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Agilent OmniBER OTN Family

OmniBER OTN
communications
performance analyzer

User Guide



Agilent Technologies

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Agilent OmniBER Family
OmniBER OTN

User Guide

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In This Guide...

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

1 Getting Started

2 Instrument Setup and Use - SDH

3 Instrument Setup and Use - SONET

4 Instrument Setup and Use - OTN

5 Instrument Setup and Use - PDH

6 Instrument Setup and Use - DSn

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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.

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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.

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Product Description

The Agilent OmniBER OTN provides all the test capability you need to test the performance of today's high-capacity transmission systems and networks, in one portable package.

OmniBER OTN J7231B



- Global test coverage (SONET, SDH) and optical transport network (OTN) G.709 testing at 10.71 Gb/s, including the availability of a range of standard and concatenated mappings
- Jitter testing at all optical rates up to 10.7 Gb/s, including Jitter Tolerance and Jitter Transfer
- Wander testing at all optical rates up to 10 Gb/s, including Wander Tolerance
- All standard error and alarm measurements, plus optical power, frequency, service disruption time, pointer movements and performance analysis
- Simultaneous all-channel testing
- Thru-mode monitoring
- Comprehensive OTN/SONET/SDH overhead testing
- Broad range of graphical results tools
- Comprehensive online help facilities including Online Help, context-sensitive help for each control field and facility for adding your own help documents

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See “Option Guide" on page 23, for more product details.

OmniBER OTN J7232A



- Global test coverage (SONET, SDH), testing up to 2.5 Gb/s, including the availability of a full range of standard and concatenated mappings, GFP/LAPS/Ethernet/VT/TU payload testing and DS1/3 and 2/34/140 Mb/s service mappings
- Virtual concatenation (VCAT) signals for low and high order SONET and SDH
- Link Capacity Adjustment Scheme (LCAS) signals transmitted and received
- All standard error and alarm measurements, plus optical power, frequency, service disruption time, pointer movements and performance analysis
- Simultaneous all-channel testing (up to 192 STSs/AUs)
- Thru-mode monitoring
- Comprehensive SONET/SDH overhead testing
- Broad range of graphical results tools
- Comprehensive online help facilities including Online Help, context-sensitive help for each control field and facility for adding your own help documents

See “Option Guide" on page 23, for more product details.

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OmniBER OTN J7230B



- Global test coverage (SONET, SDH), testing up to 10 Gb/s, including the availability of a full range of standard and concatenated mappings, GFP/LAPS/Ethernet/VT/TU payload testing and DS1/3 and 2/34/140 Mb/s service mappings
- Virtual concatenation (VCAT) signals for low and high order SONET and SDH
- Link Capacity Adjustment Scheme (LCAS) signals transmitted and received
- All standard error and alarm measurements, plus optical power, frequency, service disruption time, pointer movements and performance analysis
- Simultaneous all-channel testing (up to 192 STSs/AUs)
- Thru-mode monitoring
- Comprehensive SONET/SDH overhead testing
- Broad range of graphical results tools
- Comprehensive online help facilities including Online Help, context-sensitive help for each control field and facility for adding your own help documents

See “Option Guide" on page 23, for more product details.

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Option Guide

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

For more information, see:

- “Mainframe Test Rate Capability" on page 24
- “Optical Interfaces" on page 24
- “Optical Transport Network Testing" on page 25
- “Next Generation SONET/SDH Testing" on page 25
- “PDH/DSn Testing/Electrical Interfaces" on page 25
- “Optical Connectors (Product Options)" on page 25
- “Recommended Accessories" on page 26
- “Accessories" on page 26

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Mainframe Test Rate Capability

Mainframe	Optical Test Interfaces
J7231B BER and Jitter Tester (10 Gb/s)	OC-1, OC-3, OC-12, OC-48, OC-192 STM-0, STM-1, STM-4, STM-16, STM-64
J7232A BER Tester (2.5 Gb/s)	OC-1, OC-3, OC-12, OC-48 STM-0, STM-1, STM-4, STM-16
J7230B BER Tester (10 Gb/s)	OC-1, OC-3, OC-12, OC-48 STM-0, STM-1, STM-4, STM-16, STM-64
J7231B-004/J7232A-004/ J7230B-004	Side mounted connectors
J7231B-005/J7232A-005/ J7230-005	Rear mounted connectors

Optical Interfaces

	Wavelength	Option
Optical Interfaces operating at 2.5 Gb/s. Includes 52 and 155 Mb/s electrical interfaces.	52-2488 Mb/s test interfaces not required	100*
	1310 nm optical transmitter	104
	1310/1550 nm optical transmitter	106
Optical Interfaces operating at 10 Gb/s	1550 nm optical transmitter	108*

* Not available for J7232A instrument.

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Optical Transport Network Testing

Option for OTN G.709 testing. Not available for J7232A instrument.

	Option
OTU2 testing at 10.71Gb/s	112

Next Generation SONET/SDH Testing

Not available for J7231B instrument.

	Option
Virtual Concatenation & Ethernet-over-SONET/SDH via GFP (T&F) and LAPS	325

PDH/DSn Testing/Electrical Interfaces

	Option
DSn/PDH framed/unframed testing plus DSn/PDH electrical interfaces	012

Optical Connectors (Product Options)

Connector	Option
FC/PC Adapters fitted on all optical interfaces	609
SC Adapters fitted on all optical interfaces	610
ST Adapters fitted on all optical interfaces	611

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Recommended Accessories

Connectors 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)
J7231B/J7232A with option 104	4	4	4
J7231B/J7232A with option 106	5	5	5
J7231B with option 100	2	2	2

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

J7821A: Hard transit case (for J7231B/J7232A option 004)

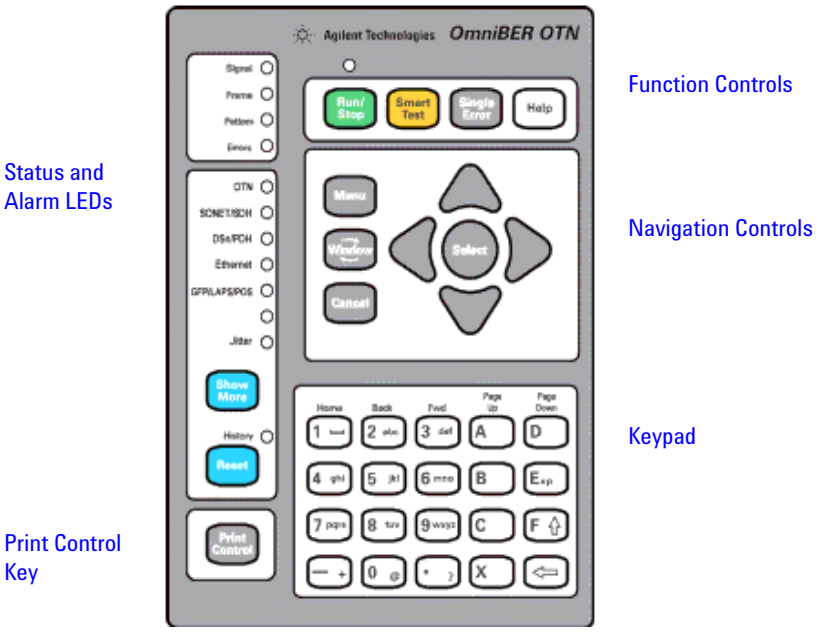
Optical Adapters and Cables

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

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Front Panel Tour



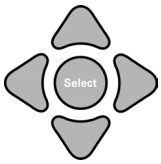
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Function Controls

	Press this key to start a new test period or terminate the current test period. The LED indicator above the button is on when a test period is in progress.
	Press this key to access the Agilent Smart Test menu.
	Press this key to add a single error to the transmitted signal. Select the error type using the Errors and Alarms Test Functions page. Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
	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. **<Cancel>** can also be used as a shortcut for the Close button on pop-up windows.

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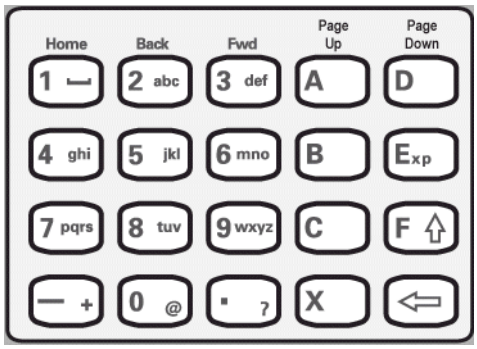
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Keypad

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. Press **<Select>** after typing the new value.



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.

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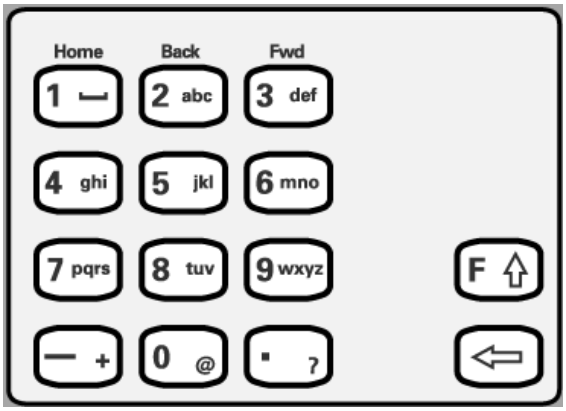
Text Entry

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.

Press **<Select>** after typing the new value.



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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 **. ? ! , : ; “ ‘ ’**

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Help Function Keys

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

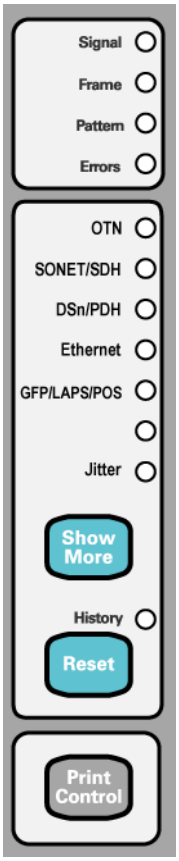
Home 	Returns you to the Home page.
Back 	Takes you back to the previous page.
Fwd 	If you have used the **<Back>** key for navigating then this key takes you forward to where you have come from. Otherwise, pressing this key has no effect.
Page Up 	Scrolls up through the displayed page.
Page Down 	Scrolls down through the displayed page.

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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 red if an error is detected.



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

FRAME Green: Correct framing detected at all levels of the received signal (on line signal plus all levels down to selected test channel). Red: Frame alignment lost at one or more levels of the received signal. Off: Unframed signal at receiver - framing not applicable.

PATTERN Green: Correct detection of expected test pattern. Red: Expected test pattern not received.

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

OTN Red: Indicates presence of at least one OTN alarm.

SONET/SDH Indicates presence of at least one SONET or SDH alarm.

DSn/PDH Indicates presence of at least one ANSI DS0, DS1, DS2 or DS3 alarm or at least one ETSI E0, E1, E2, E3 or E4 alarm.

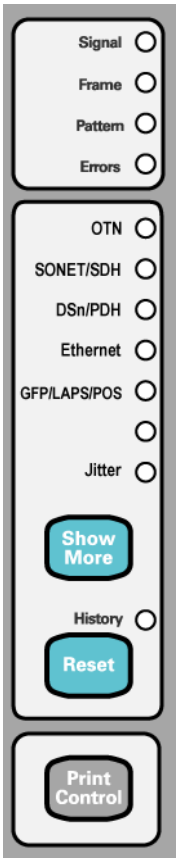
Jitter Used when the instrument has jitter functionality fitted. Indicates the presence of at least one Jitter Alarm (Jitter Unlock or Jitter over Range).

History Press **<Show More>** to see details of current and historical errors/alarms. Red: Current errors/alarms Yellow: Historical errors/alarms. If an alarm has occurred during the current test period, the History LED will be on.

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. The history data resets when you start a new test period.

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

FRAME Green: Correct framing detected at all levels of the received signal (on line signal plus all levels down to selected test channel). Red: Frame alignment lost at one or more levels of the received signal. Off: Unframed signal at receiver - framing not applicable.

PATTERN Green: Correct detection of expected test pattern. Red: Expected test pattern not received.

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

OTN Red: Indicates presence of at least one OTN alarm.

SONET/SDH Indicates presence of at least one SONET or SDH alarm.

DSn/PDH Indicates presence of at least one ANSI DS0, DS1, DS2 or DS3 alarm or at least one ETSI E0, E1, E2, E3 or E4 alarm.

Jitter Used when the instrument has jitter functionality fitted. Indicates the presence of at least one Jitter Alarm (Jitter Unlock or Jitter over Range).

History Press **<Show More>** to see details of current and historical errors/alarms. Red: Current errors/alarms Yellow: Historical errors/alarms. If an alarm has occurred during the current test period, the History LED will be on.

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. The history data resets when you start a new test period.

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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

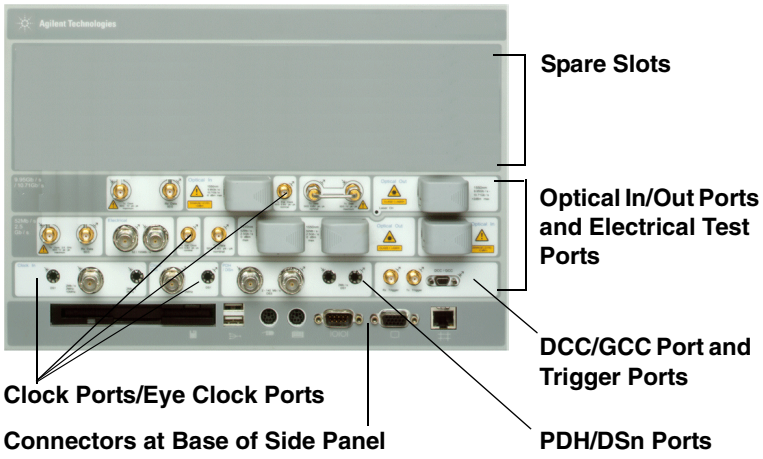


Press **<Print Control>** to access the print control page. Refer to "Print Control Key (Printer Setup and Capturing Screendumps)" on page 592 for information about the Print Control function.

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Side Panel Tour



Optical In/Out Ports and Electrical Test Ports

- OTN/SONET/SDH Optical Out Ports
- OTN/SDH/SONET Optical In Ports
- SONET/SDH Electrical Test Ports

OTN/SONET/SDH Optical Out Ports

The Optical Out Ports provide an OTN signal at 10.71 Gb/s, 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.

See the technical specifications document for details about the power output and input for the following connectors. Take particular care to note the damage level associated with each input port. To access the technical specifications go to the instrument website:

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www.agilent.com/comms/otn

52 Mb/s - 2.5 Gb/s 1310 nm Selectable optical connector (see table below) for a 52 Mb/s to 2.5 Gb/s optical output. The maximum power output is +2 dBm.

52 Mb/s - 2.5 Gb/s 1550 nm Selectable optical connector (see table below) for a 52 Mb/s to 2.5 Gb/s optical output. The maximum power output is +2 dBm.

9.95/10.71 Gb/s, 1550 nm Selectable optical connector (see table below) for a 9.95 Gb/s or a 10.71 Gb/s optical output. The maximum power output is +6 dBm.

OTN/SDH/SONET Optical In Ports

The Optical In ports accept an OTN signal at 10.71 Gb/s, 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 - 2.5/2.5 Gb/s Selectable optical connector (see table below) for a 52 Mb/s to 2.5 Gb/s optical input (OC-1, OC-3, OC-12, OC-48, STM-0, STM-1, STM-4, STM-16 signals).

9.95/10.71 Gb/s Selectable optical connector (see table below) for 9.95/10.71 Gb/s (OC-192/STM-64/OTU2) optical input signals.

Connector	Option
FC/PC Adapters fitted on all optical interfaces	609
SC Adapters fitted on all optical interfaces	610
ST Adapters fitted on all optical interfaces	611

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Clock Ports/Eye Clock Ports

TX Eye Clock 9.95 Gb/s and 10.71 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.

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

2 Mb/s, 2 MHz, 10 MHz Clock In BNC 75 ohm (nominal) unbalanced connector for an MTS (2 Mb/s and 2 MHz) external clock source input. You can also use this connector to input a 10 MHz clock reference.

2 Mb/s, 2 MHz Clock In Bantam 100 ohm (nominal) connector for a 2 Mb/s and 2 MHz MTS external clock source input.

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.

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.

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DCC/GCC Port and Trigger Ports

DCC/GCC Connector R5449 15-way D-type.

Use this port to drop and insert OTN GCC channels (OTU GCC0, ODU GCC1, ODU GCC2), the D1-D3 DCC channel or the D4-D12 DCC channel.

Pin Number	DCC/GCC
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 (+)

Rate D1-D3 DCC: 192 kb/s, D4-D12 DCC: 576 kb/s, OTU/ODU GCC0/GCC1/GCC2: 1.3124 Mb/s.

DCC/GCC Port Input Termination 100 ohms differential. 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 drop and insert capabilities are independent, meaning the transmit and receive clock rates can be set to different rates. Note that the instrument acts as a DCE (Data Communications Equipment), supplying the clock signal for both drop and insert operation.

Trigger Ports SMA connectors. Use these ports to output transmitter and receiver triggers.

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SONET/SDH 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 or 26 dB.

PDH/DSn Ports

DS1/2 Mb/s Out Bantam balanced connector for a DS1/E1 Transmit or DS1/E1 Drop signal output. Port is 100 ohm for DS1, 120 ohm for E1. Either this port or the 2-140 Mb/s, DS3 unbalanced Out port can be active for the E1 Transmit function.

DS1/2 Mb/s In Bantam balanced connector for a DS1/E1 Receive or DS1/E1 Insert signal input. Port is 100 ohm for DS1, 120 ohm for E1. Either this port or the 2-140 Mb/s DS3 unbalanced In port can be active for the E1 Receive function.

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

Connectors at Base of Side Panel

The following descriptions describe the connectors as they appear from left to right. (Note that on some options the following connectors may be on the rear of the instrument.)

Floppy Disk Drive Accepts 1.44 Mb IBM formatted disks.

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USB Two Universal Serial Bus ports for connecting to a printer. The printer may be attached after power-on.

Mouse PS/2 port for connecting a mouse.

Keyboard PS/2 port for connecting an external keyboard. 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.
- **Handshaking Protocol:** None, Xon/Xoff and RTS/CTS.
- **Speed:** 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400 baud.
- **Parity:** Odd, Even.
- **Stop Bits:** 1, 2
- **Data Length:** 8, 7 bits.

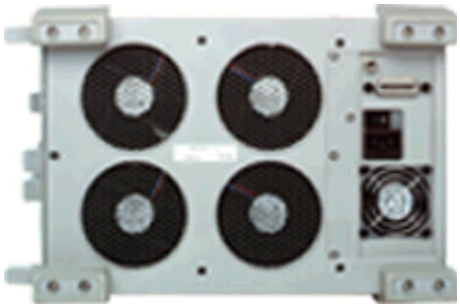
VGA Connector for displaying contents of instrument screen on an external display. Ensure that the external display is connected before powering up the instrument.

LAN 10M/100M 10/100 Base-T LAN interface port. Supports remote control of instrument and the downloading of firmware upgrades. Note that to ensure compliance with EN 55011 (1991) a category 5, STP patch lead, RJ45 cable should be used to connect to the LAN port.

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Rear Panel Tour



GPIB Allows instrument to be remotely controlled via the GPIB control bus.

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

AC Power Connect the instrument power cord here and set the switch to 1 to turn on and to 0 to turn off.

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Using the Graphical User Interface

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 43
- "Menus" on page 46
- "Basic User Interface Operations" on page 48

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 58

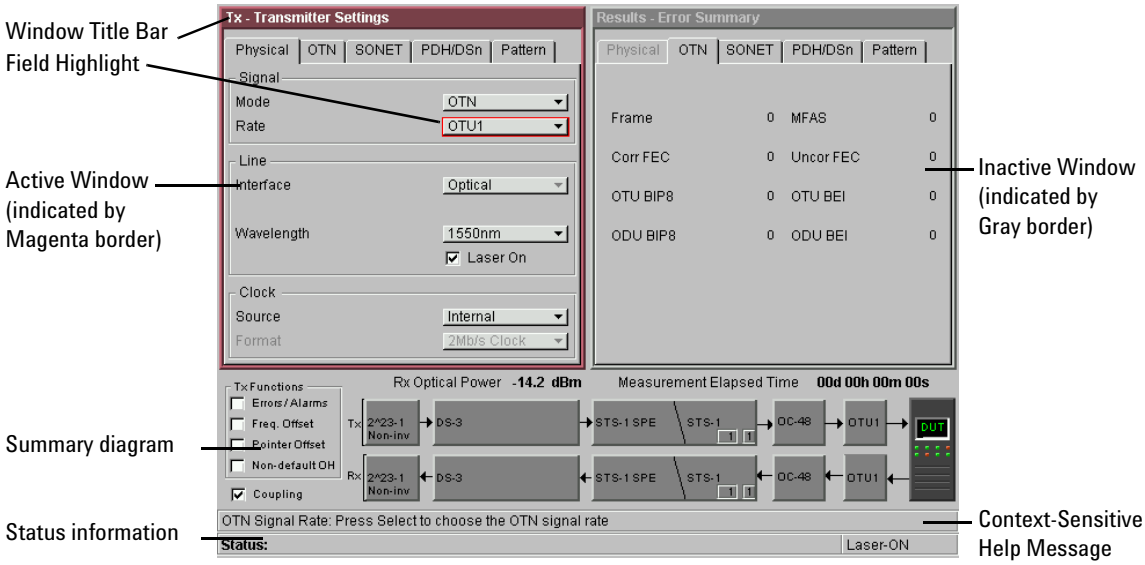
Display Windows

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.

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Instrument Window



Main Windows

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

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.

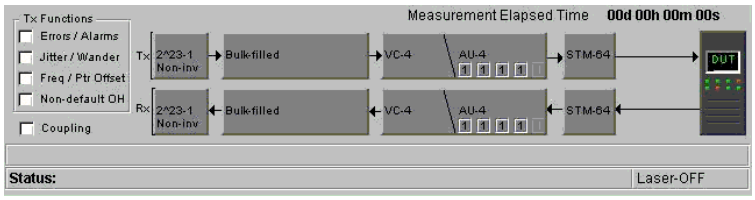
The title of the current displayed page is given at the top of the window in the title bar. The title includes the menu headings that you selected to access the page. For example, **Overhead Setup - Trace Messages** is the **Trace Messages** page selected from **Overhead Setup** on the menu.

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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 provides information relating to the area of the window that is highlighted by the red box.

Status Line

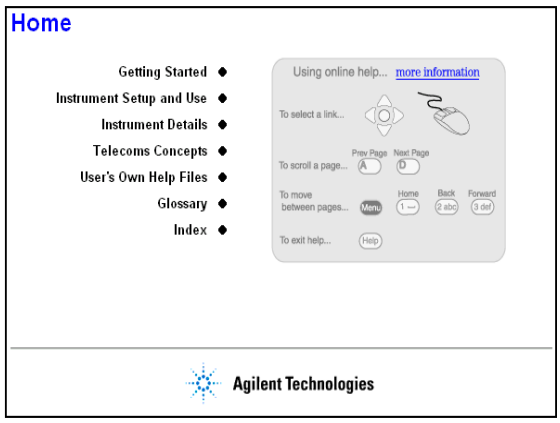
The Status line displays the instrument and keyboard status.

Online Help Window

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

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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, press the <Home> key on the instrument keypad.

Menus

Instrument Menu

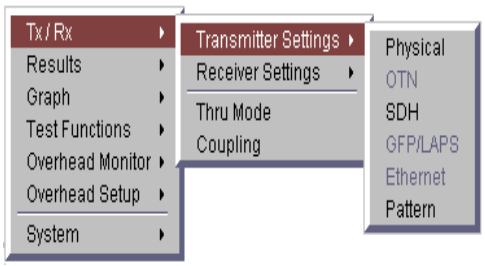
All instrument pages are accessed through the main menu.

To use the main menu

1. Press **<Menu>**. The menu is context sensitive, so the focus will highlight the last window you accessed.
2. Use the up/down arrow navigation keys to move the focus through the main menu and the left/right arrow navigation keys to move in and out of the submenus. As you move the focus up or down the menu, the submenu for each item will be displayed automatically. Note that if a menu item is greyed out and not selectable, then it is not in context for the current setup.
3. To select a menu item press **<Select>**.

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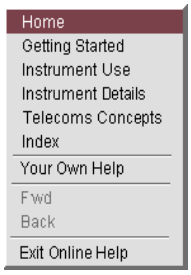


Online Help Menu

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>**.



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Basic User Interface Operations

For information on how to control the instrument, see:

- "Drop-Down List Box" on page 48
- "Numeric Entry Box" on page 49
- "Folder/Tab Selector" on page 50
- "Text Entry Box" on page 50
- "Modal Window" on page 51
- "Action Buttons" on page 51
- "More Button" on page 52
- "Mapping Diagram" on page 52
- "Checkboxes" on page 53

Drop-Down List Box

Drop-down lists have been used where multiple choices are 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>**.



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Numeric Entry Box

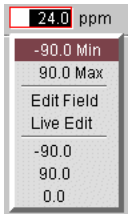
You can edit values using the keypad, Live Edit or Edit Field. Or you can choose from the preset or most recently-used values listed in the drop down menu.

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.



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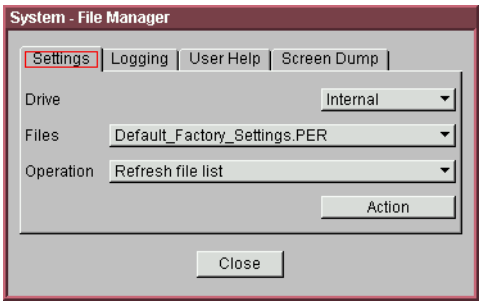
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Folder/Tab Selector

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

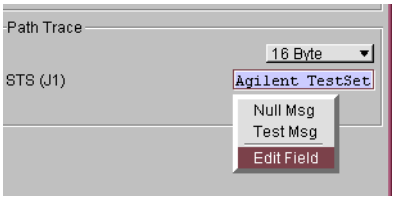
To use the text entry box

- For quick text entry use the keypad. (See "Keypad" on page 29 for details on how to use the keypad to enter text). Or, 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.

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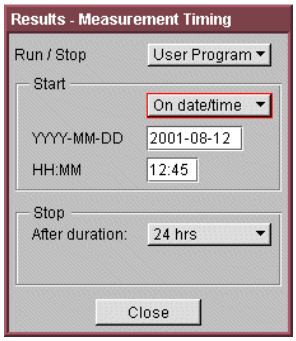
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Modal Window

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 generally 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>**.



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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.

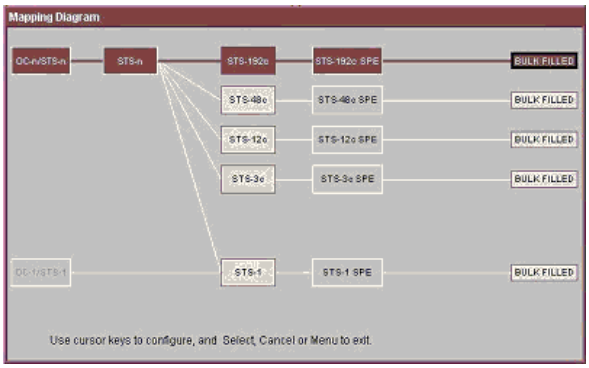


Mapping Diagram

Use the mapping diagram and/or the drop down box to select a signal mapping.

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.

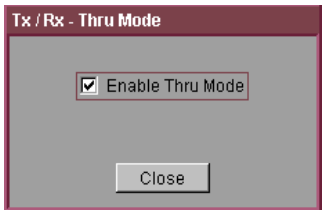


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Checkboxes

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



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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:

- "Conventions Used in the Online Help" on page 54
- "Context-Sensitive Help" on page 55
- "Accessing the Index" on page 55
- "Using Online Help - Which Keys Do I Press?" on page 56

Conventions Used in the Online Help

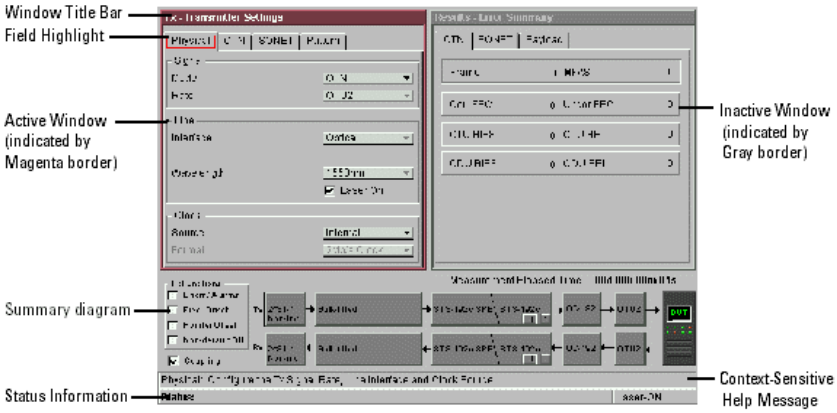
- Front Panel buttons appear in **bold** within angled brackets. For example, press **<Menu>**.
- When buttons are connected by a plus (+) sign, for example, **<2>** + **<4>**, press the listed buttons in sequence.
- Menu items appear in **bold**. The greater than (>) symbol separates each menu level. For example, '**Test Functions > Errors and Alarms'** indicates that you should choose 'Errors and Alarms' from the 'Test Functions' main menu.
- Field items and drop down list entries appear in **bold.** For example, 'select **Signal Rate** field and choose **STM-1** from the drop-down list'.

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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.



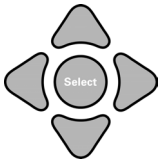
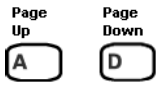
Accessing the Index

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

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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 results. There is an Instrument Setup and Use section for each network that the instrument can test (e.g. SDH, SONET).

Instrument Details - Contains supplementary product information. It includes information on:

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- **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
- **Frequently Asked Questions**

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

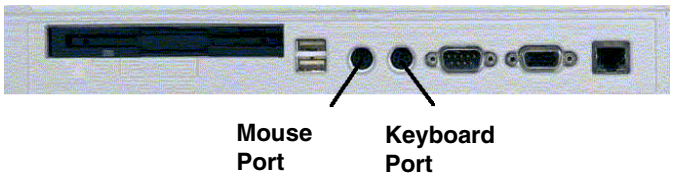
Index - Contains a list of all features and procedures.

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Using a Mouse and Keyboard with the Instrument

The mouse and keyboard connectors are located at the base of the instrument side panel.



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. A right mouse click shows the functions associated with pressing the **<Menu>** key. Connect the mouse before powering on the instrument.

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.

NOTE 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.

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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 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 Manual is supplied with the instrument and is also included on the Product CD-ROM.

Also, please note the following safety information:

- "Optical Connector Safety Information" on page 60
- "Avoiding Problems When Making Measurements" on page 62

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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.

BEFORE connecting any signal to the **Optical In** ports ensure sufficient external attenuation is inserted in the signal path so that the power level is within the 'Operating Range' for the port. Also ensure that any signal transient condition **never** exceeds the maximum stated limit for that 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.

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For further information, see:

- "Cleaning Optical Connectors" on page 595
- "Avoiding Optical Receiver Overload" on page 61

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.

When performing tests, it is recommended that you use a signal that has an average power in the middle of the receiver's operating range.

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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.

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Using Smart Test Features

You can use Smart Test to access applications (including SignalWizard, virtual concatenation (VCAT) overview and the jitter/wander applications), or 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:

- “Accessing Applications" on page 64
- “Shortcuts to Results, Measurements and Stored Settings" on page 65
- “Resetting Instrument to Default Settings" on page 65

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Accessing Applications

You can use Smart Test to access applications including SignalWizard, Jitter Tolerance, Wander Tolerance and Jitter Transfer.

To access SignalWizard

- Press **<Smart Test>**, choose **SignalWizard** then press **<Select>**.

For more information, see "Using SignalWizard" on page 66.

To access the Jitter/Wander applications

- Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.
- Press **<Smart Test>**, choose **Jitter Transfer** then press **<Select>**.

For more information on Jitter Tolerance, Wander Tolerance and Jitter Transfer, see the Instrument Setup and Use sections (Measurements and Results).

To access the VCAT Overview

- Press **<Smart Test>**, choose **VCAT Overview** then press **<Select>**.

The VCAT overview provides error and alarm information for the group and all the members of the virtual concatenation group which have been either manually set up or automatically detected in the receiver. Move the field highlight using the arrow keys to display the information for the channel of interest.

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Shortcuts to Results, Measurements and Stored Settings

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

▶ **To access shortcuts**

- Press **<Smart Test>**, choose **Shortcuts**. Select an item from the list and press **<Select>**.

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.

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Using SignalWizard

SignalWizard analyzes the signal on the currently selected receive port.

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 73
- "Out-of-Service Testing" on page 74

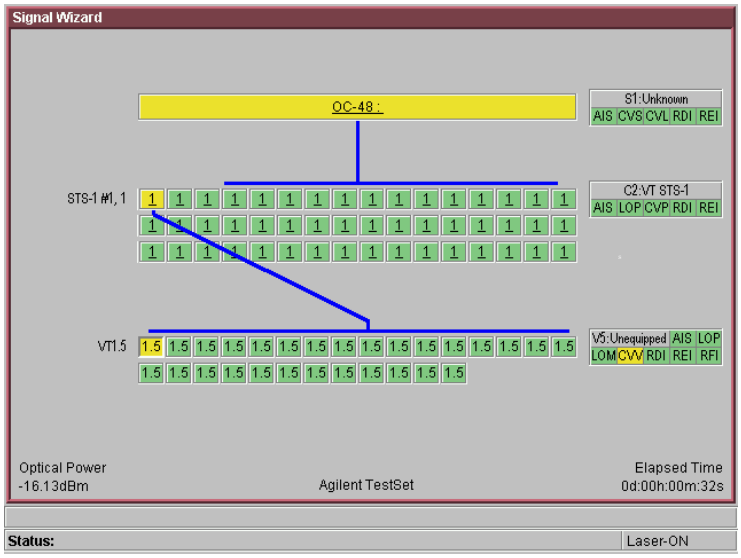
To monitor a signal with SignalWizard

1 Set up the receiver port you want to analyze. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Physical** then press **<Select>**. Select a **Signal Rate.**

2 Press **<Smart Test>**, choose **SignalWizard** then press **<Select>**. If a signal is detected at the receive port the Channel Overview window appears (see "Understanding the SignalWizard Overview Window" on page 68).
If SignalWizard detects a PDH/DSn signal, then **PDH/DSn Channel Scan** is launched. A window appears showing the status and structure of all channels.

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3 Press **<Menu>** to 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 71.

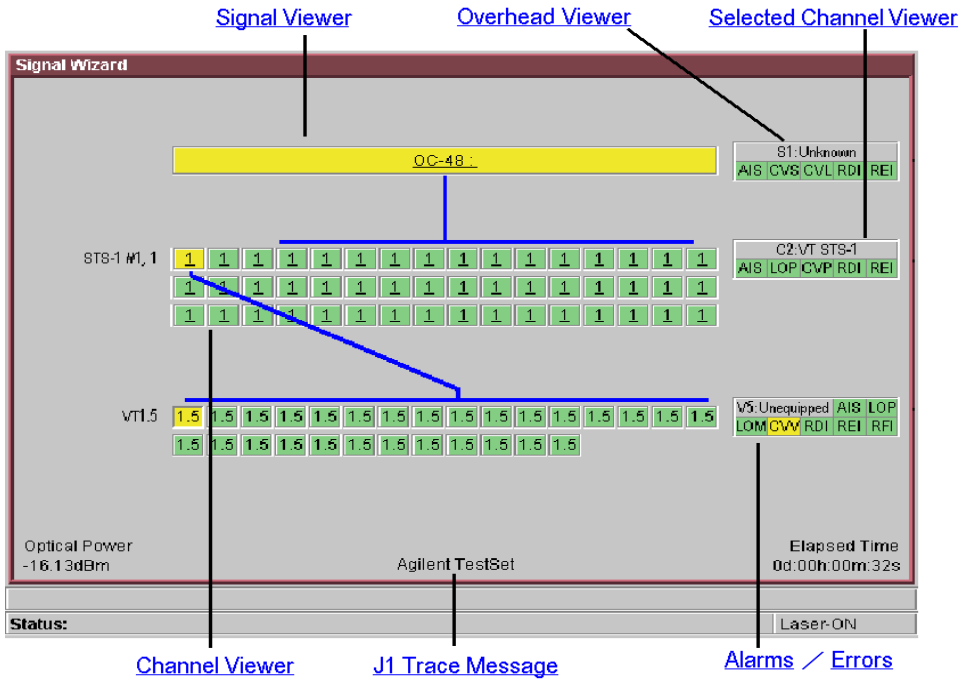
4 To close SignalWizard, do one of the following:

- Press **<Smart Test>**, choose **Stop Application** 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.

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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

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(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.

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Color Coding

Color Coding		Result
Green		No errors/alarms detected during test or since last history reset
Red		Current errors/alarms detected
Yellow		Errors/alarms detected in the past
Blue		Pointer movement
Red (white A)		Current AIS (STS-1, STS-3c/STM-0, STM-1)
Grey		Unequipped
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)

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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

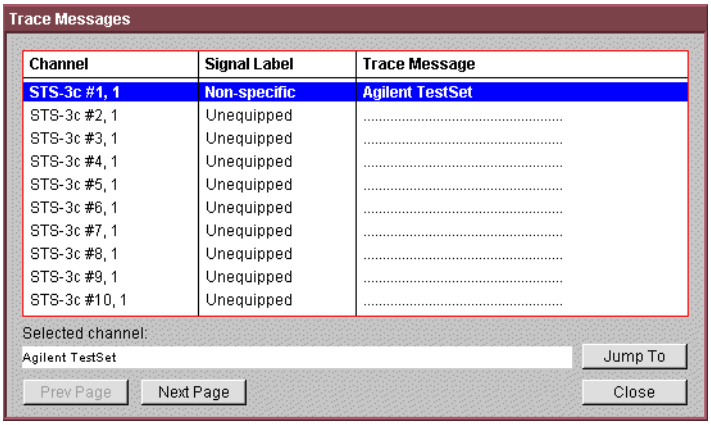
- Press **<Menu>**, choose **Trace Messages** then press **<Select>**. Select **List Current Levels**, a trace message window will be displayed.

  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**.

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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.

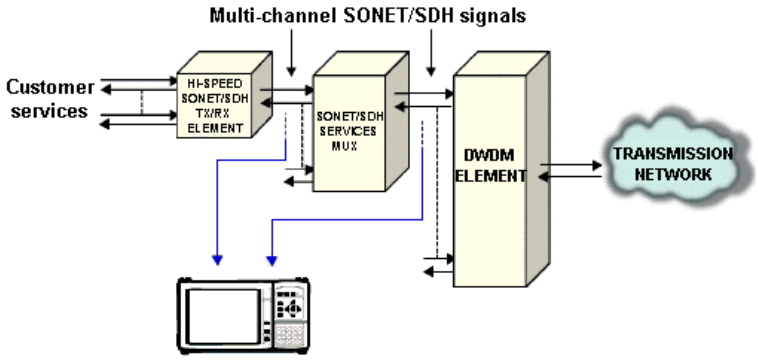
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In-Service Testing

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.



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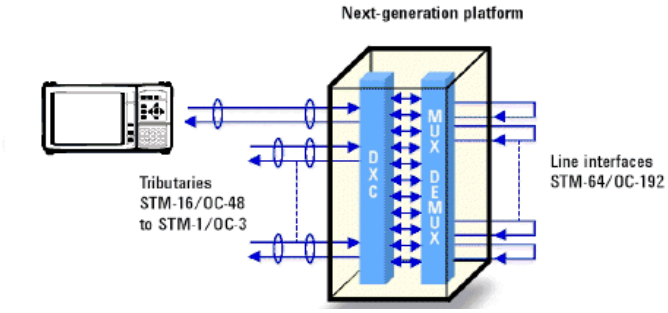
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Out-of-Service Testing

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).

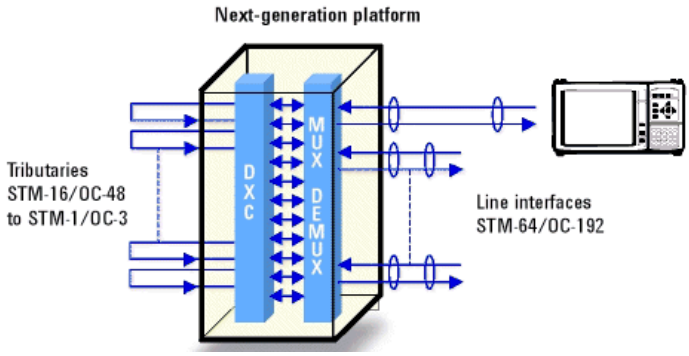
Typical tributary and line network test connections are shown below.



Tributary-Side Testing Setup

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Line-Side Testing Setup

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SDH Setup and Jitter Measurement Tutorial

This tutorial shows you how to use the instrument controls and arrow navigation buttons 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 receiver input. You can only complete steps 11-13 if the instrument has jitter functionality fitted.

Steps 1-7 show you how to configure the instrument to transmit and receive an STM-4 optical signal with a concatenated 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 add jitter (if you have jitter functionality fitted) to the transmitted signal and then measure the jitter on the incoming signal.

Step 1: Connect Optical Ports

When connecting to optical interfaces please refer to:

- "Avoiding Optical Receiver Overload" on page 61
- "Avoiding Problems When Making Measurements" on page 62.

To connect optical ports

1. Check the instrument's **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. On the instrument connect the **52 Mb/s - 2.5 Gb/s Optical Out port** (1310 or 1550 nm depending on options fitted to

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your instrument) to the receiver **52 Mb/s - 2.5 Gb/s Optical In port** through a 15 dB attenuator.

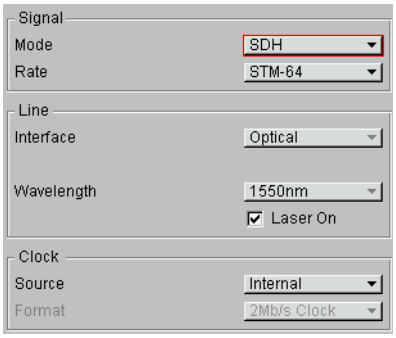
Step 2: Set Up the Transmitter

▶ **To set up the transmitter**

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

2 Select **Signal Mode** and press **<Select>** to reveal a drop down menu of the available signal modes. Use the arrow and **<Select>** keys to select **SDH**.

3 Select **Signal Rate** and press **<Select>** to show the drop down menu of available rates. Select **STM-4**. Use the arrow navigation keys to set up the other settings, including the **Line** 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 SDH Mapping

▶ **To set the SDH mapping**

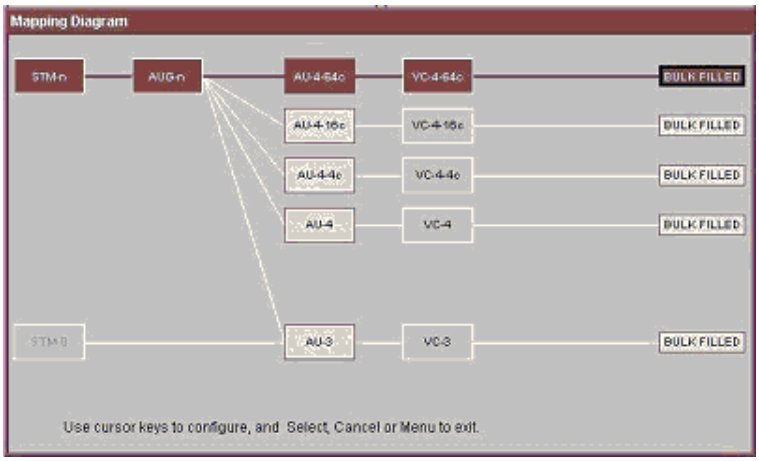
1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.

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2 Select the **Mapping Structure**. Selecting **Preset** mappings sets all the AUs to the same size. **Mixed** mappings allow you to configure the signal with different sizes of AUs.

3 If you have selected **Preset**, move the cursor to the **Mapping** field and select the payload, using the drop down box and/or the mapping diagram. Use the arrow navigation keys to select the required mapping from the mapping diagram and then press **<Select>**. Ignore the Tandem Connection Monitoring field selection for this measurement.

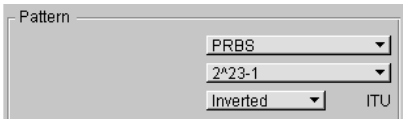


Step 4: Set the Payload Pattern

To set the transmitter payload pattern

1 Move the cursor focus to the top of the Transmitter Settings window and select **Pattern**.

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



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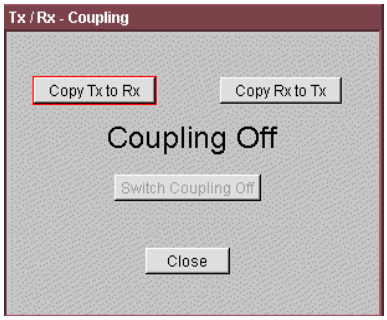
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Step 5: Couple the Tx and Rx Settings

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

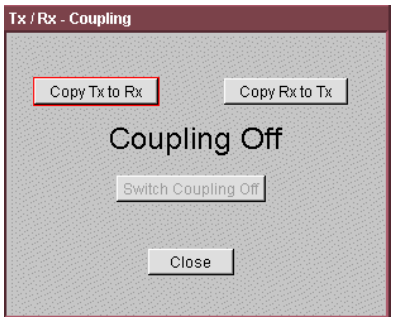
▶ **To couple the receiver to the transmitter settings**

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



2 If Coupling is **On** proceed 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.



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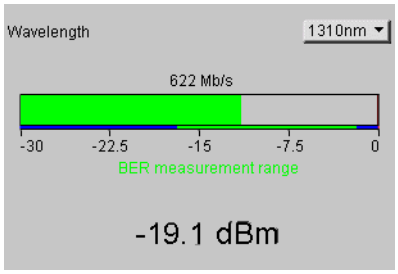
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Step 6: Check Receiver Input Power

▶ **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 > Optical Power** then press **<Select>**.



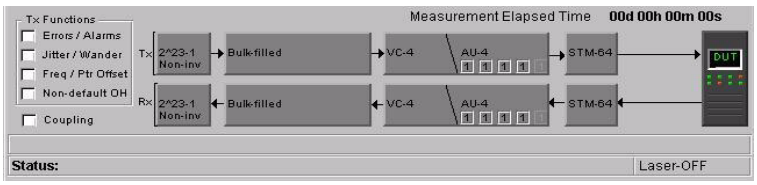
3 Check the receiver input power.

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.



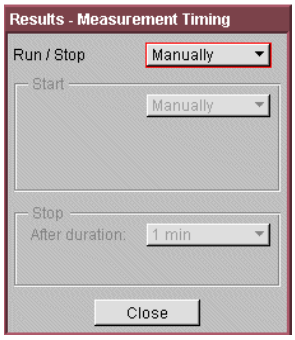
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Step 8: Set Measurement Gating

To set the measurement gating

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



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

3 Use the navigation arrows to select **Close**, then press **<Select>** to close the window.

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.

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Step 10: View Results

To view the results

1. Press **<Menu>**, choose **Results > Errors and Alarms > SDH** then press **<Select>**. Select the **Error Summary** tab.
2. Select the **Error Type** you require. Check that there are no errors displayed.
3. Press the front panel **<Run/Stop>** button to stop the measurement.

Step 11: Add Jitter to the Signal

To transmit jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the transmit **Mode** to **Jitter**.
3. In the **Jitter** setup field, select the jitter **Source** (**Internal** or **External**). For an **External** jitter source, connect the external source to the External Modulation Input connector.
4. For an **Internal** jitter source, enter the **Modulation Frequency** (Hz) and the **Amplitude** (UI). Press the **<Select>** key when you have finished. You can also enter using scientific notation, for example, 2300 could be entered as 2.3e3.

Step 12: Set Up the Jitter Receiver

To receive jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Jitter**.
3. Select an **Interface** (**Clock**, **Data**).
4. In the **Jitter** setup field, select a receiver jitter **Range** (UI).

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5 Select the **More** button and enter the positive and negative **Hit Threshold** levels (UI), to determine when a hit will be recorded.

6 Select the High Pass and/or Low Pass **Filters** checkboxes as required. If you do not select a checkbox, the receiver frequency range will be unfiltered.

7 If required, select a **Demod Output** filter from the drop down list, to be routed to the demodulated output connector.

8 Press the **Run/Stop** key to start the Jitter Measurement.

Step 13: View Jitter Results

▶ **To view Jitter results**

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

3 Press the **<Run/Stop>** button to stop the measurement.

End of tutorial.

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SONET Setup and Jitter 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. You can only complete steps 11-13 if the instrument has jitter functionality fitted.

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 add jitter (if you have jitter functionality fitted) to the transmitted signal and then measure the jitter on the incoming signal.

Step 1: Connect Optical Ports

When connecting to optical interfaces please refer to:

- "Avoiding Optical Receiver Overload" on page 61
- "Avoiding Problems When Making Measurements" on page 62.

To connect optical ports

1. Check the **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.

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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 Mb/s - 2.5 Gb/s Optical In port** through a 15 dB attenuator.

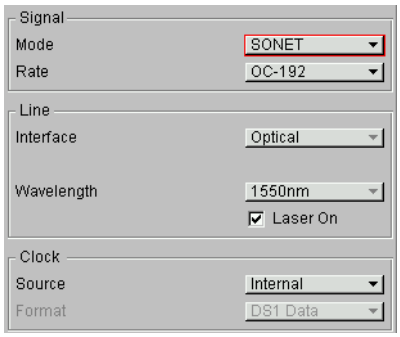
Step 2: Set Up Transmitter

To set up the transmitter

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

2 Select the **Signal Mode** field and press **<Select>** to reveal a drop down menu of the available signal modes. Use the arrow navigation and **<Select>** keys to select **SONET**.

3 In the **Signal Rate** field press **<Select>** to show the drop down menu of available rates. Select **OC-12**. Use the navigation arrows 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.



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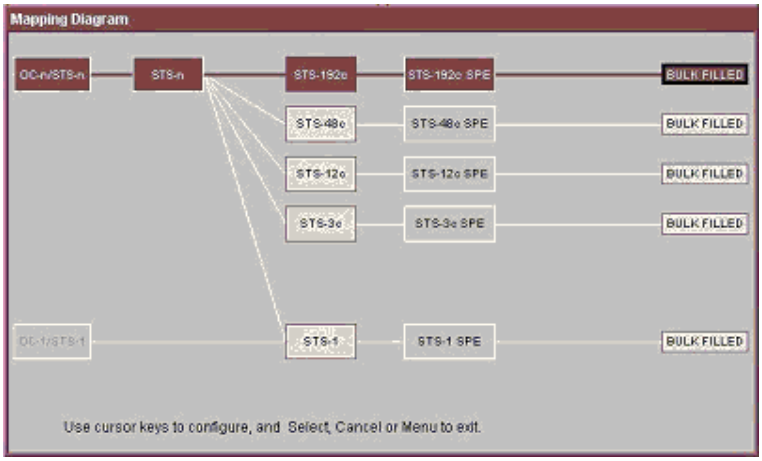
Step 3: Set Up the SONET Mapping

▶ **To set the SONET mapping**

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

2 Select the Mapping Structure. Selecting **Preset** mappings sets all the STSs to the same size. **Mixed** mappings allow you to configure the signal with different sizes of STSs.

3 If you have selected **Preset** move the cursor to the **Mapping** field and select the payload, using the drop down box and/or the mapping diagram. Use the arrow navigation keys to select the required mapping from the mapping diagram then press **<Select>**.



Step 4: Set the Payload Pattern

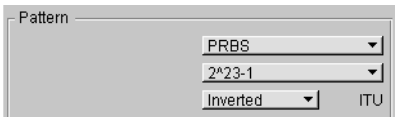
▶ **To set the transmitter payload pattern**

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

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

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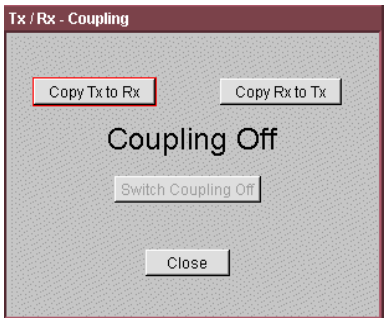


Step 5: Couple Tx and Rx Settings

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

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

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.

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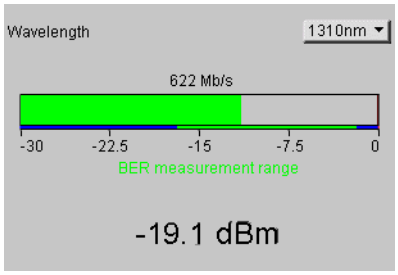
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Step 6: Check Receiver Input Power

▶ **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 > Optical Power** then press **<Select>**.



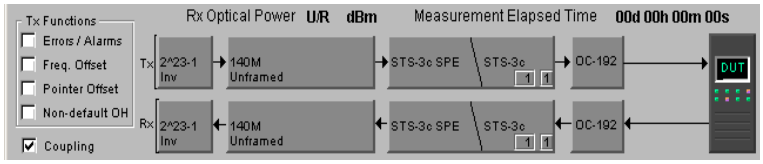
3 Check the receiver input power.

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 window at the bottom of the display. An example of this diagram is shown below.



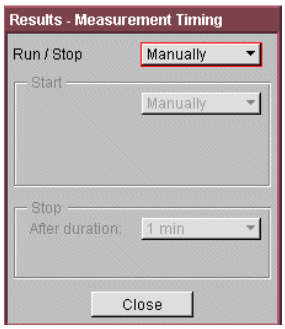
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Step 8: Set Measurement Gating

To set measurement gating

1 Press **<Menu>**, choose **Results > Measurement Setup > Logging** 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>** to close the window.

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.

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Step 10: View Results

To view the results

1. Press **<Menu>**, choose **Results > Errors and Alarms > SONET** then press **<Select>**. Select the **Error Summary** tab.
2. Select the **Error Type** you require. Check that there are no errors displayed.
3. Press the front panel **<Run/Stop>** button to stop the measurement.

Step 11: Add Jitter to the Signal

To transmit jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the transmit **Mode** to **Jitter**.
3. In the **Jitter** setup field, select the jitter **Source** (**Internal** or **External**). For an **External** jitter source, connect the external source to the External Modulation Input connector.
4. For an **Internal** jitter source, enter the **Modulation Frequency** (Hz) and the **Amplitude** (UI). Press the **<Select>** key when you have finished. You can also enter using scientific notation, for example, 2300 could be entered as 2.3e3.

Step 12: Set Up the Jitter Receiver

To receive jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Jitter**.
3. Select an **Interface** (**Clock**, **Data**).
4. In the **Jitter** setup field, select a receiver jitter **Range** (UI).

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5 Select the **More** button and enter the positive and negative **Hit Threshold** levels (UI), to determine when a hit will be recorded.

6 Select the High Pass and/or Low Pass **Filters** checkboxes as required. If you do not select a checkbox, the receiver frequency range will be unfiltered.

7 If required, select a **Demod Output** filter from the drop down list, to be routed to the demodulated output connector.

8 Press the **Run/Stop** key to start the Jitter Measurement.

Step 13: View Jitter Results

▶ **To view Jitter results**

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

3 Press the **<Run/Stop>** key to stop the measurement.

End of tutorial.

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OTN Setup and Jitter Measurement Tutorial

This tutorial shows you how to use the instrument controls and arrow navigation buttons 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 receiver input. You can only complete steps 12-14 if the instrument has jitter functionality fitted.

Steps 1-8 show you how to configure the instrument to transmit and receive an OTU2 optical signal with a SONET payload containing an STS-192c Bulk Filled payload.

In Steps 9-11 you will set the measurement test timing to be started and stopped manually, make the measurement and view the results.

Finally, in Steps 12-14 you will add jitter (if you have jitter functionality fitted) to the transmitted signal and then measure the jitter on the incoming signal.

Step 1: Connect Optical Ports

When connecting to optical interfaces please refer to:

- "Avoiding Optical Receiver Overload" on page 61
- "Avoiding Problems When Making Measurements" on page 62.

To connect optical ports

1. Check the instrument's **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.

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3 On the instrument connect the **9.95/10.71 Gb/s Optical Out port** to the receiver **9.95/10.71 Gb/s Optical In port** through a 15 dB attenuator.

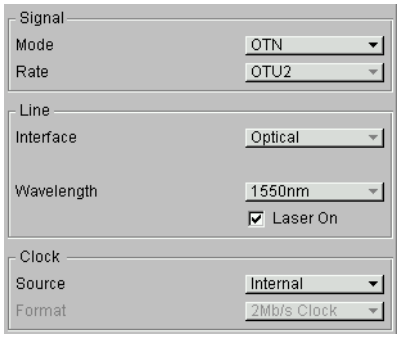
Step 2: Set Up the Transmitter

▶ **To set up the transmitter**

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

2 Select **Signal Mode** and press **<Select>** to reveal a drop down menu of the available signal types. Use the arrow navigation keys to highlight **OTN**, then press **<Select>.**

3 Set the **Signal Rate** to **OTU2**. Set up the **Clock** field. 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 OTN Signal

▶ **To set up the OTN signal**

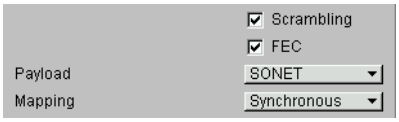
1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > OTN** then press **<Select>**.

2 Move the cursor to the **Scrambling** field and press **<Select>**. This selects the checkbox, turning scrambling on. Select the

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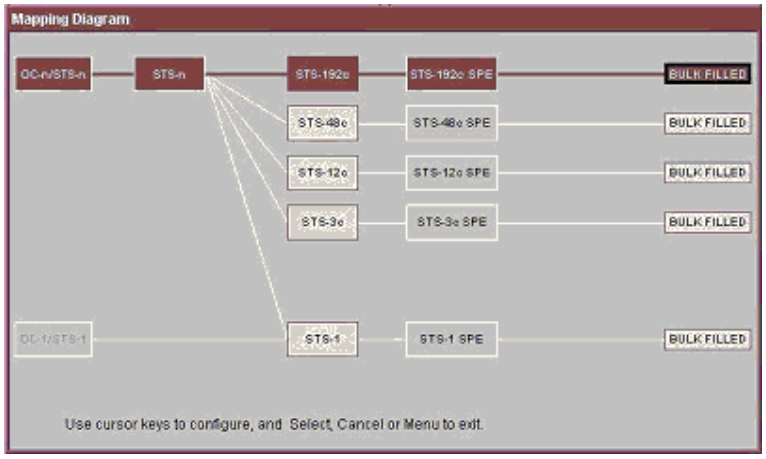
FEC checkbox, to turn forward error correction on. In the **Payload** field press **<Select>** and then select SONET from the drop down menu. Select the **Mapping** to be **Synchronous**.



Step 4: Set the OTN Payload Mapping

▶ **To set the transmitter payload mapping**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SONET** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**. Selecting **Preset** mappings sets all the STSs to the same size. **Mixed** mappings allow you to configure the signal with different sizes of STSs.
3. Move the cursor to the **Mapping** field and select the payload, using the drop down box and/or the mapping diagram. Use the arrow navigation keys to select the required mapping from the mapping diagram and then press **<Select>**.



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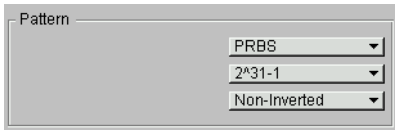
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Step 5: Set the Payload Pattern

▶ **To set the transmitter payload pattern**

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

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



Step 6: Couple the Tx and Rx Settings

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

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

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

2 If Coupling is **On** proceed to Step 9: Set Measurement Gating.

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 7: Check Receiver Input Power

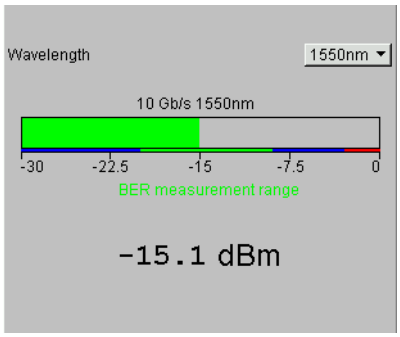
▶ **To check receiver input power**

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 > Optical Power** then press **<Select>**.

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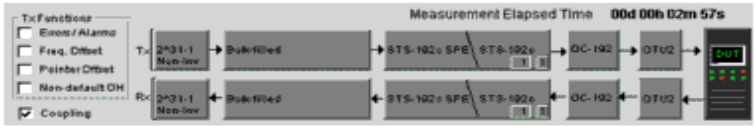
3 Check the receiver input power.

Step 8: 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 window at the bottom of the display. An example of this diagram is shown.



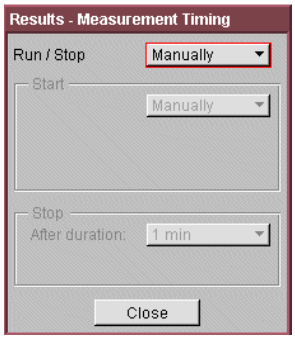
Step 9: Set Measurement Gating

To set the measurement gating

Press **<Menu>**, choose **Results > Measurement Setup > Logging** then press **<Select>**.

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

2 Use the arrow navigation keys to select **Close**, then press **<Select>** to close the window.

Step 10: 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 11: View Error Results

▶ **To view the error results**

1 Press **<Menu>**, choose **Results > Errors and Alarms > OTN** then press **<Select>**. Select the **Error Summary** tab. There should be no OTN errors.

2 Press the front panel **Run/Stop** key to stop the measurement.

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Step 12: Add Jitter to the Signal

▶ **To transmit jitter**

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the transmit **Mode** to **Jitter**.
3. In the **Jitter** setup field, select the jitter **Source** (**Internal** or **External**). For an **External** jitter source, connect the external source to the External Modulation Input connector.
4. For an **Internal** jitter source, enter the **Modulation Frequency** (Hz) and the **Amplitude** (UI). Press the **<Select>** key when you have finished.

Step 13: Set Up the Jitter Receiver

▶ **To receive jitter**

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Jitter**.
3. Select an **Interface** (**Clock**, **Data**).
4. In the **Jitter** setup field, select a receiver jitter **Range** (UI).
5. Select the **More** button and enter the positive and negative **Hit Threshold** levels (UI), to determine when a hit will be recorded.
6. Select the High Pass and/or Low Pass **Filters** checkboxes as required. If you do not select a checkbox, the receiver frequency range will be unfiltered.
7. If required, select a **Demod Output** filter from the drop down list, to be routed to the demodulated output connector.
8. Press the **Run/Stop** key to start the Jitter Measurement.

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Step 14: View Jitter Results

To view Jitter results

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

3 Press the **<Run/Stop>** button to stop the measurement.

End of tutorial.

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1 Getting Started

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2
Instrument Setup and Use - SDH

Setting up the SDH Transmitter 103
Setting up the SDH Receiver 169
Setting Up Thru Mode Operation 211
Storing and Recalling Instrument Settings 213
Measurements and Results 215

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

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Setting up the SDH Transmitter

Physical

- "Optical Connector Safety Information" on page 60
- "Setting Up the SDH Transmit Interface" on page 105
- "Selecting the SDH Transmit Clock Source" on page 110
- "Adding Frequency Offset to the SDH Signal" on page 111
- "Enabling Tandem Connection Monitoring (TCM) Signals" on page 112
- "Generating Jitter on an SDH Signal" on page 113
- "Generating Wander on an SDH Signal" on page 114

Overhead

- "Generating Trace Messages" on page 116
- "Generating High Order Tandem Path Trace Identifiers" on page 118
- "Generating Synchronization Status Messages" on page 120
- "Generating Path Signal Labels" on page 121
- "Generating Automatic Protection Switching (APS) Messages" on page 122
- "Generating Active Automatic Protection Switching (APS) Messages" on page 128
- "Editing SDH Overhead Bytes" on page 124
- "Setting Up SDH Overhead Sequences" on page 131
- "Inserting Messages into the Data Communications Channel (DCC)" on page 130

Payload

- "Setting Up Virtual Concatenation" on page 135
- "Setting Up Virtual Concatenation delays" on page 137
- "Setting Up Mixed Mappings" on page 134
- "Generating VC-3/4 and Concatenated Payloads" on page 139

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- "Generating VC-3/4 Tributary Payloads" on page 146
- "Setting Up GFP/LAPS Transmit Interface" on page 148
- "Generating Payloads for Ethernet over SDH (EOS)" on page 152
- "Transmitting DSn Payloads in an SDH Signal" on page 154
- "Inserting an External DSn Payload in an SDH Signal" on page 155
- "Transmitting PDH Payloads in an SDH Signal" on page 156
- "Inserting an External PDH Payload into an SDH Signal" on page 157

Pointer Movement, Trigger Conditions and Errors/Alarms

- "Adjusting AU or TU Pointer Values" on page 158
- "Adding SDH Errors and Alarms" on page 162
- "Adding GFP, LAPS and Ethernet Errors and Alarms" on page 163
- "Adding Runt and Jumbo Frames" on page 164
- "Adding Alarm Stress" on page 165
- "Selecting SDH Transmitter Trigger Output" on page 166
- "Switching Off All Test Function Features" on page 167

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Setting Up the SDH Transmit Interface

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

For more information, see:

- “Setting up the Optical SDH Transmit Interface" on page 106
- “Setting up the Electrical SDH Transmit Interface" on page 107
- “Transmitting an Unframed Signal" on page 107
- “Coupling the Receiver to the Transmitter Settings" on page 109
- “Storing and Recalling Instrument Settings" on page 213

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Setting up the Optical SDH Transmit Interface

SDH Optical signals are output for transmission on the Optical Out connectors.

Make sure interface settings match those of 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 109.

Also, on power up the transmitter will re-establish the laser settings (enabled or disabled) that existed prior to the last power down.

WARNING

Always switch off the laser before connecting or disconnecting optical cables. Read the laser warning information before switching ON the laser. Laser status is always shown at the bottom right of screen.

▶ **To set up the optical SDH Transmit interface**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Physical** then press **<Select>**.
2. Set the **Signal Mode** to **SDH**.
3. Select a **Signal Rate**. All rates are output optically but if you choose **STM-0** or **STM-1** then also select the **Line Interface** to be **Optical**.
4. Select a **Wavelength** (if dual wavelength option is fitted).
5. Select the **Laser On** checkbox (the **Laser-ON** message appears in the **Status:** line at the bottom of the screen).

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Setting up the Electrical SDH Transmit Interface

SDH electrical STM-0 and STM-1 signals are output on the SONET/SDH BNC Out port.

Make sure interface settings match those of 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 109.

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Physical** then press **<Select>**.
2 Set the **Signal Mode** to **SDH**.
3 Set the **Signal Rate** to **STM-1** or **STM-0**.
4 Set the **Line Interface** to **Electrical**.

Transmitting an Unframed Signal

You can transmit a signal that has no framing and is simply a repeating pattern. The patterns can be inverted or non-inverted. For a list of available test patterns, see the technical specifications which are available on the web (you can link to the website from the CD-ROM).

▶ **To transmit an unframed signal**

1 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Physical** then press **<Select>**.
2 Set the **Signal Mode** to **Unframed**.
3 Select a **Signal Rate**.

▶ **To select the signal pattern**

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

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2 Select the **Pattern** and its polarity.

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 2^n-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and an 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.

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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**.

NOTE You can view a summary of the setup at the bottom of the screen. This shows whether coupling is on or off.

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Selecting the SDH Transmit Clock Source

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

▶ **To select the transmit clock source**

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

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Adding Frequency Offset to the SDH Signal

You can apply frequency offset 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>**, then select the **Test Functions > Frequency Offset** window using the arrows and **<Select>** key.
2. Select **Line Offset**, then enter the required offset by editing the frequency offset value.
3. Select **Enable Offset**, then press **<Select>** to switch on the offset.

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Enabling Tandem Connection Monitoring (TCM) Signals

You can transmit high order TCM signals in the N1 byte of path overhead byte. The following procedure shows you how to enable tandem connection monitoring and assumes that you have already set up the SDH signal rate.

For more information, see:

- "What is a Tandem Connection?" on page 679

To enable high order TCM signals

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Select the Tandem Connection Monitoring **High Order** checkbox.
3. To generate a high order TCM identifier, see "Generating High Order Tandem Path Trace Identifiers" on page 118.

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Generating Jitter on an SDH Signal

You can add jitter to the transmitted SDH signal, if the instrument has jitter functionality fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SDH signal.

To generate jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the transmit **Mode** to **Jitter**.
3. In the **Jitter** setup field, select the jitter **Source** (**Internal** or **External**). For an **External** jitter source, connect the external source to the External Modulation Input connector.
4. For an **Internal** jitter source, enter the **Modulation Frequency** (**Hz**) and the **Amplitude** (**UI**). Press the **<Select>** key when you have finished.

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Generating Wander on an SDH Signal

You can add wander to the transmitted signal, if the instrument has jitter fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SDH signal.

To add wander to the signal

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the transmit **Mode** to **Wander**.
3. In the **Wander** setup field, select the **Modulation Frequency** (Hz) and the **Amplitude** (UI). Press the **<Select>** key when you have finished.

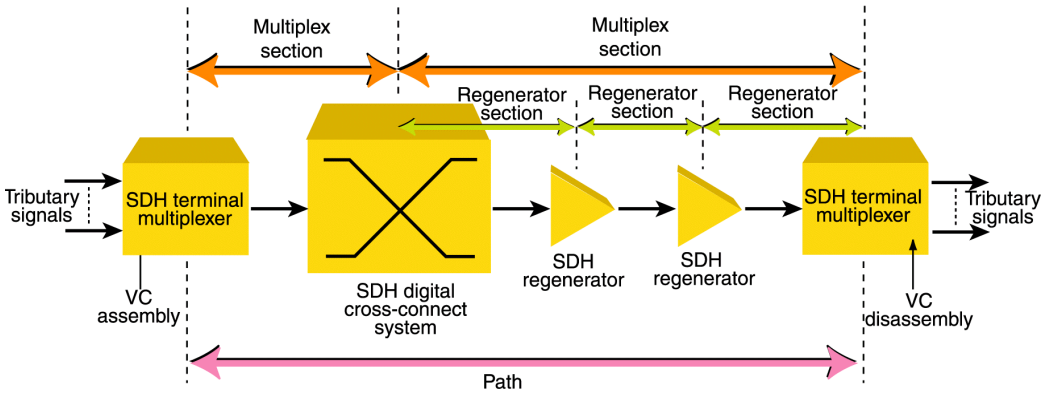
NOTE Wander generation is not available when the instrument is in Thru Mode or OTN.

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Generating SDH Overhead Signals

You can use the procedures on the following pages to transmit regenerator section, multiplexer section 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:

- "SDH Overhead Bytes" on page 621
- "Regenerator Section Overhead (RSOH)" on page 622
- "Multiplex Section Overhead (MSOH)" on page 623

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Generating Trace Messages

You can check for continuity between the transmitting and receiving ends of a regenerator section, high order path or low order (tributary) path by transmitting a message in the J0, J1 or J2 byte.

The message format can be 16-byte CRC-7, 64-byte non-CRC or fixed byte (section overhead).

When virtual concatenation (VCAT) is selected a separate J1 (high order) or J2 (low order) trace message can be set up in each member of the VCAT group. Alternatively, you can have the same trace message in all the VCAT members.

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 If VCAT is selected in the transmitter:

   1 Check the **Channel Specific** checkbox to allow you to set up different trace messages in each of the VCAT members. If this checkbox is not selected, the same trace message is copied to all VCAT members.

   2 To set up the different trace messages move the highlight to the more button and press **<Select>**.

   3 Use the arrow keys to select the VCAT member whose trace message you want to edit and press **<Select>**. Close the window.

3 Select the byte format as required.

4 Select the trace message field, then press **<Select>**.

5 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

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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.

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Generating High Order Tandem Path Trace Identifiers

If you enable Tandem Connection Monitoring (TCM), you can transmit tandem connection point identifiers (TC-APId).

The high order path tandem connection access point Identifier (TC-APId) is in bits 7 and 8 of the N1 byte (over a 76-byte multiframe). The low order path tandem connection access point Identifier (TC-APId) is in bits 7 and 8 of the N2 byte (over a 76-byte multiframe).

NOTE

First make sure you have enabled TCM:
1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Select the TCM **High/Low Order** checkboxes as required.

To generate high order TC-APIds

1. Press **<Menu>**, choose **Overhead Setup > Trace Messages** then press **<Select>**. Select the **HO Path** tab.
2. Select the **N1** trace message field, then press **<Select>**. Select a trace message from the drop down menu or select **Edit Field** then enter a new trace message using the keypad.
3. Press the **Run/Stop** key.

To generate low order TC-APIds

1. Press **<Menu>**, choose **Overhead Setup > Trace Messages** then press **<Select>**. Select the **LO Path** tab.
2. Select the **N2** trace message field, then press **<Select>**. Select a trace message from the drop down menu or select **Edit Field** then enter a new trace message using the keypad.
3. Press the **Run/Stop** key.

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For more information, see:

- “Enabling Tandem Connection Monitoring (TCM) Signals" on page 112
- “N1 (Bits 7 and 8) Multiframe Structure" on page 634.
- “N2 (bits 7 and 8) Multiframe Structure" on page 639
- “What is a Tandem Connection?" on page 679

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Generating Synchronization Status Messages

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

▶ **To generate an 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 628

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Generating Path Signal Labels

You can assign a high order path signal label to the C2 byte to reflect the current data payload mapping. Messages comply with ITU-T G.783. The C2 signal label value set up is transmitted in all virtual concatenation (VCAT) members.

You can also assign a low order path 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.

In addition, when virtual concatenation is selected, the V5 byte (bits 5. 6. 7) defaults to extended. When extended is set, you can edit the extended signal label carried in K4 bit 1.

To generate a high or low order signal label

1 Press **<Menu>**, choose **Overhead Setup > Labels** then press **<Select>**.

2 In the **Signal Labels** field select the **HO (C2)**, the **LO (V5)** and/or the **LO (K4)** signal label from the drop down menu as required. When the label is selected, its binary value is automatically displayed.

For more information, see:

- “C2 Byte Mapping" on page 631
- “V5 (bits 5 to 7) Signal Label" on page 637
- “K4 (bit 1) Low Order Extended Signal Label" on page 637

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Generating 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. For more information, see:

- "Ring APS Messages" on page 626
- "Linear APS Messages" on page 625

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 and the instrument will display the code and a description of the message being transmitted.

The following procedures assumes that you have already set up an SDH signal rate.

To generate a ring APS message

1. Press **<Menu>**, choose **Overhead Setup > APS Messages** then press **<Select>**.
2. Set the **Topology** to **Ring (G.841)**.
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 Bit 5**, then select the path.
7. Select **New Message K2 Bits 6->8**, then select the appropriate status information.
8. Select **Transmit New Message**.

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To generate a linear APS message

1 Press **<Menu>**, choose **Overhead Setup > APS Messages** then press **<Select>**.

2 Set the **Topology** to **Linear (G.783)**.

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**.

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Editing SDH Overhead Bytes

You can assign values to overhead bytes. You access the bytes by selecting the appropriate channel number. For optical signals, access the appropriate STM-1# or STM-0#.

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 and J1 section and path trace message bytes or the H4 position and sequence indicator for virtual concatenated (VCAT) signals. Also, if tandem connection is enabled N1/N2 cannot be changed.

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

- If the **Test Function** Error Add (MS-REI and HP-REI), Alarm Add (all alarms) or Section/Line DCC Insert feature is active, any byte values generated 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**.

For VCAT signals, if you edit the C2 signal label byte for the foreground signal, this value is copied into the POH of all VCAT members. When VCAT is selected you cannot edit the J2 or Z7 bytes.

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

To edit SDH overhead bytes

1 Press **<Menu>**, choose **Overhead Setup > Byte Setup** then press **<Select>**.

2 Select the required **STM-1 #** channel number.

3 Edit the overhead bytes. For more information, see "Editing Bytes" on page 126.

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

Background settings for VCAT groups

Each VCAT signal consists of several members, one of which is assigned to be the foreground signal. The remaining members are background members. The path overhead (POH) of the background signals are set as follows:

POH Byte	Value
J1	Message set up in trace message setup
B3	Calculated individually for each member
C2	Value set up in signal labels setup (same for all members)
G1	00h fixed
F2	00h fixed
H4	Contains the full H4 sequences as per G.707
F3	00h fixed
K3	00h fixed
N1	00h fixed

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Editing Bytes

Low Order POH Byte	Value
V5	BIP-2 value calculated for each member. Signal label can be set up for each member REI, RFI & RDI bits are set to 0.
J2	Message set up in trace message.
N2	00h fixed
K4	Contains the full VCAT sequence as per G.707

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.

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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.

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Generating Active Automatic Protection Switching (APS) Messages

Active Automatic Protection Switching (APS) provides emulation functionality that sets the values of K1 and K2 based on the K1 and K2 values in the received signal.

For more information, see:

- "Generating Automatic Protection Switching (APS) Messages" on page 122

In linear APS mode, you can transmit active or passive APS messages. In passive mode, you can set up any values in the transmitter in the K1 and K2 bytes, independent of the receiver. In active mode, the K1 and K2 byte setting in the transmitter is dependant on the K1 and K2 bytes setting in the received signal. You can select between two types of active APS. These are unidirectional mode and bidirectional mode and the values in the transmitter K1 and K2 bytes are set up according to the following table.

APS Mode	RX K1	TX K1		TX K2		
	b5-b8	b1-b4	b5-b8	b1-b4	b5	b6-b8
Unidirectional	xxxx	0000	0000	xxxx	user	100
Bidirectional	0000	0000	0000	0000	user	101
Bidirectional	yyyy	0010	yyyy	yyyy	user	101

where xxxx is any 4-bit binary value, user is a user programmable bit and yyyy is any non-zero 4-bit binary value. As an example of how to use the table, in unidirectional mode, if bits 5 to 8 in the K1 byte in the received signal has xxxx as its value then the transmitter sets up the K1 byte as all zeros, the K2 byte, bits 1 to 4, as xxxx; you can set bit 5 and bits 6 to 8 have 100 in them.

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

To generate a linear active APS message

1 Press **<Menu>**, choose **Overhead Setup > APS Messages** then press **<Select>**.

2 Set the **Topology** to **Linear (G.783)** and select **Active (Unidir)**.

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**.

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Inserting Messages into the Data Communications Channel (DCC)

You can insert network management messages into the regenerator section DCC or the multiplexer section DCC of a SDH signal via the DCC/GCC connector.

To insert a message into the DCC

1 Press **<Menu>**, choose **Test Functions > DCC/GCC Drop/Insert** then press **<Select>**.

2 In the **Transmitter Insert** field, select the regenerator or multiplexer DCC.

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Setting Up SDH Overhead Sequences

You can insert a sequence of values into a group of SDH overhead bytes (an overhead channel). A sequence consists of up to 256 different elements, each element being the appropriate number of bytes for the selected location.

Sequence Channels	SDH overhead bytes
9-byte channels	D4-D12
6-byte channels	A1-A2 for STM-1 to STM-64
3-byte channels	D1-D3
2-byte channels	A1-A2 for STM-0, K1-K2, H1-H2, M0-M1 (except STM-64 when M1M0 preference selected)
Single byte channels (MSOH)	S1, H3, M1 (except STM-64, M1M0 preference selected), E2, unused bytes
Single byte channels (High Order POH)	J1, C2, G1, F2, H4, F3, K3, N1(not available when virtual concatenation is selected)

Each element can be transmitted for a variable number of frames, up to 65535. This sequence can then be transmitted as a single run or repeated indefinitely.

The sequence must be stopped before the user can change the value of any element or the number of frames for any element.

You can use the sequences to check that your equipment deals with these bytes in the required way. The setup of these bytes may differ from one manufacturer to the next.

This procedure assumes that you have set up the transmitter to transmit an SDH signal.

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To set up an overhead sequence

1 Press **<Menu>**, choose **Overhead Setup > Sequence Generation** then press **<Select>**. Select the **Channel** tab.

2 Select the **Network Standard** to define the bytes in which the sequence should run.

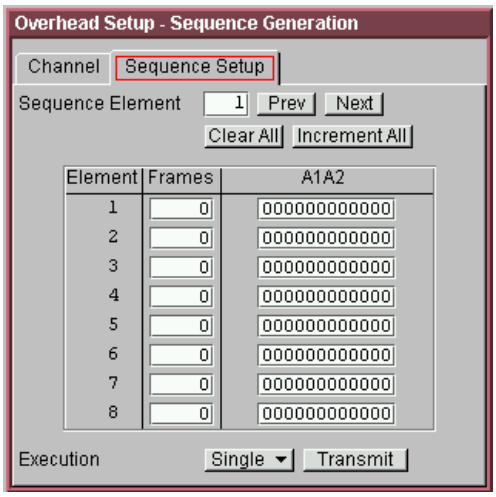
3 Select the **Change**... field.

4 Select the **A1A2 Boundary Function**.

5 Move to the fields in the SDH overhead and press **<Select>** to choose the sequence channel. (When selected, the button is pushed in). Select **Close**.

To set up sequence generation

1 Press **<Menu>**, choose **Overhead Setup > Sequence Generation** then press **<Select>**. Select the **Sequence Setup** tab.



2 Select the **Sequence Element** (values between 1 and 256). The selected element is displayed. You can move through the elements by selecting **Prev** and **Next**.

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3 Enter the number of frames you want the sequence to run for and also the sequence value for that set of frames. (After each entry press **<Select>**).

4 In the **Execution** field select **Single** or **Repeat** and then select the **Run Sequence** checkbox to run the sequence.

A1A2 Boundary Function

The A1 and A2 bytes provide a frame alignment pattern (A1 = F6h and A2 = 28h). In an SDH signal, six of the bytes at the boundary between the A1 and A2 bytes contain the bytes from the STM-1 channels as in the following table:

STM-n

STM-1 channel #	n-2	n-1	n	1	2	3
Overhead byte	A1#3	A1#3	A1#3	A2#1	A2#1	A2#1

For example, in the case of an STM-12 signal:

STM-1 channel #	10	11	12	1	2	3
Overhead byte	A1#3	A1#3	A1#3	A2#1	A2#1	A2#1

A network element will use some of these bytes (which ones are not defined in the standards, so will vary between manufacturers) to gain and maintain frame synchronization. Therefore the ability to stress test across the boundary is necessary to verify a correct synchronization algorithm within a network element.

The instrument allows you to generate a sequence in the six bytes at the A1A2 boundary as in the table above (select **A1A2 Boundary**) or in a selected channel (select **A1A2 Channel Associated**). **A1A2 Channel Associated** puts the sequence in the three A1 and three A2 bytes of the STM- 1 channel you have selected.

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Setting Up Mixed Mappings

Using mixed mappings, you can set up your SDH signal with any kind of channel payload configuration you might want to simulate your network. Use the setup window to choose the foreground channel, the channel capacity and the background patterns.

▶ **To configure the payload mappings**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Set the **Mapping Structure** field to **Mixed**.
3. Move to the **Mapping Configuration** fields, select the payload and then click on the **High** or **Low Order** more (...) button.
4. In the **Transmitter Mapping Setup** field, use the arrow keys to navigate around the payload channels.
5. Press **<Select>** to choose the channel capacity or to set the selected channel as the foreground channel (highlighted in green).
6. In the **Background Type** field select the pattern that is applied to all the background channels.
7. Select **Close** to close this setup window.

NOTE You can press the Cancel button to exit the mixed mappings window.

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Setting Up Virtual Concatenation

You can configure a virtual concatenated group (VCG) in the payload of your SDH signal. Use this group to test network equipment designed for virtual concantenation. You can fill the virtual concatenated group with Ethernet signals with GFP or LAPS encapsulation. You can also test what the receiver response in the event of non-contiguous sequence numbers being received.

One member of the VCG is chosen to be the foreground signal of the group and it is to this member that errors and alarms are added and if overhead overwrite is selected it applies to this member of the group.

▶ **To configure the virtual concatenation group**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Select the **VCAT** checkbox.
3. Move to the **Mapping Configuration** fields, select your required mapping and then click on the **High** or **Low Order** more (...) button.
4. In the **Transmitter Mapping Setup** field, use the arrow keys to navigate around the payload channels.
5. In any field, press **<Select>** to add that channel to the virtual concatenation group or to set the selected channel as the foreground channel (highlighted in green). You can choose the channels of the group in any order and the sequence number is automatically incremented.
6. Select the **Validate SQ** checkbox to allow only contiguous sequence (SQ) numbers. Uncheck this box to allow you to set any sequence number for a VCAT member.
7. If you have selected a channel as part of the VCAT group you can either delete it from the group or change its sequence number. To do this move the focus to the channel, press **<Select>** and choose the required action. Note that you cannot delete the foreground channel.

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8 In the **Background Type** field select the pattern that is applied to all the background channels.

9 Select **Close** to close this setup window.

NOTE You can press the Cancel button to exit the virtual concatenation window. This retains the selections you have just made.

For more information see:

- “K4 (bit 1) Low Order Extended Signal Label" on page 637
- “K4 (bit 2) Low Order VCAT Information" on page 638

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Setting Up Virtual Concatenation delays

You can add delay to any member of a virtual concatenation group. This allows you to simulate the different paths that a virtual concatenated (VCAT) member can take through the network, thus adding differential delay with respect to the other members of the same group. You can also change the delay to the VCAT signal member by changing the pointer of the container in which it is carried.

This procedure assumes you have set up a virtual concatenation signal.

For more information see

- “Setting Up Virtual Concatenation" on page 135
- “Numeric Entry" on page 29

To delay a virtual concatenation member

1. Press **<Menu>**, choose **Test Functions > VCAT Delay** then press **<Select>**.
2. Use the **Prev** and **Next** buttons allow you to move quickly between pages if you have more than one page of virtual concatenation members to display.
3. Move the highlight to the **Absolute Delay** field of the VCAT member you want to delay. Using the keypad, enter your required delay and then press **<Select>**.
4. Check the **Enable Delay** checkbox. The Differential Delay column is then updated and lists the delay on each member relative to the smallest delay. Note that the delay values are rounded to the closest value available.
5. You can change the pointer value of any or all of the containers for the VCAT members. In the **Pointer Adjustment** field select **Increment** or **Decrement** pointer. For each member whose pointer you want to adjust check the right-most checkbox in the **Adj** column. Then select **Action** to change the pointer. Note that the calculated delay changes.

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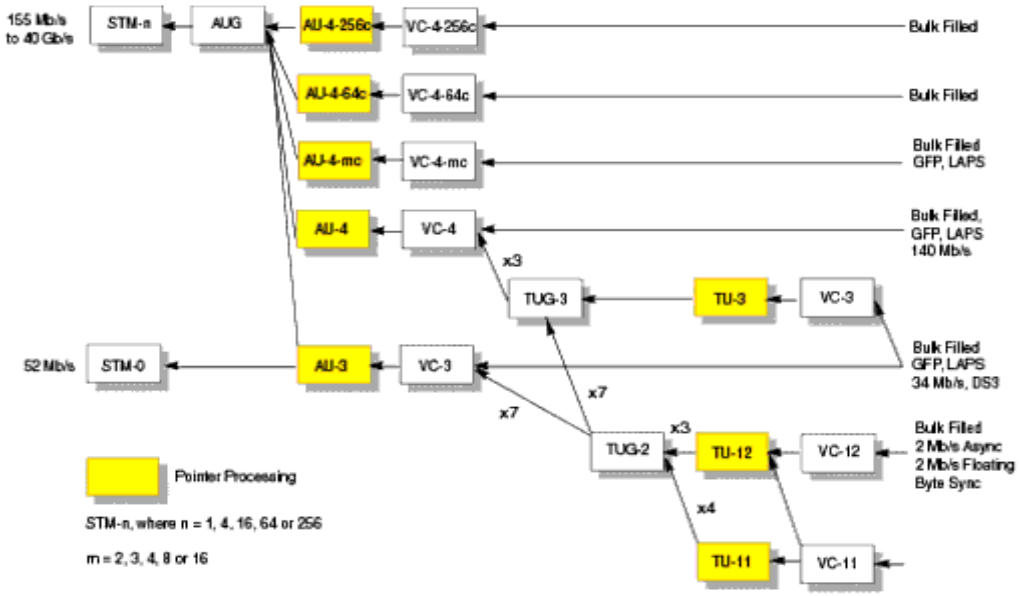
NOTE Note that pointer moves are hitless to the payload, unlike the adding of delay which may cause errors as the delay is changed.

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Generating VC-3/4 and Concatenated Payloads

You can transmit 34 Mb/s, 140 Mb/s, DS3 or bulk filled payloads in a VC-3/4 or you can bulk-fill concatenated VCs.



For more information, see:

- "Setting Up Mixed Mappings" on page 134
- "Generating VC-3/4 Payloads" on page 140
- "Generating Concatenated Payloads" on page 142

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Generating VC-3/4 Payloads

A framed or unframed DS3 (44 Mb/s), 34 Mb/s or a 140 Mb/s payload can be asynchronously mapped into a VC-3, or you can bulk fill a VC-3/4.

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

A transmitted framed signal can be structured or unstructured. With structured (or channelized) DS3, 34 Mb/s and 140 Mb/s signals, you will need to select test patterns for the foreground (test) channel and background. The test patterns can be inverted or non-inverted.

If you are transmitting an STM-4 signal (or greater) with AU-4 mapping, you will also need to select a pattern for the background AU-4s. This procedure assumes you have set up the STM-16 signal rate and pattern.

For more information, see:

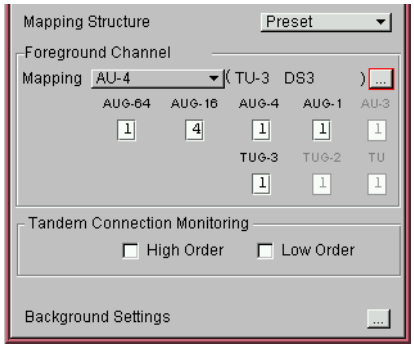
- "PRBS Polarity" on page 145

To insert a 34 Mb/s, 140 Mb/s or DS3 payload into an STM-16

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping**, using the drop down box and/or mapping diagram.
4. Select the **Channel** that is to carry the payload by selecting the appropriate **AUGs** and **TUGs**.

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5 If you are transmitting an STM-4 signal (or greater), select **Background Settings** then select a pattern for the background AU-4s.

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

7 Select a framed or unframed 34 or 140 Mb/s or DS3 payload.
For 34 or 140 Mb/s framed or unframed signals, see "Setting up the PDH Transmitter" on page 461.
For a DS3 framed or unframed signals, see "Setting up the DSn Transmitter" on page 507.

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

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Generating Concatenated Payloads

A concatenated payload can be transmitted in an SDH signal. This type of payload reduces test times by testing the entire bandwidth in one go. This procedure assumes you have selected the STM-16 signal rate and a test pattern.

SDH Signal		
STM-4	**STM-16**	**STM-64**
VC-4-4c	VC-4-4c	VC-4-4c
-	VC-4-16c	VC-4-16c
-	-	VC-4-64c

For more information, see:

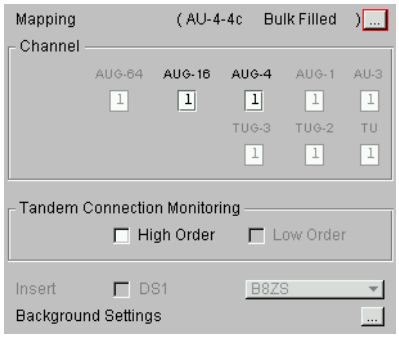
- "PRBS Polarity" on page 145
- "Reduced Test Time with Concatenated Payloads" on page 144

To insert a concatenated payload into an STM-16

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping**, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the concatenated payload by selecting the appropriate **AUGs**.

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

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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 SDH, a number (M) of TUs can be linked together to produce a concatenated container, M times the size of the TU. An example of this is the concatenation of five TU-2s to carry a 32 Mb/s video signal, known as VC-2-5c.

The concatenated virtual container (VC) 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	VC-4-16c payload	VC-4 bulk 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

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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.

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Generating VC-3/4 Tributary Payloads

You can transmit 28 TU-11s, 21 VT12s or 7 TU-2s in a VC-3, or 84 TU-11s, 63 TU-12s or 3 TU-3s in a VC-4.

The TUs are structured into tributary unit groups (TUG) within the VC-3/4. A VC-3 contains 7 TUG-2s, each TUG-2 can contain 4 TU-11s, 3 TU-12s or 1 TU-2. A VC-4 contains 3 TUG-3s, each TUG-3 contains 7 TUG-2s or 1 TU-3. A framed or unframed DS1 (1.5 Mb/s) signal can be mapped into a VC-11, a 2 Mb/s signal can be mapped into a VC-12 (mapping can be asynchronous or floating byte), or you can bulk fill a VC-11 or VC-12. 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 STM-4 signal (or greater) with AU-4 mapping, you will need to select a pattern for the background AU-4s. This procedure assumes that you have set up the STM-16 signal rate and test pattern.

For more information, see:

- PRBS Polarity

To insert a 2 Mb/s or DS1 payload into an SDH signal

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping**, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the 2 Mb/s or DS1 payload by selecting the appropriate **AUGs**, **TUGs** and **TUs**.
5. If you are transmitting an STM-4 signal (or greater), select **Background Settings** then select a pattern for the background AU-4s.
6. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > PDH/DSn** then press **<Select>**. Select a framed or unframed

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2 Mb/s or DS1 payload.
For 2 Mb/s framed or unframed signals, see “Setting up the PDH Transmitter" on page 461.
For a DS1 framed or unframed signals, see “Setting up the DSn Transmitter" on page 507.

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

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Setting Up GFP/LAPS Transmit Interface

If your instrument has Next Generation SDH functionality, you can set up an Ethernet over SDH signal using either **Generic Framing Procedure (GFP)** or **Link Access Procedure SDH/SONET (LAPS)** framing protocols. In both cases you can use the parameters defined by the relevant protocol specification or set your own custom parameters. Once the GFP or LAPS headers have been set up you can set the Ethernet payload.

The following procedures assume that you have already set up the SDH signal rate on the transmitter.

For more information, see:

- "Transmitting GFP Signals using G.7041 Protocol" on page 148
- "Transmitting a Custom GFP Signal" on page 149
- "Transmitting LAPS Signals using X.86 Protocol" on page 150
- "Transmitting a Custom LAPS Signal" on page 150
- "Generating Payloads for Ethernet over SDH (EOS)" on page 152

Transmitting GFP Signals using G.7041 Protocol

You must set up the SDH transmitter before setting up the GFP header.

To transmit a signal using G.7041 (GFP) protocol

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > GFP/LAPS** then press **<Select>**.
2. Select the **GFP** Transport Protocol.
3. Select the **G.7041** protocol.
4. Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames (PTI=000) or Client Management Frames (PTI=100).
5. Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.

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6 Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. If EXI is set to Linear Frame you can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload Identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. Transparent mode is only available when the selected mapping is AU-4-16c.

8 Set the Ethernet Settings and complete the payload settings.

- See "Generating Payloads for Ethernet over SDH (EOS)" on page 152.

Transmitting a Custom GFP Signal

You must set up the SDH transmitter before setting up the GFP header.

To transmit a custom GFP signal

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

2 Select the **GFP** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames or Client Management Frames and can be configured to any 3 bit value.

5 Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.

6 Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. You can also enter a value from the range 0000 to 1111. If EXI is set to Linear Frame you can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. If the PTI=100 the UPI can be configured to mean Client Signal Fail, either Loss of Client

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Signal (0000 0001) or Loss of Character Synchronization (0000 0010).

8 Set the Ethernet Settings and complete the payload settings. See "Generating Payloads for Ethernet over SDH (EOS)" on page 152.

Transmitting LAPS Signals using X.86 Protocol

You must set up the SDH transmitter before setting up the LAPS header.

▶ **To transmit signal using X.86 (LAPS) protocol**

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

2 Select the **LAPS** Transport Protocol.

3 Select the **X.86** protocol.

4 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

5 Select the **Rate Adaption Octets**. If enabled, enter the number of octets.

6 Set the Ethernet Settings and complete the payload settings. See "Generating Payloads for Ethernet over SDH (EOS)" on page 152.

Transmitting a Custom LAPS Signal

You must set up the SDH transmitter before setting up the LAPS header.

▶ **To transmit a custom LAPS signal**

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

2 Select the **LAPS** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Service Access Point Identifier **(SAPI)**. The SAPI can be any 4 digit hexadecimal value.

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5 Select the **Address**. The address can be any 2 digit decimal value.

6 Select the **Control**. The control can be any 2 digit decimal value.

7 Select the **FCS Length**. The length can be either 32 or 16 bit.

8 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

9 Select the **Rate Adaption Octets**. If enabled, enter the number of octets.

10 Set the Ethernet Settings and complete the payload settings. See “Generating Payloads for Ethernet over SDH (EOS)" on page 152.

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Generating Payloads for Ethernet over SDH (EOS)

If your instrument has Next Generation SDH functionality, you can set up an Ethernet over SDH signal using either GFP or LAPS transport protocols. The following procedure assumes that you have already set up SDH signal rate and the GFP or LAPS Transport Protocol.

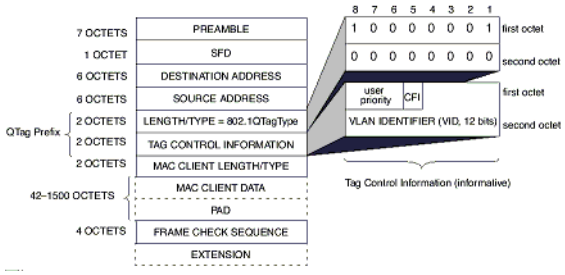
To generate Ethernet over SDH

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Ethernet** then press **<Select>**.
2. Select each of the **Ethernet Header** settings. Enter the Destination and Source Addresses. A warning message will be displayed when either a Broadcast address (FF-FF-FF-FF-FF-FF-) or a Multicast address (where there is a '1' in right most bit of address byte one, for example x1-xx-xx-xx-xx-xx, x3-xx-xx-xx-xx-xx, etc) is set.
3. Check the **Tagged** checkbox to transmit Tagged Ethernet (see diagram). User Priority and VLAN fields are only enabled when the **Tagged** option is checked.
4. Enter the **User Priority**. The User Priority values range from 0 to 7.
5. Enter the **VLAN**. The VLAN values range from 0 to 4094.
6. Enter the **Ethernet Frame Size (Bytes)**. If the frame is tagged, the difference between Length/Type and Ethernet Frame Size must be 22, otherwise length/type errors will occur. If the frame is not tagged, the difference must be 18.
7. Enter the **Length/Type** (in hex format). If you check the **Auto** box the length will be calculated automatically. Lengths are interpreted by values of 0 to 1500, Types are interpreted by values greater of equal to 1536. Values between 1501 and 1535 are undefined.
8. Enter the **Requested Data Rate (Mb/s)**. The value depends on the mapping and ethernet frame size settings. If the Requested Data Rate exceeds the available capacity a warning will be displayed. The Calculated Data Rate and Interpacket Gap are set automatically. You can use the Calculated Data Rate as a guide to the available capacity.

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Tagged Ethernet



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Transmitting DSn Payloads in an SDH Signal

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

For more information, see:

- "Generating VC-3/4 Tributary Payloads" on page 146

DSn Payload	Inserted into SDH Tributary	Mapping
DS1	TU-11 or TU-12	Async or Floating Byte
DS3	VC-3	Async

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Inserting an External DSn Payload in an SDH Signal

You can asynchronously map an external DS1 or DS3 payload into the tributary of a SDH signal. You should apply balanced signals to the DS1 In port (Siemens connector), and an unbalanced signal to the 2-140 Mb/s DS3 In port (BNC connector). The procedure below assumes that you have set up an SDH signal rate and chosen a test pattern.

External Payload	Applied to Port	Inserted into SDH Tributary
DS1	DS1 In (Siemens)	TU-11 or TU-12
DS3	2-140 M/s DS3 In (BNC)	VC-3

To insert a DS1 payload into an SDH signal

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping**, using the drop down box and/or the mapping diagram.
4. Select a **Channel** to carry the DS1 payload by choosing the appropriate **AUGs**, **TUGs** and **TUs**.
5. Select the **Insert DS1** checkbox. The external signal (from the DS1 In ports) will be inserted into the SDH signal.
6. Select the required line code **B8ZS** or **AMI**.
7. If you are transmitting an STM-4 signal (or greater), select **Background Settings** then select a pattern for the background AU-4s.

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

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Transmitting PDH Payloads in an SDH Signal

You can map a 2, 34 or 140 Mb/s PDH payload into the tributary of a SDH signal.

PDH Payload	Inserted into SDH Tributary	Mapping
2 Mb/s	TU-12	Async or Floating Byte
34 Mb/s	VC-3	Async
140 Mb/s	VC-4	Async

For more information, see:

- "Generating VC-3/4 Tributary Payloads" on page 146

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Inserting an External PDH Payload into an SDH Signal

You can asynchronously map an external PDH payload into the tributary of an SDH signal. The procedure below assumes that you have set up an SDH signal rate and chosen a test pattern.

External Payload	ITU Designator	Applied to Port	Inserted into SDH Tributary
2 Mb/s	E1	2 Mb/s In (Bantam) or 2-140 Mb/s DS3 In (BNC)	TU-12
34 Mb/s	E3	2-140 M/s DS3 In (BNC)	VC-3
140 Mb/s	E4	2-140 M/s DS3 In (BNC)	VC-4

To insert an external 2 Mb/s payload into an SDH signal

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

2 Set the **Mapping Structure** to **Preset**.

3 Select the **Foreground Channel Mapping** to **VC-12**, using the drop down box and/or the mapping diagram.

4 Select the **Channel** that is to carry the 2 Mb/s payload by selecting the appropriate **AUG**s, **TUG**s and **TU**s.

5 Select the **Insert 2 Mb/s** checkbox. The external signal (from the 2 Mb/s In ports) will be inserted into the SDH signal.

6 If you are transmitting an STM-4 signal (or greater), select **Background Settings** then select a pattern for the background AU-4s.

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Adjusting AU or TU Pointer Values

You can check network equipment's ability to handle adjustments to AU or TU pointer values. Pointers compensate for frequency and phase differences between AUs and TUs in the SDH 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 AU or TU Pointers" on page 159
- "Selecting a New AU Pointer" on page 160
- "Selecting AU or TU Pointer Offset" on page 161

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Selecting a Burst of AU or TU Pointers

You can have an incrementing, decrementing or alternating burst of pointer values. The burst size is 1 to 10 for AU pointers, and 1 to 5 for TU-11 and TU-12 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 AU pointers and 2 ms for TU 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 SDH signal rate and payload.

To transmit a burst of AU or TU pointer values

1 Press **<Menu>**, choose **Test Functions > Pointer Adjustment** then press **<Select>**.

2 Set **Pointer** to **AU** or **TU**, then select **Burst**.

3 Select the required **Burst Type**.

4 Select the **Burst Size** using the edit offset feature.

5 Select **Transmit Pointer Burst**.

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Selecting a New AU Pointer

You can select any pointer value in the valid range 0 to 782 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
AU	0 to 782
TU-2	0 to 427
TU-12	0 to 139
TU-11	0 to 103

To select a new AU or TU pointer

1. Press **<Menu>**, choose **Test Functions > Pointer Adjustment** then press **<Select>**.
2. Set **Pointer** to **AU** or **TU**, 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).

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Selecting AU or TU Pointer Offset

You can frequency offset the Transmitter output Signal Rate or the VC rate, relative to each other to produce pointer movements. If you offset the AU 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 SDH signal or the payload.

Pointer Type	Line Rate	AU Payload (VC) Rate	TU Payload (TU) Rate
AU	Constant	Offset	Tracks AU Payload
AU	Offset	Constant	Constant
TU	Constant	Constant	Offset
TU	Offset	Tracks Line Rate	Constant

To add AU or TU pointer offset

1 Press **<Menu>**, choose **Test Functions > Pointer Adjustment** then press **<Select>**.

2 Set **Pointer** to **AU** or **TU**, 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.

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Adding SDH Errors and Alarms

You can add errors and alarms to an SDH signal during testing. For a full list of errors/alarms refer to the technical specifications, available on the instrument website.

Errors can be added singly, at preset rates or at a user programmable rate. With the exception of 'Entire Frame', 'A1A2 Frame' and 'BIT', errors can be added at 'Error All' rate.

NOTE

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

To add TCM errors and alarms you must first enable the high and low order TCM features:
1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Select the TCM **High** and **Low Order** checkbox.

The procedure below assumes that you have set up the SDH 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. Use the **<Single Error>** key to add single errors.

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

NOTE

You can add errors and alarms at the same time.

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Adding GFP, LAPS and Ethernet Errors and Alarms

If your instrument has Next Generation SDH functionality, you can add GFP, LAPS and Ethernet errors. You can also add GFP and LAPS alarms to an SDH signal during testing. For a full list of errors/alarms refer to the technical specifications (available on the instrument website).

Errors can be added singly or at preset rates.

The procedure below assumes that you have set up the SDH signal rate, GFP/LAPS framing protocol and Ethernet payload.

To add errors

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

2 Select the **Add Errors Type**, and **Rate** required. Use the **<Single Error>** key to add single errors.

NOTE You can add errors and alarms at the same time.

To add alarms

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

2 Select the **Add Alarm Group.**

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

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Adding Runt and Jumbo Frames

If your instrument has Next Generation SDH functionality, you can add Runt and Jumbo Ethernet frames to an SDH signal during testing.

The procedure below assumes that you have set up the SDH signal rate, GFP/LAPS framing protocol and Ethernet payload.

To add Runt/Jumbo Frames

1. Press **<Menu>**, choose **Test Functions > Runt/Jumbo Add** then press **<Select>**.
2. Select the **Add Frame Type** and **Rate** required.
3. Select **Transmit Single Frame** to add a frame.

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Adding Alarm Stress

You can add alarm stress to the signal to simulate intermittent or periodic alarm conditions in the network.

To add an alarm stress

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

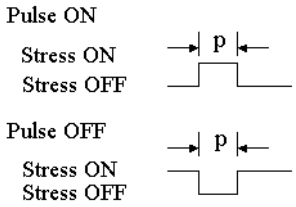
2 Select the **Add Alarms Type**.

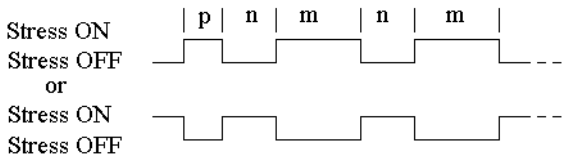
3 In the **Stress** field, depending on the alarm you have selected, you can choose a single-pulsed stress or a sequence of pulses.

For more information on alarm stress testing refer to the application note on the CD ROM supplied with the instrument The application note is also available on the product website.

Alarm Stress Sequence

The alarm stress sequence consists of either a pulse or a pnm sequence. The sequence may be started when the alarm is either in the ON state or in the OFF state as indicated in the following diagrams.





pnm Sequence

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Selecting SDH Transmitter Trigger Output

You can select from a range of different triggers associated with transmitter events. The triggers associated with SDH errors are output in the form of pulses. The triggers associated with alarms are output in the form of a level change.

For information on SDH trigger events see

- "SDH/SONET Transmit Trigger Outputs" on page 673

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

To select a trigger condition

1 Press **<Menu>**, choose **Test Functions > Trigger Output** then press **<Select>**.

2 In the **Transmit Trigger** field, select the **Type** of trigger.

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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**.

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Setting up the SDH Receiver

Physical

- "Optical Connector Safety Information" on page 60
- "Setting Up the SDH Receive Interface" on page 171
- "Enabling Tandem Connection Monitoring (TCM) Signals" on page 174
- "Monitoring Unframed Signals" on page 175
- "Monitoring Jitter on an SDH Signal" on page 176
- "Monitoring Wander on an SDH Signal" on page 177

Overhead

- "Monitoring Trace Messages" on page 179
- "Monitoring High Order Tandem Path Trace Identifiers" on page 179
- "Monitoring Synchronization Status Messages" on page 180
- "Monitoring Path Signal Labels" on page 180
- "Monitoring Automatic Protection Switching (APS) Messages" on page 181
- "Monitoring SDH Overhead Bytes" on page 182
- "Capturing SDH Overhead Sequences" on page 183
- "Capturing SDH Overhead Data" on page 186
- "Dropping Messages from the Data Communications Channel (DCC)" on page 187

Payload

- "Receiving Virtual Concatenation signals" on page 188
- "Measuring Virtual Concatenation delays" on page 190
- "Monitoring VC-3/4 and Concatenated Payloads" on page 191
- "Monitoring VC-3/4 Tributary Payloads" on page 197
- "Setting Up GFP/LAPS Receive Interface" on page 199
- "Monitoring Ethernet over SDH Payloads (EOS)" on page 203

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- "Monitoring DSn Payloads in an SDH Signal" on page 204
- "Dropping a DSn Payload from an SDH Signal" on page 205
- "Monitoring PDH Payloads in an SDH Signal" on page 206
- "Dropping a PDH Payload from an SDH Signal" on page 207
- "Dropping a Voice Channel to the Internal Speaker" on page 208

Trigger Outputs/Resetting the Instrument

- "Selecting SDH Receiver Trigger Outputs" on page 209
- "Switching Off All Test Function Features" on page 167

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Setting Up the SDH Receive Interface

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

For more information, see:

- “Setting up the Optical SDH Receive Interface" on page 172
- “Setting up the Electrical SDH Receive Interface" on page 173
- “Coupling the Transmitter to the Receiver Settings" on page 175
- “Storing and Recalling Instrument Settings" on page 213

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Setting up the Optical SDH Receive Interface

You can apply an STM-64 optical signal from network equipment to the 9.95/10.71 Gb/s (1550 nm) Optical In port, and STM-0, STM-1, STM-4 and STM-16 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 receiver and transmitter can operate independently, or they can be coupled. For more information, see "Coupling the Transmitter to the Receiver Settings" on page 175.

WARNING Always switch off the laser before connecting or disconnecting optical cables. Read the laser warning information before switching ON the laser. Laser status is always shown at the bottom right of instrument screen.

▶ **To set up the optical SDH receive interface**

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

2 Select an optical **Signal Rate**.

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Setting up the Electrical SDH Receive Interface

You should apply SDH electrical STM-0 and STM-1 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 receiver and transmitter can operate independently, or they can be coupled. For more information, see "Coupling the Transmitter to the Receiver Settings" on page 175.

To set up the electrical SDH receive interface

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

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Enabling Tandem Connection Monitoring (TCM) Signals

You can set up the receiver for Tandem Connection Monitoring. This procedure assumes that you have set up the SDH receiver.

To receive a high order TCM signal

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

2 Select the Tandem Connection Monitoring **High Order** checkbox.

For more information on TCM settings, see:

- "Monitoring High Order Tandem Path Trace Identifiers" on page 179
- "What is a Tandem Connection?" on page 679

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Monitoring Unframed Signals

You can monitor test patterns in an unframed signal. The test patterns can be inverted or non-inverted.

To set up an unframed signal

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

2 Select the Unframed **Signal Mode** from the drop down list.

3 Select a **Signal Rate**.

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 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**.

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Monitoring Jitter on an SDH Signal

You can monitor jitter on an SDH signal, if the instrument has jitter functionality fitted. Jitter is measured from the input signals using the recovered clock from the line rate signal. For direct jitter measurements on an electrical line rate clock, use an external clock reference. Select the **Clock** interface if an electrical clock is applied directly to the jitter receive Clock-In port. Select the **Data** interface if an optical data signal is applied to the Optical receiver port, or an electrical data signal is applied directly to the Clock Recover Data In port.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SDH signal. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 243

To monitor jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Jitter**.
3. Select an **Interface** (**Clock**, **Data**).
4. In the **Jitter** setup field, select a receiver jitter **Range** (UI).
5. Enter the positive and negative **Hit Threshold** levels (UI), to determine when a hit will be recorded.
6. Select the High Pass/Low Pass **Filters** checkboxes as required. If no checkboxes are selected, jitter is measured over the full demodulation bandwidth for the line rate and range.
7. If required, select a **Demod Output** filter from the drop down list, to be routed to the demodulated output connector.
8. Press the **Run/Stop** key to start/stop the jitter measurement.
9. View the Jitter/Wander results page. For more information, see "Viewing Jitter/Wander Measurement Results" on page 241.

NOTE Jitter Unlock will inhibit results when using optical and binary interfaces.

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Monitoring Wander on an SDH Signal

You can monitor wander on the received signal, if the instrument has jitter/wander fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SDH signal. Use an external clock for direct wander measurements on an electrical line rate clock.

Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 243

NOTE A wander measurement may only be performed on a locked synchronous system where one reference is used. The Clock Source must generate or be locked to the system clock of the signal being measured.

To monitor wander

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Wander**.
3. Select an **Interface** (**Clock**, **Data**).
4. Select the **External Wander Analysis** checkbox, if required. The **Timing Reference** (clock source) can be **Internal** or **External**. You should use an External Timing Reference for accurate Wander results.
5. Press the **Run/Stop** key to start/stop the Wander measurement.
6. View the Jitter/Wander results page.
   For more information, see "Viewing Jitter/Wander Measurement Results" on page 241.

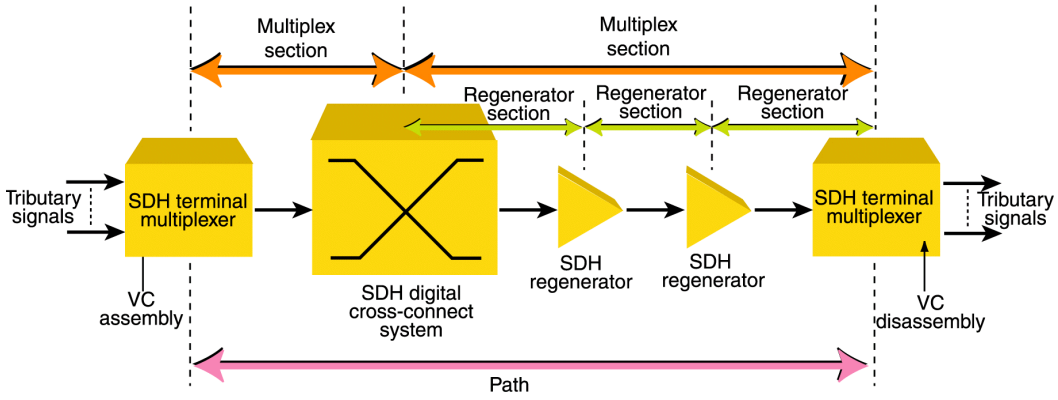
NOTE For information on setting up an external clock source, see "Selecting the SDH Transmit Clock Source" on page 110

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Monitoring SDH Overhead Signals

You can use the procedures on the following pages to monitor regenerator section, multiplexer section 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:

- "SDH Overhead Bytes" on page 621
- "Regenerator Section Overhead (RSOH)" on page 622
- "Multiplex Section Overhead (MSOH)" on page 623

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Monitoring Trace Messages

You can check for continuity between the transmitting and receiving ends of a regenerator section or high order 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 High Order Tandem Path Trace Identifiers

If you enable Tandem Connection Monitoring (TCM), you can monitor the high order path tandem connection access point Identifier (TC-APId).

The high order path tandem connection access point Identifier (TC-APId) is in bits 7 and 8 of the N1 byte (over a 76-byte multiframe). The low order path tandem connection access point Identifier (TC-APId) is in bits 7 and 8 of the N2 byte (over a 76-byte multiframe).

NOTE

First make sure you have enabled TCM:
1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SDH** then press **<Select>**.
2. Select the TCM **High** and **Low Order** checkboxes.

For more information, see:

- "N1 (Bits 7 and 8) Multiframe Structure" on page 634.
- "What is a Tandem Connection?" on page 679

To monitor the N1 TC-APId

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

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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, see:

- "Synchronization Status Messages (S1 bits 5 to 8)" on page 628

Monitoring Path Signal Labels

You can monitor the high order path signal label in the C2 byte (it reflects the current SPE payload mapping). Messages comply with ITU-T G.783. You can also monitor the low order path signal label in bits 5 to 7 of the V5 byte (the label reflects the current tributary payload mapping).

When low order virtual concatenation (VCAT) is selected in the receiver (except TU-3) you can monitor both the signal label carried in the V5 byte and the extended signal label carried in the K4 bit 1 multiframe. The labels displayed are for the foreground VCAT member.

To monitor the high order path signal label

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

For more information, see:

- "C2 Byte Mapping" on page 631.
- "V5 (bits 5 to 7) Signal Label" on page 637
- "K4 (bit 1) Low Order Extended Signal Label" on page 637

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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 SDH signal rate.

▶ **To monitor APS messages**

1 Press **<Menu>**, choose **Overhead Monitor > APS Messages** then press **<Select>**.

2 Set the **Topology** to **Linear (G783)** or **Ring (G.841)**.

For more information on APS messages, see:

- "Linear APS Messages" on page 625
- "Ring APS Messages" on page 626

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Monitoring SDH Overhead Bytes

You can 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.

Access the transport overhead bytes by selecting the appropriate channel number. For optical signals, select the appropriate STM-1# and STM-0#.

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

▶ **To monitor SDH overhead bytes**

1 Press **<Menu>**, choose **Overhead Monitor > Byte Monitor** then press **<Select>**.

2 Select the required **STM-1 #**.

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

NOTE Note that at 40Gb/s the actual value of the B1, B2, N1 bytes is not displayed. The display indicates what bit in these bytes is errored.

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Capturing SDH Overhead Sequences

You can receive a sequence of values in an overhead channel (a group of overhead bytes).

Sequence Channels	SDH overhead bytes
9-byte channels	D4-D12
6-byte channels	A1-A2 for STM-1 to STM-64
3-byte channels	D1-D3
2-byte channels	A1-A2 for STM-0, K1-K2, H1-H2, M0-M1 (except STM-64 when M1M0 preference selected)
Single byte channels (MSOH)	S1, H3, M1 (except STM-64, M1M0 preference selected), E2, unused bytes
Single byte channels (High Order POH)	J1, C2, G1, F2, H4, F3, K3, N1

256 unique values (elements) of the selected channel are displayed along with the number of frames for which the value has occurred. The capture of the channel is triggered either manually (after Capture is selected) or the trigger can be set up by the user.

Trigger Selection	When capture occurs
Manual	The capture of the overhead channel occurs immediately after **Capture** is initiated.
Pre-trigger	Up to 256 values up to and including the trigger point are displayed. The capture is triggered as soon as possible after the **Capture** is initiated, even if 256 values have not been captured.
Post-trigger	Up to 256 values including and following the trigger point are displayed. The captured data is updated every second after the capture has triggered.
Centred-trigger	Up to 128 values before the trigger point and up to 128 values including and following the trigger point are displayed.

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Trigger Pattern

The capture of the overhead channel is triggered when the value of the selected channel is equal to the trigger value or when it is NOT equal to the trigger value (binary inversion).

The trigger mask is set up by the user. Only bits corresponding to a '1' in the mask value are used to detect the trigger condition.

The procedure assumes that you have set up the SDH receiver.

To set up the sequence capture channel

1. Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Channel** tab.
2. Select the **Network Standard**.
3. Select the **Change**... field.
4. Select the **STS-1** and **STS-3** channel of interest.
5. Move to the fields in the SDH overhead and press **<Select>** to choose the channel you want to monitor (when selected, the button is pushed in). Select **Close**.

To set up the sequence capture trigger

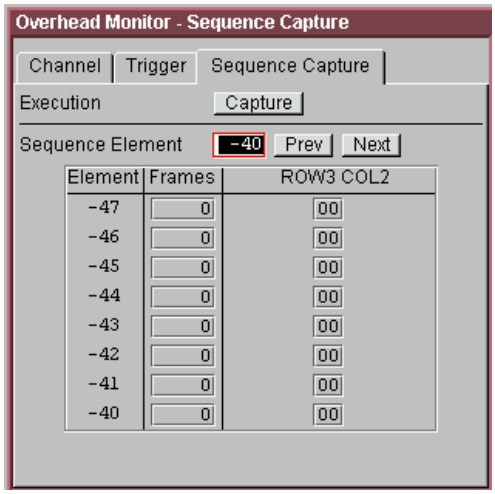
1. Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Trigger** tab.
2. Set up the trigger conditions as required.

To set up the sequence capture

1. Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Sequence Capture** tab.

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2 Select the **Sequence Element**. The selected element is displayed with its value and the number of frames for which this value occurred.

3 In the **Execution** field, select **Capture** to start the capture.

4 To stop the capture select **Stop** in the **Execution** field.

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Capturing SDH Overhead Data

You can capture the complete overhead for six frames of a SDH signal. The capture is triggered using a choice of events.

Trigger Selection	What is displayed?
Manual	Six frames following the manual capture
Pre-trigger capture	Six frames up to and including the trigger frame
Post trigger capture	Six frames including and following the trigger frame
Centred capture	Three frames before the trigger frame, the trigger frame and two frames following the trigger frame

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

To capture SDH overheads

1. Press **<Menu>**, choose **Overhead Monitor > Data Capture** then press **<Select>**. Select the **Setup** tab.
2. Select **SOH** or **POH** in the **Capture Data** field.
3. In the **Trigger Type** field select when the capture occurs relative to the trigger.
4. In the **Trigger Event** select from **Errors** or **Alarms** and then select the type of error or alarm.
5. Select **Capture** to start the capture. The status line indicates when capture is complete.
6. Press **<Menu>**, choose **Overhead Monitor > Data Capture** then press **<Select>**. Select the **Captured Data** tab. This allows you to view the captured data.

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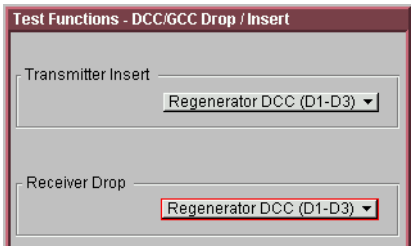
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Dropping Messages from the Data Communications Channel (DCC)

You can drop network management messages from the regenerator section DCC (D1 to D3) or the multiplexer section DCC (D4 to D12) of a SDH signal via the DCC/GCC connector.

To drop a message from the DCC of a SDH signal

1 Press **<Menu>**, choose **Test Functions > DCC/GCC Drop/Insert** then press **<Select>**.



2 Connect a Protocol Analyzer to the instrument's DCC/GCC port.

3 In the **Receiver Drop** field, then select the regenerator or multiplexer DCC.

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Receiving Virtual Concatenation signals

You can configure the instrument receiver to receive a virtual concatenated (VCAT) group in the payload of an SDH signal. Select channels as VCAT members that you expect in your received signal. Select one of the channels as the foreground. Measurements are made on the foreground channel only but you can select **Smart Test > VCAT Overview** to identify where errors and alarms are occurring.

This setup allows you to check that you have correctly set up your required VCAT signal in your equipment transmitter.

- "High Order VCAT H4 Sequence" on page 633
- "K4 (bit 2) Low Order VCAT Information" on page 638

To configure the virtual concatenation group

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > SDH** then press **<Select>**.
2. Select the **VCAT** checkbox.
3. Move to the **Mapping Configuration** fields, select your required mapping and then click on the **High** or **Low Order** more (...) button.
4. In the **Receiver Mapping Setup** field, use the arrow keys to navigate around the payload channels.
5. In any field, press **<Select>**. Choose **Discover Group** to instruct the receiver to find all valid members of a VCAT group in the received signal automatically; Choose **Add to VCAT Group** to manually set up the expected VCAT configuration.
6. Once you have set up the VCAT configuration in each channel you can then choose to remove that channel from the VCAT group, change the sequence number (SQ) of that channel or set that channel as foreground. (Measurements are made on the foreground channel.)
7. Select the **Validate SQ** checkbox to allow only contiguous sequence (SQ) numbers. Uncheck this box to allow you to set any sequence number for a VCAT member.

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8 Select **Close** to close this setup window.

NOTE You can press the Cancel button to exit the virtual concatenation window. This retains the selections you have just made.

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Measuring Virtual Concatenation delays

You can measure the delay experienced by a member of a virtual concatenation group.

This procedure assumes you have set up a virtual concatenation signal in the receiver.

For more information see

- "Receiving Virtual Concatenation signals" on page 188

To measure VCAT delay

1 Press **<Menu>**, choose **Results > Network Measurements > VCAT Delay** then press **<Select>**.

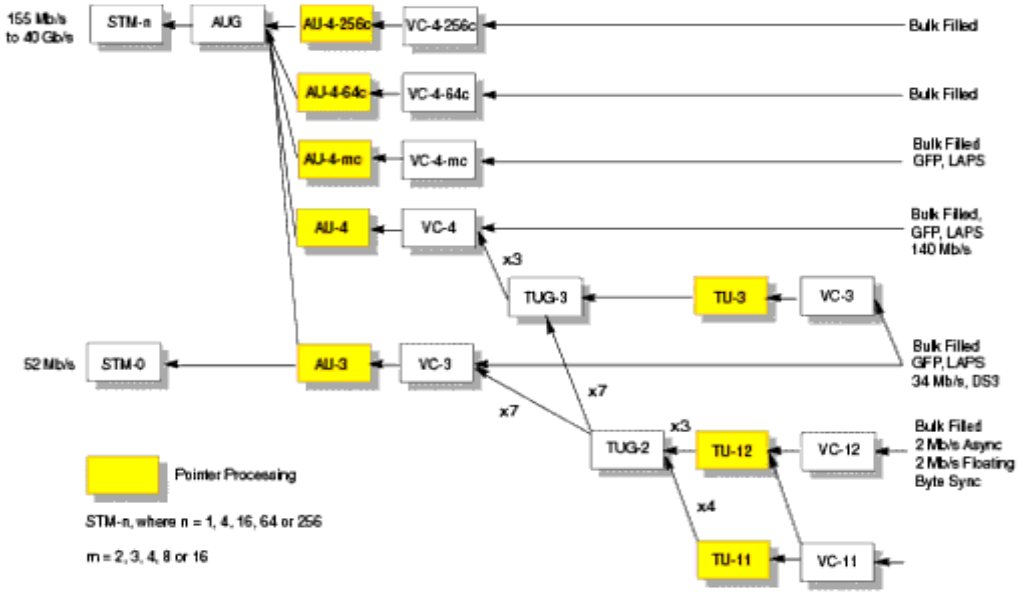
2 The **Prev** and **Next** buttons allow you to move quickly between pages if you have more than one page of VCAT members to display.

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Monitoring VC-3/4 and Concatenated Payloads

You can monitor 34 Mb/s, 140 Mb/s, DS3 or bulk filled payloads in a VC-3/4, or bulk fill concatenated VCs.



For more information, see:

- "Monitoring VC-3/4 Payloads" on page 192
- "Monitoring Concatenated Payloads" on page 193

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Monitoring VC-3/4 Payloads

You can monitor a framed or unframed DS3 (44 Mb/s) or 34 Mb/s or a 140 Mb/s signal (asynchronously mapped) in a VC-3/4, or you can monitor a bulk filled VC-3/4.

Signal	Framing	Payload Structure
DS3	C-bit, M13	DS1, 2 Mb/s, 56 kb/s, 64 Kb/s, N x 56/64 kb/s
140 M/bs	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, 34 Mb/s and 140 Mb/s signals, you will need to select test patterns (inverted or non-inverted) for the foreground (test) channel.

For more information, see:

- "PRBS Polarity" on page 196

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

▶ **To monitor a 34 Mb/s, 140 Mb/s or DS3 payload in an STM-16**

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > SDH** then press **<Select>**.
2. Select the 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 **AUGs** and **TUGs**.
4. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > PDH/DSn** then press **<Select>**. Select a framed or unframed 34, 140 Mb/s or DS3 payload.
   For 34 or 140 Mb/s framed or unframed signals, see "Setting up the PDH Receiver" on page 477.
   For a DS3 framed or unframed signals, see "Setting up the DSn Receiver" on page 527.

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

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Monitoring Concatenated Payloads

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

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

SDH Signal		
STM-4	**STM-16**	**STM-64**
VC-4-4c	VC-4-4c	VC-4-4c
	VC-4-16c	VC-4-16c
		VC-4-64c

A framed 140 Mb/s payload can be carried in a VC-4-4c, VC-4-16c or VC-4-64c. The VC-4-16c and VC-4-64c VCs are bulk filled only.

If you are monitoring a VC-4-4c, 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 transmitting an STM-16 signal (or greater) with AU-4c mappings, you will need to select a pattern for the background AU4s. The test patterns can be inverted or non-inverted.

For more information, see:

- “PRBS Polarity" on page 196
- “Reduced Test Time with Concatenated Payloads" on page 195

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

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To monitor a concatenated payload

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

2 Select the **VC4-4c** or **VC-4-16c** payload (**VC-4-64c** not available at STM-16), 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 **AUGs**.

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

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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 SDH, a number (M) of TUs can be linked together to produce a concatenated container, M times the size of the TU. An example of this is the concatenation of five TU-2s to carry a 32 Mb/s video signal, known as VC-2-5c.

The concatenated virtual container (VC) 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	VC-4-16c payload	VC-4 bulk 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

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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.

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Monitoring VC-3/4 Tributary Payloads

You can monitor 28 TU-11s, 21 VT12s or 7 TU-2s in a VC-3, or 84 TU-11s, 63 TU-12s or 3 TU-3s in a VC-4.

The TUs are structured into tributary unit groups (TUG) within the VC-3/4. A VC-3 contains 7 TUG-2s, with each TUG-2 containing 4 TU-11s, 3 TU-12s or 1 TU-2. A VC-4 contains 3 TUG-3s, with each TUG-3 containing 7 TUG-2s or 1 TU-3.

A framed or unframed DS1 (1.5 Mb/s) signal mapped into a VC-11, or a PDH (2 Mb/s) signal mapped into a VC-12 payload can be monitored (mapping can be asynchronous or floating byte), or you can monitor a bulk filled VC-11 or VC-12.

NOTE The framing information for a 2 Mb/s signal that is mapped into a VC-12 (floating byte) can be embedded into timeslot 0, or into the H4 byte of the SDH 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. The test patterns can be inverted or non-inverted.

For more information, see:

- "PRBS Polarity" on page 196.

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

To monitor a 2 Mb/s or DS1 payload in an SDH signal

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > SDH** then press **<Select>**.
2. Select the **VC-11** or **VC-12** 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 **AUGs**, **TUGs** and **TUs**.

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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 VC-12 (floating byte)).

5 Press **<Menu>**, choose **Tx/Rx > Receiver Settings > PDH/DSn** then press **<Select>**. 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 477.
For a DS1 framed or unframed signals, see "Setting up the DSn Receiver" on page 527.

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

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Setting Up GFP/LAPS Receive Interface

If your instrument has Next Generation SDH functionality, you can set up an Ethernet over SDH signal using either **Generic Framing Procedure (GFP)** or **Link Access Procedure SDH/SONET (LAPS)** framing protocols. In both cases you can chose to use the parameters defined by the relevant protocol specification or set your own custom parameters. Once the GFP or LAPS headers have been set up you can set the Ethernet payload.

The following procedures assume that you have already set up the SDH signal rate on the receiver.

For more information, see:

- "Monitoring GFP Signals using G.7041 Protocol" on page 199
- "Monitoring a Custom GFP Signal" on page 200
- "Monitoring LAPS Signals using X.86 Protocol" on page 201
- "Monitoring a Custom LAPS Signal" on page 201
- "Monitoring Ethernet over SDH Payloads (EOS)" on page 203

Monitoring GFP Signals using G.7041 Protocol

You must set up the SDH receiver before setting up the GFP header.

To monitor a signal using G.7041 (GFP) protocol

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > GFP/LAPS** then press **<Select>**.
2. Select the **GFP** Transport Protocol.
3. Select the **G.7041** protocol.
4. Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames (PTI=000) or Client Management Frames (PTI=100).
5. Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.
6. Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. If EXI is set to Linear Frame you

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can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. Transparent mode is only available when the selected mapping is AU-4-16c

8 Set the Ethernet Settings and complete the payload settings. See "Monitoring Ethernet over SDH Payloads (EOS)" on page 203.

Monitoring a Custom GFP Signal

You must set up the SDH receiver before setting up the GFP signal.

To monitor a custom GFP signal

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

2 Select the **GFP** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames or Client Management Frames and can be configured to any 3 bit value.

5 Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.

6 Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. You can also enter a value from the range 0000 to 1111. If EXI is set to Linear Frame you can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. If the PTI=100 the UPI can be configured to mean Client Signal Fail, either Loss of Client Signal (0000 0001) or Loss of Character Synchronization (0000 0010).

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8 Set the Ethernet Settings and complete the payload settings. See "Monitoring Ethernet over SDH Payloads (EOS)" on page 203.

Monitoring LAPS Signals using X.86 Protocol

You must set up the SDH receiver before setting up the LAPS header.

To monitor signal using X.86 (LAPS) protocol

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

2 Select the **LAPS** Transport Protocol.

3 Select the **X.86** protocol.

4 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

5 Set the Ethernet Settings and complete the payload settings. See "Monitoring Ethernet over SDH Payloads (EOS)" on page 203.

Monitoring a Custom LAPS Signal

You must set up the SDH receiver before setting up the LAPS header.

To monitor a custom LAPS signal

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

2 Select the **LAPS** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Service Access Point Identifier **(SAPI)**. The SAPI can be any 4 digit hexadecimal value.

5 Select the **Address**. The address can be any 2 digit decimal value.

6 Select the **Control**. The control can be any 2 digit decimal value.

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7 Select the **FCS Length**. The length can be either 32 or 16 bit.

8 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

9 Set the Ethernet Settings and complete the payload settings. See “Monitoring Ethernet over SDH Payloads (EOS)" on page 203.

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Monitoring Ethernet over SDH Payloads (EOS)

If your instrument has Next Generation SDH functionality, you can monitor an Ethernet over SDH signal using either GFP or LAPS transport protocols. The following procedure assumes that you have already set up SDH receiver with an SDH signal rate and the GFP or LAPS Transport Protocol.

To monitor Ethernet over SDH

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Ethernet** then press **<Select>**.
2. Select each of the **Ethernet Header** settings. Enter the Destination and Source Addresses. A warning message will be displayed when either a Broadcast address (FF-FF-FF-FF-FF-FF-) or a Multicast address (where there is a '1' in right most bit of address byte one, for example x1-xx-xx-xx-xx-xx, x3-xx-xx-xx-xx-xx, etc) is set.
3. Check the **Tagged** checkbox to transmit Tagged Ethernet. User Priority and VLAN fields are only enabled when the **Tagged** option is checked.
4. Enter the **User Priority**. The User Priority values range from 0 to 7.
5. Enter the **VLAN**. The VLAN values range from 0 to 4094.
6. Enter the **Length/Type**. Lengths are interpreted by values of 0 to 1500, Types are interpreted by values greater of equal to 1536. Values between 1501 and 1535 are undefined.

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Monitoring DSn Payloads in an SDH Signal

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

DSn Payload	Monitored in an SDH Tributary
DS1	TU-11 or TU-12
DS3	VC-3

For more information, see:

- "Monitoring VC-3/4 Tributary Payloads" on page 197

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Dropping a DSn Payload from an SDH Signal

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

You should 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 an SDH signal rate and test pattern.

Payload	Drop Port	Dropped from SDH Tributary
DS1	DS1 Out (Siemens)	TU-11 or TU-12
DS3	2-140 Mb/s DS3 Out (BNC)	VC-3

To drop a DS1 payload from an STM-16

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

2 Select the **VC-11** 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 choosing the appropriate **AUG**s, **TUG**s and **TU**s.

4 Select the **Drop DS1** 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.

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Monitoring PDH Payloads in an SDH Signal

You can monitor an asynchronously mapped 2, 34 or 140 Mb/s PDH payload in an SDH signal.

PDH Payload	Inserted into SDH Tributary	Mapping
2 Mb/s	TU-12	Async or Floating Byte
34 Mb/s	VC-3	Async
140 Mb/s	VC-4	Async

For more information, see:

- "Monitoring VC-3/4 Tributary Payloads" on page 197

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Dropping a PDH Payload from an SDH Signal

You can drop an asynchronously mapped 2, 34 or 140 Mb/s PDH payload from the tributary of a SDH signal.

You should obtain balanced signals at the 2 Mb/s Out port (Bantam 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 an SDH signal rate and test pattern.

Payload	Drop Port	Dropped from SDH Tributary
2 Mb/s	2 Mb/s Out (Bantam) or 2-140 Mb/s DS3 Out (BNC)	TU-12
34 Mb/s	2-140 M/s DS3 Out (BNC)	VC-3
140 Mb/s	2-140 M/s DS3 Out (BNC)	VC-4

To drop a 2Mb/s payload from an STM-16

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

2 Select the **VC-12** 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 choosing the appropriate **AUG**s, **TUG**s and **TU**s.

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.

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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 SDH signal. You can listen to the voice channel on the instrument's internal speaker.

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

To drop a voice channel to the internal speaker

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > PDH/DSn** then press **<Select>**.
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, select the appropriate volume level. Select **Close**.

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Selecting SDH Receiver Trigger Outputs

You can select from a range of different triggers associated with receiver events. The triggers associated with the SDH frame bytes are output in the form of pulses. The triggers associated with alarms are output in the form of a level change.

For information on SDH Receiver trigger events see:

- "SDH/SONET Receiver Trigger Outputs" on page 676

This procedure assumes you have set up the SDH receiver.

To select a trigger condition

1. Press **<Menu>**, choose **Test Functions > Trigger Output** then press **<Select>**.
2. In the **Receive Trigger** field, select the **Type** of trigger from **Start of Frame, Error** or **Alarm**.
3. If you have chosen Error or Alarm, you can select the part of the overhead in which the alarm or error occurs. Also, you can select the error or alarm condition required for the trigger.

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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 211
- "Overhead Overwrite Thru Mode" on page 212

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.

If jitter functionality is fitted, you can add jitter to signals in 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**.

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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.

For virtual concatenation (VCAT) signals overhead overwrite applies to the foreground VCAT signal member only. If a low order path is selected in the receiver, the low order path overhead can selected for overwrite as well as the associated high order path.

▶ **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.

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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

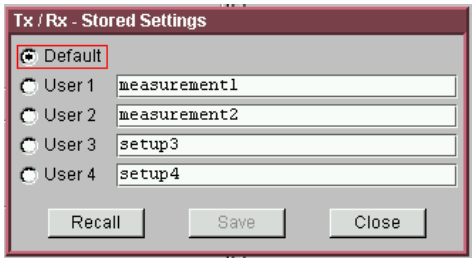
1 Press **<Menu>**, choose **System > Stored Settings** then press **<Select>**.

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 **System > 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**.

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Measurements and Results

Error, Alarm and Pointer Monitoring

- "Viewing SDH Errors" on page 216
- "Monitoring SDH Alarms" on page 219
- "Monitoring AU or TU Pointer Values" on page 220
- "Viewing Errors and Alarms Using Trouble Scan" on page 221
- "Viewing GFP, LAPS and Ethernet over SDH Errors and Alarms" on page 224

Jitter and Wander

- "Measuring Jitter Tolerance" on page 226
- "Measuring Wander Tolerance" on page 235
- "Measuring Jitter Transfer" on page 237
- "Viewing Jitter/Wander Measurement Results" on page 241

Signal/Network Measurements

- "Measuring Optical Power" on page 243
- "Measuring Frequency" on page 244
- "Viewing the ITU Analysis of SDH Errors and Alarms" on page 245
- "Measuring Service Disruption Time in an SDH Network" on page 246
- "Measuring GFP, LAPS and Ethernet over SDH" on page 248

Results Logging

- "Viewing Results Graphically" on page 563
- "Measurement Logging" on page 559
- "Shortcuts to Results, Measurements and Stored Settings" on page 65

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Viewing SDH Errors

You can view errors using the procedures listed below:

- "Viewing SDH Errors (Total or Last Second)" on page 216
- "Viewing the SDH Summary of Errors" on page 217
- "Viewing Errors/Alarms using the <Show More> Key" on page 218

Viewing SDH Errors (Total or Last Second)

You can monitor errors in an SDH signal during testing.

Refer to the technical specifications (available on the instrument website) for full details of errors results. You can view errors on the instrument as **Total** or **Last Second** results.

Total Results The instrument 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 are updated every second. A last second result is the number of errors occurring in the last second.

NOTE

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

To add TCM errors and alarms, first enable the high/low order TCM feature:
1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > SDH** then press **<Select>**.
2. Select **TCM High** and **Low Order**.

▶ **To view error results**

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

2 Select the **Error Type**.

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Viewing the SDH 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 technical specifications (available on the instrument website) for full details of available errors.

▶ **To view the error summary**

1 Press **<Menu>**, choose **Results > Errors and Alarms > SDH** then press **<Select>**. Select the **Error Summary** tab.

2 Select the **Error Type** to be displayed.

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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 displays 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 **SDH** tab.

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Monitoring SDH Alarms

You can monitor alarms in an SDH signal during testing. See the technical specifications (available on the instrument website) 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).

For more information see:

- "Summary of Errors and Alarms" on page 616

NOTE

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

To add TCM errors and alarms, first enable the high/low order TCM feature:
1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > SDH** then press **<Select>**.
2. Select **TCM High** and **Low Order**.

To view alarm seconds results

1 Press **<Menu>**, choose **Results > Errors and Alarms > SDH** then press **<Select>**. Select the **Alarm Seconds** tab.

2 Select the **Alarm Type**.

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Monitoring AU or TU Pointer Values

You can monitor AU and TU pointer values in the SDH 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 > Pointers** then press **<Select>**.

2 Set **Pointer Type** to **AU** or **TU**, as required.

You can also view a graph of the relative offset between pointer values. The graph also shows the timing relationship of pointer movements during the measurement.

For more information, see:

- "Viewing Results Graphically" on page 563

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Viewing Errors and Alarms Using Trouble Scan

You can use Trouble Scan to continuously monitor errors and alarms in a SDH 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	B1
2	B2
3	B3
4	CV-V
5	V5
6	Frame Errors (A1A2)
7	Payload: near-end errors except Bit
8	MS-REI
9	HP-REI
10	IEC
11	LP-REI
12	LP-RFI
13	Bit for bulk filled payloads
14	Payload: far-end errors and Bit

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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.

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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.

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Viewing GFP, LAPS and Ethernet over SDH Errors and Alarms

If your instrument has Next Generation SDH functionality, you can monitor GFP, LAPS and Ethernet errors. You can also monitor GFP and LAPS alarms in a SDH signal.

For more information, see:

- "Viewing GFP, LAPS and Ethernet errors" on page 224
- "Viewing GFP and LAPS alarms" on page 225

Viewing GFP, LAPS and Ethernet errors

You can monitor errors in an SDH signal during testing. Refer to the technical specifications (available on the instrument website) for full details of errors results. You can view errors on the display as **Total** or **Last Second** counts or ratios.

▶ **To view the GFP and LAPS errors**

1 Press **<Menu>**, choose **Results > Errors and Alarms> GFP/LAPS** then press **<Select>**.

2 Select the appropriate tab.

3 Select the **Error Type** if available.

▶ **To view Ethernet errors**

1 Press **<Menu>**, choose **Results > Error and Alarms > Ethernet** then press **<Select>**.

2 Select the appropriate tab.

3 Select the **Error Type** if available.

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Viewing GFP and LAPS alarms

You can monitor alarms in an SDH signal during testing.

To view GFP and LAPS alarms

1 Press **<Menu>**, choose **Results >Errors and Alarms > GFP/LAPS** then press **<Select>**.

2 Select the appropriate tab.

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Measuring Jitter Tolerance

You can measure jitter tolerance if the instrument has jitter functionality fitted. Jitter tolerance is the ability of a network element to withstand jitter without introducing errors into the output signal. The instrument provides jitter tolerance measurements within the masks as specified in the relevant ITU-T standards.

Jitter Tolerance Modes

The jitter **auto-tolerance** measurement increases the jitter amplitude until the point of failure, repeating the analysis at a range of frequencies. The results are plotted alongside the selected tolerance mask, showing the margin by which the network element differs from the mask. A failure is indicated if a measured point falls below the mask. *Note that this measurement can take a variable amount of time for each test point.*

Fast auto-tolerance verifies that the network element conforms to the selected tolerance mask. The frequency/amplitude values are set precisely to the values defined by the tolerance mask. At each frequency point, the receiver is checked against the defined performance criteria. The results are used to determine whether the network element has passed or failed against the selected tolerance mask. *Note that fast auto-tolerance mode allows a predictable test time.*

Sweep mode is an automatic jitter generation mode. In this mode the instrument generates jitter at a range of frequencies, with the amplitude defined by the selected tolerance mask. *Sweep mode does not provide any measurement results.*

Spot mode is a manual jitter generation mode, where the user selects spot frequencies at an amplitude defined by the selected tolerance mask. This can be useful for identifying any swept mask problem areas that needs further analysis. *Spot mode does not provide any measurement results.*

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NOTE The auto-tolerance and fast auto-tolerance measurements are not available when the instrument is in Thru Mode or when the receiver interface is configured to measure and electrical clock or electrical data.

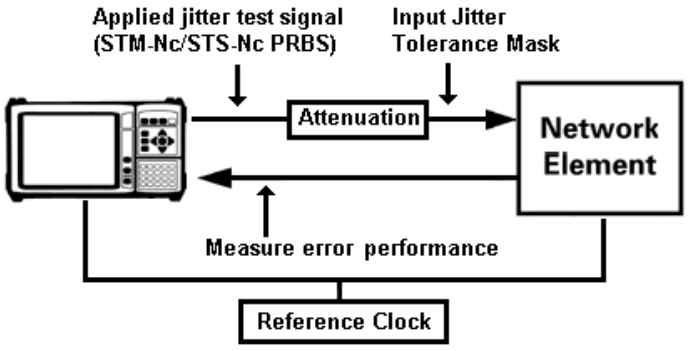
Active alarms will results in termination of the measurement and the test will record a failure, unless **Ignore Alarms** checkbox is checked.

NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

Jitter Tolerance Criteria

You can measure jitter tolerance using either the **BER Penalty** method or the **Onset of Errors** method as specified in the relevant standards.

Jitter Tolerance Measurement Setup



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BER Penalty Method

This method checks the number of bit errors against the selected error threshold at each amplitude point.

Set up the OmniBER transmitter and receiver as required, including the test pattern, before starting this procedure. When testing a regenerator, set the Transmitter and Receiver to the same line rate as the input line interface-under-test. When testing a multiplexer, set the Transmitter to the tributary rate and the Receiver to the aggregate line rate. When testing a demultiplexer, set the Transmitter to the aggregate line rate and the Receiver to the tributary rate (e.g. set the Transmitter to STM-16 with embedded STM-1 and set the Receiver to STM-1).

Use an external optical attenuator to keep optical power at optimum level if you are performing tests on optical signals. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 243

To set up the BER Penalty method for jitter tolerance

1. Connect the OmniBER to the device-under-test.
2. Ensure that there are no errors detected in the OmniBER receiver.
3. With no jitter applied, set the optical attenuator to obtain a defined error-rate (of at least 100 bit errors per second). Use this same error-rate when setting up the OmniBER jitter tolerance test.
4. Reduce the attenuation by 1dB.
5. Measure the jitter tolerance using the following procedure.

Automatic Jitter Tolerance Testing

The jitter amplitude at which the defined error threshold is reached is plotted on the graph as the jitter tolerance for that jitter frequency. The measurement is repeated for a range of test frequencies, according to the tolerance mask selected.

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To measure jitter tolerance using BER Penalty method

1 Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.

2 Set **Type** to **Jitter** and set **Mode** to **Fast** or **Auto**.

3 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset mask or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 232). Enter the mask **Start** and **Stop** frequency values (Hz).

4 In the **Error Threshold** fields:

- set **Mode** as **BER Penalty**
- in the **Source** field select what type of errors you want to detect during the measurement
- check the **Ignore Alarms** checkbox if you want the measurement to ignore all alarms (except LOS, LOF, OOF)
- in the **Count** field set the number of errors in the gating period you want to use as a threshold in the measurement

5 Select the **Settling** (delay between the jitter being applied and the error measurement being made) and **Gate** (period of error measurement at each frequency point) timing (s).

6 Select **Start**. View the results by selecting from **Status**, **Graph** or **Table** format. When viewing the results table, you can select **Prev Page** or **Next Page** to move between results pages. You can select **Stop** to stop the measurement.

7 Check there is a floppy disk in the drive. From the Table display select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box. (Only available in Auto/Fast Mode.)

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Onset of Errors Method

This method determines the jitter amplitude at which the number of errored seconds exceeds the specified threshold. The jitter amplitude at which the defined error threshold is reached is plotted on the graph as the jitter tolerance for that jitter frequency. The measurement is repeated for a range of test frequencies, according to the tolerance mask selected.

Set up the OmniBER transmitter and receiver as required, including the test pattern, before starting this procedure.

▶ **To perform the Onset of Errors method for jitter tolerance**

1 Connect the OmniBER to the device-under-test.

2 Ensure that there are no errors detected in the OmniBER receiver.

3 Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.

4 Set **Type** to **Jitter** and set **Mode** to **Fast** or **Auto**.

5 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset mask or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 232). Enter the mask **Start** and **Stop** frequency values (Hz).

6 In the **Error Threshold** fields:

- set **Mode** as **Onset of Errors**
- check the **Ignore Alarms** checkbox if you want the measurement to ignore all alarms (except LOS, LOF, OOF)
- in the **Errored Seconds** field set the number of errored seconds you want to use as a threshold in the measurement. The default number of errored seconds is 2.

7 Select the **Settling** (delay between the jitter being applied and the error measurement being made) and **Gate** (period of jitter generation at each frequency point) timing (s). The **Gate** default is 30s.

8 Select **Start**. View the results by selecting from **Status**, **Graph** or **Table** format. When viewing the results table, you can

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select **Prev Page** or **Next Page** to move between results pages. You can select **Stop** to stop the measurement.

9 Check there is a floppy disk in the drive. From the Table display select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box. (Only available in Auto/Fast Mode.)

Spot Mode Settings

To set up Spot Mode

1 Set **Mode** to **Spot**.

2 In the **Input Mask** area, select a preset **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 232).

3 Enter the **Frequency (Hz)**.

4 Select **Start**.

Sweep Mode Settings

To set up Sweep Mode

1 Set **Mode** to **Sweep**.

2 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 232). Enter the mask frequency **Start** and **Stop** values (Hz), or select the default min and/or max values.

3 Select the **Settling** (delay between the jitter frequency/amplitude being applied and the error measurement being made) timing (sec).

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Defining a User Mask

The jitter standards specify the lower limit of maximum tolerable input jitter in the form of a mask. The measured input jitter tolerance of the network element must be greater than that of the mask specified by the relevant standard.

The instrument allows you define up to 10 user masks. These are displayed in both graph and table format.

To open the user mask setup window

1 Press the **<Smart Test>** button and select **Jitter/Wander Tolerance**.

2 Set **Type** to **Jitter**.

3 Select **Edit User Masks...** button.

NOTE Note that you can not edit a user mask that is currently being used in a jitter tolerance or transfer measurement.

To create or edit a User Mask

1 In the **Manage Masks** fields, select **New** or choose a mask from the drop-down list.

2 For a new mask, enter the **Title** (Max 15 characters) using the instrument keypad. Press **<Select>**.

3 In the **Mask Points** fields, select **Add...** to add a point to the mask. Enter the **Frequency (Hz)** and **Amplitude (UI),** then select **OK**. The new point appears in the table to the right of display.

4 Select **Delete...** to delete a point; the Delete point window lets you choose which point number you want to delete.

5 Select **Edit...** to change the frequency/amplitude of a point.

6 You can also shift a mask by a percentage amount. This shift applies to all the points. The shift increases or decreases the amplitude of the point at each frequency. In the **Shift Mask** field select the required percentage change (positive or

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negative) and then select **Shift** to apply the change. The graph and table on the right reflect the change.

7 If the list of points extends beyond the end of the table, use **Prev Page** and **Next Page** to view the rest of the listed points.

8 Select **Close** when you have finished defining the mask.This saves the mask.

NOTE If any points on the selected mask are not within the capability of the transmitter, the maximum possible amplitude will be output and a warning message will be displayed on the Status line at the bottom of the screen.

To copy a User Mask

1 In the **Manage Masks** field, select **New**.

2 Move into the **Title** field and type in the name of your mask using the instrument keypad and press **<Select>**.

3 Select the **Copy...** button.

4 In the **Copy User Mask** window, select the mask you want to copy to your new mask. Select **OK**. The selected mask is now copied to your newly named mask.

5 To refine the mask, you can:
Select **Shift Mask** - Enter a plus or minus percentage value to change all the amplitude values of the mask. Select the **Shift** button.
Select **Add...** - Enter the **Frequency (Hz)** and **Amplitude (UI)** of a point, then press **OK** to add a point.
Select **Delete**... - Select the point number (refer to mask table to right of display) you want to delete, then press **OK**.
Select **Edit...** - Select the point number (refer to mask table to right of display) that you want to change. Change the **Frequency (Hz)** and/or **Amplitude (UI)**, then select **OK**.

6 If the list of points extends beyond the end of the table, use **Prev Page** and **Next Page** to view the rest of the listed points.

7 Select **Close** when you have finished copying the mask.

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To delete a User Mask

1 In the **Manage Masks** field select a mask from the drop-down list.

2 Select the **Delete** button.

3 Select **Close** to close the **User Masks** window.

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Measuring Wander Tolerance

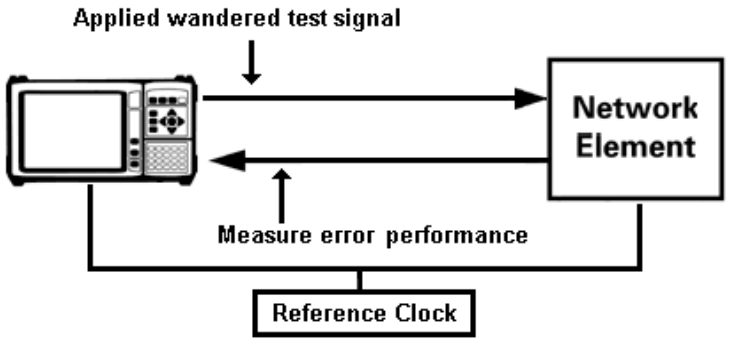
Wander tolerance is the ability of a network element to withstand wander without introducing errors into the output signal. You can measure Wander Tolerance using the instrument, if jitter/wander is fitted. The instrument provides wander tolerance measurements (using sinusoidal modulation) within the chosen mask. Masks are as specified in the relevant ITU-T standards. The instrument automatically selects the appropriate amplitude for the selected frequency. A wandered signal is applied to the device-under-test to check that its performance is with in the specified limits.

This procedure assumes that you have set up the transmitter and receiver as required, including the required test **Pattern**. Make sure the interface settings match the network equipment.

Check optical power before making the measurement, to ensure accuracy. For information, see:

- "Measuring Optical Power" on page 243

Wander Tolerance Measurement Setup



NOTE Wander Tolerance measurements are not available when the instrument is in Thru Mode.

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NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

To measure Wander Tolerance

1. Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.
2. Select **Type** as **Wander**.
3. In the **Mask** setup area, select a preset input mask from the list.
4. Enter the mask **Frequency** value. The mask amplitude will automatically be calculated.
5. Select **Start** to apply the wander.

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Measuring Jitter Transfer

You can measure jitter transfer if the instrument has jitter functionality fitted. Results are given in either graphical form (Gain versus Frequency) or tabular form.

Jitter transfer is the ratio of output jitter amplitude to input jitter amplitude versus jitter frequency for a given bit rate. For example, in a regenerator where the device output is loop-timed from the input, some of the jitter present at the input port of the regenerator will be transferred to the output port. On networks with cascaded equipment on long trunk routes it is important to limit jitter transfer to avoid accumulation of errors.

For the jitter transfer measurement, first use a default 5s Gate time (the time spent at each measurement point) and 5s Settling time (the time between jitter being applied and the measurement beginning, during which the unit under test is settling). Then increase to a 10s Gate time and 20s Settling time, to optimize measurement accuracy against the overall measurement duration. Automatic band filtering is used in the jitter receiver, providing selection and measurement of the relevant jitter components to provide accurate and repeatable results.

You must perform a back-to-back calibration run before making the jitter transfer measurement via the device-under-test.

NOTE Jitter transfer measurements are not available when the instrument is in Thru Mode.

NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

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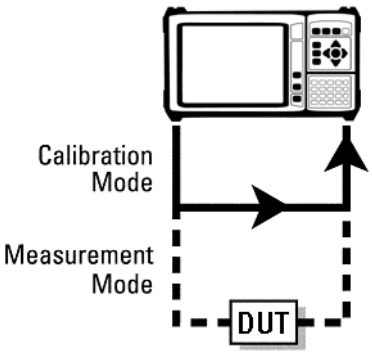
Pre-Measurement Calibration

Connect the instrument in a loopback configuration (Optical-to-Optical or Binary-to-Binary) and perform a calibration cycle before making a jitter transfer measurement.

Set up the Transmitter and Receiver as required, before completing this procedure. For example, when testing a regenerator, set the Transmitter and Receiver to the same line rate as the input line interface-under-test.

Add an optical attenuator between the IN and OUT ports of the optical module, to keep optical power at optimum level. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 243



NOTE Switch on the instrument for at least 1 hour before starting a calibration cycle. The climatic conditions must remain stable from switch-on until the end of the measurement, for accurate results.

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To calibrate the instrument

1 Press **<Smart Test>**, choose **Jitter Transfer** then press **<Select>**.

2 In the Input Mask setup area, select the number of **Test Points**. Select a preset input mask or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (for more information, see "Defining a User Mask" on page 232).

3 Enter the mask frequency **Start** and **Stop** values (Hz).

4 Select the **Settling** and **Gate** (measurement period) timing (sec).

5 In the **Run Type** field, select **Calibration**.

6 Select **Start**. The status of the calibration run is displayed. When the calibration has finished, complete the jitter transfer measurement (see "Jitter Transfer Measurement" on page 240). You can select **Stop** to stop the calibration before it has finished.

NOTE During calibration and measurement of jitter transfer the instrument goes into a locked state. This stops the user from changing the instrument settings which would make the calibration or measurement invalid. If you want to perform measurements other than jitter transfer then select the 'Release Instrument Lock' button and proceed.

NOTE It is recommended that the maximum test period (from the start of calibration to the end of the measurement) does not exceed 90 minutes, otherwise the accuracy specification cannot be guaranteed.

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Jitter Transfer Measurement

NOTE Start the jitter transfer measurement within 10 minutes of completion of the calibration cycle.

To measure jitter transfer

1. Remove the loopback configuration from the interfaces. Connect the instrument to the device-under-test.
2. You can select a **Pass Mask** to compare the measurement results with. Also, you can add an offset to the Pass Mask, by selecting a preset **Offset** or entering a user-defined offset.
3. Select **Start** to make the measurement. The results are provided in **Graph** (Gain versus Frequency) or **Table** format. You can select **Stop** to stop the measurement.
4. Check there is a floppy disk in the drive. Select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box.

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Viewing Jitter/Wander Measurement Results

You can view jitter and wander measurement results if the instrument has jitter functionality fitted. The results shown depend on the Test Function **Mode** (jitter or wander) selected.

Viewing Jitter Measurement Results

Jitter unlock (JUL) and jitter over range (JOR) are indicated by the front panel jitter LED. Details of these jitter alarms are given when you press the **<Show More>** key on the instrument's front panel, shown as general alarms. Also jitter alarms are displayed on the results page (see below for details of how to view the jitter results page).

The instrument displays the jitter hit results. Jitter hits are detected when the programmable thresholds for positive and negative jitter values are exceeded. The detector is reset when the jitter level falls below 75% of the hit threshold. Positive and negative jitter hit counts are also included in Trouble Scan.

'Total' and 'Last Second' amplitude results are displayed for each of the active receiver measurement bandwidths.

To view Jitter results

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

See "Monitoring Jitter on an SDH Signal" on page 176 for information on setting up the receiver for jitter measurements.

JUL and JOR Alarm Conditions

Jitter Unlock (JUL) can be set if the jitter receiver loses lock while measurements are being made. This can happen if Loss of Line Clock occurs at the binary clock input, if the line clock is outside the specified frequency range for the line rate or if Loss of Electrical Data occurs at the binary data interface input. JUL

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can also occur if there is Loss of Optical Data at the Optical Data input, this causes LOS alarm to be set (in 'Optical Data' jitter measurement mode), which automatically sets JUL.

The Jitter Overrange (JOR) is designed to prevent measurements being presented to the user if the instrument is measuring in a non-linear state due to high input Jitter levels. The 'HP Filters Off' path is the most likely to detect excessively high input jitter levels and is kept running even when High Path Filters is selected. This means that the JOR alarm may be raised, even though Jitter results displayed on screen may are within the specified range. If JOR is asserted, try increasing the Jitter measurement range until JOR is de-asserted.

Viewing Wander Measurement Results

Wander reference unlock is indicated on the Results page and when you press the **<Show More>** key on the instrument's front panel. The instrument displays Alarm Seconds, Time and Amplitude results.

TIE (Time Interval Error) represents the time deviation of the clock signal under test, relative to the reference source. Real-time TIE results are displayed during a measurement period. MTIE (Maximum Time Interval Error) is the largest peak-to-peak TIE observed during the measurement period.

The Time/Amplitude results (TIE/MTIE) include TIE, +ve Peak, -ve Peak, Peak-Peak, Frequency Offset, Frequency Drift.

External PC software is available that provides off-line analysis of MTIE/TDEV (Time Deviation) wander measurements.

To view Wander results

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

See "Monitoring Wander on an SDH Signal" on page 177 for information on setting up the receiver for wander measurements.

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Measuring Optical Power

You can continuously measure the optical power of the optical signal connected to the selected (active) Optical In port.

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

To measure optical power

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

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.

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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 > Frequency Meas** then press **<Select>**.

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Viewing the ITU Analysis of SDH Errors and Alarms

You can view the ITU analysis of errors and alarms.

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

For more information on these standards, see:

- "Introducing ITU Performance Analysis" on page 604

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.

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Measuring Service Disruption Time in an SDH 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. Protection switching allows the network to continue earning revenue even when equipment fails.

For more information, see "Test Configuration for Measuring Service Disruption Time" on page 689.

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 > Service Disruption** then press **<Select>**.
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 688.

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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 a pure protection-switching measurement, it is closely tied to these types of measurements as it is activated as a result of any physical layer failure, such as a fiber break.

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Measuring GFP, LAPS and Ethernet over SDH

If your instrument has Next Generation SDH functionality, you can monitor GFP, LAPS and Ethernet measurements in a SDH signal.

Viewing GFP, LAPS and Ethernet measurements

You can monitor measurements in an SDH signal during testing.

Refer to the technical specifications (available on the instrument website) for full details of measurements. You can view measurements on the display as **Total** or **Last Second** counts.

To view the GFP and LAPS measurements

1 Press **<Menu>**, choose **Results > Network Measurements> GFP/LAPS** then press **<Select>**.

2 Select the appropriate tab.

3 Select the **Error Type** if available.

To view Ethernet measurements

1 Press **<Menu>**, choose **Results > Network Measurements > Ethernet** then press **<Select>**.

2 Select the appropriate tab.

3 Select the **Error Type** if available.

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3
Instrument Setup and Use - SONET

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Measurements and Results 357

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

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Setting up the SONET Transmitter

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- "Adding Frequency Offset to the SONET Signal" on page 259
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Overhead

- "Generating Trace Messages" on page 263
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Errors/Alarms, Trigger Outputs and Pointer Movement

- "Adjusting SPE or VT Pointer Values" on page 277
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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 254
- "Setting up the Electrical SONET Transmit Interface" on page 254
- "Transmitting an Unframed Signal" on page 255
- "Coupling the Receiver to the Transmitter Settings" on page 257
- "Storing and Recalling Instrument Settings" on page 355

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Setting up the Optical SONET Transmit Interface

SONET optical signals are output on the Optical Out connectors.

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 257.

Also, on power up the transmitter will re-establish the laser settings (enabled or disabled) that existed prior to the last power down.

WARNING

Always switch off the laser before connecting or disconnecting optical cables. Read the laser warning information 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 > Physical** then press **<Select>**.
2. Set the **Signal Mode** to be **SONET**.
3. Select a Signal Rate. All SONET line rates are output optically except for STS-1 and STS-3, which are output electrically.
4. Select a **Wavelength** (if dual wavelength option is fitted).
5. 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

SONET electrical STS-1 and STS-3 signals are output on the SONET/SDH BNC Out port.

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

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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 257.

To set up the electrical SONET Transmit interface

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

2 Set **Signal Mode** to **SONET**, then set the rate to **STS-1** or **STS-3**. This is automatically output electrically.

Transmitting an Unframed Signal

You can transmit an signal which has no framing and is simply a repeating pattern. The patterns can be inverted or non-inverted.

To transmit an unframed signal

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

2 Set the **Signal Mode** to **Unframed**.

3 Select a **Signal Rate**.

4 Select the **Pattern** tab**.**

5 Select the **Pattern** and its polarity.

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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 2^n-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.

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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**.

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Selecting the SONET Transmit Clock Source

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

▶ **To select the transmit clock source**

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

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Adding Frequency Offset to the SONET Signal

You can apply frequency offset 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.

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Generating Jitter on a SONET Signal

You can add jitter to the transmitted SONET signal, if the instrument has jitter functionality fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SONET signal.

To generate jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the transmit **Mode** to **Jitter**.
3. In the **Jitter** setup field, select the jitter **Source** (**Internal** or **External**). For an **External** jitter source, connect the external source to the External Modulation Input connector.
4. For an **Internal** jitter source, enter the **Modulation Frequency** (**Hz**) and the **Amplitude** (**UI**). Press the **<Select>** key when you have finished.

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Generating Wander on a SONET Signal

You can add wander to the transmitted signal, if the instrument has jitter fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SONET signal.

To generate wander

1 Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.

2 Set the transmit **Mode** to **Wander**.

3 In the **Wander** setup field, select the **Modulation Frequency** (Hz) and the **Amplitude** (UI). Press the **<Select>** key when you have finished.

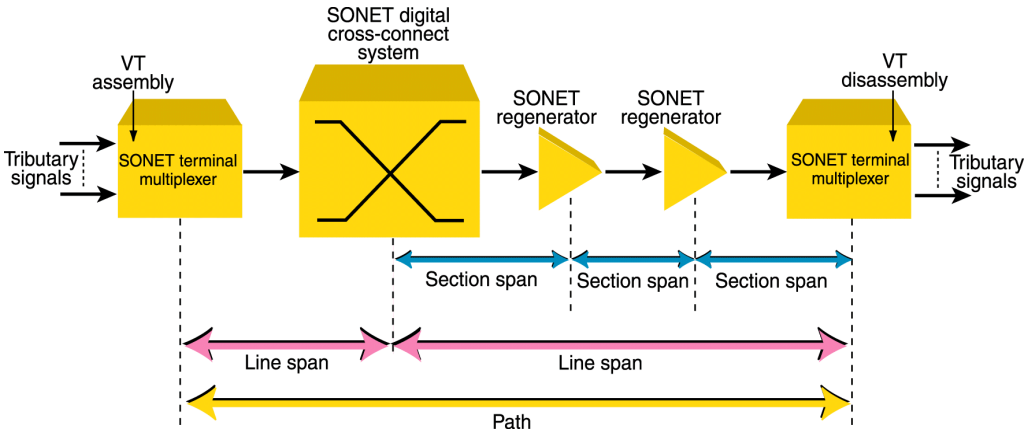
NOTE Wander generation is not available when the instrument is in Thru Mode or OTN.

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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 645
- "Line Overhead (LOH)" on page 646
- "SONET Concepts" on page 641

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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 or fixed byte (section overhead).

When virtual concatenation (VCAT) is selected a separate J1 (high order) or J2 (low order) trace message can be set up in each member of the VCAT group. Alternatively, you can have the same trace message in all the VCAT members.

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. If VCAT is selected in the transmitter:
   1. Check the **Channel Specific** checkbox to allow you to set up different trace messages in each of the VCAT members. If this checkbox is not selected, the same trace message is copied to all VCAT members.
   2. To set up the different trace messages move the highlight to the more button and press **<Select>**.
   3. Use the arrow keys to select the VCAT member whose trace message you want to edit and press **<Select>**. Close the window.
3. Select the byte format as required.
4. Select the trace message field, then press **<Select>**.
5. 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. Select the CR and LF characters by cycling the “1” key.

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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 652

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Generating Path Signal Labels

You can assign a STS path signal label to the C2 byte to reflect the current SPE payload mapping. The C2 signal label value set up is transmitted in all virtual concatenation (VCAT) members.

You can also 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.

In addition, when virtual concatenation is selected, the V5 byte, bits 5. 6 and 7 defaults to 101 (extended). When extended is set, you can edit the extended signal label carried in Z7 bit 1.

To generate an STS or VT path signal label

1 Press **<Menu>**, choose **Overhead Setup > Labels** then press **<Select>**.

2 In the **Signal Labels** field select the **STS (C2)**, the **VT (V5)** and/or the **VT (Z7)** signal label from the drop down menu as required. When you select a label, its binary value is automatically displayed.

For more information, see:

- “C2 Byte Mapping" on page 654
- “V5 (bits 5 to 7) Signal Label" on page 658
- “Z7 (bit 1) Low Order Extended Signal Label" on page 659

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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 648
- "Ring APS Messages (Telecordia GR-1230)" on page 650.

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**.

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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**.

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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 or the H4 position and sequence indicator for virtual concatenated signals.

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**.

For VCAT signals, if you edit the C2 signal label byte for the foreground signal, this value is copied into the POH of all VCAT members. When VCAT is selected you cannot edit the J2 or Z7 bytes.

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 270.

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

Background settings for VCAT groups

Each VCAT signal consists of several members, one of which is assigned to be the foreground signal. The remaining members are background members. The path overhead (POH) of the background signals are set as follows:

High Order POH Byte	Value
J1	Message set up in trace message setup
B3	Calculated individually for each member
C2	Value set up in signal labels setup (same for all members)
G1	00h fixed
F2	00h fixed
H4	Contains the full H4 VCAT sequence as per G.707
Z3	00h fixed
Z4	00h fixed
N1	00h fixed

Low Order POH Byte	Value
V5	BIP-2 value calculated for each member. Signal label can be set up for each member REI, RFI & RDI bits are set to 0.
J2	Message set up in trace message.
Z6	00h fixed
Z7	Contains the full VCAT sequence as per G.707

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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.

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Generating Active Automatic Protection Switching (APS) Messages

Active Automatic Protection Switching (APS) provides emulation functionality that sets the values of K1 and K2 based on the K1 and K2 values in the received signal.

For more information, see:

- "Generating Automatic Protection Switching (APS) Messages" on page 266

In linear APS mode, you can transmit active or passive APS messages. In passive mode, you can set up any values in the transmitter in the K1 and K2 bytes, independent of the receiver. In active mode, the K1 and K2 byte setting in the transmitter is dependant on the K1 and K2 bytes setting in the received signal. You can select between two types of active APS. These are unidirectional mode and bidirectional mode and the values in the transmitter K1 and K2 bytes are set up according to the following table.

APS Mode	RX K1	TX K1		TX K2		
	b5-b8	b1-b4	b5-b8	b1-b4	b5	b6-b8
Unidirectional	xxxx	0000	0000	xxxx	user	100
Bidirectional	0000	0000	0000	0000	user	101
Bidirectional	yyyy	0010	yyyy	yyyy	user	101

where xxxx is any 4-bit binary value, user is a user programmable bit and yyyy is any non-zero 4-bit binary value. As an example of how to use the table, in unidirectional mode, if bits 5 to 8 in the K1 byte in the received signal has xxxx as its value then the transmitter sets up the K1 byte as all zeros, the K2 byte, bits 1 to 4, as xxxx; you can set bit 5 and bits 6 to 8 have 100 in them.

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

To generate a linear active APS message

1. Press **<Menu>**, choose **Overhead Setup > APS Messages** then press **<Select>**.
2. Set the **Topology** to **Linear (G.783)** and select **Active (Unidir)**.
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**.

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Setting Up SONET Overhead Sequences

You can insert a sequence of values into a group of SONET overhead bytes (an overhead channel). A sequence consists of up to 256 different elements, each element being the appropriate number of bytes for the selected location.

Sequence Channels	SONET overhead bytes
9-byte channels	D4-D12
6-byte channels	A1-A2 for STS-3 to OC-192
3-byte channels	D1-D3
2-byte channels	A1-A2 for STS-1, H1-H2, K1-K2, M0-M1 (except OC-192 when M1M0 preference selected)
Single byte channels (LOH)	S1, H3, M1 (except OC-192, M1M0 preference selected), E2, unused bytes
Single byte channels (STS POH)	J1, C2, G1, F2, H4, Z3, Z4, N1 (not available when virtual concatenation is selected)

Each element can be transmitted for a variable number of frames, up to 65535. This sequence can then be transmitted as a single run or repeated indefinitely.

The sequence must be stopped before the user can change the value of any element or the number of frames for any element.

You can use the sequences to check that your equipment deals with these bytes in the required way. The setup of these bytes may differ from one manufacturer to the next.

This procedure assumes that you have set up the transmitter to transmit a SONET signal.

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To set up an overhead sequence

1 Press **<Menu>**, choose **Overhead Setup > Sequence Generation** then press **<Select>**. Select the **Channel** tab.

2 Select the **Network Standard** to define the bytes in which the sequence should run.

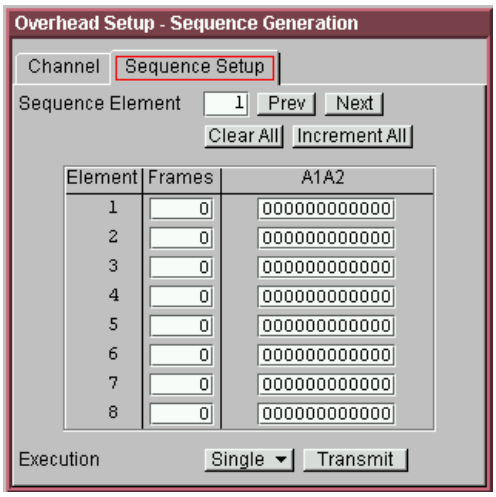
3 Select the **Change**... field.

4 Select the **A1A2 Boundary Function**.

5 Move to the fields in the SONET overhead and press **<Select>** to choose the sequence channel. (When selected, the button is pushed in). Select **Close**.

To set up sequence generation

1 Press **<Menu>**, choose **Overhead Setup > Sequence Generation** then press **<Select>**. Select the **Sequence Setup** tab.



2 Select the **Sequence Element** (values between 1 and 256). The selected element is displayed. You can move through the elements by selecting **Prev** and **Next**.

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3 Enter the number of frames you want the sequence to run for and also the sequence value for that set of frames. (After each entry press **<Select>**).

4 In the **Execution** field select **Single** or **Repeat** and select the **Run Sequence** checkbox to start the sequence running.

A1A2 Boundary Function

The A1 and A2 bytes provide a frame alignment pattern (A1 = F6h and A2 = 28h). In a SONET signal, six of the bytes at the boundary between the A1 and A2 bytes contain the bytes from the STS-3 channels as in the following table:

STS-3n

STS-3 channel #	n-2	n-1	n	1	2	3
Overhead byte	A1#3	A1#3	A1#3	A2#1	A2#1	A2#1

For example, in the case of an STS-12 signal:

STS-3 channel #	2	3	4	1	2	3
Overhead byte	A1#3	A1#3	A1#3	A2#1	A2#1	A2#1

A network element will use some of these bytes (which ones are not defined in the standards, so will vary between manufacturers) to gain and maintain frame synchronization. Therefore the ability to stress test across the boundary is necessary to verify a correct synchronization algorithm within a network element.

The instrument allows you to generate a sequence in the six bytes at the A1A2 boundary as in the table above (select **A1A2 Boundary**) or in a selected channel (select **A1A2 Channel Associated**). **A1A2 Channel Associated** puts the sequence in the three A1 and three A2 bytes of the STS-3 channel you have selected.

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Inserting Messages into the Data Communications Channel (DCC)

You can insert network management messages into the section DCC or the line DCC of a SONET signal.

To insert a message into the DCC of a SONET signal

1. Press **<Menu>**, choose **Test Functions > DCC/GCC Drop/Insert** then press **<Select>**.
2. In the **Transmitter Insert** field, select the DCC channel.

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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 278
- "Selecting a New SPE or VT Pointer" on page 279
- "Selecting SPE or VT Pointer Offset" on page 280

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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**.

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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).

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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.

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Setting Up GFP/LAPS Transmit Interface

If your instrument has Next Generation SONET functionality, you can set up an Ethernet over SONET signal using either GFP or LAPS framing protocols. In both cases you can use the parameters defined by the relevant protocol specification or set your own custom parameters. Once the GFP or LAPS headers have been set up you can set the Ethernet payload.

The following procedures assume that you have already set up the SONET signal rate on the transmitter.

For more information, see:

- "Transmitting GFP Signals using G.7041 Protocol" on page 281
- "Transmitting a Custom GFP Signal" on page 282
- "Transmitting LAPS Signals using X.86 Protocol" on page 283
- "Transmitting a Custom LAPS Signal" on page 283
- "Generating Payloads for Ethernet over SONET (EOS)" on page 298

Transmitting GFP Signals using G.7041 Protocol

You must set up the SONET transmitter before setting up the GFP header.

To transmit a signal using G.7041 (GFP) protocol

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > GFP/LAPS** then press **<Select>**.
2. Select the **GFP** Transport Protocol.
3. Select the **G.7041** protocol.
4. Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames (PTI=000) or Client Management Frames (PTI=100).
5. Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.
6. Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. If EXI is set to Linear Frame you

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can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. Transparent mode is only available when the selected mapping is STS-48c.

8 Set the Ethernet Settings and complete the payload settings.

- See "Generating Payloads for Ethernet over SONET (EOS)" on page 298.

Transmitting a Custom GFP Signal

You must set up the SONET transmitter before setting up the GFP header.

To transmit a custom GFP signal

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

2 Select the **GFP** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames or Client Management Frames and can be configured to any 3 bit value.

5 Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.

6 Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. You can also enter a value from the range 0000 to 1111. If EXI is set to Linear Frame you can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. If the PTI=100 the UPI can be configured to mean Client Signal Fail, either Loss of Client Signal (0000 0001) or Loss of Character Synchronization (0000 0010).

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8 Set the Ethernet Settings and complete the payload settings. See "Generating Payloads for Ethernet over SONET (EOS)" on page 298.

Transmitting LAPS Signals using X.86 Protocol

You must set up the SONET transmitter before setting up the LAPS header.

▶ **To transmit signal using X.86 (LAPS) protocol**

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

2 Select the **LAPS** Transport Protocol.

3 Select the **X.86** protocol.

4 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

5 Select the **Rate Adaption Octets**. If enabled, enter the number of octets.

6 Set the Ethernet Settings and complete the payload settings. See "Generating Payloads for Ethernet over SONET (EOS)" on page 298.

Transmitting a Custom LAPS Signal

You must set up the SONET transmitter before setting up the LAPS header.

▶ **To transmit a custom LAPS signal**

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

2 Select the **LAPS** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Service Access Point Identifier **(SAPI)**. The SAPI can be any 4 digit hexadecimal value.

5 Select the **Address**. The address can be any 2 digit decimal value.

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6 Select the **Control**. The control can be any 2 digit decimal value.Select the **FCS Length**. The length can be either 32 or 16 bit.

7 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

8 Select the **Rate Adaption Octets**. If enabled, enter the number of octets.

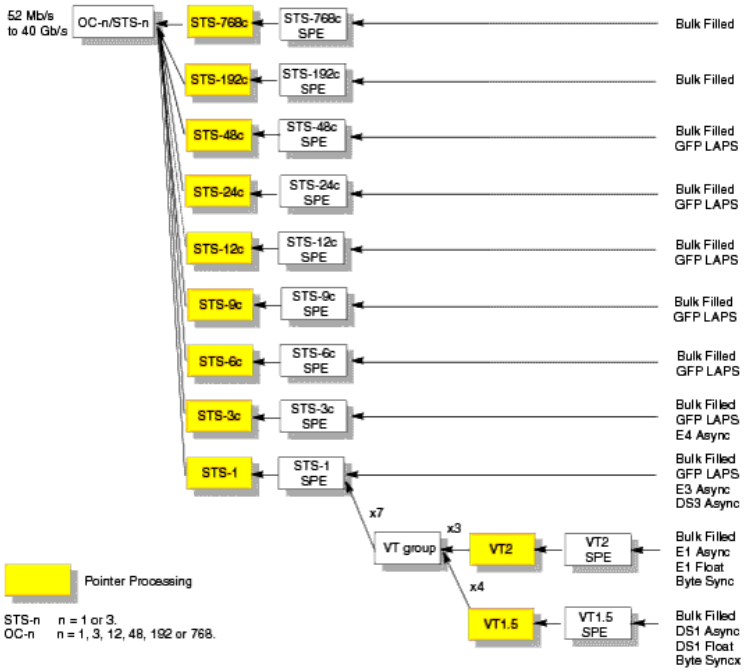
9 Set the Ethernet Settings and complete the payload settings. See "Generating Payloads for Ethernet over SONET (EOS)" on page 298.

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Generating STS-1 SPE and Concatenated Payloads

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



For more information, see:

- "Setting Up Mixed Mappings" on page 292
- "Generating STS-1 SPE Payloads" on page 286
- "Generating Concatenated Payloads" on page 288

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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 291

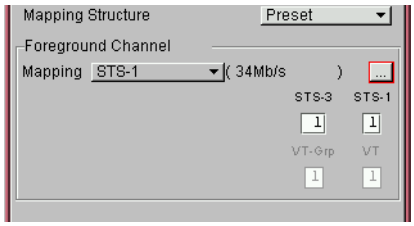
This procedure assumes that you have set up the SONET signal rate and pattern.

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

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SONET** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Set the **Foreground Channel Mapping** to **STS-1, DS3** or **34 Mb/s**, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the DS3 or 34 Mb/s payload by selecting the appropriate **STS** number.

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

6 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > PDH/DSn** then press **<Select>**. 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 461.
For a DS3 framed or unframed signals, see "Setting up the DSn Transmitter" on page 507.

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

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Generating Concatenated Payloads

A concatenated bulk filled 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:

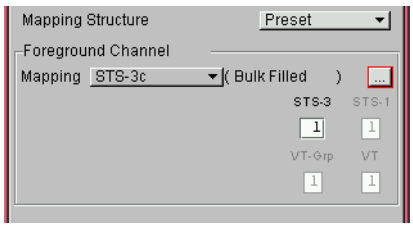
- "PRBS Polarity" on page 291.
- "Reduced Test Time with Concatenated Payloads" on page 290

▶ **To insert a concatenated payload into an OC-48**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SONET** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select a concatenated payload, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the concatenated payload by selecting the appropriate **STS**.

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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

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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.

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Setting Up Mixed Mappings

Using mixed mappings, you can set up your SONET signal with any kind of channel payload configuration you might want to simulate your network. Use the setup window to choose the foreground channel, the channel capacity and the background patterns.

▶ **To configure the payload mappings**

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SONET** then press **<Select>**.
2. Set the **Mapping Structure** field to **Mixed**.
3. Move to the **Mapping Configuration** fields, select the payload and then click on the **High** or **Low Order** more (...) button.
4. In the **Transmitter Mapping Setup** field, use the arrow keys to navigate around the payload channels.
5. Press **<Select>** to choose the channel capacity or to set the selected channel as the foreground channel (highlighted in green).
6. In the **Background Type** field select the pattern that is applied to all the background channels.
7. Select **Close** to close this setup window.

NOTE You can press the Cancel button to exit the mixed mappings window.

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Setting Up Virtual Concatenation

You can configure a virtual concatenated group in the payload of your SONET signal. Use this group to test network equipment designed for virtual concatenation. You can fill the virtual concatenated group with ethernet signals with GFP or LAPS encapsulation.

To configure the virtual concatenation group

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SONET** then press **<Select>**.
2. Select the **VCAT** checkbox.
3. Move to the **Mapping Configuration** fields, select your required mapping and then click on the **High** or **Low Order** more (...) button.
4. In the **Transmitter Mapping Setup** field, use the arrow keys to navigate around the payload channels.
5. In any field, press **<Select>** to add that channel to the virtual concatenation group or to set the selected channel as the foreground channel (highlighted in green). You can choose the channels of the group in any order and the sequence number is automatically incremented.
6. Select the **Validate SQ** checkbox to allow only contiguous sequence (SQ) numbers. Uncheck this box to allow you to set any sequence number for a VCAT member.
7. If you have selected a channel as part of the VCAT group you can either delete it from the group or change its sequence number. To do this move the focus to the channel, press **<Select>** and choose the required action.
8. In the **Background Type** field select the pattern that is applied to all the background channels.
9. Select **Close** to close this setup window.

NOTE You can press the Cancel button to exit the virtual concatenation window. This retains the selections you have just made.

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Setting Up Virtual Concatenation delays

You can add delay to any member of a virtual concatenation group. This allows you to simulate the different paths that a virtual concatenated member can take through the network, thus adding differential delay with respect to the other members of the same group.

This procedure assumes you have set up a virtual concatenation signal.

For more information see

- "Setting Up Virtual Concatenation" on page 293
- "Numeric Entry" on page 29

To delay a virtual concatenation member

1. Press **<Menu>**, choose **Test Functions > VCAT Delay** then press **<Select>**.
2. The **SQ** number (sequence number which identifies the VCAT member) and **Prev** and **Next** buttons allow you to move quickly between pages if you have more than one page of virtual concatenation members to display.
3. Move the highlight to the **Absolute Delay** field of the VCAT member you want to delay. Using the keypad, enter your required delay and then press **<Select>**.
4. Check the **Enable Delay** checkbox. The Differential Delay column is then updated and lists the delay on each member relative to the smallest delay. Note that the delay values are rounded to the closest value available.
5. You can change the pointer value of any or all of the VCAT members. In the **Pointer Adjustment** field select **Increment** or **Decrement** pointer. For each member whose pointer you want to adjust check the right-most checkbox in the **Adj** column. Then select **Action** to change the pointer. Note that the calculated delay changes.

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NOTE Note that pointer moves are hitless to the payload, unlike the adding of delay which may cause errors as the delay is changed.

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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 291

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

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > SONET** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping** to **VT2** or **VT1.5 SPE**, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the 2 Mb/s or DS1 payload by selecting the appropriate **STSs** and **VT**.
5. If you are transmitting an STS-3 signal (or greater), select **Background Settings** then select a pattern for the background VTs.
6. 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 461.

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For a DS1 framed or unframed signals, see “Setting up the DSn Transmitter" on page 507.

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

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Generating Payloads for Ethernet over SONET (EOS)

If your instrument has Next Generation SONET functionality, you can set up an Ethernet over SONET signal using either GFP or LAPS transport protocols. The following procedure assumes that you have already set up SONET signal rate and the GFP or LAPS Transport Protocol.

▶ **To generate Ethernet over SONET**

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

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

2 Select each of the **Ethernet Header** settings. Enter the Destination and Source Addresses. A warning message will be displayed when either a Broadcast address (FF-FF-FF-FF-FF-FF-) or a Multicast address (where there is a '1' in right most bit of address byte one, for example x1-xx-xx-xx-xx-xx, x3-xx-xx-xx-xx-xx, etc) is set.

3 Check the **Tagged** checkbox to transmit Tagged Ethernet (see diagram). User Priority and VLAN fields are only enabled when the **Tagged** option is checked.

4 Enter the **User Priority**. The User Priority values range from 0 to 7.

5 Enter the **VLAN**. The VLAN values range from 0 to 4094.

6 Enter the **Ethernet Frame Size (Bytes)**. If the frame is tagged, the difference between Length/Type and Ethernet Frame Size must be 22, otherwise length/type errors will occur. If the frame is not tagged, the difference must be 18.

7 Enter the **Length/Type** (in hex format). If you check the **Auto** box the length will be calculated automatically. Lengths are interpreted by values of 0 to 1500, Types are interpreted by values greater of equal to 1536. Values between 1501 and 1535 are undefined.

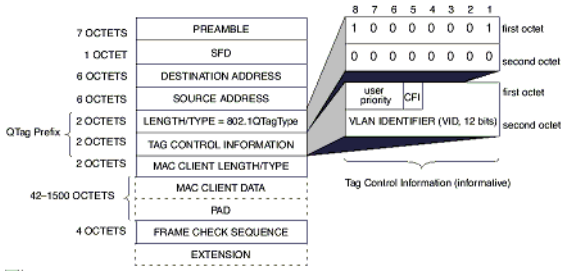
8 Enter the **Requested Data Rate (Mb/s)**. The value depends on the mapping and ethernet frame size settings. If the Requested Data Rate exceeds the available capacity a

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warning will be displayed. The Calculated Data Rate and Interpacket Gap are set automatically. You can use the Calculated Data Rate as a guide to the available capacity.

Tagged Ethernet



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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 > SONET** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping** to **VT1.5 SPE**, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the DS1 payload by selecting the appropriate **STSs** and **VT**s.
5. Select the **Insert DS1** checkbox. The external signal applied to the instrument via the DS1 In ports will be inserted into the SONET signal.
6. Select the required line code as **B8ZS** or **AMI**.
7. 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.

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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 296

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

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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 > SONET** then press **<Select>**.
2. Set the **Mapping Structure** to **Preset**.
3. Select the **Foreground Channel Mapping** to **VT2 SPE** 2 Mb/s, using the drop down box and/or the mapping diagram.
4. Select the **Channel** that is to carry the 2 Mb/s payload by selecting the appropriate **STS**s and **VT**s.
5. Select the **Insert E1** checkbox. The external signal applied to the instrument via the 2Mb/s port will be inserted into the SONET signal.
6. 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.

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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 296

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Adding SONET Errors and Alarms

You can add errors and alarms to a SONET signal during testing. Refer to the technical specifications (available on the instrument website) for a full list of errors and alarms.

Errors can be added singly, at preset rates 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.

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Adding GFP, LAPS and Ethernet Errors and Alarms

If your instrument has Next Generation SONET functionality, you can add GFP, LAPS and Ethernet errors. You can also add GFP and LAPS alarms to a SONET signal during testing. For a full list of errors/alarms refer to the technical specifications (available on the instrument website).

Errors can be added singly or at preset rates.

The procedure below assumes that you have set up the SONET signal rate, GFP/LAPS framing protocol and Ethernet payload.

To add errors

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

2 Select the **Add Errors Type**, and **Rate** required. Use the **<Single Error>** key to add single errors.

NOTE You can add errors and alarms at the same time.

To add alarms

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

2 Select the **Add Alarm Group.**

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

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Adding Runt and Jumbo Frames

If your instrument has Next Generation SONET functionality, you can add Runt and Jumbo Ethernet frames to a SONET signal during testing.

The procedure below assumes that you have set up the SONET signal rate, GFP/LAPS framing protocol and Ethernet payload.

To add Runt/Jumbo Frames

1. Press **<Menu>**, choose **Test Functions > Runt/Jumbo Add** then press **<Select>**.
2. Select the **Add Frame Type** and **Rate** required.
3. Select **Transmit Single Frame** to add a frame.

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Adding Alarm Stress

You can add alarm stress to the signal to simulate intermittent or periodic alarm conditions in the network.

To add an alarm stress

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

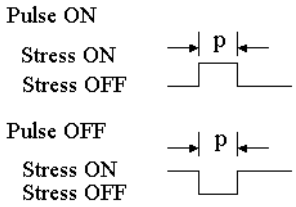
2 Select the **Add Alarms Type**.

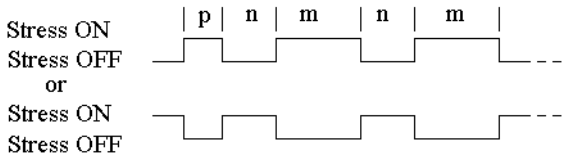
3 In the **Stress** field, depending on the alarm you have selected, you can choose a single-pulsed stress or a sequence of pulses.

For more information on alarm stress testing refer to the application note on the CD ROM supplied with the instrument The application note is also available on the product website.

Alarm Stress Sequence

The alarm stress sequence consists of either a pulse or a pnm sequence. The sequence may be started when the alarm is either in the ON state or in the OFF state as indicated in the following diagrams.





pnm Sequence

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Selecting SONET Transmitter Trigger Output

You can select from a range of different triggers associated with transmitter events. The triggers associated with SONET errors are output in the form of pulses. The triggers associated with alarms are output in the form of a level change.

For more information on SONET Trigger events see:

- "SDH/SONET Transmit Trigger Outputs" on page 673

This procedure assumes you have set up the SONET signal rate.

To select a trigger condition

1 Press **<Menu>**, choose **Test Functions > Trigger Output** then press **<Select>**.

2 In the **Transmit Trigger** field, select the **Type** of trigger.

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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**.

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Setting up the SONET Receiver

Physical

- "Optical Connector Safety Information" on page 60
- "Setting Up the SONET Receive Interface" on page 313
- "Monitoring Unframed Signals" on page 316
- "Monitoring Jitter on a SONET Signal" on page 317
- "Monitoring Wander on a SONET Signal" on page 318

Overhead

- "Monitoring Trace Messages" on page 320
- "Monitoring Synchronization Status Messages" on page 320
- "Monitoring Path Signal Labels" on page 321
- "Monitoring Automatic Protection Switching (APS) Messages" on page 322
- "Monitoring SONET Overhead Bytes" on page 323
- "Capturing SONET Overhead Sequences" on page 324
- "Capturing SONET Overhead Data" on page 327
- "Dropping Messages from the Data Communications Channel (DCC)" on page 328

Payload

- "Receiving Virtual Concatenation signals" on page 329
- "Measuring Virtual Concatenation delays" on page 331
- "Monitoring STS-1 SPE and Concatenated Payloads" on page 332
- "Monitoring SONET Tributary Payloads" on page 339
- "Monitoring GFP/LAPS Receive Interface" on page 341
- "Monitoring Ethernet over SONET Payloads (EOS)" on page 345
- "Monitoring a DSn Payload in a SONET Signal" on page 346
- "Dropping a DSn Payload from a SONET Signal" on page 347

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- “Monitoring PDH Payloads in a SONET Signal" on page 348
- “Dropping a 2 Mb/s Payload from a SONET Signal" on page 349
- “Dropping a Voice Channel to the Internal Speaker" on page 350

Trigger Outputs/Resetting the Instrument

- “Selecting SONET Receiver Trigger Output" on page 351
- “Switching Off All Test Function Features" on page 309

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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 314
- “Setting up the Electrical SONET Receive Interface" on page 315
- “Coupling the Transmitter to the Receiver Settings" on page 316
- “Storing and Recalling Instrument Settings" on page 355

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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 316.

WARNING Always switch off the laser before connecting or disconnecting optical cables. Read the laser warning information 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 > Physical** then press **<Select>**.
2. Set the **Signal Mode** to **SONET**.
3. Select a **Signal Rate.** Selecting **OC-1** or **OC-3** means the signal is output optically; selecting **STS-1** or **STS-3** means the signal is output electrically. The choice of electrical or optical is displayed in the **Line Interface** field.

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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 316.

To set up the electrical SONET Transmit interface

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

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Monitoring Unframed Signals

You can monitor test patterns in an unframed signal. The test patterns can be inverted or non-inverted.

To monitor an unframed signal

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Physical** then press **<Select>**.
2. Set **Signal Mode** to **Unframed**.
3. Select a **Signal Rate**.

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 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**.

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Monitoring Jitter on a SONET Signal

You can monitor jitter on an SDH signal, if the instrument has jitter functionality fitted. Jitter is measured from the input signals using the recovered clock from the line rate signal. For direct jitter measurements on an electrical line rate clock, use an external clock reference. Select the **Clock** interface if an electrical clock is applied directly to the jitter receive Clock-In port. Select the **Data** interface if an optical data signal is applied to the Optical receiver port, or an electrical data signal is applied directly to the Clock Recover Data In port.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SONET signal. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 385

To monitor jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Jitter**.
3. Select an **Interface** (**Clock**, **Data**).
4. In the **Jitter** setup field, select a receiver jitter **Range** (UI).
5. Enter the positive and negative **Hit Threshold** levels (UI), to determine when a hit will be recorded.
6. Select the High Pass/Low Pass **Filters** checkboxes as required. If no checkboxes are selected, jitter is measured over the full demodulation bandwidth for the line rate and range.
7. If required, select a **Demod Output** filter from the drop down list, to be routed to the demodulated output connector.
8. Press the **Run/Stop** key to start/stop the jitter measurement.
9. View the Jitter/Wander results page. For more information, see "Viewing Jitter/Wander Measurement Results" on page 382.

NOTE Jitter Unlock will inhibit results when using optical and binary interfaces.

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Monitoring Wander on a SONET Signal

You can monitor wander on the received signal, if the instrument has jitter/wander fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the SONET signal. Use an external clock for direct wander measurements on an electrical line rate clock. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 385

NOTE A wander measurement may only be performed on a locked synchronous system where one reference is used. The Clock Source must generate or be locked to the system clock of the signal being measured.

To monitor wander

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the receive **Mode** to **Wander**.
3. Select an **Interface** (**Clock**, **Data**).
4. Select the **External Wander Analysis** checkbox, if required. The **Timing Reference** (clock source) can be **Internal** or **External**. You should use an External Timing Reference for accurate Wander results.
5. Press the **Run/Stop** key to start/stop the Wander measurement.
6. View the Jitter/Wander results page.
   For more information, see "Viewing Jitter/Wander Measurement Results" on page 382.

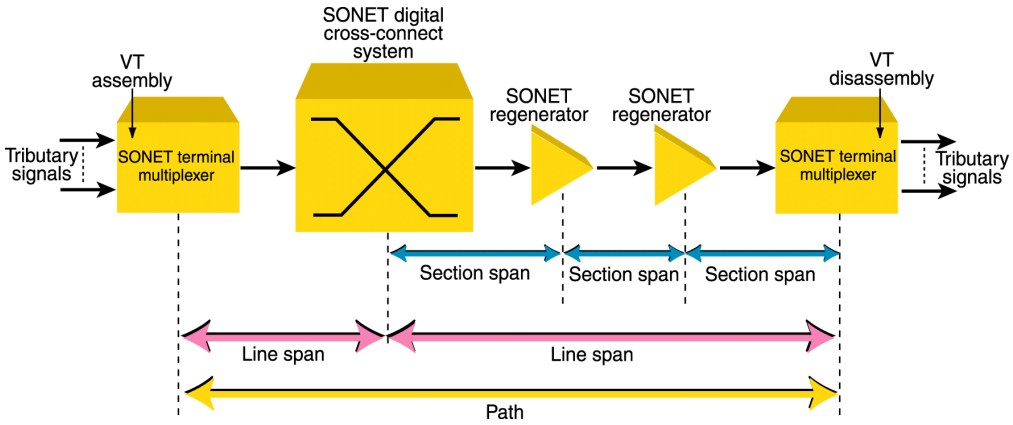
NOTE For information on setting up an external clock source, see "Selecting the SONET Transmit Clock Source" on page 258

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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 645
- "Line Overhead (LOH)" on page 646
- "SONET Concepts" on page 641

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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 628

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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).

When low order virtual concatenation (VCAT) is selected in the receiver you can monitor both the signal label carried in the V5 byte and the extended signal label carried in the Z7 bit 1 multiframe. The labels displayed are for the foreground VCAT member.

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 654
- “V5 (bits 5 to 7) Signal Label" on page 658
- “Z7 (bit 1) Low Order Extended Signal Label" on page 659

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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 648
- "Ring APS Messages (Telecordia GR-1230)" on page 650.

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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.

NOTE Note that at 40Gb/s the actual value of the B1, B2, N1 bytes is not displayed. The display indicates what bit in these bytes is errored.

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Capturing SONET Overhead Sequences

You can receive a sequence of values in an overhead channel (a group of overhead bytes).

Sequence Channels	SONET overhead bytes
9-byte channels	D4-D12
6-byte channels	A1-A2 for STM-1 to STM-64
3-byte channels	D1-D3
2-byte channels	A1-A2 for STM-0, K1-K2, H1-H2, M0-M1 (except STM-64 when M1M0 preference selected)
Single byte channels (MSOH)	S1, H3, M1 (except STM-64, M1M0 preference selected), E2, unused bytes
Single byte channels (High Order POH)	J1, C2, G1, F2, H4, F3, K3, N1

Up to 256 unique values (elements) of the selected channel are displayed along with the number of frames for which the value has occurred. The capture of the channel is triggered either manually (after Capture is selected) or the trigger can be set up by the user.

Trigger Selection	When capture occurs
Manual	The capture of the overhead channel occurs immediately after **Capture** is initiated.
Pre-trigger	Up to 256 values up to and including the trigger point are displayed. The capture is triggered as soon as possible after the **Capture** is initiated, even if 256 values have not been captured.
Post-trigger	Up to 256 values including and following the trigger point are displayed. The captured data is updated every second after the capture has triggered.
Centred-trigger	Up to 128 values before the trigger point and up to 128 values including and following the trigger point are displayed.

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Triggered Capture

The capture of the overhead channel is triggered when the value of the selected channel is equal to the trigger value or when it is NOT equal to the trigger value (binary inversion).

The trigger mask is set up by the user. Only bits corresponding to a '1' in the mask value are used to detect the trigger condition.

To set up the sequence capture channel

1 Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Channel** tab.

2 Select the **Network Standard**.

3 Select the **Change**... field.

4 Select the **STS-1** and **STS-3** channel of interest.

5 Move to the fields in the SONET overhead and press **<Select>** to choose the byte channel you want to monitor (when selected, the button is pushed in). Select **Close**.

To set up the sequence capture trigger

1 Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Trigger** tab.

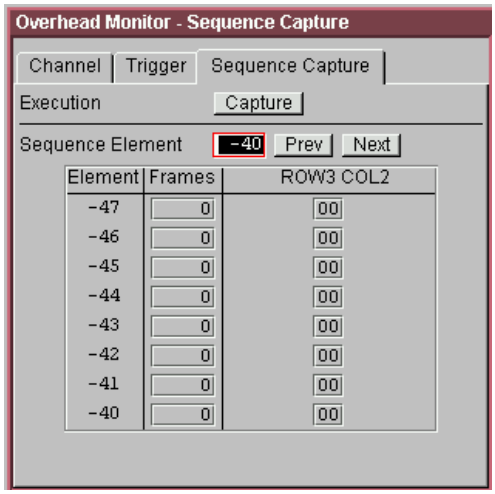
2 Set up the trigger conditions as required.

To set up the sequence capture

1 Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Sequence Capture** tab.

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2 Select the **Sequence Element**. The selected element is displayed with its value and the number of frames for which this value occurred.

3 In the **Execution** field, select **Capture** to start the capture.

4 To stop the capture select **Stop** in the **Execution** field.

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Capturing SONET Overhead Data

You can capture the complete overhead for six frames of a SONET signal. The capture is triggered using a choice of events.

Trigger Selection	What is displayed?
Manual	Six frames following the manual capture
Pre-trigger capture	Six frames up to and including the trigger frame
Post trigger capture	Six frames including and following the trigger frame
Centred capture	Three frames before the trigger frame, the trigger frame and two frames following the trigger frame

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

To capture SONET overheads

1. Press **<Menu>**, choose **Overhead Monitor > Data Capture** then press **<Select>**. Select the **Setup** tab.
2. Select **TOH** or **SONET POH** in the **Capture Data** field.
3. In the **Trigger Type** field select when the capture occurs relative to the trigger.
4. In the **Trigger Event** select from **Errors** or **Alarms** and then select the type of error or alarm.
5. Select **Capture** to start the capture. The status line indicates when the capture is complete.
6. Press **<Menu>**, choose **Overhead Monitor > Data Capture** then press **<Select>**. Select the **Captured Data** tab. This allows you to view the captured data.

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Dropping Messages from the Data Communications Channel (DCC)

You can drop network management messages from the section DCC or the line DCC of a SONET signal via the DCC/GCC connector.

To drop a message from the DCC of a SONET signal

1 Press **<Menu>**, choose **Test Functions > DCC/GCC Drop/Insert** then press **<Select>**.

2 In the **Receiver Drop** field select the required DCC.

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Receiving Virtual Concatenation signals

You can configure the instrument receiver to receive a virtual concatenated (VCAT) group in the payload of a SONET signal. Select channels as VCAT members that you expect in your received signal. Select one of the channels as the foreground. Measurements are made on the foreground channel only but you can select **Smart Test > VCAT Overview** to identify where errors and alarms are occurring.

This setup allows you to check that you have correctly set up your required VCAT signal in your equipment transmitter.

To configure the virtual concatenation group

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > SONET** then press **<Select>**.
2. Select the **VCAT** checkbox.
3. Move to the **Mapping Configuration** fields, select your required mapping and then click on the **High** or **Low Order** more (...) button.
4. In the **Receiver Mapping Setup** field, use the arrow keys to navigate around the payload channels.
5. In any field, press **<Select>**. Choose **Discover Group** to instruct the receiver to find all valid members of a VCAT group in the received signal automatically; Choose **Add to VCAT Group** to manually set up the expected VCAT configuration.
6. Once you have set up the VCAT configuration in each channel you can then choose to remove that channel from the VCAT group, change the sequence number (SQ) of that channel or set that channel as foreground. (Measurements are made on the foreground channel.)
7. Select the **Validate SQ** checkbox to allow only contiguous sequence (SQ) numbers. Uncheck this box to allow you to set any sequence number for a VCAT member.
8. Select **Close** to close this setup window.

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NOTE You can press the Cancel button to exit the virtual concatenation window. This retains the selections you have just made.

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Measuring Virtual Concatenation delays

You can measure the delay experienced by a member of a virtual concatenation group.

This procedure assumes you have set up a virtual concatenation signal in the receiver.

For more information see

- "Receiving Virtual Concatenation signals" on page 329

To measure VCAT delay

1 Press **<Menu>**, choose **Results > Network Measurements > VCAT Delay** then press **<Select>**.

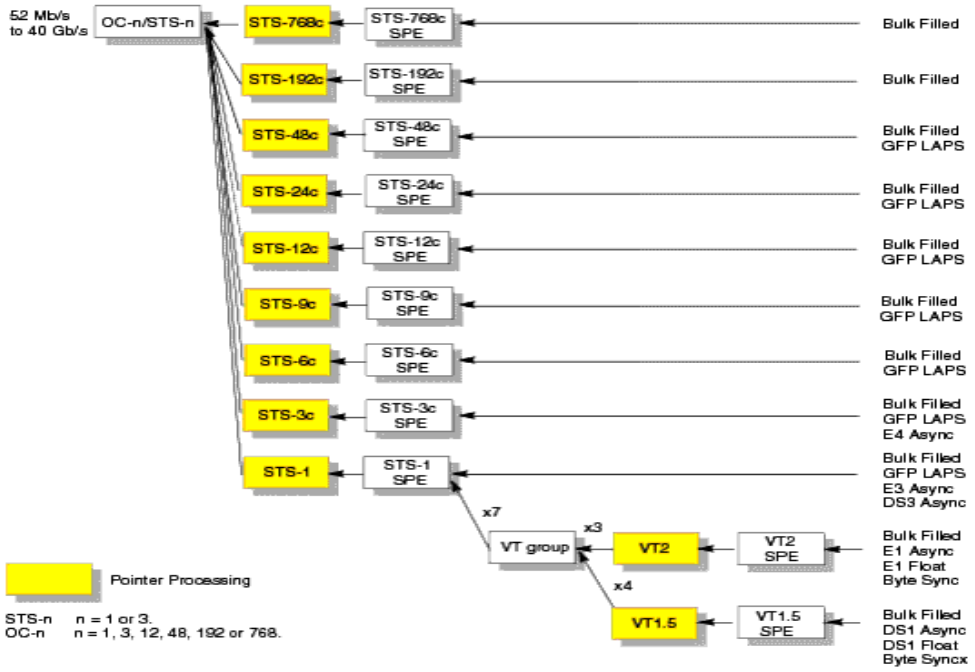
2 The **Prev** and **Next** buttons allow you to move quickly between pages if you have more than one page of VCAT members to display.

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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 333
- "Monitoring Concatenated Payloads" on page 335

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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 338

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 > SONET** then press **<Select>**.

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**.

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4 Press **<Menu>**, choose **Tx/Rx > Receiver Settings > PDH/DSn** then press **<Select>**. 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 477.
For a DS3 framed or unframed signals, see “Setting up the DSn Receiver" on page 527.

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

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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 338.
- "Reduced Test Time with Concatenated Payloads" on page 337

To monitor a concatenated payload

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

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

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

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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

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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.

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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 338.

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

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

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5 Press **<Menu>**, choose **Tx/Rx > Receiver Settings > PDH/DSn** then press **<Select>**. 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 477.
For a DS1 framed or unframed signals, see “Setting up the DSn Receiver" on page 527.

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

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Monitoring GFP/LAPS Receive Interface

If your instrument has Next Generation SONET functionality, you can set up an Ethernet over SONET signal using either **Generic Framing Procedure (GFP)** or **Link Access Procedure SDH/SONET (LAPS)** framing protocols. In both cases you can chose to use the parameters defined by the relevant protocol specification or set your own custom parameters. Once the GFP or LAPS headers have been set up you can set the Ethernet payload.

The following procedures assume that you have already set up the SONET signal rate on the receiver.

For more information, see:

- "Monitoring GFP Signals using G.70741 Protocol" on page 341
- "Monitoring a Custom GFP Signal" on page 342
- "Monitoring LAPS Signals using X.86 Protocol" on page 343
- "Monitoring a Custom LAPS Signal" on page 343
- "Monitoring Ethernet over SONET Payloads (EOS)" on page 345

Monitoring GFP Signals using G.70741 Protocol

You must set up the SONET receiver before setting up the GFP header.

▶ **To monitor a signal using G.7041 (GFP) protocol**

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > GFP/LAPS** then press **<Select>**.
2. Select the **GFP** Transport Protocol.
3. Select the **G.7041** protocol.
4. Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames (PTI=000) or Client Management Frames (PTI=100).
5. Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.

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6 Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. If EXI is set to Linear Frame you can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. Transparent mode is only available when the selected mapping is STS-48c

8 Set the Ethernet Settings and complete the payload settings. See "Monitoring Ethernet over SONET Payloads (EOS)" on page 345.

Monitoring a Custom GFP Signal

You must set up the SONET receiver before setting up the GFP signal.

▶ **To monitor a custom GFP signal**

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

2 Select the **GFP** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Payload Type Identifier **(PTI)**, The PTI is always interpreted as meaning User Data frames or Client Management Frames and can be configured to any 3 bit value.

5 Select the Payload FCS Identifier **(PFI)**, The PFI can be set to On or Off.

6 Select the Extention Header Identifier **(EXI)**, The EXI can be set to Null or Linear Frame. You can also enter a value from the range 0000 to 1111. If EXI is set to Linear Frame you can also set the Channel Identifier **(CID)**. The CID is a numeric identifier ranging from 0 to 225.

7 Select the User Payload identifier **(UPI)** and associated values. If the UPI is set to Transparent you can also set the Number of Super Blocks. If the PTI=100 the UPI can be configured to mean Client Signal Fail, either Loss of Client

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Signal (0000 0001) or Loss of Character Synchronization (0000 0010).

8 Set the Ethernet Settings and complete the payload settings. See "Monitoring Ethernet over SONET Payloads (EOS)" on page 345.

Monitoring LAPS Signals using X.86 Protocol

You must set up the SONET receiver before setting up the LAPS header.

To monitor signal using X.86 (LAPS) protocol

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

2 Select the **LAPS** Transport Protocol.

3 Select the **X.86** protocol.

4 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

5 Set the Ethernet Settings and complete the payload settings. See "Monitoring Ethernet over SONET Payloads (EOS)" on page 345.

Monitoring a Custom LAPS Signal

You must set up the SONET receiver before setting up the LAPS header.

To monitor a custom LAPS signal

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

2 Select the **LAPS** Transport Protocol.

3 Select the **Custom** Protocol Attributes.

4 Select the Service Access Point Identifier **(SAPI)**. The SAPI can be any 4 digit hexadecimal value.

5 Select the **Address**. The address can be any 2 digit decimal value.

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6 Select the **Control**. The control can be any 2 digit decimal value.

7 Select the **FCS Length**. The length can be either 32 or 16 bit.

8 Select the **Scrambler**. The Scrambler can be either Enabled or Disabled.

9 Set the Ethernet Settings and complete the payload settings. See “Monitoring Ethernet over SONET Payloads (EOS)" on page 345.

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Monitoring Ethernet over SONET Payloads (EOS)

If your instrument has Next Generation SONET functionality, you can monitor an Ethernet over SONET signal using either GFP or LAPS transport protocols. The following procedure assumes that you have already set up the SONET receiver with a SONET signal rate and the GFP or LAPS Transport Protocol.

To monitor Ethernet over SONET

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Ethernet** then press **<Select>**.
2. Select each of the **Ethernet Header** settings. Enter the Destination and Source Addresses. A warning message will be displayed when either a Broadcast address (FF-FF-FF-FF-FF-FF-) or a Multicast address (where there is a '1' in right most bit of address byte one, for example x1-xx-xx-xx-xx-xx, x3-xx-xx-xx-xx-xx, etc) is set.
3. Check the **Tagged** checkbox to transmit Tagged Ethernet. User Priority and VLAN fields are only enabled when the **Tagged** option is checked.
4. Enter the **User Priority**. The User Priority values range from 0 to 7.
5. Enter the **VLAN**. The VLAN values range from 0 to 4094.
6. Enter the **Length/Type**. Lengths are interpreted by values of 0 to 1500, Types are interpreted by values greater of equal to 1536. Values between 1501 and 1535 are undefined

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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 339

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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 > SONET** then press **<Select>**.

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.

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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 339

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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 > SONET** then press **<Select>**.

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.

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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 > PDH/DSn** then press **<Select>**.
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**.

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Selecting SONET Receiver Trigger Output

You can select from a range of different triggers associated with receiver events. The triggers associated with SONET errors are output in the form of pulses. The triggers associated with alarms are output in the form of a level change.

For more information on SONET receiver trigger events see:

- "SDH/SONET Transmit Trigger Outputs" on page 673

This procedure assumes you have set up the SONET receiver.

To select a trigger condition

1. Press **<Menu>**, choose **Test Functions > Trigger Output** then press **<Select>**.
2. In the **Receive Trigger** field, select the **Type** of trigger from **Start of Frame, Error** or **Alarm**.
3. If you have chosen Error or Alarm, in the next field, you can select the part of the overhead in which the alarm or error occurs. Also, you can select the error or alarm condition required for the trigger.

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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 353
- "Overhead Overwrite Thru Mode" on page 354

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.

If jitter functionality is fitted, you can add jitter to signals in 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**.

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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.

For virtual concatenation (VCAT) signals overhead overwrite applies to the foreground VCAT signal member only. If a low order path is selected in the receiver, the low order path overhead can selected for overwrite as well as the associated high order path.

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.

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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

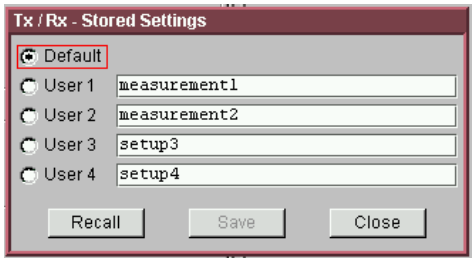
1 Press **<Menu>**, choose **System > Stored Settings** then press **<Select>**.

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 **System > 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**.

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Measurements and Results

Error, Alarm and Pointer Monitoring

- "Viewing SONET Errors" on page 358
- "Viewing SONET Alarms" on page 361
- "Monitoring SPE and VT Pointer Values" on page 362
- "Viewing Errors and Alarms Using Trouble Scan" on page 363
- "Viewing GFP, LAPS and Ethernet over SONET Errors and Alarms" on page 365

Jitter and Wander

- "Measuring Jitter Tolerance" on page 367
- "Measuring Wander Tolerance" on page 373
- "Measuring Jitter Transfer" on page 378
- "Viewing Jitter/Wander Measurement Results" on page 382

Signal/Network Measurements

- "Measuring Optical Power" on page 385
- "Measuring Frequency" on page 386
- "Viewing the ITU Analysis of SONET Errors and Alarms" on page 387
- "Measuring Service Disruption Time in a SONET Network" on page 388
- "Measuring GFP, LAPS and Ethernet over SONET" on page 390

Results Logging

- "Viewing Results Graphically" on page 563
- "Measurement Logging" on page 559
- "Shortcuts to Results, Measurements and Stored Settings" on page 65

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Viewing SONET Errors

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

- "Viewing SONET Errors (Total or Last Second)" on page 358
- "Viewing SONET Summary of Errors" on page 359
- "Viewing Errors/Alarms using the <Show More> Key" on page 360

Viewing SONET Errors (Total or Last Second)

You can monitor errors in an SONET signal during testing.

Refer to the technical specifications (available on the instrument website) 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 and Alarms > SONET** then press **<Select>**. Select the **Errors** tab.

2 Select the **Error Type**.

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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 technical specifications (available on the instrument website) for full details of available errors.

To view the error summary

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

2 Select the **Error Type**.

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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.

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Viewing SONET Alarms

You can monitor alarms in an SONET signal during testing. See the technical specifications (available on the instrument website) 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).

For more information see:

- "Summary of Errors and Alarms" on page 616

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 technical specifications document (available on the instrument website) for a full list of alarms.

To view alarms seconds results

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

2 Select the **Alarm Type**.

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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 > Pointers** then press **<Select>**.

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 563

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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

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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.

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Viewing GFP, LAPS and Ethernet over SONET Errors and Alarms

If your instrument has Next Generation SONET functionality, you can monitor GFP, LAPS and Ethernet errors. You can also monitor GFP and LAPS alarms in a SONET signal.

For more information see:

- "Viewing GFP, LAPS and Ethernet errors" on page 365
- "Viewing GFP and LAPS alarms" on page 366

Viewing GFP, LAPS and Ethernet errors

You can monitor errors in an SONET signal during testing. Refer to the technical specifications (available on the instrument website) for full details of errors results. You can view errors on the display as **Total** or **Last Second** counts or ratios.

▶ **To view the GFP and LAPS errors**

1 Press **<Menu>**, choose **Results > Errors and Alarms> GFP** then press **<Select>**.

or

1 Press **<Menu>**, choose **Results > Errors and Alarms> LAPS** then press **<Select>**.

2 Select the **Error Summary** or **Errors** tab.

3 Under the **Errors** tab select the **Error Type**.

▶ **To view Ethernet errors**

1 Press **<Menu>**, choose **Results > Error and Alarms > Ethernet** then press **<Select>**.

2 Select the **Error Summary** or **Errors** tab.

3 Under the **Errors** tab select the **Error Type**.

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Viewing GFP and LAPS alarms

You can monitor alarms in an SONET signal during testing.

To monitor GFP and LAPS alarms

1 Press **<Menu>**, choose **Results >Errors and Alarms > GFP** then press **<Select>**.

or

1 Press **<Menu>**, choose **Results >Errors and Alarms > LAPS** then press **<Select>**.

2 Select the **Alarms** tab.

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Measuring Jitter Tolerance

You can measure jitter tolerance if the instrument has jitter functionality fitted. Jitter tolerance is the ability of a network element to withstand jitter without introducing errors into the output signal. The instrument provides jitter tolerance measurements within the masks as specified in the relevant ITU-T standards.

Jitter Tolerance Modes

The jitter **auto-tolerance** measurement increases the jitter amplitude until the point of failure, repeating the analysis at a range of frequencies. The results are plotted alongside the selected tolerance mask, showing the margin by which the device-under-test differs from the mask. A failure is indicated if a measured point falls below the mask. *Note that this measurement can take a variable amount of time for each test point.*

Fast auto-tolerance verifies that the network element conforms to the selected tolerance mask. The frequency/amplitude values are set precisely to the values defined by the tolerance mask. At each frequency point, the receiver is checked against the defined performance criteria. The results are used to determine whether the device-under-test has passed or failed against the selected tolerance mask. *Note that fast auto-tolerance mode allows a predictable test time.*

Sweep mode is an automatic jitter generation mode. In this mode the instrument generates jitter at a range of frequencies, with the amplitude defined by the selected tolerance mask. *Sweep mode does not provide any measurement results.*

Spot mode is a manual jitter generation mode, where the user selects spot frequencies at an amplitude defined by the selected tolerance mask. This can be useful for identifying any swept mask problem area that needs further analysis. *Sweep mode does not provide any measurement results.*

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NOTE The auto-tolerance and fast auto-tolerance measurements are not available when the instrument is in Thru Mode or when the receiver interface is configured to measure and electrical clock or electrical data.

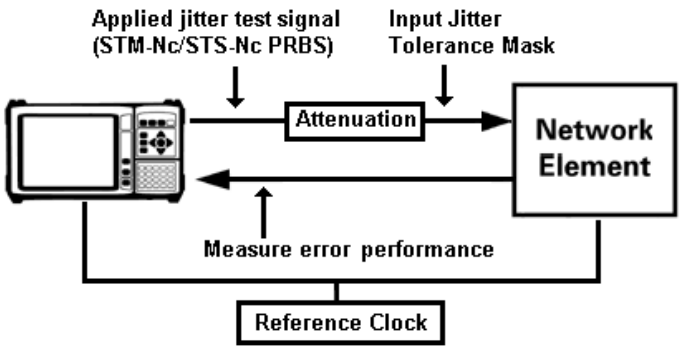
Active alarms will results in termination of the measurement and the test will record a failure, unless **Ignore Alarms** checkbox is checked.

NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

Jitter Tolerance Criteria

You can measure jitter tolerance using either the **BER Penalty** method or the **Onset of Errors** method as specified in the relevant standards.

Jitter Tolerance Measurement Setup



BER Penalty Method

This method checks the number of bit errors against the selected error threshold at each amplitude point.

Set up the OmniBER transmitter and receiver as required, including the test pattern, before starting this procedure. When testing a regenerator, set the transmitter and receiver to the

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same line rate as the input line interface-under-test. When testing a multiplexer, set the Transmitter to the tributary rate and the Receiver to the aggregate line rate. When testing a demultiplexer, set the transmitter to the aggregate line rate and the receiver to the tributary rate (e.g. set the transmitter to OC-48 with embedded OC-3 and set the receiver to OC-3).

Use an external optical attenuator to keep optical power at optimum level if you are performing tests on optical signals. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 385

To set up the BER Penalty method for jitter tolerance

1 **Connect** the OmniBER to the device-under-test.

2 Ensure that there are no errors detected in the OmniBER receiver.

3 With no jitter applied, set the optical attenuator to obtain a defined error-rate (of at least 100 bit errors per second). Use this same error-rate when setting up the OmniBER jitter tolerance test.

4 Reduce the attenuation by 1dB.

5 Measure the jitter tolerance using the following procedure.

Automatic Jitter Tolerance Testing

The jitter amplitude at which the defined error threshold is reached is plotted on the graph as the jitter tolerance for that jitter frequency. The measurement is repeated for a range of test frequencies, according to the tolerance mask selected.

To measure jitter tolerance using BER Penalty method

1 Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.

2 Set **Type** to **Jitter** and set **Mode** to **Fast** or **Auto**.

3 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset mask or a user-defined mask from the

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list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 375). Enter the mask **Start** and **Stop** frequency values (Hz).

4 In the **Error Threshold** fields:

- set **Mode** as **BER Penalty**
- in the **Source** field select what type of errors you want to detect during the measurement
- check the **Ignore Alarms** checkbox if you want the measurement to ignore all alarms (except LOS, LOF, OOF)
- in the **Count** field set the number of errors in the gating period you want to use as a threshold in the measurement

5 Select the **Settling** (delay between the jitter being applied and the error measurement being made) and **Gate** (period of error measurement at each frequency point) timing (s).

6 Select **Start**. View the results by selecting from **Status**, **Graph** or **Table** format. When viewing the results table, you can select **Prev Page** or **Next Page** to move between results pages. You can select **Stop** to stop the measurement.

7 Check there is a floppy disk in the drive. From the Table display select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box. (Only available in Auto/Fast Mode.)

Onset of Errors Method

This method determines the jitter amplitude at which the number of errored seconds exceeds the specified threshold. The jitter amplitude at which the defined error threshold is reached is plotted on the graph as the jitter tolerance for that jitter frequency. The measurement is repeated for a range of test frequencies, according to the tolerance mask selected.

Set up the OmniBER transmitter and receiver as required, including the test pattern, before starting this procedure.

▶ **To perform the Onset of Errors method for jitter tolerance**

1 Connect the OmniBER to the device-under-test.

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2 Ensure that there are no errors detected in the OmniBER receiver.

3 Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.

4 Set **Type** to **Jitter** and set **Mode** to **Fast** or **Auto**.

5 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset mask or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 232). Enter the mask **Start** and **Stop** frequency values (Hz).

6 In the **Error Threshold** fields:

- set **Mode** as **Onset of Errors**
- check the **Ignore Alarms** checkbox if you want the measurement to ignore all alarms (except LOS, LOF, OOF)
- in the **Errored Seconds** field set the number of errored seconds you want to use as a threshold in the measurement. The default number of errored seconds is 2.

7 Select the **Settling** (delay between the jitter being applied and the error measurement being made) and **Gate** (period of jitter generation at each frequency point) timing (s). The **Gate** default is 30s.

8 Select **Start**. View the results by selecting from **Status**, **Graph** or **Table** format. When viewing the results table, you can select **Prev Page** or **Next Page** to move between results pages. You can select **Stop** to stop the measurement.

9 Check there is a floppy disk in the drive. From the Table display select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box. (Only available in Auto/Fast Mode.)

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Spot Mode Settings

To set up Spot Mode

1 Set **Mode** to **Spot**.

2 In the **Input Mask** area, select a preset **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 375).

3 Enter the **Frequency (Hz)**.

4 Select **Start**.

Sweep Mode Settings

To set up Sweep Mode

1 Set **Mode** to **Sweep**.

2 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 375). Enter the mask frequency **Start** and **Stop** values (Hz), or select the default min and/or max values.

3 Select the **Settling** (delay between the jitter frequency/amplitude being applied and the error measurement being made) timing (s).

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Measuring Wander Tolerance

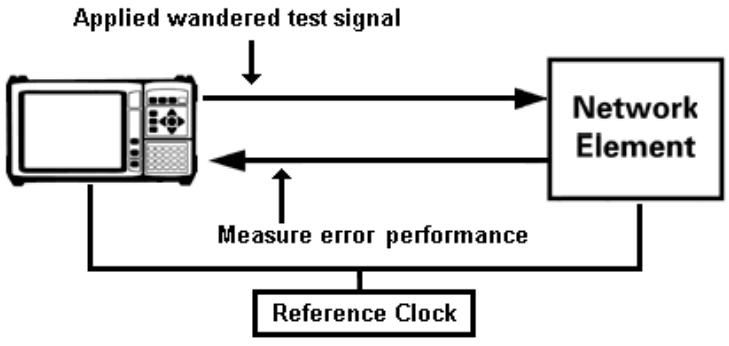
Wander tolerance is the ability of a network element to withstand wander without introducing errors into the output signal. You can measure Wander Tolerance using the instrument, if jitter/wander is fitted. The instrument provides wander tolerance measurements (using sinusoidal modulation) within the chosen mask. Masks are as specified in the relevant ITU-T standards. The instrument automatically selects the appropriate amplitude for the selected frequency. A wandered signal is applied to the device-under-test to check that its performance is with in the specified limits.

This procedure assumes that you have set up the Transmitter and Receiver as required, including the required test **Pattern**. Make sure the interface settings match the network equipment.

Check optical power before making the measurement, to ensure accuracy. For information, see:

- "Measuring Optical Power" on page 385

Wander Tolerance Measurement Setup



NOTE Wander Tolerance measurements are not available when the instrument is in Thru Mode.

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NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

To measure Wander Tolerance

1. Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.
2. Select **Type** as **Wander**.
3. In the **Mask** setup area, select a preset input mask from the list.
4. Enter the mask **Frequency** value. The mask amplitude will automatically be calculated.
5. Select **Start** to apply the wander.

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Defining a User Mask

The jitter standards specify the lower limit of Maximum Tolerable Input Jitter in the form of a mask. The measured input jitter tolerance of the network element must be greater than that of the mask specified by the relevant standard.

The instrument allows you define up to 10 user masks. These are displayed in both graph and table format.

To open the user mask setup window

1 Press the **<Smart Test>** button and select **Jitter/Wander Tolerance**.

2 Set **Type** to **Jitter**.

3 Select **Edit User Masks...** button.

NOTE Note that you can not edit a user mask that is currently being used in a jitter tolerance or transfer measurement.

To create/edit a User Mask

1 In the **Manage Masks** fields, select **New** or choose a mask from the drop-down list.

2 Enter the **Title** (Max 15 characters) using the instrument keypad. Press **<Select>**.

3 In the **Mask Points** fields, select **Add...** to add a point to the mask. Enter the **Frequency (Hz)** and **Amplitude (UI)** and then select **OK**. The new point appears in the table to the right.

4 Select **Delete...** to delete a point; the Delete point window lets you choose which point number you want to delete.

5 Select **Edit...** to change the frequency/amplitude of a point.

6 You can also shift a mask by a percentage amount. This shift applies to all the points. The shift increases or decreases the amplitude of the point at each frequency. In the **Shift Mask** field select the required percentage change (positive or

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negative) and then select **Shift** to apply the change. The graph and table on the right reflect the change.

7 If the list of points extends beyond the end of the table, use **Prev Page** and **Next Page** to view the rest of the listed points.

8 Select **Close** when you have finished defining the mask. This saves the mask.

NOTE If any points on the selected mask are not within the capability of the transmitter, the maximum possible amplitude will be output and a warning message will be displayed on the Status line at the bottom of the screen.

To copy a User Mask

1 In the **Manage Masks** field, select **New**.

2 Move into the **Title** field and type in the name of your mask using the instrument keypad and press **<Select>**.

3 Select the **Copy...** button.

4 In the **Copy User Mask** window, select the mask you want to copy to your new mask. Select **OK**. The selected mask is now copied to your newly named mask.

5 To refine the mask, you can:
Select **Shift Mask** - Enter a plus or minus percentage value to change all the amplitude values of the mask. Select the **Shift** button.
Select **Add...** - Enter the **Frequency (Hz)** and **Amplitude (UI)** of a point, then press **OK** to add a point.
Select **Delete**... - Select the point number (refer to mask table to right of display) you want to delete, then press **OK**.
Select **Edit...** - Select the point number (refer to mask table to right of display) that you want to change. Change the **Frequency (Hz)** and/or **Amplitude (UI)**, then select **OK**.

6 If the list of points extends beyond the end of the table, use **Prev Page** and **Next Page** to view the rest of the listed points.

7 Select **Close** when you have finished copying the mask.

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To delete a User Mask

1 In the **Manage Masks** field select a mask from the drop-down list.

2 Select the **Delete** button.

3 Select **Close** to close the **User Masks** window.

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Measuring Jitter Transfer

You can measure jitter transfer if the instrument has jitter functionality fitted. Results are given in either graphical form (Gain versus Frequency) or tabular form.

Jitter transfer is the ratio of output jitter amplitude to input jitter amplitude versus jitter frequency for a given bit rate. For example, in a regenerator where the device output is loop-timed from the input, some of the jitter present at the input port of the regenerator will be transferred to the output port. On networks with cascaded equipment on long trunk routes it is important to limit jitter transfer.

For the jitter transfer measurement, first use a default 5s Gate time (the time spent at each measurement point) and 5s Settling time (the time between jitter being applied and the measurement beginning, during which the unit under test is settling). Then increase to a 10s Gate time and 20s Settling time, to optimize measurement accuracy against the overall measurement duration. Automatic band filtering is used in the jitter receiver, providing selection and measurement of the relevant jitter components to provide accurate and repeatable results.

You must perform a back-to-back calibration run before making the jitter transfer measurement via the device-under-test.

NOTE Jitter transfer measurements are not available when the instrument is in Thru Mode.

NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

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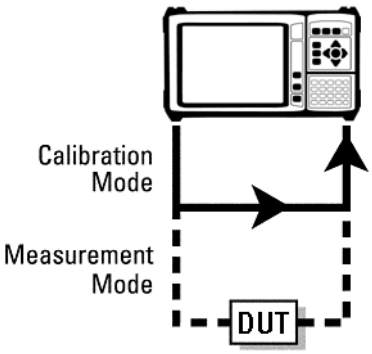
Pre-Measurement Calibration

Connect the instrument in a loopback configuration (Optical-to-Optical or Binary-to-Binary) and perform a calibration cycle before making a jitter transfer measurement.

Set up the Transmitter and Receiver as required, before completing this procedure. For example, when testing a regenerator, set the Transmitter and Receiver to the same line rate as the input line interface-under-test.

Add an optical attenuator between the IN and OUT ports of the optical module, to keep optical power at optimum level. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Measuring Optical Power" on page 385.



NOTE Switch on the instrument for at least 1 hour before starting a calibration cycle. The climatic conditions must remain stable from switch-on until the end of the measurement, for accurate results.

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To calibrate the instrument

1 Press **<Smart Test>**, choose **Jitter Transfer** then press **<Select>**.

2 In the Input Mask setup area, select the number of **Test Points**. Select either a preset input **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (for more information, see "Defining a User Mask" on page 375).

3 Enter the mask frequency **Start** and **Stop** values (Hz).

4 Select the **Settling** and **Gate** (measurement period) timing (sec).

5 In the **Run Type** field, select **Calibration**.

6 Select **Start**. The status of the calibration run is displayed. When the calibration has finished, complete the jitter transfer measurement (see "Jitter Transfer Measurement" on page 381). You can select **Stop** to stop the calibration before it has finished.

NOTE During calibration and measurement of jitter transfer the instrument goes into a locked state. This stops the user from changing the instrument settings which would make the calibration or measurement invalid. If you want to perform measurements other than jitter transfer then select the 'Release Instrument Lock' button and proceed.

NOTE It is recommended that the maximum test period (from the start of calibration to the end of the measurement) does not exceed 90 minutes, otherwise the accuracy specification cannot be guaranteed.

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Jitter Transfer Measurement

NOTE Start the jitter transfer measurement within 10 minutes of completion of the calibration cycle.

To measure jitter transfer

1. Remove the loopback configuration from the interfaces. Connect the instrument to the device-under-test.
2. You can select a **Pass Mask** to compare the measurement results with. Also, you can add an offset to the Pass Mask, by selecting a preset **Offset** or entering a user-defined offset.
3. Select **Start** to make the measurement. The results are provided in **Graph** (Gain versus Frequency) or **Table** format. You can select **Stop** to stop the measurement.
4. Check there is a floppy disk in the drive. Select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box.

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Viewing Jitter/Wander Measurement Results

You can view jitter and wander measurement results if the instrument has jitter functionality fitted. The results shown depend on the Test Function **Mode** (jitter or wander) selected.

Viewing Jitter Measurement Results

Jitter unlock (JUL) and jitter out-of-range (JOR) are indicated by the front panel jitter LED. Details of these jitter alarms are given when you press the **<Show More>** key on the instrument's front panel, shown as general alarms. Also jitter alarms are displayed on the results page (see below for details of how to view the jitter results page).

The instrument displays jitter hit results. Jitter hits are detected when the programmable threshold for positive and negative jitter values are exceeded. The detector is reset when the jitter level falls below 75% of the hit threshold. Positive and negative jitter hit counts are also included in Trouble Scan.

'Total' and 'Last Second' amplitude results are displayed for each of the active receiver measurement bandwidths.

To view Jitter results

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

See "Monitoring Jitter on a SONET Signal" on page 317 for information on setting up the receiver for jitter measurements.

JUL and JOR Alarm Conditions

Jitter Unlock (JUL) can be set if the jitter receiver loses lock while measurements are being made. This can happen if loss of line clock occurs at the binary clock input, if the line clock is outside the specified frequency range for the line rate or if loss of electrical data occurs at the binary data interface input. JUL

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can also occur if there is Loss of Optical Data at the Optical Data input, this causes LOS alarm to be set (in 'Optical Data' jitter measurement mode), which automatically sets JUL.

The Jitter Overrange (JOR) is designed to prevent measurements being presented to the user if the instrument is measuring in a non-linear state due to high input jitter levels. The 'HP Filters Off' path is the most likely to detect excessively high input jitter levels and is kept running even when High Path Filters is selected. This means that the JOR alarm may be raised, even though jitter results displayed on screen may are within the specified range.

If JOR is asserted, try increasing the jitter measurement range until JOR is de-asserted.

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Viewing Wander Measurement Results

Wander reference unlock is indicated on the Results page and when you press the **<Show More>** key on the instrument's front panel.

The instrument displays Alarm Seconds and Time and Amplitude results.

TIE (Time Interval Error) represents the time deviation of the clock signal under test, relative to the reference source. Real-time TIE results are displayed during a measurement period. MTIE (Maximum Time Interval Error) is the largest peak-to-peak TIE observed during the measurement period.

The Time/Amplitude results (TIE/MTIE) include TIE, +ve Peak, -ve Peak, Peak-Peak, Frequency Offset, Frequency Drift.

External PC software is available that provides off-line analysis of MTIE/TDEV (Time Deviation) wander measurements.

▶ **To view Wander results**

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

See "Monitoring Wander on a SONET Signal" on page 318 for information on setting up the receiver for wander measurements.

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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.

▶ **To measure optical power**

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

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.

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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 > Frequency Meas** then press **<Select>**.

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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 604

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.

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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 689.

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 > Service Disruption** then press **<Select>**.
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 688.

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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.

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Measuring GFP, LAPS and Ethernet over SONET

If your instrument has Next Generation SONET functionality, you can monitor GFP, LAPS and Ethernet measurements in a SONET signal.

Viewing GFP, LAPS and Ethernet measurements

You can monitor measurements in a SONET signal during testing.

Refer to the technical specifications (available on the instrument website) for full details of measurements. You can view measurements on the display as **Total** or **Last Second** counts.

▶ **To view the GFP and LAPS measurements**

1 Press **<Menu>**, choose **Results > Network Measurements> GFP/LAPS** then press **<Select>**.

2 Select the appropriate tab.

3 Select the **Error Type** if available.

▶ **To view Ethernet measurements**

1 Press **<Menu>**, choose **Results > Network Measurements > Ethernet** then press **<Select>**.

2 Select the appropriate tab.

3 Select the **Error Type** if available.

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4
Instrument Setup and Use - OTN

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Setting up the OTN Receiver 415
Setting Up Thru Mode Operation 433
Storing and Recalling Instrument Settings 434
Measurements and Results 435

This chapter tells you how to set the instrument interfaces to match the network being tested and how to view results

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Setting up the OTN Transmitter

Physical/Line

- "Setting Up the Transmit Optical Interface" on page 394
- "Transmitting an Unframed Signal" on page 395
- "Transmitting a Framed OTN Signal" on page 397
- "Selecting the OTN Transmit Clock Source" on page 398
- "Adding Frequency Offset" on page 399
- "Adding OPU Frequency Offset" on page 400
- "Generating Jitter on an OTN Signal" on page 401

Overhead

- "Generating Trace Messages" on page 402
- "Editing Path Signal Labels" on page 402
- "Editing OTN Overhead bytes" on page 403
- "Setting Up an OTN Overhead Sequence" on page 407
- "Inserting Messages into the General Communication Channel (GCC)" on page 409

Payload

- "Instrument Setup and Use - SDH" on page 101
- "Instrument Setup and Use - SONET" on page 249

Errors/Alarms, Resetting the Instrument

- "Adding Errors and Alarms to the OTN Signal" on page 410
- "Adding Alarm Stress" on page 411
- "Adding Errors to the OTN Signal Payload" on page 412
- "Selecting OTN Transmitter Trigger Output" on page 413
- "Switching Off All Test Function Features" on page 414

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Setting Up the Transmit Optical Interface

You can transmit optical transport network (OTN) signals that meet the G.709 standard. The signals are output on the Optical Out connectors.

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 396.

To set up the OTN transmit interface

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Physical** then press **<Select>**.
2. Set the **Signal Mode** to **OTN**.
3. Set the OTN **Signal Rate** as required.
4. To select the clock source for the OTN signal see "Selecting the OTN Transmit Clock Source" on page 398.

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Transmitting an Unframed Signal

You can transmit a signal at OTN rates which has no framing and is simply a repeating pattern. The patterns can be inverted or non-inverted.

To transmit an unframed signal

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Physical** then press **<Select>**.
2. Set the **Signal Mode** to **Unframed**.
3. Set the **Signal Rate** as required.
4. Select the **Pattern** tab**.**
5. Select the PRBS and its polarity.

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 2^n-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.

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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.

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>** and choose **Tx/Rx > Coupling** using the arrow and **<Select>** keys.
2 Choose **Copy Tx to Rx**.
3 Choose **Close**.

▶ **To turn coupling off**

1 Choose **Tx/Rx > Coupling**.
2 Choose **Switch Coupling Off**.
3 Choose **Close**.

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Transmitting a Framed OTN Signal

You can transmit a framed OTN signal with either an unstructured or a structured payload. The framing meets the standards for OTN signals set out in ITU-T Standard G.709.

When you transmit a framed OTN signal with an unstructured payload, a user-selectable test pattern fills the entire payload. A structured payload consists of a SONET or SDH framed signal.

You can enable or disable scrambling to test your scrambler circuitry. You can also enable or disable forward error correction (FEC). This allows you to test your FEC circuitry to ITU-T Recommendation G.709.

NOTE When the FEC is disabled and scrambling is off, the long run of zeros in the FEC bytes will cause most clock recovery systems to fail. Also, when scrambling is turned off and any of the following patterns are selected (null client, test signal patterns consisting of all zeros, all ones or user patterns with at least 8 zeros or ones), then you may get LOF and pattern sync loss.

You can select the mapping to be synchronous or asynchronous. If you choose synchronous the Optical Payload Unit (OPU) clock is derived from the mapped client signal. Asynchronous means that the OPU clock is independent of the mapped client signal.

To transmit a framed OTN signal

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

2 Set the **Scrambling** and **FEC** on or off as required.

3 Set the **Payload** as required. If you choose **SONET** or **SDH** use the SONET or SDH tabs to set up your required SONET or SDH signal. If you choose **Test Signal** use the **Pattern** tab to set up your pattern. Choosing **Null Client** sets up the null client pattern as defined in G.709. This is an all-zero pattern.

4 Set the **Mapping** to be **Asynchronous** or **Synchronous**.

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Selecting the OTN Transmit Clock Source

You can reference the OTN transmitter timing to an internal, external or recovered clock source. By default, the internal clock source is used.

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 ohm unbalanced Clock In port (BNC). or 2 Mb/s (ternary) MTS applied to the 120 ohm balanced clock In port (Siemens) or 10 MHz reference clock applied to the 75 ohm unbalanced Clock In port (BNC).
Recovered	Clock recovered from the signal applied to the receiver.

To select the transmit clock source

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

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Adding Frequency Offset

You can apply frequency offset to either the Optical Transport Unit (OTU) line frequency or to the Optical Payload Unit (OPU) when in asynchronous mode. You can apply frequency offset to the line signal regardless of the clock source.

In synchronous mode, when you apply an offset to the line rate, that offset is also applied to the payload rate.

When in asynchronous mode, the client signal (SONET or SDH signal) clock is independent of the line (OTN) signal. Therefore you can apply a frequency offset to the payload signal and the line signal independently. This allows you to simulate conditions where you are mapping a client signal into the OTN signal and both may have frequency offsets.

Frequency offsets are allowed when transmitting OTN signals and are handled by the OTN frame justification control bytes in the OPUk overhead.

In the instrument, when you set the frequency offsets the instrument calculates the stuffing ratio required to maintain the line rate. The stuffing ratio has a limit of +/-65ppm and will saturate with certain combinations of payload and line offset.

To add OPU frequency offset see:

- "Adding OPU Frequency Offset" on page 400

To add a line frequency offset

1. Press **<Menu>**, choose **Test Functions > Frequency Offset** then press **<Select>**.
2. Select **Enable Offset**.
3. Select the **Offset** required.
4. Press **<Select>** to start adding the offset.

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Adding OPU Frequency Offset

To add an OPU frequency offset

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > OTN** then press **<Select>**.
2. Set the **Mapping** field to **Asynchronous.**
3. Press **<Menu>** and select **Test Functions>Frequency Offset**.
4. Select the **Enable Offset** checkbox in the **OPU** field.
5. Select the **Offset** required.
6. Press **<Select>** to start adding the offset.

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Generating Jitter on an OTN Signal

You can add jitter to the transmitted OTN signal, if the instrument has jitter functionality fitted.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the OTN signal.

To generate jitter

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the **Mode** to **Jitter**.
3. In the **Jitter** setup field, select the jitter **Source** (**Internal** or **External**). For an **External** jitter source, connect the external source to the External Modulation Input connector.
4. For an **Internal** jitter source, enter the **Modulation Frequency** (**Hz**) and the **Amplitude** (**UI**). Press the **<Select>** key when you have finished.

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Generating Trace Messages

There are two types of trail trace identifiers (TTI). The Section Monitoring (SM) TTI byte is contained in the OTU overhead and the Path Monitoring (PM) TTI byte is in the ODU overhead. They can both be set independently.

The TTI message provides source access, destination access and operator specific information over 64 consecutive frames.

TTI name	Acronym	No, of bytes	1st byte	Remaining bytes
Source Access Point Identifier	SAPI	16	All 0s	User settable
Destination Access Point	DAPI	16	All 0s	User settable
Operator specific fields		32	User settable	User settable

To transmit the OTN trail trace identifier

1 Press **<Menu>**, choose **Overhead Setup > Byte Setup** then press **<Select>**. Select the **OTN** tab.

2 Using the arrow keys move to the SM or PM field you want to change.

3 Press **<Select>** and then choose **Edit Field**. You can then change the field entry.

4 Press **<Select>** when you have changed the field entry.

Editing Path Signal Labels

You can change the value in the Payload Type (PT) byte in the Optical Path Overhead (OPU). The PT byte identifies what payload is carried in the OTU signal. This is set up automatically when you set the payload but changing it allows you to test that receiver equipment can detect fault conditions.

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To edit the PT byte

1 Press **<Menu>**, choose **Overhead Setup > Labels** then press **<Select>**. Select the **OTN** tab.

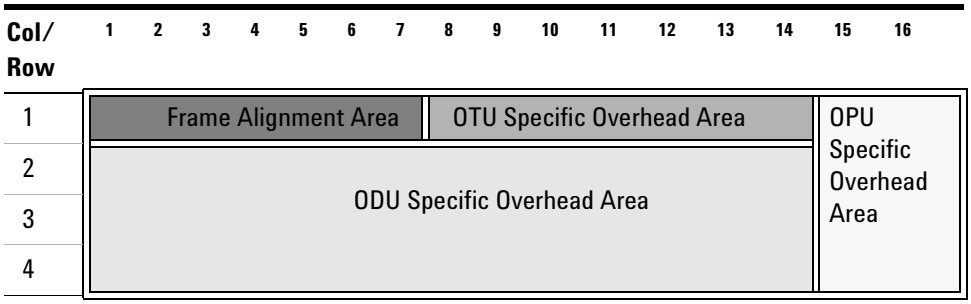
2 In the **PT Mapping** field select the PT mapping from the drop-down menu. The binary value of this byte appears in the field beside the selection.

Editing OTN Overhead bytes

You can change some of the OTU overhead bytes from their default value to simulate typical conditions at the equipment under test. The overhead is divided into the Frame Alignment Signal, the OTU overhead, the ODU overhead and the OPU overhead. The values that can be set are all zeros, all ones and user selectable settings.

For more information see:

- "Generating Trace Messages" on page 402
- "OTN Overhead Bytes" on page 661



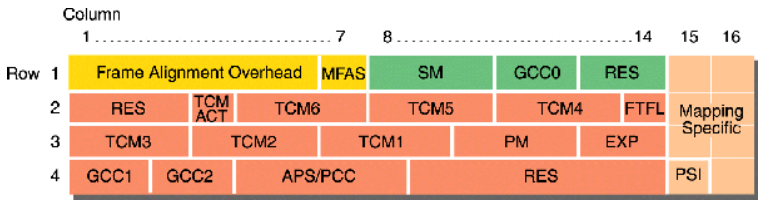
The OTN optical signal has three types of Frame Alignment Signal (FAS) bytes.

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Byte	No. of bytes	Default Value (hex)	Can be set
FAS OA1	3	F6	yes
FAS OA2	3	28	yes
MFAS	1	Increments over 256 frames	no

The OTU overhead consists of seven bytes. There are three Section Monitoring (SM) bytes, two bytes which make up a General Communication Channel (GCCO) and the remaining byte is reserved for a future application.



OTU Bytes		No, of bytes	Default Value (hex)	Note
SM	TTI	1	00	Cannot be set by user
	BIP-8	1	calculated	Cannot be set by user
	byte 3	1	00	Can be set by user
GCC0		2	0000	Can be set by user
RES		1	00	Can be set by user

The ODU overhead bytes consist of rows 2 to 4 and columns 1 to 14 of the OTN frame.

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ODU Bytes		No. of bytes	Default Value	Note
RES		3	000000h	Can be set by user
TCM ACT		1	00h	Can be set by user
TCM1,2,3,4,5 & 6		3 each	000000h	Byte 2 not settable. PM/SM BIP copied into byte 2
FTFL		1	00h	Can be set by user
PM	TTI	1	00h	Refer to "Generating Trace Messages" on page 402
	BIP-8	1	calculated	Cannot be set by user
	byte 3	1	01h	Can be set by user; this byte contains BEI, BDI & STAT.
EXP		2	0000h	Can be set by user
GCC1,2		2 each	0000h	Can be set by user
APS/PCC		4	00000000h	Can be set by user
RES		6	00h	Can be set by user

The path overhead consists of rows 1 to 4, columns 15 and 16 of the OTN frame.

Byte(s)	No. of bytes	Default Value	Notes
PSI	1	Determined by transmitter settings	Cannot be set by user. PT is one byte of a 256-byte sequence in the PSI field. The remaining 255 bytes are set to 00h.
RES(3 off)	1	00 h	Reserved bytes.
JC	3	Determined by justification process in async mode. Set to 00h in sync mode	

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Byte(s)	No. of bytes	Default Value	Notes
NJO	1	00h in sync mode. Provides data opportunity in async mode.	
PJO	1	Data in sync mode. 00h when positive justification occurs in async mode.	

To change the OTN overhead bytes

1 Press **<Menu>**, choose **Overhead Setup > Byte Setup** then press **<Select>**. Select the **OTN** tab.

2 Using the arrow keys move to the field you want to change.

3 Press **<Select>** and then choose **Edit Field**. You can then change the field entry.

4 Press **<Select>** when you have changed the field entry.

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Setting Up an OTN Overhead Sequence

You can insert a sequence of values into a group of OTN overhead bytes (an overhead channel). A sequence consists of up to 256 different elements, each element being the appropriate number of bytes for the selected location.

Sequence Channels	OTN overhead bytes
6-byte channels	FAS
4-byte channels	APS/PCC
2-byte channels	GCC0, EXP, GCC1, GCC2
Single byte channels	MFAS, TCM ACT, FTFL, RES, SM bytes 1 and 3, TCM1-6 bytes 1 and 3, OPU2 bytes (not JC, NJO, PJO)

Each element can be transmitted for a variable number of frames, up to 65535. This sequence can then be transmitted as a single run or repeated indefinitely.

If the sequence is created that is a multiple of 256 frames, the first frame of the first element is transmitted when the MFAS value equals 0. The sequence must be stopped before the user can change the value of any element or the number of frames for any element.

You can use the sequences to check that your equipment deals with these bytes in the required way. How these bytes are set up may differ from one manufacturer to the next.

In the following procedure it is assumed that the transmitter is set up to transmit an OTN signal.

To select the sequence generation channel

1 Press **<Menu>**, choose **Overhead Setup > Sequence Generation** then press **<Select>**. Select the **Channel** tab..

2 Select **OTN** as the Network Standard.

3 Select the **Change**... field.

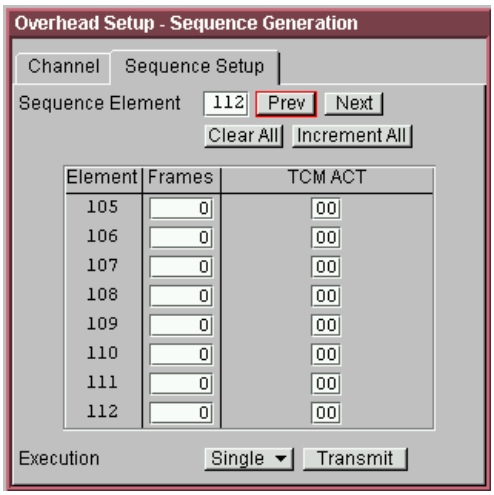
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4 Move to the TCM fields in the ODU2 overhead and press **<Select>** to choose the channel to which you want to apply a sequence. (When selected the button is pushed in). Select **Close**.

To set up the overhead sequence

1 Press **<Menu>**, choose **Overhead Setup > Sequence Generation** then press **<Select>**. Select the **Sequence Setup** tab.



2 In the Sequence Setup window, select the **Sequence Element**. The sequence can have between 1 and 256 elements. The element you select is displayed and you can move through the elements by selecting **Prev** and **Next**.

3 Enter the number of frames you want the sequence to run for and also the sequence value for that set of frames. (After each entry press **<Select>**).

4 In the **Execution** field select **Single** or **Repeat** and then select the **Run Sequence** checkbox to start the sequence running.

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Inserting Messages into the General Communication Channel (GCC)

You can insert messages into the General Communication Channels (GCC) which are in the overhead of the Optical Channel Signal. The Optical Transport Unit (OTU) overhead contains GCC0; the Optical Data Unit (ODU) overhead contains GCC1 and GCC2.

To insert a message into GCC0

1 Press **<Menu>**, choose **Test Functions > DCC/GCC Drop/Insert** then press **<Select>**.

2 Select **Transmitter Insert,** then select the GCC channel.

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Adding Errors and Alarms to the OTN Signal

You can add errors and alarms to the OTN signal using the procedure below. Refer to the technical specifications (available on the instrument website) for a full list of errors and alarms. Errors can be added singly, at preset rates or at a user programmable rate.

For more information on OTN Errors and Alarms see:

- "Equipment Response to OTN Errors" on page 672
- "Adding Errors to the OTN Signal Payload" on page 412.
- "Adding Alarm Stress" on page 411
- "OTN Alarm Description" on page 670
- "Equipment Response to OTN Alarms" on page 671

NOTE You can add errors and alarms at the same time.

To add errors and/or alarms

1. Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
2. Set the **Type** to **OTN** and select the byte(s) you want to error.
3. Select the **Add Errors Type** and **Rate** required.
4. Select the **Add Alarm Type**, then select the **Alarm ON** checkbox.

NOTE Entire Frame error add introduces an error into any part of the OTN frame (after scrambling). When you enable FEC in your receiver, entire frame errors (up to a maximum rate) can be corrected and may be recorded as corrected FEC errors.

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Adding Alarm Stress

You can add alarm stress to the signal to simulate intermittent or periodic alarm conditions in the network.

To add an alarm stress

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

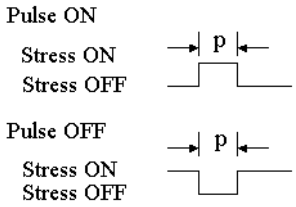
2 Select the **Add Alarms Type**.

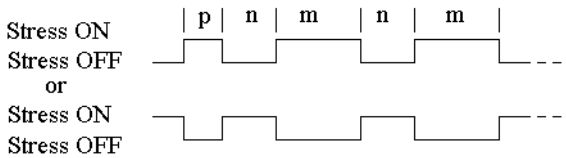
3 In the **Stress** field, depending on the alarm you have selected, you can choose a single-pulsed stress or a sequence of pulses.

For more information on alarm stress testing refer to the application note on the CD ROM supplied with the instrument The application note is also available on the product website.

Alarm Stress Sequence

The alarm stress sequence consists of either a pulse or a pnm sequence. The sequence may be started when the alarm is either in the ON state or in the OFF state as indicated in the following diagrams.





pnm Sequence

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Adding Errors to the OTN Signal Payload

You can add errors to the OTN signal payload (test pattern, SONET or SDH). A full range of SONET and SDH errors can be added and bit errors can be added if a test pattern is selected as the payload.

▶ **To add errors to the OTN signal payload**

1. Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
2. In **Add Errors Type** select the type of error you want to add to the OTN payload. Note that if SONET or SDH is selected as an OTN payload you can add bit errors to its payload from this menu.
3. Set the error rate in the **Rate** field. Select **User** to specify a particular rate which is not listed (See next step). Select **Error All** to error all the bits of the selected byte(s).
4. If you have selected **User** highlight the rate field and press **<Select>**. Select from the drop-down menu. If you choose **Edit Field** you can then enter your own value.

For more information see:

- “Adding SONET Errors and Alarms" on page 304
- “Adding SDH Errors and Alarms" on page 162

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Selecting OTN Transmitter Trigger Output

You can select from a range of different triggers associated with transmitter events. The triggers associated with the errors are output in the form of pulses. The triggers associated with alarms are output in the form of a level change.

For more information on triggers see:

- "OTN Transmit Trigger Outputs" on page 675

To select a trigger condition

1 Press **<Menu>**, choose **Test Functions > Trigger Output** then press **<Select>**.

2 In the **Transmit Trigger** field, select the **Type** of trigger. If **Start of Frame** is selected you can then, in the adjacent field, select whether it is the start of the OTN frame or the start of the mapped signal frame (SONET/SDH).

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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**.

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Setting up the OTN Receiver

Physical/Line

- "Setting Up the OTN Receive Optical Interface" on page 416
- "Receiving an Unframed Signal" on page 418
- "Receiving a Framed OTU2 Signal" on page 417
- "Monitoring Jitter on an OTN Signal" on page 420
- "Coupling the Transmitter to the Receiver Settings" on page 419

Overhead

- "Monitoring Trace Messages" on page 421
- "Monitoring Path Signal Labels" on page 421
- "Monitoring OTN Overhead Bytes" on page 422
- "Capturing an OTN Overhead Sequence" on page 423
- "Monitoring FEC Errors" on page 426
- "Dropping Messages from the General Communication Channel (GCC)" on page 428

Payload

- "Setting up the SDH Receiver" on page 169
- "Setting up the SONET Receiver" on page 311

Data Capture, Triggers and Resetting the Instrument

- "Capturing an OTN Frame" on page 429
- "Selecting OTN Receiver Trigger Output" on page 431
- "Switching Off All Test Function Features" on page 414

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Setting Up the OTN Receive Optical Interface

You can receive OTN signals that meet the G.709 standard. The signals are input on the Optical In connectors.

To set up the OTN receive optical interface

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Physical** then press **<Select>**.
2. Select the **Signal Mode** and choose **OTN**.
3. Set the **Signal Rate** as required.

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Receiving a Framed OTU2 Signal

You can receive a framed OTN signal at 10.71 Gb/s (OTU2) with either an unstructured or a structured payload. The framing meets the standards for OTU2 set out in ITU-T Standard G.709.

When you receive a framed OTU2 signal with an unstructured payload, a user-selectable test pattern fills the entire payload. A structured payload consists of a SONET or SDH framed signal.

The scrambling can be enabled or disabled to test your scrambler circuitry. The forward error correction (FEC) can be turned on or off. When turned off the FEC bytes are filled with all zeros. This allows you to test your FEC circuitry to ITU-T Recommendation G.709.

You can select the mapping to be synchronous or asynchronous. If you choose synchronous the Optical Payload Unit (OPU2) clock is derived from the mapped client signal. Choosing asynchronous means that the OPU2 clock is independent of the mapped client signal.

▶ **To receive a framed OTN signal**

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

2 Select or de-select the **Scrambling** and **FEC** checkboxes as required.

3 Set the **Mapping** to be Asynchronous or Synchronous.

4 Set the **Payload** as required. If you choose SONET or SDH use the **SONET** or **SDH** tabs to set up your required signal. If you choose **Test Signal** use the **Pattern** tab to set up your pattern. Choosing **Null Client** allows you to receive the null client pattern as defined in G.709.

For more information see:

- “Setting up the SONET Receiver" on page 311
- “Setting up the SDH Receiver" on page 169

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Receiving an Unframed Signal

You can receive a signal at an OTN rate which has no framing and is simply a repeating pattern. The patterns available at these rates can be inverted or non-inverted.

To receive an unframed signal

1. Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Physical** then press **<Select>**.
2. Set **Signal Mode** to **Unframed**.
3. Set the **Signal Rate** as required.
4. Select the **Pattern** tab**.**
5. Select from **PRBS** or **Live**. Then select the polarity of the PRBS.

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 2^n-1 PRBS will produce a longest run of n-1 zeros in the PRBS sequence and and inverted sequence produces a longest run of n zeros in the PRBS sequence.

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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.

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 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**.

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Monitoring Jitter on an OTN Signal

You can monitor jitter on an OTN signal, if the instrument has jitter functionality fitted. Jitter is measured from the input signals using the recovered clock from the line rate signal. Select the **Clock** interface if an electrical clock is applied directly to the jitter receive Clock-In port. Select the **Data** interface if an optical data signal is applied to the Optical receiver port, or an electrical data signal is applied directly to the Clock Recover Data In port.

Make sure interface settings match the network equipment. This procedure assumes you have already set up the OTN signal. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Viewing Optical Power" on page 455

▶ **To monitor jitter**

1. Press **<Menu>**, choose **Test Functions > Jitter/Wander** then press **<Select>**.
2. Set the **Mode** to **Jitter**.
3. Select an **Interface** (**Clock**, **Data**).
4. In the **Jitter** setup field, select a receiver jitter **Range** (UI).
5. Enter the positive and negative **Hit Threshold** levels (UI), to determine when a hit will be recorded.
6. Select the High Pass and/or Low Pass **Filters** checkboxes as required. If no checkboxes are selected, jitter is measured over the full demodulation bandwidth for the line rate and range.
7. If required, select a **Demod Output** filter from the drop down list, to be routed to the demodulated output connector.
8. Press the **Run/Stop** key to start/stop the jitter measurement.
9. View the Jitter/Wander results page. For more information, see "Viewing Jitter Measurement Results" on page 453.

NOTE Jitter Unlock will inhibit results when using optical and binary interfaces.

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Monitoring Trace Messages

You can check for continuity between the transmitting and receiving ends of an optical section or path by monitoring a message in the Section Monitoring (SM) bytes or the Path Monitoring bytes (PM).

For more information see:

- "Optical Transport Unit (OTU) Overhead" on page 663
- "Optical Data Unit (ODU) Overhead" on page 665

To monitor the trail trace message

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

2 In the **View trace message** field select the **PM** or the **SM** trail trace message. The trail trace message is displayed on this page.

Monitoring Path Signal Labels

You can monitor the value in the Payload Type (PT) byte. This byte indicates what type of payload is carried in the OTN signal.

To monitor the trail trace message

1 Press **<Menu>**, choose **Overhead Monitor > Labels** then press **<Select>**. Select the **OTN** tab.

2 The PT mapping and its binary equivalent are displayed.

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Monitoring OTN Overhead Bytes

All of the overhead bytes in the OTU are captured every second. The byte value can be displayed in hexadecimal format.

For more information see:

- "Optical Transport Unit (OTU) Overhead" on page 663

To monitor OTN overhead bytes

1 Press **<Menu>**, choose **Overhead Monitor > Byte Monitor** then press **<Select>**. Select the **OTN** tab.

2 To scroll along the overhead move to the double-arrow fields and press select. Alternatively, select **Full Page Monitor** at the base of the page. To link to the display of the transmitter setup of the OTN bytes put a tick in the '**Link to OTN setup scroll bar**' checkbox.

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Capturing an OTN Overhead Sequence

You can capture a sequence of values in an overhead channel (a group of overhead bytes).

Sequence Channels	OTN overhead bytes
6-byte channels	FAS
4-byte channels	APS/PCC
2-byte channels	GCC0, EXP, GCC1, GCC2
Single byte channels	MFAS, TCM ACT, FTFL, RES, SM bytes 1 and 3, TCM1-6 bytes 1 and 3, OPU2 bytes (not JC, NJO, PJO)

Up to 256 unique values (elements) of the selected channel are displayed along with the number of frames for which the value has occurred. The capture of the channel is triggered either manually (after Capture is selected) or the trigger can be set up by the user.

Trigger Selection	When capture occurs
Manual	The capture of the overhead channel occurs immediately after **Capture** is initiated.
Pre-trigger	Up to 256 values up to and including the trigger point are displayed. The capture is triggered as soon as possible after the **Capture** is initiated, even if 256 values have not been captured.
Post-trigger	Up to 256 values including and following the trigger point are displayed. The captured data is updated every second after the capture has triggered.
Centred-trigger	Up to 128 values before the trigger point and up to 128 values including and following the trigger point are displayed.

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Triggered Capture

The capture of the overhead channel is triggered when the value of the selected channel is equal to the trigger value or when it is NOT equal to the trigger value (binary inversion).

The trigger mask is set up by the user. Only bits corresponding to a '1' in the mask value are used to detect the trigger condition.

To set up the sequence capture channel

1 Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Channel** tab.

2 Select **OTN** as the Network Standard.

3 Select the **Change**... field to choose a channel to monitor.

4 Select the overhead channel you want to monitor (when selected the button is pushed in), then select **Close**.

To set up the sequence capture trigger

1 Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Trigger** tab.

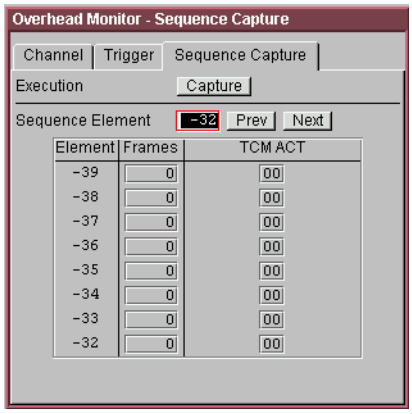
2 Set up the trigger conditions as required.

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To set up the sequence capture

1 Press **<Menu>**, choose **Overhead Monitor > Sequence Capture** then press **<Select>**. Select the **Sequence Capture** tab.



2 Enter the **Sequence Element** to monitor. The selected element is displayed with its value and the number of frames for which this value occurred.

3 In the **Execution** field, select **Capture** to start the capture.

4 To stop the capture select **Stop** in the **Execution** field.

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Monitoring FEC Errors

The forward error correction (FEC) as defined in the G.709 uses a Reed-Solomon (R-S) encoding scheme to allow detection and correction of errors in the OTN signal.

In the instrument receiver, you can monitor the number of incoming bit errors which have been corrected by the R-S code and also those FEC blocks which have had errors but which the code has been unable to correct.

In order to check that the DUT can correct errors, use the error entire frame facility in the instrument transmitter. To check for uncorrectable error detection, use the error FEC block (Uncorr FEC) feature in the instrument transmitter. This adds errors specifically to the FEC which cannot be corrected by the R-S code. This is not designed the stress the encoding but to exercise the ability of the DUT to detect and report this error.

In the following procedure it is assumed that the transmitter and receiver are set up to transmit and receive OTN signals and that they are coupled (**Tx/Rx>Coupling** is **ON**). Connect the 10G optical output of the instrument to the input of the DUT and the output of the DUT to the 10G input on the instrument, taking care not to exceed specified optical power at both inputs.

To monitor corrected FEC errors

1. Press **<Menu>**, choose **Test Functions > Errors and Alarms** then press **<Select>**.
2. Select **Add Errors Type** as **Physical, Entire Frame.**
3. In the **Rate** field, press **<Select>** and select a rate from the drop-down menu. Note that there is a maximum rate at which the DUT corrects errors: exceeding this rate means that errors cannot be corrected. Note that the DUT records corrected errors.
4. Press **<Menu>**, choose **Results > Errors and Alarms > OTN** then press **<Select>**. Select the **Errors** tab.

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5 In the **Error Type** field, select **OTN, FEC (UC)**. Note that if the DUT receiver has corrected the errors there should be no uncorrectable FEC block errors.

▶ **To monitor uncorrectable FEC blocks.**

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

2 Select **Add Errors Type** as **OTN, Uncorr FEC.** Note that the DUT detects and reports uncorrectable errors.

3 Press **<Menu>**, choose **Results > Errors and Alarms > OTN** then press **<Select>**. Select the **Errors** tab.

4 In the **Error Type** field, select **OTN, FEC (UC)**. Note that if the DUT receiver has detected and reported the uncorrectable FEC errors the instrument should report the same errors.

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Dropping Messages from the General Communication Channel (GCC)

You can drop messages from the Optical Transport Unit (OTU) General Communication Channel (GCC0) or from the Optical Data Unit (ODU) General Communication Channel (GCC1 and GCC2) via the DCC/GCC connector.

To drop a message from the GCC0 channel

1. Press **<Menu>**, choose **Test Functions > DCC/GCC Drop/Insert** then press **<Select>**.
2. Connect a Protocol Analyzer to the instrument's DCC/GCC port.
3. Select **Receiver Drop** and then select **GCC0**.

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Capturing an OTN Frame

You can capture four complete frames of the OTN signal, including overhead, payload and forward error correction (FEC) bytes. The capture is triggered either manually or after the detection of an error or alarm. The frames that are displayed after the trigger are listed in the following table.

Trigger Selection	What is displayed?
Manual	Four frames following the manual capture
Pre-trigger capture	Four frames up to and including the trigger frame
Post trigger capture	Four frames including and following the trigger frame
Centred capture	Two frames before the trigger frame, the trigger frame and one frame following the trigger frame

In the following procedure, it is assumed that the receiver is set up to receive an OTN signal.

To capture an OTN frame

1 Press **<Menu>**, choose **Overhead Monitor > Data Capture** then press **<Select>**. Select the **Setup** tab.

2 To capture the full OTN frame, select **OTN** in the **Capture Data** field.

3 In the **Trigger Type** field select when the capture occurs relative to the trigger.

4 If, in the previous step, you have selected anything other than **Manual** then select whether the trigger should occur on an alarm or error. In the **Event** field select the particular error or alarm you want to use as the trigger.

5 In the **Trigger Event** select from **Errors** or **Alarms** and then select the type of error or alarm.

6 Select **Capture** to start the capture. A status line message indicates when the capture is complete.

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To capture an OTN frame

1 Press **<Menu>**, choose **Overhead Monitor > Data Capture** then press **<Select>**. Select the **Captured Data** tab.

2 Select the **Show** field to view different sections of the data.

3 Select **Full Page View** to view the captured data on a full screen.

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Selecting OTN Receiver Trigger Output

You can select from a range of different triggers associated with receiver events. The triggers associated with the errors are output in the form of pulses. The triggers associated with alarms are output in the form of a level change.

For more information on OTN receiver triggers see:

- "OTN Receiver Trigger Outputs" on page 678

To select a trigger condition

1 Press **<Menu>**, choose **Test Functions > Trigger Output** then press **<Select>**.

2 In the **Receive Trigger** field, select the **Type** of trigger. If **Start of Frame** is selected you can then, in the adjacent field, select whether it is the start of the OTN frame or the start of the mapped signal frame (SONET/SDH).

3 In the next field select the error or alarm condition required for the trigger.

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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.

If jitter functionality is fitted, you can add jitter to signals in 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**.

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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

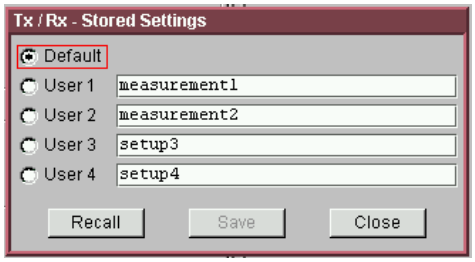
1 Press **<Menu>**, choose **System > Stored Settings** then press **<Select>**.

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 **System > 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**.

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Measurements and Results

Errors and Alarms

- "Viewing OTN Errors" on page 436
- "Viewing OTN Alarms" on page 437
- "Viewing Errors and Alarms Using Trouble Scan" on page 438

Jitter and Wander

- "Measuring Jitter Tolerance" on page 440
- "Measuring Jitter Transfer" on page 449
- "Viewing Jitter Measurement Results" on page 453

Signal/Network Measurements

- "Viewing Optical Power" on page 455
- "Viewing the Signal Frequency" on page 456
- "Viewing the OPU Frequency Offset" on page 457

Results Logging

- "Measurement Logging" on page 559

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Viewing OTN Errors

It is possible to monitor OTN errors and also errors in the SONET and SDH signals when they are payloads of the OTN signal. Similarly, bit errors are monitored when the OTN signal payload is a test signal.

In the following procedure, set up the instrument receiver to receive an OTN signal, ensuring that the mapped signal is the same as the signal being generated by the DUT (SONET or SDH).

To view OTN errors

1 Connect the output of the DUT to the appropriate optical input.

2 Press **<Menu>**, choose **Results > Errors and Alarms > OTN** then press **<Select>**. Select the **Errors** tab.

3 In the **Error Type** second field, select the error you want to view.

To view the OTN error summary

1 Press **<Menu>**, choose **Results > Errors and Alarms > OTN** then press **<Select>**. Select the **Error Summary** tab.

2 All the OTN errors are displayed on this page.

To view the OTN error/alarm conditions

- Press the **<Show More>** key on the instrument front panel.

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Viewing OTN Alarms

In the instrument, you can generate and detect a number of different alarms in the OTN signal.

In the following procedure, it is assumed that the instrument is set up to receive an OTN signal.

For a full list of alarms refer to the technical specifications (available on the instrument website).

For more details see:

- "Equipment Response to OTN Alarms" on page 671

To monitor alarms in the OTN signal

- Press **<Menu>**, choose **Results > Errors and Alarms > OTN** then press **<Select>**. Select the **Alarms Seconds** tab.

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Viewing Errors and Alarms Using Trouble Scan

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

Trouble Scan can display up to 4 error counts (in priority order) and when alarms are detected displays the **Alarms Active** or **Alarms Were Active** message. For more information about the detected alarms, press the front panel **<Show More>** key.

To start Trouble Scan

1 Press **<Menu>**, choose **Results > Trouble Scan** then press **<Select>**.

2 Press **<Run/Stop>**. The errors and an alarm message will be displayed.

3 If **Alarms Active** is displayed, then press the front panel**<Show More>** key to determine which alarms have occurred.

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

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.

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- If no alarms are detected and all error counts are zero then “No Trouble” is displayed on the **Results > Trouble Scan** page.

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Measuring Jitter Tolerance

You can measure jitter tolerance if the instrument has jitter functionality fitted. Jitter tolerance is the ability of a network element to withstand jitter without introducing errors into the output signal. The instrument provides jitter tolerance measurements within the masks as specified in the relevant ITU-T standards.

Jitter Tolerance Modes

The jitter **auto-tolerance** measurement increases the jitter amplitude until the point of failure, repeating the analysis at a range of frequencies. The results are plotted alongside the selected tolerance mask, showing the margin by which the network element differs from the mask. A failure is indicated if a measured point falls below the mask. *Note that this measurement can take a variable amount of time for each test point.*

Fast auto-tolerance verifies that the network element conforms to the selected tolerance mask. The frequency/amplitude values are set precisely to the values defined by the tolerance mask. At each frequency point, the receiver is checked against the defined performance criteria. The results are used to determine whether the network element has passed or failed against the selected tolerance mask. *Note that fast auto-tolerance mode allows a predictable test time.*

Swept mode is an automatic jitter generation mode. In this mode the instrument generates jitter at a range of frequencies, with the amplitude defined by the selected tolerance mask. *Sweep mode does not provide any measurement results.*

Spot mode is a manual jitter generation mode, where the user selects spot frequencies at an amplitude defined by the selected tolerance mask. This can be useful for identifying any swept mask problem area that needs further analysis. *Spot mode does not provide any measurement results.*

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NOTE The auto-tolerance and fast auto-tolerance measurements are not available when the instrument is in Thru Mode or when the receiver is set to Binary.

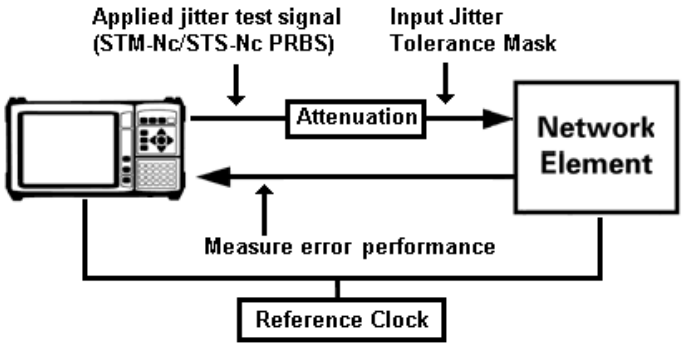
Active alarms will results in termination of the measurement and the test will record a failure, unless **Ignore Alarms** checkbox is checked.

NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

Jitter Tolerance Criteria

You can measure jitter tolerance using either the **BER Penalty** method or the **Onset of Errors** method as specified in the relevant standards.

Jitter Tolerance Measurement Setup



BER Penalty Method

This method checks the number of bit errors against the selected error threshold at each amplitude point.

Set up the OmniBER transmitter and receiver as required, including the test pattern, before starting this procedure. When testing a regenerator, set the Transmitter and Receiver to the

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same line rate as the input line interface-under-test. When testing a multiplexer, set the Transmitter to the tributary rate and the Receiver to the aggregate line rate. When testing a demultiplexer, set the Transmitter to the aggregate line rate and the Receiver to the tributary rate (e.g. set the Transmitter to OC-48 with embedded OC-3 and set the Receiver to OC-3).

Use an external optical attenuator to keep optical power at optimum level if you are performing tests on optical signals. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Viewing Optical Power" on page 455

To set up the BER Penalty method for jitter tolerance

1. Connect the OmniBER to the device-under-test.
2. Ensure that there are no errors detected in the OmniBER receiver.
3. With no jitter applied, set the optical attenuator to obtain a defined error-rate (of at least 100 bit errors per second). Use this same error-rate when setting up the OmniBER jitter tolerance test.
4. Reduce the attenuation by 1dB.
5. Measure the jitter tolerance using the following procedure.

Automatic Jitter Tolerance Testing

The jitter amplitude at which the defined error threshold is reached is plotted on the graph as the jitter tolerance for that jitter frequency. The measurement is repeated for a range of test frequencies, according to the tolerance mask selected.

To measure jitter tolerance using BER Penalty method

1. Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.
2. Set **Type** to **Jitter** and set **Mode** to **Fast** or **Auto**.

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3 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset mask or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 375). Enter the mask **Start** and **Stop** frequency values (Hz).

4 In the **Error Threshold** fields:

- set **Mode** as **BER Penalty**
- in the **Source** field select what type of errors you want to detect during the measurement
- check the **Ignore Alarms** checkbox if you want the measurement to ignore all alarms (except LOS, LOF, OOF)
- in the **Count** field set the number of errors in the gating period you want to use as a threshold in the measurement

5 Select the **Settling** (delay between the jitter being applied and the error measurement being made) and **Gate** (period of error measurement at each frequency point) timing (s).

6 Select **Start**. View the results by selecting from **Status**, **Graph** or **Table** format. When viewing the results table, you can select **Prev Page** or **Next Page** to move between results pages. You can select **Stop** to stop the measurement.

7 Check there is a floppy disk in the drive. From the Table display select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box. (Only available in Auto/Fast Mode.)

Onset of Errors Method

This method determines the jitter amplitude at which the number of errored seconds exceeds the specified threshold. The jitter amplitude at which the defined error threshold is reached is plotted on the graph as the jitter tolerance for that jitter frequency. The measurement is repeated for a range of test frequencies, according to the tolerance mask selected.

Set up the OmniBER transmitter and receiver as required, including the test pattern, before starting this procedure.

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To perform the Onset of Errors method for jitter tolerance

1 Connect the OmniBER to the device-under-test.

2 Ensure that there are no errors detected in the OmniBER receiver.

3 Press **<Smart Test>**, choose **Jitter/Wander Tolerance** then press **<Select>**.

4 Set **Type** to **Jitter** and set **Mode** to **Fast** or **Auto**.

5 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset mask or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 446). Enter the mask **Start** and **Stop** frequency values (Hz).

6 In the **Error Threshold** fields:

- set **Mode** as **Onset of Errors**
- check the **Ignore Alarms** checkbox if you want the measurement to ignore all alarms (except LOS, LOF, OOF)
- in the **Errored Seconds** field set the number of errored seconds you want to use as a threshold in the measurement. The default number of errored seconds is 2.

7 Select the **Settling** (delay between the jitter being applied and the error measurement being made) and **Gate** (period of jitter generation at each frequency point) timing (s). The **Gate** default is 30s.

8 Select **Start**. View the results by selecting from **Status**, **Graph** or **Table** format. When viewing the results table, you can select **Prev Page** or **Next Page** to move between results pages. You can select **Stop** to stop the measurement.

9 Check there is a floppy disk in the drive. From the Table display select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box. (Only available in Auto/Fast Mode.)

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Spot Mode Settings

To set up Spot Mode

1 Set **Mode** to **Spot**.

2 In the **Input Mask** area, select a preset **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 446).

3 Enter the **Frequency (Hz)**.

4 Select **Start**.

Sweep Mode Settings

To set up Sweep Mode

1 Set **Mode** to **Sweep**.

2 In the **Input Mask** setup area, select the number of **Test Points**. Select a preset **Mask** or a user-defined mask from the list, or select **Edit User masks...** to create/edit user masks (see "Defining a User Mask" on page 375). Enter the mask frequency **Start** and **Stop** values (Hz), or select the default min and/or max values.

3 Select the **Settling** (delay between the jitter frequency/amplitude being applied and the error measurement being made) timing (s).

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Defining a User Mask

The jitter standards specify the lower limit of maximum tolerable input jitter in the form of a mask. The measured input jitter tolerance of the network element must be greater than that of the mask specified by the relevant standard.

The instrument allows you define up to 10 user masks. These are displayed in both graph and table format.

To open the user mask setup window

1 Press the **<Smart Test>** button and select **Jitter/Wander Tolerance**.

2 Set **Type** to **Jitter**.

3 Select **Edit User Masks...** button.

NOTE Note that you can not edit a user mask that is currently being used in a jitter tolerance or transfer measurement.

To create/edit a User Mask

1 In the **Manage Masks** fields, select **New** or choose a mask from the drop-down list.

2 For a new mask, enter the **Title** (Max 15 characters) using the instrument keypad. Press **<Select>**.

3 In the **Mask Points** fields, select **Add...** to add a point to the mask. Enter the **Frequency (Hz)** and **Amplitude (UI),** then select **OK**. The new point appears in the table to the right of display.

4 Select **Delete...** to delete a point; the Delete point window lets you choose which point number you want to delete.

5 Select **Edit...** to change the frequency/amplitude of a point.

6 You can also shift a mask by a percentage amount. This shift applies to all the points. The shift increases or decreases the amplitude of the point at each frequency. In the **Shift Mask** field select the required percentage change (positive or

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negative) and then select **Shift** to apply the change. The graph and table on the right reflect the change.

7 If the list of points extends beyond the end of the table, use **Prev Page** and **Next Page** to view the rest of the listed points.

8 Select **Close** when you have finished defining the mask.This saves the mask.

NOTE If any points on the selected mask are not within the capability of the transmitter, the maximum possible amplitude will be output and a warning message will be displayed on the Status line at the bottom of the screen.

To copy a User Mask

1 In the **Manage Masks** field, select **New**.

2 Move into the **Title** field and type in the name of your mask using the instrument keypad and press **<Select>**.

3 Select the **Copy...** button.

4 In the **Copy User Mask** window, select the mask you want to copy to your new mask. Select **OK**. The selected mask is now copied to your newly named mask.

5 To refine the mask, you can:
Select **Shift Mask** - Enter a plus or minus percentage value to change all the amplitude values of the mask. Select the **Shift** button.
Select **Add...** - Enter the **Frequency (Hz)** and **Amplitude (UI)** of a point, then press **OK** to add a point.
Select **Delete**... - Select the point number (refer to mask table to right of display) you want to delete, then press **OK**.
Select **Edit...** - Select the point number (refer to mask table to right of display) that you want to change. Change the **Frequency (Hz)** and/or **Amplitude (UI)**, then select **OK**.

6 If the list of points extends beyond the end of the table, use **Prev Page** and **Next Page** to view the rest of the listed points.

7 Select **Close** when you have finished copying the mask.

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To delete a User Mask

1 In the **Manage Masks** field select a mask from the drop-down list.

2 Select the **Delete** button.

3 Select **Close** to close the **User Masks** window.

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Measuring Jitter Transfer

You can measure jitter transfer if the instrument has jitter functionality fitted. Results are given in either graphical form (Gain versus Frequency) or tabular form.

Jitter transfer is the ratio of output jitter amplitude to input jitter amplitude versus jitter frequency for a given bit rate. For example, in a regenerator where the device output is loop-timed from the input, some of the jitter present at the input port of the regenerator will be transferred to the output port. On networks with cascaded equipment on long trunk routes it is important to limit jitter transfer.

For the jitter transfer measurement, first use a default 5s Gate time (the time spent at each measurement point) and 5s Settling time (the time between jitter being applied and the measurement beginning, during which the unit under test is settling). Then increase to a 10s Gate time and 20s Settling time, to optimize measurement accuracy against the overall measurement duration. Automatic band filtering is used in the jitter receiver, providing selection and measurement of the relevant jitter components to provide accurate and repeatable results.

You must perform a back-to-back calibration run before making the jitter transfer measurement via the device-under-test.

NOTE Jitter transfer measurements are not available when the instrument is in Thru Mode.

NOTE Ensure that the instrument has been turned on for at least 30 minutes prior to running jitter measurement tests.

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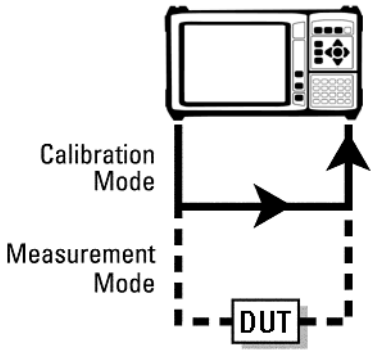
Pre-Measurement Calibration

Connect the instrument in a loopback configuration (Optical-to-Optical or Binary-to-Binary) and perform a calibration cycle before making a jitter transfer measurement.

This procedure assumes that you have set up the Transmitter and Receiver as required.

Add an optical attenuator between the IN and OUT ports of the optical module, to keep optical power at optimum level. Check optical power before making the measurement, to ensure accuracy. For more information, see:

- "Viewing Optical Power" on page 455.



NOTE Switch on the instrument for at least 1 hour before starting a calibration cycle. The climatic conditions must remain stable from switch-on until the end of the measurement, for accurate results.

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To calibrate the instrument

1 Press **<Smart Test>**, choose **Jitter Transfer** then press **<Select>**.

2 In the Input Mask setup area, select the number of **Test Points**. Select either a preset input **Mask** or a user-defined mask (for more information, see "Defining a User Mask" on page 446).

3 Enter the mask frequency **Start** and **Stop** values (Hz).

4 Select the **Settling** and **Gate** (measurement period) timing (sec).

5 In the **Run Type** field, select **Calibration**.

6 Select **Start**. The status of the calibration run is displayed. When the calibration has finished, complete the jitter transfer measurement (see "Jitter Transfer Measurement" on page 451). You can select **Stop** to stop the calibration before it has finished.

NOTE During calibration and measurement of jitter transfer the instrument goes into a locked state. This stops the user from changing the instrument settings which would make the calibration or measurement invalid. If you want to perform measurements other than jitter transfer then select the 'Release Instrument Lock' button and proceed.

NOTE It is recommended that the maximum test period (from the start of calibration to the end of the measurement) does not exceed 90 minutes, otherwise the accuracy specification cannot be guaranteed.

Jitter Transfer Measurement

NOTE Start the jitter transfer measurement within 10 minutes of completion of the calibration cycle.

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To measure jitter transfer

1. Remove the loopback configuration from the interfaces. Connect the instrument to the device-under-test.
2. You can select a **Pass Mask** to compare the measurement results with. Also, you can add an offset to the Pass Mask, by selecting a preset **Offset** or entering a user-defined offset.
3. Select **Start** to make the measurement. The results are provided in **Graph** (Gain versus Frequency) or **Table** format. You can select **Stop** to stop the measurement.
4. Check there is a floppy disk in the drive. Select **Save** to save the results. The filename will be automatically generated and displayed in a dialog box. Click **Close** to close the dialog box.

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Viewing Jitter Measurement Results

You can view jitter measurement results if the instrument has jitter functionality fitted. The results shown depend on the Test Function **Mode** (jitter) selected.

Jitter unlock (JUL) and jitter out-of-range (JOR) are indicated by the front panel jitter LED. Details of these jitter alarms are given when you press the **<Show More>** key on the instrument's front panel, shown as general alarms. Also jitter alarms are displayed on the results page (see below for details of how to view the jitter results page).

The instrument displays jitter hit results. Jitter hits are detected when the programmable threshold for positive and negative jitter values are exceeded. The detector is reset when the jitter level falls below 75% of the hit threshold. Positive and negative jitter hit counts are also included in Trouble Scan.

'Total' and 'Last Second' amplitude results are displayed for each of the active receiver measurement bandwidths.

▶ **To view Jitter results**

1 Press **<Menu>**, choose **Results > Jitter/Wander** then press **<Select>**.

2 Select the results required.

See "Monitoring Jitter on an OTN Signal" on page 420 for information on setting up the receiver for jitter measurements.

JUL and JOR Alarm Conditions

Jitter Unlock (JUL) can be set if the jitter receiver loses lock while measurements are being made. This can happen if loss of line clock occurs at the binary clock input, if the line clock is outside the specified frequency range for the line rate or if loss of electrical data occurs at the binary data interface input. JUL can also occur if there is loss of optical data at the optical data input, this causes LOS alarm to be set (in 'Optical Data' jitter measurement mode), which automatically sets JUL.

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The Jitter Overrange (JOR) is designed to prevent measurements being presented to the user if the instrument is measuring in a non-linear state due to high input jitter levels. The 'HP Filters Off' path is the most likely to detect excessively high input jitter levels and is kept running even when High Path Filters is selected. This means that the JOR alarm may be raised, even though jitter results displayed on screen may are within the specified range.

If JOR is asserted, try increasing the jitter measurement range until JOR is de-asserted.

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Viewing Optical Power

The optical power at the receiver is measured continuously. This measurement is independent of any test period. You can use this measurement to test the quality of the signal. Any degradation in the quality of the interconnections (cleanliness of the optical connectors) results in reduced optical power in the receiver.

To measure optical power

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

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

NOTE An optical power measurement is also available in the Measurement Record System. See "Viewing Results Graphically" on page 563.

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Viewing the Signal 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.

For more information see:

- "Viewing the OPU Frequency Offset" on page 457

To view signal frequency

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

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Viewing the OPU Frequency Offset

The Optical Payload Unit (OPU) can have an offset relative to the line frequency. You can measure the OPU frequency offset in the instrument receiver as follows.

To view the OPU frequency offset

- Press **<Menu>**, choose **Results > Network Measurements > OPU Offset** then press **<Select>**.

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5
Instrument Setup and Use - PDH

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Setting up the PDH Receiver 477
Storing and Recalling Instrument Settings 492
Setting Up Thru Mode Operation 491
Measurements and Results 493

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

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Setting up the PDH Transmitter

Physical

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- "Selecting the PDH Transmit Clock Source" on page 464
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Framed or Unframed Signal

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- "Transmitting a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 468
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Payload

- "Inserting an External 2 Mb/s Payload into a PDH Signal" on page 473

Error and Alarms

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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 463.

To set up the PDH transmit interface

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

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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**.

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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 > Physical** then press **<Select>**.

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.

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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.

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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 467
- “Transmitting a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 468
- “PRBS Polarity" on page 471

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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 > PDH/DSn** then press **<Select>**.

2 Set **Framing** to the required setting, then select **Unstructured**.

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

4 Select the required pattern (inverted or normal).

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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).

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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 > PDH/DSn** then press **<Select>**.

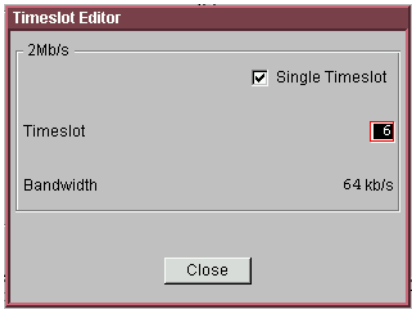
2 Set the **Framing** and select **Structured**.

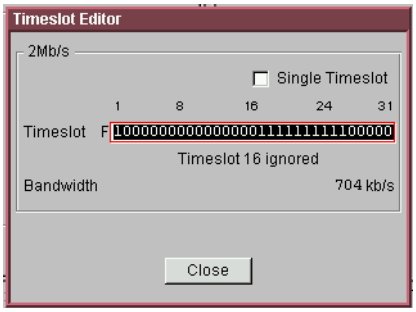
3 Set the **Test Channel Rate**. Enter values in the **Test Channel** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you select the **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** checkbox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

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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 > Pattern** then press **<Select>**.

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.

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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.

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

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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 > PDH/DSn** then press **<Select>**.
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.

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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 technical specifications (available on the instrument website) 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.

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Adding Alarms to a PDH Signal

You can transmit alarms in a PDH signal.

Refer to the technical specifications (available on the instrument website) 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.

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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**.

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Setting up the PDH Receiver

Physical

- “Setting Up the PDH Receive Interface" on page 478

Framed or Unframed Signal

- “Monitoring a Framed PDH Signal (Unstructured Payload)" on page 481
- “Monitoring a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 482
- “Monitoring an Unframed PDH Signal" on page 486

Payload

- “Dropping a 2 Mb/s Payload from a PDH Signal" on page 488
- “Dropping a Voice Channel from a PDH Signal to the Internal Speaker" on page 487

Signaling and Spare Bits, Switching Off All Test Functions

- “Monitoring Signaling Bits in Structured 2 Mb/s Signal" on page 490
- “Monitoring Spare Bits of a 2 Mb/s signal in a DS3 Signal" on page 540
- “Switching Off All Test Function Features" on page 476

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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 Settings" on page 479.

The receiver derives its timing from the input signal.

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To set up the PDH Receive interface

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

2 Set the **Signal Mode** to **PDH/DSn**.

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

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

5 Set the **Operating Level** to **Terminate** or **Monitor**. If you select **Monitor**, you can set the **Gain** to **20 dB** or **26 dB**.

6 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 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**.

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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 481
- “Monitoring a Framed PDH Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 482
- “PRBS Polarity" on page 485

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

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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).

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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 > PDH/DSn** then press **<Select>**.

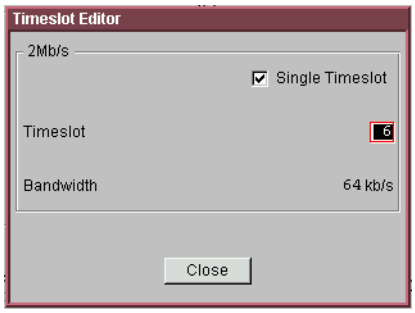
2 Set the **Framing** and select **Structured**.

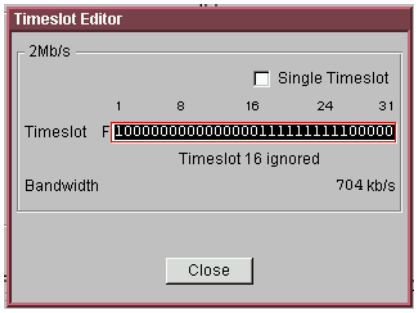
3 Set the **Test Channel Rate**. Enter values in the **Test Channel** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you select the **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** checkbox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

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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 > Pattern** then press **<Select>**. 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.

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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.

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

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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 > PDH/DSn** then press **<Select>**.
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**.

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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 > PDH/DSn** then press **<Select>**.
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.

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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.

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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>**.

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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.

If jitter functionality is fitted, you can add jitter to signals in 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**.

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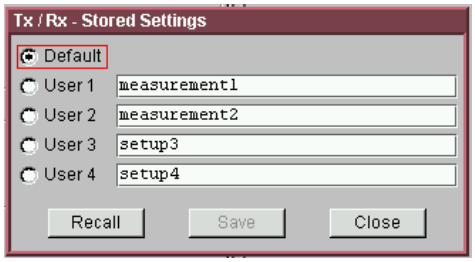
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Storing and Recalling Instrument Settings

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 **System > 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 **System > 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**.

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Measurements and Results

Physical

- "Measuring the Frequency of a PDH Signal" on page 494

Errors and Alarms

- "Viewing PDH Errors (Total and Last Second)" on page 496
- "Viewing the PDH Summary of Errors" on page 497
- "Viewing Errors/Alarms using the <Show More> Key" on page 498
- "Viewing Alarms in a PDH Signal" on page 499
- "Viewing Errors and Alarms Using Trouble Scan" on page 500

Service Disruption and Network Analysis

- "Measuring Service Disruption Time in a PDH Network" on page 501
- "Viewing the ITU Analysis of PDH Errors and Alarms" on page 503

Results Logging

- "Measurement Logging" on page 559
- "Viewing Results Graphically" on page 563

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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 > Physical** then press **<Select>**.
2. Select **Signal Rate**, then select the required signal and interface settings.
3. Press **<Menu>**, choose **Results > Signal Quality > Frequency Meas** then press **<Select>**.

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Viewing PDH Errors

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

- “Viewing PDH Errors (Total and Last Second)" on page 496
- “Viewing the PDH Summary of Errors" on page 497
- “Viewing Errors/Alarms using the <Show More> Key" on page 498

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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 technical specifications (available on the instrument website) for full details of errors results.

▶ **To view PDH errors**

1 Press **<Menu>**, choose **Results > Errors and Alarms > PDH/DSn** then press **<Select>**. Select the **Errors** tab.

2 Select the **Error Type** results to be displayed.

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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 > Errors and Alarms > PDH/DSn** then press **<Select>**. Select the **Error Summary** 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.

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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.

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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 technical specifications (available on the instrument website) for full details of the alarms.

To view alarms in a PDH signal

- Press **<Menu>**, choose **Results > Errors and Alarms > PDH/DSn** then press **<Select>**. Select the **Alarm Seconds** tab.

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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>** keyto 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.

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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 689.

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 > Service Disruption** then press **<Select>**.
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 688.

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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.

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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 604. The measurement will not be affected if you switch between the different results provided.

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6
Instrument Setup and Use - DSn

Setting up the DSn Transmitter 507
Setting up the DSn Receiver 527
Setting Up Thru Mode Operation 543
Storing and Recalling Instrument Settings 544
Measurements and Results 545

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

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Setting up the DSn Transmitter

Physical

- "Setting Up the DSn Transmit Interface" on page 508
- "Selecting the DSn Transmit Clock Source" on page 510
- "Adding Frequency Offset to the DSn Signal" on page 511

Framed or Unframed Signal

- "Transmitting a Framed DSn Signal (Unstructured Payload)" on page 513
- "Transmitting a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 514
- "Transmitting an Unframed DSn Signal" on page 518

Payload

- "Inserting an External 2 Mb/s or DS1 Payload into a DS3 Signal" on page 519

Errors, Alarms, FEAC Messages and Loop Codes

- "Adding Errors to a DSn Signal" on page 520
- "Adding Alarms to a DSn Signal" on page 521
- "Transmitting FEAC Messages in a DS3 Signal" on page 522
- "Transmitting DS1 Loop Codes" on page 523
- "Switching Off All Test Function Features" on page 526

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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 509.

To set up a DS1 or DS3 transmit interface

1. Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Physical** then press **<Select>**.
2. Set the **Signal Rate** to **DS1** or **DS3**.
3. Select the **Line Code** (DS1 line signal only).
4. Select the **Line Output Level**.

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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**.

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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 > Physical** then press **<Select>**.

2 Select the **Clock Source**. The **Clock Format** is automatically set to **DS1 Data** if you select an external clock source.

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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.

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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 513
- "Transmitting a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 514
- "PRBS Polarity" on page 517

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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 > PDH/DSn** then press **<Select>**.

2 Set **Framing** to the required setting, then select **Unstructured**.

3 Press **<Menu>**, choose **Tx/Rx > Transmitter Settings > Pattern** then press **<Select>**. Then select the required pattern (inverted or normal).

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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).

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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 > PDH/DSn** then press **<Select>**.

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

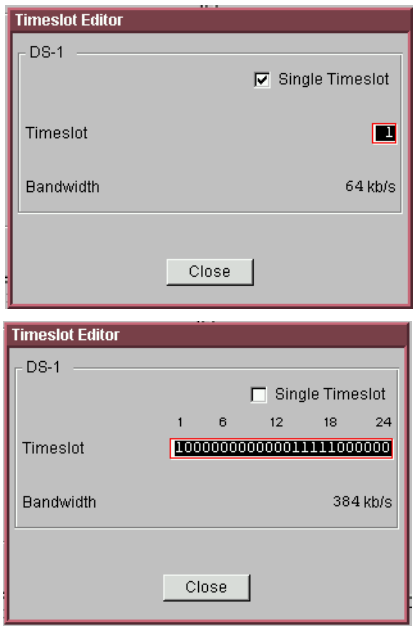
3 Set the **Test Channel Rate**. Enter values in the **Test Channel** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you select the **56 kb/s** or **64 kb/s** box, a timeslot selection window will be displayed. Select the **Single Timeslot** 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

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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 > Pattern** then press **<Select>**.

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.

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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.

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

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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 > PDH/DSn** then press **<Select>**.
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.

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Adding Errors to a DSn Signal

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

Refer to the technical specifications (available on the instrument website) 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.

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Adding Alarms to a DSn Signal

You can transmit alarms in a DSn signal.

Refer to the technical specifications (available on the instrument website) 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.

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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 > PDH/DSn** then press **<Select>**.

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**.

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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 523
- "Transmitting Out-of Band DS1 Loop Codes" on page 524

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 > PDH/DSn** then press **<Select>**.

2 Set **Framing** as required.

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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	

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To transmit an out-of-band DS1 loop code

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

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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**.

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Setting up the DSn Receiver

Physical

- “Setting Up the DSn Receive Interface" on page 528

Framed or Unframed Signal

- “Monitoring a Framed DSn Signal (Unstructured Payload)" on page 531
- “Monitoring a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 532
- “Monitoring an Unframed DSn Signal" on page 536

Payload

- “Dropping a DS1 Payload from a DS3 Signal" on page 537
- “Dropping a Voice Channel from a DSn Signal to the Internal Speaker" on page 538

FEAC Messages, Signaling and Spare bits, DS1 loop codes and Switching Off All Test Functions

- “Monitoring FEAC Messages in a DS3 Signal" on page 539
- “Monitoring Signaling Bits in Structured DS1 or 2 Mb/s Signal" on page 541
- “Monitoring Spare Bits of a 2 Mb/s signal in a DS3 Signal" on page 540
- “Monitoring DS1 Loop Codes" on page 542
- “Switching Off All Test Function Features" on page 526

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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 Settings" on page 529.

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 > Physical** then press **<Select>**.
2. Set the **Signal Mode** to **PDH/DSn**.
3. Set the **Signal Rate** to **DS1** or **DS3**.
4. Select the **Line Code** (DS1 signals only).

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5 Set the **Operating Level** to **Terminate** or **Monitor**. If you select **Monitor**, you can set the **Gain** to **20 dB** or **26 dB**.

6 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 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**.

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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 531
- “Monitoring a Framed DSn Signal (Structured Payload, Signaling Bits and Spare Bits)" on page 532
- “PRBS Polarity" on page 534

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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 > PDH/DSn** then press **<Select>**.

2 Set **Framing** to the required setting, then select **Unstructured**.

3 Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Pattern** then press **<Select>**. Then select the required pattern (inverted or normal).

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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.

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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 > PDH/DSn** then press **<Select>**.

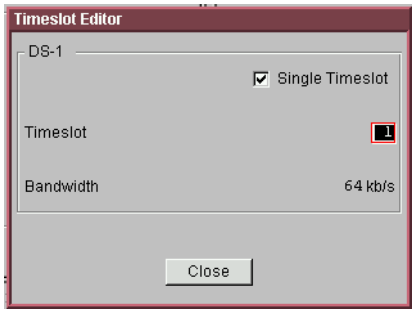
2 Set the **Framing** and select **Structured**.

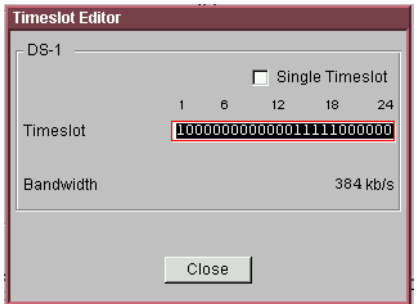
3 Set the **Test Channel Rate**. Enter values in the **Test Channel DS2**, **DS1/2Mb/s** and **56/64 kb/s** boxes to select the required channel (the selected test channel rate determines which boxes will be active). When you click on the **56 kb/s** or **64 kb/s** box, a timeslot selection window will 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

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4 Select **Test Channel Framing** (DS3 line rate only).

5 Press **<Menu>**, choose **Tx/Rx > Receiver Settings > Pattern** then press **<Select>**.

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.

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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.

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

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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 > PDH/DSn** then press **<Select>**.

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.

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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 > PDH/DSn** then press **<Select>**.
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**.

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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 > PDH/DSn** then press **<Select>**.

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.

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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>**.

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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>**.

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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>**.

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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.

If jitter functionality is fitted, you can add jitter to signals in 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**.

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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

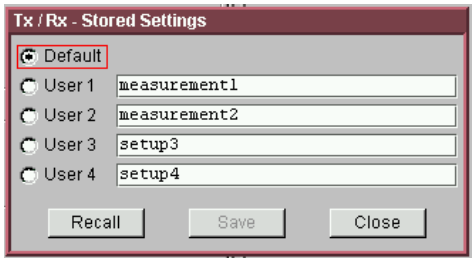
1 Press **<Menu>**, choose **System > Stored Settings** then press **<Select>**.

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 **System > 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**.

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Measurements and Results

Physical

- "Measuring the Frequency of a DSn Signal" on page 546

Errors and Alarms

- "Viewing DSn Errors (Total or Last Second)" on page 548
- "Viewing the DSn Summary of Errors" on page 549
- "Viewing Errors/Alarms using the <Show More> Key" on page 550
- "Viewing Alarms in a DSn Signal" on page 551
- "Viewing Errors and Alarms Using Trouble Scan" on page 552

Service Disruption and Network Analysis

- "Measuring Service Disruption Time in a DSn Network" on page 553
- "Viewing the ITU Analysis of DSn Errors and Alarms" on page 556

Results Logging

- "Measurement Logging" on page 559
- "Viewing Results Graphically" on page 563

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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 > Physical** then press **<Select>**.
2. Select **Signal Rate**, then select the required signal and interface settings.
3. Press **<Menu>**, choose **Results > Signal Quality > Frequency Meas** then press **<Select>**.

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Viewing DSn Errors

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

- “Viewing DSn Errors (Total or Last Second)" on page 548
- “Viewing the DSn Summary of Errors" on page 549
- “Viewing Errors/Alarms using the <Show More> Key" on page 550

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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 technical specifications (available on the instrument website) for full details of errors results.

▶ **To view errors in a DSn signal**

1 Press **<Menu>**, choose **Results > Errors and Alarms > PDH/DSn** then press **<Select>**. Select the **Errors** tab.

2 Select the **Error Type** results to be displayed.

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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 > Errors and Alarms > PDH/DSn** then press **<Select>**. Select the **Error Summary** 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.

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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.

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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 technical specifications (available on the instrument website) for full details of the alarms.

▶ **To view alarms in a DSn signal**

- Press **<Menu>**, choose **Results > Errors and Alarms > PDH/DSn** then press **<Select>**. Select the **Alarm Seconds** tab.

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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.

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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 689.

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 > Service Disruption** then press **<Select>**.
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 688.

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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.

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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.

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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 604. The measurement will not be affected if you switch between the different results provided.

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7
Instrument Details

Logging, Instrument Control and File Management Tools 558
Technical Support 594

This chapter gives information on additional features provided by the instrument, plus information on technical support.

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Logging, Instrument Control and File Management Tools

Measurement Control and Results Management

- "Measurement Logging" on page 559
- "Setting the Measurement Timing" on page 560
- "Setting Time and Date" on page 562
- "Viewing Results Graphically" on page 563

Instrument Control and Settings

- "System Options" on page 570
- "System Preferences" on page 571
- "Manufacturing Data" on page 573
- "Self Test" on page 574
- "Keyboard Lock" on page 573
- "Remote Control" on page 579

User's Own Help Files, File Management and Printing

- "Creating Your Own Help Files" on page 584
- "Accessing Your Own Help Files" on page 586
- "File Management" on page 587
- "Print Control Key (Printer Setup and Capturing Screendumps)" on page 592

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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 560.

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 Report** - 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 **Results > Measurement Setup > 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 588**

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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 Setup > Logging** 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 Setup > Logging** 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**,

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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 Setup > Logging** 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.

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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.

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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:

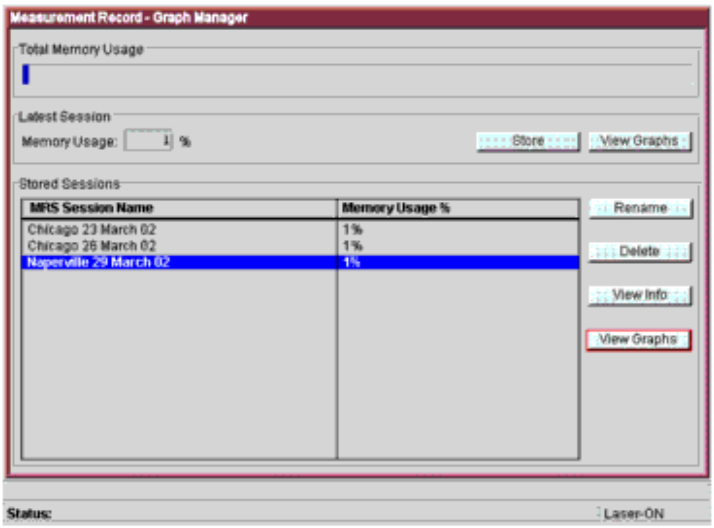
- **Total Memory Usage** - displays how much of the internal storage has been used. If this becomes full, delete some of the previously stored graphs using the Stored Sessions section.
- **Latest Session** - details the active graph and percentage of available memory currently being used.
- **Stored Sessions** - allows the recall of previously stored graphs. The session name and memory usage are displayed.

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To view graphs

1 Press **<Menu>**, choose **Graph > Graph Manager** then press **<Select>**.



2 Select **View Graphs** from either the **Latest Session** or **Stored Sessions** section as appropriate. The Graph Viewer window is displayed. This window is split into two sections.

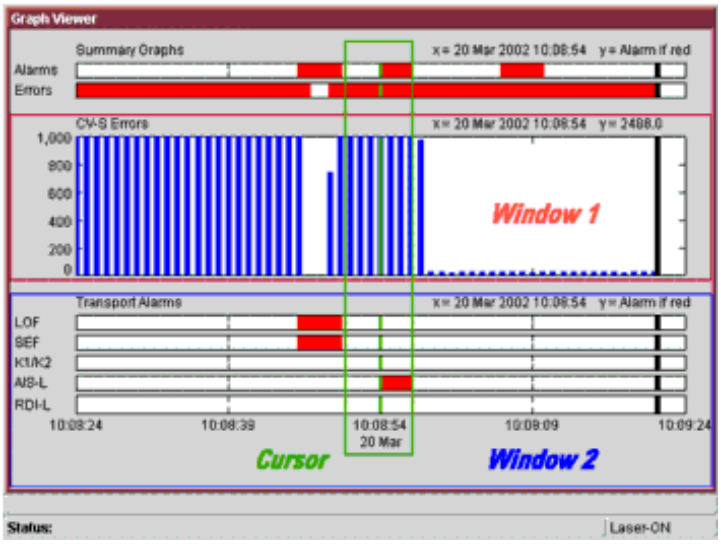
- Summary Graphs (top section)
- Detail Graphs (bottom section)

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.

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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.

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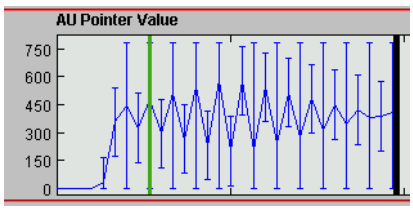
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The **<Menu>** key also allows you access to the session manager to store/recall graphs or to close the graph window and return to the user interface. For more information, see "Storing Graphs" on page 567.

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.

View Range

In the cases where the results have a minimum and maximum value, as in the case of optical power and pointer value, the graphical representation in some ranges show a maximum, minimum and average value at a single point. This is shown graphically as follows:



Data for measurement record system graphs is sampled every second so that when you have zoomed out to, say, a range of 1 hour, at each x-axis point 60 samples will have been taken. The display at this point shows the maximum, minimum and average value of these 60 points, using a vertical line with the maximum and minimum at the top and bottom of the line and the average value which is connected between adjacent points to show the trend of the data.

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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:

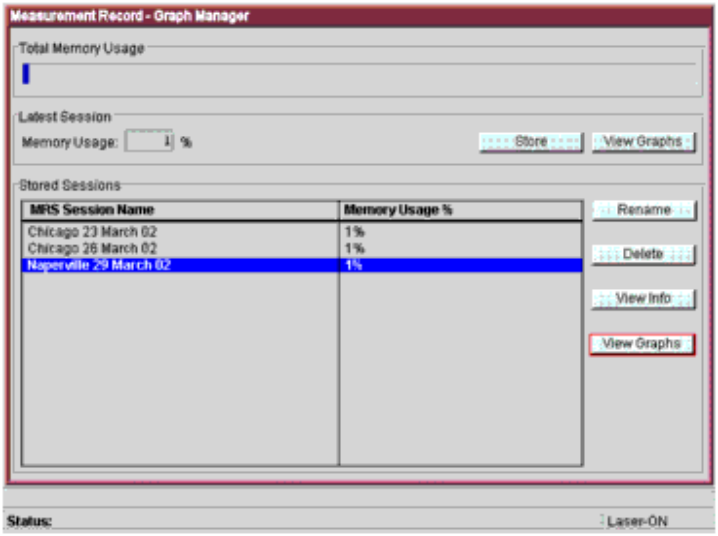
- **Total Memory Usage** - displays how much of the internal storage has been used. If this becomes full, delete some of the previously stored graphs using the Stored Sessions section.
- **Latest Session** - details the active graph and percentage of available memory currently being used.
- **Stored Sessions** - allows the recall of previously stored graphs. The session name and memory usage are displayed.

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To store graphs

1 Press **<Menu>**, choose **Graph > 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.

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To recall graphs

1 Press **<Menu>**, choose **Graph > 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 **Rename**.

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 (time) must be manually selected to suit the data being viewed.

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.

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System Options

The System Options window lets you view the following:

- Instrument Options: Options installed.
- Software Version: Firmware revision and build date/time.

▶ **To view instrument options or software version**

- 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.

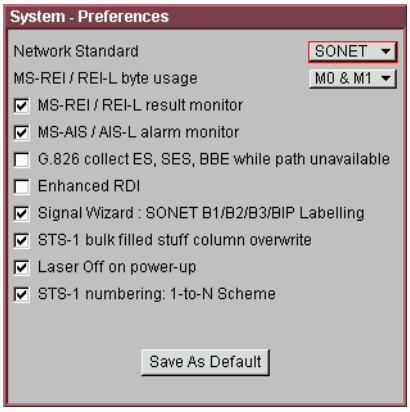
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System Preferences

To access the System Preferences window

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:

- MS-REI/REI-L Results Monitor. Use this to enable (default)/disable the collection of MS-REI/REI-L results.
- MS-AIS/AIS-L Alarm Monitor. Use this to enable (default)/disable the collection of MS-AIS/AIS-L alarms.
- G826 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 604.

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- Enhanced RDI. Use this to enable (default)/disable the Enhanced Remote Defect Indication (RDI) alarm function (Telecordia GR-253 CORE Issue 3 and ITU-T G.707).
- MS-REI/REI-L: M0, M1 Byte Usage (STM-64/OC192). 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.
- Audio Control. Select the **Audio Control** field and press the **<Select>** key. Use this window to switch on/off an audible beep that indicates reception of an error or alarm. The volume of the beep can be set to Low, Medium or High.
- STS-1 bulk-filled stuff column overwrite - You can overwrite all bytes including or excluding the fixed stuffing bytes.
- Access Control - This field cannot be enabled by the user.

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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>**.

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Self Test

The self test consists of a range of tests, including confidence tests for the measurement interfaces, to verify that the instrument is operating correctly. 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 Verification manual (on the Agilent OmniBER website).

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 If using the 2.5 Gb instrument, run the confidence test for each 2.5/2.66 Gb/s- 52 Mb/s input 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.

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Confidence Test Failure

If the confidence test fails:

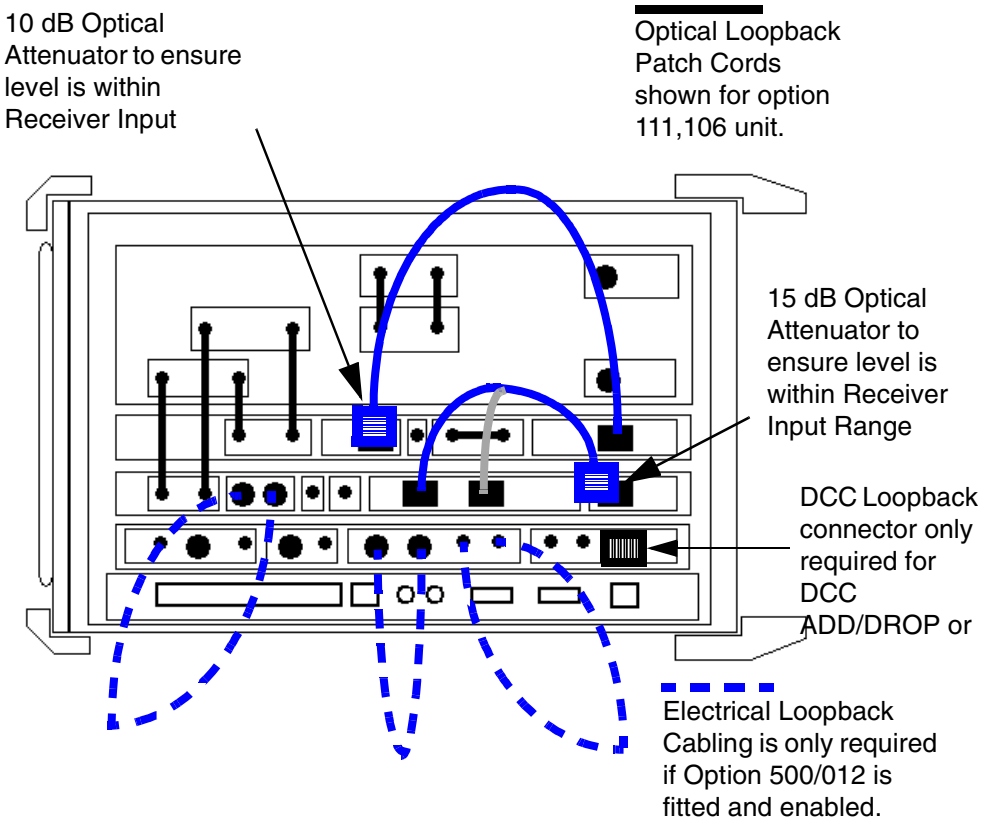
- Make sure all the correct loopback connections are in place.
- With optical interface failures, clean all optical connections with a recognized cleaning kit before repeating the confidence test. For more information on cleaning optical connectors, see the Installation and Verification Manual (on the CD-ROM).
- If the problem persists then contact your local Agilent Service Office or representative.

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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 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.

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- 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.

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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

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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

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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**.

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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.

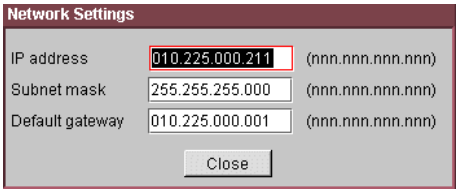
2 Press **<Menu>**, choose **System > Remote Control** then press **<Select>**.

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).

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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**.

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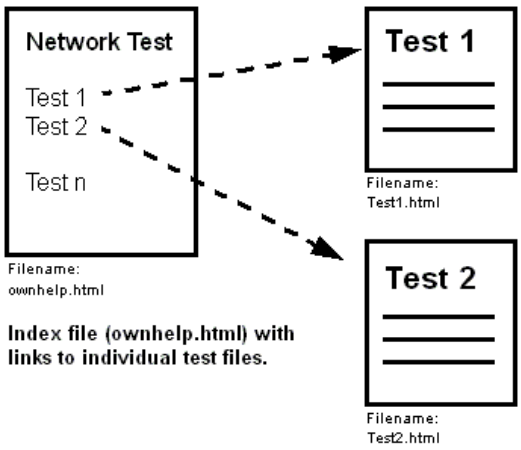
User's Own Help Files

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 583
- "Creating Your Own Help Files" on page 584
- "Accessing Your Own Help Files" on page 586

Your Own Help Files - Hierarchy



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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 585.

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 589).

6 To access your files via the instrument's Online Help system, see: "Accessing Your Own Help Files" on page 586.

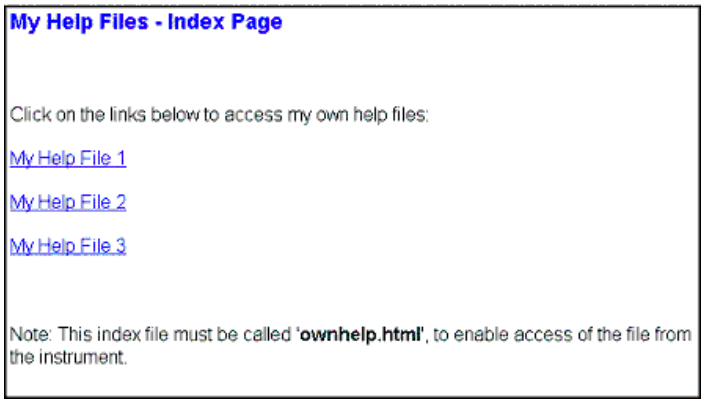
NOTE Use a meaningful name for your files, and save them with the extension'**.html**'. Images should be in JPG or GIF format.
When you add files to the instrument, any files with the same name will be overwritten by your new files.

CAUTION You **must** load your index file ('**ownhelp.html**') onto the instrument to be able to access your files.

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Example of the Index File (ownhelp.html)



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 fonts as they are not supported on the instrument.
- Any images you include should be either GIF or JPEG format.
- Design a page size and layout appropriate for the size of the instrument display. For example, write several short documents, rather than one long one, and make sure inserted tables will fit the screen width (**560 pixels** or **15cm wide**).
- Have all the documents and images in one folder/directory. The instrument does not support file tree structures.
- The total size of the files should not be more than 1.44Mb. You cannot download files 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.

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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.

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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 559

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 586

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 593.

For information on how to manage your stored files, see:

- “Copying an Internal File to a Floppy Disk" on page 588
- “Importing Files from a Floppy Disk" on page 589
- “Deleting Files from a Floppy Disk" on page 590
- “Deleting Files from the Instrument" on page 591

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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**.

3 Select **Action**, then press **<Select>**.

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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>**.

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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>**.

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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>**.

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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 593
- "Recommended Printers" on page 593

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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 591.

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 588

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.

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Technical Support

For technical support information, see:

- “Operators Maintenance" on page 595
- “Instrument Reboot (Cold Start)" on page 598
- “CD-ROM Resources" on page 599
- “Frequently Asked Questions" on page 599

For further technical support, contact your nearest Agilent Sales Office.

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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
- Cleaning SMA 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	
Lint-free swab	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.

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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 These procedures also apply to any Optical patch cords or attenuators used to avoid subsequent contamination/damage to the Optical ports.

Replace the adapters in the optical connector. Secure in place by clicking the retaining lever back into position.

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Cleaning SMA Connectors

Depending on application and environment it may be appropriate to clean the grounding threads of SMA connectors (and SMA semi-rigid links where fitted) using the materials in the following table. This ensures optimum connection and signal screening.

Description	Agilent Part Number
Compressed Air Can or Blow Brush	
Isopropyl Alcohol	
Lint-free Swab	5080-5400

CAUTION Do not insert any tool or object into the SMA connector ports to avoid damage.

To clean the SMA connectors

1. Disconnect the instrument from the power line before commencing this cleaning procedure.
2. Apply some isopropyl alcohol to a piece of the clean lint-free cloth and clean the outer threads of SMA bulkhead connectors taking care not to introduce cleaning fluid into center connection.
3. Where a unit has SMA semi-rigid links carefully remove ONE of these using an appropriate spanner, taking note of position and orientation. Clean the bulkhead connectors as in step 2 and clean the inside threads of the SMA link taking care not to bend/damage the center connector pin.
4. Carefully refit the link taking care not to mis-thread or overtighten, as damage could result in an expensive repair. Always use a torque spanner to refit and set to 0.9 Nm.

Repeat for other SMA links and also any SMA cables used in the test configuration to avoid subsequent contamination of instrument connectors.

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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. Current menu settings will be lost and the instrument will power up in its default state.

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. When the “Press the Menu key for startup options” text is displayed, immediately press the **<Menu>** key.
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.” Press Select to close this window.

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CD-ROM Resources

The instrument CD ROM is a useful resource for all users. It contains training materials and support information, including:

- User documentation
- 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.

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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:

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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 manual (available on the product CD-ROM) and the Verification manual, available on the instrument website (www.agilent.com/comms/otn_jitter or www.agilent.com/comms/otn_2-5g).

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.

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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.

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8
Telecoms Concepts

Introducing ITU Performance Analysis 604
Signal Rates 615
Summary of Errors and Alarms 616
SDH Concepts 618
SONET Concepts 641
OTN Concepts 661
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Glossary 702

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.

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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 605
- "ITU G.826 (02/99)/G.828 (02/00)" on page 606

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- "ITU M.2101 (06/00)/M.2101.1(04/97)" on page 608
- "ITU M.2100" on page 609
- "ITU M.2110" on page 610
- "ITU M.2120" on page 612

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.

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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.

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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.

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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.

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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.

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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

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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

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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).

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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

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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.

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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		

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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 616
- "Error Definition Table" on page 617

Alarm Definition Table

Acronym	Alarm
AIS	Alarm Indication Signal
BDI	Backwards Defect Indication
GID	Group Identifier mismatch
IAE	Incoming Alignment Error
INCAIS	Incoming AIS
JOR	Jitter Out of Range
JUL	Jitter UnLock
LCK	Locked Indication
LOA	Loss of Alignment
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

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Acronym	Alarm
RAI	Remote Alarm Indication
RDI	Remote Defect Indication
RFI	Remote Failure Indication
SEF	Severely Errored Frame
SQM	Loss of Sequence
TIM	Trace Identifier Mismatch
UNEQ	Unequipped

Error Definition Table

Acronym	Error
BEI	Backwards Error Indication
BIP	Bit Interleaved Parity
CRC-8	Cyclic Redundancy Check
FAS	Frame Alignment Signal
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.

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SDH Concepts

For SDH reference information, see:

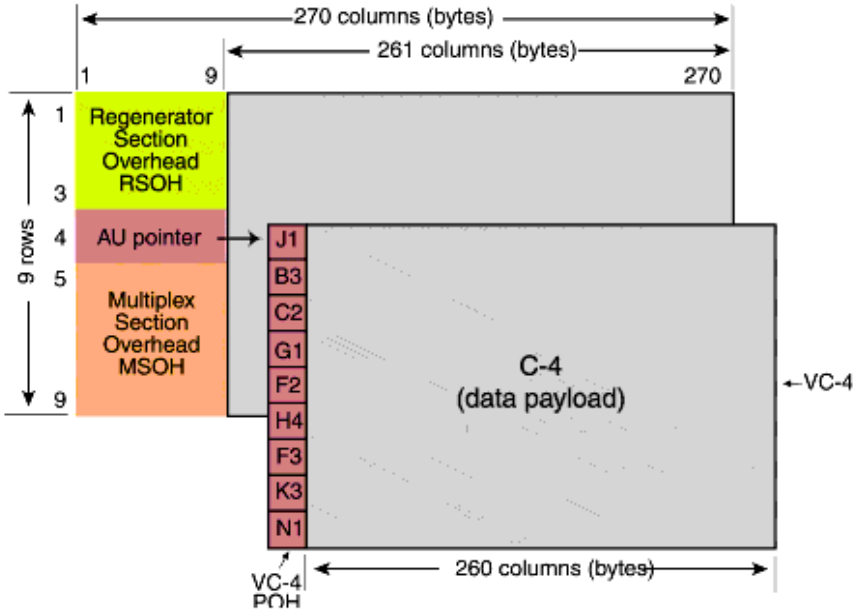
- “SDH Frame Structure" on page 619
- “SDH Payload Structure" on page 620
- “SDH Overhead Bytes" on page 621
- “What is a Tandem Connection?" on page 679

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SDH Frame Structure

The relationship between the various elements that make up an SDH signal is shown in the following diagram.



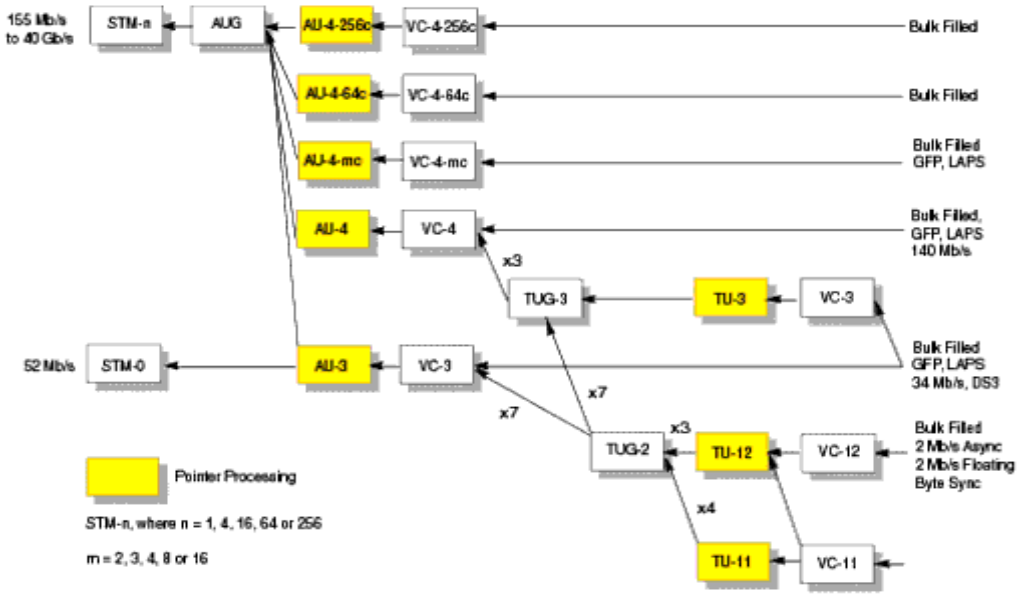
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SDH Payload Structure

The payloads that can be carried in a SDH signal are outlined below.

- You can asynchronously map a framed/unframed DS3 (44 Mb/s) or E3 (34 Mb/s) signal into a full VC-3/4, or you can bulk fill the VC-3/4.
- You can transmit 28 TU-11s, 21 VT12s or 7 TU-2s in a VC-3, or 84 TU-11s, 63 TU-12s or 3 TU-3s in a VC-4. The TUs are structured into tributary unit groups (TUG) within the VC-3/4. A VC-3 contains 7 TUG-2s, each TUG-2 can contain 4 TU-11s, 3 TU-12s or 1 TU-2. A VC-4 contains 3 TUG-3s, each TUG-3 contains 7 TUG-2s or 1 TU-3.
- You can transmit concatenated payloads in SDH signals. These types of payload reduce test times by testing the entire bandwidth in one go.

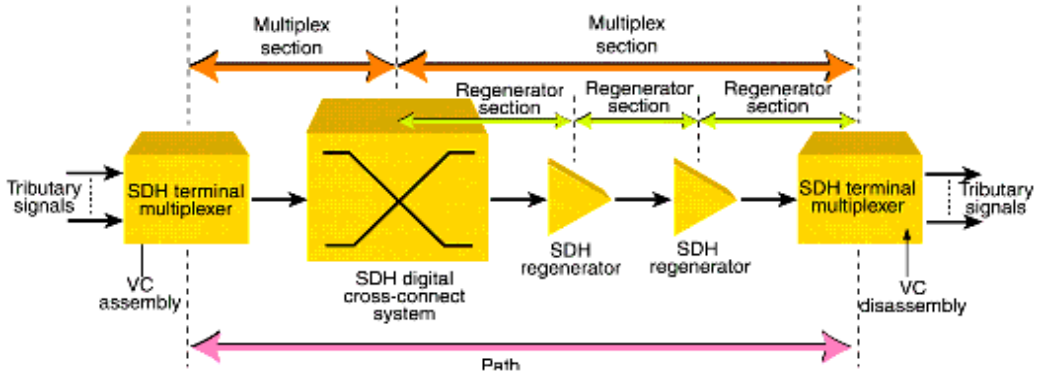


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SDH Overhead Bytes

Four overheads are used to transport SDH signals across the spans of a network.



For more information, see:

- "Regenerator Section Overhead (RSOH)" on page 622
- "Multiplex Section Overhead (MSOH)" on page 623
- "Higher Order Path Overhead (HO POH)" on page 629
- "Lower Order VC-n Path Overhead (LO POH for VC-11, VC-12 or VC-2)" on page 635

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Regenerator Section Overhead (RSOH)

The regenerator section overhead (RSOH) bytes support the transmission of an SDH signal across the regenerator 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 STM-n frame is 3 x n A1 bytes followed by 3 x n A2 bytes.
J0	Regenerator Section Trace	Regenerator section trace (16-byte frame including CRC) supports continuity testing between the transmitting and receiving device on each regenerator section span.
Z0		Spare. Reserved for future international standardization.
B1	RS-BIP	Provides regenerator section error monitoring. The regenerator section BIP-8 provides end-to-end error performance monitoring across an individual regenerator section. The BIP-8 is calculated over all bits of the previous STM-n frame after scrambling. The computed value is placed in the B1 byte of the current STM-n frame 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 regenerator 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 regenerator section terminating equipment.

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Multiplex Section Overhead (MSOH)

The multiplex section overhead (MSOH) bytes support the transmission of an SDH signal across the multiplexer section span of a network.

Byte	Label	Description
B2	MS-BIP	Provides multiplex section error monitoring. The BIP-n x 24, of an STM-n frame, provides end-to end performance monitoring across an individual multiplexer section and is calculated over all bits of the previous STM-n frame except for the first three rows of the current STM-n frame before scrambling.
K1, K2	MS-APS	Multiplexer section automatic protection switching (APS) is controlled by the K1K2 bytes. Two APS message types are used: Linear APS messages Ring APS messages Bits 6 to 8 of the K2 byte contain MS-RDI and MS-AIS. This byte is defined only for STM-1#1a of a SDH frame. For more information, see "Linear APS Messages" on page 625 and "Ring APS Messages" on page 626.
D4 to D12	Data Comm. Channel	Provides a 576 kb/s data communications channel (DCC) between multiplex section terminating equipment. Used to carry network administration and maintenance information.
S1	Sync Status	S1 bits 5 to 8 indicate which of the four levels of synchronization is being used at the transmit end of a multiplexer section span.
M1	MS-REI	Multiplexer section remote error indication conveys the B2 errors detected by downstream equipment.

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Byte	Label	Description
E2	Orderwire	Provides express orderwire channel for voice communication between Multiplex Section terminating equipment.
H1 to H3	AU Pointer	The payload pointer contained in the H1 and H2 bytes of the multiplex section overhead designates the location of the byte where the VC-n begins. The last ten bits (bits 7 to 16) of H1H2 carry the pointer value (0 to 782). The H3 bytes is allocated for VC frequency justification purposes and can carry “live” information from a VC-4 when a negative pointer adjustment occurs.

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Linear APS Messages

ITU-T G.783 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
K2	**Condition**
Bits 1 to 4	Selects bridged channel used
Bit 5	Determines APS architecture
Bits 6 to 8 110 111	 MS-RDI MS-AIS All other combinations of bits 6 to 8 not used.

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Ring APS Messages

ITU-T G.741 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

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ITU-T G.741 Protection Switching Protocol	
K2	**Condition**
Bits 1to 4	Source node ID
Bit 5	Path code: 0 = short path, 1 = long path
Bits 6 to 8	
000	Idle
001	Bridged
010	Bridged and switched
011	Not used
100	Note used
101	Not used
110	MS-RDI
111	MS-AIS

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Synchronization Status Messages (S1 bits 5 to 8)

S1 (Bits 5 to 8)	SDH synchronization quality level description
0000	Quality unknown
0001	Reserved
0010	G.811
0011	Reserved
0100	G.812 transit
0101	Reserved
0110	Reserved
0111	Reserved
1000	G.812 local
1001	Reserved
1010	Reserved
1011	Synchronous equipment timing source (SETS)
1100	Reserved
1101	Reserved
1110	Reserved
1111	Do not use for synchronization

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Higher Order Path Overhead (HO POH)

The higher order path overhead (HO POH) bytes support the transmission of an SDH signal across the high order path of a network.

Byte	Label	Description
J1	Path Trace	The first byte in the virtual container (VC). Its location is indicated by the AU pointer (H1H2). Provides a higher order trail trace identifier (64-byte free format string or 16 frame including CRC7). Supports end-to-end monitoring of a higher order path.
B3	HP-BIP	Provides higher order path error monitoring. The BIP-8 is calculated over all bits of the previous VC-n. The computed value is placed in the B3 byte before scrambling.
C2	Signal Label	Higher order signal label indicates the content of the VC, including the status of the mapped payloads. For more information, see "C2 Byte Mapping" on page 631.
G1	Path Status	Higher order path status contains status and performance monitoring information from the receiving path terminating equipment to the originating equipment. For more information, see "G1 (Bits 5 to 7) Coding and Interpretation" on page 632. Allows status and performance of the duplex path to be monitored at either end. Bits 1 to 4 of this byte contain the Path REI count. Bits 5 to 7 contain Path RDI.
F2	User Channel	Higher order path user channel. Allocated for network operator communication between path terminating equipment.
H4	Position & Sequence Indicator	This byte provides multiframe phase indication for TU structured payloads. In virtual concatenation (VCAT) mode it provides multiframe and sequence (SQ) indicators for high order signals. For more information see "High Order VCAT H4 Sequence" on page 633
F3	User Channel	Higher order path user channel. Allocated for network operator communication between path terminating equipment.

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Byte	Label	Description
K3	HO-APS	Higher order automatic protection switching (bits 1 to 4). Bits 5 to 8 are currently not used.
N1		Higher order tandem connection monitoring. There are two possible implementations described in Annex C and Annex D of ITU-T G.707. In Annex C, the N1 byte provides a tandem connection incoming error count (TC- IEC) and the remaining four bits provide an end-to-end data link. For more information, see "N1 (Bits 7 and 8) Multiframe Structure" on page 634. The Annex D option contains an incoming error count (IOC), tandem connection REI (TC-REI), outgoing error indication (OEI) and a 76-byte multiframe containing a tandem connection access point identifier (TC-APId)

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C2 Byte Mapping

Bits 1 to 4	Bits 5 to 8	Hex Code	Description
0000	0000	00	Unequipped or supervisory-unequipped
0000	0001	01	Equipped - non-specific
0000	0010	02	TUG-structure
0000	0011	03	Locked TU
0000	0100	04	Asynchronous mapping of 34 Mb/s or 45 Mb/s into the container C-3
0001	0010	12	Asynchronous mapping of 140 Mb/s into the container C-4
0001	0011	13	ATM mapping
0001	0100	14	MAN (DQDB) mapping
0001	0101	15	FDDI mapping
0001	1000	18	HDLC/LAP-S
0001	1010	1A	10 Gigabit Ethernet
00001	1011	1B	GFP
1111	1110	FE	O.181 test signal (TSS1 to TSS3) mapping
1111	1111	FF	VC-AIS

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G1 (Bits 5 to 7) Coding and Interpretation

Bits 5 to 7	Description	Triggers
000	No remote defect	No remote defect
001	No remote defect	No remote defect
010	Remote payload defect	LCD
011	No remote defect	No remote defect
100	Remote defect (RDI-P, ERDI-P)	AIS, LOP, TIM, UNEQ (or PLM, LCD)
101	Remote server defect (ERDI-P-S)	AIS, LOP
110	Remote connectivity defect (ERDI-P-C)	TIM, UNEQ
111	Remote defect (ERDI-P-P)	AIS, LOP, TIM, UNEQ (or PLM, LCD)

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High Order VCAT H4 Sequence

Table 11-1/G.707 – VC-3/4-Xv sequence and multiframe indicator H4 coding

H4 Byte								1st multi-frame number	2nd multi-frame number
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8		
				1st multiframe indicator MFI1 (bits 1-4)					
Sequence indicator MSB (bits 1-4)				1	1	1	0	14	n-1
Sequence indicator LSB (bits 5-8)				1	1	1	1	15	
2nd multiframe indicator MFI2 MSB (bits 1-4)				0	0	0	0	0	n
2nd multiframe indicator MFI2 LSB (bits 5-8)				0	0	0	1	1	
Reserved ("0000")				0	0	1	0	2	
Reserved ("0000")				0	0	1	1	3	
Reserved ("0000")				0	1	0	0	4	
Reserved ("0000")				0	1	0	1	5	
Reserved ("0000")				0	1	1	0	6	
Reserved ("0000")				0	1	1	1	7	
Reserved ("0000")				1	0	0	0	8	
Reserved ("0000")				1	0	0	1	9	
Reserved ("0000")				1	0	1	0	10	
Reserved ("0000")				1	0	1	1	11	
Reserved ("0000")				1	1	0	0	12	
Reserved ("0000")				1	1	0	1	13	
Sequence indicator SQ MSB (bits 1-4)				1	1	1	0	14	
Sequence indicator SQ LSB (bits 5-8)				1	1	1	1	15	
2nd multiframe indicator MFI2 MSB (bits 1-4)				0	0	0	0	0	n+1
2nd multiframe indicator MFI2 LSB (bits 5-8)				0	0	0	1	1	
Reserved ("0000")				0	0	1	0	2	

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N1 (Bits 7 and 8) Multiframe Structure

Frame Number	N1 Bits 7 and 8 Description	
1 to 8	Frame alignment signal: 1111 1111 1111 1110	
9 to 12	TC-APId byte # 1 [1 C1 C2 C3 C4 C5 C6 C7]	
13 to 16	TC-APId byte # 2 [0XXXXXXX]	
17 to 20	TC-APId byte # 3 [0XXXXXXX]	
. .	. .	
65 to 68	TC-APId byte # 15 [0XXXXXXX]	
69 to 72	TC-APId byte # 16 [0XXXXXXX]	
73 to 76	TC-RDI, ODI and reserved (see below)	
.	**N1 bit 7 Description**	**N1 Bit 8 Description**
73	Reserved (default = 0)	TC-RDI
74	ODI	Reserved (default = 0)
74	Reserved (default = 0)	Reserved (default = 0)
76	Reserved (default = 0)	Reserved (default = 0)

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Lower Order VC-n Path Overhead (LO POH for VC-11, VC-12 or VC-2)

The lower order path overhead (LO POH) bytes support the transmission of an SDH signal across the low order path of a network.

Byte	Label	Description
V5	LP BIP, 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 637. Bit 3 contains the Remote Error Indication (LP-REI). Bit 4 contains the Remote Failure Indication (LP-RFI). Bit 8 contains the Remote Defect Indication (LP-RDI).
Number of data bytes separating fields: VC-11 = 25, VC-12 = 34 and VC-2 = 106		
J2	Trail Trace Identifier	The lower order trail trace identifier (16-byte frame including CRC7) supports the end-to-end monitoring of a lower order path.
Number of data bytes separating fields: VC-11 = 25, VC-12 = 34 and VC-2 = 106		
N2	LO TCM	The lower order tandem connection monitoring byte contains the following information: Bits 1 and 2 contains BIP-2 error analysis. Bit 3 is set to "1". Bit 4 contains incoming AIS. Bit 5 contains Tandem Connection Remote Error Indication (TC-REI). Bit 6 contains Outgoing Error Indication (OEI). Bits 7 and 8 contain a 76-byte multiframe containing a tandem connection access point identifier (TC-APId), TC-RDI, ODI or reserved. For more information, see "N2 (bits 7 and 8) Multiframe Structure" on page 639.
Number of data bytes separating fields: VC-11 = 25, VC-12 = 34 and VC-2 = 106		

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Byte	Label	Description
K4	LO APS	The lower order automatic protection switching (APS) and enhanced RDI. Bits 1 to 4 contain the APS. For VCAT applications bit 1 contains the extended signal label information and bit 2 contains the low order VCAT information. Bits 5 to 7 contain the enhanced RDI. For more information, see "K4 (bits 5 to 7) Coding and Interpretation" on page 640.
Number of data bytes separating fields: VC-11 = 25, VC-12 = 34 and VC-2 = 106		

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V5 (bits 5 to 7) Signal Label

Bits 5 to 7	Description
000	Unequipped or supervisory unequipped
001	Equipped - non-specific
010	Asynchronous
011	Bit synchronous
100	Byte synchronous
101	Extended
110	O.181 test signal (TSS4)
111	VC-AIS

K4 (bit 1) Low Order Extended Signal Label

The K4 byte occurs every 4 frames and bit 1 makes up a 32 bit word over a period of 32 4-frame multiframes. Bits 1 to 11 consist of the multiframe alignment signal (MFAS) which is 0111 1111 110; bits 12 to 19 is the extended signal label described below; multiframe bit 20 must contain 0; the remainder of the 32 bits are reserved for future use (set to 0).

If the signal label in V5 bits 5 through 7 is 101 the contents of the extended signal label is valid and is as in table below. For all other values of V5 bits 5 through 7 the extended signal label is undefined and is ignored.

Extended Signal Label (hex) in K4 multiframe	Description
00 - 07	Reserved fields (can be set by user)
08	Experimental mapping
09	ATM mapping
0A	Mapping of HDLC/PPP framed signal

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Extended Signal Label (hex) in K4 multiframe	Description
0B	Mapping of HDLC/LAPS framed signals
0C	Virtually concatenated test signal, O.181 specific mapping
0D	GFP mapping
0E-CF, E0-FE	Spare
D0 - DF	Reserved for proprietary use
FF	Reserved fields (can be set by user)

K4 (bit 2) Low Order VCAT Information

To perform the re-alignment of the individual containers that make up a virtually concatenated (VCAT) signal it is necessary to compensate for the differential delay experienced by the individual containers and also to know the sequence number of the containers. Bit 2 of the K4 multiframe contains this information for low order VCAT signals. The information is contained in a 32-bit serial stream (over 32 4-frame multiframes).

Bits 1 to 5 contain the VCAT frame count; bits 6 to 11 (6 bits) hold the VCAT sequence indicator and the remaining 21 bits are reserved for future use.

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N2 (bits 7 and 8) Multiframe Structure

Frame Number	N2 Bits 7 and 8 Description	
1 to 8	Frame alignment signal: 1111 1111 1111 1110	
9 to 12	TC-APId byte # 1 [1 C1 C2 C3 C4 C5 C6 C7]	
13 to 16	TC-APId byte # 2 [0XXXXXXX]	
17 to 20	TC-APId byte # 3 [0XXXXXXX]	
. .	. .	
65 to 68	TC-APId byte # 15 [0XXXXXXX]	
69 to 72	TC-APId byte # 16 [0XXXXXXX]	
73 to 76	TC-RDI, ODI and reserved (see below)	
	N2 bit 7 Description	**N2 Bit 8 Description**
73	Reserved (default = 0)	TC-RDI
74	ODI	Reserved (default = 0)
74	Reserved (default = 0)	Reserved (default = 0)
76	Reserved (default = 0)	Reserved (default = 0)

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K4 (bits 5 to 7) Coding and Interpretation

Bits 5 to 7	Description	Triggers
000		
001	No remote defect	No remote defect
010	Remote payload defect	LCD, PLM
011		
100		
101	Remote server defect	AIS, LOP
110	Remote connectivity defect	TIM, UNEQ
111		

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SONET Concepts

For SONET reference information, see:

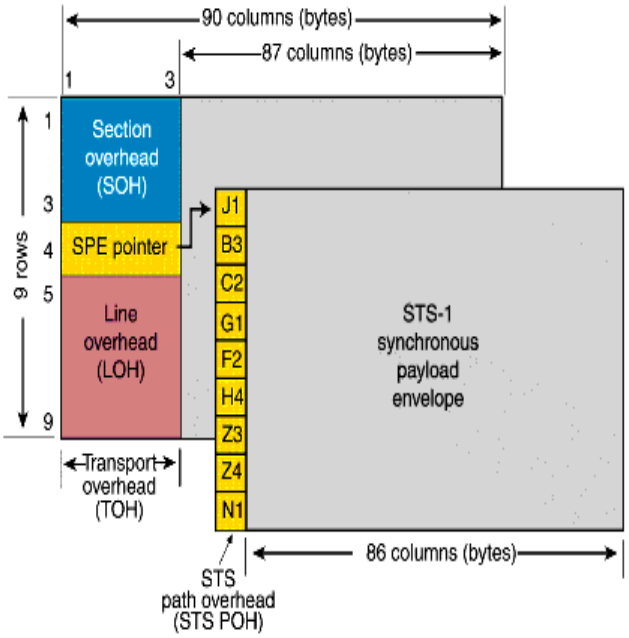
- “SONET STS-1 Frame Structure" on page 642
- “SONET Payload Structure" on page 643
- “SONET Overhead Bytes" on page 644

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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.



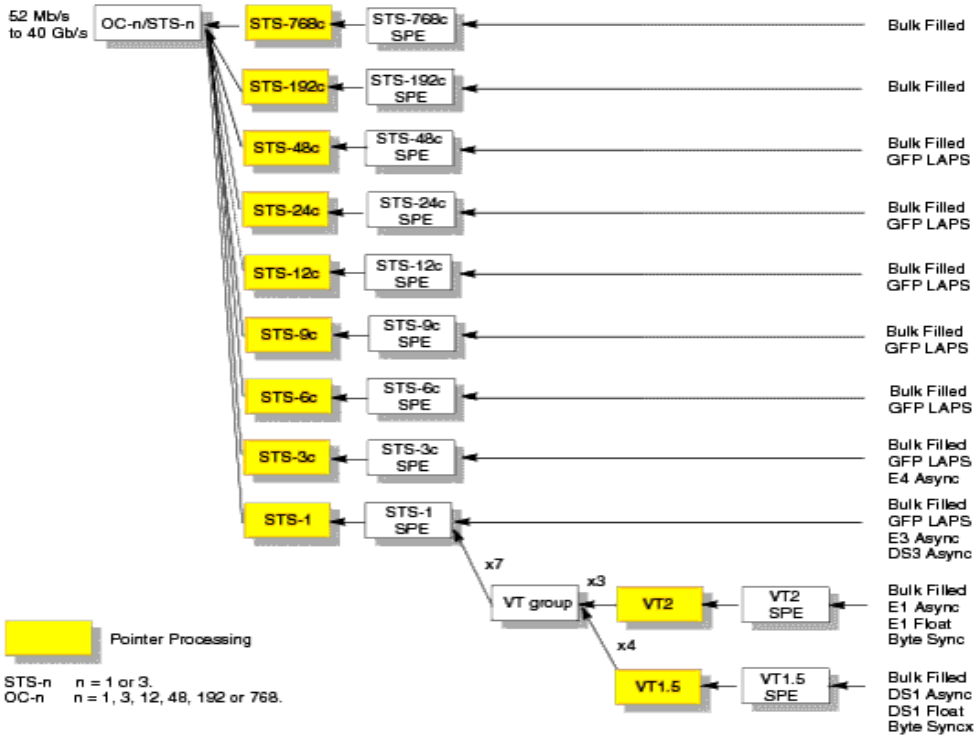
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SONET Payload Structure

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.

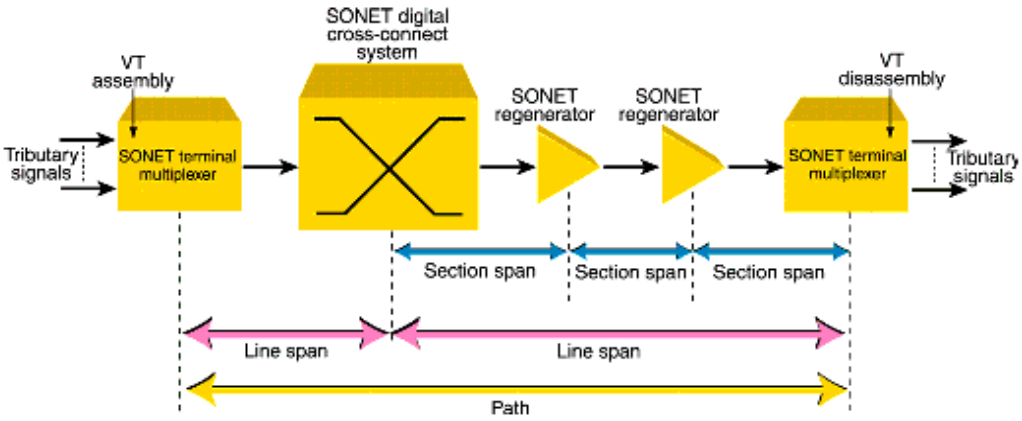


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SONET Overhead Bytes

Four overheads are used to transport SONET signals across the spans of a network.



For more information, see:

- "Section Overhead (SOH)" on page 645
- "Line Overhead (LOH)" on page 646
- "STS Path Overhead (STS POH)" on page 653
- "VT Path Overhead (VT POH for VT-1.5, VT-2 or VT-6)" on page 657

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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.

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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 648 and "Ring APS Messages (Telecordia GR-1230)" on page 650.
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 652.
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.

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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.

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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

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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.

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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

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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

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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

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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 654.
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. 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. For more information, see "G1 (Bits 5 to 7) Coding and Interpretation" on page 654.
F2	User Channel	STS path user channel. Allocated for network operator communication between STS path terminating equipment.
H4	Position & Sequence Indicator	This byte provides multiframe phase indication for TU structured payloads. In virtual concatenation (VCAT) mode it provides multiframe and sequence (SQ) indicators for high order signals.

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Byte	Label	Description
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
0001	1000	18	HDLC/LAP-S
0001	1010	1A	10 Gigabit Ethernet
0001	1011	1B	GFP

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

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Bits 5 to 7	Description	Triggers
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

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High Order VCAT H4 Sequence

Table 11-1/G.707 – VC-3/4-Xv sequence and multiframe indicator H4 coding

H4 Byte								1st multi-frame number	2nd multi-frame number
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8		
				1st multiframe indicator MFI1 (bits 1-4)					
Sequence indicator MSB (bits 1-4)				1	1	1	0	14	n-1
Sequence indicator LSB (bits 5-8)				1	1	1	1	15	
2nd multiframe indicator MFI2 MSB (bits 1-4)				0	0	0	0	0	n
2nd multiframe indicator MFI2 LSB (bits 5-8)				0	0	0	1	1	
Reserved ("0000")				0	0	1	0	2	
Reserved ("0000")				0	0	1	1	3	
Reserved ("0000")				0	1	0	0	4	
Reserved ("0000")				0	1	0	1	5	
Reserved ("0000")				0	1	1	0	6	
Reserved ("0000")				0	1	1	1	7	
Reserved ("0000")				1	0	0	0	8	
Reserved ("0000")				1	0	0	1	9	
Reserved ("0000")				1	0	1	0	10	
Reserved ("0000")				1	0	1	1	11	
Reserved ("0000")				1	1	0	0	12	
Reserved ("0000")				1	1	0	1	13	
Sequence indicator SQ MSB (bits 1-4)				1	1	1	0	14	
Sequence indicator SQ LSB (bits 5-8)				1	1	1	1	15	
2nd multiframe indicator MFI2 MSB (bits 1-4)				0	0	0	0	0	n+1
2nd multiframe indicator MFI2 LSB (bits 5-8)				0	0	0	1	1	
Reserved ("0000")				0	0	1	0	2	

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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 658. 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		For VCAT applications bit 1 contains the extended signal label information and bit 2 contains the low order VCAT information. For more information see "Z7 (bit 1) Low Order Extended Signal Label" on page 659 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 658.
Number of data bytes separating fields: VT-1.5 = 25, VT-2 = 34 and VT-6 = 106		

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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	Extended
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

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Z7 (bit 1) Low Order Extended Signal Label

The Z7 byte occurs every 4 frames and bit 1 makes up a 32 bit word over a period of 32 4-frame multiframes. Bits 1 to 11 consist of the multiframe alignment signal (MFAS) which is 0111 1111 110; bits 12 to 19 (8 bits) is the extended signal label described below; multiframe bit 20 must contain 0; the remainder of the 32 bits are reserved for future use (set to 0).

If the signal label in V5 bits 5 through 7 is 101 the contents of the extended signal label in Z7 bit 1 is valid and is as in table below. For all other values of V5 bits 5 through 7 the extended signal label is undefined and is ignored.

Extended Signal Label (hex) in Z7 multiframe	Description
00 - 07	Reserved fields (can be set by user)
08	Experimental mapping
09	ATM mapping
0A	Mapping of HDLC/PPP framed signal
0B	Mapping of HDLC/LAPS framed signals
0C	Virtually concatenated test signal, O.181 specific mapping
0D	GFP mapping
0E-CF, E0-FE	Spare
D0 - DF	Reserved for proprietary use
FF	Reserved fields (can be set by user)

Z7 (bit 2) Low Order Virtual Concatenation Information

To perform the re-alignment of the individual containers that make up a virtually concatenated (VCAT) signal it is necessary to compensate for the differential delay experienced by the individual containers and also to know the sequence number of the containers. Bit 2 of the Z7 multiframe contains this

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information for low order VCAT signals. The information is contained in a 32-bit serial stream (over 32 4-frame multiframes).

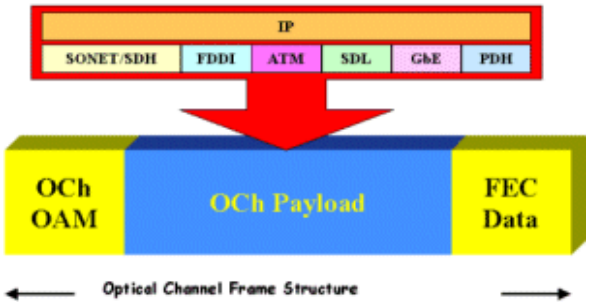
Bits 1 to 5 contain the VCAT frame count; bits 6 to 11 (6 bits) hold the VCAT sequence indicator and the remaining 21 bits are reserved for future use.

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OTN Concepts

This section contains reference information about the G.709 OTN technology.



For details, see:

- "OTN Overhead Bytes" on page 661
- "Equipment Response to OTN Alarms" on page 671
- "Equipment Response to OTN Errors" on page 672

OTN Overhead Bytes

The OTN signal overhead is divided as follows:

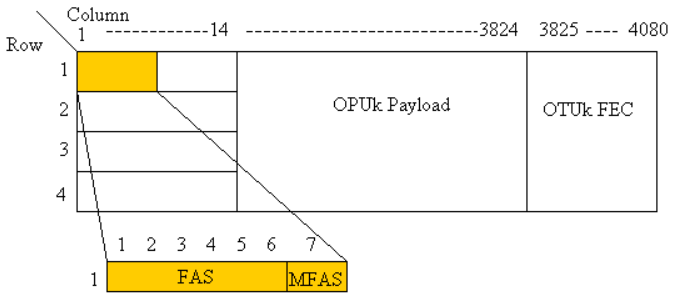
- "Frame Alignment" on page 662
- "Optical Transport Unit (OTU) Overhead" on page 663
- "Optical Data Unit (ODU) Overhead" on page 665
- "Optical Payload Unit (OPU) Overhead" on page 668

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Frame Alignment

The Frame Alignment Signal (FAS) is located in row 1, columns 1 to 7 of the OTN signal overhead.



The three types of frame alignment bytes are as follows:

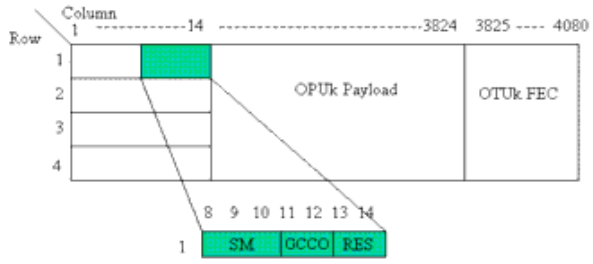
Byte	No. of bytes	Default Value (hex)
FAS OA1	3	F6
FAS OA2	3	28
MFAS	1	Increments over 256 frames

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Optical Transport Unit (OTU) Overhead

The OTUk overhead is located in row 1, columns 8 to 14 of the OTN structure.



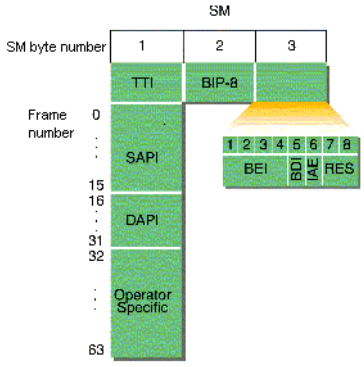
Byte	No. of bytes	Description
SM	3	Section Monitoring
GCC0	2	General Communications Channel
RES	2	Reserved for future international standardisation (RES)

OTU Section Monitoring (SM)

Columns 8 to 10 contain the section monitoring (SM) bytes, as shown in the following diagram:

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Byte	No. of bytes	Description
SM TTI	1	Section Monitoring Trail Trace Identifier
SM BIP-8	1	Section Monitoring Bit Interleaved Parity
SM byte 3	1	Backward Error Indication (BEI) Backward Defect Indication (BDI) Incoming Alignment Error (IAE) Reserved for future international standardisation (RES)

OTU Trail Trace Identifiers

There are two different types of trail trace identifiers (TTI). The Section Monitoring (SM) TTI is contained in the OTUk overhead and the Path Monitoring (PM) in the ODUk overhead.

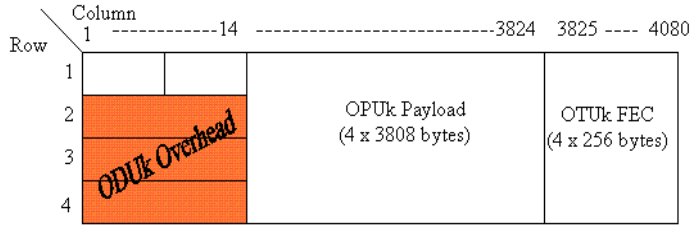
TTI name	Acronym	No, of bytes
Source Access Point Identifier	SAPI	16
Destination Access Point	DAPI	16
Operator specific fields		32

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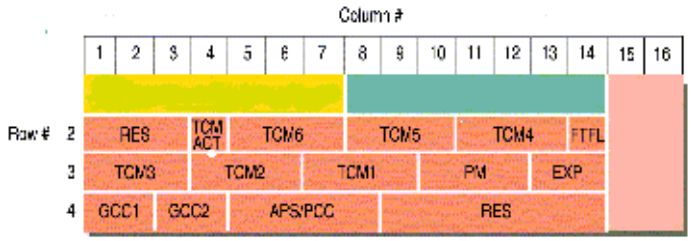
Optical Data Unit (ODU) Overhead

The Optical Data Unit (ODUk) overhead bytes are in rows 2 to 4, columns 1 to 14 of the OTN frame.



ODUk bytes

The bytes contained in the ODUk overhead are as follows:



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ODU Byte Description

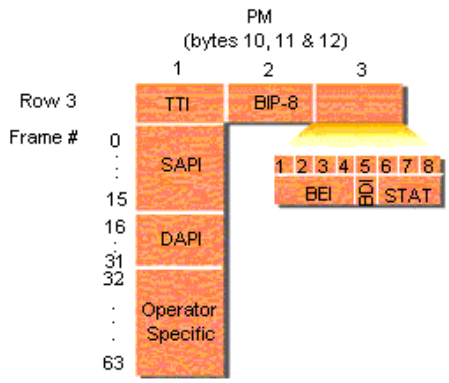
Byte	No. of bytes	Description
RES	3	Reserved for future international standardisation
TCM ACT	1	Tandem Connection Monitoring Activation/deactivation control channel
TCM1,2,3,4,5 & 6	3 each	Tandem Connection Monitoring
FTFL	1	Fault Type and Fault Location reporting channel
PM	3	Path Monitoring
EXP	2	Experimental
GCC1,2	2 each	General Communication Channel
APS/PCC	4	Automatic Protection Switching coordination channel/Protection Communication Control channel
RES(6 off)	1	Reserved for future international standardisation

ODU Path Monitoring (PM)

There are three path monitoring (PM) bytes in the ODUk overhead. They are located in columns 10, 11 and 12 in row 3 of the OTN structure. The PM bytes are used as follows:

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Byte	No. of bytes	Description
PM TTI	1	Path Monitoring Trail Trace Identifier
PM BIP-8	1	Path Monitoring Bit Interleaved Parity
PM byte 3	1	Backward Error Indication (BEI) Backward Defect Indication (BDI) Status bits indicating presence of a maintenance signal (STAT)

ODU Trail Trace Identifiers

The Path Monitoring (PM) trail trace identifier (TTI) is in the ODUk overhead.

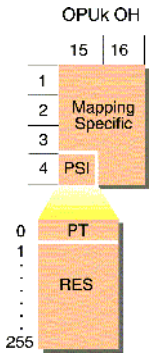
TTI name	Acronym	No, of bytes
Source Access Point Identifier	SAPI	16
Destination Access Point	DAPI	16
Operator specific fields		32

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Optical Payload Unit (OPU) Overhead

The optical payload unit overhead is contained in columns 15 and 16, rows 1 to 4 of the OTN structure. The payload structure Identifier (PSI) is a 256 byte multiframe structure. PSI(0) contains the payload type (PT) byte. PS(1) to PS(255) are reserved for future international standardisation.

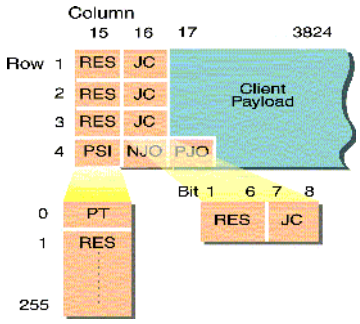


The mapping of SONET and SDH signals into the OTN signal structure can be performed using asynchronous or bit-synchronous modes. There are three justification control bytes, each containing two justification control (JC) bits. The two bits are used to indicate whether the negative or positive justification opportunity bytes contain data. A majority vote (two out of three JC bytes) are used for error protection.

The value contained in the Negative Justification Opportunity (NJO) and Positive Justification Opportunity (PJO) when they are used as justification bytes is all zeros. In bit-synchronous mode all JC bits are set to 00 and PJO is always a data byte.

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OPU Byte Description

Byte(s)	No. of bytes	Description
PT	1	Payload Type (PT) is one byte of a 256-byte sequence in the PSI field. The remaining 255 bytes are set to 00h.
RES	3	Reserved bytes.
JC	3	Justification Control
NJO	1	Negative Justification Opportunity
PJO	1	Positive Justification Opportunity

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OTN Alarm Description

Alarm	Description
OTU-AIS	OTU2 Alarm Indication Signal is transmitted by filling entire overhead, payload and FEC area with a PN-11 sequence.
OTU-IAE	OTU2 Incoming Alignment Error is transmitted by setting bit 6 of byte 3 of the SM field to 1.
OTU-BDI	OTU2 Backward Defect Indicator is transmitted by setting bit 5 of byte 3 of the SM field to 1.
ODU-AIS	ODU2 Alarm Indication Signal is transmitted by setting the entire ODU2 excluding the frame alignment and OTUk overhead and ODUk FTFL signal to an all ones pattern and PM byte 3, bits 6,7 & 8 to 111.
ODU-OCI	ODU2 Open Connection Indication is transmitted by setting the entire ODU2 excluding the frame alignment and OTUk overhead signal to a repeating 0110 0110 pattern and PM byte 3 bits 6,7 & 8 to 110.
ODU-LCK	ODU2 Locked Indication
ODU-BDI	ODU2 Backwards Defect Indication is transmitted by setting bit 5 of byte 3 of the PM field to 1.
LOS	Output signal is switched off to generate a LOS.
OTU-LOF	OTU - Loss of Frame is inserted by continuously inverting the Optical A1 and A2 (OA1 & OA2) bytes.
OTU-OOF	OTU - Out of Frame: The OTU2 frame is moved to a completely different location in a single jump. This jump will occur each time the Action field is toggled.
OTU-LOM	OTU - Loss of Multiframe is inserted by continuously inverting the MFAS byte.
OTU-OOM	OTU - Out of Multiframe: The OTU2 Multiframe MFAS byte is inverted for 5 consecutive frames each time the Action field is toggled.
Payload Alarms	SONET or SDH alarms may be generated whenever SDH or SONET is selected as a transmit payload

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Equipment Response to OTN Alarms

The following tables indicate the upstream and downstream response of equipment to the OTN alarms which can be generated. The responses in the tables allow you to predict what will happen in your equipment when you stimulate it with particular alarms.

Response at OCh/OTU termination

Stimulus	Upstream Response	Downstream response
LOS	OTU-BDI	ODU-AIS
OCI		
OCh FDI-P		
LOF		
LOM		
OTU-AIS		
OOF		OTU-IAE

Response at ODU termination

Stimulus	Upstream Response	Downstream response
ODU-AIS	ODU-BDI	STM-AIS (payload)
ODU-OCI		
ODU-LCK		

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Equipment Response to OTN Errors

Error Response at OCh/OTU termination

Stimulus	Upstream Response
OTU-BIP errors	OTU-BEI errors

Error Response at ODU termination

Stimulus	Upstream Response
ODU-BIP errors	ODU-BEI errors

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Trigger Conditions for Capturing Data

You can select an output trigger to align with an event such as an error or alarm to allow viewing of the line signal on an oscilloscope.

Triggers associated with the frame bytes are in the form of signal pulses. The triggers associated with alarms are in the form of a change in signal level.

SDH/SONET Transmit Trigger Outputs

SDH Transmit Trigger Event	SONET Transmit Trigger Event	Format
AU-AIS alarm active	AIS-P alarm active	Level
AU-LOP alarm active	LOP-P alarm active	Level
B1 BIP error added	CV-S error added	Pulse
B2 BIP error added	CV-L error added	Pulse
B3 BIP error added	CV-P error added	Pulse
CRC-8 error added		Pulse
Entire Frame error added		Pulse
Frame (A1, A2) error added		Pulse
HP REI error added	REI-P error added	Pulse
HP-RDI alarm active	RDI-P alarm active	Level
HP-UNEQ alarm active	UNEQ-P alarm active	Level
LCAS decrease bandwidth		Pulse
LCAS increase bandwidth		Pulse
LOF alarm active		Level
LOM alarm active		Level
MS REI error added	REI-L error added	Pulse
MS-AIS alarm active	AIS-L alarm active	Level

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SDH Transmit Trigger Event	SONET Transmit Trigger Event	Format
MS-RDI alarm active	RDI-L alarm active	Level
OOF alarm active	SEF alarm active	Level
OOM1 alarm active		Level
OOM2 alarm active		Level
Pointer adjust		Pulse
SQM alarm active		Level
Start of Frame		Pulse
TC-IAIS (VC-4-Xc/VC-4/VC-3) alarm active		Level
TC-IEC (VC-4-Xc/VC-4/VC-3) error added		Pulse
TC-ODI (VC-4-Xc/VC-4/VC-3) alarm active		Level
TC-OEI (VC-4-Xc/VC-4/VC-3) error added		Pulse
TC-OOM (VC-4-Xc/VC-4/VC-3) alarm active		Level
TC-RDI (VC-4-Xc/VC-4/VC-3) alarm active		Level
TC-REI (VC-4-Xc/VC-4/VC-3) error added		Pulse
TC-UNEQ (VC-4-Xc/VC-4/VC-3) alarm active		Level
VC-AIS alarm active		Level

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OTN Transmit Trigger Outputs

OTN Transmitter Trigger Event	Format
Entire frame error add	Pulse
FEC block error add	Pulse
Frame (OA1,OA2) error add	Pulse
Multiframe (MFAS) error add	Pulse
ODU-AIS alarm active	Level
ODU-BDI alarm active	Level
ODUk-BEI error add	Pulse
ODUk-BIP8 error add	Pulse
ODU-LCK alarm active	Level
ODU-OCI alarm active	Level
OTN-LOF alarm active	Level
OTN-LOM alarm active	Level
OTN-OOF alarm active	Level
OTN-OOM alarm active	Level
OTU-AIS alarm active	Level
OTU-BDI alarm active	Level
OTU-IAE alarm active	Level
OTUk-BEI error add	Pulse
OTUk-BIP8 error add	Pulse
Start of Frame	Pulse

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SDH/SONET Receiver Trigger Outputs

SDH Receiver Trigger Event	SONET Receiver Trigger Event	Format
AU-3/4 pointer activity	STS pointer activity	Pulse
AU-AIS alarm detected	AIS-P alarm detected	Level
AU-LOP alarm detected	LOP-P alarm detected	Level
B1 BIP error detected	CV-S error detected	Pulse
B2 BIP	CV-L error detected	Pulse
B3 BIP	CV-P error detected	Pulse
CRC-8 error detected		Pulse
Frame (A1, A2) error detected		Pulse
HP REI	REI-P error detected	Pulse
HP-RDI alarm detected	RDI-P alarm detected	Level
HP-UNEQ alarm detected	UNEQ-P alarm detected	Level
IEC (VC-4-Xc/VC-4/VC-3)	N/A	Pulse
K1/K2 change		Level
LOF alarm detected		Level
LOM alarm detected		Level
MS REI	REI-L error detected	Pulse
MS-AIS alarm detected	AIS-L alarm detected	Level
MS-RDI alarm detected	RDI-L alarm detected	Level
Member Status (MST) change		Pulse
OEI (VC-4-Xc/VC-4/VC-3)	N/A	Pulse
OOF alarm detected	SEF alarm detected	Level
OOM1 alarm detected		Level
OOM2 alarm detected		Level
RS-ACK error added		Pulse
Sequence Mismatch (SQM) alarm detected		Level

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SDH Receiver Trigger Event	SONET Receiver Trigger Event	Format
Start of Frame		Pulse
TC-IAIS (VC-4-Xc/VC-4/VC-3) alarm detected	N/A	Level
TC-ODI (VC-4-Xc/VC-4/VC-3) alarm detected	N/A	Level
TC-OOM (VC-4-Xc/VC-4/VC-3) alarm detected	N/A	Level
TC-RDI (VC-4-Xc/VC-4/VC-3) alarm detected	N/A	Level
TC-REI (VC-4-Xc/VC-4/VC-3)	N/A	Pulse
TC-UNEQ (VC-4-Xc/VC-4/VC-3) alarm detected	N/A	Level
VC-AIS alarm detected	N/A	Level

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OTN Receiver Trigger Outputs

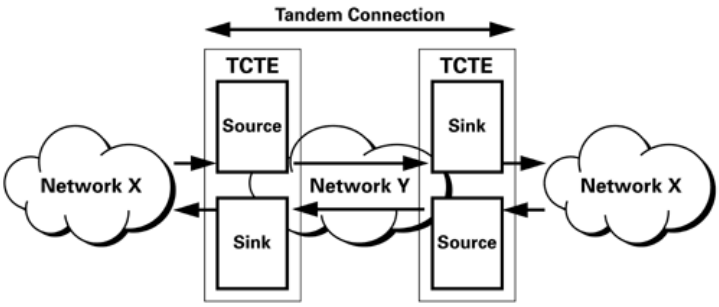
OTN Receiver Trigger Event	Format
FEC block error detected	Pulse
Frame (OA1,OA2) error detected	Pulse
Multiframe (MFAS) error detected	Pulse
ODU-AIS alarm active	Level
ODU-BDI alarm active	Level
ODUk-BEI error detected	Pulse
ODUk-BIP8 error detected	Pulse
ODU-LCK alarm active	Level
ODU-OCI alarm active	Level
OTN-LOF alarm active	Level
OTN-LOM alarm active	Level
OTN-OOF alarm active	Level
OTN-OOM alarm active	Level
OTU-AIS alarm active	Level
OTU-BDI alarm active	Level
OTU-IAE alarm active	Level
OTUk-BEI error detected	Pulse
OTUk-BIP8 error detected	Pulse
Start of Frame	Pulse

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What is a Tandem Connection?

A tandem connection is a bi-directional connection between two TCTEs (Tandem Connection Terminating Elements) in an SDH path. Each TCTE is managed as a separate entity.



The N1 of the path overhead (POH) and the N2 byte of the lower order path overhead are used to support tandem connections over the high and low order paths.

High Order: VC4 AU4 and VC3 AU3 use N1 byte.

Low Order: VC3 TU3 use N1 byte.

VC2 TU2, VC11 TU11 and VC TU12 use N2 byte.

Tandem Connection Monitoring complies with G.707 Annex D and E. Test features include error and alarm generation and detection, and access point identifier generation and decode.

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Generic Framing Procedure (GFP) Concepts

"Introduction" on page 680

"GFP Mapping Modes" on page 680

"GFP Frame Types" on page 681

"Structure of a GFP frame" on page 683

"GFP Encapulastion Techniques" on page 685

"Advantages of GFP" on page 686

"Conclusion" on page 687

Introduction

GFP is defined as a generic mechanism to transport any client signal over fixed data-rate optical channels. Any client signal like IP/PPP, Ethernet MAC, Fiber Channel, ESCON or FICON can be mapped over the transport network using GFP. As such, GFP provides a single, flexible mechanism to map any client signal into SONET/SDH and the optical transport network (OTN).

GFP supports both point-to-point and ring applications and eliminates the need for byte/bit stuffing. This avoids payload specific frame expansion, which saves bandwidth. GFP utilizes a length/HEC-based frame delineation mechanism that is more robust than that used by HDLC (High-level Data Link Control) which is single octet flag based.

GFP Mapping Modes

To cater for all mapping requirements, two mapping modes are currently defined for GFP:

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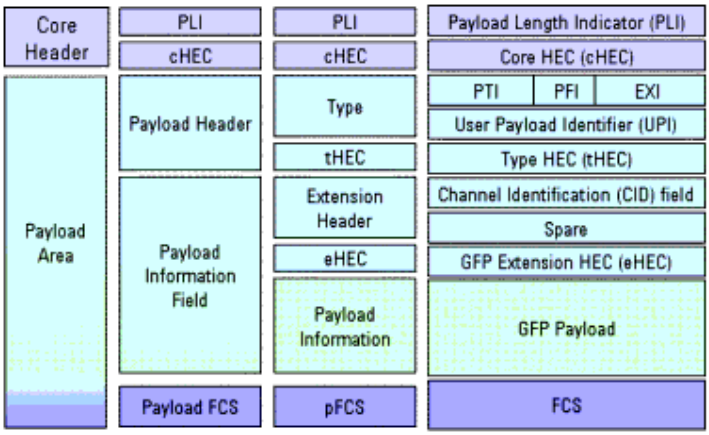
Frame-mapped GFP (GFP-F)

This mode maps the entire client frame into one GFP frame. It also describes a single client frame that is mapped into a single GFP frame, for example, an Ethernet frame mapped into a GFP frame.

Transparent-mapped GFP (GFP-T)

This mode facilitates the transport of block-coded client signals (for example Fiber Channel, ESCON or FICON) that require very low transmission latency. The individual characters of a client signal are de-mapped from the client signal and then mapped into GFP frames. This process helps avoid buffering an entire client frame before it is mapped into the GFP frame.

In the transparent mapping mode, the GFP frame contains groups of 8B/10B code-groups mapped into a 64B/65B code with a cyclic redundancy check (CRC). The GFP frame structure remains the same whether it is frame-mapped GFP or transparent-mapped GFP.



GFP Frame Types

In general, there are two types of GFP frames, GFP client frames and GFP control frames:

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GFP client frames

These can be further classified into two types:

- Client data frames, used to transport data from the client signal
- Client management frames, used to transport management information about client signals between source and sink, for example Loss of Client signal. These frames comprise the core header and payload area only and have the value of PTI as 100.

GFP control frames (GFP idle frames)

These frames are used for the management of the GFP connection, and consist of only the Core Header field (no payload area). They are used to compensate for the gaps between the client signal where the transport medium has a higher capacity than the client signal.

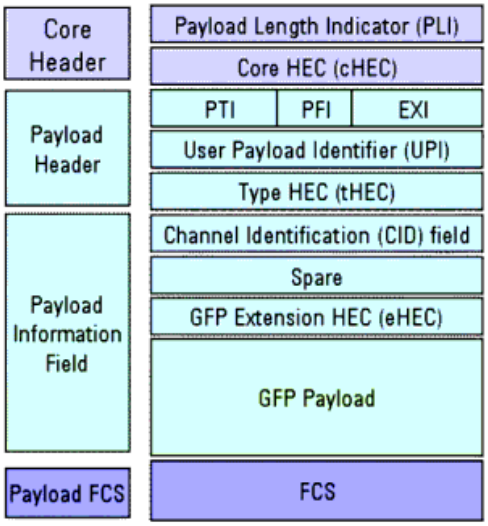
GFP frames from multiple ports or multiple client types are multiplexed on a frame-by-frame basis. GFP idle frames are inserted if there are no GFP frames available for transmission. This provides a continuous stream of frames for mapping.

In the case of a Client Signal Fail (CSF) condition, the GFP source generates a client management frame every 100 ms. On receipt of a CSF indication, the GFP sink declares a client signal failure. This condition is cleared either by receipt of a valid GFP frame, or when no CSF indications are received for 1000 ms. GFP idle frames are sent during the CSF condition.

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Structure of a GFP frame



Core Header

This describes the GFP frame, independent of the content of higher layer Protocol Data Units (PDUs). The cHEC contains a CRC error control code for protection of Core Header contents. The scrambling of the Core Header provides additional robustness of the GFP frame delineation process.

Payload Header

This supports the data link management procedures specific to client signal.

Type field identifies the format and presence of the Extension Header and Payload FCS. This field also distinguishes between GFP frame types and between different services in a multi-service environment.

Payload Type identifies the type of GFP client frames.

Payload FCS Indicator identifies the presence or absence of the Payload FCS field.

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Extension Header Identifier is used to identify the GFP Extension Header. (null, linear or ring).

User Payload Identifier is used to convey the type of payload carried in the GFP Payload Information field.

tHEC field protects the integrity of the Type field.

Payload Information Field

Channel Identification (CID) field is used to identify one communication channel at a GFP termination point.

GFP Extension Headers support the technology specific headers, for example Virtual Link Identifiers, source/destination addresses, port numbers and class of service.

- Null Extension Header is intended for dedicated transport paths of one client signal
- Linear Extension Header is intended for several independent links requiring aggregation onto a single transport path
- Ring Extension Header is intended for use where a ring transport path is shared among multiple client signals

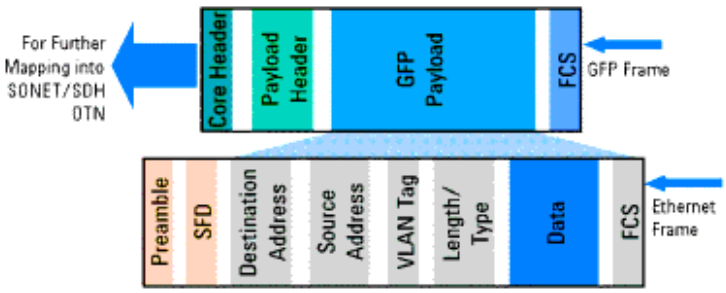
Extension HEC field is used to protect the integrity of the contents of Extension Header.In the case of Frame-mapped GFP, the GFP payload area contains the framed PDU; in the case of Transparent GFP it contains a group of client characters.

Payload FCS pFCS is used to protect the contents of the GFP payload.

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GFP Encapulastion Techniques



The relationship between an Ethernet MAC frame and GFP is shown above. There is a one-to-one mapping between a higher layer PDU and a GFP PDU, with the boundaries of both aligned.

Ethernet MAC encapsulation

In the case of Ethernet MAC's encapsulation into GFP, the fields from Destination Address to Frame Check Sequence (FCS) are placed in the GFP payload area. As the source adaptation process extracts the frame from the client bit stream, the GFP source adaptation process deletes the gaps between the packets, known as the Inter Packet Gaps (IPGs). Ethernet MAC is then forwarded for further encapsulation into the GFP frame. On the sink side, the sink adaptation process restores the IPGs, and Ethernet MAC is then forwarded to the client layer for further processing.

Error handling

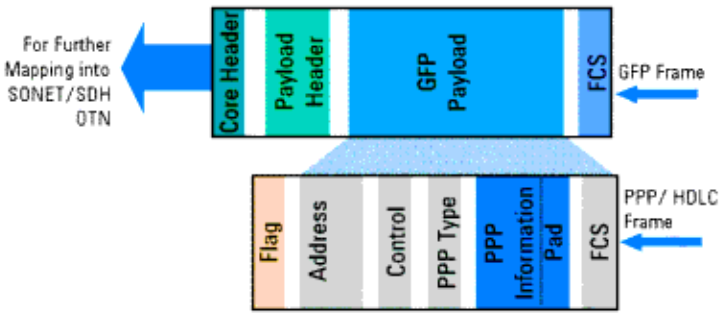
In the source adaptation process, any PDUs received with errors from the client side are discarded before transmission. However, PDUs detected for errors during transmission are padded with appropriate bit sequence and FCS. This action ensures that the client end drops the errored PDU.

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PPP/HDLC encapsulation

PPP/HDLC frame encapsulation into GFP is similar to the Ethernet MAC encapsulation procedure and is shown below.



PPP frames are first encapsulated in an HDLC-like frame. Similar to Ethernet MAC, the boundaries of the GFP PDU are aligned with boundaries of the framed PPP/HDLC PDUs. The fields from Address to FCS (including the PPP information field padding) are placed in the GFP payload area. The GFP source adaptation process removes the flags and associated escape characters and forwards the PPP/HDLC frame for further encapsulation in GFP. On the sink side, the PPP/HDLC frame is extracted from the GFP frame and forwarded to the client layer for further processing, such as the addition of flags and escape characters.

FICON/ESCON encapsulation

After the physical layer of the client signal is decoded, the decoded characters are mapped into a 64B/65B block code. The block code is then mapped into payload bytes of 64B/65B code in the order they were received.

Advantages of GFP

Of the many advantages of GFP as an encapsulation mechanism, the most significant is that GFP minimizes the protocol-specific processing and protocol translation associated with Packet over

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SONET/SDH, and avoids the complex adaptation layer processing of ATM. This is because the native FCS of the payload is preserved during encapsulation which enhances the error detection mechanism. Traditional encapsulation techniques such as Packet over SONET/SDH cannot guarantee bandwidth since the padding used inflates the frames size GFP frame headers on the other hand are exactly the same size as the Preamble (which is dropped during encapsulation) to ensure guaranteed bandwidth.

GFP also provides one uniform mechanism to adapt any payload type to any transport media. In frame-mapped mode, data signals that have been packetized/framed at Layer 2 or higher by the client service feeding the SONET/SDH network are mapped as one client packet/frame into a GFP frame. Transparent-mode, however, accepts native block-mode data signals and uses the SONET/SDH frame as a low-overhead, low-latency digital wrapper. In other words, GFP results in network flexibility, efficiency and robustness.

Conclusion

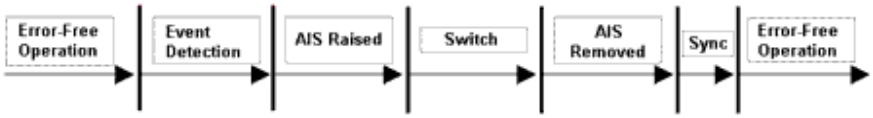
The key issue for Service Providers looking to adopt Ethernet over SONET/SDH as a transport mechanism is whether it is capable of dealing with data-oriented applications and synchronous traffic such as voice. Using GFP resolves this issue by providing an efficient, scalable and unified mode of transport for both synchronous TDM traffic and data applications such as those used in LANs, storage area networks (SANs), and the Internet. GFP is also the most economical way of adopting high-speed services in legacy metro and long-haul SONET/SDH networks, and can provide the basis for the evolving resilient packet ring (RPR) technology. In short, GFP has the potential to become the dominant encapsulation technique in the modern network.

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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.

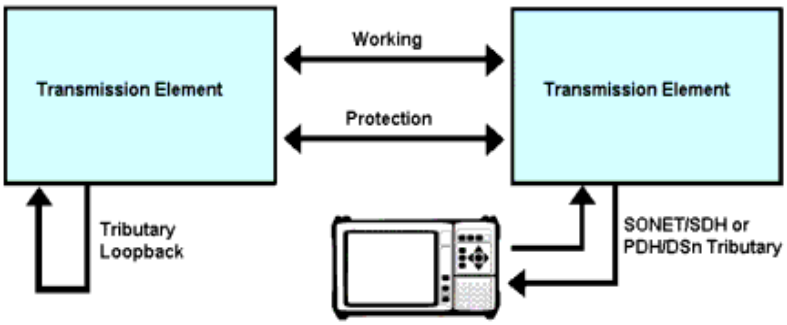
For more information, see:

- "Test Configuration for Measuring Service Disruption Time" on page 689
- "Contributors to Protection Switching Time" on page 690
- "Protection Switching Time Test Methods" on page 692
- "Measuring Protection Switch Time" on page 693
- "Understanding Service Disruption Test Results" on page 699

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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.

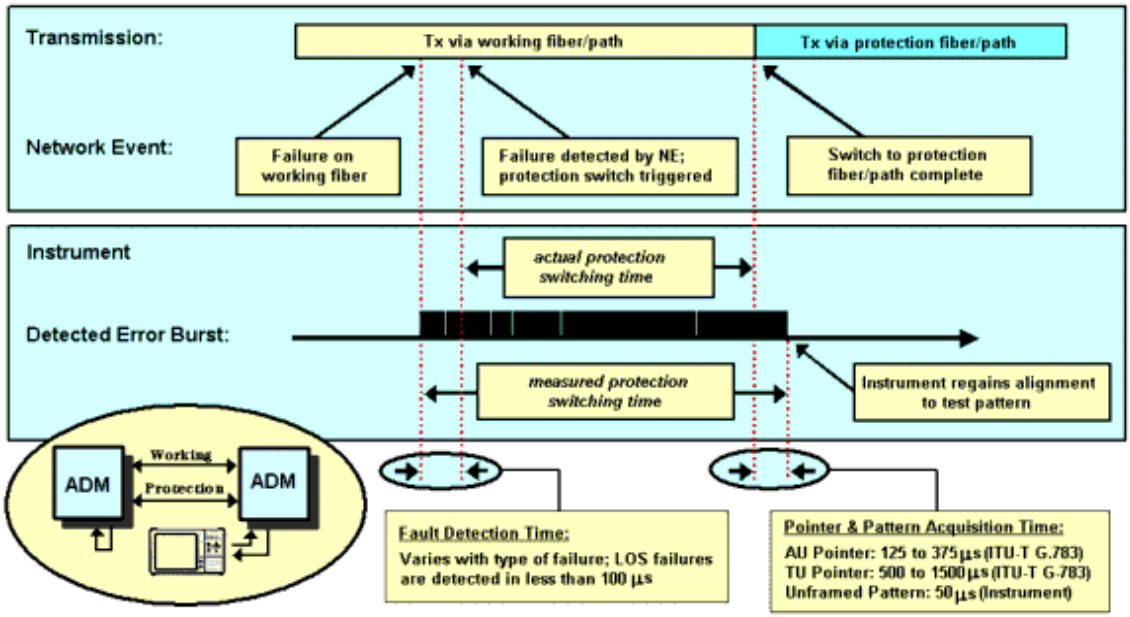
Result accuracy and reliability are based on the instrument's ability to measure the duration of error bursts associated with a protection switch event.

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.

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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

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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.

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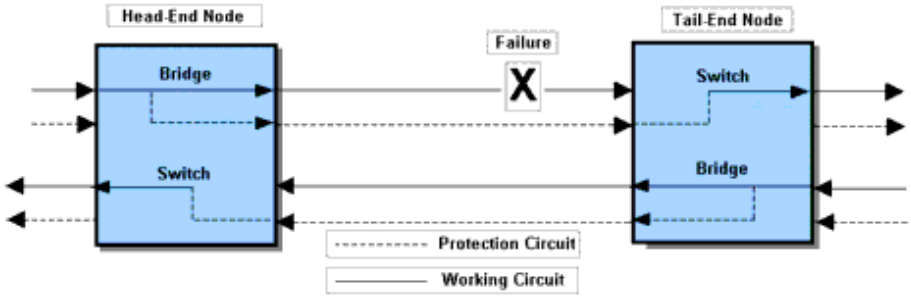
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Protection Switching Time Test Methods

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.

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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

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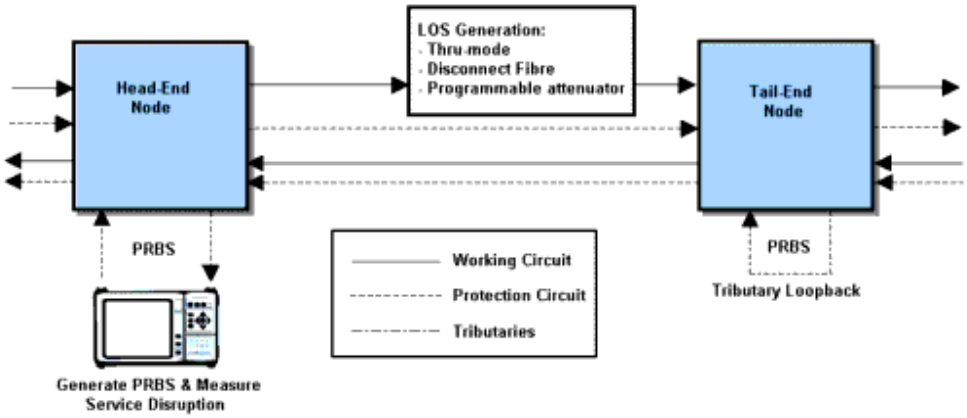
construction work it may not break cleanly. Instead, the optical signal may fade over several tens of milliseconds or vary erratically before finally disappearing. So the ITU-T standards require that, once SF/SD is detected, a Protection Switch event must be completed in 50 milliseconds or less. This 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.

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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.

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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.

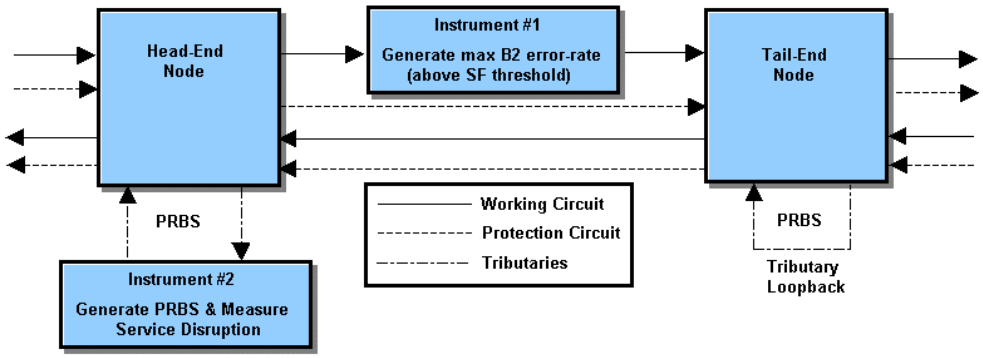
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Generating Excessive Errors (SF Trigger)

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.

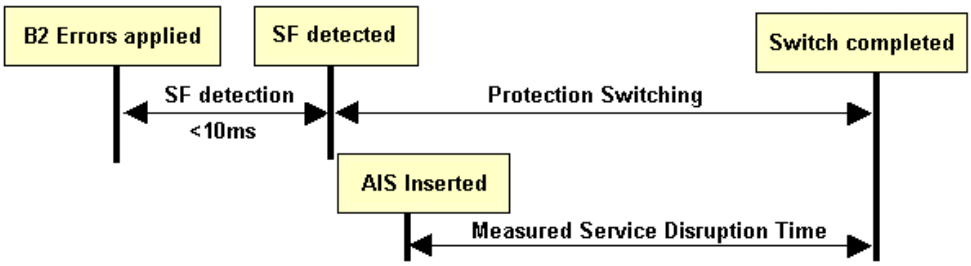
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Signal Fail (SF) Triggering a Protection Switch Sequence

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).

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Understanding Service Disruption Test Results

To interpret service disruption results you must understand the rules associated with the analysis of error-burst duration.

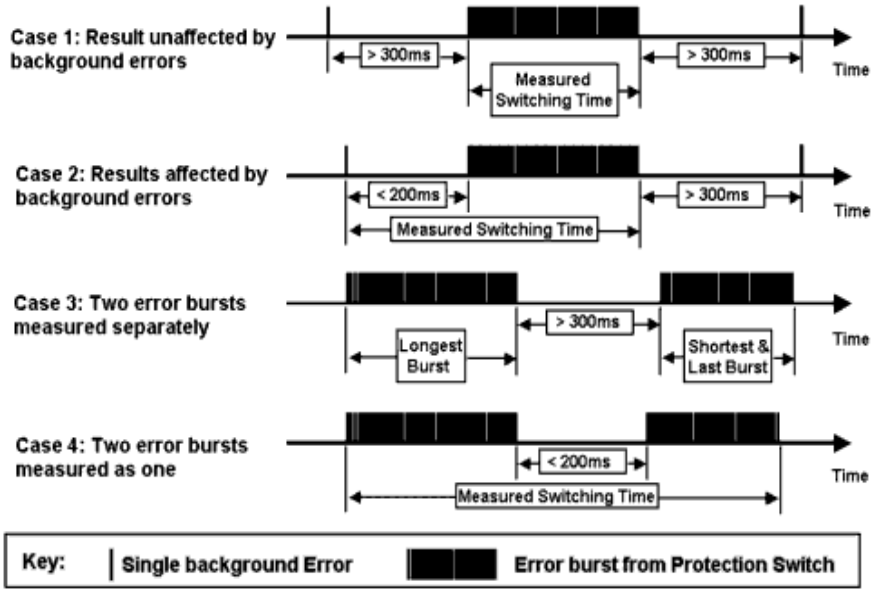
The service disruption test measures the elapsed time between the first and last error in an error-burst that consists of two or more errors. The error-burst is taken as having ended when no errors are detected for a period of greater than 200 to 300 ms following the last error. Single errors that are 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 700 shows the affect these simple rules have on measurement results when different error distributions are present in the received test pattern.

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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

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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.

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Glossary

For more details of glossary items go to the glossary in the online help on the instrument.

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.

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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.

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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.
CID	Channel ID.
CMI	Coded Mark Inversion.
CO	Central Office.
CoS	Class of Service.
CRC	Cyclic Redundancy Check.

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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.

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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.
EXI	Extension Header Identifier.

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.
GFP	Generic Framing Procedure.

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GP-IB	General Purpose Interface Bus.
GID	Group Identifier.
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.

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ITU	International Telecommunications Union - Telecommunications.
IXC	Inter eXchange Carrier.

J

JOR	Jitter Over Range.
JUL	Jitter Unlock.

K

K-bytes	K1 and K2.

L

LAN	Local Area Network.
LAPS	Link Access Procedure SDH/SONET.
L-BIP	Line Bit Interleaved Parity error, also CV-L.
LCAS	Link Capacity Adjustment Scheme.
LCD	Loss of Cell Delineation.
LEC	Local Exchange Carrier.
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.

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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.
MFI	Multiframe Indicator for VCAT signal.
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.

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MS-REI	Multiplexer Section Remote Error Indication.
MST	Member Status.
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 Multiframe.
OPU	Optical channel Payload Unit.

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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.
PCR	Peak Cell Rate.
PCS	Physical Coding Sublayer.
PDH	Plesiochronous Digital Hierarchy.
PES	Percentage Errored Seconds.
PFI	Payload FCS (Frame Check Sequence) Identifier.
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.

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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.
PTI	Payload Type Identifier.
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.

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REI-V	Virtual Tributary Path Remote Error Indication, also CV-VFE.
RFI-V	Virtual Tributary Path Remote Failure Indication.
RS	Regenerator Section.
RS-Ack	Resequence Acknowledge.
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.
SAPI	Service Access Point Identifier.
SCPI	Standard Commands for Programmable Instrumentation.
SDH	Synchronous Digital Hierarchy.
SEC	SDH Equipment Clock.
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.

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SMC	SONET Minimum Clock.
SMF	Single Mode Fiber.
SNMP	Simple Network Management Protocol.
SOH	Section OverHead.
SONET	Synchronous Optical Network.
SPE	Synchronous Payload Envelope.
SQ	Sequence Indicator for VCAT signals.
SSU	Synchronization Supply Unit.
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.

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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.
UPI	User Payload Identifier.

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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.
VCAT	Virtual Concatenation.
VCG	Virtual Concatenation Group.
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.

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X

X-Connect	Cross-Connect.
X-bits	DS3 bits, X1 and X2.

Y/Z

Yellow	Yellow Alarm.

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8 Telecoms Concepts

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