IDPHOTONICS GMBH

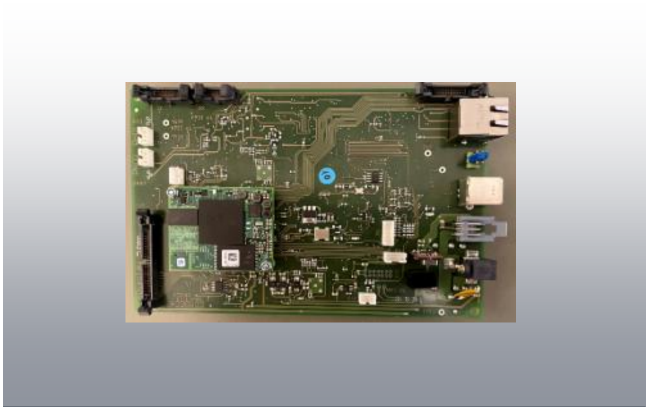
TRANSFORMING INNOVATIVE PHOTONICS IDEAS INTO REAL-WORLD SOLUTIONS REQUIRES GREAT TOOLS.

AUTOMATIC BIAS CONTROL

TRANSMITTER SOLUTIONS

USER MANUAL

ABC-BPC-13-A



ABC-BPC-11-A

ABC-BPC-14-A

P/N ABC-BPC-1x-x,

x: Wildcard, applies to all instruments

Status: 2025-11-03
Applies to Firmware 2.7.0 or later

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id-photonics.com

CONTENT

1 GENERAL INFORMATION

1.1 MANUAL DOWNLOAD

The most current version of the manual can be downloaded in the resource area of our website. Request a login via the website to access the protected content.

1.2 COMPLIANCE STATEMENT ELECTROMAGNETIC COMPATIBILITY AND DEVICE SAFETY

(Models ABC-BPC-13-x, ABC-BPC-14-x, ABC-BPC-15-x only)
Hereby, we declare that this system has been designed and tested for compliance for the following directives.

1.2.1 INTERNATIONAL

IEC 62368-1
CISPR 11:2003 in accordance with EN 61326-1: 2006

1.2.2 UNITED STATES OF AMERICA

FCC 47 CFR Part 15, Subpart B Class A, Measurement process ANSI C63.4 (2009)

1.2.3 EUROPEAN UNION

EN 55022:2011
EN 61326-1: 2013
EN 61000-6-2: 2006
EN 61000-6-4: 2011
EN 61000-3-2: 2010
EN 61000-3-3: 2009

1.3 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.

1.4 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.

1.5 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. Only use the supplied power supply to operate the unit.

1.6 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 .

1.7 SAFETY

1.7.1 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.

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.

NOTE

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

1.7.2 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.

1.7.3 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 specification 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.

1.7.4 DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

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

1.7.5 SAFETY SYMBOLS ON INSTRUMENTS

1.7.5.1 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.

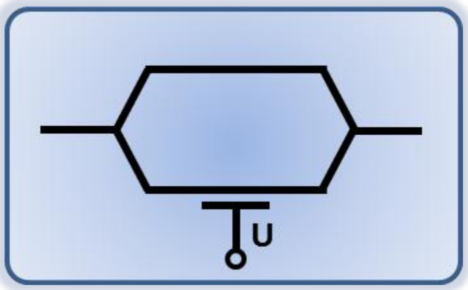
1.7.5.2 ESD SAFETY WARNING

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.

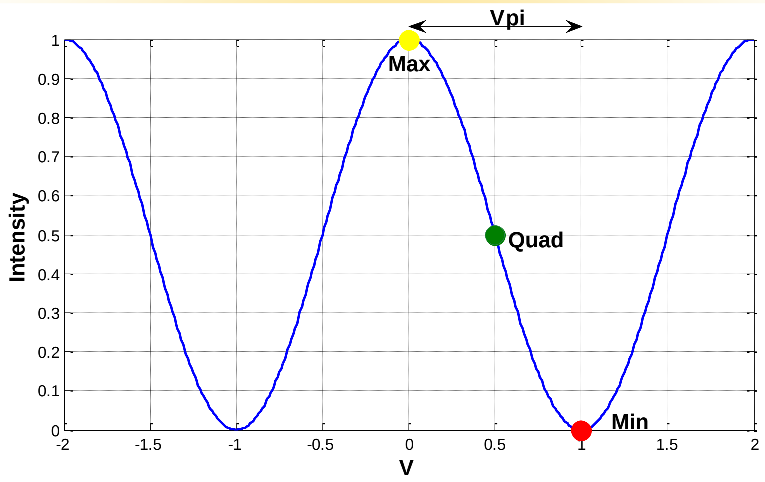
2 INTRODUCTION

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).

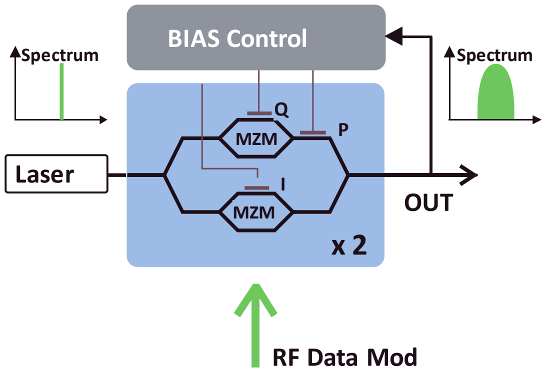
2.2 AUTOMATED BIAS CONTROL

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”:

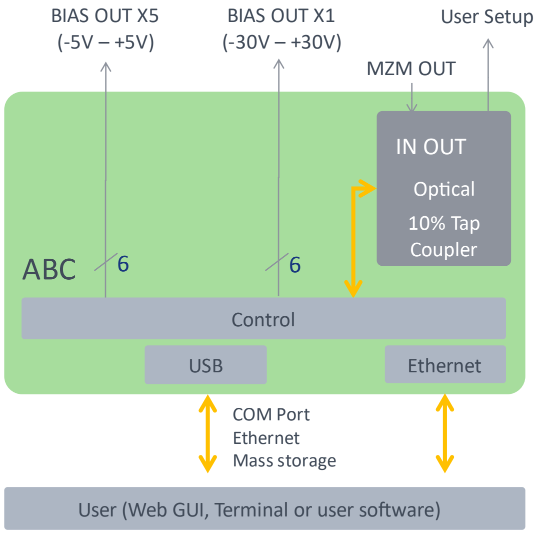
MZM TYPE	INTERNAL PHOTODIODES		EXTERNAL PHOTODIODES		APPLICATION EXAMPLE
	1 PD	2 PD	1 PD	2 PD	
Single Polarization IQ Modulator[1] (SPIQ mode)	✓	-	✓	-	SP-QPSK, SP-QAM32
Dual Polarization IQ Modulator (DPIQ mode)	(-)	✓	✓	(✓)	DP-QPSK, DP-QAM16
Single Polarization Intensity Modulator (II)[2] (SPII mode)	✓	-	✓	-	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.

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

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

2.3 OVERVIEW AND FUNCTIONAL BLOCKS



2.3.1 USER INTERFACES

A USB interface or an Ethernet interface can be used to communicate with the unit. The unit hosts a web server unit so that instant installation free access using any state-of-the-art browser is possible.
The USB Interface provides 3 modes of access:

1. Virtual Serial Port
2. Virtual Ethernet interface
3. Virtual USB stick containing manual, drivers, etc.

2.3.2 MACH-ZEHNDER BIAS INTERFACES

The unit provides 2 output terminals to cover different BIAS Voltage ranges. Both outputs are electrically separate but are fed in parallel by the DAC outputs. Thus, the two interfaces contain the same value but scaled in a relative to their corresponding output swing.
Socket X1: -30V to +30V differential or -15V to +15V Single Ended
Socket X5: 0V to +5V Single Ended
PHD1, PHD2 Photodiode 1 & 2 Inputs are non-biased inputs with wide range transimpedance conversion on the board. Either 1 or 2 inputs are used depending on the configuration used.
For more details on the control loop see chapter 0.

3 QUICK START

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

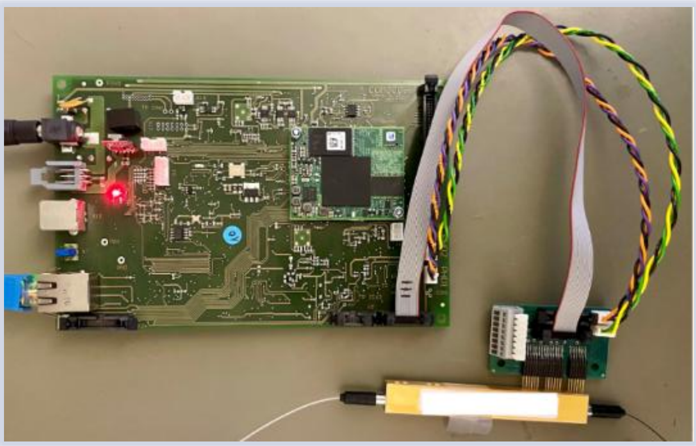
Connect the user interface of preference (USB or Ethernet) to your host computer. For details how to connect a host PC, see section 0.

The following steps depend on the MZM type you wish to connect to the unit.

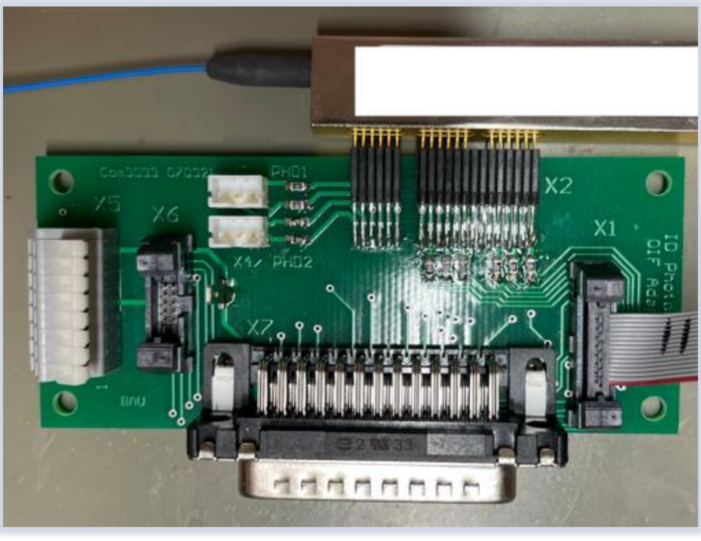
3.1.1 OIF STANDARD COMPATIBLE DUAL POL IQ MZM

Connect the MZM module to the small supplied daughter board.
Connect the daughter board via the ribbon cable to X1 and PHD1/2 of the main board.
If an OIF Standard compatible Dual Pol MZM with internal monitor diodes such as the Fujitsu FTM797xHQx is to be used, plug the MZM into the small on the small child board and connect the child board using the supplied ribbon cable to connector X1 on the ABC board.
The picture shows a typical connection setup using a OIF compliant DualPol IQ MZM and MZM internal photodiodes. For optimum performance, use a separate external PD for feedback signal generation.

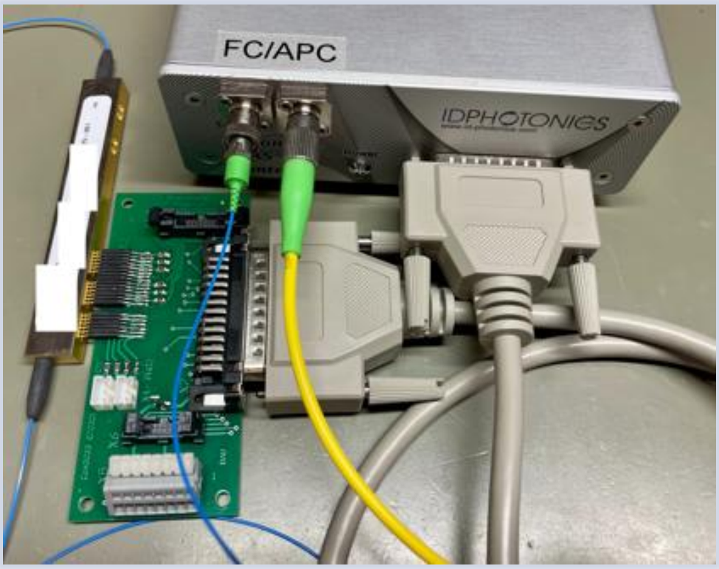
Bare Board ABC-BPC-11-x – Extension Board V1



Bare Board ABC-BPC-11-x – Extension Board V2
Connect X1, leave X7 (SuB-D) unconnected



Benchtop Unit ABC-BPC-13-x, Single PD feedback

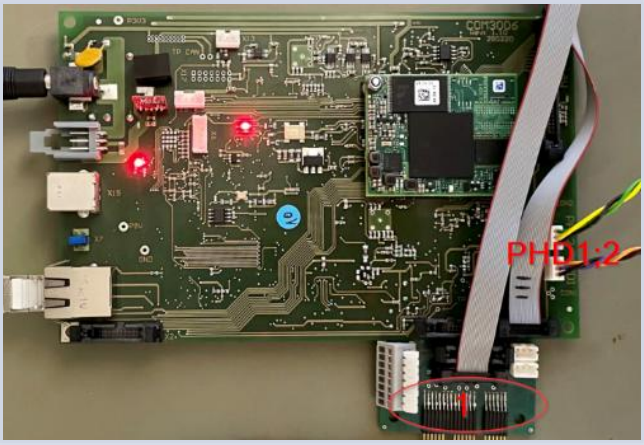


Connect X7 (SuB-D), connect MZM Optical out to “IN” of ABC unit. Connect “OUT” to your setup.

1. Connect and enable the output of laser light source to the MZM.
   In case of a separate feedback PD (i. e. ABC-BPC-13-x, ABC-BPC-14-x) connect the output of the MZM to the PDs. In case the MZM built-in feedback PD is used (ABC-BPC-11-x, ABC-BPC-15-x) and OIF compatible MZM, the PD connection is made via the adaptor board.
2. Switch on the ABC unit by plugging in the power supply into the socket
3. Wait for ~30seconds to start up the board
4. If USB and Win 10 is used, the drivers will install automatically. There are 3 drivers installed:
   a. Virtual Ethernet
   b. Virtual Serial Port
   c. Virtual Mass Storage device
5. Connect to the GUI, for details see 0.
6. Per default, the bare board is set to 2 channel PD feedback using an IQ modulator with Quad/Min/Min BIAS setting. The benchtop unit default is set to the number of PD feedback channels installed in the device.
7. Click on “`VPI setting`” and enter the VPI Voltages of the BIAS Terminals of your MZM.
8. Now, in MZM tab, enable the control via button “`ABC`”. The unit should run through its init sequence. After 30 – 200seconds it should settle (Indicator “`ABC settled`”). A proper control loop connection is characterized by fast but gradual moves of the voltages followed by a slowing down, saturation like, approach to the target (PI control loop). See reference graph in section 7.

3.1.2 +/-30V DIFFERENTIAL AND +/-15V SINGLE ENDED OUTPUT

(Default is +/-30V differential)
Usage of these outputs for non-standard OIF MZMs requires a customized connection to the board. For a block diagram of potential setups, see section 6.1.
We recommend to connect the daughter board via the ribbon cable to X1 to the main board and use the terminals of the connector highlighted with 1 to build a custom connector cable to your MZM. See 0 for pinning of this connector.
Depending on setup, connect 1 or 2 feedback photodiodes with PHD1 and/or PHD2 on the main board. For the benchtop unit, check the number of feedback channels on the front of the unit. 2 connectors (type ABC-BPC-13-x) is a single PD unit, 4 connectors (type ABC-BPC-14-x) is a dual PD unit.

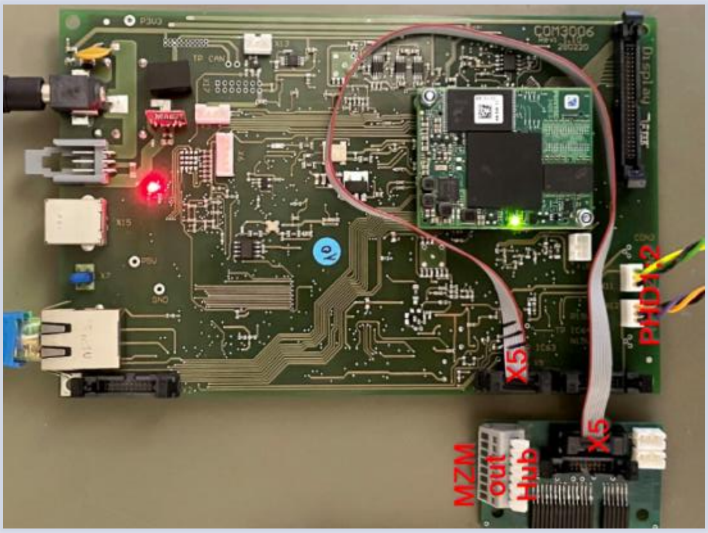


1. Connect and enable the output of laser light source to the MZM.
2. Switch on the ABC board by plugging in the power supply into the socket
3. Wait for ~30seconds to start up the device
4. If USB and Win 10 is used, the drivers will install automatically. There are 3 drivers installed:
    a. Virtual Ethernet
    b. Virtual Serial Port
    c. Virtual Mass Storage device
5. Connect to the GUI, for details see 0.
6. Make sure the ABC is in Manual mode. In connection tab, enter password “`IDP`” to elevate the user level to 1. Go to system tab, select the required mode for your setup in
“ABC config” tab. Select “`X1 differential`” or “`X1 single ended`” mode in drop down “Display output range for port”.
7. Click on “`VPI setting`” and enter the VPI Voltages of the **BIAS** Terminals of your MZM.
8. Now, in MZM tab, enable the control via button “`ABC`”. The unit should run through its init sequence. After 30 – 200seconds it should settle (Indicator “`ABC settled`”). A proper control loop connection is characterized by fast but gradual moves of the voltages followed by a slowing down, saturation like, approach to the target (PI control loop). See reference graph in section 7.

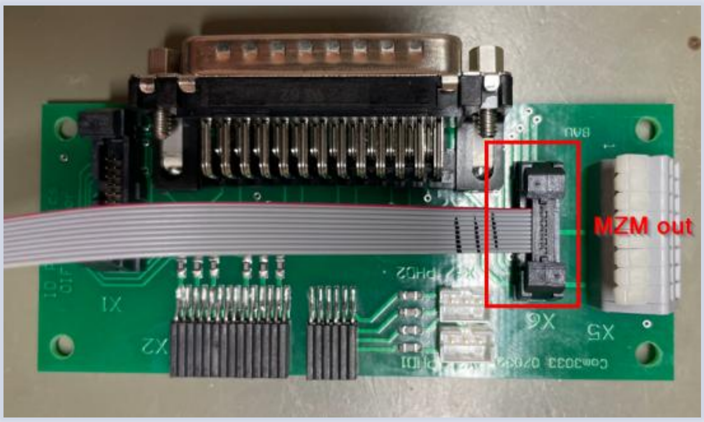
3.1.3 0 – 5V SINGLE ENDED OUTPUT

Connect to the small supplied daughter board via the ribbon cable to X5 (extension Board V1) or X6 (extension Board V2) on the main board
Depending on setup, connect 1 or 2 feedback photodiodes with PHD1 and/or PHD2 on the main board.
Use the grey MZM out hub connector block to connect MZM module. See 5.4.3 for the pinning of this hub.

Bare Board ABC-BPC-11-x – Extension Board V1



Bare Board ABC-BPC-11-x – Extension Board V2
X6 in case of bard Board, X7 (Sub-D) in case of Benchtop



1. Connect and enable the output of laser light source to the MZM.
2. Switch on the ABC board by plugging in the power supply into the socket
3. Wait for ~30seconds to start up the board
4. If USB and Win 10 is used, the drivers will install automatically. There are 3 drivers installed:
    a. Virtual Ethernet
    b. Virtual Serial Port
    c. Virtual Mass Storage device
5. Connect to the GUI, for details see 0.
6. Make sure the ABC is in Manual mode. Go to system tab, enter “`IDP`” in connection tab to elevate the user level to 1. Select the required mode for your setup in “ABC config” tab. Select “`X5 0-5V`” mode in drop down “Display output range for port”.

7. Now, in MZM tab, enable the control via button "`ABC`". The unit should run through its init sequence. After 30 – 200seconds it should settle (Indicator "`ABC settled`"). A proper control loop connection is characterized by fast but gradual moves of the voltages followed by a slowing down, saturation like, approach to the target (PI control loop). See reference graph in section 7.

3.2 QUICK START – REMOTE CONTROL

This section contains redundant information from other chapters but is useful for a first-time usage of the instrument.

1. Wait until the boot sequence is completed.
   •
2. Connect the USB Port located at the rear of the unit to your Windows10 PC or connect the Ethernet Port to your LAN.
   •
   a. **For USB** based access, all drivers will be installed automatically, Windows device manager should show now 3 devices:
      1. A storage device containing manual etc.
      2. A virtual Ethernet Interface "RNDIS"
      3. A virtual COM Port
      Both virtual COM and Ethernet Ports can be used to remote control the unit. The installed COM Port number can be retrieved from Windows device manager. The IP address by the command shell "`ping abc.local`".
      •
   b. **For Ethernet** based access, the default IP of the unit is 192.168.0.1. Make sure that the host PC IP is in the same subnet as the laser unit (192.168.0.x). If this is not the case, you can change the IP settings of the unit via the touch screen or using the USB Port of the unit. Use "`abc.local`" as an alternative to the IP address to connect to the unit.
3. Open your Web browser, enter "`abc.local`" in the address field and hit <enter>. The Webpage allowing to control the laser remotely should open now.

! NOTE

Depending on the configuration of your host PC DNS structure, the "`abc.local`" name representation might not be resolved into the correct IP address. In such a case,
open a connection to the USB virtual serial interface (COM Port) and type the command "`USBIPADDR?;`" to retrieve the USB IP Address or "`IPADDR?;`" for the IP address of the physical Ethernet interface.

! NOTE

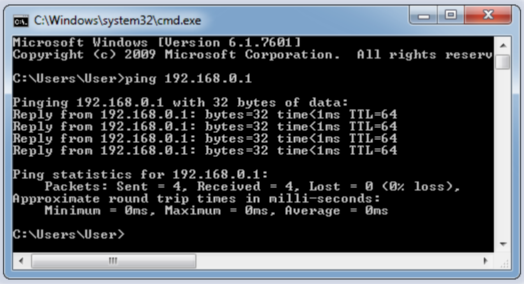
Connecting to the device's web GUI using "`abc.local`" may take some time. The faster alternative is to use the device's IP Address directly. The default IP Address is 192.168.0.1. To access the web GUI, enter "`http://192.168.0.1`" in your browser.
To retrieve the current IP address of your device, open a connection to the USB virtual serial interface (COM Port) and enter the command "`IPADDR?;`".

4 CONNECTING A HOST PC TO THE UNIT

This section contains more in-depth information on how to setup the remote interfaces on a host PC and basic principles of the laser.

4.1 ETHERNET CONNECTION

This section covers connectivity using Ethernet, skip it if you plan on using USB.
The default IP address is 192.168.0.1, DHCP off. If you plan to connect using the Ethernet interface, make sure the host PC is within the same subnet as the ABC Ethernet Interface (The PC IP Address is 192.168.0.x then). The connectivity can be tested by opening a command shell (type “cmd” in windows search field and hit <enter>, a



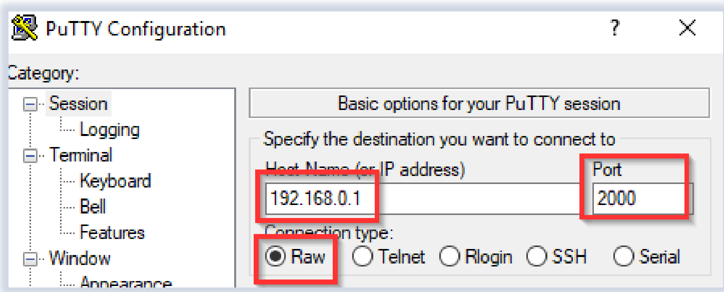
“black window with a DOS shell should open) and executing the command “ping 192.168.0.1”.

4.1.1 CHANGE OF PHYSICAL ETHERNET IP ADDRESS WITHOUT GUI ACCESS

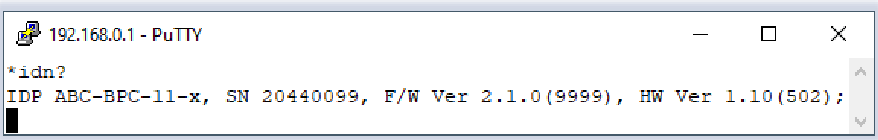
If you do wish to change the IP settings of the unit, we recommend first connecting via USB and changing the IP settings via USB connection. Use the virtual serial port (COM Port) to connect to the unit.
Use the command “`ipaddr xxx.xxx.xxx.xxx`” to set a new IP address where `xxx.xxx.xxx.xxx` is the IP address you wish to use. You can query the IP address via “`ipaddr?`”. For further IP address settings, refer to the remote section. Note that the unit must be rebooted in order for the new IP setting to become effective. Use command “`*rst`” for that.
Note that changing the IP address requires the user to be connected with user level 1 or higher. Send the command “`pass IDP`” or enter the password “`IDP`” in the GUI to elevate the user level to 1. This change will require a reboot (soft reset of the unit) to become effective.

4.1.2 OPENING A REMOTE CONNECTION VIA ETHERNET

The device supports a session based remote access on Port #2000.
Start the terminal program “putty.exe” supplied with the unit or use any other terminal program.
Set the following parameters in Putty and open the connection:



Alternatively to the default IP Address shown above, enter “`abc.local`” or the IP address currently set to the unit. If in doubt, use the touch panel display “Device config” – “IP config” to retrieve the actual IP Address.
Note that the must be a valid route on the IP layer between the device and the host PC (i.e. the ethernet port of the host PC is set to the same subnet as the device, for example 192.168.0.2) must be established before continuing. Use a command shell and command “`ping abc.local`” to test the route.
Once the connection is established, type in “`*idn?`” and hit <ENTER>. The unit responds with its *idn? String.



Alternatively, a request based remote control via http Port 80 is possible. To test this, open a browser window and type the following string into the address field:

`http://abc.local/scpi/*idn?`

For more details, see section 9.2.

4.2 USB CONNECTION

This section covers connectivity using USB, skip it if you plan using Ethernet.
Once the unit is powered up and the USB cable is connected to the host computer for the first time, a new device installation should be triggered automatically within Windows.
Once installation is complete, three devices are installed on the host computer:

1. Virtual Ethernet Interface
2. Virtual COM Port
3. Virtual Storage device that contains resources such as manual and programming devices as well as drivers for Windows 7.

4.2.1.1 WINDOWS 10

Windows 10 will automatically install 3 devices allowing to connect the unit

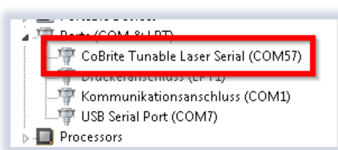
1. A virtual Ethernet interface (RNDIS)
2. A generic virtual COM port driver "Serial USB device". If you have several COM ports installed in the host PC, you may want to note the COM Port number under which the unit got installed. For further details on USB connection, see section 4.2.1.3.
3. A storage device similar to an USB Stick containing resources for the laser unit

The virtual COM Port and the virtual Ethernet interface are concurrent ways to access the unit for remote control. The web-based control is automatically accessed via entering "`abc.local`" into your browser.

4.2.1.2 WINDOWS 7

Windows 7 will install the same structure as described in the windows 10 section above. It will automatically install a virtual Ethernet interface (RNDIS) and the USB storage device ("Linux File- Store Gadget USB Device"). However, it does not have a preconfigured driver setup for the virtual COM Port. It will try to locate a driver for the unit on the host PC first and then check online. Stop the search and select the option "Install a custom driver".
Point the installation routine to the driver located on the USB storage device provided by the unit in directory "USBDriverWin7" and select file "ABCUSBSerialDriverWindows7.inf" in this folder. If the installation has been completed already, open Windows Device Manager, locate "CDC Serial", right click on it and select "Update driver". Proceed as described before.

Continue with the installation routine. Once installed, the virtual COM port should appear in Windows Device Manager as shown below as IDP ABC. The COM Port number will be different for your system. Note down the number for later usage in remote control applications.



4.2.1.3 CONNECTION TO THE DEVICE VIA USB VIA HOST PC

Once installed properly, the USB connection provides a virtual COM Port and a virtual Ethernet Port to the instrument. To access the unit via virtual Ethernet, follow the instructions as in section 4.1.2 but note that the IP Address of the unit will be different as for the physical Ethernet Port.
To access to the unit using the virtual COM port, open a terminal window using the installed COM port number per description above.

4.3 INSTALLATION OF CONTROL SOFTWARE

This instrument does not require any installation of software for operation. Once connected to a host PC or a local network, simply enter "`abc.local`" into the address field of your Web browser to access the unit.

4.4 WHAT IF "ABC.LOCAL" CANNOT BE REACHED BY HOST COMPUTER?

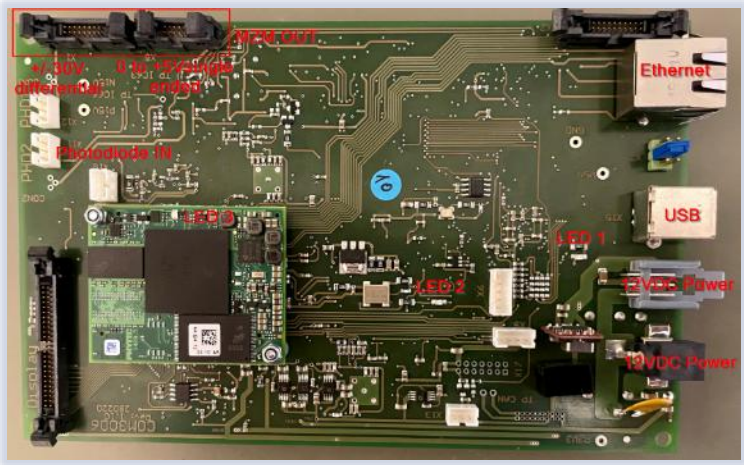
Depending on the configuration of your host PC DNS structure, the "`abc.local`" might not be resolved into the correct IP address. In such a case, open a connection to the virtual serial interface (COM Port) and type the command "`USBIPADDR?;`" to retrieve the IP Address for USB connection and "`IPADDR?;`" for physical Ethernet.

After retrieving the address, enter the corresponding IP address into your browser address field to access the unit via GUI.

5 DETAILED DESCRIPTION OF UNIT

5.1 BARE BOARD VERSION ABC-BPC-11-X

The picture below gives an overview of the Main Board. All available connectors and features are described in the next sections.
The output to the MZM is supplied at the connectors X1 and X5 located on the upper left-hand side. Both outputs are electrically independent but are fed by the control electronics (DACs) in parallel.



5.1.1 STATUS LEDS

LED 1: Is a power indicator. It will light as long as Power is supplied to 12VDC Power jacks.
LED 2: Is a heartbeat indicator
LED 3: Located on the Main CPU daughter board indicates activity of the main CPU. It is solid green at time of startup and will start to flash when ready.

5.1.2 BIAS OUTPUT CONNECTORS

Note that the 2 output connectors X1 and X2 are parallel outputs. They will exhibit the same scaled Voltages independent of the setting the output in the software. The X1 terminals will always be ~3 or 6 times larger compared to respective voltages on X5. The software setting affects the display in the GUI only.

5.1.2.1 CONNECTOR X1 - BIAS OUT 1

This connector provides a voltage range of -15V to +15V if used single ended. In differential mode, the output range is consequently -30V to +30V.
For single ended use, connect the P terminals to the MZM electrode and the other to the common GND.
The output impedance of the terminals is 330Ohms.

PIN	DESCRIPTION
1	BIAS Channel 6 P (OIF Implementation: Q Mod; Y Polarization)
2	BIAS Channel 6 N (OIF Implementation: Q Mod; Y Polarization)
3	BIAS Channel 5 P (OIF Implementation: I Mod; Y Polarization)
4	BIAS Channel 5 N (OIF Implementation: I Mod; Y Polarization)
5	BIAS Channel 3 P (OIF Implementation: Q Mod; X Polarization)
6	BIAS Channel 3 N (OIF Implementation: Q Mod; X Polarization)
7	BIAS Channel 2 P (OIF Implementation: I Mod; X Polarization)
8	BIAS Channel 2 N (OIF Implementation: I Mod; X Polarization)

9	BIAS Channel 4 P (OIF Implementation: Phase; Y Polarization)
10	BIAS Channel 4 N (OIF Implementation: Phase; Y Polarization)
11	BIAS Channel 1 P (OIF Implementation: Phase; X Polarization)
12	BIAS Channel 1 N (OIF Implementation: Phase; X Polarization)
13	GND
15	GND
16	GND

5.1.3 CONNECTOR X5 - BIAS OUT 2

This connector provides a voltage range of 5V. The output impedance of the terminals is 120Ohm.

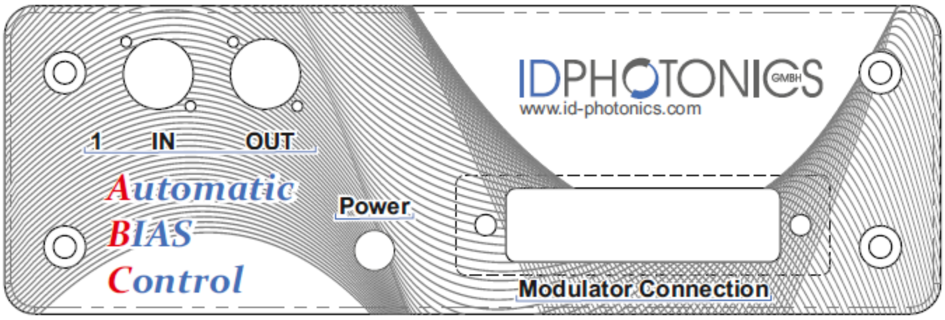
PIN	DESCRIPTION
1	BIAS Channel 2 (OIF Implementation: I Mod; X Polarization)
2	BIAS Channel 5 (OIF Implementation: I Mod; Y Polarization)
3	BIAS Channel 3 (OIF Implementation: Q Mod; X Polarization)
4	Do not connect
5	BIAS Channel 6 (OIF Implementation: Q Mod; Y Polarization)
6	GND
7	BIAS Channel 4 (OIF Implementation: Phase; Y Polarization)
8	GND
9	BIAS Channel 1 (OIF Implementation: Phase; X Polarization)
10	GND

5.1.4 CON1, CON2, PHD1, PHD2 - CONNECTOR FOR EXTERNAL FEEDBACK PHOTODIODE

PIN	DESCRIPTION
1	Photodiode, Anode
2	Photodiode, Cathode, GND
3	GND

5.2 BENCHTOP VERSION ABC-BPC-13-X, ABC-BPC-13-X

The benchtop versions provide 1 or 2 optical in- and outputs. These are internally connected to a 5% single mode tap coupler of which the 5% path is connected to a photodiode that generates the feedback signal required to operate the ABC.
The front panel hosts a 25 Pin female Sub-D Connector providing the electrical signals for the Mach-Zehnder, a Power LED and the optical in- and output connectors.

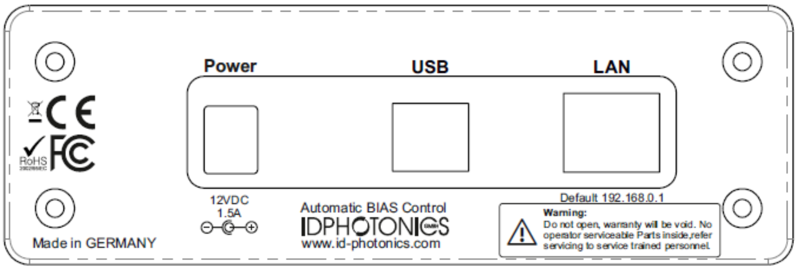


5.2.1 SUB-D CONNECTOR PINNING

PIN	DESCRIPTION
1	GND
2	+/-5V Range - BIAS Channel 1 (OIF Implementation: Phase; X Polarization)
3	+/-5V Range - BIAS Channel 4 (OIF Implementation: Phase; Y Polarization)
4	+/-5V Range - BIAS Channel 6 (OIF Implementation: Q Mod; Y Polarization)
5	+/-15V Range - BIAS Channel 6 P (OIF Implementation: Q Mod; Y Polarization)
6	+/-15V Range - BIAS Channel 6 N (OIF Implementation: Q Mod; Y Polarization)
7	+/-15V Range - BIAS Channel 5 P (OIF Implementation: I Mod; Y Polarization)
8	+/-15V Range - BIAS Channel 5 N (OIF Implementation: I Mod; Y Polarization)
9	+/-15V Range - BIAS Channel 3 P (OIF Implementation: Q Mod; X Polarization)
10	+/-15V Range - BIAS Channel 3 N (OIF Implementation: Q Mod; X Polarization)
11	+/-15V Range - BIAS Channel 2 P (OIF Implementation: I Mod; X Polarization)
12	+/-15V Range - BIAS Channel 2 N (OIF Implementation: I Mod; X Polarization)
13	+/-15V Range - BIAS Channel 4 P (OIF Implementation: Phase; Y Polarization)
14	+/-15V Range - BIAS Channel 4 N (OIF Implementation: Phase; Y Polarization)
15	+/-15V Range - BIAS Channel 1 P (OIF Implementation: Phase; X Polarization)
16	+/-15V Range - BIAS Channel 1 N (OIF Implementation: Phase; X Polarization)
17	Not connected
18	Photodiode 2, Anode
19	Photodiode 2, Cathode
20	+/-5V Range - BIAS Channel 3 (OIF Implementation: Q Mod; X Polarization)
21	Photodiode 1, Anode
22	Photodiode 1, Cathode
23	+/-5V Range - BIAS Channel 5 (OIF Implementation: I Mod; Y Polarization)
24	+/-5V Range - BIAS Channel 2 (OIF Implementation: I Mod; X Polarization)
25	GND

5.3 REAR PANEL

The rear panel provides the electrical power socket and communication interfaces.



The Power socket is used to power the device. Use only the supplied power supply provided with the unit.
USB is a standardized interface that can be used to connect to USB Hosts standardized by USB Implementers Forum (USB-IF). Make sure to only connect devices that are compliant to this standard.
The Ethernet interface complies to IEEE 802.3 standard. Make sure to only connect devices that are compliant to this standard.

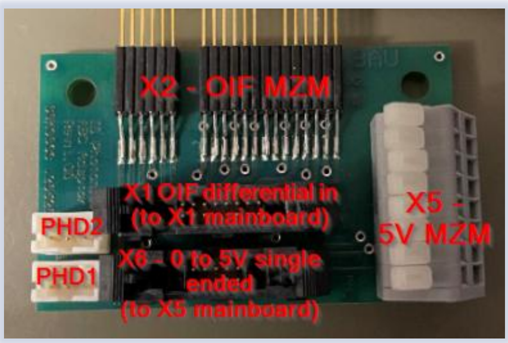
5.4 MZM CONNECTOR EXTENSION BOARD

There are 2 Versions of the extension board. Refer to the applicable part for your board at hand.

5.4.1 CONNECTORS X1, X6, X7 CONNECTORS TO MAIN UNIT

These connectors are used to connect to the main unit.
The pinning of X1, X6 and X7 (Sub-D V2 only) is identical to the pinning defined for the mainboard or benchtop device since they connect via the grey ribbon or the SUB-D jumper cable.

V1 Extension Board



V2 Extension Board

5.4.2 CONNECTOR X2 - OIF COMPATIBLE DP-IQ MZM

This board can be used if an OIF Standard compatible such as the Fujitsu FTM797xHQx series. The 100kOhm resistors located on board are switched din 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.
For this configuration, connect X1 for the MZM out signals coming from the main board.
Connect PHD2 and PHD1 Photodiode sockets to the corresponding sockets on the main board.
The MZM connector layout meets the 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 default usage is differential mode. For single ended usage, connect the corresponding P channel and GND to the electrodes of the MZM.
See section "Remote Control" for channel assignment to BIAS Electrodes.

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

5.4.3 CONNECTORS X2/3 – PHOTODIODE CONNECTORS

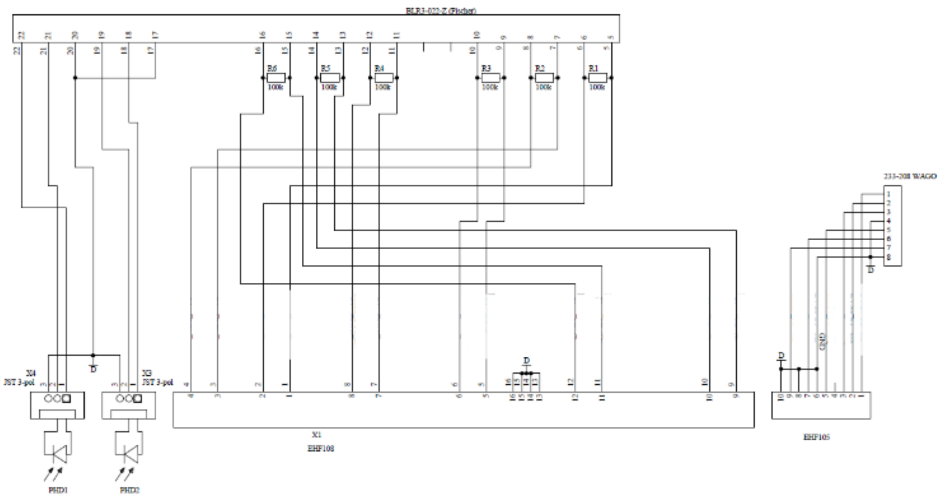
These connectors are optionally used to connect the photodiodes inside of OIF compatible MZMs connected via X2 to the main board using the supplied 3 pin jumper cables to PHD1 and PHD2 on the main board. Use these only if you want to use the MZM internal photodiodes. We recommend to use a separate photodiode for optimal performance.

5.4.4 CONNECTOR X5 - OTHER CONFIGURATIONS (GREY CONNECTOR HUB)

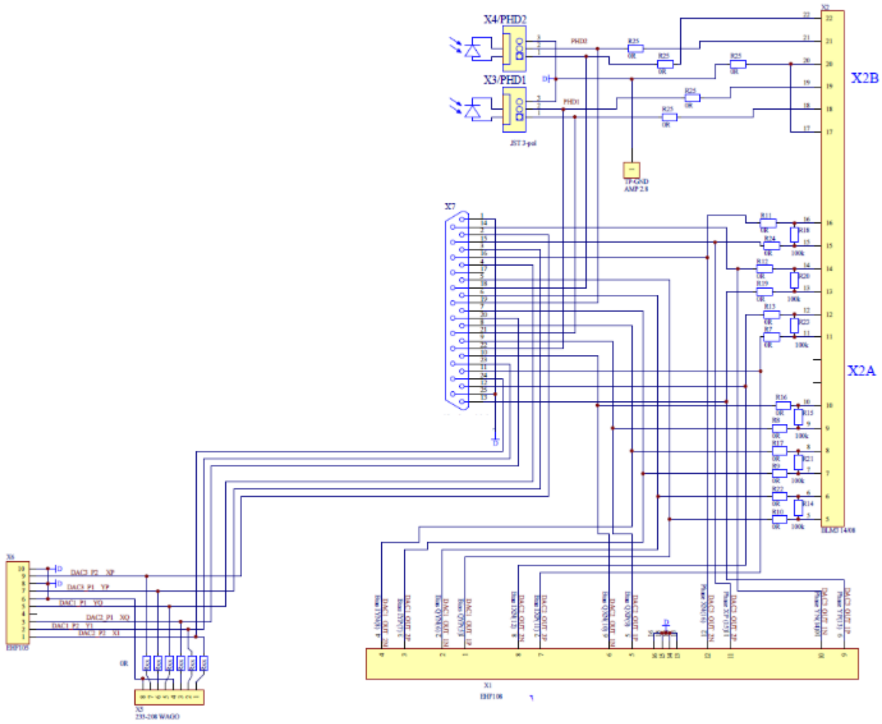
The large grey connector hub hosts the -5V to +5V output signals coming from the main board. Set the Use the X5 connection cable to use this port. Pin 1 is located to the edge of the PCB.

PIN	DESCRIPTION
1	BIAS Channel 2 (OIF Implementation: I Mod; X Polarization)
2	BIAS Channel 5 (OIF Implementation: I Mod; Y Polarization)
3	BIAS Channel 3 (OIF Implementation: Q Mod; X Polarization)
4	GND
5	BIAS Channel 6 (OIF Implementation: Q Mod; Y Polarization)
6	BIAS Channel 4 (OIF Implementation: Phase; Y Polarization)
7	BIAS Channel 1 (OIF Implementation: Phase; X Polarization)
8	GND

5.4.5 SCHEMATIC OF EXTENSION BOARD V1



5.4.6 SCHEMATIC OF EXTENSION BOARD V2



5.5 MAXIMUM BIAS RANGE

The maximum BIAS Voltage range can be limited from its hardware maximum 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.

5.5.1 DEFAULT CHANNEL ASSIGNMENT FOR DIFFERENT MZM CONFIGURATIONS

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	-	-	-

6 CONTROL LOOP

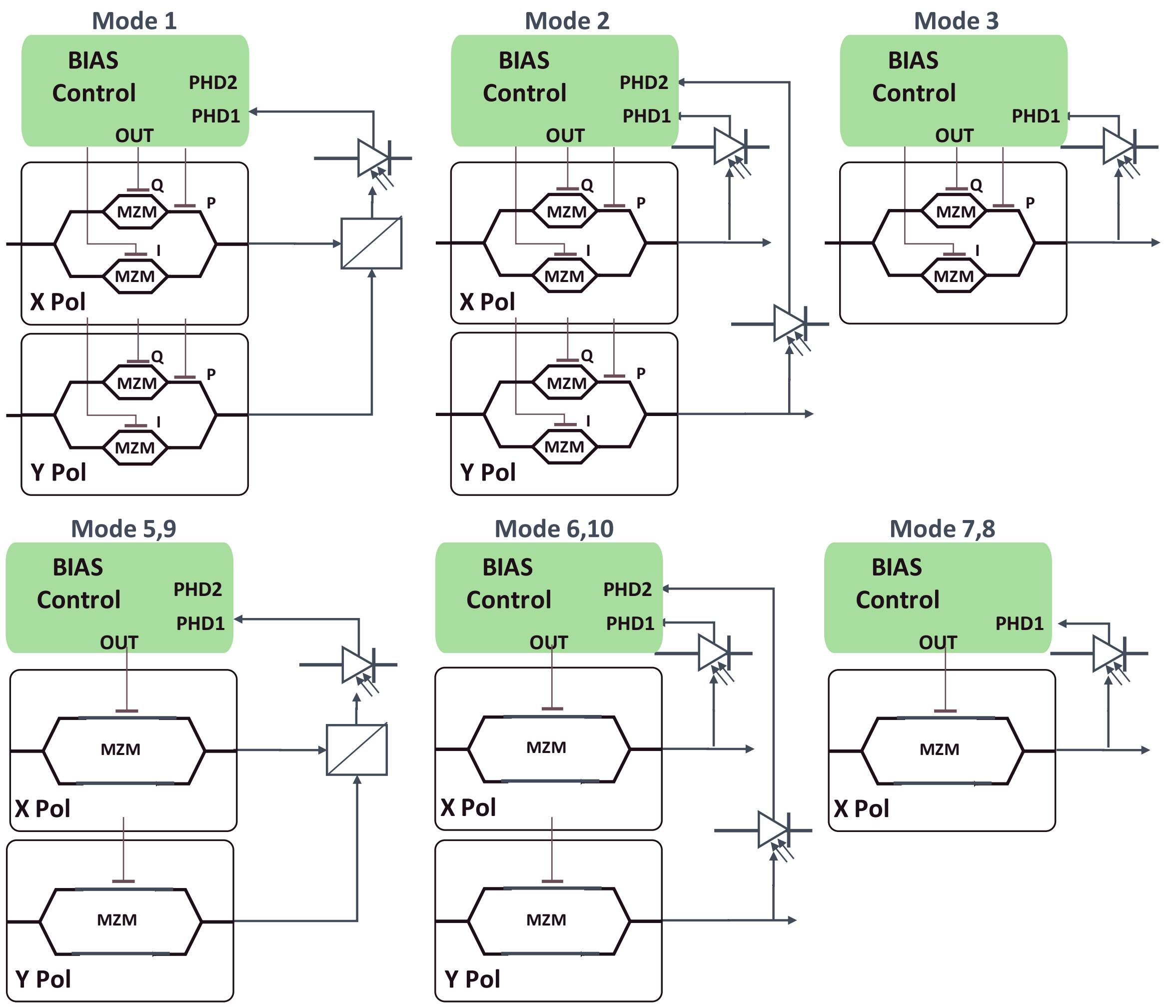
The ABC unit allows a number of configurations for various MZM configurations; see the table located in section 2.2 for an overview from application perspective. The control loop is configured either using the GUI or the SCPI command “mode”. This will set the ABC to find the target points per table below.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

6.1 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.
In case of 2 Photodiode feedback, the unit adjusts to 2 feedback channels, one for each polarization.
In case of 1 Photodiode feedback and a Dual Polarization setup, the unit requires a single photodiode that taps the signal after the Polarization MUXing stage.
Possible modes are:

MODE [3]	GUI DESCRIPTION	NUMBER OF PHOTODIODES	NUMBER OF CHANNELS USED	MZM CONTROL TARGET[4]		
				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	Do not use	-		-	-	-
5	DualPolII, 1PD	1	2	-	Quad	-
6	DualPolII, 2PD	2	2	-	Quad	-
7	SinglePolII, 1PD	1	1	-	Quad	-
8	SinglePol I Min	1	1	-	Min	-
9	DualPolII Min,1PD	1	2	-	Min	-
10	DualPolII Min,2PD	2	2	-	Min	-
11	Custom					
12	DualPolIQ Min,1PD	1	6	Min	Min	Min
13	DualPolIQ Min,2PD	2	6	Min	Min	Min
14	SinglePolIQ Min,1PD	1	3	Min	Min	Min

[3] Refer to chapter “Remote Control” for definition of the mode command.
[4] See section 2.1 for details on MZM transfer curve



6.1.1 MULTIPLE SINGLE POL MZM WITH A SINGLE ABC

6.1.1.1 SINGLE POL IQ MODULATOR

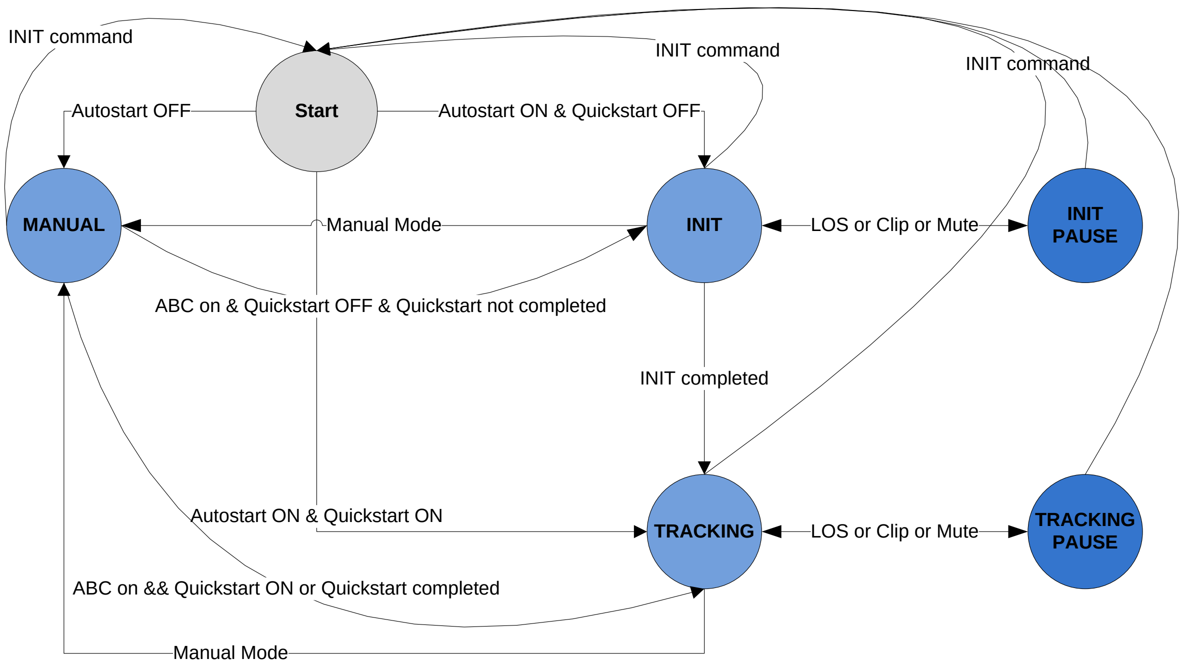
Up to 2 Modulators can be operated using a single ABC board. Configure a Dual Pol. IQ modulator and 2 Photodiodes for this case.

6.1.1.2 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.

6.2 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.

6.3 CONTROL LOOP OPTIMIZATION (FEEDBACK OFFSET)

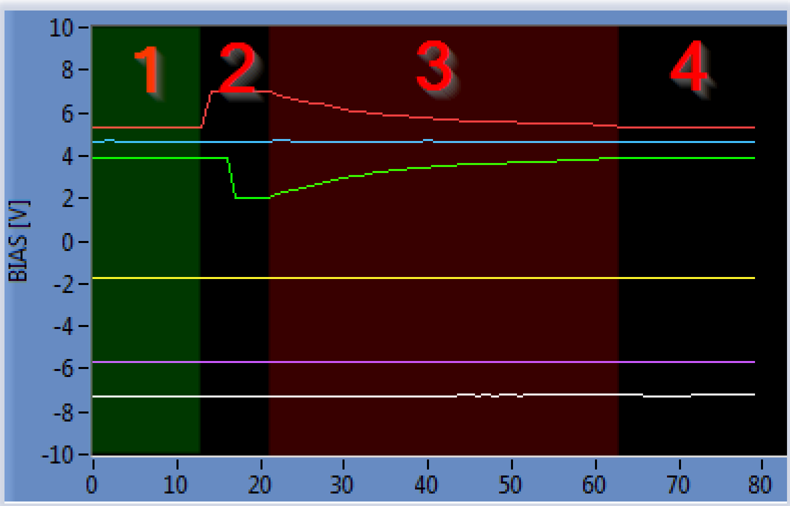
The Offset feature can be used to tune the Automated BIAS Control to achieve an optimized operating point, i. e. to improve extinction of the MZM if the BIAS control finds a suboptimal point due to i. e. feedback detector issues. It can also be used so generate non-typical MZM BIAS settings. This feature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

7 TROUBLESHOOTING AND VALIDATION

There are several scenarios that typically happen when connecting the unit to a setup. The following section describes typical issues and their fixes as well as some hints how to troubleshoot your setup.

7.1.1 GENERAL PROCEDURE

It is advisable to first test the ABC without RF modulation to be able separate issues. Use a power meter at the output of the MZM structure to validate if the unit moves close to the desired target point.
For any mode that moves the MZM to minimum transmission, the output power will naturally be minimized without RF modulation. As the ABC has a loss of signal feature (LOS), it might stop to continue to track and declare a LOS. In order to avoid that, enable the track in loss feature (GUI tab “ABC Config”) or SCPI command “`trilos 1`”. Make sure to disable the feature after completion of the test again.
For IQ structures, the inner MZM are moved to minimum transmission. Consequently, the output power should be minimal if the unit tracks properly. The phase electrodes are not tested by this scheme but typically, the issue is impacting all electrodes so that this is a good first test.
Similarly, there is no difference between a Single Polarization and Dual Polarization device. As long as the overall output power is minimized, it is a good indication that the setup is ok.
For Intensity MZMs, the output power depends on the target setting. For Quad mode, the output power should be 3dB less than the maximum transmission output power. This power can be easily determined by manually moving the BIAS point through the transfer curve.
For Min Mode, naturally, the output power should become minimal in a working feedback loop.
Besides a regular initialization and tracking sequence as described in the following section, another test can help to validate the proper operation of the feedback loop. Either move the unit manually to the target point or let the ABC do that (1).
Then, switch to manual mode and move one or more electrodes by 10-20% of VPI out of the setpoint (2). Enable the control loop again. If working properly, the unit settled indicator will turn off and you should see the control loop moving the electrodes that were offset back to the original value within a few seconds (3) and then declare settled again (4). The trace below shows are working device.



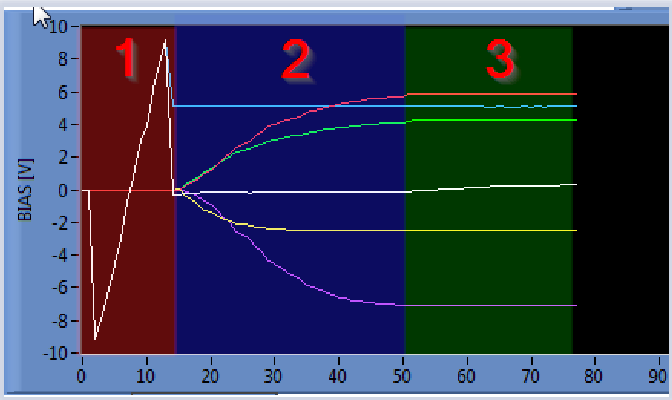
7.1.2 GOOD REFERENCE CASE

The following trace is a typical example for a regular tuning process for a DP IQ MZM. It is divided in 3 Phases.

1. Init Phase: The Phase electrodes of the IQ nested structure are swept
2. Fast Tuning Phase: The Phase electrodes are set to a good start value. The I&Q electrodes are moving fast toward the target values. As they approach it, the speed slows down. There may be a minor overshoot.

3. Tracking Phase: The settled indicator becomes green indicating that the unit is now in tracking phase. The update rate becomes smaller and, depending on MZM substrate material, the voltages will slowly drift over time as the ABC maintains the optimal operation point for the structure. There will be minimal further improvements of the setpoint over the first 2-3minutes of the phase.

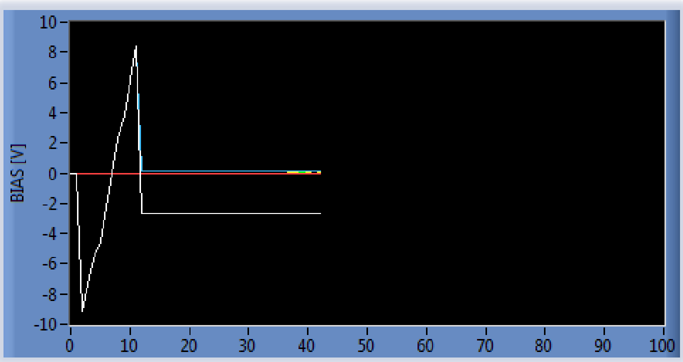
In this example, the time to enter the tracking phase took ~35seconds. The gain of the control loop depends on the feedback level provided by the optics. This feedback level depends on the laser power at the MZM, the MZM insertion loss and the coupling ratio of the Photodiode tap coupler as well as the PD responsivity.
Since the gain may be different for your setup, the speed of convergence may differ a lot.
In this example, the Laser power was +14.5dBm, intrinsic insertion loss of the MZM 8dB, the photodiodes were coupled an unused port of an internal coupler structure (no extra loss).



The shape of traces will look similar for other MZM structures.

7.1.3 MISSING OR VERY SMALL FEEDBACK

In case of missing feedback, a typical symptom is that the initial sweep is performed but then, there is virtually no move in the electrode voltages (a few Milli-Volts only) which gradually drift to the edge over a long period.
Note that in this case, the unit will declare "ABC Control loop settled" right after the init phase. This is because the unit cannot distinguish between a settled case and a missing feedback case.



The root cause for this issue is a missing feedback signal.

Possible Reasons:

- The BIAS outputs are not connected or are not connected in the correct order. Switch to manual mode and try to manually move the structure to optimal point. This helps to validate that the wiring is ok. For MZM structures, validate that the channels are connected correctly. You can also rewire the outputs via S/W using the command "chass". See remote section for details. Note that chass requires a "save current status" command to become permanent.
- The feedback photodiode(s) are not connected correctly. Check if the Percentage values in Tab "ABC Config" or the power readings change when BIAS settings are changed or when the laser power is changed. In case of 2 Feedback PDs check if they are connected in the right order. Channel PHD1 is used for X-Pol (channels 1-3), PHD2 for Y-Pol (channels 4-6).

- Check that the VPI Settings in Tab “ABC Config” are correct. Note that these are NOT the VPI values for the RF electrodes but for the BIAS electrodes. For LiNbO substrates, a typical value is 8V.

7.1.4 CONTROL LOOP IS MOVING TO THE WRONG TARGET SETTING

The trace for such an issue looks very similar to the reference case. However, i. e. for an IQ Modulator, the control tracks a maximum transmission point instead of a minimum transmission case which can be detected using a power meter (see intro to this section). Similarly, for Intensity MZMs, the setpoint is the max. transmission instead of min transmission and negative instead of positive slope or vice versa for Quad setting.
Solution: Flip the feedback direction of the control loop using “`Feedback direction`” in Tab “`ABC Config`”. Note that for nested IQ structures, it is advisable to toggle the feedback sign for all electrodes and then run the init sequence as the feedback sign and current setting of each MZM in the structure influences the other MZMs as well causing cascading jumps of the sign between the MZM BIAS points.

7.1.5 BIAS VOLTAGES ARE MOVING VERY SLOW TO TARGET POINT OR OSCILLATE

The root cause is that the gain of the feedback loop is either too small (slow movement) or to high (oscillations). The units’ parameters are set to able to work with setups as wide as possible. However, for some setups, it might be required to adapt the feedback setting.
Use the command “`ABCGain` x” to change the gain factor of the feedback loop where x is a positive number >0 . The default is 1, larger values will increase the gain and counteract too slow movements and smaller values will eliminate oscillations.

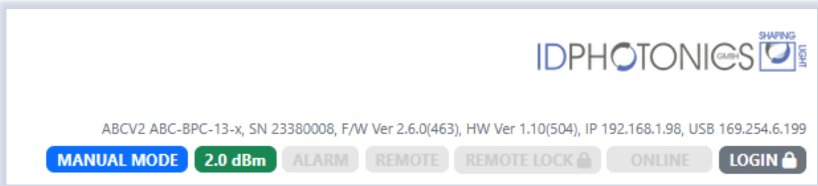
7.1.6 QUICKSTART ON

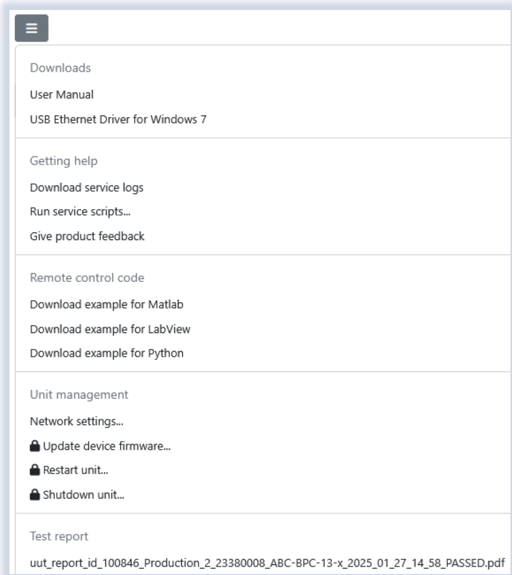
QuickStart skips the init Phase (1), see above, and should only be used if the feedback loop is working properly and a good initial working point was saved before using save current status. The typical symptom is that the initial sweep is missing.
Solution: Disable QuickStart.

8 USER INTERFACE –WEB INTERFACE (WEBGUI)

The unit can be accessed by any devices such as smartphones, PCs etc. that are able to operate a web browser. The Web Interface was tested on Windows 7, Windows 10 and Windows 11 Computers using Edge, Chrome and Firefox and iPhone/iPad using Safari browser. Note that we cannot guarantee operation in any Browser environment in general.
If connected via USB, a virtual Ethernet interface is installed on the host system so that the Web Interface based access is enabled.
To access the unit, enter "`abc.local`" or the current IP address of the unit into the address field of the browser to open the GUI. Note that DNS resolution might not work on your host PC. See section *Quick Start – Remote* Control for details on that.
All fields provide a description of their usage by tooltips when hovering the mouse arrow on them. Therefore, this manual just highlights the basic features of the tabs and sections.

8.1 HEADER BAR





On its right side, the header bar contains status indicators such as the current output power, alarm status, device mode etc., as well as the device's IDN string, which includes information such as the serial number and firmware version. Furthermore, the user has the option to log into the device.

On the header bar's left side, the user can open the main menu by clicking the burger menu icon. This menu allows the user to access resources such as the user manual related to the unit. These resources are stored locally on the device. In addition, the user can update the firmware and restart the unit from this menu.

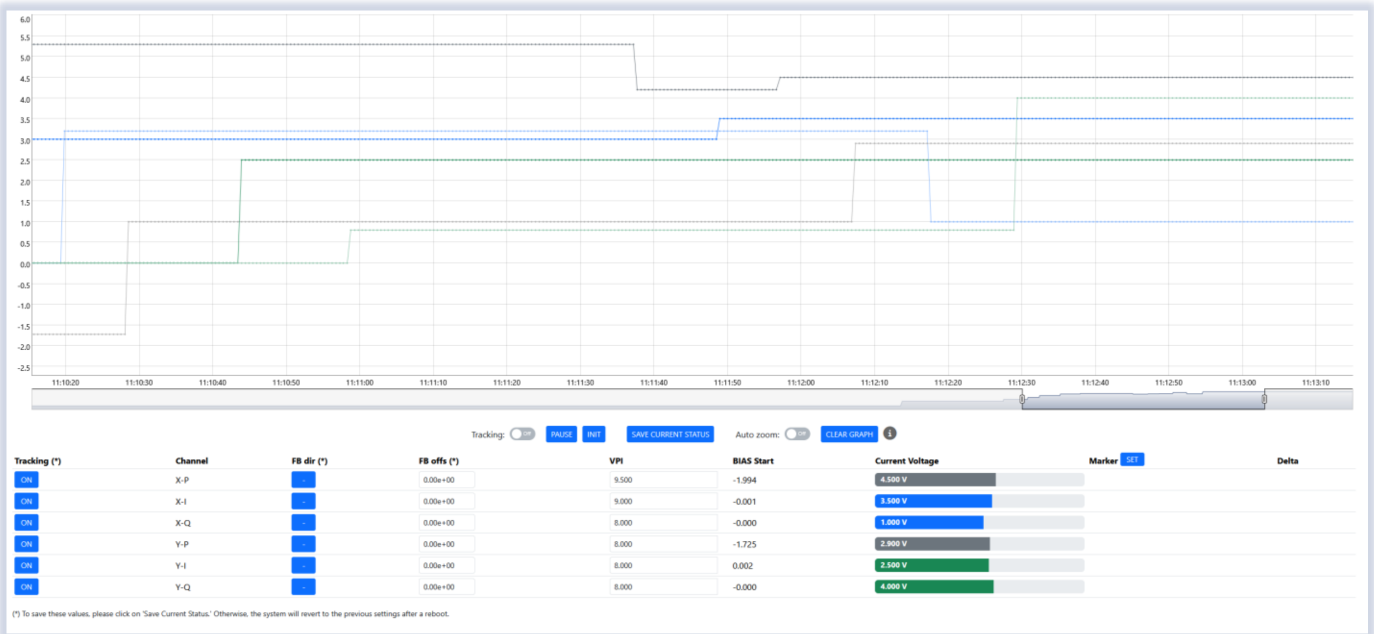
8.2 ABC CONTROL

The *ABC Control tab* is vertically divided into two sections. The upper section contains a graph that visualizes the output voltages over time. The color of each line matches the color of the corresponding output voltage shown in the lower section.

The lower section allows the user to configure the output voltages, switch between automatic and manual mode, and interact with the graph in the upper section. The following provides an overview of the most important components.

- **Tracking – Toggle Button**: switch from manual mode (off) to automatic mode (on)
- **PAUSE**: Pause automatic mode of the ABC
- **INIT**: Initialize the ABC which will change the current BIAS setting and may cause sudden optical output power changes of the MZM structure
- **SAVE CURRENT STATUS**: Save the current setting (e.g., voltages) of the device. Otherwise, the system will revert to the previous setting after a reboot.
- **Auto zoom – Toggle Button:** when activated the graph will display only the last 5 minutes
- **CLEAR GRAPH**: clears the graph data

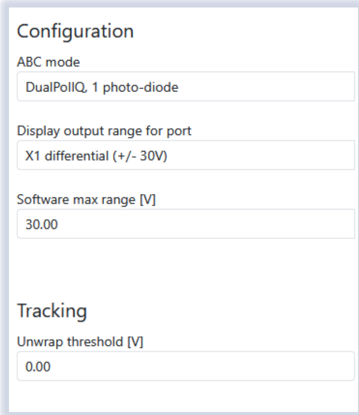
- **Tracking**: allows to switch individual channels into manual mode
- **FB Dir**: allows to invert the sign of the ABC control loops for adaption to the specific connection of user hardware to ABC unit defaults. See section *Control loop is moving to the wrong target setting* for details.
- **FB Offs**: The control loop of the corresponding channel will be offset by the value entered here. The offset value can be either positive or negative. Depending on the sign of the value, the control loop will shift the setting point in the corresponding direction. Typical offset values range from 1e+5 to 1e+6. We recommend starting with a small value while the control loop is active and observing the impact on the settling point. Gradually increase the value until the control loop tracks the desired point. If the output moves in the wrong direction, invert the sign of the offset value. Please note that the control loop may become unstable if high values are entered. ID Photonics accepts no liability for the proper operation of the unit when non-zero offset values are used, and we recommend and we recommend leaving all values at 0 unless necessary. Note that the values are stored in volatile memory only. Thus, each reset of the unit will also reset the offset values. In order to save them permanently, use the *Save Current Status* button.
- **VPI**: Sets the VPI of the MZM bias (not RF!) electrodes in volts. VPI is the voltage required to shift the MZM operating point from the minimum to the maximum transmission point (e.g., one full period). Refer to the user manual for details.
- **BIAS Start:** Provides information about the output voltage immediately after starting the device.
- **Current Voltage:** Displays the current output voltage for each channel. In manual mode, the user can click on the voltage bars and adjust the values using the arrow keys.
- **Marker:** When clicking *SET*, the current voltages of all channels are recorded. In the future, the *Delta* column to the right will display the voltage differences compared to these marked values at a later point in time.



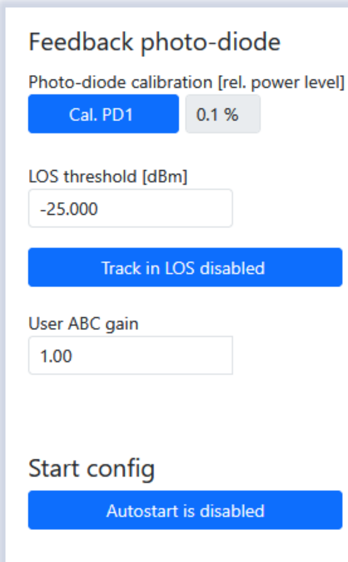
8.3 ABC CONFIGURATION

This tab is used to configure the Control loop. Some fields may be grayed out which means they can currently not be changed. Make sure to elevate the user level to 1 (default PW `IDP`) and the control loop to be in manual mode to change these.

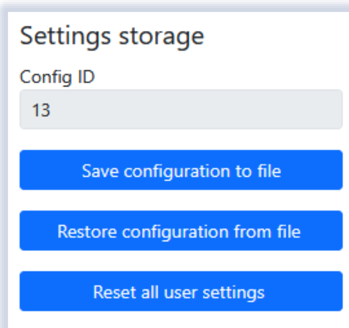
Note that some settings require to be saved via *Save current status* to be become permanent and be present after an INIT of the ABC. The following provides an overview of the most important settings.



- **ABC mode**: allows selecting the MZM configuration to be controlled by the unit
- **Display output range for port**: will change the voltage display of the GUI and SCPI queries, depending on cabling of the MZM to the ABC unit. Make sure to check the VPI setting after this change, as VPI is automatically scaled relative to the difference between the new and previous configuration.
- **Software max range**: allows to limit the available hardware output rage to a smaller range for cases where MZM hardware maximum rating is smaller than range supported by the ABC and therefore protect the hardware
- **Unwrap threshold**: The ABC will try to track the BIAS point to the limits of its output range. In order to avoid that tracking becomes impossible because the limit is reached. Setting a nonzero value will unwind the current setting to the next period of the MZM transfer curve and continue to track there if the set difference between the minimum or maximum available range and the set threshold is exceeded. Note that there will be a transitory time when the switching occurs. For a setting of 0V, the feature is disabled.
- **Feedback photo-diode**: displays the DC level photocurrent at detector in percent of maximum value if no calibration has yet been performed. There is internal gain switching so that the value is not linear across all powers present at the feedback photodiode. If *Cal PDx* is pressed, a popup is opened. Enter the current optical power present at the feedback monitor measured with an external Optical Power Meter. After the value was entered, the values will switch to “dBm”. For benchtop units with integrated photodiode feedback receiver, this has been calibrated during manufacturing process already. The number of displayed photodiodes depends on the selected ABC mode. In case of two integrated photodiodes used in a MZM, it may not be possible to properly calibrate the optical power of each PD as the port is physically inaccessible.



- **LOS threshold**: This is the threshold below which the ABC pauses tracking, as no feedback value can be generated. This feature is only active if the photodiode power has been calibrated beforehand, as described above. The number of displayed values depends on the selected ABC mode.
- **Track in LOS disabled**: The ABC will continue to track regardless of the loss of signal condition (LOS). This feature requires user level 1 or higher.
- **User ABC gain**: changes the ABC feedback control loop’s gain factor. Values bigger than 1 will increase the gain and will improve the speed but can cause oscillations. Values between 0 and 1 will decrease the gain to eliminate oscillations. The Default value is 1.
- **Start Config**: En- or disables the automatic start of the ABC loops upon startup of the ABC unit.

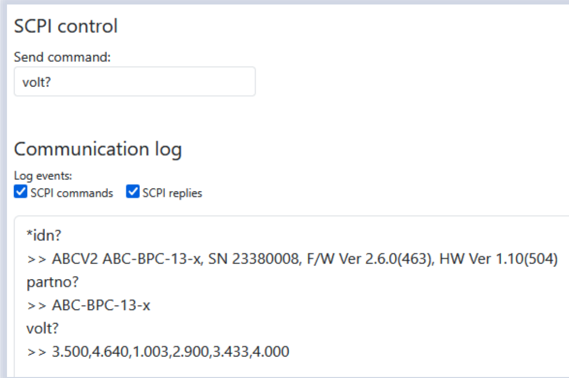


8.4 SYSTEM

This tab displays the current unit configuration number, which increments each time the unit configuration is changed. In addition, the user can store all system settings to a file or, conversely, restore system settings from a file. Restoring system settings from a file requires manual mode. The user also has the option to reset all user settings to factory defaults.

8.5 SCPI CONTROL

This tab enables the user to communicate with the device via SCPI. The responses will be displayed in a popup window. Also, the user has the option to log the SCPI commands used and their responses. Note that some SCPI commands require user level 1.
For more detailed information about SCPI commands, please refer to chapter *section General SCPI Commands* and the following sections.



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: https://www.ivifoundation.org/downloads/SCPI/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 interface 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 or applied to the laser control. Note that it is recommend to use the query “`busy?`” to determine if a laser port is still tuning as the “`*opc?`” query will only tell if the corresponding change of configuration has been triggered but might not be completed.

9.2 QUERY CONNECTION TYPES

Connections to remote control the unit via SCPI can be made either by using telnet protocol on port 2000 or HTTP queries. While for performance reasons, telnet-based access should be preferred, HTTP based access can be used in installations where Port 2000 is blocked by Network firewalls or routers since HTTP uses Port 80 which is open in most networks.

9.2.1 TELNET BASED

Connections made with the device can be session based by a raw terminal connection (see 4.1.2) using Port 2000 for Ethernet or a COM Port session (see 4.2.1.3).
Connections through HTTP Service (Port 80). In this case, the SCPI command is encapsulated in the following http request:

http://<ABC IP>/scpi/<SCPI-Command>

9.2.2 HTTP BASED

Example: `http://abc.local/scpi/*idn?` queries the identification string of the unit. For a quick test, simply copy this query into the browser address field.
The ASCII encoded response is identical to the session-based response.
<wsp> characters defined in the SCPI definitions are to be replaced with ASCII string “%20” per HTML code standard requirements. No termination character “;” or <CR> is needed for HTTP based access.

Multiple commands can be sent within a single query by means of separation via the termination character “;”

Example: `http://abc.local/scpi/*idn?;lay?`

Note that this connection type is not session based like the terminal connection. So, each query sent will establish a new session which is terminated after the query response is given. Consequently, commands requiring elevated user rights will require to send the password with the actual query in the same request.
Example: `http://abc.local/scpi/pass%20IDP;pass?`
will send the password "IDP" to the unit to elevate the user level.

9.3 SYNTAX CONVENTIONS FOR COMMANDS

9.3.1 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 in one command, other abbreviations are not permissible.
Example: "`:SYStem:IPADDRess?`" is equal to "`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.

9.3.2 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.

9.3.3 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 ",".

9.3.4 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).

9.3.5 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.

NOTE

Sending two termination characters is a common mistake causing the unit to respond with "ERR 100;" since the first command is executed once the first termination character is received and the second termination character causes the unit to interpret an empty command. Example:
Command: "`mode 1;`<CR>"
Response ";<CR>`ERR 100, unknown command;`"

The unit will set wavelength 1550nm to port 1,1,1 but additionally receives the empty command which causes the error response.

9.3.6 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.

9.3.7 COMMUNICATION EXAMPLE

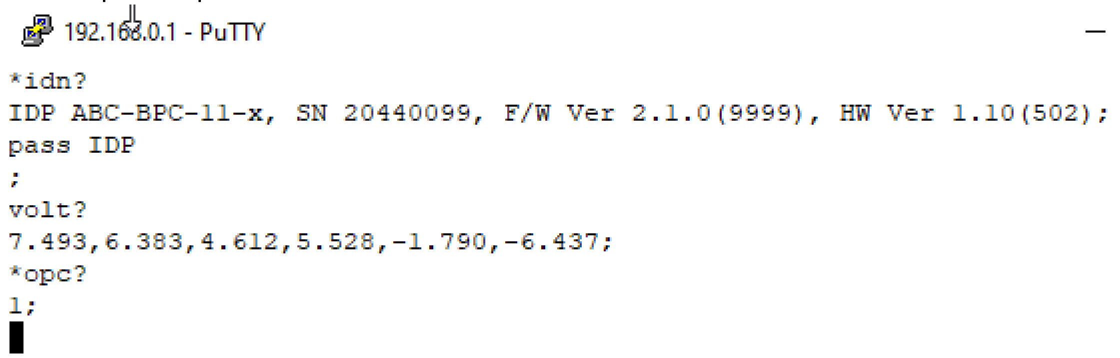
Host sends: `*idn?;`
unit response: `IDP-ABC-BPC-11-x, SN 19160001, F/W Ver 1.0.0(101), HW Ver 1.10(502);`

9.3.8 BASIC SCRIPT EXAMPLE

The following commands can be a minimal script to perform a basic set up of the unit and read the data

COMMAND	COMMENT
`*IDN?;`	Query idn string of unit
`PASS IDP;`	Raise user level to 1
`VOLT?;`	Get current BIAS Voltages
`*opc?;`	Queries if command has been executed (status 1).

Screenshot of script example result:



<ENTER> was used to execute the command. Alternatively, use ";". If both termination characters are used, it is interpreted as 2 commands of which the second one is empty so that the first command is executed but the second produces an error since empty.

9.4 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.
Custom passwords can be set to the unit for enhanced security requirements. See details in description for "`[:SYStem:]SetPASS<wsp>,<P>,<P>`".

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

9.5 NOTATION OF SYNTAX FOR COMMAND DEFINITION

SYNTAX AND TYPE	DESCRIPTION
[ ]	An optional command level that can be omitted. For example [:SYStem:]IPADDRess? allows sending the command IPADDR?.
<P>	Denotes a parameter. The placeholder is replaced with the parameter value defined for the corresponding command. For example, the definition [:SYStem:]IPADDRess<WSP><P> allows setting parameters such as [:SYStem:]IPADDRess 192.168.0.1.
/<P>	Denotes an optional parameter.
:, *	A leading colon (':') instructs the instrument to interpret the command from the root (highest level) of the command tree. However, since the instrument starts at the root each time a new command is sent, the leading colon is optional. The instrument will accept it if included, but it is not required.
<WSP>	Denominates a white space character.
<INT>	Denominates an integer value.
<FLOAT>	Denominates a float value.
Read/Write (R/W)	Provides information on whether the command reads or writes data.
User Access Level (UAL)	Specifies the User Access Level required to execute the command. It can be either 0 or 1. The password for access level 1 is 'IDP'.
Storage Behavior (SB)	Indicates whether the setting set by the command is saved permanently. Possible values are 0, 1, and 2. 0: Setting is not saved permanently. Any user setting is discarded after reboot. The unit will start with factory defaults upon restart. 1: Setting is saved only after sending command SaveCurrSTATe. The unit will start with this saved setting upon restart. 2: If STArtDEFault is set to 0, this setting is saved immediately upon executing the command. The unit will start with this last setting set by user upon restart. If STArtDEFault is set to 1, the behavior is identical to SB = 0.
Manual Mode (MM)	Indicates whether Manual Mode is required to execute the command. x: Manual Mode is required; –: Manual Mode is not required.

9.5.1 CONVENTIONS FOR WRITING TO MULTI-CHANNEL OUTPUTS

For read queries issued to a multi-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 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 CHANNEL ASSIGNMENT INDEX TO BIAS ELECTRODE TYPE FOR SCPI

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
<CH>	This parameter represents the channel. Possible values are {1;2;3;4;5;6}. When used in a query that reads data, the <CH> paramter is optional. If it is omitted, the results for all four ports are shown. Variant 1: Query: FOFFset? 1 -> Response: 0.00e+00; (The current offset value of channel 1 is 0) ; Variant 2: Query: FOFFset? -> Response: 0.00e+00,0.00e+00,0.00e+00,0.00e+00,0.00e+00,0.00e+00; (The current offset values of all six channels are 0). In the following examples, we will always use Variant 1.				

9.7 GENERAL SCPI COMMANDS

SYNTAX
`*IDN?`
Queries system type and software version. The second section is the part number that is determined by the laser configuration of the actual device and matches the part number printed on the unit's label. The commencing sections include the software version installed and hardware version. **Response Type:** `STR e.g.: ABC: ABCV2 ABC-BPC-14-x, SN 23380008, F/W Ver 2.5.2(376), HW Ver 1.10(504)` **Example:** `*IDN?`
`*OPC?`
Queries whether all pending commands have been executed. Note that this does NOT indicate whether the physical tuning of laser ports has been completed. Use the busy? query for this. **Response Type:** `INT {0;1}`

SYNTAX
Example: `*OPC?`
`*WAIt`
Unit waits to response until *opc? returns 1 and then acknowledges the command. This eliminates the need for a polling loop of *opc? on the remote side. **Example:** `*WAI`
`*RST`
Resets the controller, which will perform a warm start of the instrument. All connections and sessions will be closed. Requires user level 1. **Example:** `*RST`
`*CLS`
Clears all status and alarm registers of the unit. This command is used to clear latched alarm registers. **Example:** `*CLS`

9.8 COMMANDS ON SYSTEM LEVEL

SYNTAX	R/W	UAL	SB	MM
`[:SYStem:]INFOrmation?`	R	0	0	-
Queries system type and software version. The second section is the part number that is determined by the laser configuration of the actual device and matches the part number printed on the unit's label. The commencing sections include the software version installed and hardware version. This command is equivalent to the *idn? command. **Response Type:** `STR e.g.: ABC: ABCV2 ABC-BPC-14-x, SN 23380008, F/W Ver 2.5.2(376), HW Ver 1.10(504)` **Example:** `INFO?`				
`:SYStem:RESet`	W	1	0	-
Resets the controller, which will perform a warm start of the instrument. All connections and sessions will be closed. Requires user level 1. This command is equivalent to the *rst command. **Example:** `:SYS:RES`				
`[:SYStem:]ECHO?`	R	0	0	-
Queries the echo command's sent status. This setting applies to the current session only. **Response Type:** `INT {0;1}` **Example:** `ECHO?`				
`[:SYStem:]ECHO<WSP><P>`	W	0	0	-
Sets the echo command's sent status. This setting applies to the current session only. **Parameter Type:** `INT {0;1}`				

SYNTAX	R/W	UAL	SB	MM
Example: `ECHO 0`				
`[:SYStem:]FACtoryDEFault`	W	1	0	x
Resets all parameters saved by SCSTAT back to Factory defaults. **Example:** `FACDEF`				
`[:SYStem:]REMOte?`	R	0	0	-
Queries the remote status of the device and checks for any open remote sessions via Ethernet. **Response Type:** `INT {0;1}` **Example:** `REMO?`				
`[:SYStem:]PASSword?`	R	0	0	-
Queries the current user level status. **Response Type:** `INT {0;1}` **Example:** `PASS?`				
`[:SYStem:]PASSword<WSP><P>`	W	0	0	-
Sets a new user level status for this session by sending a password. **Parameter Type:** `STR` **Example:** `PASS IDP`				
`[:SYStem:]SetPASSword<WSP><P>`	W	1	1	-
Sets a password to access the current user level. The current user level must match the level for which the password is being set. The parameter is a string defining the password. **Parameter Type:** `STR` **Example:** `SPASS IDP`				
`[:SYStem:]INTerfaceInit`	W	0	0	-
Resets session parameters to their defaults. Call this after opening the remote port. This command resets ECHO, PASS, FORMAT, unit:X, LINLOG and EVENT. **Example:** `INTI`				
`[:SYStem:]TIME?`	R	0	0	-
Queries the system time. Note that the time is stored in volatile memory only and must be set after each cold start. **Response Type:** `INT {0;1;...;2147483647}` **Example:** `TIME?`				
`[:SYStem:]TIME<WSP><P>`	W	0	0	-
Sets the system time. Note that the time is stored in volatile memory only and must be set after each cold start. **Parameter Type:** `INT {0;1;...;2147483647}` **Example:** `TIME 946685651`				

<table>
<tr><th>SYNTAX</th><th>R/W</th><th>UAL</th><th>SB</th><th>MM</th></tr>
<tr><td>[:SYStem:]ALARm?</td><td>R</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Queries the alarm status of device. See the “Alarm code definition” section for details.
Response Type: INT {0;1;...;65535}
Example: ALAR?</td></tr>
<tr><td>[:SYStem:]ERRor[:NEXT]?</td><td>R</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Queries data from the error queue and deletes it.
Example: ERR?</td></tr>
<tr><td>[:SYStem:]FAN?</td><td>R</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Queries the chassis fan level as a percentage of the maximum level, if a fan is present in the chassis.
Example: FAN?</td></tr>
<tr><td>[:SYStem:COMMunicate:]LOCKout?</td><td>R</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Checks if other sessions are allowed to execute write commands on the unit.
Response Type: INT {0;1}
Example: LOCK?</td></tr>
<tr><td>[:SYStem:COMMunicate:]LOCKout<WSP><P></td><td>W</td><td>1</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Locks other sessions from performing write commands on the unit. The lock is automatically released if the active session closes.
Parameter Type: INT {0;1}
Example: LOCK 0</td></tr>
<tr><td>[:SYStem:COMMunicate:]ParameterREFresh?</td><td>R</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">This query detects any changes made to the unit configuration. Each time the counter increases, it indicates a configuration change. This is useful in multi-user environments to determine if a parallel session has modified the unit's settings.
Response Type: INT {0;1;...;2147483647}
Example: PREF?</td></tr>
<tr><td>[:]ABORt</td><td>W</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Aborts all currently executing pending commands as quickly as possible. Query *OPC? to determine the status once all pending commands have been aborted.
Example: ABOR</td></tr>
<tr><td>[:SYStem:]IDENTify<WSP><P></td><td>W</td><td>0</td><td>0</td><td>-</td></tr>
<tr><td colspan="5">Enables or disables blinking on the unit, allowing identification of the unit controlled by this remote session. This is helpful for installations with multiple ABC units.
Parameter Type: INT {0;1}
Example: IDENT 0</td></tr>
<tr><td>[:SCRIPTing:]WAITMilliSeconds<WSP><P></td><td>W</td><td>0</td><td>0</td><td>-</td></tr>
</table>

SYNTAX	R/W	UAL	SB	MM
This command causes the unit to wait for specified time until the next command in buffer is executed. This is helpful if a batch of commands is uploaded to the unit for execution. Requires Firmware Version 1.2.1 or later **Parameter Type:** `INT {0;1;...;60000}` **Example:** `WAITMS 100`				
`[:SYStem:]LAYout?`	R	0	0	-
Queries the chassis configuration. The response includes the chassis type and lists the installed slots along with the corresponding number of lasers. **Example:** `LAY?`				
`[:SYStem:]INTLock?`	R	0	0	-
Queries the status of the interlock setting. The optical output of lasers can only be enabled if the interlock jumper is set. A response of 0 indicates that the laser can be activated. **Response Type:** `INT {0;1}` **Example:** `INTL?`				
`[:SYStem:]CARD:INFOrmation?<WSP><C>,<S>`	R	0	0	-
Queries card-level information. The response is identical to the *IDN? query. **Example:** `CARD:INFO? 1,1`				
`[:SYStem:]ENABleAUTOSTArt?`	R	1	0	-
Queries whether the laser port on/off status is saved and applied upon reboot. **Response Type:** `INT {0;1}` **Example:** `ENABAUTOSTA?`				
`[:SYStem:]ENABleAUTOSTArt<WSP><P>`	W	1	1	-
Enables or disables whether the laser port on/off status is saved and applied upon reboot. **Parameter Type:** `INT {0;1}` **Example:** `ENABAUTOSTA 0`				
`[:SYStem:]OUTputRANGEselect?`	R	0	0	-
Queries the scaling of output BIAS values in the VOLT command. 0: X5 (0 - +5V) ; 1: X1 single-ended (+/-15V) ; 2: X1 differential (+/-30V) ; 3: X5 (+/- 5V) **Response Type:** `INT {0;1;2;3}` **Example:** `OUTRANGE?`				
`[:SYStem:]OUTputRANGEselect<WSP><P>`	W	1	1	x
Scaling of output BIAS values in the VOLT command. 0: X5 (0 - +5V) ; 1: X1 single-ended (+/-15V) ; 2: X1 differential (+/-30V) ; 3: X5 (+/- 5V) **Parameter Type:** `INT {0;1;2;3}` **Example:** `OUTRANGE 0`				
`[:SYStem:]CSTATus?`	R	0	0	-

SYNTAX	R/W	UAL	SB	MM
Queries the current state of BIAS Control. **Response Type:** `STR` **Example:** `CSTAT?`				
`[:SYStem:]LOSThresh?<WSP>/<CH>`	R	0	0	-
This queries 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. **Example:** `LOST? 1`				

9.9 BIAS CONTROL COMMANDS

SYNTAX	R/W	UAL	SB	MM
`[:BIAS:]AUToSTart?`	R	0	0	-
0: Bias Control will remain in Manual mode after startup. 1: Bias Control will automatically run INIT and continue in TRACKING state. **Response Type:** `INT {0;1}` **Example:** `AUTST?`				
`[:BIAS:]QuickSTArt?`	R	0	0	-
Skips INIT state after startup. This option is only recommended if a settled state was saved previously via SCSTAT command. States 1 and 2 are identical. **Response Type:** `INT {0;1;2}` **Example:** `QSTA?`				
`[:BIAS:]SETTled?`	R	0	0	-
Indicates whether automatic BIAS control has settled (only in TRACKING mode). **Response Type:** `INT {0;1}` **Example:** `SETT?`				
`[:BIAS:]VPI?<WSP>/<CH>`	R	1	0	-
Queries VPI of BIAS Electrodes. Note: Changing these parameters will impact the performance of the automated control loop. See section "Conventions for writing to Multi-Channel Outputs" for details on the parameter convention. **Response Type:** `FLOAT [V]` **Example:** `VPI? 1`				
`[:BIAS:]INIT?`	R	0	0	-
Set VPI of BIAS Electrodes. Note: Changing these parameters will impact the performance of the automated control loop. See section "Conventions for writing to Multi-Channel Outputs" for details on the parameter convention. Indicates whether control loop is currently in initialization phase. 1: Init active 0: No Init in progress				

SYNTAX	R/W	UAL	SB	MM
Response Type: `INT {1;2;...;6},FLOAT [-,V]` **Example:** `INIT?`				
[:BIAS:]INIT	W	0	0	-
Will trigger the initialization routine. 1: Init active 0: No Init in progress **Example:** `INIT`				
[:BIAS:]MODE?	R	0	0	-
Queries current MZM configuration. 1=DPIQ(1),2=DPIQ(2), 3=SPIQ(1), 5=DPII(1), 6=DPII(2), 7=SPII(1), 8=SPIIMin(1), 9=DPIIMin(1), 10=DPIIMin(2), 11=custom,12=DPIQMin(1),13=DPIQMin(2), 14=SPIQMin(1); Number in brackets denotes the number of feedback photodiodes. See chapter “BIAS Control Loop state machine” for details. **Response Type:** `INT {1;2;...;14}` **Example:** `MODE?`				
[:BIAS:]MODE<WSP><P>	W	1	0	x
Sets current MZM configuration. 1=DPIQ(1),2=DPIQ(2), 3=SPIQ(1), 5=DPII(1), 6=DPII(2), 7=SPII(1), 8=SPIIMin(1), 9=DPIIMin(1), 10=DPIIMin(2), 11=custom,12=DPIQMin(1),13=DPIQMin(2), 14=SPIQMin(1); Number in brackets denotes the number of feedback photodiodes. See chapter “BIAS Control Loop state machine” for details. **Parameter Type:** `{1;2;...;14}` **Example:** `MODE 1`				
[:BIAS:]VOLTage?<WSP>/<CH>	R	0	0	-
Query current BIAS voltages. Response will be all 6 BIAS Voltages without Channel ID. See section “Conventions for writing to Multi-Channel Outputs” for details on the parameter convention. **Response Type:** `FLOAT,FLOAT,FLOAT,FLOAT,FLOAT,FLOAT [V]` **Example:** `VOLT? 1`				
[:BIAS:]VOLTage<WSP><CH><P>	W	0	0	-
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. See section “Conventions for writing to Multi-Channel Outputs” for details on the parameter convention. **Parameter Type:** `INT {1;2;...;6},FLOAT [-,V]` **Example:** `VOLT 1,5.365`				
[:BIAS:]FOFFset?<WSP>/<CH>	R	0	0	-
Queries the current offset value. Response will be all 6 feedback offsets without Channel ID. See section “Conventions for writing to Multi-Channel Outputs” for details on the parameter convention. **Response Type:** `FLOAT,FLOAT,FLOAT,FLOAT,FLOAT,FLOAT [dB]` **Example:** `FOFF? 1`				
[:BIAS:]FeedBackDIRection?<WSP>/<CH>	R	0	0	-
Query control loop direction. Response will be 6 Feedback directions without Channel ID. See section “Conventions for writing to Multi-Channel Outputs” for details on the parameter convention.				

SYNTAX	R/W	UAL	SB	MM
Response Type: `INT,INT,INT,INT,INT,INT {-1,1}` **Example:** `FBDIR? 1`				
`[:BIAS:]CHannelACTive?<WSP>/<CH>`	R	0	0	-
Queries Control loop for the channel, which can be either active or inactive. **Response Type:** `INT,INT,INT,INT,INT,INT {0;1}` **Example:** `CHACT? 1`				
`[:BIAS:]CHannelASSign?<WSP>/<CH>`	R	0	0	-
Assignment of control loop channel to H/W channel. See section “Conventions for writing to Multi-Channel Outputs” for details on the parameter convention. **Response Type:** `INT,INT,INT,INT,INT,INT {1;2;...;6}` **Example:** `CHASS? 1`				
`[:BIAS:]CHannelASSign<WSP><CH><P>`	W	0	0	x
Will set control loop channel assignment to different H/W Channel Example: CHASS 1,4; Will assign logical output 1 to Hardware channel 4, logical output 1 is then left unused (0) See section “Conventions for writing to Multi-Channel Outputs” for details on the parameter convention. **Parameter Type:** `INT{1;2;...;6}` **Example:** `CHASS 1,1`				
`[:BIAS:]STAtusVOLTage?<WSP>/<CH>`	R	0	0	-
Queries if any BIAS Voltage is 5% or less to maximum or minimum. **Response Type:** `INT {0;1}` **Example:** `STAVOLT? 1`				
`[:BIAS:]CONTrol?`	R	0	0	-
Queries status of automated BIAS Control. 1: Control Active 0: Manual Mode Active **Response Type:** `INT {0;1}` **Example:** `CONT?`				
`[:BIAS:]CONTrol<WSP><P>`	W	0	0	-
Sets status of automated BIAS Control. 1: Control Active 0: Manual Mode Active **Parameter Type:** `INT {0;1}` **Example:** `CONT 0`				
`[:BIAS:]OPOWer?<WSP>/<CH>`	R	0	0	-
Queries 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. **Response Type:** `FLOAT [dBm]` **Example:** `OPOW? 1`				
`[:BIAS:]MONPower?<WSP>/<CH>`	R	0	0	-

SYNTAX	R/W	UAL	SB	MM
Queries 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 channel. i.e. OPOW? 1; reads the optical power of feedback channel 1. **Example:** `MONP? 1`				
`[:BIAS:]MUTE?`	R	0	0	-
Queries 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 **Response Type:** `INT {0;1}` **Example:** `MUTE?`				
`[:BIAS:]MUTE<WSP><P>`	W	0	0	-
Sets 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 **Parameter Type:** `INT {0;1}` **Example:** `MUTE 0`				
`[:BIAS:]LOSStatus?`	R	0	0	-
Queries 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. **Response Type:** `INT {0;1}` **Example:** `LOSS?`				
`[:BIAS:]MAXRange?`	R	1	0	-
Queries maximum Voltage applied to BIAS electrodes in [V]. 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. **Response Type:** `FLOAT {0;...;48} [ V]` **Example:** `MAXR?`				
`[:BIAS:]MAXRange<WSP><P>`	W	1	0	x
Sets 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. **Parameter Type:** `FLOAT {0;...;48}` **Example:** `MAXR 0`				
`[:BIAS:]HWMAXRange?`	R	1	0	-
Queries Voltage setting of HARDWARE. This is the maximum Voltage range addressable by the hardware in [V]. This value can be 12,24 or 48V. This value is automatically set by the S/W, following HWMAXRange > MAXRange. **Response Type:** `INT {12;24;48} [V]` **Example:** `HWMAXR?`				

SYNTAX	R/W	UAL	SB	MM
[:BIAS:]TRackInLOS?	R	1	0	-
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). **Response Type:** `INT {0;1}` **Example:** `TRILOS?`				
[:BIAS:]TRackInLOS<WSP><P>	W	1	0	-
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). **Parameter Type:** `INT {0;1}` **Example:** `TRILOS 0`				
[:BIAS:]UNWrapThresh?	R	0	0	-
(Firmware 1.5.1 or later) Will set set threshold at which unwrap of BIAS electrodes is triggered. **Response Type:** `FLOAT {0;100}` **Example:** `UNWT?`				

9.10 SCPI CODE ERROR DEFINITION

ERROR #	DESCRIPTION
100	Invalid SCPI Command: i.e. wrong parameter, parameter out of range or device is incompatible.
102	Invalid SCPI Command due to an illegal parameter.
200	Occurs when the SCPI command cannot be executed due to settings or the current system state; so far, this only occurs with 'SOAONOFF 1' when the laser is not switched on.
201	Occurs if the SCPI authentication level (= user access level / UAL) is insufficient for the command (i.e., the required 'pass xxx' is missing).
202	Occurs when the internal command queue overflows.
204	Occurs when VPISearch or offset measurement cannot be completed.
205	Occurs when VPISearch or offset measurement cannot be completed.
206	Occurs when VPISearch or offset measurement cannot be completed.
207	Occurs if 'Lock' is set using the LOCK command.
208	Occurs when a command requires MANUAL_MODE, but the system is in a different mode.
224	Error during the offset measurement.

ERROR #	DESCRIPTION
225	Occurs when an OMFT-specific command is to be executed on an ABC device.
226	Occurs if CDM is not available or shut down.
227	Occurs when a Class 80G module is required but a different module is installed.

9.11 ALARM CODE DEFINITION

BIT #	ALARM	CONDITION/DESCRIPTION
0	BIAS Value at limit	The BIAS settings of modulator are close to limit.
1	Init error	The initialization of Automatic BIAS Control failed.
2	Feedback signal warning	The feedback for Automatic BIAS Control failed.
3	Gain error, feedback signal too low or too large	The gain of the feedback circuit for the Automatic BIAS Control failed.
4	generic Fault	A general error occurred.
5	H/W error	A hardware related error occurred.
6	Reserved	
7	DC signal warning	The photocurrent of the Automatic BIAS Control feedback is high. This alarm occurs only if no LOS is present.
8	Input Signal warning PHD1	The photocurrent of the Automatic BIAS Control feedback 1 is high.
9	Input Signal warning PHD2	The photocurrent of the Automatic BIAS Control feedback 2 is high.
10	Start Init search failed	The start procedure of the Automatic BIAS Control failed.
11	FB Fail	The feedback for the Automatic BIAS Control failed.
12	Laser Fail	Due to a laser failure.
13	IQMOD Failure	Due to a modulator failure.
14	Reserved	
15	Reserved	

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