

Ditherless MZM Bias Controller on Q Point

MBC-HF-01

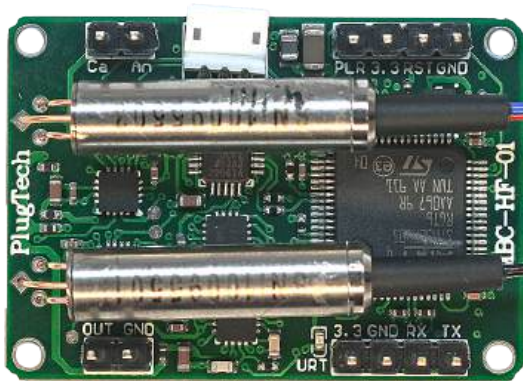


Figure 1. Top View

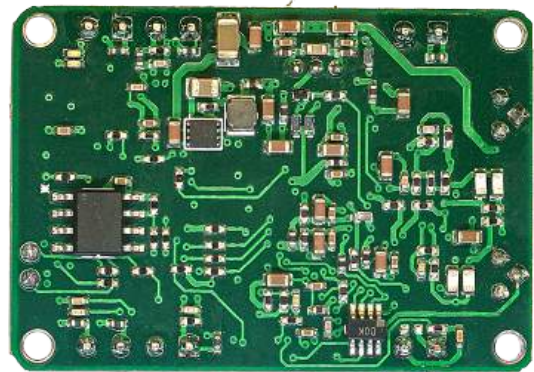


Figure 2. Bottom View

Feature

- MZM bias control within [Quad-80°, Quad+80°]
- Low profile: 40mm(W) × 28mm(D) × 12mm(H)
- Typical Second Order Distortion¹ : -60dB
- No dither injected
- High stability: with fully digital implementation
- Easy to use:
 - Manual operation with mini jumper
 - Flexible OEM operations through UART
- Two different modes to provide bias voltage:
 - a. Automatic bias control
 - b. User defined bias voltage

Application

- LiNbO₃ and other MZ modulators
- Digital NRZ, RZ
- CATV transmitter
- Analog link, RoF transmitter

Ordering Information

Part No.: MBC-HF-01

Model Type: MBC-HF-01A(Standard version)

MBC-HF-01B(Simplified version)

MBC-HF-01S(Customized version)

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Introduction

PlugTech Precision Systems' modulator bias controller is specially designed for Mach-Zehnder modulators to ensure stable operations in various operating environments. Based on its fully digitized signal processing method, the controller can provide ultra stable performance.

The controller acquiring light input to modulator and output from modulator and determines condition of the bias voltage and related error. A compensative bias voltage will be applied afterwards according to the previous measurements. In this way, the modulator is ensured to work under a proper bias voltage.

The controller does not inject dither signal. This feature is important for analog systems.

¹ Second order distortion at low frequency range (from 0 to 100kHz) is typical below -68dB. At 70MHz is typical -55dB.

Specifications

Parameter	Min	Typ	Max	Unit
Control Performance				
CSO ¹	-55	-65	-70	dBc
Stabilization time		30		s
Output power stability		±0.03		dB
Electrical				
Positive power voltage	+14.5	+15	+15.5	V
Positive power current	15		35	mA
Negative power voltage	-15.5	-15	-14.5	V
Negative power current	1.5		20	mA
Output voltage range	-11.34		+11.34	V
Output voltage precision		350		μV
Optical				
Modulator channel input optical power ²	-26		2	dBm
Laser channel input optical power ³	-26		2	dBm
Input wavelength	1100		1650	nm

¹ CSO refers to composite second order. To measure CSO correctly, the linear quality of RF signal, modulators and receivers shall be ensured. In addition, the system CSO readings may vary when running at different RF frequencies.

² Please be noted that the modulator channel input optical power does not correspond to the optical power at the selected bias point. It refers to the maximum optical power that the modulator can export to the controller when the bias voltage ranges from $-V_{\pi}$ to $+V_{\pi}$.

³ Please be noted that the laser channel input optical power does not correspond to the laser output power. It refers to the maximum optical power on the photodiode.

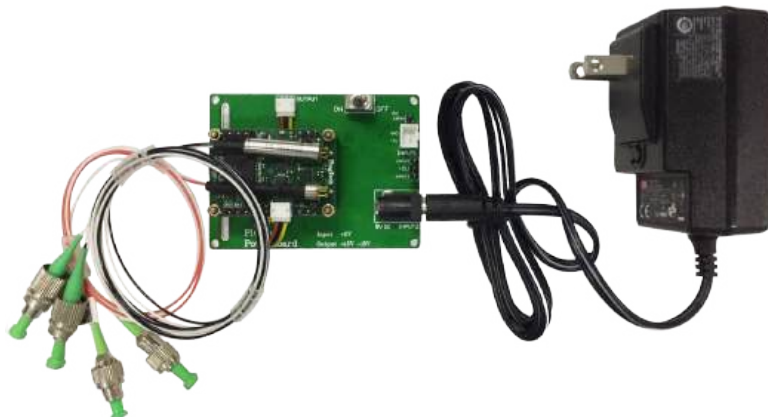


Figure 3. Controller with adaptor

User Interface

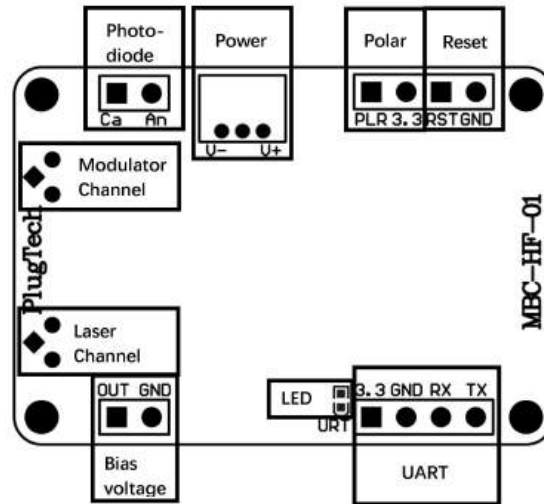


Figure 4. Assembly

Group	Operation	Explanation
Photodiode ¹	Ca: Connect MZM photodiode's Cathode	Provide modulator's output photocurrent feedback
	An: Connect MZM photodiode's Anode	
Power	Power source for bias controller	V-: connects the negative electrode
		V+: connects the positive electrode
		Middle probe: connects the ground electrode
Polar ²	Insert or pull out the jumper	No jumper: Q+ mode; with jumper: Q- mode
Reset	Insert jumper and pull out after 1 second	Reset the controller
Bias Voltage	Connect with the MZM bias voltage port	OUT and GND provide bias voltages for modulator
LED	Constantly on	Working under stable state
	On-off or off-on every 0.2s	Processing data and searching for controlling point
	On-off or off-on every 1s	Input optical power is too weak
	On-off or off-on every 3s	Input optical power is too strong
UART	Operate controller via UART	3.3: 3.3V reference voltage
		GND: Ground
		RX: Receive of controller
		TX: Transmit of controller
Modulator Channel	Connect with output optical path of the modulator	Feedback input from the modulator
Laser Channel	Connect with output optical path of laser	Feedback input from the laser

¹ Some MZ modulators have on board photodiodes. Only one choice shall be chosen between using controller photodiode or using modulator photodiode. It is recommended to use controller photodiode for Lab experiments for two reasons. Firstly, controller photodiode has ensured qualities. Secondly, it is easier to adjust the input light intensity. Note: If using modulator's internal photodiode, please make sure that the output current of photodiode is strictly proportional to input power.

² Polar depends on system RF signal. When there is no RF signal in the system, the polar should be positive. When RF signal has amplitude greater than a certain level, the polar will change from positive into negative. At this time, Null point and Peak point will switch with each other. Q+ point and Q- point will switch with each other as well. Polar switch enables user to change the polar directly without changing operation points

UART Command List

UART of the controller works at TTL(3.3V) level with following parameters: 57600 baud rate, 8 data bits, no parity bit, 1 stop bit.

Description	Command ID ¹	Data Send ¹	Data Received ²	Unit
Get modulator channel's optical power ³	0x67	NA	Current optical power on modulator channel photodiode ⁵	μ W
Get laser channel's optical power ⁴	0x79	NA	Current optical power on laser channel photodiode ⁵	μ W
Get bias voltage	0x68	NA	Current bias voltage ⁵	V
Get V_{π}	0x69	NA	Modulator V_{π} ⁵	V
Set polar	0x6D	0x01: Positive	0x11: Success; 0x88: Error	
		0x02: Negative	0x11: Success; 0x88: Error	
Set control mode	0x6B	0x01: automative control	0x11: Success; 0x88: Error	
		0x02: manually set DAC	0x11: Success; 0x88: Error	
Set output voltage ⁶	0x6C	voltage ⁷	0x11: Success; 0x88: Error	
Lock Current Point ⁸	0x7D	NA	NA	
Jump $2V_{\pi}$ ⁹	0x6F	0x01: Forward ¹⁰	0x11: Success; 0x88: Error	
		0x02: Backward ¹¹	0x11: Success; 0x88: Error	
Get operating status ¹²	0x70	NA	0x01: Stabilizing	
		NA	0x02: Stabilized	
		NA	0x03: Modulator channel light too weak	
		NA	0x04: Modulator channel light too strong	
		NA	0x05: Manual state	
		NA	0x06: Pause control state	
		NA	0x07: Laser channel light too weak	
		NA	0x08: Laser channel light too strong	
Pause Control ¹³	0x73	NA	0x11: Success; 0x88: Error	
Resume Control ¹⁴	0x74	NA	0x11: Success; 0x88: Error	
System Reset ¹⁵	0x6E	NA	NA	

¹ Bias controller can be controlled by a master device, such as a microprocessor, through UART. Command ID and Data Send refer to the data sent by master device. Each command should be send in a frame of 7 bytes following the sequence of Command ID(1 byte) + Data(6 bytes). For data bytes, it should be filled from the first byte and unused data bytes should be zero.

² Data received refer to the data received by master device. For data received, it has a frame of 9 bytes following the sequence of Command ID(1 byte)+Data(8 bytes). Similar to data send, received data bytes will be filled from the first byte and unused data bytes will be filled with zero.

³ The average power corresponds to the optical power which inputs into the modulator channel's photodiode. The responsivity used in calculation is 0.99A/W.

⁴ The average power corresponds to the optical power which inputs into the laser channel's photodiode. The responsivity used in calculation is 0.99A/W.

⁵ Data received is 4 byte floating point number(Little Endian).

⁶ Set output voltage function can only be used when bias controller is working under manual mode.

⁷ Four bytes. Byte one is fixed to 0x00. Calculation of remaining bytes is stated by an example. If 3.215V is required for output, the voltage should be multiplied by 1000 to convert the value to integer, i.e. 3215. Then convert 3215 to hex format. Hex format of 3215 is 0x0C8F. Byte two is the upper half of the final hex result, i.e. 0x0C. Byte three is the lower half, i.e. 0x8F. Byte four is sign of the voltage, 0x00 for positive, 0x01 for negative.

⁸ At manual mode, the modulator's working point can be changed by setting different output voltage, but the controller will not lock the working point. If you want to lock the working point corresponding to the current bias voltage after changing the output voltage, then you should execute the "Lock Current Point" function.

⁹ Modulators may have several working point seperated by $2V_{\pi}$. There may be difference in performance among all the working

points. This function is designed to help user select among all the working points to find the best one.

Note: it may take around 5 seconds for the controller to settle after each jump.

¹⁰ Suppose current working point at V_1 . After jumping forward, the new working point is set at $V_1 + 2V_\pi$

¹¹ Suppose current working point at V_1 . After jumping backward, the new working point is set at $V_1 - 2V_\pi$

¹² There might be a delay not exceeding 3s between the controller receives this command and send back data when the controller is in stabilizing status.

¹³ This function will pause the controller's automatic control. Controller will stop tracking and bias voltage output will remain at the value when the pause command is executed.

¹⁴ This function is used together with Pause Control. When pause control is executed and the automatic control is needed, executing this command will resume automatic control.

¹⁵ Reset the controller. It will start from initialization.

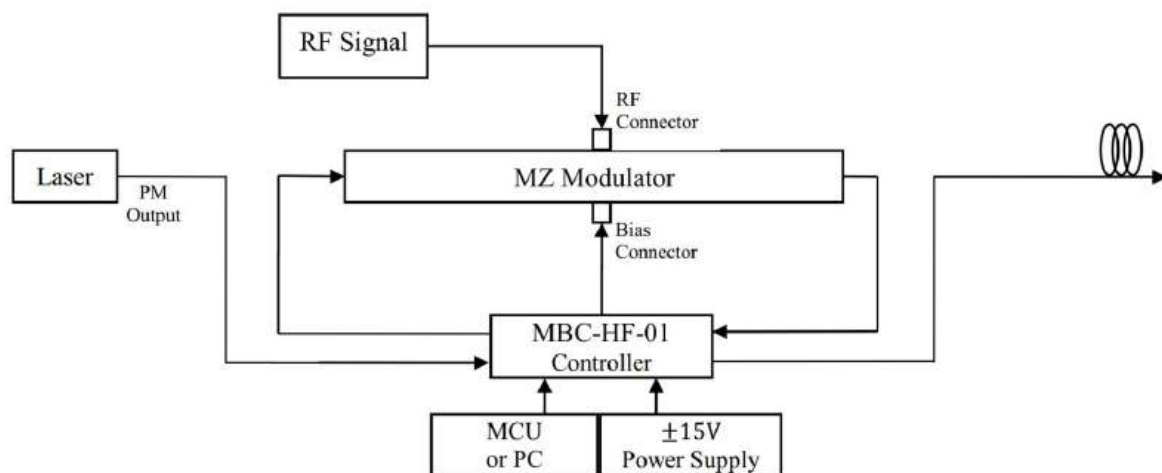
Environmental Characteristics

Parameter	Min	Typ	Max	Unit
Operating temperature	-20		85	°C
Storage temperature	-20		85	°C

Dimensions

Parameter	Value
Dimensions (W× D× H)	40mm× 28mm × 12mm
Weight	120g

Typical Application



Standard and Customized MBC-HF controller (Model: MBC-HF-01A or MBC-HF-01S)

MBC-HF-01A and MBC-HF-01S controller uses 1:99 TapPD as controller's two feedback inputs, it is easy to use.

Step1. Connect laser's polarization-maintaining output port to the L-IN port of controller's Laser Channel.

Step2. Connect modulator's optical input port to the L-OUT port of controller's Laser Channel.

Step3. Connect modulator's optical output port to the M-IN port of controller's Laser Channel.

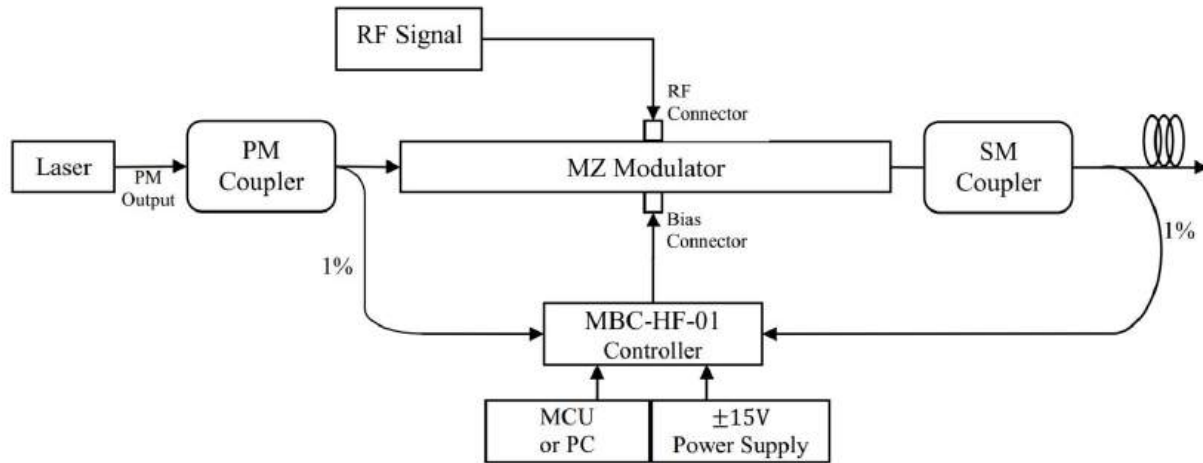
Step4. Connect bias voltage output of the controller (through SMA or 2.54mm 2-pin header) to bias port of the modulator

Step5. Provide controller with +15V and -15V DC voltages.

Step6. Reset the controller and it will start to work.

NOTE. Please be ensured that RF signal of the whole system is on before resetting the controller.

MBC-HF-01



Simplified MBC-HF controller (Model: MBC-HF-01B)

MBC-HF-01B controllers uses two single mode PD as controller' s two feedback inputs, users need to use their own polarization-maintaining coupler and single mode coupler for connection.

- Step1.** Connect laser's polarization-maintaining output port to the polarization-maintaining coupler's input port.
- Step2.** Connect modulator's optical input port to the polarization-maintaining coupler's 99% output port.
- Step3.** Connect polarization-maintaining coupler's 1% output port to the photodiode of the controller's Laser Channel.
- Step4.** Connect modulator' s optical output port to the single mode coupler's input port.
- Step5.** Connect single mode coupler's 1% output port to the photodiode of the controller's Modulator Channel.
- Step6.** Connect bias voltage output of the controller(through SMA or 2.54mm 2-pin header) to bias port of the modulator
- Step7.** Provide controller with +15V and −15V DC voltages.
- Step8.** Reset the controller and it will start to work.

NOTE. Please be ensured that RF signal of the whole system is on before resetting the controller.



This is an electrostatic-sensitive device. Please observe precautions for handling

Revision History

Version	Content	Date
1.0.0	First Release	2018-Aug
1.0.1	Update product details and picture	2020-May
1.0.2	Update Dimension Information	2020-Dec
1.0.3	Update Model Information	2024-May
1.0.4	Update Environment Information	2025-June