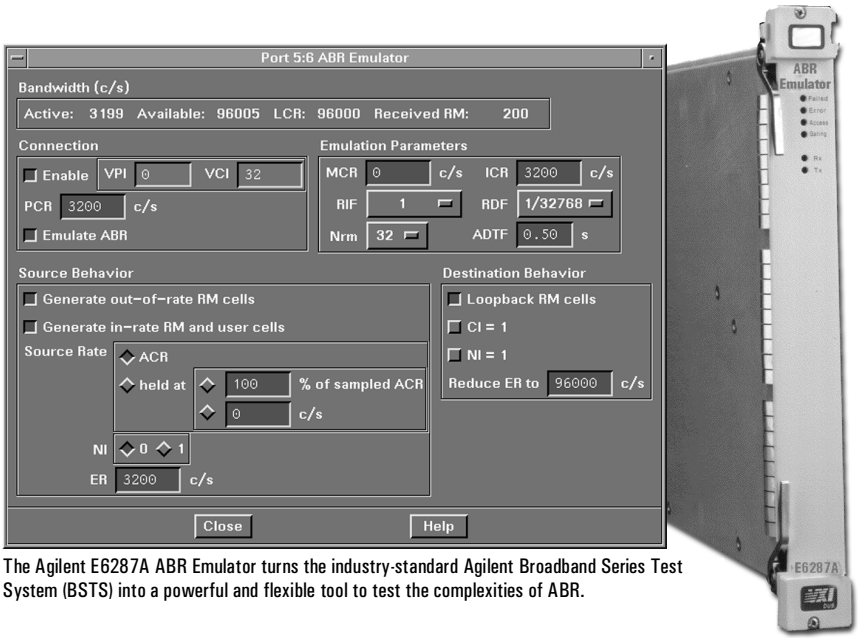
ABR Functional Testing

Agilent Technologies Broadband Series Test System

E6287A



The Agilent E6287A ABR Emulator turns the industry-standard Agilent Broadband Series Test System (BSTS) into a powerful and flexible tool to test the complexities of ABR.

Product Features

- Control of ABR parameters for simultaneous source and destination emulation
- ABR traffic generation; user and RM cells up to 149.76 Mb/s
- Ability for source to misbehave
- Use existing BSTS modules to maximize equipment reuse and minimize cost associated with ABR testing
- Comprehensive set of measurements to monitor ABR functionality in real-time
- Compliant to ATM Forum Traffic Management Specification Version 4.0 testing

The Available Bit Rate (ABR) service category is the most complex ATM traffic type yet defined by the ATM Forum. The variety of feedback mechanisms, parameters, rules, and real-time response expectations all combine to make the implementation of ABR on a switch a complex issue.

The Agilent Technologies E6287A ABR Emulator turns the industry-standard Agilent Broadband Series Test System (BSTS) into a powerful and flexible tool to test the complexities of ABR. This solution will allow you to develop and deliver ABR functionality to your customers in the shortest possible time.

In order to be confident in the functionality and reliability of your ABR implementation you can now use the BSTS to monitor switch marking behavior, measure switch reaction times, check the interaction with signalling, and measure the overall Quality of Service (QoS).

The BSTS ABR solution allows you to generate ABR traffic at rates up to 155 Mb/s, decode resource management (RM) cells, and analyze ABR flows. You can setup an SVC ABR connection and test a switch's ability to correctly negotiate, connect, transport, and clear ABR calls. A range of measurements are available to determine the functional performance of an ABR connection including cell loss, AAL-5 frame error and RM-cell error.

The ABR Emulator works with existing BSTS modules to form part of the complete ABR test solution.

Agilent Technologies
Innovating the HP Way

Typical Applications

The BSTS ABR solution is ideal for network equipment manufacturers and service providers who need to test the functional performance of ABR on ATM switches. The Agilent E6287A ABR Emulator can be used with a range of BSTS modules to answer the following questions:

- Can my switch create and support an ABR connection correctly?
- Does my switch cope with misbehaving ABR sources?
- Is my switch able to control ABR sources to avoid congestion?
- Does my switch generate out-of-rate cells when it is supposed to?
- Does my switch mark cells when it is supposed to?
- How long does it take my switch to react to the presence or absence of congestion?
- Does my switch's "Use it or lose it" feature work correctly?

Key Product Features

ABR Emulation

The Agilent E6287A can perform both ABR source and destination behavior for a single ABR connection with complete control over a number of ABR parameters such as MCR, RIF, Nrm, ICR, RDF and ADTF.

ABR Traffic Generation

The BSTS ABR solution allows you to generate ABR traffic at rates up to 149.76 Mb/s including the generation of both forward and backward ABR RM cells.

ABR Decodes

The BSTS ABR solution is capable of decoding ABR traffic using the Agilent E4209A/B Cell Protocol Processor or ATM line interface.

Statistics

The BSTS ABR solution allows you to take a range of measurements to determine the functional attributes of an ABR connection including:

Cell Counts:

- ABR RM cell count

Cell Rates:

- Throughput
- ABR RM cell rate

Cell Ratios:

- Cell loss ratio (CLR)

AAL-5 PDU Count:

- Total AAL-5 PDUs
- Total errored AAL-5 PDUs

Line Utilization:

- Transmit line utilization
- Receive line utilization

Applicable Standards

The BSTS ABR solution complies with:

- ATM Forum's Traffic Management Specification Version 4.0, April 1996
- ITU-T Recommendation I.371.

ABR Flow Control Mechanisms Supported

The Agilent E6287A ABR Emulator supports all four varieties of ABR flow control mechanisms as defined by ATM Forum Traffic Management 4.0 specification including:

- EFCI marking
- Relative rate marking
- Explicit rate marking
- VS/VD control

Integrated ATM Forum Traffic Management 4.0 Testing

To complete a comprehensive TM 4.0 conformance test you will need to emulate various scenarios that specify a range of services running over CBR, VBR, UBR and ABR connections. The ABR Emulator can be used in conjunction with the Agilent E4209B Cell Protocol Processor to provide a stimulus/response ATM traffic solution for the other service categories including CBR, VBR, and UBR.

Investment Protection

The BSTS ABR solution leverages off the functionality of existing BSTS modules protecting your current investment in the BSTS. Leveraging off commonly used modules such as the Agilent E4209A/B Cell Protocol Processor or Agilent E4214B UNI4.0Signalling Test Software provides you with a low cost solution for testing the complexities of ABR with minimal incremental cost. Additional modules that can be used with the Agilent E6287A ABR Emulator include:

- Any existing BSTS ATM Line Interfaces from 1.5 Mb/s to 622 Mb/s
- Agilent E4209B Cell Protocol Processor (CPP)
- Agilent E4214B UNI Signalling Test Software
- Agilent E4223A Policing and Traffic Characterization Test Software

ABR Testing Solution Note

ABR Technology Overview and Testing Challenges, an Agilent application note, is available and can be obtained by contacting your local Agilent sales representative.

This application note provides an overview of ABR technology and some of the challenges faced when testing the complexities of ABR.

Configuration and Use With Other BSTS Modules and Applications

The ABR Emulator works with the following existing BSTS modules in order to form the complete ABR test solution:

- Any existing BSTS ATM Line Interfaces from 1.5 Mb/s to 622 Mb/s
- Agilent E4209B Cell Protocol Processor (CPP)
- Agilent E4214B UNI 4.0 Signalling Test Software
- Agilent E4223A Policing and Traffic Characterization Test Software

Since the Agilent BSTS is a flexible and modular ATM/B-ISDN test platform, you can maximize the return on your test equipment investment by selecting a chassis, line interfaces, dedicated hardware modules, and test software that suit your specific needs. Remember that you can always add extra software or modules at any time.

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.

Software

Agilent Broadband Series Test System software and firmware products are supplied on transportable media such as disk, CD-ROM 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.

Product Numbers

- **E6287A** ABR Emulator
- **E4200B** BSTS Form-7 Transportable Chassis
- **E4210B** BSTS Form-13 Mainframe Chassis
- **E4209A/B** Cell Protocol Processor
- **E4214B** UNI 4.0 Signalling Test Software
- **E4223A** Policing and Traffic Characterization Test Software

Technical Specifications

ABR Emulator module

General Characteristics	ABR flow control: • Emulates ABR source and destination behavior on one channel; can do both simultaneously • Supports all ABR flow control methods; EFCI, RR, ER, and VS/VD ABR service class traffic: • Generates user test cells on one channel; source rate responds to BRM cells • Generates FRM and BRM cells as appropriate • Generates in-rate or out-of-rate RM cells as appropriate Real-time display of ABR connection status: • Bandwidths for active, available, received RM cells 155 Mb/s cell bus: • Interworks with BSTS line interface and protocol analysis modules
Connection & Emulation Controls	Emulation (source and destination behavior): • On (default) or off In-rate RM and user cell generation: • Enable (default) or disable Out-of-rate RM cell generation: • Enable (default) or disable Loopback RM cells: • Enable (default) or disable
Out-of-rate RM Cell Generation	• Up to 10 out-of-rate RM cells/second can be generated (see flow diagram on page 5) • Has the effect of sharing out-of-rate bandwidth between FRM and BRM cell generation • Can be disabled if chosen
Real-Time ABR Connection Status	Active: • Total user cell and RM cell bandwidth generated by the ABR Emulator module (c/s) Available: • Unused bandwidth available for user and RM cell generation by the ABR Emulator module (c/s) LCR (Line cell rate): • Maximum cell rate supported by the selected line interface (c/s) Received RM: • Total received RM cell bandwidth (c/s)

ABR Emulation

Emulation Performance	Dependent on the distribution and contents of RM cells and emulation conditions: • Up to 15,000 RM c/s • Typically 5000 RM c/s for both FRM and BRM cell processing • The user is notified if emulation overload occurs Source rate adjustment delay: • Typically < 200 µs from receipt of BRM cell to adjustment of source rate Destination loopback delay: • Typically < 200 µs from receipt of FRM cell to internal queuing of BRM cell for transmission
Global Connection Parameters	ATM cell header: UNI or NNI (default) • UNI mode: GFC = 0, VPI $\leq$ 255 • NNI mode: VPI $\leq$ 4096 Cell rates: • Specified in c/s (cells per second)
User Test Cell Format continuous 8-cell repeating sequence	Adaptation layer type: • combined AAL-1 and AAL-5 format Payload type: • PTI = user, no congestion; eighth cell indicates the end of the AAL-5 PDU Cell loss priority: • CLP = 0 (high priority) Payload; 8-cell sequence: • first octet of each cell contains a valid AAL-1 SN/SNP value • eighth cell contains a valid AAL-5 trailer; UU, CPI, Length, CRC-32 • payload bytes which are not used by the adaptation layer contain an incrementing pattern, starting from 0x00 in each cell
Source Rate Behavior ACR (Allowed Cell Rate)	Start of emulation: • ACR = ICR (Initial Cell Rate) During emulation, the ACR responds to BRM cell information: • ACR $\geq$ MCR (Minimum Cell Rate) • ACR $\leq$ PCR (Peak Cell Rate) The source rate is always adjusted to the ACR unless source rate override is enabled: • Source rate may be held at a fixed user-specified value (c/s) • Source rate may be held at a user-specified percentage of the sampled ACR; [0.01 x ACR] $\leq$ Source Rate $\leq$ [10 x ACR]; Source rate cannot exceed LCR

User-configurable ABR Emulation Parameters

Initial Cell Rate:

- $0 \leq ICR \leq PCR$; resolution = 1 c/s

Minimum Cell Rate:

- $0 \leq MCR \leq PCR$; resolution = 1 c/s

Peak Cell Rate:

- $0 \leq PCR \leq LCR$; resolution = 1 c/s;
- **Note:** When the PCR value is reduced, the instrument will automatically reduce ICR, MCR, or ER (if necessary) to ensure they do not exceed PCR

Rate Increase Factor:

- $RIF = 2^n$; n = -15 to 0

Rate Decrease Factor:

- $RDF = 2^n$; n = -15 to 0

FRM cell spacing:

- $Nrm = 2^n$; n = 1 to 8

ACR Time Decrease Factor:

- 0.01 s ≤ ATDF ≤ 10.23 s; resolution = 0.01 s

ABR Source Behavior

FRM Cell Fields

- Controlled during emulation

Current Cell Rate:

- CCR = sampled ACR value; determined from received BRM cells

Sequence Number:

- SN = incrementing, mod 2^{32}

Error Check Field:

- CRC-10 = valid

Cell Loss Priority:

- CLP = 0 (in-rate RM cells)
- CLP = 1 (out-of-rate RM cells)

FRM Cell Fields

- Static during emulation

Protocol ID:

- ID = 1

Direction:

- DIR = 0

BECN cell indicator:

- BN = 0;

Congestion Indicator:

- CI = 0

No Increase indicator:

- NI = 0 or1, as set by user

Request/Acknowledge:

- RA = 0

Explicit Rate:

- ER = value (c/s), as set by user

Minimum Cell Rate:

- MCR = value (c/s), as set by user

Queue Length:

- QL = 0

All Reserved octets:

- Res = 0

ABR Destination Behavior

General Characteristics

- On receiving a FRM cell, a BRM cell is sent at the earliest in-rate (CLP=0) or out-of-rate (CLP=1) opportunity

---

Backward RM Cell Fields

- **Note:** *unchanged* means the destination copies the value from the received FRM cell into the BRM cell

Cell Loss Priority:

- CLP = unchanged

Protocol ID:

- ID = 1

Direction:

- DIR = 1

BECN cell indicator:

- BN = 0

Congestion Indicator:

- If a forward user cell with EFCI is received, CI = 1, otherwise CI = unchanged
- **Note:** The user can force CI = 1

No Increase indicator:

- NI = unchanged
- **Note:** The user can force NI = 1

Request/Acknowledge:

- RA = 0

Explicit Rate:

- ER = value (c/s), set to the minimum of: the ER value contained in the received FRM cell; or a user-specified value

Minimum Cell Rate:

- MCR = unchanged

Current Cell Rate:

- CCR = unchanged

Queue Length:

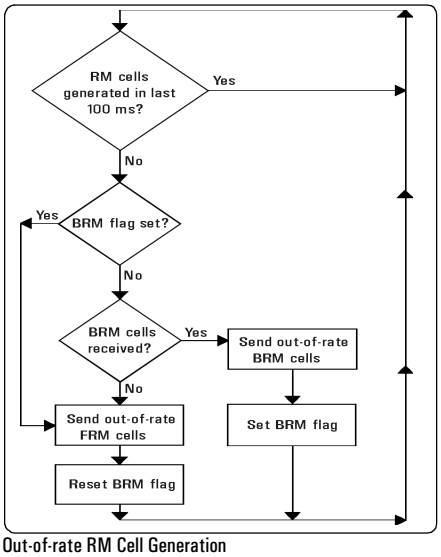
- QL = unchanged

Sequence Number:

- SN = unchanged

Error Check Field:

- CRC-10 = valid



Out-of-rate RM Cell Generation

Protocol Analysis and Physical Layer Access

155 Mb/s Cell Bus Access to other BSTS modules

- **AE**: E6287A ABR Emulator

Left-hand cell bus is compatible with the following BSTS modules:

- **CPP**: E4209A or E4209B Cell Protocol Processor with E4212A/B AAL test software and *abrExtract* conversion utility
- **AE**: additional E6287A ABR Emulator module

Right-hand cell bus is compatible with the following BSTS modules:

- **OPT**: E6270A OAM Protocol Test module
- **NEM**: E4219A Network Impairment Emulator Module
- **LIF**: BSTS Line Interface module; see list below

Typical System Configurations

AE-LIF + AE-LIF

- End-to-end ABR source-to-destination emulation

CPP-AE-LIF

- ABR emulation with ABR flow control analysis:
- E4212A/B AAL test software decodes ABR RM cells
- *abrExtract* flow control analysis utility converts captured ABR RM cells into a log file that can be viewed graphically

AE-AE-AE-AE-LIF

- Multi-channel ABR testing (up to 4 channels)

AE-NEM-LIF

- ABR source or destination emulation with ATM impairments; test ABR flow control behavior under controlled cell loss conditions

AE-OPT-LIF

- ABR source or destination emulation with insertion of F4/F5 OAM cells; use for testing fault management or performance management

Supported Module Configurations

An ABR 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:

- Priority order: LIF, NEM, OPT, AE, CPP
- 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

Supported Line Interface Modules

SONET/SDH

- E1617A OC-1 optical
- E1612A STS-3c/STM-1 electrical
- E1697A OC-3c/STM-1 optical
- E4203A OC-3c/STM-1 optical
- E1618A Rel 1.1 622 Mb/s Optical Line Interface automatically configured for 155Mb/s cell bus operation

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 RM cells

ID (octet 6)

- Message Type (octet 7); hexadecimal value representing:
- DIR (bit 8), BN (bit 7), CI (bit 6), NI (bit 5), RA (bit 4), Res (bits 3-1)

ER (octet 8-9)

CCR (octet 10-11)

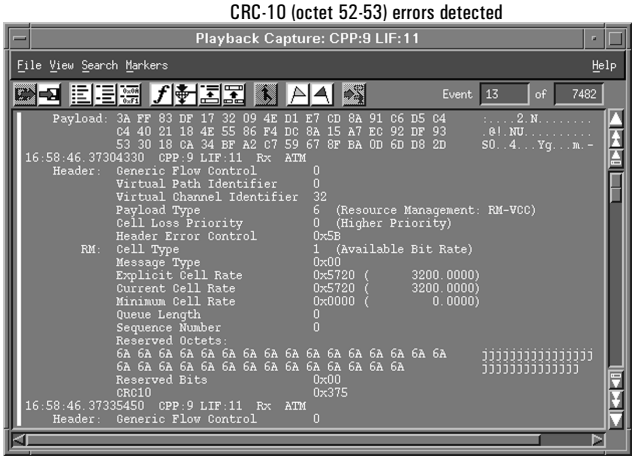
MCR (octet 12-13)

QL (octet 14-17)

SN (octet 18-21)

Res (octet 22-51)

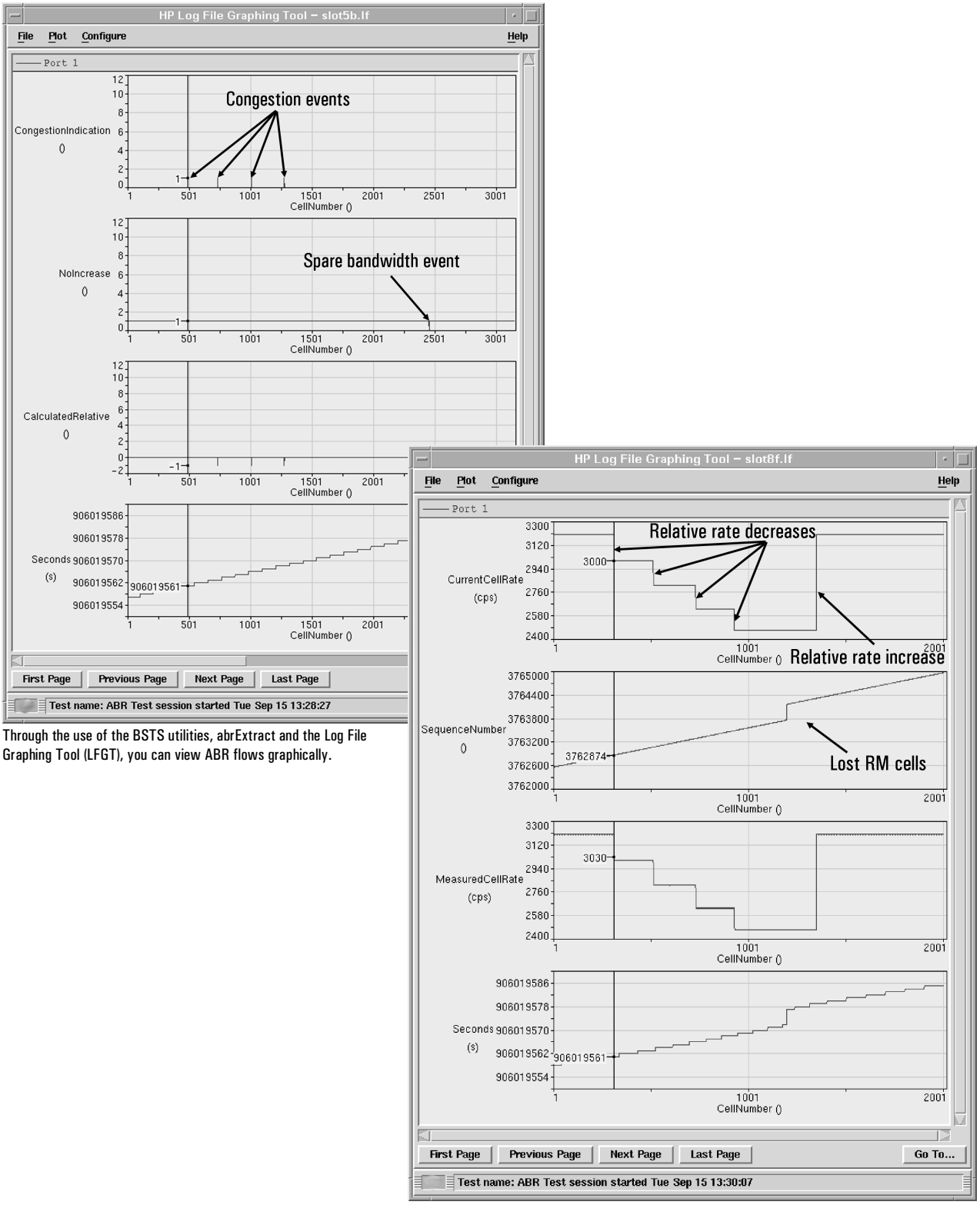
CRC-10 (octet 52-53) errors detected



RM cell decode

abrExtract Utility

General	Processes the CPP capture buffer: • Extracts ABR flow control information from ABR cells • Writes statistics to log files which can be viewed graphically, using the BSTS Log File Graphing Tool Output • A log file for FRM statistics • A log file for BRM statistics
User-defined parameters	• VPI/ VCI • NNI or UNI header format • n; the maximum number of cells to extract from the CPP capture buffer; default is to extract all cells
Extracted statistics	Congestion Indication: • the value of the CI bit in the RM cell No Increase • the value of the NI bit in the RM cell Explicit Rate • the value of the ER field in the RM cell Current Cell Rate • the value of the CCR field in the RM cell Queue Length • the value of the QL field in the RM cell Sequence Number • the value of the SN field in the RM cell Minimum Cell Rate • the value of the MCR field in the RM cell **RM cell arrival time**; used for correlation across multiple log files • **Seconds**: the *seconds* portion of the RM cell capture timestamp • **Nanoseconds**: the *nanoseconds* portion of the RM cell capture timestamp
Derived Statistics	**Measured Cell Rate**; gives an indication of the instantaneous cell rate: measured cell rate = N_{user} / (t_{RM2} - t_{RM1}) • where N_{user} is the number of user cells, matching the specified VPI/VCI, and occurring between two RM cells; • t_{RM1} & t_{RM2} are the capture timestamps of the two RM cells Interarrival Time • the time between two successive RM cells **Relative Rate Movement** (RRM); based on the CI & NI bit values; RRM = • +1; indicates a relative rate increase • 0; indicates no change • -1; indicates a relative rate decrease



Through the use of the BSTS utilities, abrExtract and the Log File Graphing Tool (LFGT), you can view ABR flows graphically.

Mechanical Specifications

Size and 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 cell on an enabled connection 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

ABR Functions	• ITU-T I.371 Traffic Control and Congestion Control in B-ISDN, October 1996 • ATM Forum Traffic Management Specification TM4.0, April 1996

Acronyms

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
ACR	Allowed Cell Rate
AE	Agilent E6287A ABR Emulator module
ASP	Agilent E1609A 0-622 Mb/s ATM Stream Processor
ATDF	ACR Time Decrease Factor
BN	Backward Explicit Congestion Notification cell indicator (RM cell)
BRM	Backward Resource Management
CBR	Constant Bit Rate
CI	Congestion Indicator (RM cell)
CLP	Cell Loss Priority
CPI	Common Part Indicator (AAL-5)
CPP	Agilent E4209A or E4209B Cell Protocol Processor
DIR	Direction (RM cell)
EFCI	Explicit Forward Congestion Indication
ER	Explicit Rate
FRM	Forward Resource Management
ICR	Initial Cell Rate
ID	Protocol ID (RM cell)
LCR	Line Cell Rate
LIF	BSTS Line Interface module
MCR	Minimum Cell Rate
NEM	Agilent E4219A Network Impairment Emulator Module
NI	No Increase indicator (RM cell)
Nrm	FRM cell spacing
OPT	E6270A OAM Protocol Test module
PCR	Peak Cell Rate
PTI	Payload Type Indicator
QL	Queue Length (RM cell)
RA	Request/Acknowledge (RM cell)
RDF	Rate Decrease Factor
RIF	Rate Increase Factor
RM	Resource Management (forward and backward)
RR	Relative Rate
SN/SNP	Sequence Number/ Sequence Number Protection (AAL-1)
UBR	Unspecified Bit Rate
UU	User-to-User Indication (AAL-5)
VBR	Variable Bit Rate
VS/VD	Virtual Source/ Virtual Destination

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.

5965-8907E 03/00 Rev C

Agilent Technologies
Innovating the HP Way