

SAG Series Electro-optic Modulators (Pockels Cell)

1. Free-Space High-Speed Modulators (Pockels Cell)

Our electro-optic modulators are based on a special crystal that has less piezo-effect and low charge migration than the traditional Mg-doped lithium niobate crystals, resulting in clean response with less ringing, more efficient with less power consumption, the ability to work at shorter wavelength and higher optical power. We produce two versions: resonant and direct driving. Both modify the phase, polarization or amplitude of a free-space laser: The resonant modulator drastically reduces driving voltage so that it can be driven by a laboratory function generator. Each device uniquely has three fixed resonance frequencies of 1MHz, 15MHz, and 30MHz that can be manually selected via a toggle switch. Our resonance electro-optic modulator is a cost effective and convenient device for testing applications. Custom frequencies up to 100MHz are also available. Another version is direct driving modulator that can be operated from DC to high frequencies. However, it needs a high voltage driver which determines its performance. We produce a high-voltage driver. Customers can use drivers from other manufacturers.

Applications:

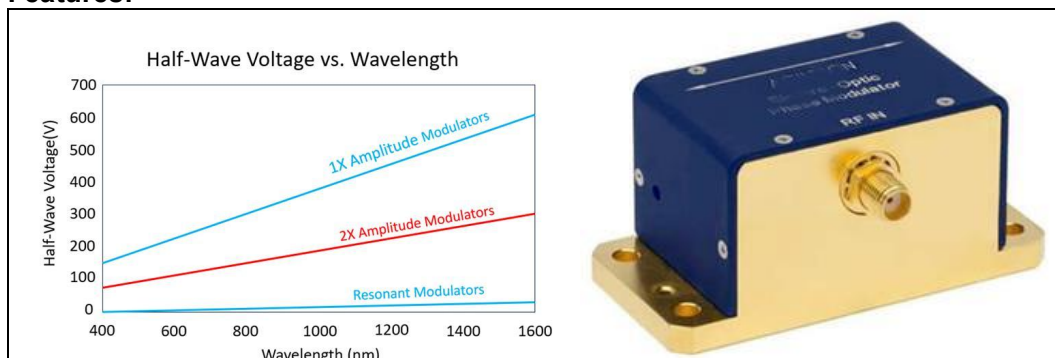
- 3mm aperture
- Wide operation wavelength 450 to 1,550nm
- High optical power handling
- Low driving voltage ~12V (resonance)
- One device with three frequencies to select (1, 15, 30MHz)
- High repetition rate up to 100MHz (Resonance)
- Broadband DC to 1MHz (non-Resonance)
- Fiber coupled available
- Customization available

1.1 Free-Space EOM (Pockels Cell)

(Phase or amplitude 3mm aperture, 300nm to 2000nm, DC-MHz)

The SAG-FEOM series free-space electro-optic Modulator uses a compensated electro-optic crystal pair — engineered for superior high-power handling and short-wavelength stability compared to conventional LiNbO_3 — to modulate the phase or amplitude of free-space laser beams across a broad wavelength range. Offered in single-pair and dual-pair crystal lengths to reduce drive voltage and enable deeper or faster modulation, the system operates from DC to MHz when paired with its matched driver. Optional accessories include polarization cubes for high-extinction-ratio amplitude modulation, isolators to prevent back-reflections, and an output detector for feedback control, with a polarized input beam required for amplitude-modulation operation.

Features:



- High performance
- Compact package
- Easy integration
- Customize available
- Low cost

Applications

- Laser modulation
- Holography
- Metal cutting/engraving
- Microfabrication

Specifications

Parameter	Specification (Unit)
Wavelength	400~600nm
	600~900nm
	900~1250nm
	1250~1650nm
Clear aperture	3mm (Min)
Halfwave voltage, non-resonant	80~600 V
Extinction ratio ^[1]	10~30dB (Typical: 20 dB)
Input impedance, resonant	50 ohms (Typical)
Input capacitance, non-resonant	14pF (Typical)
Max optical power density	532nm: 2~10 W ^[2]
	1064nm: 5~20 W ^[2]
Temperature	-20~50°C

Notes:

[1]: Related to the polarizer and beam quality

[2]: High power version available

Ordering Information:

Series	Modulation type	Wavelength	Optical power	Crystal length	Input cube **	Output cube **	Driver	Isolator
SAG-FEOM	Amplitude=A Phase=P	400~600nm = 05 600~900nm = 07 900~1250nm = 09 1250~1650nm = 14 320~500nm = 03 1920-2400nm = 20	Regular=1 High Power=2	1x/2x/3x	No=1 Polacore =3 PBS=4 Glan-Thompson =5	No=1 Polacore=3 PBS=4 Glan-Thompson=5	Non=1 Yes=2	None=1 One Stage =2 Two Stage =3

** Polacore: CW 10W/cm², PBS: CW 15W/cm², Glan-Thompson: CW 2kW/cm².

1.2 Resonant Free-Space EOM (Pockels Cell)

(2mm aperture, 400nm to 2000nm, fixed frequency from 1 to 100MHz)

The FEOM free-space electro-optic modulator is a crystal-based resonant modulator engineered to operate at a fixed resonance frequency, allowing low-voltage drive for phase, polarization, or amplitude modulation of a laser. Resonance frequencies are selectable from 5 to 20MHz. We offer both a standard version and a high-power version using RTP crystals to accommodate different application requirements. The standard unit uses a single crystal pair, while wavelengths above 1000nm require two pairs to achieve full modulation depth. The design minimizes piezo-electric effects and charge buildup, producing the characteristic sinusoidal response of resonance-driven devices. For amplitude modulation, polarized input light is required because the modulation process depends on controlling intensity through the polarization state. With input and output polarizers, the device achieves a significantly enhanced extinction ratio (ER).

Features:

- Low loss
- Ease to use
- Low cost

Applications

- Laser Modulation

Specifications

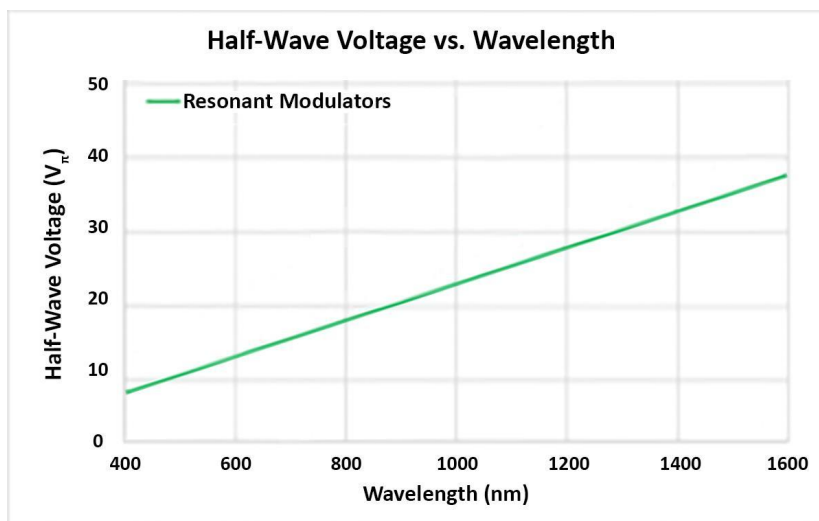
Parameter	Specification
Wavelength range	400-600nm/600-900nm/900-1250nm/1250-1650nm
Halfwave voltage (non-resonant)	225V @ 633nm
Halfwave voltage ^[1] , resonant	15V @ 633nm
Extinction ratio ^[2]	10dB (Min)
Input impedance, resonant	50ohms
Input capacitance @ non-resonance	14pF
Aperture	3mm (Max)
Max optical power density ^[3]	Standard: 2-4W/mm ² ; High Power: 1-500MW/mm ²
Temperature	20~50°C

Notes:

[1]. Maximum modulation depth or phase shift voltage. The halfwave voltage increases as the wavelength increases.

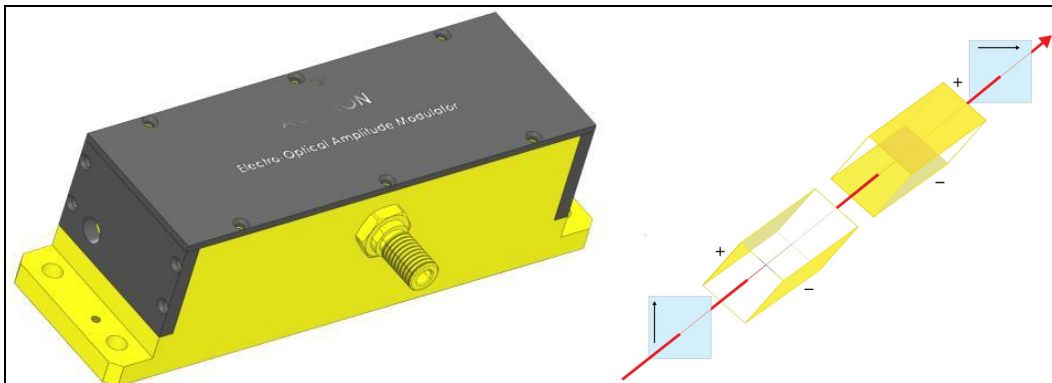
[2]. Characterized at 633nm.

[3]. Wavelength dependent, typical is for 550nm, max is for 1060nm.

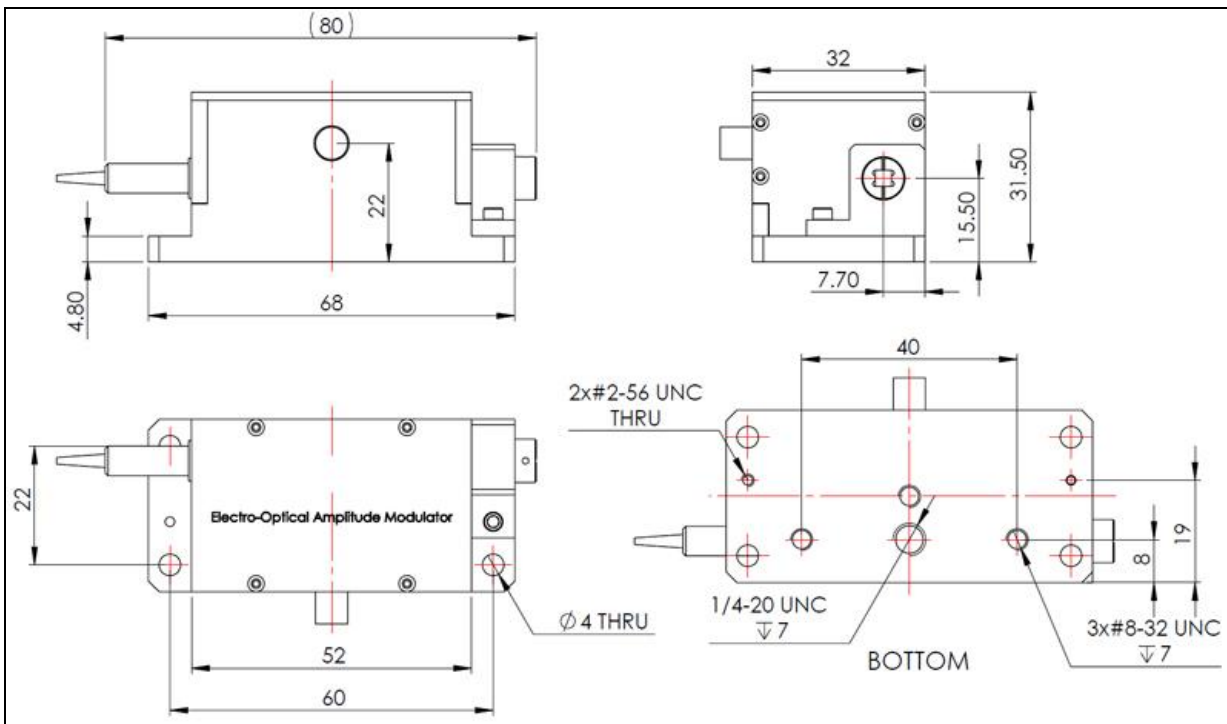
Resonant Modulator Half-Wave Voltage

Ordering Information:

Series	Modulation type	Wavelength	Optical power	Resonant frequency	Input polarizer *	Output polarizer *	Isolator
SAG-REOM	Amplitude=A Phase=P	250~400nm=03 400~600nm=05 600~900nm=07 900~1250nm=10 1250~1650nm=14	Regular=1 2W=2 5W=5 10W=10 20W=20 50W=50 100W=100 300W=300	20MHz=20 5MHz=5 10MHz=10 30MHz=30 50MHz=50	No=1 PBS=4 Glan-Thompson=5	No=1 PBS=4 Glan-Thompson=5	Single resonant Frequency version = F1

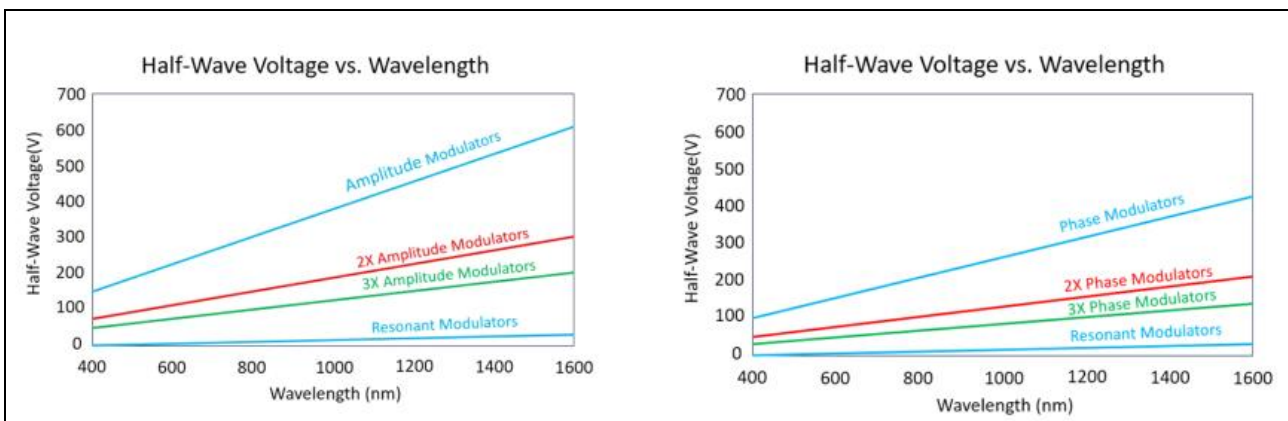
* PBS: CW 15W/cm² , Glan-Thompson: CW 2kW/cm².



Mechanical Drawing (mm)



Modulator Half-Wave Voltage



Operation Instructions

- 1. Input alignment** – Direct the laser beam through the device, ensuring proper alignment along the optical axis without hitting the crystal walls.
- 2. Input polarizer setup** – Place a vertical polarizer at the input side. Adjust the input laser polarization direction to achieve maximum output intensity.
- 3. Output polarizer setup** – Place a horizontal polarizer at the output side of the device. Carefully adjust the orientation of the output polarizer to achieve minimum transmitted output intensity (extinction condition).
- 4. Apply Control Voltage** – Gradually apply voltage to the device and observe changes in the output intensity. At the operating voltage (V_p), the output intensity will reach its maximum.

1.3 GHz Resonant Optical Phase Modulator (1-3.05GHz, temperature control option)

The GHz resonant optical phase modulator delivers high-speed optical phase modulation using advanced electro-optical technology. It features an integrated resonance electrical circuit within the package, enabling operation with a low driving voltage. Packaging options include free-space and fiber-coupled configurations, with additional choices for TEC temperature stabilization and integration with an amplifier driver to increase modulation depth. The operation requires linearly polarized light.

Features:

- High speed
- Ultra-high reliability
- Low insertion loss
- Compact

Applications

- Atomic clock
- Optical blocking
- Configurable operation
- Instrumentation

Specifications

Parameter	Specification
Resonance frequency	0.7~3.05GHz
Bandwidth	3.8~10MHz
Q factor	325
Wavefront distortion @633nm	Max: $1/6\lambda$
Modulation depth	Max: 2.5rad
Sensitivity	0.38~0.47rad/V
Required RF power (1 rad @400nm)	35dBm
Input impedance	50 Ω
RF connector	SMA-F
Max RF power	5W
Optical aperture	1~2mm ²
Max optical power	1W/mm ²
Optical wavelength	350~780nm
Operating temperature ^[1]	5°C
Storage temperature	-40~85°C

Note

[1] TEC actively cooled

Ordering Information:

Series	Type	Wavelength	Resonance Frequency	Input Fiber	TEC	RF Amplifier
SAG-GHZM	Standard=11 Special=00	532=5 780=7 650=6 550=5 450=4 350=3 Special=0	1.12GHz=112 3.05GHz= 305 1.75GHz= 175	Non=1 PM480=4 Special=0	Non=1 Yes=2	Non =1 Yes=2

2. High Voltage EO Driver (up to 400V)

The HVED series analog high voltage drivers provide up to $\pm 200V$ with 1MHz bandwidth or 400V with 0.5MHz bandwidth, ideal for driving non-resonant EO phase modulators to modulate optical signals at wavelengths up to 1060nm. A polarity modulation feature minimizes charge buildup from photorefractive effects, particularly at shorter wavelengths and higher power.

The drivers include an adjustable DC bias up to 50V for precise performance tuning. For example, with a sweep range of -200V to +200V and a 10V DC bias, the output shifts to -190V to +210V (clipping the positive side), while a 100V DC bias adjusts to -100V to +100V. This bias flexibility allows precise control, optimizing electro-optic device functionality.

For amplitude modulation, polarized light is essential because the modulation process relies on controlling the intensity of light based on its polarization state. By incorporating input and output polarizers, the extinction ratio (ER) of the device is significantly improved.

Features:

- 400V high voltage
- 10ns rise/fall
- Analog response

Applications

- EO Device Control

Specifications

Parameter	Specification
Output voltage	0~400V (Typical: $\pm 220V$)
Rise/fall time ^[1]	7~10ns (Typical: 7ns)
Bias voltage	0~50V
Delay time	Max: 200ns
Repetition rate	0.5~0.7MHz (Typical: 0.5MHz)
Pulse jitter	1~20ps
Operating temperature	-5~40°C
Power input	100~240ACV
Power consumption	Max: 10W
Control input	0~5V
Humidity 90%	Noncondensing
Storage temperature	-40~85°C

Notes

[1] At 10-90% level. Also affected by amplitude and capacitor load. For 400V output, repetition rate is 0.5MHz

Ordering Information:

Series	Max voltage	Package	Configuration	Repetition *
SAG-HVED	$\pm 220V=22$ 400V=40 Special=00	Benchtop=1 PCB=2 Special=0	Standard=1 Special=0	0.3MHz=1 0.5MHz=2 0.7MHz=3

* 1MHz only available for 220V version.

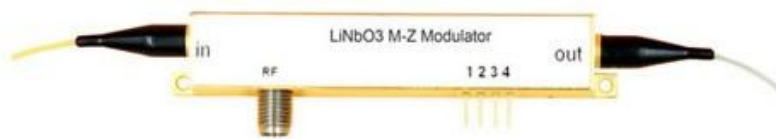


STK Series Electro-optic Modulators & Drivers

List of EO Modulators & Drivers

- Phase Modulator
- Intensity Modulator
- Driver
- Dual Parallel High-speed IQ Modulator

1. Electro-optic Intensity Modulator



The STK-AM series electro-optic intensity modulator utilizes the electro-optical effect of lithium niobate and push-pull Mach-Zehnder interference structure to achieve intensity modulation of optical signals. It features low insertion loss, high modulation bandwidth, high extinction ratio, low half-wave voltage and high damage optical power. This product is mainly used for electro-optical signal conversion in high-speed optical fiber communication systems, the generation of light sidebands, high extinction ratio light pulse generation in quantum communication, microwave fiber link and other fields.

Key Features

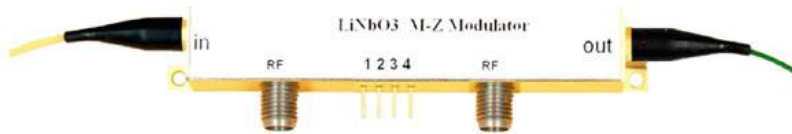
- Wavelengths optional
- Low half-wave voltage
- High bandwidth
- Low insertion loss

Applications

- High-speed optical fiber communication systems
- Microwave fiber link
- Quantum communication

Parameters	Symbol	STK- AM-08	STK-AM-10	STK-AM-15-10G	STK-AM-15-20G
Wavelength		830±40	1064±60	1550±100nm	155±100nm
Insertion loss	IL	<5 dB	<4 dB	<4 dB	<4.5 dB
Optical return loss	ORL	-40 dB	-45 dB	-45dB	-45dB
Bandwidth (-3dB)	S ₂₁	2.5GHz	10GHz-	10GHz	20GHz
Rise time 10%~90%	tr	150ps	35ps	35ps	18ps
Half-wave voltage @50KHz, RF	V _π	5V	4.5V	4V	5V
Half wave voltage @Bias	V _π	6V	6V	5V	5V
Extinction ratio	ER	28dB	30dB	>25dB	>25dB
Input resistance	Z _{RF}	50 @RF, 1M @Bias			
Electrical interface		SMA(f)			K(f)
Electrical return loss	S ₁₁	<-10dB			
Input fiber		PM Panda slow axis alignment			
Output fiber		Single mode fiber or PM fiber			
Fiber connector		FC/APC or customer specified			
Operating temperature	Top	-10~60 C			
Storage temperature	T _{st}	-40~80 C			
RF input power	P _i	<28dBm			
Max. input optical power	P _o	30mW	50mW	100mW	100mW

1.1 1064nm High Extinction Ratio Electro-optic Intensity Modulator STK-AM-10



Key Features

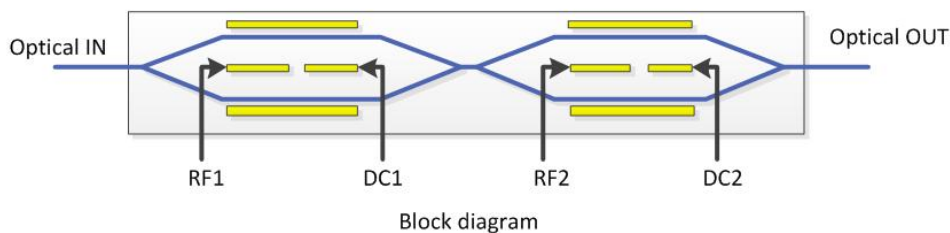
- 1064nm Operation
- Low insertion loss
- 3dB bandwidth 5GHz
- Low half-wave voltage
- High Extinction Ratio >50dB

Applications

- Optical Pulse Generation
- Optical fiber sensing system
- Laser mode locking

The 1064nm high extinction ratio electro-optical intensity modulator integrates two Mach-Zehnder intensity modulators with a push-pull structure, which can achieve an extinction ratio of up to 50dB. It is used in the fields of high-speed optical pulse generation, fiber sensing, and laser mode locking.

Block diagram

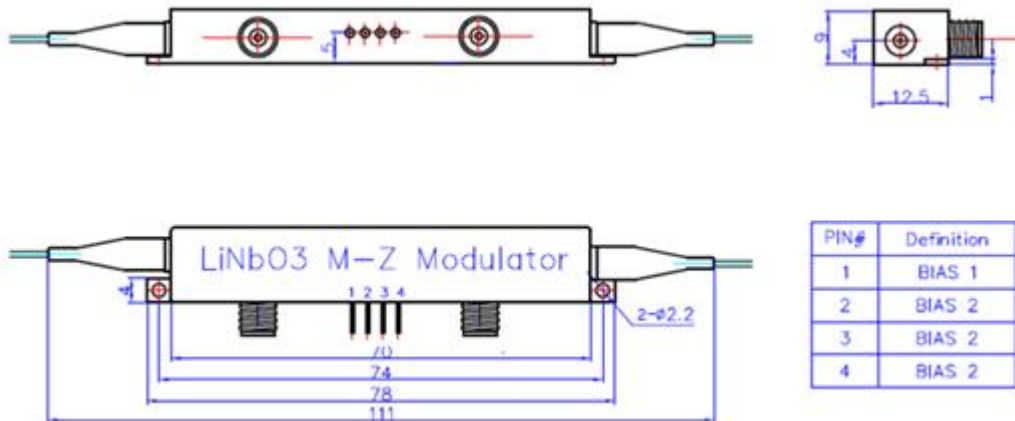


Parameters		Symbol	Min.	Typ.	Max.	Unit
Optical Parameters						
Crystal			LiNbO3 X-Cut Y-Prop			
Waveguide process			APE			
Wavelength			980	1064	1100	nm
Insertion loss*		IL		7	8	dB
Optical return loss		ORL			-40	dB
Extinction ratio @DC		ER@DC	50			dB
Polarization extinction ratio*		PER	25	28		dB
Fiber	Input		Panda PM 980			
	Output		Panda PM 980			
Fiber connector			FC/PC、FC/APC or user specified			
Electrical Parameters						
Bandwidth（-3dB）		S ₂₁	5			GHz
Half-wave voltage V _{pi}	RF1 & RF2	V _{π@50KHz}		4.5	5	V
	Bias1 & Bias2	V _{π@Bias}		4	5	V
Electrical return loss		S ₁₁		-12	-10	dB
Input impedance	RF1 & RF2	Z _{RF}	50			
	Bias1 & Bias2	Z _{BIAS}	1M			
Electrical connector	RF1 & RF2		SMA(f)			
	Bias1 & Bias2		4pin			

*with connector

Absolute Maximum Ratings

Parameters	Symbol	Unit	Min.	Typ.	Max.
Input optical power	$P_{in,Max}$	dBm			10
RF input power		dBm			28
Bias voltage	Vbias	V	-15		15
Operating temperature	Top	°C	-10		60
Storage temperature	Tst	°C	-40		85
Humidity	RH	%	5		90
Dimension		mm		111x12.5x9	



Ordering Information

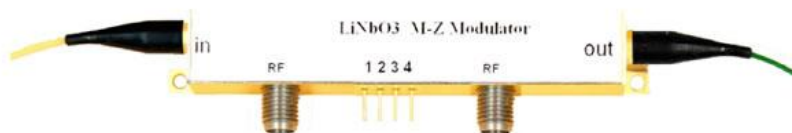
STK-AM-WL-BW-PP-FA/FP-HER

WL—Wavelength: 10-1064nm

BW—Bandwidth: 5G---5GHz

FA/FP—Connector: FA---FC/APC; FP---FC/PC

1.2 1550nm High Extinction Ratio Electro-optic Intensity Modulator



Key Features

- C and L-Band Operation
- Low insertion loss
- 3dB bandwidth 10GHz
- Extinction ratio 35/40dB
- Low half-wave voltage
- Integrated Monitor Photodiode
- Telecordia GR-468-CORE

Applications

- Microwave fiber link
- Quantum communication
- Optical pulse generation
- Optical fiber sensing system
- Laser mode locking

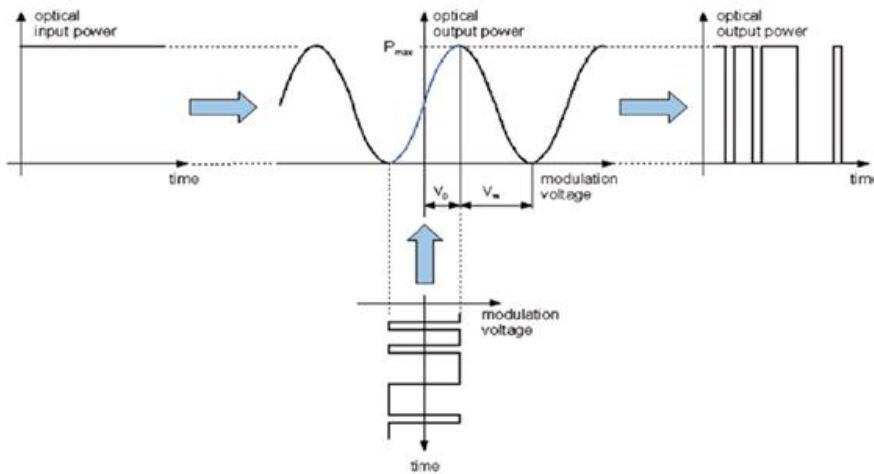
The 1550nm High Extinction Ratio LiNbO3 electro-optical intensity modulator based on the M-Z push-pull structure has a low half-wave voltage and stable physical and chemical characteristics, and the

10 Bukit Batock Crescent #07-02 The Spire Singapore 658079 Tel: 6316 7112 Fax: 63167113

<http://www.SintecOptronics.com> <http://www.sintec.sg> sales@sintec.sg sales@SintecOptronics.com

device has a high response rate, high extinction ratio(>40dB) and is therefore widely used in microwave fiber link, Quantum communication, optical Q-switched systems, laser mode-locking, and fiber sensing .

Schematic diagram

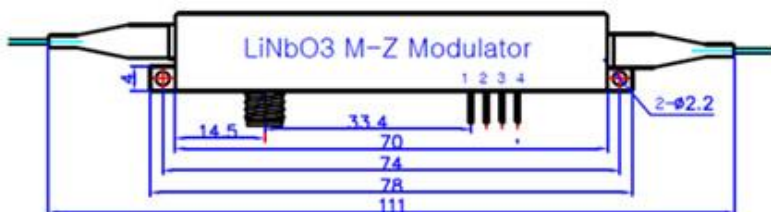
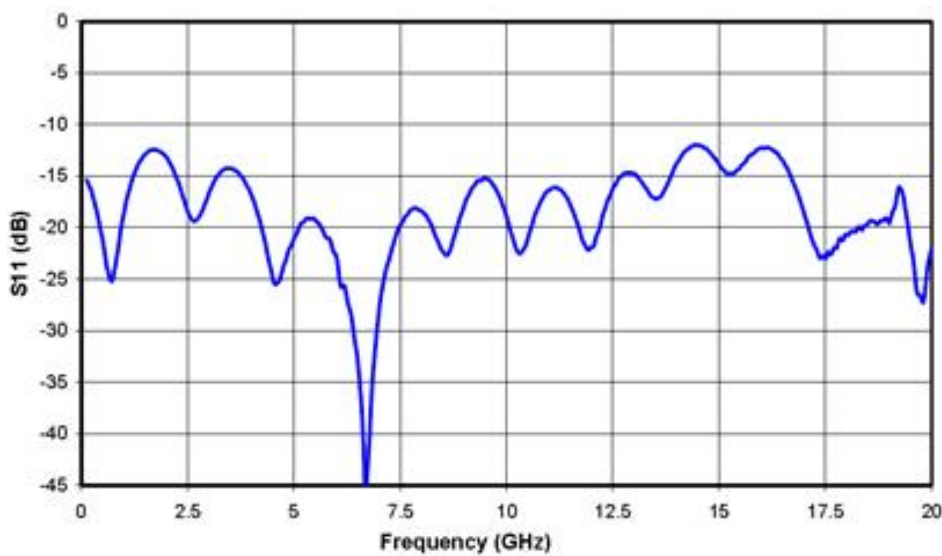
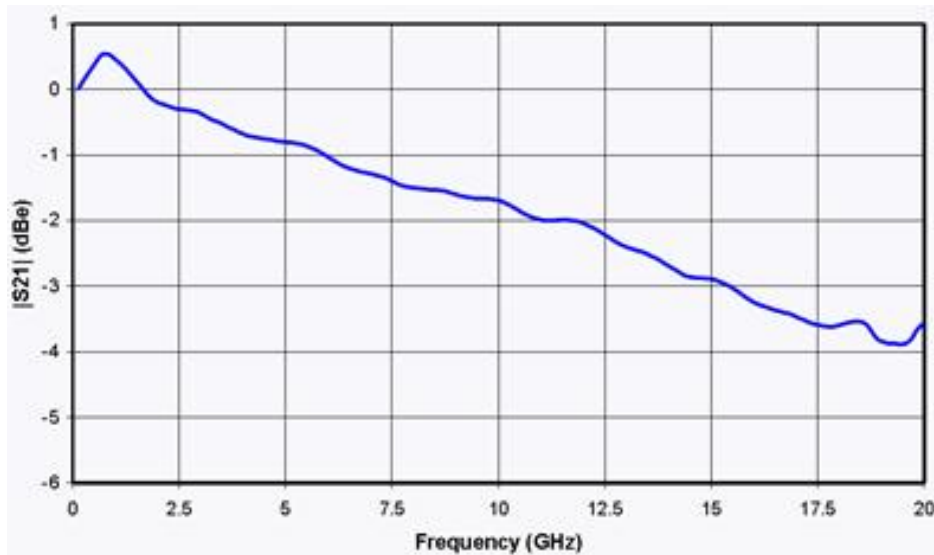


Parameters		Symbol	Min.	Typ.	Max.	Unit
Optical Parameters						
Wavelength			1525		1565	nm
Insertion loss(with connector)		IL		4	5	dB
Optical return loss		ORL			-45	dB
Extinction ratio @DC		ER@DC	35	40		dB
Fiber	Input		Panda PM Fujikura SM 15-P-8/125-UV/UV-400			
	Output		Panda PM Fujikura SM 15-P-8/125-UV/UV-400			
Fiber interface			FC/PC、FC/APC or user specified			
Electrical Parameters						
Bandwidth (-3dB)		S ₂₁	10	12		GHz
Rise time (10%~90%)		Tr	35			ps
Half-wave voltage V _{pi}	RF	V _π @50KHz			5	V
	Bias	V _π @Bias			6	V
Electrical return loss		S ₁₁		-12	-10	dB
Photodiode Responsivity		R _P	10 ⁻³			A/W
Input impedance	RF	Z _{RF}	50			
	Bias	Z _{BIAS}	1M			
Electrical interface			SMA(f)			
Dimension			111x12.5x9			mm

Absolute Maximum Ratings

Parameters	Symbol	Unit	Min.	Typ.	Max.
Input optical power	$P_{in,Max}$	dBm			20
RF input power		dBm			28
Bias voltage	V_{bias}	V	-20		20
Operating temperature	T_{op}	°C	-10		60
Storage temperature	T_{st}	°C	-40		85
Humidity	RH	%	5		90

Characteristic Curve



- PIN#
1. Bias
 2. GND
 3. PD Cathode
 4. PD Anode

Ordering Information

STK-AM-WL-BW-PP-FA/FP-ER

WL—Wavelength: 15-1550nm

BW—Bandwidth: 10G---10GHz 20G-20GHz

FA/FP—Connector: FA---FC/APC; FP---FC/PC

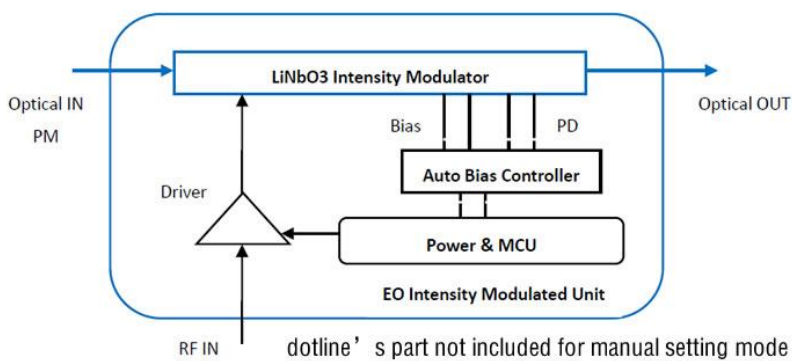
ER---Extinction Ratio: 35dB, 40dB

1.3 10GB 1550nm All-in-one Electro-optic Modulator STK-MU-15-NRZ

We can provide with the driver for the above electro-modulators and integrate the modulator, amplifier and relevant controllers together. The user can manually or automatically set the bias points. At the manual setting mode, the bias can be displayed and the EO modulator and amplifier individually operate. At the automatic setting mode, the user can set various bias points according to the demand and the bias point is locked and displayed. The modulation performance of the modulator is not influenced by external factors such as environment temperature and vibration.

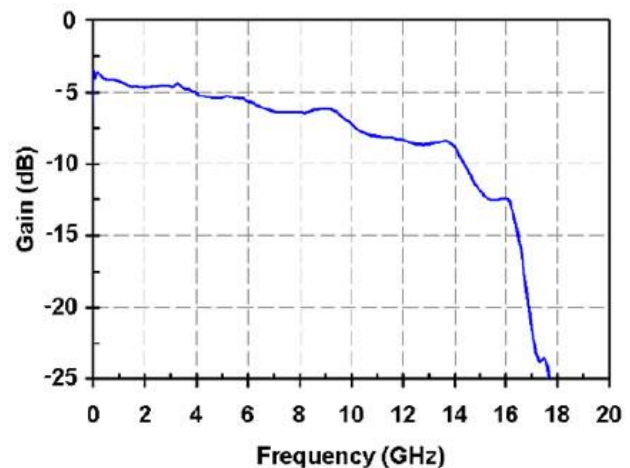
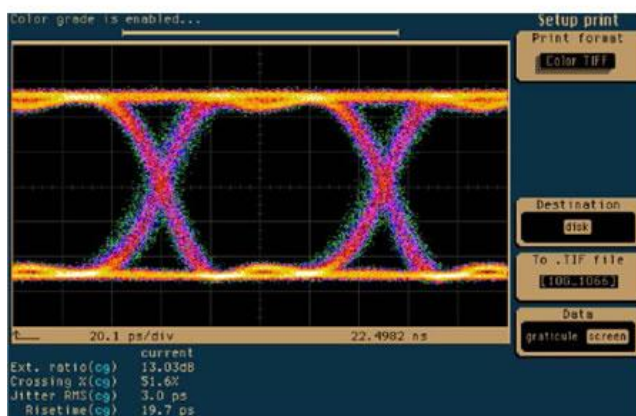


STK-MU-15-NRZ



		Symbol	Min	Typical	Max	Unit
Optical parameters						
Wavelength		λ	1520	1550	1610	nm
Crystal			LiNbO3			
Insertion loss	@Peak	IL		4.5	5.5	dB
	@Q	IL		7	8	dB
Optical return loss		ORL			-45	dB
Extinction ratio @DC		ER@DC	25	28		dB
Fiber	Input		Panda PM Fujikura SM 15-P-8/125-UV/UV-400			
	Output		Corning SMF-28			
Electrical parameters						
Bandwidth (-3dB)		S ₂₁	10	12		GHz
Working speed			10K		12.5G	bps
Input signal format				NRZ		
Input signal amplitude		V _i	0.25	0.4	0.8	V _{pp}
Half-wave voltage @10Gbps		V _π	4.5	5.0		V
Dynamic extinction ratio@10Gbps NRZ		DER	12			dB
Rise time (10%-90%)		Tr	30	35		ps
Additional vibration*		Jitter _{RMS}	1.1	1.7	2.0	ps
Amplification gain		G	0		25	dB
Loss from waves		S ₁₁		-12	-10	dB
Input impedance @RF input		Z _{RF}		50		Ω

Manual setting mode					
Bias voltage	Vbias	-10		10	V
Adj. accuracy			0.1		V
Automatic setting mode					
Bias		Null, Q+/-, Peak			
Vibration period	F		1		KHz
Vibration amplitude	Vpp		2%V π		
Harmonic extinction ratio		40	50		dB
Optical power stability	ΔP			0.1	dB
Duty		45		55	%
Other parameters					
Input interface			SMA(f)		
Optical interface	Input		FC/APC PM		
	Output		FC/APC SM		
Input power		V _{DC}	AC 220		V
Dimension		LxWxH	270x300x90		mm
Weight			<5		kg
Port			RS232		
Display contents	Manual		Amplification gain, real-time bias voltage		
	Automatic		Amplification gain, bias Vpi, real-time bias voltage, bias lock status		



Ordering Information

STK-MU-W-XX-BW-FB-YY-M/A

W: wavelength such as 15-1550nm, 13-1310nm, 10-1064nm

XX: modulation method such as NRZ, DPSK, DQPSK, DPQPSK, AN, PM

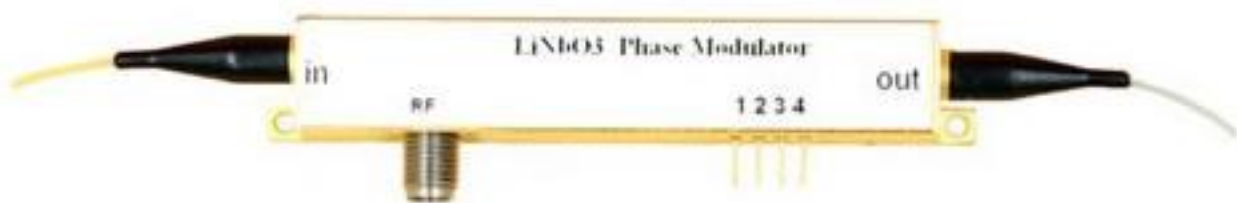
BW: bandwidth such as 02-2.5G, 10-10G, 20-20G, 40-40G

FB: input/output fiber type such as PP (input & output are PM), PS (input is PM and output is SM)

YY: fiber connector such as FA-FC/APC, FP-FC/PC

M/A: control mode, M is manual and A is automatic.

2. Electro-optic Phase Modulator



The STK-PM series electro-optic phase modulator utilizes the electro-optical effect of lithium niobate to achieve phase modulation of optical signals, and uses titanium diffusion or proton exchange process to

fabricate optical waveguides, which can achieve dual-polarization or single-polarization phase modulation. It has low insertion loss, high modulation bandwidth, low half-wave voltage, high damage optical power, etc. This product is mainly used for optical chirp control in high-speed optical communication systems, phase delay in coherent communication systems, the generation of optical sidebands, phase modulation in quantum communication, reducing stimulated Brillouin scattering (SBS) in analog optical fiber communication systems and other fields.

Key Features

- Wavelengths optional
- Low half-wave voltage
- Low insertion loss
- High damage optical power

Applications

- Optical fiber sensing systems
- Optical fiber communication
- Laser coherent synthesis
- Phase delay (movement)
- Quantum communication

Parameters	Symbol	STK-PM830-1	STK-PM1064-1	STK-PM1550-1	STK-PM1550-2
Wavelength		830 40	1064 60	1550	50nm
Insertion loss	IL	<5 dB	<4 dB	<4 dB	4 dB
Optical return loss	ORL	-40 dB	-45 dB	-45dB	-40 dB
Bandwidth (-3dB)	S ₂₁	2.5GHz	10GHz-	300MHz	10GHz
Rise time 10%~90%	tr	150ps	35ps	1ns	35ps
V _{pi} @50KHz	V _π	5V	4.5V	4V	4V
Input resistance	Z _{RF}	50		1M	50
Electrical interface		SMA(f)		3pin	SMA(f)
Electrical return loss	S11	<-10dB			
Input/output fiber		PM Panda slow axis alignment			
Fiber connector		FC/APC or customer specified			
Operating temperature	Top	-10~60 C			
Storage temperature	Tst	-40~80 C			
RF input power	Pi	<28dBm			
Maximum input optical power	Po	30mW	100mW	100mW	100mW

2.1 1550nm Optical CS-SSB Modulation Modules



The STK-MU-SSB-15 series product is an optical CS-SSB modulation module developed by our company. The modulation module integrates Mach-Zehnder dual parallel modulators, bias point control circuits, 90 degree hybrid splitter, can achieve stable and reliable single sideband modulation, and can switch between left and right sideband control as needed. This product is mainly used in Brillouin fiber sensing systems, microwave photonics, gas detection and other fields.

Key Features

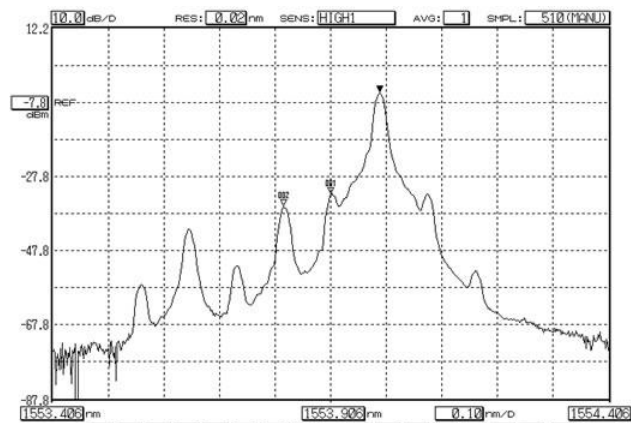
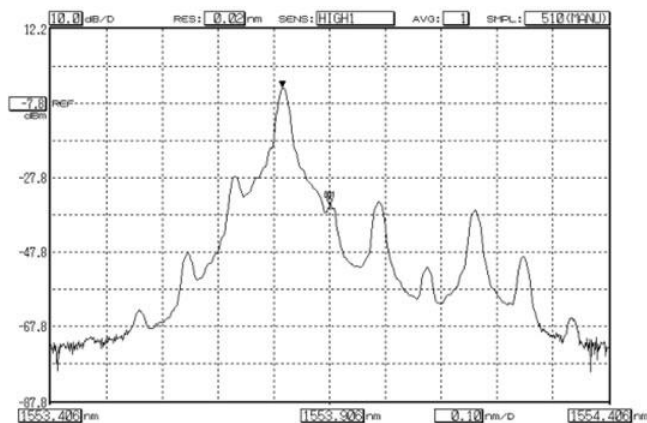
- Wavelength C-band
- Sideband suppression ratio: >30dB
- Carrier suppression ratio: >26dB
- Up and down sidebands
- Convenient to use and reliable

Applications

- Optical fiber sensing system
- Microwave photonics
- Gas detection
- Optical fiber communication systems

Parameters	Symbol	Min.	Typ.	Max.	Unit
Carrier Optical Source Parameters (Provided by the user)					
Laser type	DFB source or wavelength tunable source				
Wavelength	λ	1510		1560	nm
Line width	$\Delta\nu$	-		1	MHz
Polarization extinction ratio	PER		20	-	dB
Power	P_i		10	100	mW
Modulator Specification Parameters					
Modulator type	X-cut double parallel M-Z modulator				
Modulator bandwidth S21@3dB	BW	10	12	-	GHz
Insertion loss	IL		7	8	dB
Return loss	RL	-45	-50	-	dB
Bias Controller Parameters					
Automatic feedback bias controller		Jitter mode			
Jitter signal frequency		400	1000	1400	Hz
Jitter signal amplitude		10	50	1000	mV
Preset work point		Lowest point			
CS-SSB Optical Output Signal					
Single sideband modulation range*	F	1		12	GHz
Input RF power	PRF	-5		5	dBm

Sideband suppression ratio @1550nm		30	35	-	dB
Carrier suppression ratio @1550nm		26		32	dB
Interface					
Input fiber		Panda type polarization-maintaining fiber			
Output fiber		Panda type polarization-maintaining fiber			
Fiber optic interface		PM FC/APC Slow axis alignment			
Input RF signal interface		SMA（50Ω）			
Bias controller communication interface		J30J			
Other Parameters					
Operating temperature	To	+15	-	+35	℃
Stored temperature	Ts	-40	-	+75	℃
Power supply	V	-	15	-	V
Module size	LWH	160*125*20 mm			
Weight		-	0.3	-	Kg



3. Drive Module for Electro-optic Modulator



Key Features

- 10G, 20G, 40GHz optional bandwidth
- Gain> 25dB
- Saturated output Max.25dBm (11Vpp)
- Rise time Min.<8ps
- Low jitter
- DC12V power supply
- Easy to use

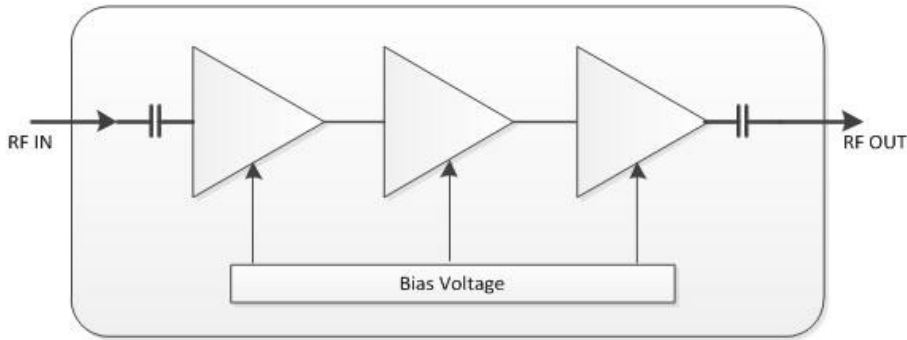
Applications

- High-speed optical fiber communication system
- Quantum communication

- Picosecond pulse amplification
- Optical fiber sensing system

Product List

- 10G driver module
- 10G high output driver module
- 20G driver module
- 40G driver module



Circuit Block Diagram

The STK-MD-XX series electro-optic modulator driver is a broadband, high-output driver amplifier mainly used for lithium niobate electro-optical intensity and phase modulator. Its working bandwidth is up to 30K ~ 40GHz, and it can achieve a maximum of 42Gbps NRZ wideband signal amplification up to 8Vpp. It is mainly used in high-speed optical fiber communication systems, quantum communication, picosecond pulse amplification, and optical fiber sensing systems.

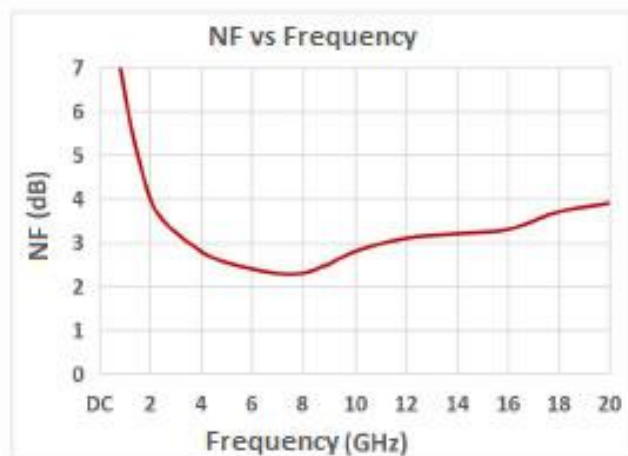
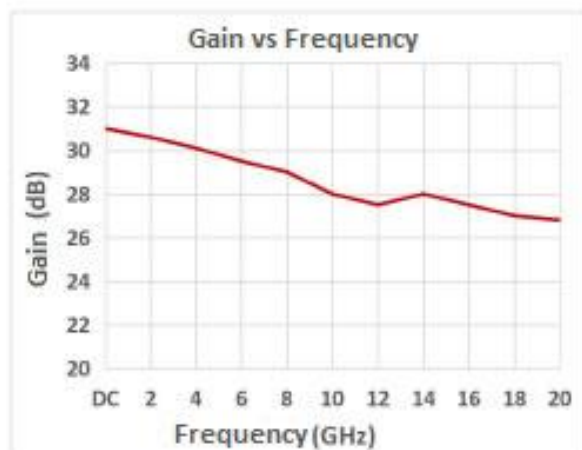
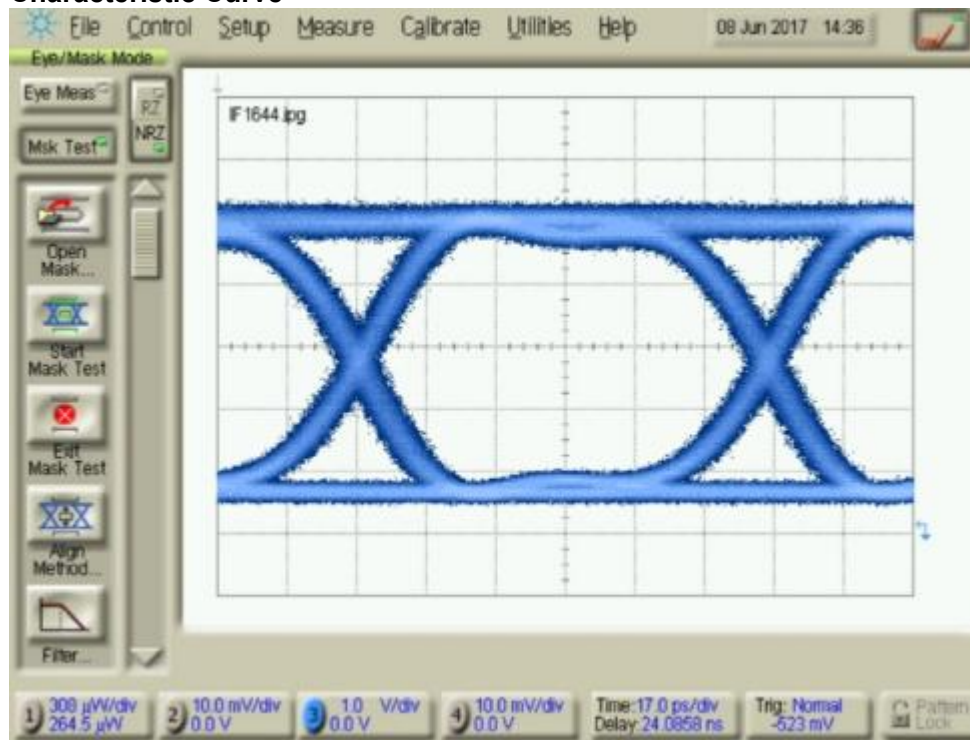
Parameters	Symbol	Unit	STK-MD-10G	STK-MD-10G-HO	STK-MD-20G	STK-MD-40G
Bandwidth（-3dB）	S _{21-High}	GHz	>10	>8	>20	>35
	S _{21-Low}	KHz	30	100	30	30
Data rate		bps	100k~12.5G	100k~10G	100k~25G	100k~42G
Gain	G	dB	>26	>30	>28	>28
Gain ripple	DG	dB	<3	<3	<3	<3
Output amplitude *	Vout	Vpp	8	11	8	8
Saturated output power	Ps	dBm	23	25	23	23
Rise time (10% -90%)	Tr	ps	35	40	18	8
Jitter **	Jitter _{RMS}	ps	<2	<2	<1	<1
Isolation	S ₁₂	dB	<-40			
Electrical return loss	S ₁₁	dB	<-12	<-10	<-10	<-10
RF connector			SMA(f)		K(f)	
Operating Voltage	V _{DC}	V		DC 12V		
Working current	Io	mA		<500		
Dimensions	LxWxH	mm		50x33x15		

* Duty cycle 1:1 **Additional jitter $Jitter_{RMS} = \sqrt{J_{RMS_total}^2 - J_{RMS_source}^2}$

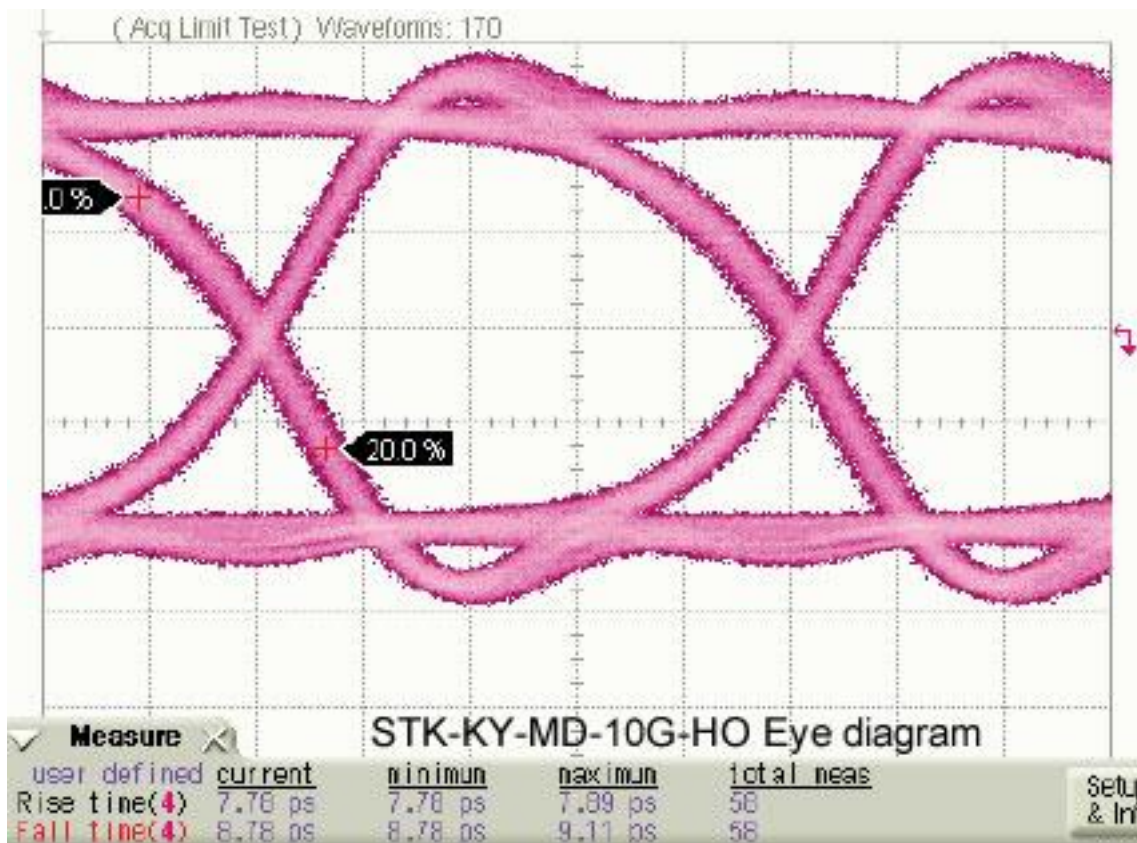
Absolute Maximum Ratings

Parameters	Symbol	Unit	Min.	Typ.	Max.
Input signal amplitude	V _{in}	V _{pp}			1.5
Operating Voltage	DC	V	11.5		13
Operating temperature	T _{op}	°C	-20		60
Storage temperature	T _{st}	°C	-40		85

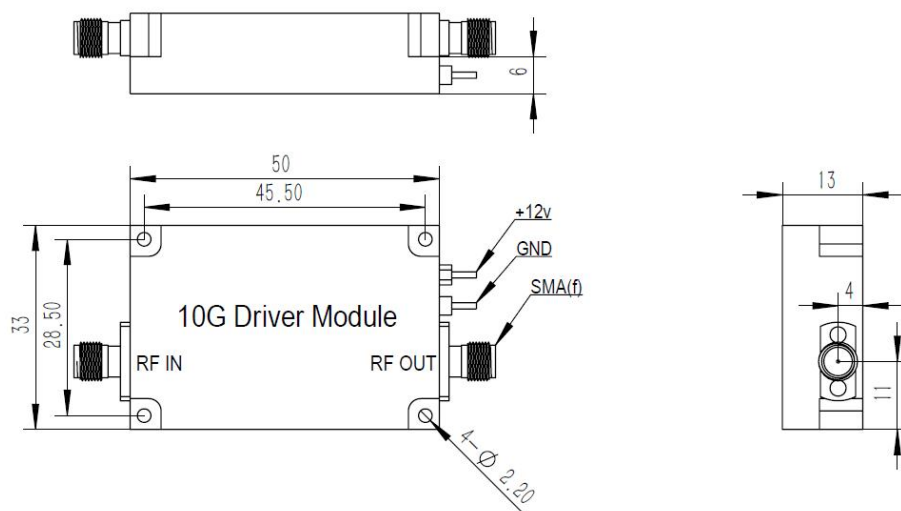
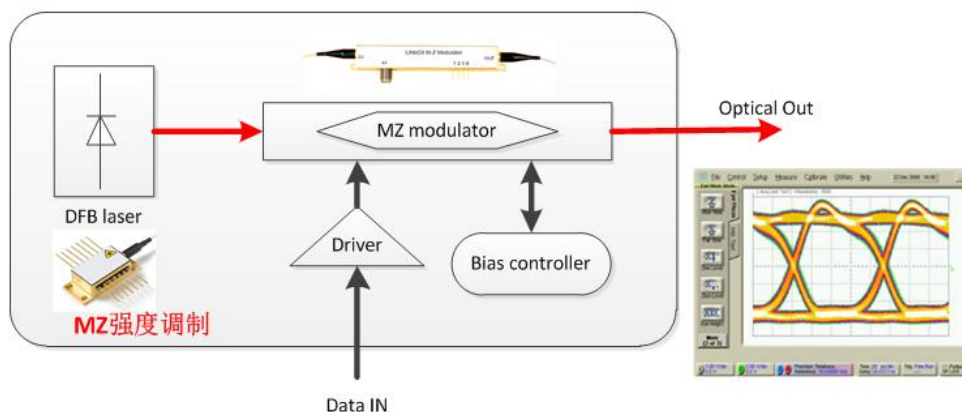
Characteristic Curve



STK-KY-MD-10G eye diagram



Typical Application



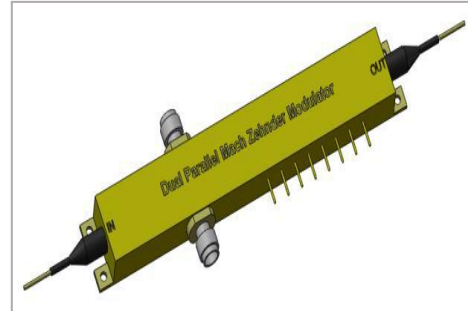
4. STK Series Dual Parallel High-speed IQ Modulator STK-IQ-15-20G-PP-FA

Features:

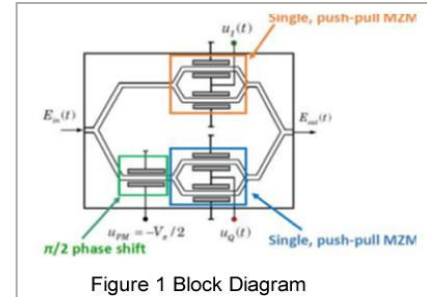
- Low insertion loss.
- Low half-wave voltage
- High extinction ratio
- Built-in detector

Application:

- Single Side Band modulation.
- QPSK, QAM, OFDM modulation
- FWCW LiDAR



STK-IQ-15-20G-PP-FA is a wideband, low insertion loss dual parallel Mach Zehnder interference modulator, which is prepared by Titanium diffusion process, with high bandwidth and low driving voltage. The dual parallel IQ modulator integrates two sub-MZs and an external master MZ with essentially the same structure and performance, as shown in Figure 1. It contains two RF signal input ports of I and Q channels, and three bias voltage ports of MZ structure, which has a high integration, stable working performance, so can independently realize single-sideband modulation and QAM modulation methods such as carrier suppression.



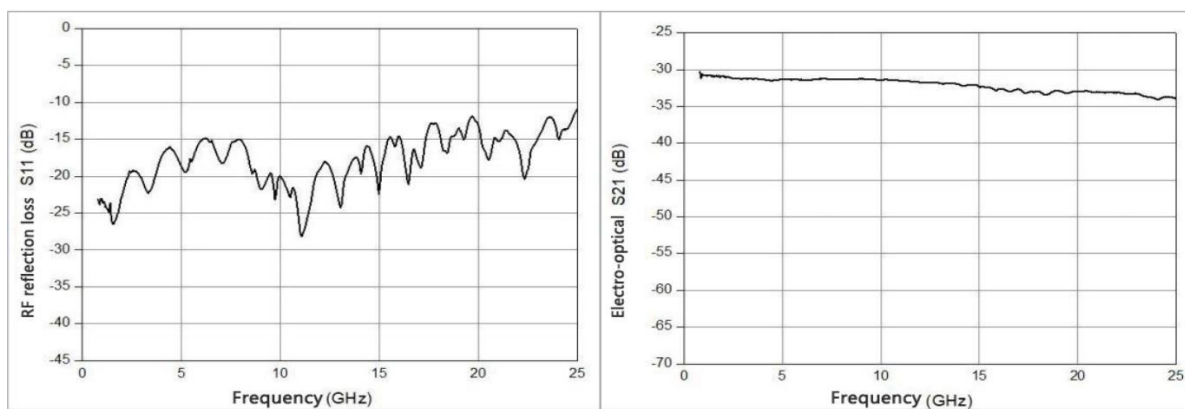
The operating wavelength of the dual parallel IQ modulator is C+L band, 3dB bandwidth can up to 25GHz. It uses 2.92mm female connector, input and output are Panda type polarization maintaining fiber, and optical fiber connector can choose FC/APC or FC/PC. It has two built-in monitoring PDs and the corresponding bias point control circuit, to realize the modulator is not affected by the external environment and works stably for long time. It mainly used in QAM and other high-speed optical fiber communication and distributed optical fiber sensing and other fields. For the application environment, we can provide industrial grade -40~70 °C, military grade -55~70 °C and anti-irradiation aerospace grade products.

Parameters

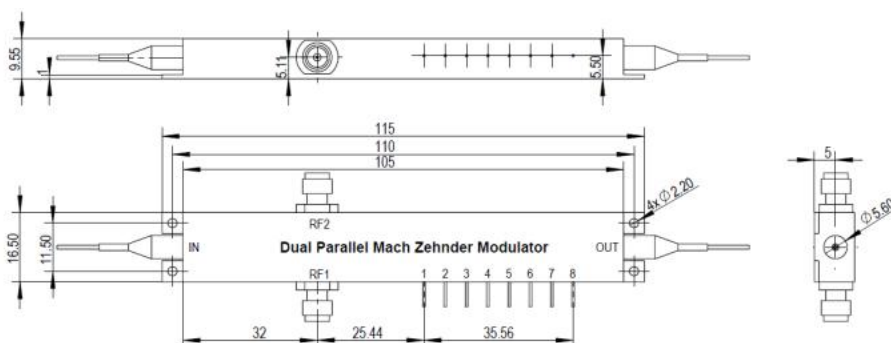
Parameters	Symbol	Min.	Typ.	Max.	Unit
Wavelength	λ	1530	1550	1610	nm
Crystal	Lithium Niobate X-Cut Y-Prop				
Insertion loss	IL		5	6.5	dB
Extinction ratio @DC	ER	20	23		dB
3dB Bandwidth	BW	20	25		GHz
Electrical Return loss	S11		-12	-10	dB
DC half-wave voltage	$V_{\pi DC1.2}$		6	7	V
	$V_{\pi DC3}$		7	8	V
RF half-wave voltage	$V_{\pi RF@50KHz}$		5	6	V
Impedance	ZRF		50		Ω
Optical Return loss	ORL	40	45		dB
Polarization Extinction Ratio	PER	20	23		dB

Absolute Maximum Ratings

Parameters	Symbol	Unit	Min.	Typ.	Max.
RF input power	RPI	dBm			27
Optical input power	OPI	dBm			20
Bias voltage	Vb	V	-15		15
Operating temperature*	Top	°C	-10		70
Storage temperature	Tst	°C	-40		85
Humidity	RH	%	5		90



Typical Curve



Dimension:

Pin definition		
PIN	Function	Note
IN	Optical input	Panda PM fiber (slow axis), FC/APC
OUT	Optical input	Panda PM fiber (slow axis) or SM fiber, FC/APC
RF1,2	RF1/2 input	2.92 female K
1	Ground	GND
2,3,4	DC1, DC2, DC3 +	DC bias
5,6	PD1 -/+	PD1 Cathode/Anode
7,8	PD2 -/+	PD2 Cathode/Anode

SCQ Series Electro-optic Light Modulators



SCQ series electro-optic modulators have the features of low insertion loss, wide bandwidth, low half-wave voltage etc and are to be used in space optical communication, time base, pulse generator and quantum optics etc.

SCQ series electro-optic modulators are mainly divided into two groups: intensity modulators and phase modulators. Their working wavelengths are 780nm, 850nm, 1064nm, 1310nm, 1550nm and 2000nm. Other wavelengths are available upon request.

Definition of EOM's Part Numbers: SCQ-XX-WW-XG-F-FC

- XX: modulator type. AM is intensity modulator and PM is phase modulator.
- WW: operation wavelength, such as 850nm, 1064nm, 1310nm, 1550nm and 2000nm
- XG: operation bandwidth, such as 2.5G, 10G, 40G
- F: In-out fiber such as PP (PM/PMF)
- FC: fiber connector such as FA (FC/APC), FP (FC/PC)

1. SCQ Series Intensity Modulators

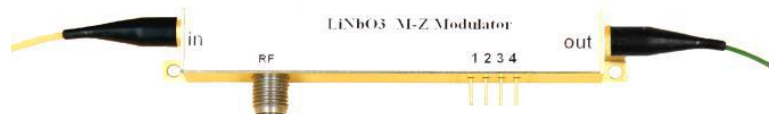
Part number	Operation wavelength nm	Min wavelength nm	Max wavelength nm	Bandwidth Hz	In/out fiber	Fiber connector
SCQ-AM-850-10G	850	830	870	10G	PM/PM	FA, FP
SCQ-AM-1064-10G	1060	980	1150	10G	PM/PM	FA, FP
SCQ-AM-1310-2.5G	1310	1290	1330	2.5G	PM/PM	FA, FP
SCQ-AM-1550-2.5G	1550	1530	1565	2.5G	PM/PM	FA, FP
SCQ-AM-1550-10G	1550	1530	1565	10G	PM/PM	FA, FP
SCQ-AM-1550-20G	1550	1530	1565	18G	PM/PM	FA, FP
SCQ-AM-1550-40G	1550	1530	1565	28G	PM/PM	FA, FP

1.1 SCQ-AM-1310 Series 1310nm Intensity Modulators

The LiNbO3 intensity modulator is widely used in high-speed optical communication system, laser sensing and ROF systems because of well electro-optic effect. The SCQ-AM series based on MZ structure and X-cut design, has stable physical and chemical characteristics, which can be applied both in laboratory experiments and industrial systems.

Features:

- Low insertion loss
- Bandwidth: 2.5GHz
- Low half-wave voltage
- Customization option



Applications:

- ROF systems
- Quantum key distribution
- Laser sensing systems
- Side-band modulation

Optical Parameters:

Parameter	Symbol	Min	Typ	Max	Unit
Operating wavelength		1290	1310	1330	nm
Insertion loss	IL		4	5	dB
Optical return loss	ORL			-45	dB
Switch extinction ratio @DC	ER@DC	20	23		dB
Dynamic extinction ratio	DER		13		dB
Optical fiber (Input port)		PM Fiber (125/250μm)			
Optical fiber (Output port)		PM Fiber or SM Fiber (125/250μm)			
Optical fiber interface		FC/PC、FC/APC Or Customization			

Electrical Parameters:

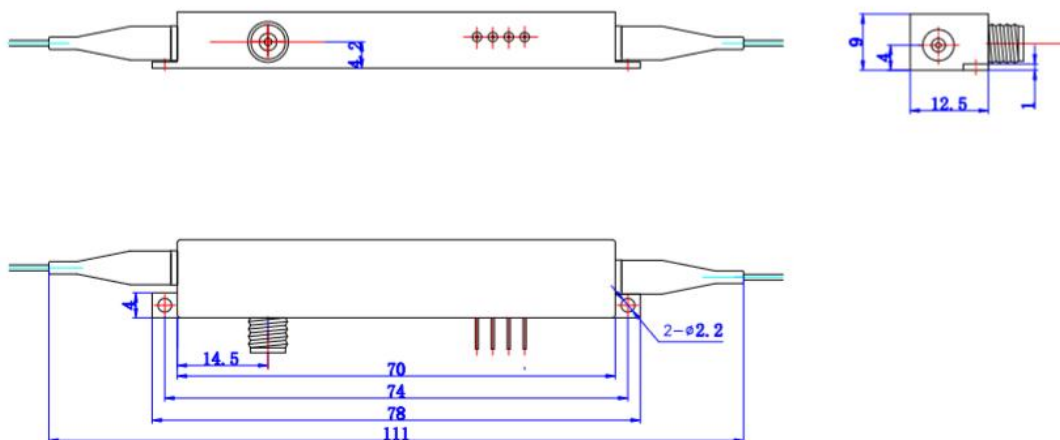
Parameter	Symbol	Min	Typ	Max	Unit
Operating bandwidth (-3dB)	S21		2.5		GHz
Half-wave voltage (RF)	V _π @1KHz		3	4	V
Half-wave voltage (Bias)	V _π @1KHz		3.5	4.5	V
Electrical return loss	S11		-12	-10	dB
Input impedance (RF)	Z _{RF}	50			Ω
Input impedance (Bias)	Z _{BIAS}	1M			Ω
Electrical interface		SMA(f)			

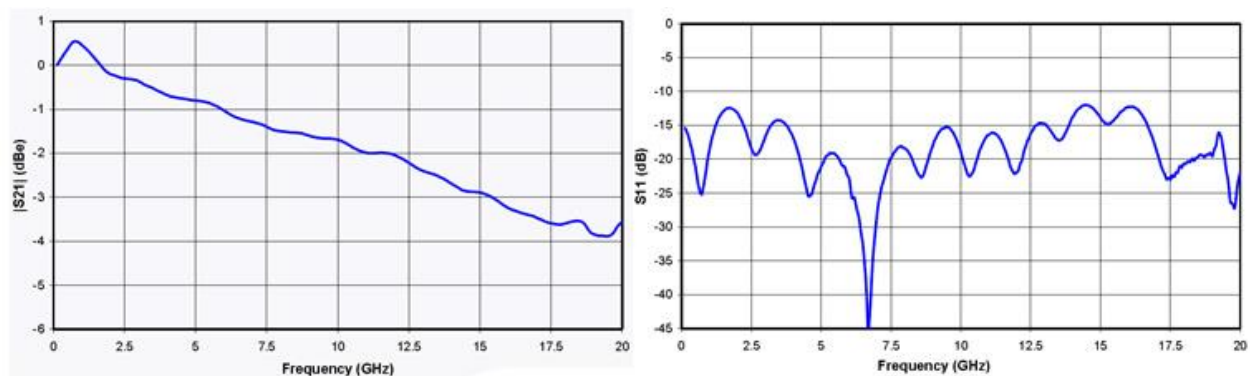
Limit Conditions:

Parameter	Symbol	Unit	Min	Typ	Max
Input optical power	P _{in} , Max	dBm			20
Input RF power		dBm			28
Bias voltage	V _{bias}	V	-15		15
Operating temperature	T _{op}	°C	-10		60
Storage temperature	T _{st}	°C	-40		85
Humidity	RH	%	5		90

Order Information:

SCQ	AM	13	2.5G	XX	XX
SCQ series	Type: AM---Intensity Modulator	Wavelength: 13---1310nm	Operation bandwidth: 2.5G---2.5GHz	In-Out Fiber type: PP---PM/PM	Optical connector: FA---FC/APC FP---FC/PC SP---Customization





S11 & S21 Curve

PORT	Symbol	Note
In	Optical input port	PM Fiber (125μm/250μm)
Out	Optical output port	PM and SM Fiber option
RF	RF input port	SMA(f)
Bias	Bias control port	1,2 Bias, 3,4-N/C (feedback)

2. SCQ Series Phase Modulators

Part number	Operation wavelength nm	Min wavelength nm	Max wavelength nm	Bandwidth Hz	In/out fiber	Fiber connector
SCQ-PM-780-10G	780	760	800	10G	PM/PM	FA, FP
SCQ-PM-850-10G	850	780	890	10G	PM/PM	FA, FP
SCQ-PM-1064-300M	1060	980	1150	300M	PM/PM	FA, FP
SCQ-PM-1064-10G	1060	980	1150	10G	PM/PM	FA, FP
SCQ-PM-1310-10G	1310	1290	1330	10G	PM/PM	FA, FP
SCQ-PM-1550-300M	1550	1530	1565	300M	PM/PM	FA, FP
SCQ-PM-1550-10G	1550	1530	1565	10G	PM/PM	FA, FP
SCQ-PM-1550-20G	1550	1530	1565	20G	PM/PM	FA, FP

2.1 SCQ-PM Series 1310nm Electro-optical Phase Modulators

The LiNbO₃ phase modulator is widely used in a high-speed optical communication system, laser sensing, and ROF systems because of well electro-optic effect. The SCQ-PM-1310 series, based on Ti-diffused technology, has stable physical and chemical characteristics, which can meet most applications in laboratory experiments and industrial systems.

Features:

- Low insertion loss
- Polarization-maintaining
- Low half-wave voltage
- Dual-polarization option

Application:

- Optical communication
- Quantum key distribution
- Frequency shifting



Optical parameters:

Parameter	Symbol	Min	Typ	Max	Unit
Operating wavelength	λ	1290	1310	1330	nm
Insertion loss	IL		3.5	4	dB
Optical return loss	ORL			-45	dB
Polarization extinction ratio	PER	20			dB
Optical fiber	Input port	PM fiber(125/250μm)			
	Output port	PM fiber(125/250μm)			

Optical fiber interface		FC/PC、FC/APC Or Customization	
-------------------------	--	-------------------------------	--

Electrical Parameters:

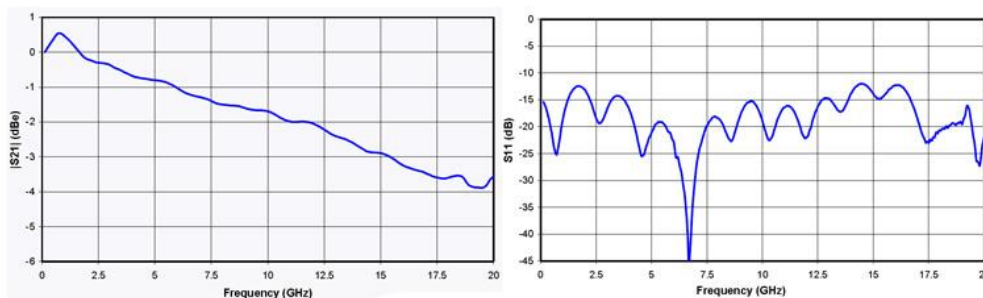
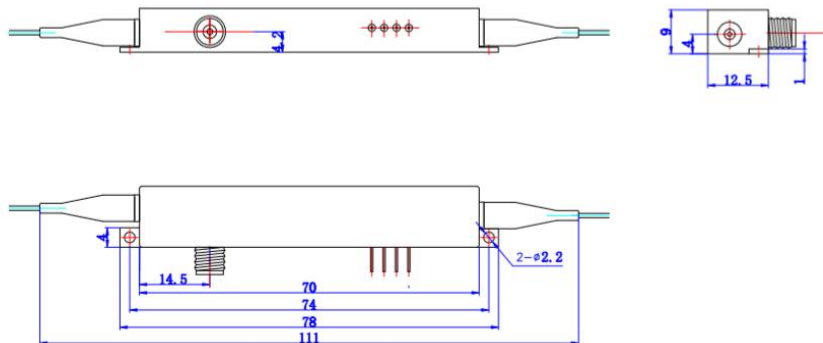
Parameter	Symbol	Min	Typ	Max	Unit
Operating bandwidth (-3dB)	S21	10	12		GHz
Half-wave voltage @50KHz	V _π		2.7	3	V
Electrical return loss	S11		-12	-10	dB
Input impedance	ZRF		50		
Electrical interface			SMA(f)		

Limit parameters:

Parameter	Symbol	Unit	Min	Typ	Max
Input optical power	P _{in,Max}	dBm			20
Input RF power		dBm			28
Operating temperature	Top	°C	-10		60
Storage temperature	Tst	°C	-40		85
Humidity	RH	%	5		90

Ordering Information:

SCQ	PM	13	XX	XX	XX
SCQ series	Modulator type: PM--- Phase modulator	Operating wavelength: 13---1310nm	Operating bandwidth: 10---10G	Input & output fiber: PM/PM	Connector: FA ---FC/APC FP ---FC/PC SP---user specified


S11 & S21 Curve

PORT	Symbol	Note
In	Optical input port	PM Fiber (125μm/250μm)
Out	Optical output port	PM and SM Fiber option
RF	RF input port	SMA(f)
Bias	Bias control port	1,2 Bias, 34-N/C

3. Drivers
3.1 SCQ-RF Series Drivers

SCQ-RF broadband RF amplifier (or called as driver) is a desktop instrument specially designed for high-speed lithium niobate electro-optic modulator. This instrument can amplify the small high-speed signal level to the higher level that can drive the modulator, thus driving the lithium niobate (LiNbO₃) electro-optic modulator to work, and has good gain flatness in the broadband range.

Features:

High bandwidth: 10, 20 or 40 GHz
 Variable gain
 The output range is up to 8V
 Highly integrated
 Easy to use

Applications:

10/20/40G optical modulating system
 Fiber optic testing system
 Optical fiber sensing system



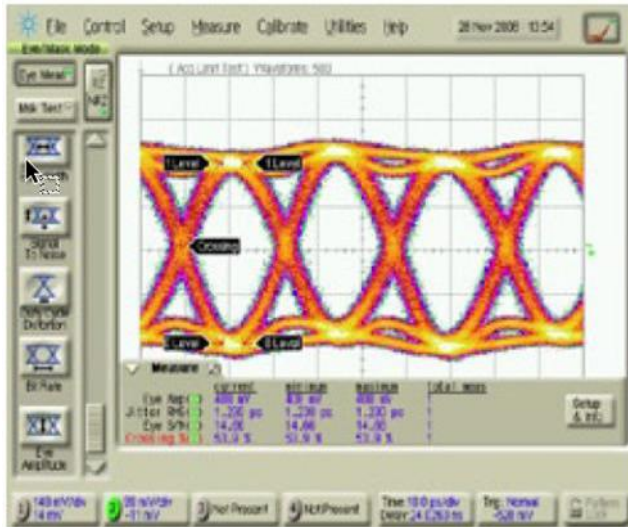
Parameters of SCQ-RF-40 Driver

Parameter	Unit	Min	Typ	Max
Transmission rate	Gb/s	0.0001		44
Operating frequency range	Hz	50K	40G	
Output voltage magnitude	V	7	8	9
Gain margin	V	0.3	0.4	0.6
Regulation precision	dB	24	27	35
Output power P1dB	V		0.1	
Gain variation (ripple)	dBm	20		
Rise/fall time	dB		±1.5	
Additional jitter	ps		8	12
Input/output impedance	ps		0.42	
Input voltage amplitude		-	50	-
Input voltage standing-wave ratio VSWR (75k to 10GHz)			1.6:1	2.25:1
Output voltage standing-wave ratio VSWR			2:1	3:1
Boundary dimension (L x W x H)	mm	270 x 200 x 70		
Operating voltage	V	AC 220		
RF interface		V(f)-V(f)		

Limit Conditions

Parameter	Unit	Min	Typ	Max
Input voltage amplitude	V			1
Working temperature	°C	-10		60
Storage e temperature	°C	-40		85
Humidity	%	5		90

Eye Diagram

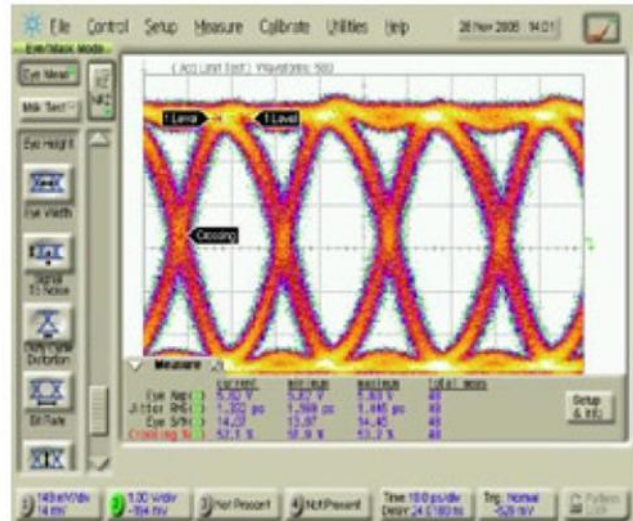


Input signal

Eye amplitude = 0.41 Vpp,

Rise time = 10.2 ps

Jitter RMS = 1.23 ps, SNR = 14.7



Output signal

Eye amplitude = 5.62 Vpp,

Rise time = 9.56 ps

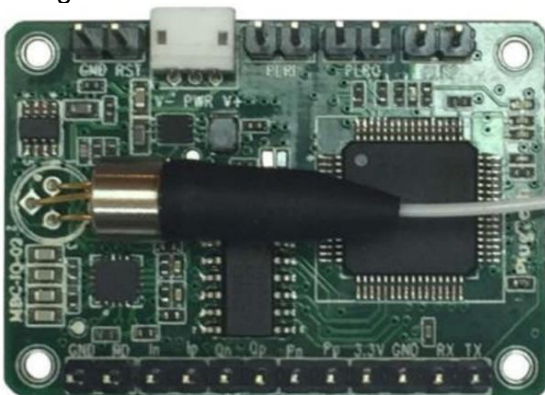
Jitter RMS = 1.33 ps, SNR = 14.1

Ordering Information:

SCQ	RF	XX	XX	We Manufacture Integrated LN Modulators
SCQ series drivers	RF amplifier	Operating rate: 10---10Gbps 20---20Gbps 40---40Gbps	Output characteristic: Blank---Standard HO---High voltage output RZ---RZ signal amplification	

3.2 MZM Bias Controller

The bias controller is specially designed for Mach-Zehnder modulators to ensure a stable operation state in various operating environments. Based on its fully digitized signal processing method, the controller can provide highly stable performance. The controller injects a low frequency, low amplitude dither signal together with bias voltage into the modulator. It keeps reading the output from the modulator and determines the condition of the bias voltage and the related error. A new bias voltage will be applied afterwards according to the previous measurement. In this way, the modulator is ensured to work under proper bias voltage.



Features:

- Bias voltage control on Peak/Null/Q+/Q-
- Bias voltage control on arbitrary point
- Ultra precise control: (1) 50dB maximum extinction ratio on Null mode; (2) $\pm 0.5^\circ$ accuracy on Q+ and Q- modes

- Low dither amplitude: (1) 0.1% V_{π} at NULL mode and PEAK mode; (2) 2% V_{π} at Q+ mode and Q- mode
- High stability: with fully digital implementation
- Low profile: 40mm(W) × 30mm(D) × 10mm(H)
- Easy to use: (1) Manual operation with mini jumper; (2) Flexible OEM operations through MCU UART2
- Two different modes to provide bias voltage: (1) Automatic bias control; (2) User defined bias voltage

Application:

- LiNbO₃ and other MZ modulators
- Digital NRZ, RZ
- Pulse applications
- Brillouin scattering system and other optical sensors
- CATV Transmitter

Ordering Information

Part No.: SCQ-RF-BC

Remark: (1) The highest extinction ratio depends on and cannot exceed modulator maximum extinction ratio. (2) UART operation is only available on some version of the controller.

Performance:



Fig.1. Carrier Suppression

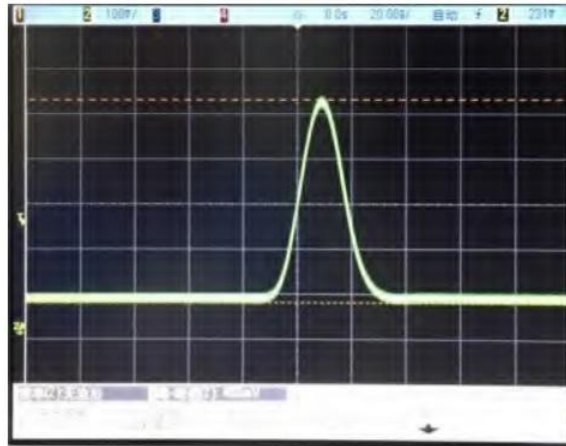


Fig.2. Pulse Generation



Maximum Power
at Peak Point



Minimum Power
at Null Point

Fig.3. Modulator max power Fig.4. Modulator minimum power

Maxim DC Extinction Ratio:

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

(1) Figure 3 demonstrates the optical power of modulator output, when modulator controlled at Peak point. It shows 3.71dBm in the diagram.

(2) Figure 4 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. Our SCQ-RF-BC-ANY bias controllers update the bias voltage every 1 second to ensure fast track response.

Specifications:

Parameter	Min	Typ	Max	Unit	Conditions
Control Performance					
Extinction ratio		MER ¹	50	dB	
CSO ²	-55	-65	-70	dBc	Dither amplitude: 2% V_{π}
Stablization time		4		s	Tracking points: Null & Peak
Stablization time		10		s	Tracking points: Q+ & Q-
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	2		4	mA	
Output voltage range	-9.57		+9.85	V	
Output voltage precision		346		μ V	
Dither frequency	999.95	1000	1000.05	Hz	Version: 1kHz dither signal
Dither amplitude		0.1% V_{π}		V	Tracking points: Null & Peak
Dither amplitude		2% V_{π}		V	Tracking points: Q+ & Q-
Input optical power ³	-30		-5	dBm	
Input wavelength	780		2000	nm	

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

² 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.

³ Please be noted that input optical power does not correspond to the optical power at selected bias point. It refers to the maximum optical power that the modulator can export to controller when bias voltage ranges from $-V_{\pi}$ to $+V_{\pi}$.

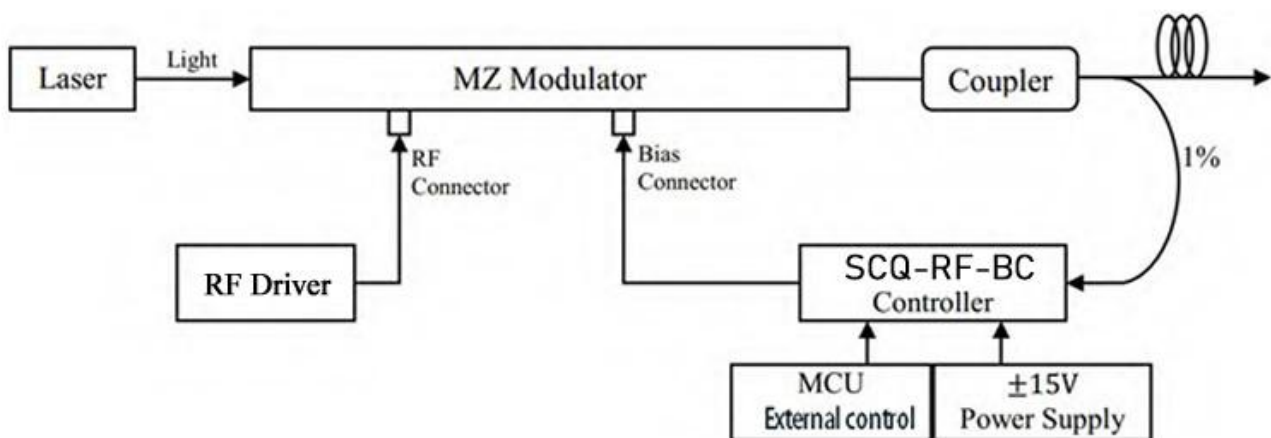
Group	Operation	Explanation
Photodiode ¹	PD: Connect MZM photodiode's Cathode	Provide photocurrent feedback
	GND: Connect MZM photodiode's Anode	
Power	Power source for bias controller	V-: connects the negative electrode
		V+: connects the positive electrode
		Middle probe: connects the ground electrode

Reset	Insert jumper and pull out after 1 second	Reset the controller
Mode Select	Insert or pull out the jumper	no jumper: Null mode; with jumper: Quad mode
Polar Select ²	Insert or pull out the jumper	no jumper: Positive Polar; with jumper: Negative Polar
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
Control Select	Insert or pull out the jumper	no jumper: jumper control; with jumper: UART control

¹ Some MZ modulators have internal photodiodes. Controller setup should be chosen between using controller's photodiode or using modulator's internal photodiode. It is recommended to use controller's photodiode for lab experiments for two reasons. Firstly, controller photodiode has ensured quality. 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 pin is used to switch the control point between Peak and Null in Null control mode(determined by Mode Select pin) or Quad+ and Quad- in Quad control mode. If jumper of polar pin is not inserted, the control point will be Null in Null mode or Quad+ in Quad mode. Amplitude of RF system will also affect the control point. When there is no RF signal or RF signal amplitude is small, controller is able to lock the work point to correct point as selected by MS and PLR jumper. When the RF signal amplitude exceeds certain threshold, polar of the system will be changed, in this case, the PLR header should be in the opposite state, i.e. the jumper should be inserted if it is not or pulled out if it is inserted.

Typical Application:



The controller is easy to use as follows:

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 +15V 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.