Keysight N4877A Clock Data Recovery and Demultiplexer 1:2

User's Guide

KEYSIGHT TECHNOLOGIES

Notices

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WARNING

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

Safety Summary

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.

Keysight Technologies 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.

Before Applying Power

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

Ground the Instrument

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

General

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

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

Environment Conditions

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

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

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.

ESD Sensitive Device

All front-panel connectors of N4877A are very sensitive to Electrostatic Discharge (ESD). We urgently recommend to operate the instrument in an electrostatic safe environment.

There is a high risk of instrument damage causing expensive repairs when connecting a not fully discharged device or cable to a front-panel connectors or when touching a connector.

Please follow these instructions:

Before connecting any coaxial cable to the connectors, short the center and outer conductor with ground.

Before touching the front-panel connectors discharge yourself by touching the properly grounded frame of the instrument.

Safety 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.

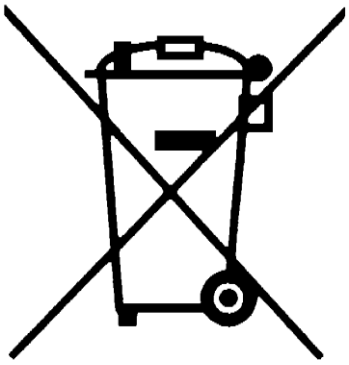
Notice for European Community: This product complies with the relevant European legal Directives: EMC Directive 89/336/EEC and Low Voltage Directive 73/23/EEC.

General Recycling Mark for plastic parts used in the product.

Safety requirements for electrical equipment for measurement, control, and laboratory use CAN/CSA C22.2 No. 1010.1 (1993) UL 3101, 3111 (First Editions). This equipment has also been evaluated to IEC 61010 edition 1 including amendments 1 and 2.

Conformity Mark of the Australian ACA for EMC compliance.

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 Keysight office, or see http://about.keysight.com/en/companyinfo/environment/takeback.shtml *for more information.*

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1 Introduction

Keysight N4877A

The N4877A is a clock data recovery with a 1:2 demultiplexer for the recovered data and an input data rate of up to 32 Gb/s.

Features and Benefits

Keysight N4877A has the following features and benefits:

- 1:2 demultiplexer with an output data rate of up to 16 Gb/s
- Small box, can be located closely to DUT
- Fully remote controllable
- Stand-alone user interface

Options Available

The N4877A has the following Options available:

- Option 100 – Electrical inputs
- Option 300 – Continuous adjustable loop bandwidth
- Option 216 – Maximum input data rate 16.5 Gb/s
- Option 232 – Maximum input data rate 32 Gb/s

The options 100 and 300 are always available in the N4877A.

What's inside this Manual

This manual provides detailed information about the following:

- N4877A Introduction
- Remote User Interface
- Remote Programming Reference
- Programming Basics

Purpose of this Manual

The purpose of this manual is to enable you to install, initialize, and start the N4877A.

Who should read this Manual

This manual is intended for testers and engineers who will be using the N4877A.

How this document is organized

This section provides information on the chapters, and their content.

Navigating this manual

Topic	What information does it contain?
Introduction	Introduces the N4877A, defines the purpose and intended audience of this manual; explains how information is organized in this manual and describes the N4877A remote user interface.
Remote User Interface	Describes the N4877A remote user interface.
Remote Programming Reference	Contains reference information to help you program the N4877A directly over the remote interface.
Programming Basics	Describes the various types of programming examples available for the N4877A and where to find them.

Conventions used in this manual

The following table lists the conventions used in this manual:

Conventions

The icon...	Indicates...
	A note or important information.
	A tip
	A caution or warning
	Notes within a table

---

Acronyms used in this manual

The following table lists the acronyms and abbreviations used in this manual:

Acronyms used in this document

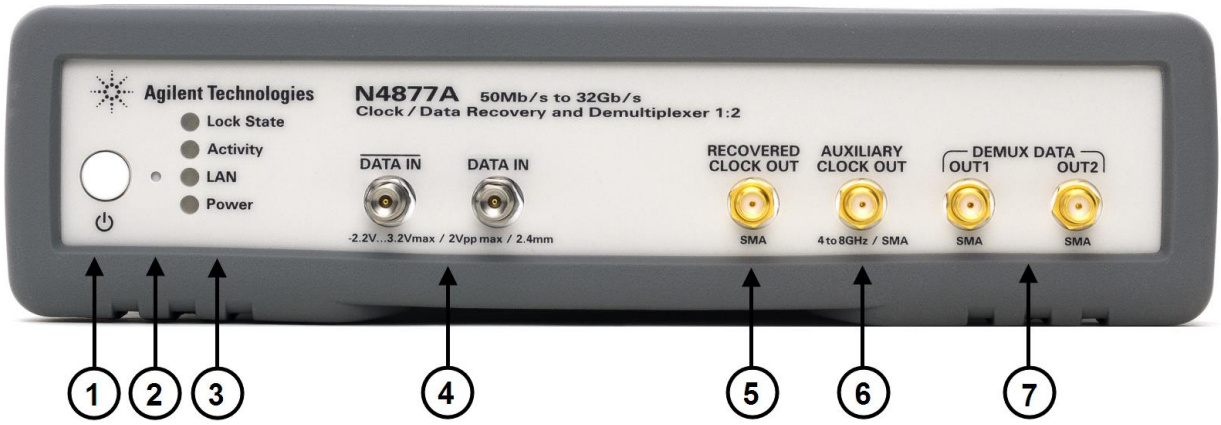
Acronym	Explanation
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Service
DUT	Device Under Test
GUI	Graphical User Interface
LAN	Local Area Network
LED	Light Emitting Diode
TCP/IP	Transmission Control Protocol/Internet Protocol
USB	Universal Serial Bus

1.1 Front Panel

Introduction

The N4877A is only operated remotely.

This section explains the Key, LEDs, Inputs and Outputs seen on the Front Panel of the N4877A.



1 Power Switch

2 Reset Button

3 Status LEDs

Lock State	Signals the lock state of the CDR Green when CDR is locked Red when CDR is unlocked
Activity	Flashes green when instrument is accessed on the remote interfaces Constantly orange during boot phase of the instrument
LAN	Constantly green when LAN is operable Constantly red when LAN is not operable Flashing green when device identification is enabled Constantly orange during boot phase of the instrument
POWER	Constantly orange when instrument is OFF (in power standby mode) Constantly green when instrument is ON (powered)

4 DATA IN / DATA IN

Non-Inverted data input

Inverted data input

Required input voltages for DATA IN and /DATA IN

- Max Input Voltage Window -2.2 V ... +3.2 V
- Max Amplitude 2.0 Vpp

5 RECOVERED CLOCK OUT

Recovered Clock Output

Electrical specification:

– Amplitude 350 mV (typ.)

– Termination 50 Ohm

6 AUXILIARY CLOCK OUT

Electrical specification:

– Sine wave in the range of 4 GHz to 8 GHz

– Termination 50 Ohm

7 DEMUX DATA OUT1

DEMUX DATA OUT2

Outputs of the 1:2 demultiplexer. The data stream provided at OUT1 and OUT2 can be swapped to allow processing of even/odd bits in the incoming data stream without the need to use 2-channels at the processing device, and to align the demultiplexed data with the expected data streams in case of a 2-channel device.

Electrical specification:

– Amplitude 350 mV (typ.)

– Termination 50 Ohm

– Single Ended, AC coupled

1.2 Rear Panel

Introduction

The rear panel contains:

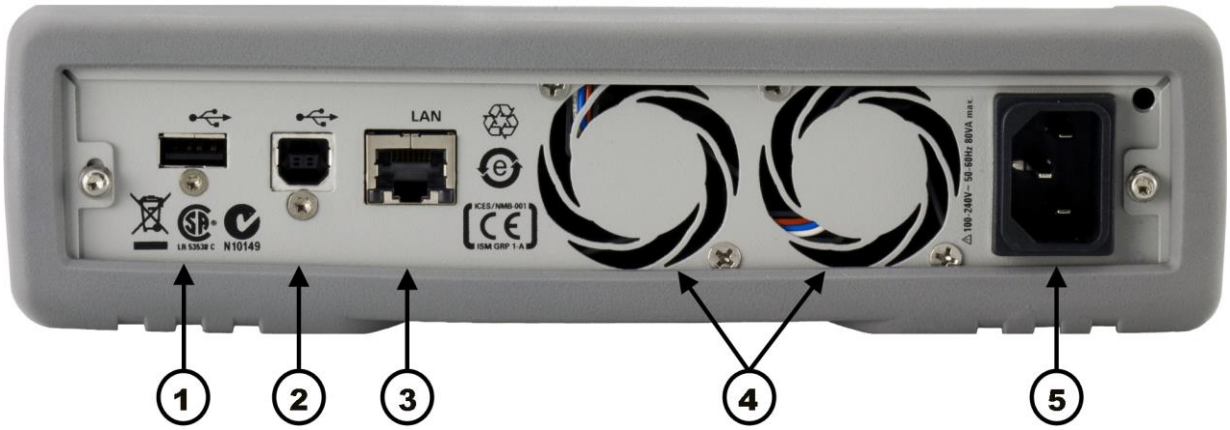
- USB device connector
- LAN connector

These are used for remote control of the instrument.

- Fan outlet for cooling the instrument
- Power Connection

A USB Host Connector is used to connect external USB storage device for recovery software updates.

The following figure shows the rear panel view of the N4877A.



1 USB Interface Connector (Host type for external mass memory)

2 USB Interface Connector (device type for remote programming)

3 LAN (10, 100 Mbps)

4 FAN outlet

5 Power Connector (100 – 240 V~ 50/60 Hz, 90 VA max.)

1.3 Use Models

For Jitter Tolerance Measurements it is recommended to use the automatic adjustment for the CDR's loop bandwidth (LBW) and peaking. This ensures the instrument uses the maximum LBW and minimum peaking.

N4877A allows manual adjustment of LBW and peaking. The minimum and maximum of the LBW and peaking is data rate dependent.

The clock recovery (JTF) loop bandwidth primarily determines how well the recovered clock tracks low-frequency jitter on the input signal. The accuracy of the LBW is ±30% typical.

Peaking adjustment determines the peaking characteristics of the Jitter Transfer Function.

1.3.1 Data Rate above 12.5 Gb/s

N4877A Clock Data Recovery and De-Multiplexer is used in combination with the J-BERT N4903B and M8061A or N4876A Multiplexer for receiver testing of high speed devices up to 28.4 Gb/s. The N4877A will recover required sub rate clocks and de-multiplexes the 28.4 Gb/s data stream enabling the
J-BERT Error Detector to measure a bit error ratio during a receive sensitivity or jitter tolerance test.

Application Example

Receiver Testing with J-BERT N4903B High-Performance Serial BERT for FCx32

Cable Connection

1. Connect RECOVERED CLOCK OUT (3.5 mm) to N4903B Error Detector CLK IN (3.5 mm) using the cable (N4877-61610).
2. Connect DEMUX DATA OUT1 or OUT2 (3.5 mm) with the N4903B Error Detector DATA IN (2.4 mm) using the cable (N4877-61610).

J-BERT Error Detector Setup

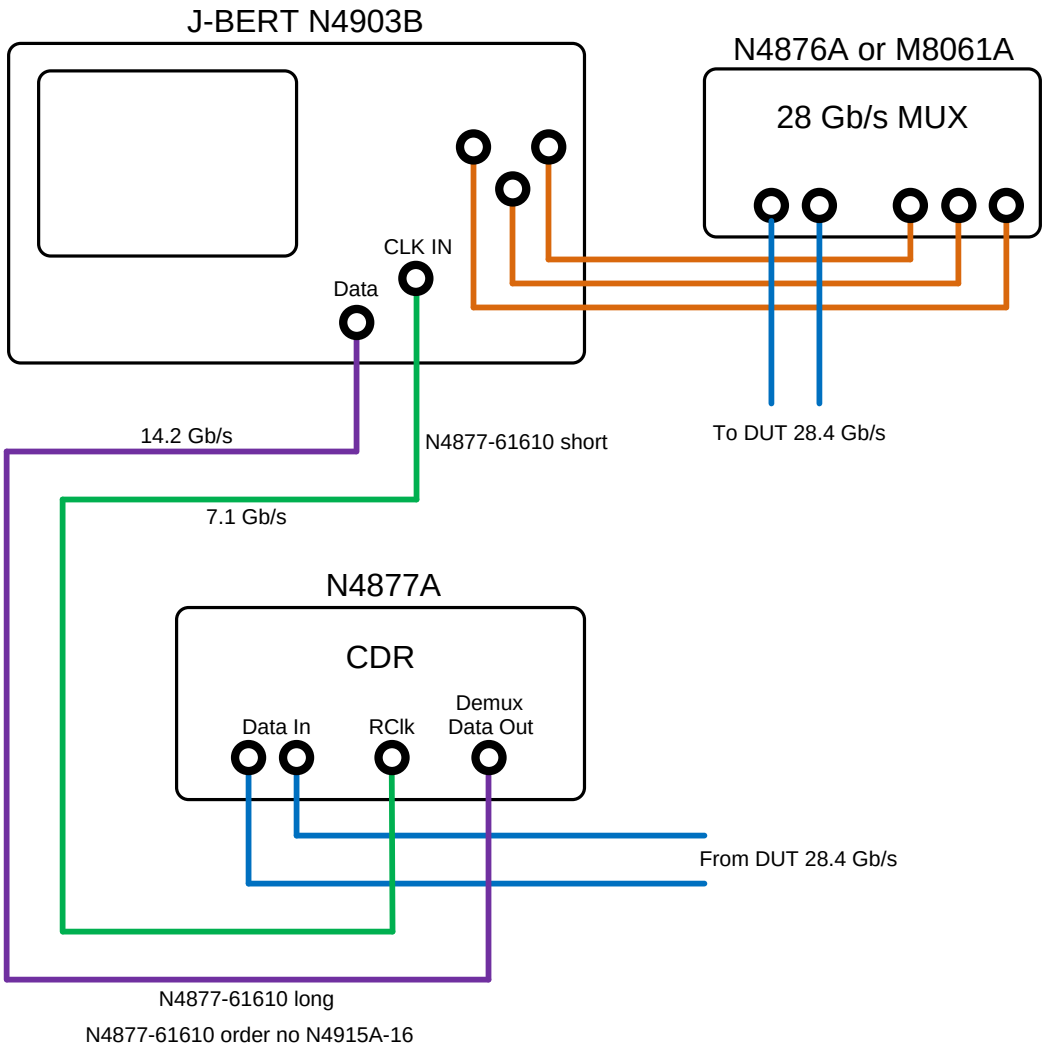
1. Set clock input source to external.
2. Set thresholds to 0.
3. Set data input to single ended normal input.
4. Use auto align for sampling point adjust.

In case of using memory based patterns the expected pattern will show up either at the even or odd bits output of the de-multiplexer of N4877A. This can change when relocking the clock data recovery. Therefore it might be necessary to switch between even and odd data output in order to provide the correct pattern to J-BERT - ED input.

Clock Divider Settings

Above 12.5 Gb/s, the J-BERT will do sub-rate sampling for:

- Data rates equal or lower 25 Gbit/s set the clock divider to 2 - half rate sampling
- Data rates above 25 Gbit/s set the clock divider to 4 - quarter rate sampling


J-BERT N4903B
N4876A or M8061A
28 Gb/s MUX
CLK IN
Data
14.2 Gb/s
N4877-61610 short
To DUT 28.4 Gb/s
7.1 Gb/s
N4877A
CDR
Data In
RClk
Demux
Data Out
From DUT 28.4 Gb/s
N4877-61610 long
N4877-61610 order no N4915A-16

1.3.2 Data Rate up to 12.5 Gb/s

N4877A Clock Data Recovery and De-Multiplexer are used in combination with the J-BERT N4903B for receiver testing of high speed devices up to 12.5 Gb/s. The DUT connects Clock Data Recovery and the Error Detector of the J-BERT with the help of Pick Offs.

Cable Connection

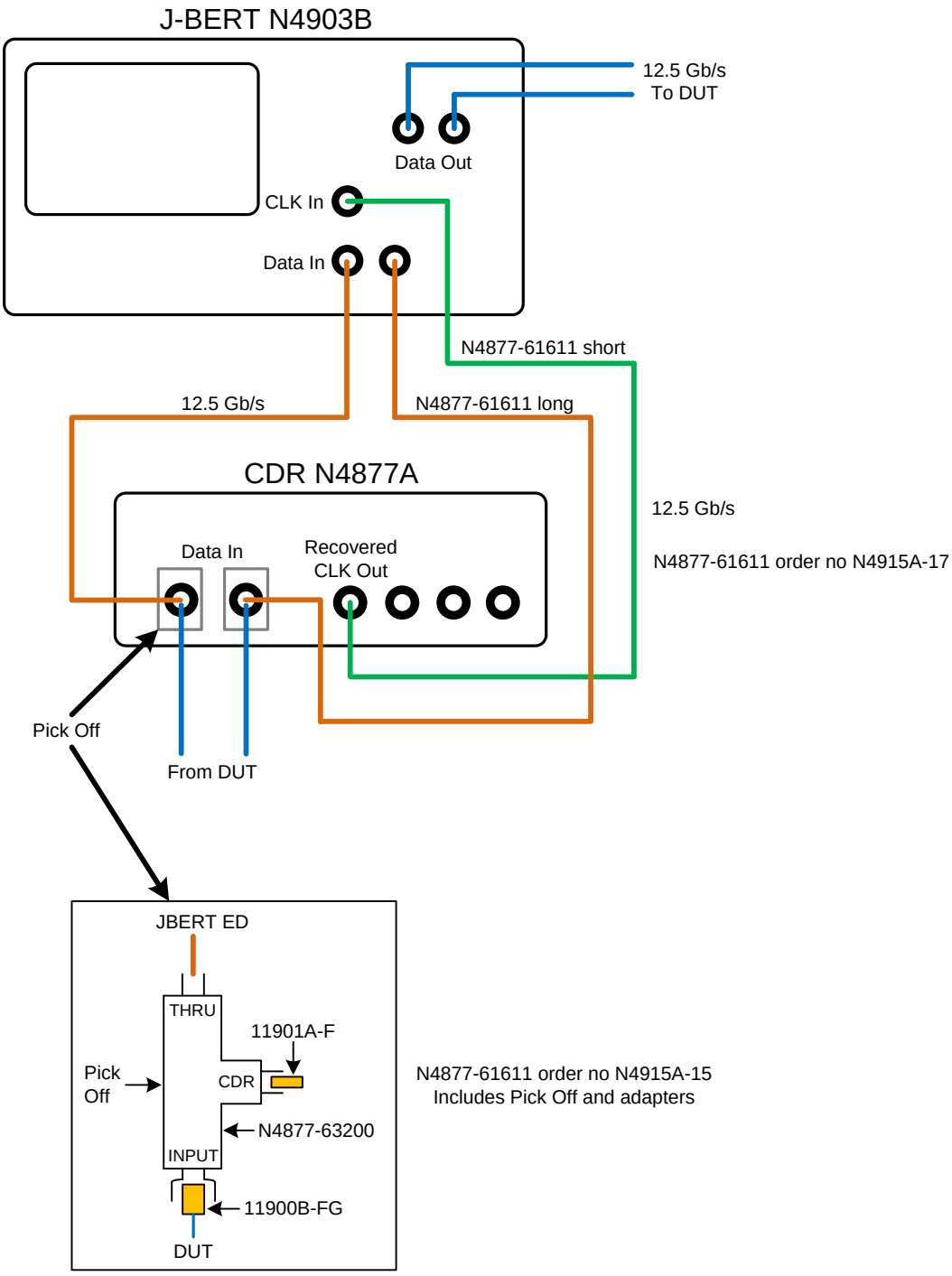
1. Connect RECOVERED CLOCK OUT (3.5 mm) to error detector CLK IN (3.5 mm) with the short cable (N4877-61611).
2. Connect each PICK OFF (N4877-63200) CDR output (3.5 mm) with the adapter (11901A-F) to N4877A DATA IN and DATA IN Inverse (2.4 mm).
3. Connect each PICK OFF (N4877-63200) THRU output (2.4 mm) with cable (N4877-61611) to N4903B Error Detector DATA IN and DATA IN Inverse (2.4 mm).
4. Use matched cables (e.g. N4910A) and adapters (11900B-FG) to connect the INPUT's (2.4 mm) of both PICK OFF's (N4877-63200) with the DUT.

J-BERT Error Detector Setup

1. Set clock input source to external.
2. Set thresholds to 0.
3. Set data input to differential input.
4. Use auto align for sampling point adjust.

Clock Divider Settings

In this setup the J-BERT's Error Detector directly compares the received bits and not the de-multiplexed data outputs of the N4877A. This requires that the ED clock input frequency matches the full data rate of the DUT. To achieve this, set the clock out divider to “1”.


J-BERT N4903B
12.5 Gb/s
To DUT
Data Out
CLK In
Data In
N4877-61611 short
12.5 Gb/s
N4877-61611 long
CDR N4877A
12.5 Gb/s
N4877-61611 order no N4915A-17
Data In
Recovered
CLK Out
Pick Off
From DUT
JBERT ED
THRU
11901A-F
Pick
Off
CDR
N4877-63200
INPUT
11900B-FG
DUT
N4877-61611 order no N4915A-15
Includes Pick Off and adapters

2 Remote User Interface

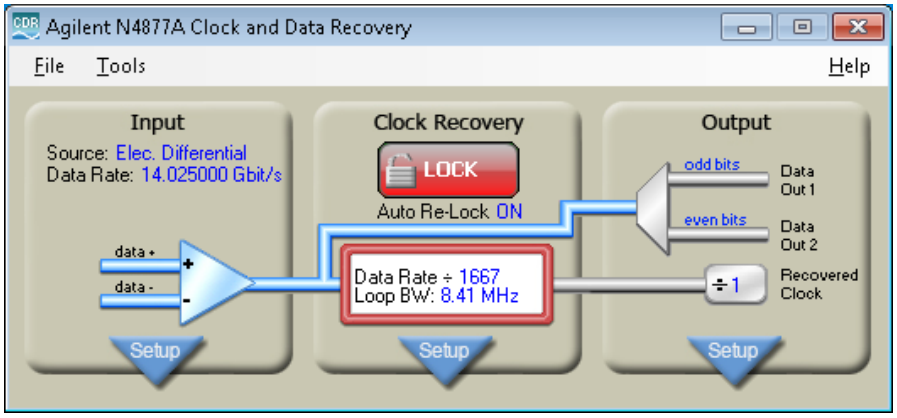
2.1 Introduction

This chapter describes the N4877A remote user interface.

The remote user interface automatically installs the correct firmware revision on the instrument.

The remote user interface does not accept any other firmware version than the one that is installed together with the remote GUI.

On launching the N4877A application, the remote user interface will appear as shown in the figure, below.



The N4877A remote user interface includes the following elements:

- Standard Windows minimize and close icons
- Menu Bar
- CDR Window

Note: If you click on minimize button, the N4877A remote user interface will reduce to an overlay Lock button displaying the CDR Lock Status. Double-clicking the Lock button will restore the remote user interface, back to its normal state.

2.2 Menu Bar

The menu bar provides the *File*, *Tools* and *Help* options.

2.2.1 File Menu

The *File* menu contains the following entries:

Preset Instrument State	Brings back the instrument to factory settings.
Recall Default Instrument State	Brings back the instrument to the default settings saved by the user.
Open	Opens a valid instrument state.
Save	Saves the current instrument state
Save As Default Instrument State	Saves the current instrument state as default instrument state.
Exit	Closes the N4877A remote user interface.

2.2.2 Tools Menu

The *Tools* menu contains the following entries:

Diagnostics	Opens the "Diagnostics" window with contains following buttons: – **Power-On Errors:** Displays the power-on self-test results on the Diagnostic window. – **Execute Self-Test:** Displays self-test results on the Diagnostic window. – **Execute Self-Calibration:** Displays self-calibration test results on the Diagnostic window. – **Export Results:** Exports the diagnostics results as an XML file.
Network Configuration	Opens a "Network Configuration" dialog which allows you to apply network configuration settings (IP Address, DNS Server WNS Server).
Device Identification	Allows you to turn the device identification either ON or OFF. When device identification is ON, the LAN LED will start blinking in green color to identify the device. If the device identification is OFF, the LAN LED will not blink but instead show the current connection status of the LAN port.

Option	Opens an "Option" window which allows you to change the connection and keyboard settings. It has the following entries: – **Instrument State Directory:** Defines the default directory for storing/recalling instrument states. – **User Defined Default State:** Display the user defined default instrument state. – **Connection Mode:** Allows you to select whether the application should automatically connect to the last used instrument or connect interactively. – **Connection Action:** Allows you to select the action you want to take whenever the connection is established with the instrument. – **On-Screen Keyboard:** Enable/disable the on screen keyboard. When enabled, the on screen keyboard will launch when the user clicks in a text box which needs an entry from keyboard like the file name while saving a state.

2.2.3 Help Menu

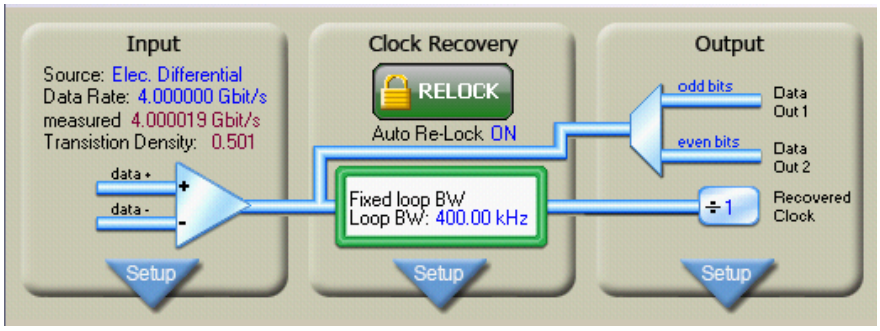
The *Help* menu contains the following entries:

User Guide	Launches the N4877A User's Guide (PDF).
About	Provides information about the version and options of the instrument.

2.3 CDR Window

CDR Window

The *CDR Window* contains the *Input*, *Clock Recovery* and *Output* tabs as shown in the figure, below.

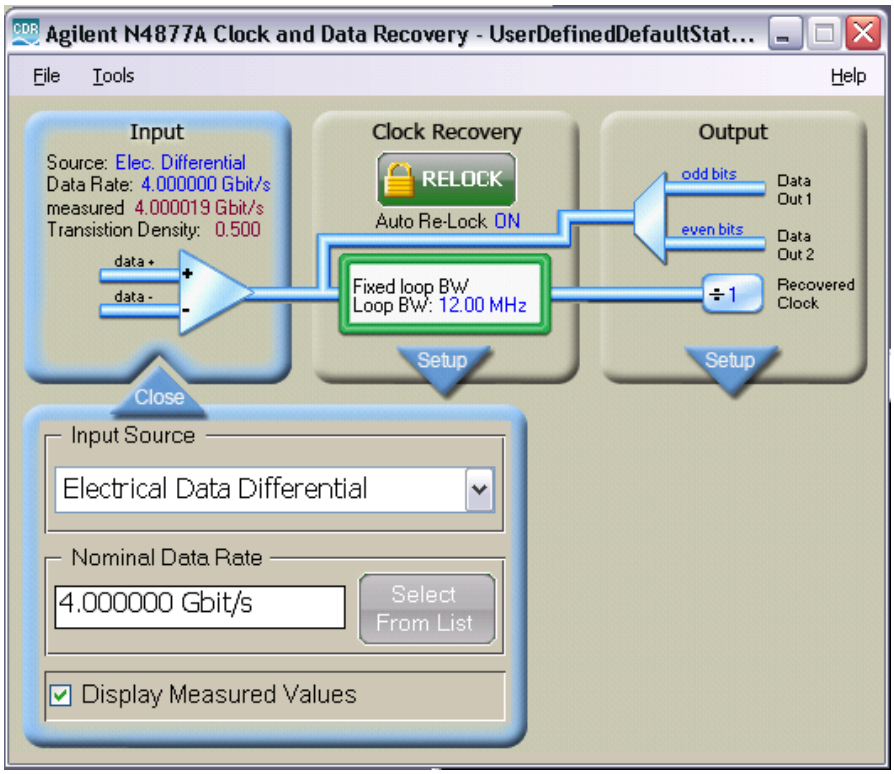


Below each tab there is a "Setup" button which opens a setup dialog linked with these tabs. The settings performed in these dialogs will be displayed in the respective tab.

You can click on "Close" button in order to close the respective dialog.

2.3.1 Input Dialog

The "Input" dialog is shown in the figure, below.



It contains the following elements:

- **Input Source:** Use the drop down list to select the input source.
- **Nominal Data Rate:** Click on the text-box, a dialog box pops up which allows you to enter the value for Nominal Data Rate. You can also select the Data Rate from the predefined list. To do so, click "Select From List" button, it will open a "Predefined Settings" dialog. Using this dialog, you can add/delete entries to/from the list. You can also reset the list to bring it back to its original state.

Note: Using the "Predefined Settings" dialog, you can only delete the user-defined values. Make sure to press "OK" once you add or delete any entry or reset the list.

- **Display Measured Values:** Select this checkbox to display the measured values of transition density and date rate.

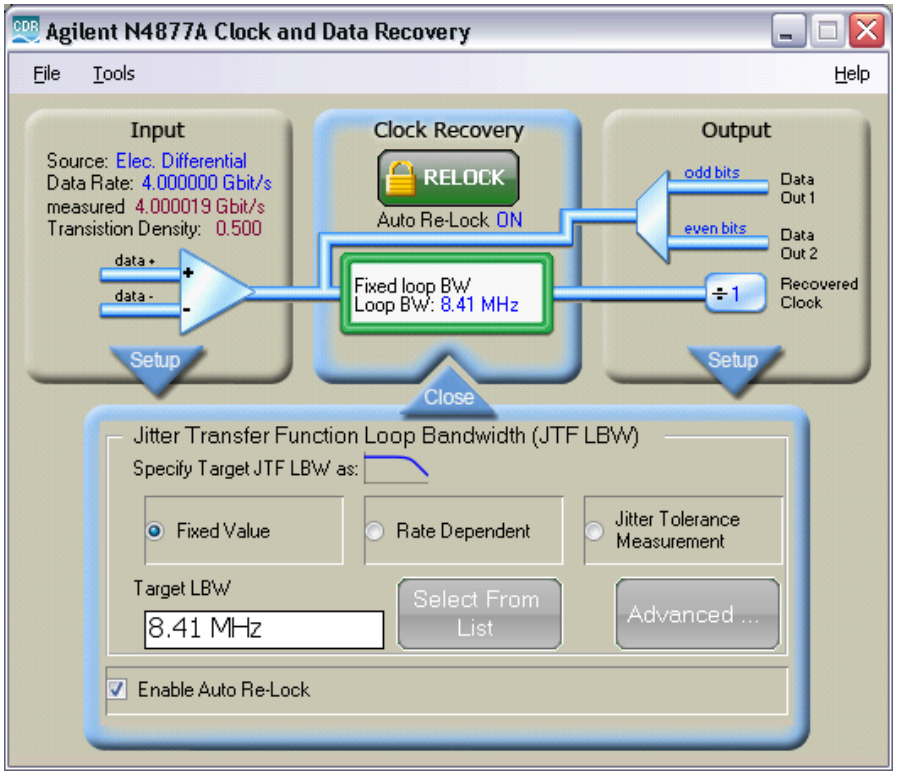
Note: The measured values are only correct when the CDR is in locked state.

Note: The settings performed in this dialog will be displayed in the Input tab.

2.3.2 Clock Recovery Dialog

Clock Recovery Dialog

The "Clock Recovery" dialog is shown in the figure, below.



It contains the following elements:

- **Jitter Transfer Function Loop Bandwidth (JTF LBW):** Use the radio button to specify Target JTF LBW among Fixed Value, Rate Dependent and Jitter Tolerance Measurement.

  (For detailed information on JTF LBW and Jitter Tolerance Measurement, refer to N4903B User's Guide.)

Fixed Value: For Fixed Value, you have to specify the value for Target LBW. Click on the text-box, a dialog box pops up which allows you to enter the value for Target JTF LBW. You also can select the Target LTF LBW from the predefined list (which is empty by default, user can create his entries to populate the list). To do so, press "Select From List", it will open a "Predefined Settings" dialog. Using this dialog, you can add/delete entries to/from the list. You can also reset the list to bring it back to its original state.

Note: Using the "Predefined Settings" dialog, you can only delete the user-defined values. Make sure to press "OK" once you add or delete any entry or reset the list.

Rate Dependent: For Rate Dependent, you have to specify the value for Data Rate Divider. Click on the text-box, a dialog box pops up which allows you to enter the value for Data Rate. When this option is selected the loop bandwidth is calculated as data rate/ data rate divider.

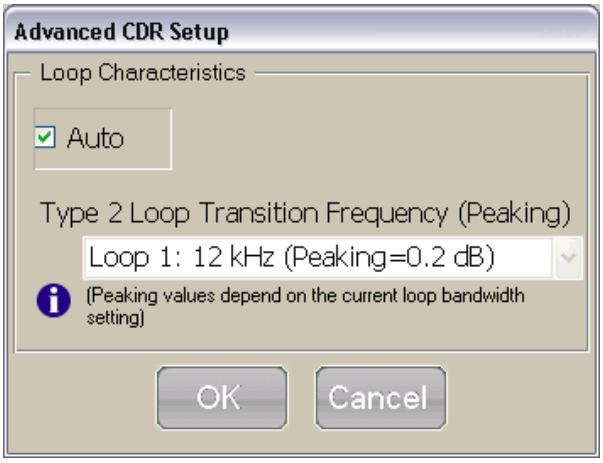
Note: Loop bandwidth and Data Rate Divider range depends upon the current value of data rate

Jitter Tolerance Measurement: For Jitter Tolerance Measurements it is recommended to use the automatic adjustment for the CDR's loop bandwidth (LBW) and peaking. This ensures the instrument uses the maximum LBW and minimum peaking.

- **Enable Auto-Lock:** Select this checkbox to enable/disable the Auto Re-Lock feature.

Note: The settings performed in this dialog will be displayed in the "Clock Recovery" tab

Click “Advanced...” to open the “Advanced CDR Setup” dialog. Using this dialog, you can the set the value of peaking from the available list of values.

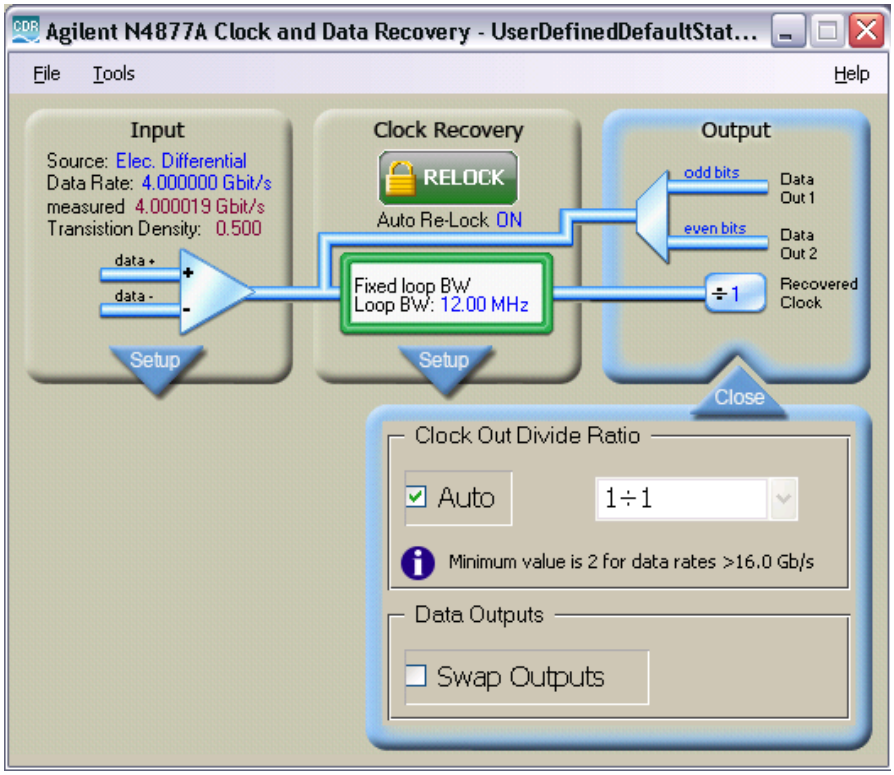


Select the “Auto” checkbox to set the peaking automatically.
You can also use the drop down list to set the peaking manually provided that the “Auto” checkbox is not selected.

Note: The dropdown list for selecting the peaking will only be enabled when the “Auto” checkbox is unselected.

2.3.3 Output Dialog

The "Output" dialog is shown in the figure, below.



It contains the following elements:

- **Clock Out Divide Ratio:** The clock out divide ratio can be set either automatically or manually.
  Select the "Auto" checkbox to set the clock out divide ratio automatically.
  You can also use the drop down list to set the clock out divide ratio manually provided that the "Auto" checkbox is not selected.
  The available settings for Clock Out Divide Ratio depend on the current data rate setting. The maximum clock frequency at the Recovered Clock output is 16.0 GHz.

Note: The dropdown list for selecting the clock out divide ratio will only be enabled when the "Auto" checkbox is unselected.

- **Data Outputs:** Select the “Swap Outputs” checkbox in order to swap the outputs at data output (Data Out 1 and Data Out2).

Note: The assignment of the incoming bits to the Data Out connectors cannot be predicted, and can change whenever the CDR is losing locked state.

This needs to be considered in the test application when measuring patterns with a sequence length that is having an even number of bits.

Swapping the Data Out 1 and Data Out 2 bit-streams can be used to compensate a phase shift that was caused by an unlocked clock without the need of rewiring the test setup.

Keep in mind that setups which process the recovered data with less than half the input data rate can see any bit-wise shifts of the recovered data at the data outputs. In this case the expected pattern needs to be exchanged against the suitable sub-rate bit sequence.

Note: The settings performed in the "Output" dialog will be displayed in the “Output” tab.

Attention:

Error free operation of the remote GUI can only be guaranteed, if there is no other remote program using the same VISA resource string!

- The remote GUI is locking the VISA resource when connecting to the instrument, so that it is impossible to use the same resource string (remote interface) with another program.
- The locking mechanism cannot prevent having multiple sessions on TCP/IP sessions. As a result of this, it is not recommended to connect on the TCP/IP remote interface.
- When running the remote GUI and a remote test program at the same time, then the remote GUI shall use the USB interface, while the remote test program shall use the TCP/IP interface.

---

3 Remote Programming Reference

Introduction

This chapter provides general information on writing SCPI programs for the N4877A.

3.1 Keysight N4877A Remote Control

Introduction

The Keysight N4877A provides remote control via USB and LAN.

USB

The USB interface requires no configuration. Just connect your Keysight N4877A to your PC using a standard USB cable and the interface will self-configure.

LAN

There are several parameters that you may need to set to establish network communication using the LAN interface. Primarily, you will need to establish an IP address. You may need to contact your network administrator for help in establishing communication with the LAN interface. The LAN interface usually configures itself due to the enabled DHCP mode. In this case all that needs to be done is querying the current IP address using the SCPI command

```
:SYST:COMM:LAN?
```

If a reconfiguration of the LAN interface is required, this has to be done using the corresponding SCPI commands over the USB interface.

3.1.1 Programming Recommendations

Recommendations for programming the N4877A

This section lists some recommendations for programming the instrument.

- Start programming from the default setting. The common command for setting the default setting is:

*RST

- The SCPI standard defines a long and a short form of the commands. For fast programming speed it is recommended to use the short forms. The short forms of the commands are represented by upper case letters. For example the short form of the command to set the continuous loop bandwidth to 10MHz is:

:CREC:CLB 10MHZ

- To improve programming speed it is also allowed to skip optional subsystem command parts. Optional subsystem command parts are depicted in square brackets, e.g.: Set amplitude to 0.5V
  `[:SOURce]:VOLTage[1][:LEVel][:IMMediate][:AMPLitude] 0.5V`
  Sufficient to use:

```
:VOLT 0.5V
```

- Selftest of the instrument can be invoked by the common command.

*TST?

- If it is important to know whether the last command is completed then send the common command.

*OPC?

3.2 N4877A SCPI Command Summary

Calibration Commands

Command	Parameter	See Page
:CALibration		
[:ALL]?		39

Data Rate Commands

Command	Parameter	See Page
:CRECovery[1]		
:RATE[?]	R155 | R622 | R1062 | R1250 | R2125 | R2488 | R2500 | R2666 | R9953 | R10312 | R10664 | R10709	42
:CRATe[?]	<NR3> | MIN | MAX	43

Loop Bandwidth Commands

Command	Parameter	See Page
:CRECovery[1]		
:LBANdwidth[?]	BW270KHZ | BW300KHZ | BW1500KHZ | BW4MHZ | CONTinuous	44
:RDIVider[?]	<NR1> | MIN | MAX	45
:CLBandwidth[?]	<NR3> | MIN | MAX	46
:LBWMode[?]	FIXed | RDEPendent | JTOLerance	47

Peaking Commands

Command	Parameter	See Page
:CRECovery[1]		
:LSELect[?]	LOOP1 | LOOP2 | LOOP3 | LOOP4	48
:LSELect		
:AUTomatic[?]	0 | 1 | OFF | ON	50
:PEAKing?		51
:T2TFrequency?		52

Locking Commands

Command	Parameter	See Page
:CRECovery[1]		
:ARELock[?]	0 | 1 | OFF | ON	53
:ARELock:STATe?		54
:ARELock:CANCel		55
:LOCKed?		57
:RELock		57

Input Source Commands

Command	Parameter	See Page
:CRECovery[1]		
:INPut[?]	ELECtrical | DIFFerential | EINVerted	58

Frequency to Transition Density Commands

Command	Parameter	See Page
:CRECovery[1]		
:CFRequency?	[<NR1>]	59
:TDENsity?		60

Clock Out Divide Ratio Commands

Command	Parameter	See Page
:CRECovery[1]		
:ODRatio[?]	-8 | -4 | -2 | 1 | 2 | 4 | 8 | 16 | 32	61
:ODRatio		
:AUTO[?]	0 | 1 | OFF | ON	62

Data Output Mode Commands

Command	Parameter	See Page
:CRECovery[1]		
:OUTPut		
:DMODe[?]	NORMal | SWAPped	63

System Related Commands

Command	Parameter	See Page
:SYSTem		
:COMMunicate		
:LAN		
:DGATeway[?]	"nnn.nnn.nnn.nnn"	71
:DHCProtocol[?]	0 | 1 | OFF | ON	72
:DNServer[1|2][?]	"nnn.nnn.nnn.nnn"	73
:DOMain?		74
:HOSTname[?]	"<hostname>"	75
[:IPADress][?]	"nnn.nnn.nnn.nnn"	76
:MACaddress?		77
:SNMask[?]	"nnn.nnn.nnn.nnn"	79
:ERRor?		80
:HELP		
:HEADer?		81
:LXI		
:IDENtify[?]	0 | 1 | OFF | ON	83
:SET[?]	<block data>	85
:TEST?	PON | NORMal | ALL	86
:VERSion?		87
:WARNing?		88
:BUFFer?		89
:STRing?		90

3.3 Common Command Summary

Command	Parameter	Description
*CLS		Clear the Status Structure
*CAL?		Start Instrument's Self-calibration
*ESE[?]	<NR1>	Standard Event Status Register
*ESR?		Standard Event Status Event Register
*IDN?		Instrument's Identification
*LRN?		Complete Instrument Setting
*OPC		Operation Complete
*OPC[?]		Return 1
*OPT?		Installed Options
*PSC[?]		Power On Status
*RST		Reset
*SRE[?]		Service Request Enable Mask
*STB?		Status Byte
*TST?		Start Instrument's Self-tests
*WAI		Wait until all pending actions are complete

3.4 N4877A SCPI Instrument Command List Format

Introduction

The following reference sections list the instrument commands in alphabetical order. In addition to a command description, the attributes of each command are described under the following headings. Not all of these attributes are applicable to all commands. The commands are conform to the IEEE 488.2 SCPI standard.

The following table presents some of the most common <suffix names> elements used while referring to some units in the instrument.

Command	Shows the short form of the command
Long	Shows the long form of the command
Parameter	The type of parameter, if any, accepted by the command. The minimum and maximum value of numeric parameters can be accessed by the option MINimum or MAXimum.
Parameter Suffix	The suffixes that may follow the parameter.
Description	A detailed description of what the command does.
Example	Example programming statements

3.5 N4877A SCPI Instrument Elements Name

Introduction

The following table presents some of the most common <suffix names> elements used while referring to some units in the instrument. The following table gives both, the short name and its expanded name for the most commonly used units.

Element	Expanded Name
DB	Decibel
DEG	Degree
HZ	Hertz
OHM	Ohm
PCT	Percent
RAD	Radian
S	Seconds
V	Volt

3.6 Calibration Commands

Introduction

The SCPI CALibration subsystem controls the built in semi-automatic input timing calibration of N4877A.

3.6.1 Calibration Commands

Command	:CAL?
Long	:CALibration[:ALL]?
Parameters	–
Parameter Suffix	–
Description	Perform the CDR calibration. The return value is 0 when the calibration has been successful, otherwise it is 1.
Example	Query calibration status :CAL? Response 0

3.7 Clock Recovery Subsystem

Introduction

The Clock RECovery (CREC) subsystem commands control the clock recovery. This includes setting data rates, as well as querying locked status and signal present conditions.

The N4877A Clock Recovery is designed to be command compatible with the Keysight 83496D modules of the Keysight 86100A/B/C/D Wide-Bandwidth Oscilloscope.

The Keysight N4877A provides electrical clock recovery selected by the INPut command. It has continuous, unbanded tuning from 50 Mb/s to 32 Gb/s. Specify the data rate with the CRATe command. Although the N4877A accepts the RATE command for compatibilty with existing programs, it is recommended that you use the CRATe command.

The N4877A does provide automatic locking, but you must issue the RELock command to establish lock and to reestablish lock whenever a setup parameter changes when automatic re-lock is disabled (for example input port or trigger on data), the data rate changes, or the signal parameters change (for example, edge density). Use the LOCKed? query to determine if the module is locked on the signal. If the module loses lock, the outputs become asynchronous with the data. Use the TDENsity query to return the edge density of the data signal.

The N4877A has four loop bandwidth settings that are selected using the LBANdwidth command. The high bandwidth setting is 4 MHz. You can specify any loop bandwidth between the range of 15 kHz to 20 MHz using the CLBandwidth command. Or use the LBWMode command to configure the module to automatically select the loop bandwidth based on data rate and data- rate divide ratio (RDIVider command). Use the ODRatio and ODRatio:AUTO commands to specify the divide ratio that is applied to the Recovered Clock Output.

3.7.1 Data Rate Commands

Command :CREC:RATE[?]

Long :CRECovery[1]:RATE[?]

Parameters R155 | R622 | R1062 | R1250 | R2125 | R2488 | R2500 | R2666 | R9953 | R10312 | R10664 | R10709

Parameter Suffix –

Description This command sets the clock recovery's data rate. RATE parameters are nominal and reflect front-panel labels and not actual data rates. Although this command will work with then N4877A, programs should use the command "CRATe" on page 43.

CONTinuous is returned whenever the data rate is not one of the standard values set using the CRECovery:RATE command. If the CONTinuous argument is returned, use the CRECovery:CRATE command to query the actual value. Refer to "CRATe" on page 43.

Example

Set data rate to 2.488 Gb/s

:CREC:RATE R2488

Query data rate

:CREC:RATE?

Response

R2488

Command	:CREC:CRAT[?]
Long	:CRECovery[1]:CRATe[?]
Parameters	<NR3> | MIN | MAX
Parameter Suffix	HZ
Description	This command sets or queries the data rate setting. Although the command "RATE" on page 42 can be used, use the preferred CRATe command in all new programs. The data rate ranges from 50 Mb/s to 32.0 Gb/s. The default data rate is 14.025 Gb/s.
Example	Set the data rate to 6.4 Gb/s :CREC:CRAT 6.4e9 Query the data rate :CREC:CRAT? Response 6.4e9

3.7.2 Loop Bandwidth Commands

Command :CREC:LBAN[?]

Long `:CRECovery[1]:LBANdwidth[?]`

Parameters `BW270KHZ | BW300KHZ | BW1500KHZ | BW4MHZ | CONTinuous`

Parameter Suffix –

Description Sets the loop bandwidth to the given value. The default setting is `CONTinuous` (default setting for CLBandwidth is 8.41 MHz). The `CONTinuous` argument can be returned in queries but cannot be sent in a command string. `CONTinuous` is returned whenever the loop bandwidth is set to a value other than the `LBANdwidth` standard values. When the `CONTinuous` argument is returned, use the `CLBandwidth` command to query the actual value. Refer to "`CLBandwidth`" on page 46.

Example

Set the loop bandwidth to 4 MHz

```
:CREC:LBAN BW4MHZ
```

Query loop bandwidth being used

```
:CREG:LBAN?
```

Response

```
BW4MHZ
```

Command :CREC:RDIV[?]

Long `:CRECovery[1]:RDIVider[?]`

Parameters `<NR1> | MIN | MAX`

Parameter Suffix –

Description This command sets or queries the data-rate divide ratio. This value is used to compute loop bandwidth when in the rate- dependent loop bandwidth mode. Refer to the `RDIVider` argument of the command "`LBWMode`" on page 47. The default value is 1667.

Example

Set data rate divider ratio to 4500

```
:CREC:RDIV 4500
```

Query data rate divider ratio

```
:CREC:RDIV?
```

Response

```
4500
```

Note The valid range of RDIV depends on the bandwidth limits at the current data rate.

Command :CREC:CLB[?]

Long `:CRECovery[1]:CLBandwidth[?]`

Parameters `<NR3> | MIN | MAX`

Parameter Suffix HZ

Description This command sets or queries the module's loop bandwidth. You must issue the `LBWMode FIXed` command before using the `CLBandwidth` command. If the module's loop bandwidth mode is set to rate dependant (RDEPendent) or Jitter Tolerance Measurement (JTOLerance), then setting the module's loop bandwidth will be ignored. Refer to "`LBWMode`" on page 47. Loop bandwidth can be any bandwidth within 15 kHz to 20 MHz. The default setting is 8.41 MHz.

Example Set the loop bandwidth to 1.7 MHz

```
:CREC:CLB 1.7MHZ
```

Query the loop bandwidth

```
:CREC:CLB?
```

Response

```
1.7e6
```

Command :CREC:LBWM[?]

Long `:CRECovery[1]:LBWMode[?]`

Parameters `FIXed | RDEPendent | JTOLerance`

Parameter Suffix –

Description This command sets or queries the module's loop bandwidth entry mode. When `FIXed` is specified, the loop bandwidth value can be entered using the `CLBandwidth` command. When `RDEPendent` (rate dependent) is specified, the loop bandwidth is indirectly set by the data rate and the data rate divide ratio (`RDIVider` command). The loop bandwidth cannot be entered when the module is in the `RDEPendent` mode. When `JTOLerance` is specified, the CDR automatically uses the maximum possible loop bandwidth setting and the minimum peaking.

`JTOLerance` is recommended for Jitter Tolerance Measurements as it automatically uses the appropriate settings for the CDR's loop bandwidth (LBW) and peaking for most setups. If there is the need to optimize the loop characteristics then use either `FIXed` or `RDEPendent` and select the loop bandwidth setting and peaking as required.

Example Set loop bandwidth mode to fixed

```
:CREC:LBWM FIX
```

Query the loop bandwidth mode

```
:CREC:LBWM?
```

Response

```
FIX
```

3.7.3 Peaking Commands

Command :CREC:LSEL[?]

Long :CRECovery[1]:LSELect[?]

Parameters LOOP1 | LOOP2 | LOOP3 | LOOP4

Parameter Suffix –

Description This command selects the Type- 2 loop transition frequency (peaking)

- LOOP1 selects 12 kHz (available for all loop bandwidths)
- LOOP2 selects 320 kHz (available for loop bandwidths > 700 kHz)
- LOOP3 selects 880 kHz (available for loop bandwidths > 2 MHz)
- LOOP4 selects 2.8 MHz (available for loop bandwidths > 6 MHz)

In normal operation, the Type- 2 transition frequency is automatically coupled to the CDR loop bandwidth and provides the desired loop characteristic for most measurements. Use "LSELect:AUTomatic" to turn off automatic coupling. Use "T2TFrequency?" to query the current Type- 2 loop transition frequency. Use "PEAKing?" to query the loop gain in dB.

The automatic coupling is selecting the highest possible Type-2 loop transition frequency for the loop bandwidth being used. In Jitter Tolerance Measurement Mode, the automatic coupling is always selecting LOOP1, which ensures minimum possible peaking.

Clock recovery extracts a clock from the incoming signal. The clock recovery loop bandwidth primarily determines how well the recovered clock tracks low-frequency jitter on the input signal. Some signals have very large low-frequency jitter from either extremely dirty clocks or intentional modulated clocks such as found in SSC (spread spectrum clocking). In this case the clock recovery system provides additional control of the loop dynamics by allowing the user to select the Type- 2 transition frequency of the loop. The Type- 2 transition frequency indicates the frequency below which the second integrator in the loop starts to provide extra gain. Increasing this frequency provides additional loop gain and improves the tracking of the loop.

Example

Set the Type 2 loop transition frequency to 12kHz

```
:CREC:LSEL LOOP1
```

Query the Type 2 loop transition frequency setting

```
:CREC:LSEL?
```

Response

```
LOOP1
```

Command :CREC:LSEL:AUT[?]

Long `:CRECovery{1}:LSELect:AUTomatic[?]`

Parameters `0 | 1 | OFF | ON`

Parameter Suffix –

Description This command turns on and off the coupling of the Type- 2 transition frequency to the CDR loop bandwidth. Refer to "`LSELect`" on page 48 for a description of this feature.

Example

Enable automatic selection of Type 2 transition frequency

```
:CREC:LSEL:AUT ON
```

Query if automatic Type 2 transition frequency selection is enabled

```
:CREC:LSEL:AUT?
```

Response

```
1
```

Command	:CREC:PEAK?
Long	:CRECovery[1]:PEAKing?
Parameters	–
Parameter Suffix	–
Description	Queries the loop gain in dB for the current Type- 2 transition frequency. Refer to "LSELect" on page 48 for a description of this feature.
Example	Query the loop gain in dB :CREC:PEAK? Response 1.4

Command	:CREC:T2TF?
Long	:CRECovery[1]:T2TFrequency?
Parameters	–
Parameter Suffix	–
Description	Queries the Type- 2 transition frequency in use for the current CDR loop bandwidth. Refer to "LSELect" on page 48 for a description of this feature.
Example	Query the Type 2 transition frequency :CREC:T2TF? Response 320e3

3.7.4 Locking Commands

Command :CREC:AREL[?]

Long `:CRECovery[1]:ARELock[?]`

Parameters `0 | 1 | OFF | ON`

Parameter Suffix –

Description Enables or disables automatic data-rate locking.

Example

Enable automatic data-rate locking

```
:CREC1:AREL ON
```

Query current state of data-rate locking

```
:CREC1:AREL?
```

Response

```
1
```

Command	:CREC:AREL:STAT?
Long	:CRECovery[1]:ARELock:STATe?
Parameters	–
Parameter Suffix	–
Description	Queries the state of automatic data-rate locking. Returns NLOCking when the N4877A is not executing any locking algorithm, LOCKing when locking the CDR.
Example	:CREC:AREL:STAT?
Note	This command only signals whether the N4877A is internally executing the locking algorithm. It has to be understood as a busy indicator, but cannot be interpreted as an indicator that locking is possible or not.

Command :CREC:AREL:CANC

Long :CRECovery[1]:ARELock:CANCel

Parameters –

Parameter Suffix –

Description During automatic data-rate locking, this command aborts the automatic re-lock attempt.
This command will be ignored when the CDR is already locked.
Sending this command while the CDR hardware is unlocked will not only cancel the lock attempt in progress, but will also turn off automatic re-lock.

Example Abort re-lock attempt
:CREC:AREL:CANC
Query if automatic re-lock is enabled
:CREC:AREL?
Response
0

Command :CREC:LOCK?

Long `:CRECovery[1]:LOCKed?`

Parameters –

Parameter Suffix –

Description This query returns the locked status of the clock recovery. Locked status returns 1, unlocked status returns 0.

Example

Query lock status

```
:CREC:LOCK?
```

Response

```
1
```

Command :CREC:REL

Long :CRECovery[1]:RELock

Parameters –

Parameter Suffix –

Description This command locks the N4877A to the data rate. Issue this command to lock the CDR whenever changes occur in the data rate or input data source. Under two conditions, the module may lock on a data rate other than the specified rate. In the first condition, lock can occur if the entered data rate is an integer multiple of the actual data rate of the signal. The second condition occurs because the acquisition range is broad (greater than ±5000 PPM). This makes it possible for the CDR to lock on a signal that is higher or lower than the selected value. For example, if you select a 2.48832 Gb/s data rate but the signal is actually 2.5 Gb/s, the module may still lock on the signal. To determine if the RELock command has completed, use the CRECovery:LOCKed? query.

Example Relock the CDR

```
:CREC:REL
```

3.7.5 Input Commands

Command :CREC:INP[?]

Long `:CRECovery[1]:INPut[?]`

Parameters `ELECtrical | DIFFerential | EINVerted`

Parameter Suffix –

Description Selects the clock recovery. `DIFFerential` is the default setting.

Example

Select differential input signal

```
:CREC:INP DIFF
```

Query currently selected input

```
:CREC:INP?
```

Response

```
DIFF
```

3.7.6 Frequency to Transition Commands

Command :CREC:CFR? [<NR1>]

Long :CRECovery[1]:CFRequency? [<NR1>]

Parameters –

Parameter Suffix –

Description This query returns the frequency of the recovered data clock. The optional argument represents the number of time periods to wait while performing the measurement. Each time period is approximately 20 milliseconds. The default value is 1.0.

Example Measure the frequency of the recovered clock

```
:CREC:CFR?
```

Response

```
2.48767e9
```

Command :CREC:TDEN?

Long :CRECovery[1]:TDENsity?

Parameters –

Parameter Suffix –

Description This query returns the calculated edge density of the data signal. The edge density value is the ratio of bit transitions to bits and is returned as a number between zero and one. Changes in edge density can cause the module to lose lock. If the edge density value is invalid, the string "9.99999E+37" is returned.

Example Query the transition density

```
:CREC:TDEN?
```

Response

```
0.5012
```

3.7.7 Clock Out Divide Ratio Commands

Command :CREC:ODR[?]

Long `:CRECovery[1]:ODRatio[?]`

Parameters `-8 | -4 | -2 | 1 | 2 | 4 | 8 | 16 | 32`

Parameter Suffix –

Description

This command sets or queries the output clock divide ratio. This determines the data rate at the recovered clock output. The ratio can be set to a value of 1, 2, 4, 8, 16, or 32.

Negative values (-n) indicate that the output clock frequency is n times the input data rate, while positive values set the output clock frequency to the input data rate divided by n.

Sending this command while the output divider is set to auto (Refer to "`ODRatio:AUTO`" on page 62), results in ignoring the remotely set value.

Example

Set the output clock divide ratio to 2

```
:CREC:ODR 2
```

Query the set output clock divide ratio

```
:CREC:ODR?
```

Response

```
2
```

Command :CREC:ODR:AUTO[?]

Long :CRECovery[1]:ODRatio:AUTO[?]

Parameters 0 | 1 | OFF | ON

Parameter Suffix –

Description This command enables or disables the N4877A's capability to automatically set the divide/multiply ratio for the recovered clock output. With auto on, the instrument automatically selects an output divide ratio setting to 1:1 for frequencies equal to or less than 16.0 GHz or 1:2 for frequencies greater than 16.0 GHz.

Example

Turn off automatic setting of the divide ratio

```
:CREC:ODR:AUTO OFF
```

Query status of automatic devide ratio setting

```
:CREC:ODR:AUTO?
```

Response

```
0
```

3.7.8 Data Output Mode Commands

Command :CREC:OUTP:DMOD[?]

Long `:CRECovery[1]:OUTPut:DMODe[?]`

Parameters `NORMal | SWAPped`

Parameter Suffix –

Description

Selects how the recovered data is routed to Data Out 1 and Data Out 2.

When selecting normal, then the odd numbered bits are routed to Data Out 1 and the even numbered bits are routed to Data Out 2.

When selecting `SWAPped`, then the even numbered bits are routed to Data Out 1 and the odd numbered bits are routed to Data Out 2.

Example

Swap the data streams at Data Out 1 and Data Out 2

```
:CREC:OUTP:DMOD SWAP
```

Query data stream routing

```
:CREC:OUTP:DMOD?
```

Response

```
SWAP
```

Note The terms even numbered bits and odd numbered bits are used to distinguish between the de-multiplexed data streams. The N4877A does not know about an absolute first bit in the incoming data stream, so the assignment of the terms even and odd are random in the application.

3.8 Status Reporting Commands

Introduction

The Questionable Data register group provides information about the quality or integrity of the instrument. Any or all of these conditions can be reported to the Questionable Data summary bit through the enable register. For more details, see "Status Model".

Command	:STAT:QUES?
Long	`:STATus:QUEStionable[:EVENt]?`
Parameters	–
Parameter Suffix	–
Description	Reads the event register in the questionable status group. It's a read-only register. Once a bit is set, it remains set until cleared by this command or `*CLS` command. A query of the register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.
Example	`:STAT:QUES?` Response: `4`

Command :STAT:QUES:COND?

Long `:STATus:QUEStionable:CONDition?`

Parameters –

Parameter Suffix –

Description Reads the condition register in the questionable status group. It's a read-only register and bits are not cleared when you read the register. A query of the register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

Example `:STAT:QUES:COND?`

Response: `4`

Command :STAT:QUES:ENAB[?]

Long :STATus:QUEStionable:ENABle[?]

Parameters <NRf>

Parameter Suffix –

Description Sets or queries the enable register in the questionable status group. The selected bits are then reported to the Status Byte. A *CLS will not clear the enable register but it does clear all bits in the event register. To enable bits in the enable register, you must write a decimal value which corresponds to the binary-weighted sum of the bits you wish to enable in the register.

Example

```
:STAT:QUES:ENAB 32
:STAT:QUES:ENAB #H20
:STAT:QUES:ENAB #B100000
:STAT:QUES:ENAB?
```

Response: 32

Command :STAT:QUES:NTR[?]

Long `:STATus:QUEStionable:NTRansition[?]`

Parameters <NRf>

Parameter Suffix –

Description Sets or queries the negative-transition register in the questionable status group. A negative transition filter allows an event to be reported when a condition changes from true to false. Setting both positive/negative filters true allows an event to be reported anytime the condition changes. Clearing both filters disables event reporting. The contents of transition filters are unchanged by `*CLS` and `*RST`.

Example

```
:STAT:QUES:NTR 4
:STAT:QUES::NTR #H4
:STAT:QUES:NTR #B100
:STAT:QUES:NTR?
```

Response: `4`

Command :STAT:QUES:PTR[?]

Long :STATus:QUEStionable:PTRansition[?]

Parameters <NRf>

Parameter Suffix –

Description Set or queries the positive-transition register in the questionable status group. A positive transition filter allows an event to be reported when a condition changes from false to true. Setting both positive/negative filters true allows an event to be reported anytime the condition changes. Clearing both filters disables event reporting. The contents of transition filters are unchanged by `*CLS` and `*RST`.

Example

```
:STAT:QUES:PTR 15
:STAT:QUES::PTR #HF
:STAT:QUES:PTR #Q17
:STAT:QUES:PTR #B1111
:STAT:QUES:PTR?
```

Response: `15`

3.9 System-Related Commands

Introduction System (Instrument) related commands.

Command	:SYST:COMM:LAN:DGAT[?]
Long	:SYSTem:COMMunicate:LANetwork:DGATeway[?]
Parameters	"nnn.nnn.nnn.nnn"
Parameter Suffix	–
Description	A gateway is a network device that provides a connection between networks. The default gateway setting is the IP address of such a device. • You need not set a gateway address if DHCP is in use. • Contact your network administrator to find out whether a gateway is being used, and for the address. • The gateway address is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.
Example	:SYST:COMM:LAN:DGAT? Response:"192.168.0.0"

Command :SYST:COMM:LAN:DHCP[?]

Long `:SYSTem:COMMunicate:LANetwork:DHCProtocol[?]`

Parameters `0 | 1 | OFF | ON`

Parameter Suffix –

Description DHCP (Dynamic Host Configuration Protocol) is a protocol for automatically assigning a dynamic IP address to a device on a network. DHCP is typically the easiest way to configure your Keysight N4877A for remote communication using the LAN interface. DHCP/Auto-IP is *On* by default.

Example

```
:SYST:COMM:LAN:DHCP?
```

Response:`1`

Command :SYST:COMM:LAN:DNS[1|2][?]

Long `:SYSTem:COMMunicate:LANetwork:DNServer[1|2][?]`

Parameters "nnn.nnn.nnn.nnn"

Parameter Suffix –

Description DNS (Domain Name Service) is an Internet service that translates Domain names into IP addresses. The DNS server address is the IP address of a server that performs this service.

- Contact your network administrator to find out whether DNS is being used, and for the correct DNS server address.
- The DNS server address is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.

Example

```
:SYST:COMM.LAN:DNS1?
```

Response: `"192.168.0.0"`

Command :SYST:COMM:LAN:DOM?

Long `:SYSTem:COMMunicate:LANetwork:DOMain?`

Parameters –

Parameter Suffix –

Description A domain name is a registered name on the Internet, which is translated into an IP address.

The Domain name cannot be changed. The N4877A simply reports the name of the domain that was determined when the instrument was connected to the LAN.

Example `:SYST:COMM:LAN:DOM?`

Response: `"my.domain.com"`

Command	:SYST:COMM:LAN:HOST[?]
Long	`:SYSTem:COMMunicate:LANetwork:HOSTname[?]`
Parameters	"<hostname>"
Parameter Suffix	–
Description	A host name is the host portion of the domain name, which is translated into an IP address. • Contact your network administrator for the correct host name. • Allowed characters are the letters "a" through "z", numbers ("0" through "9") and dash ("-"). • The host name is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.
Example	`:SYST:COMM:LAN:HOST "my-device"`

Command :SYST:COMM:LAN[?]

Long `:SYSTem:COMMunicate:LANetwork[:IPADress][?]`

Parameters “nnn.nnn.nnn.nnn.”

Parameter Suffix –

Description An IP address is actually a four-byte integer expressed in the notation "nnn.nnn.nnn.nnn" where "nnn" in each case is a byte value from 000 to 255.

- You need not set an IP address if DHCP is in use.
- Contact your network administrator for a valid IP address to use for your N4877A.
- The IP address is stored in *non-volatile* memory and does not change when power has been off or after a remote interface reset.

Example

```
:SYST:COMM:LAN "192.168.0.1"
```

Command	:SYST:COMM:LAN:MAC?
Long	:SYSTem:COMMunicate:LANetwork:MACaddress?
Parameters	–
Parameter Suffix	–
Description	The Media Access Control address (MAC address) is a unique identifier of network interface cards. The MAC address is assigned during manufacturing and cannot be changed.
Example	:SYST:COMM:LAN:MAC? Response: "0030D3117164"

Command :SYST:COMM:LAN:SNM[?]

Long `:SYSTem:COMMunicate:LANetwork:SNMask[?]`

Parameters “nnn.nnn.nnn.nnn”

Parameter Suffix –

Description Subnetting allows the network administrator to divide a network into smaller networks to simplify administration and to minimize network traffic. The subnet mask indicates the portion of the host address to be used to indicate the subnet.

- You need not set a subnet mask if DHCP is in use.
- Contact your network administrator to find out whether subnetting is being used, and for the correct subnet mask.
- The subnet mask is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.

Example

```
:SYST:COMM:LAN:SNM "255.255.255.0"
```

Command :SYST:COMM:LAN:WINS[1|2][?]

Long :SYSTem:COMMunicate:LANetwork:WINServer[1|2][?]

Parameters "nnn.nnn.nnn.nnn"

Parameter Suffix –

Description WINS (Windows Internet Naming Service) is an Internet service that translates Host names to IP addresses. The WNS server address is the IP address of a server that performs this service.

- Contact your network administrator to find out whether WINS is being used, and for the correct WINS server address.
- The WINS server address is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.

Example :SYST:COMM:LAN:WINS1?

Response: "192.168.0.2"

Command :SYST:ERR?

Long `:SYSTem:ERRor[:NEXT]?`

Parameters –

Parameter Suffix –

Description

Read and clear one error from the instrument's error queue.

A record of up to 30 command syntax or hardware errors can be stored in the error queue. Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. Errors are cleared as you read them.

If more than 30 errors have occurred, the last error stored in the queue (the most recent error) is replaced with "Queue overflow". No additional errors are stored until you remove errors from the queue.

If no errors have occurred when you read the error queue, the instrument responds with 0, "No error".

The error queue is cleared by the ***CLS** command or when the power is cycled.

The error queue is not cleared by a reset (***RST)** command.

The error messages have the following format (the error string may contain up to 255 characters).

-113,"Undefined header"

Example

`:SYST:ERR?`

Response: `0,"No error"`

Command :SYST:HELP:HEAD?

Long `:SYSTem:HELP:HEADers?`

Parameters –

Parameter Suffix –

Description The `HEADers?` query shall return all SCPI commands and queries and IEEE 488.2 common commands and common queries implemented by the instrument. The response shall be a <DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA> element The full path for every command and query shall be returned separated by linefeeds. The syntax of the response is defined as: The <nonzero digit> and sequence of <digit> follow the rules in IEEE 488.2, Section 8.7.9. An <SCPI header> is defined as: It shall contain all the nodes from the root. The <SCPI program mnemonic> contains the node in standard SCPI format. The short form shall use uppercase characters while the additional characters for the long form shall be in lowercase characters. Default nodes shall be surrounded by square brackets ([]).

Description

For example, an instrument which implemented the required commands listed in Syntax & Style, Volume 1 section 4.2.1, this query, and the required IEEE 488.2 common commands and queries might return:

```
#3425
:SYSTem:ERRor?/qonly/
:SYSTem:HELP:HEADers?/qonly/
:SYSTem:VERSion?/qonly/
:STATus:OPERation[:EVENt]?/qonly/
:STATus:OPERation:CONDition?/qonly/
:STATus:OPERation:ENABle
:STATus:QUEStionable[:EVENt]?/qonly/
:STATus:QUEStionable:CONDition?/qonly/
:STATus:QUEStionable:ENABle
:STATus:PRESet/nquery/
*IDN?/qonly/
*RST/nquery/
*TST?/qonly/
```

`*RST` shall have no direct effect on the response to this query.

Example

```
:SYST:HELP:HEAD?
```

Response: See Description above.

Command	:SYST:LXI:IDEN[?]
Long	:SYSTem:LXI:IDENtify[?]
Parameters	0 | 1 | OFF | ON
Parameter Suffix	–
Description	The IDEN command is used to enable and disable the device identification according to the LXI standard. When IDEN is set to ON, then the LAN LED starts blinking in green color to allow identification of a specific device in case of more complex measurement setups. Setting IDEN back to OFF disables the blinking, and the LAN status indicator is showing the current operational status of the LAN interface (green for operational, red for not operational).
Example	:SYST:LXI:IDEN ON

Command	:SYST:PRES
Long	:SYSTem:PRESet
Parameters	–
Parameter Suffix	–
Description	The PRESet command is an event that configures the SCPI device-dependant status data structure to its preset value, e.g. NTR to 0x00, PTR to 0xFF.
Example	:SYST:PRES

Command :SYST:SET[?]

Long `:SYSTem:SET[?]`

Parameters <block data>

Parameter Suffix –

Description In query form, the command reads a block of data containing the instrument's complete set-up. The data is in a binary format, not ASCII, and cannot be edited.

In set form, the block data must be a complete instrument set-up read using the query form of the command.

This command has the same functionality as the `*LRN` command.

Example `:SYST:SET?`

Response #527576...

Command :SYST:TEST?

Long :SYSTem:TEST?

Parameters PON | NORMal | ALL

Parameter Suffix –

Description Execute the selftest and report the result.

- PON: This does not execute any test, but simply evaluate the result of the power on selftest,
- NORMal: Execute the normal selftest (no need to disconnect DUT) and report the result.
- ALL: Execute the extended selftest and report the result. The instrument must be completely disconnected from any external setup before the extended selftest may be started.

The result is 0 if no errors are found and 1 if at least one test failed. The error queue will contain the corresponding error messages.

Example :SYST:TEST? PON

Response: 0

Command	:SYST:VERS?
Long	:SYSTem:VERSion
Parameters	–
Parameter Suffix	–
Description	Returns a string in the form “YYYY.V”, where “YYYY” represents the year of the version, and “V” represents a version number for that year (e.g., 1999.0).
Example	`:SYST:VERS?` Response: `1999.0`

Command :SYST:WARN?

Long :SYSTem:WARNing[:COUNt]?

Parameters –

Parameter Suffix –

Description Use this command to read the number of warnings, which are currently active.

✎ The warning status of voltage, time and frequency are also summarized by bits in the questionable status register.

Example :SYST:WARN?

Response: 0

Command	:SYST:WARN:BUFF?
Long	:SYSTem:WARNing:BUFFer?
Parameters	–
Parameter Suffix	–
Description	Use this command to read the maximum possible number of characters which could be returned by `:SYST:WARN:STR?` If all warnings were active.
Example	:SYST:WARN:BUFF? Response: `8627`

Command	:SYST:WARN:STR?
Long	:SYSTem:WARNing:STRing?
Parameters	–
Parameter Suffix	–
Description	It is used to read all the currently active warning messages. The warning messages are concatenated to form a single string with a ";" as separator between the messages.
Example	:SYST:WARN:STR? Response: " "

3.10 Common Command List

Command	Description
*CLS	Clear the event register in all register groups. This command also clears the error queue and cancels a ***OPC** operation. ✎ It does not clear the enable register.
*CAL?	Performs a complete self-calibration of the instrument. Returns "+0" (PASS) or "+1" (FAIL). If the test fails, one or more error messages will be generated to provide additional information on the failure. Use the `SYST:ERR?` command to read the error queue.
*ESE[?]	Enable bits in the Standard Event Status Register to be reported in the Status Byte. The selected bits are summarized in the "Standard Event" bit (bit 5) of the Status Byte Register. The *ESE? query returns a value which corresponds to the binary-weighted sum of all bits enabled decimal by the *ESE command. These bits are not cleared by a *CLS command. Value Range: 0–255.
*ESR?	Query the Standard Event Status Register. Once a bit is set, it remains set until cleared by a *CLS (clear status) command or queried by this command. A query of this register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.
*IDN?	Read the instrument's identification string which contains four fields separated by commas. The first field is the manufacturer's name, the second field is the model number, the third field is the serial number, and the fourth field is a revision code which contains four numbers separated by dashes Keysight Technologies, NxxxxA,<serial number>, **x.x.x.x-h** **x.x.x.x**= Firmware revision number **h** = Hardware revision number
*LRN?	Query the instrument and return a binary block of data containing the current settings (learn string). You can then send the string back to the instrument to restore this state at a later time. For proper operation, do not modify the returned string before sending it to the instrument. The returned string will contain about 32K characters. Use `:SYST:SET` to send down the learn string. See `:SYST:SET[?]`
*OPC	Set the "Operation Complete" bit (bit 0) in the Standard Event register after the previous commands have been completed.

Command	Description
*OPC?	Return "1" to the output buffer after the previous commands have been completed. Other commands cannot be executed until this command completes.
*OPT?	Read the installed options. The response consists of any number of fields separated by commas.
*PSC {0|1} |*PSC?	Clear the Standard Event enable register and Status Byte condition register at power on (*PSC 1). When `*PSC` 0 is in effect, these two registers *are not* cleared at power on. The default is `*PSC` 1. The `*PSC?` query returns the power-on status clear setting. Returns "0" (do not clear at power on) or "1" (clear at power on).
*RST	Reset instrument to its factory default state (*refer to "***Error! Reference source not found.***" in section* **Error! Reference source not found.**). This command will abort a sweep or burst in progress and will re-enable the front-panel display if it was previously disabled (DISP OFF command).
*SRE[?]	Enable bits in the Status Byte to generate a Service Request. To enable specific bits, you must write a decimal value which corresponds to the binary-weighted sum of the bits in the register. The selected bits are summarized in the "Master Summary" bit (bit 6) of the Status Byte Register. If any of the selected bits change from "0" to "1", a Service Request signal is generated. The `*SRE?` query returns a decimal value which corresponds to the binary-weighted sum of all bits enabled by the *SRE command.
*STB?	Query the summary (status byte condition) register in this register group. This command is similar to a Serial Poll but it is processed like any other instrument command. This command returns the same result as a Serial Poll but the "Master Summary" bit (bit 6) *is not* cleared by the `*STB?` command.
*TST?	Performs a complete self-test of the instrument. Returns "+0" (PASS) or "+1" (FAIL). If the test fails, one or more error messages will be generated to provide additional information on the failure. Use the `SYST:ERR?` command to read the error queue.

Command	Description
*WAI	Wait for all pending operations to complete before executing any additional commands over the interface.

3.11 Status Model

Introduction

This section describes the structure of the SCPI status system used by the N4877A. The status system records various conditions and states of the instrument in several register groups as shown on the following pages. Each of the register groups is made up of several *low level* registers called Condition registers, Event registers, and Enable registers which control the action of specific bits within the register group.

These groups are explained below:

What is a Condition Register?

A condition register continuously monitors the state of the instrument. The bits in the condition register are updated in real time and the bits are not latched or buffered. This is a read-only register and bits are not cleared when you read the register. A query of a condition register returns a decimal value which corresponds to the binary-weighted sum of all bits set in that register.

What is an Event Register?

An event register latches the various events from changes in the condition register. There is no buffering in this register; while an event bit is set, subsequent events corresponding to that bit are ignored. This is a read only register. Once a bit is set, it remains set until cleared by query command (such as **STAT:QUES:EVEN?**) or a ***CLS** (clear status) command. A query of this register returns a decimal value which corresponds to the binary-weighted sum of all bits set in that register.

What is an Enable Register?

An enable register defines which bits in the event register will be reported to the Status Byte register group. You can write to or read from an enable register. A ***CLS** (clear status) command will not clear the enable register but it does clear all bits in the event register. A **STAT:PRES** command clears all bits in the enable register. To enable bits in the enable register to be reported to the Status Byte register, you must write a decimal value which corresponds to the binary weighted sum of the corresponding bits.

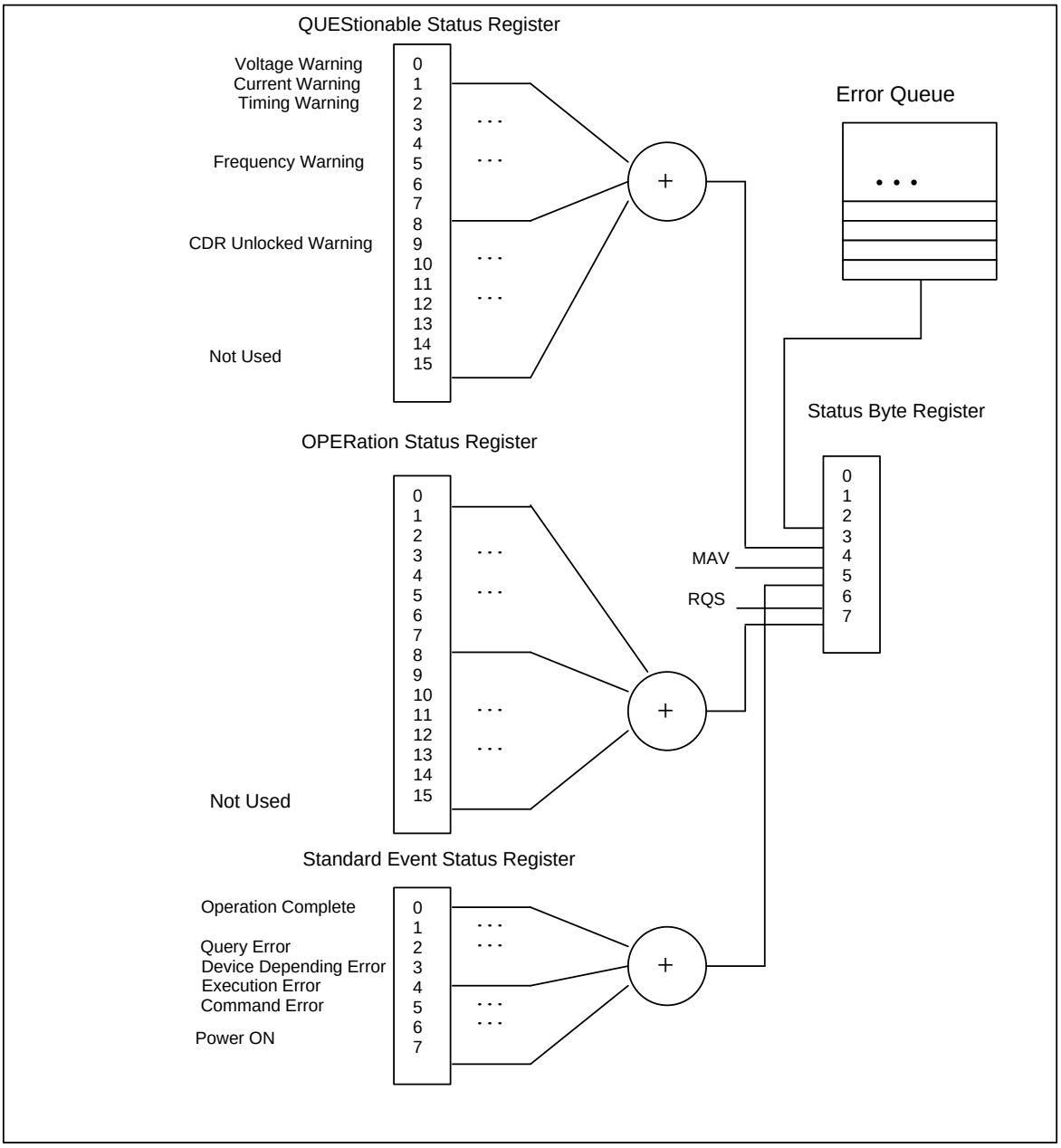
What are Transition Filters?

Transition Filters are used to detect changes of the state in the condition register and set the corresponding bit in the event register. You can set transition filter bits to detect positive transitions (PTR), negative transitions (NTR) or both. Transition filters are read/write registers. They are not affected by *CLS.

3.12 Status register structure

Introduction

The N4877A has a status reporting system conforming to IEEE 488.2 and SCPI. The figure below shows the status group available in the instrument.



3.12.1 Status Byte Register

Introduction

The Status Byte summary register reports conditions from the other status registers. Data that is waiting in the instrument's output buffer is immediately reported on the "Message Available" bit (bit 4) for example. Clearing an event register from one of the other register groups will clear the corresponding bits in the Status Byte condition register. Reading all messages from the output buffer, including any pending queries, will clear the "Message Available" bit. To set the enable register mask and generate an SRQ (service request), you must write a decimal value to the register using the ***SRE** command.

Bit Definitions – Status Byte Register

Bit Number		Decimal Value	Definition
0	Not used	1	Not Used. Returns "0"
1	Not used	2	Not Used. Returns "0"
2	Error Queue	4	One or more error are stored in the Error Queue
3	Questionable Data	8	One or more bits are set in the Questionable Data Register (bits must be enabled)
4	Message Available	16	Data is available in the instrument's output buffer
5	Standard Event	32	One or more bits are set in the Standard Event Register
6	Master Summary	64	One or more bits are set in the Status Byte Register
7	Not Used	128	One or more bits set in the Operation Data Register

3.12.2 STATus Commands

Command

The PRESet command is an event that configures the SCPI and device-dependant status data structures. The mandatory mechanism is defined in part by the IEEE 488.2.

:STATus:PRESet

It clears all status group event registers. Presets the status group, enables PTR and NTR registers as follows:

ENABle = 0x0000, PTR = 0xffff, NTR = 0x0000.

3.12.3 STATus Questionable Data Register command subsystem

Introduction

The Questionable Data register group provides information about the quality or integrity of the instrument. Any or all of these conditions can be reported to the Questionable Data summary bit through the enable register.

The N4877A has two levels of error reporting mechanism called “warnings” and “errors”. Checking for warnings and errors is always enabled by switching on the output(s). A warning is generated when due to a combination of worst case uncertainties at the current settings of all relevant parameters, an invalid signal is output. A warning will be reflected in the QUEStionable data register structure. See the following table for definitions.

Bit Definitions – Questionable Data Register

Bit Number		Decimal Value	Definition
0	Voltage warning	1	Output signal could be invalid
1	Current warning	2	Output signal could be invalid
2	Time warning	4	Output signal could be invalid
3	Not used	8	Returns “0”
4	Not used	16	Returns “0”
5	Frequency warning	32	Output signal could be invalid
6	Not used	64	Returns “0”
7	Not used	128	Returns “0”
8	Not used	256	Returns “0”
9	CDR unlocked warning	512	CDR is currently unlocked, the output signal is invalid
10	Not used	1024	Returns “0”
11	Not used	2048	Returns “0”
12	Not used	4096	Returns “0”
13	Not used	8192	Returns “0”
14	Not used	16384	Returns “0”
15	Not used	32768	Returns “0”

Commands accessing the questionable status group

The following commands access the questionable status group.

:STATus:QUEStionable[:EVENt]?

Reads the event register in the questionable status group. It's a read-only register. Once a bit is set, it remains set until cleared by this command or *CLS command. A query of the register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

:STATus:QUEStionable:CONDition?

Reads the condition register in the questionable status group. It's a read-only register and bits are not cleared when you read the register. A query of the register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

:STATus:QUEStionable:ENABle[?]

Sets or queries the enable register in the questionable status group. The selected bits are then reported to the Status Byte. A *CLS will not clear the enable register but it does clear all bits in the event register. To enable bits in the enable register, you must write a decimal value which corresponds to the binary-weighted sum of the bits you wish to enable in the register.

:STATus:QUEStionable:NTRansition[?]

Sets or queries the negative-transition register in the questionable status group. A negative transition filter allows an event to be reported when a condition changes from true to false. Setting both positive/negative filters true allows an event to be reported anytime the condition changes. Clearing both filters disable event reporting. The contents of transition filters are unchanged by *CLS and *RST.

:STATus:QUEStionable:PTRansition[?]

Set or queries the positive-transition register in the questionable status group. A positive transition filter allows an event to be reported when a condition changes from false to true. Setting both positive/negative filters true allows an event to be reported anytime the condition changes. Clearing both filters disable event reporting. The contents of transition filters are unchanged by `*CLS` and `*RST`.

4 Programming Basics

Introduction

This chapter provides the information you need for programming the N4877A using the Keysight IO Libraries Suite. Familiarity with the Keysight IO Libraries Suite is instrumental in understanding the remote programming of the N4877A.

See the user documentation delivered with the Keysight IO Libraries Suite for information on how to use them.

4.1 Before you begin

Introduction

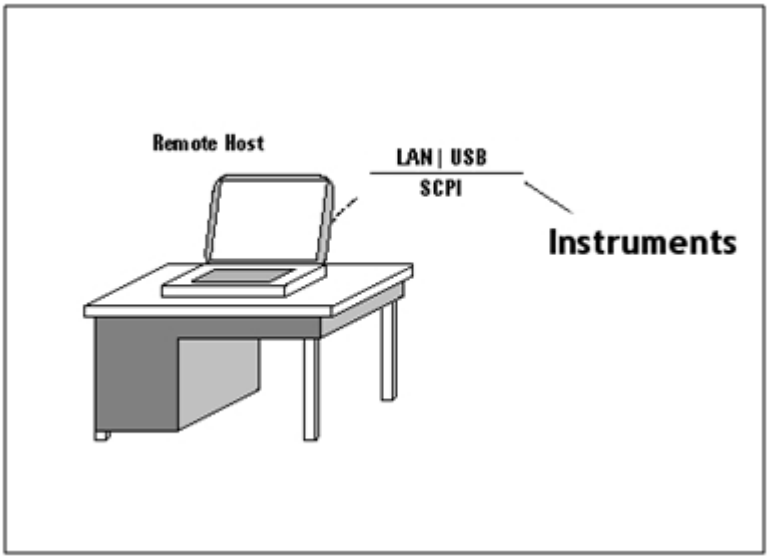
This section provides background information that you need before you start with remote programming.

Connecting to the instrument

Introduction

To communicate with the generator from a remote computer, the Keysight IO Libraries Suite must be installed on this computer.

The following description only provides you with the information you need for the instrument. For complete instructions on how to establish connections to the instrument, refer to the user documentation delivered with the Keysight IO Libraries Suite.



The instrument supports the following possibilities for remotely connecting:

LAN

The instrument's network settings are managed by the internal instrument software and the connected network environment. You can press the Utility key at the front panel, select I/O interface -> LAN using the instrument's soft keys to get the network setting. The default setting for DHCP (Dynamic Host Configuration Protocol) is ON. Contact you network administrator if you need help in defining your own instrument's IP address.

USB

The generator has a device type USB port on the rear panel for remote programming. This is the non-flat USB port close to the LAN connector. To connect to the instrument via USB, you need the instrument's USB ID. If the instrument's USB port is connected to a computer via an adequate USB cable a dialog will pop up automatically. This dialog generated by the Keysight IO Library Suite shows the USB ID. You can either use the full VISA resource string or assign an alias. See the Keysight IO Libraries Suite documentation for details.

Instrument Behavior

Introduction

The generator behaves as follows when it is turned on:

Instrument Mode

At power on, the generator will return to the same mode as it was powered down. Normally, once it has booted, the instrument is ready for remote operation.

Registers and Filters

At power on, the state of the registers and filters is:

All registers and filters are set to its initial state except the PON bit of the Standard Event Status Register. The PON (Power ON) event bit indicates that an off-to-on transition has occurred in the device's power supply.

All bits of Positive Transition Filter will be set and all bits of the Negative Transition Filter will be cleared.

4.2 Application Programs

Introduction

This chapter contains several remote interface example programs to help you develop programs for your own application. Chapter 3 Remote Programming Reference lists the syntax for the SCPI (Standard Commands for Programmable Instruments) commands available to program the generator.

These example programs are included in this chapter to demonstrate controlling the instrument using SCPI commands. All of these programs are created by means of Microsoft Visual Studio 2012 and use the Keysight IO Library Suite features.

---

*Visual Studio 2012 C++/Unmanaged - *IDN*

Introduction

This example program queries via the USB interface the instrument for an identification string and prints the result.

✎ **Notes:**

- You must change the VISA resource string accordingly. Here USB0::2391::41496::DE49C00100::INSTR is used as the VISA resource string of the instrument.
- Your application must link to VISA import libraries. To keep this example simple, configuring the Visual Studio 2012 is not described.

```
#include <visa.h>
#include "stdafx.h"

int _tmain(int argc, _TCHAR* argv[])
{
  ViStatus errorStatus = 0;
  ViSession viRm = 0, vi = 0;

  char buf [0xffff] = {0};

  /* Open session instrument */
  errorStatus = viOpenDefaultRM(&viRm);
  errorStatus = viOpen(viRm,
                       "USB0::2391::41496::DE49C00100::INSTR",
                       VI_NULL, VI_NULL, &vi);

  /* Send an *IDN? string to the device */
  viPrintf (vi, "*IDN?\n");

  /* Read results */
  viScanf (vi, "%t", &buf);
  printf ("IDN? response: %s\n", buf);

  /* Close session */
  viClose (vi);
  viClose (viRm);

  return 0;
}
```

Example output of the short C++ / Unmanaged program above:
IDN? response: Keysight Technologies,N4877A, DE49C00100,1.0.0.0-2

This is an example program of Visual Basic 2010 that queries via the USB interface the instrument for an identification string and prints the result.

```
Module Module1
  ' Visual Basic Example for Visual Studio 2010
  '
  ' To build this example, the file visa32.vb must be added to the
  ' Visual Basic project in Visual Studio 2010.
  '
  ' visa32.vb is part of the IO Library installation.
  ' On a default installation it can be found at
  ' C:\Program Files\IVI Foundation\VISA\WinNT\include
  ' or
  ' C:\Program Files (x86)\IVI Foundation\VISA\WinNT\include
  Sub Main()
    Dim errorStatus As Integer
    Dim viRm As Integer
    Dim vi As Integer

    Dim response As System.Text.StringBuilder

    errorStatus = 0
    viRm = 0
    vi = 0
    response = New System.Text.StringBuilder(65535)

    ' Open session to intrument
    errorStatus = viOpenDefaultRM(viRm)
    errorStatus = viOpen(viRm,
                         "USB0::2391::41496::DE49C00100::0::INSTR",
                         VI_NULL, VI_NULL, vi)

    ' Send an *IDN? string to the device
    errorStatus = viPrintf(vi, "*IDN?" & vbLf)

    ' Read results
    errorStatus = viScanf(vi, "%t", response)
    Console.WriteLine(response.ToString())

    ' Close session
    viClose(vi)
    viClose(viRm)

  End Sub

End Module
```

The following is a summary of the VISA function calls used in the previous example programs. For more detailed explanation of VISA functionality, see Keysight IO Libraries Suite "Programming with VISA".

visa.h	This file is included at the beginning of the file to provide the function prototypes and constants defined by VISA.
ViSession	The `ViSession` is a VISA type data type. Each program that will establish a communication channel must be defined as `ViSession`.
viOpenDefaultRM	You must first open a session with the default resource manager.
viOpen	This function establishes a communication channel with the device specified. This call must be made for each device you will be using.
viPrintf,viScanf	These are the VISA formatted "C like" I/O functions.
viClose	This function must be used to close each session. All allocated data structures that had been allocated for the session, will be deallocated.
viSetAttribute	This function is used to change attributes of an active ViSession.

Appendix

Introduction

This section covers the following:

- Factory Default Settings
- Pulse Parameter Definitions
- Preparing a USB Flash Drive using Windows Vista® or Windows 7®

A.1 Factory Default Settings

Introduction

The table on the following page summarizes the factory default settings for the Keysight N4877A. The instrument will go back to the default setting described below after power up and whenever the *RST command is received. The remote interface configuration will not be reset on power up and *RST.

Keysight N4877A Factory Default Settings

🖫 **Timing and Output Configuration**	**Factory Setting**
Input Selection	Differential
Data Rate	14.025 Gb/s
Loop Bandwidth Mode	Data Rate dependent
Data Rate Divide Ratio	1667
Loop Bandwidth	8.413317 MHz
Auto-Relock	ON
T2-Loop Selection	Automatic
Output Divide Ratio	Automatic
Data Output Mode	Normal

System-Related Operations	**Factory Setting**
Error Queue	Errors are cleared
Remote Interface Configuration	**Factory Setting**
*DHCP	*On
*IP Address	*0.0.0.0.
*Subnet Mask	*0.0.0.0.
*Default Gateway	*000.000.000.000
*DNS Server	*000.000.000.000
*Host Name	*a-n4877a-XXXXXX (where XXXXXX stands for the rightmost 6 characters of the instrument's serial number)

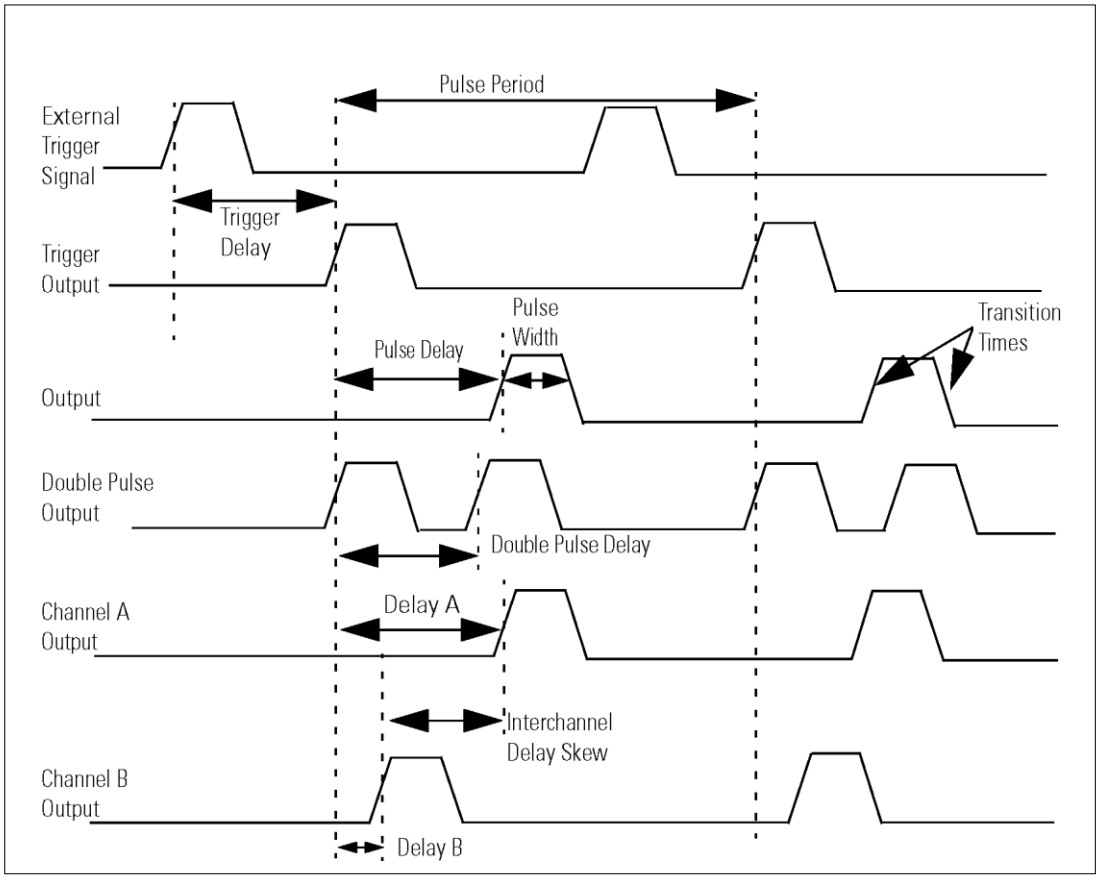
Parameters marked with an asterisk are stored in non-volatile memory. And are not reset when receiving the *RST command.

Parameter groups marked with a 🖫 are part of the instrument state reported by `*LRN?` or `:SYST:SET?`.

A.2 Pulse Parameter Definitions

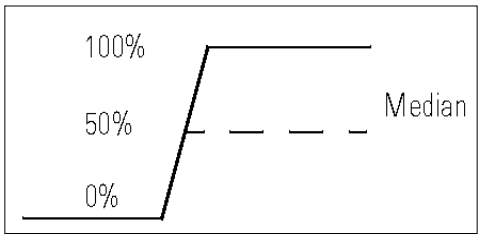
Introduction

Here you find the pulse parameter definitions of terms used in the instrument specifications. In the following figure, a graphical overview of the pulse parameters is provided.



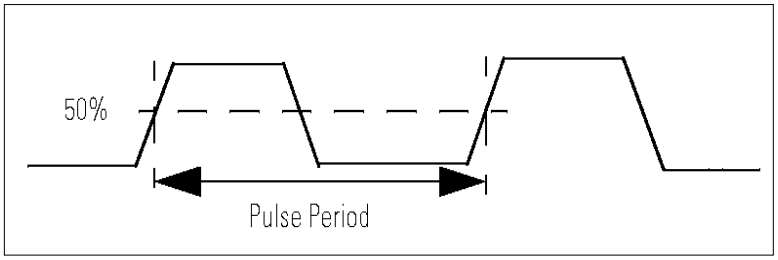
Time Reference Point

The time reference point is at the median of the amplitude (50% amplitude point on pulse edge):



Pulse Period

The time interval between the leading edge medians of consecutive output pulses:



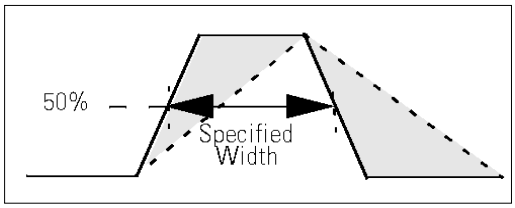
Trigger Delay

Interval between trigger point of the external trigger input signal and the trigger output pulse's leading edge median.

Pulse Width

Interval between leading and trailing edge medians:

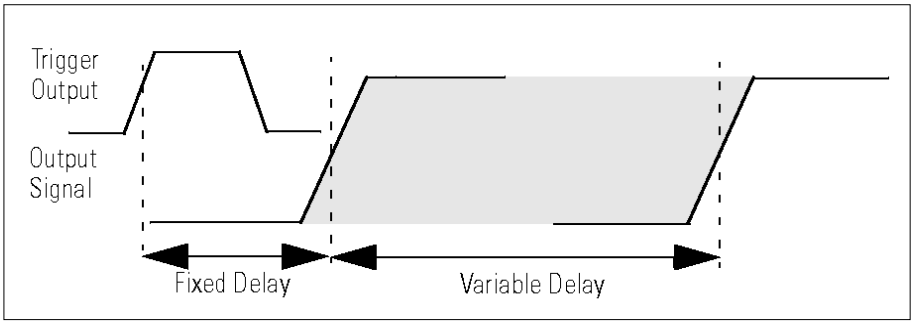
The specified and displayed value is that obtained with fastest edges, essentially equal to the interval from the start of the leading edge to the start of the trailing edge. By designing so that the pulse edges turn about their start points, the interval from leading edge start stays unchanged (in practice, start points may shift with changes in transition time) when transition times are varied. This is more convenient for programming and the width display is easy to interpret.



Pulse Delay

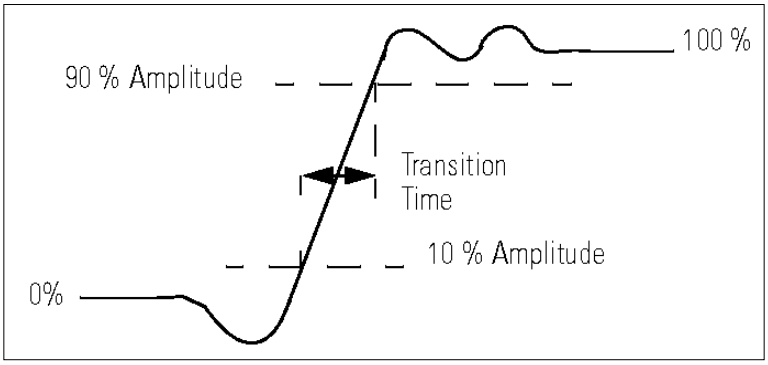
Interval between leading edge medians of trigger output pulse and output pulse:

The specified and displayed value is that obtained with the fastest leading edge. Pulse delay has two components, a fixed delay from trigger output to output signal and a variable delay with respect to the trigger output.

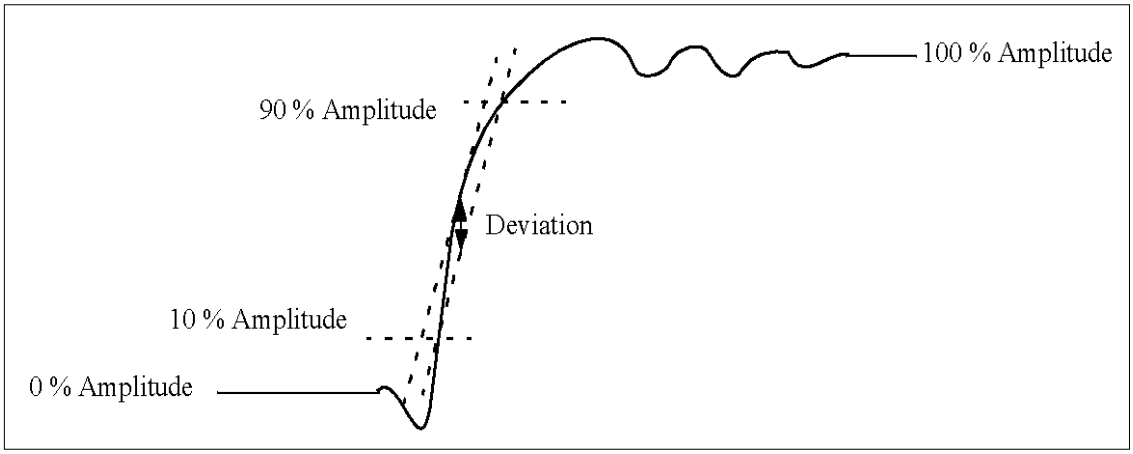


Inter channel Delay (Skew) Interval between corresponding leading edge medians of the output signals.

Transition Time Interval between the 10% and 90% amplitude points on the leading/trailing edge:



Linearity Peak deviation of an edge from a straight line through the 10% and 90% amplitude points, expressed as percentage of pulse amplitude:



Jitter

Short-term instability of one edge relative to a reference edge. Usually specified as rms value, which is one standard deviation or “sigma”. If distribution is assumed Gaussian, six sigma represents 99.74% of the peak-peak jitter.

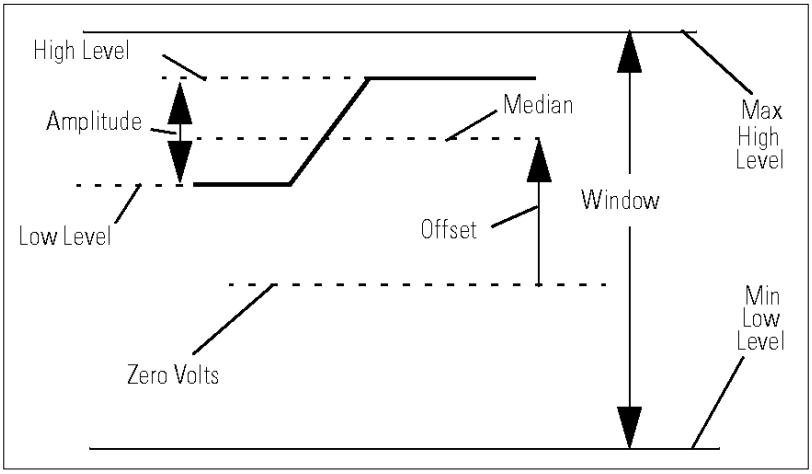
The reference edge for period jitter is the previous leading edge. That for delay jitter is the leading edge of the trigger output. Width jitter is the stability of the trailing edge with regard to the leading edge.

Stability

Long-term average instability over a specific time, for example, hour, year. Jitter is excluded.

Pulse Levels

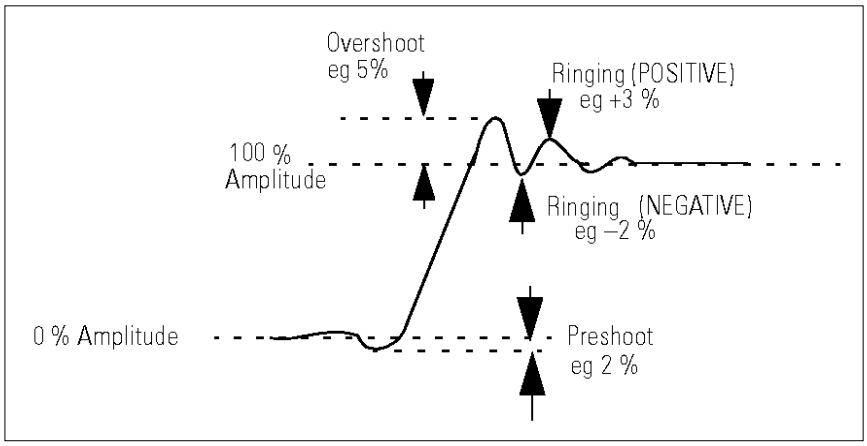
Pulse output is specified as pulse top and pulse base (usually referred to as high level and low level), or as peak to peak amplitude and median offset. A “window” specification shows the limits within which the pulse can be positioned.



Preshoot, Overshoot, Ringing

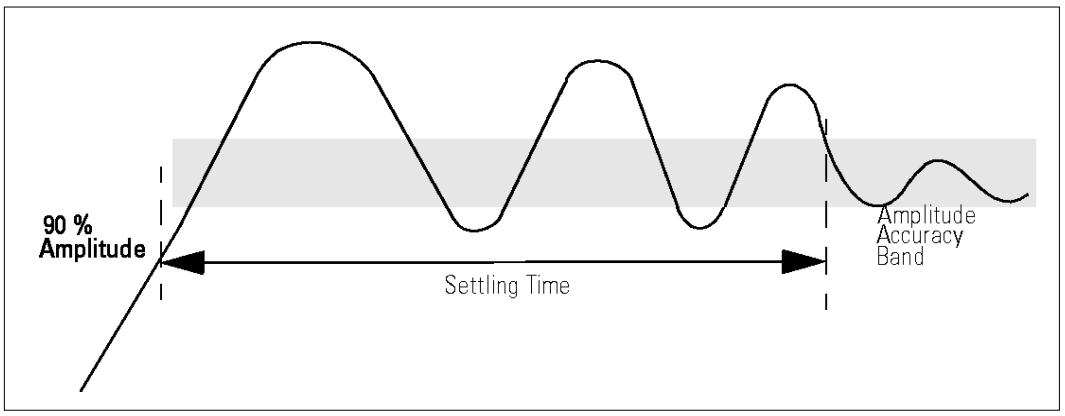
Preshoot and overshoot are peak distortions preceding/following an edge. Ringing is the positive-peak and negative-peak distortion, excluding overshoot, on pulse top or base. For example, a combined preshoot, overshoot, and ringing specification of 5% implies:

- Overshoot/undershoot < 5%
- Largest pulse-top oscillation<+ 5%, of pulse amplitude.



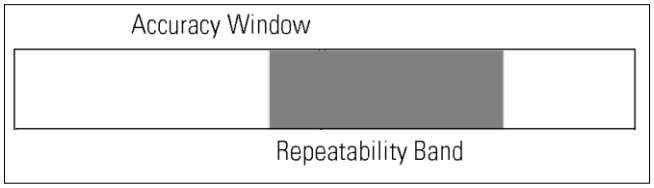
Settling Time

Time taken for pulse levels to settle within level specifications, measured from 90% point on leading edge.



Repeatability

When an instrument operates under the same environmental conditions and with the same settings, the value of a parameter will lie within a band inside the accuracy window. Repeatability defines the width of this band.



A.3 Preparing a USB Flash Drive using Windows Vista® or Windows 7®

Introduction

The following description is intended to help you prepare an USB flash drive if it is not being detected by the N4877A, or if the recovery mechanism of the software update was not able to bring up the instrument after an interrupted software update.

Important

- You need to have administrative rights on your computer to execute the steps mentioned below.
- The steps mentioned below will erase all data from the USB flash drive.
- The procedure does not work on computers that have Windows XP installed on them, since the required partition tool does not support USB flash drives on Windows XP.

Steps

- Click on the Windows logo and type "**cmd**".
- At the command prompt type "**diskpart**" and press enter (allow permissions and continue).
- When you are at the **diskpart>** prompt type "**list disk**" and press enter.
- Insert the USB flash drive into a Windows Vista PC.
- Wait until Windows Vista has recognized the USB flash drive.
- At the **diskpart>** prompt type "**list disk**" and press enter. Check which drive has been added to the list, usually disk 1 depending on how many disk drives are installed.
- Type "select disk #" where # is the disk number of the USB flash drive.
  Continue only if you are sure that the selected drive is the USB flash key that you want to prepare. The following steps will erase all data from the selected drive!
- Type "**clean**" and press enter.
- Type "**create partition primary**" and press enter. This creates the partition on the flash drive.
- Type "**active**" and press enter.
- Type "**exit**" and press enter. This exits the disk partition utility.
- Now the flash drive needs to be formatted. Click on the Windows logo and then click on Computer.
- Find the drive letter of the removable disk drive that needs to be formatted.
- In the command prompt window type "**format ?: /fs:fat32 /q**" where **?** is the removable drive letter that needs to be formatted. Press enter.
- Enter a volume label of your choice and press enter.

For recovering the N4877A....

If you need to recover the N4877A from an interrupted software update, you need to do the following in addition:

- Copy the software update zip file on the USB flash drive's root directory.
- Extract the content of the software update zip file to the root directory of the USB flash drive. Remember to maintain the folder structure in the zip file when doing this.
- Connect the USB flash drive to the N4877A and switch the instrument on.
- The N4877A will now boot the recovery image from the USB flash drive and continue to update the instrument firmware.
- The software update includes a reboot of the instrument after writing the firmware to flash memory. A visual sign of a completed update is the staus being shown on the status LEDs. After the successful reboot, the Activity LED will be off, and the LAN status LED will be either green or red (depending on LAN availability and setup). Both LEDs are orange during the recovery update and the following reboot.

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