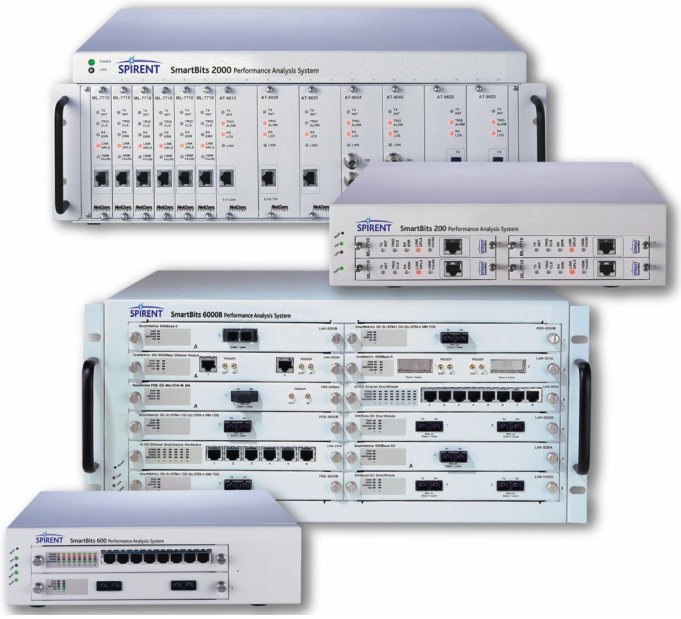
SmartBits

Performance Analysis System

SmartBits System Reference

February 2001



SPIRENT Communications

P/N 340-1087-001 REV A

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1. Formerly known as Netcom Systems, Inc.

Contents


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About This Guide

In this section . . .

This portion of the user guide contains the following topics:

Purpose

The SmartBits System Reference manual provides system architecture information, basic product information, and specifications, with an emphasis on hardware usage.

Audience

This manual is designed for engineers and technicians who are familiar with PCs and have a working knowledge of telecommunications devices and networks.

Manual Content

This manual contains the following chapters:

"About This Guide"	Provides an overview of this manual.
Chapter 1, "Documentation and Website Overview"	An overview of SmartBits documentation, related manuals, website, training information and technical support.
Chapter 2, "System Architecture"	Detailed information on SmartBits chassis, software applications, traffic generation, and performance analysis.
Chapter 3, "Multiple Users Accessing a Chassis"	Explains how to access a chassis, including multi-user requirements, operation and features
Chapter 4, "Maintenance and Upgrade Procedures"	Provides maintenance and upgrade procedures including, downloading firmware, adding SmartCards/ modules, changing timeout and fuses, and converting SmartCards/modules.
Chapter 5, "Core Software Applications"	An overview of core applications for SmartWindow, SmartLib, and SmartApplications.
Chapter 6, "Optional Applications"	Provides a list of optional applications for the SmartBits chassis.
Chapter 7, "Sample Test Topologies"	Describes testing of sample devices and networks including a summary of tests.
Chapter 8, "Chassis Specifications"	Provides specification information for all SmartBits chassis.

Chapter 9, "Ethernet Cards"	Describes Ethernet card features, performance, and methodology.
Chapter 10, "Packet over SONET Modules"	Describes POS card features, performance, and methodology.
Chapter 11, "ATM Cards"	Describes ATM card features, performance, and methodology.
Chapter 12, "WAN Cards"	Describes WAN card features, performance, and methodology.
Chapter 13, "Token Ring Cards"	Describes Tokin Ring card features, performance, and methodology.
Appendix A, "RFCs and Standards Supported"	Describes RFCs and Standards supported by SmartBits applications.
Appendix C, "Certifications and EMI Compliance"	Describes safety and emission standards, FCC statement, and EC requirements.
Appendix B, "Auto Negotiation"	Defines auto negotiation as performed by SmartBits systems and SmartCards/modules.
Appendix D, "ToS Parameters"	Describes type of service values.
Appendix E, "SMB-600/6000B Cables and Connectors"	Describes the cable and connections features available for the SMB-600/6000B
Appendix F, "SMB-200/2000 Cables and Connectors"	Describes the cable and connections features available for the SMB-200/2000
Appendix G, "Serial Port Commands"	Overview of the serial port command set.
"Glossary of Terms"	Describes common features and terms used with SmartBits chassis.

Conventions

This guide uses the following typographical conventions:

- *Italics* for parameter names, chapters, document names, areas within windows, and words of emphasis.
- **Bold** for paths in procedures, any button, key, or tab being selected, menu options and values within a field, and tab names.
- The terms *DUT* and *device under test* as well as *SUT* and *system under test* are used interchangeably in this guide.
- Text you enter or input is shown in `Courier`.
- Directory and file names are shown in Helvetica.
- The terms *packet* and *frame* are used interchangeably.
- The terms “SmartCard” and “card” refer to the circuit boards used with the SMB-200/2000 chassis. The term “module” refers to the circuit boards used with the SMB-600/6000B chassis.

Notes, cautions, and other important user information are shown as follows:

Note: Includes related information and tips.

Caution: Includes related precautions.

Important: Includes related important details.

Warning: Includes related warnings to prevent damage to equipment and or injury.

Related Manuals

Additional manuals related to this Product Name Reference manual are listed below.

- *SmartBits 200/2000 Installation Guide*: Describes how to set up the IP address of a SMB-200 or SMB-2000 chassis and perform a first-time installation.
- *SmartBits 600/6000B Installation Guide*: Describes how to set up the IP address of a SMB- 600 or SMB-6000B chassis and perform a first-time installation.
- User guides supplied with both core and optional software applications.

Online Help

In each Product Name GUI application, you can access online Help in two ways:

- Press the **F1** key in the window about which you wish information.
- From the menu bar, select **Help > Contents** to view the entire contents of the Help file.

How to Contact Us

Technical support is available Monday through Friday between 07:00 and 18:00 Pacific Standard Time.

To obtain technical support for any product, please contact our Technical Support Department using any of the following methods:

Phone: +1 800.886.8842 (available in the U.S. and Canada)

+1 818.676.2589

Fax: +1 818.880.9154

E-mail: smartbits.support@spirentcom.com

In addition, the latest versions of application Help files, application notes, and software and firmware updates are available on our website at:

http://www.spirentcom.com

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1 Documentation and Website Overview

In this chapter . . .

SmartBits Documentation

The user documentation for SmartBits Performance Analyzers is organized into manuals included in multiple binders, on CD, and/or the Spirent Communications website at: **www. spirentcom.com**

To keep pace in a fast-moving industry, the latest documentation for our new and improved product family is available as follows:

For the latest documentation for:	Please refer to:
Software programs or versions	The online help for the new program and/or the revised user guide
Firmware	Release notes under *Support* at the website
SmartCards/modules	• Data sheets under *Products* at the website • Online help for SmartWindow
Manuals	*Documentation* area of the website

Core manuals

All chassis orders ship with the following manuals on CD. The installation guides and this System Reference manual are provided in hardcopy form:

- **SmartBits 200/2000 Installation Guide**. Provide initial installation and troubleshooting procedures (for SMB-200/2000 chassis.
  or
  SmartBits 600/6000B Installation Guide. Provide initial installation and trouble-shooting procedures (for SMB-600/6000B chassis).
- **SmartWindow User Guide**. Describes how to use SmartWindow – a versatile GUI designed for custom testing.
- **SmartApplications User Guide**. Describes how to use SmartApplications – a set of automated, tests based on RFC-1242 and RFC-2544.
- **SmartApplications API Manual**. Explains how to use the SmartApplications API software – a set of canned scripts used to run SmartApplications tests.
- **SmartLib User Guide and SmartLib Message Functions Guide**. Explain how to program using SmartLib – a comprehensive programming tool to meet unique requirements or to streamline testing.
- **SmartBits System Reference** (this manual).

Additional user guides

With any additional applications purchased, you will receive a user guide on the product's software CD.

Spirent Communications Website Resources

Please visit the Spirent Communications website at:

www. spirentcom.com

Located at this site are the latest product updates, technical tips and papers, technical support information, enhanced firmware, updated documentation, and industry links.

The following website resources are only examples of the material at your fingertips.

Data Sheets and Brochures

A variety of data sheets and brochures are available on Spirent Communications chassis, applications, and cards.

Technical Support Software, Firmware, and Documentation Updates

If you have SmartBits products and wish to upgrade your version or obtain the latest firmware release, contact Spirent Communications Technical Support for the necessary passwords and then download the desired files directly from our website.

Training Classes, Seminars, and Consulting Services

Spirent Communications offers a variety of technology-based and product-specific courses and seminars. Consulting services are also available for custom work, such as scripting.

SmartTraining

Through a combination of lecture and labs, students will learn how to use SmartBits hardware and software. Our wide range of workshops can be customized for your needs.

SmartTraining courses focus on how to effectively use Spirent Communications hardware and applications. Our programs provide a hands-on approach to learning products, technology, and test methodologies. Through a variety of courses, we can provide your organization with an entire training solution, or use individual courses to enhance your technicians' skills.

Services include but are not limited to:

- Spirent Communications Training Facilities
- On-site Training
- Portable Mini-Lab
- Program Customization
- Full Testing and Certification
- Train-the-Trainer Program
- Full Administrative Support

Course Offerings:

- TRN-301 "SmartLibrary Programming using Tcl"
- TRN-402 "How to Test Multi-Layer Devices and Networks"
- TRN-501 "How to Test QoS Devices and Networks"
- TRN-601 "How to Test ATM Devices and Networks"

Seminars

Check our website regularly to find out about upcoming events. Past seminars have focused on the following topics:

- **Multi Layer Switch Testing & Analysis**. For developers, service providers, and major enterprises.
- **Broadband Test and Analysis**. Includes information on xDSL, Cable Modem, and ATM.
- **Voice over IP**. Explains voice over IP technology and introduces the SmartVoIPQoS product.

SmartConsulting

Expert technical consultants are available and offer specialized assistance in performing tests and analyzing the data to get optimum results from your equipment or network.

SmartConsulting focuses on high value-added services that provide an immediate return for your investment. These services are ideal when specialized expertise is needed, time is limited, or internal resources are unavailable. Our goal is to provide custom software applications development and support tailored to meet the specific needs of your projects. SmartConsulting provides access to applications developers with the ability to work directly on-site with you. These time-saving services can be tailored to meet your exact needs.

Services include, but are not limited to:

- Custom Application and Script Development
- Test Methodology Development
- SmartLab Testing
- On-site Support and Training
- SmartLibrary Training
- Phone Support
- ISO-9000 Compliance Testing Application Design

Technology Papers, Articles, and Application Notes

In addition to white papers and application notes, links to hot topics and key industry magazines, such as those listed below, are readily available at our website:

- *Spirent Communications Introduces World's First 10 Gigabit Ethernet Product.*
- *Spirent Communications Introduces First Network Performance Analysis Solution for Storage Area Networks (SANs).*
- *Multiprotocol Label Switching (MPLS) Performance Analysis.*
- *GX-1420B* (Most Innovative Award – InternetWeek).
- *SmartVoIPQoS* (Internet Telephony Product of the Year). Feature on VoIP and the performance of data quality Quality of Service (QoS).
- *TeraMetrics* (Best of Show Award at Networld + Interop).

Spirent Communications US Government Solutions

Spirent Communications is pleased to announce **product availability through GSA contract # GS-35S-4550G** held by Management Systems Designers, Inc., our partner holding GSA Schedules. Once you have selected the Spirent Communications products you want, order them from MSD.

Websites of Industry Lab Partners

To see outstanding examples of Spirent Communications products creating benchmark test data, explore the following websites as well:

- Centennial Networking Labs (**www.cnl.ncsu.edu**)
- ZD Labs (Morrisville, NC)(**www.zdlabs.com**)
- The Tolly Group (**www.tolly.com**)
- University of New Hampshire (**www.iol.unh.edu**)

- Network Computing Magazine (**www.nwc.com**)
- NSTL (**www.nstl.com**)
- Network Test (**www.networktest.com**)
- Government Computing News (**www.gcn.com**)

2 System Architecture

In this chapter . . .

SmartBits Chassis Models and Cards

SmartBits chassis models are available in several different models. The chassis you choose will depend on the requirements of your system.

SmartCards are custom-designed printed circuit boards (PCBs) that fit within a SmartBits chassis to generate, capture and track network traffic. They fit into the SMB-10, SMB-2000, and SMB-200 chassis.

Modules consist of one PCB, but have a higher port density than the SmartCard. Each card is attached to a tray specially designed for the SMB-600 and the SMB-6000B.

The term *"card"* can refer to any SmartCard or module.

The various models of SmartBits chassis are listed in *Table 2-1*.:

Table 2-1 SmartBits Chassis SmartCards/Modules Applications

Model [1]	Max # Ports	Card Types [2]	Available Technologies	Available Core and Software Applications
SMB-200	4	SmartCards	All [3]	All
SMB-2000	20	SmartCards	All [3]	All
SMB-600	16	Modules	Eth + POS [4]	Core Set+(5)
SMB-6000B	96	Modules	Eth + POS [4]	Core Set+ (5)
SMB-10 [5]	20	SmartCards	All	All

1 The SMB-1000, an older model chassis, requires an upgrade to the SMB-2000 level to use current SmartCards and software.
2 The different card types are not interchangeable; namely, the SmartCards are not interchangeable with modules.
3 All technologies except POS (Ethernet, ATM, Frame Relay, Token Ring).
4 Eth + POS = Fast and Gigabit Ethernet and Packet over SONET (POS).
5 The SMB-10 "slave" chassis is controlled and dependent on an SMB-2000 chassis.

SmartBits-200

The SmartBits-200 (SMB-200) is a portable, 4-slot network performance analysis test system, a streamlined version of the SMB-2000. The SMB-200 is fully compatible with the SMB-2000 system, utilizing all the same SmartCards and software applications.

Each SMB-200 is a complete performance analysis test system that measures the performance limits of network devices and complex network configurations, including 10/100/1000 Mbps Ethernet, Gigabit Ethernet, Token Ring, ATM, and Frame Relay.

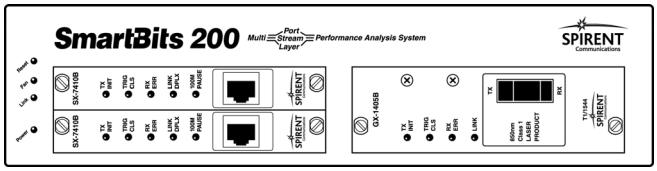


Figure 2-1. SmartBits-200 Chassis

SmartBits-2000

The SmartBits-2000 (SMB-2000) multi-user 20-slot chassis is a complete network performance analysis test system that measures the performance limits of network devices and complex network configurations, including 10/100/1000 Mbps Ethernet, Gigabit Ethernet, Token Ring, ATM, and Frame Relay.

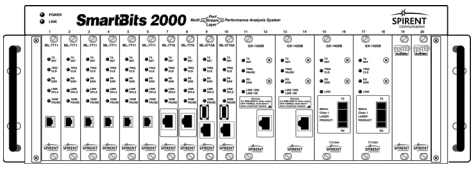


Figure 2-2. SmartBits-2000 Chassis

Differences Between SMB-200 and SMB-2000

- SMB-200 does not have the DB-37 connectors for the SmartBits stack configuration, therefore does not support multiple users and the SMB-10 extension hub.
- SMB-200 has front panel Fan, Link, and Power LEDs, and a reset switch. The SMB-2000 has only Power and Link LEDs and no reset switch.
- SMB-200 SmartBits System is the portable version of the SMB-2000 chassis.
- SMB-200 has a 4-slot chassis vs. SMB-2000 which has a 20-slot chassis.

Note: Although the SMB-200 cannot be stacked, it is able to be expanded with multiple chassis via the expansion ports.

SmartBits-10

The SMB-10 is a 20 slot chassis that connects to and expands the capacity of a SMB-2000. This chassis is totally dependent on the controller of the connecting SMB-2000, and is called a “slave.”

SmartBits-600

The SmartBits-600 (SMB-600) is a portable and compact high-density-for-its-size network performance analysis test system. Compatible with the SMB-6000B system, the SMB-600 holds up to two modules that can support up to 4 Gigabit Ethernet ports, 16 10/100 Mbps Ethernet ports, two POS (Packet over SONET) ports, two SmartMetrics Gigabit ports, or a mixture of these port types.

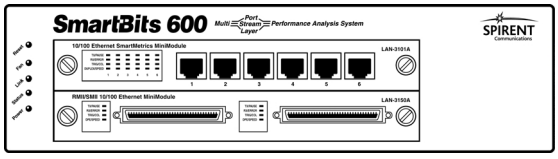


Figure 2-3. SmartBits-600 Chassis

SmartBits-6000B

The SmartBits 6000B (SMB-6000B) is an ultra high-port density network performance analysis test system. Each chassis holds up to 12 modules that can support up to 24 Gigabit Ethernet ports, 96 10/100 Mbps Ethernet ports, 12 POS (Packet over SONET) ports, 12 SmartMetrics Gigabit Ethernet ports, or a mixture of these port types.

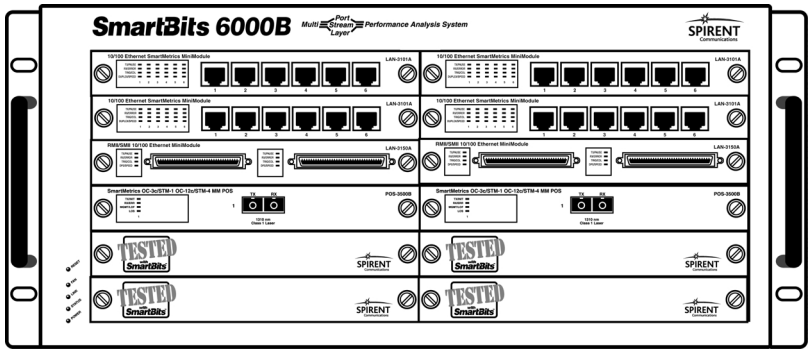


Figure 2-4. SmartBits-6000B Chassis

Summary of SmartBits Software

The SmartBits unique system design offers many user control options – from full-function graphical user interface software to a fully-documented programming library.

Please refer to *Chapter 5, "Core Software Applications"* and *Chapter 7, "Sample Test Topologies"*, for an overview of each software application currently available. For in-depth information, you can refer to the user manual or the online help at http://www.netcomsystems.com/ for each application.

SmartBits chassis have a wide range of applications available, depending on the SmartCard/module types selected.

Table 2-2. Card Types Supported by SmartBits Software

Smart Software	Ethernet [1]	ATM [1]	WAN	Token Ring	POS [1]
SmartWindow [2]		X	X	X	X
SmartLib [2]	X	X	X	X	4
SmartApplications	X	X	X	X	X
SmartSignaling		X			
SmartMulticastIP	X				
SmartxDSL	X	X			
SmartFlow	X				X
SmartVoIPQoS	X				X
AST II	X				
VAST	X				
SmartCableModem Test [2]	X				
ScriptCenter	X	X	X	X	X
SmartTCP	X				

1 Appropriate cards for an application vary according to application. Refer to *Chapter 5, "Core Software Applications,"*, and *Chapter 6, "Optional Applications,"* for program descriptions.
2 ML05710 USB mode available.

Card Architecture

The three general types of SmartBits card architecture reflect the increasingly complex demands of networks and network devices. Each type serves a vital role in performance analysis of a network and its components.

Table 2-3. Architecture of Cards by Emphasis on Layer Testing

Card Processor Type	Designed for testing...
Traditional also known as “packet-blasters”	TCP/IP Layers 1, 2 and 3
SmartMetrics	TCP/IP Layers 2 through 5, with an emphasis on Layers 3 and 4, and latency measurements
TeraMetrics	TCP/IP Layers 2 through 5, with an emphasis on high speed technologies and advanced testing methodologies implemented via a onboard Pentium/Linux processor

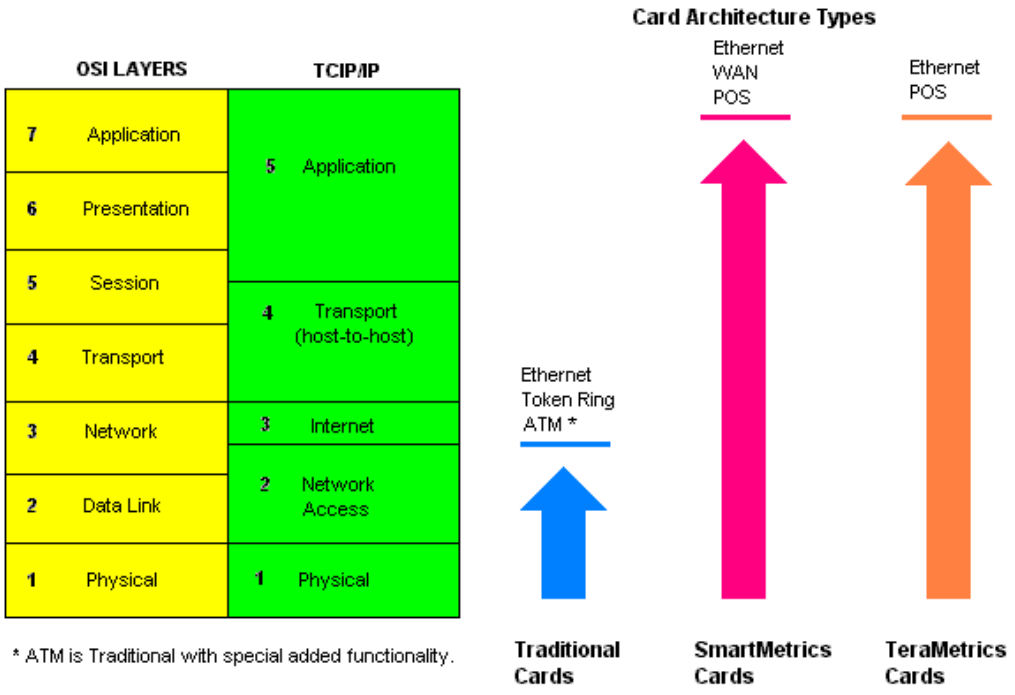


Figure 2-5. Where Card Architecture Types Function

For a list of cards supporting each application, refer to the chapter on each card type.

Traffic Generation and Performance Analysis

Each SmartBits port physically generates one frame at a time, at a user-defined rate. The port traffic can be varied, tracked, and analyzed in different ways, depending on the processor technology of each card (Traditional, SmartMetrics, or TeraMetrics).

The following terms will assist you in understanding SmartBits terminology:

- **Stream**. A common template, pattern or packet structure based on a single protocol; a single basic frame blueprint with a user-defined custom format or a selected standard protocol format. A *stream* acts like virtual host on a SmartBits card and simulates the traffic of a workstation or server on a network. Depending on the processor types, the individual frames may or may not have specialized tracking and reporting capabilities.
- **Traditional Stream**. A single frame blueprint generated from a single port, with varied frames generated via Variable Field Definitions (VFDs). These frames are counted at the receiving ports but do not include a signature field for specialized tracking.
- **SmartMetrics Stream**. Retains its own signature field with a unique timestamp and sequence ID and may generate many varied frames with specialized tracking and reporting capabilities. The signature field is the mechanism for advanced tracking and analysis methods, namely latency histograms, sequence tracking of every frame, and raw tag reporting.
- **TeraMetrics Stream**. Has SmartMetrics stream capabilities with special variations available for very high speed technologies.
- **Flow**. An industry-wide term referring to transmitted traffic sent from point A to point B, tracked based on unique source and destination combinations. In SmartBits products and documentation, this term is used as an abbreviation for the term *SmartFlow* described below.
- **SmartFlow**. A Spirent Communications term that is a superset of the above definition of “flow.” A *SmartFlow* may include a single flow of traffic from point A to point B, and may transmit many-to-one, one-to-many, or a set of different flows from either receiving or transmitting ports for statistical analysis.

  A *SmartFlow* is one or more frames from one or more sources to one or more destinations that are tracked as a single entity. The sources and destinations can be defined at the MAC, IP, TCP, or UDP level.

Traditional Cards and Traffic

The first series of SmartBits cards, called Traditional, generates one standard stream, or one frame blueprint, plus one or two alternate streams per port, with the primary processing located in the chassis controller.

For a summary of Traditional card features, please refer to *Table 2-4 on page 22*.

Each stream may also generate thousands of continuously varied frames by incrementing or decrementing source or destination addresses, or varying the frame content via VFDs (*variable field definitions)* in SmartWindow and SmartLib. These frame variations exercise the DUT or system under test at up to full wire rate but do not have latency measurements or out-of-sequence tracking for each frame.

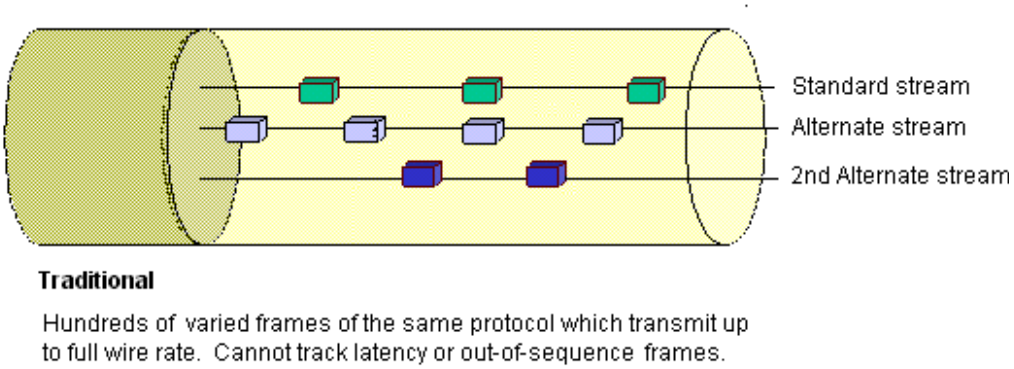


Figure 2-6. Traditional Cards and Traffic

The Traditional architecture refers to the basic capabilities of all cards, including most or all of the following features for the individual cards, available in SmartWindow and SmartLib.

- **Generate Packets Up to and Beyond Wire Speed**. Uses a variety of transmission modes, with the ability to dynamically vary packet gap and length during transmission, adjust preamble length, auto negotiate speed and duplex mode, and capture frames.
- **Each Port Generates a Standard Stream**. Also known as the Background template or frame blueprint, the standard stream generated from a Traditional card is based on one protocol (IP, UDP, or UDP) and capable of thousands of varied frames defined through Variable Field Definitions (VFDs).
- **Variable Field Definitions (VFD)**. You can use the three Variable Field Definitions (VFDs) to customize a single stream per port in that each frame may be altered via incrementing or decrementing data bits. For more details, refer to the glossary definitions on *page 340* and to the online help in the applications.
- **Alternate Streams**. In Traditional mode, there is an additional, simple Alternate stream that can be defined, that is inserted in the traffic pattern at specified intervals and can be used to simulate management frames. Gigabit Ethernet Cards have two Alternate streams.

- **Round-Robin Traffic Loading**. This method transmits the frame blueprints (streams) in the sequence of the stream numbers, and repeats the sequence in a round-robin fashion throughout the transmission.
- **Customized Frame Content**. You can customize frame content with a protocol editor, including the ability to intersperse alternate traffic with regular streams and to add VLAN tags.
- **Tracking Frames via Triggers**. You can monitor and validate packets with user-definable triggers.
- **Trigger**. A pattern tracking tool that identifies any packet with a specific pattern located inside any of the packets received by a receiving SmartBits card. The receiving card then counts the number of triggers received with the specific pattern. Most Traditional applications automatically insert triggers and add user-selectable errors depending on the application.

Enhanced Traditional Architecture.

The Enhanced Traditional cards have the ability to increment and decrement source and destination IP addresses, as well as MAC addresses.

This feature is only available with the following cards:

- GX-1420B, Gigabit Ethernet for the SMB-200/2000.
- GX-1421A, Gigabit Ethernet for the SMB-200/2000.
- LAN-3100A, 10/100 Mbps Ethernet for the SMB-600/6000B.
- LAN-3150A, 10/100 Mbps Ethernet RMII/SMII for the SMB-600/6000B.

For more details on these cards, refer to *Chapter 9, "Ethernet Cards,"*.

ATM with Traditional-Plus Architecture

ATM Cards are a type of Traditional card that have a single basic frame blueprint and can retain hundreds or thousands of PVC/SVC addresses assigned per port, depending on ATM type.

Similar to the Traditional cards, ATM cards have additional capabilities, ranging from one tracked trigger per port to over 2,000 triggers per port, depending on the card. For more information, refer to *Chapter 11, "ATM Cards,"*.

The following table highlights the various types of Traditional cards.

Table 2-4. General Characteristics of Traditional Cards

Processor Type	Used with	Max Number of Streams Per Port	Max Number of Flows Per Port	Frame Variations	Traffic Loading Method	Limitation/ Benefit
Traditional	Ethernet and Token Ring cards	1 plus 1 or 2 alternate streams	n/a	Thousands of frame blueprints through VFDs (variable field definitions), that can increment and decrement source and destination MAC fields, and alter content.	Round-Robin sequence	Full wire-rate with varied traffic. Varied frames can be generated but individual frames cannot be tracked. No signature field.
Enhanced Traditional	GX-1420B LAN-3100A	1 plus 1 or 2 alternate streams	n/a	Thousands of frame blueprints through VFDs (variable field definitions), that can increment and decrement source and destination MAC and IP fields, and alter content.	Round-Robin sequence	Full wire-rate with varied traffic. Varied frames can be generated but individual frames cannot be tracked. No signature field.
Traditional Plus	ATM-1 Cards ATM-2 Cards	1 stream per port with Up to 256 PVCs/SVCs [1] Up to 2048 PVCs/SVCs [1]	n/a	Thousands of frame blueprints through the individual addresses of PVCs/ SVCs.	Round-Robin sequence	Full wire-rate with varied traffic. Varied frames can be generated but individual frames cannot be tracked. No signature field.

1 In SmartWindow, SmartLib, and SmartApplications. In SmartSignaling, up to 8.38 million VCCs can be generated for tests. See other applications for maximum PVCs/SVCs supported.

SmartMetrics Cards and Traffic

The SmartMetrics processors are located on each card instead of on the chassis controller. They offer Traditional mode as well as SmartMetrics mode performance analysis.

For a summary of SmartMetrics card features, please refer to *Table 2-5 on page 25*. For details on individual cards, please refer to *Chapter 9, "Ethernet Cards"*.

The SmartMetrics mode offers extensive sequence and latency tracking, histograms, and analysis for every frame via a time-stamped signature field inserted into each transmitted SmartMetrics frame; this capability is also offered on TeraMetrics cards.

SmartMetrics Frame Blueprints

Hundreds of IP streams (frame blueprints), per port, feed into a sequenced, time-stamped individually tracked series of frames (see *Figure 2-7*).

Within each stream, there can be thousands of "SmartFlows" per port. Each SmartFlow within a stream carries the same protocol format but offers a number of variables which are individually time-stamped and tracked according to the test configuration.

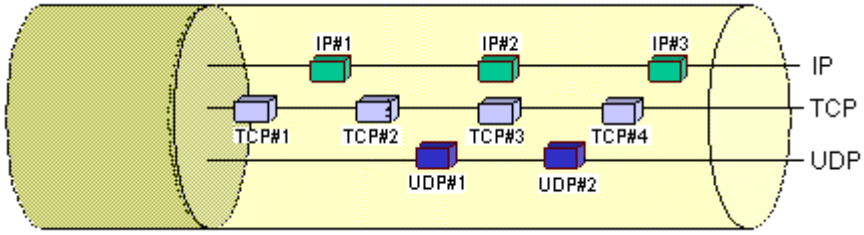


Figure 2-7. SmartMetrics Frame Blueprints

SmartMetrics Signature Field

SmartMetrics mode, streams, and measurements support the use of an embedded *Signature* field specific to each frame. The Signature field is used by the receiving card to analyze network traffic and to display the results in spreadsheets and/or histograms.

The SmartMetrics Signature field resides in the last 18 bytes of the payload of each frame and contains the following:

- Stream ID based on stream number, chassis, card slot, and port #.
- Frame sequence number.
- Transmit timestamp.

Important: If enabled, the Signature field overwrites the last 18 bytes of data at the end of payload of each frame, therefore, do not insert significant data into that area.

Multiple frame blueprints, different protocols, and varied frame sizes per stream.

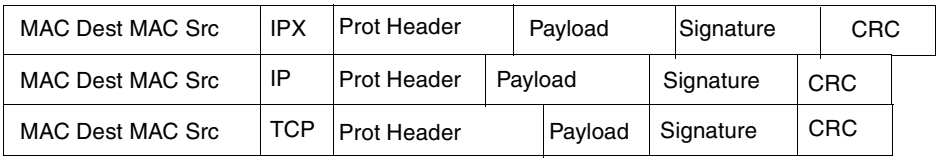


Figure 2-8. Three Streams (frame blueprints) on a single SmartMetrics port

There are three different traffic loading methods used with SmartBits cards:

- **Round-Robin Traffic Loading**. The default transmit order for SmartCards that support multiple stream definitions is a round-robin order based on the stream index. One frame is sent from each stream definition starting at index 1 until all streams have been transmitted. Then the process is repeated.

  This means that the percentage of a given type of traffic is dependent on the number of stream definitions that have been defined with the given characteristics. If thirty streams are defined with a high QOS, and seventy streams are defined with a low QOS, thirty percent of the traffic will have the high QOS.

- **Sequencer Traffic Loading.** This method sets the rate and transmit mode on a per-port basis.

- **Scheduler Traffic Loading**. Available with the POS-6500 and LAN-6201 card families, the Scheduler method allows you to specify rate (frames per second) on a per-stream basis, unlike other cards where the traffic rate is set with a global, per-port interframe gap. These cards can calculate the gap for you. If you oversubscribe the card, (i.e., specify a combination of number of streams and frame rates that causes more traffic than the medium is capable), an error is generated.

  This feature provides the ability to set multiple rates on a single port, and allows you to calculate percentages of different traffic types by setting frames-per-second on a per stream basis.

  For basic rate calculation, refer to the *SmartLib User Guide*. For a quick, easy GUI representation, you can also use the SmartWindow Rate/Load calculator, available in the *Transmit Setup* for the POS-6500 and LAN-6201 cards.

Table 2-5. General Characteristics of SmartMetrics Cards

Processor Type (SmartMetrics)	Used with	Max # Streams Per Port	Max # Flows Per Stream	Frame Variations	Traffic Loading Method	Limitation/Benefit
ML-5710A ML-6710 ML-7710	Ethernet	1,000	64K	Fields within a stream	Round-Robin sequence	Global interframe or burst gap; same weighting per stream.
Hi Density ML-7710 Version 2.00 and higher	Ethernet	1,000	64K	Flows	Sequencer	Round-Robin sequence is included in this method. Can also sequence groups of streams and flows, and analyze each group independently.
LAN-3201 (A, As, B) Gigabit POS-3500/3502 OC-3c/OC-12c	Ethernet	8,000	N/A	Fields within a stream	Scheduler	Sets up a Round-Robin sequence based on frames per sec. Requires the same frame rate per second per stream for a total of 100% wire rate to avoid bursty traffic.
WN-3405, 3415, 3420A	WAN FR and PPP	128 256 with SmartLib	N/A	N/A	N/A	N/A
WN-3441A	WAN FR and PPP	2,048 [1]	64K	Flows	Scheduler	Channelized T1
WN-3442A	WAN FR and PPP	2,048 [1]	64K	Flows	Scheduler	Channelized E1
WN-3445A	WAN FR and PPP	2,048 [1]	64K	Flows	Scheduler	Channelized DS3

1 The maximum number of streams distributed across up to 1022 PVCs (Frame Relay) or across the number of available channels (PPP).

TeraMetrics Cards and Traffic

TeraMetric Cards provide network-to-application layer performance testing and an open architecture that allows the use of third-party test applications. The TeraMetrics platform contains:

- Pentium-II 500 MHz processor
- 128 MB, 100 MHz SDRAM
- A 16 MB Flash disk memory

TeraMetrics Cards Offer Traditional, SmartMetrics, and Terametrics Functionality.

By allowing third-party code integration, TeraMetrics facilitates easy sequencing and re-sequencing of many varied streams and flows, at wire rates in excess of 1 terabit per second. Refer to *Chapter 10, "Packet over SONET Modules,"* for detailed information regarding these cards.

Table Scheduler

The TeraMetrics traffic loading method is a schedule table where each entry includes the flow number to be transmitted and the flow burstiness is controlled according to the sequence of the entries in the table.

The table can hold up to 8,192 entries. The transmission rate is calculated as follows:

$$\text{TxRate [Flow F]} = \frac{\text{(Flow F Entries in Table)} * \text{(Port TxRate)}}{\text{Table Size}}$$

Key TeraMetrics Features

The TeraMetrics cards support the following advanced set of features:

- System scalability that exceeds 1 terabit per second.
- Supports port interface speeds up to 10 Gbps.
- Supports Ethernet, ATM, and POS interfaces.
- Measures per-port performance, IP flow performance, and QoS.
- Supports full wire rate data plane testing, control plane testing, and application layer testing.
- On-board Linux/Pentium-based processing power, allowing top-to-bottom testing of the most sophisticated network systems.

3 Multiple Users Accessing a Chassis

In this chapter . . .

Requirements for Multi-User Operation

To use the multi-user function, you must meet the following requirements.

- Use SmartBits applications that support multi-user operation. The following list specifies the **minimum** version required for each program to use the multi-user feature.

  Applications with Multi-User Functionality

  - SmartWindow 6.51
  - SmartLib 3.07
  - SmartApps 2.30
  - SmartxDSL 1.01
  - SmartMulticastIP 1.20
  - SmartFlow 1.00
  - SmartVoIPQoS 1.00
  - SmartCableModem Test 1.10
  - BGP Router Test 1.00

- A stand-alone SmartBits chassis must be ***Multi-User Ready***. This includes all SMB-600, SMB-6000B, SMB-2000 and SMB-10 chassis. [This excludes all SMB-200s.]

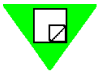
  - **SMB-600 and SMB-6000B:** All SMB-600 and SMB-6000B chassis have multi-user capability.
  - **SMB-2000 and SMB-10:** All new SmartBits 2000 and SmartBits 10 chassis have an identifying Multi-User Chassis label to support multiple users. To check your chassis (controller) firmware version (must be version 6.60 or later), connect to the chassis and select the application's **Help > About** command.

  If you have an older chassis, you can retrofit your SmartBits chassis by purchasing the hardware upgrade and sending the chassis to Spirent Communications to install the SMB-2000 multi-user compliant backplane and controller firmware.

  - **SMB-200:** The SmartBits 200 is a single-user only chassis and cannot be accessed by multiple users in a stacking configuration or run multiple programs simultaneously. However, it can be used in an expansion configuration.

- ALL CONNECTED SmartBits chassis must be ***Multi-User Ready***.

  You can connect SMB-10s and SMB-2000s in a stack with the DB-37 connectors. *If one chassis is not Multi-User Ready, all other chassis are disabled from the multi-user function.*



Note: In a stacked multi-user environment of interconnected SMB-2000 and SMB-10 chassis, all chassis must be fitted with the multi-user compliant backplanes and firmware in order to use the multi-user capability.

Preparing for Multi-User Operation

In a multi-user environment, it is helpful to schedule and assign users to desired chassis slots for specific time periods.

The SmartBits programs identify ports available to you and the ports reserved by other users and are not available to you. When you have reserved one or more cards, you have the ability to release them for other users to use.

Since your test requirements may dramatically vary at times and others may need the same ports, we highly recommend that each multi-user location set up a scheduling board, either posted or via a computer program scheduler.

The following example shows one style of scheduling boards. Design a schedule that is best suited for your environment.

Table 3-1. Example of a SmartBits Scheduling Board

Week of June 1	Morning 7:00-12:59	Afternoon 1:00-5:59	Evening 6:00-12:00
Dave	chassis 1#, slots 2, 6, 8	chassis 1#, slots 10-20	
Scot	chassis 1#, slots 10-20	chassis 1#, slots 2, 6, 8	
Joe		chassis 2#, slots 1 - 6	chassis 1#, slots 2, 6, 8
Mark	chassis 2#, slots 1-8		

How Does the Multi-User Feature Work?

With the multi-user feature, SmartBits chassis can be accessed and used by a maximum of 10 users simultaneously, *after* the users have accessed the chassis sequentially and reserved their necessary ports.

Multi-user chassis allow multiple users to connect to the same chassis simultaneously, as long as they each use different cards in that chassis. While connected to a multi-user chassis, users can reserve available ports and:

- run multiple applications
- run multiple instances of a program that supports multi-users
- run any other Spirent Communications application

SmartBits programs that support the multi-user feature identify the available and unavailable ports:

- through ownership LEDs on the main window of the program, or
- through ownership LEDs in reservations windows, or
- through multi-user checkboxes in card setup windows

The color convention of triangle LEDs (SmartWindow and SCMT) or circle LEDs (other applications) next to port numbers or hub/slot/port numbers provides the following status informatio shown in *Figure 3-1*:

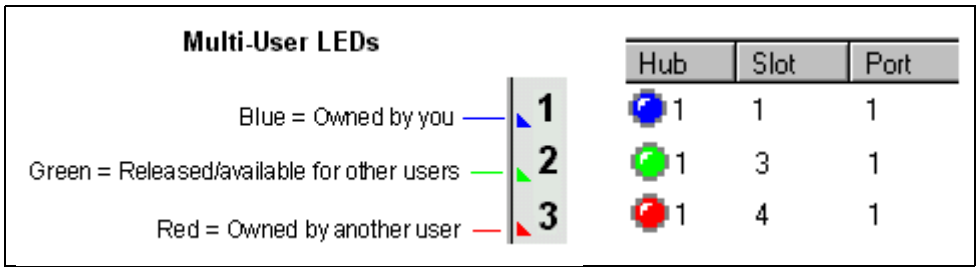


Figure 3-1. Multi-User LEDs

Multi-user operation provides current status of each port and allows the user to change the status by releasing reserved ports.

The following examples of multi-user functions demonstrate how the feature is used. For more details, please refer to the user guide or online help for each supporting application.

- All reserved cards are released when you disconnect from the SmartBits chassis.
- You can connect SMB-200s, SMB-2000s, SMB-600s, and SMB-6000Bs via the synchronizing Expansion RJ-45 ports. *If you include an SMB-200 in the connected series of chassis, all the chassis are disabled from the multi-user function.* The SMB-200 is designed to be single user only.
- All connected SmartBits chassis must be multi-user ready in order to perform the multi-user function.
- If you are working in a multi-user SmartBits chassis environment, you cannot test or configure a port if you do not have ownership of that port.

In SmartWindow, with SMB-600 and SMB-6000B Multi-Users

When on-line, the SmartWindow front panel displays virtual images of installed modules. Modules you have ownership of have an off-white background. Modules displayed with a gray background are unreserved or owned by another user.

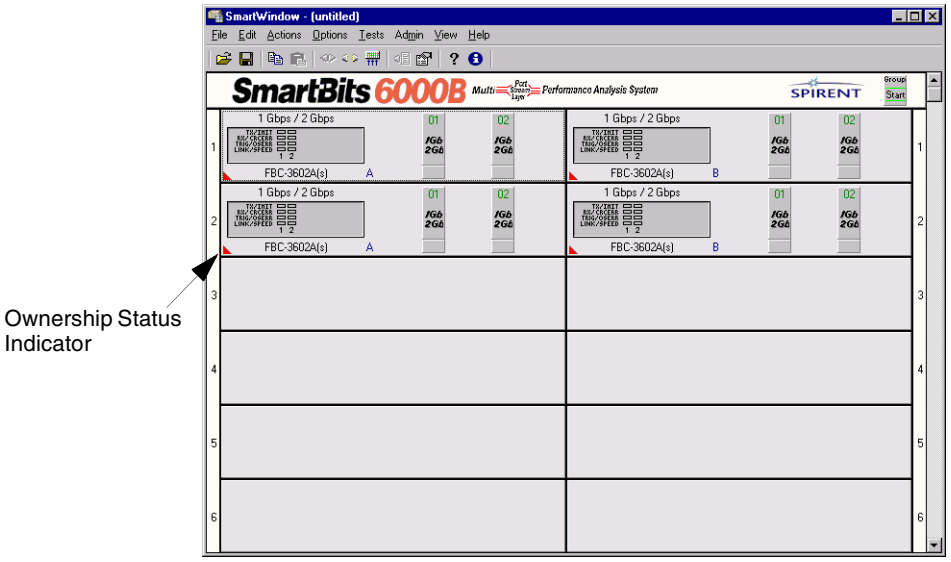


Figure 3-2. Ownership Status Indicator for the SMB-600

The ownership status indicator, located in the bottom left corner, displays the ownership of the card in a multi-user environment, and is explained as follows:

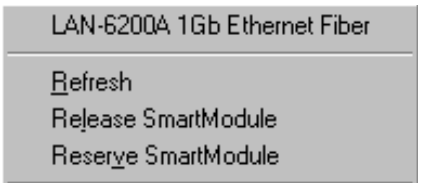
- **Blue** – the card is reserved to you
- **Green** – the card is available to other users
- **Red** – the card is reserved to another user

The ownership status light only reflects the status of the modules as of the most recent refresh. It is possible in a multi-user environment for a module to be reserved by another user in the time between the last refresh and your attempt to reserve the module.

Important: You cannot use a module unless you have reserved it. Note that once you have connected to a chassis, the chassis link is independent of any modules reserved. Therefore, even if no cards are reserved by you and all cards have been released or reserved by other users, the chassis link will remain until disconnected.

Reserve a Single Module

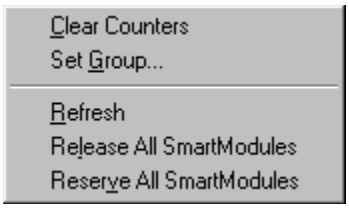
Right-click on the LED Panel to open the multi-user menu. You will see this dialog box.



Choose *Refresh*, *Release* or *Reserve Module* as needed.

Control Groups of Modules

Right-click anywhere within the Top Panel to open the multi-user menu that controls all modules. You will see this dialog box.



Select the *Refresh*, *Release* or *Reserve* command as needed.

Note: When connected to the SMB-600 chassis, the SmartWindow interface adjusts to display the more compact hardware platform. Each slot represents a module.

In SmartWindow, with SMB-2000

Refer to *Figure 3-3* and follow the steps below to access SmartWindow with SMB-2000.

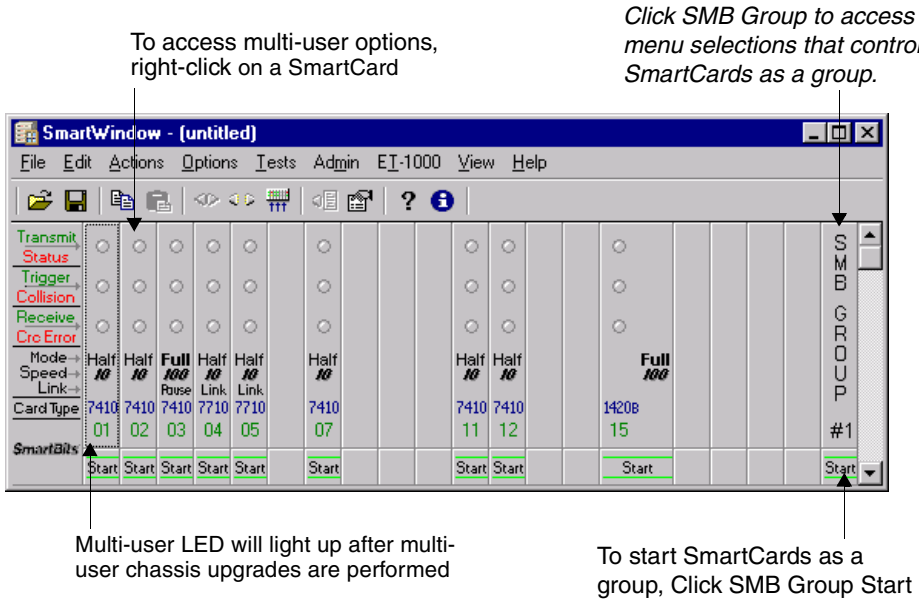
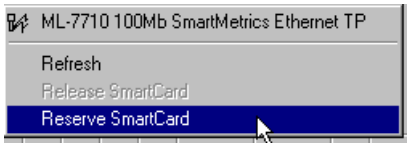


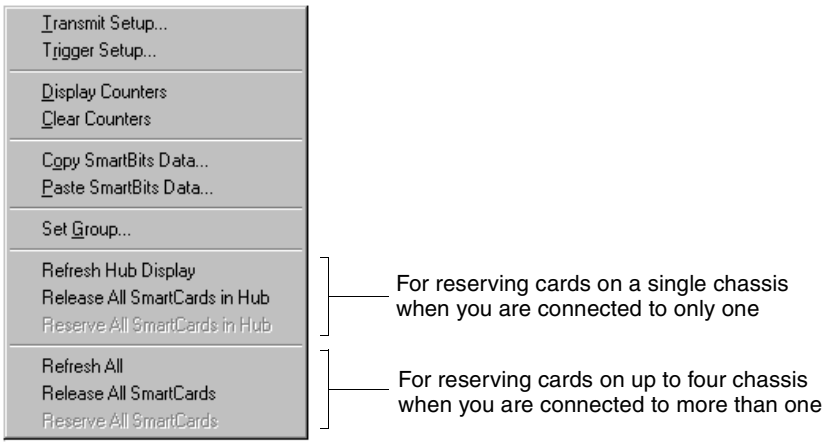
Figure 3-3. Multi-user Compliant SMB-2000 Main Menu

⇓ **Follow these steps to access SmartWindow using a SMB-2000:**

1 To refresh, release, or reserve a single SmartCard, right-click on it. You will see this dialog box.



2 To reserve all cards, right-click the **SMB Group** panel. You will see this dialog box.



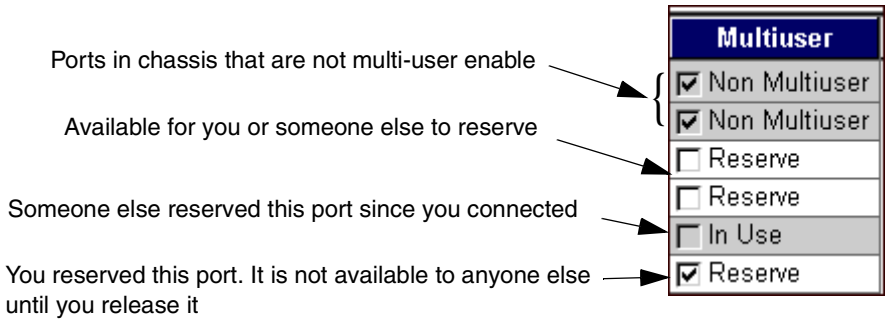
Note: You cannot group cards or configure them until you have reserved them. (Right-clicking on an unreserved card displays no configuration options; the card must first be reserved.) Cards reserved by other users are released on disconnect.

In SmartFlow

When you connect SmartFlow to chassis, it displays only the cards available and not reserved (in use) by another user. Available ports appear on the *Card Setup* tab that you use to configure and reserve the ports. When you first connect to a chassis with multi-user capabilities enabled (SMB-2000 or SMB-600/6000B) only the ports not reserved by anyone else and are available to you appear in the list.

Display Available Ports

When you connect to a multi-user chassis, only cards available (not in use by another user) will be displayed in the *Card Setup* tab, the *Group Wizard*, and the *SmartFlows* > *Traffic* tab. The following illustrates the possible states of a port in a multi-user chassis, as shown in the *Card Setup* tab:



The Multi User status only reflects the status of the SmartCards since the initial connection to SmartBits or since the last Refresh. It is possible for a port to be reserved by another user in the time between the last refresh and your attempt to configure or use the port.

Refresh the Available Ports Display

Click the heading of the **Multi-user** column to highlight the entire column. Right-click anywhere on the column while it is highlighted. A popup menu appears. Select **Refresh**. If anyone else reserved or released a card since you connected to the chassis, its status will change.

Reserve Ports in a Multi-user Chassis

To ensure that the port you have selected does not get reserved by another user prior to running your test, reserve the port by checking the box in the **Multi-user** column on the **Card Setup** tab. While it is reserved, it will not appear as available to anyone else either using another program.

You can run a test without manually reserving the ports. SmartFlow will automatically reserve the test ports while the test is running, and automatically release them when the test finishes. However, by not reserving the port prior to the test, the test may fail if someone else reserved the port before you tried to start it.

Check a Port's Availability after Connecting to the Chassis

Display the **Card Setup** tab that reflects the port's current availability or click the **Refresh** command. The *SmartFlows* > *Traffic* tab and *Group Wizard* reflect ports that were available at the time you connected to the chassis, but do not show changes since that time.

What to Do if a Port is Unavailable

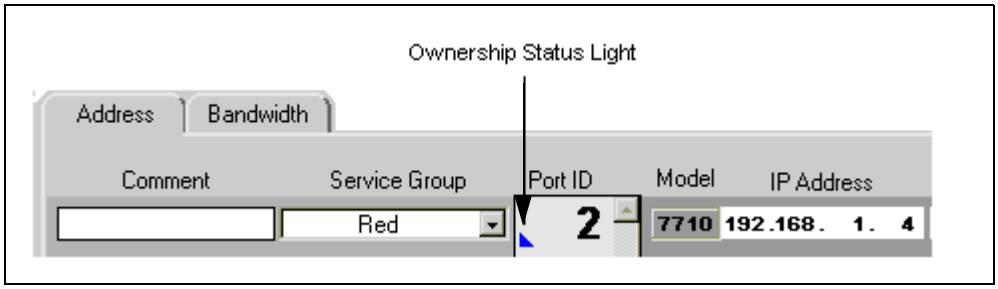
You can either select another port, omit that port from the test, or wait until the port is again available.

Release a Port for Another User to Reserve

Select the **Card Setup** tab. Click the box in the **Multiuser** field for the port. That will clear the check mark.

In SmartCableModem Test

Once connected to a SmartBits chassis, the SmartCard ports that are appropriate to SCMT testing display their Port ID, Model number, and the multi-user ownership status of each port. If you are the first user to access the SmartBits, all ports (blue status light) are automatically reserved by you.



In the above SmartCableModem Test example, the ownership status light indicates the multi-user status of each port:

- **Blue** – the port is reserved to you.
- **Green** – the port is available to other users (has been released by you). With a single-user chassis, the port is a member of the Released Service Group, and acts like any other group.
- **Red** – the port is reserved by another user. This color does not appear automatically; it appears when you try to use the port or when you apply the *Actions* > *Refresh* button.

Ownership Status of All Ports

The ownership status light only reflects the status of the SmartCards since the initial connection to SmartBits or since the last Refresh. It is possible for a port to be reserved by another user in the time between the last refresh and your attempt to configure or use the port.

To see the latest, most current ownership status of all ports, select the **Actions > Refresh** command.

Changing Multi-user Status

You must give ports a "Released" group (green status light) assignment in the Group column to make those ports available to other users. The second user automaticallly accesses and reserves all port numbers (now blue status for the second user) that have been released by the first user. Therefore, the second user must give ports a "Released" group (green status light) assignment in the Group column to make those ports available to the third user.

If any user fails to give the Released group assignment to ports presented to him, all *subsequent* users will access the SmartBits chassis and see no ports as available.

Cards reserved by you are released:

- when you disconnect from the chassis with the *Actions* > *Disconnect* command
  or
- when you assign the Group column *Released* parameter to a port.

In SmartxDSL

When you connect to a SmartBits chassis, all ports are automatically reserved for your use unless otherwise specified in the Setup menu Preferences window or already reserved by another user. While the chassis is reserved, it is not available to another user or to any other Spirent Communications application.

When you connect to a multi-user chassis, only cards available (not in use by another user) AND appropriate to the specific set of tests, will be displayed in Available Trunk and Access ports columns.

By default, the program reserves all cards and releases cards not selected after 10 minutes. However, if a test is begun during the 10-minute reserved time, the cards not selected will not be released until the test finishes and a new 10-minute reserved time period expires.

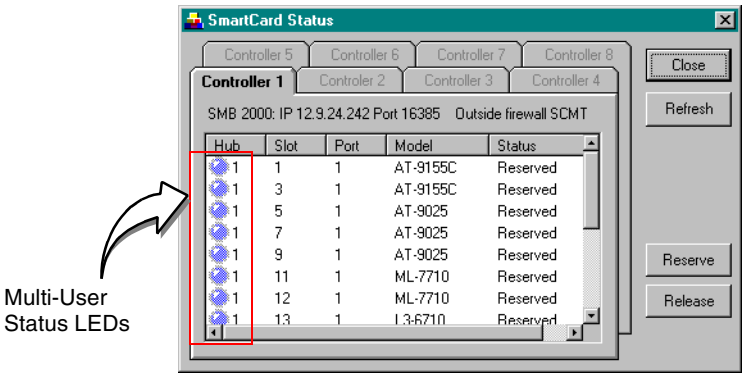
In the **Setup > Preferences** window, you can specify that the program automatically reserves all cards upon connection and does not release them after a time period.

To see all ports available in each chassis, select **Setup > SmartBits Reservations**. Up to 8 chassis controllers may be accessed at one time; each chassis controller may control up to 4 chassis or 80 ports.

The ownership status light (left-hand LED) indicates the multi-user status of each port:

- **Blue** – the port is reserved to you.
- **Green** – the port is available to other users (has not been reserved by you).
- **Red** – the port is reserved by another user.

The ownership status light only reflects the status of the SmartCards since the initial connection to SmartBits or since the last Refresh. It is possible for a port to be reserved by another user in the time between the last refresh and your attempt to configure or use the port.



To keep maximum resources available for testing, the SmartBits chassis does not update SmartxDSL on the port status unless you click the **Refresh** button.

Changing Multi-user Status

Basic operations in viewing and changing user status include the following steps:

- To check the latest status of all ports, click the **Refresh** button.
- To release cards and make them available to other users, highlight the port row, and click the **Release** button.

  You must click the Release button to make ports available to other users. The second user automaticallly accesses and reserves all available port numbers (now blue status for the second user) and have been released by the first user. Therefore, the second user must click on ports with a Release button to make those ports available to the third user.
- To reserve cards released by another user or by yourself, highlight the port row, and click the **Reserve** button.

To ensure that the port you have selected does not get reserved by another user prior to running your test, reserve the port by highlighting the port and clicking the **Reserve** button. While it is reserved, it is not available to anyone else either using another copy of SmartxDSL or any other Spirent Communications application.

If any user fails to release ports presented to him, any *subsequent* users will access the SmartBits chassis and see no ports as available.

4 Maintenance and Upgrade Procedures

In this chapter . . .

Downloading New Firmware

You can download firmware for chassis and for individual cards from our website at http://www.netcomsystems.com/support/softwareupdates.asp or from a Spirent Communications CD.

If you download from the website, be sure to obtain a password from Spirent Communications Technical Support to open the files.

There are two firmware download programs available for SmartBits chassis:

- *newfirm.exe* for SmartBits 200 and SmartBits 2000.
- *fdlmgr.exe* for SmartBits 600 and SmartBits 6000B.

For details on using each program, please refer to the appropriate *SmartBits Installation* manual.

Adding Cards to a SmartBits Chassis

Each SMB-2000 can accommodate up to 20 SmartCards; each SMB-200 can hold up to four SmartCards. Each SMB-6000B can hold up to 12 modules; each SMB-600 can hold up to two modules.

Thumb screws allow for easy insertion and removal of SmartCards/modules from a SmartBits chassis.

The connector and interface for each card slot is configured identically, thus any SmartCard/module may be installed into any equivalent slot. If less than the maximum SmartCards/modules are installed, optional blank panels can fill the empty slots.

Important: To maximize airflow inside the SmartBits Chassis, **all unused slots must be covered** with the provided blank face-plates.
Always turn the power off to the SmartBits Chassis before inserting or removing Smart-Cards/modules.

Converting the SmartBits Chassis

You can modify your SMB-6000 chassis to use SMB-600/6000B modules and you can modify your SMB-600/6000B chassis to use SMB-6000 SmartModules. Refer to the following instructions sheets for these instructions located at http://www.netcomsystems.com/support/documentation.asp:

- *How to Use Accessory Kits: Adding a MiniModule into a SmartModule Tray* (part number 340-1036-001, Rev. A)
- *How to Use Accessory Kits: Convert a SmartModule into Two MiniModules* (part number 340-1089-001, Rev. B)

Changing Chassis Timeout

By default, all SmartBits chassis disconnect from SmartBits applications after 30 minutes of inactivity (chassis timeout of 1800 seconds).

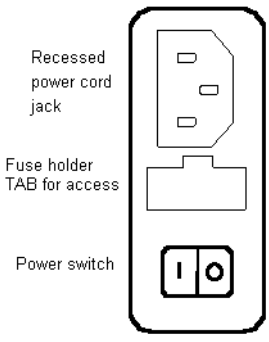
⇓ **To change the number of minutes assigned to chassis timeout for a specific chassis, access the Hyperterminal program as follows:**

1. Connect your PC to the SmartBits chassis with the serial connection (described in your *SmartBits Installation Manual*).
2. Start HyperTerminal from the Windows 98 **Start** button by selecting **Programs> Accessories> Communications> HyperTerminal** and then **Hypertrm.exe**.
3. Access the icon for access to the specific SmartBits chassis.
4. To view the current default value in the HyperTerminal window, enter: **idlemax** and press **Return**.
5. To edit the chassis timeout value in seconds, enter: **idlemax xxxxx**, where *xxxxx* indicates the number of seconds. Then press **Return**.
   This edited timeout value will remain with the SmartBits chassis for all applications until another user changes it.

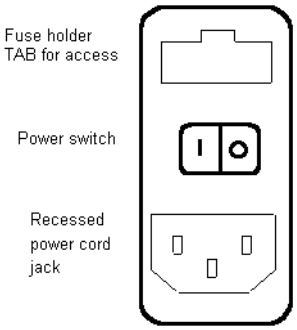
Changing Chassis Fuses

The power supply in each SmartBits chassis has a universal input that accepts 120/240 VAC requiring no selection or adjustment. The Power Supply Inlet is the main disconnect device and is located on the rear of the chassis. It houses the power switch, fuse holder and a universal 3-wire instrument power cord jack. Replacement fuses are metric.

Chassis	Fuse Amperage
SmartBits 200	F2.0 Amp, 250V, fast action
SmartBits 20003.15	3.15 Amp, 250V, fast action



Chassis	Fuse Amperage
SmartBits 600	2.0 Amp, 250V, fast action
SmartBits 6000B	10.0 Amp, 250V, fast action



Important: When cycling power to a SmartBits chassis, be sure to let the power stay off for a few seconds to allow the capacitors to discharge before restoring power to the unit.

⇓ **To remove the fuse holder:**

1 Remove the power cord from the jack.

2 Lever out the fuse holder by prying outward on the tab using a small flat-head screw-driver or other thin-edged tool.

Note: The SMB-200 employs a compact AC/DC power supply that provides a minimum of 100-watt DC output at +5 volt. An additional DC/DC switching module is installed on the backplane to provide a +12 volt DC output, that is used both by cooling fans and the plug-in SmartCards.

5 Core Software Applications

In This Chapter . . .

Overview of Core Applications

All SmartBits chassis purchases include a bundled set of three programs:

- **SmartWindow.** A Windows-based virtual front panel used to control all functions of all SmartCards/modules. It provides a convenient method to set up any combination of ports, transmit heavy traffic, monitor the status of, or capture and view data gathered by the SmartCards/modules. Refer to *page 45* for more information.
- **SmartLib.** Provides an API programming library interface to rapid test development. Software developers may also use it to develop programs in Visual Basic, C, or C++ in a Windows 98 environment, and C, C++ or TCL in a UNIX environment. Refer to *page 47* for more information.
- **SmartApplications.** A Windows-based application that automates RFC 1242 and RFC 2544 testing for determining throughput, packet loss, latency, and back-to-back testing under full load, and production go-no-go tests for minimum acceptable performance levels. Refer to *page 48* for more information.

Hardware and PC requirements for the applications listed above can be found in the individual manual for each application.

To run SmartLib or script-based programs on a SparcStation or other UNIX platform, please consult the *SmartLib User Guide* or the appropriate script user document for the latest requirements.

SmartWindow

Program Type: GUI, with a flexible Virtual Front Panel (VFP) for customized performance analysis

Where Used:

- On PC platforms.
- With all SmartBits chassis.

Devices Tested:

- NIC cards.
- servers.
- bridges.
- cable modems.
- xDSL modems.
- switches.
- routers.
- VLANs.
- firewalls.
- live networks.multimedia scenarios.

Protocols Supported:

- Ethernet.
- Token Ring.
- ATM.
- Frame Relay PVC Testing.
- PPP over ATM.
- POS Testing.

Cards Supported: All SmartCards/modules.

RFCs Supported:

- RFC 1242, Benchmarking Terminology for Network Interconnection Devices.
- RFC 1483, Multiprotocol Encapsulation over ATM Adaptation Layer 5.
- RFC 1577, Classical IP and ARP over ATM.
- RFC 2285, Benchmarking Terminology for LAN Switching Devices.
- RFC 2544, Benchmarking Methodology for Network Interconnect Devices.

Test Objectives:

- To use a suite of custom tests to verify your design, improve product quality, perform low-volume production and repair testing, and perform competitive marketing analysis.

- SmartWindow allows you to put any combination of SmartCards/modules into any SmartBits slots. SmartWindow will automatically identify the SmartCards/modules and give you the proper interface for each port. You can define the traffic to be sent from each SmartCard/module individually, then Save Global setups for the system.

Tests Supported:

- Throughput.
- Latency, Latency Variation, Latency Histograms.
- Packet Loss.
- Back-to-Back Performance.
- Point-to-Point.
- Point to Multi-point.
- Multi-point to Multi-point.
- Round Trip Transit Time.
- Illegal Packets.
- Broadcast Traffic.
- Expired Time-to-Live Filtering.
- Address Table Learning.
- Flow Table Learning.
- Congestion Testing.
- Comparative Path Testing and Comparative Protocol Testing.
- Differentiated Class of Service Testing.
- Frame Relay PVC Testing.
- ATM VCC T.

Note: Refer to the *SmartWindow User Guide* for an explanation of these tests.

SmartMetrics-Based Results:

- Sequence Tracking.
- Latency over Time.
- Latency per Stream.
- Latency Distribution.
- Raw Tags.

SmartLib

Program Type: A powerful programming tool/Software Developer's Kit.

Where Used: PC and SparcStation platforms. With all SmartBits chassis.

Devices Tested: Bridges, switches, and routers.

Protocols Supported: Ethernet, Packet over SONET (POS), ATM, WAN (FR and PPP), and Token Ring.

Cards Supported: All SmartCards/modules.

RFCs Supported:

- RFC 1242, Benchmarking Terminology for Network Interconnection Devices.
- RFC 1483, Multiprotocol Encapsulation over ATM Adaptation Layer 5.
- RFC 1577, Classical IP and ARP over ATM.
- RFC 2544, Benchmarking Methodology for Network Interconnect Devices.

Test Objectives:

- To create custom applications for testing networks and network devices, with any SmartBits chassis.
- To automate complex suites of tests.
- To create simplified GUIs specifically tailored for a production line.
- To test unique network components.

Note: Refer to the *SmartLib User Guide* located at http://www.netcomsystems.com/support/documentation.asp for more information on tests availability and functions

Environments:

- Test Environments Supported:
  - Ethernet 10/100, Mbps, and Gigabit systems.
  - Packet Over SONET (POS) OC-3, and OC-12.
  - ATM technologies including DS1, E1, 25MB, E3, DS3, OC-3c, and OC-12c with signaling control, as well as traffic generation.
  - WAN E1 and T1 (Frame Relay V.35 and RS-45).
  - IP, TCP, PPP, UDP, and IPX.
  - Token Ring 4 MB and 16 MB systems.
  - VG/AnyLan in Ethernet models.
- Operating Systems Supported:
  - Microsoft Windows 98, 20.
  - UNIX (Linux and Solaris).

- Programming Languages Supported:
  - C/C++ Borland, Microsoft Visual, and GNU.
  - Microsoft Visual Basic.
  - Borland Delphi.
  - Tcl 7.6 and 8.0p5.

SmartApplications

Program Type: GUI, for easy-to-use, automated performance analysis

Where Used: On PC platforms. With all SmartBits chassis.

Devices Tested: Bridges, switches, and routers.

Protocols Supported: Ethernet, Token Ring, ATM, and Frame Relay.

Cards Supported: All SmartCards/modules, except WN-3441A, WN-3442A, and POS modules.

RFCs Supported:

- RFC 1242, Benchmarking Terminology for Network Interconnection Devices.
- RFC 1483, Multiprotocol Encapsulation over ATM Adaptation Layer 5.
- RFC 1577, Classical IP and ARP over ATM.
- RFC 2544, Benchmarking Methodology for Network Interconnect Devices.

Test Objective: To generate a full and sustained load and perform accurate evaluations of Throughput, Latency, Packet Loss, and Back-to-Back performance limits.

Tests Supported:

- Throughput.
- Latency.
- Packet Loss.
- Back-to-Back Performance.

Test Features:

- Test across multiple topologies including Ethernet, Token Ring, ATM (25 Mbps, DS1, DS3, E1/E3, OC-3c, OC-12c), and Frame Relay.
- Test ATM with LANE SVC, Classical IP (per RFC-1577) PVC/SVC, or SNAP (per RFC-1483) PVC/SVC traffic.
- Test at layer 2, or specify network addresses and test at layer 3.
- Run tests individually, or use automatic mode to run tests automatically.
- Test full or half duplex.

- Test unidirectional or bi-directional.
- Test one-to-one port pairs, one-to-many ports, or many-to-one port pairs.
- Simulate a router with next-hop capability per RFC-2544.
- Use GPS with multiple remote SmartBits chassis for end-to-end performance testing, including remote one-way latency measurements.

Test Results:

- Tests results are displayed in real time.
- Error log provides debug information.
- Charting capability allows customization of results.
- Choose horizontal tabular report format or traditional non-tabular format.
- Cut-through and store-and-forward latency measurements are displayed individually.

Requirements:

- An SMB-200, SMB-2000, SMB-600, or SMB-6000B chassis with the appropriate SmartCards or modules.
- Proper cabling.
- An IBM or compatible Pentium PC running Windows 98 or NT.
- An RS-232 modem cable or an RJ-45 straight-through cable (Ethernet) and a 10 Mbps half duplex Ethernet controller card (in the PC).


SPIRENT
Communications

6 Optional Applications

In This Chapter...

Note: The applications described in this chapter may be purchased in addition to the core software. Each of these applications requires a separate licensing text file known as a *key file*. This file is provided on a 3.5” diskette with the program, or is available through Spirent Communications Technical Support.

Special Feature Support

The following list highlights certain features that may or may not be available with each application: (see also *Required Firmware Version* below).

- **SmartMetrics**. Refers to SmartMetrics cards and associated advanced tracking and results.
- **GPS**. The Global Positioning System accessory with an GPS receiver and cables, used to synchronize the timing between SmartBits chassis at remote locations.
- **Multi-User**. Refers to multiple users or programs accessing the same SmartBits chassis at the same time. This feature identifies which cards are available to be used, and which cards are reserved by other users.
- **Multi-Chassis**. Displays all available ports of multiple connected SmartBits chassis.
- **Test API**. A programming library that duplicates the functions of a specific GUI application information.

Required Firmware Versions

If you wish to use the following features with SmartBits applications, please check your SmartBits chassis for the following required version levels:

- **Multi-chassis feature support**. Chassis firmware version 6.08 and higher
- **Multi-user feature support**. Chassis firmware version 6.50 and higher
- **SMB-200 support**. Chassis firmware version 6.12 and higher

Local Multiple Chassis Applications

All current SmartBits applications except ScriptCenter support local multiple chassis connections. Table 6-1 lists the minimum version levels of each SmartBits application that supports the multiple chassis feature with local connections.

Table 6-1. Minimum Version Levels Required to Support Multiple Local Chassis

Program	Minimum Version Level
SmartWindow [1]	7.00 and higher
SmartLib [1]	3.06 and higher
SmartApplications [1]	2.22 and higher
SmartSignaling	3.00 and higher
SmartMulticastIP	1.10 and higher
SmartxDSL	1.00 and higher
SmartFlow	1.00 and higher
SmartVoIPQoS	1.00 and higher
AST II	1.00 and higher
SmartTCP	1.10 and higher
SCMT	1.10 and higher
VAST	2.10 and higher
ScriptCenter	1.00 and higher

1 This applications information can be found in *Chapter 5, "Core Software Applications"*, and is not included in this chapter.

Remote Multiple Chassis with GPS

Not all SmartBits applications support remote synchronized connection via GPS.

Please check that you have an appropriate application if you wish to synchronize and connect two chassis or chassis groups via GPS. Refer to *Table 6-2 on page 54* for a list of applications, and consult your Spirent Communications sales representative for additional applications information.

Table 6-2. Applicable Chassis and Applications for Synchronized Chassis via GPS

Minimum Version Level Required	SMB-200/2000	SMB-6006000B
SmartLib 3.07 [1]	X	X
SmartApplications 2.22 [1]	X	X
SmartSignaling 2.10	X	
SmartMulticastIP 1.10	X	X
SmartxDSL 1.01	X	
SmartFlow 1.00	X	X
AST II 1.00	X	X
VAST 2.11	X	

1 This applications information can be found in *Chapter 5, "Core Software Applications"*, and is not included in this chapter.

SmartSignaling

SmartSignaling tests measure the capabilities of ATM switch devices and ATM/LAN edge devices to accept calls and to set up and tear down switched virtual circuits (SVCs).

The following cards can be tested using a SmartBits 200/2000 chassis:

- AT-9015, ATM DS1.
- AT-9020, ATM E1.
- AT-9025, ATM 25 Mbps.
- AT-9034B, ATM E3.
- AT-9045, ATM DS3.
- AT-9045B, ATM DS3.
- AT-9155C, ATM Multi Mode, Fiber, OC-3.
- AT-9155Cs, ATM Single Mode, Fiber, OC-3.
- AT-9622, ATM Multi Mode, Fiber, OC-12.
- AT-9622s, ATM Single Mode, Fiber, OC-12.

Refer to the *SmartSignaling for ATM User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-3* gives a brief description of these tests.

Table 6-3. SmartSignaling Tests and Descriptions

Test	Description
Peak Call Rate	This test measures the maximum number of call setups and teardowns a device under test can process per second without failure.
Call Capacity	This tests the number of concurrent virtual circuit connections that can be established and maintained by the device under test.

SmartMulticastIP

SmartMulticastIP is a network technology, used in multimedia and data-sharing applications, that delivers a stream of IP traffic from a sender to multiple receivers simultaneously.

The following cards can be tested using the following SmartBits chassis:

- In SMB-200/2000:
  - ML-7710, 10/100 Base-TX, SmartMetrics.
  - ML-7711, 100 Base-FX Fiber, SmartMetrics.
- In SMB-600 and SMB-6000B:
  - LAN-3111A, 100 Base-FX Fiber.
  - LAN-3201A, 1000 Base Ethernet, SmartMetrics, Multi Mode.
  - LAN-3201As, 1000 Base Ethernet, SmartMetrics, Single Mode.
  - LAN-3201B, SmartMetrics, GBIC.

Refer to the *SmartMulticastIP User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-4* gives a brief description of these tests.

Table 6-4. SmartMulticastIP Tests and Descriptions

Test	Description
Aggregated Multicast Throughput	Determines the maximum transmission rate at which the DUT can forward IP multicast traffic with no frame loss as the number of destination ports increases.
Forwarding Latency	Determines the DUT's forwarding latency of IP multicast frames. Also provides the minimum, maximum, and average latencies, as well as the latency distribution per port.
Group Join/Leave Latency	Determines the time it takes the DUT to set up and tear down its multicast forwarding tables. Specifically, it measures the time it takes for: • SmartCard ports to start receiving multicast frames once an IGMP join request is sent to the DUT. • SmartCard ports to receive the last multicast frame once an IGMP join request is sent to the DUT.
Mixed Class Throughput	Determines the DUTs throughput when transmitting both multicast and unicast traffic.

Table 6-4. SmartMulticastIP Tests and Descriptions

Test	Description
Multicast Group Capacity	Measures the maximum number of multicast groups and group members that the DUT can handle.
Scaled Group Forwarding Matrix	Determines the following: • The DUT's multicast forwarding rate for a fixed port configuration. • The DUT's forwarding performance as the number of multicast groups and source IP addresses increase.

SmartxDSL

xDSL converts existing twisted-pair telephone lines into access paths for multimedia and high speed data communications. There are a number of different types of DSL technologies, all of which are suited for testing by SmartxDSL.

The following cards can be tested using a SmartBits 200/2000 chassis:

- AT-9025, ATM, 25 Mbps.
- AT-9045B, ATM, DS3.
- AT-9155C, ATM, Fiber, OC-3, Multi Mode.
- AT-9155Cs, ATM, Fiber, OC-3, Single Mode.
- AT-9622, ATM, Fiber, OC-12, Multi Mode.
- AT-9622s, ATM, Fiber, OC-12, Single Mode.
- AT-6710, 10 Base-TX, Layer 3.
- LAN-3111A, 100 Base-FX Fiber.
- ML-7710, 10/100 Base-TX, SmartMetrics.
- ML-5710A, 10 Base Ethernet, USB, SmartMetrics.

Refer to the *SmartxDSL API Manual* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-5* gives a brief description of these tests.

Table 6-5. SmartxDSL Tests and Description

Tests	Description
Frame Loss	Indicates the performance of the DUT under a given load, by measuring the percentage of frames that are not forwarded due to lack of resources (as per RFC-1242), in the upstream, downstream, or bi-directional test modes.
Frame Latency	Measures the latency of each test frame per VPI/VCI per port. The test operates in upstream or downstream test modes.
Stability Over Time	Measures the frame loss or percentage of line capacity per VPI/VCI over a prolonged period (up to one week) with sampling resolution ranging from a few seconds to an hour. Each sample is time-stamped in order to help the user to determine correlation with external events and to detect the failed VPI/VCI pairs. The test operates in upstream, downstream, or bi-directional test modes.
End-to-End IP	Measures the speed and capacity of the DUT to forward IP traffic between two or more end points. This test assumes the use of Ethernet SmartCards on the trunk side of the network as well as the use of an external router if the DSLAM does not have embedded routing functions. The test operates in upstream, downstream, and bi-directional test modes. You can perform any of the following six measurements: • Sequence Tracking • Latency per Stream • Latency Distribution • Latency over Time • Sequence + Latency
Cell Loss	This test measures loss of ATM cells. In this test each frame equals one cell in size.The test measures the difference between frames transmitted and frames received. This test is applicable only to ATM end-to-end operation, and operates in upstream, downstream, and bi-directional test modes.

Table 6-5. SmartxDSL Tests and Description (continued)

Tests	Description
Cell Latency	Measured between various end points using the ATM cell characteristics. This test is applicable only to ATM end-to-end operation. The test operates in upstream or downstream test mode.
ATM Integrity	Performs Cell Error Ratio (CER) measurements to determine the accuracy of ATM cell transfer through the ADSL-ATM network. It reports the number of AAL5 CRC errored frames received. In this test each frame equals one cell in size. Test is applicable only to ATM end-to-end operation. The test operates in upstream or downstream test modes.

SmartFlow

SmartFlow is a performance analysis tool to test Layers 2, 3, and 4 on Class of Service devices and networks built with Class of Service priority strategies.

The following cards can be tested using the following SmartBits chassis:

- In SMB-200/2000:
  - ML-7710, 10/100 Base-TX, SmartMetrics.
  - ML-7711,100 Base-FX Fiber, SmartMetrics.
  - ML-5710, 10 Base Ethernet, USB, SmartMetrics.
- In SMB-600 and SMB-6000B:
  - LAN-3101A, 10/100 Base, 12-port, SmartMetrics.
  - LAN-3111A, 100 Base-FX Fiber.
  - LAN-3201A, 1000 Base Ethernet, Multi Mode, SmartMetrics.
  - LAN-3201As, 1000 Base Ethernet, Single Mode, SmartMetrics.
  - LAN-3201B, GBIC, SmartMetrics.
  - LAN-3300A/3310A, 10/100/1G Copper, GBIC, SmartMetrics.
  - LAN-3301A/3311A, 10/100/1G Copper, GBIC, Terametrics.
  - POS-3500B, OC12/OC3, SmartMetrics.
  - POS-3500Bs, OC12/OC3, Single Mode, SmartMetrics.
  - POS-3502A, OC-3, SmartMetrics.
  - POS-3502As, OC-3, Single Mode, SmartMetrics.
  - POS-3504As, OC-48c, Single Mode, SmartMetrics.
  - POS-3505As, OC-48c, Single Mode, TeraMetrics.

Refer to the *SmartFlow User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-6* gives a brief description of these tests.

Table 6-6. SmartFlow Tests and Descriptions

Test	Description
Frame Loss	Measures the number of frames lost from flows and groups sent through a device.
Jumbo	Measures frame loss, latency, and latency distribution in flows and groups of flows sent through a device, and updates each of these results simultaneously. It also measures latency standard deviation based on latency distribution, and the number of frames received that were out of sequence.
Throughput	Measures the maximum rate at which frames from flows and groups sent through a device can be sent without frame loss.
Latency	Measures the minimum, maximum, and average latency of received frames in flows and groups of flows sent through a device. Latency is calculated for all received frames.
Latency Distribution	Measures the latency of received frames in flows and groups of flows sent through a device, and sorts them into eight latency buckets. Compared to the Latency test, this test can provide a finer view of latency behavior at the DUT's load tolerance limits.
Latency Snap Shot	Measures the latency of each received frame, for a specified number of frames in flows and groups of flows sent through a device.

SmartVoIPQoS

SmartVoIPQoS allows the user to fully stress a network and analyze the network's ability to simultaneously deliver both voice and data. Test results include IP forwarding results as well as the expected voice quality for each flow. All results are presented in a variety of formats that facilitate rapid user interpretation.

The following cards can be tested using the following SmartBits chassis:

- In SMB-200/2000:
  - ML-7710, 10/100 Base-TX, SmartMetrics.
  - ML-771, 100 Base-FX Fiber, SmartMetrics.
- In SMB-600 and SMB-6000B:
  - LAN-3101A, 10/100 Mbps, SmartMetrics, 12-port.
  - LAN-3111A, 100 Base-FX Fiber.

Refer to the *SmartVoIPQoS User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-7* gives a brief description of these tests.

Table 6-7. SmartVoIPQoS Tests and Descriptions

Test	Description
Voice QoS	Measures frame loss, latency, and latency standard deviation for data frames and frames emulating various codes, in flows and groups of flows sent through a device or system. It maps these metrics to a PSQM score for voice flows and groups.
Frame Loss	Measures the number of data frames emulating various codecs[1] that were lost from flows and groups sent through a device.
Latency	Measures the minimum, maximum, and average latency of received data frames and frames emulating various codecs[1] in flows and groups of flows sent through a device.
Latency Distribution	Measures the latency of received data frames and frames emulating various codecs[1] in flows and groups of flows sent through a device, and sorts them into eight latency buckets. Compared to the Latency test, this test can provide a finer view of latency behavior at the DUTs load tolerance limits.

1 Coder/decoder. In VoIP, that part of an integrated circuit on a telephone network switch that coverts analog signals to digital signals and vice versa. Codecs vary in how they represent analog signals digitally.

Advanced Switch Tests for Ethernet (AST II)

SmartAPI for Advanced Switch Tests II provides test routines that determine the speed and dependability of network switches, bridges, and routers.

The following cards can be tested using the following SmartBits chassis:

- In SMB-200/2000:
  - GX-1405B, Gigabit Ethernet
  - GX-1405BS, Gigabit Ethernet, Single Mode
  - L3-6710, 10 Base-TX, Layer 3
  - ML-7710, 10/100 Base-TX, SmartMetrics
  - ML-7711, 100 Base-FX Fiber, SmartMetrics
  - ML-5710A, 10 Base Ethernet, USB SmartMetrics
  - ST-6410, 10 Base-T, Full Duplex
  - SX-7205, 100 Mbps Ethernet
  - SX-7210, 10/100 Base-TX, VLAN/Data Capture
  - SX-7405, VLAN and Capture
  - SX-7410, 10/100 Base-TX
  - SX-7410B, 10/100 Base-TX
  - SX-7411, 100 Base-FX Fiber, VLAN/Data Capture
- In SMB-600/6000B:
  - LAN-3100A, 10/100 Ethernet, Full/Half Duplex
  - LAN-3101A, 10/100 Ethernet, 12-port, SmartMetrics
  - LAN-3111A, 100 Base-FX Fiber.
  - LAN-3200A, 1000 Base Ethernet, Full Duplex, Multi Mode
  - LAN-3200As, Full Duplex, Single Mode
  - LAN-3201A, 1000 Base Ethernet, Multi Mode, SmartMetrics
  - LAN-3201As, 1000 Base Ethernet, Single Mode, SmartMetrics
  - LAN-3201B, GBIC, SmartMetrics
  - LAN-3710A, 10 Gigabit Ethernet, RMII/SMII

Refer to the *SmartAPI for Advanced Switch Tests II* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available.

Table 6-8 gives a brief description of these tests.

Table 6-8. AST II Tests and Descriptions

Tests	Description
Address Catching	Determines the address catching capacity (the maximum number of addresses) the DUT can handle.
Address Learning Rate	Determines the address learning rate of the DUT (the maximum rate at which the DUT can learn addresses).
Broadcast Forwarding	Determines the broadcast forwarding performance of the DUT/SUT using a one-to-many traffic distribution. The test utilizes burst-time mode to facilitate measurement of offered load and forwarding rates.
Broadcast Latency	Determines the latency of the DUT/SUT when forwarding broadcast traffic. This test utilizes a one-to-many traffic distribution.
Congestion Control	Determines how the DUT/SUT handles congestion. The test indicates if head-of-line blocking exists at the specified ports in the DUT/SUT.
Error Filtering	Determines the performance of the DUT/SUT under error or abnormal frame conditions. Allows for various error types for the test.
Forwarding Rate	Determines the overall forwarding performance of the DUT/SUT including frame loss rate, throughput, and forwarding rate using different traffic distributions.
Forward Pressure	Determines how the DUT/SUT handles forward pressure on a port-by-port basis. The test utilizes burst-time mode.

Virtual LAN Advanced Switch Tests (VAST)

The Virtual LAN Advanced Switch Test (VAST) is a suite of test modules, based in part on RFC-2285, that measure the Layer 2 and Layer 3 capabilities of Ethernet, Fast Ethernet switches, routers and VLANs at both Layer 2 and Layer 3.

VAST provides a 10/100 Mbps, full/half duplex, stream-based set of tests that comprehensively measure different traffic patterns, throughput, and packet loss.

The following cards can be tested using a SmartBits 200/2000 chassis:

- ML-7710, 10/100 Base-TX, SmartMetrics
- ML-7711, 100 Base-FX Fiber, SmartMetrics

Refer to the *VAST User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-5* gives a brief description of these tests.

Table 6-9. VAST Tests and Descriptions

Tests	Description
Broadcast Frames	Evaluates leakage from each VLAN by generating broadcast frames.
Fanout	Measures unidirectional throughput, packet loss, and flooding when a group of ports sends frames to another group of ports. Measures device fairness.
Filter Illegal Frames	Evaluates how well the DUT filters illegal frames, such as oversize, undersize, CRC errors, dribble bit, alignment, and Time to Live equal to zero in IP headers.
Routing VLAN	Evaluates the ability of the device under test to route between different IP subnets. Measures throughput, packet loss, and flooding. Verifies that the DUTs routing table learned from the ARP requests sent.
VLAN by MAC Address	Determines throughput, accuracy, packet loss, and flooding when sending multiple streams of traffic to a VLAN.
VLAN by Port	
VLAN by Protocol	
VLAN by Subnet Address	
VLAN by Tag	

Table 6-9. VAST Tests and Descriptions (continued)

Tests	Description
VLAN Setup Time	Evaluates the ability of the DUT to update the VLAN configuration.

SmartCableModem Test

SmartCableModemTest (SCMT) allows you to test the performance of cable modem devices. SCMT allows you to measure the latency, latency variation, and out-of-sequence frames for cable modem equipment and systems.

The following cards can be tested using the following SmartBits chassis:

- SMB-200/2000:
  - L3-6710, 10 Base-TX, Layer 3
  - ML-7710, 10/100 Base-TX, SmartMetrics
  - ML-5710, 10 Base Ethernet, USB SmartMetrics
- SMB-600 and SMB-6000B:
  - LAN-3101A, SmartMetrics 10/100, 12-port.
  - LAN-3111A, 100 Base-FX Fiber.

Refer to the *SmartCableModemTest* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-10* gives a brief description of these tests.

Table 6-10. SCMT Tests and Descriptions

Test	Description
Sequence Tracking	Sequence tracking is on a per stream (end-user device) basis. Received data is monitored and a record is kept of the following: • Transmitting port number. • Transmitting stream number. • Total number of frames received. • Number of frames received in sequence. • Lagging (extremely late) frames received. • Frames expected, but not received.

Table 6-10. SCMT Tests and Descriptions (continued)

Test	Description
Latency Over Time	Every 10 microseconds, the test records the following for each port: • Total number of frames received. • Minimum latency of all frames received within this interval. • Maximum latency within this interval. The test also calculates the average latency within this interval. Measurements are stored in up to 50,000 data collectors (4,000 for L3-6710).
Latency per Stream	For each traffic stream, the test records the: • Total number of frames received. • Minimum latency of all frames received. • Maximum latency of all frames received. The test also calculates the average latency of all frames received.
Sequence + Latency	A combination of Sequence Tracking and Latency per Stream. Additionally, a distribution of latency per stream is presented across 16 pre-set time intervals.
Raw Tags	All test frames in SCMT have special signature tags that identify and track every frame in the system. This test records the unfiltered tags. Results of the test are presented for viewing in a table format that can be saved to a file in tab delimited format.

ScriptCenter

ScriptCenter is a platform-independent development tool used to write and automatically generate scripts. ScriptCenter is written in Tcl/Tk and works in Windows, UNIX, and Linux environments.

ScriptCenter can be used to set up tests, using either customized or provided scripts. The application automatically generates Tcl code through the use of wizards and task/command inserts and input screens. A set of card-independent extended commands are provided, for use anywhere within a script.

A built-in editor allows ScriptCenter to be used to set up anything from an entire test to a specific routine or single command. Essentially, ScriptCenter serves as a central repository for all scripts needed to run tests through SmartBits systems.

Refer to the *ScriptCenter User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the features available.

The following cards can be tested using the following SmartBits chassis:

- In SMB-200/2000:
  - GX-1405B, Gigabit Ethernet.
  - GX-1405Bs, Gigabit Ethernet, Single Mode.
  - GX-1420B, 100/1000 Base-Copper.
  - ML-7710, 10/100 Base-TX, SmartMetrics.
  - ML-7711, 100 Base-FX Fiber, SmartMetrics.
  - ML-5710A, 10 Base Ethernet, USB SmartMetrics.
  - SX-7410B, 10/100 Base-TX.
- In SMB-600 and SMB-6000B:
  - LAN-3201A, 1000-Base Ethernet, SmartMetrics, Multi Mode.
  - LAN-3201As, 1000-Base Ethernet, SmartMetrics, Multi Mode.
  - LAN-3201B, SmartMetrics, GBIC.
  - LAN-3710A, 10 Gigabit Ethernet, RMII/SMII.
  - POS-3500B, POS OC-12/OC-3.
  - POS-3500Bs, POS OC-12/OC-3, Single Mode.
  - POS-3502A, POS OC-3.
  - POS 3502As, POS OC-3, Single Mode.

SmartTCP

SmartTCP consists of a set of tests that measure the TCP session performance of server load balancer devices that make forwarding decisions based on Layer 4 information.

Testing is performed using a SmartBits 200/2000 chassis with two or more SmartMetrics ML-7710 SmartCards, emulating both the client and server sides of the device under test.

Refer to the *SmartTCP User Guide* located at http://www.netcomsystems.com/support/documentation.asp for a complete description of the tests available. *Table 6-11* gives a brief description of these tests.

The following cards can be tested using the following SmartBits chassis:

- In SMB-200/2000:
  - ML-7710, 10/100 Base-TX, SmartMetrics.
  - ML-7711, 100 Base-FX Fiber, SmartMetrics.
- In SMB-600 and SMB-6000B:
  - LAN-3201A, 1000-Base Ethernet, SmartMetrics, Multi Mode.
  - LAN-3201As, 1000-Base Ethernet, SmartMetrics, Multi Mode.
  - LAN-3201B, SmartMetrics, GBIC.

Table 6-11. SmartTCP Tests and Descriptions

Test	Description
Connection Setup Rate	Measures the rate of TCP connection establishment through the device under test (DUT).
Connection Setup Time	Measures connection setup time through the DUT as the rate increases. The graphical results will indicate any performance degradation which may occur as the number of open sessions increases.
Session Capacity	Determines a DUT's ability to sustain TCP sessions over a period of time. It measures the maximum number of open sessions that the DUT can support.
Session Rate	Measures the rate of TCP session setup and teardown through the DUT.
Connection Teardown Rate	Measures the rate at which the DUT closes the TCP connections.

7 Sample Test Topologies

In this chapter . . .

Sample Devices and Networks to Test

Applications available to set up and test cable modem systems:

- **SmartCable Modem Test (SCMT)** for pre-canned applications.
- **SmartWindow** for a customized virtual front panel application.
- **SmartLib** for a programming library.

Testing Cable Modems

Cable modem testing uses SmartMetrics cards and takes advantage to USB as an emerging transport media for connecting to broadband access technologies. The ML-5710A is a SmartMetrics SmartCard that has one 10 Mbps Ethernet (RJ-45) and one USB (series A) port. The USB port enables you to simulate full-field testing conditions of cable modem systems.

In addition, an ML-7710 SmartCard is used to capture, count, and compare Ethernet frames that are reassembled by the Head End router.

Refer to the *SmartWindow User Guide,* for detailed information regarding applicable tests and features.

Testing Frame Relay Switches

Applications available to set up and test frame relay switches:

- **SmartWindow** for a customized virtual front panel application.
- **SmartLib** for a programming library.
- **SmartApplications** for automated RFC-1242 testing.

Frame Relay testing uses the WAN SmartCards in the SmartBits 200 or 2000 chassis.

The Frame Relay switch is designed to support data in bursts and at high speeds in a bi-directional, conversational method of communication. The switch operates primarily on Layers 1 and 2 of the network model, and works via a *virtual circuit connection*, in that dynamic links act like a pipe for moving traffic.

There are three types of virtual circuits:

- **Switched (SVC).** The SVC is similar to voice connections made through the telephone network: when the network receives a connection request, it sets one up, data is sent, and then the call is terminated.
- **Permanent (PVC).** The PVC is a point-to-point connection that is similar to a leased data line. It is dedicated and used over long periods of time.
- **Multicast (MVC).** The MVC is a connection between groups of users, who can use both SVCs and PVCs.

Currently, the PVC is the only type of Frame Relay circuit tested by SmartBits. The local address for the Frame Relay switch is the data link connection identifier (DLCI).

Service fees are based on the committed information rate (CIR), which is equal to the bandwidth available from one end to another. The frame size ranges from 32-bytes to the maximum of 8,191-bytes.

Refer to the *SmartWindow User Guide* located at http://www.netcomsystems.com/support/documentation.asp, for detailed information regarding applicable tests and features.

Testing Packet over SONET Routers

Applications available to set up and test Packet over SONET (POS) routers:

- **SmartWindow** for a customized virtual front panel application.
- **SmartLib** for a programming library.
- **SmartApplications** for automated RFC-1242 testing.
- **SmartFlow** for forwarding and policy-based QoS testing with SmartMetrics.

POS device testing uses POS modules on the SmartBits 600/6000B chassis and are capable of:

- Generating up to 8,192 streams at any given time and analyzing the results.
- Implementing up to 65,535 flows per stream–a total of 524 million flows per port.
- Testing real POS Router performance with SmartMetrics: Per-flow Frame loss, Latency, Latency and Sequence, and Latency Distribution tracking.
- Testing core and edge router capabilities through a fully integrated array of Spirent SmartMetrics cards.

Refer to the *SmartWindow User Guide* located at http://www.netcomsystems.com/support/documentation.asp for detailed information regarding applicable tests and features.

Testing Gigabit Routers

Applications available to set up and test gigabit routers are as follows:

- **SmartWindow** for a customized virtual front panel application.
- **SmartLib** for a programming library.
- **SmartApplications** for automated RFC-1242 testing.
- **SmartFlow** for forwarding and policy-based QoS testing with SmartMetrics.

The principal function of the SmartBits module is to test Layer 3 devices. It can also test Layer 2 functionality and performance. The cards are capable of full-wire traffic generation and analysis. The card features:

- A 850nm ShortWave multi-mode fiber physical interface.
- 802.1p, 802.1q, and 802.3 ac VLAN tagging.
- 802.3x flow control.
- Optional data integrity for checking bit errors in Layer 3 forwarding devices.
- Generating up to 2,000 streams at any given time and analyzing the results.
- Implementing up to 64,000 flows per stream–a total of 524 million flows per port.
- Configuring each stream to a different data transmission mode (Continuous, Single Burst, Multi-Burst, Continuous Multi-Burst).
- Testing real Gigabit Router performance with SmartMetrics:
  - Per flow Frame loss.
  - Latency.
  - Latency and Sequence.
  - Latency Distribution tracking.
- Testing core and edge router capabilities through a fully integrated array of Spirent SmartMetrics cards.

Refer to the *SmartWindow User Guide* located at http://www.netcomsystems.com/support/documentation.asp for detailed information regarding applicable tests and features.

Testing ATM

Asynchronous Transfer Mode (ATM) is a *connection-based* technology. It requires that a specific path be established between two endpoints before data can be transferred between them.

The ATM series of SmartBits™ compatible cards can be used to generate and monitor ATM network traffic. Applications include testing:

- ATM-to-LAN internet working devices.
- Very high-performance ATM backbones.
- LAN-to-ATM edge devices.

Among the significant capabilities of these low cost/high performance ATM cards are:

- Frame-level testing at full-duplex, full-wire rate on edge devices and switches.
- Switch testing at full-cell rate.
- High-rate signaling testing for edge devices.

SmartWindow uses the concept of *streams* as a transmission engine. When you create a stream, you define *what* to transmit, *how* and *where* to transmit it, and *how fast* to transmit it.

The *what to transmit* is the frame that a stream will use. Each time you create a stream, you must give the card a data pattern (frame) to transmit for the specified stream. When you click on the Start button, the stream transmits that data pattern repeatedly in its assigned turn.

The *how* and *where to transmit* depend greatly on stream type and encapsulation. The two stream types are Permanent Virtual Connections (PVC) and Switched Virtual Connections (SVC). In ATM, one physical “pipe” is used to transmit and receive all data, but the pipe can be divided into channels (as in television transmission). When a data cell is transmitted, its data channel is indicated by two fields in the cell header that is included in each cell. These are the *Virtual Path Identifier* (VPI) and *Virtual Channel Identifier* (VCI) fields.

The how and where to transmit greatly depends on *stream* type and *encapsulation*. There are two types of streams:

- Permanent Virtual Connections (PVC).
- Switched Virtual Connections (SVC).

For ATM, although there is one physical *pipe* that all data is transmitted and received on, it is divided into *channels* much like it is for television. When a data cell is transmitted, the data channel it belongs to is indicated by the Virtual Path Indicator (VPI) and the Virtual Channel Indicator (VCI) fields in a Cell Header that accompanies every cell.

Refer to the *SmartWindow User Guide* located at http://www.netcomsystems.com/support/documentation.asp for detailed information regarding applicable tests and features.


SPIRENT
Communications

8 Chassis Specifications

In This Chapter . . .

SMB-200/2000 Specifications

Specifications for the SMB-200 and SMB-2000 are the same except as noted in *Table 8-1* below.

Table 8-1 SMB-200/2000 Specifications

Category	Description
SMB-200 Dimensions:	Width: 12.25 in. (31.1 cm.) Height: 3 in. (7.6 cm.) Depth: 12 in. (30.5 cm.) Weight: 5 lbs. (2.27 kg.) fully loaded Shipping weight, approximately 8 lbs. (3.6 kg.)
SMB-2000 Dimensions:	Width: 19 in. (48.26 cm.) Height: 6.75 in. (17.15 cm.) Depth: 15 in. (38.1 cm.) Weight: 27 lbs. (12.25 kg.) fully loaded Shipping weight, approximately 30 lbs. (13.6 kg.)
Layout Requirements:	• Must have unimpeded airflow into the fans at the side of the chassis. • Must be positioned to meet EMI guidelines (see *Appendix C, "Certifications and EMI Compliance,"*). • Local connections to multiple chassis must be within 1 meter (39 inches) of each other.
Input power:	90-264 VAC Nominal 115 or 230 VAC, 47-63 Hz. Controllable over the Internet or from a PC with Windows 98 or Windows NT.
Number of slots:	SMB-200 – 4. SMB-2000 – 20.
Max number of ports:	SMB-200 – 4. SMB-2000 – 20.
Front Panel LEDs: Back Panel LEDs:	SMB-200 – Power, Link, and Fan. SMB-2000 – Power and Link. SMB-200 – Link and Activity. SMB-2000 – Link and Activity.

Table 8-1 SMB-200/2000 Specifications

Category	Description
Connectors	• RS-232 for workstation connection. • RJ-45 10Base-T connector for Ethernet connection. • RJ-45 Expansion In/Out connectors for multiple chassis connection. • DB-37 and Hub connectors for stacked multiple chassis. • Connectors to attach to an optional GPS receiver.
Operating Temperature Operating Humidity	59-104°F (15-40°C). 20 to 80% relative humidity, non-condensing.
GPS option	Available.
Stacking Requirements	Local stacks must be located within 3 feet (1 meter) of each other.
Cards Supported	All SmartCards (Ethernet, Fast Ethernet, Gigabit Ethernet, ATM, WAN, and Token Ring).
Applications Supported	All applications (core and optional).

Differences between the SMB-200 and SMB-2000

- SMB-200 does not have the DB-37 connectors for the SmartBits stack configuration, therefore does not support:
  - Multiple users.
  - SMB-10 extension hub.
- SMB-200 has a 4-slot chassis vs. SMB-2000 which has a 20-slot chassis.
- LEDs:
  - SMB-200 has front panel Fan, Link, and Power LEDs, and a reset switch.
  - SMB-2000 has only Power and Link LEDs, and no reset switch.

Note: Though the SMB-200 cannot be stacked, it is able to be connected with multiple chassis via the expansion ports.

SMB-10

The SMB-10 is a 20-slot chassis which connects to and expands the capacity of a SMB-2000. This chassis is totally dependent on the controller of the connecting SMB-2000, and is referred to as a “slave.”

SMB-6000/6000B Specifications

Specifications for the SMB-600 and SMB-6000B are the same except as noted in *Table 8-2* below.

Table 8-2 SMB-600/6000B Specifications

Category	Description
SMB-600 Dimensions	Width: 12 in. (30.5 cm.) Height: 3.5 in. (8.9 cm.) Depth: 12.5 in. (31.8 cm.) Weight: 5.25 lbs. (2.4 kg.) fully loaded Shipping weight, approximately 8.5 lbs. (3.8 kg.)
SMB-6000B Dimensions	Width: 19 in. (48 cm.) Height: 8.5 in. (22 cm.) Depth: 16.5 in. (42 cm.) Weight: 45 lbs. (20.4 kg.) fully loaded Shipping weight, approximately 48 lbs. (21.8 kg.)
Layout Requirements	• Must have unimpeded airflow into the fans at the side of the chassis. • Must be positioned to meet EMI guidelines (see *Appendix C, "Certifications and EMI Compliance,"*). Local connections to multiple chassis must be within 1 meter of each other.
Input power	100-240 VAC. Nominal 115 or 230 VAC, 50-60 Hz. Controllable over the Internet or from a PC with Windows 98 or Windows NT.
Number of slots	• SMB-600 – 2 • SMB-6000B – 12
Max number of ports	• SMB-600 – 16 • SMB-6000B – 96
Front Panel LEDs Back Panel LEDs	Power, Fan, Link, and Status. Activity/Collision, Link/Error, Full/Half Duplex, and 10/100 Ethernet.

Table 8-2 SMB-600/6000B Specifications

Category	Description
Connectors	• RS-232 for workstation connection. • RJ-45 10 Base-T connector for Ethernet connection. • RJ-45 Expansion In/Out connectors for multiple chassis connection. • Connectors to attach to an optional GPS receiver.
GPS Option	Available
Operating Temperature Operating Humidity	59-104°F (15-40°C) 20 to 80% relative humidity, non-condensing.
Cards Supported	All 3xxx series modules (Gigabit Ethernet and POS)
Applications Supported	Core Applications, SmartFlow, AST II, BGP Router Test, SmartMulticastIP, ScriptCenter, SmartVoIPQoS, and SCMT.

Note:

- For SmartBits certifications and EMI compliance, please refer to *Appendix C, "Certifications and EMI Compliance"*
- For detailed cable, connector, and accessory information, please refer to *Appendix E, "SMB-600/6000B Cables and Connectors"* and *Appendix F, "SMB-200/2000 Cables and Connectors"*
- Other helpful topics located in include *"Downloading New Firmware" on page 40*, and *"Changing Chassis Timeout" on page 41*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Communications

9 Ethernet Cards

In this chapter . . .

Ethernet Applications

Table 9-1 gives a description of the Ethernet cards and the applications available for each SmartBits chassis.

Note: Throughout this manual, the term “card” may be used interchangeably to represent either SmartCards (SMB-200/2000), or modules (SMB-600/6000B).

Table 9-1. Ethernet Cards Used in Applications

Card/ Module	Description	SmartWindow 7.10	SmartLib 3.10	SmartApps 2.40	SmartSignaling 3.00	SmartMulticastIP 1.25	SmartFlow 1.30	SmartVoIPQoS 1.00	TeraRouting 1.00	AST II (All Tests)	SmartTCP 2.00	SmartxDSL 1.10	SCMT 2.00	VAST 2.11	ScriptCenter 1.20	SmartMetrics	TeraMetrics
Ethernet Cards Used in SMB-200/2000Chassis																	
GX-1405B	Gigabit	X	X	X						X					X		
GX-1405Bs	Gigabit, Single Mode	X	X	X						X					X		
GX-1420B	100/1000 Base- Copper	X	X	X						X					X		
GX-1421A	100/1000 Mbps Ethernet GMII/MII	X	X														
L3-6710	10 Base-TX Layer 3	X	X	X													
ML-7710	10/100 Base-TX	X	X	X		X	X	X		X	X	X	X	X	X	X	
ML-7711	100 Base-FX Fiber	X	X	X		X	X	X		X	X			X	X	X	
ML-5710A	10 Base, USB	X	X	X[1]			X			X		X[1]	X[2]		X	X	
ST-6410	10 Base-T Full Duplex	X	X	X											X		
SX-7205	100 Mbps	X	X	X											X		
SX-7210	10/100 Base-TX VLAN/Data Capture	X	X	X											X		
SX-7405	VLAN and Capture	X	X	X											X		
SX-7410	10/100 Base-TX (MII)	X	X	X						X					X		
SX-7410B	10/100 Base-TX (RJ-45)	X	X	X						X					X		
SX-7411	100 Base-FX Fiber VLAN/Data Capture	X	X	X					X	X					X		
Ethernet Cards Used in SMB-600/6000B Chassis																	
LAN-3100A	10/100 Mbps Full/Half Duplex	X	X	X						X					X		
LAN-3101A	10/100 Mbps 12-port	X	X	X		X	X			X		X	X[2]		X	X	
LAN-3111A	100 Base-FX Fiber	X	X	X	X		X	X		X	X	X	X[2]				

Table 9-1. Ethernet Cards Used in Applications

Card/ Module	Description	SmartWindow 7.10	SmartLib 3.10	SmartApps 2.40	SmartSignaling 3.00	SmartMulticastIP 1.25	SmartFlow 1.30	SmartVoIPQoS 1.00	TeraRouting 1.00	AST II (All Tests)	SmartTCP 2.00	SmartxDSL 1.10	SCMT 2.00	VAST 2.11	ScriptCenter 1.20	SmartMetrics	TeraMetrics
LAN-3150A	10/100 Mbps Ethernet GMII/MII	X	X														
LAN-3200A	1000 Base Full Duplex, Multi-mode	X	X	X						X					X		
LAN-3200As	1000 Base Full Duplex, Single Mode	X	X	X						X					X		
LAN-3201A	1000 Base Multi-mode	X	X	X		X	X			X	X				X	X	
LAN-3201As	1000 Base Single Mode	X	X	X		X	X			X	X				X	X	
LAN-3201B	GBIC	X	X	X		X	X			X	X				X	X	
LAN-3300A/ 3310A	10/100/1G Copper 1G GBIC	X	X	X			X								X	X	
LAN-3301A/ 3311A	10/100/1G Copper 1G GBIC	X	X	X			X		X						X		X
LAN-3710A[3]	10G Base (LR/ER) Ethernet	X	X							X					X		

1 Supports 10 Mbps Ethernet mode only.
2 A firmware upgrade is required to support this application version.
3 When ordering, specify the wavelength required measured in nanometers; i.e., 1310 nm for LAN-3710AL or 1550 nm for LAN-3710AE.

Minimum/Maximum Frame Lengths for Each Card

The following tables identify the range of frames sizes for traffic generated by each card, and traffic captured by each card (may include non-SmartBits traffic).

Table 9-2. Min/Max Frame Lengths in Bytes for Ethernet Cards

Card/Module	Description	Minimum Generated Frame Size	Maximum Generated Frame Size	Minimum Capture Frame Size	Maximum Capture Frame Size
Ethernet Cards Used in SMB-200/2000 Chassis					
GX-1405B	Gigabit Ethernet, Multi Mode	1	2048	24	2K
GX-1405Bs	Gigabit Ethernet, Single Mode	1	2048	24	2K
GX-1420B	100/1000 Base Copper	5	2048	24	2K
GX-1421A	100/1000 Base Ethernet, GMII/MII)	5	2048	24	2K
L3-6710	10 Base-TX Layer 3	1	2048	5	1530
ML-7710	10/100 Base-TX	24	1600	18	2000
ML-7711	100 Base-FX Fiber	24	1600	18	2000
ML-5710A	10 Base-Ethernet/ USB	24	1600	18	2000
ST-6410	10 Base-T Full Duplex	1	8191	n/a	n/a
SX-7205	100 Mbps				
SX-7210	10/100 Base-TX VLAN/Data Capture				
SX-7405	VLAN and Capture				
SX-7410	10/100 Base-TX (MII)	1	8191	1	8191
SX-7410B	10/100 Base-TX (RJ-45)	1	8191	1	8191
SX-7411	100 Base-FX VLAN/Data Capture	1	8191	1	8191
Ethernet Cards Used in SMB-600/6000B Chassis					
LAN-3100A	10/100 Mbps Full/Half Duplex	32	16,384	12	16K
LAN-3101A	10/100 Mbps Copper RJ-45	24	1600	18	64K
LAN-3150A	10/100 Mbps Full/Half Duplex (RMII/SMII)	32	16,384	12	16K
LAN-3200A	1000 Mbps Full Duplex Fiber Multi Mode	86	2048	24	2K

Table 9-2. Min/Max Frame Lengths in Bytes for Ethernet Cards

Card/Module	Description	Minimum Generated Frame Size	Maximum Generated Frame Size	Minimum Capture Frame Size	Maximum Capture Frame Size
LAN-3200As	1000 Mbps Full Duplex Fiber Single Mode	86	2048	24	2K
LAN-3201A	1000 Mbps Multi-Mode	86	2048	32	64K
LAN-3201As	1000 Mbps Single Mode	86	2048	32	64K
LAN-3201B	1000 Mbps GBIC	32	2048	32	64K
LAN-3300A	10/100/1000 Mbps GBIC				
LAN-3301A	10/100/1000 Mbps Copper	64	16,384	40	16,384
LAN-3310A	1000 Mbps Single/Multi Mode GBIC				
LAN-3311A	10/100/1000 Mbps Single/Multi Mode Fiber	64	16,384	40	16,384
LAN-3710A	10G Base (LR/ER) Ethernet				

Feature Summary of 10/100 Mbps Cards

Table 9-3. 10/100 Mbps Ethernet Cards – Feature Set for ST and SX Cards

Feature	ST-6410	SX-7210	SX-7410
Interface	RJ-48	MII	RJ-45
Speed	10 Mbit	10/100 Mbps	10/100 Mbps
Duplex Mode	Full/Half	Full/Half	Full/Half
SmartMetrics[1]	No (Traditional)		
Latency resolution	100 ns	100 ns	100 ns
Max # streams per port	1	1	1
Alternate Streams	No	1	1
Max # flows per stream	n/a	n/a	n/a
VFD1/2 (to 6 bytes)	Yes	Yes	Yes
VFD 3 Buffer	2K	2K	2K
Capture Buffer Size	n/a	86 to 2048 pkts	86 to 2048 pkts
Packet Length	1 to 8KB	1 to 8KB	1 to 8KB
IP Header Checksum/ Data Integrity verify	No	No	No
CRC Errors	Yes	Yes	Yes
Alignment, Dribble, Under/oversize Errors	Yes	Yes	Yes
Adjustable Preamble Length	No	Yes	Yes
Min Tx Interpacket Gap Max Tx Interpacket Gap Increments	100 ns 26 sec 100 ns	10 Mbps 100 Mbps 400 ns 40 ns 26.8 sec 2.68 sec 400 ns 40 ns	10 Mbps 100 Mbps 4.8 µs 40 ns 26.8 sec 2.68 sec 400 ns 40 ns
VLAN Tagging	No	Yes	Yes
Collisions Detected [2]	Yes	Yes	Yes
Flow Control	No	Yes	Yes
Traffic Rates	> wire speed	> wire speed	> wire speed
# Ports per Card	1	1	1

1 Allows SmartMetrics tracking and histograms.
2 Only works in half duplex mode; not applicable to full duplex.

Table 9-4. 10/100 Mbps Ethernet Cards – Feature Set for SmartMetrics Cards

Feature	L3-6710	ML-5710A	ML-7710 ML-7711	LAN-3100A LAN-3150A	LAN-3101A
Interface	RJ-45	RJ-45 or USB	RJ-45 (7710) Fiber (7711)	RJ-45 (3100A) RMII/SMII (3150A)	RJ-45
Speed	10 Mbps	10 Mbps (Eth) 12 Mbps (USB)	10/100 Mbps (7710) 100 Mbps only(7711)	10/100 Mbps	10/100 Mbps
Duplex Mode	Half only	Full/Half	Full/Half (7710) Full only (7711)	Full/Half	Full/Half
SmartMetrics [1]	Yes	Yes	Yes	No	Yes
Latency resolution	± 100 ns	± 100 ns	± 100 ns	± 100 ns	± 100 ns
Max # streams per port	640	1000	1000	1	1000
Alternate Streams	No	1	1	1	1
Max # Flows per stream	n/a	n/a	64K	Billions	64K
VFD1/2 (to 6 bytes)	Yes	Yes	Yes	Yes	Yes
VFD 3 Buffer	Yes	Yes	Yes	2K	
Capture Buffer Size	40 pkts	475 pkts	475 pkts	196K pkts	6500 pkts
Packet Length	1 to 2 KB	24 to 1600 bytes	24 to 1600 bytes	32 to 16 KB	25 to 1600 bytes
IP Header checksum Verify Generate	 No Yes	 No Yes	 No Yes	 No Yes	 No Yes
Data Integrity verify	No	No	No	Yes	Yes
CRC Errors	Yes	Yes	Yes	Yes	Yes
Alignment, Dribble, Under/oversize errors	Yes	Yes (Ethernet only)	Yes	Yes	Dribble + Align
Adjust Preamble Length	No	No	No	Yes	No
Min Tx IFG Max Tx IFG Increments	100 ns 1.6 sec 100 ns	10 Mbps 100 Mbps 9.6 µsec 960 ns 26.8 sec 2.68 sec 400 ns 40 ns	10 Mbps 100 Mbps 9.6 µsec 960 ns 16 sec 1.6 sec 400 ns 40 ns	10 Mbps 100 Mbps 9.6 µsec 960 ns 26.8 sec 2.68 sec 400 ns 40 ns	10 Mbps 100 Mbps 9.6 µsec 960 ns 26.8 sec 2.68 sec 400 ns 40 ns
VLAN Tagging	No	Yes	Yes	Yes	Yes
Collisions Detected [2]	No	Yes	Yes	Yes	Yes
Flow Control	No	Yes	Yes	Yes	Yes
Traffic Rates	> wire speed	> wire speed	> wire speed	> wire speed	> wire speed
# Ports per Card	1	1 USB/Ethernet	1	16 (6100) 8 (3100) 2 (3150)	12 (6101) 6 (3101)

1 Allows SmartMetrics tracking and histograms.
2 Only works in half duplex; not applicable to full duplex

Comparison of ML-7710 vs LAN-3101A

The LAN-3101A module is a high-port density version of the ML-7710.

The single-port ML-7710 is used with the SMB-200 and SMB-2000. The 6-port LAN-3101A module is used with the SMB-600 and SMB-6000B.

SmartLib Differences

In **SmartLib Version 3.09 and higher,** the following commands are used specifically for the LAN-3101A and ML-7710:

- *FST_CAPTURE_INFO* (applies to both the ML-7710 and the LAN-3101A).

  (None of the other "FST_CAPTURE_n" commands can be used with either the ML-7710 or the LAN-3101A.)
- The following command is used to show data integrity errors: *ETH_EXTENDED_COUNTER_INFO* and a parameter *u64RxDataIntegrityErrors* (applies to LAN-3101A).

Summary of Key Features, Similarities and Differences

The following table highlights key features; the shaded rows indicate feature differences between the cards.

Table 9-5. Comparison of ML-7710 and LAN-3101A Cards

Feature	ML-7710	LAN-3101A
# Ports per Card	1	12
Max # Ports per Chassis	20	72
Interface	RJ-45	RJ-45
Speed	10/100 Mbps	10/100 Mbps
Tx modes:		
Continuous	Constant frame transmit	Constant frame transmit
Single burst	UP to 16 million frames per burst	Up to 4 billion frames per burst
Multiburst	Up to 65,536 repetitive bursts with a user-defined delay between bursts	Up to 4 billion repetitive bursts with a user-defined delay between bursts
Continuous multiburst	Runs multi-burst mode continuously	Runs multi-burst mode continuously
• Continuous	• Constant frame transmit.	• Constant frame transmit.
• Single burst	• Up to 16 million frames per burst.	• Up to 4 billion frames per burst.
• Multiburst	• Up to 65,536 repetitive bursts with a user- defined delay between bursts.	• Up to 4 billion repetitive bursts with a user- defined delay between bursts.
• Continuous multiburst	• Runs multi-burst mode continuously.	• Runs multi-burst mode continuously.
Min Tx Interpacket Gap Max Tx Interpacket Gap Increments	10 Mbps / 100 Mbps 9.6 µsec / 960 ns 16 sec / 1.6 sec 400 ns / 40 ns	10 Mbps / 100 Mbps 9.6 µsec / 960 ns 26.8sec / 2.68 sec 400 ns / 40 ns
Duplex Mode	Full/Half	Full/Half
SmartMetrics [1]	Yes	Yes
Latency resolution	± 100 ns	± 100 ns
Max # streams per port	1000	1000
Alternate Streams	1	1
Max # Flows per stream	64K	64K

Table 9-5. Comparison of ML-7710 and LAN-3101A Cards

Feature	ML-7710	LAN-3101A
VFD1/2 (to 6 bytes)	Cycle count up to 16.7 million	Cycle count and stutter up to 4 billion
VFD 3 Buffer Size	2K bytes	2K bytes
Error generation: CRC, alignment, dribble bits, symbol, undersize and oversize	Yes	Yes + Data Integrity errors (per stream, L3 mode only) + Symbol errors (100 Mbps only)
Error detection: CRC, alignment, dribble bits, undersize and oversize	Yes	Yes + Data Integrity Errors
Pre-capture Filtering Options	CRC, alignment, oversize, undersize, Rx triggers, or All	CRC, alignment, oversize, undersize, data integrity errors, Rx triggers, or All
Capture Buffer Size	475 frames	6500 frames
Packet Length	24 to 1600 bytes	24 to 1600 bytes
Pre-compute/insert IP Header checksum	Yes	Yes
Verify Data Integrity	No	Yes
Adjustable Preamble Length	No	No
VLAN Tagging	predefined/selectable	predefined/selectable
Background Fill Pattern, user-selectable or random data	Yes	Yes
2 Triggers (up to 6 bytes each); can be specified using the bit offset or using a pattern and mask. The trigger counter can be set to: Trigger 1,Trigger 2; Trigger 1 or Trigger 2; Trigger 1 and Trigger 2.	Yes	Yes
Collisions Detected (Half duplex only)	Yes	Yes
Flow Control	Yes	Yes
Traffic Rates	> wire speed	> wire speed

1 Allows SmartMetrics tracking and histograms.

Feature Summary of Gigabit Cards

The gigabit card features are summarized into three tables:

- *Table 9-6 on page 91* lists general gigabit features availability.
- *Table 9-7 on page 92* lists features that apply to the SMB-200/2000 gigabit cards.
- *Table 9-8 on page 93* lists features that apply to the SMB-600/6000B gigabit cards.

Table 9-6. Advanced Gigabit Features

Card	MPLS Labeling Insertion	IP Header Checkum Gen./Valid.	Data Integrity Checksum Gen./Valid.	Multimodal Frame Length Distribution	Jumbo Frames	Address Stutter, Carry Chaining, and Bit Masking	Added Rx Triggers
GX-1405B	No	No	No	No	No	No	No
GX-1405Bs	No	No	No	No	No	No	No
GX-1420B	No	Yes	No	No	No	No	Yes
GX-1421A	No	Yes	No	No	No	No	Yes
LAN-3201B	No	Yes	Yes	No	Yes	No	No
LAN-3300A	Yes	Yes	No	No	Yes	Yes	No
LAN-3301A	Yes	Yes	Yes [1]	Yes	Yes	Yes	No
LAN-3310A	Yes	Yes	No	No	Yes	Yes	No
LAN-3311A	Yes	Yes	Yes [1]	Yes	Yes	Yes	No
LAN-3710A	No	Yes	Yes	Yes	Yes	Yes	Yes

1 With management frames and cut-through channel only (not in SmartMetrics streams).

Table 9-7. SMB-200/2000 Gigabit Ethernet Cards — Feature Set Summar

Feature	GX-1405B/1405Bs	GX-1420B
Interface	GX-1405B: 850 nm multi-mode, 1000 Base-SX GX-1405Bs: 1300 nm single mode, 1000 Base-LX	RJ-45
Speed	1 Gbps	1 Gbps
Duplex Mode	Full Only	Full Only
SmartMetrics [1]	No (Traditional)	
Latency resolution	±100 ns	±100 ns
Max Streams per Port	1	1
Alternate Streams	2	2
Max # flows per stream	N/A	N/A
VFD 3 Size	16K	16K
Capture Buffer Size	128K	128K
Packet Length	1 byte to 2KB+	5 bytes to 2KB+
Verify IP Head.Checksum	No	Yes
CRC Errors	Yes	Yes
Alignment, Dribble, Under/ oversize, Symbol Errors	All but align and dribble	All but align and dribble
Adjustable Preamble Length	Yes	Yes
Min Tx Interpkt Gap Max Tx Interpkt Gap Increments	96 ns 1.5 sec 32 ns	96 ns 1.5 sec 32 ns
VLAN Tagging	Yes	Yes
Collisions Detected [2]	N/A	N/A
Flow Control	Yes	Yes
Traffic Rates	> wire speed	> wire speed
# Ports per Card	1	1

1 Allows SmartMetrics tests and histograms.
2 Only works in half duplex mode; not applicable to full duplex.

Table 9-8. SMB-600/6000B Gigabit Ethernet Cards — Feature Set Summary

Feature	LAN-3201B	LAN-3300A	LAN-3310A	LAN-3301A	LAN-3311A
Interface	GBIC (1)	RJ-45 (2)	GBIC (2)	RJ-45 (2)	GBIC (2)
Speed	1 Gbps	100/1000 Mbps	1 Gbps	100/1000 Mbps	1 Gbps
Duplex Mode	Full	Full/Half	Full Only	Full/Half	Full Only
SmartMetrics [1]	Yes	Yes	Yes	Yes + TeraMetrics	Yes + TeraMetrics
Latency Resolut.	± 100 ns	± 100 ns	± 100 ns	± 100 ns	± 100 ns
Max streams per Port	8192 streams	512 streams	512 streams	512 streams	512 streams
Alternate Streams	1	1	1	1	1
Max Flows per Stream	512M	Billions	Billions	Billions	Billions
VFD 3 Size	16K	16K	16K	16K	16K
Capture Buffer	1MB	16MB	16MB	16MB	16MB
Packet Length	32 to 2048 bytes	40 to 16,384 bytes	40 to 16,384 bytes	40 to 16,384 bytes	40 to 16,384 bytes
Gen./Valid. IP Head Checksum	Yes	Yes	Yes	Yes	Yes
CRC Errors	Yes	Yes	Yes	Yes	Yes
Errors:Alignment Dribble, Symbol Under/oversize	Under/ oversize frames	Undersize, oversize, + pause frames	Undersize, oversize, + pause frames	Undersize, oversize, + pause frames	Undersize, oversize, + pause frames
Adj. Preamble Length	No	Yes	Yes	Yes	Yes
		100M 1000M		100M 1000M	
Min Tx Interpkt Gap	96 ns	960 ns 96 ns	96 ns	960 n 96 ns	96 ns
Max Tx Interpkt Gap	33.33 µse	5.3 sec 1.07 s	1.07 sec	5.3 sec 1.07 s	1.07 sec
Increments	32 ns	40 ns 8 ns	8 ns	40 ns 8 ns	8 ns
VLAN Tagging	Yes	Yes	Yes	Yes	Yes
Collisions Detected	N/A	N/A	N/A	N/A	N/A
Flow Control	Yes	Yes	Yes	Yes	Yes
Traffic Rates	> wire speed	> wire speed	> wire speed	> wire speed	> wire speed
# Ports per Card	2/1	4/2	4/2	4/2	4/2

1 Allows SmartMetrics tests and histograms.

SmartCards and Modules

There are two SmartCard/module categories available to use with your SmartBits chassis. The SmartCards/modules that you will use is based on the requirements of the chassis you are using. They are defined as follows:

- SmartCards (SMB-200 and SMB-2000).
- Modules (SMB-600 and SMB-6000B.

LEDs on Ethernet SmartCards/modules

Each SmartBits card has a set of LEDs that are similar in functionality but the features may vary according to the card you are using. *Table 9-9* describes the LED functions and descriptions for all the Ethernet cards.

Table 9-9. LED Functions for Ethernet SmartCards/modules

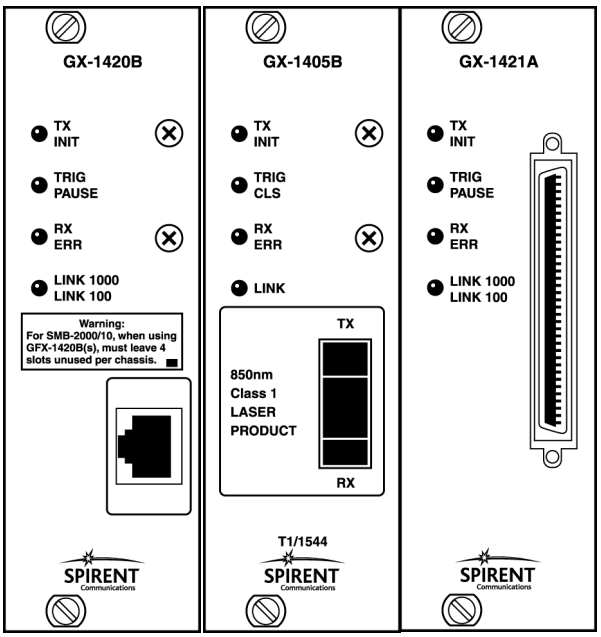
LED	Color/Status	Description
TX/INIT	Green	Transmitting. LED flashes briefly for each frame transmitted. If continuous transmission, light appears as a steady on condition.
	Red	Card not initialized. This light is red briefly until the card boots up.
	Off	When chassis and card are not connected, or after card is initialized.
TRIG CLS	Green	Trigger Event indication. Flashes briefly for each trigger detection.
	Red	Collision Event. Flashes briefly for each collision event detected.
	Yellow	Both Collision & Trigger Event occur at same time. In this case, the flash appears as yellow.
RX ERR	Green	Flashes Green once for each frame detected on the network.
	Red	Flashes Red once for each bad CRC detected in receive frames.
	Off	Not receiving.
LINK/ DPLX	Green	Full duplex with valid link.
	Yellow	Half duplex with valid link (SX-7410).
	Red	No link detected.
	Off	Half duplex, with valid link (ST-6410).

Table 9-9. LED Functions for Ethernet SmartCards/modules

LED	Color/Status	Description
LINK 1000 LINK 100	 Green Yellow	(GX-1420B) Displays green for autonegotiated 1000 Mbps. Displays amber for autonegotiated 100 Mbps.
TRIG PAUSE	 Green Yellow Off	(GX-1405 and GX-1420B) Receiving trigger frames. Receiving PAUSE frames. No trigger or pause events.
100M PAUSE	 Green Yellow Off	(SX-7410 and ML-7710) 100 Base-TX operation. Receiving PAUSE frames. 10 Base-T operation.

GX Series SmartCards

- **GX-1405B 1000 Base-SX (RJ-45)**
- **GX-1405Bs 1000 Base-LX (RJ-45)**
- **GX-1420B 100/1000 Base-Copper (RJ-45)**
- **GX-1421A 100/1000 Base GMII/MII (80-pin)**



Card Type: Full Duplex Ethernet 1000/100 Mbps SmartCards.

Where Used: SMB-200 and SMB-2000; one port per card; each card occupies two slots in a chassis.

Applications Supported: SmartWindow, SmartLib, SmartApplications, AST II.

Devices Tested: Switches and routers, over copper wire.

Test Objective: A packet-based traffic generator to test performance of devices based on industry standard RFCs and the applicable IEEE 802.3ab draft specification.

Features:

GX-1405B, GX-1405Bs	GX-1420B, GX-1421A
Transmit and receive beyond wire speed.	Supports 100/1000 Mbps with autonegotiation.
Generates, monitors, and captures data.	Wire-rate traffic generation, traffic analysis and capture with IP checksum error detection.
High port density for generating heavy and realistic loads.	Millions of IP Flows generated in hardware.
Generates good and errored traffic.	Generates oversized and undersized frames (20–2,048 bytes).
Generates oversized and undersized frames (0–2,048 bytes).	ARP reply analysis.
	Ping generation.
	VLAN Tag generation.

Additional Information:

Additional features can be found in the following tables:

- *Table 9-4, "10/100 Mbps Ethernet Cards – Feature Set for SmartMetrics Cards," on page 87*.
- *Table 9-6, "Advanced Gigabit Features," on page 91*.
- *Table 9-7, "SMB-200/2000 Gigabit Ethernet Cards — Feature Set Summar," on page 92*.

Installation Cooling Requirements

If you install the maximum of eight GX-1420B or GX-1421A SmartCards (into 16 card slots) in an SMB-2000 chassis, be sure to cover the remaining four card slots with blank panels to maintain proper air flow throughout the chassis. (This is not an issue with the SMB-200.)

When using less than eight SmartCards in a chassis, you can populate the remaining card slots with other card types. For every one GX-1420B or GX-1421A card less than the recommended maximum (eight), you can substitute either:

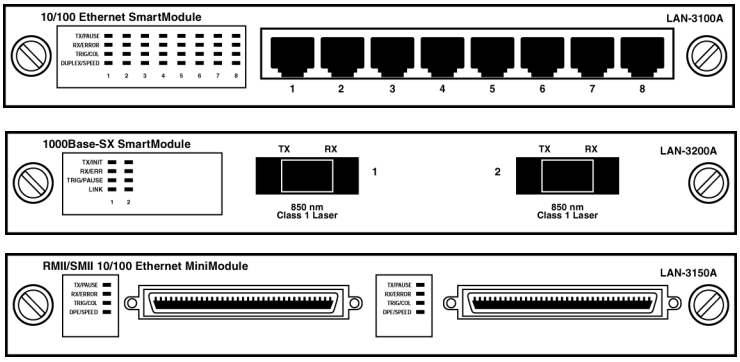
- One GX-1405B or AT-9xxx SmartCard, or
- Two SX-/ML-xxxx, WN-xxxx, or TR-8405 SmartCards.

Warning: Failure to follow these rules may result in blown fuses within the SMB-2000 chassis. To replace a blown fuse, refer to *Chapter 4, "Maintenance and Upgrade Procedures."*

LAN Series Modules

LAN-3100A and LAN-3200A Series Modules

- **LAN-3100A 8-port 10/100 Mbps full/half duplex module**
- **LAN-3150A 8-port 10/100 Mbps RMII/SMII full/half duplex**
- **LAN-3200A 2-port 1000 Mbps full duplex (multi-mode) module**
- **LAN-3200As 2-port 1000 Mbps full duplex (single mode) module**



Card Type: 10/100/1000 Mbps Ethernet modules.

Where Used: SMB-600 and SMB-6000B.

Applications Supported: SmartWindow, SmartLib, SmartApplications, and AST II.

Devices Tested: Layer 2 and Layer 3 switches and routers; gigabit Ethernet backbones.

Test Objective: A packet-based traffic generator to test performance, conformance, and interoperability of devices based on industry standard RFCs testing.

Interoperability: Upstream traffic and throughput testing can be performed by using a LAN-3200A module in combination with the LAN-3100A module.

Features:

- **LAN-3100A.** Supports auto-negotiation, flow control, VLAN tagged fields and 1522 byte packets per IEEE 802.p, 802.q and 802.3ac. The LAN-3100 filters on invalid IP checksums & collisions, provides triggers for external devices, verifies Incoming IP Header Checksum, and offers an independent background stream (VFD 3 of up to 2 KB).
- **LAN-3150A.** Operates with either RMII or SMII physical layer DUTs running on the same reference clock (50 MHz for RMII, 125 MHz for SMII) and global 12.5 MHz SYNC pulse for SMII synchronization. LAN-3150A offers filters on invalid IP checksums & collisions, provides triggers for external devices, verifies Incoming IP Header Checksum, and offers variable field data (VFD1, VFD2, VFD3).
- **LAN-3200A.** Interface 850 nanometer multi-mode fiber. Follows the IEEE 802.3z gigabit specification and are used for Gigabit Ethernet backbones, performance, conformance, and interoperability testing. The LAN-3200A offers two independent background streams (VFD 3 of up to 2KB).

Additional Features:

Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-4, "10/100 Mbps Ethernet Cards – Feature Set for SmartMetrics Cards," on page 87*.

LAN-3101A Modules

- **LAN-3101A SmartMetrics 6-port 10/100 Mbps full/half duplex module**

Card Type: SmartMetrics Ethernet 10 Base-T/100 Base-TX (RJ-45).

Where Used: SMB-600 and SMB-6000B: LAN-3101A module.

Applications Supported: SmartWindow, SmartLib, SmartApplications, SmartFlow, SmartVoIPQoS, SmartTCP, SmartxDSL, SmartCableModemTest, SmartMulticastIP, AST II.

Devices Tested: Layer 2, 3, and 4 devices and end-to-end systems.

Test Objective: A stream-based traffic generator to perform frame loss, stream latency, and sequence tracking tests on systems ranging from a single device under test to a complex routed network; to perform the following testing:

- Performance measurement and interoperability testing.
- Network-wide Network Layer QoS analysis using IP Precedence Bit.
- Tests compliance to RFCs.

Features:

- High port density.
- Full wire-rate traffic generation and analysis.
- Data integrity checking – allows verification of payload data through the DUT.

Additional Features: Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-4, "10/100 Mbps Ethernet Cards – Feature Set for SmartMetrics Cards," on page 87*.
- *Table 9-5, "Comparison of ML-7710 and LAN-3101A Cards," on page 89*.

LAN-3111A Module

- **LAN-3111A SmartMetrics 6-port 100 Base-FX fiber full duplex module**

Card Type: SmartMetrics Ethernet 100 Base-FX Fiber.

Where Used: SMB-600 and SMB-6000B.

Applications Supported: SmartWindow, SmartLib, SmartApplications, SmartFlow, SmartVoIPQoS, SmartTCP, SmartxDSL, SmartCableModemTest, SmartMulticastIP, AST II.

Devices Tested: Layer 2 and 3 devices and end-to-end systems.

Test Objective: Designed for IEEE-compliant 100 Base-FX systems and supports VLAN tagging and flow control to IEEE standards 802.3p, 802.3Q, 802.3ac, and 802.3x.

Features:

- High port density.
- Full wire-rate traffic generation and analysis.
- Data integrity checking – allows verification of payload data through the DUT.

Testing: Performs frame loss, stream latency, and sequence tracking tests on systems ranging from a single device under test to a complex routed network featuring the following SmartMetrics tests:

- Sequence Tracking.
- Latency over Time.
- Latency per Stream.
- Latency Distribution.
- Raw Tags.
- Frame Variation.

Specifications:

- Interface:
  - IEEE 802.3 serie3s 100 Base-FX specifications.
  - 1300nm multi-mode fiber.
- Connector type: LC-Fiber.
- Line Rate: 100 Mbps, full-duplex only.
- Port Density: 6 ports per LAN-3111A module.

- Transmit Characteristics:
  - Full line rate: (100 Mbps) transmit.
  - Duplex operation: full
  - Frame length: 24-1, 600 bytes (without FCS), random (L2 mode only).
  - Interpacket gap: 100 Mbps = min. 960 nsec, max. 2.68 seconds; or random (L2 mode only).
  - Background frame data fill pattern: user-specified or random.
  - Error generation: CRC, dribble bt, alignment, symbols (100 Mbps mode only), data integrity (per stream; L3 mode only).
  - Error detection: CRC, alignment, oversize, udnersize, dribble, data integrity.
  - VFD 1, VFD 2: up to 6 bytes, anywhere in a packet; static, increment, decrement, random. Cycle: max. 4 billion; increment and decrement modes only. Stutter: max. 4 billion; increment and decerment modes only.
  - VFD 3: 2K byte buffer.
- Stream-based Transmit Mode:
  - Up to 1,000 streams per port.
  - Up to 64K flows on each stream via IP source or destination addresses. Ability to vary MAC address simultaneously with IP address.
- Frame-based Transmit Mode:
  - Constant frame transmit.
  - Single burst, up to 4 billion packets in a single burst.
  - Multi-burst, up to 4 billion repetitive bursts with user-defined delay between bursts.
  - Continuous Multi-burst.
- Management Frame Transmit:
  - Configures the modules MAC and IP address, Netmask, and Gateway.
  - User-selectable Ping, SNMP, and RIP frequency.
  - Ability to reply to ARP requests.
- Capture:
  - Full line rate (100 Mbps) capture and analysis.
  - Frame length: 18–2,006 bytes.
  - Frame selection: entire frame only.
  - 6500 frame capture buffer for frames.
  - Pre-capture filtering on: CRC errors, undersize, oversize, data integrity errors, alignment errors, received triggers, or all.

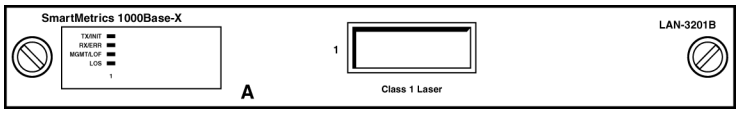
- Triggers:
  - Two triggers up to 6 bytes each.
  - Trigger combinations: Trigger 1 only, Trigger 2 only, Triggers 1 and 2, Trigger 1 or 2.
- Data Integrity: Protects and verifies, the integrity of the payload content; applies to non-VLAN IP type streams only.
- Counters:
  - Transmitted and received frames.
  - Received bytes.
  - Collisions.
  - Alignment errors (Rx).
  - CRC errors (Rx).
  - Fragment/undersized frames (Rx).
  - Oversize frames (Rx).
  - Triggers (Rx).
  - Tags (Rx and Tx).
  - Data integrity detected errors (Rx).
  - VLAN frames (Rx).
  - Pings (requests Rx and Tx; replies Rx and Tx.
  - ARPs (requests Rx and Tx; replies Rx and Tx.

Requirements:

- One slot in an SMB-600 or SMB-6000B chassis.
- A Pentium PC running Windows 98/2000/NT.

LAN-3201x Series Modules

- **LAN-3201A SmartMetrics 1-port 1000 Mbps Multi-Mode module**
- **LAN-3201As SmartMetrics 1-port 1000 Mbps Single-Mode module**
- **LAN-3201B SmartMetrics 1-port 1000 Mbps GBIC**



Card Type: SmartMetrics Ethernet 1000 Mbps modules.

Where Used: SMB-600 and SMB-6000B: LAN-3201A, LAN-3201As, LAN-3201B.

GBIC accessories (order 1 of each for LAN-3201B):

- ACC-6002A MM – Gigabit Interface Converter (GBIC) Multi-Mode.
- ACC-6003A SM – Gigabit Interface Converter (GBIC) Single-Mode.

Applications Supported: SmartWindow, SmartLib, SmartApplications, SmartFlow, and SmartMulticastIP.

Devices Tested: Gigabit Ethernet routers and networks.

Test Objective: A stream-based traffic generator to test erformance, conformance, and interoperability of Layer 2 and Layer 3 devices based on industry standard RFCs testing.

Features:

- Multi-protocol performance analysis system for networks and network devices with Gigabit Ethernet interfaces.
- Stream-based traffic generation and analysis.
- Advanced tracking capabilties.
- Histogram analysis of streams during long duration tests.
- Generates/accepts 802.1p, 802.1q, and 802.3ac VLAN tagged frames.
- Performance measuerment and interoperability testing for Layer 2 and Layer 3 devices.
- Network Layer QoS analysis.
- Generates and responds to 802.3x flow control commands.
- Data Integrity Check optionally detects Bit Errors in Layer 3 forwarding devices.
- 1MB capture buffer enables logging and exporting of filtered events to protocol analysis equipment.

- IP index: Increments with each frame transmitted.
- IP header checksum generation/validation.
- UDP/TCP port number: Optionally increments at burst count underflow.
- IP source/destination increments.
- **GBIC** (LAN-3201B only). Allows users to change the physical interface to support either multi-mode or single-mode fiber. Since the converters are hot-swappable, they allow system configuration changes simply by plugging in a different type of converter.

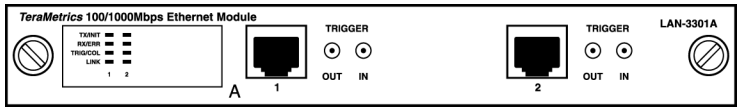
Additional Features:

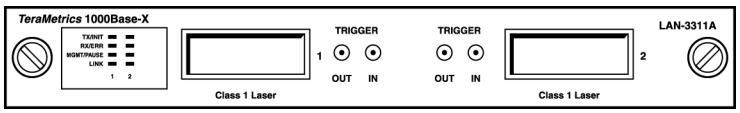
Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-6, "Advanced Gigabit Features," on page 91*.
- *Table 9-8, "SMB-600/6000B Gigabit Ethernet Cards — Feature Set Summary," on page 93*.

LAN-3300 Series Modules

- **LAN-3300A SmartMetrics 2-port 1000 Mbps full/half duplex module**
- **LAN-3310A SmartMetrics 2-port 1000 Mbps GBIC module**
- **LAN-3301A TeraMetrics 2-port 100/1000 Mbps full/half duplex module**
- **LAN-3311A TeraMetrics 2-port 1000 Mbps GBIC module**





Card Type: SmartMetrics and TeraMetrics Ethernet 10/100/1000 Mbps modules.

Where Used: SMB-600 and SMB-6000B.

GBIC accessories (order 2 of each for LAN-3xxx GBIC):

- ACC-6002A MM – Gigabit Interface Converter (GBIC) Multi-mode.
- ACC-6003A SM – Gigabit Interface Converter (GBIC) Single-mode.

Applications Supported:

- SmartWindow, SmartLib, SmartApplications, SmartFlow, and ScriptCenter.

Devices Tested: 10/100/1000 Mbps networking devices such as switches and routers.

Features: **LAN-3301A, LAN-3311A only**:

- Measure specific control plane performance of network-embedded applications, such as routing, load balancing, Multicast IP, Mobile IP, and security.
- Simulate "smart" protocols at various OSI layers while transmitting real world data.
- Run custom and third-party applications enabled by TeraMetrics architecture.

LAN-3301A, LAN-3311A, LAN3300A, LAN-3310A:

- Evaluate key performance parameters of devices under typical or extreme traffic load conditions.
- Qualify 10/100/1000 Mbps networking devices during development, quality assurance, and final regression testing.
- Perform stress and negative testing by injecting errored traffic.
- Perform comparative analysis of 10/100/1000 Mbps networking devices and re-qualify after firmware upgrades.

- Stream-based, wire-rate traffic generation (up to 1,448,095 frames per second) and analysis.
- Supports auto-negotiation.
- Supports frame sizes of 64 to 16,384 bytes.
- Ports are completely independent in operation.
- Virtually unlimited address space coverage with varying, multiple address fields.
- Allows mask-based address skipping for easier test setup.
- Supports ping and auto-ARP.
- Per-port internal trigger-in signal support to auto start transmission or capture on a per-port basis.
- Per-stream protocol and frame size (64 to 16 KB) settings and per-port transmission mode control settings (continuous, single-burst, multi-burst, continuous multi-burst, and echo).
- Arbitrary stream sequencing enables mixing of various frame rates.
- Unicast, broadcast, and multi-cast traffic effects may be analyzed.
- 16 MB capture memory enables logging and exporting of filtered events to external protocol analysis equipment.
- SmartMetrics (LAN-3300A/3310A) testing capabilities include throughput, sequence tracking per stream, latency over time, latency per stream, and latency variation; allows for histogram analysis.
- **GBIC** (LAN-3201B only). Allows users to change the physical interface to support either multi-mode or single-mode fiber. Since the converters are hot-swappable, they allow system configuration changes simply by plugging in a different type of converter.

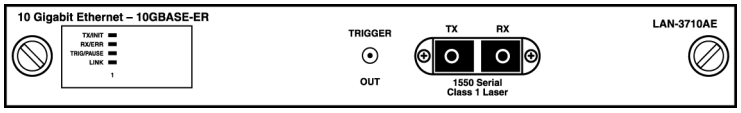
Additional Features:

Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-6, "Advanced Gigabit Features," on page 91*.
- *Table 9-8, "SMB-600/6000B Gigabit Ethernet Cards — Feature Set Summary," on page 93*.

LAN-3710A Module

- **LAN-3710A 10 Gbps module**



Card Type: Ethernet 10 Gbps module.

Where Used: SMB-600 and SMB-6000B.

GBIC accessories (order 2 of each for GBIC):

- ACC-6002A MM – Gigabit Interface Converter (GBIC) Multi-mode.
- ACC-6003A SM – Gigabit Interface Converter (GBIC) Single-mode.

Applications Supported: SmartWindow, SmartLib, AST II, and ScriptCenter.

Devices Tested: 10 Gigabit networking devices such as switches and routers.

Primary Applications:

- Evaluate key performance parameters of 10 Gigabit Ethernet routers and switches under typical or extreme traffic load conditions.
- Qualify 10 Gigabit Ethernet routers during development, quality assurance, and final regression testing.
- Perform comparative analysis of 10 Gigabit Ethernet routers.
- Analyze performance under many traffic conditions, both legal and illegal, with easy-to-customize traffic generation parameters.
- Re-qualify 10 Gigabit Ethernet routers after firmware upgrades.

Features:

- Wire-rate traffic analysis and capture with IP checksum error detection.
- Generates/accepts 802.1p, 802.1q, and 802.3ac VLAN tagged frames.
- Provides performance measurement and ineroperability testing for Layer 2 and Layer 3 devices.
- Network-wide Network Layer QoS analysis using IP Precedence bit.
- Generates and responds to 802.3x flow control commands.
- Data Integrity Check detects bit errors in Layer 3 forwarding devices.
- 4 Mbps capture buffer enables the logging and exporting of filtered events to protocol analysis equipment.
- IP index increments with each frame transmitted.

- IP header checksum generation/validation.
- CRC error generation capability.
- ARP reply analysis.
- Ping generation.

Additional Test Functions:

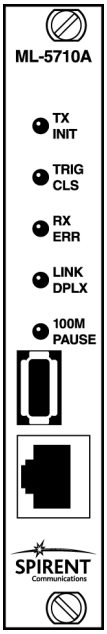
Raw Tags

Interface Specifications:

The LAN-3710A is the first product to incorporate the physical interface implementations from the first drafts for the 10 Gigabit Ethernet IEEE 802.3ae standard.

Specification	LAN-3710AL	LAN-3710AE
Number of ports per module	1	1
Reach	Single mode – from 2-10 kilometers	Single mode – from 2-40 kilometers
Wavelength	1310 nm	1550 nm

ML Series SmartCards



ML-5710A SmartCard

- **ML-5710A SmartMetrics 10 Mbps Ethernet**

Card Type: SmartMetrics 10 Mbps Ethernet SmartCard; configurable in two modes (10 Mbps Ethernet and USB)

Where Used: SMB-200 and SMB-2000: one port per card; each card occupies one slot in a chassis.

Applications Supported: SmartWindow, SmartLib.

Devices Tested: Ideal for broadband access devices such as cable modem devices.

Test Objective: Implements sophisticated flow-based stream-based traffic generation, while performing SmartMetrics analysis on receive traffic in real-time and at wire rate. End-to-end performance analysis of cable modem devices and systems.

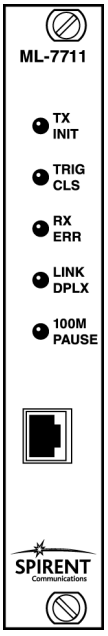
Features:

- Each port can be configured with up to 1,000 streams or VTE's (virtual transmit engine). Each stream generates a customizable stream of Layer 3 data.
- SmartMetrics Testing
- Flow Control (Ethernet only)
- Transmit Error Insertion
- VLAN Tagging
- Background Packet Data Fill Pattern
- Variable Field Data
- Packet Length
- Captured Packets

Additional Features: Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-4, "10/100 Mbps Ethernet Cards – Feature Set for SmartMetrics Cards," on page 87*.

ML-7710/7711 SmartCards



- **ML-7710A SmartMetrics 10/100 Base-TX Ethernet**
- **ML-7711 SmartMetrics 100 Base-FX Fiber (MT-RJ) Ethernet**

Card Type: ML-7710 and ML-7711.

Where Used: SMB-200 and SMB-2000: one port per card; each card occupies one slot in a chassis.

Applications Supported: SmartWindow, SmartLib, and SmartApplications, SmartMulticastIP, SmartFlow, SmartxDSL, SmartCableModem Test (SCMT), SmartTCP, AST, and VAST.

Devices Tested: Layer 2, 3, and 4 devices and end-to-end systems.

Test Objective: A stream-based traffic generator to generate the equivalent traffic of one fully loaded LAN, in half duplex mode, to perform the following testing:

- Performance measurement and interoperability testing.
- Network-wide Network Layer QoS analysis using IP Precedence Bit.
- Tests compliance to RFCs.

Features:

- Each port supports up to 1000 streams or virtual transmit engines (VTEs). Each stream generates a customizable stream of Layer 3 data.
- Each port can capture up to 475 packets.
- Flow control is Ethernet only. Generates and responds to pause commands per 802.3x.
- Can generate and accept frames with VLAN tags per 802.1p,q and 802.3ax. The user can define the outgoing VLAN tag and 1522-byte frames.

Additional Features: Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-4, "10/100 Mbps Ethernet Cards – Feature Set for SmartMetrics Cards," on page 87*.
- *Table 9-5, "Comparison of ML-7710 and LAN-3101A Cards," on page 89*.

ST Series SmartCards

ST-6410 SmartCards

- **ST-6410 10 Mbps Ethernet Full Duplex**

Card Type: 10 Mbps Ethernet Full Duplex SmartCard (RJ-45).

Where Used: SMB-200 and SMB-2000; one port per card; each card occupies one slot in a chassis.

Applications Supported: SmartWindow, SmartLib, and SmartApplications, and AST.

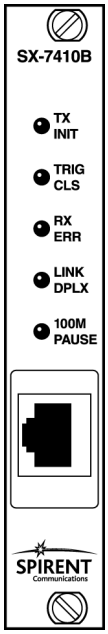
Devices Tested: Ethernet devices.

Test Objective: A packet-based traffic generator for Ethernet performance measurement and interoperability testing.

Additional Features: Additional features can be found in the following tables:

- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-3, "10/100 Mbps Ethernet Cards – Feature Set for ST and SX Cards," on page 86*.

SX Series SmartCards



SX-7000 SmartCards

- **SX-7205 100 Mbps Ethernet**
- **SX-7210 10/100 Base-TX w/VLAN and Data Capture (MII)**
- **SX-7405 VLAN and Data Capture**
- **SX-7410 10/100 Base-TX**
- **SX-7410B 10/100 Base-TX (RJ-45)**
- **SX-7411 10 Base-FX w/VLAN and Data Capture (MT-RJ)**

Card Type: 10/100 Mbps Ethernet SmartCards.

Where Used: SMB-200 and SMB-2000: one port per card; each card occupies one slot in a chassis.

Applications Supported: SmartWindow, SmartLib, and SmartApplications, and AST.

Devices Tested: Ethernet devices and backbones.

Test Objective: A packet-based traffic generator for performance, conformance and interoperability testing.

Features:

- Data capture is provided for up to 128,000 bytes of packet data.
- Interfaces other than the 100 Base-TX require the use of the SX-7210 SmartCard with an external MII transceiver.

Additional Features: Additional features can be found in the following tables:

- *Table 9-1, "Ethernet Cards Used in Applications," on page 82*.
- *Table 9-2, "Min/Max Frame Lengths in Bytes for Ethernet Cards," on page 84*.
- *Table 9-3, "10/100 Mbps Ethernet Cards – Feature Set for ST and SX Cards," on page 86*.

Standard Ethernet Features

The features described in this section apply to Ethernet card operation. Many of these features are mentioned in the summary tables at the beginning of this chapter.

The following features are described (alphabetical listing):

Address Stutter

VFDs may optionally "stutter"—keeping their values constant—for a specified number of frame transmissions. The stutter counter is 12 bits wide.

Address Skipping, Mask-based

Mask-based address skipping allows VFD1 and VFD2 to be configured with a subnet mask (a number of bits from 1 to 31). During operation, the VFD will skip host address values that correspond to the subnet and broadcast addresses. For example, with a 24-bit subnet mask, a 4-byte VFD will skip the values X.X.X.0 and X.X.X.255. This allows a single stream to be configured with a VFD that can cover multiple subnets, intelligently skipping undesirable source and destination addresses. Address skipping is available in all VFD modes (increment, decrement, random).

Adjustable Preamble Length

Each port allows the length of the Ethernet preamble to be specified between 4 and 16 bytes in 4 byte increments (i.e. 4, 8, 12, or 16 byte preamble). The default value is 8 bytes (7 preamble bytes plus 1 start frame delimiter byte).

Alignment, Dribble, Under/oversize Errors

Errored frames that can be generated and counted by the card.

The Alignment Errors Event Counter indicates the cumulative number of alignment errors that have occurred on the receiving port of the SmartCard/module. The Alignment Errors Rate Counter displays the number of alignment errors detected per second. An alignment error is a packet that does not end on the octet boundary (regardless of CRC).

Alignment errors are not checked in packets greater than 2033 bytes.

Alternate Streams

An alternate blueprint transmitted in background mode every "n" frames where "n" is a 24-bit counter.

Background Pattern

In SmartWindow and SmartLib and in applications that have a Frame Editor, the Background Pattern field defines the default contents of transmitted packets. It is called Background because it may be over written by VFD (Variable Field Data) resources on the SmartCard/module. The default pattern is all zeros.

The patterns 8-Fs, 8-0s and 8-0s, 8-Fs refer to bytes of 0x00 or 0xFF. The resulting pattern for 8-Fs, 8-0s is:

0xFF,FF,FF,FF,FF,FF,FF,FF,00,00,00,00,00,00,00,00…

Incrementing and Decrementing patterns chosen from the drop down list restart their count at the beginning of each packet transmitted.

You can design custom background patterns in Hex format with the Frame Editor. The data pattern entered in the Frame Editor is used as the background data pattern.

- *Figure 9-1* illustrates two methods of placing the background pattern in a frame: The ML-7710 method begins the pattern starting with the first byte of the IP header, and is then overwritten by the IP header.
- The other method is shown with the Gigabit and POS cards. This method places the pattern in the payload data field only.

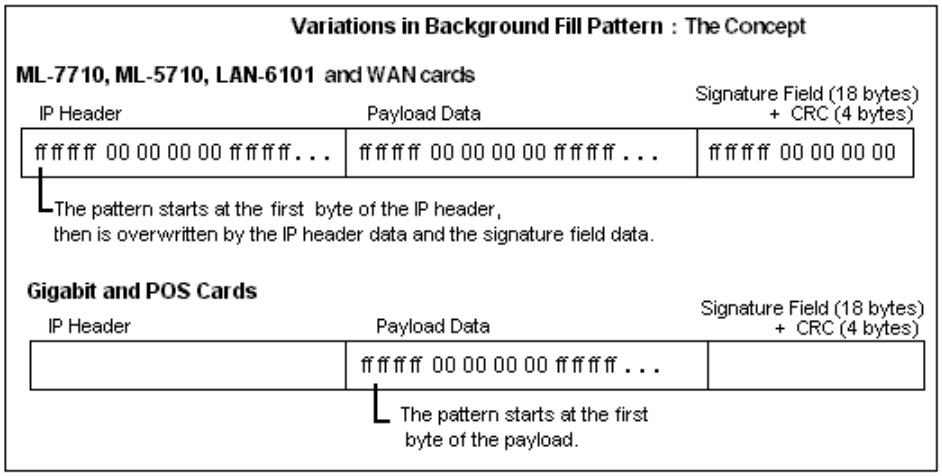


Figure 9-1. Variations in Background Fill Pattern

Background Fill Pattern Automatically Offset with Certain Cards

The ML-7710 example, shown in *Figure 9-2*, displays the initial background fill pattern and the subsequent frame content:

- The background pattern is 8 bytes of ff, followed by 8 bytes of 00 = 16 bytes.
- The IP header is 34 bytes (takes 2 sets of the pattern plus 2 bytes of the third pattern set).
- The payload is 64 bytes (continues with the third pattern set, and adds 3+ pattern sets).
- The signature field and CRC are 22 bytes (continues the pattern from the payload data).

After the IP header, signature field, and CRC are written into the frame, the payload data maintains the offset of the pattern based on the initial background fill pattern.

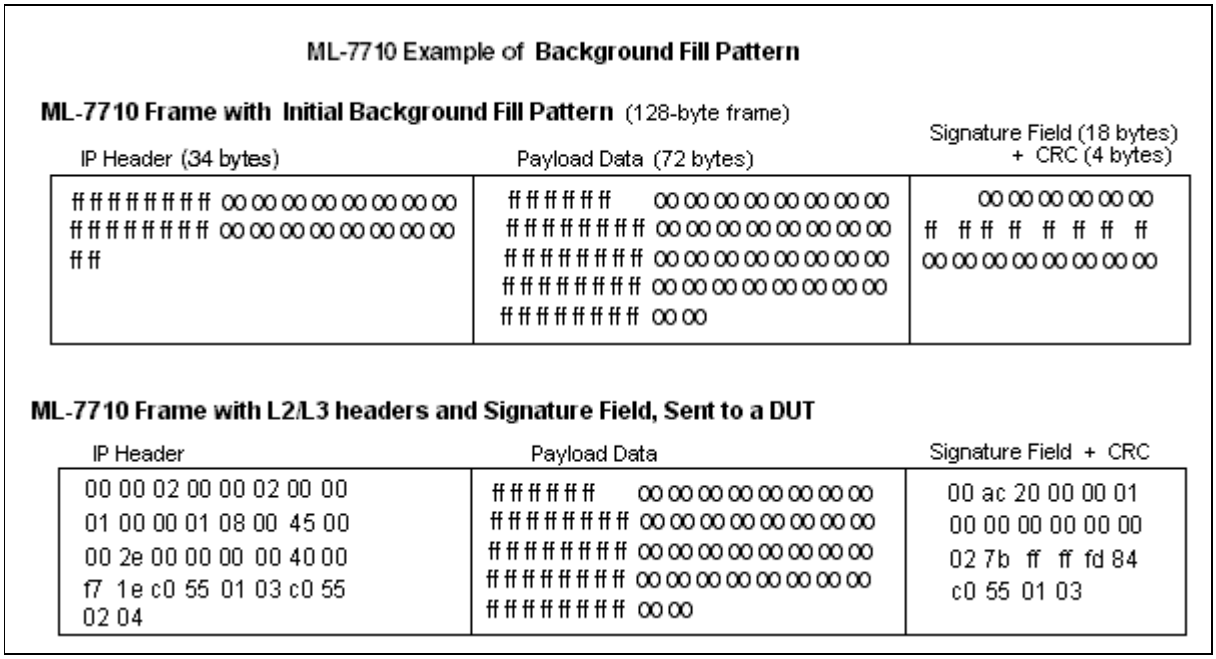


Figure 9-2. Example of Background Fill Pattern

Capture Buffer Size

Specified via allocated memory or maximum number of packets. Incoming frame data may be recorded at wire rate, filtered to reduce the amount of information, and start/stopped in response to a variety of trigger conditions.

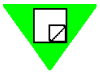
Frame capture, namely the recording of frame contents by the receiving SmartBits card, is stopped upon user request or when the capture buffer has been depleted. The maximum number of frames that can be captured depends on frame size and the available buffer size.

Captured-Data Status Codes

In SmartWindow and SmartLib, captured frames include the following status codes that identify content quickly. In SmartWindow online help, refer to **Capture Setup** for further details.

Table 9-10. Capture Frame Status Codes

Code	SX-7210, SX-7410	L3-6705, L3-6710	ML-7710	GX-1405B, LAN-3200A	LAN-3100A	POS Modules, LAN-3201A
U	Undersize	Undersize	Undersize	Undersize	Undersize	Undersize
O	Oversize	Oversize	Oversize	Oversize	Oversize	Oversize
T	Trigger	N/A	Trigger	Trigger	Trigger	Trigger
C	CRC	CRC	CRC	CRC	CRC	CRC
A	Alignment	N/A	Alignment	N/A	Alignment	N/A
R	N/A	Receive Overrun	N/A	Run Disparity	ARP	Run Disparity
E	N/A	Framing Error	N/A	N/A	N/A	N/A
S	N/A	Signature	Signature	N/A	N/A	N/A
L	N/A	Collision	N/A	N/A	Collision	N/A
V	N/A	N/A	VLAN Tag	N/A	VLAN Tag	N/A
P	N/A	N/A	N/A	N/A	Pause	N/A
F	N/A	N/A	N/A	N/A	IP Frame	N/A
K	N/A	N/A	N/A	N/A	IP Checksum	IP Checksum
I	Interframe Gap Subminimum	Interframe Gap Subminimum	Interframe Gap Subminimum	Interframe Gap Subminimum	Interframe Gap Subminimum	Interframe Gap Subminimum
D	N/A	N/A	N/A	N/A	N/A	Data Integrity Error



Note: Management frames such ARP/ICMP/IGMP frames are not given a special status code.

Status Code Definitions

Code	Description
A	Alignment errors.
C	CRC error with valid packet sizes.
D	Data integrity. Captures frames with payload errors. Data Integrity controls payload integrity. (Both SmartMetrics Sequence & Latency test as well as Capture can detect and record a data integrity error event).
F	IP frame.
I	Subminimum interframe gap (gap is lower than the allowable gap for the physical medium).
K	IP checksum. Captures the frames with incorrect IP Checksum.
L	Collision/collided.
O	Oversize packet (greater than 1518 bytes or 1522 bytes with VLAN tag) or oversized (jabber) frame.
P	Pause.
R	For L3-6705/L3-6710: **Receive overrun**. Received packet is too large for buffer and packet is truncated to fit buffer. For GX-1405: **Running Disparity Errors.** Disparity errors occur when the positive or negative disparity between two code groups (in the Gigabit 8B/10B transmission code) is incorrect. Disparity errors may indicate an encoding or line problem; excessive errors may cause the link to fail.
S	Packet contains a SmartMetrics signature field (Layer 3).
T	Packet met trigger criteria. Captures frames with receive triggers defined in the Trigger Setup window.
U	Undersize packet or (runt) frame, less than 64 bytes.
V	Packet contains a VLAN tag (for ML-7710 only).

Carry ChainingBetween VFD1 and VFD2

Carry chaining allows the carry in of a VFD counter to be tied to the carry out of another VFD counter, effectively combining disparate VFD's into a larger VFD. Carry out from a VFD occurs whenever the cycle count decrements to zero or when the VFD counter overflows. This can be useful in applications where it is desirable to completely "roll through" one counter while keeping another counter static. Stutter VFD's allow the same but more limited function. Carry chaining is only available for incrementing and decrementing VFDs (i.e., not random-mode VFDs).

Collisions Detected

Note: Only works in half duplex mode; not applicable to full duplex.

When in half-duplex mode, a port will defer transmission when it senses another station actively transmitting. When a collision occurs, the port obeys the IEEE standard truncated binary exponential back-off timing algorithm. The back-off delay is an integer multiple of the slot time. The number of slot times to delay before the nth retransmission attempt is chosen as a uniformly distributed random integer in the range:

$0 < \text{slotTimes} < 2\ k$

where:

$k = \min(n, \text{BackoffTruncationExponent})$

The Backoff Truncation Exponent parameter is configurable on a per-port basis in SmartWindow and SmartLib. The minimum exponent is 1, and the default/maximum is 10. By setting this parameter lower than 10, it is possible to make a port "more aggressive" than normal as the value of n increases.

The Collisions Event Counter indicates the cumulative number of collisions that have occurred on the transmitting port of the SmartCard/module. The Collisions Rate Counter displays the number of collisions per second.

CRC Errors

All SmartBits Ethernet cards can generate CRC-errored frames.

Data Integrity Check

The receiving card checks the frame contents for data integrity errors (CRC-16 errors) and counts the frames with them.

Duplex Mode

Available modes: full (unidirectional) and/or half (bidirectional).

Filters

Pre-capture filtering is available on one or more of the following criteria: CRC, alignment, oversize, undersize, data integrity errors, Rx triggers, or All.

Flow Control

Supports flow control (PAUSE frames) according to the IEEE 802.3x standard. On the receiver side, each port detects PAUSE frames as they are received and optionally initiates the proper throttling of the transmitter. Additionally, each port supports a counter that indicates the number of PAUSE frames received.

Frame Rates, Maximum

Size	Ethernet (pps)	Fast Ethernet (pps)	Gigabit Ethernet (pps)
64	14,880	148,809	1,488,095
128	8,445	84,459	844,594
256	4,528	45,289	452,898
512	2,349	23,496	234,962
1024	1,197	11,973	119,731
1280	961	9,615	96,153
1518	812	8,127	81,274

How to calculate the maximum frame rate:

- Constants:
  Gap = 96 bits
  Preamble = 64 bits
  Frame Size = 8 × N bits (N = number of bytes)
  Speed = 10,000,000 (Ethernet), 100,000,000 (Fast Ethernet), 1,000,000,000 (Gigabit Ethernet) in bits per second (bps)
- Formula:
  Maximum Frame Rate = Speed ÷ (Gap + Preamble + Frame Size)

Frame Transmit Modes

The following transmit modes are available on all cards:

- **Continuous.** Constant frame transmit with a constant/random interframe gap (IFG). Transmission is stopped by application request.
- **Single burst.** A single burst with a constant or random IFG. Transmission stops at the end of the burst.
- **Multiburst.** Repetitive bursts with a user-defined delay between bursts. The IFG may be constant or random; the IBG is constant. Transmission stops at the end of the final burst.
- **Continuous Multiburst.** Runs multi-burst mode continuously with a constant or random IFG. Transmission is stopped by application request.

Frame Sizes, Legal Ethernet

It is important to note the following standard minimum and maximum legal (or valid) frame sizes; any frame sizes higher or lower than these sizes are counted as undersize or oversize frames.

- Legal (valid) minimum frame lengths: 40 bytes including CRC.
- Legal (valid) maximum frame lengths: 1518 bytes including CRC or 1522 bytes including CRC and VLAN tag.
- For enabled *jumbo frames*, the maximum length is 9018 bytes including CRC, or 9022 bytes including CRC and VLAN tag.

Interface

The physical connector/media to the card.

Interpacket Gap (Tx min/max/Increments)

Defines the minimum and maximum interpacket gaps allowed per card, and the allowed increments (resolution).

Interpacket Gap or Inter Frame Gap (IFG) specifies the amount of time between successive frame transmissions in continuous or burst transmit modes.

Valid ranges for the IFG rate depend upon the network specifications.

Packets per Second and % Utilization allows corresponding IFGs to be calculated from the rate or utilization chosen assuming 100% medium availability. If transmitting on a congested or contended medium, the actual transmit rate may be lower.

Each transmit mode essentially sets the inter-frame gap (IFG) timer value between frames. When bursty-oriented transmission styles are in use, the gap timer is loaded with an alternate value, called the inter-burst gap (IBG), between bursts.

The gap timer determines the amount of time elapsed between the last bit of the CRC of a frame and the first bit of the preamble of the following frame. In a half-duplex environment, the gap timer starts at the end of the successful frame transmission, and is not necessarily the first transmission attempt. The resolution of the timer varies depending on the port speed.

IFG Based on Frame Rate

Use this calculation to find the interframe gap for a given port when the frame rate and frame size(s) is known. The unit used is bit times, varies depending on the speed of the card. With a 100 Megabit card, there are 100 million bit times per second.

Subtract the total transmitted number of bits per second from the total number of available bits per second. Then divide the remaining bits by the frames per second to obtain the interframe gap.

Interframe Gap Based on Frame Rate and Frame Size

Interframe Gap = [100% load – (frame size * frame rate)]/frame rate

The following example calculates the interframe gap to achieve 100,000 frames a second (with a frame size of 896bits):

Interframe Gap **=** [100,000,000 – (896 * 100,000)]/100,000 = 104 bit times

where:

- **100% load** in bit times per second = bits per second, based on the card speed = 100,000,000 (for 100 Mbps Ethernet).
- **Frame size** in bits = frame data size + CRC + preamble =.

  32-bit CRC + 64-bit preamble + 100 bytes of data) = 896 bits (Multiply frame data size 100 by 8 to convert it from bytes to bits).
- **Frame rate** = desired frames per second = 100,000 frames per second.

IFG Based on Load

This equation is used to calculate the global interframe gap when the desired *load* (the percentage of bandwidth used) is known. Use the load equation to first calculate the frames per second based on the desired load. Then plug frames-per-second in the initial rate calculation to find a correct gap.

The unit used is bit times, which varies depending on the speed of the card. With a 100 Megabit card, there are 100 million bit times per second.

Interframe Gap Based on Load%

Frame Rate = [100%load/(frame size + min frame gap)] * desired load

then

InterFrame Gap = [100% load – (frame size * frame rate)]/frame rate

Example:

To configure the gap for 70% traffic load (frame size of 896 bits):

Frame Rate = [100,000,000/(896 + 0.00000096)] * .7 = 78125 frames per second.

Interframe Gap = [100,000,000 – (896 * 78125)]/78125 = 384 bit times.

where:

- **100% load** in bit times per second = bits per second, based on the card speed = 100,000,000 (for 100 Mbps Ethernet).
- **Frame size** in bits = frame data size + CRC + preamble =

  32-bit CRC + 64-bit preamble + 100 bytes of data) = 896 bits (Multiply frame data size 100 by 8 to convert it from bytes to bits).
- **Min Frame Gap.** Minimum legal interframe gap based on the medium used = 0.00000096 bits per second.
- **Desired Load.** Percent of bandwidth that you want to use = 70%.
- **Frame Rate.** Desired frames per second = 100,000 frames per second.
- **InterFrame Gap.** Interframe gap (in bit times) for a desired load.

100,000,000 divided by (896 plus 0.00000096) gives the number of frames per second to achieve 100% load (111607.1 frames per second). Then take 100% frame rate, and multiply it by the percentage of bandwidth use desired (in this example 70% or 78125 frames per second).

Now that you have frames per second, calculate the correct interframe gap: [100,000,000 - (896 * 78125)] = 30,000,089.6. This is the total gap, or the amount of open space where no frames are sent. Divide this amount by the number of frames per second to find the interframe gap needed to achieve a 70% load at 100 Mbps. The result is a gap of 384 bits.

IP Header Checksum Generation/Validation

When IP-oriented streams are used, the transmitter automatically increments the identification field in the IP protocol header. When IP frames are received, the receiving card automatically verifies the IP header checksum. A counter indicates the number of frames received with bad IP header checksums.

The transmitter also supports automatic IP header checksum generation. For normal IP headers containing no options, the header checksum is automatically generated and inserted regardless of VFD usage. For extended headers that contain options, the IP header checksum is correctly generated as long as the options themselves do not contain VFDs.

Jumbo Frames

A jumbo frame is an Ethernet frame with a length between 1519 and 9018 bytes with valid CRC, or a length between 1523 and 9022 bytes with valid CRC and VLAN tag. If jumbo frame reception is not enabled, jumbo frames are counted as oversize frames.

Latency Resolution

The range of accuracy of latency measurements (ns or ms).

Max # Flows per Stream

The number of SmartFlows possible per stream; for further definition, refer to *"Traffic Generation and Performance Analysis" on page 19*.

Max # Streams per Port

Maximum number of primary frame blueprints per port. For further definition, refer to *"Traffic Generation and Performance Analysis" on page 19*.

MPLS Labeling Insertion

Supports generation and analysis of Ethernet frames that contain MPLS label stacks in accordance with the current IETF MPLS working group draft. As with VLAN frame tagging, transmission of frames containing MPLS label stacks is a matter of appropriate transmitter configuration.

The MPLS unicast (0x8847) or multicast (0x8848) Ethernet type field is inserted after the source MAC address and then followed by the MPLS label stack. If a combination of VLAN tagging and MPLS labeling is used, the MPLS label stack occurs after the VLAN tag. No special action is taken on the receiver side when an MPLS frame is received. However, the Ethernet interface is still responsible for locating the start of the IP header, regardless of the existence and depth of the MPLS label stack.

Multimodal Frame Length (MMFL)

You can set the frame length of each TeraMetrics flow in one of three ways:

- A fixed, user-specified frame length per flow.
- A "uniform random" range of frame lengths via a user-specified minimum and maximum length per port.
- Multi-modal frame length (MMFL).

The MMFL feature will generate a random set of frame lengths whose distribution can be completely controlled by the application software to represent whatever mix of traffic is desired. The random frame lengths generated will apply globally to all streams generated by the transmitting port.

The probability density function distribution may have up to 10 peaks. Each peak has a gaussian distribution, with independently controllable width (standard deviation), mean value (the length where the maximum probability occurs) and height relative to other peaks.

These frame length techniques allow the following types of flows to be created:

- A UDP flow and a TCP flow with packets uniformly distributed between 64 and 512 packets to simulate high probability Ethernet traffic.
- A TCP flow of 40 bytes to simulate the TCP SYN, FIN, RST, and telnet packets with a single keystroke. Create UDP and TCP flows at a fixed length of 1518 bytes to simulate maximum length Ethernet packets.
- TCP and UDP flows with multimodal distribution with narrow modes at 44 bytes, 512 bytes, and 4096 bytes to simulate background traffic centered at 40 bytes and extending to 4096 bytes.

Packet Length

Also known as the frame length; the range of valid frame sizes in bytes.

Ports per Card

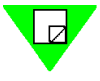
Number of connector ports on each card.

SmartMetrics Measurements

Indicates SmartMetrics capability with advanced tracking and histograms.

Based on the SmartMetrics signature field inserted into each frame, SmartMetrics processing can display the test results in one or more of the following display types, in data and/or histogram formats, depending on the application and test parameters:

- Sequence Tracking.
- Latency over Time.
- Latency per Stream.
- Latency Distribution.
- ARP Exchange Time.
- Raw Packet Tags.
- Frame Variation.



Note: Additional display types are also offered for advanced applications.

Sequence Tracking

Sequence tracking is on a per-stream basis. Received data is monitored and a record is kept of the following:

- Transmitting port number.
- Transmitting stream number.
- Total number of frames received.
- Number of frames received in sequence.
- Number of duplicate frames received.
- Number of frames expected, but not received.

Latency Over Time

In this test, the user selects a time interval such as every 10 ms. For each stream, every 10 ms histogram statistics are kept on:

- Total number of packets received.
- Minimum latency within this time period.
- Maximum latency within this time period.
- Average latency within this time period.

Latency per Stream

Same as Latency over Time except the data is displayed for each incoming stream.

Latency Distribution

The user selects up to 16 time intervals. The following information is displayed within each time interval and for each stream:

- Transmitting port number.
- Stream number.
- Total number of frames received.
- Number of frames received within each interval.

ARP Exchange Times

This is a test of ARP response. For each stream that uses IP or UDP, an ARP request is transmitted. The timestamp of the request and its response is stored for each active stream.

Raw Packet Tags

No filtering is performed on stream tags received. Up to 130,000 packets are stored and sent to the application. The user can take the data in the delta column, paste it into a spreadsheet, and determine standard deviation and latency variation.

Frame Arrival Time Variation

This is the period of time between the first bit of an arriving packet and the first bit of the next arriving packet. This time includes the media access, preamble, interpacket gap, and packet transmission time. The following measurements are made per stream: port #, VTE (stream) #, total frames, frames arriving within each of 16 user-definable time intervals.

Speed

Wire rate(s) of the card.

Traffic Rates

Wire rates of each port.

Triggers and Errored Frames

A *trigger* is a pattern tracking tool that identifies any packet with a specific pattern located inside any of the packets received by a receiving SmartBits card. The receiving card then counts the number of triggers received with the specific pattern.

In SmartWindow, SmartLib, and some applications, two 6-byte triggers can be specified using the bit offset or using a pattern and mask. The trigger counter can be set to: Trigger 1,Trigger 2; Trigger 1 or Trigger 2; Trigger 1 and Trigger 2.

In Ethernet, WAN and POS cards, the transmit trigger pattern is added to the frame content through VFDs (Variable Field Definitions) or automatically in streams. Triggers are used in two ways:

- **Ethernet/WAN/POS cards.** Increment the trigger counter if the desired pattern is in the packet, regardless of whether the packet is valid or not. The packet is labeled as *Mode E* counters (errored triggers counted) in *Figure 9-3 on page 129*.
- To maximize processing power for hundreds of streams, the following SmartMetrics cards do not increment the trigger counter if the packet is invalid, even if the pattern is in the packet. In *Figure 9-3 on page 129*, this is labeled *Mode N* (errored trigger frames NOT counted) cards:
  - ML-5710.
  - ML-7710.
  - ML-7711.
  - LAN-3101A.

  Figure 9-4 on page 129 describes how triggers and errored traffic are displayed in counters available in SmartBits applications.

Action (Black bar ▮ indicates a bit error in the frame.)	Counters Incremented by Action Mode N (error frames Not counted) Example 7710	Mode E (Error frames counted) Example 7410
1. Set trigger in bad packets [T][Data]	(Trigger for good packets only)	Trigger
2. Set CRC error only [T][Data][CRC]	CRC	Trigger CRC
3. Set Dribble error only [T][Data][CRC]▮	Alignment	Trigger Alignment
4. Set Alignment error only [T][Data]▮[CRC]	CRC Alignment	Trigger CRC Alignment
5. Set Symbol error only [T][Data][CRC]	CRC	Trigger CRC

Figure 9-3. How Triggers and Generated Errors are Displayed in Counters

Legend for Error Frames and Counters:

T = Trigger

Definitions:

2. CRC error: Invalid checksum bit (A valid CRC requires 4 aligned octets)
3. Dribble bit error: 4 Bits are attached at the end of the frame after the CRC
4. Alignment error: 4 Bits are attached to the end of the frame data field before CRC
5. Symbol error: 4 Bits of symbol error encoding HEX codes inserted into the CRC

Other conditions:

6. CRC error + Dribble bit error => CRC + Alignment counters
7. CRC error + Alignment error => CRC + Alignment counters
8. Alignment error + Dribble bit error => CRC counters
9. CRC, Alignment error + Dribble bit error => CRC counters
10. CRC, Alignment error, Dribble bit error, and Symbol errors => CRC counters

Note: The Symbol error trigger is available only in SmartLib.

Figure 9-4. Legend for Error Frames and Counters

VLAN Tagging

Refers to frames that are tagged in accordance with IEEE 802.1q. The VLAN type field (0x8100) and VLAN tag field are inserted between the source MAC address and existing Ethernet type field, effectively shifting the Ethernet payload right by four bytes.

On the receiver side, each port supports a counter indicating the number of VLAN tagged frames received. The maximum allowable frame size for counting oversize VLAN frames is 1522 bytes (or 9022 bytes if the jumbo option is enabled).

VFD 3 Size

Memory allocated for VFD 3; see glossary *page 342* for VFD details.

Gigabit Frame Rate Calculation

The LAN-3200A, LAN-3201A, and LAN-301As modules operate at 1000 Mbps.

Payload Capacity Utilization

The payload capacity utilization is calculated on how frequently frames are generated. In other words, the higher the frame rate, the higher the payload capacity utilization. The maximum frame rate is achieved with the minimum inter-frame gap. In SmartMetrics Gigabit, the minimum gap allowed is 12-bytes and the preamble minimum is 8-bytes.

Thus, the maximum payload capacity utilization, measured in *bytes per second* for a given frame size is: *Max. Payload Capacity Utilization (Bps) = (max. frame rate) * (frame size + 12 (inter-frame gap) + 8 (minimum preamble) + 4 (CRC)*

Conversely, you can calculate the frame rate from the Payload Capacity Utilization as follows: *(Max. frame rate) = Max. Payload Capacity Utilization (Bps) / (frame size + 12 (inter-frame gap) + 8 (minimum preamble) + 4 (CRC)*

Capacity Utilization by Streams

In the LAN-620x SmartModules, the frames are generated by individual streams. Each stream has its own frame generation definition and each stream utilizes part of the total payload capacity available. So, capacity utilization by any stream is:

*Stream Capacity Utilization (Bps) = (stream frame rate) * (frame size + 12 (inter-frame gap) + 8 (minimum preamble) + 4 (CRC))*

and

Aggregate Stream Capacity Utilization = sum of individual Stream Capacity Utilization

Even though streams are independent of each other, the Stream Capacity Utilization of one stream may affect the Stream Capacity Utilization of another stream, especially if the frames rates are different.

The frame rates for the LAN-320x modules fall into four categories, each with an independent clock source:

- Frame Rate
- Clock Rate
- InterFrameTime
- Calculated Rate

Refer to the *SmartWindow User Guide,* located at http://www.netcomsystems.com/support/documentation.asp for detailed information regarding applicable tests and features.

Gigabit Ethernet Testing, Clock Tolerance

If a device is transmitting at a higher clock rate than the receiving device, the receiving device will eventually have to either lose data or buffer it until it can process it. The longer the continuous stream of data, the more data that must be buffered. Considering the amount of data that is being transmitted per second at gigabit speeds, considerable buffer space may be required. The following discussion reviews common gigabit Ethernet clock problems and shows how to interpret SmartApplications Back-to-Back tests as an example of how to view test results.

All references to bytes are to 8 bit octets, and all packets will be 64 bytes and have a preamble of 64 bits including the Start Frame Delimiter.

Clock Tolerance Problem

A receiving port cannot receive at a slower rate than the transmitting device because the receiving port derives its receive clock from the asynchronous data stream that it is receiving. Therefore, its receive clock will be the same as the device transmitting to it. Where the problem comes is that once the switching device receives the data, it must process it and then transmit this data back out to its destination. The switch processor clock is usually not the same clock as the receive clock and the transmit clock is also usually a separate clock.

Assuming that the processor can keep up with the data stream, it must still be able to transmit this data without loss. If the output transmitter of this switch is slower than the device transmitting into it, eventually it could lose data. Tests have been designed to test the ability of a switch to process data and forward it through its switching fabric fast enough to keep up with large bursts of data. These tests treat the switch as a complete system, and determine the robustness of a switching device.

The clock tolerance problem in both the device under test and the testing equipment can cause difficulties when trying to obtain consistent results. This applies when different types of test analysis equipment or different DUT models are used.

Example of Worst Case Scenario

With 64 byte packets at wire speed, Gigabit Ethernet transmits 1,488,095.238095 packets per second at perfect clock tolerance. The 802.3z spec calls out for a clock tolerance of plus or minus 100ppm (Parts Per Million). At plus 100ppm wire rate would be 1,488,244.047619 packets per second and at a minus 100ppm tolerance, wire rate would be 1,487,946.428571. If we transmit into a port at plus 100ppm and the switch is transmitting back out at minus 100ppm, then the switch would have to buffer 297.619048 packets per second.

Since we do not know what each switch is doing with the packets, such as stripping off the MAC layer before buffering or adding management information, such as time stamps, we assume that it is buffering 64 bytes for each 64 byte packet. That would be 19,047 bytes per second for this port pair. To keep this simple, we assume unidirectional traffic and all

switching is per port pair. Therefore, a 24-port switch would have 12 port pairs and would have to store 228,564 bytes per second (12 x 19,047), assuming it is able to process at wire speed. This is a lot of data to store for long bursts of traffic.

Sample Test Scenarios and Interpretations

If you have a simple setup of a two-port switch and two test analyzer ports, what happens? The following example runs a SmartApplications (Back-to-Back Test) and relates the clock tolerance to the test results.

A frequency counter tested the clock tolerances of the ports on the SmartBits ports and the DUT, and showed the following values:

- SmartBits port 1: minus 14ppm
- SmartBits port 2: plus 10.16ppm
- DUT port 1: minus 4.024ppm
- DUT port 2: plus 2.64ppm

SmartApplications Test	Test Results and Related Clock Tolerance
In test 1, transmitted unidirectional traffic from port 1 of the test analyzer into port 1 of the DUT (device under test) and received test packets back on port 2 of the test analyzer from port 2 of the DUT.	The DUT was able to keep up for 500 seconds without any data loss when: input = minus 14ppm output = plus 2.64ppm (output faster by 16.64ppm)
In test 2, reversed the direction of the unidirectional traffic, leaving the ports hooked up the same way.	The test failed in 5.9 seconds when: input = plus 10.16ppm output = minus 4.024ppm (output slower by 14.184ppm)
In test 3, transmitted unidirectional traffic from port 1 of the test analyzer into port 2 of the DUT and received data back on port 2 of the test analyzer from port 1 of the DUT.	The test ran for 500 seconds without loss when: input = minus 14ppm output = minus 4.024ppm (output faster by 9.976ppm)
In test 4, reversed the direction of unidirectional traffic without changing the cable connections.	The test failed in 10.5 seconds when: input = plus 10.16ppm output = plus 2.64ppm (output slower by 7.52ppm)

Know How the Test Works

With multiple ports under tests, it is important to understand exactly what the test is doing to understand the different results that can occur.

As an example, the Smart Applications Back-to-Back test is not a full mesh test, and it works in port pairs. If you ran a 24-port test and got certain results, then moved the cables around, you could get very different results. This test stops when any one of the port pairs sees an error (loss of packets), and reruns the test for a shorter amount of time. If this passes, it runs the test for a longer length of time using a binary algorithm. If the DUT uses a single master transmit clock for all of the transmitting output ports, you can move the cables around and your results should not change unless the DUT treats its ports with different priorities. However, if the ports use different clock sources, some ports may be slower that others, and there will be differences in the results.

Know How the Test Equipment Works

Understanding the test analysis equipment also impacts results. The SMB-2000 uses a GX-1405 SmartCard for each test port. Each of these cards has its own crystal oscillator (with 50ppm tolerance), so there can be different tolerances for each port. The SMB-6000B uses LAN-3200A modules that have two printed circuit board (PCB) cards on each module with two ports on each PCB. There is one crystal oscillator (with 25ppm tolerance) for each PCB (pair of ports).

Know How the DUT Works

How the DUT assigns its buffer space to the ports can affect test results. If the total data buffer space is dynamically assigned so that ports that need more of the buffer pool can access that space, this helps to average out the port differences for a longer period of time before data loss. If the total buffer space is statically assigned per port, tests similar to the Back-to-Back test would fail the device faster if there are large clock tolerances differences from port to port.

10 Packet over SONET Modules

In this chapter . . .

Packet over SONET (POS) Applications

Table 10-1 gives a description of the Packet over SONET (POS) modules and the applications available for each SmartBits chassis.

Note: Throughout this manual, the term “card” may be used interchangeably to represent either SmartCards (SMB-200/2000), or modules (SMB-600/6000B).

Table 10-1. POS Modules Used in Applications

Module	Description	SmartWindow 7.10	SmartLib 3.10	SmartApps 2.40	SmartSignaling 3.00	SmartMulticastIP 1.25	SmartFlow 1.30	SmartVoIPQoS 1.00	TeraRouting 1.00	AST II (All Tests)	SmartTCP 2.00	SmartxDSL 1.10	SCMT 2.00	VAST 2.11	ScriptCenter 1.20	SmartMetrics	TeraMetrics
POS Modules Used in SMB-600/6000B Chassis																	
POS-3500B	10/100 Mbps Full/Half Duplex	X	X				X								X	X	
POS-3500Bs	10/100 Mbps 12-port	X	X				X								X	X	
POS-3502A	1000 Base Full Duplex, Multi-mode	X	X				X								X	X	
POS-3502As	10/100 Mbps Full/Half Duplex	X	X				X								X	X	
POS-3504As	10/100 Mbps 12-port	X	X	X		X	X			X		X	X[2]		X		
POS-3505As	1000 Base Full Duplex, Multi-mode	X	X	X		X	X		X	X					X		X

Packet over SONET (POS) Module Types

- **SmartMetrics POS Modules (POS-3500B/3500Bs, POS-3502A/3502As, POS-3504As)**

  Similar to the Ethernet SmartMetrics modules, the POS SmartMetrics modules have the SmartBits signature field per frame enabling advanced tracking of every frame, producing results in the following formats:

  – Sequence Tracking.
  – Latency over Time.
  – Latency per Stream.
  – Latency Variation.
  – Latency Distribution.
  – Raw Tags.

  Additionally, the SmartMetrics type enables the generation of thousands of streams and millions of flows per port, that may vary according to the application and the memory limitations of the host computer running the application.

- **TeraMetrics POS Module (POS-3505As)**

  This module includes the SmartMetrics functionality plus dedicated hardware that supports a Pentium/Linux based open-architecture platform. This supported platform allows the integration of Spirent Communications software with other powerful third party programs, to provide optimum testing systems.

  In addition, the on-board processing power of the TeraMetrics module enables total traffic generation and measurement in excess of 1 terabit per second.

SONET

SONET and its European cousin Synchronous Digital Hierarchy (SDH) are octet-synchronous multiplexing schemes that define a family of standard rates and formats. Transmission rates are integral multiples of 51.840 Mbps:

- OC-3c/STM-1 155.520 Mbps.
- OC-12c/STM-4 622.080 Mbps.
- OC-48c/STM-16 2488.320 Mbps.

SONET/SDH is a perfect match for PPP (Point-to-Point Protocol). The PPP octet stream is mapped into the SONET/SDH Synchronous Payload Envelope (SPE) with the octet boundaries aligned to the SPE octet boundaries, enabling the seamless integration within IP networks of SONET/SDH-smart routers and IP network elements.

PPP over SONET is a high-speed WAN transport mechanism capable of carrying IP traffic with a minimum of overhead. It is described in RFCs 1619 and 1662 as the serial transmission of data over SONET frames through the use of Point-to-Point Protocol (PPP).

Packet over SONET (POS) LEDs

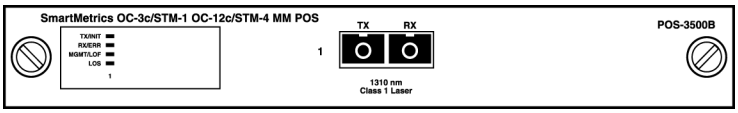
Each POS module has a set of LEDs that are described in *Table 10-2*.

Table 10-2. LED Functions for POS Modules

LED	Color/Status	Description
TX/INIT	Red Green (flashing)	Link is not ready. Frame is transmitted. Off – Ready.
RX ERR	Red (flashing) Green (flashing)	Rx frame is received with a CRC error. Rx frame is received. Off – Not receiving.
MGMT/ LOF	Yellow Green (flashing)	Loss of Frame condition exists. "Management" frame is received.
LOS	Yellow	Loss of signal (optical signal) condition exists.
TRIG/LOS	 Green Yellow	(POS-3505As) When a triggered frame is received. A loss of signal (optical signal) condition exists.

POS-3500/3502 Series Modules

- **POS-3500B OC-12c/STM-4 and OC-3c/STM-1, 1-Port, Multi-Mode module**
- **POS-3500Bs OC-12c/STM-4 and OC-3c/STM-1, 1-Port, Single- Mode module**
- **POS-3502A OC-3c/STM-1, 1-Port, Multi-Mode module**
- **POS-3502As OC-3c/STM-1, 1-Port, Single-Mode module**



Module Type: SmartMetrics Packet over SONET modules.

Where Used: SMB-600 and SMB-6000B.

Applications Supported:
- SmartWindow, SmartLib, SmartFlow, BGP Router Test, and ScriptCenter.
- ASTII application is available only on the POS-3500B module.

Devices Tested: POS routers and networks.

Test Objective: Performs frame-level testing at full OC-12c/STM-4 and OC-3c/STM-1 wire rate for Packet over SONET/SDH routers.

Tests high-speed inter-networking between POS and either Gigabit-Ethernet, Fast-Ethernet, ATM, or Frame Relay devices via Spirent Communications unique SmartMetrics Layer 2, 3, and higher tests. Simulates the millions of client and server sessions required to fully test POS systems.

Features:

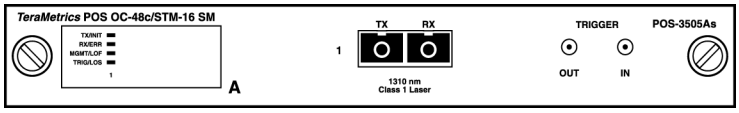
- Up to 8,192 independent IP streams (peer-to-peer) generated and analyzed at any given time. Up to 64K individual flows may be instrumented per stream. A total of 524 million flows is supported.
- SONET/SDH Overhead analysis of Section OverHead (SOH), Line OverHead (LOH) and Path OverHead (POH).
- SONET/SDH payload scrambling enabled under user control (X43+1).
- User-selectable Frame Check Sequence (FCS) of 16- or 32-bit.
- IP traffic encapsulated over PPP (as per RFC 1662) or over Cisco's HDLC with Ethertype.
- Individual control of each stream allows for frame size (40 to 64K bytes), frame rate, and transmission mode control (continuous, single-burst, multi-burst, continuous multi-burst) setting.
- 1MB capture buffer enables logging and exporting of filtered events to external protocol analysis equipment.
- Full SmartMetrics testing capabilities include sequence tracking per stream, latency over time, latency per stream, and latency variation.
- Unicast and broadcast traffic effects may be analyzed. Additional analysis capabilities include data integrity checking of payload and IP header checksum verification.

Specifications:

Category	POS-3500B	POS-3500Bs	POS-3502A	POS-3502A
Number of ports per Module	1	1	1	1
Line Rate	622 Mbps or 155 Mbps, user-controlled	622 Mbps or 155 Mbps, user-controlled	155 Mbps	155 Mbps
Reach	Multi-mode – up to 500m	Single-mode – up to 15km	Multi-mode – up to 500m	Single-mode – up to 15km
Framing	SONET or SDH	SONET or SDH	SONET or SDH	SONET or SDH

POS-3504As Module

- **POS-3504As OC-48, 1-port, single-mode module**
- **POS-3505As OC-48, 1-port, single mode module**



Module Type: SmartMetrics Packet over SONET module.

Where Used: SMB-600 and SMB-6000B.

Applications Supported: SmartWindow, SmartLib, SmartFlow, and ScriptCenter.

Devices Tested: POS/SDH routers and networks.

Test Objective:

- Evaluate and optimize hardware performance of POS routers under typical or extreme load conditions.
- Test IP Quality of Service performance including Diffserv and address-based polocies.
- Perform stress and negative testing using errored SONET/SDH frames.

Features:

- OC-48cSTM-16 wire-rate traffic generation and analysis (approximately 6.5 million frames per second).
- Capable of generating back-to-back frames supported by a single flag.
- SONET or SDH framing.
- Each POS module supports one port on the SMB-600 or SMB-6000B chassis. Up to two modules may be installed in the SMB-600 chassis. Up to twelve modules may be installed in the SMB-6000B chassis.
- SONET/SDH line analysis of, and error generation through, control of the Section OverHead (SOH), Line OverHead (LOH), and Path OverHead (POH).
- SONET/SDH payload scrambling enabled under user control ($X^{43}+1$).
- User-selectable Frame Check Sequence (FCS) of 16- or 32-bit.
- IP traffic encapsulated over PPP (as per RFC 1662) or over Cisco's HDLC with Ethertype.
- MPLS with static labels enables functional testing of routing hardware.

- Generates up to 256 independent IP streams (peer-to-peer) and analyzes up to 64K streams at any given time.
- Instruments a nearly unlimited number of flows per stream, thereby stressing a router by having to perform a different routing decision for each and every frame.
- Per-stream protocol and frame size (40 to 16K bytes) settings and per-port transmission mode control settings (continuous, single-burst, multi-burst, continuous multi-burst, echo).
- Arbitrary stream sequencing enables mixing of various frame rates.
- Real-life traffic shaping through random frame length, inter-frame gap, and frame content settings.
- Unicast, broadcast, and multi-cast traffic effects may be analyzed.
- 16MB capture buffer enables logging and exporting of filtered events to external protocol analysis equipment.
- Per-port statistics provide counters for transmitted frames, received frames, received bytes, and received CRC errors.
- Full SmartMetrics testing capabilities:
  - Sequence Tracking.
  - Latency over Time.
  - Latency per Stream.
  - Latency Variation.
  - Raw Tags.
- Additional analysis capabilities include data integrity checking of payload and IP header checksum verification.

Specifications: One port per POS-3504As module.

Line Rate: 2.4 Gbps.

Wavelength: 1300 nm.

Reach: Single mode – up to 15km.

Framing: SONET or SDH.

11 ATM Cards

In this *chapter . . .*

Using ATM SmartCards, frame-level functional testing is supported for Ethernet LAN-to-ATM, ATM-to-Ethernet LAN, and ATM-to-ATM.

Note: In all latency measurements, only the first frame in the stream is measured.

ATM Applications

Table 11-1 gives a description of the ATM cards and the applications available for each SmartBits chassis. These cards apply only to the SMB-200/2000 chassis.

Note: Throughout this manual, the term “card” may be used interchangeably to represent either SmartCards (SMB-200/2000), or modules (SMB-600/6000B).

Table 11-1. ATM Cards Used in Applications

Card/ Module	Description	SmartWindow 7.10	SmartLib 3.10	SmartApps 2.40	SmartSignaling 3.00	SmartMulticastIP 1.25	SmartFlow 1.30	SmartVoIPQoS 1.00	TeraRouting 1.00	AST II (All Tests)	SmartTCP 2.00	SmartxDSL 1.10	SCMT 2.00	VAST 2.11	ScriptCenter 1.20	SmartMetrics	TeraMetrics
ATM Cards Used in SMB-200/2000 Chassis																	
AT-9015	DS1(1.544 Mbps) (RJ-45)	X	X	X	X										X		
AT-9020	E1 (2.048 Mbps) (RJ-45)	X	X	X	X										X		
AT9025	25 Mbps (RJ-45)	X	X	X	X							X			X		
AT-9034B	E3 (34 Mbps) (BNC)	X	X	X	X										X		
AT-9045B	DS3 (45 Mbps) (BNC)	X	X	X	X							X			X		
AT-9155C	Multi Mode Fiber OC-3c/STM-1 (155 Mbps) (4 MB RAM)	X	X	X	X										X		
AT-9155Cs	Single Mode Fiber OC-3c/STM-1 (155 Mbps) 1300 nm	X	X	X	X							X			X		
AT-9622	Multi Mode Fiber OC-12c/STM-4 (622 Mbps) 1300 nm	X	X	X	X							X			X		
AT-9622s	Single Mode Fiber OC-12c/STM-4 (622 Mbps) 1300 nm	X	X	X	X							X			X		

ATM Introduction

The ATM series of SmartCards is used to generate and monitor ATM network traffic. Applications include testing ATM-to-LAN internetworking devices, very high performance ATM backbones, xDSL devices, and LAN-to-ATM edge devices. The capabilities of the ATM SmartCards include frame-level testing at full-duplex, full wire-rate testing of edge devices and switches, switch testing at full-cell rate, and high-rate signaling testing for edge devices.

For all ATM cards, latency is measured from frame transmit rates between cards, with 100ns resolution, and is measured based on the first frame of each ATM stream.

A ***trigger*** is a pattern tracking tool that identifies any packet with a specific pattern located inside any of the packets received by a receiving SmartBits card. The receiving card then counts the number of triggers received with the specific pattern.

Inserted into ATM cells as a pattern tracking tool, triggers appear in ATM cells according to the ATM card type:

- *AT-9015, AT-9020, and AT-9025 cards* – Latency is measured from frame transmit rates between an AT-9xxx and other SmartBits cards, with 100ns resolution. These cards allow one transmit or receive trigger to be defined per card and a maximum of 512 calls per second.
- *AT-034B, AT-9045B, AT-9155C, AT-9155Cs, AT-9622, and AT-9622s cards* – These cards support one trigger *per connection* for a maximum of 2,048 triggers per card and a maximum of 800 calls per second.

ATM SmartCards feature the following expanded capabilities:

- Measurement of peak call rate and setup latencies for SVCs in SmartSignaling.
- Generates frames up to 2,048, PVCs and SVCs. (AT-034B, AT-9045B, AT-9155C, AT-9155Cs, AT-9622, and AT-9622s cards.)
- Supports PPP testing with up to 2,048 PPP sessions. (AT-034B, AT-9045B, AT-9155C, AT-9155Cs, AT-9622, and AT-9622s cards.)
- Supports LANE testing with up to 64 LECs.
- Supports up to 8.38 million VCCs per port. (AT-034B, AT-9045B, AT-9155C, AT-9155Cs, AT-9622, and AT-9622s cards.)
- AAL5 protocol support for ILMI, UNI 3.x, LAN Emulation Client 1.0, and LLC/SNAP per RFC-1483; Classical IP per RFC-1577; and PPP per RFCs 1661 and 2364.
- Standard traffic contract parameters are user-definable per VCC based on:
  - Constant Bit Rate (CBR): PCR, CDVT.
  - Unspecified Bit Rate (UBR): PCR
- Supports frame latency measuerments with 100 ns timestamp resolution. Fully compatible with legacy LAN SmartCards.

ATM LEDs

The same LEDs are used throughout many ATM cards; however, specific cards may have a unique LED or special function assigned.

Note: Notes for downloading firmware:

- All LEDs turn green during downloading except for the AT-9155C, AT-9622, and AT-9622s.
- During download, the AT-9045B, AT-9155C, AT-9155Cs, AT-9622 and AT-9622s flicker red on the TRIG ALARM LED.

Each card has a set of LEDs that are described in *Table 11-2*.

Table 11-2. LED Functions for ATM SmartCards

LED	Color/Status	Description
TX/INIT	Green	Frame is transmitting. LED flashes briefly for each frame transmitted. If continuous transmission, light is in steady on condition.
	Red	Link is not ready.
TRIG ALARM		(AT-9015, AT-9020, AT-9025, and AT-9034B)
	Green	Trigger Event indication. Flickers for each trigger.
	Red	Alarm Event. Flickers for errors in physical layer (check Alarm and Line tabs via Display Counters in SmartWindow).
	Yellow	Errors in PLCP frames when PLCP is configured.
TRIG ALARM		(AT-9155 and AT-9155B)
	Green	Trigger Event indication. Flickers for each trigger.
	Red	Alarm Event. Flickers for path-level SONET alarms.
	Yellow	Alarm Event. Flickers for line- or section-level SONET alarms.
TRIG ALARM		(AT-9155C and AT-9622)
	Green	Trigger Event indication. Flickers for each trigger.
	Red	Alarm Event. Flickers for any SONET alarm.
RX LOS	Yellow	Loss of signal (optical signal) condition exists.

Table 11-2. LED Functions for ATM SmartCards

LED	Color/Status	Description
LINK	Green Off	(AT-9015, AT-9020, AT-9025, and AT-9034B) Green – No errors detected in the physical layer. Off – Not connected to an outside device or network.

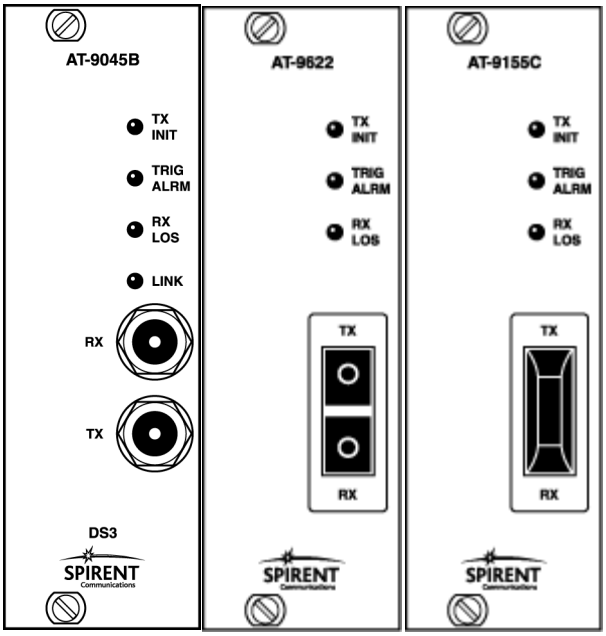
Port Specifications

Table 11-3 shows the per port specifications for the SmartBit ATM Cards.

Table 11-3.Maximum Per Port Specifications for ATM Cards

Card	Description	VCCs (PVC/SVC)	SmartSignaling		Interface	CW Output Power
			VCCs	CPS		
AT-9015	DS1 1.544 Mbps	256	8,388,606	512	RJ-45	N/A
AT-9020	E1 2.048 Mbps	256	8,388,606	512	RJ-45	N/A
AT-9025	25 Mbps	256	8,388,606	512	RJ-45	N/A
AT-9034B	E3 34 Mbps	2,048	8,388,606	800	BNC	N/A
AT-9045B	DS3 45 Mbps	2,048	8,388,606	800	BNC	N/A
AT-9155C	OC-3c/STM-1 155 Mbps	2,048	8,388,606	800	SC multimode fiber 1300nm	min = -19 dBm max = -14 dBm
AT-9155Cs	OC-3c/STM-1 155 Mbps	2,048	8,388,606	800	SC multimode fiber 1300nm	min = –15 dBm max = –8 dBm
AT-9622	OC-12c/STM-4 622 Mbps	2,048	8,388,606	800	SC multimode fiber 1300nm	min = –19.5 dBm typical = –17 dBm max = –14 dBm
AT-9622s	OC-12c/STM-4 622 Mbps	2,048	8,388,606	800	SC multimode fiber 1300nm	min = –15 dBm typical = –11 dBm max = –8 dBm

ATM SmartCards



- **AT-9015 DS1(1.544 Mbps) (RJ-45)**
- **AT-9020 E1 (2.048 Mbps) (RJ-45)**
- **AT-9025 (25 Mbps) (RJ-45)**
- **AT-9034B E3 (34 Mbps) (BNC)**
- **AT-9045B DS3 (45 Mbps) (BNC)**
- **AT-9155C ATM Multi Mode Fiber OC-3c/STM-1 (155 Mbps), 1300 nm**
- **AT-9155Cs ATM Single Mode Fiber OC-3c/STM-1 (155 Mbps), 1300 nm**
- **AT-9622 ATM Multi Mode Fiber OC-12c/STM-4 (622 Mbps), 1300 nm**
- **AT-9622s ATM Single Mode Fiber OC-12c/STM-4 (622 Mbps), 1300 nm**

Where Used: SMB-200 and SMB-2000; each card occupies two slots in a chassis.

Devices Tested: ATM-to-LAN internetworking devices, very high performance ATM backbones, xDSL devices, and LAN-to-ATM edge devices.

Test Objective: To generate and monitor Ethernet LAN-toATM, ATM-to-Ethernet LAN, and ATM-to-ATM internetworking devices, and very high performance ATM backbones. Frame-level testing at full-duplex, full-wire rate on edge devices and switches, switch testing at full-cell rate, and high-rate signaling testing for edge devices. Measures peak call rate and setup latencies for SVCs.

Applications Supported:

- SmartWindow, SmartLib, SmartApplications, and SmartSignaling. (SmartxDSL applications are available only on the AT-9025 25 Mbps Card.)

Features:

- Supports frames up to 2,048 PVCs and SVCs (AT-9045B).
- Supports PPP testing with up to 2,048 PPP sessions (AT-9045B).
- Supports LANE testing with up to 8 LECs.
- Supports up to 800 calls per second per port in SmartSignaling (AT-9045B).
- Supports up to 8,388,606 simultaneous virtual circuit connections per port utilizing a 40-port ATM test suite.

Encapsulation Modes:

- LAN Emulation Client 1.0.
- RFC 1483 (LLC/SNAP).
- RFC 1577 (Classical IP over ATM).
- RFC 2364 (PPP over AAL5).
- Null Encapsulation: Generation of user-definable frames (such as 40-byte IP) in single cell/multiple cells.
- Protocol support for ILMI, UNI 3.x, LAN Emulation Client 1.0, LLC/SNAP per RFC 1483, and Classical IP per RFC 1577, PPP per RFCs 1661 and 2364.

AT-9034B and AT-9045B Special Features

The AT-9034B and AT-9045B SmartCards have the following feature enhancements:

- Supports SmartxDSL version 1.01 and higher.
- 2K streams (compared to 256).
- Per VC triggers plus multi-burst transmit mode capabilities.
- AAL5 CRC-32 error generation.
- PPP support.

Specifications:

See *Table 11-3 on page 147*.

ATM Cell Header

Application Supported:

SmartWindow.

The ATM cell header includes the ATM address of the PVC. The VCI and VPI portion can represent either hexadecimal or decimal. The default is hexadecimal.

The ATM header contains the following fields:

- GFC 4 bits (Range 0-15).
- VPI 8 bits (Range 0-255) for UNI.
- VPI 12 bits (Range 0-4095) for NNI.
- VCI 16 bits (Range 0-65535).
- PTI 3 bits (Range 0-7).
- CLP 1 bit (Range 0-1).

Cell Header in ATM Streams:

In SmartWindow, the contents of the ATM cell header is only available for PVCs and is specified in the ATM Transmit Setup window. The VCI and VPI portion can represent either hexadecimal or decimal. The default is hexadecimal. You can modify the smartbit.ini file to change it to represent a decimal value.

To change the VCI and VPI portion of the cell header to represent decimal instead of hexadecimal, enter the following line in the *smartbit.ini* file under the Preferences:

```
ATM VPI/VCI HEX=0
```

If you change the value to 1, it represents hexadecimal.

Cell Header, Idle:

If you select the Line Parameters window for an ATM card in SmartWindow, you can specify the header contents (4-bytes in hexadecimal) of the ATM idle cell payload (the first four bytes of the header) that is transmitted when no data cells are being transmitted.

SmartWindow calculates the HEC byte for the specified header internally.

For the AT-9622/9622s OC-12c SmartCard, enter only idle cells with the VPI/VCI fields set to zeroes.

ATM Alarms

Applications Supported: SmartWindow, SmartLib.

Card Types: See specific ATM card topics.

See also: *"ATM Line Event Statistics" on page 155*.

ATM Alarms, AT-9155C/9155Cs OC-3 and AT-9622/9622s OC-12c SmartCards

In SmartWindow, select the Alarms tab from the Statistics window to display alarm conditions for the test.

Section Alarms:

- **LOS**. Loss of Signal is asserted when 20 ± 3 microseconds of continuous zero patterns have been detected. LOS is cleared when two valid framing words are detected with no LOS condition detected in the intervening time.
- **OOF**. Out of Frame is declared when 1 or more bit errors in the framing pattern of four consecutive frames is in error. Out of frame is cleared when the A1 byte and all A2 bytes of a SONET frame have been read error free.
- **LOF**. Loss of Frame is declared when an out of frame condition is declared for 3 microseconds or longer. LOF is cleared when an in frame condition exists for 3 microseconds or longer.

Line Alarms:

- **AIS**. Line Alarm Indication Signal is set when a binary 111 pattern is detected in bits 6, 7, and 8 of the K2 byte for five consecutive frames. Line AIS is cleared when a pattern other than 111 is detected in the K2 byte for five consecutive frames.
- **FERF**. The line Far End Receive Failure, also called the Remote Defect Indicator, is set when a binary 110 pattern is detected in bits 6, 7, and 8 of the K2 byte for five consecutive frames. Line AIS is cleared when a pattern other than 110 is detected in the K2 byte for five consecutive frames.
- **LOP**. Loss of Pointer is set whenever an invalid SONET pointer value is read from the H1 and H2 bytes for eight consecutive frames. The Loss of Pointer is cleared when any valid pointer value, including AIS, is received for 3 consecutive frames.

Path Alarms:

- **AIS**. Path Alarm Indication Signal is set whenever the pointer values in bytes H1 and H2 are all ones in 3 consecutive frames. Path AIS is cleared whenever a bit pattern other than all ones is read for bytes H1 and H2.
- **FERF**. The path Far End Receive Failure, also called the Remote Defect Indicator, is set when a binary 110 pattern is detected in bits 6, 7, and 8 of the K2 byte for five consecutive frames. Line AIS is cleared when a pattern other than 110 is detected in the K2 byte for five consecutive frames.
- **Yellow**. Path Yellow alarm is set to 1 when bit 5 in the G1 byte is 1 for 5 consecutive frames. This bit is cleared when bit 5 of the G1 byte is zero for 5 consecutive frames.
- **LOCD**. Loss of cell delineation is set when seven incorrect HEC values are received. LOCD is cleared when seven consecutive correct HEC values are received.

ATM Alarms, AT-9034B and AT-9045B SmartCards

In SmartWindow, select the Alarms tab from the Statistics window to display the following alarm conditions for the test:

- **LOCD**. For DS3 and E3 G.832 cell framing modes only. Loss of cell delineation. This condition is declared when seven consecutive HEC errors occur.
  - AT-9045B only: For Direct Cell and PLCP mapping modes.
- **OOF**. Out of frame (OOF) condition detected by the DS3 or E3 framer.
  - For AT-9045B DS3 framing: An out of frame condition is declared when 3 out of 4 M-frames contain M-bit or when three out of 16 F-bits are in error.
  - For AT-9034B E3 G.832 cell framing: An out of frame condition is declared when four consecutive A1/A2 framing patterns are errored. In E3 PLCP framing mode OOF is declared when there are four consecutive FAS pattern failures.
- **FERF**. Far End Receive Failure.
  - For AT-9045B DS3: The FERF error (both X bits are low) in an M-frame.
  - For AT-9034B E3 cell framing mode: The FERF bit in MA is high.
- **AIS**. Alarm indication signal detected in the DS3 or E3 frame.
  - For AT-9045B DS3: AIS is declared when 1010… payload has valid framing and parity, equal X-bits, and all subviral 3 C-bits set to 0.
  - For AT-9034B E3: AIS is declared if an unframed all ones pattern (less than 0.25% zero content) is detected.
- **Idle**. For AT-9045B only: Idle code signal detected by the DS3 framer.
  A DS3 idle cell is a 1100… payload with valid framing and parity, equal X-bits, and all C-bits set to 0.

- **LOS**. Loss of signal detected.
  - For AT-9034B: A LOS is declared if 175 ±75 zero bits are received from the line before decoding.
  - For AT-9045B: A LOS is declared if 160 ±32 zero bits are received from the line before decoding.
- **Yellow**. For AT-9034B PLCP framing mode only. This alarm is declared if the A-bit is high in an E3 G.751 frame.
- **PLCP OOF**. For AT-9045B DS3 PLCP or AT-9034B E3 G.751 mapping modes only. Physical Layer Convergence Protocol out of frame error condition detected. On the AT-9045B, PLCP OOF includes LOCD while in PLCP mapping mode.
- **PLCP LOF**. For AT-9045B DS3 PLCP or AT-9034B E3 PLCP framing modes only. PLCP loss of frame error condition detected. LOF is set when PLCP OOF is active for eight consecutive PLCP frames.
- **PLCP Yellow**. For AT-9045B DS3 PLCP or AT-9034B E3 PLCP framing modes only. PLCP yellow error condition detected. This bit is set when the yellow alarm bit in the G1 octet of the PLCP frame has been active for ten consecutive PLCP frames.

ATM Alarms, AT-9015 and AT-9020 SmartCards

In SmartWindow, select the Alarms tab from the Statistics window to display the following alarm conditions for the test.

- **LOCD**. For DS1 and E1 direct framing modes. Loss of cell delineation. This alarm is set when seven consecutive HEC errors are received.
- **OOF**. Out of frame condition detected by the DS1 or E1 framer.
- **LOS**. Loss of signal detected. In DS1, a LOS is declared when 192 zeroes are received before decoding. In E1, an LOS is declared when 255 consecutive zeroes are received before decoding.
- **RAI**. Remote alarm indication received in the frame. This is also called a yellow alarm.
  Use only the ESF mode for DS1 framing, per the ATM Forum: This bit is set when 16 consecutive patterns of 00FF appear in the facilities data link.
  For E1 framing mode: This bit is set when bit 3 of non-align frames is set to one for three consecutive occasions.
- **AIS**. Alarm indication signal detected in the frame. In DS1 mode, this bit is set when 5 or less zeros are received over a 3 mS window. In E1 mode, this bit is set when less than three zeros are received in 512 bits.
- **B8ZS**. For AT-9015 DS1 only. The absence of B8ZS encoding is detected in the frame signal.
- **EZA**. Excess zeros alarm. Use only the B8ZS coding mode for DS1, per the ATM Forum: This bit is set when a string of eight or more consecutive zeros are received.

- **PLCP OOF**. For DS1 PLCP or E1 PLCP modes only. PLCP out of frame error condition detected.
- **PLCP LOF**. For DS1 PLCP or E1 PLCP mapping modes only. PLCP loss of frame error condition detected. This alarm condition is declared when the OOF condition has been declared for eight consecutive frames.
- **PLCP RAI**. For DS1 PLCP and E1 PLCP modes only. PLCP remote alarm indication received in the DS1 or E1 PLCP frame. This is also called a yellow alarm. This alarm is declared when the yellow alarm bit of the G1 octet in the PLCP frame has been active for ten consecutive frames.
- **SEF**. For DS1 framing mode only. Severely Errored Frame event. This bit is set to one in DS1 framing modes when 2 of 6 Ft or FPS bits are received in error. This field bit is not used in E1 framing modes.

ATM Alarms, AT-9025 SmartCard

In SmartWindow, select the Alarms tab from the Statistics window to display alarm conditions for the test.

- **LOS**. Loss of Signal condition. The SmartCard monitors LOS conditions as follows:
  - The SmartCard looks at successive groups of 204 symbols. The card's internal counter increases by one if all 204 symbols in a group are valid and decreases by one if even one symbol in the group is invalid.
  - If an LOS condition exists (light is red), the alarm is cleared once the SmartCard receives seven groups of 204 valid symbols and the counter increases to 7 (maximum value).
  - When the alarm is in a cleared state (a signal is present), the alarm is asserted again once the counter decreases to 0 (minimum value). The initial counter value is 0.

ATM Line Event Statistics

Applications Supported: SmartWindow, SmartLib.

Under SmartWindow, you can view line error events (either in Smartcounters or by selecting an ATM card and selecting the Display Counters command).

Card Types: See specific ATM card topics.

Line Event Statistics for AT-9015 and AT-9020 SmartCards

SmartWindow provides these line event statistics for the AT-9015 DS1 and AT-9020 E1 SmartCards.

To access these statistics, select the following Line tabs on the Statistics window:

- **Code Violation**. The total number of line code violations. For AT-9015 DS1 and for AT-9020 E with B8ZS line encoding, this counter contains the number of bipolar violations plus the number of times that 8 consecutive zeros are received. It counts consecutive bipolar violations of the same polarity with HDB3 coding.
- **Frame Error**. The counter only counts when the card is operating in a non LOS condition.
  - For DS1 ESF framing mode. The total number of CRC-6 errors.
  - For E1 framing modes. The number of CRC-4 errors that occur.
- **Sync Error**. For AT-9015 DS1 only. The total number of multiframes out of synchronization.
- **FEBE Error**. For AT-9020 only. The total number of Far End Block errors received. This counter increments every time the E-bit is set to 0 in frames 13 and 15.
- **PLCP OOF Error**. The total number of Physical Layer Convergence Protocol out of frame errors. This counter statistic is active in the DS1 PLCP and the E1 PLCP mapping modes only.
- **PLCP Frame Error**. For DS1 PLCP and the E1 PLCP mapping modes only. The total number of PLCP framing errors.
- **PLCPL BIP Error**. For DS1 PLCP and the E1 PLCP mapping modes only. The total number of detected PLCP Bit Interleaved Parity errors.
- **PLCP FEBE Error**. For DS1 PLCP and the E1 PLCP mapping modes only. This counter is active in the DS1 PLCP and the E1 PLCP mapping modes only.

Line Event Statistics for the AT-9034B and AT-9045B SmartCards

SmartWindow provides these line event statistics for the AT-9034B E3 and AT-9045B DS3 SmartCards:

- **Code Violation**. The total number of line code violations in the B3ZS decoder. A code violation is either a bipolar rule violation or the occurrence of three or more zeros.
- **Frame Errors**. For AT-9045B, the total number of F- and M-bit framing errors in DS3 framing mode. For AT-9034B, the total number of E3 out of frame errors in E3 PLCP framing mode and FAS errors in E3 PLCP framing mode.
- **Parity Errors**. The total number of detected P1/P2 parity errors in DS3 modes or the total number of BIP-8 byte errors in E3 G.832 cell framing mode. Not used in E3 direct cell framing mode.
- **C-bit Parity Errors**. For the AT-9045B only. The total number of detected C-bit path parity errors.
- **FEBEs**. The total number of Far End Block Errors. This counter is active in the DS3 and E3 direct cell framing modes only. A FEBE error is declared when the FEBE bit in the MA octet is high in an E3 G.832 frame.
- **FERFs**. For the AT-9034B only. The total number of Far End Receive Failure errors. This counter is active in the E3 direct cell framing mode only. A FERF error is declared when the FERF bit in the MA octet is high in an E3 G.832 frame.
- **PLCP Frame Errors**. The total number of Physical Layer Convergence Protocol framing errors. This counter is active in the DS3 PLCP and the E3 PLCP framing modes only. This counter is incremented every time there is an error in either the A1 or the A2 octets in a PLCP frame.
- **PLCP BIP Errors**. The total number of detected PLCP Bit Interleaved Parity errors. This counter is active in the DS3 PLCP and the E3 PLCP framing modes only.
- **PLCP FEBEs**. The total number of PLCP FEBE errors. This counter is active in the DS3 PLCP and the E3 PLCP framing modes only. This counter is incremented every time there is a non zero value in the G1 octet of a PLCP frame.

Note: The following counters are paused on the AT-9045B SmartCard:

- Frame Error.
- Parity Error.
- C Parity Error.
- FEBEs.

Line Event Statistics for the AT-9622 SmartCard

SmartWindow provides the following line event statistics for the AT-9622 SmartCard. To access these statistics, select the Line tab on the Statistics window:

- **Section BIP-8**. Section level Bit Interleaved Parity events counted since the last clear counters event.
- **Line BIP-96**. Line level Bit Interleaved Parity events counted since the last clear counters event.
- **Line FEBE**. Line level Far End Block Error events counted since the last clear counters event.
- **Path BIP-8**. Path level Bit Interleaved Parity events counted since the last clear counters event.
- **Path FEBE**. Path level Far End Block Error events counted since the last clear counters event.

ATM ILMI Parameters

Applications Supported: SmartWindow, SmartLib.

Card Types: All ATM Cards.

Methods: Static Assignment or Dynamic Registration. The following definitions apply:

- **Cold Start Time**. Enter the frequency that Cold Start traps are sent to the switching device under test while attempting to register an ATM address until the process has been successfully completed.
- **Register Timeout Timer**. Enter the timeout value for failed address registration retries.
- **End System Identifier (ESI)**. Enter a 6-byte user-specific part of the 20-byte ATM address using hex values. SmartCards that are connected to the same device under test must have different ESIs. An easy way to assign the ESI is to map it to the slot number that the ATM SmartCard resides. For example, if an ATM SmartCard resides on slot #19, the ESI can be 00 00 00 00 00 19 or 00 00 00 00 00 13 (hexadecimal for 19). (The latter is the default.)
- **Prefix**. The 13-byte ATM network prefix.
- **Set**. Selector byte-User defined 1-byte of portion of the 20-byte ATM address used by the end station.
- **Status**. The Status pane with the following fields is display-only, but may be copied:

- **UME State**.
  - *Inactive (0)* – This is the idle state.
  - *Down (1)* – The physical interface for the card does not have a link.
  - *Cold Start (2)* – The Address Registration procedure is initiated.
  - *Running (3)* – The ATM card has successfully registered an ATM address with the device under test.
- **Cold Starts**. A timer that sets the total amount of time between registration requests. (Default = 5 secs.)
- **Good Packet**s. Number of good packets monitored on the ILMI channel.
- **Bad Packets**. Number of bad packets monitored on the ILMI channel.
- **Sent Packets**. Total amount of packets sent by the card.
- **ATM Address**. Complete 20-byte ATM address composed of 13-byte ATM network prefix, 6-byte ESI, and 1-byte Selector.

ATM LANE Parameters

Applications Supported: SmartWindow, SmartLib.

Card Types: All ATM Cards.

In SmartWindow, the LANE parameters are editable in the LANE tab in the ATM Protocol Setup window.

Note: To send packets between Ethernet and ATM SmartCards using LANE, you must:

- Send source packets from the Ethernet card so that the device under test can learn the SmartCard MAC address. Failure to do this will cause an address resolution failure when attempting to connect a stream from the ATM card to the Ethernet card.
- To add or edit an ELAN service, click the *Add ELAN* or *Edit ELAN* button. When you click either button, the ELAN Setup window appears.

Parameter definitions for ATM LANE are as follows:

- **ELAN Setup Window**. Use the ELAN Setup window to specify parameters for the specific ELAN you want to join.
- **ELAN Name**. The name of an ELAN that you want to join. The name must exactly match (case sensitive) one of the ELAN names specified on the device under test.
- **MAC Address**. The 6-byte MAC address of the LAN Emulation Client on the ATM SmartCard.

- **Initialization Method**.
  - *Normal* – This is the default initialization method, where the LEC on the ATM SmartCard attempts to contact the LECS at the default address specified by the ATM Forum to obtain addressing information of the LES and BUS.
- **Other Possible Initialization Methods**:
  - *LECS Direct* – Allows you to directly input the ATM address of the LECS. This is to be used if LECS does not reside at the default address specified by the ATM Forum.
  - LES Direct – Allows you to input the ATM address of the LES. This method can be used when no LECS service is available and the LES's ATM address is known.
- **ELAN Type**. Only LANE 802.3 is currently supported.
- **ELAN MTU**. Specify the Maximum Transmission Unit of this ELAN.
- **ARP Retry Count**. Number of ARP retries to attempt before giving up.
- **Expected ARP Reps. Time**. Amount of time to wait before retrying to send another LE_ARP or expiring (time out).

ATM ARP Parameters

Applications Supported: SmartWindow, SmartLib.

Card Types: All ATM Cards.

Use the ATM ARP tab to specify the parameters (ARP Server ATM Address, ARP Client IP Address, Inter ARP Gap, Inter Call Gap, ARP Retries).

To connect to the ATM ARP server. In order to establish a connection from the SmartCard to the ATM ARP Server, you must ensure that:

- **LMI** is up or has already obtained the ATM address of the SmartCard.
- **SCOP/UNI** must be running (i.e. SSCOP in "Data Transfer Ready State", and SAAL in "Connected" state).

ATM Line Parameters

Applications Supported: SmartWindow, SmartLib.

Card Types: Applicable to all ATM cards except where specific cards are referenced.

Framing Mode: Select to define the physical layer of the frame. Possible values for these SmartCards:

- **AT-9025 25 Mbps**. Indicates direct cell mapping at 25.6 Mbps.
- **AT-9015 DS1**. Cell maps the ATM cells directly into the DS1 frame with no intermediate mapping. DS1 PLCP maps the ATM cells into PLCP frames and maps the PLCP frames into the DS1 frame.
- **AT-9020 E1**. Cell maps the ATM cells directly into the E1 frame with no intermediate mapping. E1 PLCP maps the ATM cells into PLCP frames and maps the PLCP frames into the E1 frame.
- **AT-9034B E3**. Cell maps the ATM cells directly into an E3 G.832 frame with no intermediate mapping. E3 PLCP maps the ATM cells into the PLCP frames and maps the PLCP frames into an E3 G.751 frame.
- **AT-9045B DS3**. Cell maps the ATM cells directly into the DS3 frame with no intermediate mapping. DS3 PLCP maps the ATM cells into PLCP frames and maps the PLCP frames into the DS3 frame.
- **AT-9155C ATM OC-3c**. OC3 is for SONET, OC-3c type of optical carrier line. STM1 enables the European STM 1 framing method (equivalent to OC-3c).
- **AT-9622/9622s ATM OC-12c 622 Mbps**:
  - *OC-12* is for SONET, OC-12c type of optical carrier line. The SmartCard maps the ATM cells directly into a SONET OC-12c frame.
  - *STM1* enables the European STM-4 framing method (equivalent to OC-12c). The SmartCard maps the ATM cells directly into an STM-4 frame.
- **Tx Clock Source**. This field does not apply to the AT-9025 SmartCard, which uses only an internal clock. Specifies the clock against which you want to run the tests. Possible values:
  - *Internal* – Uses an internally generated clock as the transmit clock.
  - *Loopback* – Uses the recovered (received) clock as the transmit clock.
- **Loopback**. Specifies the type of loopback to be used. Possible values:
  - *Disabled* – No loopback is used. This is the normal operating mode of the device.
  - *Local* – Loops the SmartCard's output back to the SmartCard's input.
  - *Remote* – Loops the SmartCard's input back to the SmartCard's output.

- **Errored Cells Handling**. Specifies the action to take for cells with errors. Possible values:
  - *Drop Errored Cells* – Drops all cells that have a header error as determined by the HEC byte.
  - *Receive Errored Cells* – Receives all cells even if they have errors.
  - *Receive and Correct Errored Cells* – This option does not apply to the AT-9025 SmartCard. Receives and when possible corrects all cells with single-bit header errors. Drops any cells that cannot be corrected.
- **Buildout**. This field applies only to the AT-9015 DS1 and AT-9045B DS3 SmartCard. Select to change the electrical output of the SmartCard to either (1) accommodate the length of the cable that you are testing or (2) specify the amount of attenuation to apply to the signal.
  - AT-9015 DS1. Possible values for cable lengths:

    <=133 Feet. Pulse shaping for cable lengths up to 133 feet.

    >133, <=266 Feet**.** Pulse shaping for cable lengths more than 133 feet and up to 266 feet.

    >266, <=399 Feet. Pulse shaping for cable lengths more than 266 feet and up to 399 feet.

    >399, <=533 Feet. Pulse shaping for cable lengths more than 399 feet and up to 533 feet.

    >533, <=655 Feet. Pulse shaping for cable lengths more than 533 feet and up to 655 feet.
  - Possible values for attenuation values:

    -7.5 dB. Pulse shaping to generate -7.5 dB of attenuation.

    -15.0 dB. Pulse shaping to generate -15.0 dB of attenuation.

    -22.5 dB. Pulse shaping to generate -22.5 dB of attenuation.
  - AT-9045B DS3 Possible cable length values:

    <= 225 Feet. Pulse shaping for cable lengths up to 225 feet.

    >225 Feet. Pulse shaping for cable lengths more than 225 feet.
- **Line Encoding**. This field applies only to AT-9015 DS1 and AT-9020 E1 SmartCards. Select the type of encoding to be used for the line. Possible values:
  - *AMI* – Uses AMI line encoding (not supported by the ATM Forum).
  - *B8ZS* – DS1 mode using B8ZS line encoding. (AT-9015 only).
  - *HDB3* – E1 mode using HDB3 line encoding (AT-9020) only.
- **Line Framing**. This field applies only to the AT-9015 SmartCard. Select the framing mode for the physical layer. Possible values:
  - *D4* – Uses D4 line framing (not supported by the ATM Forum).
  - *ESF* – Uses Extended Super Frame line framing.

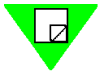
- **HEC Coset**:
  - *Checked* – Exclusively ORs (Boolean operation) the result of the header CRC with the HEC coset 0x55. Most ATM devices require this feature to be on.
  - *Unchecked* – Uses the header CRC without modification.
- **Cell Scrambling**:
  - *Checked* – Scrambles the payload content of the cells using the self-synchronized scrambler to facilitate cell delineation. Most ATM devices require this feature to be on.
  - *Unchecked* – Does not scramble the cell payloads.
- **Idle Cell Header**. Specify the header contents (4-bytes in hexadecimal) of the ATM idle cell payload (the first four bytes of the header) that is transmitted when no data cells are being transmitted. SmartWindow calculates the HEC byte for the specified header internally. For the AT-9622 OC-12c SmartCard, enter only idle cells with the VPI/VCI fields set to zeroes.

12 WAN Cards

In this chapter . . .

WAN Applications

Table 12-1 gives a description of the ATM cards and the applications available for each SmartBits chassis. These cards apply only to the SMB-200/2000 chassis.



Note: Throughout this manual, the term “card” may be used interchangeably to represent either SmartCards (SMB-200/2000), or modules (SMB-600/6000B).

Table 12-1. WAN Cards Used in Applications

Card/ Module	Description	SmartWindow 7.10	SmartLib 3.10	SmartApps 2.40	SmartSignaling 3.00	SmartMulticastIP 1.25	SmartFlow 1.30	SmartVoIPQoS 1.00	TeraRouting 1.00	AST II (All Tests)	SmartTCP 2.00	SmartxDSL 1.10	SCMT 2.00	VAST 2.11	ScriptCenter 1.20	SmartMetrics	TeraMetrics
WAN Cards Used in SMB-200/2000 Chassis																	
WN-3405	6 Mbps V.35	X	X	X	X										X	X	
WN-3415	T1	X	X	X	X										X	X	
WN-3420A	E1	X	X	X	X										X	X	
WN-3441A	T1 FR/PPP	X	X	X	X										X	X	
WN-3442A	E1 FR/PPP	X	X												X	X	

Feature Summary of WAN Cards

Refer to *Table 12-2* for a summary of WAN features.

Table 12-2 Feature Summary of WAN Cards

Feature	WN-3405	WN-3415	WN-3420A	WN-3441A	WN-3442A
Ports per Card	1 (V.35)	1	1	4	4
Maximum Cards per SMB-2000 Chassis	20	20	20	10	10
Maximum Line Speed	8.192 Mbps (full-duplex) 6.144 Mbps (half-duplex)	T1: (G.703) 1.5444 Mbps	E1: (G703) 2.048 Mbps	T1: 1.5444 Mbps	E1: 2.048 Mbps
Maximum Channels per Port	1	24	31	24	31
Loopback	N/A	Local and remote.	Local and remote.	Remote	Remote
Buildout	N/A	100 ohm balanced	120 Ohm balanced or 75 Ohm unbalanced[1]	0-110 ft 110-220 220-440 440-660	120 Ohm balanced or 75 Ohm unbalanced[1].
Network Connection	V.35, Winchester type	RJ-48C	RJ-48C: 120 Ohm balanced; dual 75 Ohm BNC connector[1].	RJ-48C	RJ-48C: 120 Ohm balanced; dual 75 Ohm BNC connector[1].
Line Framing	N/A	Super Frame (SF/D4) or Extended Super Frame (ESF).	Frame Alignment Signaling (FAS), and CRC4 Multi-frame Alignment.	Super Frame (SF/D4) or Extended Super Frame (ESF).	Frame Alignment Signaling (FAS), and CRC4 Multi-frame Alignment.
Line Encoding	NRZ or NRZI	B8ZS or AMI	HDB3 or AMI	B8ZS or AMI	HDB3 or AMI
Transmit Clock	Internal or external	Internal or loop-timed	Internal or loop-timed	Internal or loop-timed	Internal or looped-timed
Link Management Protols	LMI, Annex A, or Annex D	LMI, Annex A, or Annex D	LMI, Annex A, or Annex D	LMI, Annex A, or Annex D	LMI, Annex A, or Annex D
Max. Number of PVCs Supported	128 per port	128 per port	128 per port	1,023 per card	1,023 per card
Protocols Supported	PAP and CHAP authentication.	PAP and CHAP authentication.	PAP and CHAP authentication.	PAP and CHAP authentication. Microsoft CHAP.	PAP and CHAP authentication. Microsoft CHAP.
IP Encapsulation Support	Over FR (RFC 1490) or PPP (RFC 1662)	Over FR (RFC 1490) or PPP (RFC 1662)	Over FR (RFC 1490) or PPP (RFC 1662)	Over FR (RFC 1490) or PPP (RFC 1662)	Over FR (RFC 1490) or PPP (RFC 1662)

1 Requires external Balun for impedance matching.

WAN LEDs

All WAN cards have three *card LEDs* (located near the top of the card) and are explained in Card LEDs below, and in *Table 12-3 on page 167*.

The WN-3441A and WN-3442A cards also have individual port LEDs (two on each RJ-48C interface connector) and are explained in *"Port LEDs for the WN-3441A and WN-3442A Cards" on page 169*.

Note: In the following tables, the term *port up* denotes the following:

- The port is enabled — *and* —
- The physical link is connected or in local loopback — *and* —
- Neither a Remote Alarm Indicator (RAI) nor Out of Frame (OOF) alarm has been detected.

The term *port down* denotes the reverse of any of the above conditions:

- The port is disabled — *or* —
- The physical link is disconnected and not in local loopback — *or* —
- Either a Remote Alarm Indicator (RAI) or Out of Frame (OOF) alarm has been detected.

Card LEDs

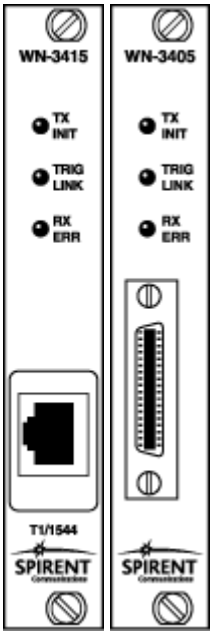
Table 12-3 on page 167 summarizes the functions of card LEDs. These three LEDs indicate status and events for the card as a whole. These are designated TX/INIT, TRIG/LINK, and RX/ERR. The TX, RX, and TRIG LEDs flash green when *any* port on the card detects one of the following events: frame transmission, frame received, or a trigger.

The LINK LED indicates the status of all four ports. If *all* ports are linked correctly, this LED is off. If *any* of the four ports is not linked correctly, the LED displays Red. To determine port-specific status and events, check the individual port LEDs (see *Table 12-3 on page 167*).

Table 12-3. Card LEDs — All WAN SmartCards

LED	Color	Description
TX/INIT	Green	One of more ports are transmitting data. LED flashes if ANY port is transmitting data.
	Yellow	Card is initializing.
	Off	Chassis and card are not connected —*or*— Card has finished initializing.
TRIG/LINK	Green	Receive Trigger Event indication. Flashes briefly for each receive trigger detection on ANY port if all four port links are up.
	Red	One or more the card's four port links are down.
	Yellow	Receive Trigger Event indication. Flashes briefly for each receive trigger detection on ANY port if one or more port links are down. —*or*— Card is initializing.
	Off	All of the card's four port links are up.
RX/ERR	Green	Flashes once when any port receives data while ALL of the card's four ports are up.
	Red	Flashes if one or more ports are receiving frames with errors.
	Yellow	Flashes if one or more ports are receiving data while one or more ports are receiving frames with errors, or the card is initializing.
	Off	No data is being received.

WN-3405, WN-3415, WN-3420A SmartCards



- **WN-3405 SmartMetrics 1-port V.35 up to 6 Mbps full-duplex, or 8 Mbps half-duplex**
- **WN-3415 SmartMetrics 1-port RJ-48 T1 (1.544 Mbps)**
- **WN-3420A SmartMetrics 1-port RJ-48 E1 (2.048 Mbps)**

Where Used: SMB-200 or SMB-2000.

Applications Supported: SmartWindow, SmartLib, and SmartApplications.

Devices Tested: WAN switches, routers, access devices, and integrated access devices (IADs).

Test Objective:

- Perform comparative analysis of WAN switches and access devices.
- Evaluate key performance parameters of WAN devices under typical or extreme traffic load conditions.
- Re-qualify WAN switches and access devices after firmware upgrades.

Features:

- These tests provides 2-byte time resolution with granularity of 100-nanosecond resolution.
- SmartMetrics tests. Sequence Tracking plus Latency, Latency Over Time, and Raw Packet Tag Information.

WN-3441A, WN-3442A, WN-3445A SmartCards

- **WN-3441A SmartMetrics 4-port channelized RJ-48 T1 (1.544 Mbps)**
- **WN-3442A SmartMetrics 4-port channelized RJ-48 E1 (2.048 Mbps)**
- **WN-3445A SmartMetrics 1-port channelized DS3 (44.736 Mbps)**

Where Used: SMB-200 or SMB-2000.

Applications Supported: SmartWindow, SmartLib, SmartApplications, and SmartFlow.

Devices Tested: WAN switches, routers, access devices, and broadband access devices.

Test Objective:

- To perform frame-level testing at up to full-wire rate for WAN and broadband access devices, routers, and switches using Frame Relay/PPP. To generate and analyze data network traffic over WAN links.
- To perform high-performance internetworking tests between WAN, LAN, and ATM devices in combination with other SmartCards.

Port LEDs for the WN-3441A and WN-3442A Cards

Table 12-4 summarizes the functions of card LEDs. Each port has two LEDs (*Figure 12-1 on page 170*), designated TX/LINK and RX/ERR. These are labeled only on Port 1 (RX/ERR) and Port 4 (TX/LINK), but their function is the same on all four ports.

Table 12-4. Port LEDS — WN-3441A and WN-3442A

LED	Color	Description
TX/LNK	Green	Flashes when this port is transmitting data.
	Red	Port link is down.
	Off	Port link is up but not transmitting data.
RX/ERR	Green	Flashes once for each frame received on this port.
	Red	Flashes once for each frame received with an error on this port.
	Off	No data is being received.

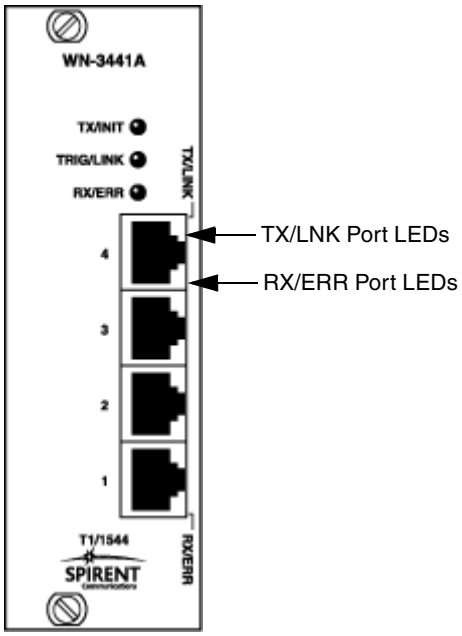


Figure 12-1. Location of Port LEDs on a WN-3442A SmartCard

13 Token Ring Cards

In this chapter . . .

Token Ring Applications

Table 13-1 gives a description of the Token Ring card and the applications that support Token Ring.

Note: Throughout this manual, the term “card” may be used interchangeably to represent either SmartCards (SMB-200/2000), or modules (SMB-600/6000B).

Table 13-1. Token Ring Card Used in Applications

Card/ Module	Description	SmartWindow 7.10	SmartLib 3.10	SmartApps 2.40	SmartSignaling 3.00	SmartMulticastIP 1.25	SmartFlow 1.30	SmartVoIPQoS 1.00	TeraRouting 1.00	AST II (All Tests)	SmartTCP 2.00	SmartxDSL 1.10	SCMT 2.00	VAST 2.11	ScriptCenter 1.20	SmartMetrics	TeraMetrics
Token Ring Cards Used in SMB-200/2000 Chassis																	
TR-8405	4/16 Mbps Token Ring	X	X	X	X	X									X		

Token Ring LEDs

Table 13-2 describes the LED functions and descriptions for the Token Ring card.

Note: When the card is running as Stations in an idling 16MBits/sec ring, then the top two LEDs (TX INIT and TRIG/BCN) will be dark, the third LED (Rx ERR) will be yellow, and the bottom two LEDs will be green. The middle LED Rx ERR will periodically flash green as monitor poll frames circulate on the ring.

Table 13-2.LED Functions for Token Ring SmartCards

LED	Color	Description
TX INIT	Green	Transmitting. LED flashes briefly for each frame transmitted. If continuous transmission, light appears as a steady on condition. Tokens transmitted automatically by Token Ring SmartCard do not activate this LED.
	Red	Card not initialized. This light is red briefly until the card boots up.
TRIG/BCN	Green	Trigger Event indication. Flashes briefly for each trigger detection.
	Red	Beacon Event. Flashes briefly for each beacon event detected.
	Yellow	Both Beacon & Trigger Event occur simultaneously. The flash appears as yellow.
RX ERR	Green	Receive. Flashes green once for each frame detected on the ring.
	Yellow	Token. Flashes yellow briefly for each token detected on ring.
	Red	CRC Errors. Flashes red once for each frame received with a bad CRC.
16M 4M	Green	16 Mbps (steady on LED operation)
	Yellow	4 Mbps (steady on LED operation)
ST PORT	Green	Station Emulation (steady on LED operation)
	Yellow	MAU (Port) Emulation (steady on LED operation)

Token Ring Counters

The counters can hold a maximum of 2^{32-1} counts before cycling. All counters can display either rates or events. The Token Ring port counter window in SmartWindow can display only 10 counters at a time; the default counters are:

- Transmit Packet Counter.
- Receive Packet Counter.
- FCS Error Counter.
- Oversize Packet Counter.
- Undersize Counter.
- Bytes Received Counter.
- Trigger Counter.
- MAC Frame Counter.
- Abort Frames Counter.
- Token Rotation Time.

Additional available counters are error counters derived from decoding MAC frames:

- Line Errors.
- Internal Errors.
- Burst Errors.
- A/C Errors.
- Abort Errors.
- Lost Frame Receiver Congestion.
- Frame Copied, Frequency Errors.
- Token Errors.
- Purge Events.
- Beacons.
- Claim Events.
- Insertions.

All undisplayed counters are continuously active and can be chosen at any time without affecting their contents.

TR-8405 Token Ring 4/16Mbps SmartCard

Card Type: Token Ring.

Where Used: SMB-200 and SMB-2000: one port per card; each card occupies one slot in a chassis.

Applications Supported: SmartWindow, SmartLib, and SmartApplications and AST for Token Ring.

Devices Tested: Token Ring devices and networks.

Test Objective:

- Generate and monitor both 16 Mbps and 4 Mbps Token Ring traffic.
- Capable of sourcing frames and measuring ring activity at very high rates, to measure Token Ring equipment accurately.

Per Port Specifications:

- Sends up to 40,000 frames/sec (by sending multiple frames per token).
- Supports half-duplex and full-duplex Token Ring operation.
- User-selectable mode: between a station (connect through an MAU to a ring) and a port (connect directly to another station).
- Supports both *TKP* ("Token Passing") and *TXI* ("Transmit Immediate") operation. The card performance is effectively doubled when the card is running in TXI mode.
- Determines frame transit times to an accuracy of 0.1µSec that is fast enough to measure the latency of individual ring components.
- Provides **Early Token Release**: User-specified option to release the token before stripping the transmitted frame.
- Offers **Transmission Error Insertion**: FCS Error, Abort, Burst 5, Code Violation, Error Bit Set, and Address Recognized Bit Set.
- **Interpacket Gap**. The Interpacket Gap at 16 Mbps can be set from 0 nanoseconds to 1.6 seconds in 62.5 nanosecond increments. The Random Gap function randomly varies the gap from 0 nanoseconds to the user-specified maximum from 6.5 ms to 1600 ms. At 4 Mbps, gap resolution is 256 ns.
- **Packet Length**. From 1 to 18006 bytes fixed, or random varying from 18 to 18191 bytes (4096 bytes for 4 Mbps). The random packet length function allows the user to control the range. The upper limit of the range is twice the length entered in the Fixed Length field.

- **Limited IEEE-802.5 MAC Protocol Support**. With limited support, the card has been designed primarily as a ring monitor, with the capability to generate high frame rates and to generate various kinds of error frames and conditions. It will not, however, function as an Active Monitor. It will not participate in the Token Ring MAC Claim process, nor will it automatically generate Beacon frames (though it will generate Beacon frames or other frames on command via SmartLib.
- The card will respond to ring polls as a Standby Monitor, and it will generate SUA (stored upstream neighbor address change) frames.

Token Ring Operational Detail

MAC Protocol Support

The TR Smartbits card is not designed to be a formal station on a ring in that it does not directly participate in MAC protocols such as Neighbor Notification. Its frames are marked as *bridged* on a standard ring analyzer. It is aware of ring protocols and will stop sourcing frames if it detects ring recovery activity. This behavior is designed to make the card as unobtrusive as possible and in particular to stop it from aggravating fault conditions.

Compared to Ethernet frames, Token Ring adapters are less tolerant of randomly formed frames and so carelessly made up frames may cause ring restarts or even crash other stations. The Token Ring Smartcard can generate Token Ring specific frame *headers* that are overlaid on the background pattern that make the frames into a form that will co-exist with other traffic on the ring. This allows users to set up traffic patterns without having to first specify the basic frame format. This facility is optional and can be switched off or overlaid with VFDs as needed.

Frame Patterns

This card generates frames based on a background fill pattern overlaid with three *variable* field patterns (VFDs). The fill pattern buffer is 2048 bytes long. If the user specifies a larger frame than this, then the pattern will be repeated. The various VFDs available are as follows:

- **VFD1**. Can be from one to six bytes long placed anywhere in the frame. If the pattern increments or decrements, then the user can specify an optional *repeat count* and the pattern is reset to the start value.
- **VFD2**. Can be from one to six bytes long placed anywhere in the frame. If the pattern increments or decrements, then the user can specify an optional *repeat count* and the pattern is reset to the start value.
- **VFD3**. An arbitrary sequence of bytes that can be placed anywhere in the frame. This sequence can be specified for a set of one or more frames, the only limitation being

that the maximum byte count (product of the sequence length and number of frames in a set) has to be less than 2048 bytes.

The VFD patterns are overlaid in sequence so that VFD2 will overlay VFD1 and VFD3 will overlay VFD1 and VFD2.

The offset of the VFDs is computed from the start of the Access Control byte.

VFDs will not appear outside their frame boundaries. If they are placed outside, then they will be truncated or switched off as appropriate. VFDs 1 & 2 can be placed between the first byte of the Destination MAC address and the last byte of the frame payload. VFD3 can be placed between the Frame Control byte and the last byte of the frame payload.

The fill pattern does not start at the first byte of the frame. The first byte, the *Frame Control*, is set from the Token Ring specific dialog box or is overwritten by the first byte of a VFD3 pattern overlaid at byte offset 1. The fill pattern will start after this byte if preset headers (see below) are disabled or at the first byte following the header if these are enabled.

VFDs are reset to their initial values on every *start* command or on a *step* command that follows a parameter change without an intervening *start* command.

Random Length Frames, Random Gaps and Random Data

The user can specify whether the frames are to be random length, to have random gaps between them and whether they have random data in them. VFDs 1 & 2 can also be specified as random.

Random frame lengths, frame gaps and frame data is not truly random because frames are precalculated before the card is started and then reused while the card is transmitting. The frame lengths and gaps will repeat every few hundred frames or so as the basic frame structures cycle. VFD random patterns are also cyclical but because these are calculated for each frame from a 32 bit feedback shift register their cycle time is quite long.

Editable Token Ring Headers

Networks users have to be careful about what data is placed in the Token Ring specific parts of generated frames. Incorrect data can cause other stations to malfunction or ring faults. Users can avoid these problems by using an optional pre-formed frame header that acts like a set of Token Ring specific templates. The header comes in five parts:

- **Access Control (AC) byte**. The Access Control byte is the first byte following the Start Delimiter. All offsets in the Token Ring Smartcard are referenced from this byte. This byte can be altered by a user command, changing all fields except the *token* marker. (This byte cannot be changed.)
- **Frame Control (FC) byte**. The Frame Control byte is set from either an applications control or by overwriting it with the first byte of a VFD3 pattern. This byte is preset to 0x40 when the optional LLC field is enabled.

Note: Neither the AC nor the FC byte can be switched off. Be careful when changing the AC and FC bytes from their default values of 0x00 and 0x40 respectively.

- **MAC addresses**. The MAC address fields are set from applications controls. These fields can be overwritten by any VFD pattern. Users should exercise care doing this because the *Routing Information Present* marker (bit 7 of the first byte of the Source Address) is only set automatically for the base header pattern; users have to ensure that they do not set this incorrectly when overlaying the source address with a VFD.

  If the MAC addresses are disabled, then both the Routing Information and the LLC fields are also disabled.

- **Source Routing field**. The Source Routing *RIF (Routing Information)* and *LLC* fields are optional. If the entire header is enabled, then the frames produced will be LLC *TEST* or Ethernet *SNAP* frames:
  - If *TEST* frames are selected, then the user can control the Source and Destination SAPs.
  - If Ethernet *SNAP* frames are enabled, then the user should set the fill pattern up so that the custom background generates believable Ethernet frames.

- **LLC field**. The RIF field controls the marker in the Source MAC Address and is decoded to the extent that the length is taken from the encoded value in the first two bytes and the maximum frame size is truncated to that in the RIF field. (An error in the RIF specification will cause the Source Routing part of the header to be turned off.)

  If the frame length is too small to accommodate the header then the entire header – except for the AC & FC bytes – will be switched off.

Background Fill Pattern

The background fill pattern behaves the same as all other SmartCards except that the fill pattern will start immediately after the automatic headers. For example, if an Ethernet *SNAP* header is enabled then the first two bytes of the fill pattern will be Ethernet frame's "type" field.

Interframe Gap and Ring Data Rates

Frames are specified in terms of a length - that exclude the CRC, FS and delimiters – and an interframe *gap*. This *gap* figure represents a countdown that will be the minimum time the card will wait before reaquiring the token and transmitting another frame.

Gap figures are expressed internally in bit clock time and are computed from the supplied value in nanoseconds by the card firmware. The interframe gap has a minimum value of one bit clock time.

Transmitting More Than One Frame per Token

Users are able to specify the *Number of Frames per Token*. The inter-frame gap figure used when the token is held is not the normal interframe gap but a *non token throw* gap figure. This defaults to 16. The user has the option of specifying whether to set the *Intermediate EDEL* bit on frames that hold the token. This gap can be varied to the same extent as the normal gap (up to about a second on a 16MBits/sec ring).

The TR Smartcard will hold a token when instructed without regard for reserved token priority on circulating frames. This facility is expected to be used in one of two ways:

- The user will send more than one frame per token with minimal gap between the frames (and the *Intermediate* bit set as appropriate on the frames) to increase the traffic density on the ring.
- The user will send more than one frame per token with a large gap between the frames (and the *Intermediate* bit unset) to lock out a port being tested from the ring.

When the gap is small the card firmware will limit the number of frames transmitted per token to keep the total Token Holding Time to below 10m/Sec.

Introducing Errors into Frames

The TR Smartcard can put one of five hardware errors into frames:

- FCS errors.
- Burst5 errors.
- Setting the *Frame Copied* bit in FS.
- Setting the *Error* bit in EDEL.
- Setting the *FS* byte so its meaningless.

Errors are currently specified by *type* and *percentage*. *Type* determines which one of the five errors will be introduced and *percentage* determines how often a bad frame will be placed in the data stream. The current firmware introduces bad frames on a countdown so the error placement is really one bad frame in *n* good ones rather than the smooth percentage implied by the Smartwindows application. Thus users can specify 100% (one bad, no good), 50% (one bad, one good), 33% (one bad, two good) and so on. The accuracy of error placement is determined by the size of frames; for 60-byte frames the accuracy level is one bad frame in a group of about 300.

The *Single Step* frame always has the specified error in it. It will even have the error when the Percentage figure is zero.

Burst Modes

The TR Smartcard supports the Burst and Multiburst modes found on other cards. Users can specify *Burst Count*, *Interburst Gap* and *Number of Frames per Burst* parameters. This translates to four modes of operation:

- Continuous.
- A Single Burst of frames.
- Continuous Bursts of frames with each burst separated by an *interburst gap.*
- A fixed number of Bursts of frames with each burst separated by an *interburst gap*.

The interburst gap can be smaller or larger than the interframe gap.

Users should bear in mind the following:

- The *Frames per Token* value with its associated inter-frame gap overrides the standard interframe gap but not the interburst gap.
- The minimum gap time for multiburst modes where the burst count is long (typically greater than 500 frames) will be restricted to 16 bit clocks, that is 2µSec on a 16MBits/sec ring.

Ring Statistics

The TR Smartcard collects all counts and computes all rate statistics itself, using the controller merely as a conduit to get the data back to the user.

There are two sources of counts on the TR Smartcard - information derived from the descriptors and information derived from MAC REM frames received from other stations on the ring.

All counts are automatically computed as a rate because counts are accumulated on a second by second basis before being added to the count totals. Not all of these rate counts are meaningful to the user so only a subset of the rates are displayed.

Counters held on the TR Smartcard that originate from internal counts, ring events or directly decoded MAC frames are tabulated below.

Counter	Size	Counts
Tx Frames	32	Number of frames transmitted.
Tx Bytes	32	Number of bytes transmitted.
Rx Frames	32	Number of frames on the ring.
Rx Bytes	32	Number of bytes on the ring.
Rx MAC	32	Number of MAC frames on the ring.
Trigger Counter	32	Trigger count.
Token Errors	32	Number of corrupted tokens.
FCS Errors	32	Frames that have FCS (CRC) errors.
Oversized	32	Frames that exceed the maximum size for the ring speed.
Aborted Frames	32	Frames that ended with an *Abort Delimiter.*
Line Errors	32	Line Error Events.
Burst Errors	32	Burst Error Events.
TRT	16	Token Rotation Time (the raw count is *Tokens per Millisecond*).
Latency Count	32	Latency counter (i.e. time count from board start, stopped by a trigger event).
Purge Events	16	Number of times Ring Purge MAC frames detected.
Claim Events	16	Number of times Claim MAC frames detected.
Beacon Events	16	Number of times Beacon MAC frames detected.
Insertions	16	Number of *Request Initialization* MAC frames.

Counters that originate from MAC reports to LAN Manager Server Functional addresses (usually REM frames) are listed below. We should expect to receive multiple error counts for *non-isolating* errors when there is more than one other station on the ring.

Counter	Size	Counts
Line Errors	16	Line Errors detected by other units (isolating).
Internal Errors	16	Recoverable internal errors on other units.
Burst Error	16	Burst Errors detected by other units (isolating).
A/C Error	16	Monitor violation detected by AMP (isolating).
Abort Delimiter	16	Abort Delimiter transmitted.
Lost Frame	16	Incompletely stripped frame (non-isolating).
Receiver Congestion	16	Unit overloaded (non-isolating).
Frame Copied	16	Possible duplicate MAC address (non-isolating).
Frequency Error	16	Excessive jitter detected by Active Monitor (non-isolating).
Token Error	16	Circulating frame or reserved token (non-isolating).

Card Triggers

The TR Smartcard has two trigger comparators that can be specified to match patterns of 1 to 6 bytes in length anywhere in a frame. The trigger offset is specified from the Access Control byte.

The trigger comparator is normally used on the ring (receive) data but it can be switched to trip on the transmitted data. This facility is only used by the latency measuring part of the Smartwindows application.

The receive trigger comparators can be set to trigger on AC byte patterns. The trigger counter will only increment when the trigger is associated with a frame so although the trigger will trip with a token pattern (that is, the Trigger indicator LED will flash) its counter will only increment if the trigger pattern specifies a frame.

Controlling Connections to the Ring

The default operation of this card is to silently connect to the ring on startup. The card is not programmed to perform the lobe tests, duplicate address tests and other MAC exchanges on startup as it is not intended to act as a ring station.

Although this process is sufficient for most applications envisaged for the card, users may need finer control for their tests. The TR card has provision to control the operation of the card through the *TRA* serial command and its corresponding *TRAdvancedControl* function in the programming library.

The *TRA* command has four parameters. The first two control alter the *AC* byte on outgoing frames. The second two control the connection actions.

The first parameter has four bit fields.

Note: Bits 2 and 3 control loopback. This parameter is *remembered* on startup and controls the default state of the card on startup.

- 0 - has no effect.
- 1 - connects the card to the ring.
- 2 - keeps the card off the ring.
- 3 - keeps the card off the ring and places it under the control of bit 1.

Bit 1 controls the connection - if zero (default) the card is off the ring, if 1 the card is placed on the ring.

Bit 0 controls the operation of the card when transmitting. If it is set then the card will halt its transmitting machine when the card receives a Beacon, Claim or Ring Purge frame.

The second parameter has four bit fields.

Note: Bit 4 is used to switch card loopback between the ring interface unit and the external cable. If it is unset - the default - then card loopback when the card is set as a station will go through the external cable (i.e. loopback will just switch off the phantom drive).

If a user wants to perform a formal connect sequence from an application then they can program the application to do the following:

- The loopback control is set to bring the card up under the control of the connection bit.
- The card is set up to send a single burst of 1500 frames using some suitable frame pattern such as the media test MAC frame. The card should receive these frames without error.
- The card can then be connected to the ring with the connection control bit.
- The card can then be instructed to complete the connection sequence as needed.

Bit 3 is used to switch the card into *Test Mode*. This mode of operation is designed to test passive equipment by allowing the card to source tokens on a ring without there being an active monitor. This sourcing mechanism bypasses regular TR connection protocols by using the token counter to detect ring activity so it can be connected to a passive piece of equipment and set sourcing frames with minimal delay. This mode should not be used on a *live* ring!

Bits 2 and 1 control *Fiber Key* generation (see section below for a description of this facility). When set to 0 - default - the key is generated as needed, when set to 1 the key is not generated, when set to 2 the key is generated only once.

Bit 0 when set will enable the generation of Standby Monitor Polls in TKP mode. The card has to have an established BIA *("Burnt In Address"* - that is card MAC address) for this mode to function.

Generating a Fiber Key

The 802.5j Fiber Connection specification describes a *key* that is intended to be used to trigger the generation of a phantom current over a fiber link.

This key consists of two short interruptions of the idle pattern. The pattern is switched off for about 800µSec, on for about 1.6mSec, off again for about 800µSec and on again for at least 1.6mSec. The key is returned by the port end of the link once recognized.

The fiber key is normally enabled and will be transmitted approximately once per second from a station when the ring or DTR link is inactive.

The fiber key should not cause a problem to most Token Ring equipment. If that equipment does have a problem - for example, it's a fiber interconnect system that generates its own key sequences so can't tolerate externally generated sequences - then the user can inhibit this facility using the *TRA* command. (See the previous topic *Controlling Connections to the Ring* regarding this command for details.)

Dedicated Token Ring (Full Duplex) Operation

Dedicated Token Ring protocols are designed to be used on a point to point link between a single station and a concentrator (or a switch acting as a concentrator). This link can operate in one of two modes:

- *Token Passing ("TKP")* - essentially the same as the normal Token Ring operation
- *Transmit Immediate ("TXI")* - a new mode that does not use token access protocols

We use the notion *Full Duplex* to indicate TXI operation.

This version of the code allows the TR-8405 to operate as an adapter in TXI mode. Since connecting to a concentrator requires an exchange of MAC frames and will include a Duplicate Address Test the TR-8405 will require a unique *BIA* ("Burnt In Address").

When the card is set to *full duplex* it will try to connect to a concentrator by issuing *Join Request* MAC frames at one second intervals. Once the request is acknowledged it will perform a lobe test, raise the phantom and issue an *insert reques*t. This process is very fast - it takes a fraction of a second - and will time out if the concentrator fails to respond promptly. Once the connection is established it is maintained using a *heartbeat* frame exchange where the TR-8405 replies to frames sourced by the concentrator.

If the heartbeat fails, then the TR-8405 will time out the connection and restart the join process.

The concentrator can force the TR-8405 back to normal Token Ring operation at any time by issuing a *Claim* MAC frame.

TR-8405 operation in TXI mode is identical to that in normal Token Passing modes. The statistics will reflect the disconnection between the transmitter and the receiver since the receiver will no longer see transmitted frames.

Ring Protocols Used by the TR-8405

This section describes the parts of the Token Ring protocols implemented by the TR-8405.

Normal (Token Passing) Operation

The TR-8405 will generate these MAC frames (assuming a BIA is set):

- Standby Monitor.
- Report SUA Change.
- Initialize Ring Station.

This is the minimum set to allow this unit to coexist with other stations on a ring. The card will not participate in claim sequences.

The Initialize Ring Station frame has no subvectors (they are all listed as *optional*). The card responds to some initialization requests to prevent adapters from failing to open due to an initialization error - it will respond if no other card does.

DTR (TXI) Operation

The TR-8405 will participate in a connection sequence based on the 802.5r draft standard. The unit has to have a BIA set to enable this mode of operation. The card will generate:

- Registration Request (when a station).
- Registration Response (when an adapter).
- Lobe Test (when a station).
- Insertion Request (when a station).
- Insertion Response (when an adapter).
- Station Heartbeat (when a station).
- Port Heartbeat (when an adapter).

The unit is set up to initiate connections when a station. It will output Registration Request frames at one second intervals. (The requests will indicate TXI protocols, Phantom to be raised just before registration and an IAC of zero.) Upon a favorable response the station will output some Lobe Test frames, raise the Phantom and issue an Insertion Request. On Receiving a favorable reply the unit will start transmitting Hearbeat frames at regular intervals.

The TR-8405 only implements a subset of the protocols and FSMs, enough to get and maintain a connection to a typical unit. Errors or denial responses are dealt with by timeouts.

Firmware Updates

This firmware is field-upgradeable by the user. The user has a choice of using the *TRLOAD* utility or doing the upgrade manually using a terminal. The upgrade mechanism works on all cards in a system simultaneously.

The card uses three firmware images, one for the code and one for each of the FPGAs. The majority of updates will only involve the firmware image. The update mechanism is identical for each of the images; the image file has the product number, image type and image version encoded in it so that each card can determine whether an image needs to be loaded and what to do with that image if it is loaded. Each card holds duplicate copies of its images so that if one of the images is corrupted - due to, say, a power glitch - then the card will be able to work from the other. The card will try to make sure that it always has a good pair of images by copying a good image over a bad one on startup.

The three image files are:

- *TR_LOAD.HEX* - The firmware image.
- *TR_RC.HEX* - The *Receive* FPGA image.
- *TR_TX.HEX* - The *Transmi*t FPGA image.

The files are in Motorola *SRecord* format and so can be handled like any other text file.

The update process using the *TRLOAD* utility is run from the MS-DOS command line. The command syntax is:

```
TRLOAD <Filename> [Port]
```

The filename is required and will be the file to upgrade. The Port is optional and is only needed if the computer is not using the default COM2 port to communicate with the SmartBits chassis. The update process continues as follows:

- This utility first opens the file and checks the image header in it to see what kind of image it is and what version it is.
- It then opens communication with the ET1000/SMB1000 and checks for Token Ring cards.
- If it does not find any of these it tells the user and exits.
- If it does find them, it checks the version number of the image on the card against that in the file. If all of the cards have the same version as the image in the file, it tells the user and exits.
- If any have different versions, then it lists them and proceeds to download the image to all of the TR cards.

The program will display the download progress as a percentage of the file transferred. The user can stop the download at any time by issuing a *Control/Break*; however, the Smartbits will probably need to be power cycled to get it communicating to the application or utility.

Once a download is started, each Token Ring card will halt any transmission in process and drop off its ring. Each card receives the file and stores it in RAM memory until the transmission is complete.

The card will then check the image for integrity, store the first copy of the image in Flash, check that image for integrity and then store that image in Flash. This process takes about 20 seconds for the firmware image and about 8 seconds for the FPGA images.

Once the image is stored, the cards will reset the FPGAs (the top LED will show red) and then reset by tripping its internal watchdog. After reset, the cards will boot up in the normal way and reconnect to their rings. In rare cases, the reset may not work and so the user may have to power cycle the hubs to restart that card.

The user can confirm that the image has loaded sucessfully to the cards by restarting the utility since this should tell the user that the images on the cards match the image in the file.

The card parameters are set to a default state after completing a firmware load. This state has the cards set as 16MBits/sec stations, half duplex, connecting to the ring at startup with the operating parameters set to continuous transmit, 64 byte frames, one frame per token with the headers set on.


SPIRENT
Communications

14 Fibre Channel Cards

In this chapter...

Fibre Channel Modules

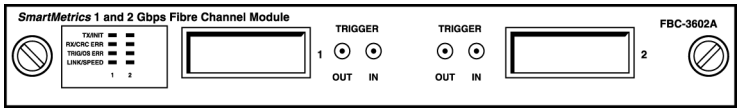
SmartBits FBC-3601A and FBC-3602A SmartMetrics modules allow SAN equipment manufacturers, storage system vendors, Storage Service Providers (SSPs), IT managers, and test labs to categorize the true performance, reliability, and quality of Fibre Channel-based SAN equipment and fabrics. These modules greatly simplify the testing process by emulating hundreds of attached devices such as servers and storage systems, thereby eliminating the need for large, complex test environments.

The wire-rate packet generation and analysis capabilities of the Fibre Channel modules allow stress testing of devices and fabrics to determine if they operate correctly under heavy load. Repeatable and sophisticated traffic generation capabilities provide a high level of testing accuracy and granularity. The modules test devices and networks by generating hundreds of streams of Fibre Channel traffic from many simulated devices. Quality of Service (QoS) metrics are analyzed on streams to determine the actual performance of Fibre Channel switches, hubs, and fabrics.

All test functionality is also available via the SmartLib API, allowing for test case automation using a variety of programming languages, including C, C++, or Tcl.

FBC-3601A, FBC-3602A Modules

- **FBC-3601A SmartMetrics 1 Gbps Fibre Channel module**
- **FBC-3602A SmartMetrics 1 and 2 Gbps Fibre Channel module**



Where Used: SMB-600 or SMB-6000B.

Applications Supported: SmartFabric, SmartWindow, SmartLib, and ScriptCenter.

Devices Tested: Fibre Channel-based SAN switches, routers, hubs, and bridges.

Test Objective:

- Performs throughput, frame loss, stream latency, and sequence tracking tests on systems ranging from a single DUT to a large complex SAN fabric.
- Comparative analysis of SAN products and re-qualify devices after hardware or firmware upgrades.
- Analyze performance under many traffic conditions.

Features:

- Generates up to 512 independent data streams and analyzes up to 64K streams at any given time.
- Supports Point-to-Point and Loop (public and private) modes.
- Performs loop initialization, fabric login, and name server registration for one or many devices.
- Emulates up to 126 source devices on a loop.
- Per-stream payload and frame size (4 to 16KB) settings and per-port transmission mode control settings (continuous, single-burst, multi-burst, continuous multi-burst, and echo).
- Real-life traffic shaping through random frame length, inter-frame gap, and frame content settings.
- Arbitrary stream sequencing enables the mixing of various frame rates.
- Per-port statistics provide counters for transmitted frames, received frames, received bytes, and received CRC errors.
- 16MB capture buffer enables the logging and exporting of filtered events to external protocol analysis equipment.

- Full SmartMetrics testing capabilities include:
  - Sequence Tracking.
  - Latency per Stream.
  - Latency Distribution.
  - Latency Over Time.
  - Raw Tags.
- Verifies payload data integrity.
- Generates impairments including: CRC, undersize, oversize, and link or loop initializations.
- Each FBC-3601A and FBC-3602A module supports two Fibre Channel ports for use in the SmartBits SMB-6000B and SMB-600 chassis. Ports are completely independent in operation. Up to 12 modules may be installed in the SMB-6000B high-density chassis and two modules may be used in the SMB-600 portable chassis.

System Requirements:

- One open slot in an SMB-6000B or SMB-600.
- An IBM or compatible Pentium PC computer running Windows 98 or NT.

Specifications:

- Two independent ports per card.
- Full line-rate traffic generation and analysis at 1 Gbps (FBC-3601A) and 1 and 2 Gbps (FBC-3602A).
- Industry standard GBIC interface allows users to change the physical interface connection.

Fibre Channel LEDs

Table 14-1 describes the LED functions and descriptions for all the Fibre Channel modules.

Table 14-1. LED Functions for Fibre Channel Modules

LED	Color/Status	Description
TX/INIT	Green	Transmitting frame.
	Red	Card not initialized.
	Off	Ready.
RX CRCERR	Green	Receiving frame.
	Red	Receiving CRC errors.
	Off	Not receiving.
TRIG/OSERR	Green	Receiving trigger.
	Red	Receiving encoding errors.
	Yellow	No OS error or trigger.
LINK/Speed	Green	Link up @ 2 Gbps.
	Red	No GBIC link – loss of signal.
	Off	Link up @ 1 Gbps.


SPIRENT
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A RFCs and Standards Supported

This appendix summarizes the RFCs and industry standards supported by SmartBits applications.

Table A-1. RFCs and Standards Supported by SmartBits Applications

Applications	RFCs/Standards Supported
AST II	RFC 2285, Benchmarking Terminology for LAN Switching Devices IETF Switch Methodology Draft
SmartApplications SmartLib SmartWindow	• RFC 1242, Benchmarking Terminology for Network Interconnection Devices • RFC 1483, Multiprotocol Encapsulation over ATM Adaptation Layer 5 • RFC 1577, Classical IP and ARP over ATM • RFC 2544, Benchmarking Methodology for Network Interconnect Devices
SmartFlow	• RFC 1242, Benchmarking Terminology for Network Interconnection Devices • RFC 2544, Benchmarking Terminology for Network Interconnect Devices • RFC 1112, Host Extensions for IP Multicasting • RFC 2285, Benchmarking Terminology for LAN Switching Devices • RFC 1700, Assigned Numbers (for IP protocol and TCP/UDP port numbers)
SmartMulticastIP	• RFC 2432, Terminology for IP Multicast Benchmarking • RFC 2236, Internet Group Management Protocol, Version 2 • RFC 2113, IP Router Alert Option • RFC 1112, Host Extensions for IP Multicasting

Table A-1. RFCs and Standards Supported by SmartBits Applications

Applications	RFCs/Standards Supported
SmartSignaling	• ATM Forum UNI Specifications 3.0, 3.1 and 4.0 • ITU-T Recommendation Q.2110
SmartxDSL	PPP over ATM support with RFC 2364 PPP over AAL5 RFC 1661 The Point-to-Point Protocol (PPP). Updated by RFC 2153. RFC 1662 PPP in HDLC-like Framing RFC 1332 The PPP Internet Protocol Control Protocol (IPCP)

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B Auto Negotiation

This appendix provides information on auto negotiation as performed by SmartBits systems and SmartCards/modules, and applies to Ethernet devices that use auto negotiation.

Note: This discussion is not applicable to WAN, POS, or ATM that use traffic descriptors and other techniques to adjust the transmission between devices.

In this appendix . . .

The default in all SmartBits applications is **AutoNegotiation Disabled**

Auto negotiation (AN) is an optional standard function defined in the 1998 IEEE 802.3 specification. AN is a process that takes control of the interface media when a connection to another network interface is established. AN detects the operating capabilities of the other interface (known as the Link Partner) and also advertises the capabilities of the local interface. The highest common performance mode is then selected and configured.

There are two auto negotiation methods used with SmartBits Ethernet cards:

- For gigabit fiber media, the PCS sub-layer state machine as defined in the IEEE standard document 802.3z.
- For copper media, the PHY transceivers and MII Registers.

Gigabit Fiber Auto Negotiation

The Gigabit Ethernet auto negotiation process is defined in the PCS sub-layer state machine of the IEEE standard document 802.3z. The **PCS** (**Physical Coding Sublayer**) contains the 8b/10b encoder/decoder, device synchronization process and the auto negotiation process. Spirent Communications has implemented the PCS sub-layer in its FPGA logic, as well as through the on-board microprocessor.

Fiber Gigabit Ethernet, in SmartBits systems, does not use MII registers. Instead, the port sends a configuration register word to the connected interface. The configuration word is composed of information similar to that contained in the MIIs and performs an equivalent function. In addition, for fiber Gigabit Ethernet, the auto negotiation protocol sets other parameters that are unique to fiber Gigabit operation.

The SmartBits port sends a configuration register word to the connected interface. The configuration word is composed of information similar to that contained in the MIIs and performs an equivalent function. In addition, for fiber Gigabit Ethernet, the auto negotiation protocol sets other parameters that are unique to fiber Gigabit operation.

Smartbits detects the following conditions through its firmware/hardware to verify that the auto negotiation process has completed successfully:

- Device synchronization must be achieved.

  —and—

- The DUT completes the auto negotiation process per the PCS state machine.

Device synchronization is achieved by controlled emission of a “comma” pattern. The comma pattern, as defined in the standard document, is **0011111XXXX**, where the leading zero corresponds to the first bit received. The comma pattern is not contained in any normal 8b/10b encoded data or pair of adjacent characters. It occurs only within special characters known as K28.1, K28.5 and K28.7. These characters have been defined specifically for synchronization.

The following steps are taken to achieve synchronization that implements the synchronization state diagram in IEEE 802.3z document Figure 36-9; after synchronization occurs, the auto negotiation process is initiated.

Loss of fiber

1 Acquire fiber detect, by using a signal from the transceiver (OCP) that indicates fiber connected.

Loss of sync

2 Send comma pattern continuously with configuration data of all zeroes.

3 Wait for response from the DUT.

4 If no response is received from the DUT, continue the above steps.

5 Once both sides receive comma pattern, then the synchronization state diagram is followed to complete the synchronization process.

6 If any time during the synchronization process an error condition is detected, the entire synchronization process is restarted from Step 1.

7 Declare synchronization acquired if no errors are detected.

Auto negotiation

8 Auto negotiation process can start.

9 Once synchronization has been achieved, the SmartBits firmware/hardware starts monitoring the PCS state transitions, following it through the auto negotiation process.

10/100/1000Mbps Copper Ethernet Auto Negotiation

The capabilities of an interface depend upon the capabilities of the PHY transceiver that is used with the interface. For auto negotiation on 10/100Mbps links, the PHY transceiver uses a set of registers to store information about its capabilities. These registers are called *MII registers*, referring to the 100BASE-T specification of a Media Independent Interface, or MII. There are 32 PHY registers altogether; however, only a few of these are involved in auto negotiation. Each MII register stores a 16-bit value. Individual bit definitions are used to indicate the presence or absence of specific operating capabilities, as well as for control information and status information.

Note: See *"Summary of MII Registers and Bit Definitions" on page 204* for lists of all MII registers, their functions, and bit definitions.

For these Ethernet transmission technologies, the following PHY registers are used.

- **Control Register (Register 0)**. This sets control and management functions—for example, to enable or disable the auto negotiation protocol, to restart the protocol (normally performed when the link initializes), or to force speed and duplex settings to desired values for the interface.
- **Status Register (Register 1)**. This read-only register defines the capabilities of the PHY as currently set, as well as some latched conditions.

- **Advertisement Register (Register 4)**. This read/write register defines the capabilities of the local interface for advertisement to the remote interface (also known as the Link Partner; see below).
- **Link Partner Register (Register 5)**. This read-only register stores information on the capabilities of the communicating interface, as detected through the auto negotiation protocol.
- **1000BASE-T2 Control Register (Register 9) (Copper Gigabit Only)**. This register sets control and management functions, such as the master/slave relationship of the communicating PHYs, for 1000BASE-T2 copper Gigabit Ethernet interfaces.
- **1000BASE-T2 Status Register (Register 10) (Copper Gigabit Only)**. This read-only register stores status information on PHY master/slave configuration, receiver status, and Idle Error count for 1000BASE-T2 copper Gigabit Ethernet interfaces.

The PHY also conducts the auto negotiation protocol that exchanges the capability information between the interfaces. Once both interfaces know each other's capabilities, the protocol selects the highest possible "common" mode of operation. Typically, other program logic for the device or interface then adapts its general operating characteristics to the characteristics selected through the auto negotiation process.

Note: The same MII register (Register 4) that advertises speed and duplex for auto negotiation advertises a port's flow-control capability. Thus, the bit for flow control is set at the same time as the bits for the speed/duplex options.

Auto Negotiation Priorities

When device interfaces have a range of capability levels, the highest performance mode is selected based on the priority table shown in *Table 1*.

For 10/100Mbps Ethernet interfaces, the full-duplex 100Mbps mode of operation has the highest priority of the available modes.

Table C-1. Auto Negotiation Priority Table

Priority Level	Description
A	100Base-T2 Full Duplex
B	100Base-TX Full Duplex
C	100Base-T2
D	100Base-T4 *
E	100Base-TX
F	10Base-T Full Duplex
G	10Base-T

* Not supported by SmartBits cards.

Fast Link Pulse (FLP) Signals

The auto negotiation protocol uses Fast Link Pulse (FLP) signals to exchange interface information. These are a modified version of the Normal Link Pulse (NLP) signals that are defined in the original 10BASE-T specifications and used to verify link integrity.

FLP signals are generated automatically at power-up. They are designed to coexist with NLP signals, to ensure that a 10BASE-T device using NLP signals will continue to detect link integrity even when it is attached to an auto negotiation hub sending FLP signals.

To ensure operation with interfaces that *do not* support Fast Link Pulses or auto negotiation, as well as with older 10BASE-T interfaces that predate auto negotiation, the AN protocol is designed to co-exist with non-AN interfaces. In these cases, the operating mode used is that of the non-AN interface.

The auto negotiation management interface allows you to disable auto negotiation or to manually force the negotiation process to take place. This enables you to select a specific operational mode for a given device.

Auto negotiation is best viewed as one phase of the link initialization and verification process. The following sections focus on the effects of having AN enabled or disabled, as well as on how AN is handled in Spirent Communications applications.

Auto Negotiation Enabled

SmartBits test applications can be run with auto negotiation enabled or disabled.

When auto negotiation is enabled for a port, SmartBits advertises the speed and duplex settings that have been set (either using the GUI interface or through SmartLib commands), using the standard auto negotiation protocol.

Because the test goal is to verify the capabilities of the device under test (DUT), not of SmartBits, the normal test methodology is to let SmartBits advertise speed and duplex options one at a time, then observe the ability of the device under test (DUT) to respond. This is done by setting the MII registers to enable auto negotiation and to advertise a specific speed and duplex capability rather than multiple speed/duplex capabilities.

A test begins with the link initialization and verification steps. It is during this stage that the auto negotiation process occurs (if selected). Then the test runs to completion, using the selected settings. SmartBits will not change a port's configuration during the execution of a test iteration. However, different capabilities can be advertised and negotiated by modifying the MII registers, then restarting the test.

Spirent Communications test applications such as SmartApplications, AST II, SmartFlow, and SmartMulticastIP also offer the following three configuration options for auto negotiation:

- Disable AN (commonly used).
- Force AN (commonly used).
- Registers Untouched (for custom advanced test applications).

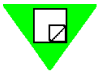
The first two of these (Disable AN and Force AN) are used in most normal test situations. The third (Registers Untouched) is designed to be used only in special test situations. All three options are described in more detail below.

Auto Negotiation Disabled

SmartBits test applications can be run with auto negotiation enabled or disabled.

In applications such as SmartApplications, AST II, SmartFlow, and SmartMulticastIP, the *Disable AN* option sets the appropriate MII registers to the user-selected flow control, speed, and duplex settings. It sets Register 0 to disable auto negotiation on the port. With this option, the SmartBits port *does not* participate in the auto negotiation protocol; however, it does advertise the speed/duplex combination that has been set in the advertisement register.

With this option, it is important to verify that both the SmartBits port and the DUT port are configured to have the same values for flow control, speed, and duplex. Because AN is disabled, a mismatch will not be resolved through the AN negotiation process.



Note: When *Disable AN* or *Registers Untouched* (see below) are selected, the application cannot verify that the duplex settings are correct, because the link verification

process cannot determine the duplex setting at the DUT. Only the *Force AN* option permits this verification to take place.

Force Auto Negotiation Option

In applications such as SmartApplications, AST II, SmartFlow, and SmartMulticastIP, the *Force AN* option sets the appropriate registers to the user-selected flow control, speed, and duplex settings. It sets Register 0 to enable auto negotiation on this port, and it sets the appropriate bit to signal a restart of the auto negotiation process.

Registers Untouched Option

In applications such as SmartApplications, AST II, SmartFlow, and SmartMulticastIP, the *Registers Untouched* auto-negotiation option has been developed for advanced, custom test requirements. With this option, the software writes no values to the MII registers for speed and duplex setting. The user must configure these settings before running the test. (The application also does not alter the flow-control advertisement.)

This option is not recommended for normal test situations and should be used with care. Although the application will make a “best attempt” to ensure that the link is up for both interfaces, it is not possible to verify the link in every case, because there is no adequate MII read-back capability for duplex mode.

Note: Do not select *Registers Untouched* unless you are certain that ports on the DUT are configured correctly and match the values in the SmartCard setup parameters.

Operation After the Auto Negotiation Protocol Completes

After the flow-control, speed, and duplex settings have been set (and/or negotiated), but before the test is started, SmartBits verifies that a communication link has been established. Once this is done, the application begins the selected test.

Summary of MII Registers and Bit Definitions

Table 2 lists all the MII registers and their functions. *Table 3* through *Table 7* provide the bit definitions for registers 0, 1, 4, 5, 9, and 10. Refer to the IEEE 802.3 specification for more detailed information.

Table C-2. MII Registers

Register Address	Register Name
0	Control
1	Status
2, 3	PHY Identifier
4	Auto Negotiation Advertisement
5	Auto Negotiation Link Partner Base Page Ability
6	Auto Negotiation Expansion
7	Auto Negotiation Next Page Transmit
8	Auto Negotiation Link Partner Received Next Page
9	1000BASE-T2 Control Register
10	1000BASE-T2 Status Register
11-14	Reserved
15	Extended Status
16	Vendor Specific
17-31	Reserved

Table C-3. Bit Definitions for MII Register 0 (Control)

Bit	Name	Description
15	PHY Reset	1 = PHY reset 0 = Normal operation
14	Enable Loopback	1 = Enable loopback mode 0 = Disable loopback mode
13	Speed Selection	Bit 6 / Bit 13 / Meaning 1 / 1 / Reserved 1 / 0 / 1000Mbps 0 / 1 / 100Mbps 0 / 0 / 10Mbps
12	Auto Negotiation Enable	1 = Enable AN 0 = Disable AN
11	Power Down	1 = Power down 0 = Normal operation
10	Isolate	1 = Electrically isolate PHY from MII or GMII 0 = Normal operation
9	Restart Auto Negotiation	1 = Restart AN 0 = Normal operation
8	Duplex mode	1 = Full duplex 0 = Half duplex
7	Collision Test	1 = Enable COL signal test 0 = Disable COL signal test
6	Speed selection	Bit 6 / Bit 13 / Meaning 1 / 1 / Reserved 1 / 0 / 1000Mbps 0 / 1 / 100Mbps 0 / 0 / 10Mbps
5-0	Reserved	Write as 0, ignore on Read

Table C-4. Bit Definitions for MII Register 1 (Status)

Bit	Name	Description
15	100BASE-T4	1 = PHY able to perform 100BASE-T4 0 = PHY not able to perform 100BASE-T4
14	100BASE-X Full Duplex	1 = PHY able to perform full duplex 100BASE-X 0 = PHY not able to perform full duplex 100BASE-X
13	100BASE-X Half Duplex	1 = PHY able to perform half duplex 100BASE-X 0 = PHY not able to perform half duplex 100BASE-X
12	10Mbps Full Duplex	1 = PHY able to perform full duplex 10 Mbps 0 = PHY not able to perform full duplex 10 Mbps
11	10Mbps Half Duplex	1 = PHY able to perform half duplex 10 Mbps 0 = PHY not able to perform half duplex 10 Mbps
10	100BASE-T2 Full Duplex	1 = PHY able to perform full duplex 100BASE-T2 0 = PHY not able to perform full duplex 100BASE-T2
9	100BASE-T2 Half Duplex	1 = PHY able to perform half duplex 100BASE-T2 0 = PHY not able to perform half duplex 100BASE-T2
8	Extended Status	1 = Extended status information in Register 15 0 = No extended status information in Register 15
7	Reserved	Ignored when read.
6	MF Preamble Suppression	1 = PHY will accept management frames with preamble suppressed 0 = PHY will not accept management frames with preamble suppressed
5	Auto Negotiation Complete	1 = AN process completed 0 = AN process not completed
4	Remote Fault	1 = Remote fault condition detected 0 = No remote fault condition detected
3	Auto Negotiation Ability	1 = PHY is able to perform AN 0 = PHY is not able to perform AN
2	Link Status	2 = Will latch until register is read; records down condition even if link comes back up until read. 1 = Link is up 0 = Link is down

Table C-4. Bit Definitions for MII Register 1 (Status)

Bit	Name	Description
1	Jabber Detect	1 = Jabber condition detected 0 = No jabber condition detected
0	Extended Capability	1 = Extended register capabilities 0 = Extended register set capabilities only

Table C-5. Bit Definitions for MII Register 4 (AN Advertisement) and Register 5 (AN Link Partner)

Bit	Name	Description
15	Next Page	1 = Next Page ability supported 0 = Next Page ability not supported
14	Acknowledge	Used by AN to indicate that the device has received its Link Partner's Link Code Word.
13	Remote Fault	Remote fault information.
12	Technology Ability	Reserved
11		Reserved
10		1 = Flow control bit supported 0 = Not supported
9		100BASE-T4
8		100BASE-TX Full Duplex
7		100BASE-TX
6		10BASE-T Full Duplex
5		10BASE-T Half Duplex

Table C-5. Bit Definitions for MII Register 4 (AN Advertisement) and Register 5 (AN Link Partner)

Bit	Name	Description
4	Selector Field	Reserved
3		
2		
1		
0		

Table C-6. Bit Definitions for MII Register 9 (1000BASE-T Control Register)

Bit	Name	Description
15	Transmitter Test Mode	Default bit values are **00**
14		
13	Receiver Test Mode	Default bit value is **0**
12	Master/Slave Manual Configuration Enable	1 = Enable Master/Slave Manual Configuration value 0 = Disable Master/Slave Manual Configuration value
11	Master/Slave Manual Configuration Value	1 = Configure PHY as Master during AN (only when Bit 12 = 1) 0 = Configure PHY as Slave during AN (only when Bit 12 = 1)
10	T2_Repeater/DTE Bit	1 = Repeater device port 0 = DTE device
9-0	Reserved	Ignored when read.

Table C-7. Bit Definitions for MII Register 10 (1000BASE-T Status Register)

Bit	Name	Description
15	Master/Slave Manual Configuration Fault	1 = Master/Slave manual configuration fault detected 0 = Master/Slave manual configuration fault not detected
14	Master/Slave Configuration Resolution Complete	1 = Master/Slave configuration resolution has completed 0 = Master/Slave configuration resolution has not completed
13	Local Receiver Status	1 = Local receiver OK 0 = Local receiver not OK
12	Remote Receiver Status	1 = Remote receiver OK 0 = Remote receiver not OK
11-8	Reserved	Ignored when read.
7-0	Idle Error Count	Idle Error Count


SPIRENT
Communications

C Certifications and EMI Compliance

In this appendix...

This appendix contains the following topics:

This appendix list SmartBits certifications and provides technical information on SmartBits systems with respect to Electro-Magnetic Interference (EMI).

Certifications

Emissions

FCC Part 15 Compliant
EMI Class A Standard

Safety

CSA Listed (CSA 22.2 No. 22)
TUV (IEC 950) approved

These chassis are marked in conformity with the following European Commission Directives:

- The Low Voltage Directive (72/23/EEC)
- The Electromagnetic Compatibility Directive (89/336/EEC)
- The CE Marking Directive (93/68/EEC)

FCC PART 15 Statement

This equipment has been tested and found to comply with the limits for a CE Mark class A digital devices, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or re-locate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a different circuit that the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

SmartBits Compliance with CE Requirements

All Spirent Communications products, including SmartBits systems and SmartCard/modules, are designed and manufactured in compliance with CE directives on EMI and EMC Class A standards, as indicated by the CE Mark on our products. The CE Mark and declaration of conformity is made by submitting our product to an independent, EU-certified test lab. In this lab, each SmartCard/module is tested individually while installed in the chassis that supports it. All certifications (including details of test configuration with photographs) are available to any customer who requires a copy.

The CE mark establishes a generic compatibility among different equipment in terms of EMI emissions. The CE directive (as with the equivalent FCC Part 15 directives) is an established standard in terms of laboratory support, available tools, and resources. It is currently the most commonly recognized and accepted engineering practice in designing electronic equipment. Spirent Communications designs and produces its products in conformance with CE directives in order to quantify performance measurements, with the ultimate goal of designing the best possible products in every respect.

To obtain the CE Mark declaration of conformity, each Spirent Communications product must pass the following standard tests:

- EN 50081-1 Electro-Magnetic Emission Standard
- EN 50082-1 Electro-Magnetic Immunity Standard
- EN-55022 Radiated and Conducted Emissions Standard
- IEC 801-2 Electro-Static Discharge Standard
- IEC 801-3 Radiated Immunity Standard
- IEC 801-4 Electrical Fast Transients/Burst Standard
- EN 61000 Power Analysis Harmonics and Flicker Standard

Guidelines on Equipment Use

In general, any equipment that is in compliance with the tests listed above will work well in a standard industrial environment. It will present minimum interference and similarly will experience minimum interference from other nearby equipment. Having passed the above tests, however, does not guarantee that an equipment will work in a “strong” EMI environment. Furthermore, it is difficult to specify what constitutes a “strong” EMI environment in the absence of any measurement standard.

With respect to SmartBits systems and cards, a typically equipped operating lab should cause no interference *provided that* all other equipment is in minimum compliance with CE Mark requirements.

To ensure that SmartBits systems perform well in your environment, observe the following guidelines when installing and using SmartBits in your lab:

1. All cables must be terminated, both at the SmartBits and at the DUT. Do not leave an unused port with a cable plugged in and dangling.
2. Use only certified cable in any SmartBits Ethernet port (both control port and test ports).
3. Use only yellow optical cable with SmartBits ports that support single-mode optics.
4. Use only orange or gray optical cable with SmartBits ports that support multi-mode optics.
5. All SmartCards/modules should be fully inserted into the chassis, and all thumb screws should be tightened.
6. In a crowded engineering prototype lab, be careful of the layout of test cables used to connect the SmartBits and devices under test. Avoid passing test cables over or under other DUT or live equipment. If test cables are very long, avoid looping cables around live equipment.
7. Use the ferrite clamp supplied with each SmartBits chassis on one end of the Ethernet cable connecting the SmartBits to the LAN or to the PC.
8. Use common sense. For example, a test or control cable laid over the AC power supply of an open DUT will most likely produce faulty measurement results.

D ToS Parameters

The following table provides common Type of Service values for reference only. For detailed information refer to RFC 1700 for assigned numbers, and to RFCs 791 and 1349 for ToS and standard IP definition.

Table D-1.Type of Service Values

Precedence Value	Bit 0-2 Precedence	Bit 3 Delay	Bit 4 Throughput	Bit 5 Reliability	Hex	Dec
0	Routine	Normal Delay	Normal Throughput	Normal Reliability	0	0
1	Priority	Normal Delay	Normal Throughput	Normal Reliability	20	32
2	Immediate	Normal Delay	Normal Throughput	Normal Reliability	40	64
3	Flash	Normal Delay	Normal Throughput	Normal Reliability	60	96
4	Flash Override	Normal Delay	Normal Throughput	Normal Reliability	80	128
5	CRITIC/ECP	Normal Delay	Normal Throughput	Normal Reliability	A0	160
6	Internetwork Control	Normal Delay	Normal Throughput	Normal Reliability	C0	192
7	Network Control	Normal Delay	Normal Throughput	Normal Reliability	E0	224
0	Routine	Low Delay	Normal Throughput	Normal Reliability	10	16
1	Priority	Low Delay	Normal Throughput	Normal Reliability	30	48
2	Immediate	Low Delay	Normal Throughput	Normal Reliability	50	80
3	Flash	Low Delay	Normal Throughput	Normal Reliability	70	112
4	Flash Override	Low Delay	Normal Throughput	Normal Reliability	90	144
5	CRITIC/ECP	Low Delay	Normal Throughput	Normal Reliability	B0	176
6	Internetwork Control	Low Delay	Normal Throughput	Normal Reliability	D0	208

Table D-1.Type of Service Values

Precedence Value	Bit 0-2 Precedence	Bit 3 Delay	Bit 4 Throughput	Bit 5 Reliability	Hex	Dec
7	Network Control	Low Delay	Normal Throughput	Normal Reliability	F0	240
0	Routine	Normal Delay	High Throughput	Normal Reliability	8	8
1	Priority	Normal Delay	High Throughput	Normal Reliability	28	40
2	Immediate	Normal Delay	High Throughput	Normal Reliability	48	72
3	Flash	Normal Delay	High Throughput	Normal Reliability	68	104
4	Flash Override	Normal Delay	High Throughput	Normal Reliability	88	136
5	CRITIC/ECP	Normal Delay	High Throughput	Normal Reliability	A8	168
6	Internetwork Control	Normal Delay	High Throughput	Normal Reliability	C8	200
7	Network Control	Normal Delay	High Throughput	Normal Reliability	E8	232
0	Routine	Low Delay	High Throughput	Normal Reliability	18	24
1	Priority	Low Delay	High Throughput	Normal Reliability	38	56
2	Immediate	Low Delay	High Throughput	Normal Reliability	58	88
3	Flash	Low Delay	High Throughput	Normal Reliability	78	120
4	Flash Override	Low Delay	High Throughput	Normal Reliability	98	152
5	CRITIC/ECP	Low Delay	High Throughput	Normal Reliability	B8	184

Table D-1.Type of Service Values

Precedence Value	Bit 0-2 Precedence	Bit 3 Delay	Bit 4 Throughput	Bit 5 Reliability	Hex	Dec
6	Internetwork Control	Low Delay	High Throughput	Normal Reliability	D8	216
7	Network Control	Low Delay	High Throughput	Normal Reliability	F8	248
0	Routine	Normal Delay	Normal Throughput	High Reliability	4	4
1	Priority	Normal Delay	Normal Throughput	High Reliability	24	36
2	Immediate	Normal Delay	Normal Throughput	High Reliability	44	68
3	Flash	Normal Delay	Normal Throughput	High Reliability	64	100
4	Flash Override	Normal Delay	Normal Throughput	High Reliability	84	132
5	CRITIC/ECP	Normal Delay	Normal Throughput	High Reliability	A4	164
6	Internetwork Control	Normal Delay	Normal Throughput	High Reliability	C4	196
7	Network Control	Normal Delay	Normal Throughput	High Reliability	E4	228
0	Routine	Low Delay	Normal Throughput	High Reliability	14	20
1	Priority	Low Delay	Normal Throughput	High Reliability	34	52
2	Immediate	Low Delay	Normal Throughput	High Reliability	54	84
3	Flash	Low Delay	Normal Throughput	High Reliability	74	116
4	Flash Override	Low Delay	Normal Throughput	High Reliability	94	148

Table D-1.Type of Service Values

Precedence Value	Bit 0-2 Precedence	Bit 3 Delay	Bit 4 Throughput	Bit 5 Reliability	Hex	Dec
5	CRITIC/ECP	Low Delay	Normal Throughput	High Reliability	B4	180
6	Internetwork Control	Low Delay	Normal Throughput	High Reliability	D4	212
7	Network Control	Low Delay	Normal Throughput	High Reliability	F4	244
0	Routine	Normal Delay	High Throughput	High Reliability	C	12
1	Priority	Normal Delay	High Throughput	High Reliability	2C	44
2	Immediate	Normal Delay	High Throughput	High Reliability	4C	76
3	Flash	Normal Delay	High Throughput	High Reliability	6C	108
4	Flash Override	Normal Delay	High Throughput	High Reliability	8C	140
5	CRITIC/ECP	Normal Delay	High Throughput	High Reliability	AC	172
6	Internetwork Control	Normal Delay	High Throughput	High Reliability	CC	204
7	Network Control	Normal Delay	High Throughput	High Reliability	EC	236
0	Routine	Low Delay	High Throughput	High Reliability	1C	28
1	Priority	Low Delay	High Throughput	High Reliability	3C	60
2	Immediate	Low Delay	High Throughput	High Reliability	5C	92
3	Flash	Low Delay	High Throughput	High Reliability	7C	124

Table D-1.Type of Service Values

Precedence Value	Bit 0-2 Precedence	Bit 3 Delay	Bit 4 Throughput	Bit 5 Reliability	Hex	Dec
4	Flash Override	Low Delay	High Throughput	High Reliability	9C	156
5	CRITIC/ECP	Low Delay	High Throughput	High Reliability	BC	188
6	Internetwork Control	Low Delay	High Throughput	High Reliability	DC	220
7	Network Control	Low Delay	High Throughput	High Reliability	FC	252

E SMB-600/6000B Cables and Connectors

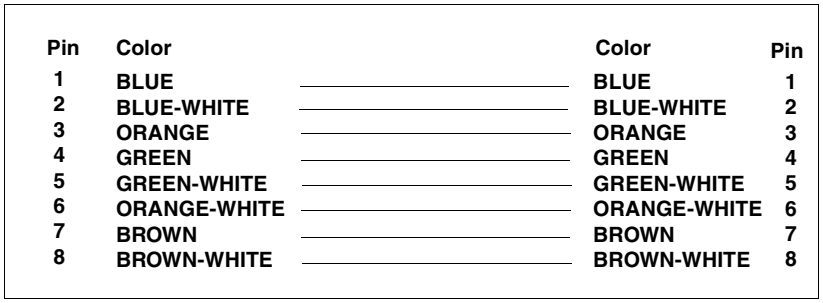
In this appendix . . .

Ethernet Cables

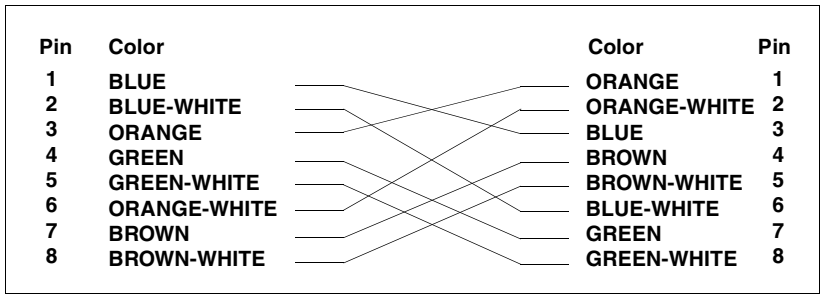
Each interface requires a different pin out depending on the type of interface and if the connection is a DCE-to-DTE or DCE-to-DCE.

Unless otherwise specified, the Ethernet cables specified below use 4 pair category 5 unshielded twisted pair (UTP) cables with a patch length of one meter used between the RJ-45 connectors.

Straight-through Cable for 10/100/1000 Base



Crossover Cable for 10/100/1000 Base



Ethernet Connectors

LAN-3150A Connectors

The LAN-3150A has two female 80-pin connectors, J1 and J2. The J1 connector is for the first four ports. The J2 connector is for the second four ports.

The DUT should have the corresponding 80-pin female connector, and can be connected to the LAN-3150A by using the two 12-inch cables that are supplied and recommended by Spirent Communications.

The J1 and J2 connectors both carry one set of MII management signals. These signals can be configured independently for each four-port DUT. However, for a single eight-port DUT, the MII management signal from the J2 connector should be used and the corresponding signal at the J1 connector should be ignored.

Table 1 shows the LAN-3150A connector pin assignment for SMII and RMII. *Input* and *output* are identified in the left column as **I** and **O** respectively.

The J1 and J2 pin structures are exactly the same except for the port numbers (0, 1, 2, 3 for J1; and 4, 5, 6, 7 for J2).

Table B-1. LAN-3150A 80-Pin Connector Assignments

I/O	Pin	Signal Name		Pin	Signal Name	
		RMII	SMII		RMII	SMII
O	1	3VCC	3VCC	41	3VCC	3VCC
O	2	5VCC	5VCC	42	5VCC	5VCC
O	3	REF_CLK+	REF_CLK+	43	REF_CLK–	REF_CLK–
O	4	GND	GND	44	GND	GND
O	5	DNC (Note 5)	SYNC+	45	DNC (Note 5)	SYNC–
O	6	/SMII (Note 1)	/SMII (Note 1)	46	/BRDCON (Note 2)	/BRDCON (Note 2)
O	7	TXD1_0+	TXD1+	47	TXD1_0–	TXD1–
O	8	TXD1_1+	DNC (Note 5)	48	TXD1_1–	DNC (Note 5)
O	9	TXEN1+	DNC (Note 5)	49	TXEN1–	DNC (Note 5)
I	10	RXD1_0+	RXD1+	50	RXD1_0–	RXD1–
I	11	RXD1_1+	DNC (Note 5)	51	RXD1_1–	DNC (Note 5)
I	12	CRS_DV1+	DNC (Note 5)	52	CRS_DV1–	DNC (Note 5)
I	13	R_CLK+ (Note 3)	R_CLK+ (Note 3)	53	R_CLK– (Note 3)	R_CLK– (Note 3)
O	14	GND	GND	54	GND	GND
O	15	TXD2_0+	TXD2+	55	TXD2_0–	TXD2–
O	16	TXD2_1+	DNC (Note 5)	56	TXD2_1–	DNC (Note 5)
O	17	TXEN2+	DNC (Note 5)	57	TXEN2–	DNC (Note 5)
I	18	RXD2_0+	RXD2+	58	RXD2_0–	RXD2–
I	19	RXD2_1+	DNC (Note 5)	59	RXD2_1–	DNC (Note 5)
I	20	CRS_DV2+	DNC (Note 5)	60	CRS_DV2–	DNC (Note 5)
I	21	DNC (Note 5)	R_SYNC+ (Note 3)	61	DNC (Note 5)	R_SYNC– (Note 3)
O	22	GND	GND	62	GND	GND
O	23	TXD3_0+	TXD3+	63	TXD3_0–	TXD3–
O	24	TXD3_1+	DNC (Note 5)	64	TXD3_1–	DNC (Note 5)
O	25	TXEN3+	DNC (Note 5)	65	TXEN3–	DNC (Note 5)
I	26	RXD3_0+	RXD3+	66	RXD3_0–	RXD3–
I	27	RXD3_1+	DNC (Note 5)	67	RXD3_1–	DNC (Note 5)
I	28	CRS_DV3+	DNC (Note 5)	68	CRS_DV3–	DNC (Note 5)
I	29	/RESET (Note 4)	DNC (Note 5)	69	DNC (Note 5)	DNC (Note 5)
O	30	GND	GND	70	GND	GND
O	31	TXD4_0+	TXD4+	71	TXD4_0–	TXD4–
O	32	TXD4_1+	DNC (Note 5)	72	TXD4_1–	DNC (Note 5)
O	33	TXEN4+	DNC (Note 5)	73	TXEN4–	DNC (Note 5)
I	34	RXD4_0+	RXD4+	74	RXD4_0–	RXD4–
I	35	RXD4_1+	DNC (Note 5)	75	RXD4_1–	DNC (Note 5)
I	36	CRS_DV4+	DNC (Note 5)	76	CRS_DV4–	DNC (Note 5)
N/A	37	DNC (Note 5)	DNC (Note 5)	77	DNC (Note 5)	DNC (Note 5)
O	38	GND	GND	78	GND	GND
Note 6	39	MDIO (Note 6)	MDIO (Note 6)	79	MDC (Note 6)	MDC (Note 6)
O	40	3VCC	3VCC	80	3VCC	3VCC

1 **SMII** Output. Low for SMII, high for RMII. Disregard this signal for single-mode DUTs.
2 **BRDCON** Input. Active low, DUT connected flag. It should be tied to ground at the DUT.
3 **R_CLK+/–** and **R_SYNC+/–.** These two LAN-3150A LVDS input pairs should be the output of 65LVDS31 drivers on the DUT. These signals must be supplied to LAN-3150A via J2.
4 **RESET** This LAN-3150A output, low active, can be used as PHY hardware reset signal.
5 **DNC** Do not connect.
6 **MDIO** This signal is bidirectional.
MDC This is an output signal.
For a single eight-port DUT, the above MII management signals from the J2 connector should be used; the corresponding signal at the J1 connector should be ignored.

LAN-3100A , LAN-3101A Connector

Connector type: RJ-45.

LAN-3200A, LAN-3201A Connector

Connector type: Fiber, SC duplex to SC duplex, multi-mode.

LAN-3200As, LAN-3201As Connector

Connector type: Fiber, SC duplex to SC duplex, single mode.

LAN-3201B, LAN-3310A, LAN-3311A Connector

Connector type: GBIC.

Pin	Function
1	Rx Gnd
2	RD+ (Rx Data Out +)
3	RD- (Rx Data Out -)
4	SD (Rx Signal Detect)
5	V_{cc} Rx
6	V_{cc} Tx
7	TD - (Tx Data In -)
8	TD + (Tx Data In +)
9	Tx Gnd

LAN-3300A, LAN-3301A Connector

Connector type: RJ-45.

Pin	Signal
1	TRD 0+
2	TRD 0 -
3	TRD 1+
4	TRD 2+
5	TRD 2 -
6	TRD 1-
7	TRD 3+
8	TRD 3 -

POS Connectors

POS-3500B, POS-3502A Connector

Connector Type: Fiber, SC duplex to SC duplex, multi mode.

POS-3500Bs, POS-3502As, POS-3504As, POS-3505As Connector

Connector Type: Fiber, SC duplex to SC duplex, single mode.

Fiber Optic Cable Signals

Multi-mode SC Duplex to SC Duplex

<table>
<tr><td>LAN-3200A
LAN-3201A
LAN-3201B</td><td>Multi-Mode fiber cable: 62.5/125, (50/125 + 100/140) microns (um)
(OCP dtr-1250-SM-L2 850nm)
<table><tr><th></th><th>Min.</th><th>Avg.</th><th>Max.</th></tr><tr><td>Transmit</td><td>-11</td><td>-7</td><td>-3</td></tr><tr><td>Receive Sensitivity</td><td>-3</td><td>--</td><td>-17</td></tr></table></td></tr>
<tr><td>POS-3500B
POS-3502A</td><td>Multi-mode fiber: 62.5/125 microns (um), 0.275 NA graded-index multimode fiber
<table><tr><th>Transmitter Performance</th><th>Min.</th><th>Typical.</th><th>Max.</th></tr><tr><td>Optical Outputt Power, dBm-</td><td>-20.00</td><td>-18.00</td><td>-14.00</td></tr><tr><td>Receive Performance</td><td></td><td></td><td></td></tr><tr><td>Receiver Sensitivity, P_{min}</td><td>-26.00</td><td>-28.00</td><td></td></tr><tr><td>Max. Input Optical Power, Pmax</td><td>-14.00</td><td>-12.00</td><td></td></tr></table></td></tr>
</table>

Single-mode SC Duplex to SC Duplex

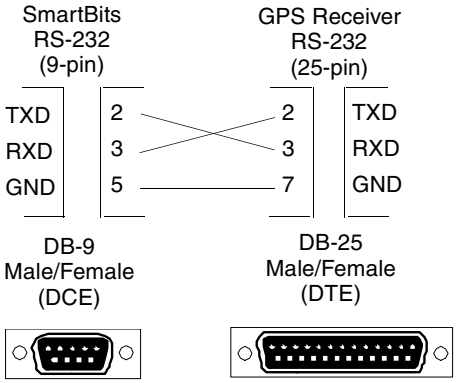
Single Mode fiber: 8.3/125, (8->10//125) microns (um)

LAN-3200As	(HP HFCT 53D5 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-9.5	-5	-3
	Receive Sensitivity =	-3	---	-20
POS-3500Bs POS-3502As	**Transmitter Performance**	**Min.**	**Typical.**	**Max.**
	Transmit Avg. Optical Power, Le	-15.00	-11.00	-8.00 dBm
	Center Wavelength λ_c, IR	1274	1310 for $\Delta\lambda_{rms}$	1356 ≤ 2.5 nm
		1293	1310 for $\Delta\lambda_{rms}$	1334 ≤ 4.0 nm
	Receiver Performance:	**Min.**	**Typical.**	**Max.**
	Receiver Sensitivity, P_{min}	-30.00	-32.00	– dBm
	Max. Input Optical Power, Pmax	-7.00	0	– dBm
	Wavelength of operation λ	1100	–	1600 nm
POS-3505As	**Transmitter Performance**	**Min.**	**Typical.**	**Max.**
	Transmit Avg. Optical Power, L1	-10.00	-11.00	-8.00 dBm
	Center Wavelength λ_c, SR	1266	1310 for $\Delta\lambda_{rms}$	1360 ≤ 4.0 nm
		1293	1310 for $\Delta\lambda_{rms}$	1334 ≤ 4.0 nm
	Receiver Performance:	**Min.**	**Typical.**	**Max.**
	Receiver Sensitivity, P_{min}	-19.00	-22.00	– dBm
	Max. Input Optical Power, Pmax	-3.00	-1.0	– dBm
	Wavelength of operation λ	1100	–	1600 nm

SmartBits-to-GPS Receiver Interface

The serial (AUX) port on the rear panel of the SmartBits chassis connects to the GPS Receiver's I/O RS-232C serial interface port via the following modem cable supplied in the GPS kit.

SmartBits P/N 240-0006-001(CC-906) Cable




SPIRENT
Communications

F SMB-200/2000 Cables and Connectors

In this appendix . . .

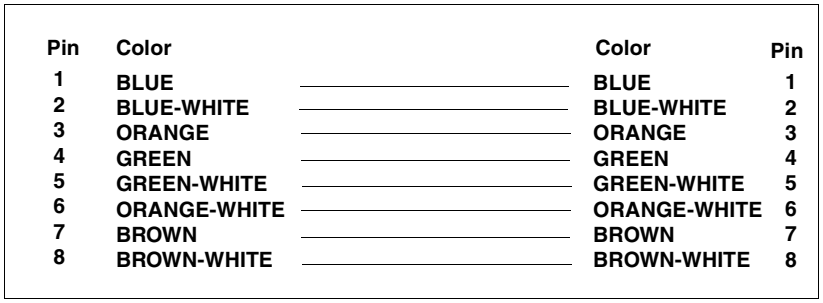
Ethernet Cables

Each interface requires a different pin out depending on the type of interface and if the connection is a DCE-to-DTE or DCE-to-DCE.

Unless otherwise specified, the Ethernet cables specified below use 4 pair category 5 unshielded twisted pair (UTP) cables with a patch length of one meter used between the RJ-45 connectors.

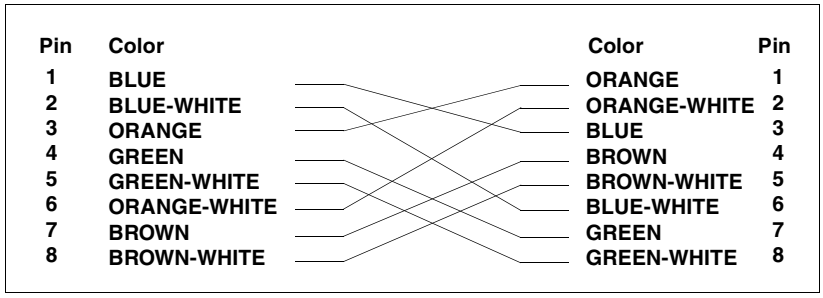
Straight-through Cable for 10/100/1000 Base

Used with: ML-7710, SX-7410, GX-1420B



Crossover Cable for 10/100/1000 Base

Used with: ML-7710, SX-7410, ST-6410, and GX-1420B



Ethernet Connectors

GX-1421A Connectors

The GX-1421A has one female 80-pin connector. The DUT should have the corresponding 80-pin female connector, and is connected to the GX-1421A by using the 12-inch cables that is supplied and recommended by Spirent Communications.

Table 1 on page 234 shows the 80-pin connector pin assignment for SMII and RMII. *Input* and *output* are identified in the left column as **I** and **O** respectively.

Table B-1. 80-Pin Connector Assignments

I/O	Pin	Signal Name		Pin	Signal Name	
		RMII	**SMII**		**RMII**	**SMII**
O	1	3VCC	3VCC	41	3VCC	3VCC
O	2	5VCC	5VCC	42	5VCC	5VCC
O	3	REF_CLK+	REF_CLK+	43	REF_CLK–	REF_CLK–
O	4	GND	GND	44	GND	GND
O	5	DNC (Note 5)	SYNC+	45	DNC (Note 5)	SYNC–
O	6	/SMII (Note 1)	/SMII (Note 1)	46	/BRDCON (Note 2)	/BRDCON (Note 2)
O	7	TXD1_0+	TXD1+	47	TXD1_0–	TXD1–
O	8	TXD1_1+	DNC (Note 5)	48	TXD1_1–	DNC (Note 5)
O	9	TXEN1+	DNC (Note 5)	49	TXEN1–	DNC (Note 5)
I	10	RXD1_0+	RXD1+	50	RXD1_0–	RXD1–
I	11	RXD1_1+	DNC (Note 5)	51	RXD1_1–	DNC (Note 5)
I	12	CRS_DV1+	DNC (Note 5)	52	CRS_DV1–	DNC (Note 5)
I	13	R_CLK+ (Note 3)	R_CLK+ (Note 3)	53	R_CLK– (Note 3)	R_CLK– (Note 3)
O	14	GND	GND	54	GND	GND
O	15	TXD2_0+	TXD2+	55	TXD2_0–	TXD2–
O	16	TXD2_1+	DNC (Note 5)	56	TXD2_1–	DNC (Note 5)
O	17	TXEN2+	DNC (Note 5)	57	TXEN2–	DNC (Note 5)
I	18	RXD2_0+	RXD2+	58	RXD2_0–	RXD2–
I	19	RXD2_1+	DNC (Note 5)	59	RXD2_1–	DNC (Note 5)
I	20	CRS_DV2+	DNC (Note 5)	60	CRS_DV2–	DNC (Note 5)
I	21	DNC (Note 5)	R_SYNC+ (Note 3)	61	DNC (Note 5)	R_SYNC– (Note 3)
O	22	GND	GND	62	GND	GND
O	23	TXD3_0+	TXD3+	63	TXD3_0–	TXD3–
O	24	TXD3_1+	DNC (Note 5)	64	TXD3_1–	DNC (Note 5)
O	25	TXEN3+	DNC (Note 5)	65	TXEN3–	DNC (Note 5)
I	26	RXD3_0+	RXD3+	66	RXD3_0–	RXD3–
I	27	RXD3_1+	DNC (Note 5)	67	RXD3_1–	DNC (Note 5)
I	28	CRS_DV3+	DNC (Note 5)	68	CRS_DV3–	DNC (Note 5)
I	29	/RESET (Note 4)	DNC (Note 5)	69	DNC (Note 5)	DNC (Note 5)
O	30	GND	GND	70	GND	GND
O	31	TXD4_0+	TXD4+	71	TXD4_0–	TXD4–
O	32	TXD4_1+	DNC (Note 5)	72	TXD4_1–	DNC (Note 5)
O	33	TXEN4+	DNC (Note 5)	73	TXEN4–	DNC (Note 5)
I	34	RXD4_0+	RXD4+	74	RXD4_0–	RXD4–
I	35	RXD4_1+	DNC (Note 5)	75	RXD4_1–	DNC (Note 5)
I	36	CRS_DV4+	DNC (Note 5)	76	CRS_DV4–	DNC (Note 5)
N/A	37	DNC (Note 5)	DNC (Note 5)	77	DNC (Note 5)	DNC (Note 5)
O	38	GND	GND	78	GND	GND
Note 6	39	MDIO (Note 6)	MDIO (Note 6)	79	MDC (Note 6)	MDC (Note 6)
O	40	3VCC	3VCC	80	3VCC	3VCC

1 **SMII** Output. Low for SMII, high for RMII. Disregard this signal for single-mode DUTs.
2 **BRDCON** Input. Active low, DUT connected flag. It should be tied to ground at the DUT.
3 **R_CLK+/–** and **R_SYNC+/–.** These two LVDS input pairs should be the output of 65LVDS31 drivers on the DUT. These signals must be supplied to LAN-3150A via J2.
4 **RESET** This low active output can be used as PHY hardware reset signal.
5 **DNC** Do not connect.
6 **MDIO** This signal is bidirectional.
MDC This is an output signal.

GX-1420B Connector

Connector type: RJ-45 female

Pin	Signal
1	TRD 0+
2	TRD 0 -
3	TRD 1+
4	TRD 2+
5	TRD 2 -
6	TRD 1-
7	TRD 3+
8	TRD 3 -

ST-6410, ML-5710, ML-7710, SX-7410 Connector

Connector type: RJ-45 female

Pin	Signal
1	Transmit+
2	Transmit -
3	Receive +
4	Not Connected
5	Not Connected
6	Receive -
7	Not Connected
8	Not Connected (or Shield for STP)

ML-7711, SX-7411 Connectors

Connector type: MT-RJ optic cable

ML-5710 Connector

Connector Type: USB 1.1 compliant, A to B

Connector type: USB

Pin	Signal	Wire color
1	VCC	Red
2	DATA -	White
3	DATA +	Green
4	Ground	Black

SE-6205 Connector

Connector type: DB-15-S female

Pin	Signal	Pin	Signal
1	Collision Shield	9	Collision -
2	Collision +	10	Transmit -
3	Transmit+	11	Transmit Shield
4	Receive Shield	12	Receive -
5	Receive +	13	Power
6	Power Return	14	Power Shield
7	Reserved	15	Reserved
8	Reserved		

SX-7210 Connector

Connector type: MII 40-pin

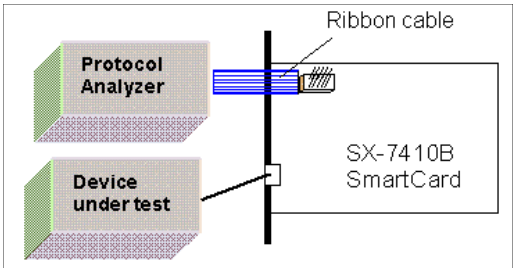
Pin Numbering:

```
  20 19 18 17 16 15 14 13 12 11 10  9  8  7  6  5  4  3  2  1
  40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
```

Pin	Signal	Pin	Signal
1	+5V	13	TX_EN
2	MDIO	14	TXD<0>
3	MDC	15	TXD<1>
4	RXD<3>	16	TXD<2>
5	RXD<2>	17	TXD<3>
6	RXD<1>	18	COL
7	RXD<0>	19	CRS
8	RX_DV	20	+5V
9	RX_CLK	21	+5V
10	RX_ER	22 - 39	COMMON (ground)
11	TX_ER	40	+5V
12	TX_CLK		

SX-7410B Internal Connector

The SX-7410B SmartCard contains an internal connector directly on the printed circuit board. This connector provides triggers for external devices such as ocilloscopes, protocol analyzers, or logic analyzers. Use a ribbon cable to connect to the external device. The trigger is on the rising edge of 0 to +5 volts.



Use this pinout to determine how to wire the connector on the ribbon cable to an external piece of test equipment:

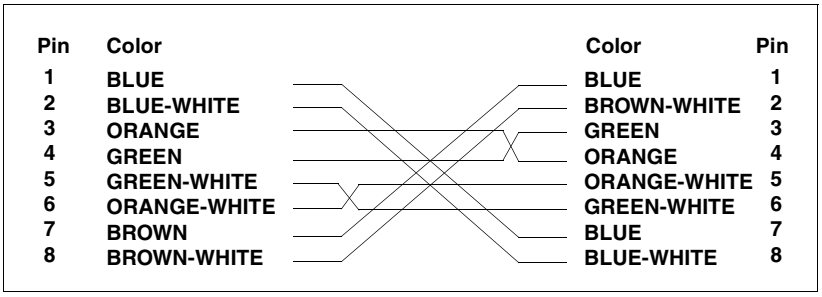
Pin	Signal		
1	Transmit Trigger	6	Gnd
2	Receive Trigger	7	Collision
3	TX en	8	CRC Error
4	Rx Dv	9	Alignment Error
5	Gnd	10	Spare

Token Ring Cable and Connector

The cable specified below uses 4 pair category 5 unshielded twisted pair (UTP) cables with a patch length of one meter used between the RJ-45 connectors.

Crossover Token Ring Cable

Token Ring Crossover Cable



TR-8405 Connector

Connector type: RJ-45 female

Pin	Signal
1	No Connection
2	No Connection
3	Transmit +
4	Receive +
5	Receive -
6	Transmit -
7	No Connection
8	No Connection

WAN Cables and Connectors

WN-3415, WN-3420 Cables

Straight-through Pin Configuration (Smartbits P/N 620-0102-001):

Typically, you use the straight-through cable to connect the card to a telephone company's demarcation point, and crossover cable to connect the card to another CSU/DSU or router/switch**.**

Description	RJ48C (J1) Pin #	RJ48C TE (J2) Pin #	Signal
Twisted Pair #1 Signal	J1-1	J2-1	RX TIP
Twisted Pair #1 RTN	J1-2	J2-2	RX RING
Twisted Pair #2 Signal	J1-4	J2-4	TX TIP
Twisted Pair #2 RTN	J1-5	J2-5	TX RING

Crossover Pin Configuration (SmartBits P/N 620-0103-001 cable):

Description	RJ48C (J1) Pin #	RJ48C TE (J2) Pin #	Signal
Twisted Pair #1 Signal	J1-1	J2-4	RX TIP
Twisted Pair #1 RTN	J1-2	J2-5	RX RING
Twisted Pair #2 Signal	J1-4	J2-1	TX TIP
Twisted Pair #2 RTN	J1-5	J2-2	TX RING

WN-3415, WN-3420 Connector

Connector Type: RJ48C or RJ45C

Pin	Signal
1	RX_RING
2	RX_TIP
3	Not Connected
4	TX_RING
5	TX_TIP
6	Not Connected
7	Not Connected
8	Not Connected

WN-3405 Cable/Connector

SmartBits cable: 620-0201-001 V.35 Male

SmartBits cable: 620-0202-001 V.35 Female

Connector Type: V.35

Champ Pin#	AMP M-34 Pin#	V.35 Pin #	Signal
1	A	101	PGND
19	B	102	SGND
4	P	103(A)	TD (A)
22	S	103 (B)	TD (B)
6	R	104 (A)	RD (A)
24	T	104 (B)	RD (B)
2	C	105	RTS
16	D	106	CTS
32	E	107	DSR
29	H	108	DTR
34	F	109	DCD
17	U	113 (A)	SCTE (A)
35	W	113 (B)	SCTE (B)
5	Y	114 (A)	SCT (A)
23	AA	114 (B)	SCT (B)
8	V	115 (A)	SCR (A)
26	X	115 (B)	SCR (B)
15	J	125	RI
14	N	140	RL
10	L	141	LL
18	NN	142	TM

WN-3445 Cable/Connector

Connector Type: BNC (B3ZS Decoding)

Cable: SmartBits P/N 620-0217-001, BNC Male to BNC Male

WN-3441A Connector

Connector Type: RJ-48C

WN-3442A Connector

Connector Type: RJ-48C for 120-Ohm external unbalanced (require Balun for impedance)

ATM Cables and Connectors

AT-9015 Cable

T1 straight-through cable

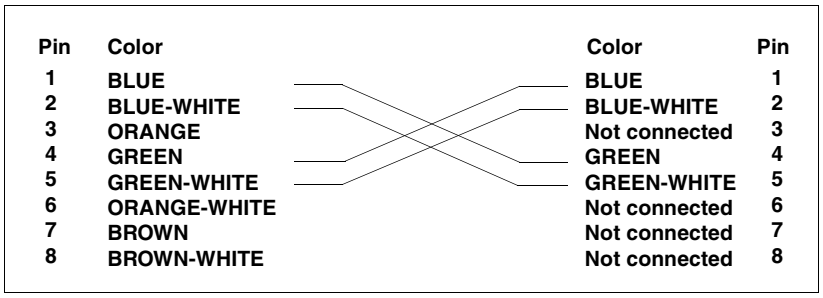
AT-9020 Connector

Connector type: RJ-48C female

Pin	Signal
1	Rx Ring
2	Rx Tip
3	Not Connected
4	Tx Ring
5	Tx Tip
6	Not connected
7	Not connected
8	Not connected

AT-9020 Cable

E1 Crossover Cable (RJ-45 at each end)



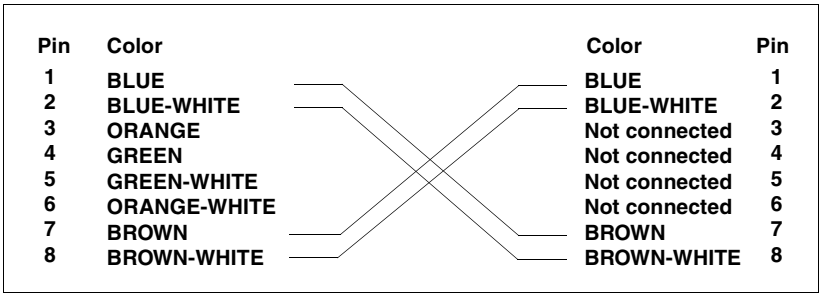
AT-9025 Connector

Connector type: RJ-48F female

Pin	Signal
1	Transmit+
2	Transmit -
3	Not connected
4	Not connected
5	Not connected
6	Not connected
7	Receive +
8	Receive -

AT-9025 Cable

Crossover Cable (RJ-45 at each end)



AT-9034B Cable/Connector

Connector Type: BNC (E3 Mode, HDB3 Decoding), with 75-Ohm Impedance

Cable: SmartBits P/N 620-0217-001, BNC Male to BNC Male

AT-9045, AT-9045B Cable/Connector

Connector Type: BNC (DS3 Mode, B3ZS Decoding), with 75-Ohm Impedance

Cable: SmartBits P/N 620-0217-001, BNC Male to BNC Male

AT-9155C, AT-9622 Connector

Connector Type: Fiber, SC Duplex to SC Duplex, Multi-Mode

For details on fiber optic signals, please refer to *page 244*.

Fiber Optic Cable Signals

Multi-mode SC Duplex to SC Duplex

Multi-mode fiber: 62.5/125, (50/125 + 100/140) microns (um)

Multi-mode fiber signal values in dBm

ML-7711 SX-7411 100/Full	(HP HFBR 5903 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-20	-15.7	-14
	Receive = Sensitivity	-14	-----	-34.5
GX-1405	(OCP dtr-1250-SM-L2 850nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-9.5	-7	-4
	Receive = Sensitivity	-4	---	-17
AT-9155C	(HP part# HFBR 5205 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-20	-10	-14
	Receive = Sensitivity	-14	---	-31
AT-9622	(HP part# HFBR 5208 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-19	-17	-14
	Receive = Sensitivity	-14	---	-26

Single-mode SC Duplex to SC Duplex

Single-mode fiber: 8.3/125, (8->10//125) microns (um)

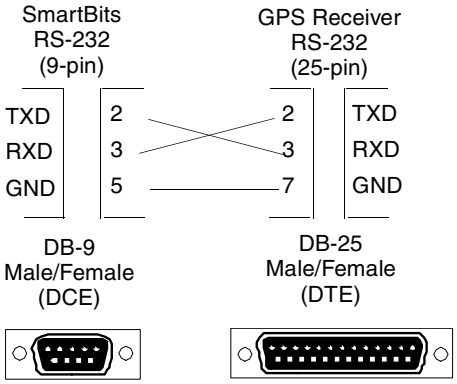
Single-mode fiber signal values

GX-1405Bs	(HP HFCT 53D5 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-9.5	-5	-3
	Receive Sensitivity =	-3	---	-20
AT-9155s	(HP part# HFCT 5205B 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-15	-10	-8
	Receive Sensitivity =	-8	---	-31
AT-9622s	(HP part# HFCT 5208B 1300nm)			
		Min.	**Avg.**	**Max.**
	Transmit =	-19	-15	-8
	Receive Sensitivity =	-8	---	-28

SmartBits-to-GPS Receiver Interface

The serial (AUX) port on the rear panel of the SmartBits chassis connects to the GPS Receiver's I/O RS-232C serial interface port via the following modem cable supplied in the GPS kit.

SmartBits P/N 240-0006-001(CC-906) cable



G Serial Port Commands

In this appendix . . .

This appendix contains the serial port commands that you can send from your PC directly over the serial port connection to a SmartBits chassis via HyperTerminal or an equivalent terminal emulation program:

Overview of the Serial Command Set

The following SmartBits firmware commands are available when you connect your PC HyperTerminal program via serial port to a SmartBits 200/2000 or SmartBits 600/6000B chassis. To view each help window and the chassis firmware version level, enter the **help** command and press Return, in the HyperTerminal window.

Commands unique to SMB-200/2000

```
SmartBits SMB-2000 Command Summary:          (f/w ver: 6.62.16)

HELP                          Display (this) help text.
VER                           Display version string.
IPADDR [xxx.xxx.xxx.xxx]      Display/modify IP address.
SVIPADDR [xxx.xxx.xxx.xxx]    Display/modify IP address.
PORTNO [xxxxx]                Display/modify TCP listen port number.
IDLEMAX [xxxx]                Display/modify TCP idle logout time (seconds).
MACADDR                       Display MAC address.
SERNUM                        Display serial number.
ECHO ON                       Allow serial input to be echoed when entered.
ECHO OFF                      Disallow serial input to be echoed when entered.
BAUD [xxxxx]                  set baud rate to 9600, 19200, 38400, or 115200
SVBAUD [xxxxx]                Changes baud rate and saves new value in flash.
USERS                         Display all logged-in users.
CLOSE [user_num]              Close selected logged-in user.
>>
```

Figure G-1. SmartBits 200/2000 Firmware Commands available via HyperTerminal

Commands unique to SMB-600/6000B

```
SmartBits SMB-6000 Command Summary:          (f/w ver: 1.05.029.00)

HELP                          Display (this) help text.
VER                           Display version string.
IPADDR   [xxx.xxx.xxx.xxx]    Display/modify IP address.
SVIPADDR [xxx.xxx.xxx.xxx]    Display/modify IP address.
PORTNO   [xxxxx]              Display/modify TCP listen port number.
IDLEMAX  [x]                  Display/modify idle logout time (seconds).
MACADDR                       Display MAC address.
SERNUM                        Display serial number.
ECHO ON                       Allow serial input to be echoed when entered.
ECHO OFF                      Disallow serial input to be echoed when entered.
SU                            Enter SuperUser mode, enables SuperUser commands.

Super-User Commands:
USERS                         Display all logged-in users.
CLOSE <user_num | ALL>        Close all or selected logged-in users.
SUPASS                        Modify SuperUser password.
EXITSU                        Exit SuperUser mode, disables SuperUser commands.
SECURITY <ENABLE | DISABLE>   Enables/disables security check.
SECURITY PW                   Sets security password for security check.
SECURITY SAVE                 Saves security setting across power cycle.
```

Figure G-2. SMB-600/6000B Firmware Commands available via HyperTerminal

For details on connecting your PC to the SmartBits serial port, please refer to your SmartBits installation manual.

The SmartBits 200/2000 chassis do not have super user commands or passwords.

The SmartBits 600/6000B chassis offer a superuser mode with additional password protection and commands; some of these commands will only be available with SmartAccess, a new SmartBits utility.

Serial Port Command Set

The following commands apply to all chassis unless otherwise specified.

Note: For additional information on how to use SmartAccess, the new security program, please refer to *Applications Note #29, SmartAccess*, under the Support page at the Spirent Communications website *www.spirentcom.com*.

Table G-1.Serial Port Command Set for SmartBits Chassis

Command	Description
HELP	The HELP command displays the available commands.
VER	This command displays the chassis firmware version.
IPADDR [xxx.xxx.xxx.xxx]	Display [or modify] IP address. This command allows changing the SmartBits IP address. The change takes effect following a power cycle or reset. If a new IP address is not entered, the SmartBits will display the current IP address. If the IP address or the syntax is bad, it will display the following error message: `IP address entered is not accepted.`
SVIPADDR [xxx.xxx.xxx.xxx]	This command specifies and saves the SmartBits IP address. The change takes effect following a power cycle or reset.
PORTNO [xxxxx]	Display or modify the TCP port number for the SmartBits chassis.
IDLEMAX [x]	Display [or modify] idle logout time, in seconds (10 seconds to a maximum of 4294967295 seconds). This command sets a time limit for the SmartBits controller to close any inactive open connection. The SmartBits controller has been designed to be a high performance multi-user system. Any user who connects to the controller but does not use it (i.e., does not send any command) will be disconnected and all resources freed after the set idle time limit expires. If a new idle time limit value is not entered, the SmartBits controller will display the current idle time limit value. The largest value for the idle_time_limit_value that is accepted is 42949672.

Table G-1.Serial Port Command Set for SmartBits Chassis

Command	Description
MACADDR	To display the SmartBits MAC address. For information only.
SERNUM	To display the SmartBits serial number. For information only.
ECHO ON	To allow text entries via the serial port to be echoed while entered. ECHO ON allows the user to see their keystrokes as they occur. It is the default echo setting.
ECHO OFF	To not allow text entries via the serial port to be displayed while being entered. The ECHO state is temporarily forced to ECHO OFF during all password entry sessions.
BAUD [xxxxx]	(SMB-200/2000 only) To set the baud rate to 9600, 19200, 38400, or 115200 for the serial connection.
SVBAUD [xxxxx]	(SMB-200/2000 only) Changes the baud rate and saves the new value to flash.
USERS	Used with Multi-User chassis only (SMB-2000/600/6000B), to display all users who are logged onto the SmartBits chassis. For information only. This command prints out a chart of all logged-on Ethernet connections (users), their IP address, their TCP port number, and a list of all cards each owns. The User Number is the parameter used to close a user's connection. Example report: Show Users detects 2 logged in users to report: USER_NUM: IPADDR (TCP) PORT_NUM: CARDS_OWNED: 1 192.168.103.50 1073 8 2 192.168.103.50 1074 9

Table G-1.Serial Port Command Set for SmartBits Chassis

Command	Description
SU	(SMB-600/6000B only) . Enter SuperUser mode, enables SuperUser command set. This command provides entry into the superuser mode, where the current logged-on Ethernet connections on the unit can be examined, and if desired, closed. The superuser mode is password protected and prompts you for an 8-character password. The factory default password is **SMB-6000**.
CLOSE < user_num | ALL >	Used with Multi-User chassis only (SMB-2000/600/ 6000B), to log out and disconnect the selected logged-in user, or ALL logged-in users. Based on the example for USERS, listed above, typing "close 2" would log out then disconnect user 2. The User Number is the parameter used to close an individual user's connection. For the SMB-6000B, this command requires super user mode.
SUPASS	(SMB-600/6000B only) . To modify SuperUser password (you must know the old password). You can guess the password as many times as you wish. The factory default password is **SMB-6000**. This command provides a mechanism to alter the superuser password. First, the current password must be correctly entered at the prompt "*Please enter Super-user password:*". If not correctly entered, an error string "Incorrect Super-user password" is displayed. Then the prompt *"Please enter new Super-user password:*" for the new password is displayed. The user is prompted again *"Please re-enter new Super-user password:"* to confirm the new password. If a mismatch is detected, the error string "T*he new passwords are not same. Existing Super-user password will not be changed*." is displayed, and the change is rejected.
EXITSU	(SMB-600/6000B only) . To exit SuperUser mode and exit access to the SuperUser command set.
SECURITY <ENABLE | DISABLE >	(SMB-600/6000B only). To enable a second level security mechanism and password for use with the new SmartAccess utility.

Table G-1.Serial Port Command Set for SmartBits Chassis

Command	Description
SECURITY PW	(SMB-600/6000B only). To set the security password for use with the SmartAccess utility. This command prompts you for a password
SECURITY SAVE	(SMB-600/6000B only). To save the security password for use with the SmartAccess utility.

Glossary of Terms

This section introduces additional common features/terms used with SmartBits chassis and cards, and is alphabetically arranged. For a list of RFCs supported, please refer to *Appendix A, "RFCs and Standards Supported"*.

Most listed features are available in SmartWindow and have corresponding commands in SmartLib; many of these features and terms are used throughout other SmartBits applications as well. For variations on a given feature, please consult the online help at http://www.netcomsystems.com/ or user guide of each application.

In this section. . .

Features and Terminology

Most of the following features are available in SmartWindow and have corresponding commands in SmartLib; many features and terms are used throughout other SmartBits applications as well.

Important: For variations on a given feature, please consult the online help or user guide of each application.

Address Resolution Protocol (ARP)

In order for data streams to be sent through a router, the SmartBits cards have to know the MAC address of the router port and the router has to know the MAC addresses of the SmartCards. This is done using ARP (Address Resolution Protocol) packet exchanges.

ARP maps an IP address to a MAC address. This IP address is the address of the router port connected to the SmartCard, not the IP destination of a packet. The router port IPaddress is specified in the entry called *Default Gateway*. When this entry is set–that is, not zero–the ARPs generated by the SmartCard will go to this address instead of the specified IP destination address.

The router will also issue ARP requests to the SmartCards. These will be replied to by either the local stack or the protocol stream if the target IP address in the ARP request packet matches the Source IP address in the stream or stack.

Setting the gateway to all 0's will direct frames to the destination IP address. This will perform ARP exchanges with the destination port for local traffic, or in Layer 2 tests will serve the purpose of learning frames through a Layer 2 device.

authentication setup

Certain SmartCards that use PPP (ATM, WAN, POS) can act as an authentication client, authentication server, or as a client and server simultaneously.

backoff truncation exponent

By default, all Ethernet SmartCards are configured for a Backoff Truncation Exponent value of 10 that coincides with the 802.3 backoff requirement standards.

In SmartWindow, this default value can be changed on a per port basis by selecting Backoff Truncation Exponent from the Options pull down menu. When selected, two windows appear: one for selecting the ports to modify and the other for selecting the new Backoff Exponent value. Integer values from 1 to 10 can be chosen. Smaller values result in the test port being more *aggressive* in a collision situation, since the truncation for backoff times will start at a lower number of successive collisions.

Class of Service

Used to designate a forwarding device as capable of prioritizing data traffic.

cut through and store & forward devices

For the SmartMetrics Ethernet latency tests, latency is defined as the difference between the time that a tagged byte leaves the transmitting port and the time that it arrives at the receiving port. This is typically used to measure the performance of "cut through" devices. Cut Through devices begin retransmission after receiving packet headers. This increases performance over "store and forward devices."

Measurement of latency through one or more "store and forward" switches can be calculated by adding the time to transfer any remaining bytes out of the transmitting port. Store and Forward devices receive a complete packet on the input port before beginning transmission on the output port. For these devices, the latency is defined as the difference between the time the last byte leaves the transmitting device and the time that the first byte arrives at the destination device.

In SmartWindow, the results are presented to cover both possibilities. A result of <NO> is shown in the Store and Forward column if the system is able to detect the type of device under test is a cut-through switch.

data integrity

Applicable to gigabit Ethernet traffic and cards, *Data Integrity* controls payload integrity. When enabled for a card, it informs you that the payload portion–and only the payload portion of the frame–has an error. The SmartMetrics *Sequence and Latency Test and Capture* function can detect and record a data integrity error event.

encapsulation types

The following types of encapsulation are available:

- **VC Mux Routed (null encapsulation)**

  VC Multiplexing creates a binding between an ATM VC and the type of the network protocol carried on that VC. Thus, there is no need for protocol identification information to be carried in the payload of each AAL5 CPCS-PDU. This reduces payload overhead and can reduce per-packet processing. VC multiplexing can improve efficiency by reducing the number of cells needed to carry PDUs of certain lengths. (RFC2684).

- **SNAP**

  The SNAP header consists of a three octet Organizationally Unique Identifier (OUI) and a two octet Protocol Identifier (PID). The OUI is administered by IEEE and identifies an organization that administers the values that might be assigned to the PID. The SNAP header thus uniquely identifies a routed or bridged protocol. The OUI value 0x00-00-00 indicates that the PID is an EtherType. (RFC2684).

- **LANE 802.3 (LAN Emulation)**

  The ATM Forum LAN Emulation specification provides an environment where the ATM network is enhanced by LAN Emulation Server(s) to behave as a bridged LAN. Stations obtain configuration information from, and register with, a LAN Emulation

Configuration Server. They resolve MAC addresses to ATM addresses through the services of a LAN Emulation Server; send broadcast and multicast frames, and also send unicast frames that have no direct VC to a Broadcast and Unicast Server. LANE uses the VC multiplexing encapsulation formats for Bridged Etherent/802.3 (without LAN FCS) or Bridged 802.5 (without LAN FCS) for the Data Direct, LE Multicast Send and Multicast Forward VCCS. However, the initial PAD field described in this memo is used as an LE header, and might not be set to all '0'.

- **Classical IP**

  Characteristics of the classical model are:

  – The same maximum transmission unit (MTU) size is the default for all VCs in a LIS. However, on a VC-by-VC point-to-point basis, the MTU size may be negotiated during connection setup using Path MTU Discovery to better suit the needs of the cooperating pair of IP members or the attributes of the communications path. (Refer to Section 7.3).

  – Default LLC/SNAP encapsulation of IP packets.

  – End-to-end IP routing architecture stays the same.

  – IP addresses are resolved to ATM addresses by use of an ATMARP service within the LIS - ATMARPs stay within the LIS. From a client's perspective, the ATMARP architecture stays faithful to the basic ARP model presented in [3].

  – One IP subnet is used for many hosts and routers. Each VC directly connects two IP members within the same LIS. (RFC2225).

- **LLC PPP**

  LLC encapsulated PPP over AAL5 is the alternative technique to VC multiplexed PPP over AAL5.

  The AAL5 CPCS-PDU payload field is encoded:

  – LLC header: 2 bytes encoded to specify a source SAP and destination SAP of the routed OSI PDU (values 0xFE 0xFE), followed by an Un-numbered Information (UI) frame type (value 0x03).

  – Network Layer Protocol IDentifier (NLPID) representing PPP, (value 0xCF).

  – The PPP protocol identifier field, can be either 1 or 2 octets long. (RFC2364).

  Available only when SmartWindow is connected to a chassis with cards supporting PPP over ATM (AT-9155C and AT-9622, firmware version 3.00 and higher).

- **VC Mux PPP**

  The Common Part Convergence Sub-layer (CPCS)-PDU Payload field contains user information up to 2^16 - 1 octets. The PAD field pads the CPCS-PDU to fit exactly into the ATM cells such that the last 48 octet cell payload created by the SAR sublayer will have the CPCS-PDU Trailer right justified in the cell. The CPCS-UU (User-to-User indication) field is used to transparently transfer CPCS user to user information. (RFC2364).

  Available only when SmartWindow is connected to a chassis with cards supporting PPP over ATM (AT-9155C and AT-9622, firmware version 3.00 and higher).

ET-1000 functions

Based on the ET-1000 controller, the grandfather of the SmartBits chassis, certain ET-functions were used with 10Mbps Ethernet cards and available in SmartWindow and SmartLib. Now obsolete, these functions are only available if you have older applications and chassis firmware version lower than Version 6.60.

fill pattern

Also known as the Background. In SmartWindow, displays the pattern template to be used for the frame. To edit a template, select the pattern from the drop down list and click the Edit button. The Frame Editor is displayed.

Frame Editor

See also Protocol Editor.

The Frame Editor window provides a template to directly control required IP header fields for native IP traffic generation over Ethernet, Token Ring, and ATM. You can edit background frame content or create custom background test frames as a means to enter a protocol into a frame.

Important: The last 18 bytes of each SmartMetrics mode stream is *Reserved for SmartBits* usage. **Any values inserted into a custom packet in the last 18 bytes will be overwritten by the SmartMetrics signature data.**

GBIC

Copper gigabit interface converter. GBIC is an industry standard interface that allows users to change the physical interface to support either multi-mode or single-mode fiber.

grouping ports

The concept of *Group* allows multiple SmartCards to be configured at the same time and set up for simultaneous transmission and testing.

For a card to be part of a group, it must be owned:

- **Implicit Ownership**–Occurs with single-user chassis. Since only one user can connect to a single user chassis, all cards are considered to be owned when you make the connection.
- **Explicit Ownership**–Occurs with multi-user chassis. More than one user can connect to the same chassis. When a connection is made, the user must reserve the desired cards. No other user can own these cards.

  Ownership is indicated visually by color-coded triangular LEDs next to the port ID number, or by color-coded button LEDs next to the port IDs in a reservations listing:

  Blue triangle LED – card is reserved to you.

  Green triangle LED – card is available.

Red triangle LED – card is reserved by another user or by another application
Once cards are owned, you can make a group.

- In all applications, the default Group is all reserved cards.
- To assign ports to a subset or a select group of ports, consult your user guide or online help for each application. Applications have a Reservations command, a Group assignment column, or Port Selection columns to create groups.
- In SmartWindow, the *Set Group* command selects all the cards you have reserved and proposes them as a default Group. To constitute a Group, you must accept the proposed Group or changed the selected ports in the *SmartBits Multiport Selection* dialog and click *OK*. Notice that all unowned cards are grayed out until you reserve them.

IGMP

IP multicast traffic is used in multimedia and data sharing applications; multicast (IGMP) is a technology that delivers a stream of traffic from a sender to multiple receivers simultaneously. Forwarding devices are informed of a host's desire to receive multi-cast IP traffic through the Internet Group Management Protocol (IGMP). IGMP allows group information and multi-cast forwarding tables to be dynamically maintained. Hosts send an IGMP membership report to "join" a group. Once joined, hosts must respond to periodic router queries to maintain their membership status. If a host fails to respond to queries for a specified interval, its membership is automatically removed.

An updated version of IGMP (version 2) allows hosts to explicitly leave groups by sending a **leave request**. This is a far more efficient way to leave a group as it minimizes the amount of unwanted traffic forwarded to the host.

jitter

The variation in latency for a series of packets, measured via the SmartMetrics mechanism. Low jitter is important in voice transmissions. In SmartFlow, this is known as “latency standard deviation.”

latency

The time interval between the transmission and reception of a frame.

Multilayer SmartCards

A group of card types also known as first series of SmartMetrics cards.

Multilayer SmartCards include the ML-7710, ML-5710A, and L3-6710.

Multilayer cards allow you to to test the performance and interoperability of both Layer 2 (frame-based) and Layer 3 (stream-based) devices as well as higher layer operations. Each multilayer SmartCard can generate multilayer, mixed protocol traffic equivalent to one fully loaded LAN with up to 1000 end-user devices. The single RJ-45 interface can

generate, monitor, and capture 10/100 Mbps Ethernet traffic at full wire speed in full or half duplex mode.

programming environments

The SmartLib programming library supports programming in:

- Microsoft Windows 98 or NT SP4
- NT SP6 and Windows 2000 supported as of June 2000
- UNIX
- Borland C/C++, Microsoft C/C++, and GNU C/C++
- Microsoft Visual Basic
- Borland Delphi
- Tcl

programming in TCL

Tcl is a *scripting language*. You can create a text-based *script* that is run from a Tcl shell. This is different from *compiled* languages like C or C++ that can create stand-alone, executable programs. *Tk* is a graphic interface toolkit for Tcl. You can use it to create GUI interfaces that work with your TCL scripts.

Tcl is a flexible programming language, noted for its on-the-fly command-line capabilities. Tcl enables you to test a function call from the text-based command line without having to compile a program. This allows you to test your code line by line.

Protocol Editor

The *Protocol Editor* is a spreadsheet that allows you to set up and edit the parameters related to a protocol in use for a VTE/stream, in most applications. The fields that are displayed vary according to the type of protocol the VTE/stream is using.

SmartCounters

SmartWindow provides a port counter with spreadsheet capabilities called SmartCounters, accessed through the Actions menu. The SmartCounters window displays two statistics for each port:

- **Events –** The number of occurrences of an action (such as transmitting or receiving a frame, collisions, Rx triggers, and CRC errors) since the last time that counter was reset or cleared.
- **Rates** – The number of events per second that the events happen.

test result formats

All applications have test results presented in a spreadsheet format, either in .csv comma delimited files, Microsoft Excel .xls files or in text files. All .xls files can be displayed in Microsoft Excel chart format as well.

Real-time test results are often available through counters.

ToS

Type of Service parameter, editable

In many applications, you can edit the ToS parameter of a frame customized for traffic, in the Protocol Editor or Frame Editor of the application.

transmit modes

You can select one of the popular transmit modes for transmitting traffic between cards and between chassis. These modes vary slightly according to card and application.

- **Continuous Mode.** Transmits a constant stream of packets at user-selected Interpacket Gap.
- **Single Burst Mode.** Up to 16 million packets in a single burst with user-selected Interpacket Gap.
- **Multiburst Mode.** Up to 65,536 repetitive bursts with a user-adjustable delay in 62.5 nanosecond intervals (maximum 1.6 seconds) between each burst.
- **Echo Mode.** Sends one packet when a trigger occurs.
- **Continuous Multiburst Mode.** Runs multiburst mode continuously.

triggers

See also *"Triggers and Errored Frames" on page 128*.

A *trigger* is a pattern tracking tool that identifies any packet with a specific pattern located inside any of the packets received by a receiving SmartBits card. The receiving card then counts the number of triggers received with the specific pattern.

Most SmartBits applications automatically insert triggers and add user-selectable errors depending on the application.

In SmartLib or SmartWindow, you can track one or two triggers per receiving SmartCard in any combination (singly and/or together). In SmartWindow, the pattern is defined in the following:

- Transmitting SmartCard
- Trigger Setup of the receiving SmartCard

VFDs (Variable Field Definitions)

Applications Supported: SmartWindow, SmartLib

A VFD (Variable Field Definition) is a field within the frame whose value can be manipulated—for example, incremented, decremented, or used in chunks. VFDs write over the background fill pattern. Variable Fields are areas of packet data that can change on a *per frame* basis at wire speeds.

VFDs are available on Ethernet cards in the Traditional mode and on frame relay cards as described below:

- **Ethernet SmartMetrics cards:** The SmartMetrics mode does not support the use of VFDs, except that in the SmartBits customizable stream VFD3 can be used to enter the custom protocol header and payload. On SmartMetrics and TeraMetrics cards, varied frame generation is accomplished via streams and "SmartFlows."
- **Frame Relay cards:** The frame relay cards support VFD1 and VFD2 in SmartMetrics streams. They support VFD3 in limited fashion, where range is the total number of bytes usable from the VFD3 buffer.

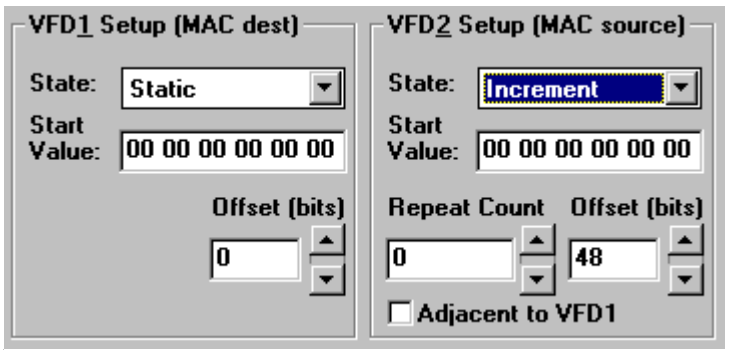
Three VFDs are supported for each Traditional card.

VFDs 1 & 2

Variable Fields 1 & 2 are up to 6 bytes long and can change on a per frame basis. Their content can be:

- **Off**. Variable field disabled**.**
- **Static**. No change frame-to-frame**.**
- **Incrementing.** Adding one to the value each frame.
- **Decrementing.** Subtracting one from the value each frame.
- **Random.** A random value each frame.

The content is defined by the *State* pull down menu.



The first pattern in the sequence for VFD 1 or 2 is a user selectable start value in HEX called *Start Value*. This pattern is entered in the *Start Value* data box. Up to 6 bytes of initial data pattern may be entered.

The location of VFD1 in the data pattern of the packet is specified by *Offset*. Offset is the number of bits from the beginning of the data packet. For some SmartCards, the offset is chosen by a number of *bytes*.

If a VFD is enabled, it overwrites the background data of the packet at the specified offset for the length of the VFD.

The only difference in the setup for VFD 2 is the ability to select an offset *Adjacent to VFD1*. This eases setting the two fields in concurrent sections of a frame.

Default offsets for VFD1 & 2 are at the Destination Address and Source Address, respectively, for Ethernet or TokenRing frames. If the offset is modified, then the area of the display that states *MAC dest* or *MAC source* is cleared.

Note: The capabilities of VFD1 & 2 differ slightly among the various SmartCard types. The most notable difference is the capability of a recycle count in the ST-6410, SX-7205 and TR-8405 SmartCards. When enabled, this feature allows the user to enter a value for the number of times to increment or decrement the VFD. Once this number is reached, the VFD recycles back to its original start value.

In the Options menu Preferences window, you can select *Allow bit level control of VFD1 and VFD2* for 10Mbps Ethernet SC-6x05 SmartCards only. When selected, this option allows the user to define the length of VFDs 1 and 2 in bits. This feature is similar to recycling VFD for 100 MB Fast SmartCards. The behavior is not identical to recycling a VFD. Because consecutive bits are modified on the output stream in network order, if this feature is used to span a byte boundary, the data will not increment or decrement in a smooth fashion, but will skip as the high order bits of the next byte change. If Random VFDs 1 and 2 are selected on a non-byte boundary, behavior will be normal. Default is *Unselected.*

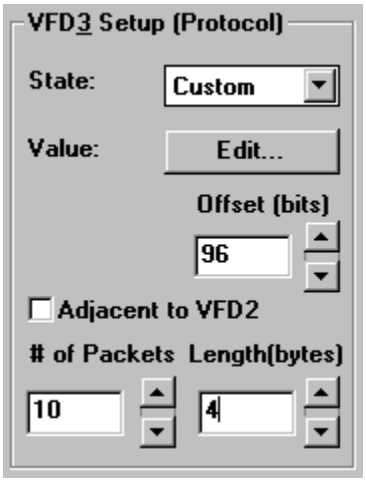
Possible uses of VFDs 1&2:

- Specific MAC addresses (unicast, multi-cast or broadcast).
- Multiple MAC addresses.
- Sequencing IP headers with correct header checksums.
- Set VFD1 offset to sequence location, use *incrementing* VFD.
- Set VFD2 offset to checksum location, use *decrementing* VFD.

VFD3 (Protocol VFD)

Unlike VFDs 1 and 2, that support up to 6 bytes of static, increment, decrement or random data, VFD3 supports a buffer of up to 2048 bytes that is segmented into pieces. Each of the pieces is then placed into outgoing frames, one piece per frame. This expanded capability makes it useful for defining the upper layer protocol fields for a frame.

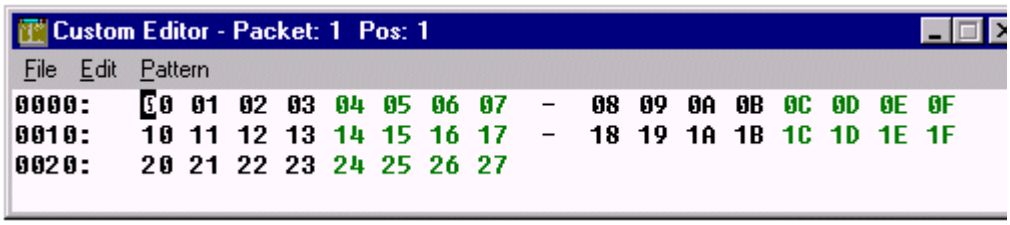
The following picture is the main setup for VFD3.



In this case, a Custom Hex state for the VFD has been selected at an offset of 96 bits into the frame. Similar to VFD2, VFD3 supports an option to place the VFD adjacent to VFD2.

In this example, the number of packets (or more easily understood as the number of *patterns*) has been chosen as 10 and the length of the pattern as 4 bytes. This produces 10 patterns of 4 bytes in length each. *The product of these two numbers cannot exceed the 2048 byte VFD3 buffer length.*

Once the number of packets and the VFD length are chosen, the data contents of the VFD can be modified by pressing the Edit button. A dialog showing the edit buffer is then presented:



Here you can see that 10 patterns of four bytes each can be edited to form the contents of the VFD. The patterns are shown in alternating colors.

Each of the bytes of each pattern can be modified as needed. There is a tool bar menu item Pattern that provides some basic *fill* capabilities. Files containing data for the VFD can be imported or saved via the File menu item.

The operation of VFD3 places pattern #1 into frame #1, pattern #2 into frame #2 and so on. Once the end of the number of patterns is reached, the VFD begins back at the first pattern and continues.

Caution: The VFD3 will not skip forward to the start of the next pattern or reuse the current pattern. The next packet will start with the next untransmitted byte of the current pattern. If VFD3 is used to control protocol information, generally this will not be a problem. Collisions usually start during the preamble and continue for 96 bit times. This duration of the collision would cover the MAC destination and source address, but not use any data from VFD3. If however the VFD3 were used for MAC destination and/or source addressing, subsequent packets will be produced incorrectly after a collision.

VTEs

A term used in SmartWindow and SmartLib applications, VTE (Virtual Transmit Engine) is a SmartBits engine that is fully customizable and generates its own "stream" of data.

VTE is synonymous with “stream.”

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