High Speed Fiber Optical Intensity Modulators
Low Voltage Thin Film Lithium Niobate

(70/100 GHz, 1550/1310nm, 3.5V, bias control option)

DATASHEET

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The Thin Film Lithium Niobate Fiberoptic Modulators (TLNM) series offers a low driving voltage of 3.5V and broadband operation up to 100 GHz, delivering exceptional efficiency and performance over traditional Lithium Niobate modulators. Leveraging Mg-doped thin-film $LiNbO_3$ technology, its reduce size waveguides optimize RF-to-optical conversion, making it ideal for ultra-high-frequency electrical-to-optical applications. A built-in bias control section with a micro-heater and photodetector ensures stable optical biasing via advanced feedback circuitry. High-speed modulation is facilitated through an SMA connector, with bias control applied via pins, while an optional automatic bias controller provides enhanced stability. Custom designs are available to meet specific application needs.

The device is based on traveling push-pull waveguide electrode design. We offer mounting the device on an automatic bias control PCB option for convenient application.

Warning: The photodetector pins are highly sensitive to electrostatic discharge (ESD). Extreme caution must be exercised during handling to prevent permanent damage.

Note: Without bias controller, the device will not function properly.

Note: This component is intended for OEM system integration and is not designed for standalone laboratory use. Units supplied without a protective benchtop enclosure are provided without warranty, as they are susceptible to damage from improper handling, installation, or operation.

Features

- Wavelength 1310/1550 nm
- Low Voltage ~3.5V
- Up to 100GHz Speed
- Bias Control
- Small Format

Applications

- Radar
- RoF
- Laboratory Uses
- Concept Proving
- Instrumentation

Specifications

Parameter		Min	Typical	Max	Unit
Operation Wavelength		1520 1290	1550 1310	1567 1340	nm
Insertion Loss			3.5	4.5	dB
Return Loss		27		40	dB
Extinction Ratio [1]		15 (H frequency)		20 (L frequency)	dB
3 dB Bandwidth(S21 start 2 GHz)	A	63	65	100	GHz
	B	103	108	100	
RF Return Loss (S11 2-6GHz)		-10			dB
Optical Input Power			12	18	dBm
Vp at 50kHz			3	3.5	V
Bandwidth		DC	60	100	GHz
RF Port Resistance (DC)				50	Ω
RF Input Power			12	18	dBm
RF Input Voltage (Vpp)		-3.5		3.5	V
RF Input Root Mean Square Voltage (Vrms)					
Bias Port Resistance (DC)				1	MΩ
Bias Voltage Range		-5		+5	V
Bias Current				50	mA
Photodetector Responsivity				20	mA/W
Photodetector Extinction Ratio				6	dB
Photodetector Bandwidth			100		kHz
Operating Temperature		-20		70	°C
Storage Temperature		-45		85	°C

Notes:
[1]. With bias control

Note: Applying over the maximum RF control voltage or optical power will burn the device. Only the protected benchtop package has warranty.

RoHS COMPLIANT

ATTENTION
OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

Rev 07/09/26

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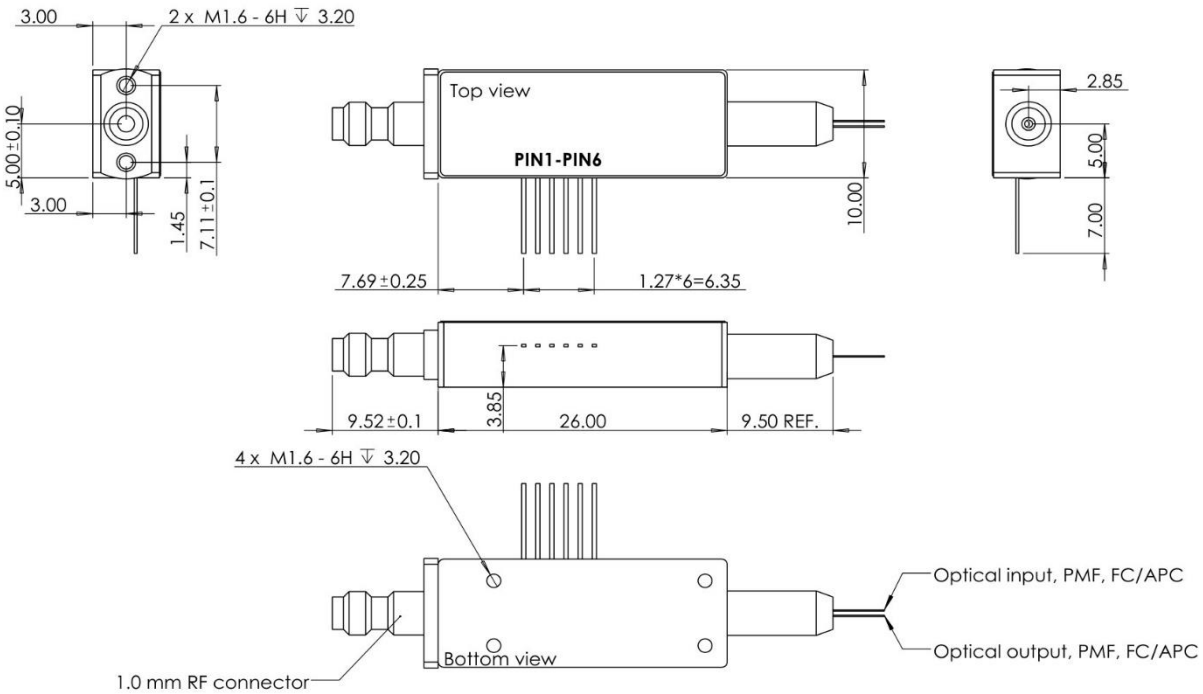
Dimensions (mm)



Electrical Pin Diameter: ***0.35 mm × 0.25 mm***
Electrical Pin Pitch: ***1.27 mm***

*Product dimensions may change without notice. This is sometimes required for non-standard specifications.

Electrical Connection

Pin	Symbol	Description
1	-	N/A
2	-	N/A
3	Heater	Electrode
4	Heater	Electrode
5	PD	Anode (+)
6	PD	Cathode (-)
RF	RF connector	1 mm K
In	Input Fiber	FC/APC, PMF
Out	Output Fiber	FC/APC, PMF

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Instruction for Comprehensive Characterization Procedure for $LiNbO_3$ Modulator

1. Initial Setup and Inspection

- **Visual inspection**: Check for fiber integrity, waveguide cleanness, electrode contacts.
- **Connector integrity**: Inspect RF and optical connectors for damage or debris.
- **Polish & clean fibers**: Use fiber scope and fiber wipes if necessary.
- **Thermal stabilization**: Place the device on a temperature-controlled stage (if needed).

2. Electrical & RF Interface Check

- Measure **RF return loss (S11)** using a VNA.
- Confirm **50 Ω impedance matching** across the modulator's bandwidth.
- Verify the **bias-T (if present)** does not short or distort the signal.
- Check for **electrode continuity** and isolation between electrodes.

3. Optical Characterization

a. Insertion Loss

- Use a narrow-linewidth laser (e.g., at 1550 nm).
- Launch light into input fiber and measure output power.
- Insertion Loss = 10·log(Pin / Pout)
  (Typical $LiNbO_3$ insertion loss: 3–7 dB)s.

b. Extinction Ratio (for MZIs)

- Apply DC voltage sweep to modulation electrodes.
- Record maximum and minimum output powers.
- ER = 10·log(Pmax / Pmin)
  (Good ER: >20 dB for analog, >30 dB for digital).

c. Vπ Measurement (Half-wave voltage)

- Apply a slowly varying triangular or sinusoidal voltage.
- Measure output optical power vs. voltage.
- Determine Vπ = voltage required to induce a π phase shift (first null).
- Also check **Vπ·L** product (performance metric).

4. Electrical & RF Interface Check

- Connect modulator RF input to a signal generator or VNA (S21 test).
- Bias the MZI at quadrature (linear point of transfer curve).
- Apply RF sweep from 100 kHz to >20 GHz (or device limit).
- Use a fast photodiode and spectrum analyzer or VNA.
- Record **modulation response (S21)**:
  - Bandwidth = −3 dB point from peak response.
  - Watch for peaking or drop-offs due to impedance mismatch or piezoelectric resonances.

5. Linearity Tests (for Analog Applications)

- Use two-tone RF input (e.g., f1 = 10 GHz, f2 = 10.01 GHz).
- Measure intermodulation distortion (IMD3).
- Calculate **Spurious-Free Dynamic Range (SFDR).**

6. Bias Drift / Stability Testing

- Apply DC bias and monitor optical output over time.
- Check for **DC drift**, typically caused by photorefractive or charge trapping effects.
- Test under light-on and light-off conditions.
- Optional: Integrate **auto-bias control loop**.

7. Thermal Response (Optional)

- Vary modulator temperature (e.g., from 20°C to 70°C).
- Track **Vπ, insertion loss, and ER** as a function of temperature.
- Identify thermal sensitivity and hysteresis.
- Important for packaged systems or field deployments.

8. High-Power Handling & Backreflection

- Gradually increase optical input power (with isolator).
- Watch for power-induced drift or photorefractive effects.
- Check backreflections using an **optical return loss meter (ORL).**

9. Data Logging and Reporting

- Capture all test data in a structured format.
- Plot:
  - Optical power vs. voltage (transfer function)
  - S21 vs. frequency
  - Vπ vs. temperature
  - Drift vs. time
- Include tables for:
  - Insertion loss
  - ER
  - Vπ and bandwidth
  - Bias stability
  - RF return loss

Optional Advanced Tests:

- **Jitter analysis** (for digital modulators)
- **Bit Error Rate Testing (BERT)** for NRZ or PAM signals
- **Eye diagram measurements**
- **Pulse response and rise/fall time**
- **Photorefractive damage threshold test**

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Ordering Information (Part Number)

	☐	☐	☐	☐	☐	☐	☐	☐	☐
Prefix	**Configuration**	**Auto Bias Controller**	**Wavelength**	**Frequency**	**Input Fiber**	**Output Fiber**	**Cable**	**Fiber Length**	**Connector[1]**
TLNM-	Amplitude = 1	No = 1 Yes = 2 Special = 3	1520-1570nm = 2 1290-1340nm = 3	70GHz = 7 100GHz = 1	PM1550 = 5 PM1310 = 3	PM1550 = 5 SMF28e = 1 PM1310 = 3	0.9mm tube = 1 Special = 0	1m = 1 Special = 0	FC/APC= 1 FC/UPC = U Special = 0

[1]. The default connector configuration uses fiber with 0.9 mm buffer protection. The connector cannot be installed directly onto bare fiber because the bare fiber is prone to damage during shipping. However, the connector can be assembled on bare fiber if a 3 cm protective loose tube is added for reinforcement. The customer may remove this protective tube after testing. The optical power handling of a standard connector is less than 0.5 W for SMF-28 fiber and decreases further for smaller-core fibers.

Application Notes

Fiber Core Alignment

Note that the minimum attenuation for these devices depends on excellent core-to-core alignment when the connectors are mated. This is crucial for shorter wavelengths with smaller fiber core diameters that can increase the loss of many decibels above the specification if they are not perfectly aligned. Different vendors' connectors may not mate well with each other, especially for angled APC.

Fiber Cleanliness

Fibers with smaller core diameters (<5 μm) must be kept extremely clean, contamination at fiber-fiber interfaces, combined with the high optical power density, can lead to significant optical damage. This type of damage usually requires re-polishing or replacement of the connector.

Maximum Optical Input Power

Due to their small fiber core diameters for short wavelength and high photon energies, the damage thresholds for device is substantially reduced than the common 1550nm fiber. To avoid damage to the exposed fiber end faces and internal components, the optical input power should never exceed 20 mW for wavelengths shorter 650nm. We produce a special version to increase the how handling by expanding the core side at the fiber ends.

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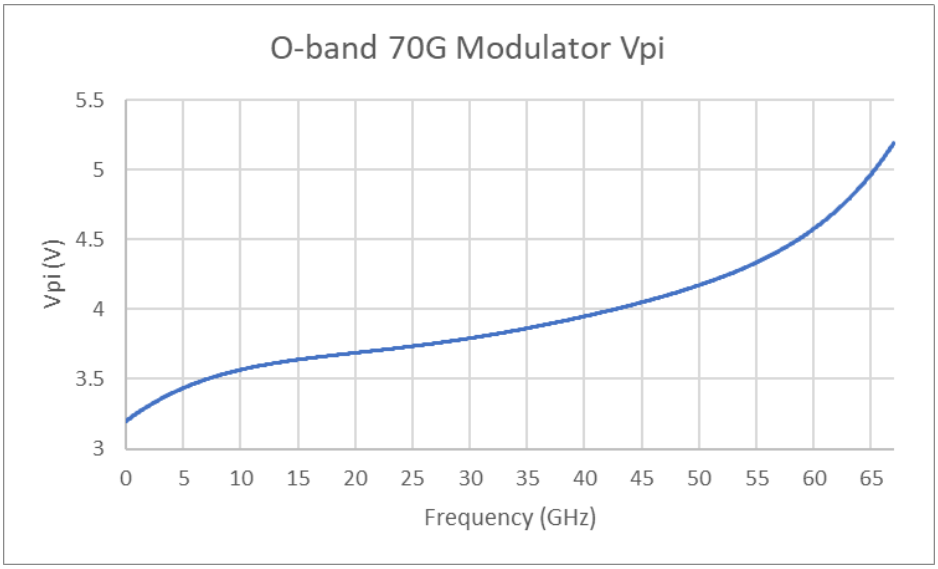
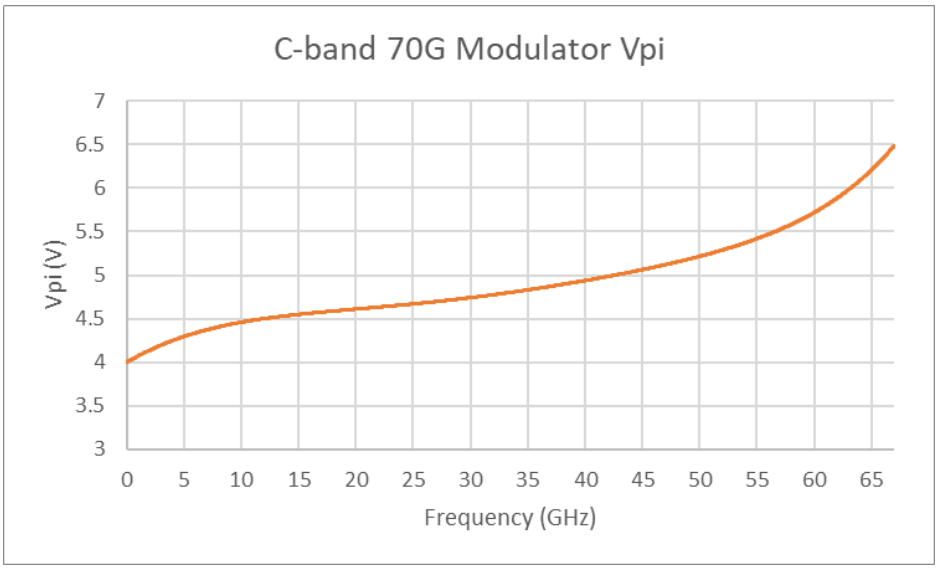
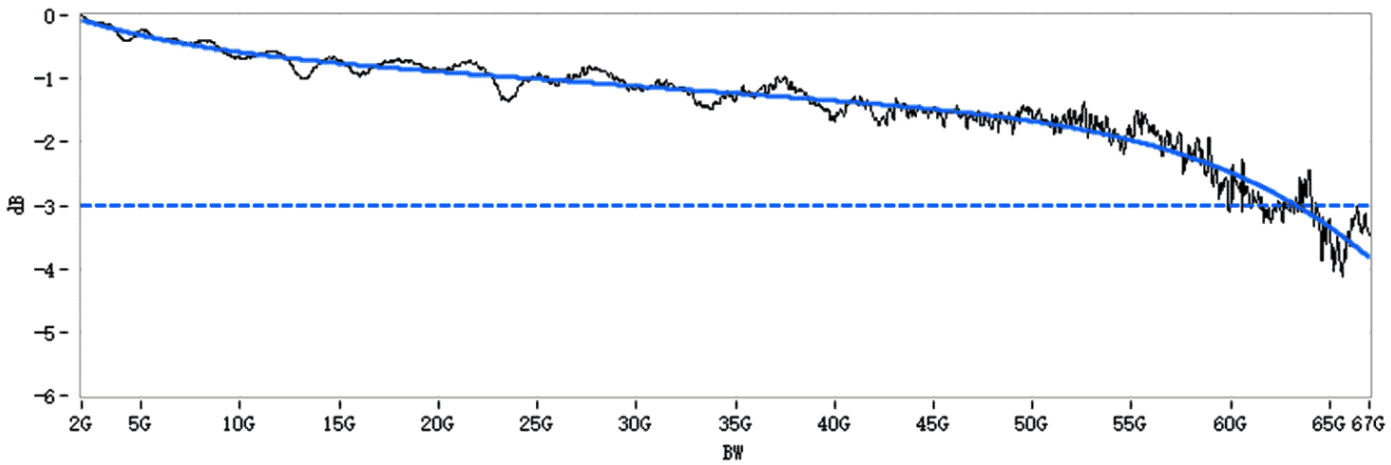
Typical Spectrum

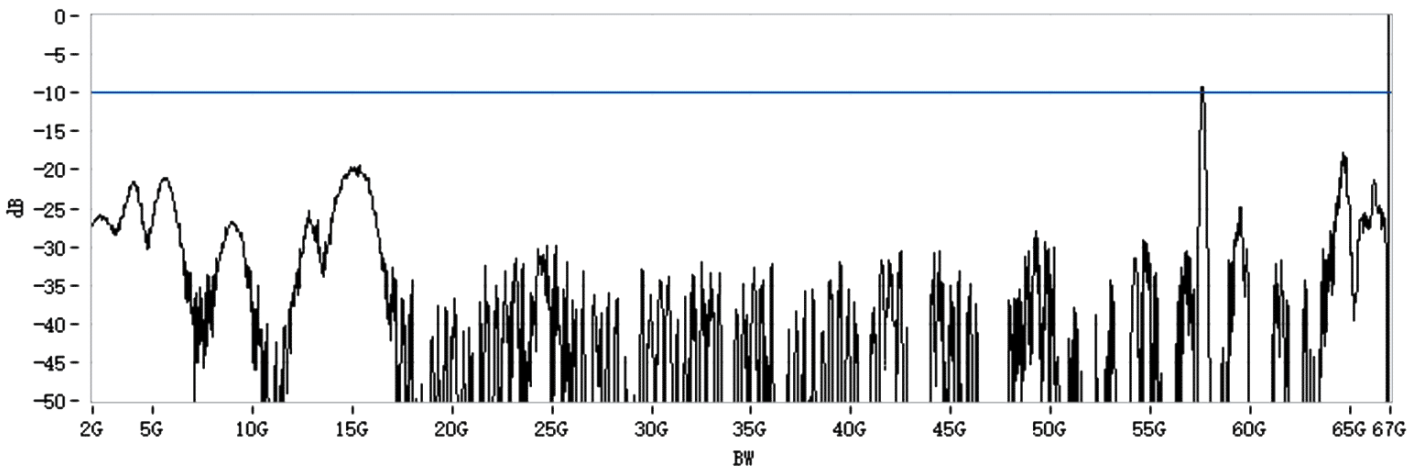




S21 & S11 (70 GHz)

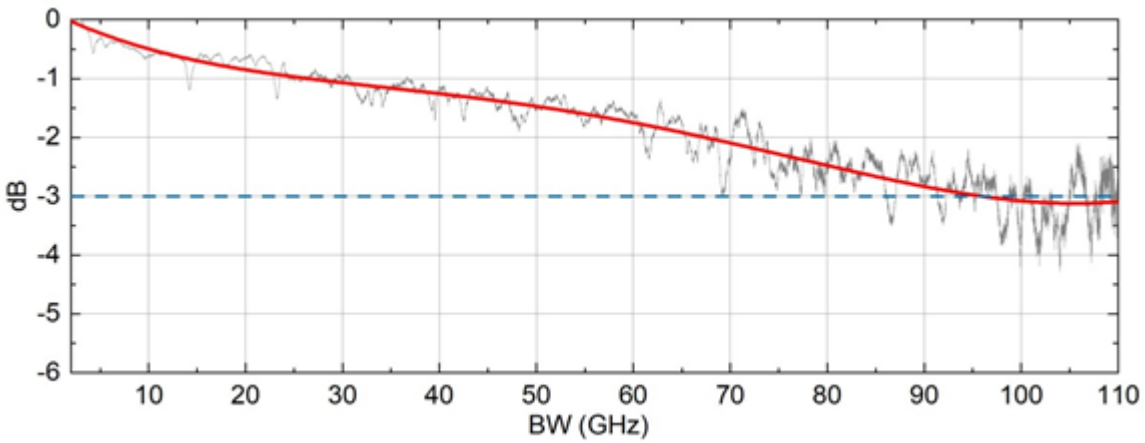


S21

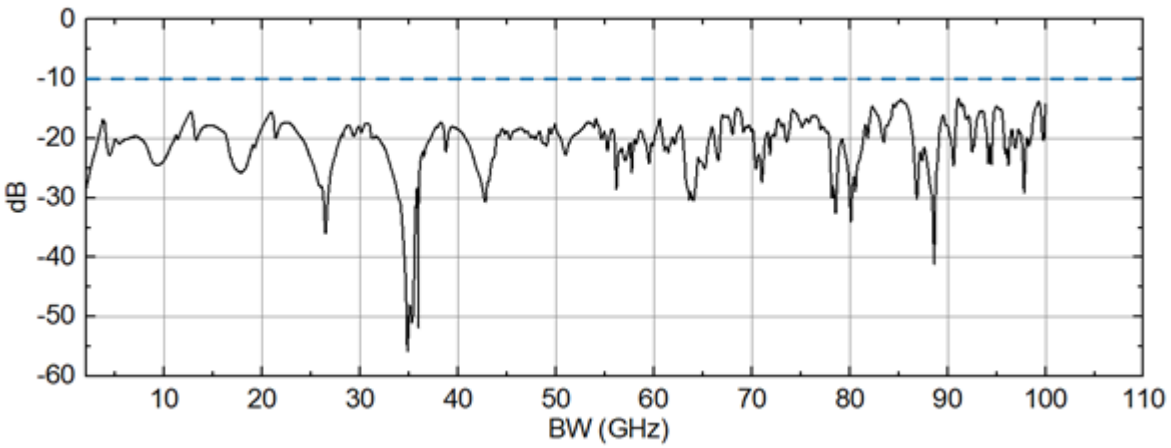


S11

S21 & S11 (100 GHz)

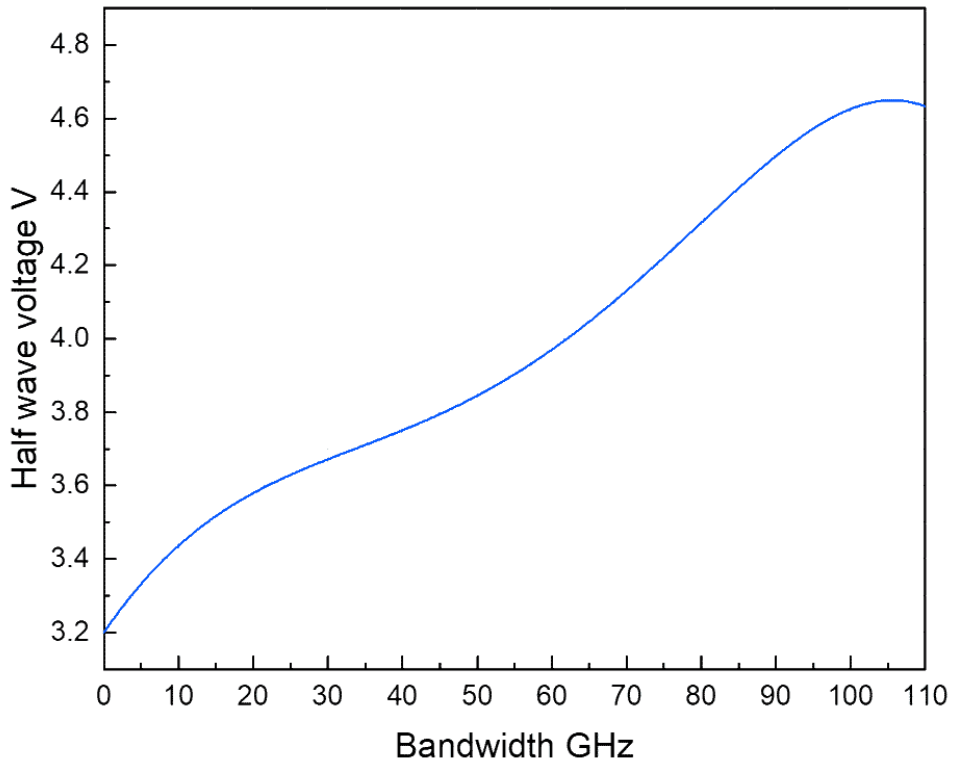


S21

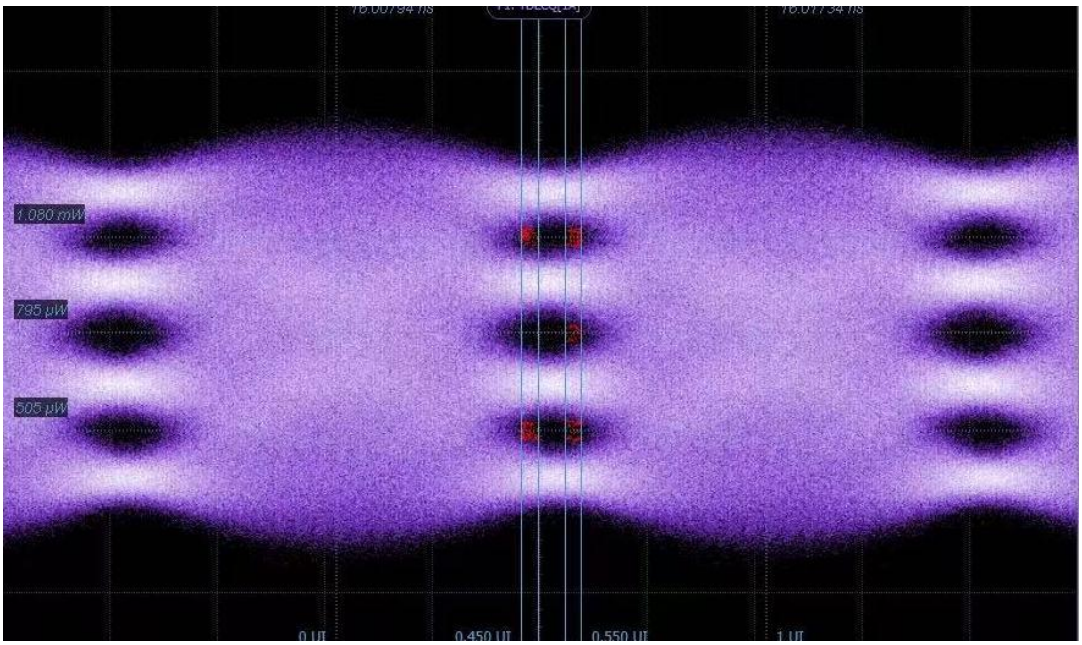


S11

Typical Vp vs Frequency Performance



Eye Diagram Measure at 100GHz



60/100 GHz Fiber Optical Transmitter/Converter

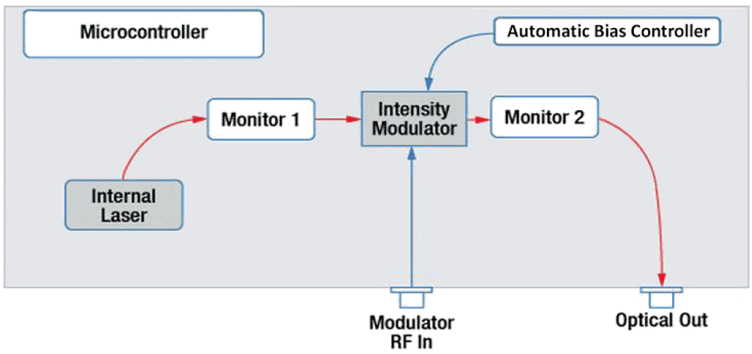
(0.01 to 60/100 GHz, analog/digital, auto bias)

DATASHEET

Fiber Optical Transmitters (Electrical-to-Optical Converters)

The EOCV series Fiber Optical Transmitters (Electrical-to-Optical Converters) provide high-fidelity analog and digital optical signals from electrical inputs, supporting a wide frequency range of DC to 20 and 40 GHz. These user-friendly turnkey modules feature a corresponding Thin Film Lithium Niobate Fiberoptic Modulator (TLNM), a DFB laser with driver, an automatic bias controller, high-performance control circuits, and a DC power supply, all integrated into a convenient plug-and-play benchtop unit. The TLNM modulators employed in the EOCV series use smaller and shorter waveguides compared to conventional $LiNbO_3$ modulators, offering greater efficiency in converting RF signals into optical signals. Their low RF driving voltage eliminates the need for an external RF amplifier, making the system compatible with standard function generators for laboratory applications.

The benchtop unit features a front switch to select between three modulator bias modes: Peak and Null for high on/off contrast, and Quadrature for superior linearity in E-O conversion. The laser output power is also adjustable via a front rotating knob, allowing users to fine-tune output settings. Designed for RF-over-Fiber applications, as well as the testing and characterization of optical-to-electrical (O-E) devices, the EOCV series offers a versatile and reliable solution for advanced optical communication and signal processing needs.



Ordering Information (Part Number)

	☐	☐☐☐☐☐	1	3	1	☐
Prefix	**RF Frequency**	**Laser Wavelength***	**Tunable Laser**	**Package**	**Configuration**	**Fiber Connector[1]**
EOCV-	70GHz = 7 100GHz =1	1550 nm =15500 1551.11 nm = 55111 1562.22 nm = 56222 Special = 00000	None = 1	Benchtop = 3 Rack = 2 Special = 0		FC/APC = 2 FC/UPC = U Special = 0

Note:

*Laser on the ITU grid can be selected

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