

Keysight N1075A Optical Pickoff and Electrical Converter

User's Guide



Notices

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CAUTION

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

WARNING

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

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The N1075A Optical Converter is an optical-to-electrical data converter for 32 Gb/s transmitter testing, receiver testing, and clock and PLL characterization. In addition to documenting the N1075A, this manual shows some of the possible test setups using the N1075A with an Keysight 86100C/D Digital Communications Analyzer, N4877A Clock Data Recovery and Demultiplexer, and Bit Error Rate Test (BERT) instruments.

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

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 protection are intact) only.

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

Front Panel

The N1075A is configured with one of two options, S32 or M14. [Figure 1](#) on page 7 shows the Option S32 front panel. Option S32 operates at 32 Gb/s and provides single-mode optical fiber inputs. [Figure 2](#) on page 7 shows the Option M14 front panel. Option M14 operates at 14 Gb/s and provides *both* single-mode and multimode optical fiber inputs.

WARNING

Light energy can radiate from the front-panel DATA OUT connectors on Keysight N1075A. The light emitted from this connector is the slightly attenuated light that is input to the front-panel optical DATA IN connector.

WARNING

THE OPTICAL TERMINALS AND FIBER CABLES TRANSMIT INVISIBLE LASER RADIATION. DO NOT STARE INTO THE OPEN INSTRUMENT TERMINALS OR THE UNCONNECTED FIBER CABLE(S). CONSULT USER DOCUMENTATION AS IT RELATES TO THE LASER SOURCES TO FULLY UNDERSTAND ALL HAZARDS ASSOCIATED WITH THE OPERATION OF LASERS.

CAUTION

MAXIMUM OPTICAL INPUT POWER. On Option M14 instruments, the maximum power at the DATA IN connectors is 5 mW (NRZ data format). On Option S32 instruments, the maximum power at the DATA IN connector is 9 mW.

CAUTION

Fiber-optic connectors are easily damaged, refer to [“Avoid Costly Repairs”](#) on page 14.

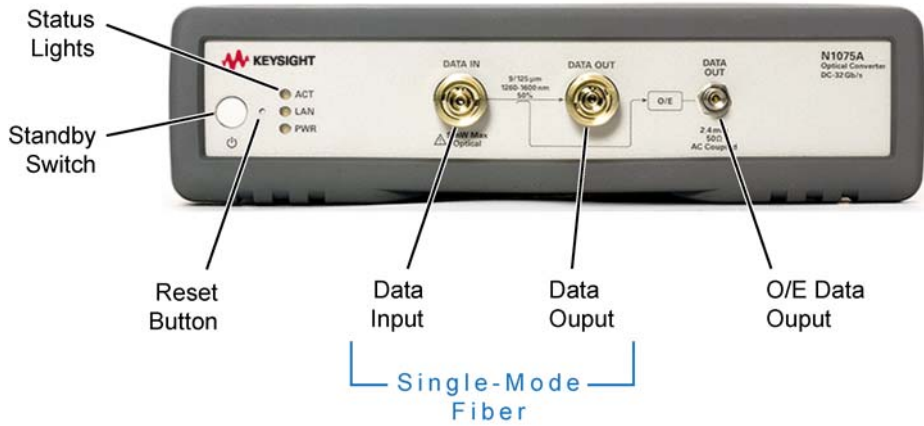


Figure 1 N1075A Option S32 Front Panel

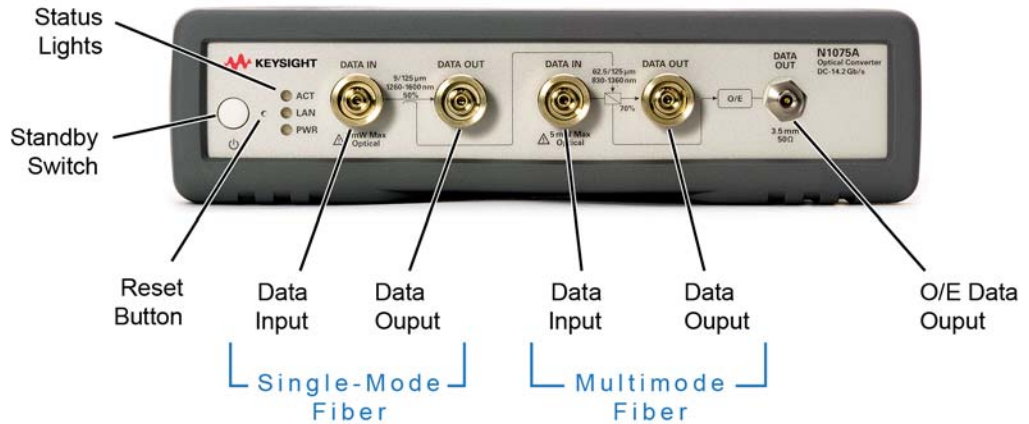


Figure 2 N1075A Option M14 Front Panel

Optical DATA IN/DATA OUT

The single-mode inputs and outputs use 9/125 μm fiber and multimode inputs and outputs use 62.5/125 μm fiber.

Table 1 Wavelength Ranges

Option	Mode	Range
S32	single-mode	1260 nm to 1600 nm
M14	single-mode	1260 nm to 1360 nm, <i>and</i> 1490 nm to 1600 nm
	Multimode	830 nm to 1360 nm

WARNING

The output from the DATA OUT connector is the slightly attenuated light that is input to the front-panel optical DATA IN connector. The input light passes through an internal coupler as illustrated on the front-panel.

The front-panel optical connectors come with screw-on FC/PC adapters pre-installed. Changing fiber-optic adapters is easy. Simply hand turn an adapter counter-clockwise to remove it from a connector. To install a different adapter, hand turn the new adapter clockwise onto the connector.

Table 2 Available Keysight Fiber-Optic Adapters

Connector Interface	Model Number	Connector Interface	Model Number
FC*	81000FI	MU	81000MI
			81002MI
DIN 4108/47256	861000SI	SC	81000KI
E-2000	81000HI	ST	81000VI
	81000PI		
LC	81000LI		
	81002LI		

* Provided with N1075A and installed on front-panel fiber-optic connections

Electrical DATA OUT








The front-panel electrical **DATA OUT** connector is the output of the internal optical-to-electrical converter. A 2.4 mm (m) to 3.5 mm (f) adapter is provided with N1075A-M14 instruments so that you can connect the 3.5 mm **DATA OUT** connector to the **DATA IN** connector on an N4877A Clock/Data Recovery and Demultiplexer.

Table 3 Electrical DATA OUT connectors

Option	Connector	Coupling
S32	2.4 mm, 50Ω	AC coupled
M14	3.5 mm, 50Ω	DC coupled

Status Lights

Table 4 Status Lights

Light	Description
PWR Indicator	
	Green. Power is turned on.
	Orange. N1075A is in standby mode.
LAN Indicator	
	Green. LAN is operable. Green (flashing). LAN device identification is enabled.
	Red. LAN is not operable.
	Orange. N1075A is in boot phase.
ACT Indicator	
	Green (flashing). N1075A is accessed on the remote LAN or USB interface.
	Orange. N1075A is in boot phase.

Standby Switch

The front-panel switch is only a standby switch and is not a LINE switch.

Reset Button

If the instrument exhibits difficulties during remote control or the front-panel status lights do not function as listed in [Table 4](#) on page 9, gently press the recessed reset button using a small object such as a toothpick.

Accessories

Table 5 Supplied Accessories

Description	Qty.	Part Number
N1075A Option M14		
SMA 50-ohm termination (m) connected to front-panel DATA OUT connector	1	1810-0118
FC Fiber-Optic Adapter. Installed on front-panel fiber-optic connections.	4	81000FI
Coaxial Cable, 2.92 mm (m) to 2.92 mm (m). 0.5 meters long.	1	N1075-60014
Adapter, 2.4 mm (m) to 3.5 mm (f)*	1	11901-60003
N1075A Option S32		
2.4 mm 50-ohm termination (m) connected to front-panel DATA OUT connector	1	54124-24101
FC Fiber-Optic Adapter. Installed on front-panel fiber-optic connections.	2	81000FI
Coaxial Cable, 2.4 mm (m) to 2.4 mm (m), 0.5 meters long.	1	N1075-60012

* The 2.4 mm to 3.5 mm adapter is used when connecting a cable between the N1075A-M14 and an N4877A's DATA IN connector.

Table 6 Available Accessories

Description	Part Number
Rack Mount Kit for 1 or 2 Units	E5810-00100
Clock Recovery Phase Matching Cable Kit	N1027A

Cleaning

WARNING

To prevent electrical shock, disconnect the Keysight Technologies Model N1075A 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.

Markings

- ⚠ The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction in the documentation.
- ⏻ The STANDBY symbol. The front panel switch is only a standby switch and is not a LINE switch.



Figure 3 Serial Number Label on Bottom Cover (The layout of the serial number label may vary from that shown here.)

Rear Panel

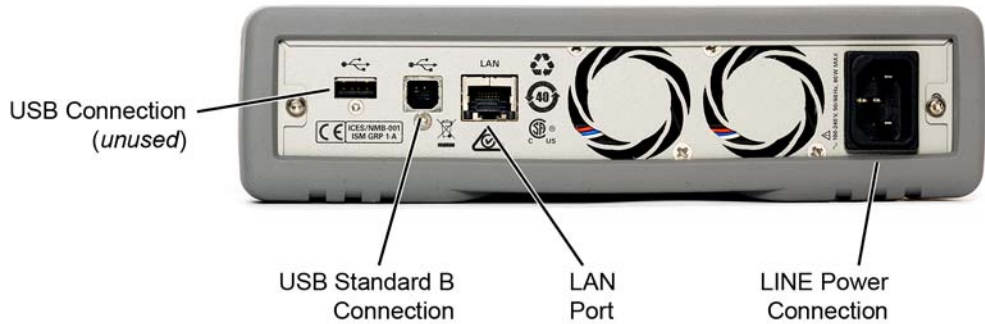


Figure 4 N1075A Rear Panel

USB Connectors

The instrument's rear panel provides two USB connectors. The USB (Standard B) connection is used to establish remote communication with the instruments as described in [Chapter 4](#), "Remote Queries". The USB port with the (Standard A) connection is unused.


LAN Connector


The LAN port is used to establish remote communication with the instruments as described in [Chapter 4](#), "Remote Queries".


LINE Power Connection


Always use the three-prong AC power cord supplied with this instrument. The main power cord can be used as the system disconnecting device. It disconnects the mains circuits from the mains supply.


Markings


 The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction in the documentation.


 **100-240V, 50/60 Hz, 80W MAX.** The AC symbol. The AC symbol is used to indicate the required nature of the line module input power.


 The CE mark is a registered trademark of the European Community.


 The CSA mark is a registered trademark of the CSA-International.

 The RCM mark is a registered trademark of the Australian Spectrum Management Agency.

 This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).

 This symbol indicates the Environmental Protection Use Period (EPUP) for the product's toxic substances for the China RoHS requirements.

 Packaging recycling symbol.

 USB Connection symbol.

 South Korean Class A EMC Declaration

 KCC-REM-AT1-BFSCDPESF01

ISM 1-A" This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 4).

ICES / NMB-001" This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001)

Avoid Costly Repairs

Damage to N1075A fiber-optic input connectors and electrical output connectors can be expensive to repair. Refer to [Chapter 5](#), "Connector Care" for information on proper care and cleaning.



Figure 5 Avoid Costly Repairs

CAUTION

Optical fiber-optic connectors are easily damaged when connected to dirty or damaged cables and accessories. When you use improper cleaning and handling techniques, you risk expensive instrument repairs, damaged cables, and compromised measurements.

CAUTION

Electrical circuits can be damaged by electrostatic discharge (ESD). Therefore, avoid applying static discharges to the front-panel connectors. Prior to connecting any coaxial cable to the connectors, momentarily short the center and outer conductors of the cable together. Avoid touching the front-panel connector without first touching the frame of the instrument. Be sure that the instrument is properly earth-grounded to prevent buildup of static charge. Wear a wrist-strap or heel-strap.

Installation

1 Step 1. Inspect the shipment.

Inspect the shipping container and instrument for damage. Keep the shipping container and cushioning material until you have inspected the contents of the shipment for completeness and have checked the instrument mechanically and electrically.

2 Locate the shipping list and verify that you received all the accessories and options that you ordered.

If anything is missing or defective, refer to “**Contacting Keysight**” on page 17. If the shipment was damaged, contact the carrier, then contact the nearest Keysight Sales Office. Keep the shipping materials for the carrier’s inspection. The Keysight Sales Office will arrange for repair or replacement at Keysight’s option without waiting for claim settlement.

3 Position the N1075A so that it will have sufficient clearance for airflow around the back and sides. Review **Table 13**, “Environmental Specifications,” on page 40 to ensure that your operating or storage environment is suitable for the instrument.

4 Connect the power cord and turn on the power *after* observing the following cautions and notes.

WARNING

This 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 product is likely to make the product dangerous. Intentional interruption is prohibited.

CAUTION

CAUTION, VENTILATION REQUIREMENTS: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4°C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

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.

NOTE

Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch. Alternatively, 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.

CAUTION

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

CAUTION

This instrument has auto-ranging line voltage input, be sure the supply voltage is within the specified range and voltage fluctuations do not to exceed ± 10 percent of the nominal supply voltage.

NOTE

The main power cord can be used as the system disconnecting device. It disconnects the mains circuits from the mains supply.

NOTE

Position the product so it is not difficult to operate the disconnecting device, which is the main power cord.

Contacting Keysight

For technical assistance, contact your local Keysight Call Center.

- Visit <http://www.keysight.com>
- Visit <http://www.keysight.com/find/assist>

Before returning an instrument for service, you must first call the Call Center at 1 (800) 829-4444

Returning the Instrument for Service

The instructions in this section show you how to properly package the instrument for return to an Keysight Technologies service office. If the instrument is still under warranty or is covered by an Keysight maintenance contract, it will be repaired under the terms of the warranty or contract. If the instrument is no longer under warranty or is not covered by an Keysight maintenance plan, Keysight will notify you of the cost of the repair after examining the unit.

When an instrument is returned to an Keysight service office for servicing, it must be adequately packaged and have a complete description of the failure symptoms attached.

When describing the failure, please be as specific as possible about the nature of the problem. Include copies of any instrument failure settings, data related to instrument failure, and error messages along with the instrument being returned.

Please notify the service office before returning your instrument for service. Any special arrangements for the instrument can be discussed at this time. This will help the Keysight service office repair and return your instrument as quickly as possible.

Preparing the instrument for shipping

- 1** Write a complete description of the failure and attach it to the instrument. Include any specific performance details related to the problem. The following information should be returned with the instrument.
 - Type of service required.
 - Date instrument was returned for repair.

- Description of the problem:
 - Whether problem is either constant or intermittent.
 - Whether instrument is temperature-sensitive.
 - Whether instrument is vibration-sensitive.
 - Instrument settings required to reproduce the problem.
 - Performance data.
 - Company name and return address.
 - Name and phone number of technical contact person.
 - Model number of returned instrument.
 - Full serial number of returned instrument.
 - List of any accessories returned with instrument.
- 2** Cover all front or rear-panel connectors that were originally covered when you first received the instrument.

CAUTION

Cover electrical connectors to protect sensitive components from electrostatic damage. Cover optical connectors to protect them from damage due to physical contact or dust.

CAUTION

Instrument damage can result from using packaging materials other than the original materials. Never use styrene pellets as packaging material. They do not adequately cushion the instrument or prevent it from shifting in the carton. They may also cause instrument damage by generating static electricity.

- 3** Pack the instrument. Use original packaging or comparable. Original materials are available through any Keysight office. Or, use the following guidelines:
- Wrap the instrument in anti-static plastic to reduce the possibility of damage caused by electrostatic discharge.
 - For instruments weighing less than 54 kg (120 lb), use a double-walled, corrugated cardboard carton of 159 kg (350 lb) test strength.
 - The carton must be large enough to allow approximately 7 cm (3 inches) on all sides of the instrument for packing material, and strong enough to accommodate the weight of the instrument.

- Surround the equipment with approximately 7 cm (3 inches) of packing material, to protect the instrument and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from Sealed Air Corporation (Commerce, California 90001). Air Cap looks like a plastic sheet filled with air bubbles. Use the pink (anti-static) Air Cap™ to reduce static electricity. Wrapping the instrument several times in this material will protect the instrument and prevent it from moving in the carton.
- 4** Seal the carton with strong nylon adhesive tape.
 - 5** Mark the carton “FRAGILE, HANDLE WITH CARE”.
 - 6** Retain copies of all shipping papers.

1 Getting Started

2 Measurement Setups

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This chapter provides example measurement setups for using the N1075A with the 86100D DCA and N4903B BERT. The N1075A can also be placed in an active communications link for monitoring with a real-time oscilloscope for protocol and pattern analysis. The coupled signal is converted by the N1075A into an electrical signal for the oscilloscope.

In the measurement setups, orange colored lines represent optical cables and blue colored lines represent electrical cables. The electrical cables should be high-speed low-dielectric constant cables. Recommended lengths described in "Measurements that Require a Delay Line" on page 26.

NOTE

As labeled on the test setup diagrams, the pair of 1m long electrical cables and the Delay Line optical cable can be acquired by ordering the N1027A Clock Recovery Phase Matching Cable Kit.

CAUTION

Do not place an 86100C/D DCA on top of the N1075A or N4877A instruments, as the weight and size differences may result in an unstable work environment and may damage the N1075A or N4877A. If you need to place the 86100C/D above these instruments, properly mount the instruments in a rack.

Optical Clock Recovery for 86100D DCA

Combine the N1075A with an N4877A Clock/Data Recovery and Demultiplexer to derive a timing reference that can be used to trigger an 86100D wide-bandwidth oscilloscope. For optical signals with very high data rates and low jitter, an 86107A Precision Timebase module is used in the 86100D. The ultra-low jitter output from the N1075A and N4877A combination provides an ideal signal for any version of the 86107A.

For the required electrical and optical test-setup cables, order the N1027A Clock Recovery Phase Matching Cable Kit. Use the kit's coaxial cable to connect the N1075A's front-panel O/E **DATA OUT** connector with the N4877A's **DATA IN** connector. Use the kit's optical cables when measuring signals that have large jitter components at discrete frequencies, such as a signal with spread-spectrum clocking. With such signals, accurate jitter measurements become dependent on maintaining the correct phase relationship between trigger events and sampling. Refer to "[Measurements that Require a Delay Line](#)" on page 26.

Signal and Trigger Paths

In the test setup, the optical data path goes through the N1075A to the 86100D's optical input channel (located on the 86105D or 86116C module). The electrical trigger path goes from the N1075A to the N4877A Clock/Data Recovery and Demultiplexer where the clock is recovered. The clock signal is output to the 86100D's **Trigger** input *and* to the 86107A precision timebase module.

N4877A Configuration

On the N4877A, you must specify the data rate of the input signal. This can be accomplished using either the N4877A's user interface or by remote programming. Refer to the N4877A's manual for more information. The N4877A automatically controls the output at the **AUXILIARY CLOCK OUT** (input for the 86107A) so that it is always between 4 GHz and 8 GHz. You cannot configure this.

86100C/D Configuration

On the 86100C/D, click **Setup > Channels > Precision Timebase** and enter the rate of the reference clock signal that is input to the 86107A.

NOTE

Because the N4877A's **AUXILIARY CLOCK OUT** signal that is input to the 86107A precision timebase module is a clean sine wave, it can be outside of the input frequency band shown in the dialog box.

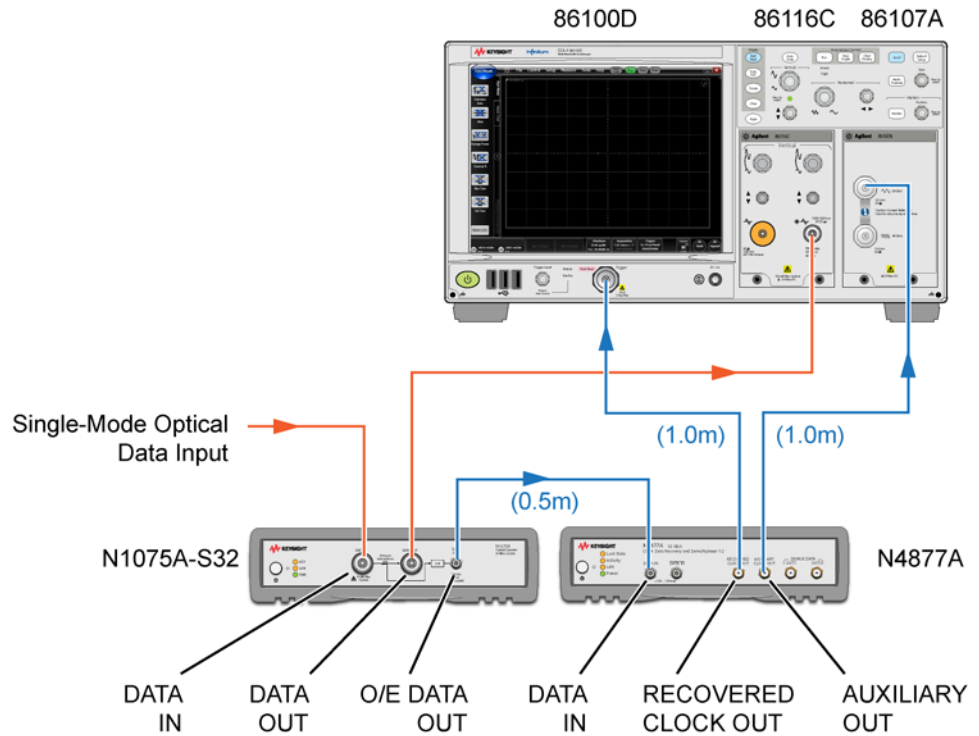


Figure 6 Single-Mode Optical with N1075A-S32

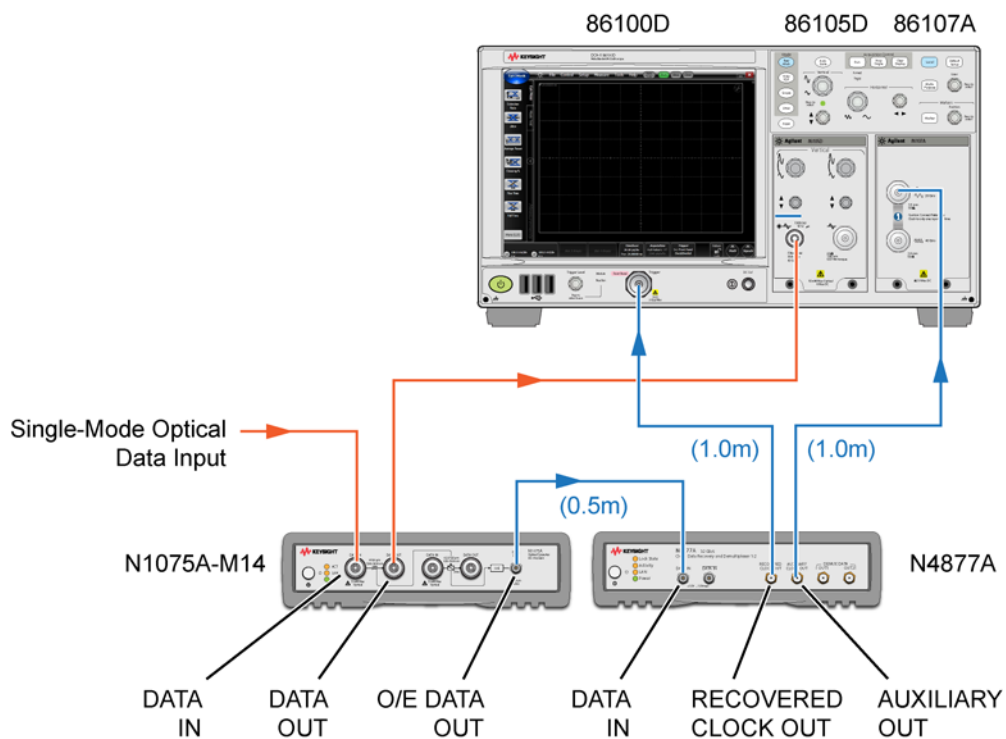


Figure 7 Single-Mode Optical with N1075A-M14

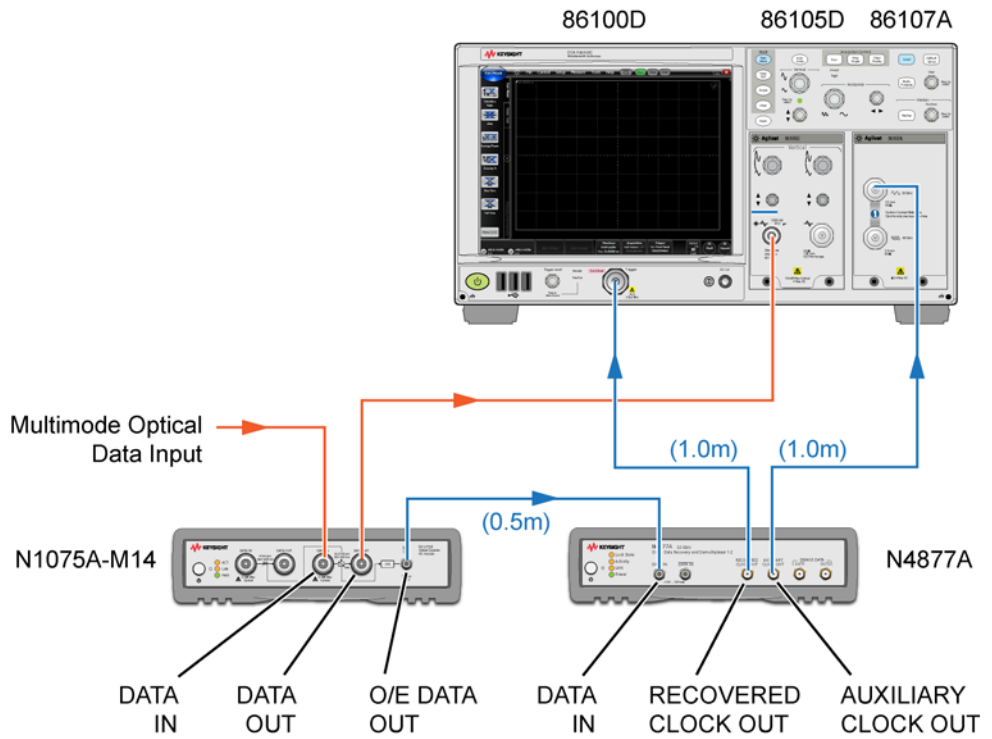


Figure 8 Multimode Optical with N1075A-M14

Measurements that Require a Delay Line

When measuring signals with an oscilloscope that is triggered with a recovered clock (in this case the 86100D), accurate jitter measurements become dependent on maintaining the correct phase relationship between trigger events and sampling. This is especially true when there are large jitter components at discrete frequencies such as a signal with spread-spectrum clocking. For example, if a large sinusoidal jitter component is present and the oscilloscope is triggered at one extreme of the jitter deviation but the sample is acquired at the opposite extreme, the apparent displayed jitter will double the actual value. Correct phase relationships are maintained by adding an optical delay line that matches the propagation delay of the signal and trigger paths. The lengths of these paths include test setup cables as well as paths internal to the test equipment. The example in [Figure 9](#) shows the significant effect, on a spread-spectrum signal, of adding a delay line to the measured PJ.

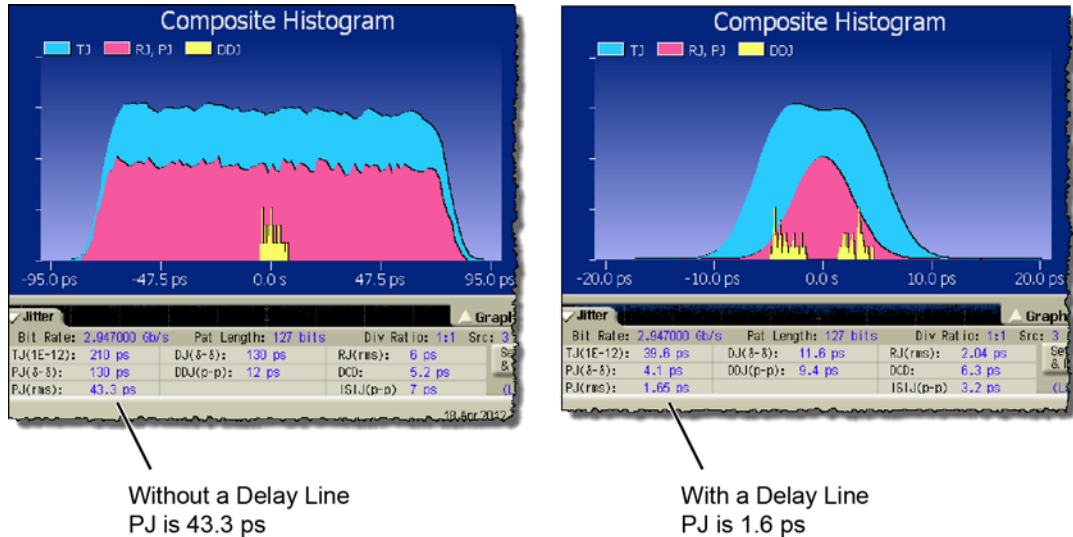


Figure 9 Effects of a Delay Line on Periodic Jitter (shown in red)

Figure 10 shows the location of the optical delay line in the test setup. The electrical cables should be high-speed low dielectric-constant cables. The 0.5 meter trigger-path cable between the N1075A and the N4877A is provided with the N1075A. An adapter is also provided with the N1075-M14, as listed in Table 7 on page 28.

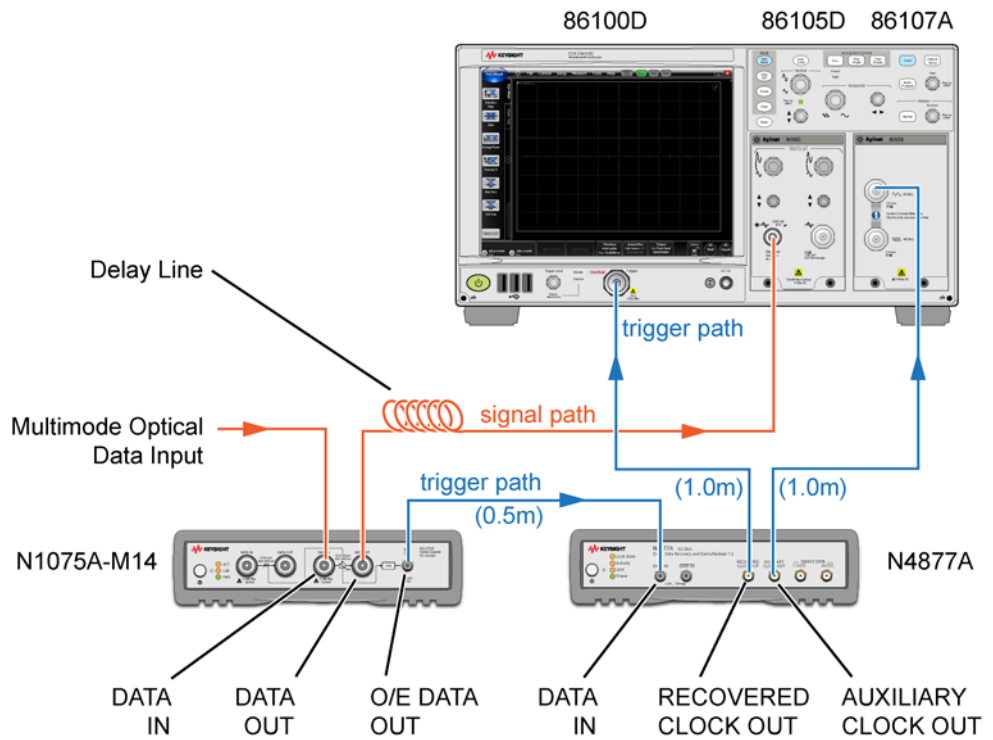


Figure 10 Test Setup with Delay Line

For the two 1m long electrical cables and the optical delay-line, order the N1027A Clock Recovery Phase Matching Cable Kit. Table 8 lists the contents of the kit, which differ depending on whether you use an N1075A-M14 or N1075A-S32 in your test setup. The lengths of the optical cables are included in case you want to build your own fiber-optic delay lines.

Table 7 Supplied Cables and Adapter

Description	Part Number
For N1075A Option M14	
Coaxial Cable, 2.92 mm (m) to 2.92 mm (m). 0.5 meters long.	N1075-60014
Adapter, 2.4 mm (m) to 3.5 mm (f)	11901-60003
For N1075A Option S32	
Coaxial Cable, 2.4 mm (m) to 2.4 mm (m), 0.5 meters long.	N1075-60012

Table 8 Contents of N1027A Clock Recovery Phase Matching Cable Kits

Description	Length	Quantity	Part Number
N1027A-M14 Clock Recovery Phase Matching Cable Kit (<i>used with N1075A-M14 instruments</i>)			
Optical cable, 9/125 μm (single mode), FC/PC	7.1m	1	N1075-60015
Optical cable, 62.5/125 μm (multimode), FC/PC	6.0m	1	N1075-60016
Coaxial cable, 2.92 mm (male) to 2.92 mm (male)	1m	2	N1075-60017
N1027A-S32 Clock Recovery Phase Matching Cable Kit (<i>used with N1075A-S32 instruments</i>)			
Optical cable, 9/125 μm (single mode), FC/PC	5.3m	1	N1075-60013
Coaxial cable, 2.92 mm (male) to 2.92 mm (male)	1m	2	N1075-60017

86100D Minimum Timebase Position

In addition to adding a delay line, you must open the 86100C/D's Trigger dialog box and set the **Minimum Timebase Position** of 24.0 ns as shown in [Figure 11](#) on page 29. Click **Setup > Trigger** to open the dialog box.

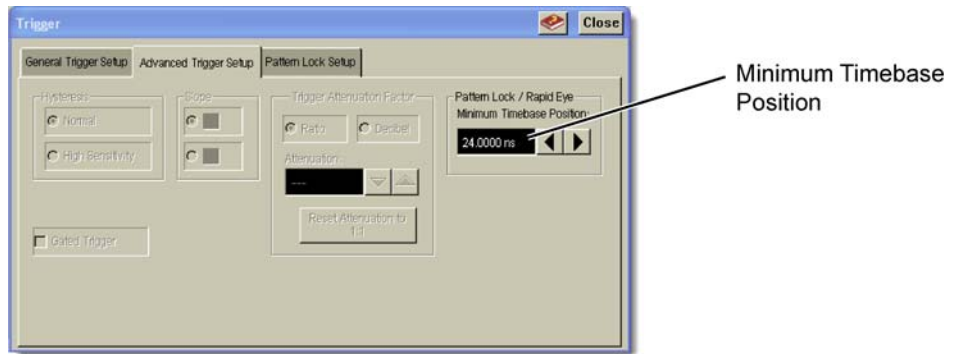


Figure 11 Entering Minimum Timebase Position

CAUTION

Do not place an 86100C/D DCA on top of the N1075A or N4877A instruments, as the weight and size differences may result in an unstable work environment and may damage the N1075A or N4877A. If you need to place the 86100C/D above these instruments, properly mount the instruments in a rack.

Clock Recovery for N4903B BERT

For BER testing with the N4903B, the following measurement setups extract the clock from optical or electrical data in order to time the BERT's error detector. For data above 14.2 Gb/s, the N4877A provides two half-rate data outputs. The setup uses the N1075A to convert a high-speed optical signal to an electrical signal. An N4877A is used to recover and provide clock and demultiplexed data to the BERT's inputs.

Optical Input Data Above 14.2 Gb/s

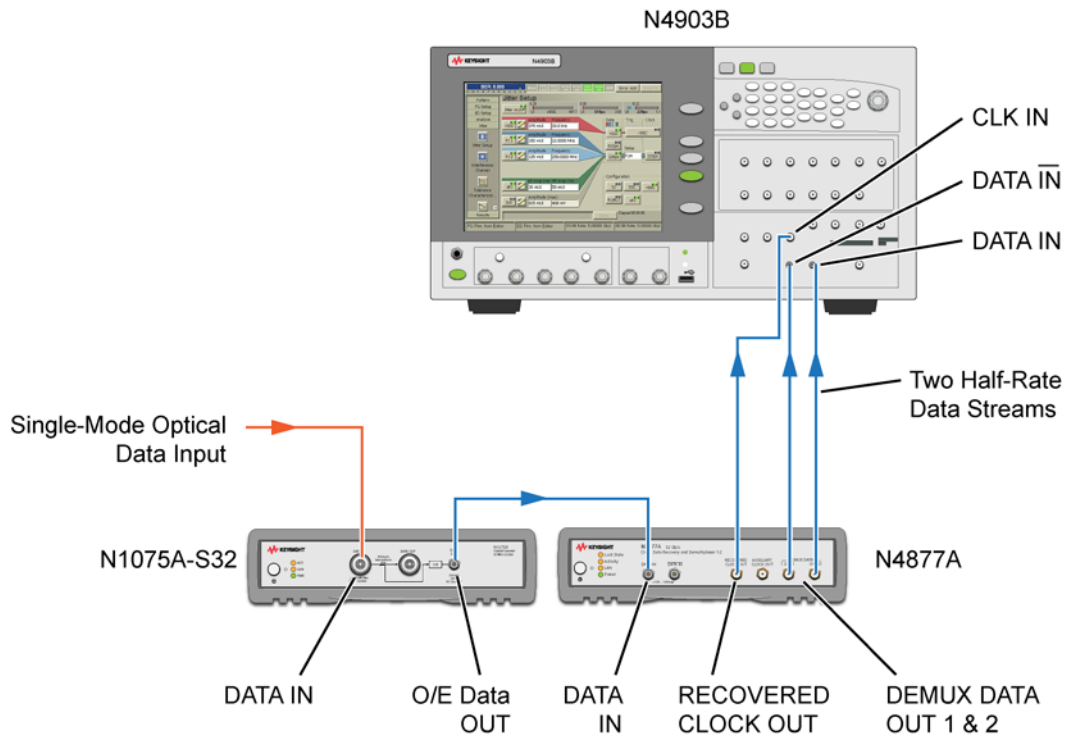


Figure 12 Single-Mode Optical with N1075A-S32

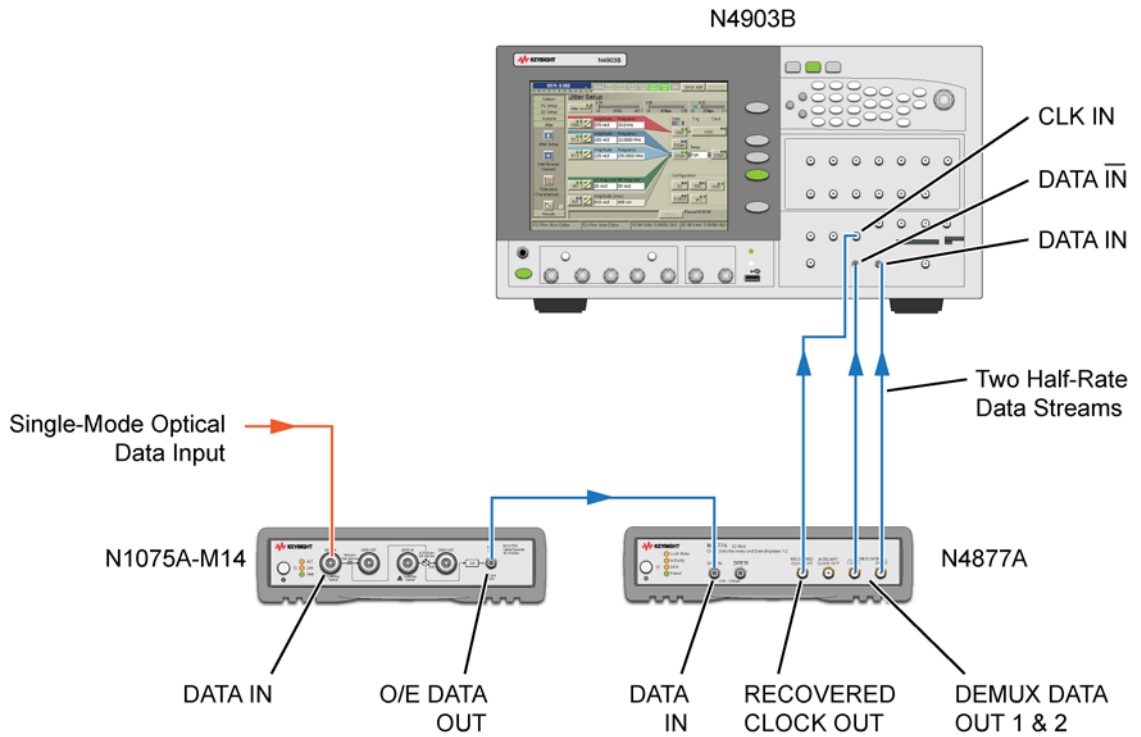


Figure 13 Single-Mode Optical with N1075A-M14

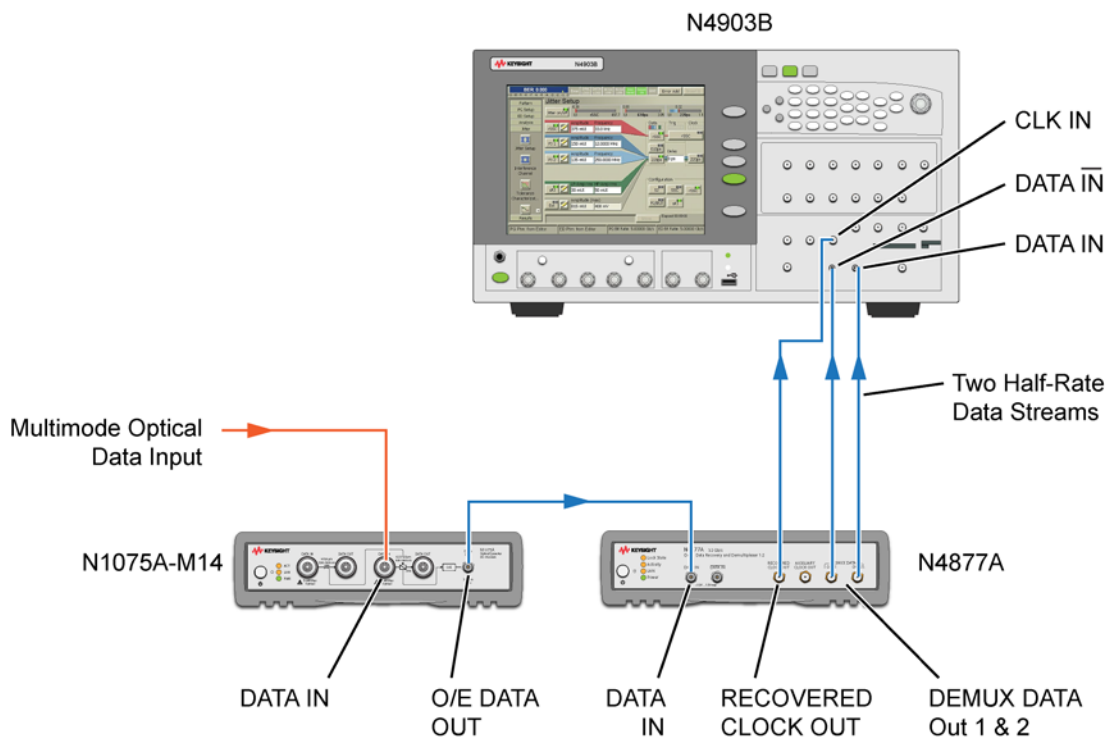


Figure 14 Multimode Optical with N1075A-M14

Electrical Data Above 14.2 Gb/s

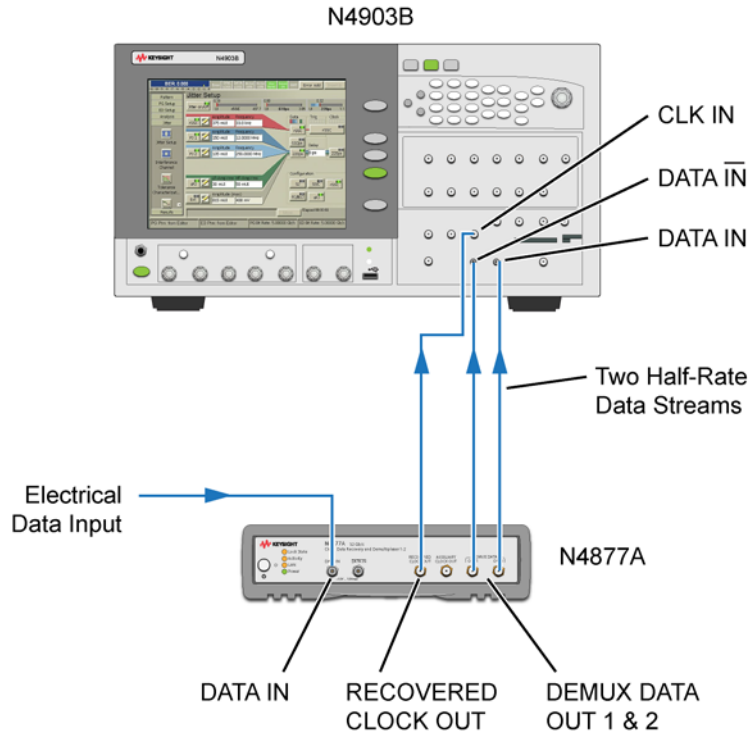


Figure 15 Electrical Clock Recovery for a BERT

Monitoring an Active Communications Link

Use the following measurement setup for monitoring an active communications link with a real-time oscilloscope for protocol and pattern analysis.

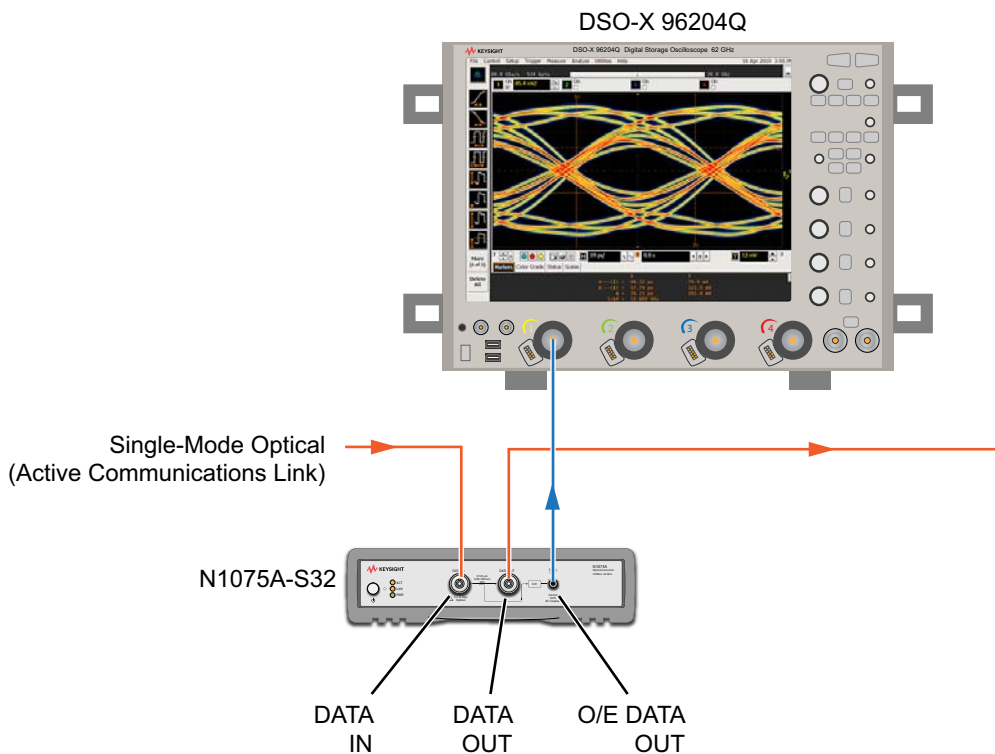


Figure 16 Example for Monitoring an Optical Signal

3 Specifications

This chapter provides the specifications for the N1075A. Should the Declaration of Conformity (DOC) be required, contact an Keysight Sales Representative or the closest Keysight Sales Office. Alternately, contact Keysight at: www.keysight.com.

NOTE

Factory Calibration Cycle. For optimum performance, the instrument should have a complete verification of specifications once every 24 months.

Option S32 Specifications and Characteristics

NOTE

All performance specifications verified at 1550 nm.

Table 9 N1075A Option S32 Specifications

Item	Specification
Maximum Optical Power	9 mW eye amplitude
Operating Wavelength Range	1260 nm to 1600 nm (characteristic)
Data Rate	50 Mb/s to 32 Gb/s
Internal Split Ratio	50/50 (<i>nominal</i>)
Insertion Loss	4 dB (characteristic)
Conversion Gain ^{* †}	110 V/W minimum 300 V/W (<i>characteristic</i>)
NEP	14 μ W maximum (characteristic) 7.5 μ W (characteristic)
Optical Return Loss	25 dB (characteristic)
Optical Input Connector	FC/PC [‡]
Electrical Connector	2.4 mm

* Conversion gain is verified at 1550 nm. Typical performance at 1310 nm is reduced by 50% of the 1550 nm performance.

† Conversion gain does not limit locking sensitivity when used with the N4877A. Refer to [Table 10](#) on page 37.

‡ Connector type depends on installed front-panel adapter. N1075A ships with FC/PC optical adapters. (Refer to [Table 2](#) on page 8.)

Table 10 Minimum Optical Modulation Power to Achieve Lock (N1075A with N4877A) (*characteristics*)

Wavelength / Data Rate	Eye Amplitude Minimum Power* (<i>characteristic</i>)
1550 nm single-mode path	
10 Gb/s	-15 dBm (characteristic)
14 Gb/s	-14 dBm (characteristic)
28 Gb/s	-10 dBm (characteristic)
32 Gb/s	-8 dBm (characteristic)
1310 nm single-mode path	
10 Gb/s	-12 dBm (characteristic)
14 Gb/s	-11 dBm (characteristic)
28 Gb/s	-7 dBm (characteristic)
32 Gb/s	-5 dBm (characteristic)

* At the input of the N1075A.

Option M14 Specifications and Characteristics

All performance specifications verified at 1550 nm and 850 nm.

Table 11 N1075A Option M14 Specifications (Sheet 1 of 2)

Item	Specification
Maximum Optical Input (NRZ)	5 mW eye amplitude
Operating Wavelength Range	
Single-Mode	1260 nm to 1360 nm and 1490 nm to 1600 nm (characteristic)
Multimode	830 nm to 1360 nm (characteristic)
Optical Input Connector	FC/PC*
Electrical Connector	3.5 mm
Specifications at 1550 nm Wavelength	
Data Rate	50 Mb/s to 16 Gb/s (For rates above 16 Gb/s, refer to Table 12 on page 39)
Optical Split Ratio	50/50 (<i>nominal</i>)
Insertion Loss	4.0 dB (characteristic)
Conversion Gain [†]	95 V/W minimum 110 V/W (characteristic)
NEP	12 μ W maximum 10 μ W (characteristic)
Optical Return Loss	25 dB (characteristic)
Specifications at 850 nm Wavelength	
Data Rate	50 Mb/s to 16 Gb/s (For rates above 16 Gb/s, refer to Table 12 on page 39)
Optical Split Ratio	70/30 (<i>nominal</i>)
Insertion Loss	4.0 dB (characteristic)
Conversion Gain ^b	55 V/W minimum 80 V/W (characteristic)
NEP	17 μ W maximum (characteristic) 10 μ W (characteristic)

Table 11 N1075A Option M14 Specifications (Sheet 2 of 2)

Item	Specification
Optical Return Loss	16 dB (characteristic)

* Connector type depends on installed front-panel adapter. N1075A ships with FC/PC adapters. (Refer to [Table 2](#) on page 8.)

† Conversion gain does not limit locking sensitivity when used with the N4877A.

Table 12 Minimum Optical Modulation Power to Achieve Lock (N1075A with N4877A) (*characteristics*)

Wavelength / Data Rate	Eye Amplitude Minimum Power* (<i>characteristic</i>)
1550 nm single-mode path	
10 Gb/s	-9 dBm (characteristic)
14 Gb/s	-8 dBm (characteristic)
25 Gb/s	-6 dBm (characteristic)
28 Gb/s	-4 dBm (characteristic)
1310 nm single-mode path	
10 Gb/s	-10 dBm (characteristic)
14 Gb/s	-9 dBm (characteristic)
25 Gb/s	-7 dBm (characteristic)
28 Gb/s	-4 dBm (characteristic)
850 nm multimode path	
10 Gb/s	-9 dBm (characteristic)
14 Gb/s	-8 dBm (characteristic)
25 Gb/s	-6 dBm (characteristic)
28 Gb/s	-4 dBm (characteristic)

* At the input of the N1075A.

Environmental, Noise, and EMC Specifications

Table 13 Environmental Specifications

Item	Specification
Use	indoor
Temperature Operating	0°C to +40 °C (32°F to + 105 °F)
Maximum Relative Humidity	80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.
Altitude Operating	Up to 3,000 meters
Line Power	100–240 VAC 50/60 Hz 80W Max.
Weight net	
Option S32	2.72 kg (6 lb)
Option M14	3.06 kg (6.75 lb)
Dimensions (H x W x D)	5.7 cm x 22.5 cm x 35.2 cm 2 1/4 in x 8 7/8 in x 13 7/8 in

CAUTION

This product is designed for use in Installation Category II and Pollution Degree 2, per IEC 61010 Second Edition and 664 respectively.

Compliance with German Noise Requirements

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung –3.GSGV Deutschland).

Table 14 Acoustic Noise Emission Geräuschemission

LpA < 70 dB	LpA < 70 dB
Operator position	am Arbeitsplatz
Normal position	normaler Betrieb
Per ISO 7779	nach DIN 45635 t.19

Compliance With Canadian EMC Requirements

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme a la norme NMB du Canada.

The N1075A complies with the European EMC Directive 2004/108/EC

- IEC 61326-2-1:2005/EN 61326-2-1:2006
- CISPR Pub 11 Group 1, Class A
- AS/NZS CISPR11:2004
- ICES/NMB-001:2006

South Korean Class A EMC Declaration

A 급 기기 (업무용 방송통신기자재)

This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

이 기기는 업무용 (A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

3 Specifications

4 Remote Queries

Connecting to the N1075A [44](#)

Common Query [46](#)

:SYStem:COMMunicate:LANetwork Queries [47](#)

The programming syntax for the N1075A conforms to the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation and to the Standard Commands for Programmable Instruments (SCPI).

NOTE

Only a limited number of instrument queries are available. Because the N1075A has no user settings, there are no programming commands that change instrument settings.

NOTE

Before you can send queries to the N1075A, you must install the Keysight IO Library Suite on your PC.

Connecting to the N1075A

The N1075A supports the common query, ***IDN?**, and several **:SYSTEM** queries that allow you, for example, to return the IP address and the instrument's identification and option strings. You can connect to the N1075A via a LAN or USB connection.

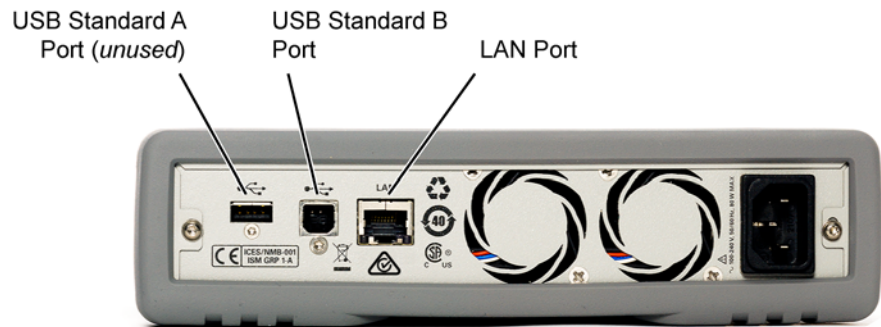


Figure 17 Rear-Panel USB and LAN Ports

USB Interface

The USB interface requires no configuration. Just connect your N1075A to your PC using a USB (Standard-B) cable and the interface will self-configure. The USB Standard A connector is unused as identified in [Figure 17](#).

The N1075A has a device type (Standard-B) USB port on the rear panel for remote programming. This is the USB port next to the LAN connector. To connect to the N1075A via USB, you need the N1075A's USB ID. When the N1075A's USB port is connected to a computer via a USB cable, a dialog automatically appears. This dialog is generated by the Keysight IO Library Suite and shows the USB ID. You can either use the full VISA resource string or assign an alias. Refer to the Keysight IO Libraries Suite documentation for details.

LAN Interface

Before you can establish a connection via LAN, you must send the

```
:SYSTEM:COMMunicate:LANetwork:IPADress?
```

query to the N1075A's rear-panel USB port. After reading the returned IP address, you can then send queries via the LAN. Refer to "USB Interface" on page 44.

The LAN interface usually configures itself, as it uses the DHCP protocol. You may need to contact your network administrator for help in establishing communication with the LAN interface.

NOTE

Before sending the query, turn on the N1075A and wait until the front-panel **LAN** status light turns green.

Common Query

The only common query supported by the N1075A is the ***IDN?** query.

*IDN?

Returns the N1075A'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. The revision code contains a firmware revision number followed by a hardware revision number separated by dashes.

Returned Format

```
"<manufacturer>,<model number>,<serial number>,<revision>"<NL>
```

Example Returned String

```
"Keysight Technologies,N1075A,US12345678, 0.8.11278.12-1"
```

:SYStem:COMMunicate:LANetwork Queries

:DGATeway?

:SYSTem:COMMunicate:LANetwork:DGATeway?

Description

Returns the N1075A's gateway IP address. A gateway is a network device that provides a connection between networks. The default gateway setting is the IP address of such a device. 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 Response

123.168.80.3

:DHCPprotocol?

:SYSTem:COMMunicate:LANetwork:DHCPprotocol?

Description

Returns a "1" if a device uses DHCP (Dynamic Host Configuration Protocol), which is always the case with the N1075A. DHCP is a protocol whereby a dynamic IP address is automatically assigned to an device.

Response

"1"

:DNServer?

:SYSTem:COMMunicate:LANetwork:DNServer?

Description

Returns the DNS (Domain Name Service) server address. DNS 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. 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 Response

192.168.42.19

:DOMain?

:SYSTem:COMMunicate:LANetwork:DOMain?

Description

Returns the domain name for the N1075A. The domain name is a registered name on the internet, which is translated into an IP address. The N1075A simply reports the name of the domain that was determined when the N1075A was connected to the LAN.

Example Response

"quality.mydomain.com"

:IPADress?

Query

:SYSTem:COMMunicate:LANetwork:IPADress?

Returns the N1075A's IP address. Before a LAN connection is established, you must send this query over a connection to the N1075A's rear-panel USB port.

Example Response

"123.456.7.8"

:HOSTname?

:SYSTem:COMMunicate:LANetwork:HOSTname?

Description

Returns the N1075A's host name. A host name is the host portion of the domain name, which is translated into an IP address. 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 Response

```
"A-n1075a-430111"
```

```
:LAN?
```

```
:SYSTem:COMMunicate:LAN?
```

Description

Returns the N1075A's IP address.

Example Response

```
"122.141.83.95"
```

```
:MACaddress?
```

```
:SYSTem:COMMunicate:LANetwork:MACaddress?
```

Description

Returns the Media Access Control address (MAC address) for the N1075A. The MAC address is a unique identifier of network interface cards. The MAC address is assigned during manufacturing and cannot be changed.

Example Response

```
"0030C31162B7"
```

```
:SNMask?
```

```
:SYSTem:COMMunicate:LANetwork:SNMask?
```

Description

Returns the subnet mask. 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. 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 Response

```
"255.255.248.0"
```

:WINServer?

:SYSTem:COMMunicate:LANetwork:WINServer?

Description

Returns the Windows Internet Naming Service (WINS) which 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.

Example Response

“141.212.69.152”

5 Connector Care

Electrical Connector Care	52
Fiber-Optic Connectors	59
Fiber-Optic Connector Care	64

Damage to electrical and fiber-optic input connectors (as well as connectors on calibration and verification devices, test ports, cables, and other devices) can degrade measurement accuracy and damage instruments. Replacing a damaged electrical and fiber-optic connectors can cost thousands of dollars, not to mention lost time! This expense can be avoided by observing the important precautions described in the topics referenced below.

Electrical Connector Care

CAUTION

The circuits can be damaged by electrostatic discharge (ESD). Therefore, avoid applying static discharges to the front-panel connectors. Before connecting any coaxial cable to the connectors, momentarily short the center and outer conductors of the cable together. Avoid touching the front-panel connectors without first touching the frame of the instrument. Be sure the instrument is properly earth-grounded to prevent buildup of static charge.

CAUTION

Electrostatic discharge (ESD) can damage or destroy electronic components. Coaxial cables with both ends unconnected may store electrostatic charges. Before connecting any coaxial cable of this sort to a device or instrument, momentarily short the center and outer conductors of the cable. When making connections, ensure the proper use of a grounded, resistor-isolated wrist strap.

Handling and storage

- Keep connectors clean
- Extend sleeve or connector nut
- Use plastic endcaps during storage
- Do not touch mating plane surfaces
- Do not set connectors contact-end down

Visual inspection

- Inspect all connectors carefully before every connection
- Look for metal particles, scratches, and dents
- Do not use damaged connectors

Cleaning

- Clean with compressed air first
- Clean the connector threads
- Do not use abrasives

- Do not get liquid onto the plastic support beads

Connector Savers

Connector savers are useful in prolonging instrument life and ensuring better quality measurements. Refer to the following table for a list of commonly used connector savers.

Table 15 Available Connector savers

Connector	Part Number	Comment
3.5 mm	85052-60013	Metrology grade
2.4 mm	85056-60007	Metrology grade

Making Connections

- Align connectors carefully
- Make preliminary connection lightly
- To tighten, turn connector nut only
- Do not apply bending force to connection
- Do not over tighten preliminary connection
- Do not twist or screw in connectors
- Do not tighten past the "break" point of the torque wrench

When mating two connectors, keep the connectors from rotating relative to one another. You can use open-ended wrenches on wrench flats on the outer bodies of the connector to help restrict rotation. The following table lists the common wrench flat widths for many Keysight connector components, as well as wrench part numbers when available. There are exceptions to this list, and connector components made by suppliers other than Keysight Technologies are unlikely to use the same wrench flat dimensions.

Table 16 Recommended Torque Wrenches

Connector	Coupling Torque (N-cm/in-lb)	Width Across Coupling Nut Wrench Flats	Keysight Torque Wrench #	Keysight Open End Wrench #	Size
3.5 mm standard	90/8	5/16"	8710-1765	8710-1761	7 mm
3.5 mm NMD	90/8	20 mm	8710-1764	8710-1770	9/16"
2.4 mm NMD	90/8	20 mm	8710-1764	8710-1770	1/2"
SMA	56/5	5/16"	8710-1582	–	–

Cleaning RF Connectors

WARNING

Cleaning connectors with alcohol shall only be done with the instrument 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.

CAUTION

Improper connector care, cleaning, or use of mismatched cable connectors can invalidate the published specifications and damage connectors. Clean all cables before applying to any connector. Repair of damaged connectors due to improper use is not covered under warranty. Dirty or damaged connectors are often the cause of measurement errors.

The best way to keep connectors clean and in good condition is to use the plastic protector caps and never rotate the connectors relative to one another during connect/disconnect cycles. Before using connectors for a critical application, inspect the connector interfaces with a microscope (~ 20X). Look for dirt, contaminants, dented or scratched outer conductor mating surfaces, and damaged center conductors.

- 1 Use a swab dipped in clean isopropyl alcohol to clean off the outer conductor mating surfaces and the ends of the center conductors. Be careful not to let the alcohol get on the insulator bead, as this may damage the bead. Be careful not to exert too much force on the center conductors, especially slotless female center conductors, as they may be damaged. Use a swab that has a sharp enough corner to clean all areas of the connector interface. Don't forget to clean off the coupling nut threads.

- 2 Blow off the alcohol with clean compressed air. Compressed air can reduce the temperature of connectors dramatically, and this can have a significant effect upon the performance of calibration and verification components. If the connector components being cleaned are to be used in a critical measurement application, the temperature of these components should be allowed to stabilize before they are used.
- 3 Reinspect the connectors under the microscope. If the outer conductor mating face of a connector has raised material that would keep it from making complete contact with another connector, it should be replaced. If the fingers of a slotted female contact are spread open, rather than crimped closed, the connector should be replaced. If a connector has a slotless contact with damaged fingers, the connector should be repaired or replaced.

Table 17 Cleaning Accessories

Description	Part Number	Comments
Swabs (100)	9301-1243	–
99.5 % Alcohol	–	Alcohol should be kept clean and free of water. Do not use other solvents as they may damage the insulator bead.
Compressed air (235 ml)	–	1,1,1,2 tetrafluoroethane aerosol CFCs: 0%; HCFCs: 100% CAUTION: Use this product only as directed! If the aerosol container is shaken or tilted, the spray will leave a residue on the parts. Filtered and regulated, piped-in compressed air is the preferred solution.
Lint free cloth (one)	–	–

3.5 mm Precision Connectors

To ensure measurement accuracy, use 3.5 mm precision connectors. However, you can use SMA connectors if special care is taken when mating the connectors, and all connectors are undamaged and clean. Before each use, check the mechanical dimensions of all connectors with a connector gauge to make sure that the center conductors are positioned correctly. Remember, all connections must be made for consistent and repeatable mechanical (and therefore electrical) contact between the connector mating surfaces. Carefully study and practice all procedures in this topic until you can successfully perform the procedures repeatedly. Accuracy and repeatability are critical for good high frequency measurements.

CAUTION

Precision 3.5 mm microwave connectors are compatible with an SMA connector within its specification. Due to the variable quality of the SMA connector, mating with an SMA can sometimes cause severe damage to the 3.5 mm connector.

NOTE

The device connection procedures differ in several important ways from traditional procedures used in the industry. Keysight Technologies have developed the following procedures through careful experimentation.

Visually Inspecting 3.5 mm Connectors

You must always begin a calibration with a careful and thorough visual inspection of the connectors, including the test set connectors, to ensure they are not damaged.

CAUTION

Ensure that you and your equipment are grounded prior to touching any center conductor so you will not produce static electricity and create a potential for electrostatic discharge. When using or cleaning connectors, be aware that you are touching exposed center connectors that are connected directly to the internal circuits of the oscilloscope. Touching the center conductor, especially with a wiping or brushing motion, can cause an electrostatic discharge and severely damage these sensitive circuits.

NOTE

Use an illuminated, 4-power magnifying glass for visual inspection.

- 1 Examine the connectors for obvious problems, such as deformed threads, contamination, or corrosion.
- 2 Examine the mating surfaces of each connector. Look for scratches, rounded shoulders, misalignment, or any other signs of wear or damage.
- 3 Ensure that the surfaces are clean, free of dust and solvent residues. Dirt or damage visible with a 4-power magnifying glass can cause degraded electrical performance and possible connector damage.
- 4 Repair or discard all damaged or worn connectors.

Mechanically Inspecting 3.5 mm Connectors

After you perform a visual inspection of the precision connectors, you must perform a mechanical inspection. This inspection consists checking the mechanical dimensions of all connectors, including those on the test set. The purpose of this inspection is to ensure that perfect mating will occur between the connector surfaces. Perfect mating assures a good electrical match and is important to avoid damaging the connectors themselves, especially on the instrument.

Center Conductor The critical dimension to be measured is the recession of the center conductor. No protrusion of the center conductor's shoulder is allowable on any connector. The maximum allowable recession of the center conductor shoulder is 0.003 in. (0.08 mm) on all connectors, except those on the channel connectors. On the channel connectors, not only is no protrusion allowable, the shoulder of the center conductor must be recessed at least 0.0002 in. (0.005 mm). The maximum allowable recession of the center conductor shoulder on the channel connectors is 0.0021 in. (0.056 mm).

Outer Conductor If any contact protrudes beyond the outer conductor mating plane, the contact is out of tolerance and must be replaced. If the center conductor is not recessed at least 0.0002 in. (0.005 mm), it is out of tolerance and must be replaced. In both cases, the out-of-tolerance connector will permanently damage any connector attached to it. Destructive electrical interference will also result due to buckling of the female contact fingers. This is often noticeable as a power hole several dB deep occurring at about 22 GHz.

If any contact is recessed too far behind the outer conductor mating plane (0.0021 in. 0.056 mm, except in test sets), poor electrical contact will result, causing high electrical reflections. Careful gauging of all connectors will help prevent this condition.

NMD connectors are rugged test port or cable connectors.

A 56 N-cm. torque wrench should be used to connect male SMA connectors to either 3.5 mm or 2.92 mm connectors. A 90 N-cm torque wrench should be used to connect male 3.5 mm or male 2.92 mm connectors to mating female connectors.

Disconnecting 3.5 mm Connectors

To disconnect, follow this procedure:

- 1 Loosen the connector nut on the male connector with the torque wrench. Leave the connection finger tight.
- 2 While supporting the calibration device, gently unfasten the connectors and pull the calibration device straight out of the channel connector. Do not twist either the center conductor or the outer conductor housing or exert lateral or vertical (bending) force on the connection.

NOTE

Some precision 3.5 mm female connector fingers are very tight and can pull the center pin of their mates out past specifications when the connectors are disconnected. If such a male pin is inserted into a female connector, it can cause considerable damage by pushing the female center conductor back too far. Be aware of this possibility and check all connectors before mating them again.

SMA Connectors

You must carefully inspect a SMA connector prior to mating with a precision 3.5 mm connector (this includes a new SMA connector). This must be both a visual and mechanical inspection. Use a precision connector gauge designed to measure SMA connectors. Remember that gauging SMA connectors is the most important step you can take to prevent damaging your equipment. Significant structural and dimensional differences exist between these SMA and precision connectors. Precision 3.5 mm connectors, also known as APC-3.5 connectors, are air-dielectric devices. Only air exists between the center and outer conductors. The male or female center conductor is supported by a plastic "bead" within the connector. On the other hand, a plastic dielectric supports the entire length of the center conductor of an SMA connector. In addition, the diameter of both the center and outer conductors of SMA connectors differ from that of a precision 3.5 mm connector. When an SMA connector is mated with a precision 3.5 mm connector, the connection exhibits a continuity mismatch (SWR), typically about 1.10 at 20 GHz. This continuity mismatch is less than the mismatch that occurs when precision 3.5 mm connectors are mated. Please keep this mismatch in mind when making measurements on SMA and precision 3.5 mm coupled junctions.

NOTE

A male SMA connector pin that is too long can smash or break the delicate fingers on the precision 3.5 mm female connector.

Fiber-Optic Connectors

A critical but often overlooked factor in making a good lightwave measurement is the selection of the fiber-optic connector. The differences in connector types are mainly in the mechanical assembly that holds the ferrule in position against another identical ferrule. Connectors also vary in the polish, curve, and concentricity of the core within the cladding. Mating one style of cable to another requires an adapter. Keysight Technologies offers additional adapters for most instruments, including the N1075A, to allow testing with many different cables. Different adapters are shown in [Table 18](#) on page 61. The following picture shows the basic components of a typical connectors.

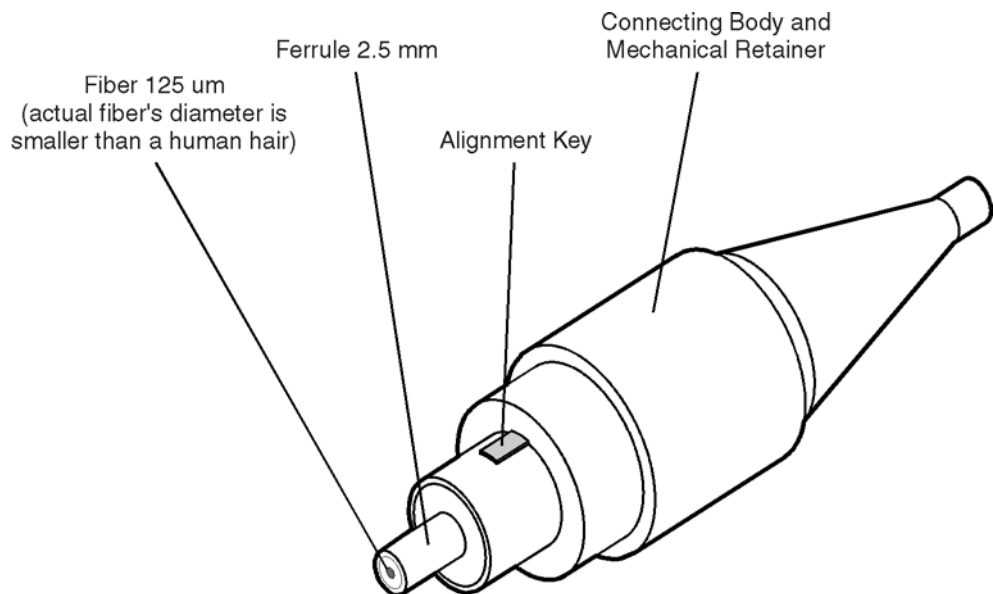


Figure 18 Basic components of a connector.

The instrument tolerance for reflection and insertion loss must be known when selecting a connector from the wide variety of currently available connectors. Some items to consider when selecting a connector are:

- How much insertion loss can be allowed?
- Will the connector need to make multiple connections? Some connectors are better than others, and some are very poor for making repeated connections.
- What is the reflection tolerance? Can the system take reflection degradation?
- Is an instrument-grade connector with a precision core alignment required?
- Is repeatability tolerance for reflection and loss important? Do your specifications take repeatability uncertainty into account?
- Will a connector degrade the return loss too much, or will a fusion splice be required? For example, many DFB lasers cannot operate with reflections from connectors. Often as much as 90 dB isolation is needed.

Over the last few years, the FC/PC style connector has emerged as the most popular connector for fiber-optic applications. While not the highest performing connector, it represents a good compromise between performance, reliability, and cost. If properly maintained and cleaned, this connector can withstand many repeated connections.

However, many instrument specifications require tighter tolerances than most connectors, including the FC/PC style, can deliver. These instruments cannot tolerate connectors with the large non-concentricities of the fiber common with ceramic style ferrules. When tighter alignment is required, Keysight Technologies instruments typically use a connector such as the Diamond HMS-10, which has concentric tolerances within a few tenths of a micron. Keysight Technologies then uses a special universal adapter, which allows other cable types to mate with this precision connector.

Table 18 Examples of Available Connector Types (Sheet 1 of 2)








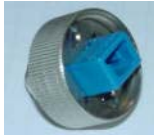



Connector Interface	Keysight Model Number	Example
DIN 4108/47256	81000SI	
E-2000	81000HI Physical Contact Connections	
	81000PI Non-Physical Contact Connections	
FC/APC	81000NI	
FC/PC	81000FI	

Table 18 Examples of Available Connector Types (Sheet 2 of 2)

Connector Interface	Keysight Model Number	Example
LC	81000LI Physical Contact Connections	
	81002LI Non-Physical Contact Connections	
MU	81000MI Physical Contact Connections	
	81002MI Non-Physical Contact Connections	
SC	81000KI	
ST	81000VI	

The HMS-10 encases the fiber within a soft nickel silver (Cu/Ni/Zn) center which is surrounded by a tough tungsten carbide casing, as shown in [Figure 19](#) on page 63.

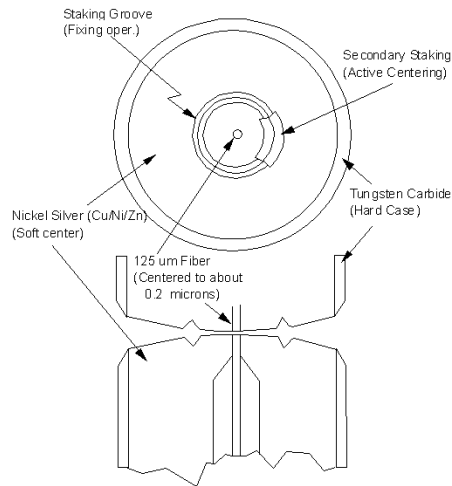


Figure 19 Cross-section of the Diamond HMS-10 connector.

The nickel silver allows an active centering process that permits the glass fiber to be moved to the desired position. This process first stakes the soft nickel silver to fix the fiber in a near-center location, then uses a post-active staking to shift the fiber into the desired position within 0.2 μm. This process, plus the keyed axis, allows very precise core-to-core alignments. This connector is found on most Keysight Technologies lightwave instruments.

The soft core, while allowing precise centering, is also the chief liability of the connector. The soft material is easily damaged. Care must be taken to minimize excessive scratching and wear. While minor wear is not a problem if the glass face is not affected, scratches or grit can cause the glass fiber to move out of alignment. Also, if unkeyed connectors are used, the nickel silver can be pushed onto the glass surface. Scratches, fiber movement, or glass contamination will cause loss of signal and increased reflections, resulting in poor return loss.

Fiber-Optic Connector Care

Today, advances in measurement capabilities make connectors and connection techniques more important than ever. Damage to the connectors on calibration and verification devices, test ports, cables, and other devices can degrade measurement accuracy and damage instruments. Replacing a damaged connector can cost thousands of dollars, not to mention lost time! This expense can be avoided by observing the simple precautions presented in the following topics. Included in the topics is a brief list of tips for caring for electrical connectors. Accurate and repeatable measurements require clean connections.

Use the following guidelines to achieve the best possible performance when making measurements on a fiber-optic system:

- Never use metal or sharp objects to clean a connector and never scrape the connector.
- Avoid matching gel and oils.

NOTE

While gel and oils often work well on first insertion, they are great dirt magnets. The oil or gel grabs and holds grit that is then ground into the end of the fiber. Also, some early gels were designed for use with the FC, non-contacting connectors, using small glass spheres. When used with contacting connectors, these glass balls can scratch and pit the fiber. If an index matching gel or oil must be used, apply it to a freshly cleaned connector, make the measurement, and then immediately clean it off. Never use a gel for longer-term connections and never use it to improve a damaged connector. The gel can mask the extent of damage and continued use of a damaged fiber can transfer damage to the instrument.

-
- When inserting a fiber-optic cable into a connector, gently insert it in as straight a line as possible. Tipping and inserting at an angle can scrape material off the inside of the connector or even break the inside sleeve of connectors made with ceramic material.
 - When inserting a fiber-optic connector into a connector, make sure that the fiber end does not touch the outside of the mating connector or adapter.
 - Avoid over tightening connections.

NOTE

Unlike common electrical connections, tighter is not better. The purpose of the connector is to bring two fiber ends together. Once they touch, tightening only causes a greater force to be applied to the delicate fibers. With connectors that have a convex fiber end, the end can be pushed off-axis resulting in misalignment and excessive return loss. Many measurements are actually improved by backing off the connector pressure. Also, if a piece of grit does happen to get by the cleaning procedure, the tighter connection is more likely to damage the glass. Tighten the connectors just until the two fibers touch.

- Keep connectors covered when not in use.
- Use fusion splices on the more permanent critical nodes. Choose the best connector possible. Replace connecting cables regularly. Frequently measure the return loss of the connector to check for degradation, and clean every connector, every time.

All connectors should be treated like the high-quality lens of a good camera. The weak link in instrument and system reliability is often the inappropriate use and care of the connector. Because current connectors are so easy to use, there tends to be reduced vigilance in connector care and cleaning. It takes only one missed cleaning for a piece of grit to permanently damage the glass and ruin the connector.

Inspecting Connectors

Fiber-optic connectors are susceptible to damage that is not immediately obvious to the naked eye. Therefore, you can make bad measurements without being aware of a connector problem. Although microscopic examination and return loss measurements are the best way to ensure good connections, they are not always practical. An awareness of potential problems, along with good cleaning practices, can ensure that optimum connector performance is maintained. With glass-to-glass interfaces, it is clear that any degradation of a ferrule or the end of the fiber, any stray particles, or finger oil can have a significant effect on connector performance.

Figure 20 on page 66 shows the end of a clean fiber-optic connector. The dark circle in the center of this graphic is the fiber's 125 μm core and cladding which carries the light. The surrounding area is the soft nickel-silver ferrule.

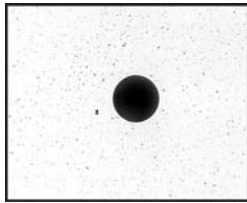


Figure 20 Clean, problem-free fiber end and ferrule.

Figure 21 shows a fiber end that is dirty from neglect or perhaps improper cleaning. Loose particles or oils are smeared and ground into the end of the fiber causing light scattering and poor reflection. Not only is the precision polish lost, but this action can also grind off the glass face and destroy the connector.

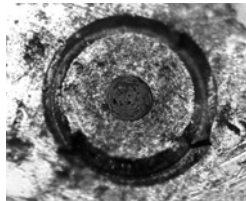


Figure 21 Dirty fiber end and ferrule from poor cleaning.

Figure 22 shows physical damage to the glass fiber end caused by either repeated connections made without removing loose particles from the fiber end or by using improper cleaning tools. This damage can be severe enough to transfer the damage from the connector end to a good connector that comes in contact with it.

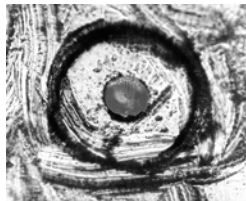


Figure 22 Damage from improper cleaning.

The cure for these problems is disciplined connector care.

Visual inspection of fiber ends can be helpful. Contamination or imperfections on the cable end face can be detected as well as cracks or chips in the fiber itself. Use a microscope (100X to 200X magnification) to inspect the entire end face for contamination, raised metal, dents in the metal, and any other imperfections.

Inspect the fiber for cracks and chips. Visible imperfections not touching the fiber core may not affect performance (unless the imperfections keep the fibers from contacting).

WARNING

Always remove both ends of fiber-optic cables from any instrument, system, or device before visually inspecting the fiber ends. Disable all optical sources before disconnecting fiber-optic cables. Failure to do so may result in permanent injury to your eyes.

Cleaning an Optical Adapter

The fiber-optic input and output connectors on many Keysight Technologies instruments employ universal adapters such as those shown in [Figure 23](#). These adapters allow you to connect the instrument to different types of fiber-optic cables.



Figure 23 Examples of Universal adapters

WARNING

If flammable fluids are used to clean connectors, the fluid shall not be placed on the instrument during use or when connected to mains voltage. Cleaning the connectors shall take place in ventilated area to allow fluid vapors to dissipate, and reduce the risk of fire.

NOTE

Cotton swabs can be used as long as no cotton fibers remain after cleaning. The foam swabs listed in this section's introduction are small enough to fit into adapters. Although foam swabs can leave filmy deposits, these deposits are very thin, and the risk of other contamination buildup on the inside of adapters greatly outweighs the risk of contamination by foam swabs.

- 1 Clean the adapter with the foam swab.
- 2 Dry the inside of the adapter with a clean, dry, foam swab.
- 3 Blow through the adapter using filtered, dry, compressed air. Nitrogen gas or compressed dust remover can also be used.

CAUTION

Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

Cleaning a Non-lensed Connector

The following procedures provide the proper steps for cleaning fiber-optic cables and universal adapters. The initial cleaning, using the alcohol as a solvent, gently removes any grit and oil. If a caked-on layer of material is still present, (this can happen if the beryllium-copper sides of the ferrule retainer get scraped and deposited on the end of the fiber during insertion of the cable), a second cleaning should be performed. It is not uncommon for a cable or connector to require more than one cleaning.

Table 19 Cleaning Accessories

Item	Keysight Part Number
Any commercially available denatured alcohol	–
Cotton swabs	8520-0023
Small foam swabs	9300-1223
Compressed dust remover (non-residue)	–

WARNING

If flammable fluids are used to clean connectors, the fluid shall not be placed on the instrument during, use or when connected to mains voltage. Cleaning the connectors shall take place in ventilated area to allow fluid vapors to dissipate, and reduce the risk of fire.

CAUTION

Keysight Technologies strongly recommends that index matching compounds not be applied to their instruments and accessories. Some compounds, such as gels, may be difficult to remove and can contain damaging particulates. If you think the use of such compounds is necessary, refer to the compound manufacturer for information on application and cleaning procedures.

CAUTION

Improper connector care, cleaning, or use of mismatched cable connectors can invalidate the published specifications and damage connectors. Clean all cables before applying to any connector. Repair of damaged connectors due to improper use is not covered under warranty.

CAUTION

Do not use any type of foam swab to clean optical fiber ends. Foam swabs can leave filmy deposits on fiber ends that can degrade performance.

- 1 Apply pure isopropyl alcohol to a clean lint-free cotton swab or lens paper.

NOTE

Cotton swabs can be used as long as no cotton fibers remain on the fiber end after cleaning.

- 2 Clean the ferrules and other parts of the connector while avoiding the end of the fiber.
- 3 Apply isopropyl alcohol to a new clean lint-free cotton swab or lens paper.
- 4 Clean the fiber end with the swab or lens paper. Move the swab or lens paper back and forth across the fiber end several times.

CAUTION

Do not scrub during this initial cleaning because grit can be caught in the swab and become a gouging element.

- 5 Immediately dry the fiber end with a clean, dry, lint-free cotton swab or lens paper.
- 6 Blow across the connector end face from a distance of 6 to 8 inches using filtered, dry, compressed air. Aim the compressed air at a shallow angle to the fiber end face.

NOTE

Nitrogen gas or compressed dust remover can also be used.

CAUTION

Do not shake, tip, or invert compressed air canisters, because this releases particles in the can into the air. Refer to instructions provided on the compressed air canister.

- 7 As soon as the connector is dry, connect or cover it for later use.

NOTE

If the performance seems poor after the initial cleaning, try cleaning the connector again. Often a second cleaning will restore proper performance. The second cleaning should be more arduous with a scrubbing action.

Measuring Insertion Loss and Return Loss

Measuring Insertion Loss and Return Loss Test your cables for insertion loss and return loss upon receipt and retain the measured data. You will then be able to compare those figures to future measurement results and determine if any degradation has occurred.

Consistent measurements with your lightwave equipment are a good indication that you have good connections. Since return loss and insertion loss are key factors in determining optical connector performance they can be used to determine connector degradation. A smooth, polished fiber end should produce a good return-loss measurement. The quality of the polish establishes the difference

between the "PC" (physical contact) and the "Super PC" connectors. Most connectors today are physical contact which make glass-to-glass connections, therefore it is critical that the area around the glass core be clean and free of scratches. Although the major area of a connector, excluding the glass, may show scratches and wear, if the glass has maintained its polished smoothness, the connector can still provide a good low level return loss connection.

If you test your cables and accessories for insertion loss and return loss upon receipt, and retain the measured data for comparison, you will be able to tell in the future if any degradation has occurred. Typical values are less than 0.5 dB of loss, and sometimes as little as 0.1 dB of loss with high performance connectors. Return loss is a measure of reflection: the less reflection the better (the larger the return loss, the smaller the reflection). The best physically contacting connectors have return losses better than 50 dB, although 30 to 40 dB is more common.

NOTE

Refer to the manuals provided with your lightwave test equipment for information on how to perform an insertion loss and/or return loss test. Typical insertion loss for cables is less than 1 dB, and can be as little as 0.1 dB. Refer to the manufacturer specifications of your particular cable or accessory.

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