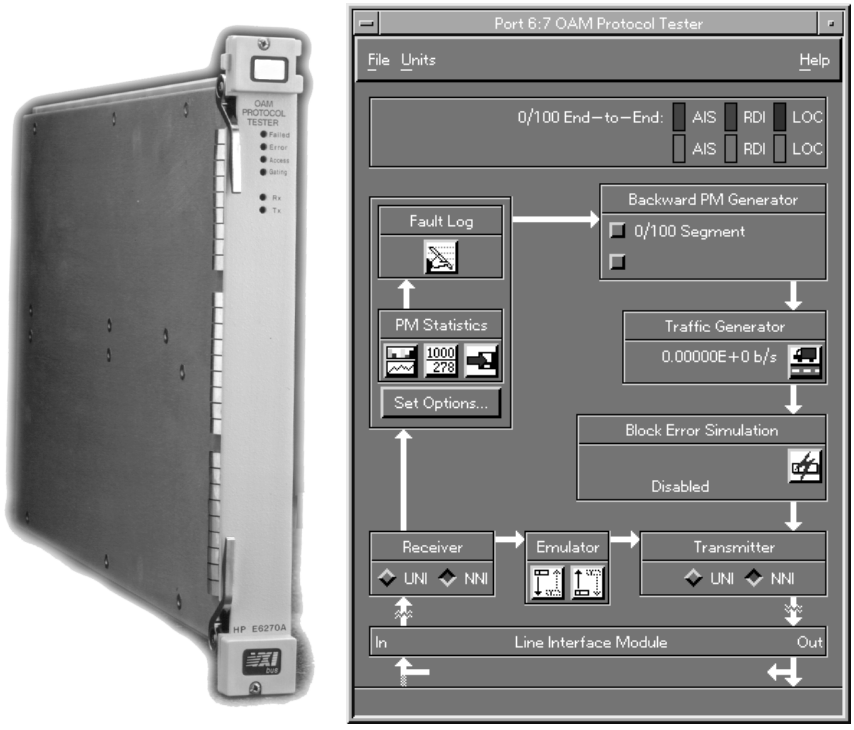
OAM Protocol Tester

Agilent Technologies Broadband Series Test System

E6270A



The E6270A OAM Protocol Tester turns the industry-standard Agilent Broadband Series Test System (BSTS) into an OAM test tool with powerful traffic generation and real-time QoS measurement capability.

Product Benefits

- Powerful 124 channel user-data generation
- Automatic generation of F4 and F5 fault management and performance management OAM cells on all user-data channels
- Generation of impaired OAM cells for stress testing
- Generation of OAM source requests and analysis of the system response
- Emulation of destination responses for conformance verification against ITU-T and Bellcore specifications
- Two-channel receiver for simultaneous real-time monitoring of F4 and F5 OAM flows: real-time logging of OAM fault management status; real-time performance management (QoS) measurements

The large-scale deployment of ATM networks and services presents complex network management challenges for both network equipment manufacturers and service providers.

Customers who pay for the delivery of multimedia services and mission-critical data over ATM networks demand that they receive the levels of performance, quality, and availability defined in the SLA (Service Level Agreement).

The ATM Operations, Administration, and Maintenance (OAM) protocol offers standardized, in-service tools for network monitoring. It enables ATM network elements to gather status information about individual ATM connections. OAM capabilities include:

- Reporting of fault conditions and fault locations
- Rapid detection of loss of ATM connection continuity
- Diagnostic loopback testing
- Real-time measurement of connection quality (block-level QoS parameters)
- Remote activation/deactivation of OAM diagnostic functions

The Agilent Technologies E6270A OAM Protocol Tester (OPT) is part of the modular Agilent Broadband Series Test System (BSTS). It is a dedicated module for in-depth verification of OAM implementations.

The OPT provides extensive simulation, monitoring, and emulation capabilities over multiple channels. It can be used for the verification of all aspects of OAM:

- Fault-detection (AIS, RDI, CC)
- Fault-localization (loopback)
- Performance management (QoS measurement and reporting)
- Activation/deactivation (of fault management and performance management functions)

Agilent Technologies
Innovating the HP Way

Key Features

Traffic Generation

The E6270A features a powerful 124 channel traffic generator, permitting testing at “real world” traffic levels, with automatic insertion of OAM cells.

Each channel is defined independently, with complete user control of content and traffic profile:

- Each channel may contain a user-defined payload sequence.
- The traffic profile can be a constant or burst profile.

Alarm Indication Signal (AIS), Remote Defect Indication (RDI), Continuity Check (CC), and forward monitoring performance management (PM) cells can be automatically inserted on each channel.

Backward reporting PM cells can be automatically generated on up to 2 channels.

Block Error Simulation

Enables verification of the robustness of an OAM implementation by subjecting it to real-world conditions:

- Inject: lost PM cells, lost user cells, tagged cells, mis-inserted cells, errored cells
- One-shot or continuous error injection modes

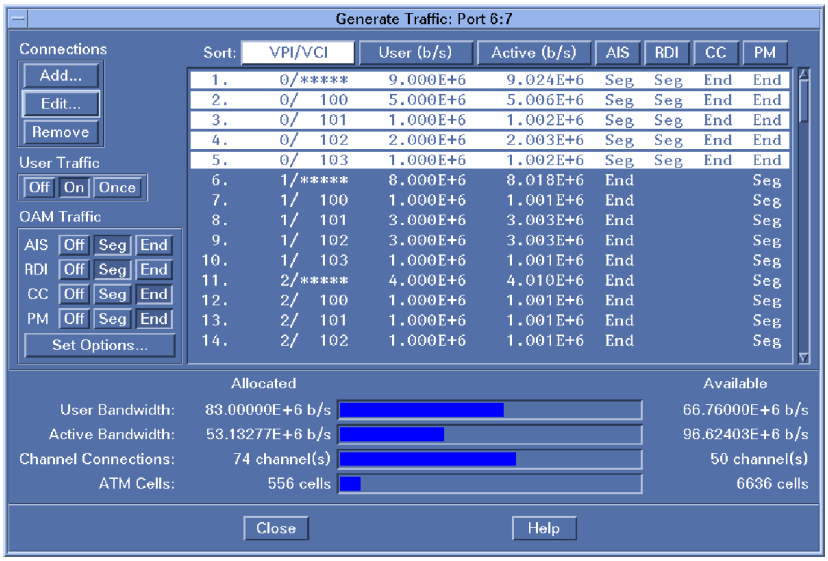
Emulation of OAM Source Behavior

Loopback and activation/ deactivation requests may be made under user control on all defined channels. The response time and type of response of the system under test is reported.

Emulation of OAM Destination Behavior

The OPT will emulate the following destination responses on up to 124 channels:

- AIS State: The OPT will automatically generate RDI cells in response to AIS cells.
- OAM Loopback: The OPT will generate loopback response cells in response to loopback request cells.
- Activation/Deactivation: The OPT will generate activation/ deactivation confirmed or denied responses in response to activation/deactivation requests.



Real-time Measurements

The module's two-channel receiver allows two OAM flows to be simultaneously monitored in real time.

The OPT measures and presents a wide array of OAM performance statistics to assist in evaluating QoS performance levels. These can be displayed using numeric or graphical viewers, or logged to disk.

Users can specify the interval at which statistics are updated, selecting from a range of 1 second to 72 hours.

Fault Management Status and Performance Management

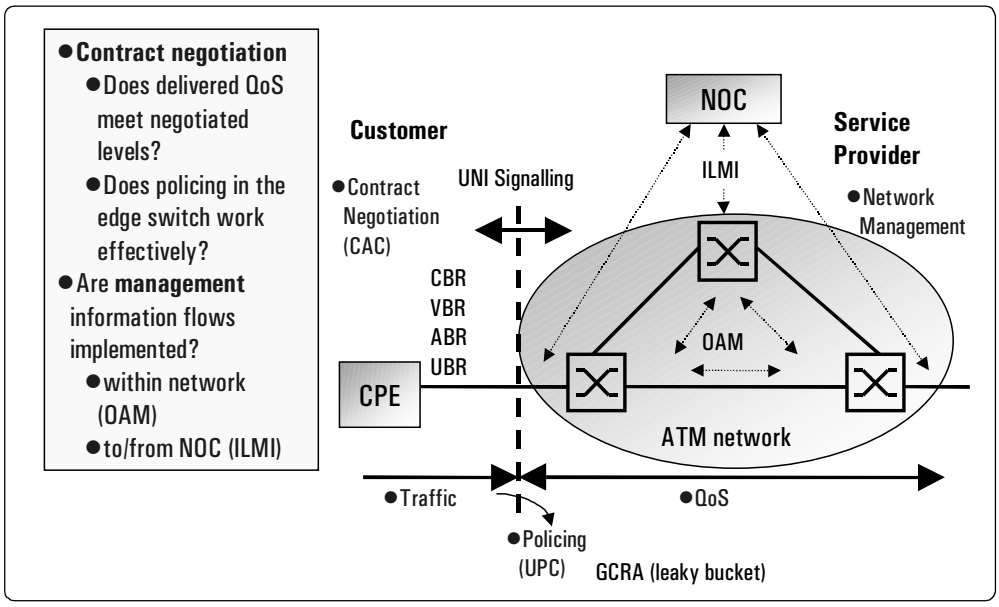
Statistics are collected and displayed for up to two selected connections.

Fault management status enables monitoring of long-term service availability:

- AIS, RDI, and Loss of Continuity (LOC) status is displayed continuously; time-stamped state change information can be logged to disk

Performance management statistics enables real-time in-service QoS measurements:

- OAM cell counts (2 statistics)
- Impaired cell blocks (5 statistics)
- Severely Errored Cell Blocks (5 statistics)
- User cell errors (6 statistics)
- User cell counts (5 statistics)
- OAM Cell Delays (4 statistics)



OAM is an important part of monitoring Service Level Agreements (SLAs). The BSTS offers solutions to test all aspects of the contract negotiations, such as UNI signalling and QoS.

Service Level Agreement (SLA) Testing Solutions

In order to fully manage service quality for each connection, a number of management protocols, of which OAM is just one, must all operate correctly.

At connection setup time, UNI signalling is used to negotiate the SLA between the customer and the service provider.

After the connection has been established, the OAM protocol enables status information to be gathered exchanged between network elements.

Once this information has been stored in the Management Information Base (MIB) of a device at the edge of the network, it can be communicated to the network management center, using the ILMI protocol.

The Agilent E6270A OAM Protocol Tester works with other BSTS modules to form a complete SLA test solution, comprising:

- Verification of Connection Admission Control (UNI signalling) functions
- Verification of Usage Parameter Control (GCRA) functions
- Traffic testing (CBR, VBR, UBR, ABR service categories)
- Verification of network management protocols and functions (OAM, ILMI)

For More Information

Two Agilent solution notes regarding OAM technology are available by contacting your local Agilent sales representative or accessing the Agilent website.

Measuring Real-time QoS Using the E6270A OAM Protocol Tester

This solution note provides:

- A tutorial on I.356 QoS parameters and I.610 OAM performance management functions
- A detailed demonstration guide for performing in-service and out-of-service QoS measurements using OAM performance management cells
- Reference information explaining how to map I.610 performance management measurements to I.356 QoS parameters

Testing Operation and Maintenance (OAM) Implementations for ATM

This solution note explains the underlying technology of OAM. This note also covers testing methodologies for all major OAM functions.

Product Numbers

- **E6270A** OAM Protocol Tester
- **E4200B** BSTS Form-7 Transportable Base
- **E4210B** BSTS Form-13 Mainframe Base
- **E4209B** 0-155 Mb/s Cell Protocol Processor
- **E1607A/E1609A** 0-622 Mb/s ATM Stream Processor
- **E4212A/B** AAL Test Software
- **E4214B** UNI Signalling Test Software
- **E4219A** ATM Network Impairment Emulator Module
- **E4223A** Policing and traffic Characterization Software
- **E6273B** ILMI Emulation Test Software
- **E6287A** ABR Emulator

Configuration & Use With Other BSTS Line Interfaces, Hardware Modules & Test Software

The E6270A OPT requires an E4210A/B or E4200A/B BSTS with system software version 3.08 or higher. The OPT also requires an ATM-based line interface (LIF) to provide a connection to the ATM equipment under test. Additional system configurations are specified in the Technical Specification section (see Protocol Analysis and Physical Access table).

The E6270A can also work in conjunction with other hardware modules and software applications to provide a complete ATM Service Level Agreement (SLA) test solution. The E4209A/B Cell Protocol Processor (CPP), E1607A/E1609A ATM Stream Processor, and E6287A ABR Emulator module provide additional CBR, VBR, UBR, and ABR traffic generation and analysis capability. Software applications for the CPP enable protocols such as OAM, signalling, and ILMI to be decoded and analyzed.

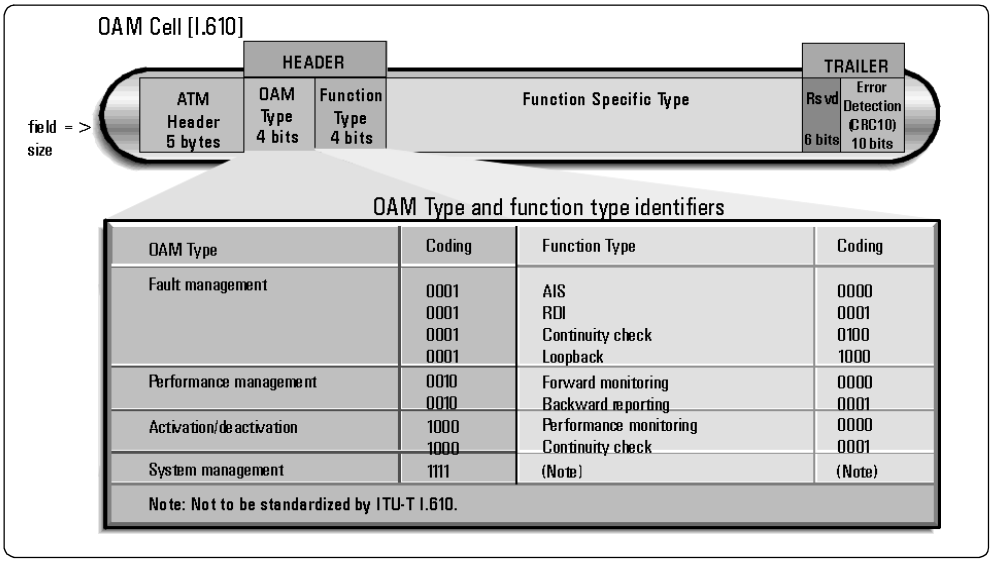
Warranty & Support Options

Hardware

All BSTS hardware components are warranted for a period of 3 years. Products must be returned to an authorized Agilent service center for service. At the time of purchase, you may select warranty option W01, a no-charge option which converts the standard 3-year return to Agilent warranty to a 1-year on-site warranty.

Software

Agilent Broadband Series Test System software and firmware products are supplied on transportable media such as disk, CD or integrated circuits. The warranty covers physical defects in the media, and defective media is replaced at no charge during the warranty period. When installed in an Agilent Broadband Series Test System, the software/firmware media has the same warranty period as the product.



Technical Specifications

General Characteristics

Traffic Generation	User cells: • Generates user cells with CBR and VBR traffic profiles on 124 connections Fault Management (FM-OAM) cells: • Automatically inserts periodic AIS, RDI, and CC (Continuity Check) fault management OAM cells Forward monitoring performance management (PM-OAM) cells: • Automatically inserts forward monitoring PM-OAM cells for block-level QoS monitoring
Block Error Simulation	• Generates user-defined impairments to blocks of user cells and forward monitoring PM-OAM cells for the selected traffic generator connection
OAM Source/Destination Emulation	OAM request generation: • Generates a single loopback, activation/ deactivation, or user-defined request cell • Monitors the response of the equipment or network under test OAM response emulation: • Automatically responds to received AIS, loopback request, or activation/ deactivation request cells on 124 connections • Generates a valid or invalid response, as defined by the user Backward reporting PM-OAM cells: • Automatically generates backward reporting PM-OAM cells, based on calculated block-level QoS information, on 2 connections; see *Performance Management monitoring* below
Fault Management and Performance Management Monitoring: • Real-time monitoring on 2 connections	Fault management display and logging: • Monitors and logs detected AIS, RDI, and LOC (Loss of Continuity) status Performance management monitoring: • Calculates QoS statistics, based on received blocks of user cells and forward monitoring PM-OAM cells **Note** This information can be used to generate backward reporting PM-OAM cells • Monitors block level QoS statistics, based on received backward reporting PM-OAM cells

Typical Test Applications

Verify that the system under test properly recognizes and processes user cells and their associated OAM cells	• Generate AIS, RDI, CC, PM, and user cell traffic on up to 124 different connections. • Remotely activate and deactivate continuity check and performance management OAM functions in the system under test • Verify connection continuity using OAM loopback tests
Verify that the system under test correctly adheres to OAM protocols by emulating a device that sends and responds to OAM cells	• Send OAM requests to verify that the system under test responds correctly and in time • Respond to OAM requests with either valid or invalid responses to verify that the system under test proceeds accordingly • Emulate OAM destination functions by generating loopback, RDI, backward reporting PM and activation/deactivation OAM response cells
Verify that the system under test correctly detects errors and reflects them in its performance management statistics	• Simulate network faults and errors by generating fault management and performance management OAM cells • Monitor network faults and errors in the received fault management and performance management OAM cells • Monitor QoS parameters for a connection, based on blocks of user cells and forward monitoring performance management OAM cells • Report back computed QoS statistics to the connection or segment endpoint by generating backward reporting performance management OAM cells

Traffic Generation: User Cells

Definition of user streams	Number of connections: • Up to 124 VCCs with user-specified VPI/VCI values; each VCC can be accompanied by an F5 OAM flow (see *Traffic Generation: OAM Cells*) • Up to 124 VPCs are automatically configured, based on the user-defined VPI values; each VPC can be accompanied by an F4 OAM flow (see *Traffic Generation: OAM Cells*) Header modes: • UNI or NNI; applies to all user-defined VCCs
Definition of VCC cell contents: • PDU and Sequence Builders	Create and edit PDUs and sequences of PDUs: • ATM-layer PDUs only • User-defined values: GFC (in UNI-mode only), PTI, CLP, payload octets Save and restore PDU/sequence library files: • ATM layer PDUs only Load user-defined PDUs/sequences into the cell octets: • Maximum PDU/sequence size per stream: 1 to 1000 cells • Total number of PDU/sequence cells for all defined streams: 7192 cells **Note 1** The VPI/VCI value of the selected VCC is not changed by loading a user-defined PDU **Note 2** The VPC cell stream contents is the aggregate of the contents of all VCCs having a common VPI value

Definition of Traffic Profiles: • Independently configured for each VCC	Disabled: • No cells transmitted Single-shot: • Sends one PDU or sequence Enabled: • Transmits continuously with a periodic distribution **Note** The VPC traffic profile is the aggregate of the profiles of all VCCs having a common VPI value
Definition of Periodic Distributions: • Independently configured for each VCC	Constant: • Average bandwidth = 80 b/s to 100% of maximum cell rate Burst: • Average bandwidth = 80 b/s to 100% of maximum cell rate • Burst bandwidth = 80 b/s to 100% of maximum cell rate; must exceed average bandwidth • Burst length = 2 to 1000 cells **Note** The maximum cell rate depends on the type of physical layer line interface being used
Traffic Distribution Resolution and Accuracy	Minimum resolution accuracy of the average bandwidth for Constant and Burst distributions: • 0.05% of the maximum cell rate Multiplexing priority: • 124 user cell streams are multiplexed into a single ATM cell stream according to a rotating priority queue • The next cell from a stream is not transmitted until all queued cells for the remaining streams have been transmitted • Average bandwidth accuracy of each stream is maintained, but distortion of the requested traffic distribution may occur • Distortion increases when the average or burst bandwidth of the combined distributions is high (e.g. many burst distributions with high burst bandwidth)

Traffic Generation: OAM Cells

Definition of OAM flows	• Up to 124 F4 flows • Up to 124 F5 flows • Each OAM flow is independently configured by selecting a user-defined VPC (F4) or VCC (F5); see *Traffic Generation: User Cells*
Configuration of F4 and F5 OAM functions types: • Any combination of AIS, RDI, CC, and PM-OAM functions can be active simultaneously for the selected VPC or VCC	AIS: • Off: Disable AIS generation • Segment: Enable continuous generation of segment flow-type AIS cells • End-to-end: Enable continuous generation of end-to-end flow-type AIS cells RDI: • Off: Disable RDI generation • Segment: Enable continuous generation of segment flow-type RDI cells • End-to-end: Enable continuous generation of end-to-end flow-type RDI cells CC: • Off: Disable continuity check generation; CC generation can be enabled/disabled in response to received activation/deactivation request cells (see *OAM Destination Emulation*) • Segment: Enable continuous generation of segment flow-type CC cells • End-to-end: Enable continuous generation of end-to-end flow-type CC cells PM: • Off: Disable forward monitoring PM cell generation; PM cell generation can be enabled/disabled in response to received activation/deactivation request cells (see *OAM Destination Emulation*) • Segment: Enable continuous generation of segment flow-type PM cells • End-to-end: Enable continuous generation of end-to-end flow-type PM cells **Note** F5 OAM cells are classified as user cells at the F4 OAM level. For example, F5 PM-OAM cells are included in the F4 PM-OAM cell count (TUC) and error check (BEDC) fields.
Fault Management Generation Options	Independently configured for the following functions: • AIS • RDI • CC OAM Cell Payload: • Default or user-defined PDU Transmit cell period: • 0.05 to 5.0 seconds (default = 1 second); a single value applies to all FM-OAM cells (AIS, RDI, or CC) for all defined OAM flows • Resolution and accuracy: 0.01 seconds • AIS/RDI/CC cells from different OAM flows are distributed evenly during each transmission period to minimize distortion of user-cell distributions Suspend user traffic function: • Yes: Disable the user cell stream if the selected OAM cell type (AIS, RDI, or CC) is being transmitted on that VPC/VCC • No: Continue sending user cells regardless of whether OAM cells are being transmitted

Performance Management Generation Options	Requested block size: • Manual: 128, 256, 512, 1024, 2048, 4096, 8192, 16384, or 32768 user cells • Automatic: Set according to received activation/deactivation request cells (see *OAM Destination Emulation*) Minimum block size: • Constant: equal to the requested block size • Variable: follows a uniformly random distribution with (min. | mean | max.) = 0.5 | 1.0 | 1.5 times the requested block size **Note** To minimize distortion of the user traffic profiles, PM cells have a lower transmission priority than user cells. The actual block size may be larger than the requested block size, particularly under high traffic load conditions.
Forward Monitoring PM-OAM Cell Field Values	CLP: • User-defined: 0 or 1; the same value applies to all active PM-OAM flows PTI congestion bit: • User-defined: 0 or 1; the same value applies to all active PM-OAM flows OAM Type: • 2 (Performance Management) Function Type: • 0 (Forward Monitoring) MCSN: • The current value of a running counter (modulo 256) of the transmitted forward monitoring PM-OAM cells TUC_{0+1}: • The current value of a running counter of the total number (modulo 65536) of transmitted CLP_{0+1} user cells $BEDC_{0+1}$: • A 16-bit BIP code calculated over the information fields of user cells transmitted since the last forward monitoring PM-OAM cell TUC_0: • The current value of a running counter of the total number (modulo 65536) of transmitted CLP_0 user cells TSTP: • Either a valid 32-bit time stamp, or the default value of 0xFFFFFFFF; the user can enable or disable timestamps; applies to all generated forward monitoring PM-OAM cells EDC: • A CRC-10 automatically calculated over the preceding OAM field values from the generator polynomial $1 + x + x^4 + x^5 + x^9 + x^{10}$

Traffic Generation: Backward Reporting of Performance Management Information

Generates Backward Reporting PM-OAM Cells on 2 connections	OAM level: • Each connection can be an F4 (VPC) or F5 (VCC) OAM flow • A backward reporting PM cell is generated in response to a received forward monitoring PM cell **Note 1** The first received forward monitoring PM-OAM cell is used for measurement initialization and does not result in the transmission of a backward reporting PM-OAM cell **Note 2** Performance management statistics must be activated; see *OAM Monitoring: Performance Management Statistics*
Backward Reporting PM-OAM Cell Fields **Note** *unchanged* means the field value is copied from the received forward monitoring PM cell into the backward reporting PM cell	Header fields: • unchanged OAM type: • unchanged Function type: • 1 (backward reporting) MCSN: • Current value of a modulo 255 counter $BEDC_{0+1}$: • 0x6A6A TUC_0 and TUC_{0+1}: • unchanged $TRCC_0$ and $TRCC_{0+1}$: • Current value of the modulo 65536 count of total received CLP_0 and CLP_{0+1} user cells $BLER_{0+1}$: • 0xFF; when TUC_{0+1} does not equal $TRCC_{0+1}$ • otherwise set to the count of errored CLP_{0+1} user cells (BIP-16 errors) TSTP: • 0xFFFFFFFF CRC-10: • Valid value

Block Error Simulation

Simulation of Performance Management Cell Block Errors	Lose forward monitoring PM cell: • Discard a PM-OAM cell Lose CLP_{0+1} user cells: • Discard n consecutive user cells; n = 1 to [(average block size)/8] Tag CLP_0 user cells: • Change CLP from 0 to 1 for n consecutive user cells; n = 1 to [(average block size)/8] • If the number of CLP_0 cells within a block is less than n, then the error event will span multiple blocks Misinsert CLP_0 user cells: • Insert a maximum rate burst of n CLP_0 user cells; n = 1 to [(average block size)/8], n $\leq$ 1000 Misinsert CLP_1 user cells: • Insert a maximum rate burst of n CLP_1 user cells; n = 1 to [(average block size)/8], n $\leq$ 1000 BIP-16 error: • Invert bits in the BEDC field of a PM-OAM cell; user-specified 16-bit error mask Error rate: • 1 error every 10^n PM cell blocks; n = 1 to 4 • **Note** Forward monitoring PM-OAM cell generation must be activated for the selected VPC or VCC; see *Traffic Generation: OAM Cells*
Format of Misinserted Cells	GFC (UNI mode only): 0 VPI: As per selected VPC or VCC VCI: • F5: as per selected VCC • F4: the lowest VCI field value of all channels in the selected VPC PTI: 0 CLP: 0 or 1 depending on misinsertion type (CLP_0 or CLP_1) Payload: Repeating 6A6A pattern

OAM Source Emulation

User-activated OAM request cell generation	Generates an OAM request cell for the selected VPC or VCC; type of request: • Loopback • Activate/Deactivate • User-defined cell Waits for a received OAM response cell and reports the result; reported parameters: • Type of response • Response delay Response timeout parameter: • Period: 0.0 to 10.0 seconds; • Resolution: 0.1 seconds • Accuracy: $\pm$ 0.05 seconds
Type of Response Message • Displayed after the request cell has been sent	Waiting: • Still waiting for the response Received: • Successful loopback response received Denied: • Activation or deactivation request rejected Confirmed: • Activation or deactivation request accepted Timed Out: • A response was not received within the response timeout period Aborted: • Test was manually aborted by the user
Loopback Request Parameters	Location ID: • 16-octet value Source ID: • 16-octet value
Activation/Deactivation Request Parameters	Function type: • CC or PM Message ID: • Activate or Deactivate Directions of Action: • A-B: away from the requester, B-A: towards the requester, or Both: Activate bi-directional CC or PM functions PM block size: • 128, 256, 512, or 1024 octets **Note** The same value is copied into the A-B and B-A PM block size fields of the request cell. To specify different block sizes in each direction, a *User-defined Request* can be sent (see below)
User-defined Request Parameters	User-defined cell: • Cell header and payload values can be specified via the PDU builder

OAM Destination Emulation

Automatically activated on all user-defined VPCs and VCCs; see *Traffic Generation: User Cells*	Responds to received OAM cells: • AIS • Loopback request • Activation/Deactivation request **Note** The AIS, loopback, or Activation/ Deactivation request cell is ignored if it does not correspond to a user-defined VPC or VCC Type of end-point emulated: • Segment (terminates a segment flow) • Connection (terminates an end-to-end flow) Responds to every n request cells: • n = 0, 1, 2, or 3 Response Delay: • 0.0 to 5.0 seconds; • Resolution: 0.1 seconds • Accuracy: ± 0.05 seconds Displays counts of received OAM cells per VPC or VCC: • AIS, loopback, activation, and deactivation • The counters can be manually reset
AIS Response	Processes a minimum of: • 248 received AIS cells/second • Automatically generates an RDI cell in response to a received AIS cell Responds with a: • Valid RDI cell • User-defined RDI cell Format of the valid RDI cell: • Same ATM header, OAM type, defect type, and defect location values as the received AIS cell • Valid CRC-10
Loopback Response	Processes a minimum of: • 10 received loopback cells/second • Automatically generates a loopback cell in response to a received loopback cell Responds with a: • Valid loopback cell • User-defined loopback cell Format of the valid loopback response cell: • Same ATM header, OAM type, OAM function, correlation tag, loopback location ID, and source ID values as the received loopback cell • Loopback indication field: 0x01 • Valid CRC-10
Activation/Deactivation Request Response	Processes a minimum of: • 10 received activation/deactivation request cells/second • Controls CC and PM-OAM cell generation on user-defined VPCs and VCCs • Automatically generates a confirmed/denied cell in response to a received activation/ deactivation request cell User-selectable response action: • Confirmed: activates or deactivates (depending on OAM message ID) PM or CC cell generation (depending on OAM function type) on the corresponding VPC or VCC; generates a valid *Confirmed* response cell • Request Denied: generates a valid *Request Denied* response cell • User-defined: generates a user-defined response cell Format of valid response cells: • Same ATM header, OAM type, OAM function, direction of action, and correlation tag as the received activation/deactivation request cell • Message ID field: *Confirmed* or *Request Denied* depending on user-selected response action • If OAM function type = PM: same PM block size A-B, and PM block size B-A as the received activation/deactivation request cell • Valid CRC-10

OAM Monitoring: Fault Management States

Monitors Fault Management states on 2 connections in real time

OAM level:

- Each connection can be an F4 (VPC) or F5 (VCC) OAM flow

Flow type:

- Segment or end-to-end

Reported information:

- Current status indicators: AIS, RDI, and LOC for each connection; red = alarm on, green = alarm off
- Fault log: timestamped trace of alarm state changes; timestamp resolution = 0.1 seconds; fault log results can be saved to disk

AIS State:

- On: when an AIS cell is detected
- Off: when either a user or CC cell is detected, or no AIS cell is detected for 2.5 ± 0.5 seconds

RDI State:

- On: when an RDI cell is detected
- Off: when no RDI cell is detected for 2.5 ± 0.5 seconds

LOC State:

- On: when no CC cell is detected for 3.5 ± 0.5 seconds
- Off: when a CC cell is detected

OAM Monitoring: Performance Management Statistics

Derives Performance Management statistics on 2 connections in real time

OAM level:

- Each connection can be an F4 (VPC) or F5 (VCC) OAM flow

Derived statistics are based on:

- User cells and segment forward monitoring PM-OAM cells
- User cells and end-to-end forward monitoring PM-OAM cells
- Segment backward reporting PM-OAM cells
- End-to-end backward reporting PM-OAM cells

Note The first received forward monitoring or backward reporting PM-OAM cell is used for measurement initialization and is not included in the statistics

Display format:

- Numeric
- Graphical
- Log to disk

Measurement interval:

- Accumulates all statistics over a user-defined integration period of 1 second to 72 hours

Block size statistics	• Average block size • Minimum block size • Maximum block size
Errored Cell Block statistics	• User cell blocks with CLP_{0+1} cell loss • User cell blocks with CLP_0 cell loss • User cell blocks with CLP_{0+1} cell misinsertion • User cell blocks with CLP_{0+1} bit errors • Total errored cell blocks; count of cell blocks with cell loss, misinsertion, or bit errors **Note 1** For forward monitoring PM-OAM cells: • Cell loss and misinsertion are determined by comparing the count of received CLP_0 and CLP_{0+1} user cells with TUC_0 and TUC_{0+1} values in the PM cell • Bit errors are determined by comparing a BIP-16 calculation over payloads of user cells with the $BEDC_{0+1}$ value in the PM cell **Note 2** For backward reporting PM-OAM cells: • Cell loss and misinsertion are determined by comparing TUC_0 and TUC_{0+1} with $TRCC_0$ and $TRCC_{0+1}$ values in the PM cell • Bit errors are determined from the $BLER_{0+1}$ value in the PM cell
Severely Errored Cell Block statistics	• Misinserted CLP_{0+1} user cells $> M_{Misinserted}$ • Lost CLP_{0+1} user cells $> M_{Lost}$ • Lost CLP_0 user cells $> M_{Lost}$ • Errored CLP_{0+1} user cells bits $> M_{Errored}$ • Total severely errored cell blocks; count of cell blocks exceeding the SECB thresholds for cell loss, misinsertion, or bit errors **Note** User-defined SECB threshold values: • M_{Lost}: 1 to 2048 cells • $M_{Misinserted}$: 1 to 2048 cells • $M_{Errored}$: 1 to 16 bit errors
Cell Error statistics	• Total lost CLP_{0+1} user cells • Total lost CLP_0 user cells • Lost CLP_{0+1} user cells • Lost CLP_0 user cells • Misinserted CLP_{0+1} user cells • Errored CLP_{0+1} user cells **Note 1** *Total lost* user cell counts includes all cell loss events; *Lost* user cell counts excludes cell losses occurring during SECBs **Note 2** If Lost CLP_0 user cells > Lost CLP_{0+1} user cells, the difference is counted as Minimum tagged CLP_0 user cells; see *Cell Count statistics* **Note 3** Errored CLP_{0+1} user cells is incremented by the number of detected BIP-16 errors (excluding errors in SECBs). It is an estimate only as it assumes 1 bit error corresponds to 1 cell error.

Cell Count statistics:	• Total CLP_{0+1} user cells • Total CLP_0 user cells • Minimum tagged CLP_0 user cells • Received PM cells • Lost PM cells; determined by comparing MCSN values in successive PM cells
OAM Cell Delay statistics	• Average cell transfer delay (CTD) • Minimum CTD • Maximum CTD • [Max - Min] CTD • Excessive CTD count; events where CTD is greater than the user-defined excessive delay threshold value **Note 1** Cell delay statistics are derived from forward monitoring PM cells with valid TSTP timestamp fields **Note 2** Displayed CTD value = derived CTD value + *cell delay calibration* value; this value is entered by the user to compensate for a timebase offset between the PM-OAM source and the OPT module

Protocol Analysis and Physical Layer Access

155 Mb/s Cell Bus Access to other BSTS modules • **OPT**: E6270A OAM Protocol Tester	Left-hand cell bus is compatible with the following BSTS modules: • **CPP**: E4209A or E4209B Cell Protocol Processor module with E4212A/B AAL test software • **AE**: E6287A ABR Emulator module • **OPT**: additional E6270A OAM Protocol Tester module Right-hand cell bus is compatible with the following BSTS modules: • **NEM**: E4219A Network Impairment Emulator Module • **LIF**: BSTS Line Interface module; see list below

Typical System Configurations	**OPT-LIF + OPT-LIF** • End-to-end OAM source-to-sink simulation, emulation, and monitoring **CPP-OPT-LIF** • OAM source or sink simulation, emulation, and monitoring; E4212A/B AAL test software decodes all types of OAM cells **AE-OPT-LIF** • Generation of a combination of CBR, VBR, and ABR traffic streams **OPT-NEM-LIF** • OAM source simulation with additional ATM impairments such as cell delay and cell delay variation **OPT-OPT-OPT-OPT-LIF** • OAM fault management and performance management simulation and emulation on up to 496 channels • Real-time analysis of OAM fault management state changes and performance management Qos parameters on up to 8 channels
Supported Module Configurations	An OPT test instrument can consist of a maximum of 8 adjacent modules: • Multiple test instruments can operate within the same VXI chassis, under control of the Test Session Manager Modules can be selected in the order shown below and cascaded from left to right to form a test instrument: • 0-4 cascaded E4209B CPP modules; a single E4209A module can be substituted for the left-most E4209B module • 0-4 cascaded AE modules • 0-4 cascaded OPT modules • 0-4 cascaded NEM modules • 0-6 cascaded LIF modules in passthrough mode • 1 active LIF module Cell generation priority is from right to left: • The active LIF module is the timing master • Cell opportunities that are not filled by one module can be passed on to modules on the left • Priority order: LIF, NEM, OPT, AE, CPP

Supported Line Interface Modules	SONET/SDH • E1617A OC-1 optical • E1612A STS-3c/STM-1 electrical • E1697A OC-3c/STM-1 optical PDH (US) • E1616A DS1/DS3 • E1695A DS3 PDH (Europe) • E4201A E1 • E1610A E3 PDH (Japan) • E1613A J2 electrical • E1614A J2 optical Desktop ATM • E1619B ATM25 • E1698A TAXI • E4205A 155 Mb/s UTP-5

E4212A/B AAL Test Software for the CPP

Decodes Captured OAM cells	Header (octets 1-4) • OAM level (F4 or F5) • OAM flow type (segment or end-to-end) Type | Function (octet 6) • OAM Cell Type: the management type (fault, performance, activation/deactivation, system) • OAM Function Type: the specific function (e.g. AIS, RDI, CC, loopback, forward monitoring PM, backward reporting PM, activation/deactivation request/acknowledge, etc.) Function Specific Field (octets 7-51) • AIS/RDI specific fields: Defect Type, Defect Location, Unused • Loopback specific fields: Loopback Indication, Correlation Tag, Loopback Location, Source ID, Unused • Performance Management specific fields: MCSN, TUC_{0+1}, TUC_0, $BEDC_{0+1}$, TSTP, $TRCC_{0+1}$, $TRCC_0$, $BLER_{0+1}$ • Activation/Deactivation specific fields: Message ID, Direction of Action, Correlation Tag, PM Block Size (A-B), PM Block Size (B-A), Unused Reserved | EDC (octets 52-53) • Reserved: reserved for future use • EDC: CRC-10 error detection code computed over the cell payload (except the CRC-10 field)

Mechanical Specifications

Size & Weight

Size	• 1 slot C-size VXI card
Weight	• 1.3 kg (2.9 lb) nominal

Front Panel LED Indicators

Tx	• On for 50 ms each time an ATM cell on an enabled connection is transmitted (forwarded to the LIF module)
Rx	• On for 50 ms each time an ATM-layer cell is received (forwarded from the LIF module)

Environmental Operation Conditions

Operating Temperature	• 0^0C to 55^0C
Storage Temperature	• -40^0C to 70^0C
Humidity	• 0% to 95% relative humidity from 25^0C to 40^0C

Applicable Standards

OAM Functions	• ITU-T I.610 B-ISDN Operation and Maintenance Principals and Functions, November, 1995 • Bellcore GR-1248-CORE, Generic Requirements for Operations of ATM Network Elements, Issue 3, August, 1996 **Note** Where inconsistencies exist between these two documents the module conforms to the ITU-T Recommendation I.610

Acronyms

ABR	Available Bit Rate
AE	Agilent E6287A ABR Emulator Module
AIS	Alarm Indication Signal (forward alarm indication)
ATM	Asynchronous Transfer Mode
$BEDC_{0+1}$	Block Error Detection Code (PM-OAM field)
BIP	Bit Interleaved Parity
$BLER_{0+1}$	Block Error Result (PM-OAM field)
BSTS	Agilent Broadband Series Test System
CBR	Constant Bit Rate (service category)
CAC	Connection Admission Control
CC	Continuity Check ("keep alive" connection polling)
CLP	Cell Loss Priority (header field)
CLP_0	Cell Loss Priority of 0 only (high priority cells)
CLP_1	Cell Loss Priority of 1 only (low priority cells)
CLP_{0+1}	Cell Loss Priority of 0 or 1
CPE	Customer Premises Equipment
CPP	Agilent E4209A or E4209B Cell Protocol Processor
CRC	Cyclic Redundancy Check
EDC	Error Detection Code (OAM field)
F4	OAM flow associated with a VPC
F5	OAM flow associated with a VCC
FM-OAM	Fault Management OAM (AIS, RDI, CC, loopback)
GCRA	Generic Cell Rate Algorithm
GFC	Generic Flow Control (header field)
ILMI	Integrated Local Management Interface
LIF	BSTS Line Interface module
LOC	Loss of Continuity (alarm indication)
MCSN	Monitoring Cell Sequence Number (PM-OAM field)
MIB	Management Information Base
NEM	HP E4219A Network Impairment Emulator Module
NNI	Network-Network Interface
NOC	Network Operations Center
OAM	Operations, Administration, and Maintenance
OPT	HP E6270A OAM Protocol Test module
PDU	Protocol Data Unit
PM-OAM	Performance Management OAM (forward monitoring and backward reporting)
PTI	Payload Type Indication (header field)
QoS	Quality of Service
RDI	Received Defect Indication (backward alarm indication)
SECB	Severely Errored Cell Block
SLA	Service Level Agreement
$TRCC_0$	Total Received Cell Count related to CLP_0 user cell flow (PM-OAM field)
$TRCC_{0+1}$	Total Received Cell Count related to CLP_{0+1} user cell flow (PM-OAM field)
TSTP	Time Stamp (PM-OAM field)
TUC_0	Total User Cell number related to CLP_0 user cell flow (PM-OAM field)
TUC_{0+1}	Total User Cell number related to CLP_{0+1} user cell flow (PM-OAM field)
UBR	Unspecified Bit Rate
UNI	User-Network Interface
UPC	Usage Parameter Control
VBR	Variable Bit Rate (service category)
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier (header field)
VPC	Virtual Path Connection
VPI	Virtual Path Identifier (header field)

This page intentionally left blank.

This page intentionally left blank.

Agilent Technologies Broadband Series Test System

The Agilent Technologies BSTS is the industry-standard ATM/BISDN test system for R&D engineering, product development, field trials and QA testing. The latest leading edge, innovative solutions help you lead the fast-packet revolution and reshape tomorrow's networks. It offers a wide range of applications:

- ATM traffic management and signalling
- Packet over SONET/SDH (POS)
- switch/router interworking and performance
- third generation wireless tesing
- complete, automated conformance testing

The BSTS is modular to grow with your testing needs. Because we build all BSTS products without shortcuts according to full specifications, you'll catch problems other test equipment may not detect.

www.Agilent.com/comms/BSTS

United States:
Agilent Technologies
Test and Measurement Call Center
P.O. Box 4026
Englewood, CO 80155-4026
1-800-452-4844

Canada:
Agilent Technologies Canada Inc.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
1-877-894-4414

Europe:
Agilent Technologies
European Marketing Organisation
P.O. Box 999
1180 AZ Amstelveen
The Netherlands
(31 20) 547-9999

Japan:
Agilent Technologies Japan Ltd.
Measurement Assistance Center
9-1, Takakura-Cho, Hachioji-Shi,
Tokyo 192-8510, Japan
Tel: (81) 426-56-7832
Fax: (81) 426-56-7840

Latin America:
Agilent Technologies
Latin American Region Headquarters
5200 Blue Lagoon Drive, Suite #950
Miami, Florida 33126
U.S.A.
Tel: (305) 267-4245
Fax: (305) 267-4286

Asia Pacific:
Agilent Technologies
19/F, Cityplaza One, 1111 King's Road,
Taikoo Shing, Hong Kong, SAR
Tel: (852) 2599-7889
Fax: (852) 2506-9233

Australia/New Zealand:
Agilent Technologies Australia Pty Ltd
347 Burwood Highway
Forest Hill, Victoria 3131
Tel: 1-800-629-485 (Australia)
Fax: (61-3) 9272-0749
Tel: 0-800-738-378 (New Zealand)
Fax: (64-4) 802-6881

Specifications subject to change.

5965-9075E 03/00 Rev C

Agilent Technologies
Innovating the HP Way