N107X-Series
Clock Recovery DCA-Ms

This document describes installation steps, environmental requirements, and safety.

KEYSIGHT

USER'S GUIDE

Notices

Manual Part Number

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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 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.**

NOTE A **NOTE** calls the user's attention to an important point or special information in the text.

Contents

1 Introduction

The N1076B, N1077A, N1077B, and N1078A DCA-M clock recovery modules provide necessary clock signals to trigger an N1000A, 86100D, N109x-series DCA-M oscilloscopes, or the error detector in a BERT.

Use clock recovery in these circumstances:

- An existing clock has excessive intrinsic jitter that prevents accurate measurements. The N107X-series can act as clean-up PLL for the clock.
- An appropriate clock signal from the Device Under Test (DUT) is not available. The clock is recovered from the data stream.
- The input data rate is between 50 MBd and 16 GBd, 32 GBd, or 64 GBd, depending on N107X-series model.

In this book, you'll learn how to setup the clock recovery DCA-M modules including examples of external cabling. An introduction to remote control of the modules is provided in *Chapter 8 , Programming*.

Like all DCA-M products, the N107X-series clock recovery modules must be connected to a PC or an N1000D or 86100D DCA-X oscilloscope via a USB connection as shown in *Figure 1* on page 8.

Table 2 on page 12 and *Table 3* on page 13 compare the various features between the different model numbers. Refer to FlexDCA help system for complete product specifications.

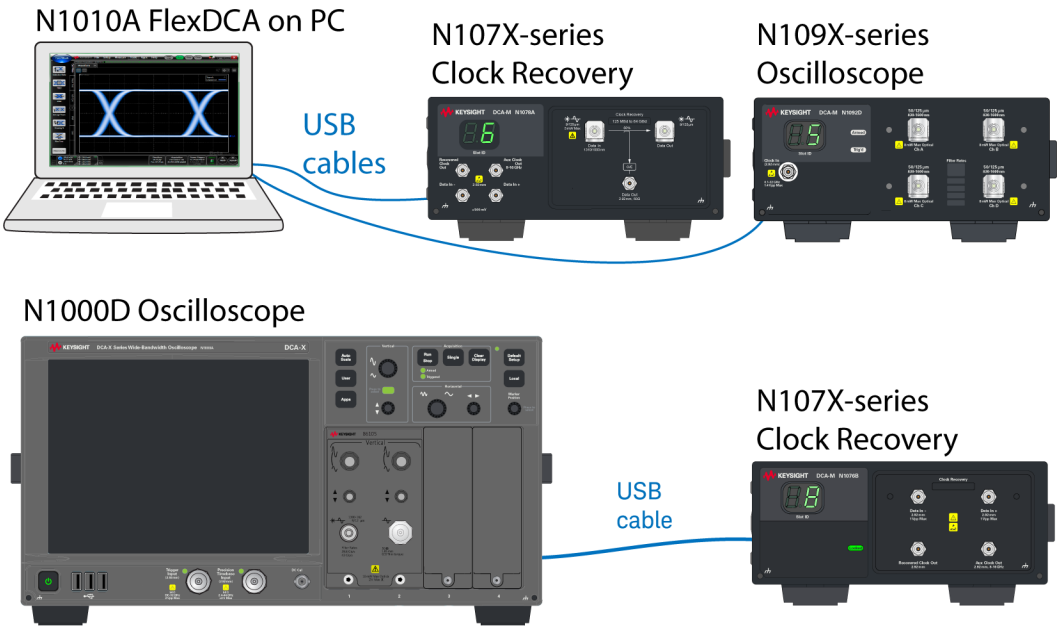


Figure 1. USB Connections to PC or DCA-X

The Graphical User Interface (GUI) as well as programming interface for the DCA-M modules is the FlexDCA application which runs on the PC, N1000A, or 86100D. On the PC, you must download and install the N1010A FlexDCA application. The N107X-series clock recovery DCA-Ms are compatible with both NRZ and PAM-4 signal types.

Minimum Required FlexDCA Firmware Version

In order for the N1000A, 86100D, or N1010A to properly recognize an N107X-series DCA-M, FlexDCA's firmware version must meet the requirements listed in the following table.

Table 1. Minimum Required Firmware Version

DCA-M	FlexDCA's Firmware Version
N1076B	≥ A.06.00
N1077A	≥ A.05.50
N1077B	≥ A.06.91
N1078A	≥ A.06.00

If using a PC, download and install the latest version of the N1010A FlexDCA remote access software. Go to www.keysight.com/find/N1010A. If using an N1000A or 86100D, upgrade the instrument's firmware to the latest version. Go to *www.keysight.com/find/N1000A_Firmware*.

N107x-Series DCA-Ms Compared

N1076B Electrical

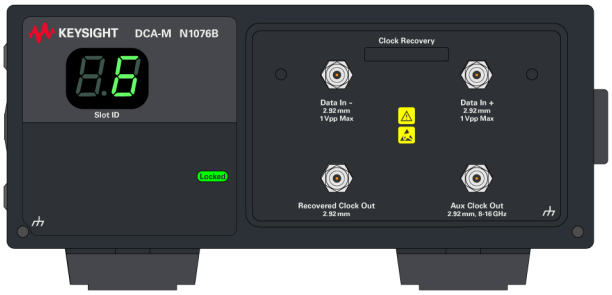
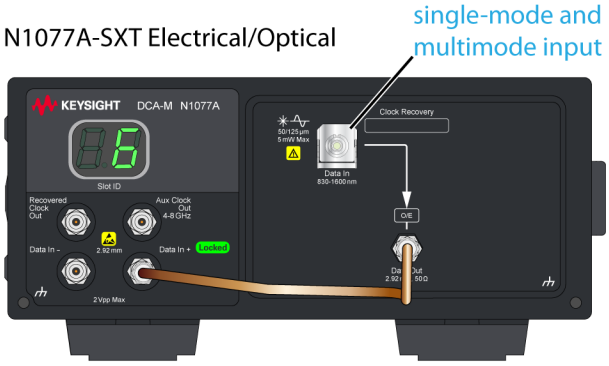


Figure 2. N1076B DCA-M Module

N1077A-SXT Electrical/Optical



N1077A-SMS Electrical/Optical

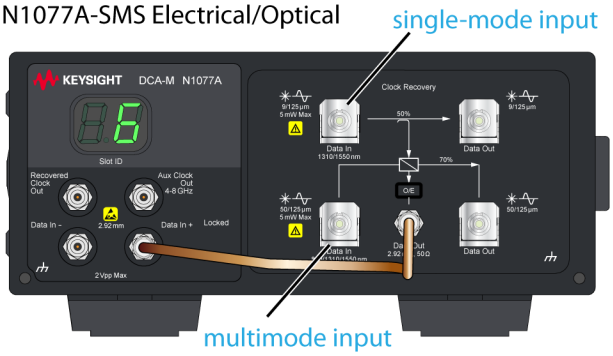


Figure 3. N1077A DCA-M Modules

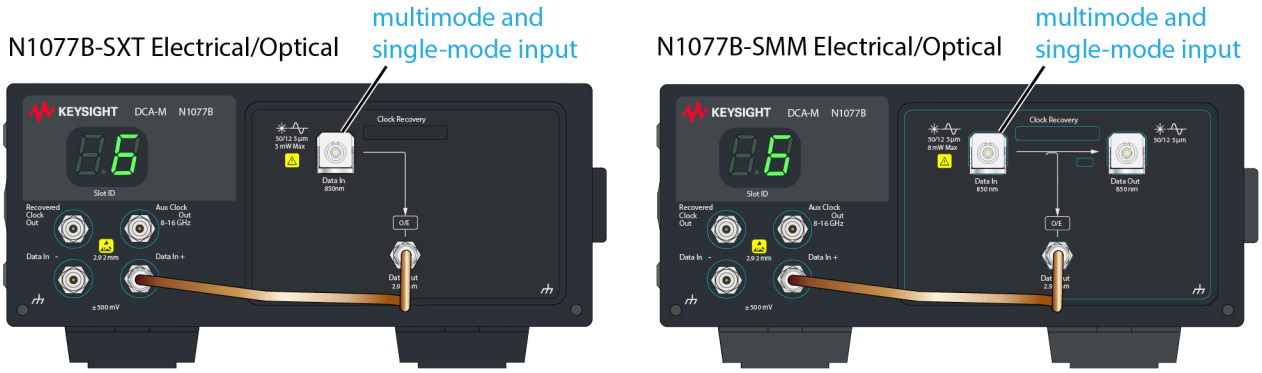


Figure 4. N1077B DCA-M Modules

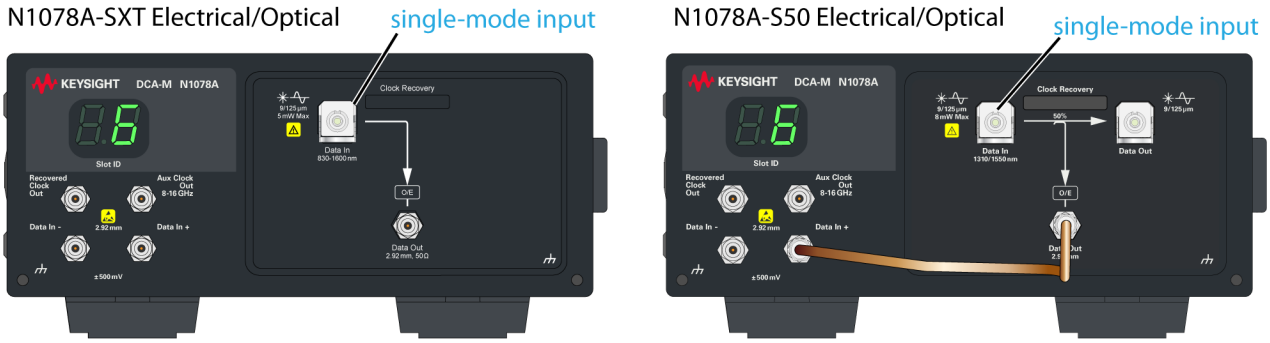


Figure 5. N1078A DCA-M Modules

NOTE

The N1010A FlexDCA application for the PC can be downloaded at www.keysight.com/find/flexdca_download.

Table 2. N107X-Series DCA-Ms Compared (Ranges)

Feature	N1076B	N1077A	N1077B	N1078A
Electrical clock recovery	♦	♦	♦	♦
Optical clock recovery	—	♦	♦	♦
Input wavelength (single-mode only)	—	1260 to 1360 nm 1490 to 1600 nm	1260 to 1340 nm[1] (Opt. SMM)	1260 to 1620 nm
Input wavelength (multimode only)	—	—	830 nm to 950 nm (Opt. SMM)	—
Input wavelength (single or multimode)	—	830 to 1360 nm 1260 to 1360 nm 1490 to 1600 nm	830 nm to 1340 nm[1] (Opt. SXT)	—
Input date rate				
Option 216	0.125 to 16 GBd	0.05 to 16 GBd	0.125 to 16 GBd	0.125 to 16 GBd
Option 225	—	—	24 to 29 GBd	25 to 29 GBd
Option 232	0.125 to 32 GBd	0.05 to 32 GBd	0.125 to 32 GBd	0.125 to 32 GBd
Option 253	—	—	48 to 58 GBd	53 to 58 GBd
Option 264	0.05 to 64 GBd		0.125 to 64 GBd	0.125 to 64 GBd
Input voltage levels	±500 mV (max.)	±2.2 Vpp (max.)	±500 mV (max.)	±500 mV (max.)
Recovered Clock Out	0.0625 to 32 GHz (Opt. 264) 0.0625 to 32 GHz (Opt. 232) 0.0625 to 16 GHz (Opt. 216)	0.050 to 16 GHz	0.0625 to 32 GHz (Opt. 264) 24 to 29 GHz (Opt. 253) 0.0625 to 32 GHz (Opt. 232) 24 to 29 GHz (Opt. 225) 0.0625 to 16 GHz (Opt. 216)	0.0625 to 32 GHz (Opt. 264) 26.5 to 29 GHz (Opt. 253) 0.0625 to 32 GHz (Opt. 232) 25 to 29 GHz (Opt. 225) 0.0625 to 16 GHz (Opt. 216)
Aux Clock Out	8 to 16 GHz 700 mVpp	4 to 8 GHz 600 mVpp	8 to 16 GHz 700m Vpp	8 to 16 GHz 700m Vpp

1 Clock Pattern Distortion Compensation feature must be enabled for single-mode wavelength.

Table 3. N107X-Series DCA-Ms Compared (Options)

Options	N1076B	N1077A	N1077B	N1078A
JSA (Jitter Spectrum Analysis)	♦	♦	♦	♦
SXT (without internal splitter)		♦	♦	♦
SMS Internal single-mode and multimode splitter		♦		
S50 Internal single-mode splitter				♦
SMM Internal multimode and single-mode splitter			♦	

For information on how to connect the N107X-series DCA-Ms in a test setup, refer to *Chapter 4 , Using the N1076B*, *Chapter 5 , Using the N1077A*, *Chapter 6 , Using the N1077B*, and *Chapter 7 , Using the N1078A*.

Opening Closed Eyes for Clock Recovery

If the input signal's eye is severely closed, the N107x-series DCA-M may not be able to recover the clock. To open the eye, use microwave equalizers which are provided in both the optional electrical and optional optical phase-matching kits. The equalizers can also be separately ordered.

To open the eye of an electrical signal, connect an equalizer directly to the **Data In +** connector as shown in Figure 6. For differential inputs, add an additional equalizer to the **Data In –** connector. The equalizers are included in the electrical phase-matching kits. Refer to *Phase Matching Kit (Electrical)* on page 53.

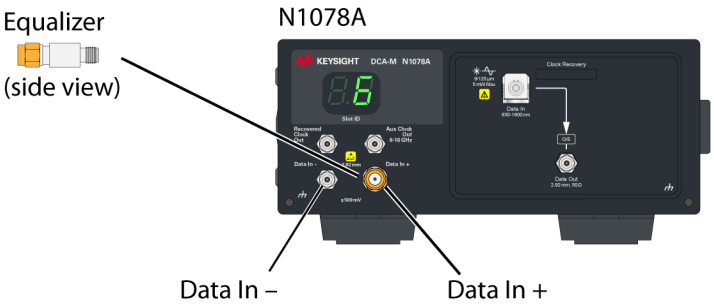


Figure 6. Equalizer for Electrical Clock Recovery

To open the eye of an optical signal, remove the semi-rigid cable shown in Figure 7 from the module. Then, connect an equalizer to the **Data In +** connector and connect an 2.92 mm coaxial cable in between the **Data Out** and **Data In +** connectors. The equalizer and coaxial cable are included in the optical phase-matching kits. Refer to *Phase Matching Kits (Optical)* on page 55.

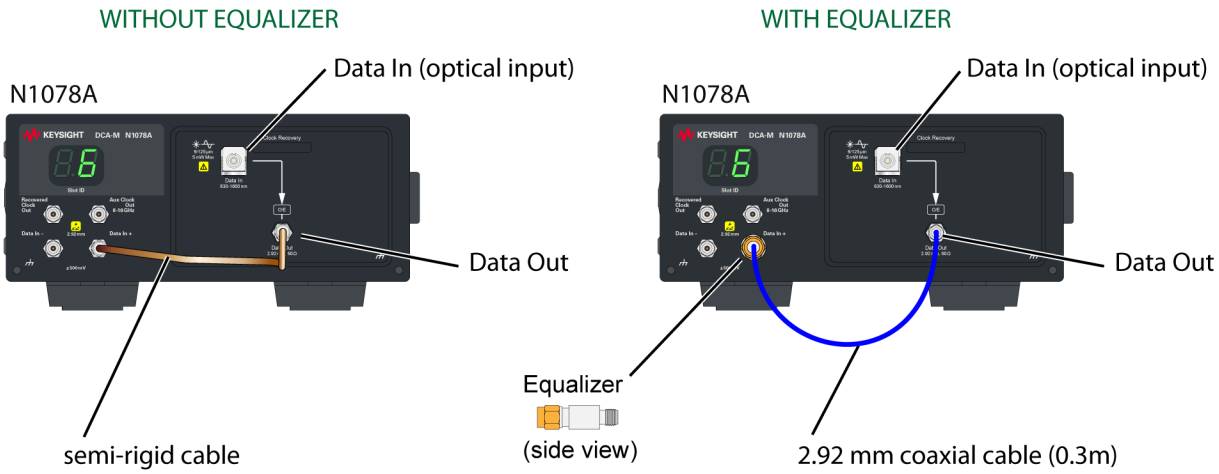


Figure 7. Equalizer for Optical Clock Recovery

Tap the Input Signal for Clock Recovery

Electrical Input Signal

You can use a microwave pickoff to transfer a small amount of signal energy to the N107X-series module's **Data In** connectors while sending the remaining signal energy to the oscilloscope's channel input. It is best to keep the cables that attach the DUT to the pickoffs as short as possible. Microwave pickoffs are included in the electrical phase-matching kits. Refer to *Phase Matching Kit (Electrical)* on page 53.

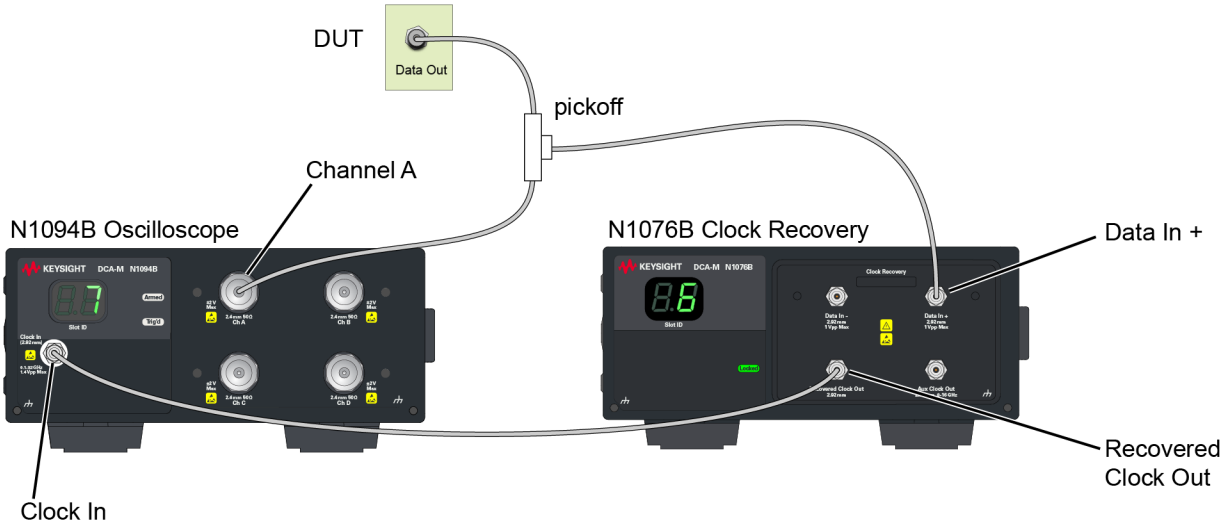


Figure 8. Example of Using a Pickoff

Optical Input Signal

Because the N1077A-SXT, N1077B, and N1078A-SXT DCA-Ms do not include an internal optical splitter, you will need to connect a user-provided external optical splitter. *Figure 9* on page 17 shows an example setup with an external optical splitter. Connect one splitter output to the N107xA's optical *Data In* connector and the other splitter output to the oscilloscope's optical channel input.

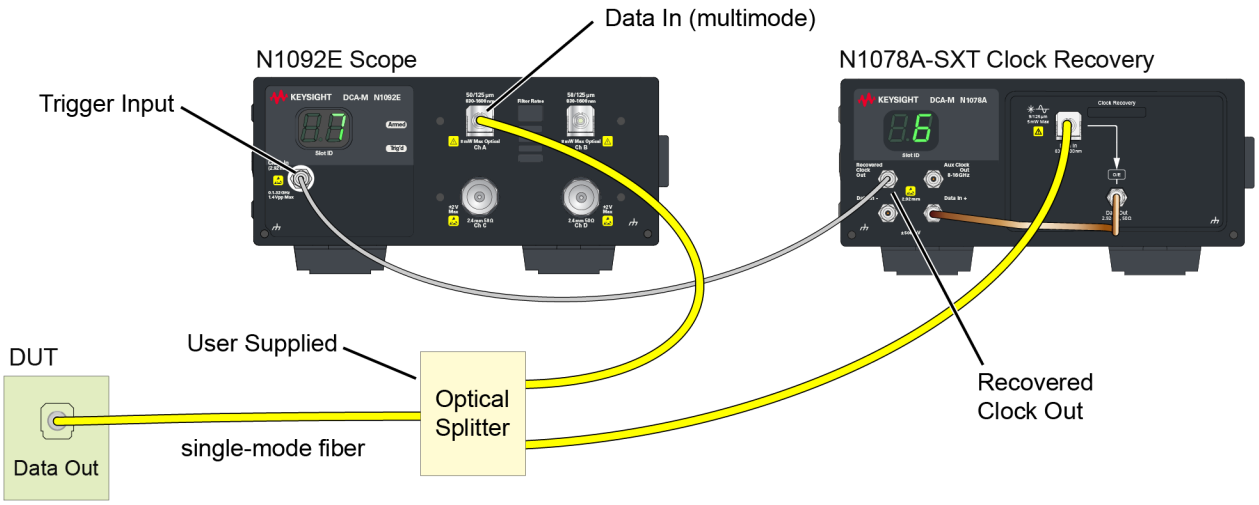


Figure 9. Example of Using an External Optical Splitter

Rear Panel

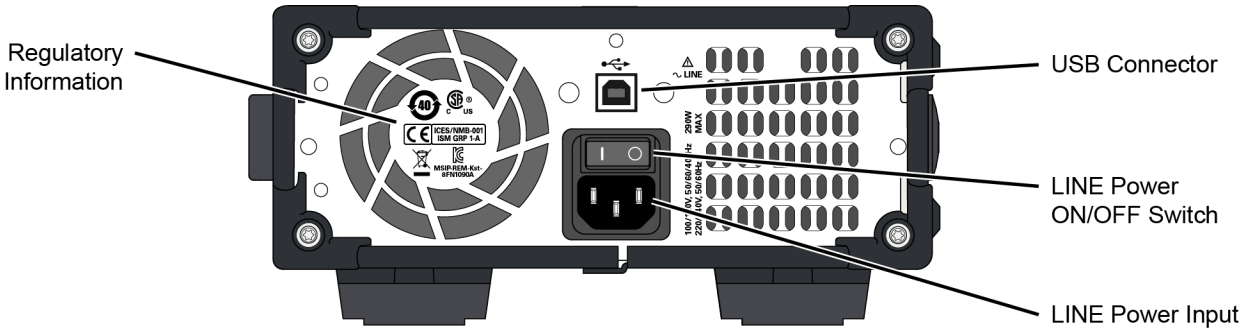
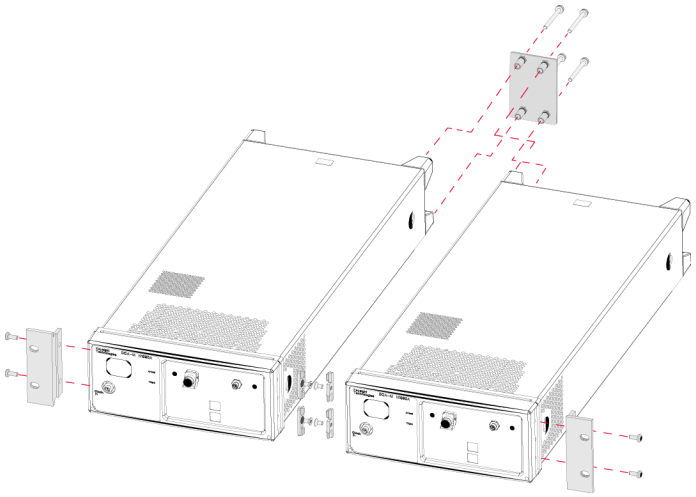


Figure 10. Rear Panel

Rack Mount Kits

Table 4. Available Rack Mount Options

Description	Option
Rack-mount kit for a single DCA-M.	1CM
Rack-mount kit for mounting any combination of two DCA-M products including : N1076A/B, N1077A, N1077B, N1078B, N1090A, N1092A, N1092B, and N1092D modules (mounted side-by-side) 	1CN

Safety Information

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.

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.

NOTE A NOTE calls the user's attention to an important point or special information in the text.

NOTE 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 This is a Safety Protection Class I 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.

WARNING To prevent electrical shock, disconnect the Keysight Technologies Model N107x-Series 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.

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.

WARNING Light energy can radiate from the front panel Data Out connectors on the Keysight N1077A-SMS DCA-M, N1077B-SMM, and N1078A-S50 DCA-M. The light emitted from these connectors is the slightly attenuated light that is input to the front-panel optical Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.

WARNING Safety of any system incorporating the equipment is the responsibility of the assembler of the system.

NOTE The input terminals for this product are classified as Measurement Category None.

N107x-Series DCA-M Regulatory Information

This is a sensitive measurement apparatus by design and may have some performance loss when exposed to ambient continuous electromagnetic phenomenon.

The N1076B is in compliance with CAN/CSA-C22.2 No. 61010-1 and UL Std. 61010-1 and with IEC 61010-1.

The N1077A is in compliance with CAN/CSA-C22.2 No. 61010-1 and UL Std. 61010-1 and with IEC 61010-1.

The N1077B is in compliance with CAN/CSA-C22.2 No. 61010-1 and UL Std. 61010-1 and with IEC 61010-1.

The N1078A is in compliance with CAN/CSA-C22.2 No. 61010-1 and UL Std. 61010-1 and with IEC 61010-1.

To find a current Declaration of Conformity for a specific Keysight product, go to:

http://www.keysight.com/go/conformity

COMPLIANCE WITH CANADIAN EMC REQUIREMENTS

This ISM device complies with Canadian ICES-001.

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

EMC

Complies with the essential requirements of the European EMC Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, Class A
- AS/NZS CISPR 11
- ICES/NMB-001

South Korean Class A EMC Declaration:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

This EMC statement applies to the equipment only for use in business environments.

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SAFETY

Complies with the essential requirements of the European Low Voltage Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- USA UL std no. 61010-1

Acoustic statement: (European Machinery Directive)

Acoustic noise emission
LpA < 70 dB
Operator position
Normal operation mode per ISO 7779

Environmental Specifications

The following tables list the environmental specifications. Performance specifications for the N107X-series clock recovery are documented in FlexDCA's help system.

Table 5. N1076B environmental specifications

Item	Description
Use	Indoor
Operating Temperature	10 °C to +40 °C (50 °F to +104 °F)
Non-operating Temperature	−40 °C to +70 °C (−40 °F to +158 °F)
Altitude (Operating)	Up to 4,600 meters (15,000 ft)
Humidity [1]	Maximum Relative Humidity (non-condensing): 95% RH
Volts-Amperes (VA)	48 VA (Typical)
Weight	6.17 kg (13.6 lb) (Typical)
Dimensions	**Description**
Without front connectors and rear feet	88.26 mm H x 212.5 mm W x 485 mm D (3.48 inch x 8.17 inch x 19.01 inch)
With front 2.92 mm connectors with load and rear feet	103.31 mm H x 219.56 mm W x 517.80 mm D (4.07 inch x 8.64 inch x 20.39 inch)
With front cover and rear feet	110.18 mm H x 219.56 mm W x 550.71 mm D (4.34 inch x 8.64 inch x 21.68 inch)

1 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.

Table 6. N1076B LINE Power Specifications

Item	Description
Line Power	100/120 VAC, 50/60/400 Hz 220/240 VAC, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Table 7. N1077A environmental specifications

Item	Description
Use	indoor
Operating Temperature	10 °C to +40 °C (50 °F to +104 °F)
Non-operating Temperature	−40 °C to +70 °C (−40 °F to +158 °F)
Altitude (Operating)	Up to 4,600 meters (15,000 ft)
Humidity [1]	Maximum Relative Humidity (non-condensing): 95% RH
Volts-Amperes (VA) *(Characteristic)*	*52 VA*
Weight *(Characteristic)*	**Description**
N1077A-SMS	*6.3 kg (13.8 lb)*
N1077A-SXT	*6.1 kg (13.4 lb)*
Dimensions	
Without front connectors and rear feet	88.26 mm H x 207.40 mm W x 485 mm D (3.48 inch x 8.17 inch x 19.01 inch)
With front connectors and rear feet	103.31 mm H x 219.56 mm W x 517.80 mm D (4.07 inch x 8.64 inch x 20.39 inch)
With front cover and rear feet	110.18 mm H x 219.56 mm W x 550.71 mm D (4.34 inch x 8.64 inch x 21.68 inch)

1 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.

Table 8. N1077A Power Specifications

Item	Description
Line Power	100/120 Vac, 50/60/400 Hz 220/240 Vac, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Table 9. N1077B environmental specifications

Item	Description
Use	Indoor
Operating Temperature	10 °C to +40 °C (50 °F to +104 °F)
Non-operating Temperature	−40 °C to +70 °C (−40 °F to +158 °F)
Altitude (Operating)	Up to 4,600 meters (15,000 ft)
Humidity [1]	Maximum Relative Humidity (non-condensing): 95% RH
Volts-Amperes (VA)	52 VA (Typical)
Weight	**Description**
N1077B-SMM	6.4 kg (14.2 lb) (Typical)
N1077B-SXT	6.4 kg (14.2 lb) (Typical)
Dimensions	**Description**
Without front connectors and rear feet	88.26 mm H x 212.5 mm W x 485 mm D (3.48 inch x 8.37 inch x 19.01 inch)
With front connectors, jumper cable (Data Out to Data In +), and rear feet	103.31 mm H x 219.56 mm W x 532.8 mm D (4.07 inch x 8.64 inch x 20.97 inch)
With front cover and rear feet	110.18 mm H x 219.56 mm W x 550.71 mm D (4.34 inch x 8.64 inch x 21.68 inch)

1 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.

Table 10. N1077B LINE Power Specifications

Item	Description
Line Power	100/120 VAC, 50/60/400 Hz 220/240 VAC, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Table 11. N1078A environmental specifications

Item	Description
Use	Indoor
Operating Temperature	10 °C to +40 °C (50 °F to +104 °F)
Non-operating Temperature	−40 °C to +70 °C (−40 °F to +158 °F)
Altitude (Operating)	Up to 4,600 meters (15,000 ft)
Humidity [1]	Maximum Relative Humidity (non-condensing): 95% RH
Volts-Amperes (VA)	52 VA (Typical)
Weight	**Description**
N1078A-S50	6.4 kg (14.2 lb) (Typical)
N1078A-SXT	6.4 kg (14.2 lb) (Typical)
Dimensions	**Description**
Without front connectors and rear feet	88.26 mm H x 212.5 mm W x 485 mm D (3.48 inch x 8.37 inch x 19.01 inch)
With front connectors, jumper cable (Data Out to Data In +), and rear feet	103.31 mm H x 219.56 mm W x 532.8 mm D (4.07 inch x 8.64 inch x 20.97 inch)
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Table 12. N1078A LINE Power Specifications

Item	Description
Line Power	100/120 VAC, 50/60/400 Hz 220/240 VAC, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Instrument Markings

The following table lists the definitions of markings that may be on the instrument.

Table 13. Instrument Markings

Marking	Description
	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
	This symbol marks the ON position of the power line switch.
	This symbol marks the OFF position of the power line switch.
	The AC symbol is used to indicate the required nature of the line module input power.
	The chassis ground symbol. The chassis ground symbol is used to indicate a chassis connection.
	This symbol identifies the Protective Conductor Terminal.
	Electrostatic sensitive devices
	The CE marking is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all relevant directives.
	The CSA mark is a registered trademark of the CSA International.
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.

	This is a combined marking to indicate product compliance with the Industry Canadian Interference-Causing Equipment Standard (ICES-001). This is also a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
	China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.
	South Korean Certification (KC) mark; includes the marking's identifier code which follows this format: MSIP-REM-YYY-ZZZZ.
	The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by DIRECTIVE 2012/19/EU and other National legislation. Please refer to *keysight.com/go/takeback* to understand your Trade in options with Keysight in addition to product takeback instructions.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper-/fiberboard packaging.
	UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.
	The Keysight email address is required by EU directives applicable to our product.

Contacting Keysight

To contact Keysight for sales and technical support, refer to support links on the following Keysight websites: *http://www.keysight.com/find* (product specific information and support, software and documentation updates) *http://www.keysight.com/find/assist* (worldwide contact information for repair and service).

For technical assistance with the, contact your local Keysight Call Center.

- In the Americas, call 1 (800) 829-4444
- In other regions, visit http://www.keysight.com/find/assist

Returning the Instrument for Service

The instructions in this section show you how to contact Keysight Technologies and how to properly package an instrument for return to a Keysight Technologies service office. Always contact the Keysight Technologies Instrument Contact Center to initiate service *before* returning the instrument to a service office. This ensures that the repair (or calibration) can be properly tracked and that your instrument will be returned to you as quickly as possible. For technical assistance, contact your local Keysight Call Center.

If the instrument is still under warranty or is covered by a 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 a maintenance plan, Keysight Technologies will notify you of the cost of the repair after examining the unit.

NOTE

Remember to always make backups of important files. Data stored on the instrument hard disk may be erased after a repair. You can restore the files from the backup.

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 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.
- The original cal data disks.

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 in the original shipping containers. Original materials are available through any Keysight Technologies 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

(antistatic) 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.

2 Installation and Care

This chapter shows you how to install and care for the DCA-M module. All DCA-Ms in a typical test setup must be connected to either a PC or DCA-X oscilloscope as shown in Figure 11. The USB cable is provided with the DCA-M. *The PC is not provided by Keysight*. The DCA-Ms are controlled either from FlexDCA (which is the DCA-X oscilloscope's graphical user interface) or from the N1010A FlexDCA application on a PC. You can download N1010A FlexDCA from *keysight.com/find/flexdca_download*.

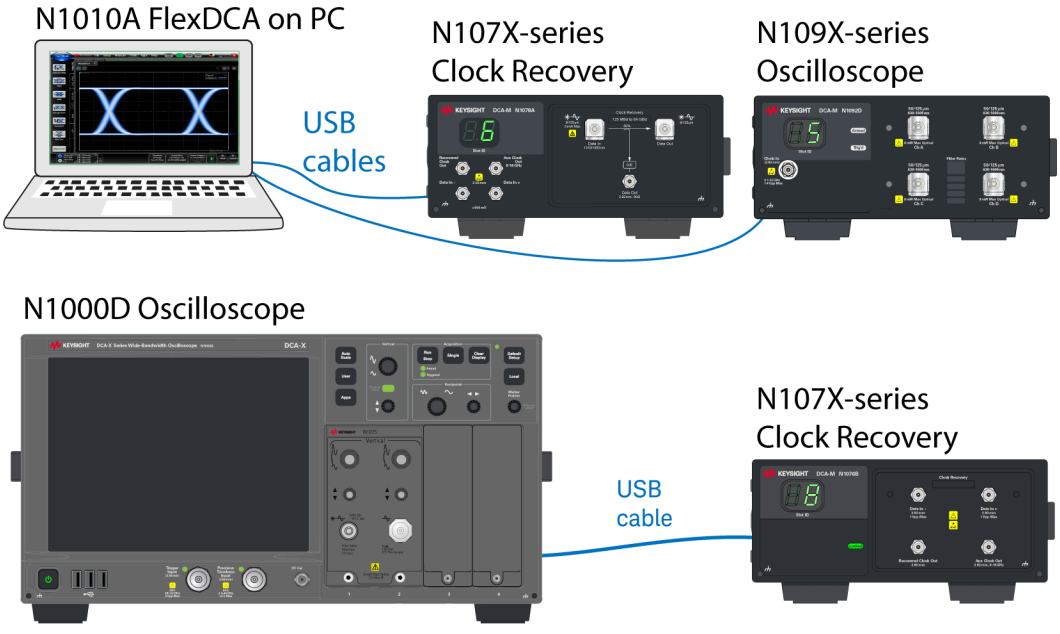


Figure 11. USB Connections for PC and N1000A

Flex-on-Flex Connection Setup

Figure 12 shows a setup that works for DCA-M #1 but does *not* work for DCA-M #2. This is known as a “Flex-on-Flex” connection, because, N1010A FlexDCA on the PC is connected to and controlling FlexDCA on the DCA-X. A Flex-on-Flex setup works great for standard DCA-X modules, but DCA-M modules can't be "seen" by FlexDCA on the PC. This is true for both front panel and remote control. The DCA-M #2 in this picture cannot be identified, accessed, or controlled from FlexDCA on the PC. The solution is to connect the DCA-M #2 directly to the PC.

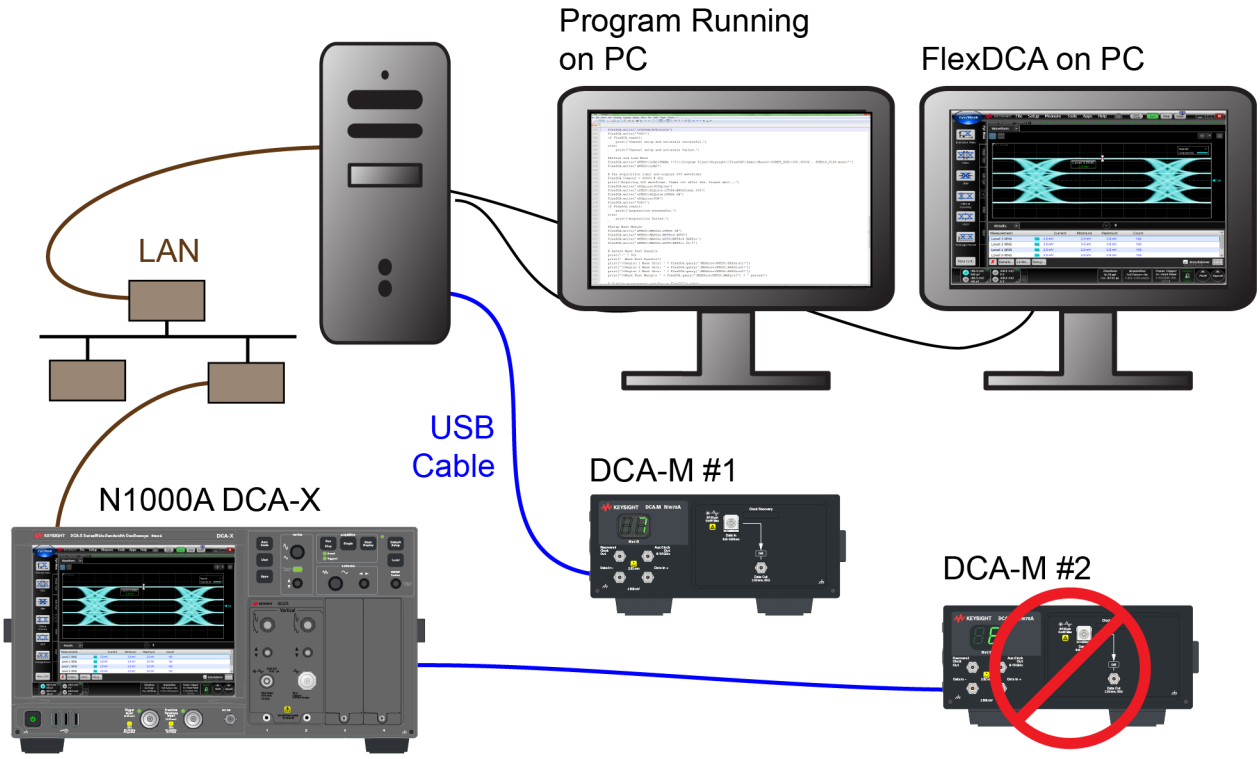


Figure 12. DCA-M #2 cannot be “seen” with a Flex-on-Flex connection

PC Requirements

A PC that is controlling the N107X-series clock recovery DCA-M, or any other DCA-M, must meet the following requirements.

Table 14. Minimum Configuration

Setup	1 Channel	4 Channels	8+ Channels
Processor	≥2 cores	≥2 cores	≥4 cores
Memory	≥4 GBytes	≥8 GBytes	≥16 GBytes
Display	≥1280x1024 pixels ≥64K colors	≥1280x1024 pixels ≥64K colors	≥1280x1024 pixels ≥64K colors
Windows 7/8/10	32-bit or 64-bit	64-bit	64-bit

Table 15. Recommended for Processing Intensive Tasks (e.g., TDECQ with equalizer optimization enabled)

Setup	1 Channel	4 Channels	8+ Channels
Processor	≥2 cores with hyper-threading	≥6 cores with hyper-threading	≥12 cores with hyper-threading
Memory	≥8 GBytes	≥16 GBytes	≥16 GBytes
Display	≥1280x1024 pixels ≥64K colors	≥1280x1024 pixels ≥64K colors	≥1280x1024 pixels ≥64K colors
Windows 7/8/10	64-bit	64-bit	64-bit
Disk Drive	Solid State Drive	Solid State Drive	Solid State Drive

The communication API between your system controller and the PC is SCPI over LAN, either VXI-11 or HiSlip. If you currently use NI-VISA or the Keysight IO Libraries to communicate with instruments via GPIB, the switch to SCPI/LAN is very simple. It is important to note that there is no need to do any USB programming. This is entirely handled by the FlexDCA interface.

Safety Notices for Installations

CAUTION This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2 environment and MEASUREMENT CATEGORY NONE.

CAUTION CAUTION, VENTILATION REQUIREMENTS: When installing the instrument(s) into a cabinet consideration shall be given to the convection flow into and out of the cabinet. Consideration shall also be given to the individual instruments to avoid having the heated discharge of one instrument, now becoming the cooling intake air for another instrument. Another area of concern is verification that the maximum ambient operating temperature of the instrument(s) is not exceeded by cabinet installation. Keysight recommends forced air convection whenever an instrument(s) are installed in a cabinet and further recommends that the maximum operating temperature of the cabinet be reduced 10°C from the lowest, of the maximum operating temperature of a single instrument. If there are any concerns or special requirements a Keysight Field Engineer should be consulted to assure instrument(s) temperature compliance and performance.

WARNING 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.

WARNING Use Keysight supplied power cord or one with same or better electrical rating.

CAUTION This instrument has auto-ranging line voltage input, be sure the supply voltage is within the specified range.

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. Removing the power cord from the ac input connector or ac power outlet will disconnect the mains circuits from the mains supply before other parts of the instrument. The instrument is equiped with an ON / OFF switch on the rear panel. It is a LINE switch, but may not readily identifiable or as easily reached by the operator as the detachable power cord. 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.

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

To Install the DCA-M

Refer to *Safety Notices for Installations* on page 36 before performing the following installation steps.

Procedure

1. Confirm that your site satisfies the LINE power requirements shown in the following tables.

Table 16. N1076B LINE Power Specifications

Item	Description
Line Power	100/120 VAC, 50/60/400 Hz 220/240 VAC, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Table 17. N1077A Power Specifications

Item	Description
Line Power	100/120 Vac, 50/60/400 Hz 220/240 Vac, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Table 18. N1077B LINE Power Specifications

Item	Description
Line Power	100/120 VAC, 50/60/400 Hz 220/240 VAC, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

Table 19. N1078A LINE Power Specifications

Item	Description
Line Power	100/120 VAC, 50/60/400 Hz 220/240 VAC, 50/60 Hz
Power in Watts	290 Watts Maximum
The products can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage.	

2. If you will be controlling the DCA-M from a PC, install N1010A FlexDCA on the PC and start FlexDCA. N1010A FlexDCA can be downloaded from *keysight.com/find/flexdca_download* .
3. Connect the supplied LINE power cord to the DCA-M. Connect the other end of the LINE power cord to the LINE power.

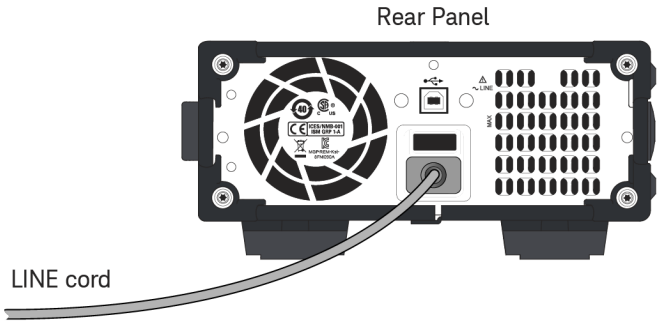


Figure 13. Connecting the LINE Cord

4. Connect the supplied USB cable to the DCA-M's rear panel as shown in *Figure 14* on page 39. Connect the other end of the USB cable to the PC, N1000A, or 86100D, depending on the setup. If connecting to an N1000A or 86100D, connect the USB cable to one of the *rear-panel* USB ports.

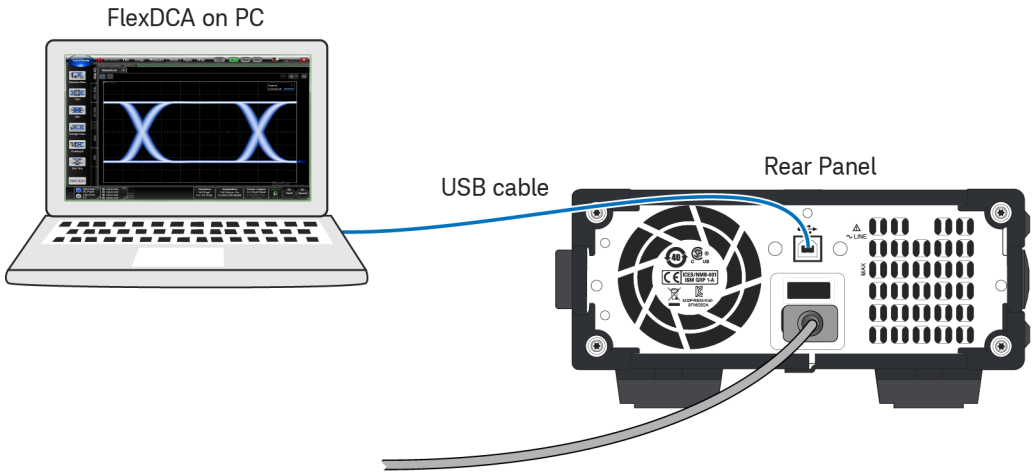
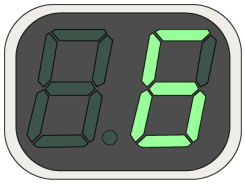


Figure 14. Connecting the USB cable

5. Turn on the DCA-M. A device driver that is installed with FlexDCA will automatically detect the DCA-M. The driver installs the DCA-M in FlexDCA's first available virtual slot. The assigned slot number is shown on the DCA-M's front-panel LED readout. For example, slot 6 as shown in this picture. Available FlexDCA slots depend on the installation:



   - If the DCA-M is connected to a PC and an N1000A or 86100D is not connected, slots 1 through 8 are available.
   - If the DCA-M is connected to an N1000A or 86100D, slots 5 through 8 are available.
   - In FlexDCA's slot button tray, shown in *Figure 15* on page 40, locate the slot button for your installed DCA-M. Click the gear button if you want to re-assign the DCA-M to a different slot. This can also be accomplished remotely as shown in *Example 3. Perform eye measurement with N109X & N1076/7A* on page 155.

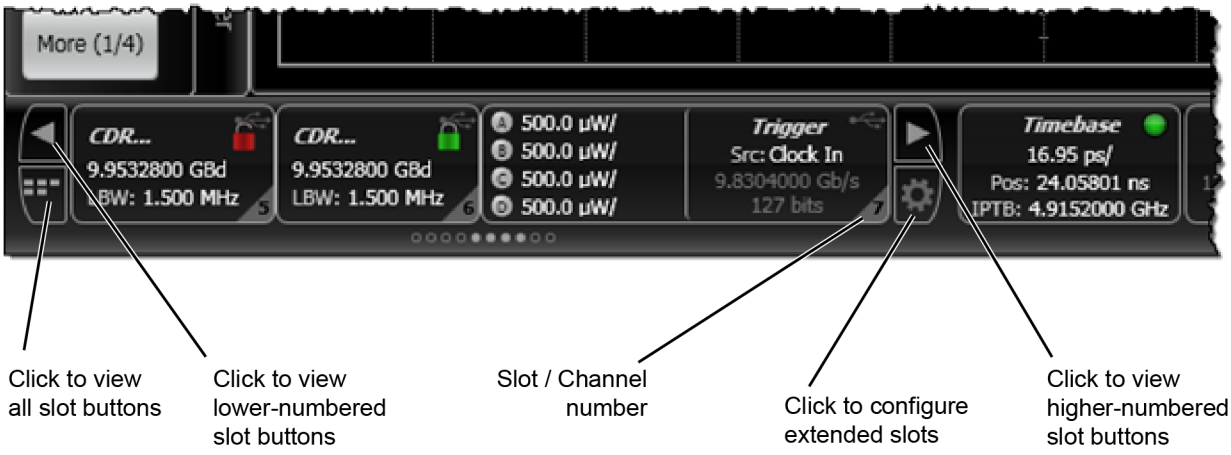


Figure 15. Slot buttons at bottom of FlexDCA application

Static-Safe Workstation

Electrostatic discharge (ESD) can damage or destroy electronic components. All work on instruments and electronic components should be performed at a static-safe workstation as shown in Figure 16. The static-safe workstation uses two types of ESD protection:

- Conductive table-mat and wrist-strap combination.
- Conductive floor-mat and heel-strap combination.

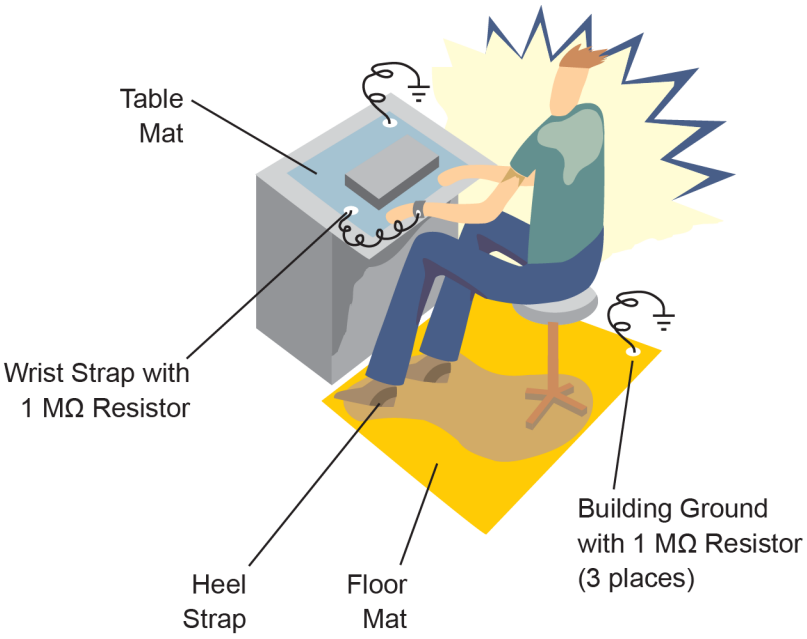


Figure 16. Example of Static-Safe Workstation

The following suggestions may reduce ESD damage that occurs during testing and servicing operations.

- Personnel should be grounded with a resistor-isolated wrist strap.
- Be sure all instruments are properly earth-grounded to prevent a buildup of static charge.

WARNING **These techniques for a static-safe workstation should not be used when working on circuitry with a voltage potential greater than 30V rms, 42.4V peak, or 60V DC volts.**

CAUTION Only the table-mat and wrist-strap combination provides adequate ESD protection when used alone. To ensure your safety, the static-safe accessories must provide at least 1 MΩ of isolation from ground. Purchase acceptable ESD accessories from your local supplier.

CAUTION Electrical channel input circuits and the trigger input circuit can be damaged by electrostatic discharge (ESD). Therefore, avoid applying static discharges to the front-panel input 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 input connectors 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.

Grounding Receptacle

If the instrument has a grounding receptacle, you can plug the wrist strap into the grounding receptacle. For example, the DCA-X mainframe has a front-panel grounding receptacle that is shown in the following picture.

Figure 17. Grounding Receptacle on a DCA-M Instrument

Daily ESD Self Check

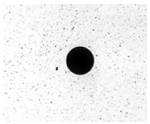
1. Visually check your work area to see that there are no static-generating materials, insulating work surfaces, or static-generating tools.
2. Clear your work area of static charge generators for a distance of at least 1 meter from ESD sensitive items.
3. Visually check that the ground wiring to the workstation has not been disconnected or damaged.
4. If applicable, make certain that your work station air ionizer is activated and correctly positioned.
5. Make sure that there are no static generators inside conductive containers with ESD sensitive items.

6. Visually check that all ESD sensitive parts, assemblies, or products are completely inside closed conductive containers.
7. Make sure that all shielding containers have an approved static attention label on the outside.
8. Make sure that all cleaners, solvents, coatings, and sprays used at your workstation are types approved by your ESD Coordinator.
9. Put on wrist strap and conductive footwear, and any special garments which are required in your job.
10. Don’t allow anyone who is not grounded closer than 1 meter to your static safe area.

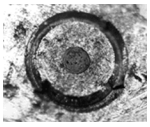
Cleaning the Fiber-Optic Connectors

Keep all fiber-optic connectors clean using professional fiber-optic cleaning products. Many products are available and are easily located via an internet search on "*fiber optic cleaning products*". You can purchase tools designed specifically for the type of fiber-optic connector that you are using. Replacing a damaged 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 this topic. Treat all fiber-optic connectors like the high-quality lens of an expensive camera.

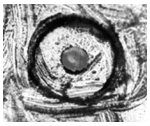
This picture shows the end of a clean, problem-free fiber-optic connector. The dark center circle is the fiber's 125 µm core and cladding which carries the light. The surrounding area is the soft nickel-silver ferrule.



This picture shows a fiber end that is dirty from neglect or 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.



This picture 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.



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.**

NOTE 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.

NOTE When making 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.

CAUTION Keysight Technologies strongly recommends that index matching compounds *not* be applied to their instruments and accessories.

Cleaning Optical Connections

Keysight instrument fiber-optic input and output connectors often employ either lever adapters (for example on an N1090-series DCA-M) or screw-on universal adapters (for example on an 86105C). These adapters, when removed, have no fiber-optic parts and can be cleaned using the procedure in this topic.

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 No liquids of any kind should be placed on top of instrument due to top cover ventilation over electrical components.

NOTE Cotton swabs can be used as long as no cotton fibers remain after cleaning. 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.

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

1. To remove a screw-on universal adapter from a module, turn the adapter counter clockwise.
2. To remove a lever adapter from an N1090A module, lift the receptacle latch as shown in the following picture.
3. Carefully pull off the receptacle without touching the ferrule or fiber end.

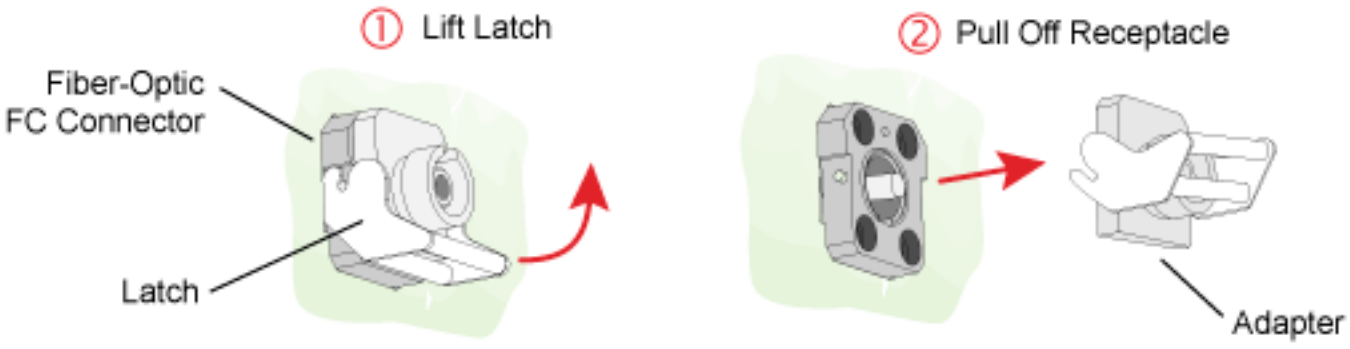


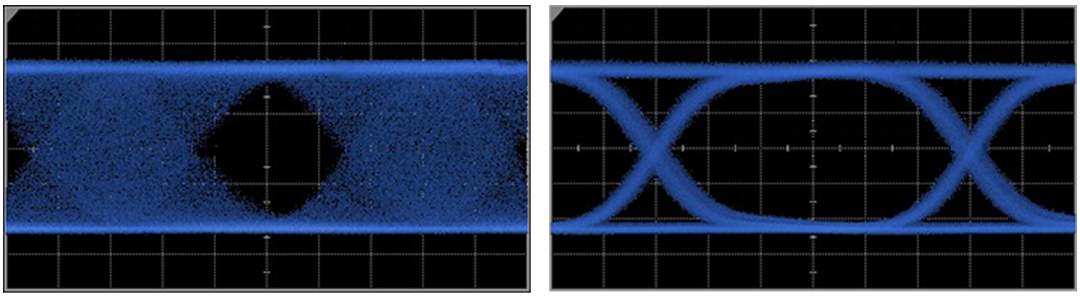
Figure 18. Removing the Receptacle to Expose the Fiber End

4. Clean the adapter with the foam swab.
5. Dry the inside of the adapter with a clean, dry, foam swab.
6. 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.

3 Matching Clock-to-Data Delays for Measurement Accuracy

In this chapter, you'll learn how to compensate for the differences in delay between the clock and data paths in your measurement setups. The differences in delay can cause the jitter on clock triggers and data signals to become uncorrelated which can result in closed eyes and reduced measurement accuracy as shown in Figure 19. This figure shows an exaggerated worst-case example using a signal with SSC applied. This is a particular problem with low-frequency jitter.



Exaggerated closed eye due to uncorrelated jitter

Eye opened by adding correct delay in paths

Figure 19. Eye closure due to clock and data jitter correlation

This chapter shows you how to identify problems in delay and how to correct the problem. Example test setups with these solutions are shown in *Chapter 4 ,*

Using the N1076B, *Chapter 5 , Using the N1077A*, *Chapter 6 , Using the N1077B*, and *Chapter 7 , Using the N1078A*.

Should data and clock paths be matched?

Table 20 lists conditions in the measurement setup that may require matching of the delay between the clock and data paths. Solutions to mismatched paths include adding cables from a phase matching kit and installing the PTB Delay Line Assembly on the DCA-X oscilloscope.

In most situations, differences in delay between the clock and data paths is not a problem and using a good quality 1m cable, instead of an 0.5m cable, between the clock recovery output and your DCA-X oscilloscope is unlikely to impact measurement accuracy. Likewise, using a 1m optical fiber instead of a 3m fiber is unlikely to degrade your optical measurements.

Table 20. Test Setup Versus Recommended Delay Matching Technique

Test Setup Includes	Electrical Input	Optical Input	Phase Matching Kit	PTB Delay Line Assembly
N1076B, N1077A, N1077B, or N1078A option JSA with Jitter Optimization turned on.	♦		♦	
N109x-series DCA-M oscilloscope.		♦	♦[1]	
86100D DCA-X option ETR/PTB oscilloscope				
and N1045A or N1055A electrical remote head module	♦		♦	♦
and any optical plug-in module		♦	♦	
Input signal				
is jitter limited		♦	♦	
has >50% low-frequency jitter		♦	♦	

1 The N1027A-77B Optical Phase Matching Kit only supports phase matching to an N1092A/B/C/D/E Option 30A DCA-Ms.

PTB Delay Line Assembly

The installation of the PTB Delay Line Assembly, which is included in the N1027A-76B kit, is described *Installing the PTB Delay-Line Assembly* on page 50.

To quickly check for unmatched clock and signal paths

1. Change the clock recovery PLL loop bandwidth by a few MHz (for example, from 5 MHz to 10 MHz) while observing Jitter Mode results.
2. If Jitter Mode results do not change significantly, matching clock and data paths is not critical.

To check if input signal is jitter limited

1. Place the oscilloscope in Eye mode and setup an eye mask test.
2. If there is less mask margin due to jitter (horizontal) impairments (more hits on the left/right sides of the mask), your signal is jitter limited and would benefit from matching clock and data paths. If more mask hits occur due to amplitude hits (the top/bottom of the mask), matching clock and data paths is unlikely to be critical.

To check the input signal for low-frequency jitter

Significant low-frequency jitter is often the result of using Spread Spectrum Clocking (SSC).

1. Place the oscilloscope in Jitter Mode.
2. Measure RJ rms with JSA Analysis off (all jitter to module BW).
3. Measure RJ rms with JSA Analysis on (low frequency jitter to 26 MHz). Make sure to Jitter Optimization is selected.
4. If the RJ rms (on) measurements if >50% of the RJ rms (off) measurement, low-frequency jitter too large.

For example, RJ rms measures 600 fs (JSA off) and 450 fs (JSA on). In this case more than 50% of the jitter is coming from low-frequency jitter sources and you should match clock-to-data path lengths.

Installing the PTB Delay-Line Assembly

Use this procedure to install the PTB delay-line assembly onto the N1000A or 86100D's rear-panel. The PTB delay-line assembly adds delay to the oscilloscope's internal precision timebase path. The delay-line assembly is provided with the N1027A-76A electrical clock recovery phase matching kit. Electrical clock recovery is available with both the N1076B and N1077A.

NOTE If you are performing optical clock recovery (N1077A, N1077B, and N1078A only) do not install the delay-line assembly as the proper delay is already included in the DCA-M module's internal optical path.

1. Remove the rear-panel jumper cable on the N1000A (or 86100D) as shown in Figure 20.
2. Use a T-20 Torx screwdriver (provided in the kit) to remove the two rear-panel screws that are shown in the picture. Save the screws for use in step 4.

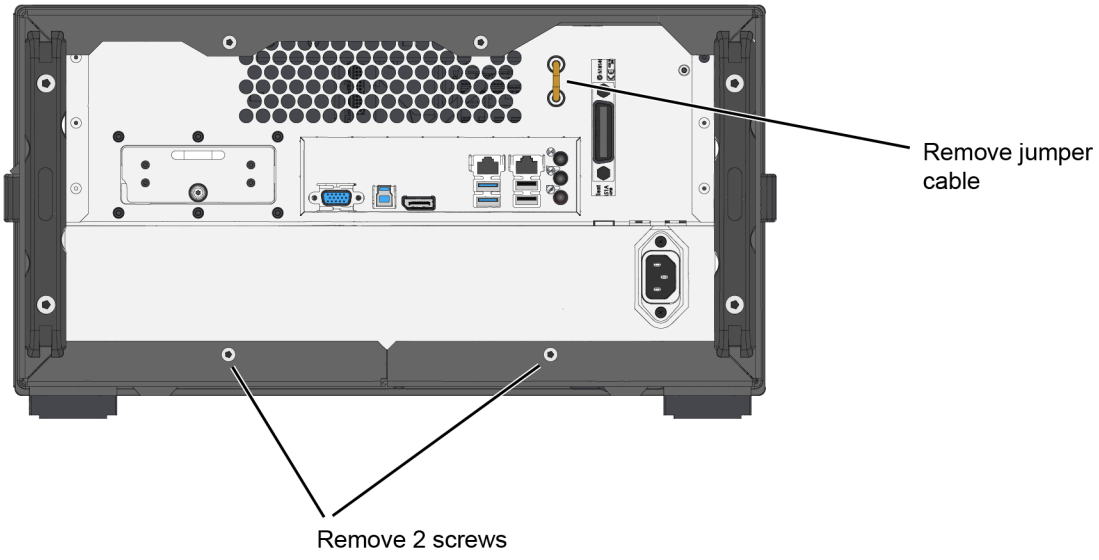


Figure 20. Remove jumper cable and screws

3. Follow the steps shown in *Figure 22* on page 52 to store the jumper that was removed in the previous step. If you ever need to remove the delay line (for example, to test optical signals), you'll have the original jumper available to re-install.

4. Use the two screws removed in step 2 above to secure the delay-line assembly to the N1000A (or, 86100D) rear panel as shown in Figure 21.

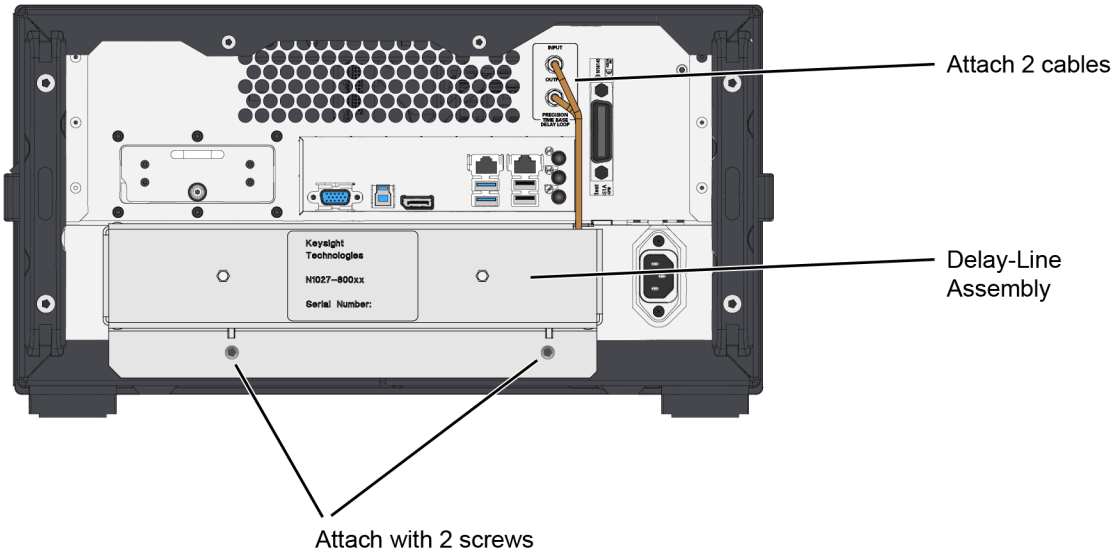


Figure 21. Securing the delay-line assembly

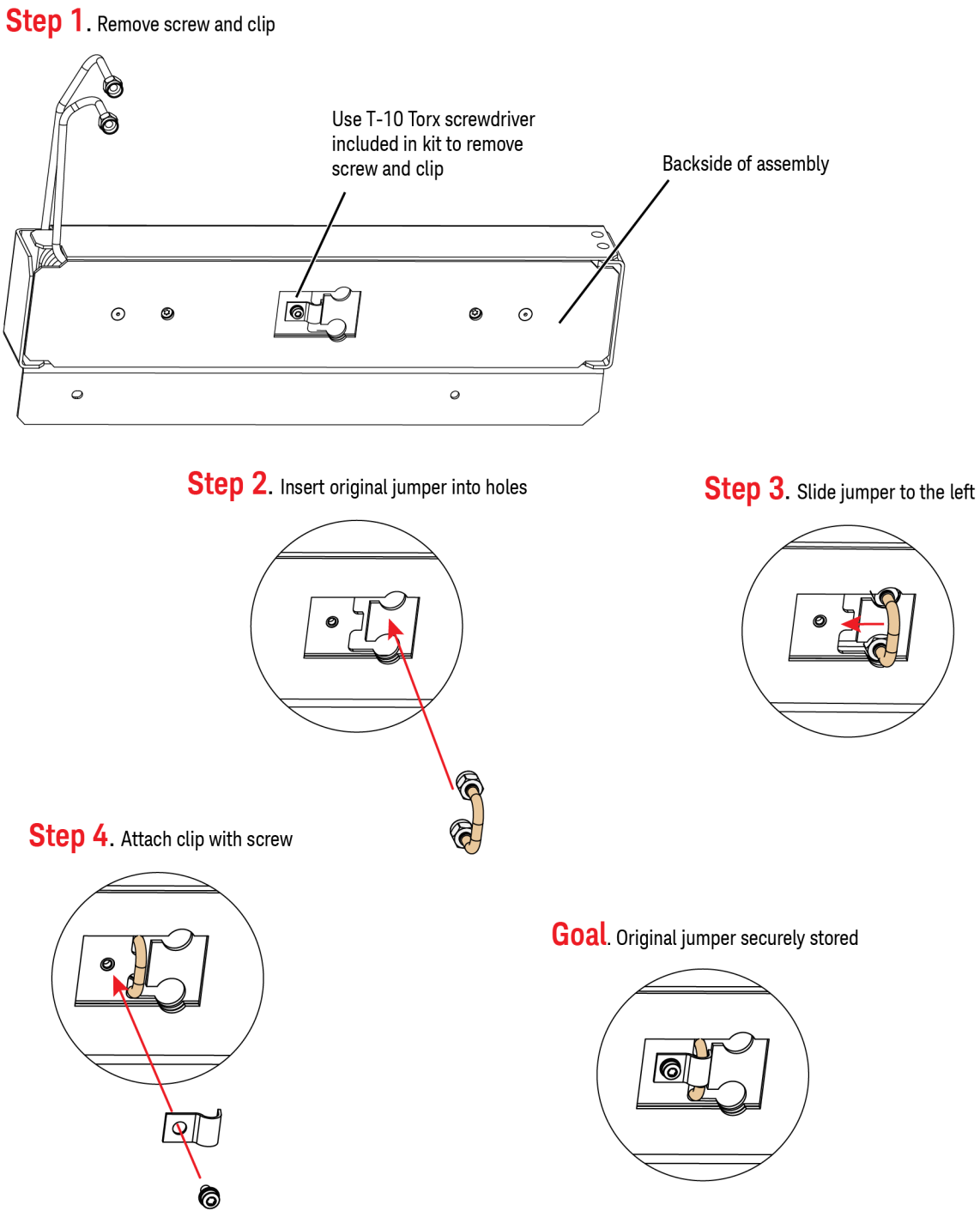


Figure 22. Storing the removed jumper cable on the delay-line assembly

Phase Matching Kit (Electrical)

For clock recovery on electrical input signals, Keysight makes available the following electrical phase-matching kit:

- N1027A-76B for N1076B, N1077B, and N1078A

Use this kit to minimize (align) clock-to-data delays and ensure accurate jitter measurements when using N1076B, N1077A, N1077B, or N1078A for external clock recovery with an:

- N109X-series DCA-M oscilloscope with an (or recovering clocks from electrical signals), or
- N1000A DCA-X mainframe with an internal precision timebase plus an N1045A, N1046A, or N1055A, module.

In the kit,

- External equalizers can be placed in front of the electrical clock recovery inputs to “open” a closed eye. They help the instrument recover a clock from a signal that has been severely degraded due to excessive frequency-dependent losses. Refer to *Opening Closed Eyes for Clock Recovery* on page 14
- Microwave pick-off tees are used to direct a small amount of the electrical input signal to the clock recovery module’s input. Refer to *Tap the Input Signal for Clock Recovery* on page 16.
- Circled numbers (ID Shown in Figures column) identifies items on the measurement setup drawings located in *Chapter 4 , Using the N1076B*, *Chapter 5 , Using the N1077A*, *Chapter 6 , Using the N1077B*, and *Chapter 7 , Using the N1078A*.

NOTE

The electrical phase matching kit can be ordered as an option at the time that the module is ordered. Thus kit contain the accessories listed in the following table.

N1027A-76B Electrical Phase Matching Kit

Table 21. N1027A-76B Electrical Phase Matching Kit

Description	ID Shown in Figures	Qty	P/N
Delay Lines			
Two sets of 2.92 mm matched pair cables (delay lines). Four cables total consisting of:		1	N1076-60015
A matched pair with 2.37 ns delay, 0.55m length.	①		
A matched pair with 4.33 ns delay, 1.0m length	②		
SMA delay-line assembly, 18.2 ns. This cable must be installed on DCA-X rear panel as explained in *Installing the PTB Delay-Line Assembly* on page 50.	③	1	N1027A-60015
Microwave Pick-Offs			
Two Microwave pick-off tees, 1.85 mm connectors, matched pair (Microwave pick-off tees are used to direct a small amount of the electrical data signal to the clock recovery input)	④	1	N1027A-2P8
Equalizers			
3 dB negative slope, 0.5 to 18 GHz, 2.92 mm (m) to 2.92 mm (f).	⑤	2	N1027A-EQ3
6 dB negative slope, 0.5 to 18 GHz, 2.92 mm (m) to 2.92 mm (f).		2	N1027A-EQ6
9 dB negative slope, 0.5 to 18 GHz, 2.92 mm (m) to 2.92 mm (f).		2	N1027A-EQ9
Tools			
T-20 Torx screwdriver. This screwdriver is used to install the kit's delay cable assembly (item 4).		1	8710-1615
T-10 Torx screwdriver. This screwdriver is used to install the kit's delay cable assembly. (item 4)		1	8710-1623
Torque wrench, 8 lb-in (0.9 Nm), 5/16 Inch (7.9 mm)		1	8710-1765

Phase Matching Kits (Optical)

For clock recovery on optical input signals, Keysight makes available the following two optical phase-matching kits:

- N1027A-77A for the N1077A
- N1027A-77B for the N1077B
- N1027A-78A for the N1078A

The optical phase matching kits provide specially matched cables that minimize (align) clock-to-data delays and ensure accurate measurements when using an N107x-series DCA-M for external clock recovery. The kit is designed to be used with any N1092 series DCA-M module or with a DCA-X that has an internal precision timebase and any optical DCA plug-in module. You can order optical phase matching kits as options at the time that the module is ordered. These kits contain the accessories listed in the following tables. In the following tables, the ID Shown in Figures column shows the circled number that is used to identify an item on measurement setup examples.

The external equalizers provided in the kit may be placed in front of the electrical clock recovery inputs to “open” a closed eye. They help the instrument recover a clock from a signal that has been severely degraded due to excessive frequency-dependent losses. Refer to *Opening Closed Eyes for Clock Recovery* on page 14.

N1027A-77A Optical Phase Matching Kit for N1077A

Table 22. N1027A-77A Optical Phase Matching Kit (for N1077A)

Description	ID Shown in Figures	Qty	P/N
Electrical Cables			
Coaxial cable, 2.92 mm (m) to 2.92 mm (m), 1m length. Cable used between the N1077A's *Recovered Clock Out* connector and the measurement instrument.	①	2	N1075-60017
Coaxial cable, 2.92 mm (m) to 2.92 mm (m), 0.3m (12 in.) length. Flexible cable used between N1077A's *Data Out* connector and *Data +* clock recovery input if an external equalizer is required. Refer to *Opening Closed Eyes for Clock Recovery* on page 14.	②	1	N1077-60005
Multimode Optical Cables (50/125 µm)			
FC/PC, 1.0m length *For general purpose optical measurements when clock-to-data delay is not critical.* This optical cable is also provided with each N1077A clock recovery.	③	1	N1077-60011
FC/PC, 2.6m length (phase matched) Multimode delay matching for N1077A with 86100D-PTB + DCA Module (86105D, 86116C)	④	1	N1077-60012
FC/PC, 4.75m length Multimode delay matching for N1077A with N1092x or N1094x.	⑤	1	N1077-60013
Single-Mode Optical Cables (9/125 µm)			
FC/PC, 1.0m length *For general purpose optical measurements when clock-to-data delay is not critical.* This optical cable is also provided with each N1077A clock recovery.	⑥	1	N1077-60008
FC/PC, 3.5m length Single-mode delay matching for N1077A with 86100D-PTB + DCA Module (86105D, 86116C)	⑦	1	N1077-60009
FC/PC, 5.6m length Single-mode delay matching for N1077A with N1092x or N1094x.	⑧	1	N1077-60010
Microwave Equalizers			
6 dB, negative slope, 0.5 GHz to 18 GHz, SMA	⑨	1	N1027A-EQ6
9 dB, negative slope, 0.5 GHz to 18 GHz, SMA	⑨	1	N1027A-EQ9

N1027A-77B Optical Phase Matching Kit for N1077B

The N1027A-77B Optical Phase Matching Kit only supports phase matching to an N1092A/B/C/D/E Option 30A DCA-Ms.

Table 23. N1027A-77B Optical Phase Matching Kit (for N1077B)

Description	ID Shown in Figures	Qty	P/N
Electrical Cables			
Coaxial cable, 2.92 mm (m) to 2.92 mm (m), 1m length. Cable used between the N1077B's *Recovered Clock Out* connector and the measurement instrument.	①	2	N1075-60017
Coaxial cable, 2.92 mm (m) to 2.92 mm (m), 0.3m (12 in.) length Flexible cable used between N1077B's *Data Out* connector and *Data* + clock recovery input if an external equalizer is required. Refer to *Opening Closed Eyes for Clock Recovery* on page 14.	②	N1077-60005	
Multimode Optical Cables (50/125 µm)			
FC/PC, 1.0m length *For general purpose optical measurements when clock-to-data delay is not critical.* This optical cable is also provided with each N1077B clock recovery.	③	1	N1077-60011
FC/PC, 6.25m length Multimode delay matching for N1077B with N1092x or N1094x.	④	1	N1077-60025
Microwave Equalizers			
6 dB, negative slope, 0.5 GHz to 18 GHz, SMA	⑤	1	N1027A-EQ6
9 dB, negative slope, 0.5 GHz to 18 GHz, SMA	⑤	1	N1027A-EQ9

N1027A-78A Optical Phase Matching Kit for N1078A

Table 24. N1027A-78A Optical Phase Matching Kit (for N1078A)

Description	ID Shown in Figures	Qty	P/N
Electrical Cables			
Coaxial cable, 2.92 mm (m) to 2.92 mm (m), 1m length. Cable used between the N1077A's *Recovered Clock Out* connector and the measurement instrument.	①	2	N1075-60017
Coaxial cable, 2.92 mm (m) to 2.92 mm (m), 0.3m (12 in.) length Flexible cable used between N1077A's *Data Out* connector and *Data +* clock recovery input if an external equalizer is required. Refer to *Opening Closed Eyes for Clock Recovery* on page 14.	②	1	N1077-60005
Single-Mode Optical Cables (9/125 µm)			
FC/PC, 1.0m length *For general purpose optical measurements when clock-to-data delay is not critical.* This optical cable is also provided with each N1078A clock recovery.	③	1	N1077-60008
FC/PC, 5.0m length Single-mode delay matching for N1078 with N1092x or N1094x.	④	1	N1077-60014
Microwave Equalizers			
6 dB, negative slope, 0.5 GHz to 18 GHz, SMA	⑤	1	N1027A-EQ6
9 dB, negative slope, 0.5 GHz to 18 GHz, SMA	⑤	1	N1027A-EQ9

4 Using the N1076B

The N1076B has options that cover these data rates:

- 50 MBd to 16 GBd (option 216)
- 50 MBd to 32 GBd (option 232)
- 50 MBd to 64 GBd (option 264)

Option JSA, Jitter spectrum analysis and clock recovery emulation, provides greater insights into jitter and improves jitter measurement accuracy. To learn about JSA, open FlexDCA help and in the Contents tab open the JSA Analysis section.

Front-panel input and output connectors along with signal parameters are shown in *Figure 23* on page 60. For additional information, refer to the N1076B specifications which are located in FlexDCA's help system.

The example setups shown in this chapter represent the most common clock recovery use cases and will help you to understand the general principles involved.

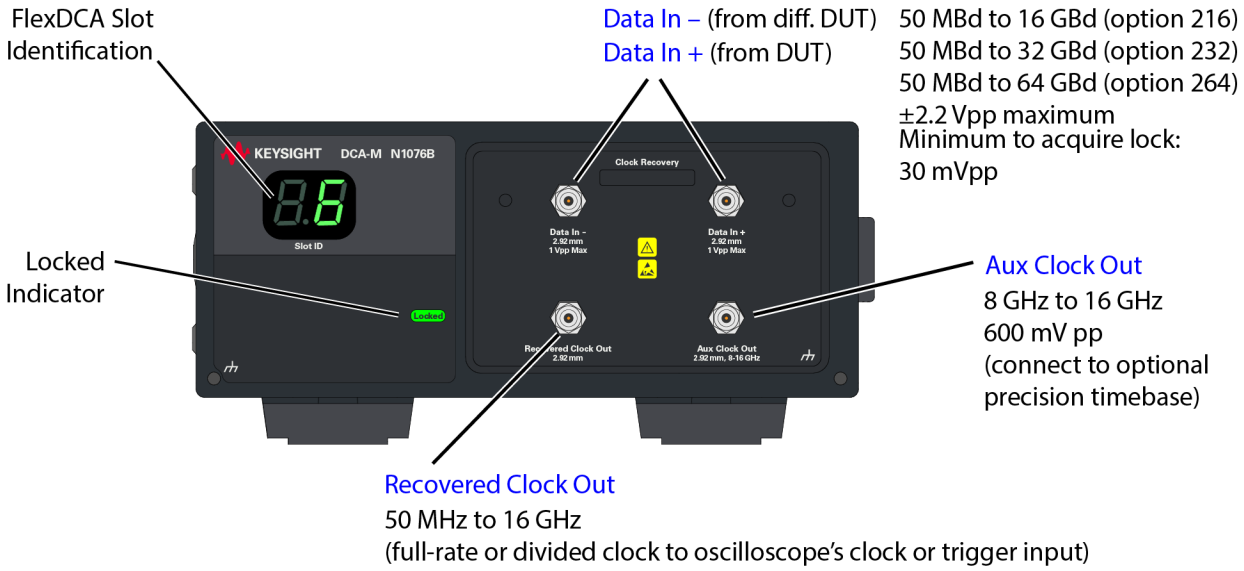


Figure 23. N1076B Front-Panel Connectors

To Setup Clock Recovery

In this example, an electrical input signal is input to an N1076B which is connected to an N1094B sampling oscilloscope. A microwave pickoff is used to tap a portion of the input signal as an input to the clock recovery module.

The settings made in this procedure can also be made using a program as shown in the Python example, *Example 3. Perform eye measurement with N109X & N1076/7A* on page 155. Perform eye measurement with N109X & N1077A.

1. Confirm that the input signal meets the baud rate and amplitude requirements shown in *Figure 23* on page 60. In this procedure, the following assumptions are made for simplicity. You can change these parameters to any acceptable values.
   - Data signal: 10.3125 GBd
   - N1094B oscilloscope slot: 5
   - N1076B clock recovery slot: 6
2. In FlexDCA, click *Setup* > **Default Setup**.
3. Connect the N1076B as shown in *Figure 24* on page 62. If connecting to an N1000A (or 86100D) instead of a PC, be sure to connect the USB cable to the N1000A's rear-panel USB port.
4. Connect the input signal to the N1076B front-panel **Data In +** input. For differential signals, also use the **Data In –** input as shown in *Example Setup 2. Differential Input with DCA-M Scope* on page 65.
5. In FlexDCA, click **Setup** > **Trigger Setup** and select the General Trigger Setup tab. Confirm that the trigger Source is set to **Front Panel**.
6. Click **Setup** > **Modules** > **(Slot 6): Clock Recovery**. The Setup dialog is shown *Figure 25* on page 63. The picture does not show settings required for this procedure.
7. For the **Input Source**, select **Electrical Data +**, which is used for single-ended or optical signal.
8. In the **Data Rate** field, enter 10.3125 GBd.
9. In the dialog's **Advanced** settings section, configure the Loop Characteristics as appropriate.
10. In the **Clock Recovery** field, click the **Lock** button to lock clock recovery. Observe the N1076B's front-panel indicator light: **Locked**

- A green light indicates clock recovery is locked on the input data.
- A flashing yellow light indicates attempting to lock.
- An off light indicates clock recovery is unlocked.

11. In FlexDCA's signals palette, turn all channels off except for channel 5A.
12. Click **Setup** > **Mode** > **Eye/Mask**.

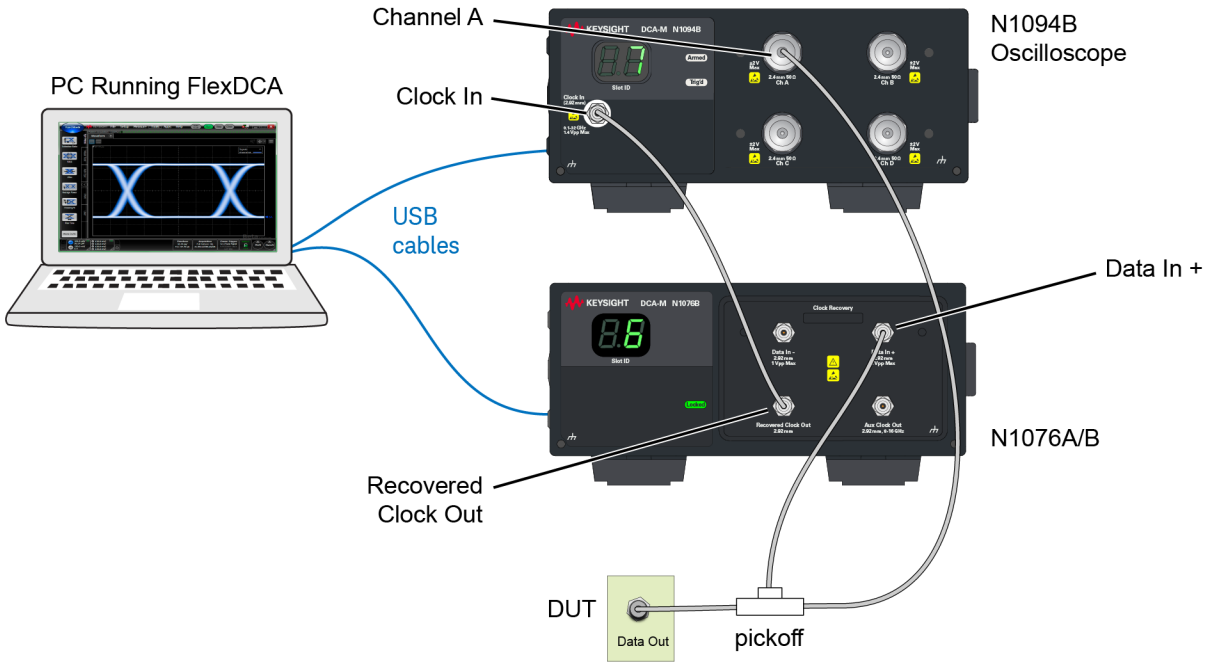


Figure 24. Typical Connection Setup

13. Click **Auto Scale**.
14. The N109X-series oscilloscope's front-panel **Trig'd** light should be green. If not, confirm that the amplitude of the signal at channel 5A is not too low due to loss in the pickoff. Consult the specifications listed in the FlexDCA help system.
15. If the N109X-series oscilloscope has pattern locking (option PLK):
    - Click **Setup** > **Trigger Setup** and select the Pattern Lock tab. In the **Data Rate** field, turn off **Auto Detect** and select 10.3125 GBd.
    - In the General Setup tab, click the **Pattern Lock** button.

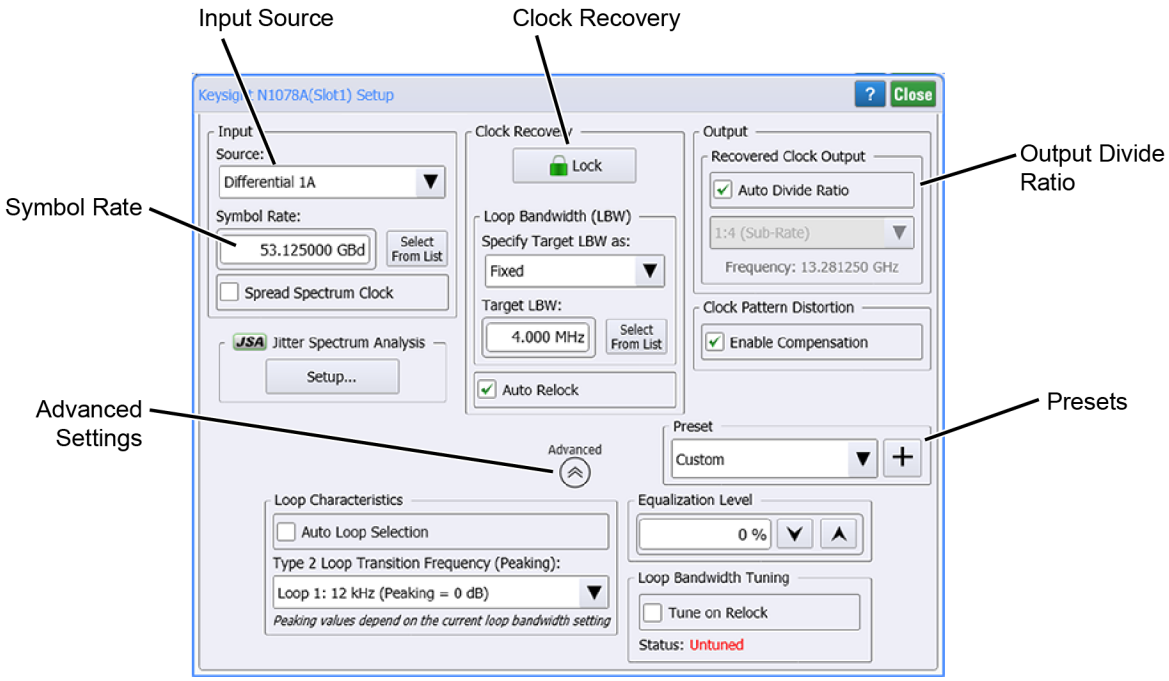


Figure 25. Clock Recovery Setup Dialog

Example Setup 1. Single-Ended Input with DCA-M Scope

This example setup shows an N1076B connected to an N1094B oscilloscope with a single-ended electrical input signal. A microwave pickoff is used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

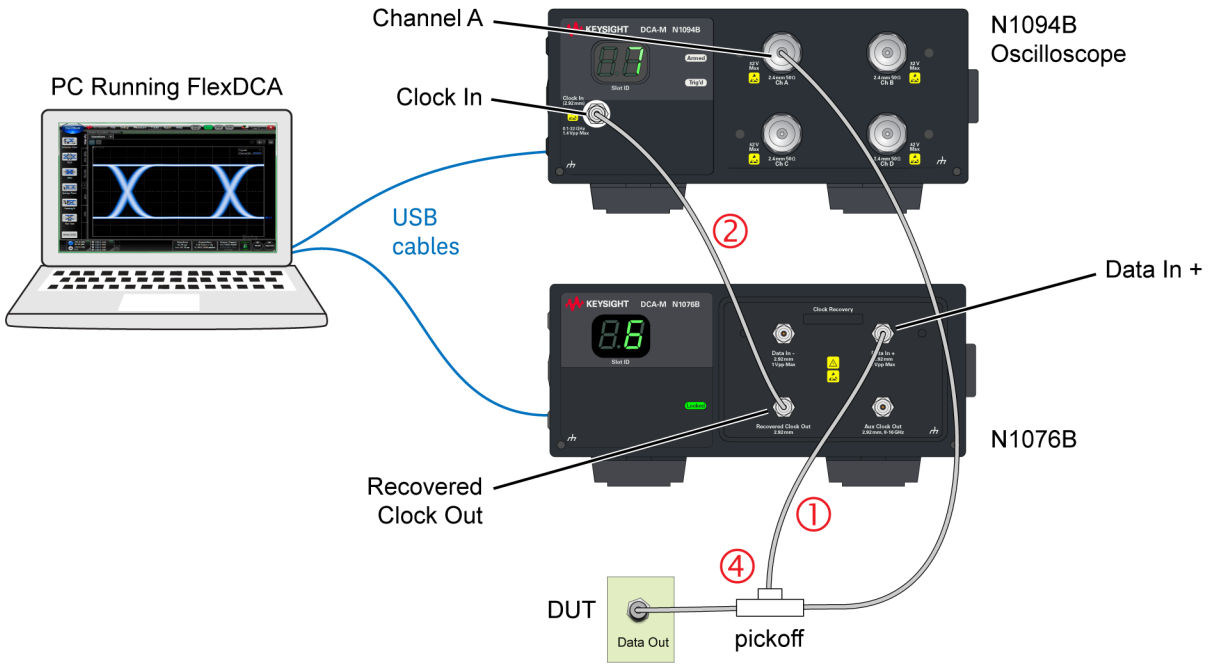


Figure 26. Single-Ended Input with N1076B DCA-M Scope

Example Setup 2. Differential Input with DCA-M Scope

This example setup shows an N1076B connected to an N1094B oscilloscope with a differential input signal. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

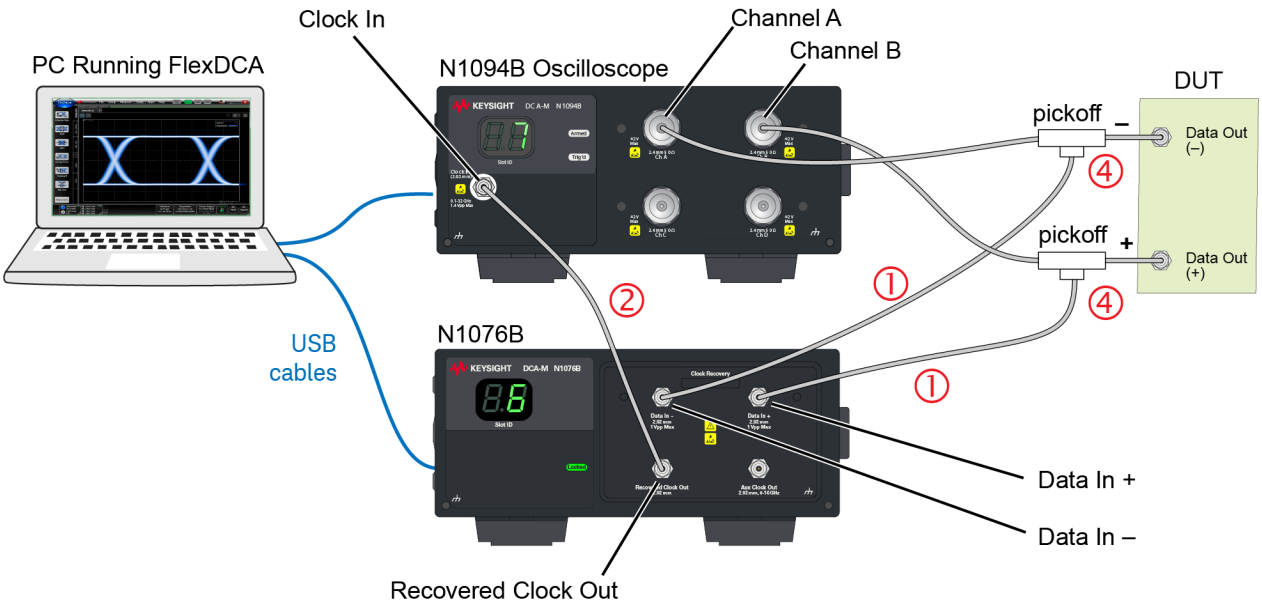


Figure 27. Differential Input with DCA-M Scope

Example Setup 3. Differential Input with DCA-X Scope

This example setup shows an N1076B connected to a DCA-X scope, which has an N1045A receiver module and an 86107A precision timebase. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

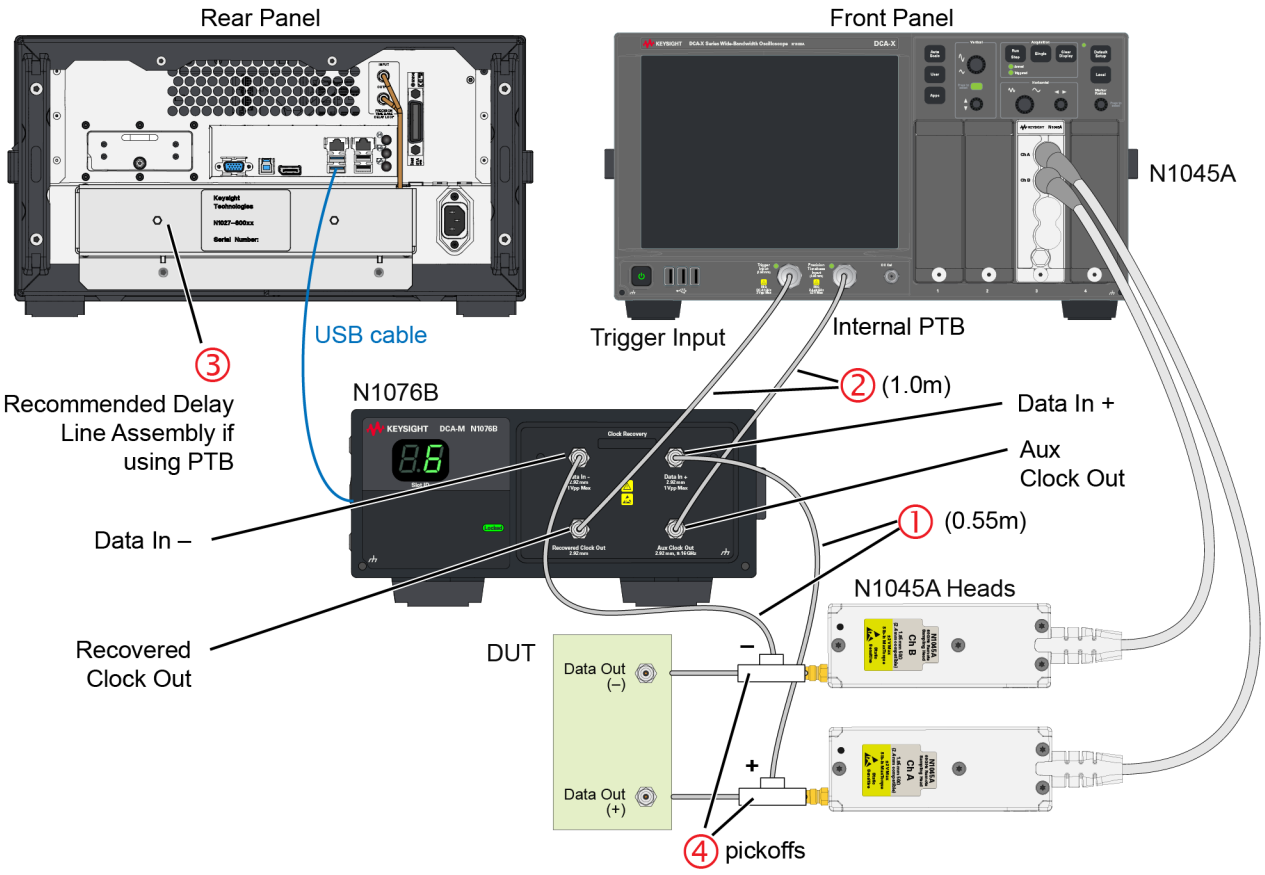


Figure 28. Differential Input with DCA-X Scope

Block Diagram

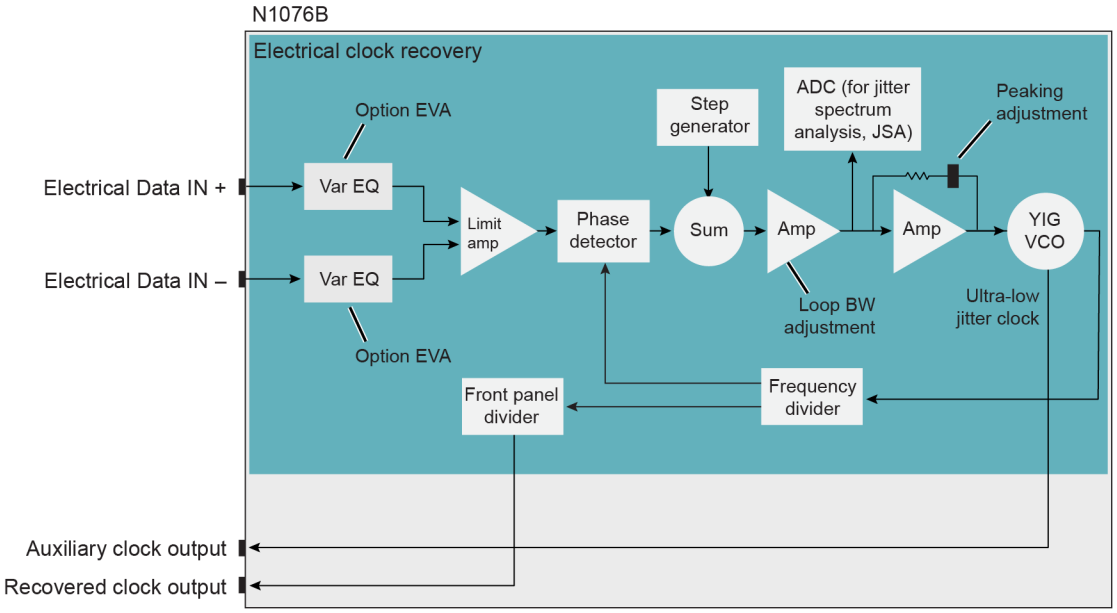


Figure 29. N1076B Block Diagram

Module Options and Accessories

Table 25. N1076B Options

Option	Description
Input Data Rates	
216	50 MBd to 16 GBd (16.4 GBd characteristic)
232	50 MBd to 32 GBd (32.8 GBd characteristic)
264	50 MBd to 64 GBd (64.8 GBd characteristic)
Equalization and Jitter Spectrum Analysis	
EVA	Integrated, variable equalizer.
JSA	Jitter spectrum analysis and clock recovery emulation. Jitter Spectrum Analysis (JSA) provides greater insights into jitter and improves jitter measurement accuracy.
External microwave pick-off "T"	
2P1	1.0 mm connectors, matched pair. Can be ordered separately as N1027A-2P1.
2P2	2.4 mm connectors, matched pair. Can be ordered separately as N1027A-2P2.
2P3	2.92 mm connectors, matched pair. Can be ordered separately as N1027A-2P3.
2P8	1.85 mm connectors, matched pair. Can be ordered separately as N1027A-2P8.
External equalizer for making "closed eye" measurements	
EQ3	2.92 mm (m) to 2.92 mm (f), 3 dB. Can be ordered separately as N1027A-EQ3.
EQ6	2.92 mm (m) to 2.92 mm (f), 6 dB. Can be ordered separately as N1027A-EQ6.
EQ9	2.92 mm (m) to 2.92 mm (f), 9 dB. Can be ordered separately as N1027A-EQ9.
External accessories, Miscellaneous	
CR1	Electrical clock recovery phase matching kit for use when using an N1000A/86100D (with *Internal Precision Timebase, option PTB)* and electrical clock input signal, and N1045A or N1055A remote-head module. This kit can be ordered separately as N1027A-76A. Refer to *Introduction* on page 7.
DC1	18.2 ns delay cable.
Rack Mount Kits	
1CM	For single DCA-M. Can be ordered separately as N1027A-RM1.
1CN	For two DCA-Ms mounted side by side. Can be ordered separately as N1027A-RM2.

Table 26. N1076B Supplied Accessories

Item	Qty
USB cable, USB-A plug to USB-B plug (2m long)	1
RF SMA 50-ohm cap (male)	4

5 Using the N1077A

The N1077A has options that cover the following data rates:

- 50 MBd to 16 GBd (option 216)
- 50 MBd to 32 GBd (option 232)

Figure 30 on page 72 and *Figure 31* on page 73 shows the N1077A-SXT and N1077A-SMS module front-panels. Option SXT modules do not have an internal optical splitter and have one multimode optical input. Option SMS models include an internal optical splitter and both single-mode and multimode optical inputs and outputs. The optical internal splitter provides a slightly attenuated input signal at the optical **Data Out** connectors. This output can be used for input to a receiver module or other test equipment.

A diagram that is printed on the N1077A's front panel associates optical **Data In** connector with Electrical **Data Out** connectors, and O/E. For additional information, refer to the N1077A specifications which are located in FlexDCA's help system.

The example setups shown in this chapter represent the most common clock recovery use cases and will help you to understand the general principles involved.

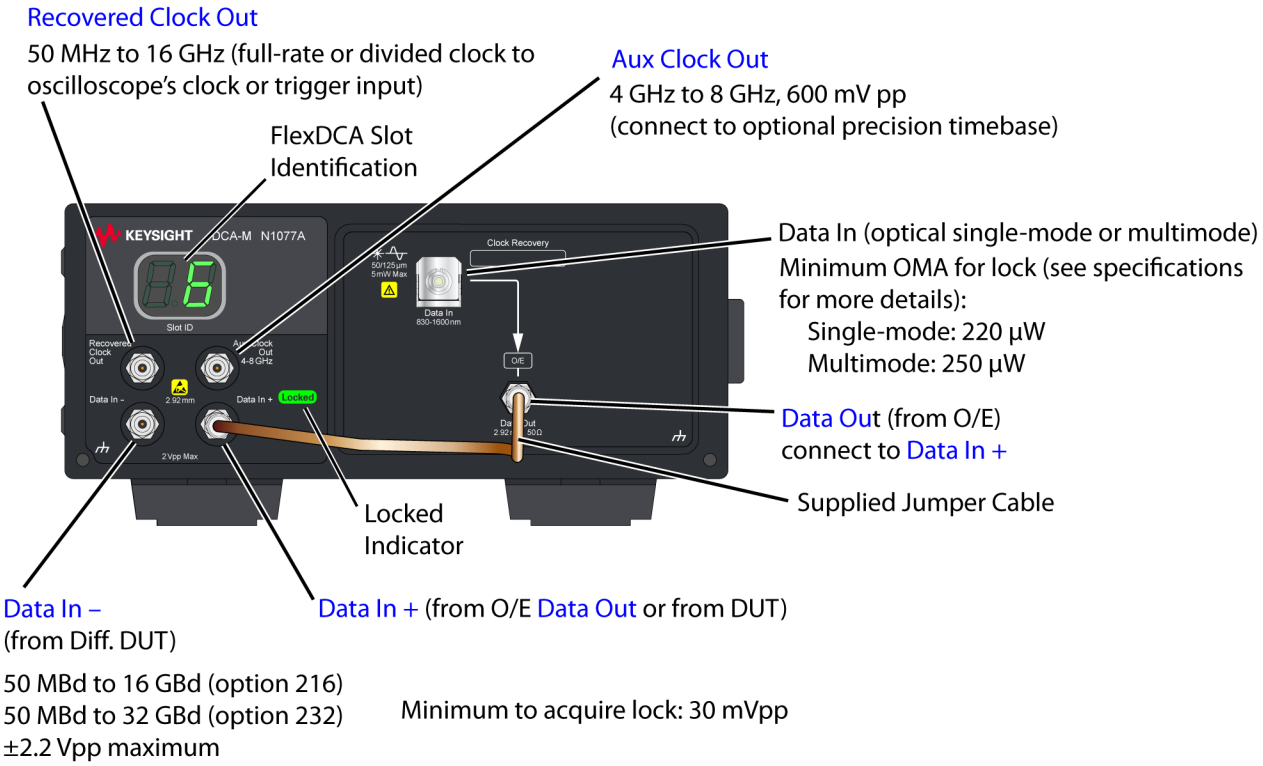


Figure 30. N1077A-SXT Front-Panel Connectors

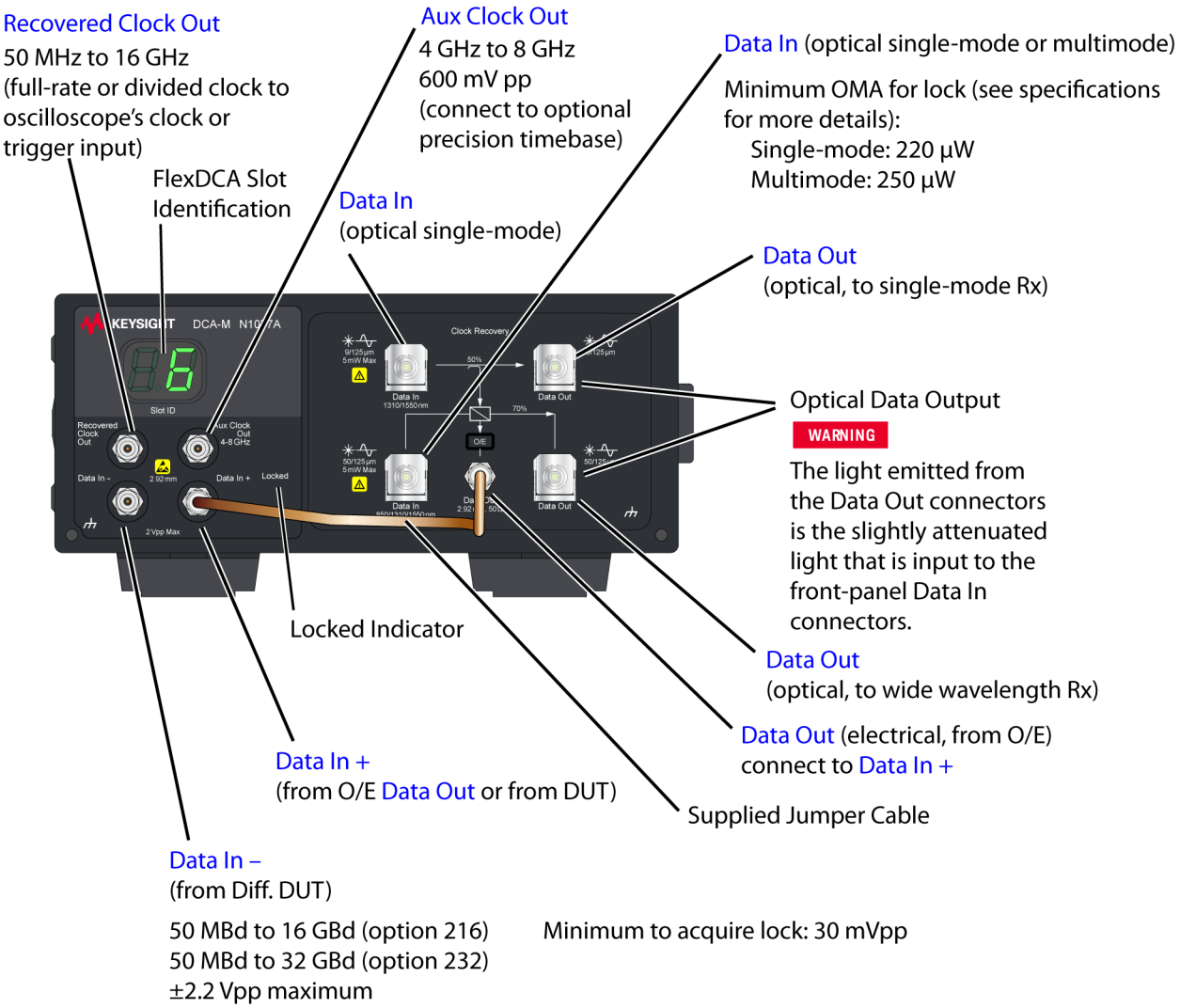


Figure 31. N1077A-SMS Front-Panel Connectors

WARNING The light emitted from the Data Out connectors is the slightly attenuated light that is input to the front-panel Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.

Option JSA, Jitter spectrum analysis and clock recovery emulation, provides greater insights into jitter and improves jitter measurement accuracy. To learn about JSA, open FlexDCA help and in the Contents tab open the JSA Analysis section.

To Setup Clock Recovery

In this example, an optical input signal is input to an N1077A-SMS which is connected to an N109X-series sampling oscilloscope. Multimode fiber is connected to the corresponding multimode connectors on the N1077A. If you are using an N1077A-SXT, you will need an external optical splitter. If you are using an electrical input signal, you will connect your electrical data signal to the front-panel **Data In +** port.

The settings made in this procedure can also be made using a program as shown in the Python example, *Example 3. Perform eye measurement with N109X & N1076/7A* on page 155.

NOTE To avoid damaging the N1077A's front-panel fiber-optic connectors, use proper connection techniques. Refer to *Cleaning the Fiber-Optic Connectors* on page 44.

WARNING **The light emitted from the Data Out connectors is the slightly attenuated light that is input to the front-panel Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.**

1. Confirm that the input signal meets the baud rate and amplitude requirements shown in *Figure 31* on page 73. In this procedure, the following assumptions are made for simplicity. You can change these parameters to any acceptable values.
   - Data signal: 10.3125 GBd
   - N1092D oscilloscope slot: 5
   - N1077A-SMS clock recovery slot: 6
2. In FlexDCA, click **Setup** > **Default Setup**.
3. Connect the N1077A as shown in *Figure 32* on page 75. If connecting to an N1000A (or 86100D) instead of a PC, be sure to connect the USB cable to the DCA-X's *rear-panel* USB port. Notice in this example that the N1077A multimode optical connectors are used:
   a. Connect the optical signal to the N1077A front-panel optical **Data In** input.
   b. Connect the supplied semi-rigid coaxial jumper cable between the front-panel **Data Out** and **Data In +** connectors as shown in the figure.

4. If using an electrical input signal, connect the signal to the N1077A front-panel electrical **Data In +** input. For differential signals, also use the **Data In –** input as shown in *Example Setup 2. Differential Input, N1077A-SXT, DCA-M Scope* on page 78.

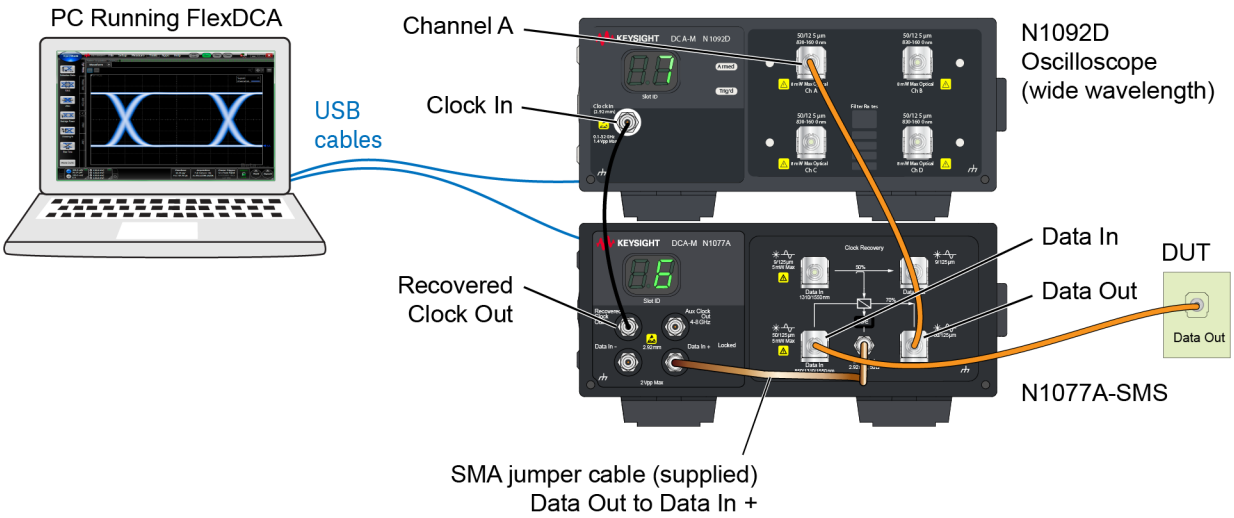


Figure 32. Typical Connection Setup

5. In FlexDCA, click **Setup** > **Trigger Setup** and select the General Trigger Setup tab. Confirm that the trigger Source is set to **Front Panel**.
6. Click **Setup** > **Modules** > **(Slot 6): Clock Recovery**. The Setup dialog is shown *Figure 33* on page 76. The picture does not show settings required for this procedure.
7. For the **Input Source**, select **Electrical Data +**, which is used for single-ended or optical signal.
8. In the **Data Rate** field, enter 10.3125 GBd.
9. In the dialog's **Advanced** settings section, configure the Loop Characteristics as appropriate.
10. In the **Clock Recovery** field, click the **Lock** button to lock clock recovery. Observe the N1077A's front-panel indicator light: **Locked**
    - A green light indicates clock recovery is locked on the input data.
    - A flashing yellow light indicates attempting to lock.
    - An off light indicates clock recovery is unlocked.
11. In FlexDCA's signals palette, turn all channels off except for channel 5A.
12. Click **Setup** > **Mode** > **Eye/Mask**.
13. Click **Auto Scale**.

14. The N109X-series oscilloscope's front-panel **Trig'd** light should be green. If not, confirm that the amplitude of the signal at channel 5A is not too low due to the "pass through" loss in the N1077A. Consult the specifications listed in the FlexDCA help system.

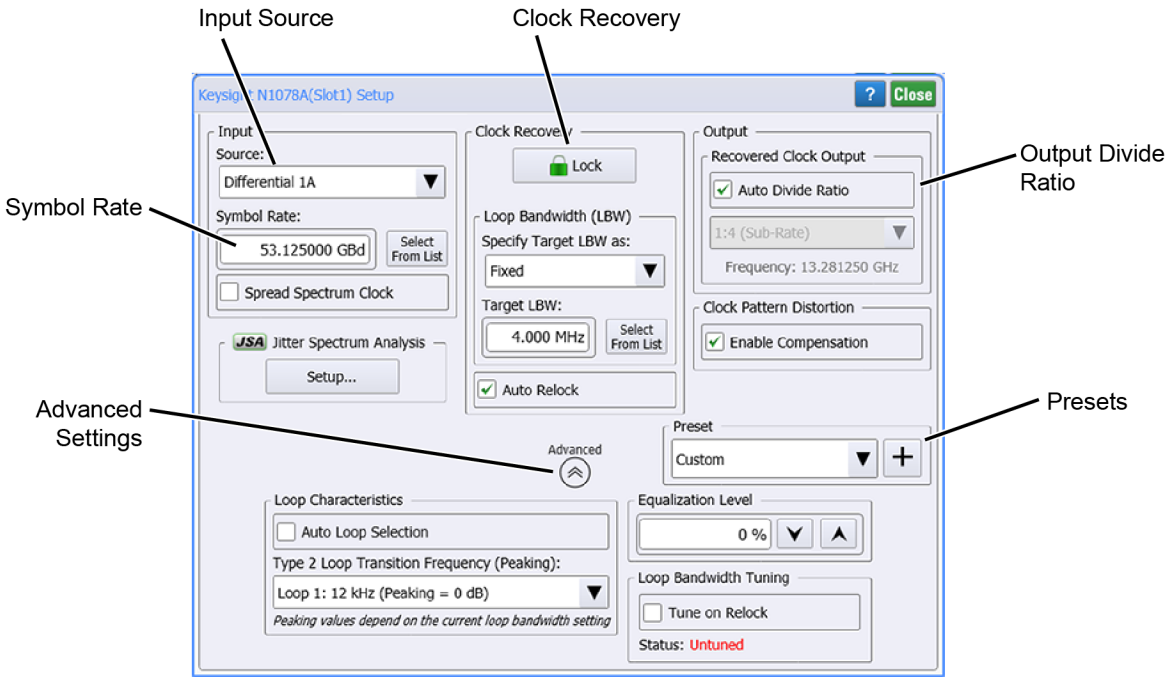


Figure 33. Clock Recovery Setup Dialog

15. If the N109X-series oscilloscope has pattern locking (option PLK):
    a. Click **Setup** > **Trigger Setup** and select the Pattern Lock tab. In the **Data Rate** field, turn off **Auto Detect** and select 10.3125 GBd.
    b. In the General Setup tab, click the **Pattern Lock** button.

Example Setup 1. Single-Ended Input, N1077A-SXT, DCA-M Scope

This example setup shows an N1077A-SXT connected to an N1094B oscilloscope with a single-ended electrical input signal. The microwave pickoff is used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

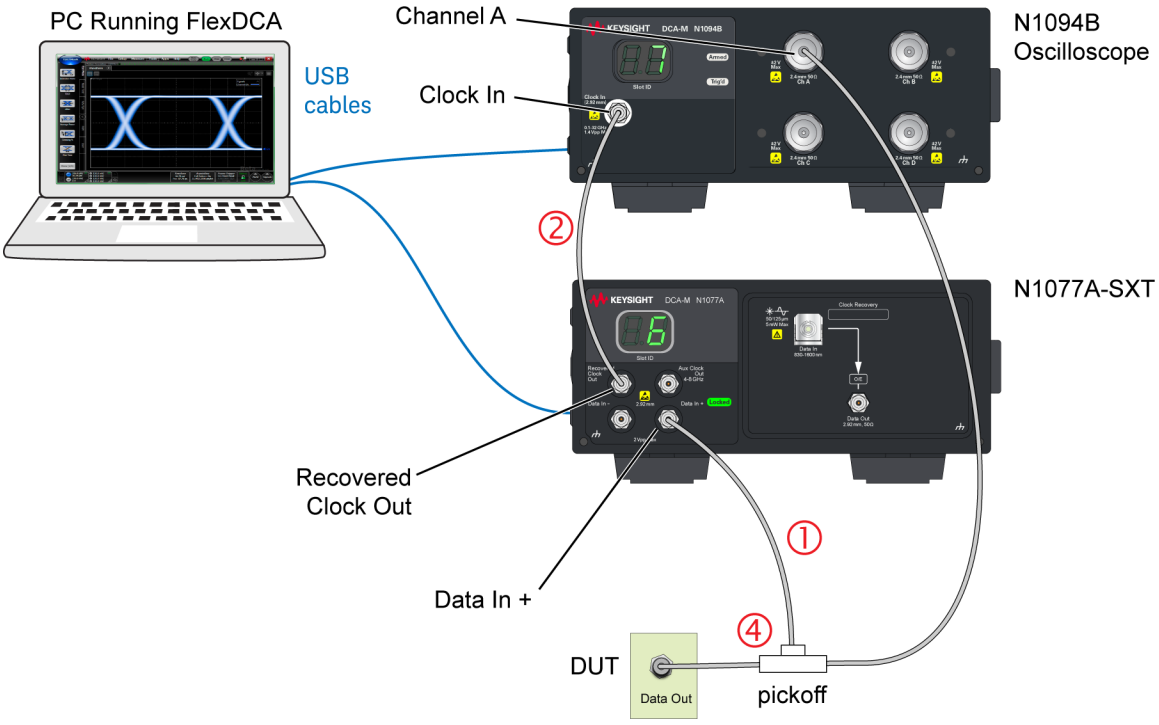


Figure 34. Single-Ended Input with N1077A-SXT, DCA-M Scope

Example Setup 2. Differential Input, N1077A-SXT, DCA-M Scope

This example setup shows an N1077A-SXT connected to an N1094B oscilloscope with a differential input signal. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

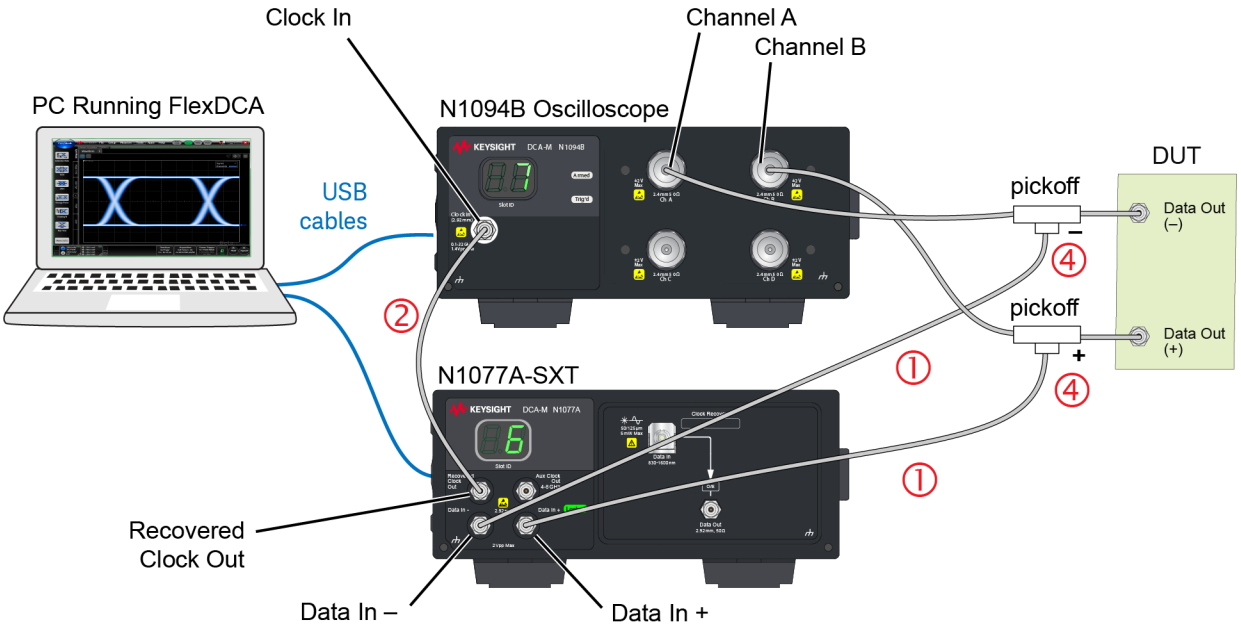


Figure 35. Differential Input with DCA-M Scope

Example Setup 3. Differential Input, N1077A-SXT, DCA-X Scope

This example setup shows an N1077A-SXT connected to a DCA-X oscilloscope. The oscilloscope has an N1045A receiver module and an 86107A precision timebase. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

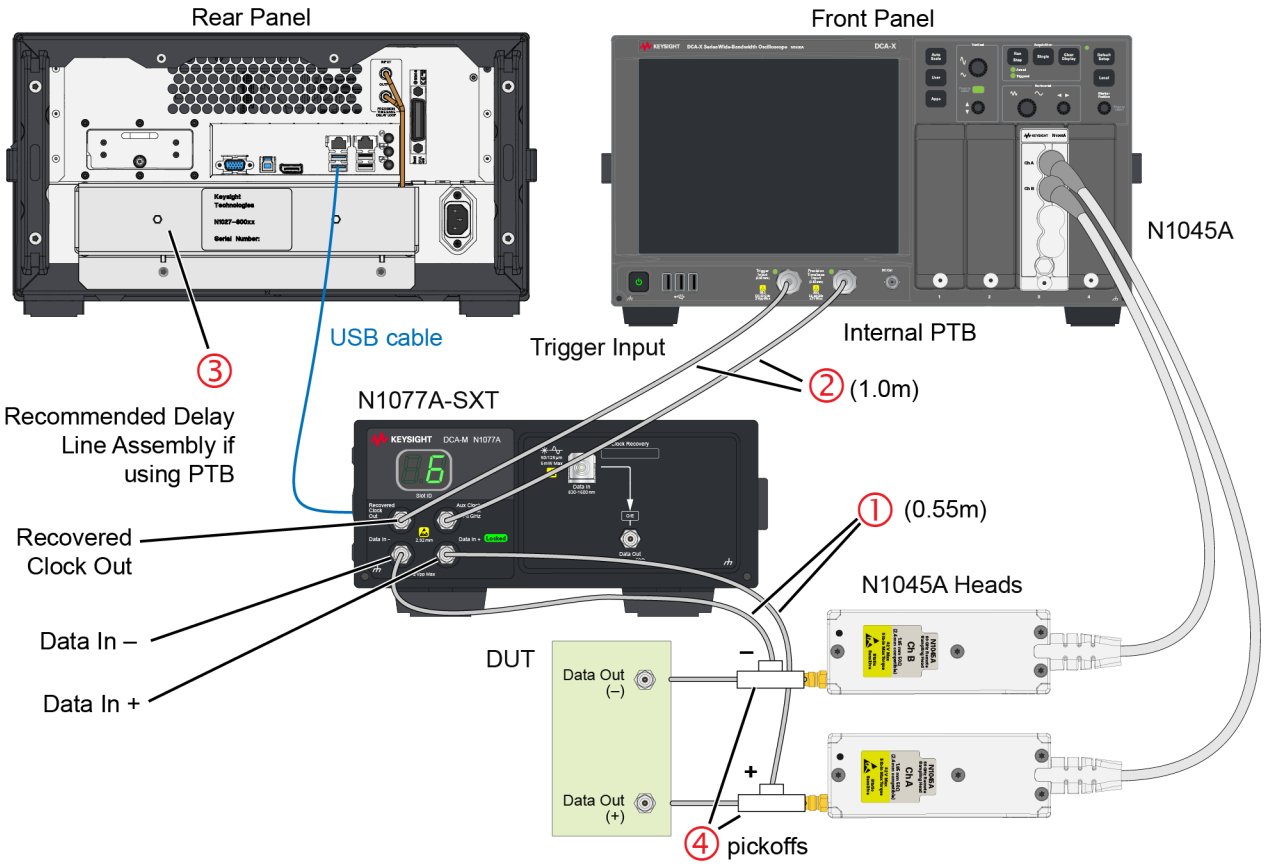


Figure 36. Differential Input with DCA-X Scope

Example Setup 4. Multimode Input, N1077A-SXT, External Splitter, DCA-X Scope

This example setup shows an N1077A connected to a DCA-X oscilloscope. The oscilloscope has an 86105D receiver module which has a multimode optical input connector. Since the N1077A-SXT does not have an internal optical splitter, the user must supply their own. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 22 N1027A-77A Optical Phase Matching Kit (for N1077A)* on page 56.

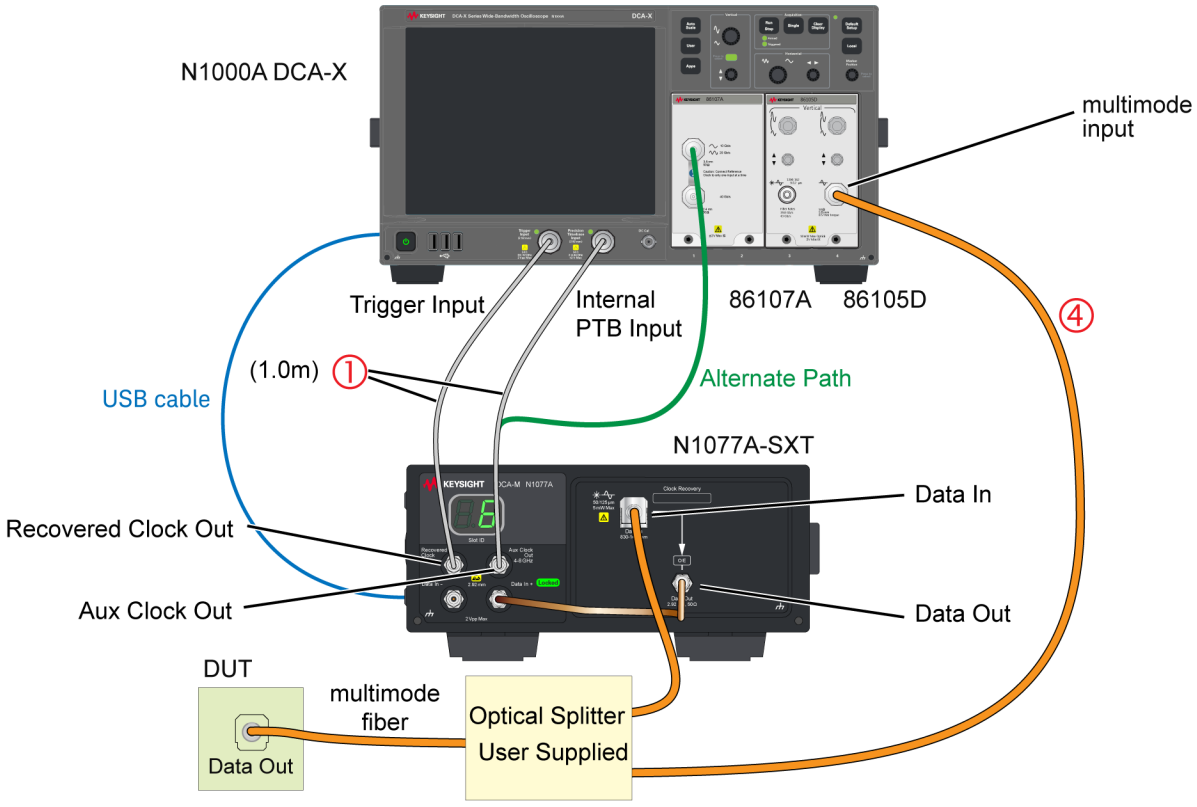


Figure 37. Multimode Input, N1077A-SXT, DCA-X Scope

Example Setup 5. Single-Mode Input, N1077A-SMS, DCA-M Scope

This example setup shows an N1077A-SMS connected to an N1092E oscilloscope. Single-mode fiber can be connected to the N1077A-SMS's single-mode input connector. Since the N1092-series oscilloscopes do not have a single-mode input, you can use a multimode patchcord in most cases. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 22 N1027A-77A Optical Phase Matching Kit (for N1077A)* on page 56.

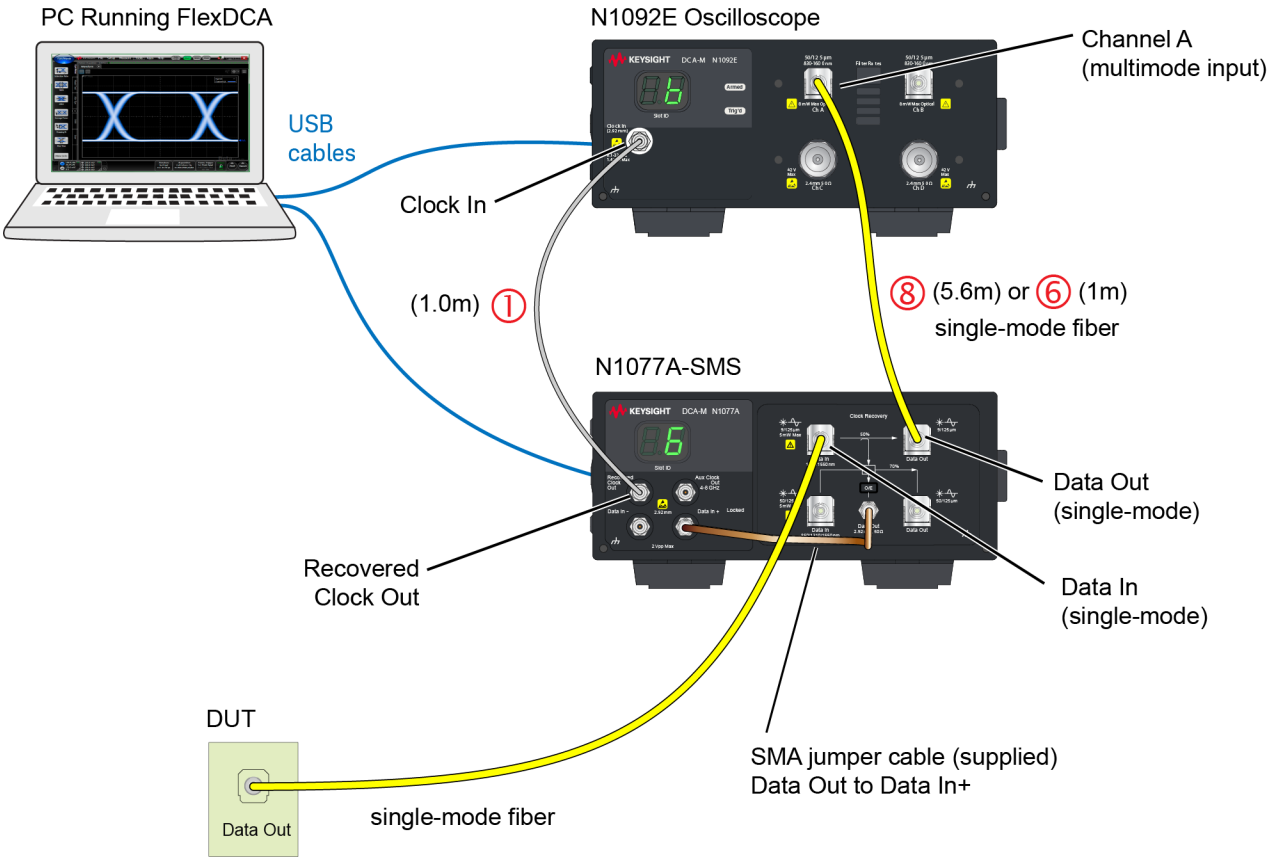


Figure 38. Single-Mode Input, N1077A-SMS, DCA-M Scope

Example Setup 6. Single-Mode Input, N1077A-SMS, 86116C

This example setup shows an N1077A-SMS connected to a DCA-X oscilloscope with an 86116C. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 22 N1027A-77A Optical Phase Matching Kit (for N1077A)* on page 56.

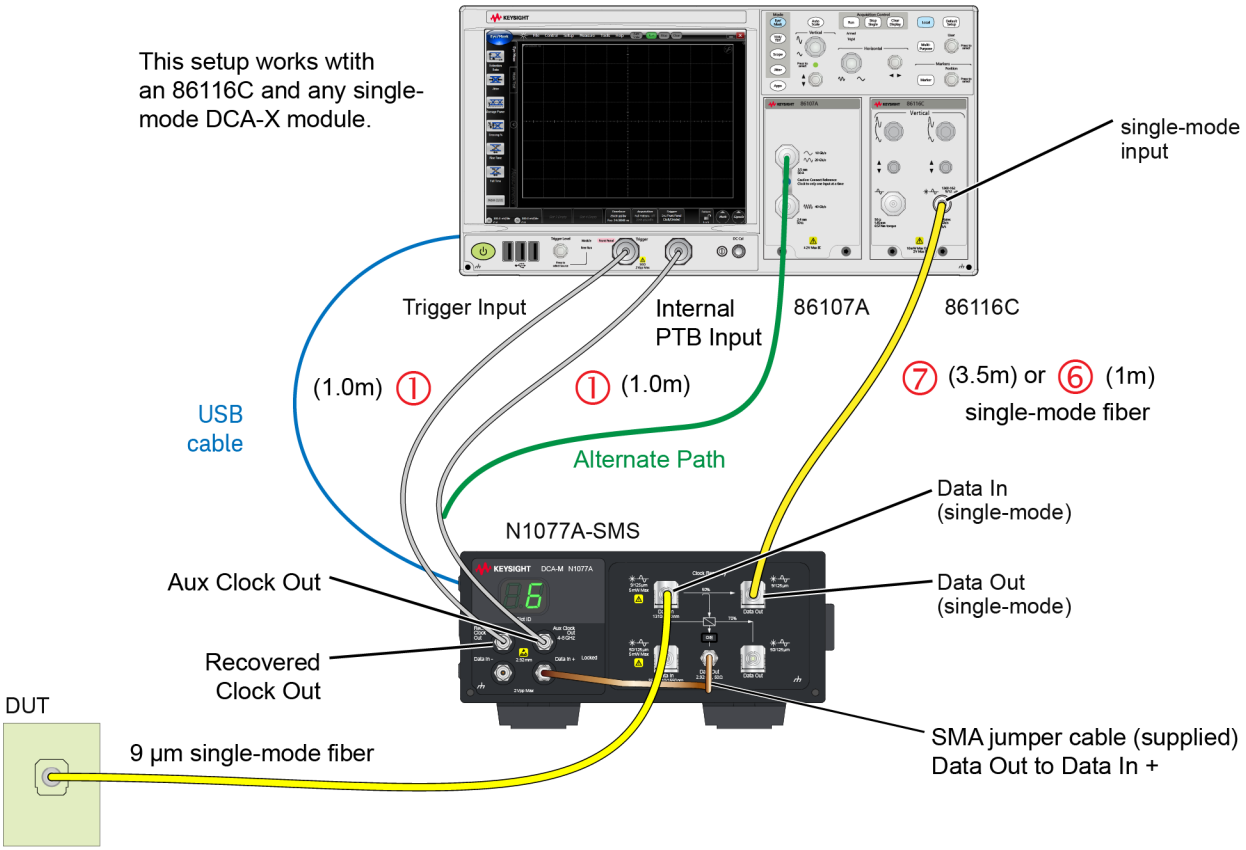


Figure 39. Single-Mode Input, N1077A-SMS, DCA-X Scope

Example Setup 7. Multimode Input, N1077A-SMS, DCA-M Scope

This example setup shows an N1077A-SMS connected to an N1092E oscilloscope. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 22 N1027A-77A Optical Phase Matching Kit (for N1077A)* on page 56.

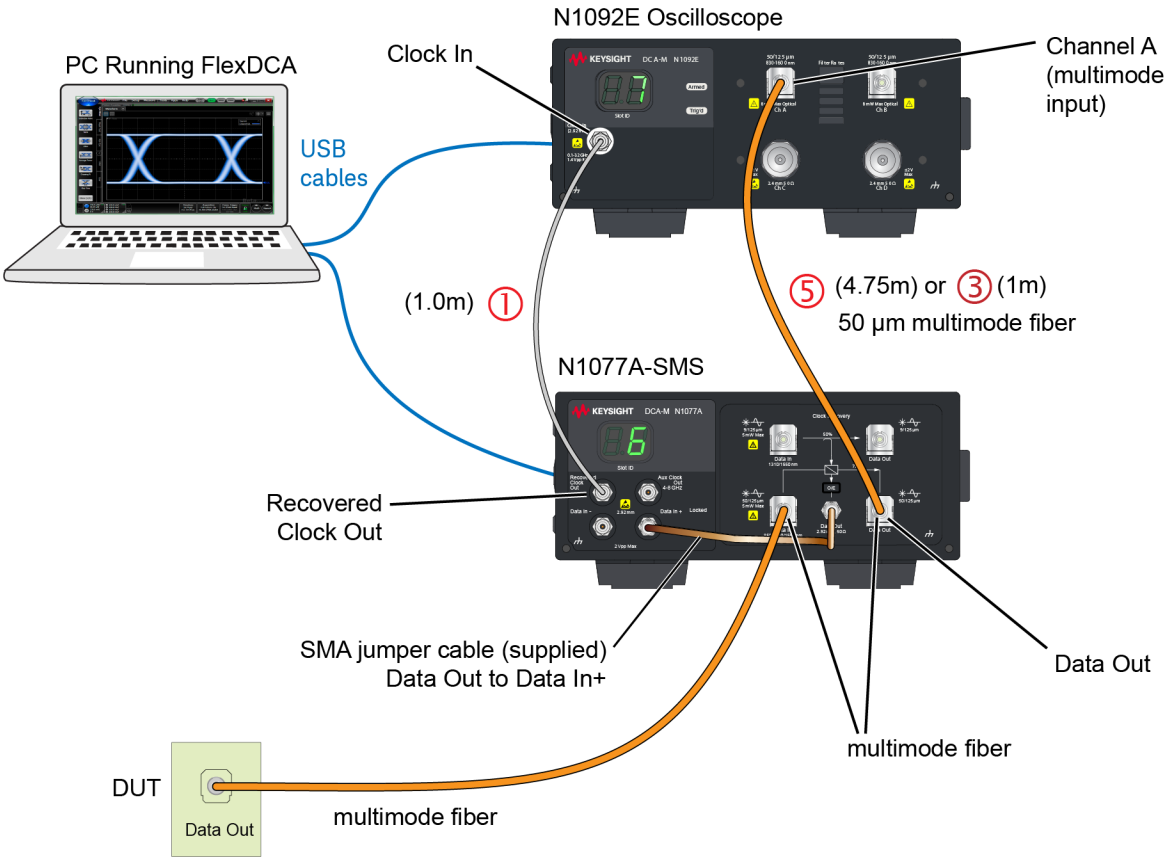


Figure 40. Multimode Input, N1077A-SMS, DCA-M Scope

Example Setup 8. Multimode Input, N1077A-SMS, 86105D

This example setup shows an N1077A-SMS connected to a DCA-X oscilloscope that has an 86105D module installed (multimode input). Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 22 N1027A-77A Optical Phase Matching Kit (for N1077A)* on page 56.

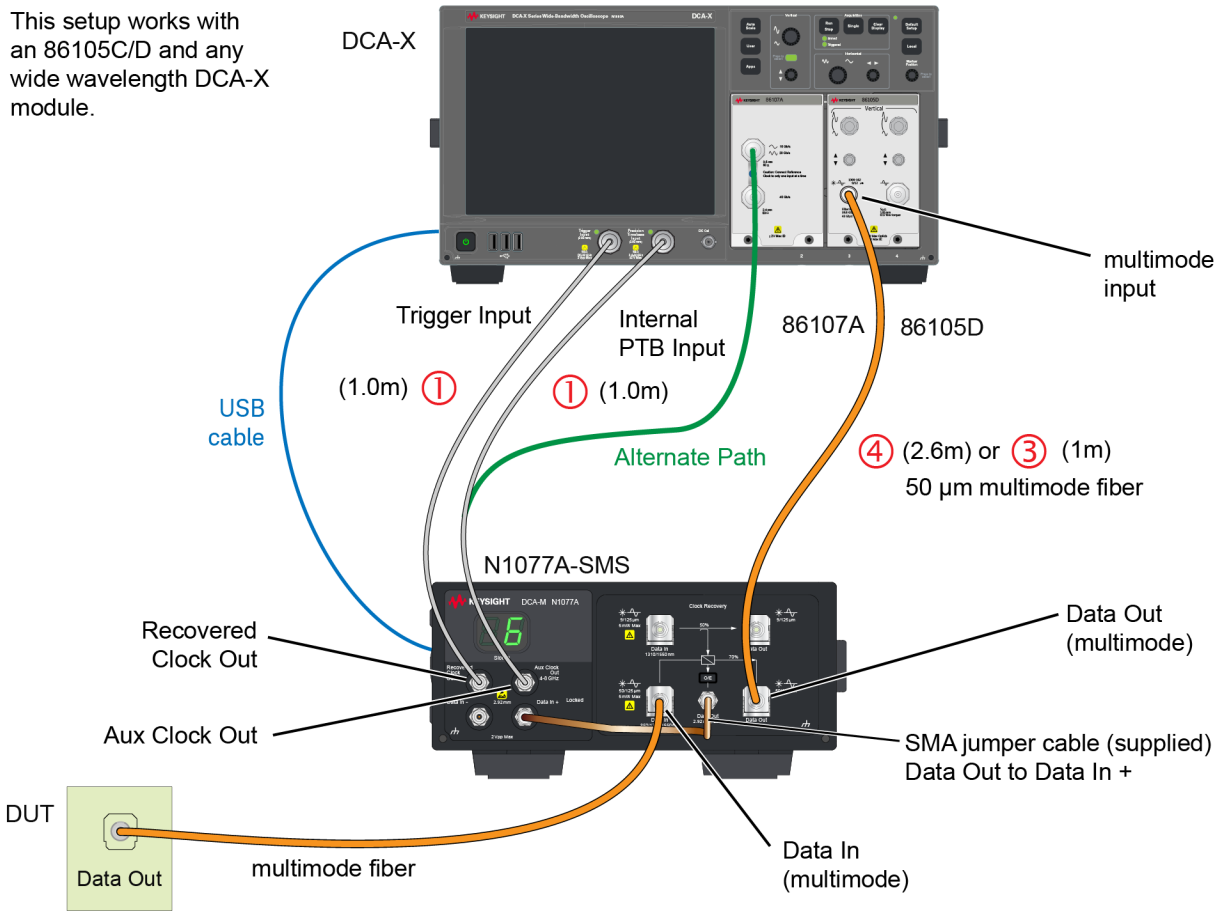


Figure 41. Multimode Input, N1077A-SMS, DCA-X Scope with 86105D

Block Diagrams

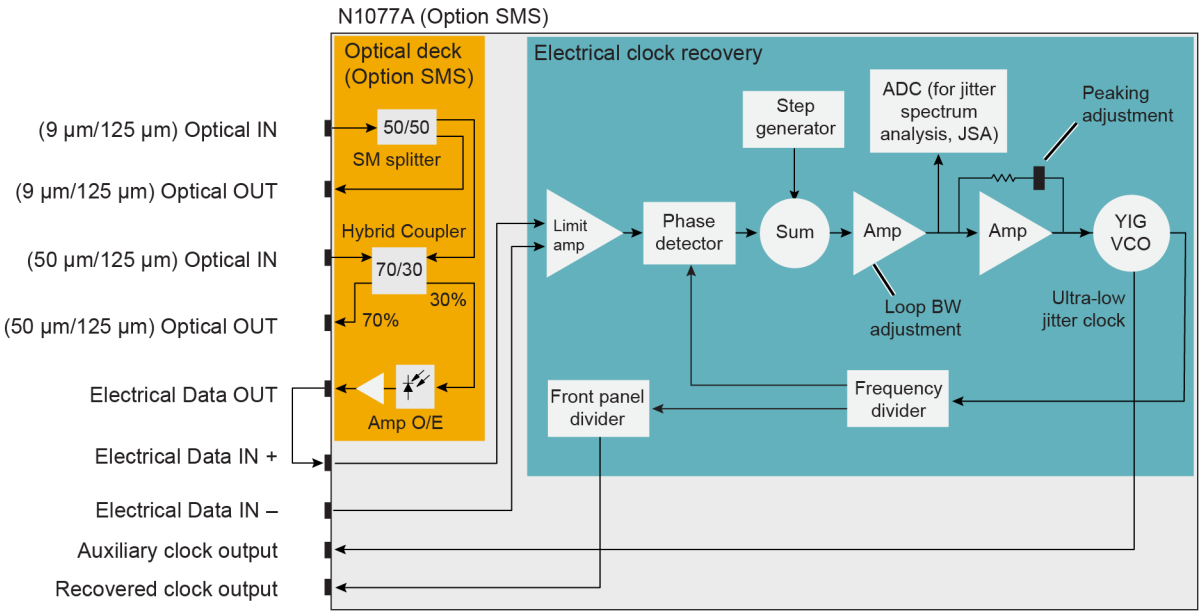


Figure 42. N1077A-SMS Block Diagram

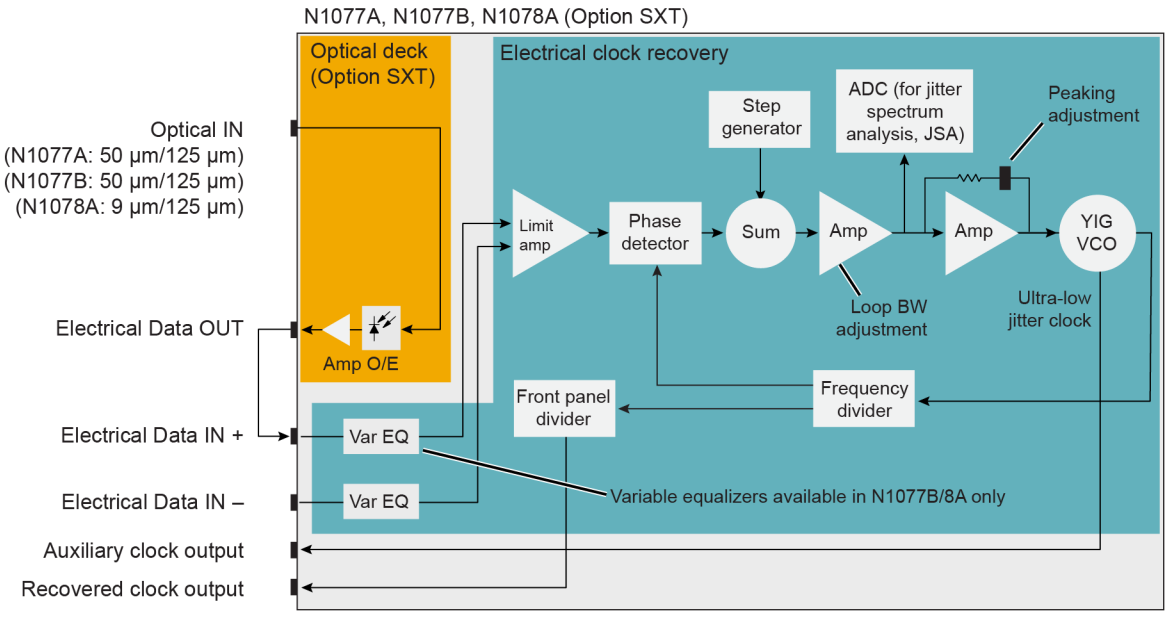


Figure 43. N1077A-SXT Block Diagram

Module Options and Accessories

Table 27. N1077A Options

Option	Description
Input Data Rates	
216	50 MBd to 16 GBd (16.4 GBd characteristic)
232	50 MBd to 32 GBd (32.8 GBd characteristic)
Optical Splitters	
SMS	Includes integrated single-mode (9/125 um) splitter and single-mode / multimode (50/125 um) coupler.
SXT	For use with external splitter (not supplied by Keysight). No installed integrated splitter/coupler.
Jitter Spectrum Analysis	
JSA	Jitter spectrum analysis and clock recovery emulation. Jitter Spectrum Analysis (JSA) provides greater insights into jitter and improves jitter measurement accuracy.
External equalizer for making "closed eye" measurements	
EQ6	2.92 mm (m) to 2.92 mm (f), 6 dB. Can be ordered separately as N1027A-EQ6.
EQ9	2.92 mm (m) to 2.92 mm (f), 9 dB. Can be ordered separately as N1027A-EQ9.
External accessories, Miscellaneous	
CR1	Electrical clock recovery phase matching kit for use when using an N1000A/86100D (with *Internal Precision Timebase, option PTB)* and electrical clock input signal, and N1045A or N1055A remote-head module. This kit can be ordered separately as N1027A-77A. Refer to *Introduction* on page 7.
Rack Mount Kits	
1CM	For single DCA-M. Can be ordered separately as N1027A-RM1.
1CN	For two DCA-Ms mounted side by side. Can be ordered separately as N1027A-RM2.

Table 28. N1077A Supplied Accessories

Item	Qty
USB cable, USB-A plug to USB-B plug (2m long)	1
RF SMA 50-ohm cap (male)	3
RF SMA cable. DATA OUT to DATA IN +.	1
Optical patch cord-SM, FC/PC connectors (1m long)	1
Optical patch cord-MM, FC/PC connectors (1m long)	1
FC fiber-optic dust cap for each fiber-optic connector (with option SXT).	1
FC fiber-optic dust cap for each fiber-optic connector (with option SMS).	4

6 Using the N1077B

The N1077B has options that cover the following data rates:

- 125 MBd to 16 GBd (option 216)
- 125 MBd to 32 GBd (option 232)
- 125 MBd to 64 GBd (option 264)
- 24 GBd to 29 GBd (option 225)
- 48 GBd to 58 GBd (option 253)

Figure 44 on page 90 and *Figure 45* on page 91 show the N1077B-SXT and N1077B-SMM module front-panels. Both model options have multimode/single-mode optical connectors. Option SXT modules do not have an internal optical splitter. Option SMM models include an internal optical splitter (50%). The optical internal splitter provides a slightly attenuated input signal at the optical **Data Out** connectors. This output can be used for input to a receiver module or other test equipment.

A diagram that is printed on the N1077B's front panel associates optical **Data In** connector with Electrical **Data Out** connectors, and O/E. For additional information, refer to the N1077B specifications which are located in FlexDCA's help system.

The example setups shown in this chapter represent the most common clock recovery use cases and will help you to understand the general principles involved.

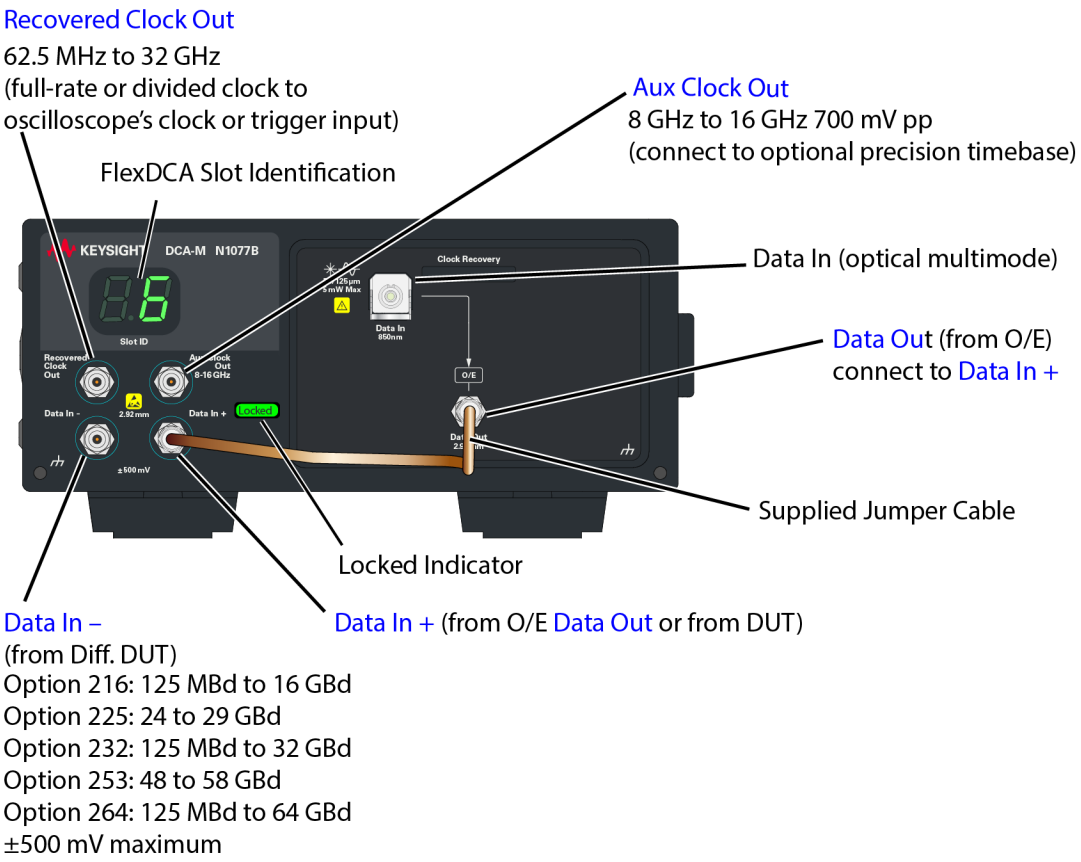


Figure 44. N1077B-SXT Front-Panel Connectors

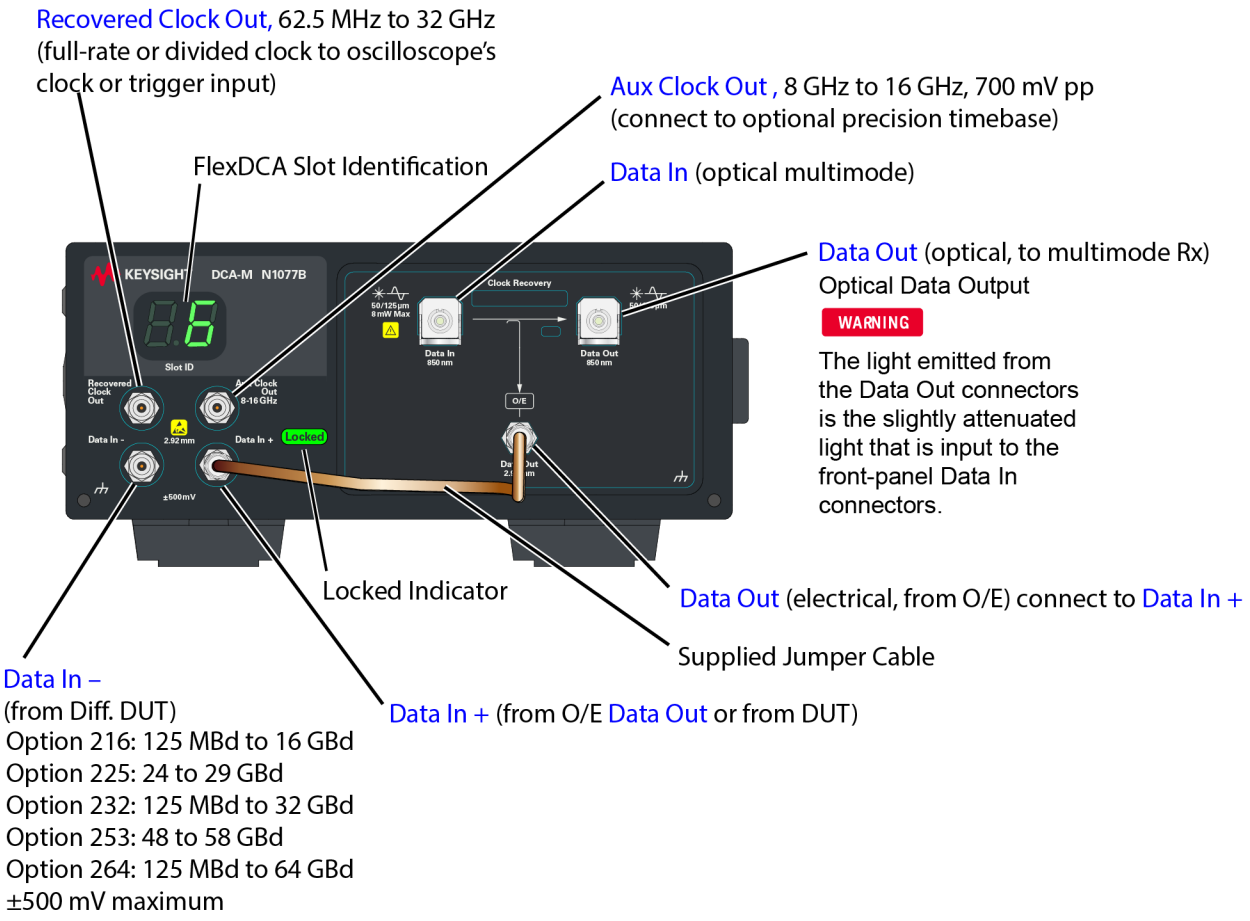


Figure 45. N1077B-SMM Front-Panel Connectors

WARNING **The light emitted from the Data Out connectors is the slightly attenuated light that is input to the front-panel Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.**

Option EVA, provided with every model, includes an integrated, variable equalizer that can be used to open closed eyes of many NRZ and PAM-4 signals.

Option JSA, Jitter spectrum analysis and clock recovery emulation, provides greater insights into jitter and improves jitter measurement accuracy. To learn about JSA, open FlexDCA help and in the Contents tab open the JSA Analysis section.

To Setup Clock Recovery

In this procedure, an optical input signal is input to an N1077B-SMM which is connected to an N109X-series sampling oscilloscope. If you are using an N1077B-SXT, you will need an external optical splitter. If you are using an electrical input signal, you will connect your electrical data signal to the front-panel **Data In +** port.

The settings made in this procedure can also be made using a program as shown in the Python example, *Example 3. Perform eye measurement with N109X & N1076/7A* on page 155.

WARNING **The light emitted from the Data Out connectors is the slightly attenuated light that is input to the front-panel Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.**

1. Confirm that the input signal meets the baud rate and amplitude requirements shown in *Figure 44* on page 90 and *Figure 45* on page 91. In this procedure, the following assumptions are made for simplicity. You can change these parameters to any acceptable values.
   - Data signal: 10.3125 GBd
   - N1092D oscilloscope slot: 7
   - N1077B-SMM slot: 6
2. In FlexDCA, click **Setup** > **Default Setup**.
3. Connect the N1077B as shown in *Figure 46* on page 93. If connecting to an N1000A (or 86100D), be sure to connect the USB cable to the DCA-X's rear-panel USB port. Notice that the N1077B has multimode optical connectors:
   a. Connect the optical signal to the N1077B front-panel optical **Data In** input.
   b. Connect the supplied semi-rigid coaxial jumper cable between the front-panel **Data Out** and **Data In +** connectors as shown in the figure.
4. If using an electrical input signal, connect the signal to the N1077B front-panel electrical **Data In +** input. For differential signals, also use the **Data In –** input. Refer to *Example Setup 1. Single-Ended Input, N1077B-SXT, DCA-M Scope* on page 96.

5. In FlexDCA, click **Setup** > **Trigger Setup** and select the General Trigger Setup tab. Confirm that the trigger Source is set to **Front Panel** .
6. Click **Setup** > **Modules** > **(Slot 6): Clock Recovery**. The dialog shown *Figure 47 on page 94* is displayed. The picture does not show settings required for this procedure.
7. For the **Input Source**, select **Electrical Data +**, which is used for single-ended or optical signal.
8. In the **Data Rate** field, enter 10.3125 GBd.

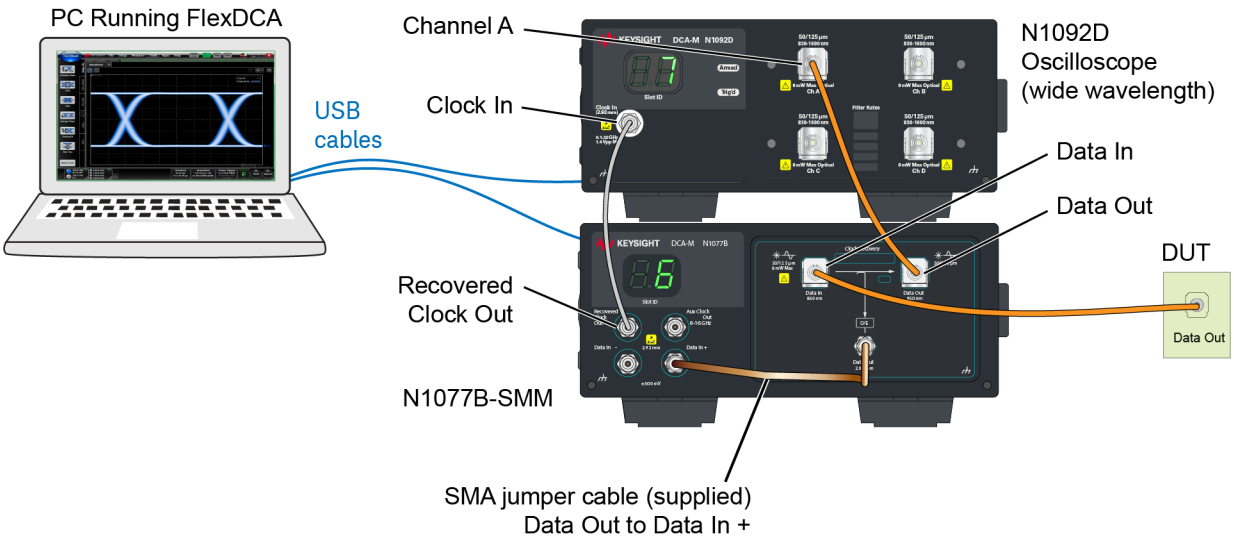


Figure 46. Typical Connection Setup

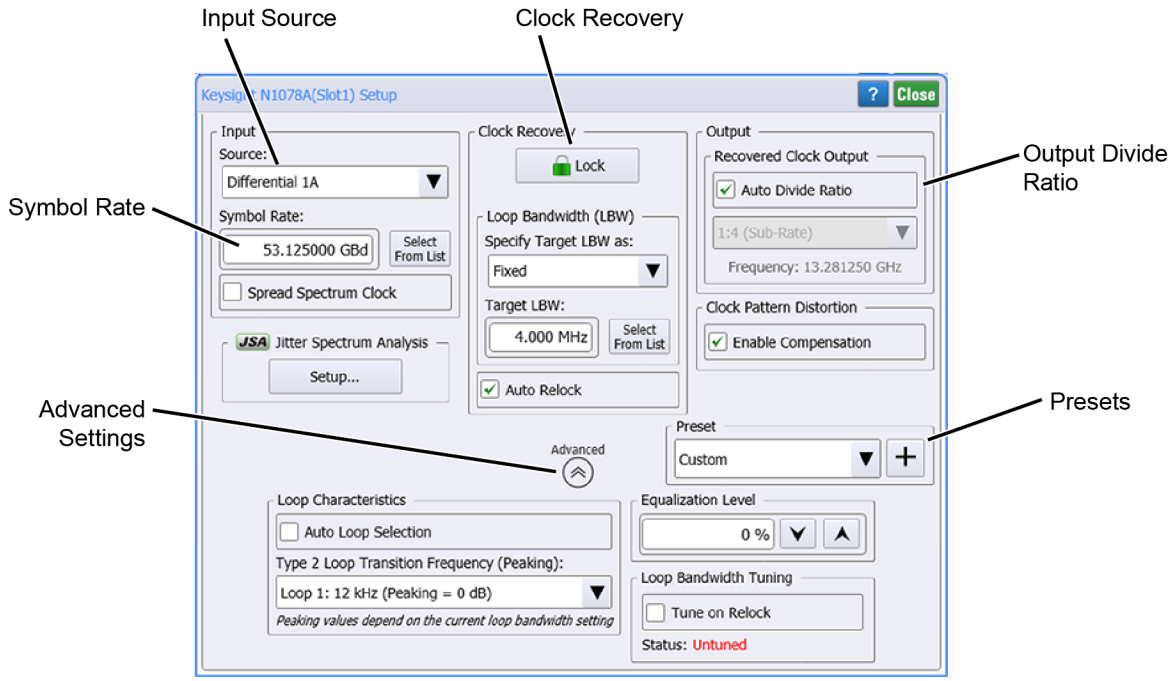


Figure 47. Clock Recovery Setup Dialog

9. In the dialog's **Advanced** settings section, configure the Loop Characteristics as appropriate.
10. In the **Clock Recovery** field, click the **Lock** button to lock clock recovery. Observe the N1077B's front-panel indicator light: **Locked**
    - A green light indicates clock recovery is locked on the input data.
    - A flashing yellow light indicates attempting to lock.
    - An off light indicates clock recovery is unlocked.

NOTE To avoid damaging the N1077B's front-panel fiber-optic connectors, use proper connection techniques. Refer to *Cleaning the Fiber-Optic Connectors on page 44*.

11. In FlexDCA's signals palette, turn all channels off except for channel 5A.
12. Click **Setup** > **Mode** > **Eye/Mask**.
13. Click **Auto Scale**.
14. The N109X-series oscilloscope's front-panel **Trig'd** light should be green. If not, confirm that the amplitude of the signal at channel 5A is not too low due to the "pass through" loss in the N1077B. Consult the specifications listed in the FlexDCA help system.

15. If the N109X-series oscilloscope has pattern locking (option PLK):
    a. Click **Setup** > **Trigger Setup** and select the Pattern Lock tab. In the **Data Rate** field, turn off **Auto Detect** and select 10.3125 GBd.
    b. In the General Setup tab, click the **Pattern Lock** button.

Example Setup 1. Single-Ended Input, N1077B-SXT, DCA-M Scope

This example setup shows an N1077B-SXT connected to an N1094B oscilloscope with a single-ended electrical input signal. The microwave pickoff is used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

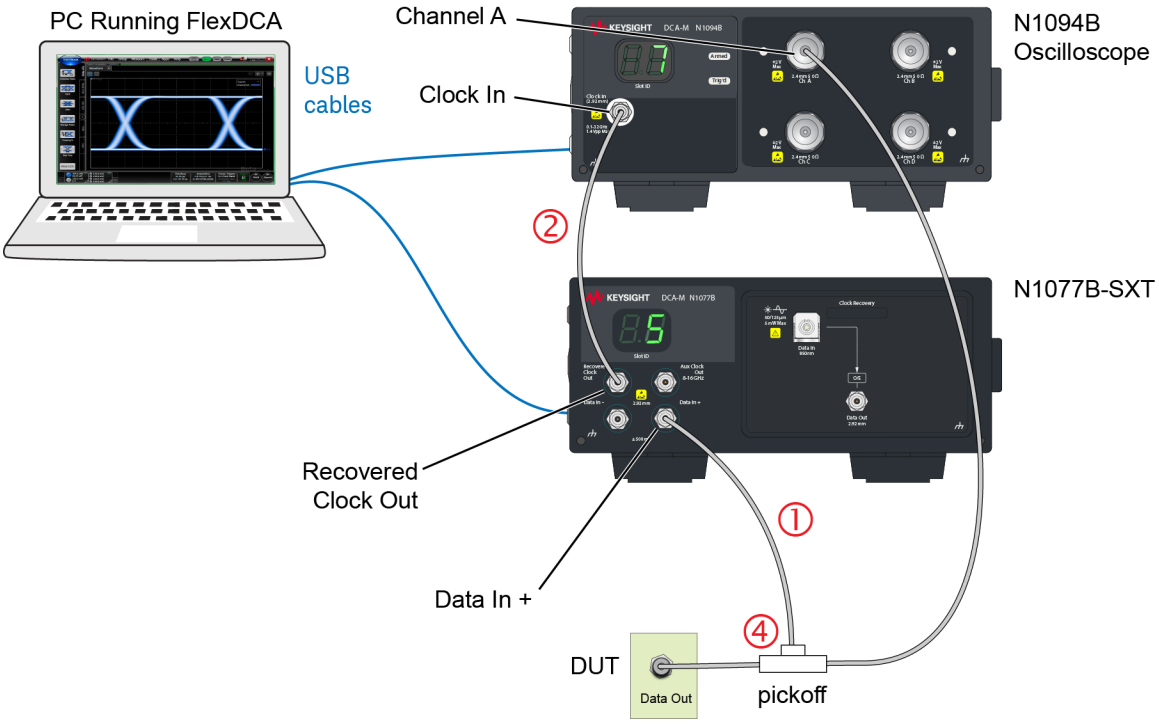


Figure 48. Single-Ended Input with N1077B-SXT, DCA-M Scope

Example Setup 2. Differential Input, N1077B-SXT, DCA-M Scope

This example setup shows an N1077B-SXT connected to an N1094B oscilloscope with a differential input signal. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

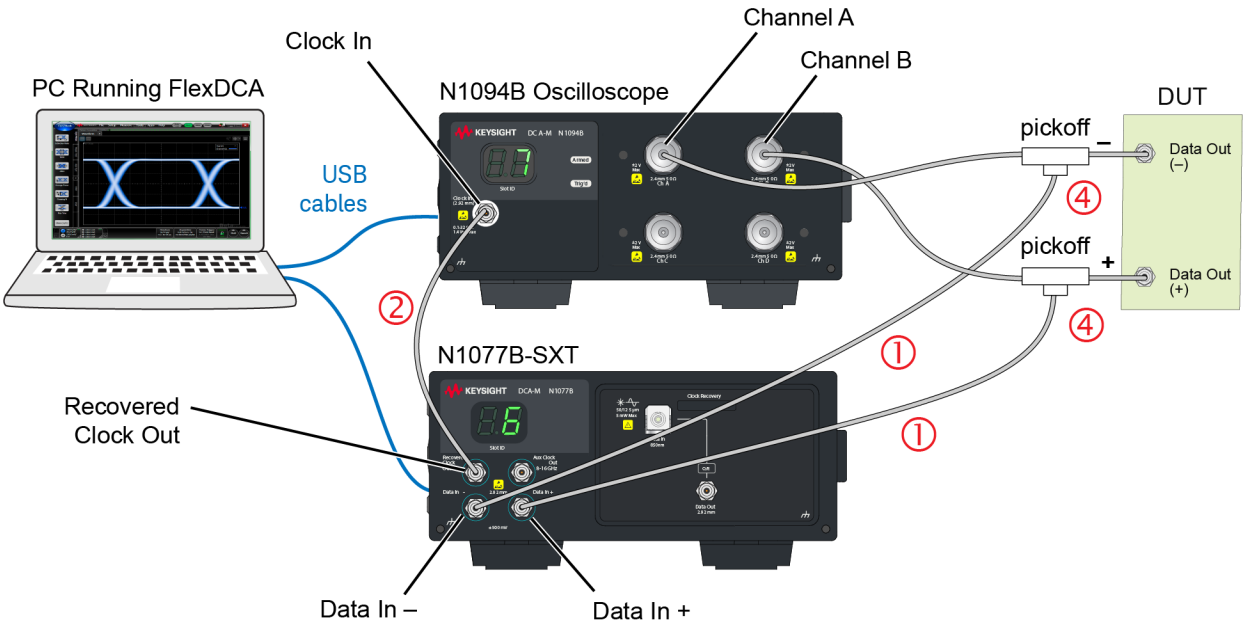


Figure 49. Differential Input with DCA-M Scope

Example Setup 3. Differential Input, N1077B-SXT, DCA-X Scope

This example setup showns an N1077B-SXT connected to a DCA-X oscilloscope with a differential input signal. The oscilloscope has an N1045A receiver module and an 86107A precision timebase. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

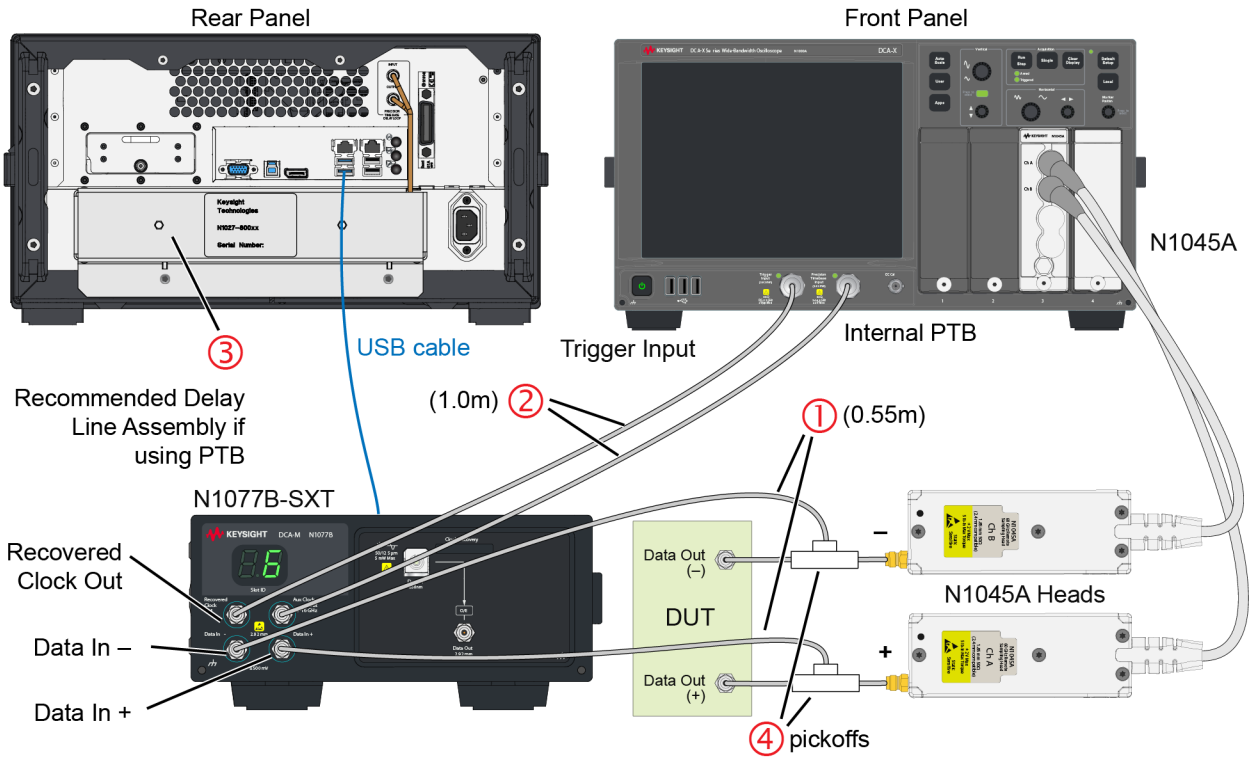


Figure 50. Differential Input with DCA-X Scope

Example Setup 4. Multimode and Single-Mode Input, N1077B-SXT, 86105D

This example setup showns an N1077B-SXT connected to a DCA-X oscilloscope. The oscilloscope has an 86105D receiver module which has a multimode and single-mode optical input connector. The N1077B has Multimode and single-mode optical input connector. Since the N1077B-SXT does not have an internal optical splitter, the user must supply their own. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 23 N1027A-77B Optical Phase Matching Kit (for N1077B)* on page 57.

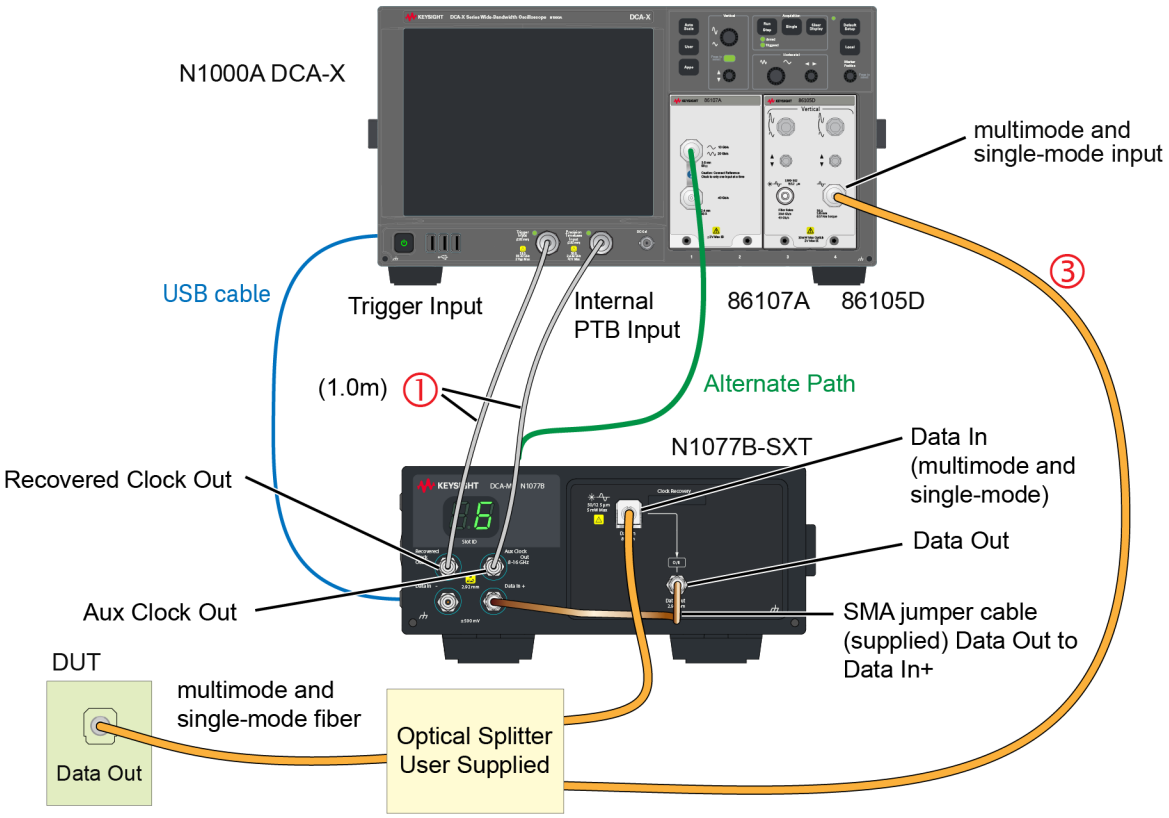


Figure 51. Multimode and Single-Mode Input, N1077B-SXT, DCA-X Scope

Example Setup 5. Multimode and Single-Mode Input, N1077B-SMM, DCA-M Scope

This example setup showns an N1077B-SMM connected to an N1092E-30A oscilloscope. Multimode and single-mode fiber is connected to the N1077B-SMM's Multimode and single-mode input connector. The N1027A-77B Optical Phase Matching Kit only supports phase matching to an N1092A/B/C/D/E Option 30A DCA-Ms. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 23 N1027A-77B Optical Phase Matching Kit (for N1077B)* on page 57.

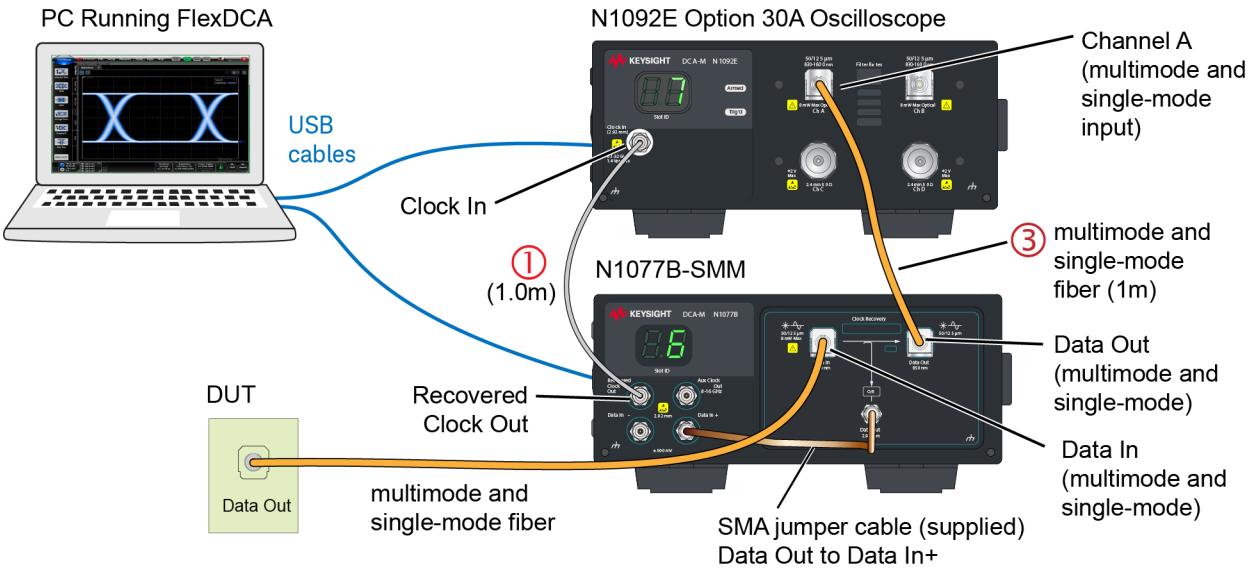


Figure 52. Multimode and Single-Mode Input, N1077B-SMM, DCA-M Scope

Example Setup 6. Single-Mode Input, N1077B-SMM, 86116C

This example setup shows an N1077B-SMM connected to a DCA-X oscilloscope with an 86116C. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 23 N1027A-77B Optical Phase Matching Kit (for N1077B)* on page 57.

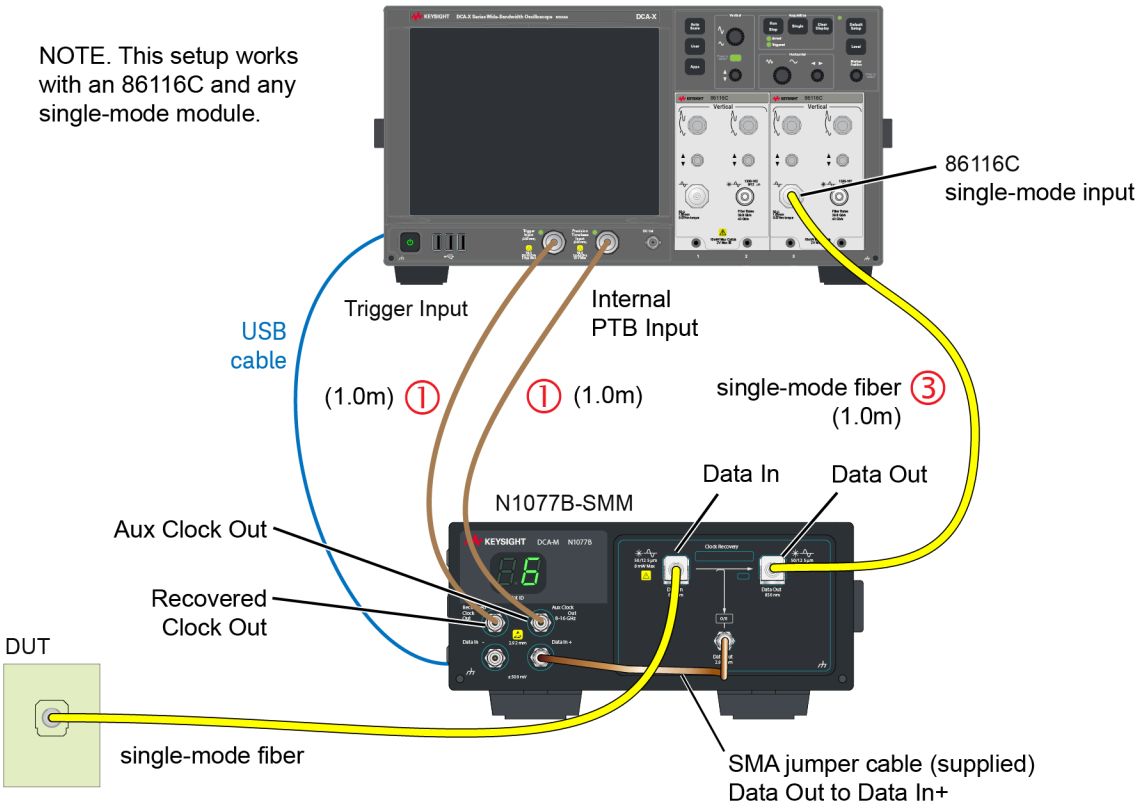


Figure 53. Single-Mode Input, N1077B-SMM, DCA-X Scope

Example Setup 7. Single-Mode Input, N1077B-SMM, N1030A/B

This example setup showns an N1077B-SMM connected to a DCA-X oscilloscope with an N1030B. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 23 N1027A-77B Optical Phase Matching Kit (for N1077B)* on page 57.

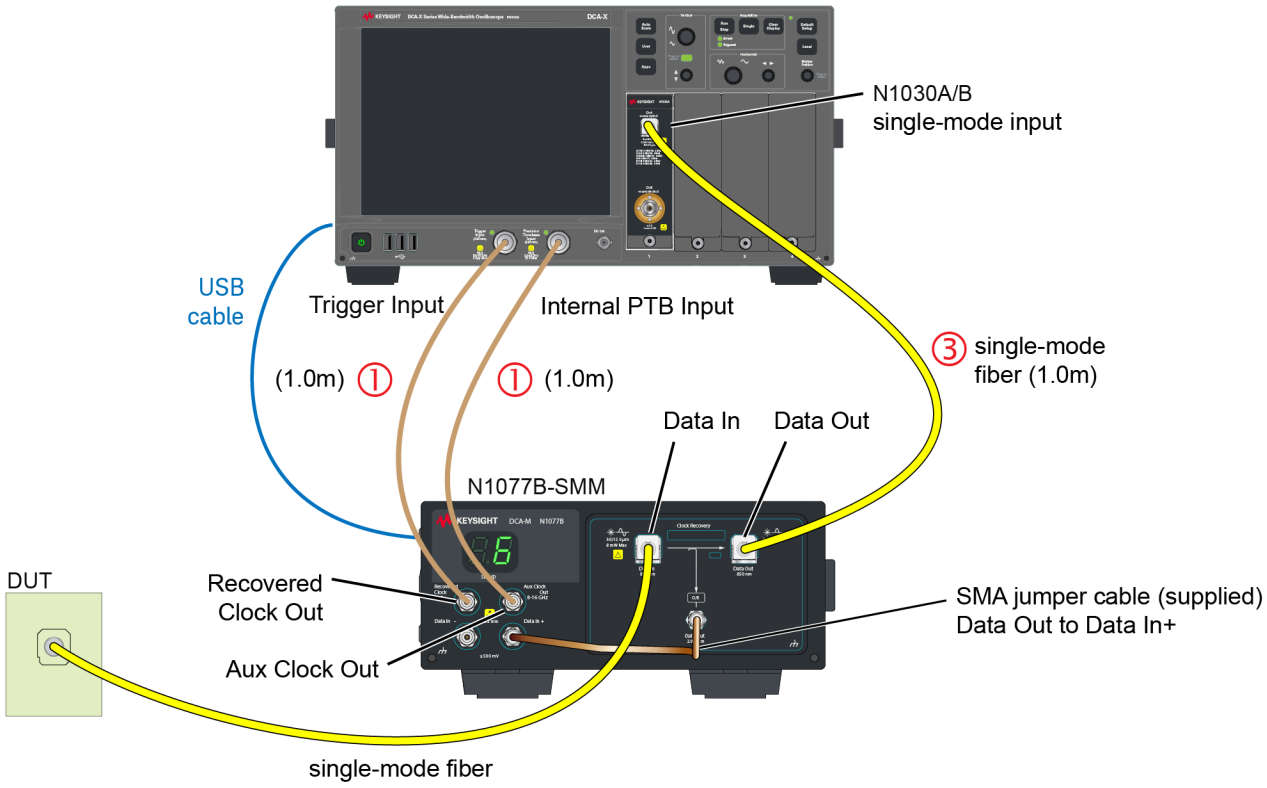


Figure 54. Single-Mode Input, N1077B-SMM, DCA-X Scope

Block Diagrams

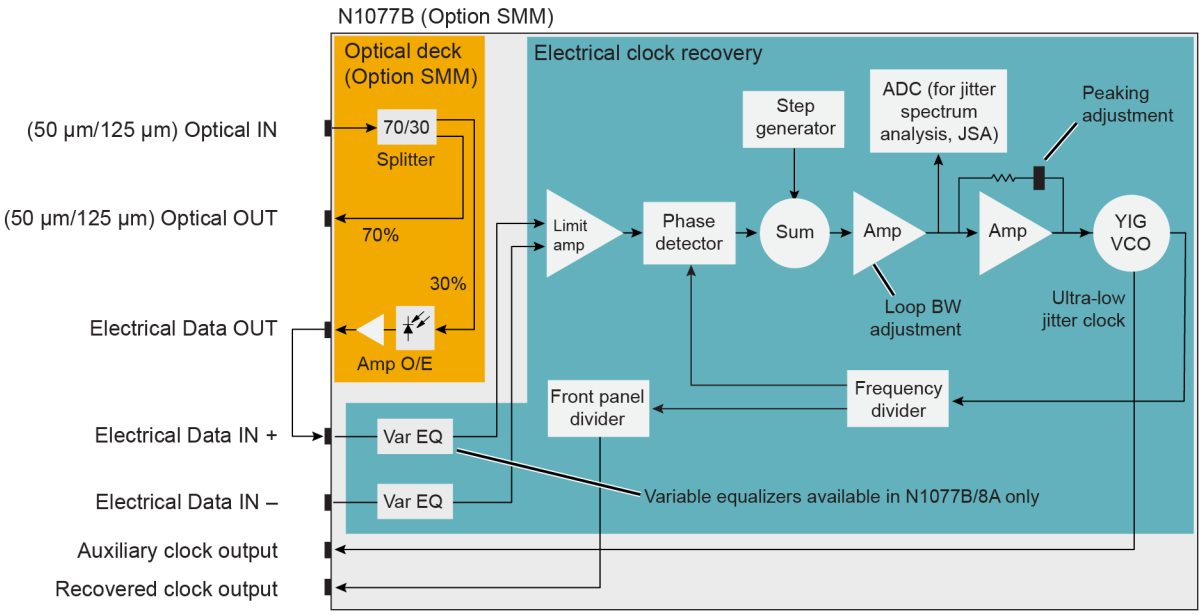


Figure 55. N1077B-SMM Block Diagram

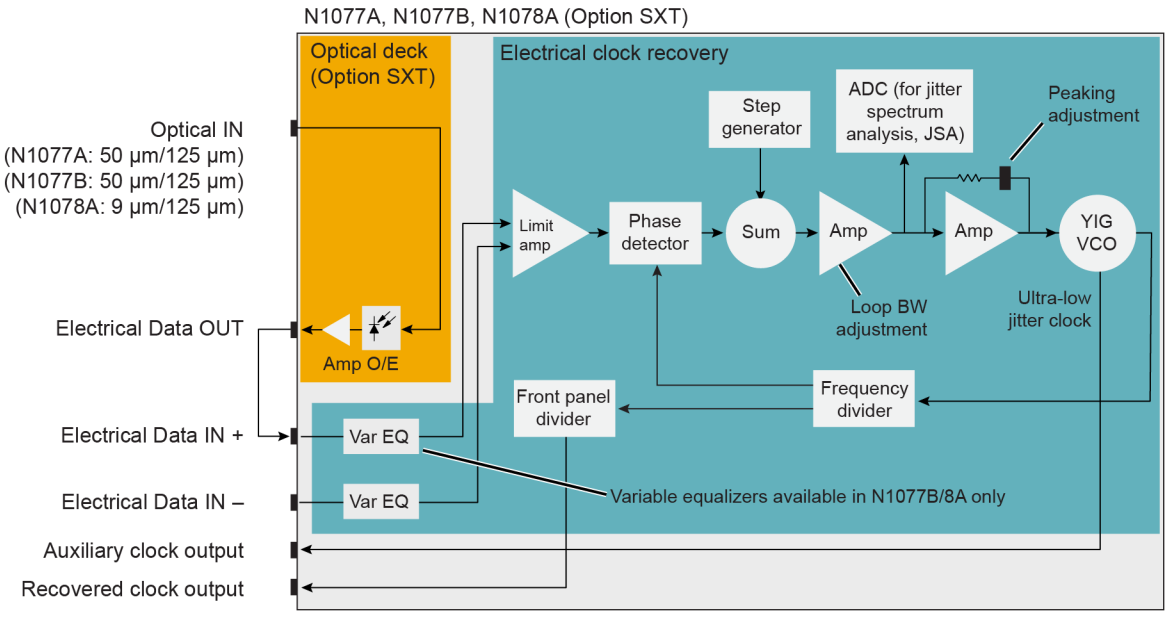


Figure 56. N1077B-SXT Block Diagram

Module Options and Accessories

Table 29. N1077B Options

Option	Description
Input Data Rates	
264	125 MBd to 64 GBd
253	53 GBd to 58 GBd
232	125 MBd to 32 GBd
225	24 GBd to 29 GBd
216	125 MBd to 16 GBd
Optical Splitter	
SMM	Includes integrated 70/30 splitter to optical output
SXT	For use with external splitter (not supplied by Keysight). No installed integrated splitter/coupler.
Equalization and Jitter Spectrum Analysis	
EVA	Integrated, variable equalizer.
JSA	Jitter spectrum analysis and clock recovery emulation. Jitter Spectrum Analysis (JSA) provides greater insights into jitter and improves jitter measurement accuracy.
External equalizer for making "closed eye" measurements	
EQ3	2.92 mm (m) to 2.92 mm (f), 3 dB. Can be ordered separately as N1027A-EQ3.
EQ6	2.92 mm (m) to 2.92 mm (f), 6 dB. Can be ordered separately as N1027A-EQ6.
EQ9	2.92 mm (m) to 2.92 mm (f), 9 dB. Can be ordered separately as N1027A-EQ9.
External accessories, Miscellaneous	
CR1	Electrical clock recovery phase matching kit for use when using an N1000A/86100D (with *Internal Precision Timebase, option PTB)* and electrical clock input signal, and N1045A or N1055A remote-head module. This kit can be ordered separately as N1027A-76A. Refer to *Introduction* on page 7.
Rack Mount Kits	
1CM	For single DCA-M. Can be ordered separately as N1027A-RM1.
1CN	For two DCA-Ms mounted side by side. Can be ordered separately as N1027A-RM2.

Table 30. N1077B Supplied Accessories

Item	Qty
USB cable, USB-A plug to USB-B plug (2m long)	1
RF SMA 50-ohm cap (male)	3
RF SMA cable. DATA OUT to DAT IN +	1
Optical patch cord-MM, FC/PC connectors (1m long)	1
FC fiber-optic dust cap for each fiber-optic connector (with option SXT)	1
FC fiber-optic dust cap for each fiber-optic connector (with option SMM)	2

7 Using the N1078A

The N1078A has options that cover the following data rates:

- 125 MBd to 16 GBd (option 216)
- 125 MBd to 32 GBd (option 232)
- 125 MBd to 64 GBd (option 264)
- 25 GBd to 29 GBd (option 225)
- 53 GBd to 58 GBd (option 253)

Figure 57 on page 108 and *Figure 58* on page 109 show the N1078A-SXT and N1078A-S50 module front-panels. Both model options have single-mode optical connectors. Option SXT modules do not have an internal optical splitter. Option S50 models include an internal optical splitter (50%). The optical internal splitter provides a slightly attenuated input signal at the optical **Data Out** connectors. This output can be used for input to a receiver module or other test equipment.

A diagram that is printed on the N1078A's front panel associates optical **Data In** connector with Electrical **Data Out** connectors, and O/E. For additional information, refer to the N1078A specifications which are located in FlexDCA's help system.

The example setups shown in this chapter represent the most common clock recovery use cases and will help you to understand the general principles involved.

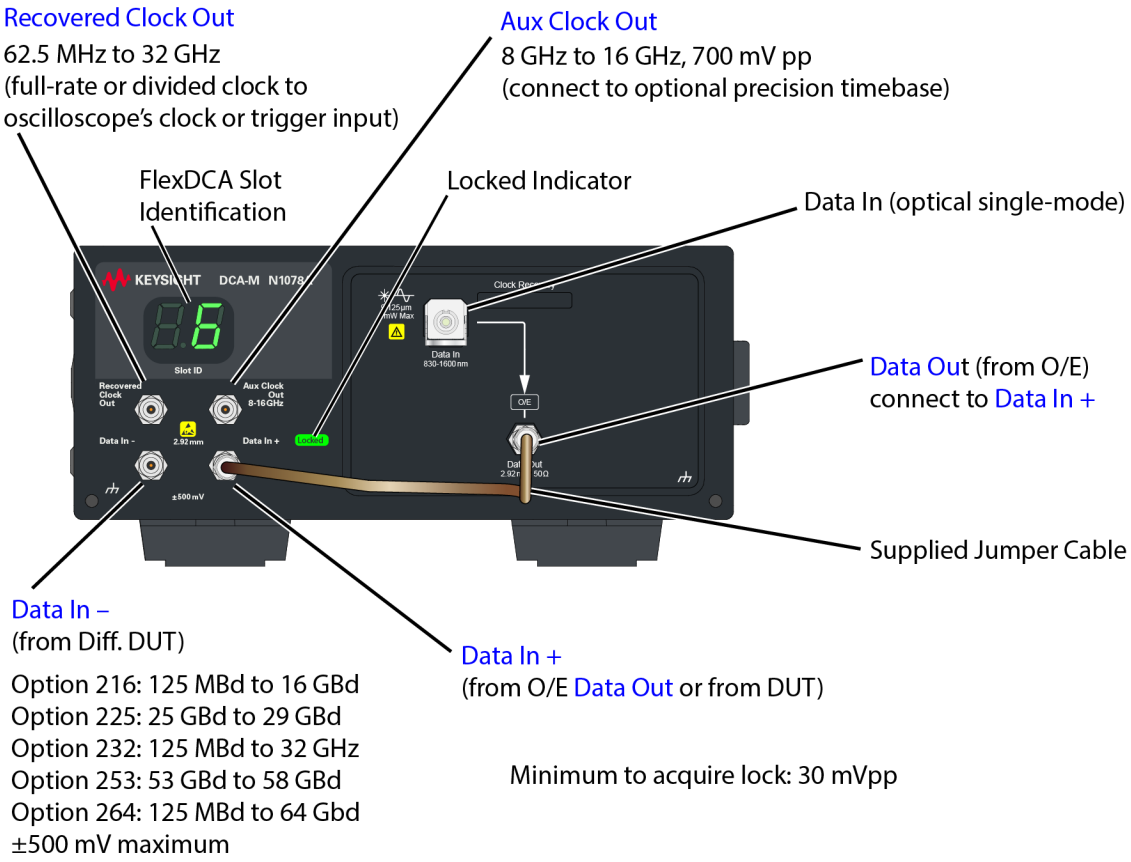


Figure 57. N1078A-SXT Front-Panel Connectors

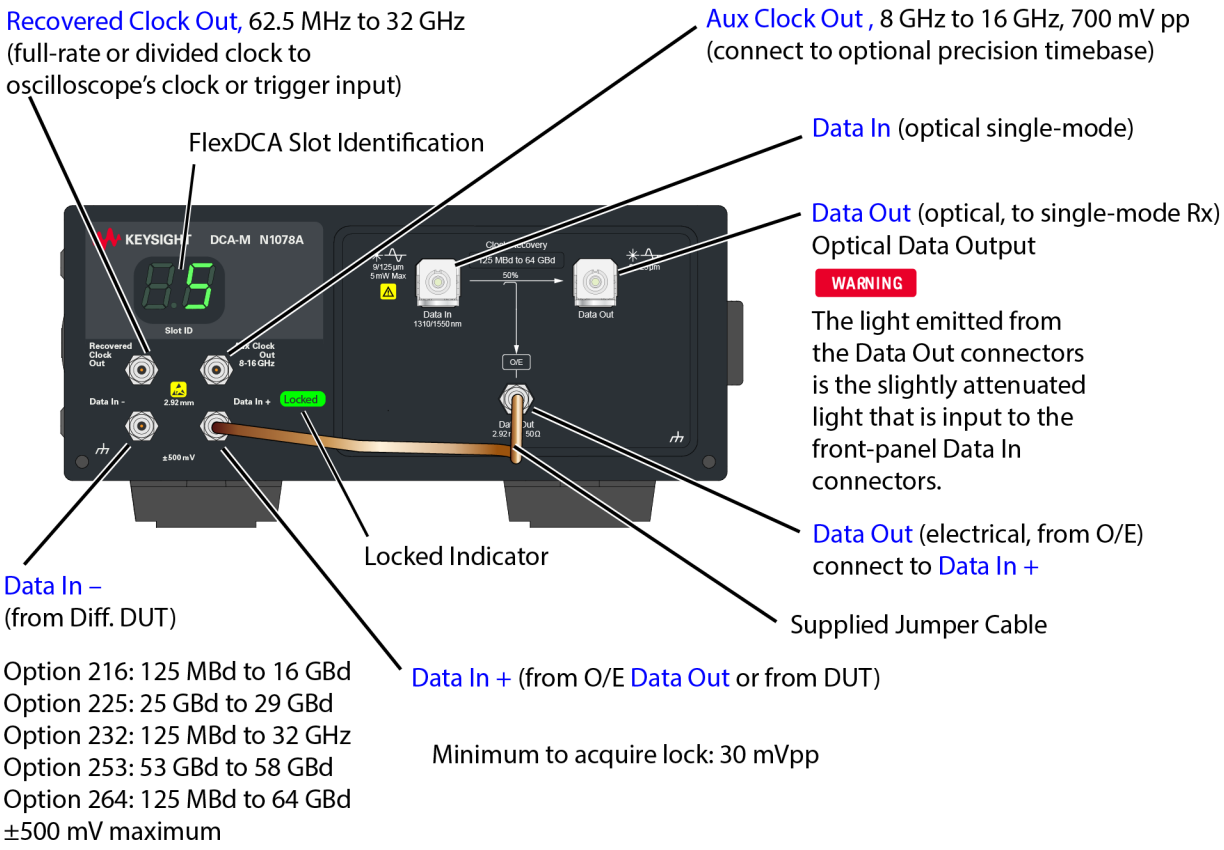


Figure 58. N1078A- S50 Front-Panel Connectors

WARNING **The light emitted from the Data Out connectors is the slightly attenuated light that is input to the front-panel Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.**

Option EVA models include an integrated, variable equalizer that can be used to open closed eyes of many NRZ and PAM-4 signals.

Option JSA, Jitter spectrum analysis and clock recovery emulation, provides greater insights into jitter and improves jitter measurement accuracy. To learn about JSA, open FlexDCA help and in the Contents tab open the JSA Analysis section.

To Setup Clock Recovery

In this procedure, an optical input signal is input to an N1078A-S50 which is connected to an N109X-series sampling oscilloscope. If you are using an N1078A-SXT, you will need an external optical splitter. If you are using an electrical input signal, you will connect your electrical data signal to the front-panel **Data In +** port.

The settings made in this procedure can also be made using a program as shown in the Python example, *Example 3. Perform eye measurement with N109X & N1076/7A* on page 155.

WARNING **The light emitted from the Data Out connectors is the slightly attenuated light that is input to the front-panel Data In connectors. To avoid unintended light exposure and protect the fiber optics, keep the protective cap over the Data Out port when not in use.**

1. Confirm that the input signal meets the baud rate and amplitude requirements shown in *Figure 58* on page 109. In this procedure, the following assumptions are made for simplicity. You can change these parameters to any acceptable values.
   - Data signal: 10.3125 GBd
   - N1092D oscilloscope slot: 5
   - N1078A-S50 slot: 6
2. In FlexDCA, click **Setup** > **Default Setup**.
3. Connect the N1078A as shown in *Figure 59* on page 111. If connecting to an N1000A (or 86100D), be sure to connect the USB cable to the DCA-X's rear-panel USB port. Notice that the N1078A has single-mode optical connectors:
   a. Connect the optical signal to the N1078A front-panel optical **Data In** input.
   b. Connect the supplied semi-rigid coaxial jumper cable between the front-panel **Data Out** and **Data In +** connectors as shown in the figure.
4. If using an electrical input signal, connect the signal to the N1078A front-panel electrical **Data In +** input. For differential signals, also use the **Data In –** input as shown in *Example Setup 2. Differential Input, N1078A-SXT, DCA-M Scope* on page 115.

5. In FlexDCA, click **Setup** > **Trigger Setup** and select the General Trigger Setup tab. Confirm that the trigger Source is set to **Front Panel** .
6. Click **Setup** > **Modules** > **(Slot 6): Clock Recovery**. The dialog shown *Figure 60 on page 112* is displayed. The picture does not show settings required for this procedure.
7. For the **Input Source**, select **Electrical Data +**, which is used for single-ended or optical signal.
8. In the **Data Rate** field, enter 10.3125 GBd.

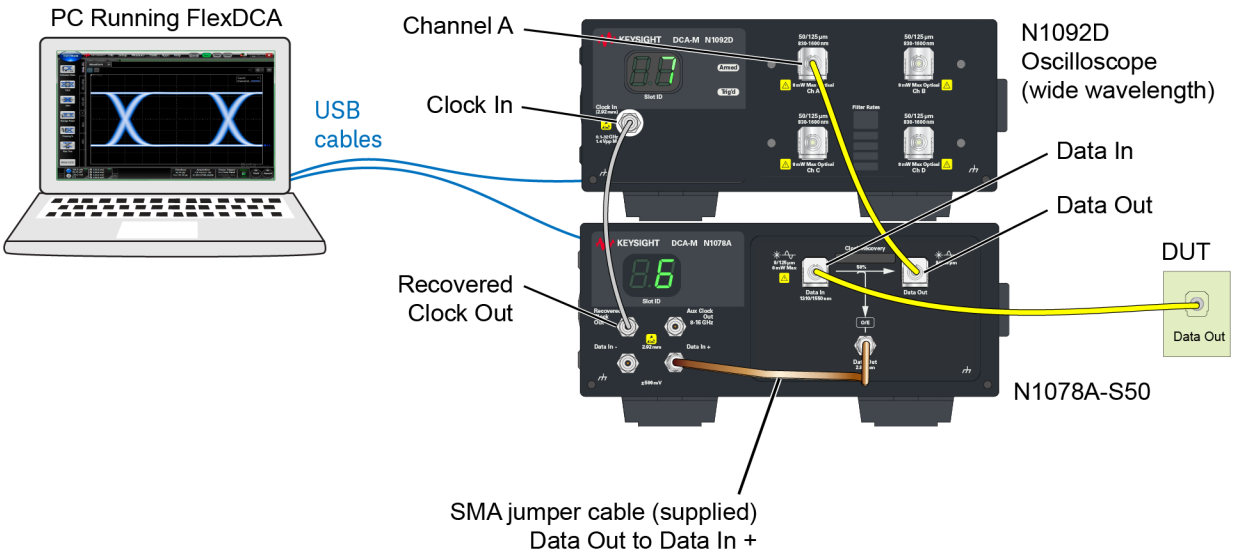


Figure 59. Typical Connection Setup

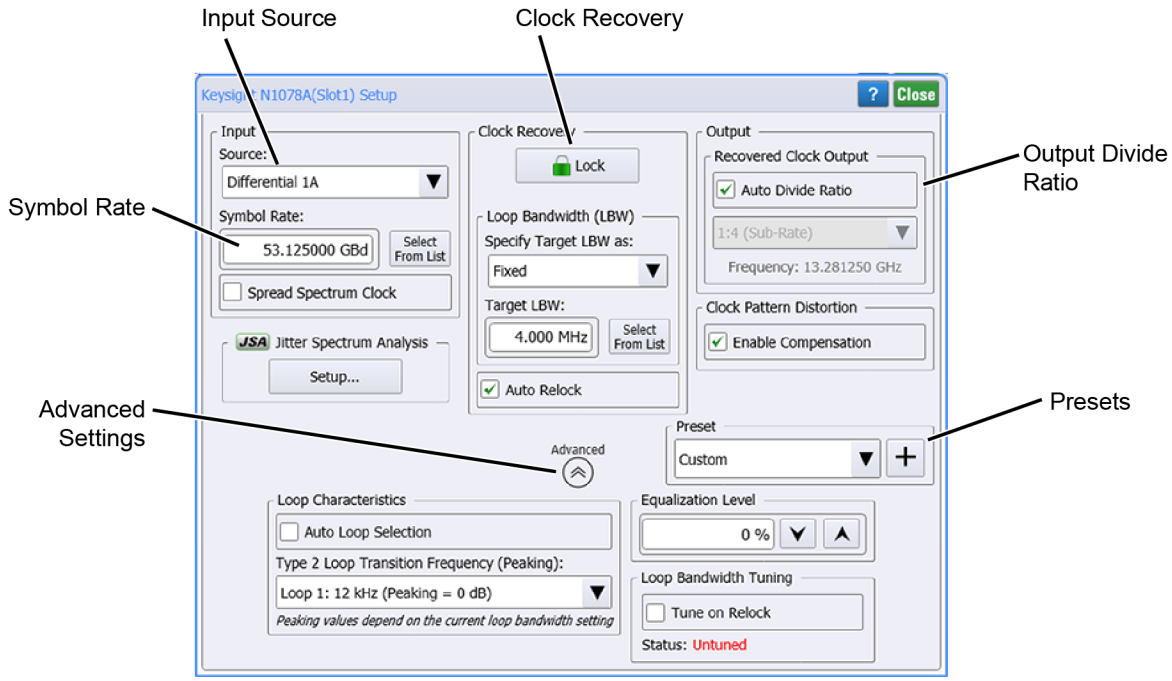


Figure 60. Clock Recovery Setup Dialog Box

9. In the dialog's **Advanced** settings section, configure the Loop Characteristics as appropriate.
10. In the **Clock Recovery** field, click the **Lock** button to lock clock recovery. Observe the N1077A's front-panel indicator light: **Locked**
    - A green light indicates clock recovery is locked on the input data.
    - A flashing yellow light indicates attempting to lock.
    - An off light indicates clock recovery is unlocked.

NOTE To avoid damaging the N1078A's front-panel fiber-optic connectors, use proper connection techniques. Refer to *Cleaning the Fiber-Optic Connectors on page 44*.

11. In FlexDCA's signals palette, turn all channels off except for channel 5A.
12. Click **Setup** > **Mode** > **Eye/Mask**.
13. Click **Auto Scale**.
14. The N109X-series oscilloscope's front-panel **Trig'd** light should be green. If not, confirm that the amplitude of the signal at channel 5A is not too low due to the "pass through" loss in the N1078A. Consult the specifications listed in the FlexDCA help system.

15. If the N109X-series oscilloscope has pattern locking (option PLK):
    a. Click **Setup** > **Trigger Setup** and select the Pattern Lock tab. In the **Data Rate** field, turn off **Auto Detect** and select 10.3125 GBd.
    b. In the General Setup tab, click the **Pattern Lock** button.

Example Setup 1. Single-Ended Input, N1078A-SXT, DCA-M Scope

This example setup shows an N1078A-SXT connected to an N1094B oscilloscope with a single-ended electrical input signal. The microwave pickoff is used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

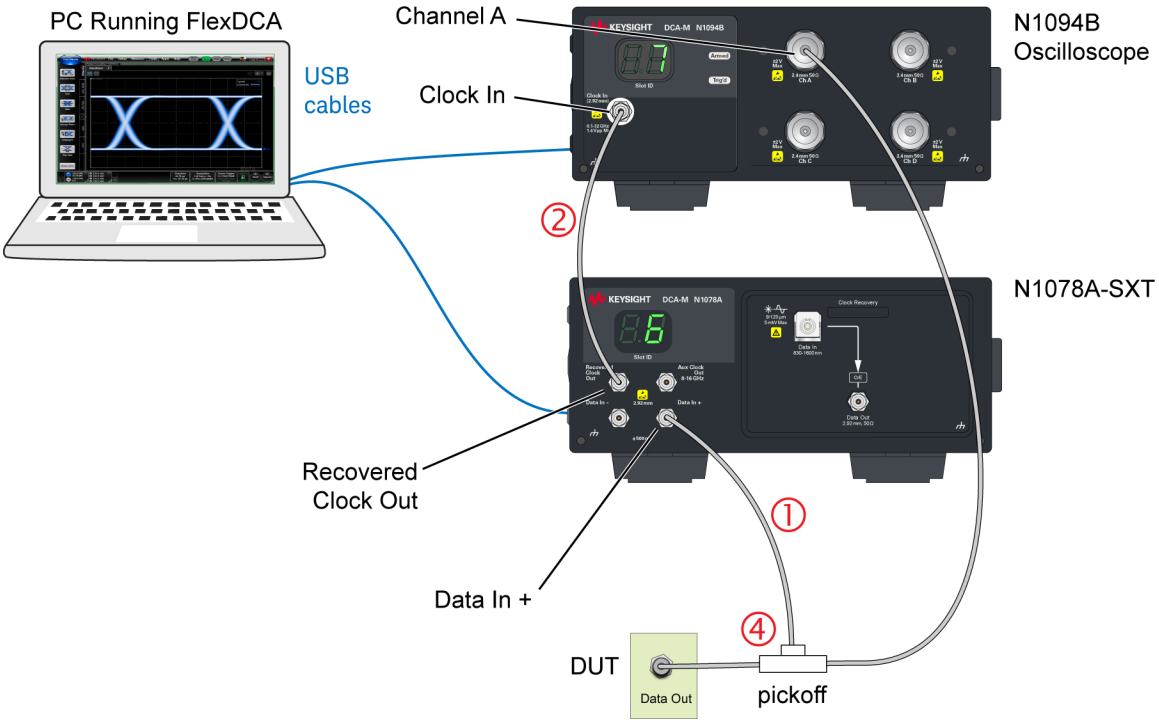


Figure 61. Single-Ended Input with N1078A-SXT, DCA-M Scope

Example Setup 2. Differential Input, N1078A-SXT, DCA-M Scope

This example setup shows an N1078A-SXT connected to an N1094B oscilloscope with a differential input signal. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

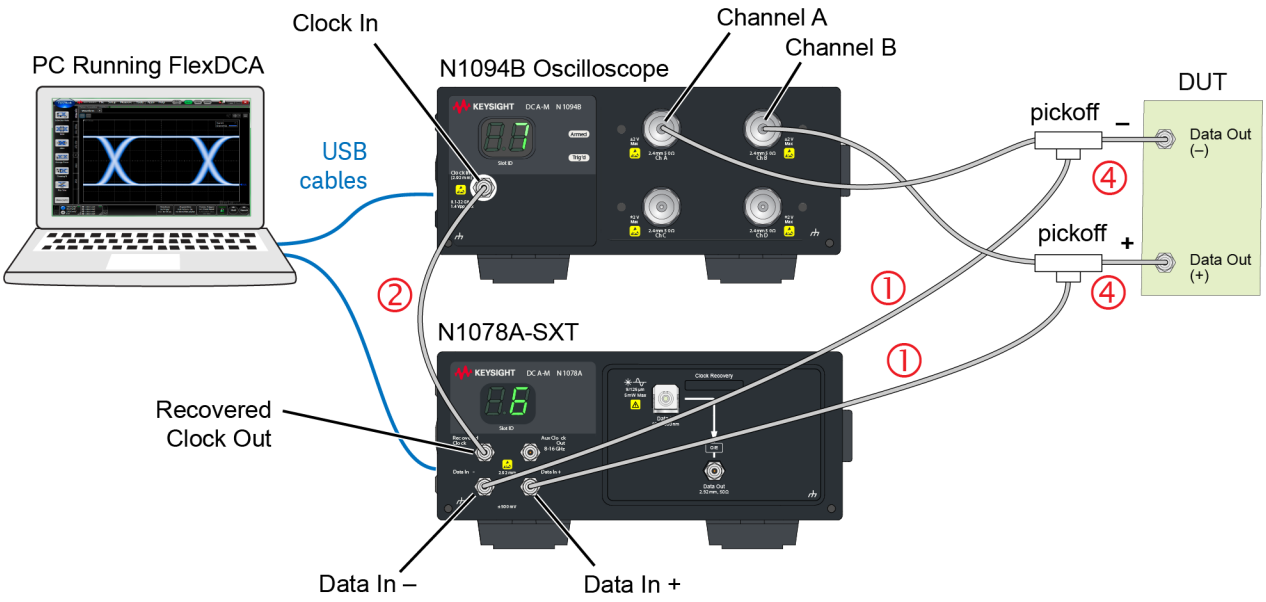


Figure 62. Differential Input with DCA-M Scope

Example Setup 3. Differential Input, N1078A-SXT, DCA-X Scope

This example setup shows an N1078A-SXT connected to a DCA-X oscilloscope with a differential input signal. The oscilloscope has an N1045A receiver module and an 86107A precision timebase. Two microwave pickoffs are used to tap a portion of the input signal as an input to the clock recovery module. An optional equalizer can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE

Circled numbers in this figure identify parts in *Table 21 N1027A-76B Electrical Phase Matching Kit* on page 54.

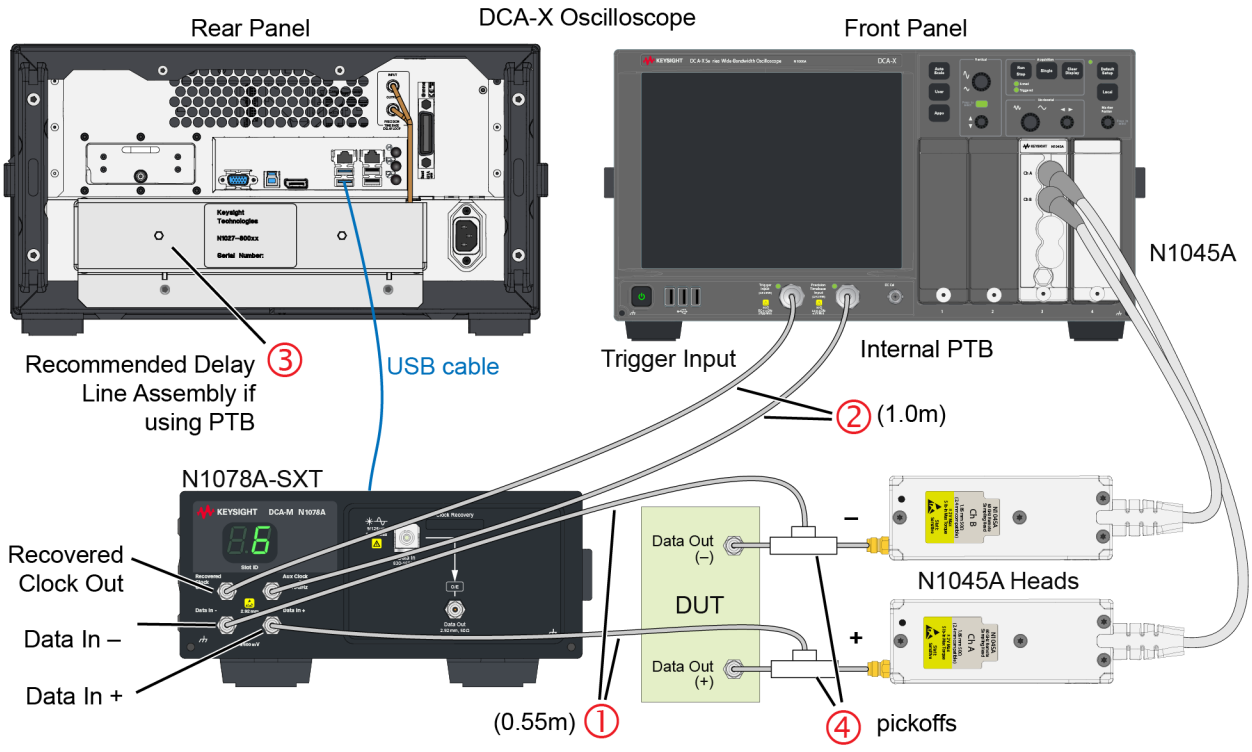


Figure 63. Differential Input with DCA-X Scope

Example Setup 4. Single-Mode Input, N1078A-SXT, 86105D

This example setup shows an N1078A-SXT connected to a DCA-X oscilloscope. The oscilloscope has an 86105D receiver module which has a multimode optical input connector. The N1078A has single-mode optical input connector. Since the N1078A-SXT does not have an internal optical splitter, the user must supply their own. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 24 N1027A-78A Optical Phase Matching Kit (for N1078A)* on page 58.

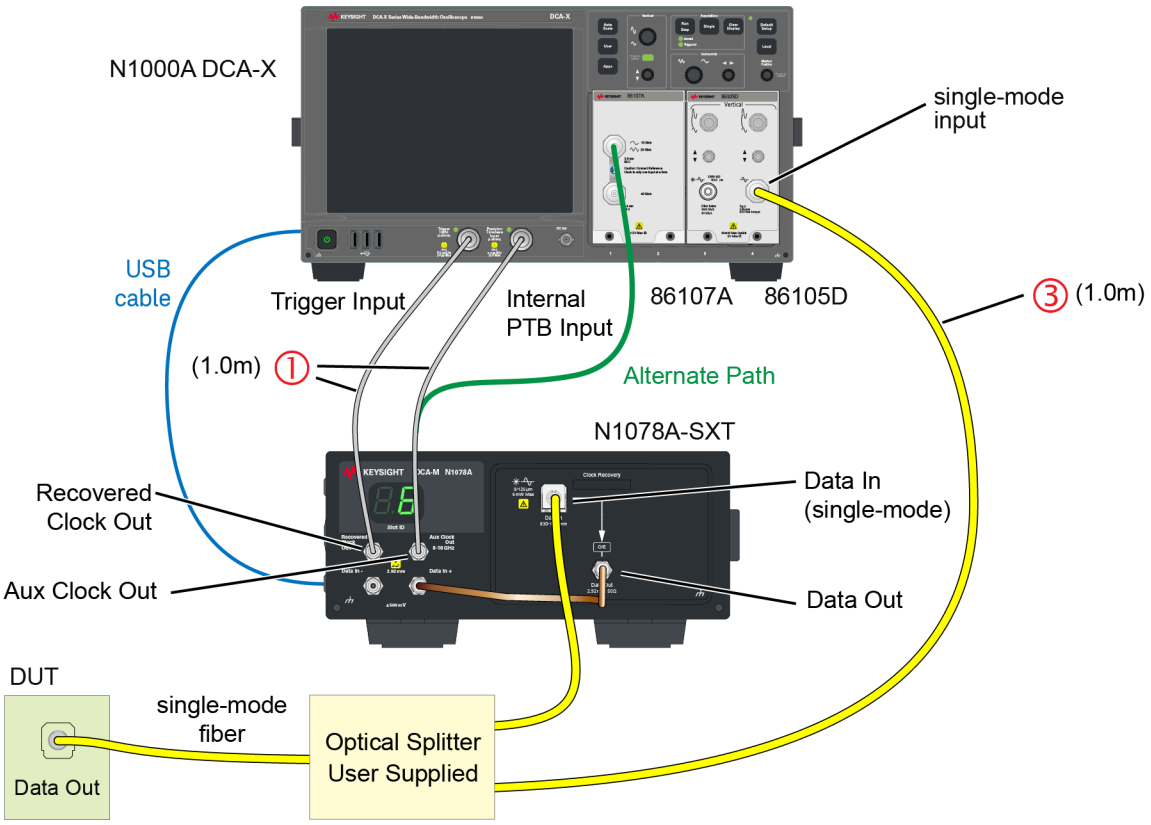


Figure 64. Single-Mode Input, N1078A-SXT, DCA-X Scope

Example Setup 5. Single-Mode Input, N1078A-S50, DCA-M Scope

This example setup shows an N1078A-S50 connected to an N1092E oscilloscope. Single-mode fiber is connected to the N1078A-S50's single-mode input connector. Since the N1092-series oscilloscopes has a multimode input, you can use a multimode patchcord in most cases. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 24 N1027A-78A Optical Phase Matching Kit (for N1078A)* on page 58.

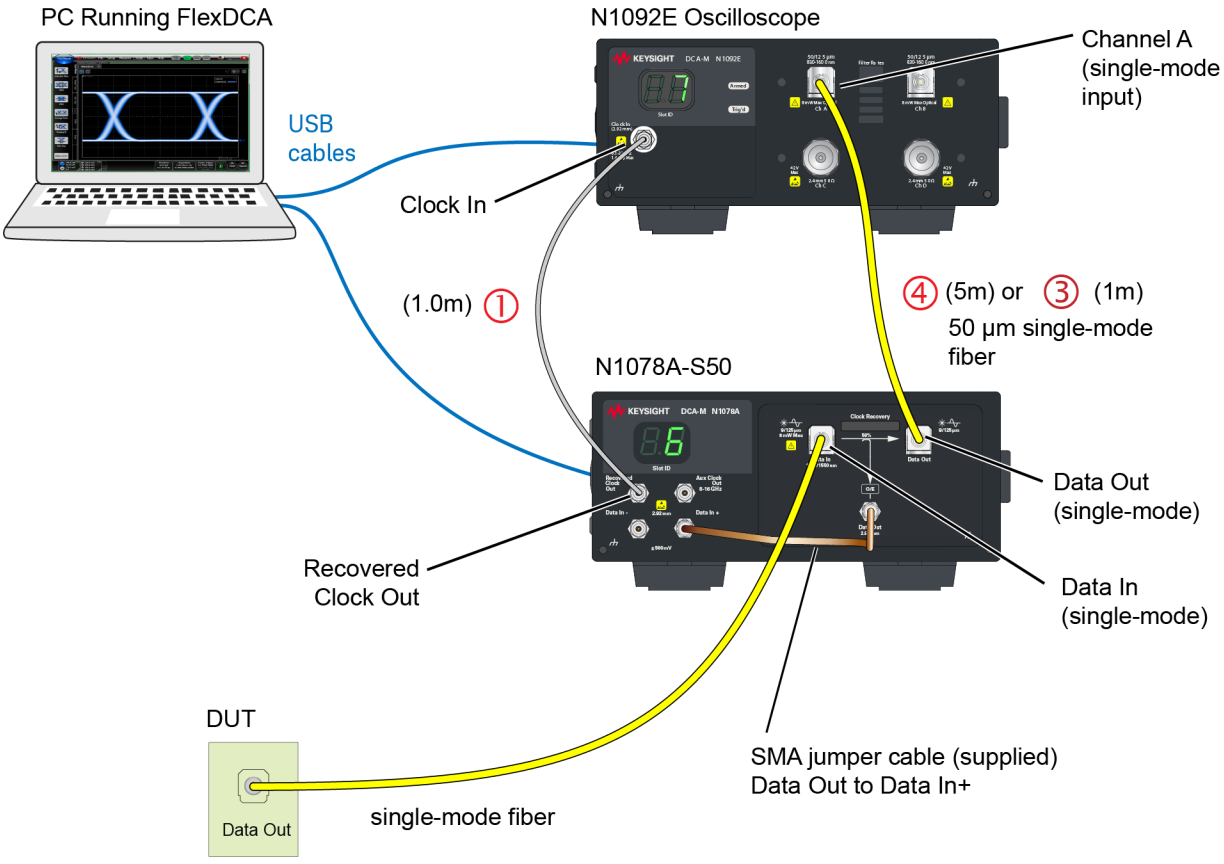


Figure 65. Single-Mode Input, N1078A-S50, DCA-M Scope

Example Setup 6. Single-Mode Input, N1078A-S50, 86116C

This example setup shows an N1078A-S50 connected to a DCA-X oscilloscope with an 86116C. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 24 N1027A-78A Optical Phase Matching Kit (for N1078A)* on page 58.

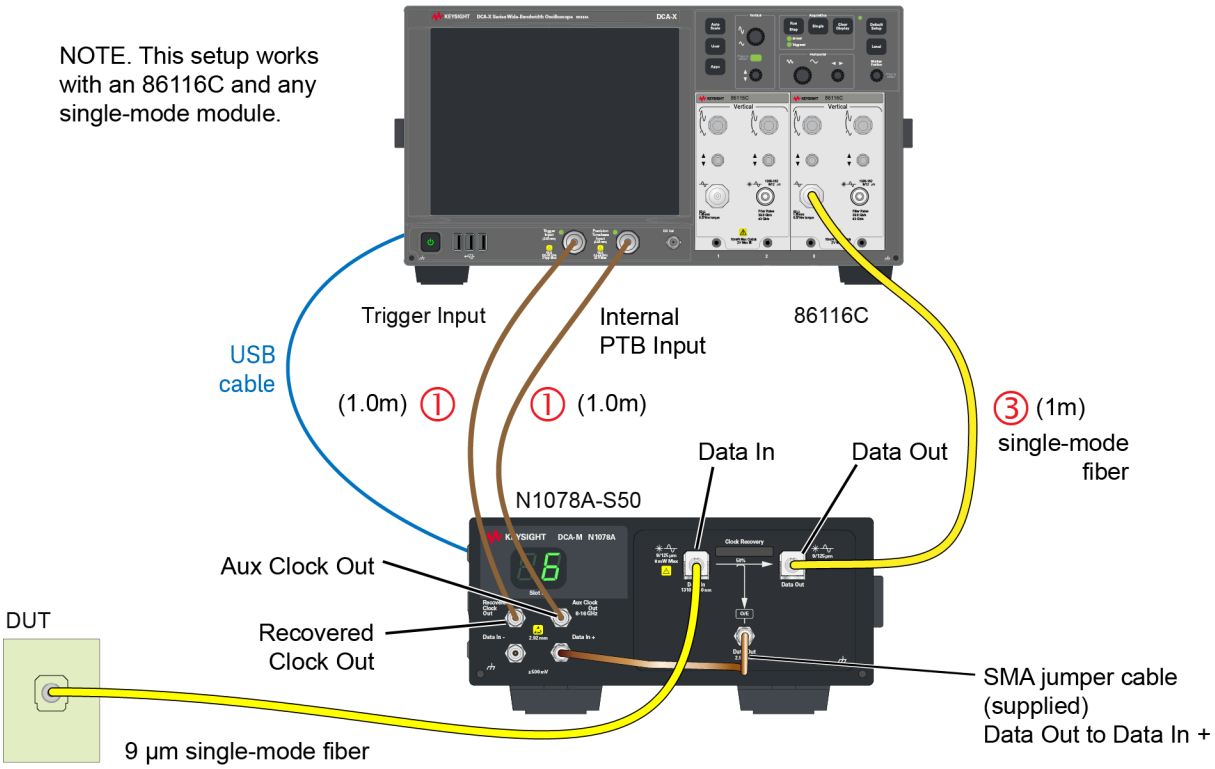


Figure 66. Single-Mode Input, N1078A-S50, DCA-X Scope

Example Setup 7. Single-Mode Input, N1078A-S50, N1030A/B

This example setup shows an N1078A-S50 connected to a DCA-X oscilloscope with an N1030B. Optional equalizers can be added to open a closed eye for clock recovery as explained in *Opening Closed Eyes for Clock Recovery* on page 14.

NOTE Circled numbers in this figure identify parts in *Table 24 N1027A-78A Optical Phase Matching Kit (for N1078A)* on page 58.

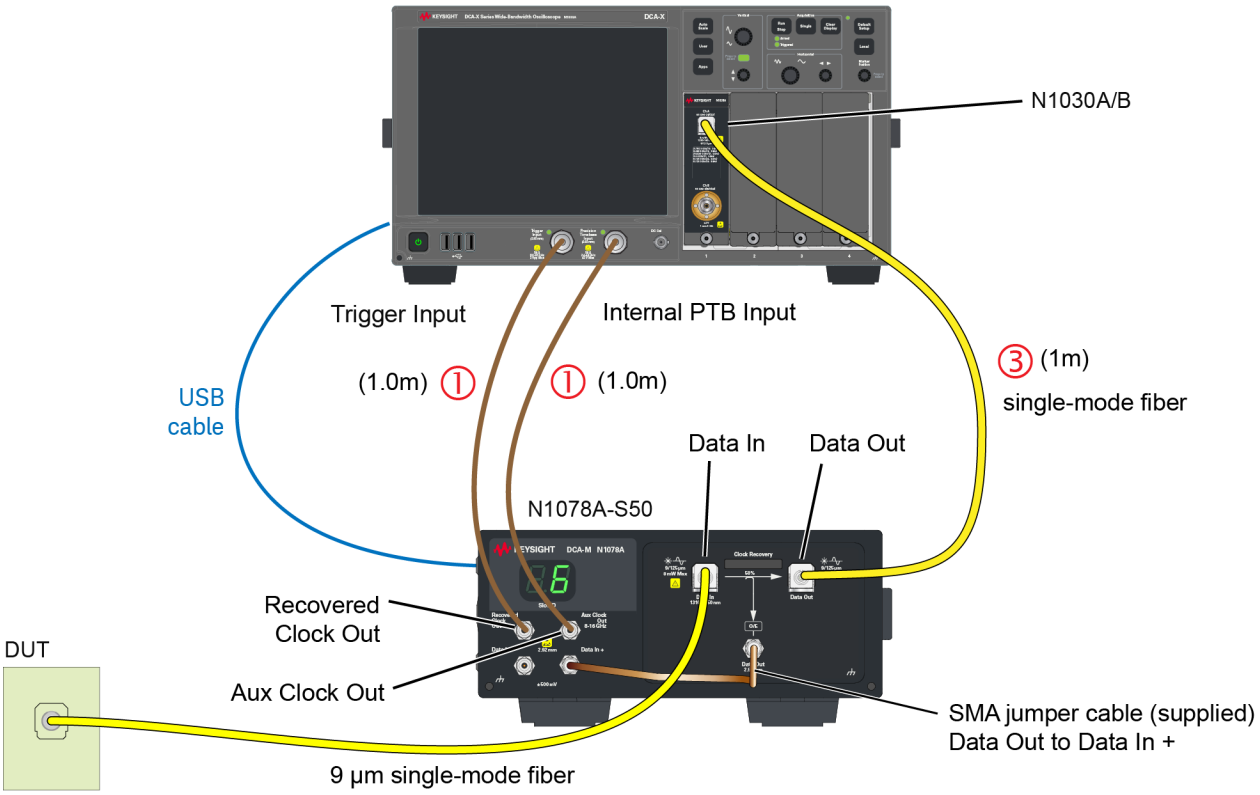


Figure 67. Single-Mode Input, N1078A-S50, DCA-X Scope

Block Diagrams

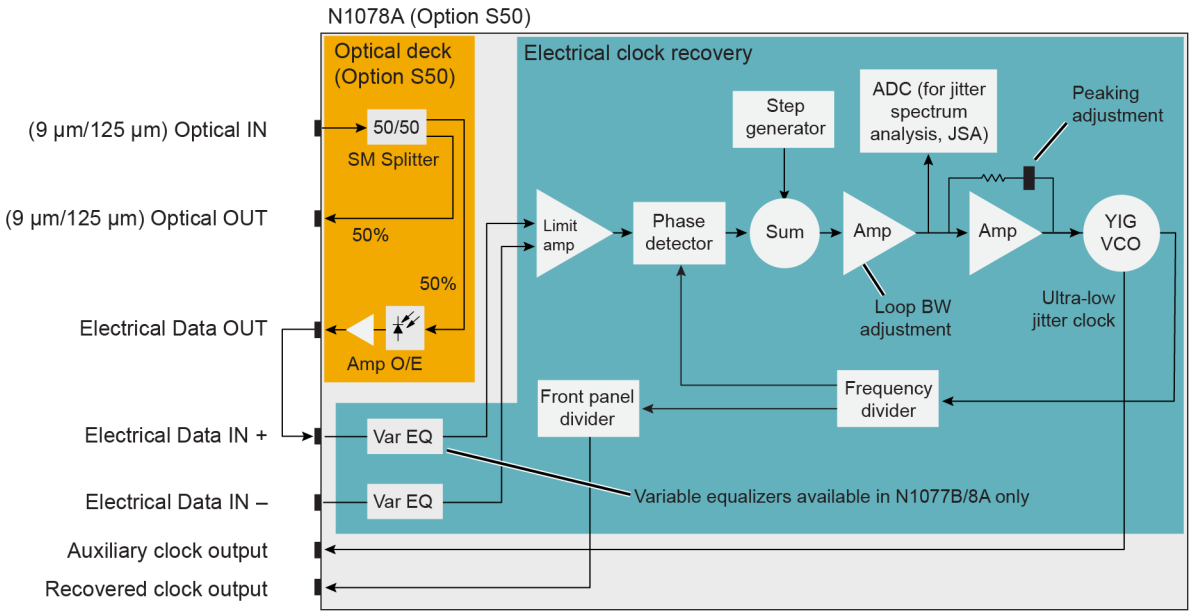


Figure 68. N1078A-S50 Block Diagram

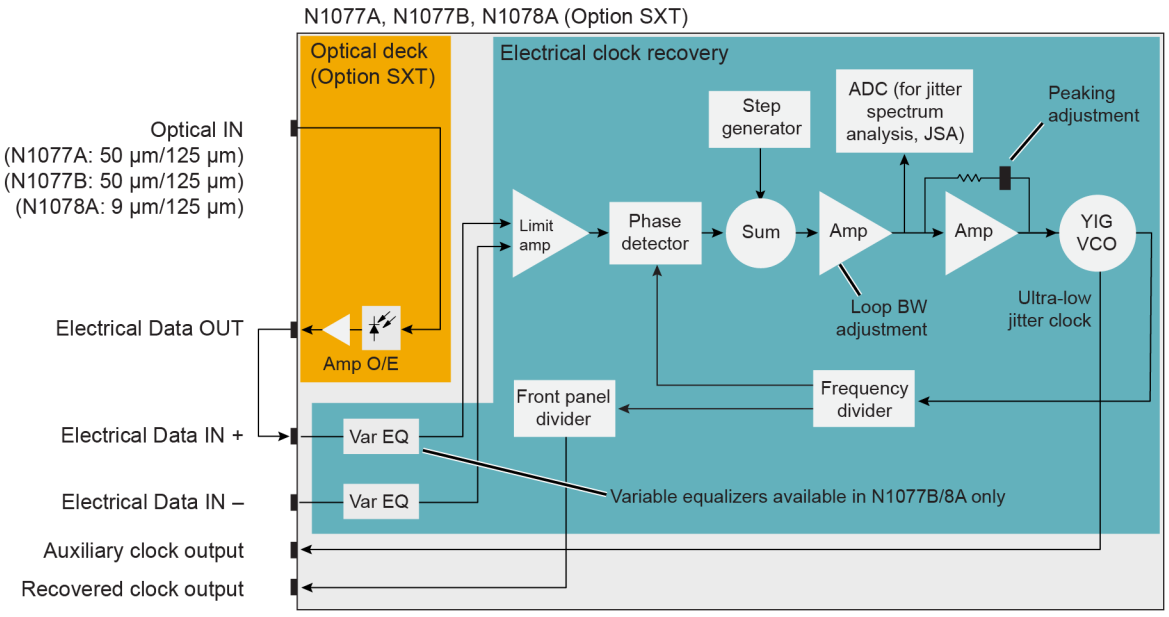


Figure 69. N1078A-SXT Block Diagram

Module Options and Accessories

Table 31. N1078A Options

Option	Description
Input Data Rates	
264	125 MBd to 64 GBd
253	53 GBd to 58 GBd
232	125 MBd to 32 GBd
225	25 GBd to 29 GBd
216	125 MBd to 16 GBd
Optical Splitter	
S50	Includes integrated single-mode, 50% splitter to optical output, 9/125 um
SXT	For use with external splitter (not supplied by Keysight). No installed integrated splitter/coupler.
Equalization and Jitter Spectrum Analysis	
EVA	Integrated, variable equalizer.
JSA	Jitter spectrum analysis and clock recovery emulation. Jitter Spectrum Analysis (JSA) provides greater insights into jitter and improves jitter measurement accuracy.
External equalizer for making "closed eye" measurements	
EQ3	2.92 mm (m) to 2.92 mm (f), 3 dB. Can be ordered separately as N1027A-EQ3.
EQ6	2.92 mm (m) to 2.92 mm (f), 6 dB. Can be ordered separately as N1027A-EQ6.
EQ9	2.92 mm (m) to 2.92 mm (f), 9 dB. Can be ordered separately as N1027A-EQ9.
External accessories, Miscellaneous	
CR1	Electrical clock recovery phase matching kit for use when using an N1000A/86100D (with *Internal Precision Timebase, option PTB)* and electrical clock input signal, and N1045A or N1055A remote-head module. This kit can be ordered separately as N1027A-76A. Refer to *Introduction* on page 7.
Rack Mount Kits	
1CM	For single DCA-M. Can be ordered separately as N1027A-RM1.
1CN	For two DCA-Ms mounted side by side. Can be ordered separately as N1027A-RM2.

Table 32. N1078A Supplied Accessories

Item	Qty
USB cable, USB-A plug to USB-B plug (2m long)	1
RF SMA 50-ohm cap (male)	3
RF SMA cable. DATA OUT to DAT IN +	1
Optical patch cord-SM, FC/PC connectors (1m long)	1
FC fiber-optic dust cap for each fiber-optic connector (with option SXT)	1
FC fiber-optic dust cap for each fiber-optic connector (with option S50)	2

8 Programming

The N107X-series clock recovery DCA-Ms are remotely controlled using the SCPI commands that are documented in FlexDCA's help system. You send these commands either to N1010A FlexDCA (on a PC) or FlexDCA (on a DCA-X oscilloscope). *Figure 70* on page 126 and *Figure 71* on page 126 show the two most common setups for controlling DCA-Ms. Generally, FlexDCA commands work the same regardless if they are sent to a DCA-M or 86100D. For example, the command:

```
:CHANnel2A:YSCale 1.0E-1
```

changes the channel's vertical scale on a DCA-M just like on an 86100D. However, this chapter does explain some important differences between programming a DCA-M versus a DCA-X sampling oscilloscope.

The following programming tools are an essential aid in locating and understanding commands for specific tasks:

- SCPI Recorder (on page 134).
- Interactive SCPI Command Tree (on page 137).
- Programming topics in FlexDCA's help system.
- Example scripts found in FlexDCA's help system.

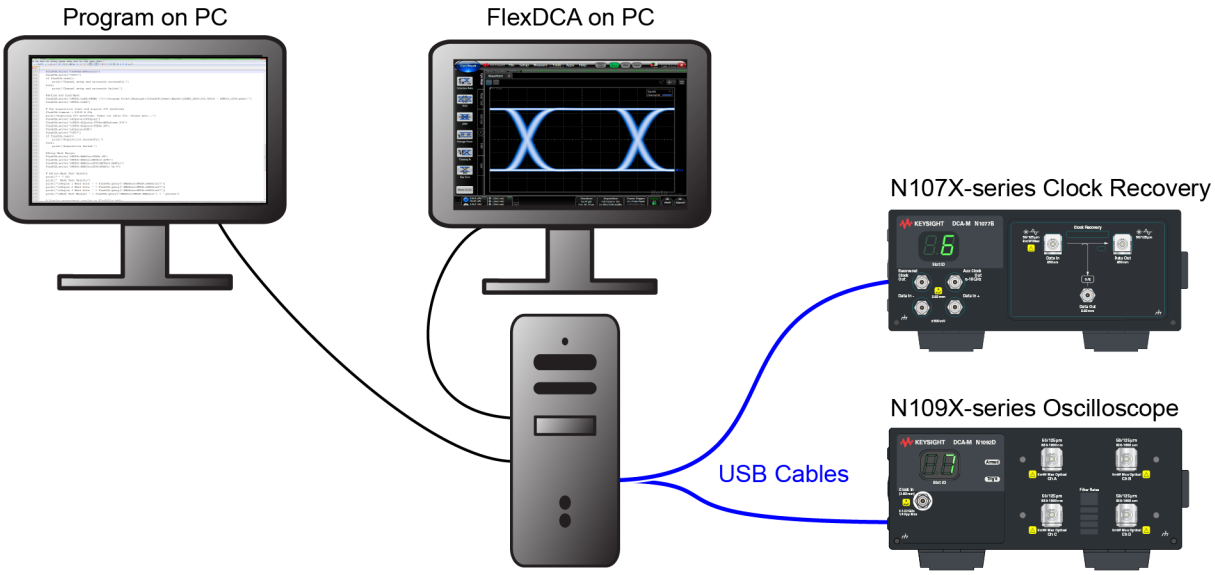


Figure 70. Controlling DCA-Ms from a PC

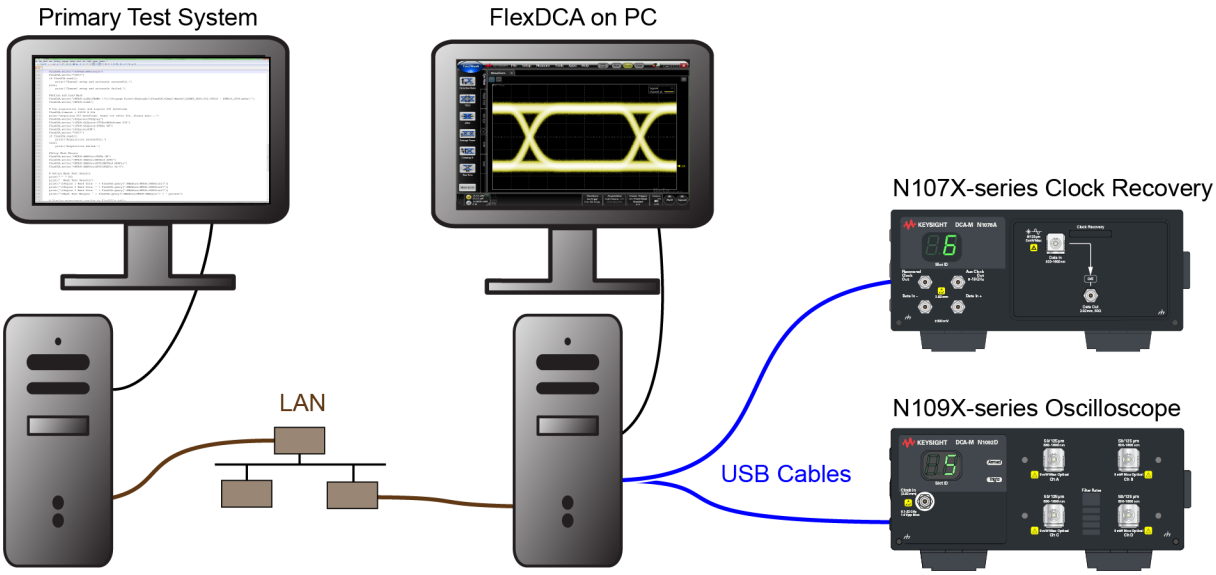


Figure 71. Controlling DCA-Ms from a Remote PC

Command Subsystems Unique to DCA-Ms

:EMODules (Extended Modules) Subsystem

FlexDCA's `:EMODules` command subsystem is unique to DCA-M instruments such as N107X-series clock recovery modules and N109X-series oscilloscopes. Use this subsystem to assign DCA-M modules to FlexDCA slots (1 through 8). On an DCA-X, only slots 5 through 8 are available.

Table 33. :EMODules Commands

Command	Description
:EMODules:DCAM:DEVice	Queries the identification string of an DCA-M extended module.
:EMODules:SLOT:CMEThod?	Returns the connection method for the module in the slot. USB is returned if a DCA-M is connected and NONE if one is not connected.
:EMODules:SLOT:CONNect	Establishes the communication connection with a DCA-M.
:EMODules:SLOT:DISConnect	Unassigns an extended module, simulated module, or mainframe from the indicated slot.
:EMODules:SLOT:SELection	Assigns an extended module, simulated module, or mainframe to a slot.
:EMODules:SLOT:STATe	Returns state of extended module connection.

:SLOT Subsystem

FlexDCA's `:SLOT` SCPI command subsystem is unique to DCA-M instruments. Use this subsystem to control the trigger setting of a DCA-M. Refer to Table 34.

N109X-series oscilloscopes with option PLK installed have the ability to pattern lock. Because these oscilloscopes use different internal hardware than the DCA-X, the `:SLOT` subsystem is used rather than the `:TRIGger` subsystem for pattern lock.

Table 34. :SLOT Commands for DCA-M Instruments

Command	Description
`:SLOT:TRIGger:MODe?`	Queries the trigger mode, which is always clock (CLOC) and cannot be set or changed (:TRIGger:MODe command). You can query CLOC (clock) with either the :TRIGger:MODe? or :SLOT:TRIGger:MODe? queries.
`:SLOT:TRIGger:MRATe?`	Queries the measured clock rate at the Clock In input of the DCA-M extended module.
`:SLOT:TRIGger:SOURce?`	The DCA-M oscilloscope's trigger source can either be front panel or free run as set by this command's FPANel or FRUN arguments. Do not use the CHANnel or SLOT arguments.
Commands of for Oscilloscopes with Option PLK (Pattern Lock)	
`:SLOT:TRIGger:BRATe`	Enters or queries the bit-rate of the trigger source.
`:SLOT:TRIGger:BRATe:AUTodetect`	Enables or disables automatic bit-rate detection.
`:SLOT:TRIGger:DCDRatio`	When using pattern lock, enters or queries the trigger-divide ratio.
`:SLOT:TRIGger:DCDRatio:AUTodetect`	Enables or disables automatic trigger-divide-ratio detection.
`:SLOT:TRIGger:MRATe?`	Queries the measured clock rate at the DCA-M's front-panel Clock In input connector.
`:SLOT:TRIGger:PLENgth`	Enters the length of the pattern in bits.
`:SLOT:TRIGger:PLENgth:AUTodetect`	Queries the measured clock rate at the Clock In input of the DCA-M extended module.
`:SLOT:TRIGger:TRACking`	Turns on pattern lock tracking where pattern lock settings are the same (linked) for all DCA-M oscilloscopes and the 86100D. The clock and data signals should be the same rate and pattern length.

Aligning Waveforms

Because the acquisition system on N109X-Series DCA-M Oscilloscopes is independent of a DCA-X, if your are using multiple DCA-Ms or a DCA-M with 86100D receiver modules, the input waveforms may not align after an Auto Scale (`:SYSTem:AUToscale`). To enable `:SYSTem:AUToscale` to align waveforms:

- If option 500, Productivity Package Software, is installed on the DCA-X or DCA-M, turn Rapid Eye on and the waveforms will align. Option 500 is the most convenient way to align the waveforms and maintains very fast throughput. To enable Rapid Eye and align waveforms, use these commands.

```
:ACQuire:REYE:ALIGn ON
:ACQuire:REYE ON
:SYSTem:AUToscale;*OPC?
```

- If option 500 is not installed, you can use the `:CHANnel:TDELay` command to add software delay to a channels, but the acquisition throughput will be reduced.

```
:CHANnel2A:TDELay 45.68e-12
:SYSTem:AUToscale;*OPC?
```

Precision Time Base

Because a DCA-M has different hardware than the DCA-X, N109X-series DCA-M oscilloscopes do not work with a Precision Time Base (PTB). However, an N109X-series DCA-M oscilloscope with option LOJ (Low Jitter Timebase) does provide PTB performance without the need for special commands. Therefore, the following FlexDCA commands do not work with DCA-M oscilloscopes:

```
:CALibrate:FRAMe:PTIMebase:STARt
:CALibrate:FRAMe:PTIMebase:STATus?
:TIMebase:PTIMebase:RFRequency
:TIMebase:PTIMebase:RMEThod
:TIMebase:PTIMebase:RTReference
:TIMebase:PTIMebase:STATe
:TIMebase:PTIMebase:VPTBsignals
```

Recommended Best Practices

The following techniques explicitly set values for selecting an optical channel's wavelength or filter rate. These methods are recommended for both DCA-M and DCA-X oscilloscopes.

Optical wavelength selection commands

:CHANnel:WAVelength

To specify an input channel's wavelength, it is recommended that you do not use the `:CHANnel:WAVelength` command. For example,

```
:CHANnel2A:WAVelength WAVelength2
```

This is because the definition of the wavelength argument can differ between modules. For example, the `WAVelength2` argument might specify a 1310 nm wavelength on an DCA-M oscilloscope and 1550 nm on an standard receiver module.

Instead, explicitly select the wavelength using the `:CHANnel:WAVelength:VALue` command. For example,

```
:CHANnel2A:WAVelength:VALue 1.310E-6
```

This is the most robust and reliable technique for making these selections and the easiest to read! This command works for both traditional modules and the DCA-M oscilloscopes. If the wavelength is not within 1% of a supported wavelength, an error will be generated.

:CHANnel:WAVelength:VALue:VSET?

You can query the available wavelengths for setting using the `:CHANnel:WAVelength:VALue:VSET?` query. This query returns a comma separated list of available wavelengths in meters for the selected optical channel. For example,

```
1.555E-6,850E-9,1.310E-6,1.550E-6,...
```

Filter rate selection commands

:CHANnel:FSELect

To specify or query the input channel's reference filter, it is recommended that you do not use the `:CHANnel:FSELect` command. For example,

```
:CHANnel2A:FSELect:FILTer2
```

This is because the definition of the filter argument can differ between modules and module options. For example, the `FILTer2` argument can specify a different filter based on DCA-M oscilloscope or standard module and with different reference filter rate options. For example, it might be 8.5 Gb/s in one case and 9.953280 Gb/s in another.

Instead, explicitly select the wavelength using the `:CHANnel:FSELect:RATE` command. For example,

```
:CHANnel2A:FSELect:RATE 10.3125E9
```

This is the most robust and reliable technique for making these selections and the easiest to read! This command works for both traditional modules and the DCA-M oscilloscopes. If the wavelength is not within 1% of a supported reference filter rate, an error will be generated.

:CHANnel:FSELect:RATE:VSET?

You can query the available reference filters for setting using the `:CHANnel:FSELect:RATE:VSET?` query. This query returns a comma separated list of available filters in b/s for the selected optical channel. For example,

```
155.000E+6,622.000E+6,1.250000E+9,2.488000E+9,...
```

:CHANnel:FILTer OFF

The `:CHANnel:FILTer OFF` command does not work with DCA-M oscilloscopes. Instead, select the highest rate filter using either of the following two commands:

```
:CHANnel:FSELect:RATE <highest rate filter>
```

```
:CHANnel:FSELect:RATE:MAXimum
```

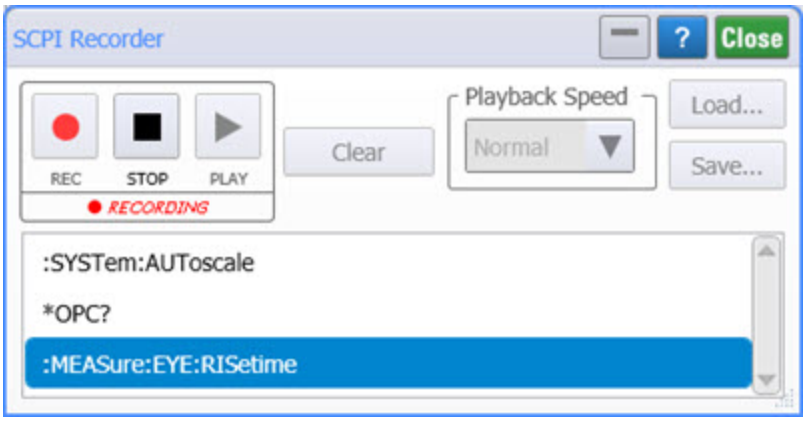
Reference filters are low-pass filters and the highest rate filter is essentially the same bandwidth as not having a filter installed.

Using the SCPI Recorder

The SCPI recorder is a powerful tool that enables you to quickly discover, record, and learn about the commands needed to perform almost any task remotely. When you've recorded your commands, you can play them back and save them as a macro. Click **REC** and the recorder performs the following tasks:

1. Captures most setting changes (mouse clicks or keyboard presses).
2. Translates the setting into an equivalent SCPI remote-programming command.
3. Records the SCPI command within the dialog.

Click **Tools** > **SCPI Programming Tools** > **SCPI Recorder** to open this dialog.



Click **REC** to begin recording. The button turns red to alert you that any mouse clicks or keyboard presses will be recorded. When you have captured all your commands, click the record button again to end the recording.

During recording, click **STOP** to end the recording.

Click **Play** to play back your recording and observe the commands as they are executed. Playback always starts at the highlighted command, which is shown in a blue box as seen in the above figure. Click any command in the dialog to highlight that command. Use **Playback Speed** to control the rate that the commands are played: Slow, Normal, or Fast.

During playback, click PAUSE to temporarily stop the playback.

During playback, click Device Clear when a command is waiting a unacceptable length of time to complete. This can happen, for example, during limit testing when a command locks the remote interface until 100 failed samples are detected. This task could take a very long time.

```
:LTESt:MTESt:FAILures 100; *OPC?
```

Click Clear to delete your recorded commands from the dialog.

Click Save to save your recorded commands into a script file (.scpi) that can be reloaded into the dialog at any time by clicking Load.

NOTE The default user data folder for saving script files is \SCPI Scripts.

SCPI script file are ASCII files, so you can edit them as well as create new script files using a text editor. SCPI scripts are often small snippets of code that may depend on FlexDCA being set to very specific settings. As a result, your scripts may not work in the same manner in different situations. This can be alleviated by starting your scripts with commands that configure starting conditions. For example, the first few lines in the following code configures FlexDCA from a default setup *before* making a rise time measurement. To include comments in your scripts, precede the comments with two forward-slash characters as shown in this example script:

```
:SYSTem:DEFault
:TRIGger:SOURce FPANel
:TRIGger:BWLimit CLOCk
:SYSTem:MODE EYE         // Place FlexDCA in Eye/Mask mode
:SYSTem:AUToscale
:TRIGger:PLOCk ON
:MEASure:EYE:RISetime // Measure risetime
:MEASure:EYE:RISetim?
```

NOTE When FlexDCA is installed, a registry entry is created to associate script files (*.scpi*) with Notepad. This makes it easier to open script files.

Windows Clipboard

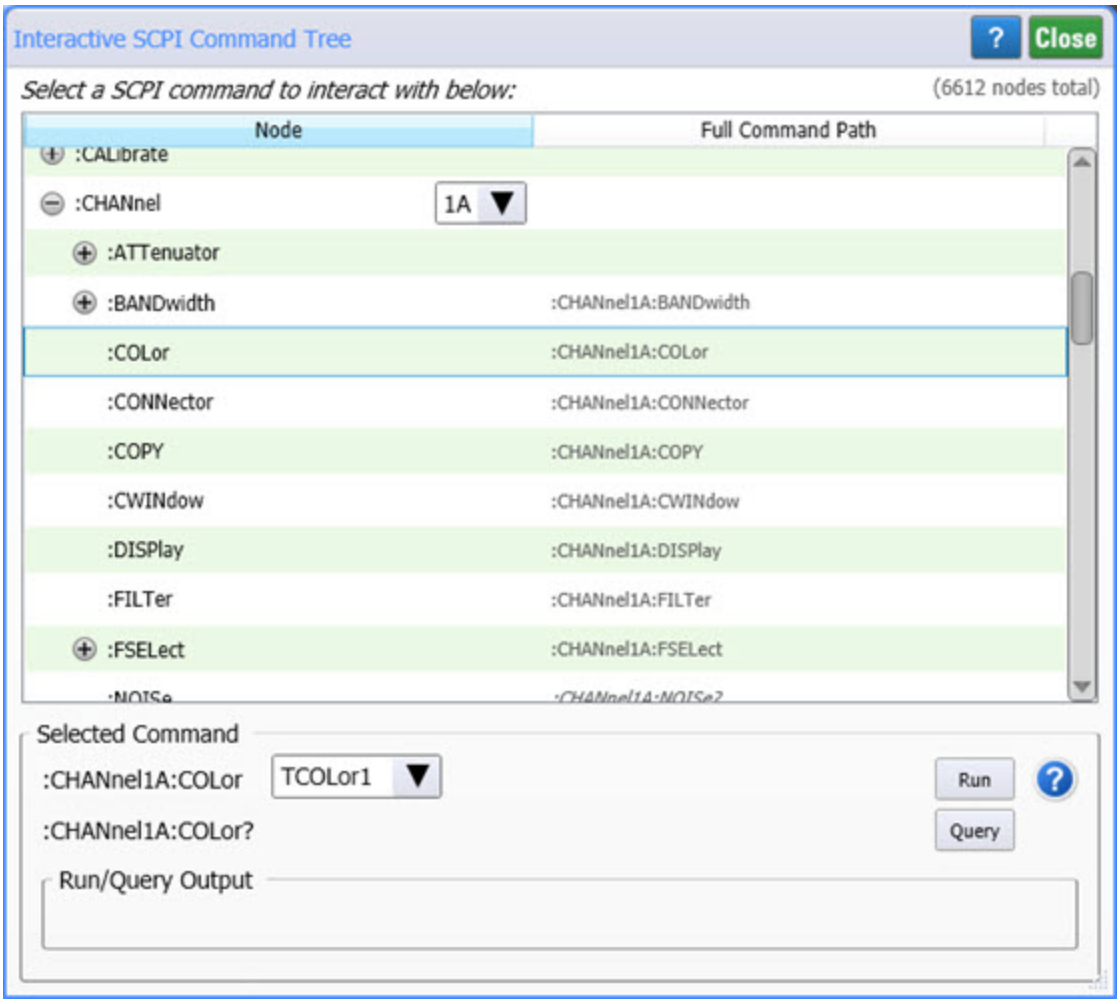
Select your recorded commands and press Ctrl-C to copy the commands to the Windows clipboard.

- Click to select a command.
- Shift click to select multiple commands.
- Ctrl click to select non-adjacent commands.
- Ctrl-A selects all commands.
- Ctrl-C copies all selected commands. You can also right-click and then click Copy.
- Ctrl-V to paste commands in another application.

Using the Interactive SCPI Command Tree

The Interactive SCPI Command Tree dialog lists all SCPI command subsystems and their commands. You can quickly traverse the tree and study the interaction between any command and FlexDCA.

Click **Tools** > **SCPI Programming Tools** > **Interactive SCPI Command Tree** to open this dialog.



Click the icon to open the help topic for the selected command.

To learn about a command or subsystem,

1. Scroll down the command tree to locate the command subsystem :SYSTem that you are interested in.
2. Click on the expand button to view the available commands. You can also expand an entry by double clicking on the row.
3. Drop-down lists for a command provide any *available* command arguments. Depending on the command, the argument may be a token, string, integer (int), or double (double) value. Click Run to execute the command.
4. Click Query to display the current value in the Run/Query Output field.

FlexDCA Configurations

This section describes the four basic setup configurations for controlling FlexDCA via the LAN as illustrated in *Figure 72* on page 140. Select the configuration that matches your needs. For each setup, there is a very simple Python script that establishes the connection to FlexDCA on the PC or DCA-X and prints the response of FlexDCA's `*IDN?` query. An N109X-series oscilloscope is not required. The four simple example scripts show how similar the task is for each setup. If you would like to install Python, refer to *Programming* on page 125.

When FlexDCA is being remotely controlled, front panel control is locked out. If you click **Local** on FlexDCA, the remote control link disconnects and control is returned to FlexDCA user interface.

FlexDCA's version (of a PC's or DCA-X) must be A.05.30 or above and, for Flex-on-Flex connections, must be the same version.

Environment

All of the examples shown in this section were written for Python 3.5 and were tested using the following environment:

- Windows 7 PC
- Keysight IO Libraries Suite installed for VISA (Virtual Instrument Software Architecture) library. Go to *http://www.keysight.com/find/iosuite*.
- Python 3.5. Anaconda Python distribution (Windows 32-bit) from Continuum Analytics installed using the graphical installer. For information on Anaconda, go to https://www.anaconda.com/distribution/.
- PyVISA which is a Python front end for the VISA library. The correct version of PyVISA is provided with Anaconda. To learn about PyVISA, go to https://pyvisa.readthedocs.io/

NOTE All of the examples shown in this section present a Python script that establishes a LAN connection using the HiSLIP interface. GPIB connections are not presented. Some firewall applications might block SICL/LAN communications.

NOTE If you are viewing this page as a PDF file, select and copy code examples to the Windows clipboard.

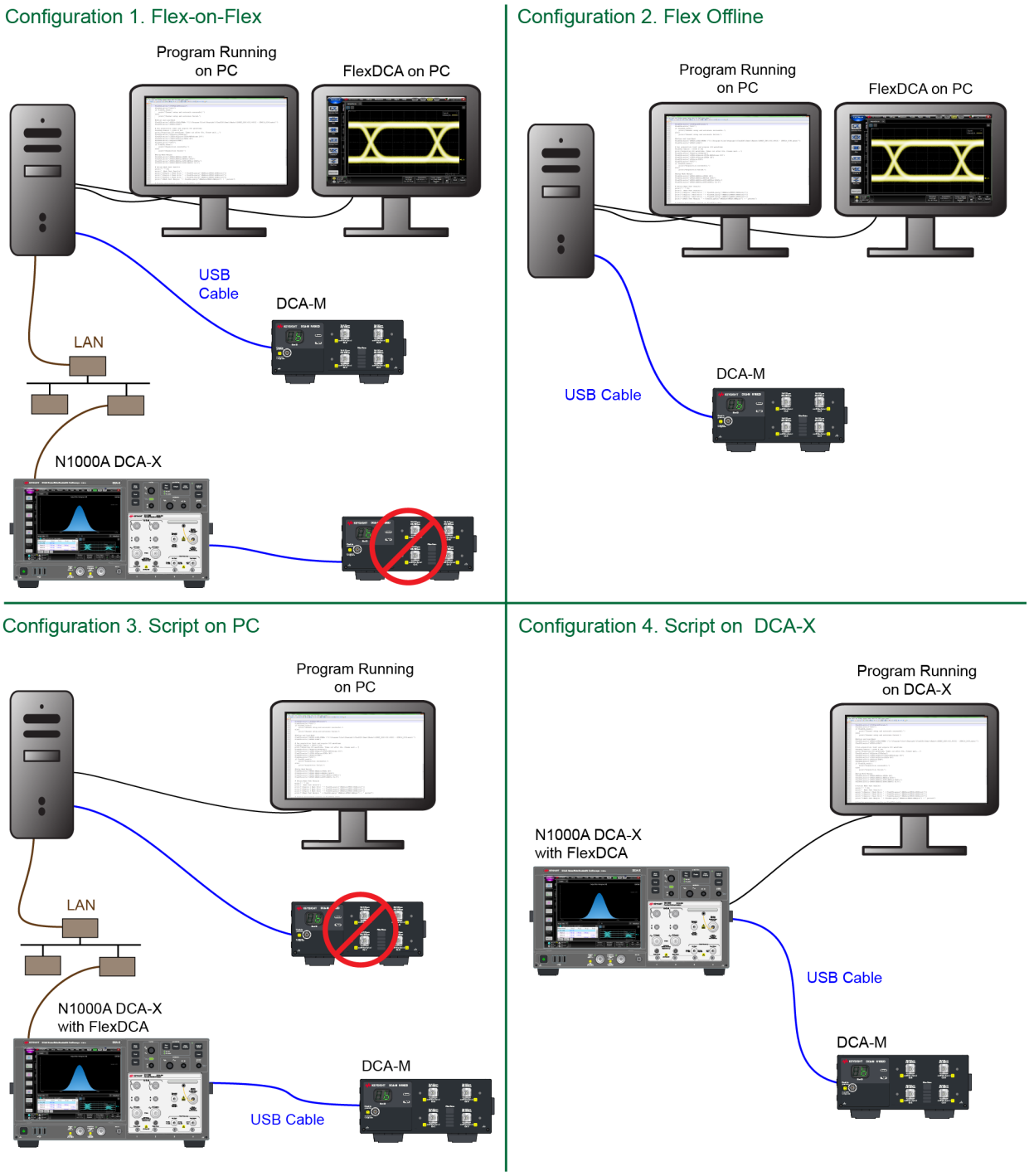


Figure 72. The Four Configurations

Configuration 1. Flex-on-Flex

In this setup, the script runs on the PC and directly controls FlexDCA on the PC.

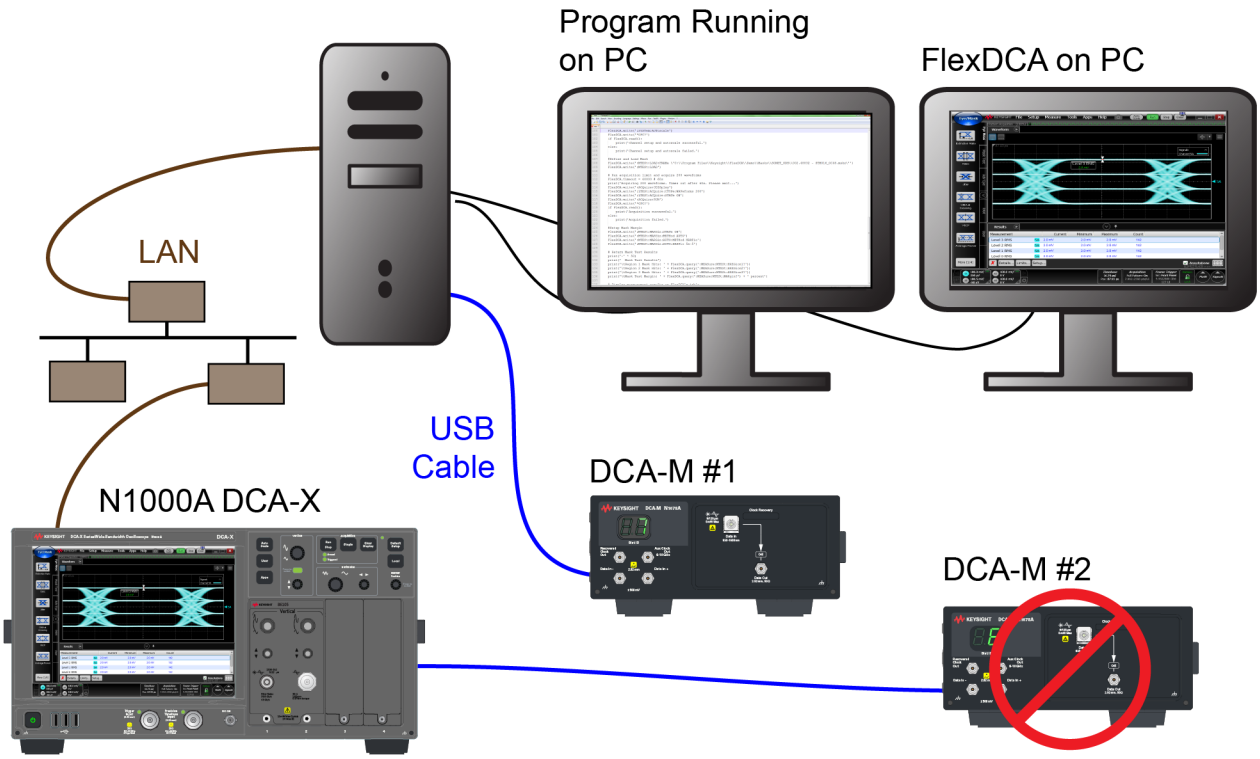


Figure 73. Flex-on-Flex Setup

Configuration 1, Flex-on-Flex on page 142 establishes a connection between the PC's FlexDCA and 86100D's FlexDCA using the commands in the `:RDCA` subsystem. In the listing, the red text opens a connection with FlexDCA on the PC. The green text is the computer name of the N1000A (or 86100D). Replace this green text with the name of your N1000A. On the N1000A, click the menu commands **Help** > **About FlexDCA**. In the About N1000A dialog box, locate the System Information field and scroll the field's listing until the Computer Name listing appears.

To manually make the Flex-on-Flex connection

You can perform this task manually using the following steps:

1. In 86100D's FlexDCA, click the menu commands **Help** > **About FlexDCA** . In the About 86100D dialog box, locate the **System Information** field and scroll the field's listing until the Computer Name listing appears.

2. Write down the computer name (for example, K-86100D-20108). Close the dialog box.
3. On the PC, start FlexDCA and click the menu commands **Setup** > **DCA Connection Setup** . In the dialog box, select LAN. In the **Hostname** field, enter the computer name that you located in step 2. Click Connect to manually connect FlexDCA with the 86100D.

Configuration 1, Flex-on-Flex

```
1
2  import visa
3  rm = visa.ResourceManager() # Create an instance of PyVISA's ResourceManager
4  print('\n\tConnecting to FlexDCA on PC. Please wait...')
5  flex=rm.open_resource('<span class="red_
   text">TCPIP0::localhost::hislip0,4880::INSTR</span>
6  ')
7  flex.timeout=20000 # wait up to 20s for response from FlexDCA
8  flex.read_termination = '\n'
9  s = flex.query('*IDN?')
10 print('\tFlexDCA connection established to:\n\t' + s) # Identify FlexDCA
11 print('\n\tConnecting FlexDCA to 86100D. Please wait...')
12 flex.write(':RDCA:CONNect:METhod LAN')
13 flex.write(':RDCA:CONNect:MODE STANdard')
14 flex.write(':RDCA:CONNect:ACTion TBSettings')
15 flex.write(':RDCA:CONNect:TSETtings ON') # Pull state upon connect
16 flex.write(':RDCA:DISConnect:TSETtings ON') # Push state upon disconnect
17 flex.write(':RDCA:CONNect:HOST <span class="green_text">K-86100D-20108</span>')
18 flex.query(':RDCA:CONNect;*OPC?')
19 s = flex.query('*IDN?')
20 print('\tFlexDCA connection established to:\n\t' + s) # Identify FlexDCA
21 flex.query(':RDCA:DISConnect;*OPC?')
22 print('\n\tFlexDCA on 86100D is disconnected.')
23 flex.write(':SYSTem:GTLocal')
24 flex.close()
25 print('\tFlexDCA on PC is disconnected.')
26
```

Configuration 2. FlexDCA Offline

In this setup, N1010A FlexDCA is being used offline without a connection to an N1000A (or 86100D). Use this configuration to work with simulated or DCA-M modules.

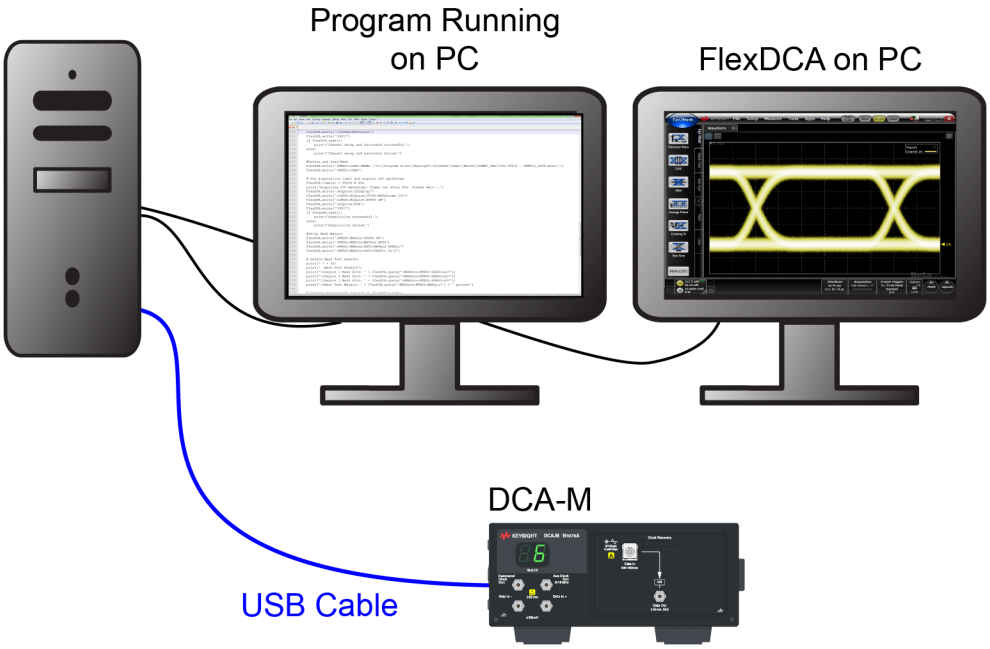


Figure 74. FlexDCA Offline Setup

Configuration 2, FlexDCA Offline on page 144 establishes a connection to the N1010A FlexDCA application on the PC. The VISA address shown in red is used to open a connection between the script and N1010A FlexDCA.

Configuration 2, FlexDCA Offline

```
import visa # import VISA library
rm = visa.ResourceManager() # Create an instance of PyVISA's ResourceManager
flex=rm.open_resource('<span class="red_
text">TCPIP0::localhost::hislip0,4880::INSTR</span>')
flex.read_termination = '\n'
s = flex.query('*IDN?')
print('\n\tFlexDCA connection established to:\n\t' + s) # Identify FlexDCA
flex.write(':SYSTem:GTLocal')
flex.close()
print('\tFlexDCA connection closed.')
```

Configuration 3. Script on PC

In this setup, the script runs on the PC and controls an N1000A (or, 86100D). Figure 75 shows that a DCA-M can be connected to the N1000A.

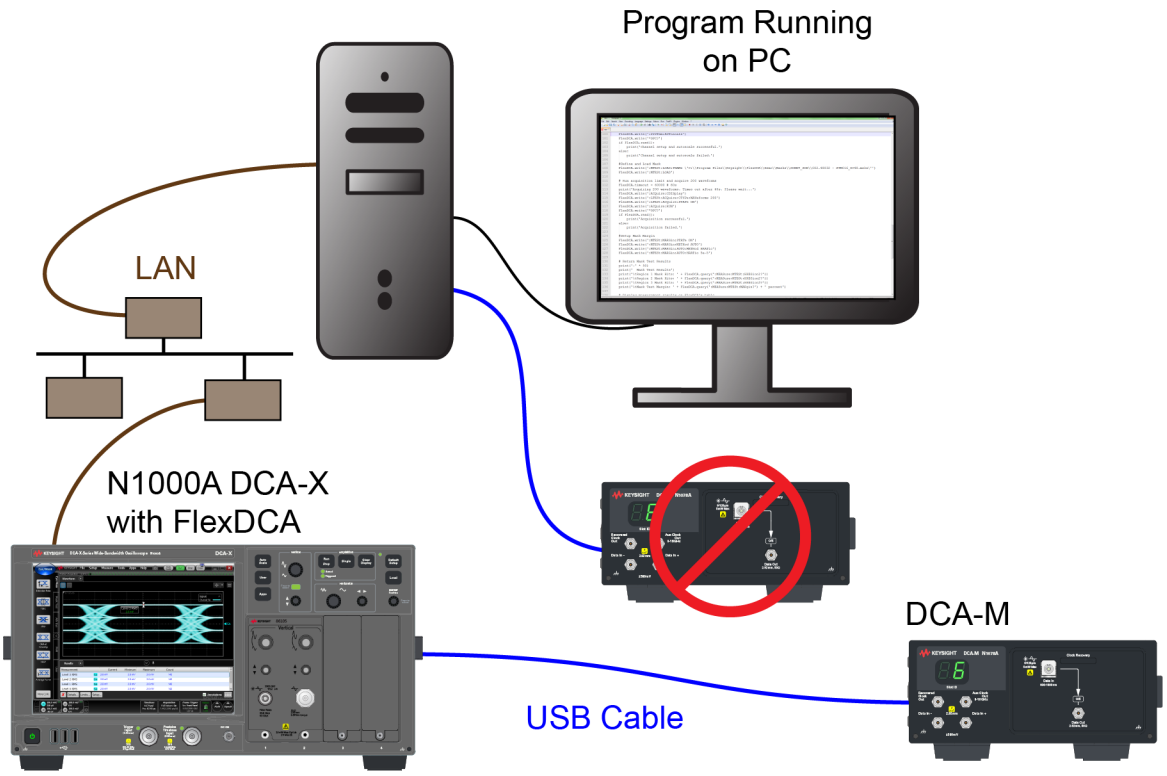


Figure 75. Script on PC Setup

Configuration 3, Script on PC on page 146 establishes a connection to the N1000A. The VISA address shown in red is used to open a connection between the script and N1000A and should be replaced with your N1000A's computer name. In N1000A, click the menu commands **Help** > **About FlexDCA**. In the About 86100D dialog box, locate the System Information field and scroll the field's listing until the Computer Name listing appears.

Configuration 3, Script on PC

```
1
2  import visa # import VISA library
3  rm = visa.ResourceManager() # Create an instance of PyVISA's ResourceManager
4  flex=rm.open_resource('<span class="red_text">TCPIP0::K-86100D-
   20108::hislip0,4880::INSTR</span>')
5  flex.read_termination = '\n'
6  s = flex.query('*IDN?')
7  print('\n\tConnection established to:\n\t' + s) # Identify FlexDCA
8  flex.write(':SYSTem:GTLocal')
9  flex.close()
10 print('\tConnection closed.')
11
```

Configuration 4. Script on DCA-X

In this setup, the script runs on the N1000A (or 86100D). *Programming* on page 125 establishes a connection between the script on the DCA-X and FlexDCA. The VISA address is shown in red in the following listing.

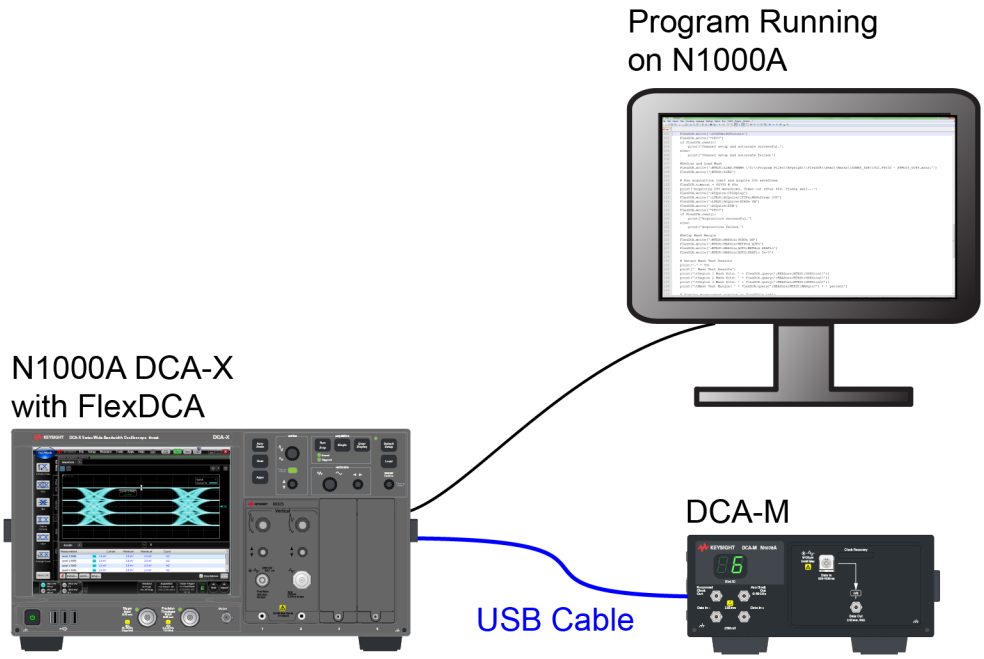


Figure 76. Script on DCA-X Setup

Configuration 4, Script on DCA-X

```
1
2  import visa # import VISA library
3  rm = visa.ResourceManager() # Create an instance of PyVISA's ResourceManager
4  flex=rm.open_resource('<span class="red
   text">TCPIP0::localhost::hislip0,4880::INSTR</span>')
5  flex.read_termination = '\n'
6  s = flex.query('*IDN?')
7  print('\n\tConnection established to:\n\t' + s) # Identify FlexDCA
8  flex.write(':SYSTem:GTLocal')
9  flex.close()
10 print('\tConnection closed.')
```

Finding the VISA Address for HiSLIP

The VISA Address for the HiSLIP interface is easy to locate and is used to identify the LAN address between your program and FlexDCA.

1. On FlexDCA, click the menu commands Tools > SCPI Programming Tools. The SCPI Server Setup dialog box opens as shown below.

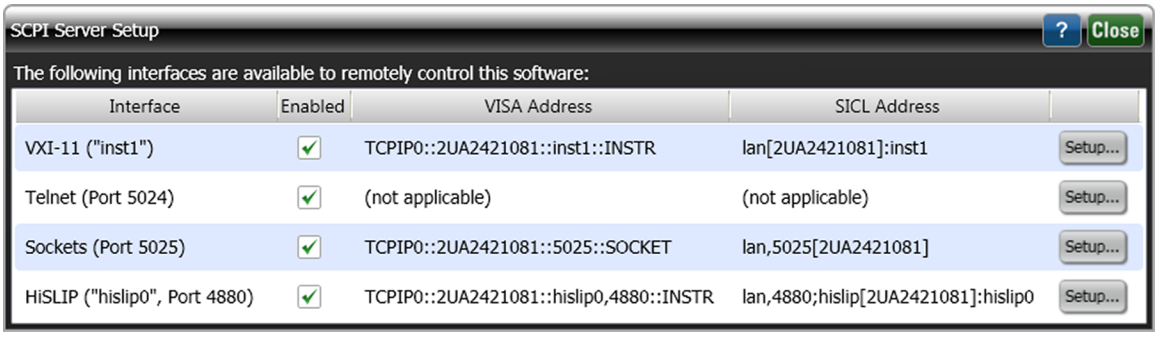


Figure 77. SCPI Server Setup dialog

2. From the dialog, write down the complete listed VISA Address for HiSLIP. As an alternative, you can highlight the string using the mouse cursor and press Ctrl-C to copy it to the clipboard for later use. In the above picture, the string for HiSLIP would be:

```
TCPIP0::2UA2421081::hislip0,4880::INSTR
```

You can substitute the IP address as shown here:

```
TCPIP0::141.121.89.103::hislip0,4880::INSTR
```

If your program is running on the same PC or 86100D as FlexDCA, you can simplify this string by substituting localhost for the computer name. For example, you would modify the above VISA address to be the following string:

```
TCPIP0::localhost::hislip0,4880::INSTR
```

Example Programs

This section presents several example programs for controlling the N107X-series clock recovery DCA-Ms. These programs will run in 3.X and are intended to show basic tasks that you can adapt to programs that are written in another language. These examples demonstrate how to establish a LAN connection to FlexDCA and how to use FlexDCA commands and techniques to accomplish specific FlexDCA tasks. These examples are not provided to teach the Python language.

NOTE Do not modify indents at the beginning of any lines within the program. The indentation of code lines in Python is critical to the ability of the code to run. Indents define code blocks.

Getting the Code Examples

You can copy the code examples from the PDF version of this documents, but the most reliable and easiest method for getting the source code is by copying it from FlexDCA's help system:

1. In FlexDCA (A.06.50 and above), click **Help** > **Programmer's Guide** to open FlexDCA's help.
2. In the help, click **Tools** > **Python** > **Python Example Scripts**, and select the kind of script that you are interested in.
3. In the script topic, click the link in the "Get Example Script" sidebar and copy the code listing and paste it in your Python editor.

General Information on the Scripts

print() statements
The Python 3.x `print()` statement is used to provide messages on the script's progress to the user. This works in Python 2.x as long as you do not pass multiple strings to the function.

Message timing
When the `print()` statement is used as described above, under certain conditions your message may appear on screen sometime later than they should and this can be very confusing. For example, if you acquiring waveforms as shown here:

```
print('Acquiring 100 waveforms.')
FlexDCA.write(:ACQuire:RUN';*OPC?)
```

You'll watch FlexDCA capture the waveforms and then write the statement "Acquiring 100 waveforms" to the screen! The solution is to flush the stdout buffer. In Python 3.x, this can be done by:

```
print('Acquiring 100 waveforms.', flush=True)
FlexDCA.write(:ACQuire:RUN';*OPC?)
```

In Python 2.x and 3.x, the same task can be accomplished with:

```
print('Acquiring 100 waveforms.')
sys.stdout.flush()
FlexDCA.write(:ACQuire:RUN';*OPC?)
```

Example 1. Identify all connected DCA-Ms and modules

The following Python script discovers all DCA-M oscilloscopes, standard modules, and simulated modules and prints their model numbers to the console. The script uses the `:SYST:MODel? SLOT` query to return the model number of a standard or DCA-M module. The `:EMODules:SLOT:SELection?` query is used to return the string "DCAM" if a DCA-M module is installed in the slot. If `EMPT` is returned, the slot is empty. These commands are shown in the color red in the script.

DCA_M_find.py

```
import pyvisa as visa # import VISA library

slots = {1:'',2:'',3:'',4:'',5:'',6:'',7:'',8:''}

def discover_modules(flex, slots):
    """ Locates each hardware, simulated, or DCA-M by slot."""
    for slot in range(1,9): # slot numbers
        model = flex.query(':SYST:MODel? SLOT' + str(slot))
        if model in 'Not Present':
            continue
        elif model in 'N1010A': # Simulated module found
            slots[slot] = flex.query(':EMODules:SLOT' + str(slot)
+ ':SELection?')
        else: # standard module found
            slots[slot] = model
    if list(slots.values()).count('') == 8:
        print('No modules found!')
        return {}
    else:
        return slots

def report_modules_found(flex, slots):
    """ Print list of installed modules."""
    print('\nInstalled modules:')
    simulated = {'DEM':'DEM (Simulated dual electrical)',
                 'DOM':'DOM (Simulated dual optical)',
                 'QEM':'QEM (Simulated quad electrical)',
                 'OEM':'OEM (Simulated electrical/optical)'}
```

```
    for slot in slots:
        model = slots[slot]
        if model in simulated: #eg. 'DEM' is a key
            print('- Slot '+ str(slot) +': '+ simulated[model
[0:3]])
        elif model: # non-simulated module exists
            print('- Slot '+ str(slot) +': '+ model) # eg, N1092A

rm = visa.ResourceManager()
flex=rm.open_resource('TCPIP0::N1000A-108::hislip0,4880::INSTR')
flex.read_termination = '\n'
flex.timeout = 30000 # Connection timeout 30s
slots = discover_modules(flex, slots)
if slots:
    report_modules_found(flex, slots)
flex.write(':SYSTem:GTLocal')
FlexDCA.close()
```

Example 2. Re-assign a DCA-M to a different slot

The script in *DCA_M_reassign.py* on page 153 moves an existing N109X-series oscilloscope from slot 5 to slot 8. The script in *DCA_M_reorder.py* on page 154 first disconnects any existing DCA-Ms and deletes any simulated modules. The script then connects up three DCA-Ms (dictionary values) in the desired slots (dictionary keys).

If you try these examples, be sure to substitute the correct device names for your DCA-Ms (shown in red).

DCA_M_reassign.py

```
import pyvisa as visa # import VISA library
rm = visa.ResourceManager()
FlexDCA=rm.open_resource('TCPIP0::N1000A-23::hislip0,4880::INSTR')
DCAM_device_id = FlexDCA.query(':EMODules:DCAM5:DEVice?')
print('DCA-M in slot 5: ', DCAM_device_id)
print('Moving DCA-M to slot 8.')
FlexDCA.query(':EMODules:SLOT5:DISConnect;*OPC?')
FlexDCA.write(':EMODules:SLOT8:SELection DCAM')
FlexDCA.write(':EMODules:DCAM8:DEVice ' + DCAM_device_id)
FlexDCA.query(':EMODules:SLOT8:CONNect;*OPC?')
DCAM_device_id = FlexDCA.query(':EMODules:DCAM8:DEVice?')
print('DCA-M in slot 8: ', DCAM_device_id)
FlexDCA.write(':SYSTem:GTLocal')
FlexDCA.close()
```

DCA_M_reorder.py

```
import pyvisa as visa # import VISA library
dcam = {'5': '"N1092D-US56140205"', '6': '"N1076A-US56030001"'}



def remove_all_dcams(FlexDCA):
    """ Disconnects all DCA-M modules and removes any simulated modules. """
    for slot in '12345678':
        model = FlexDCA.query(':EMODules:SLOT'+slot+':SELection?')
        if model in ['DCAM', 'DEM', 'QEM', 'OEM', 'DOM']:
            if 'CONN' in FlexDCA.query(':EMODules:SLOT'+slot+':STATe?'):
                print('Disconnecting module in slot '+slot+' ...', flush=True)
                FlexDCA.query(':EMODules:SLOT'+slot+':DISConnect;*OPC?')
    print('All DCA-M and simulated modules disconnected.\n', flush=True)



def connect_dcams(FlexDCA, dcam):
    """ Assigns DCA-Ms to slots. """
    for slot, hostname in dcam.items():
    FlexDCA.write(':EMODules:SLOT'+slot+':SELection DCAM')
    FlexDCA.write(':EMODules:DCAM'+slot+':DEVice ' + hostname)
    FlexDCA.query(':EMODules:SLOT'+slot+':CONNect;*OPC?')
    print(hostname + ' connected to slot '+slot, flush=True)

rm = visa.ResourceManager()
FlexDCA=rm.open_resource('TCPIP0::N1000A-23::hislip0,4880::INSTR')
remove_all_dcams(FlexDCA)
connect_dcams(FlexDCA, dcam)
FlexDCA.write(':SYSTem:GTLocal')
FlexDCA.close()
```

Example 3. Perform eye measurement with N109X & N1076/7A

This Python example uses an N1076/7A clock recovery in slot 5 to provide a clock for an N109X-series DCA-M oscilloscope in slot 6. A bit-rate eye measurement is performed on channel 6A. The program performs the following tasks:

- Places FlexDCA to its default settings. This places the FlexDCA triggering to front panel which is required to view a valid eye diagram.
- Configures the clock recovery.
- Configures N109X.
- Queries the N109X to see if it supports pattern locking (option PLK) and then turns on pattern locking if available.
- Returns the measured trigger rate that is input to the N109X.
- Runs an acquisition limit test and then activates the bit-rate measurement on the data.

About the :TRIGger:MRATe? query

The `:TRIGger:MRATe?` query returns the baud rate of the N109X's clock input signal. For this query to work, at least one of the N109X's input channels must be turned on, but a signal does not need to be connected to the channel. Also, the N109X's data acquisition must be in Run mode, or, if in single mode, a single acquisition must first be run to ensure valid data for the measurement.

To run this program

Run this program on a PC that has FlexDCA running. In *N109X_N1077A_on_PC.py* on page 156, FlexDCA is identified by the text: `localhost`. If you change localhost to an 86100D, you can run the program on a PC to control FlexDCA on an 86100D. Connect the N109X to the 86100D.

- Install an N109X-series oscilloscope to FlexDCA's slot 6. Change the DCAMSLT constant if you want to use a different slot.
- Install an N1076/7A clock recovery to FlexDCA's slot 5. Change the RECSLT constant if you want to use a different slot.
- Data in is expected to be 10.3125 Gb/s (DRATE constant). But you can change this to any acceptable rate for the oscilloscope.
- Connect valid signal to channel 6A on the N1090X.
- Connect a clock to the N1090X's Clock In.
- Display an eye diagram on FlexDCA.

N109X_N1077A_on_PC.py

```
import pyvisa as visa # import VISA library
import sys
RECSLT = '5' # N1077A's slot
DCAMSLT = '6' # N1092D's slot
DRATE = '10.312500E+9' # input data rate
def setup_86100():
     Default all settings. Set trigger and turn on channel.
    flex.query(':SYSTem:DEFault;*OPC?')
    flex.write(':TRIGger:SOURce FPANel') #
    for slot in range(1,9): # Only channel 5A on.
        for channel in ['A','B','C','D']:
            flex.write(':CHANnel'+str(slot)+channel+':DISPlay OFF')
    flex.write(':CHAN'+DCAMSLT+'A:DISPlay ON') # Turn channel 'A' on

def setup_n1077a():
     Configure N1077A clock recovery.
    flex.write(':CRECovery'+RECSLT+':SOURce ELECtrical') # set input type
    flex.write(':CRECovery'+RECSLT+':CRATe ' + DRATE) # set input data rate
    flex.write(':CRECovery'+RECSLT+':CLBandwidth 5.692E+6') # set PLL loop BW
    flex.query(':CRECovery'+RECSLT+':RELock;*OPC?') # Lock clock recovery

def setup_dcam():
     Configure DCA-M and query measured clock input rate.
    flex.write(':ACQuire:SINGle')
    clockrate = flex.query(':SLOT'+DCAMSLT+':TRIG:MRATe?')
    if '-1.00' in clockrate or '0.00' in clockrate:
        print('DCA-M is not triggered. Check inputs.')
        return False
    flex.query(':ACQ:RUN;*OPC?')
    flex.query(':SYSTem:MODE EYE;*OPC?')
    return True

def pattern_lock():
     If DCA-M pattern lock option is installed, configure acquisition
    test to acquire pattern waveforms.
    if 'PLK' in flex.query(':SYST:OPTions? SLOT'+DCAMSLT):
```

```
        flex.write(':TRIGger:BRATe:AUTodetect OFF')
        flex.write(':TIMebase:BRATe ' + DRATE)
        flex.write(':SLOT'+DCAMSLT+':TRIGger:TRACking ON')
        flex.query(':TRIGger:PLOCk ON;*OPC?')
        print('Pattern lock on.')
        return True
    return False


def make_measurement(patternlock):
     Perform acquisition limit test and bit-rate measurement.
    flex.query(':AUTOscale;*OPC?')
    flex.write(':ACQuire:SINGle;:ACQuire:CDISplay')
    if patternlock:
        flex.write(':LTESt:ACQuire:CTYPe:PATTerns 20')
        print('Acquiring 20 pattern waveforms. Please wait...')
    else:
        flex.write(':LTESt:ACQuire:CTYPe:WAVeforms 100')
        print('Acquiring 100 waveforms. Please wait...')
    sys.stdout.flush() # Flush print message
    flex.write(':LTESt:ACQuire:STATe ON')
    flex.query(':ACQuire:RUN;*OPC?')
    flex.write(':LTESt:ACQuire:STATe OFF')
    flex.write(':MEASure:EYE:BITRate')
    print('Measured:')
    print('  Eye Bit Rate: ' + flex.query(':MEASure:EYE:BITRate?') + ' b/s')
    print('  Clock rate: ' + flex.query(':SLOT'+DCAMSLT+':TRIG:MRATe?') + ' baud
(Bd)')

rm = visa.ResourceManager()
flex=rm.open_resource('TCPIP0::localhost::hislip0,4880::INSTR')
flex.timeout = 20000 # Set connection timeout to 20s
flex.read_termination = '\n'
flex.write_termination = '\n'
s = flex.query('*IDN?')
print('\nConnection established to:\n' + s) # Identify flex
setup_86100()
```

```
setup_n1077a()
if setup_dcam():
    make_measurement(pattern_lock())
flex.write(':SYSTem:GTLocal')
flex.close()

```

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