Ultra high precision

MZM bias controller on NULL point

Introduction

Rofea' modulator bias con- troller is specially designed for Mach-Zehnder modulators to ensure a stable operation state in var- ious operating environments. Based on its fully dig- itized signal processing method, the controller can provide ultra stable performance.

The controller injects a low frequency, low ampli- tude dither signal together with a bias voltage into the modulator. It keeps reading the output from the modulator and determines the condition of the bias voltage and related error. A compensate bias volt- age will be applied afterwards according to the pre- vious measurements. In this way, the modulator is ensured to work under a proper bias voltage.

The controller is very compact in volume with high performance. The maximum stable DC extinction ratio measured in Lab is 50.4dB. The highest car- rier suppression ratio measured is 43dB.

Feature

- MZM bias control on Null and Peak modes
- Low profile: 37mm(W) ×25mm(D) ×8mm(H) High extinction ratio:
- 53dB Maximum[1]
  50.4dB DC extinction ratio lab verified [2]
  43dB carrier suppression lab verified
- Low dither amplitude: 0.1% V_π
- High stability: with fully digital implementation Easy to use:
- Manual operation with mini jumper Flexible OEM operations through UART[3]
- Two different modes to output bias voltage:
  a. Automatic bias voltage
  b. User defined bias voltage

Application

- LiNbO$_3$ and other MZ modulators
- Brillouin scattering system and other optical sensors
- Radio over Fiber systems
- Pulse Generation
- Carrier Suppression

Ordering Information

Part No.:R-BC-N-03

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[1] The highest extinction ratio depends on and cannot exceed the system modulator maximum extinction ratio.
[2] This experiment is conducted by measuring and comparing the power of modulator controlled at Peak and Null respectively.
[3] UART operation is only avaliable on some version of the controller.
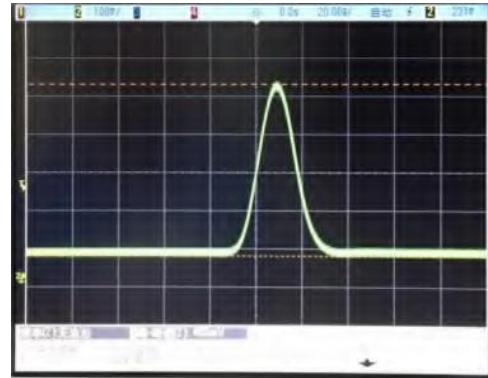
Performance

Figure 1. Carrier Supression

Figure 2. Pulse Generation

Figure 3. Modulator max power

Figure 4. Modulator minimum power

Maxim DC extinction ratio

In this experiment, no RF signals were applied to the system. Pure DC extinciton has been measured.

1. Figure 5 demonstrates the optical power of modulator output, when modulator controlled at Peak point. It shows 3.71dBm in the diagram.

2. Figure 6 shows the optical power of modulator output, when modulator controlled at Null point. It shows -46.73dBm in the diagram. In real experiment, the value varies around -47dBm; and -46.73 is a stable value.

3. Therefore, the stable DC extinction ratio measured is 50.4dB.

Requirements for high extinction ratio

1. System modulator must have high extinction ratio. Characteristic of system modulator decides the maximum extinction ratio can be achieved.

2. Polarization of modulator input light shall be taken care of. Modulators are sensitive to polarization. Proper polarization can improve extinction ratio over 10dB. In lab experiments, usually a polarization controller is needed.

3. Proper bias controllers. In our DC extinction ratio experiment, 50.4dB extinction ratio has been achieved. While the datasheet of the modulator manufacture only lists 40dB. The reason of this improvement is that some modulators drift very fast. Rofea R-BC-N-03 bias controllers update the bias voltage every 1 second to ensure fast track response.

Specifications

Parameter	Min	Typ	Max	Unit
Control Performance				
Extinction Ratio		MER[1]	53	dB
Stabilization time		10		s
Electrical				
Positive power voltage	+14.5	+15	+15.5	V
Positive power current	20		30	mA
Negative power voltage	-15.5	-15	-14.5	V
Negative power current	1.5		4	mA
Output voltage range	-11.34		+11.34	V
Output voltage precision		350		µV
Dither frequency	999.99	1000	1000.01	Hz
Dither amplitude		$0.1\%V_\pi$		V
Optical				
Input optical power[2]	-30		-9	dBm
Input wavelength	1100		1650	nm

[1] MER refers to Modulator Extinction Ratio. The extinction ratio achieved is typically the extinction ratio of the modulator specified in the modulator datasheet.

[2] Please be noted that the 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 $+V_\pi$.
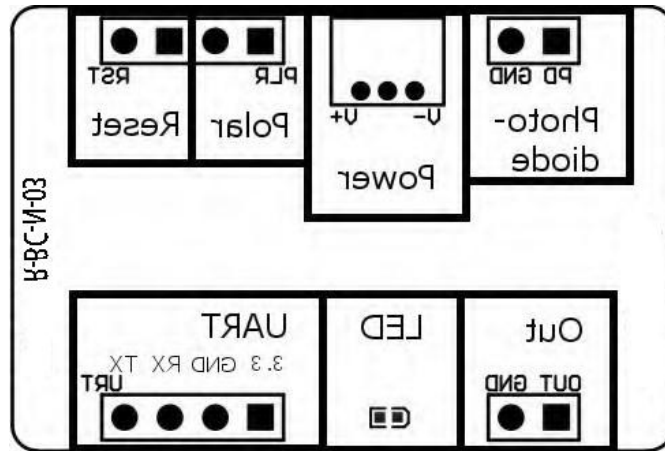
User Interface

Figure 5. Assembly

Group	Operation	Explanation
Photodiode [1]	PD: Connect MZM photodiode's Cathode	Provide photocurrent feedback
	GND: 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: Null mode; with jumper: Peak mode
Reset	Insert jumper and pull out after 1 second	Reset the controller
Out	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

[1] Some MZ modulators have on board photdiodes. 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

Typical Application
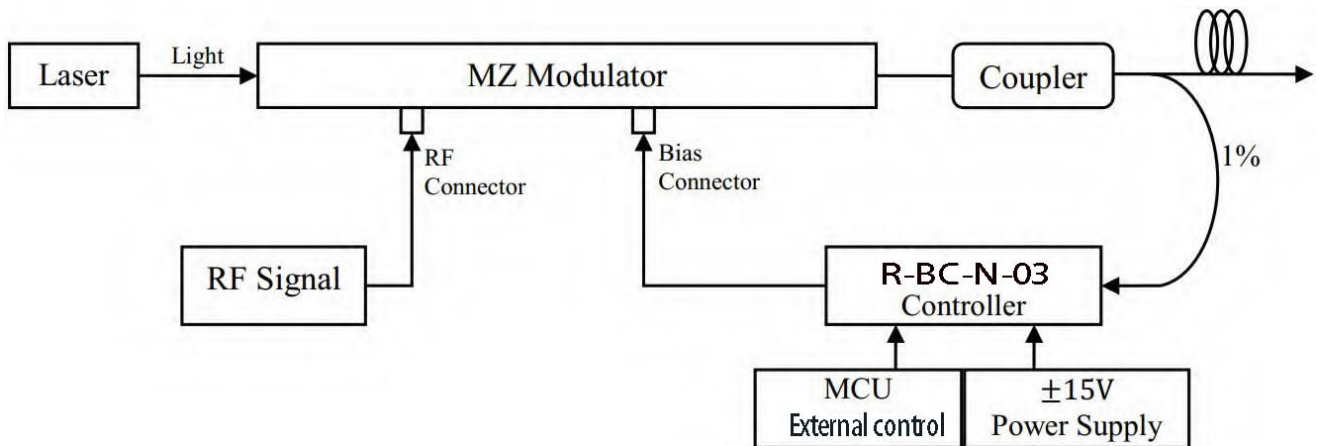
The controller is easy to use.

Step1. Connect 1% port of the coupler to the photodiode of the controller.

Step2. Connect bias voltage output of the controller(through SMA or 2.54mm 2-pin header) to bias port of the modulator.

Step3. Provide controller with $+15$V and -15V DC voltages.

Step4. 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.