QUANTIFI PHOTONICS™

LASER

2000 SERIES

Swept, tunable, continuous wave laser source

PXIE USER MANUAL

quantifiphotonics.com

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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

Quantifi Photonics LASER 2000 Series products are Class 1M laser products.

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.

CAUTION

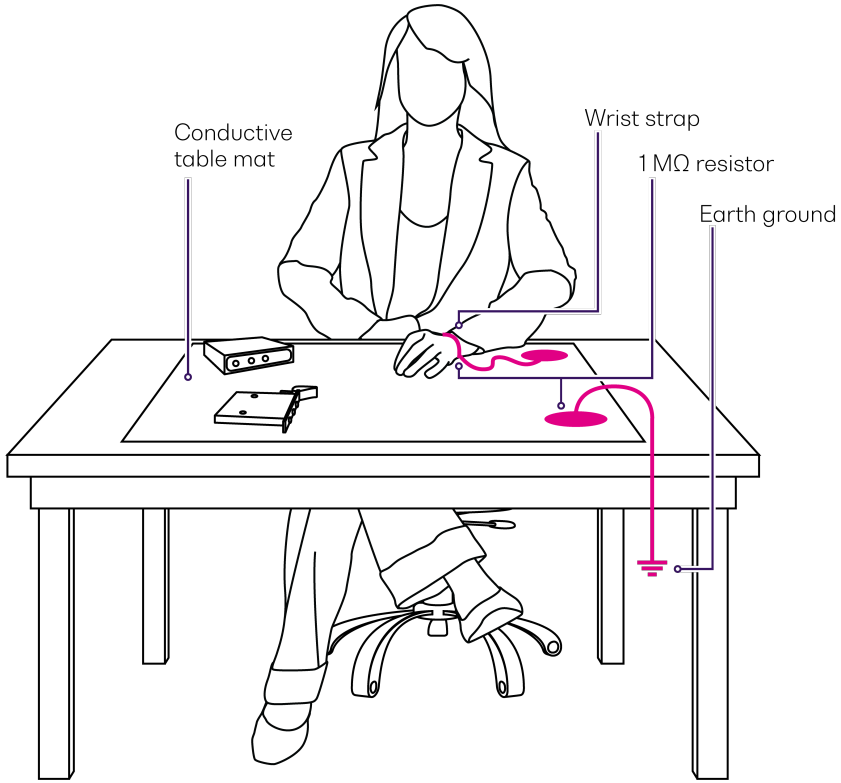
The use of controls, adjustments, and procedures other than those specified in this document may result in exposure to hazardous situations involving optical radiation.

3.2 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.



3.3 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.

4 Introducing the LASER 2000 Series

The LASER 2000 Series provides a laboratory-grade swept, tunable laser source available in O-band, E-band and C/L-band.

It can act as both a step-tuned source or a swept-wavelength laser source. It uses a high-quality grating paired with state-of-the-art micro-electromechanics tuning mechanism for quick, voltage-controlled wavelength tuning and exceptional reliability.

With 0.01 dB power stability and up to 10,000 nm/s high-speed scan rate, it is the perfect time-saving tool for R&D applications as well as production testing.

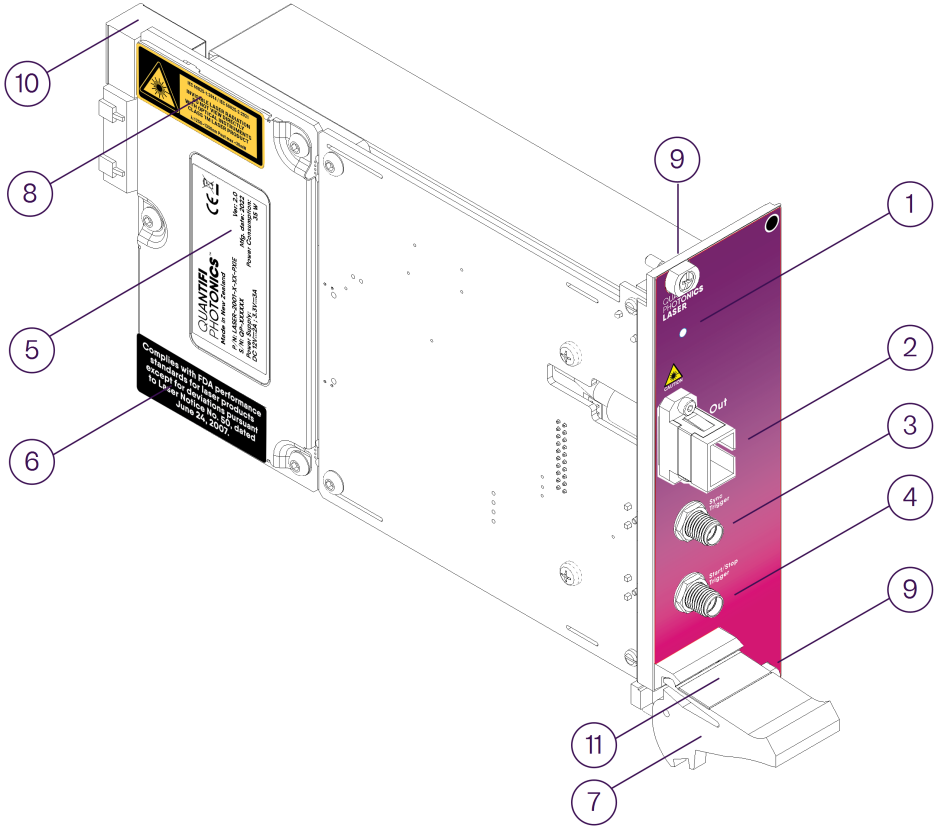
Programming interfaces

Through its programming interfaces you can take advantage of the fully 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	Fastening clip
2	Laser output port	8	IEC laser hazard warning
3	Sync trigger output (SMA max 3.3V TTL)	9	Fastening screw
4	Start/stop trigger output (SMA max 3.3V TTL)	10	PXIe header
5	Product label	11	Module identifier label
6	Product compliance label		

4.2 Status LEDs

The LED shows the status of the channel:

LED	Meaning
OFF	Product is powered OFF
	Product is powered ON and the laser is DISABLED / OFF
solid RED	Product is powered ON and the laser is ENABLED / ON Do **NOT** look into the fiber or inspect it while the laser is ENABLED / ON!
flashing red	During startup: Indicates the initialization of the LASER module.
	After startup, if flashing persists for more than 15 seconds: Indicates an error.

4.3 Operation modes

You can configure the laser to perform a sweep across a chosen wavelength range and operate your LASER module in:

- Fixed mode
- Step Dwell mode
- Step Sweep mode
- Linear Sweep mode

You can route the signal to the PXI backplane trigger lines using CohesionUI or SCPI commands, and manipulate the generated output signals by:

- setting a **skip factor** to reduce the number of trigger pulses (refer Skip factor N: Keep 1, skip N)
- inverting the **polarity** of the signal (refer Polarity inversion)

> The triggers operate at 3.3V logic.

You can synchronize other measurement tools, for example fast optical power meters, spectrum analyzers, and oscilloscopes, via the trigger outputs:

- The **start/stop trigger** output signal enables synchronization to the start/stop of each wavelength sweep and step.
- In Step Sweep mode and Linear Sweep mode, the **sync trigger** signal enables synchronization during a sweep.

4.3.1 Fixed mode

In Fixed mode the LASER behaves like a tunable laser; you set a wavelength value and the laser will output light at that wavelength.

4.3.1.1 Trigger output signal

In Fixed mode your LASER generates a ~300ms trigger signal through its Start/Stop trigger output. The ideal time to sample based on the trigger is after the falling edge of the trigger pulse on the Start/Stop trigger line.

Operation mode	Trigger output	Output
Fixed	Start/Stop trigger	**High** when changing the wavelength while the laser is ON.
	Sync trigger	Unused

4.3.2 Step Dwell mode

In Step Dwell mode you configure a sweep by setting:

- the starting and stopping wavelength (wavelength range)
- the step size
- the dwell time between steps

On starting the sweep, the laser wavelength steps by the set step size and stops for the duration of the dwell time. The laser then moves to the next wavelength until it covers the whole range. The laser power is disabled for a short period of time between each step.

If the LASER is configured for multiple sweeps, the laser returns to the starting wavelength after getting to the end of the range and repeats the sweep. Successive sweeps will begin without delay.

4.3.2.1 Step size

> **NOTE:** One wavelength sweep in Step Dwell mode can comprise a maximum of **25,000 steps**.

To ensure that the chosen wavelength range can be covered with 25,000 steps, the **minimum step size** can vary depending on the set wavelength range. The **maximum steps size** is 25nm, but it cannot exceed the chosen wavelength range.

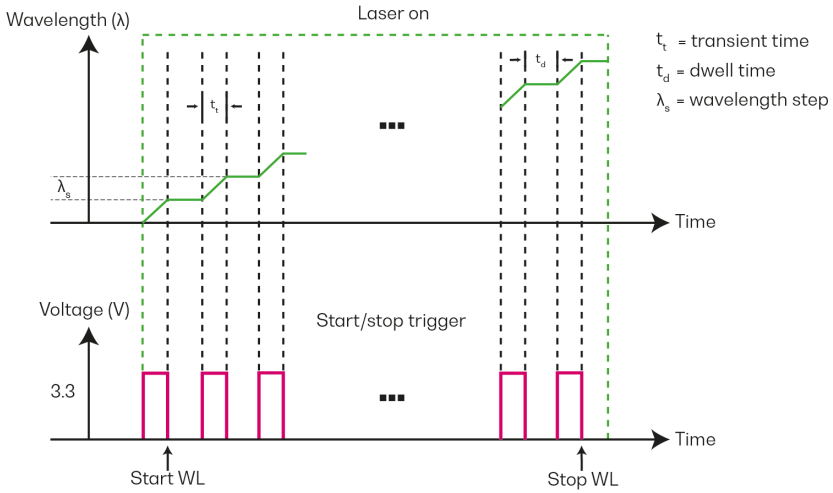
Refer to minimum and maximum values listed in this table when setting the step size for a given wavelength range:

Wavelength range	**≤ 25nm**	**≥ 25nm**
Minimum step size	**0.001nm**	$\frac{\text{wavelength range}}{25{,}000}$ Example values: 0.002nm (wavelength range of 50nm) 0.004nm (wavelength range of 100nm)
Maximum step size	**wavelength range** Example values: 10nm (wavelength range of 10nm) 15nm (wavelength range of 15nm)	**25nm**

If required, the LASER will automatically decrease or increase the step size accordingly.

4.3.2.2 Trigger output signal

In Step Dwell mode your LASER generates a trigger signal through its Start/Stop trigger output.



Operation mode	Trigger output	Output
Step Dwell	Start/Stop trigger	**High** when transitioning to a new wavelength set point. **Low** when settled and stabilized at the wavelength set point, for the set dwell time.
	Sync trigger	Unused

4.3.2.3 Sampling

The ideal time to sample based on the trigger is on/after the falling edge of a trigger pulse on the Start/Stop trigger line, within the set dwell time.

4.3.2.4 Number of pulses

The total number of pulses generated per sweep in Step Dwell mode is determined by:

$$total = floor\left[\frac{\lambda_{stopping} - \lambda_{stopping}}{\lambda_{step}}\right] + 1$$

In Step Dwell mode, the minimum value of total is 2, the maximum value is 25,001.

You can reduce the number of pulses by setting a skip factor N. For details, refer to Skip factor N: Keep 1, skip N.

4.3.3 Step Sweep mode / Linear Sweep mode

In Step Sweep mode and Linear Sweep mode you configure a sweep by setting:

- the starting and stopping wavelength (wavelength range)
- the sweep rate

On starting the sweep, the laser sweeps over the set wavelength range.

> In Step Sweep mode, the laser power is disabled for a short period of time at each wavelength tuning step.
> In Linear Sweep mode, the laser power is always on.

If the LASER is configured for multiple sweeps, the laser returns to the starting wavelength after getting to the end of the range and repeats the sweep. Successive sweeps will have a ~60ms delay between them.

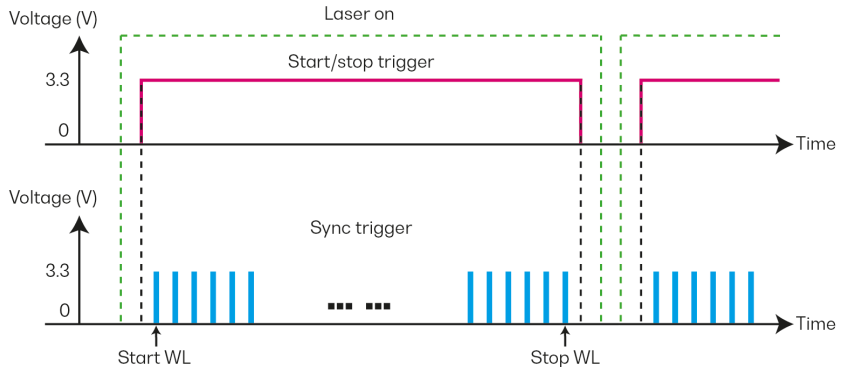
4.3.3.1 Trigger output signal

In Step Sweep and Linear Sweep mode, your LASER generates a trigger signal through its Start/Stop and Sync trigger outputs.

Approximately 15 ms before the beginning of a laser sweep, the laser optical power is enabled.

At the beginning of the sweep (starting wavelength), the Start/stop trigger output will transition to High. The Sync trigger output will generate a pulse with the rising edge corresponding to the stable optical output at the starting wavelength and with every subsequent wavelength tuning step. Every pulse of the sync trigger line represents an equal increase in wavelength, based on the selected sweep rate.

At the end of the sweep (stopping wavelength), the Start/stop trigger output will transition to Low; approximately 2 ms after this, the laser optical power will be disabled. If multiple wavelength sweeps are configured, there is approximately a 60ms delay between successive sweeps.



> **NOTE:** The illustration above is indicative only. In some instances the final Sync trigger pulse's falling edge could occur after the falling edge of the Start/stop trigger. The green dotted line denoting the optical output is indicative only, and not reflective of the actual optical power profile.

Operation mode	Trigger output	Output
Step Sweep Linear Sweep	Start/Stop trigger	**High** from the start to the stop wavelength point. **Low** at the stop wavelength point, when a sweep is completed.
	Sync trigger	An output pulse at every successive wavelength tuning step in a sweep: **High** when settled and stabilized at the wavelength tuning step. **Low** when transitioning to a new wavelength tuning step.

4.3.3.2 Sampling

The ideal time to sample based on the trigger is:

- For synchronized discrete wavelength measurements: On the rising edge of a trigger pulse on the Sync trigger line.
- For a swept wavelength measurement: On the rising edge of a trigger pulse on the Start/Stop trigger line.

4.3.3.3 Number of pulses

The total number of pulses generated per sweep is determined by this equation, with $\Delta_{step} = \Delta\lambda$ as listed against sweep rates in the tables below:

$$total = floor\left[\frac{\lambda_{stopping} - \lambda_{stopping}}{\lambda_{step}}\right] + 1$$

In Step Sweep mode, the maximum value of total is 25,001.

You can reduce the number of pulses by setting a skip factor N. For details, refer to Skip factor N: Keep 1, skip N.

4.3.3.4 Sync pulse

The following tables list the wavelength step and sync trigger pulse parameters associated with some typical sweep rates in Step Sweep and Linear Sweep mode.

Δ λ: the step between successive wavelength tuning steps during the sweep; the laser will increment the wavelength by this value

pulse width: time between the rising and falling edge of any given pulse

pulse period time between successive rising or falling edges of any two pulses

Step Sweep mode

Sweep rate (nm/s) - Step Sweep mode	Pulse period (µs)	Pulse width (µs)	Δ λ (pm)
400	50	16	20
300	66.7	24	20
200	50	16	10
160	62.5	20	10
150	66.7	24	10
120	83	32	10
100	50	16	5
80	50	16	4
60	83	32	5
50	80	28	4

Linear Sweep mode

In Linear Sweep mode you can set the sweep rate to any positive integer from 2,000 to 10,000.

The change in wavelength **Δ λ** for every sync pulse is determined by:

$$\Delta\lambda = \frac{sweep\ rate}{20{,}000}$$

Sweep rate (nm/s) - Linear Sweep mode	Pulse Period (µs)	Pulse width (µs)	Δ λ (nm)
2,000	50	16	0.10
5,000	50	16	0.25
10,000	50	16	0.50

4.3.3.5 Examples

Example 1

At a **sweep rate of 50nm/s** in **Step Sweep mode**, each Sync trigger pulse has a pulse width of 28µs and the time between successive rising edges of Sync trigger pulses is 80µs.

With a starting wavelength of 1250nm and a stopping wavelength of 1350nm, the expected number of sync pulses is 25,001.

When applying a skip factor N > 0:

N=1 increases the time between pulses to 160µs, and decreases the number of pulses to 12,501.

N=2 increases the time between pulses to 240µs, and decreases the number of pulses to 8,334.

Etc.

Example 2

At a **sweep rate of 200nm/s** in **Step Sweep mode**, each Sync trigger pulse has a pulse width of 16µs and the time between successive rising edges of Sync trigger pulses is 50µs.

With a starting wavelength of 1300nm and a stopping wavelength of 1320nm, the expected number of sync pulses is 2,001.

When applying a skip factor N > 0:

N=1 increases the time between pulses to 100µs, and decreases the number of pulses to 1,001.

N=2 increases the time between pulses to 150µs, and decreases the number of pulses to 667.

Etc.

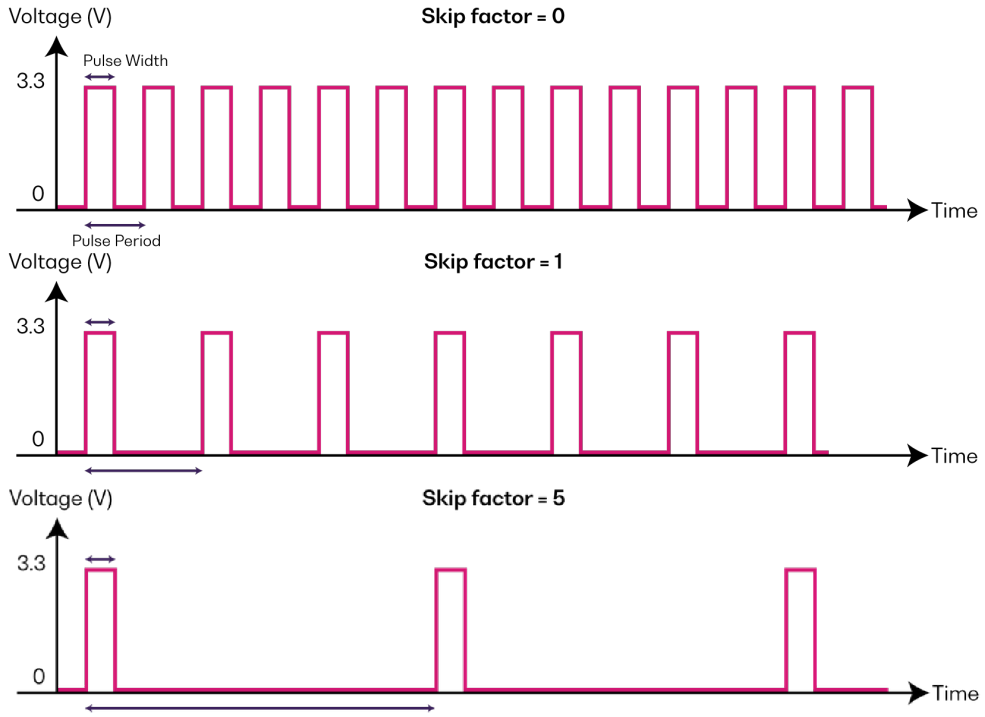
4.4 Skip factor N: Keep 1, skip N

Setting a skip factor for the trigger output signal enables you to reduce the number of trigger pulses. The skip factor N is a positive integer ≥ 0 where N pulses of the base rate are skipped between every pulse that is let through. The number of pulses that are let through is defined by:

$$output = ceil\left(\frac{total}{N+1}\right)$$

total is the total number of pulses, **output** is the total number of pulses that are let through, **N** is the skip factor.

Skip factor	Details
<**N**>	skip <**N**> pulses after the first pulse, repeat
0 (default)	the generated signal remains unchanged
1	skip **1** pulse after the first pulse, repeat
5	skip **5** pulses after the first pulse, repeat



You can onfigure the skip factor in CohesionUI or through SCPI commands.

4.5 Polarity inversion

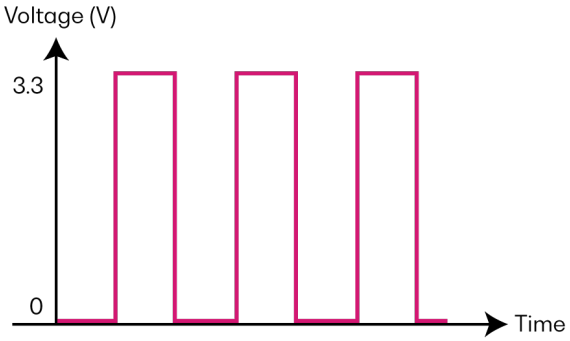
The trigger polarity inversion feature enables you to invert the trigger output signals. With polarity inversion applied, the signal will be flipped so that:

- a signal that is **high** becomes **low**
- a signal that is **low** becomes **high**

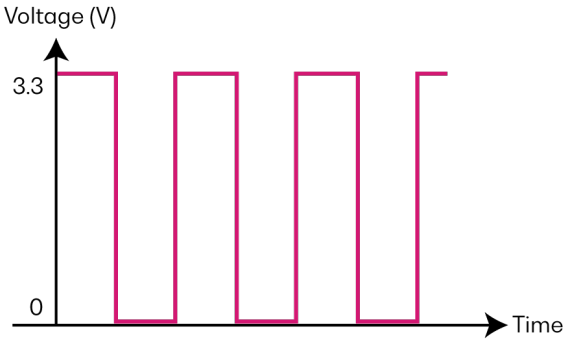
By default the unmodified signal is **high**, meaning the logic level is **high** when there is activity.

> The triggers operate at 3.3V logic.

Unmodified signal, polarity = 0



Inverted signal, polarity = 1



5 Setting up hardware

Quantifi Photonics modules are designed for easy installation in a PXIe-compatible chassis.

Ensure that the chassis being used supports PXIe (or contains PXI-hybrid compatible slots). If you are unsure if your chassis is compatible with your Quantifi Photonics product, please contact Quantifi Photonics Customer Support.

Make sure to follow these instructions when installing or removing a Quantifi Photonics module from a PXIe chassis.

CAUTION

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

- Do not remove the product from the antistatic packaging until instructed 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:

- Do not touch the optical connectors.

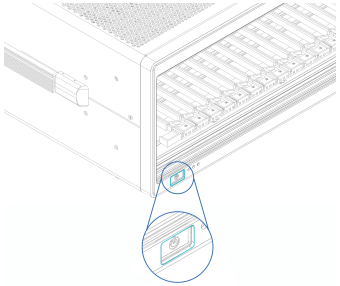
5.1 Install the module in a PXIe chassis

WARNING

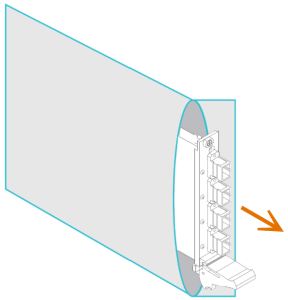
When attempting to install or remove a module or any component of the PXIe chassis:

- Power the chassis OFF.
- Follow these installation instructions.
- After powering the PXIe chassis ON, please wait at least 2 minutes before attempting to communicate with the module. This gives the chassis time to boot and initialize the communication server.

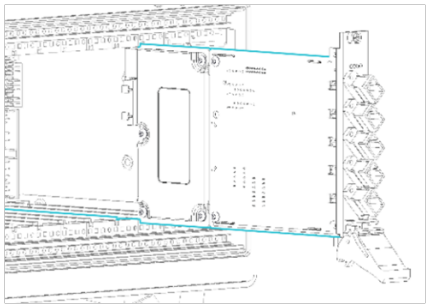
1 Power the chassis OFF.



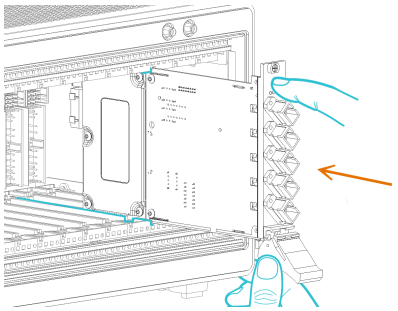
2 Remove the module from the anti-static bag. Retain the bag.



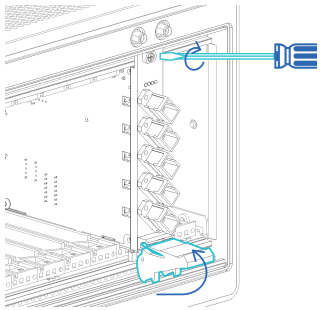
3 Align the module with the slot guide rails.



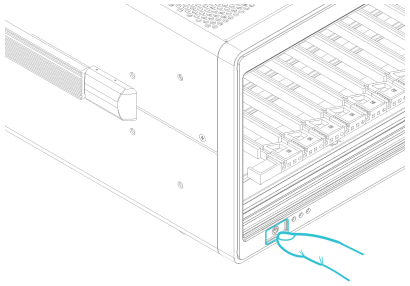
4 Push module into slot until you feel resistance from the backplane connection.



5 Engage the fastening clip. Secure all fastening screws.



6 Power the chassis ON.



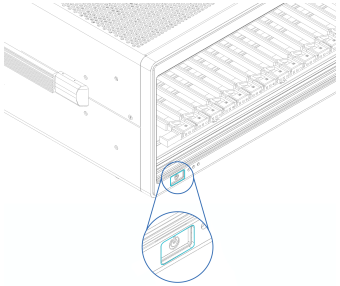
5.2 Uninstall the module from a PXIe chassis

WARNING

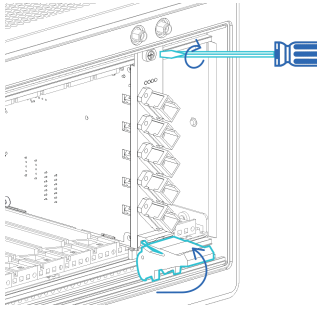
When attempting to install or remove a module or any component of the PXIe chassis:

> Power the chassis OFF.
> Follow these installation instructions.

1 Power the chassis OFF.

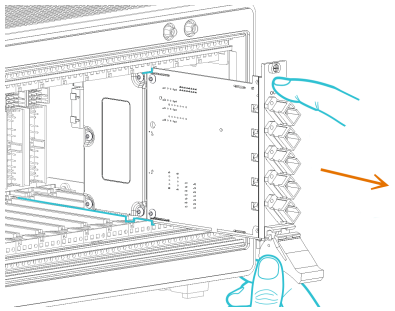


2 Unsecure the fastening screws and fastening clip.

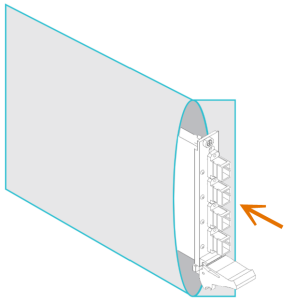


3 Pull out the module.

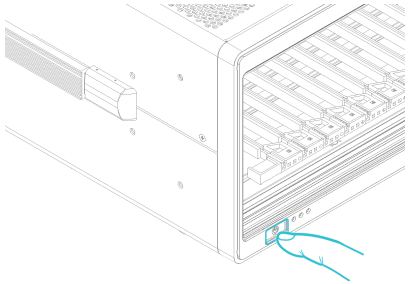
Use the fastening clip to pull. Do NOT pull on the connectors.



4 Store the module in its antistatic bag.



5 Power ON the chassis.



6 Installing software

The Cohesion Installer software package enables communication between the PXIe controller and Quantifi Photonics modules installed in a chassis.

The Cohesion Installer contains all required drivers and software:

CohesionDriver	Driver Service for Quantifi Photonics PXIe modules
CohesionSCPI	VXI11 compliant server for remote SCPI communication
CohesionUI	Web-based Graphical User Interface
Cohesion Manager	Single-window utility application that shows the status of all Cohesion Software Services running on the system. Refer Cohesion Manager.
Cohesion Firmware Updater	Single-window utility application that shows the current firmware status of all Quantifi Photonics PXIe modules installed in the chassis. Refer Cohesion Firmware Updater.

6.1 Install the Cohesion Installer software package

Install Cohesion Installer on:

- the PXIe controller of the PXIe Chassis in which the Quantifi Photonics module(s) will be installed, or
- the controller PC (multi-chassis MXI setup)

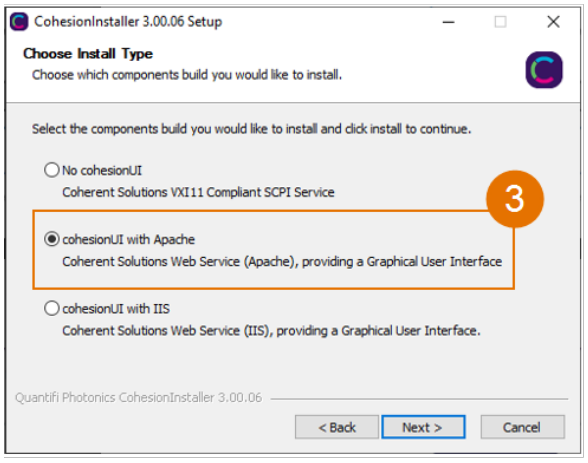
For details on system requirements, refer System requirements.

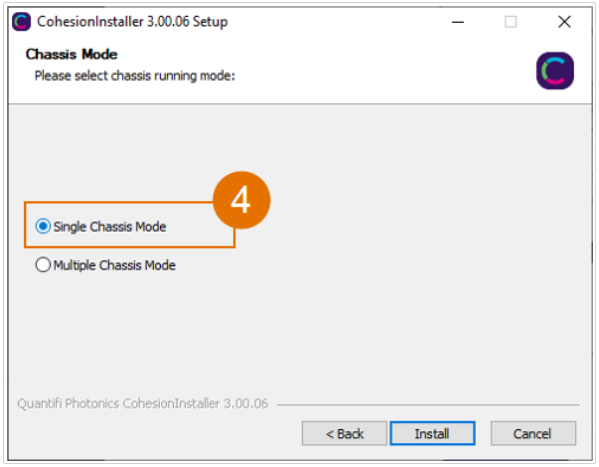
▶ To install Cohesion Installer:

Note: Modules of the LASER 2000 Series are supported by the Cohesion Installer software package version 3.03.10 or newer.

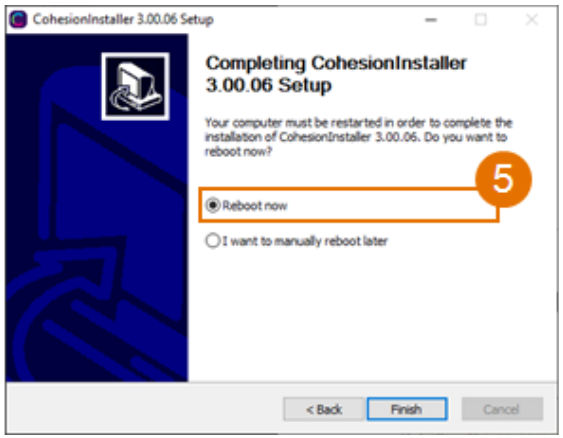
1. We recommended that you save your work and close open programs before installing Cohesion Installer.
2. Locate and run **CohesionInstaller-<version_number>.exe** from the provided USB media device (or download it from the Quantifi Photonics website) and follow the on-screen installation prompts.
3. Select the Installation Type: **CohesionUI with Apache** (this is the default setting)
4. Select the Chassis Mode: **Single Chassis Mode** (this is the default setting). If unsure, select this default setting.

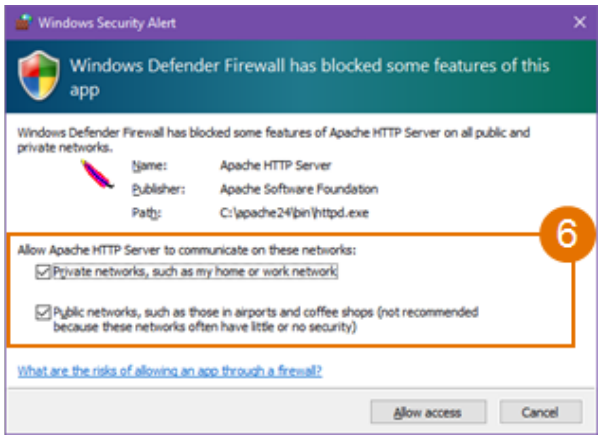
   To operate in Multiple Chassis Mode, additional hardware modules are required. As you can change the Chassis Mode later, we recommend to select **Single Mode** unless all other configuration requirements have been met.





5. At the end of the installation, we recommend you select the **Reboot now** option, and click **Finish** to complete the installation process.
6. A Windows Security Alert may prompt the user for network access. We recommend that **both options are ticked**, to allow any network configuration.





7. On startup after rebooting the system a User Account Control prompt might be displayed.
   Click **Yes** to allow running of the **Cohesion Firmware Updater Utility** and proceed with the application.

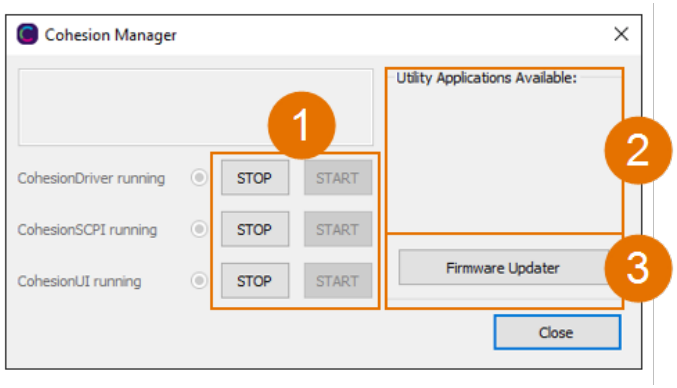
6.2 Cohesion Manager

Cohesion Manager is a single-window utitlity application that shows the status of all Cohesion Software Services running on the system.

By default, these Cohesion Software Services will start automatically on startup of Windows and need to be running to facilitate proper communication with the Quantifi Photonics PXIe modules.

CohesionDriver	required	manages installed Quantifi Photonics modules
CohesionSCPI	required	VXI11 compliant SCPI interface for TCP communication with the installed Quantifi Photonics modules
CohesionUI	optional	web service providing a graphical interface for simplified operation of installed Quantifi Photonics modules

- To open Cohesion Manager:
  - Search for Cohesion Manager in the Windows Start Menu.
- From Cohesion Manager you can:
  1. Start or stop the CohesionDriver service, CohesionSCPI service, or CohesionUI service independently.
  2. View all installed Quantifi Photonics system utilities.
  3. In this example you can open the Cohesion Firmware Updater application.



- If you can't detect or communicate with modules:
  - Open Cohesion Manager.
  - Check the status of software services, and start a service if required.

6.3 Cohesion Firmware Updater

Cohesion Firmware Updater launches automatically when you install a new version of Cohesion Installer on the system and reboot. Or, you can open it via the Cohesion Manager application.

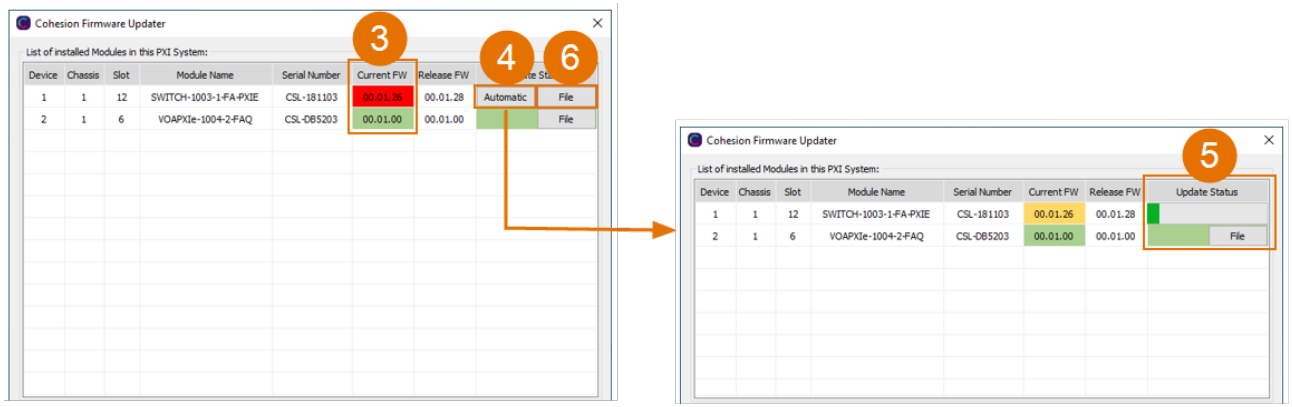
It is a single-window summary application that enables you to:

- view the current firmware status of all Quantifi Photonics PXIe modules installed in the chassis.
- update firmware to a new version if available.

> We recommended that you update firmware if a new version is available.

▶ To upgrade firmware:

1. Open **Cohesion Manager**, for example by searching for it in the Windows Start Menu.
2. In **Cohesion Manager**, click **Firmware Updater**.
3. Modules with out-of-date firmware are highlighted red.
4. Click **Automatic** to update automatically.
5. Progress will be displayed in **Update Status**.
6. Click **File** to update to a specific firmware package.

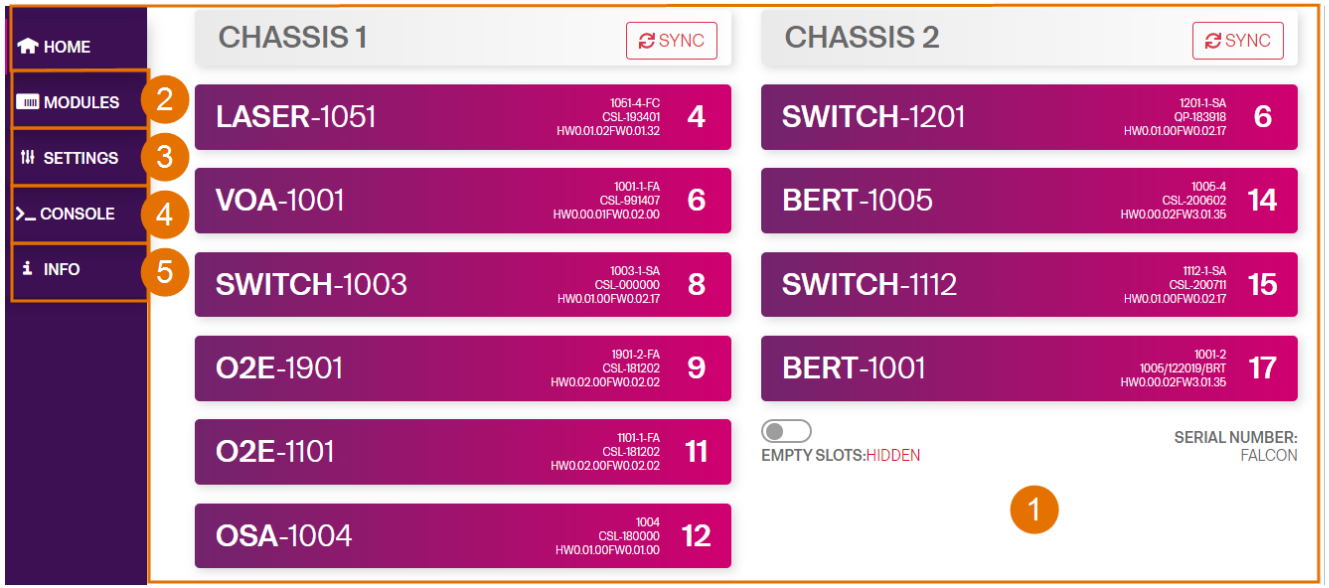


7 CohesionUI - Overview

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

> CohesionUI is part of the Cohesion Installer software package. For details on Cohesion Installer, refer Installing software.

1. **HOME**: View all modules in the chassis
2. **MODULES**: Access a module
3. **SETTINGS**: Change CohesionUI settings
4. **CONSOLE**: Communicate with modules using SCPI commands
5. **INFO**: Display chassis information



7.1 Access a module with CohesionUI

You can access Quantifi Photonics modules via CohesionUI from the chassis controller, or from a controller PC .

To connect with a module, you need the IP address of the chassis the module is installed in.

▶ To obtain the IP address of the chassis:

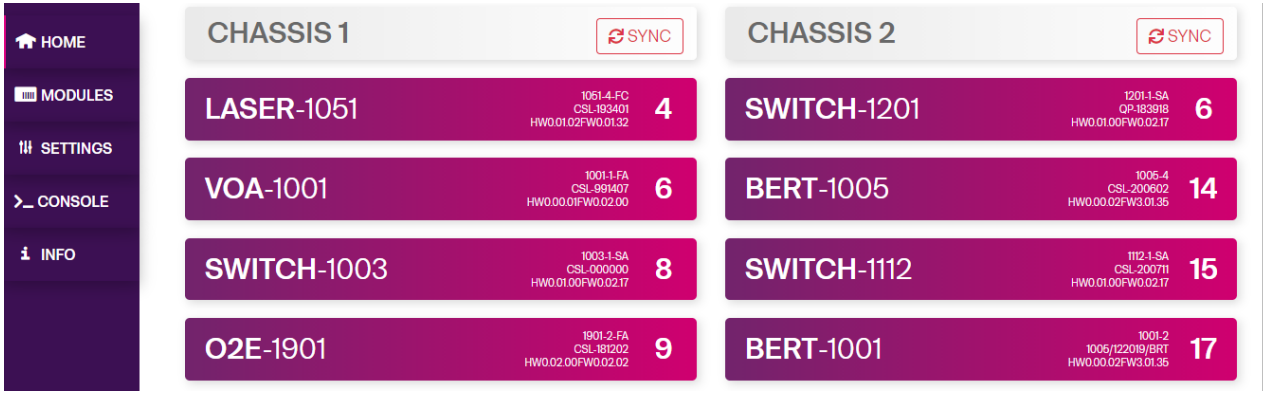
1. Open the **Command Prompt** window on the chassis controller.
2. Run the `ipconfig` command.
3. Note down the IPv4 address that is displayed.

▶ To connect with modules via CohesionUI:

1. On the controller or controller PC, open CohesionUI, for example by double-clicking the desktop icon, or open a supported browser (refer System requirements).
2. Enter the IP address of the chassis as the URL.

   On the controller you can use `127.0.0.1` as the URL instead.

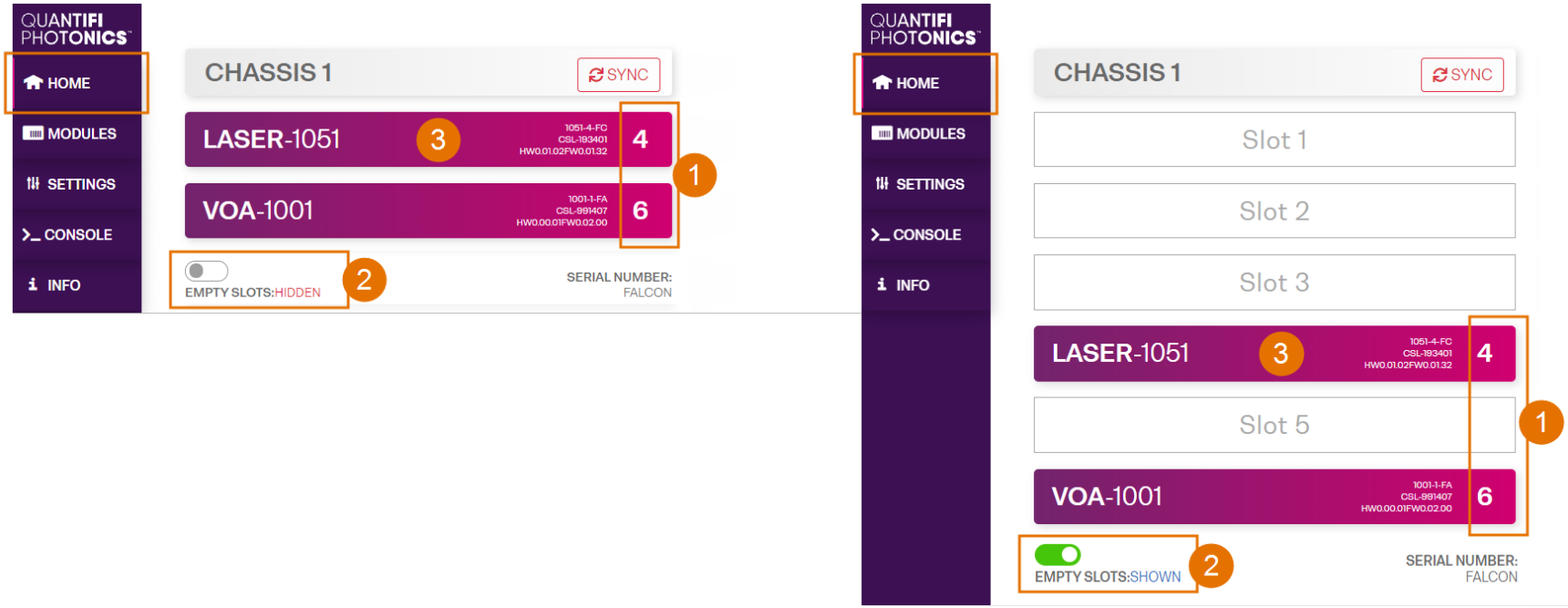
3. CohesionUI will launch in the browser, listing all available Quantifi Photonics modules installed in the chassis (refer Display modules in a chassis).



7.2 Display modules in a chassis

The **HOME** page is the main landing page in CohesionUI; it displays all available Quantifi Photonics modules in the PXIe chassis.

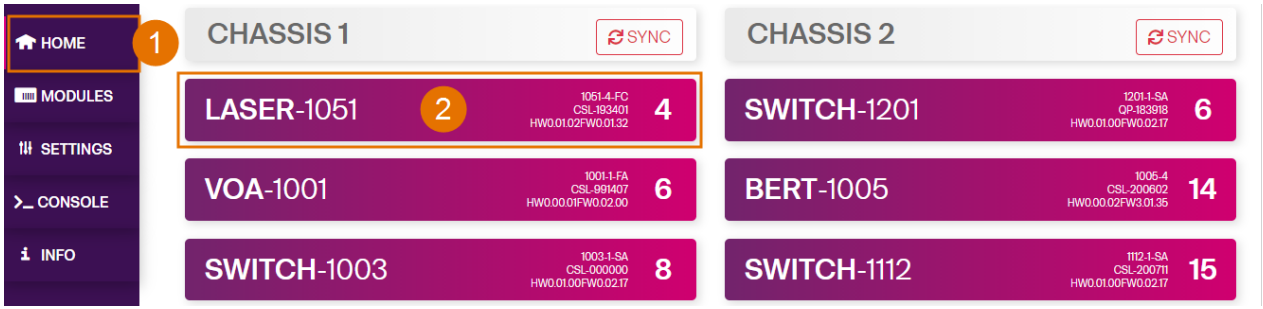
1. Numbers indicate the slots the modules are installed in.
2. You can hide (default setting) or show empty slots in the PXIe chassis by toggling the **EMPTY SLOTS** button.
3. You can select a module to work with by clicking it.



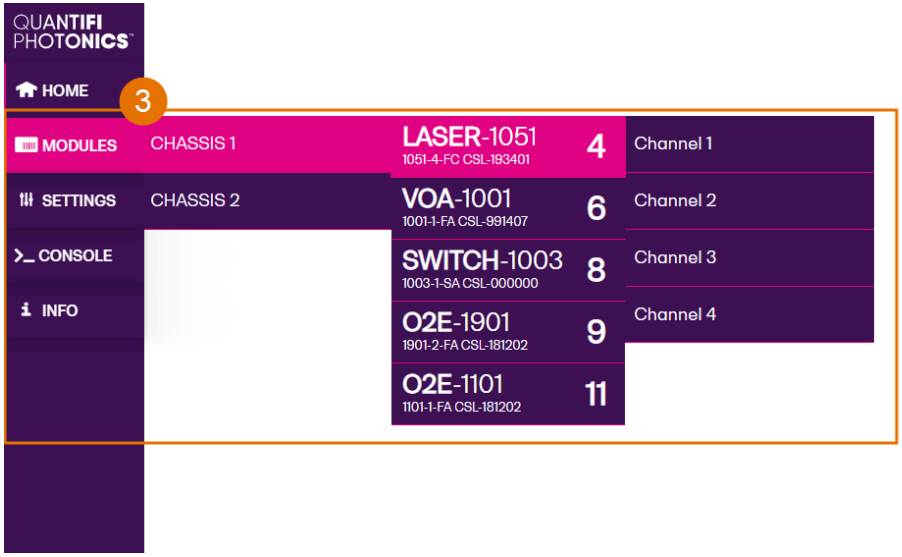
7.3 Select a module to work with

To select a module:

1. Go to the **HOME** page.
2. Click the on the module.



3. Or, hover over the **MODULES** menu and select a module or channel from the list.



7.4 Manage CohesionUI settings

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

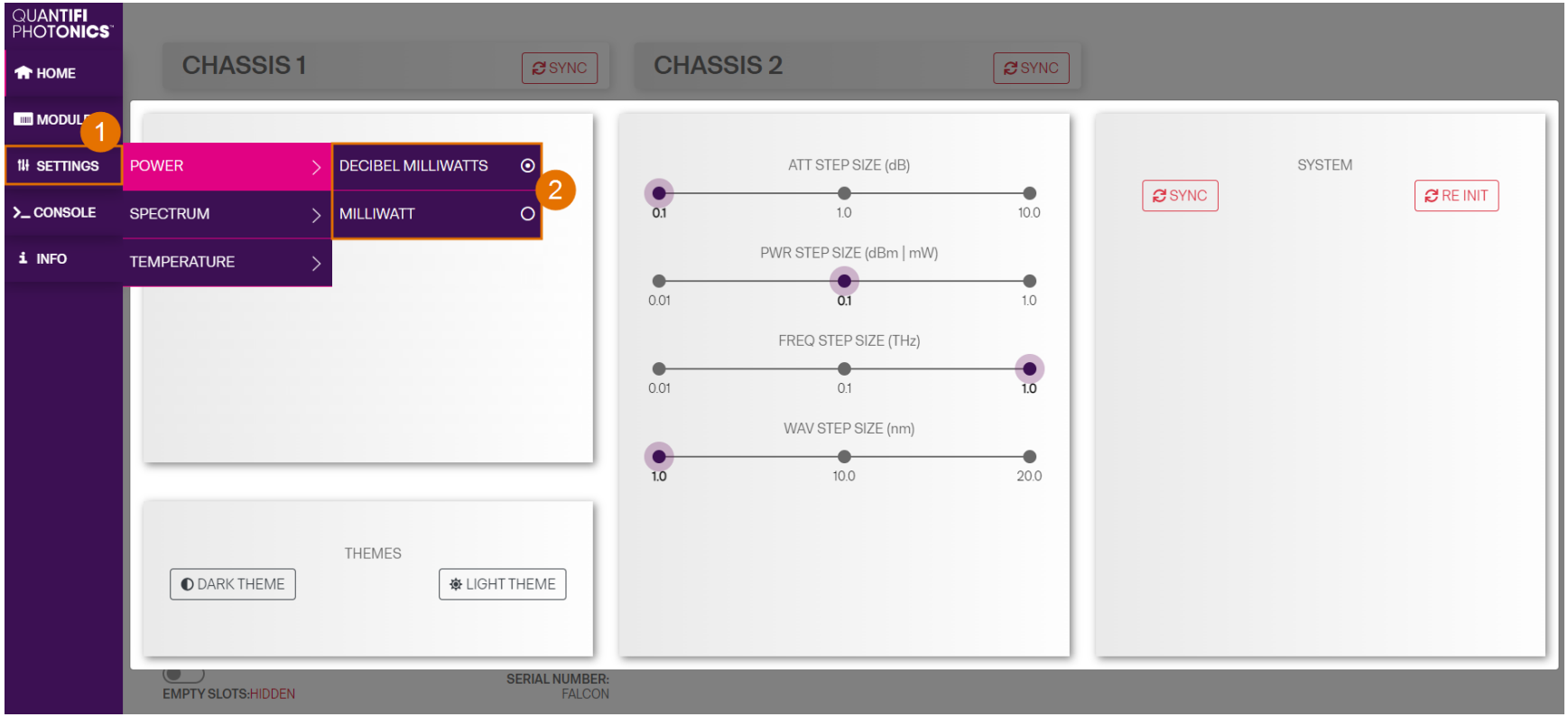
> **NOTE**
>
> CohesionUI reverts to default settings when power-cycling the chassis.

▶ 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 Synchronize and reinitialize CohesionUI

You can update CohesionUI with the latest information from your Quantifi Photonics modules by synchronizing or reinitializing.

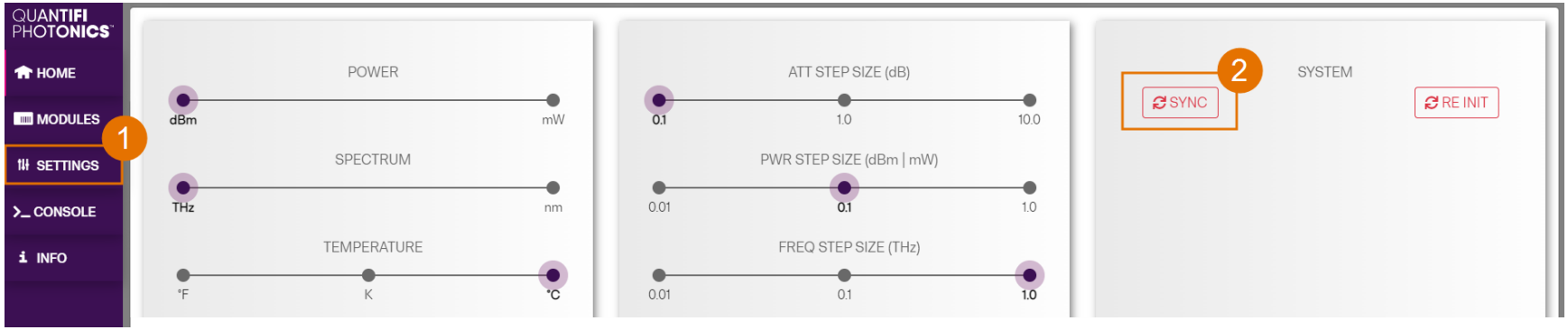
Synchronizing	Updates **CohesionUI** with the latest information from the **CohesionSCPI service**
Reinitializing	Updates **CohesionUI and the CohesionSCPI service** with the latest information from the **CohesionDriver service**

This can be particularly useful when operating a multi-chassis MXI setup and enables you to:

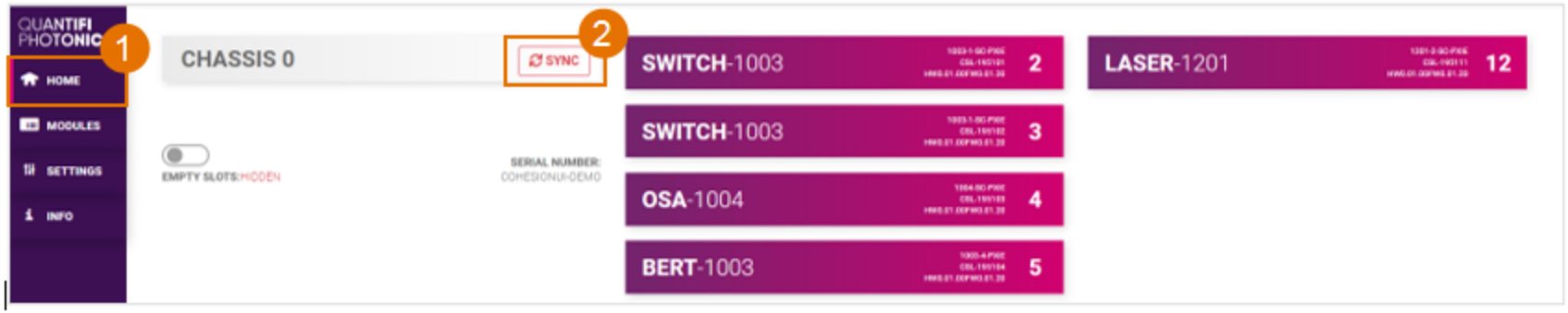
- Re-discover modules that CohesionUI does not display as expected.
- Discover modules that have been installed after the initial startup.

▶ To **synchronize** CohesionUI across **all modules in all chassis**:

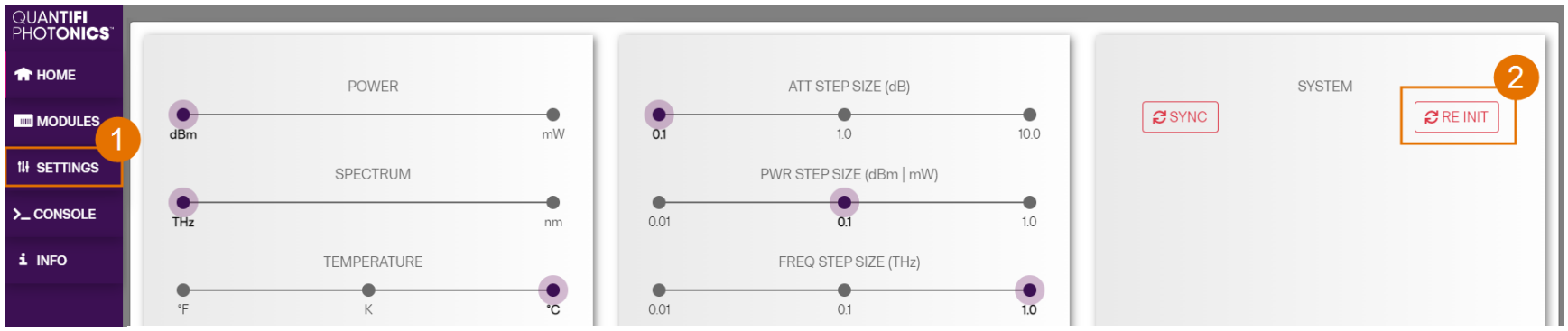
1. Click **SETTINGS**.
2. Click **SYNC**.
3. The page will be disabled while synchronizing.



- To **synchronize** CohesionUI across **all modules in a selected chassis** only:
  1. Click **HOME**.
  2. Click **SYNC** for a selected chassis.
  3. The page will be disabled while synchronizing.



- To **reinitialize** CohesionUI across **all modules in all chassis**:
  1. Click **SETTINGS**.
  2. Click **RE-INIT**.
  3. All modules will be disabled and temporarily disconnected while reinitializing.



7.6 SCPI CohesionUI Command Console

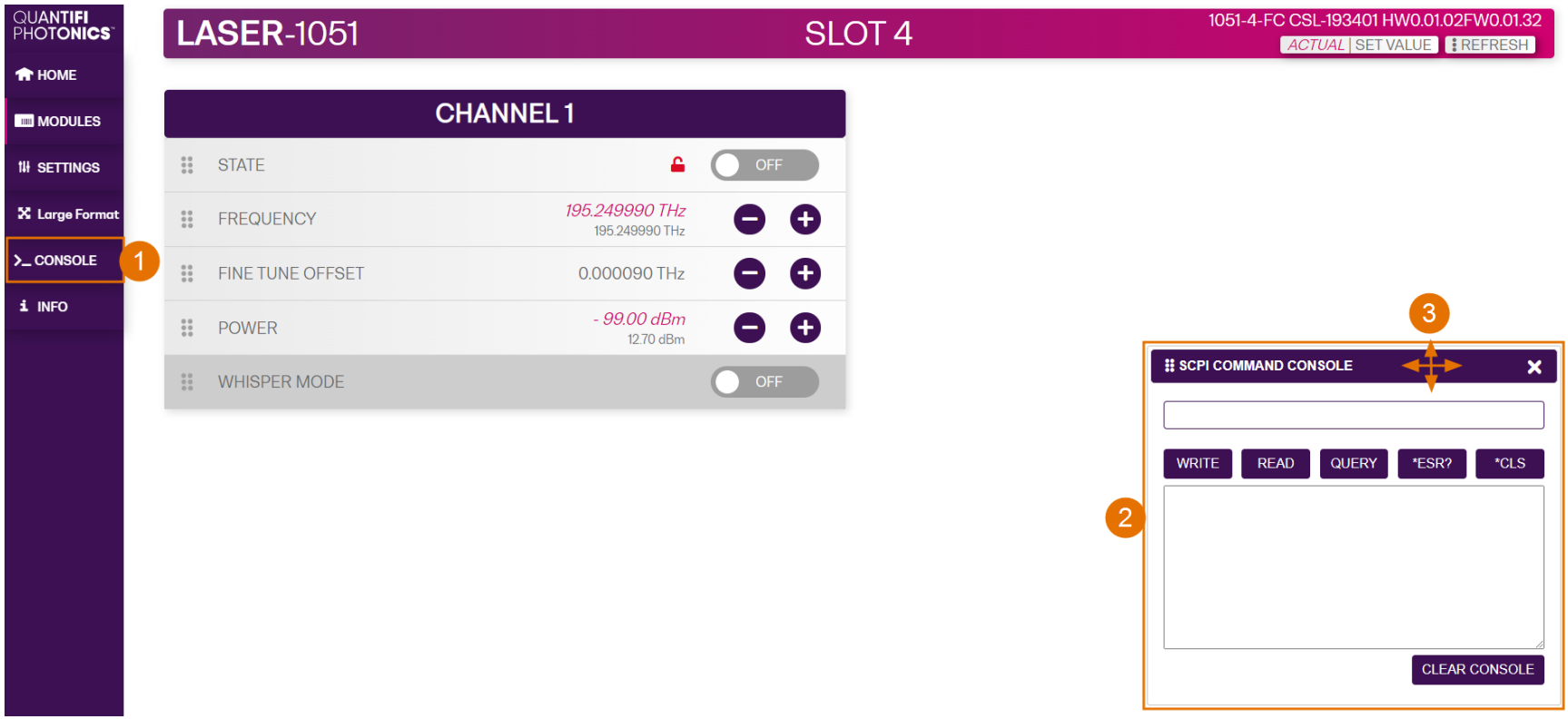
The CohesionUI SCPI Command Console enables you to communicate with Quantifi Photonics PXIe modules via SCPI commands. It enables you to test commands and verify their syntax.

For details on available SCPI commands, refer to the programming guide in this manual.

- To open the SCPI Command Console:

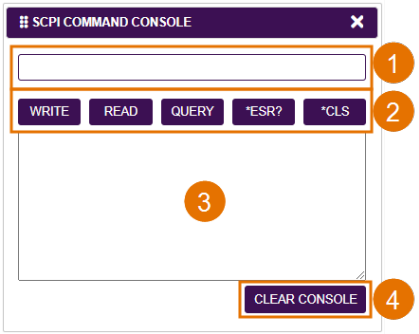
  1. On the CohesionUI menu, click **CONSOLE**.
  2. The console will appear in the bottom right corner of the screen.
  3. You can move the console by clicking on the title bar and dragging it to any position on the screen. On closing and re-opening, the console will re-appear at its last position.

The console remains open when navigating between different modules. It floats on top of the UI so that you can observe the effect of SCPI commands on a module in real-time.



▶ To communicate with a module via the SCPI Command Console:

1. Enter a command.
2. Select action(s).
3. Review the action response in the output area.
4. (optional) Clear the output area.



You can choose from these SCPI command actions:

Action	Meaning	FAILED response
WRITE	Send the command to the instrument	The command is invalid. Please check the command and syntax.
READ	(after WRITE) Request the response from the instrument	Response buffer is empty.
QUERY	WRITE and READ	
*ESR?	Query the status event status register (ESR) – this will give you more details and specific information about command failures. For details on error codes, please refer to the programming guide in this manual.	
*CLS	Clear the response buffer and start fresh – useful when getting out of sync with WRITE and READ actions	

Example 1: Send instrument identification query `*idn?`

1. Enter the command: `*idn?`
2. Click **QUERY**.
3. The module returns the requested information.

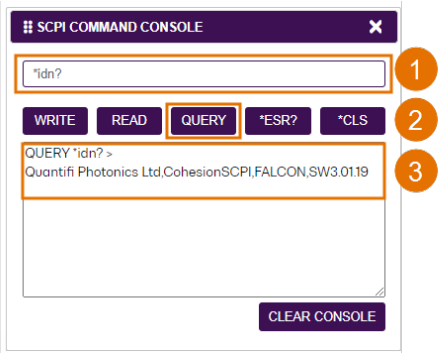
Example 2: What happens when I send an incorrect command?

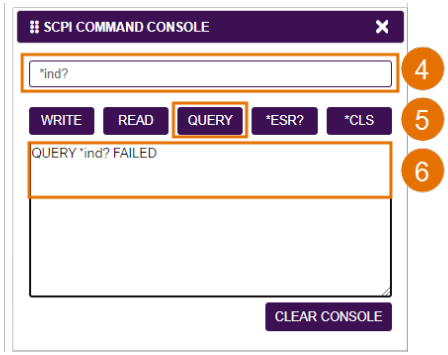
4. Enter an incorrect command, for example: ***ind?**
5. Click **QUERY**.
6. The module returns **FAILED**.

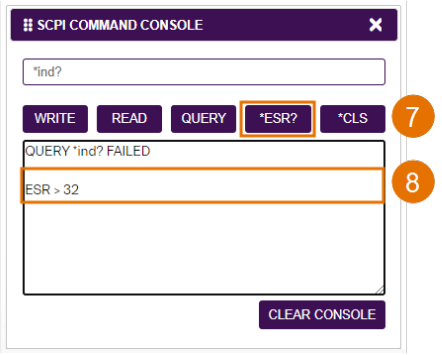
Example 3: Investigate a command failure:

7. Click `*ESR?` to query the event status register and request information about the command failure.
8. The instrument returns the error code, for example 32.

   For details on error codes, please refer to the *ESR? command in the programming guide.





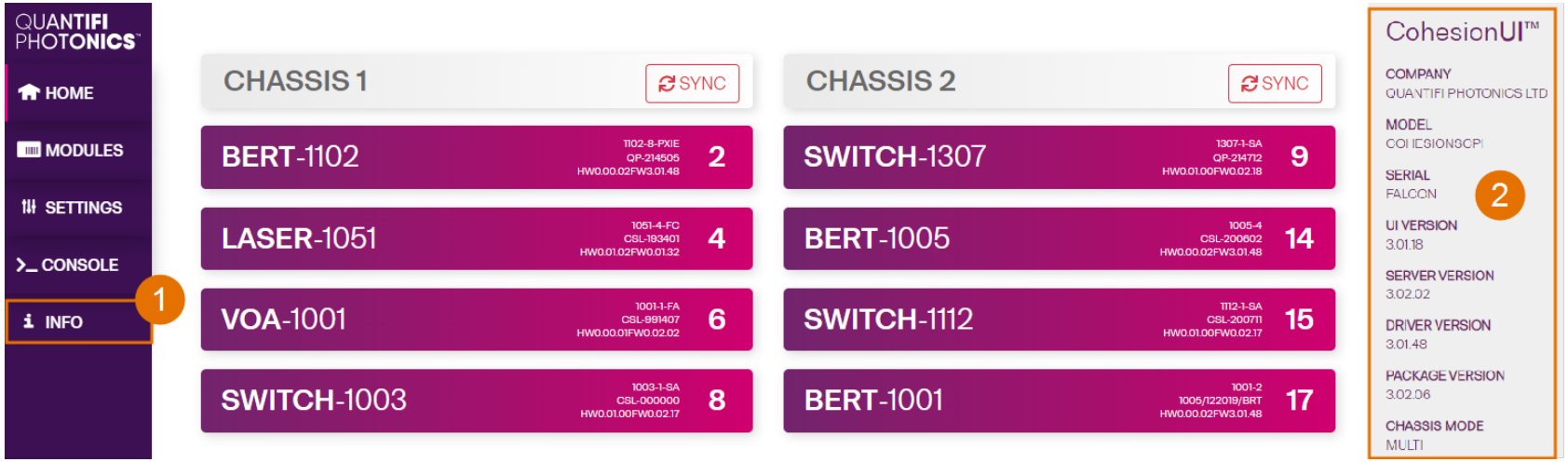


7.7 View system information

7.7.1 PXIe Chassis

- To display chassis information:

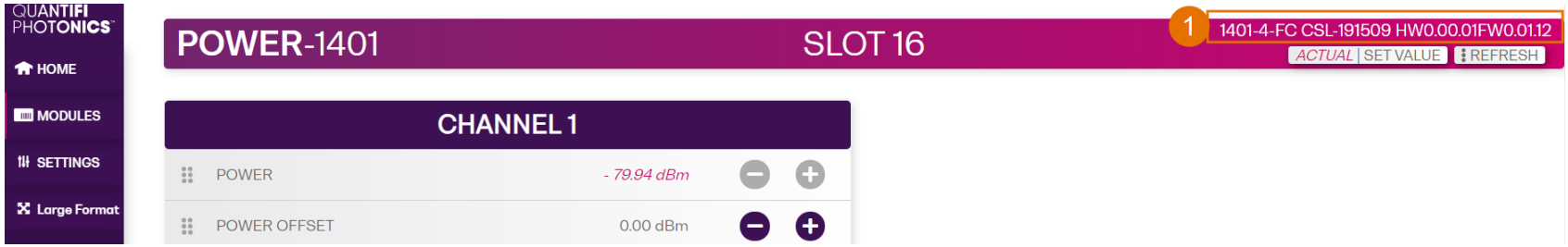
1. Click **INFO**.
2. The information panel will display operation mode, manufacturer, model, and serial number of the chassis, and the version of CohesionUI and CohesionSCPI service running on the chassis.



7.7.2 Module

- To view module information when working with a module in CohesionUI:

1. Model number, serial number and firmware versions are displayed in the top right corner.



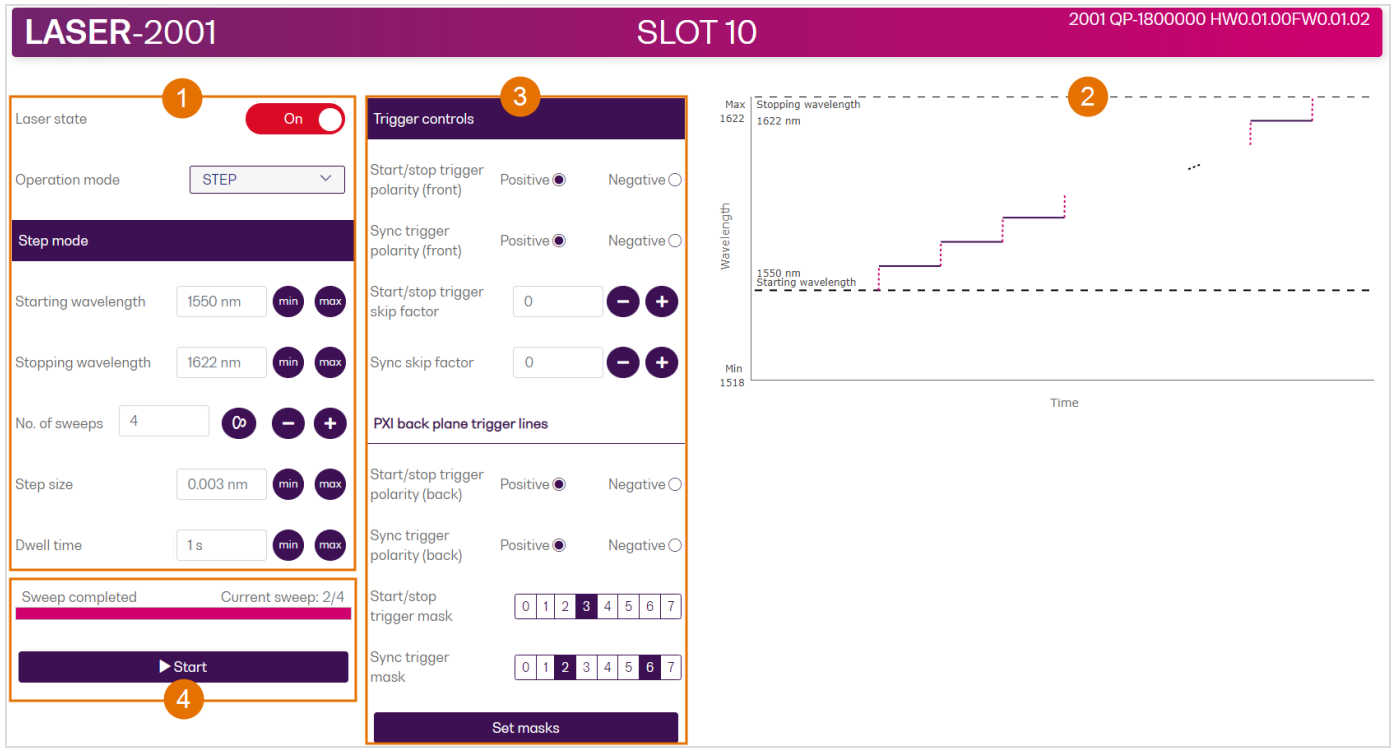
8 Controlling your LASER with CohesionUI

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

In CohesionUI you can:

1. Configure a sweep across a wavelength range in Step Dwell, Step Sweep, Linear Sweep or Fixed mode, and turn the laser on/off.
2. Visualize the wavelength sweep for the selected operation mode.
3. Synchronize connected devices via the trigger outputs.
4. Configure the trigger settings for the Start/Stop and Sync trigger outputs.

> To ensure accurate power and wavelength readings, turn the laser output ON (at any wavelength) for a **warm-up period of at least 30 minutes** before using the module with your test setup.



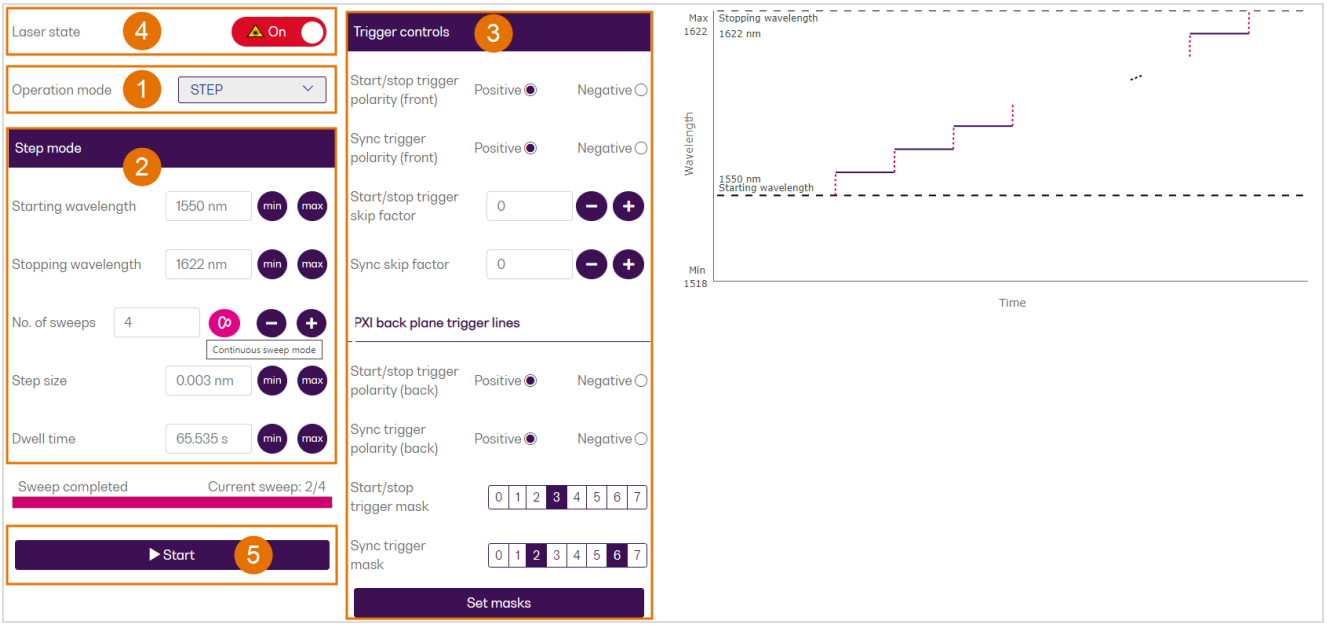
8.1 Step Dwell mode

In Step Dwell mode the laser will start the sweep at the starting wavelength, remain there for the duration of the dwell time and then move to the next wavelength as defined by the step size. On reaching the stopping wavelength the laser will stop, or repeat the sweep as per the set number of sweeps.

> **NOTE:** One wavelength sweep in Step Dwell mode can comprise a maximum of **25,000 steps**.

▶ To configure a sweep in Step Dwell mode:

1. Select **Operation mode: STEP**.



2. Configure the sweep:

   - Define the wavelength range by setting a **Starting** and **Stopping wavelength**.
   - Enter **Step size** and **Dwell time**.
   - Set **No. of sweeps** by entering an integer, or select **continuous sweep mode** to repeat the sweep until you stop it.

   For details on valid step size values, refer to Step size.

   If required, the LASER will automatically decrease or increase the step size to comply with the 25,000 step maximum.

3. Set **Trigger controls** as required, for details refer to Trigger controls.

To start/stop the sweep:

4. Set **Laser state**: **ON**.
5. Click **Start** to start the sweep. You can stop a sweep at any time by clicking **Stop**.

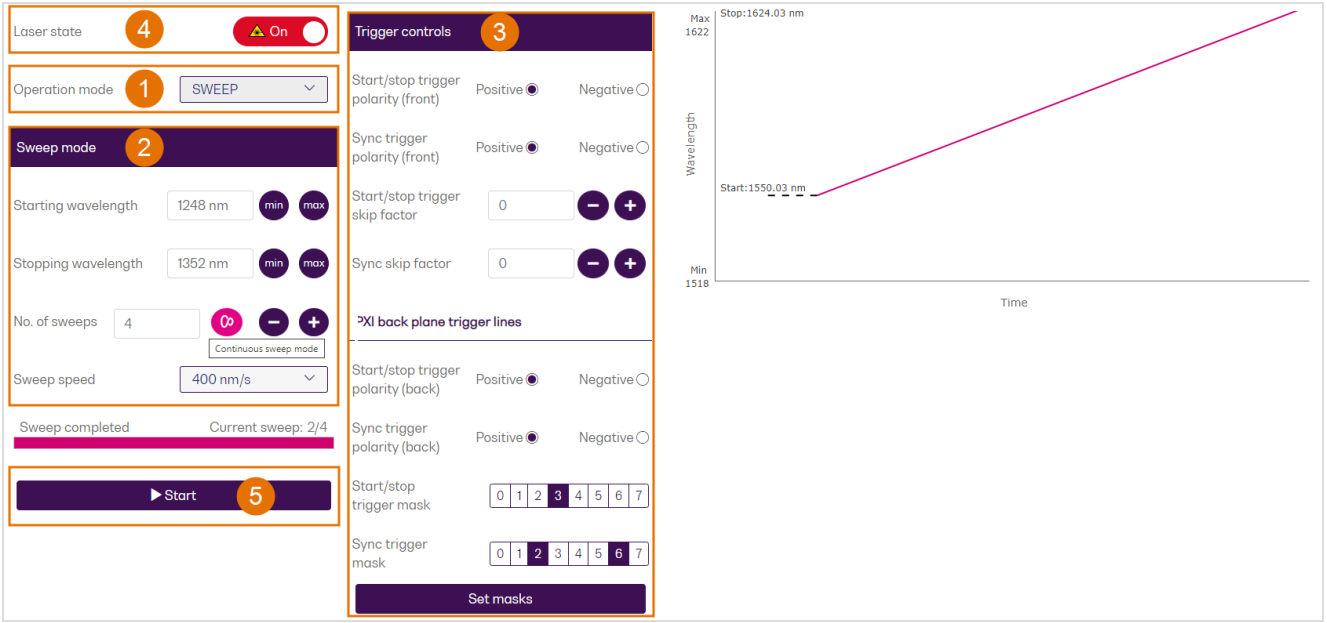
8.2 Step Sweep mode

In Step Sweep mode the laser will start the sweep at the starting wavelength and sweep over the wavelength range at the selected sweep speed. On reaching the stopping wavelength, the laser will stop or repeat the sweep as per the set number of sweeps.

> In Step Sweep mode, the laser power is disabled for a short period of time at each wavelength tuning step.

▶ To configure a sweep in Step Sweep mode:

1. Select **Operation mode: SWEEP**.



2. Configure the sweep:
    - Set **Starting** and **Stopping wavelength**
    - Select **Sweep speed**.
    - Set **No. of sweeps** by entering an integer, or select **continuous sweep mode** to repeat the sweep until you stop it.
3. Set **Trigger controls** as required, for details refer to Trigger controls.

▶ To start/stop the sweep:

4. Set **Laser state**: **ON**.
5. Click **Start** to start the sweep. You can stop a sweep at any time by clicking **Stop**.

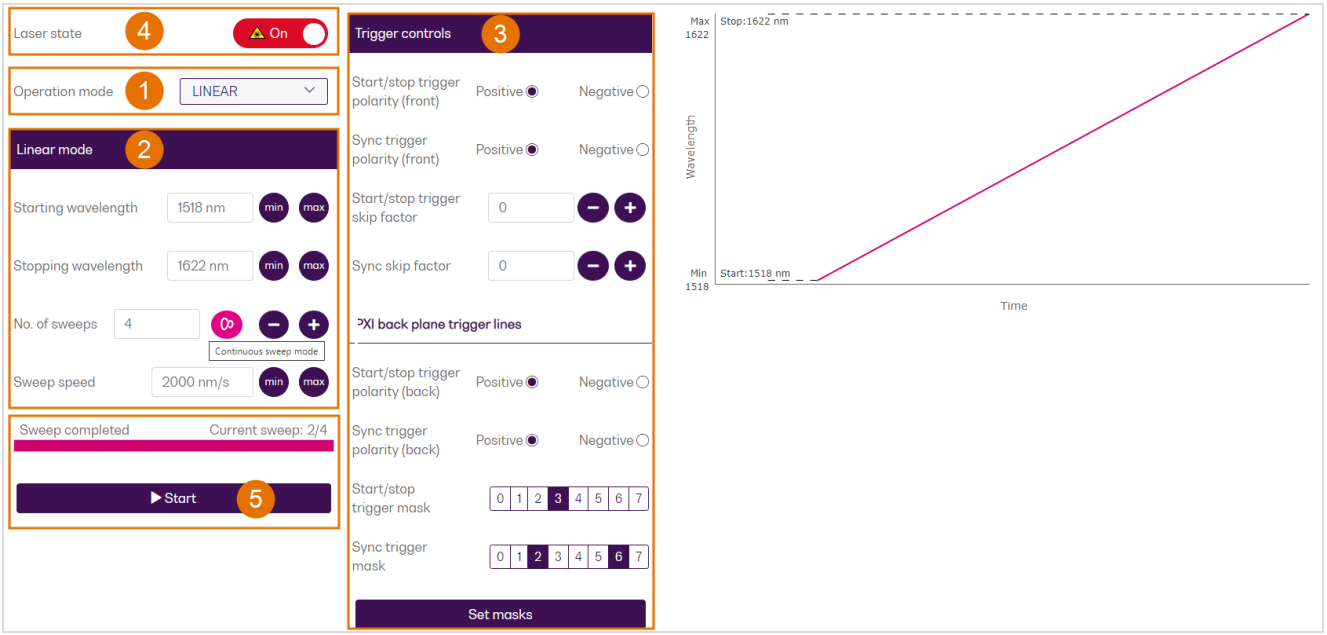
8.3 Linear Sweep mode

In Linear Sweep mode the laser will start the sweep at the starting wavelength and sweep over the wavelength range at the selected sweep speed. On reaching the stopping wavelength, the laser will stop or repeat the sweep as per the set number of sweeps.

> In Linear Sweep mode, the laser power is always enabled throughout the sweep.

▶ To configure a sweep in Linear Sweep mode:

1. Select **Operation mode: LINEAR**.



2. Configure the sweep:
   - Set **Starting** and **Stopping wavelength**
   - Select **Sweep speed**.
   - Set **No. of sweeps** by entering an integer, or select **continuous sweep mode** to repeat the sweep until you stop it.
3. Set **Trigger controls** as required, for details refer to Trigger controls.

▶ To start/stop the sweep:

4. Set **Laser state**: **ON**.
5. Click **Start** to start the sweep. You can stop a sweep at any time by clicking **Stop**.

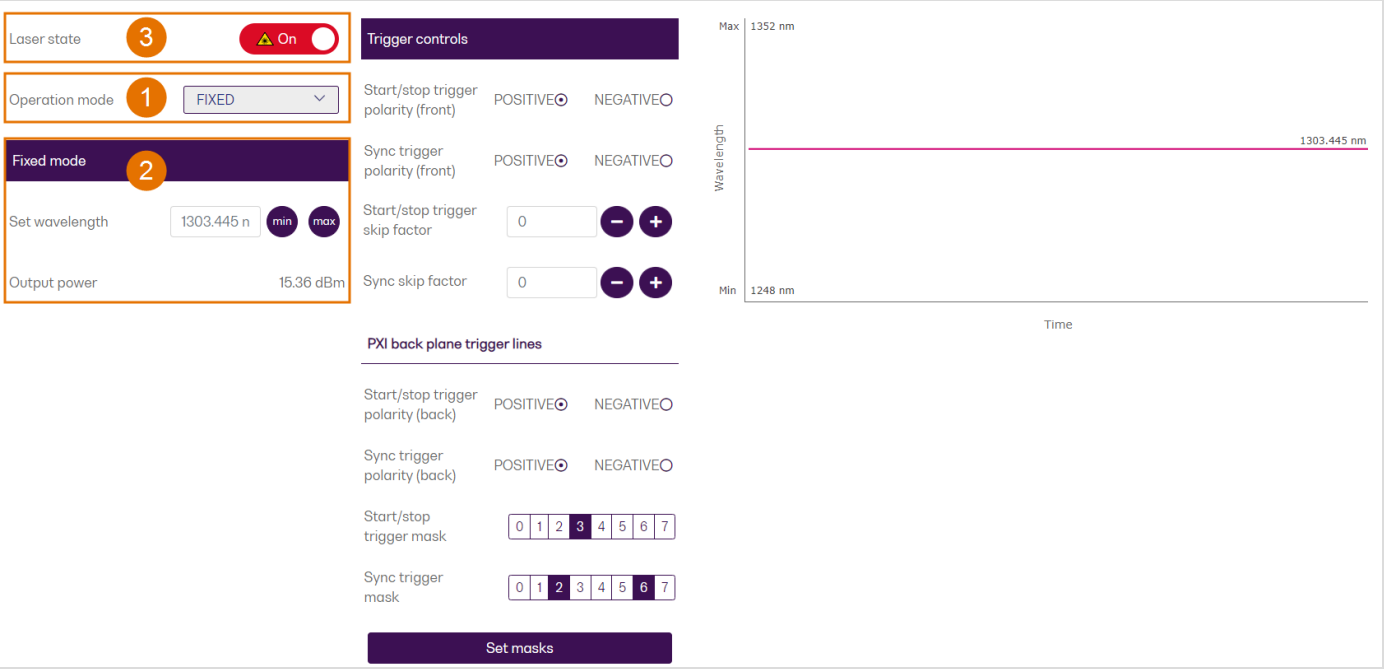
8.4 Fixed mode

In Fixed mode the laser will tune to the set wavelength value and maintain its output at this point.

In this mode you can view an optical output power reading.

- To run the module in Fixed mode:

1. Select **Operation mode: FIXED**.
2. Set the **wavelength**. The current laser output power reading for this wavelength will be displayed.
3. Set Laser state to **ON**.

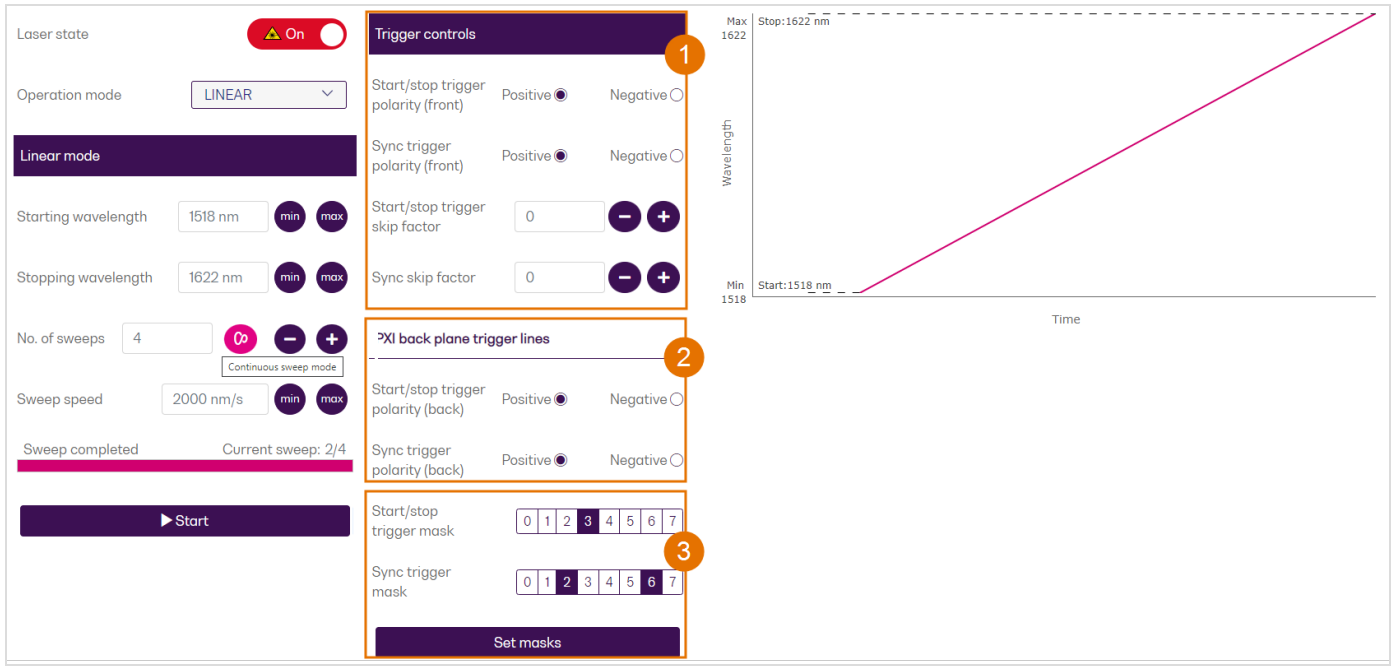


8.5 Trigger controls

You can synchronize other measurement tools, for example fast optical power meters, spectrum analyzers, and oscilloscopes, via the trigger outputs. You can define the trigger output signal by setting the polarity and skip factor (for details refer to Skip factor N: Keep 1, skip N):

Polarity	POSITIVE (default)	the signal remains unchanged (high)
	NEGATIVE	inverts the signal (low)
Skip factor N	0 (default)	the signal remains unchanged
	N > 0	skip N pulses after the first pulse: keep 1, skip N

- To define the signal of the Sync and Start/stop trigger outputs on the **front of your LASER module**:
  1. Set the **polarity** and **skip factor** of the trigger outputs.
- To route trigger output signals to the **PXI backplane trigger lines**:
  2. Set the **polarity** of the trigger output signals.
  3. Select the **trigger line(s)** and click **Set masks** to route the signal(s) to the selected trigger lines. Each trigger line can only carry either the sync or the start/stop trigger signal.



9 Controlling your LASER 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 provides information on programming conventions and on commands that are available for communication with the CohesionSCPI service remotely using the VISA I/O.

> For details on programming applications, refer to section Programming applications.

9.1 Overview

You can operate your LASER module using SCPI commands.

For details on available SCPI commands, refer to:

- Command summary
- Command descriptions

For programming examples, refer to Programming examples.

For details on the module's operation modes and trigger output signals, refer to Introducing the LASER 2000 Series.

> To ensure accurate power and wavelength readings, turn the laser output ON (at any wavelength) for a **warm-up period of at least 30 minutes** before using the module with your test setup.

9.2 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	DBM	DBM
Wavelength	NM	NM, PM
Rate	NM/S	
Time	MS	S, NS

Argument	Data Format
`<wsp>`	Specifies whitespace character (0116 – 0916, 0B16 – 2016).
`<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.

9.3 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
`<slot>`	the slot index of the module	integer `<0` to `18>`

9.4 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.

9.5 Status and event registers

9.5.1 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

9.5.2 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 default bit values within the SESR Mask are all 0.

9.5.3 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

9.5.4 Service Request Enable Register (Mask)

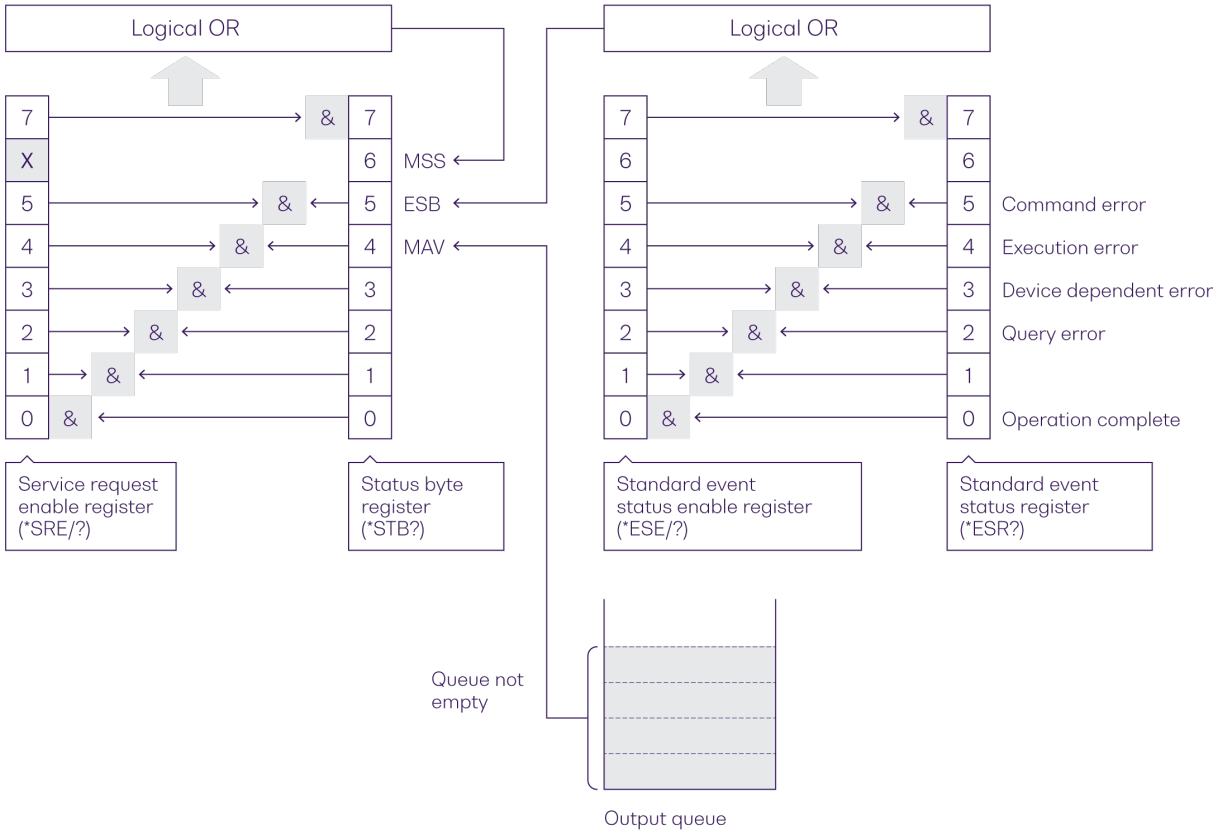
The Standard Request Enable Register (SRE Mask) is used to build the Master Summary Status Bit (MSS) within the Status Byte Register (STB). To ignore any of the events detected and set in the STB register itself, set the corresponding bit within the SRE Mask to 0. The STB can then be queried and the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

NOTE

The default bit values within the SESR Mask are all 0.

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

9.5.5 Status and event registers diagram



9.6 PXIe Multi Chassis mode operation

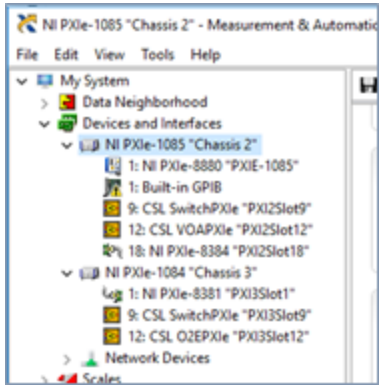
Multiple chassis can be connected to operate in **Multi Chassis Mode**.

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

9.6.1 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.



9.6.2 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 operating in SINGLE mode, this will always return 1.

Example	In Single chassis mode:
	`:SYSTEM:CHASSIS? -> 1`
	`:SYSTEM:CHASSIS? LIST -> 0`
	`:SYSTEM:CHASSIS? MODE -> SINGLE`
	
	In Multi chassis mode:
	`:SYSTEM:CHASSIS? -> 2`
	`:SYSTEM:CHASSIS? LIST -> 2,3`
	`: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`

9.7 Command summary

9.7.1 Common commands

Command	Description
`*IDN?`	Query the CohesionSCPI service identification >>
`*CLS`	Clear session message queues >>
`*OPT`	Query the modules managed by the CohesionSCPI service >>
`*OPC?`	Query the Operation Complete Status >>
`*ESR?`	Query the Standard Event Status Register >>
`*ESE?`	Query the Standard Event Status Enable Register (Mask) >>
`*ESE`	Set the Standard Event Status Enable Register >>
`*TST?`	Query the self-test status of all modules >>
`*RST`	Reset modules to default power-on settings >>

9.7.2 Slot commands

Command	Description
`:SLOT<slot>`	
`:TeST?`	Query the module self-test status >>
`:ReSeT`	Reset the module to default power-on settings >>
`:OPC?`	Query the Operation Complete Status of the module >>
`:IDN?`	Query the slot identification >>
`:OPTions?`	Query the modules managed by the CohesionSCPI service >>
`:TEMPerature?`	Query the module temperature >>

9.7.3 Configuration commands: laser operation

For details on operation modes, please refer to Operation modes.

9.7.3.1 All operation modes

Command	Description
:OUTPut<slot>	
:STATe?	Query the optical output state of the laser >>
:STATe	Set the optical output state of the laser >>
:SAFEty?	Query the status of the optical safety features >>
:MODE?	Query the laser operation mode >>
:MODE	Set the laser operation mode >>

9.7.3.2 Step Dwell mode

Command	Description
:OUTPut<slot>	
:STEP	
:STARt	Start wavelength sweep >>
:STOP	Stop wavelength sweep >>
:STATus?	Query the sweep status >>
:NUMBer?	Query the number of continuous sweeps in Step Dwell mode >>
:NUMBer	Set the number of continuous sweeps in Step Dwell mode >>
:WAVelength	
:STARt?	Query the Step Dwell mode starting wavelength >>
:STARt	Set the Step Dwell mode starting wavelength >>
:STOP?	Query the Step Dwell mode stopping wavelength >>
:STOP	Set the Step Dwell mode stopping wavelength >>
:STEP?	Query the Step Dwell mode step size >>
:STEP	Set the Step Dwell mode step size >>
:DWELltime?	Query the Step Dwell mode dwell time to remain at each step >>
:DWELltime	Set the Step Dwell mode dwell time to remain at each step >>

9.7.3.3 Step Sweep mode

Command	Description
:OUTPut<slot>	
:SWEEp	
:STARt	Start wavelength sweep >>
:STOP	Stop wavelength sweep >>
:STATus?	Query the sweep status >>
:NUMBer?	Query the number of continuous sweep cycles >>
:NUMBer	Set the number of continuous sweeps >>
:WAVelength	
:STARt?	Query the starting wavelength >>
:STARt	Set the starting wavelength >>
:STOP?	Query the stopping wavelength >>
:STOP	Set the stopping wavelength >>
:RATE?	Query the sweep rate >>
:RATE	Set the sweep rate >>

9.7.3.4 Linear Sweep mode

Command	Description
:OUTPut<slot>	
:LINEar	
:STARt	Start wavelength sweep >>
:STOP	Stop wavelength sweep >>
:STATus?	Query the sweep status >>
:NUMBer?	Query the number of continuous sweep cycles >>
:NUMBer	Set the number of continuous sweeps >>
:WAVelength	
:STARt?	Query the starting wavelength >>
:STARt	Set the starting wavelength >>
:STOP?	Query the stopping wavelength >>
:STOP	Set the stopping wavelength >>
:RATE?	Query the sweep rate >>
:RATE	Set the sweep rate >>

9.7.3.5 Fixed mode

Command	Description
:SOURce<slot>	
:POWer?	Query the output optical power >>
:WAVelength?	Query the current laser wavelength >>
:WAVelength	Set the current laser wavelength >>

9.7.4 Configuration commands: trigger functionality

For details on the skip factor, polarity inversion and sync pulse resolution, please refer to Skip factor N: Keep 1, skip N.

9.7.4.1 Start/Stop trigger

Commands	Description
:TRIGger	
:SKIP?	Query the skip factor (module start/stop trigger output) >>
:SKIP	Set the skip factor (module start/stop trigger output) >>
:POLArity?	Query polarity of the signal (module start/stop trigger output) >>
:POLArity	Set polarity of the signal (module start/stop trigger output) >>
:BACKplane	
:POLArity?	Query polarity of the signal (PXI backplane trigger lines) >>
:POLArity	Set polarity of the signal (PXI backplane trigger lines) >>
:LINEs?	Query the PXI trigger lines for the start/stop trigger output signal >>
:LINEs	Set the PXI trigger lines for the start/stop trigger output signal >>

9.7.4.2 Sync trigger

Commands	Description
:TRIGger	
:SYNC	
:SKIP?	Query the skip factor (module sync trigger output) >>
:SKIP	Set the skip factor (module sync trigger output) >>
:POLArity?	Query polarity of the signal (module sync trigger output) >>
:POLArity	Set polarity of the signal (module sync trigger output) >>
:BACKplane	
:POLArity?	Query polarity of the signal (PXI backplane trigger lines) >>
:POLArity	Set polarity of the signal (PXI backplane trigger lines) >>
:LINEs?	Query the PXI trigger lines for the sync trigger output signal >>
:LINEs	Set the PXI trigger lines for the sync trigger output signal >>

9.8 Command descriptions

9.8.1 Common commands

Command	***IDN?**	Summary >>
Syntax	`*IDN?`	
Description	Query the CohesionSCPI service identification	
Parameters	N/A	
Response	Comma separated string with the <manufacturer>,<server name>,<chassis controller name>,<server version>	
Example	`*IDN? -> Quantifi Photonics Ltd,CohesionSCPI,ARCTURUS,SW3.02.11.00`	

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

Command	***OPT?**	Summary >>
Syntax	`*OPT?`	
Description	Query the modules managed by the CohesionSCPI service	
Parameters	N/A	
Response	Comma separated string of the installed modules in the chassis	
Example	`*OPT? -> ,LASER-2001-1-FA-PXIE,SWITCH-1003-1-FC-PXIE,,VOA-1001-2-FA-PXIE,,,,O2E-1001-1-FC-PXIE,,,,,,,,,`	

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<slot>:OPC?` is NOT equal `1`, may not execute or return an error.	
Example	`*OPC? -> 1`	

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` `*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.

Command	***ESE?**	Summary >>
Syntax	`*ESE?`	
Description	Query the Standard Event Status Enable Register (Mask)	
Parameters	N/A	
Response	Unsigned integer 8 bit value for the register <0 to 255>, as a string.	
Example	`*ESE? -> 254`	

Command	***ESE**	Summary >>
Syntax	`*ESE<wsp><value>`	
Description	Set the Standard Event Status Enable Register	
Parameters	N/A	
Response	N/A	
Example	`*ESE 254`	

Command	***TST?**	Summary >>
Syntax	`*TST?`	
Description	Query the self-test status of all modules	
Parameters	N/A	
Response	**1**: error	
	0: no error	
Command	`*TST? -> 0`	

Command	***RST**	Summary >>
Syntax	`*RST`	
Description	Reset modules to default power-on settings	
Parameters	N/A	
Response	N/A	
Command	`*RST`	

9.8.2 Slot commands

Command	**:SLOT<slot>:TeST?** Summary >>
Syntax	`:SLOT<slot>: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<slot>:ReSeT** Summary >>
Syntax	`:SLOT<slot>:ReSeT`
Description	Reset the module to default power-on settings
Parameters	N/A
Response	N/A
Example	

Command	**:SLOT<slot>:OPC?** Summary >>
Syntax	`:SLOT<slot>: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 `:MODUle<slot>:OPC?` is NOT `1`, may not execute or return an error.
Syntax	`:SLOT1:OPC?` `-> 1`

Command	**:SLOT<slot>:IDN?**	Summary >>
Syntax	:SLOT<slot>:IDN?	
Description	Query the slot identification	
Parameters	N/A	
Response	A comma-separated string containing "<manufacturer>,<model name>,<serial number>,<hardware version><firmware version>". Note that the hardware and firmware versions are not comma separated.	
Example	:SLOT3:IDN? -> Quantifi Photonics Ltd,LASER-2001,QP-000000,HW0.00.01FW0.00.01	

Command	**:SLOT<slot>:OPTions?**	Summary >>
Syntax	:SLOT<slot>:OPTions?	
Description	Query the modules managed by the CohesionSCPI service	
Parameters	N/A	
Response	A comma separated array, or a single integer value based on the arguments given	
Example	:SLOT3:OPTions? -> 1,,,,,,,	

Command	**:SLOT<slot>:TEMPerature?**	Summary >>
Syntax	:SLOT<slot>:TEMPerature?[<wsp><ACT|UNIT>]	
Description	Query the module temperature	
Parameters	**ACT**: Returns the actual measured temperature	
	UNIT: Returns the default temperature unit	
Example		
Command	:SLOT9:TEMP? ACT -> 30.100000	

9.8.3 Configuration commands: laser operation

For details on operation modes, please refer to Operation modes.

9.8.3.1 All operation modes

Command	**:OUTPut<slot>:STATe?** Summary >>
Syntax	:OUTPut<slot>:STATe?[<wsp><SET|INFO>]
Description	Query the optical output state of the laser
Parameters	**SET**: Returns the set state
	INFO: Returns the mapping between the numeral and the text form of the control mode
Response	
Example	:OUTPut9:STAT? INFO -> 0:OFF 1:ON

Command	**:OUTPut<slot>:STATe** Summary >>
Syntax	:OUTPut<slot>:STATe[<wsp><value|OFF|ON>]
Description	Set the optical output state of the laser
Parameters	**value**: Enables laser output of <value> in the default Power unit
	OFF: Disables laser output
	ON: Enables laser output
Response	N/A
Example	:OUTPut9:STAT ON

Command	**:OUTPut<slot>:SAFEty?** Summary >>
Syntax	:OUTPut<slot>:SAFEty?[<wsp><INFO>]
Description	Query the status of the optical safety features
Parameters	**INFO**: Returns the mapping between the numeral and the text form of the safety interlock states
Response	
Example	:OUTP9:SAFE? INFO -> 0:OFF 1:ON 2:NOT SUPPORT

Command	**:OUTPut<slot>:MODE?**	Summary >>
Syntax	:OUTPut<slot>:MODE?[<wsp><DEF|SET|ALL|LIST|INFO>]	
Description	Query the laser operation mode	
Parameters	**DEF**: Returns the default operation mode	
	SET: Returns the currently set operation mode	
	ALL: Returns all the above parameters in a comma-separated string: <DEF>,<SET>	
	LIST: Returns a list of all supported operation modes	
	INFO: Returns the mapping between the numeral and the text form of the operation modes	
Response		
Example	:OUTP9:MODE? INFO -> 0:FIXED 1:SWEEP 2:STEP 3:LINEAR	

Command	**:OUTPut<slot>:MODE**	Summary >>
Syntax	:OUTPut<slot>:MODE[<wsp><value|DEF|FIXED|STEP|SWEEP|LINEAR>]	
Description	Set the laser operation mode	
Parameters	**value**: Sets the operation mode to this <value> (integer or text).	
	DEF: Sets the default operation mode	
	FIXED: Sets the operation mode to Fixed mode	
	STEP: Sets the operation mode to Step Dwell mode	
	SWEEP: Sets the operation mode to Step Sweep mode	
	LINEAR: Sets the operation mode to Linear Sweep mode	
Response	N/A	
Example	:OUTP9:MODE STEP	

9.8.3.2 Step Dwell mode

Command	**:OUTPut<slot>:STEP:STARt** Summary >>
Syntax	:OUTPut<slot>:STEP:STARt
Description	Start wavelength sweep NOTE: The laser state must be ON to start this operation.
Parameters	N/A
Response	N/A
Example	:OUTP9:STEP:STAR

Command	**:OUTPut<slot>:STEP:STOP** Summary >>
Syntax	:OUTPut<slot>:STEP:STOP
Description	Stop wavelength sweep
Parameters	N/A
Response	N/A
Example	:OUTP9:STEP:STOP

Command	**:OUTPut<slot>:STEP:STATus?** Summary >>
Syntax	:OUTPut<slot>:STEP:STATus?
Description	Query the sweep status
Parameters	
Response	0: not running
	1: running
Example	:OUTP9:STEP:STAT? -> state:0

Command	**:OUTPut<slot>:STEP:NUMBer?** Summary >>
Syntax	:OUTPut<slot>:STEP:NUMBer?[<wsp><MIN|MAX|DEF|SET|ALL|STEP>]
Description	Query the number of continuous sweeps in Step Dwell mode
Parameters	**MIN**: Returns the minimum number of sweeps
	MAX: Returns the maximum number of sweeps
	DEF: Returns the default number of sweeps
	SET: Returns the currently set number of sweeps
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
Response	
Example	:OUTP9:STEP:NUMB? ALL -> 0,65535,1,1

Command	**:OUTPut<slot>:STEP:NUMBer** Summary >>
Syntax	:OUTPut<slot>:STEP:NUMBer<wsp><value|MIN|MAX|DEF>
Description	Set the number of continuous sweeps in Step Dwell mode
Parameters	**value**: Sets the number of continuous sweeps to this <value>
	MIN: Sets the minimum number of continuous sweeps
	MAX: Sets the maximum number of continuous sweeps
	DEF: Sets the default number of continuous sweeps
Response	N/A
Example	:OUTP9:STEP:NUMB MAX

Command	**:OUTPut<slot>:STEP:WAVelength:STARt?** Summary >>
Syntax	:OUTPut<slot>:STEP:WAVelength:STARt?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the Step Dwell mode starting wavelength
Parameters	**MIN**: Returns the minimum starting wavelength in the default unit
	MAX: Returns the maximum starting wavelength in the default unit
	DEF: Returns the default starting wavelength in the default unit
	SET: Returns the currently set starting wavelength in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default starting wavelength unit.
Response	
Example	:OUTP9:STEP:WAV:STAR? ALL -> 1248000,1352000,1300000,1248000

Command	**:OUTPut<slot>:STEP:WAVelength:STARt** Summary >>
Syntax	:OUTPut<slot>:STEP:WAVelength:STARt<wsp><value|MIN|MAX|DEF>
Description	Set the Step Dwell mode starting wavelength
Parameters	**value**: Sets the starting wavelength to this <value> in the default unit
	MIN: Sets the minimum starting wavelength
	MAX: Sets the maximum starting wavelength
	DEF: Sets the default starting wavelength
Response	N/A
Example	:OUTP9:STEP:WAV:STAR DEF

Command	**:OUTPut<slot>:STEP:WAVelength:STOP?** Summary >>
Syntax	:OUTPut<slot>:STEP:WAVelength:STOP?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the Step Dwell mode stopping wavelength
Parameters	**MIN**: Returns the minimum stopping wavelength in the default unit
	MAX: Returns the maximum stopping wavelength in the default unit
	DEF: Returns the default stopping wavelength in the default unit
	SET: Returns the currently set stopping wavelength in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default stopping wavelength unit.
Response	
Example	:OUTPut9:STEP:WAV:STOP? STEP -> 1

Command	**:OUTPut<slot>:STEP:WAVelength:STOP** Summary >>
Syntax	:OUTPut<slot>:STEP:WAVelength:STOP<wsp><value|MIN|MAX|DEF>
Description	Set the Step Dwell mode stopping wavelength
Parameters	**value**: Sets the stopping wavelength to this <value> in the default unit
	MIN: Sets the minimum stopping wavelength
	MAX: Sets the maximum stopping wavelength
	DEF: Sets the default stopping wavelength
Response	N/A
Example	:OUTP9:STEP:WAV:STOP DEF

Command	**:OUTPut<slot>:STEP:WAVelength:STEP?** Summary >>
Syntax	`:OUTPut<slot>:STEP:WAVelength:STEP?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]`
Description	Query the Step Dwell mode step size
Parameters	**MIN**: Returns the minimum step size in the default unit. This value can vary based on the set wavelength range. For details on valid step size values, refer to Step size.
	MAX: Returns the maximum step size in the default unit This value can vary based on the set wavelength range. For details on valid step size values, refer to Step size
	DEF: Returns the default step size in the default unit
	SET: Returns the currently set step size in the default unit
	ALL: Returns all the above parameters in a comma-separated string: `<MIN>,<MAX>,<DEF>,<SET>`
	STEP: Returns the resolution/step size of settable values. `STEP = 1` allows values of 1, 2, 3 etc. `STEP = 0.1` allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default step size unit.
Response	
Example	`:OUTP9:STEP:WAV:STEP? DEF -> 1`

Command	**:OUTPut<slot>:STEP:WAVelength:STEP** Summary >>
Syntax	`:OUTPut<slot>:STEP<wsp><value|MIN|MAX|DEF>`
Description	Set the Step Dwell mode step size **Note:** One wavelength sweep in Step Dwell mode can comprise a maximum of **25,000 steps**. For details on valid step size values, refer to Step size. If required, the LASER will automatically decrease or increase the step size.
Parameters	**value**: Sets the step size to this <value> in the default unit.
	MIN: Sets the minimum step size. The value applied can vary based on the set wavelength range. For details on valid step size values, refer to Step size.
	MAX: Sets the maximum step size The value applied can vary based on the set wavelength range. For details on valid step size values, refer to Step size.
	DEF: Sets the default step size
Response	N/A
Example	`:OUTP9:STEP:WAV:STEP MAX`

Command	**:OUTPut<slot>:STEP:WAVelength:DWELltime?** Summary >>
Syntax	:OUTPut<slot>:STEP:WAVelength:DWELltime?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the Step Dwell mode dwell time to remain at each step
Parameters	**MIN**: Returns the minimum dwell time in the default unit
	MAX: Returns the maximum dwell time in the default unit
	DEF: Returns the default dwell time in the default unit
	SET: Returns the currently set dwell time in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default dwell time unit.
Response	
Example	:OUTP9:STEP:WAV:DWEL? UNIT -> ms

Command	**:OUTPut<slot>:STEP:WAVelength:DWELltime** Summary >>
Syntax	:OUTPut<slot>:DWELltime<wsp><value|MIN|MAX|DEF>
Description	Set the Step Dwell mode dwell time to remain at each step
Parameters	**value**: Sets the dwell time to this <value> in the default unit
	MIN: Sets the minimum dwell time
	MAX: Sets the maximum dwell time
	DEF: Sets the default dwell time
Response	N/A
Example	:OUTP9:STEP:WAV:DWEL MAX

9.8.3.3 Step Sweep mode

Command	**:OUTPut<slot>:SWEEp:STARt**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:STARt	
Description	Start wavelength sweep NOTE: The laser state must be ON to start this operation.	
Parameters	N/A	
Response	N/A	
Example	:OUTP9:SWEE:STAR	

Command	**:OUTPut<slot>:SWEEp:STOP**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:STOP	
Description	Stop wavelength sweep	
Parameters	N/A	
Response	N/A	
Example	:OUTP9:SWEE:STOP	

Command	**:OUTPut<slot>:SWEEp:STATus?**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:STATus?	
Description	Query the sweep status	
Parameters		
Response	**0**: not running	
	1: running	
Example	:OUTP9:SWEE:STAT? -> state:0	

Command	**:OUTPut<slot>:SWEEp:NUMBer?**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:NUMBer?[<wsp><MIN|MAX|DEF|SET|ALL|STEP>]	
Description	Query the number of continuous sweep cycles	
Parameters	**MIN**: Returns the minimum number of sweeps	
	MAX: Returns the maximum number of sweeps	
	DEF: Returns the default number of sweeps	
	SET: Returns the currently set number of sweeps	
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>	
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.	
Response		
Example	:OUTP9:SWEE:NUMB? ALL -> 0,65535,1,1	

Command	**:OUTPut<slot>:SWEEp:NUMBer**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:NUMBer<wsp><value|MIN|MAX|DEF>	
Description	Set the number of continuous sweeps	
Parameters	**value**: Sets the number of continuous sweeps to this <value>	
	MIN: Sets the minimum number of continuous sweeps	
	MAX: Sets the maximum number of continuous sweeps	
	DEF: Sets the default number of continuous sweeps	
Response	N/A	
Example	:OUTP9:SWEE:NUMB 5	

Command	**:OUTPut<slot>:SWEEp:WAVelength:STARt?**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:WAVelength:STARt?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]	
Description	Query the starting wavelength	
Parameters	**MIN**: Returns the minimum starting wavelength in the default unit	
	MAX: Returns the maximum starting wavelength in the default unit	
	DEF: Returns the default starting wavelength in the default unit	
	SET: Returns the currently set starting wavelength in the default unit	
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>	
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.	
	UNIT: Returns the default starting wavelength unit.	
Response		
Example	:OUTP9:SWEE:WAV:STAR? ALL -> 1248000,1352000,1300000,1248000	

Command	**:OUTPut<slot>:SWEEp:WAVelength:STARt**	Summary >>
Syntax	:OUTPut<slot>:SWEEp:WAVelength:STARt<wsp><value|MIN|MAX|DEF>	
Description	Set the starting wavelength	
Parameters	**value**: Sets the starting wavelength to this <value> in the default unit	
	MIN: Sets the minimum starting wavelength	
	MAX: Sets the maximum starting wavelength	
	DEF: Sets the default starting wavelength	
Response	N/A	
Example	:OUTP9:SWEE:WAV:STAR 1245000	

Command	**:OUTPut<slot>:SWEEp:WAVelength:STOP?** Summary >>
Syntax	:OUTPut<slot>:SWEEp:WAVelength:STOP?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the stopping wavelength
Parameters	**MIN**: Returns the minimum stopping wavelength in the default unit
	MAX: Returns the maximum stopping wavelength in the default unit
	DEF: Returns the default stopping wavelength in the default unit
	SET: Returns the currently set stopping wavelength in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default stopping wavelength unit.
Response	
Example	:OUTP9:SWEE:WAV:STOP? UNIT -> pm

Command	**:OUTPut<slot>:SWEEp:WAVelength:STOP** Summary >>
Syntax	:OUTPut<slot>:SWEEp:WAVelength:STOP<wsp><value|MIN|MAX|DEF>
Description	Set the stopping wavelength
Parameters	**value**: Sets the stopping wavelength to this <value> in the default unit
	MIN: Sets the minimum stopping wavelength
	MAX: Sets the maximum stopping wavelength
	DEF: Sets the default stopping wavelength
Response	N/A
Example	:OUTP9:SWEE:WAV:STOP 1305000

Command	**:OUTPut<slot>:SWEEp:WAVelength:RATE?** Summary >>
Syntax	:OUTPut<slot>:SWEEp:WAVelength:RATE?[<wsp><MIN|MAX|DEF|SET|ALL|LIST|UNIT>]
Description	Query the sweep rate
Parameters	**MIN**: Returns the minimum sweep rate in the default unit
	MAX: Returns the maximum sweep rate in the default unit
	DEF: Returns the default sweep rate in the default unit
	SET: Returns the currently set sweep rate in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	LIST: Returns a list of settable values.
	UNIT: Returns the default sweep rate unit.
Response	
Example	:OUTP9:SWEE:WAV:RATE? ALL > 50,400,50,50

Command	**:OUTPut<slot>:SWEEp:WAVelength:RATE** Summary >>
Syntax	:OUTPut<slot>:SWEEp:WAVelength:RATE<wsp><value|MIN|MAX|DEF>
Description	Set the sweep rate
Parameters	**value**: Sets the sweep rate to this <value> in the default unit
	MIN: Sets the minimum sweep rat
	MAX: Sets the maximum sweep rate
	DEF: Sets the default sweep rate
Response	N/A
Example	:OUTP9:SWEE:WAV:RATE DEF

9.8.3.4 Linear Sweep mode

Command	**:OUTPut<slot>:LINEar:STARt**	Summary >>
Syntax	:OUTPut<slot>:LINEar:STARt	
Description	Start wavelength sweep NOTE: The laser state must be ON to start this operation.	
Parameters	N/A	
Response	N/A	
Example	:OUTP9:LINE:STAR	

Command	**:OUTPut<slot>:LINEar:STOP**	Summary >>
Syntax	:OUTPut<slot>:LINEar:STOP	
Description	Stop wavelength sweep	
Parameters	N/A	
Response	N/A	
Example	:OUTP9:LINE:STOP	

Command	**:OUTPut<slot>:LINEar:STATus?**	Summary >>
Syntax	:OUTPut<slot>:LINEar:STATus?	
Description	Query the sweep status	
Parameters		
Response	**0**: not running	
	1: running	
Example	:OUTP9:LINE:STAT? -> state:0	

Command	**:OUTPut<slot>:LINEar:NUMBer?**	Summary >>
Syntax	:OUTPut<slot>:LINEar:NUMBer?[<wsp><MIN|MAX|DEF|SET|ALL|STEP>]	
Description	Query the number of continuous sweep cycles	
Parameters	**MIN**: Returns the minimum number of sweeps	
	MAX: Returns the maximum number of sweeps	
	DEF: Returns the default number of sweeps	
	SET: Returns the currently set number of sweeps	
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>	
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.	
Response		
Example	:OUTP9:LINE:NUMB? ALL -> 0,65535,1,1	

Command	**:OUTPut<slot>:LINEar:NUMBer**	Summary >>
Syntax	:OUTPut<slot>:LINEar:NUMBer<wsp><value|MIN|MAX|DEF>	
Description	Set the number of continuous sweeps	
Parameters	**value**: Sets the number of continuous sweeps to this <value>	
	MIN: Sets the minimum number of continuous sweeps	
	MAX: Sets the maximum number of continuous sweeps	
	DEF: Sets the default number of continuous sweeps	
Response	N/A	
Example	:OUTP9:LINE:NUMB 5	

Command	**:OUTPut<slot>:LINEar:WAVelength:STARt?**	Summary >>
Syntax	:OUTPut<slot>:LINEar:WAVelength:STARt?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]	
Description	Query the starting wavelength	
Parameters	**MIN**: Returns the minimum starting wavelength in the default unit	
	MAX: Returns the maximum starting wavelength in the default unit	
	DEF: Returns the default starting wavelength in the default unit	
	SET: Returns the currently set starting wavelength in the default unit	
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>	
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.	
	UNIT: Returns the default starting wavelength unit.	
Response		
Example	:OUTP9:LINE:WAV:STAR? ALL -> 1248000,1352000,1300000,1248000	

Command	**:OUTPut<slot>:LINEar:WAVelength:STARt**	Summary >>
Syntax	:OUTPut<slot>:LINEar:WAVelength:STARt<wsp><value|MIN|MAX|DEF>	
Description	Set the starting wavelength	
Parameters	**value**: Sets the starting wavelength to this <value> in the default unit	
	MIN: Sets the minimum starting wavelength	
	MAX: Sets the maximum starting wavelength	
	DEF: Sets the default starting wavelength	
Response	N/A	
Example	:OUTP9:LINE:WAV:STAR 1245000	

Command	**:OUTPut<slot>:LINEar:WAVelength:STOP?** Summary >>
Syntax	:OUTPut<slot>:LINEar:WAVelength:STOP?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the stopping wavelength
Parameters	**MIN**: Returns the minimum stopping wavelength in the default unit
	MAX: Returns the maximum stopping wavelength in the default unit
	DEF: Returns the default stopping wavelength in the default unit
	SET: Returns the currently set stopping wavelength in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default stopping wavelength unit.
Response	
Example	:OUTP9:LINE:WAV:STOP? UNIT -> pm

Command	**:OUTPut<slot>:LINEar:WAVelength:STOP** Summary >>
Syntax	:OUTPut<slot>:LINEar:WAVelength:STOP<wsp><value|MIN|MAX|DEF>
Description	Set the stopping wavelength
Parameters	**value**: Sets the stopping wavelength to this <value> in the default unit
	MIN: Sets the minimum stopping wavelength
	MAX: Sets the maximum stopping wavelength
	DEF: Sets the default stopping wavelength
Response	N/A
Example	:OUTP9:LINE:WAV:STOP 1305000

Command	**:OUTPut<slot>:LINEar:WAVelength:RATE?** Summary >>
Syntax	:OUTPut<slot>:LINEar:WAVelength:RATE?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the sweep rate
Parameters	**MIN**: Returns the minimum sweep rate in the default unit
	MAX: Returns the maximum sweep rate in the default unit
	DEF: Returns the default sweep rate in the default unit
	SET: Returns the currently set sweep rate in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default sweep rate unit.
Response	
Example	:OUTP9:LINE:WAV:RATE? ALL -> 2000,10000,2000,2000

Command	**:OUTPut<slot>:LINEar:WAVelength:RATE** Summary >>
Syntax	:OUTPut<slot>:LINEar:WAVelength:RATE<wsp><value|MIN|MAX|DEF>
Description	Set the sweep rate
Parameters	**value**: Sets the sweep rate to this <value> in the default unit
	MIN: Sets the minimum sweep rat
	MAX: Sets the maximum sweep rate
	DEF: Sets the default sweep rate
Response	N/A
Example	:OUTP9:LINE:WAV:RATE DEF

9.8.3.5 Fixed mode

Command	**:SOURce<slot>:POWer?** Summary >>
Syntax	:SOURce<slot>:POWer?[<wsp><ACT|UNIT>]
Description	Query the output optical power NOTE: The laser state has to be ON to read the power.
Parameters	**ACT**: Returns the actual measured power reading
	UNIT: Returns the default power unit
Response	
Example	:SOUR9:POW? ACT -> 15.108000

Command	**:SOURce<slot>:WAVelength?** Summary >>
Syntax	:SOURce<slot>:WAVelength?[<wsp><MIN|MAX|DEF|SET|ALL|STEP|UNIT>]
Description	Query the current laser wavelength
Parameters	**MIN**: Returns the minimum laser wavelength in the default unit
	MAX: Returns the maximum laser wavelength in the default unit
	DEF: Returns the default laser wavelength in the default unit
	SET: Returns the currently set laser wavelength in the default unit
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
	UNIT: Returns the default laser wavelength unit.
Response	
Example	:SOUR9:WAV? ALL -> 1248000,1352000,1300000,1300000

Command	**:SOURce<slot>:WAVelength** Summary >>
Syntax	:SOURce<slot>:WAVelength<wsp><value|MIN|MAX|DEF>
Description	Set the current laser wavelength
Parameters	**value**: Sets the wavelength to this <value> in the default unit
	MIN: Sets the minimum wavelength
	MAX: Sets the maximum wavelength
	DEF: Sets the default wavelength
Response	N/A
Example	:SOUR9:WAV DEF

9.8.4 Configuration commands: trigger functionality

For details on the skip factor, polarity inversion and sync pulse resolution, please refer to Skip factor N: Keep 1, skip N.

Command	**:TRIGger[slot]:SKIP?** Summary >>
Syntax	:TRIGger[slot]:SKIP?[<wsp><MIN|MAX|DEF|SET|ALL|STEP>]
Description	Query the skip factor (module start/stop trigger output)
Parameters	**MIN**: Returns the minimum skip factor
	MAX: Returns the maximum skip factor
	DEF: Returns the default skip factor
	SET: Returns the currently set skip factor
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.
Response	
Example	:TRIG9:SKIP? SET -> 0

Command	**:TRIGger[slot]:SKIP** Summary >>
Syntax	:TRIGger[slot]:SKIP<wsp><value|MIN|MAX|DEF>
Description	Set the skip factor (module start/stop trigger output)
Parameters	**value**: Sets the skip factor to this <value> in the default unit
	MIN: Sets the minimum skip factor
	MAX: Sets the maximum skip factor
	DEF: Sets the default skip factor
Response	N/A
Example	:TRIG9:SKIP 2

Command	**:TRIGger[slot]:POLArity?** Summary >>
Syntax	:TRIGger[slot]:POLArity?[<wsp><SET|INFO]
Description	Query polarity of the signal (module start/stop trigger output)
Parameters	**SET**: Returns the currently set polarity in the default unit
	INFO: Returns the mapping between the numeral and the text form of the control mode
Response	
Example	:TRIG9:POLA? INFO -> 0:OFF,POSITIVE 1:ON,NEGATIVE

Command	**:TRIGger[slot]:POLArity**	Summary >>
Syntax	:TRIGger[slot]:POLArity<wsp><1|ON|NEGATIVE|0|OFF|POSITIVE>	
Description	Set polarity of the signal (module start/stop trigger output)	
Parameters	**1|ON|NEGATIVE**: Inverts polarity to active low	
	0|OFF|POSITIVE: (default) Sets polarity to active high	
Response	N/A	
Example	:TRIG9:POLA 1	

Command	**:TRIGger[slot]:BACKplane:POLArity?**	Summary >>
Syntax	:TRIGger[slot]:BACKplane:POLArity?[<wsp><SET|INFO]	
Description	Query polarity of the signal (PXI backplane trigger lines)	
Parameters	**SET**: Returns the currently set polarity in the default unit	
	INFO: Returns the mapping between the numeral and the text form of the control mode	
Response		
Example	:TRIG9:BACK:POLA? SET -> 1	

Command	**:TRIGger[slot]:BACKplane:POLArity**	Summary >>
Syntax	:TRIGger[slot]:BACKplane:POLArity<wsp><1|ON|NEGATIVE|0|OFF|POSITIVE>	
Description	Set polarity of the signal (PXI backplane trigger lines)	
Parameters	**1|ON|NEGATIVE**: Inverts polarity to active low	
	0|OFF|POSITIVE: (default) Sets polarity to active high	
Response	N/A	
Example	:TRIG9:BACK:POLA ON	

Command	**:TRIGger[slot]:BACKplane:LINEs?**	Summary >>
Syntax	:TRIGger[slot]:BACKplane:LINEs?[<wsp><SET>]	
Description	Query the PXI trigger lines for the start/stop trigger output signal	
Parameters	**SET**, none: Returns the PXI trigger line(s) that are set for the start/stop trigger output signal	
Response	A single value, or a comma-separated array of values	
	NONE: No trigger lines are set	
Example	:TRIG9:BACK:LINE? SET -> 0,6,7	

Command	**:TRIGger[slot]:BACKplane:LINEs**	Summary >>
Syntax	:TRIGger[slot]:BACKplane:LINEs<wsp><<value1>[,<value2>,...,<value8>]|CLEAR>	
Description	Set the PXI trigger lines for the start/stop trigger output signal **Note: You cannot assign the start/stop and sync triggers to the same PXI trigger line(s). Please make sure only one trigger is set to each line or this command will report an error.**	
Parameters	**<value1...8>**: Routes the start/stop trigger output signal to these PXI trigger line(s)	
	CLEAR: The start/stop trigger output signal will not be routed to any PXI trigger line, any previously set routing will be cleared	
Response	N/A	
Example	:TRIG9:BACK:LINE 0,6,7	

Command	**:TRIGger[slot]:SYNC:SKIP?**	Summary >>
Syntax	:TRIGger[slot]:SYNC:SKIP?[<wsp><MIN|MAX|DEF|SET|ALL|STEP>]	
Description	Query the skip factor (module sync trigger output)	
Parameters	**MIN**: Returns the minimum skip factor	
	MAX: Returns the maximum skip factor	
	DEF: Returns the default skip factor	
	SET: Returns the currently set skip factor	
	ALL: Returns all the above parameters in a comma-separated string: <MIN>,<MAX>,<DEF>,<SET>	
	STEP: Returns the resolution/step size of settable values. STEP = 1 allows values of 1, 2, 3 etc. STEP = 0.1 allows values of 1.1, 1.2, 1.3 etc.	
Response		
Example	:TRIG9:SYNC:SKIP? ALL -> 0,65535,0,65535	

Command	**:TRIGger[slot]:SYNC:SKIP**	Summary >>
Syntax	:TRIGger[slot]:SYNC:SKIP<wsp><value|MIN|MAX|DEF>	
Description	Set the skip factor (module sync trigger output)	
Parameters	**value**: Sets the skip factor to this <value> in the default unit	
	MIN: Sets the minimum skip factor	
	MAX: Sets the maximum skip factor	
	DEF: Sets the default skip factor	
Response	N/A	
Example	:TRIG9:SKIP:DECI MAX	

Command	**:TRIGger[slot]:SYNC:POLArity?**	Summary >>
Syntax	:TRIGger[slot]:SYNC:POLArity?[<wsp><SET|INFO]	
Description	Query polarity of the signal (module sync trigger output)	
Parameters	**SET**: Returns the currently set polarity in the default unit	
	INFO: Returns the mapping between the numeral and the text form of the control mode	
Response		
Example	:TRIG9:SYNC:POLA? INFO -> 0:OFF,POSITIVE 1:ON,NEGATIVE	

Command	**:TRIGger[slot]:SYNC:POLArity**	Summary >>
Syntax	:TRIGger[slot]:SYNC:POLArity<wsp><1|ON|NEGATIVE|0|OFF|POSITIVE>	
Description	Set polarity of the signal (module sync trigger output)	
Parameters	**1|ON|NEGATIVE**: Inverts polarity to active low	
	0|OFF|POSITIVE: (default) Sets polarity to active high	
Response	N/A	
Example	:TRIG9:SYNC:POLA 0	

Command	**:TRIGger[slot]:SYNC:BACKplane:POLArity?**	Summary >>
Syntax	:TRIGger[slot]:SYNC:BACKplane:POLArity?[<wsp><SET|INFO]	
Description	Query polarity of the signal (PXI backplane trigger lines)	
Parameters	**SET**: Returns the currently set polarity in the default unit	
	INFO: Returns the mapping between the numeral and the text form of the control mode	
Response		
Example	:TRIG9:SYNC:BACK:POLA? INFO -> 0:OFF,POSITIVE 1:ON,NEGATIVE	

Command	**:TRIGger[slot]:SYNC:BACKplane:POLArity**	Summary >>
Syntax	:TRIGger[slot]:SYNC:BACKplane:POLArity<wsp><1|ON|NEGATIVE|0|OFF|POSITIVE>	
Description	Set polarity of the signal (PXI backplane trigger lines)	
Parameters	**1|ON|NEGATIVE**: Inverts polarity to active low	
	0|OFF|POSITIVE: (default) Sets polarity to active high	
Response	N/A	
Example	:TRIG9:SYNC:BACK:POLA POSITIVE	

Command	**:TRIGger[slot]:SYNC:BACKplane:LINEs?** Summary >>
Syntax	:TRIGger[slot]:SYNC:BACKplane:LINEs?[<wsp><SET>]
Description	Query the PXI trigger lines for the sync trigger output signal
Parameters	**SET**, none: Returns the PXI trigger line(s) that are set for the sync trigger output signal
Response	A single value, or a comma-separated array of values
	NONE: No trigger lines are set
Example	:TRIG9:SYNC:BACK:LINE? SET -> 0,6,7

Command	**:TRIGger[slot]:SYNC:BACKplane:LINEs** Summary >>
Syntax	:TRIGger[slot]:SYNC:BACKplane:LINEs<wsp><<value1>[,<value2>,...,<value8>]|CLEAR>
Description	Set the PXI trigger lines for the sync trigger output signal **Note: You cannot assign the start/stop and sync triggers to the same PXI trigger line(s). Please make sure only one trigger is set to each line or this command will report an error.**
Parameters	**<value1...8>**: Routes the sync trigger output signal to these PXI trigger line(s)
	CLEAR: The sync trigger output signal will not be routed to any PXI trigger line, any previously set routing will be cleared
Response	N/A
Example	:TRIG9:SYNC:BACK:LINE 0,6,7

9.9 Programming examples

The following are simple examples of how to control your LASER module using SCPI commands:

> 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.

9.9.1 Example: Set a single wavelength

Set the laser to 1250nm and enable the output.

The LASER module is in slot 1.

```
#Set up the Laser's wavelength
:OUTPut1:MODE FIXED            #Put the laser in Fixed mode
:SOURce1:WAVelength 1250       #Set the wavelength to 1250nm

#Turn the laser on
:OUTPut1:STATe                 #Enable laser output
```

9.9.2 Example: Wavelength sweep in Step Sweep mode with synchronized power measurement

Set the laser to sweep once over the maximum operation range of 1250nm to 1350nm, at a rate of 400nm/s.

A 1000-point trace from a POWER-1401 instrument is set up to initiate from the backplane sync trigger output.

The sync trigger is set to a skip factor of 4.

The LASER PXIe module is in slot 2, a Quantifi Photonics power meter Power-1401 is in slot 4.

```
#Set up the Laser's wavelength sweep
:OUTput2:MODE SWEEP                         #Put the laser in Step Sweep mode
:OUTPut2:SWEEp:NUMBer 1                     #Only perform one sweep
:OUTPut2:SWEEp:WAVelength:STARt 1250        #Start the sweep at 1250nm
:OUTPut2:SWEEp:WAVelength:STOP 1350         #Stop the sweep at 1350nm
:OUTPut2:SWEEp:WAVelength:RATE 400          #Set sweep rate to 400 nm/s

#Set up the Laser's trigger output
:TRIGger2:SYNC:SKIP 4                       #Set the skip factor to 4, this will result in 1,000 total sync triggers
:TRIGger2:SYNC:BACKplane:LINEs 1            #Output the sync trigger to PXI_TRIG 1

#Set up the Power-1401 for triggered acquisition
:SENSe4:CHANnel1:WAVelength 1300            #Set the wavelength to 1300nm, the midpoint of your sweep
:SENSe4:TRACE:POINts 1000                   #Set the power meter to capture a 1000 point-trace
:TRIGger4:SOURce 1                          #Set the power meter to trigger on PXI_TRIG 1
:TRIGger4:ARM                               #Arm the trigger

#Begin the sweep
:OUTPut2:SWEEp:STARt

#Check for completion
:OUTPut2:SWEEp:STATus?                      #Returns 1 if the laser is finished
:SENSe4:TRACE:CoMPlete?                     #Returns 1 if the power meter has sampled a full trace
:SENSe4:TRACE 1?                            #Returns the trace data from power meter channel 1
```

10 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.

NOTE

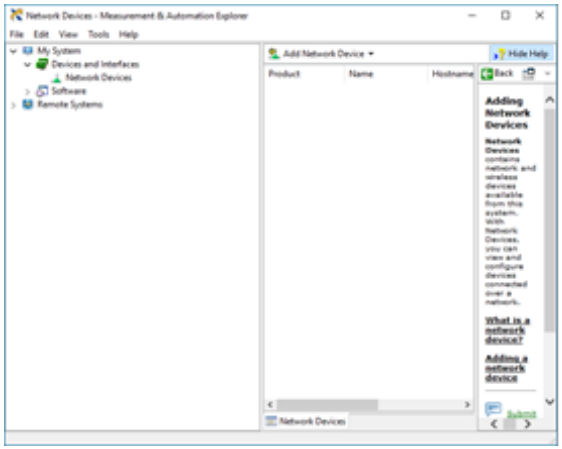
In NI-MAX a RIO interface will show up, however there are no communication methods available or implemented on this interface.

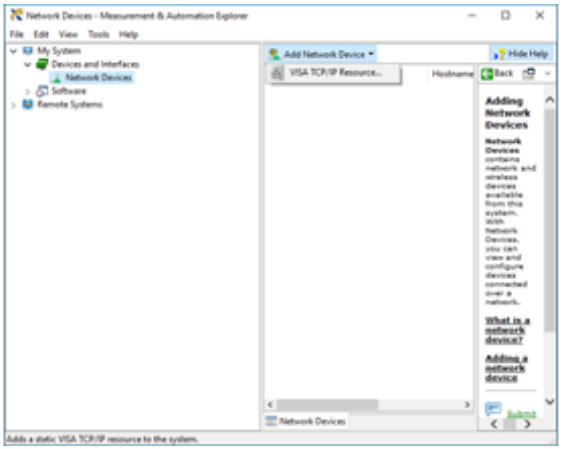
Quantifi Photonics products are **ONLY** accessible through the **VISA TCPIP INSTR** interface provided by the CohesionSCPI service installed on the system.

10.1 Setting up NI-MAX application

To communicate with any Quantifi Photonicsproduct, 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**.



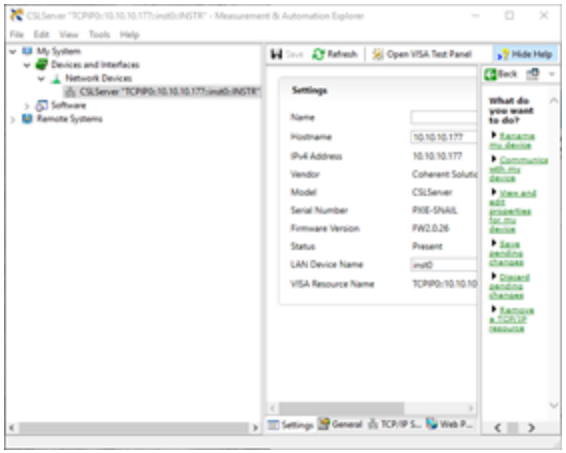


3. Select **Manual Entry of LAN Instrument**. Enter in the Hostname or IP Address.
   Note when operating locally, enter in the localhost IP address of **127.0.0.1**. Click **Finish** to end the setup process.

10.2 Setting up NI-VISA application

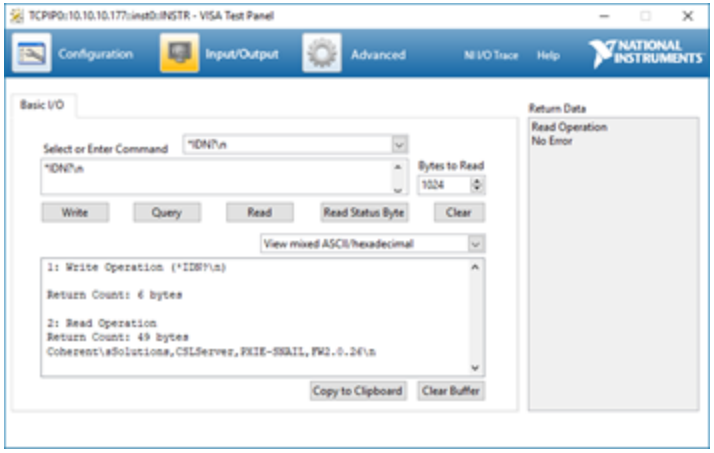
NI-VISA is used to communicate with the PXIe chassis or installed modules / instruments. The above steps must be completed before attempting to communicate using NI-VISA.

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



10.3 Python® 2.7 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))
```

10.4 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 PXIe module 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.
```

11 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:

> 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.

Quantifi Photonics is not responsible for damage or errors caused by bad fiber cleaning or handling.

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.

▶ 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 damage the fiber and the port bulkhead.

NOTE

Failing to align and/or connect fiber-optic cables properly will result in significant signal loss and reflection.

12 System requirements

Quantifi Photonics PXIe modules

Supported browsers for working with CohesionUI	Google Chrome™ Microsoft Edge®
Chassis	PXIe-compatible chassis that • supports PXIe, or • 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™ Microsoft Edge®
Recommended client computer operating system	Microsoft Windows® 10 (64-bit)

13 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.

> ⚠ **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.

13.1 Annual calibration schedule

To ensure that the unit is performing as expected, we recommend it is re-calibrated every 12 months. As an optical product will naturally degrade over time, it is important to periodically re-test the unit, to confirm that it is working to specification.

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.

14 Technical Support

14.1 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 (see the product identification label), as well as a description of your problem.

14.2 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 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.

15 Warranty Information

15.1 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.

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 www.quanitfiphotonics.com.

15.2 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 theproduct 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.

15.3 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.

15.4 Certification

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

15.5 Service and repairs

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

QUANTIFI PHOTONICS™

Test. Measure. Solve.

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.

To find out more, get in touch with us today.

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