

MICROWAVE PHOTONIC PRODUCTS

- PSI-0600 2 GHz link
- PSI-1600 Series 12 GHz link
- PSI-2600 Series 20 GHz link
- PSI-0100 chassis
- PSI-1628 Microwave amplifier
- PSI-0204 Modulator controller
- PSI-0303 Digital modulator controller

BENEFITS OF FIBER OPTIC TRANSMISSION:

- BEST SPACE UTILIZATION
- LOWEST SIGNAL LOSS
- HIGHEST SIGNAL INTEGRITY
- HIGHEST SIGNAL SECURITY
- LOW MAINTENANCE COST
- SIMPLE INSTALLATION
- APPLICATION FLEXIBILITY
- EMI/RFI PROTECTION

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Photonic Systems, Inc (PSI) offers a broad range of microwave photonic products designed for simple installation, operation and best-in-class performance. We offer our customers photonic solutions designed by leading microwave photonic technologists to solve unique signal transmission problems. Our customers include defense, research and commercial entities in all corners of the world.

PSI is pleased to offer the microwave photonic products outlined in this brochure. These standard products include direct and externally modulated fiber optic transmitters for bandwidths ranging from 2 to 30 GHz. PSI can modify these products to fit your particular system needs. Please contact us for ordering information.

- RF over fiber
- GPS timing distribution
- Antenna remoting
- Signal concentration
- Video distribution
- Radio Astronomy
- Satellite ground stations
- Wireless service enhancement



PSI-0600 MICROWAVE PHOTONIC LINK

PRODUCT DESCRIPTION

The PSI-0600 series microwave photonic link family consists of optical transmitter and receiver modules designed for microwave frequency transmission applications. Offering operating bandwidth of 2 GHz and a wide spur-free dynamic range (SFDR), the PSI-0600s are well suited for distortion-free transmission in applications such as antenna remoting, phased arrays, or optical delay lines. Providing very low distortion and low loss per unit distance, these links allow for high preservation of signal fidelity. Use of a PSI-0601 or PSI-0604 photonic link allows significant performance improvement compared to the use of coaxial cables or waveguides. Fiber optic links offer very high noise immunity and protection from unauthorized access to transmitted signals. Employing precisely controlled distributed feedback (DFB) lasers, these links are highly reliable, complete transmission solutions. The separate transmitter and receiver modules are packaged in small housings and shipped with AC power supplies.

Photonic Link Specification Highlights

PSI-0601 Microwave Photonic Link

Parameter	Value *
Operating Bandwidth	0.045 -2 GHz
Gain	- 30 dB typical
VSWR	≤ 2:1 across bandwidth
Noise Figure	≤ 45 dB, 35 dB typical
Spur-free dynamic range	98 dB minimum (in 1 Hz)
Input IP3	+10 dBm typical
Fiber-optic connectors **	FC/APC
DC Power Requirements†	Tx ≤ 7.5 W; Rx ≤ 25 mW
AC Power Requirements	110 VAC, 60 Hz

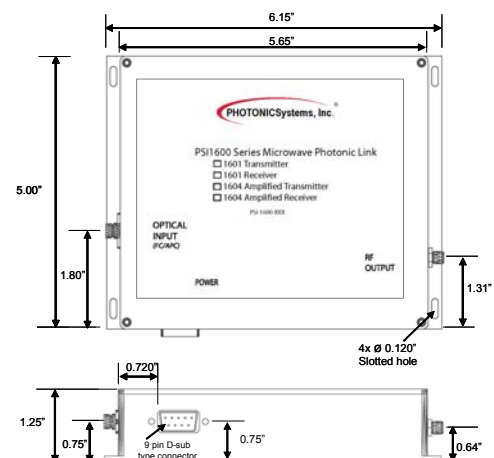
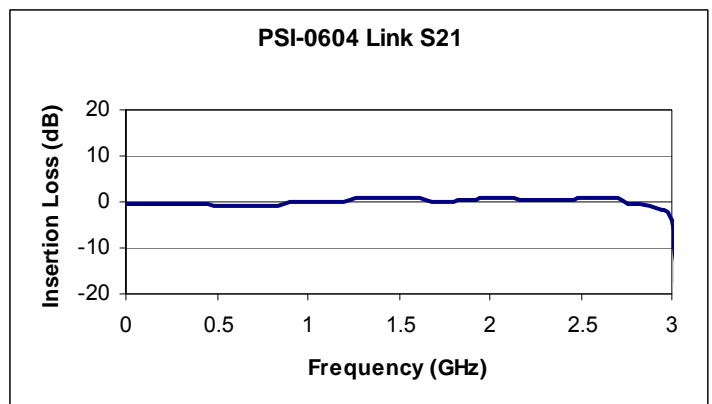
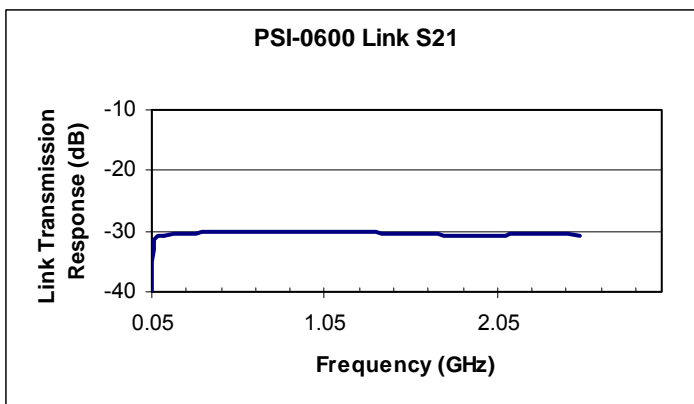
PSI-0604 Amplified Microwave Photonic Link

Parameter	Value *
Operating Bandwidth	0.045 -2 GHz
Gain	0 dB typical
VSWR	≤ 2:1 across BW
Noise Figure	TBD dB typical
Spur-free dynamic range	97 dB minimum (in 1 Hz)
Input IP3	+10 dBm typical
Fiber-optic connectors **	FC/APC
DC Power Requirements†	Tx ≤ 7.5 W; Rx ≤ 25 mW
AC Power Requirements	110 VAC, 60 Hz

* all values specified at 1dB optical loss. Greater loss from optical connectors, splices and fiber span will result in reduction of system performance.

** other connectors available upon request.

† at 25 deg. C.



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PRODUCT DESCRIPTION

The PSI-1600 series microwave photonic link family consists of optical transmitter and receiver modules designed for microwave frequency transmission applications. Offering operating bandwidth in excess of 12 GHz and a wide spur-free dynamic range (SFDR), the PSI-1600s are well suited for distortion-free transmission in applications such as antenna remoting, phased arrays, or optical delay lines. Providing very low distortion and low loss per unit distance, these links allow for high preservation of signal fidelity. Use of a PSI-1601 or PSI-1604 photonic link allows significant performance improvement compared to the use of coaxial cables or waveguides. Fiber optic links offer very high noise immunity and protection from unauthorized access to transmitted signals. Employing precisely controlled electro-absorption modulated laser diode (EML) technology, these links are highly reliable, complete transmission solutions. The separate transmitter and receiver modules are packaged in small housings and shipped with AC power supplies.

Photonic Link Specification Highlights

PSI-1601 Microwave Photonic Link

Parameter	Value *
Operating Bandwidth	0.045 -12 GHz
Gain	≥ -40 dB, -30 dB typical
VSWR	≤ 2:1 across bandwidth
Noise Figure	≤ 45 dB, 35 dB typical
Spur-free dynamic range	≥ 100 dB, 108 dB typical (in 1 Hz)
1-dB compression dynamic range	130 dB typical (in 1 Hz)
Input IP3	33 dBm typical
Fiber-optic connectors **	FC/APC
DC Power Requirements†	Tx ≤ 7.5 W; Rx ≤ 25 mW
AC Power Requirements	110 VAC, 60 Hz

* all values specified at 1dB optical loss. Greater loss from optical connectors, splices and fiber span will result in reduction of system performance.

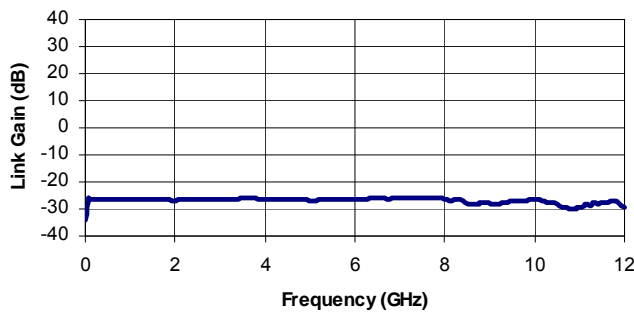
** other connectors available upon request.

† at 25 deg. C.

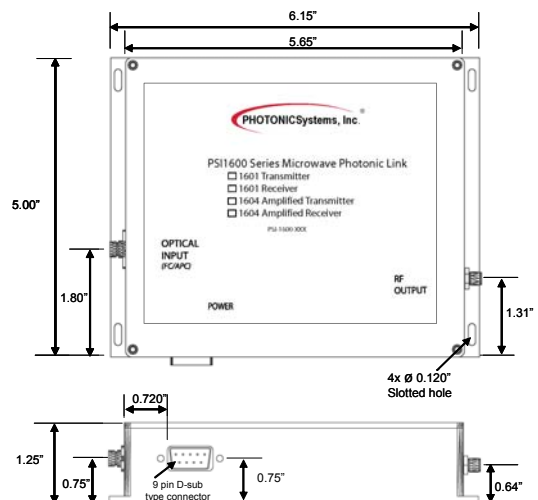
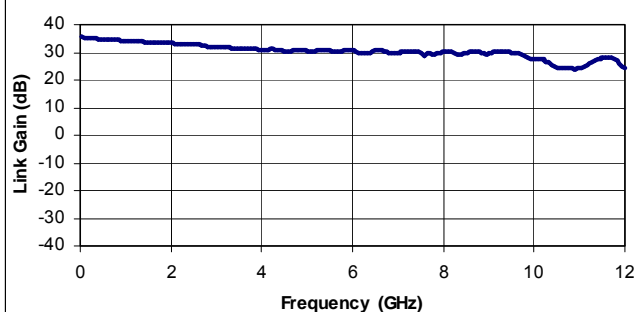
PSI-1604 Amplified Microwave Photonic Link

Parameter	Value *
Operating Bandwidth	0.045 -10 GHz
Gain	26 dB typical
VSWR	≤ 2:1 across BW
Noise Figure	18 dB typical
Spur-free dynamic range	106 dB typical (in 1 Hz)
1-dB compression dynamic range	129 dB typical (in 1 Hz)
Input IP3	4.25 dBm typical
Fiber-optic connectors **	FC/APC
DC Power Requirements†	Tx ≤ 7.5 W; Rx ≤ 25 mW
AC Power Requirements	110 VAC, 60 Hz

PSI-1601 Typical Frequency Response



PSI-1604 Typical Frequency Response



PRODUCT DESCRIPTION

The PSI-2600 series microwave photonic link family consists of optical transmitter and receiver module pairs designed for microwave frequency transmission applications. Offering operating bandwidth in excess of 20 GHz and an extremely wide spur-free dynamic range (SFDR), the PSI-2600s are well suited for distortion-free transmission in applications such as antenna remoting, phased arrays, or optical delay lines. Offering very low distortion and low loss per unit distance, these links allow for high preservation of signal fidelity. Use of a PSI-2604 amplified microwave photonic link offers significant performance improvement compared to the use of coaxial cables or waveguides. Fiber optic links offer very high noise immunity and protection from unauthorized access to transmitted signals. Employing external modulation with precisely controlled Lithium Niobate modulators, these links are highly reliable, complete transmission solutions with separate transmitter and receiver modules packaged in small housings shipped with AC power supplies.

Photonic Link Specification Highlights

PSI-2601 Microwave Photonic Link

Parameter	Value
Operating Bandwidth	0.045 -20 GHz
Gain	-21 dB
VSWR	≤ 2:1 across bandwidth
Noise Figure	32 dB
Spur-free dynamic range	108 dB typical (1 Hz)
1-dB compression dynamic range	154 dB typical (1Hz)
Input IP3	21.1 dBm
Fiber-optic connectors	FC/APC**
DC Power Requirements†	Tx ≤ 8 W; Rx ≤ 25 mW
AC Power Requirements	110 VAC, 60 Hz

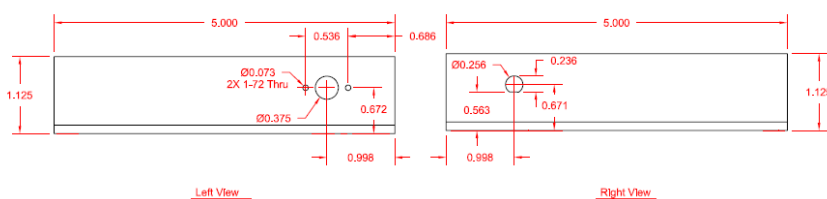
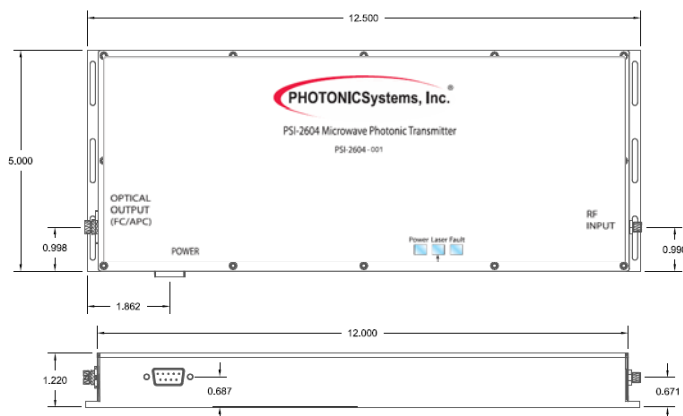
PSI-2604 Amplified Microwave Photonic Link

Parameter	Value
Operating Bandwidth	0.045 -20 GHz
Gain	+35 dB
VSWR	≤ 2:1 across bandwidth
Noise Figure	6.4 dB
Spur-free dynamic range	106 dB typical (1 Hz)
1-dB compression dynamic range	148 dB typical (1Hz)
Input IP3	-8.5 dBm
Fiber-optic connectors	FC/APC**
DC Power Requirements†	Tx ≤ 8 W; Rx ≤ 25 mW
AC Power Requirements	110 VAC, 60 Hz

* all values specified at 1dB optical loss. Greater loss from optical connectors, splices and fiber span will result in reduction of system performance.

** other connectors available upon request

† at 25 deg. C.



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PRODUCT DESCRIPTION

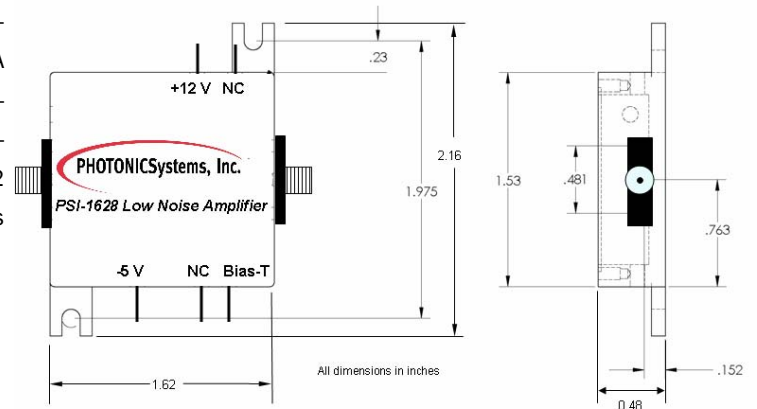
The PSI-1628 microwave low noise amplifier module provides 28 dB of gain over an exceptionally wide bandwidth. Designed for amplification in microwave photonic link transmitters and receivers, these modules provide high gain with low noise figure over the frequency range of 45 MHz to 20 GHz. This high level of gain is achieved using GaAs pHEMT technology and offers noise figure of better than 4 dB with +16 dBm of output power at 1 dB compression.

Offering high gain and excellent gain flatness over multiple octaves of bandwidth, the PSI-1628 amplifier is easily used in applications where multiple bands are transmitted over a single optical or radio span. When used in conjunction with PSI's optical link products, users are able to optimally match system losses, noise figure or gain requirements with optical link parameters. Also included is an integral bias-T for simple integration with Mach-Zehnder modulators.

Included in the compact sized module are DC power protection circuitry and RF matching to 50 ohms at both input and output SMA ports. This design allows for simple integration with microwave components and systems in either laboratory or field installation environments. The amplifier requires minimal DC power derived from +12 and -5 volt power supplies. The PSI-1628 microwave amplifier is contained in a housing measuring 1.62" x 2.16" x 0.48".

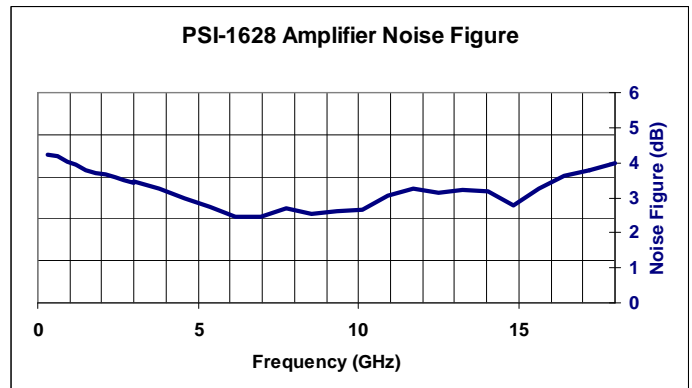
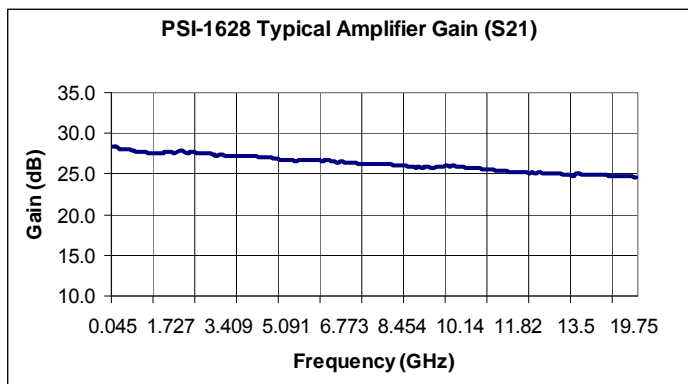
General RF and Electrical Specifications

Parameter	Value (typical)
Output third order intercept point (IP3)	+28 dBm
Output power for 1 dB compression (P1dB)	+18 dBm
Input return loss	22 dB
Input IP3	-3 dBm
Output return loss	15 dB
RF port impedance (input and output)	50 W
RF connector type	SMA
DC power supply	+12 V @ <150 mA -5 V @ <20 mA
Operating temperature range	0° to +60° C
Dimensions	1.62" x 2.16" x 0.48"

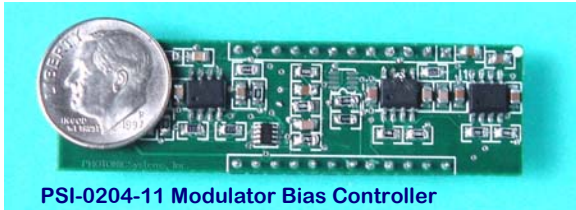


Pass-band Specifications

Parameter	Value (typical)			
	0.045-6 GHz	6-8 GHz	8-12 GHz	12-20 GHz
Gain	28 dB	28 dB	28 dB	24 dB
Gain Flatness	±1 dB	±0.3 dB	±0.3 dB	±0.5 dB
Noise Figure	4 dB	2.5 dB	2.5 dB	4 dB



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PSI-0204-11 Modulator Bias Controller

FEATURES AND BENEFITS

- ✓ **DITHER BASED CONTROL COMPATIBLE WITH MOST OPTICAL MODULATORS**
- ✓ **ADJUSTABLE DITHER AMPLITUDE: 20 TO 200MVPP**
- ✓ **POWER SUPPLY RANGE: +/-12 TO +/-18VOLTS**
- ✓ **LOW OPERATING CURRENT: <12MA TYPICAL**
- ✓ **SMALL SIZE: 2.5"X 0.7", 24PIN, 0.6" WIDTH DIP**
- ✓ **CUSTOMIZED DESIGNS AVAILABLE IN MICRO-SIZED PACKAGES**

PRODUCT DESCRIPTION

The PSI-0204-11 chip-scale optical modulator bias controller (MBC) offers comprehensive control of external optical modulators from a single, small form factor circuit board. When operated with lithium niobate (LiNbO₃) modulators, the PSI-0204-11 provides automatic or manual bias control. Users may select automatic tracking of Quad +, Quad -, Minimum or Maximum bias points as shown in Figure 1. Operation at an externally set manual bias point may also be selected.

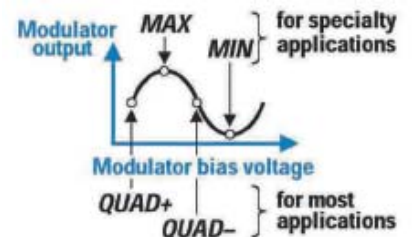


Figure 1– Modulator Transfer Function

Using a dither tone, the PSI-0204-11 tracks a user selected operating point to within +/- 1° at 1% dither of V_{π} when operating at quadrature. Dither frequency is set at 1 KHz and dither amplitude is user defined between 20 and 200mVpp. Bias point accuracy is maintained over a wide operating temperature range of 0° to +50° C. Using a common photodetector, bias point accuracy is easily maintained over a 15dB range of optical power.

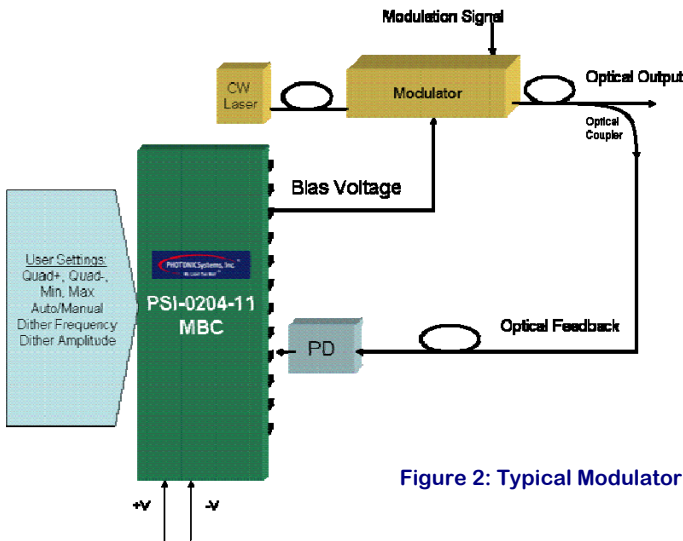


Figure 2: Typical Modulator

Designed for easy integration into the user's optical system, these controllers maintain constant bias point operation by compensating for drift in a modulator's transfer function. An external modulation fiber optical transmitter is shown in Figure 2 to illustrate how the controller is typically used. Through use of an optical coupler and photodetector, a portion of the transmitted light is detected and fed to the MBC. The dither tone is applied to the bias voltage output and sampled as a control mechanism. User settings determine bias point selection, dither frequency and amplitude.

Applications

- **Modulator design**
- **Integrated Modulator/Transmitters**
- **Fiber optic component evaluation**
- **Photonic Test Systems**
- **Spectroscopy systems**
- **Analog communications systems**
- **Telecom transmission**

Beyond standard specifications, PSI can modify the PSI-0204-11 to meet the exact requirements of your application. Smaller package sizes are offered for operation at a single bias point; other designs may also result in micro-miniature packages.

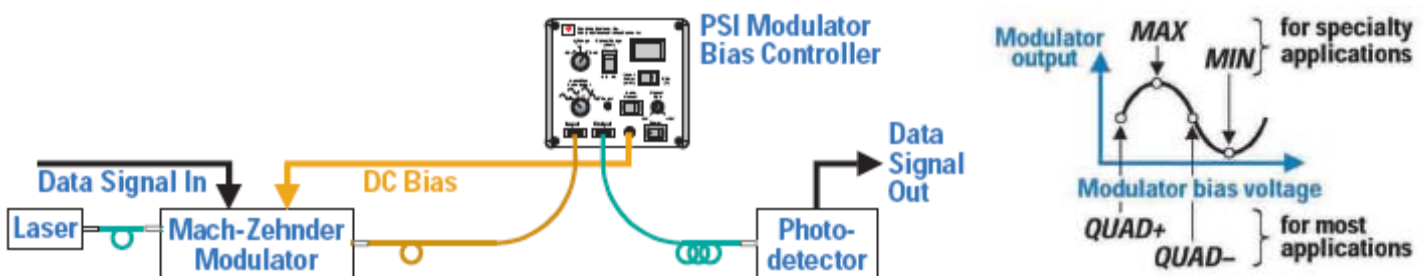
An optional evaluation kit is available to aid with design-in and proof of concept activities. The evaluation board provides a convenient means to power, control and test the MBC in a laboratory setting. Electrical connections are provided through either a DB9 or Molex plug. An optical photodetector completes the feedback loop. Included in the kit are an evaluation board with photodetector, AC power adapter and an MBC device.

PRODUCT DESCRIPTION

The PSI-0303 digital modulator bias controller is a full featured laboratory instrument designed for precise control of Mach-Zehnder interferometer fiber optic modulators. Designed to operate in the presence of a digital modulation signal, these controllers accurately prevent bias point drift from any of four preset or one user set modulator transfer function points. Through use of a proprietary control algorithm, the controller maintains bias control without the use of a dither signal.

Measurements are simplified through use of the PSI-0303 in your link or component evaluation set-up. With an internal optical coupler and photo-detector an internal feedback path automatically establishes lock on the desired bias point.

Automatic control modes allow the operator to select Quad+, MAX, Quad- or MIN bias points. A 10-turn potentiometer provides manual control for fine tuning to a specific bias point. An LCD display shows the bias voltage and optical output power. All features allow for simplified characterization of a modulator's V_{π} , optical insertion loss, optical extinction ratio and rate of bias point drift.



Specifications

Parameter	Typical Value	Units
Fiber Type	SMF-28	—
Wavelength	1300-1550	nm
Optical Insertion Loss	0.8	dB
Input Optical Power	Quad + or - 0 to -15	dBm
	Max or Min 0 to -10	
Output DC Bias Voltage	+/-15	V
DC Bias Port Impedance	<1	Ω
Modulator V_{π} standard Range; unit may be factory set for other values as needed	2.4- 7.6	V
Dither Frequency	n/a	
Bias Point Error		
<i>Quad+ or Quad- point</i>	+/- 5	Deg.
Initial Auto Bias Point Acquisition Time	10, maximum	sec.
Drift Compensation Response Time		
<i>0 to -10 dBm input power</i>	5	sec.
<i>-10 to -20 dBm input power</i>	5	sec.
Case Dimensions (WxHxD)	5.75x5.25x8.75	In.
Case Weight	3.5	Lb.
AC Adapter Weight	0.5	Lb.
Storage Temperature	-25 to +60	Deg. C
Power	115v +/-9% @25mA	—

Why use a Modulator Bias Controller?

Ideally, the desired Mach-Zehnder modulator bias point—in this example, the blue point on the curve shown here—would occur at a specific DC voltage that remains constant despite any variation of environmental conditions. However, effects in the modulator's electro-optic material can cause the transfer function to "drift" to the left or right—see, for example, the orange curve—such that a specific DC bias voltage may yield a QUAD+ point on the transfer function curve now and a different point on the curve after a slight change in the environmental conditions. As the figure at right shows, this small bias point drift can have a large impact on signal fidelity.



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