User Manual

Tektronix

ST2400
2.4 Gb/s SDH Test Set

070-9782-03

ST2400

SDH/SONET

TEST SET

SDH USER GUIDE

070-9782-03

MAY 1997

Tektronix

Microwave Logic Products

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any equipment connected to it.

Only qualified personnel should perform maintenance and service procedures on the ST2400.

To Avoid Fire and Personal Injury

⚠ **WARNING! Read and Follow all of these Safety Instructions.**
Failure to do so can cause injury to the user and damage the instrument.

Use Proper Power Cord. Use only the power cord specified for this product and certified for the country of use.

Use Proper Voltage Setting. Before applying power, ensure that the line selector is in the proper position for the power source being used.

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

The common terminal is at ground terminal. Do not connect the common terminal to elevated voltages (see Specification section for further details).

Safety Certification Compliance

Category	Standard
Temperature (operating)	+5 to +40°C
Altitude (maximum operating)	2000 meters
Equipment Type	Test and Measuring
Safety Class	Class I (as defined in IEC 1010-1, Annex H) - grounded product
Overvoltage Category	Overvoltage Category II (as defined in IEC 1010-1, Annex J)
Pollution Degree	Pollution Degree 2 (as defined in IEC 1010-1). Note - Rated for indoor use only.

Low Voltage Declaration

Category	Standard
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC EN61010-1/A1 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

Safety Standards

Category	Standard
U.S. Nationally Recognized Testing Laboratory Testing (NRTL)	UL 1244 - Electrical and Electronic Measuring and Testing Equipment
Canadian Certification	CAN/CSA-22.2 No. 231 CSA Safety Requirements for Electronically and Electronic Measuring and Testing Equipment

Safety Terms and Symbols

Paragraphs or sections in this document that contain important safety information will be identified by either a WARNING or a CAUTION label in the left hand margin. These labels are explained below:

Icon	Label	Meaning
⚠	**WARNING!**	Indicates a safety practice that must be followed to avoid **possible injury** to the user and possible damage to the instrument.
⚠	**CAUTION!**	Indicates a safety practice that must be followed to prevent **possible damage** to the ST2400 or other instruments used with the ST2400.

About This Document

This document is intended for telecommunications engineers and technicians with more than two years of experience working with optical networks, such as SDH and SONET, and data communications equipment networks.

The **ST2400 2.4 Gb/s SDH/SONET Test Set** can be software configured for use with either SDH or SONET operations in one of three hardware configurations: TRANSCEIVER, TRANSMIT-ONLY, or RECEIVE-ONLY. This document is a SDH USER GUIDE and each chapter is organized to accommodate each particular configuration as used in the default SDH environment.

Chapter 1—Introduction
This chapter describes the **ST2400 2.4 Gb/s SDH/SONET Test Set** and provides a list of standard and optional accessories for both the SDH and SONET option and for each of the three configurations: TRANSCEIVER, TRANSMIT-ONLY, and RECEIVE-ONLY.

Chapter 2—Functional Overview
This section describes **ST2400 2.4 Gb/s SDH/SONET Test Set** controls, indicators, connectors, display elements, and menu structures. It includes separate sections that detail receiver and transmitter specifics, and general sections that apply to both.

Chapter 3—LCD Menus and Displays
This chapter describes the use of the ST2400 LCD menu structures and displays. In addition to general displays and menus, there are separate sections that detail setup, receiver, and transmitter specifics.

Chapter 4—Applications and Use
This chapter provides common examples of telecommunication network applications. It details how to use the **ST2400 2.4 Gb/s SDH/SONET Test Set** for Passive Monitoring, Active Analysis, Active Throughput Analysis, and Test Signal Generation.

Chapter 5—External Controllers and Using Printers
This chapter explains how to connect external devices to the RS-232C, GPIB, and parallel ports. This chapter also includes port setup procedures.

Chapter 6—Remote Commands
This chapter explains the general syntax of the ST2400 remote command language and defines all commands. Command definitions are grouped by function. In addition, an alphabetical list of all ST2400 commands is provided with page references to individual command descriptions.

Appendix A—Specifications

Software Revision

This manual supports software revision 2.2

Manual Conventions

The **ST2400 2.4 Gb/s SDH/SONET Test Set** supports both the SDH and the SONET telecommunication signal standards. This manual supports the SDH telecommunication signal standard. Both SDH and SONET have similar terminology. Therefore, the words *SONET, OC-1 OC-3, OC-12*, and *OC-48* can be substituted with the words *SDH, STM-0, STM-1, STM-4,* and *STM-16,* respectively.

In this manual, the terminology STS-n refers to an ST2400 electrical signal and STM-n indicates the equivalent SDH optical signal, all other aspects of their configurations are the same. Therefore the words *STM-1, STM-4*, and *STM-16* and the words *STS-3*, *STS-12*, and *STS-48*, respectively, have very similar meanings.

This manual users the following conventions:

Brackets *[ ]* indicate an optional software function.

The drive letter in the following statement may not be needed:

[<drive>:]

The drive letter and the path description may not be needed:

***[<drive>:][<path>]* UPLOAD**

Product Nomenclature

The name **ST2400 2.4 Gb/s SDH/SONET Test Set** is used to describe and identify the Tektronix owned product that is the subject of this manual. At times it is necessary to substitute the words **Test Set, ST2400 Test Set,** or **ST2400** for the product's full name.

Also in this manual the name **ST112 SONET Transmission Test Set** is used to describe and identify another Tektronix owned product. At times it is necessary to substitute the word **ST112 Test Set** or **ST112** for the product's full name.

Any and all such substitutions are intended to increase the readability of this document, and it should NOT be misconstrued that such usage is intended for any other propose.

Introduction

This chapter describes the **ST2400 2.4 Gb/s SDH/SONET Test Set** and provides a list of standard and optional accessories for both the SDH and SONET option and for each of the three configurations: TRANSCEIVER, TRANSMIT-ONLY, and RECEIVE-ONLY.

Product Description

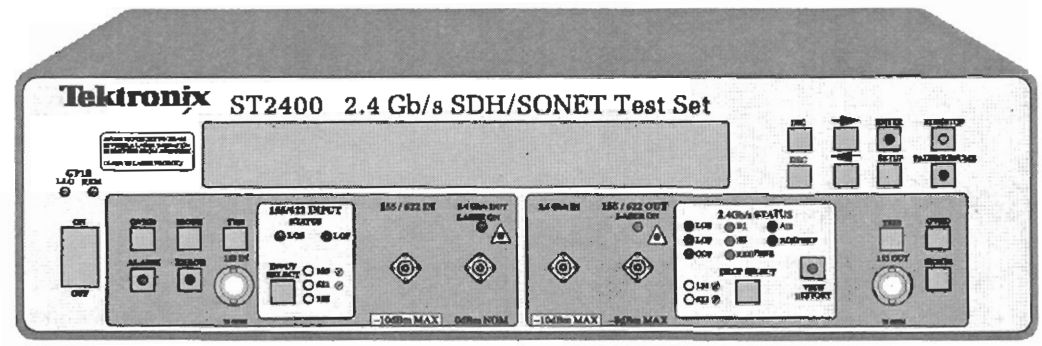


Figure 1–1 ST2400 2.4 Gb/s SDH/SONET Test Set

The **ST2400 2.4 Gb/s SDH/SONET Test Set** provides line and section signal generation and analysis for the 2.4 Gb/s SDH STM-16 or SONET OC-48 standards. The ST2400 is a versatile unit that can be ordered in one of three configurations: TRANSCEIVER, TRANSMIT-ONLY, or RECEIVE-ONLY. The front panel design (Figure 1–1) is the same for both the SDH and SONET functions. Use the following order numbers:

ST2400 STM-16/OC-48 Generator/Analyzer

ORDERING INFORMATION

Nomenclature	Description	Availability
ST2400	SDH/SONET Transceiver manual, power cord	SDH and SONET
Opt. 11	Receive Only with 2.4 Gb/s Wideband Optics	SDH and SONET
Opt. 12	Transmit Only with 1310 nm Tx Long Reach 2.4 Gb/s Optics	SDH and SONET
Opt. 13	Transceiver with Wideband Rx Optics and 1310 nm Tx Long Reach 2.4 Gb/s Optics	SDH and SONET
Opt. 14	Transmit Only with 1550 nm Tx Long Reach 2.4 Gb/s Optics	SDH and SONET
Opt. 15	Transceiver with Wideband Rx Optics and 1550 nm Tx Long Reach 2.4 Gb/s Optics	SDH and SONET
Opt. 16	Transmit Only with Switchable 1310 nm Long Reach and 1550 nm Tx Long Reach 2.4 Gb/s Optics	SDH and SONET
Opt. 17	Transceiver with Wideband Rx Optics and Switchable 1310 nm Long Reach and 1550 nm Tx Long Reach 2.4 Gb/s Optics	SDH and SONET
Opt. 1A	15 dBm FC-PC Attenuator for 2.4 Gb/s Rx	SDH and SONET
Opt. 1M	Rack Mount	SDH and SONET
Opt. 3C	Replace FC connectors with SC connectors	SDH and SONET
Opt. 4C	Replace FC connectors with ST connectors	SDH and SONET
Opt. A1	220V, Euro Plug	SDH and SONET
Opt. A2	240V, UK Plug	SDH and SONET
Opt. A3	240V, Aust Plug	SDH and SONET
Opt. A5	220V, Swiss Plug	SDH and SONET

FACTORY INSTALLED OPTIONS

Nomenclature	Description	Availability
ST2400		SDH and SONET
ST24F11	Add wideband Rx function to Tx Only Unit	SDH and SONET
ST24F12	Add 1310 nm Tx function to Rx Only Unit	SDH and SONET
ST24F15	Add 1550 nm Tx function to Rx Only Unit	SDH and SONET
ST24F17	Add dual switchable optics to Transceiver	SDH and SONET

Bellcore CLEI and CPR Product Codes

The ST2400 has been assigned the following Bellcore COMMON LANGUAGE Product Codes:

CLEI	Receive-Only Test Set (Both Frequencies):	STNQACG6AA
CPR	Receive-Only Test Set (Both Frequencies):	674835
CLEI	Transmitter-Only Test Set (Both Frequencies):	STNQACJ6AA
CPR	Transmitter-Only Test Set (Both Frequencies):	674846
CLEI	Transceiver Test Set (Both Frequencies):	STNQACH6AA
CPR	Transceiver Test Set (Both Frequencies):	674845

Overview, SDH

The ST2400 transceiver version can transmit and receive STM-16 signals. The transmitter section can internally generate a 2.4 Gb/s signal or multiplex the higher-rate signal from STM-1 or STM-4 signal inputs. The receiver section receives an STM-16 signal, demultiplexes it, and can drop out either the STM-1 or STM-4 signal as required.

The transmit-only version can generate and transmit the STM-16 signal from an internal source, or multiplex the higher-rate signal from either STM-1 or STM-4 signal inputs.

The receive-only version can receive and demultiplex the STM-16 signal and drop either the STM-1 or STM-4 signal to an auxiliary test set, as required.

The **ST2400 2.4 Gb/s SDH/SONET Test Set** is designed to integrate directly with other Transmission Analyzers, such as the Tektronix CTS750. The ST2400 unit can operate with many other STM-1 and STM-4 test sets that accept 155 or 622 Mb/s optical signals and the 155 Mb/s CMI electrical signal.

ST2400 2.4 Gb/s SDH/SONET Test Set Features and Capabilities:

- STM-16 SDH RS and MS Testing
  B1 and B2 Error Measurement
  RS and MS Alarm Detection
  MS Layer Alarm and Error Generation
- Truly portable—11.4 kilograms (25 pounds) maximum weight
- A simple menu system
- Interface Access at 155 Mb/s or 622 Mb/s
- Easily software switched between SDH and SONET
- Integrates with the CTS 750 for complete "all-rate" SDH analysis
- Wide optical range:
  3 dBm to –2 dBm Typical Output Power
  –29 dBm to –10 dBm Receiver Sensitivity
- Through Mode with Overhead Editing, Error, and Alarm Injection
- Direct user download of software updates
- CCITT/ITU G.708, G.709 and GR-253-CORE framing
- Complete Remote Control
  - RS-232 and GPIB ports, and standard printer interfaces
  - Remote Command Interpreter
- Standard tributary interfaces
  - STM-1e 155 electrical
  - STM-1 155 optical
  - STM-4 622 optical
- Interface to STE, LTE and other test equipment

The ST2400 meets the needs of development, network design, and service engineers by providing the capabilities for:

- System interrogation and conformance testing
- Manufacturing Production Testing
- Network Integrity testing
- Network Performance monitoring
- Network Troubleshooting

Accessories

Some accessory are included with the **ST2400 2.4 Gb/s SDH/SONET Test Set**. If you wish to purchase optional accessory contact your local Tektronix Representative.

Standard

- User Manual
- Certificate of Traceable Calibration
- Front Cover
- Power Cord

Optional

Interface Cables, RS-232-C, GPIB, Centronics

RS-232-C

012-1379-00	9-pin female to 9-pin male
012-1298-00	9-pin female to 25-pin male
012-1398-00	9 in. RS-232-C to plotter/printer

GPIB

012-0991-00	2m, double-shielded
012-0991-01	1m, double-shielded
012-0991-02	4m, double-shielded
012-1282-00	0.5 m, GPIB

Centronics

012-1233-00	3 m, 4693 to Terminal
012-1214-00	8 ft. Male Centronics to PC 25-Pin D
012-1284-00	9 ft. male to male

Interface Cables, used for CE Certification

1M-BM-SB142-BM	BNC to BNC (50 OHM) 1 meter length
1M-BM-4233-BM	BNC to BNC (75 OHM) 1 meter length
H1740-1	Printer Cable, 8 feet
8004570	DB25 Male to Female, 6 feet
8004569	DB9 Male to Female 6 feet
CIB24-1M	GPIB 1EEE-488 1 meter length
CIB24X	GPIB Adapter

Adapters, SMA

015-0369-00	SMA male to N
015-0572-00	SMA male to BNC male
015-0554-00	SMA male to BNC female
015-1009-00	SMA male to N female
015-0553-00	Threaded female to male slip-on connector
015-0549-00	Male to female connector (Used permanently installed to prolong life of instrument connector)
020-1693-00	SMA Kit

Attenuator, Optical

Recommended:
AMP 06-0033 FC Style Build Out Attenuator 15 dB Fixed Value
or equivalent.

Safety Instructions

⚠ **WARNING! Read and Follow all of these Safety Instructions.**
Failure to do so can cause injury to the user and damage the instrument.

AC Power

The ST2400 Test Set is designed to sense and switch line voltages between 115 VAC (90 to 132 VAC) and 230 VAC (180 to 250 VAC) and to operate at a line frequency of either 50 Hz or 60 Hz (47 to 63 Hz range). Never connect the ST2400 to a line voltage that falls outside these voltage or frequency ranges.

Ground the Instrument

The ST2400 Test Set is grounded through its AC LINE connector. Always power the ST2400 Test Set using a three-conductor power cord that is plugged into a grounded, three-conductor outlet. If you operate the ST2400 without a proper ground then all metal surfaces of the instrument can become potential shock hazards.

Use the Proper Fuse

Always replace the ST2400 Test Set's AC LINE fuse using the procedure and fuse rating specified. A 5AT fuse is used for all models: AC115, AC230, transceiver, transmit-only, and receive-only. Operating the instrument with an improper fuse will create a fire hazard.

Do Not Look Into the OPTICAL Output

The ST2400 Test Set's OPTICAL output is equipped with high-powered lasers. **Never look directly into this output or into an unterminated optical patch cord connected to this output.** If you do not follow these precautions, permanent eye injury can result.

Do Not Operate in an Explosive Atmosphere

The ST2400 Test Set does not provide protection from static discharges or arcing components and therefore must not be operated in an explosive atmosphere.

Do Not Remove Instrument Covers

To avoid a shock hazard and to maintain proper air flow, never operate the ST2400 Test Set with any of its outside covers removed.

Attenuation Requirements

Always use a 15 dB attenuator when connecting the transmitter output to the receiver input. Failure to do so will damage the optical detectors.

Laser Safety

⚠ **WARNING! Read and Follow all of these Safety Instructions.**
To prevent injury, ensure the following information is reviewed before operating this equipment.

The ST2400 Test Set is a Class IIIb (3B) laser product, which complies with the United States Food and Drug Administration (FDA) Standard 21 CFR Ch.1 1040.10 and EN 60825.

Laser classification is based on the ability of the optical beam to cause biological damage to the eye or skin. The FDA defines a Class IIIb as follows:

"Class IIIb limits apply to devices that emit in the ultraviolet, visible, and infrared spectra. Class IIIb products include laser systems ranging from 5 to 500 mw in the visible spectrum. Class IIIb emission levels are ocular hazards for direct exposure throughout the range of the Class, and skin hazards at higher levels of the Class."

This unit is in the Class IIIb category because it has a maximum output power of 10 mw and has a center wavelength of 1310 nm. This means that the laser radiation emitted from the module is in the near infrared spectrum, which is invisible to the human eye. Laser radiation in this region of the spectrum can cause damage to the retina of the eye.

Safety Mechanisms

This equipment incorporates four safety mechanisms to prevent accidental or unauthorized emission of laser radiation. These are listed as follows:

- Remote Interlock Connector
  Allows connection of a remote barrier interlock, emergency stop, switch, or similar device used to disable the laser.
- Key Control
  Prevents the laser from being activated when the key is set to the "0" OFF position. Setting the key to the "0" OFF position when the laser is active disables the laser.
- Laser Radiation Emission Warning Indicator
  The laser "ON" LED indicates that the laser is on. When the LED is off the laser is off.
- Laser Connector Cover
  This Cover must be screwed on when the cable is disconnected from the optical output connector.

Safety Precautions

To avoid exposure to hazardous laser radiation, it is recommended that the following practices are observed when operating this equipment:

- Always use serviced-trained personnel, who are aware of the hazards involved, to work with laser based equipment, circuits, and networks.
- Never examine or stare into an open or broken optical when it is connected to any laser output device or equipment—whether or not that laser is activated.
- Always assume that the laser is on whenever it is not connected to a circuit or covered.
- Always use an external device, such as a *Remote Interlock Switch* (not supplied with this equipment), connection to the rear panel REMOTE INTERLOCK connector.
- Always deactivate the laser before connecting or disconnecting optical cables. To deactivate the laser, use the following method:
    - Set the laser to OFF using the applicable LCD setup menu.
    - Set the real panel key switch to the "0" OFF position.
    - Set the *Remote Interlock Switch,* or similar device, to the off position.
    - Verify that the laser LED is off.
- When connecting or disconnecting the optical cables between this equipment and the circuit, network, or equipment-under-test, use the following connection sequences.
    - **Connecting:** Before activating the laser output (1) connect all optical cables to the equipment-under-test, circuit, network, and this equipment (2) ensure that the circuit is complete and properly terminated.
    - **Disconnecting:** Before disconnecting any part or piece of the network, circuit, or equipment-under-test (1) ensure that the laser is deactivated as detailed above.

Warning Labels

Before using this equipment and while this equipment is in use, always inspect it to ensure that the following warning labels are visible and free from damage:

- The CLASS 3B LASER label should be on the front panel, left of the LCD Display area.
- A CLASS IIIB LASER DANGER label should be located on the top panel.

The laser output is labeled with a Laser Hazard Label shown in *Chapter 2* of this manual.

Safety Certification Compliance

Category	Standard
Temperature (operating)	+5 to +40°C
Altitude (maximum operating)	2000 meters
Equipment Type	Test and Measuring
Safety Class	Class 1 (as defined in IEC 1010-1, Annex H) - grounded product
Overvoltage Category	Overvoltage Category II (as defined in IEC 1010-1, Annex J)
Pollution Degree	Pollution Degree 2 (as defined in IEC 1010-1). Note - Rated for indoor use only.

Low Voltage Declaration

Category	Standard
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC EN61010-1/A1 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

Safety Standards

Category	Standard
U.S. Nationally Recognized Testing Laboratory Testing (NRTL)	UL 1244 - Electrical and Electronic Measuring and Testing Equipment
Canadian Certification	CAN/CSA-22.2 No. 231 CSA Safety Requirements for Electronically and Electronic Measuring and Testing Equipment

Functional Overview

This section describes **ST2400 2.4 Gb/s SDH/SONET Test Set** controls, indicators, connectors, display elements, and menu structures. It includes separate seetions that detail receiver and transmitter specifics, and general sections that apply to both.

Front Panel Controls, Indicators, and Connectors

Figure 2–1 shows a complete view of the front panel. It includes an enlarged view of the Laser Product Warning Label.

⚠ **WARNING!** Always avoid exposure to the laser beam. Before power is applied to the **ST2400 2.4 Gb/s SDH/SONET Test Set** be sure that all laser outputs are either covered with the screw cap provided or connected to the appropriate circuit.

Figure 2–1 ST2400 Front Panel

The front panel can be divided into five functional sections:

- Display, Display Controls, and one LED Indicator
- Transmitter Controls, Connectors, and Status LED
- Receiver Controls, Connectors, and Status
- LEDs
- Measurement Controls and Indicators
- GPIB LED Status Indicators

Display, Display Controls, and Indicators

Figure 2–2 shows the **ST2400 2.4 Gb/s SDH/SONET Test Set** display and display controls. The display is a two-line by twenty-four character back-lit super twisted Nematic LCD (liquid crystal display) that provides a sharp image and increased viewing angle in all directions.

The LCD display is used to present main menus, submenus, and test results. There are five display controls and one LED indicator. The right and left arrows are used to position the LCD cursor. The INC (increment) and DEC (decrement) keys are used to change values. The ENTER key is used to insert the selected value.

The ENTER key houses an LED indicator that flashes whenever an action is requested or required. It will continue to flash until the ENTER key is pressed, entering a new value or executing the function.

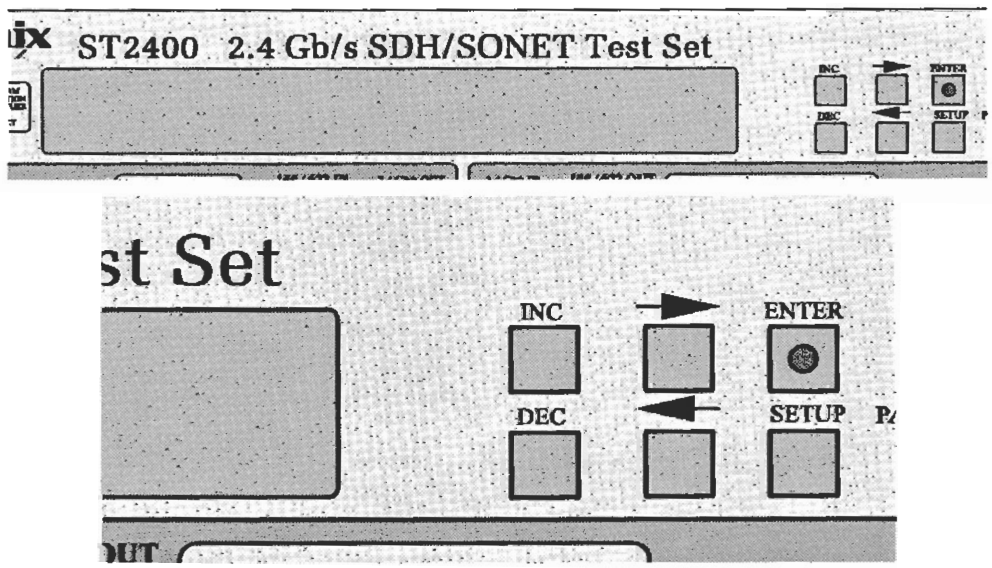


Figure 2–2 ST2400 LCD Display

Setup Menu System

The SETUP key is located below the ENTER key on the front panel. Pressing the SETUP key at any time will start the menu sequence, as Figure 2–3 shows. Each additional press, represented by the black arrow, will access the next menu. The number of main menus is mode dependent—seven in the transmit mode and five in receive. Some main menus have submenus, omitted in this chapter, but detailed in *Chapter 3 LCD Menus and Displays*. The SETUP menus are arranged in a continuous loop. Press any other key to exit the setup mode.

⚠ WARNING!

Before activating the 2.4 Gb/s LASER its output must be connected to a circuit.

⚠ CAUTION!

Always use 15 dB of attenuation when connecting the ST2400 transmitter output to its receiver input. Failure to do so will damage the optical detector.

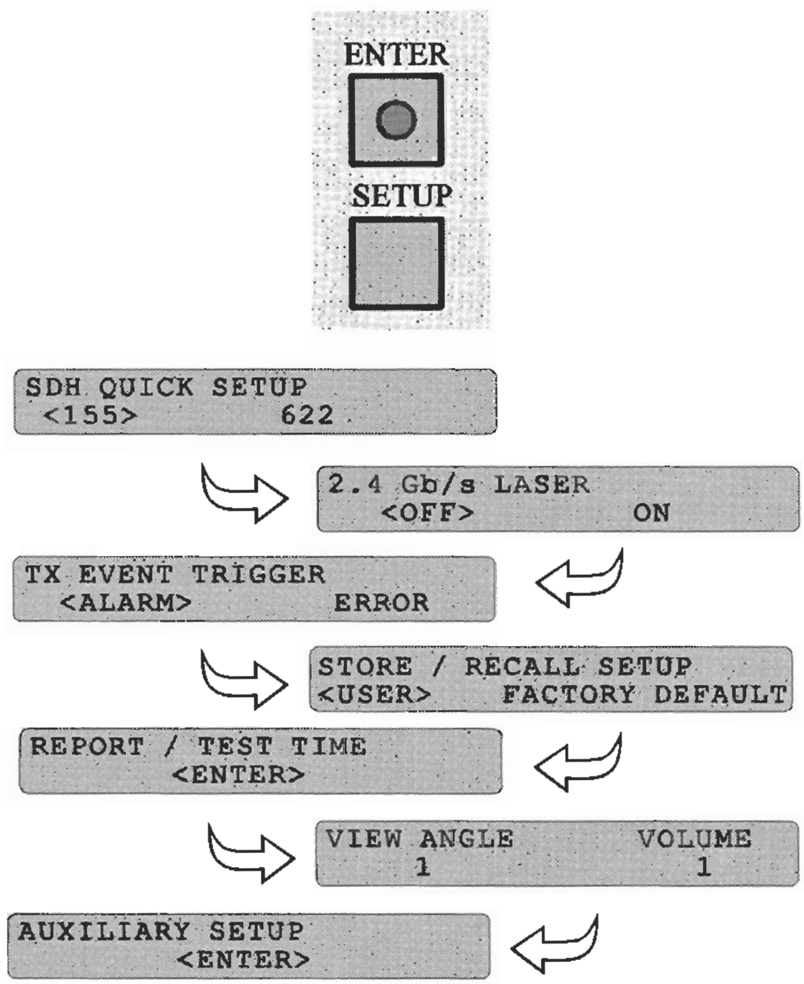


Figure 2–3 Setup Main Menus

Transmitter Description

This section describes the transmitter inputs, outputs, controls and indicators. Figure 2–4 shows the **ST2400 2.4 Gb/s SDH/SONET Test Set** transmitter front panel area.

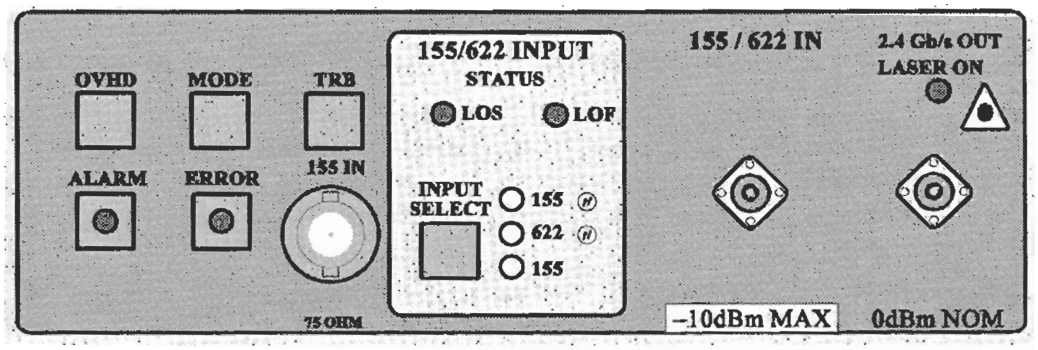


Figure 2–4 Transmitter Front Panel

Transmitter Connectors

There can be three connectors on the transmitter front panel—one CMI (Code Mark Inversion) electrical and two optical. The CMI electrical carrier connector is an industry standard BNC that is marked **155 IN**. It provides a 75 ohm load impedance and direct coupling (DC) for the 155 Mb/s SDH electrical signal.

On the right side of the transmitter section are two industry standard FC/PC optical connectors—one input and one output. ST and SC connectors are available as an option. The input optical connector is marked **155/622 IN**; it accepts either STM-1 or STM-4 signals. The output optical connector is marked **2.4 Gb/s OUT**; it outputs an STM-16 signal. Both are equipped with screw caps to protect the optics from airborne contamination, such as dust. Optical devices can be cleaned by using compressed air or with a Microtip Medium Swab dipped in isopropyl alcohol that has greater than 70 percent alcohol. Fiber optic cables should also be cleaned before connection with a lint free wipe and isopropyl alcohol.

⚠ WARNING!

Before activating the 2.4 Gb/s LASER its output must be connected to a circuit.

⚠ CAUTION!

Always use 15 dB of attenuation when connecting the ST2400 transmitter output to its receiver input. Failure to do so will damage the optical detector.

Transmitter Status Indicators

The **155/622 INPUT STATUS** section has five LED indicators—three yellow and two red. The SELECT key is used to choose between the two optical inputs and one electrical. When the input is external, the yellow LEDs indicate which input has been chosen.

The two red indicators are labeled LOS (Loss Of Signal) and LOF (Loss Of Frame). They monitor the 155 and 622 inputs for those alarm conditions. Both LEDs are off when the appropriate incoming signal is present. They are disabled when the unit is internally generating a 2.4 Gb/s or is in the through mode (see the *Mode Key* section).

Mode Key

Pressing the MODE key will access the transmitter input selection menu shown in Figure 2–5. It is used to choose one of the three data sources that will produce the 2.4 Gb/s output signal and select the wavelength when a dual wavelength transmitter option is installed. The three choices are: EXT, an external input tributary from the transmitter front panel; INT, an internally generated 2.4 Gb/s signal; and THRU, a through input from the receiver section.

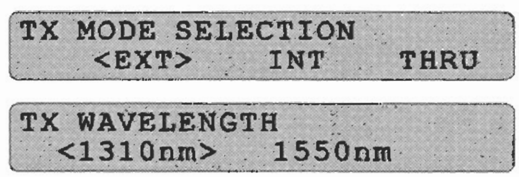


Figure 2–5 Transmitter Input and Weavelength Menu

The EXT input can be 155 Mb/s optical (STM-1), 622 Mb/s optical (STM-4), or 155 Mb/s CMI electrical signal. The appropriate yellow status LED will indicate the input signal. There are three yellow LED indicators on the transmitter 155 / 622 Input Status section, two optical and one electrical.

The INT mode generates an unequipped SDH 2.4 Gb/s (STM-16) signal with valid transport overhead bytes that can be modified.

The transceiver THRU mode will output a modified 2.4 Gb/s SDH signal that entered the receiver section from an external source before modification. All three yellow status LEDs will be off when the ST2400 is in the THRU (Through) mode.

The transceiver WAVELENGTH menu will only be present when the dual wavelength option is installed. Use the arrow keys to move the cursor to either 1310nm or 1550nm and the enter key to select the value.

Tributary and Input Select Keys, Transmitter

The transmitter TRIB key is used with the INPUT SELECT key to configure input groupings. STM-16 has sixteen STM-1 channel groups or four STM-4 channel groups.

OVHD Key, Transmitter

The transmitter OVHD (Overhead) key provides access to the Remote Section and Multiplex Section overhead bytes in the first column of the first STM-1. Figure 2–6 shows the menu used to access the E1 byte. A field change occurs when an arrow key is used to move the cursor from PASS to SET. The field change shows the current value of the particular overhead byte being viewed. Greater detail is provided in *Chapter 3 LCD Menus and Displays*.

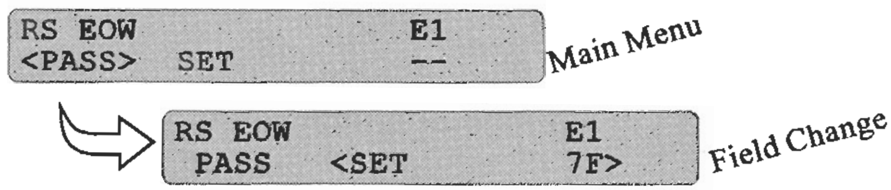


Figure 2–6 Overhead Menu Access

Alarm Key, Transmitter

The transmitter alarm key is used to inject any of the alarms in one of four modes: continuous, timed, burst, or repeat at specific intervals. The alarm displays and menus are detailed in the next chapter. The LED indicator in the alarm key will be illuminated whenever an alarm is active.

Error Key, Transmitter

The transmitter error key is used to generate specific error conditions that are detailed in *Chapter 3 LCD Menus and Displays*.

Receiver Description

This section describes the **ST2400 2.4 Gb/s SDH/SONET Test Set** receiver front panel inputs, outputs, controls, and indicators shown in Figure 2–7.

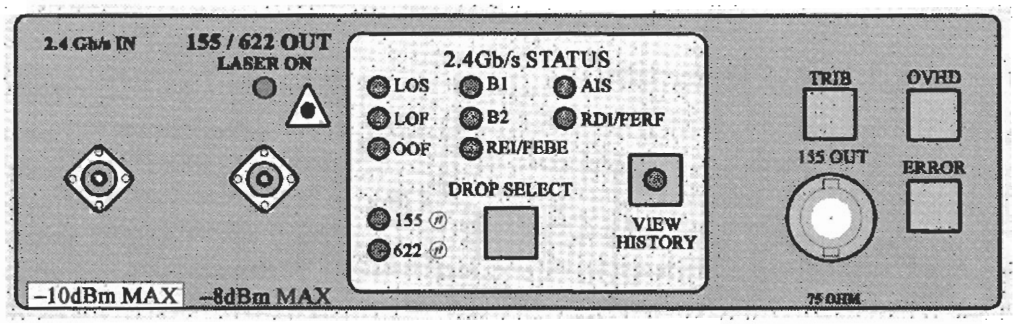


Figure 2–7 Receiver Front Panel

Receiver Connectors

There are three connectors on the receiver front panel—one CMI (Code Mark Inversion) electrical and two optical. The CMI electrical signal connector is an industry standard BNC that is marked **155 OUT**. It provides the 75 ohm load impedance and direct coupling (DC) for the SDH electrical signal.

The two industry standard FC/PC optical connectors are on the left side of the receiver section, one input and one output. ST or SC connectors are available as an option. The input optical connector is marked **2.4 Gb/s IN**, it accepts the STM-16 signal. The output optical connector, marked **155/622 OUT**, outputs STM-1 and STM-4 tributary signals. Both are equipped with screw caps to protect the optics from airborne contamination, such as dust. Optical devices can be cleaned by using compressed air or with a Microtip Medium Swab dipped in isopropyl alcohol that has greater than 70 percent alcohol. All fiber optic cables should also be cleaned before connection with a lint free wipe and isopropyl alcohol.

⚠ **WARNING!**

Before activating the 2.4 Gb/s LASER its output must be connected to a circuit.

⚠ **CAUTION!**

Always use 15 dB of attenuation when connecting the ST2400 transmitter output to its receiver input. Failure to do so will damage the optical detector.

Receiver Status Indicators

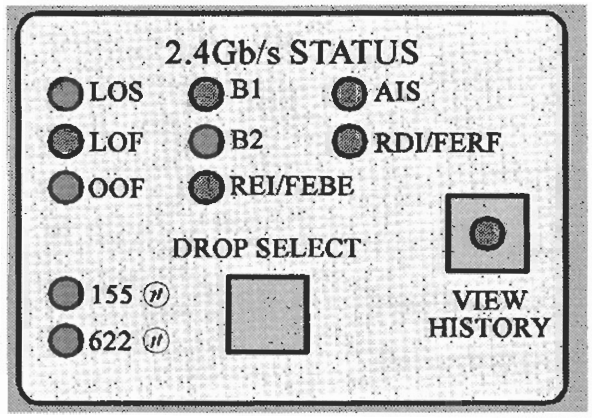


Figure 2–8 Receiver Status Indicators

The status indicators (Figure 2–8) include the alarms and errors detailed below. The appropriate LED indicator will light for a minimum of 200 milliseconds when a corresponding alarm or error is detected. Detected errors and alarms are stored as historical data.

The receiver LOS (Loss Of Signal) alarm indicates that the 2.4 Gb/s signal has been off for more than 2 microseconds. The LOS alarm will be asserted no later than 127 microseconds after receiving the low signal (all zero) condition.

The receiver LOF (Loss Of Frame) alarm indicates that more than 3 milliseconds of an *out of frame* condition has occurred.

The OOF (Out Of Frame) alarm indicates that more than 4 consecutive frames of the 2.4 Gb/s signal had frame alignment errors.

The B1 and B2 LEDs indicate that Remote Section or Multiplex Section (respectively) parity errors were detected.

The REI/FEBE (Remote Error Indication or Far End Block Error) indicates that a non-zero value in the REI byte was detected.

The RDI/FERF (Remote Defect Indication or Far End Receive Failure) alarm indicates that bits 6, 7, and 8 of the K2 byte have been a binary 110, respectively, for five or more consecutive frames.

The AIS (Alarm Indication Signal) indicates that bits 6, 7, and 8 of the K2 byte have been a binary 111, respectively, for five or more consecutive frames.

The 155 and 622 LEDs function in conjunction with the DROP SELECT key to indicate which optical drop rate has been selected. Both LEDs are off when the 155 Mb/s electrical drop is selected.

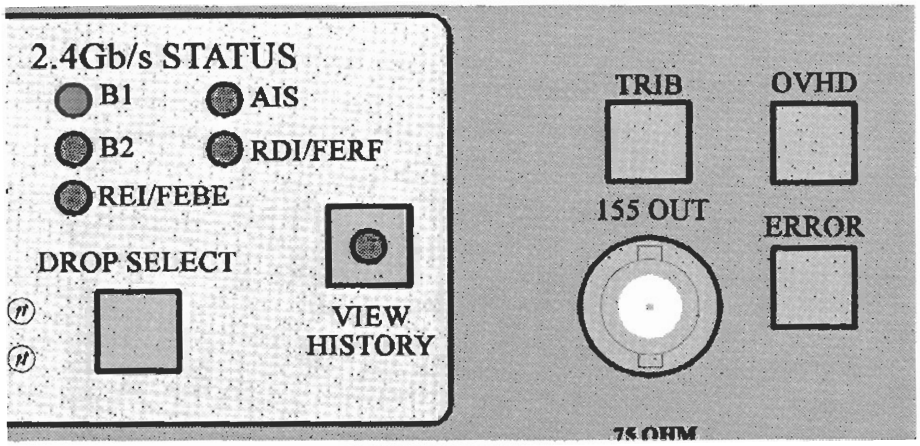


Figure 2–9 Receiver Control Keys

View History Key

The VIEW HISTORY key reviews past alarms and errors. A history status bit is set, and the status LED built into the key is lit whenever an alarm or error is detected during the run mode. Pressing this key will display the history status of the alarm and error LED indicators instead of the current status. Releasing this key will return to the current status display within 200 milliseconds. History is cleared when a new test cycle starts.

Drop Select Key, Receiver

The DROP SELECT key is used to select one of three drops from the 2.4 Gb/s (STM-16) signal. The 155 Mb/s signal (STM-1) can be either electrical or optical. The 622 Mb/s (STM-4) signal is always optical.

Tributary Select Key, Receiver

The receiver TRIB key is used to select the drop side tributaries. One of sixteen 155 Mb/s (STM-1) tributaries or one of four 622 Mb/s (STM-4) tributaries can be selected from the 2.4 Gb/s (STM-16) signal. The Drop Select Key was used to choose either the STM-1 or STM-4 drop.

OVHD Key, Receiver

The receiver OVHD (Overhead) key permits viewing of the Remote Section and Multiplexed Section overhead bytes in the first column of the first STM-1 frame, including APS (Automatic Protection Switching). Some of these bytes may be used to perform testing—review the *OVHD Key, Transmitter* section previously presented in this chapter.

Measurement Controls and Indicators

Figure 2–10 shows the **ST2400 2.4 Gb/s SDH/SONET Test Set** Measurement Controls and indicators. The RUN/STOP key provides duration control over the test cycle. RUN clears all counters, clears history data, and starts the test cycle. STOP halts the test cycle without effecting counter values. The green LED indicator, inside the key, is on during the RUN cycle. A stopped test can be restarted using the pause-run-resume sequence, saving stored history data.

The PAUSE/RESUME key permits a temporary stop of the test cycle. The red LED indicator is on when the test cycle is in the pause mode. Pressing the key, once again, extinguishes the LED and resumes the test. All counters are suspended in the PAUSE mode and continue from that point when the test cycle is resumed (RESUME).

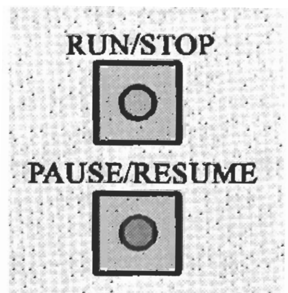


Figure 2–10 Measurement Controls and Indicators

Remote Indicators

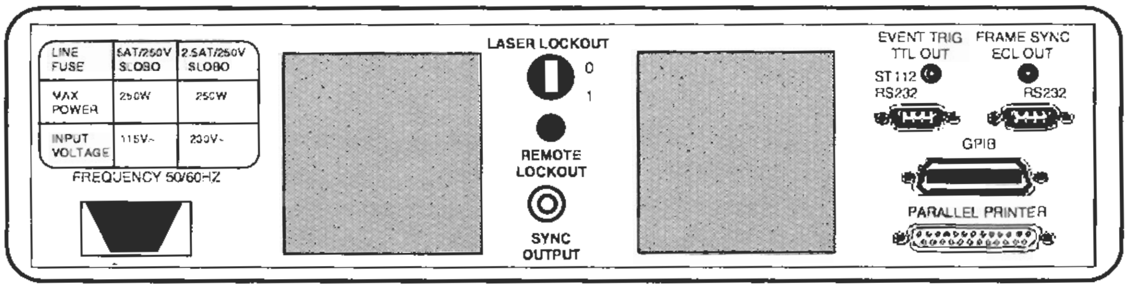
Figure 2–11 shows the two GPIB front panel LED status indicators. The Remote Operation (REM) LED indicates that the ST2400 is being controlled through its GPIB connection. The REM LED is off when the unit is in the local mode or is being controlled by an RS-232C connection. Front panel control is restored when the SETUP key is pressed.

In the Local Lockout (LLO) mode, the **ST2400 2.4 Gb/s SDH/SONET Test Set** front panel is disabled by a remote controller that is using GPIB access commands. Front panel control can only be restored by the appropriate GPIB command or by a power initialization cycle. Power initialization should only be used when the ST2400 is not being remotely operated.

Figure 2–11 Communication Indicators

Rear Panel Description

This section describes the rear panel controls and connectors. The figure shows the rear panel and an enlargement of the AC power section.



Rear Panel - ST2400

The AC power module is located in the lower left-hand corner of the rear panel. It has a removable fuse panel that can be opened with a small flat blade screw driver after the AC Line Cord has been unplugged. The AC power supply automatically detects and switches to accept either 115 (90 to 130 VAC or 230 (180 to 250) VAC inputs. A 5AT fuse is used with either AC source voltage.

⚠ **WARNING!** Always disconnect the AC Power Cord before opening the fuse panel or disconnecting the rear panel AC interlock.

SYNC Output

SYNC Output (Clock Trigger) is an AC-coupled output. The voltage level is 500 mV peak-to-peak minimum. This output needs a 50-Ohm termination to work properly. This output is used to trigger a oscilloscope to measure the eye diagram of an OC-48/STM-16 signal.

Laser Lockout, Remote Interlock

LASER LOCKOUT is a safety device. The key switch disables the Transmitter's 2.4 Gb/s laser output when its turned to the 0 (zero) position. The laser output can only be turned on when the key is in the 1 (one) position.

REMOTE INTERLOCK is a bantam plug normally closed connection internally wired in series with the laser lockout key switch. It can be used with additional hardware to disable the Transmitter 2.4 Gb/s laser output.

NOTE: The Transmitter 2.4 Gb/s Laser output cannot be enabled unless:

- The Laser Lockout key switch is set to the on (1) position.
- The Remote Interlock, which is normally enabled, is either not used or externally enabled.
- The Laser output is software enabled, as described in the *LCD Menus and Displays* chapter, or the *Virtual Front Panel* chapter.

⚠ **WARNING!**

Before activating the 2.4 Gb/s LASER its output must be connected to a circuit.

⚠ **CAUTION!**

Always use 15 dB of attenuation when connecting the ST2400 Transmitter output to its receiver input. Failure to do so will damage the optical detector.

Rear Panel Connectors

There are two BNC, two 9-pin RS-232, one GPIB, and one parallel printer.

Event Trigger and Frame Sync signals are accessible through individual BNC connectors shown in and located on the upper right rear panel. Either can be connected to an event counter or used to trigger an oscilloscope.

- The Event Trigger is a TTL output that is generated by any one of the following Transmitter programmed alarm and error conditions (AIS, FERF, LOS, and frame errors—including LOF), or by changing an overhead byte value. The event trigger signal is a minimum of 2.4 Vpeak, with a pulse width of 25 ns ±10%, and leads the event by less than 1µs.
- The Frame Sync has an ECL output that is generated by the transmitted framing bytes, A1 and A2. The frame sync signal is a minimum of 600 mvpp, with a pulse width of 25 ns ±10%. The pulse repetition rate is equal to the 125µs frame rate.

The two DB-9 receptacles are RS-232C 9-pin serial interface connectors. One is marked for use with the ST112. It can be used with a VT-100 terminal or PC running VT-100 terminal emulation software. The ST112 is only supported in the SONET configuration or mode. The other is marked RS232 it can be used for remote operations or with a serial printer.

The GPIB receptacle is an IEEE-488.2 standard connector provided for remote operation.

The DB-25 receptacle is a Centronics parallel printer interface.

Getting Started

Unpacking

Unpack the **ST2400 2.4 Gb/s SDH/SONET Test Set** and place the unit on a hard firm surface.

ST2400 Installation

Before using the ST2400 verify that it is properly set up and powered on, as follows:

1. Remove the unit from its shipping carton and place it on a hard firm surface.
2. Verify that the operating environment is within the limits detailed under the Environmental Requirement section in this manual.
3. Allow approximately 2 inches (5 cm) clearance for cooling on the top and rear of the unit. The two rear panel fans draw air into the ST2400 which is exhausted through the top vents.
4. Wire the unit for a chosen application. Never exceed the maximum optical power limits (–10dBm) listed on the front panel. Always cover the unused OC connectors.

   ⚠ **CAUTION!**
   Signal levels greater than –10dBm (negative 10dBm) may damage the Optical Input devices. Always pad the input level to less than –10dBm.

5. Verify that the rear panel key lock is in the desired position.
6. Plug the unit into the appropriate AC Power source as follows:

Table 2–1 Power Requirements

AC Voltage	Voltage Range	Frequency Range	Maximum Power
110 VAC	90 VAC - 132 VAC	48 - 62 Hz	200 Watts
220 VAC	180 VAC - 250 VAC	48 - 62 Hz	200 Watts

LCD Menus and Displays

This chapter describes the use of the ST2400 LCD menu structures and displays. In addition to general displays and menus, there are separate sections that detail setup, receiver, and transmitter specifics.

Functional Verification

A functional verification of the **ST2400 2.4 Gb/s SDH/SONET Test Set** can be performed while reviewing this chapter. To do so, use an optical cable and a 15 dB attenuator connected between the transmitter laser output the receiver laser input, as shown in Figure 3–1. To avoid damaging the receiver input always use a 15 dB attenuator in the loopback connection. Be sure to read and observe all of the appropriate safety rules and instructions in *chapters 1 and 2*.

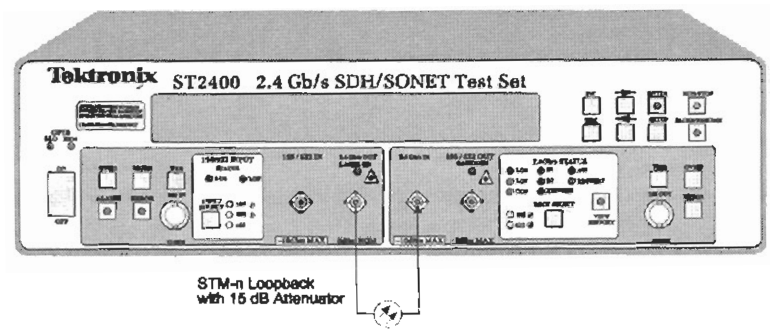


Figure 3–1 Functional Verification Test Setup

Setup Menu System

Pressing the setup key at any time will cause the **ST2400 2.4 Gb/s SDH/SONET Test Set** to enter the Setup Menu System, accessing the menus and submenus shown in Figure 3–2 and Figure 3–3. Both the setup and the enter keys are used to navigate through this menu system. The left and right arrow keys, and the increment and decrement keys are used to change values. The enter key is also used to access submenus shown in both Figure 3–2 and Figure 3–3.

The left column of Figure 3–2 shows the seven main menus that make up the Setup main menu system. It is a continuous loop that begins with the XXXxx Quick Setup LCD display, whenever the setup key is pressed, and ends with the Auxiliary Setup display menu. As noted in the Figure 3–2, the word XXXxx will either be SDH or SONET. That choice is made in the System Configuration submenu shown at the bottom of Figure 3–3. This manual details the SDH features.

When power is applied the first three LCD displays will show:

1. The *Tektronix/MWL Products* logo and *Copyright* notice.
2. Performing Self-test and Serial Number.
3. *ST2400* logotype and *Software Version* number and all front panel LEDs will illuminate, verifying their operation.

The third power-up LCD display and all of the illuminated LED indicators will be continuously displayed when you press and hold the VIEW HISTORY key before the power switch is set to on, and continue to hold it in during the power up cycle. The OUICKSET LCD will not be displayed until you release the VIEW HISTORY key.

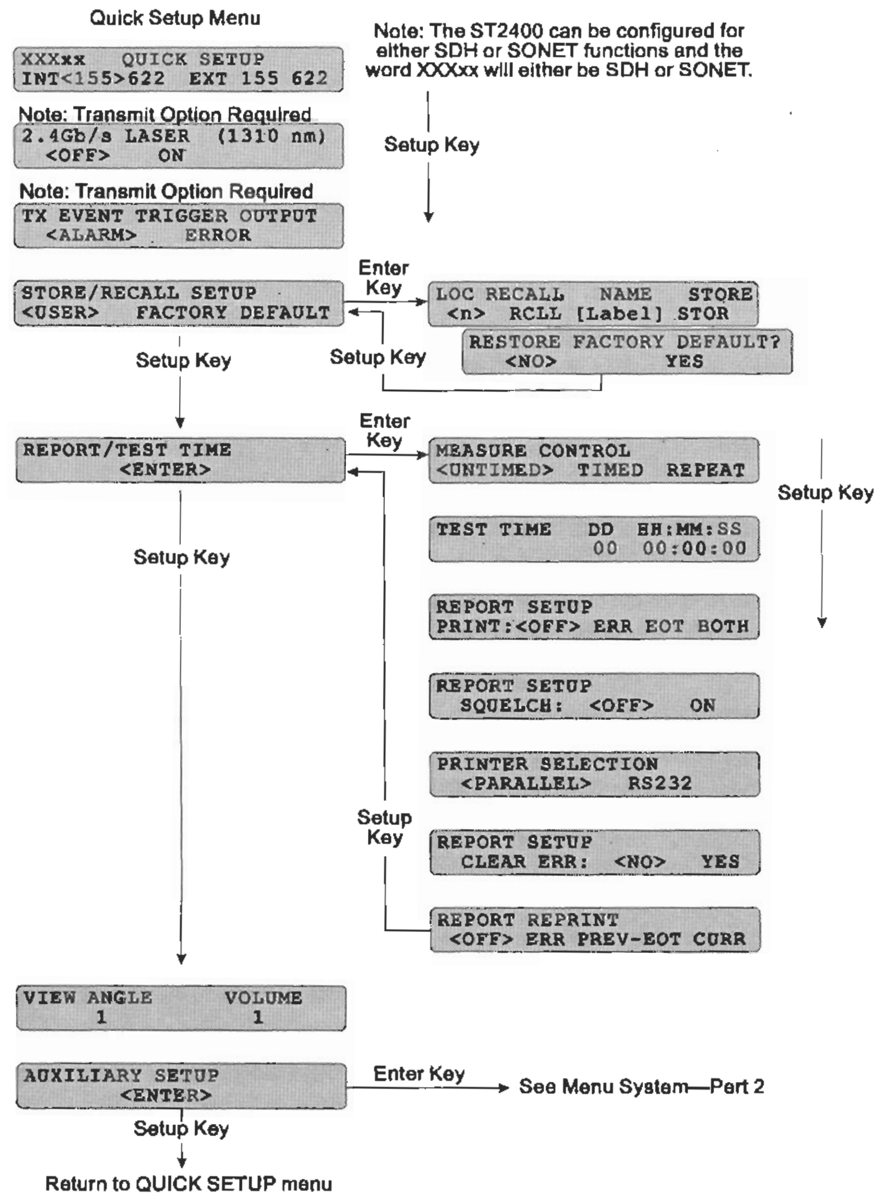


Figure 3–2 Menu System—Part 1

- The next LCD display is the XXXxx QUICK SETUP menu. The mode dependent word XXXxx will be either SDH or SONET. The menu choices are used to select the receiver drop frequencies, either 155 Mb/s (STM-1) or 622 Mb/s (STM-4), from either an internally (INT) generated 2.4 Gb/s (STM-16) rate or an externally (EXT) supplied 2.4 Gb/s (STM-16) rate. When the choice is made, by pressing the enter key, alarms and errors, if on, will be turned off. Overhead byte values will be reset and set to pass mode. The next menu will be automatically displayed. But, for safety, the QUICK SETUP will not activate the 2.4 Gb/s transmitter laser. Before it can be activated the ST2400 Test Set must be powered on, the rear panel keylock, remote interlock, and software control (in the 2.4 Gb/s LASER menu) must all be enabled.

⚠ WARNING!

Before activating the 2.4 Gb/s LASER its output must be connected to a circuit.

⚠ CAUTION!

Always use 15 dB of attenuation when connecting the ST2400 transmitter output to its receiver input. Failure to do so will damage the optical detector.

- Press the setup key to access the 2.4 Gb/s LASER menu. It is the first of two that are only displayed when the transmitter is installed. The Laser is off when the ST2400 is first powered on and can only be activated when the rear panel laser lockout key-lock is in the on position. To activate the laser use either arrow key to move the cursor to the *ON* position, then press the enter key. The laser has a five second delay when activated.
- Another push of the setup key will access the TX EVENT TRIGGER OUTPUT menu, the second transmitter only display. It is used to select whether an alarm or an error condition will be used to generate the event trigger pulse from the rear panel BNC connector. The event trigger is 2.4 Vpeak minimum, with a pulse width of 25 ns ±10%, and leads the event by less than 1µs. It can be used to synchronize other equipment, such as an oscilloscope trigger source.
- The STORE/RECALL SETUP menu is next. It is used to access either the USER stored setup or the FACTORY DEFAULT setup. Pressing the enter key will access the submenu from which one of the ten LOC (locations) can be RCLL (recalled) or STOR (stored). Up to ten individual user setups can be saved in memory locations 0 through 9. A unique 10 character label can be stored with each saved setup. The arrow keys are used to position the cursor anywhere in the label area, and the INC or DEC key is used to scroll through the ASCII characters—including numbers and symbols. Moving the cursor to FACTORY DEFAULT and pressing the enter key will access that NO or YES menu—that defaults to NO. Moving the cursor to YES and pressing the enter key will restore the factory default configuration. Pressing the setup key will return to the STORE/RECALL SETUP display.
- REPORT / TEST TIME is the next setup menu. It is used to access a complete set of measurement control, test, and report submenus that will be detailed in the next section of this chapter. Pressing the setup key will move to the next main menu.
- The VIEW ANGLE can be set to one of eight integers (0 through 7). Zero should be the best view angle when the ST2400 is positioned below the operator and 7 is best when the operator is looking up at the ST2400 front panel. The change is interactive; it is executed whenever the increment or decrement key is pressed. In the same menu, the VOLUME can be set using integers 0 through 9. Zero is off and 9 is the loudest. Errors and alarms activate the beeper, unless the volume is set to zero. The operator setting will be retained when the Test Set is powered off.
- AUXILIARY SETUP is the last of the seven main setup menus. Pressing the setup key will loop back to the QUICK SETUP (starting) menu. Pressing the enter key will access the auxiliary setup menu system shown in Figure 3–3 and described later in this chapter.

Report/Test Time Menu System

The REPORT/TEST TIME main menu provides access to the seven submenus used to configure the measurement control, test time, and report setup. Pressing the enter key will access the MEASURE CONTROL menu.

- The MEASURE CONTROL menu sets the test cycle to be used when the run key is pressed. UNTIMED will run until the stop key is pressed. TIMED will run the test for the duration of time set in the TEST TIME menu. REPEAT will run the test for the duration of time set in the TEST TIME menu, then start the test again. The stop key can stop any test that is running.
- Next is the TEST TIME menu used to set the test run duration, in terms of days (D), hours (HH), minutes (MM) and seconds (SS). The maximum time supported is 9 days, 23 hours, 59 minutes, and 59 seconds. Press the enter key to store any changes and the setup key to move to the next menu.
- Next is the REPORT SETUP menu used to control the printed report. It can be set to OFF—no printout, ERR—print a report when an error is detected, EOT—print a report summary at the end of test, or BOTH—print on error and at the end of test. The printer can be connected to either the parallel or serial (RS-232C) port. Parallel is the factory default setting.
- The REPORT SETUP SQUELCH menu is used to limit the total number of errors logged, saving memory space. When squelch is set to ON error recording will stop after 10 consecutive seconds with errors. Then error recording will be resumed after 10 consecutive seconds without any errors.
- The PRINTER SELECTION menu offers either PARALLEL or RS232 (serial) printer selection. The printer should be connected to the appropriate port on the ST2400 rear panel.
- In the REPORT SETUP menu CLEAR ERR (error) is used to clear the error log by moving the cursor to YES and pressing the enter key. It immediately clears the error log and returns to NO after execution. The error log should be cleared before running a long test, preventing buffer overflow. An error log warning message will be displayed when the run key is pressed, if the log is 95% full.
- The REPORT REPRINT menu is used to print the previous error log (ERR), the previous end of test summary (PREV–EOT), or the current error log (CURR) if it exist.

Auxiliary Setup Menu System

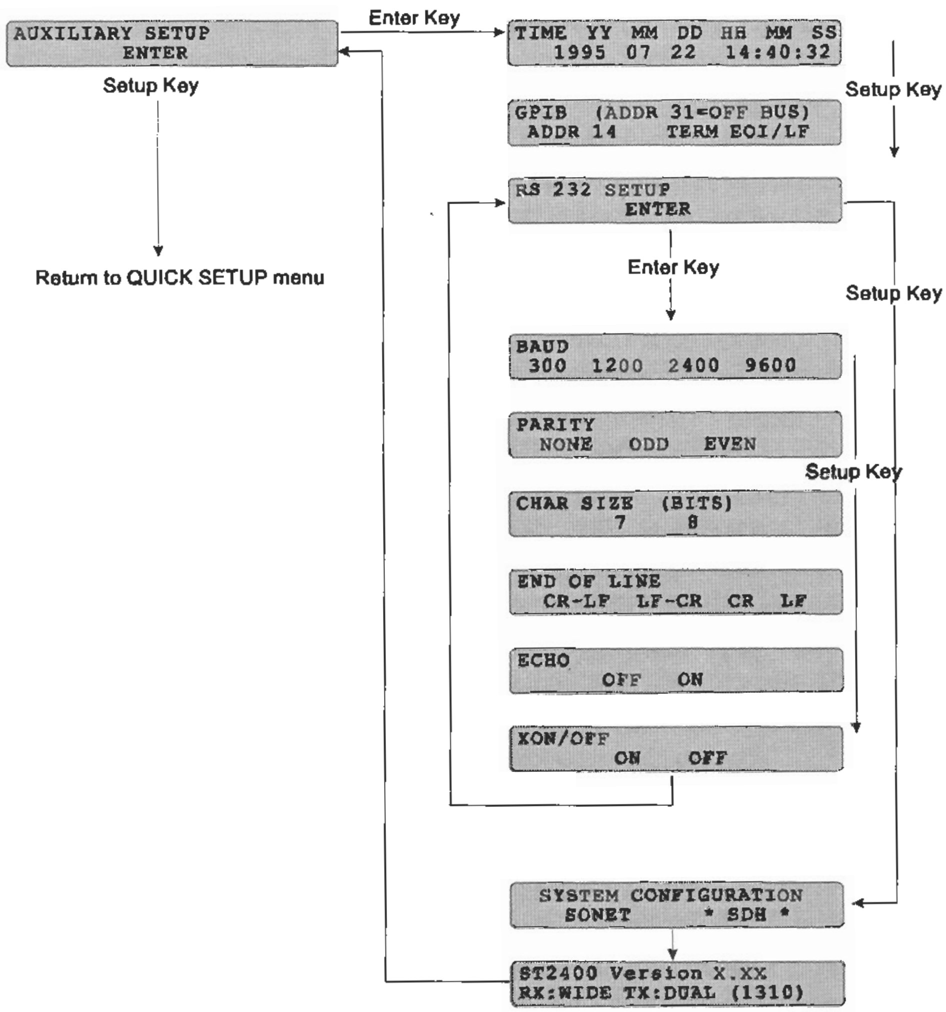


Figure 3-3 Menu System—Part 2

The left column of Figure 3–3 shows the auxiliary setup menu which is part of the seven Setup main menus. The right side shows the auxiliary submenus. Press the enter key to access them.

- TIME is the first submenu accessed from the auxiliary setup menu. It is used to store the year current (YY), month (MM), day (DD), hours (HH) minutes (MM), and seconds (SS), in a battery backed memory. Whenever changes are made, the enter key LED will start flashing. Once set, the operator setting will be retained when the Test Set is powered off.
- Use the setup key to access the GPIB port characteristics menu. The port address is an integer from 0 to 31. It can be changed with the INC or DEC keys. The enter key LED will flash, push it before proceeding. Either an EOI (End-Or-Identify) or EOI/LF (End-Or-Identify with a Line Feed) can be used to terminate the GPIB message sent by the ST2400.

- Next is the RS 232 SETUP menu. Pressing the enter key will access to the first of six port configuration submenus. They store the characteristics for BAUD rate, PARITY, CHAR (character) SIZE, END OF LINE, ECHO, and XON/XOFF (flow control).
- The SYSTEM CONFIGURATION menu can be obtained by pressing the setup key from the RS 232 SETUP menu. The ST2400 has both SDH and SONET modes. The active mode is set when the unit is powered on. It has an asterisk (*) on both sides. Figure 3–3 shows that the SDH mode is active. Using the arrow key to move the cursor to the SONET and pressing the enter key to select the SONET mode. A momentary display, that reads: *Measurement mode changed, cycle power to enable* prompts the user to power off the ST2400 and reapply power. After the power-up displays the first LCD menu will now read SONET QUICK SETUP.
- Pressing the setup key again will loop to the ST2400 Version X.XX characteristic display. It provides a software version number and the laser wavelength for both the receiver and transmitter. In Figure 3–3 a broad-band receiver, *RX: WIDE*, is shown indicating that both 1310 and 1550 nanometer lasers are supported. The transmitter wavelength, *TX: DUAL*, indicates that the transmitter can be switched to either 1310 or 1550 nanometers. The current transmitter wavelength is also shown—*(1310)* in this example. The transmitter MODE key is used to change the TX wavelength, in a dual wavelength unit.
- Pressing the setup key again will return to the AUXILIARY menu in the quick setup main menu loop. Another press of the setup key will, once again, return to the QUICK SETUP main menu display shown in Figure 3–2.

General Menus and Displays

Option Not Installed

The **ST2400 2.4 Gb/s SDH/SONET Test Set** can be ordered in one of three configurations, which are: TRANSCEIVER, TRANSMIT-ONLY, OR RECEIVE-ONLY.

The TRANSMIT-ONLY version can be easily identified because it lacks the receiver connectors for *155/622 OUT* and *2.4 Gb/s IN* and it will not detect a receiver card during the power-on cycle. (Some early models may have all front panel connectors.) Pressing any of the control keys in the receiver section will cause the following message to be displayed:

```
  RX CARD NOT FOUND
RX CONTROLS DISABLED
```

Figure 3–4 Receiver Card Not Installed

The RECEIVE-ONLY version can be easily identified because it lacks the transmitter connectors for *155/622 IN* and *2.4 Gb/s OUT* and it will not detect a transmitter card during the power-on cycle. (Some early models may have all front panel connectors.) Pressing any of the control keys in the transmitter section will cause the following message to be displayed:

```
  TX CARD NOT FOUND
TX CONTROLS DISABLED
```

Figure 3–5 Transmitter Card Not Installed

Error Log Display

No additional entries will be logged when the error log becomes full. If the error log is more than 95% full when the RUN key is pressed the message shown in Figure 3–6 will be displayed. Selecting NO will allow the test to run, but when the error log is full new data will be lost. Selecting YES will clear the error log.

```
ERROR LOG  XX% FULL
CLEAR LOG?  <NO>   YES
```

Figure 3–6 Error Log Display

Receiver Menus and Displays

Error Measurements (SDH), Receiver

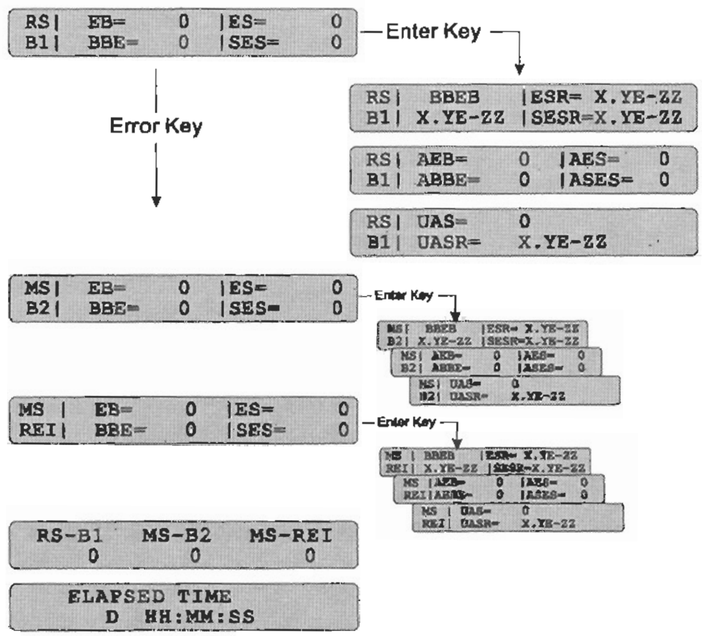


Figure 3–7 Receiver Error (SDH)

The ERROR key on the receiver side of the front panel is used to scroll through the five LCD displays shown in Figure 3–7 on the left side. The enter key on the right side of the LCD display is used to access a set of three submenus for each of the first three main menus—RS-B1, MS-B2, and MS-REI. Errors that were detected on the 2.4 Gb/s SDH signal are displayed in the RS-B1, MS-B2, and MS-REI error summary menus. These errors are totaled in the fourth menu, as illustrated on the left side of Figure 3–7. The last menu on the lower left will display the elapsed test time in: days, hours, minutes, and seconds. Each press of the error key will cycle to the next error display in a continuous loop, until some other key is pressed.

- The RS-B1, MS-B2, or MS-REI summary menus (Figure 3–7) include: the EB (Errored Blocks) which is the error count; the BBE (Background Block Errors); the ES (Errored Seconds); and the SES (Severely Errored Seconds). These measurements conform to the ITU G.826 standard.
- The first submenu conforms to the ITU G.826 standard, providing the: BBER (Background Block Error Ratio); ESR (Errored Seconds Ratio); and SESR (Severely Errored Seconds Ratio).
- The second submenu AEB, ABBE, AES, and ASES, are the Errored Blocks; Background Block Errors; Errored Seconds; and Severely Errored Seconds counted during Available time—conforming to the ITU M.2101 standard.
- The last menu UAS (Unavailable Seconds) count and UASR (Unavailable Seconds Ratio) conform to the ITU G.827 standard.

Overhead Displays (SDH), Receiver

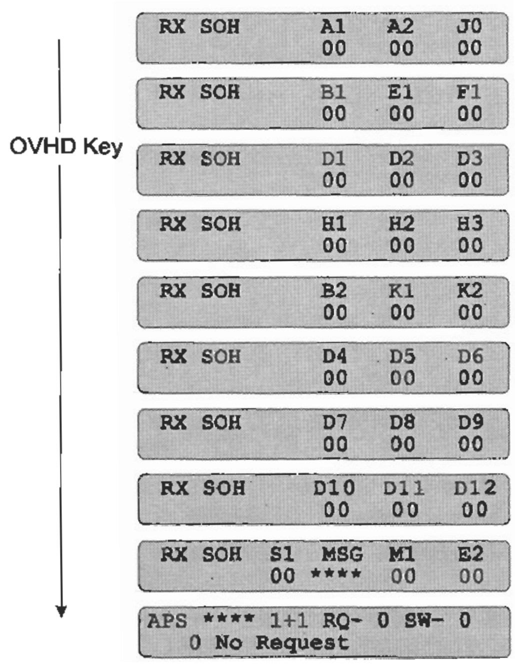


Figure 3–8 Receiver Overhead LCD Displays

The ten displays shown in Figure 3–8 are RX TOH SDH overhead bytes in the first column of the first STM-1 frame. They can be displayed by pressing the OVHD key on the receiver panel. Each time the key is pressed the next group of overhead bytes will be displayed in a continuous loop, until some other key is pressed. There are nine displays of three bytes each. The first nine are section bytes and the next eighteen are line. The ninth display provides the ASCII synchronization messages and the tenth is the APS message.

ASCII Synchronization Messages—S1 byte

For convenience both the SONET and SDH modes are compared below. The S1 byte is in hexadecimal. The unused SONET values are left blank. The unknown SDH value is marked with three question marks and unused codes are marked RES (reserved).

S1 Byte	SONET	SDH	S1 Byte	SONET	SDH
00	STU	???	08		812L
01	PSR	RES	09		RES
02		811	0A	ST3	RES
03		RES	0B		SETS
04		812T	0C	SIC	RES
05		RES	0D		RES
06		RES	0E	RES	RES
07	ST2	RES	0F	DUS	DNU

Automatic Protection Switching (APS)

Figure 3–9 shows the APS message. From the top line: The direction can be UNI (unidirectional), BI (bi-directional), REI (Remote Error Indication), AIS (Alarm Indication Signal), or four asterisks (****) indicating none of the four line types. The Protection can either be 1+1 (one-to-one) or 1:N (several unallocated lines specified by the number N). The Request Line (the line requesting to be switched) and the Switch Line (the line that the Request Line wants to switch to) can be any decimal number from 0 to 15.

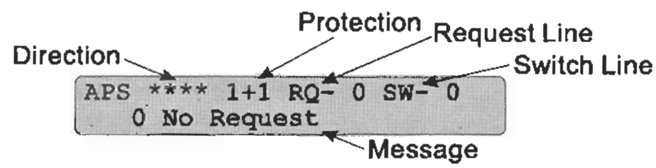


Figure 3–9 Automatic Protection Switching (APS)

The bottom line of the APS will display one of sixteen possible messages:

0	No Request	8	Manual Switch
1	Do Not Revert	9	Invalid
2	Reserve Request	10	SD-Lo Priority
3	Invalid	11	SD-Hi Priority
4	Exercise	12	SF-Lo Priority
5	Invalid	13	SF-Hi Priority
6	Wait To Restore	14	Forced Switch
7	Invalid	15	Lockout Protect

Receiver Drop Select

Figure 3–10 Receiver Drop Select Menu

Press the receiver DROP SELECT key to access the menu shown in Figure 3–10. Use the arrow and enter keys to select one of the three choices. OFF will drop a 155 Mb/s electrical signal to the CMI connector and disable the optical drop. The 155 Mb/s (STM-1) optical drop or the 622 Mb/s (STM-4) optical drop can be selected by choosing either the 155 or 622, respectively. The 155 or 622 LED on the receiver section of the front panel will indicate which drop is selected—both are off when the 155 CMI is selected. This menu is used with the *Receiver Tributary Select* menus.

⚠ WARNING!

Before activating the 2.4 Gb/s LASER its output must be connected to a circuit. Always replace the screw caps when the optical outputs are not in use.

Receiver Tributary Select (SDH)

```
155Mb/s RX DROP TRIB
 STM-1 #nn
```
display 1 of 2

```
622Mb/s RX DROP TRIB
 STM-4 #n
```
display 2 of 2

Figure 3–11 Receiver Tributary Select Menus

The TRIB key is used to select which tributary will be dropped out of the 2.4 Gb/s (STM-16) signal. One of sixteen 155 Mb/s (STM-1) tributaries or one of four 622 Mb/s (STM-4) tributaries can be selected using the front panel increment and decrement keys. This display depends on which drop was selected in the *RX DROP SELECT* or *SDH QUICK SETUP* menu—off, 155, or 622. The two possible SDH menus are shown in Figure 3–11.

- Display 1 of 2 is the SDH 155 Mb/s tributary select menu used to select 1 of 16 tributaries.
- Display 2 of 2 is the SDH 622 Mb/s tributary select menu used to select 1 of 4 tributaries.

Transmitter Menus and Displays

Tributary Source Mode

Pressing the MODE key will access the TX MODE SELECTION menu, shown in Figure 3–12. It is used to choose one of the three data modes that will produce the 2.4 Gb/s output signal. The three choices are: an external input (EXT) from the transmitter front panel 155 or 622 Mb/s inputs, an internally (INT) generated 2.4 Gb/s signal, or a through (THRU) mode from the receiver's 2.4 Gb/s input connector. The EXT and INT modes function on both the ST2400 transceiver and ST2400 transmitter units. The THRU mode only functions on an ST2400 transceiver unit.

```
TX MODE SELECTION
   <EXT>    INT    THRU
```

```
TX WAVELENGTH
  <1310nm>   1550nm
```

Figure 3–12 Transmitter Input Menu

The EXT input can be 155 Mb/s optical (STM-1), 622 Mb/s optical (STM-4), or 155 Mb/s CMI electrical signal. On the Transmitter 155 / 622 Input Status section there are three yellow LED indicators, two optical and one electrical.
The appropriate LED will indicate the input signal.

The INT mode generates an unequipped SDH 2.4 Mb/s (STM-16) signal with valid transport overhead. The first column of the first STM-1 can be modified, adding alarms and errors.

The THRU (Through) mode can be used to pass without modification, or modify, a 2.4 Gb/s SDH signal that entered the receiver from an external source. All three yellow status LEDs will be off when the ST2400 is in the THRU mode.

Pressing the MODE key a second time will access the TX WAVELENGTH menu, if the dual wavelength transmitter option is installed. It is used to switch between 1310 nm and 1550 nm.

Input Select, Transmitter

```
EXT TRIB INPUT SELECT
<155>    622    CMI
```

Figure 3–13 Input Select Menu

The transmitter SELECT key is used to pick one of three tributary choices when the MODE is set to EXT (external). The input can be 155 Mb/s (STM-1) optical, 622 Mb/s (STM-4) optical, or 155 Mb/s CMI electrical signal source from the appropriate connector.

Tributary Select, Transmitter

```
EXT 155Mb/s TRIB INSERT
  SINGLE <nn>      ALL
```
display 1 of 2

```
EXT 622Mb/s TRIB INSERT
  SINGLE <n>      ALL
```
display 2 of 2

Figure 3–14 Transmitter Tributary Select Menus

The TRIB key on the transmitter side is used to select how the external source (tributary) will be multiplexed into the 2.4 Gb/s signal. Only one of the two menus shown in Figure 3–14 will be displayed. They offer a choice between multiplexing the tributary into one specific channel or into all available 2.4 Gb/s channels. This menu depends on the choice that was made in the *Input Select* menu—155, 622, or CMI.

- Display 1 of 2 is the 155 Mb/s tributary insert menu that is used to select between multiplexing the external source tributary into 1 of 16 channels or all 16 channels of the 2.4 Gb/s signal. It refers to both the optical and electrical (CMI) 155 Mb/s transmitter input signals.
- Display 2 of 2 is the 622 Mb/s tributary insert menu that is used to select between multiplexing the external source tributary into 1 of 16 channels or all 16 channels of the 2.4 Gb/s signal. It refers to the optical tributary source.

Illegal Mode

```
    *** TX MODE ***
 EXT MUST BE SELECTER
```

Figure 3–15 Transmitter Alarms

If the TRIB or INPUT SELECT keys are pressed when the transmitter is in the INT (internal) or THRU (through) mode, the illegal mode display (Figure 3–15) will be exhibited for three seconds and then switched to the TX MODE SELECTION menu.

Alarm Generation Menus—SDH

The left column in Figure 3–16 shows the four SDH alarm displays that will be scrolled in a loop each time the transmitter alarm key is pressed. The right side shows the same alarm displays when the continuous mode is being accessed. The arrow keys, increment and decrement keys, and the enter key are used to modify the alarm conditions and access the continuous displays.

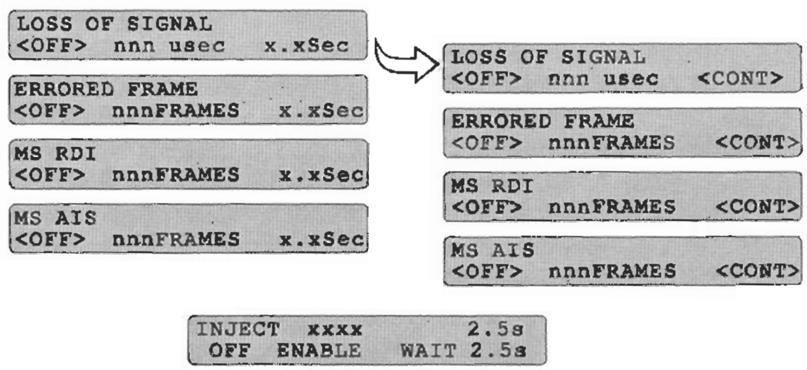


Figure 3–16 Transmitter Alarms SDH

The transmitter ALARM key is used to select one of the five alarm menus shown in Figure 3–16, four on the left, and one centered at the bottom LOS (Loss Of Signal), ERRORED FRAME, MS RDI, MS AIS, and INJECT. The alarm menus are used to set specific parameters simulating various synchronization defects as detailed below.

Each of the first four transmitter alarm menus have the following parameters:

- OFF—The alarm is disabled.
- nnn µsec (or nnn FRAMES): Sets the duration of the alarm in microseconds for the LOS alarm or frames for the other alarms. Position the cursor using the left and right arrow keys. Use the INC and DEC keys to change the value from 1 to 127 microseconds or frames. Press the enter key to generate the alarm.
- x.xSec: Sets the on time for the burst operation from 0.1 to 9.9 seconds. This alarm condition generates extensive signal failure. Each time the enter key is pressed an asterisk (*) and the word ACTIVE will be displayed in the upper right side of the display. Use the arrow keys to position the cursor, and the INC and DEC keys to change values. This field changes to CONT, as shown on the right side of Figure 3–16, when the value is incremented beyond 9.9 seconds. Or when the cursor positioned under the letter S in the x.xSec and the increment key is pressed. The DEC key is used to return to this (x.xSec) value.
- CONT: Turns the alarm condition on continuously, generating a hard failure. To access this hidden field see x.xSec above. Pressing the enter key will turn on the alarm continuously, displaying an asterisk (*) and the word ACTIVE. Use the right arrow key to move the cursor to OFF and the enter key to turn the alarm off. Then use the left arrow key to move the cursor back to CONT and the enter key to activate the alarm. Using the alarm key to leave the menu will not turn the alarm off.

The INJECT xxxx alarm menu, at the bottom of Figure 3–16, permits recurring alarm conditions to be set. Position the cursor under the alarm—xxxx in this case—and use the increment key to select the alarm type. Then set the alarm INJECT (on time) period from 0.1 to 9.9 seconds, and the WAIT (off time) for a period from 1.0 to 30.0 seconds. An asterisk (*) will switch between the wait and inject states, replacing the letter *s*, indicating which is the active state. Only one alarm condition can be activated at any one time. Enabling the recurring alarm will disable any other active alarm. Moving the cursor to
OFF and pressing the enter key will stop the alarm cycle. When off, the letter s will appear at the end of both top and bottom LCD display lines.

Overhead Menus (SDH), Transmitter

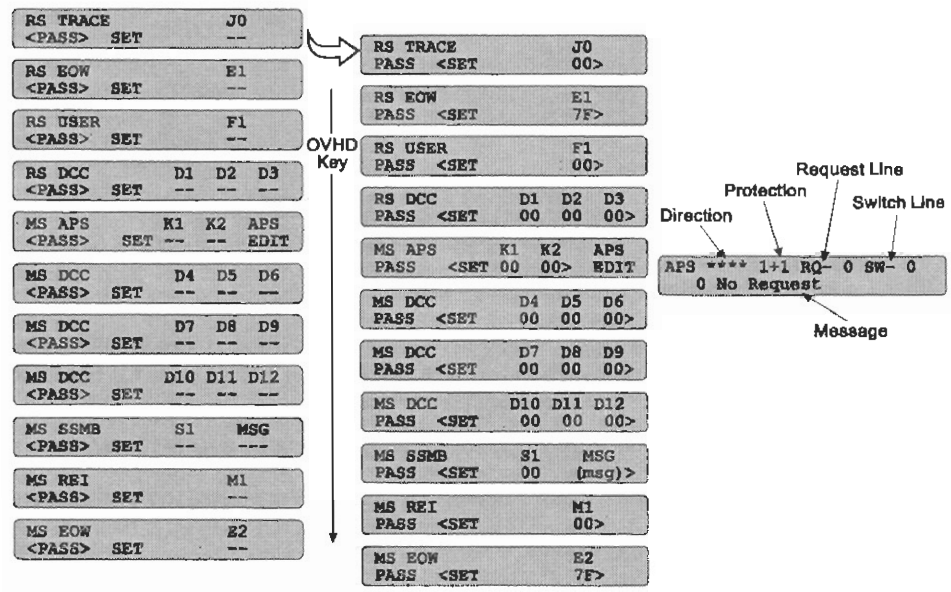


Figure 3–17 Transmitter Overhead (SDH)

The transmitter overhead byte menus can be used to pass or change the 2.4 Gb/s signal overhead bytes, in the first column of the STM-1. The transmitter OVHD (overhead) key is used to scroll through the Regenerator Section (RS) and Multiplexer Section (MS) overhead bytes shown on the left side of Figure 3–17. The top line of each display identifies the designated SDH overhead byte. The bottom line is used to either PASS or SET (change) the value. When the cursor is on PASS the byte is hidden. When the cursor is moved to SET the byte value is displayed and the enter key LED starts to flash. Use the arrow keys to move the cursor, and the INC and DEC keys to change values. Pressing the enter key or the overhead key will store the value.

Bytes D4 through D12 are passed or set as a group. Each can be individually changed, using the INC and DEC keys, but pressing the enter key to SET any one of them will set all of them. Passing any one will pass them all.

Select the EDIT command from the MS APS menu to access and change the Automatic Protection Switching bytes illustrated on the right side of Figure 3–17. Position the cursor over the word EDIT, press the enter key and the APS menu in will be displayed. Use the arrow, INC, DEC, and ENTER keys to select, change, and store values. Press the OVHD key to return to the MS APS menu.

Error Generation Menus (SDH)

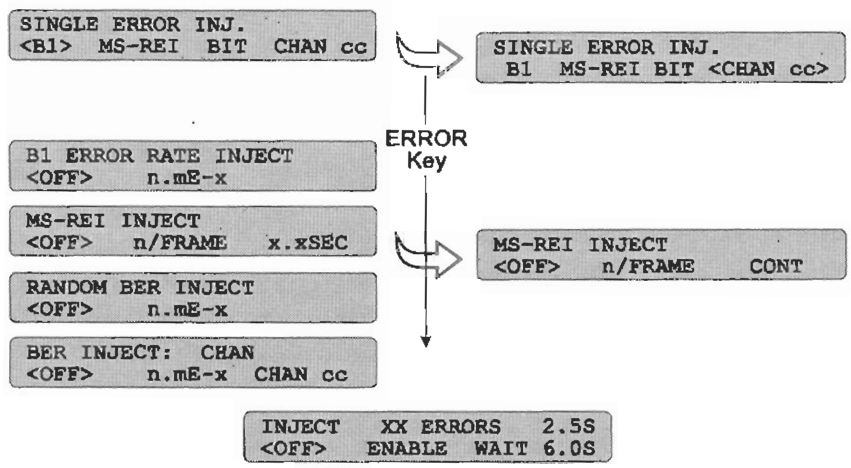


Figure 3–18 Transmitter Error Generation (SDH)

Pressing the transmitter ERROR key will scroll through the main menus shown on the left side of Figure 3–18. The arrow keys are used to move the cursor when selecting menu items. The INC and DEC keys are used to change values. The ENTER key is used to execute the function. Enabling any error will disable all other active errors.

The first menu, SINGLE ERROR INJ, is used to inject one error each time the enter key is pressed. Use the arrow keys to positioning the cursor over the B1, MS-REI, BIT, or CHAN and press the ENTER key to generate that error. Move the cursor to CHAN cc and use the INC and DEC keys to change the STM-1 channel number.

The error key is pressed again to obtain the B1 ERROR RATE INJECT menu. Use the arrow keys to move the cursor to n.mEx and the INC and DEC keys to set the error rate. Pressing the enter key will inject the B1 error at that rate, continuously. The rate is inserted as a negative exponent from 2.5E-5 to 0.1E-9. An error rate of 1.0E-6 would equate to the decimal number derived from sending one errored bit in a million bits. In other words, one divided by one million would equal 0.000001 or 1.0E-6 decimal.

The MS-REI INJECT menu has three functions:

- A number of MS-REI errors can be injected into one frame. The ERROR key is used to select the menu, and the arrow keys are used to position the cursor over the n/FRAME (n per frame) field. The number of MS-REI errors per frame can be set from 1 to 255 using the INC and DEC keys. Pressing the enter key while this field is selected will insert that number into a single frame.
- Move the cursor to x.xSEC and use the INC and DEC keys to set the period from 0.1 to 9.9 seconds. Pressing the ENTER key when the cursor is in the x.xSEC position will inject the number of MS-REI errors (n/FRAME) for the period (x.xSEC), effecting multiple frames. For example, one MS-REI per frame could be injected for

9.9 seconds. An asterisk and the word *ACTIVE* will be displayed for the duration of the MS-REI injection.

- Moving the cursor under the letter *s* in x.xSec or pressing the INC key when the period is set to 9.9 seconds will access the CONT (continuous) command, shown on the lower right side of Figure 3–18. Positioning the cursor over CONT and pressing the enter key will insert the number of MS-REI (n/FRAMES), continuously. An asterisk and the word *ACTIVE* will be displayed indicating that the error is being injected. Use the right arrow key to move the cursor to OFF and press ENTER. The asterisk and the word *ACTIVE* will no longer be displayed, indicating the error injection is off.

The RANDOM BER (Bit-Error-Rate) INJECT main menu is used to set the rate to a number from 1.0E-3 to 0.1E-9. Pressing the enter key will inject errors at that rate on different STM-16 channels, selected at random.

The BER (Bit-Error-Rate) INJECT main menu is used to set the rate to a negative exponent from 1.0E-3 to 0.1E-9 for the CHAN (channel) selected. Positioning the cursor over the selected channel (CHAN cc) in the lower right field and use the INC and DEC keys to select the STM-1 channel number.

The INJECT XX ERROR menu, at the bottom of Figure 3–18, permits recurring error conditions to be set. Position the cursor under the XX and use the INC key to select the error type. The INJECT period (on time) is located in the top right field, 2.5S in this case. It can be set from 0.1 to 9.9 seconds. The WAIT period (off time) is in the lower right field, 6.0S in this case. It can be set from 1.0 to 30.0 seconds. The rates are set in each individual menu, B1, MS-REI, RANDOM BER, and CHANxx BER. An asterisk (*) will switch between the wait and inject states, indicating which is active. Only one error condition can be activated at any one time.

NOTE: Bit Error Rates are inserted as a negative exponent. An error rate of 1.0E-6 would equate to the decimal number derived from sending one errored bit in a million bits. In other words, one divided by one million would equal 0.000001 or 1.0E-6 decimal.

Applications and Use

This section provides three common examples of telecommunication network applications. It details how the **ST2400 2.4 Gb/s SDH/SONET Test Set** can be used for:

- Passive Monitoring (Receive-Only)
- Active Analysis
- Active Throughput Analysis
- Getting Started

Applications

Three basic applications are Passive Monitoring, Active Analysis, and Active Throughput Analysis. Common **ST2400 2.4 Gb/s SDH/SONET Test Set** applications such as field service troubleshooting, engineering analysis, production testing and maintenance will be similar.

Passive Monitoring

The passive monitoring application monitors the 2.4 Gb/s signal. It uses a passive coupler, shown in Figure 4–1, to connect and disconnect the ST2400 without disrupting live traffic.

This setup is used for non-intrusive network monitoring applications. It is perfect for LEC/IXC (local exchange carrier / inter-exchange carrier) cross-boundary or other long-term, passive performance monitoring. It does not allow optical line error injection testing.

This installation splits the STM-16 optical signal through a passive coupler, which can be mounted in an optical cross-connect bay or other convenient location. Since there is no active regeneration of the optical line, the system under test must have adequate margin to accommodate the coupler insertion loss. Measurements are made with the ST2400, as required.

The CTS750, ST112, or another SDH/SONET tributary test set can be used with the ST2400 to expand its test capabilities. The ST2400 Receive-Only model is particularly useful for passive monitoring applications.

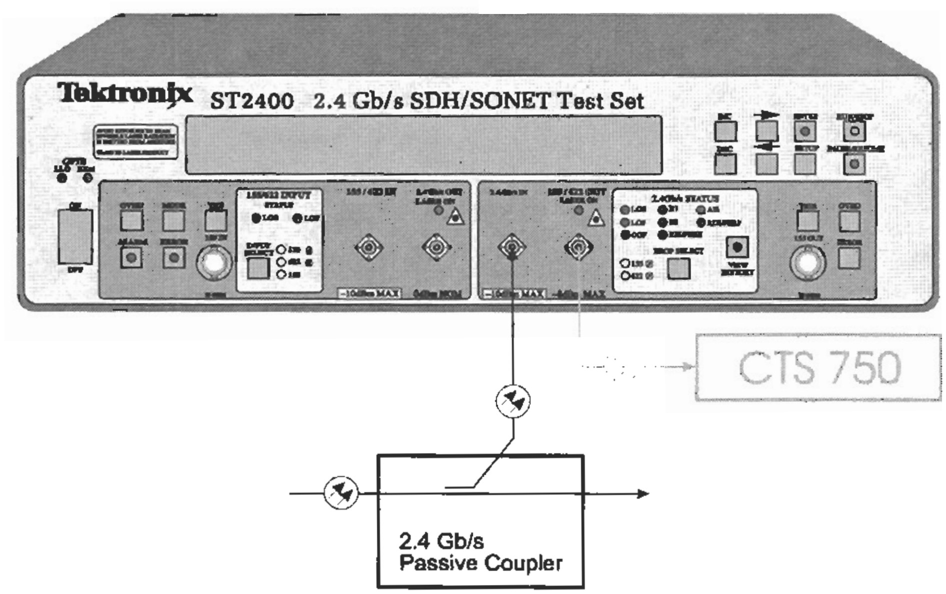


Figure 4–1 ST2400 Passive Monitoring

Active Analysis

The Active Analysis application inserts the ST2400 into an active signal path (Figure 4–2). This configuration is suitable for test or maintenance operation where live traffic is not being carried over the network, network element, or unit under test.

In this application, the CTS750 test set can provide the 155 Mb/s or 622 Mb/s framed signal input to the ST2400, which is actively inserted into the signal path. The ST2400 provides a variety of signal and analysis options for complete testing of the 2.4 Gb/s. Payload level testing can be done by applying the 155 or 622 Mb/s signal to the auxiliary test set.

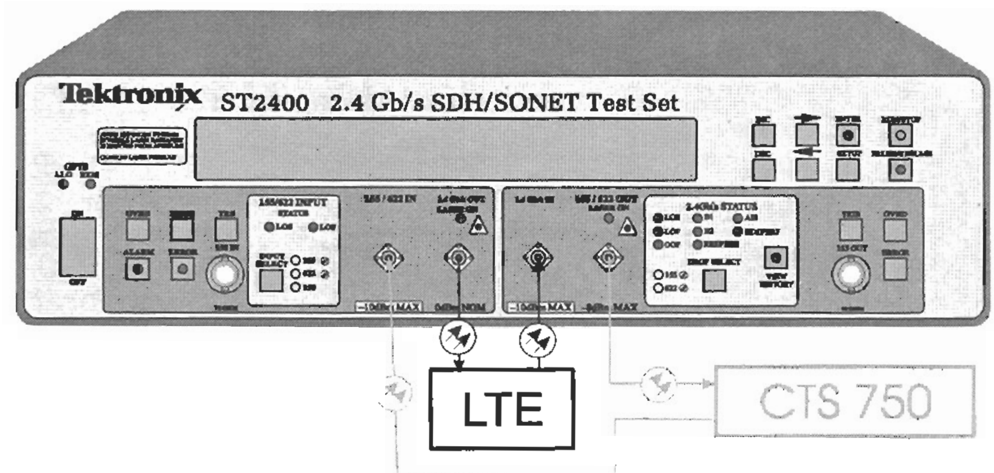


Figure 4–2 ST2400 Active Analysis

Active Through Mode Analysis

The Active Through Mode Analysis (Figure 4–3) of the 2.4 Gb/s Line is similar to the Active Analysis (Figure 4–2) application. The ST2400 is actively inserted into the signal path as either a regenerator or as a stress tester. The STM-16 signal is looped through the ST2400. The signal can be passed through and regenerated unchanged or alarms and errors can be added for conformance and stress testing.

The ST2400 can be used with a companion test set (CTS750) to make all of the transmission measurements required to completely test the network system. Or the ST2400 can be used without the additional tributary test set to quickly test, monitor, and verify the 2.4 Gb/s signal operation.

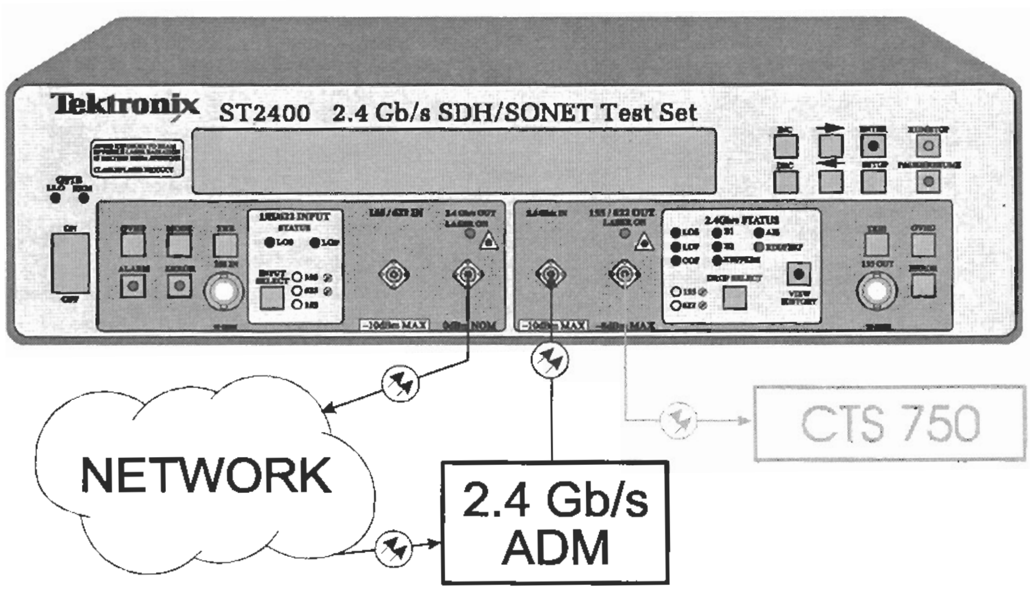


Figure 4–3 ST2400 Passive Monitoring

External Controllers and Printers

This chapter explains how to connect external devices to the RS-232C, GPIB, and parallel ports. This chapter also includes port setup procedures.

Remote Control Applications

The **ST2400 2.4 Gb/s SDH/SONET Test Set** can be remotely operated from its RS-232C or GPIB ports in one of the following ways:

- Use the RS-232C Port manually from a VT-100 terminal or VT-100 emulation program, entering commands individually. Recommended for learning commands and syntax.
- Use the GPIB or RS-232C Port Automatically from a PC or engineering workstation using a control program. Recommended for factory automation applications.

Printer Applications

The **ST2400 2.4 Gb/s SDH/SONET Test Set** can print reports to its:

- Parallel port using a centronics printer interface
- Serial port using an RS-232C serial printer interface

Using the RS-232C Port

The following section describes the RS-232C serial port. All port setup procedures are detailed in *Chapter 4, Menus and Displays*.

Serial Interface Parameters

ST2400 serial port parameters are listed in Table 5–1 along with their available values and default value. In addition, ECHO and XON/XOFF can be changed remotely via the GPIB or RS-232 port.

Table 5–1 RS-232C (Serial Port) Parameters

Parameter MENU and Description	Possible Values	Default Value
BAUD: Baud rate in bits per second.	300, 1200, 2400, or 9600	9600
PARITY: Error detection.	Even, Odd, or None	None
SIZE: Data bits per character.	7 or 8	8
EOL: End-of-Line terminator.	CR (ASCII decimal 13), LF (ASCII decimal 10), CR/LF, or LF/CR.	CR/LF
XON/XOFF: Flow control.	ON (enabled) or OFF (disabled)	ON
ECHO: Echo back to the controller each character received by the ST2400).	ON (enabled) or OFF(disabled)	ON

RS-232C Connector Pinout

The RS-232C interface is a 9-pin D-type socket connector located on the rear-panel. The pin-out of this connector is shown in Table 5–2 below. The ST2400 RS-232C port is wired as a DCE (data communications equipment) device—it receives on pin 2 and transmits on pin 3.

Table 5–2 RS-232C Connector Pin-out

PIN	NAME	FUNCTION
1.	GND	Protective Ground
2.	RxD	Received Data Input: Data is received by the ST2400 on this pin.
3.	TxD	Transmit Data Output: Data is transmitted by ST2400 on this pin.
4	CTS	Clear To Send. A high level or open applied to this pin indicates to the ST2400 that the controller or terminal is ready to receive data. A low level indicates that the controller or terminal is not ready. The ST2400 pulls this pin high internally with 27 kohms to +12V.
5.	RTS	Request to Send. The ST2400 always sets this pin high.
6.	DTR	Data Terminal Ready. The ST2400 always sets this pin high.
7.	GND	Signal Ground.
?	DSR	Data Set Ready. This input is ignored.
all other pins		not used.

Cables

Use a straight-through (modem) cable when connecting the ST2400 to a DTE (data terminal equipment) device, or a null-modem cable when connecting to another DCE device. Cables are listed in *Chapter 1, Getting Started.*

Quick Test, RS-232C Port

You can perform a quick test of the ST2400 RS-232C port using a terminal (or a PC running terminal emulation software) as follows:

1. Verify that the ST2400 echo mode is on.
2. Power off the ST2400.
3. Attach the appropriate 9-pin cable from the RS-232C port to the terminal. Terminals and controller should be configured as a DTE and therefore use straight-through (modem) cable.
4. Power on the ST2400 and verify that the following prompt appears on the terminal's display:

ST2400>

If the above prompt does not appear, then one or more of the following problems may exist:

1. The cable may be defective.
2. The cable could be the wrong cable type. Use a straight-through (modem) cable if the terminal is configured as a DTE, or a null-modem cable if the terminal is DCE configured.
3. The RS-232C port setup (baud rate, data bits, parity, etc.) may not be compatible with that of the terminal; both setups should be the same.

Protocol

The ST2400 RS-232C port operates in a terminal mode. Received characters are stored in the receive buffer until a line terminator (CR, LF, LF/CR, or CR/LF) is received, at which point the command is executed. Before a line terminator is received, the backspace key is used to erase the last (right-most) character in the receive buffer. You may use EVEN or ODD parity to perform byte-by-byte error detection.

Command Format

Refer to *Chapter 7, Remote Commands* for an explanation of the ST2400 commands. Except for terminator characters, the same commands are used on the GPIB port.

Error Messages

The ST2400 verifies all commands received on the RS-232C port to make sure that they contain the appropriate mnemonics and parameters. All valid commands will be executed. The ST2400 will issue an error message and discards the command when the mnemonic is invalid or an associated parameter is out of range. Error messages are listed in Table 5–3.

Table 5–3 RS-232C Port Error Messages

ERROR MESSAGE	MEANING
*** Input Lost	The RS-232C interface hardware has detected one or more lost or corrupted characters.
*** Input Buffer Overflow	More than 80 characters are received without a line terminator.
*** Command Mnemonic Not Found	Unknown command mnemonic received.
*** Invalid Command For Interface	Command mnemonic found, but it is not valid for the RS-232C interface.
*** Invalid Command Type	Command mnemonic found, but it has a missing or added "?" at the end.
*** Too Few Parameters	One or more expected parameters are missing.
*** Too Many Parameters	Too may parameters were received, or unknown characters were found trailing the command.
*** Invalid Parameter	Parameter is not valid for the command.
*** Parameter Out of Range	Parameter value is not in the range specified for the command.
*** Parameter Not In Set	Parameter value is not in the set of allowed values for the command.
*** Invalid String Length	Parameter character string is too long for the command.
*** Parameter Separator	An expected semicolon (;) between two parameters is missing or a command line is terminated immediately after a semicolon.
*** Invalid Non-decimal Parameter	Parameter is not in a valid non-decimal format, or the value of the parameter is out of the range 0 to 255 decimal.
*** Command Execution Error	The instrument did not execute the command properly.
*** Out of Memory	Processor is out of memory.

Storing and Printing Data

Most Terminal Emulation packages have the ability to capture data to a file or direct it to a printer. These functions are usually listed as *File Capture* and *Print Capture*. The file capture function prompts for a path and file name before saving the file to disk. saved data files can be reviewed on screen or printed on paper at any time when the data is needed.

Using the RS-232C for PC-based Printing

Enter CTRL + Q to quit VFP mode if it is active. Sequentially push the SETUP key on the ST2400 until the REPORT/TEST TIME menu is displayed. Enter the menu and set up the report as if it was going to be printed on a dedicated printer. Rather than select the default parallel printer port, however, select the RS-232C port instead.

With the RS-232 port and your emulator set up as described earlier, all reports that normally would go to the printer will be displayed on the screen. The scrolling buffer and data capture capabilities provided by your communications software are available for viewing and reviewing the data. An example of the on-screen printer display is shown in Figure 5–1 below.

```
-----------------------------------------------------
/START 1996/01/22  04:31:20          RATE:    STM16
\START 1996/01/22  04:32:20
      ELAPSED  SECONDS              60
    NO Defects  or  Errors Detected

G.826          RS-B1       MS-B2        MS-REI
-----------------------------------------------------
EB                 0           0             0
BBE                0           0             0
ES                 0           0             0
SES                0           0             0
BBER         0.0E-00     0.0E-00       0.0E-00
ESR          0.0E-00     0.0E-00       0.0E-00
SESR         0.0E-00     0.0E-00       0.0E-00

G.827          RS-B1       MS-B2        MS-REI
-----------------------------------------------------
UAS                0           0             0
UR           0.0E-00     0.0E-00       0.0E-00

M.2101         RS-B1       MS-B2        MS-REI
-----------------------------------------------------
EB                 0           0             0
BBE                0           0             0
ES                 0           0             0
SES                0           0             0
-----------------------------------------------------
```

Figure 5–1 Error Reports Available (Example Screen)

Be sure that the ST2400 printer function is turned off before activating the VT100 emulator. The printer and VT100 cannot work simultaneously through the single ST2400 RS-232 port. If a parallel printer is connected to the ST2400 parallel printer port, then the printer and VT100 remote screen can function simultaneously.

Using the GPIB Port

The following section describes the GPIB port. All port setup procedures are detailed in *Chapter 4, Menus and Displays.*

GPIB Address and Terminator

Use the Auxiliary Setup menu (shown in Chapter 4) to set the GPIB address and message terminator. They can be set as follows:

- Address from 0 to 31 (Address 31 is off the bus)
- Message terminator is set to EOI or EOI/LF

GPIB Remote and Local Modes

The GPIB controllers can be used to put the ST2400 into a remote mode, disabling all front panel setup controls. The **REM** LED (left side corner of front panel) will indicate whether the ST2400 is in the remote mode (LED on) or the normal local mode (LED off). Press the SETUP key to return the instrument to the local mode.

Local Lock Out

GPIB controllers can also put the ST2400 into the local lock out mode. The **LLO** LED (left side corner of front panel) indicates whether the ST2400 is in the local lock out mode (LED on) or not (LED off). In the LLO mode, like the REMOTE mode, the front panel is disabled. However unlike the REMOTE mode, there is no key that can disable the LLO mode. Instead, you must issue the appropriate GPIB command, or power off and then on the ST2400.

GPIB Interface Functions

The ST2400 is configured as a GPIB talker/listener. It does not provide any controller functions. Table 5–4 lists the GPIB functions described in the IEEE Std. 488.2-1987 that are supported by the ST2400.

Table 5–4 GPIB Interface Functions

Subset	Implementation
SH1	Complete source handshake.
AH1	Complete acceptor handshake.
T6	Basic talker, serial poll, no talk-only, unaddressed if addressed to listen, no extended talker.
L4	Basic listener, no listen-only, unaddressed if addressed to talk, no extended listener.
SR1	Complete service request.
RL1	Remote/local capability including local lockout.
PP0	No parallel poll capability.
DC1	Complete device clear capability.
DT0	No device trigger capability.
C0	No controller capability.
E2	Tri-state drivers used on DI0 lines for maximum data transfer rate.

GPIB Connector

An IEEE-488.2 standard GPIB connector is provided for GPIB communication

GPIB Command Format

Refer to Chapter 6 for a complete explanation of the ST2400 commands. Most remote commands are the same for both the GPIB and RS-232C ports.

IEEE 488.2 Programming Manual Requirements

This section explains how the ST2400 implements certain standard GPIB functions, as required by IEEE Std. 488.2-1987.

Power-On Settings

When powered-on, the ST2400 will automatically restore all device settings to their last powered settings. No remote commands will affect this power-on rule. However if the instrument detects a problem in non-volatile (battery-backed) RAM at power up, then factory default settings will be restored rather than the last powered settings. A RAM problem at power up will be indicated in the LCD display by the message:

RAM Corruption

Message Exchange

The GPIB message exchange characteristics are as follows:

- The input buffer is command line oriented. A new buffer is provided for each new command line.
- Each command line may contain a maximum of 80 characters.
- The only ST2400 commands that can return more than one message unit are: *lrn?, oh_all?, oh_err_all?
- Command responses are generated immediately. The ST2400 will not wait for a read command before generating a response to a query command.
- No commands are coupled.

IEEE Functional Elements

All functional elements (GPIB Message Types) from the IEEE 488.2-1987 standard that are supported in ST2400 GPIB interface are listed below. For more information refer to your computer or controller documentation and the
IEEE 488.2-1987 standard: Sections 4.3; 7.1.1; 7.3.3 and tables 4.2; 4.3.

1. <PROGRAM MESSAGE>
2. <PROGRAM MESSAGE TERMINATOR>
3. <PROGRAM MESSAGE UNIT>
4. <PROGRAM MESSAGE UNIT SEPARATOR>
5. <COMMAND MESSAGE UNIT>
6. <QUERY MESSAGE UNIT>
7. <COMMAND PROGRAM HEADER> (see note)
8. <QUERY PROGRAM HEADER> (see note)
9. <PROGRAM HEADER SEPARATOR>
10. <PROGRAM DATA SEPARATOR>
11. <PROGRAM DATA>
12. <DECIMAL NUMERIC PROGRAM DATA>
13. <CHARACTER PROGRAM DATA>
14. <NON-DECIMAL NUMERIC PROGRAM DATA>

NOTE: The ST2400 cannot process a <COMPOUND COMMAND PROGRAM HEADER> or a <COMPOUND QUERY PROGRAM HEADER>.

Specific Command Implementations

Reset Command, as defined in the IEEE 488.2-1987 standard, the ST2400 reset command (*rst) does the following:

- Resets all device settings to their default values, except remote interface settings.
- Ignores macros (macros are not implemented in the ST2400).
- Forces the ST2400 into the Operation Complete Command Idle State (OCIS) and Operation Complete Query Idle State (OQIS).

Overlapped and Sequential Commands: All ST2400 commands are sequential.

Operation Complete Message: ST2400 command operation is always immediate.

GPIB Status and Event Reporting System

The ST2400 GPIB status and event reporting functions are compatible with the IEEE 488.2-1987 standard. The status and event reporting system can be configured to alert the GPIB controller whenever a status change or event occurs. This is accomplished by maintaining two status registers and their associated enable register. The four status registers are:

- Standard Event Status Register (SESR) general purpose status register
- Event Status Enable Register (ESER) enable register
- Status Byte Register (SBR) general purpose status register
- Service Request Enable Register (SRER) enable register

The GPIB bus SRQ (service request) line is asserted when one or more status bits are set. The controller uses a serial poll procedure to find out which instrument initiated the SRQ. Specific status bits can be enable or disable to control which status changes or events result in an SRQ. The ST2400 status registers can be read and set from the RS-232 control interface, however, the SRQ function is only available on the GPIB bus.

A status register may contain defined (used) bits and undefined (unused) bits. Each defined bit in a status register corresponds to a given instrument status or event. Once cleared (set to zero), the value of a status bit will remain zero (false) as long as the corresponding event or status does not occur. However, if it is enabled, the value of a status bit will be set to one (true) when the corresponding event or status occurs. Status bits are latched once a status bit is set to one and will remain in this state even when the corresponding event or status becomes false, until the bit is reset by a command or when the ST2400 is powered off.

Each status register has an associated enable register. Moreover, each defined bit in a status register has a corresponding defined bit in the associated enable register. When an enable bit is set to zero, then the corresponding status bit is ignored by the instrument regardless of the state of the relevant event or instrument status. However when an enable bit is set to one, the corresponding status bit is enabled.

GPIB Commands

The contents of any ST2400 status or enable register can be read by an external controller using the appropriate query command. The contents of any enable register can be set to a particular value using the appropriate set command. The contents of the SESR register can be cleared using the Clear Status (*CLS) command. The SESR is automatically cleared (reset) after being queried. For more information on ST2400 remote commands, see Chapter 7.

The correspondence between ST2400 status registers, enable registers, and commands is summarized in Table 5–5.

Table 5–5 Status Registers, Enable Registers, and Related Commands

Status Register	Status Register Query Commands	Enable Register	Enable Register Commands	
			Set	Query
Standard Event Status Register (SESR)	*ESR?	Event Status Enable Register (ESER)	*ESE	*ESE?
Status Byte Register (SBR)	*STB?	Service Request Enable Register (SRER)	*SRE	*SRE?

- The *CLS command to clear (reset) the SESR and return the instrument to the Operation Complete Command Idle State and the Operation Complete Query Idle State. In this state the instrument has no data in its input or output buffers and is not executing a command.
- The *ESR? query command also clears (resets to zero) the SESR status register.

Standard Event Status Register

The Standard Event Status Register (SESR) is a status register that indicates errors in command syntax and related occurrences. The name of each bit in the SESR is shown in Table 5–6. The function of each bit in the SESR is defined in Table 5–7.

Table 5–6 Standard Event Status Register (SESR)

7	6	5	4	3	2	1	0
PON	URQ	CME	EXE	DDE	QYE	RQC	OPC

Table 5–7 SESR Bit Definitions

Bit	Definition
7 (MSB)	PON (Power On): Set to one when the instrument is first powered on.
6	URQ (User Request): Not used.
5	CME (Command Error): Set to one when a command header (mnemonic) has been received that is not recognized or is invalid.
4	EXE (Execution Error): Set to one when an error has occurred while the instrument was responding to a set command or query. May indicate: a) parameter is out of range, b) command uses too many or too few parameters, or c) command cannot be properly executed due to the instrument's current state.
3	DDE (Device Dependent Error): Set to one if input data has been lost at the interface (corrupted characters) or the input buffer has overflowed because a command exceeded the 80 character limit without a terminator.
2	QYE (Query Error): Set to one if: a) an attempt has been made to query the output queue when there are no messages available or pending, b) a command is received but the output queue is not empty, or c) an attempt has been made to query the output queue when an unterminated command is in the input queue.
1	RQC (Request Control): Not used.
0 (LSB)	OPC (Operation Complete): Set to one after a *OPC command is received.

Event Status Enable Register

The Event Status Enable Register (ESER) is the enable register associated with the SESR status register. Each enable bit in the ESER occupies the same bit position as the corresponding status bit in the SESR.

Status Byte Register

The Status Byte Register (SBR) indicates the overall status of the instrument and is used to control the SRQ line on the GPIB bus. The name of each defined bit in the SBR is shown in Table 5–8. The function of each defined bit in the SBR is described in Table 5–9.

Table 5–8 Status Byte Register (SBR)

7	6	5	4	3	2	1	0
--	MSS	ESB	MAV	--	--	--	--

Table 5–9 Status Byte Register Bit Definitions

Bit	Definition
7 (MSB)	Not defined.
6	MSS *(Master Status Summary): This bit summarizes the state of the three other bits in the SBR. It is set to 0 if all other bits are 0. It will be set to 1 when any other bit in the SBR equals 1 and its corresponding bit in the SRER is set to one. The status of the MSS bit is reevaluated each time a bit in the SBR or the Service Request Enable Register (SRER) changes.
5	ESB (Event Status Bit): This bit summarizes the Standard Event Status Register (SESR). It is set to 0 if all bits in the SESR are 0. It is set to 1 if any enabled bit in the SESR equals 1. If the ESB is enabled and set to 1, then the RQS and MSS bits will be set to 1. The status of the ESB bit is reevaluated each time one of the bits in the SESR or the Event Status Enable Register (ESER) changes.
4	MAV (Message Available): This bit is set to 1 when there is an output available for the controller.
0 - 3	Not defined.

NOTES:

*When you use a serial poll to read the SBR, bit 6 is the RQS bit. When you use the *STB? query to read the SBR, bit 6 is the MSS bit.

Service Request Enable Register

The Service Request Enable Register (SRER) is the enable register associated with the SBR status register defined above. The SRER contains an enable bit for the ESB and MAV bits in the SBR. However there is no enable bit for the MSS or RQS bits which are always enabled.

Remote Commands, SDH

This chapter explains the general syntax of the ST2400 remote command language and defines all commands. Command definitions are grouped by function. In addition, an alphabetical list of all ST2400 commands is provided with page references to individual command descriptions.

Command Types and Syntax

The ST2400 command set includes two basic types, set and query. The set commands are used to change current status, values, or states—to start or stop a test, for example. While query commands ask the instrument to respond with the contents of a status register, the value of a given setup parameter, a measurement result, or a current state.

Remote commands are directly related to setup parameters and results rather than to front panel keys or setup menus. For example, there is no remote command used to press the SETUP Key.

ST2400 commands may only have a query form or only a set form, however, many have both forms. When a command has both a set and query form, the mnemonic header used for the query form will be identical to its corresponding set command form, except for an added (?) question mark. The following examples use the mnemonics for the view angle query and set commands:

view_angle?	(query command)
view_angle n	(set command)

The view angle query command uses the header **view_angle** with a question mark and no space. The view angle set command uses the same header with a the veritable n (which represents an integer from 0 to 7) with a space.

Command Symbols and Delimiters

Symbol	Meaning	
<CR>	Carriage return (ASCII decimal 13).	
<LF>	Line Feed (ASCII decimal 10).	
numbers and integers	Decimal	10
	Hexadecimal:	#HFA
	Octal:	#Q377
	Binary:	#B11111111
	NOTE: Unless otherwise indicated, all numbers and integers are decimal.	
<string>	A character string.	
[ ]	Enclosed argument is required.	
|	Exclusive OR argument [a | b | c] that means include one and only one of the following parameters: a, b, or c.	

Multiple Commands

A given command line may contain one or more commands, up to 80 ASCII characters, both upper and lower case. Multiple commands use a semicolon as a delimiter, as follows:

Prompt> header on; sts_oof?; sect_los?; sect_lof?; b1_ber?

Arguments

Commands may include one or more arguments (parameters) following the header. The first argument following the header must be separated from the header by one or more blank characters (spaces). Subsequent arguments must be separated from previous parameters using commas.

Blank Characters (Spaces)

One or more spaces are required between the command header and first parameter (if any). Otherwise spaces are ignored and may be used on a command line between headers, parameters, or required separators for readability.

Arguments Outside of Legal Ranges

If the instrument receives a set command with an argument that is outside the legal range for that argument, then the instrument will set the indicated parameter to its maximum or minimum legal value, depending on which is closer to the received value.

Command Line Terminator

Command lines must be terminated as follows:

- **RS-232 Interface**: Command lines issued to the instrument should be terminated by a simple carriage return (CR). Responses generated by the instrument will be terminated as specified in the RS-232 End-of-Line setup menu for carriage return and line feed functions (CR, LF, CR/LF or LF/CR).
- **GPIB Interface**: Command lines issued to the instrument can be terminated by either EOI (End-Or-Identify) or EOI/LF. Responses generated by the instrument will be terminated as specified in the GPIB setup menu for End-Or-Identify and Line Feed functions (EOI or EOI/LF).

Command Examples

The following is a brief example of an interactive remote session with the that does the following:

1. Generates a random bit error rate of 1 x 10^{-6}.
2. Enables the Loss Of Signal (LOS) to occur for 135 micro seconds.
3. Sets the Line AIS Indication Signal to "Burst" and enables that Alarm output.
4. Sets the SPE Pointer set during the LOP test to "burst," with the Pointer value set to 522.

Example interactive session:

parity_rate 6	(sets error generator rate 1 x10^{-6}).
parity_rate?	(queries error generator rate setup)
PARITY_RATE 6	(response)
error_rate on	(turns error generator on)
error_rate?	(queries state of error generator)
ERROR_RATE ON	(response)
los_time 135e-06	(sets LOS generator time to 135 µs)
los_enab	(causes one LOS event)
alm_burst l_ais	(configures alarm burst generator for AIS)
alm_count 100	(sets alarm burst length to 100 STS-n frames)
alm_enab_burst	(generates one AIS alarm burst)

Table Of Commands

Standard Commands

*cls Clear Status Command

Clears the Standards Events Status Register (SESR) and the Event Status Bit (ESB) in the Status Byte Register (SBR); initiates the Operation Complete Idle State and Operation Complete Query Idle State

Example:	*cls
Response:	NONE
Note:	after execution the ST2400 will have no data in its input and output registers, and will not be executing any command.

*ese[n] Event Status Enable Command

Sets the Event Status Enable Register (ESER) to the argument n

Argument	n = a decimal number between 0 and 255
Example:	*ese 255
Response:	NONE
Note:	decimal 255 sets the register to 11111111 binary

*ese? Event Status Enable Register Query Command

Sets the Event Status Enable Register (ESER) to the argument n

Example:	*ese?
Response:	*ESER [n] (n = a decimal number between 0 and 255)
Note:	decimal 255 sets the register to 11111111 binary

*esr? Event Status Register Query Command

Returns the content of the Event Status Register (ESR)

Example:	*esr?
Response:	*ESR [n] (n = a decimal number between 0 and 255)
Note:	decimal 255 indicates the register is set to 11111111 binary

*idn? Identify

Returns a character string that includes: company name, instrument model number, and current software version.

Example:	*idn?
Response:	**** TEKTRONIX / MWL, ST2400, 0, v.vv
Note:	v.vv will be replaced by the software version number

*lrn? Learn Query Command

List the ST2400 current setup, except for: RS-232C port information.

Example: lrn?
Response: AUTO_VOL 0;
PRINT_PORT PARALLEL;
VIEW_ANGLE 1;
....
Note: The response is a series of commands (headers and parameters) separated by semicolons. They can be stored in the controller and used to restore the same setup later.

*opc? Operation Complete Query Command

Returns the ASCII character "1" when all previous commands and queries have been completed.

Example: *opc?
Response: *OPC? 1
Note: Used to determine when a group of commands have been completed.

*rst Reset Command

Returns the ST2400 to its factory default settings and initiates the Operation Complete Idle State and Operation Complete Query Idle State.

Example: *rst
Response: NONE
Note: This command does NOT: change the setup of the RS232C or GPIB ports, alter calibration data, alter the SESR (Standard Event Status Register), alter the ESER (Event Status Enable Register), change power-on status clear flag setting, alter stored word patterns.

*sre [n] Service Request Enable Command

Returns the content of the Service Request Enable Register (SRER)

Example: *sre 51
Response: NONE
Note: decimal 51 indicates the register is set to 00110011 binary.
Using the IEEE 488.2 GPIB standard, register bits are numbered 7 to 0 (left to right). However, the SONET standard labels bits 1 to 8 (left to right). In either case, the MSB is the left most binary bit, and the LSB is the right most binary bit.

*sre? Service Request Enable Query Command

Returns the content of the Service Request Enable Register (SRER)

Example: *sre?
Response: *SRE [n] (n = a decimal number between 0 and 255)
Note: decimal 255 indicates the register is set to 11111111 binary

*stb? Status Byte Query Command

Returns the content of the Status Byte Register (SBR)

Example: *stb?
Response: *STB [n] (n = a decimal number between 0 and 255)
Note: decimal 255 indicates the register is set to 11111111 binary

*tst? Self Test Command

Initiates a self-test and returns the results.

Example: *tst?
Response: *TST 0
Note: A result of 0 (zero) indicates a successful completion of self-test. Any other result would indicate a failure.

*wai Wait Command

Stop processing any additional commands until all pending operations are completed.

Example: *wai
Response: NONE

audio_vol [n] Audio Volume Set command

Sets the audio volume of the internal speaker.

Example: audio_vol n (n = a decimal integer from 0 to 9)
Response: NONE
Note: 0 = off, 1 = minimum, and 9 = maximum volume

audio_vol? Audio Volume Query Command

Returns a decimal integer from 0 to 9

Example: audio_vol?
Response: AUDIO_VOL n
Note: n = a decimal integer from 0 to 9

edit_setup [n], "[s]" Edit Setup Label Set Command

Assigns a label [s] to the saved setup [n]

Augment: n: is the setup number from 0 to 9 in decimal.
s: is the string of
Example: edit_setup 7, "OC-12 Test"
Response: NONE
Note: Up to 10 ASCII characters can be saved with each of the 10 setups.
The string must be enclosed in quotation marks.
Only upper case ASCII characters A to Z and numbers 0 to 9 can be used, along with the following ASCII symbols: # $ % & ' ( ) * + - , / :

edit_setup? [n] Edit Setup Label Query Command

Returns the current label assigned to the [n] setup saved in memory

Example: edit_setup? [n] (n = a decimal integer between 0 and 9)
Response: EDIT_SETUP OC-12 TEST
Note: Up to 10 ASCII characters can be saved with each of the 10 setups.

gpib_address? GPIB Address Query Command

Returns the current address value.

Example: gpib_address?
Response: GPIB_ADDRESS 15
Note: This command is only used through the RS-232C Port connection.

gpib_address [n] GPIB Address Set Command

Sets the value of the GPIB Port address.

Example: gpib_address 15
Response: NONE
Arguments: n = a decimal integer from 0 to 31
Note: This command is only used through the RS-232C Port connection.

gpib_bus [talk_listen | off_bus] GPIB Bus Mode Set Command

Sets the GPIB bus mode to on or off.

Arguments: talk_listen enables the gpib bus.
off_bus disables the gpib bus. In this mode the gpib bus will not respond to any commands except the GPIB Bus talk_listen from the RS-232C port.
Example: GPIB Bus off_bus
Response: NONE
Note: This command is only used through the RS-232C Port connection.
See the gpib_bus? (GPIB Bus Mode Query Command)

gpib_bus? GPIB Bus Mode Query Command

Returns the current status of the GPIB bus.

Example: gpib_bus?
Response: GPIB_BUS TALK_LISTEN
Note: The GPIB bus can be off (off_bus) or on (talk_listen)
This command is only used through the RS-232C Port connection.

header [on I off]   Header mode command

Enables or disables headers. The header is the part of a response that replicates the command .

Arguments: on enables headers in the response to any query command.
off disables headers.
Example: header on
Response: NONE
Note: When the header is on, the query command gpib_bus? will respond with both the header and the status: GPIB_BUS TALK_LISTEN
When the header is off, the query command gpib_bus? will respond with the status only: TALK_LISTEN

header?   Header Mode Query Command

Returns a response string indicating the headers are enabled or disabled.

Example: header?
Response: HEADER ON
Note: See the Header Mode Set Command.

logo?   Logo Query command

Returns a character string that includes: company name, instrument model number, current software version, and software date.

Example: logo?
Response: **** TEKTRONIX MICROWAVE LOGIC, ST2400, v.vv yyyy/mm/dd
Note: v.vv will be replaced by the software version number
yyyy/mm/dd will be replaced by the software date

options?   Options Query command

Returns one or more character strings indicating which options are installed.

Example: options?
Response: OPTIONS RX 1310 RX 1550 TX 1310
Note: The response indicates that the receiver can receive both the 1310 nm and 1550 nm wavelength, and that the 1310 nm transmitter is installed.

print_port [parallel I serial]   Print Port Select Command

Sets the default printer port to parallel or serial.

Example: print_port parallel
Response: NONE
Note: Sets the default printer port can be set to parallel or serial.

print_port?   Print Port Query Command

Returns the current printer port setting.

Example: print_port?
Response: PRINT_PORT PARALLEL
Note: The default printer port can be set to parallel or serial.

print_string "s" Print String command

Prints the string "s" out the current printer port.

Example: print_string "This is a test."
Response: This is a test.
Note: The character string [s] can be up to 80 (eighty) characters long. It begins and ends with quotation marks.

rs_echo [on | off] RS-232C Echo Control Command

Enables or disables the echo on the RS-232C port.

Arguments: When the echo is on the ST2400 will echo back each ASCII character sent to the RS-232C port (Full Duplex mode).
When the echo is off the ST2400 will NOT echo back ASCII characters sent to the RS-232C port (Half Duplex mode).
Example: rs_echo on
Response: NONE

rs_echo? RS-232 Echo Control Command

Returns a character string that indicates whether the echo control is enabled or disabled.

Example: rs_echo?
Response: RS_ECHO ON
Note: Indicates that the echo control is enable (Full Duplex Mode). The response OFF would indicate that the echo control was disable (Half Duplex Mode).

rs_pmt_lf [on | off] RS-232C Prompt Linefeed Set Command

Enables or disables the current RS-232C EOL (end-of-line) terminator.

Example: rs_pmt_lf on
Response: NONE
Note: The current EOL can be set to CR, LF, CR+LF, or LF+CR.

rs_pmt_lf? RS-232 Prompt Linefeed Query Command

Returns a character string that indicates the current RS-232C EOL (end-of-line) terminator status.

Example: rs_pmt_lf?
Response: RS_PMT_LF ON
Note: The current EOL can be on (enabled) or off (disabled). Its value is unknown. It may be set to CR, LF, CR+LF, or LF+CR using the quick setup menu.

rs_prompt "s" RS-232 prompt command

Set the character string "s" on the RS-232C prompt.

Example: rs_prompt " ST2400 Unit A> "
Response: ST2400 Unit A>
Note: The character string "s" will be at the start of each new line. Quotation marks must be used before and after the character string, and the string is limited to 12 characters in length.

rs_xon_xoff [on | off] RS-232C Flow Control Set Command

Enables or disables the RS-232C flow control mode

Example: rs_xon_xoff on
Response: NONE

rs_xon_xoff? RS-232C Flow Control Query Command

Returns a character string that indicates the current RS-232C flow control status.

Example: rs_xon_xoff?
Response: RS_XON_XOFF ON
Note: The current XON XOFF flow control can be on (enabled) or off (disabled).

General Setup Commands

date "[yy(yy)/mm/dd]" Date Set Command

Sets the instrument's internal calendar.

Example: date "1996/08/30"
Response: NONE

date? Date Query Command

Returns a character string indicating the internally stored date.

Example: date?
Response: DATE "1996/08/30"

quick_setup [n] Quick Setup Command

Used to recall one of the four factory default setups:

Arguments: 0 sets the (TX) transmitter to internal and the (RX) receiver to 155Mb/s drop
1 sets the (TX) transmitter to internal and the (RX) receiver to 622Mb/s drop
2 sets the (TX) transmitter to external 155Mb/s and the RX to 155Mb/s drop
3 sets the (TX) transmitter to external 622Mb/s and the RX to 622Mb/s drop
Example: quick_setup 1
Response: NONE
Note: The quick setup command will NOT enable the STM-12 transmit laser.

save_setup [n] Save Setup Command

Saves the current instrument setup in location n.

Example: save_setup n (n = a decimal number from 0 to 9)
Response: NONE

recall_setup [n] Recall Setup Command

Recalls the saved setup from location n.

Example: recall_setup n (n = a decimal number from 0 to 9)
Response: NONE

stored? Stored Setup Query Command

Returns the currently stored setup locations saved in memory.

Example: stored?
Response: STORED 0,1,2...
Note: Stored locations are numbered from 0 to 9 in decimal.

time? Internal Time Clock Query Command

Returns the time from the ST2400 internal time of day clock.

Example: time?
Response: TIME "15:30:45"
Note: Uses 24 hours format, HH:MM:SS (Hours Minutes Seconds)

time "[hh:mm:ss]" Internal Time Clock Set Command

Sets the internally stored time of day clock.

Example: time "15:30:45"
Response: NONE
Note: Uses 24 hours format, HH:MM:SS (Hours Minutes Seconds)

tse Test Status Enable Register Set Command

Sets the content of the TSER (Test Status Enable Register) to a decimal number from 0 to 255

Example: tse 255
Response: NONE
Note: decimal 255 indicates the register is set to 11111111 binary

tse? Test Status Event Register Query Command

Returns the content of the TSER (Test Status Event Register)

Example: tse?
Response: TSE [n] (n = a decimal number between 0 and 255)
Note: decimal 255 indicates the register is set to 11111111 binary

tsr? Test Status Register Query Command

Returns the content of the TSR (Test Status Register).

Example: tsr?
Response: TSR [n] (n = a decimal number between 0 and 255)
Note: decimal 255 indicates the register is set to 11111111 binary

view_angle? Front-panel View Angle Query Command

Returns a decimal integer that indicates the display angle of view.

Example: view_angle?
Response: VIEW_ANGLE 2
Note: View angle is an integer from 0 to 7. Zero should be the best view angle when the ST2400 is positioned below the operator.

view_angle [n] Front-panel View Angle Set Command

Sets the view angle to an integer from 0 to 7 decimal.

Example:	view_angle 1
Response:	NONE
Note:	View angle is an integer from 0 to 7. Zero should be the best view angle when the ST2400 is positioned below the operator.

Test Cycle Control Commands

log_print Print Error Log Execute Command

Prints all error log reports stored in the non-volatile memory Error Log.

Example:	log_print
Response:	NONE

elap_time? Elapsed Test Cycle Time Query Command

Returns the number of elapsed seconds in the current Test Cycle.

Example:	elap_time?
Response:	ELAP_TIME 120
Note:	Returns the total duration of the last completed Test Cycle, when no Test Cycle is currently running (between Test Cycles).

test_mode [untimed I timed I repeat] Test Mode Set Command

Sets the test measurement mode.

Arguments	untimed: sets the continuous measurement mode. timed: sets the timed measurement mode. repeat: sets the repeat-timed measurement mode.
Example:	test_mode timed
Response:	NONE
Note:	See the test time (test_time) set command The timed test runs for the duration of time set by the test_time command The repeat test runs for the duration of time set by the test_time command

test_mode? Test Mode Query Command

Returns the current status of the test measurement mode.

Example:	test_mode?
Response:	TEST_MODE TIMED
Note:	See the Test Mode Set Command.

test_print [log | prev | current | off] Test Print Set Command

Used to print or stop printing the test results.

Arguments	log: prints the content of the error log. prev: prints an end-of-test report at the end of the previous test interval. current: prints an end-of-test report from the current test interval. off: disables report printing.
Example:	test_print off
Response:	NONE

test_report [log | eot | both | off] Test Report Set Command

Enable or disable Test Report Type.

Arguments	log: enable event log reports eot: enable end-of-test reports. both: enable both log and eot reports. off: disables reports.
Example:	test_report both
Response:	NONE

test_report? Test Report Query Command

Returns a character string indicating the report status.

Example:	test_report?
Response:	TEST_REPORT BOTH
Note:	See the Test Report Set Command

test_squelch [on | off] Test Squelch Set Command

Enables or disables the Squelch.

Arguments	on: (1) logs 10 consecutive events (2) waits for 10 event free seconds. off: logs every event.
Example:	test_squelch on
Response:	NONE
Note:	When the Squelch is enabled error logging is limited to ten consecutive reports. Then Error logging is resumed after 10 event free seconds.

test_squelch? Test Squelch Query Command

Returns the current status of the Squelch

Example:	test_squelch?
Response:	TEST_SQUELCH ON
Note:	See the Test Squelch Set Command.

test_state [run I stop] Test State Set Command

Sets the test state to either run or stop.

Arguments	run: clears all counters, clears the history, and starts the test cycle. stop: suspends the test cycle.
Example:	test_state run
Response:	NONE
Note:	See pause_state command. The Trouble Scan Mode must be OFF before the Test State can be enabled.

test_state? Test State Query Command

Returns the current status of the test cycle.

Example:	test_state?
Response:	TEST_STATE ON
Note:	The test cycle can be either on (running) or off. When the test state = stop the pause-run-resume sequence can be used to save the current data and history.

test_time "[d-hh:mm:ss]" Test Time Set Command

Sets the duration of the test cycle in days (d), hours, (hh) minutes (mm), and seconds (ss).

Example:	test_time "0-02:00:00"
Response:	NONE
Note:	The Argument must be enclosed in quotation marks. One hyphen and two colons must be used as shown in the example. Maximum Test Time = 9 days, 23 hours, 59 minutes, 59 seconds.

test_time? Test State Query Command

Returns a character string indicating the current test time settings.

Example:	test_time?
Response:	TEST_TIME "0-02:00:00"

test_state [run I stop] Test State Set Command

Sets the test state to either run or stop.

Arguments	run clears all counters, clears the history, and starts the test cycle. off stops the test cycle.
Example:	test_state run
Response:	NONE
Note:	See pause_state command

test_state? Test State Query Command

Returns the current status of the test cycle.

Example:	test_state?
Response:	TEST_STATE ON
Note:	The test cycle can be either on (running) or off.

pause_state [pause | resume]   Pause State Set Command

Sets the test state to either pause or resume.

Arguments	pause interrupts the test cycle. resume restarts the test cycle.
Example:	pause_state pause
Response:	NONE
Note:	See test_state command

pause_state?   Pause State Query Command

Returns the current status of the test cycle.

Example:	pause_state?
Response:	PAUSE_STATE PAUSE
Note:	The test cycle state can be paused (interrupted) or resume (running).

System Configuration

m_mode? Measurement Mode Query Command

Returns a character string indicating the currently active measurement mode.

Example: m_mode?
Response: M_MODE SDH
Note: The current measure mode can be either SDH or SONET

new_m_mode [sdh I sonet] New Measurement Mode Set Command

Sets the measurement mode to be used after the next power-on cycle.

Example: new_m_mode sonet
Response: NONE
Note: see (new_m_mode?) New Measurement Mode Query Command

new_m_mode? New Measurement Mode Query Command

Returns a character string indicating the measurement mode that is set to be used after the next power-on cycle.

Example: new_m_mode sonet
Response: NONE
Note: see (new_m_mode?) New Measurement Mode Set Command

log_clear Log Clear Command

Clears all error log entries.

Example: log_clear
Response: NONE

rx_installed? Receiver Board Query Command

Returns receiver board status that was detected during the power–on sequence

Example: rx_installed?
Response: RX_INSTALLED YES
Note: YES indicates that the receiver board was detected.
NO indicates that the receiver board was NOT detected.

tx_installed? Transmitter Board Query Command

Returns transmitter board status that was detected during the power–on sequence

Example: rx_installed?
Response: RX_INSTALLED YES
Note: YES indicates that the transmitter board was detected.
NO indicates that the transmitter board was NOT detected.

tx_wav? TX Wavelength Query Command

Returns transmitter wavelength

Example: tx_wav?
Response: TX_WAVE 1310
Note: The transmitter wavelength can be switched to either 1310nm or 1550nm in a dual wavelength unit.

tx_wav [1310 I 1550] TX Wavelength Set Command

Switches the transmitter wavelength in a dual wavelength unit.

Example: tx_wav 1550
Response: NONE
Note: The transmitter wavelength can be switched to either 1310nm or 1550nm.

Receiver Remote Commands

RS-B1, MS-B2, and MS-REI Error Data Query Commands

b1_eb? B1 Errored Block Count Command

Returns the number of corrupted section blocks counted in the received signal.

Example: b1_eb?
Response: B1_EB [c] (c = counted seconds in decimal)
Note: RS-B1 error blocks include the total count, conforms to ITU G.826

b2_eb? B2 Errored Block Count Command

Returns the number of corrupted line blocks counted in the received signal.

Example: b2_eb?
Response: B2_EB [c] (c = counted seconds in decimal)
Note: MS-B2 error blocks include the total count, conforms to ITU G.826

rei_eb? REI Errored Block Count Command

Returns the number of path remote error indications counted in the receiver signal.

Example: rei_eb?
Response: REI_EB [c] (c = counted seconds in decimal)
Note: MS-REI error blocks include the total count, conforms to ITU G.826

b1_bbe? B1 Background Block Error Count Command

Returns the number of b1 errored blocks counted that occurred outside the SES.

Example: b1_bbe?
Response: B1_BBE [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826. Also see b1_ses?

b2_bbe? B2 Background Block Error Count Command

Returns the number of b2 errored blocks counted that occurred outside the SES.

Example: b2_bbe [b2 background block errors]
Response: B2_BBE [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826. Also see b2_ses?

rei_bbe? REI Background Block Error Count Command

Returns the number of REI errored blocks counted that occurred outside the SES.

Example: rei_eb?
Response: REI_BBE [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826. Also see rei_ses?

b1_bber? B1 Background Block Error Ratio Command

Returns the ratio of b1 errored blocks that occurred outside the SES.

Example: b1_bbe?
Response: B1_BBE [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826. Also see b1_ses?

b2_bber? B2 Background Block Error Ratio Command

Returns the ratio of b2 errored blocks that occurred outside the SES.

Example: b2_bbe [b2 background block errors]
Response: B2_BBE [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826. Also see b2_ses?

rei_bber? REI Background Block Error Ratio Command

Returns the ratio of rei errored blocks that occurred outside the SES.

Example: rei_eb?
Response: REI_BBE [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826. Also see rei_ses?

b1_es? B1 Errored Seconds Query Command

Returns the number of STM-n section BIP-8 code violation errored seconds counted in the received signal.

Example: b1_es?
Response: B1_ES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826.

b2_es? B2 Errored Seconds Query Command

Returns the number of STM-n line BIP-24 code violation errored seconds counted in the received signal.

Example: b2_es?
Response: B2_ES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826.

rei_es? REI Errored Seconds Query Command

Returns the number of REI errored seconds counted in the received signal.

Example: rei_es?
Response: REI_ES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826.

b1_ses? Severely Errored Seconds Query Command

Returns the number of STM-n section BIP-8 code violation severely errored seconds counted in the received signal.

Example: b1_ses?
Response: B1_SES [c] (c = counted seconds in decimal)

Note: Conforms to ITU G.826.

b2_ses? Severely Errored Seconds Query Command

Returns the number of STM-n line BIP-24 code violation severely errored seconds counted in the received signal.

Example: b2_ses?
Response: B2_SES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826.

rei_ses? Severely Errored Seconds Query Command

Returns the number of REI severely errored seconds counted in the received signal.

Example: rei_ses?
Response: REI_SES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.826.

b1_esr? B1 Errored Seconds Ratio Query Command

Returns the number of STM-n section BIP-8 code violation errored seconds counted in the received signal divided by the available time.

Example: b1_esr?
Response: B1_ESR [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826.

b2_esr? B2 Errored Seconds Ratio Query Command

Returns the number of STM-n line BIP-24 code violation errored seconds counted in the received signal divided by the available time.

Example: b2_esr?
Response: B2_ES [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826.

rei_esr? REI Errored Seconds Ratio Query Command

Returns the number of REI errored seconds counted in the received signal.

Example: rei_esr?
Response: REI_ES [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826.

b1_sesr? Severely Errored Seconds Ratio Query Command

Returns the number of STM-n section BIP-8 code violation severely errored seconds counted in the received signal divided by the available time.

Example: b1_ses?
Response: B1_SES [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826.

b2_sesr? Severely Errored Seconds Ratio Query Command

Returns the number of STM-n line BIP-24 code violation severely errored seconds counted in the received signal divided by the available time.

Example: b2_ses?
Response: B2_SES [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826.

rei_sesr? Severely Errored Seconds Ratio Query Command

Returns the number of REI severely errored seconds counted in the received signal divided by the available time.

Example: rei_ses?
Response: REI_SES [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.826.

b1_uas? Unavailable Seconds Query Command

Returns the number of STM-n section BIP-8 code violation unavailable seconds counted in the received signal.

Example: b1_uas?
Response: B1_UAS [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.827.

b2_uas? Unavailable Seconds Query Command

Returns the number of STM-n line BIP-24 code violation unavailable seconds counted in the received signal.

Example: b2_uas?
Response: B2_UAS [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.827.

rei_uas? Unavailable Seconds Query Command

Returns the number of REI unavailable seconds counted in the received signal.

Example: rei_uas?
Response: REI_UAS [c] (c = counted seconds in decimal)
Note: Conforms to ITU G.827.

b1_ur? Unavailable Seconds Ratio Query Command

Returns the number of STM-n section BIP-8 code violation errored seconds counted in the received signal.

Example: b1_ur?
Response: B1_UR [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.827.

b2_ur? Unavailable Seconds Ratio Query Command

Returns the number of STM-n line BIP-24 code violation errored seconds counted in the received signal.

Example: b2_ur?
Response: B2_UR [e] (e = expressed as a negative exponent)
Note: Conforms to ITU G.827.

rei_ur? Unavailable Seconds Ratio Query Command

Returns the number of REI unavailable seconds counted in the received signal.

Example: rei_ur?
Response: REI_UR [e] (e= expressed as a negative exponent)
Note: Conforms to ITU G.827

b1_aeb? B1 Available Time Errored Block Count Command

Returns the number of corrupted section blocks counted during the available time.

Example: b1_aeb?
Response: B1_AEB [c] (c = counted blocks, in decimal)
Note: Conforms to ITU G. 2101

b2_aeb? B2 Available Time Errored Block Count Command

Returns the number of corrupted line blocks counted during the available time.

Example: b2_aeb?
Response: B2_AEB [c] (c = counted blocks, in decimal)
Note: Conforms to ITU G. 2101

rei_aeb? REI Available Time Errored Block Count Command

Returns the number of path remote error indications counted during available time..

Example: rei_aeb?
Response: REI_AEB [c] (c = counted blocks, in decimal)
Note: Conforms to ITU G. 2101

b1_abbe? B1 Available Time Background Block Errors Command

Returns the number of corrupted section background blocks counted during the available time.

Example: b1_abbe?
Response: B1_ABBE [c] (c = counted background blocks, in decimal)
Note: Conforms to ITU G. 2101

b2_abbe? B2 Available Time Background Block Errors Command

Returns the number of corrupted line background blocks counted during the available time.

Example: b2_abbe?
Response: B2_ABBE [c] (c = counted background blocks, in decimal)
Note: Conforms to ITU G. 2101

rei_abbe? REI Available Time Background Block Errors Command

Returns the number of background remote error indications counted during available time..

Example: rei_abbe?
Response: REI_ABBE [c] (c = counted background blocks, in decimal)
Note: Conforms to ITU G. 2101

b1_aes? B1 Available Time Errored Seconds Query Command

Returns the number of STM-n section BIP-8 code violation errored seconds counted in the received signal, during the available time.

Example: b1_aes?
Response: B1_AES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G. 2101

b2_aes? B2 Available Time Errored Seconds Query Command

Returns the number of STM-n line BIP-24 code violation errored seconds counted in the received signal, during the available time.

Example: b2_aes?
Response: B2_AES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G. 2101

rei_aes? REI Available Time Errored Seconds Query Command

Returns the number of errored seconds counted in the received signal, during the available time.

Example: rei_aes?
Response: REI_AES [c] (c = counted seconds in decimal)
Note: Conforms to ITU G. 2101

b1_ases? B1 Available Time Severely Errored Seconds Command

Returns the number of STM-n section BIP-8 code violation severely errored seconds counted in the received signal, during the available time.

Example: b1_ases?
Response: B1_ASES [c] (c = counted seconds, in decimal)
Note: Conforms to ITU G. 2101

b2_ases? B2 Available Time Severely Errored Seconds Command

Returns the number of STM-n line BIP-24 code violation severely errored seconds counted in the received signal, during the available time.

Example: b2_ases?
Response: B2_ASES [c] (c = counted seconds, in decimal)
Note: Conforms to ITU G. 2101

rei_ases? REI Available Time Severely Errored Seconds Command

Returns the number of REI severely errored seconds counted in the received signal, during the available time.

Example:	rei_ases?
Response:	REI_ASES [c] (c = counted seconds, in decimal)
Note:	Conforms to ITU G. 2101

LED Status Query Commands

led_stat? LED Status Query Command

Returns the current state of all front panel status indicators (LEDs).

Example: led_stat?
Response: LED_STAT? CLEAR
Note: The LED status indicator can be in one of three states:
CLEAR indicates that all of the LED status indicators are off and have been off for the total duration of the current test cycle.
CUR (current) indicates that one or more LED indicators are on or had been on since last queried during the current test cycle.
HIST (history) indicates that all of the LED indicators are off but one or more of them had been on before the last query during the current test cycle.
The led_stat? command will report the CUR condition until the user remotely queries and gets the status information from all of the LED indicators that were active at any time during the test cycle. Each LED status command will also report the CUR condition if the LED was activated since its last query. Once all are queried, each LED indicator and the led_stat? command will report the HIST condition if an error or alarm had ever occurred during the current test cycle, otherwise the CLEAR condition will be reported.

rs_los? Regeneration Section Loss Signal Query Command

Request the current state of the LOS indicator.

Example: rs_los?
Response: RS_LOS? CLEAR
Notes: The section LOS indicator can be in one of three states:
CLEAR indicates that the LOS LED is now off and had been off during the current test cycle.
CUR (current) indicates that the LOS indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the LOS LED is off, but had been on during some period before the last query, during the current test cycle.

rs_lof? Regeneration Section Loss Frame Query Command

Request the current state of the LOF indicator.

Example: rs_lof?
Response: RS_LOF? CLEAR
Note: The section LOF indicator can be in one of three states:
CLEAR indicates that the LOF LED is now off and had been off during the current test cycle.
CUR (current) indicates that the LOF indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the LOF LED is off, but had been on during some period before the last query, during the current test cycle.

rs_oof? Regeneration Section Out-Of-Frame Query Command

Request the current state of the OOF indicator.

Example: rs_oof?
Response: RS_OOF? CLEAR
Note: The section LOS indicator can be in one of three states:
CLEAR indicates that the OOF LED is now off and had been off during the current test cycle.
CUR (current) indicates that the OOF indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the OOF LED is off, but had been on during some period before the last query, during the current test cycle.

rs_b1? Regeneration Section B1 Query Command

Request the current state of the section B1 byte indicator.

Example: rs_b1?
Response: RS_B1? CLEAR
Note: The section LOS indicator can be in one of three states:
CLEAR indicates that the B1 LED is now off and had been off during the current test cycle.
CUR (current) indicates that the B1 indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the B1 LED is off, but had been on during some period before the last query, during the current test cycle.

ms_b2? Multiplexer Section B2 Query Command

Request the current state of the line B2 byte indicator LED.

Example: ms_b2?
Response: MS_b2? CLEAR
Note: The section LOS indicator can be in one of three states:
CLEAR indicates that the B2 LED is now off and had been off during the current test cycle.
CUR (current) indicates that the B2 indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the B2 LED is off, but had been on during some period before the last query, during the current test cycle.

ms_ais? Multiplexer Section Alarm Indicator Signal Query Command

Request the current state of the Alarm Indicator Signal LED.

Example: ms_ais?
Response: MS_AIS? CLEAR
Note: The section AIS indicator can be in one of three states:
CLEAR indicates that the AIS LED is now off and had been off during the current test cycle.
CUR (current) indicates that the AIS indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the AIS LED is off, but had been on during some

period before the last query, during the current test cycle.

ms_rdi? Multiplexer Section Remote Defect Indication Query Cmd

Request the current state of the Multiplexer Section Remote Defect (Degrade) Indication alarm LED.

Example: ms_rdi?

Response: MS_RDI? CLEAR

Note: The section RDI indicator can be in one of three states:
CLEAR indicates that the RDI LED is now off and had been off during the current test cycle.
CUR (current) indicates that the RDI indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the RDI LED is off, but had been on during some period before the last query, during the current test cycle.

ms_rei? Multiplexer Section Remote Error Indicator Query Command

Request the current state of the Multiplexer Section Remote Error Indicator alarm LED.

Example: ms_rei?

Response: MS_REI? CLEAR

Note: The section REI indicator can be in one of three states:
CLEAR indicates that the REI LED is now off and had been off during the current test cycle.
CUR (current) indicates that the REI indicator is either on or had been on since last queried during the current test cycle.
HIST (history) indicates that the REI LED is off, but had been on during some period before the last query, during the current test cycle.

TOH Transport Overhead Bytes

rx_oh_all? Receive Overhead All Query Command

Returns 40 bytes, 27 are valid (TOH) Section and Line overhead bytes. All POH (Path Overhead) and (VT) Virtual Tributary bytes equal zero because the ST2400 only supports section and line testing.

Table 6-1 Byte Mnemonics

	TOH Section (Sec.) and Line Overhead Bytes			POH Bytes	VT Bytes
Sec.	A1	A2	J0	J1	V1
Sec.	B1	E1	F1	B3	V2
Sec.	D1	D2	D3	C2	V3
Line	H1	H2	H3	G1	V4
Line	B2	K1	K2	F2	
Line	D4	D5	D6	H4	
Line	D7	D8	D9	Z3	
Line	D10	D11	D12	Z4	
Line	S1	M1	E2	Z5	

Example: rx_oh_all?

Response: RX_OH_ALL 0,#HF6;1,#H28;... etc.

Note: The first number before the comma is the NR1 byte count format, ranging from zero to thirty-five for the TOH and POH bytes in the following order: A1, A2, J0, J1, B1, ..., B3, ..., D1, ..., Z5, and thirty-six through thirty-nine for bytes: V1, V2, V3, V4. The #H code after the comma is corresponding byte value in non-decimal numeric (hexadecimal).

rx_oh_byte? [s] Receive Overhead Byte Query Command

Returns the value of the specified TOH byte.

Whereas the argument [s] is a byte mnemonic listed in Table 6-2

Example: rx_oh_byte? K2

Response: RX_OH_BYTE K2,#H22

Note: The argument K2 in the example corresponds to the K2 byte. The K2 before the comma in the response in the corresponding byte label. The code #H22 after the comma is the hexadecimal (non-decimal numeric value) of the K2 byte.

rx_oh_offset? [n] Receive Overhead Offset Query Command

Returns the overhead byte associated with the specified offset. All POH (Path Overhead) and VT (Virtual Tributary) bytes equal zero because only section and line testing are supported by the ST2400.

Whereas the argument [n] is the corresponding offset value for the byte mnemonic using the format *byte mnemonic: offset value* listed in Table 6–2

Table 6–2 Byte Mnemonic and Offset

	TOH Section (Sec.) and Line Overhead Bytes			POH Bytes	VT Bytes
Sec.	A1: 00	A2: 01	J0: 02	J1:03	V1: 36
Sec.	B1: 04	E1: 05	F1: 06	B3: 07	V2: 37
Sec.	D1: 08	D2: 09	D3: 10	C2: 11	V3: 38
Line	H1: 12	H2: 13	H3: 14	G1: 15	V4: 39
Line	B2: 16:	K1: 17	K2: 18	F2: 19	
Line	D4: 20	D5: 21	D6: 22	H4: 23	
Line	D7: 24	D8: 25	D9: 26	Z3: 27	
Line	D10: 28	D11: 29	D12: 30	Z4: 31	
Line	S1: 32	M1: 33	E2: 34	Z5: 35	

Example: rx_oh_offset? 18

Response: RX_OH_OFFSET #H22

Note: The number 18 in the example corresponds to the K2 byte's offset value. The number #H22 is the non-decimal numeric (hexadecimal) value of the K2 byte.

Automatic Protection Switching (APS) Data

rx_aps_byte? Receiver APS Bytes Query Command

Return the current value of the APS (Automatic Protection Switching) bytes: K1 and K2

Example:	rx_aps_byte?
Response:	RX_APS_BYTE #HFF, #H55
Note:	The codes #HFF and #H55 are the hexadecimal numeric value of the K1 and K2 bytes, respectively.

Receiver Drop Commands

rx_drop [off | 155 | 622] Receiver Drop Rate Set Command

Sets the optical drop rate.

Arguments:	off: set the optical drop to off and enables the 155 Mb/s CMI drop. 155: sets the optical drop to 155 Mb/s and enables the 155 Mb/s CMI drop. 622: sets the optical drop to 622 Mb/s and disables all CMI drop.
Example:	rx_drop 155
Response:	NONE
Note:	The receiver setup is independent of the transmitter setup.

rx_drop? Receiver Drop Rate Query Command

Returns the value of the current optical drop rate selected.

Example:	rx_drop?
Response:	RX_DROP 155
Note:	See the Receiver Drop Rate Set Command.

drop_chan n Drop Channel Tributary Select Command

Selects the tributary channel to drop.

Arguments:	n = from 1 to 4 if the drop rate is set to 622 Mb/s n = from 1 to 16 if the drop rate is set to 155 Mb/s
Example:	drop_chan 5
Response:	NONE
Note:	The receiver setup is independent of the transmitter setup.

drop_chan? Drop Channel Tributary Query Command

Returns the channel number of the tributary drop selected.

Example:	drop_chan?
Response:	DROP_CHAN 5
Note:	See the Drop Channel Tributary Select Command

Transmitter Remote Commands

tx_laser_pow [on | off]   2.4 Gbps Laser Set Command

Enables or disables the transmitter laser.

Example: tx_laser_pow on
Response: NONE
Note: The transmitter setup is independent of the receiver setup.

tx_laser_pow?   2.4 Gbps Laser Query Command

Returns the status of the transmitter laser.

Example: tx_laser_pow?
Response: TX_LASER_POW ON
Note: ON indicates that the transmitter laser is enabled.
OFF indicates that the transmitter laser is disabled.
The transmitter setup is independent of the receiver setup.

tx_event_trig [alarm | error]   Event Trigger Set Command

Selects the trigger stimulus for the rear-panel event trigger output.

Arguments: alarm: generates a trigger on each occurrence of the currently configured alarm.
error: generates a trigger on each occurrence of the currently configured error.
Example: tx_event_trig alarm
Response: NONE
Note: The event trigger will lead the preset alarm by less than 1 microsecond. It is available at the rear panel and can be used to synchronize other test equipment.

tx_event_trig?   Event Trigger Query Command

Returns the value of the selected event trigger stimulus, alarm or error.

Example: tx_event_trig alarm
Response: NONE
Note: See the Event Trigger Set Command.

tx_input [155 | 622 | cmi | int | thru] Tx external input selection command

Sets the source, rate, and configuration that will produce the final transmitter output

Arguments: 155: configures the transmitter output from the transmitter 155 Mb/s external optical input
622: configures the transmitter output from the transmitter external 622 Mb/s optical input
CMI: configures the transmitter output from the transmitter 155 Mb/s external CMI electrical input
int: configures the transmitter output from an internal generator
thru: configures the transmitter output from the receiver input

Example: tx_input 155

Response: NONE

Note: The transmitter setup is independent of the receiver setup.

tx_input? TX input query command

Returns the status of the transmitter source, rate, and configuration.

Example: tx_input?

Response: TX_INPUT xxx

Note: The response can be 155, 622, cmi, int, or thru (see tx_input command)

External tributary insertion channel commands

tx_trib_mode [single | all]   TX Mode Select Command

Selects the multiplex mode that will be used for the 2.4 Gb/s signal.

Arguments:	single: will insert the 155 Mb/s tributary selected into the into the channel specified by the tx_trib_chan command. all: will insert the 155 Mb/s tributary selected into all 16 (or the 622 Mb/s tributary selected into all 4) channels in the 2.4 Gb/s transmitter output signal.
Example:	tx_trib_mode single
Response:	NONE
Notes:	This command is used with the tx_trib_chan command. The receiver setup is independent of the transmitter setup.

tx_trib_chan n   TX Channel Set Command

Selects the channel that will be used as the tributary to be multiplexed with the 2.4 Gb/s signal.

Arguments	n = from 1 to 4 if the drop rate is set to 622 Mb/s. n = from 1 to 16 if the drop rate is set to 155 Mb/s.
Example:	tx_trib_chan n
Response:	NONE
Notes:	This command is external drop rate dependent, as set by the tx_input command. When executed, this command will generate an ERROR response if the input is not set to one of the external modes (see the tx_input command). The receiver setup is independent of the transmitter setup.

STM-16 single error insertion commands

tx_serr [b1 | b2 | chan | b2_rem | rei]

Injects a single error of the specified type.

Arguments:	b1: inverts a single bit in the b1 byte to generate a parity error b2: inverts a single bit in the b2 byte to generate a parity error chan: inserts a bit error on the channel specified by the tx_err_chan command. b2_rem: inserts a single b2 error when the transmitter is in the external mode with tributary insertion on channel one or on all of the channels. This options only functions in the dual mode. rei: inserts a remote error indication (rei)
Example:	tx_serr b1
Response:	NONE
Note:	Used with the tx_err_chan command

tx_err_chan n

Sets the channel for a bit error on a specific STM-1 channel.

Example:	tx_err_chan n (n = an integer from 1 to 16)
Response:	NONE
Note:	Used with the tx_serr command The channel will be used for a single or rate error insertion.

STM-16 Error Rate Commands

tx_err_rate x.yE-z   Error Rate Generator Range Set Command

Sets the rate generator range for bit, channel, and B1 errors.

Example: tx_err_rate x.yE-z
Response: NONE
Note: Bit and channel errors can be set to a range from 0.1e-9 to 1.0e-3
B1 errors can be set to a range from 0.1e-9 to 2.5e-5
See the Error Rate Injection Enable Command

tx_err_rate? Error Rate Generator Range Set Command

Returns the current error rate settings.

Example: tx_err_rate?
Response: TX_ERR_RATE x.yE-z
Note: See the Error Rate Generator Range Set Command

tx_err_ena [b1 | bit | chan | off]   Error Rate Injection Enable Command

Enables or disables error rate insertion.

Arguments: b1: generates b1 errors at the current rate setting
bit: generates bit errors at the current rate setting
chan: generates channel errors at the current rate setting
off: disables the error that are being generated at the current rate.
Example: tx_err_ena b1
Response: NONE
Notes: The current rate was set by the Error Rate Generator Range Set Command

tx_err_ena? Error Rate Injection Enable Query Command

Returns the status of the Error Rate Injection Enable Command

Example: tx_err_ena?
Response: TX_ERR_ENA B1
Notes: The current status can be b1, bit, chan, or off.

tx_rei_cnt [n]   Tx REI Errored Frames Count Set Command

Sets the number [n] of frames that will contain a Line REI (Remote Error Indication) signal.

Argument: n is a number from 1 to 255
Example: tx_rei_cnt 14
Response: NONE
Used with the burst argument of the tx_rei_ena command.

tx_rei_cnt?   Tx REI Errored Frames Count Query Command

Returns the number of Line REI Signals set to be inserted in each frame.

Example: tx_rei_cnt?
Response: TX_REI_CNT 14

See the Tx REI Errored Frames Count Set Command.

tx_rei_secs [n.m] Tx REI Duration Set Command

Sets the duration of the Line REI (Remote Error Indication) insertion time in seconds.

Arguments:	n.m is a decimal number from 0.1 to 9.9 seconds.
Example:	tx_rei_secs 3.9
Response:	NONE
Notes:	The default value is 2.5 seconds.
	Used with the timed argument of the tx_rei_ena command.

tx_rei_secs? Tx REI Duration Query Command

Returns the current settings for the Line REI duration in seconds.

Example:	tx_rei_secs?
Response:	TX_REI_SECS 3.9
Note:	See the Tx REI Duration Set Command

tx_rei_ena [burst I timed I cont I off] Tx REI Enable Set Command

Enables or disables the REI (Remote Error Indication) insertion event.

Arguments:	burst: generates one single error event for a number of frames.
	timed: generates the event for the period set
	cont: generates a continuous event
	off: disables the event including continuous and burst
Example:	tx_rei_ena off
Response:	NONE
Note:	The number of errored frames is set by the tx_rei_cnt command
	The duration of the timed event is set by the tx_rei_secs command

tx_rei_ena? Tx REI Enable Query Command

Returns the current status REI insertion event.

Example:	tx_rei_ena off
Response:	TX_REI_ENA OFF
Note:	See the Tx REI Enable Set Command

TOH Edit and Query Commands

The Transport Overhead edit commands tx_oh_byte, tx_oh_offset, tx_oh_pass, and tx_oh_write can only be used after the tx_oh_edit on command. Either the tx_oh_edit enter or tx_oh_edit esc command should be used to end the editing session with or without saving. Query commands can be used independently.

tx_oh_edit [on | esc | enter] TX Overhead Edit Command

This command is used to start and end, with or without saving the changes, the TOH editing session.

Arguments: on: starts the editing session
esc: ends the editing session without saving any changes
enter: saves all changes and ends the edition session

Example: tx_oh_edit on

Response: NONE

Note: This command enables and disables the use of the following commands: tx_oh_byte, tx_oh_offset, tx_oh_pass, and tx_oh_write

tx_oh_edit? TX Overhead Query Command

Returns status of the TOH editing session.

Example: tx_oh_edit?

Response: TX_OH_EDIT ON

Note: The editing session can be either ON or OFF.

tx_oh_all? Transmit Overhead All Query Command

Returns 36 overhead bytes that include all section, line, and path overhead bytes.

Example: tx_oh_all?

Response: TX_OH_ALL [n],[b]; [n],[b]; [n],[b]; ... [n],[b]; [n],[b]

Note: n = the byte number from 0 to 39 and b = the byte content in hexadecimal format, such as 0,#HF6; 1,#H28; ... etc.

tx_oh_def Transmit Overhead Default Command

Sets the TOH (transmit overhead)bytes to factory default settings. This command only affects the bytes which the user may edit.

Example: tx_oh_def

Response: NONE

Note: The factory default settings are 0 for all TOH (transmit overhead) bytes except E1 and E2 which are set to 7F in hexadecimal format.
This command has no effect in an edit session (see th_oh_edit).

tx_oh_byte? [s] Transmit Overhead Byte Query Command

Returns the current value of the overhead byte [s].

Example: tx_oh_byte? [s]
Response: TX_OH_BYTE [s],[b]
Note: s = the byte mnemonic from A1 to Z5 and b = the byte content in hexadecimal format, such as K2,#H22

Table 6–3 Byte Mnemonics

	TOH Section (Sec.) and Line Overhead Bytes			POH Bytes	VT Bytes
Sec.	A1	A2	J0	J1	V1
Sec.	B1	E1	F1	B3	V2
Sec.	D1	D2	D3	C2	V3
Line	H1	H2	H3	G1	V4
Line	B2	K1	K2	F2	
Line	D4	D5	D6	H4	
Line	D7	D8	D9	Z3	
Line	D10	D11	D12	Z4	
Line	S1	M1	E2	Z5	

tx_oh_byte [s][b] Transmit Overhead Byte Set Command

Sets the specified TOH byte to any hexadecimal number between 00 and FF Hex

Example: tx_oh_byte [s],[b]
Response: NONE
Note: s = the byte mnemonic from A1 to Z5 and b = the byte content in hexadecimal format, such as K2,#H22
Enabled and disabled by the tx_oh_edit command

Table 6–4 Byte Mnemonics

	TOH Section (Sec.) and Line Overhead Bytes			POH Bytes	VT Bytes
Sec.	A1	A2	J0	J1	V1
Sec.	B1	E1	F1	B3	V2
Sec.	D1	D2	D3	C2	V3
Line	H1	H2	H3	G1	V4
Line	B2	K1	K2	F2	
Line	D4	D5	D6	H4	
Line	D7	D8	D9	Z3	
Line	D10	D11	D12	Z4	
Line	S1	M1	E2	Z5	

tx_oh_offset [n],[b] Transmit Overhead Offset Byte Set Command

Sets the overhead byte associated with offset (n) to any hexadecimal value (b) from 00 to FF

Example: tx_oh_offset 1,AA
Response: NONE
Notes: [n],[b] (n = offset and b = the byte in hexadecimal format)
The table below list each TOH byte mnemonic and its offset.
Enabled and disabled by the tx_oh_edit command

Table 6–5 Byte Mnemonic and Offset

	TOH Section (Sec.) and Line Overhead Bytes			POH Bytes	VT Bytes
Sec.	A1: 00	A2: 01	J0: 02	J1:03	V1: 36
Sec.	B1: 04	E1: 05	F1: 06	B3: 07	V2: 37
Sec.	D1: 08	D2: 09	D3: 10	C2: 11	V3: 38
Line	H1: 12	H2: 13	H3: 14	G1: 15	V4: 39
Line	B2: 16:	K1: 17	K2: 18	F2: 19	
Line	D4: 20	D5: 21	D6: 22	H4: 23	
Line	D7: 24	D8: 25	D9: 26	Z3: 27	
Line	D10: 28	D11: 29	D12: 30	Z4: 31	
Line	S1: 32	M1: 33	E2: 34	Z5: 35	

tx_oh_offset? [n] Transmit Overhead Offset Query Command

Returns the overhead byte associated with offset [n]

Example: tx_oh_offset? [n]
Response: TX_OH_OFFSET [n],[b] (n = offset and b = the byte in hexadecimal format)
Note: offset mapping is shown with the tx_oh_offset [n],[b] command.

tx_oh_pass [1...9 | all] Transmitter Overhead Pass

Sets the overwrite/pass attribute of the specified group to pass

Arguments: 1 = the E1 byte; 2 = the F1 byte; 3 = bytes D1 through D3;
4 = bytes K1 and K2; 5 = bytes D4 through D12; 6 = byte S1;
7 = byte M1; 8 = byte E2; 9= byte J0; or all = bytes listed.
Example: tx_oh_pass 4
Response: NONE
Note: Enabled and disabled by the tx_oh_edit command

tx_oh_write [1...9 | all] Transmitter Overhead Write

Sets the attribute of the specified group to overwrite.

Arguments: 1 = the E1 byte; 2 = the F1 byte; 3 = bytes D1 through D3;
4 = bytes K1 and K2; 4 = bytes D4 through D12; 6 = byte S1;
7 = byte M1; 8 = byte E2; 9= byte J0; or all = bytes listed.
Example: tx_oh_write 4
Response: NONE
Note: Enabled and disabled by the tx_oh_edit command

tx_oh_b_pass [c1 | e1 | f1 | d1 | k1 | d4 | z2 | s1 | e2 | all]

Sets the overwrite/pass attribute of the specified group to pass.

Example: tx_oh_b_pass k1
Response: NONE
Note: Uses character names for the bytes instead of numbering the groups.
d1 sets d1...d3, k1 sets k1 & k2, d4 sets d4...d12
Returns "NONE" when queried if no bytes are in overwrite mode.
Enabled and disabled by the tx_oh_edit command

tx_oh_b_write [c1 | e1 | f1 | d1 | k1 | d4 | z2 | s1 | e2 | all]

Sets the attribute of the specified group to overwrite.

Example: tx_oh_b_write d1
Response: NONE
Note: Uses character names for the bytes instead of numbering the groups.
d1 sets d1...d3, k1 sets k1 & k2, d4 sets d4...d12
Returns "NONE" when queried if no bytes are in overwrite mode.
Enabled and disabled by the tx_oh_edit command

Repeat Errors

re_type? Repeat error Query Command

Query error for the error type selected.

Example: re_type?
Response: RE_TYPE? [error type]
Note: Error types are listed with the Set Repeat Error Type Command

re_type [b1 | bit | chan | off] Set Repeat Error Type

Sets the recurring error type to be injected.

Arguments b1: b1 error
bit: bit error
chan: channel error
off: Disables all recurrent errors
Example: re_type b1
Response: NONE
Note: Only one error can be active. Enabling any error will disable all others.
Errors are injected a rate for an period of time.
Repeat errors use the rate set by each individual transmit error command listed under STM-16 error rate commands.

re_inject [n.m] Repeat Error Inject Command

Sets the on-time for the recurring error injection period from 0.1 to 9.9 seconds

Example: re_inject [n.m]
Response: NONE

re_inject? Repeat Error Inject Query Command

Returns the on-time for the recurring error injection period (cycle).

Example: re_inject?
Response: RE_INJECT [n.m] (n.m = seconds in decimal from 0.1 to 9.9)

re_wait [n.m] Repeat Error Wait Command

Sets the off-time for the recurring error injection period from 1.0 to 30.0 seconds

Example: re_inject [n.m]
Response: NONE

re_wait? Repeat Error Wait Query Command

Returns the off-time for the recurring error injection period (cycle).

Example: re_wait?
Response: RE_WAIT [n.m] (n.m = seconds in decimal from 1.0 to 30.0)

re_enable [on | off] Repeat Error Enable Set Command

Controls the repeat error cycle using preset conditions.

Arguments:	on: activates the repeat error cycle off: halts the current repeat error cycle
Example:	re_enable on
Response:	NONE
Note:	Before using this command, the preset conditions can be review using the Repeat Error Query commands: re_type?, re_inject? and re_wait?

re_enable? Repeat Error Enable Query Command

Returns the status of the Repeat Error Enable Set Command

Example:	re_enable?
Response:	RE_ENABLE ON
Note:	The Repeat Error Enable Set Command can be either ON or OFF

Alarms

alm_clear Alarm Clear Command

Turns off all alarm conditions in progress and disables all continuous alarm conditions.

Example:	alm_clear
Response:	NONE
Note:	This command has the same function as the alm_enable off command.

alm_enable [burst | multi | timed | off] Alarm Enable Command

Executes or stops the execution of the alarm conditions that were configured by other commands.

Arguments:	burst: generates one single alarm event set by the alm_count command multi: generates continuous alarm events timed: generates a timed alarm set by the alm_secs command. off: stops all alarms events including continuous and burst
Example:	alm_enable burst
Response:	NONE
Note:	Alarm events include all continuous alarm conditions and current burst alarm conditions if the burst is in progress.

alm_enable? Alarm Enable Query Command

Returns the status of the alarm condition set by the Alarm Enable Set Command

Example:	alm_enable?
Response:	ALM ENABLE MULTI
Note:	See the Alm Enable Set Command.

alm_burst [oof | rdi | l_ais | clr] Alarm Burst Command

Specifies which alarm condition will be generated when the alarm enable is set to burst.

Argument: oof: Out Of Frame
rdi: inserts a Remote Defect Indication
l_ais: Line Alarm Indication Signal
clr: clears the burst alarm condition
Example: alm_burst oof
Response: NONE
Note: Only one alarm condition at a time can be generated in the burst mode.
See the alm_enable command.

alm_burst? Alarm Burst Query Command

Returns the status of the alarms set by the Alarm Burst Set Command

Example: alm_burst?
Response: ALM_BURST OOF
Note: Only one alarm condition at a time can be generated in the burst mode.
See the alm_enable command.

alm_timed [oof | rdi | l_ais | clr] Alarm Timed Set Command

Specifies which alarm condition will be generated when the alarm mode is set to timed.

Argument: oof: Out Of Frame
rdi: inserts a remote defect indication (rdi)
l_ais: Line Alarm Indication Signal
clr: clears the burst alarm condition
Example: alm_timed rdi
Response: NONE

alm_timed? Alarm Timed Query Command

Returns the status that was set by the Alarm Timed Set Command

Example: alm_timed?
Response: ALM_TIMED CLR
Note: See the Alarm Timed Set Command.

alarm_multi [oof | rdi | l_ais | clr] Alarm Multiple Set Command

Specifies which alarm condition will be generated when the alarm mode is set to multiple.

Argument: oof: Out Of Frame
rdi: inserts a remote defect indication (rdi)
l_ais: Line Alarm Indication Signal
clr: clears the burst alarm condition
Example: alarm_multi l_ais
Response: NONE

alm_multi? Alarm Multiple Query Command

Returns the status that was set by the Alarm Multiple Set Command

Example: alm_multi?
Response: ALM_MULTI CLR
Note: See the Alarm Multiple Set Command.

alm_count [n] Alarm Count Command

Sets the alarm burst duration to on for a specified number of frames from 1 to 127

Example: alm_count 40
Response: NONE
Notes: Use the alm_enable burst command to executed the alarm condition.
The default is 5 frames.

alm_count? Alarm Count Query Command

Returns the current valu of the alarm burst duration for the specified number of frames.

Example: alm_count?
Response: ALM_COUNT 40
Note: See the Alarm count Set Command

alm_secs [n.m] Alarm Seconds Set Command

Sets timed alarm duration in seconds

Argument: n.m: is from 0.1 to 9.9 seconds. seconds.
Example: alm_secs 2.5
Response: NONE
Note: n.m defaults to 2.5 seconds during the power–on sequence.

alm_secs? Alarm Seconds Query Command

Returns the set duration of the Timed Alarm in seconds

Example: alm_secs?
Response: ALM_SECS 2.5
Note: See the Alarm Seconds Set Command

Repeat Alarms

ra_type [los | oof | rdi | l_ais] Repeat Alarm Select Command

Specifies which alarm condition will be generated, repetitively, when started.

Argument:	los: inserts a Loss Of Signal oof: inserts an Out Of Frame Signal rdi: inserts a Remote Defect Indication l_ais: inserts a Line Alarm Indication
Example:	ra_type los
Response:	NONE
Note	Used with the ra_start command.

ra_type? Repeat Alarm Select Query Command

Returns the specific alarm condition to be generated, repetitively, when started.

Example:	ra_type?
Response:	RA_TYPE LOS
Note:	Used with ra_type command

ra_inject [n.m] Repeat Alarm Inject Set Command

Sets the amount off alarm injection time from 0.1 to 1.0 seconds

Argument:	n.m = a decimal number from 0.1 to 1.0
Example:	ra_inject 0.4
Response:	NONE

ra_inject? Repeat Alarm Inject Query Command

Returns the currently set Repeat Alarm injection time (on-time) in seconds

Example:	ra_inject?
Response:	RA_INJECT 0.4
Note:	See the Repeat Alarm Inject Set Command

ra_wait [n.m] Repeat Alarm Wait Set Command

Sets the amount off wait time (off-time) between alarm injections from 9.9 to 30.0 seconds

Argument:	n.m = a decimal number from 9.9 to 30.0
Example:	ra_wait 15.5
Response:	NONE

ra_wait? Repeat Alarm Wait Query Command

Returns the currently set Repeat Alarm wait time (off-time) in seconds

Example:	ra_wait?
Response:	RA_WAIT 15.5
Note:	See the Repeat Alarm Wait Set Command

ra_enable [on | off] Repeat Alarm Enable Set Command

Controls the repeat alarm cycle using preset conditions.

Arguments:	on: activates the repeat alarm cycle off: halts the current repeat alarm cycle
Example:	ra_enable on
Response:	NONE
Note:	Before using this command, the preset conditions can be review using the Repeat Alarm Query commands: ra_type?, ra_inject? and ra_wait?

ra_enable? Repeat Alarm Enable Query Command

Returns the status of the Repeat Alarm Enable Set Command

Example:	ra_enable?
Response:	RA_ENABLE ON
Note:	The Repeat Alarm Enable Set Command can be either ON or OFF

Loss Of Signal

los_enab   Loss Of Signal Enable Command

Enables the LOS event for the amount of time specified by los_time.

Example: los_enab
Response: NONE

los_time n   Loss Of Signal Time Command

Set Loss of Signal event to a specific amount of time from 1 to 127 microseconds

Example: los_time 50
Response: NONE
Note: In the example the LOS will last for 50 microseconds

los_time?   Loss Of Signal Time Query Command

Returns the LOS time duration in microseconds

Example: los_time?
Response: LOS_TIME n (n = a decimal quantity from 1 to 127 microseconds)

los_secs [n.m]   Loss Of Signal Set Command

Sets the timed LOS event to a duration from 1.0 to 9.9 seconds

Argument n.m = a decimal number from 1.0 to 9.9
Example: los_secs 4.0
Response: NONE

los_secs?   Loss Of Signal Query Command

Returns the duration in seconds that is set for the timed LOS event

Example: los_secs?
Response: LOS_SECS 4.0
Note: See the Loss Of Signal Set Command

los_tm_enab   Loss Of Signal Enable Command

Enables the LOS event for the amount of time specified by los_secs command.

Example: los_tm_enab
Response: NONE

los_off   Loss Of Signal Disable Command

Disables the LOS event currently being generated.

Example: los_off
Response: NONE

los_cont

Generates a continuous LOS event.

Example: los_cont
Response: NONE

los_active?

Queries the current condition of the LOS event.

Example: los_active?
Response: LOS_ACTIVE ON
Note: ON indicates that the LOS event is currently activated, OFF indicates that the LOS event is inactive.

Specifications, SDH

General Specifications

Temperature Ranges

Operating Temperature: 0 to 40 degrees Centigrade

Storage Temperature: 0 to 60 degrees Centigrade

Dimensions and Weight

Approximately 4.5” (11.6 cm) H x 14.5” (37.2 cm) W x 17.5” (44.9 cm) D

The weight is 25 pounds (11.4 kilograms) maximum.

Power

Voltage Requirements: auto-ranging 110 (90 to 135) VAC or
220 (180 to 270) VAC, 47-63 Hz

Power Consumption: 250 watts maximum

Generator Specifications

155 Mb/s Source Modes

These modes are valid for the optical or CMI inputs.

155 All (Replicate) Mode

Data: 2.488 Gb/s output is made from 16 copies of the incoming 155 Mb/s data.

155 Single Channel Mode

Data: 2.488 Gb/s output is made from 1 copy of the incoming 155 Mb/s data in a user selected channel. The remaining 15 channels are filled with an unequipped pattern.

622 Mb/s Source Modes

These modes are valid for the optical input.

622 All (Replicate) Mode

Data: 2.488 Gb/s output is made from 4 copies of the 622 Mb/s incoming data.

622 Single Channel Mode

Data: 2.488 Gb/s output is made from 1 copy of the incoming 622 Mb/s data in a user selected channel. The remaining 3 channels are filled with an "unequipped" pattern.

Internal Mode

This mode requires no external test equipment to generate a valid 2.488 Gb/s output.

- Data: 2.488 Gb/s output is made with an "unequipped" pattern.
- Default Overhead: A1 and A2 are set to (hexadecimal) F6H and 28H, respectively; the J0 bytes are numbered from 1 to 48; H1 and H2 bytes are set to 60H in a SONET network; B1 contains B1 BIP and B2 contains B2 BIP; all other overhead bytes and the payload are equal 00H.

THRU (Through) Mode

This mode is only usable when the receiver is framed to a valid 2.488 Gb/s SDH/SONET signal.

- Data: 2.488 Gb/s output is copied from the incoming 2.488 Gb/s signal
- Default Overhead: Copied from the incoming 2.488 Gb/s signal

Overhead Manipulation Specifications

The SOH and LOH are constructed as follows:

Overhead bytes are copied from the multiplexed tributary. In the *All* mode copies are used to fill the entire OC-48 overhead, in the *Single* mode one copy is sent to the selected channel and the remaining channels are filled with the Unequipped channel overhead. In the Internal mode all channels are filled with the Unequipped channel overhead. In through mode the overhead is copied from the in coming OC-48. The J0 bytes are numbered 1 to 48, the first STS-1 of the OC-48 signal overhead bytes can be edited by the user (see below), error injection can be added, and finally B1 and B2 parity bytes are calculated.

Overhead byte editing.

The following bytes of the first STS-1 of the OC-48 frame can be edited and selected individually or as a group.

J0, E1, F1, D1-D3 (group selected), K1, K2, D4-D12 (group selected), S1, Z2, E2

These bytes of the first STS-1 of the OC-48 frame CANNOT be edited: A1, A2, B1, H1-H3, B2.

Overhead Bytes Generated by the ST2400:

BYTE Description:

J0 STS 1 Channels are numbered 1 to 48.

B2 STS channels 1 and 3 only , with calculated Line BIP-8 parity.

B1 STS channel 1 only with calculated Section BIP-8 parity.

Unequipped channel Overhead content:

Default Overhead: A1 and A2 are set to hexadecimal F6H and 28H, respectively; the J0 bytes are numbered from 1 to 48; the H1 and H2 bytes are set to 60H in a SONET network; B1 equals B1 BIP and B2 equals B2 BIP; all other overhead bytes and the payload are equal 00H.

Error Injection

Error Rates: All error rates, except B1, can be selected in the form X. Y e-Z.
The rates range from 1.0e–3 to 0.1e–9.

B1 Section single error or error rate is generated by inverting a random bit in the byte. The rate rangers from 2.5e–5 to 0.1e–9.

Selected Channel: Single error or error rate, caused by inverting a random bit in a specific STS-1/STM-1 of the 2.488 Gb/s signal.

All channels: Single error or error rate, caused by inverting a random bit in the 2.488 Gb/s signal.

L-FEBE: The STS channel 3 Z2 byte is overwritten to convey the error count.

Alarm Generation

LOS: 2.488 Gb/s output is forced to all zeros for a user selected time, from 1 to 127 microseconds with a resolution of 1 microseconds, or 0.1 to 9.9 seconds.

LOF, OOF: All of the A1 and A2 bytes of the 2.488 Gb/s output are inverted for a user selected time. The time is selected in frames, up to 127 or continuous, or 0.1-9.9 seconds.

L-AIS: The LOH and the entire SPE are set to all ones for a user selected time. The time is selected in frames, up to 127, or 0.1 to 9.9 seconds, or continuous.

L-FERF: The '110' code is set in the three least significant bits of the K2 byte for a user selected time. The time is selected in frames, up to 127, or 0.1 to 9.9 seconds, or continuous.

Source Monitoring

The SONET inputs to the generator section are monitored to ensure valid signals for multiplexing and timing generation.

LOS: Detects the Loss of Signal alarm by monitoring the inputs for activity.

LOF: Detects the Loss of Frame alarm by monitoring an OOF condition for 3 ms.

Analyzer Specifications

Measurements

B1 Errors: The 2.488 Gb/s input is monitored for Section level errors by comparing the B1 byte to the calculated BIP-8 parity. The errors are detected and counted. They can be displayed as a total error count or an error rate in the form X. Y e –Z

B2 Errors: The 2.488 Gb/s input is monitored for Line level errors by comparing the 48 B2 bytes to the calculated BIP-8 x 48 parity. The errors are detected and counted. They can be displayed as a total error count or an error rate in the form X.Y e –Z

Line FEBE: The 2.488 Gb/s input is monitored for Line level FEBE in the third M1. The FEBEs are detected and counted. They are displayed as a total error count.

Alarms Detection

LOS: 2.488 Gb/s input is monitored for the all zero condition. When the 2.4 Gb/s signal has been off for more than 2 microseconds the LOS condition is declared. The LOS alarm will assert no later than 127 microseconds after receiving the low signal (all zero) condition.

LOF, OOF: The last A1 byte and the first two A2 bytes (A1, A2, A2) of the 2.488 Gb/s input are monitored for errors. If 4 or more consecutive frames have errors OOF is declared and reframing is attempted. If OOF persists for more than 3 milliseconds LOF is declared.

AIS: The K2 byte is monitored for the occurrence of all ones in the three least significant bits.

- SONET: If it occurs in 5 consecutive frames Line AIS is declared.

FERF: The K2 byte is monitored for the occurrence of the '110' code in the three least significant bits.

- SONET: If it occurs in 5 consecutive frames Line FERF is declared.

Overhead Display

Approximately every 100 milliseconds each byte of the STS-1 Transport Overhead is extracted and displayed.

APS Display

Approximately every 100 milliseconds the K1 and K2 bytes are extracted. The bytes are decoded, according to Bellcore GR-253-CORE, into the APS messages, modes and channels and displayed.

SONET/SDH Drop Modes

The analyzer drops a SONET/SDH signal at either 155 Mb/s or 622 Mb/s. A valid SONET/SDH signal is constructed from a fraction of the 2.488 Gb/s input data and overhead.

155 Drop Mode

Data: User selects 1 of the 16 channels in the 2.488 Gb/s input data to copy to the drop signal.

Overhead: B1, B2 recalculated by the ST2400.

H1, H2, H3, A1, A2, J0 are copied from the selected drop channels.

The remainder of the drop signal is copied from the first three STS-1 channels of the 2.488 Gb/s input.

Output: This mode is valid on the optical and electrical (CMI) outputs.

622 Drop Mode

Data: User selects 1 of the 4 channels in the 2.488 Gb/s input data to copy to the drop signal.

Overhead: B1, B2 are recalculated by the ST2400

H1, H2, H3, A1, A2, J0 are copied from the selected drop channels.

The first three STS-1 channels of the remainder of the drop signal are copied from the first three STS-1 channels of the 2.488 Gb/s input. The last nine STS-1 channels of the remainder are copied from the selected drop channel.

Output: This mode is valid only on the optical output

Input and Output Specifications, Generator

Option #s since 11/96	Laser	Transmit or Transceiver	Specifications
12	1310	Transmit only	Type: DFB laser diode, Wavelength: 1310 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical) Extinction Ratio: 10 dB minimum Category: LR-1
13	1310	Transceiver	Type: DFB laser diode, Wavelength: 1310 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical) Extinction Ratio: 10 dB minimum Category: LR-1
14	1550	Transmit only	Type: DFB laser diode, Wavelength: 1550 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical), Extinction Ratio: 10 dB minimum Category: LR-2
15	1550	Transceiver	Type: DFB laser diode, Wavelength: 1550 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical), Extinction Ratio: 10 dB minimum Category: LR-2
16	1310/ 1550	Transmit only	Type: DFB laser diode, Wavelength: 1550 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical), Extinction Ratio: 10 dB minimum Category: LR-2 *and* Type: DFB laser diode, Wavelength: 1310 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical) Extinction Ratio: 10 dB minimum Category: LR-1
17	1310/ 1550	Transceiver	Type: DFB laser diode, Wavelength: 1550 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical), Extinction Ratio: 10 dB minimum Category: LR-2 *and* Type: DFB laser diode, Wavelength: 1310 ± 10 nm Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm (0.3 nm typical) Extinction Ratio: 10 dB minimum Category: LR-1

See the following note on the next page:

Note to previous table:

Older units may have 1310 lasers with the following specifications: Type: DFB laser diode, Wavelength: 1310 nm Typical (1280 nm -1335 nm) Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm, Extinction Ratio: 10 dB minimum Category: IR-1
Older units may have 1550 lasers with the following specifications: Type: DFB laser diode, Wavelength: 1550 nm Typical (1480 nm -1580 nm) Average power: 3 dBm to –2 dBm minimum Spectral Width: 1 nm, Extinction Ratio: 10 dB minimum Category: IR-2

Signal Name: 2.488 Gb/s Output Data

Connector: FC/PC (standard), SC, or ST available

This output can be "locked out" for safety (as U.L. safety requirements specify) using the rear panel key switch or remote interlock.

Fiber Type: Single Mode

Description: Primary output to device under test

Signal Name: 155 Mb/s / 622 Mb/s Input Data

Connector: FC/PC (standard), SC, or ST available, Type: Optical

Wavelength: 1310 nm, Maximum Input: –8 dBm

Sensitivity: –28 dBm minimum

Category: IR-1

Fiber Type: Multi-Mode

Description: 155 or 622 Mb/s data input to multiplexer, intended for connection to supplemental test equipment.

Signal Name: 155 Mb/s Electrical Input

Connector: BNC - 75 Ω

Type: CMI per Bellcore GR-253-CORE and CCITT Rec. G.708, G.709

Description: 155 Mb/s electrical data input to multiplexer, intended for connection to supplemental test equipment.

SYNC Output

SYNC Output (Clock Trigger) is an AC-coupled output. The voltage level is 500 mV peak-to-peak minimum. This output needs a 50-Ohm termination to work properly. This output is used to trigger a oscilloscope to measure the eye diagram of an OC-48/STM-16 signal.

Frame Sync:

Connector: BNC - 50 Ω Type: ECL with internal pull-down, series 50 ohm.

Description: Derived from generator, pulse width of 16 bits .

Event trigger:

Connector: BNC - 50 Ω Type: TTL

Description: Active during LOS, LOF, AIS, FERF, Error Inject, or TOH byte edit.

Input and Output Specifications Analyzer

Signal Name: 2.488 Gb/s Input Data

Connector: FC/PC (standard), ST, or SC available

Type: InGaAs APD optical receiver

Wavelength: 1310 / 1550 nm

Maximum Input: –10 dBm (damage may result)

Sensitivity: –29 dBm minimum @ 10^{-10} BER

Category: LR-2

Fiber Type: Single Mode

Description: Primary input from device under test

Signal Name: 155 Mb/s / 622 Mb/s Output Data

Connector: FC/PC (standard), ST, or SC available

Type: Optical

Wavelength: Wavelength: 1310 nm (1273 to 1355 nm)

Average Power: –15 dBm minimum

Maximum Average Power: –8 dBm

Category: IR-1

Fiber Type: Single Mode

Description: 155 or 622 Mb/s data output from demultiplexer, intended for connection to supplemental test equipment.

Signal Name: 155 Mb/s Electrical Output

Connector: BNC - 75 Ω

Type: CMI per Bellcore GR-253-CORE and CCITT Rec. G.708, G.709

Description: 155 Mb/s electrical data output from demultiplexer, intended for connection to supplemental test equipment.

GPIB I/O

Connector, signal level, and protocol per IEEE 488.2

Description: Byte serial industry standard instrument interface, used for remote or automated control of the ST2400.

Serial I/O

RS232C Connector, signal level and protocol per ANSI RS-232C

Description: Bit serial industry standard interface, used for remote control and software download of the ST2400. External null modem not required.

ST112-RS232C Connector, signal level and protocol per ANSI RS-232C

Description: Bit serial interface, used for directly connecting to an ST112 for combined mode operation. External null modem is not required.

Printer Output

Connector: DB-25, Signal: TTL

Description: Byte serial ASCII printer interface. Follows industry standard DB-25 translation of Centronics interface

Synchronization Specifications

Generator Timing

The 2.488 Gb/s output can derive synchronization from three different sources. These sources are only valid in the indicated modes.

External Timing:

The output timing is obtained by phase lock loop (PLL) multiplying the clock recovered from the source 155/622 Mb/s SONET/SDH signal. This timing mode is valid if the generator is in EXT (external) mode. To obtain loop timing in these modes the supplemental test equipment providing Path and payload testing must be set to loop timing. This is the only generator timing mode valid with external lower rate test equipment.

Source Frequency Range: 155.52 Mb/s ±100 ppm or 622.08 Mb/s ± 100 ppm

Loop Timing (THRU Mode):

The output timing is obtained from the 2.488 Gb/s SONET/SDH signal input to the analyzer. The clock recovered from this input generates the output signal.

Source Frequency Range: 2.48832 Gb/s ±20 ppm.

Internal Timing:

The output timing is obtained from an internal clock source. This timing mode can be used if the generator is in internal mode operating stand-alone.

Output Frequency Accuracy: 2.48832 Gb/s ±20 ppm.

Output Jitter: Meets Bellcore GR-253-CORE and ITU G.783, G.81S

Analyzer Timing

Analyzer Clock Recovery

Input Frequency Range: 2.48832 Gb/s ±20 ppm.

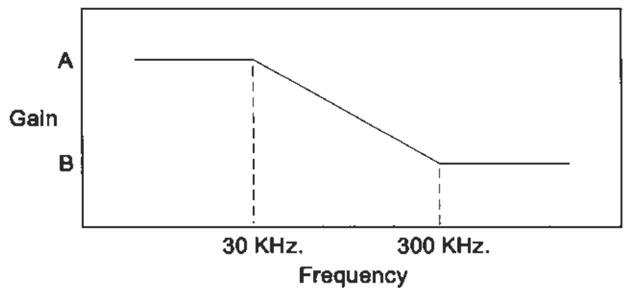
Input Jitter Tolerance: Meets Bellcore GR-253-CORE and ITU G.783, G.81S

155/622 Mb/s Output Timing

Derived by dividing the clock recovered from the Analyzer 2.488 Gb/s input.

Jitter Transfer

ST2400 Jitter Transfer is a function of the clock recovery, clock multiply, and/or clock divide function in the Transmitter or Receiver. The Transmitter recovers clock from the 155 MHz or 622 MHz inputs, then multiplies them up to 2.488 GHz. In THRU Mode, the Transmitter gets a 78 MHz clock from the Receiver and multiplies that to 2.488 GHz. The Receiver divides its input 2.488 GHz clock to 155 MHz or 622 MHz for the tributary drop rates, or to 78 MHz for the Transmitter in THRU Mode. The resulting maximum peak-peak Jitter Gain is shown in the tables and diagram below.



SONET Jitter Transfer	A	B
OC-3 input to OC-48 Tx output	25db	10db
CMI input to OC-48 Tx output	25db	10db
OC-12 input to OC-48 Tx output	15db	–5db
OC-48 Rx input to OC-48 Tx output	.3db	.3db
OC-48 Rx input to OC-3 output	–24db	–24db
OC-48 Rx input to CMI output	–24db	–24db
OC-48 Rx input to OC-12 output	–12db	–12db

SDH Jitter Transfer	A	B
STM-1 input to STM-16 Tx output	25db	10db
CMI input to STM-16 Tx output	25db	10db
STM-4 input to STM-16 Tx output	15db	–5db
STM-16 Rx input to STM-16 Tx output	.3db	.3db
STM-16 Rx input to STM-1 output	–24db	–24db
STM-16 Rx input to CMI output	–24db	–24db
STM-16 Rx input to STM-4 output	–12db	–12db

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