

# Keysight N778-C Series Polarization Instruments

N7781C Polarization Analyzer  
N7785C Synchronous Scrambler  
N7786C Polarization Synthesizer  
N7788C Optical Component Analyzer

User's Guide

# Notices

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## Safety Notices

### CAUTION

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

### WARNING









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

## Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements. Product manuals are provided on the Web. Go to [www.keysight.com](http://www.keysight.com) and type in your product number in the Search field at the top of the page.


General	<p>This product is a Protection Class 1 instrument (provided with a protective earth terminal) and has been manufactured and tested according to international safety standards. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.</p> <p>All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1:2014.</p>
Environment Conditions	<p>This instrument is intended for indoor use in an Overvoltage Category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 85% RH, non-condensing and at altitudes of up to 2000 meters. Refer to the specifications tables for the AC mains voltage requirements and ambient operating temperature range.</p>
Temperature	<p>The instrument should be protected from temperature extremes and changes in temperature that may cause condensation within it.</p> <p>The operating temperature is from 5 °C to +40 °C.</p> <p>The storage temperature is from -40 °C to +70 °C.</p>
Before Applying Power	<p>Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.</p>
Ground the Instrument	<p>To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the AC power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.</p>
Do Not Operate in an Explosive Atmosphere	<p>Do not operate the instrument in the presence of flammable gases or fumes.</p>
Do Not Remove the Instrument Cover	<p>Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel.</p> <p>Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.</p>

## Instrument Markings

Instrument Marking	Description
	<p>The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.</p>
	<p>Standby supply. Unit is not completely disconnected from AC mains when switch is off.</p>
	<p>The CE mark is a registered trademark of the European Community.</p>
	<p>The CSA mark with the 'c' and 'us' subscript indicates the instrument is certified to the applicable Canadian and United States of America standards respectively.</p>
	<p>The RCM mark is a registered trademark of the Australian Communications and Media Authority</p>
	<p>This symbol is a South Korean Class A EMC Declaration, with the product identification code "R-R-Kst-3E18526".  R - Identification of authorization prefix.  R - Identification of basic certification information.  Kst - Identification of applicant's information  3E18526 - Product identification.  This is a Class A instrument suitable for professional use and in electromagnetic environment outside of the home.</p>
	<p>The recycling symbol indicates the general ease with which the instrument can be recycled.</p>
	<p>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.</p>

## Compliance and Environmental Information

**Table 1 Compliance and Environmental Information**

Safety Symbol	Description
	<p>This product complies with WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.</p> <p>Product Category: With reference to the equipment types in WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.</p> <p>Do not dispose in domestic household waste.</p> <p>To return unwanted products, contact your local Keysight office, or see <a href="http://about.keysight.com/en/companyinfo/environment/takeback.shtml">http://about.keysight.com/en/companyinfo/environment/takeback.shtml</a> for more information.</p>

## Declaration of Conformity

Declarations of Conformity for this product and for the Keysight products may be downloaded from the Web. Go to <http://www.keysight.com/go/conformity>.

You can then search by product number to find the latest Declaration of Conformity.



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# 1

# General Operating Considerations

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## Overview

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

### **WARNING**

Ensure the proper usage for the instrument. The protection provided by the instrument may be impaired. The operator of this instrument is advised to use the equipment in a manner as specified in this document

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## General

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

Some circuits are powered whenever the instrument is connected to the AC power source. To disconnect from the line power, disconnect the power cord either at the rear power inlet or at the AC line power source (receptacle). One of these must always be accessible. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

### **WARNING**

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

---

### **WARNING**

Please pay attention to the following laser safety warning:

Under no circumstances look into the end of an optical cable attached to the optical output when the instrument is operational. The laser radiation can seriously damage your eyesight. Do not enable the laser when there is no fiber attached to the optical output connector. Refer servicing only to qualified and authorized personnel.

---

## Operating Environment

### Overview

In order for the instrument to meet specifications, the operating environment must be within these limits. Refer to [Safety Summary](#) on page 3.

### WARNING

The instrument is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the instrument to rain or other excessive moisture.

### Instrument Cooling

The instrument has a cooling fan mounted internally.

Mount or position your instrument upright and horizontally, as shown in the following figure so that air can circulate through it freely.

### Operating Position

When operating the instrument choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance may result in excessive internal temperature, reducing instrument reliability. The instrument should not be operated when resting on its rear or side panels.

Figure 1 shows the correct operating position of Keysight N7785C.

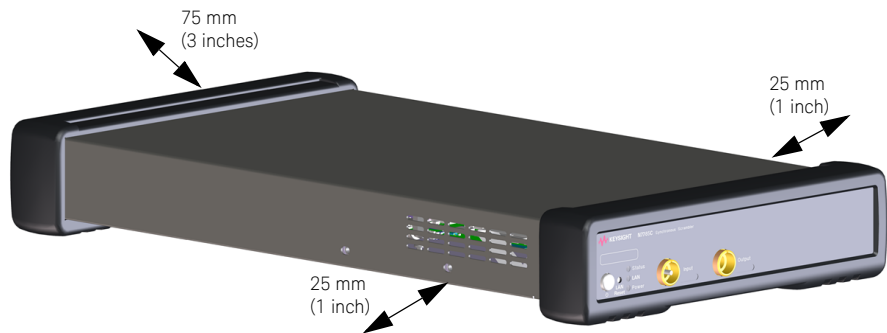


Figure 1 Operating Position of the Instrument

## Handling the Instrument

### Storage, Carrying and Shipment

Keysight N7781/85/86/88C polarization instruments can be stored, carried and shipped at temperatures between  $-40\text{ }^{\circ}\text{C}$  and  $+70\text{ }^{\circ}\text{C}$ .

The N7781/85/86/88C polarization instruments must be stored, carried in its operating position, as shown in [Figure 1](#).

### Rack Mount the Instrument

You can mount the instrument in a standard 19-inch rack cabinet using an optional kit which includes instructions and mounting hardware.

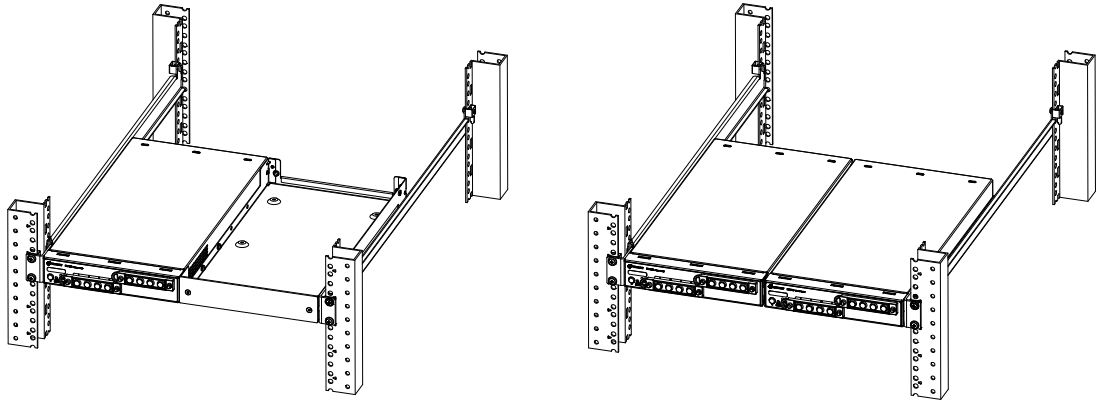
#### NOTE

**Remove the front and rear rubber bumpers, before mounting the instrument in a rack.**

Depending on whether one or two N77xxC instruments are to be mounted, different mounting kits are required:

- N7799C-1CM Rack Mount Kit 1 HU for 2 instruments - Includes low-profile rails. Requires Filler Kit N7799C-0CM for single device (See [Figure 2](#)).
- N7799C-0CM Filler Kit for N7799C-1CM - Required for single instrument. Includes front panel and base plate.





A. Single Instrument Mounted on a Rack

B. Two Instruments Mounted on a Rack

Figure 2 Instrument(s) Mounted on a Rack



# 2 Getting Started

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## Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Keysight Technologies Sales/Service Office.

### **WARNING**

**You MUST return malfunctioning instruments to a Keysight Technologies Sales/Service Center for repair and calibration.**

---

## Claims and Repackaging

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Keysight Technologies Sales/Service Office. The Keysight Technologies Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

## Return Shipments to Keysight Technologies

If the instrument is to be shipped to an Keysight Technologies Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be reusable, but the Keysight Technologies Sales/Service Office will provide information and recommendations on materials to be used if the original packing is no longer available or reusable. General instructions for repackaging are as follows:

- Wrap instrument in heavy paper or plastic.
- Use strong shipping container. A double wall carton made of 350-pound test material is adequate.
- Use enough shock absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.

- Seal shipping container securely.
- Mark shipping container FRAGILE to encourage careful handling.
- In any correspondence, refer to the instrument by model number and serial number.

## Deleting User Data

If you need to delete all your logged data and user configurations, press and hold the **LAN Reset** button (approx. 5 seconds) to reset the instrument and all your logged data and user configurations will be deleted.

## Power Supply Requirements

### Line Power Requirements

#### Line Power Requirements

The instrument complies with Overvoltage Category II and can operate from the single-phase AC power source that supplies between 100 V and 240 V at a frequency in the range 50/60 Hz. The maximum voltage fluctuation is 10% of the nominal supply voltage. The maximum power consumption is 60 VA with all options installed.

#### Line Power Cable

In accordance with international safety standards, the instrument has a three-wire power cable. When connected to an appropriate AC power receptacle, this cable earths the instrument cabinet.

#### CAUTION

Please note that the switch on the front panel of the instrument does not stop the flow of power to the instrument.

If you need to turn off the power, unplug the instrument at the mains or remove the power cable connector from the appliance coupler at the rear of the instrument. For this reason, the power cable connection should be easily accessible - allowing you to turn off the power quickly. If the instrument is in a cabinet, it must be disconnected from the line power by the system's line power switch.

The power switch allows you to switch between stand-by mode and power-on mode.



Figure 3 Power LED on the Front Panel of the Instrument

When the instrument is in stand-by mode, the Power LED is orange. When the instrument is powered-on, the Power LED is green.

The AC power requirements are summarized on the rear panel of the instrument.



Figure 4 AC Power Requirement Markings

## N778-C Series Polarization Instruments

The Keysight N778-C polarization test products enable high-speed, high performance characterization and verification of optical components and sub-systems.

### N7781C Polarization Analyzer

The Keysight N7781C is a compact high-speed polarization analyzer that provides comprehensive capabilities for analyzing polarization properties of optical signals. This includes representation of the state of polarization (SOP) on the Poincaré sphere (Stokes parameter). The on-board algorithms together with the on-board calibration data ensure highly accurate operation across a broad wavelength range.

Due to its real time measurement capability of 1 M samples/s, the instrument is well suited for analyzing disturbed and fluctuating signals as well as for control applications requiring real time feedback of polarization information, for example in digital control loops in automated manufacturing test systems.

The built-in user interface allows a comprehensive analysis of the obtained measurement data and replaces the Polarization Navigator software that was required with the N7781B, the predecessor of N7781C. Programming uses a new SCPI command set and the instrument is addressed as a VISA resource.

The instrument comes in a compact form factor of just one rack height unit, with LAN and USB interfaces.

For further details on its application and key features, refer to the product datasheet available on [www.keysight.com](http://www.keysight.com).

### N7785C Synchronous Scrambler

The Keysight Technologies N7785C is a high-speed synchronous scrambler that can repeatably switch through a series of states of polarization (SOP) with both input and output triggering functions. This unit can operate in various modes:

- As a synchronous scrambler, the device switches the SOP of the output signal in a random but repeatable pattern. Switching of the SOP occurs within a few microseconds. The SOP is stable for a predefined time until it again switches to a new SOP. An electrical trigger input can be used to synchronize the scrambler with external events.



- As an SOP switch, the N7785C allows switching the internal waveplates to user definable angles with very high speed and repeatability.
- As a traditional scrambler, the N7785C varies the output SOP smoothly in a random walk pattern.
- As a polarization stabilizer, the N7785C uses feedback via program commands to set and stabilize the SOP based on an external reference.

Programming uses a new SCPI command set and the instrument is addressed as a VISA resource. The instrument comes in a compact form factor of just one rack height unit, with LAN and USB interfaces and does not contain any moving parts.

For further details on its application and key features, refer to the product datasheet available on [www.keysight.com](http://www.keysight.com).

## N7786C Polarization Synthesizer

The Keysight Technologies N7786C contains a high-speed lithium-niobate based polarization controller and a polarization analyzer that monitors the output signal and provides feedback to the controller. This unit can operate in several modes:

- As a polarization stabilizer, it provides a stable output state of polarization (SOP) even with fluctuations and drifts of the input SOP. The stabilized output signal is guided in a standard single-mode fiber (SMF). The output SOP can be defined in the following ways:
  - When the set-and-forget switch in the user interface is activated, the current SOP is stored and maintained, even if polarization changes occur on the instrument input.
  - Defined Stokes: the target output SOP can be defined by the user using the Stokes parameters, which are then set using the polarization analyzer feedback.
  - Defined sequence: the device switches the SOP of the output signal in a chosen pattern with a cycling speed of up to 100 kSOPs/s.
- As an SOP switch, the N7786C cycles through a sequence of SOPs at a chosen rate up to more than 40 kHz. The internal settings for the SOP sequence are first determined with the stabilizer function for rapid direct switching. SOP switching occurs within a few microseconds. An electrical trigger input can be used to synchronize the scrambler with external events.
- As a traditional scrambler, the N7786C varies the output SOP in a random way. Full coverage of the Poincaré Sphere can be achieved within a few milliseconds.

- As a polarization analyzer, the instrument provides truly high-speed capabilities: Up to 1 M samples can be taken with a sample rate of up to 1 M samples per second.
- As fast-switching polarization controller for multi-channel, single-sweep wavelength dependent PDL measurements in combination with a tunable laser, a multiport power meter and the photonic application software suite (PAS). See the PAS literature for details: [www.keysight.com/find/n7700](http://www.keysight.com/find/n7700)

Many applications of the N7786C are supported by the built-in user interface. Programming uses a new SCPI command set and the instrument is addressed as a VISA resource.

For further details on its application and key features, refer to the product datasheet available on [www.keysight.com](http://www.keysight.com).

## N7788C Optical Component Analyzer

The N7788C optical component analyzer provides both polarization control and analysis functions in one instrument for flexible laboratory use.

The N7788C is especially used in combination with a tunable laser for measuring how an optical component changes the SOP of a signal. This measurement uses the unique single-sweep polarization dependent method to determine the parameters polarization mode dispersion (PMD) or differential group delay (DGD) and polarization dependent loss (PDL), based on a generalization of the standardized Jones Matrix Eigenanalysis method (JME).

For these spectral measurements of polarization dependent loss and dispersion, the N7788C is combined with a tunable laser and a new N7700 software engine.

Parameters provided by this measurement include:

- DGD/PMD
- PDL
- Power/loss
- TE/TM-loss
- Jones matrices
- Mueller matrices
- 2nd-order PMD (depolarization + PCD)

For further details on its application and key features, refer to the product datasheet available on [www.keysight.com](http://www.keysight.com).

## Input and Output Connectors

This section provides information on the front and rear panels of N7781/85/86/88C polarization instruments.

Figure 5 to Figure 8 shows the front panel of the N7781/85/86/88C polarization instruments.



Figure 5 Front Panel of the N7781C Polarization Analyzer



Figure 6 Front Panel of the N7785C Synchronous Scrambler



Figure 7 Front Panel of the N7786C Polarization Synthesizer



Figure 8 Front Panel of the N7788C Optical Component Analyzer

Figure 9 shows the rear panel of the N7781/85/86/88C polarization instruments.



Figure 9 Rear Panel of the N7781/85/86/88C polarization instruments

## Optical Connections

### Optical Output

#### Angled Contact Connectors

Angled contact connectors help you to control return loss. With angled fiber end-faces, reflected light tends to reflect into the cladding, reducing the amount of light that reflects back to the source. When reflected light remains in the fiber core at two or more locations along the optical path, such as at an open straight-polished connector output to a power meter, double reflections result in multi-path interference of the coherent light and thus power instability in the measurements.

Keysight N7781/85/86/88C polarization instruments can have the following connector interface option:

- Option (0x2) angled connector
- Option (0x1) straight connector (N7781 x=2 N7788C x=3)

#### CAUTION

If the contact connector on your instrument is angled, you can only use cables with angled connectors with the instrument.



Figure 10 Angled and Straight Contact Connector Symbol

Figure 10 shows the symbols that tell you whether the contact connector of your instrument is angled or straight. The angled contact connector symbol is colored green.

Figure 5 to Figure 8 shows the front panel of the Keysight N7781/85/86/88C polarization instruments with angled contact connector respectively.

You should connect straight contact fiber end connectors with neutral sleeves to straight contact connectors and connect angled contact fiber end connectors with green sleeves to angled contact connectors.

**NOTE**

**You cannot connect angled non-contact fiber end connectors with orange sleeves directly to the instrument.**

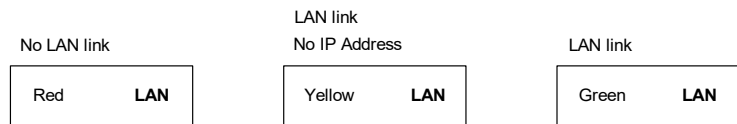
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## LAN Interface

### The LAN LED

When the LAN connection is made, you will see the following indicators:



There may be a delay between making the LAN link (yellow status) and getting the IP address (green status). This delay may be longer if there is no DHCP server, for example when the instrument is connected directly to a PC.

### The LAN Reset button

This recessed button has two functions:

- Pressing the button briefly invokes a preset of the instrument and restores default measurement settings. This is equivalent to the following programming command:  
`:SYSTem:PRESet`
- Pressing and holding the button for 5 seconds will reset the LAN parameters to the factory default. This includes removing the password. This is equivalent to the following programming command:  
`:SYSTem:COMMunicate:ETHernet:RESet`

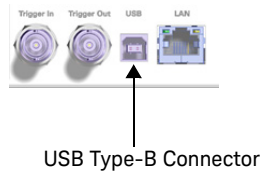
## USB Interface

### NOTE

It is recommended to use the Keysight IO Libraries Suite to enable instrument communication for a variety of development environments. It is available at: <http://keysight.com/find/iolib>

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The instrument is a USB device, with a USB Type-B connector which is available on the rear side of the instrument.



## Powering Up the Instrument

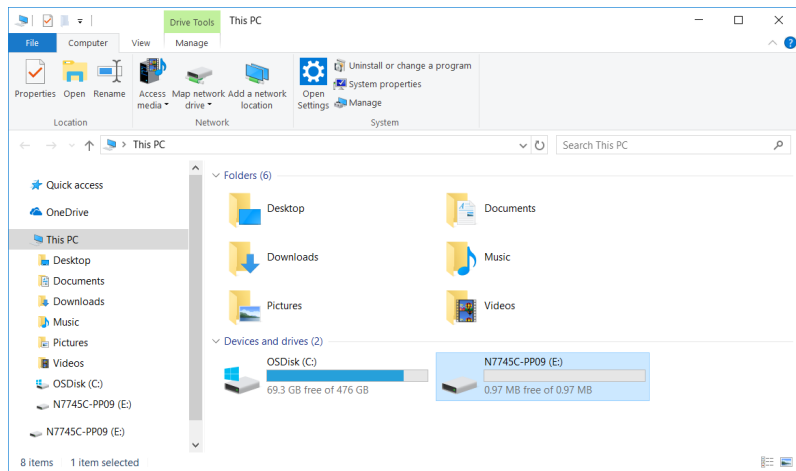
When you power on the instrument, the LEDs on the front panel show the various stages of the instrument.

	Power	LAN	Status
Yellow	Standby mode	Searching for LAN	Warming Up
Green	ON	Connected with LAN	
Blinking Green			Communicating over LAN / USB
Red		Not connected	

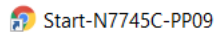
## Connecting the Instrument

### Connecting over USB

- 1 Power on the instrument.
- 2 Connect the PC to the instrument using a USB cable.
- 3 The operating system will detect and display the new instrument as a new drive.



- 4 Double-click on this new drive. It will show a shortcut to start the user interface.



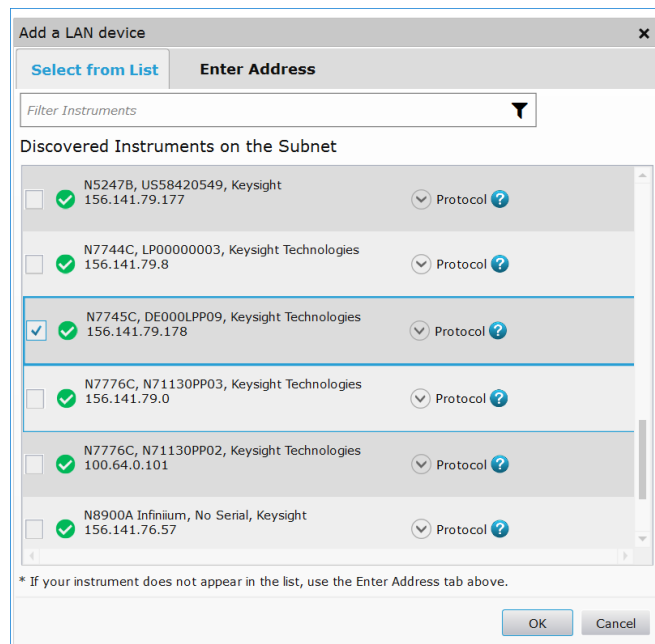
- 5 Double-click on this shortcut. This will open the user interface of the instrument in a browser.

## Connecting over LAN

- 1 Make sure the instrument is connected to the LAN, and that the LAN LED on the front panel is green.
- 2 If it is not already running, start the Keysight Connection Expert software.

The Discovery Service automatically discovers LAN instruments on the same subnet as the PC on which the service is running.

- 3 To add LAN instruments to the Connection Expert My Instruments list:
  - a Click, select LAN Instrument from the context list. This opens the list of discovered LAN instruments.



- b Click the check box for each instrument you want to add to the list.
- c Click OK.

- 4 To manually add LAN instruments outside of the local subnet:
  - a Click, select LAN Instrument from the context list. This opens the list of discovered LAN instruments.
  - b Click the Enter Address tab.
  - c Enter the LAN address or host name and select the protocol used to communicate with the instrument.

**Add a LAN device** [X]

**Select from List    Enter Address**

Set LAN Address:

Hostname or IP Address:

TCPIP Interface ID:

Set Protocol:

Instrument (VXI-11)    Remote Name:

HiSlip    Remote Name:

Socket    Port Number:

Verify Connection:

Allow \*IDN Query

   TCPIP0::169.254.186.97::inst0::INSTR  
Verified

View Web Page:

- d Click OK.

- 5 Linux or macOS can use the zeroconf / mdns discovery service with tools like Avahi (GNU/Linux) or Bonjour (Mac).

```

steffen@keysight [11:04:34 AM] [-]
-> % avahi-browse --all -t |grep N7781
+ en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      _vxi-11._tcp      local
+ en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      _scpi-telnet._tcp local
+ en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      _scpi-raw._tcp    local
+ en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      _lxi._tcp         local
+ en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      Web Site          local
steffen@keysight [11:11:34 AM] [-]
-> % avahi-browse _scpi-raw._tcp --resolve |grep N7781 -A3
+ en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      _scpi-raw._tcp    local
--
= en01 IPv4 N7781C DE0000PP03 Polarization Analyzer      _scpi-raw._tcp    local
hostname = [k-n7781c-0pp03.local]
address = [156.141.78.199]
port = [5025]
txt = ["txtvers=1" "Manufacturer=Keysight Technologies" "Model=N7781C" "SerialNumber=DE0000PP03" "FirmwareVersion=V1.000"]

```

## N778-C Instrument Setup

This section demonstrates how to connect your instruments optically and electrically for typical applications. It is strongly recommended that you read through Chapter , “[General Operating Considerations](#),” on page 13, Chapter , “[Getting Started](#),” on page 19 and Chapter , “[User Interface Application](#),” on page 53 prior to operating the instruments.

### N7781C Setup (Polarimetry)

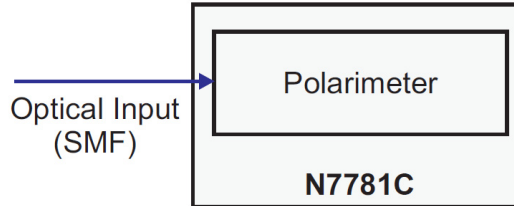


Figure 11 N7781C Setup (Polarimetry)

### N7785C Setup (Polarization Scrambling)

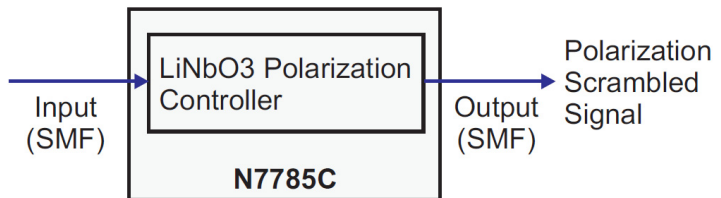


Figure 12 N7785C Setup (Polarization Scrambling)



## N7786C Setup (Polarization Synthesis)

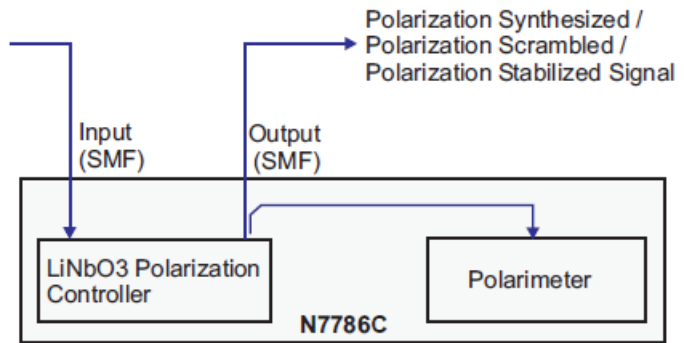


Figure 13 N7786C Setup (Polarization Synthesis)

## N7788C Setup (PMD/PDL Analysis)

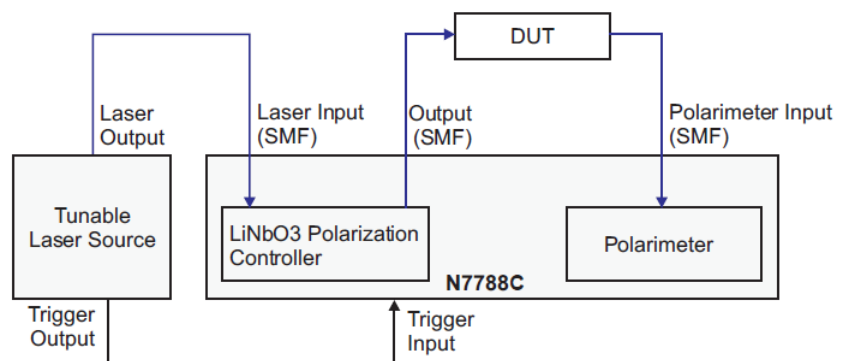
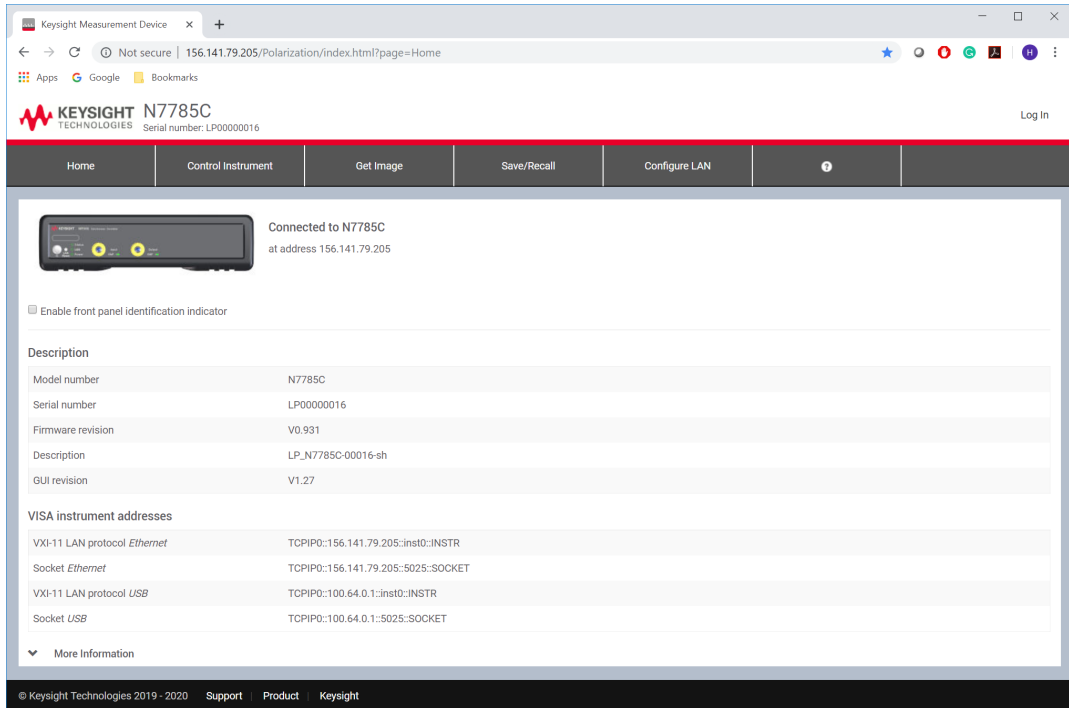


Figure 14 N7788C Setup (PMD/PDL Analysis)

## N778-C Instrument User Interface

Figure 15 depicts an example of the N7785C polarization instrument user interface that displays the instrument's connection settings. The below figure is also valid for N7781/86/88C polarization instruments.



Connected to N7785C  
at address 156.141.79.205

Enable front panel identification indicator

**Description**

Model number	N7785C
Serial number	LP00000016
Firmware revision	V0.931
Description	LP_N7785C-00016-sh
GUI revision	V1.27

**VISA instrument addresses**

VXI-11 LAN protocol <i>Ethernet</i>	TCPIP0::156.141.79.205::inst0::INSTR
Socket <i>Ethernet</i>	TCPIP0::156.141.79.205::5025::SOCKET
VXI-11 LAN protocol <i>USB</i>	TCPIP0::100.64.0.1::inst0::INSTR
Socket <i>USB</i>	TCPIP0::100.64.0.1::5025::SOCKET

▼ More Information

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Figure 15 N778-C Instrument User Interface

For details on the N7781/85/86/88C user interface and how to use it to control the instrument, refer to [User Interface Application](#) on page 53.

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This section defines terms that are used in this document.

#### Specification

Describes warranted product performance that is valid under the specified conditions. Specifications include guard bands to account for the expected statistical performance distribution, measurement uncertainties, changes in performance due to environmental changes and aging of components.

#### Typical Value (Characteristics)

Characteristics describe the product performance that is usually met but not guaranteed. Typical values are based on data from a representative set of instruments.

Generally, all specifications are valid within the specified temperature range, after warm-up, at the stated operating conditions and measurement settings.

#### Operating Conditions

The environmental conditions for system operation. The system must not be operated outside these conditions.

#### Specified Temperature

The temperature range where the specifications apply (if not differently stated).

#### Ambient Temperature Range

Temperature range of the ambient environment where specifications apply.

#### Operating Wavelength Range

The wavelength range in which the instrument's internal optics can be used.

#### Specification Wavelength Range

The wavelength range in which the specified optical performance is met.

Relative Power Uncertainty due to PDL

Two times the standard deviation of the power measured at the polarimeter input when varying the polarization state (SOP).

Relative Power Measurement Error due to Other Factors

Specifies the relative power measurement error when averaging out the polarization dependent loss.

For each wavelength, the deviation of the measured power and the input power is measured and the maximum relative deviation over all wavelengths of the defined wavelength range is determined.

Relative Output Power Uncertainty due to PDL

Two times the standard deviation of the measured output power error when varying the polarization state (SOP).

The output power is measured at the (scrambler) output port (N7786C).

Relative Output Power Measurement Error due to Other Factors

Specifies the relative power measurement error when averaging out the polarization dependent loss.

For each wavelength, the deviation of the measured power and the output power is measured and the maximum relative deviation over all wavelengths of the defined wavelength range is determined.

Input Power Range

The range of power levels for which the instrument displays a measurement readout.

Maximum Safe Optical Input Power

Higher power levels than defined by the maximum safe optical input power may damage the instrument irreversibly. Note that proper operation is only provided within the Input Power Range.

**WARNING**

**Higher power levels than defined by the maximum safe optical input power may damage the instrument irreversibly.**

---

### Output Power

The power level at the output connector interface.

### Gain (Loss, Insertion Loss)

Insertion Loss (IL) is defined as the difference in the transmitted power, expressed in dB, between the test device measurement,  $P_b$ , and the normalization measurement,  $P_a$ , given a constant power of the laser source, calculated as:

$$-IL \text{ [dB]} = 10 \log \frac{P_b}{P_a} = P_b \text{ [dBm]} - P_a \text{ [dBm]}$$

### Insertion Loss Dynamic Range

The maximum test device loss for which insertion loss measurements can be performed.

### State of Polarization (SOP)

The State of Polarization of a signal is defined by the three normalized Stokes Parameters  $s_1$ ,  $s_2$  and  $s_3$  which define a point in a three-dimensional coordinate system. For fully polarized light (DOP=100%), this point is located on a unity sphere commonly known as Poincaré sphere.

### SOP Uncertainty

The SOP uncertainty is defined to be twice the standard deviation of the angular error on the Poincaré sphere.

### Degree of Polarization (DOP)

The Degree of Polarization is the square-root of the sum of the squared normalized Stokes Parameters  $s_1$ ,  $s_2$  and  $s_3$ . DOP can be a value between 0 and 1 or between 0% and 100% accordingly:

$$DOP = \sqrt{s_1^2 + s_2^2 + s_3^2}$$

### DOP Uncertainty

The DOP uncertainty is defined to be twice the standard deviation of the DOP from the ideal value:

$$2 \cdot StDev\{DOP_i\}$$

$DOP_i$  denotes the measured DOP value and  $StDev$  denotes the standard deviation over repetitions  $i$ .

If DOP is given in %, the DOP uncertainty has the same unit.

Measurement: The polarization state of a signal with nominally 100% polarized light is randomly scrambled. The readout deviations from 100% are recorded over all polarization states and wavelengths.

### Differential Group Delay (DGD)

The dependence of the group delay at a fixed wavelength resulting from applying all possible polarization states, expressed as the difference between the maximum and the minimum group delay value.

### Differential Group Delay (DGD) Error

Specifies the error of the measurement results for differential group delay, expressed as the sum of an offset and a standard deviation.

The offset is calculated by the difference of the mean value of the golden device data and the mean value of the measured data, both mean values calculated over the wavelength.

The standard deviation over wavelength is calculated from the deviations around a calibration line shifted by this offset, again over wavelength.

- Conditions: Stable device-under-test.
- Measurement: Using a standard SM fiber with nominally 0 ps DGD and various PM fibers with specified DGD over the specified wavelength range.

### Differential Group Delay (DGD) Measurement Range

Specifies the range of DUT DGD values for which the instrument measures DGD values not disturbed by aliasing effects.



## Polarization Mode Dispersion (PMD)

The arithmetic average of the differential group delay (DGD) over a broad specified wavelength span (here unless otherwise noted 100 nm).

**NOTE**

**In highly mode-coupled devices, such as standard single mode fibers of kilometer length, the DGD depends on wavelength. Stress or temperature change may change the dependence of DGD on wavelength significantly. It can be shown that the DGD characteristics of such devices can be described statistically by PMD.**

## Polarization Mode Dispersion (PMD) Error

The PMD error is given by the deviation of the measured PMD and the PMD of the golden device.

Conditions: Measurement settings and operation mode as specified.  
Wavelength span and wavelength increment as specified.

## Polarization Mode Dispersion (PMD) Repeatability

The agreement of repeated measurements of PMD on a stable test device and under constant environmental conditions, expressed as:

$$2 \cdot \text{StDev}\{PMD_i\}$$

PMD<sub>i</sub> denotes the measured PMD and StDev denotes the standard deviation over repetitions *i*.

## Polarization Mode Dispersion (PMD) Vector

The PMD vector represents the polarization dependence of the group delay (GD). For a given wavelength, the magnitude of the PMD vector is the Differential group delay (DGD) at that wavelength, and the vector direction corresponds to the fast principal state of polarization in Mueller notation. The PMD vector is denoted by:

$$\vec{\Omega}$$

## Second Order PMD

The second-order PMD,  $S$ , quantifies the magnitude of the differential change of the Polarization mode dispersion (PMD) vector, with angular optical frequency,  $\omega$ , expressed in  $[\text{ps}^2]$ ,

$$S = \left| \frac{d\vec{\Omega}}{d\omega} \right|$$

**NOTE**

Second-order PMD can be expressed in  $[\text{ps}/\text{nm}]$  at a wavelength of 1550 nm by multiplying the  $[\text{ps}^2]$  value with the factor 0.784 nm/ps.

---

## Polarization-Dependent Chromatic Dispersion (PCD)

The PCD, quantifies the differential change of the magnitude of the Polarization mode dispersion (PMD) vector, with angular optical frequency,  $\omega$ , expressed in  $[\text{ps}^2]$ ,

$$PCD = \frac{d|\vec{\Omega}|}{d\omega}$$

## Depolarization Rate

The depolarization rate,  $d$ , quantifies the absolute value of the differential change of the normalized Polarization mode dispersion (PMD) vector, with angular optical frequency,  $\omega$ , weighted with the DGD (expressed in  $[\text{s}^2]$ ).

**NOTE**

The depolarization rate is a measure of how fast the PMD vector changes direction with the rotational frequency of the optical wave (or with the wavelength).

---

### PMD Measurement Range

Specifies the range of DUT PMD values for which the instrument measures PMD values not disturbed by aliasing effects. This value applies for highly mode-coupled devices such as single mode fibers. For non-mode-coupled devices such as polarization maintaining fibers (PMFs), the PMD measurement range equals the DGD measurement range.

### Polarization Dependent Loss (PDL)

The dependence of the loss of a device on the input polarization state, calculated as the difference between maximum and minimum loss (both in dB).

### Polarization Dependent Loss (PDL) Uncertainty

Specifies the uncertainty of the measurement results for polarization dependent loss, expressed as the sum of an offset and a standard deviation.

The offset is calculated by the difference of the mean value of the golden device data and the mean value of the measured data, both mean values calculated over the wavelength.

The standard deviation over wavelength is calculated from the deviations around a calibration line shifted by this offset, again over wavelength.

### Polarization Dependent Loss (PDL) Repeatability

The agreement of repeated measurements of PDL on a stable test device and under constant environmental conditions.

These measurements are performed over the defined wavelength range. For each wavelength the repeatability is calculated by:

$$PDL_{repeat} = 2 * \{ PDL_j - (PDL_{max} + PDL_{min}) / 2 \}, \text{ with } j = \text{number of repetitions}$$

The PDL Measurement Repeatability is the maximum of all PDL repeatability's over wavelength after excluding one out of 1000 PDL-values and smoothing over 3 neighboring wavelength values.

### Polarization Dependent Loss (PDL) Range

Specifies the maximum PDL which can be measured.

#### Maximum Sampling Rate

Specifies the maximum sampling rate into instrument memory for acquiring the State of Polarization (SOP) including DOP. Note that the time needed for transferring this data into a PC depends on the used interface.

#### SOP Cycling Time

The SOP cycling time is measured by applying a sequence with Stokes vector angles  $0^\circ - 90^\circ - 180^\circ - 90^\circ - 0^\circ$  on the Poincaré sphere at the input of the DUT with 50kHz. The cycling time is defined as the average of the four  $\tau_{90}$ -values.

#### Remaining SOP Error After Deterministic SOP Setting

This value is defined to be 5 times the standard deviation of the angular SOP error on the Poincaré sphere while the controller is turned on.

# 4 User Interface Application

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How to Use Auxiliary Functions / 67

## N778-C Instrument User Interface

Figure 16 shows the N7785C user interface with various tabs highlighted. The below figure is also valid for N7781/86/88C polarization instruments.

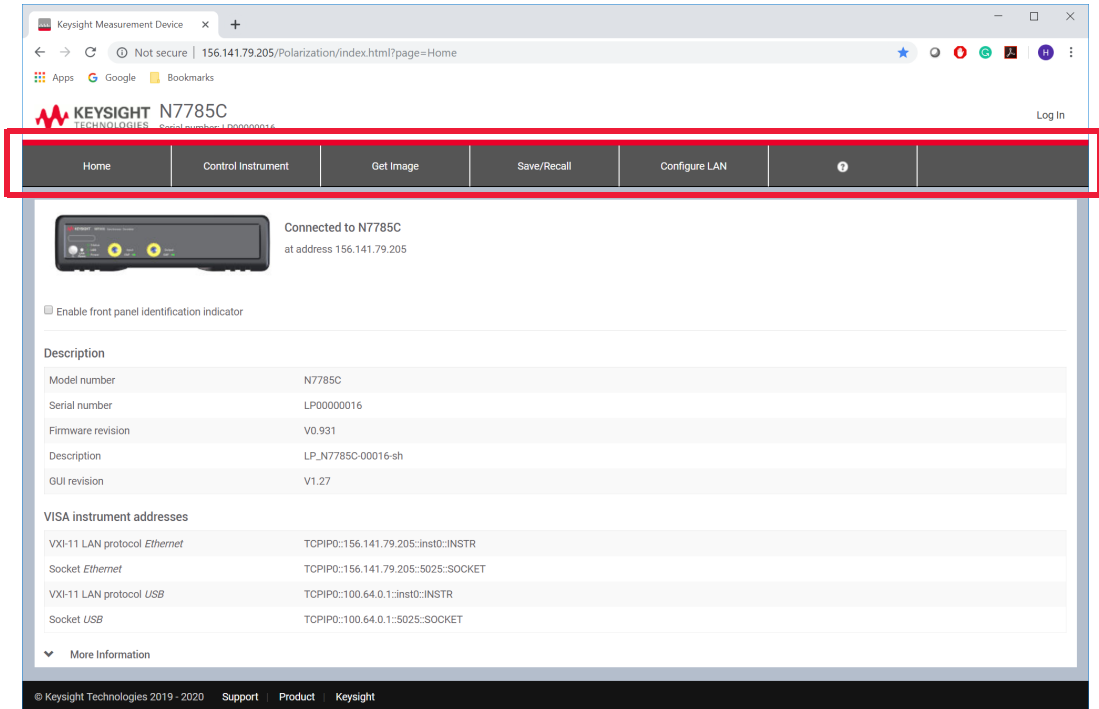


Figure 16 N778-C Instrument User Interface

The N778-C series user interface has various tabs that help the user to control the N7781/85/86/88C instruments:

- **Home** – This tab displays the various instrument settings. For details, refer [How to Get Current Instrument Settings?](#) on page 67.
- **Control Instrument** – This tab allows you to set the parameters to control the instrument. For details, refer to the sections in this chapter that follows.
- **Get Image** – This tab allows you to capture a screen of the **Control Instrument** window. The image is saved in PNG format in your PC. For details, refer [How to Capture an Image?](#) on page 68.

- **Save/Recall** – This tab allows you to save and load the user interface settings. For details, refer [How to Save/Recall Instrument Settings?](#) on page 68.
- **Configure LAN** – This tab displays the current LAN configuration of the instrument. In addition, this tab also allows you to edit the current LAN configuration of the instrument. For details, refer [How to Configure LAN?](#) on page 70.
- **Help** – This tab opens the instrument's help.

## Application: Polarimeter

### Choosing the Wavelength

To obtain accurate measurement results the operation wavelength of the light source has to be provided. If you have not already done so, click on **Settings > Measurement Settings** and then **Sampling Settings**. Enter the wavelength and choose a sweep rate of 0 nm/s.

#### Sampling Settings

Wavelength	<input type="text" value="1550.0000"/>	nm
Sampling rate	<input type="text" value="100"/>	Hz ▾
Pretrigger Samples	<input type="text" value="0"/>	
Posttrigger Samples	<input type="text" value="1000"/>	
Sweep Rate	<input type="text" value="0.0"/>	nm/s
Gain	<input type="text" value="4"/>	
Auto Gain	<input checked="" type="checkbox"/>	

### Auto Gaining

To provide a wide range of input power, the polarimeter receiver has 10 different input gain settings (0=lowest sensitivity, 9=highest sensitivity). To set the gain manually, click on **Settings > Measurement Settings** and then **Sampling Settings**. Specify the input gain. Usually the instruments choose the correct input gain settings to achieve optimum performance. You can suppress the gain switching by turning off the **Auto Gain** button.

Gain	<input type="text" value="4"/>
Auto Gain	<input checked="" type="checkbox"/>

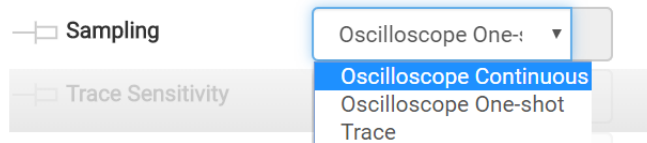


## The Oscilloscope Mode

The default operation mode is Oscilloscope. In this mode, data is sampled at a constant sampling rate. You can choose the desired number of samples.

The sampling rate together with the number of samples determines the observed time scale. The number of samples is defined by setting the Post-Trigger Samples value, even when no external trigger is used.

### Sampling Mode



There are two options in this mode: **Continuous** and **Oneshot**. In the continuous mode, the measurement is restarted after receiving a trace. In oneshot mode the acquisition has to be (re)started manually by pressing the **Trigger** button.

## Triggering

You can synchronize the start of a measurement cycle to certain events such as an external trigger signal.

When using an N778-C instrument, trigger settings are configured using the **Trigger** option.

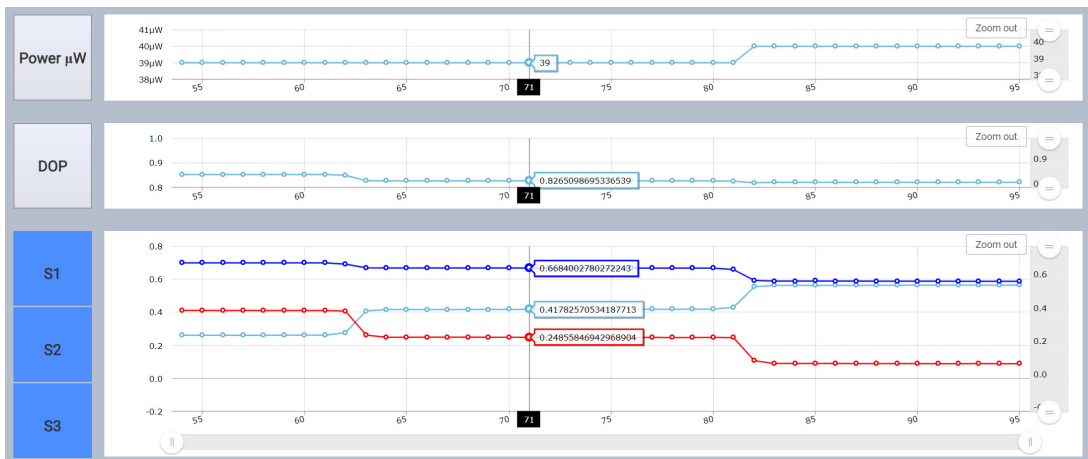
Select **TTL High** or **TTL Low** to choose the desired trigger edge of an externally applied digital signal. The signal has to be applied to the BNC input named Trig. In. The actual measurement is performed continuously, so the trigger event defines the portion of the measured data stream to be shown. You can set the number of samples to be stored from right before the trigger event (Pre-Trig. Samples) and right after the trigger event (Post-Trig. Samples).

## The Trace Mode

In **Trace** mode, data is sampled and stored only if the SOP has changed by a certain amount. The sensitivity can be adjusted by the "**Trace Sensitivity**" value. A value of 0.02 degree will record a new SOP when the normalized SOP has changed by more than 0.02 degree on the Poincaré sphere. The displayed buffer operates like a FIFO (first-in-first-out) buffer. Thus the oldest SOPs are discarded when new SOPs are stored. The number of SOPs stored is controlled by the Trace data points value.

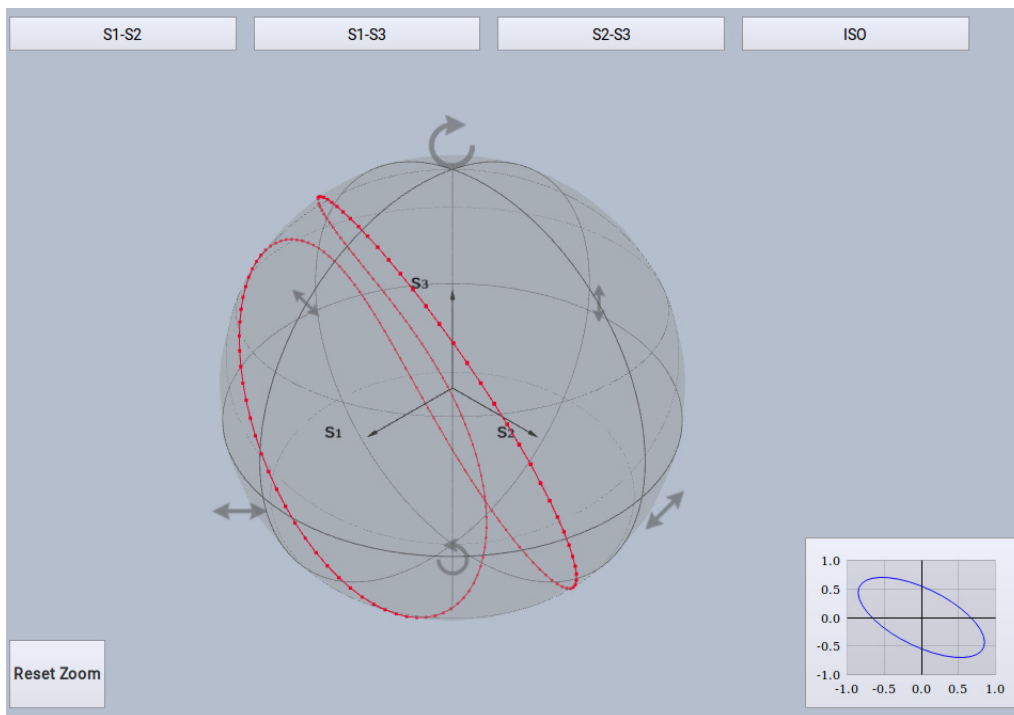
## Graph Views

Graph views are used to display the normalized Stokes parameters, the DOP and the power versus time. Click **SOP-Time** to select the graph view. Use the mouse (or touch pen) to zoom into the plot by clicking and drawing a rectangle. Click on Zoom out button on the graph area to reset the zoom. Select a datapoint to view the labels on the graph.



## The Polarimeter View

You can choose different views for the same measurement data. One of these views is the Poincaré sphere window. You can rotate the sphere by clicking onto the sphere and dragging the mouse with the left mouse button held down.



**Poincaré View Zoom** - You can scroll the wheel of an attached mouse to zoom in the Poincaré View. Click on the Reset Zoom button to zoom out the Poincaré View.

**Calculate PER** - The polarization extinction ratio (PER) of light in a PMF can be determined by creating circle trajectories on the Poincaré sphere. This can be done in realtime mode by either changing the wavelength or by slightly stretching or warming up the PMF. When you see the circle trajectory, press this button to calculate the PER. Press the button again to remove the displayed PER.

**Show Dots/Line Display** - Toggles between line-mode (all SOPs are connected by lines) and dots mode (each SOP is displayed as isolated point).

## Polarization Controller Basics

This section describes the basic operation of the polarization controller functions of the N778-C instruments.

The operation of the LiNbO<sub>3</sub> polarization controller (PC) integrated with most instruments of the N778-C series family is comparable to a cascade of six endlessly rotatable waveplates:

The state of the PC is given by the position of the waveplates which is expressed in terms of six angles  $\phi_0 \dots \phi_5$  measured in degree (ranging from 0..360. Due to the internal structure of the PC the waveplates are endlessly rotatable, i.e. there will be a continuous polarization state transition when increasing the position beyond 360, which is similar to starting from 0 again.

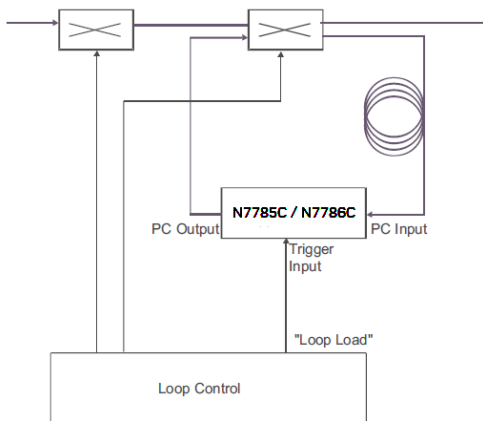
Note that the retardation may slightly differ from the nominal values depending on the operating wavelength and temperature. Furthermore, there may be a systematic deviation due to the electro-optic properties of the LiNbO<sub>3</sub> polarization controller. Usually these deviations are not an issue since in most applications the polarization is adjusted in an adaptive way (like for manual fiber-loop polarization controllers).

### Loop Synchronous Operation in Optical Loop Test Beds

In scramble mode and sequence mode the instrument can be synchronized to external events to support synchronous operation to optical loop test beds. Two configurations are recommended:

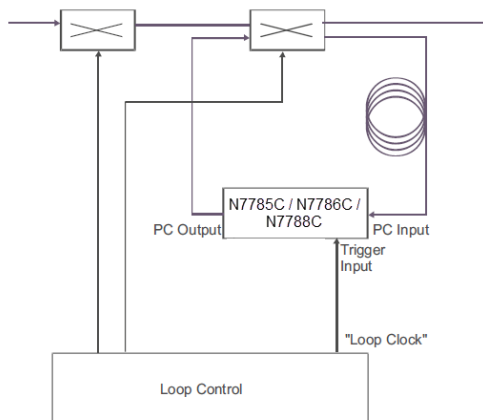
#### **No Loop Clock - Internal Timebase**

In this configuration the N778-C is synchronized to the beginning of the loop sequence when the fiber loop is loaded with the optical burst data. It then processes the look-up table (either generated for scrambling or loaded from a file) using an internal clock timer. The loop cycle time depends on the length of the fiber loop. You have to find the clock rate and the phase of the PC manually to match the switching times with the loop cycles.



**Synchronized to Loop - Clock External Timebase**

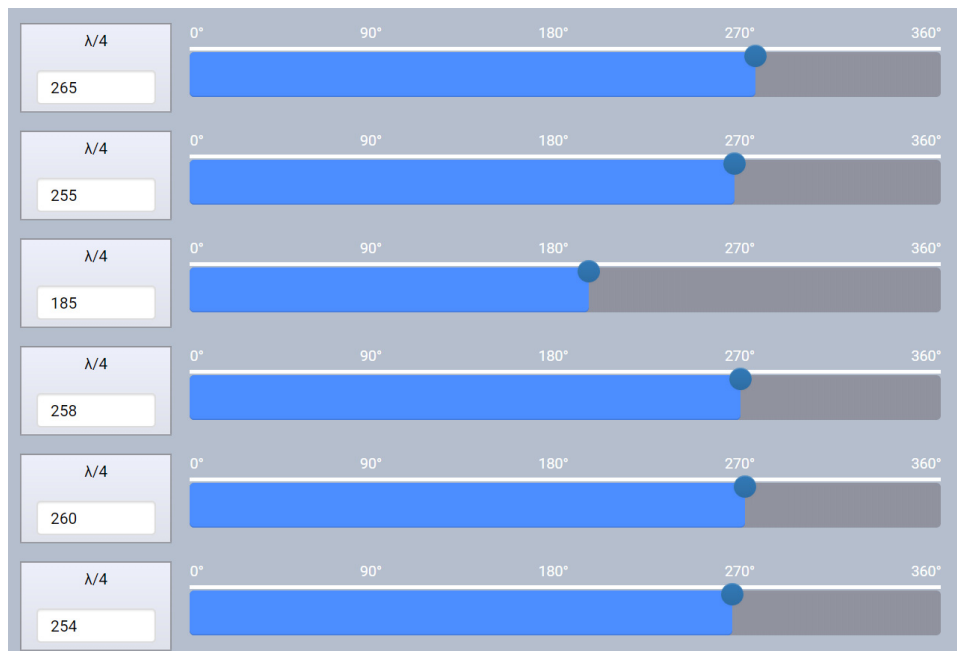
In this configuration the N778-C is synchronized to the loop clock. Switching occurs on the trigger event of the signal applied to the trigger input.



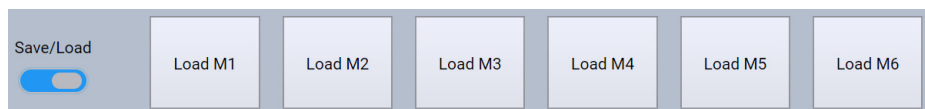
## Application: Manual Waveplate Control

In manual operation mode the polarization can be adjusted by manually setting the six angles  $\phi_0 \dots \phi_5$ . The operation is comparable to manual fiber-loop polarization controllers. The N778-C user interface allows to save and restore software settings.

The N778-C polarization controller contains six sliders. Move the sliders to adjust the position of each waveplate. The slider ranges represent a virtual  $\lambda/4$  waveplate rotation up to 360 degrees which results in two full rotations on the Poincaré sphere.



You can store six sets of slider positions by clicking on a memory button. To recall this set any time later, click on the **Save/Load** slider.



## Application: Random Polarization Scrambling

In random scrambling mode, polarization changes are created by setting all (virtual) waveplates to a sequence of randomized rotation angles at an adjustable clock rate.

The scrambler operation is activated by clicking on the Sequence/Scramble tab of the N7786C instrument. This dialog also provides parameters settings for the scrambling operation.

The screenshot shows the 'Sequence/Scramble' dialog box. At the top, there are two tabs: 'Sequence/Scramble' and 'SOP Stabilize'. Below the tabs are four buttons: 'Load Sequence', 'Generate Scramble', 'Start', and 'Stop'. The main area contains several input fields and a dropdown menu. Under 'Sequence Length', there is a text box with the value '1'. Under 'Synchronization', there is a dropdown menu with 'Auto Repeat' selected. Under 'Repetition rate (kHz)', there is a text box with the value '500'. Under 'Repetition', there is a text box with the value '1'. Under 'Hold off', there is a text box with the value '1'.

Scrambling is implemented by randomly generating a special look-up-table. The sequence length can be chosen by the field sequence length, the repetition rate and the number of repetitions. A number of 0 repetition means an endless running sequence with the defined sequence length.

If Synchronization is set to Auto Repeat, the scrambling sequence is processed repeatedly without any external synchronization. The sequence will be randomized initially and will be repeated unchanged.

If Synchronization is set to Auto Oneshot, the scrambling sequence is processed just once (the repetition value is ignored in this mode).

If Synchronization is set to External Repeat or External Oneshot, the behavior is similar except that the sequence is restarted when a trigger event occurs at the Trigger Input. The exact time relative to the external trigger signal can be adjusted using the Hold off time. This value defines the delay between the trigger pulse in 1/32 us steps up to 0.1 ms.

The external trigger signal can also be used as timebase instead of the internal timer. In this mode the sequence table is processed at the clock rate applied to Trigger Input. Set Synchronization to External Oneshot to activate this function.



## Application: Continuous Scrambling

Use this application to scramble the polarization state in a continuous manner using an N7785C, N7786C or an N7788C. The scrambling behavior resembles that of a motorized fiber-loop polarization controller.

The LiNbO3 waveplates are controlled in a way that creates a continuous movement of the output polarization state with an adjustable scrambling speed.

The scrambling operation is activated by clicking on the Sequence/Scramble tab of the N7786C instrument.

The screenshot shows the 'Sequence/Scramble' tab of the instrument's user interface. At the top, there are two tabs: 'Sequence/Scramble' and 'SOP Stabilize'. Below the tabs are four buttons: 'Load Sequence', 'Generate Scramble', 'Start', and 'Stop'. The 'Start' button is disabled. Below the buttons are three rows of controls: 1. 'Sequence Length' (text input: 36001) and 'Synchronization' (dropdown menu: Auto Repeat). 2. 'Repetition rate (kHz)' (text input: 140), 'Repetition' (text input: 0), and 'Hold off' (text input: 1).

After activating the application Continuous Scrambling, you can start and stop the scrambling operation by pressing Start Scrambler and Stop Scrambler. When pressing Start for the first time after activating the application, it may take some seconds until the scrambling sequence has been generated.

## Application: Polarization Stabilization

In addition to the manual, scramble and sequence modes described before (see previous sections), the N7786C can be used to generate a fixed output SOP, even with varying input SOPs.

Click on the SOP Stabilize tab to access the settings for the SOP stabilizer. It provides the following options:

The screenshot shows the 'SOP Stabilize' control panel. At the top, there are two tabs: 'Sequence/Scramble' and 'SOP Stabilize'. The 'SOP Stabilize' tab is active. Below the tabs, there are three toggle switches: 'Show Target SOP', 'Set-and-Forget', and 'Stabilize'. All three are currently turned on. Below these toggles, there are three input fields labeled 'SOP'. The first field is 'S1' with the value '0'. The second field is 'S2' with the value '1'. The third field is 'S3' with the value '0'.

- **Show Target SOP** - The target SOPs can be shown as well as the SOPs that are actually generated.
- **Set-and-Forget** - The Set-And-Forget mode activates the controller and stabilizes the output SOP to the output SOP present at the time of activation.
- **Stabilize** - By clicking the SOP Stabilize sub-item of an active N7786C instrument, the settings for the SOP stabilizer can be accessed.

## How to Use Auxiliary Functions

### How to Get Current Instrument Settings?

The **Home** tab on the N778-C user interface displays the current instrument settings.

KEYSIGHT N7786C  
TECHNOLOGIES Serial number: DE000LPP04

Home Control Instrument Get Image Save/Recall Configure LAN

Connected to N7786C  
at address 156.141.79.126

Enable front panel identification indicator

**Description**

Model number	N7786C
Serial number	DE000LPP04
Firmware revision	V0.930
Description	Keysight Measurement Device
GUI revision	V1.27

**VISA instrument addresses**

VXI-11 LAN protocol Ethernet	TCPIP0:156.141.79.126::instr0::INSTR
Socket Ethernet	TCPIP0:156.141.79.126::5025::SOCKET
VXI-11 LAN protocol USB	TCPIP0:100.64.0.1::instr0::INSTR
Socket USB	TCPIP0:100.64.0.1::5025::SOCKET

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This tab displays the following settings:

- **Description** – Displays the instrument description such as instrument’s model no., serial no. and firmware version.
- **VISA Instrument Address** – Displays VISA instrument addresses of the current instrument.
- **LAN Details** – Displays LAN configuration details of the current instrument.

### NOTE

Please note that the **Home** tab does not allow the user to change the displayed instrument settings.

### How to Identify a Module?

Sometimes, you may have many modules mounted in the rack. In this situation, it becomes difficult to identify a particular module which is currently connected.

To identify a particular module, select the check-box **Enable front panel identification indicator** available on the N778-C **Home** tab. The **Status** LED on the front panel of the connected module will start flashing.

**Enable front panel identification indicator**

### How to Capture an Image?

The **Get Image** tab on the N778-C user interface allows you to capture the current screen of the **Control Instrument** tab and save it as a PNG image.

## NOTE

You can only capture the screen if you are in the **Control Instrument** tab.

### How to Save/Recall Instrument Settings?

The **Save/Recall** tab on the N778-C user interface allows you to save and recall the settings.



Save

Export

Recall

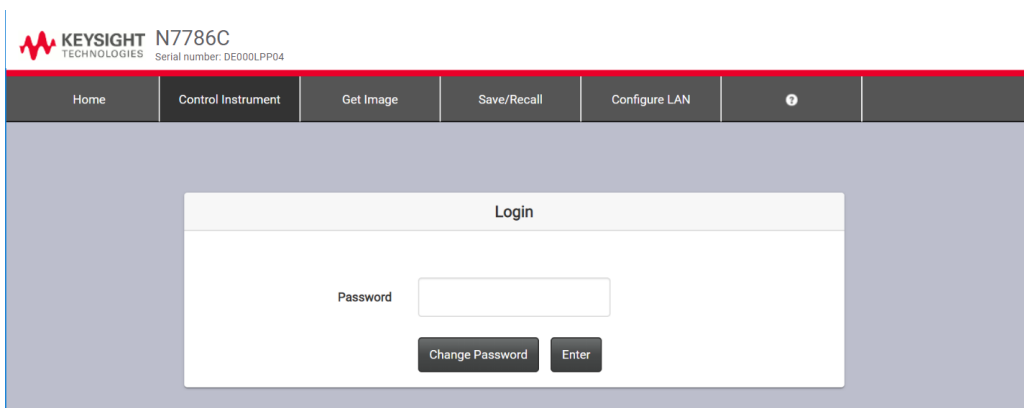
Upload your XML file here

To perform the save/recall operation do the following:

- 1 Click on the **Save/Recall** tab.
- 2 To save a file, click on **Export** button. The user interface settings will be saved as an XML file in your PC.
- 3 To recall a previously saved file, click on **Upload your XML file here** button. Locate the target file and click **Open**.


### Logging In/Out of the N778-C User Interface

The login screen allows the authorized users to control the N778-C instruments. When the users type in their password and click **Enter**, their credentials are validated and if correct they are logged in.




If you want to create a new password or change an existing password, click on the **Change Password** button. For details, see [How to Create/Change the Password?](#) on page 70.

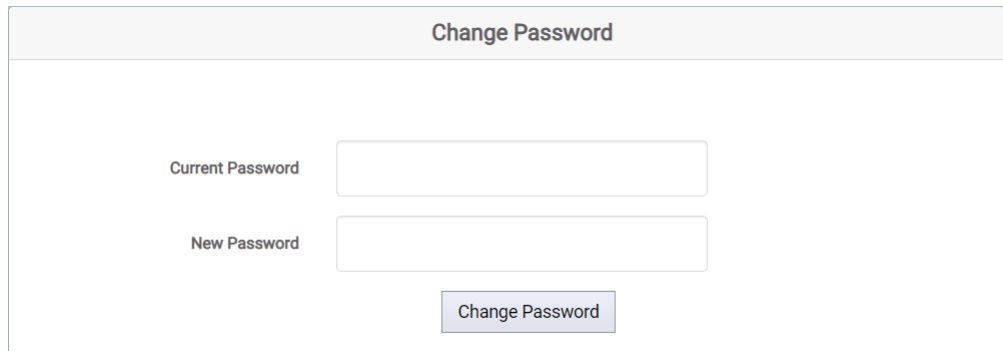
To log out the N778-C user interface, click on **Log out** icon available on the top right of the user interface.

Log out 

### How to Create/Change the Password?

The password is used for logging in to the web page to control the N778-C instrument. To create or change a password;

- 1 Click the **Password Options** icon  available on the top right of the N778-C user interface. You see a **Change Password** box requesting you to enter the password.



The screenshot shows a web form titled "Change Password". It contains two text input fields: "Current Password" and "New Password". Below the "New Password" field is a button labeled "Change Password".

- 2 Enter the current password (the default password is blank).
- 3 Enter the new password.
- 4 Click the **Change Password** button. The password will be changed. Use the new password for logging in to the N778-C web page.

### What If You Forget Your Password?

If you forget your password, please follow the instructions to reset the LAN button. See [The LAN Reset button](#) on page 33.

### How to Configure LAN?

#### Show the Current LAN Settings

The **Configure LAN** tab on the N778-C user interface displays the currently used LAN settings. It displays the following networking parameters:

- IP address configuration
- IP address
- Subnet mask
- Default gateway
- DNS server(s)

- Hostname
- Domain

## Edit LAN Settings

The **Configure LAN** tab also allows you to edit the currently used LAN settings. To do so,

- 1 Click on the **Edit** button. The **Edit Network Configuration** page will appear.
- 2 Enter the descriptions for the following LAN configuration parameters:
  - Instrument identification
  - IP address configuration
  - DNS server address configuration

### NOTE

For IP address and DNS server configuration, you can select the **Use Automatic Configuration** check-box to automatically select the IP address and DNS server.

Configure LAN > Edit Network Configuration

Warning: Your connection to the instrument may be broken after executing either of the operations below. If so, reconnect to the instrument using the new hostname or IP address.

**Instrument identification**

Desired hostname  
K/N7786C-LPP04

Description  
Keysight Measurement De

**IP address configuration**

Use automatic configuration

IP address  
192.168.0.2

Subnet mask  
.255.255.255.0

Default gateway  
192.168.0.1

**DNS server address configuration**

Use automatic configuration

Preferred DNS server

Alternate DNS server

Note: It can take up to 30 seconds for changes to these settings to take effect. You may need to refresh the Configure LAN page after 30 seconds to see the updated settings. Changes in hostname and description

Apply Changes Cancel

**WARNING**

Your connection to the instrument may be broken after executing either of the operations below. If so, reconnect to the instrument using the new hostname or IP address.

- Once, the changes are done, click on **Apply Changes** button.

**NOTE**

It can take up to 30 seconds for these changes to take effect. You may need to refresh the Configure LAN page after 30 seconds to see the updated settings. Changes in hostname and description require reboot or LAN restart to take effect.

### Reset Network Configuration

The **Configure LAN** tab also allows you to reset all LAN parameters to the factory default. To do so, click the **Advance Options** button available on **Configure LAN** tab. The **Advance Network Options** page will appear. Click on the **Reset** button to reset all LAN parameters to the factory default.

## Configure LAN > Advance Network Options

Warning: Your browser connection to the instrument may be broken after executing either of the operations below. If so, reconnect to the instrument using the new hostname or IP address.

### Reset Network Configuration

Reset all the LAN parameters to the factory default. Enables DHCP, AutoIP and reset password, description and hostname.

Reset

**WARNING**

Your browser connection to the instrument may be broken after executing the reset network configuration operation. If so, reconnect to the instrument using the new hostname or IP address.

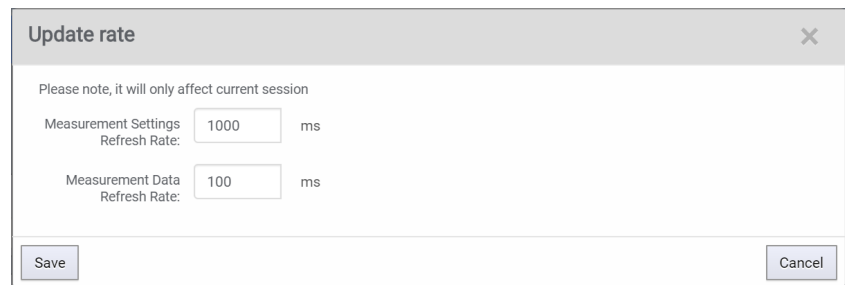


## Update Rate

You can use the **Update Rate** dialog to set the refresh rates in milliseconds for the measurement settings and measurement data.

To perform an update rate:

- 1 Go to **Settings** and click **Update Rate**. An **Update Rate** dialog appears:



**Update rate** [X]

Please note, it will only affect current session

Measurement Settings Refresh Rate:  ms

Measurement Data Refresh Rate:  ms

- 2 Enter the following details:
  - refresh rates for measurement settings, and
  - refresh rates for measurement data.
- 3 Click on **Save** button.

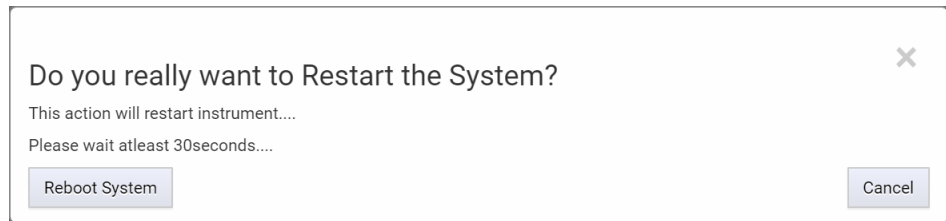
### NOTE

The new refresh rates will only be effective for the current session.

## Reboot Device

To perform a reboot do the following:

- 1 Go to Settings and click **Reboot**. A **Reboot Device** dialog will appear:



- 2 Click on the **Reboot System** button. This action will restart the firmware and take at least 30 seconds. Please wait until the reboot process is completed.

# 5 Maintenance

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## Cleaning Instructions

The following Cleaning Instructions contain some general safety precautions, which must be observed during all phases of cleaning. Consult your specific optical device manuals or guides for full information on safety matters.

Please try, whenever possible, to use physically contacting connectors, and dry connections. Clean the connectors, interfaces, and bushings carefully after use.

If you are unsure of the correct cleaning procedure for your optical device, we recommend that you first try cleaning a dummy or test device.

Keysight Technologies assume no liability for the customer's failure to comply with these requirements.

## Safety Precautions

Please follow the following safety rules:

- Do not remove instrument covers when operating.
- Ensure that the instrument is switched off throughout the cleaning procedures.
- To prevent electrical shock, disconnect the instrument from the 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.
- After cleaning, do not switch on the instrument when there is no termination to the optical output connector, to the optical fiber or to the attached device. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.

## Why is it important to clean optical devices?

In transmission links optical fiber cores are about 9  $\mu\text{m}$  (0.00035") in diameter. Dust and other particles, however, can range from tenths to hundredths of microns in diameter. Their comparative size means that they can cover a part of the end of a fiber core, and as a result will reduce the performance of your system.

Furthermore, the power density may burn dust into the fiber and cause additional damage (for example, 0 dBm optical power in a single mode fiber causes a power density of approximately 16 million  $\text{W}/\text{m}^2$ ). If this happens, measurements become inaccurate and non-repeatable.

Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

## What materials do I need for proper cleaning?

Some **Standard Cleaning Equipment** on page 77 is necessary for cleaning your instrument.

### Standard Cleaning Equipment

Before you can start your cleaning procedure you need the following standard equipment:

- Dust and shutter caps
- Isopropyl alcohol
- Cotton swabs
- Soft tissues
- Compressed air

#### Dust and shutter caps

All of Keysight Technologies' lightwave instruments are delivered with either laser shutter caps or dust caps on the lightwave adapter. All cables come with covers to protect the cable ends from damage or contamination.

We suggest these protected coverings should be kept on the equipment at all times, except when your optical device is in use. Be careful when reattaching dust caps after use. Do not press the bottom of the cap onto the fiber too hard, as any dust in the cap can scratch or pollute your fiber surface.

#### Isopropyl alcohol

This solvent is usually available from any local pharmaceutical supplier or chemist's shop.

If possible avoid using denatured alcohol containing additives. Instead, apply alcohol used for medical purposes.

Never try to drink this alcohol, as it may seriously damage your health.

Do not use any other solvents, as some may damage plastic materials and claddings. Acetone, for example, will dissolve the epoxy used with fiber optic connectors. To avoid damage, only use isopropyl alcohol.

If you use isopropyl alcohol to clean your optical device, do not immediately dry the surface with compressed air. This is because the dust and the dirt is dissolved and will leave behind filmy deposits after the alcohol is evaporated. You should therefore first remove the alcohol and the dust with a soft tissue, and then use compressed air to blow away any remaining filaments.

### **Cotton swabs**

We recommend that you use cotton swabs available from local distributors of medical and hygiene products.

Ensure that you use natural cotton swabs. Foam swabs will often leave behind filmy deposits after cleaning.

Use care when cleaning, and avoid pressing too hard onto your optical device with the swab. Too much pressure may scratch the surface, and could cause your device to become misaligned. It is advisable to rub gently over the surface using only a small circular movement.

Swabs should be used straight out of the packet, and never used twice. This is because dust and dirt in the atmosphere, or from a first cleaning, may collect on your swab and scratch the surface of your optical device.

### **Soft tissues**

These are available from most stores and distributors of medical and hygiene products.

We recommend that you do not use normal cotton tissues, but multi-layered soft tissues made from non-recycled cellulose. Cellulose tissues are very absorbent and softer. Consequently, they will not scratch the surface of your device over time.

Use care when cleaning, and avoid pressing on your optical device with the tissue. Pressing too hard may lead to scratches on the surface or misalignment of your device. Just rub gently over the surface using a small circular movement.

Use only clean, fresh soft tissues and never apply them twice. Any dust and dirt from the air which collects on your tissue, or which has gathered after initial cleaning, may scratch and pollute your optical device.

### Compressed air

Compressed air can be purchased from any laboratory supplier.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If not, this can lead to filmy deposits or scratches on the surface of your connector. This will reduce the performance of your transmission system.

When spraying compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty your optical device. First spray into the air, as the initial stream of compressed air could contain some condensation or propellant. Such condensation leaves behind a filmy deposit.

### Cleaning Instrument Housings

Use a dry and very soft cotton tissue to clean the instrument housing. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

## General Cleaning Procedure

### Light dirt

If you just want to clean away light dirt, observe the following procedure for all devices:

- Use compressed air to blow away large particles.
- Clean the device with a dry cotton swab.
- Use compressed air to blow away any remaining filament left by the swab.

### Heavy Dirt

Use this procedure particularly when there is greasy dirt on the connector:

- 1 Moisten a new cotton-swab with isopropyl alcohol.
- 2 Clean the connector by rubbing the cotton-swab over the surface using a small circular movement.
- 3 Take a new, dry soft-tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
- 4 Blow away any remaining lint with compressed air.

## Further Cleaning Information

For further information on cleaning and safety matters, refer the following document:

<https://literature.cdn.keysight.com/litweb/pdf/5989-4473EN.pdf>



## Firmware Upgrades

This section provides information about the firmware upgrade process for the N778-C series polarization instruments.

You may need to upgrade firmware:

- To enhance the usability and functionality of your instrument. New features may be available with new firmware revisions.

Firmware updates can be done by installing the firmware updates installation file, which can be downloaded from [www.keysight.com](http://www.keysight.com).

### CAUTION

Ensure to execute the firmware update procedure only under conditions of reliable power and I/O connectivity to the instrument. For example, do not update firmware with an intermittent LAN connection, a loose power cord, or during a thunderstorm that may interrupt power. Loss of power or connectivity may cause the firmware update fail, possibly making instrument non-operational.

---

### NOTE

Updating the firmware will not affect your instrument calibration.

---

## Requirements

To upgrade firmware for the N778-C series polarization instruments, you require a PC, running Windows 10 on it.

To update the firmware you need to download the current firmware which consist of two components:

- Firmware Upload Utility
- The latest firmware version (\*.bin file)

**NOTE**

This process could take a couple of minutes (5-10 minutes depending on your network speed).

---

Once you have copied both items to your computer, proceed as follows:

- 1 Run the **Firmware Update Utility** and select the device you want to update.
- 2 Browse to the location of the firmware that you just downloaded and open the file.
- 3 Press **Start**.

The update utility will copy the firmware update file on your local PC.

After the firmware has been updated, the instrument will automatically restart itself with the new software

During the update process the **Status** and the **Active LED** will flash periodically.

- 4 Check the firmware version. Go to instrument's user interface **Home** tab and check for the firmware version.

## Contact Keysight Technologies

To locate a sales or service office near you, go to [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus).



