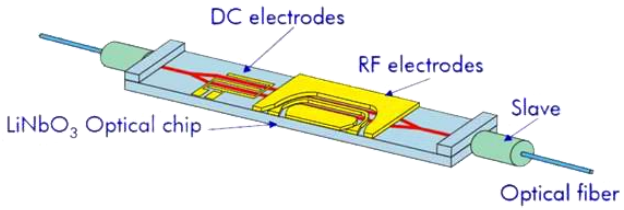
Lithium Niobate Fiber Optical Modulator

10 GHz, 4.5–5.5 V, Bias control option

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This series of Lithium Niobate (LiNbO3) fiber optic modulators employs a Mach–Zehnder interferometer structure for optical power modulation with low drive voltage, utilizing a traveling push-pull waveguide electrode design. Each Z-cut device integrates a bias control section featuring a built-in micro-heater and an optical power monitor, enabling precise bias adjustment while monitoring output intensity for optimal performance. To compensate for DC drift and maintain the optimal bias point, an optional automatic bias control (ABC) version is available; when selected, the modulator is mounted on a PCB and fully tested prior to delivery. Additionally, push-pull configuration is available that features two RF driving inputs to achieve zero-chirp operation when driven at a 180° phase difference.



Features

- Low Voltage
- Bias Control
- Dual RF Inputs
- Feedback

Applications

- Laboratory Uses
- Concept Proving
- Instrumentation

Note: The specifications provided are for general applications with a cost-effective approach. If you need to narrow or expand the tolerance, coverage, limit, or qualifications, please [click this link]:

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.

Specifications

Parameter	Min	Typical	Max	Unit
Operation Wavelength	1520		1605	nm
Insertion Loss	4	4.5	5.2	dB
Return Loss	40			dB
Extinction Ratio [1]	15 (H frequency)	20 (H-F)	27 (L frequency)	dB
Optical Input Power			150	mW
RF VπVoltage (at 1 kHz)		5	6.5	V
Bandwidth	DC	10	14	GHz
S21 (Electro-Optic Bandwidth — 3 dB)	10			GHz
S11 (130 MHz to 10 GHz)			–10	dB
RF Port Resistance (DC)			70	Ω
RF Input Power			24	dBm
Bias Port Resistance (DC)			1	MΩ
Bias Voltage Range	–15		15	V
Photodetector Responsivity			20	mA/W
Photodetector Extinction Ratio			6	dB
Photodetector Bandwidth		100		kHz
Operating Temperature	–1		+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. Hand touching may damage the photodetector inside. Only the protected benchtop package has warranty.

RoHS COMPLIANT

ATTENTION
OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

Rev 09/25/26

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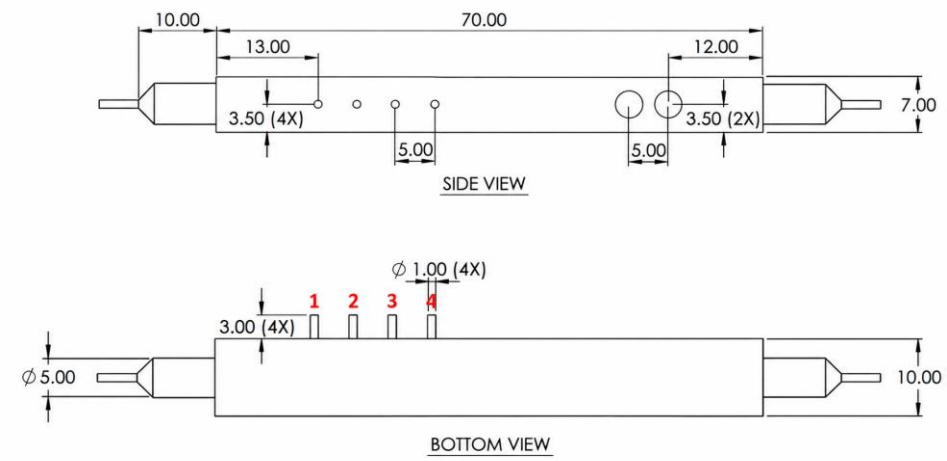
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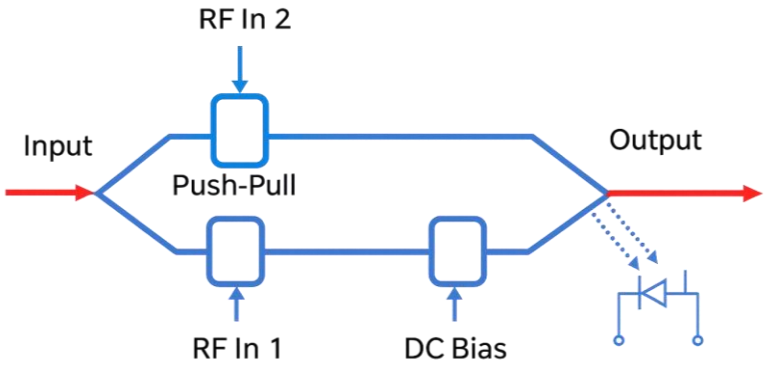
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Dual RF Input Configuration Dimensions (mm)



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

Push –Pull Function Diagram



Electrical Connection

Pin	Description
1 (PD)	PD cathode
2 (PD)	PD anode
3 (B)	DC bias
4 (G)	Ground

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Dimensions (For SM Fiber Output) (mm)

Electrical Connection

Pin	Description
1 (PD)	PD cathode
2 (PD)	PD anode
3 (B)	DC bias
4 (G)	Ground

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

Device Mounted On Automatic Bias Controller



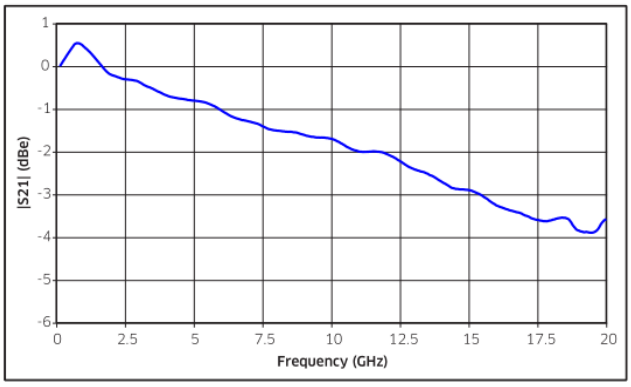
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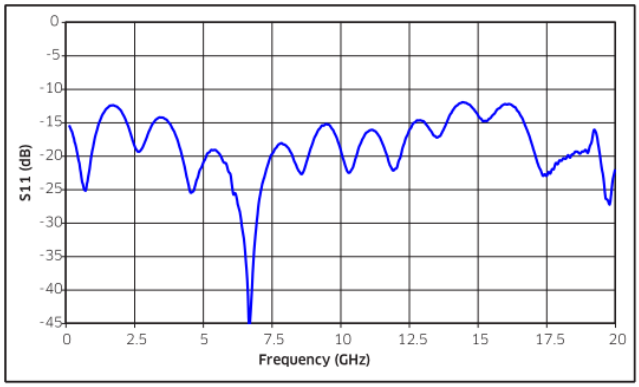
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Performances



Electro optical response



Electrical return loss

Ordering Information (Part Number)

	☐	☐	☐	2	1	5	☐	☐	1	☐	☐
Prefix	**Configuration**	**RF Input**	**Bias Controller**	**Wavelength**	**Frequency**	**Input Fiber**	**Output Fiber**	**Cable**	**Fiber Length**	**Connector [1]**	**RF Connector**
LNML-	Amplitude = 1	Single = 1 Dual = 2	No = 1 Yes = 2	1520-1620nm = 2	10GHz = 1	PM1550 = 5	SMF28 = 1 PM1550 = 5	0.9mm = 1 Special = 0	0.5m = 1 Special = 0	None = 1 FC/PC = 2 FC/APC = 3 SC/PC = 4 SC/APC = 5 ST/PC = 6 LC/APC = E LC/UPC = F FC/UPC = U Special = 0	GPPO = 1 SMA = 2

[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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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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10 GHz Fiber Optical Transmitter/Converter

(0.01 to 10 GHz, analog/digital, auto bias)

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Benchtop Integration



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 10 GHz. These user-friendly turnkey modules integrate a Lithium Niobate Fiberoptic Modulator, a DFB laser with driver, an automatic bias controller, high-performance control circuits, and a DC power supply, into a convenient plug-and-play benchtop unit. 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	☐	☐
Prefix	**RF Frequency**	**Laser Wavelength [1]**	**Tunable Laser**	**Package**	**RF Amplifier**	**Fiber Connector [2]**
EOCV-	10GHz = 1	1550 nm =15500 1551.11 nm = 55111 1562.22 nm = 56222 Special = 00000	None = 1	Benchtop = 3 Special = 0	14dBm gain = 1 Non = 2 Special = 0	FC/APC = 2 FC/UPC = U Special = 0

Note:

[1]. Laser on the ITU grid can be selected

[2]. 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.

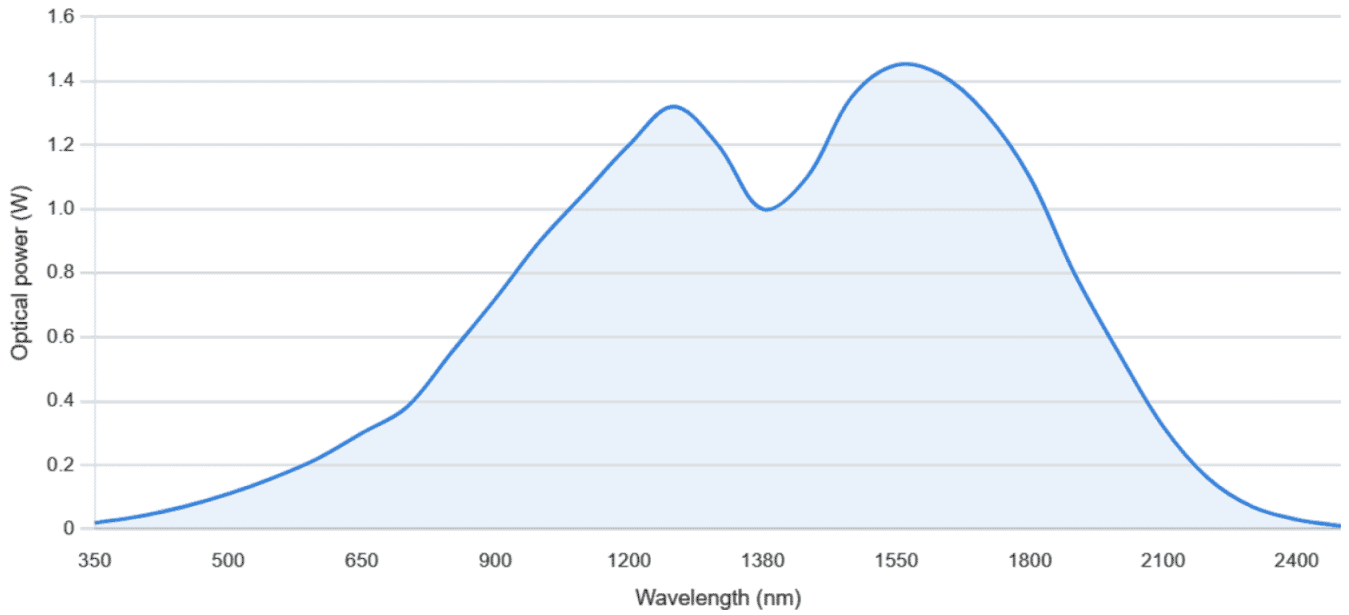
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Regular Single Mode / Polarization Maintaining Fiber Optical Power Handing vs Wavelength



Single mode fiber optical power is limited by nonlinear effects in addition to absorption that increase loss and generate heat. The curve shows the approximate safe CW power envelope for standard single-mode fiber. Actual limits depend on fiber design, core size, length, and laser characteristics. Specialty fibers can significantly increase the power limit.

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