Measurement Guide

Backhaul Analyzer

for Anritsu RF and Microwave Handheld Instruments

BTS Master™
Cell Master™

E1 Signal Analyzer	**Option 52**
T1 Signal Analyzer	**Option 51**
T1/T3 Signal Analyzer	**Option 53**

BTS Master™ MT822xB with Option 450

E1 Signal Analyzer	**Option 55**
T1 Signal Analyzer	**Option 54**
OC-3c Signal Analyzer	**Option 58**
STM-1 Signal Analyzer	**Option 59**

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Chapter 1 — General Information

1-1 Introduction

This Measurement Guide documents E1 (Option 52 or 55), OC-3c (Option 58), STM-1 (Option 59), T1/FT1 (Option 51 or 54), and T1/T3 (Option 53) backhaul measurements for the following Anritsu instruments:

- BTS Master
- Cell Master
- BTS Master MT8221B with Option 450

Note	Not all instrument models offer every option. Refer to the Technical Data Sheet of your instrument for available options.

1-2 Product Information, Compliance, and Safety

Read the Handheld Instruments Product Information, Compliance, and Safety Guide (PN: 10100-00065) for important safety, legal, and regulatory notices before operating the equipment. For additional information and literature covering your product, visit the product page of your instrument on http://www.anritsu.com/ and select the Library tab.

Not all instrument models offer every option. Please refer to the Technical Data Sheet of your instrument for available options.

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1-4 Backhaul Analysis

Anritsu offers the following backhaul signal analysis modes:

- Chapter 2, “E1 Analyzer (Option 52 or 55)”
- Chapter 3, “OC-3c Analyzer (Option 58)”
- Chapter 4, “STM-1 Analyzer (Option 59)”
- Chapter 5, “T1/FT1 Analyzer (Option 51 or 54)”
- Chapter 6, “T1/T3 Analyzer (Option 53)”

1-5 Selecting a Backhaul Analysis Mode

1. Press the **Shift** key followed by pressing the **Mode** (9) key on the numeric keypad to open the Mode Selector list box.
2. Use the directional arrow keys or the rotary knob to highlight the required mode, and press the **Enter** key to select.

Chapter 2 — E1 Analyzer (Option 52 or 55)

2-1 Introduction

This chapter provides a brief description of an E1 - 2 Mb/s circuit and E1 - 2 Mb/s measurements and also explains how to set up and measure E1 - 2 Mb/s performance using the instrument with Option 52 or Option 55 installed.

2-2 Selecting the E1 Analyzer Mode

1. Press the **Shift** key followed by pressing the **Mode** (9) key on the numeric keypad to open the Mode Selector list box.
2. Use the directional arrow keys or the rotary knob to highlight E1 Analyzer and press **Enter** to select.

2-3 E1 - 2 Mb/s Fundamentals

Wireless service providers use wired E1 - 2 Mb/s circuits as the backhaul links to connect a Base Transceiver Station (BTS) to a Mobile Switching Center (MSC). The quality of the service that is provided over those E1 - 2 Mb/s lines has a direct effect on the quality of service that is experienced by the wireless service provider customers. Call setup failures, dropped calls, data errors, and noise can often be attributed to the E1 - 2 Mb/s backhaul facilities. An example of typical wireless network backhaul E1 - 2 Mb/s links is shown in Figure 2-1.

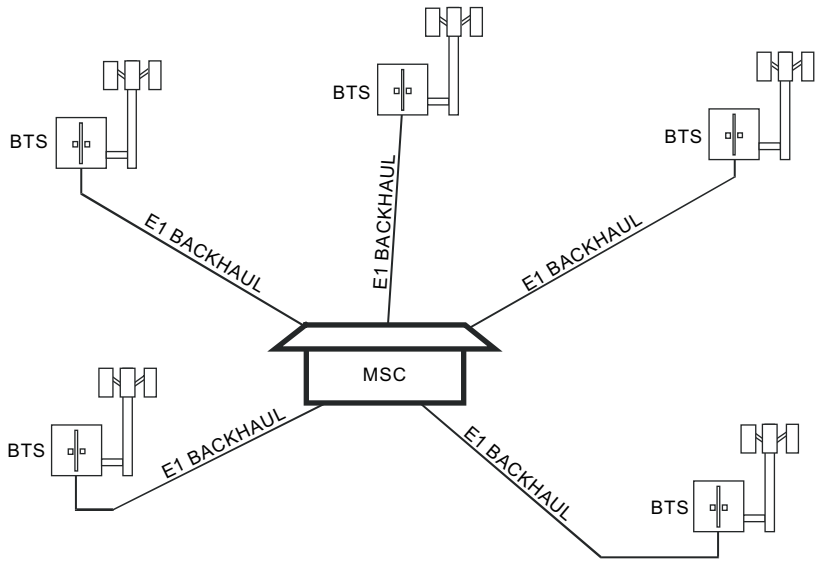


Figure 2-1. Typical Wireless Network Backhaul E1 - 2 Mb/s Link

E1 - 2 Mb/s is a digital signal that carries information at a rate of 2 Mb/s. The E1 - 2 Mb/s signal is organized into frames, which are defined in ITU-T recommendations G.704 and G.706. Four framing types are defined: PCM30, PCM31, PCM30CRC, and PCM31CRC. Each 2 Mb/s frame contains 256 bits (32 timeslots, each containing 8 bits) at a repetition rate of exactly 8 kHz. The first timeslot (timeslot zero, TS0) is reserved for framing, error checking, and alarm signals. In PCM31, the remaining 31 timeslots can be used for traffic (TS1 – TS31), either encoded telephone or data signals. In PCM30, timeslot 16 (TS16) is reserved for channel associated signaling (CAS). Framing types PCM30 CRC and PCM31 CRC add a CRC-4 check to the framing format.

FAS and NFAS Words

The transmit and receive ends of the transmission path are synchronized with a frame alignment byte or signal (FAS = S10011011) that is transmitted in TS0 of every second frame (frames 0, 2, 4, 6, and so on). A “nonframe alignment signal” (NFAS) is transmitted in TS0 of the alternate frames (that is, frames 1, 3, 5, 7 and so on).

After an FAS word has been correctly received, a '1' is expected in bit 2 of the NFAS word that is received in the next frame. If this occurs, and if the next frame contains a valid FAS word, then frame alignment is achieved. The receiving equipment can then correctly identify the individual 64 kb/s channels in the frame. If three frame alignment words in four are received in error, then the terminal equipment declares loss of frame synchronization and initiates resynchronization.

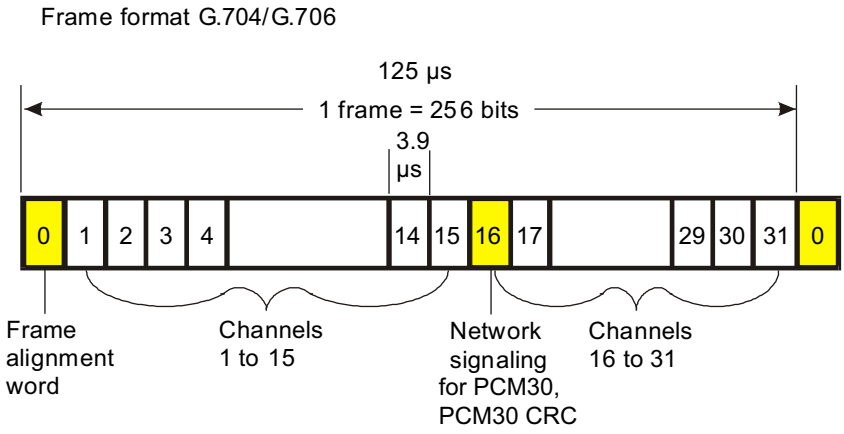
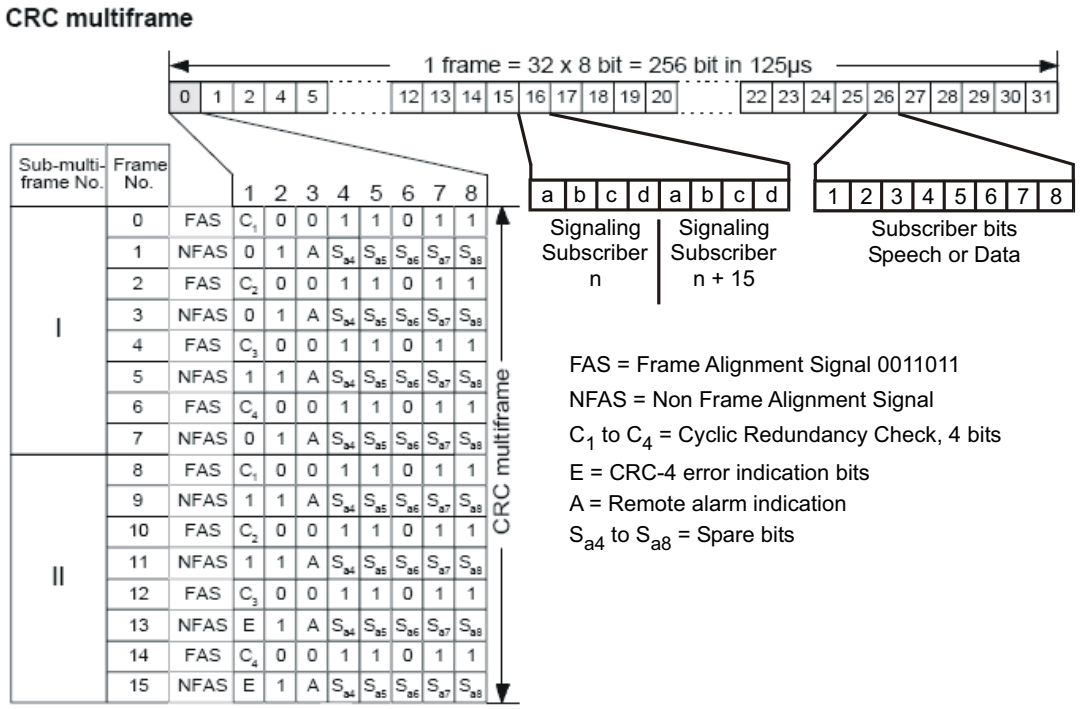


Figure 2-2. Transmission Frame Alignment

CRC-4 Framing

When the PCM30 and PCM31 framing formats are used exclusively for PCM voice transmission, the frame alignment is very reliable. However, when data is transmitted on the link, the traffic can contain the FAS and NFAS bit patterns, and false framing is possible.

To improve the reliability of the standard framing formats, recommendation G.704 specifies the use of a CRC-4 cyclic redundancy check for 2 Mb/s systems. CRC-4 framing provides reliable protection against incorrect synchronization, and also provides a means of predicting bit error ratio (BER) performance during normal operation. The CRC-4 remainder is calculated on complete blocks of data, and the 4-bit remainder is transmitted to the far end, using the first bit in the FAS of each even numbered frame (C1–C4). At the receiving end, the receiver makes the same calculation and compares its results with those in the received signal. If the two 4-bit words differ, then the receiving equipment determines that one or more errors are present in the payload. Every bit of the block is checked so that an accurate estimate of block error rate (or errored seconds) is made while the link is in-service.



Sub-multi-frame No.	Frame No.		1	2	3	4	5	6	7	8
I	0	FAS	C_1	0	0	1	1	0	1	1
	1	NFAS	0	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
	2	FAS	C_2	0	0	1	1	0	1	1
	3	NFAS	0	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
	4	FAS	C_3	0	0	1	1	0	1	1
	5	NFAS	1	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
	6	FAS	C_4	0	0	1	1	0	1	1
	7	NFAS	0	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
II	8	FAS	C_1	0	0	1	1	0	1	1
	9	NFAS	1	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
	10	FAS	C_2	0	0	1	1	0	1	1
	11	NFAS	1	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
	12	FAS	C_3	0	0	1	1	0	1	1
	13	NFAS	E	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}
	14	FAS	C_4	0	0	1	1	0	1	1
	15	NFAS	E	1	A	S_{a4}	S_{a5}	S_{a6}	S_{a7}	S_{a8}

Figure 2-3. CRC-4 Framing

To enable the receiver to locate the four bits (C1, C2, C3, and C4) that form the remainder, an additional frame (called the CRC multiframe) is formed. A CRC multiframe alignment bit pattern (001011) is used to synchronize the receiver to this frame. The pattern is inserted in the first bit position of the NFAS in frames 1, 3, 5, 7, 9, and 11. The CRC-4 multiframe is further divided into sub-multiframes (SMF) I and II, both of which span eight normal PCM frames. Because each PCM frame is 125 µs long, each SMF is 1 ms long, and one thousand CRC-4 error checks are made every second.

The first bits of frame 13 and frame 15 are called E-bits, and are used to indicate that data blocks with bit errors were detected from the far end. When no errors are detected in the received data, both E-bits are set to one (1). When an error is detected in SMF I, the receiving equipment sets the E-bit in frame 13 to zero (0). The E-bit in frame 15 indicates error status from SMF II in the same way. As a result, the local equipment can use the E-bits to monitor the performance of both the transmit and receive paths.

Signaling

Signaling is used in networks to set up the connections between the transmitting and receiving ends of a circuit. Two methods are available to carrying signaling information in E1 - 2 Mb/s frames: common channel signaling (CCS) and channel associated signaling (CAS). With CCS, the signaling data is carried in each channel. For CAS, the signaling data for all thirty channels is carried in TS16. The signaling information for each channel consists of four bits that are called ABCD bits. Historically, the state of the ABCD bits represented the On-hook and Off-hook states of a dial-pulse telephone.

The 8 bits in TS16 are not sufficient to hold the signaling information for all 30 channels in a single E1 - 2 Mb/s frame. Therefore, when CAS is used, a signaling multiframe structure is required in order to distribute the signaling information over 16 E1 - 2 Mb/s frames. After the equipment has gained primary frame alignment, it searches in timeslot 16 for the signaling multiframe alignment signal (MFAS) (0000) in bits 1 to 4. After the MFAS signal is located, the signaling information is extracted in the 15 frames following the MFAS, with the ABCD bits (for two channels) contained in each TS16.

If CCS (common channel signaling) is used, then signaling multiframe alignment is unnecessary. Timeslot 16 is used as a 64 kb/s data channel for CCS messages, or it can be turned over to revenue-earning traffic, yielding a total of 31 channels for the payload (PCM31).

2-4 Network Equipment

One possible network topology is shown in Figure 2-4.

Figure 2-4. One Possible E1 - 2 Mb/s Network Topology

The circuit between the MSC (Mobile Switching Center) and BTS (Base Transceiver Station) passes through the central office, or through multiple central offices. Within each office, it may also pass through multiple pieces of transmission equipment. An interface unit is located at the MSC and BTS. The interface unit may be a simple device having only a remote loop back capability, or it may provide sophisticated performance monitoring capabilities. Its capabilities may or may not be accessible to the wireless service provider technician.

2-5 E1 - 2 Mb/s Display

The E1 - 2 Mb/s display consists of the main display window, the left status display window, and the upper status display window.

The Left Status Display Window shows the status of E1 - 2 Mb/s key parameters, including the Test Mode, Line Code, TxClock, Receive Input, Framing Mode, Error Type, Pattern, Payload Type, Impedance, and Measurement Status.

The bottom main menu keys control the submenu keys on the right. Five active main menu keys are provided: **Configuration**, **Pattern**, **Error/Alarm**, **Measurements**, **Start/Stop.**

The Upper Status Display Window shows status of the Receive (Rx), Transmit (Tx), and Alarm/Error parameters. The Rx shows the history and current status of the Signal, Frame Alignment Signal (FAS), and the Pattern Sync. For Rx, the parameters are Signal, FAS, and Pattern Sync. For 2 Mbits, the parameters are Alarms and Errors. For TX, the parameters are Alarm ON and Error ON. The first column shows the history (H), and the second column shows the current status. A red indicator signifies an error, and a green indicator signifies no error. The history can be cleared by pressing **Measurements** and then Clear History.

Note	Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

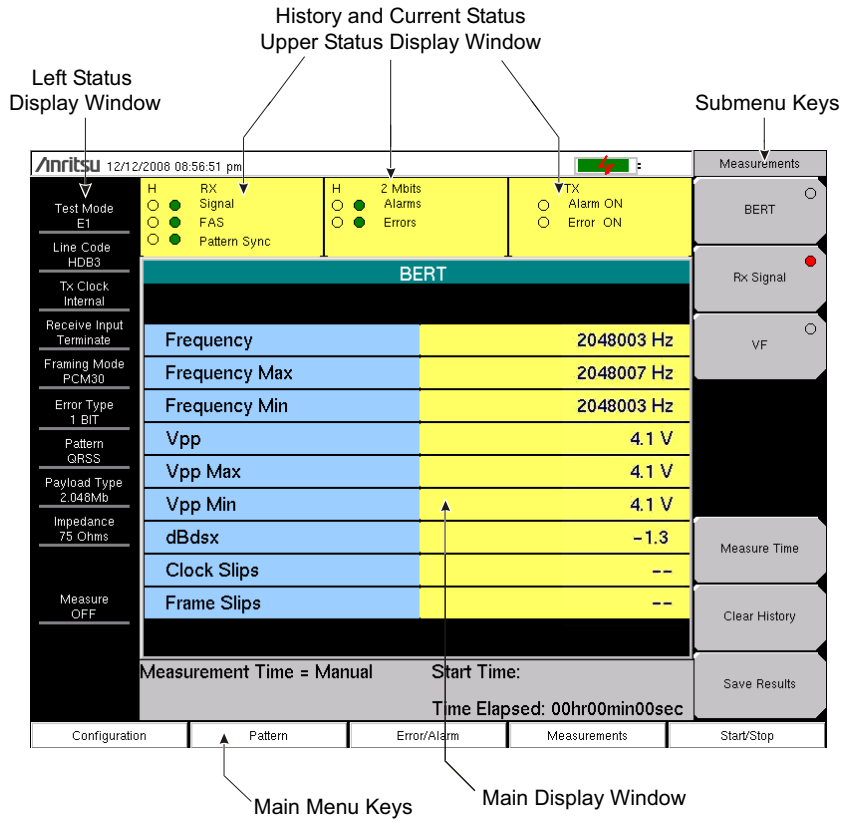


Figure 2-5. E1 - 2 Mb/s Display Overview

Configuration Menu

The configuration is accessed by pressing the **Configuration** main menu key. This menu is used to configure the Signal Setup and Payload Setup. The Signal Setup allows the user to set up the Line Code, Tx Clock, Input Connector, Rx Input, and Framing information. The Payload Setup allows the user to set up the payload type and payload channels for payload types other than 2.048 Mb.

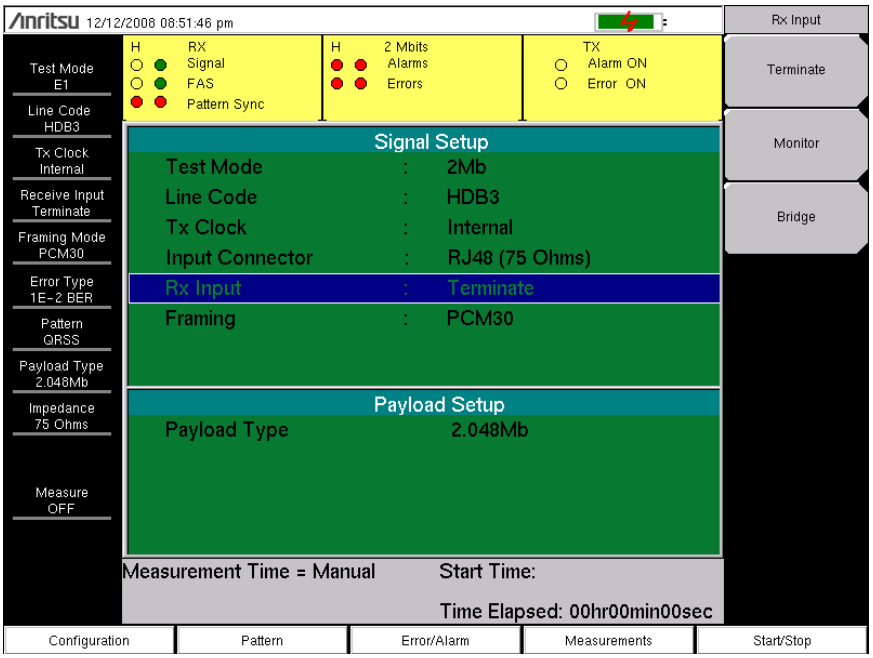


Figure 2-6. Configuration Setup

Submenu keys for the Configuration menu are shown and described in section "Configuration Menu" on page 2-25 and in Figure 2-15.

Test Mode: 2Mb

E1 - 2 Mb/s is a 2.048 Mb/s signal consisting of 32 individual timeslots. Each timeslot has individual 64 kb/s channels of data.

Line Code: HDB3 and AMI

Alternate Mark Inversion (AMI) and High Density Bipolar 3 (HDB3) are two different line coding formats used in E1 - 2 Mb/s networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the pulses alternate in polarity. Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. This can cause the receiving equipment to have timing errors. HDB3 is a line coding format which also has no DC offset, but which replaces strings of 4 or more zeros with a specific code containing a BPV. The next HDB3 insertion uses the opposite polarity to maintain a net zero DC offset on the circuit. The HDB3 code is detected and removed by the receiving equipment.

TxClock: Internal, Recovered, External

Internal Clock: Use the internal clock oscillator (2.048 MHz ± 5ppm)

Recovered Clock: The transmit clock uses the frequency recovered from the received signal.

External Clock: The transmit clocks uses the external clock that is applied to the External Trigger In connection.

Input Connector

RJ48, 120 Ω: Uses the 120 ohm RJ48 connector.

RJ48, 75 Ω: Uses the 75 ohm RJ48 connector.

BNC, 75 Ω: Uses the 75 ohm BNC connector (Option 52 only).

Rx Input

Terminate: The signal is terminated in 120 ohms or 75 ohms depending on selected Input Connector.

Monitor: The connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Bridge: The input impedance of the receiver is greater than 1000 ohms. The bridged mode is used when connecting directly to an in-service E1 - 2 Mb/s circuit to avoid causing a "hit" on the signal and to avoid disrupting service.

Measuring Clock and Frame Slips in E1 - 2 Mb/s Mode

If an E1 - 2 Mb/s SETS (Synchronous Equipment Timing Source) reference clock is available, then it can be used to measure clock slips and frame slips on the circuit under test. If two or more E1 - 2 Mb/s circuits are present, then one of these can be used as a reference.

To count clock slips, connect the reference clock to the Ext Trigger In connector on the instrument. The presence of the clock is automatically detected, and when a measurement is started, the number of clock slips and frame slips are reported. When the clock frequencies are very close, the clock slip count will hover around zero. If the frequency of the circuit under test is higher than the reference frequency, then the count will grow positive. If the frequency of the circuit under test is lower than the reference frequency, then the count will grow negative. One frame slip is counted for 256 clock slips.

Framing

PCM30: 30 voice or data channels, TS16 is used for CAS, no CRC-4 multiframe.

PCM30 CRC: 30 voice or data channels, TS16 is used for CAS, with CRC-4 multiframe.

PCM31: 31 voice or data channels, no CRC-4 multiframe.

PCM31 CRC: 31 voice or data channels, with CRC-4 multiframe.

Payload Type

The Payload identifies which portion of the 2 Mb/s data stream will be accessed for testing.

2.048 Mb: The entire data stream (excluding TS0, and TS16 when CAS is active) is tested.

Nx64kb/s: Selected combinations of 64 kb channels are tested. This mode is referred to as fractional E1 - 2 Mb/s.

64 kb: A single 64 kb channel is tested.

16 kb: 2 consecutive bits within a selected 64 kb channel are tested.

8 kb: A single bit within a selected 64 kb channel is tested.

Other Channels:

Pattern Menu

The pattern menu can be accessed by pressing the **Pattern** main menu key on the bottom. It includes 12 defined patterns. Up to six user-defined patterns can be created by pressing the Set User Pattern submenu key.

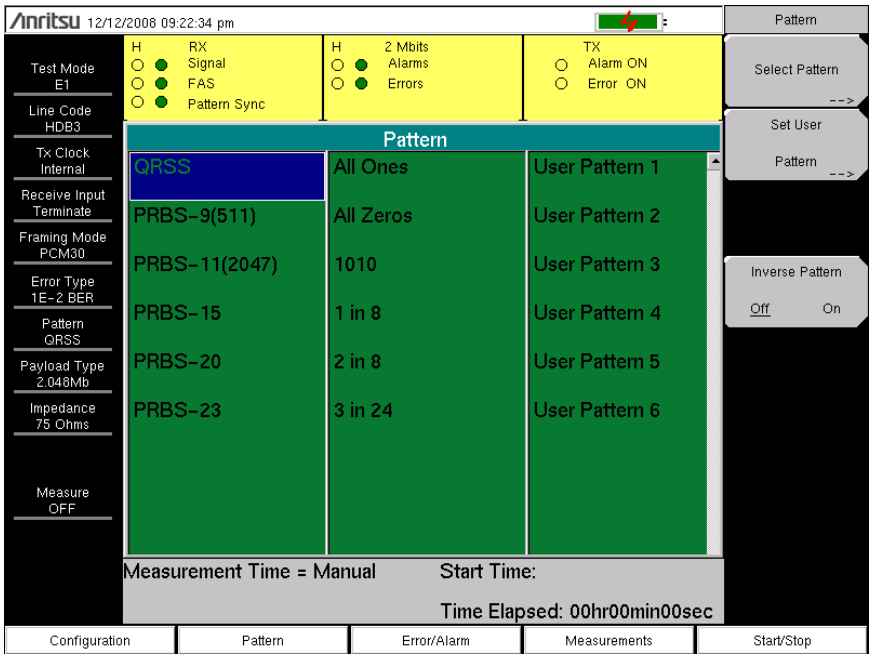


Figure 2-7. Pattern Menu

Submenu keys for the Pattern menu are shown and described in section "Pattern Menu" on page 2-28 and Figure 2-16.

QRSS

- 1,048,575-bit pattern. An output bit is forced to one whenever the previous 14 bits are zero.
- Simulates live traffic including both high-density and low-density sequences.

PRBS-9

- 511- bit pseudo-random pattern.

PRBS-11

- 2047-bit pseudo-random pattern.

PRBS-15

- 32,767-bit pseudo-random pattern.
- Tests to CCITT recommendations O.151 and G.703. Provides maximum number of zeros for testing non-HDB3 circuits.

PRBS-20

- 1,048,575-bit pseudo-random pattern.

PRBS-23

8,388,607-bit pseudo-random pattern.

1 IN 8 (also known as 1 in 7)

- 8-bit pattern of a 1 and 7 zeros.
- Checks clock recovery on circuits optioned for HDB3.

2 IN 8

- 8-bit pattern of 2 ones and 6 zeros.
- Used to determine correct optioning of AMI or HDB3 line coding.

3 IN 24

- 24-bit pattern with 3 ones and also with 15 consecutive zeros. 12.5% ones density.
- Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in HDB3 optioned circuits.

ALL ONES

- All ones sent as payload in a framed sequence.
- Stresses ability of circuit to operate under maximum power conditions.

ALL ZEROS

- All zeros sent as payload in a framed sequence.
- Checks for HDB3 optioning. Circuit will drop if optioned for AMI.

User Defined Patterns

- Custom user-defined patterns can be created by pressing the "Set User Pattern" submenu key on page 2-28.

Inverse Patterns

- Inverts the selected PRBS pattern.

Error/Alarm

The Error/Alarm menu includes all the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** main menu key to access the menu.

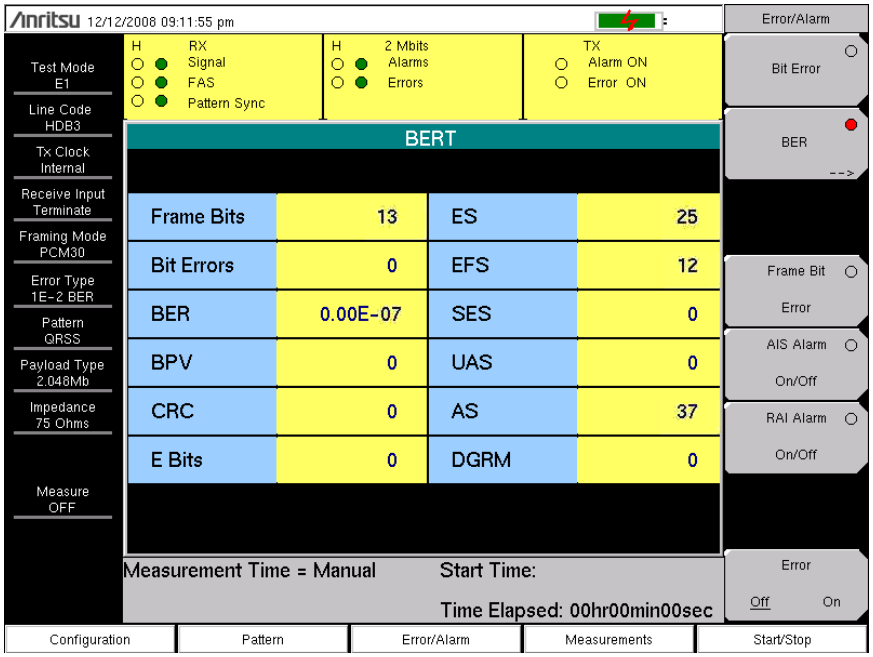


Figure 2-8. Alarm/Error Menu

Submenu keys for the Alarm/Error menu are shown and described in section "Error/Alarm Menu" on page 2-29 and Figure 2-23.

Frame Bit Errors: Inserts errors in the framing bits. Select by pressing Frame Bit Error. Press Frame Bit Error again and then press Burst. Enter a burst value between 1 and 1000 using the keypad.

Bit Errors: Inserts errors in the BER pattern. Select by pressing the Bit Error submenu key. Press Bit Error again and then Burst. Enter a burst value between 1 and 1000 using the keypad.

BER (Bit Error Rate): Errors can be added to the transmission path by pressing the BER submenu key twice. Valid BER include 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. If a BER value of 1E–3 is selected, then 1 error for every 1000 bits will be introduced. The Error On/Off submenu key is used to turn the errors on.

AIS (Alarm Indication Signal) Alarm: When the AIS is turned on, the data is replaced with an unframed signal of all ones.

RAI (Remote Alarm Indicator) Alarm: If the terminal loses its incoming signal, then an RAI signal is transmitted in the outgoing direction. RAI is also called Yellow Alarm.

2-6 Testing E1 - 2 Mb/s Circuits

E1 - 2 Mb/s circuit testing can be performed with either of two methods: In-service testing or Out-of-service testing. In-service testing is done during routine maintenance. This can be accomplished without removing the E1 - 2 Mb/s circuit from service and without interrupting live traffic. Monitoring live traffic allows the wireless service provider technician to detect alarms, bipolar violations (BPV), and frame errors, but does not allow direct BER measurements. However, bit errors may be estimated by measuring CRC errors and E-bit errors.

Out-of-service testing is done when the E1 - 2 Mb/s is initially installed and before final acceptance from the service provider. At that time the circuit should be subjected to critical testing to guarantee the level of service per contract. Out-of-service testing may also be performed when the circuit performance is very poor. For out-of-service testing, the E1 - 2 Mb/s circuit should be removed from service to allow detailed performance testing.

In-service Testing

In order to avoid disrupting service, the Bridged or Monitor receiver settings must be used when testing an E1 - 2 Mb/s circuit that is in-service. The following measurements are used to check the E1 - 2 Mb/s performance during regular maintenance:

- Vpp measurement
- Carrier Frequency
- Frame Sync
- CRC errors and E-bits
- Clock and Frame Slips
- VF (audible assessment of the signal quality of the circuit)

E-bits and CRC are very useful for in-service testing to monitor E1 - 2 Mb/s BER performance. Even when the E1 - 2 Mb/s circuit is down, these tests can be useful to identify the faulty section of the circuit. If the primary errors that are detected are E-bit errors, then the transmit path is most likely to be faulty. If the primary errors that are detected are CRC errors, then the receive path is most likely to be faulty.

Required Equipment

- The appropriate connection interfaces from the instrument to the E1 circuit under test are: 75 ohm coax, 120 ohm RJ48c and 75 ohm RJ48c. E1 cables with any of these interfaces and with the appropriate interface for their respective E1 circuit panel are sufficient for performing E1 tests.

Measurement Setup Procedure

1. Press the **Configuration** main menu key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the HDB3 or the AMI coding submenu key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Input Connector. Select from RJ48 120 ohms, RJ48 75 ohms, or BNC 75 ohms (Option 52 only).

5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input. Select from Terminate, Monitor, or Bridge. For in-service testing, select Bridge or Monitor, as appropriate for the connection.

Note	The Bridge or Monitor selection must be made before the instrument is connected to the circuit.

6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing. Select PCM30, PCM30CRC, PCM31, or PCM31CRC.

Note	The setup parameters are displayed in the setup summary table on the left side of the screen. Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

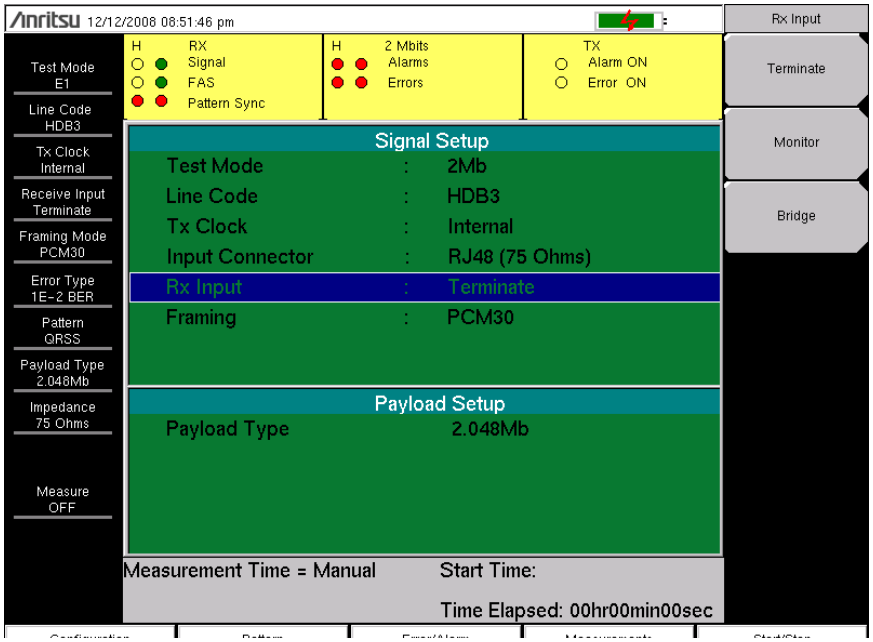


Figure 2-9. Configuration Rx Input

Submenu keys for the Configuration menus are shown and described in "Configuration Menu" on page 2-25 and in Figure 2-15.

2-7 BERT Measurement Setup Procedure

1. Press the **Configuration** main menu key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the HDB3 or the AMI coding submenu key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Input Connector. Select from RJ48 120 ohms, RJ48 75 ohms, or BNC 75 ohms (Option 52 only).
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input. Select from Terminate, Monitor, or Bridge. For in-service testing, select Bridge or Monitor.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing. Select PCM30, PCM30CRC, PCM31, or PCM31CRC.
7. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload Type. Select 2.048 Mb, Nx64kb, 64kb, 16kb, or 8kb.
8. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload Channel. Selections depend upon the payload type and are only available with Nx64kb, 64kb, 16kb, or 8kb.
9. Press Edit Channel and select the channel from the list using the **Up/Down** channel or the rotary knob. Press Select Channel and **Enter** to select the channel number from the list.
10. Use the **Up/Down** arrow keys or the rotary knob to highlight Other Channels. Selections depend upon the payload type and are only available with Nx64kb, 64kb, 16kb, or 8kb. Select All Ones or Idle.
11. Press the **Pattern** main menu key to activate the pattern menu.
12. Use the **Up/Down** arrow keys or the rotary knob to highlight the appropriate pattern, and then press **Enter.**

BERT Table Display Setup

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the Table submenu key to display the measurements in the table format.
4. Press the **Start/Stop** main menu key to start and stop the measurement.

Note	The pass/fail indicators are updated continuously even when measurements are stopped.

5. If the results are okay, then RESULTS OK is displayed in a green box at the center of the screen. If the results are not okay, then the errors or measurement results are displayed in the table.

Note	RESULTS OK can be cleared by pressing **Esc.**

Note	The measurement time can be set up in two ways: Manual (continuous), or by setting a fixed value using the Measure Time submenu in the **Measurements** menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, or 3 days).

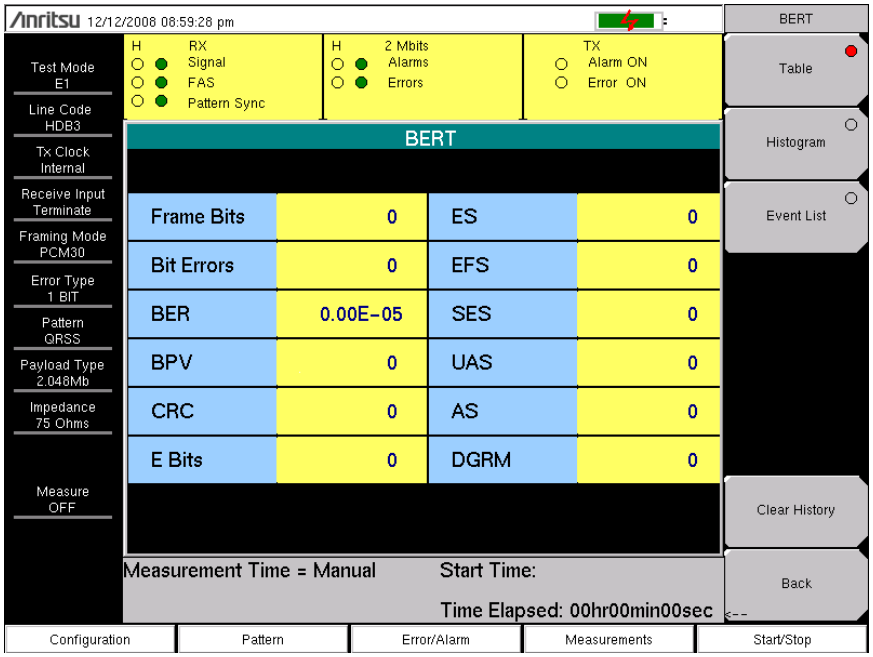


Figure 2-10. BERT Table Display

Submenu keys for the BERT menu are shown in Figure 2-18 and are described in "BERT Menu" on page 2-32.

Histogram Display

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the Histogram submenu key to display the data in Histogram format.
4. Press the Histogram submenu key again and press Zoom In to zoom in by adjusting the horizontal (minutes/div) scale.
5. Press the Zoom Out submenu key to zoom out by adjusting the horizontal (minutes/div) scale.
6. Press the Time Units submenu key to select between Relative and Absolute time units.

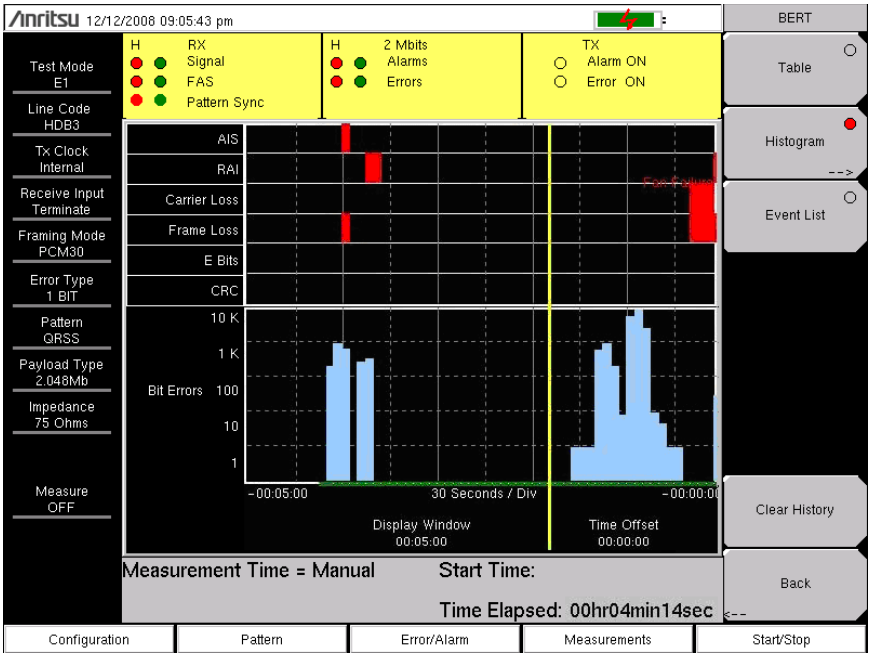


Figure 2-11. BERT Histogram Display

Submenu keys for the Histogram menu are shown in Figure 2-18 and are described in "Histogram Menu" on page 2-33.

Histogram Settings

Zoom In and Zoom Out

The zoom in and zoom out features can be used to change the resolution of the data in the histogram display at the cursor location. When the cursor passes the 10% and 90% time points of the histogram display, the time window starts scrolling back in time or ahead in time. If you need to see a detailed view of a fault occurrence, then you can use the zoom in function to change the resolution to as small as 5 seconds per division. Maximum window size is 72 hours (6 hours/div). When more than 72 hours of data are collected, the last 72 hours are shown.

Window Size

The window size adjusts the length of time that is shown on the histogram screen. More data may be stored than is shown. This parameter allows you to zoom in or zoom out to see either more time on the screen or more resolution. The minimum (1 minute) window size and maximum (3 days) window size values are based upon the data resolution that is selected with the zoom in and zoom out features.

Time Units

If Relative is selected (underlined), then the histogram axis is labeled with time since the start of the measurement record. If Absolute is selected, then the histogram axis is labeled with absolute times based upon the system clock.

Rx Signal Measurement Procedure

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the Rx Signal submenu key to activate the Rx Signal menu.

To Insert Errors/Alarms

1. Press the **Error/Alarm** main menu key to activate the Error/Alarm menu.
2. Press the Bit Error (1–1000 Burst), BER, or Frame Bit Error submenu key, as applicable to the measurement.

Note	If Bit Error is pressed, then press the Bit Error key again to select a burst number between 1 and 1000. If BER is pressed, then press BER again and select the bit error rate to be 1E-2, 1E-3, 1E-4, 1E-5, 1E-6, or 1E-7. If Frame Bit Error is pressed, then press Frame Bit Error again and select a burst number between 1 and 1000.

3. Press the AIS Alarm or RAI Alarm submenu key. These two submenu keys toggle between ON and OFF. The alarm status is displayed in the measurement status bar.

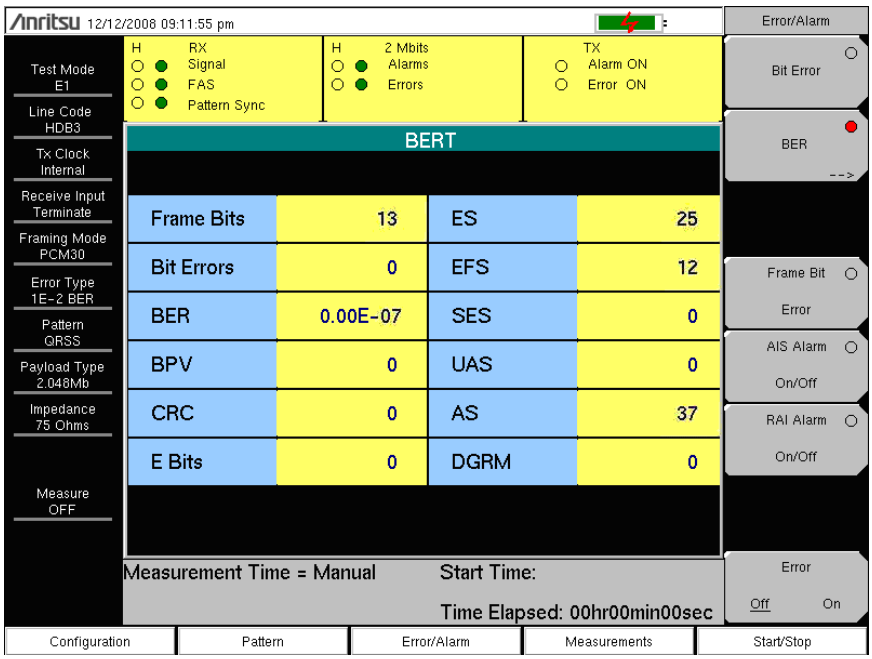


Figure 2-12. Event List

Event List

The Event List updates errors, signal loss, frame loss, and alarms every second. Alarms are: AIS ON, AIS OFF, RAI ON, and RAI OFF. The data is displayed as a log list. The display will list up to 1000 errored seconds.

2-8 Rx Signal Measurement Procedure

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the Rx Signal submenu key to activate Rx Signal measurement.
3. Press the **Start/Stop** main menu key to start and stop the measurement.

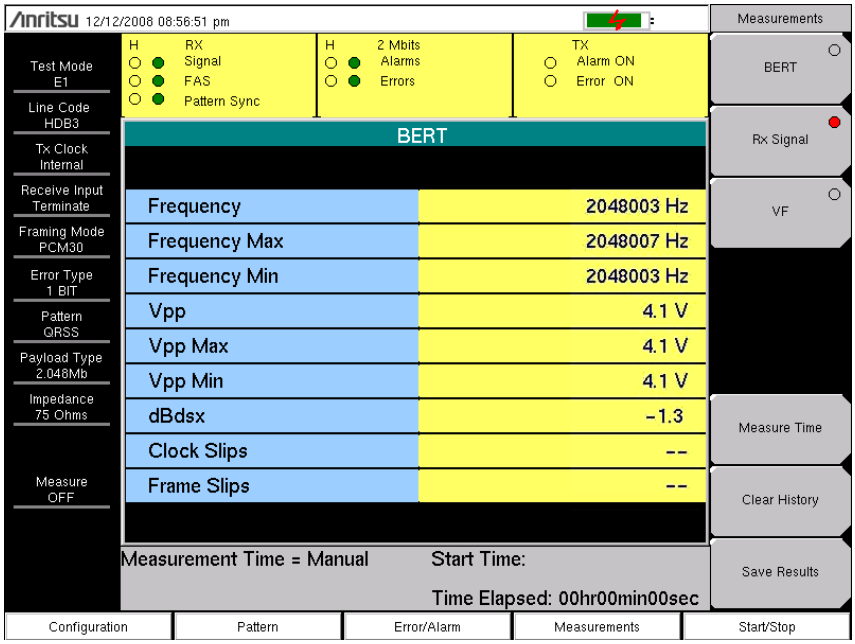


Figure 2-13. Rx Signal Measurement

Out-of-service Measurements

Out-of-service measurements are performed when the E1 - 2 Mb/s circuit is not in-service or is inactive. Typically these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the results of the in-service measurements indicate errors. These measurements provide detailed information on the E1 - 2 Mb/s circuit.

Out-of-service testing is performed using end-to-end testing, which requires a technician and an E1 - 2 Mb/s tester at each end of the circuit, or by establishing a loopback at the remote end of the circuit.

The following measurements are used to check the E1 - 2 Mb/s performance during out-of-service testing:

- Vpp
- Carrier Frequency
- CRC Errors
- Frame Sync
- Pattern Sync
- E-Bits

2-9 VF Channel Access Testing

The VF Channel Access test feature enables testing on each of the 32 channels of the E1 - 2 Mb/s line. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling the tester to make an audible assessment of the signal quality of the circuit. If the circuit is out-of-service, then a test tone can be inserted on the transmit channel for measurement at a remote location with another test set, or locally with a loopback.

Configuration

Before conducting channel tests, the E1 - 2 Mb/s interface must be properly configured. From the Configuration menu, select the correct Framing Mode, Line Coding, and Clock Source. If the testing is in-service, then the Rx Input must be configured for either Bridged or Monitor modes. The receive mode should be set up before connecting to the circuit in order to avoid creating a “hit” on the customer data. The instrument transmit pair should not be connected to the circuit. If the measurement is out-of-service, then the Receive Input mode should be terminated, and the instrument transmitter can be safely connected to the circuit. The current configuration of the E1 - 2 Mb/s interface is displayed in the status window on the left side of the screen.

Channel Tests

After the unit is correctly configured, select the VF Channel Access menu to perform tests at the channel level. Press the Select Channel submenu key to select specific channels. Either enter a specific channel number from the keypad or scroll through the channels with the **Up/Down** arrow keys. The received VF level and frequency on the selected channel are displayed, and the decoded signal is connected to a speaker for audio monitoring. When a test tone is present on the channel, the power and frequency report indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality. An overview of channel utilization can be formed by quickly scrolling through the channels.

If the circuit is out-of-service, then the user can connect to the transmit pair and insert a test tone on the selected channel (note that transmit and receive must be on the same channel). Two menus enable selection of transmit level and frequency. The frequency can be entered from the keypad, or scrolled to common test frequencies (404 Hz, 1004 Hz, 1804 Hz, and 2713 Hz) with the **Up/Down** arrow keys or the rotary knob. To check the performance of channel level equipment, the test tone can be measured at a remote location with another VF channel test set.

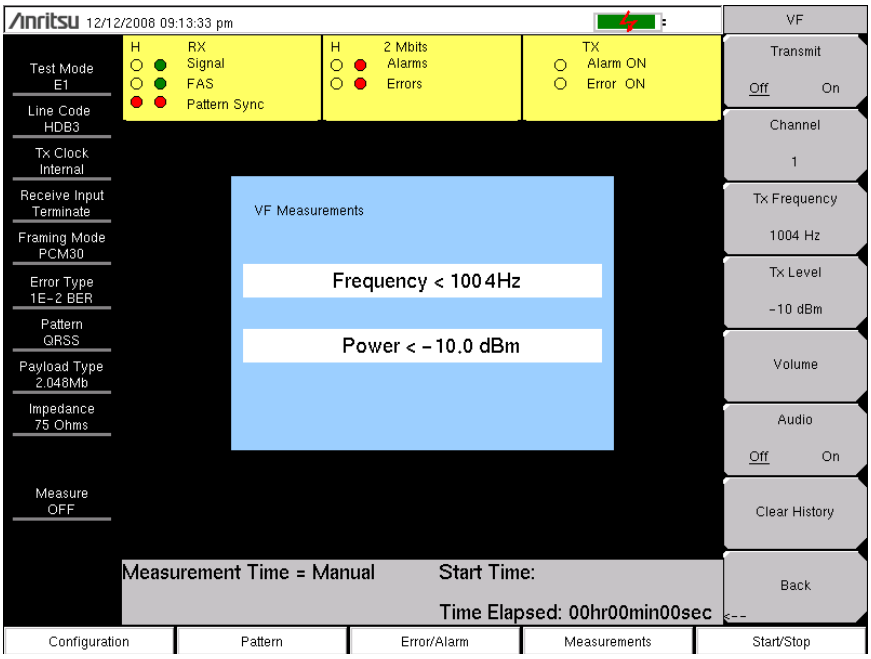


Figure 2-14. VF Measurements

Submenu keys for the VF menu are shown in Figure 2-18 and are described in "VF Menu" on page 2-34.

2-10 E1 Menus

Figure 2-15 to Figure 2-18 show the map of the E1 menus. The following sections describe main menus and associated submenus. The submenus are listed in the order they appear on the display from top to bottom under each main menu.

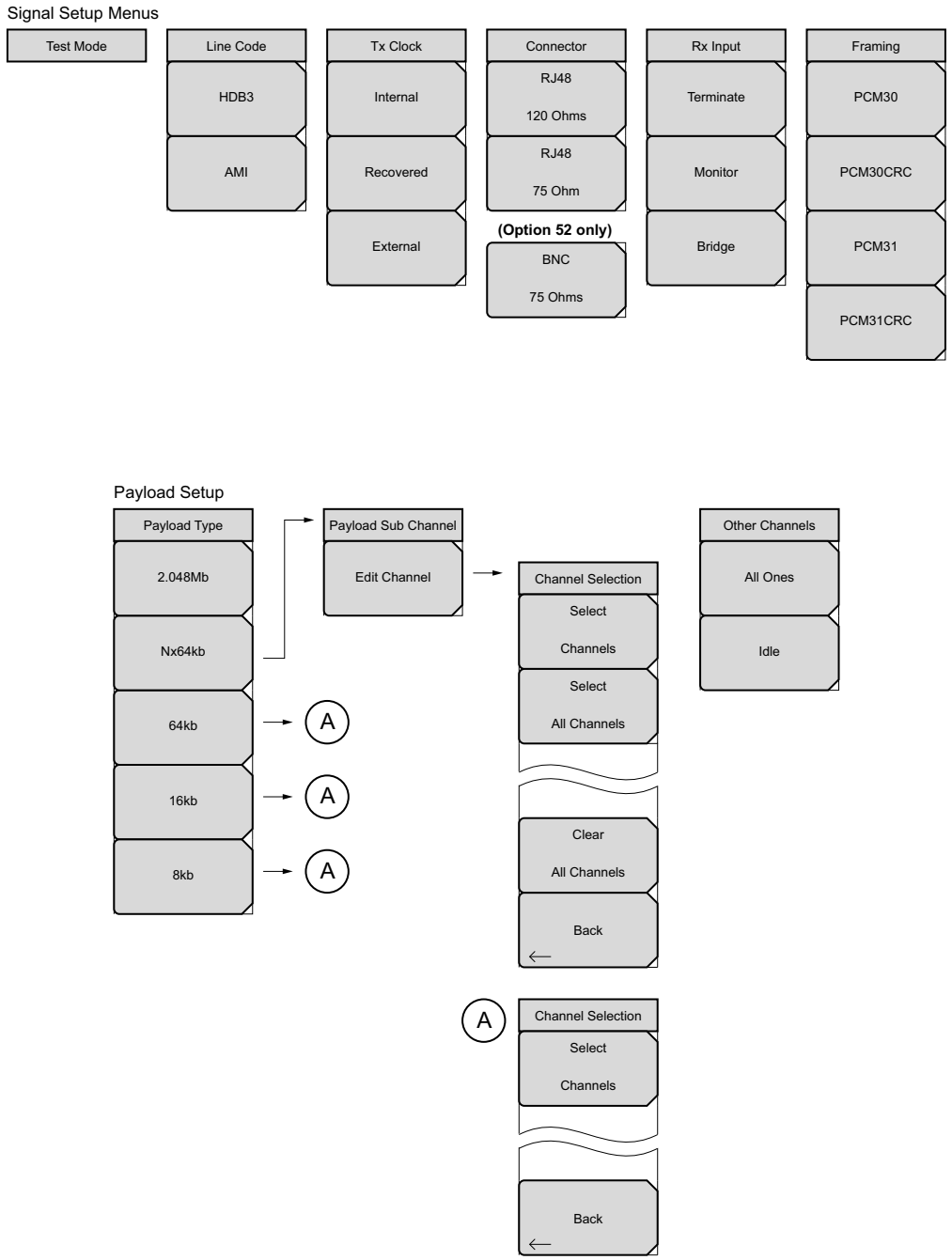


Figure 2-15. E1 Configuration Submenu Keys

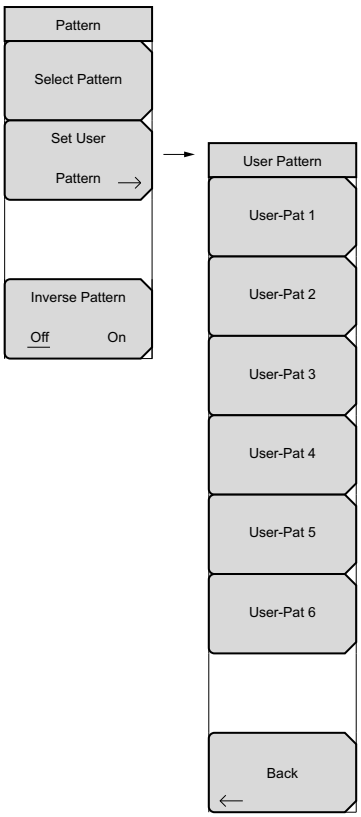


Figure 2-16. E1 Pattern Submenu Keys

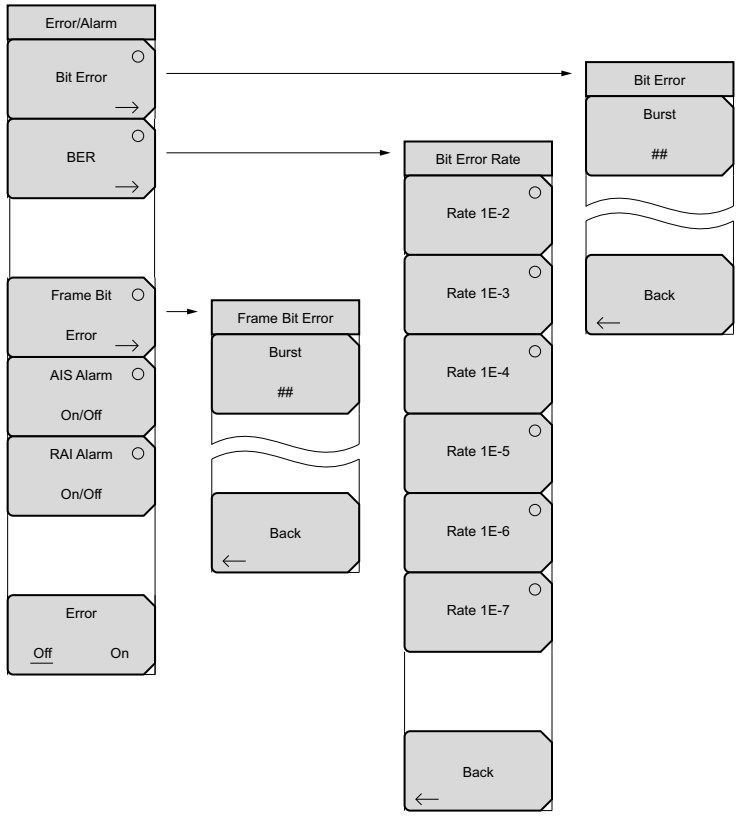


Figure 2-17. E1 Error/Alarm Submenu Keys

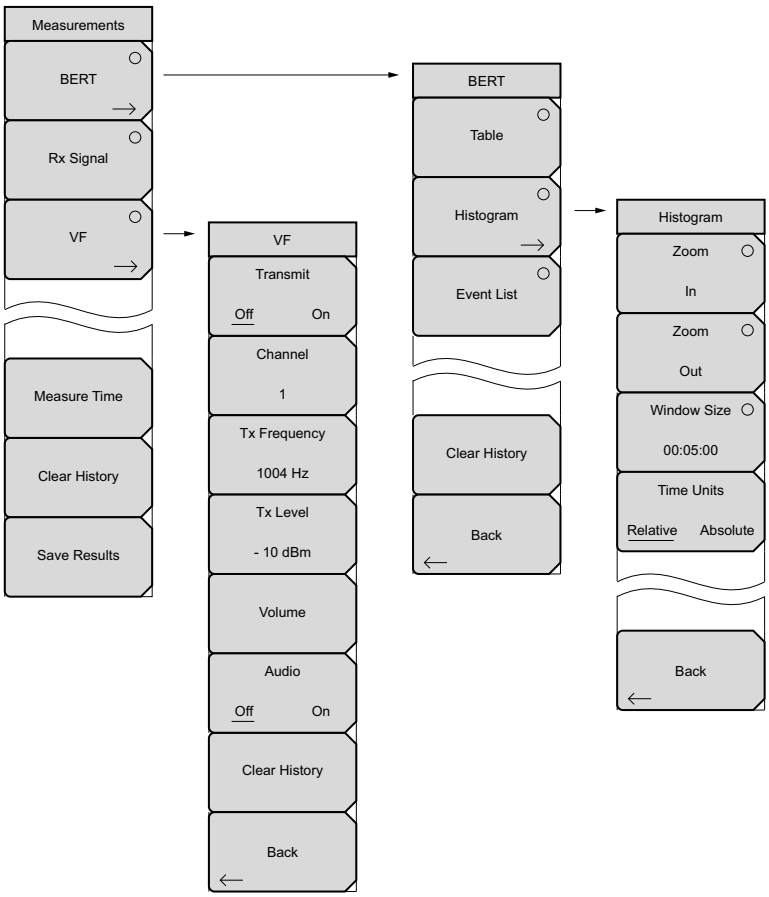
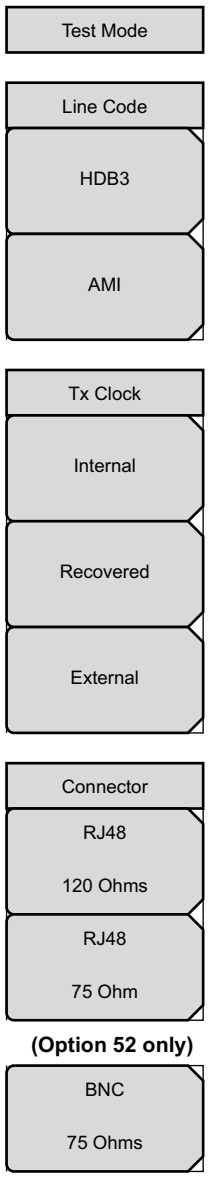


Figure 2-18. E1 Measurements Submenu Keys

2-11 Configuration Menu

Key Sequence: **Configuration**

Signal Setup



Test Mode: This signal setup has no submenu keys.

Line Code: Refer to "Line Code: HDB3 and AMI" on page 2-7.

HDB3: This submenu key selects High Density Bipolar 3 (HDB3) line coding.

AMI: This submenu key selects Alternate Mark Inversion (AMI) line coding.

Tx Clock: Refer to "TxClock: Internal, Recovered, External" on page 2-8.

Internal: This submenu key selects the internally generated Tx Clock.

Recovered: This submenu key selects a clock signal that is recovered from the receive path.

External: This submenu key selects a clock from an external reference that is applied to Ext Trigger In.

Connector:

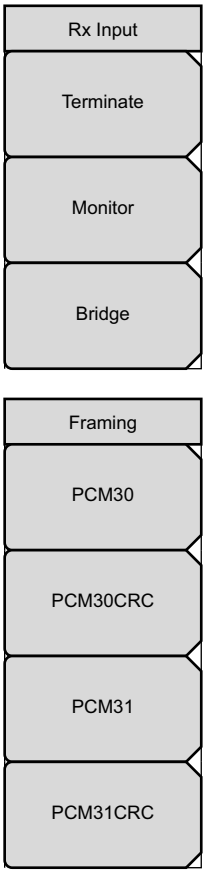
RJ48, 120 ohms: This submenu key selects the 120 ohm RJ48 connector.

RJ48, 75 ohms: This submenu key selects the 75 ohm RJ48 connector.

(Option 52 only)

BNC, 75 ohms: This submenu key selects the 75 ohm BNC connector.

Figure 2-19. E1 Signal Setup (1 of 2)



Rx Input:

Terminate: This submenu key selects terminate mode. Terminations on the receive side can be 75 ohm or 120 ohm, or can be bridged for higher resistance.

Monitor: This submenu key adds +20 dB gain to the receive path.

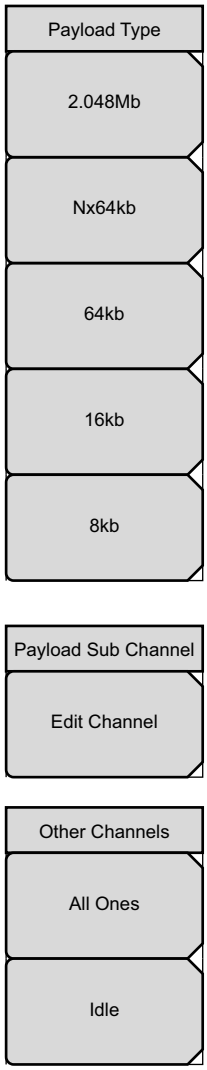
Bridge: This submenu key sets up a bridged connection with >1000 ohms.

Framing:

PCM30, PCM30CRC, PCM31, and PCM31CRC: These submenu keys select the framing format.

Figure 2-20. E1 Signal Setup (2 of 2)

Payload Setup



Payload Type:

2.048Mb: Select this payload type to test all user channels, the entire data stream (excluding TS0, and TS16 when CAS is active).

Nx64kb, 64kb, 16kb, and 8kb: In these payload types, the Channel Selection Dialog Box allows selection of one or more channels for testing, from 1 through 31. Press the Edit Channel submenu key to open the Channel Selection Dialog Box.

Use the arrow keys or the rotary knob to scroll through the channels. Press the Select Channel submenu key to select a channel or to clear an existing selection. Then press the **Enter** key or the **Rotary Knob** to enter the selection. If the Back submenu key or **ESC** is pressed, then any changes to channel selection are ignored, the dialog box is closed, and the Payload Sub Channel submenu is displayed.

Nx64kb: In this payload type, any number of channels can be selected, including all or none. Because multiple channels can be selected, the Channel Selection submenu offers two additional submenu keys: Select All Channels and Clear All Channels. Refer to Figure 2-15.

64kb: Use this payload type to select a single 64 kb channel.

16kb: Use this payload type to select 2 consecutive bits within a single 64 kb channel.

8kb: Use this payload type to select a single bit within a selected 64 kb channel.

Payload Channel:

Edit Channel: Pressing this submenu key opens the Channel Selection Dialog Box and the Channel Selection submenu.

Other Channels: When this configuration line is selected, the Other Channels submenu is displayed.

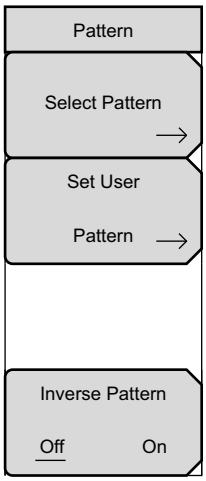
All Ones: Press this submenu key to set all unselected channels to "all ones."

Idle: Press this submenu key to set all unselected channels to "idle."

Figure 2-21. E1 Payload Setup

2-12 Pattern Menu

Key Sequence: **Pattern**



Select Pattern: After highlighting a pattern with the rotary knob or arrow keys, use this submenu key to select the pattern.

Set User Pattern: Use this submenu key to select a specific user pattern from a list of six patterns, which can be configured separately.

User-Pat #: These six submenu keys each select a different pattern. Enter zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue or **Esc** to abort.

Back: Returns to the Pattern menu.

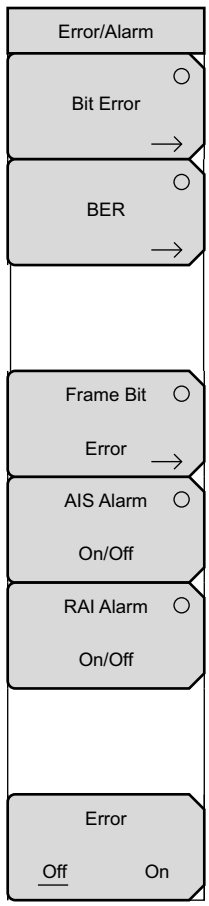
Inverse Pattern, Off/On: This submenu key toggles the Inverse Pattern function Off and On. When on, the selected PRBS pattern is inverted.

Figure 2-22. E1 Pattern Menu

2-13 Error/Alarm Menu

When not active, some submenu keys have a circular indicator with a plain background. The circular indicator with a red background arrow appears only when these submenu keys are active.

Key Sequence: **Error/Alarm**



Bit Error: Use this submenu key to insert a bit error. If not already selected, press this submenu key once to select the function, and the submenu key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the Bit Error menu.

Burst #: Bit Error Insert, 1 to 1000. Set this parameter by pressing the Burst submenu key and then using the rotary knob, arrow keys, or number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad, then the Burst submenu key label changes to Enter, and the submenu key is used to enter the parameter value.

Back: Press this submenu key to return to the Error/Alarm menu.

BER (Bit Error Rate): If not already selected, press this submenu key once to select the function, and the submenu key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the Bit Error Rate menu. Choose from the six rate options and press Back to continue.

Rate 1E-#: These six submenu keys are labeled with number 1E-2 through number 1E-7. Use these submenu keys to select a bit error rate.

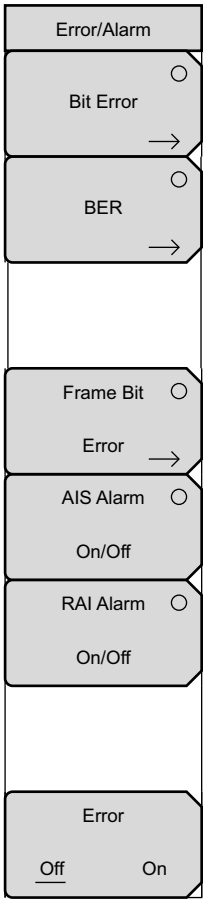
Back: Press this submenu key to return to the Error/Alarm menu.

Frame Bit Error: Use this submenu key to insert a frame bit error. If not already selected, press this submenu key once to select the function, and then the submenu key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the Frame Bit Error menu.

Burst #: Frame Error Insert, 1 to 1000. Set this parameter by pressing the Burst submenu key and then using the rotary knob, arrow keys, or number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad, then the Burst submenu key label changes to Enter, and the submenu key can be used to enter the parameter value.

Back: Press this submenu key to return to the Error/Alarm menu.

Figure 2-23. E1 Error/Alarm Menu (1 of 2)



AIS Alarm, On/Off: Press this submenu key to turn ON the AIS Alarm function, and the submenu key label displays the circle indicator in red (to show that the key is active). “Error Type AIS” is displayed in the Error Type message (in the instrument settings summary area at the left of the display window). The Alarm ON circle indicator (in the TX portion of the upper status display window) is displayed in red when this parameter is ON.

Selecting this function automatically turns the Error, Off/On submenu key function to Off, and its circle indicator in the TX portion of the upper status display window is displayed as an open circle. Pressing this submenu key again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error submenu key becomes active (its circle indicator is displayed in red).

RAI Alarm, On/Off: Press this submenu key to turn ON the RAI Alarm function, and the submenu key label displays the circle indicator in red (to show that the key is active). “Error Type RAI” is displayed in the Error Type message (in the instrument settings summary area at the left of the display window). The Alarm ON circle indicator (in the TX portion of the upper status display window) is displayed in red when this parameter is ON.

Selecting this function automatically turns the Error, Off/On submenu key function to Off, and its circle indicator in the TX portion of the upper status display window is displayed as an open circle. Pressing this submenu key again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error submenu key becomes active (its circle indicator is displayed in red).

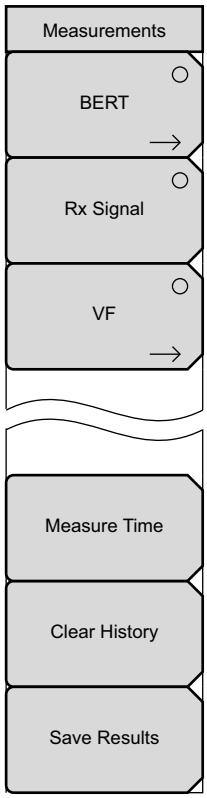
Error, Off/On: This submenu key is active only when the BER submenu key is active. Press this submenu key to toggle Error Off and On. The Error ON circle indicator (in the TX portion of the upper status display window) is displayed in green when this parameter is ON.

Figure 2-24. E1 Error/Alarm Menu (2 of 2)

2-14 Measurements Menu

When not active, some submenu keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these submenu keys are active.

Key Sequence: **Measurements**



BERT: Press this submenu key to open the "BERT Menu" on page 2-32. If not already selected, press this submenu key once to select the function, and the submenu key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the BERT menu.

Rx Signal: This submenu key has an indicator which is displayed with a red background when the function is active. The submenu key opens a table of BERT indications and their values:

- Frequency
- Frequency Max
- Frequency Min
- Vpp
- Vpp Max
- Vpp Min
- dBdsx
- Clock Slips
- Frame Slips

VF: Press this submenu key once to display the frequency and power of VF signals. Press the submenu key again to open the "VF Menu" on page 2-34 for configuration.

Measure Time: This submenu key opens a dialog box to set the measurement time from 1 minute (minimum) to 3 days (maximum) or set to Manual. Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the **Rotary Knob** to continue, or press **Esc** to abort.

Clear History: Press this submenu key to erase the history of displayed events and measurements.

Save Results: Press this submenu key to save the results of a measurement.

Figure 2-25. E1 Measurements Menu

BERT Menu

Key Sequence: **Measurements** > BERT

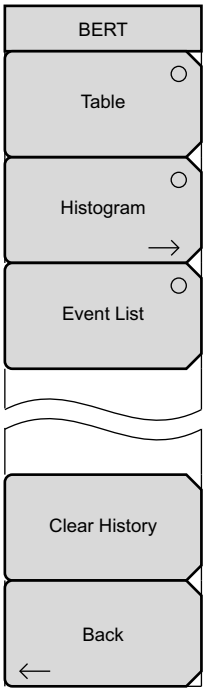


Table: Press this submenu key to display the 12 BERT parameters and their settings in a table format in the main display window. The circular indicator changes to a red background when this key has been pressed.

Histogram: Press this submenu key once to make it active and to display a histogram of parameters, as shown in Figure 2-11 on page 2-16. Press the submenu key again to bring up the "Histogram Menu" on page 2-33. The circular indicator with a red background and the sub menu arrow appear only when this submenu key is active.

Event List: Press this submenu key to display a chronological event list with 4 columns. The column labels are "Date", "Time", "Event Type", and "Events."

Clear History: Press this submenu key to erase the history of displayed events and measurements.

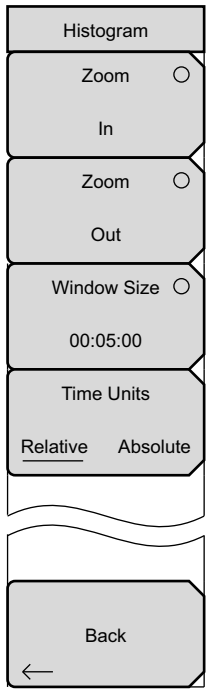
Back: Press this submenu key to return to the "Measurements Menu" on page 2-31.

Figure 2-26. E1 BERT Menu

Histogram Menu

Key Sequence: **Measurements** > BERT > Histogram

Note	Turning the rotary knob in the Histogram view scrolls a vertical yellow marker line across the histogram graph.



Zoom In: Use this submenu key to change the graph horizontal scale to a smaller value.

Zoom Out: Use this submenu key to change the graph horizontal scale to a larger value.

Window Size: This submenu key displays the time units in the format 0d:00:00:00, in days, hours, minutes, or seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; or 1, 2, or 3 days. When pressed, the submenu key color changes to a darker background, and the numeric value is displayed in red. The labels (Display window 00:10:00) in the graph area of the display are also in red. The red color indicates that the time can be changed.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys, but it will be automatically rounded up to one of the 9 standard increments. The submenu changes to Time increments as soon as any number is pressed.

Press the time units submenu key to enter the time value. The Window Size submenu key remains active until you press the **Enter** key or the Rotary Knob.

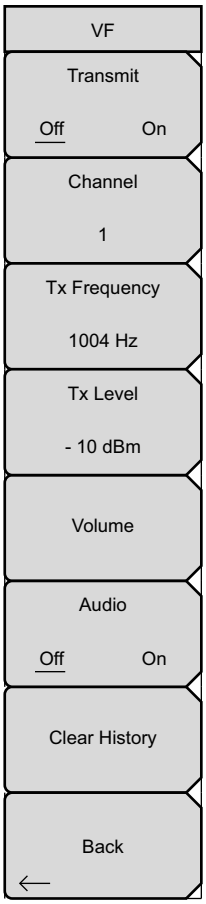
Time Units: This submenu keys toggles between relative and absolute time.

Back: Press this submenu key to return to the “BERT Menu” on page 2-32.

Figure 2-27. E1 Histogram Menu

VF Menu

Key Sequence: **Measurements** > VF



Transmit, Off/On: This submenu key toggles Transmit Off and On.

Channel: This submenu key opens a dialog box to select a channel value from 1 (minimum) to 31 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency: This submenu key opens a dialog box to select a frequency in Hz from 100 (minimum) to 3000 (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level: This submenu key opens a dialog box to select a Tx level in dBm from –30 (minimum) to 0 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume: This submenu key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio: This submenu key toggles Audio Off and On.

Clear History: Press this submenu key to erase the history of displayed events and measurements.

Back: Press this submenu key to return to the “Measurements Menu” on page 2-31.

Figure 2-28. VF Menu

2-15 Calibrate Menu

This menu is not available in E1 measurement mode.

2-16 Sweep Menu

This menu is not available in E1 measurement mode.

2-17 Measure Menu

This menu is not available in E1 measurement mode.

2-18 Trace Menu

This menu is not available in E1 measurement mode.

2-19 Limit Menu

This menu is not available in E1 measurement mode.

2-20 Other Menus

Preset, **File**, **Mode** and **System** are described in the User Guide.

Chapter 3 — OC-3c Analyzer (Option 58)

3-1 Introduction

This chapter provides a brief description of SONET telecommunications technology, Optical Carrier 3 (OC-3c), and OC-3c measurements using the handheld Anritsu instruments.

3-2 OC-3c Description

SONET (Synchronous Optical Network) is a fiber-optic transmission system standard for high-speed digital telecommunications. Its specifications define optical carrier (OC) interfaces and their electrical equivalents, Synchronous Transport Signal (STS) for the fiber-optic transmission as shown in Table 3-1. SONET is based on transmissions speeds in multiples of 51.84 Mb/s.

Table 3-1. SONET Hierarchy

Synchronous Transport Signal (STS)	Optical Carrier (OC)	Bit Rate (Mb/s)
STS-1	OC-1	51.84
STS-3	OC-3	155.52
STS-12	OC-12	622.08
STS-48	OC-48	2,488.32
STS-192	OC-192	9,953.28
STS-768	OC-768	39,813.12

SONET Frame

The STS-1 frame is composed of octets that are nine rows high and 90 columns wide. The first three columns are used by the Transport Overhead (TOH), which contains framing, error monitoring, management, and payload pointer information. The data (Payload) uses the remaining 87 columns, of which the first column is used for Path Overhead (POH). A pointer in the TOH identifies the start of the payload that is referred to as the Synchronous Payload Envelope (SPE).

9 x 90 bytes/frame x 8 bits/byte x 8,000 frames/s = 51,840,000 bits/s or 51.84 Mb/s.

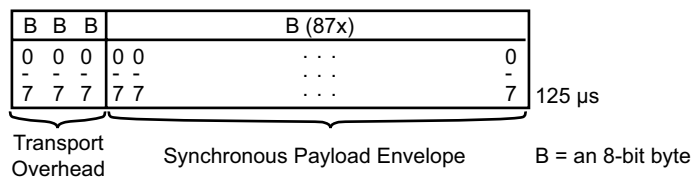


Figure 3-1. STS-1 (OC-1) Frame

OC-3c

OC-3c is an extension of the basic STS-1 speed by a multiple of three and operates at 155.520 Mb/s. Concatenating three STS-1 frames results in a OC-3c frame with nine rows and 270 columns. In OC-3c, the STS-1 frames are not independent, but have become one frame with a much larger payload.

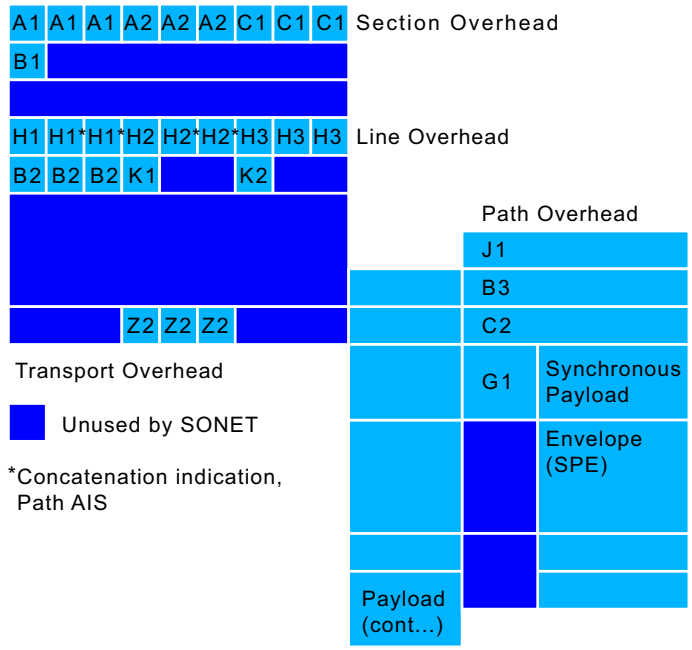


Figure 3-2. OC-3c Frame Structure

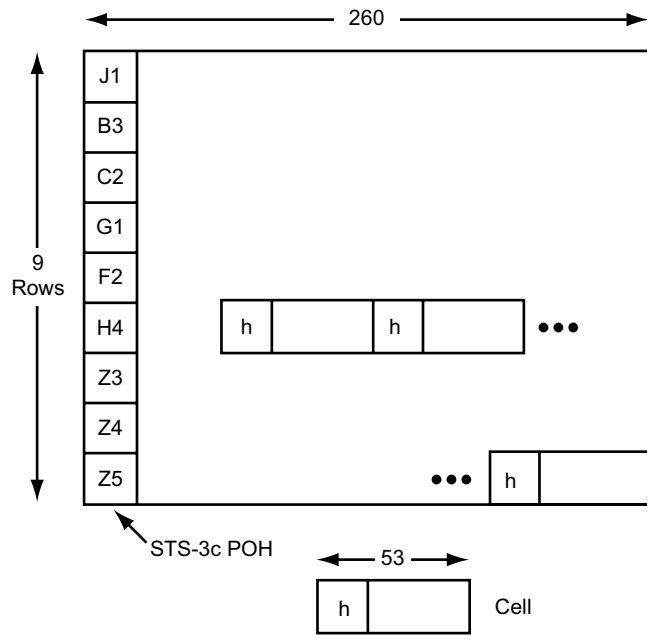


Figure 3-3. OC-3c POH & Payload, Not Including the TOH

Overheads

SONET provides substantial overhead information allowing simpler multiplexing and greatly expanded Operations, Administration, Maintenance, and Provisioning (OAM&P) capabilities. The overhead information has several layers, which are shown in Figure 3-4. Path-level overhead is carried from end-to-end. Line overhead is for the OC-n signal between OC-n multiplexers. Section overhead is used for communications between adjacent network elements, such as regenerators.

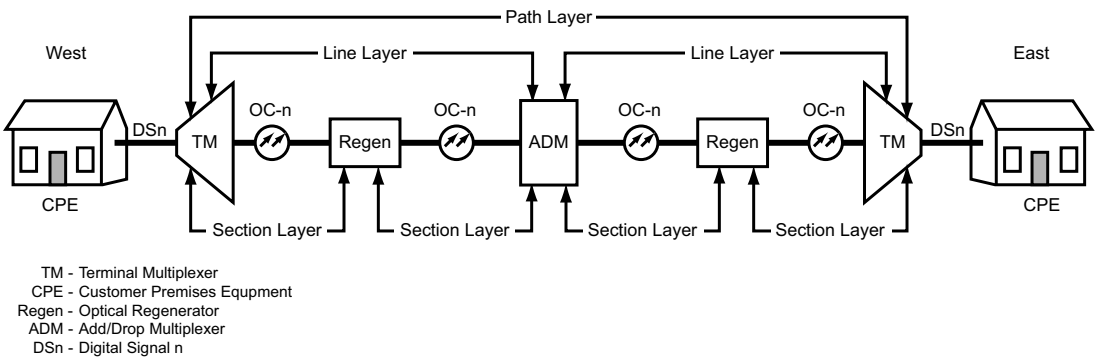


Figure 3-4. SONET Overhead Information

Enough information is contained in the overhead to allow the network to operate and allow OAM&P communications between an intelligent network controller and the individual nodes. The following sections detail the different SONET overhead information:

- Section Overhead
- Line Overhead
- Path Overhead

OC-3c Section Overhead

Section Overhead contains 10 bytes of the transport overhead accessed, generated, and processed by section-terminating equipment. This overhead supports functions such as:

- Performance monitoring
- Local orderwire
- Data communication channels to carry information for OAM&P
- Framing

This may be two regenerators, line terminating equipment, and a regenerator, or two line terminating equipment. The Section Overhead is found in the first three rows of Columns 1 through 9 illustrated in Figure 3-2.

OC-3c Line Overhead

Line Overhead contains 17 bytes of overhead accessed, generated, and processed by line terminating equipment. This overhead supports functions such as:

- Locating the SPE in the frame
- Multiplexing or concatenating signals
- Performance monitoring
- Automatic protection switching
- Line maintenance

The Line Overhead is found in Rows 4 to 9 of Columns 1 through 9 illustrated in Figure 3-2.

OC-3c Path Overhead

Path Overhead (OC POH) contains four evenly distributed Path Overhead bytes per 125 microseconds starting at the first byte of the OC SPE. OC POH provides for communication between the point of creation of an OC SPE and its point of disassembly. This overhead supports functions such as:

- Performance monitoring of the OC SPE
- Signal label (the content of the OC SPE, including status of mapped payloads)
- Path status
- Path trace

The Path Overhead is found in Rows 1 to 9 of the first column of the OC SPE illustrated in Figure 3-2.

Bit Interleaved Parity (BIP)

BIP calculations are performed over each layer of the SONET overhead such that each bit in the BIP byte will indicate the parity of all respective bits in the previous frame. For example, if the number of bits equaling one in the first bit position of every byte is odd, then the first bit position of the BIP byte will be one. This is repeated for all eight bits of each byte to determine the value of the BIP byte.

Bytes in Transmitted Signal = 0110 0100
1010 1110
BIP Calculation = 1100 1010

Each layer calculates the BIP for all information in its domain. For example, since the entire SONET signal is formed when the STE sees it, the Section BIP is calculated over the entire signal, including all SOH, LOH, and POH of the previous frame. The result is then placed in the B1 byte of the next frame. Line BIP's are calculated over the previous frame, excluding the SOH, and placed in the B2 bytes of the next frame. Path BIP's are calculated over the previous frame, minus SOH and LOH, and placed in the B3 byte of the next frame.

3-3 OC-3c Measurements

Signal quality measurements using the Anritsu handheld instrument consist of reporting the total number of BIP and Far End Block Error (FEBE) errors. Figure 3-5 illustrates the measurement results display.

Rx Signal Summary Display

BIP and FEBE errors, along with frequency and optical power, are listed in a table on the Rx Signal summary display shown below.

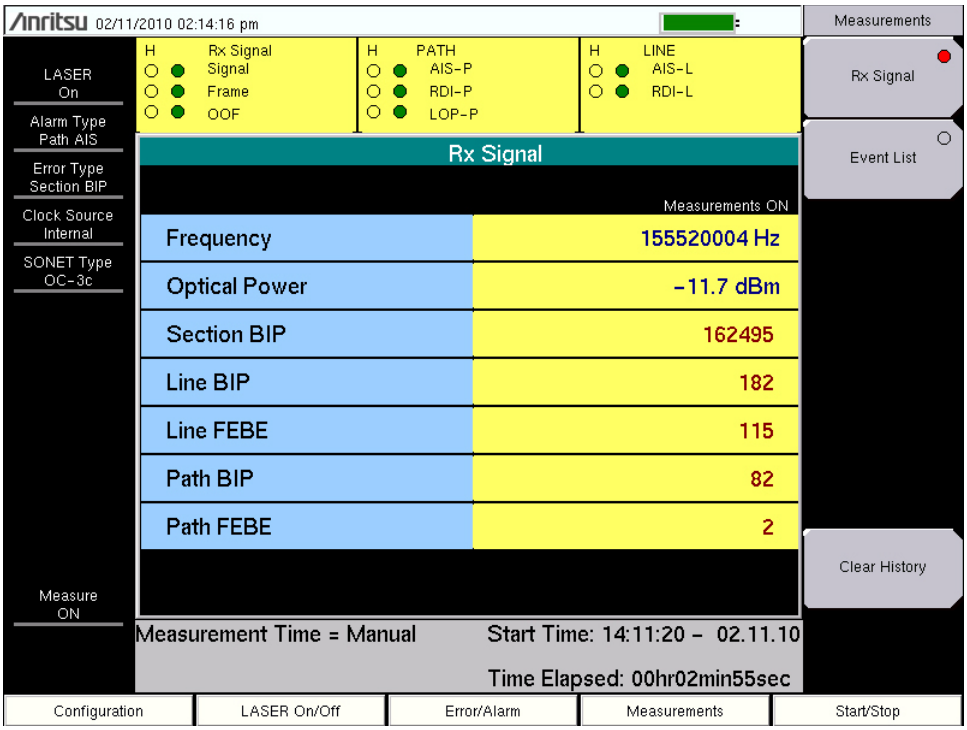


Figure 3-5. Rx Signal Summary Display

Section BIP: Section error monitoring. Contains BIP-8 of all bits in the previous frame using even parity after scrambling and placed in the B1 byte of the next frame before scrambling.

Line BIP: Line error monitoring. Contains BIP-24 calculated over the previous frame excluding the SOH before scrambling, and placed in the B2 byte of the next frame before scrambling.

Line FEBE (Remote Error Indication Line, REI-L): The number of BIP-24 errors detected by the peer Line Terminating Equipment (LTE), returned to the sender in the Z2 bytes.

Path BIP: Contains BIP-8 calculated over the previous frame, excluding the LOH and SOH, before scrambling and placed in the B3 byte before scrambling.

Path FEBE (Remote Error Indication Path, REI-P): The number of BIP-8 errors detected by the peer PTE and reported to the sender in bits 1 to 4 of the G1 byte.

Event List Display

Real-time numerical values can be viewed in the measurement Event List display shown below. The display will list up to 1000 errored seconds.

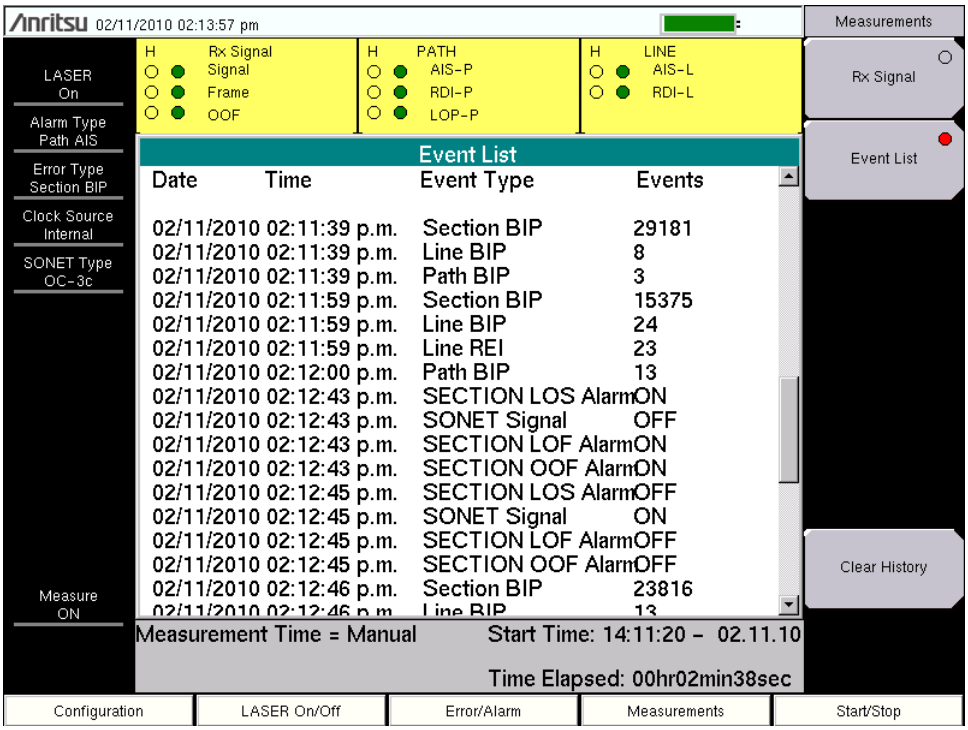
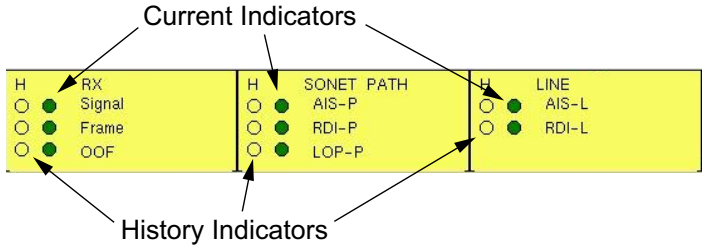


Figure 3-6. Event List Display

In the yellow rectangle viewing area above the Rx Signal/Event List display, historical (H) and current pass/fail conditions for parameters relating to Rx (Receive), SONET Path, and Line are reported. For Rx, the parameters are Signal, Frame, and OOF. For SONET Path, the parameters are AIS (Alarm Indication Signal)-P, RDI (Remote Defect Indicator)-P, and LOP (Loss of Pointer)-P. For Line, the parameters are AIS-L and RDI-L.



RX	SONET PATH	Line
Signal: A red dot indicates a Loss of Signal (LOS). A LOS occurs when the synchronous signal (OC-3c) level drops below the threshold at which a BER of 1 in 1,000 or 10^3 is predicted. The LOS state clears when two consecutive framing patterns are received and no new LOS conditions are detected. **Frame:** Loss of Frame (LOF) occurs when the OOF state exists for 3 milliseconds. The LOF state clears when an in-frame condition exists continuously for a specified time in milliseconds. **OOF:** Out of Frame (OOF) is declared when invalid framing patterns (A1 and A2 bytes) are received for four or five consecutive SONET frames. The OOF is cleared when at least two consecutive SONET frames are received with valid framing patterns.	**AIS-P:** Path AIS (AIS-P) signal is generated when an OC Path LOS and/or LOF and/or LOP is detected. An LTE generates AIS-P by filling the entire OC SPE with a all-1's, including H1, H2, and H3 bytes (after scrambling). The signal is sent downstream to the OC LTE. An RDI signal is sent upstream if the AIS is only for LOS or for LOF (not for LOP). **RDI-P:** The Path RDI (RDI-P) signal indicates to an OC PTE that a downstream defect has occurred along the OC Path. The RDI-P is cleared when a zero is in bits 5 & 6 of the G1 byte for five to ten consecutive frames. It is also cleared when it has detected an AIS-P defect on the affected path. **LOP-P:** Path LOP (LOP-P) state occurs when N consecutive invalid pointers are received or "N" consecutive New Data Flags (NDF) are received (other than in a concatenation indicator), where N = 8, 9, or 10. LOP state is cleared when three equal valid pointers or three consecutive AIS indications are received.	**AIS-L:** Line AIS (AIS-L) is generated by Section Terminating Equipment (STE) upon the detection of a LOS or LOF defect on an equipment failure. AIS-L maintains operation of the downstream regenerators, and therefore prevents generation of unnecessary alarms. At the same time, data and orderwire communication is retained between the regenerators and the downstream LTE. **RDI-L:** Line RDI (RDI-L) is a signal returned to the transmitting LTE upon detecting a LOS, LOF, or AIS-L defect.

Figure 3-7. Historical and Current Pass/Fail Conditions

3-4 Measurement Setup

1. Press the **Configuration** main menu key.
2. Select the desired Tx Clock by pressing either the Internal or Recovered submenu key.
3. Press the **Error/Alarm** main menu key. Use this menu to add error and/or alarms to the transmission path.
   a. Press the Alarm Ins Setup submenu key. The Alarm Ins menu opens.
   b. Select the desired alarm by pressing one of the 4 submenu keys – Line AIS, Line RDI, Path AIS, or Path RDI.
   c. Press the Alarm Insert submenu key to On, to activate the selected alarm for testing.
   d. Press the Back submenu key to return to the Error/Alarm menu.
   e. Press the Error Ins Setup submenu key. The Error Ins menu opens.
   f. Select the desired error by pressing one of the 3 submenu keys – Section BIP, Line BIP, or Path BIP.
   g. Press the Error Insert submenu key to On, to activate the selected alarm for testing.
   h. Press the Back submenu key to return to the Error/Alarm menu.
4. Press the **Measurements** main menu key. The Measurement menu opens.

3-5 Testing

Warning

NEVER look directly into the BTS Master optical connector or the end of a connected cable. LASER light may enter the eye and cause injury. In addition, some Small Form Pluggable (SFP) modules output high-power optical signals.

To prevent damage to connected equipment, confirm that any connected photo-receiver will not be saturated. Anritsu accepts no responsibility for damage caused to connected devices.

1. Attach the optical line to the OC3c/STM-1 connector on the connector panel of the instrument.
2. Press the **LASER On/Off** main menu key to turn on the LASER. The LASER On/Off status is located at the top of the left status column.
3. Press the **Start/Stop** main menu key to begin testing. The measurement On/Off status is located at the bottom of the left status column. Previous measurement results in either the Rx Signal table or Event List are cleared. New measurement results will be viewed in the yellow Pass/Fail display along with the selected measurement in the SONET menu. To clear any previously acquired data in the Pass/Fail indicator window, press the Clear History submenu key in the **Measurements** menu.

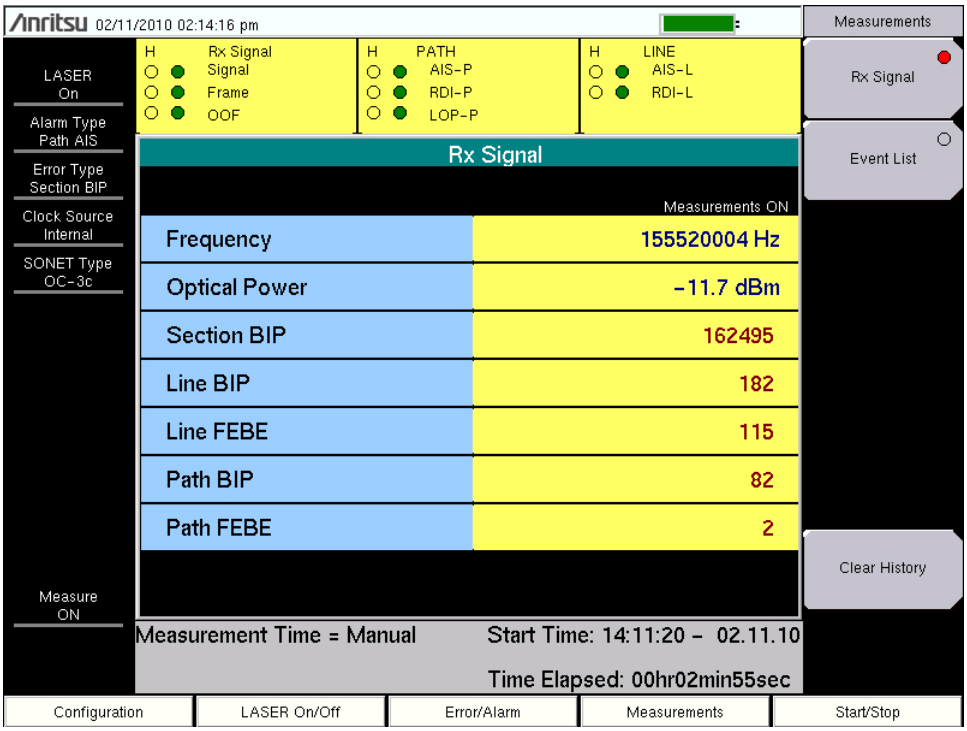


Figure 3-8. Rx Signal Summary

3-6 OC-3c Menus

Figure 3-9 shows the map of the OC-3c menus. The following sections describe main menus and associated submenus. The submenus are listed in the order they appear on the display from top to bottom under each main menu.

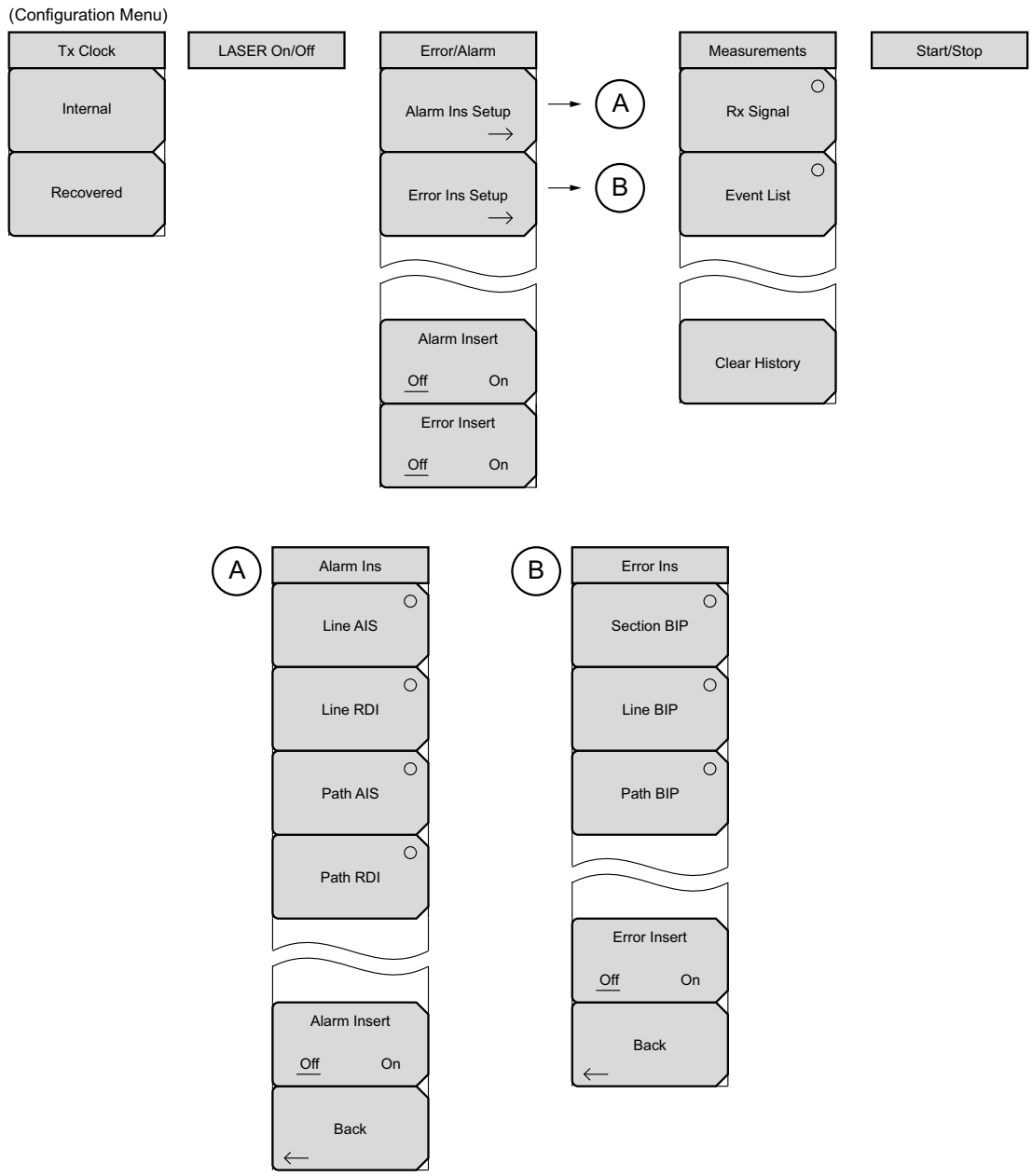
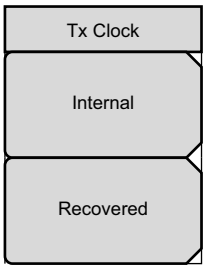


Figure 3-9. OC-3c Submenu Keys

3-7 Configuration Menu

Key Sequence: **Configuration**



Internal: The transmit clock uses the internal clock oscillator (155.52 MHz).

Recovered: The transmit clock uses the frequency recovered from the received signal.

Figure 3-10. Configuration Menu

3-8 LASER On/Off

Key Sequence: **LASER On/Off**

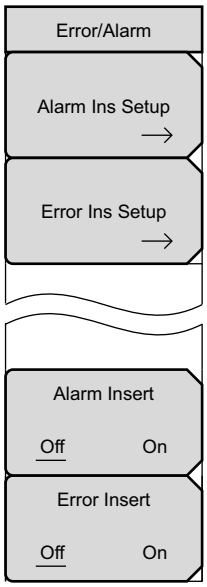
LASER On/Off: Turns on or off the data transmission LASER. When switching to OC-3c Analyzer from another measurement mode, the LASER is turned off.

Figure 3-11. LASER On/Off

Caution	Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

3-9 Error/Alarm Menu

Key Sequence: **Error/Alarm**



Alarm Ins Setup: Opens the "Alarm Ins Menu" on page 3-14.

Error Ins Setup: Opens the "Error Ins Menu" on page 3-15.

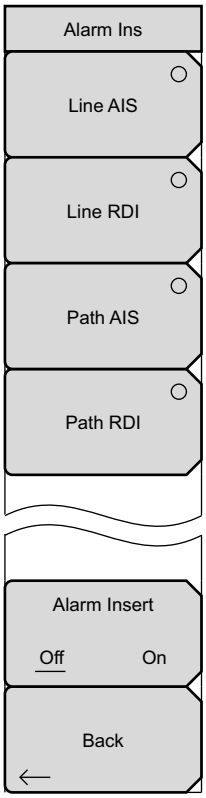
Alarm Insert: When On, activates the selected Alarm for transmission path insertion.

Error Insert: When On, activates the selected Error for transmission path insertion.

Figure 3-12. Error/Alarm Menu

Alarm Ins Menu

Key Sequence: **Error/Alarm** > Alarm Ins Setup



Use this menu to add an alarm to the transmission path. Press the submenu key of the desired alarm:

Line AIS
Line RDI
Path AIS
Path RDI

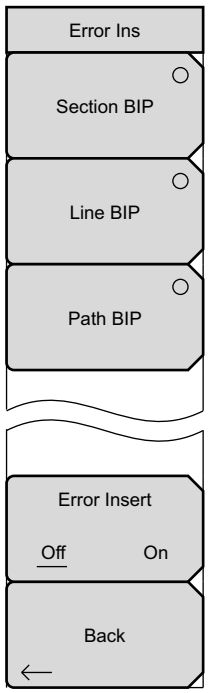
Alarm Insert Off/On: Press this key to toggle on or off the selected alarms above.

Back: Press this key to return to the "Error/Alarm Menu" on page 3-13.

Figure 3-13. Alarm Ins Menu

Error Ins Menu

Key Sequence: **Error/Alarm** > Error Ins Setup



Use this menu to add an error to the transmission path. Press the submenu key of the desired error.

Section BIP
Line BIP
Path BIP

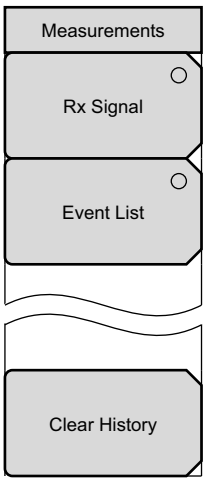
Error Insert Off/On: Press this key to toggle on or off the selected errors above.

Back: Press this key to return to the "Error/Alarm Menu" on page 3-13.

Figure 3-14. Error Ins Menu

3-10 Measurements Menu

Key Sequence: **Measurements**



Rx Signal: Pressing this key displays the "Rx Signal Summary Display" on page 3-6.

Event List: Pressing this key displays the "Event List Display" on page 3-7.

Clear History: Pressing this key clears the measurement history (H) that is displayed on the Pass/Fail window, the Rx Signal summary table, and the Event List.

Figure 3-15. Measurements Menu

3-11 Start/Stop

Key Sequence: **Start/Stop**

Start/Stop: Pressing this key starts or stops the measurement that is currently set up on the instrument.

Figure 3-16. Start/Stop

3-12 Calibrate Menu

This menu is not available in OC-3c measurement mode.

3-13 Sweep Menu

This menu is not available in OC-3c measurement mode.

3-14 Measure Menu

This menu is not available in OC-3c measurement mode.

3-15 Trace Menu

This menu is not available in OC-3c measurement mode.

3-16 Limit Menu

This menu is not available in OC-3c measurement mode.

3-17 Other Menus

Preset, **File**, **Mode** and **System** are described in the User Guide.

Chapter 4 — STM-1 Analyzer (Option 59)

4-1 Introduction

This chapter provides a brief description of Synchronous Digital Hierarchy (SDH) telecommunications technology and Synchronous Transport Module at level one (STM-1) measurements using Anritsu handheld instruments.

4-2 SDH Description

SONET (Synchronous Optical Network) is a standard for optical telecommunications. The International Telecommunication Union (ITU) established an international standard based on the SONET specifications known as the *Synchronous Digital Hierarchy* (SDH).

SDH multiplexing combines low-speed digital signals such as 2, 34, and 140 Mbit/s signals with required overhead to form a frame called Synchronous Transport Module at level one, STM-1. The STM-1 frame is created by 9 segments of 270 bytes each. The first 9 bytes of each segment, called the Section Overhead (SOH), carries overhead information. The remaining 261 bytes, called the virtual container at level four (VC-4), carries payload data. When visualized as a block, the STM-1 frame appears as 9 rows by 270 columns of bytes. The STM-1 frame is first transmitted row 1, with the most significant bit (MSB) of each byte transmitted first. See Figure 4-1 for an illustration of an STM-1 frame.

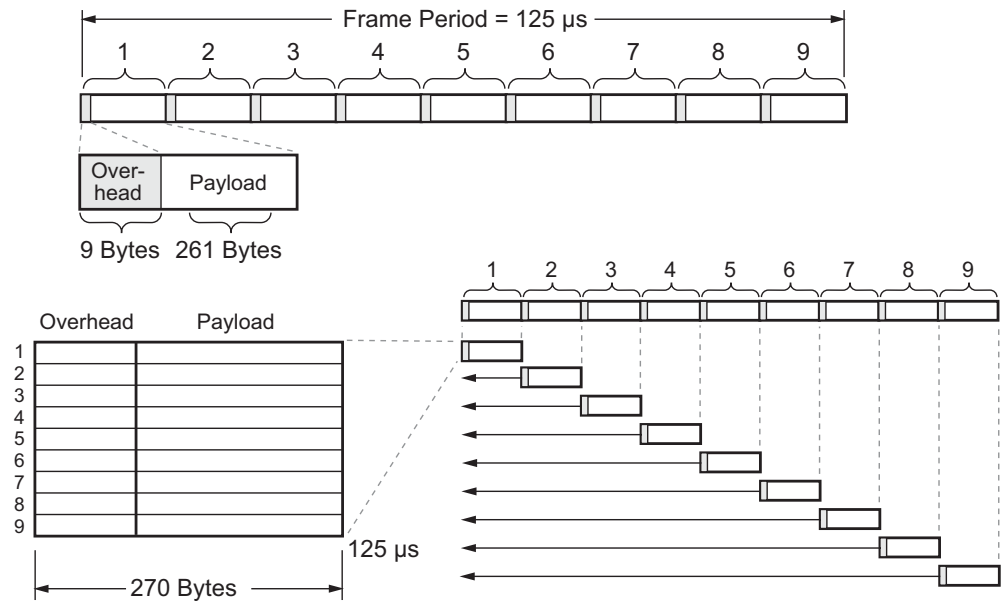


Figure 4-1. STM-1 Frame

STM-1 dedicates three rows for the Regenerator Section Overhead (RSOH), Row #4 for Pointers, and five rows for the Multiplex Section Overhead (MSOH). The Virtual Container-4 contains one column for the VC-4 path overhead (VC-4 POH), leaving the remaining 260 columns for payload data (149.76 Mbit/s).

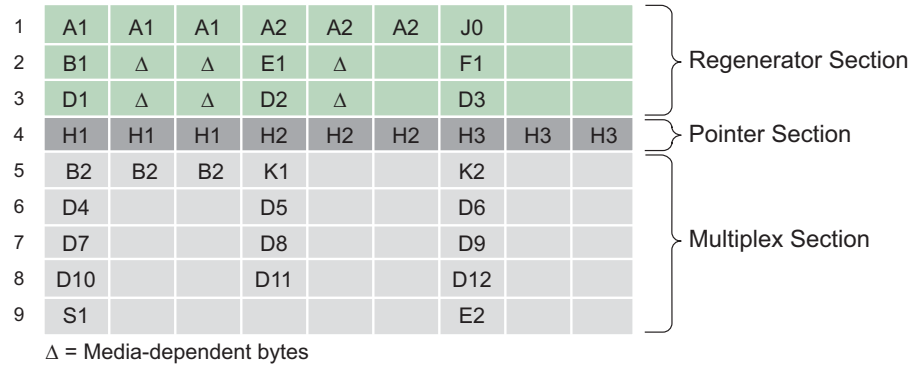


Figure 4-2. STM-1 Overhead Structure

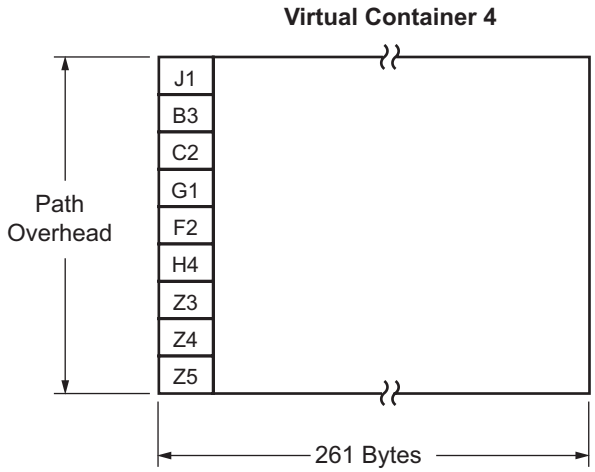


Figure 4-3. Path Overhead and Virtual Container 4 Payload Structure

SDH operates at the basic rate of 8 kHz, or 125 microseconds per frame, so the frame rate is 8,000 frames per second. The frame capacity of a signal is the number of bits contained within a single frame.

Frame Capacity = 270 bytes/row x 9 rows/frame x 8 bits/byte = 19,440 bits/frame

The bit rate of the STM-1 signal is calculated as follows:

Bit Rate = 8,000 frames/second x 19,440 bits/frame = 155.52 Mbit/s

Overheads

STM-1 provides substantial overhead information, allowing simpler multiplexing and greatly expanded Operations, Administration, Maintenance, and Provisioning (OAM&P) capabilities. The overhead information has several layers, which are shown in Figure 4-4. Path Layer overhead is carried from end-to-end between path terminating equipment (PTE). Multiplex Section Layer is for the STM-1 signals between the multiplex section termination equipment: PTE and ADM. The Regenerator Section Layer is used for communications between adjacent network elements, such as PTEs, ADM, and regenerators.

Enough information is contained in the overhead to allow the network to operate and allow OAM&P communications between an intelligent network controller and the individual nodes. The following sections detail the different SDH overhead information:

- Regenerator Section Overhead (RSOH)
- Multiplexer Section Overhead (MSOH)
- Path Overhead (POH)

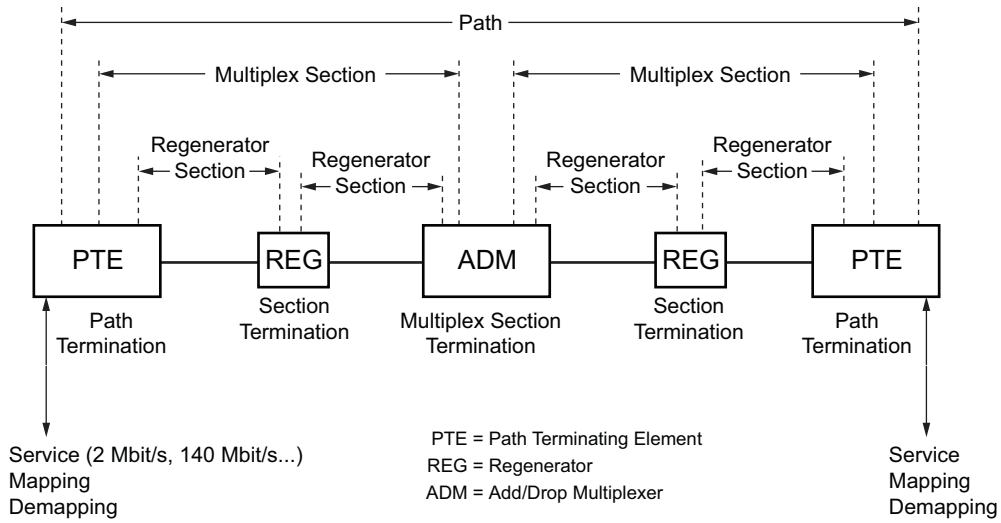


Figure 4-4. STM-1 Overhead Layers

Regenerator Section Overhead (RSOH)

RSOH contains nine bytes of the transport overhead accessed, generated, and processed by section-terminating equipment. This overhead supports functions including:

- Performance monitoring
- Local orderwire
- Data communication channels to carry information for OAM&P
- Framing

This might be two regenerators, line terminating equipment, and a regenerator, or two line terminating equipment. The Section Overhead is found in the first three rows of Columns 1 through 9. Refer to Figure 4-2.

Multiplex Section Overhead (MSOH)

MSOH contains 17 bytes of overhead accessed, generated, and processed by Path Terminating Equipment (PTE) and Add/Drop Multiplexer (ADM). This overhead supports functions including:

- Multiplexing or concatenating signals
- Performance monitoring
- Automatic protection switching
- Line maintenance

The MSOH is found in Rows 5 to 9 of Columns 1 through 9. Refer to Figure 4-2.

Path Overhead (POH)

VC-4 Path Overhead contains nine evenly distributed Path Overhead bytes each 125 microseconds starting at the first byte of the VC-4. The POH provides for communication between the point of creation and point of disassembly at the PTE. This overhead supports functions including:

- Performance monitoring of VC-4
- Signal label (the content of the VC-4, including status of mapped payloads)
- Path status
- Path trace

The POH is found in Rows 1 to 9 of the first column of the VC-4. Refer to Figure 4-2.

Bit Interleaved Parity (BIP)

BIP calculations are performed over each layer of the SDH overhead, such that each bit in the BIP byte will indicate the parity of all respective bits in the previous frame. For example, if the number of bits equaling one in the first bit position of every byte is odd, then the first bit position of the BIP byte will be 1. This is repeated for all eight bits of each byte to determine the value of the BIP byte.

Bytes in Transmitted Signal =	0110 0100
	1000 0110
	.....
	1010 0110
BIP Calculation =	0100 0100

Each layer calculates the BIP for all information in its domain. For example, the entire SDH signal is formed when the RSTE sees it, so the Regenerator Section BIP is calculated over the entire signal, including all RSOH, MSOH, VC-4 POH, and payload of the previous STM-N frame. The result is then placed in the B1 byte for STM-1. Multiplex Section BIPs are calculated over the previous STM-1 frame, minus the RSOH, and placed in the B2 bytes. Path BIPs are calculated over the previous frame, minus RSOH and MSOH, and are found in the B3 byte of every STM-1.

STM-1 Measurements

Signal quality measurements, using the Anritsu handheld instrument, consist of reporting the total number of BIPs within the RSOH, MSOH, and POH.

RSOH BIP

Section error monitoring. Contains BIP-8 of all bits in the previous frame using even parity, after scrambling and placed in the B1 byte of the next frame before scrambling.

MS BIP

Line error monitoring. Contains BIP-24 calculated over the previous frame excluding the SOH before scrambling, and placed in the B2 byte of the next frame before scrambling.

MS-REI

The M1 byte of an STM-1 or the first STM-1 of an STM-N is used for a MS layer remote error indication. Bits 2 to 8 of the M1 byte are used to carry the error count of the interleaved bit blocks that the MS BIP-24xN has detected to be in error at the far end of the section. This value is truncated at 255 for STM-N >4.

HP BIP-8

The number of BIP-8 errors detected by the peer PTE and reported to the sender in the B3 byte.

HP REI

The number of BIP-8 errors detected by the peer PTE and reported to the sender in bits 1 to 4 of the G1 byte.

These values along with frequency and optical power are listed in a table on the measurement Rx Signal display. Accumulated and real-time numerical values can be viewed in the measurement Event List display. If Event List is selected, the display will list up to 1000 errored seconds. Refer to Figure 4-5 and Figure 4-6.

In the yellow rectangle viewing area above the Rx Signal/Event List display, historical (H) and current pass/fail conditions for parameters relating to Receive (Rx) Signal, Path, and Multiplex Section are reported. For Rx Signal, the parameters are LOS, LOF, and OOF. For Path, the parameters are AU-AIS (Alarm Indication Signal), HP-RDI (Remote Defect Indicator), and AU-LOP (Loss of Pointer). For the Multiplex Section, the parameters are MS-AIS and MS-RDI. SDH defects, errors, and alarms are shown in Figure 4-7.

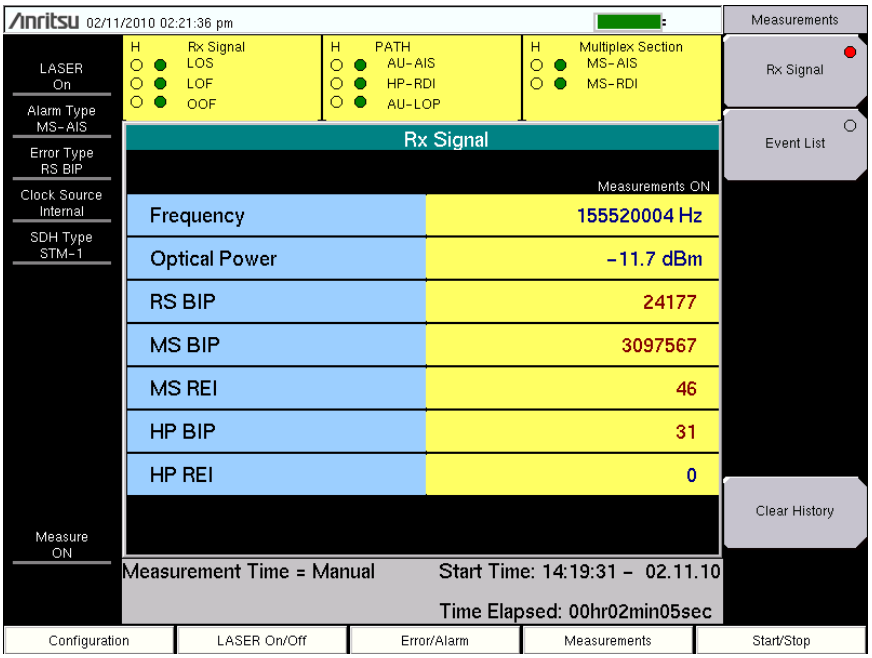


Figure 4-5. Rx Signal Summary Display

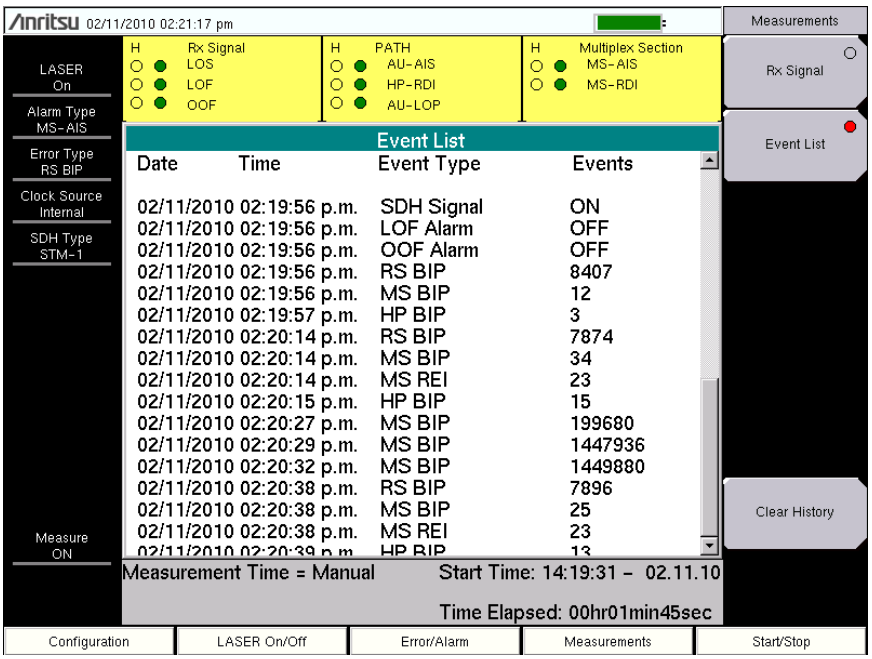


Figure 4-6. Event List Display

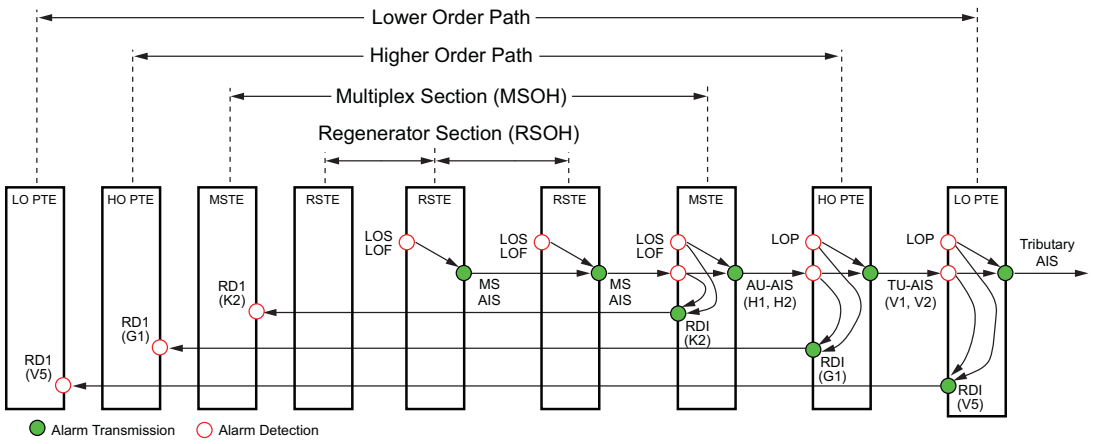


Figure 4-7. SDH Network Alarm Detection and Transmission

RX Signal

LOS: A red dot indicates a loss of signal. A LOS occurs when the synchronous signal (STM-1) level drops below the threshold at which a BER of 1 in 10^3 is predicted. The LOS state clears when two consecutive framing patterns are received and no new LOS conditions detected.

LOF: Loss of frame occurs when the OOF state exists for a specified time in microseconds. The LOF state clears when an in-frame condition exists continuously for a specified time in microseconds.

OOF: Out-of-Frame (OOF) is declared when invalid framing patterns (A1 and A2 bytes) are received for four or five consecutive SDH frames. The OOF is cleared when at least two consecutive SDH frames are received with valid framing patterns.

PATH

AU-AIS: (Path AIS) An AU-AIS, an all 1's pattern, is generated when a Multiplex Section Terminating Equipment (MSTE) LOS or LOF is detected. The signal is sent forward to the PTE. An MS-RDI signal is sent back if the AU-AIS is for LOS or LOF only (not for LOP).

HP-RDI: (Path RDI) This signal indicates to a PTE that a downstream LOS, LOF, or AIS defect has occurred along the Path.

AU-LOP: (Path LOP) LOP state occurs when N consecutive invalid pointers are received or "N" consecutive New Data Flags (NDF) are received (other than in a concatenation indicator), where N = 8, 9, or 10. LOP state is cleared when three equal valid pointers or three consecutive AIS indications are received.

Multiplex Section

MS-AIS: MS-AIS, an all 1's pattern, is generated by the Regenerator Section Terminating Equipment (RSTE) upon the detection of a LOS or LOF defect. MS-AIS maintains operation of the forward regenerators, and therefore prevents generation of unnecessary alarms. At the same time, data and orderwire communication is retained between the regenerators and the forward MSTE.

MS-RDI: (RDI) A signal returned to the transmitting equipment upon detecting a LOS, LOF, or MS-AIS defect.

4-3 Measurement Setup

1. Press the **Configuration** main menu key.
2. Select the desired Tx Clock by pressing either the Internal or Recovered submenu key.
3. Press the **Error/Alarm** main menu key. Use this menu to add error and/or alarms to the transmission path.
   a. Press the Alarm Ins Setup submenu key. The Alarm Ins menu opens.
   b. Select the desired alarm by pressing one of the 4 submenu keys – MS-AIS, MS-RDI, AU-AIS, or HP-RDI.
   c. Press the Alarm Insert submenu key to On to activate the selected alarm for testing.
   d. Press the Back submenu key to return to the Error/Alarm menu.
   e. Press the Error Ins Setup submenu key. The Error Ins menu opens.
   f. Select the desired error by pressing one of the 3 submenu keys – RS BIP, MS BIP, or HP BIP.
   g. Press the Error Insert submenu key to On, to activate the selected alarm for testing.
   h. Press the Back submenu key to return to the Error/Alarm menu.
4. Press the **Measurement** main menu key. The Measurements menu opens.

4-4 Testing

Warning

NEVER look directly into the BTS Master optical connector or the end of a connected cable. LASER light may enter the eye and cause injury. In addition, some Small FormPluggable (SFP) modules output high-power optical signals.

To prevent damage to connected equipment, confirm that any connected photo-receiver will not be saturated. Anritsu accepts no responsibility for damage caused to connected devices.

1. Attach the optical line to the OC3c/STM-1 connector on the connector panel of the instrument.
2. Press the **LASER On/Off** main menu key to turn on the LASER. The LASER On/Off status is located at the top of the left status column.
3. Press the **Start/Stop** main menu key to begin testing. The measurement On/Off status is located at the bottom of the left status column. Previous measurement results in either the Rx Signal table or Event List are cleared. New measurement results will be viewed in the yellow Pass/Fail display along with either the Rx Signal table or Event List display screen. If Event List is selected, the display will list up to 1000 errored seconds. To clear any previously acquired data in the Pass/Fail indicator window, press the Clear History submenu key in the Measurements menu.

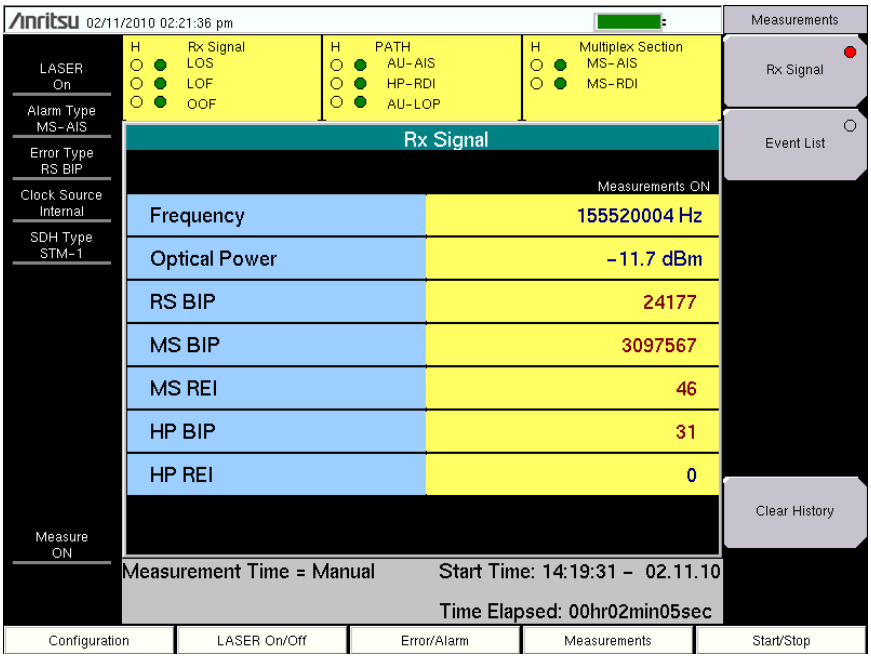


Figure 4-8. Rx Signal Display

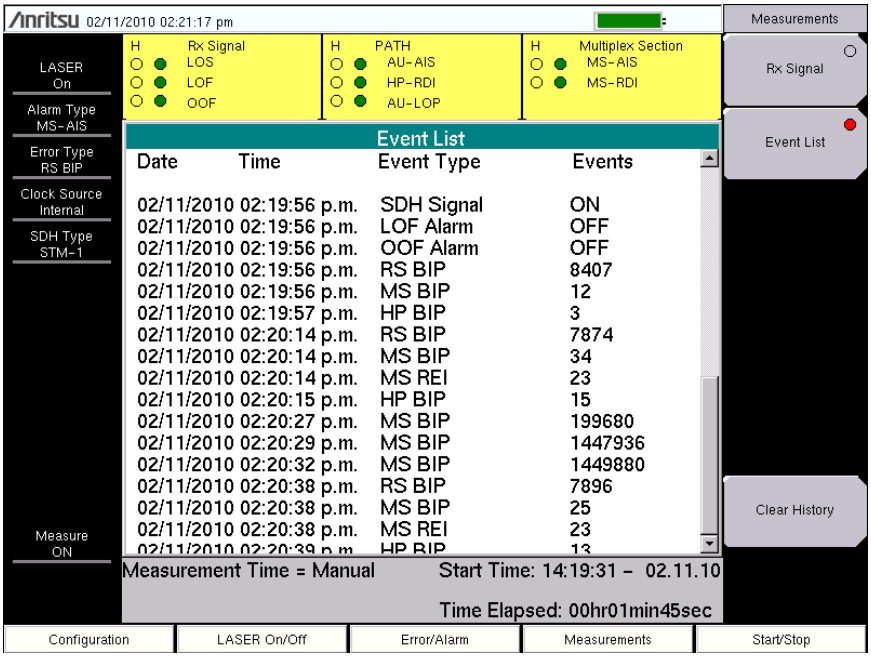


Figure 4-9. Event List Display

4-5 STM-1 Menus

Figure 4-10 shows the map of the STM-1 menus. The following sections describe main menus and associated submenus. The submenus are listed in the order they appear on the display from top to bottom under each main menu.

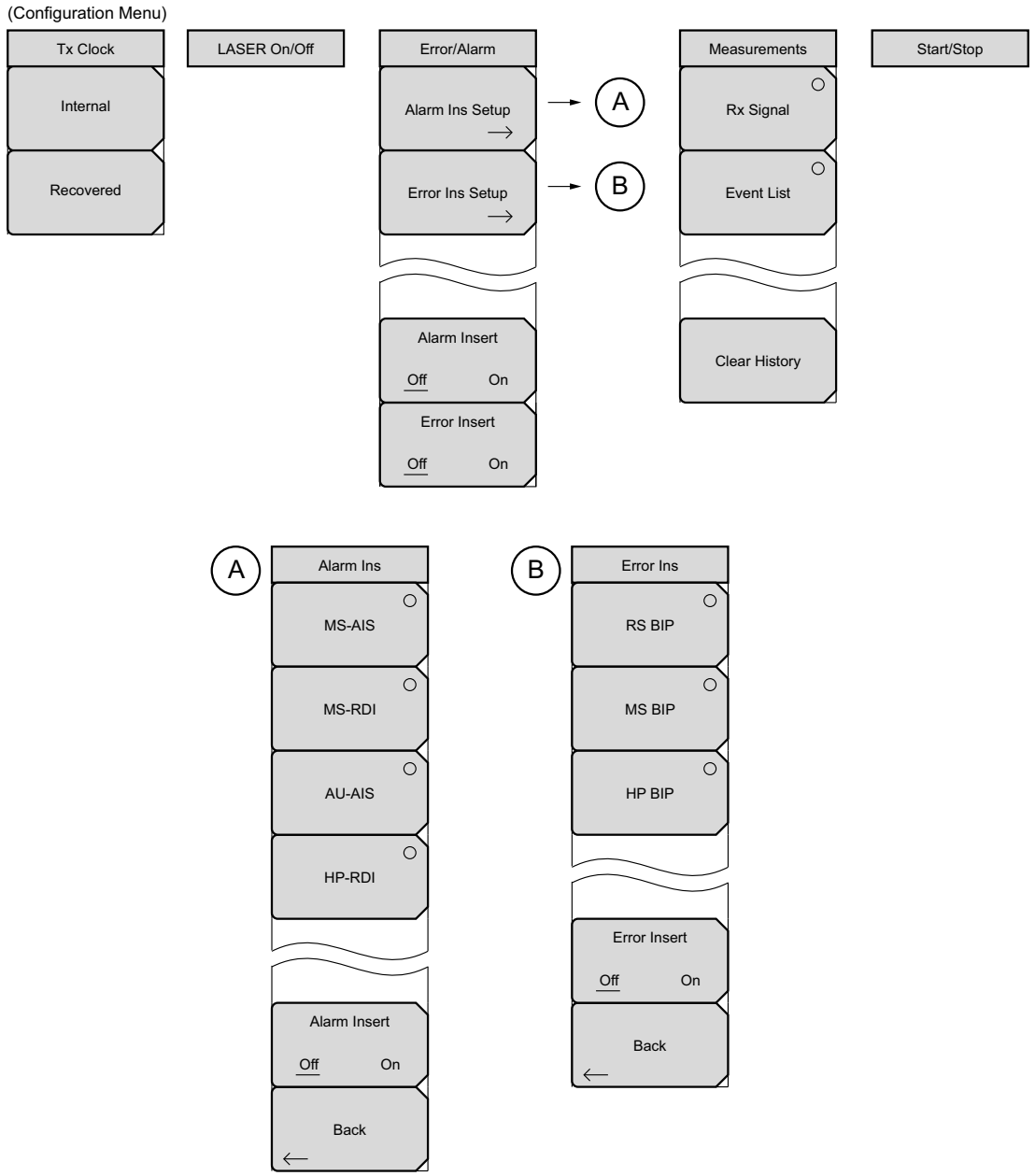
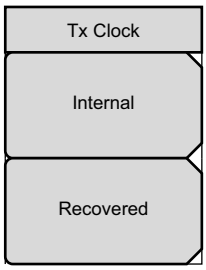


Figure 4-10. STM-1 Submenu Keys

4-6 Configuration Menu

Key Sequence: **Configuration**



Internal: The transmit clock uses the internal clock oscillator (155.52 MHz).

Recovered: The transmit clock uses the frequency recovered from the received signal.

Figure 4-11. Configuration Menu

4-7 LASER On/Off

Key Sequence: **LASER On/Off**

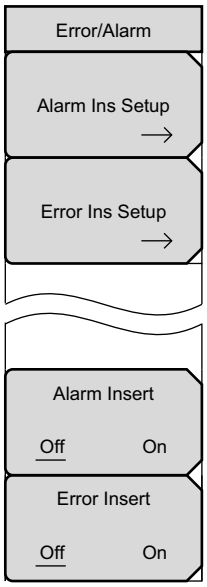
LASER On/Off: Turns on or off the data transmission LASER. When switching to STM-1 Analyzer from another measurement mode, the LASER is turned off.

Figure 4-12. LASER On/Off

Caution	Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

4-8 Error/Alarm Menu

Key Sequence: **Error/Alarm**



Alarm Ins Setup: Opens the "Alarm Ins Menu" on page 4-14.

Error Ins Setup: Opens the "Error Ins Menu" on page 4-15.

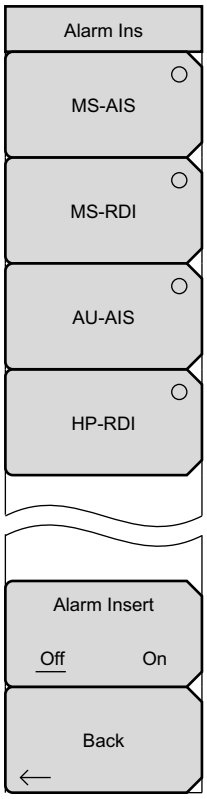
Alarm Insert: When On, activates the selected Alarm for transmission path insertion.

Error Insert: When On, activates the selected Error for transmission path insertion.

Figure 4-13. Error/Alarm Menu

Alarm Ins Menu

Key Sequence: **Error/Alarm** > Alarm Ins Setup



Use this menu to add an alarm to the transmission path. Press the submenu key of the desired alarm:

MS-AIS
MS-RDI
AU-AIS
HP-RDI

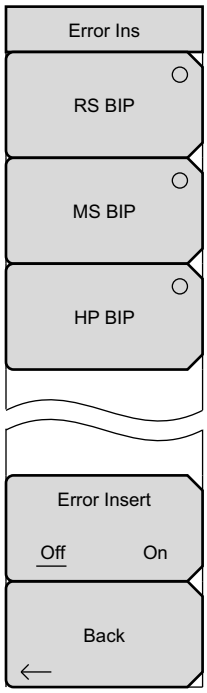
Alarm Insert Off/On: Press this key to toggle on or off the selected alarms above.

Back: Press this key to return to the "Error/Alarm Menu" on page 4-13.

Figure 4-14. Alarm Ins Menu

Error Ins Menu

Key Sequence: **Error/Alarm** > Error Ins Setup



Use this menu to add an error to the transmission path. Press the submenu key of the desired error.

RS BIP
MS BIP
HP BIP

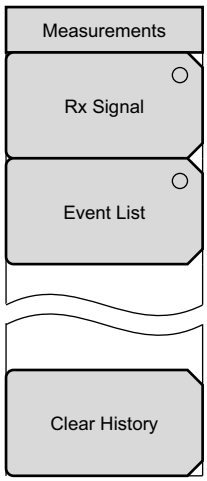
Error Insert Off/On: Press this key to toggle on or off the selected errors above.

Back: Press this key to return to the "Error/Alarm Menu" on page 4-13.

Figure 4-15. Error Ins Menu

4-9 Measurements Menu

Key Sequence: **Measurements**



Rx Signal: Pressing this key displays the "Rx Signal Summary Display" on page 4-6.

Event List: Pressing this key displays the "Event List Display" on page 4-6.

Clear History: Pressing this key clears the measurement history (H) that is displayed on the Pass/Fail window, the Rx Signal table, and the Event List.

Figure 4-16. Measurements Menu

4-10 Start/Stop

Key Sequence: **Start/Stop**

Start/Stop: Pressing this key starts or stops the measurement that is currently set up on the instrument.

Figure 4-17. Start/Stop

4-11 Calibrate Menu

This menu is not available in STM-1 measurement mode.

4-12 Sweep Menu

This menu is not available in STM-1 measurement mode.

4-13 Measure Menu

This menu is not available in STM-1 measurement mode.

4-14 Trace Menu

This menu is not available in STM-1 measurement mode.

4-15 Limit Menu

This menu is not available in STM-1 measurement mode.

4-16 Other Menus

Preset, **File**, **Mode** and **System** are described in the User Guide.

Chapter 5 — T1/FT1 Analyzer (Option 51 or 54)

5-1 Introduction

This chapter provides a brief description of T1 circuits as well as T1 measurements, and also explains how to measure T1 performance using the instrument with Option 51 installed.

5-2 Selecting the T1 Analyzer Mode

1. Press the **Shift** key followed by pressing the **Mode** (9) key on the numeric keypad to open the Mode Selector list box.
2. Use the directional arrow keys or the rotary knob to highlight T1 Analyzer and press **Enter** to select.

5-3 T1 Fundamentals

Wireless service providers use wired T1 circuits as the backhaul links to connect a Base Transceiver Station (BTS) to a Mobile Switching Center (MSC). The quality of the service that is provided over those T1 lines has a direct impact on the quality of service that is experienced by the wireless service provider customers. Call setup failures, dropped calls, and data errors can often be attributed to the T1 backhaul facilities. An example of a typical wireless network backhaul T1 link is shown in Figure 5-1.

In the United States, wireless service providers generally lease T1 lines from a Local Exchange Carrier (LEC), so a joint effort is often required to analyze and troubleshoot a T1 line.

T1 is an American National Standard Institute (ANSI) standard, used mostly in North America, in parts of Japan, and in some Asian countries. Technically, a T1 line is a digital transmission facility consisting of wire pairs and regenerators carrying a DS1 signal. **T1** refers to the physical properties of the line, for example, 1.544 MHz with a specific pulse shape, and so forth. **DS1** refers to the digital signal carrying the information at a rate of 1.544 Mb/s.

A DS1 signal contains twenty-four 8-bit DS0 channels. The channel signals are repeated 8000 times per second, resulting in a bandwidth of 64 kHz per channel (8 x 8000 = 64,000). The channels are organized into 192-bit frames, and a framing bit is added to enable synchronization to the DS1 signal (193 bits total). The frequency of the T1 signal is 193 x 8000 = 1.544 MHz. Two types of DS1 framing formats are used: Super Frame (SF), formed from 12 basic frames, and Extended Super Frame, formed from 24 basic frames.

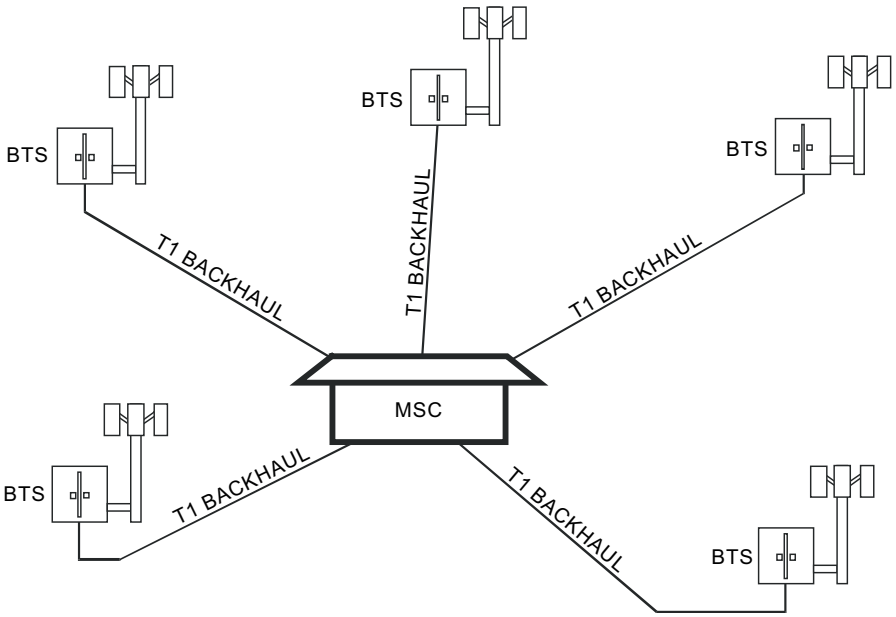


Figure 5-1. Typical Wireless Network T1 Backhaul Links

Network Equipment

One possible network topology is shown in Figure 5-2.

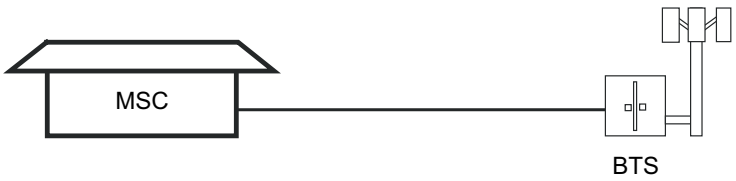


Figure 5-2. One Possible T1 Network Topology

The circuit between the MSC (Mobile Switching Center) and BTS (Base Transceiver Station) may pass through the LEC central office (see Figure 5-3), or through multiple central offices. It may also pass through multiple pieces of transmission equipment. At the BTS, the T1 line typically terminates on a Network Interface Unit (NIU). The NIU may be a very simple device having only a remote loop back capability, or it may provide very sophisticated performance monitoring capabilities. Its capabilities may or may not be accessible to the wireless service provider technician.

Some repeaters may exist in the circuit when the signal is traveling long distances. Repeaters are full duplex devices that regenerate or restore the pulse shape and amplitude. Two possible network topologies are shown in Figure 5-2 and Figure 5-3.

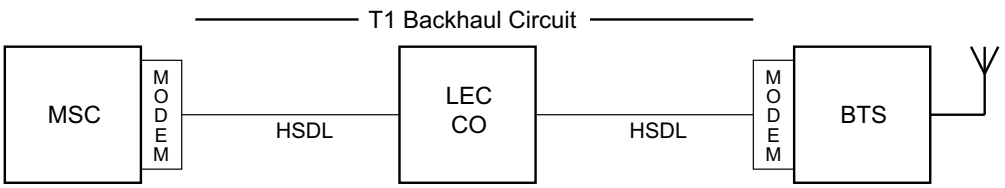


Figure 5-3. BTS and MSC Configuration

The configuration in Figure 5-3 uses a High-speed Digital Subscriber Line (HDSL) in the T1 circuit, which enables full duplex T1 service over a single pair of wires without repeaters. In most cases, the wireless service provider technician may not be concerned with the repeaters or HDSL.

5-4 T1 Display

Refer to Figure 5-4 for an illustration of the following areas of the instrument display screen. The T1 data display area of the instrument includes the real time clock and the GPS and battery indicators (at the top), the measurement data (in the middle), the instrument settings summary (at the left side), the submenu labels (at the right side), and the main menu labels (at the bottom). The submenu labels vary in relation to the main menu key selection.

In T1 measurements, the instrument settings summary shows the T1 configuration, including: Test Mode, Line Code, Tx Clock, Receive Input, Framing Mode, Error Type, Pattern, Payload Type, Loop Code, Tx LBO, and Measure.

The upper part of the measurement data display has an area that is highlighted in yellow, which reports historical (H) and current pass/fail conditions for parameters relating to Rx (Receive), DS1, and Tx (Transmit) testing. For Rx, the parameters are Signal, Frame Sync, and Pattern Sync. For DS1, the parameters are Alarms, Errors, and B8ZS. For Tx, the parameters are Alarm ON, Error ON, and Loop ON.

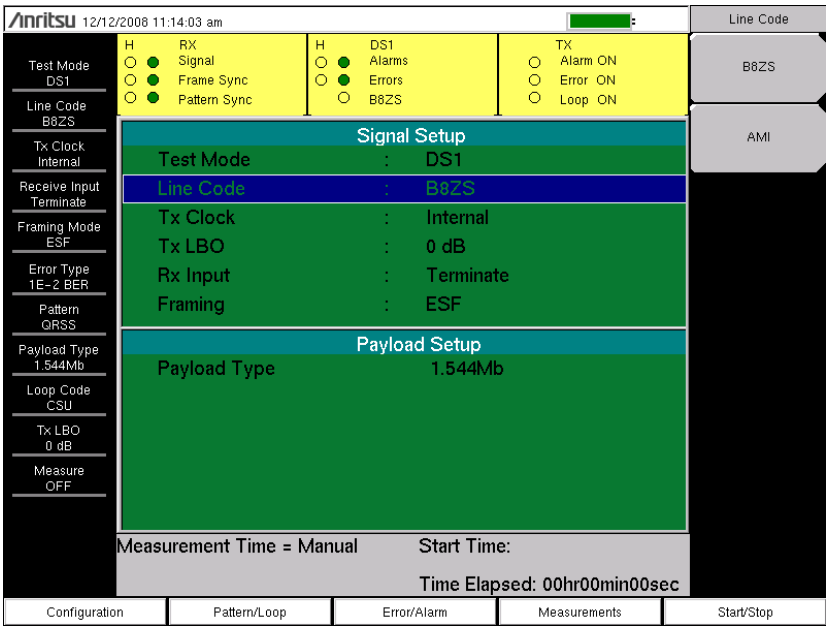


Figure 5-4. T1 Display Screen

The columns of historical data (for Rx and DS1) are labeled with an H. The adjacent columns display current (present time) conditions. The B8ZS indicator for DS1 displays only the current condition (no historical data). The H indicators turn red when an error has occurred previous to the current pass/fail condition. These error indications are cleared by pressing the Clear History submenu key in the Measurements menu. The Tx column indicators display ON/OFF status for Alarm, Error, and Loop testing.

The remainder of the measurement display is used for setups, configurations, and measurement display, which changes with the selected function.

The T1 function main menu keys are: **Configuration**, **Pattern/Loop**, **Error/Alarm**, **Measurements,** and **Start/Stop**.

5-5 Testing T1 Circuits

T1 circuit testing can be performed with either of two methods: In-service and Out-of-service testing.

In-service testing is done during the routine maintenance and troubleshooting phase. This can be done on live data without removing the T1 circuit from service. Monitoring live data allows wireless service provider technicians to detect alarms, bipolar violations (BPV), and frame errors, but bit errors cannot be measured. Bit errors may, however, be estimated by measuring CRC errors or frame errors. For a step-by-step example of in-service testing, refer to "In-service Measurements" on page 5-12.

Out-of-service testing is done when the T1 circuit is initially installed and before final acceptance from the LEC. At that time, the circuit should be subjected to critical testing in order to guarantee the level of service per contract. Out-of-service testing may also be performed when the circuit performance is very poor. For a step-by-step example of out of service testing, refer to "Out-of-service Measurements" on page 5-15.

5-6 T1 Configuration Screen

Display the configuration screen by pressing the **Configuration** main menu key. This function is used to configure the Signal Setup and Payload Setup.

Signal Setup allows the user to set up the Test Mode, Line Code, Tx Clock, Tx LBO, Rx Input, and Framing information.

Payload Setup allows the user to configure the Payload Type, Payload DS1 Channel, Payload DS0 Channel, and Other Channels that are to be tested.

Submenu keys for the T1 Configuration Menu are described in section "Configuration Menu" on page 5-26.

Signal Setup

Test Mode: AUTO

When AUTO is selected, the instrument first compares the connected signal with the current status of frame sync and pattern sync. If both are synchronized with the connected signal, then no further action is taken. If the signals are not already synchronized, then the AUTO function searches for a Line Code to match the connected signal, then searches for the framing mode of the connected signal, then searches for a matching signal pattern.

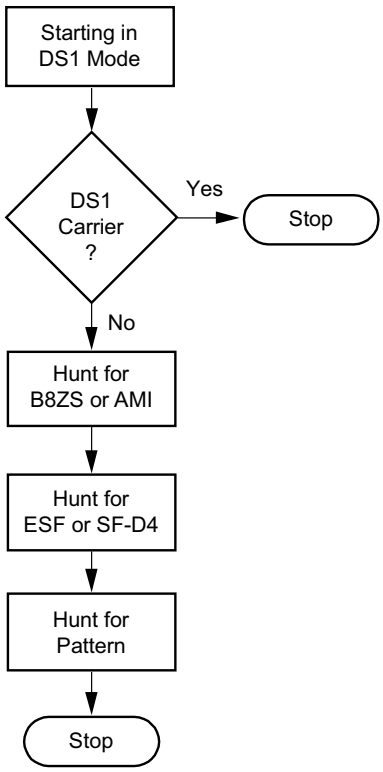


Figure 5-5. AUTO Configuration

Line Code: B8ZS or AMI

B8ZS and Alternate Mark Inversion (AMI) are two different line coding formats that are used in T1 networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the binary one pulses are bipolar (they alternate in polarity). Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. These zeros can cause the receiving equipment to have timing errors. The method used in T1 systems to maintain the density of ones (as opposed to zeros) in the data stream is known as binary 8-zero substitution, or B8ZS. For the B8ZS scheme, any time that eight consecutive zeros are detected in the data stream, the transmitter substitutes a fixed pattern of ones, zeros, and BPVs in place of those 8 zeros. The BPV is used to distinguish between a real data sequence of ones and zeros versus the fixed B8ZS pattern. Because the B8ZS fixed pattern is a known pattern, the terminating receivers can recognize the pattern and substitute the original string of 8 zeros in place of the fixed pattern.

TxClock: Internal, External, Recovered

Internal Clock: The internal clock uses an internal oscillator: 1.544 Mb/s ±5 ppm

Recovered Clock: The transmit clock uses the frequency recovered from the received signal.

External Clock: An external clock can be applied to the External Frequency Reference Input.

Tx LBO (Transmit Line Build Out): 0 dB, −7.5 dB, or −15 dB

Possible values for LBO are 0 dB, −7.5 dB, or −15 dB. When performing a test toward the far end of a circuit at a Digital System Cross-Connect (DSX), this will usually be 0 dB. The other values might be used when close to the equipment under test.

Rx Input: Terminate, Monitor, or Bridge

Terminate: Select Terminate for out-of-service testing. The signal is terminated with 100 ohms.

Monitor: The connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Bridge: The input impedance of the receiver is greater than 1000 ohms. The bridged mode is used when connecting directly to an in-service T1, 1.544 MHz circuit in order to avoid causing a “hit” on the signal and to avoid disrupting service.

Framing: ESF or SF-D4

ESF: Extended Super Frame, in which 24 frames are grouped together as an Extended Super Frame (ESF).

SF-D4: Super Frame D4, in which 12 frames are grouped together as a Super Frame (SF).

Payload Setup

Payload Type: 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb

The Payload Type identifies which portion of the T1 data stream is to be tested.

1.544 Mb: Full T1 data stream test.

Nx64kb: Selected combinations of 64 kb channels are tested. This mode is referred to as fractional T1.

64kb: A single 64 kb channel is tested.

56kb: Data stream as a result of bit robbing.

16kb: Two consecutive bits within a single 64 kb channel are tested.

8kb: A single bit within a selected 64 kb channel is tested.

Payload DS0 Channel: # (Number)

Set up the necessary channels and sub-channels when testing payloads Nx64kb to 8kb.

Other Channels: All ones or Idle

Set the other channels (that are not being tested) as IDLE or set them to All Ones.

5-7 T1 Pattern/Loop Screen

Access the test pattern screen by pressing the **Pattern/Loop** key, which includes 12 defined patterns and up to six user-defined patterns. The user-defined patterns can be created by pressing the Set User Pattern submenu key. Refer to "Set User Pattern" on page 5-29.

The available patterns are: QRSS, PRBS-9(511), PRBS-11(2047), PRBS-15, PRBS-20, PRBS-23, All Ones, All Zeros, T1 Daly, 1 in 8, 2 in 8, 3 in 24, or one of six user-defined patterns (labeled User Pattern 1 through User Pattern 6). The defined patterns are listed in Table 5-1.

Inverse patterns can be used. Loop codes can be selected and used as loop up or loop down.

Submenu keys for the Pattern/Loop Menu are described in "Select Pattern" on page 5-29. For a list of test pattern descriptions, refer to Table 5-1 on page 5-9 .

Table 5-1. Defined Test Patterns

Pattern	Description	Application
QRSS	1,048,575 bit pattern	Simulates live traffic including both high and low-density sequences
1 IN 8	Eight bit pattern of a 1 and 7 zeros	Checks clock recovery on circuits optioned for B8ZS
2 IN 8	Eight bit pattern of 2 ones and 6 zeros	Used to determine correct optioning of AMI or B8ZS line coding
3 IN 24	24 bit pattern with 3 ones and 15 consecutive zeros. 12.5% ones density	Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in B8ZS optioned circuits
ALL ONES	All ones sent as payload in a framed sequence	Stresses ability of circuit to operate under maximum power conditions
ALL ZEROS	All zeros sent as payload in a framed sequence	Checks for B8ZS optioning. Circuit will drop if optioned for AMI
T1-DALY	Framed 55 octet sequence which changes rapidly from high to low density	Stresses timing recovery and ability of automatic line build out and equalizer circuits to respond quickly to changing ones density
PRBS-9 (511)	511 bit pseudo-random pattern	Test sub-rate DDS circuits operating below 56 kb/s
PRBS-11 (2047)	2,047 bit pseudo-random pattern	Test 56 kb/s DDS circuits
PRBS-15	32,767 bit pseudo-random pattern. Generates up to 14 consecutive zeros and 15 consecutive ones	Tests to CCITT Recommendations O.151 and G.703. Provides maximum number of zeros for testing non-B8ZS circuits
PRBS-20	1,048,575 bit pseudo-random pattern. Generates up to 19 consecutive zeros and 20 consecutive ones	Used to test synchronous T1 circuits only
PRBS-23	8,388,607 bit pseudo-random pattern. Generates up to 22 consecutive zeros and 23 consecutive ones	Used to test synchronous T1 circuits

5-8 T1 Error/Alarm Screen

The Error/Alarm screen includes all of the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** main menu key to display the Error/Alarm menu.

Submenu keys for the Alarm/Error Menu are described in "Error/Alarm Menu" on page 5-31.

Bit Error: Inserts errors in the BER pattern. Bit errors can be selected by pressing Bit Error. A burst between 1 and 1000 can be selected by pressing the Bit Error submenu key. The Error Off/On submenu key is used to turn the burst ON or OFF.

BER (Bit Error Rate): Errors can be added to the transmission path by pressing the BER submenu key. Valid bit errors can be quickly set by pressing a preset submenu key: 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. For preset BER rates, refer to Table 5-2. Pressing the Error Off/On submenu key turns the error signal ON (keeps adding errors) or OFF (stops the errors).

Table 5-2. Bit Error Rates

BER Rate	Errors Inserted
1E–2	1 error is inserted for every 100 bits introduced
1E–3	1 error is inserted for every 1000 bits introduced
1E–4	1 error is inserted for every 10,000 bits introduced
1E–5	1 error is inserted for every 100,000 bits introduced
1E–6	1 error is inserted for every 1,000,000 bits introduced
1E–7	1 error is inserted for every 10,000,000 bits introduced

BPV: In a bipolar signal, this is a rule violation in which a 1 (mark or pulse) has the same polarity as the previous 1 (mark or pulse). A burst between 1 and 1000 can be selected by pressing the BPV submenu key.

Frame Bit Error: Inserts errors in the framing bits. Frame Bit errors can be selected by pressing Frame Bit Error. A burst between 1 and 1000 can be selected by pressing the Burst submenu key. The Error On/Off submenu key is used to turn the burst ON or OFF.

AIS Alarm On/Off: When the AIS (Alarm Indication Signal) alarm is turned ON, the data is replaced with an unframed signal of all ones. AIS is also called the Blue Alarm.

RAI Alarm On/Off: When the RAI (Remote Alarm Indication) alarm is turned ON, a signal is transmitted from the terminal equipment in the outgoing direction when it determines that it has lost the incoming signal, or when it receives an AIS signal in the incoming direction. RAI is also called the Yellow Alarm.

Error Off/On: This submenu key turns the error signal ON or OFF.

5-9 T1 Measurement Screen

Press the **Measurements** main menu key to display the Measurement screen.

BERT: Three different displays are available to view results. They are Table, Histogram, and Event List.

Rx Signal: Displays Rx Signal measurements.

VF: Displays VF level measurements. The submenu allows the user to set the channel number, transmit frequency, transmit level, and audio volume.

Measure Time: Sets the time period of testing, from 1 minute to 3 days.

Clear History: Clears the Event List and any of the red History indicators in the yellow highlighted area of the data display.

Save Results: This submenu key opens the File menu.

Submenu keys for the **Measurement** menu are described in section "Measurements Menu" on page 5-33.

Start/Stop Key

Press this function key to start or stop the measurement that is currently set up on the instrument.

5-10 In-service Measurements

In-service testing can be done only when the equipment has a test port. When testing a T1 circuit that is in service, the access to the circuit must be bridged via a monitor port in order to avoid disrupting service. Even when the T1 circuit is down, these tests will help to verify and identify the correct fault circuit. The following measurements can be used to check the T1 performance during regular maintenance:

- Vpp Measurement
- Carrier
- Frame Sync
- CRC Errors, for Extended Super Frame (ESF)
- BPV
- Frequency

Required Equipment

- Bantam Cables, Anritsu Part Number 806-16

Measurement Setup Procedure

1. While in the T1 Analyzer mode, press the **Configuration** main menu key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Test Mode and select DS1.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the B8ZS or AMI line coding submenu key.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Internal, Recovered, or External. For more Tx Clock information, refer to "TxClock: Internal, External, Recovered" on page 5-7.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input and press the Bridge or Monitor submenu key, as appropriate for the connection.

Note	If Monitor access is pressed, 20 dB of gain is added to the receive path. The Bridge or Monitor selection must be made before the instrument is connected to the circuit.

6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing and press the ESF or SF-D4 framing submenu key.

Note	The setup parameters are displayed in the instrument settings summary on the left side of the screen. The status window on the top of the screen is always displayed.

7. Connect the Rx cable to one of the pairs.
8. Press the **Measurement** main menu key, then the BERT submenu key, then the Table submenu key. Press the **Start/Stop** main menu key to activate the measurement.
9. Verify Rx Signal, Frame Sync, CRC, and BPV.

10. Press Rx Signal submenu key (**Measurements** menu) and verify Vpp and Frequency. When very close to the Tx source, the signal should be between 4.8 Vpp and 7.2 Vpp. The frequency should be 1.544 MHz ± 50 Hz (± 32 ppm).
11. Move the Rx connection to the other pair on the circuit under test and then repeat the tests.

Note	Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

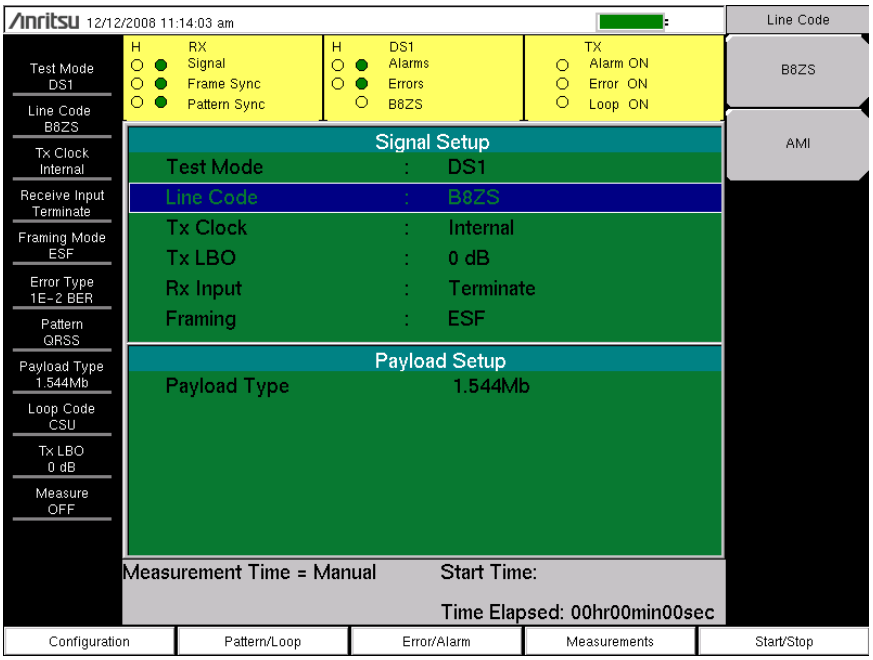


Figure 5-6. T1 Signal Setup for DS1

Vpp Measurement Procedure

This test measures the amplitude of the output signal from the PCM port to the DSX and receiving station. These measurements provide detailed information on the T1 circuit.

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the Rx Signal submenu key to select the Vpp measurement.
3. Press the **Start/Stop** main menu key to activate the Vpp measurement.

Note	The Vpp measurement is displayed in both Vpp and dBdsx.

The Vpp should meet the criteria of the service provider. When very close to the transmitter, the signal level must be 4.8 to 7.2 Vpp. Further from the transmitter, the Vpp will be lower.

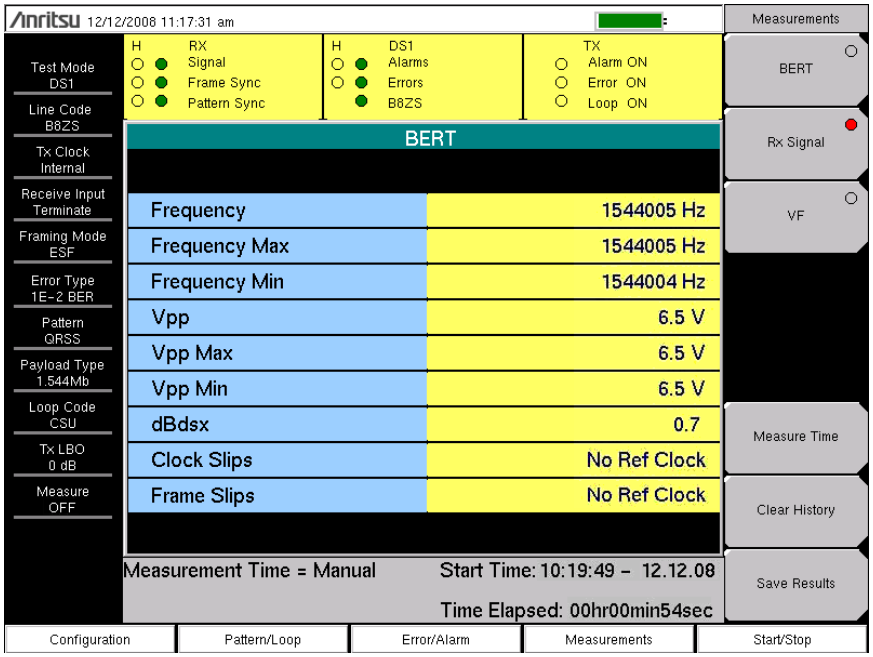


Figure 5-7. Vpp Measurement

VF, DS0 Test Procedure for In-service Measurements

1. After the unit is correctly configured, press the **Measurements** main menu key then the VF submenu key to activate the VF Measurements.
2. Press the Channel submenu key and use the directional arrow keys, rotary knob, or key pad to enter the desired channel, then press **Enter**. The received VF level and frequency on the selected channel are displayed.
3. For audio monitoring, press the Audio submenu key to toggle audio monitoring ON.

When a test tone is present on the channel, the level and frequency report will indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality.

5-11 Out-of-service Measurements

Out-of-service measurements are performed when the T1 circuit is not in-service or is inactive. Typically, these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the performance of the circuit is below acceptable levels.

Two methods of performing out-of-service testing are: end-to-end and loopback testing. End-to-end testing requires a technician and a unit at each end of the circuit. Loopback testing requires a loopback at one end of the circuit and a unit and technician at the other end to measure the round trip BER of the T1 circuit.

The ANSI T1 standard defines in-band and out-of-band loop codes. In-band codes are transmitted in place of payload data and are repeated continuously for a period of five seconds. They can be used either with SF D4 or ESF. Out-of-band loop codes can be used only with the ESF framing format, because an out-of-band communication link does not exist for SF D4.

The following measurements can be used to check T1 performance during out-of-service testing:

- Vpp
- Carrier
- Frame Sync
- CRC Errors, for Extended Super Frame (ESF)
- BPV
- BER
- Frequency

Required Equipment

- Bantam Cables, Anritsu Part Number 806-16 (2 cables required)

Measurement Setup Procedure

1. Press the **Configuration** main menu key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the B8ZS or AMI coding submenu key.
3. Select one of the three Tx Clock types: Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx LBO and select either the 0 dB, –7.5 dB, or –15 dB transmitter signal level submenu key as appropriate to the measurement.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input and press the Terminate submenu key.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing and press the ESF or SF-D4 submenu key as appropriate for the measurement.
7. Press the **Pattern/Loop** main menu key to activate the pattern and loop code menu.

8. Press the Select Pattern submenu key, use the **Up/Down** arrow keys, or use the rotary knob to highlight the appropriate pattern, and press the Select Pattern submenu key or press **Enter**. The selected pattern can be reversed (only supported for PRBS patterns) by pressing the Inverse Pattern submenu key.

Note	Up to six user-defined patterns can be created by pressing the Set User Pattern submenu key and pressing the User-Pat 1 through User-Pat 6 submenu keys. Use the **Up/Down** arrow keys, rotary knob, or key pad to enter the desired pattern. Table 5-1 on page 5-9 summarizes the T1 patterns that are available in the instrument.

9. Connect the Tx and Rx ports to the circuit under test.
10. Verify carrier and frame sync before proceeding.

Activate Remote Loop Up and Loop Down Code

1. Press the **Pattern/Loop** main menu key to activate the pattern and loop code menus.
2. Press the Select Loop Code submenu key to display the Loop menu. Press either the CSU or the NIU submenu key.
3. Select either In-Band or Data-Link by toggling the Link Type submenu key. (This selection is for ESF only.) Press Back to return to the previous menu.

Note	Custom user-defined codes can be created by pressing the Loop Code User1 or Loop Code User2 submenu key and using the **Up/Down** arrow keys, rotary knob, or key pad to enter the desired loop code.

4. Press the Remote Loop Up submenu key to activate the Loop Code.
5. Press the Remote Loop Down submenu key to deactivate the Loop Code.

Note	The current setup parameters are displayed in the instrument settings summary table on the left side of the screen.

To Set Errors/Alarms

1. Press the **Error/Alarm** main menu key to activate the Error/Alarm menu.
2. Press the Bit Error, BER, BPV, or Frame Bit Error submenu key, as applicable to the measurement.
3. Press the AIS Alarm or RAI Alarm submenu key. These two submenu keys toggle between ON and OFF. The alarm status is displayed in the yellow highlighted area of the upper part of the measurement data display.

Vpp and Frequency Measurement Procedure

This test measures the amplitude of the output signal from the PCM port at the DSX (Digital System Cross-Connect) and receiving station.

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the Rx Signal submenu key to activate the Vpp measurement.

Note	The Vpp measurement is displayed in both Vpp and dBdsx.

The Vpp should meet the criteria of the service provider. When very close to the transmitter, the signal level must be 4.8 to 7.2 Vpp. Further from the transmitter, the Vpp will be lower. Figure 5-8 shows a typical Vpp measurement display (which may not be the same as shown on your instrument). The frequency should be 1.544 MHz ±50 Hz (±32 ppm).

If the measurement meets the customer requirements for this system, then proceed to the BERT measurement.

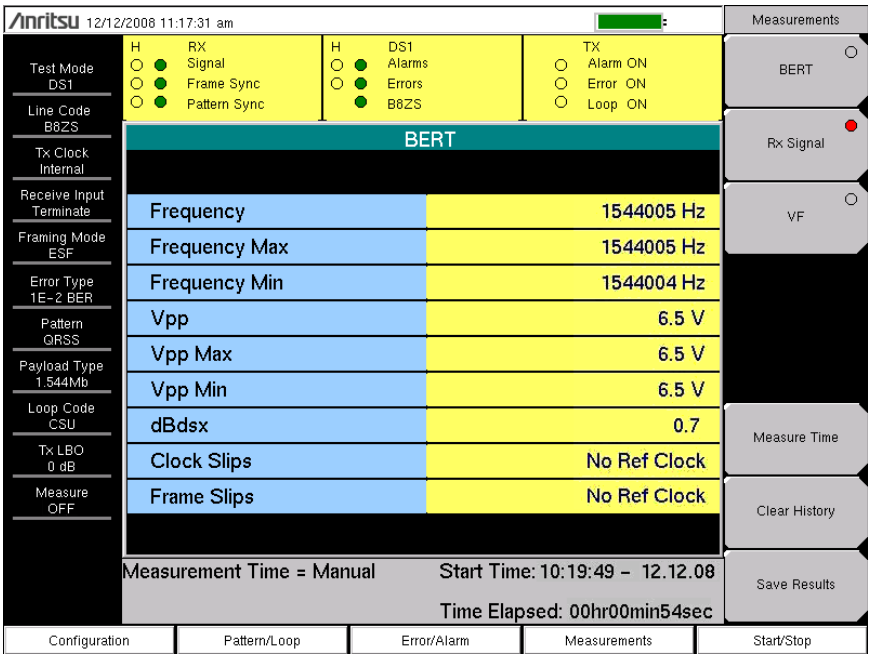


Figure 5-8. Vpp Out-of-Service Measurement

5-12 BERT Measurement Procedure

Basic BERT Measurement Procedure

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the Table submenu key to display the measurements in table format, or press Histogram or Event List.
4. From the BERT menu, press the Back submenu key. Then from the Measurements menu, press the Measure Time submenu key and use the **Up/Down** arrow keys, rotary knob, or key pad to enter the duration of the measurement. Then press **Enter**.
5. Press the **Start/Stop** main menu key to start and stop the measurement.

Note	The measurement time is set in the Measure Time menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, 3 days, or Manual). Manual runs indefinitely and allows the user to terminate the measurement at any time.

Submenu keys for the BERT menu are described in "BERT Menu" on page 5-34.

Quick Check

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the Table submenu key to display the measurements in the table format.
4. Press the **Start/Stop** main menu key to activate the measurements. To stop the measurements, press the **Start/Stop** key again.
5. If the results are within specifications, then RESULTS OK is displayed in a green box at the center of the screen. If any errors occur, then the errors/measurement results are displayed in the table..

Note	The RESULTS OK message can be cleared by pressing **Esc**.

Histogram Display

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the Histogram submenu key to display the data in histogram format.
4. Press the Histogram submenu key again to configure the histogram parameters, which are Zoom, Window Size, and Time Units.
5. Press the **Start/Stop** main menu key to activate the measurement.

To Insert Errors/Alarms

1. Press the **Error/Alarm** main menu key to activate the Error/Alarm menu.
2. Press the Error Off/On submenu key to toggle the selected error type ON. Confirm that On is underlined. (Press the Error Off/On submenu key to turn OFF the errors.)

Event List

The BERT measurement Event List updates errors, signal loss, frame loss, and alarms (AIS ON, AIS OFF, RAI ON, and RAI OFF) every second. The data is displayed as a log list. The display will list up to 1000 errored seconds.

5-13 DS0 Testing

The DS0 test feature enables testing on each of the 24 channels of the T1 line. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling the testing technician to make an audible assessment of the signal quality of the circuit. If the circuit is out-of-service, the tester can insert a test tone on the transmit channel for measurement either at a remote location with another test set, or locally with a loopback. VF is displayed above 100 Hz and up to 3000 Hz.

5-14 Measuring Clock and Frame Slips

If a T1 - 1.544 Mb/s BITS (Building Integrated Timing Source) reference clock is available, then it can be used to measure clock slips and frame slips on the circuit under test. If two or more T1 - 1.544 Mb/s circuits are present, then one of these can be used as a reference. The reference circuit (in this configuration) should be out-of-service because it will be terminated by the clock recovery circuit in the instrument.

To count clock slips, connect the reference clock to the Ext Trigger In connector on the instrument. The presence of the clock is automatically detected, and when a measurement is started, the number of clock slips and frame slips are reported. When the clock frequencies are very close, the clock slip count will hover around zero. If the frequency of the circuit under test is higher than the reference frequency, then the count will grow positive. If the frequency of the circuit under test is lower than the reference frequency, then the count will grow negative. One frame slip is counted for 193 clock slips.

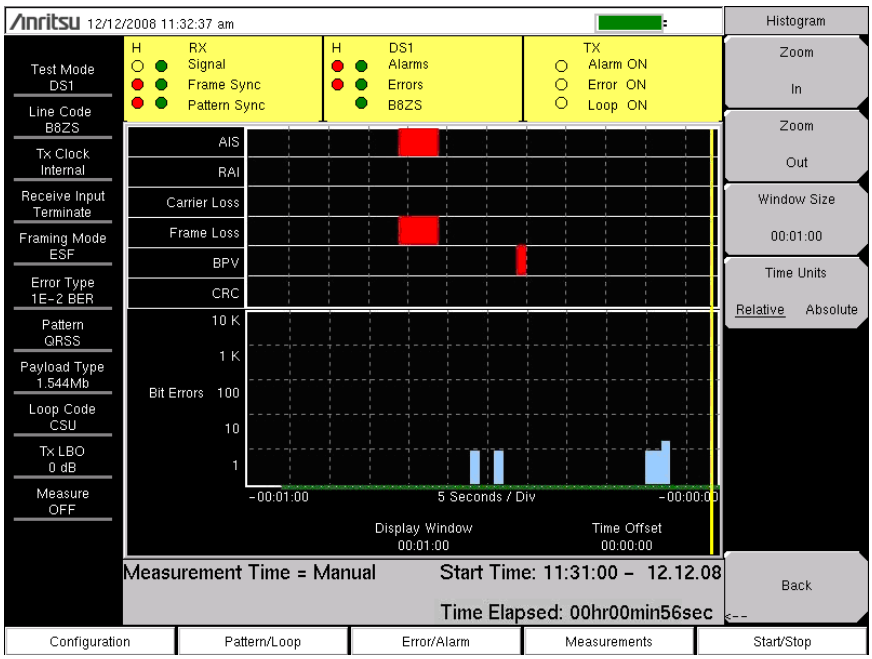


Figure 5-9. Histogram Display

Histogram Explanations

Data Resolution

If data resolution is set to a small value, then you can zoom in to see in detail when faults have occurred. However, small resolution takes up larger file sizes when saved. The maximum number of records is capped at 86,400, so if the user is interested in history longer than one day, then the resolution must be set higher than one second. If the data resolution is changed, then the entire histogram must be reset.

Display Window

The display window is the length of time shown on the histogram screen. More data may be stored than is shown. This parameter allows a user to zoom in or zoom out to see either more time on the screen or more resolution. The minimum and maximum values are based upon the data resolution.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Offset

Time offset is the offset in time of the right side of the screen from the start of the measurement. The screen may be moved left or right with this parameter. Using this feature together with a small display window provides the ability to zoom in on an event that happened some time in the past.

Time Units

If Relative is selected (underlined), then the histogram axis will be labeled with time since the start of the measurement record.

If Absolute is selected, then the histogram axis will be labeled with absolute times that are based on the system clock.

5-15 T1/FT1 Menus

Figure 5-10 to Figure 5-13 show the map of the T1/FT1 menus. The following sections describe main menus and associated submenus. The submenus are listed in the order they appear on the display from top to bottom under each main menu.

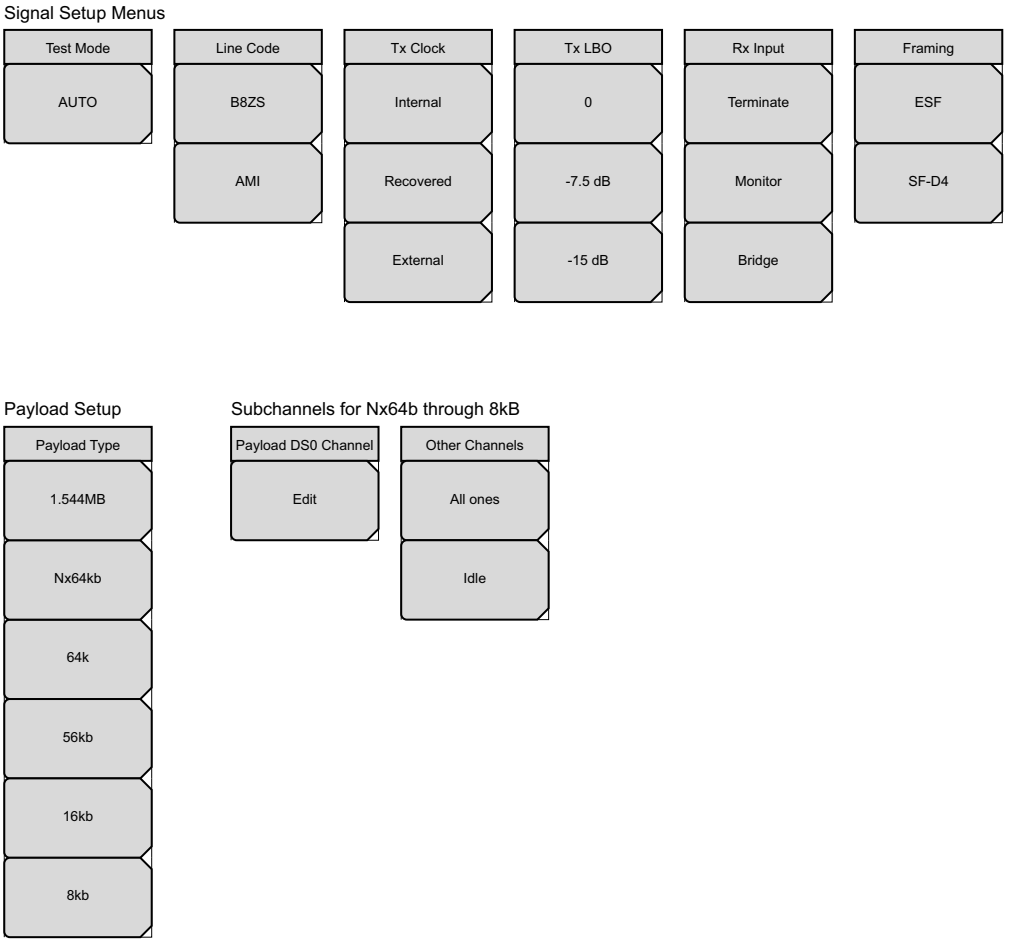


Figure 5-10. T1 Configuration Submenu Keys

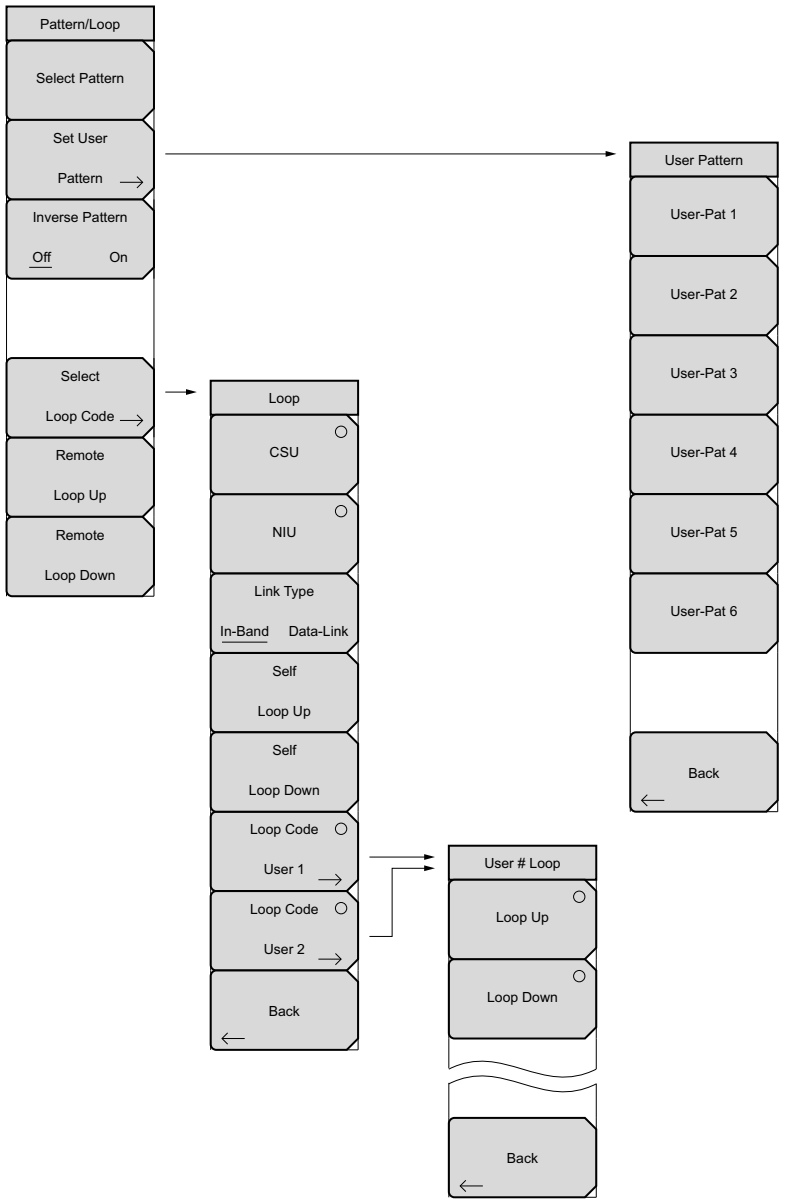


Figure 5-11. T1 Pattern/Loop Submenu Keys

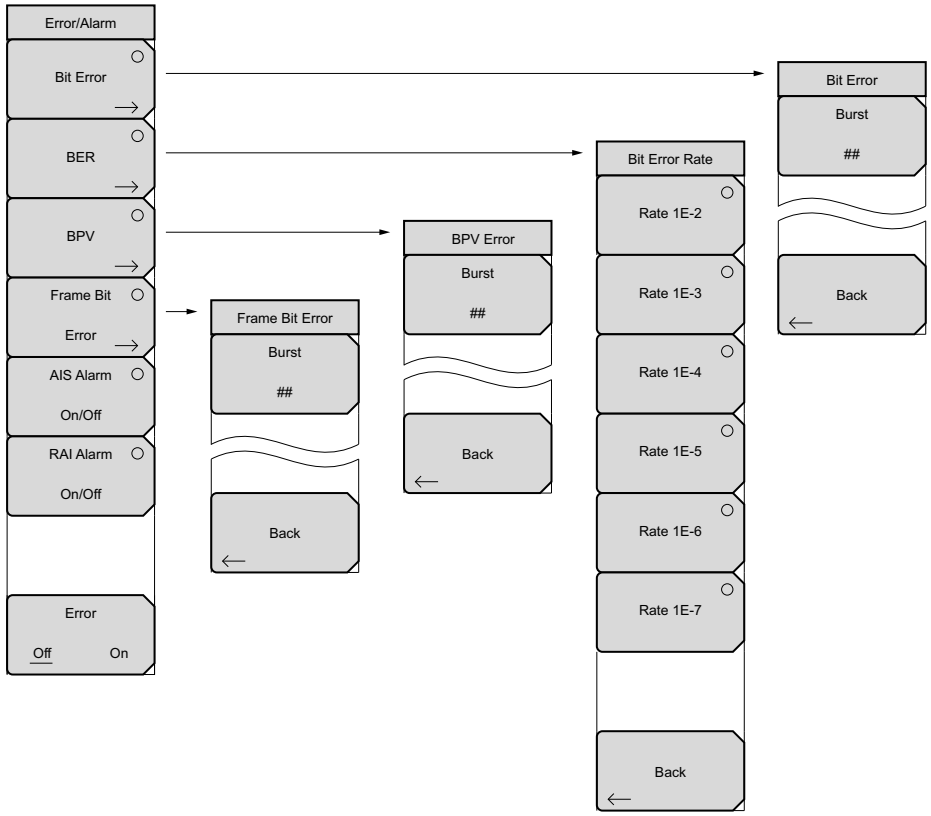


Figure 5-12. T1 Error/Alarm Submenu Keys

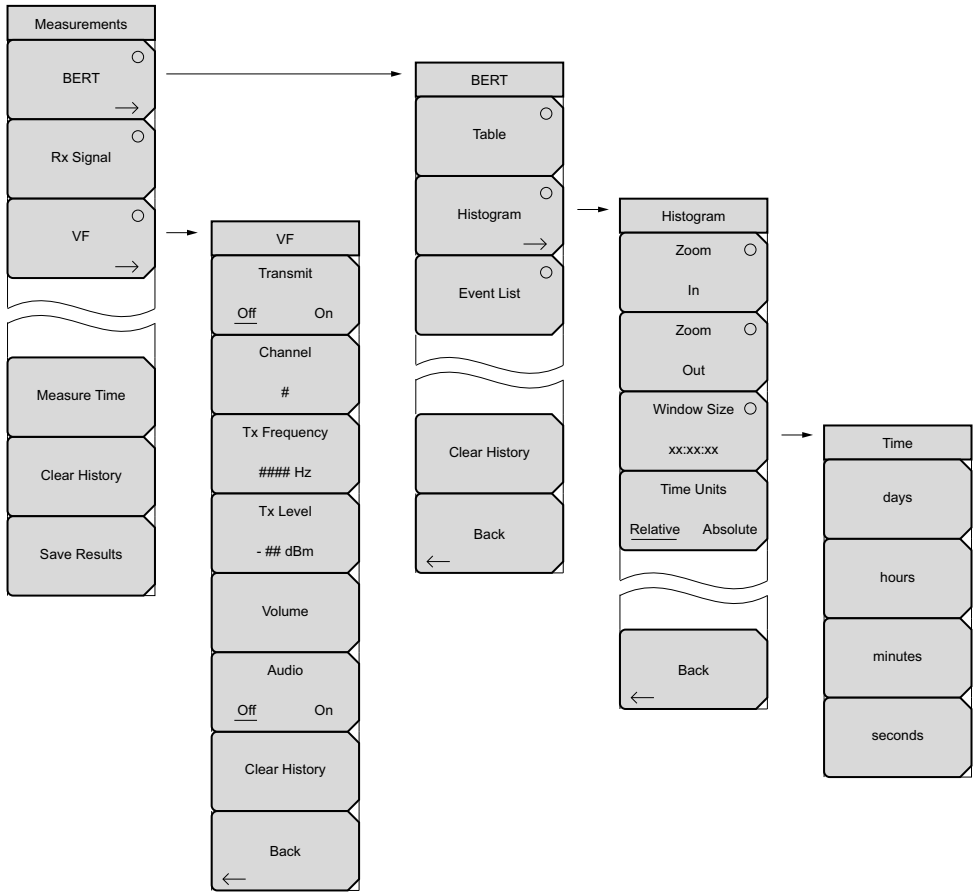
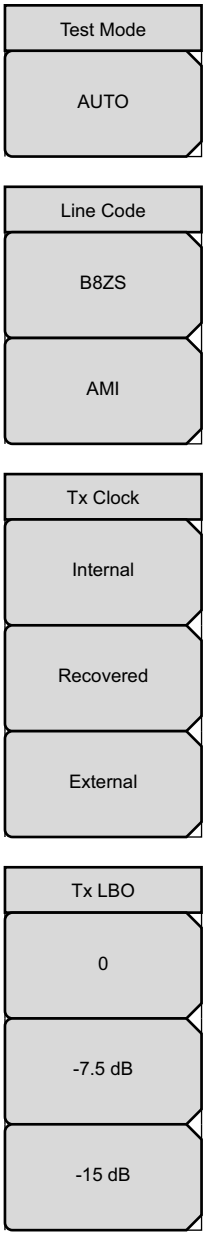


Figure 5-13. T1 Measurements Submenu Keys

5-16 Configuration Menu

Key Sequence: **Configuration**

Signal Setup



Test Mode, AUTO: Press this submenu key to automatically select a Framing Mode and Pattern to match the connected signal. For additional explanation of the use of this key, refer to “Test Mode: AUTO” on page 5-6.

Line Code: Select either AMI or B8ZS line code format. For additional information, refer to “Line Code: B8ZS or AMI” on page 5-7 .

B8ZS: Press this submenu key for B8ZS.

AMI: Press this submenu key for AMI.

Tx Clock:

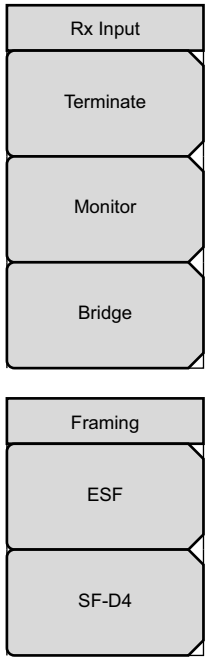
Internal: Press this submenu key to use an internal clock, for testing toward the equipment at the local site.

Recovered: Press this submenu key when you want the transmit clock to use the frequency that is recovered from the received signal.

External: Press this submenu key to use an external reference clock.

Tx LBO, 0 dB, –7.5 dB, or –15 dB: Press one of these submenu keys depending upon whether you are testing toward local equipment or toward the far end of a circuit. For additional information, refer to “Tx LBO (Transmit Line Build Out): 0 dB, –7.5 dB, or –15 dB” on page 5-7.

Figure 5-14. T1 Signal Setup (1 of 2)



Rx Input:

Terminate: Press this submenu key to terminate the circuit in 100 ohms.

Monitor: Press this submenu key to perform a monitor test by using the monitor jack at a DSX. This selection properly terminates the signal coming from the DSX monitor jack and compensates for the 20 dB loss found at that jack.

Bridge: Press this submenu key to connect to the circuit with >1000 ohms.

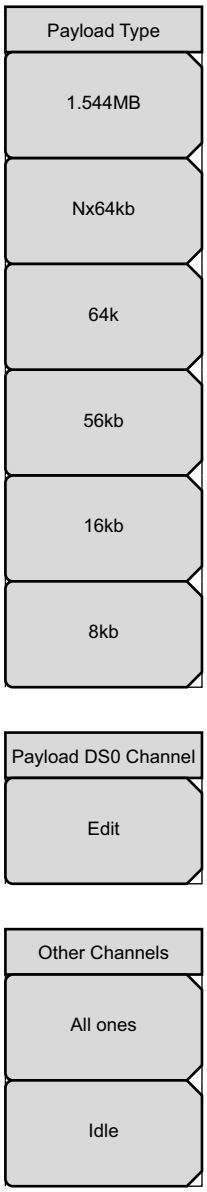
Framing:

ESF: Press this submenu key for Extended Super Frame format.

SF–D4: Press this submenu key for Super Frame D4 format.

Figure 5-15. T1 Signal Setup (2 of 2)

Payload Setup



Payload Type: The payload type identifies which portion of the T1 data stream is to be accessed for testing. For additional information, refer to section "Payload Setup" on page 5-8.

Payload DS0 Channel, Edit: Press this submenu key to set up the necessary channels and sub-channels when testing payloads Nx64kb through 8kb.

Other Channels:

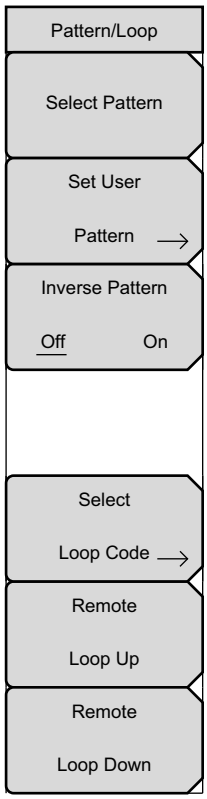
All ones: Press this submenu key to set channels that are not being tested to contain all ones (no zeros).

Idle: Press this submenu key to set channels to contain idle code.

Figure 5-16. T1 Payload Setup

5-17 Pattern/Loop Menu

Key Sequence: **Pattern Loop**



Select Pattern: After highlighting a pattern, press this submenu key to select the highlighted pattern.

Set User Pattern: Use this submenu key to set a specific user pattern in one or more of the six available user patterns.

> **User-Pat #:** These six submenu keys each select a different user pattern. Set the patterns by entering zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue or **Esc** to abort.

Inverse Pattern, Off/On: This submenu key toggles the Inverse Pattern function OFF and ON. When on, the selected PRBS pattern is inverted.

Select Loop Code: This submenu key opens the "Select Loop Code Menu" on page 5-30, from which you can select 1 of 7 loop configurations.

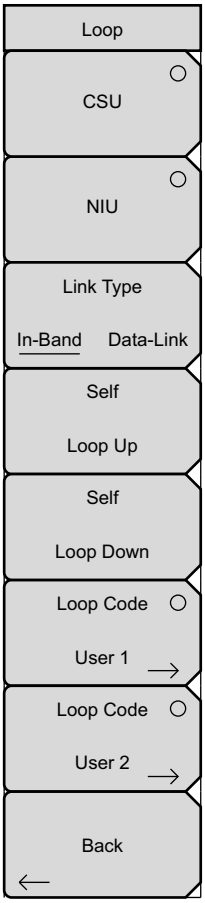
Remote Loop Up: This submenu key causes the loop-up code to be transmitted on the circuit under test.

Remote Loop Down: This submenu key sends the loop-down code to the circuit under test.

Figure 5-17. T1 Pattern Loop

Select Loop Code Menu

Key Sequence: **Pattern Loop** > Select Loop Code



CSU: Press this submenu key to select CSU (Channel Service Unit) codes.

NIU: Press this submenu key to select NIU (Network Interface Unit) codes.

Link Type: Press this submenu key to toggle between In-Band and Data-Link. Use Data-Link when framing is ESF.

Self Loop Up: Press this submenu key to activate internal loop back.

Self Loop Down: Press this submenu key to deactivate internal loop back, reverting the instrument to a through mode.

Loop Code User 1
Loop Code User 2: Press one of these submenu keys to set the user Loop Up and Loop Down codes.

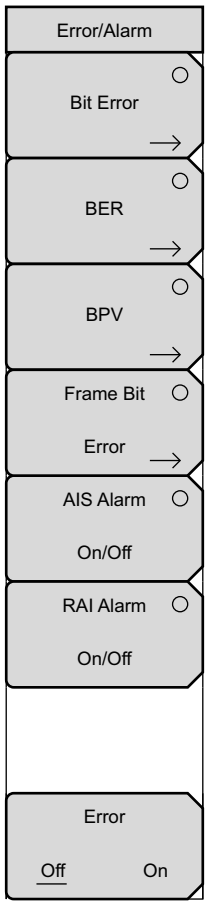
Back: Return to the "Pattern/Loop Menu" on page 5-29.

Figure 5-18. T1 Loop Code

5-18 Error/Alarm Menu

When not active, some submenu keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these submenu keys are active.

Key Sequence: **Error/Alarm**



Bit Error: Use this submenu key to insert a bit error. Press this submenu key once to select the function. Press the key again to display the Bit Error submenu. The “Error Type” field in the instrument settings summary table at the left side of the measurement display changes to “### BIT”, where ### is the burst setting.

Burst: A burst can contain from 1 to 1000 errors. Set this parameter by pressing the Burst submenu key and then using the rotary knob, arrow keys, or number keypad. The following text appears in red at the top of the BERT table: **Bit Error Insert ###**. The number digits appear as they are pressed on the number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad to enter the burst setting, then the Burst submenu key label changes to Enter. The submenu key can be used to enter the parameter value.

Back: Press this submenu key to return to the Error/Alarm menu.

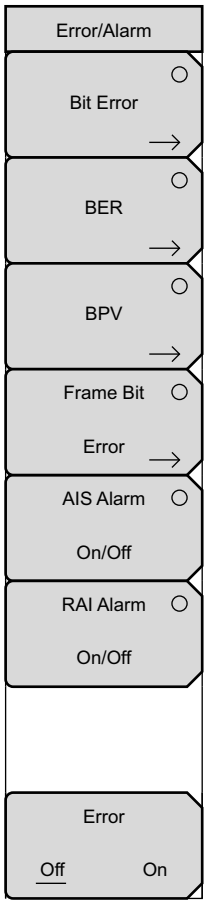
BER: Errors can be added to the transmission path by pressing the BER submenu key. Valid BER include 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. If a BER value of 1E–3 is selected, then 1 error will be introduced for every 1000 bits in the transmission path. Pressing ON keeps adding errors. Pressing OFF stops the errors. Press this submenu key once to select the function. The “Error Type” field in the instrument settings summary table at the left side of the measurement display changes to “1E–# BER”, where # indicates the bit error rate setting. Press the key again to display the Bit Error Rate submenu. Choose from the six rate options and press Back to continue.

Rate 1E–#: These six submenu keys are labeled with number 1E–2 through number 1E–7. Use these submenu keys to select a bit error rate.

Back: Press this submenu key to return to the Error/Alarm menu.

BPV: Use this submenu key to configure error bits for bipolar violation testing. Press this submenu key once to select the function. The “Error Type” field in the instrument settings summary table at the left side of the measurement display changes to “### BPV”, where ### is the burst setting. Press the key again to set the Burst count described above. Press the Back submenu key to return to the Error/Alarm menu.

Figure 5-19. T1 Error/Alarm (1 of 2)



Frame Bit Error: Use this submenu key to insert a frame bit error. Press this submenu key once to select the function. The “Error Type” field in the instrument settings summary table at the left side of the measurement display changes to “### FRAME”, where ### is the burst setting. Press the key again to enter the Frame Bit Error menu and set the burst count, see “Burst” on page 5-31. Press the Back submenu key to return to the Error/Alarm menu.

AIS Alarm On/Off: When the AIS is turned ON, the data is replaced with an unframed signal of all ones. Press this submenu key to turn ON the AIS Alarm function. The “Error Type” field in the instrument settings summary table at the left side of the measurement display changes to “Error Type AIS”. The Alarm ON circle indicator (in the yellow TX portion of the upper part of the measurement data display) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On submenu key function to OFF, and its circle indicator (in the yellow TX portion of the upper display) is displayed as an open circle. Pressing this submenu key again turns the alarm OFF, its circle indicator is displayed as an open circle, and the Bit Error submenu key becomes active (its circle indicator is displayed in red).

RAI Alarm On/Off: If the terminal loses its incoming signal, then an RAI signal is transmitted in the outgoing direction. RAI is also called Yellow Alarm. Press this submenu key to turn ON the RAI Alarm function. The “Error Type” field in the instrument settings summary table at the left side of the measurement display changes to “Error Type RAI”. The Alarm ON circle indicator (in the yellow TX portion of the upper part of the measurement data display) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On submenu key function to OFF, and its circle indicator (in the yellow TX portion of the upper display) is displayed as an open circle. Pressing this submenu key again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error submenu key becomes active (its circle indicator is displayed in red).

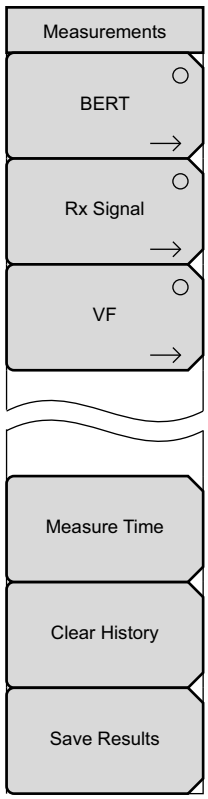
Error, Off/On: This submenu key is active only when the BER submenu key is active. Press this submenu key to toggle Error Off and On. The Error ON circle indicator (in the yellow TX portion of the upper display) is displayed in green when this parameter is ON.

Figure 5-20. T1 Error/Alarm (2 of 2)

5-19 Measurements Menu

When not active, some submenu keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these submenu keys are active.

Key Sequence: **Measurements**



BERT: Press this submenu key to open the "BERT Menu" on page 5-34 and select the display type for viewing test results, choosing from: Table, Histogram, or Event List.

Rx Signal: Press this submenu key to display Rx Signal measurements.

VF: Press this submenu key to display VF level measurements. Press the submenu key again to open the "VF Menu" on page 5-36 for configuration.

Measure Time: This submenu key opens a dialog box to set the measurement time. Choose from 12 settings, which range from 1 minute (minimum) to 3 days (maximum). You can also choose Manual, which runs any length of time, indefinitely, until the **Stop/Start** main menu key is pressed. Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the Rotary Knob to continue, or press **Esc** to abort.

Clear History: Press this submenu key to erase the history of displayed events and measurements. Also, clears any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Save Results: Press this submenu key to save the results of a measurement. See Chapter 3 of the User Guide for more information.

Figure 5-21. Measurements Menu

BERT Menu

Key Sequence: **Measurements** > BERT

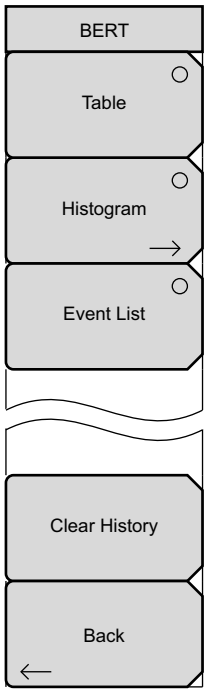


Table: Press this submenu key to view test results in table format.

Histogram: Press this submenu key to view test results in the histogram screen display. Press the submenu key again to configure the "Histogram Menu" on page 5-35.

Event List: Press this submenu key to view test results in the Event List format.

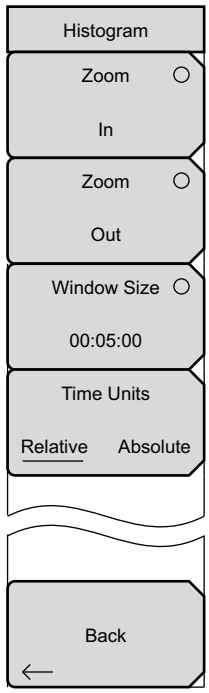
Clear History: Press this submenu key to clear any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Back: Press this submenu key to return to the "Measurements Menu" on page 5-33.

Figure 5-22. BERT Menu

Histogram Menu

Key Sequence: **Measurements** > BERT > Histogram



Zoom In: Use this submenu key to change the graph display width to a smaller value. The graphical display units are described in the Window Size submenu key description.

Zoom Out: Use this submenu key to change the graph display width to a larger value. The graphical display units are described in the Window Size submenu key description.

Window Size, ##:##:##: This submenu key displays the time units in the format 0d:00:00:00, in days, hours, minutes, and seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; or 1, 2, or 3 days. When pressed, the submenu key color changes to a darker background, and the numeric value is displayed in red. The labels (Display Window ##:##:00) in the graph area of the display are also in red. The red color indicates that the time is being changed. The red label at the top line of the histogram and the one below the histogram remain red while the value is open to change. When the numeric value has been set, the upper label is removed, and the lower label changes to plain text, showing the setting.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys. Press an appropriate number or numbers, and the submenu changes to time increments: days, hours, minutes, seconds. For example, entering 3600 and pressing seconds sets the display width to 1 hour, and entering 3601 and pressing seconds sets the display width to 6 hours (the next available increment).

Press the desired time units submenu key to enter the time value in days, hours, or minutes (seconds, for example, can be used in multiples for any of the discrete hour, minute, or day settings, but the number of seconds in the final setting are always 00). The Window Size submenu key remains active (available for change) until you press the **Enter** key or the Rotary Knob.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

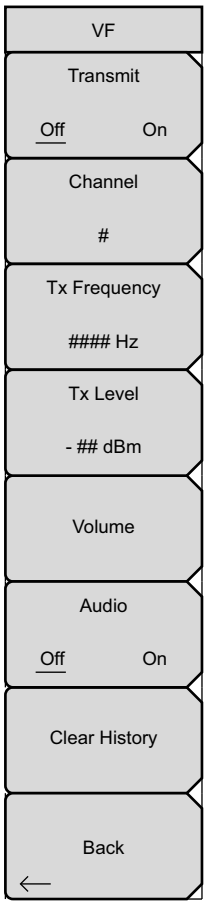
Time Units, Relative or Absolute: This submenu keys toggles between Relative and Absolute time. The units are displayed at the bottom edge of the histogram.

Back: Press this submenu key to return to the "BERT Menu" on page 5-34.

Figure 5-23. Histogram Menu

VF Menu

Key Sequence: **Measurements** > VF



Transmit: This submenu key toggles Transmit OFF and ON.

Channel #: This submenu key opens a dialog box to select a channel value from 1 (minimum) to 24 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency: This submenu key opens a dialog box to select a frequency from 100 Hz (minimum) to 3000 Hz (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a default value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level: This submenu key opens a dialog box to select a Tx Level from –30 dBm (minimum) to 0 dBm (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume: This submenu key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio: This submenu key toggles Audio OFF and ON.

Clear History: Press this submenu key to clear any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Back: Press this submenu key to return to the “Measurements Menu” on page 5-33.

Figure 5-24. VF Menu

5-20 Calibrate Menu

This menu is not available in T1 measurement mode.

5-21 Sweep Menu

This menu is not available in T1 measurement mode.

5-22 Measure Menu

This menu is not available in T1 measurement mode.

5-23 Trace Menu

This menu is not available in T1 measurement mode.

5-24 Limit Menu

This menu is not available in T1 measurement mode.

5-25 Other Menus

Preset, **File**, **Mode** and **System** are described in the User Guide.

Chapter 6 — T1/T3 Analyzer (Option 53)

6-1 Introduction

This chapter provides a brief description of T3 circuits as well as T3 measurements, and also explains how to measure T3 performance using the instrument with Option 53 installed.

Chapter 5, "T1/FT1 Analyzer (Option 51 or 54)" describe T1 technology and testing, and this chapter describes T3 technology and testing.

6-2 Selecting the T1/T3 Analyzer Mode

1. Press the **Shift** key followed by pressing the **Mode** (9) key on the numeric keypad to open the Mode Selector list box.
2. Use the directional arrow keys or the rotary knob to highlight T1/T3 Analyzer and press **Enter** to select.

6-3 T1 Fundamentals

Refer to Section 5-3 "T1 Fundamentals" on page 5-1 for an overview of T1 fundamentals.

Signal Setup

Test Mode: AUTO, DS1, DS3

Displays the selected signal test mode.

DS1 sets the instrument in T1 testing mode. DS3 test mode is for testing T3/DS3 signals.

When AUTO is selected, the instrument first compares the connected signal with the current status of frame sync and pattern sync. If both are synchronized with the connected signal, then no further action is taken.

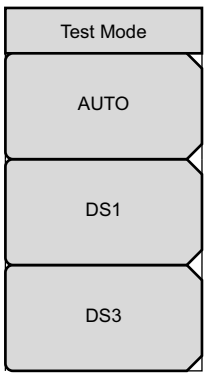
If the current mode is DS1, then when AUTO is pressed, the instrument first seeks the frame sync (ESF or SF-D4). If frame sync is found, then the Framing Mode is displayed in the instrument settings summary (at the left side of the data display area). Then the instrument seeks the pattern sync, stepping through all possible patterns. If pattern sync is found, then the Pattern is displayed in the instrument settings summary. The framing mode and pattern are thereby set, and the instrument is ready for use on the connected circuit.

For additional explanation of the use of this key, refer to section "AUTO Signal Setup Explanation" on page 6-36.

6-4 T1 Configuration Menu

Key Sequence: **Configuration**

Signal Setup



Test Mode: Select from one of three submenu keys for the type of test mode desired.

AUTO: Press this submenu key to automatically select a Framing Mode and Pattern to match the connected signal. For additional explanation of the use of this key, refer to section "AUTO Signal Setup Explanation" on page 6-36.

DS1: Press this submenu key for T1 testing.

DS3: Press this submenu key for T3 testing.

Figure 6-1. T1 Signal Setup

6-5 T3 Fundamentals

A T3 circuit (also referred to as a DS3 circuit) is formed by multiplexing together 28 T1 signals in a two-step process. In the first stage of the two-step process, 4 T1 (DS1) signals are combined to form a T2 (DS2) signal. Overhead bits are interleaved with the user data to enable framing. Stuff bits are also added to each of the T1 signals to compensate for differences in frequency. Seven T2 signals are then combined to form a T3 signal. Overhead bits are interleaved with the T2 data for framing and error detection at the T3 level.

Two methods are used for combining the seven T2 signals. One method is called M13 framing, and the other method is called C-bit framing.

M13 Framing

M13 multiplexers perform bit stuffing when forming the DS2 signals from the DS1 signals. The DS2 signals that are formed in this manner are synchronous to each other, but the M13 framing assumes that the T2 signals are asynchronous and also uses all 21 DS3 C-bits for bit stuffing control. This second stage of bit stuffing is not strictly necessary.

C-bit Framing

The second method is called C-bit framing, and assumes that the T2 signals are synchronous. The C-bit parity format does not use the DS3-level C-bits for bit stuffing control. With C-bit framing, the bits that were used by M13 framing to control stuffing are instead used for other functions.

With M13 framing, two of the overhead bits (called P-bits) are used for a parity check. If the parity of the P-bits does not match the parity of the data, then a P-bit error is reported. The parity calculation is repeated on each section of the circuit, so P-bit errors cannot be used to assess the health of the circuit from end to end.

With C-bit framing, the DS3-level overhead bits (that were not used for bit stuffing) are used for other functions, including a C-bit parity check, a Far End Block Error (FEBE) report, and a Far End Alarm and Control (FEAC) channel. The C-bit parity bits are set at the originating equipment and are not modified by intervening equipment. They therefore provide an end-to-end parity check. When the receiving equipment detects a C-bit parity error, it sends an error report back to the originating equipment in the FEBE channel. The FEAC channel is used to report alarm and status information from the far-end terminal to the near-end terminal.

DS3 Path Parity Bits: The three C-bits in subframe 3 of the DS3 signal (which are designated CP-bits) are used to carry the DS3 path parity information. At the DS3 terminal equipment (TE) transmitter, the CP-bits are set to the same value as the two P-bits. Because the CP-bits will pass through the network unchanged (except in the case of errors), the DS3 TE receiver can determine if an error occurred in an M-frame by computing the parity based upon the contents of the given M-frame and then comparing this parity value with the parity received in the CP-bits in the following M-frame.

Far-End Block Error (FEBE) Function

The FEBE function uses the three C-bits in subframe 4 of the DS3 signal. This is illustrated in the following example (refer to Figure 6-2):

The near-end terminal equipment (TE) continuously monitors its incoming direction of transmission (west-bound in Figure 6-2) for the occurrence of a framing or parity error event. Upon detecting a framing or parity error event via the west-bound CP-bits, the near-end TE will count the event as a C-bit parity error, and indicate (via the east-bound FEBE bits) to the far-end TE that an error has occurred. The C-bit parity error is indicated via the east-bound FEBE bits by setting the three FEBE bits to “000” in order to indicate the error. The three FEBE bits are set to “111” if no parity error event has occurred. Because the DS3 terminal equipment (TE) monitors both the CP-bits and FEBE bits (as well as the FEAC channel), the overall performance of the DS3 path can be determined at either end of the path for both directions of transmission.

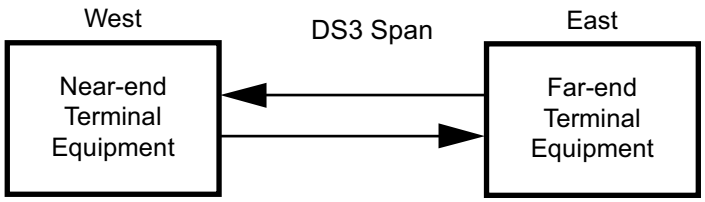


Figure 6-2. DS3 Far-End Block Error (FEBE)

6-6 T3 Display

The T3 data display area includes the real time clock and the GPS and battery indicators (at the top), the measurement data (in the middle), the instrument settings summary (at the left side), the submenu key labels (at the right side), and the main menu key labels (at the bottom). The submenu key labels vary in relation to the main menu key selection.

The instrument settings summary shows the status of the T3 configuration, including: Test Mode, Line Coding, Clock Source, Receive Input, Framing Mode, Error Insert, Pattern, Payload Type, Loopback Type, LBO Select, and Measure.

The upper part of the measurement data display has an area that is highlighted in yellow, which reports historical and current pass/fail conditions for parameters relating to Rx (Receive), DS3, DS1, and Insert testing. See Figure 6-3 for an example of this display when testing DS1 from DS3. For Rx, the parameters are Signal, Frame Sync, and Pattern Sync. For DS3, the parameters are Alarms, Errors, and B3ZS. For DS1, the parameters are Alarms, Errors, and B8ZS. For Insert, the parameters are Alarm ON, Error ON, and Loop ON.

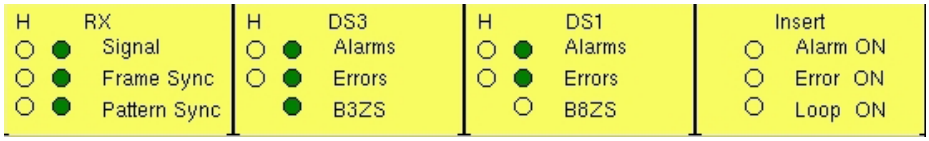


Figure 6-3. T3 Parameters for Historical and Pass/Fail Conditions

The columns of historical data (for Rx, DS3, and DS1) are labeled with an H. The adjacent columns display current (present time) conditions. The B3ZS indicator for DS3 displays only the current condition (no historical data). The H indicators turn red when an error has occurred previous to the current pass/fail condition. These history error indications are cleared by pressing the Clear History submenu key in the Measurements menu. The Insert column indicators display ON/OFF status for Alarm, Error, and Loop testing. Two views are presented for this status window: DS3 with DS3 full payload, and DS3 with DS1 payload. The B8ZS light is OFF in this configuration (as shown in Figure 5-3) because the DS3 signal does not use B8ZS encoding. Compare this with Figure 5-4 on page 5-4, which is for DS1 only.

The remainder of the measurement display is used for set ups, configurations, and measurement display, which changes with the selected function.

The T3 main menu key labels are: **Configuration**, **Pattern/Loop**, **Error/Alarm**, **Measurements,** and **Start/Stop**.

6-7 T3 Configuration Screen

The configuration screen is accessed by pressing the Configuration main menu key. This menu is used to configure the Signal Setup and the Payload Setup. The Signal Setup allows the user to set up the Test Mode, Line Code, Tx Clock, Tx LBO, Rx Input, and Framing information. The Payload Setup allows the user to set up the Payload Type, Payload DS1 Channel, Payload DS0 Channel, Payload Frame, and Other Channels.

Submenu keys for the Configuration/Test Mode Menu are described in "T3 Configuration Menu" on page 6-15.

Test Mode: Auto, DS1, or DS3

For an explanation of the use of the AUTO submenu key, refer to section "AUTO Signal Setup Explanation" on page 6-36.

Pressing the DS3 submenu key sets the instrument in T3 testing mode. The DS1 submenu key is for T1/DS1 signals only and is not appropriate for testing DS3 signals.

Line Code: B3ZS and AMI

B3ZS and Alternate Mark Inversion (AMI) are two different line coding formats that are used in T3 networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the binary one pulses alternate in polarity. Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. These zeros can cause the receiving equipment to have timing errors. The method used in T3 systems to maintain the density of ones (as opposed to zeros) in the data stream is known as binary 3-zero substitution, or B3ZS.

B3ZS (Bipolar 3-Zero Substitution) is a line code in which bipolar violations (BPV) are deliberately inserted if the stream of user data contains strings of 3 or more consecutive zeros. It is used to ensure that the system has a sufficient number of bipolar transitions to maintain system synchronization when the user data stream contains an insufficient number of ones to do so. Compare this with B8ZS, "T1 Configuration Menu" on page 6-2.

Tx Clock: Internal or Recovered

The Internal clock uses an internal oscillator, 44.736 Mb/s ±5 ppm. With Recovered clock, the transmit clock uses the frequency that is recovered from the received signal.

Tx LBO: Low or DSX

Tx LBO sets the Tx signal level. Select Low when testing the signal near the receiving equipment (less than 225 feet), and select DSX when testing from more than 225 feet.

Rx Input: DSX3 or Monitor

Select DSX3 for testing at the cross-connect point of a T3 line. Select Monitor when the connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Framing: M13, C-Bit, or Unframed

Select M13, C-bit, or Unframed, as required.

Payload Type: 45Mb, 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb

The Payload Type identifies which portion of the T3 data stream is to be accessed for testing.

Payload Type 45Mb is selected for testing a full T3 data stream. 1.544Mb is selected for testing 1 channel of the 28 DS1 channels. Nx64kb is selected for testing combinations of 64 kb channels. 64kb is selected for testing a single 64 kb channel. 56kb is selected when the data stream is created as a result of bit robbing. 16kb is selected for testing 2 consecutive bits within a single 64 kb channel. 8kb is selected for testing a single bit within a selected 64 kb channel.

Payload DS1 Channel

Uses the Edit Channel submenu key to set up the necessary channels and sub-channels, selecting 1 of 28 DS1 channels.

Payload DS0 Channel

Uses the Edit Channel submenu key to set up the necessary channels and sub-channels when testing payloads Nx64kb to 8kb.

Payload Frame: ESF or SF-D4

Set the payload frame for either ESF or SF-D4.

Other Channels: All ones, Broadcast, or AIS

Set the other channels (that are not being tested) to All Ones, Broadcast, or AIS.

6-8 T3 Pattern/Loop Menu

The Pattern/Loop menu includes 12 defined patterns (refer to Table 6-1). Up to 6 user-defined patterns can be created by pressing the Set User Pattern submenu key.

Use this function to select a pattern, to set and select a user pattern, to use an inverse pattern, to select a loop code, or to loop up or loop down.

Submenu keys for the Pattern/Loop Menu are described in "T3 Pattern/Loop Menu" on page 6-19.

Table 6-1. Pattern Descriptions and Applications

Pattern	Description	Application
QRSS	1,048,575 bit pattern	Simulates live traffic including both high and low-density sequences
1 IN 8	Eight bit pattern of a 1 and 7 zeros	Checks clock recovery on circuits optioned for B3ZS
2 IN 8	Eight bit pattern of two ones and 6 zeros	Used to determine correct optioning of AMI or B3ZS line coding
3 IN 24	24 bit pattern with 3 ones and 15 consecutive zeros. 12.5% ones density	Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in B3ZS optioned circuits
ALL ONES	All ones sent as payload in a framed sequence	Stresses ability of circuit to operate under maximum power conditions
ALL ZEROS	All zeros sent as payload in a framed sequence	Checks for B3ZS optioning. Circuit will drop if optioned for AMI
1010	Alternating 1s and 0s	Stresses ability of circuit to operate under 50% power conditions
PRBS-9 (511)	511 bit pseudo-random pattern	Test sub-rate DDS circuits operating below 56 kb/s
PRBS-11 (2047)	2047 bit pseudo-random pattern	Test 56 kb/s DDS circuits
PRBS-15	32,767 bit pseudo-random pattern. Generates up to 14 consecutive zeros and 15 consecutive ones	Tests to CCITT Recommendations O.151 and G.703. Provides maximum number of zeros for testing non-B8ZS circuits
PRBS-20	1,048,575 bit pseudo-random pattern Generates up to 19 consecutive zeros and 20 consecutive ones	Used to test synchronous T1 circuits only
PRBS-23	8,388,607 bit pseudo-random pattern Generates up to 22 consecutive zeros and 23 consecutive ones	Used to test synchronous T1 and T3 circuits

6-9 T3 Error/Alarm Menu

The Error/Alarm menu includes all of the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** main menu to access the menu.

Submenu keys for the Error/Alarm Menu are described in section "T3 Error/Alarm Menu" on page 6-22.

To add an error to the transmission path, press Error Ins Setup to choose an error type. For example, press DS3 Frame Bit Error to insert errors into the framing bits. A burst between 1 and 1000 can be selected by pressing the DS3 Frame Bit Error submenu key again and then the Burst submenu key. After the burst size is set, the Error Insert On/Off submenu key is used to turn the burst on.

Valid BER (Bit Error Rate) can be quickly set by pressing a preset submenu key: 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. For preset BER rates, refer to Table 5-2 on page 5-10. Pressing Error Insert On keeps errors adding. Pressing Error Insert Off stops the errors.

To add an alarm to the transmission path, press Alarm Ins Setup to choose an alarm type. For example, press DS3 AIS Alarm and then press Alarm Insert Off/On until "On" is underlined. Data is replaced with the AIS alarm signal.

DS3 AIS (Alarm Indication Signal) Alarm: When the AIS is turned ON, the data is replaced with properly framed `1010...` pattern.

DS3 RAI (Remote Alarm Indication) Alarm: The remote alarm indication is a signal that is transmitted from the terminal equipment in the outgoing direction when it determines that it has lost the incoming signal, or when it receives an AIS signal in the incoming direction.

DS3 Idle Alarm: When Idle Alarm is pressed, the data is replaced with a properly framed `1100...` pattern.

6-10 T3 Measurement Screen

Submenu keys for the Measurement Menu are described in section "T3 Measurements Menu" on page 6-25.

BERT: Three different displays are available to view results: Table (DS1 or DS3), Histogram, and Event List:

Rx Signal: Displays Rx Signal measurements.

VF: Displays VF level measurements. Press the submenu key a second time to select Channel number, Tx Frequency, Tx Level, and Volume.

Measure Time: Set up the measurement time period from 1 minute minimum to 3 days maximum.

Clear History: Clears the Event List and any of the red History indicators in the yellow highlighted area of the upper measurement display. History is updated each second.

BERT Histogram Display

Histogram Settings, Zoom In and Zoom Out

The zoom in and zoom out features can be used to change the resolution of the data in the histogram display at the cursor location. When the cursor passes the 10% and 90% time points of the histogram display, the time window starts scrolling back in time or ahead in time. If you need to see a detailed view of a fault occurrence, then you can use the Zoom In function to change the resolution to as small as 5 seconds per division. Maximum window size is 72 hours (6 hours/div). When more than 72 hours of data are collected, the last 72 hours are shown.

Window Size

The window size adjusts the length of time that is shown on the histogram screen. More data may be stored than is shown. This parameter allows you to zoom in or zoom out to see either more time on the screen or more resolution. The minimum (1 minute) window size value and maximum (3 days) window size value are based upon the data resolution that is selected with the zoom in and zoom out features.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Units

If Relative is selected (underlined on the submenu key label), then the histogram axis is labeled with time since the start of the measurement record. If Absolute is selected, then the histogram axis is labeled with absolute times based upon the system clock.

6-11 Start/Stop Key

Press this function key to start or stop the measurement that is currently set up on the instrument.

6-12 T3 Menus

Figure 6-4 to Figure 6-7 show the map of the T3 menus. The following sections describe main menus and associated submenus. The submenus are listed in the order they appear on the display from top to bottom under each main menu.

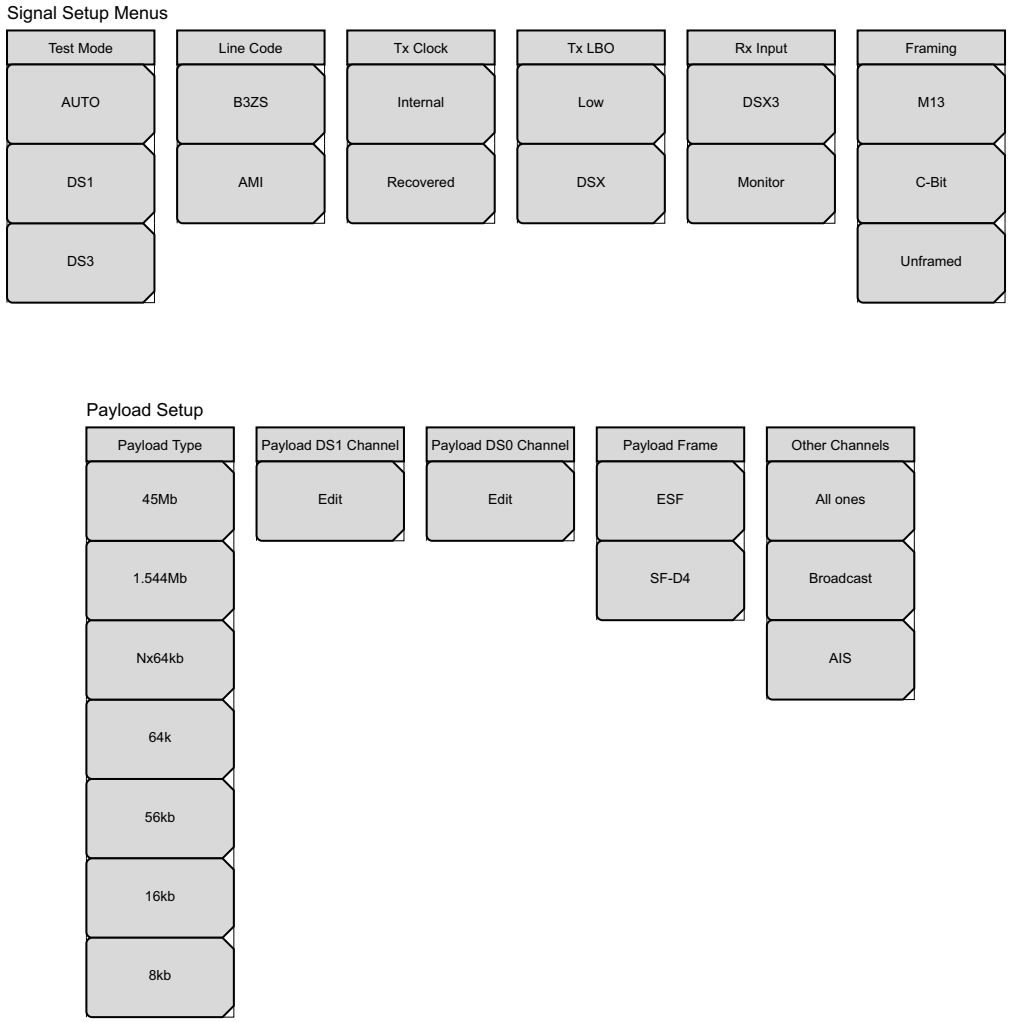


Figure 6-4. T3 Configuration Submenu Keys

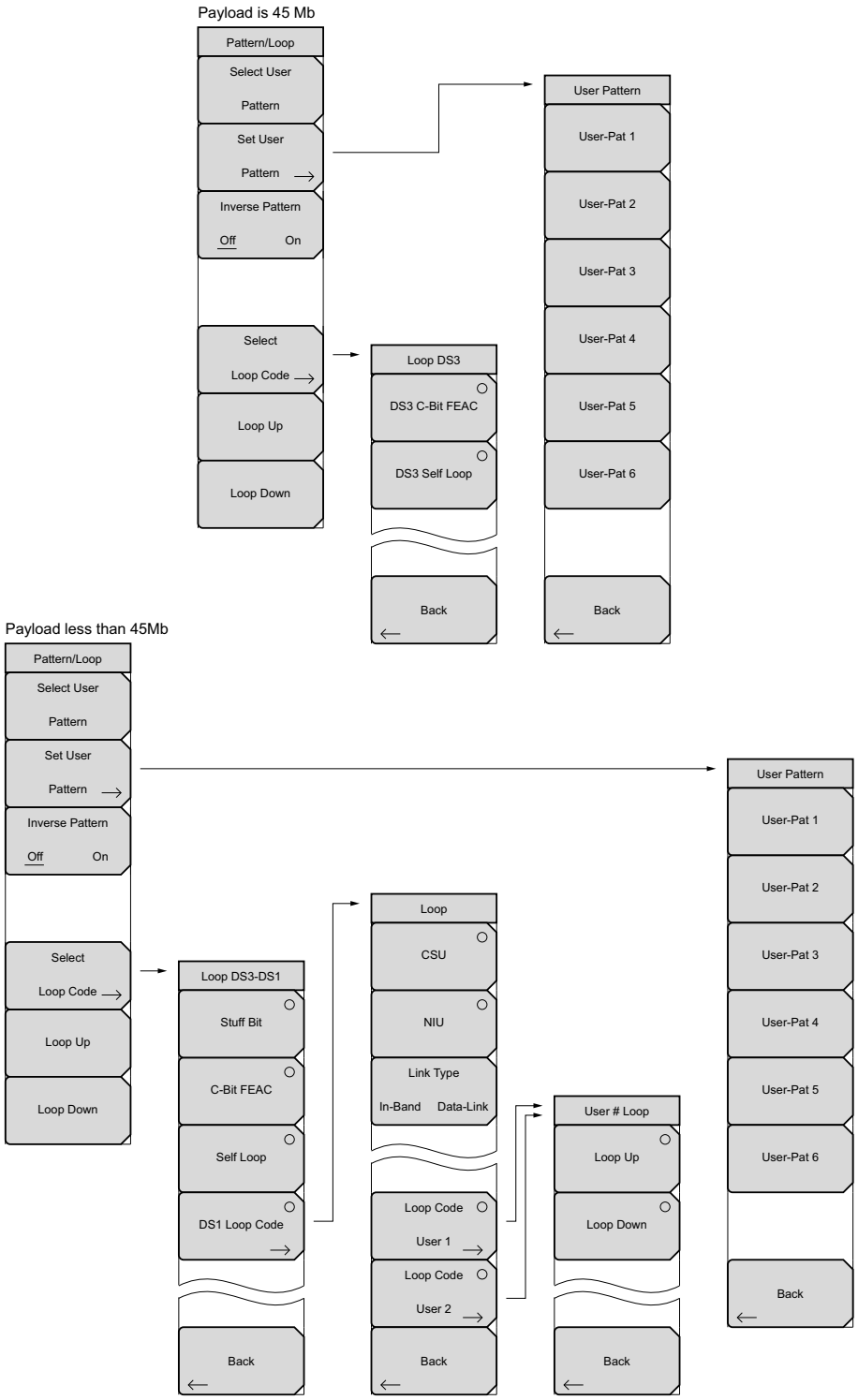


Figure 6-5. T3 Pattern/Loop Menu

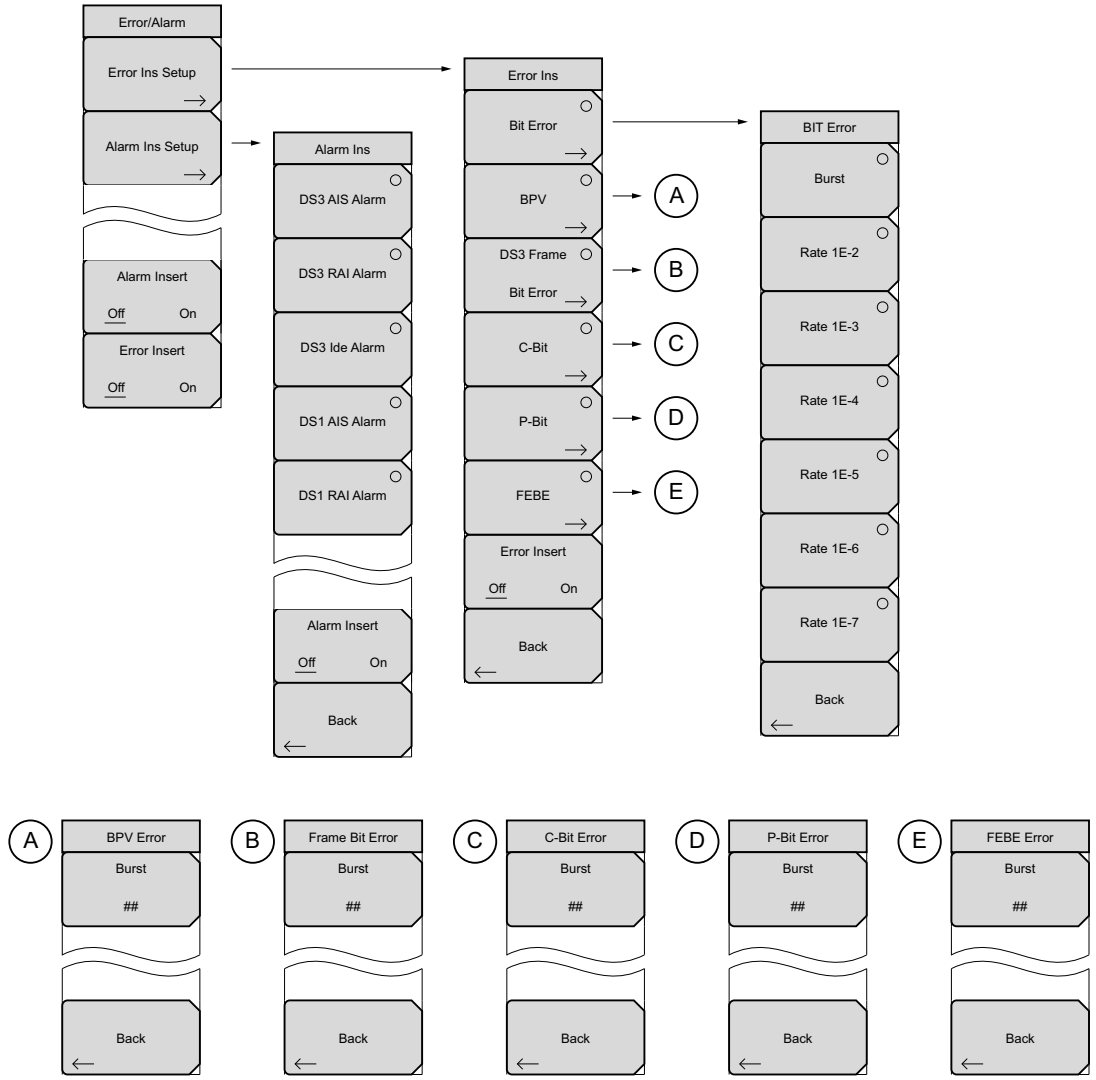


Figure 6-6. T3 Error/Alarm Menu

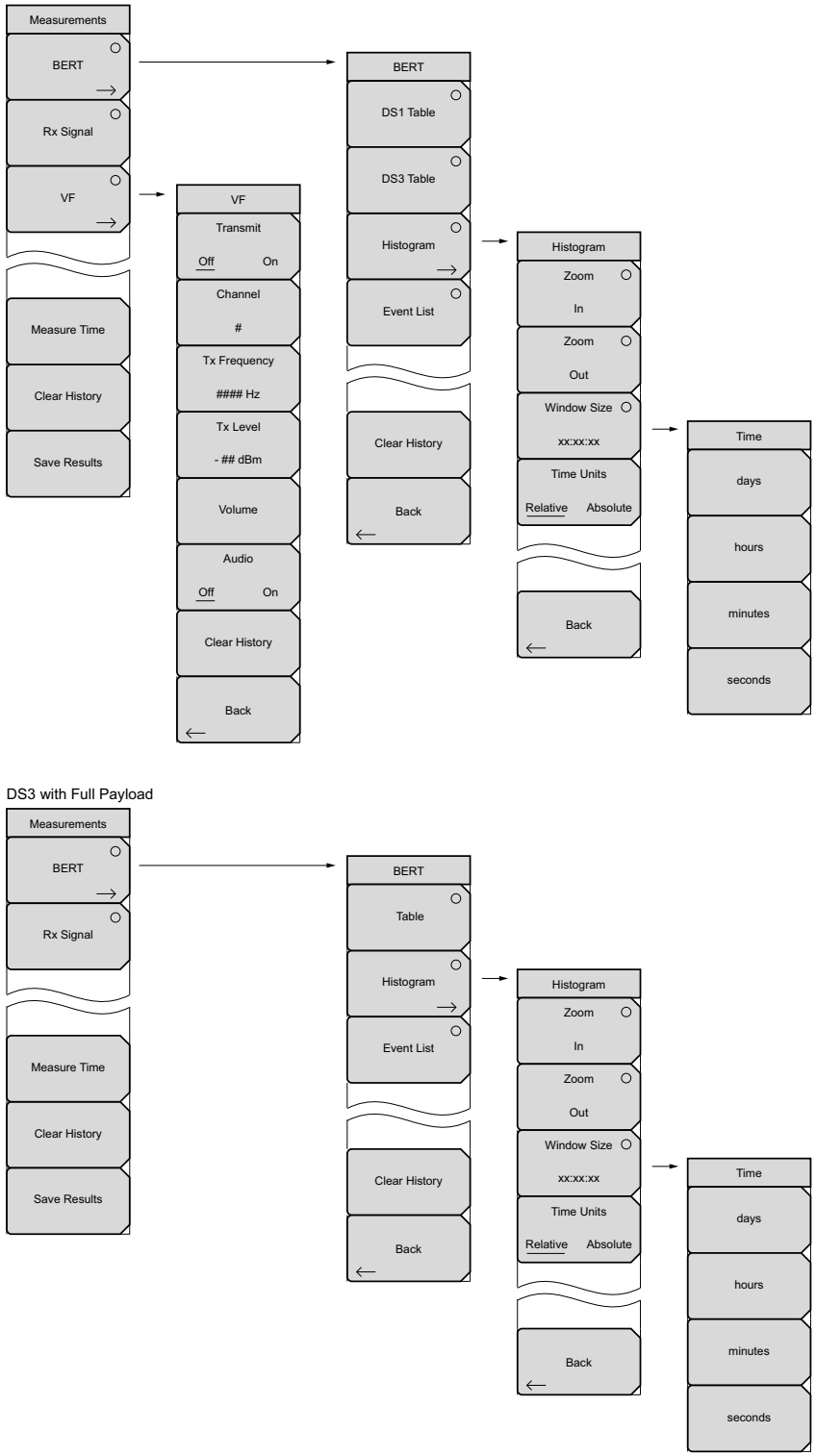
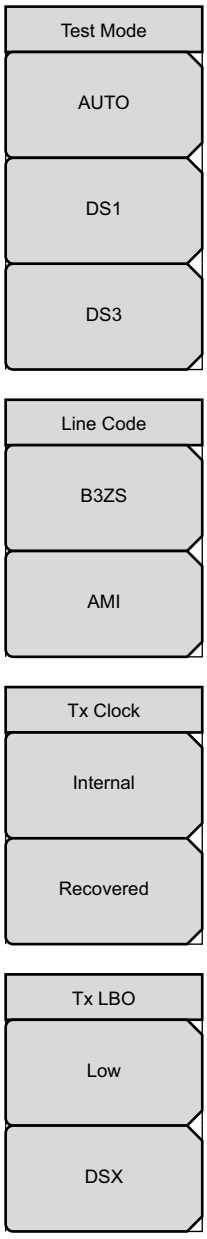


Figure 6-7. T3 Measurements Submenu Keys

6-13 T3 Configuration Menu

Key Sequence: **Configuration**

Signal Setup



Test Mode: While in DS3 test mode, select DS1 to change modes.

AUTO: Refer to section *AUTO Signal Setup Explanation* on page 6-36.

DS1: Press this submenu key when connected to a 1.5 MHz T1 circuit.

DS3: Press this submenu key when connected to a 45 MHz T3 circuit.

Line Code:

B3ZS: Press this submenu key to select B3ZS line coding.

AMI : Press this submenu key to select Alternate Mark Inversion (AMI) line coding.

Tx Clock:

Internal: Press this submenu key to select the internally generated Tx Clock.

Recovered: Press this submenu key to select a clock signal that is recovered from the receive path.

Tx LBO:

Low: Press this submenu key to test the signal near the Base Transceiver Station (within 225 feet).

DSX: Press this submenu key to select a signal configuration in order to test at the cross-connect point (more than 225 feet).

Figure 6-8. T3 Signal Setup (1 of 2)

Rx Input:

Terminate: Press this submenu key to select terminate mode. This terminates the circuit in 75 ohms.

Monitor : Press this submenu key to add +20 dB gain to the receive path.

Framing:

M13: Press this submenu key to test the M13 framing format.

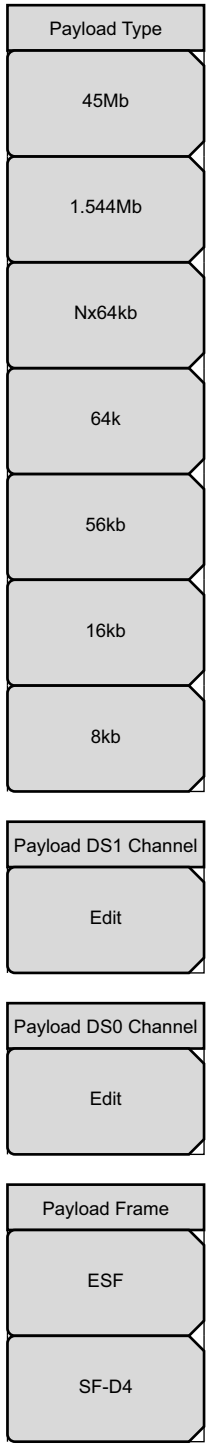
C-Bit: Press this submenu key to select the C-bit parity format, which redefines the use of the C-bits in the M13 frame, thereby making it possible to provide in-service, end-to-end path performance monitoring of the DS3 signal and in-band data links.

Unframed: Press this submenu key to select testing without any framing format. The full pattern is transmitted without any formatting. No fractional T1 or subrate testing can be performed when unframed is selected.

Figure 6-9. T3 Signal Setup (2 of 2)

Payload Setup

The Payload Setup identifies which portion of the T3 data stream is to be accessed for testing.



Payload Type:

45Mb: Press this submenu key to select full T3 data stream testing.

1.544Mb: Press this submenu key to select 1 of the 28 T1 channels.

Nx64kb: Press this submenu key to select combinations of 64 kb channels for testing. This mode is referred to as fractional T1.

64kb: Press this submenu key to select a single 64 kb channel for testing.

56kb: Press this submenu key to select and test a data stream that has been reduced in size as a result of bit robbing.

16kb: Press this submenu key to select 2 consecutive bits for testing within a single 64 kb channel.

8kb: Press this submenu key to select a single bit for testing within a selected 64 kb channel.

Payload DS1 Channel:

1.544Mb: Press this submenu key to select 1 of the 28 DS1 channels.

Nx64kb: Press this submenu key to select combinations of 64 kb channels to be tested.

64kb: Press this submenu key to select a single 64 kb channel for testing.

56kb: Press this submenu key to select and test a data stream that has been reduced in size as a result of bit robbing.

16kb: Press this submenu key to select 2 consecutive bits for testing within a single 64 kb channel.

8kb: Press this submenu key to select a single bit for testing within a selected 64 kb channel.

Payload DS0 Channel:

Edit Channel

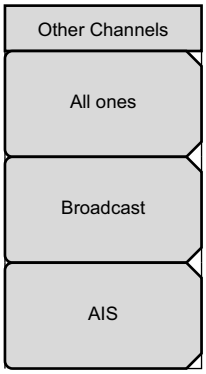
Edit channel and sub-channels when testing payloads from Nx64kb to 8kb.

Payload Frame:

ESF: Press this submenu key to set the payload frame for ESF.

SF–D4: Press this submenu key to set the payload frame for SF-D4.

Figure 6-10. T3 Payload Setup (1 of 2)



Other Channels:

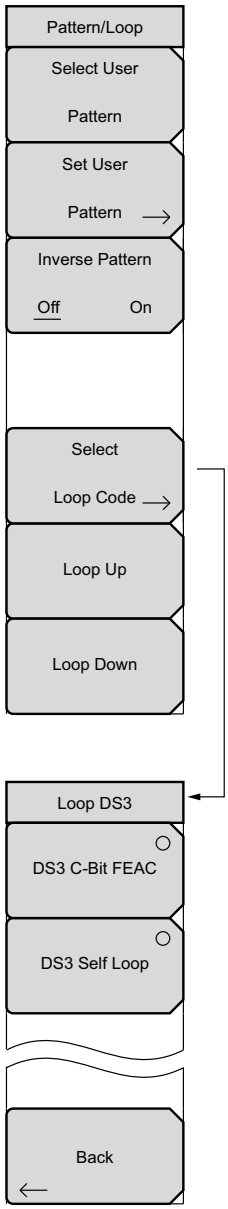
All ones, Broadcast, AIS: Press these submenu keys to set the other channels (those channels that are not being tested) to All ones, to Broadcast, or to AIS.

Figure 6-11. T3 Payload Setup (2 of 2)

6-14 T3 Pattern/Loop Menu

Key Sequence: **Pattern Loop**

Payload is 45MB



Select Pattern: After highlighting a pattern, use this submenu key to select the pattern.

Set User Pattern: Use this submenu key to select a specific user pattern from a list of six patterns, which can be configured separately.

> **User-Pat #:** These six submenu keys each select a different pattern. Enter zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue, or press **Esc** to abort.
>
> **Back:** Returns to the Pattern menu.

Inverse Pattern, Off/On: Press this submenu key to toggle the Inverse Pattern function OFF and ON. When on, the selected PRBS pattern is inverted.

Select Loop Code: Press this submenu key to display the Loop DS3-DS1 menu. With a payload of 45 Mb, only a DS3 signal can be tested, and the submenu offers a reduced set of functions.

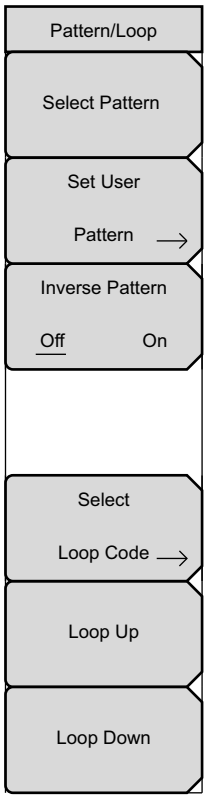
> **DS3 C-Bit FEAC:** Press this submenu key to set the DS3 loop code to C-Bit FEAC.
>
> **DS3 Self Loop:** Press this submenu key to activate a Self Loop test.
>
> **Back:** Press this submenu key to return to the Pattern/Loop menu.

Loop Up: Press this submenu key to initiate a loopback.

Loop Down: Press this submenu key to remove a loopback.

Figure 6-12. T3 Pattern Loop, Payload is 45MB

Payload is less than 45MB



Select Pattern: After highlighting a pattern, use this submenu key to select the pattern.

Set User Pattern: Use this submenu key to select a specific user pattern from a list of six patterns, which can be configured separately.

> **User-Pat #:** These six submenu keys each select a different pattern. Enter zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue, or press **Esc** to abort.
>
> **Back:** Returns to the Pattern menu.

Inverse Pattern, Off/On: Press this submenu key to toggle the Inverse Pattern function OFF and ON. When on, the selected PRBS pattern is inverted.

Select Loop Code: Press this submenu key to display the Loop DS3-DS1 menu. See "Select Loop Codes Menu" on page 6-21.

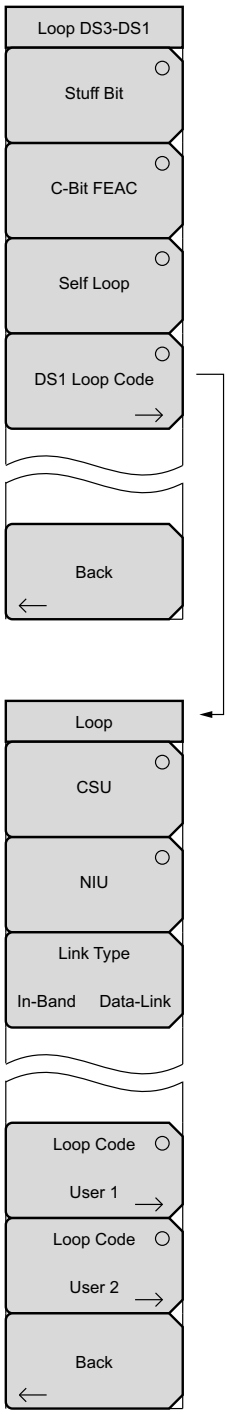
Loop Up: Press this submenu key to initiate a loopback.

Loop Down: Press this submenu key to remove a loopback.

Figure 6-13. T3 Pattern Loop, Payload is less than 45 Mb

Select Loop Codes Menu

Key Sequence: **Pattern/Loop >** Select Loop Codes



Stuff Bit: Press this submenu key once to select the Stuff Bit loop code. Press this submenu key again to select one or more channels for testing.

DS1, #: Press this submenu key to insert DS1 loopback channels (minimum 1 through maximum 28).

Select All: Press this submenu key to select all 28 DS1 channels.

Back: Press this submenu key to return to the Loop DS3-DS1 menu.

C-Bit FEAC: Press this submenu key to set the loop code to C-Bit FEAC. Press the submenu key again to select channels for testing.

DS1, #: Press this submenu key to insert DS1 loopback channels (minimum 1 through maximum 28).

Select All: Press this submenu key to select all 28 DS1 channels.

Back: Press this submenu key to return to the Loop DS3-DS1 menu.

Self Loop: Press this submenu key to loop back the circuit Rx to the circuit under test Tx.

DS1 Loop Codes: Press this submenu key to display the Loop menu.

CSU: Press this submenu key to select Channel Service Unit (CSU) for the loop code.

NIU: Press this submenu key to select Network Interface Unit (NIU) for the loop code.

Link Type: Press this submenu key to toggle between In-Band and Data-Link types of link.

Loop Code User1: Press this submenu key once to select Loop Code User1, and press it again to configure the loopback loop code for User1.

Loop Code User2: Press this submenu key once to select Loop Code User2, and press it again to configure the loopback loop code for User2.

Loop Up: Press this submenu key for loop up.

Loop Down: Press this submenu key for loop down.

Back: Press this submenu key to return to the Loop menu.

Back: Press this submenu key to return to the Loop DS3–DS1 menu.

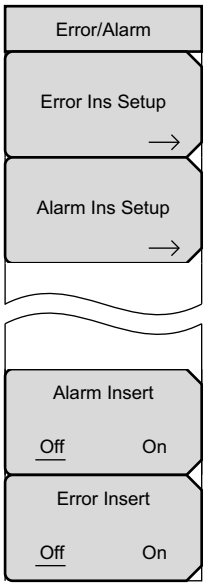
Back: Press this submenu key to return to the “T3 Pattern/Loop Menu” on page 6-19.

Figure 6-14. Loop D3S-DS1, Payload is less than 45 Mb

6-15 T3 Error/Alarm Menu

When not active, some submenu keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these submenu keys are active.

Key Sequence: **Error/Alarm**



Error Ins Setup: Press this submenu key to display the "Error Ins Menu" on page 6-23.

Alarm Ins Setup: Press this submenu key to display the Alarm Ins submenu. Select one of the five alarms for testing – DS3 AIS Alarm, DS3 RAI Alarm, DS3 Idle Alarm, DS1 AIS Alarm, and DS1 RAI Alarm. The submenu key label for the selected alarm displays the circle indicator in red to show that the key function is active.

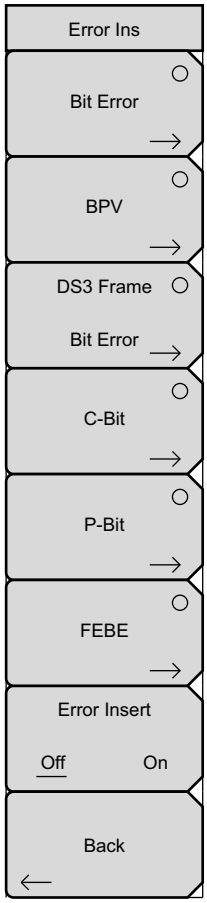
Alarm Insert Off/On: Press this submenu key to toggle the selected alarm signal OFF and ON.

Error Insert Off/On: Press this submenu key to toggle the selected error insert OFF and ON.

Figure 6-15. T3 Error/Alarm Menu

Error Ins Menu

Key Sequence: **Error/Alarm** > Error Ins Setup



Bit Error: Press this submenu key once to activate the BIT Error function. Press this submenu key again to display the Bit Error submenu in order to select Burst or any one of the Rate 1E-# submenu keys. Bit errors are inserted into the payload vehicle, whichever that is (full DS3, T1, FT1, and so forth.)

Burst: Press this submenu key to configure the Burst count.

Rate 1E–# (2 through 7): Press this submenu key to set the BIT Error rate to one of the six preset values.

BPV: Press this submenu key once to activate the BPV error function. Press this submenu key again to configure the Burst count.

DS3 Frame Bit Error: Press this submenu key once to activate DS3 frame bit errors. Press this submenu key again to configure the Burst count.

C-Bit: Press this submenu key once to activate the C-Bit error function. Press this submenu key again to configure the Burst count.

P-Bit: Press this submenu key once to activate the P-Bit error function. Press this submenu key again to configure the Burst count.

FEBE: Press this submenu key once to activate the FEBE error function. Press this submenu key again to configure the Burst count.

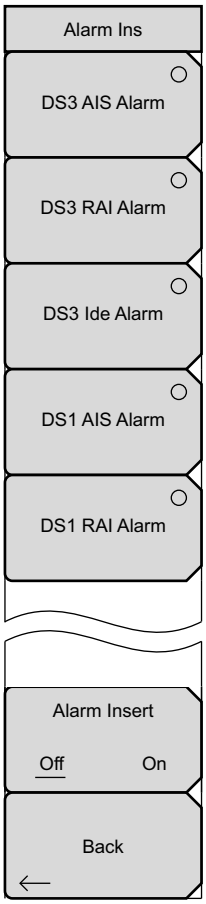
Error Insert Off/On: Press this submenu key to toggle error inserts ON and OFF during tests. This submenu key toggles error inserts ON until turned OFF only for BER options. For any other error type, error insertion is toggled ON and then immediately OFF.

Back : Press this submenu key to return to the “T3 Error/Alarm Menu” on page 6-22.

Figure 6-16. T3 Error Ins Menu

Alarm Ins Menu

Key Sequence: **Error/Alarm** > Alarm Ins Setup



DS3 AIS Alarm: Press this submenu key to insert AIS alarm signaling.

DS3 RAI Alarm: Press this submenu key to insert RAI alarm signaling.

DS3 Idle Alarm: Press this submenu key to insert an Idle Alarm pattern.

DS1 AIS Alarm: Press this submenu key to insert AIS alarm signaling. Data is replaced with an unframed signal of all ones.

DS1 RAI Alarm: Press this submenu key to insert RAI alarm signaling. RAI alarms send a signal from terminal equipment in the outgoing direction. this is useful when the incoming signal is lost or when an AIS signal is received (incoming direction).

Alarm Insert Off/On: Press this submenu key to toggle the selected alarm signal OFF and ON.

Back : Press this submenu key to return to the “T3 Error/Alarm Menu” on page 6-22.

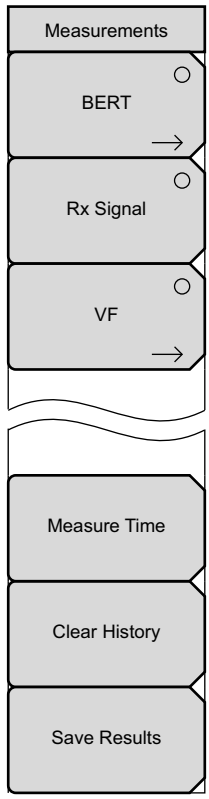
Figure 6-17. T3 Alarm Ins Menu

6-16 T3 Measurements Menu

When not active, some submenu keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these submenu keys are active.

When the configuration is for the DS3 Test Mode with a DS1 Payload Type, the Measurement menu offers a VF submenu key. When the configuration is for a DS3 Test Mode with a Payload Type of 45 Mb, the Measurement menus does not have a VF submenu key.

Key Sequence: **Measurements**



BERT: This submenu key displays the "BERT Menu" on page 6-26. Press this submenu key once to select the desired test results view.

Rx Signal: Press this submenu key to display the Rx Signal measurements.

VF: Press this submenu key to display VF level measurements. Press the submenu key again to open the "VF Menu" on page 6-28 for configuration.

Measure Time: This submenu key opens a dialog box to set the measurement time. Choose from 12 settings, which range from 1 minute (minimum) to 3 days (maximum). You can also choose Manual, which runs any length of time, indefinitely, until the **Stop/Start** main menu key is pressed. Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the Rotary Knob to continue, or press **Esc** to abort.

Clear History: Press this submenu key to erase the history of displayed events and measurements. Also, clears any red History indicators in the Upper Status Window.

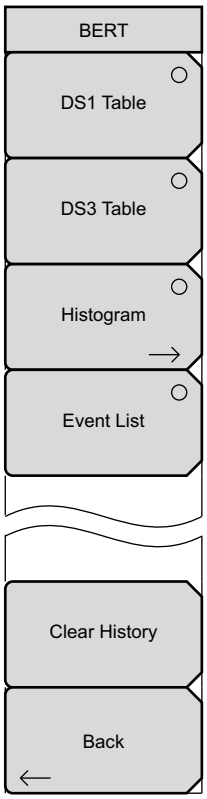
Save Results: Press this submenu key to save the results of a measurement.

Figure 6-18. DS3 Measurements Menu with DS1 Payload

BERT Menu

When the configuration is for a DS3 Test Mode with a DS1 Payload Type, the BERT measurement menu offers both DS1 and DS3 Table submenu keys. When the configuration is for a DS3 Test Mode with a Payload Type of 45 Mb, the BERT menus has one Table key.

Key Sequence: **Measurements** > BERT



DS1 Table: Press this submenu key to display the 10 BERT parameters and their settings in a table format.

DS3 Table: Press this submenu key to display the DS3 Results table that consists of BPV, Frame Bits, P-bit Errors, C-bit Errors, and FEBE Errors.

Histogram: Press this submenu key once to make it active and to display a histogram of parameters. Press the submenu key again to display the "Histogram Menu" on page 6-27.

Event List : Press this submenu key to display a chronological event list with 4 columns. The column labels are "Date", "Time", "Event Type", and "Events."

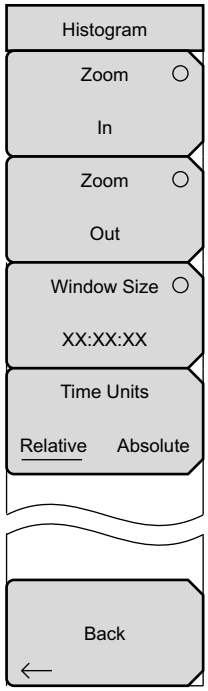
Clear History: Press this submenu key to erase the history of displayed events and measurements. Pressing this submenu key also clears any red History indicators in the yellow-highlighted upper measurement display.

Back: Press this submenu key to return to the "T3 Measurements Menu" on page 6-25.

Figure 6-19. DS3 BERT Menu with DS1 Payload

Histogram Menu

Key Sequence: **Measurements** > BERT > Histogram



Zoom In : Use this submenu key to change the graph display width to a smaller value. The graphical display units are described in the Window Size submenu key description.

Zoom Out : Use this submenu key to change the graph display width to a larger value. The graphical display units are described in the Window Size submenu key description.

Window Size, ##:##:## : This submenu key displays the time units in the format 0d:00:00:00, in days, hours, minutes, or seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; 1, 2, or 3 days. When pressed, the submenu key color changes to a darker background, and the numeric value is displayed in red. The labels (Display Window ##:##:00) in the graph area of the display are also in red. The red color indicates that the time is being changed. The red label at the top line of the histogram and the one below the histogram remain red while the value is open to change. When the numeric value has been set, the upper label is removed, and the lower label changes to plain text, showing the setting.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys. Press an appropriate number or numbers, and the submenu changes to Time increments, as shown in “T3 Measurements Submenu Keys” on page 6-14.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

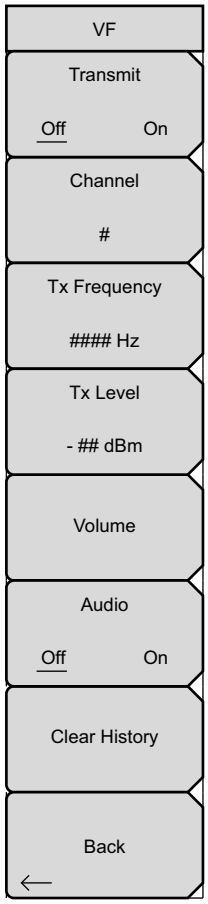
Time Units, Relative or Absolute : This submenu keys toggles between relative and absolute time. The units are displayed at the bottom edge of the histogram.

Back : Press this submenu key to return to the “BERT Menu” on page 6-26.

Figure 6-20. DS3 Histogram Menu with DS1 Payload

VF Menu

Key Sequence: **Measurements** > VF



Transmit: This submenu key toggles VF transmission OFF and ON.

Channel #: This submenu key opens a dialog box to select a channel value from 1 (minimum) to 24 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency: This submenu key opens a dialog box to select a frequency in Hz from 100 (minimum) to 3000 (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a default value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level: This submenu key opens a dialog box to select a Tx level in dBm from –30 (minimum) to 0 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume: This submenu key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio: This submenu key toggles Audio Off and On.

Clear History : Press this submenu key to erase the history of displayed events and measurements. Also, clears any red History indicators in the Upper Status Window.

Back: Press this submenu key to return to the “T3 Measurements Menu” on page 6-25.

Figure 6-21. VF Menu

6-17 Calibrate Menu

This menu is not available in T1/T3 measurement mode.

6-18 Sweep Menu

This menu is not available in T1/T3 measurement mode.

6-19 Measure Menu

This menu is not available in T1/T3 measurement mode.

6-20 Trace Menu

This menu is not available in T1/T3 measurement mode.

6-21 Limit Menu

This menu is not available in T1/T3 measurement mode.

6-22 Other Menus

Preset, **File**, **Mode** and **System** are described in the User Guide.

6-23 T3 In-service Testing

In order to avoid disrupting service, Monitor receiver settings must be used when testing a T3 circuit that is in-service. The following measurements are used to check T3 performance during regular maintenance:

- Vpp measurement
- Carrier Frequency
- Frame Bit Errors
- C-bit Errors
- FEBE Errors
- P-bit Errors
- Bipolar Violations

Required Equipment

- BNC Cables, Anritsu Part Number 3-806-169

Measurement Setup Procedure

1. Confirm that the instrument is in T1/T3 Analyzer Mode, see "Selecting the T1/T3 Analyzer Mode" on page 6-1.
2. Press the **Configuration** main menu key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the B3ZS or the AMI coding submenu key.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Recovered.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input and select Monitor.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing and select M13, C-Bit, or Unframed.

Note	The setup parameters are displayed in the instrument settings summary table on the left side of the measurement display.

7. Connect to the Monitor jack on one direction of the circuit under test.

Submenu keys for the Configuration Test Mode Menu are described in the "T3 Configuration Menu" on page 6-15.

Rx Signal Measurement Procedure

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key and check P-bit errors, C-bit errors, and FEBE errors. Press the Back key to return to the Measurements menu.
3. Press the Rx Signal submenu key and verify Frequency and Vpp. When close to the transmitter, the Vpp result should be between 0.72 Vpp and 1.7 Vpp. The Frequency should be 44.736 MHz ±895 Hz (±20 ppm).

4. Move the connection to the other circuit pair and repeat these measurements.

6-24 T3 Out-of-service Measurements

Out-of-service measurements are performed when the T3 circuit is not in-service or is inactive. Typically, these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the results of the in-service measurements indicate significant errors. These measurements provide detailed information about the T3 circuit.

Out-of-service testing is performed using end-to-end testing, which requires a technician and a T3 tester at each end of the circuit, or it is performed by establishing a loopback at the remote end of the circuit.

The following measurements check the T3 performance during out-of-service testing:

- Vpp
- Carrier Frequency
- Frame Sync
- Pattern Sync
- P-bits
- C-bits
- FEBE
- Insert Errors/Alarms
- BER

Required Equipment

- BNC Cables, Anritsu Part Number 3-806-169

BERT Measurement Setup Procedure

1. In the T1/T3 Analyzer mode, press the **Configuration** main menu key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the B3ZS or the AMI coding submenu key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Internal or Recovered.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx LBO and select either Low or DSX.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input and select DSX3.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing and select M13, C-Bit, or Unframed.

The remaining steps of this procedure (7. through 15.) apply only when using M13 or C-bit framing and testing at T3 subrates.

7. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload Type and select from 45Mb, 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb (framed modes only).
8. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload DS1 Channel. Selections depend upon the payload type and are available only with Nx64kb, 64kb,

56kb, 16kb, or 8kb. Select one of the 28 DS1 channels. Press the Edit Channel submenu key and select the channel from the list by using the **Up/Down** arrow keys or the rotary knob. Press Select Channel and press **Enter** to select the channel number in the edit box.

9. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload DS0 Channel. Selections depend upon the payload type and are available only with Nx64kb, 64kb, 56kb, 16kb, or 8kb. Press the Edit Channel submenu key and select the channel from the list using the **Up/Down** channel or the rotary knob. Press **Enter** to select the channel number in the edit box.
10. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload Frame and select either ESF or SF–D4.
11. Use the **Up/Down** arrow keys or the rotary knob to highlight Other Channels and select All Ones, Broadcast, or AIS.
12. Press the **Pattern/Loop** main menu key to activate the Pattern/Loop menu.
13. Use the **Up/Down** arrow keys or the rotary knob to highlight the appropriate pattern, and then press the Select Pattern submenu key or the **Enter** key.
14. Connect the instrument Rx BNC jack to the circuit Tx jack, and the instrument Tx BNC jack to the circuit Rx jack.
15. If a test set is not connected to the far end, then set up a loopback.

Basic BERT Measurement Procedure

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press either the DS1 Table or the DS3 Table submenu key to display the measurements in the table format, or press Histogram or Event List.
4. From the BERT menu, press the Back submenu key. Then from the Measurements menu, press the Measure Time submenu key and use the **Up/Down** arrow keys, rotary knob, or key pad to enter the duration of the measurement. Then press **Enter**.
5. Press the **Start/Stop** main menu key to start and stop the measurement.

Note	The measurement time is set in the Measure Time menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, 3 days, or Manual). Manual runs indefinitely and allows the user to terminate the measurement at any time.

Submenu keys for the BERT menu are described in section "T3 Measurements Menu" on page 6-25.

Quick Check

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the DS1 Table or the DS3 Table submenu key to display the measurements in the table format.
4. Press the **Start/Stop** main menu key to activate the measurements. To stop the measurements, press the **Start/Stop** key again. If the results are acceptable, then RESULTS OK is displayed in a green box at the center of the screen. If any errors are detected, then the errors or the measurement results are displayed in the table.

Note	RESULTS OK can be cleared by pressing **Esc**.

Histogram Display

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the BERT submenu key to activate the BERT menu.
3. Press the Histogram submenu key to display the data in Histogram format.
4. Press the Histogram submenu key again to open the Histogram submenu. Then press the Zoom In submenu key to zoom in by adjusting the horizontal (minutes/div) scale.
5. Press the Zoom Out submenu key to zoom out by adjusting the horizontal (minutes/div) scale.
6. Press the Time Units submenu key to toggle between Relative and Absolute time units.
7. Press the Window Size submenu key to set the time units of the histogram display.

Submenu keys for the Histogram menu are described in section "T3 Measurements Menu" on page 6-25.

To Insert Errors/Alarms

1. Press the **Error/Alarm** main menu key to activate the Error/Alarm menu.
2. Press the Error Ins Setup submenu key to open the Error Ins (Error Insert) submenu.
3. Select an error type from the submenu, as applicable to the measurement.
   - Bit Error
   - BPV
   - DS3 Frame Bit Error
   - C-Bit
   - P-Bit
   - FEBE

   If Bit Error is selected, then press the Bit Error key again to select a burst number between 1 and 1000 or a bit error rate of 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, or 1E–7. Refer to Figure 5-2 on page 5-2. If another type of error is selected (BPV, DS3 Frame Bit, and so forth), then press that submenu key again to select a burst number between 1 and 1000.

4. Press the Alarm Ins Setup submenu key to insert an alarm. The 5 alarm types that are available are:
   - DS3 AIS Alarm
   - DS3 RAI Alarm
   - DS3 Idle alarm
   - DS1 AIS Alarm
   - DS1 RAI Alarm
5. Press the Alarm Insert Off/On submenu key to toggle the selected alarm between ON and OFF. The alarm status is displayed in the yellow Insert section of the upper measurement display.
6. After you have selected an error type and an alarm type, you can press the Alarm Insert and Error Insert submenu keys from the main Error/Alarm submenu in order to turn these functions ON and OFF.

Event List

The BERT measurement Event List updates errors, signal loss, frame loss, and alarms every second. Alarms are: AIS ON, AIS OFF, RAI ON, and RAI OFF. The data is displayed as a log list. The display will list up to 1000 errored seconds.

Rx Signal Measurement Procedure

1. Press the **Measurements** main menu key to activate the Measurements menu.
2. Press the Rx Signal submenu key to activate the Rx Signal menu.
3. Verify frequency and voltage.

For frequency and voltage specifications, refer to "Rx Signal Measurement Procedure" on page 6-30.

VF Channel Access Testing

The VF Channel Access test feature enables testing on each of the 1 to 24 DS1 64kb DS0 channels from one of the 28 T1 sub-channels on the T3 signal. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling you to make an audible assessment of the signal quality of the circuit. If the circuit is out-of-service, then you can insert a test tone on the transmit channel for measurement at a remote location with another test set, or locally with a loopback.

Configuration

Before conducting channel tests, the T3 interface must be properly configured. Press the **Configuration** main menu key to display the Signal Setup and Payload Setup windows. Select the correct Framing Mode, Line Coding, and Clock Source. Set the cursor on Payload Type and press the 1.544Mb submenu key.

Note	The receive mode must be set up before connecting to the circuit in order to avoid creating a "hit" on the customer data.

Channel Tests

After the unit is correctly configured, select the VF Channel Access menu to perform tests at the DS0 channel level. Press the Channel submenu key to select specific channels. Either enter a specific channel number from the keypad or scroll through the channels with the **Up/Down** arrow keys. The received VF level and frequency on the selected channel are displayed, and the decoded signal is connected to a speaker for audio monitoring. When a test tone is present on the channel, the level and frequency report indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality. An overview of channel utilization can be obtained by quickly scrolling through the channels.

If the circuit is out-of-service, then you can connect to the transmit pair and insert a test tone on the selected channel (note that transmit and receive must be on the same channel). Two menus enable selection of transmit level and frequency. The frequency can be entered from the keypad, or scrolled to common test frequencies (404 Hz, 1004 Hz, 1804 Hz, and 2713 Hz) with the **Up/Down** arrow keys. To check the performance of channel level equipment, the test tone can be measured at a remote location with another VF channel test set.

Submenu keys for the VF menu are described in section "T3 Measurements Menu" on page 6-25.

6-25 AUTO Signal Setup Explanation

When AUTO is selected, the instrument first compares the connected signal with the current status of frame sync and pattern sync. If both are matched with the connected signal, then no further action is taken.

The instrument will also hunt for signal. If the instrument is configured for DS1, and if no DS1 signal is present, then it will change mode to DS3 and test for a signal at the DS3 rate. If the instrument is configured for DS3, and if no DS3 signal is detected, then it will change mode to DS1 and test for a signal at the DS1 rate. The AUTO algorithm does not hunt for subrate payloads.

If the current mode is DS1, then when AUTO is pressed, the instrument first seeks the frame sync (ESF or SF-D4). If frame sync is found, then the Framing Mode is displayed in the instrument settings summary (at the left side of the data display area). Then the instrument seeks the pattern sync, stepping through all possible patterns. If pattern sync is found, then the Pattern is displayed in the instrument settings summary. The framing mode and pattern are thereby set, and the instrument is ready for use on the connected circuit.

If the current mode is DS3, then the current DS3 Framing Mode and Line Code configuration are used when testing for Pattern. The default Framing Mode is C-Bit, and the default Line Code is B3ZS. The instrument does not search for Framing Mode when configured for DS3. If pattern sync is found, then the Pattern is displayed in the instrument settings summary. The framing mode and pattern are thereby set, and the instrument is ready for use on the connected circuit.

Figure 6-22 illustrate the logic of AUTO configuration.

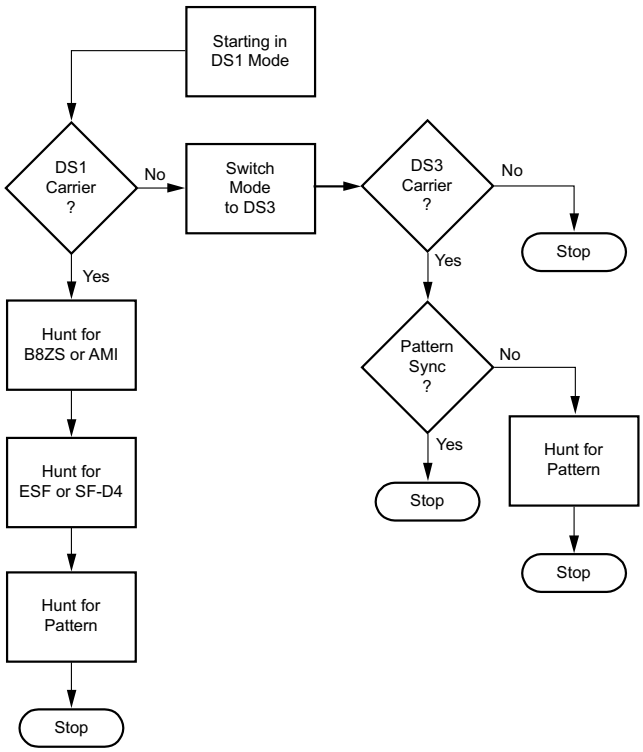


Figure 6-22. DS1 AUTO Configuration

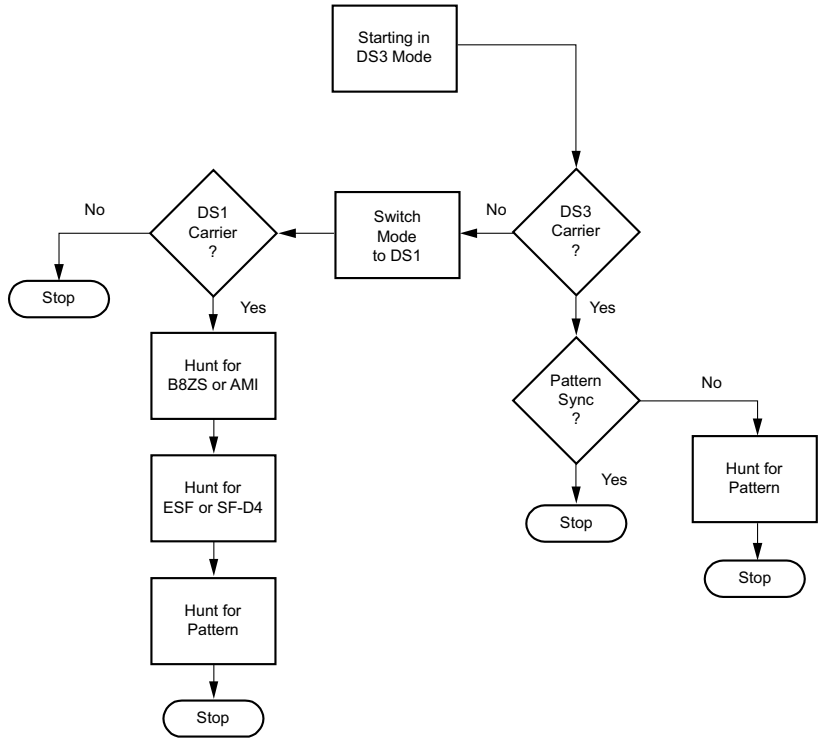


Figure 6-23. DS3 AUTO Configuration

Appendix A — Glossary

A-1 General Terms

Alternate Mark Inversion (AMI)

A three level serial line code for transmitting binary digits. A format in T1 transmission systems in which binary digits are sent with equal time periods and in which zeros have zero amplitude, and ones (marks) have equal amplitudes that alternates in polarity (positive and negative).

Backhaul

A term that is commonly used for a circuit that is used to carry signals from one point in a network back to another point, For example, a signal may be carried from the Base Transceiver Station (BTS) site back to the Mobile Switching Center (MSC).

CRC

Cyclic Redundancy Check. A bit pattern determined by a formula, applied to a block of data, and used to verify data integrity over a communications link.

CSU

Channel Service Unit or CSU/DSU (where DSU is Data Service Unit) is a device that terminates a digital channel on a customer's premises. A CSU is located between the incoming digital line and the customer's equipment.

D4

Refers to a "D4" channel bank, but is commonly used to refer to the signal framing originally used by the D4 channel bank. Also called Super Frame.

DSX

Digital Cross-connect. A manual cross-connect point that primarily serves as a test access point for DS1signals and for substituting operational equipment when necessary.

ESF

Extended Super Frame is a framing format that is employed in T1 systems. The ESF format consists of 24 consecutive T1 frames (each T1 frame containing 24 DS0 signals). This format provides FPS bits for framing, CRC bits for error checking, and FDL bits for maintenance-signaling information that is out-of-band from payload data.

FDL

Facility Data Link refers to the bits that are included as part of ESF framing format and that provide an out-of-band path for communication of performance data.

Framing

The digital bit stream is organized into fixed units, called frames. A frame typically consists of a block of data (payload) plus overhead bits that are used for frame synchronization and for out-of-band communication.

LBO

Line Build Out. An electrical network that is used to simulate a length of cable.

LEC

Local Exchange Carrier. Local service provider.

Loopback

A type of diagnostic test in which the transmitted signal is returned to the sending device after passing through a network or devices. A transmission facility may be said to be in loopback when it is set up in a condition such that a received signal is returned towards the sender.

M13

A multiplexer in the digital hierarchy that multiplexes 28 DS1 signals into a single DS3 signal.

NIU

Network Interface Unit, may also be called a Network Interface Device (NID). The NIU is a device that is placed at the demarcation point between the network and the customer premises. It typically provides regeneration, isolation, and testing loopback capabilities. It may also provide performance monitoring information, which is available either locally or via the FDL on ESF circuits.

PCM

Pulse Code Modulation is a common method of encoding an analog voice signal into a digital bit stream.

A-2 Timing Measurements

Available Seconds (AS)

The count of available seconds since the beginning of the test. Available seconds equals the total test time minus any unavailable seconds.

Degraded Minutes (DGRM)

The count of Degraded Minutes since the start of the test. A Degraded Minute occurs when there is a 10-6 bit error rate during 60 available, non-severely bit errored seconds.

Errored Second (ES)

The number of seconds with at least one error.

Error Free Seconds (EFS)

The count of error free seconds since the beginning of the test. Error free seconds equals the total test time minus the number of errored seconds.

Severely Errored Seconds (SES)

This is the count of Severely Errored Seconds since the beginning of the test. A second with a bit error rate of 10-3 or higher is a severely errored second. Severely errored seconds are not counted during unavailable time. Loss of signal (LOS), loss of frame (LOF) and loss of pattern synchronization (LOP) are treated as severely errored seconds.

Unavailable Seconds (UAS)

This is the count of UnAvailable Seconds that have occurred since the beginning of the test. Unavailable time begins at the onset of 10 consecutive severely errored seconds, and ends after 10 consecutive non-severely errored seconds. The onset of unavailable seconds cause the SES count to be adjusted downward by 10. When unavailable time ends, the UAS count is adjusted downward by 10.

A-3 G.821 Measurement Definitions

The following error parameters were developed for testing error performance of digital links in terms of performance parameters.

Errored Second (ES)

This is the number of seconds with at least one error.

Error Free Seconds (EFS)

This is the count of error free seconds since the beginning of the test. Error free seconds equals the total test time minus the number of errored seconds.

Available Seconds (AS)

This is the count of available seconds since the beginning of the test. Available seconds equals the total test time minus any unavailable seconds.

Severely Errored Seconds (SES)

This is the count of Severely Errored Seconds since the beginning of the test. A second with a bit error rate of 10^{-3} or higher is a severely errored second. Severely errored seconds are not counted during unavailable time. Loss of signal (LOS), loss of frame (LOF), and loss of pattern synchronization (LOP) are treated as severely errored seconds

Unavailable Seconds (UAS)

This is the count of UnAvailable Seconds that have occurred since the beginning of the test. Unavailable time begins at the onset of 10 consecutive severely errored seconds, and ends after 10 consecutive non-severely errored seconds. The onset of unavailable seconds causes the SES count to be adjusted downward by 10. When unavailable time ends, the UAS count is adjusted downward by 10.

Degraded Minutes (DGRM)

This is the count of Degraded Minutes since the start of the test. A Degraded Minute occurs when a 10^{-6} bit error rate exists during 60 available, non-severely bit errored seconds.

Appendix B — Fiber Optic Care for Options 58 & 59

B-1 Introduction

Special care must be taken with the fiber optic cables and connectors on the instrument panel. Cleaning and adhering to the cautions guarantee cables optimal performance. Figure B-1 compares a dirty ferrule tip to a clean tip.

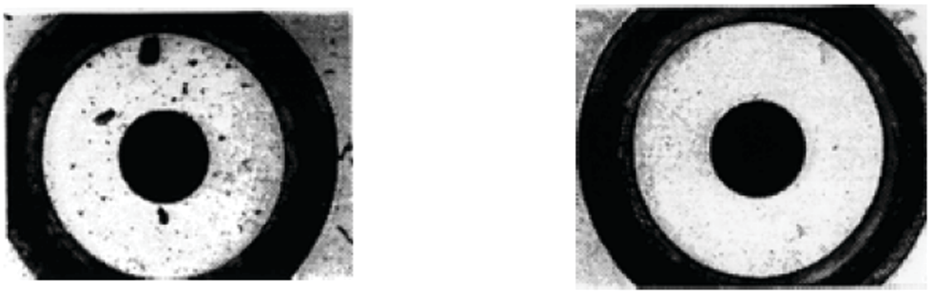


Figure B-1. Magnified Ferrule Tip

B-2 Cleaning

Anritsu recommends purchase of the Anritsu Fiber Optic Cleaning Kit, PN: 2000-1623. The kit contains a cleaning solution, Q-tips, and wipes. Refer to the cleaning instructions included in the kit.

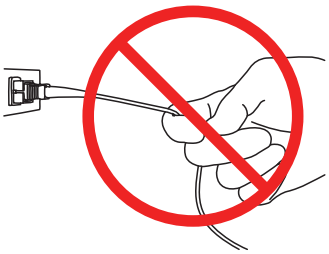
B-3 Fiber Optic Cable Care and Use

Optical fiber cables may degrade in performance or be damaged if handled improperly. Note the following cautions and warning when handling them.

Caution

Do not pull the cable when removing the connector.

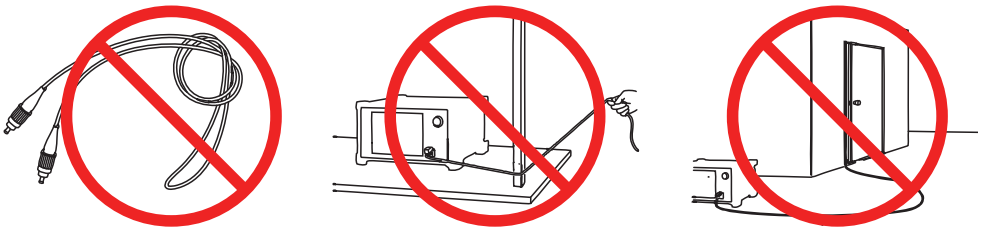
Doing so may break the optical fiber inside the cable, or remove the cable sheath from the optical connector.



Caution

Do not excessively bend, fold, or pinch an optical fiber cable.

Doing so may break the optical fiber inside the cable. Keep the bend radius of an optical fiber cable at 30 mm or more. If the radius is less, optical fiber cable loss will increase.



Caution

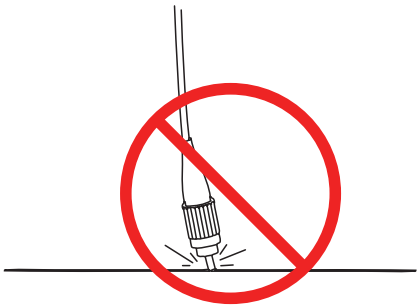
Do not excessively pull on or twist an optical fiber cable.

Also, do not hang anything by using a cable. Doing so may break the optical fiber inside the cable.

Caution

Be careful not to hit the end of an optical connector against anything hard such as the floor or a desk by dropping the optical fiber cable.

Doing so may damage the connector end and increase connection loss.



Warning

Do not touch the end of a broken optical fiber cable.

The broken optical fiber may pierce the skin, causing injury.

Caution

Do not disassemble optical connectors.

Doing so may cause part to break or the performance to degrade.

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