

# User Manual

## *Automatic **BIAS** Control*

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V1.22

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## 1 General Information

### 1.1 Manual download

The most current version of the manual can be downloaded under [http://www.id-photonics.com/downloads/Manual\\_AutomaticBIASControl.pdf](http://www.id-photonics.com/downloads/Manual_AutomaticBIASControl.pdf)

### 1.2 Limitation of communication interfaces

Operation of all USB Ports is limited to a maximum cable length of 3 m and a maximum length of 30 m for all Ethernet ports present.

#### NOTE

**This instrument is not compatible to Power over Ethernet(POE). Connecting the unit to a POE Port will permanently damage the Ethernet port of the unit.**

### 1.3 European WEEE Directive Compliance

ID PHOTONICS has established processes in compliance with the Waste Electrical and Electronic Equipment (WEEE) Directive, 2002/96/EC. This product should not be disposed of as unsorted municipal waste and should be collected separately and disposed of according to your national regulations. In the European Union, all equipment purchased from ID PHOTONICS can be returned for disposal at the end of its useful life. ID PHOTONICS will ensure that all waste equipment returned is reused, recycled, or disposed of in an environmentally friendly manner, and in compliance with all applicable national and international waste legislation. It is the responsibility of the equipment owner to return the equipment to ID PHOTONICS for appropriate disposal. If the equipment was imported by a reseller whose name or logo is marked on the equipment, then the owner should return the equipment directly to the reseller. If you have questions concerning disposal of your equipment, contact ID PHOTONICS's at [WEEE@id-photonics.com](mailto:WEEE@id-photonics.com).

### 1.4 Line Voltage Selection

The unit operates from a DC power source that supplies any voltage 9 – 36VDC with a minimum output power of 30W transient and 10W typical during operation. Make sure that the power supply supports transient currents of at least 3A.

If a line power supply was delivered with the unit, it will automatically adapt to any AC Voltage ranging from 100V to 240V, 50/60Hz.

## 1.5 Help and User Feedback

ID Photonics GmbH is dedicated to continuously improve customer experience of our products. Thus, if you have any feedback that might help us to improve our products send us an E-Mail to: [feedback@id-photonics.com](mailto:feedback@id-photonics.com) .

## 1.6 Safety

### 1.6.1 General Safety Precautions

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument.

**NOTE**

**ID Photonics assumes no liability for the customer's failure to comply with these requirements**

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

### 1.6.2 General

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

### 1.6.3 Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environments. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters.

Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

**Note:** Before connecting electrical power to the unit, make sure the unit could acclimatize to ambient temperature for at least 2 hours to avoid damage by i.e. condensed humidity on electrical parts inside the unit.

### 1.6.4 Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

## 1.6.5 Safety Symbols on Instruments

### 1.6.5.1 Warning or Caution



If you see this symbol on the product, you must refer to the manuals for specific Warning or Caution information to avoid personal injury or damage to the product.

### 1.6.5.2 ESD Safety Warning

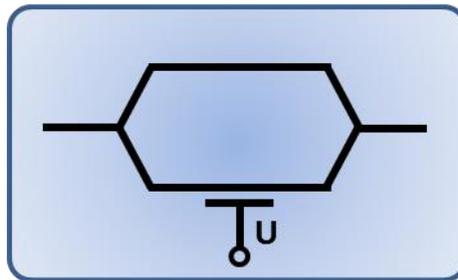


This sign indicates that the respective modules, boards or RF inputs and outputs are susceptible to damage by electro static discharge (ESD), and require proper protection procedures for storage and handling.

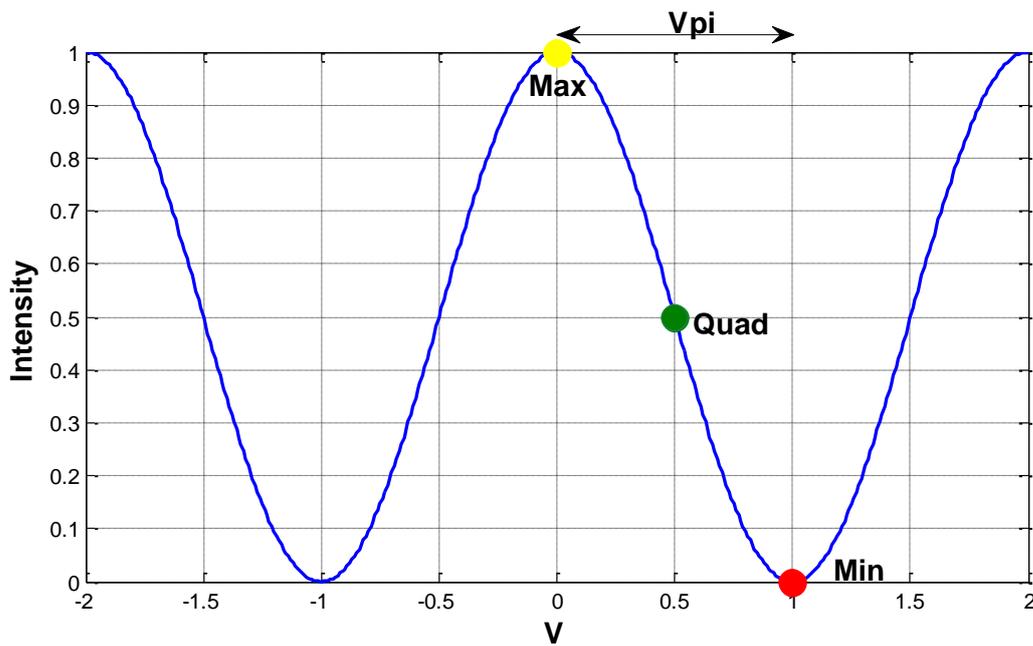
## 2 Introduction

### 2.1 Mach Zehnder Modulator - Theory of operation

Mach-Zehnder modulator structures are a popular way of modifying the intensity or phase of light waves that are based on a Mach Zehnder interferometric setup. The light is split, guided in 2 distinct paths and combined again to achieve interference. Utilizing materials with a strong electro optical effect allow changing the relative phase of the optical carrier waves that are converted into intensity changes by means of interference at the output achieving a modulation of the light.



The power transfer curve of a single MZM as a function of applied voltage is shown below.



The Voltage change required to change the output power from maximum to minimum or vice versa is defined as  $V_{\pi}$  ( $V\pi$ ). The mid-point between maximum and minimum transmission is defined as Quadrature (Quad).

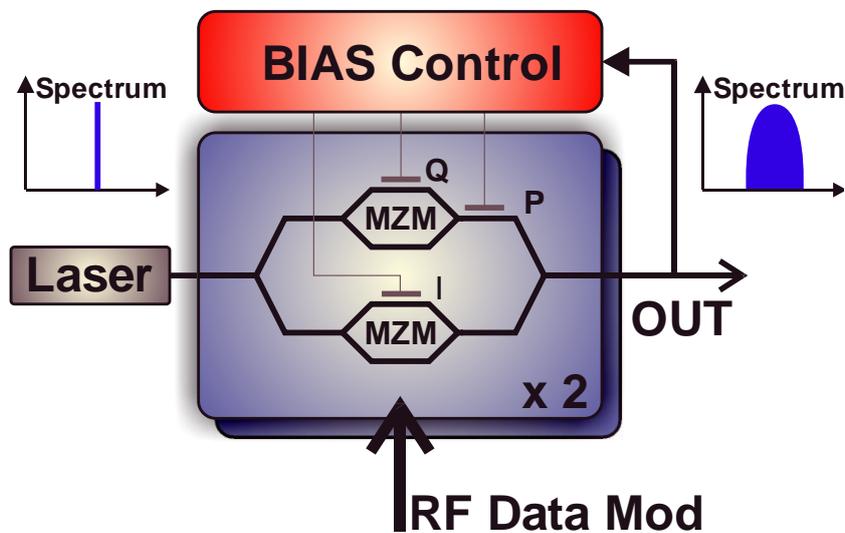
### 2.2 Automated BIAS Control

This unit is used to set the BIAS Voltage of Mach Zehnder Modulators (MZM) to its optimal operating point by means of dither tones imposed onto the BIAS Electrodes and feedback signals generated from a photodiode monitor tap located after the MZM components.

A key feature is the independence of the applied modulation format for IQ Modulator control supporting advanced modulation formats such as Nyquist shaped signals, QAM, SSB and pre-distorted signals. Furthermore, a BIAS optimization is possible without a RF signal present.

The control loop utilizes feedback signals derived from a feedback photodiode located after the MZM by means of dither tones that are applied to the BIAS electrodes of the MZM.

It supports the usage of Photodiodes that are built into the MZM package (internal) or discrete Photodiodes that are connected by means of an external tap coupler (external). The functional diagram below shows a typical configuration for a dual Pol IQ Modulator setup using a Super MZM structure of 2 nested MZMs used for I and Q modulation:



The following configurations are supported by the board (x: supported, “-“: not supported/available”:

MZM Type	Internal Photodiodes		External Photodiodes		Application example
	1 PD	2 PD	1 PD	2 PD	
Single Polarization IQ Modulator <sup>1</sup> (SPIQ mode)	✓	-	✓	-	SP-QPSK, SP-QAM32
Dual Polarization IQ Modulator (DPIQ mode)	(-)	✓	✓	(✓)	DP-QPSK, DP-QAM16
Single Polarization Intensity Modulator (II) <sup>2</sup> (SPII mode)	✓	-	✓	-	SP-OOK, SSB
Dual Polarization Intensity Modulator (II) (DPII mode)	(-)	✓	✓	✓	DP-OOK, DP-Multi-Level

The architecture of the control is mostly software based allowing a maximum of performance, versatility and configurability.

A USB interface or an Ethernet interface can be used to communicate with the unit.

A number of LEDs on the board allow to easily gathering info on the state of the unit without the need of a host PC.

The maximum BIAS Voltage range can be set continuously from 0V to 48V (0V to 30V for Hardware revisions 1.30 or later) via Software.

For more details on the control loop see chapter 5.

<sup>1</sup> Up to 2 Modulators can be operated using a single ABC board. Configure a Dual Pol. IQ modulator and 2 Photodiodes for this case

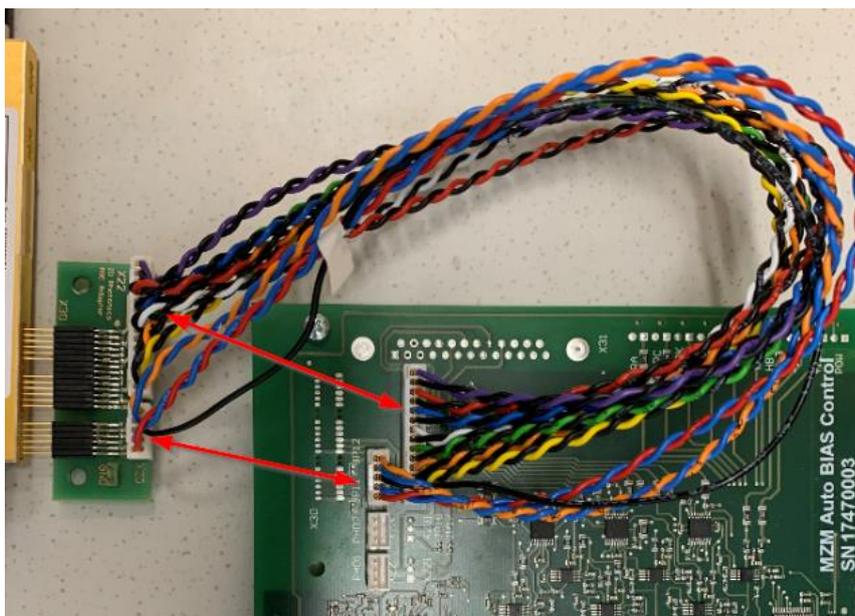
<sup>2</sup> Up to 2 Modulators can be operated using a single ABC board. Configure a Dual Pol. II modulator and 2 Photodiodes for this case

### 3 Quick Start

#### 3.1 ABC Board Version

We propose to perform the following steps to set up the Automated BIAS Control (ABC) with your setup:

1. Install the Graphical User Interface using the supplied USB Stick on a Windows 7 or later host computer. A new Icon is installed on Windows Desktop.
2. Connect the MZM module
  - a. If an OIF Standard compatible Dual Pol MZM with internal monitor diodes such as the Fujitsu FTM797xHQx is to be used, plug it into the connector X30 on the ABC board or connect the supplied Adaptor board with the 2 cables in connectors X20 and X21 on the board. See section 4.5 for details. For the onboard X30 connector and internal Photodiodes, make sure that Jumpers J11&J12 are set.
  - b. If external photodiodes or any other modulator type is to be used, refer to section 4.14 on how to connect the specific setup to the unit.
  - c. **If you are using an MZM with a maximum rating of <48V for BIAS electrodes (typically non LiNBO<sub>3</sub> based products), we recommend to set the maximum Voltage of the board first before connecting the MZM hardware!** See section “Software” for details.
  - d. Typical connection setup using a OIF compliant DualPol IQ MZM and MZM photodiodes. Do NOT set the jumper und the small extension board for H/W Version 1.30 and later.



3. Connect and enable the output of laser light source to the MZM.

- a. Connect the Feedback Photodiode using an optical coupler at the output if an external Photodiode is used.
- b. Make sure that the ABC ground is connected to ground of the MZM component to avoid ripple pickup by floating ground levels. For OIF Standard compatible MZM devices, this is guaranteed by the standard pinning.
4. Connect the electrical Power to X10 using either the supplied power supply or a DC Voltage source with 9-36VDC supporting 3A current using the adaptor cable.
  - a. Switch on or plug in the power supply
  - b. The LEDs “POW”, +/-12V and 5 smaller LEDs close to the daughter board should light up. The “HB” LED should start blinking after a few seconds.
5. Proceed to section 3.3, step 1.

### 3.2 Benchtop ABC Version

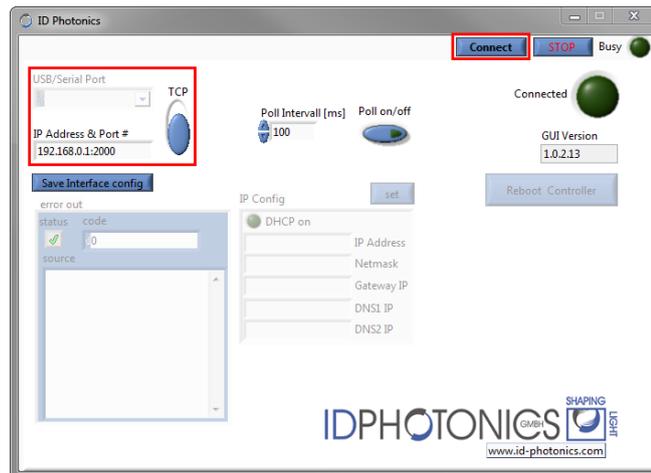
We propose to perform the following steps to set up the Automated BIAS Control (ABC) with your setup:

1. Install the Graphical User Interface using the supplied USB Stick on a Windows 7 or later host computer. A new Icon is installed on Windows Desktop.
2. Connect the MZM module
  - a. If an OIF Standard compatible Dual Pol IQ MZM such as the Fujitsu FTM797xHQx is to be used, connect the SUB D output on the ABC unit “Modulator connection” to the supplied Adaptor board using the supplied cable. See section 4.5 for details. **Make sure that the 5 Pin connector coming of the Cable is NOT connected to the unit.** Connect only the 12 pin connector.
3. Connect and enable the output of laser light source to the MZM.
  - a. Connect the optical output of the MZM to “Optical IN” of the ABC unit.
4. Connect the electrical Power to the unit the supplied power supply.
  - a. Switch on or plug in the power supply
  - b. The LEDs “POW” and +/-15V located at the front plate should light up. The “Heartbeat ” LED should start blinking after a few seconds.
5. Proceed to next section step 1.

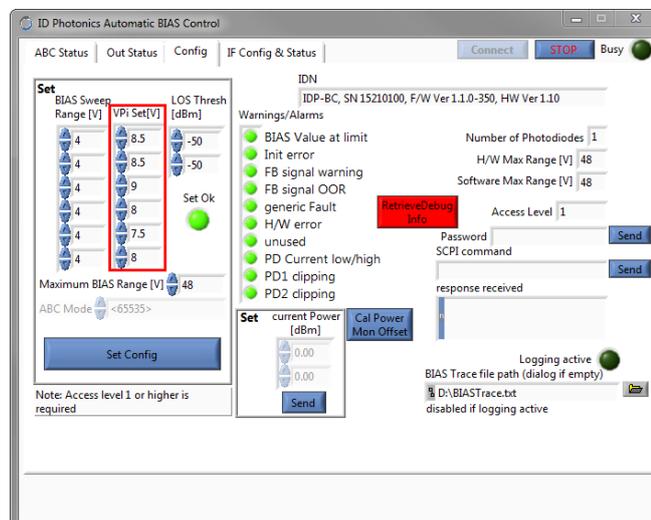
### 3.3 Setup of unit using the provided GUI

1. Connect the remote Port (USB: X12 or Ethernet X8, default IP 192.168.0.1) using one the supplied cables to the host PC. We recommend to start with USB as it can be used to do the initial Ethernet configuration easily.
  - a. If USB is used, the host PC should start installing the USB driver. Direct the routine to the according directory for the driver on the supplied USB stick. Once the installation is completed, a virtual serial port is installed on the host PC. Start Windows Device Manager to validate the availability.

- b. If Ethernet is used, set your Ethernet connection up such to be able to address 192.168.0.1 of the BIAS board. Use i.e. the command “ping 192.168.0.1” to test the connection before proceeding.
- 2. Start the application installed in step 1.
  - c. For USB based connection, select USB and configure the according serial port. For Ethernet based connection, type the IP address as configured in previous step and press “Connect”. The “Connected” LED should be solid green now and the “Busy” LED should be blinking.

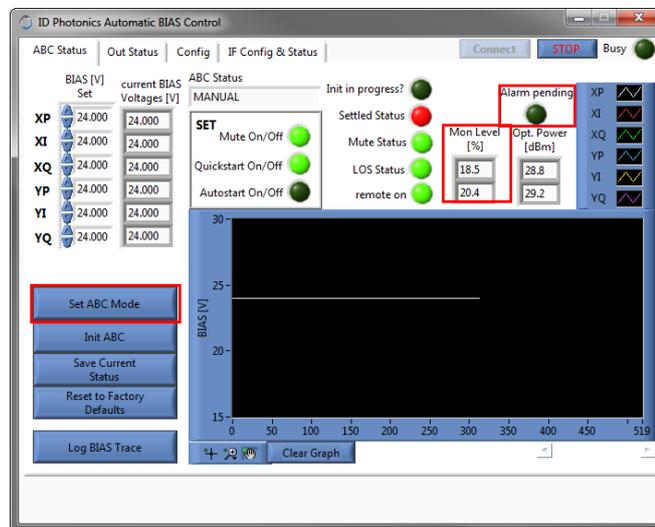


- 3. Switch to tab “Config”
  - d. Set VPi: These are MZM device specific and are usually supplied by the manufacturer on the device test sheet. Note that there are separate VPi voltages for the BIAS electrodes and RF electrodes. Use Vpi values for BIAS electrodes. For LiNBO<sub>3</sub> based devices, these voltages are typically 7-8V. If you are unsure, start with a default of 8V for each electrode. Make sure that the correct mode for your MZM configuration is selected is selected.



4. Switch to tab “ABC Status”.
  - e. Check that the Mon Level readings show values  $> 5\%$  and  $< 60\%$  with RF modulation on. Use DIP SW3 to adjust the gain to suit your configuration. For Hardware version 1.30 or later, this step is not needed. For details, see section 4.11. This can be performed while the board is in operation. For Fujitsu FTM797xHQx, internal Photodiodes and about 13dBm of optical input power, set switch number 1 to ON, all other off. The optical power reading will not be consistent as it needs to be calibrated first.

**Note** : If the gain is too high, and a PDx clipping alarm is raised. The control loop will pause as no valid feedback signal can be derived.



- f. Check that no Alarm is pending.
- g. Press “Set ABC Mode” to start the automated BIAS Control. The control loop will start to operate; the plot shows traces of the BIAS Voltage evolution. Once the operating point is reached, the “settled” indicator should be solid green.



**Note:** The target setting for IQ modulators is the zero transmission. If no RF modulation (=data) is applied, the feedback signal on the photodiodes will become minimal. If the LOS (=loss of signal) threshold set in “Config” is crossed, the control loop will pause before the optimum is reached. If the LOS threshold is set to a very low value, the ABC will try to optimize the setting but might not be able to fully optimize the signal. In this, case a PD Current low/high warning is raised. The control loop will continue to operate.

5. Once the control loop is settled, you may press “Save Current Status”. This feature will save the current BIAS Voltages as start settings and may speed up initialization process next time. Enable the Quickstart feature to start next time with these settings.

## 4 Description of unit

### 4.1 Important note on Operation

This device operates a Linux System. Data loss might occur if power is disconnected from the device before shutting down the Linux System.

Execute the command “SHUTDown” in SCPI command of GUI or any other remote-control connection. The GUI will lose connection immediately after due to system shutdown.

3 out of 5 LEDs next to the daughterboard will switch off indicating that the shutdown process is completed. It is now safe to power off the unit.

### 4.2 Main Board version

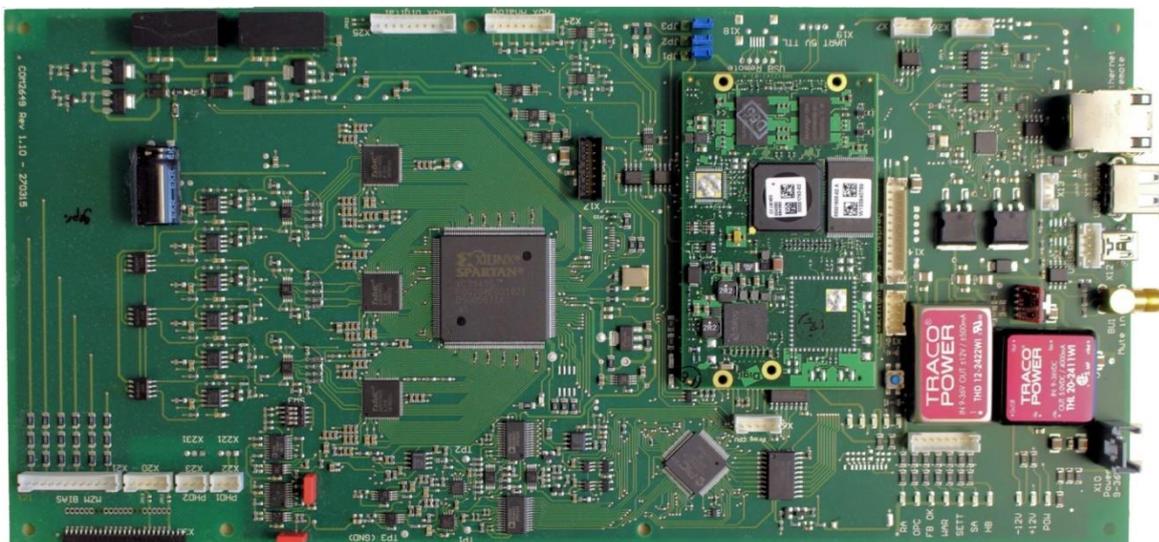
This section does not apply to the ABC benchtop version (ABC-BPC-03-X).

The picture below gives an overview of the Main Board. All available connectors and features are described in the next sections.

Note that there is a small blue button next to the silver “Traco” power supply which can be used to perform a hard reset.

A red heartbeat LED close to the large Xilinx FPGA device indicates the readiness of this component.

Note that Board Version 1.30 or later provides a USB Type B adaptor instead of USB Mini Type and an additional power connector is available.

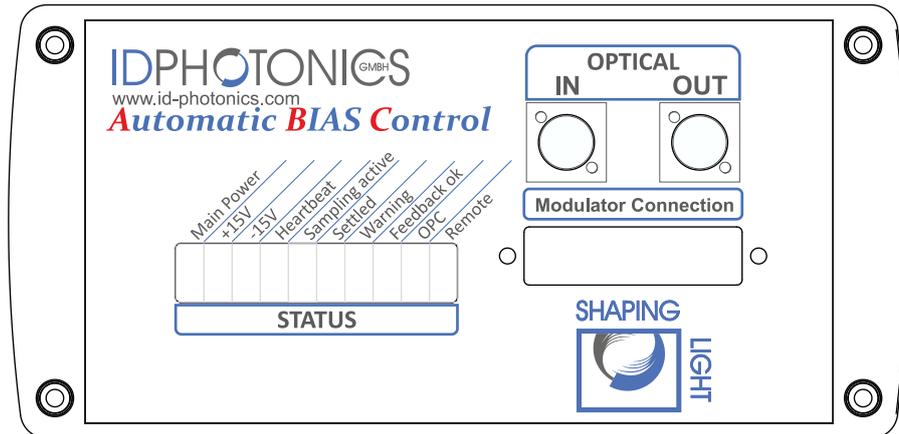


### 4.3 ABC Benchtop version (ABC-BPC-03-x)

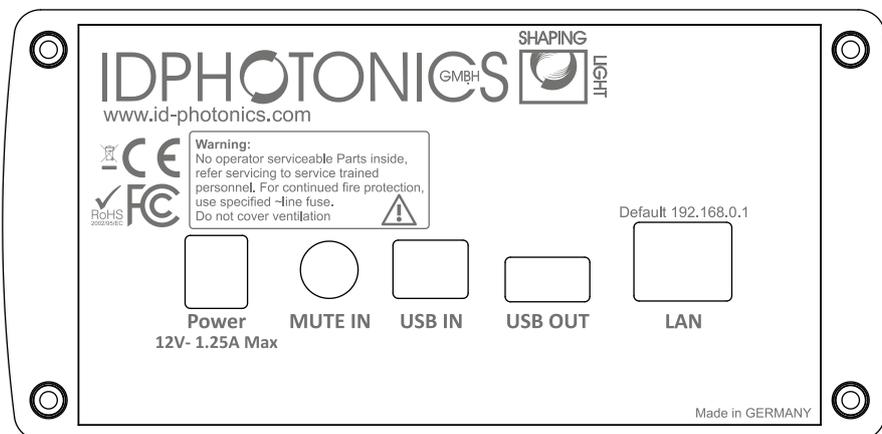
The benchtop version comprises an internal 20dB coupler with photodiode for feedback generation. The optical input and output adaptors are used to route the signal through the unit.

A Sub D compatible connector allows connecting the BIAS electrodes to the unit via a supplied cable. The MZM Connector extension board is connected to the cable for ease of operation for OIF Standard compatible DP-IQ modulators.

Status LEDs display the current status of the unit.



The rear part provides connectivity for the remote controlling the unit, a power connector and an SMA based “Mute in” connector.



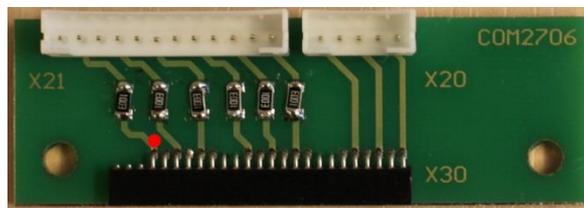
#### 4.4 MZM Connector extension board

This board can be used if an OIF Standard compatible such as the Fujitsu FTM797xHQx is to be used but the application requires the MZM to be connected remotely to the ABC board. Use the 2 supplied Jumper cables to connect X20 and X21/X22 (depending on Revision) on the ABC Board to X20 and X21/X22 on the extension board. If external Photodiodes are used do NOT connect X20 Jumper cable to leave the connection to the 2 internal photodiodes open. The 100kOhm resistors located on board are switched in parallel to the BIAS electrodes. They are used to reduce the local impedance of the BIAS electrodes and help to reduce ripple pickup that may be introduced by the extension cables. See sections 4.7.12 and 4.7.6 for details of the connector pinning.

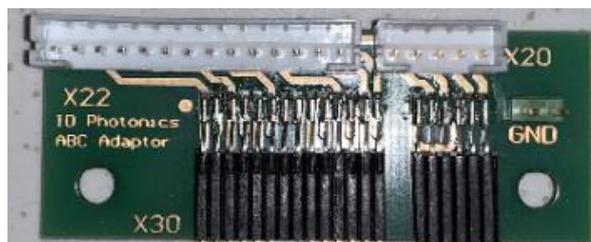
This board may also feature a jumper which connects GND coming from the Photodiode connector X20 to ground to one input of the XP Electrode which can improve performance for some modulator types. For BIAS board H/W 1.20 or earlier, we recommend setting this jumper.

**For board H/W 1.30 or later, do not connect this jumper** as the BIAS control signals are differential signals!

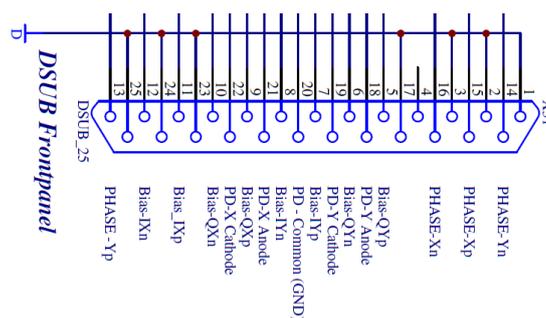
Revision 1 Board



Revision 2 Board



#### 4.5 Connector Overview Benchtop Version (ABC-BPC-03-X)



Pin	Description
1	GND
2	GND
3	GND
4	Not connected
5	BIAS Channel 6 P (OIF Implementation: Q Mod; Y Polarization)
6	BIAS Channel 6 N (OIF Implementation: Q Mod; Y Polarization)
7	BIAS Channel 5 P (OIF Implementation: I Mod; Y Polarization)
8	BIAS Channel 5 N (OIF Implementation: I Mod; Y Polarization)
9	BIAS Channel 3 P (OIF Implementation: Q Mod; X Polarization)
10	BIAS Channel 3 N (OIF Implementation: Q Mod; X Polarization)
11	BIAS Channel 2 P (OIF Implementation: I Mod; X Polarization)
12	BIAS Channel 2 N (OIF Implementation: I Mod; X Polarization)
13	BIAS Channel 4 P (OIF Implementation: Phase; Y Polarization)
14	BIAS Channel 4 N (OIF Implementation: Phase; Y Polarization)
15	BIAS Channel 1 P (OIF Implementation: Phase; X Polarization)
16	BIAS Channel 1 N (OIF Implementation: Phase; X Polarization)
17	GND
18	Photodiode Channel 2 Anode; do not connect for units with optical feedback
19	Photodiode Channel2 Cathode; do not connect for units with optical feedback
20	Photodiode common ground (GND)
21	Photodiode Channel 1 Anode; do not connect for units with optical feedback
22	Photodiode Channel1 Cathode; do not connect for units with optical feedback
23	GND
24	GND
25	GND

#### 4.6 Connector Overview Board Version (ABC-BPC-01-X and (ABC-BPC-00-X))

This section does not apply to the ABC benchtop version (ABC-BPC-03-X).

This table gives an overview of connectors available on the board. The connectors highlighted in bold need to be connected.

Connector	Description
BU1	Mute Input, SMA , 10kOhm Impedance, 5V TTL logic
JP1-3	Voltage Polarity setting for AUX Analog (0V to +5V or -5V to 0V, default: 0V to 5V)
JP11,JP12	These solder pads must be bridged if the MZM is connected to X30 and the internal Photodiodes of the MZM component shall be used.
JP15, JP16	These Jumpers can be used to Hardware limit the output range to -5V to 0V (set JP16) or 0V to +5V (set JP15)
SW3	Gain setting for Feedback amplification of feedback Photodiodes (board versions 1.20 or earlier)
<b>X10</b>	<b>Power Supply, 9 – 36VDC, 3A maximum</b>
X11	USB A Port, S/W Update
<b>X12</b>	<b>USB OTG Port, Remote Control</b>
X13	USB A Port, S/W Update, parallel to X11, can be used for extension cable
X14	Internal socket, Do not use!
X15	LED Status connector. Can be used to use external Status LEDs
X16	Display Connector, do only use for display option
X17	Internal Programming socket, Do not use!
X18	Internal socket, Do not use!
X19	Internal socket, Do not use!
X20	Connector for internal feedback Photodiodes 1&2 using extension cable
X24	AUX Analog output
X21	Connector for BIAS Electrodes using extension cable
X22,PHD1	Connector for external feedback Photodiode 1
X221	Direct solder pad for external feedback Photodiode 1, parallel to X22
X23,PHD2	Connector for external feedback Photodiode 2
X231	Direct solder pad for external feedback Photodiode 2, parallel to X23
X25	AUX Digital output
X26	USB Port, Remote Control, can be used for extension cable
X3	Display Connector, do only use for display option
<b>X30</b>	<b>MZM Board connector, OIF Standard compatible Pin Layout</b>
X6	Internal Programming socket, Do not use!
X7	5V UART, Remote Control
X8	Ethernet Remote Control

#### 4.7 Connector Pin Layout

This section does not apply to the ABC benchtop version (ABC-BPC-03-X).

The Pin numbering orientation is from left to right if the “open” part of a connector is oriented to the top. In the picture below, Pin 1 is marked with a red dot and the “open” part is marked with a red arrow.

Additionally, Pin 1 can be identified by locating the square soldering pad at the bottom side of the PCB of the corresponding connector.



**4.7.1 X7 – UART**

The UART complies with 5V TTL signal level standard.

Pin	Description
1	+5VDC Reference
2	RXD
3	TXD
4	GND

**4.7.2 X10 – Power Supply**

Pin	Description
1	9-36VDC, 3A maximum
2	Not connected
3	Power GND

**4.7.3 X13 - USB A Port, S/W Update, parallel to X11, can be used for extension cable**

Pin	Description
1	USB +5V
2	USB Data Negative
3	USB Data Positive
4	USB/Digital GND

**4.7.4 X15 – LED Status connector**

This connector can be used to remotely display status LEDs. The impedance of the outputs is 220Ohms so that LEDs can be connected without separate resistor. See section 4.8for details on output behavior.

Pin	On Board LED Description
1	RA
2	OPC
3	SETT
4	WAR
5	FB OK
6	HB
7	SA
8	+3.3V

#### 4.7.5 X20 - Connector for internal feedback Photodiodes 1&2 using extension cable

The impedance of all BIAS Channels is 990Ohms to protect the electronics against short circuits.

Pin	Description
1	Photodiode 1, Anode (OIF Implementation: X Pol.)
2	Photodiode 1, Cathode (OIF Implementation: X Pol.)
3	GND
4	Photodiode 2, Cathode (OIF Implementation: Y Pol.)
5	Photodiode 2, Anode (OIF Implementation: Y Pol.)

#### 4.7.6 X21 - Connector for BIAS Electrodes using extension cable

See section “Remote Control” for channel assignment to BIAS Electrodes.

##### 4.7.6.1 Hardware Version <= 1.30

For H/W Version 1.30 and earlier, the BIAS electrode outputs are single ended.

Pin	Description
1	GND
2	BIAS Channel 1 (OIF Implementation: Phase; X Polarization)
3	GND
4	BIAS Channel 4 (OIF Implementation: Phase; Y Polarization)
5	GND
6	BIAS Channel 2 (OIF Implementation: I Mod; X Polarization)
7	GND
8	BIAS Channel 3 (OIF Implementation: Q Mod; X Polarization)
9	GND
10	BIAS Channel 5 (OIF Implementation: I Mod; Y Polarization)
11	GND
12	BIAS Channel 6 (OIF Implementation: Q Mod; Y Polarization)

#### 4.7.6.2 Hardware Version 1.40

Since H/W Version 1.40, the BIAS electrode outputs are differential.

Pin	Description
1	BIAS Channel 1 N (OIF Implementation: Phase; X Polarization)
2	BIAS Channel 1 P (OIF Implementation: Phase; X Polarization)
3	BIAS Channel 4 N (OIF Implementation: Phase; Y Polarization)
4	BIAS Channel 4 P (OIF Implementation: Phase; Y Polarization)
5	BIAS Channel 2 N (OIF Implementation: I Mod; X Polarization)
6	BIAS Channel 2 P (OIF Implementation: I Mod; X Polarization)
7	BIAS Channel 3 N (OIF Implementation: Q Mod; X Polarization)
8	BIAS Channel 3 P (OIF Implementation: Q Mod; X Polarization)
9	BIAS Channel 5 N (OIF Implementation: I Mod; Y Polarization)
10	BIAS Channel 5 P (OIF Implementation: I Mod; Y Polarization)
11	BIAS Channel 6 N (OIF Implementation: Q Mod; Y Polarization)
12	BIAS Channel 6 P (OIF Implementation: Q Mod; Y Polarization)

#### 4.7.6.3 Hardware Version >= 1.50

Since H/W Version 1.40, the BIAS electrode outputs are differential.

Pin	Description
1	BIAS Channel 1 N (OIF Implementation: Phase; X Polarization)
2	BIAS Channel 1 P (OIF Implementation: Phase; X Polarization)
3	BIAS Channel 4 N (OIF Implementation: Phase; Y Polarization)
4	BIAS Channel 4 P (OIF Implementation: Phase; Y Polarization)
5	BIAS Channel 2 N (OIF Implementation: I Mod; X Polarization)
6	BIAS Channel 2 P (OIF Implementation: I Mod; X Polarization)
7	BIAS Channel 3 N (OIF Implementation: Q Mod; X Polarization)
8	BIAS Channel 3 P (OIF Implementation: Q Mod; X Polarization)
9	BIAS Channel 5 N (OIF Implementation: I Mod; Y Polarization)
10	BIAS Channel 5 P (OIF Implementation: I Mod; Y Polarization)
11	BIAS Channel 6 N (OIF Implementation: Q Mod; Y Polarization)
12	BIAS Channel 6 P (OIF Implementation: Q Mod; Y Polarization)
13	GND
14	Not connected

#### 4.7.7 X22, X221, PHD1 - Connector for external feedback Photodiode 1

Pin	Description
1	Photodiode 1, Anode
2	Photodiode 1, Cathode
3	GND

#### 4.7.8 X23, X231, PHD2 - Connector for external feedback Photodiode 2

Pin	Description
1	Photodiode 2, Anode
2	Photodiode 2, Cathode
3	GND

#### 4.7.9 X24 - AUX Analog output

The output impedance of all analog AUX Channels is 10Ohms and can drive up to 15mA currents.

Pin	Description
1	GND, Analog
2	OUT Channel 1
3	GND, Analog
4	OUT Channel 2
5	GND, Analog
6	OUT Channel 3
7	GND, Analog
8	OUT Channel 4

#### 4.7.10 X25 - AUX Digital output

All AUX digital Channels can drive up to 20mA per channel.

Pin	Description
1	OUT Digital Channel 1
2	OUT Digital Channel 2
3	OUT Digital Channel 3
4	OUT Digital Channel 4
5	OUT Digital Channel 5
6	OUT Digital Channel 6
7	OUT Digital Channel 7
8	OUT Digital Channel 8
9	+5V Reference Voltage
10	GND, Digital

4.7.11 X26 - USB Port, Remote Control, can be used for extension cable

Pin	Description
1	USB +5V
2	USB Data Negative
3	USB Data Positive
4	USB/Digital GND

4.7.12 X30 - MZM Board connector, OIF Standard compatible Pin Layout

**Pin 1 is marked with a white dot** and is facing the corner of the board. Note that the orientation is flipped relative to other white connectors on the board.

Layout according to OIF Standard definition, see

<https://www.oiforum.com/wp-content/uploads/OIF-PMQ-TX-01.1.pdf>

**Note:** The OIF Pin numbering definition does count RF Inputs (1-4). Furthermore, space between 3 groups equaling to 2 pins pitch is NOT counted by OIF.

The impedance of all BIAS Channels is 990Ohms to protect the electronics against short circuits.

**Note:** The jumpers J11/J12 MUST be bridged by solder if MZM board connector and the **internal** Photodiodes are to be used. For **external** Photodiodes, jumpers must be open.

See section “Remote Control” for channel assignment to BIAS Electrodes.

Pin	OIF Pin	Description
1	5	BIAS Channel 6 (OIF Implementation: Q Mod; Y Polarization)
2	6	GND
3	7	BIAS Channel 5 (OIF Implementation: I Mod; Y Polarization)
4	8	GND
5	9	BIAS Channel 3 (OIF Implementation: Q Mod; X Polarization)
6	10	GND
7	-	Not connected
8	-	Not connected
9	11	BIAS Channel 2 (OIF Implementation: I Mod; X Polarization)
10	12	GND
11	13	BIAS Channel 4 (OIF Implementation: Phase; Y Polarization)
12	14	GND
13	15	BIAS Channel 1 (OIF Implementation: Phase; X Polarization)
14	16	GND
15	-	Not connected
16	-	Not connected
17	17	Not connected
18	18	Photodiode 1, Anode (OIF Implementation: Y Pol.)
19	19	Photodiode 1, Cathode (OIF Implementation: Y Pol.)
20	20	GND
21	21	Photodiode 2, Cathode (OIF Implementation: X Pol.)
22	22	Photodiode 2, Anode (OIF Implementation: X Pol.)

#### 4.8 Jumper settings

This section does not apply to the ABC benchtop version (ABC-BPC-03-X).

##### 4.8.1 Jumpers JP1 – 3

These Jumpers define the voltage range of the Analog AUX channels.

Bridge Pins 1&2 (default) for setting output range of -5V to 0V. Do not alter the setting of these jumpers.

##### 4.8.2 Jumpers JP11&JP12

The jumpers J11/J12 configure the setting for internal/external Photodiodes in case the onboard MZM connector X30 is used. They **MUST** be bridged by solder if **internal** Photodiodes are to be used. For **external** Photodiodes, jumpers must be open.

If the Adaptor board is used, the jumpers do not have an effect.

#### 4.9 Adaptor ABC-BPC-ACC-AD-02

This adaptor kit translates the X20 socket of the mainboard into SMA Adaptors required for certain MZMs.

SMA connectors utilize GND level on its outer pole while ABC board Revision 1.40 or later provides differential outputs, Therefore, the adaptor uses the positive pole for each channel and Board common ground and is therefore converted to single ended. As a result, voltages shown in the GUI will be twice as high as actually applied to the target MZM via the SMA adaptor.

Also note that VPI setting in the software needs to be twice as high to reflect the single ended mode of the adaptor.

#### 4.10 Status LEDs

A red heartbeat LED close to the large Xilinx FPGA device indicates the readiness of this component by flashing with about 1Hz frequency.

LED	Description
POW	Power supply voltage ok
+12V	+12V Power ok
-12V	-12V Power ok
HB	Heartbeat blinking: Application is active
SA	Sampling data status On: sampling Off: idle
SETT	Control loop settled status; blinking: tuning; on: settled
WAR	Warning status On: Warning active, query "Alarm?" for details Off: no Warning
FB OK	Feedback signal Status On: Feedback Signal ok Off: Feedback Signal error
OPC	Operation complete status, analog to command "**opc" On: all commands processed, ready Off: Commands in processing
RA	Remote session status. Indicates if one or more remote sessions are opened. On: active

#### 4.11 SW3 - Gain Setting

This section does not apply to the ABC benchtop version (ABC-BPC-03-X).

Note that this switch is only present for Board version 1.20 or earlier. If the switch is not present, the setting is automatically done via software.

For board versions 1.20 or earlier, use the gain setting of DIP switch “SW3” which is located close to Photodiode connector PHD1 to adjust your particular configuration in terms of current available on the feedback photodiode. The gain setting can be changed while power is on. Note that you need to recalibrate the Power reading monitor (if used) and LOS threshold each time you change the gain setting. Use the “MONPOWER” reading to set the gain into optimal range.

**Note:** The feedback monitor is located after the MZM. Therefore, the output power and therefore the setting of this switch depends on the BIAS setting of the MZM and whether an RF Signal is applied to the RF inputs of the MZM or not.

We recommend the following tuning procedure:

Preparation: Make sure the light source is set to the highest output power at which you intend to use the ABC. An RF signal applied to the MZM is not required for this procedure.

1. Set Gain to minimum
2. Manually Adjust BIAS voltages to achieve Maximum transmission of the MZM by reading the power shown in the GUI or using an external Power meter (only single Polarization).
3. Increase gain setting until MONPOWER delivers a value <80%.

Switch setting 1-4 1=on;0=off	Relative Gain Factor
0000	100
1000	24
0100	11
0010	2
0001	1

#### 4.12 Maximum BIAS range

The maximum BIAS Voltage range can be set continuously from 0V to maximum via Software to avoid damage to MZM H/W that may have a limit lower than what is supported by the ABC. Consult the data sheet of the connected MZM to obtain the corresponding Voltage usually found in the Maximum Rating section. Refer to the section “Software” for details setting this parameter via GUI or via remote control.

##### 4.12.1 Board Version 1.30 or later

The differential symmetric output uses voltages of up to +/-30V across the electrodes yielding in a total of 60V range. The maximum voltage relative to GND will be +/-15V at each input.

Example: Input A of Electrode 1 has +15V, Input B -15V which yields in a voltage of 30V across the electrode.

#### 4.12.2 Board Version 1.20 or earlier

The maximum BIAS Voltage range to 48V via Software.

Depending on the S/W maximum range setting, the Hardware limit will be automatically set according to the table below to avoid accidental damage due to Software errors.

Software maximum range setting	Hardware Limit
0 - 11.5V	12V
11.5-23.5V	24V
23.5V – 48V	48V

#### 4.13 Mute Input Port

The mute input port BU1 can be used optionally. It allows the user to temporarily turn-off the automatic bias control, i.e. fix the present bias values, triggered by external hardware allowing measurements under constant conditions. The same functionality can be achieved by using the S/W based mute function.

The input impedance of this port is 10kOhm and uses 5V TTL logic levels. Mute is activated if 5V are applied to this input.

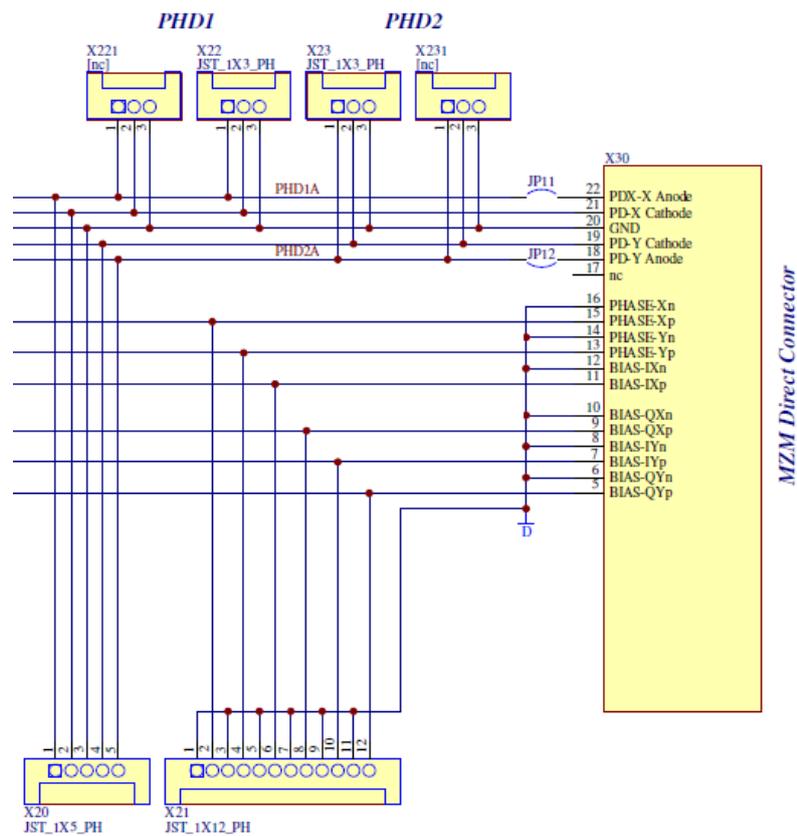
**Note:** If not used, leave the mute input unterminated.

#### 4.14 MZM Configuration variants

This section does not apply to the ABC benchtop version (ABC-BPC-03-X).

This ABC board supports a large variety of MZM and feedback diode configurations which are described in the following.

For OIF Standard compatible dual pol IQ MZM, the pinning of X30 matches the OIF definition and the MZM can be plugged into the supplied connector without any modifications. In all other cases, a custom jumper cable must be fabricated that connects the electrodes. Refer to section 4.7.12 for details. Use connectors X21, X22, x23 as needed. See below a schematic for the connection of the available connectors.



#### 4.14.1 On Board MZM Connector - X30

##### 4.14.1.1 Internal Photodiodes

If the MZM internal feedback diodes are to be used, connect the MZM component to the ABC onboard connector X30, make sure that solder jumpers JP11&JP12 are connected. Configure 2 feedback diodes using the supplied GUI (default).

##### 4.14.1.2 External Photodiodes

If external feedback diodes are to be used, connect the MZM component to the ABC onboard connector X30, make sure that solder jumpers JP11&JP12 are open (NOT connected). Use the supplied cable(s) to connect the external Photodiode(s) to connector X22, X23 or use X221, X231 if you wish to solder on the board. If a single Photodiode is used, connect it to

X22/X221. Note that a single photodiode is sufficient even in a dual Pol configuration if both polarizations are fed to the feedback photodiode. This is the standard case for most integrated Dual Pol MZMs which have an internal polarization MUX.

#### 4.14.2 Remote Connected MZM using the extension PCB

##### 4.14.2.1 Internal Photodiodes

If the MZM internal feedback diodes are to be used, connect the MZM component to the supplied extension board connector X30 and connect both supplied extension cables to the ABC onboard connectors X20&X21 to X20&X21 on the extension board. Configure 2 feedback diodes using the supplied GUI (default).

##### 4.14.2.2 External Photodiodes

If external feedback diodes are to be used, connect the MZM component to supplied extension board connector X30 and connect the supplied extension cable to the ABC onboard connectors X21 to X21 on the extension board. Do NOT connect the extension cable for X20. Use the supplied cable(s) to connect the external Photodiode(s) to connector X22, X23 or use X221, X231 if you wish to solder on the board. If a single Photodiode is used, connect it to X22/X221. Note that a single photodiode is sufficient even in a dual Pol configuration if both polarizations are fed to the feedback photodiode. This is the standard case for most integrated Dual Pol MZMs which have an internal polarization MUX.

#### 4.14.3 Channel assignment

The following table summarizes the default channel assignment for different MZM control modes. Note that it is possible to alter this assignment by Software using the `CHASS` command. For details refer to the programming section.

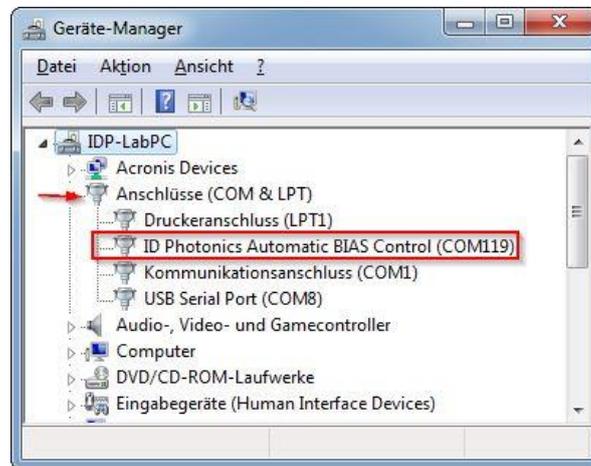
Channel #	DualPol IQ	SinglePol IQ	DualPol I	SinglePol I
1	XP	P	XI	I
2	XI	I	YI	-
3	XQ	Q	-	-
4	YP	-	-	-
5	YI	-	-	-
6	YQ	-	-	-

#### 4.15 Remote Control interfaces

##### 4.15.1 USB

The USB Remote Control can be performed using connector X12 which is a USB OTG type connector. If connected to a Windows host PC, driver installation will start. Please direct Windows installer to the directory “USB-Driver” located on the supplied USB Stick. The device will install as a virtual serial interface (COM Port) in the host computer.

Once the installation is completed, a check for successful installation can be performed by opening Windows Device Manager, i.e. press <Windows Key> + <Pause> and click on “Device Manager”. The interface should be displayed in Section COM & LPT Ports as “ID Photonics Automatic BIAS Control”. The Port number is determined automatically by Windows and depends on the system configuration.



Start the supplied GUI to connect to the interface and select the COM Port that was installed per the description above.

Use any terminal program such as “Teraterm” which can be found on the supplied USB Stick to test custom remote control.

The connection parameters are:

- Baud rate: 115.200
- Serial settings: 8N1

#### 4.15.2 Ethernet

The default configuration for the Ethernet interface is

- IP address: 192.168.0.1
- SubNet Mask: 255.255.255.0
- DHCP Off (Fixed IP Address)
- TCP Port #2000

For connection via Ethernet, use i.e. Telnet Protocol to connect. For testing the connection, use Terminal Program “Putty” to connect. Select connection type “Raw” and set Port to “2000”.

#### 4.15.3 UART

The UART interface uses 5V TTL logic. See section 4.7.1 for Pin layout.

The connection parameters are:

- Baud rate: 115.200

- Serial settings: 8N1

## 5 Control loop

The ABC unit allows a number of configurations for various MZM configurations; see the table located in section 2.2 for an overview from application perspective. The control loop is configured either using the GUI or the SCPI command “mode”. This will set the ABC to find the target points per table below. For channel assignment depending on the mode, see chapter “Remote Control”.

### 5.1 Control Loop modes

The acronym “IQ” refers to a nested MZM structure used for complex IQ modulation; see section 2.2 for details.

The acronym “II” refers to a single MZM used for intensity modulation as depicted in section 2.1.

Mode <sup>3</sup>	GUI Description	Number of Photodiodes	Number of channels used	MZM Control Target <sup>4</sup>		
				Phase	I	Q
1	DualPolIQ, 1PD	1	6	Quad	Min	Min
2	DualPolIQ, 2PD	2	6	Quad	Min	Min
3	SinglePolIQ, 1PD	1	3	Quad	Min	Min
4	-	-	-	-	-	-
5	DualPolII, 1PD	1	2	-	Quad	-
6	DualPolII, 2PD	2	2	-	Quad	-
7	SinglePolII, 1PD	1	1	-	Quad	-
8	custom	tbd	tbd	tbd	tbd	Tbd

Note that the benchtop version does not support external Photodiodes.

#### 5.1.1 Multiple Single Pol MZM with a single ABC

##### 5.1.1.1 Single Pol IQ Modulator

Up to 2 Modulators can be operated using a single ABC board. Configure a Dual Pol. IQ modulator and 2 Photodiodes for this case.

##### 5.1.1.2 Single Pol Intensity (II) Modulator

Up to 2 Modulators can be operated using a single ABC board. Configure a Dual Pol. II modulator and 2 Photodiodes for this case.

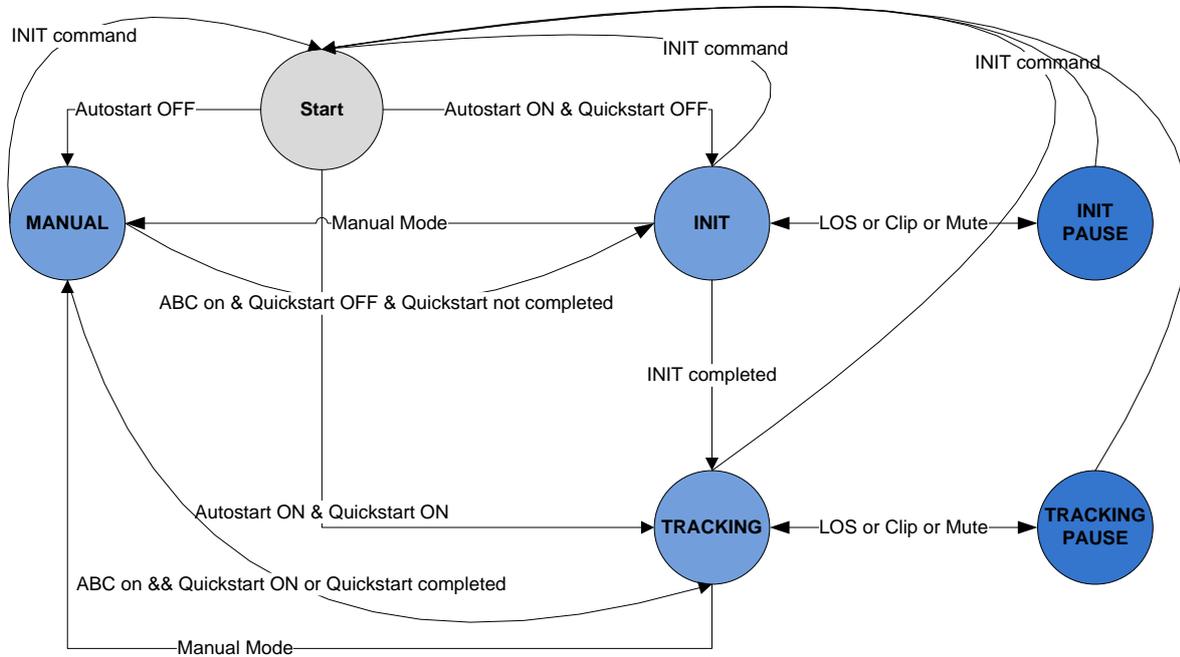
<sup>3</sup> Refer to chapter “Remote Control” for definition of the mode command.

<sup>4</sup> See section 2.1 for details on MZM transfer curve

### 5.2 BIAS Control Loop state machine

The ABC is based on a finite state machine model. It can assume the following states MANUAL, TRACKING, TRACKING\_PAUSE, INIT, INIT\_PAUSE and FAULT

Please see below a state diagram including all possible state transition conditions.



The ABC will find and track the optimal BIAS points in 3 phases:

1. INIT (if Quickstart is off): A coarse sweep of one or multiple BIAS electrodes is done.
2. TRACKING (not settled): The control loop runs in an accelerated tracking mode to swiftly move close to the target setting.
3. TRACKING (settled): The control loop runs in a slower tracking mode to achieve best accuracy and performance.

### 5.3 Control loop optimization

(Firmware 1.4.8 or later).

The Offset feature can be used to tune the Automated BIAS Control to achieve an optimized operating point, i.e. to improve extinction of the MZM if the BIAS control finds a suboptimal point due to i.e. feedback detector issues. It can also be used so generate non-typical MZM BIAS settings. This feature applies to each channel separately; refer to the sections “Graphical User Interface” and “Remote Control” for details.

Note that there are limitations if offset values chosen too high as the steepness of the feedback curve drops relative to the nominal setting point. At first, accuracy of the control loop will suffer and gradually become instable.

## 6 Graphical User Interface

A Graphical User Interface (GUI) is provided with the instrument. This Software requires a Windows based Host PC with Windows 7 or later. This software will install a runtime engine and VISA compatible drivers to connect to the instrument.

### 6.1 GUI download

The most recent available version of the GUI can be downloaded from [http://www.id-photonics.com/downloads/IDP\\_ABC\\_GUI.zip](http://www.id-photonics.com/downloads/IDP_ABC_GUI.zip) . The following description is based on GUI Version 1.3.1.2.

### 6.2 GUI Installation

Connect the supplied USB Stick to your computer and start “Setup.exe” in installer directory if it is not automatically executed.

Follow the instructions shown on the screen. Once finished, an icon is installed on your computer to start the GUI.

### 6.3 USB driver installation

If you connect via USB, plug in the USB cable and perform the installation as described in section “Remote Control Interfaces”.

### 6.4 GUI Description

#### 6.4.1 IF Config&status Tab, Connecting the instrument

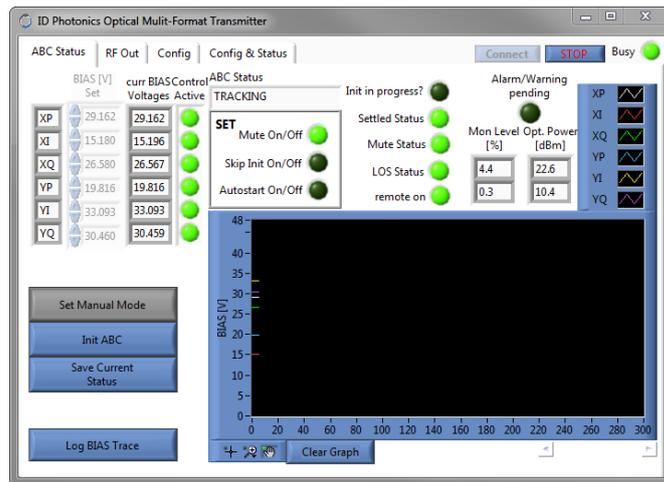
After starting the GUI, please configure the access to the instrument using the controls highlighted in the screenshot shown below.

First, chose whether to connect via Ethernet (TCP) or USB and then enter the required information. See below for details.

Press “connect” to establish the connection as shown in the screenshot shown below. If you wish to save the Interface configuration press “Save Interface Config” at any time to store it permanently.



Once the GUI has connected to the instrument, the GUI will display the Interface configuration and the previously disabled Tabs become available. The “Connected” indicator will be solid green. The “Busy” indicator will flash each time the GUI’s readings are updated. The interval time can be changed by setting the “Poll interval” parameter.



**Note:** Multiple parallel connections using both USB and Ethernet are possible.

#### 6.4.1.1 Ethernet [TCP]

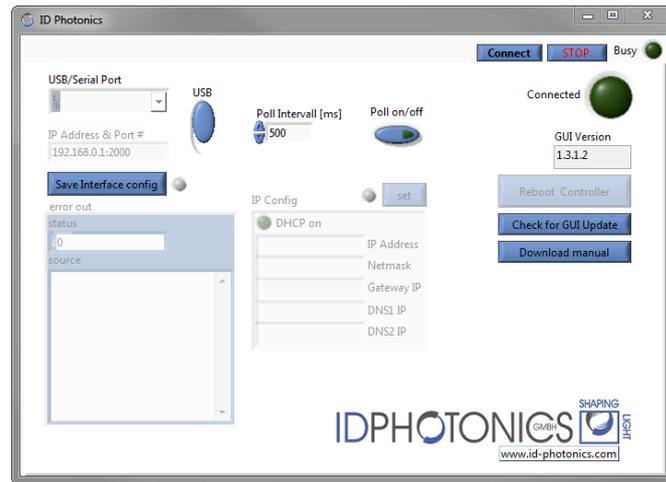
Please enter the IP Address of the instrument followed by the Port Number that is listening to the SCPI Commands. The format is xxx.xxx.xxx.xxx where x denotes the IP Address.

**Note:** The default IP Address is 192.168.0.1.

Please make sure that the LAN and your Host Computer TCP/IP address is configured properly to ensure that a connection to the instrument is possible. In doubt, use the Windows shell/console command “ping” to test basic connectivity. Furthermore, make sure that TCP connections Port #2000 is not blocked by a router or firewall which may be between the host PC and the instrument.

#### 6.4.1.2 USB

If USB connection method is selected, click on the “down” arrow to see all available serial port interfaces on the remote computer. Please select the one that corresponds to the interface of the instrument. In case of doubt, open Windows “device manager” and check the “Serial Interface (COM&LPT)” section. The instrument will show as COM Port with the description “Serial Gadget 2.4” or “ID Photonics Automatic BIAS Control” depending on installation method of the serial driver, see section “Remote Control Interfaces” for details.



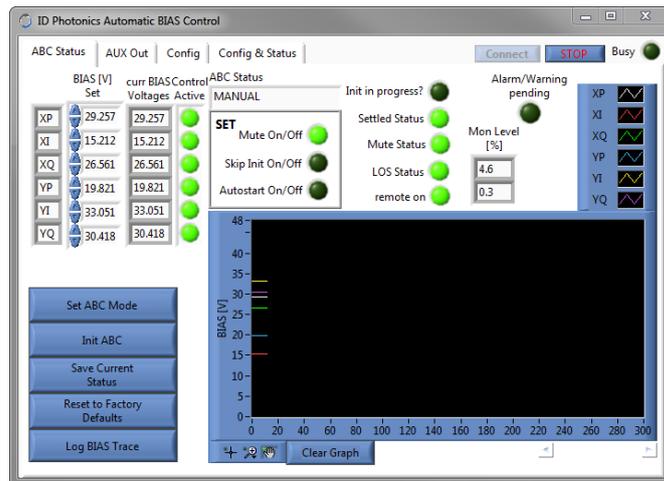
#### 6.4.1.3 Check for GUI Update

Press this button if you wish to check for a more recent version is available on the ID Photonics Server. This feature requires a working Internet connection and a browser installed on the host computer. If a new version is available, the browser of the host computer is automatically opened and the installer for the new GUI can be downloaded.

#### 6.4.1.4 Download manual

Press this button if you wish to download the most recent version of the manual available on the ID Photonics Server. This feature requires a working Internet connection, a browser and a PDF Reader installed on the host computer. The browser of the host computer is automatically opened and the PDF can be downloaded.

### 6.4.2 ABC Status Tab



#### 6.4.2.1 BIAS Voltage set/current

This control allows changing the BIAS Settings of the Modulator if the unit is in manual mode. Note that new values are sent to the instrument immediately after entered. If TRACKING is active, these controls are disabled. The current voltage reading indicator shows actual setting in the instrument.

#### 6.4.2.2 Control Active

These buttons switch on/off the automated control for the corresponding channels.

#### 6.4.2.3 Set ABC Mode/ ABC Status

This button toggles between manual mode and automatic BIAS control. The “ABC Status” indicator shows the current mode of the device. It can assume the states MANUAL, TRACKING, TRACKING\_PAUSE, INIT, INIT\_PAUSE and FAULT.

The pause states are automatically entered if no valid feedback signal could be retrieved. The root cause can be Loss Of Signal, feedback signal clipping or mute active. Please check the alarm indicators on Tab “config” to check which alarm is pending and resolve the issue. The ABC will automatically resume once all relevant alarms are cleared. See section “BIAS Control Loop state machine” for details on state transition conditions.

#### 6.4.2.4 Init ABC

This initializes the Control loop to default as currently saved to disk.

#### 6.4.2.5 Save current status

This button saves the current setting to disk which are loaded after a power cycle or a reset/restart. Refer to the section “SCPI Remote Control” for details on which parameters is stored.

#### 6.4.2.6 *Reset to Factory defaults*

This button will clear **all** settings that were saved using “Save current Status” and re-establish the factory default settings.

#### 6.4.2.7 *Log BIAS Trace*

This button will log the BIAS Voltages versus time to the host PC into an ASCII File specified in the “Config” tab. Make sure that the File location and name is defined in “Config” before start logging data.

**Note:** Data will always be appended to an existing file. In case no file exists, it is created. This feature will require a permanent connection to the instrument to function. The recording is asynchronous to the change of the BIAS Control. Use the “Poll Interval” control under “IF config & status” to set the recording speed. “Poll on/off” button needs to be on.

#### 6.4.2.8 *Set Button section*

##### 6.4.2.8.1 *Mute on/off*

This button toggles the Mute status of the unit. It allows the user to temporarily turn-off the automatic bias control, i.e. fix the present bias values and disable any noise introduced by the control.

##### 6.4.2.8.2 *Quickstart on/off*

This button toggles Quickstart of the unit. If Quickstart is active, the unit will skip the initialization routine and resume with the saved BIAS Voltages after a reboot/cold start.

##### 6.4.2.8.3 *Autostart on/off*

This button toggles Autostart behavior of the unit. If Autostart is on, the unit will immediately enter tracking mode upon a reboot/coldstart. If it is disabled, the unit will remain in manual mode until tracking is activated.

#### 6.4.2.9 *Indicator section*

##### 6.4.2.9.1 *Init in Progress?*

This indicator signals an ongoing initialization process triggered by a reboot or “Restart ABC” button press.

##### 6.4.2.9.2 *Settled Status*

This indicator signals if the automated BIAS control settled to optimal values on all electrodes.

##### 6.4.2.9.3 *Mute Status*

This indicator signals the status of the mute feature that can be triggered by software using the “Mute On/Off” button or the external Hardware input mute located at the rear side of the unit.

#### 6.4.2.9.4 LOS Status

This indicator signals if the internal feedback signal required for the automated BIAS control is too low (=Loss of Signal). If this warning appears, the output power of the light source(s) connected to the OMFT input might be too low. Another reason for a LOS warning might be that no RF modulation is applied to the RF Inputs or the RF amplifiers are switched off as the transmission of the Modulator is close to 0 without RF modulation at its optimal working point. Thus, the automated control will optimize the BIAS settings close to the optimum until the output power drops below the LOS threshold. In case of LOS, the BIAS control loop will stop at current setting and continue once the LOS Alarm is cleared.

#### 6.4.2.9.5 Remote On

This indicator signals an active remote session connected via Ethernet to the controller.

#### 6.4.2.10 Alarm pending

This indicator signals the composite alarm status. For details which alarm is raised, see the “Config” tab described in section 6.4.3.

#### 6.4.2.11 Monitor Level [%]

These indicators display the average electrical power level detected by the feedback circuit. Note that starting from H/W 1.30 or later, there is an automatic gain section before the monitor so that these values do not correlated to the optical power present at the feedback diode(s).

#### 6.4.2.12 BIAS Trace Graph

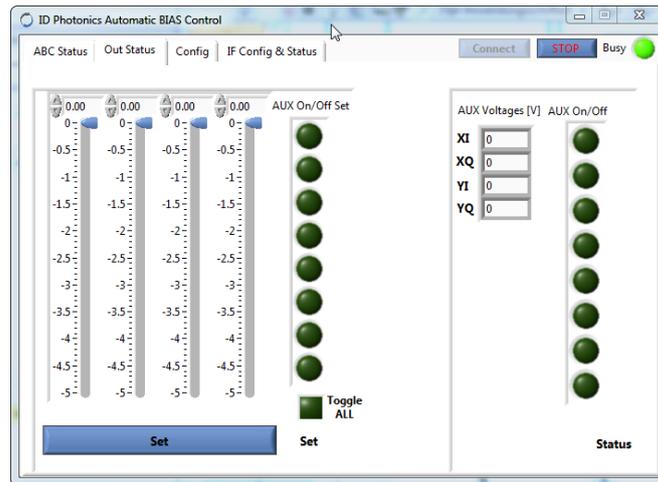
This plots the evolution of the BIAS setting versus time. The “Clear Graph” button will clear the stored data and restart recording.

### 6.4.3 Out Status Tab

This Tab allows configuring the digital and analog AUX channels available on the board. These are not related to the ABC itself but can be used for application specific general purposes.

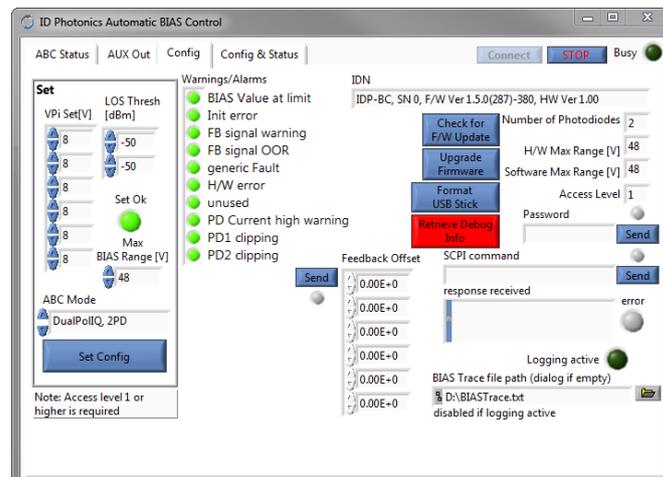
Use the slider bars to set the analog Output voltages and the AUX On/Off buttons in the set section to configure a setting. Press “Set” to send the current configuration to the board.

The status section displays the current setting active on the board. Note that the voltages shown for the analog part refer to the default range of -5V to 0V. If the range setting was changed using the on board jumpers as described in section “Board and Connector description” the GUI will not adapt to this.



### 6.4.4 Config Tab

The “Config” tab allows setting some configurations and details on the system level status of the unit.



#### 6.4.4.1 Set Config section

Note that changes for this control become active only after pressing the “Set Config” button, if the user access level has been elevated to 1 or higher. Furthermore, the ABC must be in mode “manual” which is automatically set when the button is pressed. The set functions on this tab are only available for user level 1 or higher. These settings are permanently saved. Note that previous settings made are lost by pressing this button.

##### 6.4.4.1.1 VPi Set

This control set configures the VPi voltage of the Mach-Zehnder component inside the OMFT: Changing these parameters will have impact on the performance of the automated BIAS control. Therefore, do not change these values unless needed. Note that changes for this control become active only after pressing the “Set Config” button, if the user access level has been elevated to 1 or higher.

**Note:** There are separate VPi voltages for the BIAS electrodes and RF electrodes. Use Vpi values for BIAS electrodes. For LiNBO3 based devices, these voltages are typically 7-8V. If you are unsure, start with a default of 8V for each electrode.

#### 6.4.4.1.2 LOS Thresh

This control set configures the optical output power at which a Loss of Signal (LOS) alarm is raised and the automated BIAS control loop will stop.

#### 6.4.4.1.3 Maximum BIAS Range

This parameter limits the maximum BIAS Voltage that be applied by the user or the automated mode. This value can be set continuously from 0V to 48V. See section “Board and Connector description” for details.

#### 6.4.4.1.4 ABC Mode

This dropdown list allows setting the MZM and feedback photodiode configuration. See sections “Introduction” and “Board and Connector description” for details. Note that changing “ABC Mode” will cause all settings saved via “save current Status” will be overwritten by default values.

#### 6.4.4.2 IDN

This field indicates S/W version status of the unit and identification information such as serial number.

#### 6.4.4.3 Warnings/Alarms

See section “Alarm code definition” in “Remote Control” for definition of these alarms.

#### 6.4.4.4 Feedback Offset

The Control loop for the corresponding channel will be offset by the value entered here. The sign of offset values can be positive or negative. Depending on the sign of the value entered, the control loop will shift the settled point to the corresponding directing. Typical offset values would be  $1e+5$  to  $1e+6$ . We recommend starting with a small value while the control loop is active and observe the impact on the settling point. Slowly start to increase the value until the control loop tracks the desired value. If it move is the wrong direction, invert the sign of the offset value. Note that the control loop will become instable if high values are entered. ID Photonics can take no liability on effective operation of the unit if these values are non-zero and recommend leaving all values at 0.

Note that the values are set are stored in volatile memory only. Thus, each reset will also reset the offset values. In order to store them permanently, use the “save current status” button to save the values set.

#### 6.4.4.5 Upgrade Firmware

Note that this button only appears for F/W version 1.3.0 or later. It triggers the firmware upgrade procedure. Refer to section 7.1 for details.

#### 6.4.4.6 Format USB Stick

This feature will prepare an USB stick to be used with the unit for Firmware upgrades or to save debug data.

1. Plug in USB stick into port X11/USB Update
2. Press the button "Retrieve debug Info" at the time the issue occurs.
3. Confirm the popup displayed.
4. The USB stick will be prepared wait for confirmation of process to be completed.

**Note:** Executing this procedure will erase all data located on the USB stick. Once formatted, the content can still be read by a Windows based computer. The USB stick delivered with the unit has already the required format and can be used for Firmware upgrades or collecting debug info.

#### 6.4.4.7 Retrieve debug Info

This feature can be used to debug potential issues found in operation and will help ID Photonics staff to identify these.

##### 6.4.4.7.1 Firmware version 1.4.3 and newer

After pressing the button, select a directory and a filename on the host PC in the popup dialog. After pressing ok, the data is collected and saved to file selected.

Send the files to ID Photonics staff ([info@id-photonics.com](mailto:info@id-photonics.com)) for processing and analysis.

##### 6.4.4.7.2 Firmware version older than 1.4.3

Note that this section is only applicable if the unit is still running on a legacy firmware version. Check the Firmware version in IDN field of the Config Tab.

1. Plug in a VFAT formatted USB stick into port X11/USB Update. See chapter 6.4.4.4 for instructions to generate a suitable format of a USB stick. The USB stick provided with the unit already has the required format.
2. Press the button "Retrieve debug Info" at the time the issue occurs.
3. Confirm the popup displayed.
4. The board will start to process data and save it on the USB stick. This step may take up to 45 seconds to complete. A LED indicator will flash in the GUI near the button during the process.
5. A popup will be displayed that returns the status of the process.
6. The above steps may be repeated as many times as needed since the file name will be incremented automatically.

7. The USB stick may be removed now. The stick content can be read using any Windows 7 or later PC. The data is contained in files named : “abc-dumpx.tar” Send the files to ID Photonics staff ([info@id-photonics.com](mailto:info@id-photonics.com)) for processing and analysis.

#### 6.4.4.8 User Access Level

The field “Access Level” displays the current user access level available. The set functions on this tab are only available for user level 1 or higher.

#### 6.4.4.9 Password

This field allows changing the user access level. See section “Remote Control” for details. Use this setting cautiously as a wrong configuration setting might lead to a non-functional automatic BIAS control. If the “Save Current Status” feature on the “ABS Status” tab is used, these settings will become permanent and can only be reverted by “Reset to Factory Defaults”.

#### 6.4.4.10 SCPI Command – Send

The “Send” button along with the “SCPI command” field allows sending custom commands to the unit. Responses are shown in “response received”. Note that set commands sent successfully will not have a response. All errors will be reported. See section “Remote Control” for details on SCPI commands.

#### 6.4.4.11 BIAS Trace File Path

This control configures the location of the BIAS trace logging file. The logging can be enabled on the “ABC status” tab.

## 7 Firmware Update

Please confirm the firmware version of your unit by either sending a “\*idn?” query or by checking under the “Config” Tab of the GUI before proceeding.

### 7.1 Firmware version 1.3.0 or later

Start the provided GUI and connect to the unit as described in earlier sections.

Select the “Config” tab and click on the “update Firmware” button.

Select the new Firmware File provided by ID Photonics which has the extension “.zip” in the “File select” popup. The upload will start once the “open” button is clicked. Once the upload is completed the upgrade process is automatically initiated.

The unit will check the validity of the file uploaded. If the installation was successful, a popup will confirm the successful completion. If an error message is displayed, please fix the issue or contact ID Photonics.

If the upgrade was successful, the new firmware will automatically start upon next reboot of the unit. This can be performed in Tab “IF Config & status” by clicking button “reboot controller”.

**Note:** If you prefer to perform the upgrade the firmware using a USB stick, proceed to the following section 7.2.

## 7.2 Firmware version older than 1.3.0

Note that this section is only applicable if the unit is still running on a legacy firmware version. Check the Firmware version in IDN field of the Config Tab.

For upgrading the firmware of the unit provides a dedicated USB port type A X12.

### 7.2.1 Preparation

If a firmware update is required, a USB Stick formatted in VFAT disk structure and a single partition is required. The USB stick provided with the unit already has the required format.

Retrieve the necessary firmware upgrade files from ID Photonics. Section 6.4.4.4 describes the generation of a suitable USB stick format.

### 7.2.2 Firmware Upgrade

1. Copy the following files supplied by ID Photonics into the root directory of the prepared USB stick.
  - Mzmbias.bin
  - Mzmbias\_key (Note that this file must not have an extension!)
2. Safely remove the USB stick from the host computer
3. Plug the USB stick into port X11 labelled “USB Update”
4. Power cycle the unit OR send a “\*rst” SCPI command OR press button “Reboot Controller” on the “IF Config & Status” tab in the supplied GUI.
5. The unit will perform the upgrade and will become available after a few seconds.
6. Check if upgrade was successful by sending a “\*idn?” SCPI command OR by reading the IDN displayed in the supplied GUI in the tab “Config”.

## 8 LabView drivers

National Instruments LabView® drivers covering all SCPI commands are supplied with the USB stick delivered with the unit in directory “LabView drivers”. The drivers are compatible to National Instruments LabView® R8.6 or later.

## 9 Remote Control

This device operates using SCPI standard style commands which are ASCII based and allow easy communication and interpretation with the instrument. Refer to chapter “Board and Connector description” on how to establish communication to the ports available at the instrument. More detailed information on SCPI syntax can be found here:

<http://www.ivifoundation.org/docs/SCPI-99.PDF>

### 9.1 Operating multiple Interface Ports

This unit supports parallel usage of all remote-control ports available. Note that responses to commands issued are only returned to the according port from where the command was issued.

Commands are generally executed in order of time wise arrival to the controller and buffered into an Event queue. If a stack overflow occurs, an error is issued.

Note that there is no control exclusivity for a specific interface or user. Thus, parallel commands issued by different instances will be might lead to inconsistencies. It is therefore recommended to poll current parameter status to ensure integrity of set vs. actual parameters and query the operation complete register (“\*opc”) to make sure all previous commands have been executed.

### 9.2 Syntax conventions for commands

#### 9.2.1 Long and short form

The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permissible.

Example: :SYStem:IPADDRess?= IPADDR?

**Note:** The short form is marked by upper-case letters; the long form corresponds to the full expression. Upper-case and lower-case notation only serve the above purpose, the instrument itself accept both upper-case and lowercase letters.

**Note:** All commands are case insensitive. Long and short form may not be mixed within a single command.

#### 9.2.2 Query commands

Most commands serve a double function that allows either setting or executing a query on a parameter.

**Note:** Query commands are terminated by a “?” character.

### 9.2.3 Parameter

Parameters must be separated from the header by a "white space". If several parameters are specified in a command they are separated by a comma ",",

### 9.2.4 Colon Character

A leading colon character `:` instructs the instrument to interpret the command starting at the root (highest level) of the command tree. Since the Instrument also starts at the root each time you send it a new command, the leading colon is not required (although the instrument will accept it if you send it).

### 9.2.5 Command Termination character

Each command must be terminated either by a ";" character or a carriage return (ASCII #13) to signal completion of the command telegram to the controller

### 9.2.6 Acknowledgement of executed commands

The mainframe controller will always acknowledge successful execution of commands by a ";" character. If the echo option is set (for details, see command list), the accordingly sent command is returned first.

## 9.3 User access level

This feature allows execution of commands protected in standard access level to avoid accidental change of important parameters. See command description

"[:SYStem:]PASSword" for details on how to enable enhanced access.

**Note:** User access level is granted session based. Each time, a new remote connection is made; the standard User access level 0 is set per default.

User access level	Password
0	-
1	IDP

## 9.4 Channel assignment index to BIAS Electrode type for SCPI

Channels assignment in SCPI commands are coded in integer numbers. Refer to the table below to determine assignment of Channel ID to electrode type.

Channel #	DualPol IQ	SinglePol IQ	DualPol I	SinglePol I	custom
1	XP	P	XI	I	1
2	XI	I	YI		2
3	XQ	Q			3
4	YP				4
5	YI				5
6	YQ				6

## 9.5 Notation of Syntax for command definition

Syntax and Type	Description
[ ]	Optional command level that can be omitted. Example: Definition [:SYStem:] IPADDRess/? /<P> Allows sending the command: IDADDR?
< >	Denotes a parameter. Placeholder is replaced with parameter value defined for according command. Definition [:SYStem:] IPADDRess/? /<P> Allows setting the parameters: [:SYStem:] IPADDRess 192.168.0.1
/?	Denotes the optional character “?” that is used if the command can also be used as a query. Example: Definition [:SYStem:] IPADDRess/? /<P> “?” is used to query current IP Address of the device: IPADDR?;
:	Usage of Colon see 9.2.4

### 9.5.1 Conventions for writing to Multi-Channel Outputs

For read queries issued to a Mult-Channel output such as the BIAS Electrodes, the interpreter will return the current setting of all channels available, i.e.:

Query VOLT?;

Response: 2.34, -5, 6.98, 3.1, 9.99, 12.93;

For Write Commands, each channel must be set set separately by a command. The following example sets the BIAS Voltage for channel 2 to 5.67V:

Command VOLT 2, 5.67

Response: ;

## 9.6 General SCPI Commands

Syntax	Example read	Description
*idn?	*idn?; IDP-BC, 1, F/W Ver 1.1.1(246)- 380, HW Ver 1.10;"	Query System Type and Software version
*opc	*opc; 1;"	Query all pending commands executed
*rst	*rst	Reset Controller; will cold start the instrument. All connections/sessions will be closed. Requires user level 1

## 9.7 Commands on system level

Syntax	Read Write	User access level	Parameter format	Description
[ :SYStem:]ECHO/? /<P>	RW	0	"0" or "1"	Sets or query echo command sent status, this setting applies to current session only
[ :SYStem:]SaveCurrSTATe	W	0	-	Saves current BIAS Voltages of device to Disc.
[ :SYStem:]INFOrmation?	R	0	IDP-BC, SN xxx, F/W Ver xxx, HW Ver xxx	see *idn? for description
[ :SYStem:]DHCP/? /<P>	RW	1	"off" or "on"	configure DHCP Setting for Ethernet interface
[ :SYStem:]IPADdResS/? /<P>	RW	1	xxx.xxx.xxx.xx x	IP Address Setting of Ethernet interface
[ :SYStem:]NETMAsK/? /<P>	RW	1	xxx.xxx.xxx.xx x	Netmask Setting of Ethernet interface
[ :SYStem:]GATEWAYIP/? /<P>	RW	1	xxx.xxx.xxx.xx x	IP address for Gateway of Ethernet interface
[ :SYStem:]DNSIP/? /<P>	RW	1	xxx.xxx.xxx.xx x	IP address for 1st DNS of Ethernet interface
[ :SYStem:]DNSIP2/? /<P>	RW	1	xxx.xxx.xxx.xx x	IP address for 2nd DNS of Ethernet interface
[ :SYStem:]MACADdResS?	R	0	-	queries die MAC Address of the unit's Ethernet interface, (S/W Version 1.5.3 or later)
[ :SYStem:]REMOte?	R	0	"0" or "1"	Query remote status of device. Any open remote sessions via Ethernet?
[ :SYStem:]PASSwOrd/? /<P>	RW	0	x	Set new User level status by sending password or query current User level status
[ :SYStem:]TIME? /<P>	R/(W)	0	xxxxxxxx	Query or set system time
[ :SYStem:]ALARm?	R	0	xxxxx	Query alarm status of device, see Alarm code definition for details

Syntax	Read Write	User access level	Parameter format	Description
[ :SYStem: ] STATus?	R	0	"TRACKING", "TRACKING_PAUSE", "INIT", "INIT_PAUSE", "MANUAL", "FAULT"	Query current state of BIAS Control
[ :BOOT: ] BootLoaDerRESe t	W	0		Resets upload procedure for firmware upgrade. All data uploaded already is erased. New process can be restarted
[ :BOOT: ] BootLoaDerAPPend	W	0		send portions of the binary Firmware Image, each Byte is coded into 2 Characters 1..F, send max. 100 Bytes per command
[ :BOOT: ] BootLoaDerEXEC ute/?	RW	0		Set: Executes upgrade of previously uploaded Firmware image. Query responds with current status of execution.
[ :SYStem: ] SHUTDown	W	1	-	The unit operates on a LINUX System. Shut down the unit before power off using this command to avoid data loss.

## 9.8 BIAS Control Commands

### 9.8.1 Command description

Command	Parameter Options	Description
[ :BIAS: ] MODE/?	"1" to "8"	Set or query current MZM configuration. 1=DPIQ(1), 2=DPIQ(2), 3=SPIQ(1), 5=DPPII(1), 6=DPPII(2), 7=SPPII(1), 8=custom; Number in brackets denotes the number of feedback photodiodes. See chapter "Control loop" for details.
[ :BIAS: ] AUToStArt/? /<P>	"0" or "1"	0: Bias Control will remain in Manual mode after startup 1: Bias Control will automatically run INIT and continue in TRACKING state
[ :BIAS: ] QuickStArt/? /<P>	"0" or "1"	Skips INIT state after startup. This option is only recommended

Command	Parameter Options	Description
[ :BIAS:]FACToryDEFault	-	Resets all parameters saved by SCSTAT back to Factory defaults.
[ :BIAS:]SETTled? /<P>	"0" or "1"	Indicates if Automatic BIAS Control is settled (only TRACKING mode)
[ :BIAS:]VPI/? /<P>, /<P>	x,x.xxx	Query or set VPI of BIAS Electrodes. Note: Changing these parameters will impact the performance of the automated control loop. See 9.5.1 for details on the parameter convention.
[ :BIAS:]INIT/?	"0" or "1"	Write: Will trigger the initialization routine Read: Indicates whether control loop is currently in initialization phase. 1: Init active 0: No Init in progress
[ :BIAS:]VOLTage/? /<P>, /<P>	-	Write: Set BIAS Voltages. First Parameter is Channel ID, second is BIAS Voltage to be set to selected electrode. Set is only possible in manual mode. See according table for electrode type assignment. Example: VOLT 1, 5.365; Read: Query current BIAS voltages. Response will be all 6 BIAS Voltages without Channel ID. Example: VOLT?; 1.987, 5.365,8.487,6.456,11.567,15.734; See 9.5.1 for details on the parameter convention.
[ :BIAS:]STAtusVOLTage? /<P>	"0" or "1"	Query if any BIAS Voltage is 5% or less to maximum/minimum
[ :BIAS:]CONTRol/? /<P>	"0" or "1"	Query or set status of automated BIAS Control. 1: Control Active 0: Manual Mode Active
[ :BIAS:]OPOWer? /<P>	+/-x.xx	Query current optical output power in [dBm]. For ABC only: This value is only correct if power calibration was performed before. The optional parameter allows to read only 1 channel. i.e. OPOW? 1; reads the optical power of feedback channel 1
[ :BIAS:]MONPower? /<P>	+/-x.xx	Query current DC feedback level. Note that the unit uses an automated gain switch so that this value cannot be used as a power monitor. The optional parameter allows to read only 1

Command	Parameter Options	Description
		channel. i.e. OPOW? 1; reads the optical power of feedback channel 1
[ :BIAS:]MUTE/? /<P>	"0" or "1"	Query or set MUTE status. If MUTE is active, automated BIAS Control will not change any BIAS Voltage and switch to a low noise mode intended for delicate measurements. A query will also indicate the MUTE status that is set by the external H/W input. 1: Mute Active 0: Standard operation
[ :BIAS:]LOSStatus? /<P>	"0" or "1"	"Query if output power of device is too low for automatic BIAS Control. 1: Loss of Signal (LOS) - Signal too low. Control loops stops 0: Signal within valid range" Note that this feature requires a valid power calibration of the feedback path. For OMFT, these values are calibrated at production.
[ :SYSTEM:]LOSThresh/? /<P>, /<P>	Ch, Power[dBm]	This sets the Loss of Signal (LOS) threshold of the unit. If the power at the feedback path drops below the specified value, the ABC stops tracking and a warning is issued. Note that this feature requires a valid power calibration of the feedback path. For OMFT, these values are calibrated at production.
[ :BIAS:]INitPROGress?	xxx	Progress of Init Procedure reported in [%]
[ :BIAS:]MAXRange/? /<P>	xx.xx	Query or set maximum Voltage applied to BIAS electrodes in [Volts]. Setting is possible only with User Access level 1 or higher and in MANUAL mode of BIAS control. This value can be between 0V and 48V.
[ :BIAS:]HWMAXRange?	xx.xx	Query or set Voltage setting of HARDWARE. This is the maximum Voltage range addressable by the hardware in [Volts]. This value can be 12,24 or 48V. This value is automatically set by the S/W, following HWMAXRange > MAXRange.
[BIAS:]TRackInLOS/? /<P>	"0" or "1"	(Firmware 1.2.2 or later) If enabled(1), control loop is forced to continue operating even if LOS alarm is present. CAUTION: The control loop will drift away if no feedback signal is present (i.e. no photodiode connected).

Command	Parameter Options	Description
[:BIAS:]FOFFset/? /<P>, /<P>	x,x.xxx	<p>(Firmware 1.4.8 or later)            Write: Set Feedback Offset target. First Parameter is Channel ID, second is offset of Feedback signal to selected electrode. See according table for electrode type assignment.            Read: Query current offset value.            Response will be all 6 Feedback offsets without Channel ID.            Example: FOFF?;            1.987,            5.365,8.487,6.456,11.567,15.734;            See 9.5.1 for details on the parameter convention.</p>
[:BIAS:]FeedBackDIRection/? /<P>, /<P>	1 to 6, "-1" or "1"	<p>(Firmware 1.4.8 or later)            Write: Sets direction of Feedback signal control loop. First Parameter is channel #, second is direction +/-1.            Read: Query control loop direction.            Response will be 6 Feedback directions without Channel ID.            Example: FBDIR?;            1, -1, 1, 1, 1, 1            See 9.5.1 for details on the parameter convention.</p>
[:BIAS:]CHannelACTive/? /<P>, /<P>	1 to 6, "0" or "1"	<p>(Firmware 1.4.9 or later)            Write: Set control loop for selected channel to active/inactive            Read: Query Control loop for channel active/inactive            Write: Set control loop for selected channel to active/inactive            Example: CHACT?;            1, 0, 1, 0, 1, 1            See 9.5.1 for details on the parameter convention.</p>
[:BIAS:]CHannelASSign/? /<P>, /<P>	1 to 6, 1 to 6	<p>(Firmware 1.4.9 or later)            Write: Will set control loop channel assignment to different H/W Channel            Read: Assignment of control loop channel to H/W channel            Example:            CHASS 1, 4;            Will assign logical output 1 to Hardware channel 4, logical output 1 is then left unused (0)            CHASS?; Will be            0, 2, 3, 1, 4, 5;            See 9.5.1 for details on the parameter convention.</p>

Command	Parameter Options	Description
		This command may not be used for the OMFT.

### 9.8.2 Command Property overview

Command	Read Write	Set in Manual Mode only	User access level	Stored by SCSTAT
[ :BIAS:]MODE/?	RW	X		
[ :BIAS:]AUToStArt/? /<P>	RW	-	0	X
[ :BIAS:]QUICKStArt/? /<P>	RW	-	0	X
[ :BIAS:]FACToryDEFault	W	X	1	-
[ :BIAS:]SETTled? /<P>	R	-	0	-
[ :BIAS:]VPI/? /<P>, /<P>	RW	X	1	X
[ :BIAS:]INIT/?	RW	-	0	-
[ :BIAS:]VOLTage/? /<P>, /<P>	RW	X	0	X
[ :BIAS:]STAtusVOLTage? /<P>	R	-	0	-
[ :BIAS:]CONTRol/? /<P>	RW	-	0	-
[ :BIAS:]OPower? /<P>	R	-	0	-
[ :BIAS:]MONPower? /<P>	R	-	0	-
[ :BIAS:]MUTE/? /<P>	RW	-	0	-
[ :BIAS:]LOSStatus? /<P>	R	-	0	-
[ :SYSTEM:]LOSThresh/? /<P>, /<P>	RW	-	0;1	-
[ :BIAS:]INitPROGress?	R	-	0	-
[ :BIAS:]MAXRange/? /<P>	RW	X	1	X
[ :BIAS:]HWMAXRange?	R	-	1	X
[BIAS:]TRackInLOS/? /<P>	RW	-	1	-
[ :BIAS:]FOFFset/? /<P>, /<P>	RW	X	1	X
[ :BIAS:]FeedBackDIRection/? /<P>, /<P>	RW	X	1	X
[ :BIAS:]ChANnelACTive/? /<P>, /<P>	RW	X	1	X
[ :BIAS:]ChANnelASSign/? /<P>, /<P>	RW	X	1	X

## 9.9 AUX/RF Amplifier Control Commands

### 9.9.1 Command description

Command	Parameter Options	Description
<code>[ :AUX: ] ONOFF/? /&lt;P&gt;, /&lt;P&gt;</code>	"0" or "1"	Command controls the Digital outputs. In case of OMFT, it enables (1) or disables (0) the RF amplifiers built into the unit. See 9.5.1 for details on the parameter convention.
<code>[ :AUX: ] ANAlogV/? /&lt;P&gt;, /&lt;P&gt;</code>		Command controls the Analog outputs. In case of OMFT, it controls the electrical RF gain of the RF amplifiers built into the unit. See 9.5.1 for details on the parameter convention.

### 9.9.2 Command Property overview

Command	Read Write	Set in Manual Mode only	User access level	Stored by SCSTAT
<code>[ :AUX: ] ONOFF/? /&lt;P&gt;, /&lt;P&gt;</code>	RW	-	0	-
<code>[ :AUX: ] ANAlogV/? /&lt;P&gt;, /&lt;P&gt;</code>	RW	-	0	-

### 9.10 SCPI Code error definition

Error #	Description
100	Command Syntax Command error
200	Command execution error

### 9.11 Alarm code definition

Bit #	Alarm	Condition/Description
0	BIAS Value at limit	current Voltage <5% or 95% of avail range
1	Init error	An error occurred during init process
2	Feedback signal warning	feedback signal invalid
3	Gain error, feedback signal too low or too large	feedback signal too small or too large
4	generic Fault	general error
5	H/W error	Hardware error
6	Unused	-
7	DC signal warning	Photocurrent out of range warning, <5% or 95% of avail range; only if no LOS present. Control will continue to operate if warning is present (unless LOS is present as well)
8	PD1 clipping error	Input Signal warning PHDx. The feedback photodiode current saturates the electronic circuit. Change the gain using SW3 as described in section "Board and Connector description". The control will pause as long as error is present.
9	PD2 clipping error	
10	Start Init search failed	Start Init search failed due to i.e. Clipping of input signals or improper feedback signal. Initialize unit and start again. If unit settled as required by user, the warning can be ignored.
11	Feedback Fail	Feedback signal is too weak or not present. Check if Feedback Photodiodes are connected properly.
12	Not used	
13	Not used	
14	Not used	
15	Not used	

## 10 Uninstalling GUI Software

Software may be uninstalled by either using the well-known central Windows built-in "Add/remove Programs" function or by running "setup.exe" from installation medium again.