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1 Conventions

Before using the instruments described in this document, take note of the following conventions:

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

**CAUTION**
Indicates a potentially hazardous situation which, if not avoided, may result in component damage. Do not proceed unless the required conditions are met and understood.

**IMPORTANT**
Refers to information about this module that you should not overlook.

**NOTE**
Indicates some information that requires your attention or some extra information for the current topic.
2 Safety information

Before using the IQABC 1000 Series MATRIQ, ensure that the following safety information has been read and understood.

2.1 Optical laser radiation precautions

**WARNING**
Do not install or terminate fibers while the light source is active. Care must be taken to ensure that the instrument has been **turned OFF before inspecting the end face(s) of the instrument, or any optical patch cords** connected to this instrument. 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 herein may result in exposure to hazardous situations involving optical radiation.

2.2 Electrostatic discharge precautions

**CAUTION**
The IQABC MATRIQ is sensitive to electrostatic discharge (ESD). Store the unused instrument in the original protective electrostatic packaging that the IQABC MATRIQ was shipped in.

Ensure that a wrist strap and grounding table mat is used when unpacking or handling the IQABC 1000 Series MATRIQ. Proper grounding and ESD management practices should always be followed to ensure that no ESD damage is caused to the IQABC 1000 Series MATRIQ.
2.3 Electromagnetic compatibility

🎉 CAUTION

- For electromagnetic compatibility, this instrument 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.

- Wherever the ⚠️ symbol is printed on the unit, refer to the instructions provided in the device documentation for related safety information. Ensure that the required conditions are met and understood before using the instrument.
3 Connecting optical fibers

🚨 CAUTION
To ensure maximum power and to avoid erroneous readings always inspect fiber end faces. Make sure they are cleaned as detailed below before inserting into any port. Quantifi Photonics is not responsible for damage or errors caused by bad fiber cleaning or handling.

⚠️ IMPORTANT
The type of optical connectors on the IQABC 1000 Series MATRIQ can be found printed on the front plate of the instrument. Joining mismatched connectors will damage the ferrules and fibre faces.

To keep connectors clean and in good condition, Quantifi Photonics strongly recommends inspection with a fiber inspection probe before connecting them. Failure to do so will result in permanent damage to the connectors and degradation of future measurements.

Quantifi Photonics uses high quality connectors in compliance with EIA-455-21A standards.

3.1 Cleaning and connecting optical fibers

To connect the fiber-optic cable to the port:

1. Inspect the fiber using a fiber inspection microscope. If the fiber is clean, proceed to connect it to the desired port.
2. If the fiber is dirty, clean it as detailed below.
3. Gently wipe the fiber end with a lint-free swab dipped in isopropyl alcohol.
4. Use compressed air to dry completely.
5. Visually inspect the fiber end to ensure its cleanliness.
6. Carefully align the connector and port to prevent the fiber end from touching the outside of the port or rubbing against other surfaces. If the connector features a key, ensure that it is correctly mated into the corresponding notch of the port bulkhead.
7. Push the connector in so that the fiber-optic cable is firmly in place, thus ensuring adequate contact. If your connector features a screw sleeve, tighten the connector enough to firmly maintain the fiber in place. **Do not over tighten, as this will damage the fiber and the port bulkhead.**

⚠️ NOTE
If your fiber-optic cable is not properly aligned and/or connected, you will notice large signal loss and reflection.
4 Introducing the IQABC 1000 Series MATRIQ

The IQABC 1000 Series MATRIQ has an advanced Automatic Bias Control (ABC) algorithm to accurately and reliably control and optimize all of the modulator bias points, regardless of the modulation format or pattern.

The external modulator adaptor board provides simple and quick connectivity to any IQ modulator with OIF compatibility. Each of I, Q or phase DC biases can be controlled independently in either automatic or manual mode.

4.1 IQABC 1000 Series MATRIQ overview & features

1. Status LED
2. Modulated signal in port
3. Signal out port
4. Modulator connection
5. Optical connector type
6. USB type B port
7. Power supply port
8. IP address LCD screen
9. Ethernet port
10. Ventilation fan (DO NOT OBSTRUCT)
11. On / Off push button

⚠️ IMPORTANT

- You must use the external power supply that has been supplied by Quantifi Photonics with the unit. Any attempt to use a different external power supply may cause product damage and will void your warranty.
- The external power supply that has been used with the unit can only be used with that unit. Do not use it with any other product.
4.2 Status LED

The Status LED is used to denote the operation state of the IQABC 1000 Series MATRIQ.

- **Off** - Indicates that the instrument is DISABLED.
- **Solid red** - Indicates that an error was registered.
- **Blinking red / green** - Indicates initialization of the instrument during startup. If blinking persists for more than a few seconds, it indicates an error was registered.
- **Blinking orange** - Indicates that the ABC optimizer is searching for optimal points.
- **Solid Green** - Indicates that the ABC is locked, and the bias points reached the optimal points.
5 Handling the IQABC 1000 Series MATRIQ

⚠️ CAUTION
- Do not remove the IQABC 1000 Series MATRIQ instrument from the antistatic packaging until instructed during the following installation procedure.
- The IQABC MATRIQ is sensitive to ESD. Ensure you are wearing a grounded wrist strap at all times when handling the IQABC MATRIQ to prevent damage from electrostatic discharge.
- Take care not to handle the optical connectors on the IQABC MATRIQ instrument, as once they are exposed to skin contact this may leave corrosive residue and damage the connector.

**STEP 1:** Insert power cord

**STEP 2:** Power ON the instrument

**STEP 3:** Via USB – Connect USB cable

**STEP 3:** Via Ethernet – Connect Ethernet cable

**STEP 4:** IP address will appear on the LCD screen

Via USB

Via Ethernet

⚠️ NOTE
It may take approximately **2 minutes** for the instrument to display an IP address.
⚠️ IMPORTANT

- You must use the external power supply that has been supplied by Quantifi Photonics with the unit. Any attempt to use a different external power supply may cause product damage and will void your warranty.
- The external power supply that has been used with the unit can only be used with that unit. Do not use it with any other product.
6 Installing software for the IQABC 1000 Series MATRIQ

6.1 Installing Cohesion Operator on client computer(s)
Set up any computer you use to connect with the instrument by installing the latest Cohesion Operator software package. Cohesion Operator enables you to connect with Quantifi Photonics instruments on your network and manage firmware upgrades.

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

⚠️ IMPORTANT
If another MATRIQ instrument is already connected to the client computer over USB, consult the Network and Update settings on configuring the Ethernet / USB IP address for multi-instrument control.

To install the software package on a client computer:

• (recommended) Save your work and close all programs.
• If using the USB media device, insert it on the computer.
• Double-click CohesionOperator-<version>.exe and follow the prompts.

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

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

To open the Cohesion Operator application:

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

From Cohesion Operator you can:

1. Select a Quantifi Photonics instrument that is available on your network.
2. Validate the IP address of the instrument and retrieve instrument information.
3. Communicate with the instrument through the SCPI Command Console.
4. Access the instrument through CohesionUI, a web-based graphical user interface.
5. Upgrade instrument firmware.
6. Restore the instrument to factory settings.
6.2 Checking MATRIQ firmware versions and other product information
You can check the details of a MATRIQ instrument, for example by doing one of the following:

**In the Cohesion Operator:**

1. Select the instrument.
2. Click **Connect**.
3. Current instrument information will be displayed.
   - **Installed Package** shows the version of the instrument firmware package.

**In CohesionUI:**

1. Select **INFO** on the menu.
2. Instrument information will be displayed in the info panel. 

Server Version shows the version of the instrument firmware package.

6.3 Upgrading a MATRIQ instrument with the latest firmware

**NOTE**

The Cohesion Operator can upgrade MATRIQ instruments that currently use firmware package version 2.08.24 or greater. To upgrade MATRIQ instruments that use older software packages, refer to the user manual that came with your instrument.

To upgrade a MATRIQ instrument:

1. Get the latest MATRIQ firmware package CohesionMTRQ-<version>.tgz, for example by downloading it from quantifiphotonics.com (go to Resources > Drivers, software and manuals > MATRIQ Series), and save it to your network.

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

3. Select the instrument by entering its IP address or by selecting it from the Discovery drop down list.

4. To confirm that you have selected the correct instrument, click Connect. This will retrieve instrument information, with Installed Package showing the current firmware version.

5. In Package, click the Browse button, navigate to the previously downloaded firmware package and select it.

6. Click Upgrade. The instrument will be upgraded to the selected firmware package. This can take a few minutes and the instrument might reboot several times in the process.

7. A message shows when the upgrade is complete.

**NOTE**

To confirm the new firmware version, click Connect to retrieve the latest instrument information.
### NOTE

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

To restore factory settings:

1. Open the Cohesion Operator, for example by double-clicking the Cohesion Operator desktop icon.
2. Select the instrument by entering its IP address or by selecting it from the Discovery drop down list.
3. (optional) Retrieve instrument information, including current firmware versions, by clicking Connect.
4. Click Restore.

### NOTE

IP address settings will also revert to factory settings.
7 CohesionUI

CohesionUI is a web-based application that you can use to control any IQABC 1000 Series MATRIQ instrument from Quantifi Photonics. Its cutting-edge design offers a sleek modern interface, cross-device compatibility, multi-instrument control, customizable views, and remote access.

7.1 Accessing CohesionUI for MATRIQ instruments

You can open CohesionUI:

- from the Cohesion Operator application, or
- from your browser.

⚠️ NOTE

The IP address of the MATRIQ instrument is displayed on the LCD screen on the back of the instrument. When the instrument is connected via both, Ethernet and USB cables, the displayed IP address will alternate between the USB and Ethernet IP address.

⚠️ NOTE

If required, the IP address can be statically assigned to the Ethernet or USB connection.

To open CohesionUI from Cohesion Operator:

1. Open Cohesion Operator on a client computer, for example by double-clicking the Cohesion Operator desktop icon.
2. Select the instrument by entering its IP address or by selecting it from the Discovery drop down list.
3. Click Open CohesionUI.
To open CohesionUI from a browser:

1. Launch Google Chrome or Microsoft Edge on a client computer.
2. Type in the MATRIQ instrument IP address into the address bar of the browser, e.g. 10.10.10.89.

### 7.2 Home page
The main landing page in CohesionUI is called the **HOME** page and it displays the MATRIQ instrument channels. All the information relating to the instrument such as the model number, serial number and firmware versions are displayed in the top right corner of the window.

![CohesionUI Home Page](image)

### 7.2.1 Set and Actual values
Some Quantifi Photonics products will allow the user to set a given parameter’s value and then read that parameter (e.g. Laser, VOA, O2E, etc). In order to help the user to distinguish between a set value and an actual read value, CohesionUI will format these values differently according to the legend in the top right corner of the window.

- **ACTUAL**: the actual value of the parameter, defined by querying the module
- **SET**: the intended value of a given parameter, defined by user input

The SET and **ACTUAL** values are only displayed for appropriate parameters which require user input. For parameters that report a value and do not depend on user input, only an **ACTUAL** value is displayed.

In the following example, the **POWER** is **SET** to **10.00 dBm**, but the **ACTUAL** value is **-99.00 dBm**. Thus, the user can see both the current and user defined value of a given parameter.
7.3 Settings page

The **SETTINGS** page is used to configure the CohesionUI settings and unit preferences or to synchronize / reinitialize the system. These controls can be accessed by clicking the **SETTINGS** button.

Step size refers to the amount by which the attenuation, frequency, or power increases or decreases when the + or - button is clicked.

![Settings page](image)

**NOTE**

The unit preferences and settings can be set by hovering over the **SETTINGS** button in the left-hand side menu. This will bring up a dropdown menu that lists all settings for a quick access.

![NOTE](image)
7.3.1 Network and Upgrade settings controls
The network configuration control panel enables the user to set the preferred communication interface (Ethernet or USB).

[NOTE]
The Network interface controls are only available when connected over USB.

7.3.2 Configuring the Network Interface settings
The MATRIQ instruments can operate over either an Ethernet or USB connection. To communicate with the instrument, the IP address is required.

[NOTE]
The Network interface controls are only available when connected over USB. When connected over Ethernet the settings will be locked, as highlighted as follows.

7.3.3 Setting the USB IP address
When connected via USB, the default IP address is 192.168.101.201. This is a static address set during instrument calibration. If necessary, this address can be changed. Typing the default IP address in a supported web browser will open the CohesionUI page for the instrument. The Network Interface configuration controls are available in the SETTINGS page.
The value in the 3rd octet of the IP address can be changed to any available value. It is important to make sure that any other instruments connected to the computer do not share this new IP address, as there will be an addressing conflict.

Clicking APPLY will write the new IP address to the instrument settings. Once set, the new IP address will be displayed on the LCD screen on the back of the instrument.

7.3.4 Setting the Ethernet IP address
The default Ethernet IP addressing method is dynamic, as the DHCP will automatically assign the instrument an IP address. This address can be found on the back of the instrument on the LCD screen.

While connected over USB, typing in the assigned IP address in a supported web browser will open the CohesionUI page for the instrument.

The addressing method can be changed to a static method, where the MATRIQ instrument will always have the same IP address over Ethernet. Typing in a valid IP address and Subnet mask, and then clicking APPLY will save the IP address into the settings of the instrument.
To test if the IP addressing has worked, power **OFF** the instrument, and disconnect the USB cable. Turn the unit back **ON**, and once it has finished booting, check the IP address shown on the LCD screen.

### 7.4 Info panel
Clicking the **INFO** button will display an information panel on the right-hand side of the page. Information such as the chassis operation mode, manufacturer, model, and serial number of the chassis, CohesionUI version number, and the version of CohesionSCPI service running on the chassis is displayed in this panel.
8  IQABC 1000 Series MATRIQ control with CohesionUI

The IQABC MATRIQ instrument controls are displayed on the HOME page in CohesionUI. All information relating to the module such as model number, serial number and firmware versions are displayed in the top right corner of the window.

8.1  Instrument control tab

To control the IQABC MATRIQ instrument operation mode and bias values, click the CONTROL tab.

8.1.1  Setting the modulator bias operation mode

The modulator biases can operate in AUTO mode (the default) or MANUAL mode. The selected control mode can either be applied to all modulator biases at the same time in GLOBAL MODE, or separately by changing the mode of a specific modulator bias. Changing the mode of a specific bias will show a CUSTOM mode in the GLOBAL MODE field.
### 8.1.2 Setting the modulator bias values

The voltage value for each modulator bias can be set by clicking the parameter field, or by using the + and – control buttons to increase or decrease the value by a set amount. This step size is set in the SETTINGS menu.

Alternatively, the BIAS voltage can also be set to the MIN and MAX value by clicking the dropdown in the name of the parameter.

⚠️ **IMPORTANT**

The tick mark **MUST** be clicked in order for any changes or values that were entered to be applied successfully.

### 8.1.3 Output power value

The global **OUTPUT POWER** dBm value of the IQABC MATRIQ is displayed in the top-middle ribbon of the screen.
8.1.4 Force calibration button
The FORCE CALIBRATE button initiates a new DC-bias scan. It can be used after the initial power-up of the unit and whenever a new scan of the current Min-Min-Quad bias points is desired. During the recalibration process, the color strip under the bias label will turn orange. Once the ABC has found the correct bias point, the color strip will turn green.

Advanced configuration tab
To control the IQABC MATRIQ modulator dither size values and interval, click the ADVANCED tab.

8.2.1 Setting the dither size
The DITHER SIZE value (percentage of VPI) for each modulator bias can be set by clicking the parameter field, or by using the + and - control buttons to increase or decrease the value by a set amount. The step size is set to 2%.

Alternatively, the DITHER SIZE can also be set to the MIN and MAX value by clicking the dropdown in the name of the parameter.

Increasing the dither size will lead to a more accurate bias optimization, but a larger dither will show up as an occasional perturbation to the bias voltage.

It is recommended to use the default dither size unless a residual bias error is constantly observed. In such cases, increasing the step size can improve the bias convergence accuracy.
8.2.2 Setting the dither interval

The DITHER INTERVAL value for each modulator can be set by clicking the parameter field, or by using the + and – control buttons to increase or decrease the value by a set amount.

Alternatively, the DITHER INTERVAL can also be set to the MIN and MAX value by clicking the dropdown in the name of the parameter.

The dither interval determines how frequently the bias control dither is applied. Lower dither interval will result in a faster convergence, while a higher dither interval will result in a more stable bias control.

8.3 Error history tab

To review the IQABC MATRIQ modulator bias value vs. time error history plots, click the HISTORY tab.

The polarization (X or Y) and the modulator biases (All, I, Q, P) can be selected and filtered by clicking the drop down lists above the plots area.
The plots can be zoomed to show a specific section of the analysis by clicking and dragging the desired area with the cursor. To reset the zoom, click the Autoscale button or double-click on the plot area.

To download a plot as a PNG file, click the ‘Download plot as a png’ button.

8.3.1 Force calibration button
The FORCE CALIBRATE button is also found within the History page for convenience. Clicking the button will initiate a new DC bias scan.
8.3.2 Restart history button
To clear the modulator’s error plots history, click the RESTART HISTORY tab.

8.4 Scans tab
To review the IQABC MATRIQ modulator biases power vs. biases voltage plots, click the SCANS tab.

The polarization (X or Y) and the modulator biases (All, I, Q, P) can be selected and filtered by clicking the drop down lists above the plots area.

The plots can be zoomed to show a specific section of the analysis by clicking and dragging the desired area with the cursor. To reset the zoom, click the Autoscale button or double-click on the plot area.
To download a plot as a PNG file, click the ‘Download plot as a png’ button.
9 Programming guide

Introduction
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 guide provides general information on the commands available to communicate with the CohesionSCPI service remotely using the VISA I/O.

You can use the SCPI Command Console that you can access from the Cohesion Operator.

⚠️ IMPORTANT
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 TCP/IP INSTR interface provided by the CohesionSCPI service installed on the system.

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Unit</th>
<th>Alternative Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>MW</td>
<td>MW, W</td>
</tr>
<tr>
<td>Frequency</td>
<td>HZ</td>
<td>THZ, GHZ, MHZ, KHZ</td>
</tr>
<tr>
<td>Frequency Fine</td>
<td>HZ</td>
<td>THZ, GHZ, MHZ, KHZ</td>
</tr>
<tr>
<td>Wavelength</td>
<td>NM</td>
<td>NM, PM</td>
</tr>
<tr>
<td>Voltage</td>
<td>V</td>
<td>MV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Argument</th>
<th>Data Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;wsp&gt;</td>
<td>Specifies whitespace character (01₁₆ – 09₁₆, 0B₁₆ – 20₁₆).</td>
</tr>
<tr>
<td>&lt;value&gt;</td>
<td>Is numerical data, an integer, a decimal, exponential (10⁻⁹ or 5.8e6) or string.</td>
</tr>
<tr>
<td>[VALUE1</td>
<td>VALUE2]</td>
</tr>
</tbody>
</table>

9.1.1 Index addressing of modules (slot, source) and units (channel)
When executing commands, it is almost always necessary to provide the index of a specific IQABC MATRIQ instrument or an index of a specific installed unit.

For the commands that require index values:
- <c>: is the chassis index in which the specific blade module is installed; this is an integer, inclusive of 0.
- <n>: is the slot (or source) index of the specific blade module, this is an integer, <1 to 18>.
- <m>: is the channel index of a specific unit in the module, this is an integer, <1 to 6>.

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.

9.2 Status and event registers

9.2.1 Standard Event Status Register

The Standard Event Status Register (SESR) is modified by the IQABC MATRIQ with the results of the command operations.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (MSB), 6</td>
<td>Not used</td>
</tr>
<tr>
<td>5</td>
<td>Is set when a Command Error event has been detected</td>
</tr>
<tr>
<td>4</td>
<td>Is set when a command Execution Error has been detected</td>
</tr>
<tr>
<td>3</td>
<td>Is set when a Device Dependent Error event has been detected</td>
</tr>
<tr>
<td>2</td>
<td>Is set when there a Query Error event has been detected</td>
</tr>
<tr>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>0 (LSB)</td>
<td>Is set when an Operation Complete event has been generated</td>
</tr>
</tbody>
</table>

9.2.2 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.

9.2.3 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.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (MSB)</td>
<td>Not used</td>
</tr>
<tr>
<td>6</td>
<td>The Master Summary Status (MSS) bit is set from the STB and SRE Mask</td>
</tr>
<tr>
<td>5</td>
<td>The Event Status Bit (ESB) is set from the SESR and the SESR Mask</td>
</tr>
<tr>
<td>4</td>
<td>Message Available (MAV) is set when there is data in the output queue</td>
</tr>
<tr>
<td>3, 2, 1, 0 (LSB)</td>
<td>Not used</td>
</tr>
</tbody>
</table>

9.2.4 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.
### Status and event registers diagram

#### Bit Description

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Not used</td>
</tr>
<tr>
<td>6</td>
<td>The Master Summary Status (MSS) bit is set from the STB and SRE Mask</td>
</tr>
<tr>
<td>5</td>
<td>The Event Status Bit (ESB) is set from the SESR and the SESR Mask</td>
</tr>
<tr>
<td>4</td>
<td>Message Available (MAV) is set when there is data in the output queue</td>
</tr>
<tr>
<td>3, 2, 1, 0 (LSB)</td>
<td>Not used</td>
</tr>
</tbody>
</table>

---

[ Logical OR diagram with Bit 7, X, 5, 4, 3, 2, 1, 0 connected to MSS, ESB, MAV, and a logical OR gate. ]

[ Queue not empty sign, Output queue, Standard event status enable register (*ESE?), Standard event status register (*ESR?), Command error, Execution error, Device dependent error, Query error, Operation complete. ]
9.3 Common system command summary

<table>
<thead>
<tr>
<th>Common commands</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>*CLS</td>
<td>- Clear Status command</td>
</tr>
<tr>
<td>*IDN?</td>
<td>- Query the chassis identification</td>
</tr>
<tr>
<td>*OPC?</td>
<td>- Query the Operation Complete Status</td>
</tr>
<tr>
<td>*OPT?</td>
<td>- Query the modules managed by the CohesionSCPI service</td>
</tr>
<tr>
<td>*ESR?</td>
<td>- Query the Standard Event Status Register</td>
</tr>
</tbody>
</table>

9.4 Common system command descriptions

<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
<th>Description</th>
<th>Parameters</th>
<th>Response</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>*CLS</td>
<td>*CLS</td>
<td>Clear Status command</td>
<td>No parameters</td>
<td>No response</td>
<td>*CLS</td>
</tr>
<tr>
<td>*ESR?</td>
<td>*ESR?</td>
<td>Query the Standard Event Status Register</td>
<td>No parameters</td>
<td></td>
<td>*ESR? \rightarrow 8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
<th>Decimal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (MSB)</td>
<td>Not used</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Not used</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Command Error</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>Execution Error</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Device dependent Error</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Not used</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Not used</td>
<td>0</td>
</tr>
<tr>
<td>0 (LSB)</td>
<td>Operation Complete</td>
<td>0</td>
</tr>
</tbody>
</table>

⚠️ IMPORTANT

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.
- **Operation Complete** – The current user’s command queue for this instrument has completed execution.
Automatic Bias Control | IQABC 1000 Series MATRIQ

<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>*OPC?</td>
<td>*OPC?</td>
</tr>
</tbody>
</table>

| Description | Query the Operation Complete Status |
| Parameters  | No parameters |
| Response    | 1 is returned if all the modules installed in the chassis are ready to execute commands. 0 is returned if any module installed in the chassis still has a command to execute in the input queue. |
| Example     | *OPC? -> 1 |

**Command summary**

<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>*OPT?</td>
<td>*OPT?</td>
</tr>
</tbody>
</table>

| Description | Query the modules managed by the CohesionSCPI service |
| Parameters  | No parameters |
| Response    | Response will be a comma separated string of the installed modules in the chassis |
| Example     | *OPT? -> IQABC-1001-1-FA~MATRIQ |

### 9.5 Specific command summary

#### System commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:SYSTEM</td>
<td>- Query the driver and the server version numbers from the instrument  - Query the number of slots installed in the instrument</td>
</tr>
<tr>
<td>:INFO?</td>
<td></td>
</tr>
<tr>
<td>:SLOTS?</td>
<td></td>
</tr>
</tbody>
</table>

#### Slot commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:SLOT</td>
<td>- Query the status of the Operation Complete bit  - Query the modules installed on the slot  - Query the Identifier for the slot; returns the manufacturer, part number, serial number, hardware, and firmware versions</td>
</tr>
<tr>
<td>:OPC/?</td>
<td></td>
</tr>
<tr>
<td>:OPTIONS?</td>
<td></td>
</tr>
<tr>
<td>:IDN?</td>
<td></td>
</tr>
</tbody>
</table>

#### Configuration commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:SLOT</td>
<td>- Set or query the modulation channel auto-bias state  - Set or query the modulation channel DC bias voltage  - Query whether the bias is locked to its optimal position  - Query the error history timeframe and reason  - Query the DC value  - Set or query the gain VPi percentage  - Query the output power of the unit (mW)  - Query the dark nulling time remained to complete  - Perform dark current nulling on the channel  - Force or query the recalibration of the auto-bias control system  - Set a reset of the error history  - Query the DC scan VPi  - Set or query the optimizer timing factor</td>
</tr>
<tr>
<td>:&lt;XI</td>
<td>XQ</td>
</tr>
<tr>
<td>:PILOT/?</td>
<td></td>
</tr>
<tr>
<td>:BIAS/?</td>
<td></td>
</tr>
<tr>
<td>:LOCK?</td>
<td></td>
</tr>
<tr>
<td>:HISTORY?</td>
<td></td>
</tr>
<tr>
<td>:SCAN?</td>
<td></td>
</tr>
<tr>
<td>:GAIN/?</td>
<td></td>
</tr>
<tr>
<td>:PDPower?</td>
<td></td>
</tr>
<tr>
<td>:TIMEnulling?</td>
<td></td>
</tr>
<tr>
<td>:NULLing</td>
<td></td>
</tr>
<tr>
<td>:CALibrate/?</td>
<td></td>
</tr>
<tr>
<td>:HISTORY:START</td>
<td></td>
</tr>
<tr>
<td>:VPI?</td>
<td></td>
</tr>
<tr>
<td>:SLOWfactor/?</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**

The modulator biases :<XI|XQ|XP|YI|YQ|YP> can be replaced with :MODulator<1|2|3|4|5|6>. 
### 9.6 Specific command descriptions

#### 9.6.1 System commands

<table>
<thead>
<tr>
<th>Command</th>
<th>:SYSTEM:INFO?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>:SYSTEM:INFO?&lt;wsp&gt;&lt;ALL</td>
</tr>
<tr>
<td>Description</td>
<td>Query the driver and the server version numbers from the instrument</td>
</tr>
<tr>
<td>Parameters</td>
<td>ALL: Get the driver and the server version numbers</td>
</tr>
<tr>
<td></td>
<td>SERVER: Get the server version number</td>
</tr>
<tr>
<td></td>
<td>DRIVER: Get the driver version number</td>
</tr>
<tr>
<td>Response</td>
<td>Comma separated string containing the &lt;parameter&gt;,&lt;version number&gt;</td>
</tr>
<tr>
<td>Example</td>
<td>:SYSTEM:INFO? ALL -&gt; DRIVER,3.01.04 SERVER,3.00.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>:SYSTEM:SLOTS?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>:SYSTEM:SLOTS?</td>
</tr>
<tr>
<td>Description</td>
<td>Query the number of slots installed in the IQABC</td>
</tr>
<tr>
<td>Parameters</td>
<td>No parameters</td>
</tr>
<tr>
<td>Response</td>
<td>Returns the number of slots installed in the IQABC</td>
</tr>
<tr>
<td>Example</td>
<td>:SYSTEM:SLOTS? -&gt; 1</td>
</tr>
</tbody>
</table>

#### 9.6.2 Slot commands

<table>
<thead>
<tr>
<th>Command</th>
<th>:SLOT&lt;n&gt;:OPC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>:SLOT&lt;n&gt;:OPC?</td>
</tr>
<tr>
<td>Description</td>
<td>Query the status of the Operation Complete bit</td>
</tr>
<tr>
<td>Parameters</td>
<td>No parameters</td>
</tr>
<tr>
<td>Response</td>
<td>1 is returned if the module is ready to execute a new operation</td>
</tr>
<tr>
<td></td>
<td>0 is returned if the module is busy</td>
</tr>
<tr>
<td>Example</td>
<td>:SLOT1:OPC? -&gt; 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>:SLOT&lt;n&gt;:OPTions?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>:SLOT&lt;n&gt;:OPTions?</td>
</tr>
<tr>
<td>Description</td>
<td>Query the modules installed on the slot</td>
</tr>
<tr>
<td>Parameters</td>
<td>No parameters</td>
</tr>
<tr>
<td>Response</td>
<td>Comma separated string of detectors installed in the IQABC. If a module is not installed in a channel, it will not return any identification string</td>
</tr>
<tr>
<td>Example</td>
<td>:SLOT1:OPT? -&gt; 1,1,1,1,1,1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>:SLOT&lt;n&gt;:IDN?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax</td>
<td>:SLOT&lt;n&gt;:IDN?</td>
</tr>
<tr>
<td>Description</td>
<td>Query the Identifier for the slot; returns the manufacturer, part number, serial number, hardware and firmware versions</td>
</tr>
<tr>
<td>Parameters</td>
<td>No parameters</td>
</tr>
<tr>
<td>Response</td>
<td>Comma separated string containing the &lt;manufacturer&gt;, &lt;part number&gt;, &lt;serial number&gt;, &lt;hardware version&gt;&lt;firmware version&gt;</td>
</tr>
<tr>
<td>Example</td>
<td>:SLOT1:IDN? -&gt; Quantifi Photonics Ltd, IQABC-1001-FA, CSL-000000, HW0.01.06FW0.00.05</td>
</tr>
</tbody>
</table>

Hardware and firmware versions are not separated by a comma
### 9.6.3 Configuration commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
<th>Description</th>
<th>Parameters</th>
<th>Response</th>
<th>Example</th>
</tr>
</thead>
</table>
| :ABC<n>:<XI|XQ|XP|YI|YQ|YP>:PILOT | :ABC<n>:<XI|XQ|XP|YI|YQ|YP>:PILOT<sp><1|ON|0|OFF|DEF> | Set the modulator channel auto-bias state | ON: Set to the modulation auto-bias state to on<br>OFF: Set to the modulation auto-bias state to off<br>DEF: Set the default programmable modulator channel auto-bias state | No response | :
<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
<th>Description</th>
<th>Parameters</th>
<th>Response</th>
<th>Example</th>
</tr>
</thead>
</table>
| :ABC<n>:<XI|XQ|XP|YI|YQ|YP>:BIAS? | :ABC<n>:<XI|XQ|XP|YI|YQ|YP>:BIAS?<sp>[MIN|MAX|DEF|SET|ALL|STEP|UNIT] | Query the modulator channel bias voltage | MIN: Set to the minimum programmable value<br>MAX: Set to the maximum programmable value<br>DEF: Set to the default programmable value<br><value>: Sets to the user value (V is default)<br>The valid range is <-14.0 to 24.0> | Returns the string for the specified channel<br>UNIT: Returns the BIAS measurement unit | Returns the string for the modulator DC bias voltage for the specified channel | :
<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
<th>Description</th>
<th>Parameters</th>
<th>Response</th>
<th>Example</th>
</tr>
</thead>
</table>
| :ABC<n>:<XI|XQ|XP|YI|YQ|YP>:LOCK? | :ABC<n>:<XI|XQ|XP|YI|YQ|YP>:LOCK?<sp>[INFO] | Query whether the bias is locked to its optimal position | INFO: Returns the string for the specified channel LOCK states | 1: LOCKED<br>0: UNLOCKED | :

---

Quantifi Photonics Ltd.  Version 1.04  38
### Automatic Bias Control

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:ABC&lt;n&gt;:&lt;XI</td>
<td>XQ</td>
</tr>
</tbody>
</table>

#### Syntax

:ABC<n>:<XI|XQ|XP|YI|YQ|YP>:HISTORY?<wsp>[<start_time>,<end_time><BIAS ERROR FULL] |

#### Parameters

- **<wsp>:** The start and end time of the error history
- **BIAS:** The bias voltage value and time when the error occurred
- **ERROR:** The error number and time when the error occurred
- **FULL:** Returns all of the above parameters in a comma separated string

#### Response


#### Example


### Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:ABC&lt;n&gt;:&lt;XI</td>
<td>XQ</td>
</tr>
</tbody>
</table>

#### Syntax

:ABC<n>:<XI|XQ|XP|YI|YQ|YP>:SCAN?<wsp>[POWER ERROR PHASE FULL UNIT] |

#### Parameters

- **POWER:** The measured power values at the time of the scan for the current bias value
- **ERROR:** The error numbers at the time of the scan for the current bias value
- **PHASE:** The phase values at the time of the scan for the current bias value
- **FULL:** Returns all of the above parameters in a comma separated string
- **UNIT:** Get the scan measurement unit

#### Response

- **POWER:** <number of points N>:<dcbias x-axis for all>:<power1,...,powerN>  
- **ERROR:** <number of points N>:<dcbias x-axis for all>:<error1,...,errorN>  
- **PHASE:** <number of points N>:<dcbias x-axis for all>:<phase1,...,phaseN>  
- **FULL:** <number of points N>:<dcbias x-axis for all>:<power1,...,powerN>:<error1,...,errorN>:<phase1,...,phaseN>  
- **UNIT:** The scan measurement unit

#### Example

6.125000,-5.250000,-4.375000,-3.500000,-2.625000,-1.750000,  
0.875000,0.000000,0.875000,1.750000,2.625000,3.500000,4.375000,5.250000,  
6.125000,7.000000,7.875000,8.750000,9.625000,10.500000,11.375000,  
12.250000,13.125000:0.000987,0.000926,0.000987,0.001094,0.000865,0.001  
048,0.000865,0.000926,0.000835,0.000987,0.000774,0.001018,0.000850,0.  
001109,0.000896,0.000896,0.000957,0.000926,0.000822,0.001021,0.143313  
,0.143236,0.143236,0.143236,0.143267,0.143145,0.143221,0.143236,0.143  
175,0.143099,0.143221,0.143130 |

#### Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>:ABC&lt;n&gt;:&lt;XI</td>
<td>XQ</td>
</tr>
</tbody>
</table>

#### Syntax


#### Parameters

- **Value:** Set the gain VPI percentage value of the modulation channel
- **MIN:** Set the minimum gain VPI percentage value of the modulation channel
- **MAX:** Set the maximum gain VPI percentage value of the modulation channel
- **DEF:** Set the default gain VPI percentage value of the modulation channel

#### Response

No response

#### Example

:ABC1:X1:GAIN SET 20.75
<table>
<thead>
<tr>
<th>Command</th>
<th>Syntax</th>
<th>Description</th>
<th>Parameters</th>
<th>Response</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>:ABC&lt;n&gt;:&lt;XI</td>
<td>XQ</td>
<td>XP</td>
<td>YI</td>
<td>YQ&gt;:GAIN?</td>
<td>:ABC&lt;n&gt;:&lt;XI</td>
</tr>
<tr>
<td>:ABC&lt;n&gt;:PDPower?</td>
<td>:ABC&lt;n&gt;:PDPower?&lt;wsp&gt;[MIN</td>
<td>MAX</td>
<td>ALL</td>
<td>UNIT]</td>
<td>Query the output power of the unit in mW</td>
</tr>
<tr>
<td>:ABC&lt;n&gt;:CALibrate</td>
<td>:ABC&lt;n&gt;:CALibrate</td>
<td>Forces recalibration of the auto-bias control system</td>
<td>No parameters</td>
<td>No response</td>
<td>:ABC1:CAL</td>
</tr>
<tr>
<td>:ABC&lt;n&gt;:CALibrate?</td>
<td>:ABC&lt;n&gt;:CALibrate&lt;wsp&gt;[COM</td>
<td>REQ</td>
<td>INFO]</td>
<td>Queries the recalibration status of the auto-bias control system</td>
<td>COMpleted: Get the recalibration status of the auto-bias control system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>REQuested: Query if the recalibration of the auto-bias control system was requested</td>
<td>0: Returned if the recalibration status is COMPLETED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>INFO: Returns a string of the auto-bias control system recalibration states</td>
<td>TRUE / FALSE: Returned depending on the REQ / COM state</td>
<td></td>
</tr>
</tbody>
</table>

Quantifi Photonics Ltd.  Version 1.04  40
### Command Reference

#### Command: :ABC<n>:HISTory:STARt

**Syntax:** :ABC<n>:HISTory:STARt

**Description:** Set a reset of the error history

**Parameters:** No parameters

**Response:** No response

**Example:** :ABC1:HIST:STAR

#### Command: :ABC<n>:VPI?

**Syntax:** :ABC<n>:MODulator<m>:VPI?[<wsp>[POWER|ERROR|PHASE|UNIT]]

**Description:** Query the DC scan Vpi

**Parameters**
- POWER: Get the Vpi value as measured from the Output power vs DC Voltage scan
- ERROR: Get the Vpi value as measured from the bias control error signal vs DC Voltage scan
- PHASE: Get the Vpi value as measured from the Phase vs DC Voltage scan
- UNIT: Get the unit of the Vpi value

**Response:** Depending on the parameters the response will be a single value or a comma separated string of values.

**Example:** :ABC1:MODulator1:VPI? POWER -> 3.073177, 3.030208, 3.753062, NAN, NAN, NAN

#### Command: :ABC<n>:SLOWfactor

**Syntax:** :ABC<n>:SLOWfactor<wsp><value|MIN|MAX|DEF>

**Description:** Set the optimizer timing factor

**Parameters**
- Value: Set the optimizer timing factor value of the modulation channel
- MIN: Set the minimum optimizer timing factor value of the modulation channel
- MAX: Set the maximum optimizer timing factor value of the modulation channel
- DEF: Set the default optimizer timing factor value of the modulation channel

**Response:** No response

**Example:** :ABC1:SLOWfactor MAX

#### Command: :ABC<n>:SLOWfactor?

**Syntax:** :ABC<n>:SLOWfactor?[<wsp>[MIN|MAX|DEF|SET|ALL]]

**Description:** Set the optimizer timing factor

**Parameters**
- MIN: Get the minimum optimizer timing factor value of the modulation channel
- MAX: Get the maximum optimizer timing factor value of the modulation channel
- DEF: Get the default optimizer timing factor value of the modulation channel
- SET: Get the default optimizer timing factor value of the modulation channel
- ALL: Returns all of the above parameters in a comma separated string

**Response:** Depending on the parameters the response will be a single value or a comma separated string of values.

**Example:** :ABC1:SLOW? MAX -> 250

### 9.7 SCPI Command Console

The SCPI Command Console enables you to communicate with Quantifi Photonics devices via SCPI commands. You can easily test commands and verify their syntax.

**NOTE**

For available SCPI commands, refer to the user manual of the Quantifi Photonics device you are communicating with.
NOTE

The two most common error codes are:

17: IO write error: the command was invalid or not accepted by the instrument.
15: IO timeout: there was no response available before expiry of the reading wait time.

To open the SCPI Command Console:

- Open the Cohesion Operator, for example by double-clicking the Cohesion Operator desktop icon.
- Select the instrument by entering its IP address or by selecting it from the Discovery drop down list.
- Click Open SCPI Command Console.

1. To verify that you are communicating with the right device:
   - Enter *idn? and press <ENTER>.
   - The device will return identification details.

2. To switch to another Quantifi Photonics device:
   - Enter ip and press <ENTER>.
   - Enter the IP address of the Quantifi Photonics product you would like to switch to and press <ENTER>.
   - Confirm you are communicating with the right product: Enter *idn? and press <ENTER>.
   - The device will return identification details.

3. To send a command or query to a Quantifi Photonics device:
   - Enter a command and press <ENTER>.
   - The device will execute the command and return an action response to the console if applicable.

4. To exit the SCPI Command Console:
   - Enter q and press <ENTER>. 
Example: Send instrument identification query *idn? 

5. Enter the command: *idn?
The instrument returns the requested information.

6. If you enter the command incorrectly, for example: *ind?
The instrument returns error code 32.
For details on error codes, please refer to the *ESR? Command.

Example: Send a WRITE only command 

7. Enter a command correctly, for example: *cls
The instrument executes the command, there will be no action response.

8. Enter the command incorrectly: *csl
The instrument returns error code 17: IO write error.
10 Example: Control of the IQABC 1000 Series MATRIQ

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

After any command, it is recommended to query the *ESR? command. This will allow debugging of unreceived or incorrect commands that were sent to the product.

<table>
<thead>
<tr>
<th>Description</th>
<th>Command example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify and setup the IQABC MATRIQ instrument</td>
<td></td>
</tr>
<tr>
<td>1. Query to confirm the correct IQABC setup</td>
<td>:ABC1:IDN?</td>
</tr>
<tr>
<td>2. Query the number of biases available</td>
<td>:ABC1:OPT?</td>
</tr>
<tr>
<td>3. Force calibrate the IQABC</td>
<td>:ABC1:CAL</td>
</tr>
<tr>
<td>Query if the setup was successful</td>
<td></td>
</tr>
<tr>
<td>1. Query if the calibration has been completed</td>
<td>:ABC1:CAL?</td>
</tr>
<tr>
<td>2. Query if the XI bias is locked</td>
<td>:ABC:X1:LOCK?</td>
</tr>
<tr>
<td>3. Query if the XQ bias is locked</td>
<td>:ABC:XQ:LOCK?</td>
</tr>
<tr>
<td>4. Query if the XP bias is locked</td>
<td>:ABC:XP:LOCK?</td>
</tr>
<tr>
<td>5. Query if the YI bias is locked</td>
<td>:ABC:Y1:LOCK?</td>
</tr>
<tr>
<td>6. Query if the YQ bias is locked</td>
<td>:ABC:YQ:LOCK?</td>
</tr>
<tr>
<td>7. Query if the YP bias is locked</td>
<td>:ABC:YP:LOCK?</td>
</tr>
<tr>
<td>Manually set the bias voltage</td>
<td></td>
</tr>
<tr>
<td>1. Change the control state of the XI bias from AUTO (default) to MANUAL</td>
<td>:ABC1:X1:PILOT OFF</td>
</tr>
<tr>
<td>2. Set the static bias voltage of XI to 2 V</td>
<td>:ABC1:X1:BIAS 2</td>
</tr>
</tbody>
</table>
The following section details the various methods that a user may send these commands to the IQABC MATRIQ via SCPI commands.

10.1 NI-MAX application
To communicate with any IQABC MATRIQ instrument, the chassis / instrument 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. The top image is an example of operating remotely, the bottom image is an example of operating locally. Note when operating locally, enter in the localhost IP address of 127.0.0.1. Click Finish to end the setup process.
10.2 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 IQABC MATRIQ instrument using Python code. For a list of supported and valid SCPI commands, refer to the Programming Guide.

```python
# You can get VXI11 from pip:
# pip install python-vxl11==0.9
import vx11
from vx11.vx11 import Vx11Exception
#
# replace this with the IP of your device
ip = "127.0.0.1"
try:
    print("connecting to " + ip + " ... ")
    instrument = vx11.Instrument(ip)
    print("connected")
    command = "*IDN?"
    data = instrument.ask(command)
    print("IDN: " + data)
    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 = ""
    instrument.write(command)
    print("writing a specific command")
    command = "*ESR?"
    data = instrument.ask(command)
    print("*ESR?: " + data)
except Vx11Exception as e:
    # pass
    print("ERROR" + str(e) + ", command: " + str(command))
```
10.4 MATLAB® code example

To communicate with the IQABC MATRIQ instrument 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 IQABC MATRIQ 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.

⚠️ IMPORTANT
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 the IQABC MATRIQ using MATLAB code. For a list of supported and valid SCPI commands, refer to the Programming Guide.

```matlab
% 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-tcip', ...
                         '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.
```

MATLAB 2010x or later with the Instrument Control Toolbox is required to execute the code detailed in this section.
11 Example: QPSK configuration procedures

The various modulation adjustments on certain models of the IQABC are used to calibrate and configure the optical signal. This section provides detail on the calibration for the example QPSK hardware setups.

11.1 Set the laser frequency and power

Make sure the laser frequency and power are set to the desired values. This is always displayed within the LCD display and CohesionUI for easy reference.

**NOTE**

For calibration purposes it may be convenient to set the laser to maximum power providing you are transmitting within the specifications of the coherent receiver you are using.

11.2 Setting RF delay for IQ Skew (optional, certain models only)

11.2.1 I & Q RF delay adjustment

The I & Q RF delay adjustment is used to set the correct delay between the In-phase (I) and Quadrature (Q) RF input signals, hence reducing the IQ skew (see definition below).

The delay will have to be calibrated to the particular hardware configuration in operation, due to the internal connections combined with the lengths of the RF cables connecting the RF pattern generator to the IQABC.

11.2.2 IQ skew

To adjust the IQ skew within the IQABC modulator, the 'I & Q RF delay dial is adjusted to increase or decrease the delay of the RF quadrature input signal. Very small adjustments should be made.

The IQ skew is a measure of the time difference between the In-phase (I) and Quadrature (Q) crossing points in the eye diagrams as shown in section 11.3.1 Modulator bias-I and bias-Q.

\[ Skew_{IQ}(s) = t_I(s) - t_Q(s) \]
11.3  Modulator adjustments

The modulator adjustments provide manual adjustment of the In-phase (I), Quadrature (Q) and optical output signals. With the auto-bias control option, these biases will be automatically varied to compensate for the errors below and if the user wishes to manually control the bias voltages, they can do so with CohesionUI.

11.3.1  Modulator bias-I and bias-Q

The bias-I and bias-Q dials are used to set the bias offset ($\Delta A$) for either the In-phase (I) or Quadrature (Q) components of the optical signal.

Changing the bias offset for a given component (I, Q) is related to reducing bias error within the constellation, represented by $\Delta I$ and $\Delta Q$ in section 11.3.2 I & Q optical phase offset.

The bias offset is a measure of how far the center of the constellation is with respect to the ideal center point. For QPSK and QAM modulation formats, the ideal center point is [0, 0] (I, Q). It is more convenient to represent the bias errors in percentages to make it independent of the average optical power.

Additionally, the bias error can be separated into orthogonal components (I and Q) as shown in the equation below, to help identify the origin of the bias error. Since the electrical to optical transfer function of optical modulators is typically non-linear, a 5% bias offset as measured in the optical domain may not necessarily correspond to a 5% error in bias voltage.

$$I_{\text{bias Error}}\% = \frac{\text{Re(centre)}}{\text{Re(reference)}} \times 100$$

$$Q_{\text{bias Error}}\% = \frac{\text{Im(centre)}}{\text{Im(reference)}} \times 100$$
11.3.2 I & Q optical phase offset

The I & Q optical phase offset dial is used to set the phase offset, or phase difference ($\Delta \Phi$ as seen in both Figure 26 and Figure 25), between the in-phase and quadrature phase components of the optical output signal generated by the IQABC.

In-Phase (I) and Quadrature (Q) Phase Offset

The I & Q optical phase offset dial should be adjusted to align the clusters to the ideal phase relationship of 90° which is shown in Figure 26.

The quadrature error is a measure of the phase error of the constellation points with respect to the ideal phase relationship between the constellation points.

For QPSK and QAM modulation formats, the ideal phase between the constellation points is 90°.

The quadrature error is an average measurement taken over all the constellation points as shown in Equation 3.

\[ \text{Quad Error} = \frac{\angle A - \angle B + \angle C - \angle D}{4} \]

Equation 2 - Quadrature Error Calculation
12 Measurement definitions

12.1 IQ RF imbalance

The IQ RF imbalance is the ratio of the in-phase component versus the quadrature component of the constellation points.

The ratio is represented as a percentage, so 10% IQ RF imbalance would mean that the in-phase component is 10% larger than the quadrature component.

\[ IQ_{\text{imbalance}} \% = \left( \frac{|B|}{|A|} - 1 \right) \times 100 \]

Equation 3 - IQ RF Imbalance Calculation

![Figure 16 - IQ RF Imbalance for QPSK](image)

12.2 Error vector

The error vector can be separated into its two primary components: Error Vector Magnitude (EVM) and Phase Error (PE). The error vector magnitude is the magnitude of the error vector, which is the difference between the signal vector and the ideal reference vector. It is more convenient to represent the EVM as a percentage to make it independent of the average signal power, as shown in Equation 5. The phase error is the phase difference between the signal vector and the ideal reference vector, as shown Equation 6.

\[ EVM\% = \left( \frac{|\text{signal} - \text{reference}|}{|\text{reference}|} \right) \times 100 \]

Equation 4 - Error Vector Magnitude Calculation

\[ \text{Phase Error} = \theta_R - \theta_S \]

Equation 5 - Phase Error Calculation

![Error Vector, Single Sample Point](image)
13 Maintenance

To help ensure long, trouble-free operation:

- Always inspect fiber-optic connectors before using them and clean them if necessary.
- Keep the instrument free of dust.
- Store the instrument 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 instrument, power off the chassis immediately. Remove the instrument 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 IQABC 1000 Series MATRIQ instrument 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 instrument, 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 instrument, contact Quantifi Photonics.

The Technical Support Group is available to take your calls Monday to Friday, 9:00 a.m. to 5:00 p.m. (New Zealand Time).

Technical Support Group
Tel.: +64 9 478 4849
support@quantifiphotonics.com

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

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 instrument in its original packing material when shipping.
- Avoid high humidity or large temperature fluctuations.
- Keep the instrument out of direct sunlight.
- Avoid unnecessary shocks and vibrations.


15 Warranty

15.1 General information
Quantifi Photonics Ltd. (Quantifi Photonics) warrants from the date of the original shipment (the Warranty Period) that this instrument 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.

⚠️ IMPORTANT
The warranty can become null and void if:

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

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL QUANTIFI PHOTONICS BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.
For full warranty terms and conditions, please visit www.quantifiphotonics.com.

15.2 Liability
Quantifi Photonics shall not be liable for damages resulting from the use of the instrument, nor shall be responsible for any failure in the performance of other items to which the instrument is connected or the operation of any system of which the instrument may be a part.
Quantifi Photonics shall not be liable for damages resulting from improper usage, transportation or unauthorized modification of the instrument, its accompanying accessories and software.
The external power supply that has been supplied by Quantifi Photonics with the unit can only be used with that unit, do not use it with any other product.

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.
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.

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