

2.5 Gb/s Bias-Free Modulator with Integral Attenuator



Key Features

- Bias-free operation for fast transmitter development and manufacturing
- Built-in 20 dB variable optical attenuator
- Single package for less splicing, lower overall insertion loss and more usable board space
- 1535 to 1565 nm operation; L-band versions available
- Low drive voltage; compatible with commercial drivers
- Low chirp for maximum transmission distance (>1000 km)
- Voltage-controlled lithium niobate attenuator provides proven high reliability

Applications

- Medium- and long-haul DWDM transmission requiring dynamic optical power leveling
- Transmitters with limite component space

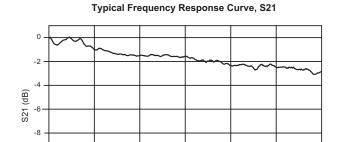
The 2.5 Gb/s bias-free modulator with integral attenuator combines a modulator and a 20 dB variable attenuator within one small-outline package, simplifying component count and fiber splicing. The bias point of the interferometer is set to operate at about the half-intensity point (quadrature). A bias control circuit is not required. The attenuator is based on proven integrated optical waveguide technology, making it highly reliable. The modulator provides superior signal quality over a wide range of wavelengths in the C and L bands, and can be used to modulate tunable lasers. These devices are used for 2.5 Gb/s modulation and dynamic power leveling in dense wavelength division multiplexing (DWDM) systems.

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Typical Performance Characteristics



1.5

Frequency (GHz)

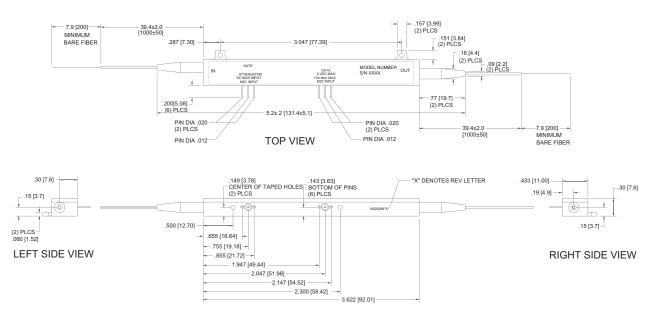
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Typical Return Loss Curve, S11

-2.50
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Dimensions Diagram

(Specifications in inches [mm] unless otherwise noted.)



FRONT VIEW

Specifications

Specification Material Lithium niobate Crystal orientation x-cut, y-propagating Waveguide process APE/titanium-indiffused Operating wavelength Insertion loss, no connectors (note²) ≤6.5 dB On/off extinction ratio, low frequency ≥20 dB Optical return loss ≥50 dB Electrical February RF port 3.6 V typical Vπ at 100 kHz (note²) ≤3.7 V S21 electro-optic bandwidth (-3 dBe) (note¹-3) ≥2.5 GHz S11 return loss 0.03 to 2.5 GHz (note²) ≤-9.5 dB RF input power ≤24 dBm Chirp, alpha parameter α <0.2 Attenuator port Vπ at DC ≤5.0 V	The state of the s	
MaterialLithium niobateCrystal orientationx-cut, y-propagatingWaveguide processAPE/titanium-indiffusedOpticalOperating wavelength1535 to 1565 nmInsertion loss, no connectors (note²)≤6.5 dBOn/off extinction ratio, low frequency≥20 dBOptical return loss≥50 dBElectricalRF portDrive voltage, V peak-to-peak, at 2.5 Gb/s PRBS (note³)3.6 V typicalVπ at 100 kHz (note³)≤3.7 VS21 electro-optic bandwidth (-3 dBe) (note¹-3)≥2.5 GHzS11 return loss0.03 to 2.5 GHz (note³)≤-9.5 dBRF input power≤24 dBmChirp, alpha parameter α <0.2Attenuator port√π at DC≤5.0 V	Parameter	Specification
$ \begin{array}{ c c c } \hline Crystal \ orientation & x-cut, y-propagating \\ \hline Waveguide \ process & APE/titanium-indiffused \\ \hline \textbf{Optical} & & & & \\ \hline \textbf{Operating wavelength} & 1535 \ to 1565 \ nm \\ \hline \textbf{Insertion loss, no connectors (note²)} & \leq 6.5 \ dB \\ \hline \textbf{On/off extinction ratio, low frequency} & \geq 20 \ dB \\ \hline \textbf{Optical return loss} & \geq 50 \ dB \\ \hline \textbf{Electrical} & & & \\ \hline \textbf{RF port} & & & \\ \hline \textbf{Drive voltage, V peak-to-peak, at 2.5 Gb/s PRBS (note³)} & 3.6 \ V \ typical \\ \hline \textbf{Vπ at 100 kHz (note³)} & \leq 3.7 \ V \\ \hline \textbf{S21 electro-optic bandwidth (-3 dBe) (note¹-3)} & \geq 2.5 \ GHz \\ \hline \textbf{S11 return loss} & & \\ \hline \textbf{0.03 to 2.5 GHz (note³)} & \leq -9.5 \ dB \\ \hline \textbf{RF input power} & \leq 24 \ dBm \\ \hline \textbf{Chirp, alpha parameter} & \alpha < 0.2 \\ \hline \textbf{Attenuator port} & & \\ \hline \textbf{Vπ at DC} & \leq 5.0 \ V \\ \hline \end{array} $	General	
$\begin{tabular}{lllllllllllllllllllllllllllllllllll$	Material	Lithium niobate
		x-cut, y-propagating
$ \begin{array}{ c c c c } \hline Operating wavelength & 1535 to 1565 nm \\ \hline Insertion loss, no connectors (note²) & \leq 6.5 dB \\ \hline On/off extinction ratio, low frequency & \geq 20 dB \\ \hline Optical return loss & \geq 50 dB \\ \hline \hline Electrical & & \\ \hline RF port & & \\ \hline Drive voltage, V peak-to-peak, at 2.5 Gb/s PRBS (note³) & 3.6 V typical \\ \hline V_{\pi} at 100 kHz (note³) & \leq 3.7 V \\ \hline S21 electro-optic bandwidth (-3 dBe) (note¹,³) & \geq 2.5 GHz \\ \hline S11 return loss & & \\ \hline 0.03 to 2.5 GHz (note³) & \leq -9.5 dB \\ \hline RF input power & \leq 24 dBm \\ \hline Chirp, alpha parameter & \alpha < 0.2 \\ \hline Attenuator port & \\ \hline V_{\pi} at DC & \leq 5.0 V \\ \hline \end{array} $	Waveguide process	APE/titanium-indiffused
Insertion loss, no connectors (note²)≤6.5 dBOn/off extinction ratio, low frequency≥20 dBOptical return loss≥50 dBElectricalRF portDrive voltage, V peak-to-peak, at 2.5 Gb/s PRBS (note³)3.6 V typical V_{π} at 100 kHz (note³)≤3.7 VS21 electro-optic bandwidth (-3 dBe) (note¹,³)≥2.5 GHzS11 return loss≤-9.5 dB0.03 to 2.5 GHz (note³)≤-9.5 dBRF input power≤24 dBmChirp, alpha parameter α <0.2		
$ \begin{array}{c c} \hline On/off \ extinction \ ratio, low \ frequency \\ \hline Optical \ return \ loss \\ \hline \hline SElectrical \\ \hline \hline RF \ port \\ \hline \hline Drive \ voltage, V \ peak-to-peak, at 2.5 \ Gb/s \ PRBS \ (note^3) \\ \hline V_{\pi} \ at \ 100 \ kHz \ (note^3) \\ \hline S21 \ electro-optic \ bandwidth \ (-3 \ dBe) \ (note^{1,3}) \\ \hline S21 \ return \ loss \\ \hline 0.03 \ to \ 2.5 \ GHz \ (note^3) \\ \hline RF \ input \ power \\ \hline Chirp, \ alpha \ parameter \\ \hline V_{\pi} \ at \ DC \\ \hline \hline \\ Attenuator \ port \\ \hline \hline \\ V_{\pi} \ at \ DC \\ \hline \end{array} $		1535 to 1565 nm
$ \begin{array}{ c c c }\hline \text{Optical return loss} & \geq 50 \text{ dB} \\ \hline \textbf{Electrical} \\ \hline \textbf{RF port} \\ \hline & Drive voltage, V peak-to-peak, at 2.5 Gb/s PRBS (note³) & 3.6 V typical \\ \hline & V_{\pi} \text{ at } 100 \text{ kHz (note³)} & \leq 3.7 \text{ V} \\ \hline & S21 \text{ electro-optic bandwidth (-3 dBe) (note¹,³)} & \geq 2.5 \text{ GHz} \\ \hline & S11 \text{ return loss} & \\ \hline & 0.03 \text{ to } 2.5 \text{ GHz (note³)} & \leq -9.5 \text{ dB} \\ \hline & RF \text{ input power} & \leq 24 \text{ dBm} \\ \hline & Chirp, alpha parameter & \alpha < 0.2 \\ \hline & \\ \hline & \\ \hline & Attenuator port & \\ \hline & V_{\pi} \text{ at DC} & \leq 5.0 \text{ V} \\ \hline \end{array} $	Insertion loss, no connectors (note ²)	≤6.5 dB
	On/off extinction ratio, low frequency	≥20 dB
RF portDrive voltage, V peak-to-peak, at 2.5 Gb/s PRBS (note³)3.6 V typical V_{π} at 100 kHz (note³) $\leq 3.7 \text{ V}$ S21 electro-optic bandwidth (-3 dBe) (note¹,³) $\geq 2.5 \text{ GHz}$ S11 return loss0.03 to 2.5 GHz (note³) $\leq -9.5 \text{ dB}$ RF input power $\leq 24 \text{ dBm}$ Chirp, alpha parameter $ \alpha < 0.2$ Attenuator port V_{π} at DC $\leq 5.0 \text{ V}$	Optical return loss	≥50 dB
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Electrical	
$\begin{array}{c c} V_{\pi} \text{ at } 100 \text{ kHz (note}^3) & \leq 3.7 \text{ V} \\ \hline S21 \text{ electro-optic bandwidth (-3 dBe) (note}^{1.3}) & \geq 2.5 \text{ GHz} \\ \hline S11 \text{ return loss} & \\ \hline 0.03 \text{ to } 2.5 \text{ GHz (note}^3) & \leq -9.5 \text{ dB} \\ \hline RF \text{ input power} & \leq 24 \text{ dBm} \\ \hline Chirp, alpha parameter} & \alpha < 0.2 \\ \hline \hline Attenuator port & \\ \hline V_{\pi} \text{ at DC} & \leq 5.0 \text{ V} \\ \hline \end{array}$		
$\begin{array}{c c} S21 \ electro-optic \ bandwidth \ (-3 \ dBe) \ (note^{1,3}) & \geq 2.5 \ GHz \\ \hline S11 \ return \ loss & \\ \hline 0.03 \ to \ 2.5 \ GHz \ (note^3) & \leq -9.5 \ dB \\ \hline RF \ input \ power & \leq 24 \ dBm \\ \hline Chirp, \ alpha \ parameter & \alpha < 0.2 \\ \hline Attenuator \ port & \\ \hline V_{\pi} \ at \ DC & \leq 5.0 \ V \end{array}$		3.6 V typical
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		≤3.7 V
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	S21 electro-optic bandwidth (-3 dBe) (note ^{1,3})	≥2.5 GHz
$ \begin{array}{c c} RF \ input \ power & \leq 24 \ dBm \\ \hline Chirp, \ alpha \ parameter & \alpha < 0.2 \\ \hline Attenuator \ port & \\ \hline V_{\pi} \ at \ DC & \leq 5.0 \ V \\ \end{array} $	S11 return loss	
		≤-9.5 dB
$\frac{\text{Attenuator port}}{V_{\pi} \text{ at DC}} \leq 5.0 \text{ V}$		≤24 dBm
V_{π} at DC \leq 5.0 V		$ \alpha $ <0.2
	Attenuator port	
X 1		
	Impedance	≥1 MΩ
Mechanical	Mechanical	
Input Fujikura SM-15-P-8/125-UV/UV-400	1	,
Output (note ⁴) SMF-28		SMF-28
RF connection Pins	RF connection	Pins
Bias connection Pins		Pins
Environmental	Environmental	
Operating temperature 0 to 65 °C		1 11 11 1
Storage temperature -40 to 85 °C	Storage temperature	-40 to 85 °C

^{1.} Relative to 30 MHz.

^{2.} Insertion loss is measured at the maximum of the modulator's transfer function and does not include the 3 dB loss incurred when operating at quadrature.

 $^{{\}it 3. \, Variances \, with \, temperature \, and \, wavelength \, included.}$

^{4.} PM output fiber also available.



Ordering Information	

For more information on this or other products and their availability, please contact your local JDSU account manager or JDSU directly at 1-800-498-JDSU (5378) in North America and +800-5378-JDSU worldwide or via e-mail at customer.service@jdsu.com.

Sample: 10021970

Product Code	Description
10021970	2.5 Gb/s modulator with integral attenuator and no optical connectors
10021971	2.5 Gb/s modulator with integral attenuator and FC/SPC optical connectors

Note: Other connectors available upon special request. Call JDSU for more information.

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