Keysight N778xB

User's Guide

KEYSIGHT TECHNOLOGIES

Notices

Manual Part Number

N7781-90001

Edition

Edition 7.1, October 2020

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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.

Compliance and Environmental Information

Table 1 Compliance and Environmental Information

Safety Symbol	Description
	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. Product Category: With reference to the equipment types in WEEE Directive Annex I, this product is classed as a “Monitoring and Control instrumentation” product. Do not dispose in domestic household waste. To return unwanted products, contact your local Keysight office, or see http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

Contents

4 Applications

7 LabView™ Drivers (Discontinued)

8 GPIB Command Reference (Discontinued)

1 Quick Start Information

This section demonstrates how to connect your instruments optically and electrically for typical applications. They are intended as a quick start guide, although it is strongly recommended that you read through Chapter, “General,” on page 27, Chapter, “Getting Started,” on page 33 and Chapter, “Applications,” on page 71 prior to operating the instruments.

Each application supports different modes of operation, some of which may require additional connections, which are described in the respective application section of this user guide.

NOTE Please install the polarizationNAVIGATOR™ software before you plug in the instrument(s) to the USB port of the PC! This ensures that the drivers are available when you plug-in the instrument(s). If you have connected the instrument(s) prior to software installation, you may have to delete the instrument(s) manually from the Windows device manager. This does not apply to the N7781BD or the N7788BD. It also does not apply to instruments that are used with GPIB only.

NOTE Run the Configuration Wizard each time you connect additional instruments.

N7781B Setup (Polarimetry)

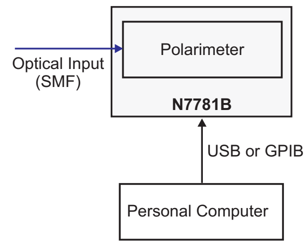


Figure 1 N7781B Setup

N7782B Setup (PER Analysis)

Standard Option (No Internal Laser Source)

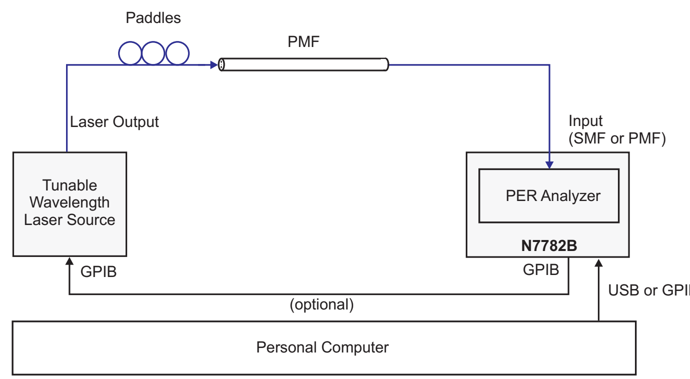


Figure 2 N7782B Setup

Option 401, 501, 101 (With Internal Laser Source) and N7783B

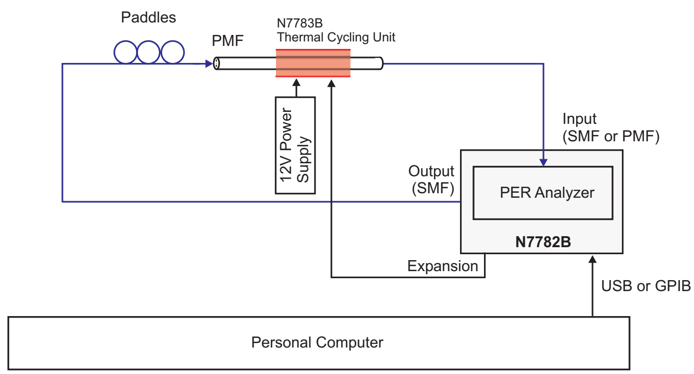


Figure 3 N7782B with internal laser source and N7783B Setup

WARNING

Please read the laser safety warnings of section Safety Instructions on page 28 if your instrument contains a laser source (N7782B with Option #101, #401, #501).

For further PER/PMF crosstalk measurement setups refer to Application: PER/PMF Crosstalk on page 103.

N7784B Setup (Polarization Stabilization)

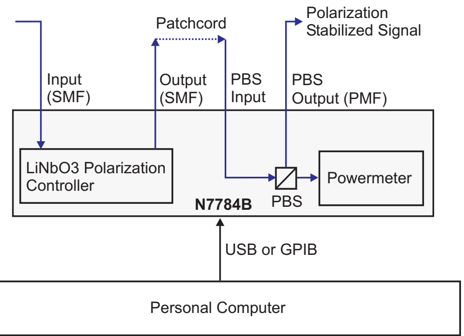


Figure 4 N7784B Setup

N7785B Setup (Polarization Scrambling)

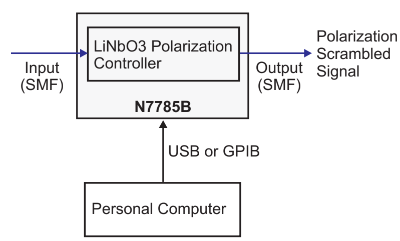


Figure 5 N7785B Setup

N7786B Setup (Polarization Synthesis)

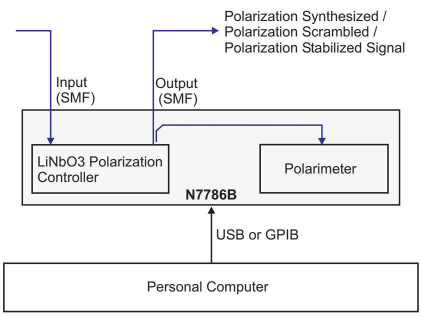


Figure 6 N7786B Setup

N7788B Setup (PMD/PDL Analysis)

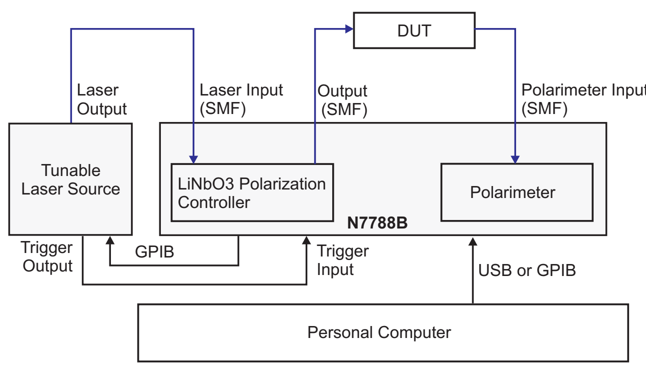


Figure 7 N7788B Setup

N7783B Setup (PER Analysis)

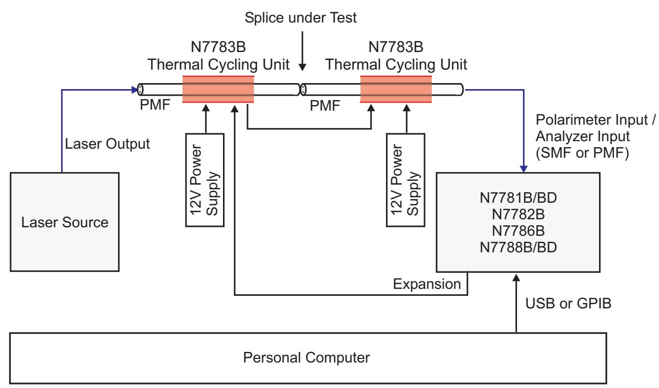


Figure 8 N7783B Setup

For further PER/PMF crosstalk measurement setups refer to Application: PER/PMF Crosstalk on page 103.

N7781BD Setup (Polarimetry)

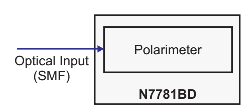


Figure 9 N7781BD Setup

NOTE

Press the Modify Knob twice to access the on-screen keyboard.

N7788BD Setup (PMD/PDL Analysis)

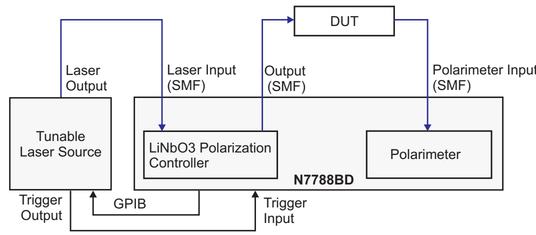


Figure 10 N7788BD Setup

NOTE Press the Modify Knob twice to access the on-screen keyboard.

2 General

This chapter contains safety, regulatory and warranty information.

KEYSIGHT TECHNOLOGIES

Safety Instructions

- This instrument shall only be operated according to the instructions in this manual.
- Before this instrument (including external power supply) is connected to an electricity outlet make sure the outlet is provided with a protective earth contact. Also make sure that you use a three line AC power cord.
- The instrument and any external power supply shipped with the instrument do not contain operator serviceable parts. To prevent personal injuries or damage to the instrument do not open the devices.
- 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.
- This instrument may be labeled with one of the safety symbols shown below (if the instrument is not labeled with a certain safety label, the respective safety measures do not apply to that instrument):

This label is located near certain parts of the instrument that get hot during operation. This applies to the white surface below the lid of the N7783B Thermal Cycling Unit, i.e. the trench that the fiber is placed into. Avoid touching this surface during operation.

This label denotes laser output ports of instruments that contain laser sources. Refer to Table 2 on page -29 for further details.

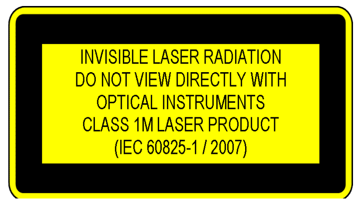


Table 2 Parameters of Lasers Included in certain instruments (see column headers for respective product options

N7782B	#101	#401	#401/#501
Laser Type	Fabry-Perot	Fabry-Perot	Fabry-Perot
Wavelength or Wavelength Range	850nm	1310nm	1550nm
Max. CW output power[*]	0.2mW	1mW	1mW
Beam waist diameter	9µm	9µm	9µm
Numerical aperture	0.1	0.1	0.1
Laser class according to IEC 60825-1 (2001)	Class 1	Class 1	Class 1
Max. permissible CW output power[†]	0.8mW	15.6mW	10mW

* Max. CW output power means the highest possible optical CW power that the laser source can produce at its output.

† Max. permissible CW output power is the highest optical power that is permitted within the appropriate IEC laser class.

WARNING

Please pay attention to the following laser safety warnings if your instrument contains a laser source (N7782B with Option #101, #401, #501):

- Under no circumstances look into the optical output of the instrument or to an optical cable attached to the optical output when the device 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.
- The laser is enabled by starting the PER application in the polarizationNAVIGATOR™ software. In that application there is also a button to enable/disable the laser source once the application is running. The laser is on when one of the green LEDs to the right of the optical connector labeled ”Output” is lit.
- The use of optical instruments with this product will increase eye hazard.
- Refer servicing only to qualified and authorized personnel.

Regulatory Information

- Compliance with Canadian EMC Requirements:
  This ISM device complies with Canadian ICES-001.
  Cet appareil ISM est conforme à la norme NMB-001 du Canada.

Table 3 Notice for Germany: Noise Declaration

Acoustic Noise Emission
LpA < 50 dB
Operator position
Normal operation
per ISO 7779

Declaration of Conformity

Latest declaration of conformity is available at

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

3 Getting Started

This chapter gives information for setting up your instruments.

About this manual

This manual covers all N778xB/BD instruments. There may be applications or functions described within, which cannot be performed with a specific instrument. The sections or chapters of this manual contain product numbers like N778xB/N778xBD. These product numbers indicate the instruments that the specific section applies to.

Many functions and applications are controlled using an external Personal Computer (PC), or an integrated PC, so a large portion of this manual is about software and refers to screenshots.

Instruments from the N778xBD series comprise an integrated PC, where the polarizationNAVIGATOR™ software will run in a compact display mode, optimized for touch-screen control, which will be called Integrated PC Mode throughout this manual. Therefore you will often find pairs of screenshots, one of them referring to the External PC Mode, the other one referring to the Integrated PC Mode. In most cases, the functions are exactly the same in both modes, but for better accessibility they may be rearranged.

System Requirements

Light source with single mode fiber output (connector: FC/APC or FC/PC, depending on instrument input). In case of an N7782B with option #101, #401 or #501 such a source is included.

Personal Computer (included with instruments of the N778xBD family):

- Intel Pentium III, 700 MHz or higher
- Windows 10, Windows 7 or Windows XP SP2 (32 bit)

If connected via USB:

- Available USB (1.1 or higher)

If connected via GPIB:

- VISA-compliant GPIB interface
- VISA driver (usually shipped with the interface)

Unpacking the N778xB/BD

- Unpack your shipment.
- Inspect the shipping containers for damage.
- Inspect the instruments.
- Verify that you received the options and accessories that you ordered.

Keep the shipping containers and cushioning material until you have inspected the contents of the shipment for completeness and have checked the equipment mechanically and electrically. In addition to the respective instruments the shipment should contain:

N7783B

- 12V power supply
- Power cable
- Expansion cable
- Additional documents

N778xB (except N7783B)

- Power cable
- USB cable
- BNC cable (N7788B only)
- Analog-In cable, p/n N7784-61601 (N7784B only)
- Expansion port trigger cable, p/n N7786-61601 (N7786B only)
- CD: includes User Guides and software
- Getting Started Guide
- Additional documents

N7781BD / N7788BD (discontinued)

- Power cable
- BNC cable (N7788BD only)
- User Guide
- Additional documents

Refer also to the contents list of the N778xB/BD shipment.

If anything is missing or defective, contact your nearest Keysight Technologies sales office. If the shipment was damaged, contact the carrier, then contact the nearest Keysight Technologies sales office.

Connectors and Controls

The following sections provide an overview of the optical and electrical connectors, as well as the control elements of the N778xB/BD instruments. Throughout this document you will find references to the connectors and controls shown in the respective figures.

N7781B Front Panel

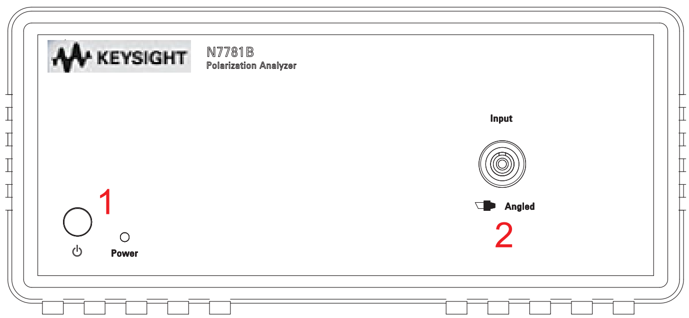


Figure 11 N7781B Front Panel

1 Power button and power LED

2 Optical connector - Polarimeter Input (SMF)

N7782B Front Panel

Standard Option (No Internal Laser Source)

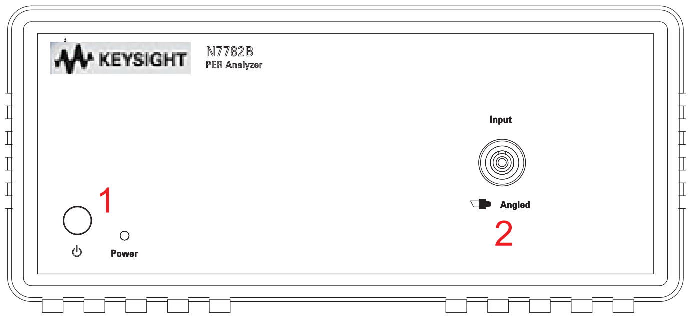


Figure 12 N7782B Front Panel

1 Power button and power LED
2 Optical connector - Analyzer Input (SMF)

Option 401, 501, 101 (With Internal Laser Source)

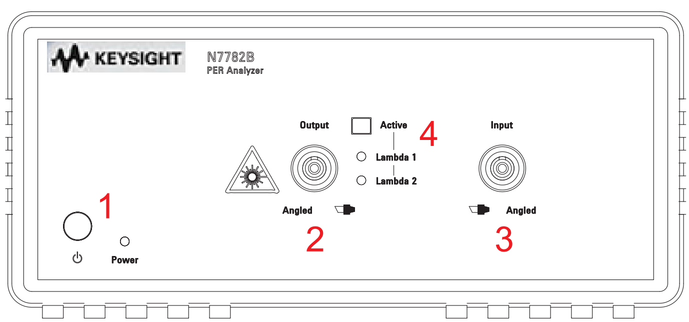


Figure 13 N7782B Front Panel with internal laser source

1 Power button and power LED
2 Optical connector - Laser Output (SMF)
3 Optical connector - Analyzer Input (SMF)
4 Laser switch and laser operation LED

N7784B Front Panel

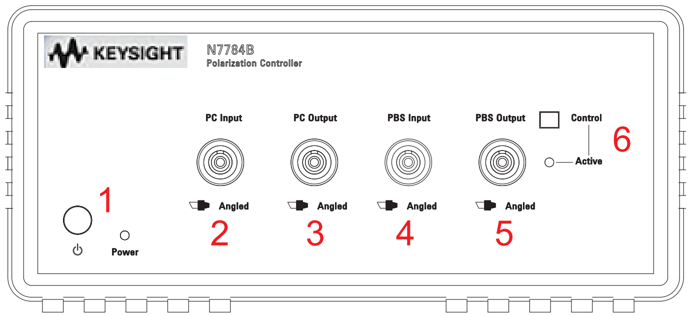


Figure 14 N7784B Front Panel

1 Power button and power LED
2 Optical connector - LiNbO3 polarization controller (PC) Input (SMF)
3 Optical connector - LiNbO3 polarization controller (PC) Output (SMF)
4 Optical connector - Polarization beam splitter (PBS) Input (SMF)
5 Optical connector - Polarization beam splitter (PBS) Output (PMF)
6 Control button and control operation LED

N7785B Front Panel

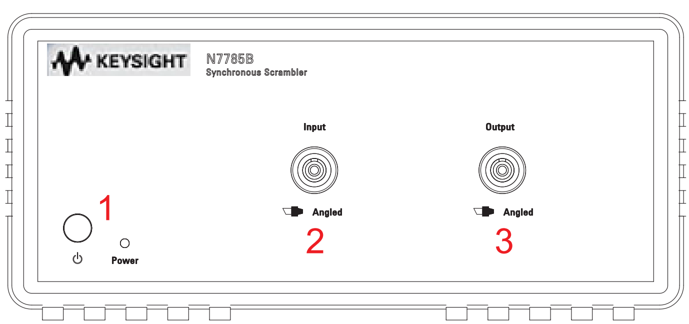


Figure 15 N7785B Front Panel

1 Power button and power LED
2 Optical connector - Synchronous Scrambler Input (SMF)

3 Optical connector - Synchronous Scrambler Output (SMF)

N7786B Front Panel

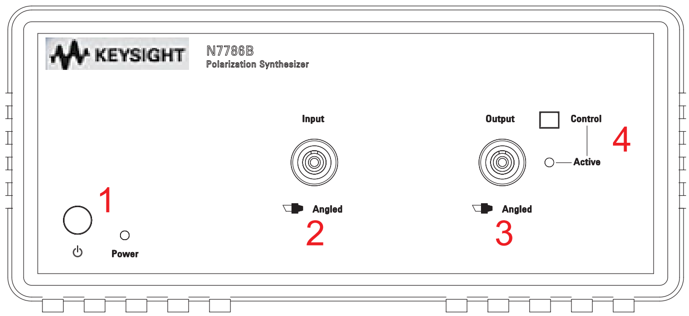


Figure 16 N7786B Front Panel

1 Power button and power LED
2 Optical connector - Polarization Synthesizer Input (SMF)
3 Optical connector - Polarization Synthesizer Output (SMF)
4 Control button and control operation LED

N7788B Front Panel

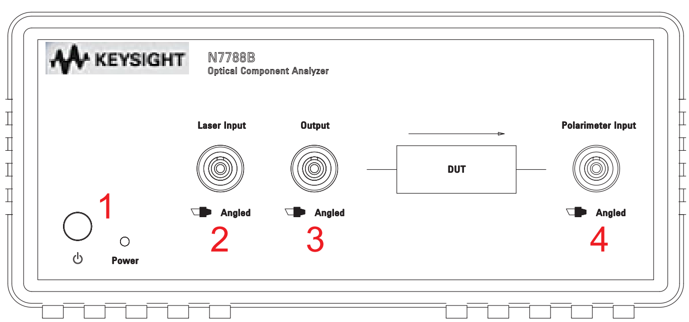


Figure 17 N7788B Front Panel

1 Power button and power LED
2 Optical connector - Laser Input (SMF)

3 Optical connector - LiNbO3 polarization controller (PC) Output (SMF)

4 Optical connector - Polarimeter Input (SMF)

N778xB Rear Panel

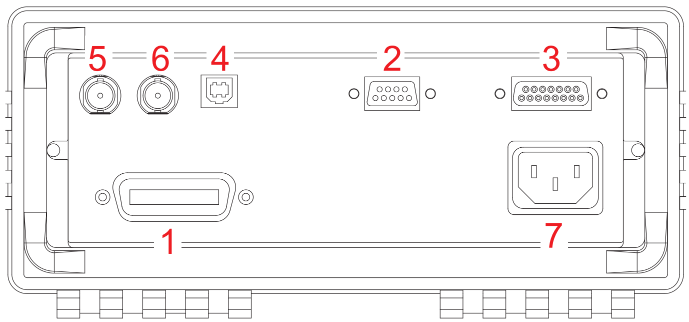


Figure 18 N778xB Rear Panel

1 IEEE 488.2 connector (GPIB)

2 Service connector

3 Expansion connector (e.g. used for Trigger #2, Analog-Input, Analog-Output, control of N7783B Thermal Cycling Units, see Expansion Port Connector Pinout on page 142)

4 USB connector

5 Trigger Input #1, TTL-Compatible (see Digital Inputs on page 144)

6 Trigger Output, TTL-Compatible (see Digital Outputs on page 144)

7 Power Cord Input (see Power Supply Information and Environmental Conditions on page 143)

N7783B Rear Panel

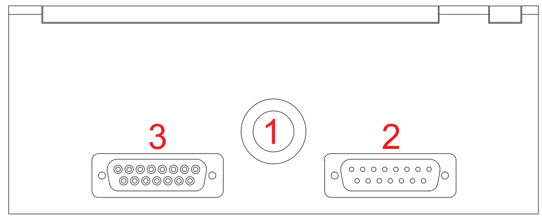


Figure 19 N7783B Rear Panel

1 Power Supply input (see Power Supply Information and Environmental Conditions on page 143)
2 Expansion input (connect to N778xB/BD)
3 Expansion output (can be used to connect a second N7783B)

N7781BD Front Panel

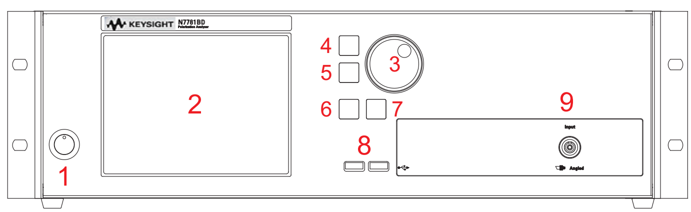


Figure 20 N7781BD Front Panel

1 Power button
2 Touch screen
3 Modify knob
4 Escape (ESC) button
5 Accept (OK) button
6 Cursor left button
7 Cursor right button
8 USB connector (compliant with USB2.0)
9 Optical connector - Polarimeter Input (SMF)

N7788BD Front Panel

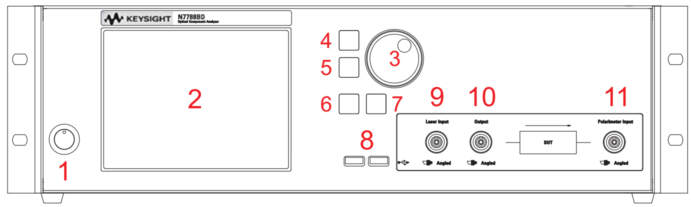


Figure 21 N7788BD Front Panel

1 Power button
2 Touch screen
3 Modify knob
4 Escape (ESC) button
5 Accept (OK) button
6 Cursor left button
7 Cursor right button
8 USB connector (compliant with USB2.0)
9 Optical connector - Laser Input (SMF)
10 Optical connector - Polarization Controller Output (SMF)
11 Optical connector - Polarimeter Input (SMF)

N778xBD Rear Panel

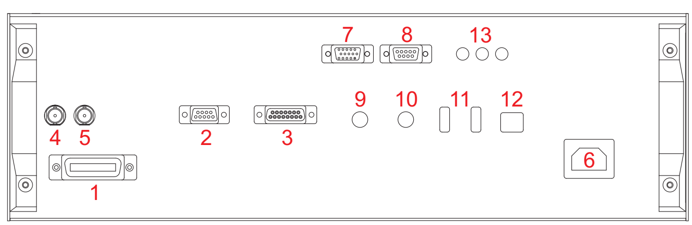


Figure 22 N778xBD Rear Panel

1 IEEE 488.2 connector (GPIB)
2 Service connector

3 Expansion connector (e.g. used for Trigger #2, Analog-Input, Analog-Outputs, control of N7783B Thermal Cycling Units)

4 Trigger Input #1, TTL-Compatible (see Digital Inputs on page 144)

5 Trigger Output, TTL-Compatible (see Digital Outputs on page 144)

6 Power Cord Input (see Power Supply Information and Environmental Conditions on page 143)

7 VGA output

8 RS 232 connector (Use standard 9-pin extension cable for connection to RS 232-controlled device)

9 PS/2 keyboard connector

10 PS/2 mouse connector

11 USB connector (compliant with USB2.0)

12 LAN connector (10/100MBit/s)

13 Audio connectors (not supported)

Software Installation/Software Updates

Install the software before you plug-in the hardware

The N778xB/BD instruments come with the polarizationNAVIGATOR™ software to provide optimum performance. All drivers and supplements are included in the installation package.

This section explains how to install the Photonic Application Suite and the polarizationNAVIGATOR™ on your computer.

NOTE You need administrative permissions to install the *Photonic Application Suite* and the polarizationNAVIGATOR™.

The polarizationNAVIGATOR™ is now part of the Photonic Application Suite, which is a framework of measurement engines for various applications.

The polarizationNAVIGATOR™ requires the Photonic Application Suite (Main) package to be installed, which contains a number of common elements.

NOTE Please install the Photonic Application Suite (Main) package before you plug in any Keysight N778xB instrument(s) to the USB port of the PC! This ensures that the drivers are available when you plug-in the instrument(s). If you have connected the instrument(s) prior to software installation, you may have to delete the instrument(s) manually from the Windows Device Manager. This does not apply to instruments that are connected via GPIB.

The polarizationNAVIGATOR™ software is pre-installed on N778xBD instruments.

To install the polarizationNAVIGATOR™ on a personal computer for use with N778xB instruments use the CD supplied with the instrument, or download the Package Manager from the webpage www.keysight.com/find/n7700

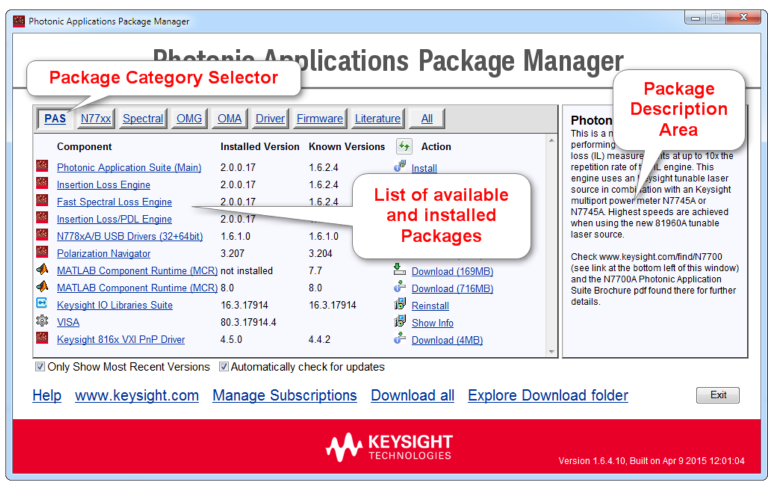
The Package Manager software is used to install and update the different packages of the Photonic Application Suite, including the polarizationNAVIGATOR™.

The Package Manager should start automatically once you put the CD into the drive. Otherwise run “setup.exe” from the CD root directory.

If you downloaded the Package Manager from the Keysight website run “setup.exe” from the download folder.

NOTE

If an Internet connection is available, the Package Manager will check whether newer packages are available on the Keysight Update Server. Using the same mechanism, the Package Manager will update itself if a newer version is found on the Update Server.



NOTE

Click the Help link on the bottom left of the Package Manager window to access instructions and troubleshooting tips for using the Package Manager.

The Package manager lists all known packages and shows which version of each of the packages is installed on your PC, if any. It also lists all packages that are available for download or installation.

The packages are grouped into categories like “Driver” and “Literature”. Click on the group buttons to show only packages belonging to that group.

When moving the mouse cursor over the names in the “Components” column, a description of this package is shown in the package description area. When moving the mouse cursor over the links (download/install) or the version numbers of the “Known Versions” column, release notes (if available) and specific information (like missing requirements) for this package are displayed in the package description area.

The “Known Version” number is colored green, if there is a version available that is newer than the one currently installed.

To the right there is a list of available actions for each of the packages:

- Download

  If your computer is connected to the Internet, the Package Manager will check for the latest available versions and show the action “Download” for any available packages. The size of the compressed package is listed for each one. Once download is complete, the Package Manager checks the file integrity.

  If you’ve downloaded a package in the past or you’re running the Package Manager from CD, the packages don’t need to be downloaded.

- Install

  By pressing install, the package will be uncompressed and the installer will be launched.

- Show Info

  Some packages do not contain an installer, but documents instead. By pressing Show Info, these documents will be shown (e.g. text files).

- Not available

  There may be package versions known to the Package Manager that are no longer available on the Update Server and that have not been downloaded to your PC before. Those packages are listed, but no action is available.

NOTE Certain packages require other packages to be installed. Once you installed a package that requires one or more other packages, those packages will be indicated by an arrow to the right of the action list. It is strongly recommended to install all these packages as well before running any applications.

NOTE By removing the “Only Show Most Recent Versions” checkmark, all known and available package versions are listed.

NOTE By default some of the applications of this suite will check regularly whether updates are available on the Keysight Update Server (requires Internet access). To disable this feature, remove the “Automatically Check for Updates” checkmark.

There are a number of functions at the bottom of the Package Manager Window:

- www.keysight.com/find/N7700

  Show Photonic Application Suite product website including ordering information (Internet access required).

- Manage Subscriptions

  Enter or remove access codes for accessing restricted packages (Internet access required).

- Download All

  Download all packages visible in the current group, if they are newer than the installed ones (Internet access required).

- Explore Download Folder

  Delete files from the 'Packages' folder to free disk space.

NOTE

Please install the Photonic Application Suite (Main) before you plug in any Keysight N778xB instrument(s) to the USB port of the PC. This ensures that the drivers are available when you plug-in the instrument(s). If you have connected the instrument(s) prior to software installation, you may have to delete the instrument(s) manually from the Windows Device Manager. This does not apply to instruments that are connected via GPIB.

Connect the Instrument

Install the software before you plug-in the hardware

If you have installed the software, you can connect the instrument to your computer.

Instruments of the N778xBD family don't require an external computer and therefore this section does not apply. To connect N778xB instruments to your personal computer there are two options:

- Use the USB interface (preferred)
- Use the GPIB interface

Connecting the Instrument to the USB Interface

Connect the instrument to the computer and power it up if you have not yet done so. Depending on the type of instrument, you may have to wait up to 20 seconds until the instrument has finished the boot-up phase.

The driver is not signed - Please install anyway.

On first installation, WINDOWS will come up with a message stating that the driver is not signed. Please install the driver anyway.

After the driver installation is complete, start the polarizationNAVIGATOR™ software.

NOTE When an N778xB instrument is connected to the USB bus, it will not be listed in the Keysight Connection Expert.

Starting with revision 1.5 of the Photonic Application Suite, we are using the libusb-win32 driver package (details at the end of this section). The main reason for this change is the availability of this driver package for 64bit operating systems.

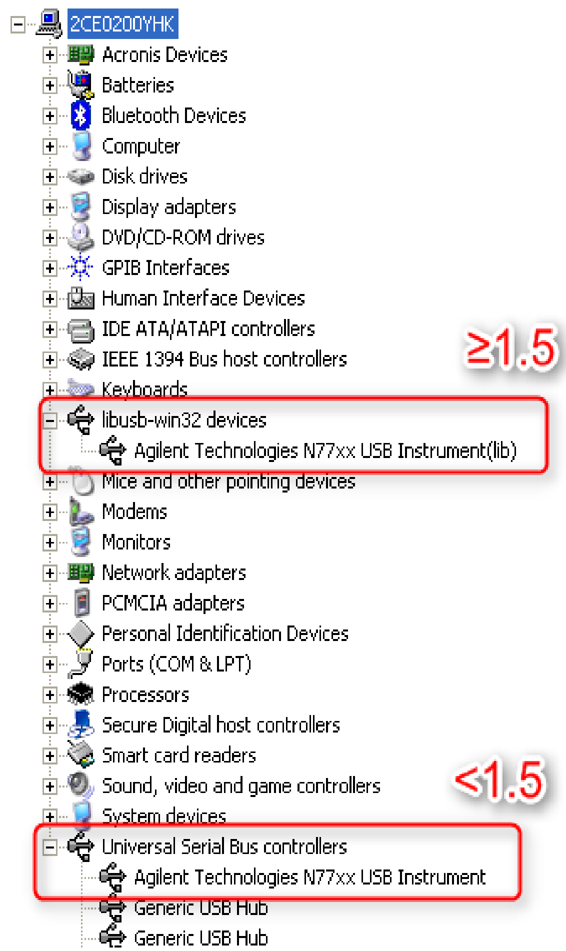
NOTE If you want to revert to a version of the Photonic Application Suite less than 1.5, the old USB drivers will be installed on the PC again, but they are not necessarily applied to N778x instruments. Below you will find instructions on how to apply the correct drivers.

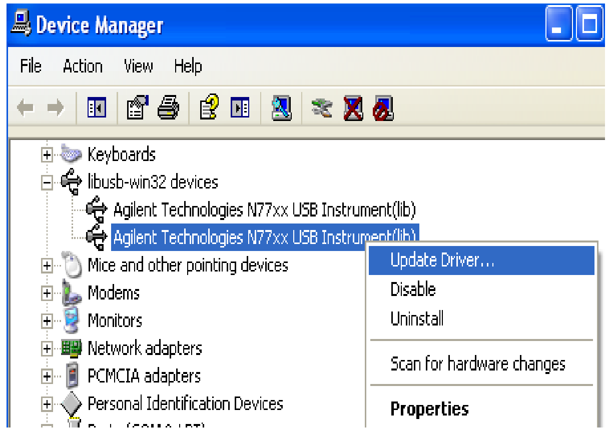
If you connect an N778x instrument through USB to the PC (power it up and wait until it is recognized by Windows) and is not recognized by the Photonic Application Suite software, please check the computer's Device Manager (in Windows XP: right-click **My Computer**, then select **Properties**, then switch to tab **Hardware**, then click **Device Manager**).

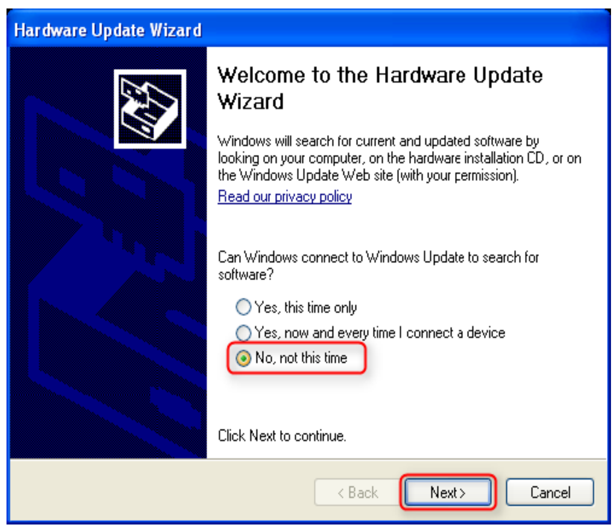
If USB drivers have been installed for the corresponding instrument with a PAS revision less than 1.5 installed on the PC, they will be listed as **Keysight Technologies N778x USB Instruments** in the section **Universal Serial Bus controllers**.

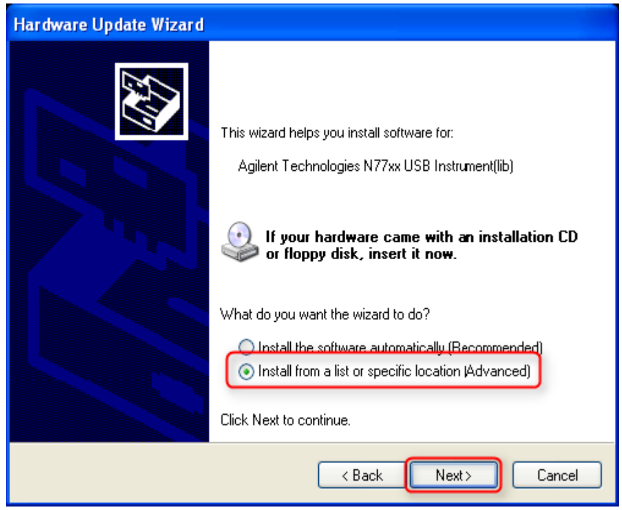
If USB drivers have been installed for the corresponding instrument with a PAS revision 1.5 or higher installed on the PC, they will be listed as **Keysight Technologies N778x USB Instruments (lib)** in the section **libusb-win32 devices**.

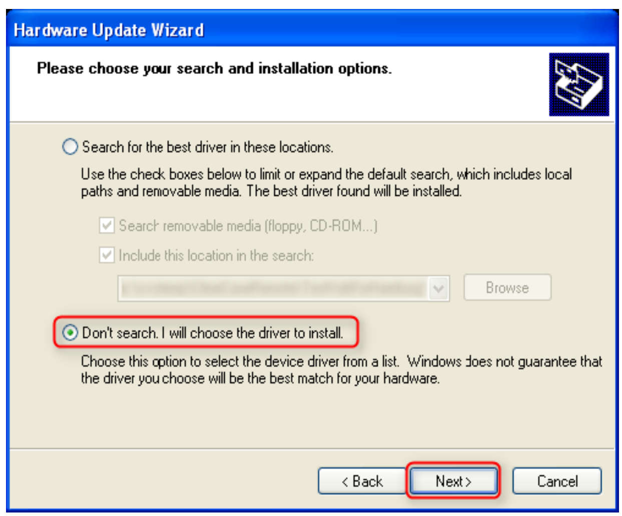
You can manually change the associated drivers from the Windows Device Manager as shown in the following pictures.

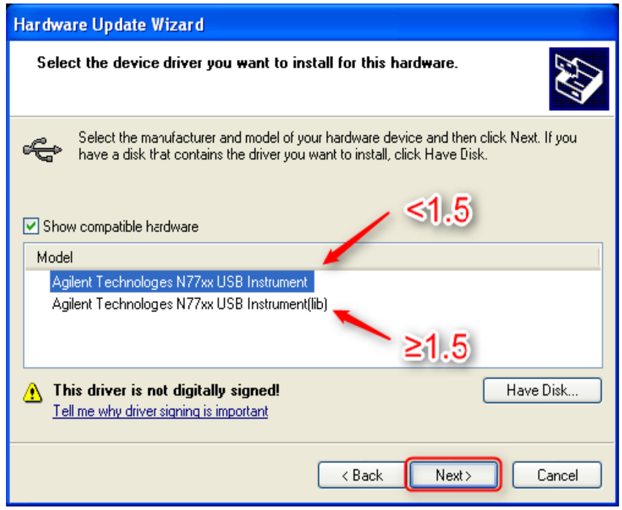

2CE0200YHK
Acronis Devices
Batteries
Bluetooth Devices
Computer
Disk drives
Display adapters
DVD/CD-ROM drives
GPIB Interfaces
Human Interface Devices
IDE ATA/ATAPI controllers
IEEE 1394 Bus host controllers
≥1.5
Keyboards
libusb-win32 devices
Agilent Technologies N77xx USB Instrument(lib)
Mice and other pointing devices
Modems
Monitors
Network adapters
PCMCIA adapters
Personal Identification Devices
Ports (COM & LPT)
Processors
Secure Digital host controllers
Smart card readers
Sound, video and game controllers
<1.5
System devices
Universal Serial Bus controllers
Agilent Technologies N77xx USB Instrument
Generic USB Hub
Generic USB Hub


Device Manager
File Action View Help
Keyboards
libusb-win32 devices
Agilent Technologies N77xx USB Instrument(lib)
Agilent Technologies N77xx USB Instrument(lib)
Mice and other pointing devices
Modems
Monitors
Network adapters
PCMCIA adapters
Personal Identification Devices
Update Driver...
Disable
Uninstall
Scan for hardware changes
Properties


Hardware Update Wizard
Welcome to the Hardware Update Wizard
Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).
Read our privacy policy
Can Windows connect to Windows Update to search for software?
Yes, this time only
Yes, now and every time I connect a device
No, not this time
Click Next to continue.
< Back
Next >
Cancel


Hardware Update Wizard
This wizard helps you install software for:
Agilent Technologies N77xx USB Instrument(lib)
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel


Hardware Update Wizard
Please choose your search and installation options.
Search for the best driver in these locations.
Use the check boxes below to limit or expand the default search, which includes local paths and removable media. The best driver found will be installed.
Search removable media (floppy, CD-ROM...)
Include this location in the search:
Browse
Don't search. I will choose the driver to install.
Choose this option to select the device driver from a list. Windows does not guarantee that the driver you choose will be the best match for your hardware.
< Back
Next >
Cancel



NOTE

When reverting to the <1.5 drivers, there may be a warning about the drivers not having passed Windows Logo testing. If so, please click **Continue Anyway** to complete the operation.

NOTE

Libusb- win32 is a library that allows userspace application to access USB devices on Windows operation systems

(Win2k, WinXP, Vista, Win7).

It is derived from and fully API compatible to libusb available at http://libusb.sourceforge.net.

The complete license document will be displayed by running the USB driver installer from the Package Manager.

For more information visit the project's web site at:

http://libusb- win32.sourceforge.net

http://sourceforge.net/projects/libusb- win32

Connecting the Instrument to the GPIB Interface

VISA has to be installed.

Use a standard GPIB cable to connect the N778xB/BD to the PC. On the PC, VISA has to be installed to provide the GPIB functionality. Usually VISA comes with your GPIB board, but may not be automatically installed on your system. Check your GPIB board's driver CD or contact the vendor of your GPIB interface for more information about VISA. Keysight VISA is provided by the IO Libraries Suite, which can be installed from the Package Manager.

The default GPIB address is 30. Please refer to Changing the GPIB Address on page 60 on how to change the GPIB address. You can check the correct installation if you turn on the instrument and wait for some seconds. Start the Keysight Connection Expert or the National Instruments Automation Explorer on your PC and scan for new instruments. The instrument should be detected on address 30.

NOTE

You have to quit the Polarization Navigator software on the N778xBD to put the GPIB port into non-controller mode. Only in this mode can you control the instrument from outside. Otherwise the N778xBD uses the GPIB port as controller port to control other instruments such as tunable laser sources.

NOTE

When an N778xB instrument is connected to the GPIB bus, the Keysight Connection Expert will display a warning icon next to it. You can safely ignore this warning. Clearing this warning from the instrument’s details view won’t prevent it from reoccurring immediately afterwards.

Connecting Tunable Laser Sources

Connect your TLS to the GPIB port of the N778xB/BD.

The polarizationNAVIGATOR™ software can communicate with Keysight Tunable Laser Sources (TLS) either via the instrument's GPIB port (in that case the instrument's GPIB port is used as GPIB-Master, see Using the N778xB/BD GPIB Interface (Remote GPIB) on page 59 for details) or via a GPIB board installed in your PC.

Connect the TLS to the appropriate interface, turn it on and run the Configuration Wizard. The TLS should then be listed under "Misc. Instruments".

Don't forget the BNC trigger cable!

Some laser sources need a trigger cable connected to the N778xB/BD. Refer to Measurement Setup on page 99 for details on how to connect the trigger cable.

Run the Configuration Wizard

Now that the software is installed and the instrument is connected and turned on, you can start the polarizationNAVIGATOR™ software and run the **Configuration Wizard**.

On first startup the **Configuration Wizard** will come up automatically. If you want to rerun the **Configuration Wizard**, you can click on the button named **Wizard** or click on **Tools** > **Configuration Wizard** in the menu.

Please follow the instructions shown in the dialog box.

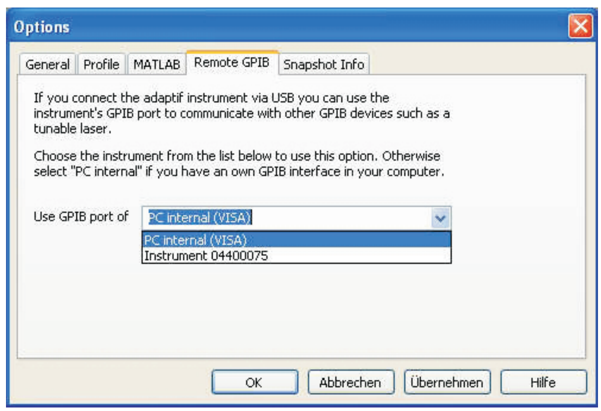
Instruments of the N778xBD family only require execution of the **Configuration Wizard** if external devices are connected via GPIB (e.g. tunable laser sources).

Using the N778xB/BD GPIB Interface (Remote GPIB)

The N778xB/BD instrument can be used as GPIB-Master to control third-party instruments. This mode is referred to as Remote GPIB. In that case, the N778xB/BD has to be connected to the PC via the USB port.

We recommend connecting your GPIB instrument to the GPIB port of the N778xB/BD instrument and running the Configuration Wizard.

Go to **Tools** > **Options** > **Remote GPIB** to change the settings manually. If you have one or more N778xB/BD instrument connected to your PC via USB, you can select the instrument you want to use as remote GPIB interface by its accordant serial number listed in the drop-down menu. For using the internal GPIB interface of an external computer please choose PC internal (VISA).



NOTE The polarizationNAVIGATOR™ software fully supports the remote GPIB port. However, it does not behave like a standard GPIB interface for other software such as LabView™.

Changing the GPIB Address

The default GPIB address of the N778xB/BD is set to 30. To change the GPIB address, proceed as follows:

- Make sure that the N778xB/BD is the only instrument connected to the GPIB interface and turn it on.
- Start the polarizationNAVIGATOR™
- If the instrument is not yet listed in the browser tree click on **Tools** > **Scan for Instruments** and scan for new **GPIB** instruments. If not shown automatically, the browser bar can be accessed from the **View** menu. The instrument should be detected with its current GPIB address (factory setting: 30). One or more new items appear in the browser tree representing the instrument. Some instruments are listed as Polarimeters, as Polarization Controllers, as both or as Misc. Instruments. The N7783B is not listed as an individual instrument.
- Show the properties dialog of the instrument by right-clicking on its item and choosing **Properties**
- Click on **Change at Device** on the Interface-Tab.
- Enter new GPIB address (10..30) and click on **OK**.
- Turn the instrument off and back on to apply the changed address.
- In the **Properties** dialog click on **OK**.
- Run the **Configuration Wizard** again.

Options

Table 4 Keysight Options 1

Keysight Option No	Narrative Description
N7781B	Polarization Analyzer
N7781B-300	Polarization Analyzer, 1270nm to 1375nm
N7781B-400	Polarization Analyzer, 1270nm to 1375nm and 1460nm to 1620nm
N7781B-500	Polarization Analyzer, 1460nm to 1620nm
N7781B-021	straight contact connector
N7781B-022	angled contact connector
N7782B	PER-Analyzer
N7782B-101	PER-Analyzer, 850nm to 1000nm with 850nm VCSEL
N7782B-400	PER-Analyzer, 1270nm to 1375nm and 1460nm to 1620nm
N7782B-401	PER-Analyzer, 1270nm to 1375nm and 1460nm to 1620nm with 1300nm / 1550nm dual VCSEL
N7782B-500	PER-Analyzer, 1460nm to 1620nm
N7782B-501	PER-Analyzer, 1460nm to 1620nm with 1550nm VCSEL
N7782B-021	straight contact connector
N7782B-022	angled contact connector
N7783B	Thermal Cycling Unit
N7784B	Polarization Controller
N7784B-021	straight contact connector
N7784B-022	angled contact connector
N7785B	Synchronous Scrambler
N7785B-021	straight contact connector
N7785B-022	angled contact connector
N7786B	Polarization Synthesizer

Keysight Option No	Narrative Description
N7786B-400	Polarization Synthesizer, 1270nm to 1375nm and 1460nm to 1620nm
N7786B-500	Polarization Synthesizer, 1460nm to 1620nm
N7786B-021	straight contact connector
N7786B-022	angled contact connector
N7788B	Optical Component Analyzer
N7788B-300	Optical Component Analyzer, 1270nm to 1375nm
N7788B-400	Component Analyzer, 1270nm to 1375nm and 1460nm to 1620nm
N7788B-500	Optical Component Analyzer, 1460nm to 1620nm
N7788B-021	straight laser input Port
N7788B-022	angled laser input Port
N7788B-031	straight DUT Port
N7788B-032	angled DUT Port

Table 5 Keysight Options 2

Keysight Options No	Narrative Description
N7781BD	Polarization Analyzer
N7781BD-300	Polarization Analyzer, 1270nm to 1375nm
N7781BD-400	Polarization Analyzer, 1270nm to 1375nm and 1460nm to 1620nm
N7781BD-500	Polarization Analyzer, 1460nm to 1620nm
N7781BD-021	straight contact connector
N7781BD-022	angled contact connector
N7788BD	Optical Component Analyzer
N7788BD-300	Optical Component Analyzer, 1270nm to 1375nm
N7788BD-400	Component Analyzer, 1270nm to 1375nm and 1460nm to 1620nm
N7788BD-500	Optical Component Analyzer, 1460nm to 1620nm
N7788BD-021	straight laser input Port
N7788BD-022	angled laser input Port
N7788BD-031	Straight DUT Port
N7788BD-032	Angled DUT Port

Operating N778xB/BD instruments

When the polarizationNAVIGATOR™ is started it will not automatically perform any measurements. The application bar will list all installed applications, while the browser window will show an icon for each N778xB/BD or supported external instrument (e.g. tunable laser sources) that has been either added by using the **Configuration Wizard** or added and configured manually and that can be directly interacted with. The N7783B for example will not be listed here.

The browser window can be shown or hidden, by setting or removing the checkmark in front of the **browser bar** entry in the **View** menu. The installed applications are listed in the **Applications** section of the browser bar, in case of an N778xB, and in the top button row, in case of an N778xBD. If an application is activated, it will automatically activate the associated and required instruments. From the browser bar, an application is activated by double-clicking or by choosing **Activate** from the context menu. In the GUI of an N778xBD instrument, a single click on the buttons in the top row will activate the application. In case you have several similar instruments connected to the PC that the polarizationNAVIGATOR™ is running on, you might want to activate individual instruments from the browser bar.

A green arrow indicates that an instrument is activated, i.e. communication has been established. Before using an instrument with the polarizationNAVIGATOR™ it has to be activated either directly or by activating the corresponding application. An application may activate several instruments at once, which will be indicated by a yellow lock symbol.

Double-click on an instrument to activate it (or click on activate in its context menu). The polarizationNAVIGATOR™ can activate instruments automatically at startup. To use this feature, check **Activate On Startup** in the instruments context menu. After activation, a green arrow should appear on the icon of the instrument in the browser bar.

In the browser bar there will appear sub-items below an activated instrument or application, allowing you to choose between different types of view of the acquired data, as well as providing access to instrument or application specific settings.

The PMD/PDL/Loss- Application, for instance, will activate a tunable laser source and N778xB/BD instruments for polarization analysis and polarization control. If any of the instruments required for the specific application is missing, there will be an error message and the application won't open. This may also occur if the application has been used with a different instrument that is no longer available.

NOTE

You can add applications by right-clicking the root of the application-node and selecting "add". To reset the linkage of an application to certain instruments, you can delete the application using the "delete" key and re-adding it. On next activation, the application will try to find the necessary instruments again.

Refer to Application: Polarimeter on page 74 for a detailed description of the polarimeter functions.

Refer to Application: PMD/PDL (PMD/PDL/Loss) on page 87 for a detailed description of the component test functions, i.e. Loss, PMD, PDL measurement.

Refer to Application: PER/PMF Crosstalk on page 103 for a detailed description of the functions for measuring the polarization extinction ratio in a polarization maintaining fiber and for measuring the splicing angle between two polarization maintaining fibers.

NOTE

A proper light source has to be connected to the instrument for performing measurements. N7782B with certain options already includes such a laser source.

Operating N778xBD instruments

Use the supplied power cable to connect the instrument to a power socket. Depending upon the previous state of the instrument it may power up immediately. Otherwise push the button at the left of the instruments front plate. The computer will boot Windows and will auto-login with administrative privileges. In case you need to login manually, use:

User: **Administrator**

Password: **sphere314**

The polarizationNAVIGATOR™ software will start up automatically after login. Once closed, it can be started manually using the icon on the desktop or the entry in the start menu.

Throughout the system the touch screen acts as a mouse. For right click operations there is an always-on-top icon, which will turn the next touch to a right-click touch. If this icon is not on the screen it can be reactivated from the system tray by clicking on the pm-icon and setting a mark next to the **Right** button. You will have to quit the polarizationNAVIGATOR™ in order to access the system tray.

In addition, the knob on the front plate can be used for cycling through lists of buttons and for changing numerical values. Pressing the wheel is similar to pressing the **OK** button and will push a button or accept a numerical value. The **ESC** key will toggle between menu access (File, Edit, View, etc.) and button access and it will abort changing numerical values. The **Left Arrow** and **Right Arrow** buttons will switch between different graphs (PMD, PDL, DOP, Stokes-Parameters, etc.) and will change the cursor position in dialog boxes. For most dialogs, special on-screen-keyboard-dialogs will appear. In case you need to enter additional characters, Windows provides an always-on-top on-screen keyboard, which can be activated by pressing the wheel twice in quick succession. For using this feature, the polarizationNAVIGATOR™ has to be running. A link to the on-screen keyboard is placed on the desktop, which can be used otherwise. When powering up the instrument, it will log on automatically. To login again after logging out, you can use the on-screen keyboard which is displayed at the bottom of the login screen. Enter username and password provided at the beginning of this section.

Furthermore, USB and PS/2 keyboards and mice can be connected to the N778xBD.

Using any of these controls, choose an application and use the control buttons for setting the specific parameters and controlling the application. Usually the horizontal row of buttons switches between several subsets of functions or parameters, which are then listed as a column of buttons to the right. There may be more items in a horizontal or vertical set than buttons. In this case **More** will be among the set of buttons. Usually you will find an **Exit** button, which will stop the active application. The actual parameters and functions are similar to those described in the specific chapters of the manual (N7781B/BD: see Application: Polarimeter on page 74 and N7788B/BD: see Application: PMD/PDL (PMD/PDL/Loss) on page 87).

Network Access

Measurements are stored in *D:\My Documents\My PolarizationNavigator Files* and *D:\My Documents\My PolarizationNavigator History*.

You can access these files from a remote computer by using the Windows Explorer, the Internet Explorer or an FTP client. When connected through a local area network, you can use the instruments name, which is its serial number to access the folders, e.g.:

```
ftp://DE47800301/Measurements/
ftp://DE47800301/History/
```

When connected through the Internet, you have to use the IP address of the instrument to access the folders, e.g.

```
ftp://192.168.0.1/Measurements/
ftp://192.168.0.1/History/
```

For accessing these folders, you have to login with the following information

User: **Administrator**

Password: **sphere314**

NOTE You can find the IP address of the instrument by using the corresponding polarizationNAVIGATOR™ function from the Tools menu or by running the `ipconfig` command from the command prompt if you have a keyboard connected.

NOTE When using the Internet Explorer, you have to make sure that FTP is set to active mode. You can do this by opening the menu Tools, choosing **Internet Options...**, selecting the tab **Advanced** and removing the mark from **Use passive FTP (for Firewall and DSL modem compatibility)** in the section **Browsing**. This may also apply when using other FTP tools.

Remote Control

The N778xBD can be controlled remotely. Doing this you can either use the *Remote Desktop Connection* tool of Windows XP or a web interface based on an Active-X control. The N778xBD is configured to listen for remote access requests. Routers and Firewalls have to be configured to allow TCP port 3389 for Remote Desktop access and TCP port 80 for the web based interface.

Remote Desktop Connection Tool

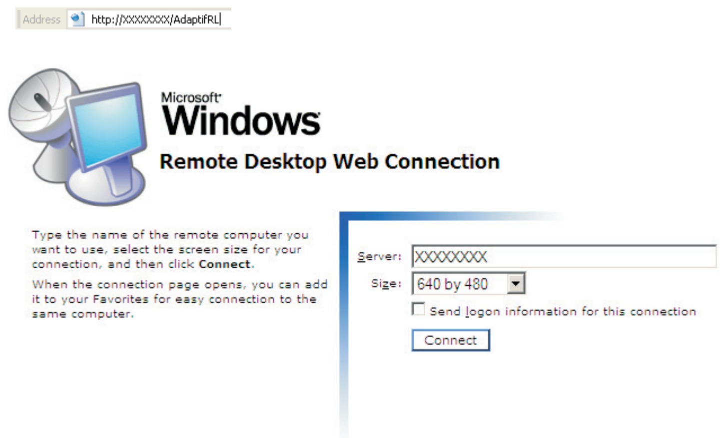
On the computer from which you want to remote-control the instrument open the start menu and run **Programs** > **Accessories** > **Communications** > **Remote Desktop Connections**. If the instrument is in the same local network it can be addressed by the instruments serial number of the instrument (e.g. DE48200001). If the instrument is not in the same local network, you have to enter the IP address of the instrument instead of its name. You then are prompted with the remote login screen and have to login as administrator.

User: **Administrator**

Password: **sphere314**

Web-Interface

You can use the Internet explorer to connect to the IP address of the instrument at port 80 and choosing the sub-folder called agilentRL (e.g. http://192.168.1.1:80/agilentRL). For using the remote control access you need a certain Active-X plugin provided by Microsoft, which will be installed automatically the first time you visit this URL.



You will then be prompted to enter the server name, i.e. its IP address, if you connected using the IP address or the instruments serial number (e.g. DE47800301) if you connected using the instruments name. In addition you can choose the screen resolution (640x480 is the native resolution of the instrument). After pressing Connect you have to press space or a mouse button to gain control of the remote instrument. You then are prompted with the remote login screen and have to login as administrator.

User: **Administrator**

Password: **sphere314**

You can create a link like this

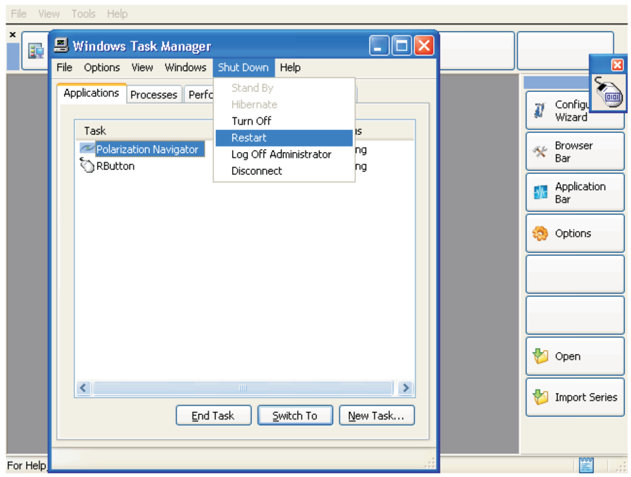
http://x.x.x.x/agilentRL/?Server=x.x.x.x&AutoConnect=1&FS=1

to skip the configuration screen, where x.x.x.x is the IP address or the name of the remote instrument.

NOTE There may appear an error message in your browser window if you choose **Full Screen** and have the desktop resolution of the computer that you're logging on to the N778xBD with set to a very high resolution. Try logging in while choosing a lower resolution in the web interface or by changing the desktop resolution of the computer that you're logging in with.

Rebooting the Remote System

You can force a reboot of the remote instrument by pressing **CTRL-ALT-END** in the remote session and then select **Shut Down** > **Restart**.



Recovery Console

The N778xBD instruments provide an emergency recovery tool. If the system is corrupted, you can connect a keyboard to the instrument and press **ESC** during the boot process. You will be prompted to do so while still in text mode. You can then select the **Recovery Console** from the boot menu and will be guided through the recovery process. This recovery tool will only recover the C:\ drive, i.e. the system drive. It will reset the polarizationNAVIGATOR™ to the version the instrument has been delivered with. Therefore the polarizationNAVIGATOR™ may prompt you for updating the instruments firmware, if you have performed any updates since purchasing the instrument. You will have to re-apply any such updates after the recovery. The D:\ drive, which contains your measurements, will not be modified during the recovery.

4 Applications

General

Shown in the following sections are, among other information, screenshots of the polarizationNAVIGATOR™ software running in the Integrated PC Mode, which is used for instruments of the N778xBD series. When clicking buttons from the top row in this mode, the button columns to the right will change. Sometimes there are more function buttons than the number of available slots in the respective row or column. In that case there will be a button labeled **More...**, which will replace the row/column with another set of buttons. If the polarizationNAVIGATOR™ is running on a desktop or notebook PC with N778xB/BD instruments connected to it, it will be running in External PC Mode, which basically supports the same functions with a slightly different screen layout. Sections of screenshots from the polarizationNAVIGATOR™ in the External PC Mode are shown for specific functions as well.

Table 6 **Instruments that support certain applications**

Application	Supporting instruments
"Application: Polarimeter"	N7781B/BD, N7786B*, N7788B/BD
"Application: PMD/PDL (PMD/PDL/Loss)"	N7788B/BD
"Application: PMD/PDL/Loss (Stepped)"	N7788B/BD
"Application: PER/PMF Crosstalk"	N7781B/BD, N7782B, N7786B†, N7788B/BD
"Application: Polarimeter Calibration"	N7781B/BD, N7786B, N7788B/BD
"Application: Manual Waveplate Control"	N7784B, N7785B, N7786B, N7788B
"Application: Random Polarization Scrambling"	N7784B, N7785B, N7786B, N7788B
"Application: Sequence Operation"	N7784B, N7785B, N7786B, N7788B
"Application: Continuous Scrambling"	N7784B, N7785B, N7786B, N7788B
"Application: Polarization Stabilization"	N7784B, N7785B, N7786B, N7788B

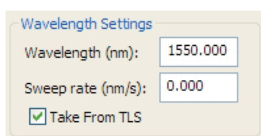
* The N7786B instrument is able to perform all polarimeter operations described in section Application: Polarimeter on page 74. Keep in mind, though, that since the polarimeter of the N7786B is in the monitor path of the device, the optical power at the polarimeter is about one tenth (-10dB) of the power at the polarimeter in an N7781B/BD. This is included in the instruments calibration, so the power readout will be ok, but the minimum input power of the instrument will be increased by about 10dB.

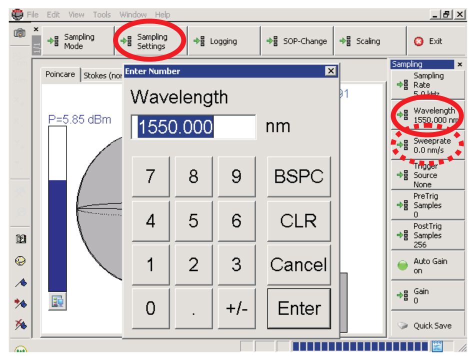
† see previous footnote

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, open the **Settings** window of the N778xB by clicking on the **Settings** entry in the browser window. Enter the wavelength and choose a sweep rate of 0 nm/s. If a TLS is activated[1] and the mark **Take from TLS** is set, the polarimeter wavelength will be updated automatically if the laser wavelength is changed using the polarizationNAVIGATOR™. The polarimeter wavelength will *not* be updated if the laser wavelength is changed at the laser front panel. In the Integrated PC Mode (N778xBD) open the corresponding button subset by clicking **Sampling Settings**.

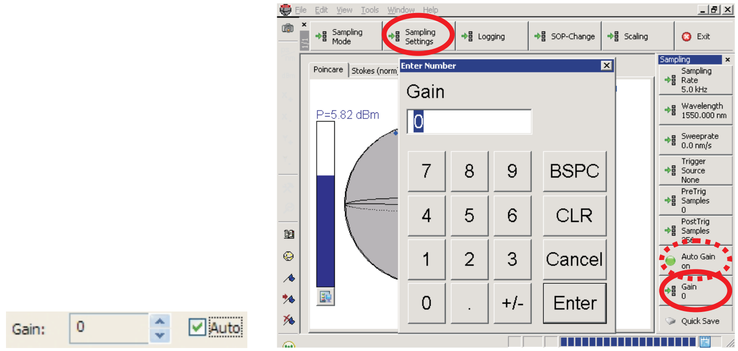




Auto Gaining

To provide a wide range of input power, the polarimetric receiver has 14 different input gain settings (0=lowest sensitivity, 13=highest sensitivity). Usually the instruments choose the correct input gain settings to achieve optimum performance. You can suppress the gain switching by removing the check on the **Auto** field next to the gain display.

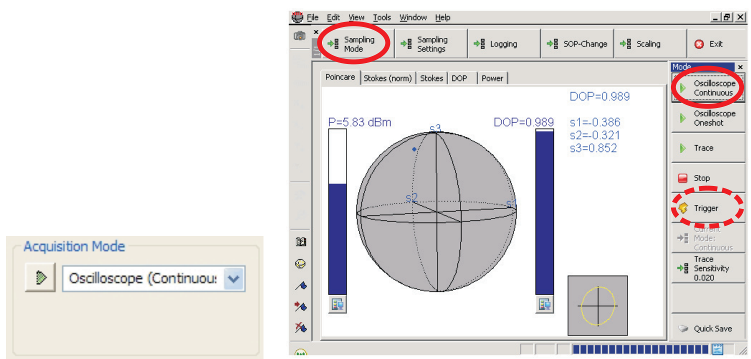
1 This needs to be configured and will be listed under **Misc. Instruments.**



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.



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 manually (re)started by pressing the button next to the list box or by pressing **Trigger**, when using the Integrated PC Mode. To stop measuring in continuous mode select **Hold** from the drop-down menu or by pressing **Stop** respectively.

Triggering

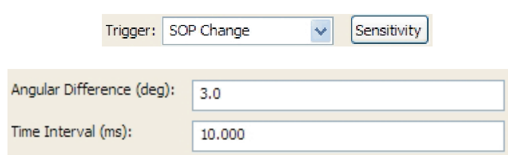
You can synchronize the start of a measurement cycle to certain events such as an external trigger signal.

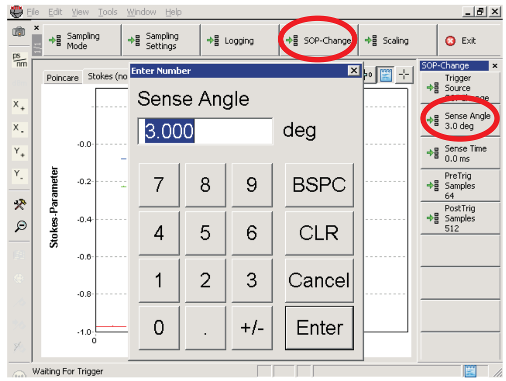
When using an N778xB instrument, trigger settings are configured using the Trigger list box. When using an N778xBD instrument, trigger settings are accessed by pressing the **Trigger Source** button in the Sampling Settings sub-bar.

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).

Choose **SOP Change** if you want to trigger on a changing SOP. You can set the sensitivity by pressing on **Sensitivity**. In the example, a trigger event is detected when the SOP changes by at least 3 degree on the Poincaré sphere within a time interval of 10 ms. Note that in principle you could achieve the same sensitivity by choosing different values (e.g. 1,5 deg and 5 ms). However this may cause false trigger events due to measurement noise.

In the External PC Mode (N778xB) the SOP Change parameters, like angular sensitivity, are accessed by clicking on the **Sensitivity** button, which will show up when the SOP Change mode is active. In the Integrated PC Mode (N778xBD) these settings are located in the SOP Change sub section. You can also set the number of samples to be stored from before the SOP change event (Pre-Trig. Samples) and after the SOP change event (Post-Trig. Samples).





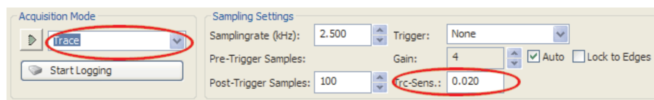
Setting an SOP reference frame

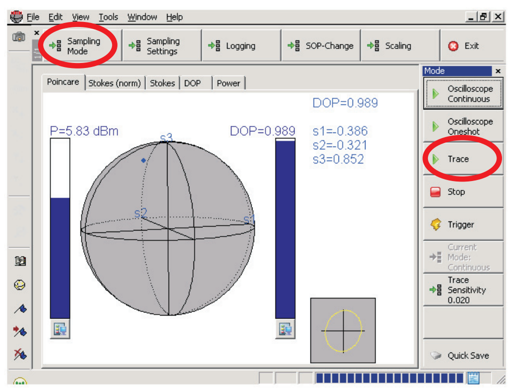
Since the polarimeters in the N778xB/BD instruments are connected with single-mode fibers, there is no absolute SOP reference frame, i.e. the Stokes parameter system displayed by the polarizationNAVIGATOR™ is rotated by an arbitrary amount with respect to the system with s1, s2, s3 being the directions of horizontal/vertical, +/-45° and left/right circular polarization. If the absolute state of polarization at some point of the setup is known and controllable, you can rotate the Stokes readout to compensate for the rotations introduced by single-mode or polarization maintaining fibers in the system, as long as there are only such fibers or components that rotate the state of polarization, i.e. they must not exhibit a significant amount of PDL.

You need to set two states of polarization that are orthogonal in Stokes space, i.e. e.g. horizontal and +45°. Set the first state of polarization at your reference point in the setup. Go to **Tools** > **Set SOP Reference**, select the corresponding SOP from the top drop-down list, press **SET**, then **OK**. Set the second state of polarization at your reference point in the setup. Repeat the steps described above. You can remove a reference frame by pressing CLR for both SOPs in **Tools** > **Set SOP Reference**. Using SOPs that do not fulfill the above mentioned requirements will result in invalid readouts for the DOP and the Stokes parameters.

The Trace Mode

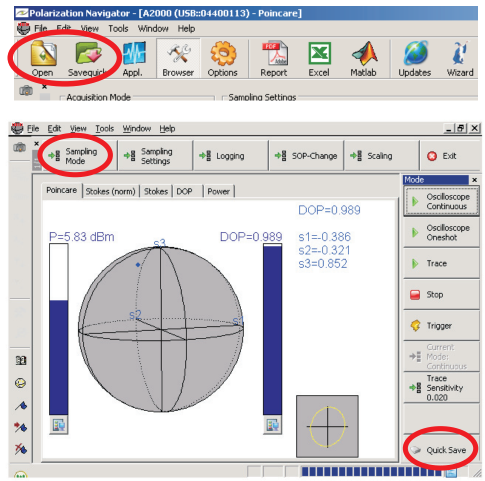
In Trace mode, data is sampled with a fixed sampling rate of 2.5 kHz and stored only if the SOP has changed by a certain amount. The sensitivity can be adjusted by the ”Trace Sensitivity” value. A value of 0.02 will record a new SOP when the normalized SOP has changed my more than 0.02 on the Poincaré sphere. A value of 0.00 will record SOPs with a constant sampling rate of 2.5 kHz. 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 Post-Trig. Samples value. Switch to the Stokes-window and change the input polarization to see how SOPs are stored in this mode. You can clear the current trace by choosing **Clear Measurement** from the **Edit** menu or by pressing **F2**.





Saving Measurements / Snapshots

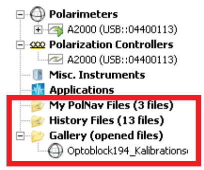
You can save measurement data using the **Save as** option from the File menu and providing a filename or by pressing the **Quick Save/Savequick** button. This will assign an automatic filename and store it in the folder *\My Documents\My PolarizationNavigator Files*. The name format for these automatically generated filenames can be configured in the **Save** tab of the **Options** dialog in the **Tools** menu (the default is the current date with an increasing counter). Alternatively you can make a snapshot by pressing the camera button on the left side of a window. The current measurement is transferred to the Gallery shown in the browser window, but not saved at this time. This allows you to compare different measurements with each other. In addition, the most recent files will be placed in your *My Documents**My PolarizationNavigator History* folder.

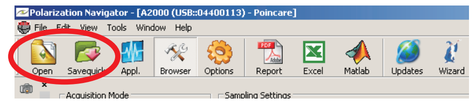


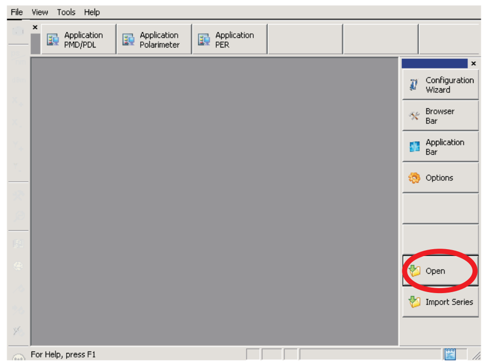
You can change the default folders for measurement and for history files in the **General** > **Path Settings** tab of the **Options** dialog in the **Tools** menu. Here you can also set the maximum number of history files to be kept.

Loading Measurements / Snapshots

Saved files can be accessed through the **Open...** dialog from the **File** menu, by pressing **Open** or by opening the corresponding file using the Windows Explorer. Open files will be listed in the **Gallery** portion of the browse tree. When using an N778xBD, you can cycle through open windows (saved documents as well as activated applications) by pressing the **Next Window** button in the top row. The content of the *My Documents**My PolarizationNavigator Files* and *My Documents**My PolarizationNavigator History* folders can also be accessed from the respective entries in the browser bar.







NOTE

When you press the camera button a new gallery entry is created and a new window is opened. This also happens if you open a saved document. Any running application remains active in the background. You can cycle through open documents and active applications by either clicking on the corresponding entry in the browser bar, by choosing entries in the **Windows** menu, by pressing **CTRL+F6** or by using the **Next Window** button in the top button row of the N778xBD interface.

NOTE

The gallery is not stored on the hard disk. You have to click on **Save** or **Save As** to save the measurement displayed in the current window.

Exporting Measurement Data

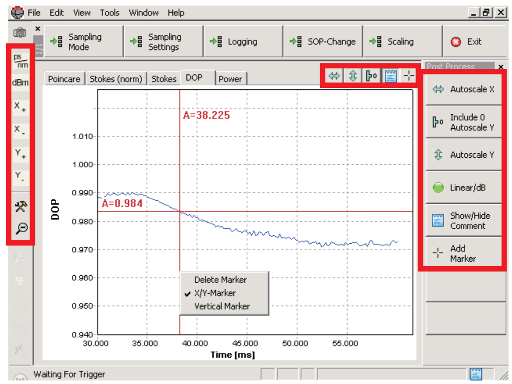
Measurement data can be exported to different file types (e.g. ASCII, CSV). You can export the current measurement by selecting **Export** from the **File** menu, providing a file name and choosing the desired file format from the drop-down list. For details on supported file formats refer to ASCII File Formats on page 338.

Graph Views

Graph views are used to display the normalized Stokes parameters, the DOP and the power versus time. Use the mouse (or touch pen) to zoom into the plot by clicking and drawing a rectangle. Double-click the graph area to reset the zoom. Double-click the trace to set the axis properties. By this you can manually set the axis ranges. Basic scaling changes and marker settings are performed using the buttons to the top right of the graph window or by using the **Scaling** and **Markers** button subsets, which can be accessed from the top button row of an application or document in Internal PC mode. The buttons have the following functions:

- **Autoscale X-Axis** - Toggle button. If set, the x-axis settings are automatically changed to always show the whole plot.
- **Autoscale Y-Axis** - Toggle button. If set, the y-axis settings are automatically changed to always show the whole plot.
- **Include Zero** - Toggle button. When auto-scaling is active, the Y-scaling is chosen to include 0. This is especially useful when viewing e.g. the DOP.
- **Show/Hide Comment** - Toggle button. Toggles a Window containing information about the measurement.
- **Add Marker** - Add a Marker to the current measurement.

Markers can be moved by left-clicking them and holding the left mouse button (or using the touch pen) while moving the marker. If the current graph view contains a single trace (DOP, power), the marker will be an X/Y-marker, i.e. it will stick to the trace and display the X and Y values for the marked point on the trace. If the graph contains several traces (Stokes parameters), the marker will be a Vertical Marker, i.e. it will just mark and display an X value. When switching between the graph view tabs, the markers will stay at their chosen X positions and may change their vertical behavior, depending upon the type of data displayed. In the External PC Mode, the marker behavior can be toggled manually from the marker context menu, which is brought up by right-clicking the marker. In the Internal PC mode, the marker settings can be accessed by choosing the **Markers** sub-set from the top button row of the application or document; from these menus, the markers can be deleted as well. Markers will be erased if a new measurement is performed. Before working with markers, it is therefore recommended to stop the measurement by setting the acquisition mode to **Hold** in the External PC mode or by pressing **Stop** from the **Sampling Mode** button sub-set in the Integrated PC Mode.



The Graph Bar

These buttons on the left side of the window are not always shown. You can toggle this **Graph Bar** from the **View** menu. The buttons on the left side of the window have the following functions:

- **Toggle X-axis unit** - Toggles between the display of the appropriate unit (e.g. ms, nm) and the display of an increasing counter (number datapoints).
- **Linear/dB power plot** - Toggles between a logarithmic (dB) and a linear power scale.
- **X-Unit** - Selects the desired unit modifier (e.g. pm, nm etc.)
- **Y-Unit** - Selects the desired unit modifier (e.g. nW, mW etc.)
- **Graph Properties** - Opens the Graph Properties dialog box.
- **Restore Last Scaling** - If zoomed into a plot, this restores the previous scaling.

The Poincaré View

As described before, 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.

In addition there's a toolbar to the left of the graph view.

The Graph Bar

These buttons may not always be shown. You can toggle this **Graph Bar** from the **View** menu.

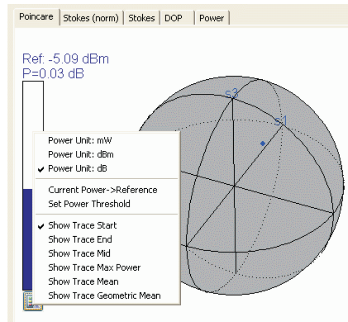
The buttons have the following functions:

- **Show Gallery Measurements** - Displays all measurements of the gallery in the same sphere. This is especially useful for comparison purposes.
- **Line/Point Display** - Toggles between line-mode (all SOPs are connected by lines) and point mode (each SOP is displayed as isolated point).
- **Show Marker** - Displays stored markers (see next button)
- **Store Marker** - Adds the current SOP to a list of markers. If more than one marker is stored, the angular difference is displayed on the right side of the window. Markers are cleared if another display tab (graph view) is chosen.
- **Clear All Markers** - Clears the list of markers
- **Show 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 twisting the PMF. When you see the circle trajectory, press this button to calculate the PER. Press the button again to remove the displayed PER.

- **Poincare View Zoom** - By pressing this button, a slider appears that allows you to zoom in and out of the Poincaré View. The same behavior is achieved by using the wheel of an attached mouse.

Power Unit and Reference Power

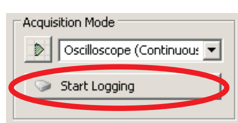
Pressing the button below the power or DOP bar will bring up a context menu. Here you can choose the power unit (mW, dBm, dB) and store the current power value as a reference which is later on used for the dB representation. Furthermore you can choose which portion of the trace is used for the numerical Poincaré view displays (e.g. start of trace, sample with maximum power, average).



Data Logging

The N778xB/BD instruments support data logging, i.e. you can define an interval at which measurements will be stored. In between the instrument continues to perform measurements and refreshes the display but does not save these intermediate measurements to disk. Before starting a logging session you should set appropriate parameters like sampling rate, number of samples per measurement (Post-Trig. Samples) and gain.

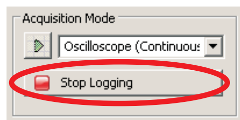
In the External PC Mode, a wizard will guide you through the setup of the actual logging parameters after you press **Start Logging**. This wizard is going to be described first. Using the logging feature in the Internal PC mode is described further below.

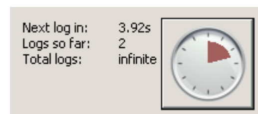


First you have to choose whether to store the measurements in a **single** file or as **multiple** files, i.e. one file for each individual measurement. A single document should be chosen only for small logging series, since all data is stored in memory until the logging sequence has stopped and saved to disk. Long logging series should be stored as separate files, since no memory restrictions apply, except for the total free space on the hard disk. In addition the measurements are each saved to disk, which can be useful in case of, for example, a power failure.

The next step is to set the **Logging Interval** in seconds, the maximum number of measurements to log and the filename body. The filename body is used as the first part of the automatically generated filename, followed by an increasing counter. If **Maximum Logs** is set to zero, measurements will be logged until you press **Stop logging**.

During the logging process there will appear a small window, informing about the current logging state.

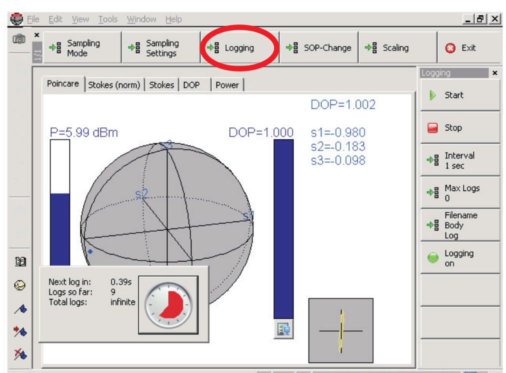




Once the logging has been stopped, there will be a dialog, allowing you to immediately open the logging series. Opening a very long series that has been saved to separate files can take some time.

When a logging series has been opened, there will be a horizontal slider below the data figures, allowing you to navigate within the series.

In the Integrated PC Mode, the logging parameters described above can be set directly in the **Logging** section that is accessed from the top button row of the application.



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NOTE SOP/DOP data logging can be combined with the **SOP Change** trigger mode. By setting the logging interval to zero and choosing appropriate sensitivity parameters in the trigger configuration, events can be monitored over long periods of time without storing unnecessarily large amounts of data.

Importing Logging Series

If logging data has been saved to a single file before, it can be opened using the opening functions described above (see section Loading Measurements / Snapshots on page 79). If logging data from a single series has been stored to individual files you need to use the **Import Series** function, which can be found in the **File** menu, as well as in the right button bar when using the Integrated PC mode. Choosing **Import Series** will bring up a file dialog in which you have to choose the folder that the logging files have been stored in (by default this is an automatically generated sub-folder of your *\My Documents\My PolarizationNavigator Files* folder). You have to navigate into the specific folder and press the **Open** button. It does not matter which file of the logging series has been selected before.

If the logging series had been stored in individual files, there will be a dialog when closing the document or exiting polarizationNAVIGATOR™ that asks you about saving the changes. Actually the data itself has not been altered, but at this point, the polarizationNAVIGATOR™ suggests you save the whole series in a single file. By doing this, you can avoid importing the data the next time you're working with it. On the other hand this will create a file of about the same size as the initial set of files, which can be quite a large number.

Streaming SOP Data to Hard Disk

When sampling mode is set to Trace, the logging function acts slightly differently. Instead of performing measurements at predefined intervals, starting logging in trace mode will stream the measured data into an ASCII file (see ASCII File Formats on page 338 for details on the data format). In this file you will find rows containing the four not normalized Stokes parameters in mW (S0 represents the optical power) and the DOP.

Application: PMD/PDL (PMD/PDL/Loss)

Use this application for PDL/PMD sweep measurements. It uses a continuous sweep of the tunable laser source (TLS) to measure the following parameters versus wavelength:

- PDL, Best Case SOP (i.e. SOP with the maximum transmission coefficient, denoted **PDLPSP**)
- Pmin/Pmax
- Power/Loss
- DGD, PSP, second-order PMD (denoted **PMD2nd**)

See Measurement Setup on page 99 for details on how to connect the DUT and the trigger cable.

Before starting a measurement you should check or set the measurement parameters.

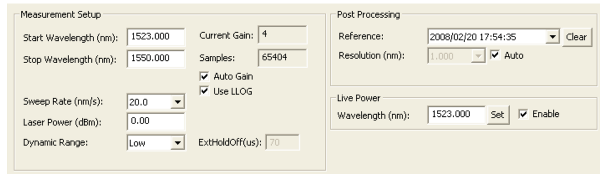
Application Setup Parameters

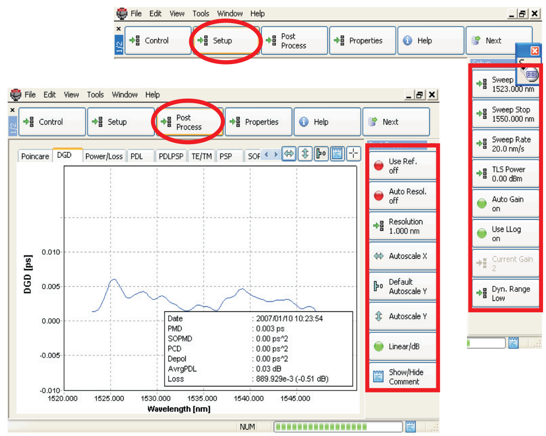
When using External PC mode, the measurement control buttons are displayed in the top left portion of the application window, the measurement parameters are shown to the right of these and the evaluation parameters are shown even further to the right. When using Integrated PC mode, the measurement control buttons can be found in the **Control** sub-set, the measurement parameters in the **Setup** sub-set and the evaluation parameters in the **Post Process** sub-set. Details of those parameters are given in the table below.

Table 7 Application PDL/PMD Setup Parameters

Parameter	Description
Start wavelength (nm):	Defines the start of the wavelength sweep.
Stop wavelength (nm):	Defines the stop of the wavelength sweep.
Sweep rate (nm/s):	Defines the nominal sweep rate of the laser. Note, that the number of data points changes with the sweep rate since the sampling rate is constant. The resulting number of samples are shown in the field Samples.
Laser Power (dBm):	Defines the optical output power of the laser source.

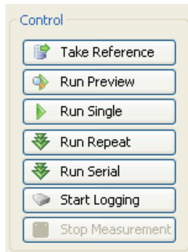
Parameter	Description
Dynamic Range (Low/ Med/ High):	Sets up the power dynamic range of the measurement. A dynamic range of approximately 20dB can be achieved within a single laser sweep. Higher dynamic ranges are achieved by performing several sweeps with different input amplifier gain settings.
Samples:	Shows the estimated number of samples.
Current Gain:	Shows the current gain setting of the input amplifiers (0=lowest sensitivity, 13=highest sensitivity). Each step changes the allowed optical input power range by approximately 3dB.
Auto Gain:	Defines if the next measurement is done using the autogaining feature, otherwise the measurement will be done using a fixed gain. Autogaining is recommended for DUTs with high dynamic loss range (e.g. filters).
Use LLOG:	Keysight tunable laser sources provide a built-in optical wavemeter to increase wavelength accuracy. Check this box to use the internal wavemeter functionality (Lambda Logging).
Reference:	If a reference measurement is done you can select whether it will be used for the measurement or not. If more than one reference is available, you can choose between those.
Resolution (nm):	Defines the width of the averaging window as well as data interleaving. Use smaller values for a better wavelength resolution.

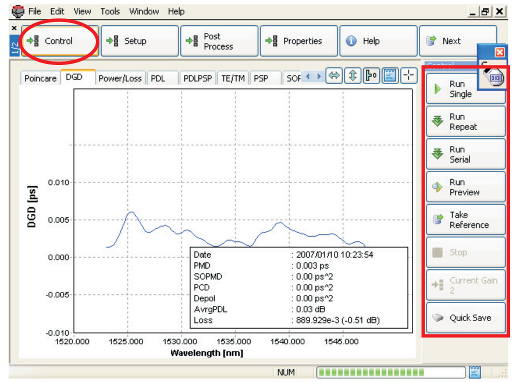




Performing Measurements

In the Integrated PC Mode, measurements are performed by using the buttons in the Control subset, while in External PC Mode these buttons are always shown.





Performing a Preview Measurement

A preview measurement can be performed to check power/loss levels of a DUT. Evaluation is faster than a standard measurement, but it contains no information on PDL or DGD. Connect the DUT and enter the desired settings (see Application Setup Parameters on page 87). Then press **Preview**. A preview measurement is performed and a power/loss trace is acquired.

Performing a Non-Referenced Measurement

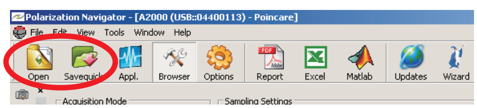
Connect the DUT and enter the desired settings (see Application Setup Parameters on page 87) then press **Run Single** or **Run Repeat**. Referenced measurements allow for maximum PDL and Loss accuracy. Referenced measurements typically do not increase DGD accuracy.

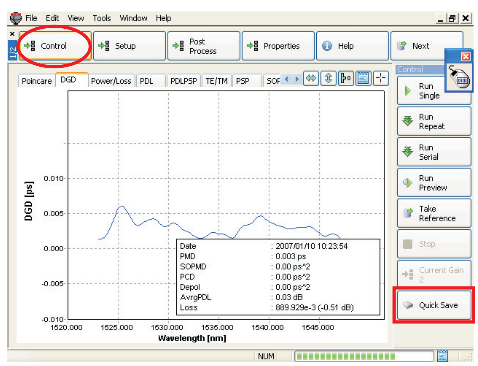
Performing a Referenced Measurement

Connect a patchcord to the DUT ports, enter the desired settings (see Application Setup Parameters on page 87) and perform a reference measurement by pressing **Take Reference**. Then connect the DUT and press **Run Single** or **Run Repeat**. Best performance will be achieved in this mode. A referenced measurement requires the reference sweep to cover the whole range of the DUT sweep, therefore the measurement parameters should be entered before taking the reference, or the reference sweep chosen should be large enough to be able to vary the DUT sweep wavelengths later on.

Saving Measurements / Snapshots

You can save measurement data using the **Save as** option from the **File** menu and providing a filename or by pressing the **Quick Save** / **Savequick** button. This will assign an automatic filename (current date with increasing counter) and store it in the folder *\My Documents\My PolarizationNavigator Files*. The name format for these automatically generated filenames can be configured in the **Save** tab of the **Options** dialog in the **Tools** menu (the default is the current date with an increasing counter). Alternatively you can make a snapshot by pressing the camera button on the left side of a window. The current measurement is transferred to the Gallery shown in the browser window, but not saved at this time. This allows you to compare different measurements with each other. In addition, the most recent files will be placed in your *\My Documents\My PolarizationNavigator History* folder.

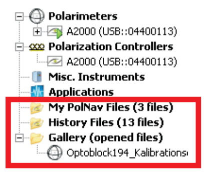


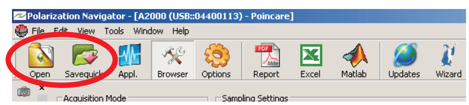


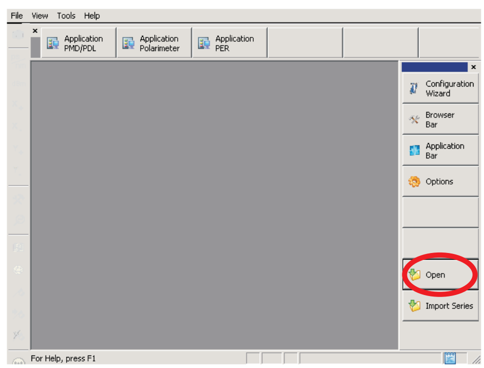
You can change the default folders for measurement and for history files in the **General** > **Path Settings** tab of the **Options** dialog in the **Tools** menu. Here you can also set the maximum number of history files to be kept.

Loading Measurements / Snapshots

Saved files can be accessed through the **Open...** dialog from the **File** menu, by pressing **Open** or by opening the corresponding file using the Windows Explorer. Open files will be listed in the **Gallery** portion of the browse tree. When using an N778xBD, you can cycle through open windows (saved documents as well as activated applications) by pressing the **Next Window** button in the top row. The content of the *\My Documents\My PolarizationNavigator Files* and *\My Documents\My PolarizationNavigator History* folders can also be accessed from the respective entries in the browser bar.







NOTE

When you press the camera button a new gallery entry is created and a new window is opened. This also happens if you open a saved document. Any running application remains active in the background. You can cycle through open documents and active applications by either clicking on the corresponding entry in the browser bar, by choosing entries in the **Windows** menu, by pressing **CTRL+F6** or by using the **Next Window** button in the top button row of the N778xBD interface.

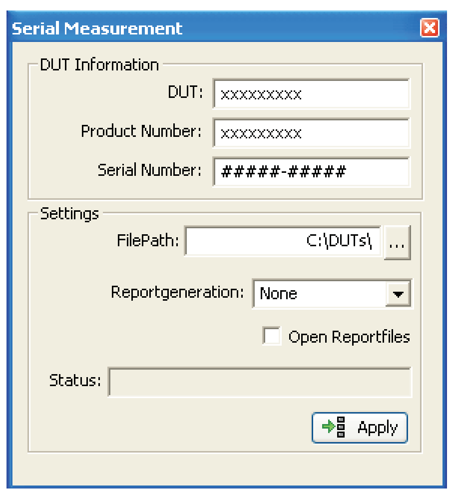
NOTE The gallery is not stored on the hard disk. You have to click on **Save** or **Save As** to save the measurement displayed in the current window.

Exporting Measurement Data

Measurement data can be exported to different file types (e.g. ASCII, CSV). You can export the current measurement by selecting **Export** from the **File** menu, providing a file name and choosing the desired file format from the drop-down list. For details on supported file formats refer to ASCII File Formats on page 338.

Performing Measurements associated with Serial Numbers

This mode is used if you want to characterize a number of similar DUTs and store the data with a reference to the devices' serial numbers. Make sure to set measurement parameters (e.g. wavelength range) before performing the first measurement. You may also perform a reference measurement before starting the first measurement (see Performing a Referenced Measurement on page 90). Measurements associated with serial numbers are performed by pressing **Run Serial**.



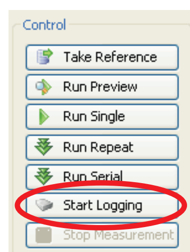
In the dialog you can enter a **DUT** description, a **Part Number**, the **Serial Number** of the current DUT, as well as the path where the files should be saved and whether to automatically generate a pdf report. The files will be saved in the specified path with the serial number as file name. An actual measurement is performed every time you change the serial number and press the **Enter** key or the **Apply** button. When using Integrated PC mode, the on-screen keyboard can be used to enter the serial numbers if no external keyboard is attached to the N778xBD.

Exit this measurement mode by pressing **Stop Measurement** and closing the dialog window.

Data Logging

The N778xB/BD instruments support data logging, i.e. you can define an interval at which measurements will be stored. Before starting a logging session you should set appropriate parameters like wavelength range, dynamic range and gain.

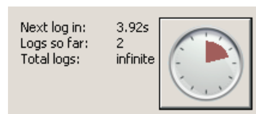
In the External PC Mode, a wizard will guide you through the setup of the actual logging parameters after you press **Start Logging**. This wizard is going to be described first. Using the logging feature in the Internal PC mode is described further below.



First you have to choose whether to store the measurements in a single file or as separate files. A single document should be chosen only for small logging series, since all data is stored in memory until the logging sequence has stopped and saved to disk. Long logging series should be stored as separate files, since no memory restrictions apply, except for the total free space on the hard disk. In addition, the measurements are saved to each disk, which can be useful in case of, for example, a power failure.

The next step is to set the logging interval in seconds, the maximum number of measurements to log and the filename body, which is used as the first part of the filenames, followed by an increasing counter. If **Maximum Logs** is set to zero, measurements will be logged until you press **Stop logging**.

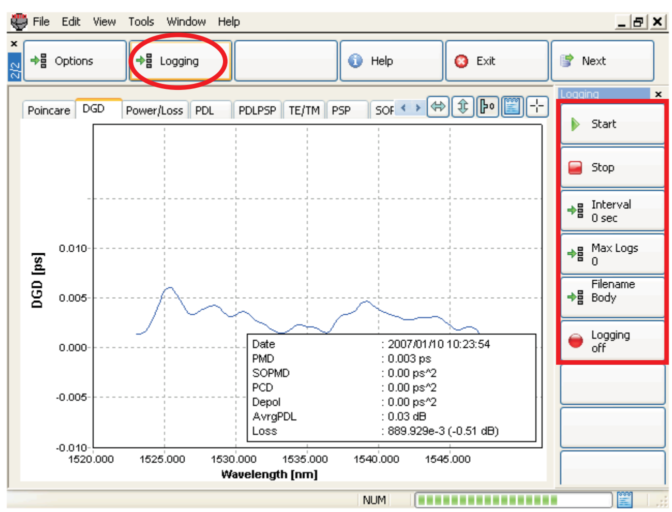
During the logging process there will appear a small window, informing you about the current logging state.



Once the logging has been stopped, there will be a dialog, allowing you to immediately open the logging series. Opening a very long series that has been saved to separate files can take some time.

When a logging series has been opened, there will be a horizontal slider below the data figures, allowing you to navigate within the series.

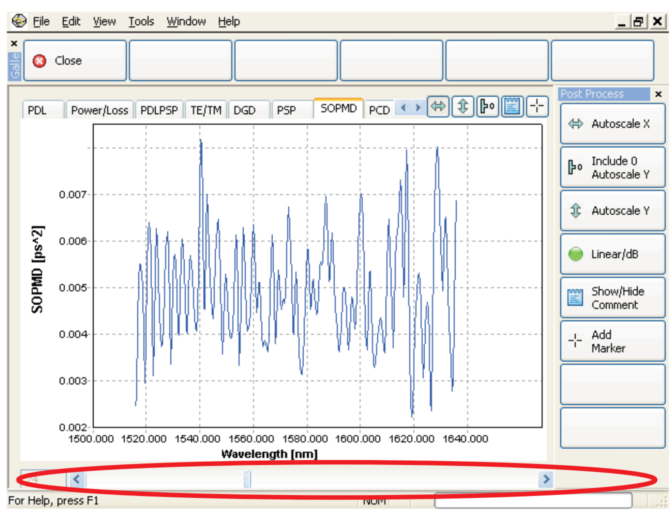
In the Integrated PC Mode, the logging parameters described above can be set directly in the **Logging** section that is accessed from the top button row of the application.



Importing Logging Series

If logging data has been saved to a single file before, it can be opened using the opening functions described above (see section Loading Measurements / Snapshots on page 92). If logging data from a single series had been stored to individual files you need to use the **Import Series** function, which can be found in the **File** menu. It can be found in the right button bar when using the Integrated PC mode (as long as no document is opened and no application is activated). Choosing **Import Series** will bring up a file dialog in which you have to choose the folder that the logging files have been stored in (by default this is an automatically generated sub-folder of your *My Documents**My PolarizationNavigator Files* folder). You have to navigate into the specific folder and press the **Open** button. It does not matter which file of the logging series has been selected before.

If the logging series had been stored in individual files, there will be a dialog when closing the document or exiting polarizationNAVIGATOR™ that asks you about saving the changes. Actually the data itself has not been altered, but at this point, the polarizationNAVIGATOR™ suggests you save the whole series in a single file. By doing this, you can avoid importing the data the next time you're working with it. On the other hand this will create a file of about the same size as the initial set of files, which can be quite a large number.



Application Properties

Application properties can be accessed by pressing the Properties button, which is located at the right side of the application window in External PC mode and in the top button row of the application in Internal PC mode.

KeepRawData

Raw data can be stored together with the measurement result if the option **Keep Raw Data** is set. The default setting is **Yes**. Setting this option to **No** will reduce the size of the saved files, setting it to **Yes** stores additional data about the measurements. This data includes the measured SOPs at the output of the DUT and the assumed SOPs at the input of the DUT which are derived from the reference measurement. In case of the referenced measurement, Mueller matrices for each wavelength are also included. This additional raw data cannot be displayed by the Polarization Navigator. It can be exported to an ASCII-file or to a MATLAB .mat-file by clicking on **File/Export**.

It can also be accessed by loading a .pbin-file into the MATLAB workspace:

```
Data=PBinRead('Result.pbin');
figure;plot(Data.Lambda,Data.MuellerMatrix);
figure;plot(Data.SOPInput(:,1),Data.SOPInput(:,2:5));
figure;plot(Data.SOPOutput(:,1),Data.SOPOutput(:,2:5));
```

The Mueller Matrix elements are stored in 16 columns. Each row belongs to a different wavelength. The Mueller Matrix of the 10th row can be derived by the following command:

```
M= reshape(Data.MuellerMatrix(10,:),4,4)';
```

You can convert the Mueller matrix data into Jones space using the following MATLAB command:

```
Jones=Mueller2Jones(Data.MuellerMatrix);
```

The resulting matrix contains a row for each wavelength. Each 4 elements of a row form a Jones matrix, where the first 2 elements contain the top row of the Jones matrix and the next 2 elements contain the bottom row of the Jones matrix.

Also note that the input SOP is cycled through a system of 6 input SOPs. If you want to access only one SOP out of the whole system use following command:

```
nSystem=3;
figure;
plot( Data.SOPOutput(nSystem:6:end,1),
      Data.SOPOutput(nSystem:6:end,2:5) );
```

NOTE

To use the MATLAB commands described above requires some MATLAB script files that can be found in the *\Bin\Matlab* subfolder of the polarizationNAVIGATOR™ install path.

NOTE

Changing this parameter will affect any future measurement. It will not affect any open documents or measurements.

UseInternalRef

This option determines whether or not an internal reference measurement is used. If set to yes, an internal reference measurement will be performed before each actual measurement or after a customizable refresh time. Setting this option to **Yes** results in maximum DGD accuracy. The default value is **Yes**. Although setting this option to **No** reduces measurement time it is not recommended you do so, because of the reduced accuracy.

InternalRefValidMinutes

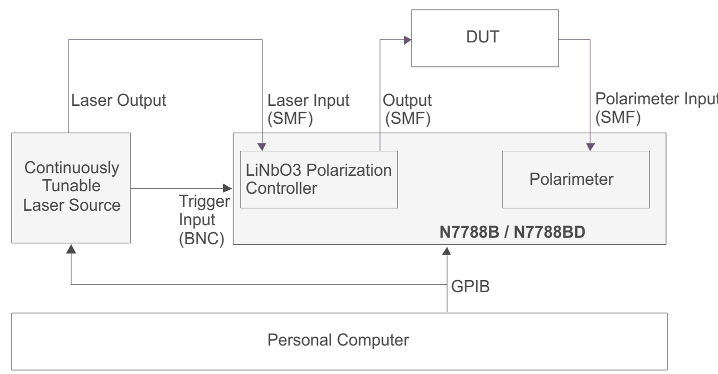
This option determines the period of time after which an internal measurement becomes invalid, if **UseInternalRef** is set to **Yes**. When set to zero, the polarizationNAVIGATOR™ automatically decides on when to perform internal reference measurements Otherwise internal reference measurement are performed with the given refresh rate, in minutes.

DetectModeHops

When sweeping tunable laser sources across large wavelength ranges there may occur mode-hops. When **DetectModeHops** is set to **Yes**, the polarizationNAVIGATOR™ tries to detect such mode-hops and to handle the data as if no mode-hop had occurred, i.e. interpolate data in between the samples right before and right after the mode-hop.

Measurement Setup

The N7788B/BD combines polarization control functions and polarimetric measurement functions within a single instrument. Therefore optical connections are reduced to a minimum. A tunable laser source (TLS) is connected to the input and the device under test (DUT) is connected to the corresponding optical ports.



Application: PMD/PDL/Loss (Stepped)

Use this application for PDL/PMD stepped measurements, i.e. if your laser source is not capable of continuous sweeping. The application uses a stepped sweep of the tunable laser source (TLS) to measure the following parameters versus wavelength:

- PDL, Best Case SOP (i.e. SOP with the maximum transmission coefficient, denoted **PDLPSP**)
- Pmin/Pmax
- Power/Loss
- DGD, PSP, second-order PMD (denoted **PMD2nd**)

See Measurement Setup on page 99 for details on how to connect the DUT and the trigger cables.

Most of the functions of this application work closely resemble the functions explained in Application: PMD/PDL (PMD/PDL/Loss) on page 87. Therefore, in the following sections, only the differences between the stepped and the continuous application will be mentioned in detail.

Application Setup Parameters

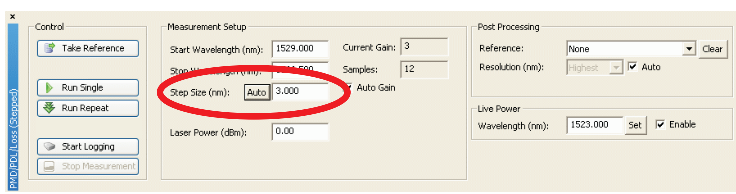
Table 8 Application PDL/PMD (Stepped) Setup Parameters

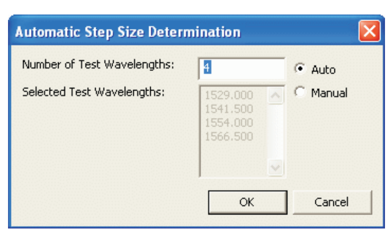
Parameter	Description
Start wavelength (nm):	Defines the start of the wavelength sweep.
Stop wavelength (nm):	Defines the stop of the wavelength sweep.
Step Size (nm):	Defines the wavelength step size for the measurement.
Laser Power (dBm):	Defines the optical output power of the laser source.
Current Gain:	Shows the current gain setting of the input amplifiers (0=lowest sensitivity, 13=highest sensitivity). Each step changes the allowed optical input power range by approximately 3dB.

Parameter	Description
Samples:	Shows the estimated number of samples.
Reference:	If a reference measurement is done you can select whether it will be used for the measurement or not.
Resolution (nm):	Defines the width of the averaging window as well as data interleaving. Use smaller values for a better wavelength resolution.

Performing measurements

Performing measurements works just as described in Performing Measurements on page 89, except there is no preview and no serial number mode available and that you have to define the **Step Size** for the measurement. The minimum required number of steps basically depends upon the DGD of the DUT. Large DGD values require relatively small wavelength steps. By pressing the **Auto** button, the step size is determined automatically by the polarizationNAVIGATOR™.





Application Properties

In stepped mode there is one application property in addition to those described in Application Properties on page 97.

ReferenceStepSize

When performing reference measurements, the laser source is using this step size instead of that entered in the application controls. Reference measurements are performed with a fiber with negligible DGD, so large wavelength steps are appropriate. They are thus less time consuming than when the same step-size was used as for DUTs with high DGDs. The default setting is 5nm.

Application: PER/PMF Crosstalk

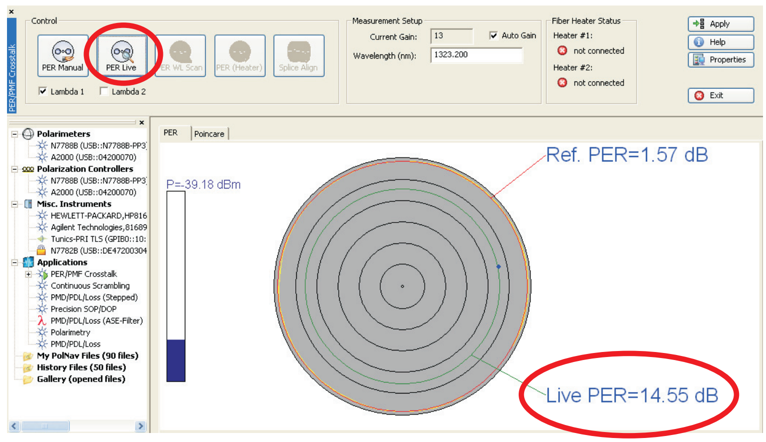
Use this application for crosstalk measurements in polarization maintaining fibers (PMF) or for measuring misalignment angles between PMF connectors or splices. Typically the light inside a PMF has to be guided either in the slow or in the fast axis. Usually this can only be achieved to some extent and the signal inside the PMF can be divided into two components guided in the fast and the slow axis. The power ratio between these two components is called polarization extinction ratio (PER). Typical values are between 20dB and 40dB meaning that the power in the *wrong* axis is 20dB (40dB respectively) below the light in the desired axis.

In case of limited PER the output polarization will move on a small-circle on the Poincaré sphere when mechanically disturbing the PMF, changing its temperature or when changing the wavelength of the source. The radius is a measure for the PER. This application measures the radius of the trajectory of the output polarization and calculates the PER. A laser source is used as stimulus and the trajectory can either be generated by continuously changing the source wavelength or by disturbing the PMF (either manually or using N7783B Thermal Cycling Unit).

For details on the different methods, please refer to the following sections:

- Manual PER Measurement on page 105
- Swept Wavelength Method on page 107
- Using a single N7783B Thermal Cycling Unit on page 108
- Splice Alignment (using two N7783B Thermal Cycling Units) on page 110
- Automatic Splice Alignment (using Fujikura PM splicer) on page 112

These applications (except Automatic Splice Alignment) use different means to measure the PER in a fiber. Once this value has been obtained, they allow you to switch to **PER Live** mode, in which you can, for example, optimize the input polarization into a PM patchcord and will get a realtime readout of the PER without any further stretching, heating or sweeping. For these live measurements it is required that no polarization changes are introduced after the PM fibre (e.g. moving a single-mode patchcord that connects the PM fiber to the N7782B input). In general, polarimetric PER measurements will perform best when polarization disturbances are minimized. You can do this by making sure that no fiber movements occur during the measurement and that the fibers are not subject to temperature changes anywhere else than in the Thermal Cycling Units.



There are a number of options that can be used to influence certain aspects of the measurements. These can be configured in a dialog that can be accessed by pressing the **Properties** button, which is located at the right side of the application window in External PC mode and in the top button row of the application in Internal PC mode. Details on these options can be found in Application Properties on page 115.

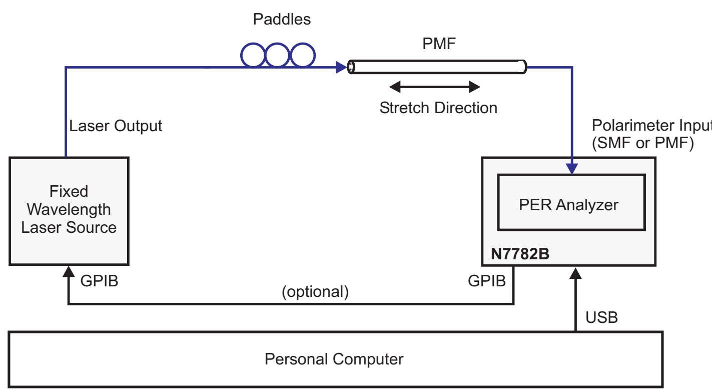
Integrated Laser Sources

N7782B units can be equipped with integrated VCSEL sources. These laser sources can be turned on and off using the button near the **Output** connector on the front panel of the N7782B or using the checkmarks below the control buttons of the PER application. If the N7782B contains more than one VCSEL (e.g. dual-VCSEL option #401), the active VCSEL can be chosen by setting the mark in front of either **Lambda 1** or **Lambda 2**. The polarimeter wavelength will be set automatically according to the selected VCSEL. Removing the mark will turn both VCSELs off. Using the button on the front panel, you can cycle through the VCSELs and the off-state. If the VCSEL is switched using the front panel button, the polarimeter wavelength is not updated in the polarizationNAVIGATOR™; you have to do it manually to obtain accurate results in that case.

Manual PER Measurement

Use this application for crosstalk measurements of polarization maintaining fibers (PMF) using a laser source at a fixed wavelength and by stretching / disturbing the PMF manually. The crosstalk is often expressed by the Polarization Extinction Ratio (PER) which is given by the ratio between the power levels of the two PMF axes (typically expressed in dB).

Connect the instrument and the PMF according to the following setup:



To optimize the PER inside the PMF follow these steps:

1 Set up your device so that coherent light is guided through the PMF (e.g. turn on your laser diode or connect a tunable laser source to the PMF). If you're using an N7782B with VCSEL option (#101, #401, #501), you can connect the PMF to the input of the N7782B, assuming the wavelength option matches the operating range of the DUT. The internal source will be activated automatically, so you don't have to turn it on before starting the application

2 Start the **PER / PMF Crosstalk** application.

3 Enter the correct wavelength of the laser source. If the internal source of an N7782B with VCSEL option is used, the wavelength is set automatically.

4 Click on **PER Manual**

5 Gently stretch the PMF so that a yellow circle appears. Try to make a full circle, then the PER-fit will be most accurate.

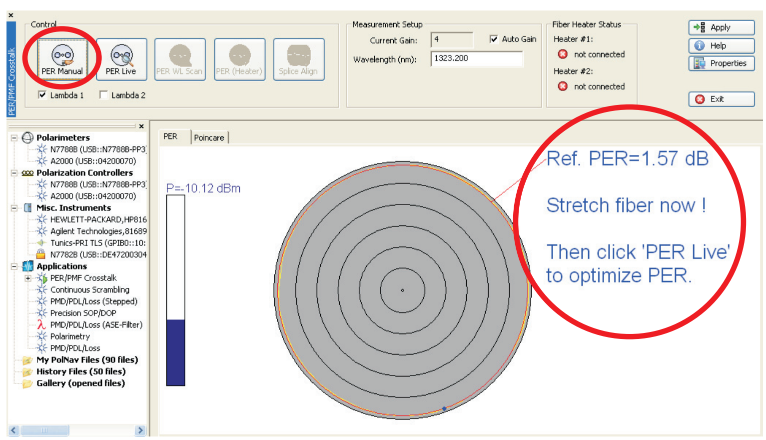
6 The number displayed on the screen is the current PER.

7 Once a PER value is stable, you can click on **PER Live** for real time alignment.

8 Now the current PER is measured in real time based on the reference stored automatically during the previous steps.

9 Optimize the input polarization into the PMF by trying to move the blue spot into the center of the display which indicates the optimum input polarization.

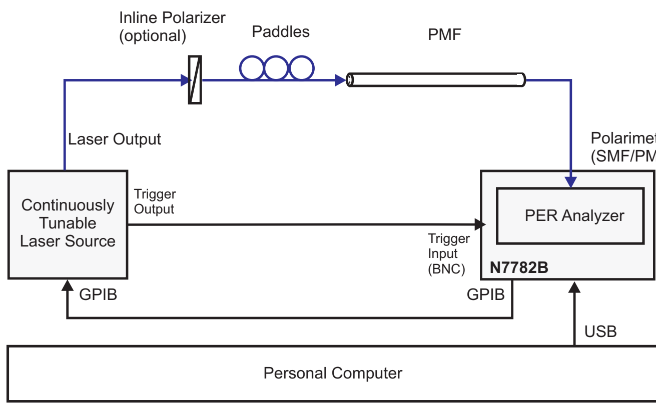
10 If you think you have reached the optimum, you can repeat the measurement by clicking on **PER Manual** and stretching the fiber again, thus verifying the input polarization obtained in the previous steps.



Swept Wavelength Method

Use this application for crosstalk measurements in polarization maintaining fibers (PMF) using a swept laser source. The crosstalk is often expressed by the Polarization Extinction Ratio (PER) which is given by the ratio between the power levels of the two PMF axes (typically expressed in dB).

Connect the instrument and the PMF according to the following setup[1]:



To optimize the PER inside the PMF follow these steps:

1 Set up your device so that light is guided through the PMF. If you connected your laser source using GPIB it will be controlled automatically. Otherwise use the manual mode and setup the laser so that it permanently sweeps over the desired wavelength range (typically 5nm to 10nm). The sweep speed should be around 40 nm/s.

2 If you use a Keysight laser source you have to configure it beforehand so that it appears under **Misc. Instruments** in the browser. Please run the configuration wizard before using this application, so that the laser source is installed properly.

3 Start the **PER / PMF Crosstalk** application.

4 Enter the correct center wavelength and the sweep range. You may also choose a manual gain setting, but by default the application uses automatic gain. When using a properly configured Keysight laser source you can also set the output power of that source.

5 Click on **PER WL Scan / Wavelength Scan**

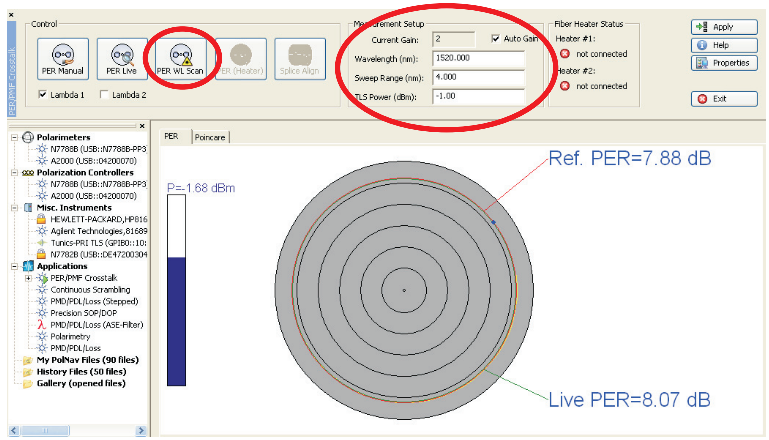
1 Many tunable laser sources have a PMF output. Therefore, the limited PER inside this output PMF can reduce measurement performance. An inline polarizer can reduce this effect.

6 Now the current PER is measured in real time by continuously evaluating the circle-trajectory.

7 Once a PER value is stable, you can click on **PER Live** for real time alignment.

8 Now the current PER is measured in real time based on the reference stored automatically during the previous steps.

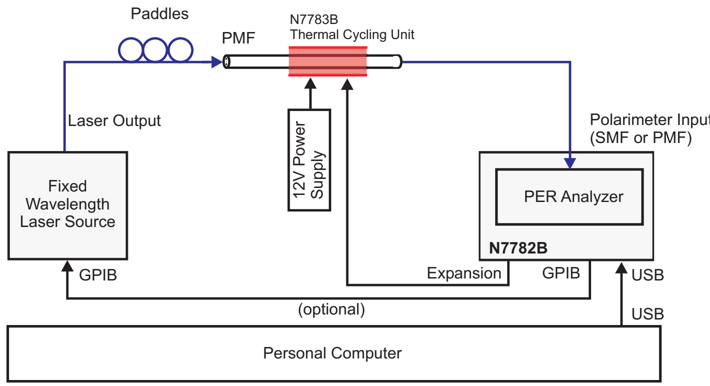
9 Optimize the input polarization into the PMF by trying to move the blue spot into the center of the display which indicates the optimum input polarization.



Using a single N7783B Thermal Cycling Unit

Use this application for crosstalk measurements of polarization maintaining fibers (PMF) using a laser source at a fixed wavelength and an N7783B to automatically heat up and cool down the PMF.

Connect the instrument and the PMF according to the following setup:

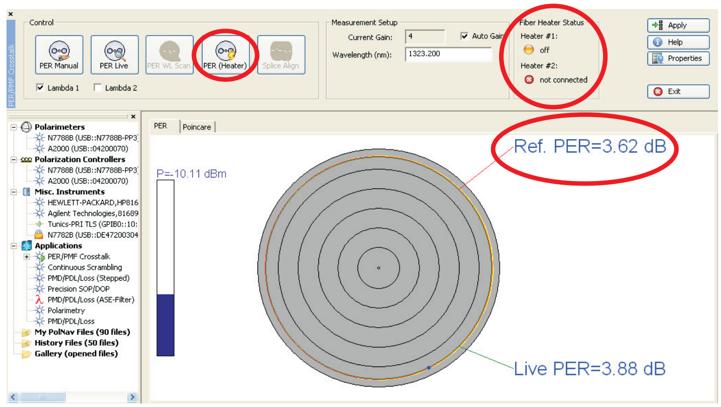


To optimize the PER inside the PMF follow these steps:

1 Set up your device so that coherent light is guided through the PMF (e.g. turn on your laser diode or connect a tunable laser source to the PMF). If you're using an N7782B with VCSEL option (#101, #401, #501), you can connect the PMF to the input of the N7782B, assuming the wavelength option matches the operating range of the DUT. The internal source will be activated automatically, so you don't have to turn it on before starting the application.
2 Start the **PER / PMF Crosstalk** application.
3 If a Thermal Cycling Unit is connected to the N7782B, Heater #1 should appear as off in the Fiber Heater Status area. If this heater entry shows **not connected** check cable connections and restart application.
4 Enter the correct wavelength of the laser source. If the internal source of an N7782B with VCSEL option is used, the wavelength is set automatically.
5 Click on **PER (Heater)**
6 The N7783B starts a temperature cycle by heating up the PMF (LED=red), cooling it down (LED=green) and turning the device off (LED=off).
7 The number displayed on the screen is the current PER.
8 Once a PER value is stable, the software automatically switches to the **PER Live** mode for real time alignment.
9 Now the current PER is measured in real time based on the reference stored automatically during the previous steps.

10 Optimize the input polarization into the PMF by trying to move the blue spot into the center of the display which indicates the optimum input polarization.

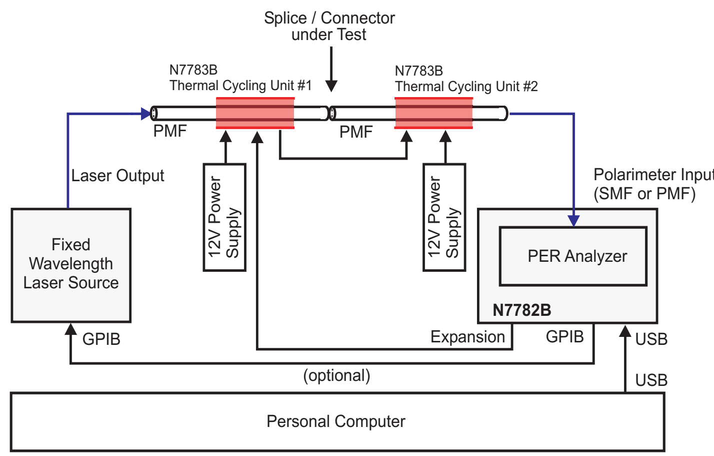
11 If you think you have reached the optimum, you can repeat the measurement by clicking on **PER (Heater)** again, thus verifying the input polarization.



Splice Alignment (using two N7783B Thermal Cycling Units)

Use this application for characterizing splices or connections between two polarization maintaining fibers. In that configuration, two N7783B Thermal Cycling Units are needed (one for each PMF) in a daisy-chain configuration.

Connect the N7783B units to the N7782B according to the following setup:



To optimize the splice angle follow these steps:

1 Set up your device so that coherent light is guided through the PMF (e.g. turn on your laser diode or connect a laser source to the PMF). If you're using an N7782B with VCSEL option (#101, #401, #501), you can connect the PMF to the input of the N7782B, assuming the wavelength option matches the operating range of the DUT. The internal source will be activated automatically, so you don't have to turn it on before starting the application.

2 Start the **PER / PMF Crosstalk** application.

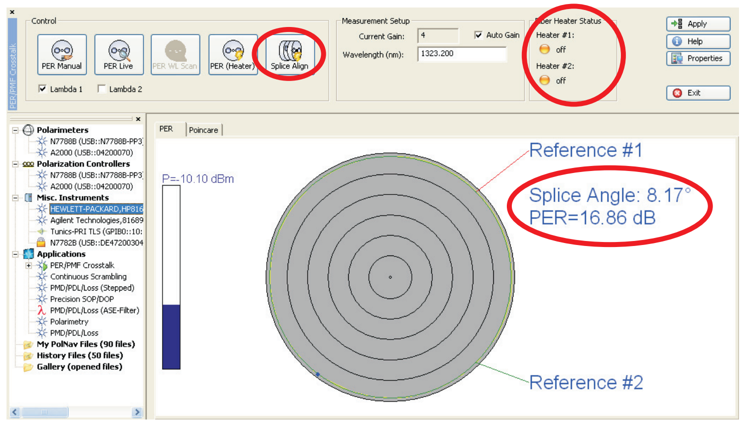
3 If two **Thermal Cycling Unit** are connected to the N7782B, **Heater #1** and **Heater #2** should appear as **off** in the **Fiber Heater Status** area. If any of the heater entries show **not connected** check cable connections and restart application.

4 Enter the correct wavelength of the laser source. If the internal source of an N7782B with VCSEL option is used, the wavelength is set automatically.

5 Click on **Splice Align**

6 The first N7783B starts a temperature cycle by heating up the PMF (LED=red), cooling it down (LED=green) and turning the device off (LED=off). After that, the second N7783B does a similar temperature cycle.

7 The number displayed on the screen is the current PER / Splice Angle.



Automatic Splice Alignment (using Fujikura PM splicer)

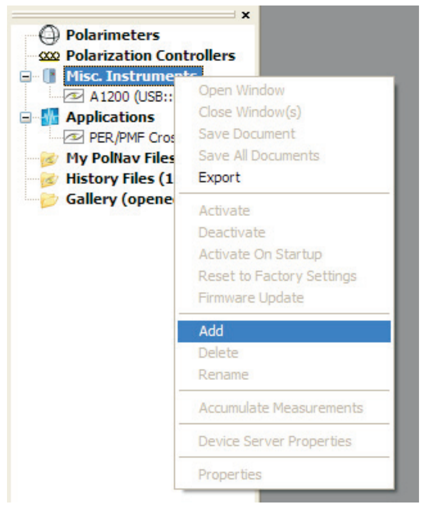
You can use the N7782B PER-Analyzer in combination with a Fujikura FSM-45PM / FSM-45PM-LDF splicer to automatically optimize the splice angle. You will need the following equipment:

- N7782B PER-Analyzer
- 2 x N7783B Thermal Cycling Unit
- Fujikura FSM-45PM / FSM-45PM-LDF Splicer (Firmware revision higher than 1.37)

The measurement setup is very similar to the setup shown in Splice Alignment (using two N7783B Thermal Cycling Units) on page 110. In addition, connect the splicer using an RS-232 null-modem cable to the PC.

Use the following steps to configure the polarizationNAVIGATOR™ and the PM splicer for automatic splice alignment (these steps have to be performed once before the application can be used):

1 Select **Add** from the context menu of the **Misc. Instruments** node:



2 Choose the **Fujikura Splicer** from the list and press **OK**.

3 If you are using a serial port other than COM1, go to the **Properties** menu of the splicer by right-clicking the **Fujikura Splicer (COMx)** entry in the browser tree. Double click the **COMPortNo** entry and enter the appropriate COM-Port.

4 To check whether the communication with the splicer is working, you can double-click on the splicer entry in the browser tree. You will see a panel allowing you to remote control the splicer keys:

5 Modify one of the splice programs of the PM splice and select **A1200 (R-A1200** in case there are two entries containing A1200) as theta-aligning method. If you start the splice operation now, the splicer uses the Splice-Angle readout of the polarizationNAVIGATOR™.

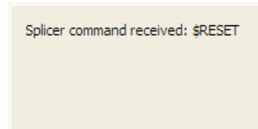
6 You may set **Pause 1** and / or **Pause 2** to **On** in the **Utility Menu** of the PM splicer. This will make the Splicer pause between the alignment and the actual splice, so you can check the alignment result before performing the splicing operation.

The following steps describe how to perform PM splices with automatic angular alignment using an N7782B and two N7783B:

1 Start the **PER / PMF Crosstalk** application. If the application recognizes the splicer (i.e. it is configured in polarizationNAVIGATOR™, the COM port is chosen correctly and the null modem cable is plugged in correctly) it should be marked with a lock symbol in the browser tree.

2 Connect a laser source to one of the PM fibers that are going to be spliced and connect the other fiber to the N7782B input. Prepare the fibers as usual (stripping, cleaning and cleaving) and put them into the clamps of the splicer.

3 To make sure that the splicer can communicate with the application, you may press **RESET** on the splicer. A small window should appear in the lower right corner of the polarizationNAVIGATOR™, confirming the reception of the command:



4 Use the **Set** button of the PM splicer to start the alignment. x-, y- and z- alignment will be performed by visual feedback of the PM splicer, but the angular alignment will be performed using the splice angle readout of the N7782B. The application performs a number of steps until it approaches the target angle with the desired accuracy,

- By changing the splice program at the PM splicer, you can choose a target angle other than zero.
- You can select the desired angle accuracy from the properties menu (see Application Properties on page 115).
- If you are using an instrument with internal laser source, e.g. an N7782B with option #401, you can let the software automatically turn off the laser source when not in use (see Application Properties on page 115). This can reduce effects caused by scattered light seen by the splicer camera.

Application Properties

Application properties can be accessed by pressing the **Properties** button, which is located at the right side of the application window in External PC mode and in the top button row of the application in Internal PC mode. Some of these options apply to some of the measurement modes only

HeatingTime

When using N7783B units, this value defines the heating time in seconds. If **HeatingTimeAuto** is set to **Off**, the N7783B will heat the fiber for this number of seconds. If **HeatingTimeAuto** is set to **On**, the N7783B will automatically stop heating if the required information has been obtained, but will not exceed the number of seconds defined in **HeatingTime**. Regardless of this value, the N7783B will stop heating/cooling after a period of 30-60s.

CoolingTime

When using N7783B units, this value defines the cooling time in seconds. If HeatingTimeAuto is set to Off, the N7783B will cool the fiber for this number of seconds. If HeatingTimeAuto is set to On, the N7783B will automatically stop heating if the required information has been obtained, but will not exceed the number of seconds defined in HeatingTime. Regardless of this value, the N7783B will stop heating/cooling after a period of 30-60s.

SettlingTime

This is the time between the end of the heating cycle and the beginning of the cooling cycle.

SpliceAngleAccuracy

When using an N7782B together with a Fujikura FSM-45PM splicer to automatically optimize the splice angle, this value defines the limit at which the application does not try to improve the angle any further.

LightSourceAutoOff

If this option is set to **Yes**, the integrated VCSEL of an N7782B is turned off during visual alignment periods of the Fujikura FSM-45PM splicer.

HeatingTimeAuto

If this is set to Yes, the N7782B will choose the heating and cooling time automatically, but uses the values defined in **HeatingTime**, **CoolingTime** and **SettlingTime** as maximum values.

Application: Polarimeter Calibration

Use this application to calibrate the polarimeter at a wavelength not included in the factory calibration range.

NOTE Make sure the calibration wavelength is within the operating wavelength range of the instrument.

NOTE You may have to add this application manually to the application tree by right-clicking on **Applications** and then selecting **Add** and choosing **Polarimeter Calibration** from the list.

Obtaining Calibration Data

The calibration is done in the following steps:

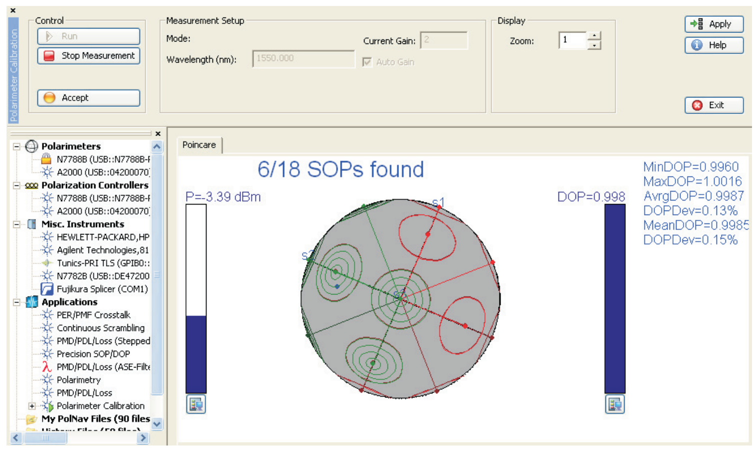
1 Enter the wavelength you want to use in the dialog box.

2 Connect the light source you are using to the polarimeter input. For the calibration process, it is recommended that you insert a polarization controller (e.g. a fiber-loop polarization controller) in between both, so you can easily and continuously change the state of polarization.

NOTE The light source should be fully polarized (DOP=1). In case you are using an unpolarized broadband source, make sure it is filtered by an inline polarizer.

- Turn on the light source and start the application **Polarimeter Calibration**.
- Click on **Run** and move the blue spot on the Poincaré sphere into the red marked regions. When passing one region, it will turn to green. You may have to rotate the sphere view, to find which regions have not yet been passed. You can abort the calibration data acquisition by pressing the **Stop Measurement** button.
- After all regions have been passed by the blue spot or the **Accept** button is pressed, the calibration data is generated. You can assign a name to this calibration set.

After running this application, the polarimeter automatically uses the calibration set. You can leave the application now by clicking on **Exit** and use the polarimeter by double-clicking on the instrument.



Managing Calibration Data

NOTE

After restarting the polarizationNAVIGATOR™, the factory calibration data is selected automatically.

You can select the desired calibration data set used in this session by right-clicking on the polarimeter in the browser tree and clicking on **Properties**.

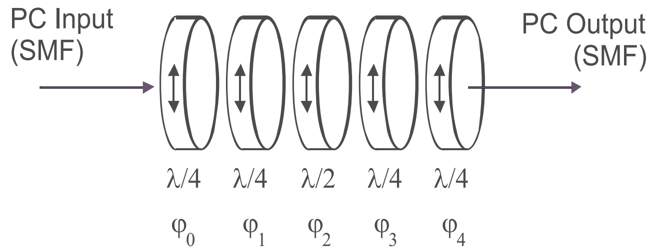
Go to the **Calibration** tab and select the appropriate calibration data set.

Individual calibration data sets can be removed by selecting them from the drop-down list and pressing the **Clear** button in the **Calibration** tab.

Polarization Controller Basics

This chapter describes the basic operation of the polarization controller functions of the N778xB/BD instruments.

The operation of the $LiNbO_3$ polarization controller (PC) integrated with most instruments of the N778xB/BD series family is comparable to a cascade of five endlessly rotatable waveplates:



The state of the PC is given by the position of the waveplates which is expressed in terms of five angles $\varphi_0 ... \varphi_4$ measured in rad (ranging from 0..π. Due to the internal structure of the PC the waveplates are endlessly rotatable, i.e. there will be a continuous and polarization state transition when increasing the position beyond 2π, which is similar to starting from 0 again. The polarization state for a waveplate setting of $2\pi+\phi$ is similar to a waveplate setting of $0+\phi$.

Note that the retardation may slightly differ from the nominal values depending on the operating wavelength and also temperature. Furthermore there may be a systematic deviation due to the electro-optic properties of the $LiNbO_3$ 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).

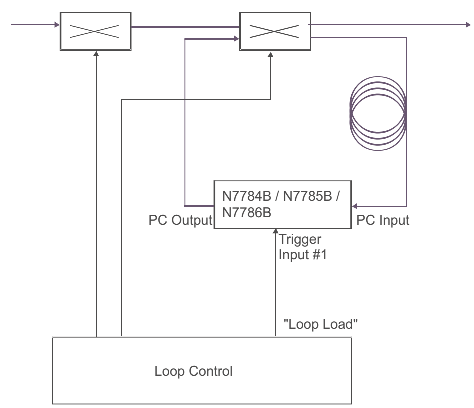
The angles can either be set statically or dynamically. Dynamic change is implemented by means of a look-up table stored in the memory of the instrument. This look-up table can be processed once or repeatedly at different clock rates. Triggering or synchronizing with an external clock is also possible. There are different modes of operation described in the following sections.

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:

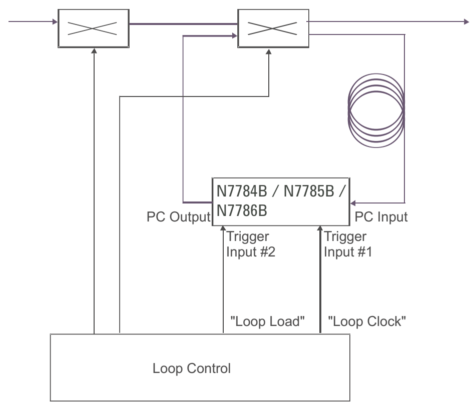
No Loop Clock - Internal Timebase

In this configuration the N778xB/BD 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. A more detailed description of the scrambler parameters is given in Application: Random Polarization Scrambling on page 124.



Synchronized to Loop - Clock External Timebase

In this configuration the N778xB/BD is synchronized to the loop clock. Switching occurs on the rising edge of the signal applied to the trigger input #1. The look-up table pointer is reset to the beginning when trigger input #2 is set to logical high for at least 100 µs. A more detailed description of the scrambler parameters is given in Application: Random Polarization Scrambling on page 124. Trigger #1 and trigger #2 are not the BNC connectors on the instrument rear panel, but pins of the expansion port (see Expansion Port Connector Pinout on page 142 for details.

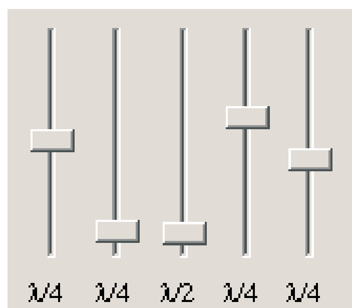


Application: Manual Waveplate Control

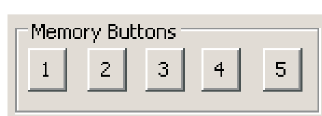
In manual operation mode the polarization can be adjusted by manually setting the five angles $\varphi_0 ... \varphi_4$. The operation is comparable to manual fiber-loop polarization controllers. In the polarizationNAVIGATOR™ software settings can be saved and restored.

When the N778xB/BD polarization controller is activated by clicking on the corresponding polarization controller symbol in the browser tree, sub-items named **Sequence**, **Manual** and **Scramble** appear below the symbol.

By double-clicking the **Manual** sub-item, a dialog is opened, containing five sliders. Move the sliders to adjust the position of each waveplate. The slider ranges represent a rotation angle range of 4π, i.e. two full rotations. The initial slider position (vertically centered) denotes a rotation angle of 0; moving the slider to the top rotates the corresponding (virtual) waveplate by 2π into one direction, moving it to the bottom rotates the waveplate by the same amount in the other direction.



You can store five sets of slider positions by pressing **CTRL** while clicking on a memory button of the control bar. All five waveplate positions are stored for each memory button. Simply click on the desired memory button to recall this set any time later.



NOTE The software remembers the stored slider settings even when you exit and restart the polarizationNAVIGATOR™.

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.

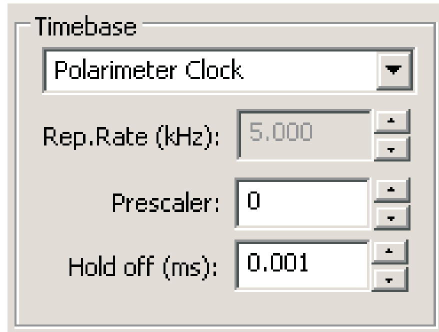
When the N778xB/BD polarization controller is activated by clicking on the corresponding polarization controller symbol in the browser tree, sub-items named **Sequence**, **Manual** and **Scramble** appear below the symbol.

The scrambler operation is activated by double-clicking the sub-item **Scramble** of the N778xB/BD instrument. This will also show a dialog for setting the parameters of the scrambling operation.

For simple asynchronous operation turn **Timebase** to **Timer** and choose a **Repetition Rate**. The repetition rate is the clock used for processing the look-up table.

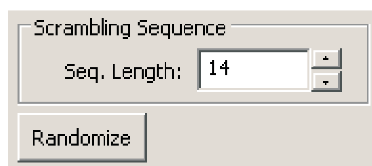
The default setting is **Polarimeter Clock**. In this mode, the scrambler clock is synchronized to the internal clock of the sampling electronics when using an N7786B or an N7788B/BD as polarization controller and polarimeter at the same time. In this mode the repetition rate of the scrambling operation cannot be changed. In that case, the periods of constant polarization can be increased by using the **Prescaler** setting, thus effectively slowing down the scrambling operation. The repetition rate is divided by **Prescaler+1**, i.e. the polarization controller switches to the next waveplate setting every **Prescaler+1** clock pulses, regardless of the clock source.

NOTE In random or sequence operation, the actual polarization switching from one waveplate setting to the next occurs within some µs. Changing the repetition rate or the prescaler extends the delay between these switches.

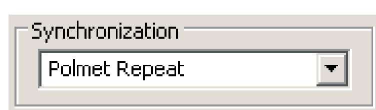


Scrambling is implemented by automatically generating a special look-up-table. The table length can be chosen by the field **Seq. Length**. When changing this value, the new sequence will be randomized, which may take some seconds, depending upon the sequence length. Larger values will increase the size of the look-up table.

By pressing the **Randomize** button, the current pattern is replaced by a new set of random SOPs.



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 polarization controller remains in the state defined by the last table entry.

If Synchronization is set to **External Repeat** or **External Oneshot**, the behavior is similar except that the sequence is restarted when a low/high transition occurs at the Trigger Input #1. 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 and the restart of the sequence.

The external trigger signal can also be used as timebase instead of the internal timer. In this mode the look-up-table is processed at the clock rate applied to Trigger Input #1. Set **Timebase** to **External** to activate this function.

When using an external timebase, a restart of the sequence can be achieved by applying a TTL signal to Trigger Input #2. This input is not edge-triggered, instead a logical high level of at least 100 µs duration will trigger a restart of the sequence on the next rising edge of Trigger Input #1.

Application: Sequence Operation

This application can be used with N7784B, N7785B, N7786B, N7788B/BD.

In sequence mode a look-up table given in an ASCII text file can be uploaded to the instrument.

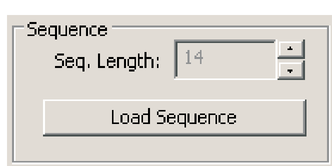
When the N778xB/BD polarization controller is activated by clicking on the corresponding polarization controller symbol in the browser tree, sub-items named **Sequence**, **Manual** and **Scramble** appear below the symbol.

The sequence mode is activated by double-clicking the **Sequence** sub-item of the N778xB/BD instrument. The sequence mode is very similar to the scrambling mode except that the randomized sequence is replaced by a customizable sequence that can be uploaded to the instrument. The sequence has to be stored in an ASCII file with decimal numbers ranging from 0 to 2π. Each row represents an entry of the look-up table, each of the five columns represents a waveplate position. Use ',' as decimal symbol and ';' to seperate waveplate values and put each sequence step in a new line like this:

```
0,00;0;0;0;0
1,57;0;0;0;0
3,14;0;0;0;0
```

You can find some sample sequences in the *Examples\DemoSequences* subfolder of the polarizationNAVIGATOR™ folder.

By pressing **Load Sequence** a file dialog will be shown. After selecting an ASCII file containing waveplate positions, the waveplate settings are transferred to the instrument and the sequence is started. Refer to Application: Random Polarization Scrambling on page 124 for a description of the parameters **Timebase**, **Rep. Rate**, **Prescaler**, **Hold off** and **Synchronization**. **Seq. Length** cannot be set in the polarizationNAVIGATOR™ interface, since it is defined by the number of lines in the ASCII file.

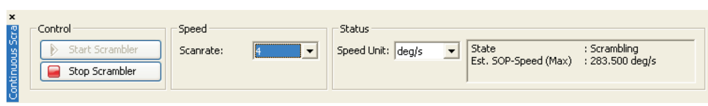


Application: Continuous Scrambling

Use this application to scramble the polarization state in a continuous manner using an N7784B, N7785B, N7786B or an N7788B/BD. 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.

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. The parameter **Scanrate** defines the scrambling speed. An estimation of the resulting scrambling speed is given in the status field. You can change the unit this estimation is displayed in by using the **Speed Unit** drop-down list.



The scanrate settings 1-8 correspond approximately to the scanrate settings of the Keysight 11896 polarization controller.

See also Target ContScrambling on page 266.

Application: Polarization Stabilization

N7784B Polarization Stabilization

In addition to the manual, scramble and sequence modes described before (see previous sections), the N7784B can be used to generate a fixed output SOP, even with varying input SOPs.

When the N7784B polarization controller is activated by clicking on the corresponding polarization controller symbol in the browser tree, sub-items named **Sequence**, **Manual**, **Scramble** and **Stabilize** appear below the symbol.

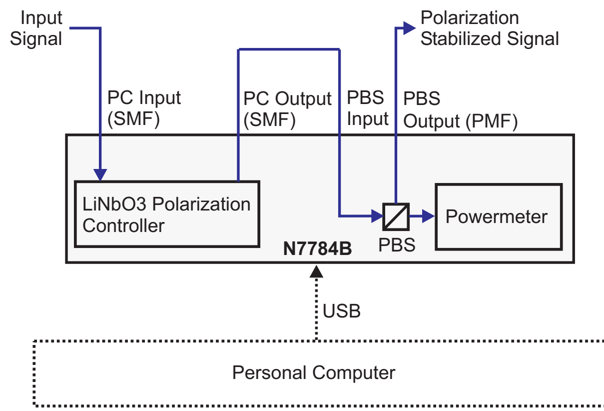
By double-clicking the **Stabilize** sub-item of an active N7784B instrument, the settings for the stabilizer operation can be accessed.

By pressing **Settings**, several control parameters of the SOP controller (see N7784B / N7786B Settings on page 134) can be modified. The same dialog can be accessed by selecting **Properties** from the context menu of an N7784B in the browser tree.

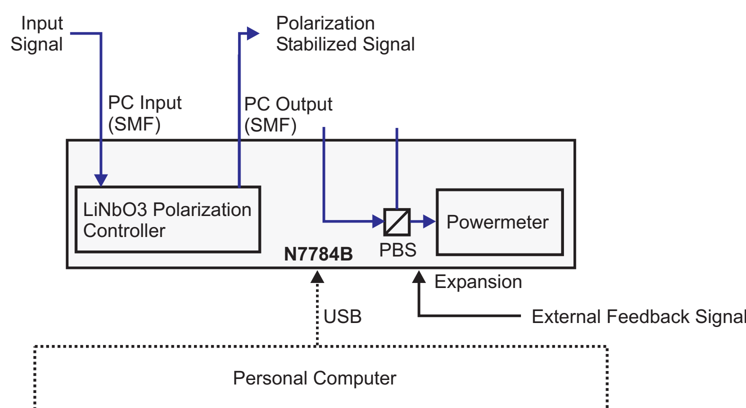
By clicking the Stabilize check mark, the controller can be stopped or resumed. When the Criterion is set to **Internal** (see N7784B / N7786B Settings on page 134), the controller generates a fixed, stable output SOP. Configure the N7784B according to the following setup:

NOTE

You only need to connect a computer to the N7784B for changing the control parameters. Otherwise you can activate and deactivate the stabilizer operation by pressing the **Control** button on the front panel of the N7784B. The **Active** LED will be lit while the instrument is stabilizing.



When it is set to **Analog In**, an appropriate external signal has to be provided and the N7784B will optimize the output SOP with respect to this feedback signal. Configure the N7784B according to the following setup:



NOTE Make sure that the instrument providing the external signal does not perform any auto-ranging. If it does, the analog signal will be discontinuous and thus prevent the controller from finding the optimum.

N7786B Polarization Stabilization

In addition to the sequence, manual and scramble modes described before (see N7784B / N7786B Settings on page 134), the N7786B can be used to generate specific output SOPs, even with varying input SOPs.

When the N7786B polarization controller is activated by clicking on the polarization controller symbol in the browser tree, sub-items named **Sequence**, **Manual**, **Scramble** and **SOP Stabilize** appear below the symbol.

By double-clicking the **SOP Stabilize** sub-item of an active N7786B instrument, the settings for the SOP stabilizer can be accessed. By default a list of four SOPs is shown in the **SOP Table**, which can be replaced with an arbitrary list of SOPs by pressing **Import**. The imported file is expected to contain one normalized Stokes vector per line, with spaces or tabs as separators between the vector components, like this:

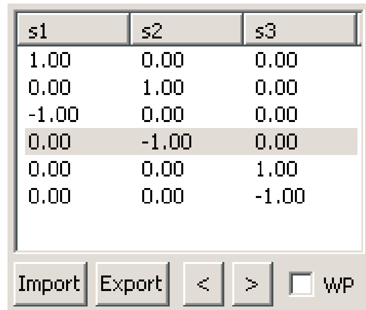
```
0  0  -1
-1  0  0
0  -1  0
```

or

```
-7.2138585e-002  2.2201973e-001 -9.7236992e-001
-2.5000000e-001  1.8163563e-001 -9.5105652e-001
```

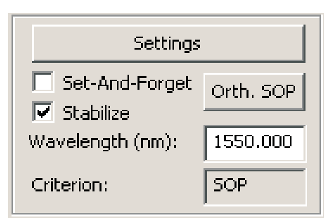
You can find some sample sequences in the *Examples\DemoSOPTables* subfolder of the polarizationNAVIGATOR™ folder. By clicking the **WP** checkbox, the corresponding waveplate angles are shown instead of the Stokes vectors. These Settings, however, are only available once the N7786B has been set to stabilize the corresponding SOP. Before that all waveplate positions will read 0. The waveplate position display of the currently selected row of the sequence will be updated continuously if the input SOP is changed.

By setting the appropriate check marks, the target SOPs can be shown (**Show Target SOPs**, red dots), as well as the SOPs actually generated (**Show Ctrl SOPs**, green dots)



and the N7786B can be set to **Auto Cycle** through the list of SOPs with an adjustable delay between two successive SOPs (note that for high-speed cycling the Trace mode (described below) is more appropriate). This delay can be set in the text box to the right of the **Auto Cycle** checkbox.

By pressing **Settings**, several control parameters (see N7784B / N7786B Settings on page 134) of the SOP controller can be modified.



The **Stabilize** checkmark is set automatically, when choosing an SOP from the list or when activating the **Auto Cycle** or the **Set-And-Forget** feature.

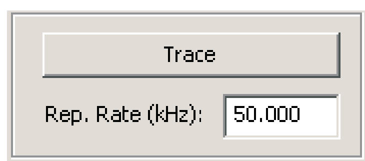
By unchecking or checking this option manually, the controller can be stopped or resumed. The **Set-And-Forget** mode activates the controller and stabilizes the output SOP to the output SOP present at the time of activation. By pressing the Orth. SOP button, the target SOP is replaced with its orthogonal SOP.

For optimum performance the operating **Wavelength** has to be entered in the corresponding text box.

N7786B Trace Mode

The Trace mode is designed for high speed SOP cycling. While in the Stabilizer mode the N7786B continuously adapts to any changes of the input polarization, the trace mode finds appropriate waveplate settings once and does not adapt to changes of the input polarization and thus allows for significantly faster repetition rates.

An appropriate pattern of polarization controller settings yielding the desired sequence of output SOPs is generated automatically once you press the **Trace** button, which may take some seconds. Once this pattern has been generated, it is repeated by the N7786B at the adjustable **Repetition Rate**, without any further SOP stabilization, i.e. without adaptation to subsequent changes of the input SOP.



Exit the trace mode by checking the **Stabilize** check box or by deactivating the instrument in the browser tree.

NOTE When using the Trace mode of the N7786B, make sure that the input polarization remains stable.

N7784B / N7786B Settings

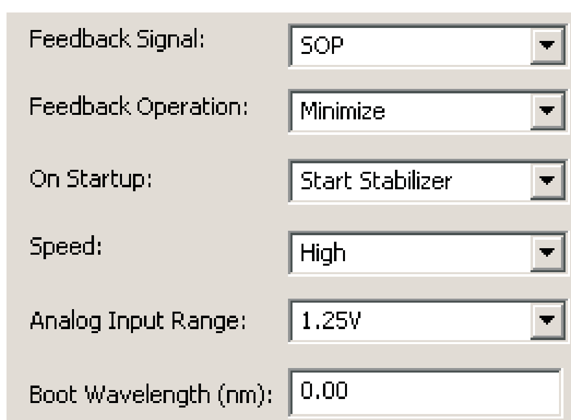
By pressing **Settings** from the SOP Stabilize sub-item of an N7784B/N7786B instrument, several startup options as well as control parameters can be set. This dialog can also be accessed by choosing **Properties** from the N7784B / N7786B instruments context menu and selecting the **Stabilizer Settings** tab.

In case of the N7784B, you can choose whether to use the **Internal** or an external (**Analog In**) Feedback Signal and the Feedback Operation (i.e. whether to **Maximize** or to **Minimize** the feedback signal) as well as the **Analog Input Range** of the external signal. In case of an N7786B these settings are not used.

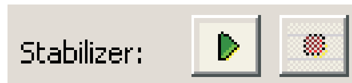
You can choose, whether the SOP stabilizer feature should be activated automatically **On Startup** or not, as well as the **Control Speed** and the operating wavelength (**Boot Wavelength**).

Pressing the **Write To Flash** button will store the new settings. This is only required if you want to set these values as default when powering up the unit next time.

NOTE You need to press the **Write To Flash** button to make the changes persistent. Otherwise, they will be reset to the default values once the instrument is being restarted.



By pressing the **Play** and **Stop** buttons (green arrow, red circle), the stabilizer is started and stopped respectively. The control button on the front panel of the instrument will cycle through these two states.



N7784B / N7786B Control Parameters

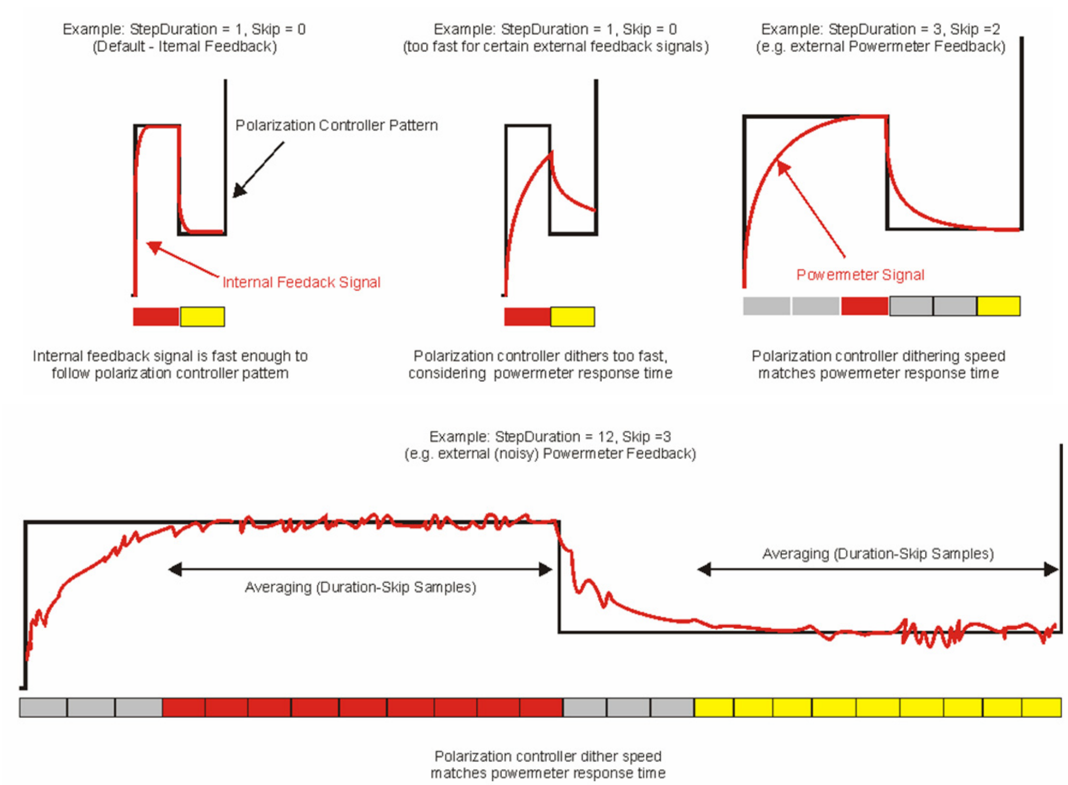
In addition, the internal control parameters can be overridden from the dialog described in N7784B / N7786B Settings on page 134. You can configure the control behavior to optimize the controller to your particular system.

If you click on **Override Default Settings** on the **Settings** dialog, you can enter the following values:

- **Control Step Size**: Increase this parameter to make the control steps larger.
- **Gradient Step Size**: The controller measures the gradient of the feedback signal with respect to the control parameters. This is done by dithering the control parameters. Increase this parameter to make the dithering steps larger.
- **Coarse Threshold**: If the feedback signal differs too much from the optimum, the controller switches to the *coarse* mode, i.e. the control steps are temporarily increased to quickly move back into the optimum.
- **Off Threshold**: This parameter is no longer used
- **Dither Step Duration**: Dither Step Duration defines the number of samples that the instrument will keep a certain polcontroller dithering setting, thus allowing for slower analog-in rise times (see illustrations below).
- **Dither Step Skip**: Dither Step Skip makes the algorithm skip the first number of samples of new each polarization controller dithering setting, so a slow powermeter rise time won't impact the dithering operation. If (Dither Step Duration - Dither Step Skip) > 1, an averaging over the respective samples is performed (see illustrations below). Dither Step Skip must never be greater than Dither Step Duration - 1.
- **Stop Stabilizer if Target SOP reached**: This setting is only valid for SOP stabilization. If the controller reaches the target SOP, it will stop active control, i.e. it will stop dithering. The **Accuracy** parameter lets you define how close the SOP needs to come to the target SOP before deactivation of control.

NOTE

You can only change the control parameters if the controller is turned off.



Using Applications with Multiple Laser Sources

The software tsupports the connection of several laser sources to the GPIB port of the computer or the instrument (make sure these laser sources are configured to communicate at different GPIB addresses). However, the applications can only control one laser source at a time. Therefore, you can add the same application twice to the browser window and associate the two applications with two laser sources.

Use, for example, the following steps to configure the PMD / PDL / Loss - Application (see Application: PMD/PDL (PMD/PDL/Loss) on page 87) for two laser sources:

1 Run the wizard to perform the automatic configuration. Your two laser sources should be listed under Misc.Instruments.
2 Double-click on the PDL/PMD-Application (see Application: PMD/PDL (PMD/PDL/Loss) on page 87). You will be asked for the laser source you want to use together with this application. This configuration will also be used for the next time you start the application.
3 Exit the application.
4 Rename the application by right-clicking and selecting **Rename** or by clicking on the entry twice with a short delay in between. Choose a name describing the laser source (e.g. *“Component Test (C-Band)”*)
5 Add the same application again by right-clicking in the browser window and choosing **Add**. Choose **Swept PMD/PDL/Loss Test**.
6 Double-click on the new application and choose the other laser source.
7 Exit the application.
8 Rename the application as described above.

NOTE Once the link to an instrument is stored, it can only be changed by deleting the application and adding it again.

Trigger Configuration

If you are using two or more laser sources, the trigger outputs of these laser sources have to be combined and connected to the trigger input port of the instrument.

If you are using the PMD/PDL/Loss-Application (see Application: PMD/PDL (PMD/PDL/Loss) on page 87) together with Keysight Tunable Laser sources, this can be done by daisy-chaining the trigger signals:

- Connect the trigger output of laser 1 to the trigger input of the laser 2.
- Connect the trigger output of laser 2 to the trigger input of the N778xB/BD.

The polarizationNAVIGATOR™ will configure the trigger settings of these sources to **PASSTHROUGH** automatically.

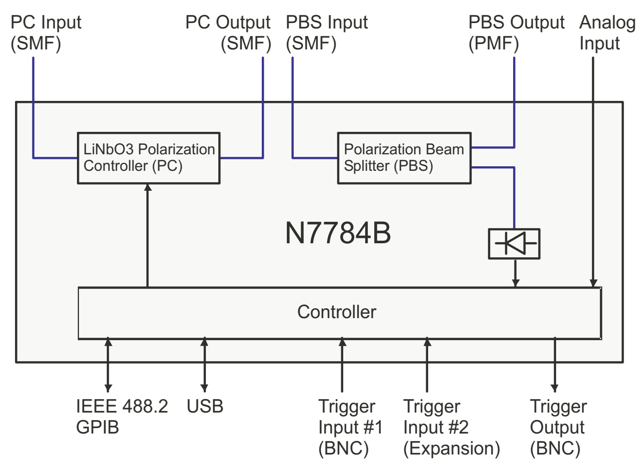
5 Hardware

This chapter describes the Polarization Solution hardware.

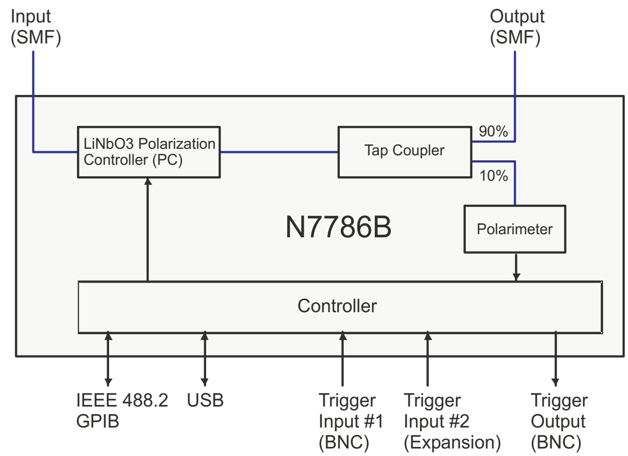
Instrument Block Diagrams

Some N778xB/BD instruments allow for different applications, each of which may require a different optical setup. This section contains block diagrams for instruments that contain several functional blocks that can be used for individual applications.

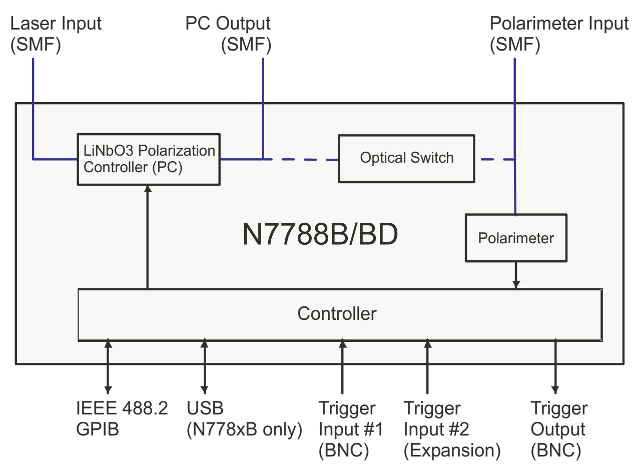
N7784B



N7786B



N7788B



Expansion Port Connector Pinout

Pin	Function
1	Analog Out A
2	Analog Out C
3	GND
4	Trigger Input #1
5	Trigger Input #2
6	
7	
8	Analog In GND
9	Analog Out B
10	Analog Out D
11	GND
12	Trigger Out
13	Analog In
14	
15	

Electrical Data and Environmental Conditions

Power Supply Information and Environmental Conditions

N7781B/N7782B/N7784B/N7785B/N7786B/N7788B

Power	100-240 V~, 50-60 Hz, 60 VA max.
Voltage Fluctuation	up to 10%
Use	Indoor
Altitude	up to 2000m
Operating Temperature	+5°C...+40°C
Operating Humidity Range	0%-80% r.h. non-condensing
Installation Category	II
PollutionDegree	2
Interfaces	GPIB, USB

N7781BD/N7788BD

Power	100-240 V~, 50-60 Hz, 200 VA max.
Voltage Fluctuation	up to 10%
Use	Indoor
Altitude	up to 2000m
Operating Temperature	+5°C...+40°C
Operating Humidity Range	0%-80% r.h. non-condensing
Installation Category	II
Pollution Degree	2
Interfaces	GPIB, LAN

N7783B

Power (Instrument)	12 V=, 36W
Power (Power Supply*)	100-240 V~, 47-63 Hz, 1.0 A max.
Voltage Fluctuation	up to 10%
Use	Indoor
Altitude	up to 2000m
Operating Temperature	+5°C...+40°C
Operating Humidity Range	0%-80% r.h. non-condensing
Installation Category	II
Pollution Degree	2

* Use UMEC UP0451E-12P82L power supply only

Digital Inputs

Table 9 Digital Inputs

Technology:	AC series (advanced high-speed CMOS)
Input Voltage Range:	0V.. 5V
Digital Input Levels:	1,65V .. 2,75V (low level threshold) 2,75V .. 3,85V (high level threshold)

Digital Outputs

Table 10 Digital Outputs

Technology:	AC series (advanced high-speed CMOS)
Digital Output Levels:	0,36V .. 0,44V (low level threshold) 4,76V .. 4,86V (high level threshold)

6 Direct Instrument Control

This chapter describes how to control instruments using the COM/ActiveX-interface library (AgServerN778xLib).

KEYSIGHT TECHNOLOGIES

Introduction

A comfortable way to communicate with N778x instruments is to use the COM/ActiveX-interface offered by the library AgServerN778xLib. This library is installed when the “Photonic Application Suite (Main)” package is installed.

Modern programming languages typically offer an easy way to access COM/ActiveX-interfaces. For example, C#, Visual Basic .NET, LabView and MATLAB allow to browse all available methods and properties. If you use one of these languages, we therefore recommend to use the COM/ActiveX-interface.

If a language does not allow to easily browse the methods/properties of a COM/ActiveX library, it may be easier to just use the method “SCPIQuery” of the library AgServerN778xLib. This method takes a string as a parameter which defines the desired action. This string needs to be formatted according to the so-called SCPI standard (Standard Commands for Programmable Instruments). The library parses the SCPI strings and converts them into the binary format used by the instruments.

NOTE

Use the COM/ActiveX-interface if you use C#, Visual Basic .NET, LabView or MATLAB.

NOTE

Up to version 2.0 of the Photonic Application Suite (PAS), the library was implemented as a DLL (AgN778xLib.dll) and accessed through the COM/Active-X class AgN778xLib. This DLL did not support 64 bit remoting environments.

With PAS version 2.1 it has been replaced by a COM server executable accessed through the class AgServerN778xLib which supports both 32 bit and 64 bit remote environments.

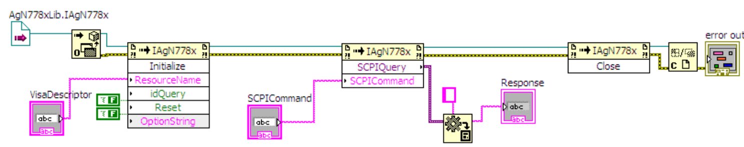
Migrating from the old class to the new class just means changing the name of the class at the very beginning of an automation program / method.

For the sake of compatibility, the DLL is still part of any PAS installation.

Using LabView for controlling instruments

NOTE The screenshots used in this section still refer to the DLL implementation of the library. Choose AgServerN778xLib instead of AgN778xLib to use the 64 bit capable implementation instead.

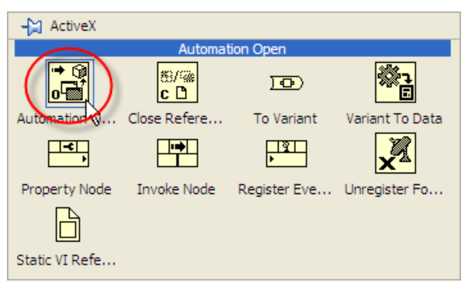
This is a simple VI to send a SCPI-command to an instrument:



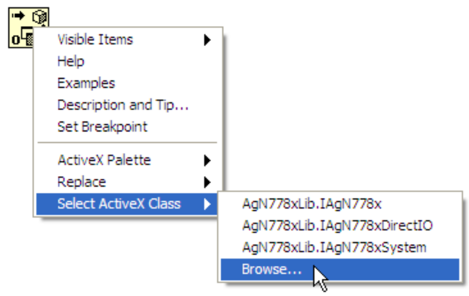
You can find this VI in the DemoLabView8.5 folder.

Creating the reference to the driver is the origin for all activities. You can create this reference either by copying it from the example or create it as follows:

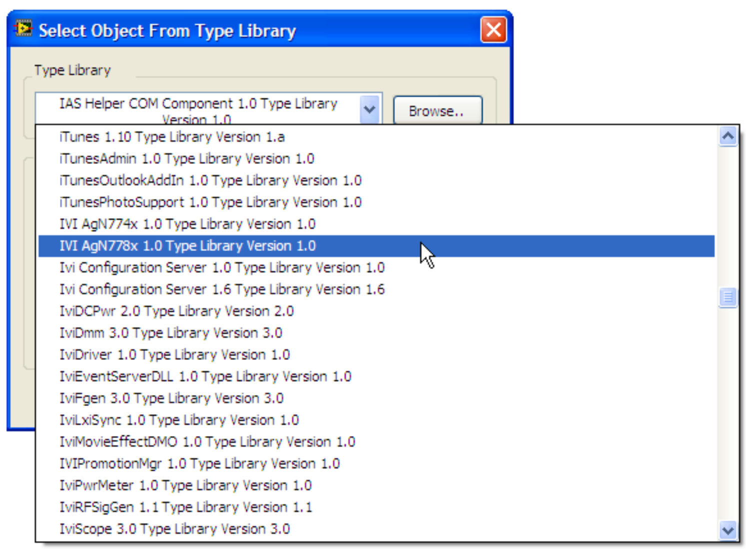
- Add the VI “Automation Open” from the ActiveX palette:



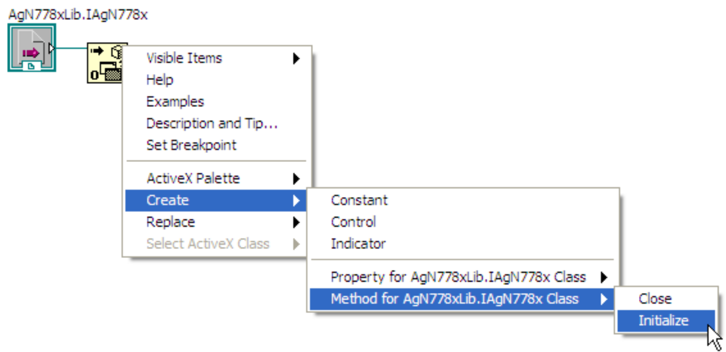
- Right-Click on the VI and click on “Select ActiveX Class” and then on “Browse”:



- Then select the COM automation object “IVI AgServerN778x ...”



- To access the objects, right-click on the VI and select "Create->Property" or "Create->Method":



Using MATLAB for controlling instruments

Use the following MATLAB-command sequence to send a SCPI command:

```
% Create COM-Object
N778X = actxserver('AgServerN778xLib.AgN778x');
% Initialize
N778X.Initialize(’USB::04400133’,0,0);
% Send SCPI-command
Response=N778X.SCPIQuery('*IDN?');
```

Note that you have to replace the VisaDesciptor ’USB::04400133’ by the serial number of your instrument. You can also use a GPIB card installed in your computer. In this case, use ’GPIB::30::INSTR’ as descriptor. When finished, you should close the instrument:

```
N778X.Close;
```

Use this SCPI-Command to measure a polarization state:

```
SOP=N778X.SCPIQuery(':POL:SOP?');
```

Alternatively, you can use the corresponding COM-command:

```
SOP=N778X.Polarimeter.SOP;
```

Please refer to the MATLAB examples located in the DemoMATLAB folder.

COM/ActiveX-based examples:

- N778xCOMDemo_SOPSweep.m
  Free running SOP measurement sweep.
- N778xCOMDemo_SOPSweep_Triggered.m
  SOP measurement sweep triggered by the digital BNC input.
- N778xCOMDemo_SOPSweep_PreTrigger.m
  Measurement sweep with pre-trigger phase, triggered by the digital BNC input.
- N778xCOMDemo_SOPSweep_Continuous.m
  Continuous streaming of SOPs.

SCPI-based examples:

- N778xSCPIDemo_SOPSweep.m
  Free running SOP measurement sweep.
- N778xSCPIDemo_SOPSweep_Triggered.m
  SOP measurement sweep triggered by the digital BNC input.
- N778xSCPIDemo_SOPSweep_PreTrigger.m
  Measurement sweep with pre-trigger phase, triggered by the digital BNC input.
- N778xSCPIDemo_SOPSweep_Continuous.m
  Continuous streaming of SOPs.

COM/ActiveX-Interface

The COM/ActiveX-Interface allows you to control the instruments more comfortably since modern programming languages allow to browse the methods and properties.

For most commands, there is a corresponding SCPI command. These commands are described in the next chapter.

Interface List

To use the COM/ActiveX-Interface, you have to create a COM-object using the following identifier:

`AgServerN778xLib.AgN778x`

In some languages, the library is listed as “IVI AgServerN778xLib ...”.

These are the interfaces offered by the COM Class:

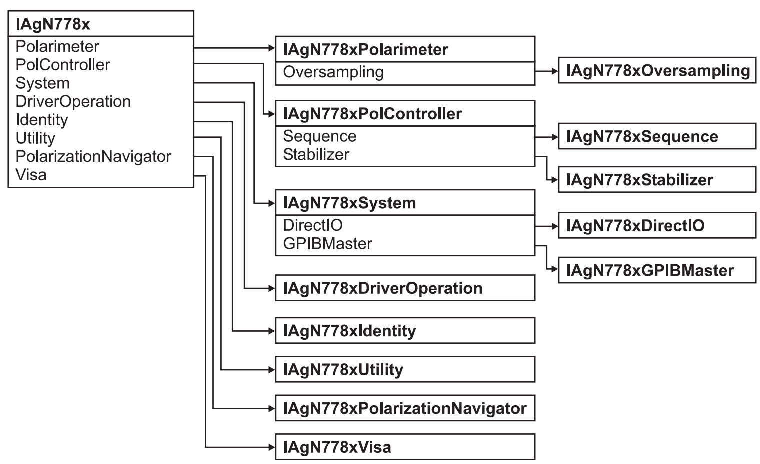


Figure 23 Diagram of COM/ActiveX-interface classes

IAgN778x

Table 11 Methods of interface IAgN778x

Initialize	Initializes the communication to an instrument.
Close	Closes an instrument.
SCPIQuery	Send a SCPI command.
SCPI2SingleArray	Send a SCPI command and interpret the result as array of 32-bit floating point numbers (single-precision).
SCPI2DoubleArray	Send a SCPI command and interpret the result as array of 64-bit floating point numbers (double-precision).
SCPI2IntArray	Send a SCPI command and interpret the result as array of 32-bit integer numbers.
SCPIQueryBin	Send a SCPI command with binary content.

Table 12 Properties of interface IAgN778x

Polarimeter (read only)	IAgN778xPolarimeter*	Returns the IAgN778xPolarimeter interface to control the polarimeter.
PolController (read only)	IAgN778xPolController*	Returns the IAgN778xPolController interface to control the polarization controller.
System (read only)	IAgN778xSystem*	Returns the IAgN778xSystem interface to control system commands.
DriverOperation (read only)	IAgN778xDriverOperation*	Returns the IAgN778xDriverOperation interface to control driver-related settings.
Identity (read only)	IAgN778xIdentity*	Returns the IAgN778xIdentity interface to access the instruments identity information.
Utility (read only)	IAgN778xUtility*	Returns the IAgN778xUtility interface to access some miscellaneous functions.
PolarizationNavigator (read only)	IAgN778xPolarizationNavigator*	Returns the IAgN778xPolarizationNavigator interface to control the Polarization Navigator.
Visa (read only)	IAgN778xVisa*	Returns the IAgN778xVisa interface to use the instrument’s GPIB port as master.

method Initialize

```
Initialize(
   [in] BSTR ResourceName,
   [in] VARIANT_BOOL idQuery,
   [in] VARIANT_BOOL Reset,
   [in,optional] BSTR OptionString)
```

Initializes the communication to the instrument. You have to call this method at the beginning of your program.

`ResourceName`

Defines which interface is to be used to communicate with the instrument. Examples: “USB::04011133”, “GPIB::30::INSTR”

`idQuery`

Defines whether to communicate with the instrument during initialization.

`Reset`

Defines whether the instrument is to be reset during initialization.

`OptionString`

Set this string to “DriverSetup= Trace=true” to enable the trace log file. See property IAgN778xSystem.TraceEnabled for more details.

method Close

```
Close()
```

Closes communication and frees resources.

method SCPIQuery

```
SCPIQuery(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

See IAgN778xDirectIO.SCPIQuery

method SCPI2SingleArray

```
SCPI2SingleArray(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

See IAgN778xDirectIO.SCPI2SingleArray

method SCPI2DoubleArray

```
SCPI2DoubleArray(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

See IAgN778xDirectIO.SCPI2DoubleArray

method SCPI2IntArray

```
SCPI2IntArray(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

See IAgN778xDirectIO.SCPI2IntArray

method SCPIQueryBin

```
SCPIQueryBin(
   [in] SAFEARRAY(BYTE) SCPICommand,
   [out, retval] VARIANT* Response)
```

See IAgN778xDirectIO.SCPIQueryBin

IAgN778xPolarimeter

Interface path: `IAgN778x.Polarimeter`

Table 13 Methods of interface IAgN778xPolarimeter

Stop	Stops an ongoing measurement.
SweepStart	Starts an SOP measurement sweep.
QuerySweepState	Returns the current sweep status.

Table 14 Properties of interface IAgN778xPolarimeter

Oversampling (read only)	IAgN778xOversampling*	Returns the IAgN778xOversampling interface to control the polarimeter oversampling. **This interface is not for public use.**
SOP (read only)	ARRAY(FLOAT)	Returns a single SOP.
Wavelength	DOUBLE	Sets/gets the operating wavelength in nm.
Gain	LONG	Sets/gets the current amplifier gain setting.
AutoGainFlag	LONG	Sets/gets the automatic gain setting. **0**: Auto gaining off **1**: Auto gaining on. If input power is too low even at the highest gain level, an underrange-error will be generated. **2**: Auto gaining on. The underrange-error will be suppressed at the highest gain setting.

SweepGet (read only)	ARRAY(FLOAT)	Returns the measurement result. The result is an array of single-precision floatling point numbers. The element order is as follows: S0, S1, S2, S3, S0, S1, S2, S3, ... or in case of the continuous mode (`eN778xSweepModeSOPContinuous`): TickCount, S0, S1, S2, S3, TickCount, S0, S1, S2, S3, ... Note that TickCount is based on a 16-bit unsigned integer number which wraps around when exceeding the value 65535. The TickCount value allows to find out the exact time at which each sample has been taken in the continuous mode.
SweepSamples	LONG	Sets/gets the desired number of samples.
SweepRate	DOUBLE	Sets/gets the sweep rate in nm/s. When performing a swept measurement, very often, the wavelength is changed over time. This parameter allows you to inform the instrument about the speed at which the wavelength of the laser source is changing. The start wavelength is given by the property Wavelength.
SweepSamplingRate	DOUBLE	Sets/gets the sampling rate in kHz. Maximum samplingrate is 1041 kHz.
SweepLastPeakRange	DOUBLE	Returns how well the ADC range was used for the last peak power. If this value is below 0.5, the measurement sweep should be repeated with a higher amplifier gain setting.
SweepPreTriggerSamples	LONG	Sets/gets the desired number of pre-trigger samples (only valid using the trigger modes eN778xTrigSOPCHANGE, eN778xTrigPRETRIGTTLHIGH and eN778xTrigPRETRIGTTLLOW), see property SweepTriggerSource.
SweepPostTriggerSamples	LONG	Sets/gets the desired number of post-trigger samples.
SOPTrigSampleDiff	DOUBLE	Sets/gets the observed time interval in s for the SOP trigger detection.
SOPTrigSampleThres	DOUBLE	Sets/gets the minimum angular changein deg for the SOP trigger detection. NOTE: Sampling rate must be set prior to setting this value.

SweepContSOPAccuracy	DOUBLE	Sets/gets the SOP accuracy in rad used in the continuous sampling mode (see method SweepStart). A value of 0 causes all samples to be stored. This corresponds to a constant sampling rate of 2.5 kHz. Otherwise SOP changes smaller than SweepContSOPAccuracy will not cause a sample to be stored.
SweepTriggerSource	enum eN778xTrig_t eN778xTrigNone= 0 eN778xTrigTTLHIGH= 2 eN778xTrigTTLLOW= 3 eN778xTrigSOPCHANGE= 5 eN778xTrigPRETRIGTTLHIGH = 7 eN778xTrigPRETRIGTTLLOW= 8	Sets/gets the current trigger source. The values are: **eN778xTrigNone**: No triggering. **eN778xTrigTTLHIGH**: A measurement is triggered on the high edge of the BNC TTL input. **eN778xTrigTTLLOW**: A measurement is triggered on the low edge of the BNC TTL input. **eN778xTrigSOPCHANGE**: A trigger is created on an SOP-movement. Use the properties SOPTrigSampleDiff and SOPTrigSampleThres to adjust the sensitivity. Note that in this mode, the number of samples is set by the properties SweepPreTriggerSamples and SweepPostTriggerSamples. **eN778xTrigPRETRIGTTLHIGH**: A trigger is created on an high transition on the BNC TTL input. However, in this mode, the number of samples is set by the properties SweepPreTriggerSamples and SweepPostTriggerSamples. **eN778xTrigPRETRIGTTLLOW**: A trigger is created on an low transition on the BNC TTL input. However, in this mode, the number of samples is set by the properties SweepPreTriggerSamples and SweepPostTriggerSamples.
TriggerLog (read only)	ARRAY(DOUBLE)	During sweep sampling, trigger events on the BNC trigger input are recorded. The property TriggerLog returns an array with the sample numbers for which a trigger event has been detected. This is helpful when receiving digital trigger data from a wavelength locker during a wavelength sweep.

method Stop

```
Stop()
```

Stops any ongoing SOP measurement.

method SweepStart

```
SweepStart([in] enum eN778xSweepMode_t Value)

enum eN778xSweepMode_t
{
  eN778xSweepModeSOP = 1,
  eN778xSweepModeSOPContinuous = 2,
}
```

Starts an SOP measurement sweep.

`Value:`

Defines the sweep mode.
A value of eN778xSweepModeSOP starts a normal one-shot measurement.
A value of eN778xSweepModeSOPContinuous corresponds to the “Trace” mode in the Polarization Navigator. This allows streaming of SOP data at a maximum speed of 2.5 kHz. See the MATLAB example “N778xCOMDemo_SOPSweep_Continuous.m” for more details.

method QuerySweepState

```
QuerySweepState(
   [out] LONG *nSamples,
   [out] LONG *SweepErrorCode,
   [out] BSTR *SweepErrorString,
   [out, retval] enum eN778xSweepState_t* SweepState)

enum eN778xSweepState_t
{
  eN778xSweepStateIdle = 0,
  eN778xSweepStateArmed = 1,
  eN778xSweepStateSampling = 2,
  eN778xSweepStateDataAvailable = 3,
  eN778xSweepStateError = 4
}
```

Returns the current sweep status consisting of the number of samples sampled so far, the sweep status and a corresponding error code.

`nSamples:`

Number of samples so far.

`SweepErrorCode:`

Error code occurred during sampling.

`SweepErrorString:`

Corresponding error string.

`SweepState:`

Current sweep status.
eN778xSweepStateIdle: No sweep has been started.
eN778xSweepStateSampling: A measurement is in progress.
eN778xSweepStateArmed: The instrument waits for a trigger signal.
eN778xSweepStateDataAvailable: Data can be read from the instrument.
eN778xSweepStateError: An error occurred.

IAgN778xPolController

Interface path: `IAgN778x.PolController`

Table 15 Methods of interface IAgN778xPolController

Stop	Stops any ongoing polarization controller activity such as a sequence operation.
Waveplates	Sets the orientation and retardation of the polarization controller waveplates.

Table 16 Properties of interface IAgN778xPolController

Sequence (read only)	IAgN778xSequence*	Returns the IAgN778xSequence interface to control the sequence.
Stabilizer (read only)	IAgN778xStabilizer*	Returns the IAgN778xStabilizer interface to control the stabilizer.
WaveplatesPosition	ARRAY(DOUBLE)	Sets/gets the orientation of the polarization controller waveplates in rad. The array needs to have a length of 5 elements.
WaveplatesRetardation	ARRAY(DOUBLE)	Sets/gets the retardation of the polarization controller waveplates. The array needs to have a length of 5 elements. The is defined as fractions of Lambda. A value of 0.25 corresponds to a quarter waveplate. The maximum value of the 1st, 2nd, 4th and 5th waveplate is 0.25. Only the 3rd waveplate can create a retardation of up to 0.5.

Smoothing	DOUBLE	Sets/gets the polarization controller smoothing switching speed in °/s. Values can range from 100°/s to 80000°/s. A value of 0 selects the fastest possible switching time.
Program	enum eN778xPolConProgram_t eN778xPolConProgramManual = 0 eN778xPolConProgramScramble = 10 eN778xPolConProgramSequence = 32 eN778xPolConProgramReload= 33	Sets the operation mode of the polarization controller or starts a sequence. **eN778xPolConProgramManual**: The waveplate positions and retardations can be manually set. **eN778xPolConProgramScramble**: Generates a random scrambling sequence. **eN778xPolConProgramSequence**: Starts a sequence which has been written to the polarization controller using the IAgN778xSequence interface. **eN778xPolConProgramReload**: Restarts a sequence which has been stopped using the Stop method.

method Stop

```
Stop()
```

Stops any ongoing polarization controller activity such as a sequence operation.

method Waveplates

```
Waveplates(
   [in] SAFEARRAY(DOUBLE) Position,
   [in] SAFEARRAY(DOUBLE) Retardation);
```

Sets the orientation and retardation of the polarization controller waveplates.

`Position:`

Defines the orientation of the 5 waveplates in rad. The array needs to have a length of 5 elements.

`Retardation:`

Defines the retardation of the 5 waveplates in fractions of Lambda. A value of 0.25 corresponds to a quarter waveplate. The maximum value of the 1st, 2nd, 4th and 5th waveplate is 0.25. Only the 3rd waveplate can create a retardation of up to 0.5. The array needs to have a length of 5 elements.

IAgN778xSequence

Interface path: `IAgN778x.PolController.Sequence`

Table 17 Methods of interface IAgN778xSequence

SeqVoltage	Sets the polarization controller sequence using direct voltage values.
Sequence	Sets the polarization controller sequence using waveplate positions and retardations.

Table 18 Properties of interface IAgN778xSequence

Length	LONG	Sets/gets the polarization controller sequence length.
RepetitionRate	DOUBLE	Sets/gets the polarization controller repetition rate in kHz.
Timebase	enum eN778xPolConTimebase_t eN778xPolConTimebaseTimer= 0 eN778xPolConTimebasePolarimeter= 1 eN778xPolConTimebaseExternal= 2	Sets/gets the polarization controller time base. **eN778xPolConTimebaseTimer**: Uses an independent timer as clock. **eN778xPolConTimebasePolarimeter**: Uses the same timer as the polarimeter. **eN778xPolConTimebaseExternal**: Uses the BNC input as clock.
AutoOversampling	BOOL	Sets/gets the polarization controller auto-oversampling flag. If set to true, the internal sampling rate might chosen to be higher than set by the property RepetitionRate. This allows to compensate for certain drift behavior of the LiNbO3 chip.
Retrigger	BOOL	Sets/gets the polarization controller retrigger flag. A value of true allows a running sequence to be retriggered and thus interrupted by a trigger event. If set to false, subsequent trigger events are ignored.

DriftCompensation	BOOL	Sets/gets the polarization controller drift-compensation flag. Normally, this value is set to true. When set to true, the drift behavior of the LiNbO3 chip is partailly compensated using internal calibration data.
Prescaler	LONG	Sets/gets the polarization controller pre-scaler value. This parameter allows to divide the sequence clock. The default value is 0 which does not divide the clock. A value of 1 divides by 2. A value of 2 divides by 3 etc.
Holdoff	LONG	Sets/gets the polarization controller hold-off value in µs. The hold-off value defines a latency time between the trigger event and the sequence start.
Oversampling	LONG	Sets/gets the polarization controller oversampling value. A value greater than 1 increases the internal sampling rate. E.g. RepetitionRate set to 10kHz and Oversampling set to 10 creates an internal sampling rate of 100kHz. The missing sequence entries are calculated to minimize drift (only if DriftCompensation is set to true). Note that this value is automaticaly set by the instrument if AutoOversampling is set to true.
SyncOutTrigger	LONG	Sets/gets the synchronization shift of the synchronous sequence output trigger feature. This feature allows to output a clock signal to the first analog output on the expansion port. A value of 0 turns this feature off. A non-zero value turns this feature on. Note that the property Oversampling needs to be greater than 1. In that case, values of 1..Oversampling can define the phase shift of the clock output.

SyncMode	enum eN778xPolConSyncMode_t eN778xPolConSyncModeAutoRepeat = 0 eN778xPolConSyncModeAutoOneshot = 1 eN778xPolConSyncModeExternalRepeat = 2 eN778xPolConSyncModeExternalOneshot =3 eN778xPolConSyncModePolarimeterRepeat = 4 eN778xPolConSyncModePolarimeterOneshot = 5	Sets/gets the polarization controller synchronization mode. **eN778xPolConSyncModeAutoRepeat**: Sequence will automatically start and restart when reaching the end. **eN778xPolConSyncModeAutoOneshot**: Sequence will automatically start and run only once. **eN778xPolConSyncModeExternalRepeat**: Sequence will start when a low/high-transition is detected on the BNC input. When reachig the end of the sequence, it will be restarted. **eN778xPolConSyncModeExternalOneshot**: Same as above, except that the sequence will not be repeated. **eN778xPolConSyncModePolarimeterRepeat**: Sequence is started when the polarimeter starts sampling. The sequence is repeated when reaching the end. **eN778xPolConSyncModePolarimeterOneshot**: Same as above, except that the sequence will not be repeated.
SuggestPolMetOversampling	LONG	See SuggestPolMetSamplingRate.
SuggestPolMetSamplingRate	DOUBLE	Not all ratios between the polarimeter clock and the polarization controller clock can be exactly synchronized to each other. Writing into this property will optimize the settings. First, set the RepetitionRate property to the desired value. Then set the property SuggestPolMetOversampling to the desired polarimeter oversampling value. If AutoOversampling is false, set the property Oversampling to the desired value. Now write the desired polarimeter sampling rate into the property SuggestPolMetSamplingRate. This will trigger the optimization process. As a result, the property RepetitionRate and SuggestPolMetSamplingRate has been modified. You should read the property SuggestPolMetSamplingRate and write it to IAgN778xPolarimeter.SweepSamplingRate.

method SeqVoltage

`SeqVoltage([in] SAFEARRAY(USHORT) pVal)`

Sets the polarization controller sequence using direct voltage values.

`pVal:`

Defines the voltage values. The voltage levels are defined by 16-bit unsigned integer values. Each element may range from 0 to 4095, where 2048 is the neutral setting. Each waveplate is controlled by two voltages. Thus, each sequence row contains 10 voltage levels. Hence, the array length has to be a multiple of 10.

method Sequence

`Sequence([in] SAFEARRAY(FLOAT) pVal)`

Sets the polarization controller sequence using waveplate positions and retardations.

`pVal:`

Defines the orientation and retardation values. Each waveplate is controlled by two float values: Orientation in rad and Retardation in fractions of Lambda (0.25 corresponds to l/4). Thus, each sequence row contains 10 float values. Hence, the array length has to be a multiple of 10. Each row has the following order:

```
Orientation waveplate 1
Retardation waveplate 1
Orientation waveplate 2
Retardation waveplate 2
Orientation waveplate 3
Retardation waveplate 3
Orientation waveplate 4
Retardation waveplate 4
Orientation waveplate 5
Retardation waveplate 5
```

IAgN778xStabilizer

Interface path: `IAgN778x.PolController.Stabilizer`

Table 19 Methods of interface IAgN778xStabilizer

FlashWrite	Writes current settings to the flash memory.

Table 20 Properties of interface IAgN778xStabilizer

Stabilize	BOOL	Sets/gets the state of the polarization stabilizer.
OnStartupStabilize	BOOL	Sets/gets the stabilizer stabilize-on-startup flag. A value of true will cause the instrument to start the stabilizer immediately after power on. Note that you have to use the method FlashWrite to store this setting in flash memory.
Invert	BOOL	Sets/gets the stabilizer invert flag. A value of true inverts the error criterion.
SOP	ARRAY(DOUBLE)	Sets the target SOP or returns the current SOP. The target SOP can be provided as a 3-element normalized Stokes vector or a 4-element Stokes vector (with DOP=1). Reading this property will read the currently measured SOP from the stabilizer. Note that this property is only valid if the instruemnt contains a polarization analyzer such as N7788B or N7786B.
Feedback	enum eN778xPolConFeedback_t eN778xPolConFeedbackSOP= 0 eN778xPolConFeedbackInternal= 1 eN778xPolConFeedbackPower= 2 eN778xPolConFeedbackAnalogIn= 3 eN778xPolConFeedbackDOP= 4	Sets/gets the stabilizer feedback mode. **eN778xPolConFeedbackSOP**: Uses the SOP as a feedback (only N7788B or N7786B). **eN778xPolConFeedbackInternal**: Uses the internal photodetector of the N7784B. **eN778xPolConFeedbackPower**: Uses the optical power (S0) as feedback (only N7788B or N7786B), **eN778xPolConFeedbackAnalogIn**: Uses the analog input of the N7784B. **eN778xPolConFeedbackDOP**: Uses the DOP as feedback (only N7788B or N7786B).

method FlashWrite

```
FlashWrite()
```

Writes current settings to the flash memory. Use this command to write the state of the property OnStartupStabilize into the flash memory.

IAgN778xSystem

Interface path: `IAgN778x.System`

Table 21 Properties of interface IAgN778xSystem

DirectIO (read only)	IAgN778xDirectIO*	Returns the IAgN778xDirectIO interface to control direct input/output.
GPIBMaster (read only)	IAgN778xGPIBMaster*	Returns the IAgN778xGPIBMaster interface to use the instrument's GPIB port as master. **Note: This interface is not for public use. Use the interface provided by IAgN778x.Visa instead.**
SerialNumber (read only)	BSTR	Returns the instrument's serial number.
ModelCode (read only)	BSTR	Returns the instrument's serial mode code (e.g. "N7788B").
Temperature (read only)	DOUBLE	Returns the internal temperature in °C.
GPIBAddress	LONG	Sets/gets the GPIB address.
TraceEnabled	BOOL	Sets/gets the "trace" flag. Setting this value to true will generate a log file on the desktop. The generated file is an XML file wich can be opened e.g. using the Internet Explorer.
AnalogOut	ARRAY(DOUBLE)	Sets/gets the analog output levels on the expansion port. The array needs to have a 4 elements ranging from -1 to 1. This corresponds to an output voltage of 0V .. 5V. Note: Reading this property returns the last value written into this property. If the instrument writes into the DACs, the property is left unchanged.

IAgN778xDirectIO

Interface path: `IAgN778x.System.DirectIO`

Table 22 Methods of interface IAgN778xDirectIO

SCPIQuery	Sends a SCPI command to the instrument and reads the response.
SCPI2SingleArray	Sends a SCPI command to the instrument and reads the response as array of single-precision floating point values.
SCPI2DoubleArray	Sends a SCPI command to the instrument and reads the response as array of double-precision floating point values.
SCPI2IntArray	Sends a SCPI command to the instrument and reads the response as array of 32-bit integer values.
SCPIQueryBin	Sends a binary SCPI command to the instrument and reads the response as binary (array of 8-bit unsigned integer values).

method SCPIQuery

```
SCPIQuery(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

Sends a SCPI command to the instrument and reads the response.

`SCPICommand:`

The SCPI command.

`Response:`

Normally, a string will be returned (BSTR). If the response starts with a '#', the data will be decoded and returned as BYTE array.

method SCPI2SingleArray

```
SCPI2SingleArray(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

Sends a SCPI command to the instrument and reads the response. A binary response will be interpreted as array of single-precision floating point values.

`SCPICommand:`

The SCPI command.

`Response:`

Normally, a string will be returned (BSTR). If the response starts with a '#', the data will be decoded and returned as FLOAT array.

method SCPI2DoubleArray

```
SCPI2DoubleArray(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

Sends a SCPI command to the instrument and reads the response. A binary response will be interpreted as array of double-precision floating point values.

`SCPICommand:`

The SCPI command.

`Response:`

Normally, a string will be returned (BSTR). If the response starts with a '#', the data will be decoded and returned as DOUBLE array.

method SCPI2IntArray

```
SCPI2IntArray(
   [in] BSTR SCPICommand,
   [out, retval] VARIANT* Response)
```

Sends a SCPI command to the instrument and reads the response. A binary response will be interpreted as array of 32-bit integer values.

`SCPICommand:`

The SCPI command.

`Response:`

Normally, a string will be returned (BSTR). If the response starts with a '#', the data will be decoded and returned as LONG array.

method SCPIQueryBin

```
SCPIQueryBin(
   [in] SAFEARRAY(BYTE) SCPICommand,
   [out, retval] VARIANT* Response);
```

Sends a SCPI command to the instrument and reads the response. A binary response will be interpreted as array of single-precision floating point values.

`SCPICommand:`

The SCPI command as BYTE array.

`Response:`

Normally, a string will be returned (BSTR). If the response starts with a '#', the data will be decoded and returned as BYTE array.

IAgN778xDriverOperation

Interface path: `IAgN778x.DriverOperation`

Table 23 Methods of interface IAgN778xDriverOperation

ThrowError	Generates an error with the passed error code for testing purposes.
ConvertErrorCode	Converts an error code to a human readable string.

Table 24 Properties of interface IAgN778xDriverOperation

ExceptionOnError	BOOL	Enables (default) or disables the generation of an exception if an error occurs. Temporarily disabling the exceptions can be useful to prevent program interruption if a controlled error handling is desired. You can use the property LastError to query the last error result.
LastError (read only)	LONG	Returns the last error result.

method ThrowError

```
ThrowError([in] LONG ErrorCode)
```

Generates an error with the passed error code for testing purposes. Normally, an exception will be generated and the program should stop execution.

`ErrorCode:`

The desired error code.

method ConvertErrorCode

```
ConvertErrorCode(
   [in] LONG ErrorCode,
   [out, retval] BSTR* pVal);
```

Converts an error code to a human readable string.

`ErrorCode:`

The error code to be converted.

`pVal:`

The generated error string.

IAgN778xUtility

Interface path: `IAgN778x.Utility`

Table 25 Methods of interface IAgN778xUtility

Reset	Sets the instrument to a predefined state.

Table 26 Properties of interface IAgN778xUtility

SelfTestResult (read only)	LONG	Returns the self-test result. A value of 0 indicates “no error”.
USBInstruments (read only)	ARRAY(BSTR)	Returns VISA descriptors of the connected USB instruments.

method Reset

```
Reset()
```

Sets the instrument to a predefined state.

IAgN778xIdentity

Interface path: `IAgN778x.Identity`

Table 27 Properties of interface IAgN778xIdentity

IdentityString (read only)	BSTR	Returns the identity-string (the response to the "*IDN?" SCPI-Command.

IAgN778xVisa

Interface path: `IAgN778x.Visa`

Table 28 Methods of interface IAgN778xVisa

Initialize	Initializes the communication either to a VISA instrument or an instrument connected to the GPIB-master port of the N778x instrument.
Write	Writes a string to the interface.
WriteBin	Writes binary data to the interface.
Read	Reads a string from the interface.
ReadSingleArray	Reads from the interface and interprets binary data as array of single-precision floating point values.
ReadDoubleArray	Reads from the interface and interprets binary data as array of double-precision floating point values.
ReadIntArray	Reads from the interface and interprets binary data as array of 32-bit integer values.

method Initialize

```
Initialize(
   [in] BSTR ResourceName,
   [in,optional] BSTR RemoteGPIBInterface)
```

Initializes the communication either to a VISA instrument or an instrument connected to the GPIB-master port of the N778x instrument. We recommend to use this interface if you want the flexibility to either connect your supporting instrument (e.g. a tunable laser) to the GPIB master port of the N778x instrument or to use the VISA library installed on your computer. Any read/write operations have to be done using the methods of IAgN778xVisa. As a consequence, you can redirect the communication either to the VISA library or the GPIB master port just by changing the call to the “Initialize” method (see the following examples).

`ResourceName:`

The VISA descriptor of the instrument to talk to (e.g. “GPIB::20::INSTR“).

`RemoteGPIBInterface:`

Leave this empty if you want to use the VISA library on our computer. Otherwise, set this value to the VISA descriptor of the N778x instrument to be used as GPIB master (e.g. “USB::DE04400133“).

Examples:

```
IAgN778x.Visa.Initialize(“GPIB::20::INSTR”,””);
```

Start communication to a GPIB instrument with the address 20 using the GPIB interface installed in your computer.

```
IAgN778x.Visa.Initialize(“TCPIP0::134.40.9.177::inst0::INSTR”,””);
```

Start communication to an instrument via TCP/IP using the VISA library installed on your computer.

```
IAgN778x.Visa.Initialize(“GPIB::20::INSTR”,”USB::DE04400133”);
```

Start communication to a GPIB instrument with the address 20 which is connected to the GPIB port of the N778x instrument with the serial number DE04400133 which is connected to the USB-port of your computer.

IAgN778xPolarizationNavigator

Interface path: `IAgN778x.PolarizationNavigator`

Table 29 Methods of interface IAgN778xPolarizationNavigator

SendCommand	Sends a command to the Polarization Navigator
Disconnect	Disconnects any remotely connected Polarization Navigator instances.

method SendCommand

```
SendCommand(
   [in] BSTR Target,
   [in] BSTR Command,
   [out, retval] BSTR* Result)
```

Sends a command to the Polarization Navigator using its Automation Interface (see Polarization Navigator Automation on page 241).

`Target:`

The target name.

`Command:`

The automation command.

`Result:`

The result from sent by the Polarization Navigator.

Examples:

```
IAgN778x.PolarizationNavigator.SendCommand("Global","Get Version");
```

Retrieves the Polarization Navigator version.

method Disconnect

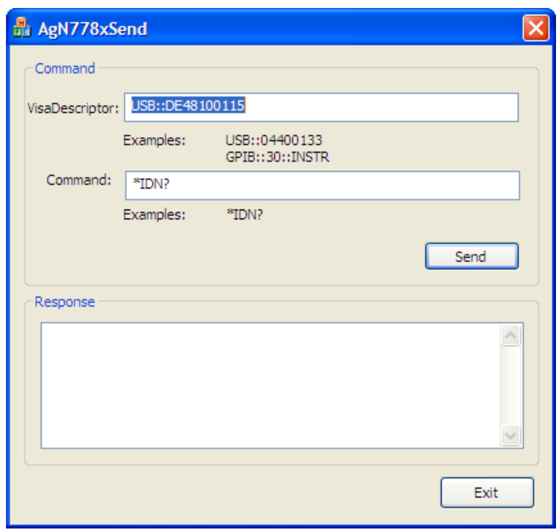
```
Disconnect()
```

Disconnects any remotely connected Polarization Navigator instances (see Polarization Navigator Automation on page 241).

SCPI Commands

SCPI commands can be used for device communication over USB and the GPIB interface. This chapter summarizes all available SCPI commands with their syntax and parameter lists. Every command returns an error code (see Error Codes on page 336). If a command or result has more than one parameter handed over, each parameter is separated by a comma (,). Note that floating point values use a "." as decimal point. SCPI commands can be sent to the instrument using the COM Class AgServerN778xLib which comes with the software. Please refer to the examples which are included for LabView and MATLAB.

For testing purposes, you can use the program "AgN778xSend.exe" which you can find the in start menu in "Keysight Photonic Application Suite->N778x":



Command Reference

Table 30 Summary of SCPI commands and corresponding COM/ActiveX functions. See COM/ActiveX documentation for a detailed description.

SCPI-Command	COM/ActiveX function
*IDN?	IAgN778xIdentity.IdentityString Returns the instrument identification string.
*TST?	IAgN778xUtility.SelfTestResult Returns selftest result.
*RST	IAgN778xUtility.Reset Sets the instrument to a predefined state.
:HELLO?	No corresponding COM/ActiveX function Returns the string “Hello World”. Works without an instrument connected.
:POLarimeter:SOP?	IAgN778xPolarimeter.SOP Returns a single SOP.
:POLarimeter:WAVElength {DOUBLE} :POLarimeter:WAVElength?	IAgN778xPolarimeter.Wavelength Sets/gets the operating wavelength in nm.
:POLarimeter:GAIN {LONG} :POLarimeter:GAIN?	IAgN778xPolarimeter.Gain Sets/gets the current amplifier gain setting.
:POLarimeter:AUTOGAINflag [0,1,2] :POLarimeter:AUTOGAINflag?	IAgN778xPolarimeter.AutoGainFlag Sets/gets the automatic gain setting.
:POLarimeter:STOP	IAgN778xPolarimeter.Stop Stops an ongoing measurement.
:POLarimeter:SWEep:START [SOP,SOPCONTINUOUS]	IAgN778xPolarimeter.SweepStart Starts an SOP measurement sweep.
:POLarimeter:SWEep:STATE?	IAgN778xPolarimeter.QuerySweepState Returns the current sweep status. The result is formatted as follows: nSamples, [IDLE, ARMED, SAMPLING, DATA_AVAILABLE, ERROR], ErrorCode, ”Error String”
:POLarimeter:SWEep:GET?	IAgN778xPolarimeter.SweepGet Returns the measurement result. In case of the SOPCONTINUOUS mode, tick count values are included. The result is formatted as follows: {BINBLOCK(FLOAT): S0, S1, S2, S3, S0, S1, S2, S3, ... } or in case of the SOPCONTINUOUS mode: {BINBLOCK(FLOAT): TickCount, S0, S1, S2, S3, TickCount, S0, S1, S2, S3, ... }

:POLarimeter:SWEep:SAMPLES {LONG} :POLarimeter:SWEep:SAMPLES?	IAgN778xPolarimeter.SweepSamples Sets/gets the desired number of samples.
:POLarimeter:SWEep:SWEEPrate {DOUBLE} :POLarimeter:SWEep:SWEEPrate?	IAgN778xPolarimeter.SweepRate Sets/gets the sweep rate in nm/s.
:POLarimeter:SWEep:SAMPLINGrate {DOUBLE} :POLarimeter:SWEep:SAMPLINGrate?	IAgN778xPolarimeter.SweepSamplingRate Sets/gets the sampling rate in kHz.
:POLarimeter:SWEep:LASTPEAKrange?	IAgN778xPolarimeter.SweepLastPeakRange Returns how well the ADC range was used for the last peak power.
:POLarimeter:SWEep:PREtrigger:PRETRIGsamples {LONG} :POLarimeter:SWEep:PREtrigger:PRETRIGsamples?	IAgN778xPolarimeter.SweepPreTriggerSamples Sets/gets the desired number of pre-trigger samples (only valid using for the trigger modes SOPCHANGE, PRETRIGGER_TTLHIGH and PRETRIGGER_TTLLOW), see ":TRIGger:SOURce".
:POLarimeter:SWEep:PREtrigger:POSTTRIGsamples {LONG} :POLarimeter:SWEep:PREtrigger:POSTTRIGsamples?	IAgN778xPolarimeter.SweepPostTriggerSamples Sets/gets the desired number of post-trigger samples (only valid using for the trigger modes SOPCHANGE, PRETRIGGER_TTLHIGH and PRETRIGGER_TTLLOW), see ":TRIGger:SOURce".
:POLarimeter:SWEep:PREtrigger:SAMPLEDIFF {DOUBLE} :POLarimeter:SWEep:PREtrigger:SAMPLEDIFF?	IAgN778xPolarimeter.SOPTrigSampleDiff Sets/gets the observed time interval in s for the SOP trigger detection.
:POLarimeter:SWEep:PREtrigger:SAMPLETHRESHold {DOUBLE} :POLarimeter:SWEep:PREtrigger:SAMPLETHRESHold?	IAgN778xPolarimeter.SOPTrigSampleThres Sets/gets the minimum angular change in deg for the SOP trigger detection. NOTE: Sampling rate must be set prior to setting this value.
:POLarimeter:SWEep:CONTinuous:SOPACCuracy {DOUBLE} :POLarimeter:SWEep:CONTinuous:SOPACCuracy	IAgN778xPolarimeter.SweepContSOPAccuracy Sets/gets the SOP accuracy in rad used in the continuous sampling mode (see ":POLARIMETER:SWEEP:START").
:TRIGger:SOURce [NONE, TTLHIGH, TTLLOW, SOPCHANGE, PRETRIGGER_TTLHIGH, PRETRIGGER_TTLLOW] :TRIGger:SOURce?	IAgN778xPolarimeter.SweepTriggerSource Sets or returns the trigger source.
:POLCONtroller:STOP	IAgN778xPolController.Stop Stops any ongoing polarization controller activity such as a sequence operation.

:POLCONtroller:WAVEPLates {DOUBLE,DOUBLE,...} :POLCONtroller:WAVEPLates?	IAgN778xPolController.Waveplates Sets or returns the orientation and retardation of the polarization controller waveplates. The data consists of 10 floating point values. The order is given by: Orientation Waveplate 1, Retardation Waveplate 1, Orientation Waveplate 2, Retardation Waveplate 2, Orientation Waveplate 3, Retardation Waveplate 3, Orientation Waveplate 4, Retardation Waveplate 4, Orientation Waveplate 5, Retardation Waveplate 5 *The orientation is given in rad, the retardation is given in fractions of λ. A retardation of 0.25 corresponds to a quarter waveplate. The maximum value of the 1st, 2nd, 4th and 5th waveplate is 0.25. Only the 3rd waveplate can create a retardation of up to 0.5.*
:POLCONtroller:PROGRAM [MANUAL, SCRAMBLE, SEQUENCE, RELOAD] :POLCONtroller:PROGRAM?	IAgN778xPolController.Program Sets the operation mode of the polarization controller or starts a sequence.
:POLCONtroller:SMOOTHing {DOUBLE} :POLCONtroller:SMOOTHing?	IAgN778xPolController.Smoothing Sets/gets the polarization controller smoothing switching speed in °/s. Values can range from 100°/s to 80000°/s. A value of 0 selects the fastest possible switching time.
:POLCONtroller:SEQuence:LENgth {LONG} :POLCONtroller:SEQuence:LENgth?	IAgN778xSequence.Length Sets/gets the polarization controller sequence length.
:POLCONtroller:SEQuence:REPRATE {DOUBLE} :POLCONtroller:SEQuence:REPRATE?	IAgN778xSequence.RepetitionRate Sets/gets the polarization controller repetition rate in kHz.
:POLCONtroller:SEQuence:SYNCMODE [AUTOREPEAT, AUTOONESHOT, EXTERNALREPEAT, EXTERNALONESHOT, POLMETREPEAT, POLMETONESHOT] :POLCONtroller:SEQuence:SYNCMODE?	IAgN778xSequence.SyncMode Sets/gets the polarization controller synchronization mode.
:POLCONtroller:SEQuence:TIMEbase [TIMER, POLARIMETER, EXTERNAL] :POLCONtroller:SEQuence:TIMEbase?	IAgN778xSequence.SyncMode Sets/gets the polarization controller time base.
:POLCONtroller:SEQuence:AUTOOVERsampling [0,1] :POLCONtroller:SEQuence:AUTOOVERsampling?	IAgN778xSequence.AutoOversampling Sets/gets the polarization controller auto-oversampling flag.
:POLCONtroller:SEQuence:RETRIGger [0,1] :POLCONtroller:SEQuence:RETRIGger?	IAgN778xSequence.Retrigger Sets/gets the polarization controller retrigger flag.
:POLCONtroller:SEQuence:DRIFTcompensation [0,1] :POLCONtroller:SEQuence:DRIFTcompensation?	IAgN778xSequence.DriftCompensation Sets/gets the polarization controller drift-compensation flag.
:POLCONtroller:SEQuence:PREscaler {LONG} :POLCONtroller:SEQuence:PREscaler?	IAgN778xSequence.Prescaler Sets/gets the polarization controller pre-scaler value.

:POLCONtroller:SEQuence:HOLDoff {LONG} :POLCONtroller:SEQuence:HOLDoff?	IAgN778xSequence.Holdoff *Sets/gets the polarization controller hold-off value in μs.*
:POLCONtroller:SEQuence:OVERsampling {LONG} :POLCONtroller:SEQuence:OVERsampling?	IAgN778xSequence.Oversampling Sets/gets the polarization controller oversampling value.
:POLCONtrollerSEQuence:SEQUENCE {DOUBLE,DOUBLE, ...} :POLCONtrollerSEQuence:SEQUENCE {BINBLOCK(FLOAT)}	IAgN778xSequence.Sequence Sets the polarization controller sequence using waveplate positions and retardations. The parameter list is a series of floating point values. Each waveplate is controlled by two float values: Orientation in rad and Retardation in fractions of Lambda (0.25 corresponds to $\lambda/4$). Thus, each sequence row contains 10 float values. Hence, the series length has to be a multiple of 10. Each row has the following order: Orientation waveplate 1 Retardation waveplate 1 Orientation waveplate 2 Retardation waveplate 2 Orientation waveplate 3 Retardation waveplate 3 Orientation waveplate 4 Retardation waveplate 4 Orientation waveplate 5 Retardation waveplate 5 The sequence can also be supplied as a binary block of single-precision floating point numbers.
:POLCONtroller:SEQuence:SEQVOLTage {INT16, INT16, ... } :POLCONtroller:SEQuence:SEQVOLTage {BINBLOCK(INT16)}	IAgN778xSequence.SeqVoltage Sets the polarization controller sequence using direct voltage values. The parameter list is a series of integer values corresponding to the voltage levels. Each element may range from 0 to 4095, where 2048 is the neutral setting. Each waveplate is controlled by two voltages. Thus, each sequence row contains 10 voltage levels. Hence, the series length has to be a multiple of 10. The sequence can also be supplied as a binary block of single-precision 16-bit integer numbers.
:POLCONtroller:SEQuence:SYNCOUTtrigger {LONG} :POLCONtroller:SEQuence:SYNCOUTtrigger?	IAgN778xSequence.SyncOutTrigger Sets/gets the synchronization shift of the synchronous sequence output trigger feature.
:POLCONtroller:SEQuence:SUGGESTPOLMETOVERsampling {LONG} ::POLCONtroller:SEQuence:SUGGESTPOLMETOVERsampling?	IAgN778xSequence.SuggestPolMetOversampling
:POLCONtroller:SEQuence:SUGGESTPOLMETRATE {DOUBLE} ::POLCONtroller:SEQuence:SUGGESTPOLMETRATE?	IAgN778xSequence.SuggestPolMetSamplingRate

:STABilizer:STABilize [0,1] :STABilizer:STABilize?	IAgN778xStabilizer.Stabilize Sets/gets the state of the polarization stabilizer.
:STABilizer:FLASHwrite	IAgN778xStabilizer.FlashWrite Writes current settings to the flash memory.
:STABilizer:ONSTARTUPstabilize [0,1] :STABilizer:ONSTARTUPstabilize?	IAgN778xStabilizer.OnStartupStabilize Sets/gets the stabilizer stabilize-on-startup flag.
:STABilizer:INVert [0,1] :STABilizer:INVert?	IAgN778xStabilizer.Invert Sets/gets the stabilizer invert flag.
:STABilizer:SOP {DOUBLE, DOUBLE, DOUBLE [,DOUBLE]} :STABilizer:SOP?	IAgN778xStabilizer.SOP Sets the target SOP or returns the current SOP.
:STABilizer:FEEDbackmode [SOP, DOP, POWER, INTERNAL, ANALOGIN] :STABilizer:FEEDbackmode?	IAgN778xStabilizer.Feedback Sets/gets the stabilizer feedback mode.
:SYSTem:ERRor?	Returns the last error code. Note that reading the error will clear the error state.
:SYSTem:TRACEenabled [0,1] :SYSTem:TRACEenabled?	IAgN778xSystem.TraceEnabled Enables or disables the trace log file.
:SYSTem:COMMunicate:GPIB:[SELF:]ADDress {LONG} :SYSTem:COMMunicate:GPIB:[SELF:]ADDress?	IAgN778xSystem.GPIBAddress Sets/gets the GPIB address.
:SYSTem:SPECial:TEMPerature?	IAgN778xSystem.Temperature Returns the temperature measured by the internal temperature sensor.
:SYSTem:ANALOGout:IMMediate {DOUBLE, DOUBLE, DOUBLE, DOUBLE}	IAgN778xSystem.AnalogOut Sets the analog outputs.

Table 31 SCPI Datatypes

Datatype	Explanation
DOUBLE	64-bit double-precision floating point number. The parameter is written in the standard IEEE format (e.g. “1e-6” or “1.234”)
FLOAT	32-bit single-precision floating point number. The parameter is written in the standard IEEE format (e.g. “1e-6” or “1.234”)
LONG	32-bit integer number.
INT16	16-bit integer number.
BINBLOCK(FLOAT)	Describes a block of binary single-precision floating point values. A binary block always begins with a ’#’ character. The next character is numeric and denotes the number of bytes to skip (including the ’#’ character) before the actual binary data begins. The following numeric characters form the number of bytes in the actual binary block. Example: A single-precision floating point number (“FLOAT”) consists of 4 bytes. Thus, three FLOATs are 12 bytes long. The binary block looks like #412xxxxyyyyzzzz where “xxxx”, “yyyy” and “zzzz” denote the 4 bytes of one FLOAT value. The byte order is little-endian.
BINBLOCK(INT16)	Describes a block of binary 16-bit integer values. The format is the same as in BINBLOCK(FLOAT).

7 LabView™ Drivers (Discontinued)

NOTE Please note that in the future, only the COM/ActiveX drivers will be supported since they offer a much easier way to access the instruments. See Direct Instrument Control on page 145 for more information.

This chapter describes the LabView™ driver libraries installed at installation of the polarizationNAVIGATOR™.

Introduction

Installation The LabView™ driver libraries are installed upon installation of the polarizationNAVIGATOR™. You can find them in the *Examples\ LabView* subfolder of the polarizationNAVIGATOR™ installation directory.

The LabView™ driver libraries contain the following files:

Table 32 LabView™ Driver Library Files

File	Description
MIP.llb	Collection of VIs for LabView VISA initialization and low-level communication
MIPCommands.llb	Collection of VIs for device programming on application level
Changed.llb	Miscellaneous VIs used in `DemoPolarimeter.vi`
PoincareSphere.llb	Miscellaneous VIs for graphical Poincaré sphere display

Starting a VISA Session

To initialize a new VISA session to any of the N778xB/BD devices from your LabView™ VI, start with the `VI MIP Init.vi` which can be found in library `MIP.llb`.

The VI initializes the communication between your VI and the device over the desired interface port and assigns the device a unique device descriptor number which can be used throughout the whole LabView session to address that particularly device. When using these VIs, the VISA resource name (or VISA alias) for the desired port must be provided as a parameter, e.g. GPIB::30::INSTR. The VISA resource name is identical to that used in National Instruments *Measurement & Automation Explorer* (for further information please refer to the NI-VISATM Programmer Reference Manual). When using an USB interface for communication, the VISA resource name consists of the prefix string USB:: followed by the serial number of the device, e.g. USB::DE48100001. If the PC controlling the instrument is equipped with an Ethernet adapter, the instrument can be accessed remotely by using an additional TCP prefix, containing the IP address of that PC, followed by the GPIB or USB string, which is used locally on the PC the instrument is connected to, e.g.

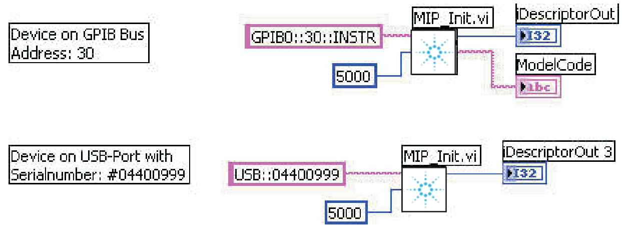
TCP::192.168.0.1::USB::DE48100100.

Instruments of the N778xBD series are equipped with an internal PC, internal USB communication and an ethernet adapter, so if such an instrument is connected to the local area network or the internet and its IP address is known, it can be accessed from LabView VIs running on a remote PC by using a descriptor as just described, where the IP address and the serial number have to be changed to the actual instrument. The IP address of a computer that the polarizationNAVIGATOR™ is installed on can easily be obtained by selecting Show IP Address from the Tools menu of the polarizationNAVIGATOR™.

One additional parameter can optionally be handed over to the VI, which is the device timeout settings in ms (not mandatory).

The VI returns the device descriptor number as stated above and the model identification code for the device found on that interface address.

An examples for a VISA session setup is shown below (here: timeout is set to 5000ms):


Device on GPIB Bus
Address: 30
GPIB0::30::INSTR
5000
MIP_Init.vi
iDescriptorOut
I32
ModelCode
abc
Device on USB-Port with
Serialnumber: #04400999
USB::04400999
5000
MIP_Init.vi
iDescriptorOut 3
I32

Variable Handling

All variables available for communication on the device are arranged in a tree structure and are addressed by their tree/branch (TreeNo) and variable number (VarNo). Additionally each variable has a type from the following list:

Binary, UINT8, UINT16, UINT32, INT8, INT16, INT32, TEXTSTRING, ARRAYUINT8, ARRAYUINT16, ARRAYUINT32, ARRAYINT8, ARRAYINT16, ARRAYINT32, ARRAYTEXTSTRING, FLOAT32, ARRAYFLOAT32

All variables and trees available on the devices are listed under Instrument Variables (Discontinued) on page 233. When using variables with an (1D) array type, you can address each sub element by its index number (Index).

Error Codes

All VIs return an error code after execution which shows the result of the latest operation. If no error has occurred the VI should return zero, otherwise you can find the corresponding explanation in the error list (see Error Codes on page 336).

Generic Instrument Settings VIs

All VIs described here can be found in the library `MIPCommands.llb` and are used to get or set any device specific variables. The device you want to communicate with is addressed by the device descriptor number as described above (see Starting a VISA Session on page 189).

Not all listed input and output parameters are mandatory or valid for operations on different variable types. The parameters which are optional or only valid for only one type of variables are indicated with square brackets in the following list of MIP-Functions.

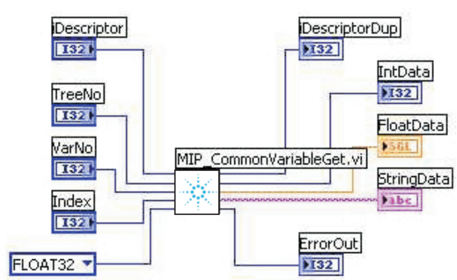
MIP_CommonVariableGet

To get the value of a variable available on your device, you can use the VI `MIP CommonVariableGet.vi`. You specify the descriptor numbers and type for the requested variable and receive its current value in the matching output field.

Please note that array type variables can only be accessed through their single elements using the index parameter.

Table 33 MIP_CommonVariableGet Parameters

Input parameters:	Device descriptor, tree number, variable number, index number, variable type
Output parameters:	Device descriptor, (integer data, float data, string data), error code

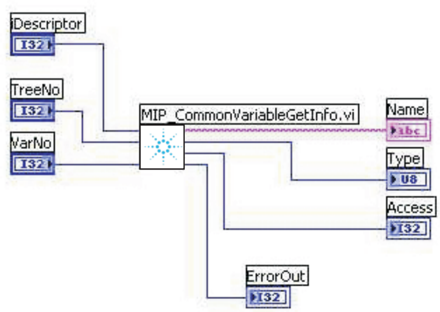


MIP_CommonVariableGetInfo

Use the VI `MIP CommonVariableGetInfo` to get information about a specific variable. The VI returns the name (as plain text) of the specified variable plus its type and access mode.

Table 34 MIP_CommonVariableGetInfo Parameters

Input parameters:	Device descriptor, tree number, variable number
Output parameters:	Variable name, variable type, variable access

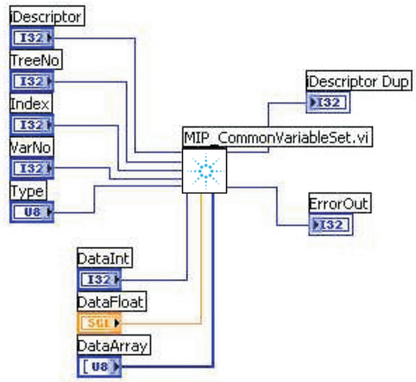


MIP_CommonVariableSet

To set the value of any accessible variable on your device use the VIMIP CommonVariableSet. The usage is very similar to reading variables from the device (see MIP_CommonVariableGet on page 193).

Table 35 MIP_CommonVariableSet Parameters

Input parameters:	Device descriptor, tree number, variable number, (index number), variable type, (DataInt, DataFloat, DataArray)
Output parameters:	Device descriptor, error code


iDescriptor
I32
TreeNo
I32
Index
I32
VarNo
I32
Type
U8
iDescriptor Dup
I32
MIP_CommonVariableSet.vi
ErrorOut
I32
DataInt
I32
DataFloat
SGL
DataArray
[U8]

Polarization Controller VIs

The following VIs can be used to control the polarization controller (applicable to N7784B, N7785B, N7786B and N7788B/BD) in your application, i.e. to set all important control parameters and to start and stop the different scrambling modes.

MIP_PolConSettings

This is the central VI to control the different modes of the polarization controller. All necessary parameters to start the polarization controller can be specified according to the following list:

Table 36 MIP_PolConSettings Parameters

Input parameters:	Device descriptor, scrambling mode, timebase, synchronization, sequence starttrigger, repetition rate, divider, holdoff delay, sequence length
Output parameters:	Device descriptor, error code

Scrambling mode

- Off (turns off all scrambling modes)
- Random (scrambling with a pseudo random sequence)
- Sequence (scrambling with user-definable sequence)

Timebase

- Internal Timer (uses polarization controller timer)
- Polarimeter Clock (uses polarimeter timer for synchronization purpose, only valid on N7788B/BD and N7786B)
- External Trig-In (uses external trigger input #1)

Synchronization

- Auto Repeat (scrambling sequence is processed repeatedly)
- OneShot (scrambling sequence is processed just once. The polarization controller remains on the last table entry)

Sequence starttrigger

- Auto (scrambling sequence is untriggered and started by software)

- External (scrambling sequence is (re-)started by external event. The input port is dependent on timebase settings, i.e. for internal timers trigger input #1 is used and for external timebase trigger input #2 on expansion port is used)
- Polarimeter (scrambling sequence is (re-)started with every polarimeter measurement start)

Repetition rate

- Scrambling rate in kHz (only applicable to internal timer as timebase)

Prescaler

- Additional prescaler m for timebase (default: m=0); the resulting scrambling rate is: repetition rate / (m+1), (i.e. m=0 means no prescaling, m=1 means half repetition rate, etc.)

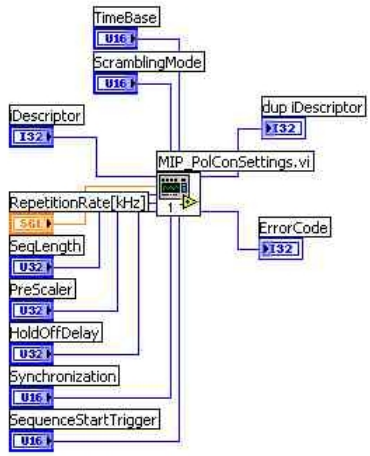
Holdoff delay

- Time of sequence restart relative to the external trigger signal in µs; only applicable to external trigger events.

Sequence length

- Scrambler sequence length; applicable to pseudo random sequence. When using user-definable scrambling sequence, length is determined by sequence length in memory.

NOTE This VI replaces `MIP PolConStart.vi`, which was used in previous revisions.



MIP_PolConSetMode

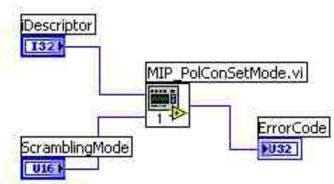
This VI starts the polarization controller with the specified mode using the current settings from the device variables.

Table 37 MIP_PolConSetMode Parameters

Input parameters:	Device descriptor, scrambling mode
Output parameters:	Error code

Scrambling Mode

- Off (turns off all scrambling modes)
- Random (scrambling with a pseudo random sequence)
- Sequence (scrambling with user-definable sequence)



MIP_PolConWaveplateGet

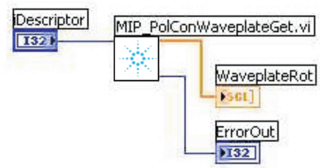
This VI is used to get the current rotation angles of all 5 virtual waveplates of the $LiNbO_3$ polarization controller (see Polarization Controller Basics on page 119).

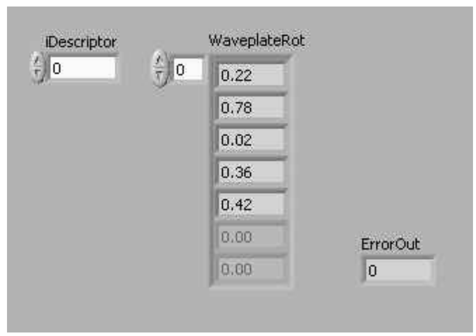
Table 38 MIP_PolConWaveplateGet Parameters

Input parameters:	Device descriptor
Output parameters:	Waveplate positions (1D), error code

WaveplateRot

- Current positions of the waveplates returned as 1-dimensional array, consisting of 5 values representing the rotation angle of each waveplate in radians.





MIP_PolConWaveplateSet

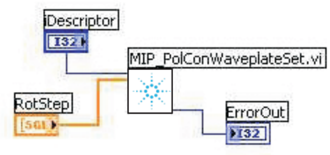
This VI is used to manually set the rotation position of the 5 virtual waveplates of the LiNbO3 polarization controller.

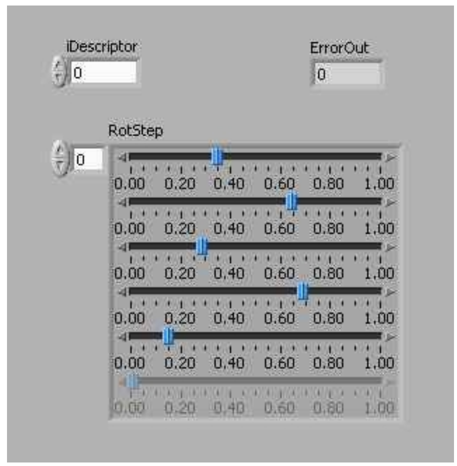
Table 39 MIP_PolConWaveplateSet Parameters

Input parameters:	Device descriptors, waveplate positions (1D)
Output parameters:	Error code

WaveplateRot

- 1D array of 5 elements representing the waveplate rotation angles (in radians 0..2π) of the polarization controller to bet set. Larger values than 2π for the rotation angle can be accepted, though they represent the same rotation angle, due to the internal structure of endlessly rotatable waveplates.





MIP_PolConSeqWaveplateSet

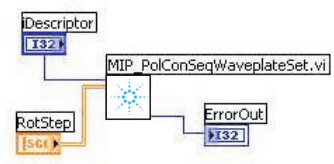
This VI is used to program a sequence of waveplate rotation settings into the polarization controller, which can then be used as sequence source in *sequence* mode (see `MIP PolConStart`).

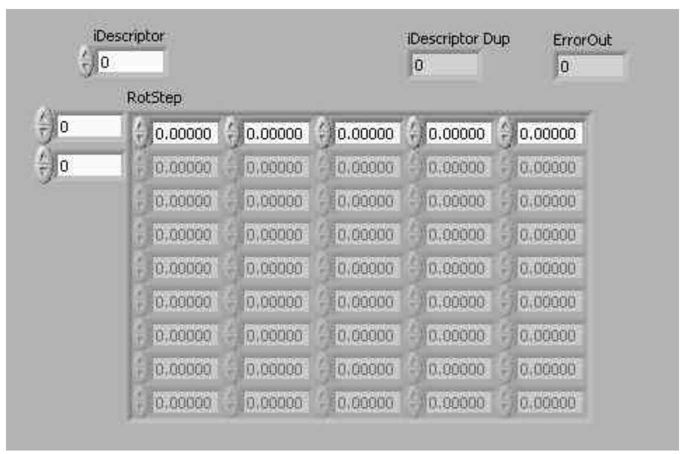
Table 40 MIP_PolConSeqWaveplateSet Parameters

Input parameters:	Device descriptor, waveplate positions sequence (2D)
Output parameters:	Error code

RotStep

- 2D table consisting of n rows (n= length of sequence steps), each representing one waveplate rotation setting (similar to 1D-WaveplateRot in `MIP PolConWaveplateSet`).





MIP_PolConSeqWaveplateSetRetard

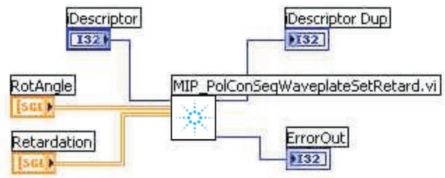
This VI is used to program a sequence of waveplate rotation settings into the polarization controller, which can then be used as sequence source in sequence mode (see MIP PolConStart).

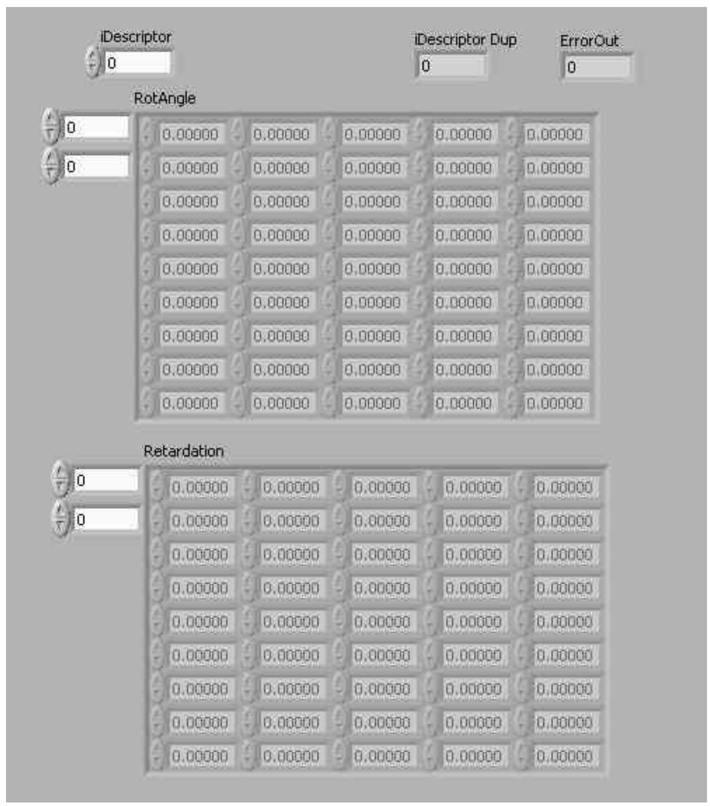
Table 41 MIP_PolConSeqWaveplateSetRetard Parameters

Input parameters:	Device descriptor, waveplate positions sequence (2D)
Output parameters:	Error code

RotStep

- 2D table consisting of n rows (n= length of sequence steps), each representing one waveplate rotation setting (similar to 1D-WaveplateRot in `MIP PolConWaveplateSet`).


iDescriptor
I32
iDescriptor Dup
I32
RotAngle
SGL
MIP_PolConSeqWaveplateSetRetard.vi
Retardation
SGL
ErrorOut
I32


iDescriptor
0
iDescriptor Dup
0
ErrorOut
0
RotAngle
0
0
Retardation
0
0

Polarimeter Control VIs

The following VIs are used to control and readout the polarimeter (applicable to N7781B/BD, N7786B and N7788B/BD). For a complete polarimeter demo application see PolarimeterDemo on page 212.

MIP_PolarimeterMeasStart

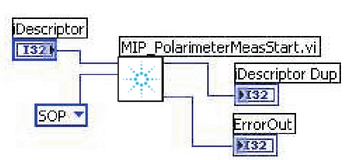
This VI is used to start a new polarimeter measurement. The measurement parameters (e.g. sampling rate, number of samples, etc.) used for the data acquisition are stored in the variable tree structure and can be changed prior using the `VI MIP CommonVariableSet`.

Table 42 MIP_PolarimeterMeasStart Parameters

Input parameters:	Device descriptor, measurement mode
Output parameters:	Device descriptor, Error code

Measurement mode

- IDLE (currently running measurement is stopped)
- SOP (measurement results are returned as 4-element Stokes parameters)
- SOPCONTINUOUS (time-continuous measurement is started; please ensure that you pick up all results in appropriate time intervals to prevent data loss due to internal ring buffer structure)



MIP_PolarimeterMeasState

This VI is used to get information about the current measurement state of the device.

Table 43 MIP_PolarimeterMeasState Parameters

Input parameters:	Device descriptor
Output parameters:	Device descriptor, number of samples, trigger state, measure state

nSamples

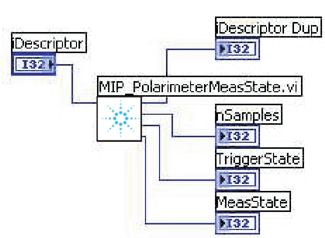
- Number of samples available

TriggerState

- IDLE (no measurement)
- ARMED (measurement initialized, waiting for trigger)
- SAMPLING (measurement in progress)
- DATA AVAILABLE (measurement completed)
- ERROR (error occurred)

MeasState

- Measurement error code (see Error Codes on page 336)



MIP_PolarimeterMeasStartGet

This VI starts a measurement and waits for completion. Measurement parameters are stored in the variable tree structure prior to starting this VI. The results of the measurement are returned either in a floating-point or integer array, depending on the measurement mode. Currently only floating-point data will be returned when measuring SOPs.

Table 44 MIP_PolarimeterMeasStartGet Parameters

Input parameters:	Device descriptor, measurement mode
Output parameters:	Device descriptor, float results, short results, number of samples, rows, error code

Measurement mode

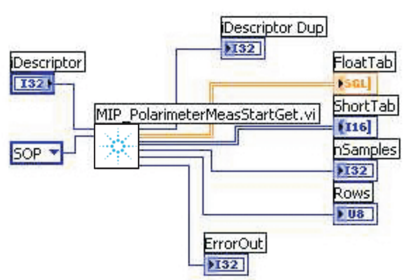
- See MIP_PolarimeterMeasStart on page 205.

FloatTab/ShortTab

- Results of previous measurement according to selected measurement mode.

nSamples

- Number of samples available. Rows Number of valid rows (depends on measurement mode)



MIP_PolarimeterMeasGet

This VI is used to retrieve data available on the device.

Table 45 MIP_PolarimeterMeasGet Parameters

Input parameters:	Device descriptor, measurement mode, fraction start, fraction length
Output parameters:	Device descriptor, float results, short results, number of samples, rows, error code

Measurement mode

- See MIP_PolarimeterMeasStart on page 205.

FractionStart

- Startindex in results for fraction data transfer (for no fraction transfer use default: -1).

FractionLength

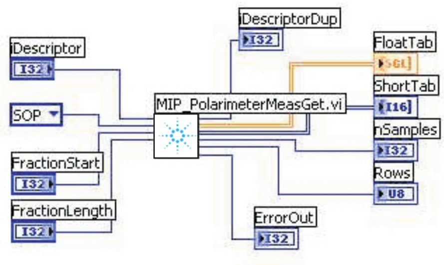
- Length of fraction.

FloatTab/ShortTab

- Results of previous measurement according to selected measurement mode.

nSamples

- Number of samples available. Rows Number of valid rows (depends on measurement mode)



MIP_PolarimeterMeasPlot

This VI can be used as standalone VI to start a measurement and display the results in a graph. All important parameters can be set prior to the measurement using the defined control elements. Changes in the control elements are valid only after restarting the VI.

Table 46 MIP_PolarimeterMeasPlot Parameters

Input parameters (control elements):	VISA descriptor, Baudrate, measurement mode, trigger source, sampling rate, number of samples, wavelength, sweeprate, gain
Output parameters (display on screen):	Results plot, error code

TriggerSource

- NONE (starts immediately; software trigger)
- TTL HIGH (low-to-high transition on external trigger-in starts measurement)
- TTL LOW (high-to-low transition on external trigger-in starts measurement)

SamplingRate

- Sampling rate in kHz

Wavelength

- Lightsource wavelength in nm

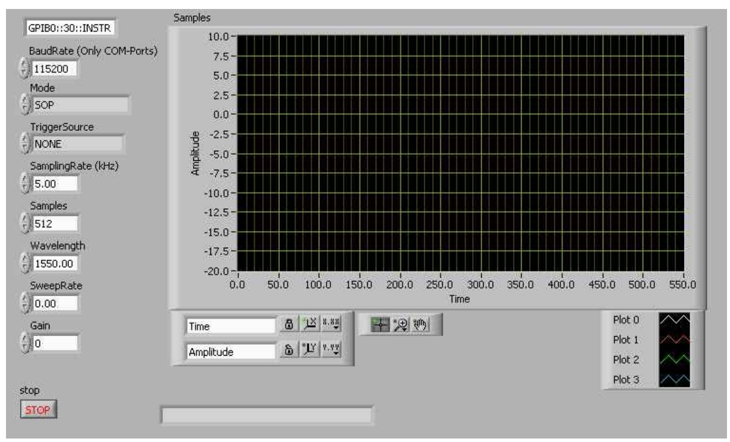
SweepRate

- Lightsource wavelength sweeprate in nm/s

NOTE For fixed wavelength source set to 0 nm/s

Gain

- Amplifier gain (0-13)

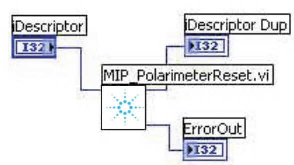


MIP_PolarimeterReset

This VI is used to reset the polarimeter to its initial state. All measurement parameters are set to their values after device power-up.

Table 47 MIP_PolarimeterReset

Input parameters:	Device descriptor
Output parameters:	Device descriptor, error code

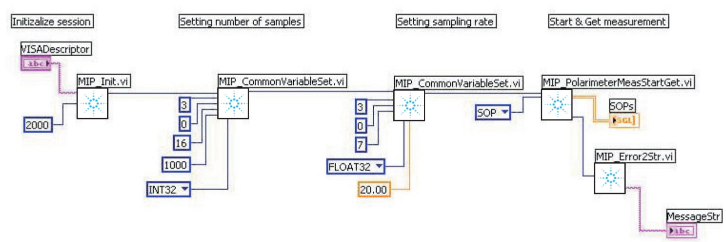


Demo VIs

DemoPolarimeterSimple

This VI demonstrates the basic usage of the interface VIs. It first opens a session to the instrument connected via GPIB, address 30. Then the desired number of samples is set to 1000 and the sampling rate is chosen to be 20 kHz.

Note that the VI MIP PolarimeterMeasStartGet.vi (see MIP_PolarimeterMeasStartGet on page 207) waits until a measurement has been successfully completed, i.e. it waits until the polarimeter receives a suitable power level.



PolarimeterDemo

This VI demonstrates a complete polarimeter measurement application. You must specify the desired VISA communication port (use **`GPIB0::30::INSTR`** for an instrument at GPIB address 30). The measurement parameters can be changed during runtime and include the following parameters:

Tab Polarimeter

- AutoGainFlag, TriggerSource, Samples, SamplingRate, Gain(manual)

Tab Source

- Wavelength(fixed or startwavelength if sweeped), Sweeprate (in nm/s, 0 for fixed wavelength)

The results of the measurement are displayed in different diagrams.

Tab Polarimeter

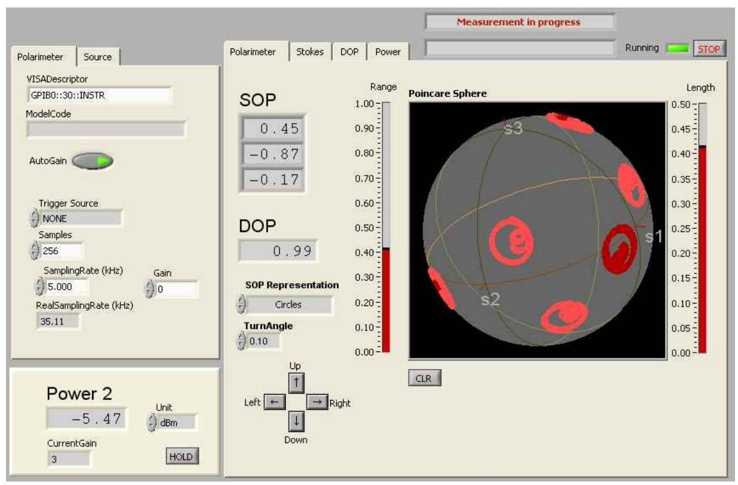
- SOP displayed on Poincaré sphere. Use cursor array in VI to rotate sphere.

Tab Stokes

- Stokes parameters displayed in graph

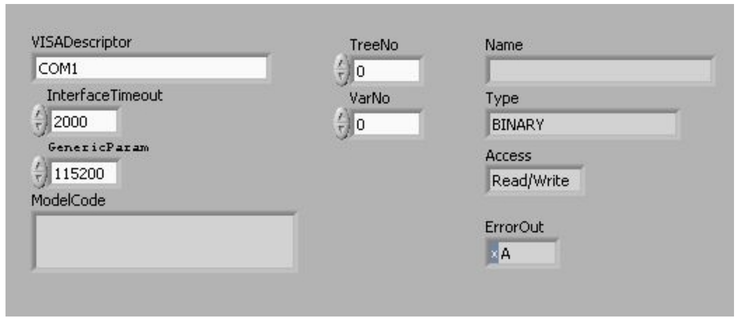
Tab DOP

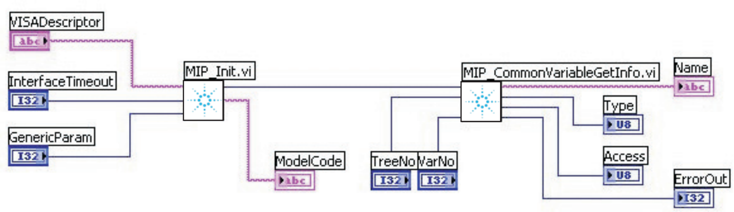
- DOP displayed in graph Tab Power



DemoVarInfo

This VI starts a VISA session with a device (here: at port COM1 with 115200 kBaud) and receives its model code. Afterwards the VI reads the variable information from the specified tree and variable number and shows the results in the appropriate fields.


VISADescriptor
COM1
InterfaceTimeout
2000
GenericParam
115200
ModelCode
TreeNo
0
VarNo
0
Name
Type
BINARY
Access
Read/Write
ErrorOut
A


VISADescriptor
InterfaceTimeout
GenericParam
MIP_Init.vi
ModelCode
TreeNo
VarNo
MIP_CommonVariableGetInfo.vi
Name
Type
Access
ErrorOut

8 GPIB Command Reference (Discontinued)

NOTE

Please note that in the future, only the COM/ActiveX drivers will be supported since they offer a much easier way to access the instruments. See Direct Instrument Control on page 145 for more information.

This chapter describes all commands (ASCII-) with their syntax and parameter lists.

Introduction

This chapter summarizes all available (ASCII-) commands with their syntax and parameter lists. ASCII commands can be used for device communication over the GPIB interface. Every command starts with an asterisk (*) and returns an error code (see Error Codes on page 336) from the device. If a command or result has more than one parameter handed over, each parameter is separated by a comma (,). Note that floating point values use a "." as decimal point. You can send these commands, e.g. by using the National Instruments *Measurement & Automation Explorer*, where you can select an instrument connected to a GPIB interface and send ASCII commands as well as read the instrument responses.

NOTE

When using the USB port for device communication the ASCII commands are not applicable. In this case please use the LabView™ VIs provided in the driver libraries instead (see LabView™ Drivers (Discontinued) on page 187).

Generic Control Commands

These commands are used to get device specific information and access device variables.

Table 48 Explanation - Control Commands

TreeName	Name of variable tree (Instrument Variables (Discontinued) on page 233) as plain text
TreeNo	Number of variable tree (Instrument Variables (Discontinued) on page 233) as integer
VarName	Name of variable (Instrument Variables (Discontinued) on page 233) as plain text
VarNo	Number of variable (Instrument Variables (Discontinued) on page 233) as integer
Index	Variable index in arraytype [0..max]

*IDN?

Get device identification

Table 49 *IDN?

Syntax:	`*IDN?`
Results	`*{ErrorCode},{IDString}`

*VAR?

Get device variable value

Table 50 *VAR?

Syntax:	`*VAR? {TreeName},{VarName}`
	`*VAR? {TreeNo},{VarNo}`
	`*VAR? {TreeName},{VarName},{Index}`
	`*VAR? {TreeNo},{VarNo},{Index}`

Results	`*{ErrorCode},{Value}`

*VARNAME?

Get device variable description

Table 51 *VARNAME?

Syntax:	`*VARNAME? {TreeName},{VarName}` `*VARNAME? {TreeNo},{VarNo}`
Results	`*{ErrorCode},{VarType},{VarAccess},{VarTextName}`

*VAR

Set device variable value

Table 52 *VAR

Syntax:	`*VAR {TreeName},{VarName},{Value}` `*VAR {TreeName},{VarName},{Index},{Value}`
Results	`*{ErrorCode}`

Buffer Control Commands

*BUF?

Returns the current buffer size in bytes.

Table 53 *BUF?

Syntax:	`*BUF?`
Results	`*{ErrorCode},{buffersize}`

Parameters:

buffersize(int)	Buffer size in bytes

*BUFR?

Returns the contents of the buffer as binary, hex or numeral values. The startindex and length of returned data can be specified by the fraction parameters.

NOTE When using GPIB as communication interface, the maximum transfer size per command is limited to approximately 800 bytes (i.e. 400 hex values). For transferring buffers of larger size, you have to split the read out in successive buffer read commands of appropriate transfer size.

NOTE The startindex and length depends on the requested data type. For hex and binary dumps the indices refer to byte positions. For numeral outputs the indices refer to number positions.

NOTE Floating point numbers are returned in single precision format (IEEE 754)

Table 54 *BUFR?

Syntax:	`*BUFR?`
	`*BUFR? {HEX|NUM},{ALL}`
	`*BUFR? {HEX|NUM},{fractionstart},{fractionlength}`

Results	`*{ErrorCode},{results}`

Parameters:

fractionstart(int)	startindex of requested data block
fractionlength(int)	Length of requested data block
results (in specified format)	HEX: hex dump NUM: int/float numbers

NOTE

Hex dumps are returned in little endian format

*BUFALLOC

Reserves space in memory for writing into buffer.

Table 55 *BUFALLOC

Syntax:	`*BUFALLOC {length}`
Results	`*{ErrorCode}`

Parameters:

length (int)	specifies the size of allocated memory and is interpreted as number of (float/int) elements in buffer

*BUFW

Writes into allocated buffer memory

Table 56 ***BUFW**

Syntax:	`*BUFW {offset},{value0[,value1,value2,...]}`
Results	`*{ErrorCode}`

Parameters:

offset (int)	Specifies the starting index for writing into the buffer. Larger values than actual buffer length returns an error
value0..n (float)	Are the values interpreted as floating point numbers, written in the buffer starting at specified offset address. Writing more value than buffer length returns an error.

Polarization Controller Commands

*POLCON:START

Starts the polarization controller

Table 57 *POLCON:START

Syntax:	`*POLCON:START {SCR|SEQ}`
Results	`*{ErrorCode}`

Parameters:

SCR	Starts pseudo-random scrambling
SEQ	Starts scrambling with defined sequence

*POLCON:STOP

Stops the polarization controller

Table 58 *POLCON:STOP

Syntax:	`*POLCON:STOP`
Results	`*{ErrorCode}`

*POLCON:WP?

Get current positions of polarization controller waveplate elements. Returned are the rotation angles for the controller elements in rad.

Table 59 *POLCON:WP?

Syntax:	`*POLCON:WP?`
Results	`*{ErrorCode},{angle0},{angle1},{angle2},{angle3},{angle4}`

Parameters:

angle(float)	Rotation angle in rad

*POLCON:WP

Set current positions of polarization controller waveplate elements.

Table 60 *POLCON:WP

Syntax:	`*POLCON:WP {angle0},{angle1},{angle2},{angle3},{angle4}`
Results	`*{ErrorCode}`

Parameters:

angle(float)	Rotation angle in rad

*POLCON:SEQSET

Sets a new programmable scrambling sequence based on the values written previously into the buffer memory. To set up the values for a new sequence, write the rotation angle values for each waveplate into the buffer memory using the commands BUFALLOC and BUFW. The number of sequence elements must be a multiple of the number of control elements (nPolConRot) of the polarization controller otherwise an error is returned.

Table 61 *POLCON:SEQSET

Syntax:	`*POLCON:SEQSET`
Results	`*{ErrorCode}`

Polarimeter Control Commands

*POLMET:RESET

Resets the polarimeter and sets all measurement parameters to their default values.

Table 62 *POLMET:RESET

Syntax:	`*POLMET:RESET`
Results	`*{ErrorCode}`

*POLMET:START

Starts a new polarimeter acquisition using the current measurement parameters. The measurement type is determined by the indicated mode parameter.

Table 63 *POLMET:START

Syntax:	`*POLMET:START SOP`
Results	`*{ErrorCode}`

*POLMET:STATE?

Returns the current polarimeter acquisition status, including number of samples taken, trigger state and polarimeter error code.

Table 64 *POLMET:STATE?

Syntax:	`*POLMET:STATE?`
Results	`*{ErrorCode},{data sampled},{trigger state},{polarimeter errorcode}`

Parameters:

data sampled(int)	Number of samples taken so far
trigger state(int)	Current polarimeter trigger status (see variable TriggerState (see Tree 3: Polarimeter on page 236)
polarimeter errorcode(int)	Current polarimeter error status (see Error Codes on page 336 for explanation)

*POLMET:SOP?

Returns the current SOP from the polarimeter as single Stokes vector.

Table 65 *POLMET:SOP?

Syntax:	`*POLMET:SOP?`
Results	`*{ErrorCode},{s0},{s1},{s2},{s3}`

Parameters:

s0..3(float)	Stokes parameters

*POLMET:NSOP?

Returns the current SOP from the polarimeter as DOP and single normalized Stokes vector.

Table 66 *POLMET:NSOP?

Syntax:	`*POLMET:NSOP?`
Results	`*{ErrorCode},{DOP},{s0},{s1},{s2}`

Parameters:

DOP(float)	Degree of polarization
s0..3(float)	Normalized Stokes parameters

*POLMET:GET?

Reads out the data from the current data acquisition and saves the results in the buffer. Note that successive calls of this command without restarting the measurement will return a measurement sequence error. For the results see Buffer Control Commands on page 219.

Table 67 *POLMET:GET?

Syntax:	`*POLMET:GET?`
Results	`*{ErrorCode},{buffersize}`

Parameters:

buffersize(int)	Buffer size after read-out in bytes

Examples

Polarimeter Measurements

Table 68 Polarimeter Measurements

*POLMET:RESET	Reset the Polarimeter to default values	Result: *0
*POLMET:SOP?	Get a Stokes vector from polarimeter	Result: *0,0.0657170,0.0121462,-0.0557056,0.0317337
*POLMET:NSOP?	Get a normalized Stokes vector from polarimeter	Result: *0,0.993527,0.184831,-0.847659,0.484158
*VAR Polarimeter,SamplingRate,40	Set sampling rate to 40kHz	Result: *0
*VAR Polarimeter,Samples,1000	Set number of samples to 1000	Result: *0
*VAR Polarimeter,WavelengthStart,1540.0	Wavelength=1540nm	Result: *0
*VAR Polarimeter,SweepRate,0	Fixed wavelength mode	Result: *0
*VAR Polarimeter,TriggerSource,0	Disable external trigger source	Result: *0
*VAR Polarimeter,AutoGainFlag,1	Enable polarimeter autogaining	Result: *0
*POLMET:START SOP	Start SOP measurement	Result: *0
*POLMET:START SOP	Get measurement state	Result: *0,1000,3,0
*POLMET:GET?	Readout measurement results	Result: *60A
60A indicates a power under range for the first measurement. Note that when using autogaining, a new gain is automatically chosen for the next measurement after an over-/underrange condition. Thus simply restarting the measurement will retry the measurement with another gain setting.		
*POLMET:START SOP	Restarting SOP measurement	Result: *0
*POLMET:START SOP	Get measurement state	Result: *0,1000,3,0
*POLMET:GET?	Readout next measurement results	Result: *0,16000

*BUFR? NUM,0,32	Readout measurement from buffer first 32 float values, corresponding to 8 Stokes vectors	Result: *0 0.062 0.021 -0.050 0.027 0.062 0.021 -0.050 0.027 0.063 0.021 -0.051 0.027 0.062 0.021 -0.050 0.027 0.062 0.021 -0.050 0.027 0.062 0.021 -0.050 0.027 0.062 0.021 -0.050 0.027 0.062 0.021 -0.050 0.027
*BUFR? HEX,0,400	Read buffer Example for buffer readout with limited packet size Buffer size: 2048 bytes	Result: *0 D38AA43DFC0CF0BA98BEBABD146D683D 549E803DC0AC053D0DCE3FBD7069C33C ...
*BUFR? HEX,800,400	Read remaining data	
*BUFR? HEX,1200,400		
*BUFR? HEX,1600,400		
*BUFR? HEX,2000,48		

Setting Up the Polarization Controller

This example shows how to set up the polarization controller to scramble with a pseudo random scrambling sequence of (sequence length: 1000 elements).

Table 69 Polarization Controller - Example 1

*VAR PolController,RepRate,10.0	Scrambling rate = 10kHz	Result: *0
*VAR PolController,Synchronization,0	Use autorepeat mode	Result: *0
*VAR PolController,TimeBase,0	Use internal timer as timebase	Result: *0
*VAR PolController,PolConStartTrigger,0	Use software trigger	Result: *0
*VAR PolController,SeqLength,1000	Sequence length: 1000	Result: *0
*POLCON:START SCR	Use pseudo random scrambling mode	Result: *0

This example shows how to manually set the polarization controller position.

Table 70 Polarization Controller - Example 2

*POLCON:STOP	Stop polarization controller (all modes)	Result: *0
*POLCON:WP 0.1,0.4,-0.2,0.8,1.2	Set manually to a position	Result: *0
*POLCON:WP?	Get current polarization controller position	Result: *0,0.1,0.4,-0.2,0.8,1.2

This example shows how to program a sequence of 2 entries (sequence length = 2 elements).

Table 71 Polarization Controller - Example 3

*VAR? PolController,nPolConRot	Get number of waveplates	Result: *0,5
*BUFALLOC 10	Allocate buffer 2 sequence elements multiplied with 5 waveplates yields 10 floating point entries.	Result: *0
*BUFW 0,0.11,-0.22,0.33,-0.44,0.55	Write first sequence step	Result: *0
*BUFW 5,-0.66,0.77,-0.88,0.99,-1.00	Write 2nd step	Result: *0
*POLCON:SEQSET	Generate sequence from buffer contents	Result: *0
*POLCON:START SEQ	Use sequence mode	Result: *0

9 Instrument Variables (Discontinued)

NOTE

Please note that in the future, only the COM/ActiveX drivers will be supported since they offer a much easier way to access the instruments. See Direct Instrument Control on page 145 for more information.

This chapter describes a list of variables supported by the instruments.

Introduction

In the following a list of variables is given which are supported by the instruments.

Each variable has a unique variable number and variable name which are used to address the corresponding variable. Additionally each variable has a type and access code.

Table 72 Variable Types

Type	Description
INT	integer number
FLOAT	floating point number
ARRAYINT	1D-array of integer numbers
ARRAYFLOAT	1D-array of floating point numbers
TEXT	text string

Table 73 Variable Access Codes

R	read only access
W	write only access
R/W	read/write access

Tree 0: Common

The variable tree `Common` is available on all instruments.

Table 74 Tree 0: Common

No	Name	Type	Acc.	Def.	Description
0	`GPIBAddress`	INT	R/W	30	GPIB address (1..30), only valid after restart
9	`ModelCode`	TEXT	R/W		instrument model code
10	`SerialCode1`	TEXT	R		instrument serial number
11	`SerialCode2`	TEXT	R		add. instrument serial number
12	`SerialCode3`	TEXT	R		add. instrument serial number
13	`SerialCode4`	TEXT	R		add. instrument serial number
17	`SelfTestResult`	INT	R	0	Result of selftest. 0=Selftest successful. Other values indicate a hardware damage.

Tree 3: Polarimeter

The variable tree `Polarimeter` is available on N778xB/BD instruments with polarimetry capabilities.

Table 75 Tree 3: Polarimeter

No	Name	Type	Acc.	Def.	Description
1	`WavelengthStart`	FLOAT	R/W	1550.0	Wavelength in nm. In sweep mode: start wavelength in nm
2	`SweepRate`	FLOAT	R/W	0.00	Sweep rate in nm/s. 0: Fixed wavelength mode.
3	`TriggerSource`	INT	R/W	0	Trigger source 0: none 1: software 2: TTL high 3: TTL low
7	`SamplingRate`	FLOAT	R/W	5.0	Sampling rate in kHz
14	`AutoGainFlag`	INT	R/W	1	Auto gain 0: disable 1: enable
15	`SweepState`	INT	R	0	Sweep status 0: idle 1: SOP acq. running 2: SOP continuous acq. running
16	`Samples`	INT	R/W	256	Desired number of samples for data acquisition.
17	`Gain`	INT	R/W	0	Current polarimeter gain. Valid gain settings: 0..13. Write into this variable to manually select the gain setting.
28	`LastPeakRange`	FLOAT	R		Last occurred peak range. A value between 0..1 indicates the maximum power level occurred in the last measurement. A value of 1 corresponds to the maximum detectable power level in the used gain setting. Note that values below 0.3 can reduce SOP accuracy.

No	Name	Type	Acc.	Def.	Description
29	`LastPeakPower`	FLOAT	R		Last occurred peak power in mW. This value is the power level corresponding to the peak value of variable `LastPeakRange`.
30	`TriggerState`	INT	R		Trigger state: 0: idle 1: armed 2: sampling 3: data available 4: error
31	`Progress`	INT	R/W		This variable will be increased whenever a new measurement has been taken.

Tree 4: PolController

The variable tree `PolController` is available on all N778xB/BD instruments that contain a $LiNbO_3$-polarization controller.

Table 76 Tree 4: PolController

No	Name	Type	Acc.	Def.	Description
4	`nPolConRot`	INT	R	5	Number of waveplates of the polarization controller
5	`RepRate`	FLOAT	R/W	5.0	Repetition rate in kHz
6	`ScramblingMode`	INT	R/W	0	PolController mode 0: off 1: random scrambling 2: sequence scrambling
7	`Synchronization`	INT	R/W	0	Synchronization: 0: autorepeat 1: oneshot `autorepeat` will restart the sequence when finished. `oneshot` will stop the sequence at the end.
8	`TimeBase`	INT	R/W	0	Timebase 0: timer 1: polarimeter clock 2: external (BNC Trig-In) `polarimeter clock` is only valid for N7788B/BD and N7786B
9	`SequenceStartTrigger`	INT	R/W	0	0: auto 1: external 2: polarimeter auto will start the sequence immediately. `external` will start the sequence on an external event. `polarimeter` will start the sequence with every polarimeter measurement start (valid for AN7788B/BD and N7786B).

No	Name	Type	Acc.	Def.	Description
11	`Prescaler`	INT	R/W	0	prescaler for repetition rate 0: no prescaling 1: div by 2 etc.
12	`HoldOffDelay`	INT	R/W	100	Hold off delay in µs after receiving a trigger.
13	`SeqLength`	INT	R/W	12	Length of sequence.

10 Polarization Navigator Automation

This chapter describes the polarization navigator automation.

Introduction

The polarizationNAVIGATOR™ can be remotely controlled by sending human-readable commands and receiving a response from the software.

There are virtual devices you can communicate with, so-called *Targets*.

As an example, you can send the following command to the target Global:

```
Get Version
```

The response will look like:

```
Version 2.53 (1315), Built on Feb 22 2006 16:14:01
```

Use PolNavClientTest.exe to test the automation interface.

You can use the test program `PolNavClientTest.exe` (you can find it in the Start menu) to communicate with the polarizationNAVIGATOR™.

If the polarizationNAVIGATOR™ is not started, it will be automatically launched and minimized to the system tray.

Sending Commands

Using PolNavClientTest.exe to Send Commands

Use PolNavClientTest.exe to test the automation interface

You can use the test program *PolNavClientTest.exe* to communicate with the polarizationNAVIGATOR™. You can find a shortcut to *PolNavClientTest.exe* in the *Examples* folder of the polarizationNAVIGATOR™ entry in the Windows Start menu.

Command Line Tool

You can use the command line tool `PolNavSendCommand.exe` for sending commands to the polarizationNAVIGATOR™. During the installation process, this file is placed into the system directory, so you don't have to set a path to access it.

For example, start the polarizationNAVIGATOR™ and type the following command at the command line:

```
polnavsendcommand Global "Get Version"
```

The response will look like:

```
Version 2.53 (1315), Built on Feb 22 2006 16:14:01
```

You can print the result code on the command line using the standard variable `ERRORLEVEL`:

```
echo %ERRORLEVEL%
```

The communication is implemented using a DLL which can be called from any software which supports DLL calls such as LabView, MATLAB, Visual C++ or Visual Basic.

In the subfolder
`Examples\PolNavSendCommand_VisualC++7.0 SourceCode`
of the polarizationNAVIGATOR™ installation directory you can find the source code to the command line tool and see how the DLL-calls can be implemented.

COM/ActiveX Interface

We recommend to use the COM/ActiveX class AgServerN778xLib as shown in Direct Instrument Control on page 145. You can use the interface IAgN778xPolarizationNavigator to send an automation command. Please take a look at the following examples:

MATLAB: N778xCOMDemo_PolNav.m

LabView: N778xPolNav.vi

DLL Interface

The communication with the polarizationNAVIGATOR™ is also implemented using a DLL interface.

The name of the DLL is `PolNavClient.dll`. It is installed in the `WINDOWS\SYSTEM32` directory during the setup process.

There are four exported functions. The C function prototypes are as follows:

- PolNav_SendCommand: Sending commands to the polarizationNAVIGATOR™ and get a response.
- PolNav_ReadResponse: For long responses, this function reads the response in little pieces.
- PolNav_Disconnect: In case of a TCP/IP connection, disconnect the client from the server.
- PolNav_HelloWorld: Tests the communication to the polarizationNAVIGATOR™

You can find a header file with the function prototypes in a subfolder of the polarizationNAVIGATOR™ installation directory: *\Examples\Visual C++7.0 SourceCode SendCommand\PolNavClientDll.h*

NOTE

The PolarizationNavigator DLL interface only supports 32bit automation environments.

Use the AgN778xPolarizationNavigator class within the AgServerN778xLib COM/Active-X server to access PolarizationNavigator functionality from 64bit automation environments.

Command: PolNav_SendCommand

This function sends a command to the polarizationNAVIGATOR™ and retrieves the response[1].

Function prototype:

```
int __stdcall PolNav_SendCommand(const char *Target,
    const char *Command,char *Response,int MaxLen,
    int &ResponseLen);
```

Table 77 Variables

Parameter	Description
Target	Target Name (see Polarization Navigator Automation: Target Names on page 249)
Command	The command string to be sent to the Navigator.
Response	Pointer to a buffer reserved for the response. The calling application has to allocate enough memory to receive the response. The response is a 0-terminated string.
MaxLen	The size of the allocated response buffer.
ResponseLen	Here, the total length of the response is returned. If the response does not fit into the allocated buffer, only the first part is copied into the response buffer. Use `PolNav_ReadResponse` to access smaller fractions of the response.
Return Value	The return value is an Error Codes (Error Codes on page 336). A zero (0) indicates successful operation.

1 Depending upon the amount of data and the automation environment that you are working with you may need the “Command: PolNav_ReadResponse (see next section) to retrieve the full response

Command: PolNav_ReadResponse

This function retrieves portions of a response that has been acquired using `PolNav_SendCommand`.

Using this function you can access fractions of the last received response. Particularly in VBA, strings cannot be longer than 32767 characters. Thus you will have to access longer response strings using this function.

Function prototype:

```
int __stdcall PolNav_ReadResponse(int iStart,int iLength,
    char *Response,int MaxLen,int &ResponseLen);
```

Table 78 Variables

Parameter	Description
iStart	Start index of the fraction.
iLength	Number of characters to be read from the total response.A value of zero (0) reads the total response. A value of -1 reads from the beginning indicated by iStart to the next CR or LF. This is particularly useful to parse plot data returned by the `GetPlot Default` command.
Response	Pointer to a buffer reserved for the response. The calling application has to allocate enough memory to receive the response. The response is a 0-terminated string.
MaxLen	The size of the allocated response buffer.
ResponseLen	Here, the total length of the fraction is returned.
Return Value	The return value is an Error Codes (Error Codes on page 336). A zero (0) indicates successful operation.

Command: PolNav_Disconnect

This disconnects a TCP/IP client from the server.

If you communicate with the polarizationNAVIGATOR™ via TCP/IP (see next chapter), you should terminate the connection after leaving your program.

Function prototype:

```
int __stdcall PolNav_Disconnect();
    char *Response,int MaxLen,int &ResponseLen);
```

Table 79 Variables

Parameter	Description
Return Value	The return value is an Error Codes (Error Codes on page 336). A zero (0) indicates successful operation.

Command: PolNav_HelloWorld

This function is for debugging purposes only.

If you call this function, the polarizationNAVIGATOR™ will be started and a value of 123 will be returned.

Function prototype:

```
int __stdcall PolNav_HelloWorld();
```

Table 80 Variables

Table 81 Parameter	Table 82 Description
Return Value	The return value is always 123.

See also Using MATLAB on page 268, Using LabView on page 270, Using Python on page 272, Using VBA on page 273, Using Keysight VEE on page 274 to learn more about the usage of these functions.

Remote Control via TCP/IP

You can communicate to a polarizationNAVIGATOR™ running on a different machine just by changing the target name. You simply have to add the IP-Address of the computer you want to control followed by a ':' to the target name. The target name Global will thus be changed to:

192.168.2.15:Global

NOTE You have to enable the option **Remote Server** in the **Options** dialog to make the polarizationNAVIGATOR™ listen to incoming commands.

Command Reference

Polarization Navigator Automation: Target Names

The communication with the polarizationNAVIGATOR™ uses so-called targets which act as virtual instruments. When communicating with the polarizationNAVIGATOR™ you have to specify the target name of the instrument or application you want to control.

You can query the target name of the instrument/application you want to control by right-clicking in the browser window and choosing Device Server Properties. The target names are generated automatically. For the component test application the target name can be for example `CompTest00000`. If you specify `CompTest*` as target name, the first component test application in the tree will be used as communication partner.

The communication with the polarizationNAVIGATOR™ is implemented using a DLL Interface (see DLL Interface on page 244). A command string is sent to the Navigator which returns a response string. The following targets are supported:

Target Name	Application/Instrument
Global (see Target Global on page 250)	Global Variables
CompTest* (see Target CompTest on page 257)	Component Test (PDL/PMD)
CompTestStepped* (see Target CompTestStepped on page 260)	Component Test(Stepped)
PERTest* (see Target PERTest on page 263)	PER Test
Polarimeter* (see Target Polarimeter on page 251)	Polarimeter
PolCon* (see Target PolController on page 254)	PolController

See Commands Applying to All Targets on page 250 for common commands applying to all targets.

Commands Applying to All Targets

The following commands apply to all targets:

Command	Description
`Activate`	Activates the Instrument/Application.
`DeActivate`	Deactivates the Instrument/Application.
`Get VarName`	Retrieves the content of a variable. See table below for available variables.
`Set VarName,Value`	Sets the value of a variable. See table below for available variables.
`Dir TargetName`	Returns the available target names. Dir without any parameter will return all available target names. `Dir PolCon*` will return all target names beginning with PolCon.
`Echo XYZ`	Sends the characters XYZ as response. This is can be used to test the communication.
`TestData n`	Returns sample plot data for debugging purposes. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a comma (,). Rows are separated by a LF (ASCII code 10). The number of rows is defined by the parameter n.

Target Global

The target name `Global` will select global variables such as the version number of the polarizationNAVIGATOR™.

VarName	R/W	Type	Description
`Version`	R	string	Retrieves the version string of the polarizationNAVIGATOR™.
`SnpTitle`	R/W	string	The title field which is included in the saved PBIN files.
`SnpComment`	R/W	string	The comment which is included in the saved PBIN files.
`SnpOperator`	R/W	string	The name of the operator which is included in the saved PBIN files.
`PolNavReady`	R	bool	1=polarizationNAVIGATOR™ is launched and ready to accept commands

Target Polarimeter

The target name `Polarimeter*` will select the first polarization analyzer from the browser tree.

Commands

The following commands are available:

Command	Description
`Continuous`	Activates the Continuous Oscilloscope mode. In this mode, the polarimeter will be retriggered after finishing a measurement.
`Oneshot`	Activates the Oneshot Oscilloscope mode. In this mode, the polarimeter will be triggered only once.
`Trigger`	In Oneshot Oscilloscope mode, this (re-)activates the measurement cycle and the polarimeter is ready to take a measurement. If no trigger source is configured, sampling will start immediately.

Command	Description
`Trace`	Activates the Trace mode. In this mode, the polarimeter samples with a sampling rate of 2.5 kHz. If the parameter `TraceSensitivity` is set to 0, every incoming data point will be used. If `TraceSensitivity` is set to a value greater than zero, only data points are stored if the SOP has been changed by more than the value indicated by `TraceSensitivity`. If `TraceSensitivity` is set to 0.02, for example, a new data point is taken only if the SOP has changed by at least 0.02 rad.
`Stop`	Stops a measurement.
`StartLogging`	Enables data logging. In the Trace mode, an ASC-II file is opened and all incoming SOP data is streamed into this file. The columns are: S0, S1, S2, S3, DOP.
`StopLogging`	Disables data logging.
`GetPlot Default`	Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a comma (,). Rows are separated by a LF (ASCII code 10). See SOP Data (Default) on page 338 for details on the meaning of each column.

Variables

VarName	R/W	Type	Description
`Mode`	R	string	Returns the current acquisition mode: Stop, Continuous, Oneshot, Trace.
`SamplingRate`	R/W	double	The sampling rate in kHz
`Wavelength`	R/W	double	The (start-) wavelength in nm.
`SweepRate`	R/W	double	The sweep rate in nm/s.

VarName	R/W	Type	Description
`TriggerSource`	R/W	string	Defines the trigger source. `TTLLow`: Trigger on high-to-low edge on the digital input. `TTLHigh` : Trigger on low-to-high edge on the digital input. `TTLLow(Pre)` : Trigger on high-to-low edge on the digital input. Supports pre-trigger buffering. `TTLHigh(Pre)` : Trigger on low-to-high edge on the digital input. Supports pre-trigger buffering. `SOPChange`: Trigger on an SOP event. The sensitivity can be defined by `TrigSenseAngle` and `TrigSenseTime`.
`PreTrigSamples`	R/W	int	Number of pre-trigger samples.
`PostTrigSamples`	R/W	int	Number of post-trigger samples.
`AutoGain`	R/W	bool	Auto gaining on (1) or off (0).
`Gain`	R/W	int	Current gain setting. 0: lowest sensitivity. 13: highest sensitivity.
`LoggingInterval`	R/W	double	Defines the minimum time (in seconds) between two logging events. A value of 0 will disable the timer.
`LoggingMax`	R/W	int	Maximum number of logging events (0=infinite)
`LoggingFilenameBody`	R/W	string	Defines a string to be used for R/W string automatic filename generation. The filename will be generated by adding a number to this string. The data will be stored in My Polarization-Navigator Files.
`IsLogging`	R	bool	Returns the current logging state. 0:Inactive, 1:Active.

VarName	R/W	Type	Description
`TraceSensitivity`	R/W	double	Defines the trace accuracy (in rad) if the polarimeter is in the Trace mode. A value of 0 will store every data point. Values greater than 0 will only store data if the SOP has moved by more than `TraceSensitivity`.
`TrigSenseAngle`	R/W	double	Configures the SOPChange trigger mode. An event is generated if the SOP has moved by more than `TrigSenseAngle` (in deg) within the time indicated by `TrigSenseTime`.
`TrigSenseTime`	R/W	double	Defines the time interval observed in SOPChange trigger mode. A value of 0 indicates that `TrigSenseAngle` is relative to the last event, i.e. an event is created if the SOP has moved by more than `TrigSenseAngle` compared to the last event (regardless of the time).
`Laser`	R/W	bool	Internal laser source on/off (1/0).

Target PolController

The target name `PolCon*` will select the first polarization controller instrument from the browser tree.

Commands

The following commands are available:

Command	Description
`Manual`	Activates Manual Mode of the Instrument
`Scramble`	Activates Scrambling Mode of the Instrument
`Sequence`	Activates Sequence Mode of the Instrument

Command	Description
`Randomize`	Loads a new random sequence in scrambling mode
`Stabilize`	Activates Stabilization Mode of the Instrument
`LoadSOPTable Filename`	Loads an ASCII file containing target SOPs.

Variables

VarName	R/W	Type	Description
`WPL`	R/W	double [5]	Waveplate positions in rad (5 comma-separated values).
`Timebase`	R/W	int	Timebase used for polcontroller. Valid values: 0,1,2; for details see PolController Tree (see Tree 4: PolController on page 238)
`RepetitionRate`	R/W	double	Repetition rate in kHz used for polcontroller
`Prescaler`	R/W	int	Prescaler value used for polcontroller
`HoldOff`	R/W	int	HoldOff value in ms used for polcontroller
`Synchronization`	R/W	int	Synchronization value in ms used for polcontroller Valid values: 0..5; 0=”Auto Repeat”, 1="Auto Oneshot", 2="External Repeat", 3="External Oneshot", 4="Polarimeter Repeat", 5="Polarimeter Oneshot".
`SeqLength`	R/W	int	Length for random sequences. Only valid when in scrambling mode
`Sequence`	W	string	Filename (optional with path) for sequence data to load (only valid when in sequence mode).
`DigitalOutput`	W	int	Sets the Trigger-Out BNC port to logical 0 or 1.

VarName	R/W	Type	Description
`Wavelength`	R/W	double	Operation wavelength of the polarization controller.
`Stabilize`	R/W	int	Activates (1) or deactivates (0) the control loop (only in stabilize mode).
`TargetSOP`	W	double [3]	Sets the desired target SOP. The command accepts 3 comma-separated values corresponding to the 3 normalized Stokes parameters.
`CurrentSOP`	R	double [4]	Reads the current SOP. The result is given by 4 comma-separated values representing the current SOP (not normalized).
`CurrentSOPN`	R	double [3]	Reads the current SOP. The result is given by 3 comma-separated values representing the current SOP (normalized).
`CurrentDOP`	R	double	Reads the current DOP.
`TargetDist`	R	double	Returns the distance of the current SOP to the target SOP.
`TargetAccuracy`	R/W	double	Use an value greater than zero to turn the controller off after the target SOP has been reached. The value defines the maximum distance to the target SOP.
`SOPTableIndex`	R/W	int	Current SOP table index.
`SOPTableSize`	R	int	Current SOP table size.

Example (pseudo code) for activating the stabilizer function (only N7786B):

```
PolNav_SendCommand("PolCon*","Activate")
PolNav_SendCommand("PolCon*","Stabilize")
PolNav_SendCommand("PolCon*","Set TargetSOP,1,0,0")
PolNav_SendCommand("PolCon*","Set Stabilize,1")
PolNav_SendCommand("PolCon*","Get CurrentSOPN")
```

Example (pseudo code) for setting the current waveplate positions:

```
PolNav_SendCommand("PolCon*","Set WPL,0.1,0.2,0.3,0.4,0.5")
```

Target CompTest

The target name `CompTest*` will select the component test application.

A simple pseudo program controlling the component test application could be as follows:

```
DECLARE STRING PROGRESS,PLOTDATA
PolNav_SendCommand("CompTest*","Activate")
PolNav_SendCommand("CompTest*","Set WavelengthStart,1540")
PolNav_SendCommand("CompTest*","Set WavelengthStop,1550")
PolNav_SendCommand("CompTest*","SingleMeasurement")
DO
   PROGRESS=PolNav_SendCommand("CompTest*","Get Progress")
   WAIT
WHILE PROGRESS<>"2"
PLOTDATA=PolNav_SendCommand("CompTest*","GetPlot Default")
```

Commands

The following commands are available:

Command	Description
`GetPlot Default`	Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a comma (,). Rows are separated by a LF (ASCII code 10). See PDL/PMD Data (Default) on page 338 for details on the meaning of each column.
`SingleMeasurement`	Starts a single measurement. This is similar to pressing the button **Single Measurement** in the application.
`RepeatMeasurement`	Starts a repeated measurement. This is similar to pressing the button **Repeat Measurement** in the application.
`StopMeasurement`	Stops a measurement. This is similar to pressing the button **Stop Measurement** in the application.
`TakeReference`	Starts a reference measurement. This is similar to pressing the button **Take Reference** in the application.
`StartLogging`	Enables data logging.

Command	Description
`StopLogging`	Disables data logging.
`Save Filename`	Saves the current measurement into a PBIN-File
`Export Filename`	Saves the current measurement into an ASCII-File
`SaveReference Filename`	Saves the current reference measurement into a PBIN-File
`LoadReference Filename`	Loads the file into the reference list. The file is appended at the end of the list and selected as active reference.
`ClearReference`	Removes the current reference measurement.
`ClearReferenceAll`	Removes all reference measurements from the list.

Variables

VarName	R/W	Type	Description
`Progress`	R	int	This variable is set to 0 when a measurement is started. It is increased once when the measurement is in progress. And it is increased once when the data has been evaluated. Thus you can wait until this variable becomes 2 before retrieving the data using the `GetPlot Default` command. In repeat mode the variable is not reset to 0. Thus the next measurement will be available if the variable becomes 4.
`WavelengthStart`	R/W	double	Start wavelength in nm.
`WavelengthStop`	R/W	double	Stop wavelength in nm.
`AutoResolution`	R/W	int	Turns the automatic resolution on/off (1/0).
`Resolution`	R/W	double	Resolution in nm.

VarName	R/W	Type	Description
`PowerResolution`	R/W	double	Resolution of Power trace in nm. 0 = Default.
`SweepRate`	R/W	double	Sweep rate nm/s. Allowed values are 0.5, 5.0, 10.0, 20.0, 40.0, 80.0
`TLSPower`	R/W	double	TLS power in mW.
`UseLambdaLog`	R/W	bool	Lambda logging on/off (1/0).
`AutoGain`	R/W	bool	Auto gaining on/off (1/0).
`UseReference`	R/W	bool	Use reference measurement on/off (1/0).
`UseReferenceNo`	R/W	int	Selects/queries the number of the current reference measurement.
`CurrentGain`	R/W	int	Current gain setting. Allowed values are 0..13
`DynamicRange`	R/W	string	Configures the dynamic range for the measurement. Allowed values are low, med, high.
`Properties`	R	string	Dumps the properties which are attached to the last measurement.
`LastEvalError`	R/W	int	Result of last evaluation. See Error Codes (Error Codes on page 336) for possible values.
`Busy`	R	bool	Application busy (1) or not (0).
`Active`	R	bool	Application activated (1) or not (0).
`PlotNum`	R	int	Number of available plots.
`UseLivePower`	R/W	bool	Enable (1) or disable (0) measurement of Live power level (which is shown on the Poincaré-Tab).
`LivePower`	R	double	Live power level (which is shown on the Poincaré-Tab).
`LiveDOP`	R	double	Live DOP

VarName	R/W	Type	Description
`LiveSOP`	R	double	Live SOP
`LiveWavelength`	R/W	double	Writing this variable immediately sets the laser wavelength to the specified wavelength in nm.
`UseInternalRef`	R/W	bool	Internal optical reference path is used (Yes) or not (No). It is recommended to leave this value set to Yes.
`KeepRawData`	R/W	bool	Raw data is embedded in the PBIN files (Yes) or not (No). Embedding raw data enables offline post processing but increases file size.
`DetectModehops`	R/W	bool	Try to detect mode hops (Yes) or not (No). Some laser sources can detect mode hops during the continuous sweep.
`InternalRefValidMinutes`	R/W	double	This value defines the maximum R/W double lifetime of an internal reference measurement in minutes. A value of 0 (default) defines infinite lifetime. Use a value greater than 0 if the power of your laser source is slowly drifting.

Target CompTestStepped

The target name `CompTestStepped*` will select the component test application.

A simple pseudo program controlling the component test application could be as follows:

```
DECLARE STRING PROGRESS,PLOTDATA
PolNav_SendCommand("CompTestStepped*","Activate")
PolNav_SendCommand("CompTestStepped*","Set WavelengthStart,1540")
PolNav_SendCommand("CompTestStepped*","Set WavelengthStop,1550")
PolNav_SendCommand("CompTestStepped*","Set WavelengthStep,0.1")
```

```
PolNav_SendCommand("CompTestStepped*","SingleMeasurement")
DO
   PROGRESS=PolNav_SendCommand("CompTestStepped*","Get Progress")
   WAIT
WHILE PROGRESS<>"2"
PLOTDATA=PolNav_SendCommand("CompTestStepped*","GetPlot Default")
```

Commands

The following commands are available:

Command	Description
`GetPlot Default`	Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a comma (,). Rows are separated by a LF (ASCII code 10). See PDL/PMD Data (Default) on page 338 for details on the meaning of each column.
`SingleMeasurement`	Starts a single measurement. This is similar to pressing the button **Single Measurement** in the application.
`RepeatMeasurement`	Starts a repeated measurement. This is similar to pressing the button **Repeat Measurement** in the application.
`StopMeasurement`	Stops a measurement. This is similar to pressing the button **Stop Measurement** in the application.
`TakeReference`	Starts a reference measurement. This is similar to pressing the button **Take Reference** in the application.
`StepPredict Lambda0; Lambda1; ...`	Starts the automatic step prediction algorithm. This is similar to pressing the button "Auto" in the application. You have to specify the desired wavelengths at which the measurements will be performed (given as list of values separated by semicolons), e.g.: PolNav_SendCommand("CompTestStepped*", "StepPredict 1530.0;1550.0;1580.0")
`Save Filename`	Saves the current measurement into a PBIN-File
`Export Filename`	Saves the current measurement into an ASCII-File

Command	Description
`SaveReference Filename`	Saves the current reference measurement into a PBIN-File
`LoadReference Filename`	Loads the file into the reference list. The file is appended at the end of the list and selected as active reference.
`ClearReference`	Removes the current reference measurement.
`ClearReferenceAll`	Removes all reference measurements from the list.

Variables

VarName	R/W	Type	Description
`Progress`	R	int	This variable is set to 0 when a measurement is started. It is increased once when the measurement is in progress. And it is increased once when the data has been evaluated. Thus you can wait until this variable becomes 2 before retrieving the data using the `GetPlot Default` command. In repeat mode the variable is not reset to 0. Thus the next measurement will be available if the variable becomes 4.
`WavelengthStart`	R/W	double	Start wavelength in nm.
`WavelengthStop`	R/W	double	Stop wavelength in nm.
`WavelengthStep`	R/W	double	Step size in nm.
`AutoResolution`	R/W	int	Turns the automatic resolution on/off (1/0).
`Resolution`	R/W	double	Resolution in nm.
`PowerResolution`	R/W	double	Resolution of Power trace in nm. 0 = Default.
`TLSPower`	R/W	double	TLS power in mW.
`AutoGain`	R/W	bool	Auto gaining on/off (1/0).

VarName	R/W	Type	Description
`UseReference`	R/W	bool	Use reference measurement on/off (1/0).
`CurrentGain`	R/W	int	Current gain setting. Allowed values are 0..13
`Properties`	R	string	Dumps the properties which are attached to the last measurement.
`UseInternalRef`	R/W	bool	Internal optical reference path is used (Yes) or not (No). It is recommended to leave this value set to Yes.
`UseReferenceNo`	R/W	int	Selects/queries the number of the current reference measurement.
`KeepRawData`	R/W	bool	Raw data is embedded in the PBIN files (Yes) or not (No). Embedding raw data enables offline post processing but increases file size.
`LastEvalError`	R/W	int	Result of last evaluation. See Error Codes on page 336 for possible values.

Target PERTest

The target name `PERTest*` will select the component test application.

A simple pseudo program controlling the component test application could be as follows:

```
DECLARE STRING PER
PolNav_SendCommand("PERTest*","Activate")
PolNav_SendCommand("PERTest*","Set Wavelength,1550")
PolNav_SendCommand("PERTest*","Set Mode,2")
PolNav_SendCommand("PERTest*","StartMeasurement")
WAIT 4000
PolNav_SendCommand("PERTest*","SetPER")
DO
   PER=PolNav_SendCommand("PERTest*","Get PERCurrent")
   PRINT "PER = ";PER;" dB"
WHILE FOREVER
```

Commands

The following commands are available:

Command	Description
`Manual`	Starts the measurement. This is similar to pressing the button **PER Manual** in the application.
`Live`	Stops a measurement and shows the Live PER. This is similar to pressing the button **PER Live** in the application.
`Wavelength Scan`	Starts a PER measurement using the wavelength scan method. This is similar to pressing the button **PER WL Scan** in the application.
`Heater` (or Heater0)	Starts a single-TCU PER measurement. This is similar to pressing the button **PER (Heater)** in the application.
`Heater1`	Starts a single-TCU PER measurement with the second TCU. This is similar to pressing the button **PER (Heater)** in the application while holding down the CTRL key.
SpliceAngle	Starts a dual-TCU PER measurement for splice angles. This is similar to pressing the button **Splice Align** in the application.
`GetPlot Default`	Returns the plot data of the last measurement. The response is a string which is formatted like a spreadsheet consisting of rows and columns. Columns are separated by a comma (,). Rows are separated by a LF (ASCII code 10). See PDL/PMD Data (Default) on page 338 for details on the meaning of each column.
`TempHeat0`	Sets the first Thermal Cycling Unit into heating mode.
`TempCool0`	Sets the first Thermal Cycling Unit into cooling mode.

Command	Description
TempHeat1	Sets the second Thermal Cycling Unit into heating mode.
TempCool1	Sets the second Thermal Cycling Unit into cooling mode.
TempOff	Turns off the power (no heating, no cooling) of the Thermal Cycling Unit.

Variables

VarName	R/W	Type	Description
Wavelength	R/W	double	Center wavelength in nm.
SweepRange	R/W	double	Sweep range in nm.
TLSPower	R/W	double	TLS power in mW.
AutoGain	R/W	bool	Auto gaining on/off (1/0)
CurrentGain	R/W	int	Current gain setting. Allowed values are 0..13
PERCurrent	R	double	Current PER value in dB.
PERLive	R	double	Current Live-PER in dB.
PowerLive	R	double	Current live power level in mW.
SpliceAngle	R	double	Current Splice Angle in deg.
SplicePER	R	double	Current Splice PER in dB.
HeaterAvail0	R	bool	1st TCU: 0=not installed, 1=installed
HeaterAvail1	R	bool	2nd TCU: 0=not installed, 1=installed
HeaterState0	R	int	1st TCU: -1=not installed, 0=off, 1=cooling, 2=heating
HeaterState1	R	int	2nd TCU: -1=not installed, 0=off, 1=cooling, 2=heating
HeatingTime	R/W	double	Maximum heating time in s.
CoolingTime	R/W	double	Maximum cooling time in s.

VarName	R/W	Type	Description
SettlingTime	R/W	double	Settling time in s.
SpliceAngleAccuracy	R/W	double	Threshold in deg for finishing automatic splice alignment. If the splice angle is below this value, alignment will stop.
LightSourceAutoOff	R/W	string	Yes = The internal laser source (if present) will be automatically turned on/off. No = The laser source remains on.
HeatingTimeAuto	R/W	string	On = Automatic heating time adjustment is activated, No = Use HeatingTime and CoolingTime instead.
`Laser`	R/W	bool	Internal laser source on/off (1/0). Only if the instrument has a built-in laser source.

Target ContScrambling

The target name `ContScrambling*` will select the continuous scrambling application (see Application: Continuous Scrambling on page 128 for more details).

A simple pseudo program starting the scrambler could be as follows:

```
DECLARE STRING MaxSpeed
PolNav_SendCommand("ContScrambling*","Activate")
PolNav_SendCommand("ContScrambling*","Set Scanrate,8")
PolNav_SendCommand("ContScrambling*","Set Enable,1")
MaxSpeed=PolNav_SendCommand("ContScrambling*","Get MaxSpeed")
```

Variables

VarName	R/W	Type	Description
`Enable`	W	bool	Enables (1) or disables (0) the scrambling mode.

VarName	R/W	Type	Description
`IsScrambling`	R	bool	Returns the state of the scrambler: 0=Off, 1=Scrambling.
`Scanrate`	R/W	int	Defines the scrambling speed (1-1000).
`MaxSpeed`	R	double	Maximum expected SOP movement rate (in rad/s).

Using MATLAB

As described in the chapter DLL Interface (DLL Interface on page 244), the `DLL PolNavClient.dll` can be used to send commands to the polarizationNAVIGATOR™. Making use of this DLL is very simple if the MATLAB extension (MEX-Files) is used which comes with the software. We recommend that you set a permanent path in MATLAB to the *Bin\Matlab* subfolder of the polarizationNAVIGATOR™ installation directory.

After having done so, you can use the following new MATLAB commands:

Commands

`[response,result]=MEX PolNav SendCommand(target,command)`

Send a command to the polarizationNAVIGATOR™ and receive a string response. `result` contains an error code.

`[response,result]=MEX PolNav SendCommandEx(target,command)`

Send a command to the polarizationNAVIGATOR™ and receive plot data. `result` contains an error code.

Please type `help MEX PolNav SendCommand or help MEX PolNav SendCommandEx` at the MATLAB command prompt for details of the calling parameters.

Here is a simple example of how the component test application (see Target CompTest on page 257) can be automated using MATLAB:

```
MEX_PolNav_SendCommand('CompTest*','Activate');
MEX_PolNav_SendCommand('CompTest*','Set WavelengthStart,1540');
MEX_PolNav_SendCommand('CompTest*','Set WavelengthStop,1550');
MEX_PolNav_SendCommand('CompTest*','SingleMeasurement');
while 1
     [response,result]=MEX_PolNav_SendCommand('CompTest*',
       'Get Progress');
     if str2num(response)==2;
       break;
     end
     pause(1);
end;
[PlotData,result]=MEX_PolNav_SendCommandEx('CompTest*',
       'GetPlot Default');
plot(PlotData(:,1),PlotData(:,2));
```

Make sure that the polarizationNAVIGATOR™ is already started before executing the MATLAB script. In the folder DemoMATLAB, you can find the m-file `PolNavPERTest.m` which is an example for controlling the PER-measurement application.

Using LabView

As described in the DLL Interface on page 244, the DLL `PolNavClient.dll` can be used to communicate with the polarizationNAVIGATOR™. Making use of this DLL is very simple if the LabView-VIs are used which come with the polarization NAVIGATOR. The necessary VIs are located in the library file `PolNavClient.llb`.

There is only one VI named `SendCommand.vi` which communicates with the polarizationNAVIGATOR™.

Input parameters:	Target, Command, MaxResponseSize
Output parameters:	Response, ResponseSize, ErrorCode

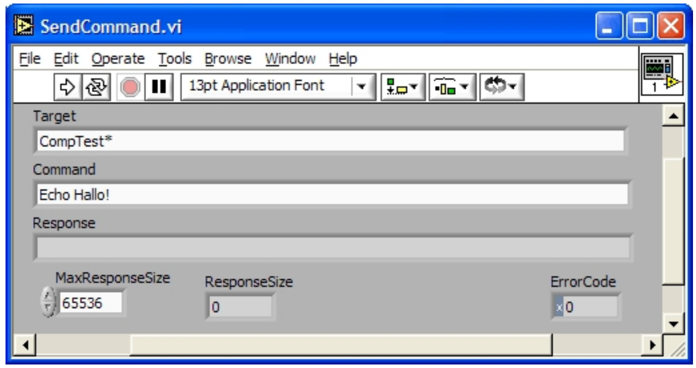
Input parameters are the communication target and the actual command. Refer to Polarization Navigator Automation: Target Names on page 249 for details on the available commands.

Refer to Error Codes on page 336 for details of the possible error results.

Note that the polarizationNAVIGATOR™ has to be started prior to sending these commands.

You can also find some example VIs in the library `PolNavClient.llb`:

- `PolNavClient_ComponentTest_Demo.vi` gives an example implementation for automating the component test application (Target CompTest on page 257).
- `PolNavClient_PER_Demo.vi` gives an example implementation for automating the PER application (Target PERTest on page 263).


SendCommand.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Target
CompTest*
Command
Echo Hallo!
Response
MaxResponseSize
65536
ResponseSize
0
ErrorCode
0

Using Python

As described in DLL Interface on page 244, the DLL `PolNavClient.dll` can be used to communicate with the polarizationNAVIGATOR™. Making use of this DLL is very simple if the Python-extension is used which comes with the polarizationNAVIGATOR™. We recommend that you copy the DLL `PyPolNav.dll` into your Python DLL directory (typically named `c:\Program Files\PythonXX/DLLs\`). You can find this DLL in the directory DemoPython2.2 or DemoPython2.4 depending on the Python version you are using.

After having done so, you can use the extension by importing the DLL using the following command:

import PyPolNav

Check the availability of the DLL as follows (returns the version number):

```
print "PyPolNav.dll version:" print PyPolNav.GetDLLVersion()
```

A simple communication with the polarizationNAVIGATOR™ could be as follows:

```
print "polarization NAVIGATOR version:" print
PyPolNav.SendCommand("Global","Get Version")
```

The last error code can be read as follows:

```
ErrorCode=PyPolNav.LastError()
```

Note that the polarizationNAVIGATOR™ has to be started prior to sending these commands. Refer to Polarization Navigator Automation: Target Names on page 249 for details on the available commands. Refer to Error Codes on page 336 for details on the possible error results.

You can also find a simple demo script `PERTest.py` located in the folder DemoPython2.2 or DemoPython2.4 showing how to use the PER application with Python.

Using VBA

As described in DLL Interface on page 244, the DLL `PolNavClient.dll` can be used to communicate with the polarizationNAVIGATOR™. You can directly access the DLL functions from Microsoft Visual Basic for Applications (VBA), e.g. from EXCEL.

The corresponding declarations are:

```
Declare Function PolNav_SendCommand& Lib "PolNavClient.dll" _
     Alias "?PolNav_SendCommand@@YGHPBD0PADHAAH@Z" _
     (ByVal Target As String, ByVal Command As String, _
     ByVal Response As String, ByVal MaxLen As Long, _
     ByRef ResponseLen As Long)

Declare Function PolNav_ReadResponse& Lib "PolNavClient.dll" _
     Alias "?PolNav_ReadResponse@@YGHHHPADHAAH@Z" _
     (ByVal iStart As Long, ByVal iLength As Long, _
     ByVal Response As String, ByVal MaxLen As Long, _
     ByRef ResponseLen As Long)
```

See DLL Interface on page 244 for details on the parameters. An example using Microsoft EXCEL is included in the software package. The filename is `PolNavClientDemo1.xls` located in the *Examples* subfolder of the polarizationNAVIGATOR™ installation directory.

Using Keysight VEE

You can find an example VEE program in the *Examples* subfolder of the polarizationNAVIGATOR™ installation directory:

\Examples\Vee\Hello World.vee

Please note that Keysight VEE cannot call C++ functions. Therefore, the DLL also contains corresponding functions in ANSI-C calling convention:

- PolNavC_SendCommand
- PolNavC_ReadResponse
- PolNavC_Disconnect
- PolNavC_HelloWorld

The corresponding header file is named *PolNavClientDll_Vee.h*.

See DLL Interface on page 244 for details on the parameters.

11 File Types

This chapter lists all file types used by the polarizationNAVIGATOR™.

PBIN-Files

The default file format used by the polarizationNAVIGATOR™ is a binary file format with the extension .pbin. These files contain measurement data such as SOP measurements or PMD measurements. For MATLAB integration, m-files are provided to load PBIN-files (see MATLAB File Handling on page 282).

Measurement Series

The polarizationNAVIGATOR™ supports handling of measurement series. You can load a series of measurements (e.g. a collection of long term data) into a single document. Use the File>Import Series to import all PBIN-files contained in a single directory. Use File>Save As to save the complete series into a single PBIN-file.

Once the series is loaded into a single document, you can export the data as CSV-file (see CSV-Files (Comma Separated Values) on page 278) or MAT-file (see Exporting MATLAB Files on page 282).

CSV-Files (Comma Separated Values)

If you want to export data in CSV format use the menu entry File>Export. Please choose a target filename with the extension .csv. After selecting the target filename a dialog box may appear allowing you to choose which data will be exported into that file. See ASCII File Formats on page 338 for details on the data organization.

The generated files can be imported e.g. to EXCEL. Please note that the polarizationNAVIGATOR™ uses the localized decimal point. For English systems, this is usually full stop (.), the value separator is a comma (,) accordingly. For German systems, the decimal point is a comma (,) and the value separator is a semi-colon (;). You can change these settings in the Windows control panel.

Measurement Series

For measurement series, data of one type is formatted to form a block. Thus, for example, all DOP values belonging to different measurements are grouped together to simplify generation of 3-dimensional plots.

Note that only series can be exported containing measurements with the same number of data points each.

ASCII-Files

If you want to export data in ASCII format use the menu entry File>Export. Please choose a target filename with the extension .asc. After selecting the target filename a dialog box may appear allowing you to choose which data will be exported into that file. See ASCII File Formats on page 338 for details on the data organization.

PMR-Files

Files with the extension .pmr are created by the PMD field tester module N3909A belonging to the Keysight Modular Network Tester (MNT) platform. These files can be imported into the polarizationNAVIGATOR™ to be viewed. Furthermore, they can be exported as PDF reports (see chapter Report Generation on page 283).

CD-Files

Files with the extension .cd are created by the 4-wavelength OTDR module N3916AL belonging to the Keysight Modular Network Tester (MNT) platform. These files can be imported into the polarizationNAVIGATOR™ to be viewed. Furthermore, they can be exported as PDF reports (see chapter Report Generation on page 283).

MATLAB File Handling

Exporting MATLAB Files

If you want to export data as MATLAB .mat files use the menu entry File>Export. Please choose a target filename with the extension .mat. Note that you need MATLAB to use this feature.

If you load the .mat file into the MATLAB workspace the variable `Data` contains the exported information as a struct variable. Type in `Data` to see the contents:

```
Data Data =
      Lambda:   [2077x1 double]
      DGD:      [2077x1 double]
      PDL:      [2077x1 double]
      Power:    [2077x1 double]
      PDLDivided:  [2077x2 double]
      PDLPSP:   [2077x3 double]
      PSP:      [2077x3 double]
      PMD2nd:   [2077x1 double]
      Info:     [1x1 struct]
      Mueller:  [2077x16 double]
      Jones:    [2077x4 double]
```

See also Application: PMD/PDL (PMD/PDL/Loss) on page 87.

Loading PBIN-Files into MATLAB

You can load PBIN-files into the MATLAB workspace using the following command:

```
Data=PBinRead('Filename.pbin');
```

Note that you have to set a path into the directory containing the .m files. The .m files that come with the polarizationNAVIGATOR™ are located in the `\Bin\Matlab\` subfolder of the polarizationNAVIGATOR™ installation directory.

12 Report Generation

This chapter provides information for report generation.

Generating PDF Reports

The documents containing the measurements can be exported as a PDF file. This includes graphical data (e.g. DGD curves) as well as scalar results such as the PMD value. The report generator can process multiple files in a single run. For example, all `.pbin` files contained in a directory can be converted into multiple PDFs or they can be written into a single PDF.

The appearance of these reports can be highly customized. For example, a company logo can be placed on the page(s) or the information can be reduced to only the relevant data of a specific customer. Also specific parameters can be interactively queried from the customer in a customizable dialog (e.g. DUT name or serial number).

The layout is defined by a definition file, the so-called report template. This file uses the XML syntax and can be seen as a simple script language. The command reference is given in the next chapters.

Creating a Report for the Current Document

You can generate a single report from the current document using the following steps:

1. Open your document.
2. Click on Tools>Report Generator or on the PDF icon in the toolbar.
3. The report generator wizard appears. Select Current document from the list.
4. Select a report template from the list (apparently only one template is selectable).
5. Click on Next.
6. Enter additional information if desired in the next page.
7. Click on Next.
8. Click on Finish.
9. You will be asked for a target filename.

Now, a PDF file is generated and opened afterwards.

NOTE **A PDF viewer such as the Acrobat Reader needs to be installed on your system.**

Creating a Report for all Gallery Documents

You can generate multiple reports from all opened documents in the gallery using the following steps:

1. Open several documents.
2. Only documents of the same class can be processed at once (e.g. either only SOP measurements or PMD measurements). Bring a typical document you want to process to the front.
3. Click on Tools>Report Generator or on the PDF icon in the toolbar.
4. The report generator wizard appears. Select All gallery documents from the list.
5. Select a report template from the list (apparently only one template is selectable).
6. Click on Next.
7. Choose if you want several PDF files to be generated or a single PDF file.
8. Click on Next.
9. Choose the target directory.
10. Click on Next.
11. Enter additional information if desired in the next page.
12. Click on Next.
13. Click on Finish.
14. You will be asked for a target filename and if needed for a target directory.

Creating a Report for all Documents Contained in a Directory

You can generate multiple reports from all documents contained in a single directory using the following steps:

1. Only documents of the same class can be processed at once (e.g. either only SOP measurements or PMD measurements). Bring a typical document you want to process to the front or close all documents.
2. Click on Tools>Report Generator or on the PDF icon in the toolbar.
3. The report generator wizard appears. Select All document contained in a folder from the list.
4. Select a report template from the list.
5. Click on Next.
6. Choose if you want several PDF files to be generated or a single PDF file.

7 Click on Next.
8 Choose the target directory.
9 Click on Next.
10 Enter additional information if desired in the next page.
11 Click on Next.
12 Click on Finish.
13 You will be asked for a target filename and if needed for a target directory.

Report Templates

The report templates are located in the subfolder `\Bin\ReportTemplates\` of the polarizationNAVIGATOR™ installation folder. You can make a copy of one of the existing `.xml` files and modify it according to your needs.

File structure

A typical template file has the following structure:

```
<?xml version="1.0" ?>
   <ReportTemplate>
     <Info>
         <Value Name="DocClasses">3</Value>
         <Value Name="LongName">Keysight PBIN Files,
         PMD-Measurement</Value>
         <Value Name="Extension">pbin</Value>
         <Value Name="CountPages">no</Value>
     </Info>
     <UserDialog>
         <Input Name="DUT" Prompt="Device Under Test :" Default="" />
     </UserDialog>
     <PageTemplate>
         {Common Page Layout}
     </PageTemplate>

     {Pages}
   </ReportTemplate>
```

The <*Info*> node tells the polarizationNAVIGATOR™ something about the template file (e.g. which documents can be used, which filename extensions can be used for the source files etc.).

The <*UserDialog*> node includes additional parameters queried from the customer during the report generation.

The <*PageTemplate*> node contains commands which are processed whenever a new page begins.

The report layout itself is placed after the PageTemplate section.

Command Reference: Main Nodes

<Info> Node

The <Info> node tells the polarizationNAVIGATOR™ something about the template file (e.g. which documents can be used, which filename extensions can be used for the source files etc.).

A typical <Info> node looks as follows:

```
<Info>
     <Value Name="DocClasses">3</Value>
     <Value Name="LongName">Keysight PBIN Files, PMD-Measurement</Value>
     <Value Name="Extension">pbin</Value>
     <Value Name="CountPages">no</Value>
</Info>
```

Items:

```
<Value Name="DocClasses">DocClass1;DocClass2...</Value>
```

Enter the document classes this report is valid for. Valid class numbers are:

DocClass	Document Type
1	.pbin-files (SOP-Measurement)
2	.pbin-files (PMD-Measurement)
4	.pmr-files
5	.cd-files

```
<Value Name="LongName">Name</Value>
```

This entry defines the name displayed in the wizard dialog.

```
<Value Name="Extension">FilenameExtension1;FilenameExtension2...</Value>
```

This entry defines a list of applicable filename extensions (usually only `pbin`).

```
<Value Name="CountPages">{no/yes}</Value>
```

The total number of pages might depend in certain cases on the measurement content. If you want the total number of pages to appear in the report, the report generator is called twice to count the pages. If Count-Pages is set to no, this behavior is suppressed to speed up the process. If you know the number of report pages in advance, we recommend to set this value to no.

<UserDialog> Node

The <UserDialog> node allows to configure a special page within the report generator wizard to query additional parameters from the user.

A typical <UserDialog> node looks as follows:

```
<UserDialog>
    <Input Name="DUT" Prompt="Device Under Test :" Default="" />
    <Input Name="ProductNumber" Prompt="Product Number :" Default="" />
    <Input Name="ProductSN" Prompt="Product S/N :" Default="" />
</UserDialog>
```

Items:

```
<Input Name="{VariableName}" Prompt="{UserPrompt}" Default="{DefaultValue}" />
```

Parameter	Description
`VariableName`	Identifier name for storing the user entry.
`UserPrompt`	String printed into the dialog box.
`DefaultValue`	Initial value of the input field. Will be pasted into the input field if the user clicks on **Reset to Defaults**.

<PageTemplate> Node

The <PageTemplate> node contains commands which are processed at the beginning of every page. It can contain all commands listed in the following command reference.

A typical <PageTemplate> node looks as follows:

```
<PageTemplate>
    <Image x="0" y="0" Width="paper" Height="paper">Background.png</Image>
</PageTemplate>
```

This command places an image named `Background.png` located in the same directory as the template file on the top left corner of every page and scales it to the page width and page height.

Command Reference: Placing Text

< t >< /t >

Examples:

```
<t>Hello World</t>
<t Align="center">Hello World</t>
<t Linefeed="yes">Hello World</t>
```

Prints the text at the current cursor position.

Attribute	Description
Align	center: The text will be horizontally centered.
Linefeed	yes: A linefeed is performed at the end. no: No linefeed is performed at the end (default).

< p >< /p >

Examples:

```
<p>Hello World</p>
<p Align="center">Hello World</p>
<p Linefeed="no">Hello World</p>
```

Prints the text at the current cursor position and does a linefeed afterwards.

Attribute	Description
Align	center: The text will be horizontally centered.
Linefeed	yes: A linefeed is performed at the end (default). no: No linefeed is performed at the end.

< Space/>

Example:

```
<t>Hello</t><Space/><t>World</t>
```

Prints a single space.

< Font >< /Font >

```
<Font Size="24"><t>Hello World</t></Font>
<Font Size="8" LineWidth="1.3"><p>abc</p><p>def</p></Font>
<Font Face="Helvetica"><t>Hello World</t></Font>
<Font Face="Helvetica-Bold"><t>Hello World</t></Font>
<Font Face="Symbol"><t>abg</t></Font>
```

Defines the appearance of the font

Attribute	Description
Size	Defines the font size. Default: 10
LineWidth	Defines the vertical space between the lines. Default: 1.0
Face	Defines the font to be used. Valid values are: Helvetica, Helvetica-Bold, Helvetica-Oblique, Helvetica-BoldOblique, Symbol, Courier, Courier-Bold, Courier-Oblique, Courier-BoldOblique, Times-Roman, Times-Bold, Times-Italic, Times-BoldItalic, ZapfDingbats. Default: Helvetica
Encoding	Defines the font encoding. Valid values are: WinAnsiEncoding, StandardEncoding, MacRomanEncoding, Symbol-Set, ZapfDingbats-Set. Default: WinAnsiEncoding

Command Reference: Text Layout

< MoveTo/ >

Examples:

```
<MoveTo x="30" y="14%" />
<MoveTo x="-170" />
<MoveTo dy="6" />
<MoveTo x="-34%" y="-4%" />
<MoveTo x="25%" />
<MoveTo y="48%" />
<MoveTo x="30" dy="24" Margin="left" />
```

Moves the virtual cursor to a position on the page.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
dx	Relative x-Position in points or in percent of the page width.
dy	Relative y-Position in points or in percent of the page height.
Margin	Sets the text margin. left: Moves to the specified position and sets this position to be the left text box margin. right: Moves to the specified position and sets this position to be the right text box margin.

< Box >< /Box >

Examples:

```
<Box Style="frame"><p>Hello World</p></Box>
<Box Style="overline"><p>Hello World</p></Box>
<Box Color="gray" Width="40%"><p>Hello World</p></Box>
<Box Color="toggle" Width="40%"><p>Hello World</p></Box>
<Box Color="toggle" Width="40%" Style="underline"><p>Hello World</p></Box>
```

Puts the commands between the tags into a box. The box boundaries can be marked with lines. The box background can have different colors.

The default width is given by the current x-position. In that case the right boundary is right page limit minus the current x-position. The vertical size is given by the current y-position when opening the box and the current y-position when closing the box.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
Width	The desired width of the box, either absolute or in percent.
Height	The desired height of the box, either absolute or in percent.
Style	frame: Draws a frame around the box. overline: Draws a line on the top side of the box. underline: Draws a line on the bottom side of the box.
Color	gray: Sets the background color to gray. white: Sets the background color to white. toggle: Toggles between gray and white.
Border	Defines the border size between the frame and the text. A value of 1.0 corresponds to a character height.

< TabClear/>;< TabSet/>;< TabNext/>;

Examples:

```
<TabClear />
<MoveTo x="0%" />
<TabSet />
<MoveTo x="25%" />
<TabSet />
<MoveTo x="37%" />
<TabSet />
<t>Hello</t><TabNext/><p>World</p>
```

`<TabClear/>`

clears the tabulator list.

`<TabSet/>`

stores the current position in the tabulator list.

`<TabNext/>`

Moves the current position to the next tabulator position.

< HLine/>

Examples:

```
<HLine/>
<p>Hello World</p>
<HLine/>
```

Draws a horizontal line at the current y position between the left and right text boundaries.

< PushPos/>;< PopPos/>

Examples:

```
<p>Hello</p>
<PushPos/>
<MoveTo x="-10%" y="-10%">
<DocParam Name="Today" />
<PopPos/>
<p>World</p>
```

`<PushPos/>`

Saves the current position on the position stack.

<PopPos/>

Recalls the current position from the position stack.

< PageBreak/>

Examples:

```
<PageBreak/>
<PageBreak Orientation="portrait" Paper="Letter" />
```

Begins a new page.

Attribute	Description
Orientation	tt portrait: Portrait format (default). tt landscape: Landscape format.
Paper	Defines the paper size. Valid values are: a4, a3, a5, legal, letter.

Command Reference: Placing Data from the Document

< DocParam/>

Examples:

```
<DocParam/>
<DocParam Name="PolNavVersion"/>
<DocParam Name="PolNavVersion" StopChar=","/>
<DocParam Name="WavelengthStartDesired" Format="%.3f"/>
<DocParam Name="SweepRateMain" Format="%.0f"/>
```

Retrieves property values from the current document and writes them using the specified format onto the page.

Without any attributes, the command prints a list of available properties and their values. If you define a tab position using `< TabSet/>`, the values will be horizontally aligned.

Usually, a property name is specified using the Name attribute. See Command Reference: Document Property Values on page 308 for a complete list of available properties.

Attribute	Description
Name	The name of the desired property.
Format	A C-style format string defining how the data will be formatted. An empty value indicates a string. %.3f Floating point value with 3 decimal digits. %.3g Floating point value with 3 significant decimal digits. Variable format. %d Integer value (signed). %u Integer value (unsigned).
StopChar	Defines a character which terminates the output. Only used with strings.

< DocParamLoadReg/>;< PrintReg/>

Example 1 (Print highest instead of 0):

```
<DocParamLoadReg Name="Resolution"/>
<Compare Operation="eq">0</Compare>
<If>
   <t>highest</t>
</If>
<Else>
   <DocParam Name="Resolution" Format="%.3f"/>
</Else>
```

Example 2 (Convert mW into dBm):

```
<DocParamLoadReg Name="Loss"/>
<Calc Operation="log10"/>
<Calc Operation="multiply">10</Calc>
<PrintReg Format="%.2f"/>
```

Simple computations can be performed using a global accumulator register.

`<DocParamLoadReg/>` loads a document property value into this accumulator register. Further computations or conditional formats can be implemented in this way (e.g. a conversion from mW into dBm).

The property name is specified using the Name attribute. See Command Reference: Document Property Values on page 308 for a complete list of available properties.

Attribute	Description
Name	The name of the desired property.

`<PrintReg/>` prints the current content of the accumulator.

Attribute	Description
Format	A C-style format string defining how the data will be formatted. An empty value indicates a string. %.3f Floating point value with 3 decimal digits. %.3g Floating point value with 3 significant decimal digits. Variable format. %d Integer value (signed). %u Integer value (unsigned).

< PageNo/>;< SetPageNo ></SetPageNo >

Example:

```
<SetPageNo>1</SetPageNo>
<t>This is page</t><Space><PageNo/>
```

`<SetPageNo>`

Sets the page counter to the specified value.

`<PageNo/>`

Prints the current page number.

< Filename/>

Example:

```
<t>Source file:</t><Space><Filename/>
```

Prints the current source file name.

Command Reference: Placing Images/Plots

< Image >< /Image >

Examples:

```
<Image x="0" y="0" Width="paper" Height="paper">Background.png</Image>
<Image x="0" y="0" Width="320" Height="200">Logo.jpg</Image>
```

Places a JPG or PNG image onto the page.

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
Width	The desired width of the box, either absolute or in percent. A value of paper scales the width to the paper width.
Height	The desired height of the box, either absolute or in percent. A value of paper scales the height to the paper height.
Scaling	The picture can be scaled using the `Scaling` attribute. Default: 1.0

< Plot >< /Plot >

Examples:

```
<Plot Width="512" Height="384">DGD</Plot>
<Plot Width="512" Height="384" Scaling="0.5">TE/TM</Plot>
```

Places plot data onto the page. The name of the plot appears between the Tags. Valid values are:

- PMD measurements (.pbin-files)
  `DGD, TE/TM, PDL, Power/Loss, SOPMD, Depol, PCD.`
- SOP measurements (.pbin-files)
  `Poincaré, Stokes (norm), DOP, Stokes, Power.`
- PMD measurements (.pmr-files)
  `DGD, MaxDGD, SOPMD2nd Order PMD, PCD, Depol., DOP, Loss.`
- CD measurements (.cd-files)
  `absolute D, relative D, RGD, Slope, D/Slope.`

Attribute	Description
x	x-Position in points or in percent of the page width. Negative value indicate positions relative to the right page border.
y	y-Position in points or in percent of the page height. Negative value indicate positions relative to the bottom page border.
Width	The desired width of the box, either absolute or in percent. A value of paper scales the width to the paper width.
Height	The desired height of the box, either absolute or in percent. A value of paper scales the height to the paper height.
Scaling	The picture can be scaled using the Scaling attribute. Default: 1.0

Command Reference: Placing Measurement Table Data

< DocPlot/ >;< IsLastRow/ >;< NextDocRow/ >;< ResetDocRow/ >

Examples:

```
<ResetDocRow />
<IsLastRow />
<Not />
<While>
    <DocPlot Name="Wavelength" Format="%.2f" />
    <NextDocRow />
    <IsLastRow />
    <Not />
</While>
```

The measurement plot data can be accessed using a row counter. The initial value of the row counter is 0.

`<ResetDocRow/>`

Resets the row counter.

`<NextDocRow/>`

Increments the row counter.

`<IsLastRow/>`

Checks if the row counter is beyond the last entry and sets the global accumulator register to TRUE (1) or FALSE (0) accordingly.

`<DocPlot/>`

Retrieves one data point and prints it as text into the document. The data point is identified by the plot name and the current row counter position.

Valid plot names are:

- PMD measurements (.pbin-files)
  `DGD, TE/TM, PDL, Power/Loss, SOPMD, Depol, PCD.`
- SOP measurements (.pbin-files)
  `Poincaré, Stokes (norm), DOP, Stokes, Power.`
- PMD measurements (.pmr-files)
  `DGD, MaxDGD, 2nd Order PMD, PCD, Depol., DOP, Loss, Wavelength.`
- CD measurements (.cd-files)
  `absolute D, relative D, RGD, Slope, D/Slope, Wavelength, Frequency, No., Pass/Fail.`

The attributes for the <DocPlot/> command are:

Attribute	Description
Name	The name of the plot data.
Format	A C-style format string defining how the data will be formatted. An empty value indicates a string. %.3f Floating point value with 3 decimal digits. %.3g Floating point value with 3 significant decimal digits. Variable format. %d Integer value (signed). %u Integer value (unsigned).

< DocPlotLoadReg/>

Example:

```
<DocPlotLoadReg Name="Pass/Fail" />
<If>
  <t>passed</t>
</If>
<Else>
  <t>failed</t>
</Else>
```

Loads the data point identified by the plot name and the current row counter position into the global accumulator register. Further evaluation or conditional commands can be processed afterwards.

Attribute	Description
Name	The name of the plot data. See < DocPlot/ >;< IsLastRow/ >;< NextDocRow/ >;< ResetDocRow/ > on page 302 for a list of valid plot names.

```
<NextDocRow/>
```

Command Reference: Conditional Structures

< If >< /If >;< Else >< /Else >

Example:

```
<IsEmpty Name="Location A" />
<Not />
<If>
   <t>Location A</t>
   <TabNext />
   <DocParam Name="Location A" />
   <p></p>
</If>
<Else>
   <p>No location defined.</p>
</Else>
```

The `<If>` command executes the commands placed between its tags if the content of the global accumulator register is non-zero (TRUE). The `<Else>` command immediately following the if clause will be executed if the global accumulator contained a zero value (FALSE).

< While >< /While >

Example 1:

```
<TabClear />
<MoveTo x="0" />
<TabSet />
<LoadReg>1</LoadReg>
<While MaxIterations="20">
   <MoveTo dx="60" />
   <TabSet />
   <LoadReg>1</LoadReg>
</While>
```

Example 2:

```
<ResetDocRow />
<IsLastRow />
<Not />
<While>
   <DocPlot Name="Wavelength" Format="%.2f" />
   <NextDocRow />
   <IsLastRow />
   <Not />
</While>
```

The while command allows the creation of simple loops. The while command decides according to the state of the global accumulator register whether the statement is to be executed or not. In this example, the accumulator is loaded with 1 (TRUE) causing the loop to be started. Note that at the end of the loop, the condition has to be updated manually. You can limit the number of iterations using the `Maxiterations` attribute.

Attribute	Description
MaxIterations	The maximum number of iterations of the loop.

< LoadReg >< /LoadReg >

Example:

```
<LoadReg>1.0</LoadReg>
<While MaxIterations="20">
   <MoveTo dx="60" />
   <TabSet />
</While>
```

Loads the global accumulator register with a constant.

< IsEmpty/ >

Example:

```
<IsEmpty Name="Location A" />
```

Checks if the document property value described by the Name attribute is empty (TRUE) or not (FALSE). The result is stored in the global accumulator register.

Attribute	Description
Name	Document property name. See Command Reference: Document Property Values on page 308 for a complete list of available properties.

< Not/ >

Example:

```
<IsEmpty Name="Location A" />
<Not/>
<If>
   <p>Variable contains something</p>
</If>
```

Inverts the logical state of the global accumulator register, i.e. turns TRUE (1) into FALSE (0) or vice versa.

< IsLastRow/ >

```
<ResetDocRow />
<IsLastRow />
<Not />
<While>
   <DocPlot Name="Wavelength" Format="%.2f" />
   <NextDocRow />
   <IsLastRow />
   <Not />
</While>
```

Checks if the current row counter is beyond the last measurement row. The result is stored in the global accumulator register.

< Compare/ >

Example:

```
<DocParamLoadReg Name="Resolution"/>
<Compare Operation="eq">0</Compare>
<If>
   <t>highest</t>
</If>
<Else>
   <DocParam Name="Resolution" Format="%.3f"/>
</Else>
```

Compares the current content of the global accumulator register with the value between the tags. Different compare operations can be selected by means of the `Operation`-tag. The result is stored in the global accumulator register.

Attribute	Description
Operation	Defines the compare operation. eq : equals ne : not equal le : less or equal lt : less than ge : greater or equal gt : greater than

< Calc/ >

Example:

```
<DocParamLoadReg Name="Loss"/>
<Calc Operation="log10"/>
<Calc Operation="multiply">10</Calc>
<PrintReg Format="%.2f"/>
```

Allows you to apply simple calculations on the global accumulator register. The `Operation` tag defines which calculation is to be performed.

Attribute	Description
Operation	Defines the operation. `multiply` : multiplies the accumulator with the value between the tags. `divide` : divides the accumulator by the value between the tags. `add` : adds the value between the tags to the accumulator. `sub` : subtracts the value between the tags from the accumulator. `log` : calculates the natural logarithm from the accumulator. `log10` : calculates the logarithm to the basis 10 from the accumulator. `pow` : let V be the value between the tags, then $V^{Accumulator}$ will be calculated.

Command Reference: Document Property Values

Predefined Properties

Property Name	Description
`Today`	The current time/date.
`DestFilename`	The name of the destination file.
`SourceFilename`	The name of the source file.
`TotalPages`	The total number of pages. Only valid if the CountPages entry in the Info block is set to "yes". Refer to <Info> Node on page 288 for details.

PMD Measurement (.pbin files)

Property Name	Description
`Date`	The date/time the measurement was taken.
`SNPolarimeter`	Serial number of the polarimeter.
`PolNavVersion`	Version of the Polarization Navigator.
`WavelengthStartDesired`	Start wavelength in nm.
`WavelengthStopDesired`	Stop wavelength in nm.
`SweepRateMain`	Sweep rate in nm/s.
`Resolution`	Resolution in nm.
`AutoResolution`	Resolution mode: 1=auto, 0=manual.
`UseLambdaLogging`	Lambda-Logging mode: 1=on, 0=off.
`PMD`	PMD Value in ps.
`AvrgPDL`	Average PDL in dB.
`Loss`	Average transmission coefficient. Either in linear scale or in mW depending on the measurement mode.

SOP Measurement (.pbin files)

Property Name	Description
`Date`	The date/time the measurement was taken.
`SNPolarimeter`	Serial number of the polarimeter.
`PolNavVersion`	Version of the Polarization Navigator.
`SamplingRate`	Sampling rate in kHz.
`Wavelength`	Start wavelength in nm.
`SweepRate`	Sweep rate in nm/s.
`PeakPower`	Peak power in mW.

PMD Measurement (.pmr-files)

Property Name	Description
`Date/Time`	The date/time of taking the measurement.
`Cable ID`	The cable ID.
`Fiber ID`	The fiber ID.
`Network Element`	The name of the network element.
`Problem ID`	The problem ID.
`Operator Name`	The operator name.
`Mainframe ID`	The product name of the mainframe.
`Mainframe SN`	The serial number of the mainframe.
`Mainframe Rev`	The revision number of the mainframe firmware.
`Module ID`	The product name of the measurement module.
`Module SN`	The serial number of the module.
`Module Rev`	The revision number of the module firmware.
`Tx ID`	The product name of the transmitter unit.

Property Name	Description
Tx SN	The serial number of the transmitter unit.
Tx Rev	The revision number of the transmitter firmware.
Tx Start Position [nm]	The start wavelength configured at the transmitter.
Tx StopPosition [nm]	The stop wavelength configured at the transmitter.
Tx StartPosition [THz]	The start frequency in THz configured at the transmitter.
Tx StopPosition [THz]	The stop frequency in THz configured at the transmitter.
Tx Output Power [dBm]	The output power in dBm configured at the transmitter.
Start Position [nm]	The start wavelength configured at the receiver.
Stop Position [nm]	The stop wavelength configured at the receiver.
Measurement Mode	The measurement mode. E.g. Single Sweep, Continuous, Averaging - Unlimited number of sweeps, Averaging - Number of Sweeps x.
MaxHold Mode	The state of the max-hold mode. E.g. "On" or "Off".
Fiber Length [km]	The fiber length.
PMD Value [ps]	The PMD value.
Peak DGD [ps]	The peak DGD value.
Peak DGD (MaxHold) [ps]	The peak DGD value of the max-hold trace.
PMD Coeff. [ps/sqrt(km)]	The PMD coefficient.
SOPMD (avg) [ps^2]	The average second-order PMD.
PCD (avg) [ps/nm]	The average polarization dependent chromatic dispersion.
Depol.Rate (avg) [ps^2]	The average depolarization rate.

Property Name	Description
`DOP (avg) [%]`	The average degree of polarization.
`Loss (avg) [dB]`	The average loss.
`Loss (max) [dB]`	The maximum loss.

CD Measurement (.cd-files)

Property Name	Description
Instr. Type	The instrument product name.
Instr. SerialNo	The instrument serial number.
Instr. FW-Rev	The revision number of the instrument firmware.
Module Type	The product name of the module.
Module SerialNo	The serial number of the module.
Module FW-Rev	The revision number of the module firmware.
Module Calibrated	The last calibration date of the module.
AbsDispMin [ps/nm]	Minimum absolute dispersion.
AbsDispMax [ps/nm]	Maximum absolute dispersion.
RelDispMin [ps/(nm*km)]	Minimum relative dispersion.
RelDispMax [ps/(nm*km)]	Maximum relative dispersion.
Timestamp	The date/time the measurement was taken.
FiberLength Mode	Values: auto or manual.
FiberLength [m]	The fiber length.
FiberType	The fiber type. Values: SSMF (G.652), DSF (G.653), NZDSF (G.655), NegDSF (G.655), Unknown, Mixed.
CurveFit	Values: 3 term Sellmeier, 4 term Sellmeier.
R2	The R2 value.
Lambda0 [nm]	The Lambda0 value.

Property Name	Description
S0 [ps/(nm2*km)	The S0 value.
D1550 [ps/(nm*km)	The D1550 value.
Comment Label0	Space for comments.
Comment Label1	Space for comments.
Comment Label2	Space for comments.
Comment Label3	Space for comments.
Comment Label4	Space for comments.

13 Specifications

This chapter contains instrument specifications.

KEYSIGHT TECHNOLOGIES

Specifications[1] N7781B/N7781BD Polarization Analyzer

Specification Wavelength Range	Opt 300, O-Band: 1270 nm to 1375 nm (Opt 400, O/C/L-Band): 1270 nm to 1375 nm, 1460 nm to1 620 nm (Opt 500, C/L-Band): 1460 nm to 1620 nm
Operating Wavelength Range [2]	1260 nm to 1640 nm
SOP Uncertainty (typ.) [3, 4]	1.5° on the Poincaré sphere
DOP Uncertainty [3]	±2.0%
DOP Uncertainty after User Calibration (typ.) [3, 5]	±0,5%
Maximum Sampling Rate	up to 1 MHz
Relative Power Uncertainty [3]	C/L-Band: ± 0.03 dB (± 0.02 dB typ.) O-Band: ±0.07 dB (± 0.04 dB typ.)
Input Power Range	-50 dBm to +7 dBm
Maximum Safe Optical Input Power	12 dBm

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

2 *SOP/DOP measurements are possible outside the specification wavelength range if a manual user calibration is performed.*

3 *Input power > -30 dBm*

4 *DOP > 95%*

5 *User calibration requires a source with DOP = 100%. User calibration is valid for a fixed wavelength.*

Specifications[1] N7782B PER Analyzer

Specification Wavelength Range	O-Band (Opt. 300): 1270 nm to 1375 nm O/C/L-Band (Opt. 400): 1270 nm to 1375 nm 1460 nm to 1620 nm C/L-Band (Opt. 500): 1460 nm to 1620 nm
Operating Wavelength Range [2]	1260 nm to 1640 nm
PER Range [3, 4]	0 to 50 dB
PER Uncertainty, Single-TCU Method [3, 4] (typ.)	PER= 0 dB to 30 dB: 0.30 dB PER=30 dB to 50 dB: 0.60 dB
Splice Angle Uncertainty, Dual-TCU Method [3, 4] (typ.)	± (0,1° + 4% x Angle)
Input Power Range	-50 dBm to +7 dBm
Relative Power Uncertainty [3]	C/L-Band: ± 0.03 dB (± 0.02 dB typ.) O-Band: ±0.07 dB (± 0.04 dB typ.)
Internal Laser Source Wavelength	O-Band (Opt. 401): 1290 nm to 1360 nm (1310 nm typ.) C-Band (Opt. 501/401): 1510 nm to 1580 nm (1550 nm typ.)
Internal Laser Source Output Power [5] (typ.)	O-Band (Opt. 401): -12 dBm C-Band (Opt. 501/401): -10 dBm

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

2 *PER measurements are possible outside the specification wavelength range if the user performs a manual calibration. Note that a fully polarized light source is needed for calibration.*

3 *Input power > -30 dBm*

4 *Narrow-band light source with DOP > 95% needed.*

5 *At room temperature.*

Specifications[1] N7782B-101 PER Analyzer (Discontinued)

Specification Wavelength Range [1, 2]	850 nm nominal
Operating Wavelength Range	830 nm to 1000 nm
PER Range [3, 4]	0 .. 40 dB
PER Uncertainty, Single-TCU Method [3, 4] (typ.)	PER= 0 dB to 30 dB: 0.30 dB PER= 30 dB to 40 dB: 0.60 dB
Splice Angle Uncertainty, Dual-TCU Method [3, 4] (typ.)	± (0,1% + 5% x Angle)
Input Power Range	-35 dBm to +10 dBm
Internal Laser Source Wavelength	830 nm to 880 nm, 850 nm typ.
Internal Laser Source Output Power [5](typ.)	-11 dBm

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

2 *The specification wavelength matches the wavelength of the internal laser source.*

PER measurements are possible outside the specification wavelength range if the user performs a manual calibration. Note that a fully polarized light source is needed for calibration.

3 *Input power > -20 dBm*

4 *Narrow-band light source with DOP > 95% needed.*

5 *At room temperature.*

Specifications[1] N7788B/N7788BD Optical Component Analyzer

Specification Wavelength Range	Opt 300, O-Band: 1270 nm to 1375 nm Opt 400, O/C/L-Band: 1270 nm to 1375 nm, 1460 nm to 1620 nm Opt 500, C/L-Band: 1460 nm to 1620 nm
Operating Wavelength Range [2]	1260 nm to 1640 nm
DGD Uncertainty [3]	Resolution 2,0 nm:±(30 fs+ 0,3%*DGD) Resolution 0,1 nm:±(30 fs+ 3,0%*DGD)
DGD Measurement Range [3]	0 to 1000 ps
PMD Uncertainty [4]	±(30 fs + 2.0%*PMD)
PMD Repeatability (typ.)	±3 fs
PMD Measurement Range [4]	0 to 300 ps
PDL Uncertainty [5]	C/L-Band: ±(0.05 dB + 4%*PDL) O-Band: ±(0.10 dB + 4%*PDL)
PDL Repeatability (typ.)	±5 mdB
Insertion Loss Uncertainty (typ.) [3]	C/L-Band: ±0.03 dB O-Band: ±0.07 dB
Insertion Loss Dynamic Range (typ.) [3]	> 41dB (for TLS power levels higher than -6 dBm, increase value accordingly)
Polarization Analysis	See N7781B/BD
Optical Power Measurement	See N7781B/BD
Polarization Control	See N7785B

1 *Ambient temperature change max. ± 0.5°C since normalization. Valid for 81600B Tunable Laser Source Family. Tunable laser power set to -6 dBm. Sweep over Specification Wavelength Range. Specification does not include instability in test device. Specified loss ranges include loss of test device and any additional switches or connections in the optical path. Specification valid on day of calibration.*

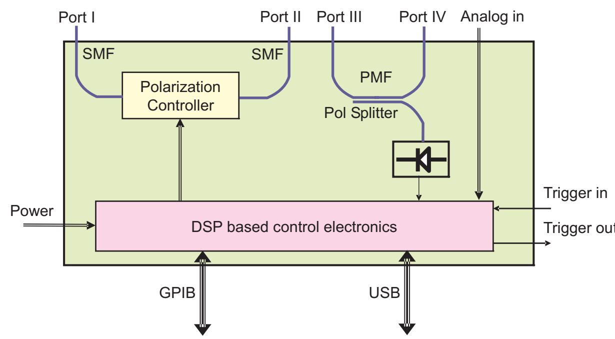
2 *SOP/DOP measurements outside the specification wavelength range are only possible if a manual user calibration is performed.*

3 *DUT properties: Insertion Loss < 30 dB, PDL < 1 dB, DGD < 150 ps. Specification is typical for DGD > 150 ps.*

4 DUT properties: Insertion Loss < 41 dB, PDL < 3 dB, PMD < 50 ps. Applies for highly mode-coupled devices such as single mode fibers. Specification applies for PMD being the averaged DGD over a wavelength span of 100 nm. Specification is typical for PMD > 50 ps.

5 DUT properties: Insertion Loss < 25 dB, PDL < 6 dB. Note: DUT connectors are considered part of the DUT. Thus, angled connectors will add to the device PDL.

Specifications[1] N7784B Polarization Controller



Operating Wavelength Range	1260 nm to 1640 nm
Wavelength Range in Stabilizer Mode [2]	1520 nm to 1580 nm
SOP Switching Time (open-loop)	< 10 µs
PER at PMF Output (typ.)	> 23 dB
Stabilizer Response Time (typ.) [3]	2 ms
Insertion Loss Port I to Port II [4]	< 3.5 dB (< 3.0 dB, typ.)
Insertion Loss Port III to Port IV [5]	< 1.8 dB (< 1.4 dB, typ.)
PDL Port I to Port II (typ.)	C/L-Band: < 0.2 dB O-Band: < 0.5 dB
Maximum Safe Input Power	Port I: 20 dBm Port III: 3 dBm
Input Power Range in Stabilizer Mode	Port III: -30 dBm to 0 dBm

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

2 *Outside the stabilizer wavelength range, the PER at PMF Output may be degraded.*

3 *Input power at Port III > -30 dBm, response to an immediate step of 180° on the Poincaré sphere.*

4 *For SOP scrambling/switching, only ports I/II are used.*

5 *Valid for optimum input polarization at PBS input (Port III). Add insertion loss of port I/II and III/IV to obtain total insertion loss for SOP stabilizing mode.*

Specifications[1] N7785B Synchronous Scrambler

Operating Wavelength Range	1260 nm to 1640 nm
SOP Switching Time	< 10 µs
Insertion Loss	< 3.5 dB (< 3.0 dB, typ.)
PDL (typ.)	C/L-Band: < 0.2 dB O-Band: < 0.5 dB
Maximum Safe Input Power	20 dBm

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

Specifications[1] N7786B Polarization Synthesizer

Specification Wavelength Range	Opt 400, O/C/L-Band: 1270 nm to 1375 nm,1460 nm to 1620 nm Opt 500, C/L-Band: 1460 nm to 1620 nm
Operating Wavelength Range [2]	1260 nm to 1640 nm
SOP Switching Time (non deterministic)	< 10 µs
SOP Cycling Time [3]	< 25 µs
Remaining SOP Error after deterministic SOP setting (typ.) [4]	< 3° at input SOP movement rate of 1.2 rad/s < 6.5° at input SOP movement rate of 40 rad/s
SOP Uncertainty (typ.) [5, 6]	1.5° on the Poincaré sphere
DOP Uncertainty [5]	±2,0%
DOP Uncertainty after User Calibration (typ.) [5, 7]	±0,5%
Relative Power Uncertainty [5]	C/L-Band: ± 0.14 dB (± 0.12 dB typ.) O-Band: ±0.16 dB (± 0.14 dB typ.)
Input Power Range	-38 dBm to +19 dBm
Insertion Loss	< 4.0 dB (< 3.5, typ.)
PDL (typ.)	C/L-Band: < 0.2 dB O-Band: < 0.5 dB
Maximum Safe Input Power	20 dBm

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

2 *SOP/DOP measurements are possible outside the specification wavelength range if a manual user calibration is performed.*

3 *The instrument adaptively finds the polarization controller settings to let the SOP cycle through user-defined polarization states (closed loop operation). After having found these settings, the SOP can cycle through the polarization states in open loop operation.*

4 *This value is defined to be 5 times the standard deviation of the angular SOP error on the Poincaré sphere. Valid if controller is turned on. Power at instrument input > -10 dBm.*

5 *Input power > -20 dBm*

The polarization analyzer readout reflects the SOP at the instrument output. Thus, effects caused by the internal polarization controller are included.

6 *DOP > 95%*

7 *User calibration requires a source with DOP = 100%. User calibration is valid for a fixed wavelength.*

Specifications[1] N7783B Thermal Cycling Unit

Minimum Peak-to-Peak Temperature Tuning Range (typ.) [2]	50 K
Ambient Temperature Range	20°C to 30°C

1 *Ambient temperature change max. ± 0.5°C since normalization. Specification valid on day of calibration.*

2 *Measured on the surface of the TEC elements.*

Definition of Terms

Specification

Specification describes a guaranteed product performance that is valid under the specified conditions. Specifications are based on a coverage factor1 of 2 (unless otherwise stated), corresponding to a level of confidence of >95%.

Typical Value

A characteristic describing the product performance that is usually met, but not guaranteed.

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.

NOTE For a system mounted in a rack the environmental conditions within the rack.

Specified Temperature

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

NOTE For a system mounted in a rack the environmental conditions within the rack.

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. If the wavelength is outside the specification wavelength range, the SOP/DOP performance can be improved by a user calibration. This calibration is done by applying the desired light source by means of a standard SMF. The calibration data is collected while the SMF is (manually) randomly moved.

NOTE DGD/PMD measurements outside the specification wavelength range are not supported.

Specification Wavelength Range

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

NOTE DGD/PMD measurements outside the specification wavelength range are not supported.

Relative Power Uncertainty

The relative power uncertainty is defined as the peak-to-peak variation of the measured power level when varying the polarization state (SOP).

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 connector interface.

Input Power Range in Stabilizer Mode

The input power range at Port III where specifications for stabilizer mode apply.

Gain (Loss, Insertion Loss)

Gain 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:

$$Gain[\mathrm{dB}] = 10\log\frac{P_b}{P_a} = P_b[\mathrm{dBm}] - P_a[\mathrm{dBm}]$$

Loss is calculated with the same formula as gain, but with opposite sign (in dB).

NOTE

The Polarization Navigator shows gain (rather than loss). That is, lossy test devices are shown with negative values.

Gain (loss) includes connector effects at normalization and at test device measurement.

In general, loss depends on wavelength and polarization state.

Insertion Loss Uncertainty

The insertion loss uncertainty is given by the doubled standard deviation of the insertion loss error at each given wavelength.

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.

NOTE Although the uncertainty unit is %, the deviation is not relative to the actual value. It is calculated $DOP_{measured}$-DOP_{actual}.

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) Uncertainty

Specifies the uncertainty of the measurement results for *differential group delay*, expressed as the sum of the absolute value of the DGD measurement error and its standard deviation at each given 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) Uncertainty

The PMD uncertainty is given by twice the standard deviation of the PMD error.

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:

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

PMD_i 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 rotational frequency, ω, expressed in [ps^2],

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

NOTE **Second-order PMD can be expressed in [ps/nm] at a wavelength of 1550 nm by multiplying the [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, ω, expressed in [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 rotational frequency change, ω, weighted with the DGD (expressed in [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 (gain)* of a device on the input polarization state, calculated as the difference between maximum and minimum loss (gain), usually expressed in dB.

Polarization Dependent Loss (PDL) Uncertainty

Specifies the uncertainty of the measurement results for *polarization dependent loss*, expressed as the doubled standard deviation of the PDL error at each given wavelength.

Conditions: Loss range as specified. DUT connectors are considered being part of the DUT. Thus, angled connectors will add to the device PDL.

Polarization Dependent Loss (PDL) Repeatability

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

$$2 \cdot StdDev\{PDL_i(\lambda)\}$$

$PDL_i(\lambda)$ denotes the PDL at any wavelength λ and StDev denotes the standard deviation over repetitions i.

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.

Wavelength Range in Stabilizer Mode

The wavelength range where specifications for stabilizer mode apply.

SOP Switching Time

The time needed to move to another SOP setting of the polarization controller in open loop mode.

SOP Cycling Time

The instrument adaptively finds the polarization controller settings to let the SOP cycle through user-defined polarization states (closed loop operation). After having found these settings, the SOP can cycle through the polarization states in open loop operation. The SOP cycling time is the time needed to move to the next SOP.

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.

One-Heater Method for PER-Measurement

The one-heater method for PER-measurement uses one thermal cycling unit (N7783B) to create temperature changes in a PMF. This allows to measure the PER of the light guided in the PMF.

Two-Heater Method for Splice Angle Measurement

The two-heater method for splice angle measurement uses two thermal cycling units (N7783B) to create temperature changes in two sections of PMF. This allows to measure the angular misalignment of the two PMFs at the connection point (typically a PMF splice or two misaligned connectors).

PER Range

Specifies the maximum PER level which can be measured using the one-heater method.

PER Uncertainty

This value is defined as being twice the standard deviation of the Polarization Extinction Ratio (PER) measurement error. It is given in dB.

Splice Angle Uncertainty

Is specified as twice the standard deviation of the splice angle error between two PMFs at a connection point (typically a PMF splice or two misaligned connectors).

Minimum Peak-to-Peak Temperature Tuning Range

The minimum temperature tuning range measured on the surface of the thermo electric coolers of the N7783B (Unit: Kelvin).

14 Reference

This chapter contains reference data.

Command Line Parameters

The following command line parameters are supported by the software:

Command Line Switch	Description
`/minimize`	The software will be minimized to the system tray on startup. This may be useful if the polarizationNAVIGATOR™ is only needed for remote control or as automation target.

Polarimeter Input Ranges

The following table shows the permitted input power ranges for all available gain settings. If the input power falls below the lower boundary measurement, results become noisy due to quantization. If the input power exceeds the upper boundary, errors may appear due to limits of the input amplifier. You can manually choose a specific gain setting by disabling the auto-gain function (i.e. TreeNo=3/VarNo=14 (Tree 3: Polarimeter on page 236) AutoGainFlag = 0).

Gain	Max. Input Power	Power Range
0	7 dBm	0dBm .. 7dBm
1	4 dBm	-3dBm .. 4dBm
2	0 dBm	-7dBm .. 0dBm
3	-3 dBm	-10dBm .. -3dBm
4	-6 dBm	-13dBm .. -6dBm
5	-10 dBm	-17dBm .. -10dBm
6	-13 dBm	-20dBm .. -13dBm
7	-16 dBm	-23dBm .. -16dBm
8	-20 dBm	-27dBm .. -20dBm
9	-23 dBm	-30dBm .. -23dBm
10	-26 dBm	-33dBm .. -26dBm
11	-30 dBm	-37dBm .. -30dBm
12	-33 dBm	-40dBm .. -33dBm
13	-36 dBm	-43dBm .. -36dBm

Error Codes

The following table lists all available error codes and their explanation:

Error Code (HEX)	Description
0x0000	No error
0x0003	Undefined function
0x0007	Memory allocation error
0x0008	Memory overflow error
0x000B	Variable type mismatch
0x0011	Generic error
0x0035	Unknown tree number
0x0036	Unknown variable
0x0037	Variable access violation
0x0038	Unknown variable type
0x0039	Parameter missing/Wrong number of parameters
0x0054	Health check error
0x0063	Target not found
0x0064	Unknown command
0x0065	Response buffer overflow
0x0067	Referencing error
0x0068	Resolution error
0x0400	Polcontroller generic error
0x0401	Polcontroller memory allocation error
0x0601	Polarimeter no calibration data
0x0602	Polarimeter calibration range
0x0603	Polarimeter measurement timeout
0x0604	Polarimeter measurement in progress

Error Code (HEX)	Description
0x0605	Polarimeter measurement sequence error
0x0609	Polarimeter measurement over range
0x060A	Polarimeter measurement under range

ASCII File Formats

SOP Data (Default)

Column 1:	Wavelength in nm
Column 2:	Time in s
Column 3:	DOP
Column 4:	S_0 in mW
Column 5:	S_1 in mW
Column 6:	S_2 in mW
Column 7:	S_3 in mW
Column 8:	Corresponding ADC Range (0..1)
Column 9:	s_1
Column 10:	s_2
Column 11:	s_3

PDL/PMD Data (Default)

Column 1:	Wavelength in nm
Column 2:	DGD in ps
Column 3:	PDL in dB
Column 4:	Power in mW or -Loss (linear scale)
Column 5:	TE (Power in one PDL axis)
Column 6:	TM (Power in other PDL axis)
Column 7:	s_1 of PDLPSP
Column 8:	s_2 of PDLPSP
Column 9:	s_3 of PDLPSP
Column 10:	s_1 of PSP

Column 11:	s_2 of PSP
Column 12:	s_3 of PSP
Column 13:	2nd-order PMD in ps^2
Column 14:	PCD in ps^2
Column 15:	Depolarization in ps^2

Mueller Data

Column 1:	M_{11}
Column 2:	M_{12}
Column 3:	M_{13}
Column 4:	M_{14}
Column 5:	M_{21}
Column 6:	M_{22}
.	
.	
.	

Jones Data

Column 1:	RE (J_{11})
Column 2:	RE (J_{12})
Column 3:	RE (J_{21})
Column 4:	RE (J_{22})
Column 5:	Im (J_{11})
Column 6:	Im (J_{12})
Column 7:	Im (J_{21})
Column 8:	Im (J_{22})

Jones Data + Lambda

Column 1:	Wavelength in nm
Column 2:	RE (J_{11})
Column 3:	RE (J_{12})
Column 4:	RE (J_{21})
Column 5:	RE (J_{22})
Column 6:	Im (J_{11})
Column 7:	Im (J_{12})
Column 8:	Im (J_{21})
Column 9:	Im (J_{22})

SOP Data

Column 1:	S_0 in mW
Column 2:	S_1 in mW
Column 3:	S_2 in mW
Column 4:	S_3 in mW

SOP Streaming Data

Column 1:	S_0 in mW
Column 2:	S_1 in mW
Column 3:	S_2 in mW
Column 4:	S_3 in mW
Column 5:	DOP

15 Troubleshooting

Symptoms and Solutions

Connection Expert displaying a warning icon next to an N778xB instrument connected to GPIB

Possible Reason	Solution
N778xB instruments return an IDN string that differs slightly from most other Keysight instruments, resulting in a warning icon next to the instrument.	You can safely ignore this warning.

Connection Expert not showing an N778xB instrument connected to USB

Possible Reason	Solution
By design N778xB instruments are not listed in the Connection Expert.	Use the Polarization Navigator or tools from the Photonic Application Suite for checking and adressing N778xB instruments.

Can't find any instrument connected to GPIB

Possible Reason	Solution
If you're using a GPIB interface connected to your PC and an N778xB instrument is connected to the GPIB bus and it is configured for Remote GPIB, communication on the GPIB bus doesn't work.	Power-cycle the N778xB instrument to set it back to default settings (Remote GPIB off). Refer to Using the N778xB/BD GPIB Interface (Remote GPIB) on page 59 for further details.

Can’t find individual instruments connected to GPIB

Possible Reason	Solution
By default all N778xB instruments are configured for GPIB address 30. If there are multiple instruments with the same GPIB address connected to the same GPIB bus, usually none of them is visible on the bus.	Either use a USB connection to change the N778xB instruments’ GPIB addresses or temporarily remove the instruments and connect single instruments to the bus subsequently. For each instrument, change the GPIB address appropriately. In both cases, use the PolarizationNavigator to change the GPIB address (refer to Changing the GPIB Address on page 60 for details).

Edition 7.1, October 2020
N7781-90001
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