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Tektronix BSX Series
Bit Error Rate Analyzers

User Manual

077-1288-00

Tektronix BSX Series
Bit Error Rate Analyzers

User Manual

Revision A

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. (See page vi, *Service safety summary*.)

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use. Do not use the provided power cord for other products.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded. Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

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

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

The measuring terminals on this product are not rated for connection to mains or Category II, III, or IV circuits.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged. Do not use probes or test leads if they are damaged, if there is exposed metal, or if a wear indicator shows.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Use only the Tektronix rackmount hardware specified for this product.

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

Terms in this manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

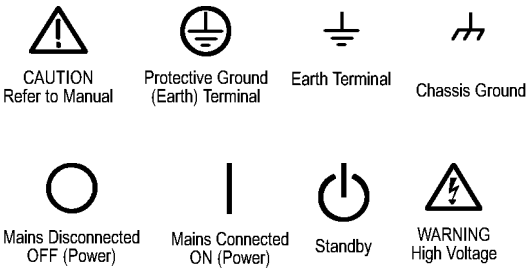
Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



Preface

This document provides basic information for using the Tektronix BSX series of BERTScope instruments.

Features and benefits

The BERTScope series of instruments provide the following features and benefits:

- Pattern Generation and Error Analysis up to 32 Gb/s
- Optional built-in 4-tap Tx equalization with support for interactive link training
- Protocol-oriented and bit-oriented multi-chain pattern sequencing with enhanced pattern/sequence editor
- User-defined detector pattern matching with stimulus-response feedback
- Patented Error Location Analysis™ goes beyond BER measurement to provide insight into the sources of errors through analysis of correlations and deterministic error patterns
- Optional Forward Error Correction analysis provides for simulation of post-FEC error rate based upon measured error location patterns
- Integrated Eye Diagram Analysis with BER Correlation including Mask Testing, Jitter Peak, BER Contour
- Optional Jitter Map Comprehensive Jitter Decomposition - with Long Pattern (such as, PRBS-31) Jitter
- Provides a single solution for Receiver stress testing, debug and compliance
- Test Gen3 and Gen4 standards including PCIe, SAS, and USB3.1 and proprietary standards
- DUT handshaking capability up to 32 Gb/s supporting RX test requirements for loopback initiation and adaptive link training for key standards such as PCIe and SAS
- Protocol-aware pattern generation and error detection supports flexible stimulus response programmability and debugging of handshaking issues
- Forward error correction (FEC) emulation option supports measurement of BER both before and after error correction for commonly used Reed-Solomon FEC codes
- Calibration and test automation software available for key standards

Models

This document covers the following instrument models:

- BSX125A, BERTScope 12.5 Gb/s Bit Error Rate Analyzer
- BSX240A, BERTScope 24.0 Gb/s Bit Error Rate Analyzer
- BSX320A, BERTScope 32.0 Gb/s Bit Error Rate Analyzer

The Tektronix BERTScope Bit Error Rate Analyzers provide methods of measuring the signal integrity of serial data systems. They provide quick, accurate, and thorough bit error ratio detection by bridging eye diagram analysis with BER pattern generation. These instruments help isolate problematic bit and pattern sequences and analyze seven types of advanced error analysis with statistical measurement depth.

The instruments have a software-based graphical user interface from a series of View menus. Detailed information on the operation of the control interface can be accessed at any time through the Help menus available in the separate View menus.

Related documentation

In addition to this manual, the following documentation can be downloaded from the Tektronix Web Site at www.tek.com:

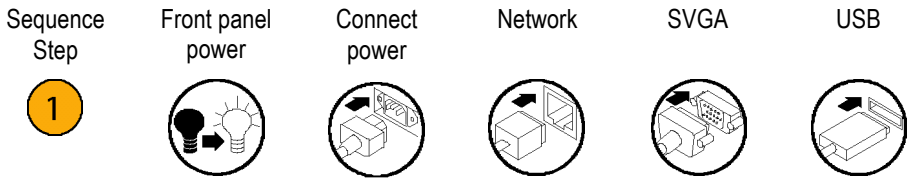
- *BSX Series Installation & Safety Manual*. This document provides operating requirements, installation information, and other information for the BSX series products. Tektronix part number: 071-3496-xx.
- *Online help*. The online help is part of the BSX products, available from the Help menu. You can also touch a control on the screen and the select the "Help on ..." listing for help on that control or feature.
- *Remote control guide* (PDF). This document provides remote control commands used to control the BSX products. This document is available on the BSX hard disk or can be downloaded from the Tektronix Web site. Tektronix part number: 077-1284-xx.

  This document is also located on the BSX-series BERTScope instrument in the following location: `C:\Program Files\BERTScope\Help`. The software release notes are also located in this folder.

- *BERTScope BSX Series Bit Error Rate Analyzer Declassification and Security Instructions*. Instructions for declassifying or sanitizing BERTScope BSX series instruments. Tektronix part number: 077-1286-xx.

Conventions used in this manual

The following icons are used throughout this manual.



The terms “touch” and “click” are used interchangeably in this document. The instrument has a touchscreen interface to control the instrument by touching buttons or controls on the screen or by using a mouse.

The terms “view” and “menu” are used interchangeably in this document. A view is defined as the current on-screen menu.

Preventing ESD

CAUTION. *A direct electrostatic discharge can damage the instrument input. To learn how to avoid this damage, read the following information.*

Electrostatic discharge (ESD) is a concern when handling any electronic equipment. The instrument is designed with robust ESD protection; however it is still possible that large discharges of static electricity directly into the signal input may damage the instrument. To avoid damage to the instrument, use the following techniques to prevent electrostatic discharge to the instrument.

1. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while connecting and disconnecting cables and adapters. The instrument provides a front panel connection for this purpose.
2. A cable that is left unconnected on a bench can develop a large static charge. Discharge the static voltage from all cables before connecting them to the instrument or device under test by momentarily grounding the center conductor of the cable, or by connecting a 50 Ω termination to one end, before attaching the cable to the instrument.

Getting Started

BSX options

The following table lists the options are available when you order your BSX instrument.

Table 1: BSX Instrument options

Option	Description
Opt. FEC	Forward error correction emulation
Opt. UPM	User-defined detector pattern match
Opt. F2	F/2 jitter generation
Opt. J-MAP	Add jitter decomposition software
Opt. LDA	Add live data analysis software
Opt. STR	Stressed signal generation
Opt. SLD	Add stressed live data option software
Opt. TXEQ	Add 4-tap Tx equalization

Accessories

The following table lists the accessories recommended for your BSX instrument.

Table 2: Recommended BSX instrument accessories

Accessory	Description
BSXSICOMB	Sinusoidal interference combiner kit
BSXPCI3EQ	Eye opener kit for PCIe Gen3
BSXPCI4EQ	Eye opener kit for PCIe Gen4
LE160/LE320	16 Gbps / 32 Gbps, 2-channel linear equalizers
CR125ACBL	High-performance Delay Matched Cable set (required for BERTScope and CRU in SSC applications)
100PSRTFILTER	100 ps rise time filter
BSA12500ISI	Differential ISI board
PMCABLE1M	Precision phase matched cable pair, 1 m
BSARACK	BSA/BSX-rackmount kit

Installation information

Refer to the *BSX Series Installation & Safety Manual* for installation information, site considerations, and other information for the BSX series products. Tektronix part number: 071-3496-xx.

Functional check

For a brief functional check, power on the instrument, verify that all diagnostics pass and the instrument displays the Home view as shown below. The power-on process may take a few minutes due to the complexity of the instrument.

Figure 1: Home view

Operating Basics

This section includes information on the external controls and connectors on the instrument and then provides a brief overview of the menu system.

Front panel controls and connectors

The following figure and table describe common front panel controls and connectors.

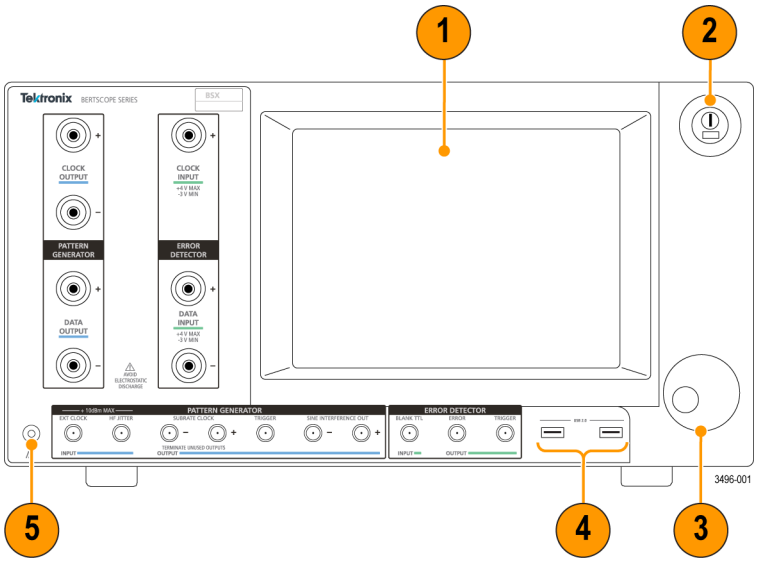


Figure 2: Front panel

Table 3: Common front panel controls and connectors

Connector		Description
1	Display	TFT touchscreen display to set up, control, and view information in the menus.
2	Power switch	Activates the power supply to provide power to the primary circuits in the instrument. The switch has a green light when power is turned on. The primary power control circuitry is always live whenever the power cord is connected to the instrument. To completely disconnect power from the instrument, disconnect the power cord at the rear of the instrument.
3	Control knob	Use the multifunction knob in stead of directly entering values to control items in the display such as moving the cursor, scaling inputs, changing stress or amplitude levels, and scrolling data.
4	USB	Use the USB connectors for connecting USB devices such as a mouse, keyboard, or USB flash drive. Four additional USB connectors are located on the back of the instrument.
5	Ground connector	Use this connector to connect a common ground to other instruments.

Pattern Generator connectors

The following figure and table describe the Pattern Generator front panel connectors.

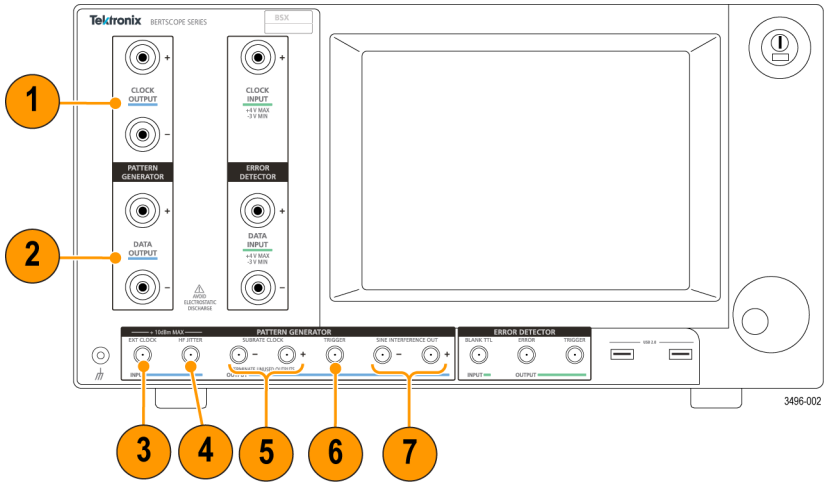


Figure 3: Pattern Generator front panel connectors

Table 4: Pattern Generator front panel connectors

Connector		Description
1	CLOCK OUTPUT	Clock Output connectors. Use the differential connectors to output a clock signal from the Pattern Generator. (Amplitude range: 250 mV to 1.8 V_{p-p}).
2	DATA OUTPUT	Data Output connectors. Use the differential connectors to output data from the Pattern Generator. (Amplitude range: 50 mV to 1.8 V_{p-p}, each leg).
3	EXT CLOCK	External clock input connector. Use this input to connect an external clock source to the BERTScope analyzer; (maximum input amplitude of +10 dBm or 2 V_{p-p}).
4	HF JITTER	High-frequency jitter insertion input connector. Use this connector to add external high-frequency jitter (DC to 1 GHz) to the instrument with up to 0.5% UI. Apply signals up to 16 dBm (4 V_{p-p}) if needed.
5	SUBRATE CLOCK	Pattern Generator Subrate clock output connectors. The signal available at these differential output connectors depend on the settings in the Generator view. Select SUBRATE to produce a Pattern Generator clock or a submultiple of the clock without any added jitter (useful for measuring any jitter that was added to the Pattern Generator output). Select STRESS to produce a version of the Pattern Generator clock including any added jitter.
6	TRIGGER	Pattern Generator trigger output connector. Use this connector to synchronize external equipment, such as an oscilloscope to the BERTScope analyzer.
7	SINE INTERFERENCE OUT	Sine Interference output connectors. The signals at these output connectors provide the summed differential output of two internal interference channel sources. In-phase and out-of-phase interference can be output, or with the GUI selection, two independent single-ended tones are available.

Error Detector connectors

The following figure and table describe the Error Detector front panel connectors (outlined in green).

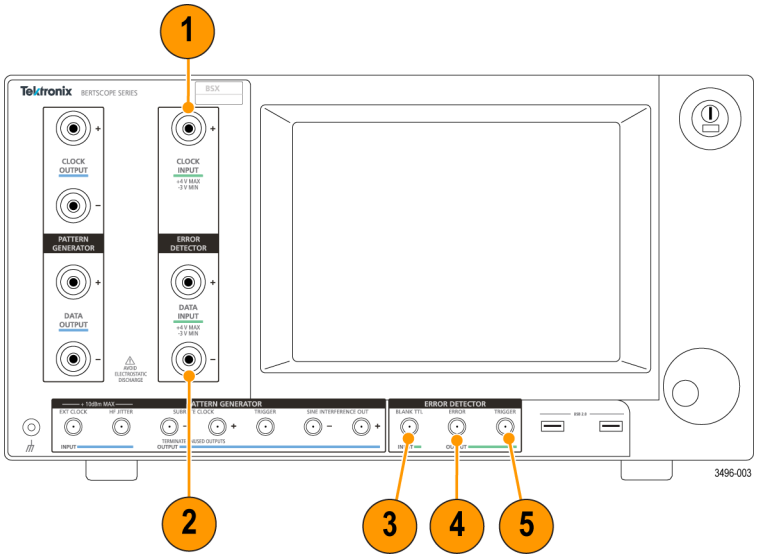


Figure 4: Error Detector front panel connectors

Table 5: Error Detector front panel connectors

Connector		Description
1	CLOCK INPUT	Error Detector clock input connector. Use this connector to provide a single-ended clock input to the Error Detector. The input frequency range depends on the instrument model. (Amplitude range: –3 V to +4 V, 50 Ω, AC-coupled)
2	DATA INPUT	Error Detector data input connectors. Use the Data+ and Data– connectors to input differential data signals to the Error Detector. (Amplitude range: –3 V to +4 V, 50 Ω, AC-coupled)
3	BLANK	Error Blank input connector. Use this connector to accept a TTL-level signal to cause the Error Detector to ignore errors. The Error Detector will ignore errors while this signal is active.
4	ERROR	Error output connector. Use this connector to provide a 1000 mV pulse when an error is detected. The minimum pulse width is 128 serial clock periods.
5	TRIGGER	Trigger output connector. Use this connector to synchronize external equipment, such as an oscilloscope to the BERTScope analyzer.

Rear panel controls and connectors

The following figure and table describe the rear panel power and communication connectors.

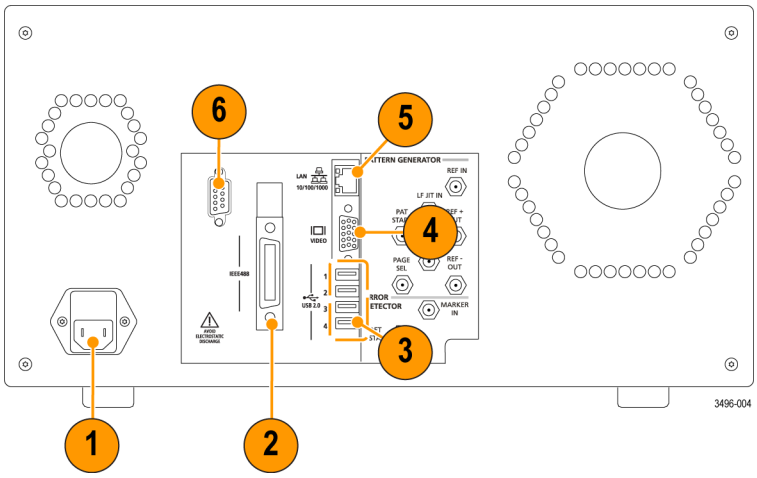


Figure 5: Rear panel connectors

Table 6: Rear panel power and communications connectors

Connector		Description
1	AC power	Connect a suitable power cord to match the local power outlet type.
2	IEEE4888	GPIB connector.
3	USB	Four USB connectors (two additional connectors are located on the front of the instrument). Connect USB devices such as keyboard, mouse, or USB flash drive.
4	VIDEO	Monitor/display connector. Connect an external VGA display device.
5	LAN	Connect the instrument to a network for remote control operation, file sharing, and other network operations.
6	SERIAL	Reserved for future use.

The following figure and table describe the rear panel BNC connectors.

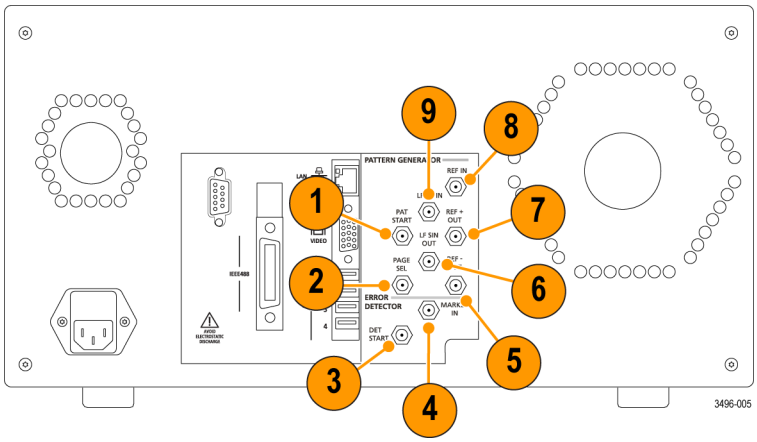


Figure 6: Rear panel BNC connectors

Table 7: Rear panel BNC connectors

Connector		Description
1	PAT START	Pattern Start input. Use this input connector to simultaneously synchronize the patterns of multiple data streams from multiple instruments.
2	PAGE SEL	Page Select. When enabled in the Pattern Sequencer, this input will cause the Pattern Sequencer to advance to the next state depending upon the TTL level of the input signal. In legacy Page A/Page B mode, a logic 0 selects Page A; and logic 1 selects Page B
3	DET START	Detector Start Input. Use this input to synchronize the Error Detector with external equipment. (LVTTL logic level, >1 kΩ into 0 V)
4	MARKER IN	Detector Marker input connector. Use this connector to accept a TTL-level Marker signal. The signal can be used to synchronize error analysis with low-speed reference signals, such as mechanical frequencies, packet boundaries, or loop markers. The minimum pulse width is 128 clock periods with a maximum repetition rate of 512 serial clock periods.
5	REF- OUT	Reference Output (–). Use this connector with the (+) connector to provide a differential reference frequency for other instruments (typically 100 MHz). For single-ended applications, use the (+) connector.
6	LF SIN OUT	Low-Frequency Sine Jitter Out. Use this connector to track the internal sine jitter modulation frequency. It can be used to ensure that two BERTScope analyzers are both in-phase or out-of-phase.
7	REF+ OUT	Reference Output (+). Use this connector with the (–) connector to provide a differential reference frequency for other instruments (typically 100 MHz).
8	REF IN	Reference Input. Use this connector to provide an input reference signal (amplitude: –6 dBm to +6 dBm). When the Synthesizer clock mode is selected, the fixed reference clock frequencies are: 10, 100, 106.25, 133.33, 165.25, 166.67, and 200 MHz. When the Reference Clock Multiplier (RCM) mode is selected, the input frequency can be any frequency between 10 MHz and 200 MHz.
9	LF JIT IN	Low Frequency Jitter In. Use this connector to add external low frequency jitter (DC to 80 MHz) to the instrument. The maximum signal level for this connector for normal operation is +10 dBm (2 V_{p-p}).

Menu overview

The BERTScope analyzer is controlled by a graphical user interface and on-screen controls. The on-screen controls can be accessed with the touch screen or with a mouse and keyboard.

The Home view displays when you first power on the instrument. The Home view introduces the instrument and provides high-level on-screen information to help you get started using the instrument.

Figure 7: Home view

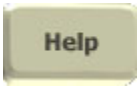
The Control console is common to all views. It consists of three major areas to help you control and navigate the different views:

- Title bar. The Title bar contains the name of your instrument and a history of recent views or views within a group. Click any of the listed views to quickly return to that view.
- Control buttons. Use the buttons on the right side of the display to control the overall instrument operation. The following table provides a high-level overview of each button.

Table 8: Control console button overview

Item	Description
	Click **View** to access a variety of views available on the BERTScope analyzer. The contents of the pop-up list depend on the features and options available with your instrument.
	Click **Back** or **Forward** to quickly scroll through the history of displayed views. The buttons become active after selecting different views.

Table 8: Control console button overview (cont.)

Item	Description
	Click **Run** to start the Pattern Generator, Error Detector, or other data analysis application in the current view. The button lights up while the applications are running. Click the button a second time to stop the applications.
	Click the Print button to print the current view to a designated printer or to a file. Printer settings are made in the System view, on the Tools tab, under the Setup column. (Click **View** and select System to access the System view).
	Click the Config button to access configuration files, which store the setups of your instrument.
	Click the Help button for easy access to the online help on the current view.
	Click the Editor button to launch the Pattern Sequencer view in a separate window. Use the Pattern Sequencer to edit existing files for use with different BERTScope applications.
	Click the Shutdown button to quit the BERTScope application or to turn off the instrument.

- Status bar. The Status bar provides information about the current operating status. It is made up of the following different areas:
  - Pattern Generator (Gen) and Error Detector (Det). These areas display the data pattern, measured clock frequency, and synchronization status. The areas will be yellow and display error messages if the system is not in sync.
  - Measured BER, Error Count, Bit Count. Click this area to display the measured BER, error count, or bit count. The small image to the right animates when an analysis is running.
  - Local/remote control. This area indicates how the instrument is being controlled, locally or by remote control.

NOTE. *The Gen or Det areas are shortcuts; click one of these areas to take you directly to that view.*

Access system information

The System view includes access to system tools, registry, settings, and other instrument information. You might need access to this information when you first set up your instrument.

1. Click **View** and then select **System** as shown.

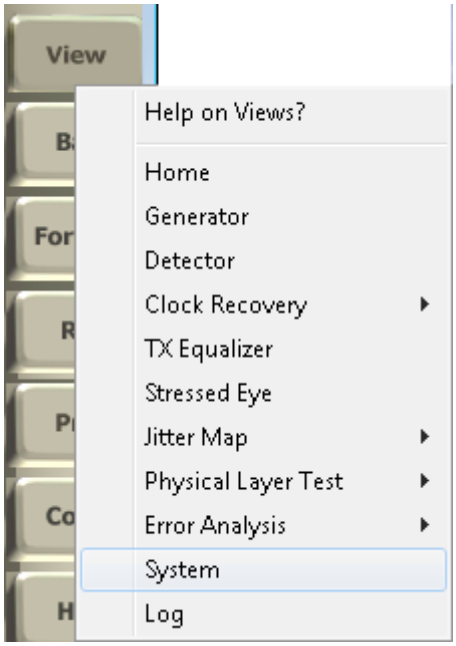


Figure 8: Selecting the System view

The System view opens showing separate tabbed pages to access system information.

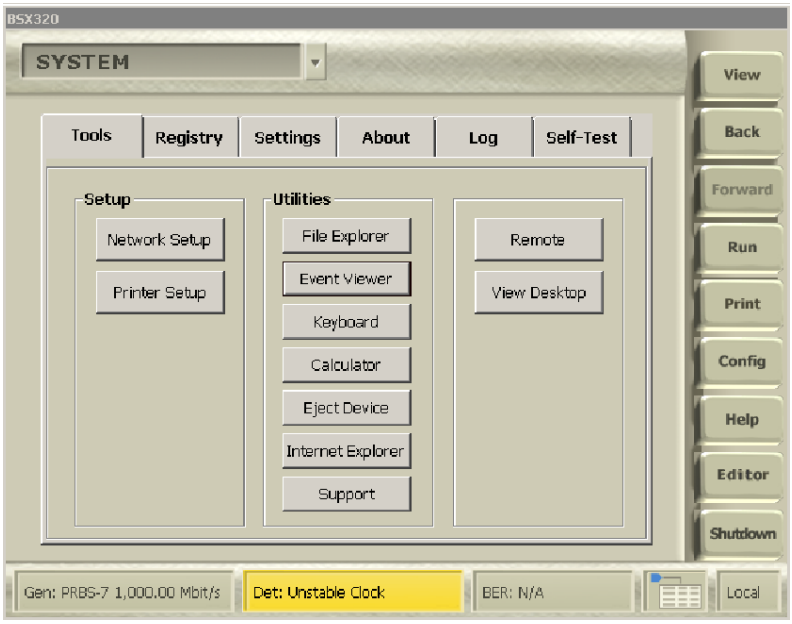


Figure 9: System view: Tools tab

2. Under the Tools tab, click any of the buttons to access setup information, view the desktop, use the Microsoft tools, or access the Internet.
3. Select other tabs in the System view for additional information:
   - The Registry tab displays the current paths in the Windows file system for assets, such as user patterns or configurations.
   - The Settings tab displays a list of user-definable settings. It also allows you to set preferences, such as whether dialog boxes appear to recommend calibration as appropriate. It also display product options installed in the instrument.
   - The About tab provides information about your instrument, such as product name, serial number, and software versions.
   - The Log tab allows you to view or clear the Error Log file. It also displays the path to the log file on your instrument.
   - The Self-Test tab allows you to run the self test routine. The results of the self test are displayed on the screen and saved to the Error Log file.

Application examples

The following examples provide steps to set up the instrument to view the results in the Eye Diagram view, the TX Equalizer view, and the Pattern Sequencer.

The examples in this section provide typical examples. For more information on the setups and individual views, refer to the online help.

Typical setup and eye diagram example

Use the steps in the following procedure to connect cables to the instrument and to set up the Pattern Generator and Error Detector to view the results in the Eye Diagram view.

Connect the front panel cables

When connecting cables to the front panel use high quality coaxial cables with APC3.5 or SMA connectors.

Refer to the following figure and connect the SMA cables on the front panel as described below:

Figure 10: Initial front panel cable connections

1. Connect an SMA cable from the Pattern Generator + Clock Output connector to the Error Detector Clock Input connector.

   Terminate the Pattern Generator – Clock Output with a 50 Ω terminator.

2. Connect an SMA cable from the Pattern Generator + Data Output connectors to the Error Detector + Data Input connectors.

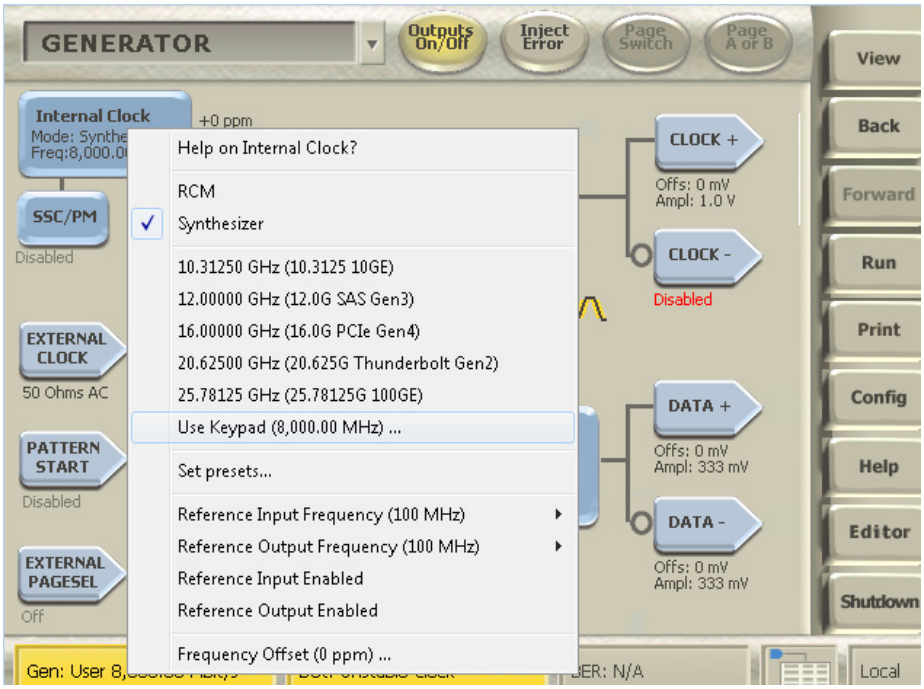
3. Power on the instrument.

Initial Pattern Generator settings

Complete the following steps for the initial Pattern Generator view settings:

1. Click **View** on the right side of the display and select **Generator** to go to the Generator view.

2. Click the **Internal Clock** button at the top left side of the Generator view and then click **Use Keypad** from the list.



NOTE. *By default the Internal Clock uses the Synthesizer mode where you can use one of the internal clock selections or select a value from the pop-up keypad. Refer to the online help for more information on the Internal Clock selections.*

3. Use the pop-up keypad to set the clock speed to **10.7 GHz**.

4. Click the **Generator** button and set the pattern to PRBS-7 as shown.

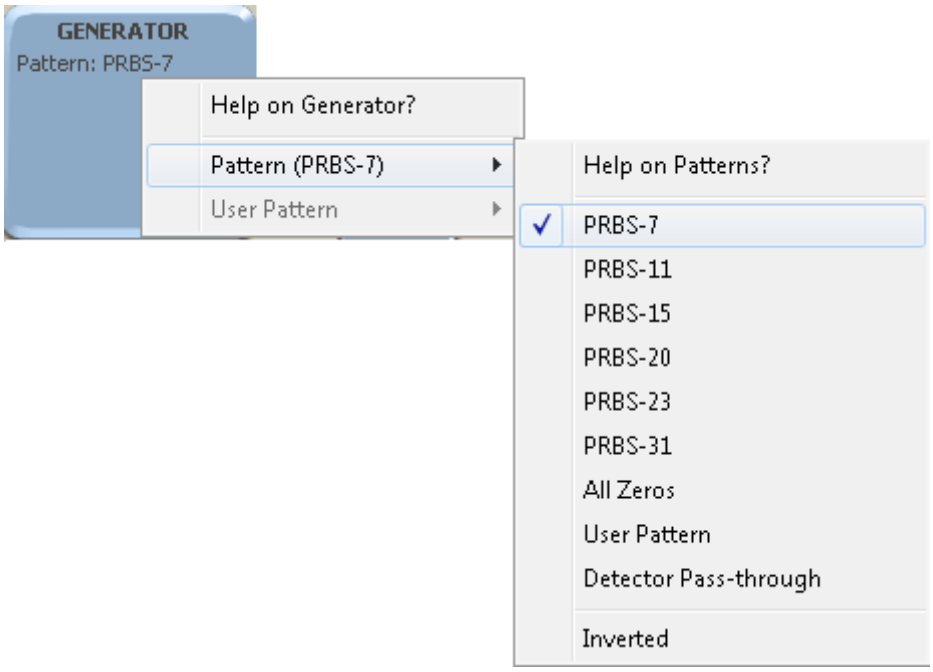


Figure 11: Set the User Pattern to PRBS-7

5. Go to the top of the Generator view and click the **Outputs On/Off** button to turn the clock and data outputs on; the button will be lighted.
6. Click the **Clock +** button and do the following steps:
   a. Set the Signal Level Offset to **0 mV**.
   b. Set the Signal Level Amplitude to **1.0 V** (1000.0 mV).
7. Click the **Clock -** button and confirm that the **Link Clock +/- Signals** is selected in the list. If it isn't selected, select it now.
8. Similar to the clock selections, repeat the above steps for the Data output selections.
9. Verify that the settings on the labels in the Generator view match those in the following figure.

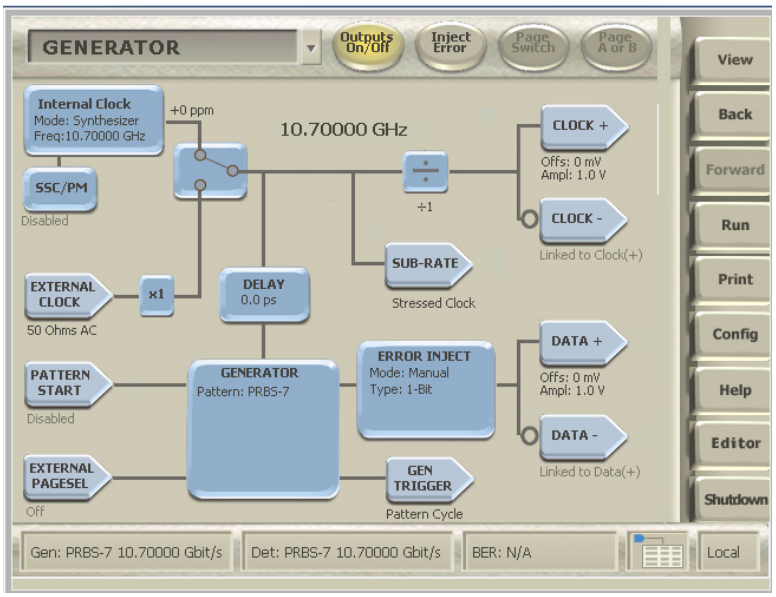


Figure 12: Initial Pattern Generator view settings

Initial Detector view settings

Complete the following steps for the initial Detector view settings.

1. Click **View** on the right side of the display and select **Detector** to go to the Error Detector view.
2. Click the **Auto Align** button at the top of the Detector view.

   This sets the Error Detector to the optimum delay and threshold settings for best BER or eye diagram performance.

3. If the following menu appears on the screen, click the **Yes** button.

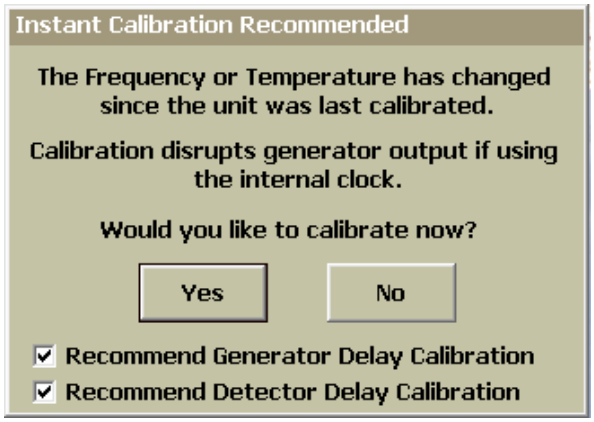


Figure 13: Calibration recommendation menu

The instrument will perform the calibration setups to automatically align the system settings.

4. When the Auto Align Results menu appears, click **OK** to accept the calibrated settings.

Eye diagram checks

The following steps show a typical example of how to display and measures signals in an eye diagram.

1. Click **View** on the right side of the display and select **Physical Layer Test** and then select **Eye Diagram** to go to the Eye Diagram view.
2. If the Measurement sidebar menu is missing at the left of the Eye Diagram display, click the Sidebar button 

located at the lower left corner.

   The Sidebar button provides easy access to other tools to help with setups and measurements without changing views.
3. In the Sidebar menu, select **Measurements** to add the Measurements sidebar menu to the Eye Diagram view.
4. Click the **Auto Center** button at the top of the view to center the eye display.

   You can see the progress of the auto-center operation on the scroll bar below the chart.

NOTE. *Avoid clicking the Run button during an auto-center operation; this could cause the display to be out-of-sync with the actual running state and cause unnecessary confusion.*

5. Click **Run** on the right side of the display and wait for the acquisition to complete.

   The Eye Diagram display should look similar to the following figure.

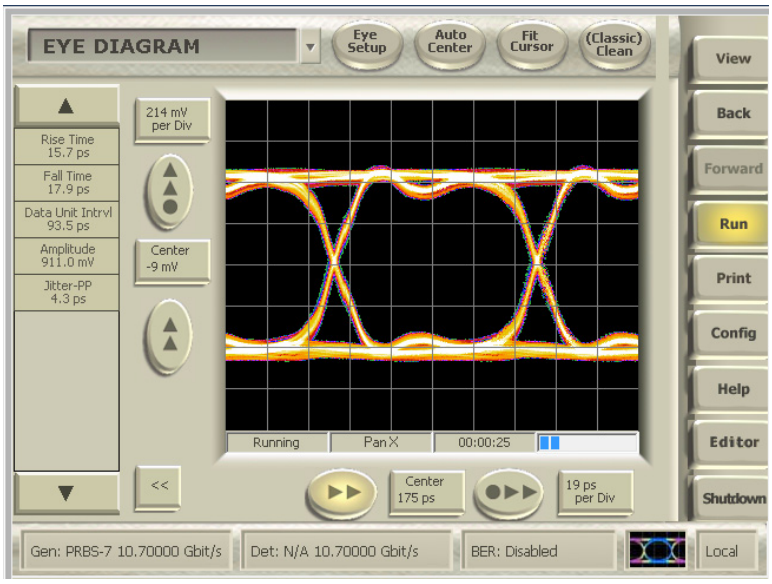


Figure 14: Typical eye diagram

6. Note the measurements in the sidebar menu on the left side of the display.

   The measurements, such as the amplitude, should be similar to the settings that you made in the Generator display.

TX Equalizer examples

The TX Equalizer view shows processing characteristics as time-domain taps and frequency domain responses. When enabled, the TX Equalizer is intended to compensate for or simulate degradation in the signal step response resulting from a cable fault or a long backplane.

To access the TX Equalizer view, click the **View** button and then select **TX Equalizer**. The default TX Equalizer view displays:

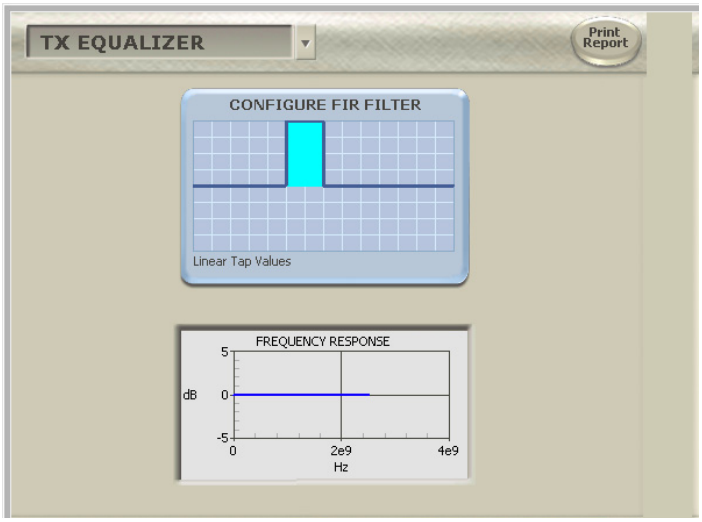


Figure 15: Default TX Equalizer view

The Configure FIR (Finite Impulse Response) Filter in the center of the view represents a graphical response display or it shows the current TAP settings depending on the FIR format. The Frequency Response graph at the bottom of the view shows the equivalent frequency response of the selected configuration.

Click the blue Configure FIR Filter box to open the setup menu for controlling the equalizer. The menu should look similar to the following figure:

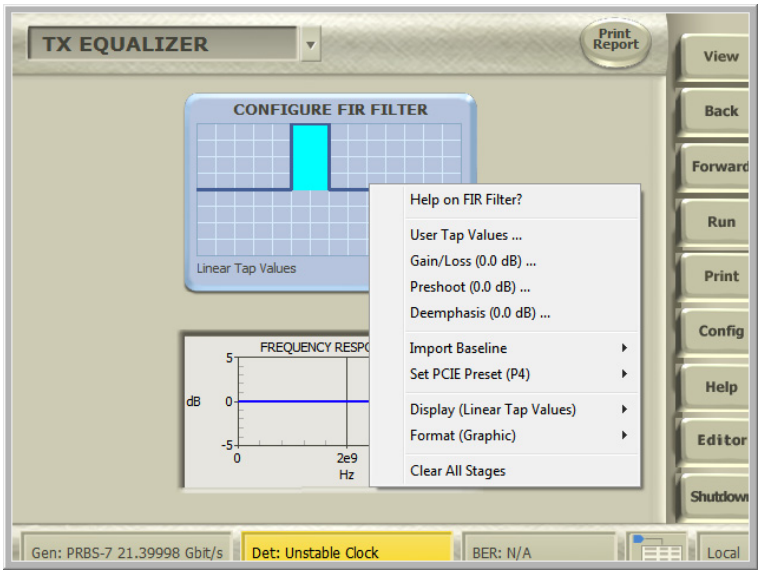


Figure 16: TX Equalizer menu

NOTE. *If nothing happens when you click on the Configure FIR Filter box, the TXEQ is not enabled on your instrument. Contact your local Tektronix representative for information on enabling Opt. TXEQ on your instrument.*

To compensate for signal degradation the TX Equalizer increases the relative amplitude, or pre-emphasizes, the first few bits of the step. To simulate the signal degradation, the first few bits of the step are decreased in relative amplitude, or de-emphasized.

The following examples show how you can use the setup menus to setting the equalization settings. In each of the examples, settings are suggested and the results of those settings are shown in the TX Equalizer view. The examples assume that you are starting from the default view.

Enter FIR Tap values directly

From the setup menu, select **User Tap Values** to open a dialog box to enter the base tap values or bit amplitude settings. The frequency responses from all of the different components of frequency response shaping are combined and a set of four tap values are chosen to best represent the desired aggregate frequency response.

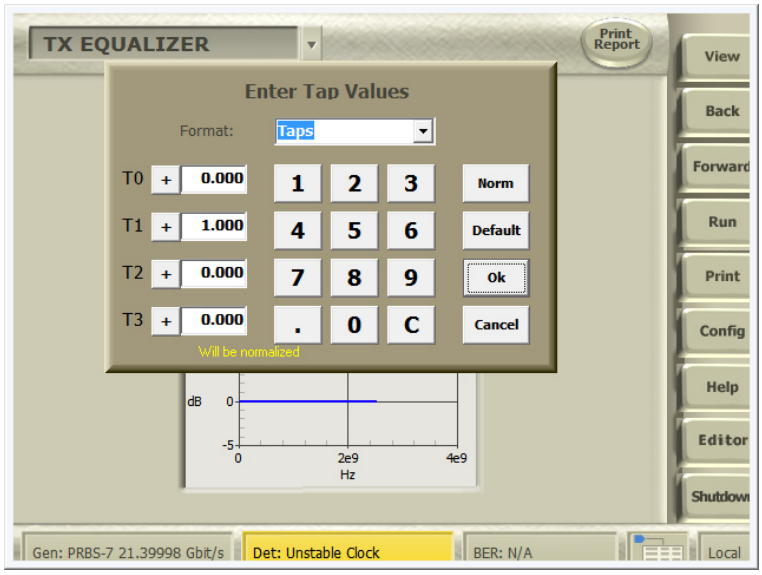


Figure 17: Enter Tap Values dialog box

You have the option of displaying the current tap settings as tap values or bit amplitudes (in dB or percent of amplitude).

Enter Gain or Loss in dB

From the setup menu, select **Gain/Loss** to open a dialog box to enter the gain or loss within the range of -12 dB to +12 dB. The number can be a positive gain or negative loss.

For example, enter a value of **-3 dB** as shown in the following figure and click **OK**.

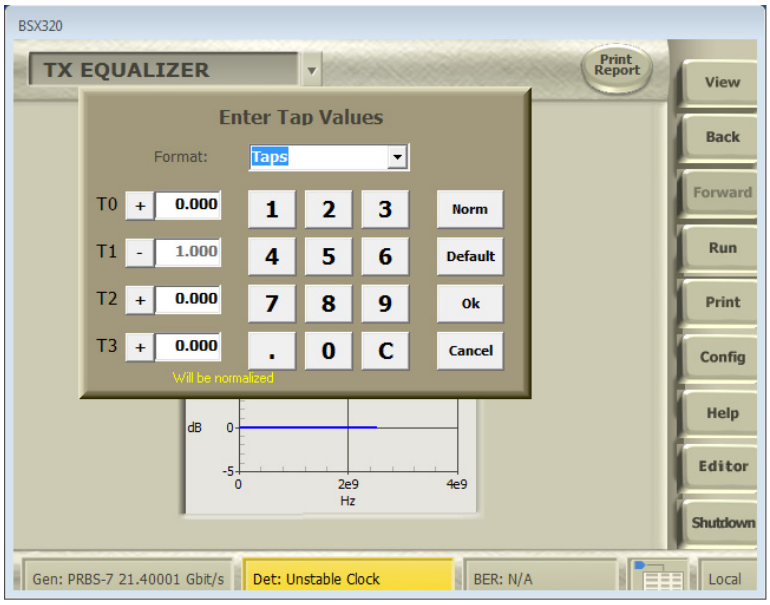


Figure 18: Entering Gain/Loss value of -3dB

The resultant TX Equalizer view changes to show the linear tap value display and the resultant frequency response. Note the Gain/Loss label below the tap value display.

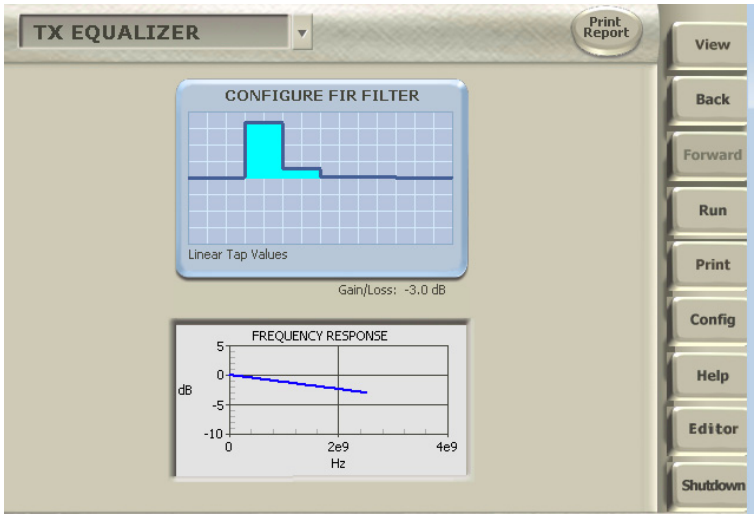


Figure 19: TX Equalizer view showing -3 dB Gain/Loss

Click **Clear All Stages** in the setup menu to return the values to the default settings.

Enter Preshoot and De-emphasis in dB

Similar to the previous example, select either **Preshoot** or **Deemphasis** from the setup menu to enter the preshoot or de-emphasis values in the respective dialog boxes.

The preshoot value is normally positive to increase the magnitude of frequencies to improve the overall signal-to-noise ratio. Enter a value from 0.00 dB to +12 dB.

The de-emphasis value is usually a negative value to decrease the magnitude of frequencies to improve the overall signal-to-noise ratio.

For example, enter a preshoot value of **3 dB** as shown in the following figure and click **OK**.

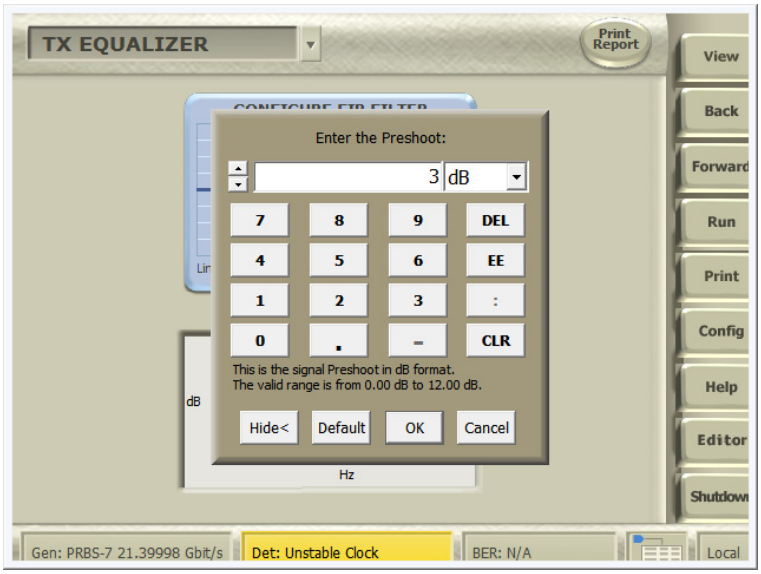


Figure 20: Entering a 3 dB preshoot value

The resultant TX Equalizer view changes to show the linear tap value display and the resultant frequency response. Note the Preshoot label below the tap value display.

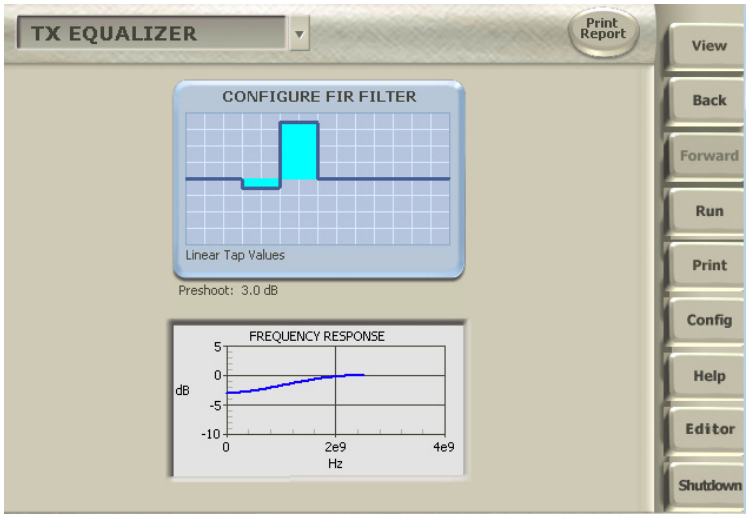


Figure 21: TX Equalizer view showing 3 dB preshoot

Click **Clear All Stages** in the setup menu to return the values to the default settings.

Enter PCIe preset values

The TX Equalizer view provides an easy way to setup PCIE values using one of the Preset settings. The default setting is P4 which defines the preshoot as 0.0 dB and the De-emphasis as 0.0 dB.

From the setup menu select one of the preset values, such as P0. The TX Equalizer view changes for those settings with a preshoot value of 0.0 dB and a de-emphasis value of -6 dB.

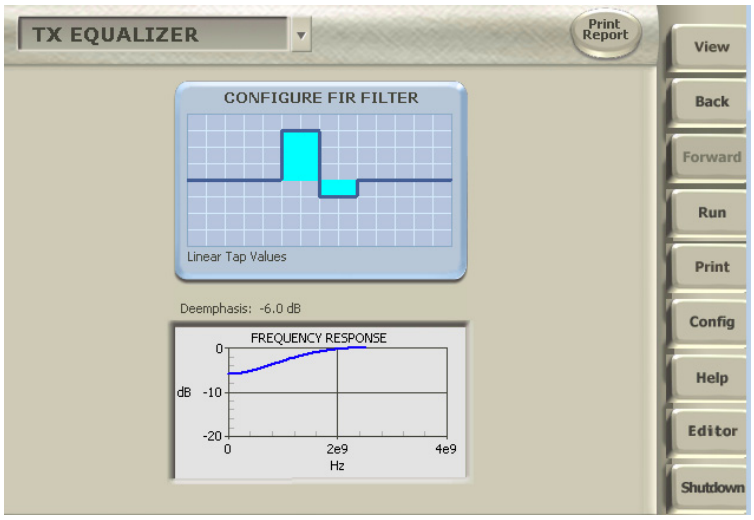


Figure 22: TX Equalizer view with PCIe preset P0

Click **Clear All Stages** in the setup menu to return the values to the default settings.

Pattern Sequencer examples

The Pattern Sequencer is a stand-alone application that runs separately on the BERTScope BSX-series instruments. It has three modes of operation selected from the tabs along the top of the application window:

- Editor mode. Use the Editor mode to create, load, edit, and save Bit Oriented and Protocol Aware memory segments and pattern match files, legacy BERTScope RAM files, BERTScope ASCII files, or BERTScope eye mask files. Use this view to also view Universal Event Record (UER) files. Refer to the online help for more information on the Editor mode.
- Bit Oriented sequencer mode. Use this mode to create, load, edit, save, and execute Bit Oriented sequences. An example of using this mode is provided in this section.
- Protocol Aware sequencer mode. Use this mode to create, load, edit, save, and execute Protocol Aware sequences. An overview of using this mode is provided in this section.

For detailed information on the Pattern Sequencer, refer to the online help included on the instrument.

NOTE. *Tektronix recommends using an external monitor with the BERTScope when using the Pattern Sequencer. A monitor with a minimum resolution of 1024 x 768 is highly recommended.*

All of the screen shot images in this section were displayed on an external monitor.

To start the Pattern Sequencer, go to the View menu and click the **Editor** button on the bottom right of the screen. The Pattern Sequencer displays on top of the BERTScope application. It is a good idea to move the Pattern Sequencer to an external monitor connected to the BERTScope make the best use of screen real estate.

Bit Oriented Sequencer example

This example shows basic steps for setting up a Bit Oriented sequence. This sequence will output several PRBS patterns; the Auto Pattern mode of the Detector will detect each PRBS as the states advance in real-time.

NOTE. *When connecting cables to the front panel use high quality coaxial cables with APC3.5 or SMA connectors.*

Refer to the following figure and connect the SMA cables on the front panel:

Figure 23: Front panel cable connections for the Pattern Sequencer examples

1. Connect an SMA cable from the Pattern Generator + Clock Output connector to the Error Detector Clock Input connector.

   Terminate the Pattern Generator – Clock Output with a 50 Ω terminator.

2. Connect an SMA cable from the Pattern Generator + Data Output connectors to the Error Detector + Data Input connectors.

3. If you haven't already done so, connect an external monitor to the BERTScope to display the Pattern Sequencer application.

4. Power on the instrument and the external monitor; wait for the Home view to appear.

5. Click the **Editor** button near the bottom of the View menu on the BERTScope to open the Pattern Sequencer application.

6. Click the **Bit Oriented Sequencer** tab to access the controls for the Bit Oriented Sequencer mode.
7. Click the **New** button on the toolbar to generate a new sequence.

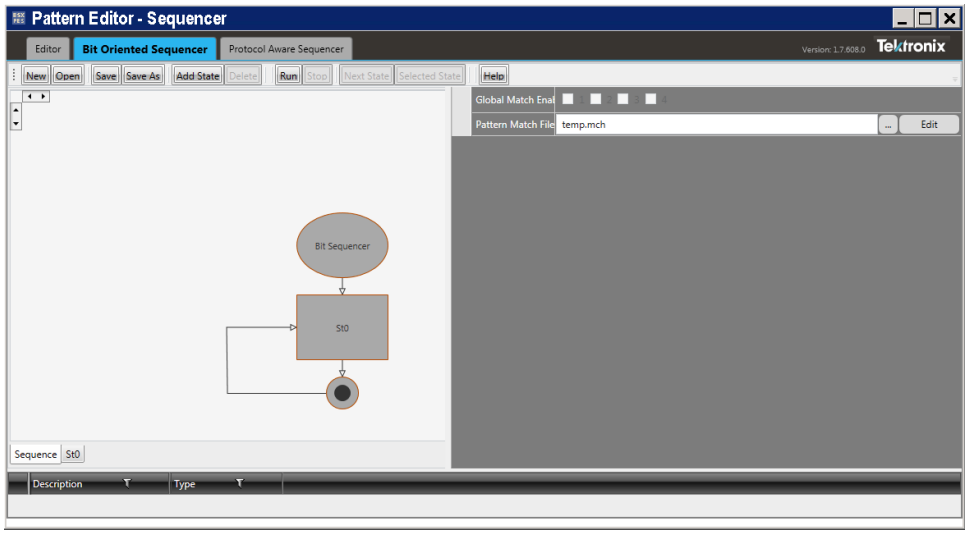


Figure 24: Default sequence in the Bit Oriented Sequencer

8. Select the **St0** box and change the State Repeat Count field to **500000**.
9. Click the **St0** tab near the bottom of the window to switch to the State view.

   The State view currently contains a single segment.

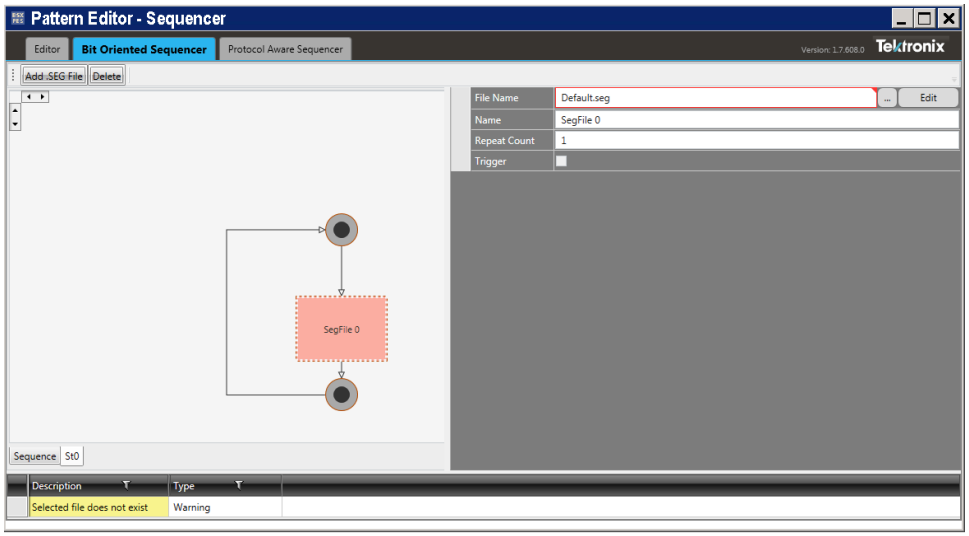


Figure 25: State view with a single segment

10. Click the Segment box and choose a segment file in the Properties section on the top right side of the State view:

    a. Click ... to open a folder location.

    b. Navigate to the following location:

    ```
    D: > BitAlyzer > Sequences > Examples > BitOriented > PRbsPatterns
    ```

    c. Select the **PRBS7.seg** file and click **Open**.

11. Click the **Sequence** tab at the bottom left side of the State view to switch to the Sequence view.

12. Click the **St0** box to select it.

13. Click the **Add State** button in the toolbar.

    This creates a new state (St1) after the currently selected (St0) state and creates a new tab near the bottom of the Sequence window for navigating to the new St1 state.

14. With the new St1 state selected, change the State Repeat Count property from Count to **Until Match**.

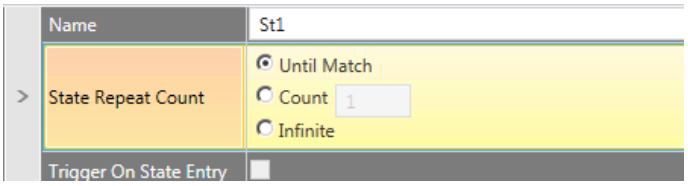


Figure 26: State Repeat Count properties

The Bit Sequencer oval turns red to indicate a failed requirement. To address this failed requirement you need to specify a Match file.

15. Click the red Bit Sequencer oval and go to the Properties area near the top right side of the window and specify a Pattern Match File:

    a. Click ... to open a folder location.

    b. Navigate to the following location:

    ```
    D: > BitAlyzer > Sequences > Examples > BitOriented > PRbsPatterns
    ```

    c. Select the **PRBS23.mch** file and click **Open**.

16. Click the **St1** tab near the bottom of the window to switch to the State view for the newly created state.

    The State diagram looks different because it now contains a Match? diamond because you changed the State Repeat Count property of the Bit Sequencer to Until Match.

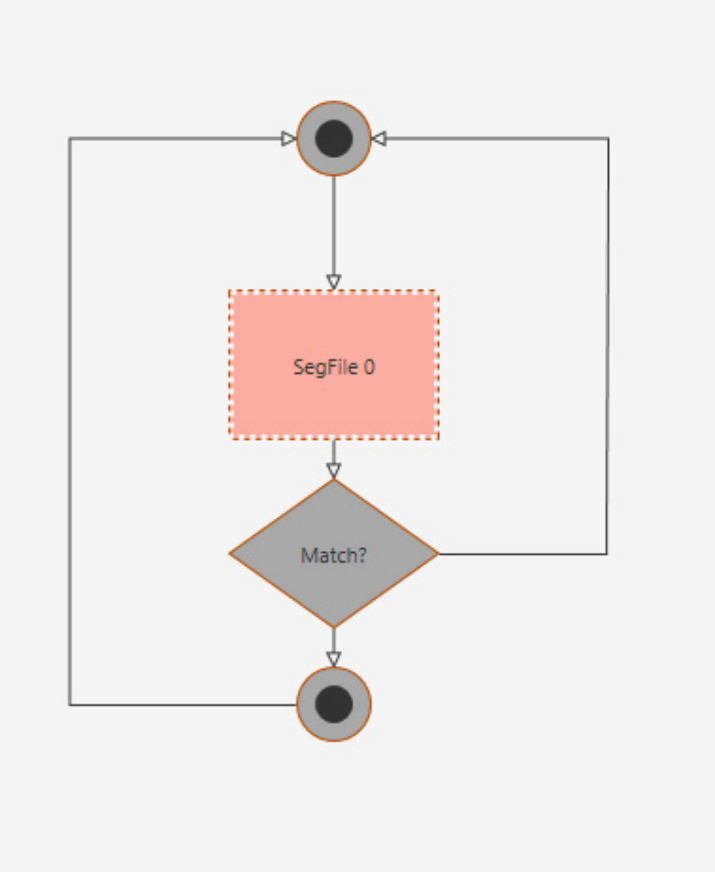


Figure 27: State diagram with a new Match? diamond

17. Click the Match? diamond and go to the Properties area and click the **1** check box in the Matcher Enables field.

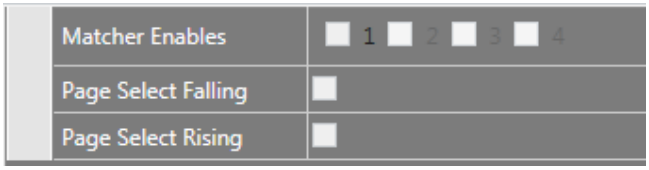


Figure 28: Matcher Enables properties

- The Matcher Enables field allows you to indicate which patterns will allow the sequence to continue. If the Detector does not detect one of the selected patterns when the Match? diamond is reached, the state will repeat from the beginning.
- Matcher files (selected at the Sequence level) contain up to four matchers. The first matcher in the file is **1**. The second is **2**, and so on. If the Matcher file contains less than four matchers, the unavailable options will be disabled.

18. Click the **SegFile 0** Segment and choose a segment file:

    a. Click  to open a folder location.

    b. Navigate to the following location:

    ```
    D: > BitAlyzer > Sequences > Examples > BitOriented > PRbsPatterns
    ```

    c. Select the **PRBS11.seg** file and click **Open**.

    Note that PRBS11 is *not* a multiple of 128 bits in length.

19. Click the **Add .SEG File** button in the toolbar to insert a new Segment file after the PRBS23 segment (SegFile 0).

20. Click the new segment (**SegFile 1**) and choose a segment file:

    a. Click  to open a folder location.

    b. Navigate to the following location:

    ```
    D: > BitAlyzer > Sequences > Examples > BitOriented > PRbsPatterns
    ```

    c. Select the **PRBS23.seg** file and click **Open**.

21. Set the Segment Repeat Count to **10000**.

22. Click the Sequence tab at the bottom of the window to switch to the Sequence view.

23. Click the **Run** button in the toolbar to start the sequence.

    The current running state will be highlighted.

24. Observe the Detector as it recognizes the PRBS patterns and continues through the Sequence in a loop:

    - The first state (**St0**) is in the Count Repeat mode so it will not wait for the Detector to continue to the next state. It will repeat all segments the desired number of times and continue.

      Based on the settings in this example, this state will run for approximately four seconds.

    - The second state (**St1**) is in the Until Match Repeat mode, and will not continue to the next state until the Detector recognizes one of the indicated patterns in the Match? diamond.

    - At the end of the sequence, the process starts again from the first state (**St0**).

25. Click the **Stop** button in the toolbar to stop the sequence.

    This forces the Generator to output all zeros.

26. To see another example of a Bit Oriented Sequence, click the **Open** button in the toolbar:

    a. Navigate to the following location:

    `D: > BitAlyzer > Sequences > Examples > BitOriented > PRbsPatterns`

    b. Select the **PrbsPattern.bsi** file and click **Open**.

NOTE. *If any errors occur, they will be identified in the Status area near the bottom of the window. All errors must be resolved before running the sequence.*

*For information on the errors, click the **T** next to **Description** in the Status area to open a dialog box listing the errors.*

Protocol Aware Sequencer overview

The Protocol Aware Sequencer is visually similar to the Bit Oriented Sequencer, but focuses on features for specific protocols and communication standards, including the following:

- 8b/10b Encoding
- PCIe Gen3 PHY Layer (128b/130b)
- PCIe Gen4 PHY Layer (128b/130b)
- USB SuperSpeedPlus PHY Layer (128b/132b)

Each State in the Protocol Aware Sequencer is aligned to a protocol. Sequences can be created to achieve DUT loopback and send compliance patterns for a variety of situations. The following overview is designed to put a PCIe DUT into Gen3 loopback during the *Config.LW.Start* State and then send the Gen3 PCIe Modified Compliance pattern (from the PCIe specification) to the DUT. This overview will open an existing Sequence and shows some of the feature differences between the Protocol Aware sequencer and Bit Oriented sequencer.

1. Click the **Editor** button near the bottom of the View menu on the BERTScope to open the Pattern Sequencer application.
2. Click the **Protocol Aware Sequencer** tab to access the controls for the Protocol Aware Sequencer mode.
3. Click the **Open** button on the toolbar to open a new sequence.
   a. Navigate to the following location:

      `D: > BitAlyzer > Sequences > Examples > ProtocolAware > PCIeLoopback > Gen3`

   b. Select the **Training_No_Link_EQ.psi** file and click **Open**.

4. Select the Protocol Sequencer node at the top to see the Matcher file, as well as the Protocol Aware options for various standards as shown in the following figure:

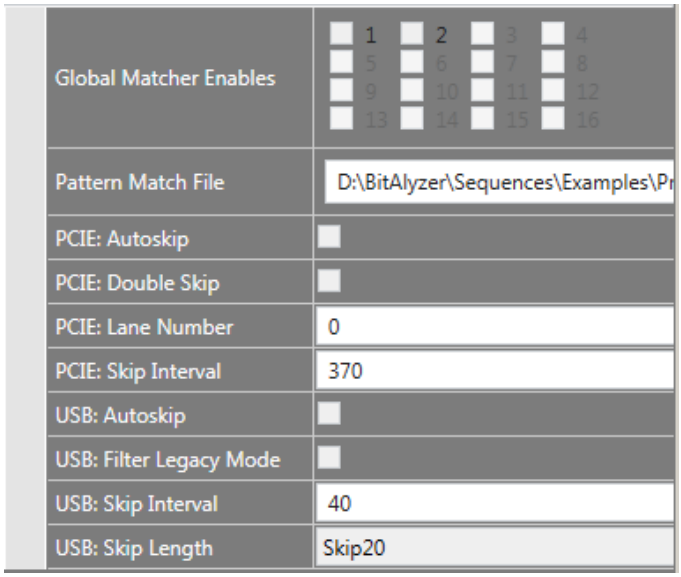


Figure 29: Protocol Aware options and related standards

5. Select the first state in the sequence, the **Polling.Active** state.

   The Protocol Aware Sequencer offers more options for State nodes as shown in the following figure:

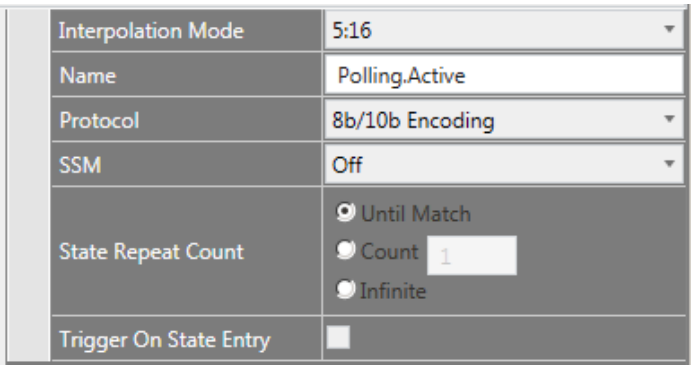


Figure 30: Protocol Aware options for State nodes

6. Click the **Polling.Config** tab at the bottom left side of the Sequence view.

   This appears very similar to the Bit Oriented Sequencer, with the exception that the nodes are Protocol Segment ((.pseg) files rather than Segment files (.seg).

   A *Match?* node is present because the Polling.Config state in the Sequence view is set to **Until Match**.

7. Click the **Sequence** tab at the bottom left side of the State view to switch to the Sequence view.
8. Select the **Loopback Pattern** State.

   Notice that this state has the State Repeat Count set to Infinite as shown in the following figure:

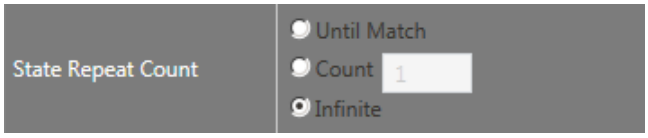


Figure 31: Protocol Aware State Repeat Count options

   The state will continue to run until it is forced to the next state with either the **Next State** or **Selected State** buttons in the toolbar.

The preceding overview showed some of the differences between the Bit Oriented Sequencer and the Protocol Aware Sequencer. The Protocol Aware Sequencer can be used to generate complex compliance patterns and to get the DUTs into loopback for compliance testing. For more information on the Protocol Aware Sequencer, refer to the online help on the BERTScope instrument.

Reference

Identify Pattern Generator and Error Detector synchronization problems.

If the Pattern Generator and the Error Detector are not synchronized, you must address the problem before continuing. Use the following steps to help identify the source of the synchronization problems:

1. Verify that you are using the correct, high-quality coaxial cables with APC3.5 or SMA connectors.
2. Carefully check the cable connections to the instrument and the polarity of the connections; make any corrections as needed.
3. Check that the Pattern Generator has its clock outputs switched on (click **Outputs On/Off**).
4. If the status information on the bottom of the Error Detector says **Unstable Clock**, check for the following:
   - Check that the Pattern Generator clock has the internal clock source selected, rather than external.
   - Check that the Clock Input termination is set to the same termination as the Generator clock output.
5. Verify that the Status Bar at the bottom of the Generator and Detector views show the same data type and data rate.

   If synchronization is not achieved, the Status Bar will be a bright yellow color and displays **No Sync**. If this happens, check for the following:
   - Check that the Error Detector Data Input termination is set to the same termination as the Generator output setting.
   - Check that the Error Detector Data Input is set to Differential input.
6. Verify that the data type is PRBS-7. If not, check for the following:
   - Check that the Data Type setting on the Generator view is set to PRBS-7. If necessary reset it to PRBS-7.
   - Check that the Data Type setting on the Detector view is set to PRBS-7. If necessary reset it to PRBS-7.
7. Verify that the X1/X2 settings in the Detector view are correct for your application.
8. Verify that the Generator Clock rate is set to 1 GHz. If necessary, reset it to 1.0 GHz.

9. Verify that the Error Detector settings are the same as the Generator Clock and Data settings. This includes the Interface Mode and Logic Family settings. Change them as necessary.
10. Try to resynchronize again by clicking the **Auto Align** button.

Operating system restore

The instrument contains an operating system restore file in a separate partition of the hard disk drive. Should the need arise, use this file to restore the instrument operating system.

CAUTION. *Using the restore process reformats the hard disk drive and reinstalls the operating system. All saved data is lost. If possible, save important files to external media before performing a system restore.*

1. Restart the instrument. During the boot-up process you will see the following message at the top of the screen:

   ```
   Acronis Loader

   Press F5 to start the Acronis Startup Recovery Manager.
   ```

2. Repeatedly press the F5 key until the Acronis True Image Tool opens. There is a 15-second delay after the message appears until the instrument proceeds with normal instrument startup. If the instrument does not open the Acronis application, power off the instrument, then power on the instrument and try again.
3. Click **Restore**.
4. In the Confirmation dialog box, click **Yes** to restore the instrument operating system, or **No** to exit the restore process. The restore process takes approximately 30 minutes; the actual time depends on the instrument configuration.
5. Go to www.tek.com/software to search for and download the BERTScope application software; then follow the instructions to install the software for your instrument.

User service

This section describes high-level service information and procedures for your instrument.

Service offerings

Tektronix provides service to cover repair under warranty and other services that are designed to meet your specific service needs.

Whether providing warranty repair service or any of the other services listed below, Tektronix service technicians are well equipped to service the instrument. Services are provided at Tektronix Service Centers and on-site at your facility, depending on your location.

Warranty repair service

Tektronix warrants this product as described in the warranty statements at the front of this manual. Tektronix technicians provide warranty service at most Tektronix service locations worldwide.

Calibration and repair service

In addition to warranty repair, Tektronix Service offers calibration and other services that provide cost-effective solutions to your service needs and quality standards compliance requirements. Tektronix instruments are supported worldwide by the leading-edge design, manufacturing, and service resources of Tektronix to provide the best possible service.

General care

Protect the instrument from adverse weather conditions. The instrument is not waterproof. Do not store or leave the instrument where the display will be exposed to direct sunlight for long periods of time.

CAUTION. *To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents.*

Preventive maintenance

Preventive maintenance mainly consists of periodic cleaning. Periodic cleaning reduces instrument breakdown and increases reliability. Clean the instrument as needed, based on the operating environment. Dirty conditions may require more frequent cleaning than computer room conditions.

Clean the flat panel display

The flat panel display is a soft plastic display and must be treated with care during cleaning.

CAUTION. *Improper cleaning agents or methods can damage the flat panel display.*

- Do not use abrasive cleaners or commercial glass cleaners to clean the display surface.
- Do not spray liquids directly on the display surface.
- Do not scrub the display with excessive force.
- Avoid getting moisture inside the instrument while cleaning the display; use only enough solution to dampen the wipe.
- Clean the flat panel display surface by gently rubbing the display with a cleanroom wipe (such as Wypall Medium Duty Wipes, #05701, available from Kimberly-Clark Corporation).
- If the display is very dirty, moisten the wipe with distilled water or a 75% isopropyl alcohol solution and gently rub the display surface. Avoid using excess force or you may damage the plastic display surface.

Clean the exterior surfaces

Clean the exterior surfaces with a dry, lint-free cloth or a soft-bristle brush. If dirt remains, use a cloth or swab dampened with a 75% isopropyl alcohol solution. A swab is useful for cleaning in narrow spaces around the controls and connectors. Do not use abrasive compounds on any part of the instrument.

To avoid damaging the instrument follow these precautions:

- Avoid getting moisture inside the instrument during external cleaning and use only enough solution to dampen the cloth or swab.
- Do not wash the front-panel power switch. Cover the switch while washing the instrument.
- Use only deionized water when cleaning. Use a 75% isopropyl alcohol solution as a cleanser and rinse with deionized water.
- Do not use chemical cleaning agents; they may damage the instrument. Avoid chemicals that contain benzene, toluene, xylene, acetone, or similar solvents.

Battery information

The coin cell battery on the instrument computer motherboard is not a user replaceable part. The coin cell battery is not rechargeable. Under no circumstances attempt to recharge the battery.

Connector replacement

The Pattern Generator CLOCK OUTPUT and DATA OUTPUT connectors and the Error Detector CLOCK INPUT and DATA INPUT connectors use 3.5 mm to PAC Planar Crown® adapters. Replacement adapters can be ordered from Tektronix.

To replace the front panel connectors, complete the following steps:

1. Remove a damaged connector by grasping the knurled outer part of the ring with your fingers and turning counterclockwise.

   Do not allow foreign material to enter the connector body when replacing the adapter.

2. Position the two locating tabs in the corresponding slots of the instrument-mounted part of the connector and seat the replacement adapter

3. Align the retaining ring and tighten by rotating clockwise.

   Tightened the connector finger-tight. To avoid over-tightening and possibly damaging the connector, do not use a tool to tighten it.

Fuse replacement

The instrument is protected by a fuse placed in series with the power line input. The fuse is conservatively rated and should never open through the life of the instrument. A blown fuse would generally indicate a problem with the instrument which requires factory service. It is recommended that you arrange to have the instrument serviced if you experience a blown fuse.

Instrument calibration

The instrument uses digital calibration of the output buffers. To maintain the accuracy of the output amplitude and offset, annual calibration is recommended. Contact Tektronix to schedule instrument calibration.

Repack the instrument for shipment

If the instrument is to be shipped to a Tektronix service center for repair, attach a tag showing the following information:

- Name of the product owner
- Address of the owner
- Instrument serial number
- A description of the problems encountered and/or service required

When packing an instrument for shipment, use the original packaging. If it is unavailable or not fit for use, contact your Tektronix representative to obtain new packaging.

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