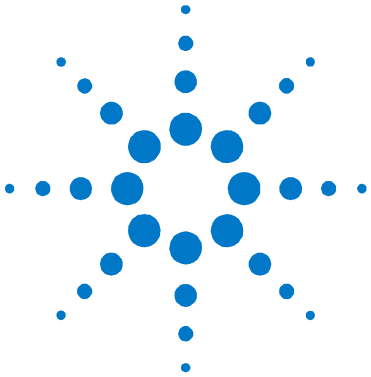

Agilent N4971A

Pattern Generator 13 Gb/s

User Guide

Agilent Technologies

Notices

Manual Part Number

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For Assistance and Support

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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

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NOTE

A **NOTE** provides important or special information.

Safety Summary

General Safety Precautions

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 elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument.

Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

Before operation, review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically. The Performance Tests give procedures for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Agilent Technologies Sales/Service Office.

WARNING To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

General

This product is a Safety Class 1 product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside of the instrument, will make the instrument dangerous. Intentional interruption is prohibited.

Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment per IEC 61010 Second Edition and 664 respectively. It is designed to operate within a temperature range of 10 to 40 °C at a maximum relative humidity of 80% for temperatures up to 31 °C, decreasing linearly to 50% relative humidity at 40 °C at an altitude of 2000 meters.

This module can be stored or shipped at temperatures between -40°C and +70°C. Protect the module from temperature extremes that may cause condensation within it.

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

Install the instrument so that the ON / OFF switch is readily identifiable and is easily reached by the operator. The ON / OFF switch is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. Or the detachable power cord can be removed from the electrical supply. Alternately, an externally installed switch or circuit breaker which is readily identifiable and is easily reached by the operator may be used as a disconnecting device.

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.

Symbols on Instruments

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.

C-Tick Conformity Mark of the Australian ACA for EMC compliance.

Indicates that protective earthing ground is incorporated in the power cord.

The CSA mark is a registered trademark of the CSA International. This instrument complies with Canada: CSA 22.2 No. 61010-1 -04.

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.

This symbol indicates that internal circuits can be damaged by electrostatic discharge (ESD), therefore, avoid applying static discharges to the panel input connectors.

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.

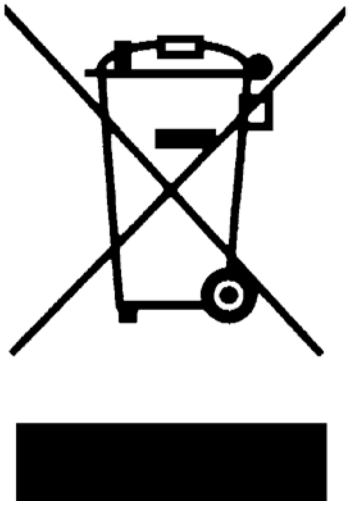
Indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Twenty five years is the expected useful life of the product.

This symbol indicates that the instrument requires alternating current (AC) input.

This symbol indicates that the power line switch is in the ON position.

This symbol indicates that the power line switch is in the OFF position.

Environmental Information



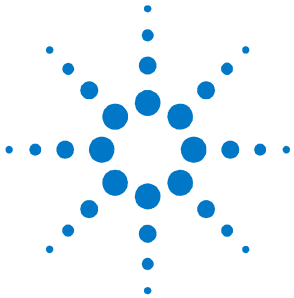
This product complies with the WEEE Directive (2002/96/EC) marketing requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product category: With reference to the equipment types in the WEEE Directive Annexure 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 Agilent office, or see **www.agilent.com/environment/product/** for more information.

Contents



1 Setting Up the N4971A

The N4971A pattern generator 13 Gb/s is shipped in a protective box with all the accessories required for operation. The box includes:

- N4971A pattern generator 13 Gb/s
- Accessory kit, which includes:
  - (4) 2.92 mm female to female adaptors
  - (2) SMA male to male phase stable cables 36"
  - (2) 50 Ω 18 GHz 1W SMA male terminations
  - (2) 5x20 mm ceramic 250 V 2 A fuses
- AC power cord
- CD, which includes:
  - N4971A data sheet
  - N4971A getting started guide
  - N4971A user guide

1.1 Unpacking

Carefully remove the N4971A from the case in an ESD-safe environment.

1.2 Important Notes

- Use ESD protection at all times when using the instrument
- Review min/max specifications before applying input signals
- Use 2.92 mm adapters on 2.92 mm clock and data ports

CAUTION Excessive mating of low quality SMA components to 2.92mm female receptacles may degrade the 2.92mm female receptacle.

- Use high quality SMA connectors on the SMA ports
- Leave dust jackets on unused back panel connectors
- Situate the instrument away from heat sources, do not block the fans, and do not block the exhaust vents on the sides of the BERT controller and remote heads (minimum of 3 inches clearance).
- Use 50 Ω terminations on all unused differential ports

1.3 Measurement Best Practices

- When using differential-mode connections, ensure the cables are phase balanced for best performance
- Differential outputs may be used single-ended if unused outputs are terminated in 50 Ω
- Use high quality cables and connector savers (or adaptors)
- Keep cable lengths short and minimize the number of cable bends
- Use an 8 in-lbs (90 N-cm) torque wrench when attaching connectors

1.4 General Specifications

Before installing the N4971A, review the specifications in **Table 1**.

Table 1. Specification considerations before installation

Parameter	Specification
Operating Temperature	+10 °C to +40 °C
Storage Temperature	–40 °C to +70 °C
Voltage	100 to 240 VAC 10% autoranging
Frequency	50/60 Hz
Power	170 Watts MAX
Current	1.8A RMS MAX
Fuse	250 V 2 A 5x20 mm (p/n 12260-002) Always replace instrument fuse with one of the same type and rating.
EMC	CISPR Pub 11 Group 1, class A AS/NZS CISPR 11 ICES/NMB-001 This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.
Safety	Complies with European Low Voltage Directive 2006/95/EC IEC/EN 61010-1, 2nd Edition Canada: CSA C22.2 No. 61010-1 USA: UL std no. 61010-1, 2nd Edition Acoustic noise emission Geraeuschemission LpA <70 dB LpA <70 dB Operator position Am Arbeitsplatz Normal position Normaler Betrieb Per ISO 7779 Nach DIN 45635 t.19
Weight	7.0 lb
Height	2.1 in
Width	16.7 in
Depth	16.7 in

1.5 Safety and Regulatory

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

WARNING **Do not remove instrument covers. There are no user serviceable parts within. Operation of the instrument in a manner not specified by Agilent Technologies may result in personal injury or loss of life.**

WARNING **For continued protection against fire hazard, replace fuses, and or circuit breakers only with same type and ratings. The use of other fuses, circuit breakers or materials is prohibited.**

WARNING **To prevent electrical shock, disconnect instrument from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.**

CAUTION The Mains wiring and connectors shall be compatible with the connector used in the premise electrical system. Failure, to ensure adequate earth grounding by not using the correct components may cause product damage, and serious injury.

CAUTION Before switching on this instrument, make sure the supply voltage is in the specified range.

1.6 Connector Care

The N4971A pattern generator 13 Gb/s features high-quality SMA and 2.92 mm connectors for the front and rear panel input and output connections. Connector damage will degrade signal fidelity.

Use 2.92 mm adapters on 2.92 mm clock and data ports and high quality SMA-connectors on the SMA ports. Always leave dust jackets on unused ports.

CAUTION Excessive mating of low quality SMA components to 2.92 mm female receptacles may degrade the 2.92mm female receptacle.

Inspect the connectors for the following:

- Worn or damaged threads
- Scratches to mating surface
- Burrs and loose metal particles
- Ensure that female contacts are straight and aligned

Clean the connectors as described in the following procedure. Cleaning connectors with alcohol shall only be done with the instruments power cord removed, and in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

1. Remove any loose particles using a low-pressure air source.
2. Moisten a lint-free swab with isopropyl alcohol. Do not saturate the swab.
3. Minimize the wicking of the alcohol into the connector structure.
4. Clean the mating plane surfaces and threads.
5. Allow alcohol to evaporate, and then use a low-pressure air source to blow surfaces clean.
6. Make sure no particles or residue remains.
7. Inspect connector for damage.

1.7 Installation

1. Install on a flat surface with unobstructed airflow to the back panel and side vents.
2. Plug the AC power cord into a wall socket .

WARNING **If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protections are intact) only.**

3. Plug the AC power cord into the N4971A.

CAUTION This instrument has autoranging line voltage input. Be sure the supply voltage is within the specified range..

4. Connect the N4971A to a clock source and high speed sampling scope as shown in Figure 1.
5. Tighten cables to 8 lbf-in (90 N-cm) and use 50 Ω terminations on all unused differential outputs.

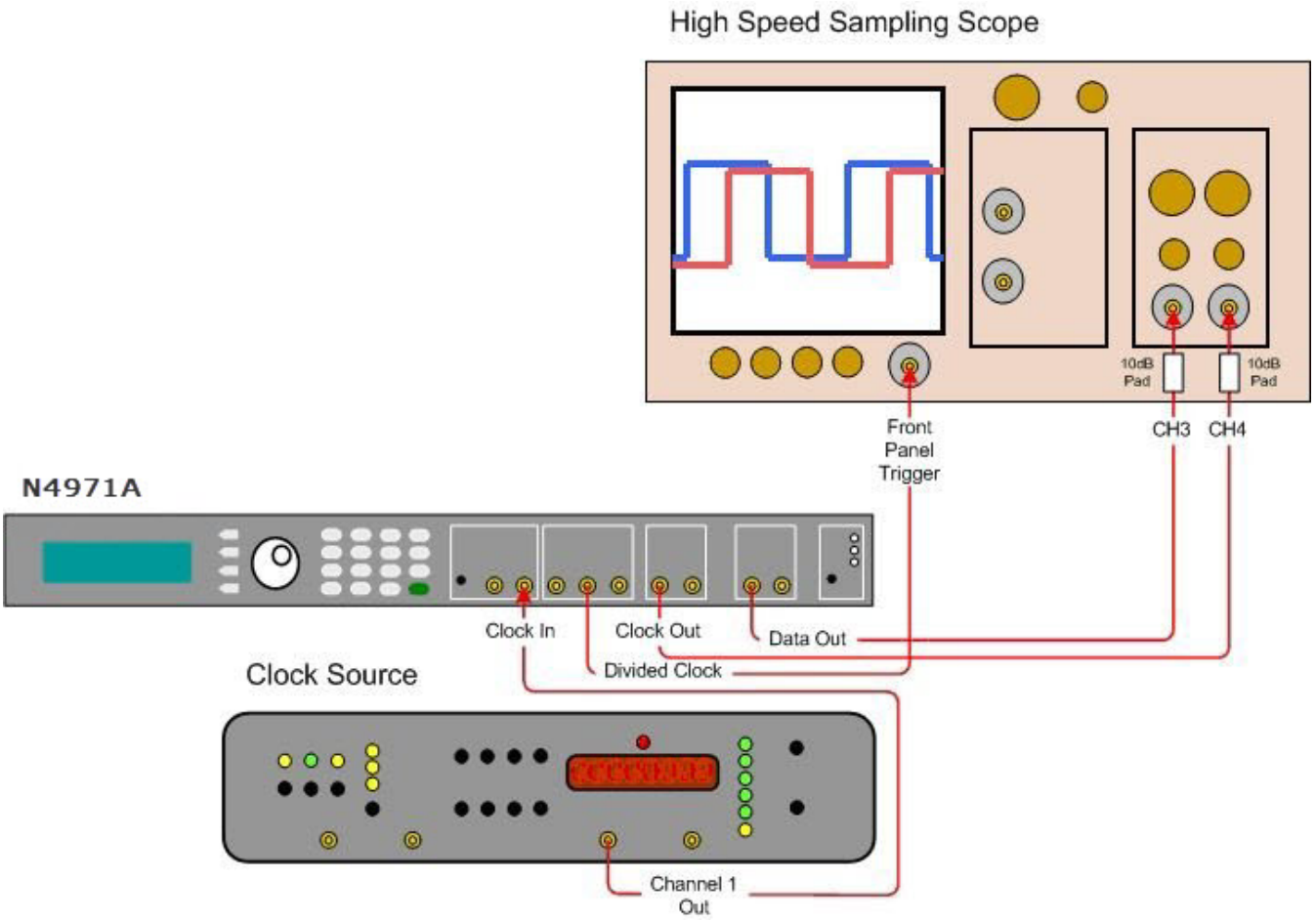


Figure 1. Factory default setup

6. Set up the clock source as follows:
   - Frequency: 10 GHz
   - Level: 0 dBm
   - Output: On
7. Set up the high speed sampling scope as follows:

NOTE For purposes of this example setup, an Agilent 86100A Infiniium DCA was used. High-speed sampling scope setup option names may differ between models.

Set the high speed sampling scope to Eye/Mask mode.

Trigger setup	Trigger Level:	0 V
	Slope:	Rising Edge
	Trigger Bandwidth:	Standard (DC-2.5 GHz)
Timebase setup	Scale:	50 ps/div
Channel 3 setup (data)	Attenuation:	10 dB (10 dB pad placed at the input)
	Bandwidth:	maximum
	Display:	On
	Scale:	316 mV/Div
	Offset:	-600 mV
Channel 4 setup (clock)	Attenuation:	10 dB (10 dB pad placed at the input)
	Bandwidth:	maximum
	Display:	On
	Scale:	316 mV/Div
	Offset:	+600 mV

8. Press the **PRST** button on the front panel of the N4971A to set the instrument to the following settings:

    Dat Amp: 1.00 V
    Dat Ofs: +0.00 V
    Dat Term: +0.00 V
    De-Emph: 00.0 dB
    Dat Xover: 50%
    DatDel: +00.00 UI
    ClkDel: +00.00 UI
    Clk Amp: 1.00 V
    Clk Ofs: +0.00 V
    Clk Term: +0.00 V
    Frq Mode: auto

9. Press the **Output On/Off** button on the N4971A to turn on the clock and data signals.
10. Verify that the waveform is similar to the one shown in Figure 2.

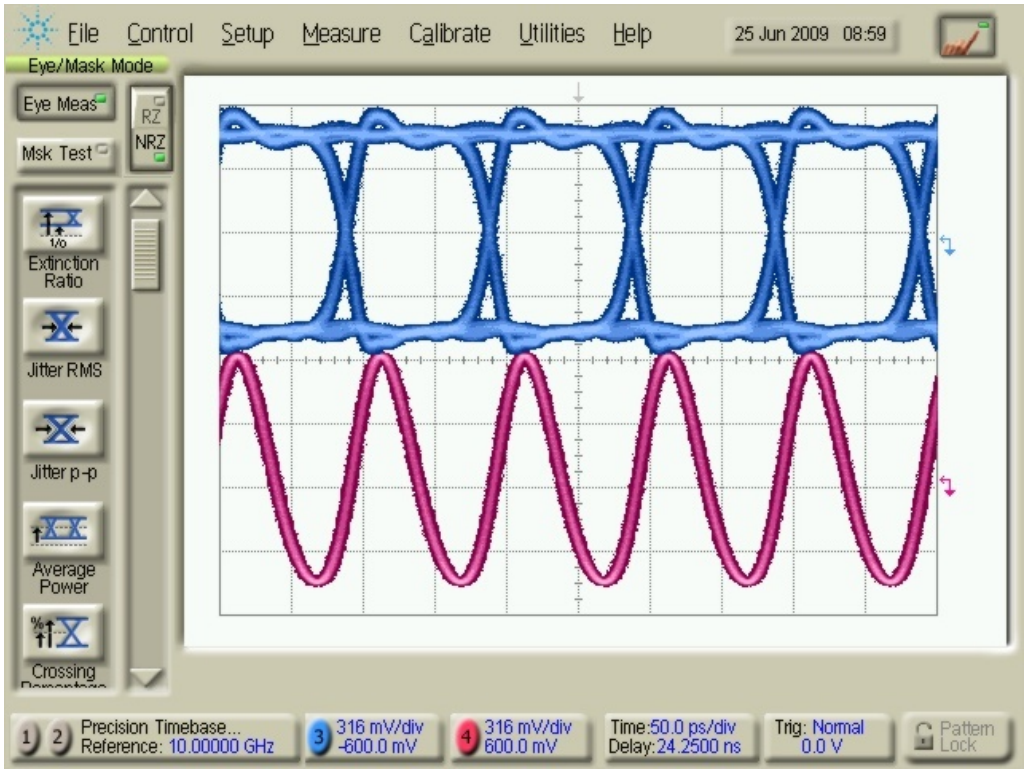


Figure 2. Factory default setup waveform

1.8 Pattern Utility Software

The N4971A comes preloaded with data test patterns. These test patterns are selectable using the control panel of the N4971A or remote commands. You can also create test patterns using the N4971A pattern utility software and load them into the N4971A memory. The software runs on a personal computer and uploads pattern to the N4971A via a USB connection.

The N4971A pattern utility software has a built-in editor used for bit-by-bit input (binary or hex) and import/export capability. For further information, refer to the N4971A pattern utility software user guide.

2 N4971A Operation Overview

The N4971A is a single-channel pattern generator 13 Gb/s used in the characterization of jitter and BER performance of high-speed serial architecture from 1 to 13 Gb/s.

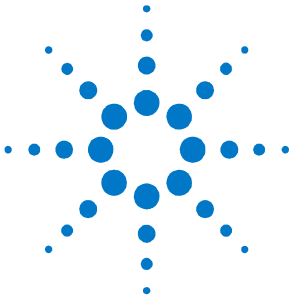
2.1 Features

All features can be controlled through the N4971A control panel, or remotely through the GPIB or USB interface using the remote commands.

- pattern generator 13 Gb/s
- 24 Mbit pattern memory
- Preloaded telecom and datacom test patterns
- Two-tap de-emphasis
- Operation from 1 to 13 Gb/s
- Divided clock and pattern trigger outputs
- Independently adjustable clock and data phase
- Adjustable differential data output:
    - Amplitude
    - DC offset
    - Crossover
    - De-emphasis
- Adjustable differential clock output:
    - Amplitude
    - DC offset
- GPIB or USB control

2.2 Control

System configuration settings are all available from the local control panel interface, the remote GPIB (IEEE 488.2) interface, or the USB interface. Instrument status is conveyed on the front panel by LED indicator.



3 Performance Specifications

Specifications describe the instrument's warranted performance. Non-warranted values are stated as typical. All specifications are valid in a range from 10°C to 40°C ambient temperatures after a 30-minute warm-up phase. Unless stated otherwise, all specifications are valid at the output of the included 36" high performance coax cables.

3.1 N4971A Specifications

Table 2 shows the data output specifications. Unless otherwise stated, the specifications for data outputs are measured at 1.0 V amplitude, 0 V offset with PRBS2^31-1 pattern.

Table 2. Data Output specifications.

Parameter	Specification
Data Output	
Range of Operation	1 to 13 Gb/s
Data Format	NRZ (non-return-to-zero)
Amplitude Adjustment	200 mV to 1.6 V, 50 mV steps
Offset Adjustment	–2.0 V to +2.0 V, 50 mV steps
Termination Voltage	–2.0 V to +2.0 V, 50 mV steps
De-emphasis	0 to 20 dB, .1 dB steps typical
Cross-over Adjustment	25% to 75%, 1% steps typical
Transition Times 20% to 80%	30 ps maximum, < 25 ps typical
Data Delay Range	±10 UI, 10 mUI steps
Jitter	< 20 ps p-p typical < 6.5 Gb/s < 10 ps p-p typical > 6.5 Gb/s

Parameter	Specification
Error Injection	Single error mode Fixed error rates of 10^{-n}; n = 3 to 9 Burst lengths of 1, 2, 4, 8, 16, 32, 64, 128
Interface	Differential data (unused output must be terminated 50 Ω to ground) AC coupled and bias tee 50 Ω nominal
Connectors	2.92 mm, male with F-F connector protectors

3.1.1 Termination Voltage, Offset Voltage and Pattern Mark Space Density

3.1.1.1 Termination Voltage

The choice of termination voltage for the N4971A should be determined by the user's DUT. Changing the termination voltage setting on the N4971A while connected to a DC voltage sensitive DUT could apply DC voltages that may stress the user's DUT.

Best practices include disabling the N4971A outputs before connecting a DUT. Once a DUT has been connected, the user should set up the proper output amplitude, offset and termination voltage before enabling the N4971A outputs.

The PPG limits the range of the termination voltage to ± 2.0 V. Common examples of terminations voltage settings are listed below:

For driving test equipment inputs the termination voltage should be set to 0 V. This assumes the equipment input presents an impedance of 50 Ω to ground.

For driving an AC coupled DUT the termination voltage should be set 0 V.

A DUT with an ECL input would be an example of the N4971A termination voltage being set to –2.0 V.

3.1.2 Offset Voltage and Mark Space Density

The PPG offset voltage range is dependent on the data output amplitude (VAMP), termination voltage (VTERM), and the mark density (MD) of the pattern[1] selected.

The offset range can be calculated for particular set ups using the equation below:

V_{OFFSET} MAX = Lesser value of [+2.0 V] or [V_{TERM} + (2.0V – V_{AMP} * ABS(MD – 0.5))]

V_{OFFSET} MIN = Greater value of [-2.0 V] or [V_{TERM} - (2.0V – V_{AMP} * ABS(MD – 0.5))]

Table 3 shows the clock output specifications. . Unless otherwise stated, the specifications for clock outputs are measured at 800 mV amplitude, 0 V offset.

Table 3. Clock Output specifications.

Parameter	Specification
Clock Output	
Output frequency range	1 to 13 GHz
Amplitude adjustment	200 mV to 1.8 V, 50 mV steps, 1 to 5 GHz 200 mV to 1.3 V, 50 mV steps, > 5 to 10.5 GHz 200 mV to 800 mV, 50 mV steps, > 10.5 to 13 GHz
Offset adjustment	–2.0 V to +2.0 V, 50 mV steps
Termination voltage	–2.0 V to +2.0 V, 50 mV steps
Residual jitter	< 3 ps rms typical < 6.5 GHz < 1.5 ps rms typical > 6.5 GHz
Transition times 20% to 80%	40 ps maximum
Clock delay range	±10 UI, 10 mUI steps
Interface	Differential (unused output must be terminated 50 Ω to ground)

[1] Mark space density is a ratio that describes the DC balance of a pattern, calculated by dividing the number of one bits in a pattern to the total number of bits in a patterns, MD = (# of 1 bits/total # of bits). A pattern is DC balanced when the number of ones and zeros in a pattern are equal, MD = 0.5.

Parameter	Specification
	AC coupled and bias tee 50 Ω nominal
Connectors	2.92 mm, male with F-F connector protectors

Table 4 shows the divided clock output specifications.

Table 4. Divided Clock Output specifications.

Parameter	Specification
Divided Clock Output	
Divider factors	N = 8, 9...511
Amplitude adjustment	200 mV to 600 mV, 50 mV steps
Transition times	< 50 ps typical
Interface	Differential data (unused output must be terminated 50 Ω to ground) AC coupled 50 Ω nominal
Connectors	SMA, female

Table 5 shows the Trigger Output specifications.

Table 5. Trigger Output specifications.

Parameter	Specification
Trigger Output	
Pulse type	Clock/256 (trigger output follows data delay timing) Pattern
Amplitude	> 400 mV typical (offset around 900 mV)
Transition times	< 80 ps typical
Interface	DC coupled 50 Ω nominal
Connectors	SMA, female

Table 6 shows the Clock input specifications.

Table 6. Clock Input specifications.

Parameter	Specification
Clock input	
Input frequency range	1 to 13 GHz
Amplitude range	200 mV to 2 V (–10 dBm to +10 dBm)
Interface	Single ended AC coupled 50 Ω nominal
Connectors	SMA, female

Table 7 shows the Aux Input specifications.

Table 7. AUX Input specifications.

Parameter	Specification
AUX input	
Input amplitude	TTL levels, active low
Interface	5 kΩ to 3.3 VDC nominal
Connectors	SMA, female

Table 8 and Table 9 show the 10 MHz Reference specifications.

Best practice is to set N4971A 10 MHz reference to external and connect it to the 10 MHz reference of the clock source. Output 10 MHz reference is a buffered version of the selected reference.

Table 8. 10 MHz reference input specifications.

Parameter	Specification
10 MHz reference input2	
Input amplitude	200 mV to 2 V, typical
Interface	50 Ω nominal, AC coupled
Connector	SMA, female

Table 9. 10 MHz reference output specifications.

Parameter	Specification
10 MHz reference output[2]	
Frequency accuracy	± 100 PPM (internal reference selection) Tracks external input (external reference selection)
Output amplitude	1 Vp-p typical
Interface	50 Ω nominal, AC coupled
Connector	SMA, female

[2] Internal and External 10 MHz is the timebase reference for internal frequency measurements.

Table 10 shows the Patterns specifications.

Table 10. Patterns specifications.

Parameter	Specification
Patterns	
PRBS	2^n-1, n = 7, 9, 10, 11, 15, 23, 29, 31
PRBS with mark density of 1/8, 1/4, 1/2, 3/4, or 7/8	2^n, n = 7, 10, 11, 13, 15, 23
User definable patterns	24 Mbit
Library of common patterns	CJPAT, CRPAT, K28-3, K28-5, K28-7, DE_TEST, STM16, STM16CID, STM64, STS48, STS48CID, STS192, 127_0_S1, 127_1_S0, 1100, PRBS7

3.2 External Clock

An external clock is required for operation of the N4971A. The N4971A is recommended to be purchased with the N4963A clock synthesizer 13.5 GHz. For more information please view the N4963A 13 GHz clock synthesizer datasheet on our website.
(www.agilent.com/find/N4963A).

For best performance, the external clock source used should have jitter Performance <300 fs RMS.

4 Operation

The following section provides detailed information regarding the use of the N4971A pattern generator 13 Gb/s.

4.1 General Information

The N4971A pattern generator 13 Gb/s used in accordance with the following:

- Read and follow operating instructions of all system equipment and do not exceed min/max specifications.
- Use ESD protection at all times, but especially when handling RF input/outputs.
- Situate the instrument away from heat sources.
- Do not block airflow to the fans or exhaust vents and do not allow foreign material into enclosure.
- Do not modify the power plug or wall outlet to remove the third (ground) pin.

NOTE There are no user-serviceable parts within. Return damaged instruments for factory-authorized repair. Refer to instrument warranty for more information.

4.1.1 Performance Recommendations

The following recommendations ensure best performance:

- When using differential mode connection for outputs, ensure the cables are phase balanced. If the electrical length of one cable is a significant fraction of a unit interval longer than the other, the quality of the differential signal will be degraded.

- Keep cable lengths short and minimize number of cable bends.
- When using a single port of differential output channel for single-ended measurements, the complementary port must be terminated with a 50 Ω termination.

4.1.2 Connector Care

The N4971A pattern generator 13 Gb/s features high-quality SMA and 2.92 mm connectors for the front and rear panel input and output connections. Connector damage will degrade signal fidelity.

Use 2.92 mm adapters on 2.92 mm clock and data ports and high quality SMA-connectors on the SMA ports. Always leave dust jackets on unused ports.

CAUTION Excessive mating of low quality SMA components to 2.92mm female receptacles may degrade the 2.92mm female receptacle.

Inspect the connectors for the following:

- Worn or damaged threads
- Scratches to mating surface
- Burrs and loose metal particles
- Dust or foreign material in the space surrounding the center pin (type K only)
- Ensure that female contacts are straight and aligned

Clean the connectors as described in the following procedure. Cleaning connectors with alcohol shall only be done with the instruments power cord removed, and in a well-ventilated area. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

1. Remove any dust or loose particles using a low-pressure air source.
2. Moisten a lint-free swab with isopropyl alcohol. Do not saturate the swab.
3. Minimize the wicking of the alcohol into the connector structure.
4. Clean the mating plane surfaces and threads.
5. Allow alcohol to evaporate, and then use a low-pressure air source to blow surfaces clean.
6. Make sure no particles or residue remains.
7. Inspect connector for damage.

4.1.3 Connecting

1. When mating precision connectors, always rotate and torque the connector nut and not the connector/adapter/cable body.
2. When connecting adapters to the clock and data outputs on the front panel, rotate the connector nuts counter-clockwise while holding the adapter still. Torque the connector nut to 8 lbf-in (90 N-cm) while holding the adapter hex with another wrench.
3. Hold the adapter hex with its own wrench when tightening or loosening cables on the adapter.

CAUTION Never tighten or loosen the front panel output connectors without holding the mating adapter hex to prevent rotation. Do not over-tighten the connectors; doing so may seriously damage the instrument.

4.2 Front Panel

The N4971A front panel indicates the system status and contains a control panel for local operation of the instrument.

Figure 3 shows the front panel of the N4971A.

Figure 3. N4971A front panel

Table 11 describes the front panel functions.

Table 11. Front panel

Item	Description
Display	The display is part of the control panel and is used to view the menu structure.
Softkey buttons	The four softkey buttons to the right of the display are part of the control panel and are used to switch between the STAT (Status) and MENU (Main Menu) items, move the highlight up or down, and edit or select parameters.
Rotary knob	The rotary knob is part of the control panel and is used to increase or decrease a numeric value and switch between the STAT (Status) and MENU (Main Menu) items.
Keypad	The keypad is part of the control panel and is used to enter numeric values for parameters. The PRST hardkey button is used to perform an instrument preset.

Item	Description
Aux Control Connector	
Aux in button	The Aux In button initiates a programmable function. There are two options which can be set using the control settings menu: ADDError: injects one error into the bit stream. Off: disables the Aux In button.
Aux in connector	The Aux In connector initiates a programmable function. There are two options which can be set using the control settings menu: ADDError: injects one error into the bit stream. Off: disables the Aux In connector.
Clock input connector	The clock input connector accepts a master clock input from an external source to drive the N4971A.
Trigger output connector	The output signal from the trigger output connector is used to trigger an event synchronized to a specific point in the pattern. In addition, the trigger output can be set to divide the clock signal by 256 to view data as an eye waveform. These options are set using the trigger settings menu.
Clock outputs connector (2)	
Divided	The divided differential clock output connectors produce a signal that is related to the full clock rate by a divider factor. The clock signal can be divided by an integer value from 8, 9...511. The divider factors and amplitude can be set using the clock settings menu.
Full rate	The full rate differential clock output connectors provide adjustable clock signals. The options for the full rate clock can be set using the clock settings menu.
Data outputs connectors (2)	The differential data output connectors provide adjustable data signals. The option for the data can be set using the data settings menu.
Status LEDs	
Output ON	The output ON LED indicator is lit when the clock and data outputs are turned on.
Attention	The attention LED indicator is lit when an event has occurred. The indicator will not turn off until the error message has been cleared in the event log using the system settings menu or B4 commands using remote operation.
Clock loss	
Output	The clock loss LED indicator is lit when the master clock signal has been lost. The output On/Off button turns the clock and data outputs on and off.

[1] The output ON LED is temporarily extinguished automatically when a new pattern is selected. This coincides with the data output turning off while the new pattern is loading. The clock output remains active during a pattern change.

4.3 Rear Panel

Figure 4 shows the rear panel of the N4971A.

Figure 4. N4971A rear panel

Table 12 describes the rear panel functions.

Table 12. Rear panel

Item	Description
USB connector	The USB connector is a type B USB port that connects the N4971A to an external PC for data transfers and remote operation.
GPIB connector	The GPIB connector is a general purpose interface bus (GPIB, IEEE 488.1) connection that can be used for remote operation.
Sync In connector	This connector is reserved for future enhancements.
Sync Out connector	This connector is reserved for future enhancements.
Sync Trig connector	This connector is reserved for future enhancements.
SI In connector (2)	This connector is reserved for future enhancements.
10 MHz in connector	The 10 MHz In connector accepts a 10 MHz reference signal from an external source.
10MHz out connector	The 10 MHz Out connector is a 10 MHz reference output used to lock the frequency reference of other equipment to the N4971A.
S/N	N4971A serial number.
Fuse drawer	Remove and replace the fuse by depressing the snap-in tab and withdrawing the fuse drawer.
Power switch	N4971A main power switch (1=On; 0=Off).

4.4 Control Panel Operation

This section describes how to use the control panel to operate the N4971A. Refer to Figure 5.

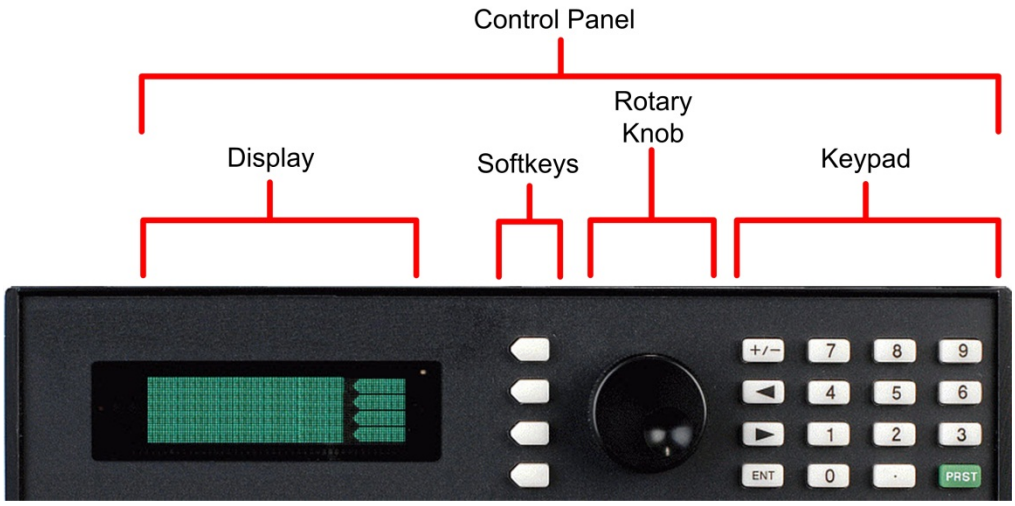


Figure 5. Control Panel

4.4.1 Power On Status Menu

When the N4971A is powered on, the STAT (status) menu appears in the display window of the control panel. Refer to Figure 6. The STAT menu is a list of the most common commands.

Figure 6. Status Menu

Pressing the softkey corresponding to the MENU label accesses the main menu. Refer to Figure 7. Similarly, pressing the softkey corresponding to the STAT label will once again access the status menu.

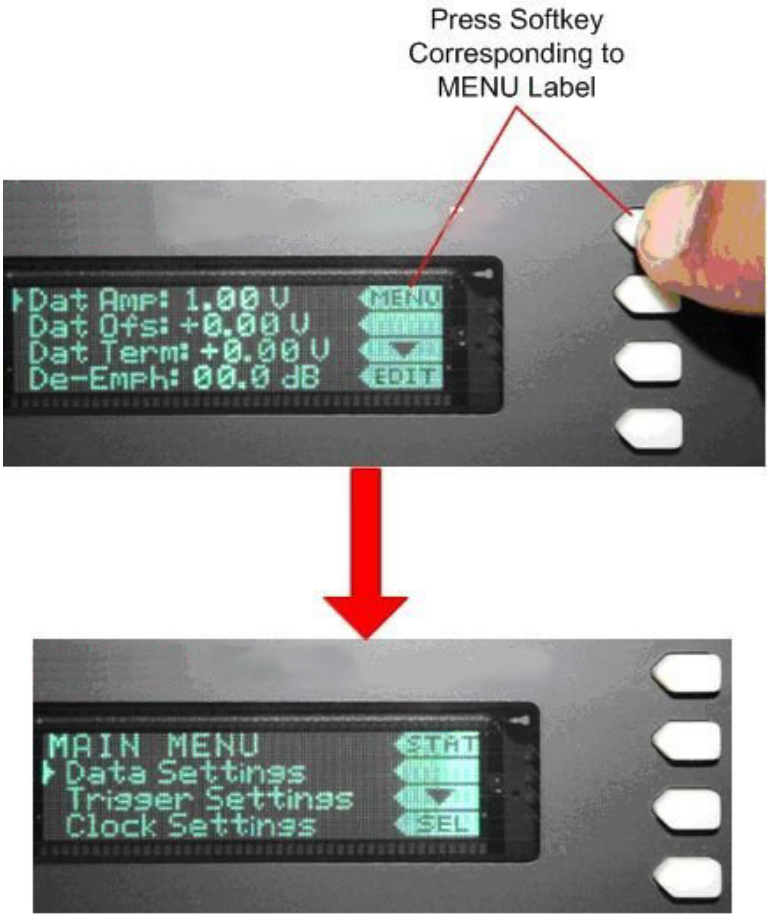


Figure 7. Accessing Main menu

4.4.2 Menu Structure

Figure 8 through Figure 10 show the hierarchical structure of the menus.

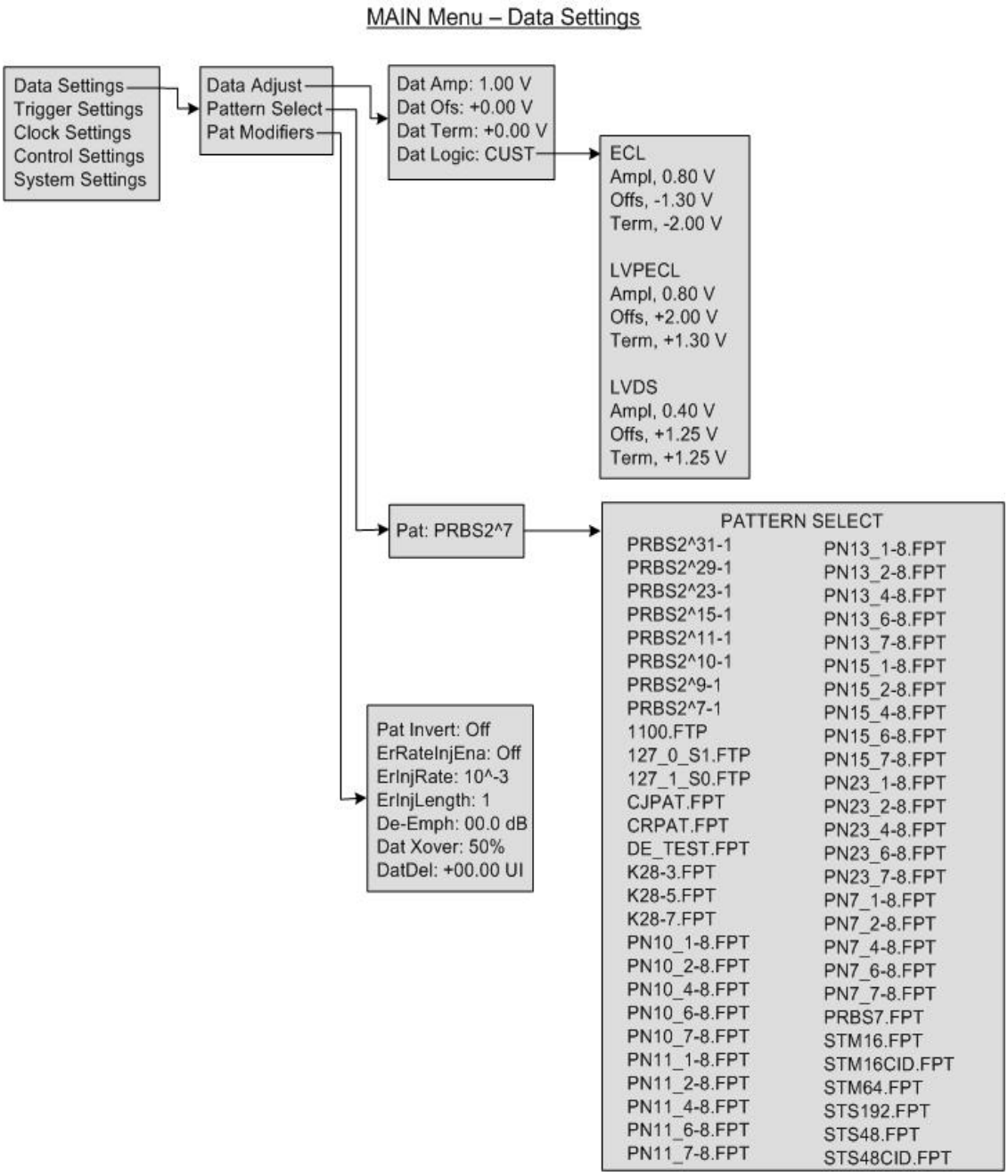


Figure 8. Data settings structure

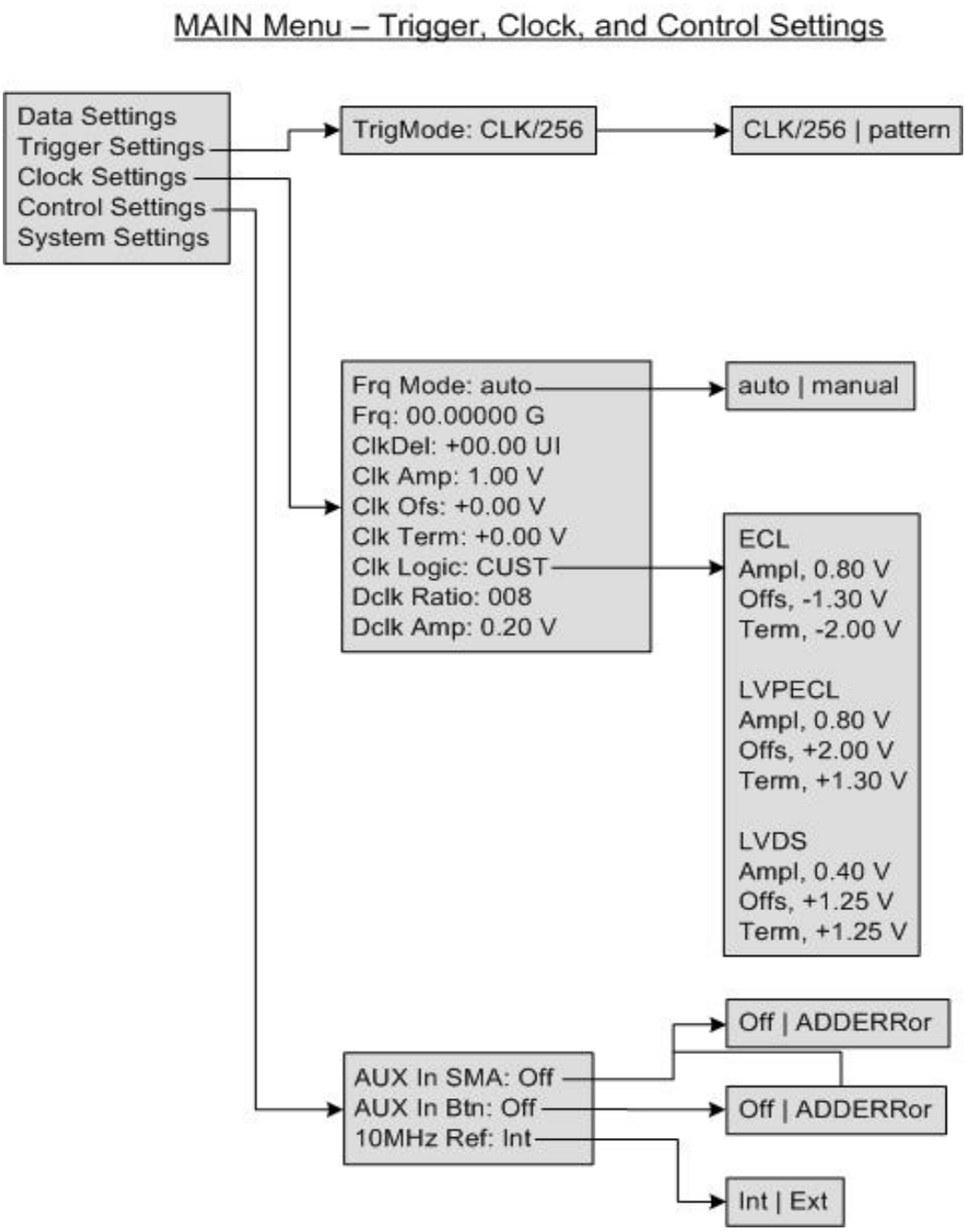


Figure 9. Trigger, clock, and control settings structure

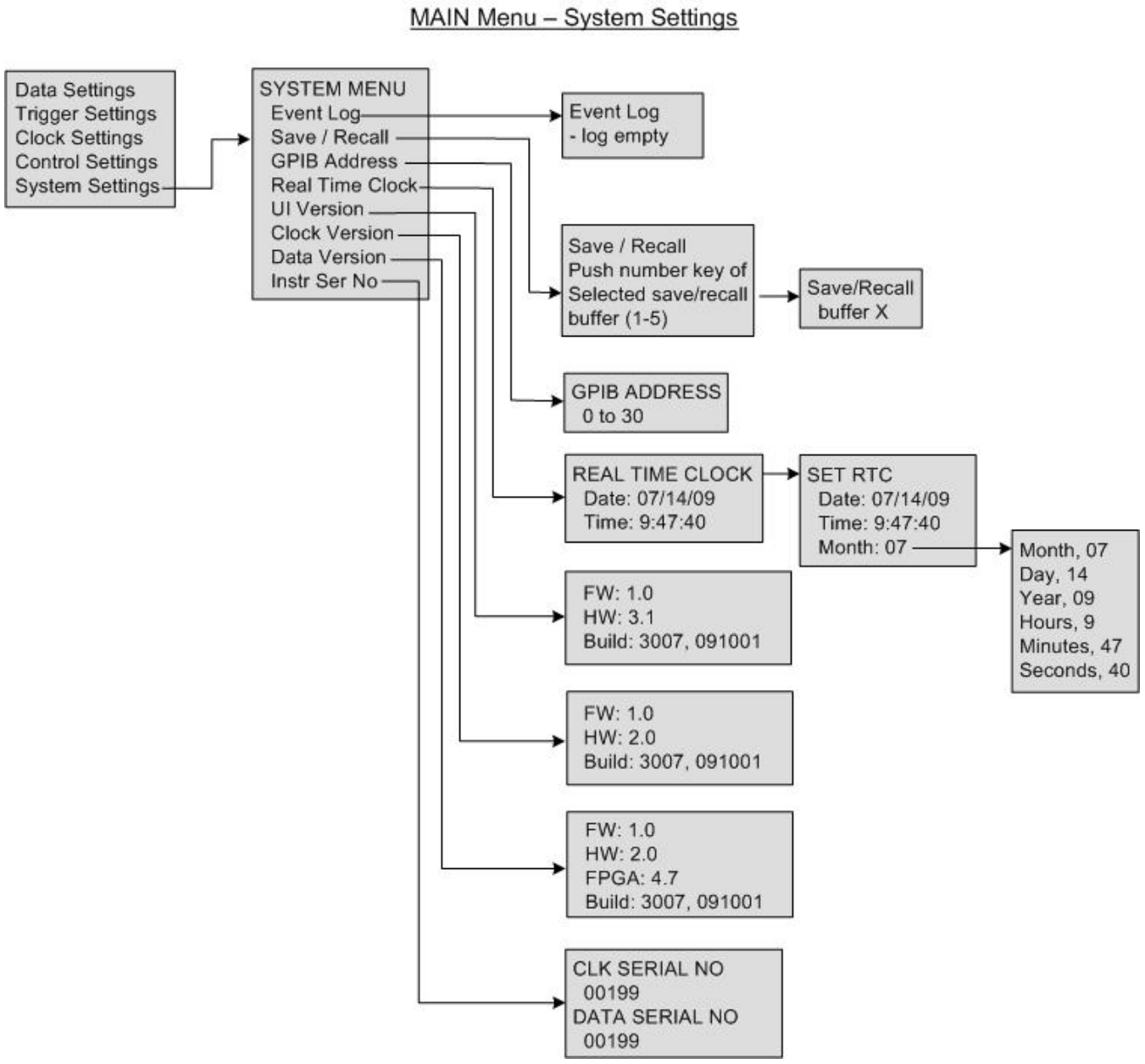


Figure 10. System settings structure

4.4.3 Menu Label Descriptions

Refer to Table 13 and Table 14 for the data settings descriptions.

Table 13. Data settings descriptions – data adjust

Label Name	Description
Dat amp	Adjusts the data amplitude.
Dat ofs	Adjusts the data offset.
Dat term	Internally compensates the offset voltage setting to support a user's DUT termination voltage.
Dat logic	Selects ECL, LVPECL, or LVDS data logic. CUST: appears when the amplitude, offset, and termination combination do not match a particular logic family.

Table 14. Data settings descriptions – pattern select and pat modifiers

Label Name	Description
Pat:	Selects the data test pattern.
Pat invert	Inverts the data pattern.
ErRateInjEna	Enables/disables error injection capability.
ErInjRate	Adjusts fixed error rates.
ErInjLength	Adjusts burst lengths.
De-emph	Adjusts de-emphasis.
Dat xover	Adjusts the data crossover.
DatDel	Adjusts the phase relationship between the master clock input and data output.

Refer to Table 15 for the trigger settings descriptions.

Table 15. Trigger settings descriptions

Label Name	Description
CLK/256	Selects a divided output trigger signal to the trigger output connector to view data as an eye diagram.
Pattern	Selects the pattern output trigger signal to trigger an event synchronized to a specific point in the pattern to view the data pattern.

Refer to Table 16 for the clock settings descriptions.

Table 16. Clock settings descriptions

Label Name	Description
Frq Mode	The Frq Mode options include: auto: automatically update N4971A when full rate clock source frequency changed. manual: manually update N4971A when full rate clock source frequency changed.
Frq	Displays the clock frequency. auto: displays the measured clock frequency of the input master clock signal when in auto mode. manual: editable field for user to enter the frequency of the master clock. NOTE In manual mode, all internal frequency dependent settings of the instrument are set by the frequency entered in this field.
ClkDel	Adjusts the phase relationship between the master clock input and clock output.
Clk Amp	Adjusts the clock amplitude.
Clk Ofs	Adjusts the clock offset.
Clk Term	Internally compensates the offset voltage setting to support a user's DUT termination voltage covering the range.
Clk Logic	Selects ECL, LVPECL, or LVDS data logic. CUST: appears when the amplitude, offset, and termination combination do not match a particular logic family.
Dclk Ratio	Sets the divide factors for the divided clock output.
Dclk Amp	Sets the amplitude of the divided clock output.

Refer to Table 17 for the clock settings descriptions.

Table 17. Control settings descriptions

Label Name	Description
AUX In SMA	The Aux In connector accepts a pulse from an external source to initiate a programmable function. The options include: ADDError: injects one error into the bit stream. Off: disables the Aux In connector.
AUX In Btn	The Aux In button manually initiates a programmable function. The options include: ADDError: injects one error into the bit stream. Off: disables the Aux In button.
10 MHz Ref	Selects a 10 MHz reference output used to lock the frequency reference of other equipment to the N4971A. The options include: Int: internal 10 MHz reference. Ext: external 10 MHz reference at the 10 MHz In connector on the rear panel of the N4971A.

Refer to Table 18 for the System Settings descriptions.

Table 18. System settings descriptions

Label Name	Description
Event log	Accesses the list of event messages. The Attention LED indicator on the front panel of the N4971A is lit when an event occurs and added to the event log.
Save / recall	Stores the current instrument state into a buffer (1-5), which can later be recalled.
GPIB address	Sets the GPIB Address from 0 to 30.
Real time clock	Sets the instrument time and date.
UI version	Accesses the user interface firmware and hardware version information.
Clock version	Accesses the clock firmware and hardware version information.
Data version	Accesses the data firmware and hardware version information.
Inst Ser no	Accesses the instrument serial number.

4.4.4 Menu Navigation

Navigation through the menus is accomplished with the four softkeys to the right of the display and the rotary knob. Refer to Figure 11.

Figure 11. Softkey navigation buttons and rotary knob

Toggle between the **STAT** (Status) menu and the **MENU** (Main Menu) using the top navigation softkey. Refer to Figure 7. Scroll through menu items using either the softkeys corresponding to the up and down arrow labels, or using the rotary knob. Refer to Figure 12.

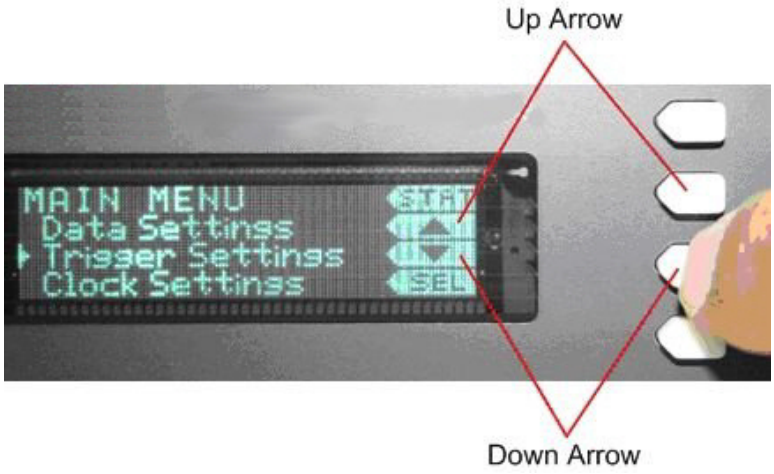


Figure 12. Scrolling through menu items

If a menu item has a lower-level menu that can be accessed, the **SEL** softkey appears. Press it to access the corresponding lower-level menu. Refer to Figure 13.

Figure 13. Accessing lower-level menus

4.4.5 Changing Parameters

If a menu item has a numeric value that can be changed or has multiple selections (for example, on and off), then the **EDIT** label appears. Refer to Figure 14.

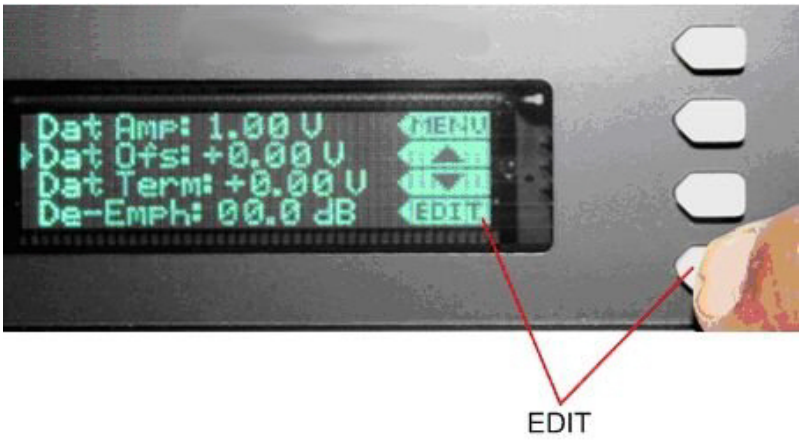


Figure 14. EDIT label

When the softkey corresponding to the **EDIT** label is pressed, the function's parameter can be changed using the rotary knob or the keypad.

NOTE The keypad can only be used if a parameter is a numeric value.

Figure 15 is an example of changing parameters using the rotary knob.

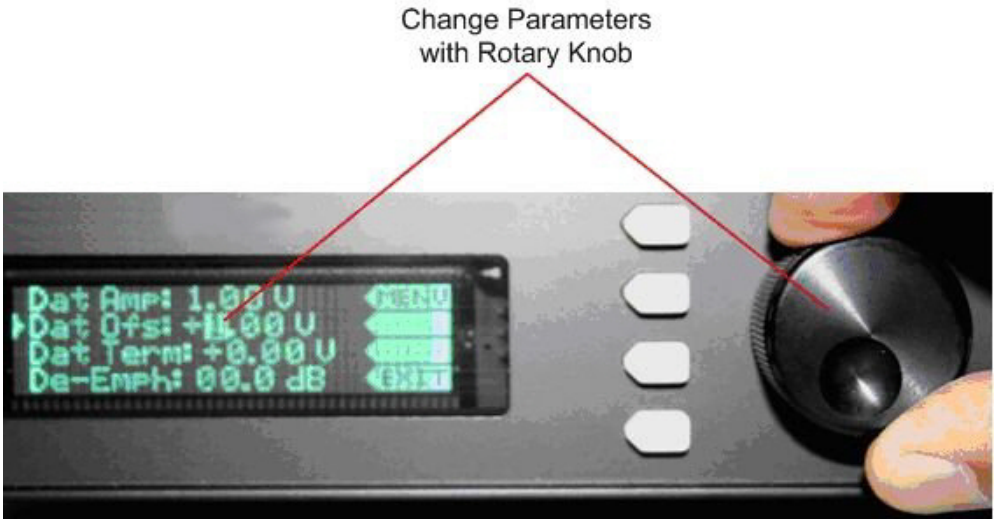


Figure 15. Changing parameters using the rotary knob

If you are using the rotary knob to change numeric values, use the right/left arrows on the keypad to highlight the digit you wish to change. The right arrow highlights the digit to the right. The left arrow highlights the digit to the left. When finished, press the softkey corresponding to the **EXIT** label to accept the changes. Refer to Figure 16.

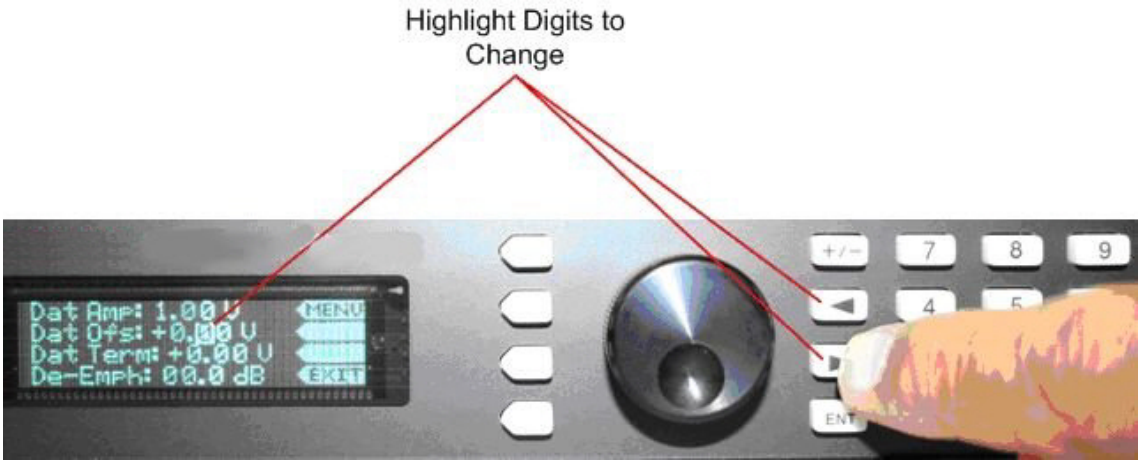


Figure 16. Highlighting digits to change

In addition to the rotary knob, the numeric keypad can be used to change numeric values. Once the softkey corresponding to the **EDIT** label is pressed, simply enter the value using the numeric keypad. When finished, either press the **ENT** hardkey on the keypad, or press the softkey corresponding to the associated units label to accept the entry. Refer to Figure 17.

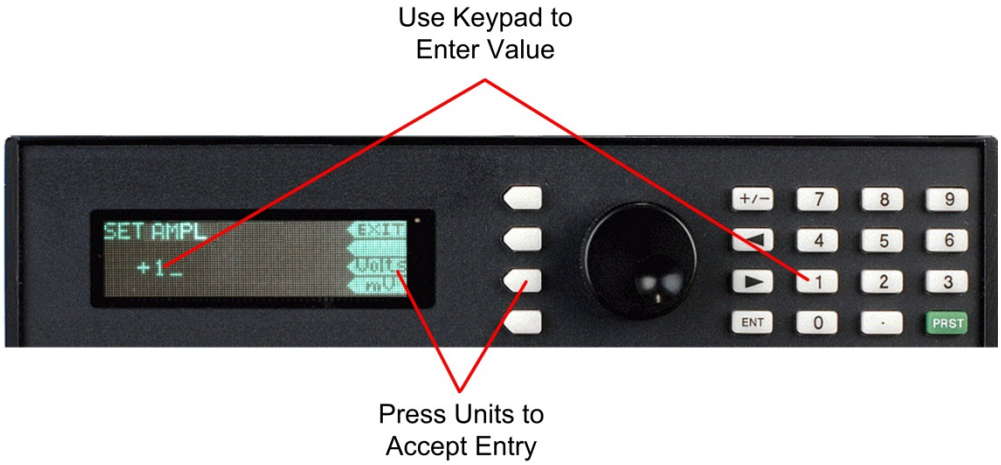


Figure 17. Using the numeric keypad

4.5 Creating and Uploading Patterns

The N4971A pattern utility software enables users to create new patterns and upload them into the N4971A. This software application is installed on a PC that communicates with the N4971A over the USB interface.

Refer to the N4971A pattern utility software user guide for information on how to create patterns and upload them into the N4971A.

4.6 Selecting Preloaded Patterns

The following procedure shows how to select from a list of preloaded patterns.

1. In the **MENU** (Main Menu), position the arrow next to the **Data Settings** label then press the softkey corresponding to the **SEL** label.
2. Position the arrow next to the **Pattern Select** label then press the softkey corresponding to the **SEL** label.
3. Press the softkey corresponding to the **EDIT** label and scroll through the list of test patterns until the desired pattern is highlighted.
4. Press the softkey corresponding to the **SEL** label to select the pattern.
5. Press the softkey corresponding to the **BACK** label until the top menu is displayed.

4.7 Setting Up De-emphasis

De-emphasis is used to compensate for transmission loss. For example, de-emphasis is used to compensate for loss in cabling or loss due to long printed circuit board traces.

After a bit transition, if the data pattern has more than one bit of the same logic level in succession, the de-emphasis feature reduces the level of the second and all successive bits until the next bit transition. The first bit is not changed. The amount of de-emphasis can be adjusted from 0 to 20 dB. With de-emphasis set to 0 dB, no de-emphasis is applied to the pattern.

The following procedure shows how to set up the de-emphasis feature.

1. Connect the N4971A to a clock source and high speed sampling scope as shown in Figure 18 Tighten cables to 8 lbf-in (90 N-cm) and use 50 Ω terminations on all unused ports.

NOTE For purposes of this example setup, an Agilent 86100A Infiniium DCA was used. High-speed sampling scope setup option names may differ between models.

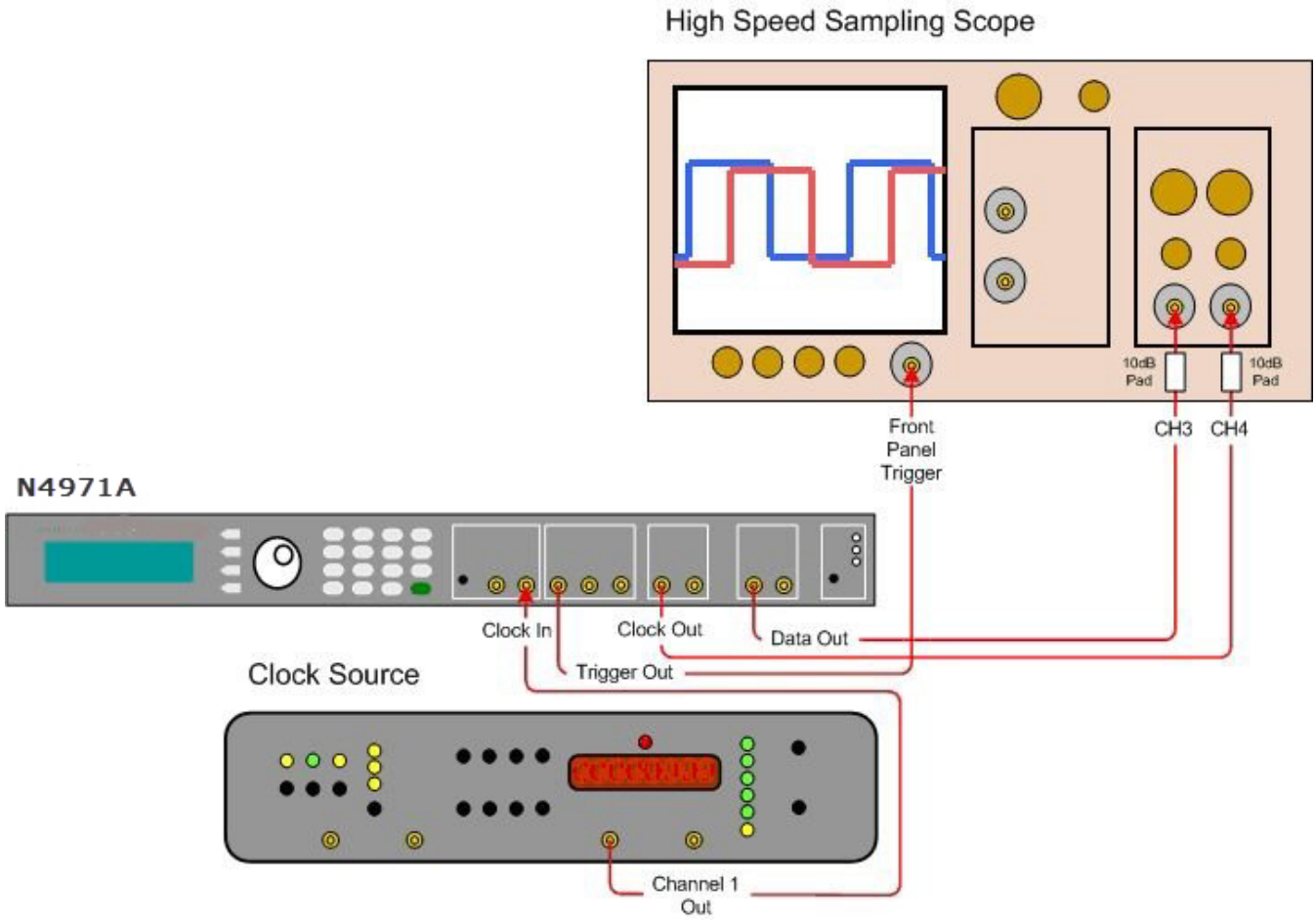


Figure 18. De-emphasis setup

2. Set up the clock source as follows:
   - Frequency: 10 GHz
   - Level: 0 dBm
   - Output: On
3. Set up the high speed sampling scope as follows:

Set the high speed sampling scope to Oscilloscope mode

Trigger setup	Trigger Mode	
	Trigger Level:	900 mV
	Slope:	Rising Edge
	Trigger Bandwidth:	DC-2.5 GHz
Timebase setup	Scale:	200 ps/div
	Position:	adjust position on screen
	Reference:	center

Channel 3 setup (data)	Display:	On
	Scale:	maximum
	Offset:	0 V
	Bandwidth:	maximum
	Attenuation:	10 dB (a 10 dB pad is placed at the input)
Channel 4 setup (clock)	Display:	Off

4. Press the **PRST** button on the front panel of the N4971A to set the instrument to the following settings:

   Dat Amp: 1.00 V
   Dat Ofs: +0.00 V
   Dat Term: +0.00 V
   De-Emph: 00.0 dB
   Dat Xover: 50%
   DatDel: +00.00 UI
   ClkDel: +00.00 UI
   Clk Amp: 1.00 V
   Clk Ofs: +0.00 V
   Clk Term: +0.00 V
   Frq Mode: auto

5. Set the N4971A to pattern trigger mode:
   a. Press the softkey corresponding to the **MENU** label to access the Main Menu items.
   b. Position the arrow next to the **Trigger Settings** label then press the softkey corresponding to the **SEL** label.
   c. Position the arrow next to the **TrigMode** label then press the softkey corresponding to the **EDIT** label.
   d. Select **pattern** then press the softkey corresponding to the **EXIT** label to accept the change.
   e. Press the softkey corresponding to the **BACK** label to return to the top menu.

6. Select the DE_TEST.FPT pattern:
    a. Position the arrow next to the **Data Settings** label then press the softkey corresponding to the **SEL** label.
    b. Position the arrow next to the **Pattern Select** label then press the softkey corresponding to the **SEL** label.
    c. Press the softkey corresponding to the **EDIT** label and scroll through the list of test patterns until DE_TEST.FPT is highlighted.
    d. Press the softkey corresponding to the **SEL** label to select the pattern.
    e. Press the softkey corresponding to the **BACK** label until the top menu is displayed.
7. Press the **Output On/Off** button on the N4971A to turn on the clock and data signals.
8. Change the de-emphasis:
    a. Press the softkey corresponding to the **STAT** label on the N4971A to access the Status Menu.
    b. Position the arrow next to the **De-Emph** label then press the softkey corresponding to the **EDIT** label.
    c. Use the rotary knob or keypad on the N4971A to change the de-emphasis value while viewing the effect on the high speed sampling scope.
    d. Press the softkey corresponding to the **EXIT** label when completed.
9. Figure 19 shows a pattern with 0 dB and 6 dB of de-emphasis applied. Figure 20 shows an example of an eye waveform at the end of a long trace on an FR4 circuit board with 0 dB de-emphasis, and the same signal cleaned up by applying 6 dB de-emphasis.

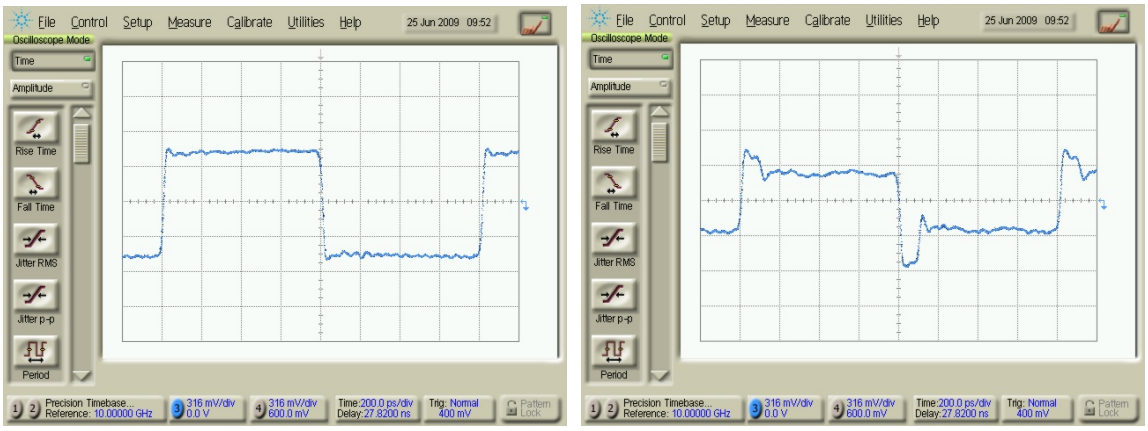


Figure 19. Pattern with 0dB and 6dB de-emphasis applied

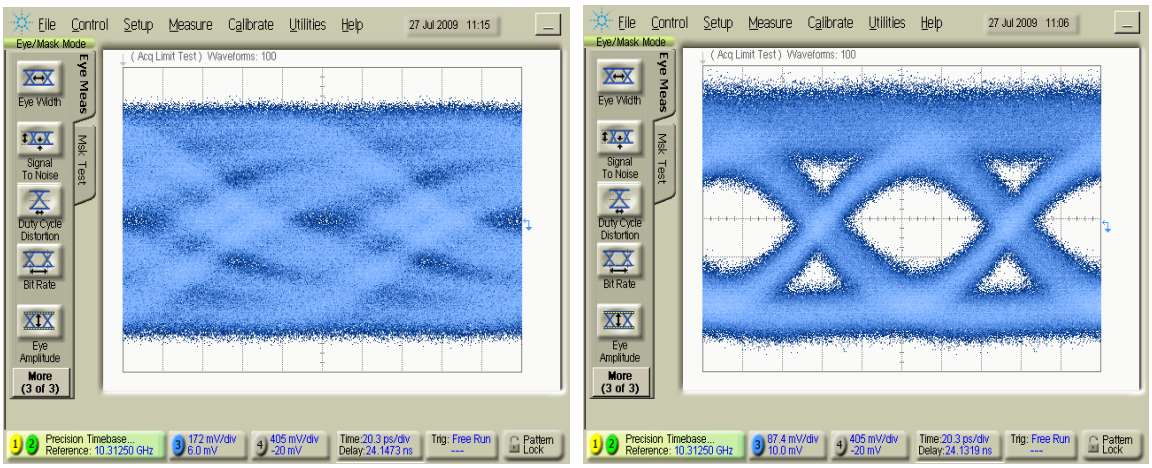


Figure 20. Real world eye waveform through a lossy channel with 0 dB and 6 dB de-emphasis applied

4.8 Measuring Random Jitter

The following procedure is used to characterize jitter. Before measuring the jitter of a device under test (DUT), you must consider the jitter of the N4971A. Figure 21 is a setup for measuring the jitter of the N4971A. Figure 23 is a setup for measuring the jitter of a typical device under test (DUT).

NOTE The precision timebase of the high-speed sampling scope is used in the following jitter setups. If the high speed sampling scope you are using does not have a precision timebase, you must use the front panel trigger. However, since the front panel trigger induces more noise into the measurement, the measured jitter of the N4971A will be large.

1. Connect the N4971A to a clock source and high speed sampling scope as shown in Figure 21.Tighten cables to 8 lbf-in (90 N-cm) and use 50 Ω terminations on all unused ports.

NOTE For purposes of these example setups, an Agilent 86100A Infinium DCA was used. High-speed sampling scope setup option names may differ between models.

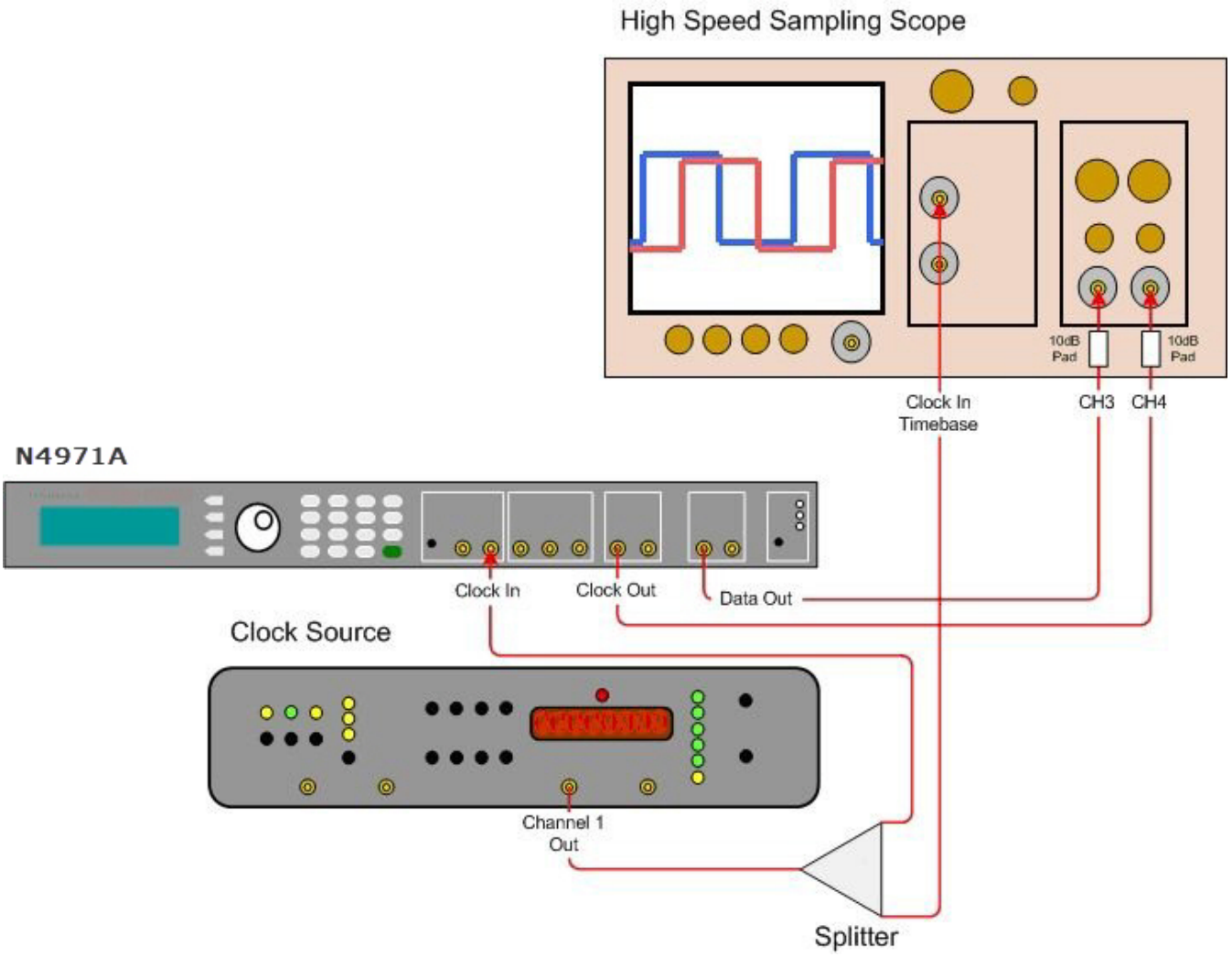


Figure 21. Setup for measuring N4971A jitter

2. Set up the clock source as follows:
   Frequency: 10 GHz
   Level: +6 dBm (accounts for 6 dB loss in splitter)
   Output: On
3. Set up the high speed sampling scope as follows:
   Set the high speed sampling scope to Eye/Mask mode

Precision Timebase	Turn on the precision timebase	
	Frequency:	10 GHz
	Reset timebase after frequency entry	
Channel 3 Setup (data)	Attenuation:	10 dB (10 dB pad placed at the input)
	Bandwidth:	maximum
	Display:	On
	Scale:	316 mV/Div
	Offset:	–600 mV
Channel 4 Setup (clock)	Attenuation:	10 dB (10 dB pad placed at the input)
	Bandwidth:	maximum
	Display:	On
	Scale:	316 mV/Div
	Offset:	+600 mV

4. Press the **PRST** button on the front panel of the N4971A to set the instrument to the following settings:
   Dat Amp: 1.00 V
   Dat Ofs: +0.00 V
   Dat Term: +0.00 V
   De-Emph: 00.0 dB
   Dat Xover: 50%
   DatDel: +00.00 UI
   ClkDel: +00.00 UI
   Clk Amp: 1.00 V
   Clk Ofs: +0.00 V
   Clk Term: +0.00 V
   Frq Mode: auto
5. Press the **Output** button on the N4971A to turn on the clock and data signals.

6. Figure 22 shows the measured jitter of the N4971A, clock, and data outputs.

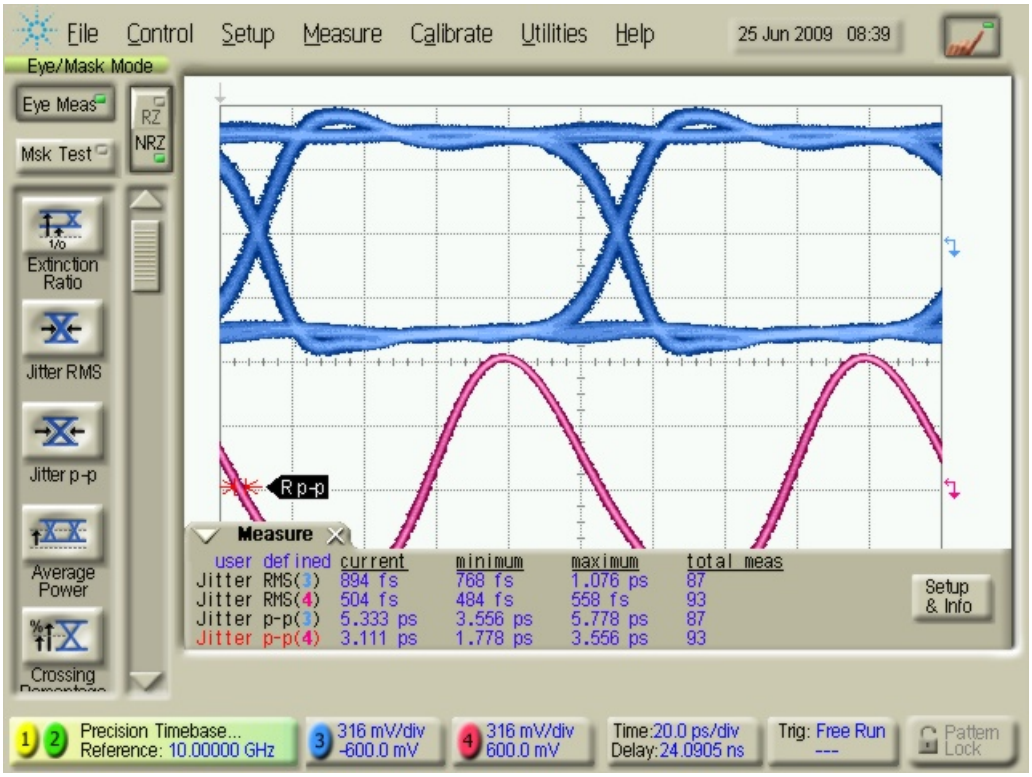


Figure 22. Jitter measurement of the N4971A

7. Figure 23 is an example of a setup for measuring the jitter of a DUT.

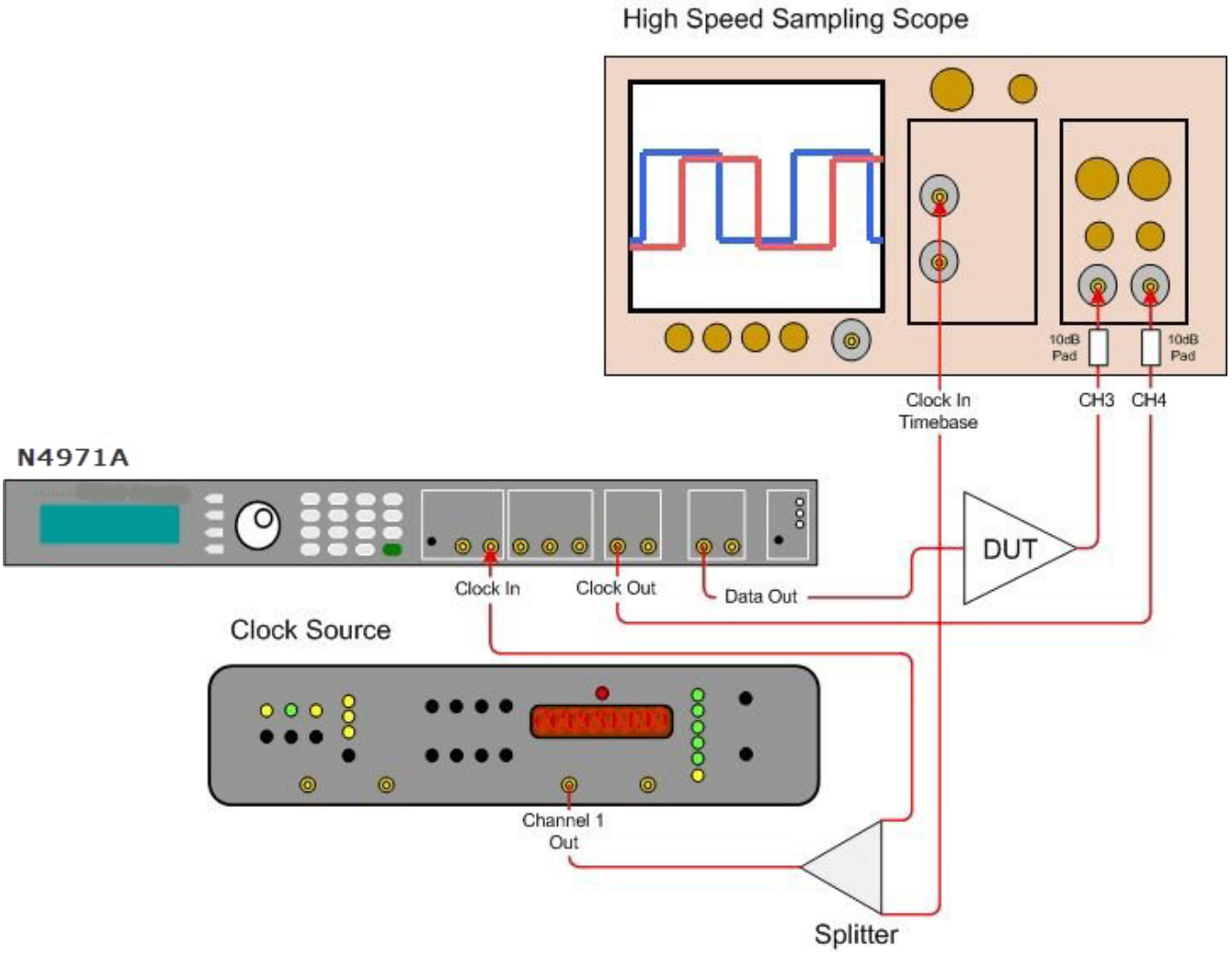


Figure 23. Setup for measuring DUT jitter

4.9 Setting Up Bit Error Rate (BER) Measurements

The following procedure shows how to set up the N4971A for performing bit error rate (BER) measurements. A BER measurement is a ratio between bit values measured after transmission through a DUT to the bit values of the input signal.

NOTE Before performing the following procedure, it is recommended that the procedure in section 1.6 Installation be performed to ensure proper data and clock output from the N4971A.

1. Connect the N4971A to a clock source and a BERT as shown in Figure 24. Tighten cables to 8 lbf-in (90 N-cm) and use 50 Ω terminations on all unused ports.

NOTE For purposes of these example setups, a Agilent Technologies N4962A serial BERT 12.5 Gb/s was used. BERT option names may differ between models.

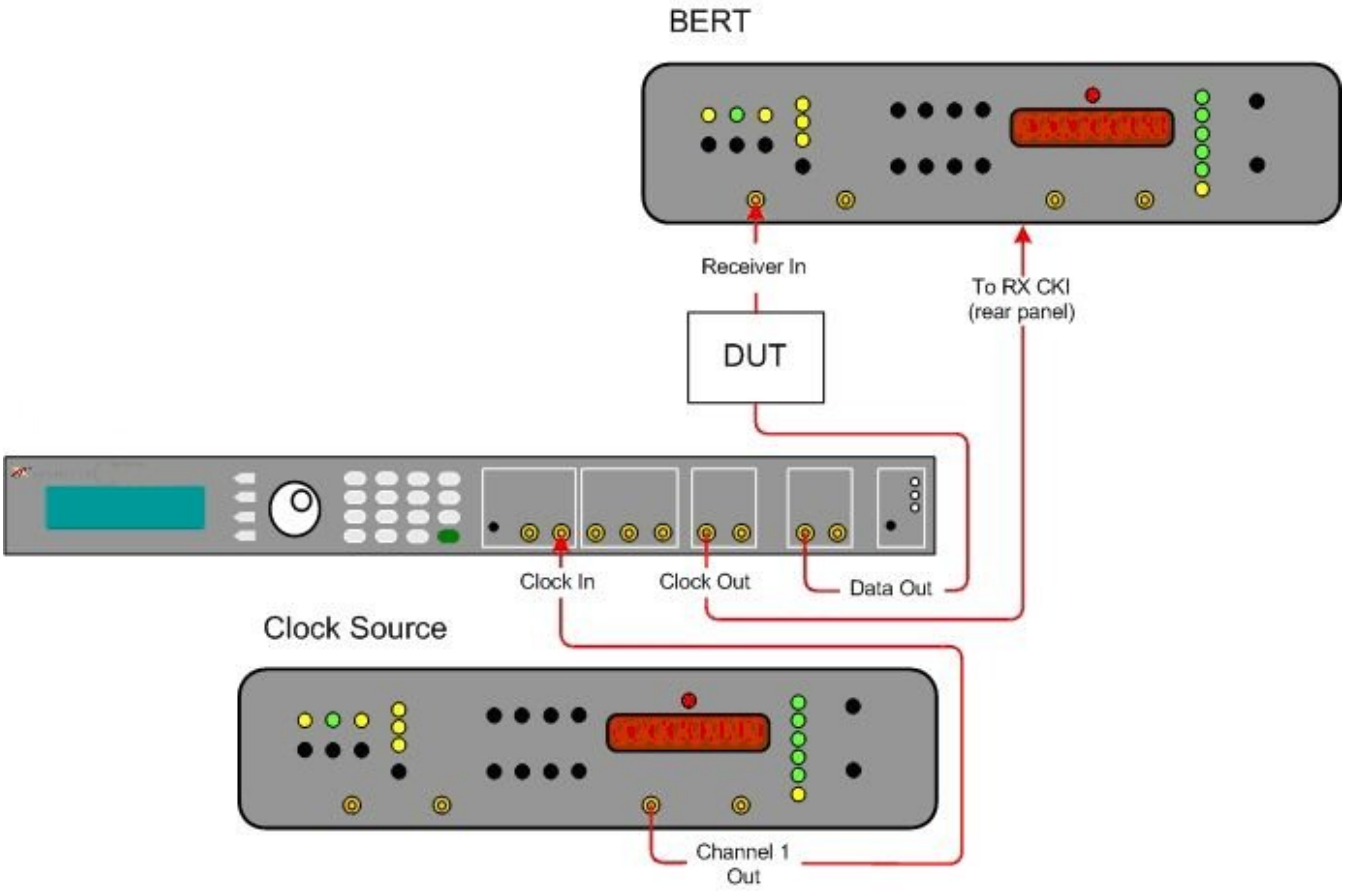


Figure 24. BER setup

2. Set up the clock source as follows:
   Frequency: 10 GHz
   Level: 0 dBm
   Output: On
3. Press the **PRST** button on the front panel of the N4971A to set the instrument to the following settings:
   Dat Amp: 1.00 V
   Dat Ofs: +0.00 V
   Dat Term: +0.00 V
   De-Emph: 00.0 dB
   Dat Xover: 50%
   DatDel: +00.00 UI
   ClkDel: +00.00 UI
   Clk Amp: 1.00 V
   Clk Ofs: +0.00 V
   Clk Term: +0.00 V
   Frq Mode: auto
4. Press the **Output** button on the N4971A to turn on the clock and data signals.
5. Set up the TG1B1-A 10G BERT as follows:
   Pattern: PAT 2E7 (27-1 PRBS Pattern)
   Clock: Synth 0 (external clock)
6. Perform the following on the BERT:
   a. Press the + button under Adjust/Config State to perform an automatic phase alignment.
   b. Select BER to display measured bit error rate.
   c. Press the **Receiver** button to turn on the receiver and start the BER measurement.

4.10 Event Log

NOTE When an event is detected, the Attention LED will illuminate.

Each event log entry contains the following information:

- Log number: 1 to n, with 1 being the most recent event and 'n' being the oldest event.
- Event type: Identifies the source sub-system of the event.
- Event value: Identifies the event itself.
- Timestamp: Time of event receipt (hh/mm/ss).
- Datestamp: Date of event receipt (mm/dd/yy).

4.11 Returning the N4960A Serial BERT to Agilent Technologies

If the N4971A fails system verification and you cannot correct the problem, return it to Agilent Technologies for repair following the steps shown below.

1. Record all symptoms.
2. Contact Agilent Technologies using the "Request an RMA" form at http://www.agilent.com/find/assist.
3. Use the original packing material or comparable packing material to ship the instrument to Agilent Technologies.

5 Remote Operation

The N4971A can be controlled and queried with the rear-panel GPIB or USB interface.

5.1 GPIB Interface

The GPIB interface complies with IEEE standard 488.2-1992. To learn more about the GPIB interface, consult the following books from the IEEE:

- The International Institute of Electrical and Electronic Engineers. *IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation*. New York, NY, 1987.
- The International Institute of Electrical and Electronic Engineers. *IEEE Standard 488.2-1987, IEEE Stand Codes, Formats, Protocols and Communication Commands for Use with ANSI/IEEE Std 488.1-1987*. New York, NY, 1987.

A GPIB interface requires that all devices on a common bus have different addresses. The address of the N4960A serial BERT 32 and 17 Gb/s is set up using the System Settings menu. The range is 0 to 30.

The GPIB interface capabilities are described in Table 19.

Table 19. N4971A GPIB capabilities

Mnemonic	Function
SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T6	Basic talker; serial poll; unaddressed to talk if addressed to listen; no talk only
L4	Basic listener; unaddressed to listen if addressed to talk; no listen only
SR1	Complete service request capability
RL2	Remote/local capability with local lockout (LLO)
PP0	No parallel poll capability
DC1	Device clear capability
DT1	Device trigger capability (accepted but ignored)
C0	No controller capability
E2	Tristate outputs (except the handshake line)

5.2 USB Interface

The USB interface connects to an external PC controller to control the N4971A and for data transfers. The USB interface supports the N4971A to be connected and disconnected without rebooting the computer or turning off the N4971A (hot swapping).

Connect a Type-A to Type-B 5 pin cable from the USB port of the PC controller to the USB port on the rear panel of the N4971A.

5.2.1 USB Driver

Installation of the appropriate driver is required. The N4971A USB port can be accessed from a PC as a virtual COM port (VCP). Virtual COM port drivers cause the USB device to appear as an additional COM port available to the PC. Application software can access the USB device in the same way as it would access a standard COM port.

The N4971A uses a hardware interface chip manufactured by Future Technologies Devices International (FTDI). VCP drivers are available for several operating systems at their web site:
www.ftdichip.com/FTDrivers.htm.

5.3 Remote Command Syntax

The commands and queries are documented in the Backus-Naur Form notation, detailed in Table 20.

Table 20. Remote command and query syntax

Symbol	Meaning
<>	Defined element (for example: <arg>)
::=	Is defined as (for example: <arg> ::= argument)
|	Exclusive OR
{ }	One of this group is required
[ ]	Optional item
...	Previous elements may be repeated

5.3.1 Command Structure

The GPIB and USB interfaces allow commands that tell the instrument to take a specific action. In addition, these interfaces allow queries, which ask the instrument to return information.

Commands are composed of syntactic elements:

- Header – the command name; if it ends with a question mark, it's a query.
- Delimiter – a space ' ', colon ':', comma ',', or semi-colon ';'.
- Link – a command sub-function. Not all commands have links.
- Argument – a quantity, quality, or limit associated with the header or link.

Commands are case insensitive, although they are documented in an uppercase and lowercase manner that indicates the minimum characters required to make the command. The commands can be shortened to the minimum length illustrated by the uppercase letters in the documentation.

- The command
  - **:TRIGger:DIVClock**
- Can be written in lowercase
  - **:trigger:divclock**
- And it can be shortened
  - **:TRIG:DIVC**

5.4 IEEE Common Commands

The IEEE 488.2 standard has a list of reserved commands that must be implemented by all instruments using the standard. The N4971A implements the commands listed in Table 21.

Table 21. IEEE common commands

Command	Function
*CLS	Clear status command
*RST	Reset command
*WAI	Wait to continue
*IDN?	Identification query
*STB?	Status byte query
*TST?	Self test query (always returns “0”)
*ESR?	Event status register query
*ESE	Event status enable register set
*ESE?	Event status enable register query
*OPC	Operation complete clear flag
*OPC?	Operation complete query
*SRE	Service request enable set
*SRE?	Service request enable query

5.5 SCPI Protocol Description

The N4971A supports a simple SCPI syntax. SCPI has an associated hierarchy with it. The top level is referred to as the Root mode. SCPI remembers the current hierarchy so you don't need to repeat it for subsequent commands.

5.5.1 SCPI Example

The capital letters in the commands denote the required subset of mnemonic for correct state control. The lower case letters are optional but if they are used they must be spelled correctly.

:GENerator:DATA:DELay?	Query data delay value.
:GENerator:DATA:DELay 9.8 UI	Set delay value.
DELay?	Query data delay value. Only the DELay? command is required since it is part of the GENerator:DATA group.
LLEVel?	Query data logic family. Only the LLEVel? command is required since it is part of the GENerator:DATA group.
:GENerator:CLOCk:LLEVel:AMPLitude?	Query the clock amplitude level.
AMPLitude .2 V	Set the clock amplitude to 200mV. Only the AMPLitude command is required since it is part of the GENerator:CLOCk:LLEVel group.
TERMination 135 mV	Set the clock termination voltage to 135 mV. Only the TERMination command is required since it is part of the GENerator:CLOCk:LLEVel group.

5.6 SCPI Numeric Parameters and Optional Units

The following are examples of SCPI numeric parameters for SCPI commands that have numeric values:

.2 digits before decimal point not required

500. digits after decimal point not required

500 no decimal point required

-1000 accepts negative '–' or positive '+' signs

200E-3 accepts uppercase 'E' or lowercase 'e' to specify exponent

The following are examples of optional units:

200 mV	mV used in place of e-3
5MHz	MHz used in place of e6
-1000UI	unit interval of negative 1000.

5.7 N4971A Command Summary

The following conventions are used in the following summary:

GENerator indicates that the GEN characters are required and that the keyword may optionally appear as GENERATOR instead. No other spellings are valid

value is a placeholder in the command and is described elsewhere in the text for the command.

[unit] indicates that the unit placeholder is optional; it may or may not appear in the command.

string is a placeholder in the command and is described elsewhere in the text for the command.

ON | OFF indicates a choice may be made between ON or OFF.

{ ON | OFF } indicates that a choice *must* be made between ON or OFF; one or the other must appear in the command.

The N4971A device commands are summarized in Table 22.

Table 22. N4971A command summary

Command	Parameters / Results
:GENerator:CLOCk:DELay	value
:GENerator:CLOCk:DELay?	–10 to +10 UI
:GENerator:CLOCk:DIVClock	value
:GENerator:CLOCk:DIVClock?	8 to 511
:GENerator:CLOCk:DIVClock:AMPLitude	value [unit]
:GENerator:CLOCk:DIVClock:AMPLitude ?	0.20 V to 0.60 V
:GENerator:CLOCk:LLEVel	{LVDS | ECL | LVPECL | CUSTom}
:GENerator:CLOCk:LLEVel?	LVDS, ECL, LVPECL, or CUST

Command	Parameters / Results
:GENerator:CLOCk:LLEVel:AMPlitude	value [unit]
:GENerator:CLOCk:LLEVel:AMPlitude?	0.2 to 1.8 V
:GENerator:CLOCk:LLEVel:OFFSet	value [unit]
:GENerator:CLOCk:LLEVel:OFFSet?	–2 to +2 V
:GENerator:CLOCk:LLEVel:TERMination	value [unit]
:GENerator:CLOCk:LLEVel:TERMination?	–2 to +2V
:GENerator:CLOCk:MODE	{AUTO | MANual}
:GENerator:CLOCk:MODE?	AUTO or MAN
:GENerator:CLOCk:FREQ	value [unit]
:GENerator:CLOCk:FREQ?	1000 MHz to 13000 MHz
:GENerator:CONTrol:AUXin:SMA	{OFF | ADDError}
:GENerator:CONTrol:AUXin:SMA?	OFF or ADDE
:GENerator:CONTrol:AUXin:BUTTon	{OFF | ADDError}
:GENerator:CONTrol:AUXin:BUTTon?	OFF or ADDE
:GENerator:CONTrol:REFerence	{INTernal | EXTernal}
:GENerator:CONTrol:REFerence?	INT or EXT
:GENerator:DATA:DEEMphasis	value [unit]
:GENerator:DATA:DEEMphasis?	0 to 20dB
:GENerator:DATA:DELay	value [unit]
:GENerator:DATA:DELay?	–10 to +10UI
:GENerator:DATA:LLEVel	{LVDS | ECL | LVPECL | CUSTom}
:GENerator:DATA:LLEVel?	LVDS, ECL, LVPECL, or CUST
:GENerator:DATA:LLEVel:AMPLitude	value [unit]
:GENerator:DATA:LLEVel:AMPLitude?	0.2 to 1.6 V
:GENerator:DATA:LLEVel:OFFSet	*value [unit]*
:GENerator:DATA:LLEVel:OFFSet?	–2 to +2 V
:GENerator:DATA:LLEVel:TERMination	*value [unit]*
:GENerator:DATA:LLEVel:TERMination?	–2 to +2 V
:GENerator:DATA:PATTern:LIST?	*string*
:GENerator:DATA:PATTern:ERRInjection :LENgth	{1 | 2 | 4 | 8 | 16 | 32 | 64 | 128}
:GENerator:DATA:PATTern:ERRInjection :LENgth?	1, 2, 4, 8, 16, 32, 64, or 128
:GENerator:DATA:PATTern:ERRInjection :MODE	{ON | OFF}

Command	Parameters / Results
:GENerator:DATA:PATTern:ERRInjection :MODE?	ON or OFF
:GENerator:DATA:PATTern:ERRInjection :RATE	{10^{-3} | 10^{-4} | 10^{-5} | 10^{-6} | 10^{-7} | 10^{-8} | 10^{-9}}
:GENerator:DATA:PATTern:ERRInjection :RATE?	10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, or 10^{-9}
:GENerator:DATA:PATTern:NAME	*string*
:GENerator:DATA:PATTern:NAME?	*string*
:GENerator:DATA:PATTern:POLarity	{INVert | NONInvert}
:GENerator:DATA:PATTern:POLarity?	INV or NONI
:GENerator:DATA:XOVer	*value [unit]*
:GENerator:DATA:XOVer?	25% to 75%
:GENerator:OUTPut	{ON | OFF}
:GENerator:OUTPut?	ON or OFF
:GENerator:TRIGger	{CLK/256 | PATTern}
:GENerator:TRIGger?	CLK/256 or PATT
:STATus:OPERation:CONDition?	TBD
:STATus:OPERation:ENABle?	TBD
:STATus:OPERation:EVENt?	TBD
:STATus:QUEStionable:CONDition?	TBD
:STATus:QUEStionable:ENABle?	TBD
:STATus:QUEStionable:EVENt?	TBD
:SYSTem:PRESet	-
:SYSTem:VERSion?	*string*
:SYSTem:ERRor?	*string*
:SYSTem:ERRor:ALL?	*string*
:SYSTem[:NEXT]?	TBD
*SAV	1 to 5
*RCL	1 to 5

5.8 Long and Variable Length Remote Commands in the N4971A

Many commands are quickly executed by the N4971A. However, some commands have a long or variable execution time. These are listed below with their approximate durations and recommended best practices for remote operation:

Table 23: Long and Variable Length Remote Commands

Command	Condition	Maximum observed duration	Best remote command practice
Pattern select	Varies with pattern size	130 seconds[4]	Pause automated measurement scripts while loading long patterns
System preset	-	10 seconds	Use *OPC? after a system preset
Frequency mode change	Changing from MANUAL to AUTO	6 seconds	Use *OPC? after a frequency mode change
	Changing from AUTO to MANUAL	5 seconds	Use *OPC? after a frequency mode change
Pattern generator settling time from a frequency change	Frequency mode set to AUTO	10 seconds	Pause automated measurement scripts for observed duration time
	Frequency mode set to MANUAL	5 seconds	Use *OPC? after programming the new frequency (only works when frequency mode is MANUAL)
Pattern generator settling time after applying a clock signal (Off to On)	Frequency mode set to AUTO	12 seconds	Pause automated measurement scripts for observed duration time

[4] Factory and User Patterns (patterns with names ending in .FPT and .USR) are loaded into high speed memory that feeds the pattern generator output. The load rate for filling memory is ~185 kbits/second. For the largest pattern of 24 Mbits the load time is approximately 130 seconds. To achieve the most reliable and efficient automated script, the user should manually measure the load time for their particular pattern and use a slightly larger value for the pause time in their program.

There are three remote commands that are commonly used with variable length remote commands:

*OPC

*OPC?

*WAI

The *OPC command sets a bit in the standard event status register allowing a controlling program to poll the instrument periodically to check if a pending operation is complete. This allows the controlling program to continue to parallel operations.

*OPC? and *WAI have a similar behavior in that they block further execution of commands to the instrument until the present operation has completed.

Understanding the duration of remote commands and the proper use of *OPC, *OPC?, and *WAI should improve the reliability and efficiency of automated measurements using the N4971A.

However, loading a large pattern from internal instrument disk storage to high speed memory can take considerable time and is not interruptible. This operation locks the instrument remote interface until the pattern loading operation is complete. Sending commands to the instrument while it is loading a long pattern may disrupt the instrument remote interface and require a power cycle to recover.

Factory and user patterns (patterns with names ending in .FPT and .USR) are loaded into high speed memory that feeds the pattern generator output. The load rate for filling memory is ~185 kbits/second. For the largest pattern of 24 Mbits the load time is approximately 130 seconds. To achieve the most reliable and efficient automated script, the user should manually measure the load time for their particular pattern and use a slightly larger value for the pause time in their program.

5.8.1 Communication Timeouts

Remote commands that take more than a couple seconds to execute may cause a communication timeout in an automated script if default timeout values are used. It is recommended to use timeout values that exceed long or variable length commands.

From the maximum observed duration list in the table above, a simplistic approach of setting a global communication timeout to 15 seconds would meet the requirement for all remote commands with the exception of the pattern loading command. There is no penalty for this if communication is operating properly; a quick command paired with a long timeout will work the same as if it had a quick timeout. This would leave the timeout value of the pattern load command as the only one needing to be customized based on the particular pattern used.

5.9 N4971A Device Commands

Command **:GENerator:CLOCk:DELay**

Description Set the data delay from –10.0 to +10.0 in 0.01UI increments. The optional [unit] is UI (Unit Interval).

Command **:GENerator:CLOCk:DELay?**

Description Return the value of the clock delay. The clock delay range is –10 to +10 UI.

Command **:GENerator:CLOCk:DIVClock**

Description Set the divider factor for the divided clock output. The divider factor values are 8 to 511.

Command **:GENerator:CLOCk:DIVClock?**

Description Return the divider factor value set to produce the divided clock output. The divider factor values are 8 to 511.

Command **:GENerator:CLOCk:DIVClock:AMPLitude**

Description Set the divided clock output amplitude from 200 mV to 600 mV. Optional [units] are V and mV. The default unit is V.

Command **:GENerator:CLOCk:DIVClock:AMPLitude?**

Description Return the divided clock output amplitude. The amplitude range is 200 mV to 600 mV.

Command **:GENerator:CLOCk:LLEVel**

Description Set the clock logic level. The options include:

LVDS

ECL

LVPECL

CUSTom

The CUSTom option is set when the amplitude, offset, and termination combination do not match a particular logic family.

Command **:GENerator:CLOCk:LLEVel?**

Description Return the status of the logic level. The returned string will be LVDS, ECL, LVPECL, or CUST.

Command **:GENerator:CLOCk:LLEVel:AMPLitude**

Description Set the amplitude of the clock logic level from 200 mV to 1.8 V in .05 V increments. The default value is 1 V. The optional [units] are V and mV. The default unit is V.

Command **:GENerator:CLOCk:LLEVel:AMPLitude?**

Description Return the amplitude value of the clock logic level. The amplitude range is 200 mV to 1.8 V.

Command **:GENerator:CLOCk:LLEVel:OFFSet**

Description Set the offset voltage of the clock logic level from –2.0 V to +2.0 V in .05 V increments. The optional [units] are V and mV. The default unit is V.

Command **:GENerator:CLOCk:LLEVel:OFFSet?**

Description Return the offset value of the clock logic level. The offset level range is –2 to +2 V.

Command **:GENerator:CLOCk:LLEVel:TERMination**

Description Set the termination voltage of the clock logic level from –2.0 V to +2.0 V in .05 V increments. The optional [units] are V and mV. The default unit is V.

Command **:GENerator:CLOCk:LLEVel:TERMination?**

Description Return the termination value of the clock logic level. The termination voltage range is –2 to +2 V.

Command **:GENerator:CLOCk:MODE**

Description Set the clock mode to AUTO or MANual. The default is AUTO.

In AUTO mode, the N4971A is updated automatically whenever the full rate clock source frequency is changed.

In MANual mode, the user enters the frequency of the master clock manually.

Command **:GENerator:CLOCk:MODE?**

Description Return the status of the clock mode. The returned string is either AUTO or MAN.

Command **:GENerator:CLOCk:FREQ**

Description Set the frequency of the master clock from 1 GHz to 13 GHz. Note this command does not actually set the frequency of the external master clock; but it lets the N4971A know what the incoming clock frequency is so that internal frequency dependent settings can be utilized.

Command **:GENerator:CLOCk:FREQ?**

Description Return the frequency value of the master clock. Values are between 1 GHz and 13 GHz if clock mode is Manual, or actual measured value if clock mode is AUTO.

Command **:GENerator:CONTrol:AUXin:SMA**

Description Set the AUX In SMA connector to accept a pulse to initiate a programmable function. The options include:

OFF: disables the User Event.

ADDError: injects one error into the bit stream.

Command **:GENerator:CONTrol:AUXin:SMA?**

Description Return the status of the AUX In SMA connector. The returned string is either OFF or ADDE.

Command **:GENerator:CONTrol:AUXin:BUTTon**

Description Set the AUX In button to initiate a programmable function. The options include:

OFF: disables the user event

ADDError: injects one error into the bit stream

Command **:GENerator:CONTrol:AUXin:BUTTon?**

Description Return the status of the AUX In button setting. The returned string is either OFF or ADDE.

Command **:GENerator:CONTrol:REFerence**

Description Set to INTernal to use the internal 10 MHz reference signal; set to EXTernal to use an external 10 MHz reference signal. The default is INTernal.

Command **:GENerator:CONTrol:REFerence?**

Description Return the status of the reference signal. The returned string is either INT or EXT.

Command **:GENerator:DATA:DEEMphasis**

Description Set the data de-emphasis from 0 to 20 in 0.1 increments. The optional [unit] is dB.

Command **:GENerator:DATA:DEEMphasis?**

Description Return the value of the data de-emphasis. The de-emphasis range is 0 dB to 20 dB.

Command **:GENerator:DATA:DELAY**

Description Set the data delay from –10.00 to +10.00 in 0.01 UI increments. The optional [unit] is UI (Unit Interval).

Command **:GENerator:DATA:DELAY?**

Description Return the value of the data delay. The data delay range is –10.00 UI to +10.00 UI.

Command **:GENerator:DATA:LLEVel**

Description Set the data logic level. The options include:

LVDS

ECL

LVPECL

CUSTom

The CUSTom option is set when the amplitude, offset, and termination combination do not match a particular logic family.

Command **:GENerator:DATA:LLEVel?**

Description Return the status of the logic level. The returned string will be LVDS, ECL, LVPECL, or CUST.

Command **:GENerator:DATA:LLEVel:AMPLitude**

Description Set the amplitude of the data logic level from 200mV to 1.6 V in .05 V increments. The default value is 1 V. The optional [units] are V and mV. The default unit is V.

Command **:GENerator:DATA:LLEVel:AMPLitude?**

Description Return the amplitude value of the data logic level. The amplitude range is 200 mV to 1.6 V.

Command **:GENerator:DATA:LLEVel:OFFSet**

Description Set the offset voltage of the data logic level from –2.0 V to +2.0 V in .05 V increments. The optional [units] are V and mV. The default unit is V.

Command **:GENerator:DATA:LLEVel:OFFSet?**

Description Return the offset value of the data logic level. The offset range is –2 to +2 V.

Command **:GENerator:DATA:LLEVel:TERMination**

Description Set the termination voltage of the data logic level from –2.0 V to +2.0 V in .05 V increments. The optional [units] are V and mV. The default unit is V.

Command **:GENerator:DATA:LLEVel:TERMination?**

Description Return the termination value of the data logic level. The termination voltage range is –2 to +2 V.

Command **:GENerator:DATA:PATTern:LIST?**

Description Return the list of names of patterns the pattern generator can output.

Command **:GENerator:DATA:PATTern:ERRInjection:LENgth**

Description Set the burst length of the error injection signal. The lengths are 1, 2, 4, 8, 16, 32, 64, and 128.

Command **:GENerator:DATA:PATTern:ERRInjection:LENgth?**

Description Return the burst length of the error injection signal. The lengths are 1, 2, 4, 8, 16, 32, 64, and 128.

Command **:GENerator:DATA:PATTern:ERRInjection:MODE**

Description Set the error injection mode to ON (enable) or OFF (disable). The default is OFF.

Command **:GENerator:DATA:PATTern:ERRInjection:MODE?**

Description Return the status of the error injection mode. The returned string is either ON or OFF.

Command **:GENerator:DATA:PATTern:ERRInjection:RATE**

Description Set the fixed error rate of the error injection signal. The fixed rates are 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9}.

Command **:GENerator:DATA:PATTern:ERRInjection:RATE?**

Description Return the error rate of the error injection signal. The fixed rates are 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, 10^{-9}.

Command **:GENerator:DATA:PATTern:NAME**

Description Set the data pattern name. The name can contain a maximum of eight characters with a three-character extension.

Command **:GENerator:DATA:PATTern:NAME?**

Description Return the data pattern name.

Command **:GENerator:DATA:PATTern:POLarity**

Description Set the data pattern polarity to INVert or NONInvert.

Command **:GENerator:DATA:PATTern:POLarity?**

Description Return the data pattern polarity. The returned string is either INV or NONI.

Command **:GENerator:DATA:XOVer**

Description Set the data crossover from 25% to 75% in 1% increments.

Command **:GENerator:DATA:XOVer?**

Description Return the data crossover value. The data crossover range is 25% to 75%.

Command **:GENerator:OUTPut**

Description Turn the data and clock outputs ON or OFF. The default is OFF.

Command **:GENerator:OUTPut?**

Description Return the status of the data and clock outputs. The returned string is either ON or OFF.

Command **:GENerator:TRIGger**

Description Set the trigger output mode to one of the following:

CLK/256: selects a divided output trigger signal to the Trigger Output connector to view data as an eye diagram.

PATTern: selects the pattern output trigger signal to trigger an event synchronized to a specific point in the pattern to view the data pattern.

Command **:GENerator:TRIGger?**

Description Return the trigger output mode. The returned string is either CLK/256 or PATT.

Command **:STATus:OPERation:CONDition?**

Description TBD

Command **:STATus:OPERation:ENABle?**

Description TBD

Command **:STATus:OPERation:EVENt?**

Description TBD

Command **:STATus:QUEStionable:CONDition?**

Description TBD

Command **:STATus:QUEStionable:ENABle?**

Description TBD

Command **:STATus:QUEStionable:EVENt?**

Description TBD

Command **:SYSTem:PRESet**

Description Return instrument settings to a default state.

Command **:SYSTem:VERSion?**

Description Return UI, CLK, and DATA FW and HW information for models.

Command **:SYSTem:ERRor?**

Description Return event/error number and message from error queue.

Command **:SYSTem:ERRor:ALL?**

Description Returns all event/error numbers and messages from error queue.

Command **:SYSTem[:NEXT]?**

Description TBD

Command ***SAV**

Description Stores the current instrument settings to a buffer 1 to 5.

Command ***RCL**

Description Recalls instrument settings to a buffer 1 to 5.

5.10 Programming Example

The following programming example assumes the user is programming with Agilent BASIC, a simple interpretative language that is convenient for instrument programming.

For the example programs below, the device being programmed is located at GPIB device address 710. The actual address varies according to how you have configured the GPIB bus for your own application.

This first block of code shows how to reset the instrument, ask for the instrument ID, and check the system for errors.

```
10 OUTPUT 710; "*RST"                    ! reset the N4971A
20 OUTPUT 710; "*IDN?"                   ! request the instrument ID
30 ENTER 710; result$                    ! read the return
40 PRINT result$                         ! print the results to stdout
50 DIM $error [89]                       ! Dimension variable
60 OUTPUT 710; ":SYSTEM:ERROR?"          ! check for errors
70 ENTER 710; error$                     ! read the return
80 PRINT error$                          ! print the error
```

The next block shows how to save the instrument state in one of the save/recall registers (1-9), how to change the amplitude of the data output, save the previous instrument state into the register 1, and recall the saved the instrument state from save/recall register.

```
90 OUTPUT 710; ":GEN:DATA:LLEV:AMPL 1.2"  ! set the data output
amplitude=1.2V
100 OUTPUT 710; ":GEN:DATA:LLEV:AMPL?"    ! query the data output amplitude
110 ENTER 710; ampl$                      ! read the return
120 PRINT ampl$                           ! print the clock output amplitude
130 OUTPUT 710; "*SAV 1"                  ! save current instrument
                                            state in register 1
140 OUTPUT 710; "*RCL 1"                  ! recall the prior state
```

This section below shows how to work with the data outputs.

```
150 OUTPUT 710; ":GEN:OUTP ON"            ! set the data outputs ON
160 OUTPUT 710; " GEN:OUTP? "             ! query the output state
170 ENTER 710; out$                       ! read the return
180 PRINT out$                            ! print the output state of data
                                            outputs.
190 DIM $list [850]                       ! Dimension variable
200 OUTPUT 710; ":GEN:DATA:PATT:LIST?”    ! query the list of the pattern
                                            names stored in the memory.
210 ENTER 710; list$                      ! read the return
```

```
220 PRINT list$                          ! print the list of pattern
                                           names. The first element of the
                                           list is the total patterns in
      the                                  memory.
230 OUTPUT 710; ":GEN:DATA:PATT:NAME PRBS2^31”! set the pattern PRBS2^31 on
                                              the data output.
240 OUTPUT 710; " GEN:DATA:PATT:NAME?"       ! query the pattern.
250 ENTER 710; patt$                         ! read the return
260 PRINT patt$                              ! print the pattern

270 OUTPUT 710; ":GEN:DATA:PATT:NAME PN15_7_8.USR”! set the user defined
                                            pattern PRBS2^15 with the Mark
                                            space Density 0.875 (7/8).
280 OUTPUT 710; " GEN:DATA:PATT:NAME?"       ! query the pattern on the
                                            data output.
290 ENTER 710; pattern$                      ! read the return
300 PRINT pattern$                           ! print the pattern. The
                                            return should be PN15_7_8.USR.

310 OUTPUT 710; ":GEN:DATA:PATT:POL INV”     ! invert the pattern’s
                                            polarity.
320 OUTPUT 710; " GEN:DATA:PATT:POL?"        ! query the pattern’s
                                            polarity.
330 ENTER 710; pol$                          ! read the return
340 PRINT pol$                               ! print the pattern’s
                                            polarity.

350 OUTPUT 710; ":GEN:DATA:PATT:ERRI:MODE ON”! enable the error injection
                                             capability.
360 OUTPUT 710; " GEN:DATA:PATT:ERRI:MODE?"! query the state of error
                                             injection capability.
370 ENTER 710; errj$                         ! read the return
380 PRINT errj$                              ! print the state of error
                                             injection capability.

390 OUTPUT 710; ":GEN:DATA:PATT:ERRI:RATE 10^-7”! inject the error injection
                                             rate = 10^-7 into the data
                                             stream.
400 OUTPUT 710; " GEN:DATA:PATT:ERRI:RATE?"! query the injected rate of
                                             error injection.
410 ENTER 710; errrate$                      ! read the return
420 PRINT errrate$                           ! print the injected rate of
                                             error injection capability.

430 OUTPUT 710; ":GEN:DATA:PATT:ERRI:LEN 16”! set the burst length of the
                                             error injection = 16 bits.
440 OUTPUT 710; " GEN:DATA:PATT:ERRI:LEN?"! query the burst length of the
                                             injected error.
450 ENTER 710; errlen$                       ! read the return
460 PRINT errlen$                            ! print the burst length of
                                             the injected error.

470 OUTPUT 710; ":GEN:DATA:LLEV LVDS"        ! set the data output at
                                             logic LVDS
480 OUTPUT 710; ":GEN:DATA:LLEV?"            ! query the data output logic
                                             family
```

```
490 ENTER 710; log$                              ! read the return
500 PRINT log$                                   ! print the logic family

510 OUTPUT 710; ":GEN:DATA:LLEV:AMPL 0.55"! set the data output
                                                   amplitude=0.55V
520 OUTPUT 710; ":GEN:DATA:LLEV:AMPL?"           ! query the data output
                                                   amplitude
530 ENTER 710; am$                               ! read the return
540 PRINT am$                                    ! print the return

550 OUTPUT 710; ":GEN:DATA:LLEV:OFFS 0.1"        ! set the data offset=0.1V
560 OUTPUT 710; ":GEN:DATA:LLEV:OFFS?"           ! query the data offset
570 ENTER 710; off$                              ! read the return
580 PRINT off$                                   ! print the data output
                                                   offset voltage


590 OUTPUT 710; ":GEN:DATA:LLEV:TERM 1"          ! set the data output
                                                   termination
                                                   voltage = 1V
600 OUTPUT 710; ":GEN:DATA:LLEV:TERM?"           ! query the termination
                                                   voltage
610 ENTER 710; termination$                      ! read the return
620 PRINT termination$                           ! print the termination
                                                   voltage

630 OUTPUT 710; ":GEN:DATA:DEEM 15"              ! set the data output de-
                                                   emphasis
                                                   level = 15dB
640 OUTPUT 710; ":GEN:DATA:DEEM?"                ! query the de-emphasis value
650 ENTER 710; deemp$                            ! read the return
660 PRINT deemp$                                 ! print the de-emphasis value

670 OUTPUT 710; ":GEN:DATA:XOV 35"               ! set the data output cross-
                                                   over=35%
680 OUTPUT 710; ":GEN:DATA:XOV?"                 ! query the cross-over value.
690 ENTER 710; xo$                               ! read the return
700 PRINT xo$                                    ! print the cross-over value

710 OUTPUT 710; ":GEN:DATA:DEL 3.5"              ! set the data output delay
                                                   3.5UI
720 OUTPUT 710; ":GEN:DATA:DEL?"                 ! query the delay value
730 ENTER 710; del$                              ! read the return
740 PRINT del$                                   ! print the delay value
```

This block shows how to work with the full-rate clock.

```
750 OUTPUT 710; ":GEN:CLOC:MODE MAN”          ! set the clock frequency
                                              measurement to manual mode

760 OUTPUT 710; ":GEN:CLOC:MODE?”             ! query the clock mode
770 ENTER 710; mode$                          ! read the return
780 PRINT mode$                               ! print the clock mode
```

```
790 OUTPUT 710; ":GEN:CLOC:FREQ 10 GHz”      ! set the clock frequency 10
                                             GHz
800 OUTPUT 710; ":GEN:CLOC:FREQ?”            ! query the clock frequency
810 ENTER 710; freq$                         ! read the return
820 PRINT freq$                              ! print the clock frequency

830 OUTPUT 710; ":GEN:CLOC:MODE AUTO”        ! set the clock in auto mode

840 OUTPUT 710; ":GEN:CLOC:MODE?”            ! query the clock mode
850 ENTER 710; mode$                         ! read the return
860 PRINT mode$                              ! print the clock mode
870 OUTPUT 710; ":GEN:CLOC:FREQ?”            ! query the auto-detected
                                             frequency from auto mode

880 ENTER 710; freq$                         ! read the return
890 PRINT freq$                              ! print the clock frequency
```

This block shows how to set the logic family, amplitude, offset, and termination voltage for the full-rate clock output.

```
900 OUTPUT 710; ":GEN:CLOC:LLEV ECL"      ! set the clock at logic ECL
910 OUTPUT 710; ":GEN:CLOC:LLEV?"         ! query the clock logic family
920 ENTER 710; logic$                     ! read the return
930 PRINT logic$                          ! print the logic family, should
be ECL

940 OUTPUT 710; ":GEN:CLOC:LLEV:AMPL 1.5" ! set the clock output
amplitude=1.5V
950 OUTPUT 710; ":GEN:CLOC:LLEV:AMPL?"    ! query the clock output amplitude
960 ENTER 710; ampl$                      ! read the return
970 PRINT ampl$                           ! print the clock output amplitude

980 OUTPUT 710; ":GEN:CLOC:LLEV:OFFS -1"  ! set the clock offset=-1V
990 OUTPUT 710; ":GEN:CLOC:LLEV:OFFS?"    ! query the clock offset
1000 ENTER 710; offset$                   ! read the return
1010 PRINT offset$                        ! print the clock offset voltage

1020 OUTPUT 710; ":GEN:CLOC:LLEV:TERM -0.5"! set the clock termination=-0.5V
1030 OUTPUT 710; ":GEN:CLOC:LLEV:TERM?"   ! query the clock term
1040 ENTER 710; term$                     ! read the return
1050 PRINT term$                          ! print the clock termination
voltage

1060 OUTPUT 710; ":GEN:CLOC:LLEV?"        ! query the clock logic family
1070 ENTER 710; logic$                    ! read the return
1080 PRINT logic$                         ! the logic family should be
CUST(om)

1090 OUTPUT 710; ":GEN:CLOC:DEL -1.25"    ! set the clock delay at -1.25 UI
1100 OUTPUT 710; ":GEN:CLOC:DEL?"         ! query the clock delay
1110 ENTER 710; del$                      ! read the return
1120 PRINT del$                           ! print the return
```

This block shows how to set amplitude voltage and the divide ratio for the sub-rate clock output.

```
1130 OUTPUT 710; ":GEN:CLOC:DIVC:AMPL 0.5"    ! set the sub-clock output
                                               amplitude=0.5V
1140 OUTPUT 710; ":GEN:CLOC:DIVC:AMPL?"       ! query the sub-rate clock
                                               output amplitude
1150 ENTER 710; ampl$                          ! read the return
1160 PRINT ampl$                               ! print the return

1170 OUTPUT 710; ":GEN:CLOC:DIVC 127"         ! set the sub-clock output
                                               divide ratio 127
1180 OUTPUT 710; ":GEN:CLOC:DIVC?"            ! query the sub-rate clock
                                               divide ratio
1190 ENTER 710; div$                           ! read the return
1200 PRINT div$                                ! print the return
```

This block shows how to work with the trigger clock output.

```
1210 OUTPUT 710; ":GEN:TRIG CLK/256"          ! set the trigger output in
                                               divide mode.
1220 OUTPUT 710; ":GEN:TRIG?"                 ! query the state of trigger
                                               output
1230 ENTER 710; trmode$                        ! read the return
1240 PRINT trmode$                             ! print the return

1290 OUTPUT 710; ":GEN:TRIG PATT"             ! set the trigger output in
                                               pattern mode.
1300 OUTPUT 710; ":GEN:TRIG?"                 ! query the state of trigger
                                               output
1310 ENTER 710; trmode$                        ! read the return
1320 PRINT trmode$                             ! print the return. The value
                                               should be “PATT”.
```

This block shows how to work with the control settings.

```
1330 OUTPUT 710; ":GEN:CONT:AUX:SMA OFF"      ! disable the Aux IN SMA
                                               connector from the front
                                               panel.

1340 OUTPUT 710; ":GEN:CONT:AUX:SMA ADDE"     ! enable the Aux IN SMA
                                               connector from the front
                                               panel.

1360 OUTPUT 710; ":GEN:CONT:AUX:SMA?"         ! query the state of the AUX
                                               In.
1370 ENTER 710; auxin$                         ! read the return
1380 PRINT auxin$                              ! print the return

1390 OUTPUT 710; ":GEN:CONT:REF INT"          ! enable the internal 10 MHz
                                               reference source.
```

```
1400 OUTPUT 710; ":GEN:CONT:REF EXT"          ! the 10 MHz reference signal
                                              comes from an external
                                              source.
1410 OUTPUT 710; ":GEN:CONT:REF?"             ! query the state of the 10
                                              MHz reference source.
1420 ENTER 710; ref$                          ! read the return
1430 PRINT ref$                               ! print the return
```

6 Appendix A Preset State

The following settings are the default values after performing an instrument preset:

Table 24. Data settings preset state

Setting	Preset State
Data output	Off
Data amplitude	1.0 V
Data offset	0.00 V
Data termination voltage	0.00 V
Data logic level	Custom
Data test pattern	PRBS2^7
Pattern invert	Off
Error rate injection enable	Off
Error injection rate	10^-3
Error injection length	1
De-emphasis	00.0 dB
Dat crossover	50%
Data delay	00.00 UI

Table 25. Trigger settings preset state

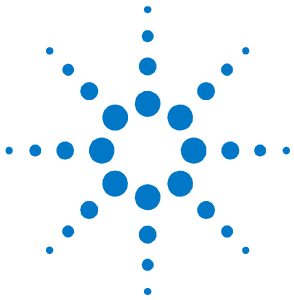
Setting	Preset State
Trigger mode	Divide

Table 26. Clock settings preset state

Setting	Preset State
Clock output	Off
Frequency mode	Auto
Clock delay	00.00 UI
Clock amplitude	1.00 V
Clock offset	0.00 V
Clock termination voltage	0.00 V
Clock logic level	Custom
Divided clock ratio	008
Divided clock amplitude	0.20 V

Table 27. Control settings preset state

Setting	Preset State
AUX in sma	Off
AUX in button	Off
10 MHz reference	Internal



7 Appendix B Workaround for Version 1.0

7.1 Error Condition Observed

GPIB interface hang during long pattern load

It has been observed with some GPIB drivers and/or workstation environments that issuing a GPIB query command while loading a long pattern may cause the GPIB interface to lock up. In this case, a power cycle is the only way to restore GPIB communications with the PPG.

Should this situation arise, be advised that ":GEN:DATA:PATT:NAME <long_pattern_name>;*OPC?" should not be used to load a long pattern in an automated test script.

In some instances, inserting a set command between the pattern load command and the query command will resolve the issue. Following are some workaround examples.

- Send the :GEN:DATA:PATT:NAME <long_pattern_name>;*WAI followed by the query :GEN:DATA:PATT:NAME?
- Send the :GEN:DATA:PATT:NAME <long_pattern_name>;*OPC followed by the query *ESR?

It is important to note that the query command timeout for an automated test script will begin as soon as the query command is sent. This will likely be immediately after the previous two set commands are sent. Therefore, timeout duration for the query command will need to encompass the total time of the pattern load plus the subsequent set command plus the time to execute and respond to the original query.

7.2 Error Condition Observed

The front panel AUX In and Output ON/OFF buttons are active while the PPG is in remote operation over GPIB.

Users need to be aware that while most user interface components on the instrument front panel are locked out while the PPG is under GPIB remote control, the AUX In and Output ON/OFF buttons remain active. Users must refrain from pushing these buttons while the instrument is in remote operation to keep from interfering with the intent of the remote testing.

7.3 Error Condition Observed:

Messages are written to the event log in response to valid instrument operations.

The users will observe messages accumulating in the event log under normal operating conditions. Below are the conditions with the logged results:

- At instrument power up
  Code# +2616
  REFCLK, LOS
  MM/DD/YY HH:MM:SS
- Change to the 10 MHz reference from internal to external, or visa-versa
  Code# +2616
  REFCLK, LOS
  MM/DD/YY HH:MM:SS
- Change to the frequency of the high speed clock input to the N4971A
  Code# +1916
  PHASE, LOS
  MM/DD/YY HH:MM:SS

It is recommended to review and clear the event log after setting up the N4971A for a given test, and then review and clear it again after the testing has completed. Events logged without the N4971A being exposed to the above conditions is an indication of a legitimate event.

7.4 Error Condition Observed:

Using :SYST:ERR:ALL? immediately following :SYST:PRES command results in the message: -100, “Command error”.

Adding *OPC? after :SYST:PRES resolves this issue.

7.5 Error Condition Observed:

Using the combination of *OPC;*ESR? does not work.

If it is desired to use these commands in succession, issue them as separate commands.

7.6 Error Condition Observed

Pressing the "RTL" softkey after communication with the instrument over GPIB has been initiated returns the display to a state with missing characters/details.

Navigating to any other display resolves the issue.

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