Ultra Compact DP-IQ Modulator Bias Controller

Introduction

A DP-IQ modulator consists of two IQ modulators and a polarization rotator. Each IQ modulator consists of three different modulators: I, Q arms are intensity modulators, P arm is a phase modulator. The DP-IQ modulator is typically applied to DP- QPSK systems. Rofea'mod- ulator bias controller is specially designed for DP- IQ modulators to ensure stable operations in vari- ous 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 modulator and the related error. A compensate bias voltage will be applied afterwards according to the previous measurements. In this way, the DP-IQ modulator is ensured to work under a proper bias voltage.

Feature

- Simultaneously provides six automatic bias voltages for Dual Polarization IQ modulators
- Modulation format independent:
  SSB, QPSK, QAM, OFDM verified.
- Plug and Play:
  No manual calibration needed Everything automatic
- I, Q arms: controll on Peak and Null modes High extinction ratio:50dB max[1]
- P arm: controll on Q+ and Q- modes Accuracy: ±2°
- Low profile: 40mm(W) × 29mm(D) ×8mm(H)
- High stability: fully digital implementation Easy to use:
- Manual operation with mini jumper
  Flexible OEM operations through UART[2]/IO
- Two modes to provide bias voltages: a.Automatic Bias Control b.User defined bias voltage

Application

- $LiNbO_3$ and other DP-IQ modulators
- Coherent Transmission

[1] The highest extinction ratio depends on and cannot exceed 1 the system modulator maximum extinction ratio.
[2] UART operation is only avaliable on some version of the controller.

Performance

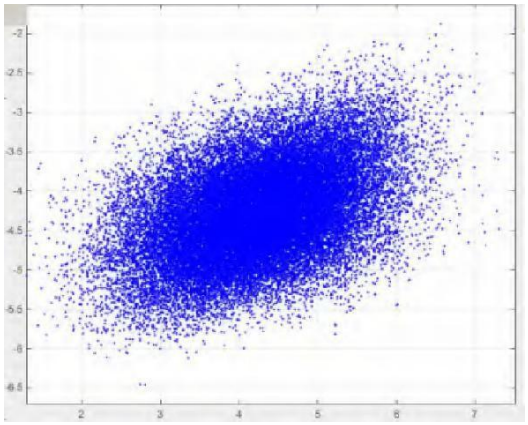

Figure 1. QPSK Constellation pattern (without controller)

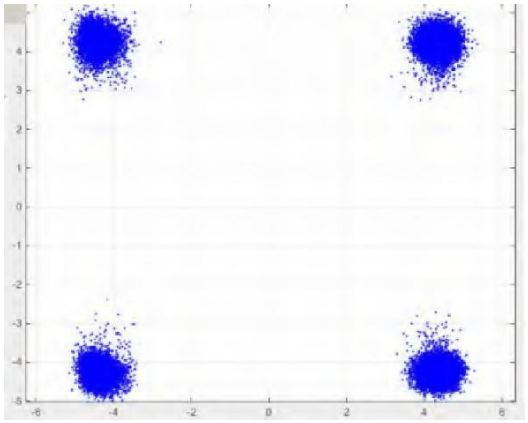

Figure 2. QPSK Constellation pattern (with controller)

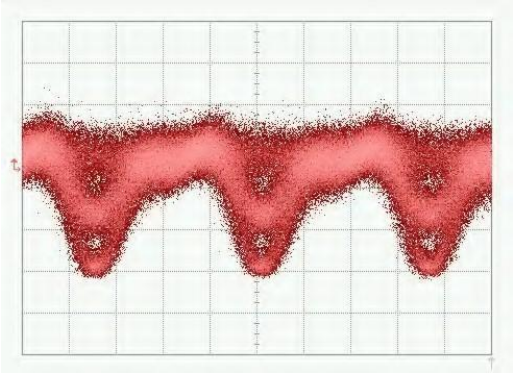

Figure 3. QPSK-Eye pattern

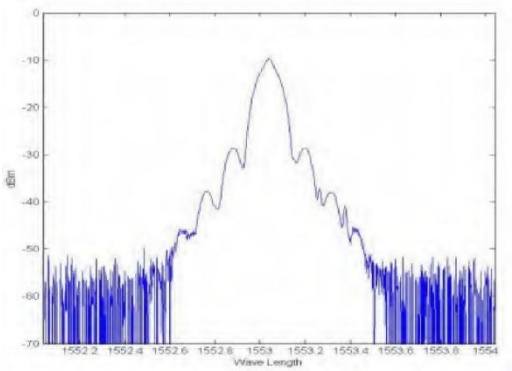

Figure 4. QPSK-Spectrum pattern

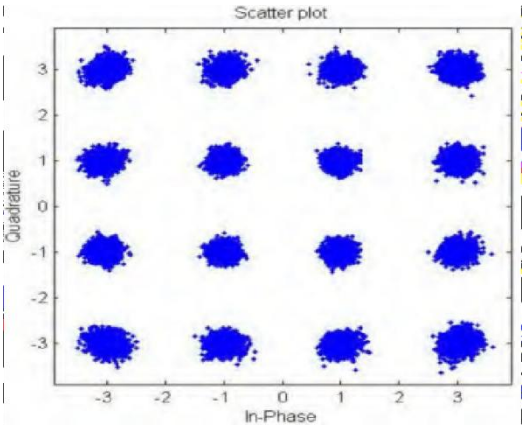

Figure 5. 16-QAM Constellation pattern

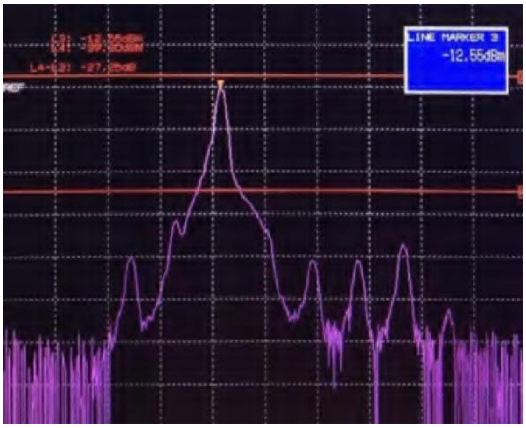

Figure 6. CS-SSB Spectrum

Specifications

Parameter	Min	Typ	Max	Unit
Controll Performance				
I, Q arms are controlled on **Null(Minimum)** or **Peak(Maximum)** point				
Extinction ratio		MER[1]	50	dB
P arm is controlled on **Q+(right quadrature)** or **Q-(left quadrature)** point				
Accuracy at Quad	−2		+2	degree[2]
Stablization time	45	50	55	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	8		15	mA
Output voltage range of YI/YQ/XI/XQ	-14.5		+14.5	V
Output voltage range of YP/XP	-13		+13	V
Dither amplitude		1%V_π		V
Optical				
Input optical power[3]	-30		-8	dBm
Input wavelength	1100		1650	nm

[1] MER refers to intrinsic Modulator Extinction Ratio. The extinction ratio achieved is typically the extinction ratio of the modulator specified in modulator datasheet.
[2] Let V_π denote the bias voltage at 180° and V_P denote the most optimized bias voltage at Quad points.
[3] Please be noted that the input optical power does not refer to the optical power at the selected bias point. It is 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

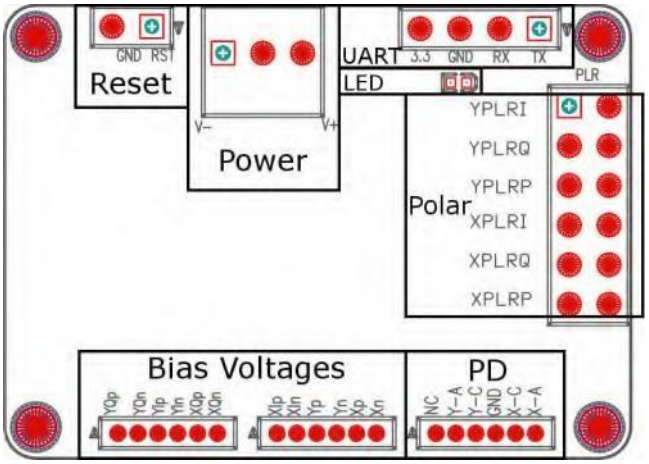

Figure 7. Assembly

Group	Operation	Explanation
Rest	Insert jumper and pull out after 1 second	Reset the controller
Power	Power source for bias controller	V- connects the negative electrode of the power supply
		V+ connects the positive electrode of the power supply
		Middle port connects with the ground electrode
UART	Operate controller via UART	3.3: 3.3V reference voltage
		GND: Ground
		RX: Receive of controller
		TX: Transmit of controller
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
Polar[1]	XPLRI: Insert or pull out the jumper	no jumper: Null mode; with jumper: Peak mode
	XPLRQ: Insert or pull out the jumper	no jumper: Null mode; with jumper: Peak mode
	XPLRP: Insert or pull out the jumper	no jumper: Q+ mode; with jumper: Q- mode
	YPLRI: Insert or pull out the jumper	no jumper: Null mode; with jumper: Peak mode
	YPLRQ: Insert or pull out the jumper	no jumper: Null mode; with jumper: Peak mode
	YPLRP: Insert or pull out the jumper	no jumper: Q+ mode; with jumper: Q- mode
Bias Voltages	YQp, YQn: Bias for Y polarization Q arm	YQp: Positive side; YQn: Negative side or ground
	YIp, YIn: Bias for Y polarization I arm	YIp: Positive side; YIn: Negative side or ground
	XQp, XQn: Bias for X polarization Q arm	XQp: Positive side; XQn: Negative side or ground
	XIp, XIn: Bias for X polarization I arm	XIp: Positive side; XIn: Negative side or ground
	YPp, YPn: Bias for Y polarization P arm	YPp: Positive side; YPn: Negative side or ground
	XPp, XPn: Bias for X polarization P arm	XPp: Positive side; XPn: Negative side or ground

[1] 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 point

Group	Operation	Explanation
PD[1]	NC: Not Connected	
	Y-A: Y-polarization photodiode Anode	Y-A and Y-C: Y polarization photocurrent feedback
	Y-C: Y-polarization photodiode Cathode	
	GND: Ground	
	X-C: X-polarization photodiode Cathode	X-A and X-C: X polarization photocurrent feedback
	X-A: X-polarization photodiode Anode	

[1] 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. If using modulator's internal photodiode, please make sure that the output current of photodiode is strictly proportional to input power.