QUANTIFI PHOTONICS®
A Teradyne Company

# DOPPLER

## SERIES

Modular Photonic Doppler Velocimetry

**MATRIQ User Manual**




quantifiphotonics.com

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# 1 What's in this user manual?

You can find the following information in this document:

| | |
|---|---|
| **Before you begin** | Conventions<br>Safety information<br>Working with optical fibers<br>System requirements |
| **Getting started** | Introducing the Doppler Series<br>Setting up hardware<br>Managing your product with Cohesion Operator<br>Instrument IP address |
| **Working with your device** | Doppler operation mode overview<br>Functional diagrams<br>**CohesionUI GUI:**<br>CohesionUI - Overview<br>Controlling your product with CohesionUI<br>**SCPI commands:**<br>Controlling your product with SCPI commands<br>Programming applications |
| **Maintenance** | Upgrade firmware<br>Restore factory settings |

## 2 Conventions

Please make yourself familiar with these conventions; we use them throughout this user manual:

**WARNING**

Indicates a potentially hazardous situation which, if not avoided, could result in **death or serious injury**.

Do not proceed unless the required conditions are met and understood.

**CAUTION**

Indicates a potentially hazardous situation which, if not avoided, may result in **minor or moderate injury** or **component damage**.

Do not proceed unless the required conditions are met and understood.

**NOTE**

Indicates relevant information that requires your attention.

# 3 Safety information

Carefully read all safety information before using your Quantifi Photonics product.

## 3.1 Optical laser radiation precautions

**WARNING**

To protect yourself from harm caused by optical radiation:

- Do not install or terminate fibers while the light source is active.
- Turn the Quantifi Photonics product OFF before inspecting the end face(s) of the product, or any optical patch cords connected to it.
- Never look directly into a live fiber; ensure that your eyes are protected at all times.
- Equip all unused ports with protective caps or blanking covers.

**CAUTION**

The use of controls, adjustments, and procedures other than those specified in this document may result in exposure to hazardous situations involving optical radiation.

## 3.2 Electromagnetic compatibility

**CAUTION**

For electromagnetic compatibility, this product is a Class A product. It is intended for use in an industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

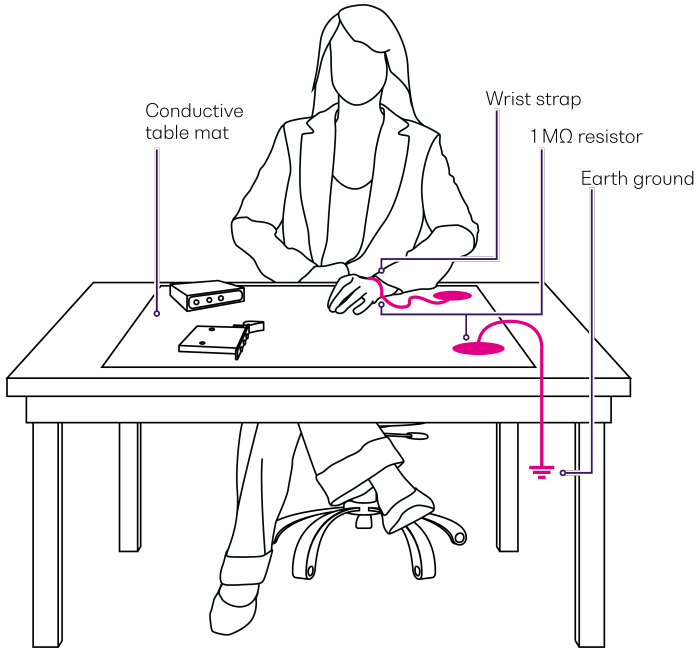

This symbol on the unit refers to documentation provided with the product for related safety information. Ensure that the required conditions are met and understood before using the product.

## 3.3 Electrostatic discharge precautions

**CAUTION**

The product is sensitive to electrostatic discharge (ESD). To ensure that you do not cause ESD damage to the product:

- Always follow proper grounding and ESD management practices.
- Store the unused product in the original protective electrostatic packaging that it was shipped in.
- Use a wrist strap and grounding table mat when unpacking or handling the product.



# 4 Introducing the Doppler Series

The Doppler is a reliable, fast, and high-density optical module designed specifically for Photonic Doppler Velocimetry applications. In a single product, the Doppler packs Variable Optical Attenuator, Power Meter and Optical circulator to enable high-density optical routing necessary for PDV systems.



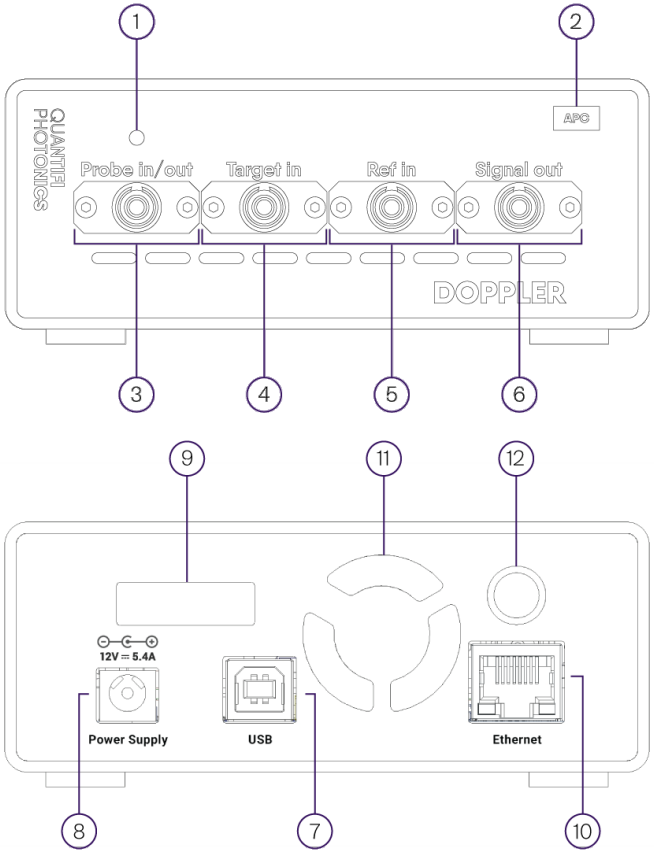

### Programming interfaces

Through its programming interfaces you can take advantage of the SCPI-compliant command language and choose from programming tools such as LabView, C++, Python, or any of the other popular programming languages used to control automatic test equipment (ATE).

### CohesionUI™

Quantifi Photonics' web-based graphical user interface CohesionUI is hosted on Microsoft Windows® and enables you to control your device from any supported web browser.

## 4.1 Hardware description




| | | | |
|---|---|---|---|
| 1 | Status LED | 7 | USB type B port |
| 2 | Optical connector type | 8 | Power supply port |
| 3 | Optical probe input/output port | 9 | IP address screen |
| 4 | Optical target input port | 10 | Ethernet port |
| 5 | Optical reference input port | 11 | Ventilation fan (DO NOT OBSTRUCT) |
| 6 | Optical signal output port | 12 | On / off push button |

## 4.2 Status LEDs

The LED shows the status of the channel:

| LED | Meaning |
|---|---|
| OFF | Product is powered OFF |
| solid RED | Indicates that there is an error during the initialization of the product. |
| flashing RED | Indicates that there is an error, and the product is busy. |
| solid GREEN | Indicates that the product is operational. |
| flashing GREEN | Indicates that initialization was successful, and the module is busy. |

## 4.3 Environmental conditions

Range of environmental conditions:

| | |
|---|---|
| Indoor or outdoor use | Indoor only |
| Altitude | Max. 2000m |
| Operating temperature range | 5°C to 40°C \| 41°F to 104°F |
| Storage temperature range | -40°C to 70°C \| -40°F to 158°F |
| Relative humidity range | 20% to 80% |
| DC voltage supply | 12V DC, 5.41A |
| Pollution degree | 2 |

# 5 Setting up hardware

Follow the instructions in this section when setting up your instrument.

**CAUTION**

The product is sensitive to electrostatic discharge (ESD). To prevent damage from ESD:

- Do not remove the product from the antistatic packaging until required to do so.
- Wear a grounded wrist strap at all times when handling the product.

**CAUTION**

Skin contact may leave corrosive residue and damage a connector:

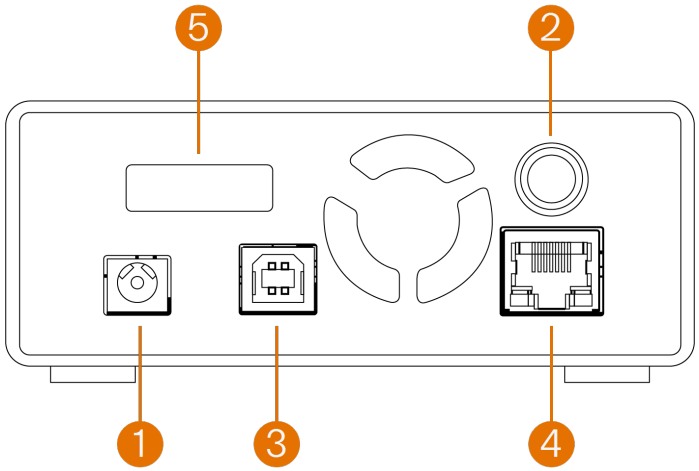
- Always clean optical end faces before mating.

**NOTE**

- You must use the external power supply that has been supplied by Quantifi Photonics with the unit. Any attempt to use a different external power supply may cause product damage and will void your warranty.
- The external power supply that has been supplied with the unit can only be used with that unit. Do not use it with any other product.
- DO NOT attempt to remove or adjust any component of the product while the power is on. Ensure the product is powered OFF, and that the correct handling procedure detailed herein is followed when you remove or install any products.
- Please check for the fiber end-face type of the optical ports, such as PC or APC, and only use the same type optical connector to avoid damaging the end-face.

For advice on connector and fiber care, please refer to Working with optical fibers.

## 5.1 Set up your DOPPLER and power ON




▶ To set up your instrument and power ON:

To allow for optimal air flow and avoid thermal issues, do not block the ventilation fans in the front and back of the instrument and set up your instrument with a minimum clearance of 2 inches (50.8mm) around it.

1. Insert the power cord - you must use the IEC cable supplied with the unit.
2. Power the instrument ON by pushing the ON button.
3. Connect to a client computer using a USB cable,

   **OR**
4. Connect to your network or client computer using an Ethernet cable.
5. The instrument IP address will appear on the LCD screen. When the unit is connected via both Ethernet and USB cable, both the Ethernet and USB IP addresses are displayed.

After powering ON, please wait at least **1 minute** before attempting to communicate with the unit. This gives the unit time to finish boot procedures and initialize the communication server.

## 5.2 Instrument IP address

To access your Quantifi Photonics instrument from a client computer, you need the IP address of the instrument.

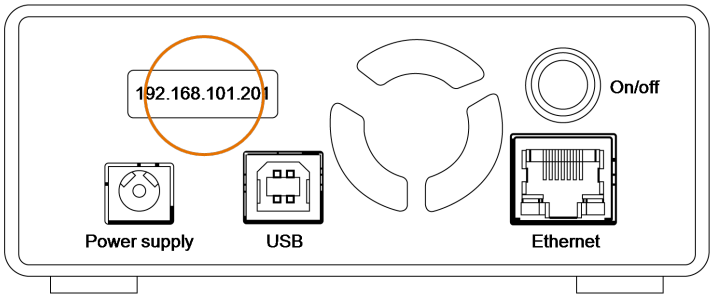
Your instrument can have two different IP addresses depending on your chosen connection method (USB or Ethernet):

- The default **USB IP address** is **192.168.101.201**. This is a static address set during instrument calibration.
- The default **Ethernet IP address** is dynamically assigned by the DHCP.

### ▶ To view an instrument's IP address:

With your instrument powered ON, you can view the current IP address on the LCD display.

If your instrument is connected with both, Ethernet and USB cables, both the USB and Ethernet IP address are displayed.




### ▶ To change an instrument's IP address:

You can change the instrument's static USB IP address and you can assign a static Ethernet IP address using CohesionUI.

**Multi-instrument control**

If you have several Quantifi Photonics instruments with static IP addresses on your network, make sure to assign a unique IP address to each instrument before connecting.

For details, refer to Change the instrument IP address.

# 6 Managing your product with Cohesion Operator

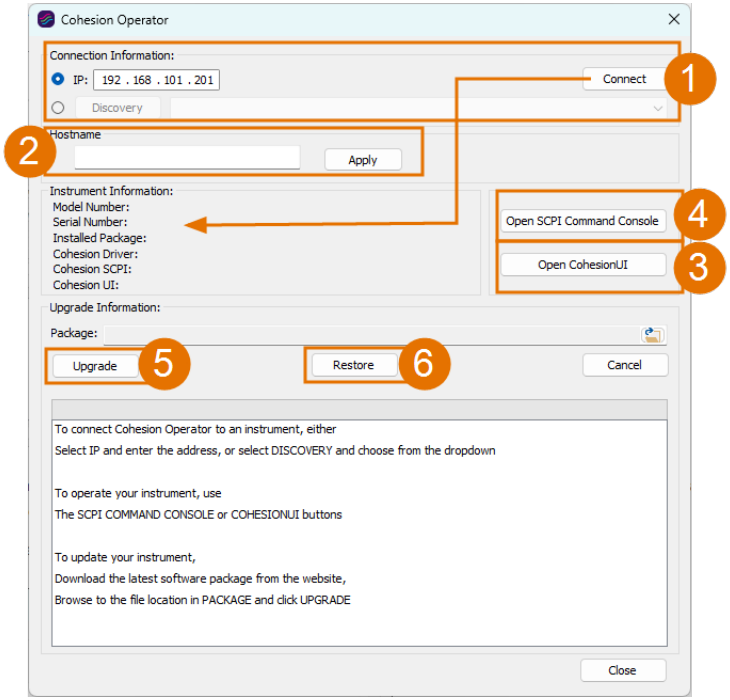
(Cohesion Operator 3.2.6)

To work with Quantifi Photonics instruments, you need to install the latest version of the **Cohesion Operator** software package on any computer that you use to connect with your instrument (client computer).

The software package is included on the USB media device that we provide with your instrument, or you can download it from quantifiphotonics.com (go to Resources > Drivers, software and manuals > MATRIQ Series).

Cohesion Operator enables you to:

1. **Connect** with instruments that are available on your network to retrieve instrument information and validate the instrument's IP address.
2. View and modify the **hostname** of the instrument.
3. Access an instrument using **CohesionUI**, a web-based graphical user interface.
4. Work with an instrument using the **SCPI Command Console**.
5. Upgrade instrument **firmware**.
6. Restore an instrument to **factory settings**.



**Static vs dynamic IP address**

Use one of the following methods to connect Cohesion Operator to the instrument:

- **Static IP Address** (recommended, USB cable required)

  Connect using the instrument's static IP address as shown on the instrument screen (for example, **192.168.101.201**). A USB cable is typically required for the initial connection.

- **Dynamic IP Address** (USB cable not required)

  Connect using a dynamic IP address.To enable automatic IP detection, ensure the computer running Cohesion Operator has at least one IP address on the same subnet as the instrument. For example, if the instrument IP address is **10.198.177.xxx**, the computer must also have an IP address in the **10.198.177.xxx** subnet.

  This allows Cohesion Operator to automatically detect IP address changes after an instrument reboot and maintain communication.

## 6.1 Install the Cohesion Operator software package

▶ To install the software package on a client computer:

1. (recommended) Save your work and close all programs.
2. Download the Cohesion Operator software package from the website, or insert the **USB media device** that includes the software package in the computer.
3. Double-click **CohesionOperator-<version>.exe** and follow the prompts.

   A Windows Security Alert may prompt you to allow network access. We recommend that you allow access to both, private and public networks, to enable any network configuration.

   The installation wizard will install required drivers, applications, and desktop icons on the computer.

**Multi-instrument control**

If another Quantifi Photonics instrument is already connected to the client computer via USB, make sure each instrument has a unique USB IP address to avoid any addressing conflicts.

▶ To open the Cohesion Operator application:

- Double-click the **Cohesion Operator** desktop icon or open **Cohesion Operator** from the Start menu.

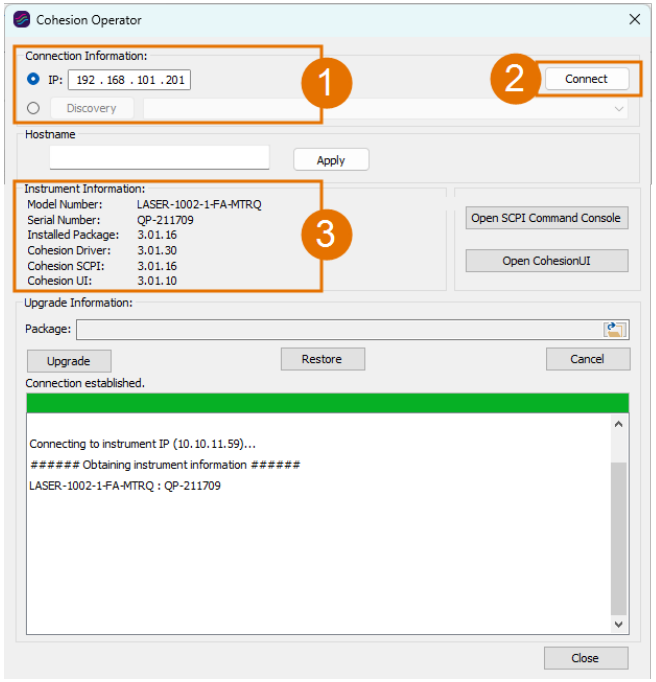
## 6.2 Connect with an instrument and retrieve instrument information

Using Cohesion Operator, you can check the firmware version and other details of Quantifi Photonics instruments that are available on your network.

▶ To check details in Cohesion Operator:

1. Select the instrument.
2. Click **Connect**.
3. Current instrument information will be displayed.

   **Installed Package** refers to the currently loaded firmware version.



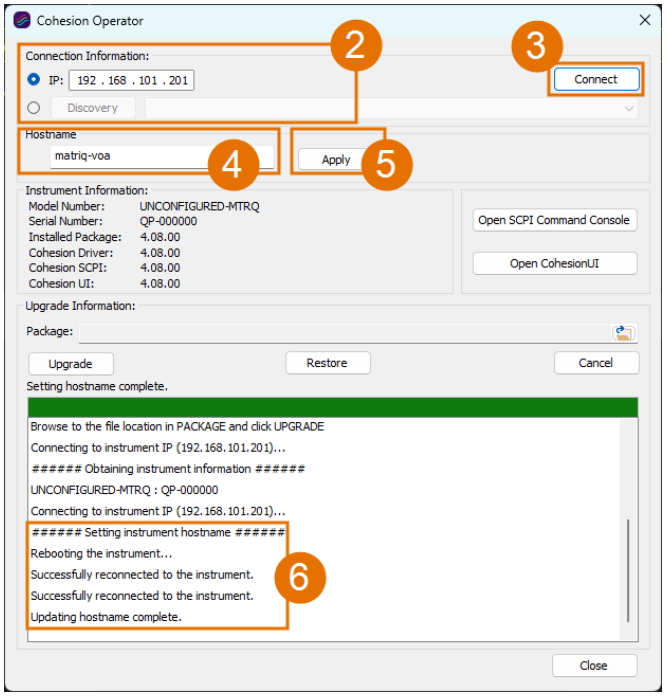
## 6.3 Set a hostname

Using Cohesion Operator, you can view and modify the hostnames of connected instruments.

> We recommend that you assign a hostname via a USB connection to prevent possible connection loss when using an Ethernet connection.

▶ To assign a hostname:

1. Open the Cohesion Operator, for example by double-clicking the **Cohesion Operator** desktop icon.



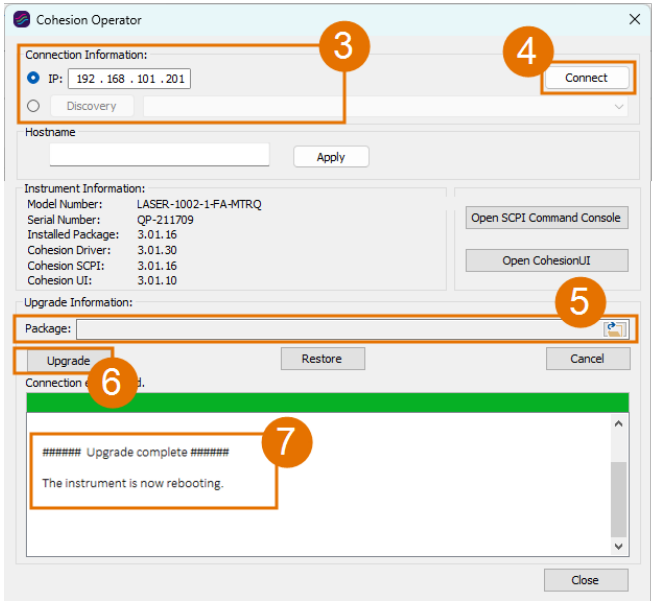

2. Select the instrument by entering its **IP address** or by selecting it from the **Discovery** drop down list.
3. To confirm that you have selected the correct instrument, click **Connect**. This will retrieve instrument information.
4. Enter a hostname.
5. Click **Apply**. Cohesion Operator will assign the hostname to the instrument. This can take a few minutes and the instrument might reboot several times in the process.
6. A message shows when setting the hostname was successful.

## 6.4 Upgrade firmware

We recommend that you upgrade firmware via a USB connection to prevent possible connection loss when using an Ethernet connection.

▶ To upgrade an instrument with the latest firmware:

1. Get the latest MATRIQ firmware package **CohesionMATRIQ-<version>.qfw**, for example by downloading it from quantifiphotonics.com (go to **Resources > Drivers, software and manuals > MATRIQ Series**), and save it to your network.
2. Open the Cohesion Operator, for example by double-clicking the **Cohesion Operator** desktop icon.




3. Select the instrument by entering its **IP address** or by selecting it from the **Discovery** drop down list.
4. To confirm that you have selected the correct instrument, click **Connect**.
   This will retrieve instrument information, with **Installed Package** showing the current firmware version.
5. In **Package**, click the Browse button, navigate to the previously downloaded firmware package and select it.
6. Click **Upgrade**. The instrument will be upgraded to the selected firmware package. This can take a few minutes and the instrument might reboot several times in the process.
7. A message shows when the upgrade is complete.

To verify the new firmware version, click **Connect** (4) to retrieve the latest instrument information.

**NOTE**

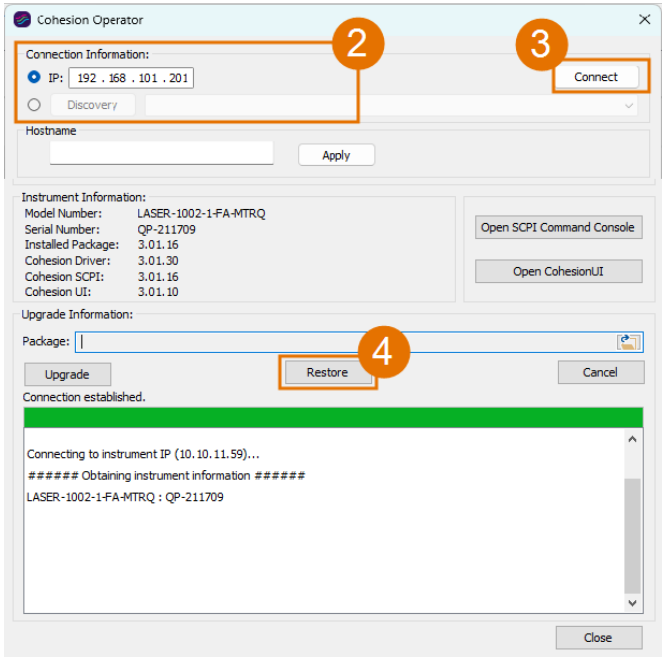
If an upgrade attempt is unsuccessful, the Cohesion Operator will stop the upgrade process and restore the instrument to its previous firmware version. Messages will be displayed accordingly.

## 6.5 Restore factory settings

We recommend that you restore factory settings via a USB connection to prevent possible connection loss when using an Ethernet connection.

▶ To restore factory settings:

1. Open the Cohesion Operator, for example by double-clicking the **Cohesion Operator** desktop icon.




2. Select the instrument by entering its **IP address** or by selecting it from the **Discovery** drop down list.
3. To confirm that you have selected the correct instrument, click **Connect**.
   This will retrieve instrument information, with **Installed Package** showing the current firmware version.
4. Click **Restore**.
   The instrument will be returned to factory settings, including IP address settings.

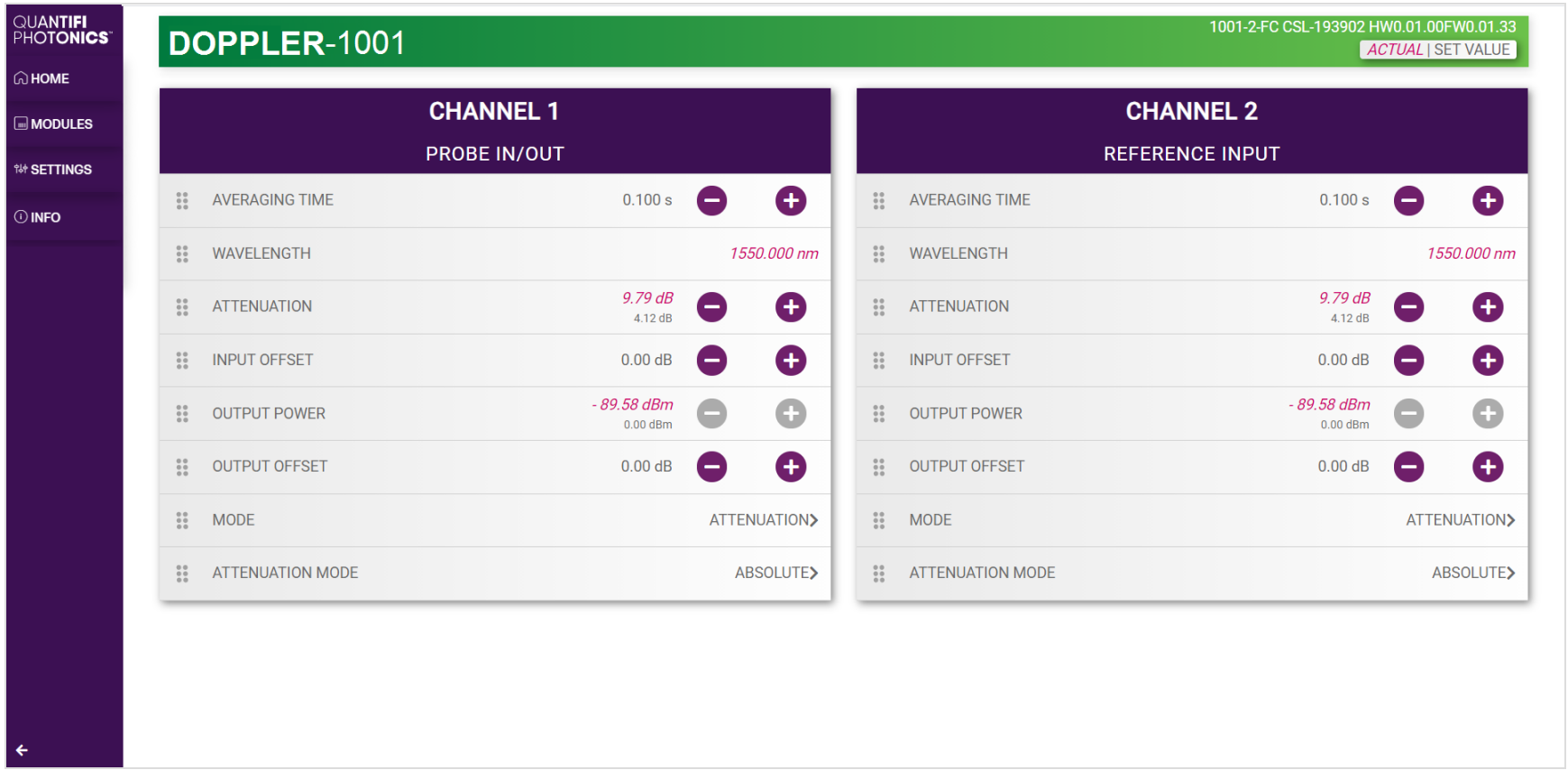
# 7 CohesionUI - Overview

CohesionUI is a web-based graphical interface that you can use to work with your Quantifi Photonics product.

> CohesionUI is part of the MATRIQ firmware package running on your Quantifi Photonics instrument.

From the menu on the left you can navigate to the following pages:

1. **HOME**: This is your main page. From here you can access all controls for your instrument
2. **SETTINGS**: Here you can change CohesionUI settings and/or instrument IP address
3. **INFO**: Here you can display instrument information, e.g. model number and firmware version



## 7.1 Access instruments with CohesionUI

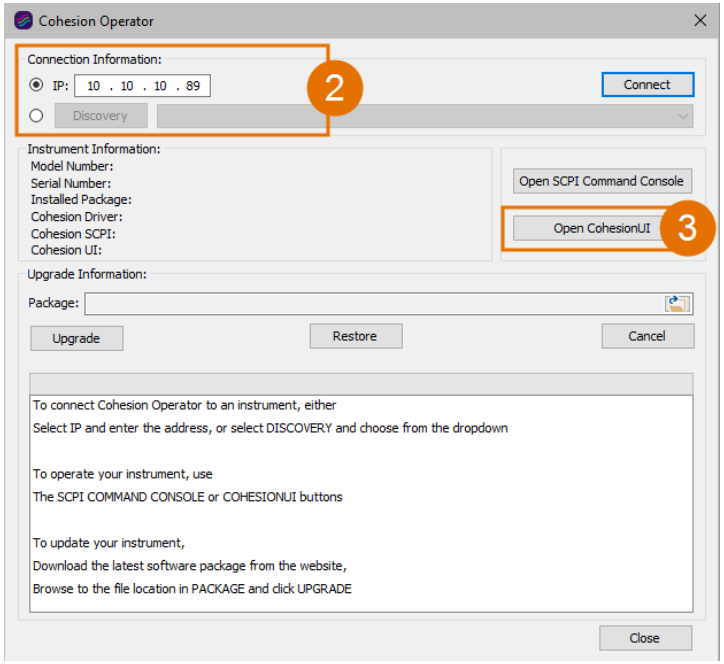
You can open CohesionUI for Quantifi Photonics MATRIQ and EPIQ instruments:

- from Cohesion Operator, or
- in a supported browser by entering the instrument IP in the address bar.

To open CohesionUI, you need the IP address of the instrument. For details, refer to the Instrument IP address section.

▶ To open CohesionUI from Cohesion Operator:

1. Open **Cohesion Operator** on a client computer, for example by double-clicking the Cohesion Operator desktop icon
2. Select the instrument by entering its **IP address** or by selecting it from the **Discovery** dropdown.
3. Click **Open CohesionUI**.
   CohesionUI will open in your standard browser.



To open CohesionUI in a browser:

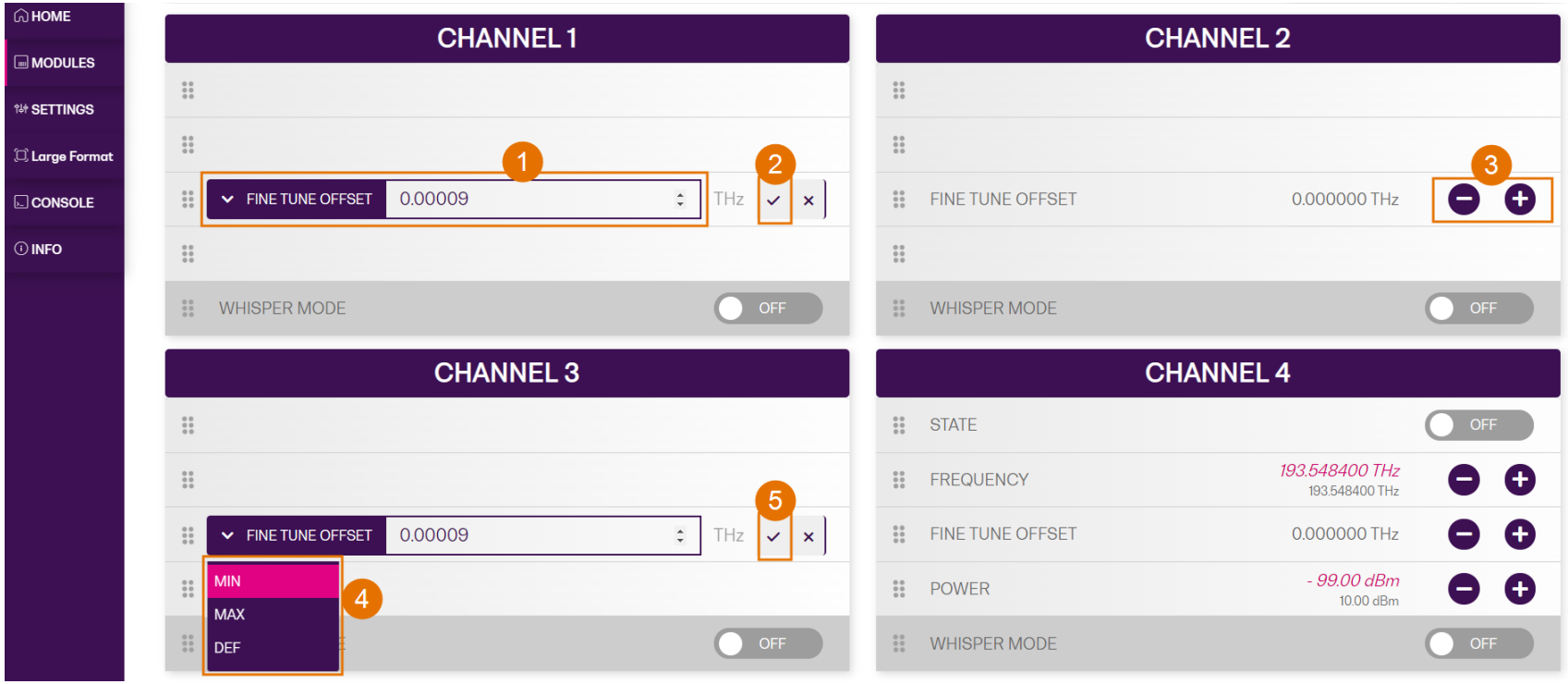
1. Launch a supported **browser**.
2. Enter the instrument **IP address** in the address bar.
   CohesionUI will launch in the browser.



## 7.2 Set values

In CohesionUI you can set values for parameters where applicable.

- To set a value:
  1. Click on a parameter and enter a value.
  2. Confirm the value.
  3. Alternatively, you can use + and - to increase or decrease the value. You can edit the step size in the **SETTINGS** menu.
- To set a pre-defined value, for example **MIN**, **MAX** or **DEF**:
  4. Click on a parameter and select a value from the dropdown menu.
  5. Confirm the value.

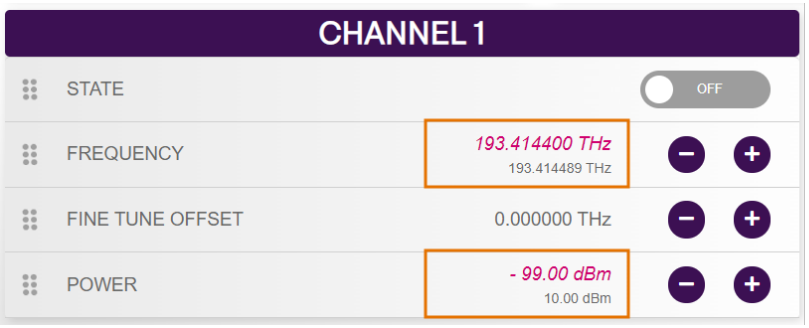



For details on how to change the step size, refer to Manage CohesionUI settings.

## 7.3 SET values and ACTUAL values

In some cases you can manually set a value that will be displayed alongside the actual value as follows:

- ***ACTUAL***: The actual value of the parameter as queried by the product.
- SET: The intended value of a given parameter as set by the user.



## 7.4 Manage CohesionUI settings

On the **SETTINGS** page you can configure CohesionUI settings and unit preferences.

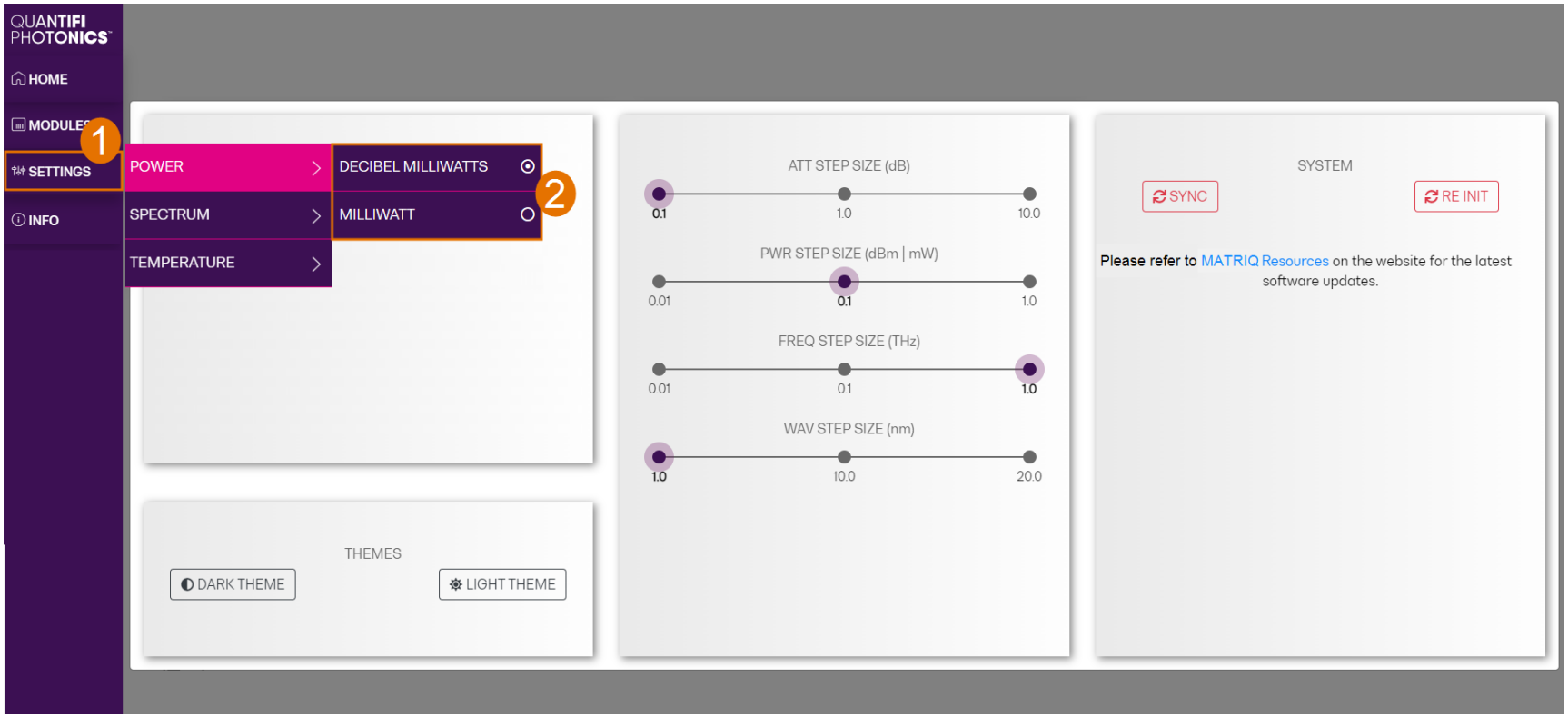
▶ To view all settings and unit preferences and adjust as required:

1. Click **SETTINGS**.
2. Change settings or unit preferences as required, for example temperature units.
   Please note that the units displayed on this page are not always relevant for each product.
3. **Step size** refers to the amount by which a value is increased or decreased when clicking the **+** or **-** button.



To adjust unit preferences one at a time:

1. Hover over **SETTINGS**.
2. Select a unit from the dropdown, for example the power unit.



## 7.5 Change the instrument IP address

Your instrument can have two different IP addresses depending on your chosen connection method (USB or Ethernet):

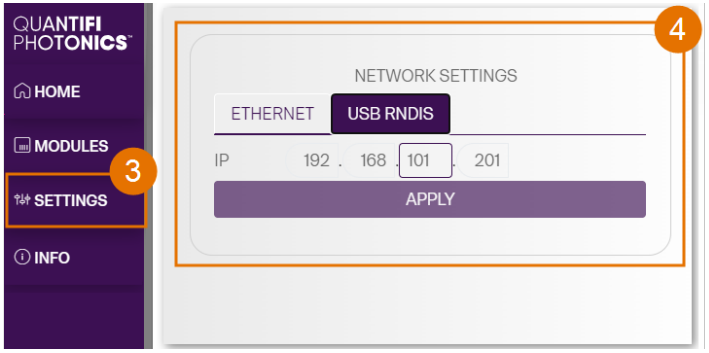
- The default **USB IP address** is **192.168.101.201**. This is a static address set during instrument calibration.
- The default **Ethernet IP address** is dynamically assigned by the DHCP.

You can change the instrument's static USB IP address, and assign a static Ethernet IP address if required.

> **Multi-instrument control**
>
> If you have several Quantifi Photonics instruments with static IP addresses on your network, make sure to assign a unique IP address to each instrument before connecting.

▶ To change the **USB IP address**:

1. Connect with the instrument from a client computer via USB. Ensure that this is the only Quantifi Photonics instrument currently connected via USB.
2. Open CohesionUI using the currently assigned USB IP address.
3. Go to **SETTINGS**.
4. In **NETWORK SETTINGS > USB RNDIS** tab:
   - The currently assigned IP address is displayed. Enter the new IP address by changing the **3rd octet** of the IP address.
     To avoid any addressing conflicts, make sure that this is a unique IP address that is not shared with any other instrument on the network.
   - Click **APPLY**. The new IP address will show in CohesionUI and on the display.



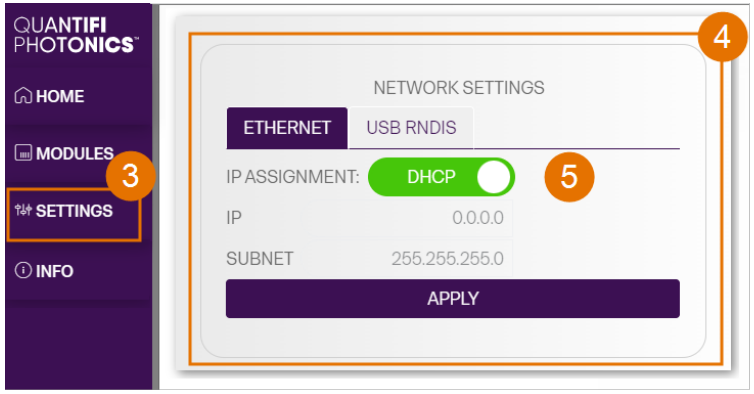
To change the **Ethernet IP address**:

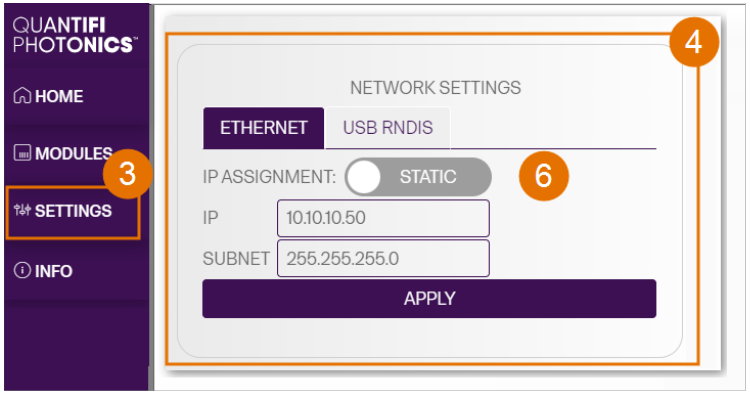
1. Connect with the instrument from a client computer via USB. Ensure that this the only Quantifi Photonics instrument currently connected via USB.
2. Open CohesionUI using the currently assigned USB IP address.
3. Go to **SETTINGS**.
4. In **NETWORK SETTINGS > ETHERNET** tab:
5. Toggle **IP ASSIGNMENT** to **DHCP** to enable the DHCP to automatically assign the Ethernet IP address (this is the default setting) and click **APPLY**.

   OR

6. Toggle **IP ASSIGNMENT** to **STATIC** to assign a static Ethernet IP address.
   Enter the new **IP address** and **SUBNET mask** and click **APPLY**.
   To avoid any addressing conflicts, make sure that this is a unique IP address that is not shared with any other instruments on the network.

   The new IP address will show in CohesionUI and on the display.



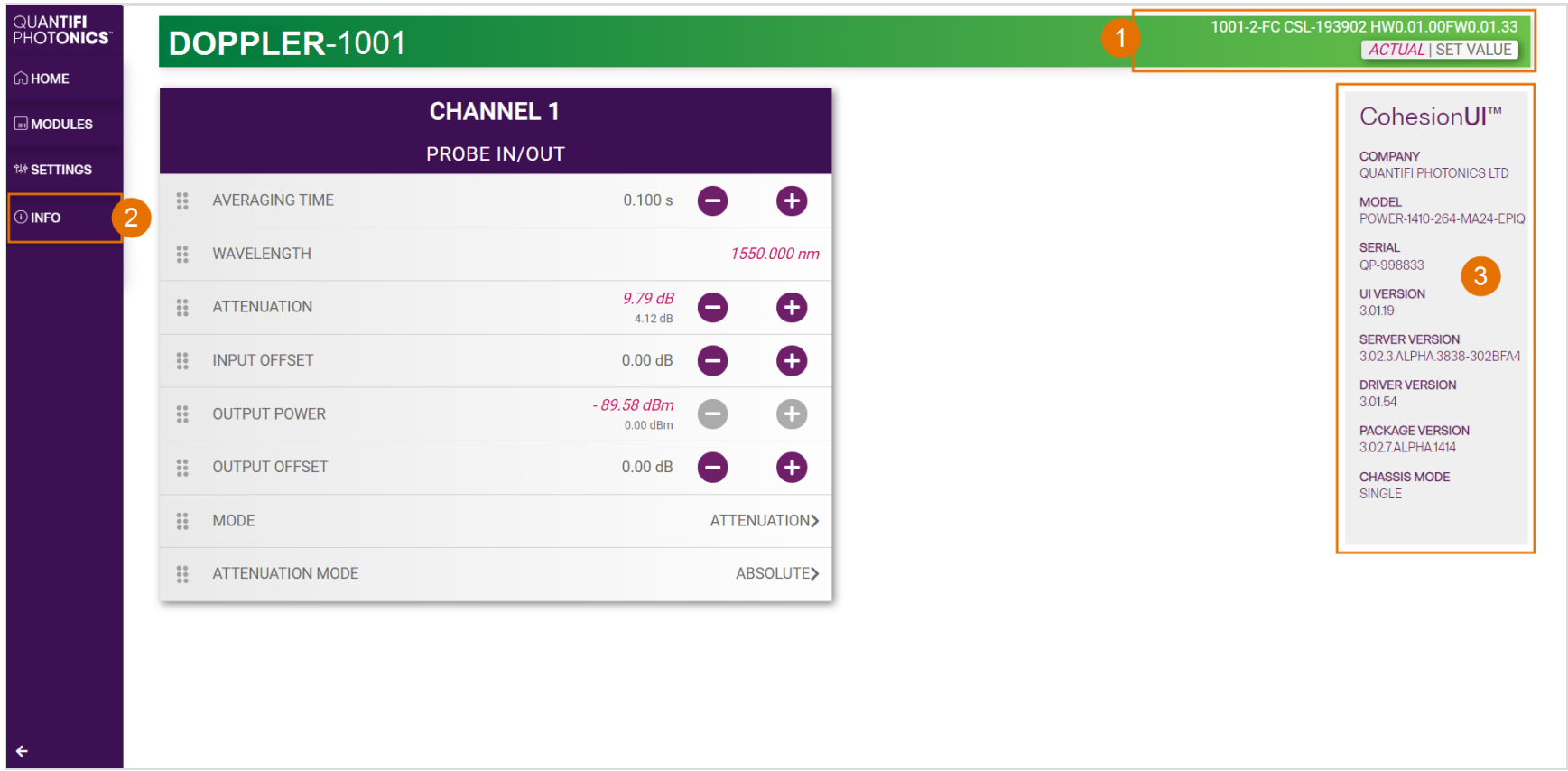



## 7.6 View system information

You can easily access instrument information, for example the model number and firmware version.

- To display instrument information in CohesionUI:

1. Refer to the top right corner in CohesionUI.
2. For more details, click **INFO** to display the information panel.
3. The information panel lists the instrument's serial number, and software and firmware versions.



# 8 Controlling your product with CohesionUI

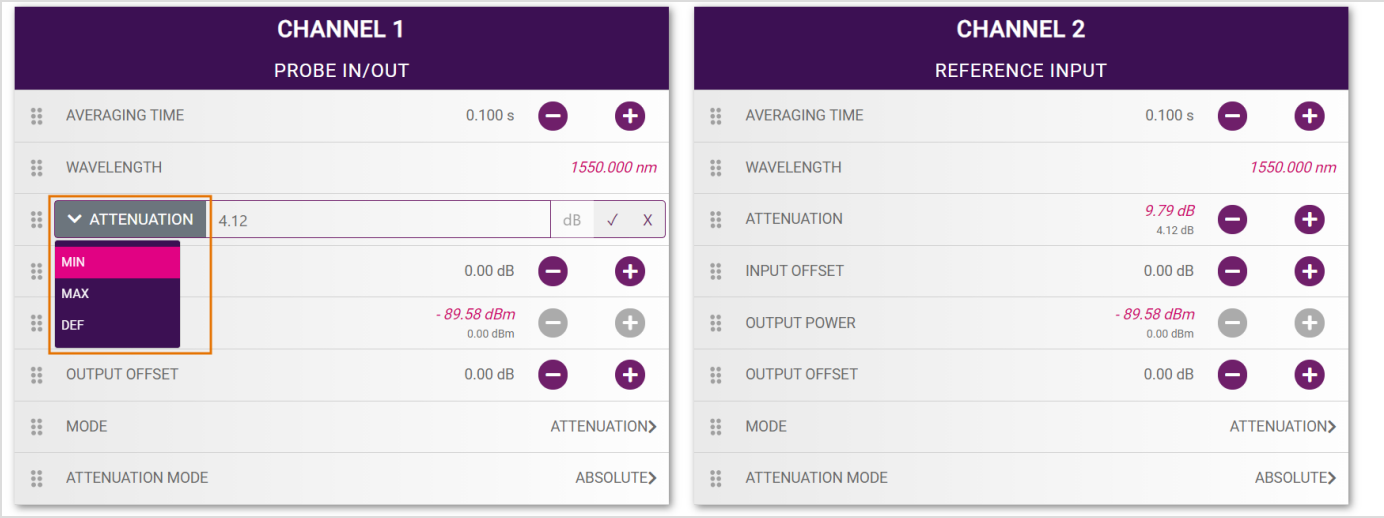
You can use Quantifi Photonics' graphical user interface CohesionUI to work with your module. For details on how to get started with CohesionUI, refer to CohesionUI - Overview.

## 8.1 Setting channel parameter values

Specific control parameters for a given channel in the product can be set by clicking the parameter button, or by using the **+** and **–** control buttons to increase or decrease the value field by a set amount. This step size is set in the **SETTINGS** menu. Alternatively, the parameter can also be set to the **MIN** and **MAX** value by clicking the dropdown in the name of the parameter.

This applies to the following parameters:

| | |
|---|---|
| **AVERAGING TIME** | The amount of time the optical power is logged for before calculating an average power reading. |
| **WAVELENGTH** | The wavelength (frequency) of the input light. This is used to set the correct responsivity for calculating optical input power. |
| **ATTENUATION** | In **ATTENUATION** control mode, set the desired attenuation. In **POWER** control mode, the current attenuation is displayed. |
| **INPUT OFFSET** | If desired, enter the amount of fixed external attenuation which you wish to include as part of the Doppler attenuation. |
| **OUTPUT OFFSET** | If desired, enter the amount of fixed external attenuation which you wish to include as part of the Doppler attenuation. |
| **OUTPUT POWER** | In **POWER** control mode, set the output power. In **ATTENUATION** control mode, the measured output power is displayed. |

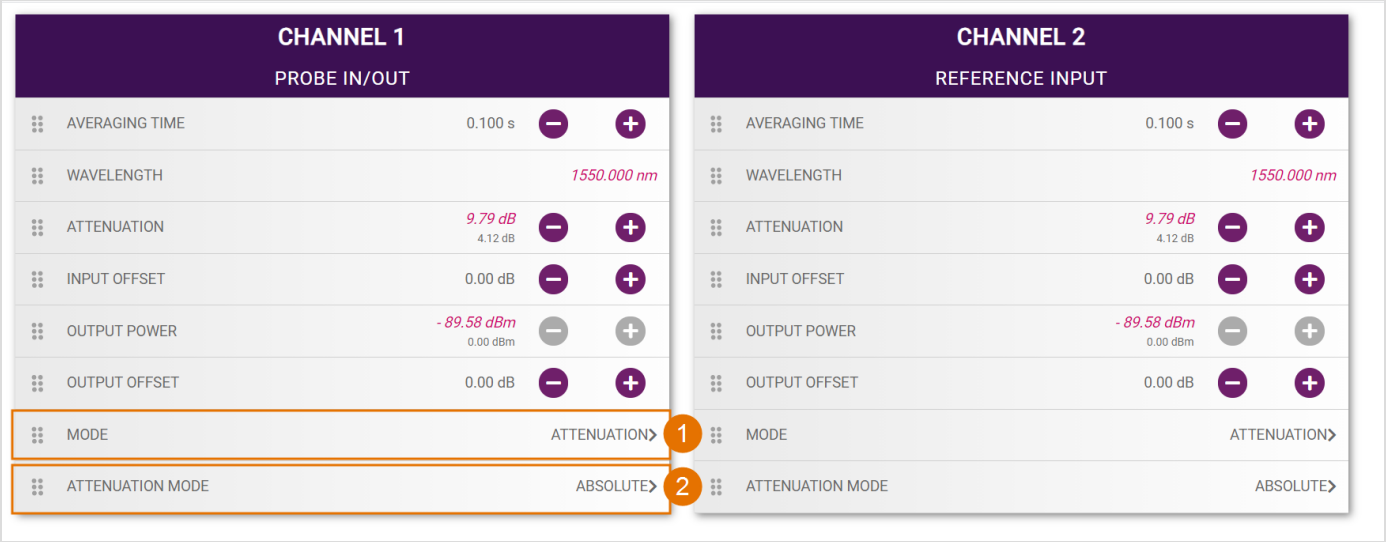



In the above example, the **ATTENUATION** for CHANNEL 1 has been set to **4.12 dB** by manual input. To apply the change, click the tick mark.

## 8.2 Setting channel control mode

The Doppler can operate in **POWER** control mode or **ATTENUATION** control mode. See Doppler operation mode overview for more information.

1. Select the control mode: **ATTENUATION** or **POWER**.
2. In **ATTENUATION** control mode, select an available option: **OFFSET**, **ABSOLUTE** (default) or **RELATIVE**.



# 9 Doppler operation mode overview

The Doppler product enables to operate in two control modes: **ATTENUATION** control mode and **POWER** control mode:

- **ATTENUATION** control mode: The Doppler maintains the set attenuation value by applying a constant amount of attenuation to the input optical signal. There are three sub-modes available in **ATTENUATION** control mode: **ABSOLUTE**, **RELATIVE** and **OFFSET** (see Attenuation mode).
- **POWER** control mode: The Doppler maintains the set output power value by applying an automatically calculated amount of attenuation to the input optical signal. **POWER** control mode can be used with / without specifying **OFFSETS** (see Power mode).

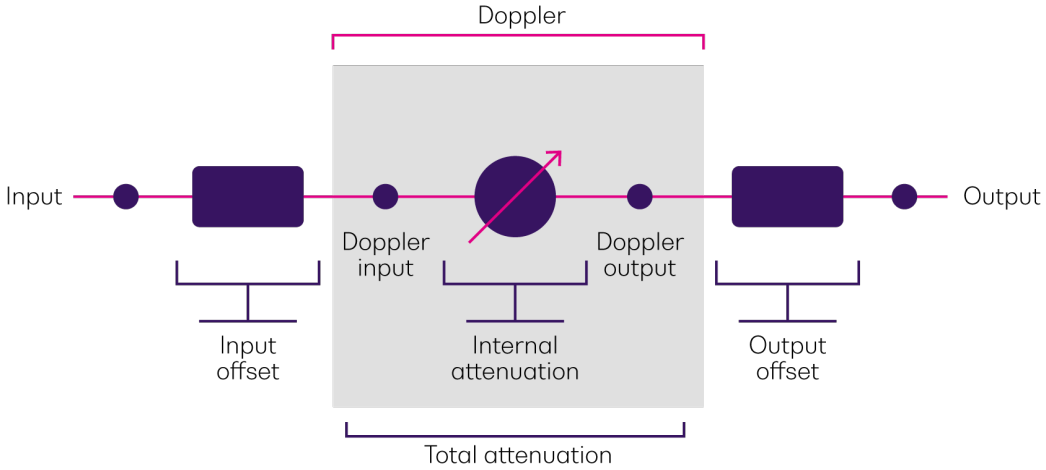
## 9.1 Functional diagram - no offset

The Doppler comprises an Internal Attenuator along with input and output offsets.

The functional diagram below illustrates the operation of the Doppler product in the following modes:

- ABSOLUTE ATTENUATION mode
- RELATIVE ATTENUATION mode
- POWER control mode with NO OFFSETS

**No offsets specified:**




If some input and / or output offsets are specified, the VOA works as described in Functional diagrams - offset.

## 9.2 Functional diagrams - offset

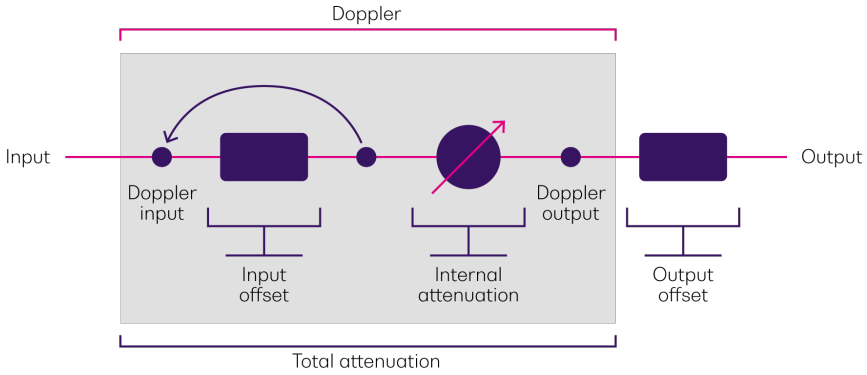
The Doppler accounts for any given input or output offsets when operating in the following modes:

- OFFSET ATTENUATION mode
- POWER OFFSET mode

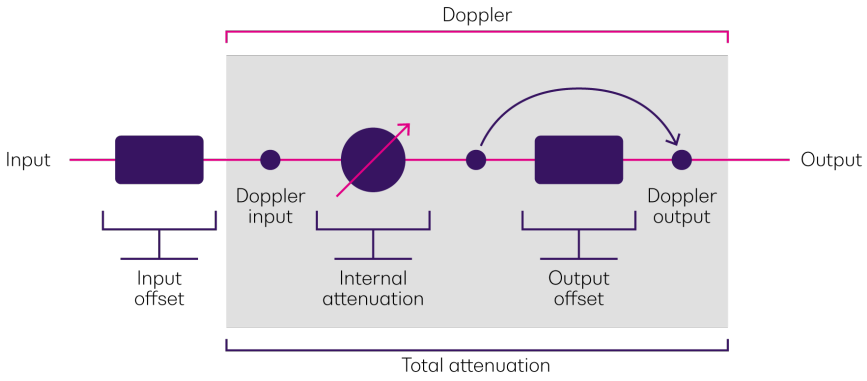
In a test setup, this operation mode is useful if there are test components that must be accounted for before or after the Doppler product. For example, splitters, amplifiers, optical stub attenuators, or fiber coils. Because of this offset inclusion, the Doppler automatically adjusts any set parameters.

The functional diagrams below illustrate how the Doppler accounts for input and/or output offsets:

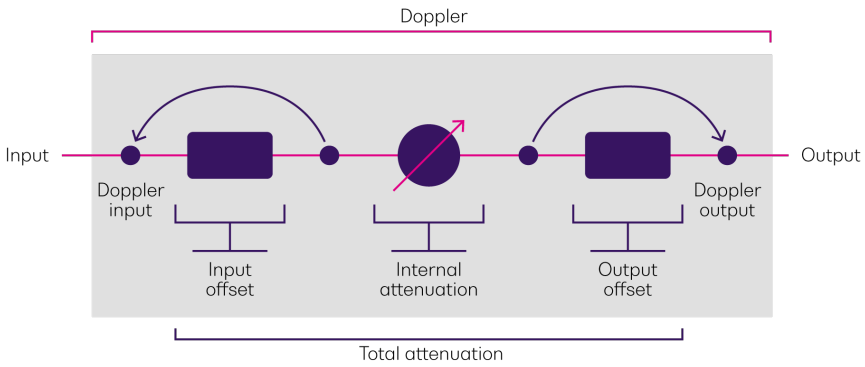
**Input offset only:**




**Output offset only:**



**Both offsets:**




For examples of input and output offset operation with the VOA see Attenuation mode and Power mode.

## 9.3 Attenuation mode

When the Doppler product is in an **ATTENUATION** control mode, it has three possible attenuation sub-modes:

- **ABSOLUTE**
- **OFFSET**
- **RELATIVE**

When operating in **ABSOLUTE** or **RELATIVE ATTENUATION** control modes, the Doppler will ignore all **OFFSET** values.

### 9.3.1 Absolute mode

When **ABSOLUTE** is selected for the **ATTENUATION** mode, the Doppler evaluates the attenuation using only the internal loss of the Doppler. This means that the minimum attenuation that can be applied is equal to the Insertion Loss (IL) of the Doppler, as measured at factory calibration; and the maximum attenuation is equal to the Calibrated Maximum Attenuation (CAL MAX), as measured at factory calibration.

| | |
|---|---|
| MIN Attenuation | IL |
| MAX Attenuation | CAL MAX |

Example:

| Doppler Input | Set attenuation | Insertion Loss (IL) | Internal attenuation | Doppler output |
|---|---|---|---|---|
| 10 dBm | MIN | 0.8 dB | 0.8 dB | 9.2 dBm |
| | 5 dB | | 5 dB | 5 dBm |
| | MAX | | CAL MAX | 10 dBm - CAL MAX |

### 9.3.2 Relative mode

When **RELATIVE** is selected for the attenuation mode, the Doppler channel attenuation is calculated with respect to the Insertion Loss (IL) of the Doppler. This means that the applied attenuation of the Doppler is offset by the Insertion Loss.

As a result, the minimum attenuation is 0 dB, and the maximum attenuation is less than the maximum attenuation as applied in the ABSOLUTE attenuation mode.

| | |
|---|---|
| MIN Attenuation | 0 dB |
| MAX Attenuation | CAL MAX - IL |

Example:

| Doppler Input | Set attenuation | Insertion Loss (IL) | Internal attenuation | Doppler output |
|---|---|---|---|---|
| 10 dBm | MIN | 0.8 dB | 0 dB | 9.2 dBm |
| | 3 dB | | 3 dB | 6.2 dBm |
| | MAX | | CAL MAX - 0.8 dB | 10 dBm - CAL MAX - IL |

### 9.3.3 Offset mode

When **OFFSET** is selected for the attenuation mode, the input and output offset values can be set for a given Doppler channel.

The Doppler channel attenuation is evaluated as the difference between the Internal Loss (IL) of the Doppler (ABSOLUTE) and the sum of all the user specified input and output offset values.

The convention for the offset value is as follows:

- **Positive for loss**, eg. 1x2 50:50 splitter will have an offset of 3 dB
- **Negative for gain**, eg. An EDFA with 23dB of gain will have an offset of -23 dB

| | |
|---|---|
| MIN Attenuation | IL + (Input Offset + Output Offset) |
| MAX Attenuation | CAL MAX + (Input Offset + Output Offset) |

Example:

| Input power | Input offset | Output offset | Set attenuation | Total attenuation | Internal attenuation | Doppler output |
|---|---|---|---|---|---|---|
| 10 dBm | 0 dB | 0 dB | 15 dB | 15 dB | 15 dB | -5 dBm |
| | 3 dB | 0 dB | | | 12 dB | |
| | 0 dB | 2 dB | | | 13 dB | |
| | 3 dB | 2 dB | | | 10 dB | |

## 9.4 Power mode

Unlike the **ATTENUATION** control mode, the **POWER** control mode has no sub control mode options. If an **OFFSET** is specified in the **POWER** control mode, it is always applied.

Nominally, in **POWER** control mode, the Doppler always works to ensure that the set output power value is maintained, which means that the Doppler automatically adjusts the internal attenuation to satisfy this condition.

The convention for the offset value is as follows:

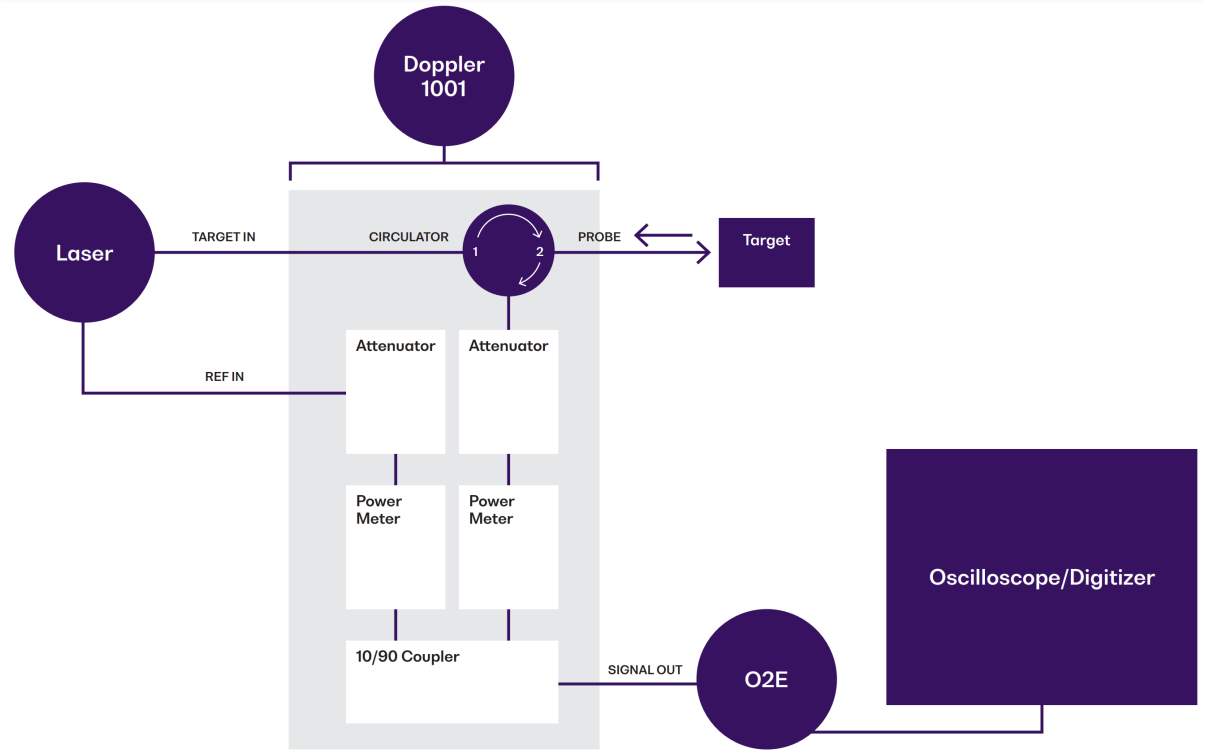
- **Positive for loss**, eg. 1x2 50:50 splitter will have an offset of 3 dB
- **Negative for gain**, eg. An EDFA with 23dB of gain will have an offset of -23 dB

| | |
|---|---|
| MIN Output Power | Input Power – (CAL MAX + (Input Offset + Output Offset)) |
| MAX Output Power | Input Power – (IL + (Input Offset + Output Offset)) |

Example:

| Input power | Input offset | Output offset | Set output power | Total attenuation | Internal attenuation | Doppler output |
|---|---|---|---|---|---|---|
| 10 dBm | 0 dB | 0 dB | -5 dBm | 15 dB | 15 dB | -5 dBm |
| | 3 dB | 0 dB | | | 12 dB | |
| | 0 dB | 2 dB | | | 13 dB | |
| | 3 dB | 2 dB | | | 10 dB | |

# 10 Functional diagrams




A laser is connected to the **Target** input port and the **Reference** input port, respectively. The Target laser passes through a circulator and exits the **Probe** port. This beam will interact with the DUT (target) and be reflected into the **Probe** port.

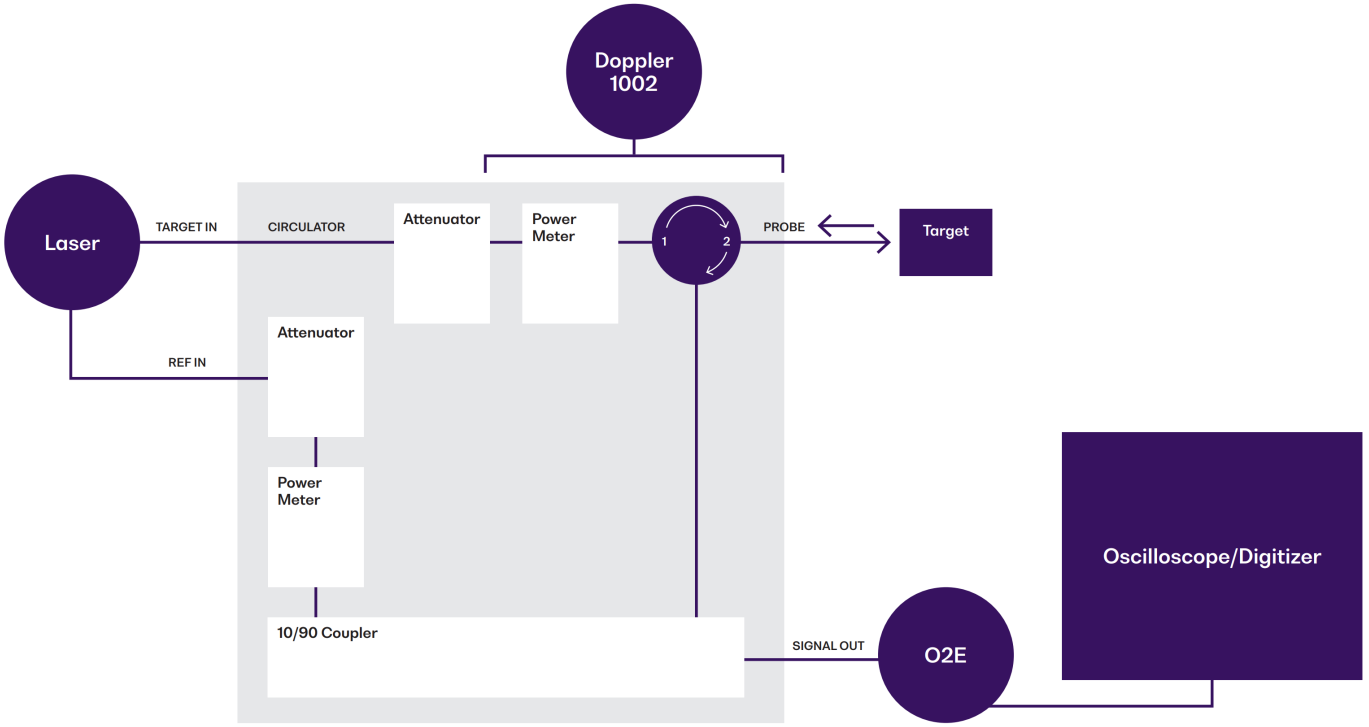
The input into the **Probe** port from the DUT will pass through the circulator and be directed to the optical attenuator and inline power meter.

The **Reference** laser passes through an optical attenuator and inline power meter.

The **Reference** laser and the **Probe** input are coupled to the output port through a 10%:90% coupler, respectively.

Through this configuration, independent control of the **Probe** power and the **Reference** power is achieved. The **Power Meter** is referenced to the output port, so it takes all internal losses of the optical coupler into consideration when reporting the optical power of the probe and reference.

The **Doppler 1002** is another configuration in which the **Target** input attenuator and **Power Meter** are situated before the circulator. With the power control before the **Probe**, this reduces the optical power transmitted to the Probe and the DUT which may be desirable in some circumstances.



# 11 Controlling your product with SCPI commands

Remote communication with the CohesionSCPI service is achieved through the Standard Commands for Programmable Instruments (SCPI).

Support for VISA I/O API over TCP/IP is provided by the VXI-11 compliant CohesionSCPI service. With VISA communication drivers installed on the client, the implementation of VISA programming within environments such as MATLAB becomes available.

This section details the programming and measurement conventions to follow while executing the commands for the CohesionSCPI service.

**NOTE**

In NI-MAX a RIO interface will show up, however there are no communication methods available or implemented on this interface. Quantifi Photonics products are **ONLY** accessible through the **VISA TCPIP INSTR** interface provided by the CohesionSCPI service installed on the system.

## 11.1 Overview

You can operate your Quantifi Photonics module using SCPI commands.

For details on available SCPI commands, refer to:

- Command summary
- Command descriptions

## 11.2 Programming conventions

This section details the programming and measurement conventions to follow while executing the commands for the CohesionSCPI service.

| Parameter | Default Unit | Alternative Units |
|---|---|---|
| Power | DB | MDB |
| Wavelength | NM | M, MM, UM, PM |
| Time | S | MS, US, NS |
| Rate | HZ | |

| Argument | Data Format |
|---|---|
| `<wsp>` | Specifies whitespace character ($01_{16}$ – $09_{16}$, $0B_{16}$ – $20_{16}$) |
| `<value>` | Is numerical data, an integer, a decimal, exponential (10e-9 or 5.8e6) or string |
| `[VALUE1 \| VALUE2]` | A parameter choice. The '\|' separates the unique parameters available, only one of the choices can be used. In the example, either the input parameter `[VALUE1]` or `[VALUE2]` can be used, but not both. Some commands may have more than two choices available. This parameter can be omitted where the command has a default defined in the command description. |

### 11.2.1 Index addressing of modules (slot, source) and units (channel)

When executing commands, it is almost always necessary to provide the index of a specific module or an index of a specific installed unit.

For the commands that require index values:

| Index | Description | Value |
|---|---|---|
| <c> | the chassis index in which the specific blade module is installed | integer, inclusive of 0 |
| <n> | the slot (or source) index of the specific blade module | integer <1 to 18> |
| <m> | the channel index of a specific unit in the module | integer 1 |

Message queues

Information is exchanged in the form of messages. These messages are held in input and output queues.

The output queue stores responses to query commands. The CohesionSCPI service transmits any data in the output queue when a read request is received. Unless specified, all output response data is transmitted in ASCII format.

## 11.3 Status and event registers

### 11.3.1 Standard Event Status Register

The Standard Event Status Register (SESR) is modified by the Quantifi Photonics product with the results of the command operations.

| Bit | Description |
|---|---|
| 7 (MSB), 6 | Not used |
| 5 | Is set when a Command Error event has been detected |
| 4 | Is set when a command Execution Error has been detected |
| 3 | Is set when a Device Dependent Error event has been detected |
| 2 | Is set when there a Query Error event has been detected |
| 1 | Not used |
| 0 (LSB) | Is set when an Operation Complete event has been generated |

### 11.3.2 Standard Event Status Enable Register (Mask)

The Standard Event Status Enable Register (SESR Mask) is used to build the Event Status Bit (ESB) within the Status Byte Register (STB). To ignore any of the events detected and set in the SESR, set the corresponding bit within the SESR Mask to 0. The STB can then be queried and the value of the ESB can be used to determine service request requirements based on the SESR Mask applied.

**NOTE**

The 0 (LSB) value within the SESR Mask is 0.

### 11.3.3 Status Byte Register

The Status Byte Register (STB) is built from all other status registers and masks. This register can be used in queries to determine if an event has been detected and where that event has been detected.

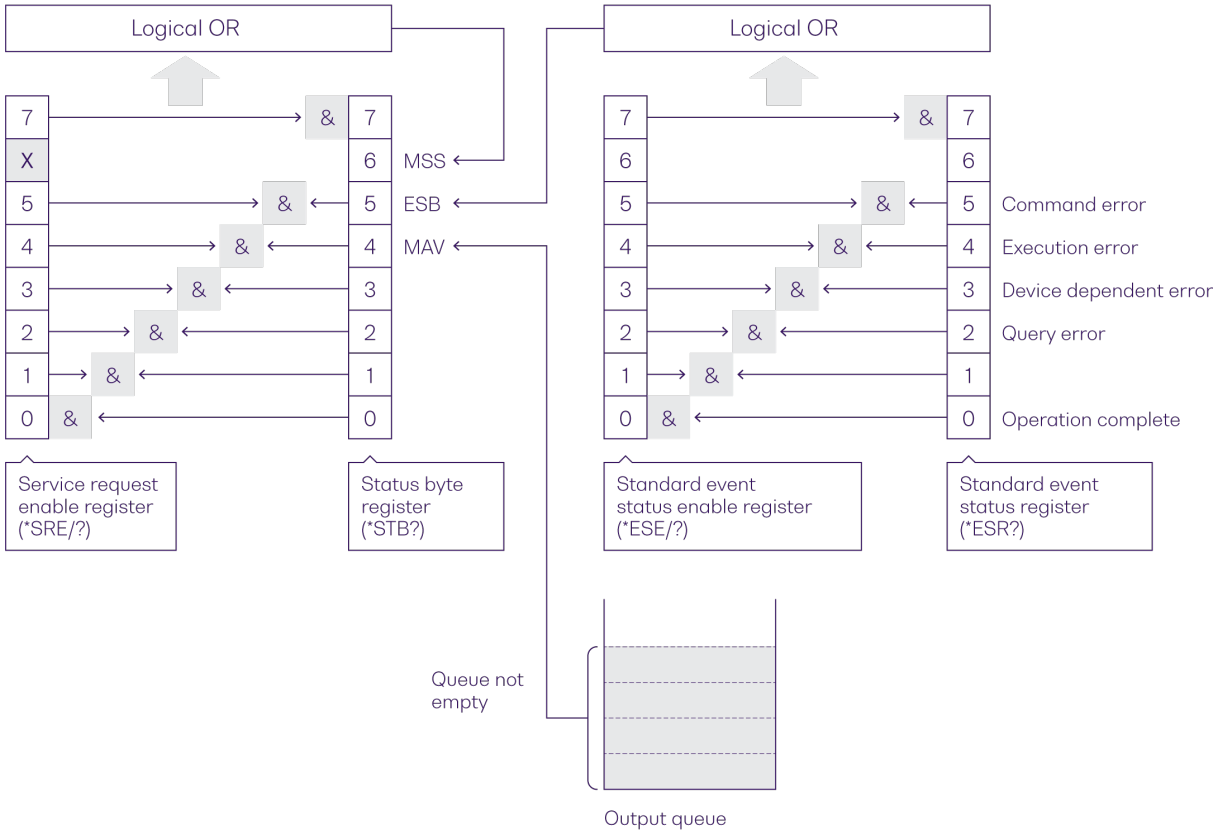
| Bit | Description |
|---|---|
| 7 (MSB) | Not used |
| 6 | The Master Summary Status (MSS) bit is set from the STB and SRE Mask |
| 5 | The Event Status Bit (ESB) is set from the SESR and the SESR Mask |
| 4 | Message Available (MAV) is set when there is data in the output queue |
| 3, 2, 1, 0 (LSB) | Not used |

### 11.3.4 Service Request Enable Register (Mask)

The Standard Request Enable Register (SRE Mask) is used to build the Master Summary Status Bit (MSS) within the Status Byte Register (STB). To ignore any of the events detected and set in the STB register itself, set the corresponding bit within the SRE Mask to 0. The STB can then be queried and the value of the MSS can be used to determine the type of service request required based on the SRE Mask applied.

| Bit | Description |
|---|---|
| 7 (MSB) | Not used |
| 6 | The Master Summary Status (MSS) bit is set from the STB and SRE Mask |
| 5 | The Event Status Bit (ESB) is set from the SESR and the SESR Mask |
| 4 | Message Available (MAV) is set when there is data in the output queue |
| 3, 2, 1, 0 (LSB) | Not used |

### 11.3.5 Status and event registers diagram



## 11.4 PXIe Multi Chassis mode operation

Multiple chassis can be connected to operate in **Multi Chassis Mode**.

To operate in Multi Chassis Mode, **CohesionSCPI service must be version 1.02.06 or later**.

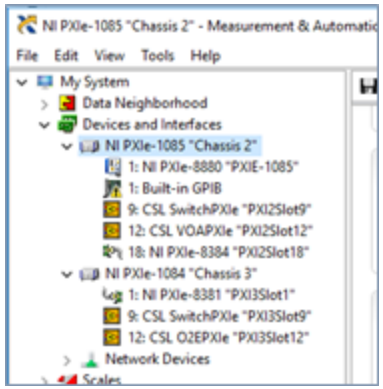
### 11.4.1 NI-MAX application Multi Chassis mode

**NOTE**

The CohesionSCPI service does not manage the chassis numbers. These are controlled by the NI Platform Services (and through NI-MAX).

Even if the CohesionSCPI service is in Multi Chassis mode, if a chassis is connected but has no installed modules, it will not show up when `*OPT?` is run.

In the example shown below, there are two chassis connected via the PXIe-8384 to PXIe-8381 connection. Chassis #2 has the controller running CohesionSCPI service, and Chassis #3 is the 'extended' chassis.



### 11.4.2 SCPI Multi Chassis commands

**NOTE**

Changing the CohesionSCPI service Chassis Mode will rediscover all Chassis and installed modules.

| Command | `:SYSTEM:CHASSIS?` |
|---|---|
| Syntax | `:SYSTEM:CHASSIS?<wsp>[LIST\|MODE]` |
| Description | Query the Chassis Mode configuration |
| Parameters | No parameters |
| Response | **`List`**: Returns a comma separated list of valid chassis index numbers discovered by the CohesionSCPI service. These are chassis that have modules installed. |
| | **`MODE`**: Returns the current Chassis Mode the CohesionSCPI service is operating in (SINGLE or MULTI). |
| | **`None`**: Returns the number of chassis managed by the CohesionSCPI service. If this is greater than 1, then the system should be set to MULTI mode for correct operation. |
| Example | In Single chassis mode:<br>`:SYSTEM:CHASSIS? -> 1`<br>`:SYSTEM:CHASSIS? LIST -> 0`<br>`:SYSTEM:CHASSIS? MODE -> SINGLE`<br><br>In Multi chassis mode:<br>`:SYSTEM:CHASSIS? -> 2`<br>`:SYSTEM:CHASSIS? LIST -> 2,3`<br>`:SYSTEM:CHASSIS? MODE -> MULTI` |

| Command | `:SYSTEM:CHASSIS` |
|---|---|
| Syntax | `:SYSTEM:CHASSIS<wsp>[SINGLE\|MULTI]` |
| Description | Set the Chassis Mode configuration |
| Parameters | **`SINGLE`**: Set CohesionSCPI service to operate in SINGLE Chassis Mode |
| | **`MULTI`**: Set CohesionSCPI service to operate in MULTI Chassis Mode |
| Response | No response |
| Example | `:SYSTEM:CHASSIS SINGLE` |

In Multi chassis mode, all commands listed in the command summary section will still work, but they must be prefixed with `:CHASSIS<c>`.

Common command example:

| | |
|---|---|
| Single Chassis Mode | `:SLOT2:IDN?` |
| Multi Chassis Mode | `:CHASSIS1:SLOT2:IDN?` |

Specific command example:

| | |
|---|---|
| Single Chassis Mode | `:SOUR2:CHAN2:POW? MAX` |
| Multi Chassis Mode | `:CHASSIS1:SOUR2:CHAN2:POW? MAX` |

## 11.5 Command summary

### 11.5.1 Common commands

| Command | Description |
|---|---|
| *CLS | Clear session message queues >> |
| *IDN? | Query the instrument identification >> |
| *OPC? | Query the Operation Complete Status >> |
| *OPT? | Query the modules installed in the instrument >> |
| *ESR? | Query the Standard Event Status Register >> |

### 11.5.2 System commands

| Command | Description |
|---|---|
| :SYSTEM | |
| :PRESet | Restore instrument settings to power-on default values >> |

### 11.5.3 Slot commands

| Slot commands | Description |
|---|---|
| :SLOT<n> | |
| :OPC? | Query the Operation Complete Status of the module >> |
| :OPTions? | Query installed modules >> |
| :IDN? | Query the module identification >> |
| :TeST? | Query the module self-test status >> |
| :ReSeT | Reset the module to default power-on settings >> |
| :PRESet | Restore instrument settings to power-on default values >> |
| :TRIGger<n> | |
| :ARM? | Query the Trigger ARMed state >> |
| :ARM | Set the Trigger ARMed state >> |

### 11.5.4 Configuration commands

| Configuration commands | Description |
|---|---|
| :CONTrol<n> | |
| :CHANnel<m> | |
| :MODE? | Query the control mode >> |
| :MODE | Set the power measurement offset >> |
| :INPut<n> | |
| :CHANnel<m> | |
| :AMODE? | Query the attenuation mode >> |
| :AMODE | Set the attenuation mode >> |
| :ATTenuation? | Query the attenuation >> |
| :ATTenuation | Set the attenuation >> |
| :OFFSet? | Query the attenuation mode offset >> |
| :OFFSet | Set the attenuation mode offset >> |
| :POWer? | Query the input optical power >> |
| :WAVelength? | Query the input optical wavelength configuration >> |
| :WAVelength | Set the input optical wavelength configuration >> |
| :OUTPut<n> | |
| :CHANnel<m> | |
| :OFFSet? | Query the attenuation mode offset >> |
| :OFFSet | Set the attenuation mode offset >> |
| :POWer? | Query the constant power output >> |
| :POWer | Set the constant power output >> |
| :AVERagingtime? | Query the output power averaging time >> |
| :AVERagingtime | Set the output power averaging time >> |
| :NULLing | Perform dark current nulling >> |
| :TIMEnulling? | Query the amount of time remaining for dark current nulling to complete >> |
| :TRACE | |
| :CoMPlete? | Query the trace completion status >> |
| :PoinTS? | Query the number of trace buffer data elements >> |
| :PoinTS | Set the number of trace buffer data elements >> |
| :RATE? | Query the trace buffer sampling rate >> |

| Configuration commands | Description |
| --- | --- |
| :RATE | Set the trace buffer sampling rate >> |
| :TRIGger | Set the trace trigger mode >> |
| :TRACE<m>? | Query the trace buffer >> |

## 11.6 Command descriptions

### 11.6.1 Common commands

| Command | ***CLS** | Summary >> |
|---|---|---|
| Syntax | `*CLS` | |
| Description | Clear session message queues | |
| Parameters | N/A | |
| Response | N/A | |
| Example | `*CLS` | |

| Command | ***IDN?** | Summary >> |
|---|---|---|
| Syntax | `*IDN?` | |
| Description | Query the instrument identification | |
| Parameters | N/A | |
| Response | Comma separated string with the <manufacturer>,<server name>,<chassis controller name>,<server version> | |
| Example | `*IDN? -> Quantifi Photonics, CohesionSCPIService,PXIE-8133,FW3.00.08` | |

| Command | ***OPC?** | Summary >> |
|---|---|---|
| Syntax | `*OPC?` | |
| Description | Query the Operation Complete Status | |
| Parameters | | |
| Response | **1**: all modules installed in the chassis are ready to execute commands | |
| | **0**: modules installed in the chassis still have commands to execute in the input queue | |
| | NOTE: Any commands sent to the module when `:MODUle:OPC?` is NOT equal `1`, may not execute or return an error. | |
| Example | `*OPC? -> 1` | |

| Command | ***OPT?** | Summary >> |
|---|---|---|
| Syntax | `*OPT?` | |
| Description | Query the modules installed in the instrument | |
| Parameters | N/A | |
| Response | Comma separated string of the installed modules in the chassis | |
| Example | `*OPT? -> ,Switch-1002-2-FA-PXIe,Switch-1003-1-FC-PXIe,,VOA-1001-2-FA-PXIe,,,,O2E-1001-1-FC-PXIe,,,,,,,,` | |

| Command | ***ESR?** | | Summary >> |
|---|---|---|---|
| Syntax | `*ESR?` | | |
| Description | Query the Standard Event Status Register | | |
| Parameters | N/A | | |
| Response | Unsigned integer 8 bit value for the register <0 to 255>, as a string. | | |
| | Bit | Description | Decimal Value |
| | 7 (MSB) | Not used | 0 |
| | 6 | Not used | 0 |
| | 5 | Command error | 32 |
| | 4 | Command Execution Error | 16 |
| | 3 | Device Dependent Error | 8 |
| | 2 | Not used | 0 |
| | 1 | Not used | 0 |
| | 0 (LSB) | Operation Complete | 1 |
| Example | `*ESR? -> 8`<br>`*ESR? -> 32` | | |

**NOTE**

It is recommended to use the `*ESR?` command query after every command that is sent to the device. The `*ESR?` query will be able to catch:

- **Device dependent Error** – the device is reporting an error in operation.
- **Execution Error** – SCPI was unable to execute the given command.
- **Command Error** – SCPI was unable to parse the given command, likely due to an incorrect command.

### 11.6.2 System commands

| Command | **:SYSTEM:PRESet** | Summary >> |
|---|---|---|
| Syntax | `:SYSTEM:PRESet` | |
| Description | Restore instrument settings to power-on default values<br>Disables triggering by setting the trace trigger mode to `STOPped`.<br>Disables Trigger ARM by setting the Trigger ARMed state to `DISABLE`. | |
| Parameters | N/A | |
| Response | N/A | |
| Example | `:SYSTEM:PRES` | |

### 11.6.3 Slot commands

| Command | **:SLOT<n>:OPC?** Summary >> |
|---|---|
| Syntax | `:SLOT<n>:OPC?` |
| Description | Query the Operation Complete Status of the module |
| Parameters | N/A |
| Response | **1**: the module is ready to accept a new command |
| | **0**: the module is busy performing a previous operation |
| | NOTE: Any commands sent to the module when `:SLOT:OPC?` is NOT `1`, may not execute or return an error. |
| Description | `:SLOT1:OPC? -> 1` |

| Command | **:SLOT<n>:OPTions?** Summary >> |
|---|---|
| Syntax | `:SLOT<n>:OPTions?` |
| Description | Query installed modules |
| Parameters | N/A |
| Response | A comma separated array, or a single integer value based on the arguments given. If a module is not installed in a channel, it will not return any identification string. |
| Example | `:SLOT1:OPT? -> 1,1,,` |

| Command | **:SLOT<n>:IDN?** Summary >> |
|---|---|
| Syntax | `:SLOT<n>:IDN?` |
| Description | Query the module identification |
| Parameters | N/A |
| Response | A comma-separated string containing "<manufacturer>,<part number>,<serial number>,<hardware version><firmware version>".<br><br>Note that the hardware and firmware versions are not comma separated. |
| Example | `:SLOT1:IDN? ->`<br>`Quantifi Photonics, DOPPLER-1003-2-FC-PXIE,QP-991100, HW0.01.00FW01.00.00` |

| Command | **:SLOT<n>:TeST?** Summary >> |
|---|---|
| Syntax | `:SLOT<n>:TeST?` |
| Description | Query the module self-test status |
| Parameters | N/A |
| Response | Functional readiness status of the module. A non-zero response reports an error. |
| Example | `:SLOT1:TST? -> 0` |

| Command | **:SLOT<n>:ReSeT** | Summary >> |
|---|---|---|
| Syntax | :SLOT<n>:ReSeT | |
| Description | Reset the module to default power-on settings | |
| Parameters | N/A | |
| Response | N/A | |
| Example | :SLOT1:RST | |

| Command | **:SLOT<n>:PRESet** | Summary >> |
|---|---|---|
| Syntax | :SLOT<n>:PRESet | |
| Description | Restore instrument settings to power-on default values<br>Disables triggering by setting the trace trigger mode to STOPped.<br>Disables Trigger ARM by setting the Trigger ARMed state to DISABLE. | |
| Parameters | N/A | |
| Response | N/A | |
| Example | :SLOT1:PRES | |

| Command | **:TRIGger<n>:ARM?** | Summary >> |
|---|---|---|
| Syntax | :TRIGger<n>:ARM? | |
| Description | Query the Trigger ARMed state | |
| Parameters | N/A | |
| Response | the current state of the Trigger ARM | |
| Example | :TRIG1:ARM? -> ENABLE | |

| Command | **:TRIGger<n>:ARM** | Summary >> |
|---|---|---|
| Syntax | :TRIGger<n>:ARM<wsp><ENABLE\|DISABLE> | |
| Description | Set the Trigger ARMed state | |
| Parameters | **ENABLE**: Enable the Trigger ARM, which will trigger on the next event | |
| | **DISABLE**: Disable the Trigger ARM | |
| Response | N/A | |
| Example | :TRIG1:ARM ENABLE | |

### 11.6.4 Configuration Commands

| Command | **:CONTrol<n>:CHANnel<m>:MODE?** Summary >> |
|---|---|
| Syntax | :CONTrol<n>:CHANnel<m>:MODE? |
| Description | Query the control mode |
| Parameters | N/A |
| Response | A string (non-abbreviated) of the current control mode for the specified channel |
| Example | :CONT1:CHAN1:MODE? -> ATTENUATION |

| Command | **:CONTrol<n>:CHANnel<m>:MODE** Summary >> |
|---|---|
| Syntax | :CONTrol<n>:CHANnel<m>:MODE<wsp>[ATT\|POW] |
| Description | Set the power measurement offset |
| Parameters | **ATT**: Set to Attenuation mode |
| | **POW**: Set to Power control mode |
| Response | N/A |
| Example | :CONT1:CHAN1:MODE ATT |

| Command | **:INPut<n>:CHANnel<m>:AMODE?** Summary >> |
|---|---|
| Syntax | :INPut<n>:CHANnel<m>:AMODE? |
| Description | Query the attenuation mode |
| Parameters | N/A |
| Response | A string (non-abbreviated) of the current attenuation mode for the specified channel |
| Example | :INP1:CHAN1:AMODE? -> ABSOLUTE |

| Command | **:INPut<n>:CHANnel<m>:AMODE** Summary >> |
|---|---|
| Syntax | :INPut<n>:CHANnel<m>:AMODE<wsp>[ABS\|REL\|OFFSET] |
| Description | Set the attenuation mode |
| Parameters | **ABS**: Set the attenuation reference to absolute |
| | **REL**: Set the attenuation reference to relative |
| | **OFFSET**: Set the attenuation reference to the user offset |
| Response | N/A |
| Example | :INP1:CHAN1:AMODE ATT |

| Command | **:INPut<n>:CHANnel<m>:ATTenuation?** Summary >> |
|---|---|
| Syntax | :INPut<n>:CHANnel<m>:ATTenuation<wsp>[MIN\|MAX\|DEF\|SET\|ACT\|ALL] |
| Description | Query the attenuation |
| Parameters | **MIN**: Query the minimum programmable attenuation value |
| | **MAX**: Query the maximum programmable attenuation value |
| | **DEF**: Query the default attenuation value |
| | **SET**: Query the current set attenuation value |
| | **ACT**: Query actual attenuation value |
| | **ALL**: Query all the above parameters in a comma separated string |
| Response | Depending on the parameters the response will be a single value or a comma separated string of values. |
| Example | :INP1:CHAN1:ATT? DEF -> 5.00 |

| Command | **:INPut<n>:CHANnel<m>:ATTenuation** Summary >> |
|---|---|
| Syntax | :INPut<n>:CHANnel<m>:ATTenuation<wsp>[<value>\|MIN\|MAX\|DEF] [DB\|MDB] |
| Description | Set the attenuation |
| Parameters | **<value>**: Set to the user attenuation value with the specified units (DB default) |
| | **MIN**: Set to the minimum programmable attenuation value |
| | **MAX**: Set to the maximum programmable attenuation value |
| | **DEF**: Set to the default attenuation value |
| Response | N/A |
| Example | :INP1:CHAN1:ATT 5.0 |

| Command | **:INPut<n>:CHANnel<m>:OFFSet?** | Summary >> |
|---|---|---|
| Syntax | :INPut<n>:CHANnel<m>:OFFSet?<wsp>[MIN\|MAX\|DEF\|SET\|ALL] | |
| Description | Query the attenuation mode offset | |
| Parameters | **MIN**: Query the minimum programmable offset value | |
| | **MAX**: Query the maximum programmable offset value | |
| | **DEF**: Query the default offset value | |
| | **SET**: Query the current set offset value | |
| | **ALL**: Query all the above parameters in a comma separated string | |
| Response | A single value, or a comma-separated array of values | |
| Example | :INP1:CHAN1:OFFS? -> 5.00 | |

| Command | **:INPut<n>:CHANnel<m>:OFFSet** | Summary >> |
|---|---|---|
| Syntax | :INPut<n>:CHANnel<m>:OFFSet<wsp><value>[DB\|MDB] | |
| Description | Set the attenuation mode offset | |
| Parameters | **<value>**: Set to the user offset value with the specified units (DB default) | |
| Response | N/A | |
| Example | :INP1:CHAN1:OFFS 5.0 | |

| Command | **:INPut<n>:CHANnel<m>:POWer?** | Summary >> |
|---|---|---|
| Syntax | :INPut<n>:CHANnel<m>:POWer?<wsp>[MIN\|MAX\|DEF\|SET\|ACT\|ALL] | |
| Description | Query the input optical power | |
| Parameters | **MIN**: Returns the minimum programmable power value | |
| | **MAX**: Returns the maximum programmable power value | |
| | **DEF**: Returns the default power value | |
| | **SET**: Returns the current set power value | |
| | **ACT**: Returns the actual power value | |
| | **ALL**: Returns all the above parameters in a comma separated string | |
| Response | A single value, or a comma-separated array of values | |
| Example | :INP1:CHAN1:POW ALL -> -45.00,20.00,10.00,5.00,4.99 | |

| Command | **:INPut<n>:CHANnel<m>:WAVelength?** | Summary >> |
|---|---|---|
| Syntax | :INPut<n>:CHANnel<m>:WAVelength?<wsp>[MIN\|MAX\|DEF\|SET\|ALL] | |
| Description | Query the input optical wavelength configuration | |
| Parameters | **MIN**: Returns the minimum programmable wavelength | |
| | **MAX**: Returns the maximum programmable wavelength | |
| | **DEF**: Returns the default programmable wavelength | |
| | **SET**: Returns the current set wavelength | |
| | **ALL**: Returns all the above parameters in a comma separated string | |
| Response | A single value, or a comma-separated array of values | |
| Example | :INP1:CHAN1:WAV? ALL -> 1271,1550,1550,1550 | |

| Command | **:INPut<n>:CHANnel<m>:WAVelength** | Summary >> |
|---|---|---|
| Syntax | :INPut<n>:CHANnel<m>:WAVelength<wsp><value>[NM\|M\|MM\|UM\|PM] | |
| Description | Set the input optical wavelength configuration | |
| Parameters | **<value>**: Set to the user wavelength of the channel with the specified units (NM default) | |
| Response | N/A | |
| Example | :INP1:CHAN1:WAV 1310 NM | |

| Command | **:OUTPut<n>:CHANnel<m>:OFFSet?** | Summary >> |
|---|---|---|
| Syntax | :OUTPut<n>:CHANnel<m>:OFFSet?<wsp>[MIN\|MAX\|DEF\|SET\|ALL] | |
| Description | Query the attenuation mode offset | |
| Parameters | **MIN**: Query the minimum programmable offset value | |
| | **MAX**: Query the maximum programmable offset value | |
| | **DEF**: Query the default offset value | |
| | **SET**: Query the current set offset value | |
| | **ALL**: Query all the above parameters in a comma separated string | |
| Response | A single value, or a comma-separated array of values | |
| Example | :OUTP1:CHAN1:OFFS? -> 5.00 | |

| Command | **:OUTPut<n>:CHANnel<m>:OFFSet** | Summary >> |
|---|---|---|
| Syntax | :OUTPut<n>:CHANnel<m>:OFFSet<wsp><value>[DB\|MDB] | |
| Description | Set the attenuation mode offset | |
| Parameters | **<value>**: Set to the user offset value with the specified units (DB default) | |
| Response | N/A | |
| Example | :OUTP1:CHAN1:OFFS 5.0 | |

| Command | **:OUTPut<n>:CHANnel<m>:POWer?** Summary >> |
|---|---|
| Syntax | :OUTPut<n>:CHANnel<m>:POWer?<wsp>[MIN\|MAX\|DEF\|SET\|ACT\|ALL] |
| Description | Query the constant power output |
| Parameters | **MIN**: Returns the minimum programmable power value |
| | **MAX**: Returns the minimum programmable power value |
| | **DEF**: Returns the default power value |
| | **SET**: Returns the current set power value |
| | **ACT**: Returns the actual power value |
| | **ALL**: Returns all the above parameters in a comma separated string |
| Response | A single value, or a comma-separated array of values |
| Example | :OUTP1:CHAN1:POW ALL -> -45.00,20.00,10.00,5.00,4.99 |

| Command | **:OUTPut<n>:CHANnel<m>:POWer** Summary >> |
|---|---|
| Syntax | :OUTPut<n>:CHANnel<m>:POWer<wsp>[<value>\|MIN\|MAX\|DEF] [DB\|MDB] |
| Description | Set the constant power output |
| Parameters | **<value>**: Set to the user power value with the specified units (DB default) |
| | **MIN**: Set to the minimum programmable power value |
| | **MAX**: Set to the maximum programmable power value |
| | **DEF**: Set to the default power value |
| Response | N/A |
| Example | :OUTP1:CHAN1:POW 5.0 |

| Command | **:OUTPut<n>:CHANnel<m>:POWer:AVERagingtime?** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:CHANnel<m>:POWer:AVERagingtime?<wsp>[MIN\|MAX\|DEF\|SET\|ALL]` | |
| Description | Query the output power averaging time | |
| Parameters | **MIN**: Returns the minimum programmable averaging time value | |
| | **MAX**: Returns the maximum programmable averaging time value | |
| | **DEF**: Returns the default averaging time value | |
| | **SET**: Returns the current set averaging time value | |
| | **ALL**: Returns all the above values in a comma separated string | |
| Response | A single value, or a comma-separated array of values | |
| Example | `:OUTP1:CHAN1:POW:AVER? MIN -> 0.0000` | |

| Command | **:OUTPut<n>:CHANnel<m>:POWer:AVERagingtime** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:CHANnel<m>:POWer:AVERagingtime<wsp>[<value>\|MIN\|MAX\|DEF][S\|MS\|US\|NS]` | |
| Description | Set the output power averaging time | |
| Parameters | **<value>**: Set to the user averaging time value with the specified units (S default) | |
| | **MIN**: Set the minimum programmable averaging time value | |
| | **MAX**: Set the maximum programmable averaging time value | |
| | **DEF**: Set the default averaging time value | |
| Response | N/A | |
| Example | `:OUTP1:CHAN1:POW:AVER 0.5` | |

| Command | **:OUTPut<n>:CHANnel<m>:POWer:NULLing** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:CHANnel<m>:POWer:NULLing` | |
| Description | Perform dark current nulling on the channel<br><br>Note: Use this command in conjunction with `*OPC?` to check for dark power nulling completion. | |
| Parameters | N/A | |
| Response | N/A | |
| Example | `:OUTP1:CHAN1:POW:NULL` | |

| Command | **:OUTPut<n>:CHANnel<m>:POWer:TIMEnulling?** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:CHANnel<m>:POWer:TIMEnulling?` | |
| Description | Query the amount of time remaining for dark current nulling to complete | |
| Parameters | N/A | |
| Response | Averaging time in seconds | |
| Example | `:OUTP2:CHAN1:POW:TIME? -> 0.00` | |

| Command | **:OUTPut<n>:TRACE:CoMPlete?** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:TRACE:CoMPlete?` | |
| Description | Query the trace completion status | |
| Parameters | N/A | |
| Response | **1**: the trace has been acquired and the buffer is ready to be read out | |
| | **0**: the trace acquisition is still in progress, or the buffer is not ready to be read out | |
| Example | `:OUTP2:TRACE:CMP? -> 1` | |

| Command | **:OUTPut<n>:TRACE:PoinTS?** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:TRACE:PoinTS?<wsp>[MIN\|MAX\|DEF\|SET\|ALL]` | |
| Description | Query the number of trace buffer data elements | |
| Parameters | **MIN**: Returns the minimum programmable number of points | |
| | **MAX**: Returns the maximum programmable number of points | |
| | **DEF**: Returns the default number of points set at power on | |
| | **SET**: Returns the current set number of points | |
| | **ALL**: Returns all the above parameters in a comma separated string | |
| Response | Returns the number of points captured after each trigger | |
| Example | `:OUTP2:TRACE:PTS? ALL -> 1,1024,1024,512` | |

| Command | **:OUTPut<n>:TRACE:PoinTS** | Summary >> |
|---|---|---|
| Syntax | `:OUTPut<n>:TRACE:PoinTS<wsp>[\|MIN\|MAX\|DEF\|<value>]` | |
| Description | Set the number of trace buffer data elements | |
| Parameters | **<value>**: Set the desired number of points per trigger | |
| | **MIN**: Set the minimum programmable number of points | |
| | **MAX**: Set the maximum programmable number of points | |
| | **DEF**: Set the default number of points which is also set at power on | |
| Response | N/A | |
| Example | `:OUTP2:TRACE:PTS 512` | |

| Command | **:OUTPut<n>:TRACE:RATE?** | Summary >> |
|---|---|---|
| Syntax | :OUTPut<n>:TRACE:RATE?<wsp>[MIN\|MAX\|DEF\|SET\|ALL] | |
| Description | Query the trace buffer sampling rate | |
| Parameters | **MIN**: Returns the minimum sample rate in samples per second (Hz) | |
| | **MAX**: Returns the maximum sample rate in samples per second (Hz) | |
| | **DEF**: Returns the default sample rate set at power on | |
| | **SET**: Returns the current set sample rate in samples per second (Hz) | |
| | **ALL**: Returns all the above parameters in a comma separated string | |
| Response | Sample rate for the trace in seconds per sample | |
| Example | :OUTP2:TRACE:RATE? ALL -> 0.183,12000.000,12000.000,5000.000 | |

| Command | **:OUTPut<n>:TRACE:RATE** | Summary >> |
|---|---|---|
| Syntax | :OUTPut<n>:TRACE:RATE<wsp>[<value>\|MIN\|MAX\|DEF] | |
| Description | Set the trace buffer sampling rate | |
| Parameters | **<value>**: Set the desired sample rate in samples per second (Hz) | |
| | **MIN**: Set the minimum sample rate in samples per second (Hz) | |
| | **MAX**: Set the maximum sample rate in samples per second (Hz) | |
| | **DEF**: Set the default sample rate set at power on | |
| Response | N/A | |
| Example | :OUTP2:TRACE:RATE 5000 | |

| Command | **:OUTPut<n>:TRACE:TRIGger** | Summary >> |
|---|---|---|
| Syntax | :OUTPut<n>:TRACE:TRIGger<wsp>[STOP\|IMMEDIATE\|FORCE] | |
| Description | Set the trace trigger mode | |
| Parameters | **STOPped**: Triggering is disabled | |
| | **IMMEDIATE\|FORCE**: Software trigger, start sampling immediately (default) | |
| | Note: OUTP<n>:TRACE:PTS samples is required before OUTP<n>:TRACE:CMP? completes. | |
| Response | N/A | |
| Example | :OUTP2:TRACE:TRIG FORCE | |

| Command | **:OUTPut<n>:TRACE<m>?** Summary >> |
|---|---|
| Syntax | :OUTPut<n>:TRACE<m>? |
| Description | Query the trace buffer<br><br>Note: the user should wait for :OUTP<n>:TRACE:CMP? to complete before reading this.<br><br>Note: this command will error out if no sample points have been triggered. |
| Parameters | N/A |
| Response | Comma separated list of values for each channel, new lines [ie '\n'] separated rows per sample.<br><br>The :OUTP<n>:TRACE? command will return a comma separated string of values units of dBm. |
| Example | :OUTP2:TRACE:PTS 10<br><br>:OUTP2:TRACE:RATE 0.183<br><br>:OUTP2:TRACE:TRIG<br><br>:OUTP2:TRACE:CMP? -> 1<br><br>:OUTP2:TRACE2? -> 10.01,10.01,10.02,10.01,10.01,10.01,10.02,10.02,10.02,10.02,10.01,10.01<br><br>:OUTP2:TRACE:TRIG<br><br>:OUTP2:TRACE:CMP? -> 1<br><br>:OUTP2:TRACE2? -> 10.01,10.01,10.02,10.01,10.01,10.01,10.02,10.02,10.02,10.02,10.01,10.01 |

## 11.7 Triggering example

This is an example of the commands and procedure for configuration and use of the system (or chassis) triggering features of the Quantifi Photonics products.

### 11.7.1 System commands

```
:TRIGger<slot>:ARM ENABLE          #Arm the triggering in preparation for the next event.
```

### 11.7.2 Module commands

The following is the example of a Doppler MATRIQ instrument:

```
:OUTP1:TRACE1:TRIGGER IMMEDIATE    #Once the above system commands are configured, set the module to the desired Trigger
                                   #event mode.
                                   #This is for the sampling to be started immediately

:OUTP1:TRACE1:COMPLETE? -> 1       #Monitor the Trace completion status.

:OUTP1:TRACE1? -> “x1,x2,x3,….,xn” #Query (Read) the Trace buffer once populated (data elements depend on trace
                                   #configuration)
```

| Name | Trigger Event | Sampling Event | Description |
|---|---|---|---|
| `STOP` | None | None | triggering is disabled (or cancelled), no events will occur |
| `FORCED \| IMMEDIATE` | Software | Internal Clock | triggered upon command execution and sampling aligned to internal timer |

## 11.8 Programming example: Control of the Doppler with SCPI

The following is a simple example of how to control the Doppler product using SCPI commands. See the previous section for specific details and extra parameters that the listed commands accept.

We recommend that you use the `*ESR?` query after every command that is sent to the device. This enables you to debug unreceived or incorrect commands sent to the product.

```
#Identifying the product
:*IDN?                                  #Query to confirm the correct instrument is setup
:*OPT?                                  #Query the available module configuration
:SLOT1:IDN?                             #Query the identification information for a specific module

#Running a Trace on the Doppler product
:OUTP1:TRACE:RATE 1000                  #Set up the Trace parameters
:OUTP1:TRACE:POINTS 1024
:OUTP1:CHAN1:POW:AVER 0.02
:OUTP1:TRACE:TRIGGER IMMEDIATE          #Trigger the Trace acquisition
:OUTP1:TRACE:COMPLETE?                  #Query the status of the Trace (for completion)
:OUTP1:TRACE?                           #Query the Trace data once complete
```

# 12 Programming applications

Remote communication with the CohesionSCPI service is achieved through the Standard Commands for Programmable Instruments (SCPI).

Support for VISA I/O API over TCP/IP is provided by the VXI-11 compliant CohesionSCPI service. With VISA communication drivers installed on the client, the implementation of VISA programming within environments such as MATLAB becomes available.

This section details the programming and measurement conventions to follow while executing the commands for the CohesionSCPI service.

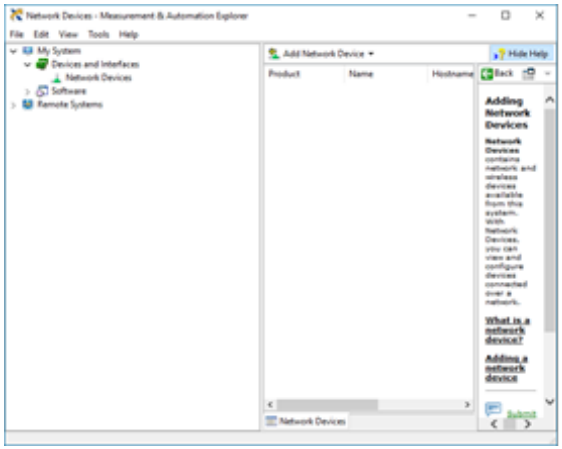
**NOTE**

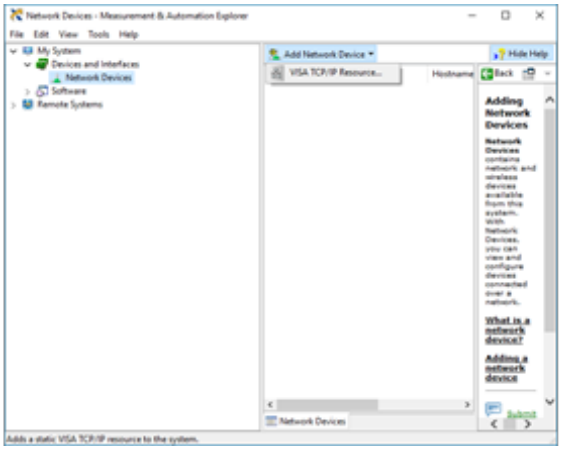
In NI-MAX a RIO interface will show up, however there are no communication methods available or implemented on this interface. Quantifi Photonics products are **ONLY** accessible through the **VISA TCPIP INSTR** interface provided by the CohesionSCPI service installed on the system.

## 12.1 Setting up NI-MAX application

To communicate with any Quantifi Photonics product, the chassis / benchtop product must first be setup as a TCP/IP instrument.

1. After installing NI-MAX, launch the application. In the left side panel of the window, click the **Devices and Interfaces** option. A drop down of available instruments detected will show up.
2. Click on **Network Devices**, then click **Add Network Devices** and select **VISA TCP/IP Resource**.





3. Select **Manual Entry of LAN Instrument**. Enter in the Hostname or IP Address.
   Note when operating locally, enter in the localhost IP address of **127.0.0.1**. Click **Finish** to end the setup process.

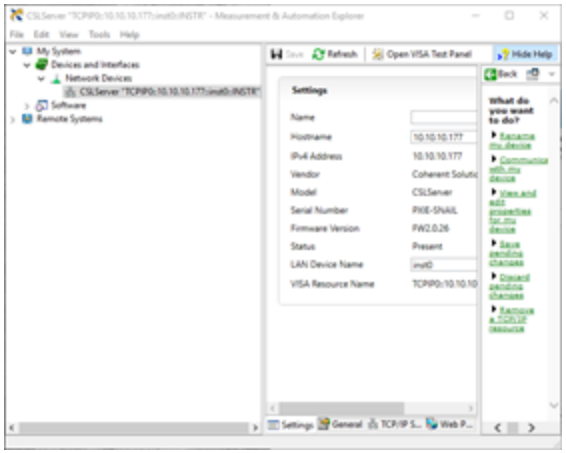





## 12.2 Setting up NI-VISA application

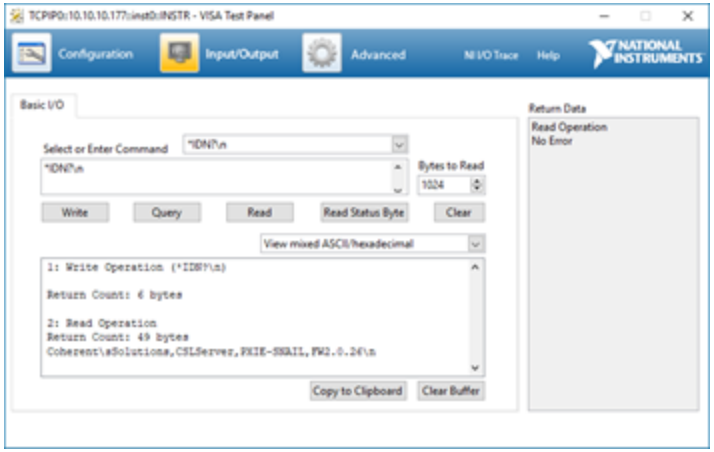
NI-VISA is used to communicate with the PXIe chassis or installed modules / instruments. The above steps must be completed before attempting to communicate using NI-VISA.

1. Launch NI-MAX. In the left-hand side menu, select an instrument from the **Network Devices** list.



2. On the right-hand side panel, select **Open VISA Test Panel**. A new window will popup. Click the **Input / Output** button from the window menu.

   Valid chassis and module commands can be entered in, and their returns queried



## 12.3 Python® code example

The following example shows how to communicate with the Quantifi Photonics product using Python code.

```
# You can get VXI11 from pip:
# pip install python-vxi11==0.9
import vxi11
from vxi11.vxi11 import Vxi11Exception
# replace this with the IP of your device
ip = "127.0.0.1"
try:
    print("connecting to " + ip + " ... ")
    instrument = vxi11.Instrument(ip)
    print("connected")
    print("checking IDN...")
    command = "*IDN?"
    data = instrument.ask(command)
    print("IDN: " + data)
    print("checking OPT...")
    command = "*OPT?"
    data = instrument.ask(command)
    print("OPT: " + data)
    # replace this with a valid command for your device (read # the programming guide section for examples)
    command = ""
    print("writing a specific command")
    instrument.write(command)
    print("checking ESR")
    command = "*ESR?"
    data = instrument.ask(command)
    print("*ESR?: " + data)
except Vxi11Exception as e:
    # pass
    print("ERROR" + str(e) + ", command: " + str(command))
```

## 12.4 MATLAB® code example

To communicate with the Quantifi Photonics product in MATLAB® the installation of a VISA IO driver is required. These drivers enable the creation of the Interface Object for instrument communication.

If developing locally on the PXIE Platform, then these will already be installed. However, if development is on a remotely connected system the VISA Libraries, e.g. National Instruments NI-VISA will have to be installed.

**NOTE**

MATLAB 2010x or later with the Instrument Control Toolbox is required to execute the code detailed in this section.

The following example shows how to communicate with a Quantifi Photonics product using MATLAB code.

```
% Find a VISA-TCPIP object. This is if the VISA object has already been
% created with tmtool or has been removed from the workspace without
% first being closed (cleanly disconnected).
PXIE_Chassis = instrfind('Type', 'visa-tcpip', ...
'RsrcName', 'TCPIP0::10.10.10.89::inst0::INSTR', 'Tag', '');
% Create the ‘agilent’ VISA-TCPIP object if it does not exist
% otherwise use the object that was found.
if isempty(PXIE_Chassis)
    PXIE_Chassis = visa('agilent', 'TCPIP0::10.10.10.89::inst0::INSTR');
else
    fclose(PXIE_Chassis);
    PXIE_Chassis = PXIE_Chassis (1);
end
% Open the connection to the VISA object.
fopen(PXIE_Chassis);
% Query the PXIE_Chassis.
response = query(PXIE_Chassis, '*IDN?');
disp('The *IDN query response:');
disp(response);
response = query(PXIE_Chassis, '*OPT?');
disp('The *OPT query response:');
disp(response);
% Replace this with a valid command for your device (read the programming
% guide section for examples)
command = ''
% Close the connection to the object.
```

# 13 Working with optical fibers

Quantifi Photonics products are equipped with high quality optical connectors in compliance with EIA-455-21A standards.

**CAUTION**

Keep connectors clean and in good condition to ensure maximum power and to avoid erroneous readings. Quantifi Photonics is not responsible for damage or errors caused by bad fiber cleaning or handling.

- Always inspect fiber end faces for cleanliness using a fiber inspection probe before inserting them into a port..
- If required, clean fibers and faces as detailed below.

**NOTE**

- To avoid damaging ferrules or fiber faces due to mismatched connectors, always check ports and connector type information before inserting a connector. All Quantifi Photonics units are labeled with connector type information.
- Failing to align and/or connect fiber-optic cables properly will result in significant signal loss and reflection.

▶ When connecting a fiber-optic cable to a port:

1. Visually inspect the fiber end face using a fiber inspection microscope.
2. If a **connector end face** is dirty:
    - Wipe the connector end face using a reel-type cleaner and inspect again.
    - For stubborn hard to clean connectors:
        - Use lint-free fiber-cleaning wipes soaked in a fiber optic cleaning solution.
        - Wipe the connector on the soaked part.
        - Dry the connector by wiping on the dry part of the wipe, or by using a reel-type cleaner.
    - Repeat the process until connector inspection shows a clean fiber face.
3. If a **bulkhead inner connector face** is dirty:
    - Use a pen-type dry cleaner, align the cleaning tip with the port and push the cleaner until you hear the characteristic click. Inspect again.
    - For stubborn hard to clean bulkhead connectors:
        - Use a stick-type cleaner dipped in a fiber optic cleaning solution.
        - Carefully align and insert the stick into the connector and gently rotate the stick for several seconds applying light pressure.
        - Use a pen-type cleaner to dry the connector.
    - Repeat the process until connector inspection shows a clean fiber face.
4. If the fiber end face is clean:
    - Carefully align the connector and port to prevent the fiber end from touching the outside of the port or other surfaces. If the connector features a key, mate it correctly into the corresponding notch of the port bulkhead.

- Push the connector in so that the fiber-optic cable is firmly in place with adequate contact. If your connector features a screw sleeve, tighten the connector to firmly maintain the fiber in place. Do not over-tighten, as this will dam-age the fiber and the port bulkhead.

# 14 System requirements

**Quantifi Photonics PXIe modules**

| | |
|---|---|
| Supported browsers for working with CohesionUI | Google Chrome™<br>Microsoft Edge® |
| Chassis | PXIe-compatible chassis that<br>• supports PXIe, or<br>• contains PXI hybrid compatible slots |
| Recommended PXIe controller operating system | Microsoft Windows® 10 (64-bit) |

**Quantifi Photonics MATRIQ / EPIQ instruments**

| | |
|---|---|
| Supported browsers for working with CohesionUI | Google Chrome™<br>Microsoft Edge® |
| Recommended client computer operating system | Microsoft Windows® 10 (64-bit) |

# 15 Maintenance

To help ensure long, trouble-free operation:

- Always inspect fiber-optic connectors before using them and clean them if necessary.
- Keep the unit free of dust.
- Store the unit at room temperature in a clean and dry area. Keep the unit out of direct sunlight.
- Avoid high humidity or significant temperature fluctuations.
- Avoid unnecessary shocks and vibrations.
- If any liquids are spilled on or into the unit, power off the chassis immediately. Remove the unit and allow to dry completely.
- To allow for sufficient air flow and avoid thermal issues, set up your instrument with a minimum clearance of 2 inches (50.8mm) around it and do not block any ventilation fans.

**WARNING**

The use of controls, adjustments, and procedures other than those specified herein may result in exposure to hazardous situations or impair the protection provided by this unit.

## 15.1 Annual calibration schedule

To ensure that the unit is performing within specification, we recommend it is re-calibrated every 12 months.

All Quantifi Photonics products are calibrated during manufacture, and each product is shipped to the customer with a Calibration Certificate. On this certificate, the calibration date, as well as the next calibration due date are mentioned.

We recommend your product is returned for re-calibration before the listed due date, to ensure continued performance of the product. For re-calibration service information, or to send in a product for re-calibration service, email support@quantifiphotonics.com.

If the Calibration Certificate has been misplaced, or the calibration due date is not known, email support@quantifiphotonics.com.

# 16 Technical Support

## 16.1 Contacting the Technical Support Group

To obtain after-sales service or technical support for this product, contact Quantifi Photonics:

support@quantifiphotonics.com

To accelerate the process, please provide information such as the name and the serial number of the product (see the product identification label), as well as a description of your problem.

## 16.2 Transportation

Maintain a temperature range within specifications when transporting the unit.

**Transportation damage can occur from improper handling.**

The following steps are recommended to minimize the possibility of damage:

- Pack the product in its original packing material when shipping. If the original packaging is unavailable, use appropriate foam packaging to provide shock absorption and avoid displacement of the product inside the shipping box. Please keep all input connectors covered with the supplied anti-static plastic covers during transport and avoid any shipping material making contact with the sensitive connectors of the product.
- Avoid high humidity or large temperature fluctuations.
- Keep the product out of direct sunlight.
- Avoid unnecessary shocks and vibrations.

# 17 Warranty Information

## 17.1 General information

Quantifi Photonics Ltd (Quantifi Photonics) warrants from the date of the original shipment (the Warranty Period) that this product will conform to specifications and will be free from defects in material and workmanship for the applicable Warranty Period. Quantifi Photonics also warrants that the equipment will meet applicable specifications under normal use.

**NOTE**

The warranty can become null and void if:

- The unit has been tampered with, repaired, or worked upon by unauthorized individuals or non-Quantifi Photonics personnel.
- The warranty sticker has been removed.
- The unit has been opened, other than as explained in this guide.
- The unit serial number has been altered, erased, or removed.
- The unit has been misused, neglected, or damaged by accident.
- The unit has been used with an external power supply not supplied by Quantifi Photonics with the unit.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL QUANTIFI PHOTONICS BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

For full warranty terms and conditions, please visit quantifiphotonics.com.

## 17.2 Liability

Quantifi Photonics shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the product is connected or the operation of any system of which the product may be a part.

Quantifi Photonics shall not be liable for damages resulting from improper usage, transportation or unauthorized modification of the product, its accompanying accessories and software.

The external power supply that has been supplied by Quantifi Photonics with the unit can only be used with that unit, do not use it with any other product.

## 17.3 Exclusions

Quantifi Photonics reserves the right to make changes in the design or construction of any of its products at any time without incurring obligation to make any changes whatsoever on units purchased. Accessories, including but not limited to fuses, pilot lamps, batteries and universal interfaces (EUI) used with Quantifi Photonics products are not covered by this warranty.

This warranty excludes failure resulting from: Improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the product or other factors beyond the control of Quantifi Photonics.

## 17.4 Certification

Quantifi Photonics certifies that this equipment met its published specifications at the time of shipment from the factory.

## 17.5 Service and repairs

To send any equipment for service, repair or calibration please contact the Technical Support Group: support@quantifiphotonics.com.

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Quantifi Photonics is transforming the world of photonics test and measurement. Our portfolio of optical and electrical test instruments is rapidly expanding to meet the needs of engineers and scientists around the globe. From enabling ground-breaking experiments to driving highly efficient production testing, you'll find us working with customers to solve complex problems with optimal solutions.

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