MODULATOR BIAS CONTROLLER
MBC-DG-BOARD

USER MANUAL

Version 1.0

iXblue S.A.S.
Photonic Solutions Business Unit
3, rue Sophie Germain, TEMIS
25000 Besançon, France

T. : +33 3 81 85 31 80
F. : +33 3 81 85 15 57
www.photonics.ixblue.com

Société par Actions Simplifiée au capital de 11 366 319 €
R.C.S. Versailles 433 185 121 - SIRET 433 185 121 00137
Code APE 2651B - N° TVA Intra. FR 09 433 185 121

Legal Notice

Disclaimers

No warranties : This documentation is provided « as is » without any express or implied warranty of any kind.

Limitation of Liability : Photline does not assume any liability arising out of the application or use of any products, or software described herein. In no event shall Photline be liable for any damage whatsoever (including, without limitation, consequential or incidental damages, damages for lot of profits, or otherwise) arising out of the use of the information provided in this documentation.

The contents of this publication have been carefully checked for accuracy. However, Photline makes no warranty as to the completeness, correctness, or accuracy of the information contained within this documentation. In the interest of continued product improvement, Photline further reserves the right to make any change in any products describers herein without notice. This publication is subject to change without notice.

About this Manual

Purpose

The purpose of this instruction manual is to explain how to set up the MBC-DG-BOARD and to utilize the various features of the product.

Audience

This manual is designed to professionals with the necessary technical background and prerequisites needed to use fiber optics components, including Mach-Zehnder lithium niobate modulators, and the related test equipments and accessories.

Prerequisites

Reader is assumed to be familiar with fiber optics technology.

Terms and Symbols in this Manual

The following terms and symbols may appear throughout this manual :

WARNING : Warning statement identify conditions or practices that could result in injury or loss of life

CAUTION : Caution statement identify conditions or practices that could result in damage to this product or other property

Electrical Safety

	WARNING	**ESD Considerations** MBS-DG-BOARD is sensitive to electrostatic discharge. Carry the board only in a shielded bag when you are out of a Electrostatic Protected Area. Handle the board only in Electrostatic Protected Area, with conductive wrist or shoes connected to earth.
	WARNING	**Do not attempt to perform servicing or maintenance** To avoid personal injury, do not operate this instrument without the protective cover of the chassis. Do not make any service or maintenance of any kind to the system. Refer servicing only to authorized personnel from Photline.
	WARNING	**Operate under the proper environmental conditions.** The board is designed for indoor use, only. To avoid the possibility of injury, do not expose this instrument to rain or excessive moisture. Do not operate the instrument in the presence of flammable gases or fumes.

Ventilation of the Board

	WARNING	Do not cover the board with any covering or overlay.

Contacting Ixblue PSD:

For application oriented questions, for questions related to service, please contact Ixblue PSD Besançon

General Information

Mach-Zehnder intensity modulators

Lithium niobate (LiNbO3) Mach-Zehnder intensity modulators are external modulators that have been widely used since the mid-nineties, mostly in long haul optical networks for their ability to modulate optical signal from 1300 nm and 1550 nm laser diodes with short transition times and without chirp. Thanks to their broad wavelength performance, they currently also offer modulation solutions to 1064 nm and other near infrared lasers.

Mach-Zehnder modulators are interferometric devices and exhibit a sine transfer function (Figure 1). Although highly stable components, their operating point can suffer slow drift due to variations of external conditions and that drift may result in variations of key performances like extinction ratio.

In order to adjust the operating point of Mach-Zehnder modulators independently from the high frequency modulation signal applied, they can be designed with two sets of electrodes: one set of electrodes, the RF Electrodes, is used to apply the RF signal (PRBS data stream, analog signal, short pulses…). The second set of electrodes, the DC Bias Electrodes, is generally used to adjust with a fixed voltage the working point of the modulator. Figure 2 illustrate the typical electrode architecture of Mach-Zehnder modulator.

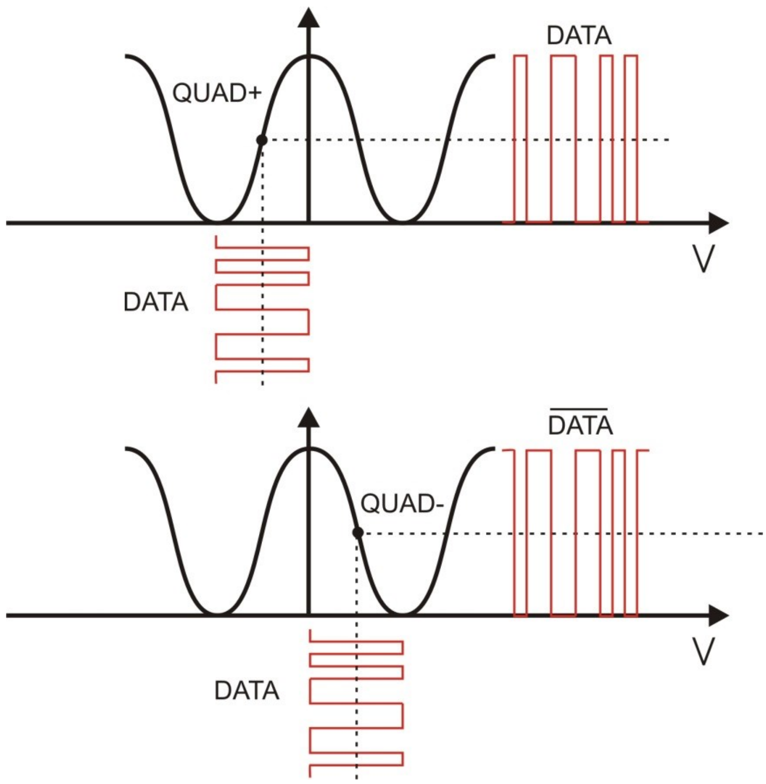


Figure 1 : transfer function of a Mach-Zehnder modulator and data output vs data input at QUAD+ and QUAD- operating point

iXblue S.A.S.
Photonic Solutions Business Unit
3, rue Sophie Germain, TEMIS
25000 Besançon, France
T. : +33 3 81 85 31 80
F. : +33 3 81 85 15 57
www.photonics.ixblue.com

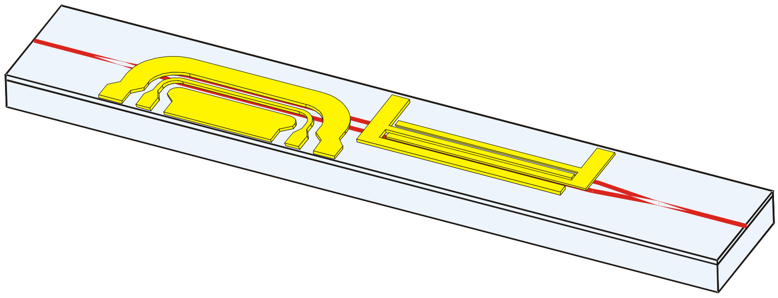


Figure 2 : typical electrode and waveguide architecture of a Mach-Zehnder modulator

Product Overview

MBC is a bias controller specially designed to stabilize the operating point of LiNb03 Mach-Zehnder modulators by monitoring the bias voltage applied on the DC electrodes of the devices.

The MBC controllers can lock any modulator and allows for continuous tuning of the operating point. The continuous format such as ERZ (Electrical Return to Zero) where the operating point must be set at 33% or 66% of the maximum transmission.

Principle

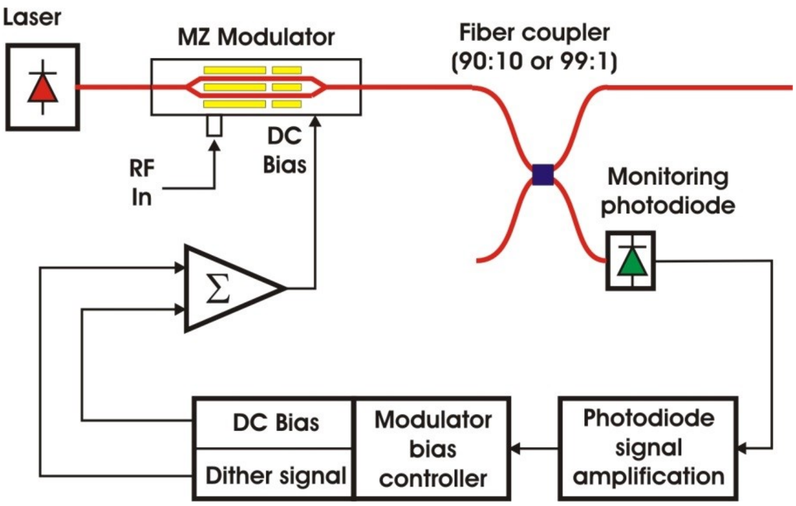


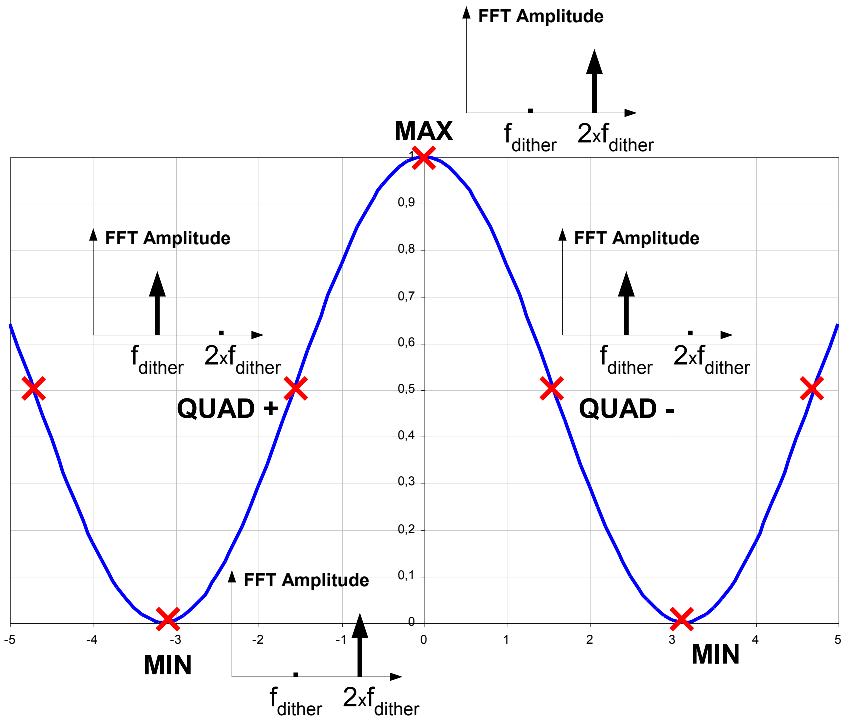
Figure 3: basic scheme of a modulation set-up including a modulator bias controller and an external monitoring photodiode

iXblue S.A.S.
Photonic Solutions Business Unit
3, rue Sophie Germain, TEMIS
25000 Besançon, France
T. : +33 3 81 85 31 80
F. : +33 3 81 85 15 57
www.photonics.ixblue.com

A Mach-Zehnder modulator is illuminated by a laser at the optical input. The data stream is applied to the RF electrodes. At the output of the MZ modulator, a fiber coupler with a strong imbalance (10:90 or 1:99) allows to detect a small portion of the transmitted light with a monitoring photodiode. The signal is amplified and processed in order to control the stability of the operating point. Any deviation is compensated by a new value of the electrical bias voltage applied by the feedback loop in order to maintain the operating point at the desired position.

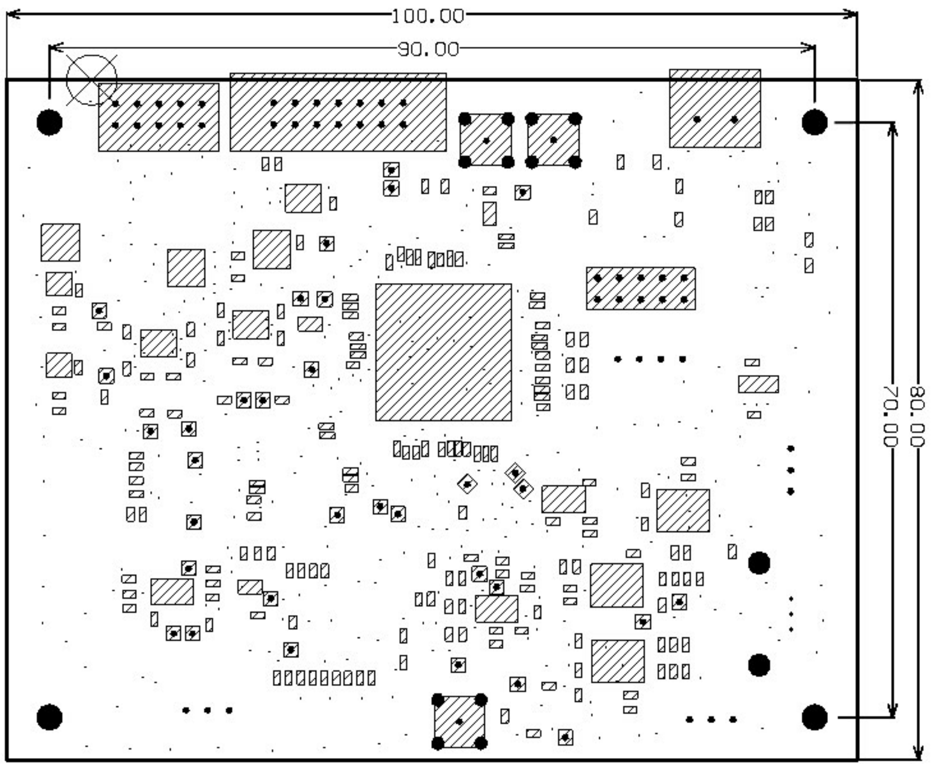
The principle of operation of the MBC is based on the generation of a very low frequency and low amplitude electrical signal (dither signal), which is summed to the DC bias voltage. Any deviation from the working point creates harmonics that can be measured and compared by frequency analysis and by signal processing carried out by a specific algorithm, developed by Photline, in order to retrieve the sign and the amplitude of the deviation.

The modulator is polarized in quadrature QUAD+ or QUAD- as the second harmonic is null. Otherwise, the modulator can be polarized on MIN or MAX as the first order is null. Any other transmission state is also possible thanks to a dedicated algorithm function.



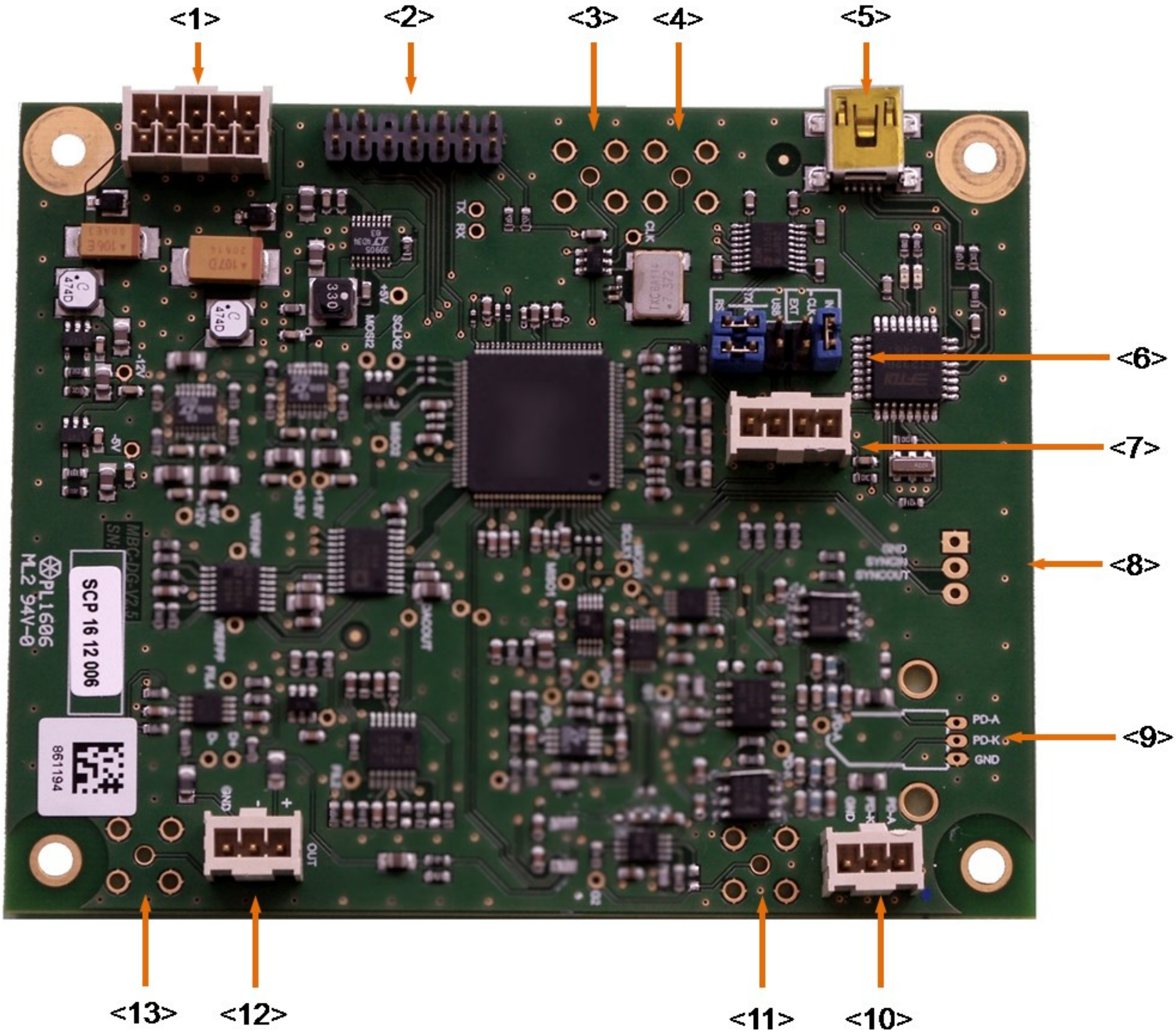
iXblue S.A.S.
Photonic Solutions Business Unit
3, rue Sophie Germain, TEMIS
25000 Besançon, France
T. : +33 3 81 85 31 80
F. : +33 3 81 85 15 57
www.photonics.ixblue.com

Mechanical Dimensions

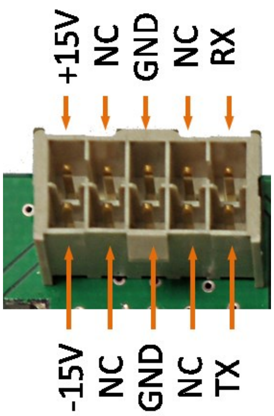


iXblue S.A.S.
Photonic Solutions Business Unit
3, rue Sophie Germain, TEMIS
25000 Besançon, France
T. : +33 3 81 85 31 80
F. : +33 3 81 85 15 57
www.photonics.ixblue.com

Board Features



<1> Power Supply input and RS232



(NC: Not Connected)

<2> Programmation connector

iXblue S.A.S.
Photonic Solutions Business Unit
3, rue Sophie Germain, TEMIS
25000 Besançon, France

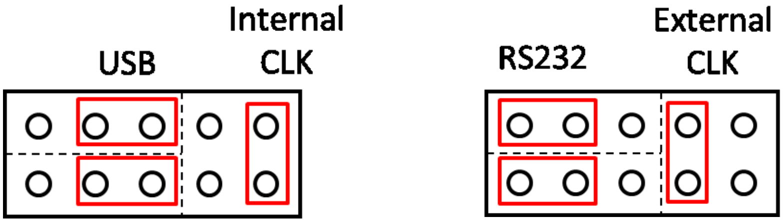
T. : +33 3 81 85 31 80
F. : +33 3 81 85 15 57
www.photonics.ixblue.com

<3> DSP clock input (MCX connector)

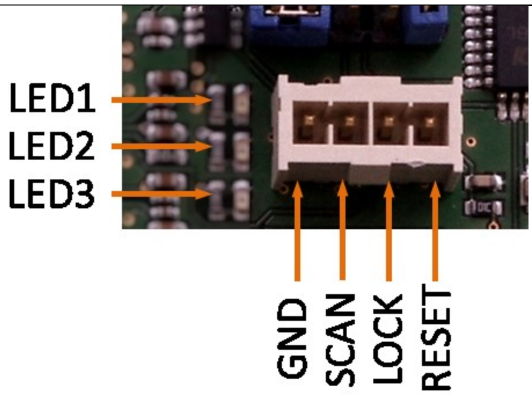
<4> DSP clock output (MCX connector)

<5> Mini-B USB connector

<6> Selection connector
Switch between the internal quartz or an external quartz.
Switch between the USB connector, or the RS232 connection.

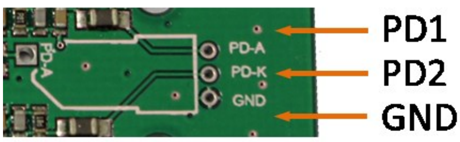


<7> LED connector

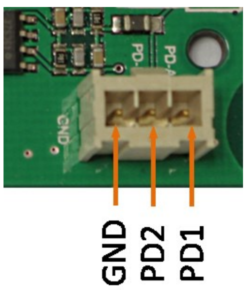
	SCAN: On when a modulator scan is performed. LOCK: On when feedback loop locked RESET : DSP RESET

<8> Synchronization connector

<9-10> Photodiode connection



or

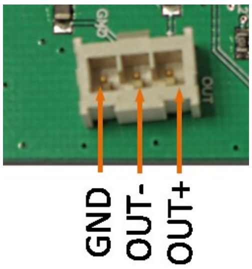


PD1: Anode

PD2: Cathode

<11> Photodiode signal (MCX or SMA connector)

<12> Dither connector



<13> OUT+ (MCX or SMA Connector)

Getting started

Standard Accessories

User Manual
Interface User Manual
Cord Kit
USB Cord (Option)

Installation and first time operation

Proceed as follow to install the MBC-DG-BOARD:

- Set the board on a flat stable surface
- Use a stabilized power supply with current limitation
- Connect the power supply to "power input" (<1>) on the board with the provided cord
- Connect the photodiode cord to "photodiode input" (<9-10>) respectively to the anode and cathode of the photodiode.
- Connect DC and ground outputs of the MBC to the DC and ground bias electrode inputs of the modulator.
- Connect DC and ground of the MBC (<12>) to DC and ground bias electrodes of the modulator.
- Switch on the laser to illuminate the modulator and set the desired optical power level.
- Supplied voltages should be respectively in the range (+12V +15V) and (-12V -15V).
- Switch on power supply sequence: (+15V +12V) then (-12V -15V).
- Electrical consumption
  - +12V rail < 135 mA
  - -12V rail < 61 mA
- Turn on the power supply.
- A procedure of initialization by scanning the Vbias range from –10V to +10V will start to adjust automatically the operating point by using the pre-loaded conditions.
- After stabilization of the bias voltage, the RF signal can be applied and the MBC parameters can be modified.
- Any change of the dither frequency results in a new search of the operating point by scanning the bias voltage from –10V to +10V.

IMPORTANT NOTES:

1- A Mach-Zehnder modulator can integrate an internal monitoring photodiode. Such a photodiode taps a part of the complementary optical field diffracted at the end of the waveguide modulation circuit. The advantage of this scheme is it avoids the optical losses due to a tapping coupler. Moreover the setup is more compact than the one using an external fiber coupler. The most significant difference is that the variation of modulation on the tapping photodiode is strictly opposite to the one obtained by the direct detection on the output fiber. This question has to be considered when defining the polarity of the monitoring photodiode signal. Please refer to the « select the photodiode signal » section for practical instructions.

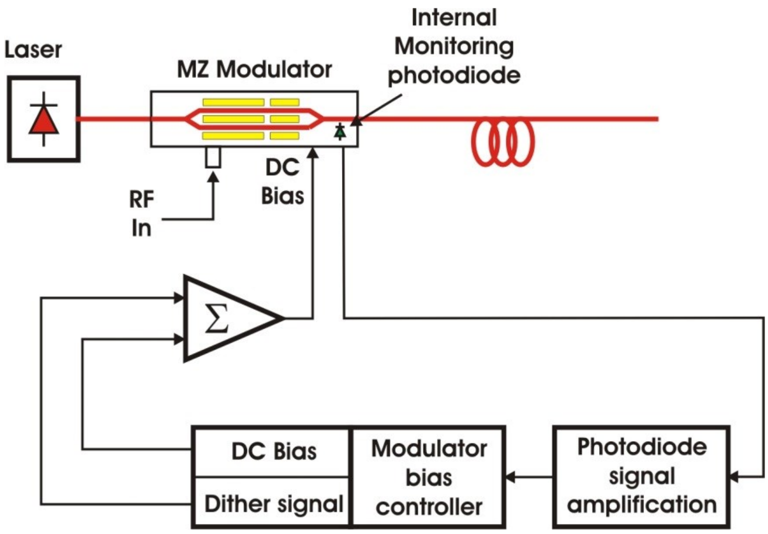


Figure 5: basic scheme of a modulation set-up including a modulator bias controller and an internal monitoring photodiode

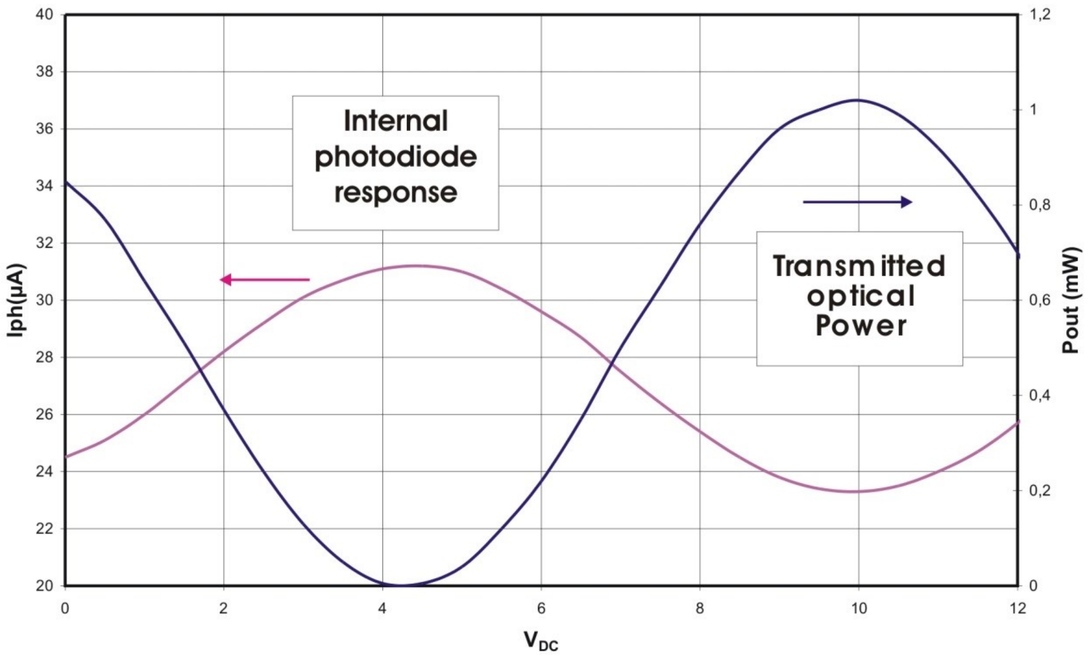


Figure 6 illustrates the difference between the responses of an internal monitoring photodiode tapping the complementary modulated optical field and the external monitoring photodiode tapping the directly modulated optical field.

2- The optical signal processing in the MBC is such that the value of the RF amplitude voltage is limited. The limit is 0.75Vπ and the MBC will not work correctly if the RF signal with a larger amplitude is applied to the modulator.
A 0.75Vπ amplitude is equivalent to a 1.5Vπ peak-to-peak value and the majority of the applications operate with a lower RF signal: typically 0.5Vπ amplitude (or 1Vπ peak-to-peak). Thus, in spite of that restriction, the MBC will operate correctly with most of the application.

Operation

For more information on the way to set parameters, please refer to the GUI interface handbook.

Selecting Auto/Manual mode

One can choose between two operation modes: AUTO or MANUAL.
In AUTO mode, the board searches the bias value corresponding to the selected transfer level.
In MANUAL mode, one set the DC bias value, and no dither is applied to DC Bias.

Selecting transfer level

Transfer Level is characterized by its level in % (MIN is 0, MAX is 100, QUAD+ is +50, QUAD – is –50). In general for digital NRZ and analog signals, the transfer level is set to QUAD. For pulse application, MIN point is privileged.

Auto Calibration

Auto Calibration will set the parameter dither amplitude and photodiode gains to an optimum, depending on the chosen transfer level point: Quad, Min or Max. The board will switch to Auto mode at the end of the calibration sequence.

Adjusting dithering frequency

The MBC allows the user to adjust the dithering frequency between 400 Hz and 1400 Hz. It is set by default at 1000Hz. This feature proves especially useful to avoid any interference between the RF signal and the dithering signal or when more than one modulator with MBC are used in the same link.

Adjusting dithering amplitude

The MBC allows the user to adjust the dithering amplitude between 10 mV and 1 V. This feature proves especially useful to optimize the overall performance of the MBC and to adapt to various conditions such as modulator Vpi or photodiode response. In auto calibration mode dither amplitude is set to 3% of the Vpi in Quad mode and 0.2% in Min and Max mode. Increasing dither, in general 20 to 50mVpp can help for feedback loop stabilization at low optical power (-20dBm on photodiode for example).
After modifying this parameter, one must do a scan restart.

Selecting the photodiode signal

As explained in the "Connection to the Photodiode" section, photodiode signals coming from an external or internal photodiode are inverted. The **photodiode signal** set up allows the MBC to work in both configurations. Select the NOT INVERTED mode when the photodiode is external and the INVERTED mode when the photodiode is internal.

Adjusting the photocurrent gain circuit

The MBC 2 offers 127 different gain values for the photocurrent circuit so as to adapt to the largest variety of applications and to offer the widest dynamic range for the input photocurrent. For Quad mode it is recommended to keep the gain under 110, otherwise the feedback loop may oscillate.
After modifying this parameter, one must do a scan restart.

It must be noticed that the photocurrent range within a gain position may slightly vary with the operating mode and the dithering amplitude. The Min mode requires less photocurrent than the Quad+ mode due to the higher sensitivity of the detection. Also, higher dithering amplitude will make the detection easier and will lower the low limit of the photo current range.

Troubleshoot:

Shifted Quad point	Quad point can be shifted, when the optical power illuminating the photodiode is too high. It will happen when the photodiode current increase over 500µA at max point. Optical power onto the photodiode has to be decreased.
Feedback loop oscillation	If the feedback loop oscillates fast, one should increase the dither amplitude (10 to 50mVpp) and reduce the photodiode gain (10 to 20). If it doesn’t work, one should check that the optical power on the photodiode at MAX point is sufficient to obtain a minimum of 8.5µA at the output of the photodiode.