User Guide

Keysight N4980A Multi-Instrument BERT Software

KEYSIGHT TECHNOLOGIES

Notices

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Safety Notices

CAUTION

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

WARNING

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

Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements. Product manuals are provided with your instrument on CD-ROM and/or in printed form. Printed manuals are an option for many products. Manuals may also be available on the Web. Go to www.keysight.com and type in your product number in the Search field at the top of the page.

General

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1.

Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters.

Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

Before Applying Power

Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Safety Symbols

Table 1. Safety Symbol

Symbol	Description
	Indicates warning or caution. If you see this symbol on a product, you must refer to the manuals for specific Warning or Caution information to avoid personal injury or damage to the product.
	Frame or chassis ground terminal. Typically connects to the equipment's metal frame.
	Indicates hazardous voltages and potential for electrical shock.
	Indicates that antistatic precautions should be taken.
	Indicates hot surface. Please do not touch.
	CSA is the Canadian certification mark to demonstrate compliance with the Safety requirements.
	CE compliance marking to the EU Safety and EMC Directives. ISM GRP-1A classification according to the international EMC standard. ICES/NMB-001 compliance marking to the Canadian EMC standard.
	The RCM mark indicates that this product meets EMS/Product Safety Requirements and may be imported to Australia and New Zealand.
ICES/NMB-001	This mark indicates compliance with the Canadian EMC regulations.
ISM 1-A	This text denotes the instrument is an Industrial Scientific and Medical Group 1 Class A product.
	China RoHS regulations include requirements related to packaging, and require compliance to China standard GB18455-2001. This symbol indicates compliance with the China RoHS regulations for paper/fiberboard packaging.
	Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.
	The South Korean Class A EMC declaration (KC) mark indicates that this product is Class A suitable for professional use and is for use in electromagnetic environments outside of the home. The KC mark includes the marking's identifier code that has up to 26 digits and follows this format: KCC-VWX-YYY-ZZZZZZZZZZZZZ.

Compliance and Environmental Information

Table 2. Compliance and Environmental Information

Safety Symbol	Description
	This product complies with WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in WEEE Directive Annex I, this product is classed as a “Monitoring and Control instrumentation” product. Do not dispose in domestic household waste. To return unwanted products, contact your local Keysight office for more information.

Contents

1 Introduction

The N4980A multi-instrument BERT software application provides users of Keysight Technologies instruments the ability to control many of their instruments through a rich Windows-based Graphical User Interface (GUI) and perform several types of measurements across multiple Keysight Technologies instruments. For example, this software can record and display a series of BER measurements, enabling the following capabilities:

- Monitor the instantaneous BER over time and report the accumulated BER. This is useful for watching for patterns of bit errors over time and monitoring changes in the measured BER.
- Measure BER across multiple Error Detectors simultaneously and report the parallel (aggregated) BER across multiple channels, ideal for monitoring the performance of multiple receivers at once.
- View the BER measurement-based Bathtub, or horizontal slice through the eye as seen by a Keysight Technologies Error Detector. Viewing the Bathtub is useful for examining transmitted signals, and can be used for comparing the width of the eye opening in different conditions. For example, users can quickly view how crosstalk aggressors affect a transmitted signal by comparing the width of the resulting Bathtub with and without the presence of aggressors.
- Perform jitter tolerance characterization and compliance testing on multiple DUT channels simultaneously.

1.1 Instrument Compatibility

The N4980A multi-instrument BERT software provides easy-to-use control panels for the following instruments:

- N4971A pattern generator 13 Gb/s
- N4965A multi-channel BERT 12.5 Gb/s
  - N4955A-P12 12.5 Gb/s pattern generator remote head
  - N4955A-D12 12.5 Gb/s pattern generator with 4-tap de-emphasis remote head
  - N4956A-E12 12.5 Gb/s error detector remote head
  - N4957A-C12 clock doubler remote head
- N4962A serial BERT 12.5 Gb/s
- N4963A clock synthesizer 13.5 GHz
- N4972A clock synthesizer 16 GHz
- N4960A serial BERT 17 and 32 Gb/s
  - N4951A-P17 17 Gb/s or N4951A-P32 32 Gb/s pattern generator remote head
  - N4951B-H17 17 Gb/s or N4951B-H32 32 Gb/s pattern generator high amplitude remote head
  - N4951B-D17 17 Gb/s or N4951B-D32 32 Gb/s pattern generator with 5-tap de-emphasis remote head
  - N4952A-E17 17 Gb/s or N4952A-E32 32 Gb/s error detector remote head

1.2 Backward Compatibility

The N4980A multi-instrument BERT software is also backward compatible with the following instruments:

- PPG12500 pattern generator 13 Gb/s
- PCB12500 multi-channel BERT 12.5 Gb/s
  - TG5P1A 12.5 Gb/s pattern generator remote head
  - TG7P1A 12.5 Gb/s pattern generator remote head with 4-tap de-emphasis
  - TR2P1A 12.5 Gb/s error detector remote head
  - TG3C1A clock doubler remote head
- TG1B1A serial BERT 12.5 Gb/s
- TG1C1A clock synthesizer 13.5 GHz
- SCS16000 clock synthesizer 16 GHz
- SSB16000 serial BERT Controller
  - PG17 (17 Gb/s) or PG32 (32 Gb/s) pattern generator remote head
  - ED17 (17 Gb/s) or ED32 (32 Gb/s) error detector remote head

The backward compatibility allows control of older products to be used with the current Keysight products as shown in Figure 1.

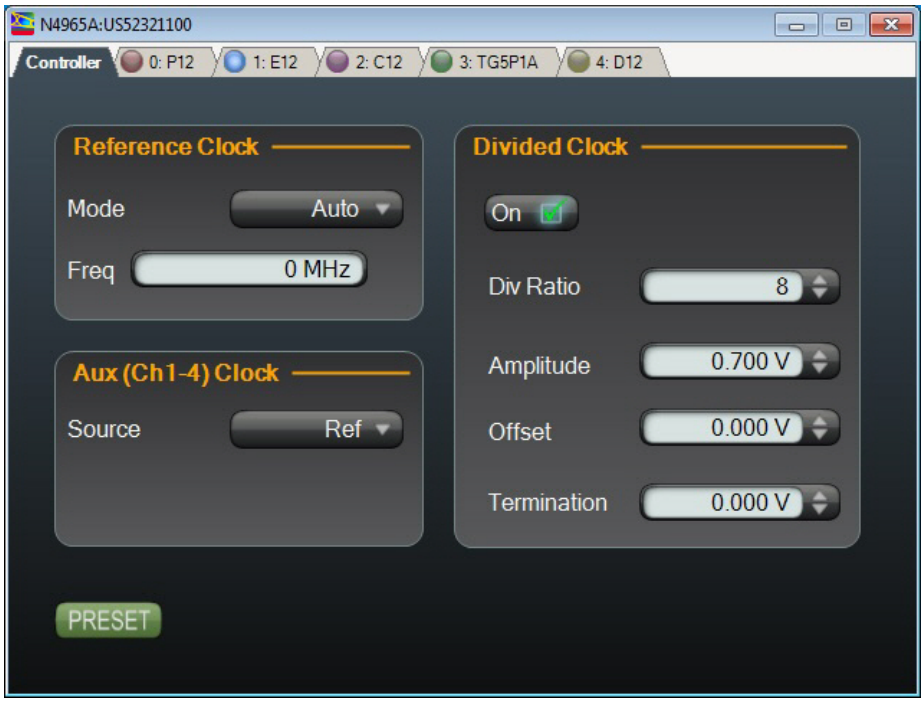


Figure 1. Instrument compatibility

Figure 1 shows an N4965A controller configured with Keysight remote heads and a TG5P1A.

NOTE

The firmware in the SSB16000 and PCB12500 controllers can be upgraded to support Keysight N4951A, N4951B, N4952A, and N4955A, N4956A, and N4957A remote heads respectively. Go to www.Keysight.com/find/n4960a or www.Keysight.com/find/N4965A and click on the Technical Support link then select the Drivers, Firmware & Software tab to access the latest firmware.

1.3 Setup Overview

Before the N4980A multi-instrument BERT software can be used to perform measurements, the following steps are performed:

1. Discover instruments.
2. Connect instruments.
3. Control instruments.

NOTE

Before discovering instruments, connecting instruments, and controlling instruments, ensure that the computer meets the minimum system requirements described in chapter 2 “System Requirements”, the software has been installed according to the instructions in chapter 3 “Installation”, the instruments have been interconnected for remote control through either USB or GPIB, and electrically connected to the circuit under test.

1.3.1 Step 1: Discover Instruments

Discovery identifies the instruments which are connected to the remote control bus (USB or GPIB).

Figure 2. Discover instruments

NOTE

The discovered instruments are displayed as:
<*model number*>:<*last 4 digits of serial number*>.

1.3.2 Step 2: Connect Instruments

Once the Discovery process is complete, Connect All links the instruments to be used to the software.

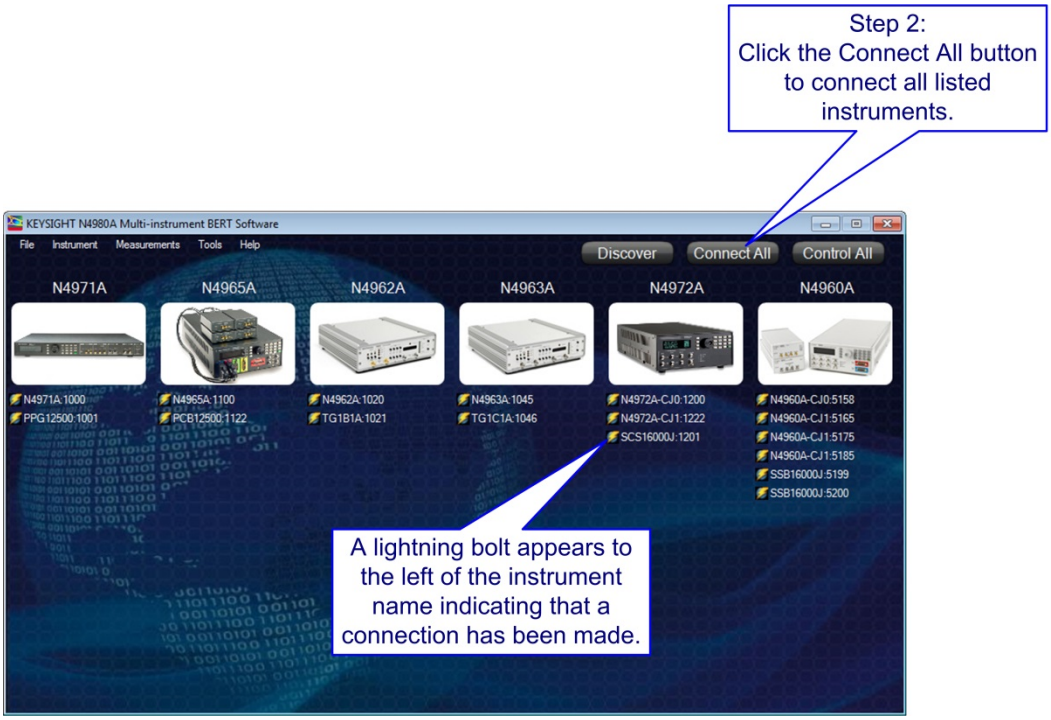


Figure 3. Connect instruments

1.3.3 Step 3: Control Instruments

The Control All button opens the control user interface for all instruments which have been Connected. An individual control user interface can be opened by right-clicking on an instrument name located below the instrument image and selecting Control.

Measurements can be performed without opening the control windows for the instruments.

Figure 4. Control instruments

1.4 Measurement Overview

This section provides an overview of the measurement panels used to set up the following measurements:

- Single channel BER
- Multi-channel BER
- Bathtub view
- Jitter tolerance

For more detailed information, refer to the section corresponding to the specific measurement panel in Section 5 “Measurements”.

1.4.1 Set Up a Single Channel BER Instrument

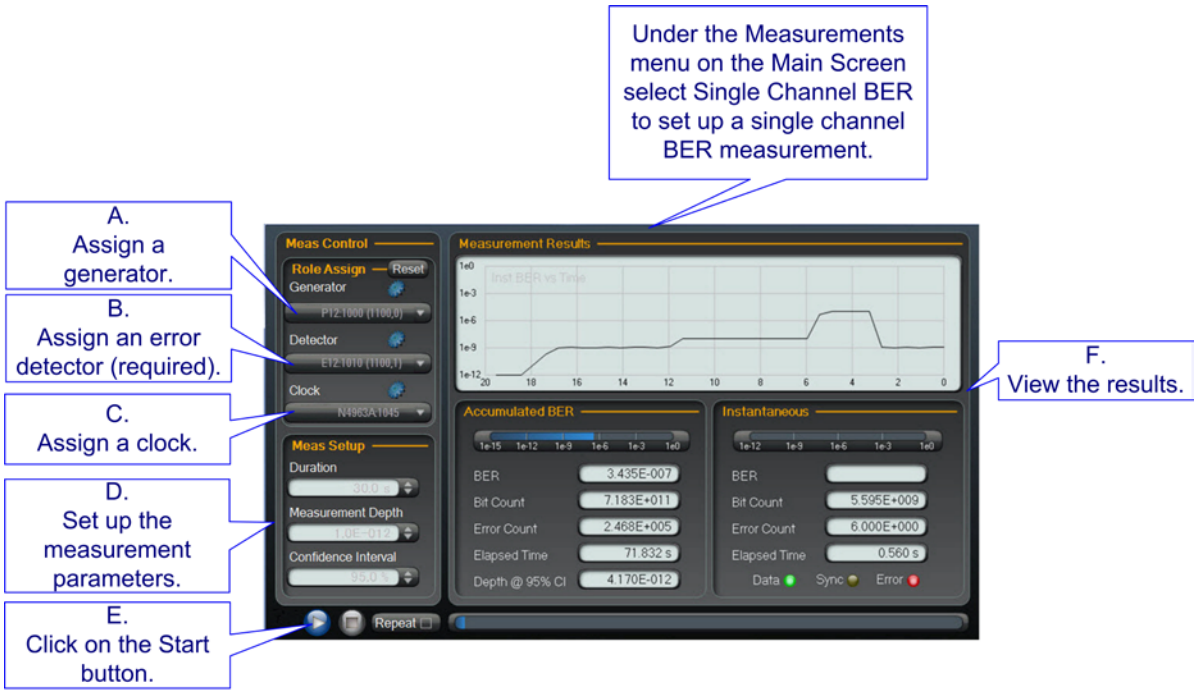


Figure 5. Set up a single channel BER measurement

1.4.2 Set Up a Multi-channel BER Instrument

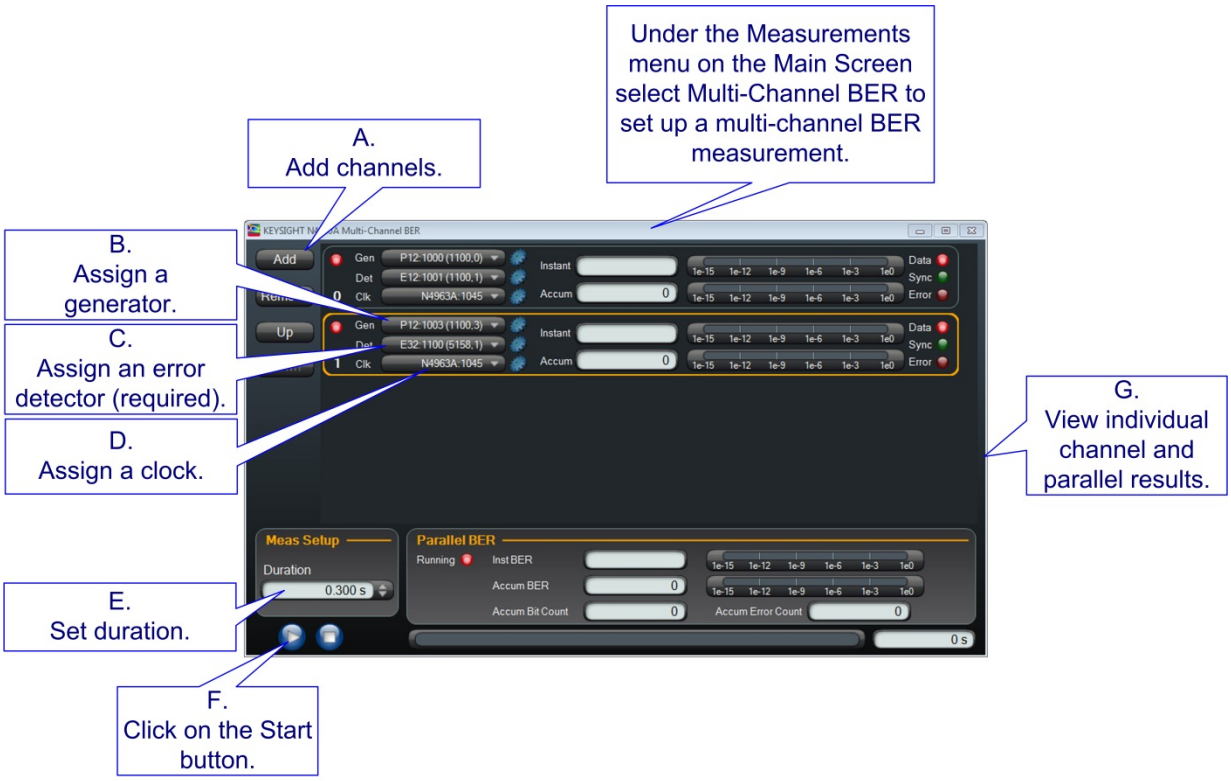


Figure 6. Set up a multi-channel BER measurement

1.4.3 Set Up a Bathtub View Measurement

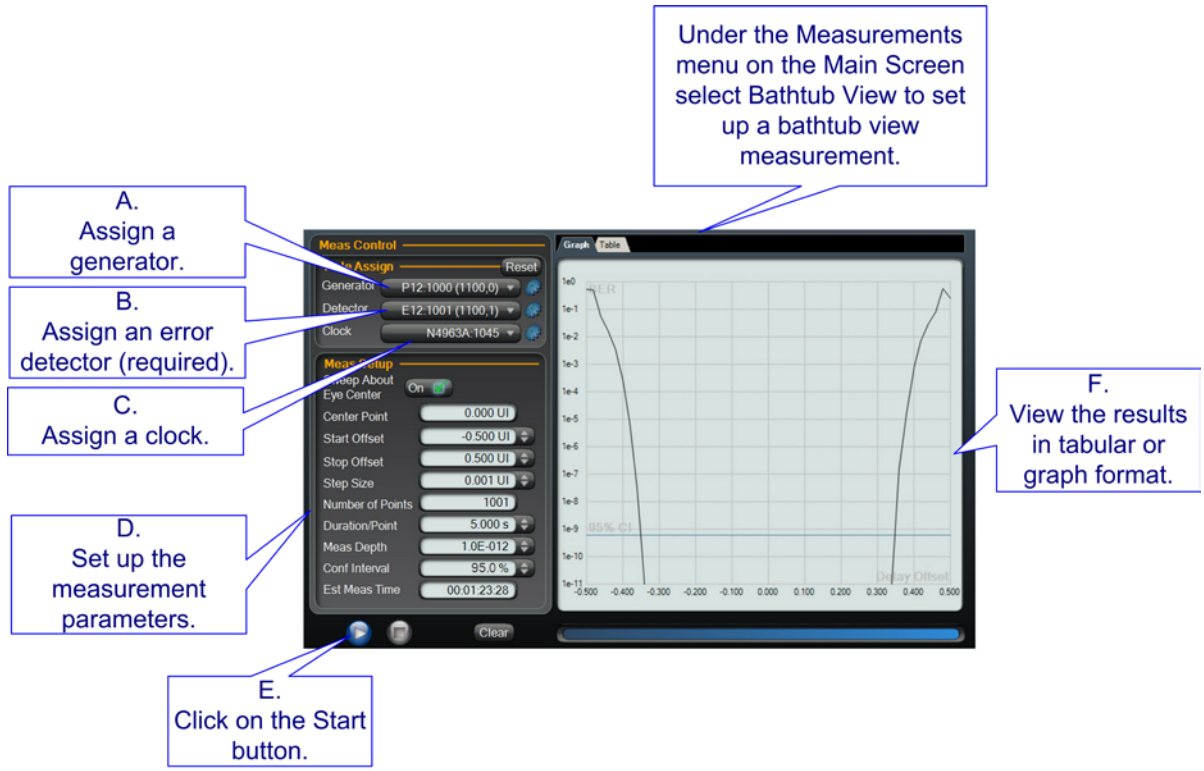


Figure 7. Set up a Bathtub view measurement

1.4.4 Set Up a Jitter Tolerance Measurement

Jitter Tolerance is an optional feature only available when the software license has been installed.

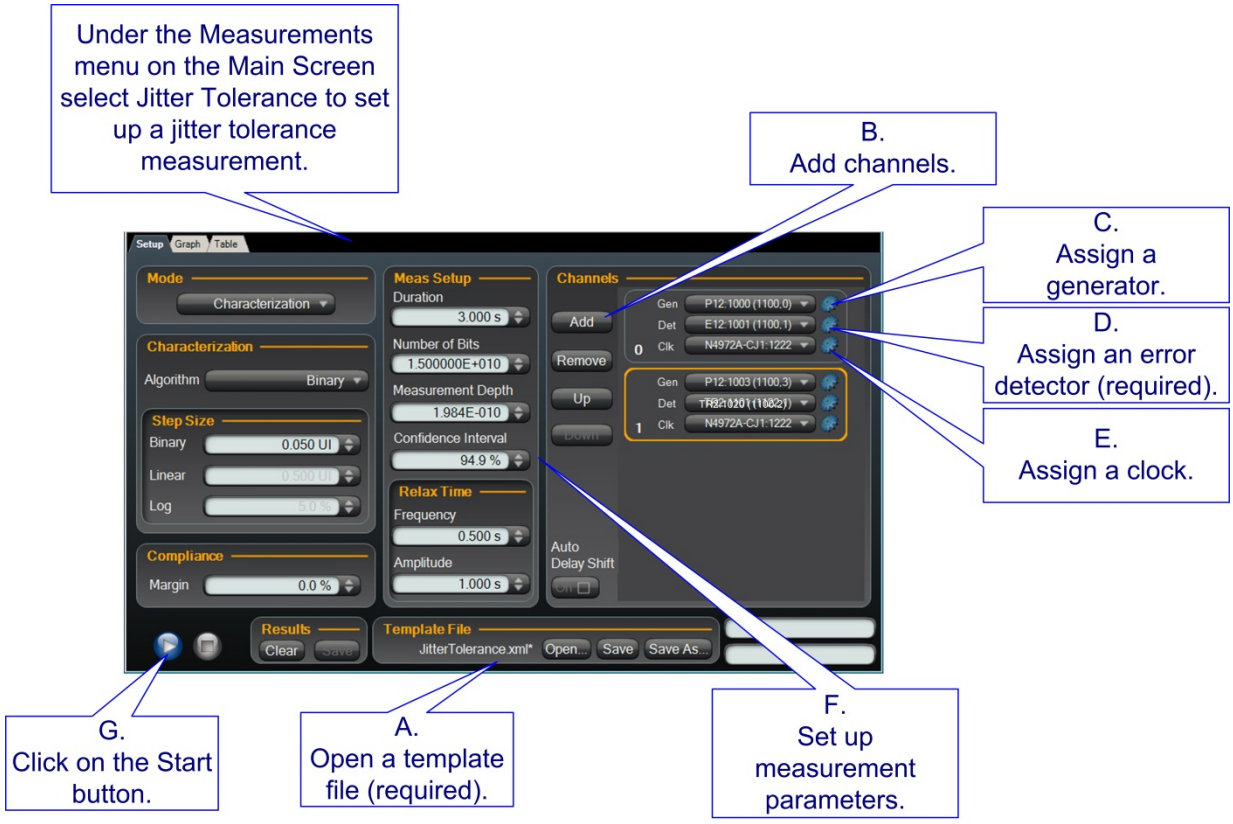


Figure 8. Set up a jitter tolerance measurement

2 System Requirements

- PC: Intel Pentium processor or equivalent
- OS: Windows 7 32-bit and 64-bit operating system
- Screen resolution: XGA+ (1152 x 864) min
- RAM: 500 MB (minimum); 4 GB (minimum for Windows 7 64-bit)
- Disk space for installation: 100 MB
- .NET framework version 3.5
- I/O libraries (for GPIB, not required for USB)

Systems that do not meet these requirements may not operate correctly.

NOTE

N4980A multi-instrument BERT software operation may be adversely affected by Windows standby, sleep, or hibernation. Long measurements may be aborted, and in some cases the program may need to be restarted. For computers running N4980A multi-instrument BERT software, the sleep/standby/hibernate settings should be set to “never”.

3 Installation

3.1 Downloading Installation File

The Keysight Technologies N4980A multi-instrument BERT software can be downloaded from the Keysight Technologies web site at www.Keysight.com/find/N4980A.

3.2 Installing the Software

Please refer to the Keysight Technologies N4980A multi-instrument BERT software Getting Started Guide for installation instructions. The guide can be found on the Keysight Technologies website at www.Keysight.com/find/N4980A.

3.3 Installing a License

A license is required to perform jitter tolerance measurements and use the de-emphasis tap weight calculator. Refer to Section 6.1 Licensed measurements for information on how to install license keys for specific measurements.

4 Using the N4980A Multi-Instrument BERT Software

4.1 Using the Main Screen

The main screen is divided into the areas shown in Figure 9.

Figure 9. Main screen overview

NOTE For proper display of the N4980A screen text, ensure that the maximum DPI setting on your PC is no greater than 100% (default).

The Title Bar is located at the top of the main screen and displays the name of the product. Also, the Minimize and Close buttons are displayed in the upper right corner.

The Menu Bar is located just below the Title Bar and is a drop down menu system for setting up instruments and making measurements.

The Setup Buttons are located just below the Title Bar and are used to automatically add instruments to the instrument list, connect instruments, and control instruments.

The Supported Instruments are located just below the Menu Bar and Setup Buttons and display which instruments are supported. Clicking on an individual instrument image adds the specific instrument to the instrument list. Multiple instruments of the same model, as well as multiple instruments of different models, can be connected at the same time.

The Instrument List displays the list of added instruments, their serial number, and if they are connected (indicated by the lightning bolt icon to the left of the instrument name and serial number). The control panel of each connected instrument can also be accessed.

4.1.1 Title Bar

The product name is displayed in the Title Bar. Clicking on the waveform icon in the title bar of any N4980A open window accesses the menu shown in Figure 10, from where the window can be moved, minimized, closed, or a jpeg image of the window can be saved with the Save Dialog option. This save window feature is particularly useful with a measurement such as bath tub view and jitter tolerance allowing a quick way to save a screen shot of the graphical result.

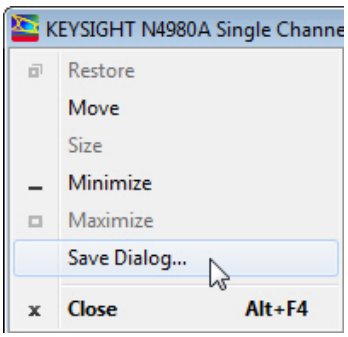


Figure 10. Title bar menu access

4.1.2 Menu Bar

4.1.2.1 File Menu

Table 3. File Menu Description

Name	Description
Save...	Saves configuration data to a file on the hard drive. Information such as what instruments were connected during the session, their settings, and the location of the control panels on the computer screen is stored.
Recall...	Recalls previously saved configuration data.
Exit	Closes the N4980A multi-instrument BERT software application. This is the same as the Close button (X) on the Title Bar.

4.1.2.2 Instrument Menu

Table 4. Instrument Menu Description

Name	Description
Discover	Keysight Technologies instruments connected to the bus are queried and an Instrument List is created.
Connect All	Connects to all Keysight Technologies instruments on the bus that are listed.
Control All	Opens the control panel of each instrument currently connected (indicated by the lightning bolt icon to the left of the instrument name and serial number).
Remove All	Removes all instruments from the Instrument List and disconnects connected instruments.
Virtual Instruments	Creates systems from instruments in the instrument list.

4.1.2.3 Measurements menu

Table 5. Measurement Menu Description

Name	Description
Single Channel BER	Accesses the Measurement Panel for performing Single Channel BER measurements.
Multi-Channel BER	Accesses the Measurement Panel for performing Multi-Channel BER measurements.
Bathtub View	Accesses the Measurement Panel for performing Bathtub View measurements.
Jitter Tolerance	Accesses the Measurement Panel for performing Jitter Tolerance measurements.

4.1.2.4 Tools menu

Table 6. Tools Menu Description

Name	Description
Licensed Measurements	Accesses the Measurements Panel for installing license keys.
Programmable Pattern Editor	Accesses the Programmable Pattern Editor for creating and uploading patterns.
Instrument upgrade	Accesses a dialog box for upgrading instrument firmware.
De-emphasis Tap Weight Calculator	Calculates tap weights, based on an S-parameter file of the channel loss, to create the ideal compensation filter response.
Command Viewer	Accesses a dialog box for viewing SCPI commands and queries to/from an instrument(s). Once an instrument is selected, the Command Viewer is used to view commands controlling the instrument.

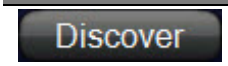
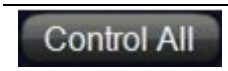
4.1.2.5 Help menu

Table 7. Help Menu Description

Name	Description
User's Guide	Accesses the online version of the User's Guide.
Keysight Website	Accesses the Keysight Technologies website for technical assistance.
About	Accesses information about the software.

4.1.3 Setup Buttons

Table 8. Setup Button Description

Name	Description
	Keysight Technologies instruments connected to the bus are queried and an Instrument List is created.
	Connects to all Keysight Technologies instruments on the bus that are listed.
	Opens the control panel of each instrument currently connected (indicated by the lightning bolt icon to the left of the instrument name and serial number).

4.1.4 Supported Instruments and Instrument Lists

The following instruments are supported:

- N4971A pattern generator 13 Gb/s
- N4965A multi-channel BERT 12.5 Gb/s
  - N4955A-P12 12.5 Gb/s pattern generator remote head
  - N4955A-D12 12.5 Gb/s pattern generator remote head with 4-tap de-emphasis
  - N4956A-E12 12.5 Gb/s error detector remote head
  - N4957A-C12 clock double remote head
- N4962A serial BERT 12.5 Gb/s
- N4963A clock synthesizer 13.5 GHz
- N4972A clock synthesizer 16 GHz
- N4960A serial BERT 17 and 32 Gb/s
  - N4951A-P17 17 Gb/s or N4951A-P32 32 Gb/s pattern generator remote head
  - N4951B-H17 17 Gb/s or N4951B-H32 32 Gb/s pattern generator high amplitude remote head
  - N4951B-D17 17 Gb/s or N4951B-D32 32 Gb/s pattern generator with 5-tap de-emphasis remote head
  - N4952A-E17 17 Gb/s or N4952A-E32 32 Gb/s error detector remote head

The N4980A multi-instrument BERT software is also backward compatible with the following instruments:

- PPG12500 pattern generator 13 Gb/s
- PCB12500 multi-channel BERT 12.5 Gb/s
  - TG5P1A 12.5 Gb/s pattern generator remote head
  - TG7P1A 12.5 Gb/s pattern generator remote head with 4-tap de-emphasis
  - TR2P1A 12.5 Gb/s error detector remote head
  - TG3C1A clock doubler remote head
- TG1B1A serial BERT 12.5 Gb/s
- TG1C1A clock synthesizer 13.5 GHz
- SCS16000 clock synthesizer 16 GHz
- SSB16000 serial BERT Controller
  - PG17 (17 Gb/s) or PG32 (32 Gb/s) pattern generator remote head
  - ED17 (17 Gb/s) or ED32 (32 Gb/s) error detector remote head

The menu shown in Figure 11 is accessed by right-clicking on an instrument name/serial number located below the corresponding image of the instrument. Each instrument name/serial number has its own menu for individual setup. This provided functionality is similar to Connect All and Control All, but only applies to the selected instrument.

Figure 11. Instrument setup menu

NOTE Multiple instruments can be controlled at the same time.

Table 9. Instrument Setup Menu Description

Name	Description
Connect	Connects the selected instrument. After the connection is made, a lightning bolt icon appears to the left of the instrument name and serial number.
Control	Opens the control panel of the selected instrument. Instruments must be connected before the control panel can be opened.
Disconnect	Disconnects the selected instrument. After disconnecting, the lightning bolt icon to the left of the instrument name disappears.
Reconnect	Reconnects the selected instrument after a configuration change has been made. For example, if a N4965A is being used and a new remote head is added, select Reconnect to remove the old configuration and accept the new one.
Remove From List	Removes the selected instrument name/serial number from the list.
Rename	Accesses a text field used to change the instrument name. This feature allows alias names to be set up for any instrument.

4.1.5 Virtual Instruments

Virtual instruments are systems created from instruments in the instrument list. The instruments comprising a virtual instrument must be discovered and connected before they can be added as a virtual instrument.

Virtual instrument control windows contain the most often used instrument features, and are designed to simplify instrument control by using simpler GUI window and also by combining multiple activities into one (e.g. the user only needs to choose the bit rate in one place with a virtual instrument setup, and the software will take care of programming each instrument within virtual instrument to the correct bit rate).

If required, the full control window for any instrument in a virtual instrument window can be accessed by clicking on the blue gear wheel next to the instrument name.

4.1.5.1 10G BERT System

Each 10G BERT system consists of a N4962A serial BERT 12.5 Gb/s and a N4963A clock synthesizer 13.5 GHz. These instruments are discovered automatically using the Discover function, but they must be added manually by selecting **Instrument -> Virtual Instruments -> Add -> 10G BERT System** as shown in Figure 12.

Figure 12. 10G BERT system menu items

Unlike the other instruments/systems that display their name/serial number under their corresponding image, each 10G BERT system is numbered in sequence as shown in Figure 13.

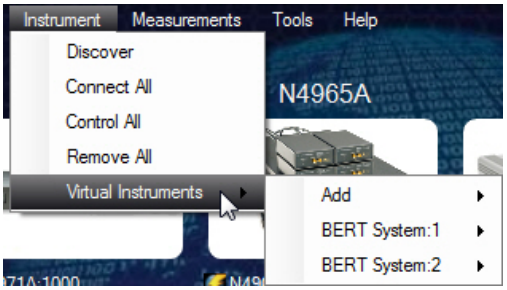


Figure 13. List of added N4962A & N4963A 10G BERT systems

To open the control panel of a 10G BERT system, select **Instrument -> Virtual Instruments -> BERT System:x -> Control** as shown in Figure 14.

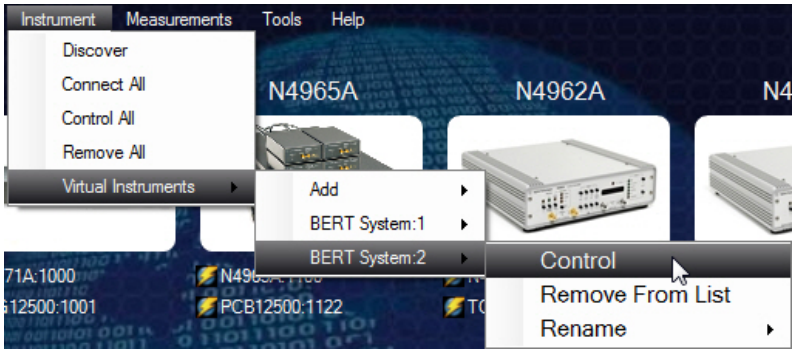


Figure 14. Opening 10G BERT system control panel

Figure 15 is an example of a control panel showing the N4962A & N4963A assigned to BERT System:2.

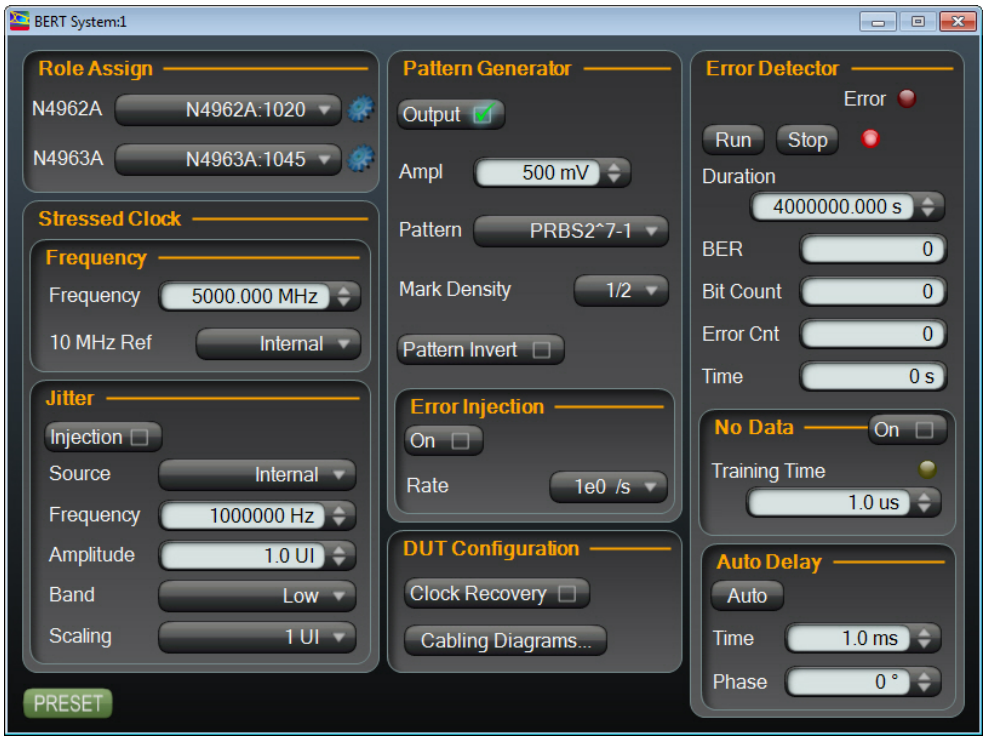


Figure 15. 10G BERT system control panel example

If a N4962A and N4963A are connected in the instrument list and the corresponding 10G BERT system has been added, disconnecting one of these instruments from the instrument list will also disconnect it from the corresponding 10G BERT system. Reconnecting the instrument in the instrument list will not reconnect it to the corresponding 10G BERT system.

Removing a 10G BERT system from the list will not disconnect the corresponding instruments from the instrument list.

4.1.5.2 Multi-channel N4960A System

Each multi-channel N4960A system consists of multiple N4960A serial BERT 17 and 32 Gb/s instruments that form a multi-channel system (up to four). Each N4960A (with/without remote heads attached) represents a single channel. The intent of this interface is to facilitate the setup and execution of multi-channel BER measurements.

The N4960A instruments are discovered automatically using the Discover function, but a multi-channel N4960A system must be added manually by selecting **Instrument -> Virtual Instruments -> Add -> Multi-channel N4960A** as shown in Figure 16.

Figure 16. Multi-channel N4960A system menu items

Unlike the other instruments/systems that display their name/serial number under their corresponding image, each multi-channel N4960A system is numbered in sequence as shown in Figure 17.

Figure 17. List of added multi-channel N4960A systems

To open the control panel of a multi-channel N4960A system, select **Instrument -> Virtual Instruments -> Multi-channel N4960A:x -> Control** as shown in Figure 18.

Figure 18. Opening multi-channel N4960A system control panel

Figure 19 is an example of a control panel showing the multi-channel N4960A system assigned to Multi-channel N4960A:1.

Figure 19. Multi-channel N4960A system control panel example

Figure 20 shows the cabling diagrams for the asynchronous and synchronous clock setups.

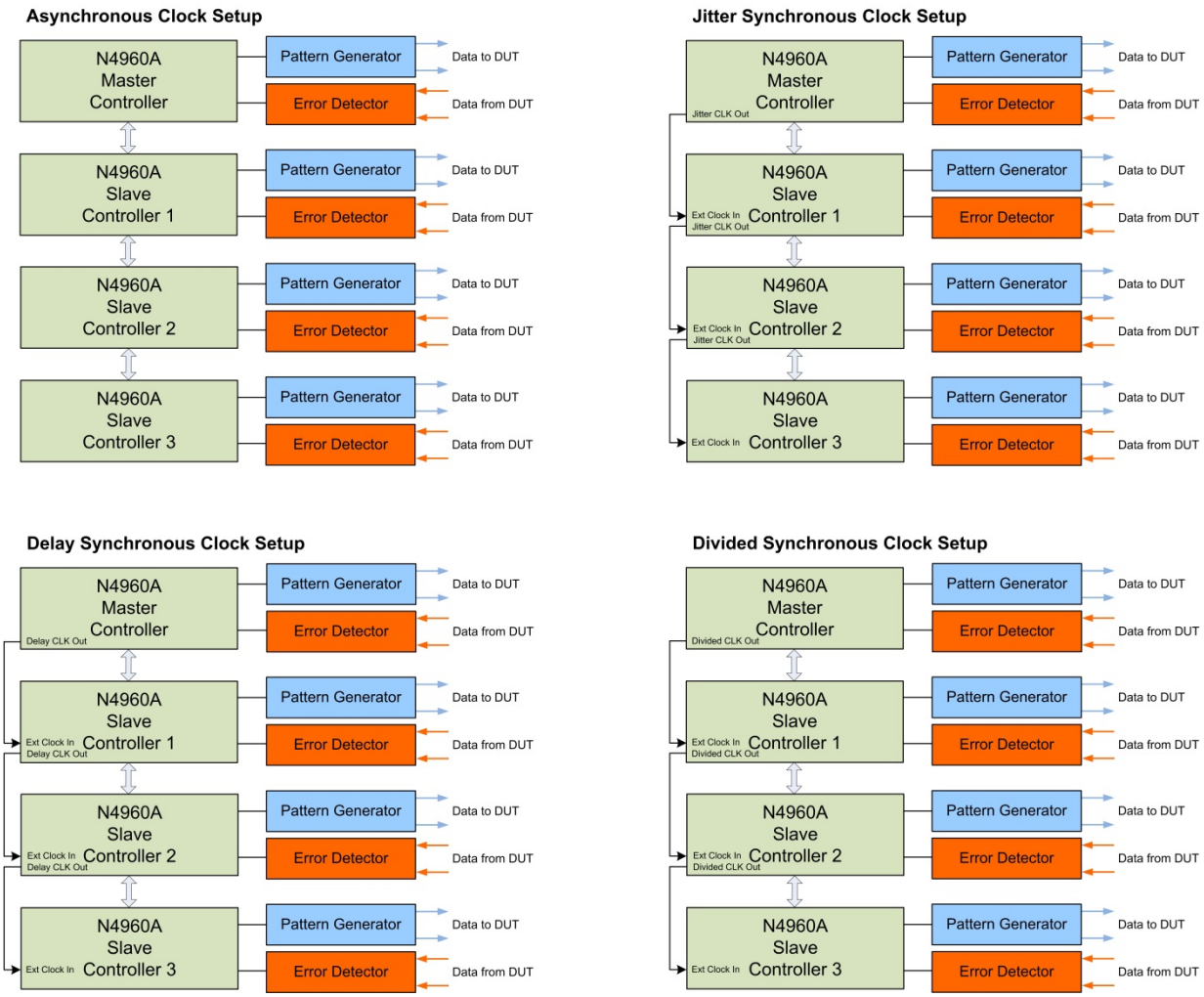


Figure 20. Cabling diagrams

After selecting more than one controller, the global controls are activated as shown in Figure 21.

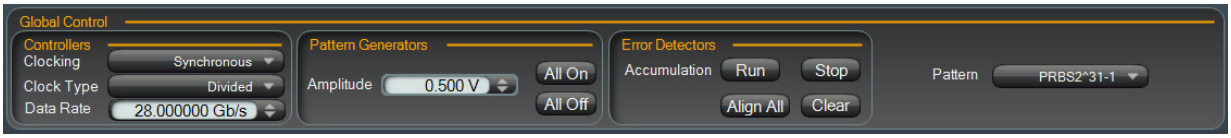


Figure 21. Global controls

Global controls provide a quick method to set key parameters such as date rate, data pattern, auto align etc. on all instruments in the multi-channel N4960A virtual instrument.

Global controls will override individual channel settings.

Table 10. Global controls description

Name	Description
Controllers	
Clocking	Sets all controllers to Asynchronous or Synchronous clocking. Asynchronous clocking sets each controller to use its internal clock source. If a clock source for one of the channels is later changed to external and there are only two channels in the system, this will change to Synchronous. If a clock source for one of the channels is later changed to external and there are more than two channels in the system, the clocking name is removed in the global control and the field is left blank. Synchronous clocking sets the multi-channel system to use the master controller internal clock source as the clock source for all channels and sets the slave controllers to external clock source. If a clock source for one of the channels is later changed to internal and there are only two channels in the system, this will change to Asynchronous. If a clock source for one of the channels is later changed to internal and there are more than two channels in the system, the clocking name is removed in the global control and the field is left blank.
Clock Type	Specifies which clock output is used to connect up the N4960A controllers for synchronous operation and enables the chosen output. Choices are Jittered, Delayed, or Divided clock outputs.
Data Rate	Sets the data rate of all pattern generators and error detectors and sets the frequency of all controllers. If a data rate for one of the channels is later changed, the data rate value is removed in the global control and the field is left blank.
Pattern Generators	
All On	Enables all pattern generator outputs.
All Off	Disables all pattern generator outputs.
Amplitude	Sets the amplitude of all pattern generators. If any of the pattern generator channels has an attenuation value entered then the software sets the amplitude of the pattern generator output AFTER the attenuator. If the amplitude for one of the channels is later changed, the amplitude value is removed in the global control and the field is left blank.
Error Detectors	
Accumulation	Select the Run button to start, or Stop button to stop, accumulation on all error detectors.
Align All	Aligns all error detectors simultaneously.
Reset	Resets all BER counters for all error detector accumulated measurements.
Pattern	Selects the pattern for all pattern generators and error detectors. If a pattern for one of the channels is later changed, the pattern name is removed in the global control and the field is left blank.

The channel controls shown in Figure 22 are used to set up the controller, pattern generator, and error detector of an individual channel independent of all other channels. The controls shown are a subset of those found by clicking on the respective blue gear wheel.

Figure 22. Channel controls

Table 11. Channel controls description

Name	Description
Master Controller/ Slave Controller x	
Controller	Selects a controller from the list of available controllers. If a pattern generator and error detector are connected to the selected controller, they will also be connected and display their properties in the respective fields. The controller will function without a pattern generator or error detector connected, with both connected, with only a pattern generator connected, or with only an error detector connected. For controllers to appear in this list, they must first be discovered and connected.
Clock Source	Selects Internal to use the internal clock source, or External to use an external clock source connected to the front panel Ext. Clock In. In Synchronous clocking mode, the master controller is set to Internal and the slave controllers are set to External; in Asynchronous clocking mode, all controllers are set to Internal.
Frequency	Sets the clock source frequency (half the data rate).
Clock Loss	The Clock Loss LED is lit when the clock signal is lost.
	After selecting a controller, the gear wheel turns blue. While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the full control panel for the corresponding controller.

Name	Description
Pattern Generator	
On	Enables/disables the pattern generator output.
Amplitude	Sets the amplitude of the pattern generator.
Attenuation	Used to enter the value of any external attenuation connected to the pattern generator output. If a non-zero value is entered here, then the pattern generator output after the attenuator is shown in parenthesis next to the Amplitude field.
Data Rate	Sets the data rate of the pattern generator.
Pattern	Selects the pattern.
	While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the full control panel for the corresponding pattern generator.
Error Detector	
Logic Thresh	Sets the decision point vertically.
Delay	Sets the decision point horizontally.
Data Rate	Displays the data rate of the error detector.
Pattern	Selects the pattern.
Pattern Invert	Inverts the pattern when selected.
iBER	View instantaneous BER, always running.
aBER	View accumulated BER during channel accumulation.
Eye Width	View eye width results after Align is performed.
Eye Height	View eye height results after Align is performed.
Elapsed Time	Displays the elapsed time of the accumulation measurement.
Running/Not Running LED	The LED in the upper-right part of a channel control panel is red when the channel is not accumulating and green when the channel is accumulating.
Run	Starts the channel accumulation.
Stop	Stops the channel accumulation.
Clear	Clears the results of the previous BER measurement, but does not affect settings.
Align	Aligns the error detector automatically, setting the Logic Thresh voltage and Delay to optimum values for BER measurement.
	While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the full control panel for the corresponding error detector.

Name	Description
Data	The Data LED is green when data at the error detector input has been detected. If not, the LED is red and a measurement cannot be performed.
Sync	The Sync LED is green when the error detector data pattern is synchronized with the incoming data from the DUT. If not, the LED is turned off and a measurement cannot be performed.
Error	The Error LED is red when bit errors have been detected. If not, the LED is turned off.

If an N4960A is connected in the instrument list and the N4960A is part of a multi-channel N4960A system, disconnecting the N4960A from the instrument list will also disconnect it from the corresponding multi-channel N4960A system. Reconnecting the instrument in the instrument list will not reconnect it to the corresponding multi-channel N4960A system.

Removing an N4960A controller from a multi-channel N4960A system will not disconnect it from the instrument list.

4.1.6 Viewing Instrument Information from the Main Screen

By hovering over an instrument name/serial number located below its image on the main screen, specific instrument information appears as shown in Figure 23. Hovering over a N4965A name/serial number will display its model number, serial number, and address as well as remote head information including model number, channel connection, hardware version, software version, serial number, and alias if assigned. All other instruments display their model number, serial number, address, and alias. Viewing instrument information is a quick way to identify which instruments are available for measurements.

Figure 23. Viewing instrument configurations

4.1.7 Tool Tips

Tool tips are text boxes that help describe the function of an item. Tool tips appear by hovering over an item (without clicking on it). The control and measurement panels have tool tips available to help with specific functions.

4.1.8 Adding Instruments Automatically

Clicking on the Discover button in the main screen (or selecting Discover from the Instrument menu) queries instruments connected to the bus and determines their addresses and adapters automatically. Table 10 shows the available interface for each instrument.

Table 12. Available interface

Instrument Name	GPIB Interface	USB Interface
N4971A	✓	✓
N4965A	✓	✓
N4962A	✓	
N4963A	✓	
N4972A	✓	✓
N4960A	✓	✓

4.1.8.1 Adding Instrument Using the Discover Button or Instrument Menu

1. To discover the instruments using the button, click on the **Discover** button in the main screen to query the instruments.
2. To discover the instruments using the menu, click on the **Instrument** menu in the main screen then click on **Discover** to query the instruments.
3. The instrument names/serial numbers appear below the instrument images in the instrument list.

4.1.9 Connecting All Instruments Automatically

1. Add the instrument as described in 4.1.8.1 “Adding Instrument Using the Discover Button or Instrument Menu” in this chapter.
2. Click on the **Connect All** button in the main screen (or select **Connect All** from the **Instrument** menu) to connect all instruments at once.
3. After a short delay, ensure that the lightning bolt icon appears to the left of each instrument name as shown in Figure 24.

Figure 24. Connecting all instruments

4.1.10 Connecting Individual Instruments Manually

1. Add the instrument as described in 4.1.8.1 “Adding Instrument Using the Discover Button or Instrument Menu” in this chapter.
2. Right-click on the instrument name/serial number located below the image of the instrument to access the pop-up menu shown in Figure 25 then click on **Connect**.

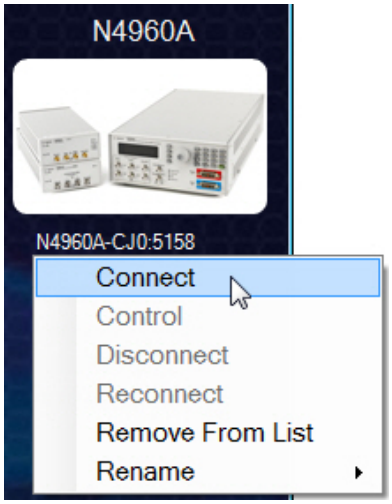


Figure 25. Connecting a single instrument

3. After a short delay, ensure that the lightning bolt icon appears to the left of the instrument name as shown in Figure 26. This indicates that the instrument is connected.

Figure 26. Connection icon

4.1.11 Renaming an Instrument

Once an instrument has been added, the **Rename** feature allows alias names to be set up for instruments. This is particularly useful for assigning signal names to remote pattern generators and error detector heads in the N4965A 12.5 Gb/s and N4960A 17/32 Gb/s BERT.

1. Right-click on the instrument name/serial number located below the image of the instrument and then position the mouse pointer over **Rename** then over the instrument name to change as shown in Figure 27.

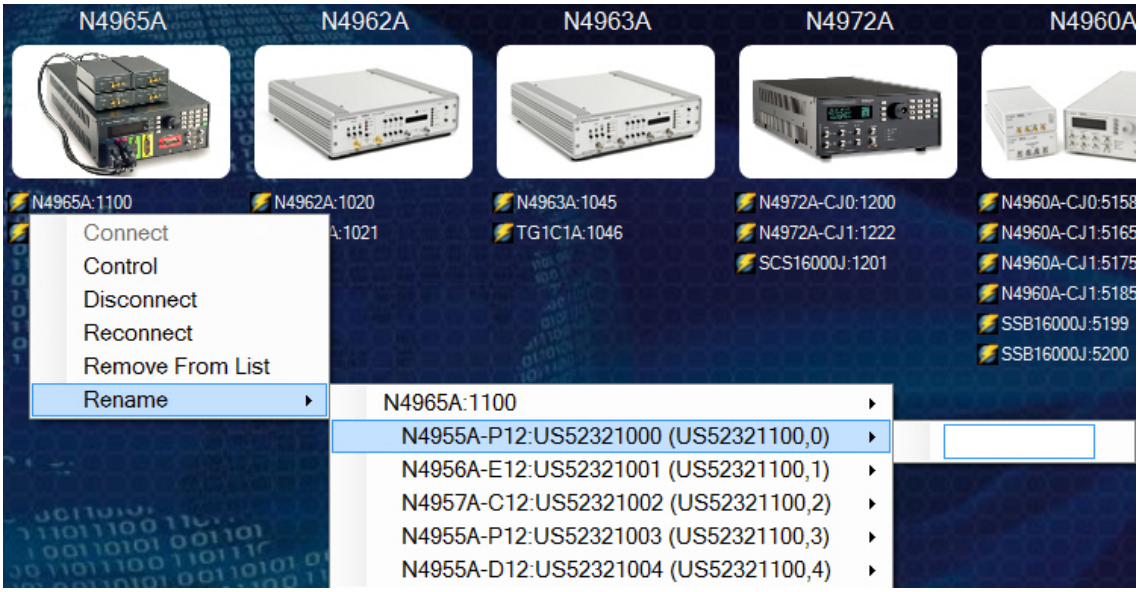


Figure 27. Renaming an instrument

2. Type the new name for the instrument then press **Enter** on the computer keyboard or click outside the text field to accept the new name.
3. To reset back to the original model name, simply use the same procedure but delete the previously entered alias name.

4.2 Using the Interface Controls to Change Settings

Instrument settings can be changed using built-in interface tools such as pop-up menus, numeric entries, drop down list boxes, and check box buttons shown in Figure 28 and Figure 29.

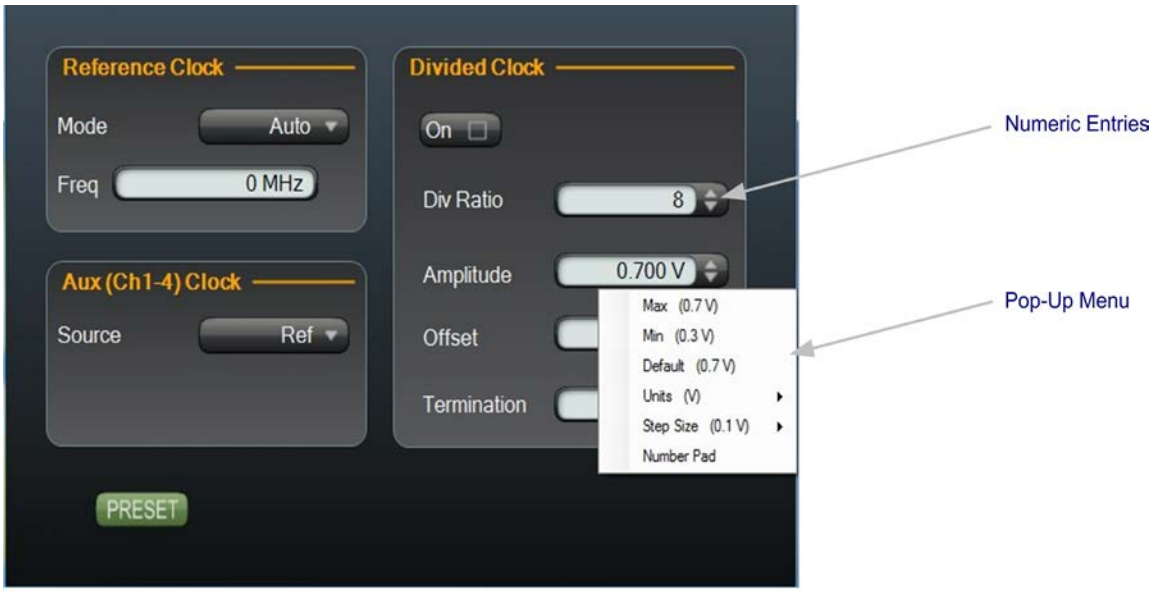


Figure 28. Pop-up menus and numeric entries

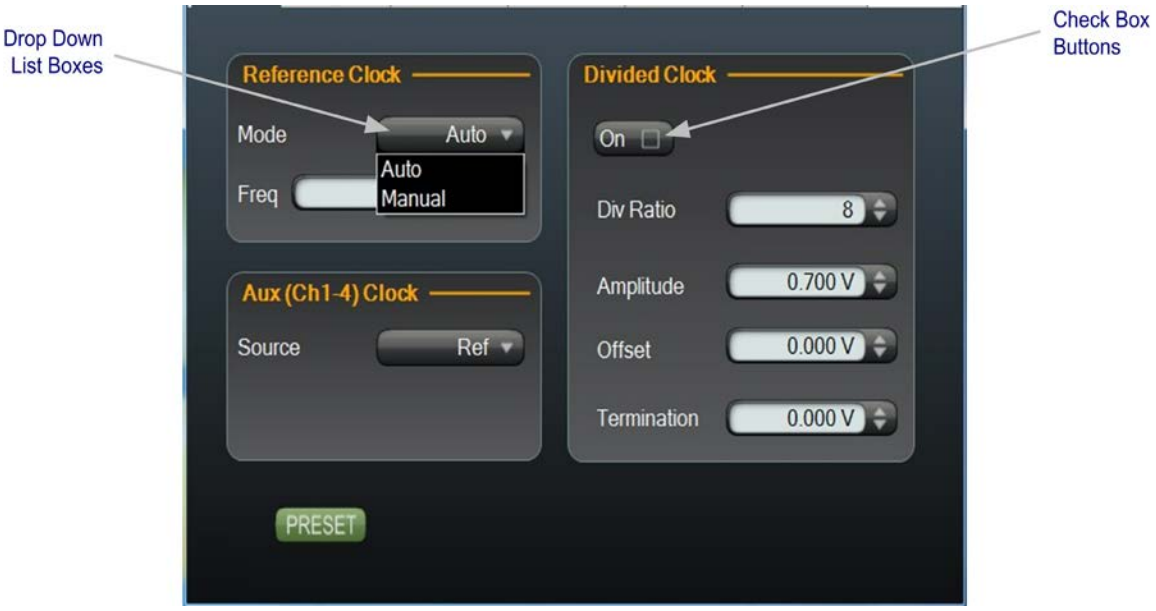


Figure 29. Drop down list box and check box buttons

4.2.1 Pop-Up Menus

The pop-up menus are accessed by clicking the right mouse button in a numeric entry. The following items are listed in the pop-up menus:

- Max[1]
- Min
- Default
- Units
- Step Size
- Number Pad
- Apply to All

The Max menu item sets the number to the maximum allowable value.

The Min menu item sets the number to the minimum allowable value.

The Default menu item resets the number to the default value.

The Units menu item is used to select the allowable units from a list. Figure 30 is an example of a units menu where the allowable selections are V (volts) or mV (millivolts).

[1] Menu item appears where applicable.

The selections are accessed by hovering over Units (which opens the list of units), clicking on the down arrow, and then clicking on the desired units.

NOTE The Units menu is not displayed in a list if it is not applicable to the setting.

Figure 30. Selecting units

The Step Size menu item is used to select the allowable step sizes from a list. The value displayed in the numeric field increases (up arrow) or decreases (down arrow) by the step size value. Figure 31 is an example of a step size where the allowable selections are 0.005 V, 0.01 V, 0.1 V, and 1 V.

The selections are accessed by hovering over Step Size (which opens the list of step sizes), clicking on the down arrow, and clicking on the desired step size.

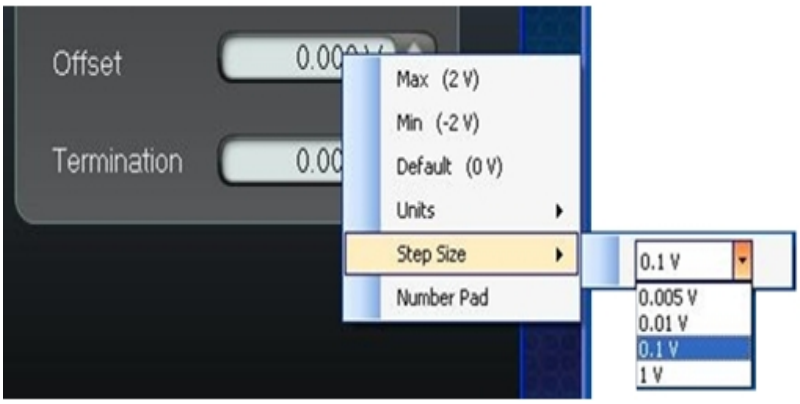


Figure 31. Selecting step size

The Number Pad menu item is used to enter a numeric value into a numeric entry. After the value is entered into the Number Pad, click on the desired unit button to accept the entry into the numeric field. Figure 32 is an example of the Number Pad.

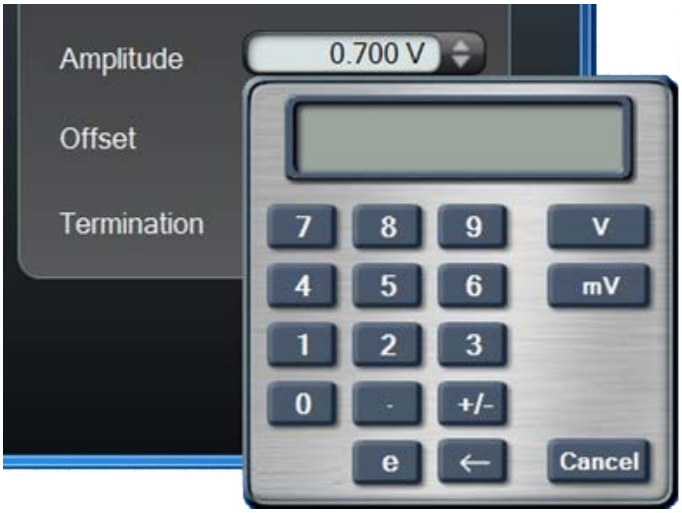


Figure 32. Entering values with the number pad

NOTE

Displayed units will be the last units that were selected using the Number Pad. For example, if the units were V and a value of 200 mV was entered, the displayed units will now be mV.

Click on the Cancel key at any time to close the Number Pad with no change to the setting value.

Values can also be entered in exponential notation using the **"e"** key. For example, enter 1.23e–3 V for 1.23 mV.

The backspace key (←) is used to correct key entry errors.

The Apply to All menu item applies the current setting value to all connected instruments of the same type.

4.2.2 Numeric Entries

Figure 33 is an example of a numeric entry. Most numeric entries have a pre-defined maximum, minimum, and default value displayed in their corresponding pop-up menu (right-click in the numeric entry field).

Figure 33. Numeric entries

Numeric values in numeric entries can be changed in one of four ways:

1. Use the up/down arrows to increase/decrease the value by the step size amount.
2. Hover over the numeric field, enter the value and optional units using the computer keyboard, then press Enter or move the mouse pointer outside the field (use the escape key to cancel entry).
3. Double-click in the numeric field and use the online Number Pad to enter the value.

NOTE

If the allowable range for the parameter is exceeded, the value briefly flashes red and remains set to the maximum or minimum value depending on which was exceeded.

4. Right-click in the numeric field then select the pre-defined Max (maximum value), Min (minimum value), or Default (default value).

4.2.3 Drop Down List Box

Figure 34. Drop down list box

A parameter that can be changed by using a drop down list is indicated by a down arrow on the right end of a button. Access the drop down list box by clicking anywhere within the button. Once the list appears, click on the desired selection. The selection appears in the button. Figure 34 shows **Custom** as being the current selection in the button. The mouse pointer and mouse wheel can also be used to scroll through the choices.

4.2.4 Check Box Buttons

Figure 35 is an example of check box buttons.

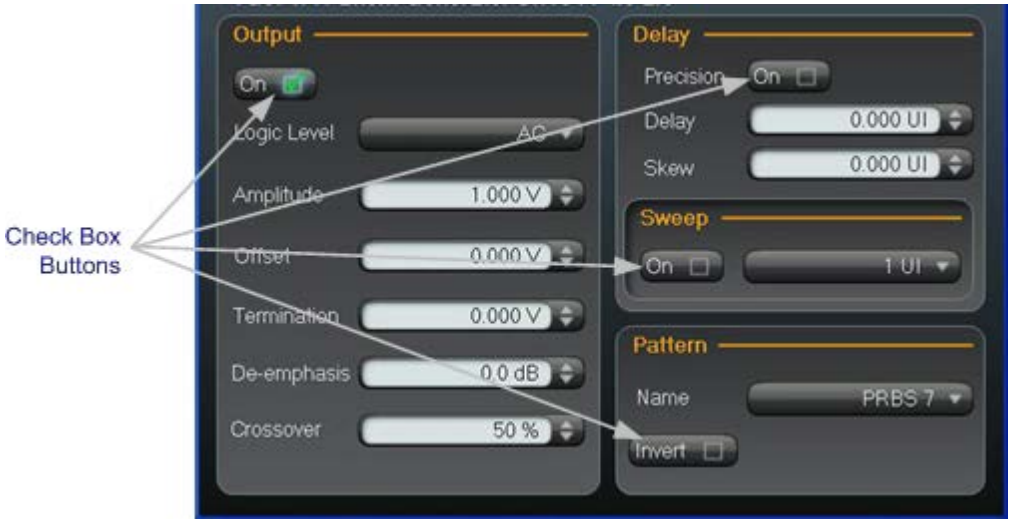


Figure 35. Check box buttons

Check box buttons toggle the setting on and off by clicking them. When selected (on), a green checkmark is displayed as shown in Figure 36.

Figure 36. Selecting check box control

4.3 Using Control Panels to Control Instruments

An instrument control panel can be accessed for setting up its specific settings after the instrument has been connected (indicated by the lightning bolt icon to the left of the instrument name and serial number). The settings displayed in a control panel are the same as those on the instrument's front panel. Therefore, these settings are not documented in this user's guide. For information about specific instrument settings, refer to the corresponding instrument User's Guide.

If a control panel has a Preset button, clicking it resets the instrument to its default settings.

4.3.1 N4971A Pattern Generator Control Panel

The settings for the N4971A are on a single screen as shown in Figure 37.

Refer to the N4971A pattern generator 13 Gb/s User's Guide or use the tool tips for descriptions of each setting.

Figure 37. N4971A control panel

4.3.2 N4965A Multi-Channel BERT Controller

The settings for the N4965A multi-channel BERT controller are accessed by selecting the **Controller** tab and are on a single screen as shown in Figure 38. In addition, all of the settings for the remote heads currently connected to the controller are accessed from this screen by selecting their corresponding tab.

Each tab shows the channel number and instrument connected to the N4965A multi-channel BERT controller, and if it's on (LED on) or off (LED off). For example, **1: E12** shown in Figure 38 indicates that a N4956A-E12 remote head is connected to channel 1 of the N4965A multi-channel BERT controller. The LED colors correspond to the channel colors on the front panel of the corresponding remote head.

Refer to the N4965A multi-channel BERT controller User's Guide or use the tool tips for descriptions of each setting.

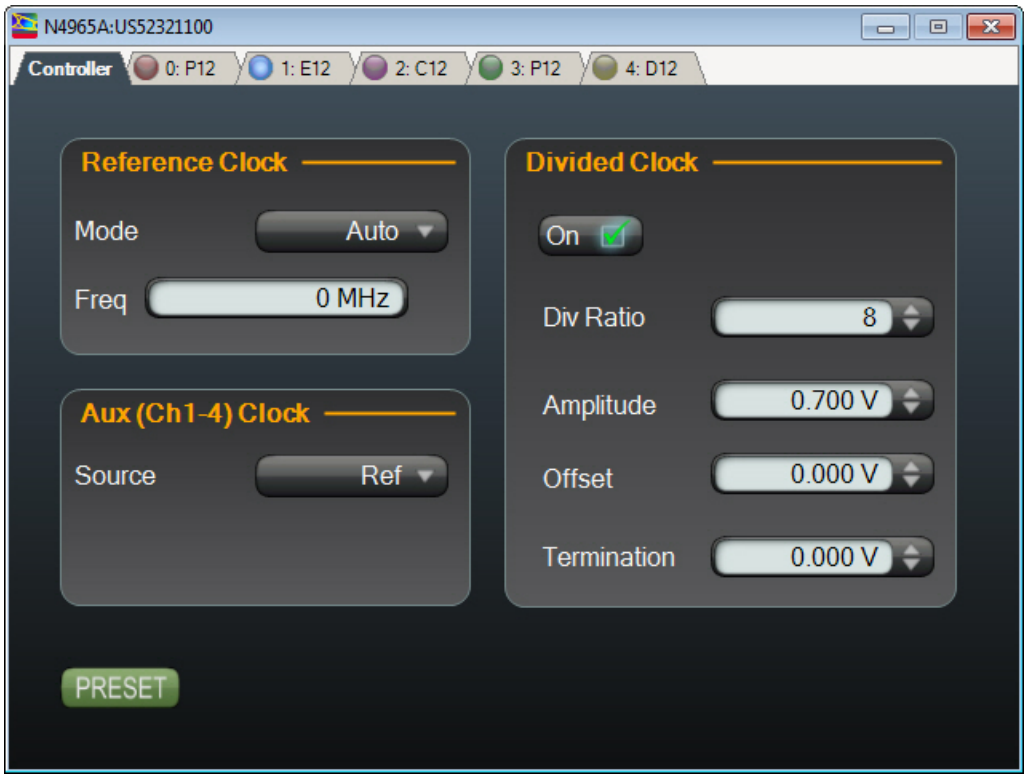


Figure 38. N4965A control panel

4.3.2.1 N4955A-P12 12.5 Gb/s Pattern Generator Remote Head

The settings for the N4955A-P12 12.5 Gb/s pattern generator remote head are on a single screen and are accessed by selecting the N4955A-P12 tab in the N4965A control panel as shown in Figure 39.

Refer to the N4965A multi-channel BERT controller User's Guide or use the tool tips for descriptions of each N4955A-P12 setting.

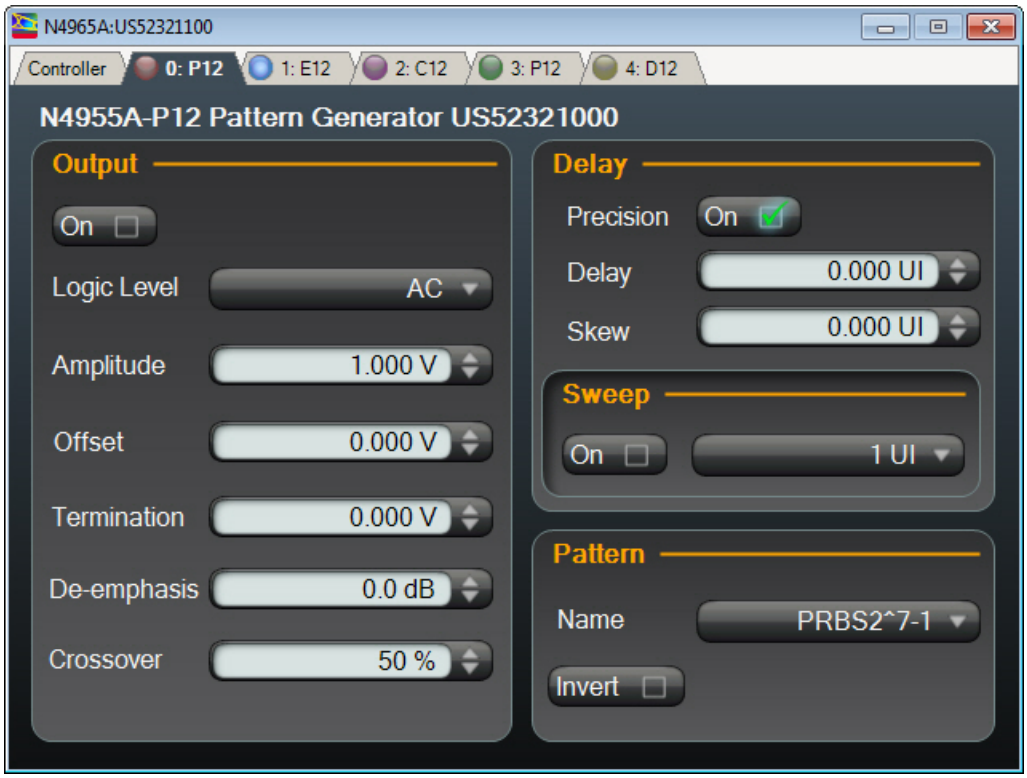


Figure 39. N4955A-P12 remote head control panel

4.3.2.2 N4955A-D12 12.5 Gb/s Pattern Generator Remote Head with 4-tap De-emphasis

The settings for the N4955A-D12 are on a single screen and are accessed by selecting the N4955A-D12 tab in the N4965A control panel as shown in Figure 40.

Refer to the N4965A multi-channel BERT controller User's Guide or use the tool tips for descriptions of each N4955A-D12 setting.

Figure 40. N4955A-D12 remote head control panel

4.3.2.3 N4956A-E12 12.5 Gb/s Error Detector Remote Head

The settings for the N4956A-E12 are on a single screen and are accessed by selecting the N4956A-E12 tab in the N4965A control panel as shown in Figure 41.

Refer to the N4965A multi-channel BERT controller User's Guide or use the tool tips for descriptions of each N4956A-E12 setting.

Figure 41. N4956A-E12 remote head control panel

4.3.2.4 N4957A-C12 Clock Doubler Remote Head

The settings for the N4957A-C12 are on a single screen and are accessed by selecting the N4957A-C12 tab in the N4965A control panel as shown in Figure 42.

Refer to the N4965A multi-channel BERT controller User's Guide or use the tool tips for descriptions of each N4957A-C12 setting.

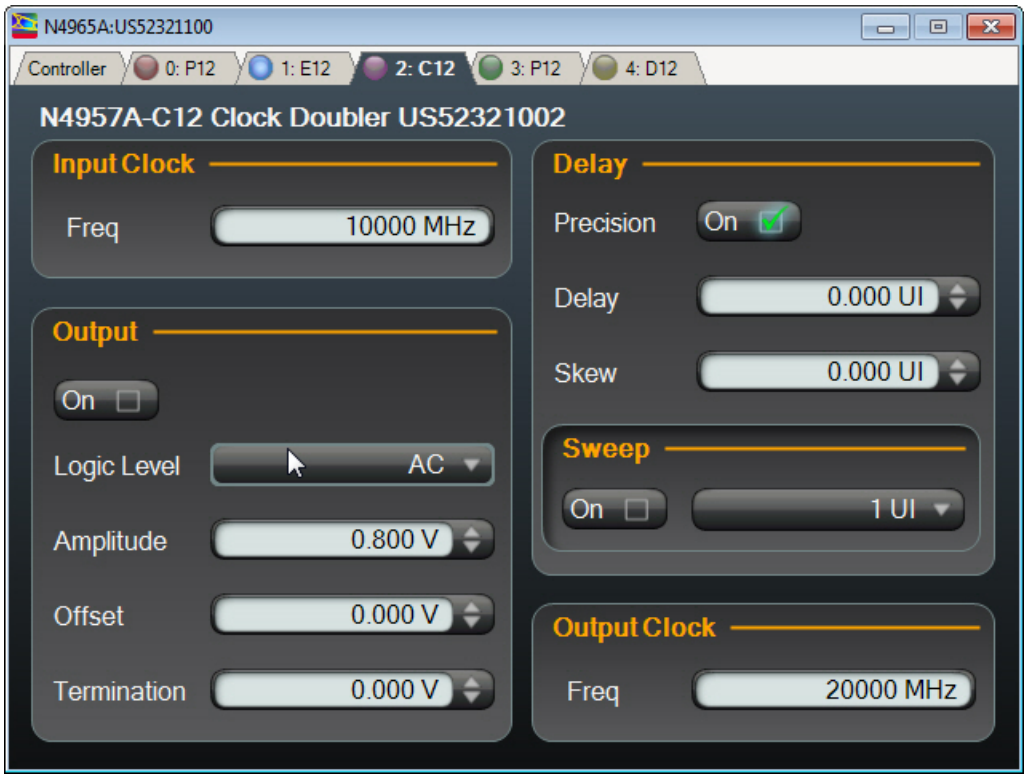


Figure 42. N4957A-C12 remote head control panel

4.3.3 N4962A Serial BERT 12.5 Gb/s

The settings for the N4962A are on a single screen as shown in Figure 43.

Refer to the N4962A serial BERT 12.5 Gb/s User's Guide or use the tool tips for descriptions of each setting.

Figure 43. N4962A control panel

4.3.4 N4963A Clock Synthesizer 13.5 GHz

The settings for the N4963A are on a single screen as shown in Figure 44.

Refer to the N4963A clock synthesizer 13.5 Gb/s Clock Synthesizer User's Guide or use the tool tips for descriptions of each setting.

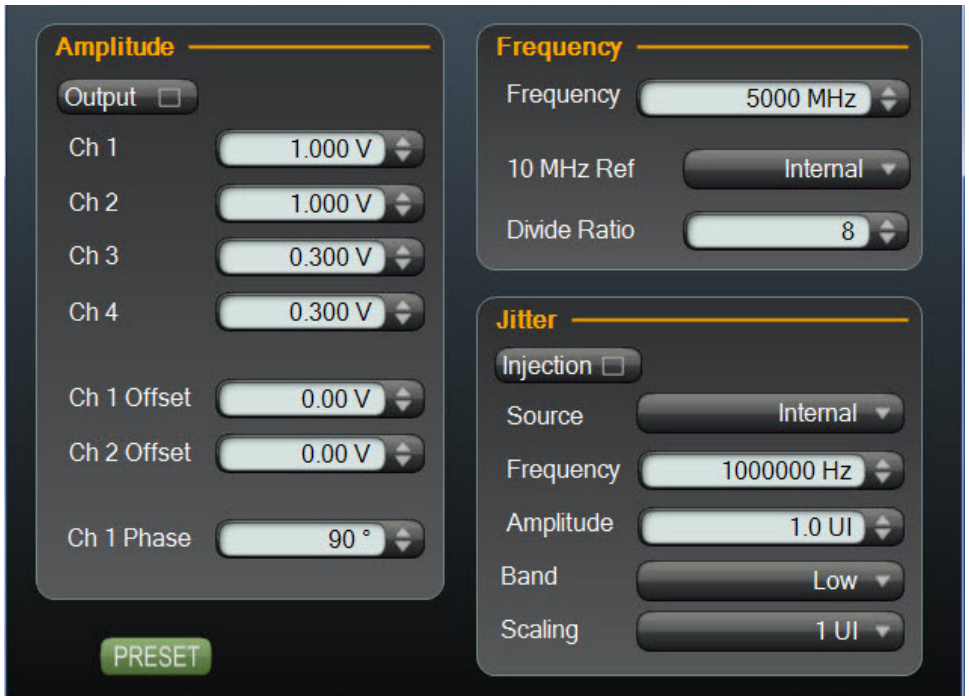


Figure 44. N4963A control panel

4.3.5 N4972A Clock Synthesizer 16 GHz

The settings for the N4972A-CJ0/N4972A-CJ1 are on a single screen as shown in Figure 45.

Refer to the N4972A clock synthesizer 16 GHz User's Guide or use the tool tips for descriptions of each setting.

Figure 45. N4972A-CJ0/N4972A-CJ1 control panel

4.3.6 N4960A Serial BERT 17 and 32 Gb/s

The settings for the N4960A-CJ0/N4960A-CJ1 controller are accessed by selecting the **Controller** tab and are on a single screen as shown in Figure 46. In addition, all of the settings for the remote heads currently connected to the controller are accessed from this screen by selecting their corresponding tab.

Each tab shows the channel number and instrument connected to the N4960A-CJ0/N4960A-CJ1 controller, and if it is on (LED on) or off (LED off).

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

Figure 46. N4960A-CJ0/N4960A-CJ1 control panel

4.3.6.1 N4951A/N4951B-H17/-H32 Pattern Generator Remote Head in Channel 0

The settings for the N4951A/N4951B-H17/-H32 connected to the Jitter connector (channel 0) on the front panel of the N4960A are on a single screen and are accessed by selecting the corresponding tab in the N4960A-CJ0/ N4960A-CJ1 control panel as shown in Figure 47.

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

Figure 47. N4951A/N4951B-H17/-H32 remote head control panel – channel 0

4.3.6.2 N4951A/N4951B-H17/-H32 Pattern Generator Remote Head in Channel 1

The settings for the N4951A/N4951B-H17/-H32 connected to the Delay connector (channel 1) on the front panel of the N4960A are on a single screen and are accessed by selecting the coresponding tab in the N4960A-CJ0/ N4960A-CJ1 control panel as shown in Figure 48.

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

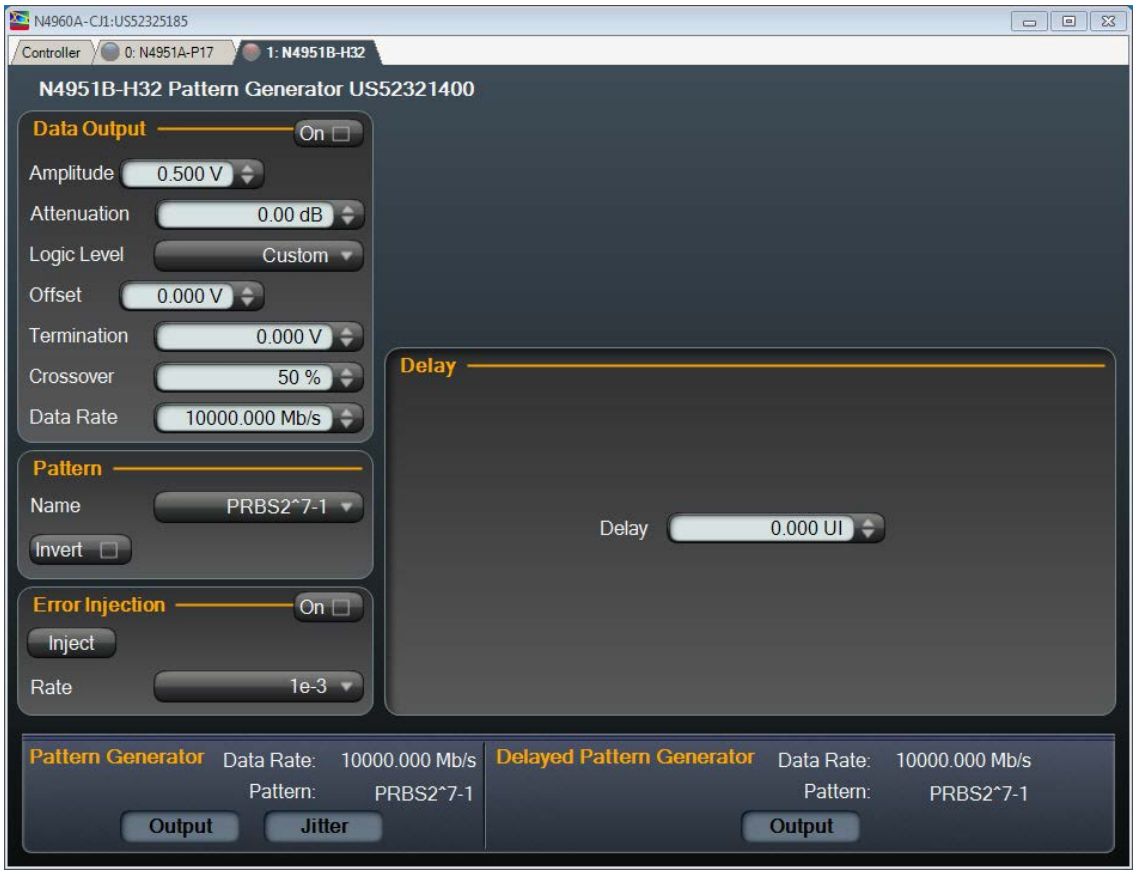


Figure 48. N4951A/N4951B-H17/-H32 remote head control panel – channel 1

4.3.6.3 N4951B-D17/-D32 Pattern Generator Remote Head in Channel 0

The settings for the N4951B-D17/-D32 connected to the Jitter connector (channel 0) on the front panel of the N4960A are on a single screen and are accessed by selecting the coresponding tab in the N4960A-CJ0/ N4960A-CJ1 control panel as shown in Figure 49.

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

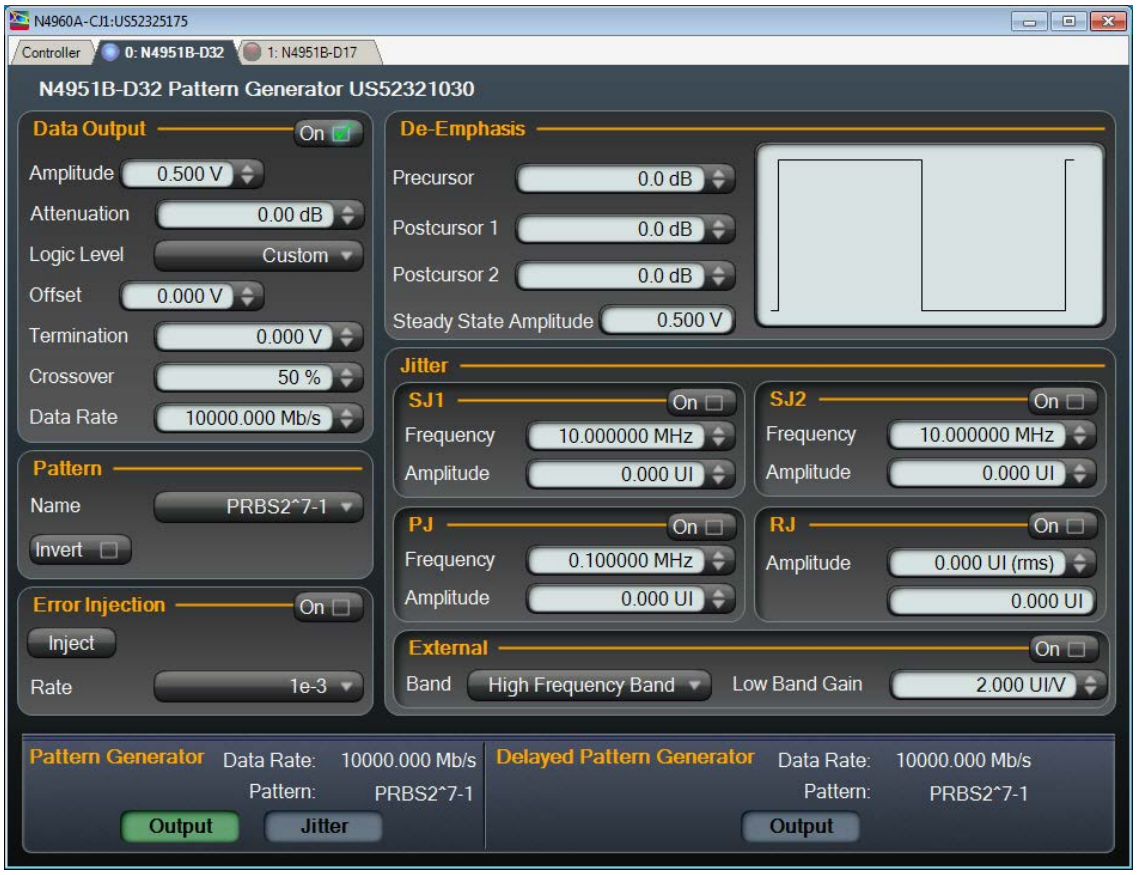


Figure 49. N4951B-D17/-D32 remote head control panel – channel 0

4.3.6.4 N4951B-D17/-D32 Pattern Generator Remote Head in Channel 1

The settings for the N4951B-D17/-D32 connected to the Delay connector (channel 0) on the front panel of the N4960A are on a single screen and are accessed by selecting the coresponding tab in the N4960A-CJ0/ N4960A-CJ1 control panel as shown in Figure 50.

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

Figure 50. N4951B-D17/-D32 remote head control panel – channel 1

4.3.6.5 N4952A-E17/N4952A-E32 Error Detector Remote Head

The settings for the N4960A-E17/N4960A-E32 are on a single screen and are accessed by selecting the E17 or E32 tab in the N4960A-CJ0/ N4960A-CJ1 control panel as shown in Figure 51.

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

Figure 51. N4952A-E17/N4952A-E32 remote head control panel

4.3.7 10G BERT System Control Panel

The 10G BERT system control panel is designed to configure a N4962A serial BERT 12.5 Gb/s and a N4963A clock synthesizer into a 10 Gb/s BERT system. Figure 52 shows the 10G BERT system control panel. Cabling diagrams are provided for setting up the system with and without a clock recovered from the DUT. Refer also to Virtual Instruments.

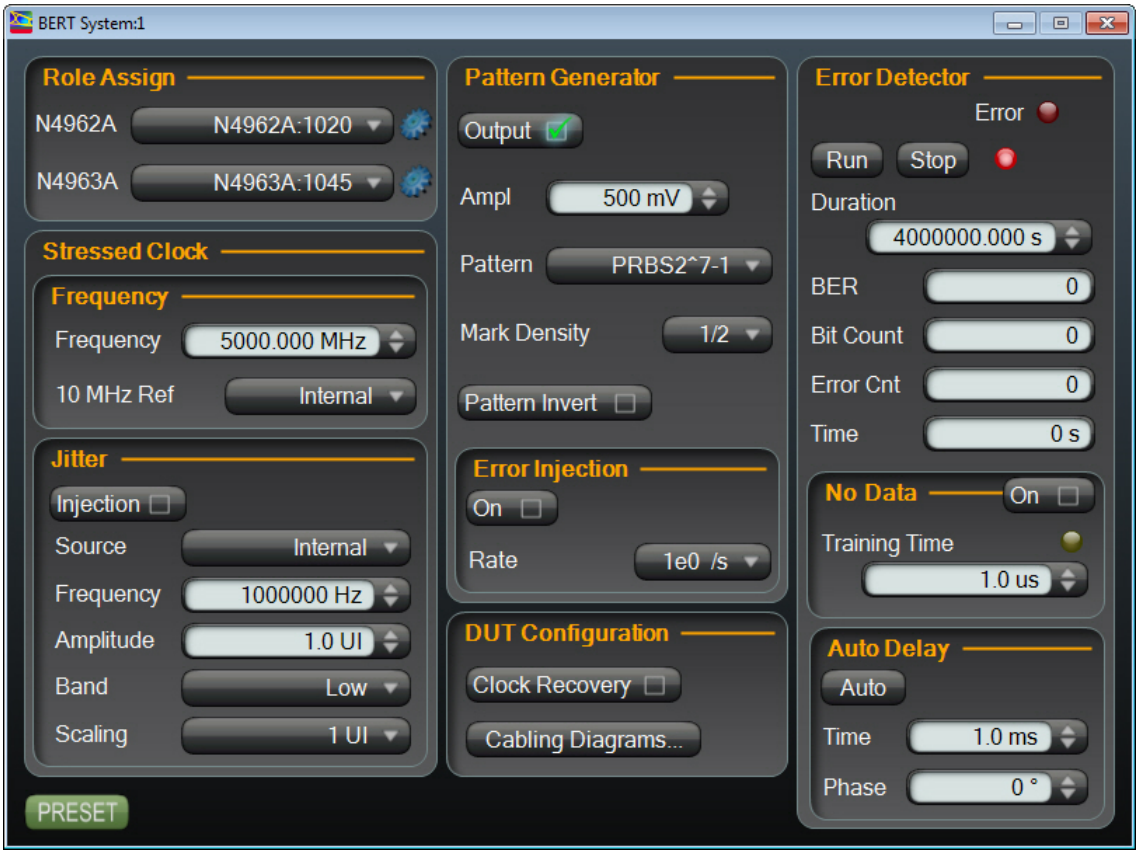


Figure 52. 10G BERT system control panel

Each 10G system is numbered and is displayed in the title bar to differentiate between the systems. Refer to Figure 52.

Refer to the N4962A serial BERT 12.5 Gb/s User's Guide and the N4963A clock synthesizer User's Guide or use the tool tips for descriptions of each setting.

4.3.8 Multi-channel N4960A Control Panel

The multi-channel N4960A control panel is designed to configure multiple N4960A serial BERT 17 and 32 Gb/s instruments into a multi-channel BERT system. Figure 53 shows the multi-channel system control panel. Refer also to Virtual Instruments.

Figure 53. Multi-channel N4960A control panel

Each multi-channel system is numbered and is displayed in the title bar to differentiate between the systems. Refer to Figure 53.

Refer to the N4960A serial BERT 17 and 32 Gb/s User's Guide or use the tool tips for descriptions of each setting.

5 Measurements

The Measurements menu contains a list of panels that are designed to facilitate instrument setup, execution, monitoring, and results management. The list includes the following:

- Single channel BER
- Multi-channel BER
- Bathtub view
- Jitter tolerance

Not all instrument combinations are possible. Refer to chapter 7 “Configurations” for the compatible instrument configurations.

5.1 Using the Single Channel BER Panel

The single channel BER panel provides a common interface regardless of which instruments are being used to perform single channel bit error ratio tests.

The detector, generator, and clock must be assigned under Role Assign to make measurements.

Prior to running a bit error ratio test, the software performs a series of checks to ensure that the system is ready for the measurement.

Figure 54 shows the single channel BER panel.

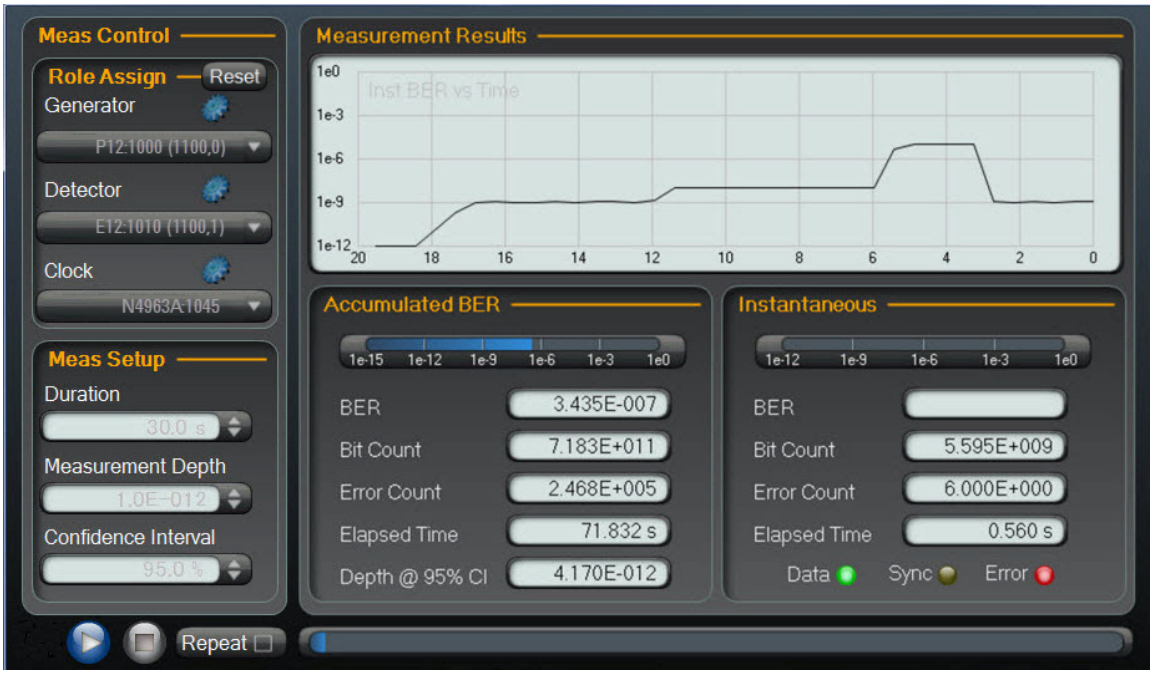
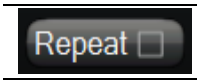


Figure 54. Single channel BER panel

5.1.1 Meas Control

Table 13. Meas Control Description

Name	Description
Role Assign	
Reset button	Resets all currently displayed information in the single channel BER panel.
Generator	The Generator drop down list box accesses all available connected pattern generators and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A generator must be specified to perform the measurement. In Figure 54 P12: 1000 (1100,0) indicates the generator selected is a N4955A-P12 remote head with a serial number of 1000 connected to channel 0 of a N4965A with a serial number of 1100.
Detector	The Detector drop down list box accesses all available connected error detectors and is used to select one for use in the measurement. A detector must be specified to perform the measurement. In Figure 54 E12: 1010 (1100,1) indicates that the detector selected is a N4956A-E12 remote head with a serial number of 1010 connected to channel 1 of a N4965A with a serial number of 1100.

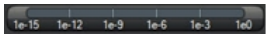
Name	Description
Clock	The Clock drop down list box accesses all available connected clock sources and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A clock must be specified to perform the measurement. In Figure 54 N4963A:1045 indicates that the clock selected is a N4963A with a serial number of 1045.
	After selecting a Generator, Detector, or Clock, the corresponding gear wheel turns blue. While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the control panel for the corresponding instrument.
Meas Setup	
Duration	Sets the length of the measurement in seconds or ms. The range is 1 ms to 99999.992s. The default is 0.3s. Duration depends on instrument selected.
Measurement Depth	Measurement Depth = -log(1 – confidence interval) / (data rate * gate time) The range is 0 to 1.0E+000. The default is 1.0E-012.
Confidence Interval	Confidence Interval = 1 – exp(-data rate * gate time * measurement depth) The range is 0% to 99.9%. The default is 95%.
	Starts the BER measurement.
	Stops the BER measurement.
	Select if you want the measurement to repeat indefinitely.
	The progress bar provides a graphical representation of the measurement time.
	The Data LED is green when data from a pattern generator has been detected. If not, the LED is red and a measurement cannot be performed. The Data LED is not available for the N4962A.
	The Sync LED is green when the detector is synchronized to the DUT. If not, the LED is turned off and a measurement cannot be performed. The Sync LED is not available for the N4962A.
	The Error LED is red when bit errors have been detected. If not, the LED is turned off.

5.1.2 Measurement Results

The Measurement results consist of a graph of the instantaneous bit error ratio on the “Y” axis versus time on the “X” axis. Note that the time begins on the right side of the graph and data scrolls to the left.

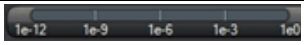
5.1.3 Accumulated BER

Table 14. Accumulated BER Description

Name	Description
	The scale shows the bit error ratio over the measurement time from 1e-15 to 1e0.
BER	Displays the accumulated bit error ratio over the measurement time.
Bit Count	Displays the total bit count.
Error Count	Displays the total number of bit errors.
Elapsed Time	Displays the elapsed time of the measurement.
Depth @ 95% CI	Estimate of the measurement depth for a 95% confidence interval.

5.1.4 Instantaneous

Table 15. Instantaneous BER Description

Name	Description
	The scale shows the instantaneous bit error ratio. The range is 1e-12 to 1e0.
BER	Displays the instantaneous bit error ratio.
Bit Count	Displays the instantaneous bit count at a specific point during the measurement.
Error Count	Displays the instantaneous number of bit errors at a specific point during the measurement.
Elapsed Time	Displays the instantaneous elapsed time of the measurement.

5.2 Using the Multi-channel BER Panel

The multi-channel BER panel is similar to the single channel BER panel except that it supports multiple measurements in parallel.

A detector, generator, and clock must be assigned to each channel to make measurements.

Prior to running a bit error ratio test, the software performs a series of checks to ensure that the system is ready for the measurement.

Figure 55 shows the multi-channel BER panel.

Figure 55. Multi-channel BER panel

5.2.1 Channel Control Buttons

Table 16. Channel Control Button Description

Name	Description
Add	Adds a measurement channel to the list.
Remove	Removes the selected measurement channel from the list.
Up	Moves the selected measurement channel up in the list.
Down	Moves the selected measurement channel down in the list.

5.2.2 Channel Role Selection and Measurement Results

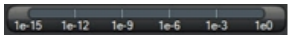
Figure 56 shows the channel role selection and measurement results for two channels.

Figure 56. Channel role selection and measurement results

A channel must be selected before its controls can be changed. The selection indicator is a rectangular box outlining the channel controls. In Figure 56 channel 1 is selected.

Table 17. Channel Control Description

Name	Description
Running/Not Running LED	The LED in the upper-left part of a channel control panel is red when the instrument is not running and green when the instrument is running.
0...X channel number	The number displayed in the lower-left part of a channel control panel indicates the channel number.
Gen	The Generator drop down list box accesses all available connected pattern generators and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A generator must be specified to perform the measurement. In Figure 56 P12: 1000 (1100,0) indicates the generator selected for channel 0 is a N4955A-P12 remote head with a serial number of 1000 connected to channel 0 of a N4965A with a serial number of 1100. In Figure 56 P12: 1030 (1100,3) indicates the generator selected for channel 1 is a N4955A-P12 remote head with a serial number of 1030 connected to channel 3 of a N4965A with a serial number of 1100.
Det	The Detector drop down list box accesses all available connected error detectors and is used to select one for use in the measurement. A detector must be specified to perform the measurement. In Figure 56 E12: 1010 (1100,1) indicates that the detector selected for channel 0 is a N4956A-E12 remote head with a serial number of 1010 connected to channel 1 of a N4965A with a serial number of 1100. In Figure 56 E12: 1020 (1100,2) indicates that the detector selected for channel 1 is a N4956A-E12 remote head with a serial number of 1020 connected to channel 2 of a N4965A with a serial number of 1100.
Clk	The Clock drop down list box accesses all available connected clock sources and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A clock must be specified to perform the measurement. In Figure 56 N4963A:1045 indicates that the clock selected for channel 0 and channel 1 is a N4963A with a serial number of 1045.
	After selecting a generator (Gen), detector (Det), or clock (Clk), the corresponding gear wheel turns blue. While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the control panel for the corresponding instrument.
Instant 	Displays the instantaneous bit error ratio. The corresponding scale shows the instantaneous bit error ratio. The range is 1e-15 to 1e0.

Name	Description
Accum	Displays the bit error ratio over the measurement time.
	The corresponding scale shows the bit error ratio over the measurement time from 1e-15 to 1e0.
	The Data LED is green when data from a pattern generator has been detected. If not, the LED is red and a measurement cannot be performed. The Data LED is not available for the N4962.
	The Sync LED is green when the detector is synchronized to the DUT. If not, the LED is turned off and a measurement cannot be performed. The Sync LED is not available for the N4962A
	The Error LED is red when bit errors have been detected. If not, the LED is turned off.

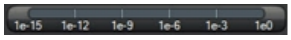
5.2.3 Meas Setup

Table 18. Meas Setup Description

Name	Description
Duration	Sets the length of the measurement in seconds or ms. The range is 1 ms to 99999.992s. The default is 0.3s. Duration depends on instrument selected.
	Starts the BER measurement.
	Stops the BER measurement.

5.2.4 Parallel BER

Table 19. Parallel BER Description

Name	Description
Running LED	The Running LED is red when the instrument is not running and green when the instrument is running.
Inst BER	Displays the parallel instantaneous bit error ratio.
	The corresponding scale shows the parallel instantaneous bit error ratio from 1e-15 to 1e0.
Accum BER	Displays the parallel bit error ratio over the measurement time.
	The corresponding scale shows the parallel bit error ratio over the measurement time from 1e-15 to 1e0.
Accum Bit Count	Displays the parallel total bit count over the measurement time.
Accum Error Count	Displays the parallel total number of bit errors over the measurement time.
	The progress bar provides a graphical representation of the measurement time as well as the elapsed time in the field to the right of the progress bar.

5.3 Using the Bathtub View Panel

The bathtub view panel is used to set up BER measurements at different points across the data eye. The resulting plot is BER versus position in the eye, relative to the center. The units for the X axis are fractional UI, with 0 being the center of the eye. The plot is extrapolated from actual BER measurements, as they are made.

The detector, generator, and clock must be assigned under Role Assign to make measurements.

Prior to running a bit error ratio test, the software performs a series of checks to ensure that the system is ready for the measurement.

Figure 57 shows the bathtub view panel.

This screen can be saved as a jpg image by clicking on the waveform icon in the title bar of Bathtub View, and selecting 'Save Dialog'.

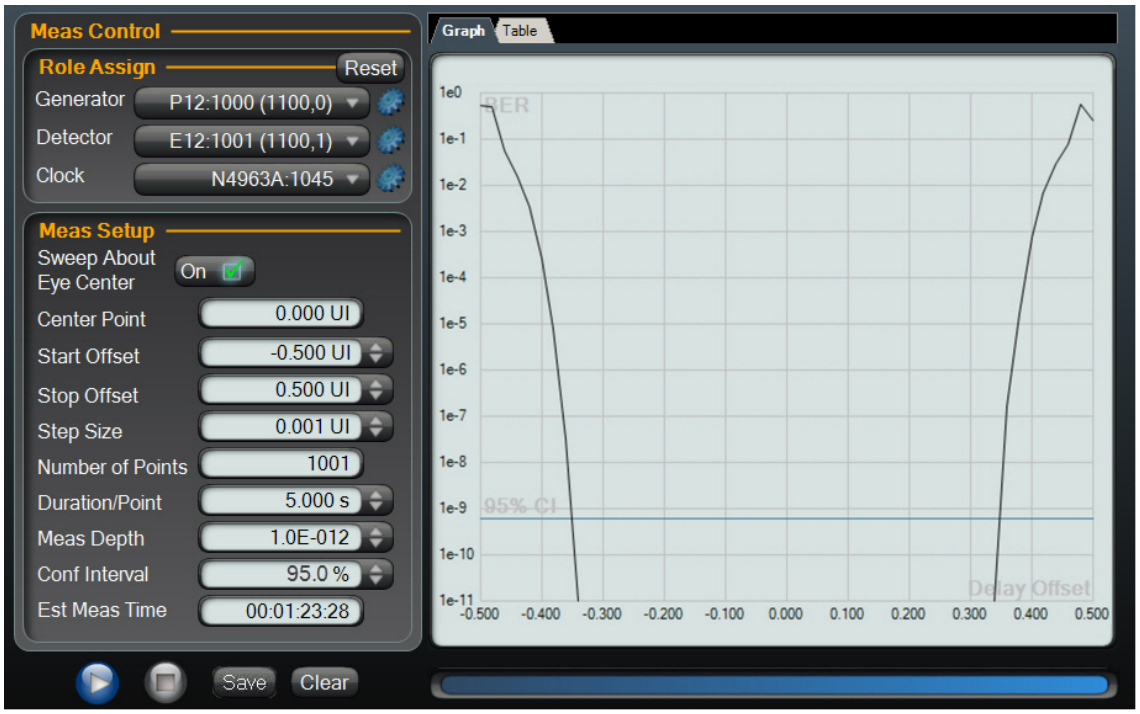


Figure 57. Bathtub view panel showing graph of results

5.3.1 Meas Control

Table 20. Meas Control description

Name	Description
Role Assign	
Reset button	Resets all currently displayed information in the bathtub view panel.
Generator	The Generator drop down list box accesses all available connected pattern generators and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A generator must be specified to perform the measurement. In Figure 57 P12: 1000 (1100,0) indicates the generator selected is a N4955A-P12 remote head with a serial number of 1000 connected to channel 0 of a N4965A with a serial number of 1100.
Detector	The Detector drop down list box accesses all available connected error detectors and is used to select one for use in the measurement. A detector must be specified to perform the measurement. In Figure 57 E12: 1001 (1100,1) indicates that the detector selected is a N4956A-E12 remote head with a serial number of 1001 connected to channel 1 of a N4965A with a serial number of 1100.
Clock	The Clock drop down list box accesses all available connected clock sources and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A clock must be specified to perform the measurement. In Figure 57 N4963A:1045 indicates that the clock selected is a N4963A with a serial number of 1045.
	After selecting a Generator, Detector, or Clock, the corresponding gear wheel turns blue. While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the control panel for the corresponding instrument.
Meas Setup	
Center Point	Performs delay center alignment prior to start of measurement. If set to 0 UI, uses the current delay value as the center.
Start offset	Sets the starting point offset from the eye center.
Stop offset	Sets the stopping point offset from the eye center.
Step size	Sets the step size between measurement points.
Number of points	Number of measurement points.
Duration/Point	Sets the length of the measurement in seconds or ms. The range is 1 ms to 99999.992s. The default is 0.3s. Duration depends on instrument selected.
Meas Depth	Measurement Depth = -log(1 – confidence interval) / (data rate * gate time) The range is 0 to 1.0E+000. The default is 1.0E-012.

Name	Description
Conf Interval	Confidence Interval = 1 – exp(-data rate * gate time * measurement depth) The range is 0% to 99.9%. The default is 95%.
Est meas time	Displays the estimated measurement duration.
	Starts the BER measurement.
	Stops the BER measurement.
	Clears the results of the previous measurement, but does not affect settings.
	The progress bar provides a graphical representation of the measurement time.
	Saves the tabular measurement results shown in the Table tab. This button only appears in the Table tab.

5.3.2 Bathtub View Measurement Results

The measurement results consist of a graph of the instantaneous bit error ratio on the “Y” axis versus time on the “X” axis relative to the center of the eye in units of UI.

In addition, the measurement results are provided in tabular form showing the offset, delay (ps), bit count, error count, and BER value at each measurement point.

5.4 Using the Jitter Tolerance Panel

The jitter tolerance panel is used to set up and perform jitter tolerance characterization and compliance testing on multiple DUT channels simultaneously.

NOTE **Jitter tolerance is a licensed option for N4980A multi-instrument BERT software. The panels described below are only visible in systems with a valid license installed.**

Jitter tolerance is often performed to test the clock and data recovery (CDR) circuitry of receivers. During this test, a specified amount of sinusoidal jitter (SJ) is added to the data signal sent to the receiver. The receiver is tested to see if it can tolerate the applied SJ (in other words, if the CDR can track out the applied SJ) by monitoring its BER. The receiver passes if it can operate below the designated BER threshold.

There are two modes of testing Jitter tolerance, compliance and characterization. During a compliance test, a set of specific SJ frequencies and amplitudes are tested. Each individual test generates a pass/fail result, and the receiver passes the entire jitter tolerance test if it can pass all SJ test points in the test set, or "template". During characterization, the same set of SJ frequencies are used but instead of testing just one SJ amplitude for each SJ frequency, the applied SJ amplitude is varied to allow the jitter tolerance test to determine the point at which the receiver starts to make errors. The user can optionally set an error threshold greater than one bit error as the fail point. This tells the engineer where their receiver's pass/fail point is for each SJ frequency. There are several different search algorithms to use in characterization mode available in N4980A multi-instrument BERT software jitter tolerance, as will be described in the following section.

The SJ frequencies, the SJ amplitudes for compliance testing, and the SJ amplitude range over which to search during characterization testing are contained in the jitter tolerance template file as shown in Figure 58. The x-axis of the template graph is SJ frequency, and the y-axis is SJ amplitude. The SJ frequencies are marked by black circular markers. The compliance template is shown with a dashed line. The minimum and maximum bounds for the characterization test are shown with a solid line.

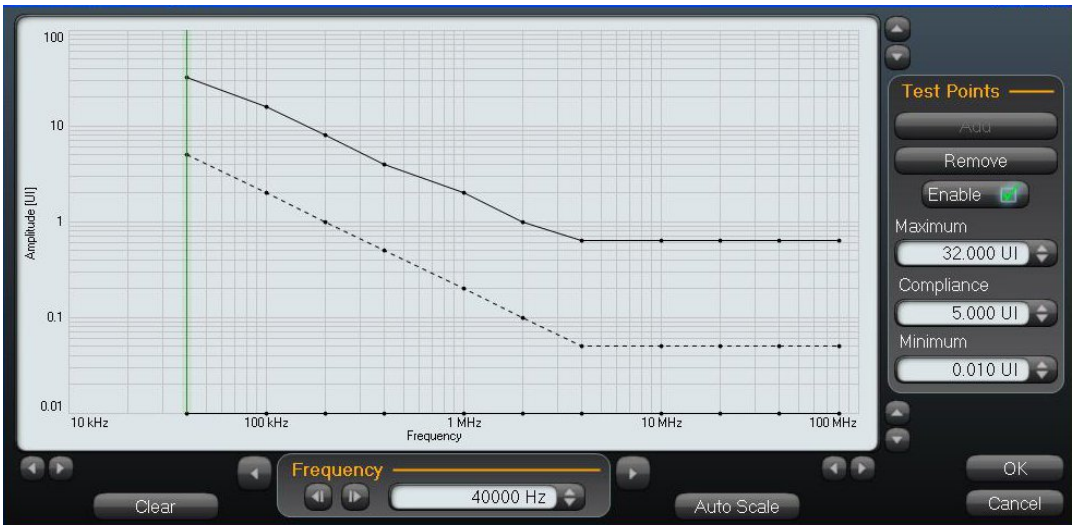


Figure 58. Jitter tolerance template file

Measurements are not performed on a channel unless a clock, generator, and detector are assigned.

Prior to running a jitter tolerance test, the software performs a series of checks to ensure that the system is ready for the measurement.

Figure 59 shows the jitter tolerance panel.

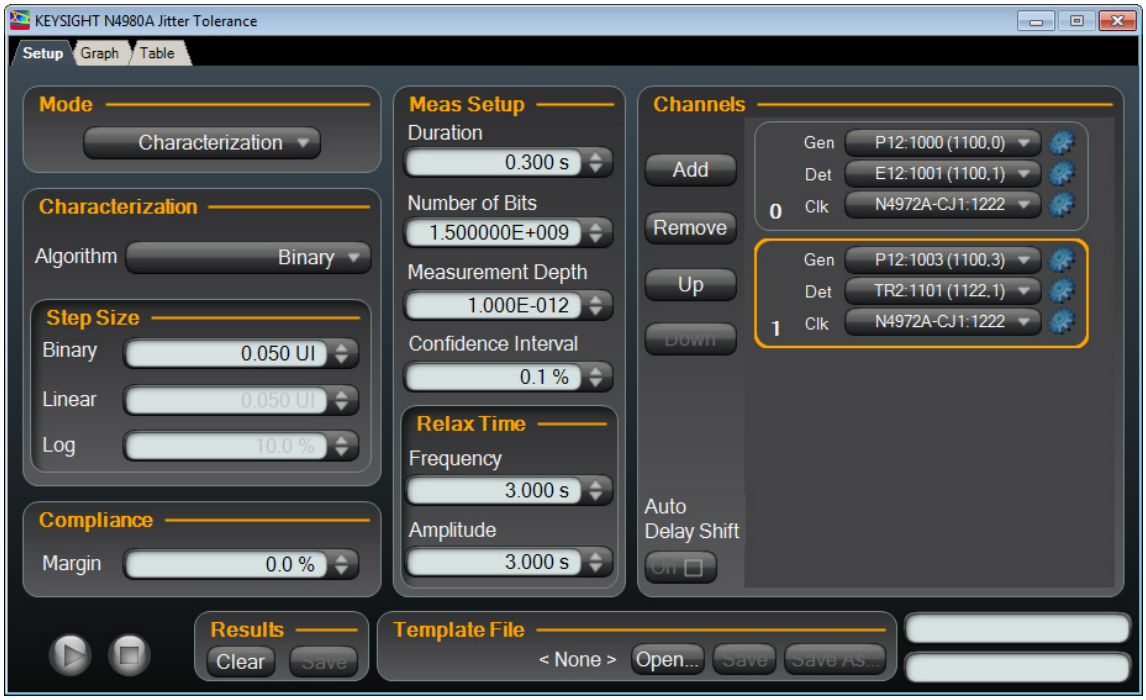


Figure 59. Jitter tolerance panel

5.4.1 Mode

Table 21. Mode Description

Name	Description
Mode	
Compliance	Tests a receiver's tolerance to a specific template of sinusoidal jitter frequencies and amplitudes. This is often performed when checking that a device passes the minimum required for compliance to an interconnect standard.
Characterization	Tests a receiver's tolerance to sinusoidal jitter to establish the pass/fail amplitude at each measurement frequency.

5.4.2 Characterization

Table 22. Search algorithm descriptions for characterization mode

Name	Description
Algorithm	Search algorithms apply to characterization measurements only.
Binary	The Binary algorithm uses a variable step size to find the highest passing SJ amplitude at each SJ frequency in the template. Starting at the maximum SJ amplitude determined by the upper limit in the template file or the instrument limit, whichever is lower, followed by the minimum SJ amplitude determined by the lower limit in the template file, the Binary algorithm then sets subsequent SJ amplitudes at the logarithmic midpoint between the highest passing and lowest failing SJ amplitudes. A test point is determined to be a passing point if the BER measured is below the BER threshold set by the user. The equation for the midpoint (c) between points a and b on a log scale is: c = 10^((log(a) + log(b)) / 2). The algorithm exits if the channel is tolerant of the maximum jitter amplitude or is intolerant of the minimum jitter amplitude. Otherwise, the algorithm continues until the last step size is less than the minimum step size set by the user for Binary algorithms. The jitter tolerance result at each jitter modulation frequency is the highest jitter amplitude at which the measurement was made below the threshold BER. However, if the device is intolerant of even the minimum jitter value, the result is not valid and is not plotted. In many cases, the Binary algorithm is the quickest. However, devices with hysteresis may not have consistent results when using the Binary algorithm since the approach direction (up vs. down) will cause the result to vary. This occurs because the PLL in the clock data recovery unit will typically hold lock longer as the jitter is increased, then it would establish lock as the jitter is reduced. For example, a receiver may have a higher passing SJ amplitude

Name	Description
	when the previous step was a lower (passing) SJ amplitude, compared to a lower passing SJ amplitude when the previous step was a higher (failing) SJ amplitude. If this is a problem, see the Binary + Down Linear and Binary + Up Linear algorithms.
	The following is an example of the Binary algorithm. At a single SJ frequency, if the true pass/fail SJ amplitude is 0.7 UI, the minimum step size is 0.1 UI, the template minimum is 0.1 UI, and the template maximum is 1.0 UI, then the binary algorithm would follow these test points: 1 Template maximum 1.0 UI - FAIL 2 Template minimum 0.1 UI - PASS 3 Log midpoint between 1.0 UI (FAIL) and 0.1 UI (PASS) = 0.32 UI - PASS 4 Log midpoint between 1.0 UI (FAIL) and 0.32 UI (PASS) = 0.57 UI - PASS 5 Log midpoint between 1.0 UI (FAIL) and 0.57 UI (PASS) = 0.75 UI - FAIL 6 Log midpoint between 0.75 UI (FAIL) and 0.57 UI (PASS) = 0.65 UI - PASS 7 Log midpoint between 0.75 UI (FAIL) and 0.65 UI (PASS) 0.70 UI - PASS 8 Last step size < 0.1 UI, highest passing SJ amplitude is 0.70 UI
Binary + down linear	The Binary + Down Linear algorithm is the same as the Binary algorithm followed by the Down Linear algorithm. Refer to the descriptions for Binary and Down Linear in this table.
Binary + up linear	The Binary + Up Linear algorithm is the same as the Binary algorithm followed by the Up Linear algorithm. Refer to the descriptions for Binary and Up Linear in this table.
Down linear	The Down Linear search algorithm starts at the maximum jitter value determined by the template. If a BER measurement has errors above the measurement threshold, the jitter amplitude is adjusted lower by the linear step size. This algorithm exits when the BER is measured below the measurement threshold BER, or if the last amplitude measurement point was at the minimum jitter value in the template. The jitter tolerance result at each jitter modulation frequency is the highest jitter amplitude at which the measurement was made below the threshold BER. However, if the device is intolerant of even the minimum jitter value, the result is not valid and is not plotted.

Name	Description
Down logarithmic	The Down Logarithmic search algorithm starts at the maximum jitter value determined by the template. If a BER measurement has errors above the measurement threshold, the jitter amplitude is adjusted lower by the coefficient calculated from the logarithmic step size. For example, if the coefficient is 10%, then the next amplitude equals the previous amplitude minus 10% of the previous amplitude. This algorithm exits when the BER is measured below the measurement threshold BER, or if the last amplitude measurement point was at the minimum jitter value in the template. The jitter tolerance result at each jitter modulation frequency is the highest jitter amplitude at which the measurement was made below the threshold BER. However, if the device is intolerant of even the minimum jitter value, the result is not valid and is not plotted.
Up linear	The Up Linear search algorithm starts at the minimum jitter value determined by the template. If a BER measurement has errors below the measurement threshold, the jitter amplitude is adjusted higher by the linear step size. This algorithm exits when BER is measured above the measurement threshold BER, or if the last amplitude measurement point was at the max jitter value in the template. The jitter tolerance result at each jitter modulation frequency is the highest jitter amplitude at which the measurement was made below the threshold BER. However, if the device is intolerant of even the minimum jitter value, the result is not valid and is not plotted.
Up logarithmic	The Up Logarithmic search algorithm starts at the minimum jitter value determined by the template. If a BER measurement has errors below the measurement threshold, the jitter amplitude is adjusted higher by the coefficient calculated from the logarithmic step size. For example, if the coefficient is 10%, then the next amplitude equals the previous amplitude plus 10% of the previous amplitude. This algorithm exits when the BER is measured above the measurement threshold BER, or if the last amplitude measurement point was at the maximum jitter value determined by the template. The jitter tolerance result at each jitter modulation frequency is the highest jitter amplitude at which the measurement was made below the threshold BER. However, if the device is intolerant of even the minimum jitter value, the result is not valid and is not plotted.

5.4.3 Step Size

Table 23. Step size descriptions for characterization algorithms

Name	Description
Binary	The Step Size for the Binary algorithm defines the exit criteria for the algorithm. The Binary search algorithm stops once its step size falls below this user defined Step Size. The Binary Step Size applies to the Binary algorithm and the binary portions of the Binary + Down Linear and Binary + Up Linear algorithms. Refer to Table 20 for more information on the Binary, Binary + Down Linear, and Binary + Up Linear algorithms.
Linear	This defines the step size for each step of the Up Linear and Down Linear algorithms. When Down Linear is enabled as the search algorithm, the measurement starts from the maximum (which depends on the jitter frequency). A step size of 100 mUI, for example, may result in a sequence of 1000 UI, 999.9 UI, 999.8 UI, and so on. The test for one frequency stops when the BER limit is met or zero amplitude is reached. When Up Linear is enabled as the search algorithm, the measurement starts from the minimum. A step size of 100 mUI, for example, will result in a sequence of 0.1 UI, 0.2 UI, 0.3 UI, and so on. The test for one frequency stops when the BER limit is exceeded or the maximum amplitude is reached.
Log	This defines the step size for each step of the Up Logarithmic and Down Logarithmic algorithms. When Down Logarithmic is enabled as the search algorithm, the measurement starts from the maximum (which depends on the jitter frequency). A percentage of 50%, for example, may result in a sequence of 1000 UI, 500 UI, 250 UI, and so on. The test for one frequency stops when the BER limit is met or the specified minimum amplitude is reached. When Up Logarithmic is enabled as the search algorithm, the measurement starts from the specified minimum amplitude. A percentage of 50%, for example, may result in a sequence of 0.1 UI, 0.15 UI, 0.23 UI, and so on. The test for one frequency stops when the BER limit is crossed or the maximum amplitude (which depends on the jitter frequency) is reached.

5.4.4 Compliance

Table 24. Compliance Setting

Name	Description
Margin	In Compliance mode, the test starts at points defined on the jitter tolerance curve and is increased or decreased by the specified margin percent. The compliance template is adjusted according to the equation SJ Amplitude (with margin) = original SJ Amplitude * (1.0 + margin(%)/100). This can be used to test if a receiver can withstand a certain percentage more jitter than dictated by the compliance template. Conversely, if a receiver is failing, the margin can be lowered to test if a receiver can pass a compliance test with a less stringent template.

5.4.5 Meas Setup

Table 25. Measurement setup description

Name	Description
Duration	Sets the BER measurement time from 0.001 s to 1000 s. Changing this setting affects the Number of Bits setting.
Number of bits	Sets the number of bits to measure. Changing this setting affects the Duration setting.
Measurement Depth	Measurement Depth = -log(1 – confidence interval) / (data rate * gate time) The range is 0 to 1.0E+000. The default is 1.0E-012.
Confidence Interval	Confidence Interval = 1 – exp(-data rate * gate time * measurement depth) The range is 0% to 99.9%. The default is 95%.

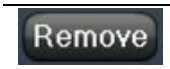
5.4.6 Relax Time

Table 26. Relax time description

Name	Description
Frequency	Sets the amount of time to pause the measurement after a change in jitter modulation frequency.
Amplitude	Sets the amount of time to pause the measurement after a change in jitter modulation amplitude.

5.4.7 Channels

Table 27. Channel description

Name	Description
Gen	The Gen drop down list box accesses all available connected pattern generators and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A generator must be specified to perform the measurement.
Det	The Det drop down list box accesses all available connected error detectors and is used to select one for use in the measurement. A detector must be specified to perform the measurement.
Clk	The Clk drop down list box accesses all available connected clock sources and is used to select one for quick access to its control panel by clicking on the blue gear wheel icon to change its settings. A clock must be specified to perform the measurement.
	After selecting a generator, detector, and clock, the corresponding gear wheel turns blue. While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the control panel for the instrument.
	Adds a measurement channel to the list.
	Removes the selected measurement channel from the list.
	Moves the selected measurement channel up in the list.
	Moves the selected measurement channel down in the list.

Name	Description
Auto delay shift	This feature is used specifically with the N4963A which injects jitter asymmetrically. When enabled, N4980A multi-instrument BERT software automatically moves the sampling point in time by half the amount of the additional jitter injected. This is helpful when testing in a back-to-back configuration where the transmitter and the receiver are connected directly.

NOTE

When using the N4960A as the clock source, jitter tolerance will automatically use the Periodic Jitter (PJ) source for the high jitter amplitude, low jitter frequency range, up to 6.25 MHz. Jitter tolerance will automatically use the sinusoidal jitter 1 (SJ1) source above 6.25 MHz.

When PJ is used in the low frequency range, all other jitter sources will be disabled. If the user has other jitter sources enabled when jitter tolerance is started, all sources will be automatically disabled in order for PJ to be enabled. As the jitter frequency in the Jitter Tolerance template is increased beyond 6.25 MHz, and the jitter source is switched from PJ to SJ1, if any other high frequency path jitter sources were automatically disabled when starting jitter tolerance, they will be re-enabled when SJ1 is enabled. The other high frequency path jitter sources include sinusoidal jitter 2 (SJ2) (N4960A-CJ1 only), random jitter (RJ) (N4960A-CJ1 only), and external jitter (High Band).

5.4.8 Start/Stop Buttons

Table 28. Start/Stop buttons description

Name	Description
	Starts the jitter tolerance measurement.
	Stops the jitter tolerance measurement.

5.4.9 Results

Table 29. Results description

Name	Description
Clear	Clears the results of the jitter tolerance measurement.
Save	Saves the results, descriptions of all instruments, and settings of all instruments used in the jitter tolerance measurement to the specified filename and location.

5.4.10 Template File

Table 30. Template description

Name	Description
Open...	Opens an existing template file which includes limits, compliance, and jitter tolerance measurement state.
Save	Saves the currently open template file to the current filename.
Save As...	Saves the currently open template file to a different filename and/or location.

5.4.11 Using the Jitter Tolerance Graph View

After a jitter tolerance measurement has been run, results can be viewed by clicking on the Graph tab. The graph displays the sinusoidal jitter frequency on the x-axis, and the sinusoidal jitter amplitude on the y-axis.

Figure 60 is an example showing results in the graph view.

This screen can be saved as a jpg image by clicking on the waveform icon in the title bar of Jitter Tolerance Graph, and selecting 'Save Dialog'.

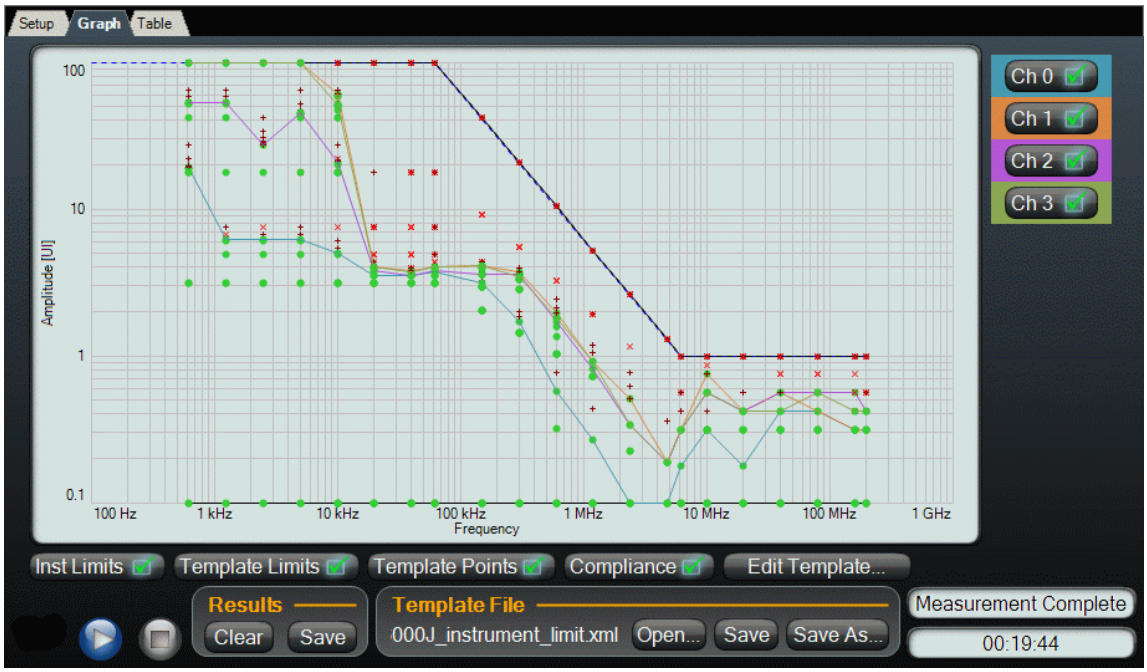


Figure 60. Jitter tolerance example showing results in the graph view

5.4.11.1 Result Points

The graph displays the BER measurement results of each tested sinusoidal jitter point. Passing results are displayed as a green dot.

If the N4965A or N4960A is being used, a failure due to a “no sync” error is displayed as a red “X”. An error due to the BER threshold being exceeded is displayed as a maroon “+”.

If the N4962A is being used, an error due to the BER threshold being exceeded is also displayed as a maroon “+”.

5.4.11.2 Instrument Limit Line

The dashed blue line on the graph shows the maximum SJ modulation the instrument can apply to the pattern generator.

5.4.11.3 Maximum and Minimum Template Limit Lines

The solid black lines on the graph show the search range during characterization. This feature reduces test time by eliminating points where the DUT is likely to pass when its performance range is known.

5.4.11.4 Template Points

The black dots on the graph are the measurement points defined in the Template File.

5.4.11.5 Compliance Limit Line

The dashed black line on the graph shows the compliance test defined in the Template File.

5.4.11.6 Graph Functions

Table 31. Graph Function description

Name	Description
	Enables/disables the dashed blue instrument limit line.
	Enables/disables the solid black template limit lines.
	Enables/disables the black dots representing the measurement points.
	Enables/disables the dashed black compliance limit line.
	Accesses the functions used to modify the currently loaded template file.
Ch X	Displays/hides the measurement results for the specific channel.

5.4.12 Using the Jitter Tolerance Template Editor

The jitter tolerance template editor is used to modify the currently loaded template file. the jitter tolerance template editor is accessed by clicking on the **Edit Template**... button in the Graph tab.

Figure 61 is an example of the jitter tolerance template editor showing the measurement point values (frequency and amplitude) for the currently loaded template file.

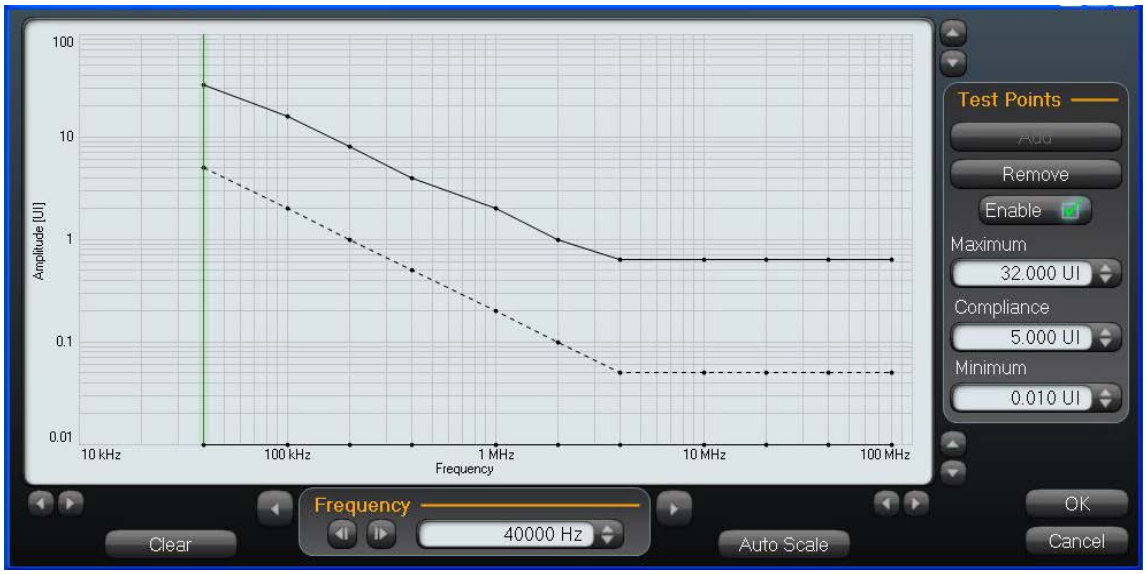
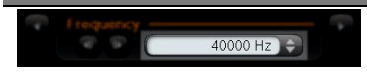
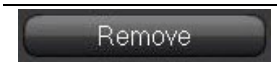
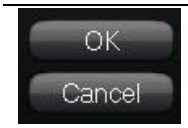


Figure 61. Template editor

5.4.12.1 Template Editor Functions

Table 32. Template editor function Description

Name	Description
	The left and right arrow buttons located below the graph change the range of the graph.
	Clears all current frequency and amplitude measurement point definitions except the end points.
 and 	The left and right arrow buttons located to the left and right of the Frequency function pan the graph.
	The left and right arrow buttons located to the left of the frequency display cause the vertical marker to jump to the next/previous measurement point.

Name	Description
	The frequency at the current vertical marker position is displayed in this window. Changing this frequency using the up or down arrows, or keypad, allows new measurement points to be defined.
	Scales the graph to the optimum setting.
	The up and down arrow buttons located to the right of the graph change either the low-end or high-end amplitude limits of the graph.
	Becomes active when the frequency of the vertical marker is changed to an undefined point on the graph. Clicking this button adds the current frequency point to the measurement.
	Removes the measurement point at the current vertical marker position.
	Enables/disables the measurement point at the current marker position. Disabled measurement points will not be run during a Jitter Tolerance measurement.
Maximum	Changes the maximum amplitude of the measurement point at the current vertical marker position. These are the points along the solid black line on the graph.
Compliance	Changes the compliance amplitude of the measurement point at the current vertical marker position. These are the points along the upper solid black line on the graph.
Minimum	Changes the minimum amplitude of the measurement point at the current vertical marker position. These are the points along the lower solid black line on the graph.
	The OK button accepts the modifications; the Cancel button cancels the modifications.

5.4.13 Using the Jitter Tolerance Table View

Measurement results can also be viewed in tabular form by clicking on the Table tab. Measurement results are saved in tabular format only.

Figure 62 is an example of the results at each measurement point in tabular form.

Figure 62. Jitter tolerance table view

6 Tools

The Tools file menu accesses various utilities for performing specific tasks. The tools include:

- Licensed measurements
- Programmable pattern editor
- Instrument upgrade
- De-emphasis tap weight calculator
- Command viewer

The Licensed Measurements tool is used to install license keys for measurements that require a license.

The Programmable Pattern Editor tool is used for creating pattern sequences from the existing library of patterns, or used to create user-designed patterns. These patterns can then be uploaded to the N4960A.

The Instrument Upgrade tool is used to upgrade an instrument's firmware.

The De-emphasis Tap Weight Calculator is used to calculate optimum de-emphasis settings from s-parameter files for use with pattern genertor heads with integrated de-emphasis capability.

The Command Viewer tool is used to view commands (in SCPI format) as theyoccur during operation.

6.1 Licensed measurements

Certain measurements and tools require a license before they can be used. Licenses are issued on a per-instrument basis, and are keyed to instrument model and serial numbers. Once a license key has been issued for an instrument, that key may be used on any PC. Licenses can be obtained through the Keysight Technologies Sales organization. Trial licenses are also available for evaluation purposes.

The following procedure describes how to install the Jitter Tolerance license but can be used for any future measurements and tools requiring a license.

6.1.1 Installing the license

1. Contact Keysight Technologies and purchase a license. A license is issued for an individual instrument model and serial number. The license key will be emailed to the user.
2. Start the N4980A multi-instrument BERT software.
3. In the main screen, click on the Tools menu then click on Licensed Measurements... to access the Measurements screen as shown in Figure 63.

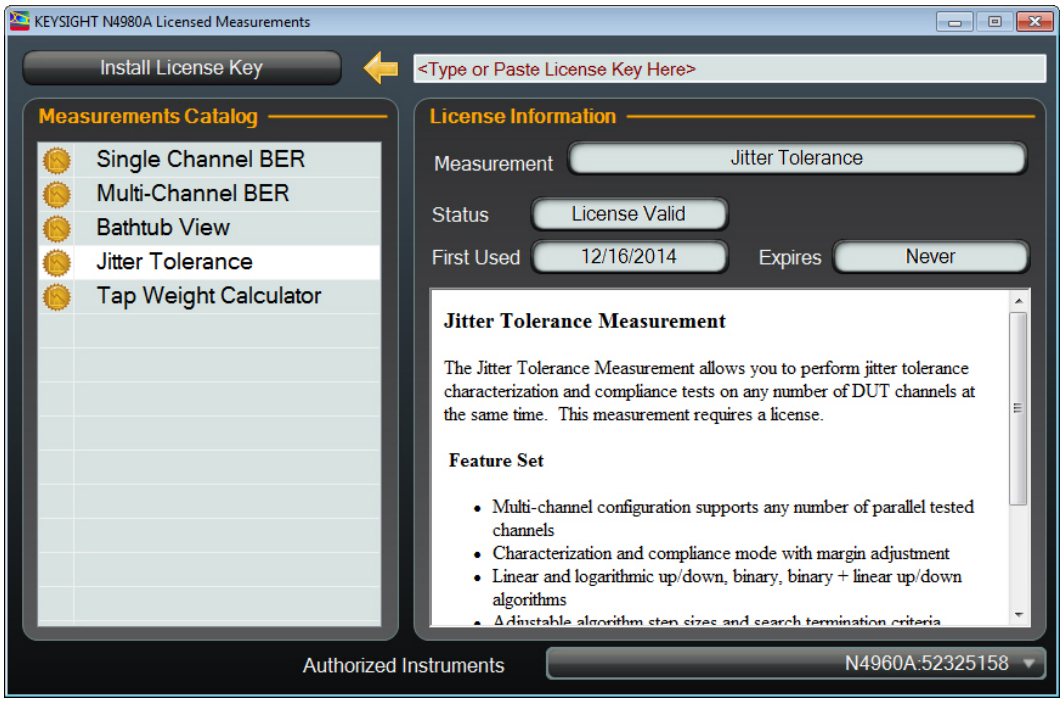


Figure 63. Licensed measurements screen

4. Under Measurements Catalog, click on Jitter Tolerance or Tap Weight Calculator, as appropriate.
5. In the Install License Key text box, type or paste in the license key.
6. Click on the Install License Key button. After the license key has been entered, the message in the Status text box changes to License Valid and the instrument model and serial number contained in the license is added to the authorized instruments list. Select the newly added instrument from the list, and the License #, First Used, and Expires information is displayed as shown in Figure 63.

NOTE

A Jitter Tolerance license will be active at this point. However, it requires the N4980A to be 'connected' to the licensed instrument in order to run a Jitter Tolerance measurement. A Tap Weight Calculator license requires a one-time connection to the licensed instrument in order to activate the license. Once activated, the Tap Weight Calculator can be used with or without the connected instrument.

6.2 Programmable pattern editor

The programmable pattern editor is an interface for creating custom patterns and pattern sequences and uploading them into the N4960A.

Figure 64 shows the programmable pattern editor screen.

Figure 64. Programmable pattern editor screen

The Programmable Pattern Editor is organized as follows:

- Pattern sequences are composed of one or more sub-patterns. Each sub-pattern contains a single pattern definition. Using sub-patterns allows users to break down complex patterns for easier organization. Sub-patterns are managed in the main programmable pattern editor dialog.
- Each sub-pattern, except utility patterns, can be edited at the bit level using the edit pattern dialog. Simply click the "..." button next to the sub-pattern description to bring up the Edit Pattern dialog. In this dialog, users can view, edit, and find specific bit sequences.
- Once the pattern definition is complete, it can be validated and uploaded to the N4960A. It can also be saved to the PC as a *.cpf file.

6.2.1 Creating and saving a user pattern

The following procedure describes how to create custom (user) patterns that can then be integrated into pattern sequences.

1. In the **Programmable Pattern Editor**, click on the **New Pattern...** button under **Insert**. A new sub-pattern is displayed as shown in Figure 65.

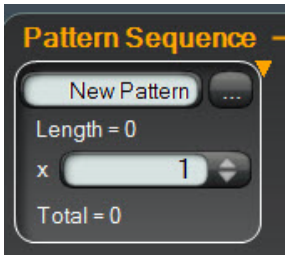


Figure 65. Creating a custom pattern

2. Click in the text box to change the name of the pattern.
3. Click on the ... button located to the right of the text box to access the screen shown in Figure 66.

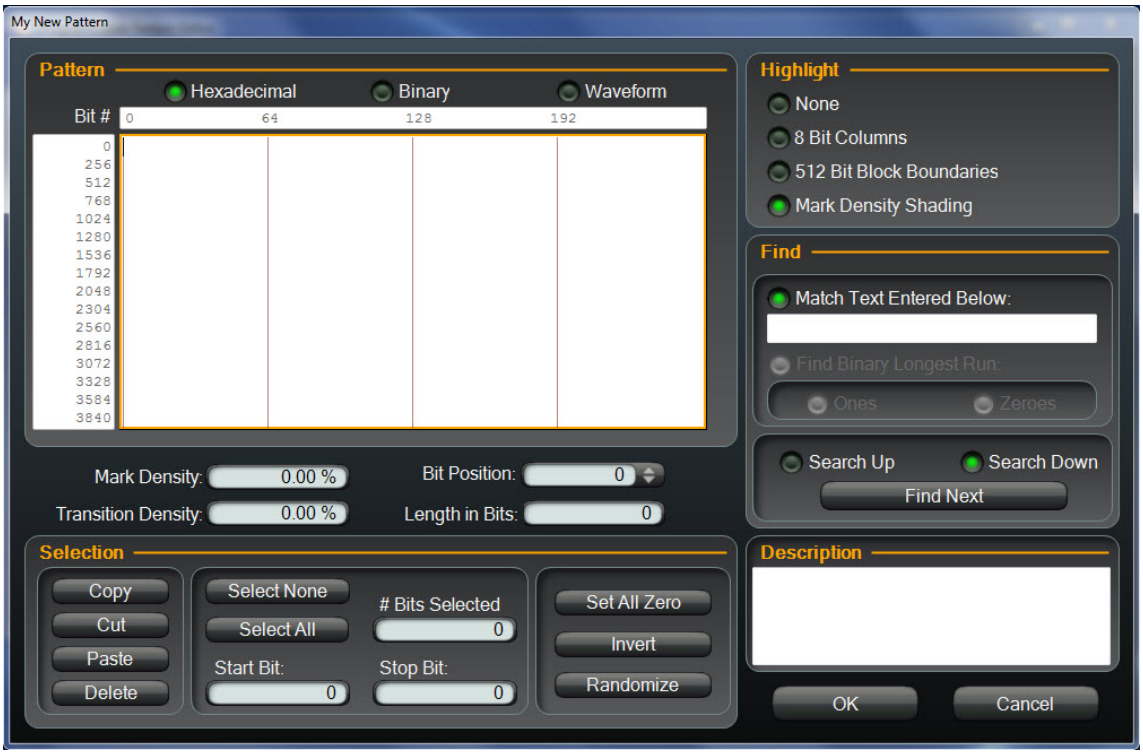


Figure 66. Insert new pattern

4. Select **Hexadecimal** to enter the pattern as a hexadecimal number, select **Binary** to enter the pattern as a binary number, or select **Waveform** to enter the pattern as a waveform. Figure 67 shows a pattern being entered with binary selected and with the highlight function turned off (none).

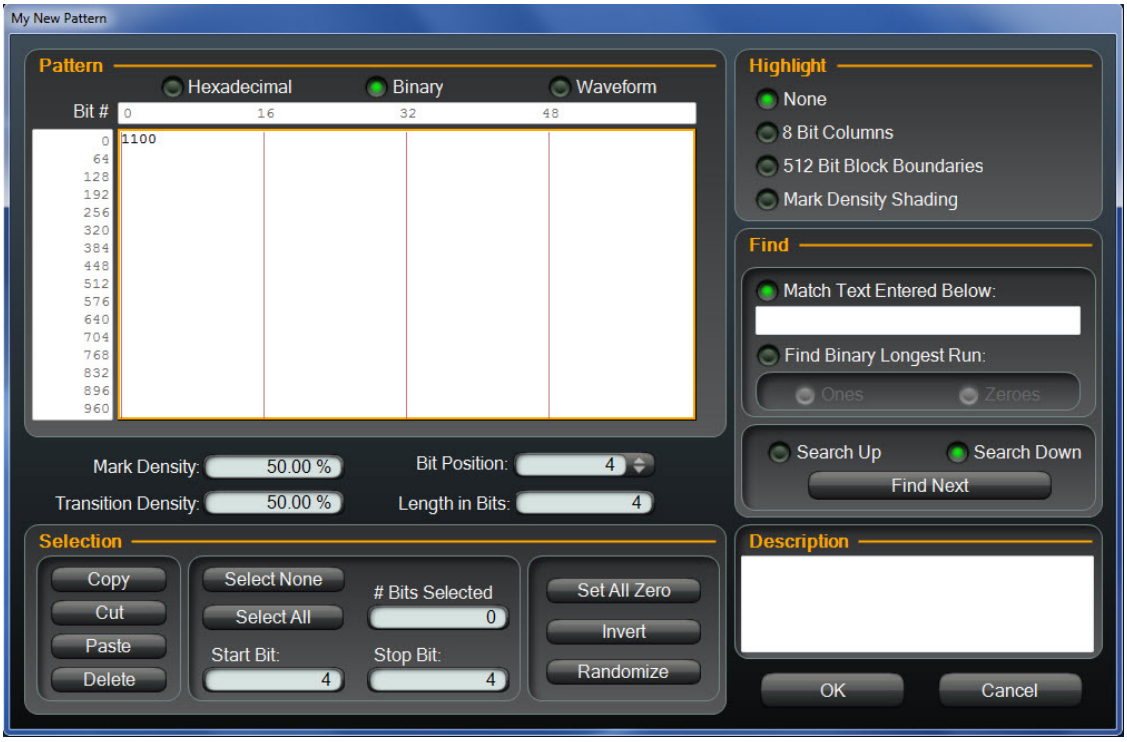


Figure 67. Define pattern

5. Type the desired pattern using the numeric keypad on the computer keyboard. If an error is made, the common editing functions can be used to make corrections.
6. When the pattern has been completed, click on the **OK** button.
7. In the **Programmable Pattern Editor** screen, click on the **Save...** button.
8. Enter a file name for this pattern then click on the save button. The pattern is saved as a *.cpf file.

6.2.2 Editing a pattern sequence

Pattern sequences can be edited at any time and saved for later use. Sub-patterns can be moved, deleted, copied and pasted anywhere in the pattern sequence, and can be grouped together into a single sub-pattern (flattened).

6.2.2.1 Inserting a Factory Pattern

Factory patterns are the patterns included in the preloaded pattern library including some PRBS patterns, some K28.x control symbols, and some industry standard test patterns.

1. In the Programmable Pattern Editor, click on the Factory Pattern... button under Insert.
2. In the Load Sub-Pattern dialog box, click on the pattern to load then click on the open button. The pattern is displayed in the Pattern Sequence window as shown in Figure 68.

Figure 68. Loading a factory pattern

6.2.2.2 Inserting a User Pattern

User patterns are inserted into a pattern sequence in much the same way as factory patterns.

1. In the **Programmable Pattern Editor**, click on the **User Pattern...** button under insert.
2. In the **Load Sub-Pattern** dialog box, click on the pattern to load then click on the **Open** button.

6.2.2.3 Inserting a Utility Pattern

1. In the **Programmable Pattern Editor,** click on the **Utility Pattern...** button under **Insert**. The utility patterns selection buttons are displayed as shown in Figure 69.

Figure 69. Utility pattern

2. Click on the **Clock Pattern** button to insert a clock pattern. The **#Ones, #Zeroes** numeric field shown in Figure 70 defines the number of ones and the number of zeroes in the clock pattern. The **Length** field defines the total bit length of the pattern.

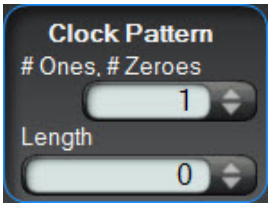


Figure 70. Clock pattern

3. Click on the **All Ones** button to insert a pattern consisting of logic ones. The **Length** field defines the total bit length of the pattern. Refer to Figure 71.

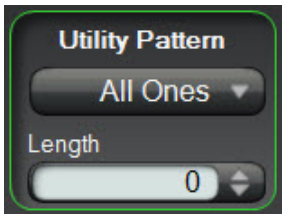


Figure 71. All ones pattern

4. Click on the **All Zeroes** button to insert a pattern consisting of logic zeroes. The **Length** field defines the total bit length of the pattern. Refer to Figure 72.

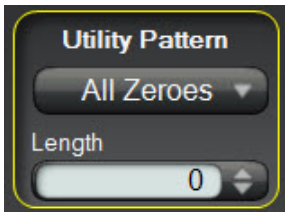


Figure 72. All zeroes pattern

5. Click on the **Random** button to insert a pattern consisting of random logic ones and zeroes. The **Length** field defines the total bit length of the pattern. Refer to Figure 73.

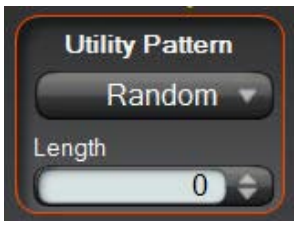


Figure 73. Random pattern

6.2.2.4 Inserting a New Pattern

1. In the **Programmable Pattern Editor**, click on the **New Pattern...** button under **Insert**. A new sub-pattern is displayed as shown in Figure 74.

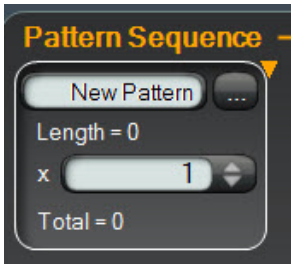


Figure 74. Inserting a new pattern

2. Click in the text box to change the name of the pattern.
3. Click on the ... button located to the right of the text box. Refer to 6.2.1 Creating and saving a user pattern.

6.2.2.5 Selecting a Sub-Pattern

1. To select a single sub-pattern, click in the sub-pattern box. When selecting, do not click on the text fields, up or down arrows, or the ... button. Refer to Figure 75.

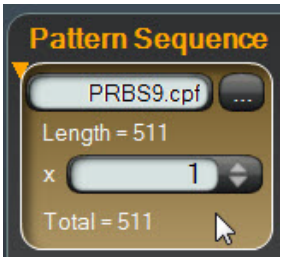


Figure 75. Selecting a single sub-pattern

2. To select multiple sub-patterns, press and hold the **Ctrl** key and click in each sub-pattern box as shown in Figure 76.

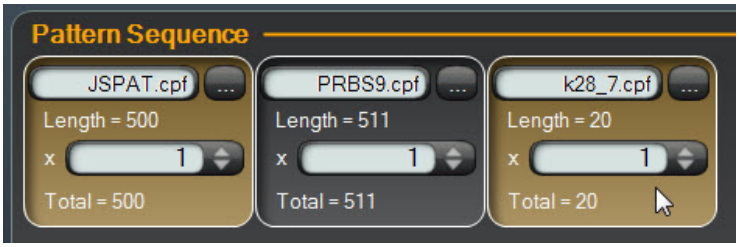


Figure 76. Selecting multiple sub-patterns

6.2.2.6 Moving a Sub-Pattern

1. Select the sub-pattern by clicking in the sub-pattern box and dragging it to the new location. The inverted triangle indicates the insertion point as you drag the sub-pattern across the sequence. Figure 77 is an example showing the JSPAT.cpf sub-pattern being moved to the end of the sequence.

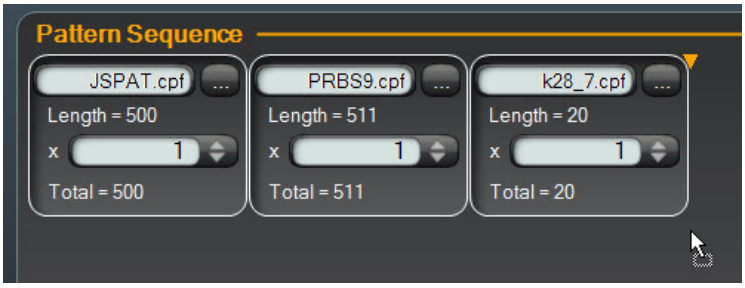


Figure 77. Moving a sub-pattern

2. When the sub-pattern is positioned at the new location, release the mouse button.

6.2.2.7 Copying and Pasting a Sub-Pattern

1. Select the sub-pattern by clicking in the sub-pattern box. When selecting, do not click on the text fields, up or down arrows, or the ... button.
2. Under **Edit Selection**, click on the **Copy** button.
3. Position the inverted triangle (insertion point) where the copy of the sub-pattern is to be pasted. The insertion point is always to the left of a selected sub-pattern as shown in Figure 78.

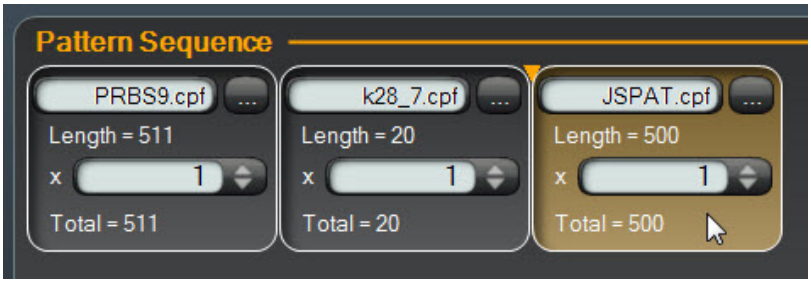


Figure 78. Copying and pasting a sub-pattern

4. Under **Edit Selection**, click on the **Paste** button.

6.2.2.8 Deleting Selected Sub-Pattern(s)

1. Select a single sub-pattern by clicking in the sub-pattern box. Select multiple sub-patterns by pressing and holding the **Ctrl** key while clicking in each sub-pattern box to delete. When selecting, do not click on the text fields, up or down arrows, or the ... button.
2. Under **Edit Selection**, click on the **Delete** button or the **Cut** button (to copy the deleted item to the clipboard).

6.2.2.9 Grouping (Flattening) Multiple Sub-Patterns

When using the flattening function, note that all sub-patterns in the pattern sequence will be flattened.

1. Under **Tools,** click on the **Flatten button**. Figure 79 is an example of three sub-patterns that were grouped (flattened) together to form a single sub-pattern.

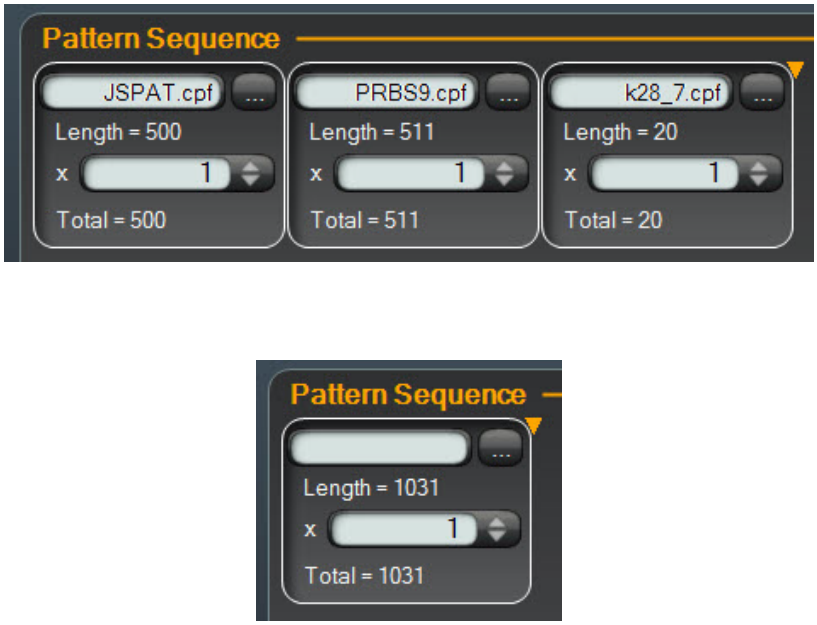


Figure 79. Flattening sub-patterns

2. Click in the text field to add a descriptive sub-pattern name.
3. To save the flattened sub-pattern, click on the Save... button.
4. Enter a name for the pattern sequence file, then click on the Save button.

6.2.3 Editing a Pattern at the Bit Level

The Cut, Copy, and Paste editing functions common to Windows applications are also available in the Pattern Editor for editing patterns.

NOTE

Some sub-patterns, such as the Utility Patterns, do not contain a bit sequence, only a definition of how the bit sequence will be generated. If a Utility Pattern is flattened, it will then contain the actual bit pattern. Utility patterns cannot be edited at the bit level.

To edit a pattern, click on its ... button. The ... button is located to the right of the text box displaying its name. Refer to Figure 80.

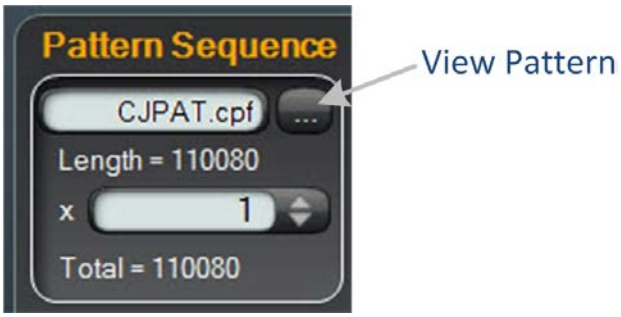


Figure 80. Editing a pattern

6.2.3.1 Selecting Hexadecimal, Binary, or Waveform View

1. To view the pattern in hexadecimal, select **Hexadecimal** as shown in Figure 81.

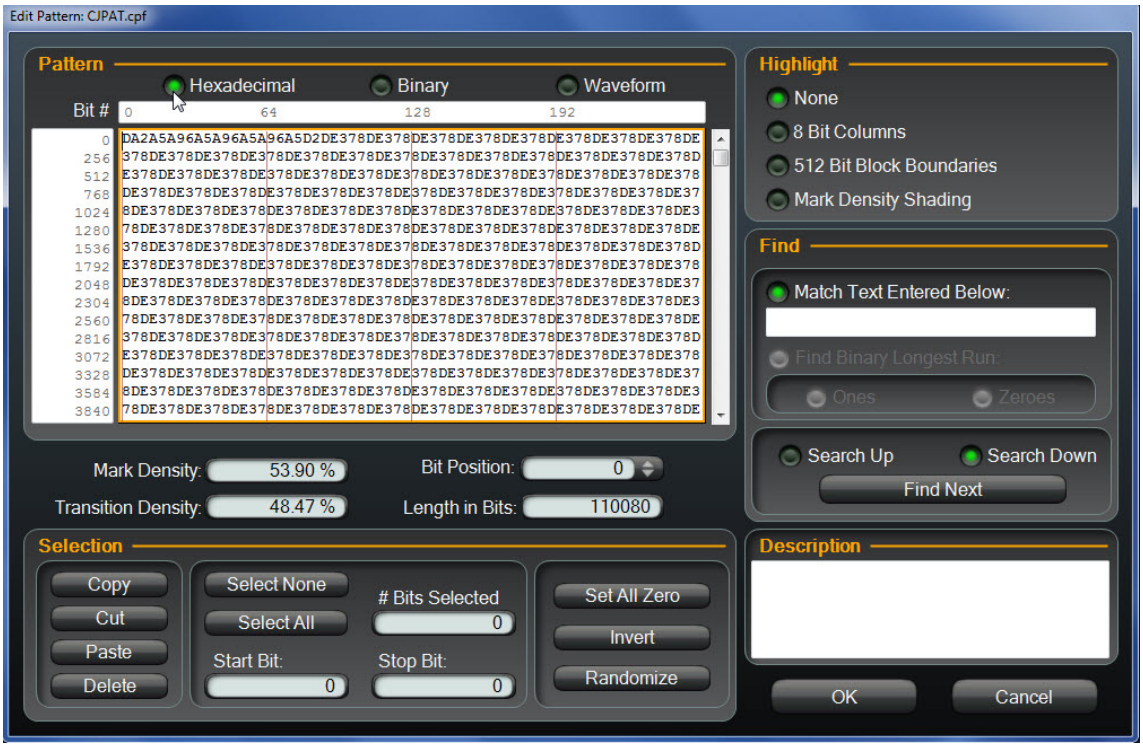


Figure 81. Hexadecimal view

2. To view the pattern in binary, select **Binary** as shown in Figure 82.

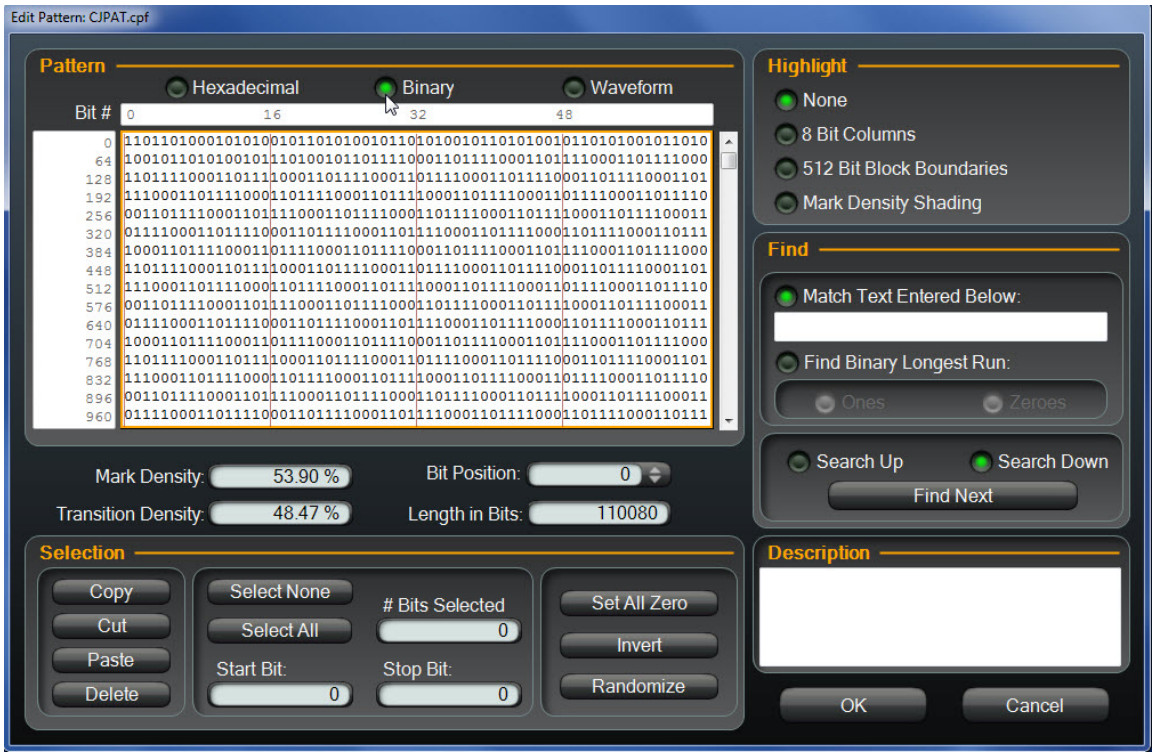


Figure 82. Binary view

3. To view the pattern as a waveform, select **Waveform** as shown in Figure 83.

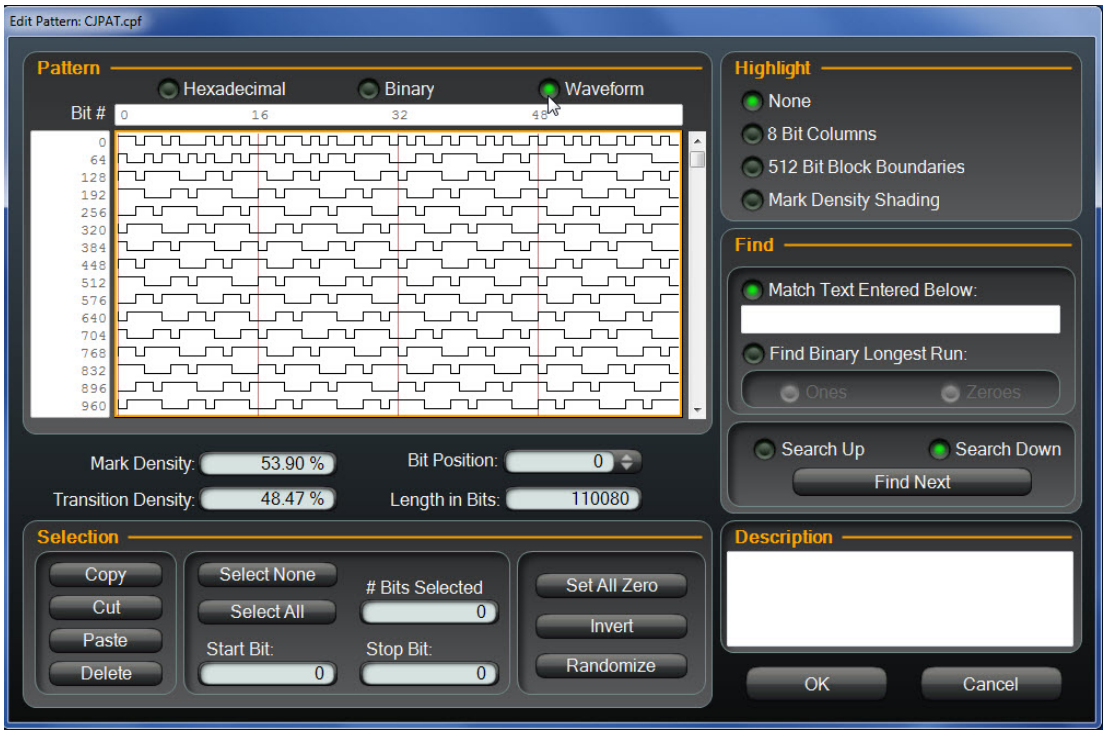


Figure 83. Waveform view

6.2.3.2 Selecting Pattern Highlight Options

1. To highlight the pattern in columns of 8 bits, select **8 bit Columns** as shown in Figure 84.

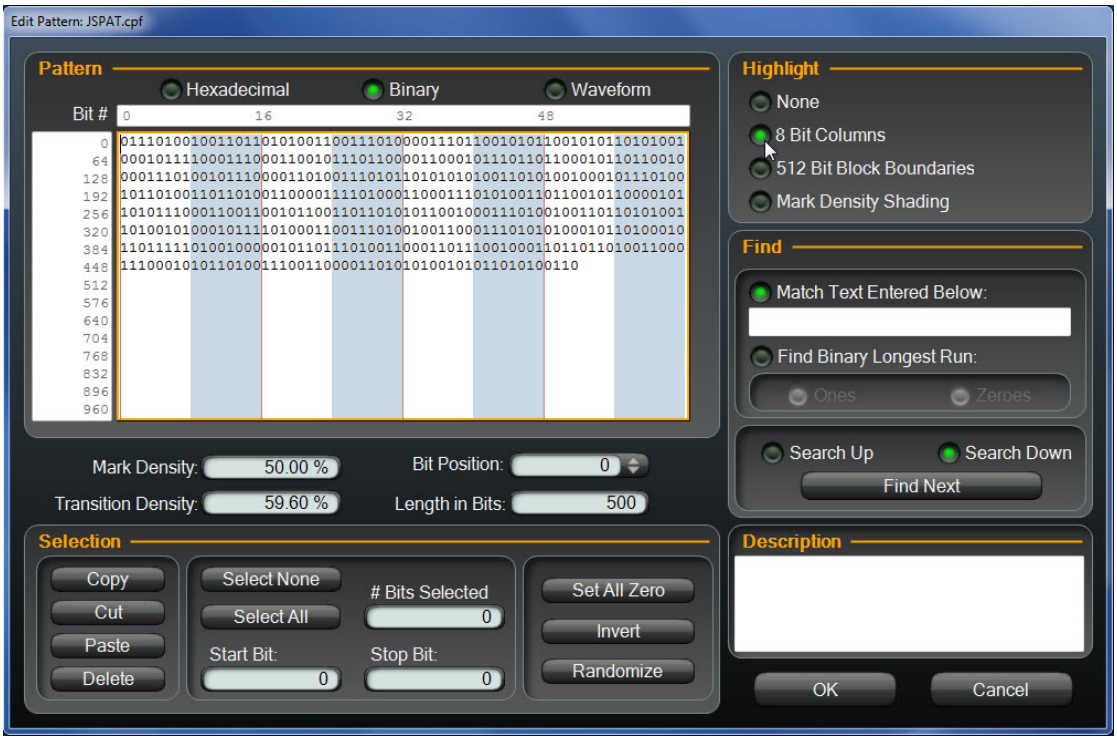


Figure 84. Highlight pattern in 8 bit columns

2. To highlight the pattern in blocks of 512 bits, select **512 Bit Block Boundaries** as shown in Figure 85.

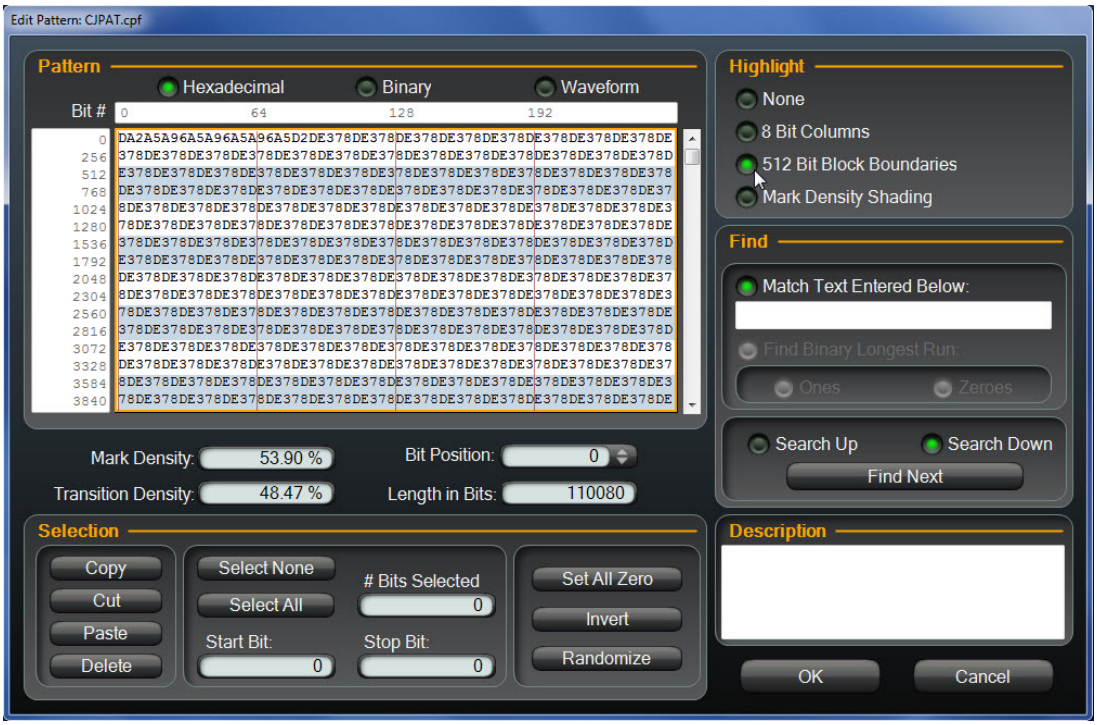


Figure 85. Highlight pattern in 512 blocks

3. To highlight the pattern by mark density, select Mark Density

Mark density uses variable shading to give a visual cue to the number of logic ones in the pattern. In binary mode, there are only two magnitudes, and only two shades as shown in Figure 86. When the pattern is viewed in hexadecimal mode, there are five different shades as shown in Figure 87.

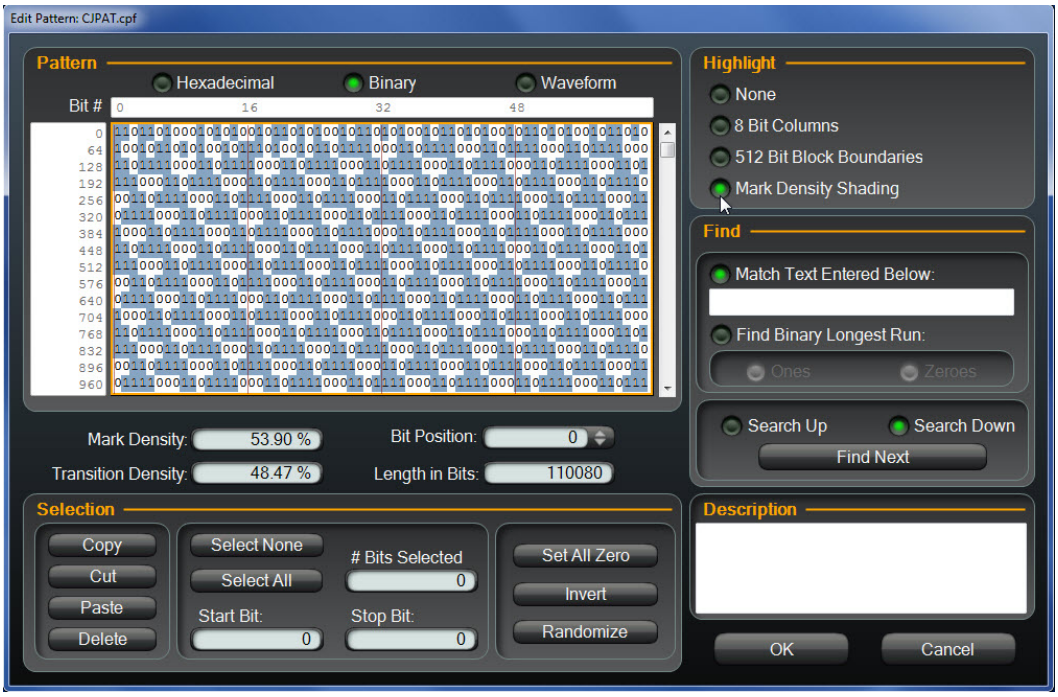


Figure 86. Highlight binary pattern by mark density

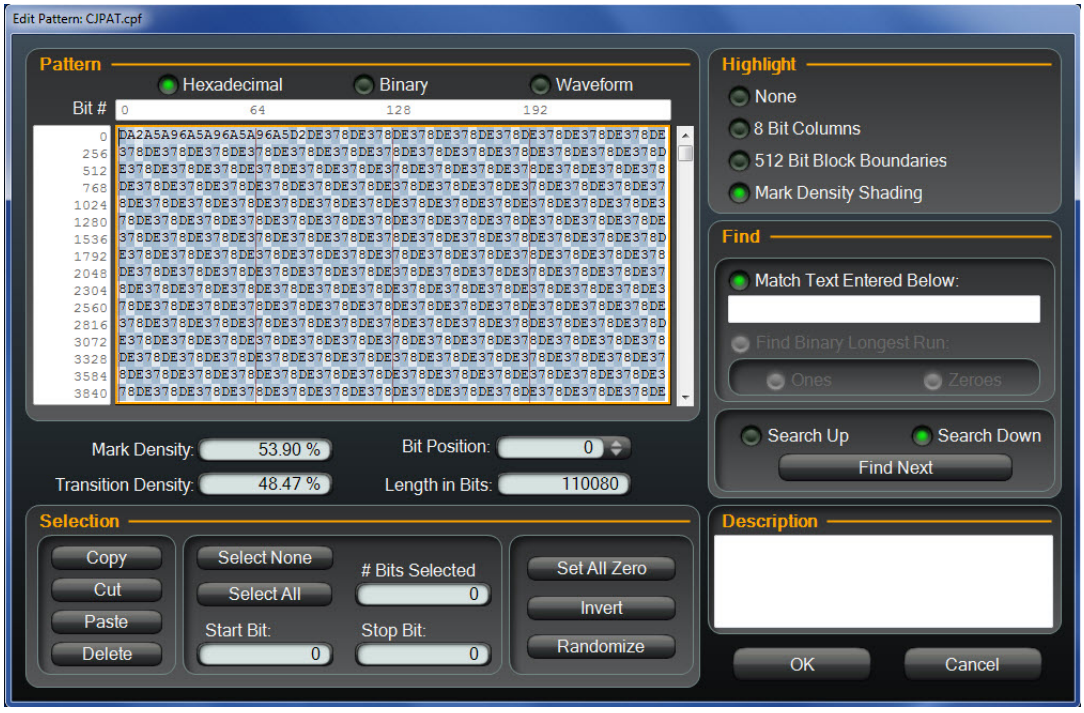


Figure 87. Highlight hexadecimal pattern by mark density

6.2.3.3 Selecting All or Part of a Pattern

1. To select or deselect the entire pattern, click on the **Select All** or **Select None** button respectively.
2. To highlight a specific range of bits, position the insertion point at the first bit, click and hold the mouse button, then drag to the last bit. Another method is to position the mouse pointer at the first bit, click the mouse, and then press and hold the Shift or Ctrl key while pressing the arrow keys until the region is highlighted.

6.2.3.4 Changing Bit Values

1. Use the **Set All Zero** button to set all or just the highlighted range of bits to zero.
2. Use the **Invert** button to invert all or just the highlighted range of bits.
3. Use the **Randomize** button to set all or just the highlighted range of bits to random values.

6.2.3.5 Searching for a Bit Pattern

1. Position the mouse pointer in the **Match Text Entered Below** text field.
2. Enter the bit pattern to find.
3. Select the **Search Down** option to search downward, or select **Search Up** to search upward.
4. Click on the **Find Next** button to begin the search. Refer to Figure 88.

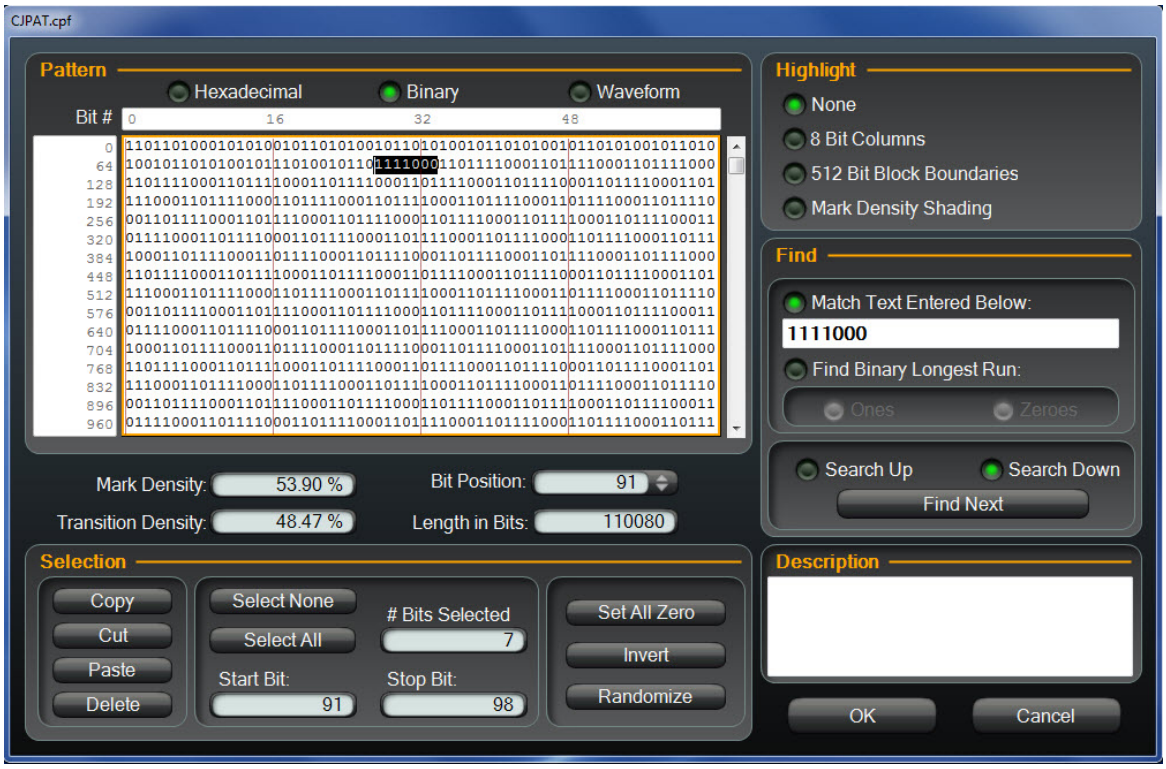


Figure 88. Searching for bit pattern

6.2.3.6 Finding the Longest Run of Ones or Zeroes

This feature is only available in binary mode.

1. Under Find, select Find Binary Longest Run.
2. Select the **Ones** option to search for the longest run of ones or select **Zeroes** to search for the longest run of zeroes.
3. Select the **Search Down** option to search downward, or select **Search Up** to search upward.
4. Click on the **Find Next** button to begin the search. Refer to Figure 89.

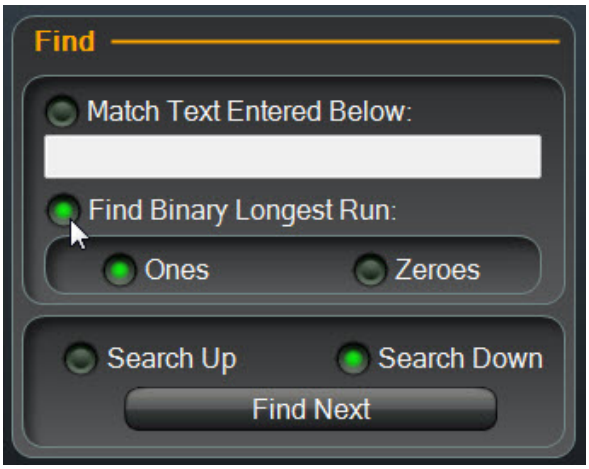


Figure 89. Finding longest run of ones or zeroes

6.2.3.7 Copying and Pasting a Bit Pattern

1. Highlight the range of bits as described in 6.2.3.3 Selecting All or Part of a Pattern.
2. Click on the **Copy** button to copy the bit pattern to the clipboard.
3. Position the mouse pointer at the insertion point where the bit pattern is to be inserted.
4. Click on the **Paste** button.

6.2.4 Creating and Saving a Pattern Sequence

A pattern sequence consists of one or more sub-patterns loaded into the Pattern Editor. The sub-patterns can be factory or custom (user) patterns. Pattern sequences are saved as ***.cpf** for later use.

1. In the Programmable Pattern Editor, click on the Factory Pattern... button or User Pattern... button under Insert.
2. In the **Load Sub-Pattern** dialog box, click on the pattern name then click on the **Open** button. The pattern is displayed in the **Pattern Sequence** window as shown in Figure 68.
3. Repeat this procedure to load additional sub-patterns. Figure 90 is an example of a pattern sequence consisting of a PRBS9 and a custom (user) pattern.

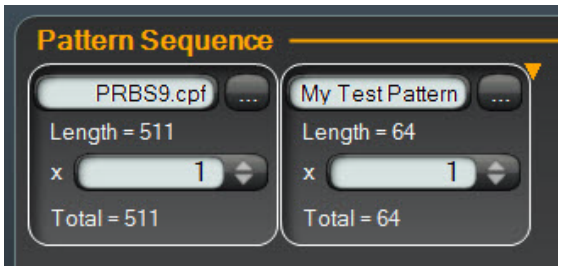


Figure 90. Creating a pattern sequence

6.2.5 Validating a Pattern

Before a pattern sequence can be uploaded to an instrument, it must be validated to ensure that it meets pattern length requirements. The software will indicate if the user must increase or decrease the number of bits manually or indicate that the number of bits will be multiplied by a number to meet the pattern length requirements.

1. Under **Validate,** click on the **Instrument Type** drop down list box and select the instrument. Refer to Figure 91.

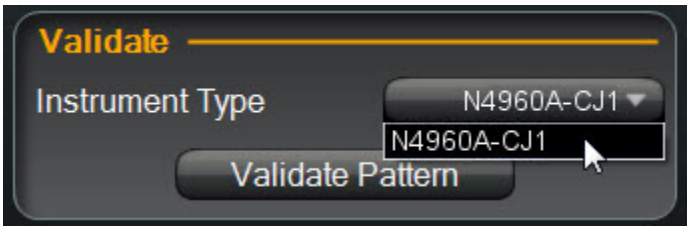


Figure 91. Instrument Type drop down list box

2. Click on the **Validate Pattern** button. Figure 92 is an example of a message indicating that the pattern length of the pattern sequence will be increased to meet the requirements. In this case, clicking the **OK** button is the only action required by the user.

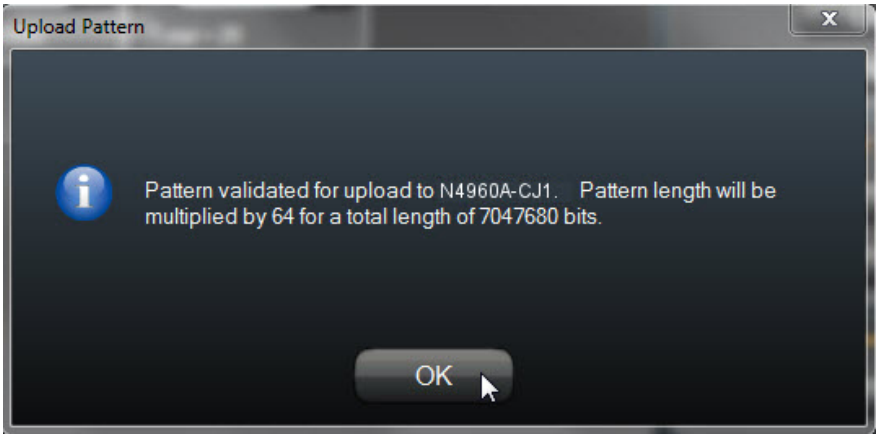


Figure 92. Validate pattern message

When the pattern cannot be multiplied by an integer number to meet the pattern length requirements, the user is prompted to pad the pattern. The user must add or subtract the number of bits required using the built-in editing features.

6.2.6 Uploading a Pattern

After the validation process has been completed, the pattern sequence can be uploaded to the instrument. Validation occurs automatically when upload is activated. If the pattern is not valid for upload, the user will be notified and the upload will be aborted.

1. Under **Upload**, click on the **Connected Instrument** drop down list box and select the instrument. Refer to Figure 93.

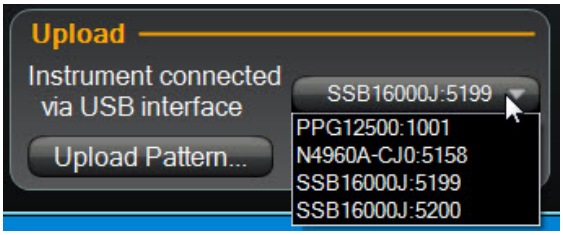


Figure 93. Connected Instrument drop down list box

2. Under **Upload**, click on the **Upload Pattern...** button. The **Upload Pattern** dialog box is displayed as shown in Figure 94. It displays a list of the existing patterns in the instrument memory. Existing patterns can be overwritten.

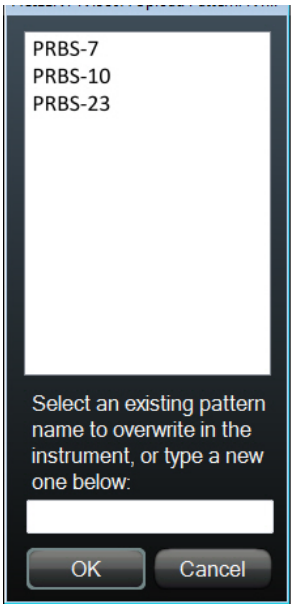


Figure 94. Upload Pattern dialog box

3. Select a pattern from the displayed list or type a new pattern name then click on the **OK** button. Acceptable characters include letters, digits, and the characters '-' and '_'. The pattern name cannot exceed 8 characters.

6.2.7 Deleting a Pattern from Instrument Memory

Pattern sequences that were previously uploaded to an instrument may need to be deleted to create memory space for another pattern sequence to be uploaded.

1. Under **Upload,** click on the **Connected Instrument** drop down list box and select the instrument.
2. Under **Upload,** click on the **Delete Patterns**... button.
3. In the **Delete Patterns** dialog box, click on a pattern sequence name to delete.
4. Click on the Delete Selected Pattern button.

6.2.8 Programmable Pattern Editor Function Descriptions

Refer to Table 31 for descriptions of the Programmable Pattern Editor functions.

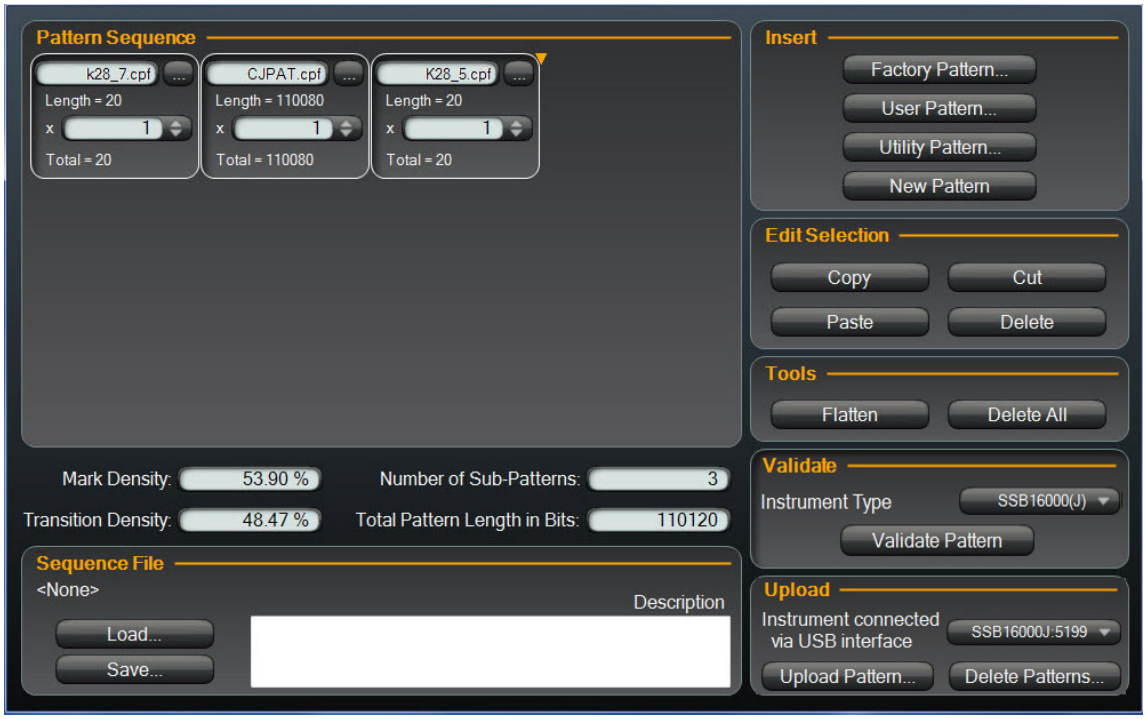
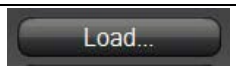
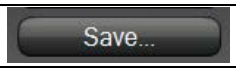
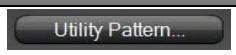
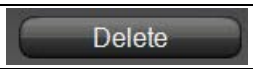
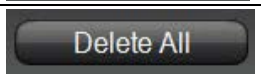


Figure 95. Programmable Pattern Editor screen

Table 33: Programmable Pattern Editor function descriptions

Name	Description
Pattern Sequence	
Name field	Displays the sub-pattern name.
...Button	Accesses the screen for editing the sub-pattern.
Length	Displays the number of bits in the sub-pattern.
Multiplier/Up Down Arrows	Displays the number of times to multiply the sub-pattern. The Up/Down arrows increment/decrement the value by one. Double-clicking in the field accesses the numeric keypad to enter a number directly.
Total	Displays the total number of bits in the sub-pattern (Length * Multiplier).
Mark Density	Displays the ratio of "ones" bits to total bits. For example, a Mark Density of 50% has exactly 50% ones and 50% zeroes.
Transition Density	Displays the ratio of the number of transitions to total bits. For example, a 1010 clock pattern has a Transition Density of 100% and a clock pattern of 1100 has a Transition Density of 50%.
Number of Sub-Patterns	Displays the total number of sub-patterns in the current pattern sequence.
Total Pattern Length in Bits	Displays the combined total bits of all sub-patterns in the current pattern sequence.
Sequence File	
	Loads a pattern sequence file (*.cpf). The Load function overwrites the current pattern sequence
	Saves a pattern sequence or user sub-pattern.
Insert	
	Accesses a dialog for opening a factory pattern to insert into the pattern sequence.
	Accesses a dialog for opening a user pattern to insert into the pattern sequence.

Name	Description
	Clock Pattern: #Ones, #Zeroes numeric field defines the number of ones and the number of zeroes in the clock pattern. For example, if a number 2 is entered, the resulting pattern will have 2 ones followed by 2 zeroes (1100). In addition, as the Length numeric field is incremented using the Up/Down arrows, note that the value increases/decreases in increments of four because the pattern bit length in this example is four. All Ones: creates a sub-pattern consisting of all ones. The bit length is specified in the Length numeric field using the Up/Down arrows or double-clicking to access the numeric keypad for entry. All Zeroes: creates a sub-pattern consisting of all zeroes. The bit length is specified in the Length numeric field using the Up/Down arrows or double-clicking to access the numeric keypad for entry. Random: creates a sub-pattern consisting of random ones and zeroes. The bit length is specified in the Length numeric field using the Up/Down arrows or double-clicking to access the numeric keypad for entry.
	Inserts a sub-pattern box for creating a blank user pattern.
Edit Selection	
	Copies the selected sub-pattern(s) to the clipboard.
	Pastes the sub-pattern(s) at the insertion point.
	Cuts the selected sub-pattern(s) and copy to the clipboard.
	Deletes the selected sub-pattern(s).
Tools	
	Groups the selected sub-patterns into a single sub-pattern.
	Deletes all sub-patterns currently displayed.
Validate	
	The Instrument Type drop down list box selects the instrument to use for validation of the pattern.
	Determines whether the pattern meets the requirements for the Instrument Type selected.

Name	Description
Upload	
N4960A-CJ1: 5199	The Connected Instrument drop down list box selects the instrument to which the pattern will be uploaded.
Upload Pattern...	Uploads the pattern to the instrument selected in the Connected Instrument drop down list box.
Delete Patterns...	Deletes patterns from the selected instrument.

6.2.9 Sub-Pattern Editor Function Descriptions

Refer to Table 32 for descriptions of the Sub-Pattern Editor functions.

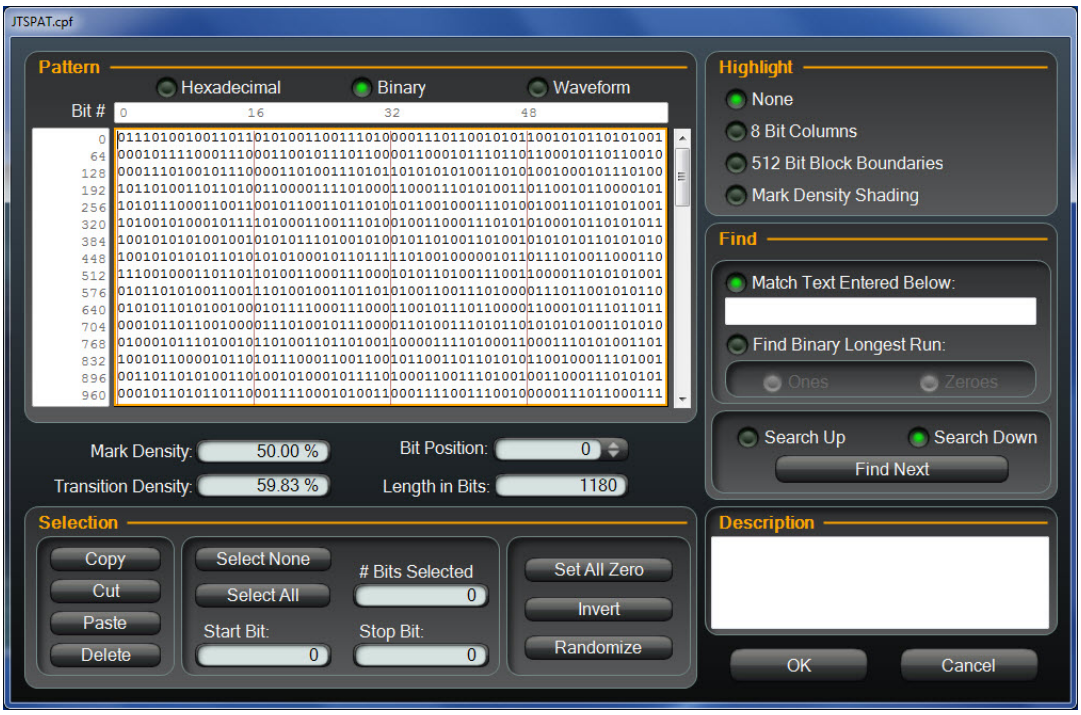
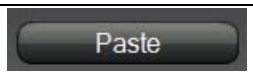
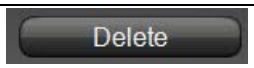
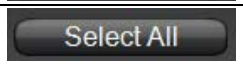
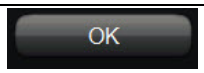
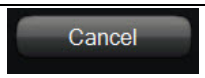


Figure 96. Sub-Pattern Editor screen

Table 34. Sub-Pattern Editor function descriptions

Name	Description
Pattern	
Hexadecimal	Displays the pattern in hexadecimal.
Binary	Displays the pattern in binary.
Waveform	Displays the pattern as a waveform.
Mark Density	Displays the ratio of “ones” bits to total bits. For example, a Mark Density of 50% has exactly 50% ones and 50% zeroes.
Transition Density	Displays the ratio of the number of transitions to total bits. For example, a 1010 clock pattern has a Transition Density of 100% and a clock pattern of 1100 has a Transition Density of 50%.
Bit Position	Displays the current bit position of the cursor.
Length in Bits	Displays the total number of bits in the pattern.
Selection	
	Copies the selected sub-pattern(s) to the clipboard.
	Cuts the selected sub-pattern(s) and copy to the clipboard.
	Pastes the sub-pattern(s) at the insertion point.
	Deletes the selected sub-pattern(s).
	Deselects currently selected bits.
	Select all bits.
Start Bit	Displays the first bit of a selected group of bits.
# Bits Selected	Displays the number of bits currently selected.
Stop Bit	Displays the last bit of a selected group of bits.
	Sets all selected bits to zero.
	Inverts the values of the selected bits.
	Randomizes the values of the selected bits.
Highlight	
None	Removes shading.
8 Bit Columns	Shades the pattern in 8 bit columns.
512 Bit Block Boundaries	Shades the pattern in 512 bit blocks.
Mark Density Shading	Shades the background according to the Mark Density. In Hexadecimal view, the background will be shaded according to how many of the 4 bits representing the hex value are ones (all ones, or 0xF being the darkest).

Name	Description
Find	
Match Text Entered Below	Defines a search based on text entered in this field.
Find Binary Longest Run	Finds the longest pattern of either ones or zeroes.
Search Up/Search Down	Selects whether to search upward or downward through the pattern.
	Begins a search in the downward direction.
	Begins a search in the upward direction.
	Accepts changes made to the pattern including any notes entered.
	Cancels any changes made to the pattern including any notes entered.

6.3 Instrument Upgrade

The Instrument Upgrade tool is used to upgrade firmware in a connected N4960A controller, N4951A/B pattern generator (not implemented in this version), or N4952A error detector (not implemented in this version). Upgrade packages are available on the Keysight Technologies website.

NOTE

In order for N4951B remote heads to function properly with N4960A controllers, ensure that the N4960A has a serial number higher than US53083001. If your N4960A is below this serial number, then a firmware upgrade is required. In addition, the Controller Version and UI Version of the N4960A must be FW 2.02/build number 5406 or higher.

CAUTION

This process reprograms the flash memory in the instrument. It is important to maintain connection with the instrument, and make sure the power is not interrupted during the upgrade process. Failure to do so may result in a corrupted upgrade which cannot be recovered, requiring returning the instrument to the factory for service.

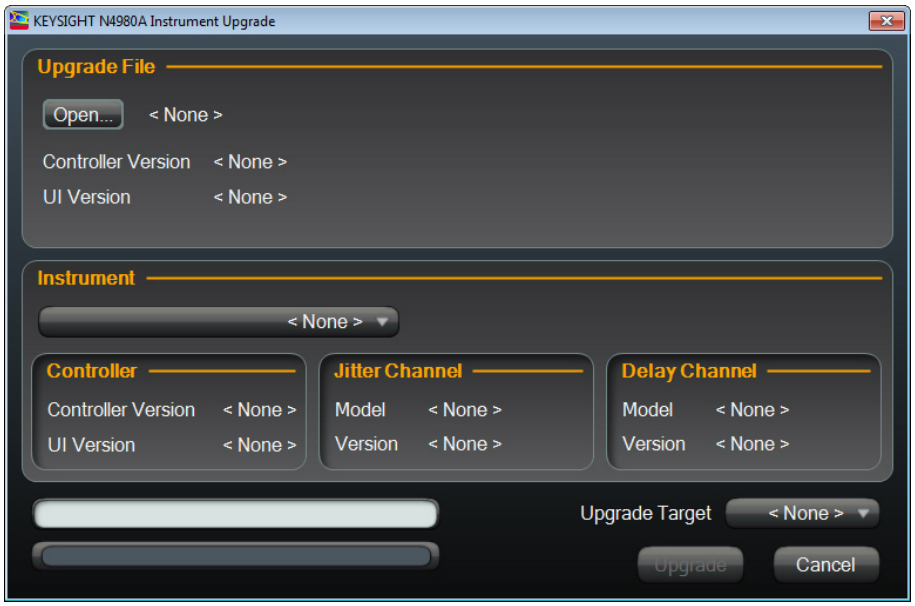


Figure 97. Instrument Upgrade screen

6.3.1 Firmware Upgrade Procedure

1. Turn the N4960A power on.
2. When the N4960A is booted, start the N4980A software.
3. Discover and connect the instrument.
4. In the main menu click on the **Tools** menu then select **Instrument Upgrade**. The instrument upgrade screen appears as shown in Figure 98.

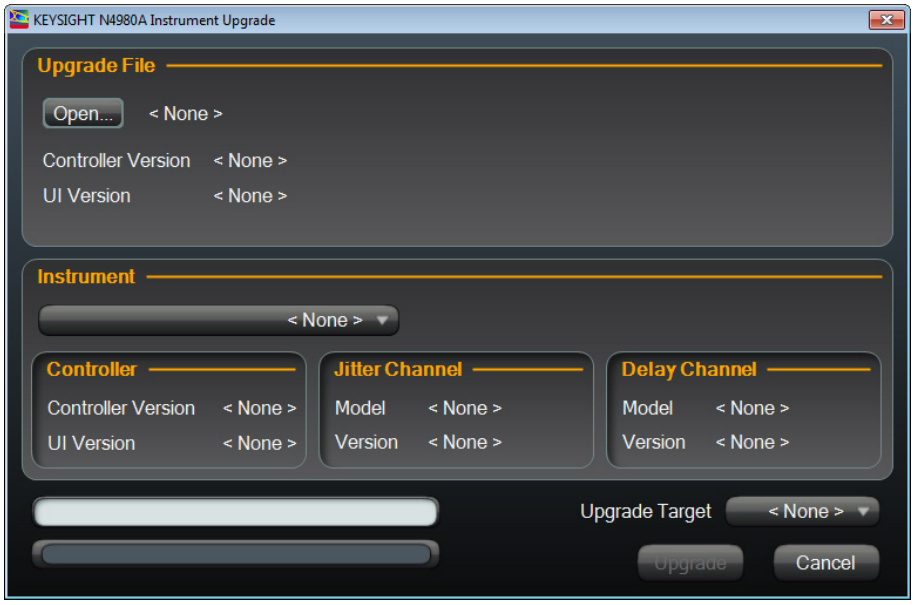


Figure 98. N4980A Instrument Upgrade screen

5. In the instrument upgrade window, click on the **Open...** button to open the Windows browser as shown in Figure 99.

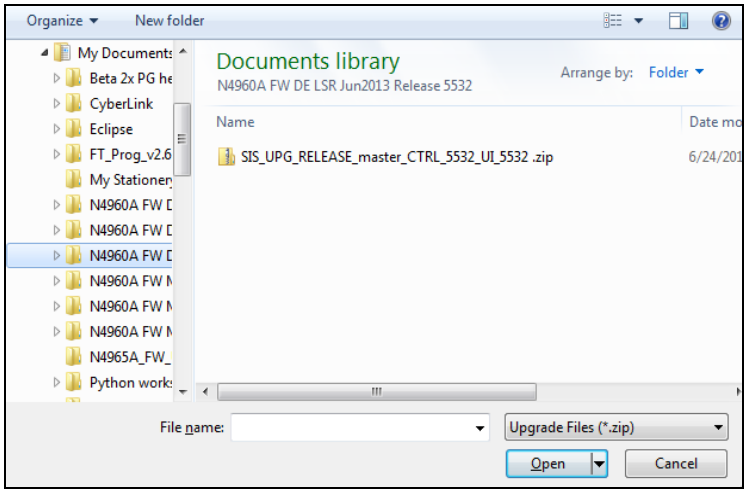


Figure 99. Open upgrade file

6. Navigate to the location of the firmware upgrade zip file, select it, then click on the **Open** button.
7. Under **Instrument**, click on the drop down list box and select the instrument to be upgraded as shown in Figure 100.

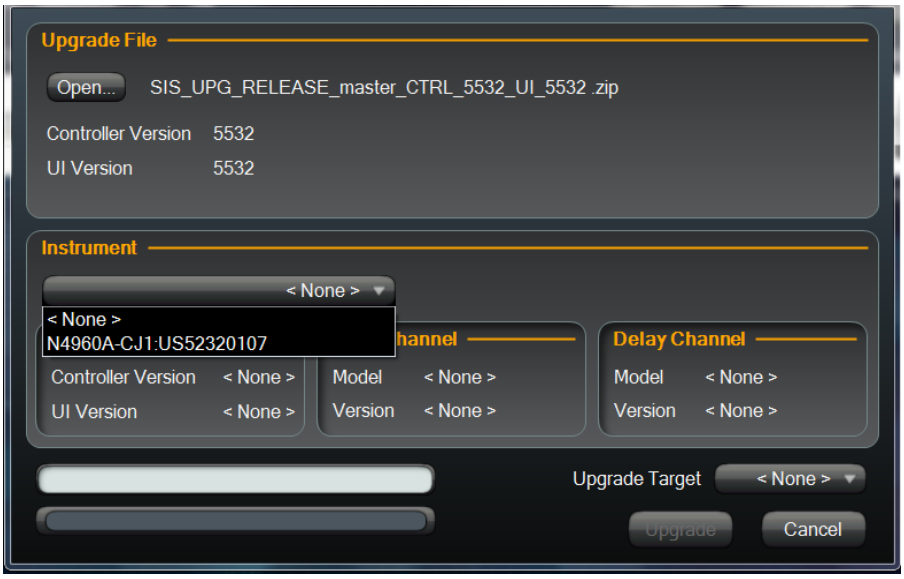


Figure 100. Select instrument

8. Once the instrument is selected, its **Controller Version** and **UI Version** (for a controller), and **Model** and **Version** (for a remote head), are displayed as shown in Figure 101.

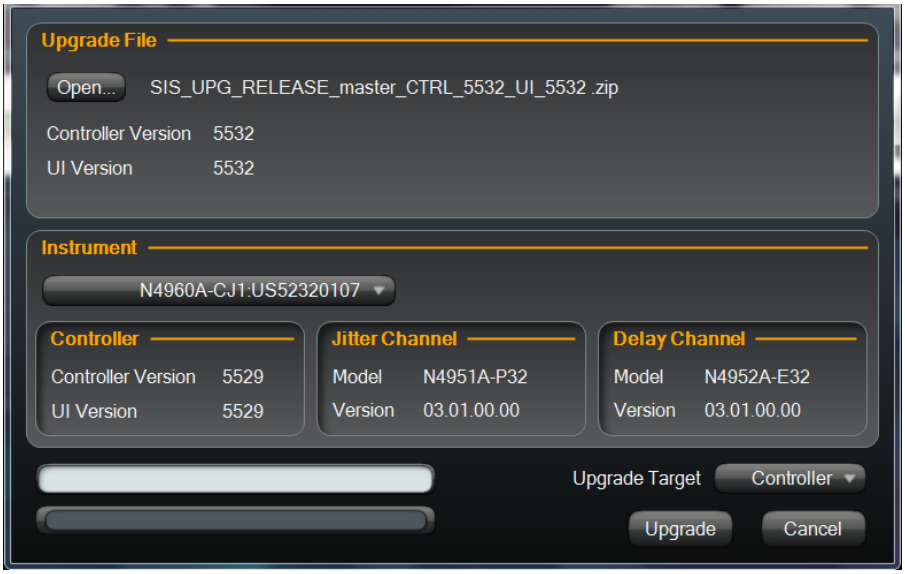


Figure 101. View instrument version information

9. Confirm that the information for the instrument shown under **Instrument** is correct for the revision of firmware you are uploading.
10. Click on the **Upgrade Target** drop down list box and select the target as shown in Figure 102.

NOTE When upgrading remote head firmware, ensure that the correct target is selected (not implemented in this version).

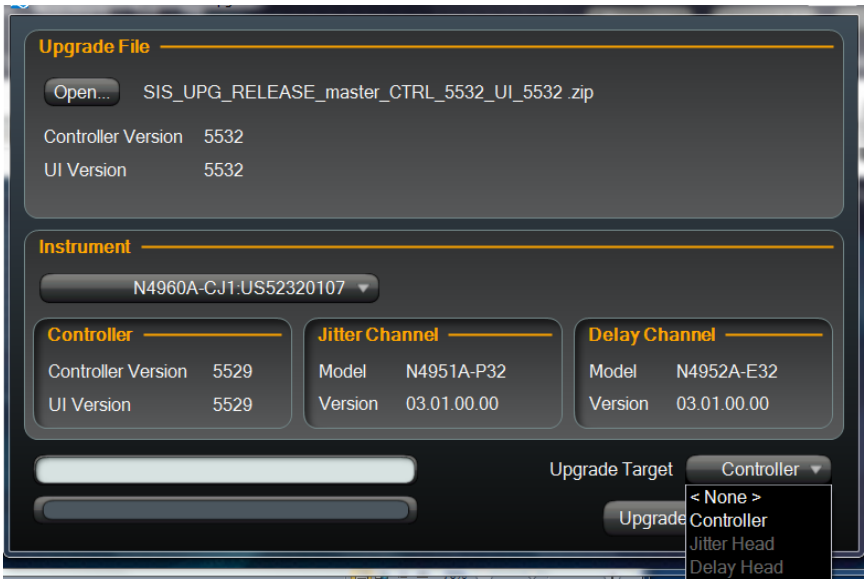


Figure 102. Select target

11. Click on the **Upgrade** button to begin the firmware upgrade. The controller upgrade process takes approximately 15 minutes to complete. The remote head upgrade process takes several hours to complete (not implemented in this version).

CAUTION During this process do not turn off the N4960A or close the N4980A software. Failure to do so may result in a corrupted upgrade which cannot be recovered, requiring returning the instrument to the factory for service.

NOTE Although the N4980A software will report that the upgrade process is complete, this only indicates that the files have been transferred. At this stage, the N4960A will re-boot. This may take several more minutes before the re-boot completes.

12. When the N4960A has re-booted, cycle the power.
13. If upgrading an N4960A controller, perform the following steps:
    a. When the N4960A has re-booted, use the front panel interface to navigate to the **System** menu, then select **UI Info**.
    b. Verify that the first 4 digits of the Build number match the UI Version number.
    c. Select **BACK** then select **Controller Info**.
    d. Verify that the first 4 digits of the Build number match the Controller Version number.
14. If upgrading a remote head, perform the following steps (not implemented in this version):
    a. When the N4960A has re-booted, use the front panel interface to navigate to the **System** menu, then select **Jit**

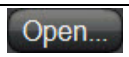
Head Info or Dly Head Info depending on which head has been upgraded.

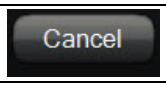
b. Verify that the FW number shown in the front panel interface matches the Version number for the specific head shown in the N4980A interface.

6.3.2 Instrument Upgrade Function Descriptions

Refer to Table 33 for descriptions of the Instrument Upgrade functions.

Table 35: Instrument Upgrade function descriptions

Name	Description
Upgrade File	
	Opens the dialog box for selecting and opening an upgrade file.
Controller Version	Displays the controller version of the upgrade file.
UI Version	Displays the user interface version of the upgrade file for a controller upgrade file.
Head Models	Displays the remote head models supported by the upgrade file (not implemented in this version).
Head Version	Displays the remote head version number of the upgrade file (not implemented in this version).
Instrument	
	Select an instrument to upgrade in the drop down list box. The instrument must match the upgrade file or the upgrade will not be permitted.
Controller	
Controller Version	Displays the current controller version in the instrument.
UI Version	Displays the current user interface version in the instrument.
Jitter Channel	
Model	Displays the current model number of the pattern generator connected to the jitter channel.
Version	Displays the current user interface version of the pattern generator connected to the jitter channel.

Name	Description
Delay Channel	
Model	Displays the current model number of the error detector or pattern generator connected to the delay channel.
Version	Displays the current user interface version of the error detector or pattern generator connected to the delay channel.
	Displays the status of the upgrade process.
	The progress bar provides a graphical representation of the upgrade progress.
Upgrade Target	
	Select the controller, pattern generator connected to the jitter channel, or error detector/pattern generator connected to the delay channel. Only the controller, pattern generator(s), or error detector matching the upgrade file and instrument will be active for selection.
	Starts the upgrade process.
	Cancels the upgrade operation.

6.4 De-emphasis Tap Weight Calculator

The de-emphasis tap weight calculator tool provides a simple way to calculate the correct equalization settings for the N4951B and N4955A pattern generator heads with integrated de-emphasis capability. The tap weights are computed based on an s-parameter file of the channel loss. The pattern generator can then be set to these tap weight values.

Figure 103 shows the de-emphasis tap weight calculator screen.

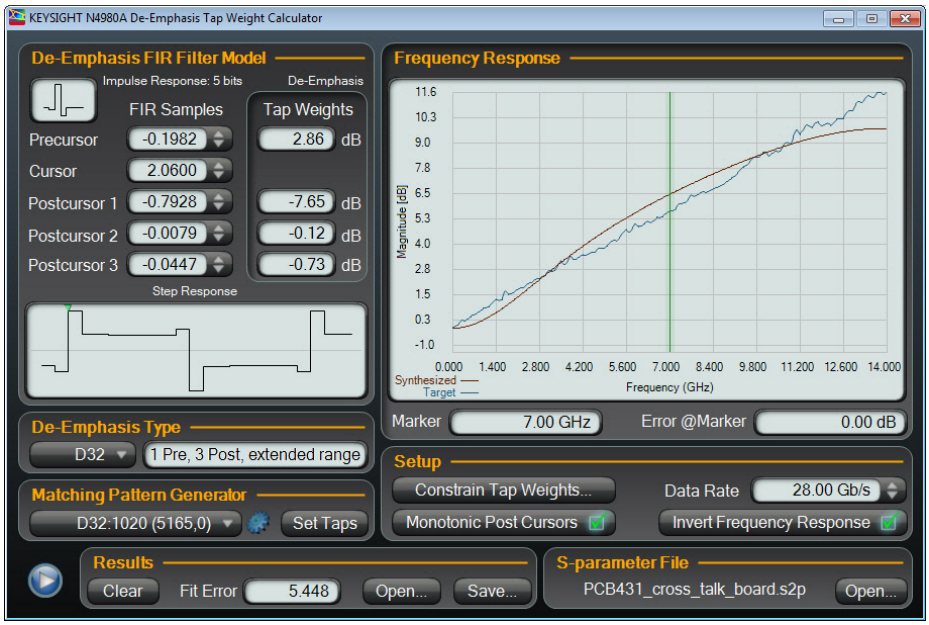


Figure 103. De-emphasis tap weight calculator screen

6.4.1 Computing and Loading Tap Weights

The following procedure describes how to set up a tap weight computation and load the tap weights into the pattern generator.

1. In the main menu, click on the **Tools** menu then select **De-emphasis Tap Weight Calculator**.

NOTE

A license is required for the tap weight calculator. The license comes with the shipment of a de-emphasis head e.g. N4951B-D32 or N4951B-D17. If a license is needed for the N4955A pattern generator heads contact Keysight. The license requires a one-time connection between the PC running the N4980A software and the N4960A/N4951B or N4965A/N4955A hardware. Thereafter the tap weight calculator can be used offline for analysis, however direct programming of tap weights to a de-emphasis head requires a USB or GPIB connection to the hardware.

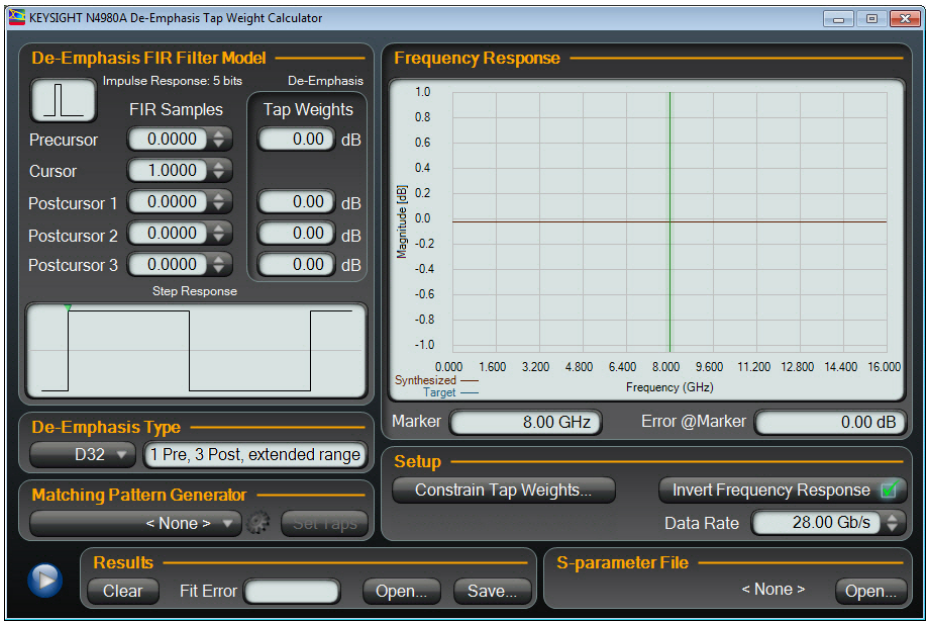


Figure 104. Access the tap weight calculator

2. Under **De-Emphasis Type**, select the type of de-emphasis head for the analysis.

   P12 = N4955A-P12 Pattern Generator with 2-tap de-emphasis 12.5 Gb/s

   D12 = N4955A-D12 Pattern Generator with 4-tap de-emphasis 12.5 Gb/s

   D17 = N4951B-D17 Pattern Generator with 5-tap de-emphasis 17 Gb/s

   D32 = N4951B-D32 Pattern Generator with 5-tap de-emphasis 32 Gb/s

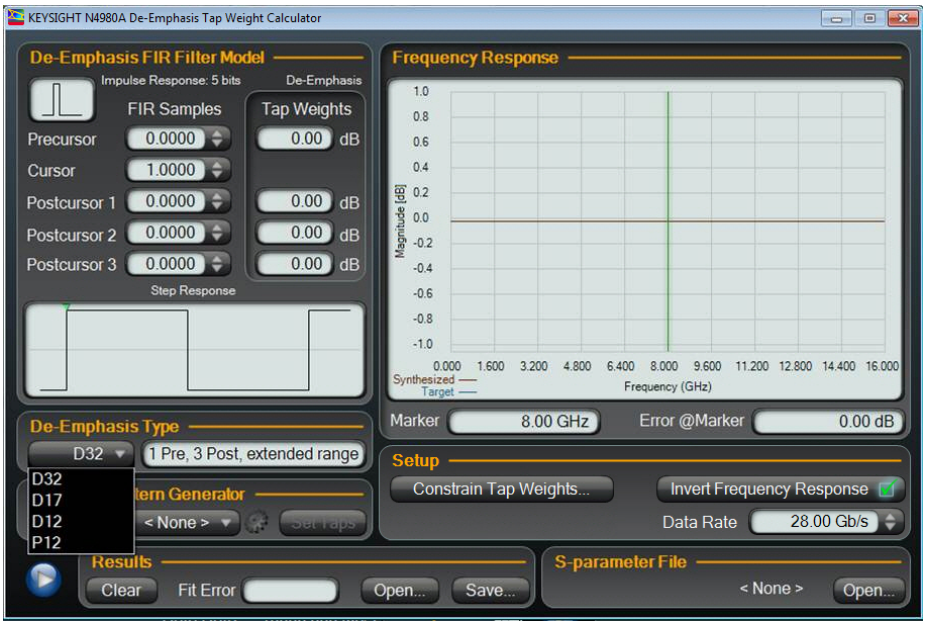


Figure 105. Select type of de-emphasis head

3. Under **S-parameter File**, click on the **Open** button to open the S-parameter file to be analyzed. The file must be in S2P format. Only 2-port s-parameter files are supported.

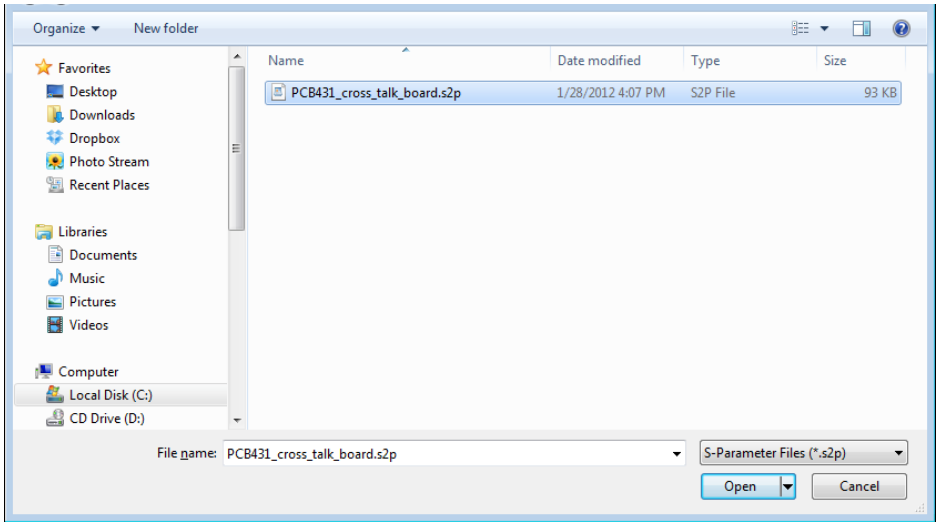


Figure 106. Open an s-parameter file

NOTE The displayed response is an inverse of the channel loss, and represents the target response for the equalizer to be created.

4. Under **Setup**, choose the data rate for the analysis in the **Data Rate** field.

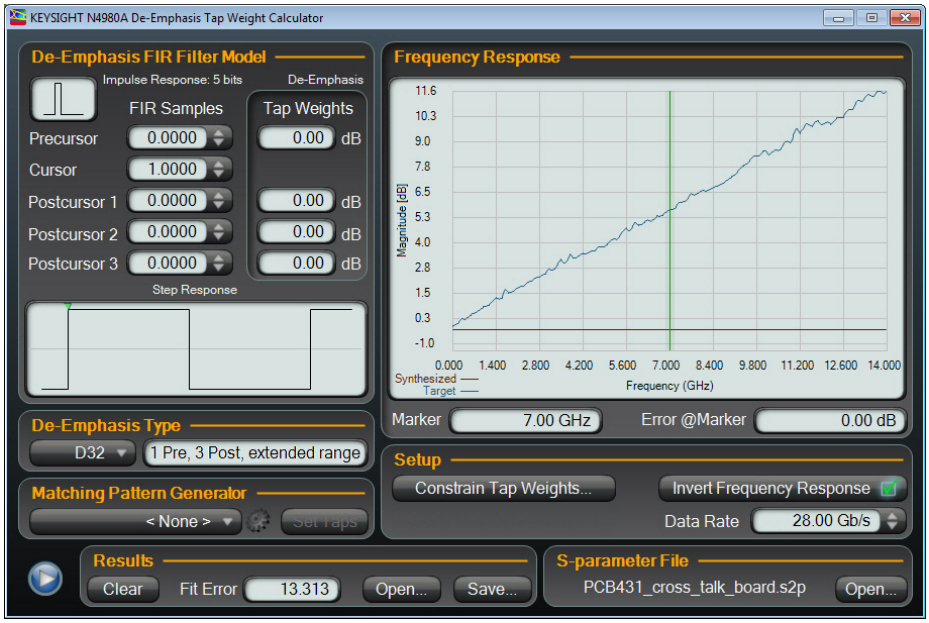


Figure 107. Choose the data rate

5. Press the Play button to run the analysis ().

   Synthesized FIR samples and related tap weights in dB of the analysis are shown along with a graphical representation of the waveform
   (8x '1's followed by 8x '0's).

   At this point further analysis of the synthesis can be conducted by moving the **Marker** in the **Frequency Response** window and reading out the **Error @Marker** at specific frequencies. Overall fit error is shown in the Results section of the window in the **Fit Error** field. Results can be saved and later re-called.

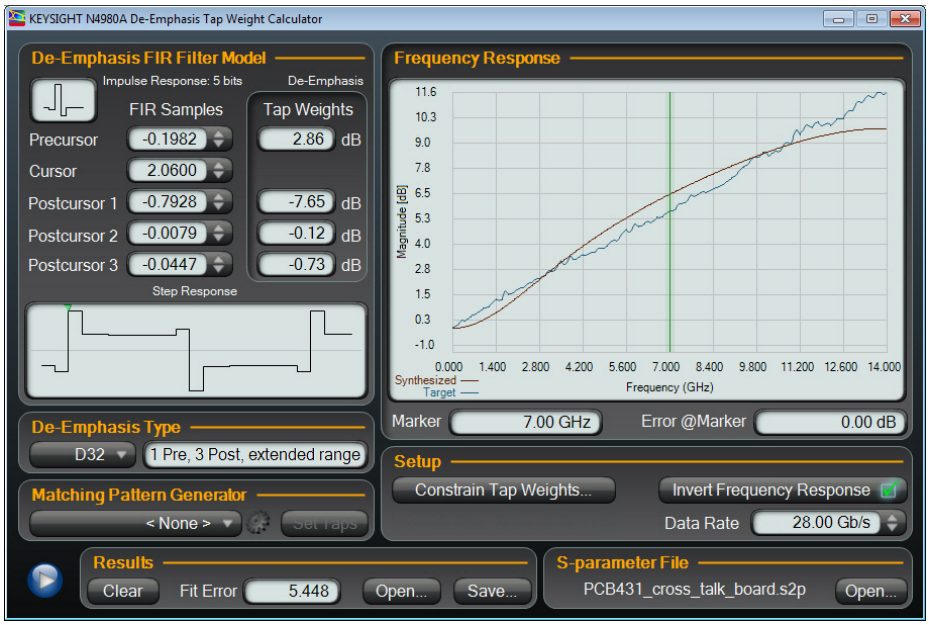


Figure 108. Analyze synthesized FIR samples

6. Send tap weights to pattern generator head.

   If the PC is connected to the controller with de-emphasis head attached, then the tap weights can be directly programmed to the head by selecting the head in the **Matching Pattern Generator** section of the window, then clicking the **Set Taps** button.

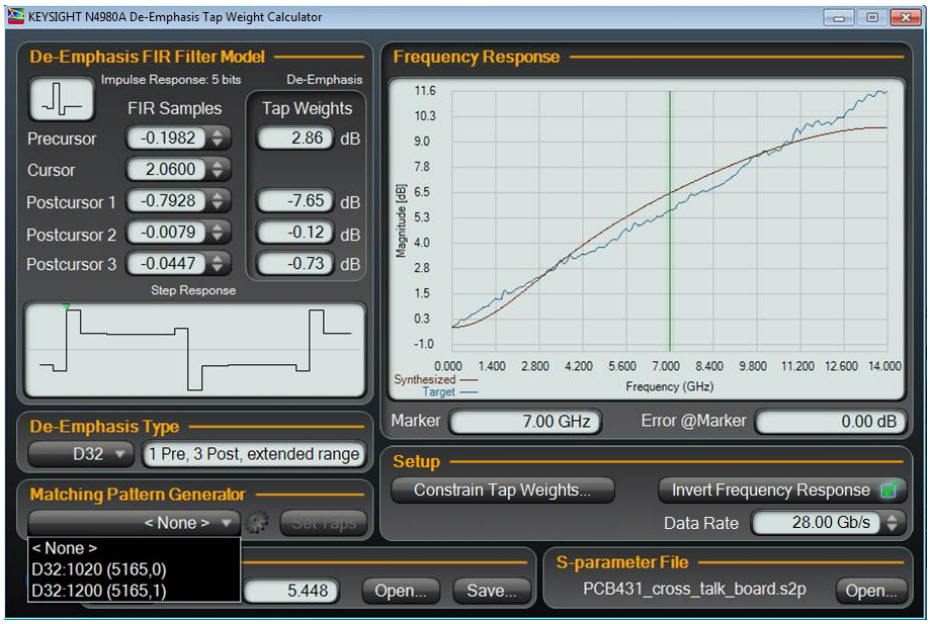


Figure 109. Send tap weights to pattern generator

7. Clicking on the blue gearwheel next to the connected de-emphasis head accesses the control panel for the head, where the tap weights and other head parameters can be controlled or optimized.

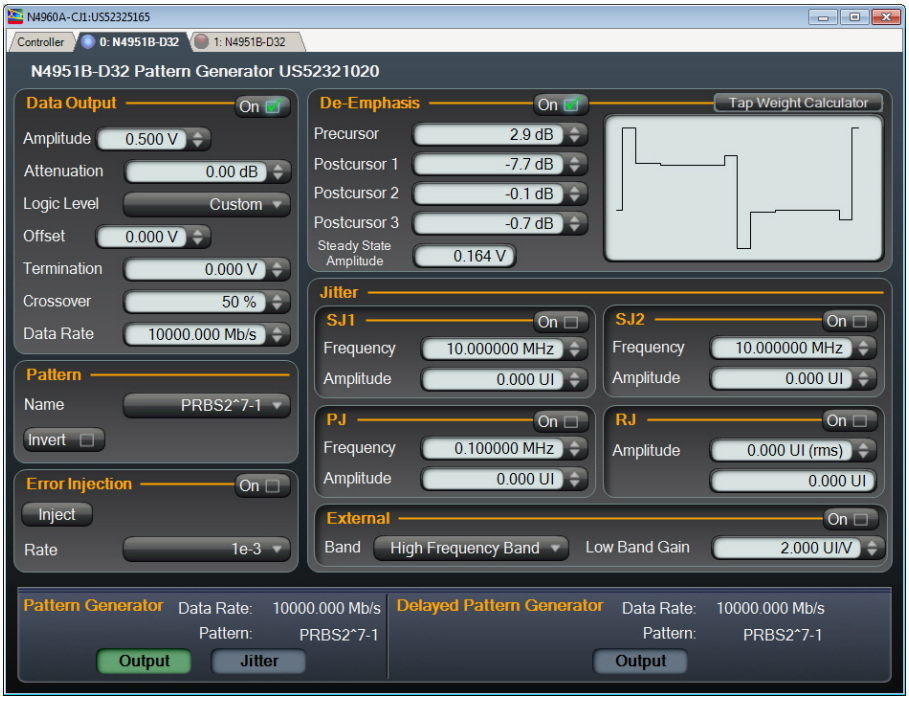


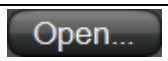
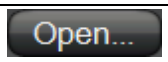
Figure 110. Access pattern generator control panel

6.4.2 De-emphasis Tap Weight Calculator Function Descriptions

Table 36: De-emphasis tap weight calculator function descriptions

Name	Description
De-Emphasis FIR Filter Model	
Impulse Response	Displays a graphical representation of the output response after de-emphasis is applied.
Precursor	Adjust the impulse response sample of the bit before the cursor bit.
Cursor	Adjust the impulse response sample of the cursor bit.
Postcursor 1	Adjust the impulse response sample of the bit after the cursor bit.

Name	Description
Postcursor 2	Adjust the impulse response sample of the bit that is two bits after the cursor bit.
Postcursor 3	Adjust the impulse response sample of the bit that is three bits after the cursor bit.
Tap Weights	The de-emphasis tap weights are computed from the voltage levels of the precursor, cursor, and postcursor FIR samples. Each tap is equal to 1 UI (1 bit time).
Step Response	Displays a graphical representation of the de-emphasized pulses. The green marker indicates the cursor bit.
De-Emphasis Type	Select the type of pattern generator with de-emphasis: • P12 – N4955A-P12, 2-tap 12.5 Gb/s • D12 – N4955A-D12, 4-tap 12.5 Gb/s • D17 – N4951B-D17, 5 tap 17 Gb/s • D32 – N4951B-D32, 5 tap 32 Gb/s
Frequency Response	
Graph	Displays S21 magnitude (vertical axis) vs frequency (horizontal axis) using data from the imported s2p file. This plot is shown in blue as the 'Target'. If the Invert Frequency Response button is checked then the plot is inverted. Inverted response is required in order to synthesize the required frequency equalization with the de-emphasis tap weights. After an analysis is performed the synthesized response will also be shown on the graph. The green vertical line is a measurment marker showing the FIT error at the marker frequency.
Marker	Displays the current measurement marker frequency (clock frequency). Click and drag the measurement marker to change its frequency position.
Error @Marker	Displays the error magnitude between the target and synthesized response at the measurement marker position.

Name	Description
Matching Pattern Generator	
	Select a pattern generator with de-emphasis from a list of connected pattern generators that matches the de-emphasis type selection.
	After selecting a pattern generator, the corresponding gear wheel turns blue. While hovering over the blue gear wheel it becomes brighter. Clicking on the blue gear wheel accesses the control panel for the corresponding pattern generator.
	Loads the computed tap weights into the selected pattern generator.
Setup	
	Constrain the tap weights to the selected pattern generator.
	Inverts the frequency response of the currently loaded s-parameter file of the channel loss. The inverted frequency response is the target response to counteract the high frequency loss. The Default setting is inverted as this is required in order to synthesize the tap weights for frequency compensation.
Data Rate	Sets the desired data rate.
	Starts the tap weight computation which will match the frequency response shown in the graph.
Results	
	Clears the current tap weight computation results.
	Error between the target and synthesized response.
	Opens the dialog box for selecting and opening a previously computed de-emphasis tap weight file.
	Opens the dialog box for saving a computed de-emphasis tap weight file.
S-parameter File	
	Opens the dialog box for selecting and opening an s-parameter file.

6.5 Command Viewer

The Command Viewer contains a log of commands being sent and received from one or more instruments. To view commands, the instrument(s) must be selected in the Command Viewer.

6.5.1 Setting Up the Command Viewer

1. In the main menu, click on the **Tools** menu then select **Command Viewer**. Figure 111 is an example of the Command Viewer screen.

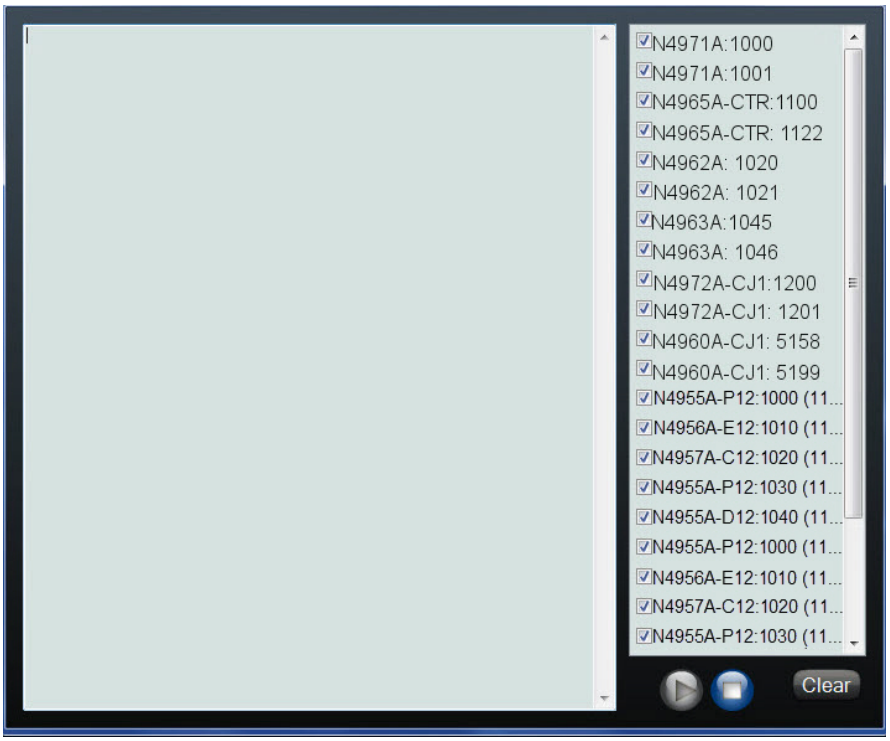


Figure 111. Enabling command viewing

2. Select the instruments to monitor in the right pane.
3. Click on the start button to begin monitoring commands. Figure 112 is an example of a Command Viewer screen showing commands.

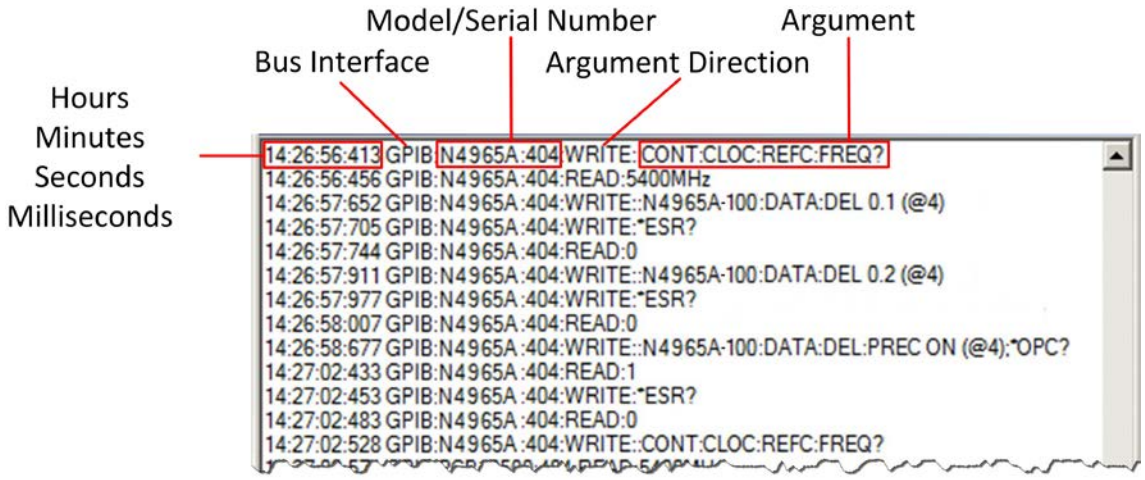


Figure 112. Command viewer

7 Configurations

When selecting instruments for measurements using the N4980A multi-instrument BERT software, certain instrument combinations will not function properly. This chapter describes the configuration requirements.

7.1 Available Instruments

Table 37. Available instruments

Clocks	Controllers	Pattern Generators	Error Detectors
N4962A	N4965A	N4962A	N4962A
N4963A	N4960A-CJ0/N4960A-CJ1	N4971A	N4956A-E12
N4972A-CJ0/N4972A-CJ1		N4955A-D12	N4952A-E17
N4960A-CJ0/N4960A-CJ1		N4955A-P12	N4952A-E32
		N4951A-P17	
		N4951A-P32	
		N4951B-H17	
		N4951B-H32	
		N4951B-D17	
		N4951B-D32	

7.2 Configuration Requirements

There are several general configuration requirements for running measurements:

- All clocks must be set to the same frequency
- Clock, pattern generator, and error detector must be selected for making some types of measurements
- Pattern generator and error detector patterns must match

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