N109X-Series DCA-M Sampling Oscilloscopes

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

KEYSIGHT

USER'S GUIDE

Notices

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

WARNING **A WARNING 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 Keysight Technologies N109X-series DCA-M sampling oscilloscopes combine the high-performance elements of both the DCA-X oscilloscope mainframe acquisition system and the hardware of a receiver plug-in module. The N1010A FlexDCA application provides both the Graphical User Interface (GUI) as well as programming interface either on a PC or on a DCA-X (N1000A or 86100D).

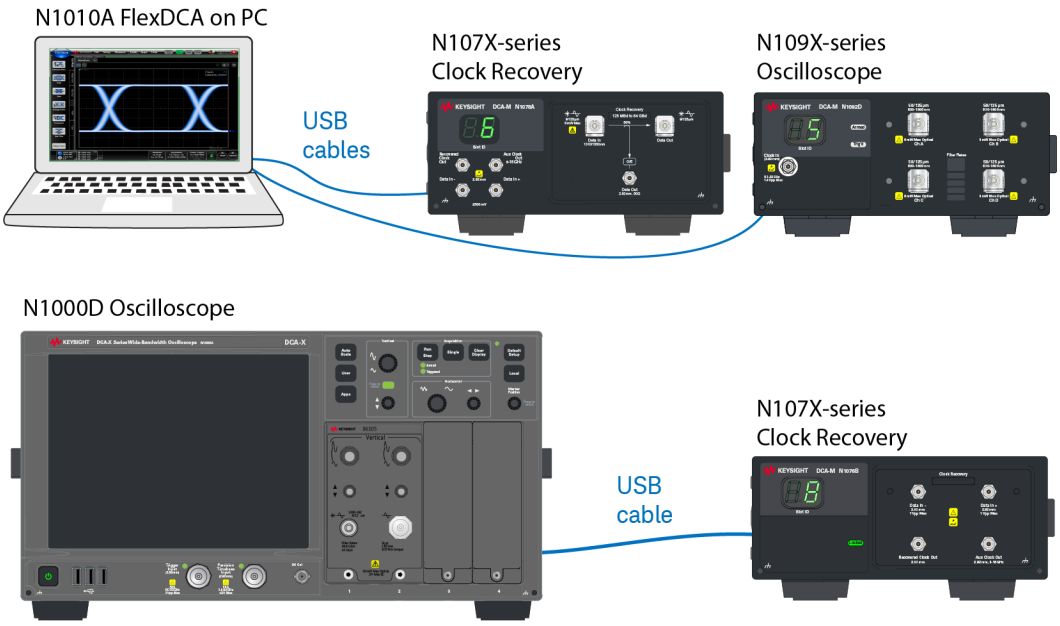


Figure 1. USB Connections to PC or N1000A (or 86100D)

With a DCA-M, you can perform eye-mask tests, measure eye diagram parameters including extinction ratio, and basic oscilloscope mode measurements of pulses (single-valued waveforms rather than eye diagrams). This is limited to patterns less than 2 ns in duration. You can also perform optical transmitter compliance tests at a variety of standard data rates depending on options installed at the time of order. Installed filter rates must be selected at the time of order and cannot be changed.

Multiple DCA-M instruments can be connected to FlexDCA. But, delta time measurements between channels on separate DCA-M oscilloscopes cannot be compared because each N109X-series oscilloscope (and DCA-X if connected) uses an independent trigger. Because the N109X-series oscilloscope have a significantly faster sampling rate when compared to an 86100D, measurement results can be returned up to 50% faster.

As shown in Table 1, a variety of optical and electrical channels are available depending on the model number. *Table 2* on page 8 compares the inputs and outputs for the different models. The information in this table is presented to help you see the differences at a glance; it is not meant to be a replacement for the product specifications, which are located in FlexDCA's help system.

Table 1. DCA-M Channels Compared

Model	Channel Count		Minimum FlexDCA Firmware Version
	Optical	Electrical	
N1094B		4	A.05.50
N1094A		2	A.05.50
N1092E	2	2	A.05.50
N1092D	4		A.05.40
N1092C	1	2	A.05.50
N1092B	2		A.05.40
N1092A	1		A.05.40
N1090A-EEC	1	1	A.05.00
N1090A	1		A.05.00

Table 2. Inputs/Outputs Compared[1]

Feature	N1090-Series	N1092-Series	N1094-Series
Wavelength range (nominal)	750 nm to 1650 nm	830 nm to 1600 nm	—
Maximum input power (non-destruct)			
Optical (peak power)	5 mW (+7 dBm)	8 mW (+9 dBm)	—
Optical (average power)	0.5 mW (–3 dBm)	—	—
Electrical (peak power)	±2V (+16 dBm)	±2V (+16 dBm)	±2V (+16 dBm)
Electrical 3 dB BW			
Option 030	—	20 and 33 GHz	20 and 33 GHz
Option 035	—	20, 33, 40, and 50 GHz	20, 33, 40, and 50 GHz
N1090-series only	12.4 and 20 GHz	—	—
Data Input	1 to 10 Gb/s	20 to 28 Gb/s	20 to 33 Gb/s (Opt. 030) 20 to 50 Gb/s (Opt. 050)
Clock input			
Recommended	< 500 mVp-p to prevent crosstalk between trigger and channel input.		
Maximum non-destruct voltage		1.4 Vp-p	1.4 Vp-p
Frequency (full or sub-rate clocks)	455 MHz to 12 GHz, full or sub-rate clocks	500 MHz to 28.5 GHz, full or sub-rate clocks[2]	500 MHz to 28.5 GHz, full or sub-rate clocks[2]
Frequency (sub-rate clocks only)[3]	100 MHz to 455 MHz	100 MHz to 500 MHz[4]	100 MHz to 500 MHz[4]
Trigger input (maximum)	1.4 Vp-p[5]	—	—

1 Refer to FlexDCA help system for complete, official specifications.
2 Pattern lock mode on or off.
3 Provided that the data rate exceeds 455 Mb/s and the clock divide ratio is a power of two.
4 Pattern lock off. Provided that the data rate exceeds 500 Mb/s and the clock divide ratio is a power of two.
5 < 500 mVp-p recommended.

CAUTION To avoid damaging front-panel fiber-optic connectors, use proper connection techniques. Refer to *Cleaning the Fiber-Optic Connectors* on page 49.

NOTE The N1010A FlexDCA interface is free and can be downloaded at "*www.keysight.com/find/flexdca_download*".

N1090A

The N1090A sampling oscilloscope has one optical channel input and, if option EEC is installed, an electrical channel input. Refer to *Options* on page 21 and *Supplied Accessories* on page 25 for tables of available options and accessories.

The N1090A can perform the following tasks:

- Eye-mask mode tests and measuring eye diagram parameters including extinction ratio.
- Basic oscilloscope mode measurements of pulses (single-valued waveforms rather than eye diagrams). This is limited to patterns less than 2 ns in duration.
- You can also perform optical transmitter compliance tests at a variety of standard data rates from 1.25 to 11.3 Gb/s.

NOTE The N1090A specifications are located in FlexDCA's help system. Open FlexDCA and click **Help** > **Specifications**.

CAUTION Maximum Clock In non-destruct input voltage is 1.4Vpp. The recommended input is <500 mVp-p.

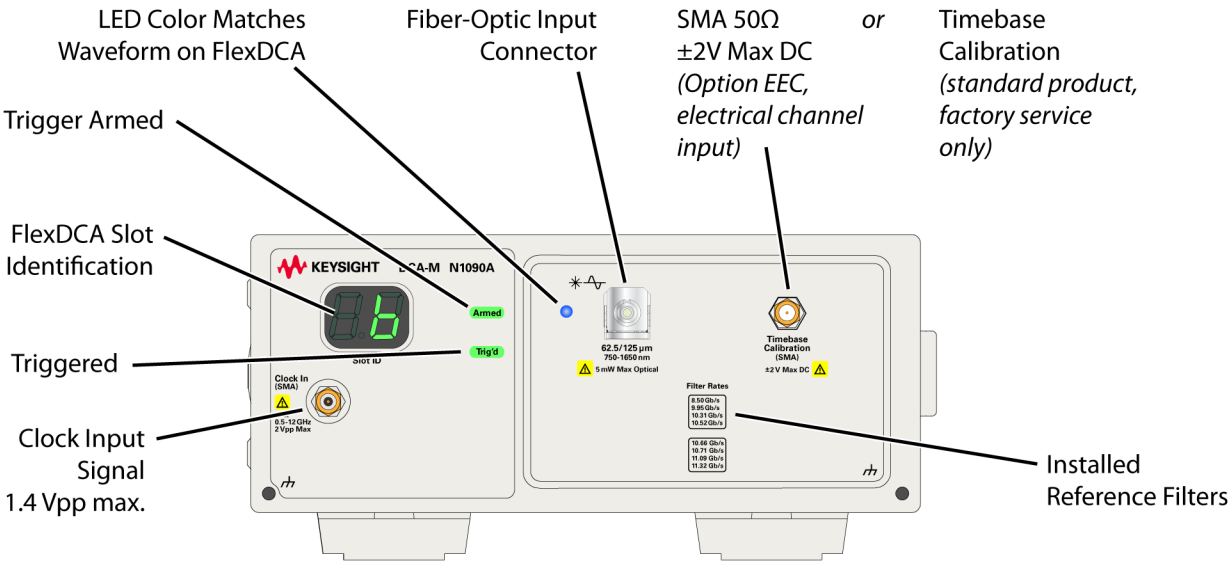


Figure 2. N1090A Front Panel

N1092A/B/C/D/E

The N1092A/B/C/D/E sampling oscilloscopes provide 1, 2, or 4 optical channels respectively. If option PLK is installed, you can lock data acquisition on a pattern trigger. Refer to *Options* on page 21 and *Supplied Accessories* on page 25 for tables of available options and accessories.

The N1092A/B/D/E can perform the following tasks:

- Eye-mask mode tests and measuring eye diagram parameters including extinction ratio.
- Basic oscilloscope mode measurements of pulses (single-valued waveforms rather than eye diagrams). This is limited to patterns less than 2 ns in duration.
- You can also perform optical transmitter compliance tests at a variety of standard data rates from 1.25 to 11.3 Gb/s.
- Use pattern lock if option N1092A/B/D-PLK is installed.

NOTE The N1092A/B/D/E specifications are located in FlexDCA's help system. Open FlexDCA and click **Help** > **Specifications**.

CAUTION Maximum Clock In non-destruct input voltage is 1.4Vpp.

N1092A Front Panel

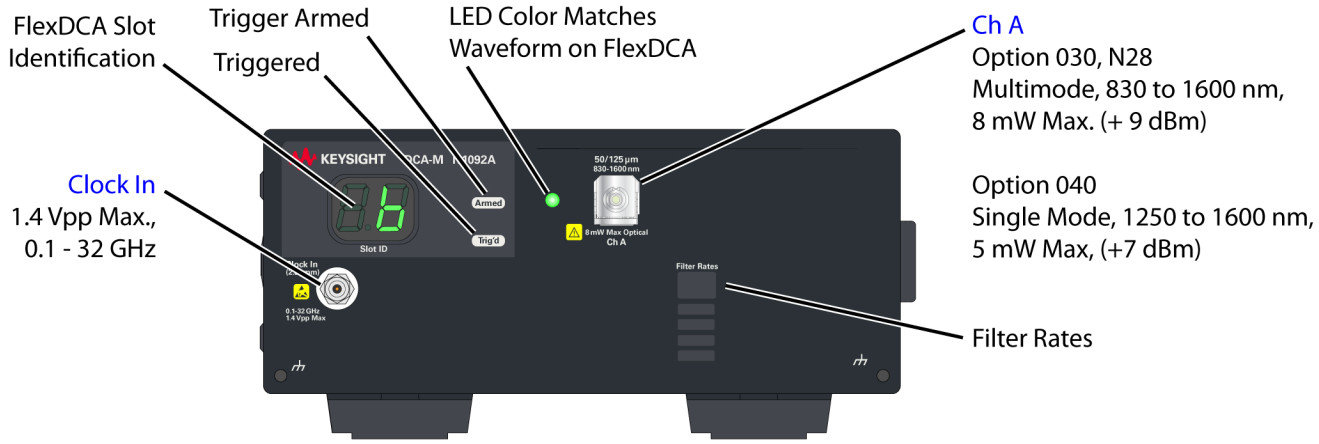


Figure 3. N1092A Front Panel

N1092A Option CDR Front Panel

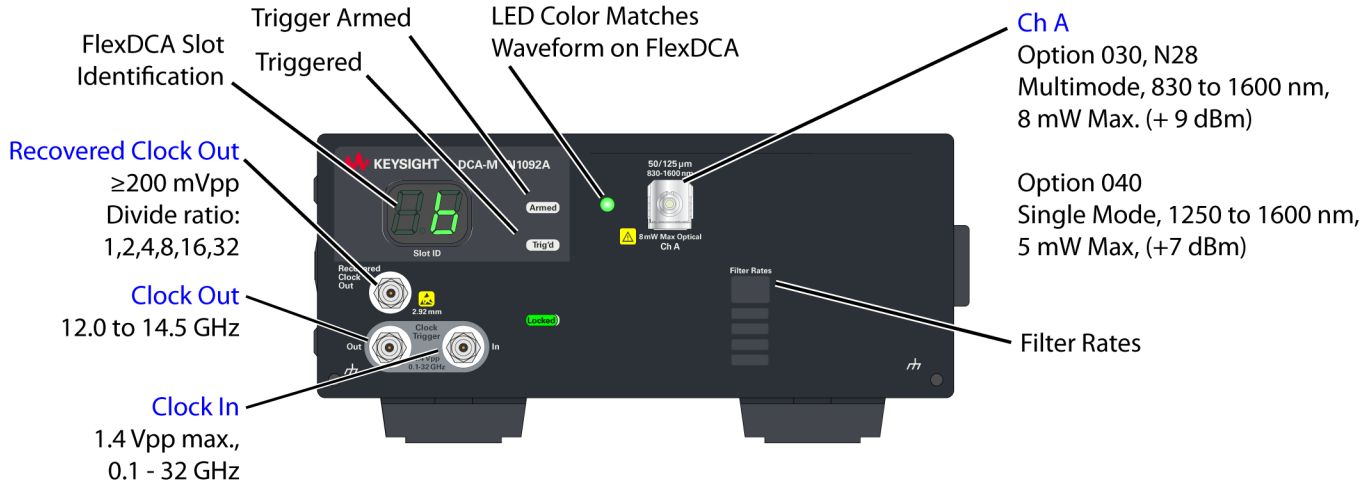


Figure 4. N1092A Option CDR Front Panel

N1092B Front Panel

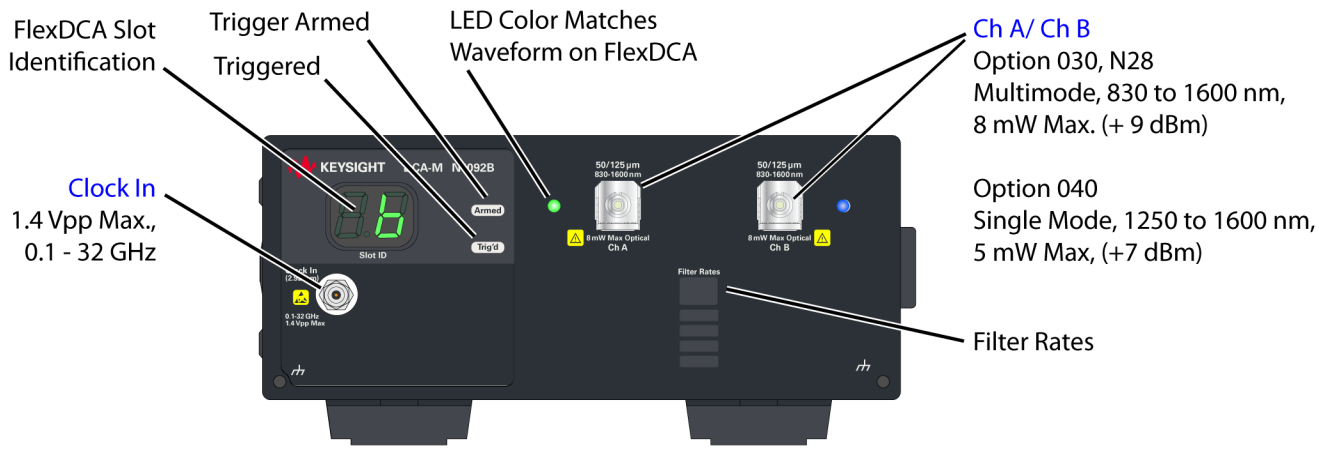


Figure 5. N1092B Front Panel

N1092B Option CDR Front Panel

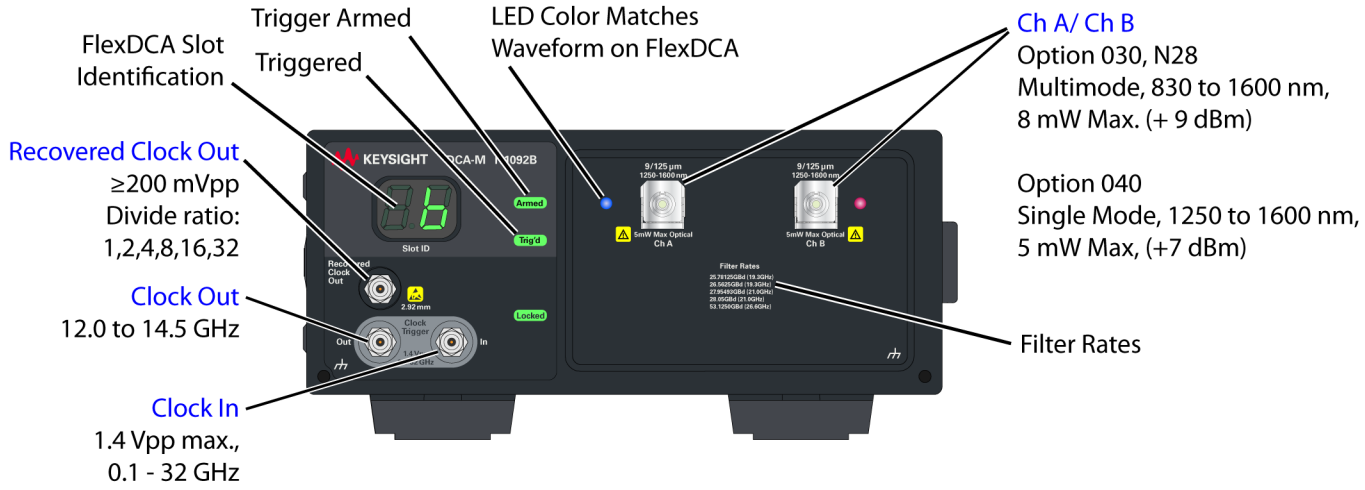


Figure 6. N1092B Option CDR Front Panel

N1092C Front Panel

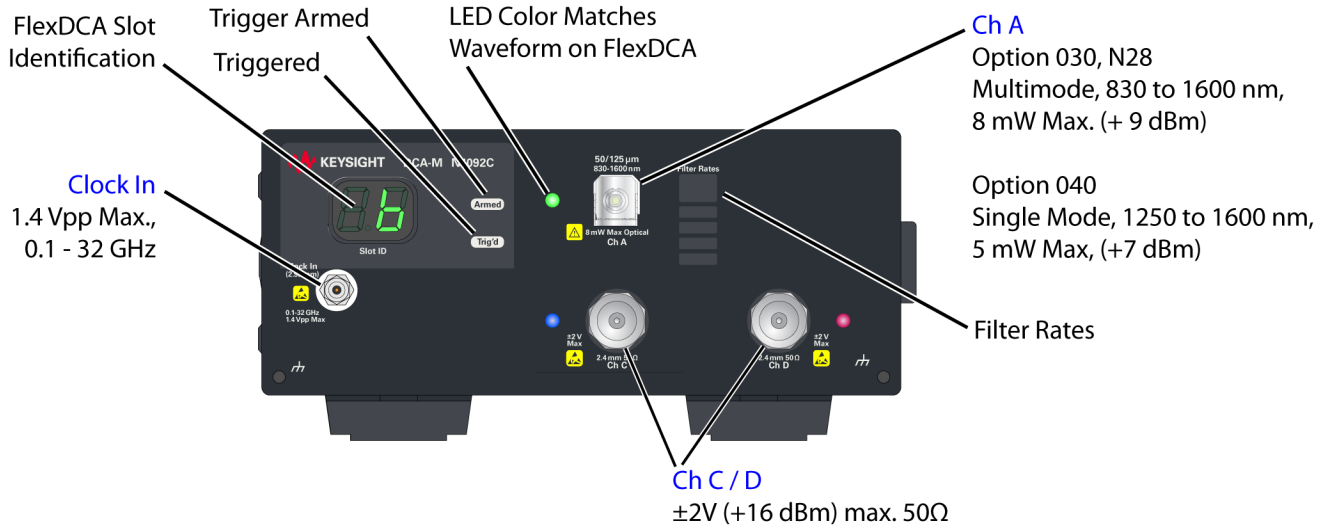


Figure 7. N1092C Front Panel

N1092D Front Panel

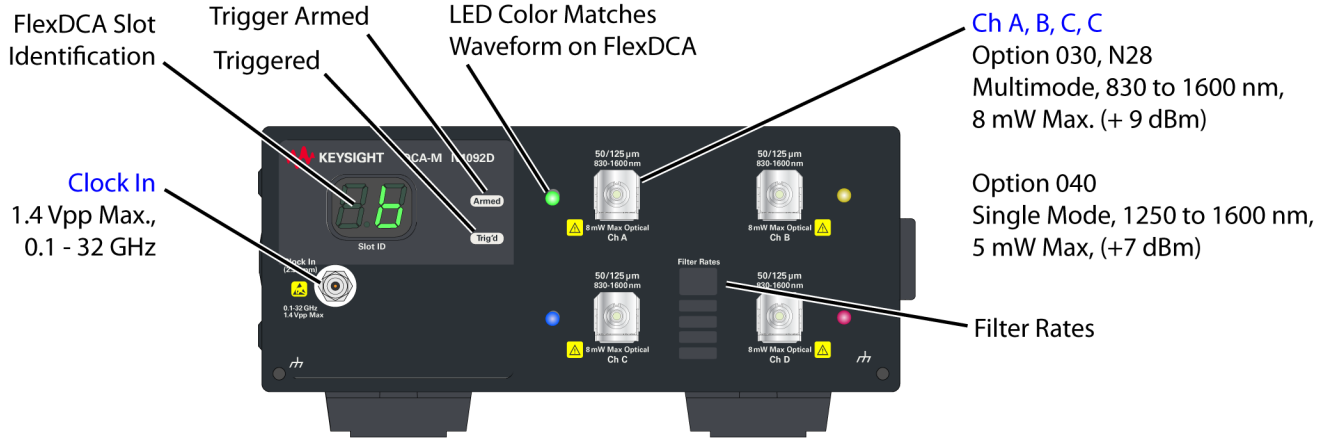


Figure 8. N1092D Front Panel

N1092E Front Panel

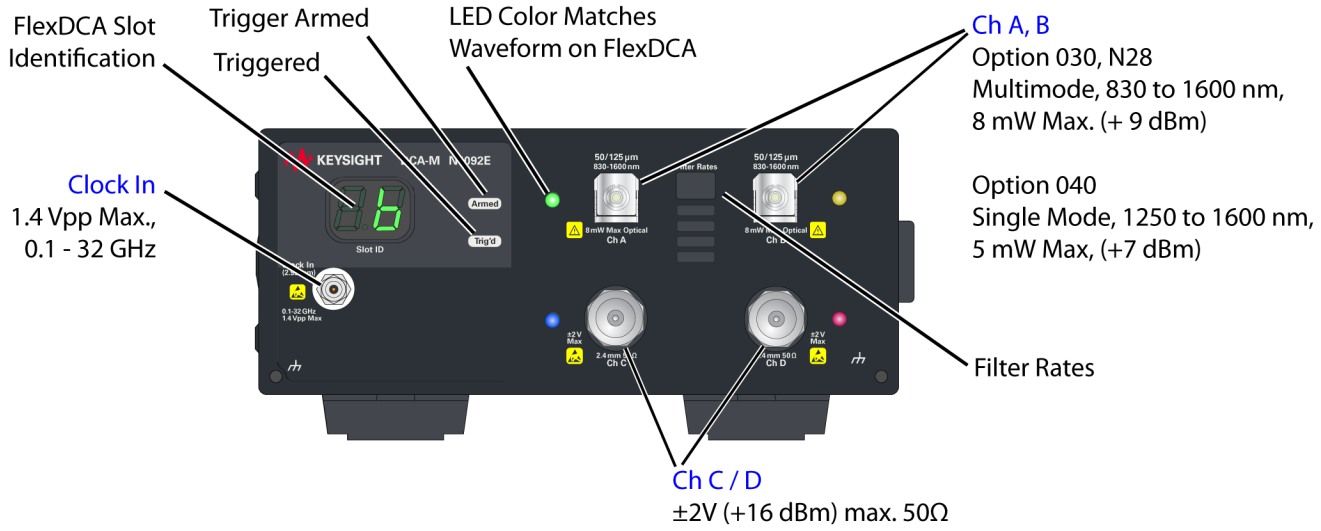


Figure 9. N1092E Front Panel

N1094A/B

The N1094A/B sampling oscilloscopes provide 2 or 4 electrical channels. If option PLK is installed, you can lock data acquisition on a pattern trigger. Refer to *Options* on page 21 and *Supplied Accessories* on page 25 for tables of available options and accessories.

The N1094A/B can perform the following tasks:

- Eye-mask mode tests and measuring eye diagram parameters including extinction ratio.
- Basic oscilloscope mode measurements of pulses (single-valued waveforms rather than eye diagrams). This is limited to patterns less than 2 ns in duration.
- You can also perform optical transmitter compliance tests at a variety of standard data rates from 1.25 to 11.3 Gb/s.
- Use pattern lock if option N1094A/B-PLK is installed.

NOTE The N1094A/B specifications are located in FlexDCA's help system. Open FlexDCA and click Help > Specifications.

CAUTION Maximum Clock In non-destruct input voltage is 1.4Vpp.

N1094A Front Panel

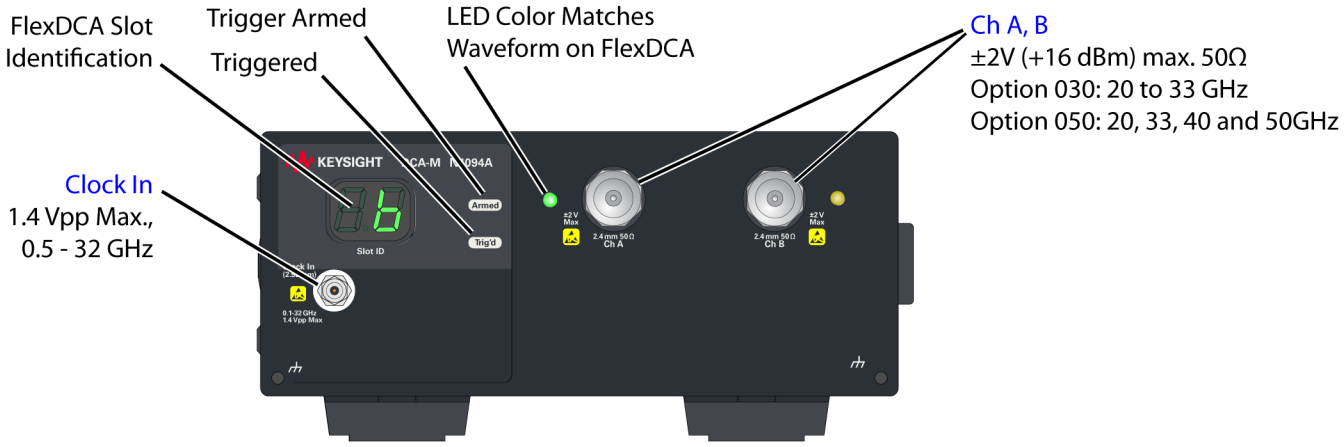


Figure 10. N1094A Front Panel

N1094B Front Panel

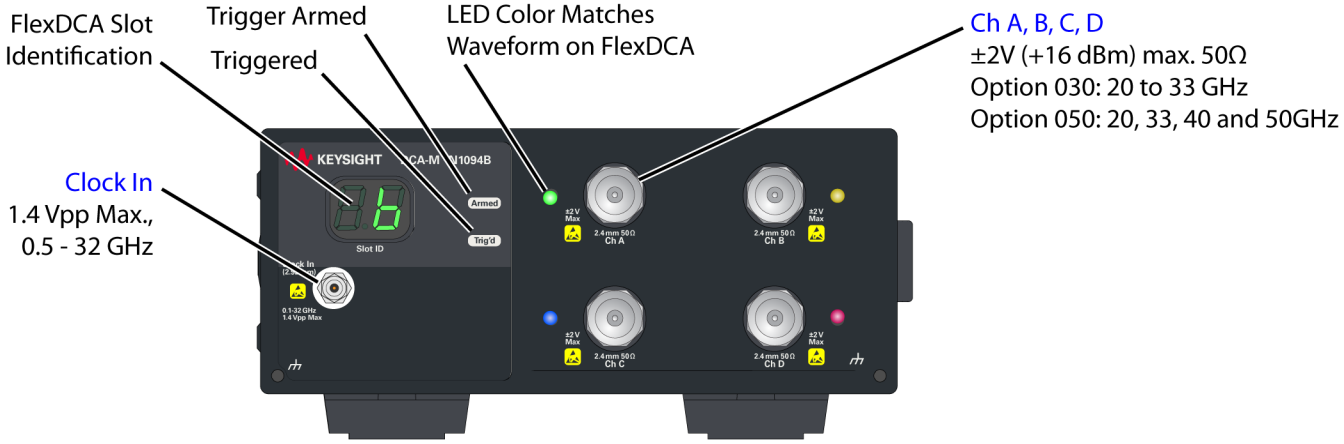
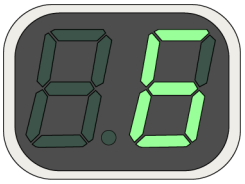


Figure 11. N1094B Front Panel

Front-Panel Indicator Lights

Table 3. DCA-M Front-Panel Indicator Lights

Indicator	Description
	Displays the FlexDCA extended module slot where the DCA-M is installed. The number indicates the slot, which in this picture would indicate slot 6 resulting in channel 6A, 6B, and so forth.
Trig'd	**Trig'd** light light color indicates the state of the DCA-M:
	Green. The DCA-M is being triggered. As with a DCA-X, this does not indicate that the trigger signal is synchronous with the channel input signal. In single acquisition, the light momentarily turns green each time **Single** is pressed.
	Red. The clock input signal is missing.
	Off. The channel is turned off or FlexDCA is in single/stop acquisition mode or the clock is missing.
Armed	Trigger armed light. This light is red if FlexDCA is in single/stop acquisition mode.
	Channel indicator light. This light is next to the fiber-optic input connector. When on, the light indicates that the associated FlexDCA channel is turned on and that the waveform is displayed. The light is the same color as the displayed waveform. The Trig'd and Armed indicators do not light unless the channel is turned on.

Rear Panel

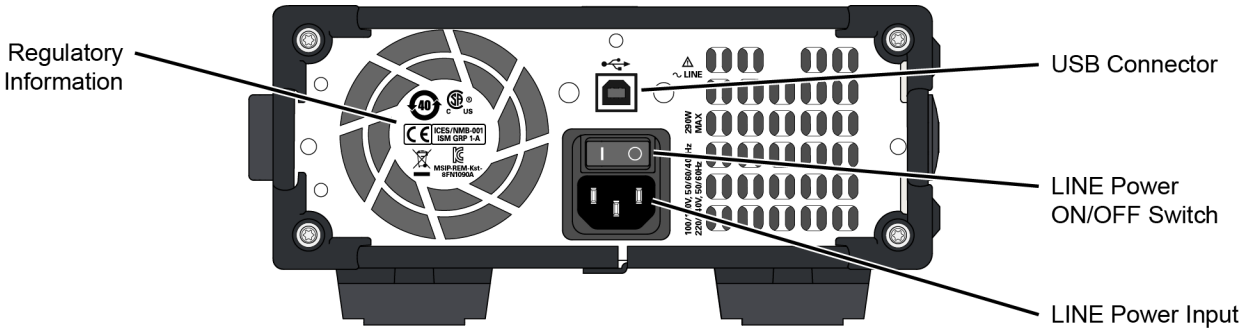


Figure 12. Rear Panel

Options

Table 4. N1090A Options

Model/option number		Description
N1090A-140		Reference receiver filters for 1.244/1.25/1.229 Gb/s
N1090A-160		Reference receiver filters for 2.458/2.488/2.5 Gb/s
N1090A-180		Reference receiver filters for 3.072/3.125 Gb/s
N1090A-200		Reference receiver filters for 8.5/9.95/10.3/10.5/10.66/10.71/11.1/11.3 Gb/s
N1090A-204		Reference receiver filters for 8.5/9.95/10.3/10.5 Gb/s
N1090A-EEC		Enable electrical channel
N1090A-PLK		Pattern lock trigger hardware
N1090A-IRC		Impulse response correction[1]
N1090A-C0C		Certificate of Calibration
N1090A-UK6		Commercial calibration certificate with test data
N1090A-1CM		Single instrument rack mount kit
N1090A-1CN		Dual instrument side-by-side rack mount kit

1 Requires option PLK.

Table 5. N1092A/B/C/D/E Options

Model/Option Number		Description
N1092A		Single optical channel oscilloscope
N1092B		Dual optical channel oscilloscope
N1092C		Single optical, dual electrical channel oscilloscope
N1092D		Quad optical channel oscilloscope
N1092E		Dual optical, dual electrical channel oscilloscope
N1092A/B-CDR		25 to 29 GBd and 53 to 58 GBd Clock data recovery
N1092x-30A		30 GHz amplified
N1092A-N28		30 GHz amplified, 280 kHz high-pass
N1092x-40A		> 40 GHz amplified (includes an unfiltered path and 53 GBd PAM4 TDECQ filter)
N1092x-280		25.781, 27.739, 27.952, 28.050 Gbaud filters (mandatory)
N1092x-LOJ		Low jitter timebase

N1092x-STB		Standard timebase
N1092x-PLK		Pattern lock capability
N1092x-FS1		Fast sampling rate
N1092x-200		Enhanced jitter analysis software, fixed perpetual license
N1092x-201		Advanced waveform analysis software, fixed perpetual license
N1092x-300		Advanced amplitude analysis/Rin/Q-Factor, fixed perpetual license
N1092x-401		Advanced eye analysis software, fixed perpetual license
N1092x-500		Productivity package, fixed perpetual license
N1092x-9FP		PAM-N analysis SW, fixed perpetual license
N1092x-TFP		IEEE TDECQ analysis, fixed perpetual license
N1092x-PLK		Pattern lock trigger hardware
N1092x-IRC		Impulse response correction
N1092x-EFP		FlexEye Independent Channel Acquisition and Control
N1092x-SIM		InfiniiSim-DCA waveform transformation SW, fixed perpetual license
N1092x-168		Additional 25.78 Gb/s TDEC filter (requires Option 500)
N1092x-206		Additional 20.625 Gb/s filter
N1092x-C0C		Certificate of Calibration
N1092x-UK6		Commercial calibration certificate with test data
N1092x-1CM		Single instrument rack mount kit
N1092x-1CN		Dual instrument side-by-side rack mount kit

Table 6. N1094A/B Options

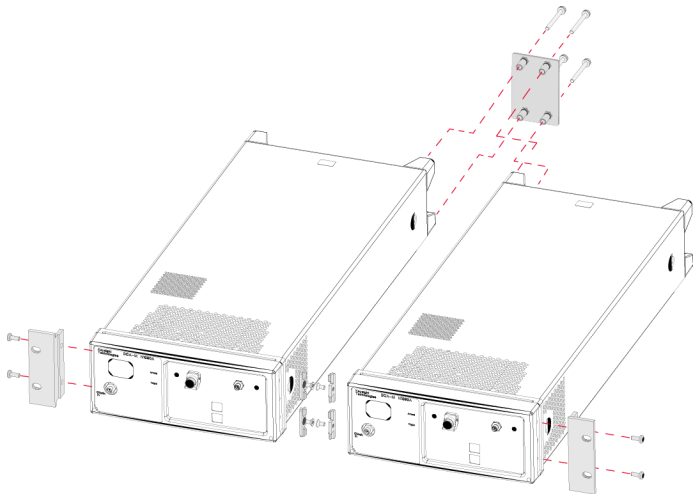
Model/Option Number		Description
N1094A		Dual electrical channel oscilloscope
N1094B		Quad electrical channel oscilloscope
N1094x-030		20 and 30 GHz bandwidth settings
N1094x-050		20, 33, 40 and 50 GHz bandwidth settings
N1094x-LOJ		Low jitter timebase
N1094x-STB		Standard timebase
N1094x-PLK		Pattern lock capability
N1094x-FS1		Fast sampling rate
N1094x-200		Enhanced jitter analysis software, fixed perpetual license [1]
N1094x-201		Advanced waveform analysis software, fixed perpetual license
N1094x-300		Advanced amplitude analysis/Rin/Q-Factor, fixed perpetual license [1]

N1094x-401		Advanced eye analysis software, fixed perpetual license
N1094x-500		Productivity package, fixed perpetual license
N1094x-9FP		PAM-N analysis software, fixed perpetual license
N1094x-TFP		IEEE TDECQ analysis, fixed perpetual license
N1094x-PLK		Pattern lock trigger hardware
N1094x-EFP		FlexEye independent channel acquisition and control
N1094x-SIM		InfiniiSim-DCA waveform transformation software, fixed perpetual license
N1094x-C0C		Certificate of calibration
N1094x-UK6		Commercial calibration certificate with test data
N1094x-1CM		Single instrument rack mount kit
N1094x-1CN		Dual instrument side-by-side rack mount kit

1 Requires option PLK.

Table 7. Available Rack Mount Options for all DCA-M Products

Option	Description
1CM	Rack-mount kit for a single DCA-M
1CN	Rack-mount kit for mounting any combination of two of the N109X-series DCA-M products.



Supplied Accessories

Table 8. Supplied Accessories

Item	Quantity					
	N1090A	N1092A	N1092B	N1092D	N1094A	N1094B
USB cable, USB-A plug to right-angle USB-B plug (3m long)	1	1	1	1	1	1
RF SMA 50-ohm cap (male)	2	1	1	1	1[1]	1[2]
FC fiber-optic dust cap	1	1	2	4		

1 3 with option 030
2 5 with option 030

Safety Information

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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.

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 N109x-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 For continued protection against fire hazard, replace fuses, and or circuit breakers only with same type and ratings. The use of other fuses, circuit breakers or materials is prohibited.

WARNING 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.

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.

N109x-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 N1090A is in compliance with CAN/CSA-C22.2 No. 61010-1 and UL Std. 61010-1 and with IEC 61010-1.

The N1092A/B/D is in compliance with CAN/CSA-C22.2 No. 61010-1 and UL Std. 61010-1 and with IEC 61010-1.

The N1094A/B 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.

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 DCA-M are documented in FlexDCA's help system.

Table 9. N1090A Environmental Specifications

Item	Description
Use	For indoor use only
Temperature	**Description**
Operating	10 °C to +40 °C (50 °F to +104 °F)
Non-operating	–40 °C to +70 °C (–40 °F to +158 °F)
Altitude	Up to 4,600 meters (15,000 ft)
Humidity [1]	Type tested at 95%, +40 °C (non-condensing)
Weight (Characteristic)	**6.20 kg (13.68 lb)**
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 10. N1090A LINE Power Specifications

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

Table 11. N1092A/B/C/D/E Environmental Specifications

Item	Description		
Use	Indoor		
Temperature	**Description**		
Operating	+10 °C to +40 °C (+50 °F to +104 °F)		
Non-operating	−40 °C to +70 °C (−40 °F to +158 °F)		
Altitude (Operating)	Up to 4,600 meters (15,000 ft)		
Humidity [1]	Type tested at 95%, +40 °C (non-condensing)		
Volts-Amperes (VA) ***(Characteristic)***	**Option 30A**	**Option 40A**	**Option CDR**
N1092A	*48 VA*	*48 VA*	*70 VA*
N1092B	*52 VA*	*50 VA*	*82 VA*
N1092C	*52 VA*	*52 VA*	—
N1092D	*60 VA*	*54 VA*	—
N1092E	*52 VA*	*54 VA*	—
Weight ***(Characteristic)***	**Option 30A**	**Option 40A**	**Option CDR**
N1092A	*6.0 kg (13.4 lb)*	*6.0 kg (13.4 lb)*	*6.8 kg (15 lb)*
N1092B	*6.1 kg (13.6 lb)*	*6.1 kg (13.6 lb)*	*6.8 kg (15 lb)*
N1092C	*6.1 kg (13.6 lb)*	*6.1 kg (13.6 lb)*	—
N1092D	*6.3 kg (14.0 lb)*	*6.3 kg (14.0 lb)*	—
N1092E	*6.1 kg (13.6 lb)*	*6.1 kg (13.6 lb)*	—
Dimensions	**Description**		
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 12. N1092A/B/C/D/E LINE Power Specifications

Item	Description
Nominal voltage and/or range	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 13. N1094A/B Environmental Specifications

Item	Description
Use	Indoor
Temperature	**Description**
Operating	+10C to +40C (+50 °F to +104 °F)
Non-operating	−40C to +70C (−40 °F to +158 °F)
Altitude (Operating)	Up to 4,600 meters (15,000 ft)
Humidity [1]	Type tested at 95%, +40 °C (non-condensing)
Volts-Amperes (VA) ***(Characteristic)***	**Description**
N1094A	*48 VA*
N1094B	*52 VA*
Weight ***(Characteristic)***	**Description**
N1094A	*6.0 kg (13.4 lb)*
N1094B	*6.1 kg (13.6 lb)*
Dimensions	**Description**
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 14. N1094A/B LINE Power Specifications

Item	Description
Nominal voltage and/or range	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 15. 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.
	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.
	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 13. 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*.

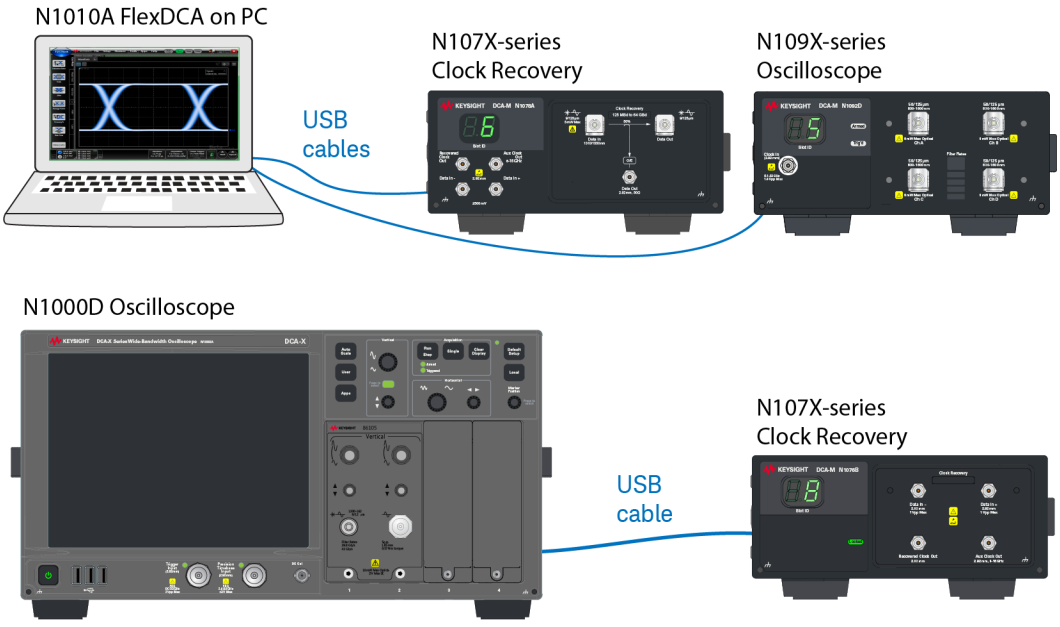


Figure 13. USB Connections for PC and N1000A

Flex-on-Flex Connection Setup

Figure 14 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.

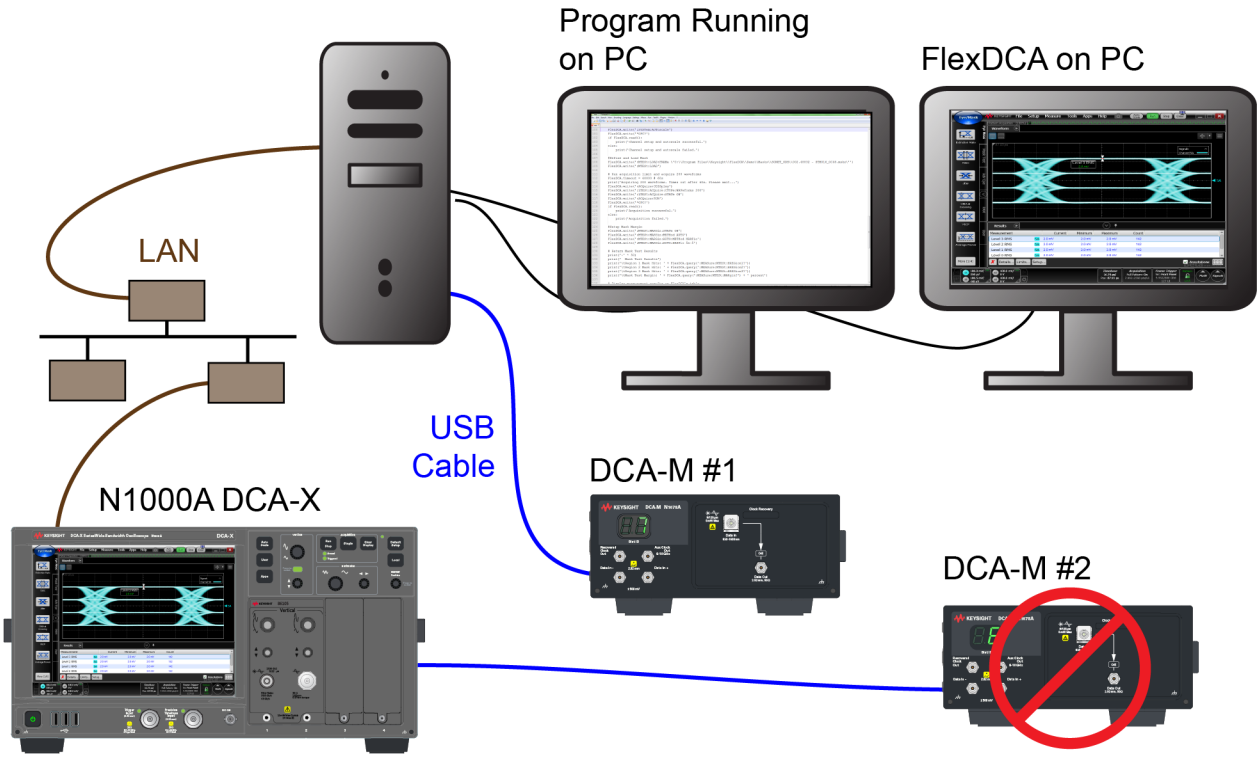


Figure 14. DCA-M #2 cannot be “seen” with a Flex-on-Flex connection

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 16. 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 17. 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 41 before performing the following installation steps.

Procedure

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

Table 18. N1090A LINE Power Specifications

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

Table 19. N1092A/B/C/D/E LINE Power Specifications

Item	Description
Nominal voltage and/or range	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 20. N1094A/B LINE Power Specifications

Item	Description
Nominal voltage and/or range	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.

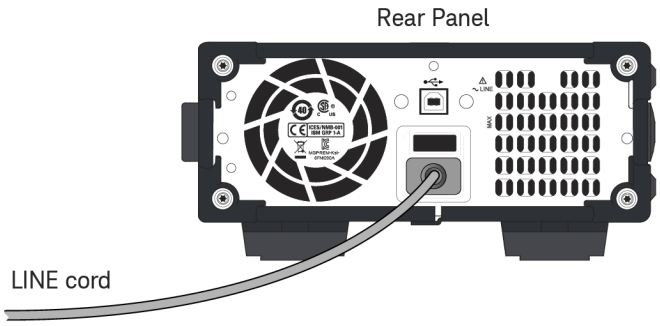


Figure 15. Connecting the LINE Cord

4. Connect the supplied USB cable to the DCA-M's rear panel as shown in *Figure 16* on page 44. 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.

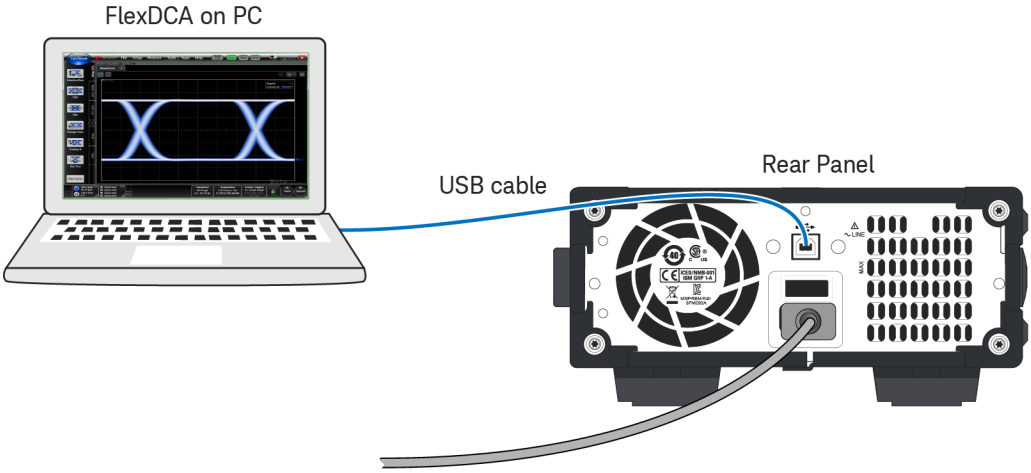
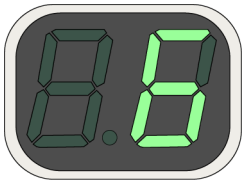


Figure 16. Connecting the USB cable

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 17* on page 45, 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 96.

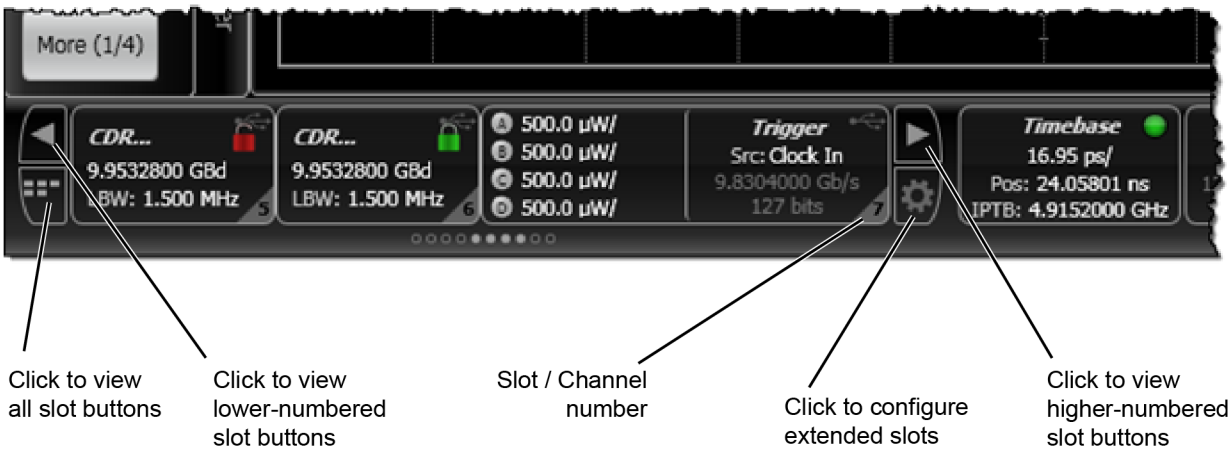


Figure 17. Slot buttons at bottom of FlexDCA application

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 18. The static-safe workstation uses two types of ESD protection:

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

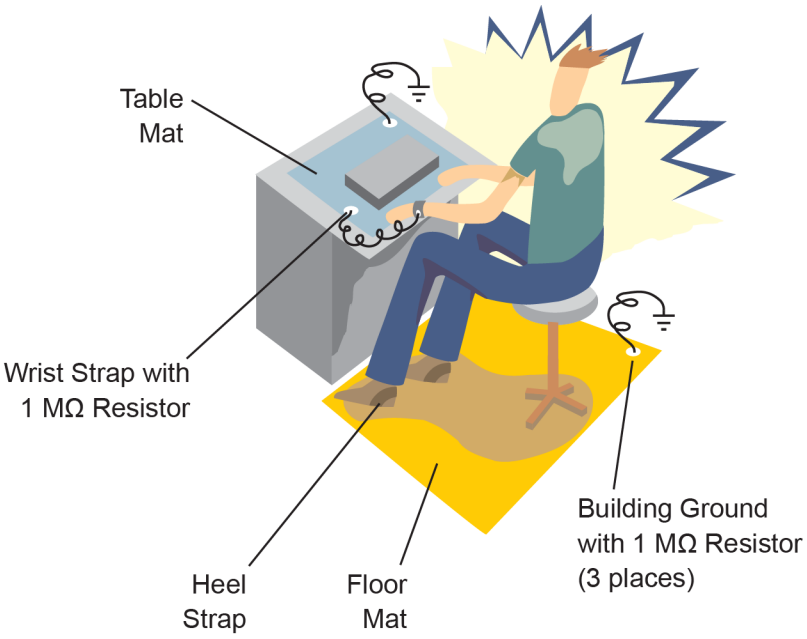


Figure 18. Example of Static-Safe Workstation

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 19. Grounding Receptacle on a DCA-M Instrument

Daily ESD Self Check

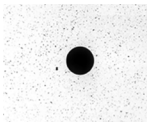
1. Visually check your work area to see that there are no static-generating materials, insulating work surfaces, or static-generating tools.
2. Clear your work area of static charge generators for a distance of at least 1 meter from ESD sensitive items.
3. Visually check that the ground wiring to the 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.

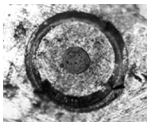
Cleaning the Fiber-Optic Connectors

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.

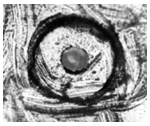
This picture shows the end of a clean, problem-free fiber-optic connector. The dark center circle is the fiber's 125 µm core and cladding which carries the light. The surrounding area is the soft nickel-silver ferrule.



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.

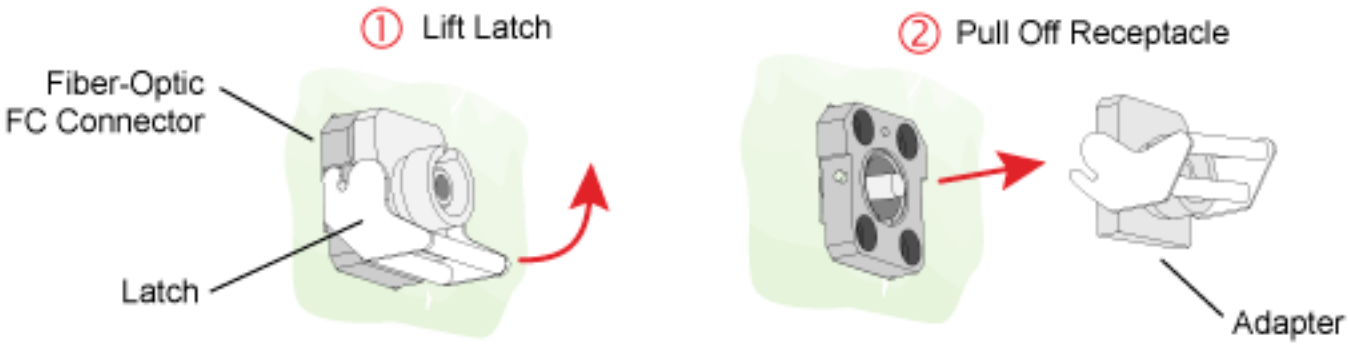


Figure 20. Removing the Receptacle to Expose the Fiber End

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 Using

A N109X-series oscilloscope is controlled using the FlexDCA user interface that is running on a PC or an DCA-X. Because, this is the DCA-X's graphical user interface, DCA-X users will be familiar with operating an N109X-series oscilloscope.

Multiple DCA-Ms can be connected to FlexDCA, but delta-time measurements between two channels cannot be compared because each DCA-M (and DCA-X if connected) uses an independent trigger.

NOTE

The N1010A FlexDCA interface is free and can be downloaded at "www.keysight.com/find/flexdca_download".

Remote programs previously developed for the DCA-X FlexDCA interface can be leveraged directly to control an N109X-series oscilloscope. Use FlexDCA's SCPI Recorder and SCPI Interactive Command Tree to simplify the writing of your code, as noted in *Chapter 4 , Programming*.

To Setup the Oscilloscope

This example shows an N1092D-series sampling oscilloscope. You can substitute any N109X-series oscilloscope. The input **Clock In** signal must be a synchronous clock or sub-rate clock. The N109X-series oscilloscope will trigger with any clock signal between 100 MHz and 32 GHz.

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 slot: 5

1. In FlexDCA, click **Setup** > **Default Setup**.
2. Connect the N109X-oscilloscope as shown in Figure 21. If connecting to a DCA-X, be sure to connect the USB cable to the DCA-X's *rear-panel* USB port.

CAUTION The maximum non-destruct amplitude of the clock input is 1.4 Vpp.

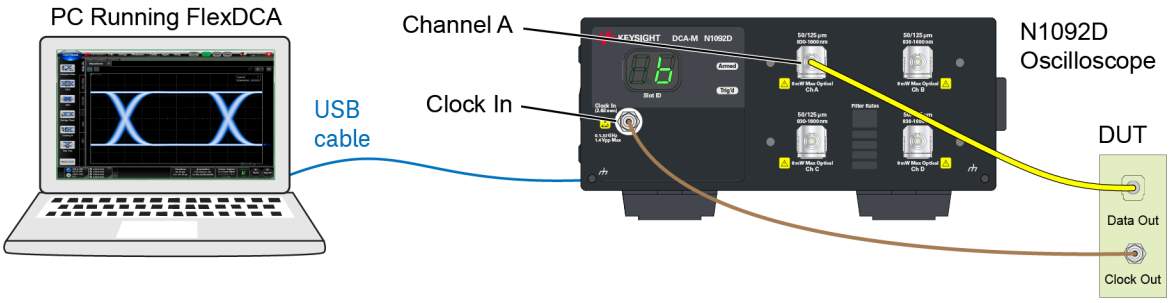


Figure 21. Typical Connection Setup

3. In FlexDCA's signals palette, turn all channels off except for channel 5A.
4. Click **Run**.
5. Click **Setup** > **Mode** > **Eye/Mask**.
6. Click **Auto Scale**.
7. 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 oscilloscope user's guide.

Configure pattern lock (optional)

The N109X-series oscilloscope must have option PLK.

8. Click **Setup** > **Trigger Setup** and select the Pattern Lock tab. In the **Data Rate** field, turn off **Auto Detect** and select 10.3125 GBd.
9. In the General Setup tab, click the **Pattern Lock** button.

To Setup the Oscilloscope with Clock Recovery

This example shows an N1077A-SMS that is connected to an N1092D-series sampling oscilloscope. You can substitute any N109X-series oscilloscope. If you are using an N1077A-SXT, you will need an external optical splitter. If you are using an N1076A, you will connect your electrical data signal to the N1076A's front-panel **Data In +** port.

The input **Clock In** signal must be a synchronous clock or sub-rate clock. The N109X-series oscilloscope will trigger with any clock signal within the range specified in the FlexDCA help system.

CAUTION The maximum non-destruct amplitude of the clock input is 1.4 Vpp.

To learn more about using the N1076/7A clock recovery DCA-M, download the N1076/7A user's guide from www.keysight.com.

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 slot: 5
- N1076/7A slot: 6

1. In FlexDCA, click **Setup** > **Default Setup**.
2. Connect the N1076/7A as shown in Figure 22. If connecting to anDCA-X, be sure to connect the USB cable to the DCA-X's *rear-panel* USB port.

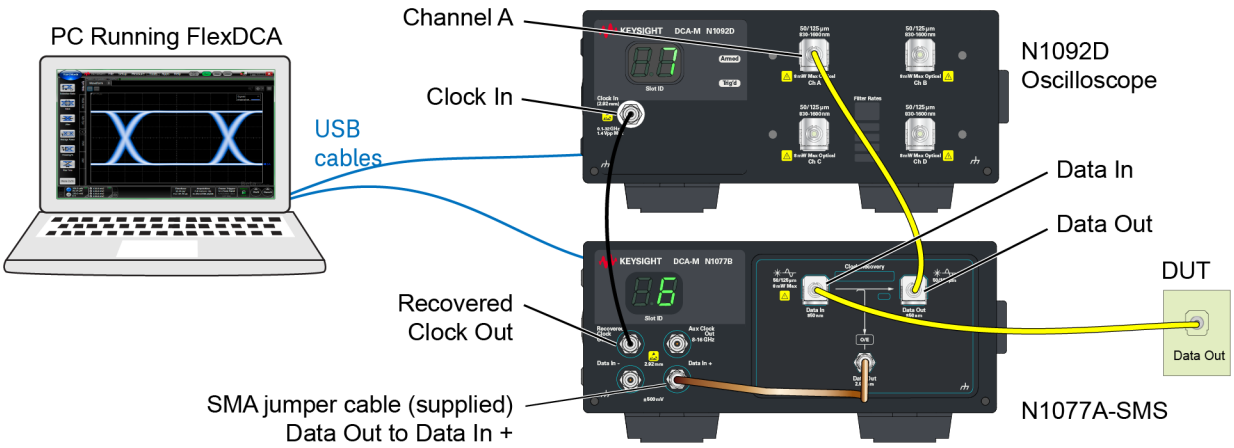


Figure 22. Typical Connection Setup

Configure clock recovery

3. In FlexDCA, click **Setup** > **Trigger Setup** and select the General Trigger Setup tab. Confirm that the trigger Source is set to **Front Panel**.
4. Click **Setup** > **Modules** > **(Slot 6): Clock Recovery**. The dialog box shown Figure 23 is displayed.
5. For the **Input Source**, select **Electrical Data +**, which is used for single-ended or optical signal.
6. In the **Data Rate** field, enter 10.3125 GBd.
7. In the **Clock Recovery** field, click the **Lock** button to lock clock recovery. The N1076/7A front-panel locked light should be green. If not, confirm the input signal's amplitude and baud rate against the values described in *Table 2* on page 8.

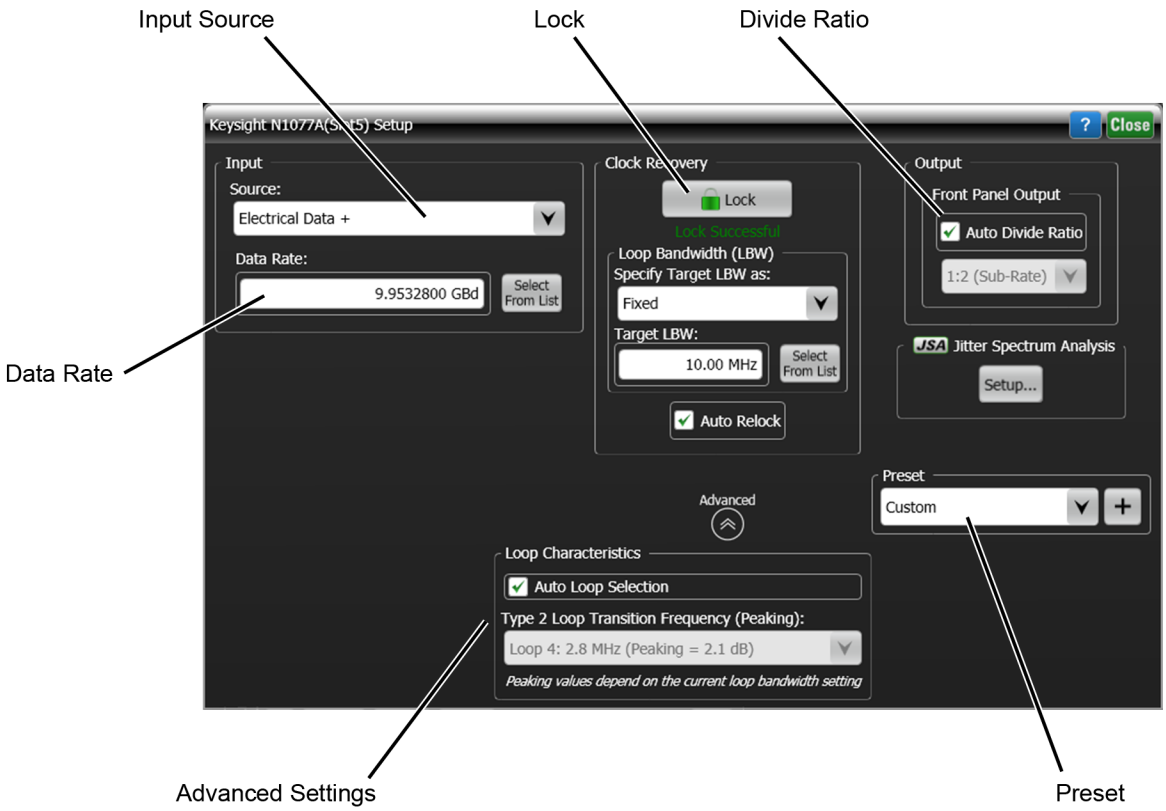


Figure 23. Clock Recovery Setup Dialog Box

Configure N109X-series oscilloscope

8. In FlexDCA's signals palette, turn all channels off except for channel 5A.
9. Click **Run**.
10. Click **Setup** > **Mode** > **Eye/Mask**.
11. Click **Auto Scale**.
12. 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 oscilloscope user's guide.

Configure pattern lock (optional)

The N109X-series oscilloscope must have option PLK.

13. Click **Setup** > **Trigger Setup** and select the Pattern Lock tab. In the **Data Rate** field, turn off **Auto Detect** and select 10.3125 GBd.
14. In the General Setup tab, click the **Pattern Lock** button.

Reference Clock

Like a DCA-X, for proper display of the input signal the input Clock In signal must be a synchronous clock or sub-rate clock. The N109X-series oscilloscope will trigger with any clock signal between 100 MHz and 32 GHz. The clock input range for the N1090A is 455 MHz to 12 GHz, and the N1092 is 500 MHz to 28.5 GHz. A timebase calibration, previously performed at service centers, can be performed by users.

Unlike an DCA-X, the trigger setting for the N109X-series can only be selected to be Front Panel or Free Run.

Table 21. N1090A Clock Input Specifications

Item	Description
Clock Input Non-destruct Voltage	1.4 Vp-p
Clock Input Frequency	455 MHz to 12 GHz (full rate or sub-rate clocks, pattern lock mode on or off)
	100 MHz to 455 MHz (sub-rate clocks only, pattern lock off, provided that the data rate exceeds 455 Mb/s and the clock divide ratio is a power of two)
Clock Input Sensitivity	200 mVp-p
Minimum Clock Slew Rate	0.5 V/ns
Nominal Input Impedance	50 Ω (AC coupled)
Clock Input Connector	2.92 mm (female)

Table 22. N1092A/B/C/D/E Clock Input Specifications

Item	Description
Clock Input Non-destruct Voltage	1.4 Vp-p
Clock Input Frequency	500 MHz to 32 GHz (full rate or sub-rate clocks, pattern lock mode on or off)
	100 MHz to 500 MHz (sub-rate clocks only, pattern lock off, provided that the data rate exceeds 500 Mb/s and the clock divide ratio is a power of two)
Clock Input Sensitivity	200 mVp-p
Minimum Clock Slew Rate	0.5 V/ns
Nominal Input Impedance	50 Ω (AC coupled)

Clock Input Connector	2.92 mm (female)

Table 23. N1094A/B Clock Input Specifications

Item	Description
Clock Input Non-destruct Voltage	1.4 Vp-p
Clock Input Frequency	500 MHz to 32 GHz (full rate or sub-rate clocks, pattern lock mode on or off)
	100 MHz to 500 MHz (sub-rate clocks only, pattern lock off, provided that the data rate exceeds 500 Mb/s and the clock divide ratio is a power of two)
Clock Input Sensitivity	200 mVp-p
Minimum Clock Slew Rate	0.5 V/ns
Nominal Input Impedance	50 Ω (AC coupled)
Clock Input Connector	2.92 mm (female)

Pattern Lock

On N1092-series and N1094-series oscilloscopes, option PLK adds pattern lock capability. The following measurement features require pattern lock:

- Option 200 (Advanced Jitter Analysis)
- Option 201 (Advanced Waveform Analysis)
- Option 300 (Advanced Amplitude Analysis/RIN)
- Option SIM (InfiniiSim-DCA Waveform Transformation Toolset).

Reference Filters

The rates of all installed reference filters are listed on the front panel. These rates correspond to internal, calibrated reference filters that are selected as an instrument option at the time of order. These reference filters allow for optical transmitter compliance testing at the listed filter rates. The available options cover a variety of standard data rates from 1.25 to 11.3 Gb/s as shown in *1* on page 5.

Aligning Waveforms

Because a DCA-M's acquisition system is independent of the DCA-X, if you are using multiple DCA-Ms or a DCA-M with DCA-X receiver modules, the input waveforms may not align after an Auto Scale.

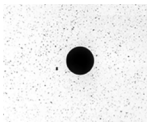
The waveforms will align If option 500, Productivity Package Software, is installed on the DCA-X or DCA-M and Rapid Eye is turned on. Rapid Eye is enabled from the Acquisition Setup dialog box's Waveform tab.

If option 500 is not installed, you can manually add software delay to channels to align them. To align the eyes, open the channel's Setup dialog box, click Advanced, and enter the Software Delay.

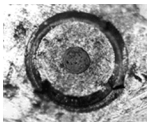
Cleaning the Fiber-Optic Connectors

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.

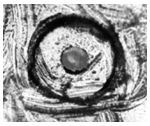
This picture shows the end of a clean, problem-free fiber-optic connector. The dark center circle is the fiber's 125 µm core and cladding which carries the light. The surrounding area is the soft nickel-silver ferrule.



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.

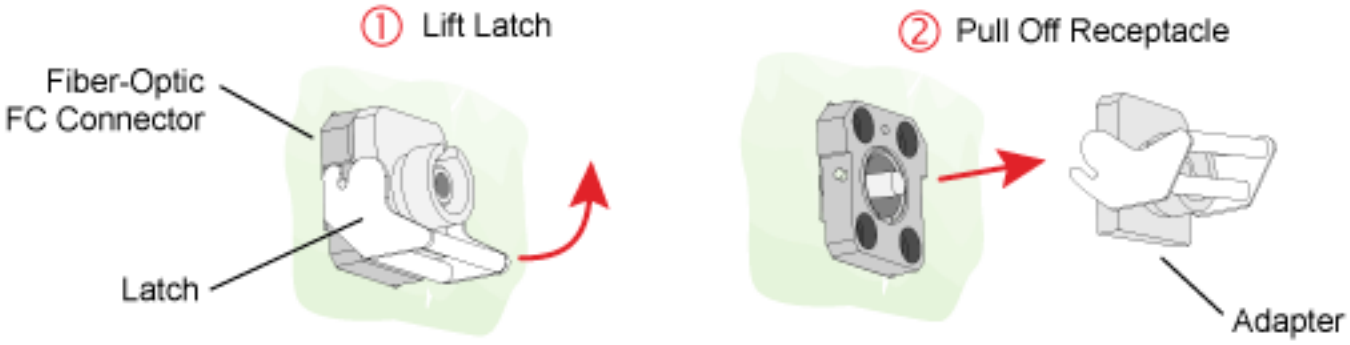


Figure 24. Removing the Receptacle to Expose the Fiber End

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.

4 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 25* on page 68 and *Figure 26* on page 68 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 75).
- Interactive SCPI Command Tree (on page 78).
- Programming topics in FlexDCA's help system.
- Example scripts found in FlexDCA's help system.

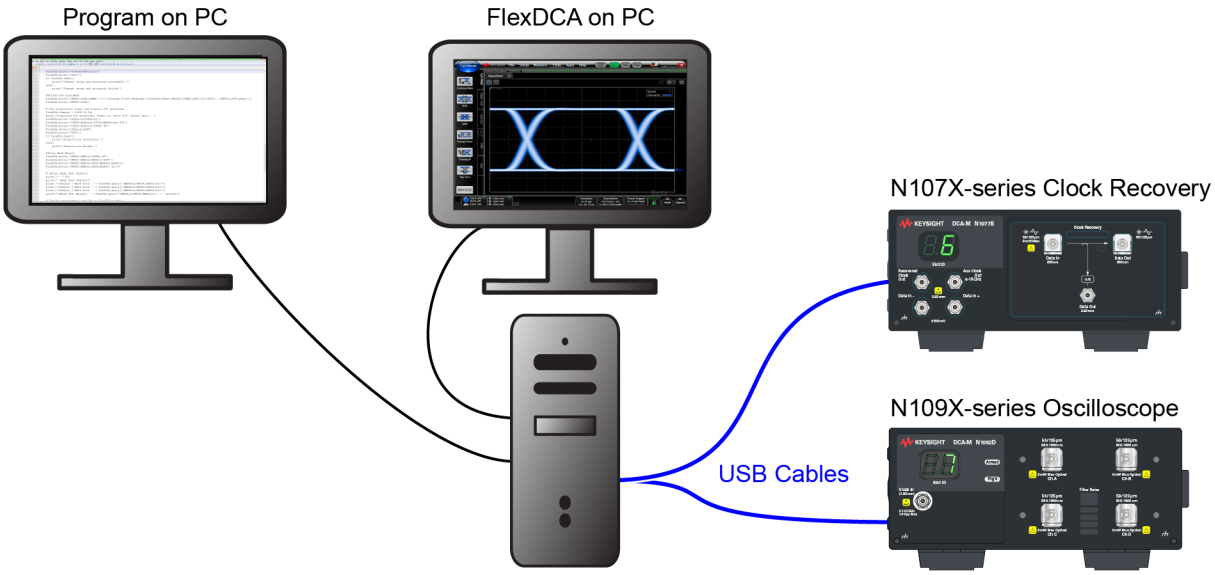


Figure 25. Controlling DCA-Ms from a PC

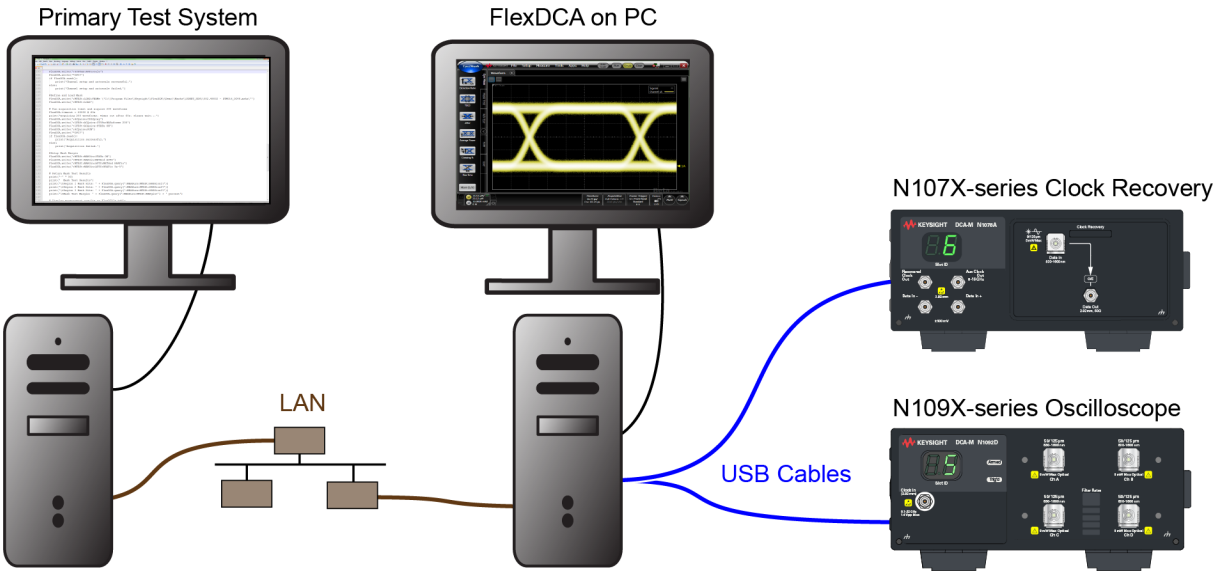


Figure 26. Controlling DCA-Ms from a Remote PC

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 24. :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 25.

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 25. :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
```

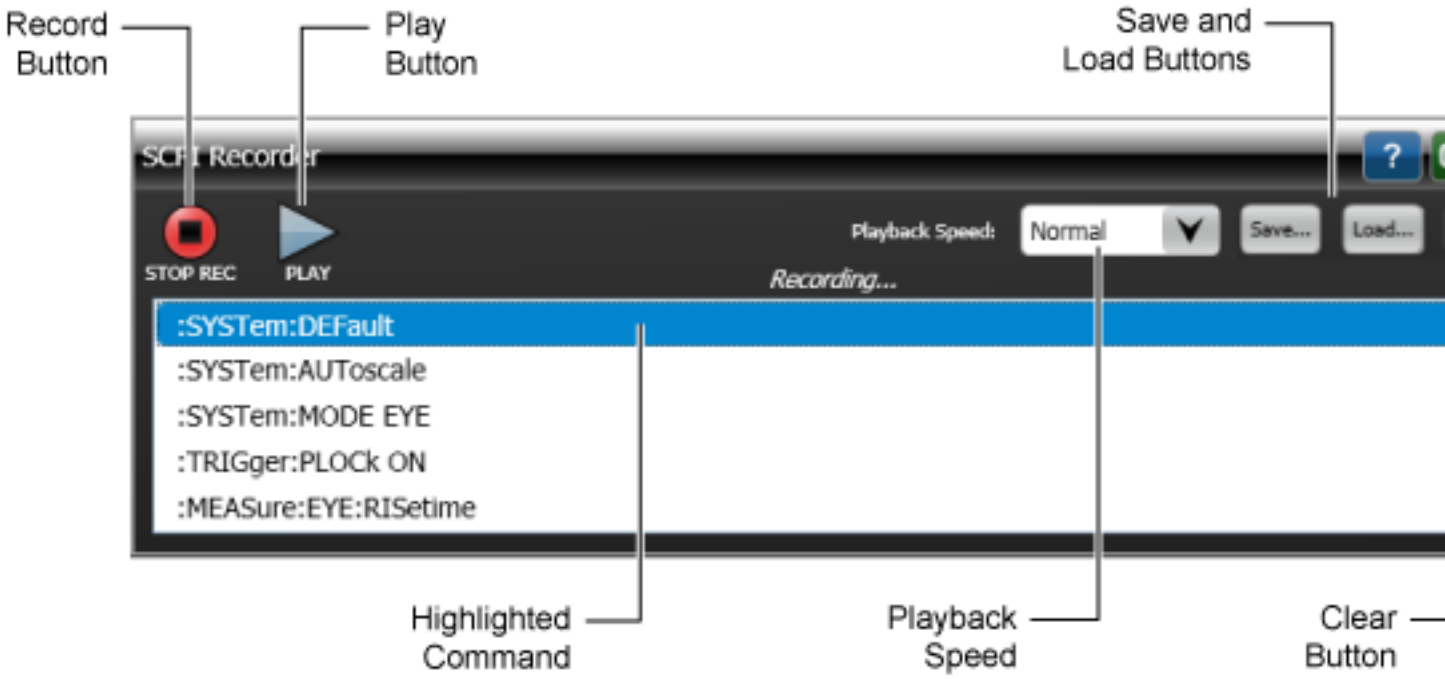
Reference filters are low-pass filters and the highest rate filter is essentially the same bandwidth as not having a filter installed.

Using the SCPI Recorder

FlexDCA's 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. To open the SCPI recorder in FlexDCA, click Tools > SCPI ProgrammingTools > SCPI Recorder.

When you've recorded your commands, you can copy them to the Windows clipboard, play them back, or save them as a macro. Click REC and the recorder performs the following tasks:

1. Captures most FlexDCA 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 box.



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.

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 box 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 if you use a command that locks the remote interface until 100 failed samples are detected, which could take a very long time.

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

Click **Clear** to delete your recorded commands from the dialog box.

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

```
: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 You can use the Windows clipboard to copy your recorded commands. Click on a command to select it. Shift click to select a range of commands. Ctrl click to select non-adjacent commands. Ctrl-A selects all commands. Ctrl-C copies all selected commands. In another application, use Ctrl-V to paste the commands. You can also right-click and then click Copy.

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

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.

Using the Interactive SCPI Command Tree

FlexDCA's SCPI Remote Command Tree Viewer lists all SCPI command subsystems and their commands. You can quickly traverse the tree and test the interaction between any command and FlexDCA.

To open the SCPI recorder in FlexDCA, click **Tools** > **SCPI Programming Tools** > **Interactive SCPI Command Tree**.

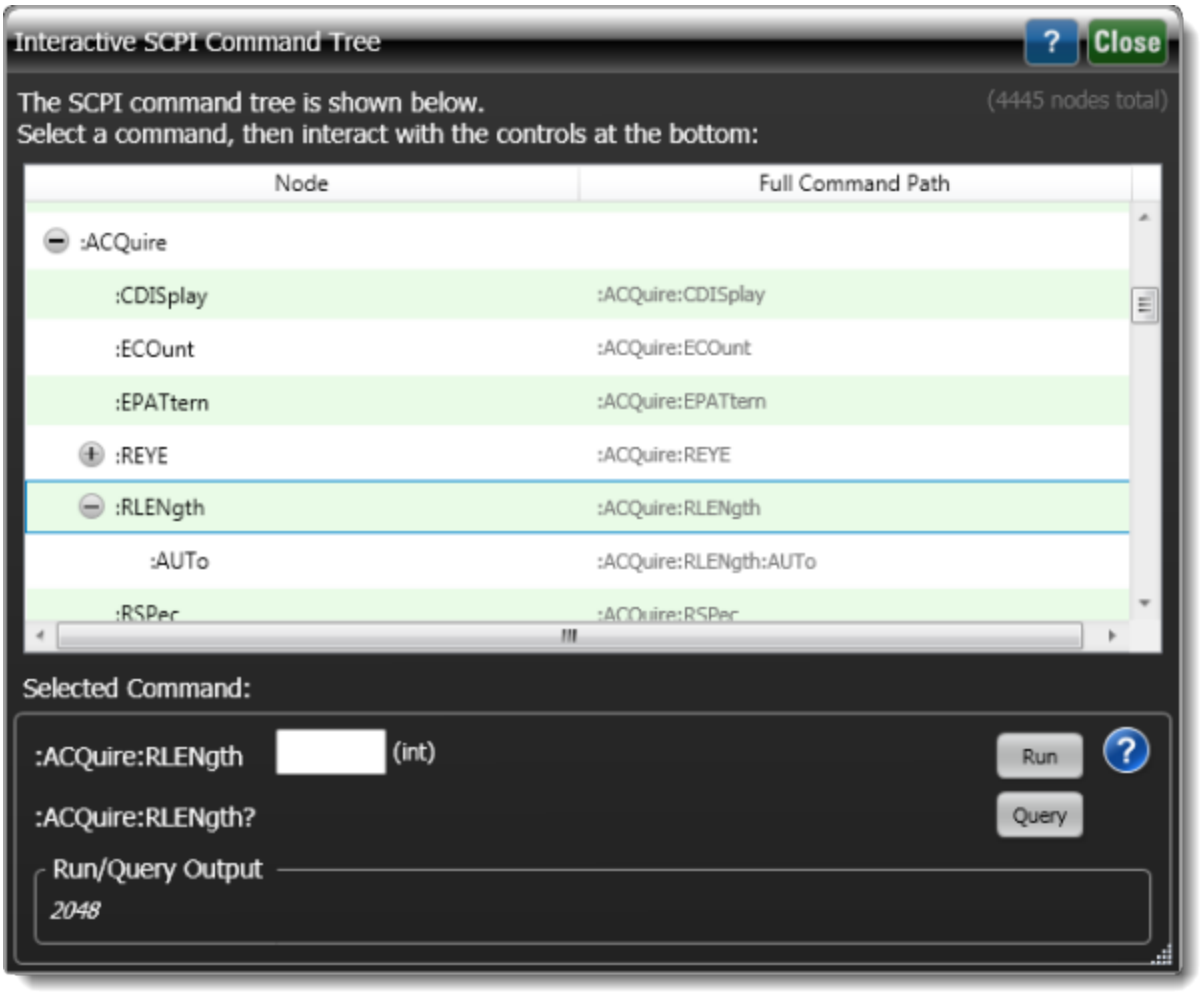
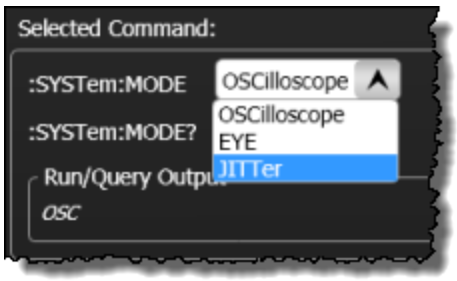


Figure 27. Interactive SCPI Command Tree

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

To learn about a command or subsystem, scroll down the command tree to locate the commands that interest you, such as the `:SYSTem` subsystem. Click on the expand button to view the available commands. You can also expand an entry by double clicking on the row.

This picture shows the `:SYSTem:MODE` command. Notice that the drop-down list provides all of the available arguments for the command. You can make a selection, and click Run to execute the command. Click Query to display the current value in the Run/Query Output field. Some commands, like `:ACQuire:RLENgth` shown in the above figure, take an integer (int) or real (double) value.



FlexDCA Configurations

This section describes the four basic setup configurations for controlling FlexDCA via the LAN as illustrated in *Figure 28* on page 81. 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 *To Install Python 3.5* on page 90.

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.

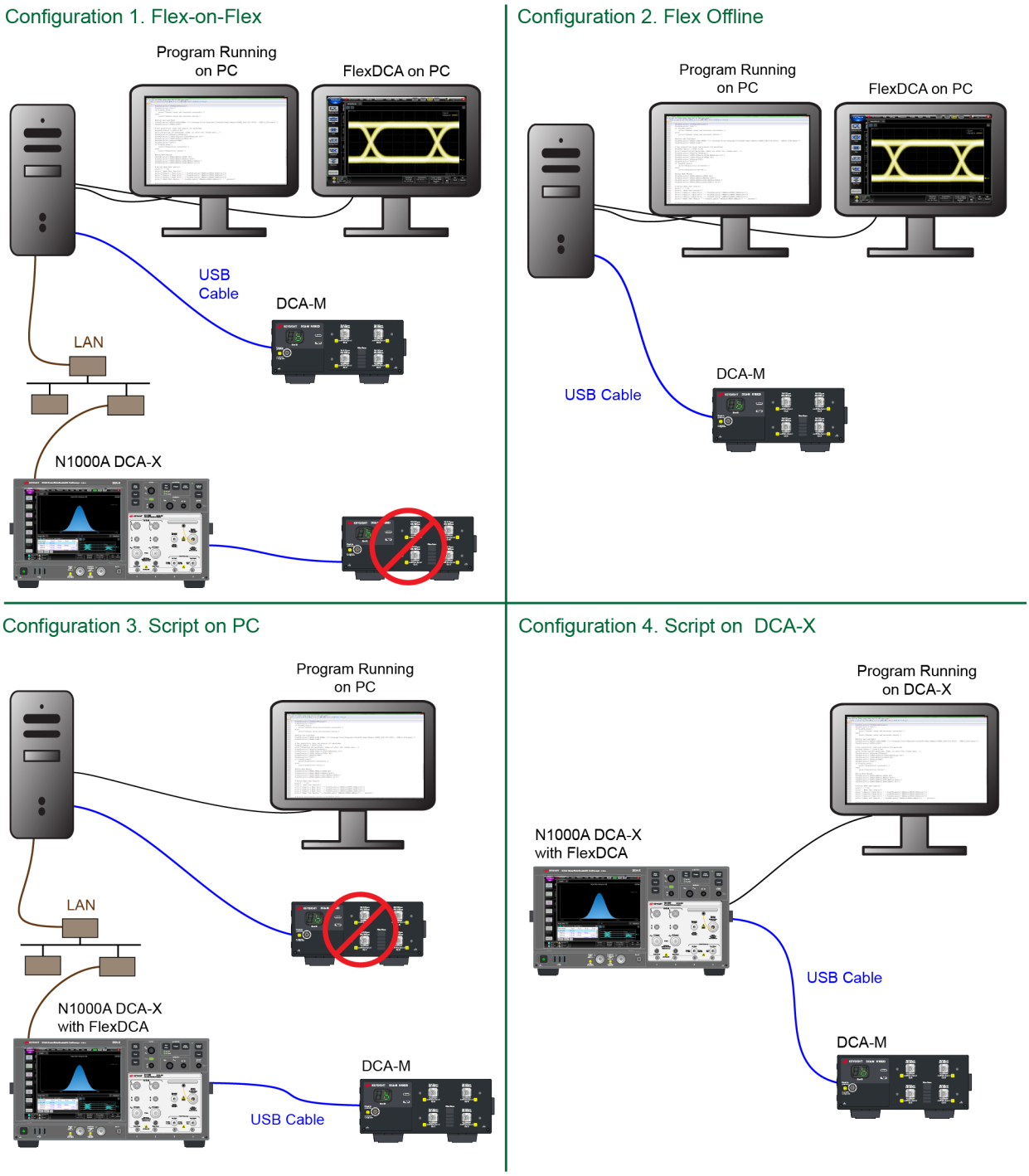


Figure 28. The Four Configurations

Configuration 1. Flex-on-Flex

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

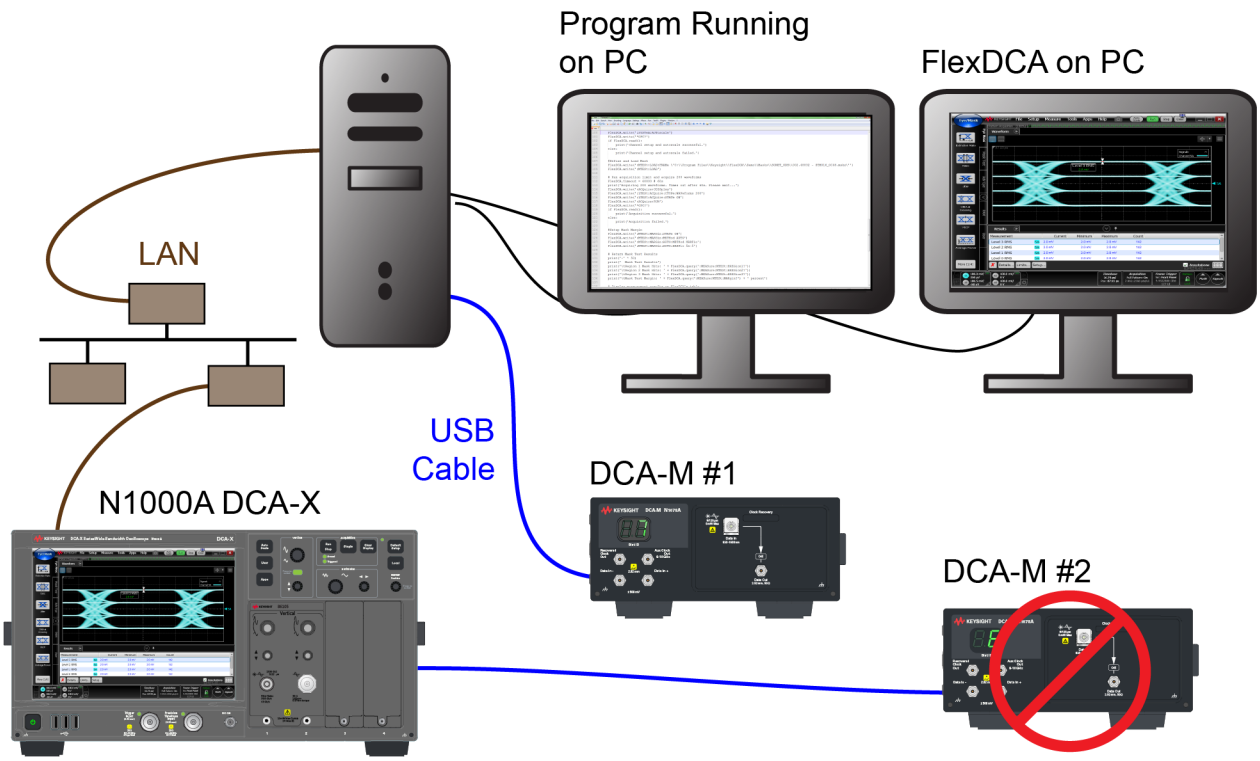


Figure 29. Flex-on-Flex Setup

Configuration 1, Flex-on-Flex on page 83 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

```
import visa # import VISA library
rm = visa.ResourceManager() # Create an instance of PyVISA's
ResourceManager
print('\n\tConnecting to FlexDCA on PC. Please wait...')
flex=rm.open_resource('TCPIP0::localhost::hislip0,4880::INSTR
')
flex.timeout=20000 # wait up to 20s for response from FlexDCA
flex.read_termination = '\n'
s = flex.query('*IDN?')
print('\tFlexDCA connection established to:\n\t' + s) # Identify
FlexDCA
print('\n\tConnecting FlexDCA to 86100D. Please wait...')
flex.write(':RDCA:CONNect:METhod LAN')
flex.write(':RDCA:CONNect:MODE STANdard')
flex.write(':RDCA:CONNect:ACTion TBSettings')
flex.write(':RDCA:CONNect:TSETtings ON') # Pull state upon connect
flex.write(':RDCA:DISConnect:TSETtings ON') # Push state upon dis-
connect
flex.write(':RDCA:CONNect:HOST K-86100D-20108')
flex.query(':RDCA:CONNect;*OPC?')
s = flex.query('*IDN?')
print('\tFlexDCA connection established to:\n\t' + s) # Identify
FlexDCA
flex.query(':RDCA:DISConnect;*OPC?')
print('\n\tFlexDCA on 86100D is disconnected.')
flex.write(':SYSTem:GTLocal')
flex.close()
print('\tFlexDCA on PC is disconnected.')
```

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.

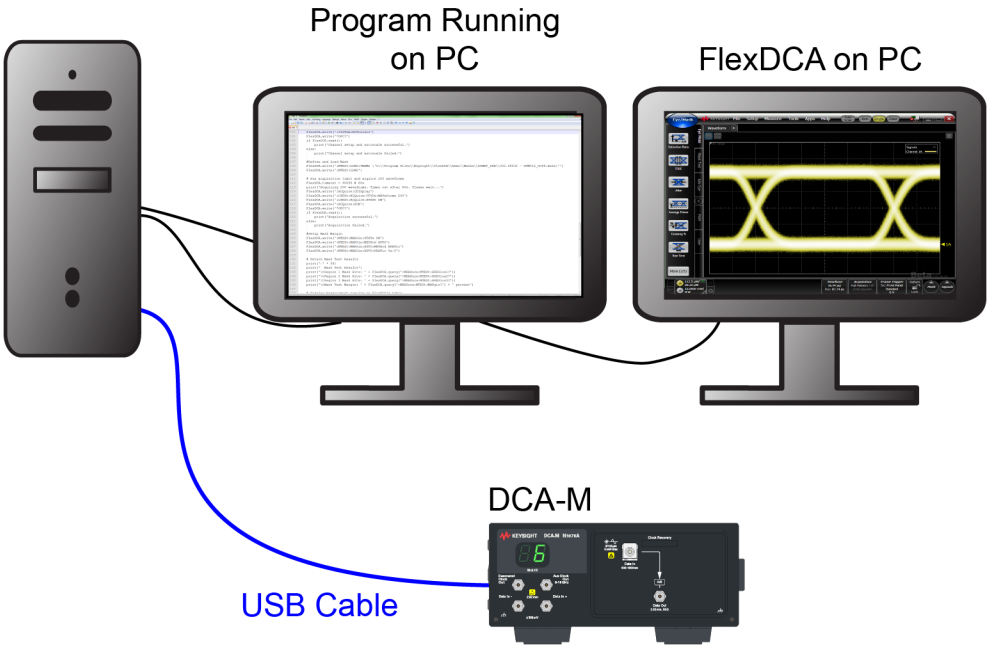


Figure 30. FlexDCA Offline Setup

Configuration 2, FlexDCA Offline on page 84 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('TCPIP0::localhost::hislip0,4880::INSTR')
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 31 shows that a DCA-M can be connected to the N1000A.

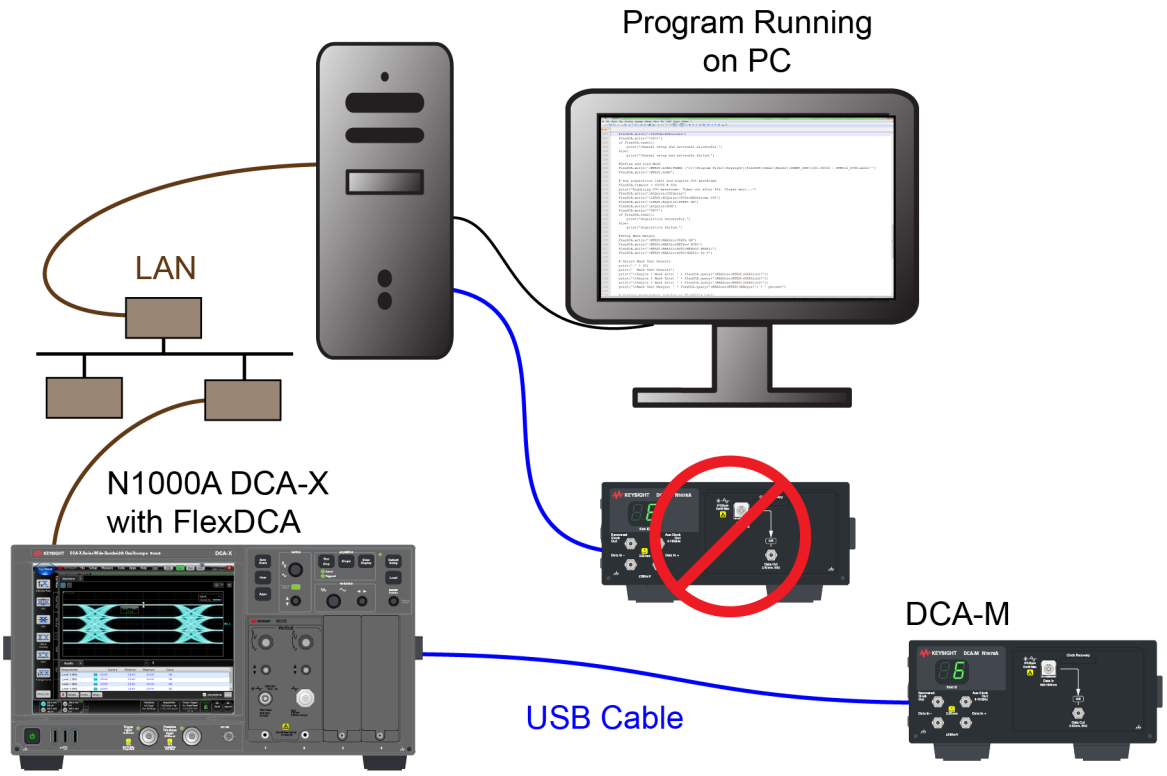


Figure 31. Script on PC Setup

Configuration 3, Script on PC on page 87 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

```
import visa # import VISA library
rm = visa.ResourceManager() # Create an instance of PyVISA's
ResourceManager
flex=rm.open_resource('TCPIP0::K-86100D-20108::hislip0,4880::INSTR')
flex.read_termination = '\n'
s = flex.query('*IDN?')
print('\n\tConnection established to:\n\t' + s) # Identify FlexDCA
flex.write(':SYSTem:GTLocal')
flex.close()
print('\tConnection closed.')
```

Configuration 4. Script on DCA-X

In this setup, the script runs on the N1000A (or 86100D). *Configuration 4, Script on DCA-X* on page 88 establishes a connection between the script on the DCA-X and FlexDCA. The VISA address is shown in red in the following listing.

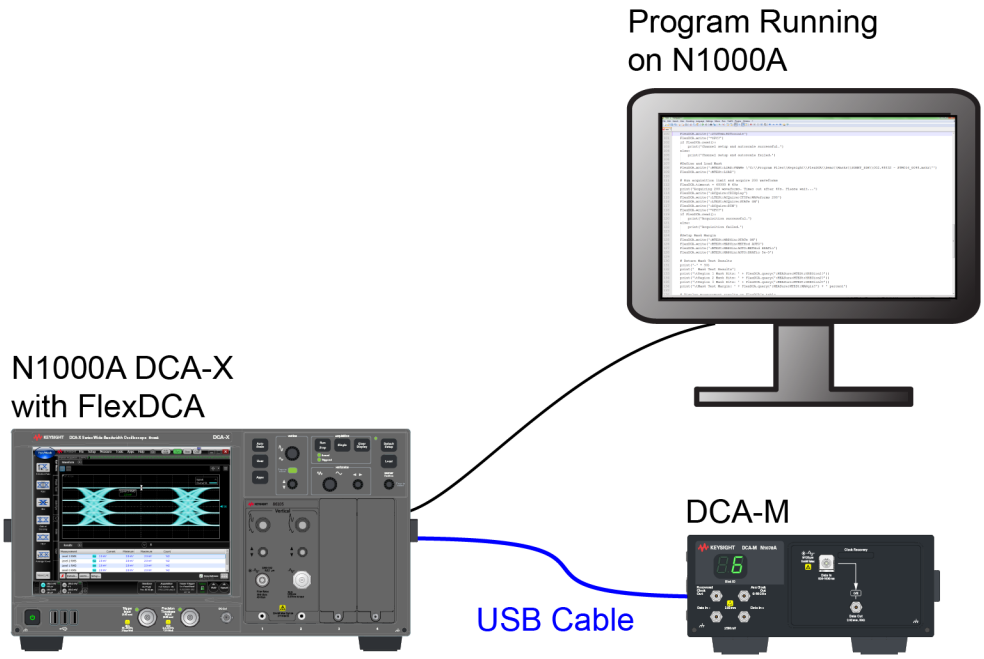


Figure 32. Script on DCA-X Setup

Configuration 4, Script on DCA-X

```
import visa # import VISA library
rm = visa.ResourceManager() # Create an instance of PyVISA's
ResourceManager
flex=rm.open_resource('TCPIP0::localhost::hislip0,4880::INSTR')
flex.read_termination = '\n'
s = flex.query('*IDN?')
print('\n\tConnection established to:\n\t' + s) # Identify FlexDCA
flex.write(':SYSTem:GTLocal')
flex.close()
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.

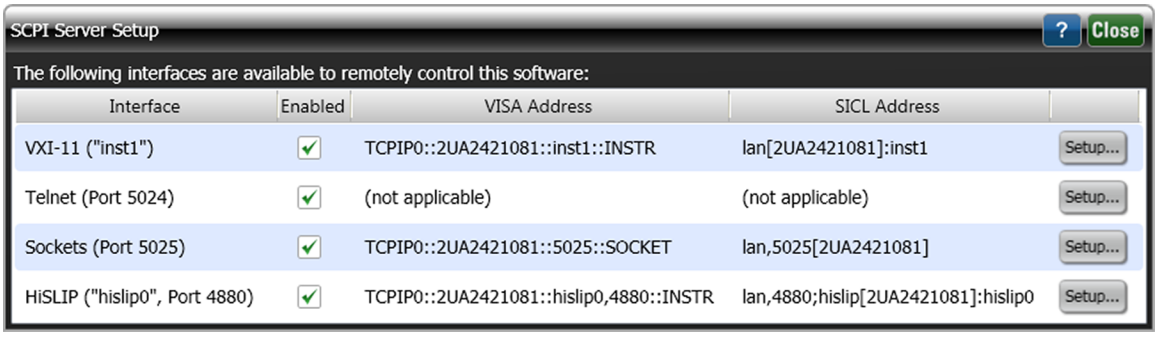


Figure 33. SCPI Server Setup dialog

2. From the dialog box, 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 **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.

To Install Python 3.5

Anaconda automatically installs the code for both Python 3.x. The example Python scripts in this book are relatively simple, so you should be able to convert them to 2.x is you prefer to work in Python 2.x.

1. Install Keysight IO Libraries Suite. Download the suite from *http://www.keysight.com/find/iosuite*.
2. Go to https://www.anaconda.com/distribution/ and download and install the current Python 3 Anaconda distribution.
3. Open Windows Command Prompt. To locate Command Prompt, search for cmd on the Start menu.
4. In Windows Command Prompt, enter the following commands to confirm the installation and to install PyVISA for Python 3.5.

```
cd c:\
conda info
pip install pyvisa
```

5. In Windows Start menu, locate the Anaconda 3 folder and start the Spyder IDE application.

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 94 moves an existing N109X-series oscilloscope from slot 5 to slot 8. The script in *DCA_M_reorder.py* on page 95 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 97, 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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