RS, MS, HP, and LP)
- Text decode of all applicable bytes (K1/K2, S1, C2, etc.)

Overhead Programming
- Hex input for all bytes except parity (B1/B2/B3), pointers (H1-H3, V1-V3), and undefined bytes
- Text encoding of all applicable bytes (K1/K2, S1, C2, etc.)

Trace Generation
- J0 Section trace: 1 byte, 16 bytes E.164 ASCII sequence + CRC-7 or 64 bytes E.164 ASCII sequence
- J1/J2 Path trace: 16 bytes E.164 ASCII sequence + CRC-7 or 64 bytes E.164 ASCII sequence
- Selection: Default, user, or through

Pointer Monitor
- AU (bytes H1 and H2), TU (bytes V1 and V2)
- Instantaneous pointer value display
- Loss of pointer seconds
- Total justification counts
- Positive justification counts
- Negative justification counts
- NDF seconds

Pointer Adjustment
- Programming of AU and TU pointer value, New Data Flag (NDF), and SS bits
- Pointer increase or decrease

Overhead Sequence Generation
- Bytes: A1/A2 (6 bytes), J0/J1/J2 (1, 16, and 64 bytes), D1-D3 (3 bytes), D4-D12 (9 bytes), K1/K2 (2 bytes), or any single overhead byte
- Generates up to 16 elements, where each element (value) can be transmitted in up to 65536 consecutive frames

Overhead Sequence Capture
- Capture: A1/A2 (6 bytes), J0/J1/J2 (1, 16, and 64 bytes), D1-D3 (3 bytes), D4-D12 (9 bytes), K1/K2 (2 bytes), or any single overhead byte
- Each new value is captured with a timestamp (absolute or elapsed) and duration (in ms or frames)
- Trigger: Manual or user-defined value
- Resolution: 125 ms (1 frame)
- Captures up to 4096 elements, where each element (value) can be detected in up to 65536 consecutive frames

Data Communications Channel (DCC)
- DCC BER testing: PRBS on D1-D3 or D4-D12 bytes (user-selectable) with G.821 analysis
- DCC Drop/Insert

Pointer Test Sequences
Specifications: ITU-T G.783
Sequences: Single, burst, phase transient burst, periodic, 87-3, 26-1, opposite, and custom
Movement: Increase, decrease, increase + decrease
Anomalies: Added, cancel, and none
Frequency offset: Positive, negative, and none
Sequence timing: Initialization, cool down, and measurement

Automatic Protection Switch Time Measurement
Resolution: 125 microseconds (1 frame)
Sensors: LOS, LOF, MS-AIS, MS-RDI, MS-REI, AU-AIS, HP-RDI, HP-REI, LP-RDI, LP-BIP, LP-REI, TU-AIS, B1, B2, B3
1 ms resolution with Pass/Fail indication
Programmable switch time and gate time

SONET

Payloads
STS-192c SPE, STS-48c SPE, STS-12c SPE, STS-3c SPE, STS-1 SPE, VT2, VT1.5

Test Patterns
Applies to payloads of STS-1 SPE and above (concatenated rates)
PRBS: 2^{31}-1 (2.5/10G), 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1, 2^{9}-1
Fixed: All 1s, All 0s, Alt 1010, 1-4
User: 10 programmable 16-bit user patterns. Pattern names up to 10 characters.
Test pattern inversion

Error Injection
Code (STS-1e, STS-3e), Bit, Frame (except at 10 Gbps), B1 (CV-S), B2 (CV-L), B3 (CV-P), BIP-V, REI-L, REI-P, REI-V
Burst: 1 to 8000
Rate: $1x10^{-9}$ to $2x10^{-3}$ (depending on configuration)

Alarm Generation
Section: LOS, LOF, TIM-S
Line: AIS-L, RDI-L
Path: LOP-P, AIS-P, UNEQ-P, TIM-P, RDI-P, ERDI-P
VT-Path: LOP-V, AIS-V, UNEQ-V, TIM-V, RDI-V, ERDI-V

Measurements
Errors: B1 (CV-S), B2 (CV-L), B3 (CV-P), BIP-V (CV-V), REI-V, REI-L, REI-P
Alarms
- LOS, LOF, TIM-S/P/V, AIS-L/P/V, RDI-L/P/V, ERDI-P/V, LOP-P/V, PLM-P/V, UNEQ-P/V, TIM-P (optional)
- Failure indications for all alarms

Error performance analysis: Telcordia GR-253-CORE
- Section: SEFS-S, CV-S (B1), ES-S, SES-S
- Line Near End: CV-L (B2), ES-L, SES-L, UAS-L, FC-L
- Line Far End: CV-LFE (REI-L), ES-LFE, SES-LFE, UAS-LFE, FC-LFE
- Path Near End: CV-P (B3), ES-P, SES-P, UAS-P, FC-P
- Path Far End: CV-PFE (REI-P), ES-PFE, SES-PFE, UAS-PFE, FC-PFE
- VT Path Near End: CV-V (BIP-2), ES-V, SES-V, UAS-V, FC-V
- VT Path Far End: CV-VFE (REI-V), ES-VFE, SES-VFE, UAS-VFE, FC-VFE
- Pointers: PPJC-P/VDet, NPJC-P/VDet, PPJC-P/VGen, NPJC-P/VGen, PJCDiff-P/V, PJCS-P/VDet, PJCS-P/VGen, plus Pointer Value and NDF-P/V counter

Overhead Features

Overhead Monitor
- Hex display of all bytes (Section, Line, Path, and VT Path)
- Text decode of all applicable bytes (K1/K2, S1, C2, etc.)

Overhead Programming
- Hex input for all bytes except parity (B1/B2/B3), pointers (H1-H3, V1-V3), and undefined bytes
- Text encoding of all applicable bytes (K1/K2, S1, C2, etc.)

Trace Generation
- J0 Section trace: 1 byte, 16 bytes E.164 ASCII sequence + CRC-7 or 64 bytes E.164 ASCII sequence
- J1/J2 Path trace: 16 bytes E.164 ASCII sequence + CRC-7 or 64 bytes E.164 ASCII sequence
- Selection: Default, user, or through

Pointer Monitor
- STS (bytes H1 and H2), VT (bytes V1 and V2)
- Instantaneous pointer value display
- Loss of pointer seconds
- Total justification counts
- Positive justification counts
- Negative justification counts
- NDF seconds

Pointer Adjustment
- Programming of STS and VT pointer value, New Data Flag (NDF), and SS bits
- Pointer increase or decrease

Overhead Sequence Generation
- Bytes: A1/A2 (6 bytes), J0/J1/J2 (1, 16 and 64 bytes), D1-D3 (3 bytes), D4-D12 (9 bytes), K1/K2 (2 bytes), or any single overhead byte
- Generates up to 16 elements, where each element (value) can be transmitted in up to 65536 consecutive frames

Overhead Sequence Capture
- Capture: A1/A2 (6 bytes), J0/J1/J2 (1, 16, and 64 bytes), D1-D3 (3 bytes), D4-D12 (9 bytes), K1/K2 (2 bytes), or any single overhead byte
- Each new value is captured with a timestamp (absolute or elapsed) and duration (in ms or frames)
- Trigger: Manual or user-defined value
- Resolution: 125 ms (1 frame)
- Captures up to 4096 elements, where each element (value) can be detected in up to 65536 consecutive frames

Data Communications Channel (DCC)
- DCC BER testing: PRBS on D1-D3 or D4-D12 bytes (user-selectable) with bit error performance analysis
- DCC Drop/Insert

Pointer Test Sequences

Specifications: ANSI T1.105.03, Telcordia GR-253
Sequences: Single, burst, phase transient burst, periodic, 87-3, 26-1, opposite, and custom
Movement: Increase, decrease, increase + decrease
Anomalies: Added, cancel, and none
Frequency offset: Positive, negative, and none
Sequence timing: Initialization, cool down, and measurement

Automatic Protection Switch Time Measurement

Resolution: 125 microseconds (1 frame)
Sensors: LOS, LOF, AIS-L, AIS-V, RDI-L, AIS-P, REI-L, RDI-P, RDI-V, REI-P, REI-V, BIP-V, B1, B2, B3
1 ms resolution with Pass/Fail indication
Programmable switch time and gate time

Common to OTN, SDH/SONET

Measurements

Optical power level measurement
- Accuracy: ± 1 dBm
- Wavelength: 1310 nm or 1550 nm
- Optical saturation indication

Frequency measurements: Current frequency, max frequency, min frequency
Clock slip measurements: Clock slips, frame slips, positive wander, negative wander, plus moving bar graph of slip count when reference clock set to External
Histogram analysis
- Errors/Alarms/Pointer graphic display in real-time
- Stores current results with 1-second resolution for the last 60 minutes, 1-minute resolution for the last 72 hrs, and 15-minute resolution for the last 60 days
- Compare two parameters to visually detect correlation

Propagation delay
Service disruption measurement
Measurement setting
- Continuous measurement
- Programmable start time and duration
- Elapsed time, remaining time display

Measurement result management
- Save As: Save measurement results to the hard drive (or other removable media)
- Open: Open a previously saved measurement result
- Print: Print a measurement result report
- Export: Export a measurement result report file with comma separated values (which can be read by either a text editor, word processor, or spreadsheet program) or external markup language format (which can be converted into pdf)

Next-Generation SDH/SONET (STT-6200)

Virtual Concatenation (VCAT)

SDH Virtual Concatenation per ITU-T G.707

High Order Paths: VC-4-X-v, X=1 to 16, VC-3-X-v, X=1 to 48
Low Order Paths: VC-11-X-v, VC-12-X-v, X=1 to 64 (from 12 different AU3 or 4 different AU4)

SONET Virtual Concatenation per ANSI T1.105-2001

High Order Paths: STS-1-X-v, X=1 to 48, STS-3-X-v, X=1 to 16
Virtual Tributary Paths: VT1.5-X-v, VT-2-X-v, X=1 to 64 (from 12 different STS-1s or 4 different STS-3s)

Measurements/Generation

Differential Delay Measurement & Generation (per group member)
- Individual and group wide measurement
- Measurement and generation range: 256 ms
- VCAT reassembly range: Up to 256 ms

Errors (per group member)
- SDH: Bit, B3, HP-REI, LP-BIP, LP-REI
- SONET: Bit, B3 (CV-P), BIP-V, REI-P, REI-V

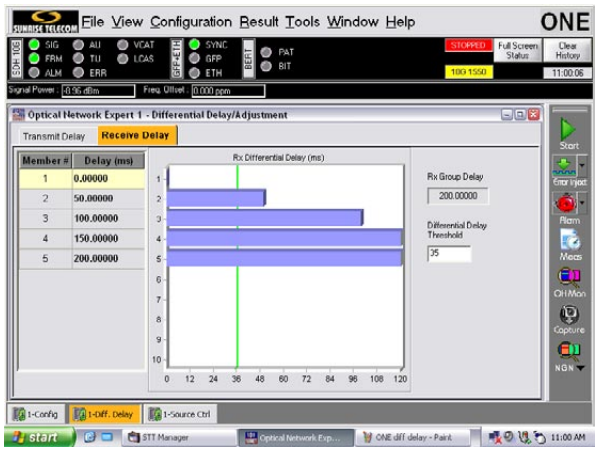
Alarms (per group member)
- SDH: AU-AIS, AU-LOP, HP-AIS, HP-RDI, HP-ERDI (Payload, Server, Connectivity), HP-UNEQ, HP-TIM, TU-LOM, TU-AIS, TU-LOP, LP-RDI, LP-ERDI (Payload, Server, Connectivity), LP-UNEQ, LP-TIM
- SONET: TIM-P/V, AIS-P/V, RDI-P/V, ERDI-P/V (Payload, Server, Connectivity), LOP-P/V, UNEQ-P/V, H4 LOM

Error performance analysis (per group member)
- SDH: Per ITU-T G.821, G.826, G.828, M.2101, M.2120
- SONET: Per Telcordia GR-253

Generic Framing Procedure (GFP)

Per ITU-T G.7041, G.707, and ANSI T1.105.02-2001
Traffic generation; Ethernet frames
- Frame size: Up to 65539 bytes

Bandwidth dependent on Virtual Concatenation
GFP Payload type header control: PTI, PFI, EXI (linear and null), CID (linear only), and UPI
GFP-F (Frame) frames generation
- Measurements: Idle frames, Total frames, Total octets, Client frames, Client frames with FCS, Client management frames, Extension header OK frames, Type header OK frames, Null extension frames, Linear frames, Ring frames, Ethernet mapped frames
- Errors (GFP-F): Correctable cHEC errors, uncorrectable cHEC errors, correctable tHEC, uncorrectable tHEC, correctable eHEC, uncorrectable eHEC, payload FCS, invalid payload
- Alarms: GFP Synchronization failure



Link Capacity Adjustment Scheme (LCAS)

Per ITU-T G.7042, G.707, and ANSI T1.105.02-2001
LCAS mode: Enable, disable
H4, K4/Z7 monitoring: Control packets

LCAS Protocol Emulation

Emulation of Source and Sink state machines (per group member)
- Direct commands
  - Source: Add/Remove member, Add/Remove members
  - Sink: Add/Remove member, Add/Remove members
- Overwrite received member status (source): OK, FAIL, AUTO
- Overwrite generated member status (sink): FAIL, AUTO
- Force resequence acknowledge: RX RS-Ack (source), TX RS-Ack (sink)
- Force member status alarm (sink): MSU

Generation and Capture of Member Status Information

Transmitted (source) and received (sink) sequence numbers
Received (source) and transmitted (sink) resequence acknowledge
Source machine state decode: IDLE, ADD, NORM, DNU (Do Not Use), REMOVE
Sink machine state decode: IDLE, FAIL, OK
Source transmitted control word: ADD, NORM, EOS, IDLE, DNU
Sink received control word: ADD, NORM (normal transmission), EOS (End of Sequence indication and normal transmission), IDLE, DNU, FIXED (non-LCAS mode)
Sink received alarms: LOS (Loss of Sequence), MSU (Member Status Unavailable), FOP CRC (Failure of Protocol Excessive CRC errors)
Sink received errors: Failure of Protocol Excessive errors (CRC failure)

LCAS Errors Generation and Detection

Source (Tx): LCAS-CRC per member
Error injection: Single

Ethernet over SDH/SONET (EoS)

Test Layer

Layer 2: MAC
Layer 3: MAC + IP
- User-defined IP Header
- TOS, ID, Fragmentation, TTL, Protocol

VLAN

VLAN ID: 0 to 4095
Priority: 0 to 7
Stacked VLAN: Up to 3 VLAN tags

MPLS

Up to 3 MPLS tags
Unicast or Multicast

Frame Length*

60 to 12,000 bytes
- Fixed
- Gaussian distribution
- Multiple gaussians
- Uniform distribution

** Minimum frame lengths apply to Layer 2 traffic. Layer 3 traffic or the addition of VLAN or MPLS tags will affect this value.*

Traffic Generation

Traffic groups: 2 (each group is assigned a frame length & traffic shape)
Traffic shapes: Constant, ramp, burst, short burst, manual burst
Bandwidth: 0.01% to 100.00%
Traffic streams: Single stream with unique MAC, VLAN, MPLS, IP address, and IP

Throughput Measurements

Aggregate Defects
Data errors: IP checksum, FCS/CRC, Lost Frames

Tx/Rx Traffic Statistics
General: Total Frames, Total Octets
Allocated Line Rate, Real Line Rate and Data Rate
Frame rate: Current, Minimum, Maximum, Average
Utilization: Current, Minimum, Maximum, Average
Frame types: Unicast, Multicast, Broadcast, Non Test Traffic (Rx only), Flow Control, Bad Frames (Rx only)
Frame size counters: Runt/Undersized, 64, 65-127, 128-255, 256-511, 512-1023, 1024-1518, Jumbo/Oversized

Per Stream Statistics
Data errors: IP checksum, Lost Frames
Tx/Rx statistics: Total Frames, Total Octets

PRODUCT DESCRIPTION

Configuration
- Auto-configuration: Automatically determines rate framing, payload structure, and test pattern
- Configures Tx to match the receiver
- Save/View/Load configurations: Save and reload configuration profiles

Upgrades: SW upgradable via CD-ROM, PCMCIA memory card, or USB memory device
Power consumption: 105 watts (powered from STT Platform Power Module or SA427)
Environmental
- Operating temperature: 32 to 104°F (0 to 40°C)
- Storage temperature: -4 to 158°F (-20 to 70°C)
- Humidity: 5% to 90% noncondensing

Dimensions
- Size: 12.6 x 8.7 x 5.9 in (320 x 220 x 150 mm)
- Weight: 8.5 lb (3.86 kg)

ORDERING INFORMATION

Control Module

STT-1001	STT Control Module *[STT Control and Display Module. Windows XP Professional SP2 OS. Includes STT Manager Software (STT-1000-SW1), STT User's Manual (SA920), Qty 2 Stylus (SA142), STT bus bridge case (SA144), Small Accessory Storage case (SA149), and three-year warranty on chassis. One-year warranty on battery and accessories. Requires STT Power Module and Test Module(s)]*

Power Module

STT-1501	Power Module, AC. 216 Watt maximum output.
STT-1505A	Power Module, AC and Battery. 120 Watt maximum output.
STT-1521	Power Module, AC. 340 Watt maximum output.
STT-1525	Power Module, AC and Battery. 150 Watt maximum output.

Test Module

STT-6001	STT-ONE Module. SDH/SONET analysis at transmission rates from 52 Mbps up to 2.5 Gbps. Support 52 Mbps and 155 Mbps electrical interfaces, BNC connectors. Support 52 Mbps, 155 Mbps, 622 Mbps, and 2.5 Gbps optical interfaces. Software upgradeable to OTU1 (2.66 Gbps). *[Includes optical attenuator, FCPC, -10 dB (SA521) or SCPC, -10 dB (SA531), Optical Network Expert Module Software (STT-6000-SW1), Optical Network Expert Module User's Manual (SA925), and Certificate of Calibration]*

2.5/2.66G Optics Options

STT-6010	1310 nm Short Reach Tx/Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and 52 Mbps.
STT-6011	1310 nm Intermediate Reach Tx/Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and 52 Mbps.
STT-6012	1310 nm Long Reach Tx/Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and 52 Mbps.
STT-6014	1550 nm Long Reach Tx/Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and 52 Mbps.
STT-6022	Dual wavelength. 1310 nm Short Reach Tx, 1550 nm Long Reach Tx, Wideband Long Reach Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and 52 Mbps.
STT-6023	Dual wavelength. 1310 nm Intermediate Reach Tx, 1550 nm Long Reach Tx, Wideband Long Reach Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and 52 Mbps.
STT-6024	Dual wavelength. 1310 nm Long Reach Tx, 1550 nm Long Reach Tx, Wideband Long Reach Rx. For rates of 2.66 Gbps, 2.5 Gbps, 622 Mbps, 155 Mbps, and, 52 Mbps.

10/10.7G Optics

STT-6100	SDH/SONET analysis at 10 Gbps transmission rate. 1550 nm 20 km Tx. Wideband standard sensitivity PIN detector Rx. Software upgradeable to OTU2 (10.7 Gbps). *[Includes Optical Attenuator, FCPC, -10 dB (SA521) or SCPC, -10 dB (SA531)].*
STT-6101	SDH/SONET analysis at 10 Gbps transmission rate. 1550 nm 40 km Tx. Wideband high sensitivity APD detector Rx. Software upgradeable to OTU2 (10.7 Gbps). *[Includes Optical Attenuator, FCPC, -10 dB (SA521) or SCPC, -10 dB (SA531)].*

STT-6102 SDH/SONET analysis at 10 Gbps transmission rate. 1550 nm 80 km Tx. Wideband standard sensitivity APD detector Rx. Software upgradeable to OTU2 (10.7 Gbps). *[Includes Optical Attenuator, FCPC, -10 dB (SA521) or SCPC, -10 dB (SA531)].*

STT-6103 SDH/SONET analysis at 10 Gbps transmission rate. 1310 nm 24 km Tx. Wideband standard sensitivity PIN detector Rx. Software upgradeable to OTU2 (10.7 Gbps). *[Includes Optical Attenuator, FCPC, -10 dB (SA521) or SCPC, -10 dB (SA531)].*

Optical Connectors

STT-6951 FCUPC connectors for all optical interfaces
STT-6952 SCUPC connectors for all optical interfaces
STT-6953 Universal optical base connectors. UPC termination.

Hardware Options

STT-6200 EoS Hardware option (VCAT, GFP, LCAS Testing for all SDH/SONET rates)
STT-6250 PDH/T-Carrier Hardware option
Primary port for bit rates from 1.5/2 Mbps to 140 Mbps. Bantam connector for balanced 1.5M/2M. BNC connector for 2 Mbps, 8 Mbps, 34 Mbps, 45 Mbps, and 140 Mbps. Auxiliary port: unbalanced BNC for 2 Mbps and 34 Mbps.

Universal Connector Adapters

SA527 FC adapter for Universal Optical connector
SA528 SC adapter for Universal Optical connector
SA529 LC adapter for Universal Optical connector
SA530 ST adapter for Universal Optical connector
SA532 DIN adapter for Universal Optical connector

Software Option

STT-6300 OTN Testing. Adds OTN testing to STT ONE.
[Requires STT-601X/602X for OTU1 and STT-61XX for OTU2]

Optical Accessories

SS427 Telephone Handset
SA501 Optical Patch Cord, SMF, FCUPC to FCUPC, 6'
SA502 Optical Patch Cord, SMF, FCUPC to SCUPC, 6'
SA503 Optical Patch Cord, SMF, FCUPC to STUPC, 6'
SA504 Optical Patch Cord, SMF, FCUPC to FCAPC, 6'
SA508 Optical Patch Cord, SMF, LCUPC to SCUPC, 6'
SA509 Optical Patch Cord, SMF, LCUPC to FCUPC, 6'
SA511 Optical Patch Cord, SMF, SCUPC to SCUPC, 6'
SA512 Optical Patch Cord, SMF, SCUPC to STUPC, 6'
SA513 Optical Jumper, SMF, FCUPC to FCUPC, 1'
SA514 Optical Jumper, SMF, SCUPC to SCUPC, 1'
SA519 Optical Patch Cord, SMF, SCUPC to FCAPC, 6'
SA520 Optical Patch Cord, SMF, FCAPC to FCAPC, 6'
SA521 Optical Attenuator, FC-PC, -10 dB
SA523 Optical Connector Adapter, SCUPC to FCUPC
[Changes an FC (f) appearance to an SC (f) appearance]
SA524 Optical Connector Adapter, FCUPC to SCUPC
[Changes an SC (f) appearance to an FC (f) appearance]
SA531 Optical Attenuator, SC-PC, -10 dB
SA541 Optical Splitter, FC-PC, 90/10
SA545 Optical Splitter, FC-PC, 50/50
SA551 Optical Splitter, SC-PC, 90/10
SA555 Optical Splitter, SC-PC, 50/50

Electrical Cables and Adapters

SA301 Cable, single bantam (m) 120Ω to 800 DSx plug (m) 120Ω, 6'
SA302 Cable, single bantam (m) 120Ω to two heavy test clips 120Ω, 6'
SS106 Cable, single bantam (m) 120Ω to single bantam (m) 120Ω, 6'
SS108 Cable, single bantam (m) 120Ω to single 310 (m) 120Ω, 6 '
SS109 Cable, single bantam (m) 120Ω to alligator clips 120Ω, 6'
SS122B Null Modem Adapter. DB-9 (f) to DB-9 (f) with Full Hand-shaking
SS210 Conversion Cable, BNC (m) 75Ω to 3-pin banana CF (m) 120Ω, 6'
SS211 Cable, BNC (m) 75Ω to BNC (m) 75Ω, 6'
SS212 Conversion Cable, single bantam (m) 120Ω to BNC (m) 75Ω, 6'
SS220 Conversion Cable, BNC (m) 75Ω to 1.6/5.6 mm (m) 75Ω, 6 '
SS225 Cable, bantam (m) 120Ω to 3-pin banana CF (m) 120Ω, 6 '
SS227 Conversion Cable, BNC (m) 75Ω to probe clips 120Ω, 6'
SS303 Cable, BNC (m) 75Ω to WECO 440A (m) 75Ω, 6'
SS315 Cable, BNC (m) 75Ω to WECO 358A (Large) (m) 75Ω, 6'

Other Accessories

SA155-UK 3-prong Power Cord for use in United Kingdom
SA155-EU 2-prong Power Cord plus ground for use in Europe (except UK)
SA155-NA 3-prong Power Cord for use in Latin America, North America, and Asia
SA427 Standalone Accessory Package for the STT Modules, 130 Watt
SA620 Semi-rigid Carrying Case with wheels and telescoping handle
SA622 Hard Carrying Case with wheels, STT