User Guide (SONET)

Agilent Technologies

Agilent J2126/7A Transmission Test Set

User Guide (SONET)

Agilent Technologies

Notices

Manual Part Number

J7280-90004

Edition

First edition, September 2002

Printed in UK

Agilent Technologies UK Limited
Transmission & Transport Test Operation
South Queensferry, West Lothian, Scotland
EH30 9TG

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Safety Notices

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

In This Guide...

This User's Guide provides information in the following chapters on how to use your instrument.

Conventions Used in this Manual

The conventions used in this manual to illustrate instrument keys and display information are as follows:

<Menu> This is an example of a hardkey. Hardkeys (located to the right of the display) are used to give access to different sets of instrument settings, or select dedicated instrument functions.

Menu Items Menu items appear in text as **bold** face with the greater than (>) symbol separating each menu level. For example, if you are instructed to choose Errors and Alarms from the Test Functions menu item, it appears as **Test Functions > Errors and Alarms**.

Field Items Field items you are instructed to select in a window will appear in **bold** face, for example select **Signal Rate** field.

Drop Down Lists The item you must select from a drop down list is also shown in **bold**. For example, select **Signal Rate** field and choose **STM-1** or **OC-3** from the drop down list.

Contents

7 Telecoms Concepts

1
Getting Started

This chapter provides general information on how to install and configure the instrument. It includes a brief description of the product and safety requirements for the user to follow. Also, it includes tutorials on how to use the instrument to carry out a simple BER measurement.

Product Description

The instrument provides all the test capability you need to install and verify the performance of today’s high-capacity transmission systems and networks in one portable package.

In addition, there is an Ethernet module that can fully test the data capabilities of the new generation of multi-service network elements.

SONET/SDH Capability

- Global test coverage (SONET, SDH, PDH and T-Carrier).
- Full integrated all-rate testing:
  - 52 Mb/s to 10 Gb/s optical.
  - 52/155 Mb/s; DS1/3; 2/8/34/140 Mb/s electrical.
- Full range of standard and concatenated mappings.
- All standard error and alarm measurements, plus:
  - optical power, electrical level, pulse mask, frequency.
  - service disruption time, pointer movements, delay.
- Simultaneous all-channel testing (up to 192 STSs/AUs).
- Intrusive and non-intrusive Thru-mode.
- Comprehensive SONET/SDH overhead testing.

- Electrical interfaces
  (DS1/3; 2/8/34/140 Mb/s; 52/155 Mb/s)
- VT/TU payload testing
- DS1/3 and 2/34/140 Mb/s service mappings
- DSn and PDH (En) testing
- Pulse mask testing (up to 52 Mb/s electrical)
- Service disruption measurement
- Round trip delay measurement
- Electrical level measurement
- Graphical error and alarm result displays
- G.821, M2100, M2101, M2101.1, M2110, M.2120 performance analysis
- Fast access to key measurement tasks using Smart Test.
- Line and payload frequency offset.
- Transmit and Receive can be independently configured.
- Broad range of graphical results tools.
- Comprehensive online help facilities:
  - Online User manual.
  - Context-sensitive help for each control field.
  - Ability to add your own help documents.

See “Option Guide" on page 17, for more product details.

Ethernet Capability

- Test data services at Layer 1 and Layer 2
- Multi-port testing - 8x10/100 Mb/s and 2x1 Gigabit Ethernet
- Simultaneous operation of all ports
- Simultaneous SONET/SDH and Ethernet operation
- Extremely simple to set-up and operate
- Hot-swap GBIC modules for wavelength choice
- Automated RFC 2544 benchmark testing
- Full rate traffic generation and reception

- Can be used for end-to-end or loopback testing
- Unique “Loopthru” mode allows loopback testing even at Layer 2
- Measure the “Transmission” elements of Ethernet:
  - Throughput
  - Latency
  - Frame Loss
  - Errors
- User selectable full/restricted/fixed auto negotiation
- User selectable VLAN/priority tagging and flow control
- Frame capture facility
- Comprehensive online help facilities:
  - Online User manual
  - Context-sensitive help for each control field
  - Ability to add your own help documents

See “Option Guide" on page 17, for more product details.

Option Guide

This guide explains the features offered with each instrument mainframe and its associated options.

For more information, see:

- "Mainframes and Potential Test Rate Capability" on page 17
- "Optical Interfaces" on page 18
- "Optical Connectors (product options)" on page 18
- "Alternative Optical Connectors (available accessories)" on page 19
- "Ethernet Options" on page 19
- "Other Options" on page 19
- "Accessories" on page 20

Mainframes and Potential Test Rate Capability

There are three mainframes:

- J2126A - 3-slot chassis
- J2127A - 4-slot chassis
- J2127A - 6-slot extended chassis

Mainframe	Optical Test Interfaces	Frequency Range
J2126A (see Note 1)	OC-1, OC-3, OC-12, OC-48 STM-0, STM-1, STM-4, STM-16	52 Mb/s to 2.5 Gb/s
J2127A (see Notes 1, 2 and 3)	OC-1, OC-3, OC-12, OC-48, OC-192 STM-0, STM-1, STM-4, STM-16, STM-64	52 Mb/s to 10 Gb/s

1. With option 103 fitted, maximum line rate restricted to OC-12/STM-4.

2. Can be configured with maximum line rate of OC-48/STM-16 and later upgraded to OC-192/STM-64.

3. Can have a 4-slot chassis or extended (6-slot) chassis.

Optical Interfaces

	Tx Optical Wavelength	Option
Optical interfaces operating up to 2.5 Gb/s	1310 nm	100
	1550 nm	101
	1310/1550 nm	102
Optical interfaces operating up to 10 Gb/s	1550 nm	111 (HS*), 121 (SR**)
	1310 nm	120 (SR**)

* HS - High Rx sensitivity optics.

** SR - Short reach optics.

Optical Connectors (product options)

Connector	Option
FC/PC Adapters fitted on all optical interfaces	190
SC Adapters fitted on all optical interfaces	191
ST Adapters fitted on all optical interfaces	192

Alternative Optical Connectors (available accessories)

Alternative optical connectors are available for your product, order the appropriate J7283A (FC/PC), J7284A (SC) or J7285A (ST) accessory (connector). The number of connectors required for your product is shown below.

	J7283A (FC/PC)	J7284A (SC)	J7285A (ST)
J2126A with option 100/101	2	2	2
J2126A with option 102	3	3	3
J2127A* with option 100/101 and 111/120/121	5	5	5
J2127A* with option 102 and 111/120/121	6	6	6

* Can have a 4-slot chassis or extended (6-slot) chassis.

Ethernet Options

	Option
Ethernet testing (8 x 10/100 Mb/s; 2 x 1 Gb/s)	323
1000Base-SX (850 nm) GBIC modules (two)	325
1000Base-LX (1310 nm) GBIC modules (two)	326

Other Options

Certificate of Calibration

Option UK6: Calibration certificate with test data

Warranty and Service Plans

Terms and conditions of the applicable warranty for this product are contained in the sales and related documentation supplied separately.

Please contact your nearest Agilent Technologies Sales Office for further information on warranty and extended warranty options.

For access to Agilent Product information and sales/service contacts, please visit:
http://www.agilent.com.

Accessories

Additional Documentation

J7280A: Full set of printed manuals:
User Guide, Quick Reference Guide, Remote Control, and Installation and Verification manual.

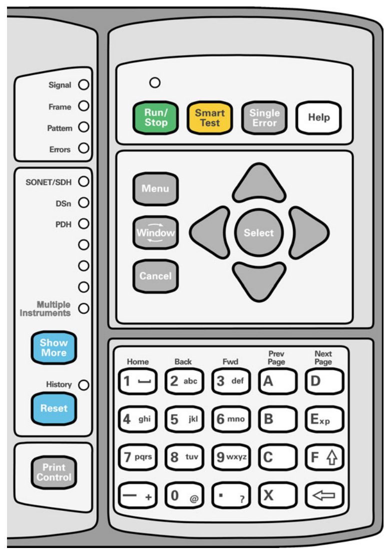
Carrying Cases

J7286A: Hard transit case (for J2126A)
J7287A: Hard transit case (for J2127A)
J7288A: Soft carrying case (for J2126/7A)
J7289A: Hard transit case (for J2127A 6-slot extended chassis)
J7290A: Soft carrying case (for J2127A 6-slot extended chassis)

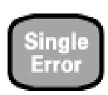
Optical Adapters and Cables

J7283A: FC/PC optical connector (exchangeable)
J7284A: SC optical connector (exchangeable)
J7285A: ST optical connector (exchangeable)
J7281A: DCC port converter cable: 9-pin miniature D-type to 37-pin D-type (RS-449, female)

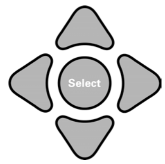
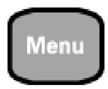
Front Panel Tour



Function Controls

	Press this key to start a new test period or terminate the current test period. The LED indicator above the key is on when a test period is in progress.
	Press this key to access the Agilent Smart Test menu.Operates on the foreground instrument.
	Press this key to add a single error to the transmitted signal. Select t0he error type using the Errors and Alarms Test Functions page. Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**. Operates on the foreground instrument.
	Press this when you need to refer to the online help. Press it again to take you back to the instrument display.

Navigation Controls

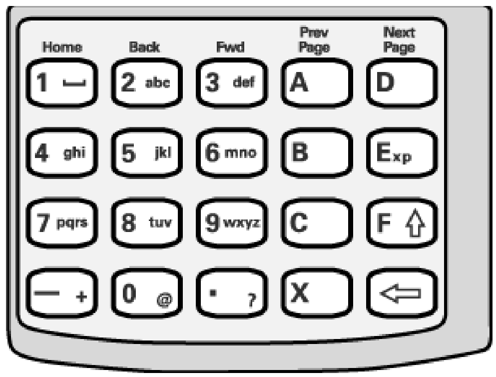
	The **<Arrow Navigation>** keys move the focus up/down/left/right through menus, drop-down lists and the instrument display. Press **<Select>** to enter any selected menu item or value you have entered into a field.
	Press **<Menu>** to display the main menu for the current application. Press **<Menu>** again, or press **<Cancel>,** to close the menu.
	Press **<Window>** to change the focus between the left and right windows.
	**<Cancel>** will close any menu or drop down list without making any changes.

Keypad

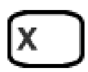
The keypad provides text and numeric entry and online help navigation.

Numeric Entry

In a numeric entry field, enter the number you want using the keypad. Decimal, binary and hexadecimal entries are all made directly from the keypad.



Special keys used in numeric entries:

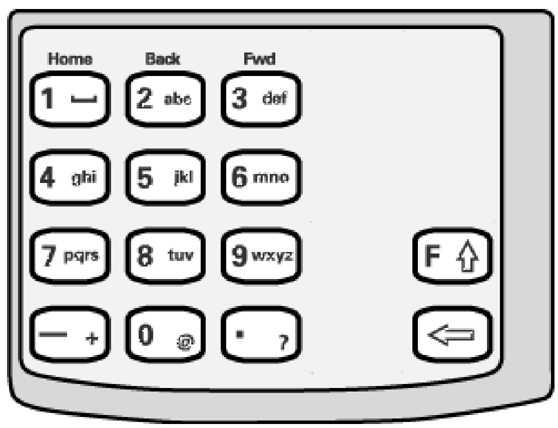
	Use this key to enter a negative value, for example for a frequency offset of -99.9 ppm, press: **< - > + <9> + <9> + < . > + <9>**
	Press **< X >** for 'don't care' entries.
	Use this key to enter an exponent, for example for an error rate of 9.9E-9 press: **<9> + < . > + <9> + <Exp> + < - > + <9>**
	To edit a number press the **<Left Arrow>** key for backspace operation, so deleting the preceding entry.

Text Entry

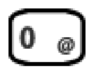
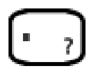
In a text entry field, for example when editing a trace message, the keypad will be in text mode.

You enter text in the same way as you would enter text into a cell phone. The keys are labelled “abc2ABC”, “def3DEF” and so on. Press the key with the character you want: once for the first character, twice (pressing the key quickly in succession) for the second and so on.

To enter numbers or upper case letters quickly, use the **<F/up arrow>** key to switch between lower case characters (CapsOff), upper case (CapsOn) and number (Num). The current mode is displayed in the Status Line at the bottom right of the screen.



Special keys used in text entries:

	This key switches between upper and lower case characters and numbers. The current mode, either “Caps” or “Num”, is displayed at the bottom right of the screen on the Status Line.
	Press this key for these special characters: **space _ NUL LF CR**
	Press this key for these math symbols **- + / * = < >% ^.**
	Press this key for these miscellaneous symbols **@ # 0 $ \& ~( ) [ ] { }**
	Press this key for these punctuation symbols **. ? ! , : ; “ ‘ ‘**

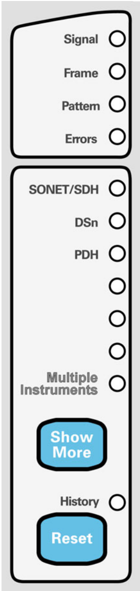
Help Function Keys

You can use the help function keys for additional navigation when in Online Help.

Home [1]	Returns you to the Home page.
Back [2 abc]	Takes you back to the previous page.
Fwd [3 def]	If you have used the **<Back>** key for navigating then this key takes you forward to where you have come from. Otherwise, pressing this key has no effect.
Prev Page [A]	Scrolls up through the displayed page.
Next Page [D]	Scrolls down through the displayed page.

Status and Alarm LEDs

The Status LED indicators provide information about the status of the instrument's receiver. The Signal, Frame and Pattern indicators are green if the signal is good, and red during an alarm condition. Error indicator is off or red if error detected.



SIGNAL Green: Valid signal (level; data transitions) detected at input. Red: No data transitions detected at input or low optical/electrical power. Operates on the foreground instrument.

FRAME Green: Correct framing detected at all levels of the received signal (on the line signal plus all levels down to the selected test channel). Red: Frame alignment lost at one or more levels of the received signal. Operates on the foreground instrument.

PATTERN Green: Correct detection of expected test pattern. Red: Expected test pattern not received. Operates on the foreground instrument.

ERRORS Red: An error has been detected in the received signal. The indicator remains red for 100 ms, then returns to off. Operates on the foreground instrument.

SONET/SDH: Indicates that at least one SONET or SDH alarm is present. Operates on the foreground instrument.

DSn: Indicates that at least one ANSI DS1, DS2 or DS3 alarm is present. Operates on the foreground instrument.

PDH: Indicates that at least one ETSI E1, E2, E3 or E4 alarm is present. Operates on the foreground instrument.

Multiple Instruments: Indicates that an error or alarm has been detected by a background instrument.

History: Press **<Show More>** to see details of current and historical errors/alarms. Current errors/alarms are shown red, historical ones are shown yellow. If an alarm has occurred during the current test period, the History LED will be on. Operates on the foreground instrument.

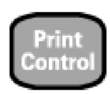
Press **<Reset>** to reset the Alarm History data. The History LED will go off. If an alarm condition is present during the reset, then the LEDs associated with that alarm will remain on after the reset. Resetting of the history data also occurs when you start a new test period. Operates on the foreground instrument.

Viewing Error/Alarm Details using the <Show More> Key

When the front panel LED lights, error and alarm conditions have been detected. The front panel **<Show More>** key allows you to view detailed alarm information.

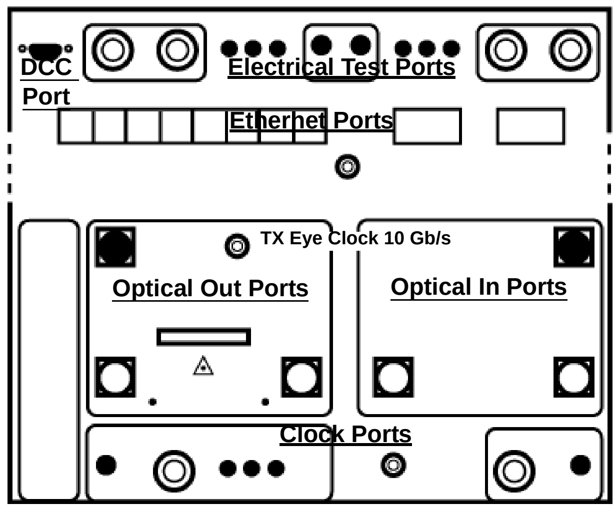
- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when you press the History **<Reset>** key on the front panel.

Print Control Key



Press **<Print Control>** to access the print control page. Refer to “Print Control Key (Printer Setup and Capturing Screendumps)" on page 362. Operates on the foreground instrument.

Top Panel Connectors



For information on the instrument's connectors, see:

- "Optical Out Ports" on page 30
- "Optical In Ports" on page 31
- "Clock Ports" on page 32
- "DCC Port" on page 33
- "Electrical Test Ports" on page 34
- "Ethernet Ports" on page 35

Optical Out Ports

Provides SONET optical signals OC-1, OC-3, OC-12, OC-48, OC-192, and SDH optical signals STM-0, STM-1, STM-4, STM-16, STM-64 at wavelength 1310 and 1550 nm, depending on instrument model and options.

52 Mb/s - 2.5 Gb/s 1310 nm Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 52 Mb/s to 2.5 Gb/s optical output. Nominal wavelength is 1310 nm. Power output is -5 to +0 dBm.

52 Mb/s - 2.5 Gb/s 1550 nm Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 52 Mb/s to 2.5 Gb/s optical output. Nominal wavelength is 1550 nm. Power output is -2 to +3 dBm.

10 Gb/s, 1550 nm Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 10 Gb/s optical output. Nominal wavelength is 1550 nm. Power output is -1 to +1 dBm.

10 Gb/s, 1550 nm (SR) Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 10 Gb/s optical output. Nominal wavelength is 1550 nm. Power output is -5 to -1 dBm.

10 Gb/s, 1310 nm (SR) Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 10 Gb/s optical output. Nominal wavelength is 1310 nm. Power output is -6 to -1 dBm.

Optical Connector	Order Option
FC/PC	190
SC	191
ST	192

Optical In Ports

Accepts SONET OC-1, OC-3, OC-12, OC-48 and OC-192 and SDH STM-0, STM-1, STM-4, STM-16, STM-64 signals, depending on the model and options fitted.

52 - 622 Mb/s Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 52 Mb/s to 622 Mb/s optical input (OC-1, OC-3, OC-12/STM-0, STM-1, STM-4 signals). Wavelength 1200 to 1600 nm. Input damage power >+3 dBm; never exceed maximum input power. The recommended input power operating level for OC-1, OC-3/STM-0, STM-1 signals is -33 to -10 dBm and for OC-12/STM-4 signals -28 to -8 dBm.

2.5 Gb/s Selectable optical connector (see “Optical Connectors (product options)" on page 18) for a 2.5 Gb/s optical input (OC-48/STM-16 signals). Wavelength 1200 to 1600 nm. Input damage power >+3 dBm; never exceed maximum input power. The recommended input power operating level for OC-48/STM-16 signals is -28 to -8 dBm.

10 Gb/s High Rx Sensitivity Optics Selectable optical connector (see “Optical Connectors (product options)" on page 18) for 10 Gb/s (OC-192/STM-64) optical input signals. Wavelength 1200 to 1600 nm. Input damage power >+1 dBm; never exceed maximum input power. The recommended input power operating level for OC-192/STM-64 signals is -20 to -9 dBm.

10 Gb/s (SR) Optics Selectable optical connector (see “Optical Connectors (product options)" on page 18) for 10 Gb/s (OC-192/STM-64) optical input signals. Wavelength 1200 to 1600 nm. Input damage power >+3 dBm; never exceed maximum input power. The recommended input power operating level for OC-192/STM-64 (1310 nm) signals is -11 to -1 dBm. The recommended input power operating level for OC-192/STM-64 (1550 nm) signals is -14 to -1 dBm.

Clock Ports

2 Mb/s, 2 MHz Clock In BNC 75 ohm (nominal) unbalanced connector for a 2 Mb/s and 2 MHz MTS external clock source input.

2 Mb/s, 2 MHz Clock In 3-pin Siemens connector for a 2 Mb/s and 2 MHz MTS external clock source input.

DS1 Clock In Bantam 100 ohm (nominal) connector for a DS1 BITS external reference clock input.

2 MHz Clock Out BNC 75 ohm (nominal) unbalanced connector for a 2 MHz MTS clock reference output. Generated relative to the selected transmit reference clock.

DS1 Clock Out Bantam 100 ohm (nominal) connector for a DS1 BITS clock reference output. Generated relative to the selected transmit reference clock.

TX Eye Clock 52 - 2.5 Mb/s SMA connector providing a TX Eye Clock signal (at 1/4 of the line rate) which can be used to trigger an oscilloscope when examining data signals.

TX Eye Clock 10 Gb/s SMA connector providing a TX Eye Clock signal (at 1/16 of the line rate) which can be used to trigger an oscilloscope when examining data signals.

DCC Port

Connector 9-pin miniature D-type.

Use this port to insert and drop either the D1-D3 DCC channel or the D4-D12 DCC channel. The first bit of data inserted will be put into the MSB of the DCC channel. The MSB of the dropped data bytes will be output first. The transmit (drop) and receive (insert) capabilities are independent, that is the transmit and receive clock rates can be set to different rates. The instrument acts as a DCE (Data Communications Equipment), supplying the clock signal for both drop and insert operation.

Rates D1-D3 DCC: 192 kb/s, D4-D12 DCC: 576 kb/s

Signal Type Unipolar differential signal as defined in ANSI EIA-422-B and EIA-423-B.

Input Termination 100 ohms differential.

Input Sensitivity 500 mV over a +/-15 V common mode range and 200 mV over a +/–7 V range.

Pin Number	RS-449/422 Circuit
1	Rx Data Output (+)
2	Rx Clock Output (+)
3	Signal ground
4	Tx Clock Output (+)
5	Tx Data Input (+)
6	Rx Data Output (-)
7	Rx Clock Output (-)
8	Tx Clock Output (-)
9	Tx Data Input (+)

Electrical Test Ports

SONET/SDH Out BNC 75 ohm unbalanced connector for an STS-1/STM-0 (B3ZS) or STS-3/STM-1 (CMI) electrical output.

SONET/ SDH In BNC 75 ohm unbalanced connector for an STS-1/STM-0 (B3ZS) or STS-3/STM-1 (CMI) electrical input. Input Mode - Terminate or Monitor. Monitor mode conforms to G.772-1993. Monitor Gain - 20 dB.

2 Mb/s Out 3-pin Siemens 120 ohm balanced connector for an E1 Transmit or E1 Drop signal output. Either this port or the 2-140 Mb/s, DS3 unbalanced Out port can be active for the E1 Transmit function.

2 Mb/s In 3-pin Siemens 120 ohm balanced connector for an E1 Receive or E1 Insert signal input. Either this port or the 2-140 Mb/s DS3 unbalanced In port can be active for the E1 Receive function.

DS1 Out Bantam 100 ohm balanced connector for a DS1 Transmit or DS1 Drop signal output.

DS1 In Bantam 100 ohm balanced connector for a DS1 Receive or DS1 Insert signal input.

2-140 Mb/s DS3 Out BNC 75 ohm unbalanced connector for E1, E2, E3, E4, DS3 transmit or E3, E4, DS3 Drop signals. Either this port or the 2 Mb/s balanced Out port can be active for the E1 Transmit function.

2-140 Mb/s DS3 In BNC 75 ohm unbalanced connector for E1, E2, E3, E4, DS3 receive or E3, E4, DS3 Insert signals. Either this part or the 2 Mb/s balanced In port can be active for E1.

Ethernet Ports

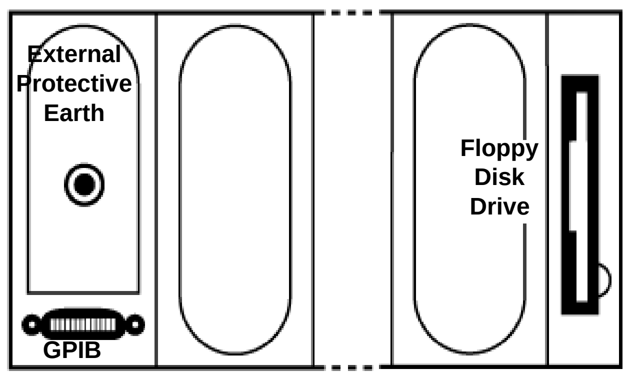
10M/100M Ethernet Ports Eight RJ-45 connectors are provided, each of which can support 10 Mb/s or 100 Mb/s data rates.

1G Ethernet Ports Two Gigabit Interface Convertors (GBICs) are provided as follows:

Instrument Option Number	Ethernet Type	GBIC Agilent Part Number
325	1000BASE-SX (850 nm)	HFBR-5601
326	1000BASE-LX (1310 nm)	HFBR-5611

Tx Eye Clock SMA connector providing a TX Eye Clock signal that can be used to trigger an oscilloscope when examining data signals.

Connectors on Instrument Front/Left Side Panel

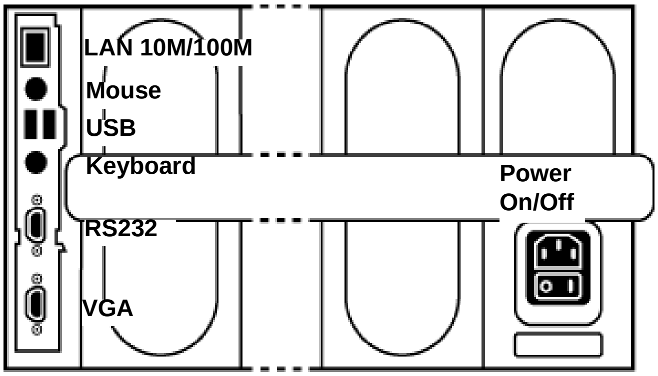


GPIB Allows test set to be remotely controlled via the GPIB control bus.

External Protective Earth Connect an external earth connection to the instrument at this point.

Floppy Disk Drive Accepts 1.44 Mb IBM formatted disks.

Connectors on Instrument Front/Right Side Panel



LAN 10M/100M 10/100 Base-T LAN interface port. Supports remote control of the test set and the downloading of firmware upgrades.

10 Base-T LAN Connection Radiated Emissions To ensure compliance with EN 55011 (1991) a category 5, STP patch lead, RJ45 cable should be used to connect to the LAN port.

Mouse PS/2 port for connecting a mouse. To prevent possible damage, the mouse should only be connected and disconnected when the instrument is powered off.

USB Two Universal Serial Bus ports for connecting to a Printer.

Keyboard PS/2 port for connecting an external keyboard. Can be hot-plugged for use at any time. Ensure that keyboard port is used - if connected to mouse PS/2 port in error the instrument will require to be restarted.

RS232 Remote Control port providing following configurations:

- **Controller Type:** Computer and Terminal.
- **Protocol:** None and Xon/Xoff.
- **Speed:** 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 baud.
- **Parity:** Odd, Even, 1s, 0s.
- **Stop Bits:** 1, 2
- **Data Length:** 7 bits.

VGA Connector for displaying contents of instrument screen on an external display. Ensure that the external display is connected before powering up the instrument.

Using the Graphical User Interface (GUI)

The graphical user interface (GUI) with windows, menus and dialog boxes provides easy access to all the instrument setup, monitoring and results pages together with constant display of context sensitive help and a summary diagram showing instrument status. The interface includes an Online Help system which gives detailed information on using the instrument.

For more information, see:

- “Display Windows" on page 39
- “Menus" on page 43
- “Basic User Interface Operations" on page 45

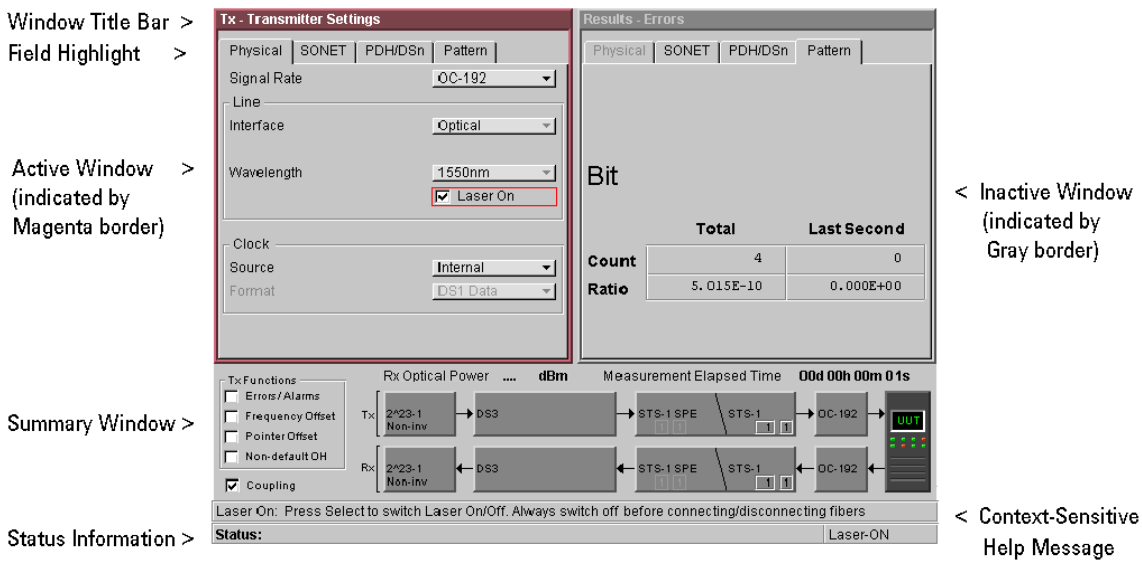
You can use a mouse and keyboard, instead of the arrow navigation keys, **<Select>** key and keypad on the front panel, to access the graphical user interface. For more information, see:

- “Using a Mouse and Keyboard with the Instrument" on page 57

Display Windows

There are two types of windows that you can display on the instrument. The Instrument Window is used to display the user interface for setting up and using the instrument. The Online Help window is used to display user help information.

Instrument Window



Main Windows

Two main windows display the pages for setting up, monitoring and viewing results.

Only one of these windows is active at a time. The active window is indicated by a colored (magenta) border. You can change the active window by pressing the **<Window>** button next to the arrow navigation keys.

Move around within a window by using the arrow navigation keys. The current position on the window is shown by a red highlight box around the control field.

The title of the current displayed page is given at the top of the window in the title bar. The title includes the menu headings that you selected to access the page. For example, **Overhead Setup - Trace Messages** is the **Trace Messages** page selected from **Overhead Setup** on the menu.

Summary Diagram

The current setup of the Transmitter and Receiver, along with Test Function Indicators and the Elapsed Time for the current measurement period are displayed in the diagram at the bottom of the screen. An example of the summary diagram is shown below.

Context-Sensitive Help

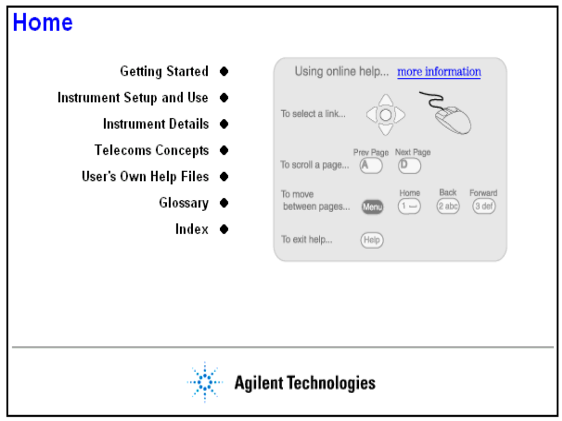
A single line of Context-Sensitive Help appears at the bottom of the display. This gives you helpful information relating to the area of the screen that is highlighted by the red box.

Status Line

The Status line displays the instrument and keyboard status.

Online Help Window

You can access this at any time by pressing **<Help>**. To close the help just press **<Help>** again.



NOTE

The **<Help>** button toggles the display between the online help and the instrument windows - when you go back into online help it will be in the same page as when you left it. If you want to return to the Home Page of the online help, press the <Home> key on the instrument keypad.

Menus

Instrument Menu

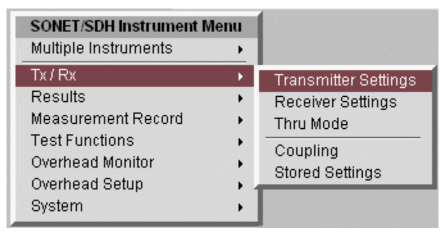
All instrument pages are accessed through the main menu.

▶ To use the main menu

1 Press **<Menu>**. The focus will be on the first menu item and the submenu will also be displayed.

2 Use the up/down arrow navigation buttons to move the focus through the main menu and the left/right arrow navigation buttons to move in and out of the submenus. As you move the focus down the menu, the submenu for each item will be displayed automatically.

3 To select a menu item press **<Select>**.



Online Help Menu

This feature allows you to quickly navigate through the Online Help system and provides quick access to the index and your own help files.

▶ To use the Online Help Menu

1 Press **<Menu>** while in the Online Help. A list of the main sections in the Online Help will appear.
2 Use the arrow navigation keys to select a menu item, then press **<Select>**.

Basic User Interface Operations

For information on how to control the instrument, see:

- “Drop-Down List Box" on page 45
- “Numeric Entry Box" on page 46
- “Folder/Tab Selector" on page 47
- “Text Entry Box" on page 47
- “Modal Window" on page 48
- “Action Buttons" on page 48
- “More Button" on page 49
- “Mapping Diagram" on page 49
- “Checkboxes" on page 50

Drop-Down List Box

Drop-down lists have been used where there are multiple choices required.

▶ To use a drop-down list box

1 Move to the drop-down box and press **<Select>**.
2 Use the arrow navigation keys to highlight your choice, then press **<Select>**.
3 To close the drop-down list without making a selection press **<Cancel>**.

Numeric Entry Box

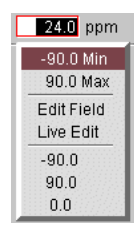
You can edit values using the keypad, Live Edit or Edit Field. Or you can choose from the preset or most recently-used values listed in the drop down menu.

▶ To use the numeric entry box

- Use the keypad to enter the value into the numeric entry box. If you make a mistake, press **<Cancel>**, otherwise press **<Select>** to save your entry. Alternatively, press **<Select>** to display a drop-down list of min/max settings, **Edit Field**, **Live Edit** and a list of the most recently used values for that field.

  Edit Field allows you to select individual digits and edit them using the keypad. This is useful when you want to edit one digit of an eight-digit number. Press **<Select>** to enter the value. Each time you enter a new value the focus moves to the right.

  Live Edit allows you to increment or decrement a value during a measurement, using the arrow navigation keys. Use the left/right arrow keys to highlight the digit to be changed and use the up/down arrow keys to increase or decrease the value. Note that you cannot enter new values via the keypad while in Live Edit mode.

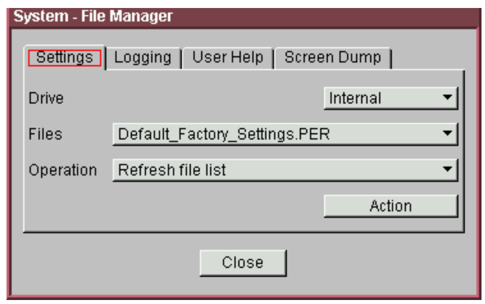


Folder/Tab Selector

Some windows have multiple pages within a window that are separated into different folders/tabs.

▶ To select a folder/tab

- Use the arrow navigation keys to move to the required folder.

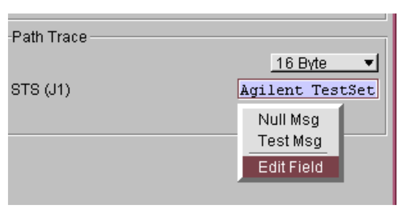


Text Entry Box

▶ To use the text entry box

- For quick text entry, see the “Keypad" on page 24. For example to edit text the J1 message (shown below), press **<Select>** to display a list of preset values, **Edit Field** and a list of recently used text.

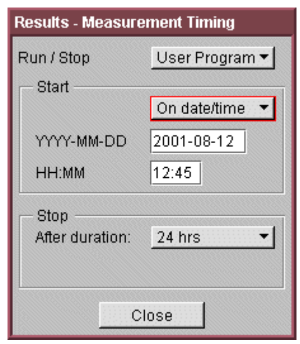
  Edit Field allows you to select individual letters in a string of text and edit them using the keypad. Press **<Select>** when you have finished. Each time you input a letter the focus moves to the right.



Modal Window

A modal window is a secondary window (dialog box) used when an action is required on certain settings. For example, when setting up Measurement Timing, the Measurement Timing modal window will be displayed. You must select **Close** to close the window.

You can use the **<Cancel>** button to close the window without making any changes to the settings.



Action Buttons

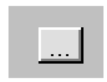
Buttons are used to process an action. For example, in Pointer Adjustment, to action a pointer burst you would move to the **Transmit Pointer Burst** button and press **<Select>**.

More Button

A **More** button, indicated by three dots, is used to indicate that there are more selections available.

▶ To use the More button

- Move to the button and press **<Select>**. For example, in the mapping setup area of the **Transmitter Settings** pages, select the **More** button to open the mapping diagram.

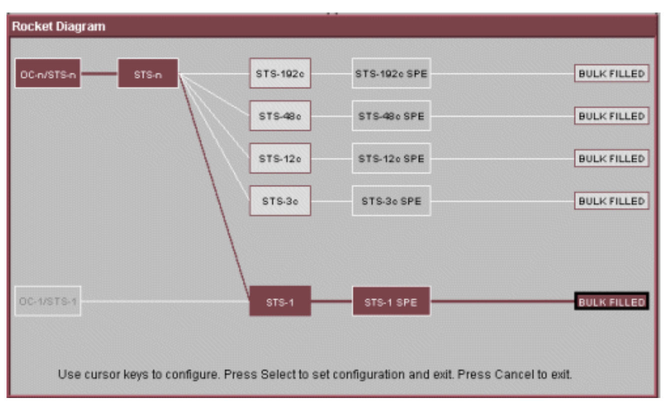


Mapping Diagram

Use the mapping diagram to select a signal mapping structure.

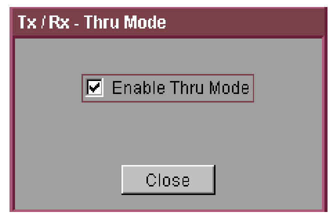
▶ To use the mapping diagram

- Use the arrow navigation keys to select the required mapping. Press **<Select>** when you have finished, or **<Cancel>** to close the mapping diagram without changing the settings. An example of a mapping diagram is shown below.



Checkboxes

These are used to set a control either OFF or ON. For example, to enable Thru mode, move to the checkbox and press **<Select>**.



Using Multiple Instruments

Products Supported

This product supports multiple instruments, namely:

SONET/SDH	Up to 10 Gb/s line rates T-carrier (DS1/DS3) PDH (2/8/34/140 Mb/s)
Ethernet	2-port 1 Gb/s 8-port 10/100 Mb/s

Feature Summary

- These instruments continue to transmit and receive, and make measurements irrespective of which is the foreground instrument.
- The main menu changes to contain the selections for just the foreground instrument.
- The **<Run/Stop>** key controls measurements on foreground and background instruments simultaneously.
- The **<Smart Test>**, **<Single Error>**, **<Show More>**, **<Reset>** and **<Print Control>** keys operate on the foreground instrument.
- The front panel **Signal**, **Frame**, **Pattern**, **Errors**, **SONET/SDH**, **DSn**, **PDH** and **History** LEDs operate only on the foreground instrument.
- The **Multiple Instruments** LED indicates errors or alarms in all background instruments. If on, check the **Multiple Instruments > Status** page to locate the problem.
- **Trouble Scan**/**Results Summary** operates only on the foreground instrument.
- A **Multiple Instruments Status** page is available. It is a full product SONET/SDH Trouble Scan and Ethernet Results Summary.

Foreground Instrument Selection

▶ **To select the foreground instrument**

- Press **<Menu>**, choose **Multiple Instruments > Select** then press **<Select>**. Choose **SONET/DSn (SDH/PDH)** or **Ethernet** then press **<Select>**.

  The name of the selected foreground instrument is shown at the top of the main menu.

  A combined SONET/SDH Trouble Scan and Ethernet Results Summary report is available. Press **<Menu>**, choose **Multiple Instruments > Status** then press **<Select>**.

  A summary of the main features of Multiple Instruments is also available. Press **<Menu>**, choose **Multiple Instruments > Quick Help** then press **<Select>**.

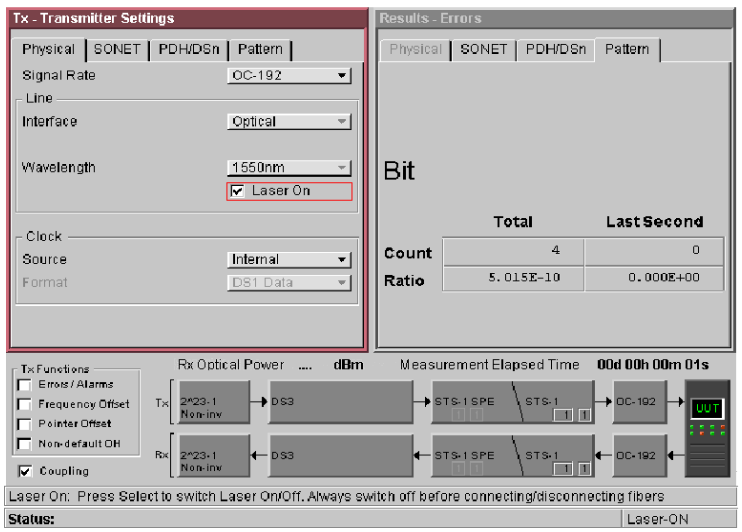
Using Online Help

You can use the instrument's Online Help to guide you while using the instrument. For information on how to use the Online Help, see:

- “Context-Sensitive Help" on page 54
- “Accessing the Index" on page 54
- “Using Online Help - Which Keys Do I Press?" on page 55

Context-Sensitive Help

A single line of text appears at the bottom of the display, above the Status line. This gives you helpful information relating to the area of the screen that is highlighted by the red box.

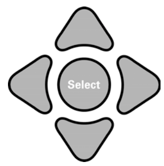
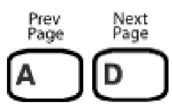
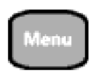


< Context-Sensitive Help Message

Accessing the Index

To find information quickly on a particular topic press **<Menu>** and select **Index**, when in Help mode.

Using Online Help - Which Keys Do I Press?

	Use the **Arrow Navigation** keys to move between hypertext links on a page. Once a hypertext link is highlighted, press the **<Select>** key to jump to the chosen topic.
	Press the **<Help>** key to **enter** or **exit** the Online Help. Press the **<Home>** key to go to the **Home** page.
	Use these keys to move **backwards** and **forwards** between pages.
	Use these keys to **scroll up** and **scroll down** through the displayed page.
	Press **<Menu>** to display a list of the main Online Help sections. Use the **Arrow Navigation** keys to select a heading, then press **<Select>**.

What is Included in the Online Help?

The Online Help is divided into sections to help you quickly find the information you want.

Getting Started - Contains an instrument tour, safety information and measurement tutorials.

Instrument Setup and Use - Explains how to set up the instrument, recall stored settings, make measurements and view, save and print results. There is an Instrument Setup and Use section for each network that the instrument can test (for example, SDH, SONET).

Instrument Details - Contains supplementary product information. It includes:

- **System Features -** available options, manufacturing data, setting time and date, using the keyboard lock, printing results, file management and creating/storing your own help files.
- **Technical Support -** maintenance, instrument reboot information.
- **Specifications**
- **Frequently Asked Questions**

Telecoms Concepts - A reference section including a glossary, reference tables (for example, payloads, signal rates, overhead bytes), a summary of the ITU Standards, information on applications.

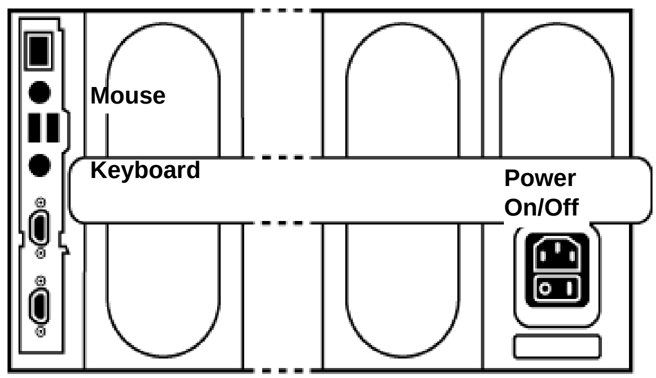
Index - Contains a list of all features and procedures.

Using a Mouse and Keyboard with the Instrument

CAUTION

If you connect the keyboard to the **Mouse Port (PS/2)**, the keyboard will not function. Re-connect the keyboard and mouse to the correct ports, then restart the instrument.

To prevent possible damage, the mouse should only be connected and disconnected when the instrument is powered off.



Mouse Port (PS/2) You can use an external mouse (to point and click) instead of the arrows and **<Select>** key to select instrument settings on the display.

Keyboard Port (PS/2) You can use an external keyboard instead of the front panel keypad to enter data. The keyboard can be connected to the instrument at any time.

Safety Information

This instrument has been designed and tested in accordance with publication EN61010-1(1993) / IEC 61010-1(1990) +A1(1992) +A2(1995) / CSA C22.2 No. 1010.1(1993) Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, and has been supplied in a safe condition.

The **Installation and Verification Manual** (supplied with the instrument) contains safety information and warnings. These must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

The Installation and Verification Manual is supplied with the instrument and included on the Product CD-ROM.

Also, please note the following safety information:

- “Optical Connector Safety Information" on page 59
- “Avoiding Problems When Making Measurements" on page 61

Optical Connector Safety Information

WARNING

Always switch off the laser before connecting or disconnecting the optical cables.

NEVER examine or stare into the open end of a broken, severed or disconnected optical cable when it is connected to one of the instrument's Optical Out connectors.

When connecting/disconnecting optical cables between the instrument and device-under-test, observe the correct connection sequences given below.

Connecting: Connect the optical cable to the input of the device-under-test **before** connecting to any of the instrument's **Optical Out** connectors. When connecting to the **Optical In** ports ensure the power level never exceeds the maximum stated limit for that port. Also ensure that the power level of a signal applied to an instrument receive port is within the recommended operating level for that port. Recommended input operating power levels for each input port are printed on the connector panel adjacent to the port.

Disconnecting: Disconnect the optical cable from the **Optical Out** connector **before** disconnecting from the device-under-test. Close the fiber optic connector dust caps over the laser port. Arrange for service-trained personnel, who are aware of the hazards involved, to repair optical cables.

CAUTION

When connecting or disconnecting, ensure you are grounded or, make contact with the metal surface of the mainframe with your free hand to bring you, the module, and the mainframe to the same static potential.

For additional ESD information, see the Installation and Verification manual.

For further information, see:

- “Cleaning Optical Connectors" on page 365
- “Avoiding Optical Receiver Overload" on page 60

Avoiding Optical Receiver Overload

When connecting an optical transmitter to an optical receiver, check that you do not overload the receiver.

Status Message Warnings Check the Status message on the instrument display. This will warn you of overload conditions.

Maximum/Recommended Optical Power Levels Maximum output/input power levels for the Tx Optical Out and Rx Optical In ports are printed on the connector panel, as is the recommended Rx Optical In port input power operating range. When performing tests, it is recommended that you use a signal that has an average power comparable to the middle of the receiver’s operating range.

Avoiding Problems When Making Measurements

Bit errors can occur due to network defects (such as faulty network elements, damaged optical fiber or dust/dirt particles in the fiber connections) or problems with the test environment/setup. Follow the steps below to avoid problems when making measurements.

▶ **To avoid introducing errors when performing tests:**

1 Ensure that optical fibers connecting the instrument to the network are not damaged - check that fibers have not been crimped.
2 Avoid acute bends in the fiber. Ensure that fibers only have gentle arcs.
3 If the instrument is left unattended for a long term test, ensure that the equipment is not in a position where people will disturb the connecting fibers.
4 Ensure that all fiber connections are clean and dirt-free. Use a fiberscope to measure the cleanliness of a (unpowered) fiber. A poorly cleaned fiber results in a drop in power. Alternatively, use a power meter (e.g. the instrument's internal power meter) to measure the power at the end of a fiber, the other end of which is connected to the network.
5 Before connection is made, always clean the connector ferrule tip with acetone or alcohol using a cotton swab. Dry the connector with compressed air. Failure to maintain cleanliness of connectors is liable to cause excessive insertion loss.
6 Ensure that the correct time and date is set on the instrument.

Using Smart Test Features

You can use Smart Test to access the SignalWizard feature (when the foreground instrument is set to SONET/SDH) or to the RFC Conformance Tests (when set to Ethernet). It also provides shortcuts to results, measurements and stored settings. Smart Test also allows you to reset the instrument to its default settings. For specific measurement setup information, refer to Instrument Setup and Use sections.

▶ To access Smart Test features

- Press **<Smart Test>**, choose the appropriate feature from the drop-down menu using the arrows and **<Select>** key.

For more information on Smart Test features, see:

- “Using SignalWizard" on page 64
- “RFC 2544 Conformance Tests" on page 304
- “Shortcuts to Results, Measurements and Stored Settings" on page 63
- “Resetting Instrument to Default Settings" on page 63

Shortcuts to Results, Measurements and Stored Settings

You can use Smart Test to access results, measurements and stored settings.

▶ To access shortcuts

1 Press **<Smart Test>**, choose **Shortcuts**. Select an item from the list and press **<Select>**.
2 Select an item from the list of shortcuts.

Resetting Instrument to Default Settings

You can use the Smart Test to reset the instrument to its default values.

▶ To reset instrument to default settings

1 Press **<Smart Test>**, choose **Reset Instrument** then press **<Select>**.
2 Select **OK** in the “Warning” window to reset the instrument settings.

Using SignalWizard

SignalWizard checks the test ports for valid signals. A signal is valid if its power level and frequency are with in the specified limits of the port it is connected to. The line rate and interface level for optical signals is determined along with the termination, signal level and line coding for electrical signals.

SignalWizard then scans all STS/AU channels (up to 192) and selected 'expanded' VT/TU channels simultaneously for error and alarm information. For VT/TU channels that are not 'expanded' in the display, error and alarm information is obtained sequentially (within milliseconds).

SignalWizard can also scan PDH/DSn sub-channels, and shows which channels are unequipped and the type of service being carried by equipped channels.

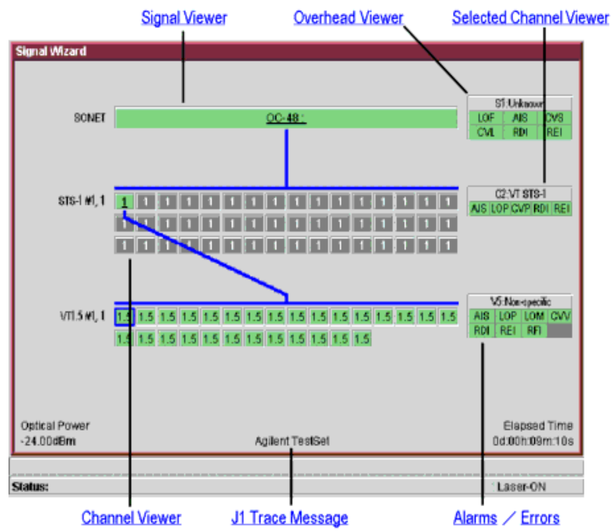
For information on connecting to a network when testing with SignalWizard, see:

- “In-Service Testing" on page 71
- “Out-of-Service Testing" on page 72

▶ To monitor a signal with SignalWizard

1 Press **<Smart Test>**, choose **SignalWizard** then press **<Select>**. A progress indicator is displayed. If more than one valid signal is detected, the port selection window is displayed. Select the port you want to examine, then select **Continue**. If only one valid signal is detected or if the instrument is in Thru mode, the Channel Overview window will automatically appear on the display. For more information, see “Understanding the SignalWizard Overview Window" on page 66.

   If SignalWizard detects a DSn/PDH signal, then **PDH/DSn Channel Scan** will automatically be launched. A window will appear showing the status and structure of all channels.
   If no valid signal is detected, you can re-scan the ports or return to the main instrument.



2 Press **<Menu>** to further investigate channels, errors or path trace messages using **Next Error**, **Previous Error**, **Expand** or **Collapse**. If any STS/AU contains VT/TU tributaries, you can view a tributary in more detail. Press **<Menu>**, choose **Expand** then press **<Select>**. You can also manually start the **PDH/DSn Channel Scan** from the menu.

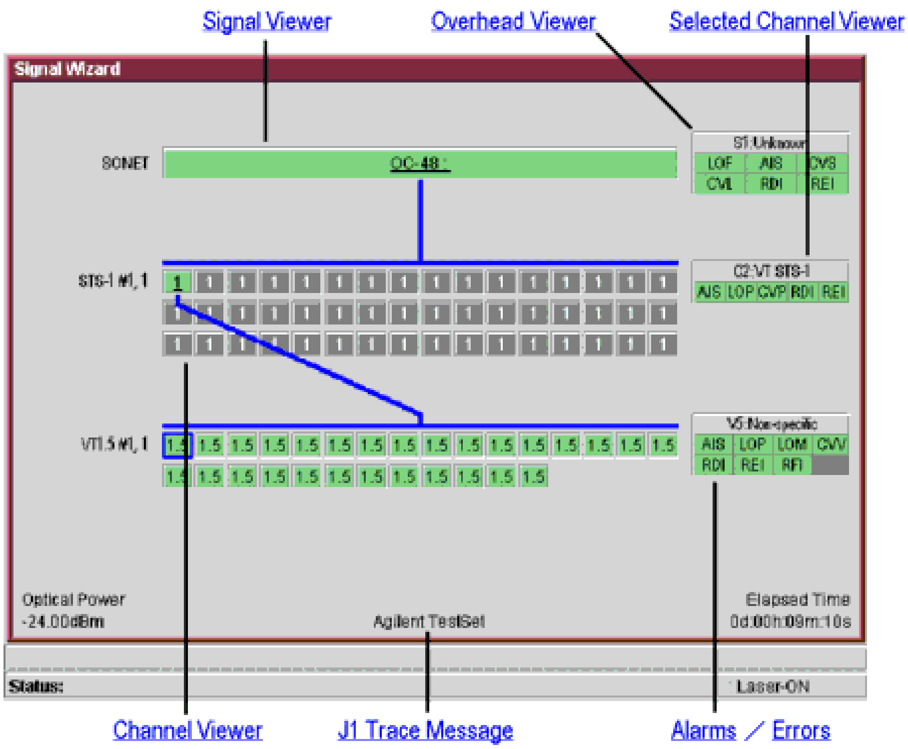
For more information on path trace messages, see “Monitoring Path Trace Messages" on page 69.

3 To close SignalWizard, do one of the following:

Press **<Smart Test>**, choose **Stop Wizard** then press **<Select>**.

Press **<Menu>**, choose **Exit** then press **<Select>**. Before closing SignalWizard, you can automatically configure the transmitter and/or receiver settings to match the signal being applied to the instrument (not available in Thru mode). This feature is useful if you intend doing further testing, it saves you from having to manually configure the instrument settings.

Understanding the SignalWizard Overview Window



Signal Viewer

Displays the detected signal. If a J0 trace message is detected this is also displayed (both 16- and 64-byte message formats are supported).

Overhead Viewer

Displays results information associated with the overhead layer of the signal, including:

- Synchronization status message (decoded S1 byte)
- CV-S (RS-BIP), CV-L (MS-BIP) and REI-L (MS-REI) error status

- AIS-L (MS-AIS) and RDI-L (MS-RDI) alarm status

(LOS and LOF alarms are displayed on the instrument's front panel LEDs.)

Selected Channel Viewer

Displays result information associated with the selected channel, including:

- Type of payload (traffic) being carried in the channel (decoded C2 byte)
- CV-P (HP-BIP) and REI-P (HP-REI) error status
- AIS-P (AU-AIS), LOP-P (AU-LOP) and RDI-P (HP-RDI) alarm status
- Indicator for detected pointer adjustments

J1 Trace Message

Displays the decode path trace message associated with the selected channel. Both 16- and 64-byte messages formats are supported.

Channel Viewer

The Overview window shows a summary (using color coding) of the results for all channels. Each channel detected in the signal is provided with a dedicated box that summarizes the channel status. A channel carrying VT/TU channels is highlighted by its size designator being underlined. Broadband mappings are not underlined.

The size designator identifier is displayed within each box. While any non-standard concatenated channels will be detected and displayed, no errors or alarms are reported for that channel. Unequipped channels are on a grey background. Pointer activity within a channel is indicated by the channel background flashing blue.

Color Coding

Color Coding	Result
Green	No Errors/Alarms during test or since last history reset
Red	Errors/Alarms detected
Yellow	History (errors/alarms detected in the past)
Red/white A	AIS (STS-1, STS-3c/STM-0, STM-1)
Blue	Pointer Move
Grey	Unequipped
White/black dot	Other Standard
Black	Illegal Pointer Combination

Errors

An Error flag is raised when one or more errors occur in any one sampling period.

Alarms

An Alarm flag is raised when one or more alarms occur in any one sampling period.

- Loss of Pointer LOP
- Path AIS (AIS-P)
- Remote Path Alarm (RDI-P)
- Pointer Adjustment LOP (LOP flashes blue on each adjustment)

Monitoring Path Trace Messages

When running SignalWizard any routing errors in the network will be shown in the Overview window.

During the installation and commissioning of new services, or troubleshooting, the ability to generate and monitor path trace messages is essential. This allows you to confirm correct routing paths through network equipment with software controlled routing capability. You can also use path trace messages for checking routing performance of network elements during protection switching to confirm the correct signals have been protected in fault conditions.

You can view all the J1 path trace messages for the received signal at the same time. Alternatively, you can view all the J2 path trace messages associated with VT/TU channels in a selected STS/AU.

▶ **To view path trace messages**

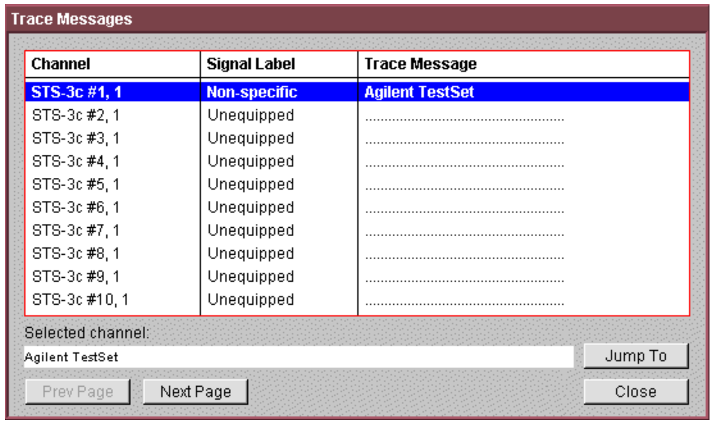
- Use the arrow keys to select the STS/AU channel of interest. View the J1 path trace message at the bottom of the display.

▶ **To list/search all J1 Path trace messages in the receive signal**

- Press **<Menu>**, choose **Trace Messages** then press **<Select>**. Select **List Current Levels**, a trace message window will be displayed.

  or

- Press **<Menu>**, choose **Trace Messages** then press **<Select>**. Select **Search Current Level**. Enter the trace message you are searching for in the dialog box, then select **OK**.



▶ To view J2 Path trace message in a VT /TU channel

1 Use the arrow keys to highlight the channel for further analysis.

2 Press **<Menu>**, choose **Expand** then press **<Select>**. This expands the VT/TU substructure.

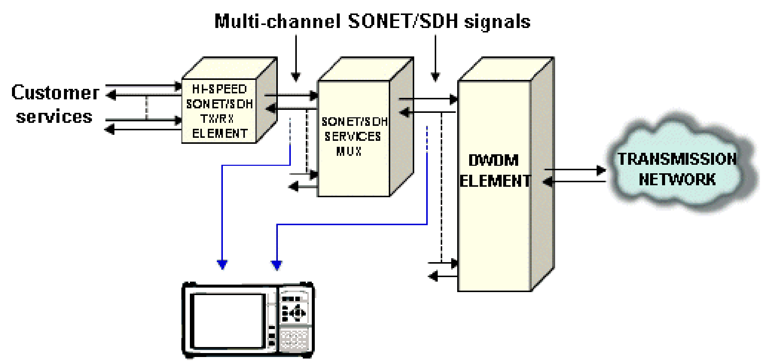
3 Press **<Menu>**, choose **Collapse** then press **<Select>**. This closes the VT/TU substructure.

NOTE STS/AU channels that contain VT/TU channels are shown underlined on the display.

In-Service Testing

You can use SignalWizard for in-service testing, to simultaneously monitor all channels in the received signal. This feature is useful when commissioning new transmission systems or performing routine maintenance checks.

A typical in-service network test connection is shown below.

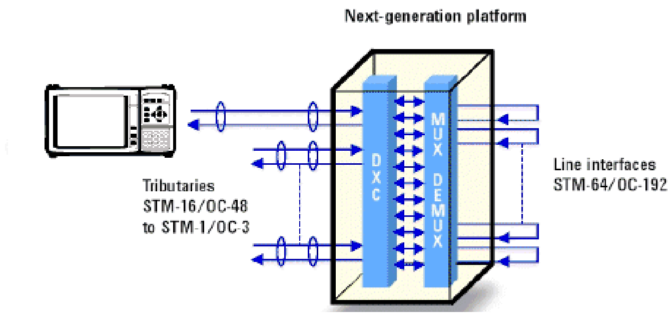


Out-of-Service Testing

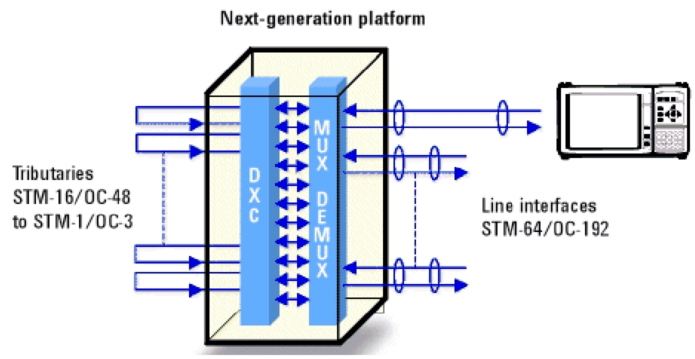
You can use the instrument's transmitter in conjunction with SignalWizard all channel test feature to test each path carried within a tributary or line signal. You can apply the test signal to the tributary or line side of the network element.

Applying a test signal to the line side of the network element may reduce the number of ports that need to be checked. SignalWizard will identify the type of network paths present in the received signal (including the mix of channel types), and the traffic carrying status of each channel (showing which are equipped).

Typical tributary and line network test connections are shown.



Tributary-Side Testing Setup



Line-Side Testing Setup

SONET Measurement Tutorial

The following procedure shows you how to use the instrument controls and arrow navigation keys to set up and perform a measurement. In this procedure the instrument's transmitter output is connected directly to the receiver input. Under normal operating conditions the transmitter output would be connected to a system under test and the output from the system connected to the instrument's receiver input.

Steps 1-7 show you how to configure the instrument to transmit and receive an OC-12 optical signal with an STS-3c SPE payload containing a 2^{23}-1 PRBS test pattern.

In Steps 8-10 you will set the measurement test timing to be started and stopped manually, make the measurement and view the results.

Finally, in Steps 11-13 you will insert errors and alarms into the transmitted signal to confirm that the instrument receiver measures and displays those conditions.

Step 1: Connect Optical Ports

When connecting to optical interfaces please refer to:

- “Avoiding Optical Receiver Overload" on page 60
- “Avoiding Problems When Making Measurements" on page 61.

▶ **To connect optical ports**

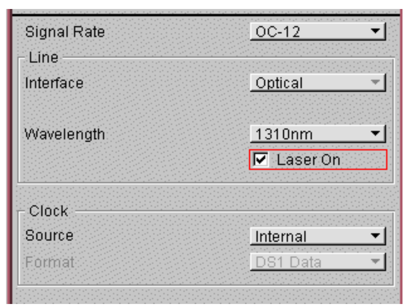
1 Check the Test Set **Optical Out** ports and ensure that all **Laser On** LEDs are Off. There should also be a **Laser-OFF** message on the instrument **Status** line (bottom of display).
2 Before making any connections to the receiver **Optical In** ports always check the input power level on a Power Meter.
3 Connect the **52 Mb/s - 2.5 Gb/s Optical Out port** (1310 or 1550 nm depending on options fitted to your instrument) to the receiver **52-622 Mb/s Optical In port** through a 15 dB attenuator.

Step 2: Set Up Transmitter

▶ **To set up the transmitter**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.

2 Select **Signal Rate** and press **<Select>** to reveal a drop down menu of the available signal rates. Use the arrow navigation keys to highlight OC-12, then press **<Select>** to set the signal rate. Use the arrow navigation keys to set up the other settings, including the **Line** (includes Wavelength and Laser On/Off selection, set Laser to **On**), and **Clock Source**. For safety, only turn laser on after the fiber has been connected to the transmitter. Check the **Status** line for any warnings of optical power overload.

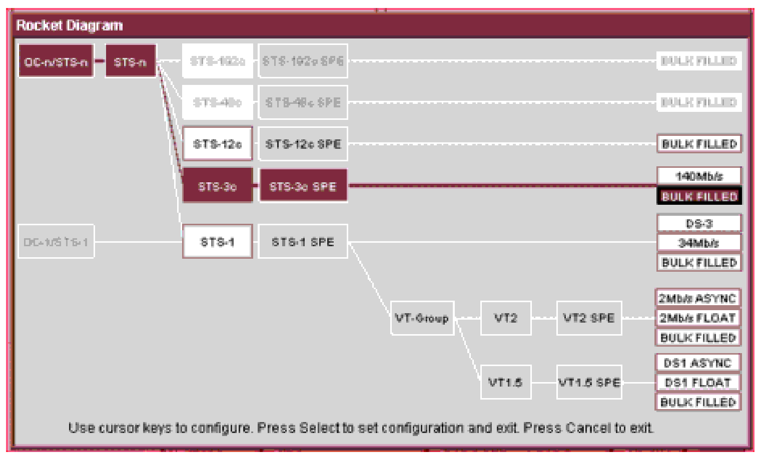


Step 3: Set Up the SONET Mapping

▶ **To set the SONET mapping**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **SONET** tab.

2 Move the cursor to the **Mapping** field and press **<Select>**. Use the arrow navigation keys to select the required mapping from the mapping diagram then press **<Select>**.

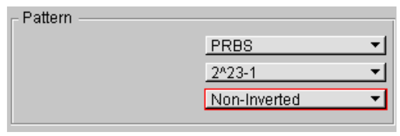


Step 4: Set the Payload Pattern

▶ **To set the transmitter payload pattern**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab.

2 Set up **Payload Pattern** as shown.

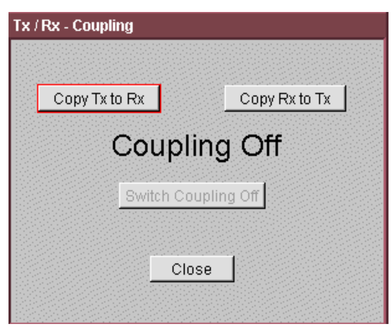


Step 5: Couple Tx and Rx Settings

This setting ensures the receiver has the same setting as the transmitter.

▶ **To couple the transmitter to the receiver**

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.



2 If Coupling is **On** proceed directly to Step 8: Set Measurement Gating. If it is **Off**, proceed to the next step.

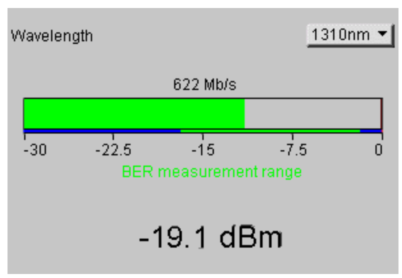
3 Select **Copy Tx to Rx** (this selection copies Transmitter settings to the Receiver) and press **<Select>**. Move the cursor to **Close** then press **<Select>** to exit the coupling window.

Step 6: Check Receiver Input Power

▶ **To check receiver input power**

1 Check the **Status** line at the bottom of the display for any warning messages and check Receiver Input Power as follows.

2 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Optical Power** tab.



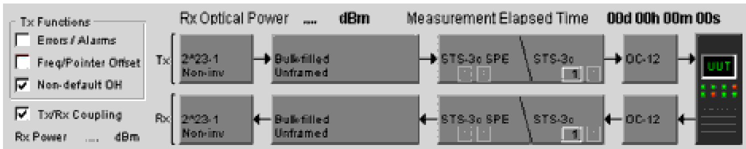
3 Check the receiver input power.

Step 7: Check Setup

The Transmitter and Receiver settings should now be identical.

▶ **To check the transmitter and receiver settings**

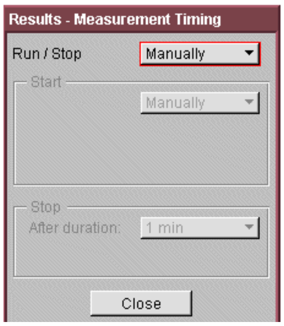
- You can check this by viewing the summary diagram at the bottom of the display. An example of this diagram is shown below.



Step 8: Set Measurement Gating

▶ **To set measurement gating**

1 Press **<Menu>**, choose **Results > Measurement Timing** then press **<Select>**.



2 Set the measurement **Run/Stop** to **Manually** to ensure that testing is controlled via the green **<Run/Stop>** button on the instrument front panel.

3 Use the arrow navigation keys to choose **Close**, then press **<Select>**.

Step 9: Start Measurement

▶ **To start the measurement**

1 Press the front panel **<Run/Stop>** button to start the measurement.

2 The measurement will continue until you end the measurement (gating) period by pressing **<Run/Stop>**. Leave the instrument running the measurement.

Step 10: View Results

▶ **To view the results**

1 Press **<Menu>**, choose **Results > Error Summary** then press **<Select>**. Select the **SONET** tab.

2 Select the **Error Type** you require. Check that there are no errors displayed.

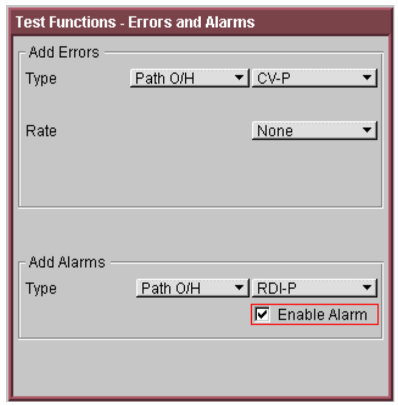
3 To confirm that the instrument is measuring correctly, add errors and alarms to the output signal.

Step 11: Add an Error and an Alarm to Tx Output

▶ **To add a single error and an RDI-P Alarm**

1 Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.

2 Use the arrow navigation keys to set up errors and alarms.



Step 12: Add a Single Error

▶ **To add a single error**

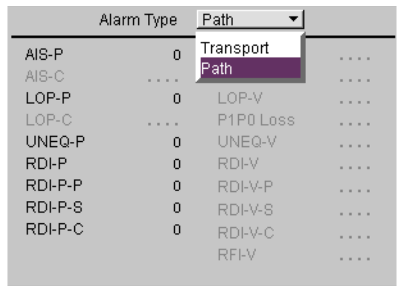
- Press the front panel **<Single Error>** button a number of times. Check that with each button press the CV-P error count increments on the **Error Summary** results page. Try selecting other Error Types and Error Rates and observe the change to the results displayed.

Step 13: View Alarm Results

▶ **To view the alarm results**

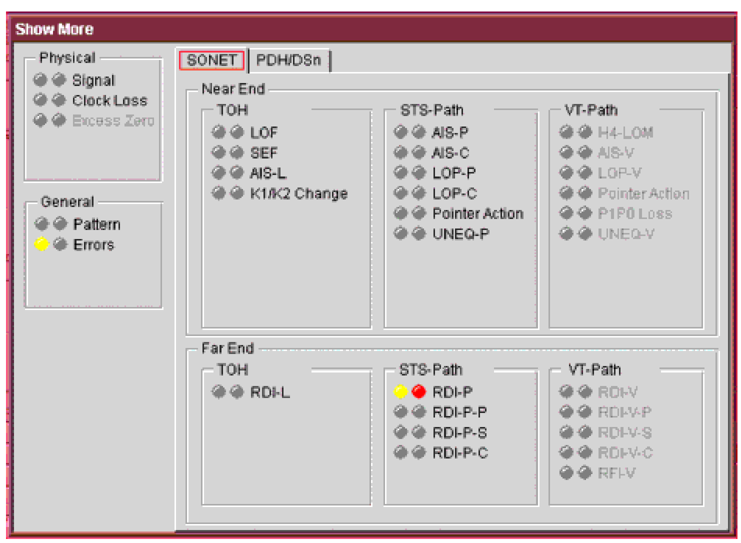
1 Press **<Menu>**, choose **Results > Alarm Seconds** then press **<Select>**. Select the **SONET** tab.

2 Set the **Alarm Type** to **Path**.



3 Check that the RDI-P alarm seconds count is incrementing, and that the front panel SONET/SDH LED alarm indicator is on.
(The RDI-P alarm was enabled in Step 11: Add an Error and an Alarm to Tx Output).

4 Press the blue front panel **<Show More>** key to see details of current and historical errors/alarms. Current errors/alarms are shown red, historical ones are shown yellow.



5 Press the front panel **<Run/Stop>** button to stop the measurement.

End of tutorial.

Ethernet Measurement Tutorials

These tutorials show you how to use the instrument to set up and perform Ethernet measurements.

Before you start, you will need to decide how to configure the system under test. For advice on this and for background information on Ethernet and Ethernet measurements, see “Ethernet in Telecommunications Transmission Networks" on page 393.

End To End Testing Tutorial

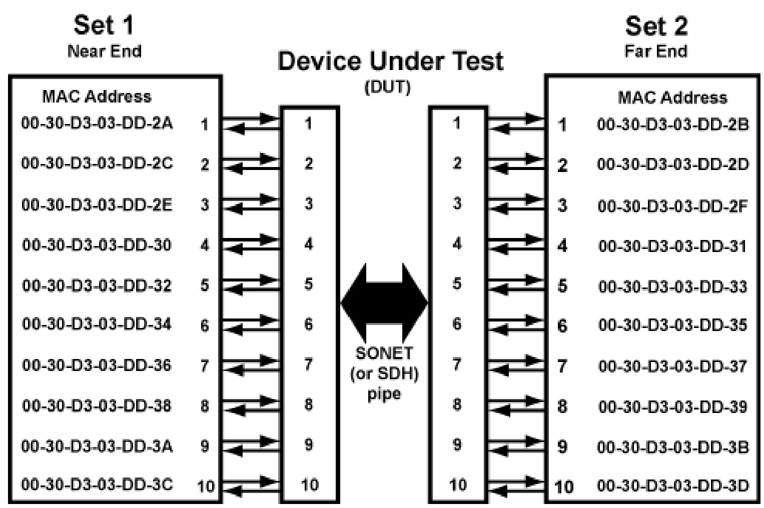
In End To End mode, test frames are sent from one instrument through the network under test to another instrument. The frames should arrive error-free.

Step 1: The End To End Testing Setup

1 Connect patchcords to one or more ports on the instruments from the line cards at **both** ends of the link.

2 Provision the paths through the network between the ports on the two line cards.

3 Designate one instrument as **Near End** and the other as **Far End**.



End-to-End Setup (ten ports shown)

Step 2: Near End Instrument Setup

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.

2 In the **Test Mode** field, select **End To End Test**.

3 In the **Setup Mode** field, select **Pre-set**.

4 In the **Designate This Instrument As** field, select **Set 1**.
5 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
6 Select **Transmit Duration ...** then select **Burst** as the **Duration Type**.
7 Set a **Burst Duration**, either a time or number of frames, to suit your application. For example, 1000000 frames.
8 Select **Close** to return to the **Ethernet: Manual Tests** page.

Step 3: Far End Instrument Setup

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 In the **Test Mode** field, select **End To End Test**.
3 In the **Setup** field, select **Pre-set**.
4 In the **Designate This Instrument As** field, select **Set 2**.
5 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
6 For the **Receiver**, set the **Result Type** to display **Port Frame Rate/Count** results.

Step 4: Run the End To End Test

1 On the **Far End** instrument press **<Run/Stop>**.
2 Then, on the **Near End** instrument press **<Run/Stop>**.
3 On the **Near End** instrument, when the burst has finished transmitting, the Transmitter **Status** will change from **Tx Burst Frames** to **Tx Idle Frames**.
4 When this happens, check that the **Far End** instrument **Receiver** results are as follows:

   The **Port Frame Count** should be 1000000 frames on the relevant ports.

   The **Port Errored Frame Count** should be 0.

   The **Port Broadcast/Multi-cast Frame Count** should be 0.

   The **Out of Sequence Event Count** should be 0.

1 Port Loopback Testing Tutorial

In 1 Port Loopback mode, the instrument is connected at one end of a link. At the far end of the link, the transmitter on the relevant port is looped to the receiver.

Test frames sent from the instrument into the network travel around the Tx-Rx loop and are sent back to the instrument. The frames should arrive error-free.

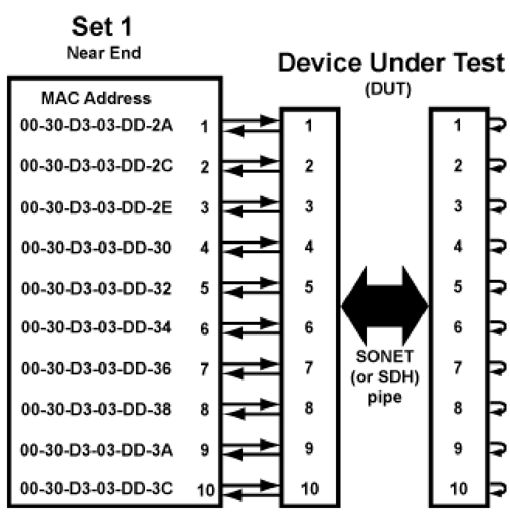
NOTE

This type of loopback will only work on simple Layer 1 systems. See “Ethernet in Telecommunications Transmission Networks" on page 393 for more details.

An alternative is to use “Loopthru Testing Tutorial" on page 92 at the far end.

Step 1: The 1 Port Loopback Testing Setup

1 Apply transmitter/receiver loopback(s) at the **Far End** and connect patchcords to the instrument at the **Near End**.



1 Port Loopback Setup

Step 2: Near End Instrument Setup

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 In the **Test Mode** field, select **Loopback Test**.
3 In the **Setup Mode** field, select **Pre-set**.
4 In the **Loopback Mode** field, select **1 Port Loopback**.
5 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
6 Select **Transmit Duration ...** then select **Burst** as the **Duration Type**.
7 Set a **Burst Duration**, either a time or number of frames, to suit your application. For example, 1000000 frames.
8 Select **Close** to return to the **Ethernet: Manual Tests** page.
9 For the **Receiver**, set the **Result Type** to display **Port Data Rate** results.

Step 3: Run the 1 Port Loopback Test

1 Press **<Run/Stop>**.
2 While the burst is transmitting, check that the **Port Data Rate** on the **Receiver** matches the expected bandwidth provisioned in your system.
3 When the burst has finished transmitting, the Transmitter **Status** will change from **Tx Burst Frames** to **Tx Idle Frames**.
4 When this happens, press **<Run/Stop>** again and check that the **Receiver** results are as follows:

   The **Port Errored Frame Count** should be 0 frames on the relevant ports.

   The **Dropped Frame Count** should be 0.

   The **Average Latency** is within the limits expected for your system.

2 Ports Loopback Testing Tutorial

In 2 Ports Loopback mode, ports are connected together in pairs at the far end of a link. The test instrument is then connected to similar pair(s) of port(s) at the near end.

Test frames are sent from the first of the pair of ports on the test instrument through the network and are sent back from the first port of a pair at the far end into the second port of the pair by the loopback. The test frames then travel back through the network to the second port of the pair on the test instrument. The frames should arrive error-free.

NOTE

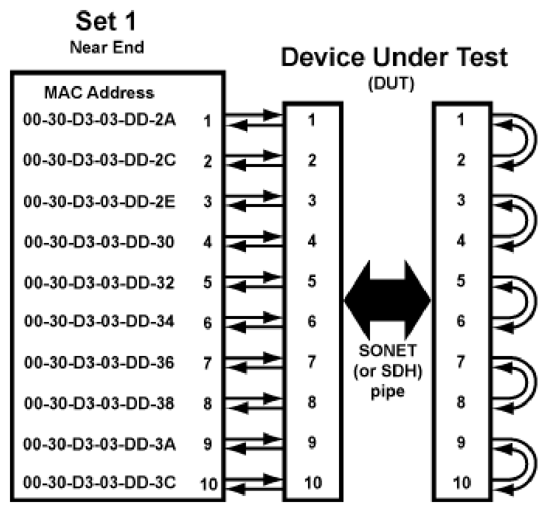
This type of loopback can only be used on networks working at Layer 1.

For networks working at Layer 2 (networks that include Ethernet switching), the 2 ports loopback method can be used by correct use of VLAN tags. See “VLAN Tagging Test Method Tutorial" on page 94 for details. An alternative is to use “Loopthru Testing Tutorial" on page 92 at the far end.

See “Ethernet in Telecommunications Transmission Networks" on page 393 for more details.

Step 1: The 2 Ports Loopback Testing Setup

1 Connect loopback(s) between the relevant pair(s) at the **Far End** and connect patchcords to the instrument at the **Near End**.
2 Provision paths between pair(s) of ports on the network elements at the ends of a link.



2 Ports Loopback Setup

Step 2: Near End Instrument Setup

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 In the **Test Mode** field, select **Loopback Test**.
3 In the **Setup Mode** field, select **Pre-set**.
4 In the **Loopback Mode** field, select **2 Ports Loopback**.
5 In the **Designate This Instrument As** field, select **Set 1**.
6 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
7 Select **Transmit Duration ...** then select **Burst** as the **Duration Type**.
8 Set a **Burst Duration**, either a time or number of frames, to suit your application. For example, 1000000 frames.
9 Select **Close** to return to the **Ethernet: Manual Tests** page.
10 For the **Receiver**, set the **Result Type** to display **Port Data Rate** results.

Step 3: Run the 2 Ports Loopback Test

1. Press **<Run/Stop>**.
2. While the burst is transmitting, check that the **Port Data Rate** on the **Receiver** matches the expected bandwidth provisioned in your system.
3. When the burst has finished transmitting, the Transmitter **Status** will change from **Tx Burst Frames** to **Tx Idle Frames**.
4. When this happens, press **<Run/Stop>** again and check that the **Receiver** results are as follows:

   The **Port Errored Frame Count** should be 0 frames on the relevant ports.

   The **Dropped Frame Count** should be 0.

   The **Average Latency** is within the limits expected for your system.

Loopthru Testing Tutorial

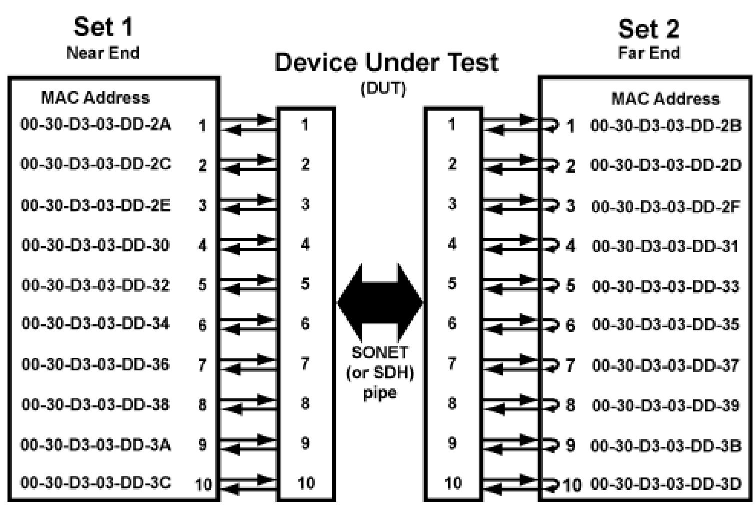
Loopthru is a means of testing Ethernet services on a loopback, even if the network under test contains a Layer 2 (Ethernet) switch.

Loopthru can therefore be used to test single or multiple Ethernet services on any type of network. Also, the service(s) are tested exactly as an end user will see them, with no special network provisioning required.

Step 1: The Loopthru Testing Setup

1 Connect patchcords to one or more ports on the instruments from the line cards at **both** ends of the link.

2 Provision the paths through the network between the ports on the two line cards.



Loopthru Setup

Step 2: Near End Instrument Setup

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.

2 In the **Test Mode** field, select **Loopback Test**.
3 In the **Setup Mode** field, select **Pre-set**.
4 In the **Loopback Mode** field, select **1 Port Loopback**.
5 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
6 Select **Transmit Duration ...** then select **Burst** as the **Duration Type**.
7 Set a **Burst Duration**, either a time or number of frames, to suit your application. For example, 1000000 frames.
8 Select **Close** to return to the **Ethernet: Manual Tests** page.
9 For the **Receiver**, set the **Result Type** to display **Port Data Rate** results.

Step 3: Far End Instrument Setup

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 In the **Test Mode** field, select **Loopthru**.

Step 4: Run the Loopthru Test

1 Press **<Run/Stop>**.
2 While the burst is transmitting, check that the **Port Data Rate** on the **Receiver** matches the expected bandwidth provisioned in your system.
3 When the burst has finished transmitting, the Transmitter **Status** will change from **Tx Burst Frames** to **Tx Idle Frames**.
4 When this happens, press **<Run/Stop>** again and check that the **Receiver** results are as follows:

The **Port Errored Frame Count** should be 0 frames on the relevant ports.

The **Dropped Frame Count** should be 0.

The **Average Latency** is within the limits expected for your system.

VLAN Tagging Test Method Tutorial

VLAN Tagging is a technique used on networks containing Layer 2 (Ethernet) switches so that testing can be carried out on a loopback, instead of end to end.

The method forces networks to return test frames to the source instrument for testing to be carried out. This method should work on any network where the network elements can use VLAN tagging.

NOTE

For more information on network types, see “Ethernet in Telecommunications Transmission Networks" on page 393.

For networks where this method cannot be used, see “End To End Testing Tutorial" on page 85 or “Loopthru Testing Tutorial" on page 92

The VLAN Method

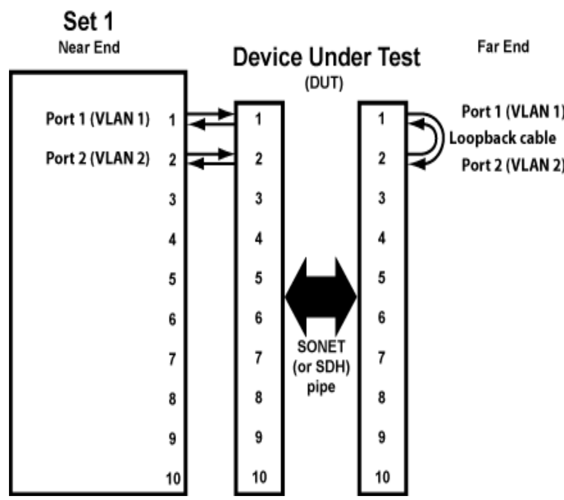
The network is provisioned so that pairs of ports on network elements at opposite ends of a link have a valid path between them. For the purposes of this tutorial, only a single pair are considered.

1 The network element at the **Near End** is programmed such that Port 1 belongs to VLAN 1 and Port 2 belongs to VLAN 2. Similar programming occurs at the **Far End**.
2 Test frames are sent in to Port 1 where they will be tagged as belonging to VLAN 1. The switch in the network element, not recognizing the Destination MAC Address as belonging to VLAN 1, will send the frames to the **Far End**.
3 The switch at the **Far End**, also not recognizing the frames as being in VLAN 1, will broadcast the frames to all ports in VLAN 1 - in this case, only Port 1. As the frames are sent out of Port 1, the VLAN tag will be stripped off.
4 You have looped Port 1 to Port 2, so the frames will now be received on Port 2 where they will be re-tagged as VLAN 2.
5 The switch, once again, will not recognize the Destination MAC Address as belonging to VLAN 2 and will therefore send the frames back to the **Near End**.

6 The **Near End** switch will receive the frames and will now recognize the Destination MAC Address as being Port 2 - which does belong to VLAN 2.

7 The switch will send the frames to Port 2 where they will be received by the test instrument.

Testing can therefore be carried out from the **Near End** using the method described in “2 Ports Loopback Testing Tutorial" on page 89.



VLAN Tagging

2
Instrument Setup and Use - SONET

This chapter tells you how to set the instrument interfaces, to match the network being tested, and how to make measurements.

Setting up the SONET Transmitter

Physical

Overhead

Payload

Errors, Alarms, Frequency Offset and Pointer Movement

- “Adding SONET Errors and Alarms" on page 133
- “Adding Frequency Offset to the SONET Signal" on page 106
- “Adjusting SPE or VT Pointer Values" on page 116
- “Switching Off All Test Function Features" on page 134

Selecting SONET or SDH Operation

You can use this instrument to check the operation of individual SONET or SDH network elements, or you can check the performance of the spans that make up a network.

▶ To select SONET or SDH operation

1 Press **<Menu>**, choose **System > Preferences** then press **<Select>**.
2 Select the **SONET** or **SDH** network standard (as required).

Setting Up the SONET Transmit Interface

You can set up the interfaces to transmit optical or electrical SONET signals.

For more information, see:

- “Setting up the Optical SONET Transmit Interface" on page 102
- “Setting up the Electrical SONET Transmit Interface" on page 103
- “Coupling the Receiver to the Transmitter Settings" on page 104
- “Storing and Recalling Instrument Settings" on page 162

Setting up the Optical SONET Transmit Interface

You apply the OC-192 optical signals to network equipment via the 10 Gb/s (1550 nm) Optical Out port, and OC-1, OC-3, OC-12 and OC-48 via the 52 Mb/s - 2.5 Gb/s (1310 nm or 1550 nm) Optical Out port.

Make sure the transmit interface settings match the network equipment.

NOTE

The transmitter and receiver can operate independently, or they can be coupled. For more information, see “Coupling the Receiver to the Transmitter Settings" on page 104.

Also, on power up the transmitter will re-establish the laser settings (enabled or disabled) that existed prior to the last power down. If you want the laser to always be disabled on power up, select the laser control setting, see “System Preferences" on page 342.

WARNING

Always switch off the laser before connecting or disconnecting optical cables. Read the laser warning information given in “Optical Connector Safety Information" on page 59 before switching ON the laser. Laser status is always shown at the bottom right of screen.

▶ To set up the optical SONET Transmit interface

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.
2 Select an optical **Signal Rate**.
3 Select a **Wavelength** (if dual wavelength option is fitted).
4 Select the **Laser On** checkbox (the Laser-ON message appears in the Status: line at the bottom of the screen).

Setting up the Electrical SONET Transmit Interface

You apply SONET electrical STS-1 and STS-3 signals to network equipment via the 52/155 Mb/s Out port.

Make sure the transmit interface settings match the network equipment being test.

NOTE The transmitter and receiver can operate independently, or they can be coupled. For more information, see “Coupling the Receiver to the Transmitter Settings" on page 104.

▶ **To set up the electrical SONET Transmit interface**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.
2 Select an electrical **Signal Rate**.

Coupling the Receiver to the Transmitter Settings

You can set up the instrument so that the receiver will automatically configure to the transmitter's settings.

▶ To couple the receiver to the transmitter settings

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Copy Tx to Rx**.
3 Select **Close**.

▶ To switch off coupling

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Switch Coupling Off**.
3 Select **Close**.

Selecting the SONET Transmit Clock Source

You can reference the transmitter's timing to an internal, external or recovered clock source.

Mode	Clock Source
Internal	Clock generated within the instrument.
External	1.5 Mb/s (ternary) BITS clock applied to the 100 ohm balanced Clock In port (Bantam connection).
Recovered	Clock recovered from the SONET signal applied to the receiver.

▶ **To select the transmit clock source**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.
2 Select a **Clock Source**.
3 Select a **Clock Format** if you are using an external clock source.

Adding Frequency Offset to the SONET Signal

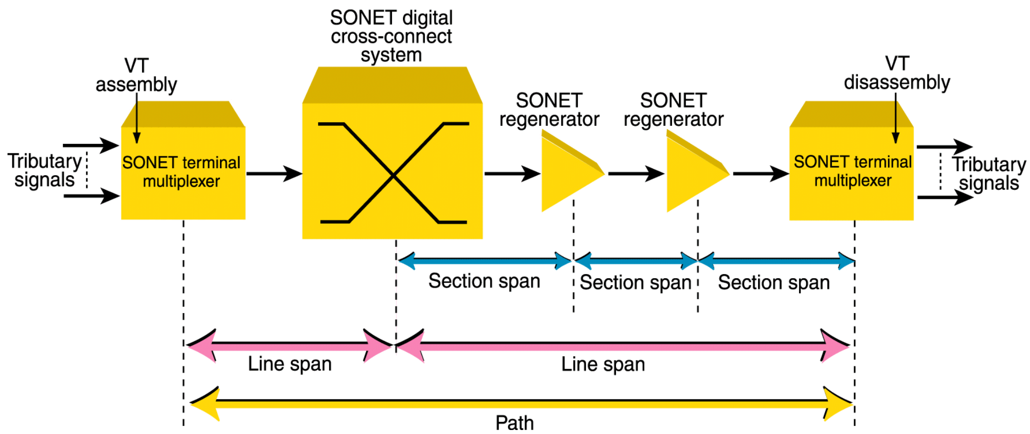
You can apply frequency offset of up to +/-90 ppm (for 10 Gb/s operation) or +/-100 ppm (for 2.5 Gb/s operation) to a signal, regardless of the selected clock source. Offset can be applied while measurements are taking place.

▶ To add frequency offset to a signal

1 Press **<Menu>**, choose **Test Functions > Frequency Offset** then press **<Select>**.
2 Select **Line Offset**, then enter the required offset by editing the frequency offset value.
3 Select the **Enable Offset** checkbox, then press **<Select>** to switch on the offset.

Generating SONET Overhead Signals

You can use the procedures on the following pages to transmit section, line or path signals (they include trace messages, synchronization status messages, signal labels and APS messages). You can also edit and transmit overhead bytes and send messages in the Data Communications Channel (DCC).



For more information, see:

- "Section Overhead (SOH)" on page 378
- "Line Overhead (LOH)" on page 379
- "SONET Concepts" on page 374

Generating Trace Messages

You can check for continuity between the transmitting and receiving ends of a section, STS path or VT path by transmitting a message in the J0, J1 or J2 byte.

The message format can be 16-byte CRC-7 or 64-byte non-CRC.

▶ To generate a J0, J1 or J2 trace message

1. Press **<Menu>**, choose **Overhead Setup > Trace Messages** then press **<Select>**. Select the required tab.
2. Select the **J0**, **J1** or **J2** byte format as required.
3. Select the trace message field, then press **<Select>**.
4. Select a trace message from the drop down menu or select **Edit Field** then enter a new trace message using the keypad.

   If you selected a 16 byte formatted message, you can only edit 15 bytes, the 16th byte is used for frame alignment and CRC bits.

   If you selected a 64 byte formatted message, you must terminate the message with CR and LF for the 63rd and 64th bytes. The CR and LF characters are selected by cycling the "1" key.

Generating Synchronization Status Messages

You can transmit synchronization status message in bits 5 to 8 of the S1 byte.

▶ To generate a S1 synchronization status message

1 Press **<Menu>**, choose **Overhead Setup > Labels** then press **<Select>**.
2 Select **Synchronization Status S1**, then select a message as required. When you select a message, its binary value is automatically displayed.

For more information, see:

- “Synchronization Status Messages (S1 bits 5 to 8)" on page 385

Generating Path Signal Labels

You can assign a STS path signal label to the C2 byte to reflect the current SPE payload mapping. Or, you can assign the VT path overhead signal label to bits 5 to 7 of the V5 byte to reflect the current tributary payload mapping. Messages comply with ITU-T G.783.

▶ To generate an STS or VT path signal label

1 Press **<Menu>**, choose **Overhead Setup > Labels** then press **<Select>**.
2 Select **STS (C2)** or **VT (V5)**, then select a label from the drop down menu. When you select a label, its binary value is automatically displayed.

For more information, see:

- “C2 Byte Mapping" on page 387
- “V5 (bits 5 to 7) Signal Label" on page 410

Generating Automatic Protection Switching (APS) Messages

You can check a network equipment's ability to switch to a standby line (to maintain service when a failure is detected). Switching is controlled by messages provided by the K1 and K2 bytes.

APS occurs when there is signal failure, signal degradation, or in response to commands from a local terminal or remote network manager.

You can transmit linear or ring APS messages, the instrument will display the code and a description of the message being transmitted.

The following procedure assumes that you have already set up SONET signal rate.

For more information, see:

- "Linear APS Messages (Telecordia GR-253-CORE Issue 3)" on page 381
- "Ring APS Messages (Telecordia GR-1230)" on page 383.

▶ To generate a ring APS message

1. Press **<Menu>**, choose **Overhead Setup > APS Messages** then press **<Select>**.
2. Set the **Topology** to **Ring (GR-1230)**.
3. Select **New Message K1 Bits 1->4**, then select the APS condition.
4. Select **New Message K1 Bits 5->8**, then select the destination node.
5. Select **New Message K2 Bits 1->4**, then select the source node.
6. Select **New Message K2 Bits 5**, then select the path.
7. Select **New Message K2 Bits 6->8**, then select the appropriate status information.
8. Select **Transmit New Message**.

To generate a linear APS message

1 Press **<Menu>**, choose **Overhead Setup > APS Messages** then press **<Select>**.
2 Set the **Topology** to **Linear (GR-253)**.
3 Select **New Message K1 Bits 1->4**, then select the APS condition.
4 Select **New Message K1 Bits 5->8**, then select the working channel.
5 Select **New Message K2 Bits 1->4**, then select the bridged channel.
6 Select **New Message K2 Bits 5**, then select the APS architecture.
7 Select **New Message K2 Bits 6->8**, then select the appropriate status information.
8 Select **Transmit New Message**.

Editing SONET Overhead Bytes

You can assign values to overhead bytes. You access the bytes by selecting the appropriate STS channel number. For OC-12, OC-48 or OC-192, you access the appropriate STS-3# and STS-1#.

NOTE You cannot use **Overhead Setup** to edit the H1 to H3 pointer bytes, the B1, B2 or B3 BIP bytes (as these are calculated values), or the J0 or J1 section and path trace message bytes.

The instrument's **Test Function** features interact with overhead byte values set using the Overhead Setup feature.

- If the **Test Function** Error Add (REI-L and REI-P), Alarm Add (all alarms) or Section/Line DCC Insert feature is active, any byte values generate from these features will override the values previously assigned using **Overhead Setup**.
- If the **Test Function** Error Add (Entire Frame and A1, A2 Frame) feature is active, it will act on the framing byte values previously assigned using **Overhead Setup**.

The following procedure assumes that you have already set up SONET signal rate.

▶ To edit SONET overhead bytes

1 Press **<Menu>**, choose **Overhead Setup > Byte Setup** then press **<Select>**.
2 Select the required **STS** Channel Number.
3 Edit the overhead bytes. For more information, see "Editing Bytes" on page 114.

NOTE Note that the Test Path (POH) bytes shown correspond to the channel you have selected on the Receiver Settings page and are not necessarily the path bytes associated with the transport overhead bytes currently on display.

Editing Bytes

You can use the following procedures to edit overhead bytes.

To edit a byte using the keypad

1. Use the arrow keys to select the overhead byte for editing.
2. Use the keypad to key in the new value in hexidecimal (0 to 9 and A to F).
3. Press **<Select>** (current byte value is replaced by new value). Or press **<Cancel>** if you want to continue using the current byte value.

To edit a byte using Edit Field from the popup menu

1. Use the arrow keys to select the overhead byte for editing.
2. Press **<Select>**, then use the arrow keys to select **Edit Field** from the popup menu.
3. Press **<Select>**, then use the keypad to key in the new value in hexidecimal (0 to 9 and A to F).
4. Use the arrow keys to select the next digit (if it requires editing).
5. Press **<Select>** (current byte value is replaced by new value). Or press **<Cancel>** if you want to continue using the current byte value.

To restore the default value of an individual overhead byte

1. Use the arrow keys to select the overhead byte for editing.
2. Press **<Select>**, then press **<Select>** again to select the default value from the popup menu.

To restore the default value of all overhead byte

1. Press **<Menu>**, choose **Overhead Setup > Restore Defaults** then press **<Select>**.
2. Select **Yes**, then press **<Select>** to restore the default values to all overhead bytes.

Inserting Messages into the Data Communications Channel (DCC)

You can insert network management messages into the section DCC (D1 to D3) or the line DCC (D4 to D12) of a SONET signal.

▶ **To insert a message into the DCC of a SONET signal**

1 Press **<Menu>**, choose **Test Functions > DCC Drop/Insert** then press **<Select>**.
2 Connect a Protocol Analyzer to the instrument DCC port.
3 Select **Transmitter DCC Insert**, then select the Section DCC.

Adjusting SPE or VT Pointer Values

You can check network equipment's ability to handle adjustments to SPE or VT pointer values. Pointers compensate for frequency and phase differences between VTs and STS-ns in the SONET frames.

Adjustments to pointer values can occur at random, can be periodic or can occur in bursts. Pointer values can also be individually adjusted. Pointer adjustments are byte wide, and can cause significant amounts of jitter on payload signals.

For more information, see:

- "Selecting a Burst of SPE or VT Pointers" on page 117
- "Selecting a New SPE or VT Pointer" on page 118
- "Selecting SPE or VT Pointer Offset" on page 119

Selecting a Burst of SPE or VT Pointers

You can have an incrementing, decrementing or alternating burst of pointer values.

The burst size is 1 to 10 for STS and STS-Nc pointers and 1 to 5 for VT-1.5 and VT-2 pointers.

An alternating burst results in a movement in the same direction for the burst size specified (that is, if burst size 7 is selected then all 7 movements are in the same direction). The generated burst is in the opposite direction to the previous burst. The interval between movements within a burst is 500 us for STS-N pointers and 2 ms for VT pointers.

Use **Burst Size** to select the size of the burst. If, for example, you choose 5 the pointer value will be stepped 5 times in unit steps. That is, 0 (start value), 1, 2, 3, 4, 5 (final value).

The following procedure assumes that you have already set up SONET signal rate and payload.

▶ **To transmit a burst of SPE or VT pointer values**

1 Press **<Menu>**, choose **Test Functions > Pointer Adjustment** then press **<Select>**.
2 Set **Pointer** to **SPE** or **VT** and then select **Burst**.
3 Select the required **Burst Type**.
4 Select the **Burst Size** using the edit offset feature.
5 Select the **Transmit Pointer Burst**.

Selecting a New SPE or VT Pointer

You can select any pointer value in the valid range for the selected pointer. The new pointer value is transmitted with or without a New Data Flag. The current pointer value is displayed for information purposes.

Pointer Type	Range
STS	0 to 782
VT-1.5	0 to 103
VT-2	0 to 139

▶ **To select a new SPE or VT pointer**

1 Press **<Menu>**, choose **Test Functions > Pointer Adjustment** then press **<Select>**.
2 Set **Pointer** to **SPE** or **VT** and then select **New Value**.
3 Select the **New Pointer Value**, using the edit offset feature.
4 Select the **New Data Flag** checkbox if required.
5 Select **Transmit New Pointer** to transmit the new pointer value (the payload jumps to the new position).

Selecting SPE or VT Pointer Offset

You can frequency offset the Transmitter output Signal Rate or the STS rate, relative to each other to produce pointer movements. If you offset the VT pointer, an 87:3 sequence of pointer movements is generated.

NOTE Pointer Offset is not available if you are currently adding frequency offset to the SONET signal or the payload.

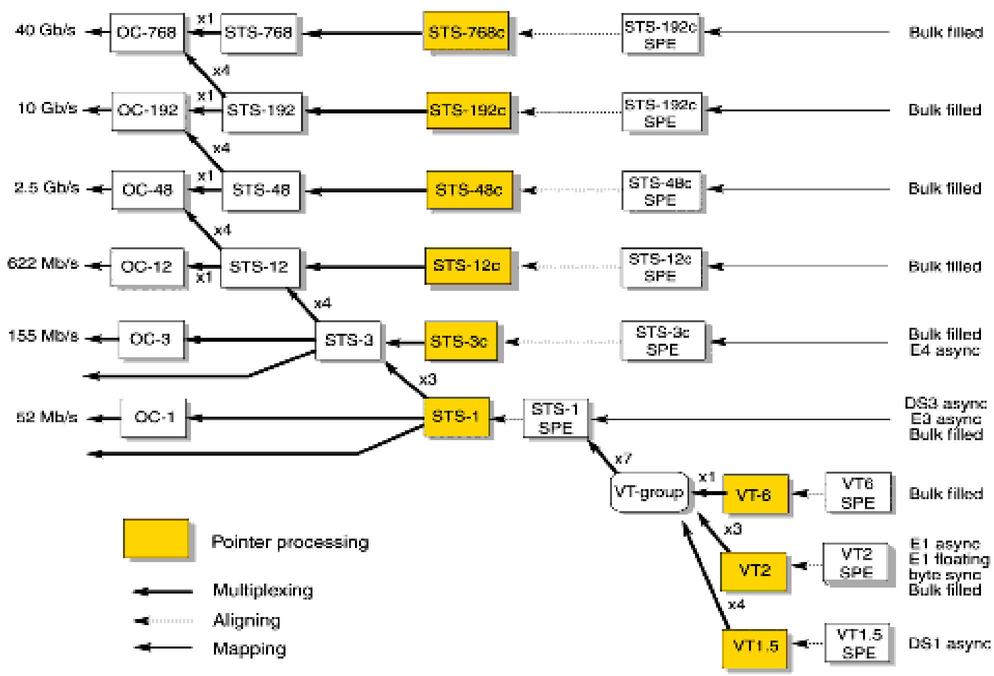
Pointer Type	Line Rate	STS Payload (VC) Rate
STS	Constant	Offset
STS	Offset	Constant
VT	Constant	Constant
VT	Offset	Tracks Line Rate

▶ **To add SPE or VT pointer offset**

1 Press **<Menu>**, choose **Test Functions > Pointer Adjustment** then press **<Select>**.
2 Set **Pointer** to **SPE** or **VT**, then select **Pointer Offset**.
3 Select the **Offset** value (in the range +/– 100 ppm), using the edit offset feature.
4 Select **Offset Applied to**, then select **Line** or **Payload**.
5 Select the **Enable Offset** checkbox.

Generating STS-1 SPE and Concatenated Payloads

You can transmit 34 Mb/s, DS3 and bulk-filled payloads in a STS-1 SPE, you can bulk-fill concatenated STSs.



For more information, see:

- "Generating STS-1 SPE Payloads" on page 121
- "Generating Concatenated Payloads" on page 123

Generating STS-1 SPE Payloads

A framed or unframed DS3 (44 Mb/s) or 34 Mb/s signal can be asynchronously mapped into a full STS-1 SPE payload, or you can bulk fill the STS-1 SPE. If you are using a bulk-filled payload, you can choose to overwrite all bytes including or excluding the fixed stuffing bytes. (Press **<Menu>**, choose **System > Preferences** then press **<Select>**.)

Signal	Framing	Payload Structure
DS3	C-bit, M13	DS1, 2 Mb/s, 56 kb/s, 64 Kb/s, N x 56/64 kb/s
34 Mb/s	ITU-T G.751	8 Mb/s, 2 Mb/s or 64 kb/s

If you are transmitting a framed signal it can be structured or unstructured. With structured (or channelized) DS3 and E3 signals, you will need to select test patterns for the foreground (test) channel and background (non-test) channels in the payload. The test patterns can be inverted or non-inverted.

If you are transmitting an OC-3/STS-3 signal (or greater), you will also need to select a pattern for the background STS-1s.

For more information, see:

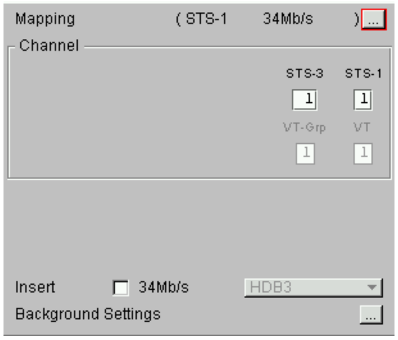
- “PRBS Polarity" on page 126

This procedure assumes that you have set up the SDH signal rate and pattern.

▶ To insert DS3 or 34 Mb/s in a STS-1 SPE in a SONET signal

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **SONET** tab.
2. Select the **DS3** or **34 Mb/s** payload, using the drop down box and/or the mapping diagram.

3 Select the **Channel** that is to carry the DS3 or 34 Mb/s payload by selecting the appropriate **STS**.



4 If you are transmitting an STS-3 signal (or greater), select **Background Settings** then select a pattern for the background STSs.

5 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab. Select a framed or unframed DS3 or 34 Mb/s payload.
For 34 Mb/s framed or unframed signals, see “Setting up the PDH Transmitter" on page 182.
For a DS3 framed or unframed signals, see “Setting up the DSn Transmitter" on page 230.

NOTE You can view a summary of the setup at the bottom of the screen.

Generating Concatenated Payloads

A concatenated payload can be transmitted in a SONET signal. This type of payload reduces test times by testing the entire bandwidth in one go. If you are using a bulk-filled payload, you can choose to overwrite all bytes including or excluding the fixed stuffing bytes. (Press **<Menu>**, choose **System > Preferences** then press **<Select>**.)

This procedure assumes you have selected the OC-48 signal rate and a test pattern.

SONET Signal			
OC-3	**OC-12**	**OC-48**	**OC-192**
STS-3c SPE	STS-3c SPE	STS-3c SPE	STS-3c SPE
-	STS-12c SPE	STS-12c SPE	STS-12c SPE
-	-	STS-48c SPE	STS-48c SPE
-	-	-	STS-192c SPE

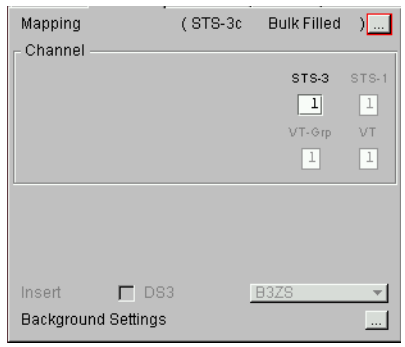
For more information, see:

- “PRBS Polarity" on page 126.
- “Reduced Test Time with Concatenated Payloads" on page 125

▶ To insert a concatenated payload into an OC-48

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **SONET** tab.
2. Select a concatenated payload (**STS-3c**, **STS-12c** or **STS-48c**), using the drop down box and/or the mapping diagram.

3 Select the **Channel** that is to carry the concatenated payload by selecting the appropriate **STS**.



NOTE You can view a summary of the setup at the bottom of the screen.

Reduced Test Time with Concatenated Payloads

Bulk filled and concatenated (contiguously structured) payloads carry entire broadband services with no structured mapping or channelization. These types of payload reduce test times (see table below) by testing the entire bandwidth in one go.

NOTE Concatenation is the linking together of various data structures, for example two channels joined together to form a single channel. In SONET, a number (M) of SPEs can be linked together to produce a concatenated container, M times the size of the SPE. An example of this is the concatenation of forty-eight STS-1 SPEs to carry an STS-48c 2.5 Gb/s signal.

The concatenated SPE contains one Path Overhead and a single container that carries the payload. The payload is multiplexed, switched and transported through the network as a single entity.

	Test Time (based on 100 errors)	
Test limit	STS-48c SPE payload	STS-3c SPE payload
10E-14	48 days	>2 years
10E-13	4.8 days	77 days
10E-12	11.6 hours	7.7 days
10E-11	1.2 hours	18.5 hours
10E-10	7 minutes	1.9 hours

PRBS Polarity

The definition of PRBS polarity may differ between ITU-T Recommendation O.150 and common practice in the USA. This is illustrated by the table below.

Pattern	ITU-T	USA
PRBS9	Non-inverted	Non-inverted
PRBS11	Non-inverted	Non-inverted
PRBS15	Inverted	Non-inverted
QRSS	Non-inverted	Non-inverted
PRBS23	Inverted	Non-inverted
PRBS31	Inverted	Inverted

Note that a non-inverted (2En)-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and inverted sequence produces a longest run of n zeros in the PRBS sequence.

You can select PRBS polarity to be inverted or non-inverted. For all signal types except SONET, either ITU or non-ITU is displayed beside your selection to indicate if it conforms to ITU-T O.150.

Transmitting SONET Tributary Payloads

You can transmit 28 VT1.5s, 21 VT2s or 7 VT6s in a STS-1 SPE.

The VTs are structured into 7 virtual tributary groups (VT Groups) within a STS-1 SPE. Each VT-group can contain 4 VT1.5s, 3 VT-2s or 1 VT-6. The VTs can carry internally generated or externally sourced PDH or DSn signals. A framed or unframed DS1 (1.5 Mb/s) signal can be mapped into a VT1.5, an E1 (2 Mb/s) signal can be mapped into a VT2 payload (mapping can be asynchronous or floating byte), or you can bulk fill a VT6. If you are transmitting a framed signal it can be structured or unstructured. With structured (or channelized) DS1 and 2 Mb/s signals, you will need to select test patterns for the foreground (test) channel and background (non-test) channels in the payload. The test patterns can be inverted or non-inverted. If you are transmitting an OC-3/STS-3 signal (or greater) with STS-1 mapping, you will need to select a pattern for the background STS-1s. This procedure assumes that you have set up an STS-48 signal rate and test pattern.

For more information, see:

- “PRBS Polarity" on page 152

▶ To insert a 2 Mb/s or DS1 payload in a STS-48

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **SONET** tab.
2. Select the **VT2** or **VT1.5 SPE** payload, using the drop down box and/or the mapping diagram.
3. Select the **Channel** that is to carry the 2 Mb/s or DS1 payload by selecting the appropriate **STSs** and **VT**.
4. If you are transmitting an STS-3 signal (or greater), select **Background Settings** then select a pattern for the background VTs.
5. Select the **PDH/DSn** tab, then select a framed or unframed 2 Mb/s or DS1 payload.
   For 2 Mb/s framed or unframed signals, see “Setting up the PDH Transmitter" on page 182.
   For a DS1 framed or unframed signals, see “Setting up the

DSn Transmitter" on page 230.

NOTE You can view a summary of the setup at the bottom of the screen.

Transmitting a DSn Payload into a SONET Signal

You can asynchronously map a DS1 or DS3 payload into the tributary of a SONET signal.

For more information, see:

- “Transmitting SONET Tributary Payloads" on page 127

DSn Payload	Inserted into SONET Tributary
DS1	VT1.5
DS3	STS-1 SPE

Inserting an External DSn Payload into a SONET Signal

You can asynchronously map an external DS1 or DS3 payload into the tributary of a SONET signal. This procedure assumes that you have setup the OC-48 signal and a test pattern.

External Payload	Applied to Port	Inserted into SONET Tributary
DS1	DS1 In (Siemens)	VT1.5
DS3	2-140 M/s DS3 In (BNC)	STS-1 SPE

▶ To insert an external DS1 payload in a OC-48 signal

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **SONET** tab.

2 Select the **VT1.5 SPE** DS1 payload, using the drop down box and/or the mapping diagram.

3 Select the **Channel** that is to carry the DS1 payload by selecting the appropriate **STSs** and **VT**s.

4 Select the **Insert DS1** checkbox. The external signal applied to the instrument via the DS1 In ports will be inserted into the SONET signal.

5 Select the required line code as **B8ZS** or **AMI**.

6 If you are transmitting an OC-12 signal (or greater), select **Background Settings** then select a pattern for the background SPEs.

NOTE You can view a summary of the setup at the bottom of the screen.

Transmitting PDH Payloads in a SONET Signal

You can asynchronously map a 2 Mb/s PDH payload into the tributary of a SONET signal.

PDH Payload	Framing	Payload Structure	Inserted into SONET Tributary
2 Mb/s	PCM30, PCM30CRC, PCM31 or PCM31CRC	64 kb/s or N x 64 Kb/s	VT2

For more information, see:

- “Transmitting SONET Tributary Payloads" on page 127

Inserting an External PDH Payload into a SONET Signal

You can asynchronously map an external 2 Mb/s payload into the tributary of a SONET signal. This procedure assumes that you have setup the OC-48 signal and a test pattern.

External Payload	Applied to Port	Inserted into SONET Tributary
2 Mb/s unbalanced	2-140 M/s DS3 In (BNC)	VT2
2 Mb/s balanced	2Mb/s In (3-pin Siemens)	

To insert an external 2 Mb/s payload in a OC-48 signal

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **SONET** tab.
2. Select the **VT2 SPE** 2 Mb/s payload, using the drop down box and/or the mapping diagram.
3. Select the **Channel** that is to carry the 2 Mb/s payload by selecting the appropriate **STS**s and **VT**s.
4. Select the **Insert E1** checkbox. The external signal applied to the instrument via the 2Mb/s port will be inserted into the SONET signal.
5. If you are transmitting an STS-16 signal (or greater), select **Background Settings** then select a pattern for the background SPEs.

NOTE You can view a summary of the setup at the bottom of the screen.

Adding SONET Errors and Alarms

You can add errors and alarms to a SONET signal during testing. Refer to the Specifications, available on the CD-ROM, for a full list of errors and alarms. Errors can be added singly, at preset rates (1E-3, 1E-4 1E-5, 1E-6, 1E-7, 1E-8 and 1E-9) or at a user programmable rate. With the exception of Entire Frame, A1A2 Frame and BIT, errors can be added at all rates. You can also generate CV-L errors by setting the APS threshold.

NOTE

To add enhanced RDI alarm (RDI-P-Payload, RDI-P-Server, and RDI-P-Connection) you must first enable the enhanced RDI feature:
1. Press **<Menu>**, choose **System > Preferences** then press **<Select>**.
2. Select the **Enhanced RDI** checkbox.

The following procedure assumes that you have already set up SONET signal rate and payload.

▶ **To add errors and/or alarms.**

1 Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.

2 Select the **Add Errors Type** and **Rate** required.

3 Select the **Add Alarm Type**, then select the **Alarm ON** checkbox.

NOTE

You can add errors and alarms at the same time.

Switching Off All Test Function Features

You can switch off all Test Functions features. This is useful if you want to start configuring the instrument from a known state.

To switch off all Test Function features

1 Press **<Menu>**, choose **Test Functions > Switch Off** then press **<Select>**.
2 Select **Switch Off All Active Test Functions**.
3 Select **Close**.

Setting up the SONET Receiver

Physical

Overhead

Payload

Resetting Instrument

Setting Up the SONET Receive Interface

You can set up the interfaces to receive optical or electrical SONET signals.

For more information, see:

- “Setting up the Optical SONET Receive Interface" on page 137
- “Setting up the Electrical SONET Receive Interface" on page 138
- “Coupling the Transmitter to the Receiver Settings" on page 139
- “Storing and Recalling Instrument Settings" on page 162

Setting up the Optical SONET Receive Interface

You can apply OC-192 optical signals from network equipment to the 10 Gb/s (1550 nm) Optical In port, and OC-1, OC-3, OC-12 and OC-48 to the 52 Mb/s - 2.5 Gb/s (1310 nm or 1550 nm) Optical In port.

Make sure the receive interface settings match the network equipment being tested.

NOTE The transmitter and receiver can operate independently, or they can be coupled. For more information, see “Coupling the Transmitter to the Receiver Settings" on page 139.

CAUTION Network elements can produce transient power levels > 10 dBm at switch on. These power levels will damage the instrument’s optical receiver. To prevent damage, fit a suitable attenuator to the instruments receiver port to ensure the received power level does not exceed the maximum specified for the port.

WARNING Always switch off the laser before connecting or disconnecting optical cables. Read the laser warning information given in “Optical Connector Safety Information" **on page 59** before switching ON the laser. Laser status is always shown at the bottom right of screen.

▶ **To set up the optical SONET Receive interface**

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Physical** tab.

2 Select an optical **Signal Rate.**

Setting up the Electrical SONET Receive Interface

You apply SONET electrical STS-1 and STS-3 signals from network equipment to the 52/155 Mb/s In port.

Make sure the receive interface settings match the network equipment being tested.

NOTE The transmitter and receiver can operate independently, or they can be coupled. For more information, see “Coupling the Transmitter to the Receiver Settings" on page 139.

▶ To set up the electrical SONET Transmit interface

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Physical** tab.

2 Select an electrical **Signal Rate**.

3 Set the **Line Interface** to **Electrical**.

4 Set the **Operating Level** to **Terminated** or **Monitor**. If **Monitor** is selected the input gain is boosted by 20 dB.

5 Select the **Equalization On** checkbox if required.

Coupling the Transmitter to the Receiver Settings

You can set up the instrument so that the transmitter will automatically configure to the receiver's settings.

▶ To couple the transmitter to receiver the settings

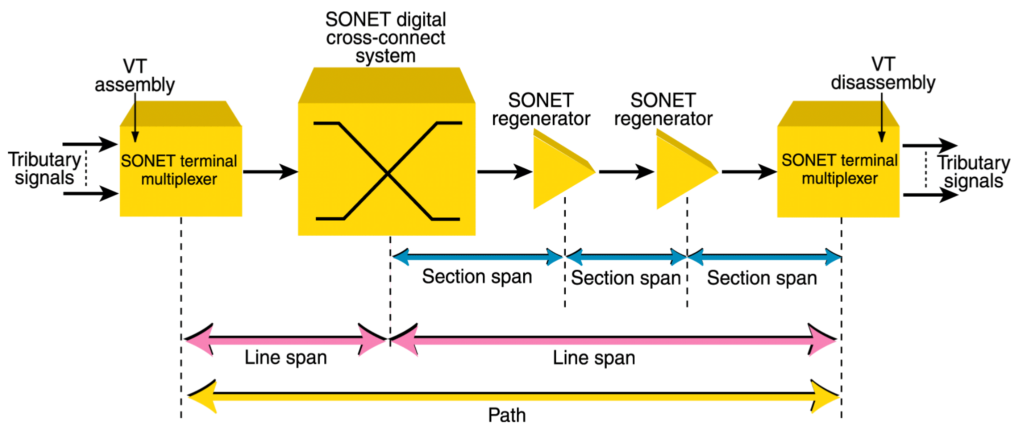
1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Copy Rx to Tx**.
3 Select **Close**.

▶ To switch off coupling

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Switch Coupling Off**.
3 Select **Close**.

Monitoring SONET Overhead Signals

You can use the procedures on the following pages to monitor section, line or path signals (they include trace messages, synchronization status messages, signal labels and APS messages). You can also monitor overhead bytes and drop messages from the Data Communications Channel (DCC).



For more information, see:

- “Section Overhead (SOH)" on page 378
- “Line Overhead (LOH)" on page 379
- “SONET Concepts" on page 374

Monitoring Trace Messages

You can check for continuity between the transmitting and receiving ends of a section, STS or VT path by monitoring a message in the J0, J1 or J2 byte.

The message format can be 16-byte CRC-7 or 64-byte non-CRC.

▶ To monitor a J0, J1 or J2 trace message

- Press **<Menu>**, choose **Overhead Monitor > Trace Messages** then press **<Select>**. Select the required tab.

Monitoring Synchronization Status Messages

You can monitor the synchronization status message in bits 5 to 8 of the S1 byte.

▶ To monitor the S1 synchronization status message

- Press **<Menu>**, choose **Overhead Monitor > Labels** then press **<Select>**.

For more information on this part of the overhead, see:

- “Synchronization Status Messages (S1 bits 5 to 8)" on page 402

Monitoring Path Signal Labels

You can monitor the STS path signal label in the C2 byte (it reflects the current SPE payload mapping). Or, you can monitor the VT path signal label in bits 5 to 7 of the V5 byte (the label reflects the current tributary payload mapping).

▶ **To monitor an STS (C2) or VT (V5) path signal label**

- Press **<Menu>**, choose **Overhead Monitor > Labels** then press **<Select>**.

For more information, see:

- “C2 Byte Mapping" on page 387
- “V5 (bits 5 to 7) Signal Label" on page 390

Monitoring Automatic Protection Switching (APS) Messages

You can check network equipment's ability to switch to a standby line (to maintain service when a failure is detected). Switching is controlled by Automatic Protection Switching (APS) messages provided by the K1 and K2 bytes.

APS occurs when there is signal failure, signal degradation, or in response to commands from a local terminal or remote network manager.

You can transmit linear or ring APS messages, the instrument will display the code and a description of the message being transmitted.

The following procedure assumes that you have already set up an SONET signal rate.

▶ To view an APS messages

1 Press **<Menu>**, choose **Overhead Monitor > APS Messages** then press **<Select>**.
2 Set the **Topology** to **Linear (GR-253)** or **Ring (GR.1230)**.

For more information on APS messages, see:

- “Linear APS Messages (Telecordia GR-253-CORE Issue 3)" on page 381
- “Ring APS Messages (Telecordia GR-1230)" on page 383.

Monitoring SONET Overhead Bytes

You monitor all overhead bytes including the H1 to H3 pointer bytes, the B1, B2 or B3 BIP bytes (calculated values), and the J0 and J1 section and path trace message bytes.

You access TOH bytes by selecting the appropriate STS channel number. For OC-12, OC-48 or OC-192, you access the appropriate STS-3# and STS-1#.

The following procedure assumes that you have already set up SONET signal rate.

▶ To monitor SONET overhead bytes

1 Press **<Menu>**, choose **Overhead Monitor > Byte Monitor** then press **<Select>**.
2 Select the required **STS-3#** and **STS-1#** channel numbers.

NOTE Note that the Test Path (POH) bytes shown correspond to the channel you have selected on the Receiver Settings page and are not necessarily the path bytes associated with the transport overhead bytes currently on display.

Dropping Messages from the Data Communications Channel (DCC)

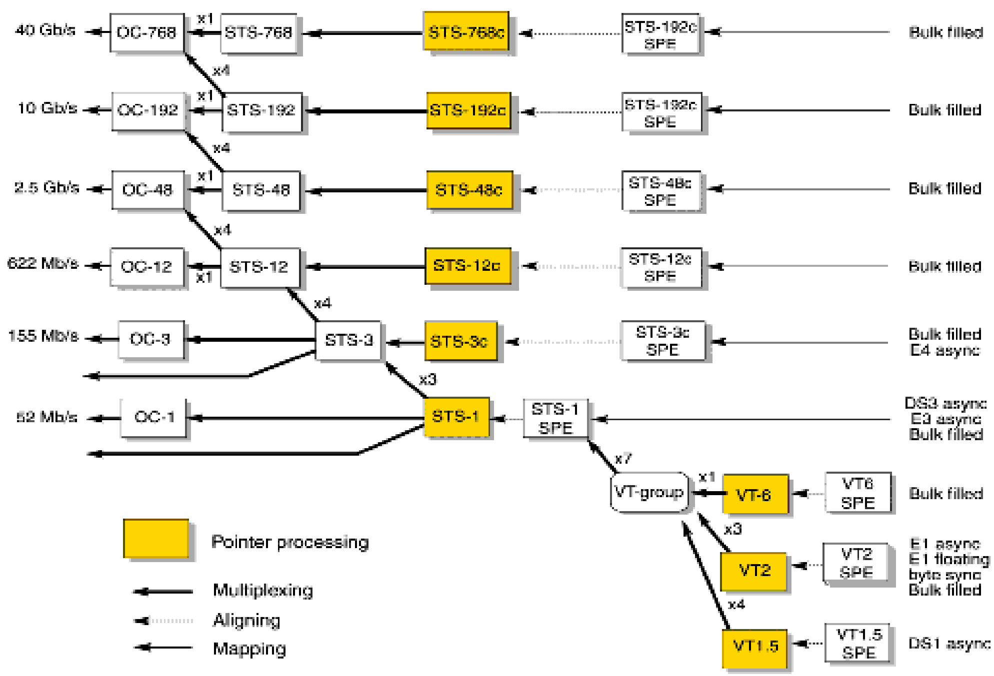
You can drop network management messages from the section DCC (D1 to D3) or the line DCC (D4 to D12) of a SONET signal via the DCC connector.

▶ To drop a message from the DCC of a SONET signal

1 Press **<Menu>**, choose **Test Functions > DCC Drop/Insert** then press **<Select>**.
2 Connect a Protocol Analyzer to the instrument's DCC port.
3 Select the required DCC, and **Drop**.

Monitoring STS-1 SPE and Concatenated Payloads

You can monitor 34 Mb/s, DS3 and bulk-filled payloads in an STS-1, or bulk fill concatenated STSs.



For more information, see:

- “Monitoring STS-1 SPE Payloads" on page 147
- “Monitoring Concatenated Payloads" on page 149

Monitoring STS-1 SPE Payloads

A framed or unframed DS3 (44 Mb/s) or E3 (34 Mb/s) payload can be monitored in a full STS-1 SPE, or you can monitor a bulk filled STS-1 SPE.

Signal	Framing	Payload Structure
DS3	C-bit, M13	DS1, 2 Mb/s, 56 kb/s, 64 Kb/s, N x 56/64 kb/s
E3	ITU-T G.751	8 Mb/s, 2 Mb/s or 64 kb/s

If you are receiving a framed signal it can be structured or unstructured. With structured (or channelized) DS3 and E3 signals, you will need to select test patterns for the foreground (test) channel and background (non-test) channels in the payload. The test patterns can be inverted or non-inverted.

For more information, see:

- “PRBS Polarity" on page 152

This procedure assumes that you have set up the SDH receiver signal rate and test pattern.

▶ **To monitor a DS3 or 34 Mb/s payload in an SDH signal**

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **SONET** tab.
2. Select a **DS3** or **34 Mb/s** payload, using the drop down box and/or the mapping diagram.
3. Select the **Channel** that is to carry the DS3 or 34 Mb/s payload by selecting the appropriate **STS**.

4 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab. Select a framed or unframed DS3 or 34 Mb/s payload.
For 34 Mb/s framed or unframed signals, see “Setting up the PDH Receiver" on page 198.
For a DS3 framed or unframed signals, see “Setting up the DSn Receiver" on page 250.

NOTE You can view a summary of the setup at the bottom of the screen.

Monitoring Concatenated Payloads

A concatenated payload can be monitored in a SONET signal. This type of payload reduces test times by testing the entire bandwidth in one go.

SONET Signal			
OC-3	**OC-12**	**OC-48**	**OC-192**
STS-3c SPE	STS-3c SPE	STS-3c SPE	STS-3c SPE
-	STS-12c SPE	STS-12c SPE	STS-12c SPE
-	-	STS-48c SPE	STS-48c SPE
-	-	-	STS-192c SPE

A framed or unframed 140 Mb/s (E4) payload can be carried in a STS-3c SPE, or it can be bulk filled. The STS-12c, STS-48c and STS-192c SPEs are bulk filled only.

If you are monitoring a STS-3c SPE, the framed 140 Mb/s signal can be structured or unstructured. With structured signals, you will need to select test patterns for the foreground (test) channel and background (non-test) channels in the payload. If you are monitoring an OC-3/STS-3 signal (or greater), you will also need to select a pattern for the foreground STS-1. The test patterns can be inverted or non-inverted.

For more information, see:

- “PRBS Polarity" on page 152.
- “Reduced Test Time with Concatenated Payloads" on page 151

▶ **To monitor a concatenated payload**

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **SONET** tab.

2 Select a concatenated payload, using the drop down box and/or the mapping diagram.

3 Select the **Channel** that is to carry the concatenated payload by selecting the appropriate **STS**.

NOTE You can view a summary of the setup at the bottom of the screen.

Reduced Test Time with Concatenated Payloads

Bulk filled and concatenated (contiguously structured) payloads carry entire broadband services with no structured mapping or channelization. These types of payload reduce test times by testing the entire bandwidth in one go.

NOTE Concatenation is the linking together of various data structures, for example two channels joined together to form a single channel. In SONET, a number (M) of SPEs can be linked together to produce a concatenated container, M times the size of the SPE. An example of this is the concatenation of forty-eight STS-1 SPEs to carry an STS-48c 2.5 Gb/s signal.

The concatenated SPE contains one Path Overhead and a single container that carries the payload. The payload is multiplexed, switched and transported through the network as a single entity.

	Test Time (based on 100 errors)	
Test limit	STS-48c SPE payload	STS-3c SPE payload
10E-14	48 days	>2 years
10E-13	4.8 days	77 days
10E-12	11.6 hours	7.7 days
10E-11	1.2 hours	18.5 hours
10E-10	7 minutes	1.9 hours

PRBS Polarity

The definition of PRBS polarity may differ between ITU-T Recommendation O.150 and common practice in the USA. This is illustrated by the table below.

Pattern	ITU-T	USA
PRBS9	Non-inverted	Non-inverted
PRBS11	Non-inverted	Non-inverted
PRBS15	Inverted	Non-inverted
QRSS	Non-inverted	Non-inverted
PRBS23	Inverted	Non-inverted
PRBS31	Inverted	Inverted

Note that a non-inverted (2En)-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and inverted sequence produces a longest run of n zeros in the PRBS sequence.

You can select PRBS polarity to be inverted or non-inverted. For all signal types except SONET, either ITU or non-ITU is displayed beside your selection to indicate if it conforms to ITU-T O.150.

Monitoring SONET Tributary Payloads

You can monitor 28 VT1.5s, 21 VT2s or 7 VT6s in a STS-1 SPE.

The VTs are structured into 7 virtual tributary groups (VT Groups) within a STS-1 SPE. Each VT-group can contain 4 VT1.5s, 3 VT-2s or 1 VT-6.

A framed or unframed DS1 (1.5 Mb/s) signal mapped into a VT1.5 or a 2 Mb/s signal mapped into a VT2 payload can be monitored (mapping can be asynchronous or floating byte), or you can monitor a bulk filled VT6.

NOTE The framing information for a 2 Mb/s signal that is mapped into a VT2 (floating byte) can be embedded into timeslot 0, or into the H4 byte of the SONET signal.

If you are monitoring a framed signal it can be structured or unstructured. With structured (or channelized) DS1 and 2 Mb/s signals, you will need to select test patterns for the foreground (test) channel and background (non-test) channels in the payload. The test patterns can be inverted or non-inverted.

This procedure assumes that you have set up the SDH receiver signal rate and test pattern.

For more information, see:

- “PRBS Polarity" on page 152.

▶ **To monitor a 2 Mb/s or DS1 payload in a SONET signal**

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **SONET** tab.
2. Select the **VT2** or **VT1.5 SPE** payload, using the drop down box and/or the mapping diagram.
3. Select the **Channel** that is to carry the 2 Mb/s or DS1 payload by selecting the appropriate **STSs** and **VT**.
4. Select **Timeslot 0** if the framing information of the received signal is embedded in timeslot 0 (only applicable for 2 Mb/s signals mapped into a VT2 (floating byte)).

5 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab. Select a framed or unframed 2 Mb/s or DS1 payload.
For 2 Mb/s framed or unframed signals, see “Setting up the PDH Receiver" on page 198.
For a DS1 framed or unframed signals, see “Setting up the DSn Receiver" on page 250.

NOTE You can view a summary of the setup at the bottom of the screen.

Monitoring a DSn Payload in a SONET Signal

You can monitor an asynchronously mapped DS1 or DS3 payload in a SONET signal.

DSn Payload	Monitored in a SONET Tributary
DS1	VT1.5
DS3	STS-1 SPE

For more information, see:

- “Monitoring SONET Tributary Payloads" on page 153

Dropping a DSn Payload from a SONET Signal

You can drop an asynchronously mapped DS1 or DS3 payload from the tributary of a SONET signal.

You obtain balanced signals at the DS1 Out port (Siemens connector), and an unbalanced signal at the 2-140 Mb/s DS3 Out port (BNC connector). The procedure below assumes that you have set up the receiver with a SONET signal rate and test pattern.

Payload	Drop Port	Dropped from a SONET Tributary
DS1	DS1 Out (Siemens)	VT1.5
DS3	2-140 Mb/s DS3 Out (BNC)	STS-1 SPE

▶ To drop a DS1 payload from a SONET signal

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **SONET** tab.

2 Select the **VT1.5 SPE** DS1 payload, using the drop down box and/or the mapping diagram.

3 Select the **Channel** that is to carry the DS1 payload by selecting the appropriate **STSs** and **VT**.

4 Select the **Drop DS1** checkbox. The signal is available at the DS1 Out ports.

NOTE You can view a summary of the setup at the bottom of the screen.

Monitoring PDH Payloads in a SONET Signal

You can monitor a 2 Mb/s PDH payload into the tributary of a SONET signal.

PDH Payload	Framing	Payload Structure	Monitored in a SONET Tributary
2 Mb/s	PCM30, PCM30CRC, PCM31 or PCM31CRC	64 kb/s or N x 64 Kb/s	VT2

For more information, see:

- “Monitoring SONET Tributary Payloads" on page 153

Dropping a 2 Mb/s Payload from a SONET Signal

You can drop an asynchronously mapped 2 Mb/s PDH payload from the tributary of a SONET signal.

You obtain balanced signals at the 2 Mb/s (Bantam connector), and an unbalanced signal to at the 2-140 Mb/s DS3 Out port (BNC connector). The procedure below assumes that you have set up the receiver with a SONET signal rate and test pattern.

Payload	Drop Port	Dropped from a SONET Tributary
2 Mb/s	2 Mb/s Out (Bantam) or 2-140 Mb/s DS3 Out (BNC)	VT2

To drop a 2Mb/s payload from a SONET signal

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **SONET** tab.
2 Select the **VT2 SPE** 2 Mb/s payload, using the drop down box and/or the mapping diagram.
3 Select the **Channel** that is to carry the 2 Mb/s payload by selecting the appropriate **STSs** and **VT**.
4 Select the **Drop 2 Mb/s** checkbox. The signal is available at the 2 Mb/s Out ports.

NOTE You can view a summary of the setup at the bottom of the screen.

Dropping a Voice Channel to the Internal Speaker

You can drop a 56 kb/s or 64 kb/s voice channel from a PDH or DSn signal carried in the payload of a SONET signal to the instrument's internal speaker.

This procedure assumes you have selected an SONET line rate. Also you must set up the SONET receiver by selecting a payload mapping and choosing a channel to carry the DS3 or 34 Mb/s payload, by selecting the appropriate STSs, VT groups and VTs.

▶ To drop a voice channel to the internal speaker

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to **Framed, M13** or **C-Bit** and **Structured**. Set the **Test Channel Rate** to 2 Mb/s (64 kb/s), DS1 (64kb/s) or DS-1 (56kb/s) as required.
3 Enter values in the **Test Channel DS2, DS1, 34 Mb**, **8 Mb, 2Mb** and **64 kb** boxes to select the required channel (the selected test channel rate determines which boxes will be active).
4 When you click on the 56 kb/s or 64 kb/s box, select the **Single Timeslot** checkbox, then select the appropriate timeslot carrying the voice channel.
5 Select the **Listen** checkbox, then select the appropriate volume level. Select **Close**.

Setting Up Thru Mode Operation

Thru mode is used to monitor signals in networks with no protected monitor points. The instrument is inserted into the communications path and the received signal is routed through to the transmit port. Two types of thru mode are available on the instrument.

- “Transparent Thru Mode" on page 160
- “Overhead Overwrite Thru Mode" on page 161

Transparent Thru Mode

In transparent thru mode, the signal on the receive port is routed, unchanged, to the transmit port. The instrument operates as normal, monitoring errors and alarms in the received signal.

The instrument’s timing is derived from a clock recovered from the received data.

NOTE

Settings cannot be changed once you have selected Transparent THRU mode. This stops you from selecting settings which would affect the data path.

You must select the signal rate you want before selecting THRU mode.

▶ **To set up transparent thru mode operation**

1 Press **<Menu>**, choose **Tx/Rx > Thru Mode** then press **<Select>**.
2 Select the **Enable Thru Mode** checkbox (a tick appears in the box).
3 Select **Close**.

Overhead Overwrite Thru Mode

NOTE

Overhead Overwrite Thru Mode is applicable only for **SONET** and **SDH** line signals.

You must select the signal rate you want before selecting THRU mode.

In overhead overwrite thru mode, the signal on the receive port is routed to the transmit port. You can overwrite the trace messages J0 and J1, the labels S1 and C2 and the APS message bytes K1/K2 before you retransmit the received signal. You can also perform DCC drop and insert. In addition you can add errors and alarms to the high order path level. The B1, B2 and B3 BIP values are recalculated before retransmission. Errors can be added to the frame (Entire Frame and A1A2 errors) before you retransmit the received signal.

The instrument operates as normal, monitoring errors and alarms in the received signal.

The instrument's timing is derived from a clock recovered from the received data.

▶ **To set up overhead overwrite thru mode**

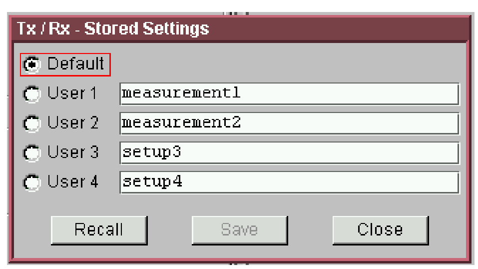
1 Press **<Menu>**, choose **Tx/Rx > Thru Mode** then press **<Select>**.
2 Select the **Enable Thru Mode** checkbox.
3 Select the **Overhead Overwrite** checkbox.
4 Select **Close**.
5 Use the **Overhead Setup** menu to change the overhead bytes from the **As Received** setting.

Storing and Recalling Instrument Settings

You can store four sets of instrument settings (i.e. those shown in the summary diagram at the bottom of the display). These, along with the factory default settings, can be recalled. This procedure assumes that you have already set up the instrument.

▶ To store instrument settings

1. Press **<Menu>**, choose **Tx/Rx > Stored Settings** then press **<Select>**.
2. Select one of the **User (1 to 4)** radio buttons.
3. Press the right arrow key, then enter a suitable title using front panel keypad.
4. Select **Save** to store the settings.
5. Select **Close**.



▶ To recall stored settings

1. Press **<Menu>**, choose **Tx/Rx > Stored Settings** then press **<Select>**.
2. Select one of the **User (1 to 4)** radio buttons.
3. Select **Recall**. A warning dialog box will appear. Select **OK** and the instrument will reconfigure using the recalled settings.
4. Select **Close**.

Measurements and Results

Physical

Errors and Alarms

Pointers, Service Disruption and Round Trip Delay

Analysis, Network Testing and Shortcuts to Results

Measuring Optical Power

You can continuously measure the optical power of the optical signal connected to the selected (active) Optical In port, to a resolution of 0.1 dBm.

This procedure assumes that you have connected the optical input signal to the Optical In port and set up the SONET receiver.

Rate	Range	Accuracy
10G 10G (SR)	-3 to -25 dBm -1 to -14 dBm	+/- 1.5 dB +/- 2 dB
2.5G	0 to -28 dBm	+/- 2 dB
622M and below	0 to -30 dBm	+/- 1 dB

To measure optical power

1 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Optical Power** tab.

2 If your instrument has the dual wavelength featured fitted, set **Wavelength** to **1310 nm** or **1550 nm**.

NOTE The green portion of the colored bar shows the power range for accurate BER measurement. The blue portion indicates power levels beyond the receiver's operating range for accurate BER measurement. If the power level is too high and reaches damage level the colored bar turns red.

Measuring STS-1 or STS-3 Signal Level

You can measure the level of a STS-1 or STS-3 electrical signal at the instrument's SONET. In port. This procedure assumes that you have connected the electrical signal to the appropriate input port and set up the SONET receiver.

To measure level of an STS-1 or STS-3 electrical signal

- Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Electrical** tab.

Measuring Frequency

The frequency of a valid receive signal is continuously measured and available for display (independent of any test period). During signal loss, the measurement is disabled and the results invalidated.

The measured frequency and the amount of offset from the expected standard rate can be used to give an indication of the probability of errors.

This procedure assumes that the test signal has been connected to the appropriate optical or electrical input port and that the receiver signal rate has been set.

▶ **To measure frequency**

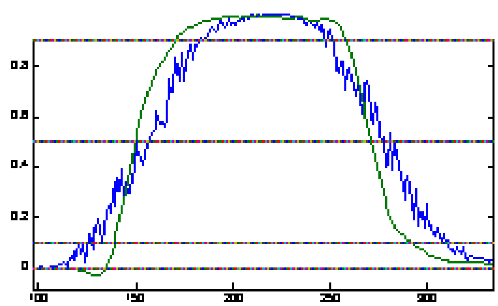
- Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Frequency** tab.

Viewing and Capturing the Pulse Mask of a SONET Signal (STS-1)

With the instrument connected to the appropriate cross-connect level (STSX-1), you can check that the pulse shape of a STS-1 electrical signal meets the ANSI T1.102 standard. You can also view the level and pulse width of both the positive and negative pulses. Level ratio and width ratio are also displayed.

This procedure assumes that you have set up the SONET receiver.

NOTE Excessive jitter on the input signal may adversely affect the pulse shape.



▶ **To view and capture the pulse mask of a STS-1 signal**

1 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Pulse Mask** tab.

2 Set the mask to **ANSI T1.102**.

3 Select **Capture**. The +ve and -ve LEDs are grey while data is being captured.

4 Select the appropriate **+ve** or **-ve** radio button to view the positive or negative pulse shape and measurements.

If the +ve and -ve LEDs are green, the pulse shape will also be green and within specification.
If an LED is red, the part of the pulse that violates the mask envelope will be red and out of specification.

Viewing SONET Alarms

You can monitor alarms in an SONET signal during testing. See the Specifications on the CD-ROM, for a full list of alarms.

The instrument displays alarms as **Alarm Seconds** results (the total number of seconds in the test period during which the alarm was active).

NOTE

To view enhanced RDI alarms (RDI-P-Payload, RDI-P-Server, and RDI-P-Connection), first enable the enhanced RDI feature:
1. Press **<Menu>**, choose **System > Preferences** then press **<Select>**.
2. Select **Enhanced RDI**.

Refer to the instrument specifications document on the instrument CD-ROM, for a full list of alarms.

▶ **To view alarms seconds results**

1 Press **<Menu>**, choose **Results > Alarm Seconds** then press **<Select>**. Select the **SONET** tab.
2 Select the **Alarm Type**.

Viewing SONET Errors

You can view errors using either of the procedures listed below:

- “Viewing SONET Errors (Total or Last Second)" on page 170
- “Viewing SONET Summary of Errors" on page 171
- “Viewing Errors/Alarms using the <Show More> Key" on page 172

Viewing SONET Errors (Total or Last Second)

You can monitor errors in an SONET signal during testing.

Refer to the Specifications, on the CD-ROM for full details of errors results. You can view errors on the instrument as **Total** or **Last Second** results.

Total Results The display shows the running total of errors as they occur throughout the measurement gating period. The total result stops when measurement gating stops.

Last Second The errors results display is updated every second. A last second result is the number of errors occurring in the last second.

NOTE

To view enhanced RDI alarms (RDI-P-Payload, RDI-P-Server, and RDI-P-Connection), first enable the enhanced RDI feature:
1. Press **<Menu>**, choose **System > Preferences** then press **<Select>**.
2. Select **Enhanced RDI**.

▶ **To view SONET errors**

1 Press **<Menu>**, choose **Results > Errors** then press **<Select>**. Select the **SONET** tab.

2 Select the **Error Type**.

Viewing SONET Summary of Errors

The Error Summary window provides a running total of the number of errors occurring during the current measurement period.

Refer to the Specifications, provided on the CD-ROM supplied with your instrument, for full details of available errors.

▶ To view the error summary

1 Press **<Menu>**, choose **Results > Error Summary** then press **<Select>**. Select the **SONET** tab.
2 Select the **Error Type**.

Viewing Errors/Alarms using the <Show More> Key

When the front panel LED lights, error and alarm conditions have been detected. The front panel **<Show More>** key allows you to view detailed alarm information.

- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when History **<Reset>** on the front panel is pressed.

To view the error/alarm conditions

- Press **<Show More>**. Select the **SONET** tab.

Viewing Errors and Alarms Using Trouble Scan

You can use Trouble Scan to continuously monitor errors and alarms in a SONET signal (gives an initial indication of the problems existing when you first test a channel). Initial errors and/or alarms may indicate problems with connections to the instrument or problems with the network.

Trouble Scan displays up to 4 error counts (in priority order).

Priority	Error
1	CV-S
2	CV-L
3	CV-P
4	CV-V
5	CV-V (V5)
6	Frame Errors (A1A2)
7	Payload: near-end errors except Bit
8	REI-L
9	REI-P
10	IEC-P
11	REI-V
12	RFI-V
13	Bit for bulk filled payloads
14	Payload: far-end errors and Bit

To start Trouble Scan

1 Press **<Menu>**, choose **Results > Trouble Scan** then press **<Select>**. The errors and an alarm message will be displayed.
2 If no alarms are detected and all error counts are zero then “No Trouble” is displayed. If “Alarms Active” or “Alarms Were Active” is displayed, then press the front panel <Show More> key for details on which alarms have occurred.

Front Panel LEDs and <Show More> key

The front panel **<Show More>** key allows you to view detailed alarm information.

- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when History **<Reset>** on the front panel is pressed.

NOTE Clock Loss and Power Loss alarms are not monitored in Trouble Scan.

Monitoring SPE and VT Pointer Values

You can monitor the pointer values in the SONET signal. The pointer results that can be displayed are shown below:

Pointer Value: The received pointer value is displayed as a decimal number.

NDF Seconds: The number of seconds containing one or more active New Data Flag (NDF) events.

Missing NDF: The number of seconds containing one or more new pointer value moves with no accompanying active NDF.

Implied Offset: The calculated average offset that would cause the pointer adjustments measured during the test period.

Positive Adjustments (Count): The number of pointer increments in the test period.

Positive Adjustments (Seconds) The number of seconds in the test period which contain one or more pointer increments.

Negative Adjustments (Count): The number of pointer decrements in the test period.

Negative Adjustments (Seconds): The number of seconds in the test period which contain one or more pointer decrements.

▶ To monitor pointer values

1 Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Pointers** tab.
2 Set **Pointer Type** to **SPE** or **VT**, as required.

You can also graphically view the relative offset between pointer values. The Graph feature also shows the timing relationship of pointer movements during the measurement.

For more information, see:

- “Viewing Results Graphically" on page 335

Measuring Service Disruption Time in a SONET Network

You can measure the time it takes (service disruption time) for the automatic protection switch (APS) circuit to detect and activate the standby equipment when a fault occurs. This protection switch action allows the network to continue earning revenue even when equipment goes faulty.

For more information, see “Test Configuration for Measuring Service Disruption Time" on page 443.

You can deliberately invoke a protection switch in a network carrying a PRBS by generating a burst of PRBS errors.

To view disruption time

1 Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Service Disruption** tab.
2 Press **<Run/Stop>**.
3 Verify error-free reception of the PRBS test pattern.
4 Invoke a protection switch on a working section of the transmission system that is transporting the PRBS. The instrument will display the service disruption results.

NOTE

You can deliberately invoke a protection switch in a network carrying a PRBS by generating a burst of PRBS errors. You can simulate a node failure by removing the power from the transmission element, or you can simulate fiber break by disconnecting a fiber. For background information, see “Service Disruption" on page 442.

Service Disruption Test Results

The instrument provides three separate results:

- **Longest**: The duration of the longest error burst detected during the test
- **Shortest**: The duration of the shortest error burst detected during the test
- **Last**: The duration of the most recent error burst detected during the test

When you press the **<Run/Stop>** key at the beginning of a protection-switching time test, all result fields are reset to 0 ms.

When the protection switch is triggered, the duration of the resulting error burst is measured and displayed.

For the system under test to pass, a single error burst of duration less than 50 ms should be detected. Detection of a single error burst is indicated by an identical value being displayed in the three result fields.

Three separate results are provided because some transmission systems exhibited a characteristic similar to switch-bounce during a protection-switching event. This results in multiple distinct error bursts being present on the received test pattern. By providing three separate results, the instrument's service disruption measurement clearly identifies the presence of this unwanted operating characteristic.

Other additional measurement features include:

- Relative timestamping of the beginning and end of each service disruption event.
- **History**: A record of the first ten service disruption measurements.

While an Alarm Indication Signal is not strictly speaking a pure protection-switching measurement, it is closely tied to these types of measurements by being activated as a result of any physical layer failure, such as a fibre break.

Measuring Round Trip Delay in a SONET Network

You can measure round trip delay using an electrical or optical SONET signal. Round trip delay is the time taken for traffic to pass through a network.

When you run a round trip delay measurement, the instrument’s transmitter and receiver operate together. First, the instrument transmits a burst of bit errors, it then measures the time it takes for the errors to be detected by the receiver. The time difference between transmitting and receiving errors is the round trip delay.

This procedure assumes that you have set up a loopback connection in the network you are testing. Also, make sure that the bit rate, line code, input operating level and termination settings match the network element being tested and that the Transmit and Receive SONET signal structures match. Set up the instrument to transmit a SONET signal with a PRBS pattern and ensure there are no Signal, Frame or Pattern errors.

▶ To measure the round trip delay of a SONET network

1 Press **<Menu>**, choose **Test Functions > Switch Off** then press **<Select>**.
2 Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Round Trip Delay** tab.
3 Select **Measure**.

Viewing the ITU Analysis of SONET Errors and Alarms

You can view the ITU analysis of section, line or STS path errors and alarms.

First make sure the bit rate, line code, input operating level and termination settings match the network element being tested. Also check that the receive SONET framing structure and payload are set correctly.

For more information, see:

- “Introducing ITU Performance Analysis" on page 428

▶ To view the ITU analysis of results

1 Press **<Menu>**, choose **Results > Performance Analysis** then press **<Select>**.
2 Set the G- or M-series **Analysis Type** as required.

NOTE All supported types of analysis are available during a measurement. The measurement will not be affected if you switch between the different results provided.

3
Instrument Setup and Use - PDH

This chapter tells you how to set the instrument interfaces to match the network being tested and how to make measurements.

Setting up the PDH Transmitter

Physical

Framed or Unframed Signal

Payload

Error and Alarms

Setting Up the PDH Transmit Interface

You can transmit a balanced 2 Mb/s signal or an unbalanced 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s signal via the 2 Mb/s Out and the 2-140 Mb/s DS3 Out ports.

Make sure the instrument's bit rate, line code, output level and termination settings match the network element being tested.

Signal	Bit Rate	Line Code	Output Level	Termination
E1	2 Mb/s	HDB3	3 V	75 ohm unbalanced (BNC) 120 ohm balanced (3-pin Siemens)
E2	8 Mb/s	HDB3	2.37 V	75 ohm unbalanced (BNC)
E3	34 Mb/s	HDB3	1 V	75 ohm unbalanced (BNC)
E4	140 Mb/s	CMI	1 V	75 ohm unbalanced (BNC)

NOTE The transmitter and receiver can operate independently, or they can be coupled. For more information, see "Coupling the Receiver to the Transmitter" on page 184.

To set up the PDH transmit interface

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.
2 Select **Signal Rate**, then select the required bit rate.
3 Set the **Line Termination** to **75 ohm (Unbal)** or **120 ohm (Bal)** (2 Mb/s line signals only).

Coupling the Receiver to the Transmitter

You can set up the instrument so that the receiver will automatically configure to the transmitter's settings.

▶ To couple the receiver to the transmitter settings

1 Press **<Menu>**, then select **Tx/Rx > Coupling** using the arrow and **<Select>** keys.
2 Select **Copy Tx to Rx**.
3 Select **Close**.

▶ To switch off coupling

1 Press **<Menu>**, then select **Tx/Rx > Coupling** using the arrow and **<Select>** keys.
2 Select **Switch Coupling Off**.
3 Select **Close**.

Selecting the PDH Transmit Clock Source

You can reference the transmitter's timing to an internal, external or recovered clock source.

Mode	Clock Source
Internal	Clock generated within the instrument.
External	2 Mb/s (ternary) or 2 MHz (binary) Master Timing Signal (MTS) applied to the 75 Ω unbalanced Clock In port (BNC). or 2 Mb/s (ternary) MTS applied to the 120 Ω balanced clock In port (Siemens).
Recovered	Clock recovered from the 2 Mb/s signal applied to the receiver.

▶ **To select the transmit clock source**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.

2 Select the **Clock Source**. The **Clock Format** is **2 Mb/s Data** or **2 Mb/s Clock** if you select an external clock source.

Adding Frequency Offset to the PDH Signal

You can apply frequency offset of up to +/-100 ppm (resolution 0.1 ppm and accuracy 0.02 ppm) to a signal, regardless of the selected clock source. Offset can be applied while measurements are taking place.

▶ To add frequency offset to a signal

1 Press **<Menu>**, choose **Test Functions > Frequency Offset** then press **<Select>**.
2 Select **Line Offset**, then enter the required offset by editing the frequency offset value.
3 Select the **Enable Offset** checkbox, then press <**Select>** to switch on the offset.

Transmitting a Framed PDH Signal

You can transmit a framed 2 Mb/s, 8Mb/s, 34 Mb/s or 140 Mb/s PDH signal via the 2 Mb/s or 2-140 Mb/s DS3 Out ports. Also, a framed signal can be inserted into the payload of a SONET/SDH signal. The framed PDH signal can be structured or unstructured and can carry inverted or non-inverted (normal) PRBS patterns.

For more information, see:

- “Transmitting a Framed PDH Signal (Unstructured Payload)" on page 188
- “Transmitting a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 189
- “PRBS Polarity" on page 192

Transmitting a Framed PDH Signal (Unstructured Payload)

You can transmit a framed PDH signal with an unstructured payload via the 2 Mb/s or 2-140 Mb/s DS3 Out ports. Also, you can insert an unstructured PDH signal into the payload of a SONET or SDH signal. The test pattern transmitted in the PDH signal fills the entire payload and can be inverted or non-inverted (normal).

This procedure assumes you have set up a PDH signal rate.

Signal	Framing
2 Mb/s	PCM30, PCM30CRC, PCM31 or PCM31CRC
8 Mb/s	Framed (ITU-T G.751)
34 Mb/s	Framed (ITU-T G.751)
140 Mb/s	Framed (ITU-T G.751)

▶ **To transmit an unstructured payload**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to the required setting, then select **Unstructured**.
3 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab.
4 Select the required pattern (inverted or normal).

Transmitting a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)

When you transmit a framed PDH signal with a structured (channelized) payload, you will need to select the test patterns for the foreground (test) channel and background (non-test) channels in the payload. The test patterns can be inverted or non-inverted (normal).

Signal	Framing	Payload Structure
2 Mb/s	PCM30, PCM30CRC, PCM31 or PCM31CRC	2 Mb/s (64 kb/s)
8 Mb/s	Framed (ITU-T G.751)	2 Mb/s or 64 kb/s
34 Mb/s	Framed (ITU-T G.751)	8 Mb/s, 2 Mb/s or 64 kb/s
140 Mb/s	Framed (ITU-T G.751)	34 Mb/s, 8 Mb/s, 2 Mb/s or 64 kb/s

You can also select the signaling bits of 2 Mb/s signal with PCM30 or PCM30CRC framing.

Signal	Framing	Signaling bits
2 Mb/s	PCM30 or PCM30CRC	A B C D individually set to 1 or 0. The signaling bits of all timeslots are set to the 4-bit user-defined value.

The Si and Sa spare bits can also be transmitted if a framed PDH signal is selected (see the final step of this procedure).

PDH Signal	Spare Bits
2 Mb/s	Si bits (international bits) - Located in Timeslot 0 Bit 1of both the FAS and NFAS frames. Si bits can be modified when in non-CRC-4 frames. E bits - Are the Si bits of frames 13 and 15 of a CRC-4 frame, and can be independently modified. When transmitted as 0, they inform the far end that block errors have occurred. Sa bits (national bits) - located in bits 4 to 8 of NFAS timeslot can be independently modified. Sa bit Sequences - Defines sync status, it is an 8-bit sequence transmitted in selected NFAS Sa bits of a CRC-4 frame. The sequence appears in odd numbered CRC-4 frames (starting from frame 1). CAS Multiframe - Located in MFAS timeslot bits 5, 7 and 8 can be modified.
8 Mb/s	FAS bit 12 can be modified.
34 Mb/s	FAS bit 12 can be modified.
140 Mb/s	FAS bits 14 and 16 can be modified.

This procedure assumes you have set up a PDH signal rate.

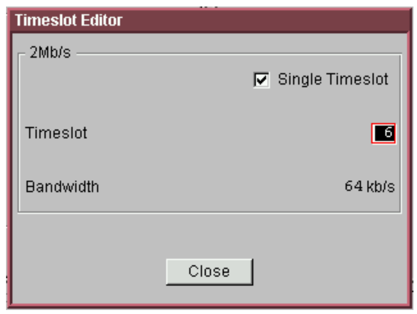
▶ To transmit a PDH signal with a structured payload

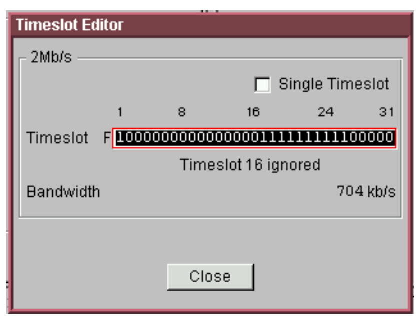
1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.

2 Set the **Framing** and select **Structured**.

3 Set the **Test Channel Rate**. Enter values in the **Test Channel** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you select the **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** checkbox and a timeslot (or de-select the **Single Timeslot** checkbox for N x 64 kb/s foreground channels), then select **Close**.

When transmitting 2 Mb/s channelized payloads, you can transmit either a single 64 kb/s foreground channel or N x 64kb/s foreground channels (contiguously or non-contiguously). Use the N x 64kb/s channels when testing wideband services such as high speed data and LAN links (112 or 336 kb/s).





4 Select the **Test Channel Framing** (line rates over 8 Mb/s).

5 Select **Background Settings** and select a background pattern.

6 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab.

7 Choose a test pattern.

8 Press **<Menu>**, choose **Overhead Setup > Signaling Bits** then press **<Select>**. This lets you access the signaling bits.

9 Press **<Menu>**, choose **Overhead Setup > Spare Bits** then press **<Select>**. This lets you access the spare bits.

PRBS Polarity

The definition of PRBS polarity may differ between ITU-T Recommendation O.150 and common practice in the USA. This is illustrated by the table below.

Pattern	ITU-T	USA
PRBS9	Non-inverted	Non-inverted
PRBS11	Non-inverted	Non-inverted
PRBS15	Inverted	Non-inverted
QRSS	Non-inverted	Non-inverted
PRBS23	Inverted	Non-inverted
PRBS31	Inverted	Inverted

Note that a non-inverted (2En)-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and inverted sequence produces a longest run of n zeros in the PRBS sequence.

You can select PRBS polarity to be inverted or non-inverted (normal). For all signal types except SONET, either ITU or non-ITU is displayed beside your selection to indicate if it conforms to ITU-T O.150.

Transmitting an Unframed PDH Signal

You can transmit test patterns in an unframed 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s PDH signal via the 2 Mb/s or 2-140 Mb/s DS3 Out port. Also, an unframed PDH signal can be inserted into the payload of a SONET/SDH signal. The test patterns can be inverted or non-inverted (normal).

This procedure assumes you have set up a PDH signal rate.

▶ **To transmit an unframed PDH signal**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** to **Unframed**.
3. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab.
4. Select the required pattern (inverted or normal).

Inserting an External 2 Mb/s Payload into a PDH Signal

You can insert an external 2 Mb/s payload into a framed 8 Mb/s, 34 Mb/s or 140 Mb/s PDH signal via the 2 Mb/s In port.

This procedure assumes you have set up a PDH signal rate.

▶ **To insert an external 2 Mb/s payload into a PDH signal**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** to **Framed** and **Structured**.
3. Set the **Test Channel Rate** to **2 Mb/s.**
4. Enter values in the **Test Channel 34 Mb, 8 Mb** and **2 Mb** boxes to select the required channel (the selected line rate determines which boxes will be active).
5. Select the **Insert** checkbox.
6. Connect the external 2 Mb/s signal to the In port.

Adding Errors to a PDH Signal

You can add bit errors to the PDH signal either singly or at a selectable rate.

Refer to the Specifications provided on the CD-ROM for full details of the errors.

▶ To add bit errors to a PDH signal

1 Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.

2 Select the appropriate **Add Errors Type,** then select the required error.

3 Set the **Add Errors Rate** as required. If you select a **User** rate, then enter the required value. The errors will be added to the signal during the measurement period. Also, you can use the **<Single Error>** key to add single errors.

Adding Alarms to a PDH Signal

You can transmit alarms in a PDH signal.

Refer to the Specifications provided on the CD-ROM for full details of the alarms.

▶ To add alarms to a PDH signal

1 Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
2 Select the appropriate **Add Alarm Type,** then select the required alarm.
3 Select the **Enable Alarm** checkbox. The alarm will then be transmitted during the measurement period.

Switching Off All Test Function Features

You can switch off all Test Functions features. This is useful if you want to start configuring the instrument from a known state.

▶ To switch off all Test Function features

1. Press **<Menu>**, choose **Test Functions > Switch Off** then press **<Select>**.
2. Select **Switch Off All Active Test Functions**.
3. Select **Close**.

Setting up the PDH Receiver

Physical

- “Setting Up the PDH Receive Interface" on page 199

Framed or Unframed Signal

- “Monitoring a Framed PDH Signal (Unstructured Payload)" on page 202
- “Monitoring a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 203
- “Monitoring an Unframed PDH Signal" on page 207

Payload

- “Dropping a 2 Mb/s Payload from a PDH Signal" on page 209
- “Dropping a Voice Channel from a PDH Signal to the Internal Speaker" on page 208

Signaling and Spare Bits, Switching Off All Test Functions

- “Monitoring Signaling Bits in Structured 2 Mb/s Signal" on page 211
- “Monitoring Spare Bits of a 2 Mb/s signal in a DS3 Signal" on page 263
- “Switching Off All Test Function Features" on page 197

Setting Up the PDH Receive Interface

You can receive a balanced 2 Mb/s signal or an unbalanced 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s signal via the 2 Mb/s In or 2-140 Mb/s DS3 In ports.

Make sure the bit rate, line code, input operating level and termination settings match the network element being tested.

Signal	Bit Rate	Line Code	Input	
			Termination	Operating Level
E1	2 Mb/s	HDB3	75 Ω unbalanced (BNC)	Terminate (2.37 V_{pk}) Monitor (2.37 V_{pk} but with additional gains of 20, 26 or 30 dB)
			120 Ω balanced (3-pin Siemens)	Terminate (3.0 V_{pk}) Monitor (3.0 V_{pk} but with additional gains of 20, 26 or 30 dB)
E2	8 Mb/s	HDB3	75 Ω unbalanced (BNC)	Terminate (2.37 V_{pk}) Monitor (2.37 V_{pk} but with additional gains of 20, 26 or 30 dB)
E3	34 Mb/s	HDB3	75 Ω unbalanced (BNC)	Terminate (1.0 V_{pk} with equalization automatic or off) Monitor (1.0 V_{pk} but with additional gains of 20 or 26 dB)
E4	140 Mb/s	CMI	75 Ω unbalanced (BNC)	Terminate (1.0 V_{pk} with automatic equalization) Monitor (1.0 V_{pk} but with additional gains of 20 dB)

NOTE

The receiver and transmitter can operate independently, or they can be coupled. For more information, see “Coupling the Transmitter to the Receiver" on page 200.

The receiver derives its timing from the input signal.

▶ To set up the PDH Receive interface

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Physical** tab.

2 Set the **Signal Rate** to **2 Mb/s**, **8 Mb/s**, **34 Mb/s** or **140 Mb/s**.

3 Set **Line Termination** to **75 ohm (Unbal)** or **120 ohm (Bal)** (2 Mb/s line rate only).

4 Set the **Operating Leve**l to **Terminate** or **Monitor**. If you select **Monitor**, you can set the **Gain** to **20 dB** or **26 dB**.

5 Select the **Equalization On** checkbox if required.

Coupling the Transmitter to the Receiver

You can set up the instrument so that the transmitter will automatically configure to the receiver's settings.

▶ To couple the receiver to the transmitter settings

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.

2 Select **Copy Rx to Tx**.

3 Select **Close**.

▶ To switch off coupling

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.

2 Select **Switch Coupling Off**.

3 Select **Close**.

Monitoring a Framed PDH Signal

You can monitor a framed 2 Mb/s, 34 Mb/s or 140 Mb/s PDH signal or drop the framed PDH signal from the payload of a SONET or SDH signal. The framed PDH signal can be structured or unstructured. The PRBS patterns carried in these signals can be inverted or non-inverted (normal).

You should connect the 2 Mb/s or 2-140 Mb/s DS3 In port to the network element being tested.

For more information, see:

- “Monitoring a Framed PDH Signal (Unstructured Payload)" on page 202
- “Monitoring a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 203
- “PRBS Polarity" on page 206

Monitoring a Framed PDH Signal (Unstructured Payload)

You can monitor a framed 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s PDH signal with an unstructured payload. The transmitted test pattern fills the entire payload and can be inverted or non-inverted (normal).

This procedure assume you have set up a PDH signal rate.

▶ To view a PDH signal with an unstructured payload

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to the required setting, then select **Unstructured**.
3 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Pattern** tab.
4 Select the required pattern (inverted or normal).

Monitoring a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)

When you monitor a framed PDH signal with a structured (or channelized) payload, you will need to select test patterns for the foreground (test) channel and the background (non-test) channels in the payload. The test patterns can be inverted or non-inverted (normal).

Signal	Framing	Payload Structure
2 Mb/s	PCM30, PCM30CRC, PCM31 or PCM31CRC	2 Mb/s (64 Kb/s)
8 Mb/s	ITU-T G.742	2 Mb/s or 64 kb/s
34 Mb/s	ITU-T G.751	8 Mb/s, 2 Mb/s or 64 kb/s
140 Mb/s	ITU-T G.751	34 Mb/s, 8 Mb/s, 2 Mb/s or 64 kb/s

You can also monitor the signaling bits of a 2 Mb/s with PCM30 or PCM30CRC framing.

Signal	Framing	Signaling bits
2 Mb/s	PCM30 or PCM30CRC	A B C D individually set to 1 or 0. The signaling bits of all timeslots are set to the 4-bit user-defined value.

The Si and Sa spare bits can also be monitored if a framed PDH signal is selected (see the final step of this procedure).

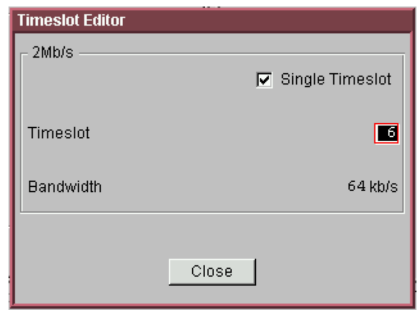
PDH Signal	Spare Bits
2 Mb/s	Si bits (international bits) - Located in Timeslot 0 Bit 1of both the FAS and NFAS frames. E bits - Are the Si bits of frames 13 and 15 of a CRC-4 frame, and can be independently modified. When transmitted as 0, they inform the far end that block errors have occurred. Sa bits (national bits) - located in bits 4 to 8 of NFAS timeslot. Sa bit Sequences - Defines sync status, it is an 8-bit sequence in the selected NFAS Sa bits of a CRC-4 frame. The sequence appears in odd numbered CRC-4 frames (starting from frame 1). CAS Multiframe - Located in MFAS timeslot bits 5, 7 and 8.
8 Mb/s	FAS bit 12.
34 Mb/s	FAS bit 12.
140 Mb/s	FAS bits 14, 15 and 16.

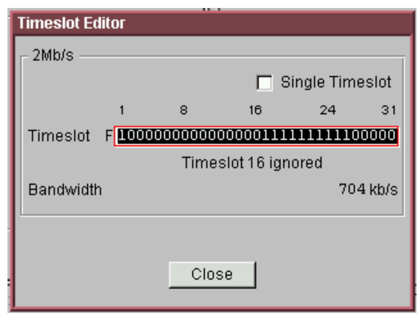
This procedure assumes you have set up a PDH signal rate.

▶ To view a PDH signal with a structured payload

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set the **Framing** and select **Structured**.
3 Set the **Test Channel Rate**. Enter values in the **Test Channel** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you select the **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** checkbox and a timeslot (or de-select the **Single Timeslot** checkbox for N x 64 kb/s foreground channels), then select **Close**.

When monitoring 2 Mb/s channelized payloads, you can monitor a single 64 kb/s foreground channel or N x 64kb/s foreground channels (contiguously or non-contiguously). Use the N x 64 kb/s channels when testing wideband services such as high speed data and LAN links (112 or 336 kb/s).





4 Select **Test Channel Framing** (line rates 8 Mb/s and above).

5 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Pattern** tab. Choose a test pattern.

6 Press **<Menu>**, choose **Overhead Monitor > Signaling Bits** then press **<Select>**. View the signaling bits.

7 Press **<Menu>**, choose **Overhead Monitor > Spare Bits** then press **<Select>**. View the Sa bits.

PRBS Polarity

The definition of PRBS polarity may differ between ITU-T Recommendation O.150 and common practice in the USA. This is illustrated by the table below.

Pattern	ITU-T	USA
PRBS9	Non-inverted	Non-inverted
PRBS11	Non-inverted	Non-inverted
PRBS15	Inverted	Non-inverted
QRSS	Non-inverted	Non-inverted
PRBS23	Inverted	Non-inverted
PRBS31	Inverted	Inverted

Note that a non-inverted (2En)-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and inverted sequence produces a longest run of n zeros in the PRBS sequence.

You can select PRBS polarity to be inverted or non-inverted (normal). For all signal types except SONET, either ITU or non-ITU is displayed beside your selection to indicate if it conforms to ITU-T O.150.

Monitoring an Unframed PDH Signal

You can monitor test patterns in an unframed 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s PDH signal applied to the 2 Mb/s In or 2-140 Mb/s DS3 In ports, or drop the unframed signal from the payload of a SONET or SDH signal. The test patterns can be inverted or non-inverted.

This procedure assumes you have set up a PDH signal rate.

▶ **To receive an unframed PDH signal**

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to **Unframed**.
3 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Pattern** tab.
4 Select the required pattern (inverted or normal).

Dropping a Voice Channel from a PDH Signal to the Internal Speaker

You can drop a 64 kb/s voice channel from a 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s framed PDH signal to the instrument's internal speaker.

This procedure assumes you have set up a PDH signal rate.

▶ To drop a voice channel to the internal speaker

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** to **Framed** and **Structured**. Set the **Test Channel Rate** to 2 Mb/s (64 kb/s).
3. Enter values in the **Test Channel 34 Mb**, **8 Mb, 2Mb** and **64 kb** boxes to select the required channel (the selected test channel rate determines which boxes will be active).
4. When you click on the 56 kb/s or 64 kb/s box, select the **Single Timeslot** check box, then select the appropriate timeslot carrying the voice channel.
5. Select the **Listen** checkbox, select the appropriate volume level. Select **Close**.

Dropping a 2 Mb/s Payload from a PDH Signal

You can drop a 2 Mb/s payload from a framed 8 Mb/s, 34 Mb/s or 140 Mb/s signal via the 2 Mb/s Out port.

The PDH signal carrying the 2 Mb/s payload (to be dropped) must be connected to the 2-140 Mb/s DS3 In port.

This procedure assumes you have set up a PDH signal rate.

▶ To drop an 2 Mb/s payload from a PDH signal

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** the to **Framed** and **Structured**.
3. Set the **Test Channel Rate** to **2 Mb/s**.
4. Enter values in the **Test Channel 34 Mb, 8 Mb** and **2 Mb** boxes to select the required channel (the selected line rate determines which boxes will be active).
5. Select the **Drop 2 Mb/s** checkbox.

Monitoring Si and Sa Spare Bits of a 2 Mb/s signal in a PDH Signal

You can view the Si and Sa spare bits of a structured 2 Mb/s signal carried in a PDH signal.

PDH Signal	Spare Bits
2 Mb/s	Si bits (international bits) - Located in Timeslot 0 Bit 1of both the FAS and NFAS frames. E bits - Are the Si bits of frames 13 and 15 of a CRC-4 frame, and can be independently modified. When transmitted as 0, they inform the far end that block errors have occurred. Sa bits (national bits) - located in bits 4 to 8 of NFAS timeslot. Sa bit Sequences - Defines sync status, it is an 8-bit sequence in the selected NFAS Sa bits of a CRC-4 frame. The sequence appears in odd numbered CRC-4 frames (starting from frame 1). CAS Multiframe - Located in MFAS timeslot bits 5, 7 and 8.
8 Mb/s	FAS bit 12.
34 Mb/s	FAS bit 12.
140 Mb/s	FAS bits 14, 15 and 16.

To view Si and Sa spare bits

- Press **<Menu>**, choose **Overhead Monitor** > **Spare Bits** then press **<Select>**. View the Si bits
- Press **<Menu>**, choose **Overhead Monitor** > **Sa Bits** then press **<Select>**. View the Sa bits.

Monitoring Signaling Bits in Structured 2 Mb/s Signal

You can monitor signaling bits in a 2 Mb/s (with PCM30 or PCM30CRC framing) signal.

Signal	Framing	Signaling bits
2 Mb/s	PCM30 or PCM30CRC	A B C D individually set to 1 or 0. The signaling bits of all timeslots are set to the 4-bit user-defined value.

▶ To view signaling bits of a 2 Mb/s signal

- Press **<Menu>**, choose **Overhead Monitor > Signaling Bits** then press **<Select>**.

Setting Up Thru Mode Operation

Use transparent thru mode to non-intrusively monitor signals in networks with no protected monitor points.

The instrument is inserted into the communications path and the received data is routed unaltered to the Transmit Out port for retransmission.

The instrument operates as normal, monitoring errors and alarms in the received signal.

The instrument's timing is derived from a clock recovered from the received data.

NOTE

Settings cannot be changed once you have selected THRU mode. This stops you from selecting settings which would affect the data path.

You must select the signal rate you want before selecting THRU mode.

▶ **To set up transparent thru mode operation**

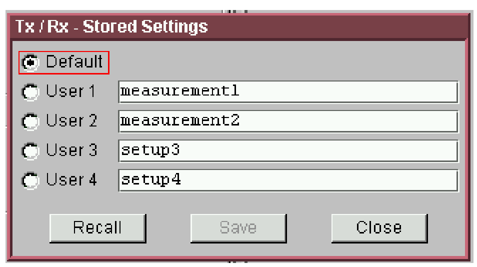
1 Press **<Menu>,** then select the **Tx/Rx > Thru Mode** window using the arrows and **<Select>** key.
2 Select the **Enable Thru Mode** checkbox (a tick appears in the box).
3 Select **Close**.

Storing and Recalling Instrument Settings

You can store four sets of instrument settings (i.e. those shown in the summary diagram at the bottom of the display). These, along with the factory default settings, can be recalled. This procedure assumes that you have already set up the instrument.

▶ To store instrument settings

1. Press **<Menu>**, choose **Tx/Rx > Stored Settings** then press **<Select>**.
2. Select one of the **User (1 to 4)** radio buttons.
3. Press the right arrow key, then enter a suitable title using front panel keypad.
4. Select **Save** to store the settings.
5. Select **Close**.



▶ To recall stored settings

1. Press **<Menu>**, choose **Tx/Rx > Stored Settings** then press **<Select>**.
2. Select one of the **User (1 to 4)** radio buttons.
3. Select **Recall**. A warning dialog box will appear. Select **OK** and the instrument will reconfigure using the recalled settings.
4. Select **Close**.

Measurements and Results

Physical

Errors and Alarms

Service Disruption

Analysis

Measuring PDH Signal Level

You can measure the level of a balanced 2 Mb/s signal or unbalanced 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s signal at the instrument's 2 Mb/s In or 2-140 Mb/s DS3 In port.

This procedure assumes you have set up the PDH receiver and connected the electrical PDH signal to the appropriate input port.

▶ To measure the level of a PDH signal

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.

2 Set **Signal Rate** to the appropriate PDH rate, then select the interface settings as required.

3 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Electrical** tab.

Measuring the Frequency of a PDH Signal

You can measure the frequency of a balanced 2 Mb/s signal or an unbalanced 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s signal at the instrument's 2 Mb/s In or 2-140 Mb/s DS3 In port.

You can also measure frequency offset in the incoming signal. The amount of offset gives an indication of the probability of errors in the incoming signal.

This procedure assumes that the bit rate, line code, input operating level and termination settings match the network element being tested. Also make sure that the test signal is connected to the appropriate optical or electrical input port.

▶ To measure the frequency of a PDH signal

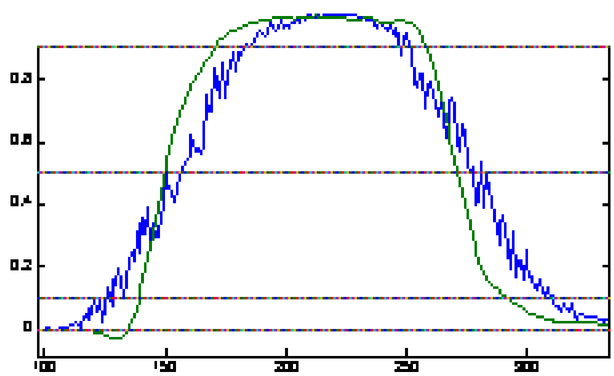
1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Physical** tab.
2 Select **Signal Rate**, then select the required signal and interface settings.
3 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Frequency** tab.

Viewing the Pulse Mask of a PDH Signal

With the instrument connected to the appropriate cross-connect level, you can check that the pulse shape of an unbalanced 2 Mb/s, 8 Mb/s or 34 Mb/s signal meets the G.703, GR-449 and ANSI T1.102 standards. You can view the level and pulse width of both the positive and negative pulses. Level ratio and width ratio are also displayed.

This procedure assumes you have set up the PDH receiver.

NOTE Excessive jitter on the input signal may adversely affect the pulse shape.



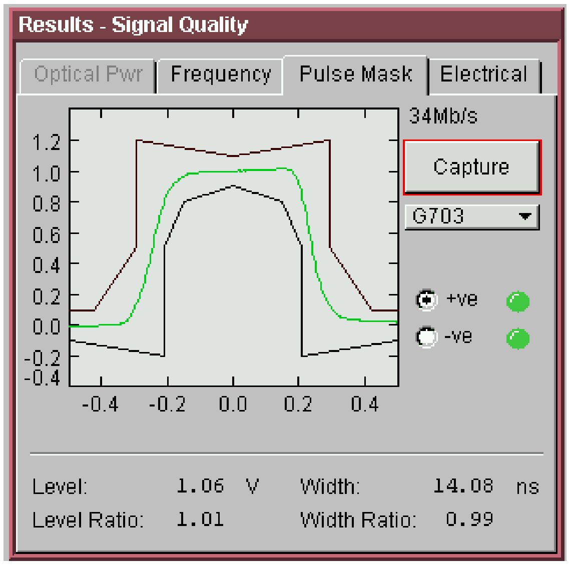
▶ To view the pulse mask of a PDH signal

1. Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Pulse Mask** tab.
2. Set the mask to **G703**, **GR-449** or **ANSI T1.102**.
3. Select **Capture**. The +ve and -ve LEDs are grey while data is being captured.

4 Select the appropriate **+ve** or **-ve** radio button to view the positive or negative pulse shape and measurements.

If the +ve and -ve LEDs are green, the pulse shape will also be green and within specification. If an LED is red, the part of the pulse that violates the mask envelope will be red and out of specification.

5 After data has been captured, you can apply different masks.



Viewing PDH Errors

You can view errors using any of the procedures listed below:

- “Viewing PDH Errors (Total and Last Second)" on page 220
- “Viewing the PDH Summary of Errors" on page 221
- “Viewing Errors/Alarms using the <Show More> Key" on page 222

Viewing PDH Errors (Total and Last Second)

You can view PDH errors during a test or at the end of the test.

You can view errors on the display as **Total** or **Last Second** results.

Total Results The display shows the running total of errors as they occur throughout the measurement gating period. The total result stops when measurement gating stops.

Last Second The errors results display is updated every second. A last second result is the number of errors occurring in the last second.

Refer to the Specifications provided on the CD-ROM for full details of errors results.

▶ To view PDH errors

1 Press **<Menu>**, choose **Results > Errors** then press **<Select>**. Select the **PDH/DSn** tab.
2 Select the **Error Type** results to be displayed.

Viewing the PDH Summary of Errors

The Error Summary window provides a running total of the number of errors occurring during the current measurement period.

▶ To view the PDH error summary

1 Press **<Menu>**, choose **Results > Error Summary** then press **<Select>**. Select the **PDH/DSn** tab.
2 You can then view errors in more detail. Press **<Menu>**, then select the **Results > Errors** window to view the Error Ratio or errors occurring in the last second.

Viewing Errors/Alarms using the <Show More> Key

When the front panel LED lights, error and alarm conditions have been detected. The front panel **<Show More>** key allows you to view detailed alarm information.

- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when History **<Reset>** on the front panel is pressed.

To view the error/alarm conditions

- Press **<Show More>**. Select the **PDH/DSn** tab.

Viewing Alarms in a PDH Signal

You can monitor the time an PDH alarms is active for (Alarm Second) on the Results screen.

Refer to the Specifications provided on the CD-ROM for full details of the alarms.

▶ **To view alarms in a PDH signal**

- Press **<Menu>**, choose **Results > Alarm Seconds** then press **<Select>**. Select the **PDH/DSn** tab.

Viewing Errors and Alarms Using Trouble Scan

You use Trouble Scan to continuously monitor errors and alarms in a framed PDH signal, or the framed PDH signal in the payload of a SONET or SDH signal.

Trouble Scan is useful for testing new networks as it can simultaneously detect up to four error types in the following priority order: Code, CRC4, Frame, E-bit and Bit.

▶ To monitor errors and alarms using Trouble Scan

1 Press **<Menu>**, choose **Results > Trouble Scan** then press **<Select>**. The errors and the alarms that have been detected will be displayed.
2 If **Alarms Active** is displayed, then press the front panel **<Show More>** key to determine which alarms have occurred.

Front Panel LEDs and <Show More> key

The front panel **<Show More>** key allows you to view detailed alarm information

- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when History **<Reset>** on the front panel is pressed.
- If no alarms are detected and all error counts are zero then “No Trouble” is displayed on the **Results > Trouble Scan** page.

NOTE Clock Loss and Power Loss alarms are not monitored in Trouble Scan.

Measuring Service Disruption Time in a PDH Network

You can measure the time it takes (service disruption time) for the automatic protection switch (APS) circuit to detect and activate the standby equipment when a fault occurs. This protection switch action allows the network to continue earning revenue even when equipment goes faulty.

For more information, see “Test Configuration for Measuring Service Disruption Time" on page 443.

You can deliberately invoke a protection switch in a network carrying a PRBS by generating a burst of PRBS errors.

▶ **To view disruption time**

1. Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Service Disruption** tab.
2. Press **<Run/Stop>**.
3. Verify error-free reception of the PRBS test pattern.
4. Invoke a protection switch on a working section of the transmission system that is transporting the PRBS. The instrument will display the service disruption results.

NOTE You can deliberately invoke a protection switch in a network carrying a PRBS by generating a burst of PRBS errors. You can simulate a node failure by removing the power from the transmission element, or you can simulate fiber break by disconnecting a fiber. For more information, see “Service Disruption" on page 442.

Service Disruption Test Results

The instrument provides three separate results:

- **Longest**: The duration of the longest error burst detected during the test
- **Shortest**: The duration of the shortest error burst detected during the test
- **Last**: The duration of the most recent error burst detected during the test

When you press the **<Run/Stop>** key at the beginning of a protection-switching time test, all result fields are reset to 0 ms.

When the protection switch is triggered, the duration of the resulting error burst is measured and displayed.

For the system under test to pass, a single error burst of duration less than 50 ms should be detected. Detection of a single error burst is indicated by an identical value being displayed in the three result fields.

Three separate results are provided because some transmission systems exhibited a characteristic similar to switch-bounce during a protection-switching event. This results in multiple distinct error bursts being present on the received test pattern. By providing three separate results, the instrument's service disruption measurement clearly identifies the presence of this unwanted operating characteristic.

Other additional measurement features include:

- Relative timestamping of the beginning and end of each service disruption event.
- **History**: A record of the first ten service disruption measurements.

While an Alarm Indication Signal is not strictly speaking a pure protection-switching measurement, it is closely tied to these types of measurements by being activated as a result of any physical layer failure, such as a fiber break.

Measuring Round Trip Delay in a PDH Network

You can measure round trip delay using a balanced 2 Mb/s signal or unbalanced 2 Mb/s, 8 Mb/s, 34 Mb/s or 140 Mb/s signal. Round trip delay is the time taken for traffic to pass through a network.

When you run a round trip delay measurement, the instrument's transmitter and receiver operate together. First, the instrument transmits a burst of bit errors, it then measures the time it takes for the errors to be detected by the receiver. The time difference between transmitting and receiving errors is the round trip delay.

This procedure assumes that you have set up a loopback connection in the network you are testing. Also, make sure that the bit rate, line code, input operating level and termination settings match the network element being tested and that the Transmit and Receive PDH signal structures match. Set up the instrument to transmit a PDH signal with a PRBS pattern and ensure there are no Signal, Frame or Pattern errors.

For more information, see:

- "Setting Up the PDH Transmit Interface" on page 183
- "Coupling the Receiver to the Transmitter" on page 184
- "Transmitting a Framed PDH Signal" on page 187

▶ **To measure the round trip delay of a PDH network**

1. Press **<Menu>**, choose **Test Functions > Switch Off** then press **<Select>**.
2. Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Round Trip Delay** tab.
3. Select **Measure**.

Viewing the ITU Analysis of PDH Errors and Alarms

You can view the ITU analysis of a framed PDH signal, or framed PDH signal in the payload of a SONET or SDH signal. Make sure the bit rate, line code, input operating level and termination settings match the network element being tested. Also ensure that the Receive PDH signal framing structure is set correctly.

▶ **To view the ITU analysis of result**

1 Press **<Menu>**, choose **Results > Performance Analysis** then press **<Select>**.
2 Set the G- or M-series **Analysis Type** as required.

NOTE All supported types of analysis are available during a measurement. For more information, see "Introducing ITU Performance Analysis" on page 428. The measurement will not be affected if you switch between the different results provided.

4
Instrument Setup and Use - DSn

This chapter tells you how to set the instrument interfaces to match the network being tested and how to make measurements.

Setting up the DSn Transmitter

Setting Up the DSn Transmit Interface

You can transmit a balanced DS1 signal or an unbalanced DS3 signal via the DS1 Out and 2-140 Mb/s DS3 Out ports.

Make sure the instrument's bit rate, line code, output level and termination settings match the network element being tested.

Signal	Bit Rate	Line Code	Output Level	Termination
DS1	1.5 Mb/s	AMI B8ZS	DSX-1 DS1-LO	100 Ω balanced (Bantam)
DS3	45 Mb/s	B3ZS	DS3-HI DSX-3 DS3-900	75 Ω unbalanced (BNC)

NOTE The transmitter and receiver can operate independently, or they can be coupled. For more information, see "Coupling the Receiver to the Transmitter" on page 232.

▶ To set up a DS1 or DS3 transmit interface

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.
2 Set the **Signal Rate** to **DS1** or **DS3**.
3 Select the **Line Code** (DS1 line signal only).
4 Select the **Line Output Level**.

Coupling the Receiver to the Transmitter

You can set up the instrument so that the receiver will automatically configure to the transmitter's settings.

▶ To couple the receiver to the transmitter settings

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Copy Tx to Rx**.
3 Select **Close**.

▶ To switch off coupling

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Switch Coupling Off**.
3 Select **Close**.

Selecting the DSn Transmit Clock Source

You can reference the timing to an internal, external or recovered clock source.

Mode	Clock Source
Internal	Clock generated within the instrument.
External	DS1 Data clock applied to the DS1 Clock In port.
Recovered	Clock recovered from the Dsn signal applied to the receiver.

▶ To select the transmit clock source

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Physical** tab.

2 Select the **Clock Source**. The **Clock Format** is automatically set to **DS1 Data** if you select an external clock source.

Adding Frequency Offset to the DSn Signal

You can apply frequency offset of up to +/-100 ppm (resolution 0.1 ppm and accuracy 0.02 ppm) to a signal regardless of the selected clock source. Offset can be applied while measurements are taking place.

▶ To add frequency offset to a signal

1 Press **<Menu>**, choose **Test Functions > Frequency Offset** then press **<Select>**.
2 Select **Line Offset**, then enter the required offset by editing the frequency offset value.
3 Select the **Enable Offset** checkbox, then press **<Select>** to switch on the offset.

Transmitting a Framed DSn Signal

You can transmit a framed DS1 or DS3 signal via the DS1 or 2-140 Mb/s DS3 Out ports. Also, a framed signal can be inserted into the payload of a SONET/SDH signal. The framed DS1 or DS3 signal can be structured or unstructured and can carry inverted or non-inverted (normal) PRBS patterns.

For more information, see:

- “Transmitting a Framed DSn Signal (Unstructured Payload)" on page 236
- “Transmitting a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 237
- “PRBS Polarity" on page 240

Transmitting a Framed DSn Signal (Unstructured Payload)

You can transmit a framed DSn signal with an unstructured payload via the DS1 or 2-140 Mb/s DS3 Out ports. Also, you can insert an unstructured DSn signal into the payload of a SONET or SDH signal. The test pattern transmitted in the DSn signal fills the entire payload.

Signal	Framing
DS1	ESF, D4, SLC-96 or Unframed
DS3	C-bit, M13, Unframed

The test patterns can be inverted or non-inverted (normal).

This procedure assume you have set up a DSn signal rate.

▶ **To transmit an unstructured DSn signal**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to the required setting, then select **Unstructured**.
3 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab. Then select the required pattern (inverted or normal).

Transmitting a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)

When you transmit a DSn signal with a structured (or channelized) payload, you will need to select the test patterns for the foreground (test) channel and background (non-test) channels in the payload.The test patterns can be inverted or non-inverted.

Signal	Framing	Payload Structure
DS1	ESF, D4, SLC-96 or Unframed	DS1(56 kb/s), DS1 (64 kb/s)
DS3	C-bit, M13, Unframed	DS1, DS1(56 kb/s), DS1 (64 kb/s), 2 Mb/s, 2 Mb/s (64 kb/s)

You can also select the signaling bits of a DS1 (56 kb/s) or 2 Mb/s with PCM30 or PCM30CRC framing.

Signal	Framing	Signaling bits
DS1	ESF D4 SLC-96 No framing bit	A B C D individually set to 1 or 0. A B individually set to 1 or 0. A B individually set to 1, 0 or alternating. A B C D individually set to 1 or 0. The same signaling bit pattern is carried in all foreground timeslots.
2 Mb/s	PCM30, PCM31, PCM30CRC, PCM31CRC	A B C D individually set to 1 or 0. The signaling bits of all timeslots are set to the 4-bit user-defined value.

The Si and Sa spare bits can also be transmitted if a 2 Mb/s signal is selected (see the final step of this procedure).

PDH Signal	Spare Bits
2 Mb/s	Si bits (international bits) - Located in Timeslot 0 Bit 1of both the FAS and NFAS frames. Si bits can be modified when in non-CRC-4 frames. E bits - Are the Si bits of frames 13 and 15 of a CRC-4 frame, and can be independently modified. When transmitted as 0, they inform the far end that block errors have occurred. Sa bits (national bits) - located in bits 4 to 8 of NFAS timeslot can be independently modified. Sa bit Sequences - Defines sync status, it is an 8-bit sequence transmitted in selected NFAS Sa bits of a CRC-4 frame. The sequence appears in odd numbered CRC-4 frames (starting from frame 1). CAS Multiframe - Located in MFAS timeslot bits 5, 7 and 8 can be modified.

This procedure assumes you have set up a DSn signal rate.

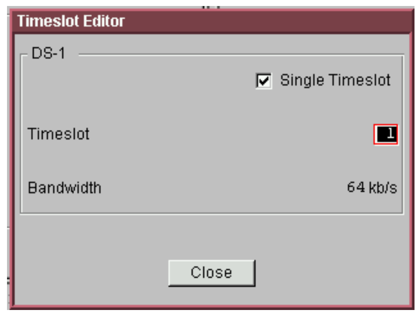
▶ To transmit a DSn signal with a structured payload

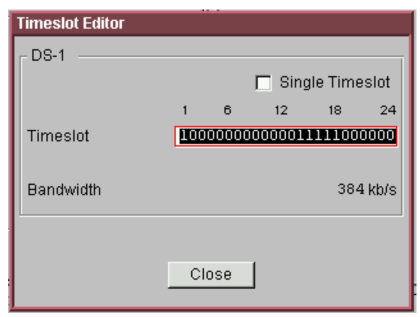
1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.

2 Set the **Framing** and select **Structured**.

3 Set the **Test Channel Rate**. Enter values in the **Test Channel** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you select the **56 kb/s** or **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** checkbox and a timeslot (or de-select the **Single Timeslot** checkbox for N x 56/64 kb/s foreground channels), then select **Close.**

   When transmitting DS1 channelized payloads, you can transmit either a single 56/64 kb/s foreground channel or N x 56/54 kb/s foreground channels. Use the N x 56/64 kb/s channels when testing wideband services such as high speed data and LAN links (112 or 336 kb/s). The N x 64 kb/s foreground channels can be contiguous or non-contiguous.





4 Select the **Test Channel Timing** reference.

5 Select the **Test Channel Framing** (DS3 line rate only).

6 Select **Background Settings**, then select a background pattern.

7 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab.

8 Choose a test pattern.

9 Press **<Menu>**, choose **Overhead Setup > Signaling Bits** then press **<Select>**. This lets you access the signaling bits feature.

10 Press **<Menu>**, choose **Overhead Setup > Spare Bits** then press **<Select>**. This lets you access the spare bits feature.

PRBS Polarity

The definition of PRBS polarity may differ between ITU-T Recommendation O.150 and common practice in the USA. This is illustrated by the following table.

Pattern	ITU-T	USA
PRBS9	Non-inverted	Non-inverted
PRBS11	Non-inverted	Non-inverted
PRBS15	Inverted	Non-inverted
QRSS	Non-inverted	Non-inverted
PRBS23	Inverted	Non-inverted
PRBS31	Inverted	Inverted

Note that a non-inverted (2En)-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and inverted sequence produces a longest run of n zeros in the PRBS sequence.

You can select PRBS polarity to be inverted or non-inverted (normal). For all signal types except SONET, either ITU or non-ITU is displayed beside your selection to indicate if it conforms to ITU-T O.150.

Transmitting an Unframed DSn Signal

You can transmit test patterns in an unframed DS1 or DS3 signal via the instrument’s DS1 or 2-140 Mb/s DS3 Out ports. Also, an unframed signal can be inserted into the payload of a SONET/SDH signal. The test patterns can be inverted or non-inverted (normal).

This procedure assumes you have set up a DSn signal rate.

▶ **To transmit an unframed DSn signal**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to **Unframed**.
3 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **Pattern** tab.
4 Select the required pattern (inverted or normal).

Inserting an External 2 Mb/s or DS1 Payload into a DS3 Signal

You can insert an external 2 Mb/s or DS1 signal into a DS3 signal via the 2 Mb/s In ports (balanced).

This procedure assumes you have set up the DS3 signal rate.

▶ To insert an external 2 Mb/s or DS1 signal into a DS3

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to **M13** or **C-Bit** and **Structured**.
3 Set the **Test Channel Rate** to **2 Mb/s** or **DS1.**
4 Select the **Test Channel** to be used by the external signal by selecting the appropriate **DS2**, **DS1** or **2 Mb** channel settings.
5 Select the **Insert** checkbox.
6 Select **Background Settings**, then select the required background pattern.
7 Connect the external 2 Mb/s or DS1 signal to the appropriate In port.

Adding Errors to a DSn Signal

You can add errors to the DSn signal either singly or at a selectable rate.

Refer to the Specifications provided on the CD-ROM for a full list of errors.

Mode	Errors Transmitted
Single	One error transmitted when you press the **<Single Error>** key.
Rate	M.PE-0N errors are transmitted, where N = 4 to 9, and M.P = 1.0 to 9.9 in 0.1 steps.

▶ To add errors to a DSn signal

1. Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
2. Select the appropriate **Add Errors Type,** then select the required error.
3. Set the **Add Errors Rate** as required. If you select a **User** rate, then enter the required value. The errors will be added to the signal during the measurement period. Also, you can use the **<Single Error>** key to add single errors.

Adding Alarms to a DSn Signal

You can transmit alarms in a DSn signal.

Refer to the Specifications provided on the CD-ROM for a full list of the alarms.

▶ To add alarms to a DSn signal

1 Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
2 Select the appropriate **Add Alarm Type,** then select the required alarm.
3 Select the **Enable Alarm** checkbox. The alarm will then be transmitted during the measurement period.

Transmitting FEAC Messages in a DS3 Signal

You use the FEAC channel (the 3rd C-bit of a framed DS3 signal) to transmit loopback, alarm or status information from far-end to near-end network elements.

This procedure assumes you have set up the DS3 signal rate.

FEAC Message	
Loopback Codes	You can transmit N loopcodes and M messages in a single burst, where N and M are selectable in the range 1 to 15.
Alarm/Status Messages	You can transmit ANSI T1.107-1995 messages or any user specified code (11111111 0XXXXXX0) continuously, or in a single burst.

To transmit a FEAC message in a DS3 signal

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** to **C-Bit**.
3. Press **<Menu>**, choose **Overhead Setup > DS3 FEAC** then press **<Select>**.
4. Set **FEAC Code Type** to **Loopback** or **Alarm/Status**.
5. Select the **Message** for transmitting in **All Channels** or in a **Single Channel**. If you select **Single Channel**, you will need to select a channel value between 1 and 28.
6. Select the **Repeat (Times)** for **Loopback** and **Message**.
7. Select **Transmit Code**.

Transmitting DS1 Loop Codes

You use in-band or out-of-band loop codes to locate faults. They are used to remotely control loop circuits in network equipment.

Typically, the far-end equipment activates the loop circuit when it detects the loop code. The DS1 signal is then routed back to the near-end equipment where you can verify signal integrity.

For more information on loop codes, see:

- “Transmitting In-band DS1 Loop Codes" on page 246
- “Transmitting Out-of Band DS1 Loop Codes" on page 247

Transmitting In-band DS1 Loop Codes

When you select an in-band loop code, the entire payload of the DS1 signal is overwritten with the loop code, and transmitted for 8 seconds.

If you are transmitting a framed DS1 signal, the framing bit overwrites the DS1 loop code (as per T1.403-1999.CORE). This overwriting action can be prevented by setting the instrument for 156 MTS compatibility (the loop code is gapped).

This procedure assumes you have set up theDS1 signal rate.

Loop	Activate	Deactivate
Line	00001	001
Payload	1100	1110
Network	11000	11100
User	XXXXXXXX	XXXXXXXX

▶ **To transmit an in-band DS1 loop code**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.

2 Set **Framing** as required.

3 Press **<Menu>**, choose **Overhead Setup > DS1 Loopcodes** then press **<Select>**.
4 Set **Inband Loop Code** to **F-bit gaps** or **F-bit overwriten**, then select the appropriate code.
5 Select **Transmit Code**.

Transmitting Out-of Band DS1 Loop Codes

When you select an out-of-band loop code, it can be transmitted continuously or in a burst of N-messages, where N is the number of frames in the range 1 to 15.

These loop codes are located in the data link of an ESF framed DS1 signal.

When the data link is not transmitting loop code, it transmits idle code (01111110). The switching of idle to loop code occurs at the end of the idle message, and not part way through it.

This procedure assumes you have set up the DS1 signal rate.

Loop	Activate	Deactivate
Line	11111111 01110000	11111111 00011100
Payload	11111111 00101111	11111111 01001100
Network	11111111 01001000	n/a
Universal	n/a	11111111 00100100
User	11111111 0XXXXXX0	

To transmit an out-of-band DS1 loop code

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to **ESF**.
3 Press **<Menu>**, choose **Overhead Setup > DS1 Loopcodes** then press **<Select>**.
4 Select the **Outband Loop Code** as required.

5 Set **Burst Length** to **Burst** or **Continuous**. If you select **Burst** you will also need to select the burst length.

6 Select **Transmit Code**.

Switching Off All Test Function Features

You can switch off all Test Functions features. This is useful if you want to start configuring the instrument from a known state.

▶ To switch off all Test Function features

1 Press **<Menu>**, choose **Test Functions > Switch Off** then press **<Select>**.
2 Select **Switch Off All Active Test Functions**.
3 Select **Close**.

Setting up the DSn Receiver

Physical

- "Setting Up the DSn Receive Interface" on page 251

Framed or Unframed Signal

- "Monitoring a Framed DSn Signal (Unstructured Payload)" on page 254
- "Monitoring a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 255
- "Monitoring an Unframed DSn Signal" on page 259

Payload

- "Dropping a DS1 Payload from a DS3 Signal" on page 260
- "Dropping a Voice Channel from a DSn Signal to the Internal Speaker" on page 261

FEAC Messages, Signaling and Spare bits, DS1 loop codes and Switching Off All Test Functions

- "Monitoring FEAC Messages in a DS3 Signal" on page 262
- "Monitoring Signaling Bits in Structured DS1 or 2 Mb/s Signal" on page 264
- "Monitoring Spare Bits of a 2 Mb/s signal in a DS3 Signal" on page 263
- "Monitoring DS1 Loop Codes" on page 265
- "Switching Off All Test Function Features" on page 249

Setting Up the DSn Receive Interface

You can receive a balanced DS1 signal or an unbalanced DS3 signal via the DS1 In port or 2-140 Mb/s DS3 In ports.

Make sure the instrument's bit rate, line code, input operating level and termination settings match the network element being tested.

Signal	Bit Rate	Line Code	Input	
			Termination	Operating Level
DS1	1.5 Mb/s	AMI B8ZS	100 ohm balanced (Bantam connection)	Terminate (3.0 V_{pk}) Monitor (3.0 V_{pk} but with additional gains of 20, 26 or 30 dB)
DS3	45 Mb/s	B3ZS	75 ohm unbalanced (BNC connection)	Terminate (0.9 V_{pk} with equalization automatic or off) Monitor (0.9 V_{pk} but with additional gains of 20 or 26 dB)

NOTE

The receiver and transmitter can operate independently, or they can be coupled. For more information, see "Coupling the Transmitter to the Receiver" on page 252.

The receiver derives its timing from the input signal.

▶ **To set up the DS1 or DS3 Receive interface**

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Physical** tab.
2. Set the **Signal Rate** to **DS1** or **DS3**.
3. Select the **Line Code** (DS1 signals only).
4. Set the **Operating Level** to **Terminate** or **Monitor**. If you select **Monitor**, you can set the **Gain** to **20 dB** or **26 dB**.
5. Select the **Equalization On** checkbox if required.

Coupling the Transmitter to the Receiver

You can set up the instrument so that the transmitter will automatically configure to the receiver's settings.

▶ To couple the transmitter to the receiver settings

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Copy Rx to Tx**.
3 Select **Close**.

▶ To switch off coupling

1 Press **<Menu>**, choose **Tx/Rx > Coupling** then press **<Select>**.
2 Select **Switch Coupling Off**.
3 Select **Close**.

Monitoring a Framed DSn Signal

You can monitor a framed DS1 or DS3 signal or drop the framed DSn signal from the payload of a SONET or SDH signal. The framed DS1 or DS3 signal can be structured or unstructured. The PRBS patterns carried in these signals can be inverted or non-inverted (normal).

You should connect the DS1 or 2-140 Mb/s DS3 In port to the network being tested.

For more information, see:

- “Monitoring a Framed DSn Signal (Unstructured Payload)" on page 254
- “Monitoring a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 255
- “PRBS Polarity" on page 257

Monitoring a Framed DSn Signal (Unstructured Payload)

You can monitor a framed DS1 or DS3 signal with an unstructured payload. The transmitted test pattern fills the entire payload and can be inverted or non-inverted (normal).

This procedure assumes you have set up a DSn signal rate.

▶ To view a DSn signal with an unstructured payload

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** to the required setting, then select **Unstructured**.
3. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Pattern** tab. Then select the required pattern (inverted or normal).

Monitoring a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)

When you monitor a DSn signal with a structured (channelized) payload, you will need to select the test patterns for the foreground (test) channel and background (non-test) channels in the payload. The test pattern can be inverted or non-inverted (normal).

Signal	Framing	Payload Structure
DS1	ESF, D4, SLC-96 or Unframed	DS1(56 kb/s), DS1 (64 kb/s)
DS3	C-bit, M13, Unframed	DS1, DS1(56 kb/s), DS1 (64 kb/s), 2 Mb/s, 2 Mb/s (64 kb/s)

You can also monitor the signaling bits of a DS1 (56 kb/s) or 2 Mb/s with PCM30 or PCM30CRC framing.

Signal	Framing	Signaling bits
DS1	ESF SF (D4) SLC-96 No framing bit	A B C D individually set to 1 or 0. A B individually set to 1 or 0. A B individually set to 1, 0 or alternating. A B C D individually set to 1 or 0. The same signaling bit pattern is carried in all foreground timeslots.
2 Mb/s	PCM30 or PCM30CRC	A B C D individually set to 1 or 0. The signaling bits of all timeslots are set to the 4-bit user-defined value.

Si and Sa spare bits can also be viewed if a 2 Mb/s signal is selected (see the final step of this procedure).

This procedure assumes you have set up a DSn signal rate.

PDH Signal	Spare Bits
2 Mb/s	Si bits (international bits) - Located in Timeslot 0 Bit 1of both the FAS and NFAS frames. E bits - Are the Si bits of frames 13 and 15 of a CRC-4 frame, and can be independently modified. When transmitted as 0, they inform the far end that block errors have occurred. Sa bits (national bits) - located in bits 4 to 8 of NFAS timeslot. Sa bit Sequences - Defines sync status, it is an 8-bit sequence in the selected NFAS Sa bits of a CRC-4 frame. The sequence appears in odd numbered CRC-4 frames (starting from frame 1). CAS Multiframe - Located in MFAS timeslot bits 5, 7 and 8.

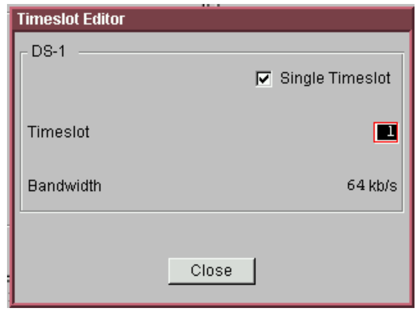
▶ To view a DSn signal with a structured payload

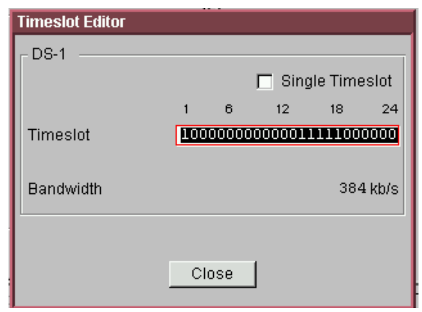
1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.

2 Set the **Framing** and select **Structured**.

3 Set the **Test Channel Rate**. Enter values in the **Test Channel DS2**, **DS1/2Mb/s** and **56/64 kb/s** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you click on the **56 kb/s** or **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** checkbox and a timeslot (or de-select the **Single Timeslot** checkbox for N x 56/64 kb/s foreground channels, then select **Close**.

   When monitoring DS1 channelized payloads, you can monitor a single 56/64 kb/s foreground channel or N x 56/64 kb/s foreground channels. Use the N x 56/64 kb/s channels when testing wideband services such as high speed data and LAN links (112 or 336 kb/s). The N x 64 kb/s foreground channels can be contiguous or non-contiguous





4 Select **Test Channel Framing** (DS3 line rate only).

5 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Pattern** tab.

6 Press **<Menu>**, choose **Overhead Monitor > Signaling Bits** then press **<Select>**. View the signaling bits.

7 Press **<Menu>**, choose **Overhead Monitor > Spare Bits** then press **<Select>**. View the spare bits.

   Or: Press **<Menu>**, choose **Overhead Monitor > Sa Bits** then press **<Select>**. View the Sa bits.

PRBS Polarity

The definition of PRBS polarity may differ between ITU-T Recommendation O.150 and common practice in the USA. This is illustrated by the following table.

Pattern	ITU-T	USA
PRBS9	Non-inverted	Non-inverted
PRBS11	Non-inverted	Non-inverted
PRBS15	Inverted	Non-inverted
QRSS	Non-inverted	Non-inverted
PRBS23	Inverted	Non-inverted
PRBS31	Inverted	Inverted

Note that a non-inverted (2En)-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and inverted sequence produces a longest run of n zeros in the PRBS sequence.

You can select PRBS polarity to be inverted or non-inverted (normal). For all signal types except SONET, either ITU or non-ITU is displayed beside your selection to indicate if it conforms to ITU-T O.150.

Monitoring an Unframed DSn Signal

You can monitor test patterns in an unframed DS1 or DS3 signal applied to the DS1 In or 2-140 Mb/s DS3 In ports, or dropped from the payload of a SONET or SDH signal. The test patterns can be inverted or non-inverted.

This procedure assumes you have set up a DSn signal rate.

▶ **To view an unframed DSn signal**

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing** to **Unframed**.
3 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Pattern** tab.
4 Then select the required pattern (inverted or normal).

Dropping a DS1 Payload from a DS3 Signal

You can drop a DS1 payload from a framed DS3 signal via the DS1 Out port.

The DS3 signal (carrying the DS1 payload to be dropped) must be connected to the 2-140 Mb/s DS3 In port.

This procedure assumes you have set up a DS3 signal rate.

▶ **To drop a DS1 payload from a DS3 signal**

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Framing,** then select the required DS3 frame setting, then select **Structured**.
3 Set the **Test Channel Rate** to **DS1**.
4 Enter values in the **Test Channel DS2** and **DS1** boxes to select the required channel.
5 Select the **Drop DS-1** checkbox.

Dropping a Voice Channel from a DSn Signal to the Internal Speaker

You can drop a 56 kb/s or 64 kb/s voice channel from a framed DSn signal to the instrument's internal speaker.

This procedure assumes you have set up a DSn signal rate.

▶ **To drop a voice channel to the internal speaker**

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2. Set **Framing** to **M13** or **C-Bit** and **Structured**. Set the **Test Channel Rate** to 2 Mb/s (64 kb/s), DS1 (64kb/s) or DS-1 (56kb/s) as required.
3. Enter values in the **Test Channel DS2**, **DS1** and **64 kb** boxes to select the required channel (the selected test channel rate determines which boxes will be active).
4. When you click on the 56 kb/s or 64 kb/s box, select the Single Timeslot checkbox, then select the appropriate timeslot carrying the voice channel.
5. Select the **Listen** checkbox (a tick appears in the box), select the appropriate volume level. Select **Close**.

Monitoring FEAC Messages in a DS3 Signal

You can monitor the current and previous loopback, alarm or status information contained in the FEAC channel (the 3rd C-bit of a framed DS3 signal).

This procedure assumes you have set up a DS3 signal rate.

FEAC Message	
Loopback Codes	You can transmit N loopcodes and M messages in a single burst, where N and M are selectable in the range 1 to 15.
Alarm/Status Messages	You can transmit ANSI T1.107-1995 messages or any user specified code (0XXXXXX0 11111111) continuously, or in a single burst.

To view a FEAC message in a DS3 signal

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.

2 Set **Framing** to **C-Bit**.

3 Press **<Menu>**, choose **Overhead Monitor > DS3 FEAC** then press **<Select>**. View the current and last non-idle FEAC messages.

Monitoring Spare Bits of a 2 Mb/s signal in a DS3 Signal

You can view the Si and Sa spare bits of a structured 2 Mb/s signal carried in a DS3 signal.

PDH Signal	Spare Bits
2 Mb/s	Si bits (international bits) - Located in Timeslot 0 Bit 1of both the FAS and NFAS frames. E bits - Are the Si bits of frames 13 and 15 of a CRC-4 frame, and can be independently modified. When transmitted as 0, they inform the far end that block errors have occurred. Sa bits (national bits) - located in bits 4 to 8 of NFAS timeslot. Sa bit Sequences - Defines sync status, it is an 8-bit sequence in the selected NFAS Sa bits of a CRC-4 frame. The sequence appears in odd numbered CRC-4 frames (starting from frame 1). CAS Multiframe - Located in MFAS timeslot bits 5, 7 and 8.

▶ To view Si spare bits

- Press **<Menu>**, choose **Overhead Monitor > Spare Bits** then press **<Select>**.

▶ To view Sa spare bits

- Press **<Menu>**, choose **Overhead Monitor > Sa Bits** then press **<Select>**.

Monitoring Signaling Bits in Structured DS1 or 2 Mb/s Signal

You can monitor signaling bits in a DS1 (56 kb/s) or 2 Mb/s (with PCM30 or PCM30CRC framing) signal.

Signal	Framing	Signaling bits
DS1	ESF SF (D4) SLC-96 No framing bit	A B C D individually set to 1 or 0. A B individually set to 1 or 0. A B individually set to 1, 0 or alternating. A B C D individually set to 1 or 0. The same signaling bit pattern is carried in all foreground timeslots.
2 Mb/s	PCM30 or PCM30CRC	A B C D individually set to 1 or 0. The signaling bits of all timeslots are set to the 4-bit user-defined value.

▶ To view signaling bits of a DS1 or 2 Mb/s in a DS3 signal

- Press **<Menu>**, choose **Overhead Monitor > Signaling Bits** then press **<Select>**.

Monitoring DS1 Loop Codes

You use in-band or out-of-band loop codes to locate faults. They are used to remotely control loop circuits in network equipment.

Typically, the far-end equipment activates the loop circuit when it detects the loop code. The DS1 signal is then routed back to the near-end equipment where you can verify signal integrity.

The in-band loopcodes are shown below.

Loop	Activate	Deactivate
Line	00001	001
Payload	1100	1110
Network	11000	11100
User	XXXXXXXX	XXXXXXXX

The out-of-band loopcodes are shown below.

Loop	Activate	Deactivate
Line	11111111 01110000	11111111 00011100
Payload	11111111 00101111	11111111 01001100
Network	11111111 01001000	n/a
Universal	n/a	11111111 00100100
User	11111111 0XXXXXX0	

▶ **To view in-band and out-of-band DS1 loop codes**

- Press **<Menu>**, choose **Overhead Monitor > DS1 Loopcodes** then press **<Select>**.

Setting Up Thru Mode Operation

Use transparent thru mode to non-intrusively monitor signals in networks with no protected monitor points.

The instrument is inserted into the communications path and the received data is routed unaltered to the Transmit Out port for retransmission.

The instrument operates as normal, monitoring errors and alarms in the received signal.

The instrument's timing is derived from a clock recovered from the received data.

NOTE

Settings cannot be changed once you have selected THRU mode. This stops you from selecting settings which would affect the data path.

You must select the signal rate you want before selecting THRU mode.

▶ **To set up transparent thru mode operation**

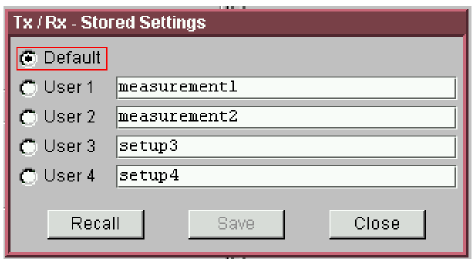
1 Press **<Menu>,** then select the **Tx/Rx > Thru Mode** window using the arrows and **<Select>** key.
2 Select the **Enable Thru Mode** checkbox (a tick appears in the box).
3 Select **Close**.

Storing and Recalling Instrument Settings

You can store four sets of instrument settings (i.e. those shown in the summary diagram at the bottom of the display). These, along with the factory default settings, can be recalled. This procedure assumes that you have already set up the instrument.

▶ To store instrument settings

1 Press **<Menu>**, choose **Tx/Rx > Stored Settings** then press **<Select>**.
2 Select one of the **User (1 to 4)** radio buttons.
3 Press the right arrow key, then enter a suitable title using front panel keypad.
4 Select **Save** to store the settings.
5 Select **Close**.



▶ To recall stored settings

1 Press **<Menu>**, choose **Tx/Rx > Stored Settings** then press **<Select>**.
2 Select one of the **User (1 to 4)** radio buttons.
3 Select **Recall**. A warning dialog box will appear. Select **OK** and the instrument will reconfigure using the recalled settings.
4 Select **Close**.

Measurements and Results

Physical

Errors and Alarms

Service Disruption

Analysis

Measuring DSn Signal Level

You can measure the +ve peak, -ve peak, and peak-to-peak voltage of the balanced DS1 signal or unbalanced DS3 signal at the instrument's DS1 In or 2-140 Mb/s DS3 In port.

Results are also displayed in dBdsx as defined in ANSI T1.102 (the +ve peak, -ve peak, and peak-to-peak signal level relative to the nominal level).

This procedure assumes you have set up the DSn receiver and connected the electrical DSn signal to the appropriate input port.

▶ **To measure the level of a DSn signal**

1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **PDH/DSn** tab.
2 Set **Signal Rate** to the appropriate DSn signal rate, then select the interface settings as required.
3 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Electrical** tab.

Measuring the Frequency of a DSn Signal

You can measure the frequency of a balanced DS1 signal or an unbalanced DS3 signal at the instrument's DS1 In or 2-140 Mb/s DS3 In port.

You can also measure frequency offset in the incoming signal. The amount of offset gives an indication of the probability of errors in the incoming DSn signal.

This procedure assumes that the bit rate, line code, input operating level and termination settings match the network element being tested. Also make sure that the test signal is connected to the appropriate optical or electrical input port.

▶ To measure the frequency of a DSn signal

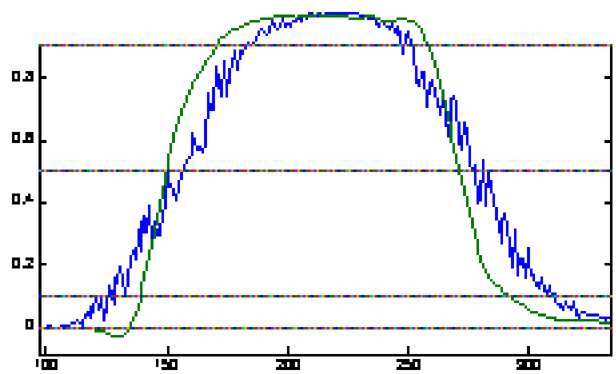
1 Press **<Menu>**, choose **Tx/Rx > Receiver Settings** then press **<Select>**. Select the **Physical** tab.
2 Select **Signal Rate**, then select the required signal and interface settings.
3 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Frequency** tab.

Viewing the Pulse Mask of a DSn Signal

With the instrument connected to the appropriate cross-connect level (DSX-1 or DSX-3), you can check that the pulse shape of a balanced DS1 signal or an unbalanced DS3 signal meets the G.703, GR-449 and ANSI T1.102 standards. You also view the level and pulse width of both the positive and negative pulses. Level ratio and width ratio are also displayed.

This procedure assumes you have set up the DSn receiver.

NOTE Excessive jitter on the input signal may adversely affect the pulse shape.



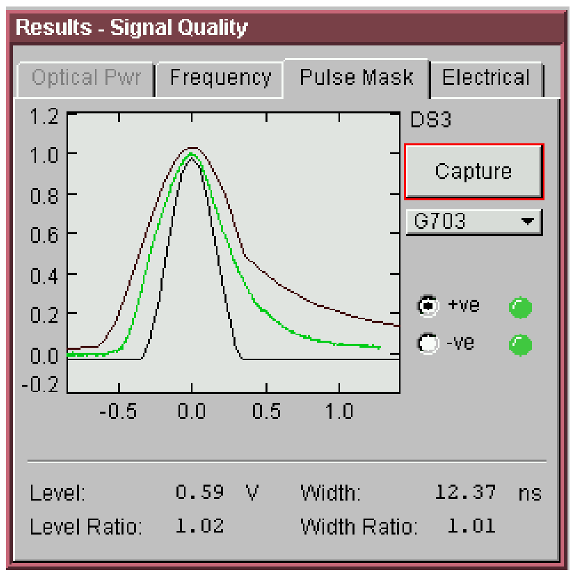
▶ To view the pulse mask of a DSn signal

1 Press **<Menu>**, choose **Results > Signal Quality** then press **<Select>**. Select the **Pulse Mask** tab.
2 Set the mask to **G703**, **GR-449** or **ANSI T1.102**.
3 Select **Capture**. The +ve and -ve LEDs are grey while data is being captured.

4 Select the appropriate **+ve** or **-ve** radio button to view the positive or negative pulse shape and measurements.

If the +ve and -ve LEDs are green, the pulse shape will also be green and within specification. If an LED is red, the part of the pulse that violates the mask envelope will be red and out of specification.

5 After data has been captured, you can apply different masks.



Viewing DSn Errors

You can view errors using any of the procedures listed below:

- “Viewing DSn Errors (Total or Last Second)" on page 274
- “Viewing the DSn Summary of Errors" on page 275
- “Viewing Errors/Alarms using the <Show More> Key" on page 276

Viewing DSn Errors (Total or Last Second)

You can monitor errors in a DSn signal during testing.

You can view errors on the display as **Total** or **Last Second** results.

Total Results The display shows the running total of errors as they occur throughout the measurement gating period. The total result stops when measurement gating stops.

Last Second The errors results display is updated every second. A last second result is the number of errors occurring in the last second.

Refer to the Specifications provided on the CD-ROM for full details of errors results.

▶ To view errors in a DSn signal

1 Press **<Menu>**, choose **Results > Errors** then press **<Select>**. Select the **PDH/DSn** tab.
2 Select the **Error Type** results to be displayed.

Viewing the DSn Summary of Errors

The Error Summary window provides a running total of the number of errors occurring during the current measurement period.

▶ To view the DSn error summary

1 Press **<Menu>**, choose **Results > Error Summary** then press **<Select>**. Select the **PDH/DSn** tab.
2 You can then view errors in more detail. Press **<Menu>**, then select the **Results > Errors** window to view the Error Ratio or errors occurring in the last second.

Viewing Errors/Alarms using the <Show More> Key

When the front panel LED lights, error and alarm conditions have been detected. The front panel **<Show More>** key allows you to view detailed alarm information.

- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when History **<Reset>** on the front panel is pressed.

To view the error/alarm conditions

- Press **<Show More>**. Select the **PDH/DSn** tab.

Viewing Alarms in a DSn Signal

You can monitor the time a DSn alarms is active for (Alarm Second) on the Results screen (except for Clock Loss and FEAC Codes). Refer to the Specifications provided on the CD-ROM for full details of the alarms.

▶ **To view alarms in a DSn signal**

- Press **<Menu>**, choose **Results > Alarm Seconds** then press **<Select>**. Select the **PDH/DSn** tab.

Viewing Errors and Alarms Using Trouble Scan

You use Trouble Scan to continuously monitor errors and alarms in a framed DSn signal, or the framed DSn signal in the payload of a SONET or SDH signal.

Trouble Scan is useful for testing new networks as it can simultaneously detect up to four error types in the following priority order; Code, CRC6, Frame, CP-Parity, P-Parity, FEBE, and Bit (useful for testing new networks).

▶ To monitor errors and alarms using Trouble Scan

1 Press **<Menu>**, choose **Results > Trouble Scan** then press **<Select>**. The errors and the alarms that have been detected will be displayed.

2 If **Alarms Active** is displayed, then press the front panel **<Show More>** key to determine which alarms have occurred.

Front Panel LEDs and <Show More> key

The front panel **<Show More>** key allows you to view detailed alarm information

- Current alarms are shown red, while previous (historical alarms) are shown yellow.
- The History LED indicates that an alarm has occurred since the History alarms were last reset. It is reset either when a test period is started or when History **<Reset>** on the front panel is pressed.
- If no alarms are detected and all error counts are zero then “No Trouble” is displayed on the **Results > Trouble Scan** page.

NOTE Clock Loss and Power Loss alarms are not monitored in Trouble Scan.

Measuring Service Disruption Time in a DSn Network

You can measure the time it takes (service disruption time) for the automatic protection switch (APS) circuit to detect and activate the standby equipment when a fault occurs. This protection switch action allows the network to continue earning revenue even when equipment goes faulty.

For more information, see “Test Configuration for Measuring Service Disruption Time" on page 443.

You can deliberately invoke a protection switch in a network carrying a PRBS by generating a burst of PRBS errors.

▶ To view disruption time

1 Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Service Disruption** tab.
2 Press **<Run/Stop>**.
3 Verify error-free reception of the PRBS test pattern.
4 Invoke a protection switch on a working section of the transmission system that is transporting the PRBS. The instrument will display the service disruption results.

NOTE You can deliberately invoke a protection switch in a network carrying a PRBS by generating a burst of PRBS errors. You can simulate a node failure by removing the power from the transmission element, or you can simulate fiber break by disconnecting a fiber. For more information, see “Service Disruption" on page 442.

Service Disruption Test Results

The instrument provides three separate results:

- **Longest**: The duration of the longest error burst detected during the test
- **Shortest**: The duration of the shortest error burst detected during the test
- **Last**: The duration of the most recent error burst detected during the test

When you press the **<Run/Stop>** key at the beginning of a protection-switching time test, all result fields are reset to 0 ms.

When the protection switch is triggered, the duration of the resulting error burst is measured and displayed.

For the system under test to pass, a single error burst of duration less than 50 milliseconds should be detected. Detection of a single error burst is indicated by an identical value being displayed in the three result fields.

Three separate results are provided because some transmission systems exhibited a characteristic similar to switch-bounce during a protection-switching event. This results in multiple distinct error bursts being present on the received test pattern. By providing three separate results, the instrument's service disruption measurement clearly identifies the presence of this unwanted operating characteristic.

Other additional measurement features include:

- Relative timestamping of the beginning and end of each service disruption event.
- **History**: A record of the first ten service disruption measurements.

While an Alarm Indication Signal is not strictly speaking a pure protection-switching measurement, it is closely tied to these types of measurements by being activated as a result of any physical layer failure, such as a fibre break.

Alarm Indication Signal (AIS)

The instrument can provide details of AIS duration measurements, AIS timestamping and an AIS history. When used in conjunction with the instrument's service disruption measurements, it becomes possible to show a relationship between alarms within a device and automatic protection switches in a network. This provides the ability to quickly and accurately debug network elements. For example, using the timestamping and AIS duration measurements, it is easy to see if a device fails due to AIS not being raised quickly enough, or if it fails due to AIS not being removed quickly enough once the switch has taken place.

Measuring Round Trip Delay in a DSn Network

You can measure round trip delay using a balanced DS1 signal or an unbalanced DS3 signal. Round trip delay is the time taken for traffic to pass through a network.

When you run a round trip delay measurement, the instrument's transmitter and receiver operate together. First, the instrument transmits a burst of bit errors, it then measures the time it takes for the errors to be detected by the receiver. The time difference between transmitting and receiving errors is the round trip delay.

This procedure assumes that you have set up a loopback connection in the network you are testing. Also, make sure that the bit rate, line code, input operating level and termination settings match the network element being tested and that the Transmit and Receive DSn signal structures match. Set up the instrument to transmit a DSn signal with a PRBS pattern and ensure there are no Signal, Frame or Pattern errors

For more information, see:

- "Setting Up the DSn Transmit Interface" on page 231
- "Coupling the Receiver to the Transmitter" on page 232
- "Transmitting a Framed DSn Signal" on page 235

▶ **To measure the round trip delay of a DSn network**

1 Press **<Menu>**, choose **Test Functions > Switch Off** then press **<Select>**.
2 Press **<Menu>**, choose **Results > Network Measurements** then press **<Select>**. Select the **Round Trip Delay** tab.
3 Select **Measure**.

Viewing the ITU Analysis of DSn Errors and Alarms

You can view the ITU analysis of a framed DSn signal, or framed DSn signal in the payload of a SONET or SDH signal.

Make sure the bit rate, line code, input operating level and termination settings match the network element being tested. Also ensure that the Receive DSn signal framing structure is set correctly.

▶ **To view the ITU analysis of result**

1 Press **<Menu>**, choose **Results > Performance Analysis** then press **<Select>**.
2 Set the G- or M-series **Analysis Type** as required.

NOTE All supported types of analysis are available during a measurement. For more information, see “Introducing ITU Performance Analysis" on page 428. The measurement will not be affected if you switch between the different results provided.

5
Instrument Setup and Use - Ethernet

This chapter tells you how to access and use the Ethernet capabilities of the instrument and view the results.

Setting up the Transceiver

Test Mode Selection

Three test modes are available for rapidly configuring the instrument for specific test scenarios:

- End-to-End Test
- Loopback Test
- Loopthru

For End-to-End and Loopback, there are two setup modes:

- **Pre-set** mode pre-configures the stream information including source and destination addresses automatically for either loopback or end-to-end testing.
- **Expert** mode allows you to override the pre-configured settings, if required.
- See “Setup Mode Selection" on page 291 for details.
- In Loopthru, the setup mode is automatically set to **Expert**.

For each of the test modes, the Ethernet frame type can be selected.

- See “Ethernet Frame Type Selection" on page 296 for details.

Finally, you can re-negotiate the status of each link individually.

- See “Negotiation Status" on page 296 for details.

End-to-End Test

End-to-end testing requires two instruments, one at the near or local end, the other at the far or remote end.

Note that RFC 2544 Conformance Testing is not available when testing in end-to-end mode.

▶ To select end-to-end mode

1 Press **<Menu>**, choose **Tx/Rx** > **Transceiver Settings** then press **<Select>**.

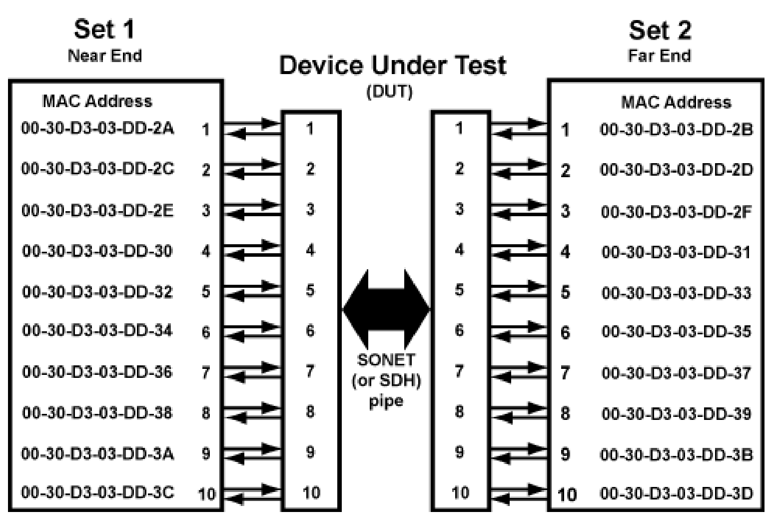
2 Select the **Test Mode** field and choose **End To End Test** from the drop-down list.

3 Choose which **Setup Mode** you require.

   If you choose **Pre-set**, then all settings are chosen for you automatically.

   If you choose **Expert**, see “Settings Available" on page 292.

4 In the **Designate This Instrument As** field, set the near end instrument to **Set 1** and the far end instrument to **Set 2**, or the other way round as appropriate.



End-to-End Testing

Loopback Test

There are two ways of performing loopback testing with this instrument:

- **1 port loopback** at the far end. This involves looping back the data sent on one port back to the same port at the near end.

  Depending on the type of device under test, this may require the use of a second instrument at the far end to perform the loopback using the loopthru mode.
- **2 ports loopback** at the far end. This involves looping back the data sent on one port to another port at the near end.

Note that RFC 2544 Conformance Testing is available only in loopback mode.

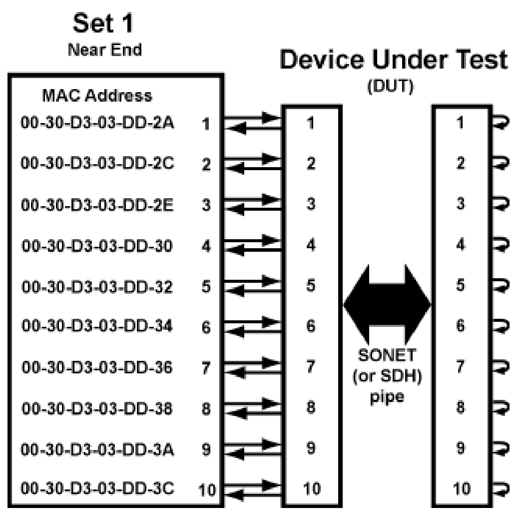
▶ To select loopback mode

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **Test Mode** field and choose **Loopback Test** from the drop-down list.
3 Choose which **Setup Mode** you require.

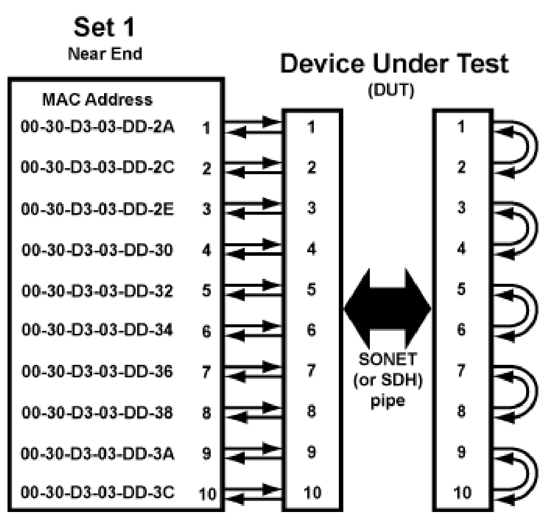
   If you choose **Pre-set**, then in the **Loopback Mode** field, select **1 Port Loopback** or **2 Ports Loopback** as appropriate.

   For **2 Ports Loopback**, in the **Designate This Instrument As** field, choose MAC Address **Set 1** or **Set 2**, as appropriate.

   If you choose **Expert**, see “Settings Available" on page 292.



1 Port Loopback Testing



2 Port Loopback Testing

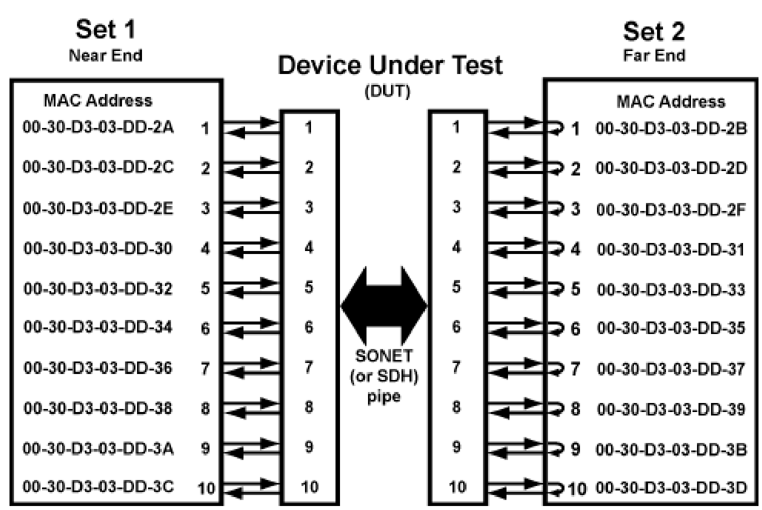
Loopthru

This mode uses two testers, one at each end of the Ethernet circuit. However, the far end tester does not actively test the circuit. It simply acts as a “loopthru”. It receives the test frames and strips the source and destination MAC addresses. It then re-inserts the original source address as the new destination address and the original destination address as the new source address before re-transmitting the frames.

Using this method it is possible for all tests to be carried out, including latency, on a single circuit, without provisioning an extra path through the network.

To select loopthru mode

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **Test Mode** field and choose **Loopthru** from the drop-down list.



1 Port Loopback Testing, with Loopthru

Setup Mode Selection

For the End To End and Loopback Tests there are two setup modes available:

- Pre-set Mode pre-configures the stream information including source and destination addresses automatically.
- Expert Mode allows you to override the pre-configured settings, if required.

Pre-set Mode

All stream information including source and destination addresses is set automatically, except for negotiation status and laser control. The exact settings chosen by the instrument depend on whether loopback or end-to-end testing is chosen.

Negotiation Status lets you re-negotiate each link individually.

Laser On/Off applies only to 1 Gb/s Ethernet.

▶ **To select pre-set mode**

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **Setup Mode** field and choose **Pre-set** from the drop-down list.

To see what the settings are in pre-set mode, refer to “Settings Available" on page 292.

Expert Mode

All the default settings selected automatically in Pre-set Mode can be overridden in Expert Mode.

▶ **To select expert mode**

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **Setup Mode** field and choose **Expert** from the drop-down list.

For information on what settings are available to choose from, see “Settings Available" on page 292.

Settings Available

1 Gb/s Settings - Pre-set Mode

Auto Neg	Data Rate / Duplex Mode	Flow Control *
On	1 Gb/s / Full	Auto
* See “Flow Control" on page 293		

1 Gb/s Settings - Expert Mode

Auto Neg	Data Rate / Duplex Mode	Flow Control *
On	1 Gb/s / Full	Auto Off TX + RX
Off	1 Gb/s / Full	Off TX + RX
* See “Flow Control" on page 293		

10/100 Mb/s Settings - Pre-set Mode

Auto Neg	Data Rate / Duplex Mode / Flow Control *
On	Auto
* See “Flow Control" on page 293	

10/100 Mb/s Settings - Expert Mode

Auto Neg	Data Rate	Duplex Mode	Flow Control *
On	Auto 100 Mb/s 10 Mb/s	Auto Full	Auto Off TX + RX
		Half	Auto
Off	100 Mb/s 10 Mb/s	Full	Off TX + RX
		Half	Off

* See “Flow Control" on page 293

Laser

The laser can be turned on or off. This applies only to 1 Gb/s Ethernet.

WARNING **Always deactivate the laser before connecting or disconnecting optical cables.**

Flow Control

If two stations are capable of flow control, the way Ethernet initiates it is through PAUSE frames. PAUSE frames are special control frames that are sent to a reserved multicast address and contain a request to stop transmitting frames for a certain period of time (usually configured in the send device). The receiving station should obey this request and start transmitting when that time has elapsed.

Flow Control choices:

- **Off**
- **Auto** - flow control auto-negotiated
- **TX + RX** - can transmit and receive PAUSE frames

Source and Destination Addresses

The instrument is not a standard Ethernet device. It can transmit and receive frames with any source and destination address.

However, there are nominal MAC (Media Access Control) addresses for each port that are used by default as the source address of all frames transmitted from that port. The default addresses are used when the instrument is in **Pre-set** mode.

These addresses may be overridden in **Expert** mode.

Setting MAC Address Sets

There are two sets of Default MAC Addresses, see page 295, which can be selected as **Set 1** or **Set 2**.

▶ **To change a source or destination address**

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **Setup Mode** field and choose **Expert** from the drop-down list.
3 Select the Source or Destination Address that you wish to change. Press **<Select>** again to edit the field.
4 Use the keypad to enter the new address in hexadecimal. Press **<Select>** to save the new address or **<Cancel>** to revert to the original address.

Default MAC Addresses

	Set 1	Set 2
Port	MAC Address	MAC Address
1 (10/100 Mb/s)	00-30-D3-03-DD-2A	00-30-D3-03-DD-2B
2 (10/100 Mb/s)	00-30-D3-03-DD-2C	00-30-D3-03-DD-2D
3 (10/100 Mb/s)	00-30-D3-03-DD-2E	00-30-D3-03-DD-2F
4 (10/100 Mb/s)	00-30-D3-03-DD-30	00-30-D3-03-DD-31
5 (10/100 Mb/s)	00-30-D3-03-DD-32	00-30-D3-03-DD-33
6 (10/100 Mb/s)	00-30-D3-03-DD-34	00-30-D3-03-DD-35
7 (10/100 Mb/s)	00-30-D3-03-DD-36	00-30-D3-03-DD-37
8 (10/100 Mb/s)	00-30-D3-03-DD-38	00-30-D3-03-DD-39
9 (1 Gb/s)	00-30-D3-03-DD-3A	00-30-D3-03-DD-3B
10 (1 Gb/s)	00-30-D3-03-DD-3C	00-30-D3-03-DD-3D

These addresses may be overridden in **Expert** mode.

Frame Size

This field can be changed only in **Expert** mode.

The Frame Size can be set in 1 byte steps from:

- 58 bytes up to 16384 bytes for 10/100 Mb/s Ethernet
- 58 bytes up to 65536 bytes for 1 Gb/s Ethernet.

VLAN

This field can be changed only in **Expert** mode.

When enabled, you can set the Priority Level between 0 (highest) and 7 (lowest) and the VID (VLAN ID) between 0 and 4095, in decimal.

Ethernet Frame Type Selection

The Ethernet frame type can be selected from hexadecimal values between **0000** (the default value) and **FFFF**.

See “Frame Type Selection" on page 296 for more details.

▶ **To select Ethernet frame type**

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **Setup Mode** field and choose **Expert** from the drop-down list.
3 Select the **Ethernet Frame Type** field and enter the hexadecimal value required, then press **<Select>**.

Frame Type Selection

The type/length field in an Ethernet frame can describe either the **type of protocol** unit that is held in the frame data field or it can be **how many bytes** of Logical Link Control (LLC) information are in the frame data field. The difference is in the value of the field:

- If the value is more than 1536 decimal (or 0600 in hexadecimal), then it describes the protocol type.
- If the value is 1518 decimal (or 05EE in hexadecimal) or less, then it is the number of LLC bytes in the data field.

Negotiation Status

This lets you re-negotiate each link individually. It applies only to those links whose **Auto Neg** status is set to **On**.

For more details, see “Auto-negotiation" on page 297.

▶ **To display negotiation status**

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.

2 Select the **Negotiation Status More** button (indicated by three dots).
3 Select **Re-Negotiate** to re-negotiate the links, as appropriate.
4 Select the **Registers More** buttons to view the auto-negotiation registers, as appropriate.

Auto-negotiation

Auto-negotiation is a means of automatically connecting two Ethernet stations for the best possible performance without intervention from a user. This can include link speed and flow control for 10/100 Mb/s. For 1 Gb/s it applies to flow control only since the speed is preset to 1 Gb/s.

Auto-negotiation is done by sending out signals called Fast Link Pulses that contain a mixture of clock information and data to identify the Ethernet technology and flow control support. The stations work out between themselves the best way they can connect.

In 1000BASE-X the stations exchange special code groups of control data to perform the auto-negotiation but they look identical from a signal level, timing point of view to normal data.

If the stations cannot connect, then manual configuration is required.

In the auto-negotiation registers:

- **Advertisement Register** shows the value of the auto-negotiation register the port has advertised during auto-negotiation.
- **LP Ability Register** shows the value the port received from it's Link Partner (LP) during auto-negotiation.
- **MDIX Status Bit** is set if a crossed connection is used, clear if not. A crossed connection is one where the Tx lines from one end are connected to the Rx line at the other end and vice versa. These cables are primarily used to connect two pieces of DTE (Data Terminal Equipment) together, for example two laptop Ethernet ports together to allow file transfer.

Physical Interfaces

Gigabit Ethernet Ports

Connector Type	Two slots for GBIC Modules
Data Rate	1000 Mb/s This is 8B/10B encoded as per ANSI X3.230-1994 (FC-PH), clause 11 (referenced in IEEE802.3(2000) 36.2.4) to give a Line Transmission rate of 1250 Mb/s
Port Settings (with Auto Negotiate ON)	Full duplex
	Flow Control ON, Flow Control OFF or Auto Negotiate Flow Control
Port Settings (with Auto Negotiate OFF)	Full duplex
	On/Off
Tx Power	GBIC dependent
Rx Sensitivity	GBIC dependent

The gigabit interfaces use GBIC (GigaBit Interface Converter) plug-in modules and parameters such as connector type or optical signal specifications are therefore dependent on the GBIC that is fitted.

“Standard” GBICs are 1000BASE-SX (850 nm, multi mode) and 1000BASE-LX (1300 nm, multi mode or single mode). Agilent recommend the following GBICs:

Interface Type		GBIC Agilent Part Number
1000 BASE-SX	850 nm, multi-mode	J5491A (1 pair)
1000 BASE-LX	1300 nm, multi-mode or single-mode	J5492A (1 pair)

There are many other GBICs available, including "non-standard" formats such as 1000BASE-ZX (1550 nm, single mode) or GBICs with non-standard connector types. Any of these GBICs can be used provided they operate at the 1.25 Gb/s line rate and meet the GBIC specification (SFF Standard, Document Number SFF-8053 Rev 5.5).

The Ethernet module GBIC interfaces comply with the GBIC standard and full details of the electrical connections can be found in that standard.

Information about any GBIC that is inserted into ports 9 or 10 is displayed automatically on the **Ethernet Transceiver - Port Setup** page.

▶ To view GBIC information

1 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.
2 Select the **1 Gb/s** folder.
3 Information about any GBIC inserted into ports 9 or 10 is displayed at the bottom of the page. The information displayed is:

   Ethernet Type

   MOD_DEF

   Data Rate

   Vendor

   Part Number

10/100 Mb/s Ethernet Ports

Connector Type	Eight RJ45 connectors	
Port Settings (With Auto Negotiate ON)	Data Rate	10 Mb/100 Mb (Restricted Negotiation) / Auto Negotiate
	Duplex Mode	Full/Half (Restricted Negotiation) / Auto Negotiate
	Flow Control	On/Off/(Restricted Negotiation) / Auto Negotiate
Port Settings (With Auto Negotiate OFF)	Data Rate	10 Mb/s or 100 Mb/s, Fixed Setting
	Duplex Mode	Full or Half, Fixed Setting
	Flow Control	On/Off
10 Mb/s Operation	Complies with IEEE802.3 (2000) 10BASE-T for operation over two pairs of CAT5 UTP cabling. Note: To guarantee RFI performance shielded twisted pair must be used.	
	Maximum Cable Length	100 metres
	Modes of Operation	Full Duplex, Half Duplex
	Data Rate	10 Mb/s, Manchester encoded to give a binary signal at 10 Mbaud in accordance with IEEE802.3 (2000)
100 Mb/s Operation	Complies with ANSI X3.1995(TP-PMD) referenced in IEEE802.3 (2000) 100BASE-TX for operation over two pairs of CAT5 UTP cabling. Note: To guarantee RFI performance shielded twisted pair must be used	
	Maximum Cable Length	100 metres
	Modes of Operation	Full Duplex, Half Duplex
	Data Rate	100 Mb/s, 4B/5B encoded to give tertiary signal at a symbol rate of 125 Mbaud in accordance with IEEE802.3 (2000)

Ethernet Port Status

The instrument will display the following status information for the test ports.

All Ports	Auto Negotiation Status	This will display the outcome of the auto-negotiation process
	Paused	Displayed if Flow control is enabled and PAUSE frames are being received
10/100Mb Ports	No Signal	This is defined as loss of fast link pulse
Gigabit Ethernet Ports	No Signal	This is defined as a Loss of Signal indication from the GBIC module
	Tx Fault	Displayed if the GBIC module detects a fault
	Data Invalid	Indicates a fault with the received data
	GBIC information	Displays the type of GBIC installed, for example 1000BASE-SX

▶ To display port status

1 Press **<Show More>**. This displays the status of all 10 ports.

2 Press **<Menu>**, choose **Tx/Rx > Transceiver Settings** then press **<Select>**.

   Select **1 Gb/s** to view the GBIC information.

   Select **Negotiation Status** to view the auto negotiation status.

Ethernet Tx Eye Clock

The transmit eye clock is operational only for 100 Mb/s and 1000 Mb/s.

Connector Type	SMA
Frequency	100 Mb/s - 25 MHz
	1000 Mb/s - 125 MHz
Impedance	Drives 50 ohm inputs
Signal Level	Nominal ECL level, AC coupled

▶ To select the Ethernet Tx Eye Clock

1. Press **<Menu>**, choose **Tx/Rx > Tx Eye Clock** then press **<Select>**.
2. In the **Eye Clock** field, select Off, 100 Mb/s or 1 Gb/s, as appropriate.
3. Then select **Close**.

Measurements and Results

RFC 2544 Conformance Tests

This test suite produces results that allow comparisons between network equipment. The tests give specific results for throughput, latency and frame loss rate.

The test options allow for full RFC compliance to be selected, or a reduced time 'quick test' option to be chosen. This dramatically reduces the test execution time and has little impact on the acquired results.

The tests are run in loopback mode only. For details on the setup, see “Loopback Test" on page 288.

Path Select lets you choose 1-port or 2-port loopback testing and the individual ports over which the tests will be performed.

The **Test Point Options** page lets you choose the number of test points, which tests you wish to perform, and the test point parameters.

Test Point Options

This page lets you choose the number of test points, which tests you wish to perform, and the test point parameters.

The tests are designed to be run automatically as a sequence, but you can select a sub-set to run as a preliminary check. However, the latency test cannot be run without first running the throughput test. The tests can also be selected to run in one or both directions. This allows for testing traffic load under both conditions.

▶ **To select test point options**

1 Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.
2 Select **Test Point Options ...** to reveal the pop-up page.
3 Set the **Test Point Options** as appropriate.
4 Select **Close** to close the pop-up page.

Test Point Choices

Run All Tests selects all tests.

- **Throughput**, **Latency** and **Frame Loss** are the individual tests.

In **Test Point Parameters**, choose the **Duration Setting** from **Default**, **Quick** or **User**. When **User** is chosen, enter individual values using the keypad as follows:

- **Preliminary Throughput**: from 5 to 9 seconds
- **Final Throughput**: from 10 to 60 seconds
- **Latency**: from 10 to 180 seconds
- **Frame Loss**: from 10 to 60 seconds
- **Number of Latency Trials**: from 1 to 30

Path Select

This lets you choose 1-port or 2-port loopback testing and the individual ports over which the tests will be performed.

Select the **Use Pre-set Settings** checkbox to override the user settings made on the **Transceiver Setting** page.

▶ To select the test paths

1. Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.
2. Choose **Path Select ...** then, from the **Loopback Type** field, select:

   One Port for 1-port loopback testing. For details, see “1 Port Loopback Testing" on page 289 and “1 Port Loopback Testing, with Loopthru" on page 290.

   Two Port for 2-port loopback testing. For details, see “2 Port Loopback Testing" on page 289.
3. Select the ports you wish to connect.
4. Select **Close** to return to the **Ethernet RFC 2544** page.

RFC 2544 Throughput Test

The throughput test runs to determine at what rate the device under test can sustain transmission without erroring frames, or dropping frames.

A search is implemented through a selection of frames sizes, namely 64, 128, 256, 512, 1024, 1280 and 1518. At each frame size the maximum throughput at which error free transfer takes place is found. This is done by running a series of tests where a count of transmitted frames is compared to a count of received frames looking for any dropped frames. When a rate where no dropped frames is found, the maximum throughput is also found.

The results are presented in a table and graphically.

▶ To set up an RFC 2544 throughput test

1 Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.
2 Set up the paths to be tested as detailed in “Path Select" on page 306.
3 Set the “Test Point Options" on page 305 as appropriate.
4 To run only the Throughput Test, deselect **Run All Tests** and select **Throughput**.
5 Select **Close** to close the pop-up page.
6 Select **Start** in the **Test Control** field and then press **<Select>** to start the test.
7 The progress of the test is displayed in the **RFC Test Status** field.

RFC 2544 Latency Test

The latency test is run at the maximum throughput rate found in the throughput test, to determine the latency through the device under test.

For this instrument, this has been extended to include the network transmission delays and far end device under test latency too. This gives a more accurate picture of round trip delay. A series of tests are run at the specified frame sizes. The latency figure is averaged over a number of runs; this number is configurable.

The results are presented in a table and graphically.

▶ To set up an RFC 2544 latency test

1 Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.
2 Set up the paths to be tested as detailed in “Path Select" on page 306.
3 Set the “Test Point Options" on page 305 as appropriate.
4 To run only the Latency Test, deselect the **Run All Tests** field and select **Latency**.
5 Select **Close** to close the pop-up page.
6 Select **Start** in the **Test Control** field and then press **<Select>** to start the test.
7 The progress of the test is displayed in the **RFC Test Status** field.

RFC 2544 Frame Loss Rate Test

Finally run the frame loss rate test.

This starts at 100% loading for each of the specified frame sizes and drops by 10% until 10% load is reached. That is, it runs a series of tests at 100%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20% and 10% load. These tests are run at each of the specified frame sizes.

The results are presented in a table and graphically.

▶ To set up an RFC 2544 frame loss rate test

1 Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.
2 Set up the paths to be tested as detailed in “Path Select" on page 306.
3 Set the “Test Point Options" on page 305 as appropriate.
4 To run only the Frame Loss Rate Test, deselect the **Run All Tests** field and select **Frame Loss**.
5 Select **Close** to close the pop-up page.
6 Select **Start** in the **Test Control** field and then press **<Select>** to start the test.
7 The progress of the test is displayed in the **RFC Test Status** field.

Viewing and Printing Results

You can log the RFC 2544 results to a file or printer (connect the printer to the instrument's USB port).

▶ To view the results of an RFC 2544 frame loss test

1 Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.

2 Select the **Port x to Port y** field in the **View Results For Path** area and press **<Select>**. Choose which results you wish to view and press **<Select>**.

▶ To print the results of an RFC 2544 frame loss test

1 Press **<Menu>**, choose **Test Functions & Results > RFC2544 Tests & Results** then press **<Select>**.

2 Select **Print Results...**. Select a **Destination** (**File** or **Printer**). If you choose **File**, enter a filename and press **<Select>**.

3 Select **Generate Report**.

4 Select **Close** to return to the **RFC 2544** page.

Manual Tests - Functions and Results

Before carrying out any of the procedures in this section, it is assumed you have followed the steps detailed in “Setting up the Transceiver" on page 286.

With this set of pages, you can set the transmit duration, the type of errors to add and the requested port data rates for the transmitter and receiver. In addition, you can view the results for the measurements you have set up.

Transmit Duration

The transmission period for test frames can be either **Continuous** or **Burst**.

For **Continuous**, the period is started and stopped by selecting **Start** then **Stop**.

For **Burst**, the duration can be programmed in:

- **Frames**: from 1 to 1,000,000,000
- **Time**: from 1 second to 99 days, 23 hr, 59 min, 59 sec
- For both Frames and Time, the period is started by selecting **Start**

When frames are selected, an equivalent time is displayed for the currently selected frames size and bandwidth. For example, for 64 byte frames at 10 Mb/s, a 1,000,000,000 frames burst will take 18.7 hours.

▶ **To set transmit duration**

1 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
2 Select **Transmit Duration** and then, from the **Duration Type** field in the pop-up page, **Continuous** or **Burst**.
3 If **Burst** is chosen, then select **Frames** or **Time** and enter the values you require.
4 Select **Close** to save the values you have entered and return to the **Ethernet Manual Tests** page.

Error Add

This feature controls the generation of errors. It allows you to select the type of error to be added and the port(s) onto which the error condition is injected.

The types of errors that can be added are:

- Non-testset Frame
- Drop Frame
- Error Frame
- Out of Sequence Event

▶ How to add errors

1. Press **<Menu>**, choose **Test Functions & Results > Error Add** then press **<Select>**.
2. Select from the **Add Frame Errors** field in the pop-up page the type of error to add.
3. Select the port(s) onto which you wish to inject the error condition.
4. Select **Close** to save the values you have entered.
5. Errors are added by pressing the **<Single Error>** button.

Non-testset Frame

This inserts a frame that does not have a valid test set data area. The frame is counted in the port transmit frame count. The action does not affect the port data rate which is constant but does affect the stream data rate (although the effect should be small). This should produce a non-testset frame count on the receiver. The second transmission of the frame will be without corruption.

Drop Frame

This mimics the dropping of a frame by a network. Note that the transmitter frame count will increment.

Error Frame

This errors the Frame Check Sequence (FCS) in the next transmitted frame.

An errored frame is measured at the receiver as either a dropped frame (Ethernet devices such as switches will drop errored frames) or as an errored frame (where no Ethernet switch is in the path).

Out of Sequence Event

This adds an out-of-sequence event to the specified stream and should be registered in the Out of Sequence Event Count by the receiver.

Data Throughput (Port Data Rate)

You can change the data transmission rate for each port individually. You can also change the receive rate, assuming that flow control is supported by the device under test (DUT).

This allows you to set the transmission rate higher than the rate the receiver can handle. When this happens the receiver will issue PAUSE commands to the DUT and potentially frames will be lost. If the DUT is not capable of full-bandwidth transmission then frames will also be lost. Alternatively the DUT will issue PAUSE commands to the test set transmitter to reduce the transmission rate. PAUSE indication on the test set lets you see this happening in real time.

The port date rate ties in to the negotiated line rate and sets an upper limit for itself. The test set will also be aware of the frame size and if changed will re-calculate the frames required per second to achieve the set bandwidth.

For more information, see “Theoretical Frame Rate" on page 426.

▶ **To change the data throughput**

1 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
2 From the **Result Type** field, select **Port Data Rate** or **Port Data Rate (Frame Size)**.
3 Highlight the **Requested** Port Data Rate of the port you wish to change the data throughput on and press **<Select>**.
4 Using **Edit Field** or **Live Edit**, set the data rate to the value you require and press **<Select>**.
5 Repeat until all the Port Data Rates are set.

Viewing Results

A variety of measurement results are provided for both the transmitter and receiver. In addition, LEDs are provided to indicate error conditions.

Transmitter and Receiver Results

Results are displayed port by port. All the 10/100 Mb/s port results are displayed on one folder and all the 1 GbE port results on another.

NOTE When you select a folder (10/100 Mb/s or 1 GbE) on the transmitter, the same folder is automatically displayed on the receiver.

▶ **How to view transmitter and receiver results**

1 Press **<Menu>**, choose **Test Functions & Results > Manual Tests & Results** then press **<Select>**.
2 In the **Result Type** field, select the Results Format you wish to view.
3 Select the **10/100 Mb/s** or **1 GbE** folder.

Results Format

Error Count Format: Displayed as an integer for counts up to 999,999,999; then changes to X.XXX E+nn, where nn is between 9 and 15.

Transmitter Results

Result Type	Results Displayed
Port Data Rate	Port Data Rate (Mb/s): • Requested • Actual • Minimum • Maximum
Port Data Rate (Frame Size)	Frame Size (Bytes) Port Data Rate (Mb/s): • Requested • Actual
Port Frame Rate/Count	Port Frame Rate: the port frame count transmitted in the last second Port Frame Count: the total number of frames transmitted, including learning frames but excluding PAUSE frames
Stream Data Rate	Stream Data Rate (Mb/s): • Actual • Minimum • Maximum
Stream Frame Rate/Count	Stream Frame Rate: the number of frames in a stream transmitted in the last second Stream Frame Count: the total number of frames in a stream transmitted, excluding learning frames

Receiver Results

Result Type	Results Displayed
Port Data Rate	Port Data Rate (Mb/s): • Requested • Actual • Minimum • Maximum
Port Frame Rate/Count	Port Frame Rate: the port frame count received in the last second Port Frame Count: the total number of frames received, including any learning frames and errored frames but excluding PAUSE frames
Port Errored Frame Count	The total number of frames for which the received Frame Check Sequence (FCS) does not match the FCS calculated by the test set. The count relates to all frames on the port
Port Non-testset Frame Count	The total number of frames that have not been transmitted from an Agilent test set.
Port Jumbo/Runt Frame Count	Port Jumbo Frame Count: the total number of frames that exceed 1518 bytes in length (1522 bytes with VLAN) Port Runt Frame Count: the total number of frames that are less than 64 bytes in length
Port Broad/Multi-Cast Frame Count	Port Broadcast Frame Count: the total number of frames that have been broadcast, that is, the destination MAC address is all ones Port Multicast Frame Count: the total number of frames that have the multicast bit set in the destination MAC address field
Stream Data Rate	Stream Data Rate (Mb/s): • Actual • Minimum • Maximum
Stream Frame Rate/Count	Stream Frame Rate: the number of frames in a stream transmitted in the last second Stream Frame Count: the total number of frames in a stream transmitted, excluding learning frames

Receiver Results (Continued)

Result Type	Results Displayed
Stream Errored Frame Count	The total number of frames for which the received Frame Check Sequence (FCS) does not match the FCS calculated by the test set. The count relates to frames in an identifiable test set stream where the test set data area must be intact
Dropped Frame Count	This measurement is available only in loopback mode Frames in Transit Count: transmitter frame count minus receiver frame count. This is updated every second and finally on stop gating Dropped Frame Count: transmitter frame count minus receiver frame count. This is only updated at the end of the receiver measurement period
Out of Sequence Event Count	This counter increments if the received current sequence number is less than or equal to the last sequence number Gaps in a positively incrementing sequence are not counted
Latency	This is a measure of the frame transmission time from port to port and is available only in loopback mode The latency measurement excludes any delays due to half duplex and flow control (PAUSE) effects Latency results are: • Maximum • Minimum • Average These are measured since the start of gating in milliseconds up to 1,999.99 with an accuracy of 10 us

Stream Summary

The stream summary shows which instrument port the stream was received on. It allows rapid matching of source port and destination port through stream ID interpretation.

Also displayed are:

- Stream contents
- Source address
- Destination address
- Frame size
- Frame type
- Priority
- VLAN tag information
- Stream status, updated every second:
    - **Active** = One or more frames received in last 10 seconds for this stream
    - **Quiet** = No frames received in last 10 seconds for this stream

▶ **To view the stream summary**

- Press **<Menu>**, choose **Test Functions & Results > Stream Summary** then press **<Select>**.

LED Port Status Indicators

LEDs are used in a variety of ways to indicate activity on a port, that errors have been received or even that everything is satisfactory with a connection. The LEDs are situated on the front panel, on the top panel beside the Ethernet ports and on the GUI on a page displayed by pressing the **<Show More>** button. **Front Panel LEDs**

On the front panel only two LEDs relate to Ethernet capability:

Errors LED

This indicates Ethernet errors only when Ethernet is selected as the **Foreground** instrument.

LED Color	Error(s) Detected
Red	Any of the following counters have incremented in the last deci-second: • Port Errored Frames • Stream Errored Frames • Out of Sequence Order Frames • Non Test Set Frames • Runt Frames
Off	None of the above counters has incremented in the last deci-second

Multiple Instruments LED

This indicates Ethernet errors only when Ethernet is selected as the **Background** instrument.

LED Color	Error(s) Detected
Red	Any of the following counters have incremented in the last deci-second: • Port Errored Frames • Stream Errored Frames • Out of Sequence Order Frames • Non Test Set Frames • Runt Frames
Off	None of the above counters has incremented in the last deci-second. This LED will only be Off if all background instruments have no active errors or alarms in the last deci-second.

Top Panel LEDs

There are two LEDs beside each of the Ethernet ports on the top panel of the instrument.

LED Color	Condition Indicated	
	10/100 Mb/s Ports	1 GbE Ports
Green (flashing)	Activity	Activity
Amber (solid)	Link up	Laser on

<Show More> LEDs

The port status for all 10 Ethernet ports is displayed on the **Show More** page.

To display the Show More page

1 Press **<Show More>**.

2 For details of the meaning of these LEDs see <Show More> LEDs.

3 Close the Show More page by pressing **<Cancel>** or **<Show More>**.

The <Show More> LEDs

LED	**Fault Detected**	
	10/100 Mb/s Ports	**1 GbE Ports**
LOS	This alarm is set if the link is down in the last deci-second.	This alarm is set if the Loss of Signal line is set from the GBIC transceiver.
PAUSED	On if port is PAUSED any time in last deci-second. Off if never PAUSED in last deci-second.	
GBIC Tx Fault	-	Set if the GBIC tx fault line is set.
Data Invalid	-	This alarm is set if the instrument cannot synchronize to the incoming stream. For example, if an incompatible signal has been inserted into the GBIC
Red LED: indicates current fault. **Yellow LED: indicates historical fault.**		
None of these status indicators will light a physical LED on the front panel.		

Frame Capture

It is possible to capture up to 8 frames of the following data. Each captured frame is timestamped on capture. The following fields are captured:

- Source Address
- Destination Address
- Frame Length/Type
- VLAN Frame
- VLAN Priority Level and ID
- Up to 20 Bytes Client Data
- FCS Status
- Instrument Frame indicator

See “Frame Capture Criteria" on page 322 for details on when frames are captured.

To set up frame capture and show results

1 Press **<Menu>**, choose **Frame Capture** then press **<Select>**.
2 Select the **Frames to Capture** and the ports you wish to capture on.

   For guidance on the settings, see “Frame Capture Settings Choices" on page 323
3 Select **Start Capture** and press **<Select>**.

Frame Capture Criteria

The following table summarizes when frames are captured. The mechanism is to store only those frames which match the trigger condition.

The trigger is applied to all ports. Captured data is then filtered by port.

The captured data will report the port on which the frame was captured.

Frame Capture Criterion

Triggers	Trigger format
Source Address	xx-xx-xx-xx-xx-xx
Destination Address	xx-xx-xx-xx-xx-xx
Length/Type	xx-xx
VLAN frames	Boolean select
VID	XXXX
Priority	Value = 0 to 7
FCS	Errored
Non-testset frames	Boolean
Immediate	Action Field

Frame Capture Settings Choices

First choose whether you want to capture on **All Frames** or on **Filtered Frames**.

If you choose **Filtered Frames**, then choose which type of frame you wish to capture from and which ports you wish to inspect:

- Non-Instrument Frames
- Errored Frames
- Specific Frames

Non-Instrument Frames

Select this to capture any frames that have not been sent by your Transmission Test Set. The expected result is 0 as the instrument operates in either Loopback or End To End modes. That is, it is either talking to itself or to another instrument of its own kind.

Errored Frames

Select this to capture only errored frames.

Specific Frames

This selection gives most control.

When **Destination MAC** is selected, you can choose from:

- **Specific -** you then choose the specific MAC address of the device the frame is being sent to.
- **Broadcast -** this is used send to all devices in the Ethernet domain. The broadcast address is all 1s (or FF-FF-FF-FF-FF-FF in hexadecimal notation).
- **Any Multicast -** a multicast address is used to send to multiple addresses that have already been defined as being within a group.

When **Source MAC** is checked, you then choose your MAC Address.

When **VLAN** is checked, you then choose your **Priority Level** and **VID**:

- Select **Priority Level** to choose the priority from 0 up to 7.
- Select **VID** to choose a VLAN ID of between 0 and 4095.

Select **Frame Length/Type** and enter a value between 0000 and FFFF.

Viewing Ethernet Errors Using Results Summary

You can use Results Summary to continuously monitor errors in Ethernet networks. Initial errors and/or alarms may indicate problems with connections to the instrument or problems with the network.

Results Summary operates on only the foreground instrument. Errors or alarms detected by the background instrument are indicated by the Multiple Instruments LED being turned on.

For more information about the detected alarms, press the **<Show More>** key.

▶ **To start Results Summary**

1 Press **<Menu>**, choose **Test Functions & Results > Results Summary** then press **<Select>**. A results window will be displayed.

2 More information on any errors detected is available. Press **<Show More>**. Refer to “The <Show More> LEDs" on page 321 for details of the meaning of these LEDs.

Transmitter and Receiver Start/Stop

The transmitter and receiver within the Ethernet instrument can be started and stopped in several ways:

- The transmitter and receiver can be started and stopped simultaneously by pressing the **<Run/Stop>** key. This is the default setting. For this mode, couple the transceiver to the **<Run/Stop>** key. In this mode, the SONET/SDH instrument is started and stopped simultaneously with the ethernet instrument.
- The transmitter can be started and stopped using the **Start/Stop** field on the **Ethernet: Manual Tests** page, while the receiver is started and stopped independently of the transmitter by pressing the **<Run/Stop>** key. For this mode, deselect coupling the transceiver to the **<Run/Stop>** key. Use this mode to count dropped frames.
- The start and stop time can be programmed. See “Setting the Measurement Timing" on page 332 for details.

To set the Tx/Rx coupling

1. Press **<Menu>**, choose **Tx/Rx > Transceiver Coupling** then press **<Select>**.
2. Select **Couple Transceiver to Run/Stop gating key** to start and stop the transmitter and receiver using the **<Run/Stop>** key.

   Deselect **Couple Transceiver to Run/Stop gating key** to start and stop the transmitter and receiver independently.

Transmitter Start/Stop

This is controlled using the **<Run/Stop>** key and the **Start/Stop** controls in the measurement timing capability. The transmitter will start only once the receiver measurements have started. The transmitter will stop at the same time as the receiver measurements stop.

The measurement timing allows for the transmitter to start immediately the **<Run/Stop>** key is pressed, or using a programmed start/stop time.

The transmitter has two states:

- **Stopped** (or **Idle**): In this state, a “Learning Stream" on page 327 is transmitted at a nominal low line rate.

  The transmitter stream frame count does **not** increment in this state.

- **Started**: In this state, defined frames at a defined rate are transmitted for a defined duration. No learning frames are transmitted.

  The transmitter stream frame count increments.

The **Start/Stop** action applies to all Ethernet ports simultaneously. The transmission can be prematurely stopped by selecting **Stop**.

Receiver Measurement Run/Stop

When **Run** is selected, the receiver zeros all counters, clears the list of identified streams and starts accumulating results. The receiver continues to measure and accumulate results until **Stop** is selected.

The **Run/Stop** action applies to all Ethernet ports simultaneously. Measurements can be prematurely stopped by selecting **Stop**.

Learning Stream

A learning stream is transmitted in advance of tests to teach the device under test the MAC address of the test instrument connected to it. The stream is identical to the port stream in content but is transmitted with a stream ID = 0. It contains the instrument test fields.

6
Instrument Details

This chapter gives information on additional features provided by the instrument, plus information on technical support.

Logging, Instrument Control and File Management Tools

Measurement Logging

You can generate a report at the end of the measurement period or create an interval report at any time during the measurement. Before logging results, set the measurement period, see “Setting the Measurement Timing" on page 332.

You can log the measurement results to a file or printer (connect the printer to the instrument’s USB port).

The measurement results you can log include:

- **Interval Repor**t **-** generated every “Logging Interval”. This report can contain **Cumulative Totals** (the running total for the measurement period) and **Interval Totals** (the totals for the Interval).
- **End of Measurement Report -** generated at the end of the measurement period. This includes report **Totals** (the total for the measurement period).

▶ **To set up measurement logging**

1 Press **<Menu>**, choose **System > Measurement Logging** then press **<Select>**.

2 Select **Enable logging**. Select a **Destination** (**File** or **Printer**). If you choose **File**, enter a filename and press <**Select**>.

3 Select the checkboxes for **Interval Report** (the minimum Logging interval is 10 minutes), **End of Measurement Report**, **Logged Events** and **Logged Reports** as required.

4 Press **<Run/Stop>** to start a new measurement. The instrument will now log the results requested.

5 Select **Snapshot Interval Report** for an interval report.

NOTE Use an underscore “_”, not spaces, in filenames. Files are given the suffix ‘_A1.LOG’. If you log to an existing filename the suffix letter will increment. Up to ten logging files can be stored on the instrument.

Logged results are stored in ASCII text format. You can copy these files to a floppy disk and import them to a PC. See:

- “Copying an Internal File to a Floppy Disk" **on page 358**

Setting the Measurement Timing

You can control the start/stop time of a test period, as follows:

- **Manual Start and Stop** - Press the **<Run/Stop>** key to start. The test runs until you press the **<Run/Stop>** key again.
- **Manual Start and Timed Stop** - Press the **<Run/Stop>** key to start. The test runs for a fixed period (1 min, 5 min, 15 min, 1 hr, 24 hrs or 72 hrs) or for a user-defined period.
- **Timed Start and Stop** - Use the **Start On date/time** feature to set the exact date/time when a test is to start. The test runs for a fixed period (1 min, 5 min, 15 min, 1 hr, 24 hrs or 72 hrs) or for a user-defined period.

Manual Start and Stop

▶ **To set manual control of the measurement period**

1 Press **<Menu>**, choose **Results > Measurement Timing** then press **<Select>**.
2 In the **Run/Stop** field, choose **Manually**. This allows you to use the **<Run/Stop>** button to manually start and stop a measurement gating period.

Manual Start and Timed Stop

You can use this setting to capture results for a single measurement period.

▶ **To set up a manual start/timed stop measurement period**

1 Press **<Menu>**, choose **Results > Measurement Timing** then press **<Select>**.
2 To start manually - In the **Run/Stop** field choose **User Program**. Select the **Start** field and choose **Manually**.
3 To stop after a fixed or user defined period - Select the **Stop After duration** field and choose either one of the fixed periods (1min, 5 min, 15 min, 1 hr, 24 hrs or 72 hrs) or **User**,

for a user-defined duration. If **User** is chosen, use the keyboard to set an end of measurement time.

Start On Date/Time and Timed Stop

You can define an exact date/time when you wish to start a measurement and whether the measurement stops after a fixed or user-defined period.

▶ To set up a timed measurement period

1 Press **<Menu>**, choose **Results > Measurement Timing** then press **<Select>**.
2 To choose a start time - In the **Run/Stop** field and select **User Program**. Now select the **Start** field and choose **On date/time**. Use the Keyboard to enter the start time then press <**Select**>.
3 To stop after a fixed or user defined period - Select the **Stop After duration** field and choose either one of the fixed periods (1min, 5 min, 15 min, 1 hr, 24 hrs or 72 hrs) or **User**, for a user-defined duration. If **User** is chosen, use the keyboard to set an end of measurement time.

Setting Time and Date

You should set the time and date correctly to enable timestamping of logged results.

▶ **To set time and date**

1 Press **<Menu>**, choose **System > Time and Date** then press **<Select>**.
2 Set up the required date and time using the keypad.
3 Select **Close** and press **<Select>** to exit.

Viewing Results Graphically

The Measurement Record System (MRS) time stamps all captured errors, alarms and pointer movements. You can view graphs that track pointer movements and graphs of error distributions or alarm seconds durations, with respect to time. The graphical data can also be stored and used for future reference. Viewing and management of measurement record data is controlled using the Measurement Record Graph Manager.

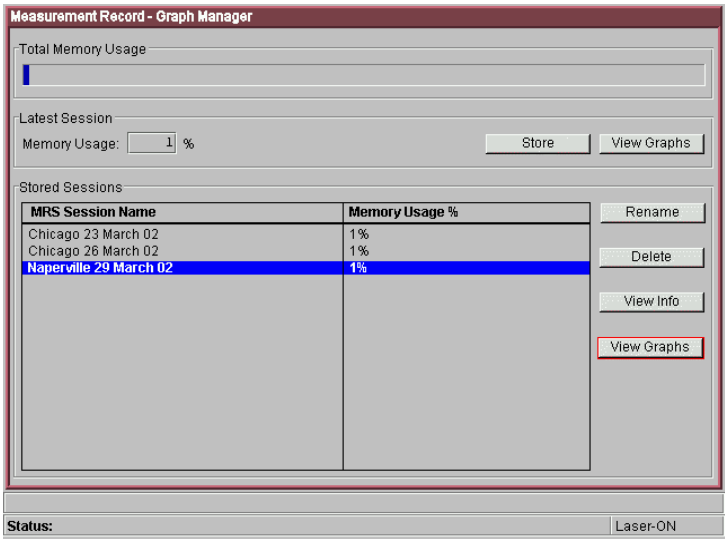
Viewing Graphs

Use the graph manager window to view graphs of all error, alarm and pointer information during a measurement period. This window is split into three sections:

- **Total Memory Usage -** displays how much of the internal storage has been used. If this becomes full, delete some of the previously stored graphs using the Stored Sessions section.
- **Latest Session -** details the active graph and percentage of available memory currently being used.
- **Stored Sessions -** allows the recall of previously stored graphs. The session name and memory usage are displayed.

To view graphs

1 Press **<Menu>**, choose **Measurement Record > Graph Manager** then press **<Select>**.

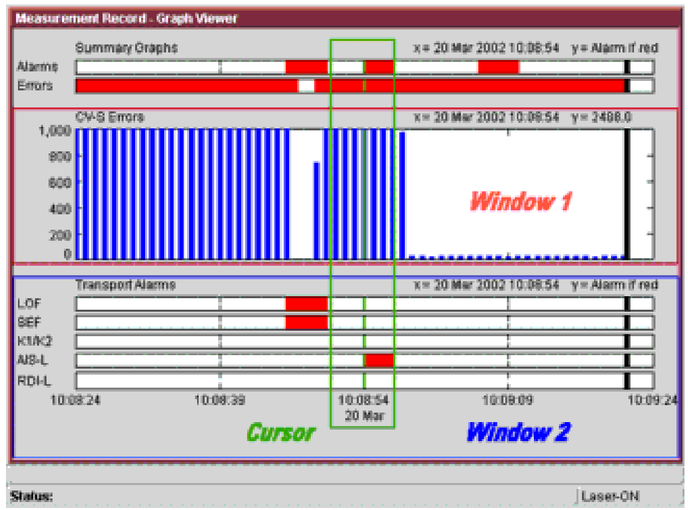


2 Select **View Graphs** from either the **Latest Session** or **Stored Sessions** section as appropriate. The Graph Viewer window will be displayed. This window is split into two sections.

- Summary Graphs (top section)
- Detail Graphs (bottom section)

The summary section shows a summary of alarm and error seconds. A solid red bar depicts the time of occurrence of detected alarms and errors.

The detail graphs section can be configured to show either one or two graphs.



3 Use the **<Menu>** key to access the selection and navigation features.

4 From **Select**, select the item you want to view, then press **<Select>**. A menu appears showing Physical, Section, Path, TCM, PDH, DSn and Pattern (errors and alarms are grouped into each of these layers). Any item in the menu with active error/alarm information within the visible time range is shown in red. Graphs of pointer positions are found at **Path > SPE/VT** or **AU/TU Pointer Value**. A green cursor allows you to interrogate results for a particular time period. Use the arrow navigation keys to pan through the results. Error counts or pointer values are shown on the graph against the selected time period.

5 Select **View Range** to rescale the time axis. The time taken to view will depend on the amount of data stored. The message “Retrieving data...” is displayed on the status line during data processing.

6 Select **Show** to pan Page Left or Page Right or to select a Single/Double Graph.

The **<Menu>** key also allows you access to the session manager to store/recall graphs or to close the graph window and return to the user interface. For more information, see "Storing Graphs" on page 338.

NOTE

If power fails during a measurement period, this is recorded in the graph viewer window, under **Power** loss seconds in the **Physical Alarms** section. When power is restored to the instrument, re-select the graph viewer to see results being captured again.

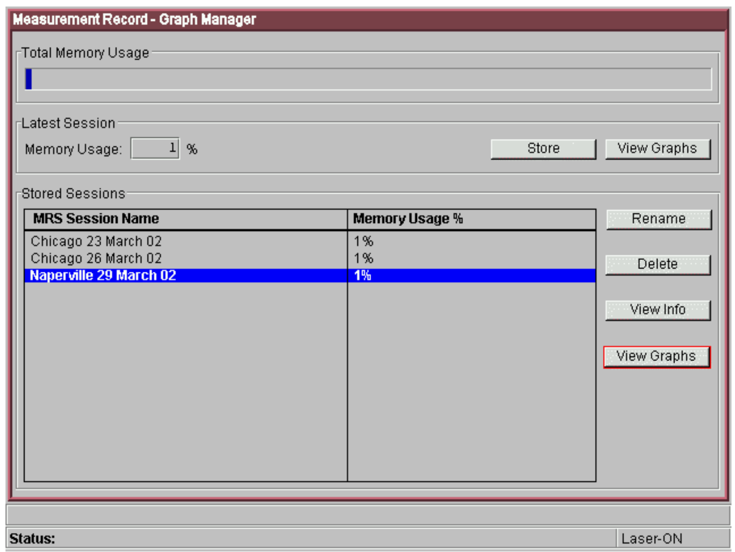
Storing Graphs

Use the Graph Manager window to store results of all error, alarm and pointer information during a measurement period. This window is split into three sections:

- **Total Memory Usage -** displays how much of the internal storage has been used. If this becomes full, delete some of the previously stored graphs using the Stored Sessions section.
- **Latest Session -** details the active graph and percentage of available memory currently being used.
- **Stored Sessions -** allows the recall of previously stored graphs. The session name and memory usage are displayed.

▶ To store graphs

1 Press **<Menu>**, choose **Measurement Record > Graph Manager** then press **<Select>**.



2 Select **Store** to save a current graph. If **Store** is unavailable, the test is still running. Wait until the end of the test period before storing results. When storing a graph, include the date in the filename.

NOTE

Store results from the last graph session before starting a new test.

If the graph storage space is full, use the session manager to delete previously stored sessions. Text results will still be stored.

To recall graphs

1 Press **<Menu>**, choose **Measurement Record > Graph Manager** then press **<Select>**.
2 Use the arrow keys to move to the **Stored Sessions** section, then press **<Select>**.
3 Move to the session you wish to view, then press **<Select>** (it will be highlighted in blue).
4 Move to **View Graphs** to see the captured information.
5 If you wish to rename a graph, select the appropriate result and press **Modify**.
6 Select **View Info** to view details about the configuration of the instrument during a graph capture.
7 If required (for example if the 10 available store locations are used), use **Delete** to free up space.
8 To exit the session manager, press **<Menu>** then select the appropriate screen to view.

Dynamic Axis Scaling and Scrolling

The graph is continually updated during a measurement and the X-axis (time) automatically scrolls. When the plotted points reach the X-axis limit the graph will scroll and continue plotting from the X-axis mid point.

The X-axis range must be manually selected to suit the data being viewed. The ranges are 1 minute (default), 1 hour, 12 hours, 2 days, 3 days, 4 days and so on in 1 day increments up to a maximum of 7 days.

The Y-axis is dynamically scaled for pointer movements. The Y-axis for error and alarm measurement histograms is a fixed logarithmic scale. Histograms are capped at 10000 errors/alarms (actual values can be viewed by using the cursor to select the event of interest). A single error/alarm can also be viewed on the same graph.

System Options

The System Options window lets you view the following:

- Instrument Options: Options installed.
- Software Version: Firmware revision and build date/time.
- Option Control: Use this page to enable/disable options and enter serial numbers and code words when upgrading your instrument.

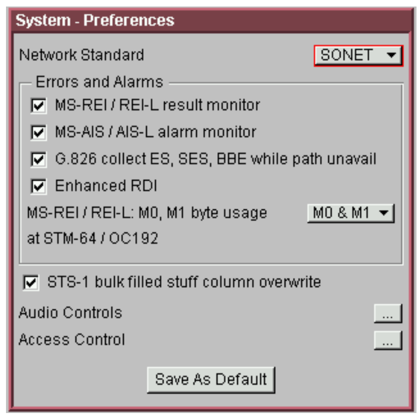
▶ To view system options

- Press **<Menu>**, choose **System > Options** then press **<Select>**. Select the **Instrument** tab.
  Or,
- Press **<Menu>**, choose **System > Options** then press **<Select>**. Select the **Software** tab.
  Or,
- Press **<Menu>**, choose **System > Options** then press **<Select>**. Select the **Option Control** tab.

System Preferences

▶ To access the System Preferences

1 Press **<Menu>**, choose **System > Preferences** then press **<Select>**.



2 Select the preferences you require.

3 Select the **Save as Default** button. A dialog box is displayed. This prompts you to confirm any changes you have made to the settings.

Use the system preferences window to select the following settings:

- Network Standard - Select from SDH or SONET operation.
- MS-REI/REI-L byte usage - Select from M1 only or M0 & M1. The G.707 (October 2000) ITU specification introduced the use of two bytes (M0, M1) for MS-REI/REI-L error monitoring in STM-64/OC-192 line signals. To support interfaces of equipment designed prior to this new recommendation the instrument supports both single (M1) and two (M0, M1) byte MS-REI. If the measurement results are not as expected, check that the MS-REI field selection is correct for the network-under-test. Try repeating the test with a different MS-REI selection.

- MS-REI/REI-L Results Monitor - Enable (default)/disable collection of MS-REI/REI-L results.
- MS-AIS/AIS-L Alarm Monitor - Enable (default)/disable collection of MS-AIS/AIS-L alarms.
- G.826 Collect ES, SES, BBE While Path Unavailable. Use this to enable/disable the collection of results for Errored Seconds (ES), Severely Errored Seconds (SES) and Background Block Error (BBE) while the path is unavailable. These counts are not included in the calculation of ESR, SESR and BBER. For more information, see: “Introducing ITU Performance Analysis" on page 428.
- Enhanced RDI - Enable/disable (default) the Enhanced Remote Defect (RDI) alarm function (as specified in Telecordia GR-253 CORE Issue 3 and ITU-T G.707).
- Signal Wizard: SONET B1/B2/B3/BIP Labelling - Allows the CVS, CVL and CVP bits to be labelled as B1, B2 and B3 on the Signal Wizard screen.
- STS-1 bulk-filled stuff column overwrite - You can overwrite all bytes including or excluding the fixed stuffing bytes.
- Laser Off on power up - Ensures the laser is always disabled on power up. If this checkbox is not selected, the instrument on power up will re-establish the laser setting (enabled or disabled) that existed prior to the last power down.
- STS-1 numbering: 1-to-N Scheme - Allows the default numbering system to be replaced with the G.707 STS-1 numbering, 1-to-N scheme.

Manufacturing Data

The manufacturing data window lists the modules/assemblies fitted to your instrument. The information may be useful to an engineer if your instrument requires repair or calibration.

▶ To open the manufacturing data window

- Press **<Menu>**, choose **System > Manufacturing Data** then press **<Select>**.

The information given in the window indicates the following, reading from left to right.

- **J1413-60502** 0200 SL119 000107 - Module or PCA drawing number
- J1413-60502 **0200** SL119 000107 - Material List Revision Code
- J1413-60502 0200 **SL**119 000107 - Vendor Code
- J1413-60502 0200 SL**119** 000107 - Year/Week of assembly (YWW)
- J1413-60502 0200 SL119 **000107** - Board serial number
- **J1413-60502 0200 SL119 000107** - Total board unique identification number

Keyboard Lock

This feature calls up the Keyboard Lock window to deter others from using the instrument.

NOTE The keyboard is not actually locked. The message displayed advises other users not to change the current settings. All keys are still operable.

▶ To lock the keyboard

- Press **<Menu>**, choose **System > Keyboard Lock** then press **<Select>**.

Self Test

The self test consists of a confidence test to verify that the instrument is operating correctly. This includes a range of tests for the main measurement interfaces. You can run an ‘all interface’ confidence test (which takes approximately 5 minutes) or individual interface tests. If a failure occurs then a descriptive text message and error code is returned. For further information on the self test and error codes, refer to the Installation and Verification manual (on the CD-ROM).

▶ To run the confidence test

1 Press **<Menu>**, choose **System > Self Test** then press **<Select>**.
2 Ensure all loopbacks are in place. Select the appropriate 1310/1550 nm 2.5 G - 52 M optical loopback cabling configuration.
3 Select **Run Selected test** radio button, then select **Confidence Test**.
4 Select **Start**. The elapsed test time and remaining test time is displayed. If any sub-test fails a error message and error code will be returned. Up to six errors are recorded.

NOTE Perform the Confidence Test twice if single wavelength optics are fitted to the 2.5 Gb/s-52 Mb/s Optical Out port, to verify all Optical In ports. For the first test connect the 2.5 Gb/s-52 Mb/s Optical Out port to the 2.5 Gb/s Optical In port. For the second test connect the 2.5 Gb/s-52 Mb/s Optical Out port to the 662-52 Mb/s Optical In port. Select the cable configuration from the test menu as appropriate.

CAUTION Observe safety precautions, care and connection cleanliness to avoid damage or degradation of the optical connections. Ensure the recommended optical attenuation is present in all optical loopback connections to avoid self test failure or damage to the optical receivers.

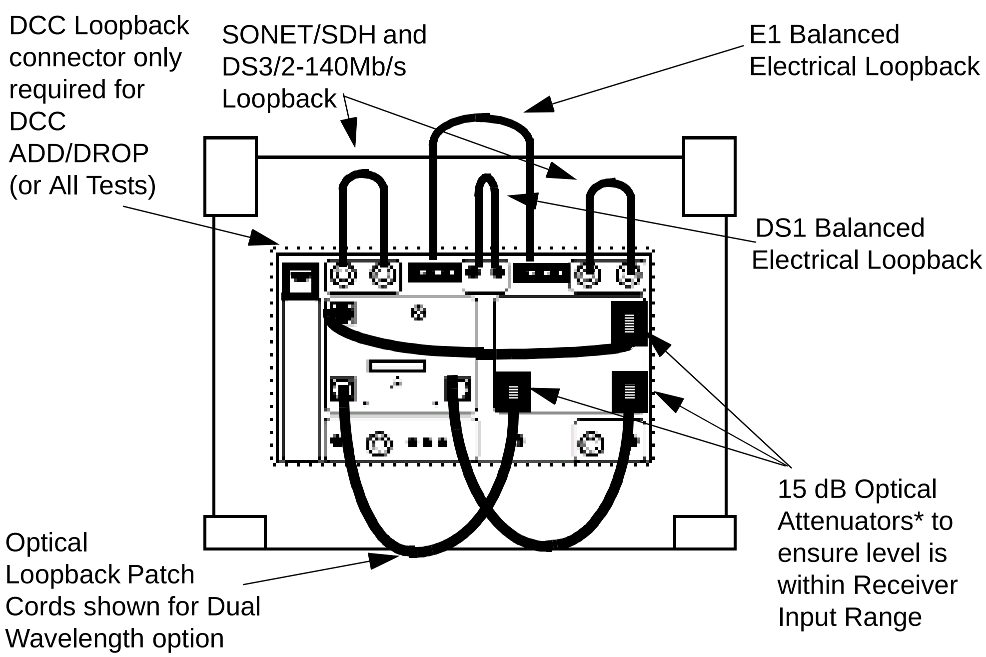
Confidence Test Failure

If the confidence test fails:

- Make sure all the correct loopback connections are in place.
- With optical interface failures, clean all optical connections with a recognized cleaning kit before repeating the confidence test. For more information on cleaning optical connectors, see the Installation and Verification Manual (on the CD-ROM).
- If the problem persists then contact your local Agilent Service Office or representative.

Self Test Loopback Connections

The confidence test verifies all the optical and electrical test ports on the unit therefore loopback connections are required on the instrument.



* Optical attenuators not required when connecting the Tx and Rx ports of short reach (SR) optical modules

Optical Loopback Connections (All Instruments)

Use optical cables (Part Number 1005-0337) and 15 dB attenuators* (Part Number 1005-0433):

- 10 Gb/s 1550 nm Optical Out via 15dB Attenuator to 10 Gb/s Optical In.
- 52 Mb/s-2.5 Gb/s Optical Out via 15 dB Attenuator to 2.5 Gb/s Optical In.
- 52 Mb/s-2.5 Gb/s Optical Out via 15 dB Attenuator to 52 Mb/s-622 Mb/s Optical In.

Electrical Connections 155 Mb/s to 8 Mb/s)

Use BNC cables (Part Number 15525A):

- 52/155 Mb/s Out (BNC) to 52/155 Mb/s In (BNC)
- 2-140 Mb/s DS3 Out (BNC) to 2-140 Mb/s DS3 In (BNC)

Balanced Electrical Connections 2M/DS1 (Enhanced Testing Product Required)

Use 3-pin Siemens cable (Part Number 15512A) and Bantam Cable (Part Number 15670A):

- 2M Out (3-pin Siemens) to 2M In
- DS1 Out to DS1 In

Remote Control

▶ To access the remote control window

- Press **<Menu>**, choose **System > Remote Control** then press **<Select>**.

The following options are available for remote control of the instrument through your PC/terminal:

- RS232 connection
- LAN connection
- GPIB connection

RS232 Operation

▶ To remotely control the instrument via an RS232 connection.

1 Connect your PC/terminal via a suitable RS232 cable to the instrument RS232 port.
2 Press **<Menu>**, choose **System > Remote Control** then press **<Select>**.
3 Set **Connection mode** to **RS232**.
4 Select the **Command prompt** checkbox if you are going to remotely control the instrument. Do not select **Command prompt** if a computer program is going to control the instrument.
5 Select the **Baud rate**, **Data bits**, **Stop bits**, **Parity** and **Handshaking**.
6 Select **Close**.

LAN Operation

You can remotely control an instrument via a LAN connection.

▶ To remotely control the instrument via a LAN connection.

1 Connect your PC/terminal and instrument to your LAN.

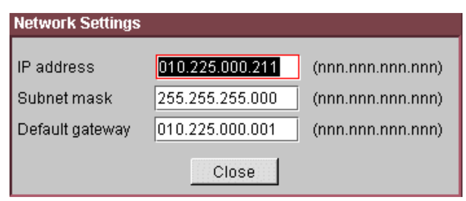
2 Press **<Menu>**, choose **System > Remote Control** then press **<Select>**.

3 Set **Connection mode** to **LAN**.

4 Select the **Command prompt** checkbox if you are going to remotely control the instrument. Do not select **Command prompt** if a computer program is going to control the instrument.

5 Select **Network Settings**.

6 Enter the **IP address**, **Subnet mask** and **Default gateway** values. These values are typically assigned by your Information Technology (IT) department. Then select **Close**.



7 Ensure the **Port number** is to **5001**.

8 Run Telnet on your PC. Enter the IP address assigned to the instrument and the Port number (5001).

GPIB Operation

▶ To remotely control the instrument via a GPIB connection.

1 Connect your PC/terminal via a suitable GPIB card and cable to the instrument GPIB port.
2 Press **<Menu>**, choose **System > Remote Control** then press **<Select>**.
3 Set **Connection mode** to **GPIB**.
4 Enter the required **GPIB address.**
5 Select **Close**.

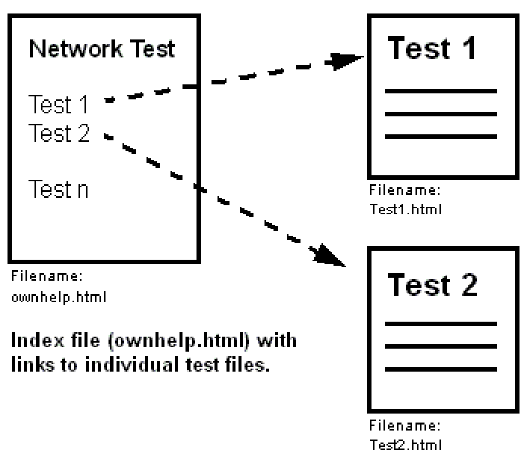
User’s Own Help Files

You can add your own help files to the instrument and refer to them when carrying out your routine procedures, solving problems or following detailed test procedures. To produce your own help system, create HTML files using a standard word-processor. To access these files on the instrument, you need to create an index file containing hypertext links to each of the files. You must call the index file ‘**ownhelp.html**’.

For more information on creating and accessing your own help files, see:

- “Your Own Help Files - Hierarchy" on page 353
- “Creating Your Own Help Files" on page 353
- “Accessing Your Own Help Files" on page 356

Your Own Help Files - Hierarchy



Creating Your Own Help Files

▶ **To create your own help files**

1 Use a standard word processor or HTML editor to create the file. If you keep your document short, it will load quickly and

be easy to navigate through. Save the document(s) with the extension '**.html**'. For more information on how to structure your HTML pages, see "Guidelines for Creating HTML Files" on page 355.

2 Create an index file with hypertext links to each of your files. Save this file as '**ownhelp.html**'.

3 Before loading your own help files onto the instrument, check them in a Web browser.

4 Copy all of your files, including your '**ownhelp.html**' index file and any image files, onto a floppy disk.

5 Copy the files from the floppy disk to the instrument (see: "Importing Files from a Floppy Disk" on page 359).

6 To access your files via the instrument's Online Help system, see: "Accessing Your Own Help Files" on page 356.

NOTE

Use a meaningful name for your files, and save them with the extension'**.html**'.
Images should be in JPG or GIF format. When you add files to the instrument, any files with the same name will be overwritten by your new files.

CAUTION

You **must** load your index file ('ownhelp.html') onto the instrument to be able to access your files.

Guidelines for Creating HTML Files

- Use only a sans serif font (such as Arial) of size 12, 14 or 16 point, Normal or Bold - DO NOT use italic as this font is not supported on the instrument and can cause problems with the presentation of your document.
- Any images you include should be either GIF or JPEG format.
- Design a page size and layout that is appropriate for the size of the instrument display. For example, write several short documents, rather than one long one, and make sure any inserted tables will fit the screen width (maximum **560 pixels** or **15cm wide**).
- Have all the documents and images in one folder/directory. The instrument does not currently support file tree structures.
- The total size of the files should not be more than 1.44Mb. You cannot download files that are larger than the capacity of a floppy disk.

CAUTION

Format your document to fit the instrument's screen-width.
If you insert tables that are larger than the screen, they will not display properly.

The instrument supports HTML Standard 3.2. Documents produced using later HTML standards are not guaranteed to operate or display on the instrument.

Accessing Your Own Help Files

To access your own help files

1 Press **<Help>** to access the Online Help system.

2 Press **<Menu>**, select **Your Own Help** and press **<Select>.**

3 Select the link to the file you require, using the arrow navigation and **<Select>** keys.

4 If a file is longer than one screen-size, use the **<Next Page>** and **<Prev Page>** keys (on the instrument keypad) to scroll up or down.

5 Press the <**Back**> key to return to the ‘ownhelp.html’ index, or the **<Home>** key to return to the Online Help Home page.

File Management

While using the instrument, you will generate a number of different types of files:

Stored Settings Files - There is one Factory Default Stored Setting and four User Defined Stored Settings. You can recall these settings, saving you time when setting up measurements.

Measurement Logging Files - During a measurement you can log the measurement results to an internal file or to an external printer. For more information, see:

- “Measurement Logging" on page 331

User Help Files - You can create your own help files to add to the instrument and then access them through the Online Help system. For more information on accessing your own files, see:

- “Accessing Your Own Help Files" on page 356

Screendump Files - You can capture screen images using the Print Control key on the Front Panel. These can be stored as files or printed directly. For more information, see:

- “Saving and Printing Screendumps" on page 363.

For information on how to manage your stored files, see:

- “Copying an Internal File to a Floppy Disk" on page 358
- “Importing Files from a Floppy Disk" on page 359
- “Deleting Files from a Floppy Disk" on page 360
- “Deleting Files from the Instrument" on page 361

Copying an Internal File to a Floppy Disk

You can copy different file types (settings, logging, user's own help or screen dumps) from the instrument to a floppy disk, ready for transfer to another instrument or to a PC.

First you should view the latest list of files stored on the instrument, by completing the **Refresh List** function. Then you can choose which file to copy to the floppy disk. If a file approaches the capacity of a floppy disk, it will be split automatically.

▶ To refresh the list of files

1 Press **<Menu>**, choose **System > File Manager** then press **<Select>**.
2 Select the required file type.
3 Set **Drive** to **Internal**.
4 Set **Operation** to **Refresh file list**.
5 Select **Action**, then press **<Select>** to refresh the list of files.

▶ To copy a file to a floppy disk

1 Select the **Files** field, then choose a file from the list.
2 Set **Operation** to **Copy file to floppy**.
3 Select **Action**, then press **<Select>**.

Importing Files from a Floppy Disk

You can copy different file types (your own help files or settings) to the instrument from a floppy disk.

First you should view the latest list of files stored on the floppy disk, by completing the **Refresh List** function. Then you can choose which file to copy to the instrument.

▶ To refresh the list of files

1 Insert the Floppy disk, containing the files to be imported, to the instrument’s Floppy disk drive.
2 Press **<Menu>**, choose **System > File Manager** then press **<Select>**.
3 Select the required file type.
4 Set **Drive** to **Floppy.**
5 Set **Operation** to **Refresh file list**.
6 Select **Action**, then press **<Select>** to refresh the list of files.

▶ To import files from a floppy disk

1 Select the **Files** field, then choose the file to be imported.
2 Select the **Operation** field, then choose the destination to import the file to.
3 Select **Action**, then press **<Select>**.

Deleting Files from a Floppy Disk

You can use the instrument to delete different file types (settings, logging, user's own help or screen dumps) from a floppy disk.

First you should view the latest list of files stored on the floppy disk, by completing the **Refresh List** function. Then you can choose which file to delete.

▶ To refresh the list of files

1 Insert the Floppy disk in the instrument Floppy disk drive.
2 Press **<Menu>**, choose **System > File Manager** then press **<Select>**.
3 Select the required file type, depending on which file type you wish to delete.
4 Set **Drive** to **Floppy.**
5 Set **Operation** to **Refresh file list.**
6 Select **Action**, then press **<Select>** to refresh the list of files.

▶ To delete files from a floppy disk

1 Select the **Files** field and choose the file to be deleted.
2 Set **Operation** to **Delete file**.
3 Select **Action**, then press **<Select>**.

Deleting Files from the Instrument

You can delete different file types (logging, user's own help or screen dumps) from the instrument.

First you should view the latest list of files stored on the instrument, by completing the **Refresh List** function. Then you can choose which file to delete.

▶ To refresh the list of files

1 Press **<Menu>**, choose **System > File Manager** then press **<Select>**.
2 Select the required file type, depending on which file type you wish to delete.
3 Set **Drive** to **Internal.**
4 Set **Operation** to **Refresh file list**.
5 Select **Action**, then press **<Select>** to refresh the list of files.

▶ To delete files

1 Select the **Files** field and choose the file to be deleted.
2 Set **Operation** to **Delete file**.
3 Select **Action**, then press **<Select>**.

Print Control Key (Printer Setup and Capturing Screendumps)

You can connect a printer to the instrument via the USB port.

Use the print control to check your printer connection, or use it to print or save the current screen graphics (screendump).

▶ To open the print control window

- Press **<Print Control>** on the instrument's front panel. The print control window is split into two areas:
  The **Screendump** area allows you to control the printing or saving of the current screen graphics. Saved graphics are stored internally on the instrument. You can then transfer these files to a floppy disk.
  The **Printer Setup** area shows details of the connected printer and the printer driver being used.

For more information, see:

- “Saving and Printing Screendumps" on page 363
- “Recommended Printers" on page 363

Saving and Printing Screendumps

You can capture screen graphics and save or print them.

To print the screendumps, connect a printer to the instrument via the USB port.

Up to ten screendump (.bmp) files can be saved on the instrument. You can then transfer these saved files to a floppy disk.

NOTE If you already have ten screendumps stored, you will need to delete some files before you can store new files. If you need to retain a copy of the existing files, then copy them to a floppy disk before you delete them from the instrument. See: "Deleting Files from the Instrument" on page 361.

▶ **To capture a screendump**

1 Press **<Print Control>** on the instrument's front panel.

2 Select the **Screendump - Destination** field and choose **Printer** or **File**. If you choose **File,** use the keypad to enter a filename and press **<Select>**.

3 Select the **Close Dialog and Dump Screen Image** box and press **<Select>**. The screen image is either stored or printed, depending on whether you selected **Printer** or **File**.

To copy saved files from the instrument to a floppy disk, see:

• "Copying an Internal File to a Floppy Disk" on page 358

Recommended Printers

• HP DeskJet 970Cxi
• HP DeskJet 930C/cm
• HP DeskJet 959C
• HP DeskJet 950C
• HP DeskJet 895Cxi
• HP DeskJet 840C

NOTE If you are not using a recommended printer, the printer output will be text only.

Technical Support

For technical support information, see:

- “Operators Maintenance" on page 365
- “Instrument Reboot (Cold Start)" on page 367
- “CD-ROM Resources" on page 368
- “Frequently Asked Questions" on page 368

For further technical support, contact your nearest Agilent Sales Office.

Operators Maintenance

WARNING **No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.**

Maintenance appropriate for the operator is:

- Cabinet cleaning - clean the cabinet using a dry cloth only.
- Cleaning Optical Connectors
- Ensure ventilating fan cover is clean.

Cleaning Optical Connectors

You should clean the optical connectors at regular intervals using the following materials:

Description	Agilent Part Number
Compressed Air Can or Blow Brush	
Isopropyl Alcohol	8500-5344
Lens Cleaning Paper	9300-0761
Swabs	5080-5400

CAUTION Do not insert any tool or object into the optical IN or OUT ports of the instrument as damage to or contamination of the optical fiber may result.

▶ **To clean the optical connectors**

1. Disconnect the instrument from the Power Line or switch off the laser transmitter before commencing this cleaning procedure.
2. Remove the adapters from the optical IN and OUT ports by flipping back the lever on the optical adapter.

3. Using the blow brush with the brush removed blow through the ferrule of the standard flexible connector and the adapter.
4. If the optical fiber of the fixed connector requires further cleaning this entails disassembly of the module. This should be carried out only by suitably trained service personnel.
5. Apply some isopropyl alcohol to a piece of the cleaning paper and clean the barrel of the adapter. Using a new piece of cleaning paper, clean the face of the adapter. Repeat this operation, using a new piece of cleaning paper each time.
6. Use a blow brush or compressed air to remove any particles of cleaning paper which may be present.
7. Replace the adapters in the optical connector. Secure in place by clicking the retaining lever back into position.

Instrument Reboot (Cold Start)

An instrument “cold start” routine is provided to reset the instrument in the event of an unplanned hardware or firmware event. A cold start reboots the instrument and restarts the instrument using a default configuration file. Performing a cold start erases existing configuration information.

▶ To perform a cold start

1 Switch the instrument off and wait a few seconds.

2 Switch the instrument on and as the instrument boots up, look carefully at the display.

3 Wait for the “Initialising instrument” . . . . . text to be displayed. After a few seconds start to repeatedly press the **<Menu>** key until the Agilent splash screen appears with an options menu in the top left corner of the display.

   The following options are available:

   1 Reload configuration.

   3 Cold start.

   5 Normal start.

   6 Upgrade software.

4 Press 3 on the numeric keypad to select cold start. The unit will then continue with the boot up process.

5 When the boot-up procedure is complete, the instrument displays a dialog box with the message: “Instrument reset to default settings.”

CD-ROM Resources

The instrument CD ROM is a useful resource for all users. It contains training materials and support information, including:

- User documentation
- Full technical specifications
- Remote control manual
- Product/application notes
- Multimedia presentations including an instrument tour
- Links to the product website
- Telecommunications glossary
- Frequently asked questions

Frequently Asked Questions

1. Is there a reference list to quickly remind me how to set up the instrument?

Use the Quick Reference Guide to remind you of the main key presses required to set up and control the instrument. This booklet was provided with the product CD-ROM.

2. Can I change the optical connectors to a different type?

Yes, your instrument will have been fitted with FC/PC, SC or ST connectors. If you wish to change the connector type, you need to order the appropriate accessory. See the product Option Guide, in the **Getting Started > Product Description** section of the Online Help, for details.

For details on changing the connectors, please consult the Installation and Verification manual (available on the product CD-ROM). While performing the operation, care must be taken to avoid damaging the connectors or instrument optics and to ensure cleanliness of parts at all times.

3. How often should I check the calibration of the instrument?

The calibration interval is every two years. However, adjustment is expected to be less frequent as it is only required if any of the performance tests (as detailed in the Installation and Verification manual, available on the product CD-ROM) fail. Please contact your local Agilent Service Center for details of calibration services.

4. How do I control the instrument remotely?

The instrument can be remotely controlled via a LAN connection, RS-232 modem or GPIB connection. The instrument is controlled by sending SCPI commands or by using the Virtual Instrument software (from Agilent's website) and Sun Java Virtual Machine (from Sun's website). There is no cost associated with this software. The software will run on any platform with the appropriate Java VM installed; however Agilent only warrants use under Windows 95, 98, NT and XP and 2000 based PC systems.

5. How do I upgrade instrument firmware?

You can download firmware upgrades to a PC/laptop and transfer them to the instrument via a LAN or RS-232 connection. For more information, contact your nearest Agilent Office or contact Customer Support through the product web site (see the product CD-ROM for more details).

6. Can I use a mouse and keyboard with the instrument?

Yes, the mouse and keyboard PS/2 connectors are enabled. PS/2 connections must always be made before the instrument is powered-on.

7. How do I print my results?

Connect a suitable printer to the USB port. This enables you to print results and screendumps.

For information on how to log to a printer, see the Online Help:

1 Press the **<Help>** key on the instrument to open the Online Help.
2 Press the **<Home>** key to open the Online Help Home Page.
3 Use the arrow navigation and **<Select>** keys to select the options: **Instrument Details > System Features > Measurement Logging**.

8. What printers are compatible with the instrument?

The instrument supports printing via the USB interface with PCL 3.0 compatible printers. PCL 3.0 covers Hewlett-Packard DeskJets & LaserJets. Because of the wide variety of printers on the market and due to the differences in implementing the PCL 3.0 standard, Agilent cannot guarantee that all PCL compatible printers will operate issue-free. The following (non-exhaustive) list of printers have been tested and verified to work error-free: HP DeskJets 840c, 895cxi, 930c/cm, 950c, 959c, 970Cxi.

9. Where can I find information on instrument installation, verification and self testing?

Refer to the Installation and Verification Manual (available on the product CD-ROM).

Also, details of the instrument Self Test (Confidence Test are contained in the Online Help. To access this information:

1 Press the **<Help>** key on the instrument to open the Online Help.
2 Press the **<Home>** key to open the Home Page.
3 Use the arrow navigation and **<Select>** keys to select the options **Instrument Details > System Features > Self Test**.

10. How do I transfer my own help files to the instrument

Save your help file in HTML format. Transfer your files to a floppy disk, then load them onto the instrument.

The Online Help contains full instructions for installing and managing your own help files. To access this information:

1 Press the **<Help>** key on the instrument to open the online help.
2 Press the **<Home>** key to open the **Home** page.
3 Select the option **Users Own Help Files** from the Online Help Home Page.

NOTE

Remember, if a help page is longer than one screen, use the **<Next Page>** and **<Prev Page>** navigation keys on the instrument keypad to view the whole page.

7
Telecoms Concepts

This chapter provides useful reference material, including a summary of the ITU standards, explanations of telecoms terms and lists of overhead bytes, signal rates and errors/alarm.

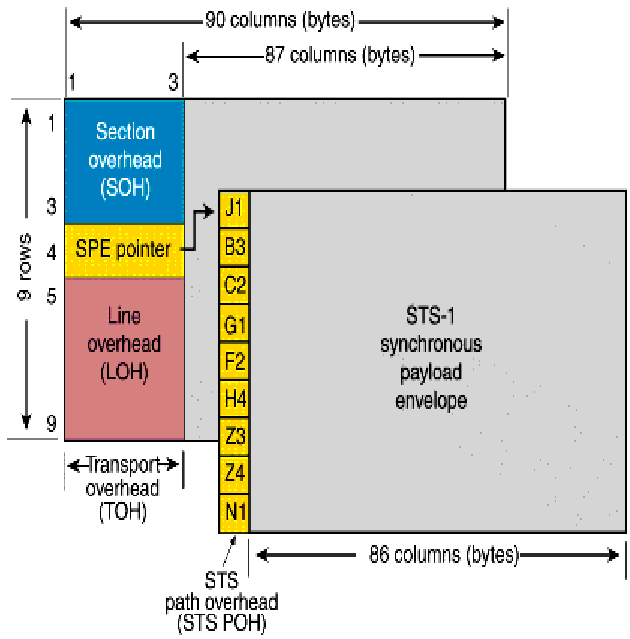
SONET Concepts

For SONET reference information, see:

- “SONET STS-1 Frame Structure" on page 375
- “SONET Payload Structure" on page 376
- “SONET Overhead Bytes" on page 377

SONET STS-1 Frame Structure

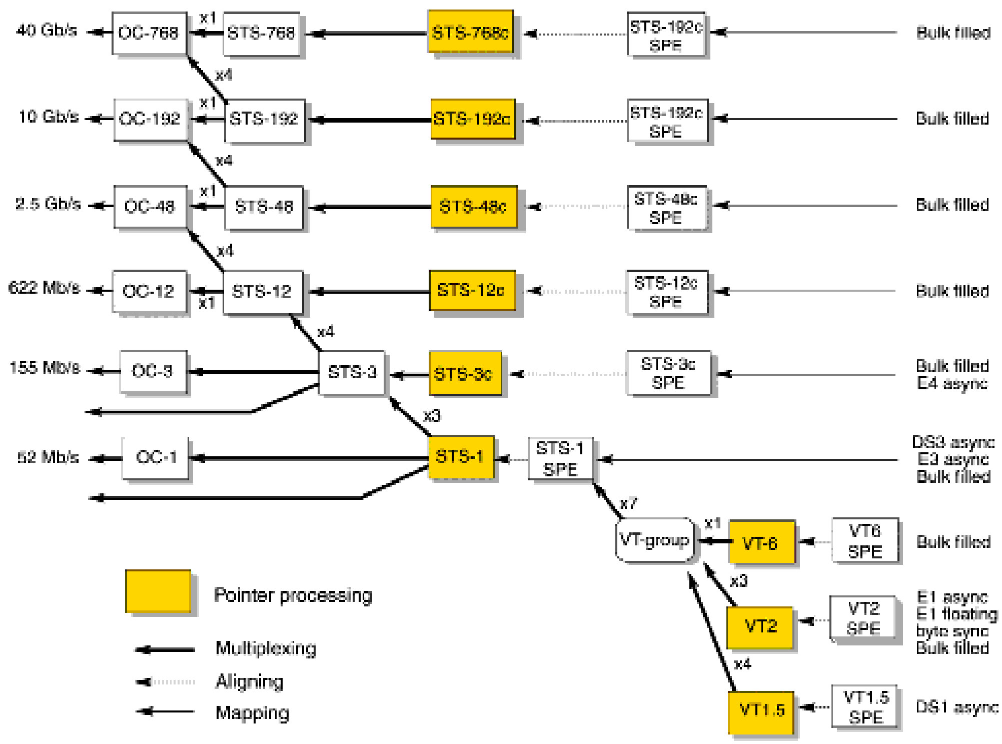
The relationship between the various elements that make up a SONET STS-1 signal is shown in the following diagram.



SONET Payload Structure

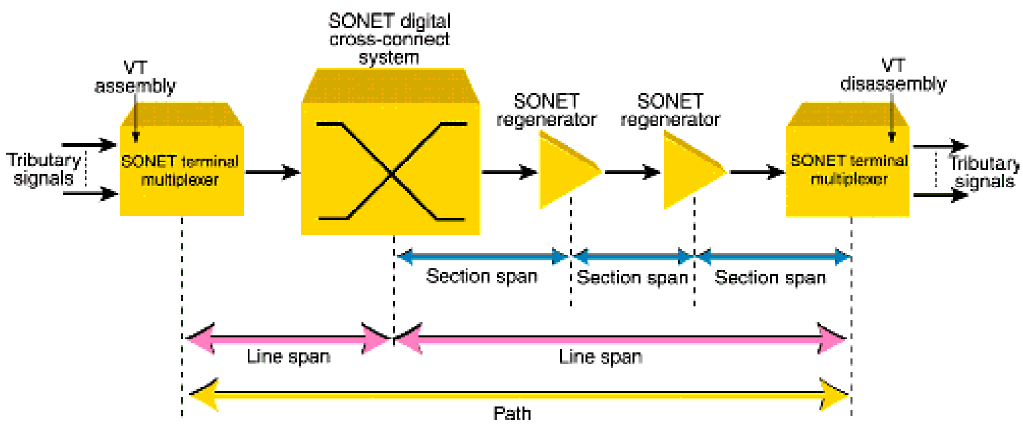
The payloads that can be carried in a SONET signal are outlined below.

- You can asynchronously map a framed/unframed DS3 (44 Mb/s) or E3 (34 Mb/s) signal into a full STS-1 SPE, or you can bulk fill the STS-1 SPE.
- You can transmit 28 VT1.5s, 21 VT2s or 7 VT6s in a STS-1 SPE. The VTs are structured into 7 virtual tributary groups (VT Groups) within a STS-1 SPE. Each VT-group can contain 4 VT1.5s, 3 VT-2s or 1 VT-6.
- You can transmit concatenated payloads in SONET signals. These types of payload reduce test times by testing the entire bandwidth in one go.



SONET Overhead Bytes

Four overheads are used to transport SONET signals across the spans of a network.



For more information, see:

- “Section Overhead (SOH)" on page 378
- “Line Overhead (LOH)" on page 379
- “STS Path Overhead (STS POH)" on page 386
- “VT Path Overhead (VT POH for VT-1.5, VT-2 or VT-6)" on page 389

Section Overhead (SOH)

The Section overhead (SOH) supports the transmission of SONET signals across the section span of a network.

Byte	Label	Description
A1, A2	Framing	Provides a frame alignment pattern (A1=F6 Hex, A2=28 Hex), The frame alignment word of an STS-n frame is n A1 bytes followed by n A2 bytes.
J0	Section Trace	Supports continuity testing between the transmitting and receiving device on each section span.
Z0		Reserved for future international standardization.
B1	Section Code Violation (CV-S)	Provides section error monitoring. The section BIP-8 provides end-to-end error performance monitoring across an individual section. The BIP-8 is calculated over all bits of the previous STS-n frame after scrambling. The computed value is placed in the B1 byte of the current STS-n before scrambling.
E1	Orderwire	Provides local orderwire channel for voice communication between regenerators, hubs and remote terminal locations.
F1	User Channel	Provides a 64 kb/s proprietary data communications channel for the user. It is terminated at each section terminating equipment.
D1 to D3	Data Comm. Channel	Provides a 192 kb/s message-based data communications channel (DCC) for administration, monitor, alarm and maintenance functions between section terminating equipment.

Line Overhead (LOH)

The LOH carries SONET signals over the line span of a network.

Byte	Label	Description
B2	Line Code Violation (CV-L)	Provides line error monitoring. The BIP-8 is calculated over all bits of the line overhead and envelope capacity of the previous STS-n frame before scrambling and is placed in the B2 byte of the current STS-n frame before scrambling.
K1, K2	APS Channel	Line automatic protection switching (APS) is controlled by the K1K2 bytes. Two APS message types are used: Linear APS messages Ring APS messages For more information, see “Linear APS Messages (Telecordia GR-253-CORE Issue 3)" on page 381 and “Ring APS Messages (Telecordia GR-1230)" on page 383.
D4 to D12	Data Comm. Channel	Provides a 576 kb/s data communications channel (DCC) between line terminating equipment. Used for network administration/maintenance information.
S1	Sync Status	S1 bits 5 to 8 show which levels of synchronization are being used at the transmit end of a line span. For more information, see “Synchronization Status Messages (S1 bits 5 to 8)" on page 385.
Z1, Z2		Allocated for future growth.
M0	REI-L	STS-1 line remote error indication (defined only for STS-1) conveys the B2 errors detected by the downstream line terminating equipment.
M1	REI-L	STS-n line remote error indication (defined for n>3) conveys the B2 errors detected by the downstream line terminating equipment.
E2	Orderwire	Provides express orderwire channel for voice communication between line terminating equipment.

Byte	Label	Description
H1 to H3		The payload pointer contained in the H1 and H2 bytes of the line overhead designates the location of the byte where the STS SPE begins. The last ten bits (bits 7 to 16) of H1H2 carry the pointer value (0 to 782). The H1 and H2 bytes are also used to indicate a concatenated payload by transmitting the pointer word “1001XX1111111111” in the second to Nth STS-1 in an STS-Nc.The H3 bytes is allocated for SPE frequency justification purposes and can carry “live” information from a STS SPE when a negative pointer adjustment occurs.

Linear APS Messages (Telecordia GR-253-CORE Issue 3)

Protection Switching Protocol	
K1	**Condition**
Bits 1 to 4	
1111	Locked out of protection
1110	Forced switch
1101	Signal fail high priority
1100	Signal fail low priority
1011	Signal degrade high priority
1010	Signal degrade low priority
1001	Unused
1000	Manual switch
0111	Unused
0110	Wait-to-restore
0101	Unused
0100	Exercise
0011	Unused
0010	Reverse request
0001	Do not revert
0000	No request
Bits 5 to 8	Selects channel used by APS messages

Protection Switching Protocol	
K2	**Condition**
Bits 1 to 4	Selects bridged channel used
Bit 5	Determines APS architecture
Bits 6 to 8	
100	Provisional mode is unidirectional
101	Provisional mode is bidirectional
110	RDI-L
111	AIS-L
	All other combinations of bits 6 to 8 not used.

Ring APS Messages (Telecordia GR-1230)

Protection Switching Protocol	
K1	**Condition**
Bits 1 to 4	
1111	Locked out of protection (span) or signal fail (protection)
1110	Forced switch (span)
1101	Forced switch (ring)
1100	Signal fail (span)
1011	Signal fail (ring)
1010	Signal degrade (protection)
1001	Signal degrade (span)
1000	Signal degrade (ring)
0111	Manual switch (span)
0110	Manual switch (ring)
0101	Wait-to-restore
0100	Exercise (span)
0011	Exercise (ring)
0010	Reverse request (span)
0001	Reverse request (ring)
0000	No request
Bits 5 to 8	Destination node ID

Protection Switching Protocol	
K2	**Condition**
Bits 1 to 4	Source node ID
Bit 5	Path code: 0 = short path request, 1 = long path request
Bits 6 to 8	
000	Idle
001	Bridged
010	Bridged and switched
011	Extra traffic (ET) on protection channels
100	Note used
101	Not used
110	RDI-L
111	AIS-L

Synchronization Status Messages (S1 bits 5 to 8)

S1 (Bits 5 to 8)	Quality level	SONET synchronization quality level description
0001	1	Stratum 1 traceable
0000	2	Synchronized-traceable
0111	3	Stratum 2 traceable
1010	4	Stratum 3 traceable
1100	5	SONET minimum clock traceable
n/a	6	Stratum 4 traceable
1111	7	Do not use for synchronization
0111	User-assignable	Reserved for network synchronization use

STS Path Overhead (STS POH)

The STS Path overhead (STS POH) support the transmission of SONET signals across the path of a network.

Byte	Label	Description
J1	Path Trace	The first byte in the STS SPE. Its location is indicated by the pointer (H1H2). Provides an STS path trail trace identifier (64-byte free format string or 16 frame including CRC7). Supports end-to-end monitoring of an STS path.
B3	Path Code Violation (CV-P)	Provides STS path error monitoring. The BIP-8 is calculated over all bits of the previous STS SPE. The computed value is placed in the B3 byte before scrambling.
C2	Signal Label	STS path signal label indicates the content of the STS SPE, including the status of the mapped payloads. For more information, see “C2 Byte Mapping" on page 387.
G1	Path Status	STS path status contains status and performance monitoring information from the receiving path terminating equipment to the originating equipment. Allows status and performance of the complete duplex path to be monitored at either end.For more information, see “G1 (Bits 5 to 7) Coding and Interpretation" on page 388. Bits 1 to 4 of this byte indicate the count of interleaved-bit block errors, based on the B3 count, to the upstream path terminating equipment.
F2	User Channel	STS path user channel. Allocated for network operator communication between STS path terminating equipment.
H4	Position Indicator	This byte provides multiframe phase indication for VT structured payloads.
Z3, Z4		Allocated for future use.
N1		Allocated for tandem connection maintenance and the path data channels. Bits 1 to 4 are used to provide tandem connection incoming error count (IEC). Bits 5 to 8 ar used to provide the path data channel. For more information, refer to ANSI T1.105.05.

C2 Byte Mapping

Bits 1 to 4	Bits 5 to 8	Hex Code	Description
0000	0000	00	Unequipped
0000	0001	01	Equipped - non-specific
0000	0010	02	VT-structured STS-1 SPE
0000	0011	03	Locked VT mode
0000	0100	04	Asynchronous mapping for DS3
0001	0010	12	Asynchronous mapping for DS4NA
0001	0011	13	ATM mapping
0001	0100	14	Mapping DQDB
0001	0101	15	Asynchronous mapping for FDDI

G1 (Bits 5 to 7) Coding and Interpretation

Bits 5 to 7	Description	Triggers
000	No remote defect	No defect
001	No remote defect	No defect
010	Remote payload defect	LCD-P, PLM-P
011	No remote defect	No defect
100	Remote defect (RDI-P, ERDI-P)	AIS-P, LOP-P
101	Remote server defect (ERDI-P-S)	AIS-P, LOP-P
110	Remote connectivity defect (ERDI-P-C)	TIM-P, UNEQ-P
111	Remote defect (ERDI-P-P)	AIS-P, LOP-P

VT Path Overhead (VT POH for VT-1.5, VT-2 or VT-6)

The VT Path Overhead (VT POH) support the transmission of SONET signals across the tributary path of a network.

Byte	Label	Description
V5	CV-V, Signal Label and Path Status	This byte contains error analysis, signal label and path status information. Bits 1 and 2 contain lower order path error analysis (BIP-2). Bits 5, 6 and 7 contain signal label. For more information, see “V5 (bits 5 to 7) Signal Label" on page 390. Bit 3 contains the Remote Error Indication (REI-V). Bit 4 contains the Remote Failure Indication (RFI-V). Bit 8 contains the Remote Defect Indication (RDI-V).
Number of data bytes separating fields: VT-1.5 = 25, VT-2 = 34 and VT-6 = 106		
J2	VT Path Trace Identifier	Supports the end-to-end monitoring of a path.
Number of data bytes separating fields: VT-1.5 = 25, VT-2 = 34 and VT-6 = 106		
Z6		Reserved for future use.
Number of data bytes separating fields: VT-1.5 = 25, VT-2 = 34 and VT-6 = 106		
Z7		Bits 5 to 7 of Z7 provide enhanced RDI-V. Bits 5 to 7 of Z7 together with bit 8 of V5 provide codes to indicate both the old version and enhanced version of RDI-V. For more information, see “Z7 (bits 5 to 7) Coding and Interpretation" on page 391.
Number of data bytes separating fields: VT-1.5 = 25, VT-2 = 34 and VT-6 = 106		

V5 (bits 5 to 7) Signal Label

Bits 5 to 7	Description
000	Unequipped
001	Equipped - non-specific
010	Asynchronous mapping
011	Bit synchronous mapping (no longer valid for DS1)
100	Byte synchronous mapping
101	Unassigned
110	Unassigned
111	Unassigned

Z7 (bits 5 to 7) Coding and Interpretation

V5 bit 8 Z7 bit5	Z7 bit 6	Z7 bit 7	Interpretation	Triggers
0	0	0	No remote defect	No defect
0	0	1	No remote defect	No defect
0	1	0	Remote payload defect	PLM-V
0	1	1	No remote defect	No defect
1	0	0	Remote defect	AIS-V, LOP-V
1	0	1	Remote server defect	AIS-V, LOP-V
1	1	0	Remote connectivity defect	UNEQ-V
1	1	1	Remote defect	AIS-V, LOP-V

Ethernet Concepts

For Ethernet reference information, see:

- Ethernet in Telecommunications Transmission Networks
- Theoretical Frame Rate

Ethernet in Telecommunications Transmission Networks

This paper provides useful background information that will help you when using your instrument.

Introduction

The object of this paper is to discuss the use and testing of Ethernet services in telecommunications transmission networks, with the emphasis on the installation through to maintenance phases of network deployment and use. These phases are generally taken to be:

- Installation
- Commissioning
- Acceptance testing
- Service turn-up/hand-over
- Network maintenance/troubleshooting

This paper introduces Ethernet in its various forms and discusses its increasing use as a transport protocol in telecommunications networks. It then discusses what testing should be done, and how that testing can be carried out, in order to ensure quality of service for the end user of an Ethernet service.

This paper is intended for telecommunications engineers and technicians involved in the deployment and use of Ethernet services. It will be of particular interest to those who are familiar with SONET/SDH services and who now find themselves deploying the “new” Ethernet services.

It is assumed the reader has a good working knowledge of SONET/SDH transmission systems.

For more details, see:

The Need to Use Ethernet in Transmission

The need to transmit data on telecommunications networks is not new. In fact the very first telecommunications systems could only transmit “data”, in the form of Morse code. The networks that have since been built around the world however were designed to carry only one type of traffic - voice. The telephony network is the biggest machine in the world, with many millions of interconnections. Until recently this network served its purpose well and it is only with the huge increase in the need for data transport, driven mostly by the Internet, that there has been any real need for change.

Until recently data traffic was carried on the telecommunication network by making it “look” like voice traffic, either by using a modem or, for higher bandwidth connections, packaging the data in such a way that it would fit into the standard 56/64 kb/s channel structure of the telecoms network. However as the amount of data traffic in the network continues to grow, other means have to be found of carrying the new traffic that are more bandwidth efficient, less complex and less costly.

There are several options for dealing with this increase in data traffic and the various approaches all have advantages and disadvantages. For example, one option is to build an entirely new data-only network. The biggest disadvantage of this approach, and most of the other options, is the large amount of capital investment required. For this reason most network operators are integrating data services into their existing networks and they are doing this by utilizing the “next generation” of SONET/SDH network elements.

These new network elements carry all of the traditional T-carrier/PDH and SONET/SDH services but also allow the transport of data services in their native format, Ethernet. This reduces the complexity of the network for both the customer and the operator leading to a lower overall cost and more efficient use of bandwidth.

It is the use of these “next generation” elements that this paper addresses.

Introduction to Ethernet

Ethernet is an asynchronous, frame-based protocol originally intended to provide a means of communication between more than two data devices, using shared media. Ethernet, fully defined by the IEEE 802.3(2000) standard, has changed and evolved over time, increasing in speed and allowing the use of full-duplex transmission, rather than shared media.

The current version of the standard allows for many variations of speed and media type and these are described by the following notation:

<data rate in Mb/s> <medium type> <Maximum segment length(x100 m)>

For example, the standard contains a specification for a 10 Mb/s, baseband system with a maximum segment length of 500m. The notation for this would be 10BASE5. A media type identifier often replaces the segment length, for example the 'T' identifier is used for systems running on unshielded twisted pair cabling.

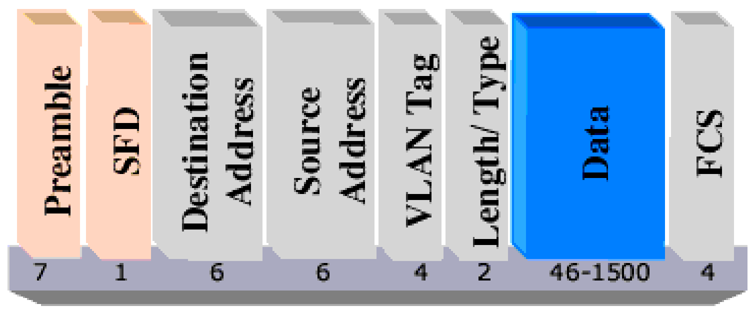
All of the variations of Ethernet share the same basic frame structure, access/control method (MAC - Media Access Control) and, for systems using shared media, the same collision detection scheme (CSMA/CD - Carrier Sense Multiple Access / Collision Detect). The most common Ethernet physical interfaces in current use are:

- 10BASE-T - 10 Mb/s, baseband system, using category 3,4 or 5 twisted pair cabling
- 100BASE-TX - 100 Mb/s, baseband system, using category 5 twisted pair cabling
- 1000BASE-SX - 1000 Mb/s, baseband system, using 850 nm, multi-mode optical fibre
- 1000BASE-LX - 1000 Mb/s, baseband system, using 1300 nm, single-mode or multi-mode fibre

Discussions in this paper refer to these physical interfaces, unless otherwise stated.

Ethernet Frame Structure

The structure of an Ethernet frame is:



The function of the various parts is as follows:

Preamble/Start of Frame Delimiter, 8 Bytes

Alternate ones and zeros for the preamble, 10101011 for the SFD. This allows for receiver synchronization and marks the start of frame.

Destination Address, 6 Bytes

The MAC destination address of the frame, usually written in hex, is used to route frames between devices. Some MAC addresses are reserved, or have special functions. For example FF:FF:FF:FF:FF:FF is a broadcast address which would go to all stations.

Sources Address, 6 Bytes

The MAC address of the sending station, usually written in hex. The source address is usually built into a piece of equipment at manufacture. The first three bytes would identify the manufacturer and the second three bytes would be unique to the equipment. However there are some devices, test equipment for example, in which the address is changeable.

VLAN Tag, 4 Bytes (optional)

The VLAN tag is optional. If present it provides a means of separating data into “virtual” LANs, irrespective of MAC address. It also provides a “priority tag” which can be used to implement quality of service functions.

Length/Type, 2 Bytes

This field is used to give either the length of the frame or the type of data being carried in the data field. If the length/type value is less than 0600 hex then the value represents the length of the frame. If the value is greater that 1536 then it represents the type of protocol in the data field, for example 0800 hex would mean the frame was carrying IP. XXXX hex would mean the frame was carrying AppleTalk.

Data, 46 to 1500 Bytes

The client data to be transported. This would normally include some higher layer protocol, such as IP or AppleTalk.

Frame Check Sequence, 4 Bytes

The check sequence is calculated over the whole frame by the transmitting device. The receiving device will re-calculate the checksum and ensure it matches the one inserted by the transmitter. Most types of Ethernet equipment will drop a frame with an incorrect or missing FCS.

The minimum legal frame size, including the FCS but excluding the preamble, is 64 bytes. Frames below the minimum size are known as “runts” and would be discarded by most Ethernet equipment.

The maximum standard frame size is 1522 bytes if VLAN tagging is being used and 1518 bytes if VLAN is not being used. It is possible to use frames larger than the maximum size. Such frames are called “Jumbo Frames” and are supported by some manufacturer's equipment in various sizes up to 64 Kbytes. Jumbo frames are identical in form to standard frames but with a bigger data field. This produces a better ratio of “overhead” bytes to data bytes and hence more efficient transmission. Jumbos are non-standard and manufacturer specific and therefore inter operability cannot be guaranteed.

The frames are transmitted from left to right, least significant bit first. The frames are separated by an “inter-packet gap”. The minimum length of the inter-packet gap is 12 bytes. The inter-packet gap exists because in a half duplex system time is needed for the medium to go quiet before the next frame starts transmission. The inter-packet gap is not really needed for full duplex operation but is still used for consistency.

Auto Negotiation and Flow Control

Most Ethernet devices support auto-negotiation. When two devices are first connected together they will send information to each other to “advertise” their capabilities. The devices will then configure themselves to the highest common setting. The capabilities negotiated are speed, full or half duplex operation and the use of flow control. For gigabit Ethernet nearly all systems are 1000 Mb/s and full duplex, leaving only flow control to be negotiated. If one end of a link does not support auto-negotiation the link will have to be manually configured.

Flow control is only used in full-duplex mode and is achieved by sending PAUSE requests to the station at the other end of an Ethernet link when a receiver is being overloaded with data. Flow control can be either non-symmetrical, when only one station can issue pause requests or symmetrical, where both stations can issue PAUSE requests. The PAUSE request contains a field that tells the far end station how long to stop transmitting for in order to give the receiver an opportunity to catch up. If flow control is not being used data will be lost under overload conditions.

Transmission Schemes

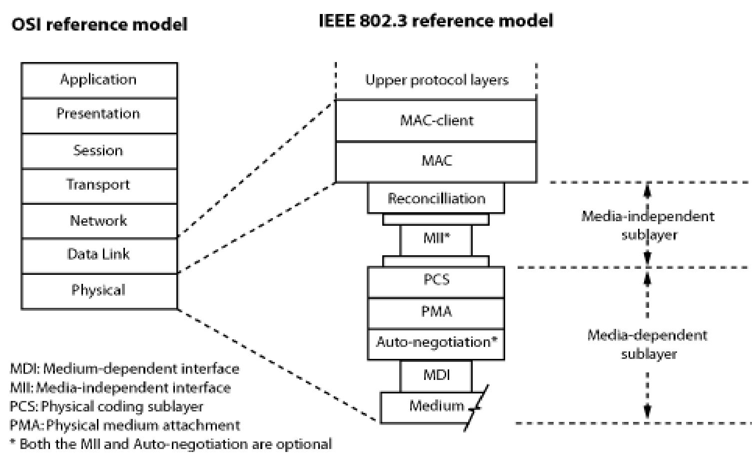
Various line-coding schemes are used to transmit Ethernet frames at the physical layer.

For 100 BASE-X (TX or FX) a 4b/5b encoding scheme is used, giving a physical line rate of 125 Mb/s. Other coding schemes are used to suit various media types.

For gigabit Ethernet the most common transmission scheme is the 8b/10b encoding scheme used for 1000BASE-X (CX, SX, LX), giving a line rate of 1250 Mb/s. As well as coding data for transmission the 8B/10B scheme has special code groups, including a “line idle” and a “start of frame”. This means that at the physical layer a gigabit Ethernet transmitter is always “on” and the receiver is always synchronized, even during the inter-packet gap. This, combined with full duplex operation, makes both the inter-packet gap and the preamble redundant for gigabit Ethernet. However both are still used to provide consistency of operation to the upper layers.

Introduction to the OSI Seven Layer Model

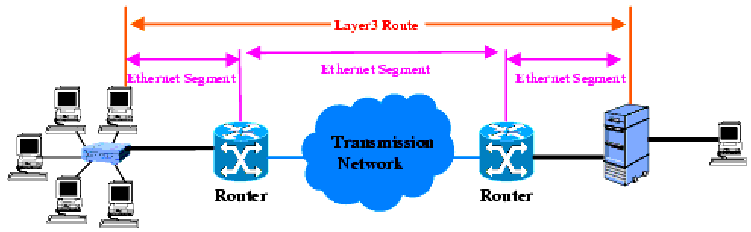
The OSI seven layer model presents a means of describing the functions of the various sections, or layers, of a data communication system. Ethernet covers the bottom two layers of this model, Layer 1, the physical medium (UTP, Co-ax, Fibre) over which the data is transferred and Layer 2 (Data Link Layer), the control mechanism for transmitting data onto the medium and receiving data from the medium.



Relationship between the OSI Seven Layer Model and Ethernet

Layer 3 is the network layer and this function is most commonly carried out by IP, but could also be AppleTalk, IPX or other such protocols.

The purpose of Ethernet is to ensure data is transferred over a link in a communications network, while the Layer 3 protocol has the job of ensuring the data is transferred over the whole network, from the original source to the ultimate destination. This may use any number of separate Ethernet links. The simplified network diagram below illustrates this.



The higher layer protocols, Layers 4 and above, have the task of ensuring the integrity of transmitted data and presenting the data to the user or application. The function of these higher layer protocols is of little interest in a transmission environment. A detailed description of the function of all seven layers of the model, and the advantages and disadvantages of the various protocols used in each layer, can be found in any good text on data networking.

Transmission Methods

Current telecommunications networks are, of course, built using SONET/SDH and DWDM technologies. Transmitting an asynchronous, “self-routing”, frame-based protocol such as Ethernet on a synchronous, fixed-routing, fixed-bandwidth SONET/SDH network creates numerous potential problems. In order to address these problems Network Equipment Manufacturers have created numerous different methods of getting the Ethernet frames onto the transmission network and each of the methods has advantages and disadvantages. It is essential to know how the Ethernet frames are being transported when using or testing an Ethernet service as it affects the way the service is used or tested. The different methods of transmission can be loosely categorized as follows:

Layer 1 - Ethernet-on-Light Solutions

In these systems the Ethernet signal is simply transported, in native format, on a DWDM wavelength. These systems are only used with Gigabit Ethernet.

Advantages:	Simplicity Security
Disadvantages:	Uses an entire wavelength No grooming/muxing of traffic No grooming/muxing of traffic No value-added services can be applied Reliability is dependent on the DWDM system protection scheme

Since no Layer 2 switching is involved, these systems can be expected to operate in a different manner to a “normal” Ethernet device. For example, a Layer 1 system should propagate errored frames rather than rejecting them.

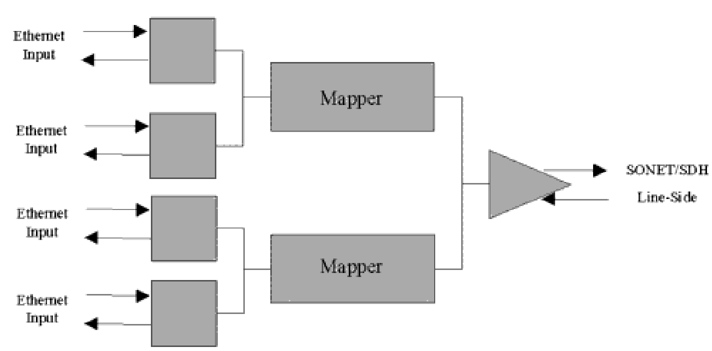
Layer 1/2- Ethernet-in-SONET/SDH (Unswitched)

In these systems the Ethernet frames are received by the equipment, encapsulated in some way and then transported as a SONET payload. The encapsulation can be done in a number of ways; the most common methods are PPP over HDLC, GFP, LAPS or a proprietary method. See “Encapsulation" on page 406 for more details on encapsulation schemes.

These systems may incorporate some Layer 2 “intelligence”, switching the Ethernet frames into the correct SONET channel by using VLAN tags for example. Most of the current systems however simply send all received frames to SONET line-side and vice-versa.

The advantages and disadvantages of the unswitched method are:

Advantages:	Does not use an entire DWDM wavelength Uses the SONET protection scheme
Disadvantages:	Grooming/muxing/switching of traffic is not possible Sharing of line-side bandwidth is not possible Inefficient use of line-side bandwidth

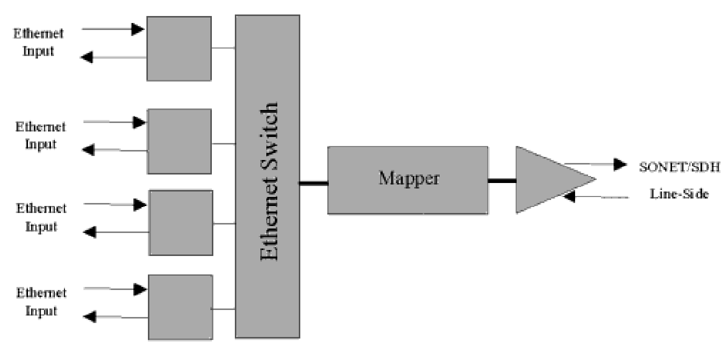


Layer 2 - Ethernet-in-SONET/SDH (Switched)

In these systems a Layer 2 Ethernet (MAC) switch is built into the network element tributary card. The SONET/SDH channel(s) that the Ethernet traffic are to be carried over are treated by the switch as an “extra” Ethernet port, or ports, with the Ethernet frames being encapsulated into SONET/SDH by using the same methods as the un-switched solution. An Ethernet switch will learn the MAC addresses of all the devices connected to it and then route frames to the correct port based upon the destination MAC address.

This method therefore allows for the switching/grooming and statistical multiplexing of the Ethernet traffic. This gives far greater flexibility in allocating bandwidth on the line side of the device. A single line-side channel can now be used to serve several customers. This greatly enhances the bandwidth efficiency when carrying a “bursty” Ethernet service that at times may have no traffic on it. The downside to sharing of line-side bandwidth is that when all of the customers are trying to access the service at the same time bandwidth contention, with a consequent loss of traffic, will occur.

Advantages:	Does not use a wavelength Uses SONET protection scheme Allows for efficient use of line-side bandwidth Traffic grooming and prioritisation is possible using VLAN or priority tags (If NE supports this)
Disadvantages:	Shared bandwidth may lead to contention Shared bandwidth may have security concerns



Layer 3 - IP Switch/Router

A few systems have a Layer 3 switch incorporated into a SONET network element. These systems are an extension of the switched Layer 2 solutions with the customer traffic being sent to the correct port or SONET line-side channel based upon IP address instead of MAC address. These systems have the same advantages as the Layer 2 solutions. They also have the additional benefit of negating the need for all the customers to have a router in a multi-tenant building environment. On the downside such devices can be difficult to provision and manage.

Encapsulation

There are various methods of encapsulating Ethernet frames into a SONET/SDH bearer. Encapsulation is needed in order to ensure that the Ethernet frames are packaged in the correct format for transport. Encapsulation is used to mark the beginning and end of the frames and to deal with the interpacket gap between frames. The most common encapsulation schemes are:

PPP over HDLC

Point-to-Point Protocol over High Level Data Link Control. This is the encapsulation method used to carry IP datagrams in Packet over SONET (PoS) systems. For Ethernet over SONET/SDH systems PPP/HDLC is simply used to carry Ethernet frames instead of IP datagrams.

LAPS (ITU-T, X86)

Link Access Protocol, SDH. This method of mapping has been specifically designed to carry Ethernet frames over SDH or SONET links. It is being adopted by the ITU-T as a standard, number X86. It is very similar to HDLC in operation.

GFP

Generic Framing Protocol. As the name implies this method of encapsulation can be used to carry most types of data service, not just Ethernet.

Proprietary

Many manufacturers use their own encapsulation schemes. However most of these schemes are simply variations on one of the methods described above.

Generally the manufacturer sets the type of encapsulation scheme and little needs to be known about it during the installation and maintenance phases of network deployment. However the type of encapsulation scheme and how it is used can have an effect on the data throughput rate and so it should not be ignored. For example GFP can have two modes of operation: framed or transparent. In transparent mode all the data from an incoming signal, including the interpacket gap and the preamble, will be transported. This means that line-side bandwidth is being used to transport “overhead” data. Conversely if GFP is operated in framed mode it will only transport the actual frame and not the preamble or IPG. This can obviously lead to bandwidth efficiencies.

Most of the equipment currently available uses a proprietary encapsulation scheme, preventing inter operability between vendors. However many vendors are moving towards LAPS or GFP. This should mean that future network equipment is inter-operable.

Testing Ethernet Services

For more details, see:

Service Quality

There is a perceived difference in the quality allowed for an Ethernet service compared to a SONET/SDH or T-Carrier/PDH service. In general for SONET/SDH or T-carrier/PDH any errors are considered significant and in some circumstances even a single bit error can affect the quality of the end service.

Conversely, Ethernet has its origins in a shared medium environment where collisions, and subsequent loss of data, are normal. In addition the discarding of packets by routers under “overload” conditions is a normal control mechanism. For this reason one of the primary functions of the upper layer protocols is to ensure the completeness and correctness of the data. Small amounts of data loss are therefore inconsequential and the data is simply re-transmitted, the re-transmit being initiated by the Ethernet layer if due to collisions or the upper layer protocol if due to frame loss. This leads to the belief that a lower quality of service can be acceptable for an Ethernet service when compared to a SONET/SDH service. While this is generally true it is still very important to set limits for the amount of errors or data loss allowed and to be able to measure these limits.

The reason that quality of service is important for Ethernet is because as more data is lost the number of re-transmits increases. This leads to more collisions/overloads and more data loss, which in turn leads to more re-transmits and so on. This situation will very quickly make a network unusable. It is therefore necessary to keep the number of re-transmits to a minimum. In a shared-medium environment this is done by keeping the network utilization low and thus preventing collisions. In a full duplex environment this is done by minimizing the number of errored or lost frames and thus preventing the upper layer protocol requesting re-sending of data.

As with any other telecommunications service Ethernet services need to be tested. Testing the service will ensure quality of service for the end user and optimum network utilization for the operator. The parameters to be tested and how they are measured are discussed below.

Parameters to be Measured

There are three fundamental measures of performance for data/Ethernet networks. These are:

- Data Throughput
- Frame Loss
- Latency
- Other Measures

Data Throughput

Data throughput is simply the maximum amount of data, usually measured in Mb/s, that can be transported from source to destination. However the definition and measuring of throughput is complicated by the need to define an acceptable level of quality. For example, if 10% errored or lost frames were deemed to be acceptable then the throughput would be measured at 10% error rate. This document shall use the generally accepted definition that throughput should be measured with zero errors or lost frames.

In any given Ethernet system the absolute maximum throughput will be equal to the data rate, e.g.10Mb/s 100Mb/s or 1000Mb/s. In practice these figures cannot be achieved because of the effect of frame size. The smaller size frames have a lower effective throughput than the larger sizes because of the addition of the pre-amble and the inter-packet gap bytes, which do not count as data. The maximum achievable throughput for various frame sizes is given in the following tables.

On any system incorporating a Layer 2 switch throughput (and Frame Loss) will be affected by the way the service is used, or tested. This is because of over-subscription. For example, it is common to map a number, say eight, of 10/100 Mb/s Ethernet services into a 622 Mb/s SONET or SDH bearer. If we test, or use, only six ports we would expect to see full bandwidth available on all six ports. If we now re-test with all eight ports fully loaded there will only be approximately 622/8 = 77 Mb/s available on each port and this is what our throughput test would reveal. In addition, if PAUSE flow control is not being used between the network element and the customer equipment/test set then the "extra" 23 Mb of data will be lost.

10 Mb/s System

Frame Size (bytes)	Data Throughput (Mb/s)	Preamble and IPG (Mb/s)	Frames Rate (Frames/s)
64	7.62	2.38	14880
128	8.65	1.35	8445
256	9.27	0.72	4528
512	9.62	0.38	2349
1024	9.81	0.19	1197
1280	9.84	0.15	961
1518	9.87	0.13	812
1522 (includes VLAN)	9.87	0.13	810

100 Mb/s System

Frame Size (bytes)	Data Throughput (Mb/s)	Preamble and IPG (Mb/s)	Frames Rate (Frames/s)
64	76.19	23.81	148809
128	86.49	13.51	84459
256	92.75	7.25	45289
512	96.24	3.76	23496
1024	98.08	1.92	11973
1280	98.46	1.54	9615
1518	98.69	1.30	8127
1522 (includes VLAN)	98.70	1.30	8106

1000 Mb/s System

Frame Size (bytes)	Data Throughput (Mb/s)	Preamble and IPG (Mb/s)	Frames Rate (Frames/s)
64	761.90	238.10	1488095
128	864.86	135.14	844594
256	927.54	72.46	452898
512	962.40	37.59	234962
1024	980.84	19.16	119731
1280	984.61	15.38	96153
1518	986.99	13.00	81274
1522 (includes VLAN)	987.02	12.97	81063

Frame Loss

Frame loss is simply the number of frames that were transmitted successfully from the source but were never received at the destination. It is usually referred to as frame loss rate and is expressed as a percentage of the total frames transmitted. For example if 1000 frames were transmitted but only 900 were received the frame loss rate would be:

(1000-900) / 1000 x 100% = 10%

Frames can be lost, or dropped, for a number of reasons including errors, over-subscription and excessive delay.

Errors

Most Layer 2 devices will drop a frame with an incorrect FCS. This means that a single bit error in transmission will result in the entire frame being dropped. For this reason BER, the most fundamental measure of a SONET/SDH service, has no meaning in Ethernet since the ratio of good to errored bits cannot be ascertained.

Oversubscription

The most common reason for frame loss is oversubscription of the available bandwidth. For example, if two 1000Mb/s Ethernet services are mapped into a single 622Mb/s SONET/SDH pipe (a common scenario) then the bandwidth limit is quickly reached as the two gigabit Ethernet services are loaded. When the limit is reached, frames may be dropped.

Under these circumstances it might be necessary to know not only how many frames are being dropped but which frames. For example, some network elements claim to be able to prioritize traffic based upon VLAN ID or priority tag. If this function is being used then as the bandwidth limit is reached it should be the low priority packets which get dropped. This functionality needs to be tested.

Excessive Delay

The nature of Ethernet networks means that it is possible for frames to be delayed for considerable periods of time. This is important when testing as the tester is “waiting” for all of the transmitted frames to be received and counted. At some point the tester has to decide that a transmitted frame will not be received and count the frame as lost. The most common time period used to make this decision is the RFC specification of two seconds. Thus any frame received more then two seconds after it is transmitted would be counted as lost.

Latency

Latency is the total time taken for a frame to travel from source to destination. This total time is the sum of both the processing delays in the network elements and the propagation delay along the transmission medium.

In order to measure latency a test frame containing a time stamp is transmitted through the network. The time stamp is then checked when the frame is received. In order for this to happen the test frame needs to return to the original test set by means of a loopback (round-trip delay) or the test frame needs to be read by a similar set at the other end of the network path.

If a single test set on loopback is to be used then the “out” and “return” paths need to be symmetrical in order for the measurement to be accurate. Whether this is the case depends up on the capabilities of the network under test. If separate test sets are used then some means of synchronizing the two sets to a single time source will be required. The only practical means of doing this is to synchronize the two test sets using GPS receivers but this can be difficult to achieve in practice due to the need for the GPS antenna to have a clear view of the satellites. Which of the two techniques needs to be used to measure latency will depend upon the capabilities and setup of the device/network under test.

In a pure-data network operating at Layer 3 it will probably be necessary to measure latency end-to-end in order to achieve an accurate figure. There are several reasons for this. Firstly, the processing delays in the network elements, routers, can be considerable and will vary depending upon a number of factors including load and the size of the routing tables. Secondly, if more than one route is available to the router there is no guarantee that packets will be sent by the same physical route “out” and “return”. Finally, if traffic management is being used then the router will delay “ordinary” traffic, possibly including the test frame, to allow high priority traffic such as voice-over-IP through. These factors mean that the “out” and “return” routes will almost certainly not have a symmetrical delay and the end-to-end method must be used.

However, the networks being examined in this paper are not pure-data networks but Ethernet over SONET/SDH transmission networks. In addition, with a few exceptions, these networks will operate at Layer 2 or below. This means the loopback method for testing latency can usually be used.

In a transmission network operating at Layer 2 the processing delays inside the network elements should be relatively small, when compared to the propagation delays. For example the time taken for a bit to propagate down one kilometre of fibre is approximately 3.33 us (this, rather crudely, ignores the refractive index of the fibre). For 1000 Mb/s Ethernet the bit time is 1 ns. This gives the network element 3300 bit times to carry out processing and switching before the processing delays become greater than the propagation delays, even on very short fibre runs.

Layer 2 switching is relatively simple compared to Layer 3 and it should not be affected by factors such as loading. Therefore the time taken to process frames should be roughly symmetrical in both the “out” and “return” directions. In addition for an Ethernet over SONET/SDH link the physical paths will be the same in the “out” and “return” directions.

Since the propagation delays should be very large compared to the processing delays, thus swamping any small variation that does occur in the processing times, and the physical paths are identical it is safe to assume that the “out” and “return” delays will be symmetrical for an Ethernet over SONET/SDH system. This means that the complications of end-to-end latency measurements can be avoided and hence the simpler loopback method can be used.

Other Measures

As well as these fundamental measures there are many other parameters that may need to be tested. These include:

- Counts of errored frames
- Counts of out of sequence frames,
- Counts of runt frames
- Counts of jumbo frames
- Counts of broadcast frames
- Counts of multicast frames

As with the fundamental parameters the methods used to measure these parameters, and the results obtained, will depend upon the capabilities and setup of the network under test.

Errored Frames

These are Ethernet frames with an incorrect or missing FCS. Devices operating at Layer 2 will simply reject errored frames and testing such a device would show a dropped frame rather than counting an errored frame. On some Layer 1 solutions however it is possible to transmit and receive errored frames.

Out of Sequence Frames

At Layer 3 it is possible for some frames to be delayed to allow the prioritisation of other traffic and out of sequence frames are possible. At Layer 2 or below out of sequence frames should not normally be encountered. However a frame that arrives after the test set has made the decision that the frame is lost (see “Frame Loss” section, above) will count as an out of sequence frame, provided the test set is capable of dealing with such events.

Runts

These are frames below the minimum frame size of 64 bytes. As with errored frames, most devices will reject runts and a lost frame will be counted instead. Some devices will however allow the transmission of runts so they may need to be counted.

Jumbo Frames

These are frames above the maximum size of 1518/1522 bytes. They may or may not be allowed in the network depending upon configuration. If they are not allowed by the switches then they would be dropped and a lost frame would result when testing.

Broadcast/Multicast Frames

Broadcast and Multicast frames can use up a lot of network bandwidth and for this reason some operators will restrict their use. For example broadcasts could be restricted to 5% of overall bandwidth. If this is being done then it will be required to count broadcast frames.

The tests highlighted above are the most common but not all possible requirements are covered. For example, it may also be necessary to be able to test the response of the device or network under test to different MAC addresses, or its ability to handle VLAN tagging. The need for these “other” tests will depend upon many factors including the functionality of the device/network under test, the nature of the service being tested, the expectations of the end-user and the availability of test equipment. These factors should be borne in mind when designing test scenarios.

Test Methods

When testing any telecommunications service it is necessary to transmit test traffic into the network and then receive the test traffic either back on the original test set or on a similar device at the “other end” of the service being tested. In this way the test set can measure what effect travelling through the network has had on the test traffic.

In a SONET/SDH network the most usual method of achieving this is to apply a transmitter to receiver loopback at the far end and test the service around this loop. For multi-port services, tributaries can be “daisy-chained” to speed testing as long as jitter build up is taken into account.

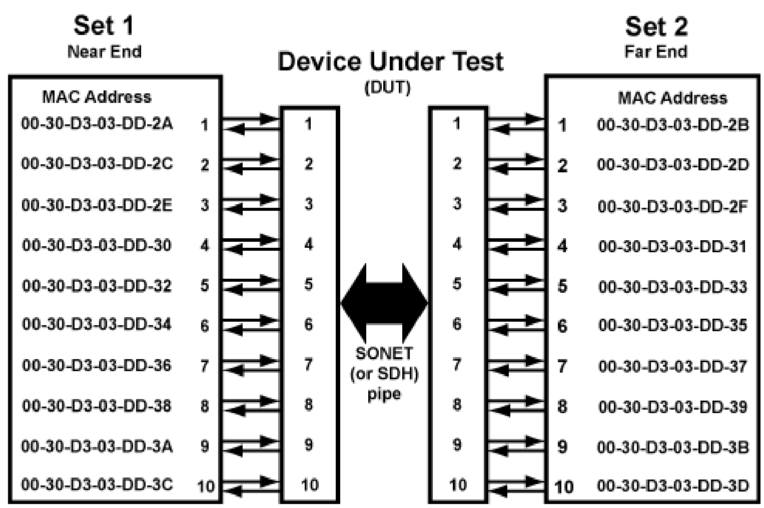
With most types of network element this test methodology will not work for Ethernet services and other methods must be used. Which test methods will work and which will not depends upon the method being used to transport the Ethernet frames across the SONET/SDH network and the set-up of the network element(s).

Ethernet frames are routed based upon their MAC address. Ethernet switches, such as those built into some network elements, need to “learn” what MAC address is connected to a port before they will send any traffic to that port. If the transmitter is looped to the receiver the switch will never see a frame being received to learn the MAC address and so will not transmit any frames to the port. This also applies to a port-to-port loopback although it is sometimes possible to overcome this problem by correct use of VLAN tags. This means that Ethernet tributary cards, unlike their SONET/SDH equivalents, cannot be “daisy-chained” to reduce test time. A multi-port test set is therefore required if test time is to be kept to a minimum.

The methods outlined below are general examples but their use will depend on the circumstances.

End-to-End Method

In this method testing is carried out between two separate test sets, one at each end of an Ethernet circuit. The destination address of the near end tester is the corresponding port on the far end tester and vice-versa. This method can be used irrespective of the functionality of the network under test. However if latency testing is to be carried out some means of synchronizing the clocks in the test sets will be required. An external GPS receiver is often used for this.



End-to-End Method (ten ports shown)

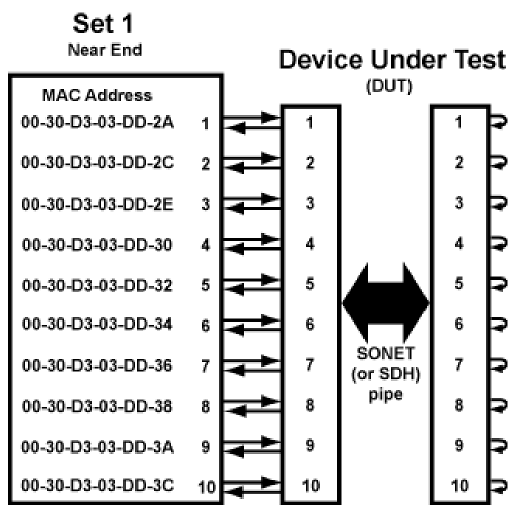
Loopback

In this method testing is carried out from a single test set. Two possible types of loopback can be used. The use of the different loopback methods depends upon the functionality of the device under test. The loopback types are:

- Single Port Loopback
- Port-to-Port Loopback

Single Port Loopback

In a single port loopback the tester is connected to the near end port(s) of the device under test and a Tx-Rx loop is applied to the far end. This method only works with network equipment that operates at Layer1, such as some Ethernet-on-light solutions. It will not normally work with a Layer 2 Ethernet device, as the port at the far end will be unable to route the test frames. This method requires the source and destination MAC addresses to be the same and so will not be supported by all types of test set.



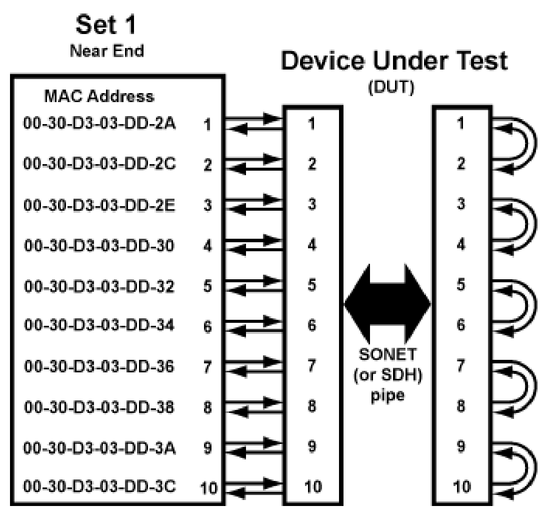
Single Port Loopback

Port-to-Port Loopback

In a port-to-port loopback the tester is connected to two (or more) near end ports and the loopback is applied from port to port at the far end. This method only works on network equipment that operates at Layer 1. It can be made to work with some Layer 2 equipment by using VLAN tagging, as follows.

Port 1 on the “Set 1" end switch is provisioned to transmit to port 1 on the “Set 2" end switch. Port(s) 2 are connected in the same way. Both Ethernet switches then have port 1 set to belong to VLAN 1 and port 2 set to belong to VLAN 2. Port 1 is physically looped to port 2. Test frames tagged as VLAN 2 are then transmitted into port 1 (and vice versa). The receiving switch will ignore the MAC address and because the frame does not belong on VLAN1 it will route the frame out of the far end port 1, where it will be received on port 2. Since the far end port 2 is on VLAN 2 the switch will broadcast the frame to that port and hence the frame will arrive back at the test set. This process is repeated on all ports to be tested.

As can be seen this method, if it can be made to work, requires a lot of provisioning. This includes the provisioning of some paths which may already be in use for customer traffic, in which case this method cannot be used.



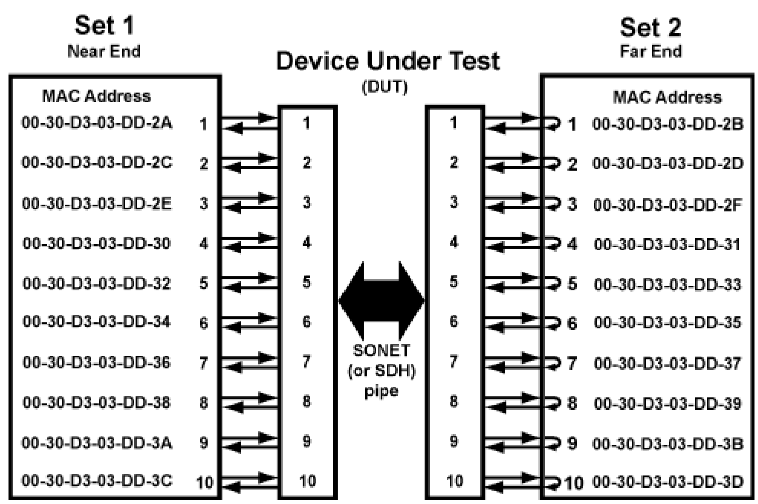
Port-to-Port Loopback

Loopthru

Loopthru is a phrase coined by Agilent Technologies to describe the functionality available on some of its Ethernet test equipment. This functionality will not be available on all test sets. The method works as follows:

This method uses two testers, one at each end of the Ethernet circuit. However the far end tester does not actively test the circuit. The far end instrument simply acts as a “loopthru”. It will receive the test frames and strip the source and destination MAC addresses. It then re-inserts the source address as the destination address and vice-versa before re-transmitting the frames.

Using this method it is possible for all tests to be carried out, including latency, on a single circuit, without the provisioning of extra paths through the network or the use of VLAN tags.



Loopthru

Test Method Summary

The advantages and disadvantages of the different test methods are summarized in the table:

Method	Advantages	Disadvantages
End-to-End	• Can be used on a single circuit • Can be used to isolate unidirectional faults	• Requires two units • Requires two operators • Latency measurement is not possible
Loopback (Single Port)	• Can be used on a single circuit • Only requires one instrument and one operator	• Only works on some types of network equipment
Loopback (Dual Port)	• Only requires one instrument and one operator	• Requires the provisioning of a second circuit and/or the use of VLAN tags • Only works on some types of network equipment
Loopthru	• Can be used on a single circuit • All measurements available • Only requires one operator once set-up • Works on all types of network equipment	• Requires the use of two instruments

An Example

The results below were obtained while testing an Ethernet service on a multi-service platform. The platform in question is of the Layer 2 variety with multiple Ethernet “input” ports, a Layer 2 switch and a line-side “output” port. The line-side ports are connected together across the network by the provisioning of an SDH pipe of various sizes. The pipe size used in the results below was a C-12 (2.176 Mb/s). The tests were run on a single port using the end-to-end test method.

Frames Sent

Rate (Mb/s)	Frame Size					
	64	**128**	**256**	**512**	**1024**	**1500**
1.024	120000	60000	30000	15000	7500	5100
1.4	164040	82020	40980	20460	10200	6960
1.536	180000	90000	45000	22500	11220	7680
1.7	199200	99600	49800	24900	12420	8460
2	234360	117180	58560	29280	14640	9960
2.048	240000	120000	60000	30000	15000	10200
2.5	292920	146460	73200	36600	18300	12480
5	585900	292920	146460	73200	36600	24960
10	1171860	585900	292920	146460	73200	49980

Frames Received

Rate (Mb/s)	Frame Size					
	64	**128**	**256**	**512**	**1024**	**1500**
1.024	120000	60000	30000	15000	7500	5100
1.4	164040	82020	40980	20460	10200	6960
1.536	169919	90000	45000	22500	11220	7680
1.7	169990	99600	49800	24900	12420	8460
2	170083	102092	56718	29280	14640	9960
2.048	170095	102098	56761	30000	15000	10200
2.5	169410	101934	56718	30092	15549	10749
5	169443	101676	56679	30074	15549	11189
10	169435	101698	56537	30050	15541	10748

Frames Lost

Rate (Mb/s)	Frame Size					
	64	128	256	512	1024	1500
1.024	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1.4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1.536	5.60%	0.00%	0.00%	0.00%	0.00%	0.00%
1.7	14.66%	0.00%	0.00%	0.00%	0.00%	0.00%
2	27.43%	12.88%	3.15%	0.00%	0.00%	0.00%
2.048	29.13%	14.92%	5.40%	0.00%	0.00%	0.00%
2.5	42.17%	30.40%	22.52%	17.78%	15.03%	13.87%
5	71.08%	65.29%	61.30%	58.92%	57.52%	55.17%
10	85.54%	82.64%	80.70%	79.48%	78.77%	78.50%

Round Trip Delay (ms)

Rate (Mb/s)	Frame Size					
	64	128	256	512	1024	1500
1.024	20	10	10	11	20	20
1.4	40	20	21	20	40	21
1.536	60	20	20	30	21	20
1.7	51	31	21	20	30	21
2	60	80	121	30	31	21
2.048	60	80	121	40	40	21
2.5	60	80	130	230	401	561
5	60	80	131	220	401	571
10	61	90	131	220	401	571

These results are very interesting. At the larger frame sizes, no frame loss is encountered until we reach the bandwidth limit of the SDH bearer. At the smaller frame sizes, we see substantial frame loss before we reach the bandwidth limit. This is most likely due to the frame processing software in the network element being unable to keep up with the large number of frames present at small sizes.

The latency/round trip delay results are also very interesting. These show a distinct step, particularly at larger frame sizes, when the bandwidth limit is reached. It is not possible to speculate on the reason for this without more information on how the network element is operating.

Summary

Ethernet has become a transport protocol in telecommunication networks. The use of native Ethernet interfaces on telecommunications transmission equipment can bring cost savings to the end customer and revenue to the network operator. It can also offer simplicity and ease-of-use.

In order to deploy the technology and realize these benefits, an understanding of how the technology works and how to test it is required. Ethernet differs from the “traditional” SONET/SDH and DSn/PDH services and these differences have to be taken into consideration. If this is done then the “next generation” of data-ready network elements can help network operators meet their customers needs and maximize revenue from their networks.

Theoretical Frame Rate

The instantaneous **frame rate** in Ethernet is entirely dependent on any current frames to be transported. If there is no data to transfer, the frame rate goes to 0.

Frames can be any size, from 64 to 1518 bytes in length (excluding Jumbo Frames). For every frame to be transmitted there is a fixed **preamble** (fixed at 8 bytes) and **interpacket gap** (the equivalent of 12 bytes). Frames may also contain 4 additional **VLAN** bytes.

For any particular size of frames, you send a preamble, the frame, and then the interpacket gap, and then a preamble, and then a frame and an interpacket gap, and so on as shown:

Theoretical frame rate is calculated from:

Frame Rate = 1 / Frame Period

where, Frame Period = Total Frame Size / Port Rate;

Total Frame Size includes preamble, frame, VLAN and interpacket gap and is expressed in bit times.

Minimum and Maximum Frame Sizes

Frame Size	Minimum Period per Frame Sent	
Minimum - 64 bytes	8 * (8 + 64 + 12) bit times*	= 672 bit times*
Maximum - 1518 bytes (non-jumbo, non-VLAN)	8 * (8 + 1518 + 12) bit times*	= 12304 bit times*
Maximum - 1522 bytes (non-jumbo, VLAN)	8 * (8 + 1522 + 12) bit times*	= 12336 bit times*

* Bit time is dependent on the port rate.
- For 10BASE-T, the bit time is 1/10 Mb/s = 100 ns
- For 100BASE-T, the bit time is 1/100 Mb/s = 10 ns
- For 1000BASE-X, the bit time is 1/1000 Mb/s = 1 ns

Using this yields the following table of frame rates and frame sizes for each port rate:

Frame Rate v Frame Size

Frame Size (bytes)	Frame Rate (frames/second) Port Rate 10 Mb/s	100 Mb/s	1000 Mb/s
64	14880	148809	1488095
128	8445	84459	844594
256	4528	45289	452898
512	2349	23496	234962
1024	1197	11973	119731
1280	961	9615	96153
1518	812	8127	81274
1522 (includes VLAN)	810	8106	81063

Introducing ITU Performance Analysis

You can use the G- or M-series ITU recommendations to analyze results.

- **G-series** focuses on telecommunications design, checking of performance limits, expected behaviors and design structures (whether it's the structure of the SDH/SONET itself or its expected behaviors and conformances).
- **M-series** focuses on installation and maintenance of the network. It includes "Bringing Into Service" (BIS) procedures and test limits or fault detection and localization procedures.

Both ITU recommendations do the following:

1 They interpret the basic error and alarm information, and categorize them into anomalies and defects as defined by each recommendation.

   The instrument processes the anomalies and defects into a series of **Performance Event** results for each in-context digital path.

2 They interpret the **Performance Event** results.

   You assign an **Allocation** value to the distance, media and network elements of the path being tested. These values are added together to provide a working figure known as the **Path Allocation** (PA). The PA is then compared with tables in the ITU recommendations to provide **Performance Objective** (PO) figures.

   You can further adjust the PO based on your own experience, and so the PO can have a proprietary element to it. At the end of a test period, the instrument's **Performance Event** results can be compared with your own PO figures to produce a pass or fail result. For M.2110 and M.2120, the instrument automatically displays the pass or fail result.

For more information, see:

- "ITU G.821 (08/96)" on page 429
- "ITU G.826 (02/99)/G.828 (02/00)" on page 430

- "ITU M.2101 (06/00)/M.2101.1(04/97)" on page 432
- "ITU M.2100" on page 433
- "ITU M.2110" on page 434
- "ITU M.2120" on page 436

ITU G.821 (08/96)

Provides a standard for evaluating **Out-Of-Service** long term (e.g. 30-day) error performance objectives of international digital connections operating below the primary rate and forming part of an ISDN network. This includes voice traffic as well.

This instrument will cover structured bit rates at N x 56 or 64 kb/s, where N is between 1 and 32 or 24. The ITU recommendation focuses on BER test results and associated alarm conditions.

Test Method

The Path Under Test can be unidirectional or bi-directional.

For a bi-directional (go and return) path, the instrument can transmit and receive the same test signal.

For a unidirectional path, a measurable test signal must be generated at the far-end by suitable test equipment (two-box testing).

In both cases, the Path Under Test is always Out-Of-Service (OOS) and a measurable test pattern is transmitted and received. Prior to full testing, a simple one hour BER test is recommended. The full test itself should be run for one month (30-days). At the end of the time, a comparison of the results should be made with the calculated Performance Objective for the Path Under Test.

Performance Events

Errored Seconds (ES): A one second period in which one or more bits are in error.

Severely Errored Seconds (SES): A one second period during available time which has a BER >1E-3.

Unavailable Seconds (UAS): Unavailable time starts at the onset of 10 consecutive SES and ends at the onset of 10 consecutive non-SES.

Performance Parameters

Error Second Ratio (ESR): The ratio of ES to total seconds in available time.

Severely Errored Second Ratio (SESR): The ratio of SES to total seconds in available time.

Error Performance During Unavailable Time

ES and SES are not usually accumulated during unavailable time. However, you will be allowed to do this in accordance with Annex A.4/G.826(02/99) and Annex A.4/G.828(02/00). In this case the Error Performance Parameters ESR and SESR remain unaffected.

ITU G.826 (02/99)/G.828 (02/00)

Provide standards for long term (~30-day) error performance objectives for constant bit rate international digital paths at or above the primary rate.

G.826 focuses on SDH/SONET and PDH/DSn paths.

G.828 focuses on SDH/SONET paths and is the more modern of the two and is recommended for new designs. Both ITU recommendations focus on block based error counts based on Error Detection Codes and associated alarm conditions.

Test Method

The Digital Path Under Test can be either unidirectional or bi-directional.

For a bi-directional (go and return) path, the instrument can transmit and receive the same signal.

For the unidirectional path, the instrument only needs to receive the incoming signal.

In both cases, the Path Under Test can either be In-Service or Out-Of-Service (OOS), although the OOS parameters are not used. This is because the ITU recommendation only requires the monitoring of In-Service parameters. Prior to full testing, a simple one hour test is recommended. The full test itself should be run for one month (30-days). At the end of the test period, comparison of the results should be made with the calculated Performance Objective for the Path Under Test.

Performance Events

Errored Blocks (EB): A block in which one or more bits are in error.

Errored Seconds (ES): A one second period with one or more errored blocks (anomaly), or at least one defect.

Severely Errored Seconds (SES): A one second period during available time which contains >30% errored blocks, or at least one defect.

Background Block Errors (BBE): An errored block (BIP or REI) not occurring as part of a SES.

Unavailable Seconds (UAS): Unavailable time starts at the onset of 10 consecutive SES and ends at the onset of 10 consecutive non-SES

Path Unavailable Seconds (PUAS): A bi-directional path includes both the transmit and receive direction. This path becomes unavailable when either the near end (receive) or far end (transmit) results become unavailable.

Se**verely Errored Period (SEP) - G.828 only:** A sequence of between 3 to 9 consecutive SESs.

Performance Parameters

Error Second Ratio (ESR): The ratio of ES to total seconds in available time.

Severely Errored Second Ratio (SESR): The ratio of SES to total seconds in available time.

Background Block Error Ratio (BBER): The ratio of BBE to total blocks in available time. The count of blocks excludes all blocks during SESs.

Severely Errored Period Intensity (SEPI) - G.828 only: The ratio of SEPs to total seconds in available time.

Error Performance During Unavailable Time

ES, SES and BBE are not usually accumulated during unavailable time. However, you will be allowed to do this in accordance with Annex A.4/G.826(02/99) and Annex A.4/G.828(02/00). In this case the Error Performance Parameters ESR, SESR, BBER and SEPI remain unaffected.

ITU M.2101 (06/00)/M.2101.1(04/97)

Provide standards and limits for the “bringing into service” and maintenance of international SDH/SONET paths and multiplex sections.

For SDH/SONET paths designed to G.826, maintenance must be performed using M.2101.1. For SDH/SONET paths designed to G.828, maintenance must be performed using M.2101. Both ITU recommendations focus on block based error counts based on Error Detection Codes and associated alarm conditions.

Test Method

The same as M.2110 for Bringing into Service (BIS) and M.2120 for Maintenance.

Performance Events

Errored Seconds (ES): A one second period with one or more errored blocks (anomaly), or at least one defect.

Severely Errored Seconds (SES): A one second period during available time which contains >30% errored blocks, or at least one defect.

Background Block Errors (BBE) - M.2101 only: An errored block (BIP or REI) not occurring as part of a SES.

Unavailable Seconds (UAS): Unavailable time starts at the onset of 10 consecutive SES and ends at the onset of 10 consecutive non-SES

Path Unavailable Seconds (PUAS): A bi-directional path includes both the transmit and receive direction. This path becomes unavailable when either the near end (receive) or far end (transmit) results become unavailable.

Error Performance During Unavailable Time

ES, SES and BBE are not usually accumulated during unavailable time. However, you will be allowed to do this in accordance with Annex A.4/G.826(02/99) and Annex A.4/G.828(02/00).

ITU M.2100

Provides limits for the “bringing into service” and maintenance of international PDH/DSn paths, sections and transmission systems.

For paths designed to G.821 (sub-primary level) and G.826 (primary level and above), maintenance must be performed using M.2100. The ITU recommendation focuses on block based error counts based on Error Detection Codes and associated alarm conditions.

Test Method

The same as M.2110 for Bringing into Service (BIS) and M.2120 for Maintenance.

Performance Parameters

Errored Seconds (ES): A one second period with one or more errored blocks (anomaly), or at least one defect.

Severely Errored Seconds (SES): A one second period during available time which contains >30% errored blocks, or at least one defect.

Unavailable Seconds (UAS): Unavailable time starts at the onset of 10 consecutive SES and ends at the onset of 10 consecutive non-SES

Path Unavailable Seconds (PUAS): A bi-directional path includes both the transmit and receive direction. This path becomes unavailable when either the near end (receive) or far end (transmit) results become unavailable.

Error Performance During Unavailable Time

ES and SES are not usually accumulated during unavailable time. However, you will be allowed to do this in accordance with Annex A.4/G.826(02/99).

ITU M.2110

Provides a generic method for "bringing into service" PDH/DSn paths, sections and transmission systems and SDH/SONET paths and multiplex systems.

- **M.2110** defines threshold testing methods.
- **M.2100, M.2101 or M.2101.1** defines the derivation and type of thresholds.

Test Method

The Path Under Test can be either unidirectional or bi-directional.

For a bi-directional (go and return) path, the instrument can transmit and receive the same signal.

For the unidirectional path, the instrument only needs to receive the incoming signal.

In both cases, the Path Under Test can either be In-Service or Out-Of-Service (OOS). The OOS parameters are not used as the ITU recommendations are for In-Service parameters only.

When you select the digital Path Under Test, an instrument Test Period must be selected which is at least as long as the *BIS Test Period* in the following table. The test period is dependent on the *Usage* intended. For the 24 hour test, at least a 7-day test period is selected. This is because if a 24 hour test exhibits marginal performance then its is permitted to proceed contiguously to the 7-day test.

You then calculate the Performance Objective (PO) for the Path Under Test. This is entered into the instrument as a percentage figure in the range 0.5% – 63%. The instrument then calculates the thresholds S1 and S2, and also the Bring into Service Objective (BISO) for 7-day testing. (These can also be programmed by you in the light of your experience).

The test is then run. Threshold test results can then be read direct from the display.

Bring Into Service (BIS) Test Periods

M.2110 will run concurrent threshold tests for the following BIS test times. The BIS test times, usage, threshold and results are shown in the table below. If the Error Performance Event (ES, SES, BBE or SEP) exceeds the **FAIL** threshold then the instrument will report this early, otherwise the instrument will report either **-?-** or **PASS** as the BIS Test Period elapses.

BIS Test Time and Usage	BIS Thresholds Used in Threshold Tests				BIS Result
	ES	SES	BBE (M.2101 only)	SEP (M.2101 only)	
15 min. Multiple tributary testing on existing paths	S1, S2	S1, S2	S1, S2	S1, S2	PASS, ?, FAIL
1 hour Tributary testing on new paths	S1, S2	S1, S2	S1, S2	S1, S2	PASS, ?, FAIL
1 hour Tributary testing on new paths	S1, S2	S1, S2	S1, S2	S1, S2	PASS, ?, FAIL

BIS Test Time and Usage	BIS Thresholds Used in Threshold Tests				BIS Result
	ES	SES	BBE (M.2101 only)	SEP (M.2101 only)	
24 hour Tributary testing of the first tributary in a path	S1, S2	S1, S2	S1, S2	S1, S2	PASS, ?, FAIL
7 day For paths exhibiting marginal performance	BISO	BISO	BISO	BISO	PASS, FAIL

ITU M.2120

Provides methods for detecting and locating faults for PDH/DSn paths, sections and transmission systems and SDH/SONET paths and multiplex systems.

- **M.2120** defines threshold testing methods.
- **M.2100, M.2101, or M.2101.1** defines the derivation and type of thresholds. Note, only M.2100/M.2101 are applicable for this instrument.

Test Method

The Path Under Test can be either unidirectional or bi-directional.

For the bi-directional (go and return) path, the instrument can transmit and receive the same signal.

For the unidirectional path, it only needs to receive the incoming signal.

In both cases, the Path Under Test can either be In Service or Out-Of-Service (OOS).

You select the digital Path Under Test. The instrument Test Period is set to MANUAL. There is no time limit on this test as it is intended for long term (rack mount?) performance monitoring.

You calculate the Performance Objective (PO) for the Path Under Test from which you determine the thresholds T1 and T2 which can also be programmed by you in the light of your experience.

You can connect the instrument into a Performance Monitoring network via it's remote access capabilities or it can operate and gather results as a stand alone.

Threshold Reports

A threshold report (TR) is an unsolicited error performance report with respect to either a 15-minute or a 24-hour evaluation period. TR's can only occur when the concerned direction is in the available state. All TR's are delayed within the instrument by 10s, as stated in 5.3.5.4/M.2120. Threshold reports are offered for each of the RX and TX directions (where present) and they are timestamped into the MRS along with the availability state.

Evaluation of TR1: The Performance Events provided by M.2100 or M.2101 are counted, second by second, over consecutive 15-minute rectangular fixed windows. A threshold can be crossed at any second within each window at which time a "Threshold Report" TR1-ES, TR1-SES or TR1-BBE is recorded and timestamped into the instrument's MRS. Thus, a maximum of only one of each TR1-xx event can be recorded in a 15-minute period.

The T1 evaluation period (15-minutes) assists in the detection of degraded performance.

N.B. This instrument only operates the Transient Condition Method (M.2120) which does not concern itself with Reset Thresholds (RTR1).

Evaluation of TR2: The events are further counted, second by second, over consecutive 24-hour rectangular fixed windows. A threshold can be crossed at any second within each window at which time a “Threshold Report” TR2-ES, TR2-SES or TR2-BBE is recorded and timestamped into the instrument’s MRS. Thus, a maximum of only one of each TR2-xx event can be recorded in a 24-hour period.

The T2 evaluation period (24-hour) assists in the detection of degraded performance.

Note that only the Transient Condition Method (M.2120) applies for TR2s.

Signal Rates

Rate (Mb/s)	Optical Carrier	SONET	SDH
51.84	OC-1	STS-1	STM-0
155.52	OC-3	STS-3	STM-1
466.56	OC-9	STS-9	STM-3
622.08	OC-12	STS-12	STM-4
933.12	OC-18	STS-18	STM-6
1 244.16	OC-24	STS-24	STM-8
1 866.24	OC-36	STS-36	STM-12
2 488.32	OC-48	STS-48	STM-16
2 666.06	OTU-1		
4 976.64	OC-96	STS-96	STM-32
9 953.28	OC-192	STS-192	STM-64
10709.23	OTU-2		
39 813.12	OC-768	STS-768	STM-256
43 018.41	OTU-3		

Summary of Errors and Alarms

The following tables show the instrument errors and alarms, what their acronyms mean and how each alarm is implemented in the instrument. Note that not all errors and alarms listed may be available on your instrument.

- “Alarm Definition Table" on page 440
- “Error Definition Table" on page 441

Alarm Definition Table

Acronym	Alarm
AIS	Alarm Indication Signal
BDI	Backwards Defect Indication
IAE	Incoming Alignment Error
INCAIS	Incoming AIS
LCK	Locked Indication
LOF	Loss of Frame
LOM/LOMF	Loss of Multiframe
LOP	Loss of Pointer
LOS	Loss of Signal
OCI	Open Connection Indication
ODI	Outgoing Defect Indication
OOF	Out of Frame
OOM	Out of Multiframe
PDI-P	Payload Defect Indicator
RAI	Remote Alarm Indication
RDI	Remote Defect Indication
RFI	Remote Failure Indication
SEF	Severely Errored Frame

Acronym	Alarm
TIM	Trace Identifier Mismatch
UNEQ	Unequipped

Error Definition Table

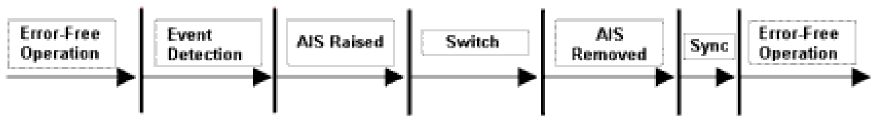
Acronym	Error
BEI	Backwards Error Indication
BIP	Bit Interleaved Parity
IEC	Incoming Error Count
OEI	Outgoing Error Indication
REI	Remote Error Indication

RDI-P/HP-RDI is only available when the enhanced RDI preference is OFF. To check this, Press **<Menu>**, choose **System > Preferences** then press **<Select>**. The **Enhanced RDI** checkbox should be unchecked.

RDI-P-P/HP-RDI- P, RDI-P-S/HP-RDI-S, RDI-P-C/HPDI-C alarms are only available when the enhanced RDI preference is ON. To check this, Press **<Menu>**, choose **System > Preferences** then press **<Select>**. The **Enhanced RDI** checkbox should be checked.

Service Disruption

Service disruption is the time it takes for a transmission system to perform an automatic protection switch following the detection of a transmission defect. Events occurring during protection switching are shown:



If a fiber break causes protection switching in a network element, an Alarm Indication Signal may be initiated by the network element. Once switching takes place, the AIS is removed. After a period of synchronization on the protection signal path, error-free operation is resumed.

ITU-T recommend that protection switching should take 50 milliseconds or less. While this is a difficult standard to meet, a large part of the problem is in actually initiating the protection switch. There are two methods to achieve this effectively:

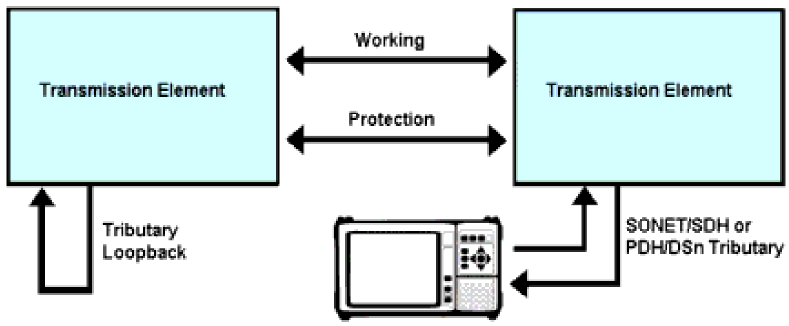
- Create a LOS failure, which will typically be detected in under 100 microseconds.
- Generate control parity errors on the protected system.

Each method has its own advantages and is ideal for particular test scenarios.

For more information, see:

- “Test Configuration for Measuring Service Disruption Time" on page 443
- “Contributors to Protection Switching Time" on page 444
- “Protection Switching Time Test Methods" on page 446
- “Measuring Protection Switch Time" on page 447
- “Understanding Service Disruption Test Results" on page 453

Test Configuration for Measuring Service Disruption Time

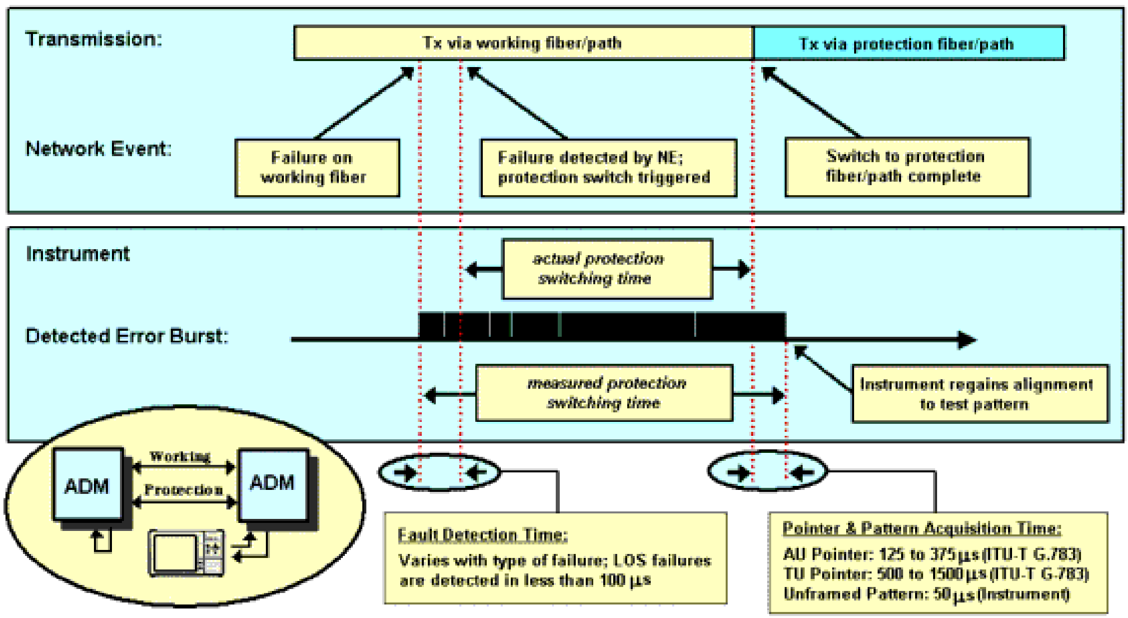


To measure service disruption time, insert a PRBS pattern at the tributary side of the device-under-test, looping it back on itself on the corresponding drop-side tributary. Monitor the received PRBS for errors as a switch occurs.

Result accuracy and reliability are based on the instrument's ability to measure the duration of error bursts associated with a protection switch event.

By measuring service disruption time from the tributary-side of the system-under-test, the measurement will be independent of the protection switching architecture. This setup supports all protection switching architectures. The performance of the system-under-test cannot be affected by the instrument since results are obtained through passive monitoring of the PRBS for errors.

Contributors to Protection Switching Time



When a protection switch is triggered (a fiber break can trigger a protection switch), it results in the PRBS test pattern being corrupted for a short period. The duration of this corruption is controlled by the following factors:

- The system's fault detection time
- The system's protection-switching time
- The time taken by the instrument to re-align to the pointers (SONET/SDH tributary only) and test pattern

System Fault Detection Time

For fault detection time, this is achieved by triggering the protection switch using a failure that results in a LOS defect. Although ITU-T G.783 (2000) defines LOS detection time as being "in the province of regional standards", it provides an example based on a value of less than 100 microseconds (less than 0.2% of the maximum acceptable protection-switching time). In the case of pointer and pattern acquisition, the required times are 125 to 375 microseconds for STS/AU pointers, and 500 to 1500 microseconds for VT/TU pointers.

System Protection Switching Time

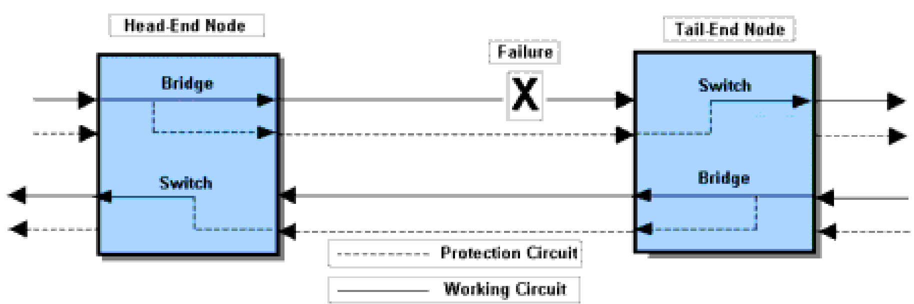
When measuring a system's protection-switching time, the total systematic error associated with the instrument's service disruption measurement can be restricted to between +0.3% to +4.05% of the maximum acceptable switching time. Consequently, it can be relied on to accurately evaluate this important system specification.

Protection Switching Time Test Methods

Many SONET/SDH linear and ring networks have built-in fault restoration known as Automatic Protection Switching (APS). However, the basic principles behind the instrument's Service Disruption measurement, and its application in verifying a transmission system's protection switching time, remain valid.

Following a failure, full service is not restored until all the Bridge and Switch operations are completed. A key goal for Network Equipment Manufacturers (NEMs) is to keep service disruption as short as possible, as their customers (Network Operators) will demand that all systems deployed in the network meet or exceed the specification published by the governing standards body (Telcordia or ITU-T). This section deals with the challenge of making meaningful and repeatable measurements of Protection Switch Time.

Protection Switching Summary



The diagram shows the state of the nodes after a switch has taken place. A typical sequence of events is listed below:

1 The Tail-End node detects the failure and signals the Head-End to request a Protection Switch.

2 The Head-End node performs a Bridge or Bridge and Switch operation, and sends back an acknowledgement.

3 The Tail-End node receives the acknowledgement and performs a Bridge and Switch operation, then finishes by sending a status message to the Head-End.
4 The Head-End node finishes by performing a Switch operation if necessary.

Measuring Protection Switch Time

The Protection Switch Time of a transmission system should be equal to or less than 50 milliseconds. The switching process is dominated by the protocol processing time at each node on the Protection Circuit. The ITU-T standards specifies Protection Switch Time and the ‘detection times’ for various SF and SD conditions.

Protection switching can be initiated by the following events:

1 Signal Fail (SF): usually loss of signal, loss of framing, or a very high error ratio such as 10E-03 or greater.
2 Signal Degrade (SD): a persistent background error rate that exceeds a provisioned threshold in the range 10E-05 to 10E-09. Note that, at the Multiplex Section level, ITU-T G.806 (October 2000 draft) specifies the ‘detection time’ for these errors as 10E-09.

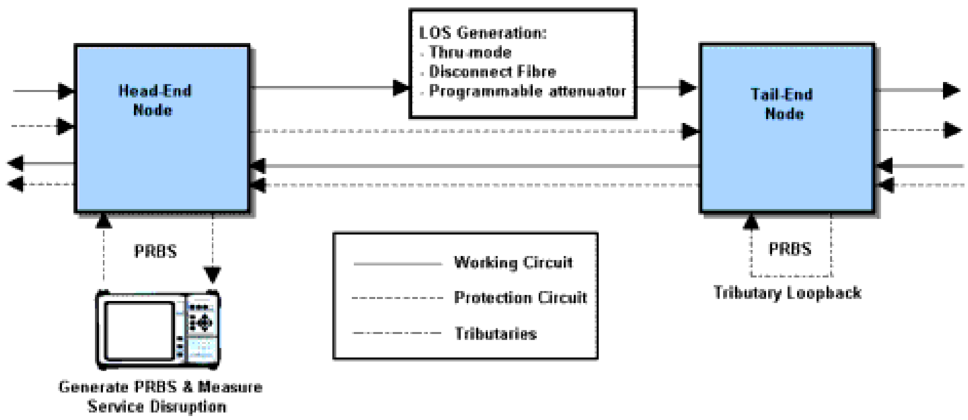
To reliably measure protection switching time, you need to measure the service disruption time associated with a SF/SD condition that either minimizes the ‘detection time’ (create a LOS failure – typically detected in less than 100 ms), or eliminates the ‘detection time’ (generate control Parity Errors (B2 and B3) on the entity being protected). Dividing service disruption time into its component parts is necessary due to the wide variation in detection times for different SF/SD conditions.

Detection Times

These range from 100 microseconds for a LOS failure to 10,000 seconds for a Signal Degrade that has a provisioned threshold of 10E-09 error rate. Also, the nature of some faults can be very unpredictable. For example, when a fiber is damaged during construction work it may not break cleanly. Instead, the optical signal may fade over several tens of milliseconds or vary erratically before finally disappearing. So the ITU-T standards require that, once SF/SD is detected, a Protection Switch event must be completed in 50 milliseconds or less. This is a tough requirement, but if it is met, end-users will not normally notice a Protection Switch event even allowing for a realistic SF/SD detection time.

Generating LOS Failure

This diagram shows three ways to generate a LOS failure.



If you use **Thru mode**, the LOS condition is induced by either switching off the instrument's laser transmitter or using its alarm generation controls to transmit LOS. Both of these controls produce a predictable and instantaneous LOS condition, and consequently enable repeatable and accurate protection switching time measurements to be performed.

The only source of measurement error associated with this method will be due to the LOS detection time being included in the service disruption time result. This is the recommended method for generating a LOS failure when measuring protection switch times.

If you **manually disconnect** an optical fiber, you will generate the LOS (but it is not an instantaneous LOS). The power level will roll-off over the time taken to perform the disconnect. Consequently, variation in the 'speed' of manual disconnection can lead to poor result repeatability.

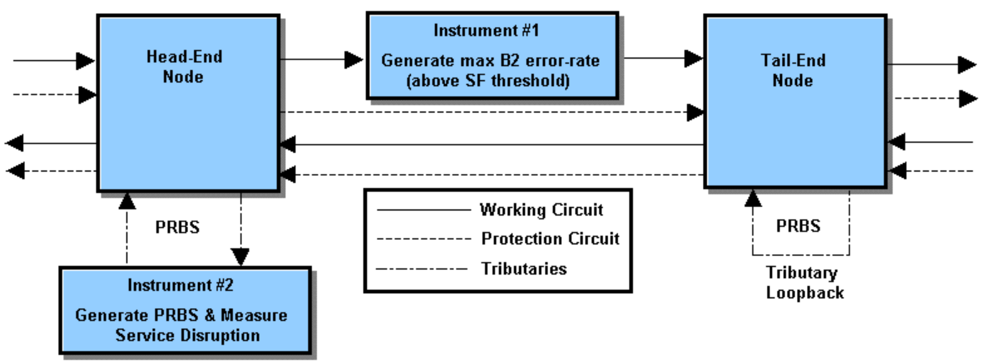
WARNING Exercise extreme caution when disconnecting an optical fiber – follow your organization's standard safety procedures.

If you insert a **programmable optical attenuator** in to the working circuit, you have a more predictable method of inducing LOS. However, it may not fully address the issue of ‘measurement error’ due to the optical power level rolling-off over a finite period of time. Most programmable optical attenuators have a specified response time.

Generating Excessive Errors (SF Trigger)

With the instrument in Thru mode, inject a high-rate of errors into the parity-check byte(s) associated with the protection system under test. In a Multiplex Section/Line protected system, B2 parity errors are used, while HP-B3 and LP-B3/BIP-2 parity errors are used for High-order Path and Low-order Path protected system respectively.

In the following example, the system-under-test is protected at the Multiplex Section/Line level.



To generate excessive errors and create a Signal Fail condition in the system-under-test, inject B2 errors at rate that exceeds the receiving NE's provisioned threshold for the Excessive Error condition.

To always exceed the provisioned error threshold, inject the maximum error rate supported by the parity-check bytes (in this case – continuously error all bits of all B2 bytes).

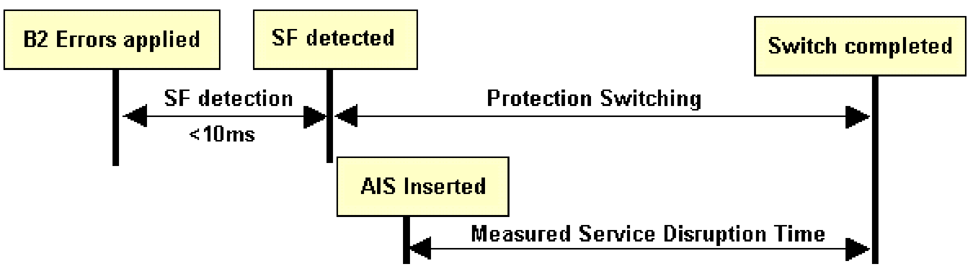
Since errors are only injected into the B2 parity bytes they will not affect the traffic being carried. Consequently, no errors will be added to the PRBS test pattern.

This method will produce accurate and repeatable protection switching time results.

Signal Fail (SF) Triggering a Protection Switch Sequence

Within 10 ms of injecting the B2 errors, the Tail-End node (the NE receiving the B2 errors) will detect the Excessive Error condition. This causes the NE to declare a SF and to initiate a protection switch sequence.

In addition, the Tail-End node is required to insert an AIS alarm in all down-stream traffic channels within 250 microseconds of declaring SF. And since this AIS will overwrite the PRBS test pattern that is transmitted and monitored by test set#2, it causes the service disruption measurement to be triggered (started).



For standards compliant network elements, this method will produce accurate and repeatable protection switching time results. Its main advantage over the 'LOS methods' discussed earlier is that it eliminates the 'SF detection time' error from the measured result. The only technical drawback is that its results slightly under-estimate a system's protection switching time – but only by up to 250 microseconds (assuming that the Tail-End node inserts the downstream AIS within the 250 microseconds period specified in ITU-T G.783). Possibly the most serious 'drawback' associated with this measurement method is a commercial one – it requires two transmission test sets (one covering the required tributary rates, the other covering required line rates).

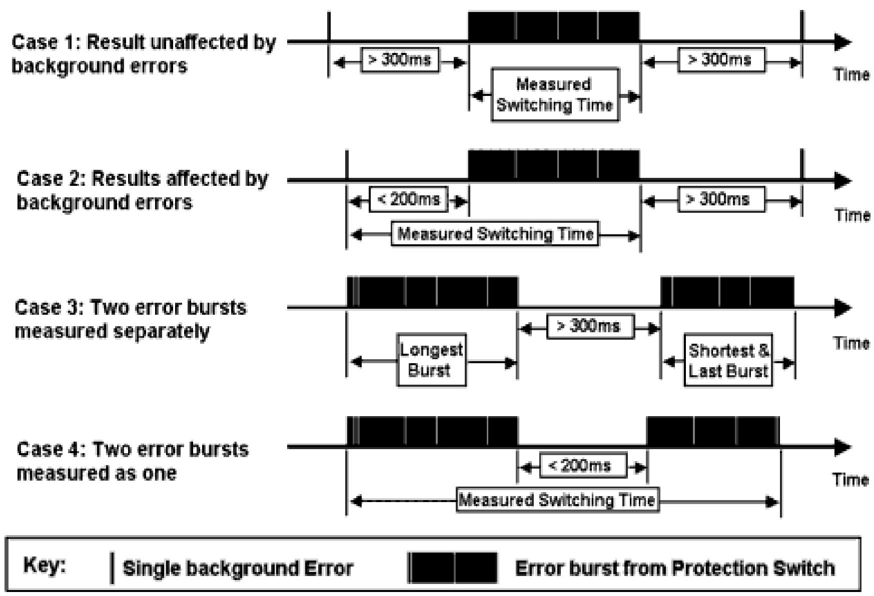
Understanding Service Disruption Test Results

To interpret service disruption results you must understand the rules associated with the analysis of error-burst duration.

The service disruption test measures the elapsed time between the first and last error in an error-burst that consists of two or more errors. The error-burst is taken as having ended when no errors are detected for a period of greater than 200 to 300 ms following the last error. Single errors that are separated by more than 200 to 300 ms are not considered as being part of an error-burst (no result is returned).

“Illustrating Service Disruption Results" on page 454 shows the affect these simple rules have on measurement results when different error distributions are present in the received test pattern.

Illustrating Service Disruption Results



In Case 1 and Case 2, there are single errors due to a low background error rate in the transmission system, plus an error-burst associated with a protection-switching event. In Case 1 the measured protection-switching time is not affected by the background errors as these occur outside the 200 to 300 ms period used to define the end of the error-burst. In contrast, the result obtained in Case 2 is affected due to a single background error being present for less than 200 ms before the error-burst actually starts. This leads to the reporting of an artificially high protection switching time and emphasizes the importance of ensuring that the system-under-test is error-free before performing the measurement.

In Cases 3 and 4 the system-under-test generates two error-bursts when a protection switch is made. The results will be affected by the separation of these two error-bursts. In Case 3 a result for each error-burst will be reported (since they are more than 300 ms apart), while in Case 4 only a single high value will be reported (since they are less than 200 ms apart). In both cases the reported results will indicate that a problem exists in the system-under-test.

Glossary

Numerics

10BASE-2	10 Mb/s Ethernet on 200-meter segments of thin copper - standard 75 ohm coax. (“Cheapernet” or “Thinlan”.)
10BASE-5	10 Mb/s Ethernet on 500-meter segments of coaxial cable - “fat” 75 ohm coax. (The original Ethernet.)
10BASE-FL	10 Mb/s Ethernet on 2-km multimode fiber-optic cables at 850 nm.
10BASE-T	10 Mb/s Ethernet on 200-meter loops of unshielded twisted pair copper - UTP Cat 3.
100BASE-FX	100 Mb/s Ethernet on 2-km multimode or 10-km single-mode fiber-optic cables at 1310 nm.
100BASE-SX	100 Mb/s Ethernet on 2-km multimode fiber-optic cables at 850 nm.
100BASE-T	100 Mb/s Ethernet on 200-meter loops of unshielded twisted pair copper.
100BASE-TX	100 Mb/s Ethernet on 200-meter loops of unshielded twisted pair copper - UTP Cat 5.
1000BASE-LX	1 Gb Ethernet on 2-km multimode or 10-km single-mode fiber-optic cables at 1310 nm.
1000BASE-SX	1 Gb Ethernet on 2-km multimode fiber-optic cables at 850 nm.
1000BASE-T	1 Gb Ethernet on 30-meter loops of unshielded twisted pair copper - UTP Cat 5.
802.3ae	The IEEE standard for 10 Gb Ethernet.
802.3z	The IEEE standard for 1 Gb Ethernet.

A

AAL	ATM Adaption Layer.
ABR	Available Bit Rate.
ADM	Add and Drop Multiplexer.
ADPCM	Adaptive Coded Differential Pulse Coded Modulation.
AIS	Alarm Indication Signal.
AIS-P	Synchronous Transport Signal Path Alarm Indication Signal.
AIS-L	Line Alarm Indication Signal.
AIS-V	Virtual Tributary Path Alarm Indication Signal.
AIS-C	Concatenated Signal Alarm Indication Signal.
AMI	Alternate Mark Inversion.
ANSI	American National Standards Institute.
APS	Automatic Protection Switch.
ASCII	American Standard Code for Information Exchange.
ATM	Asynchronous Transfer Mode.
AU	Administrative Unit.
AU-AIS	Administrative Unit Alarm Indication Signal.
AU-LOP	Administrative Unit Loss Of Pointer.
AU-NDF	Administrative Unit New Data Flag.

B

BBE	Background Block Error.
BBER	Background Block Error Ratio.
BC	Background Channel.
BCD	Binary Coded Decimal.

BER	Bit Error Rate.
BERT	Bit Error Rate Test.
BIP	Bit Interleaved Parity.
BPS	Bits Per Second.
BPV	Bipolar Violation.
B3ZS	Bipolar with 3 Zero Substitution.
B8ZS	Bipolar with 8 Zero Substitution.

C

CAN	Campus Area Network.
CAS	Channel Associated Signaling.
Cat 5	Category 5 unshielded twisted pair copper.
CATV	Cable Television.
CBR	Constant Bit Rate.
CCITT	Consultative Committee for International Telephony and Telegraphy.
CCS	Common Channel Signaling.
CDT	Cell Delay Tolerance.
CDV	Cell Delay Variation.
CEPT	Committee of European PTTs.
CMI	Coded Mark Inversion.
CO	Central Office.
CoS	Class of Service.
CRC	Cyclic Redundancy Check.
CSES	Consecutive Severely Errored Seconds.

CSMA/CD	Carrier Sense, Multiple Access with Collision Detection.
CV-L	Line Code Violation, also L-BIP.
CV-LFE	Line Far End Code Violation, also REI-L.
CV-P	Synchronous Transport Signal Path Code Violation, also P-BIP.
CV-PFE	Synchronous Transport Signal Path Far End Code Violation, also REI-P.
CV-S	Section Code Violation, also S-BIP.
CV-V	Virtual Tributary Path Code Violation, also V-BIP.
CV-VFE	Virtual Tributary Far End Code Violation, also REI-V.

D

D/I	Drop and Insert.
DACS	Digital Access and Cross-connect Switch.
dB	Decibel.
DCC	Data Communications Channel.
DCS	Digital Cross-connect Switch.
DDF	Digital Distribution Frame.
DDN	Digital Data Network.
DSn	Digital Signal Hierarchy.
DTMF	Dual Tone Multi-Frequency signaling.
DUT	Device Under Test.
DWDM	Dense Wave Division Multiplexing.
DXC	Digital Cross-connect Switch.

E

EB	Errored Block.
EBCDIC	Extended Binary Coded Decimal Interchange Code.
EOW	Engineering Order Wire.
ES	Errored Second.
ESF	Extended SuperFrame format.
ESR	Errored Second Ratio.
ETSI	European Telecommunications Standards Institute.

F

FAS	Frame Alignment Signal.
FC	Foreground Channel.
FCS	Frame Check Sequence.
FDDI	Fiber Distributed Data Interface.
FDM	Frequency Division Multiplexing.
FEAC	Far End Alarm Channel.
FEBE	Far End Block Error.
FEC	Forward Error Correction.
FERF	Far End Receive Failure.

G

GBIC	Gigabit Interface Converter.
GP-IB	General Purpose Interface Bus.
GUI	Graphical User Interface.

H

HDB3	High Density Bipolar 3.
HDLC	High-level Data Link Control.
HEC	Header Error Control.
HO	High Order.
HO PTE	High Order Path Terminating Equipment.
HP-BIP	High Path Bit Interleaved Parity error.
HP-PLM	High Path Payload Label Mismatch.
HP-RDI	High Path Remote Defect Indication.
HP-REI	High Path Remote Error Indication.
HP-TIM	High Path Trace Identifier Mismatch.
HP-UNEQ	High Path Unequipped.
Hz	Hertz.

I

ICMP	Internet Control Message Protocol.
IEC	Incoming Error Count.
IHL	Internet Header Length.
IP	Internet Protocol.
ISDN	Integrated Services Digital Network.
ISO	International Organization for Standardization.
ITU	International Telecommunications Union - Telecommunications.
IXC	Inter eXchange Carrier.

J

K

K-bytes	K1 and K2.

L

LAN	Local Area Network.
LCD	Loss of Cell Delineation.
LEC	Local Exchange Carrier.
L-BIP	Line Bit Interleaved Parity error, also CV-L.
LCP	Link Control Protocol.
LLC	Logical Link Control.
LO	Low Order.
LOF	Loss of Frame.
LOM/LOMF	Loss of Multiframe.
LOP	Loss of Pointer.
LOP-C	Loss of Concatenation.
LOP-P	Synchronous Transport Signal Path Loss Of Pointer.
LOP-V	Virtual Tributary Path Loss Of Pointer.
LOS	Loss of Signal.
LP-BIP	Low Path Bit Interleaved Parity error.
LP-PLM	Low Path Payload Label Mismatch.
LP-RDI	Low Path Remote Defect Indication.
LP-REI	Low Path Remote Error Indication.
LP-RFI	Low Path Remote Failure Indication.
LP-TIM	Low Path Trace Identifier Mismatch.
LP-UNEQ	Low Path Unequipped.

LSB	Least Significant Bit.
LTM	Line Terminal Multiplexer.

M

MAC	Media Access Control.
MAN	Metropolitan Area Network.
M/F LOSS	Loss of Multiframe (PDH).
MMF	Multi Mode Fiber.
MS	Multiplexer Section.
MS-AIS	Multiplexer Section Alarm Indication Signal.
MS-BIP	Multiplexer Section Bit Interleaved Parity error.
MSOH	Multiplexer Section OverHead.
MSP	Multiplexer Section Protection.
MS-RDI	Multiplexer Section Remote Defect Indication.
MS-REI	Multiplexer Section Remote Error Indication.
MSTE	Multiplexer Section Terminal Equipment.
MTBF	Mean Time Between Failures.
MTJ	Maximum Tolerance Input Jitter.
MUX	Multiplexer.

N

NDF	New Data Flag.
NE	Network Element.
NFAS	Non Frame Alignment Signal.

O

OAM	Operations, Administration and Management.
OC	Optical Carrier.
OCh	Optical Channel.
ODI	Outgoing Defect Indication.
ODU	Optical channel Data Unit.
OEI	Outgoing Error Indication.
OH	Overhead.
OLTU	Optical LIne Terminal Unit.
ONNI	Optical transport Network Node Interface.
OOF	Out Of Frame.
OOM	Out Of Frame.
OPU	Optical channel Payload Unit.
OS	Operating System.
OSC	Optical Supervisory Channel.
OSI	Open Systems Interconnection.
OTM	Optical Transport Module.
OTN	Optical Transport Network.
OTU	Optical channel Transport Unit.

P

P/AR	Peak to Average Ratio.
P-BIP	Synchronous Transport Signal Path Bit Interleaved Parity error, also CV-P.
PBX	Private Branch Exchange.

PC	Personal Computer.
PCM	Pulse Code Modulation.
PCS	Physical Coding Sublayer.
PCR	Peak Cell Rate.
PDH	Plesiochronous Digital Hierarchy.
PES	Percentage Errored Seconds.
PHY	Physical layer device.
PLM	Payload Label Mismatch.
PLM-P	Synchronous Transport Signal Path Payload Label Mismatch.
PLM-V	Virtual Tributary Path Payload Label Mismatch.
PMD	Physical Media Dependent.
POH	Path OverHead.
PoP	Point of Presence.
POS	Packet Over SONET.
PPP	Point-to-Point Protocol.
PRBS	Pseudo-Random Bit Sequence.
PSN	Packet Switched Network.
PSTN	Public Switched Telephone Network.
PTE	Path Terminating Equipment.
PUAS	Path UnAvailable Seconds.

Q

QoS	Quality of Service.

R

RAI	Remote Alarm Indication.
RAI (M/F)	Loss of Multiframe Remote Alarm Indication.
RDI	Remote Defect Indication.
RDI-L	Line Remote Defect Indication.
RDI-P	Synchronous Transport Signal Path Remote Defect Indication.
RDI-V	Virtual Tributary Path Remote Defect Indication.
REBE	Remote End Block Error.
REI	Remote Error Indication.
REI-L	Line Remote Error Indication, also CV-LFE.
REI-P	Synchronous Transport Signal Path Remote Error Indication, also CV-PFE.
REI-V	Virtual Tributary Path Remote Error Indication, also CV-VFE.
RFI-V	Virtual Tributary Path Remote Failure Indication.
RS	Regenerator Section.
RS-BIP	Regenerator Section Bit Interleaved Parity error.
RSOH	Regenerator Section OverHead.
RSTE	Regenerator Section Terminating Equipment.
RS-TIM	Regenerator Section Trace Identifier Mismatch.
RX	Receiver

S

S/N	Signal to Noise Ratio.
S-BIP	Section Bit Interleaved Parity error, also CV-S.
SCPI	Standard Commands for Programmable Instrumentation.

SDH	Synchronous Digital Hierarchy.
SEF	Severely Errored Frame.
SEP	Severely Errored Period.
SEPI	Severely Errored Period Intensity.
SES	Severely Errored Seconds.
SESR	Severely Errored Seconds Ratio.
SF	Super Frame.
SFD	Start Frame Delimiter.
SLA	Service Level Agreement.
SMF	Single Mode Fiber.
SNMP	Simple Network Management Protocol.
SOH	Section OverHead.
SONET	Synchronous Optical Network.
SPE	Synchronous Payload Envelope.
STM	Synchronous Transport Module.
STS	Synchronous Transport Signal.

T

TC	Tandem Connection.
TC-APId	Tandem Connection Access Point Identifier.
TC-BIP	Tandem Connection Bit Interleaved Parity error.
TC-IAIS or TC-INCAIS	Tandem Connection Incoming Alarm Indication Signal.
TC-IEC	Tandem Connection Incoming Error Count.
TC-OOM	Tandem Connection Out of Multiframe.

TCI	Tag Control Information.
TCP/IP	Transmission Control Protocol/Internet Protocol.
TC-RDI	Tandem Connection Remote Defect Indication.
TC-REI	Tandem Connection Remote Error Indication.
TC-UNEQ	Tandem Connection Unequipped.
TDM	Time Division Multiplexing.
TDMA	Time Division Multiple Access.
TE	Terminal Equipment.
TIM	Trace Identifier Mismatch.
TIM-P	Synchronous Transport Signal Path Trace Identifier Mismatch.
TIM-V	Virtual Tributary Path Trace Identifier Mismatch.
TM	Terminal Multiplexer
TMN	Telecommunications Management Network.
TOH	Transport OverHead.
TPID	Tag Protocol Identifier.
TU	Tributary Unit.
TU-AIS	Tributary Unit Alarm Indication Signal.
TUG	Tributary Unit Group.
TU-LOM	Tributary Unit Loss Of Multiframe.
TU-LOP	Tributary Unit Loss Of Pointer.
TU-NDF	Tributary Unit Pointer New Data Flag.
TX	Transmitter.

U

UAS	UnAvailable Second.
UI	Unit Interval.
UNEQ	Unequipped.
UNEQ-P	Synchronous Transport Signal Path Unequipped.
UNEQ-V	Virtual Tributary Path Unequipped.
UTP	Unshielded Twisted Pair.
UUT	Unit Under Test.

V

V-BIP	Virtual Tributary Path Bit Interleaved Parity error, also CV-V.
VBR	Variable Bit Rate.
VC	Virtual Channel (ATM).
VC-AIS	Virtual Container Alarm Indication Signal.
VC-n	Virtual Container.
VID	VLAN Identifier.
VLAN	Virtual Local Area Network.
VP	Virtual Path (ATM).
VT	Virtual Tributary.
VT PTE	Virtual Tributary Path Terminating Equipment.

W

WAN	Wide Area Network.
WDM	Wave Division Multiplexing.

WIS	WAN Interface Sublayer.
WWDM	Wide Wave Division Multiplexing.

X

X-Connect	Cross-Connect.
X-bits	DS3 bits, X1 and X2.

Y/Z

Yellow	Yellow Alarm.

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In this book

This book contains all the information you need to be able to uthe full capabilities of the Transmission Test Sets.It is aimed at both new and experienced users.

Printed in UK 09/02
J7280-90004

Agilent Technologies