



**exail**

**MODULATION SOLUTIONS**

## **MODULATION SOLUTIONS: YOUR CHALLENGE, OUR DEDICATED AND CUSTOM SOLUTIONS**

Exail is a leading high-tech industrial group specializing in cutting-edge robotics, maritime, navigation, aerospace and photonics technologies. With a strong entrepreneurial culture, Exail delivers unrivaled performance, reliability and safety to its civil and defense clients operating in severe environments. From the deep sea to outer space, Exail expands their capabilities with a full range of robust in-house manufactured components, products and systems.

Exail specializes in the design and manufacture of lithium niobate optical modulators for fiber optic systems. Manufacturing is carried out in an ISO 6 cleanroom facility featuring microelectronics technologies, employing advanced integration, packaging and test processes for optoelectronic components.

Exail has also developed a production line for microwave amplifiers used to drive the modulators. The company has extended its product line with bias control systems (Modulator Bias Controllers - MBC) to deliver optimal modulator operation.

Mastering all of the basic building blocks of an efficient modulation system, Exail Photonics is able to offer a range of complex optoelectronic modulation instruments known as «ModBox», featuring custom integration of active and passive optoelectronic modules, controllable through an adapted and reconfigurable human-machine interface.



Sensors



Linear  
modulation



Fiber Lasers



Telecom



Spacecom

# exail at a glance

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**80**

YEARS OF  
EXPERIENCE

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**250+**

MILLION EUROS  
OF TURNOVER

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**80%**

OF TURNOVER  
ACHIEVED ABROAD

---

**1500+**

EMPLOYEES

---

**200+**

PRODUCTS

---

**20%**

OF TURNOVER  
REINVESTED  
EACH YEAR IN R&D

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**WORLDWIDE  
PRESENCE**

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**500+**

CUSTOMERS  
DELIVERED  
EVERY YEAR

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**200+**

MODULATORS  
IN SPACE

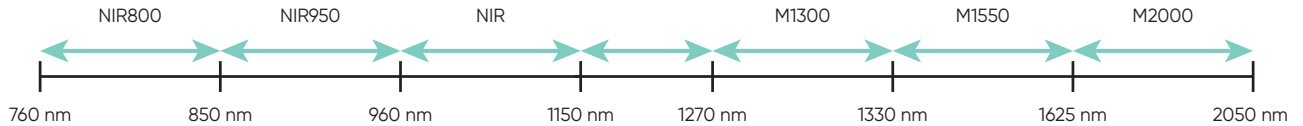
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# LiNbO<sub>3</sub> MODULATORS

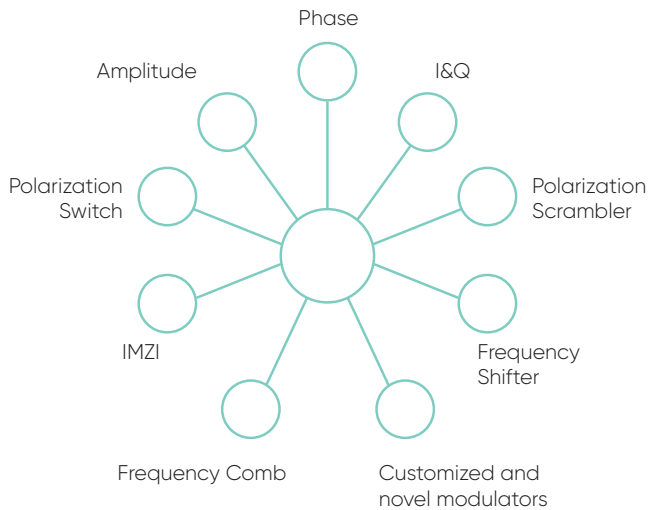
Exail delivers the most comprehensive range of commercial LiNbO<sub>3</sub> modulators. Exail's modulators address a wide range of wavelength and frequencies. Leveraging our expertise in electro optics we stand ready to work with our customers on new requirements and customizations.



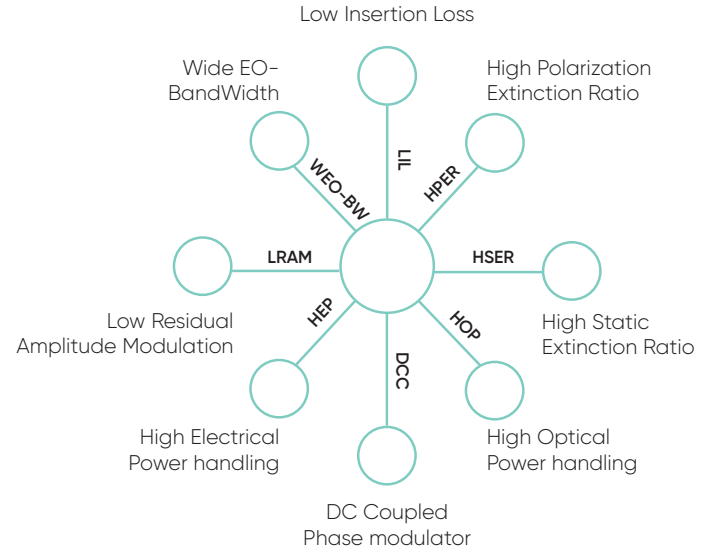
## Operating wavelength



## Modulator types



## Key Features

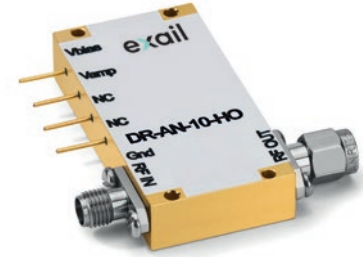


# DRIVERS

## Modulators-matching components

Exail's RF amplifiers product range offers a variety of matching drivers designed to drive an optional modulator in the best suited conditions.

The modulator driver comes in a compact connectorized module that matches (mechanically and impedance) directly with Exail modulators.



### ANalog DRIVER

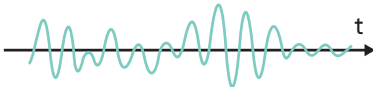


#### Key Features

- Medium to high output voltage
- Low noise figure
- Linear amplifier
- Low group delay variation

#### Modulation format

- OFDM
- RF Over Fiber (RFoF)
- Linear amplification



### DiGital DRIVER



#### Key Features

- Medium to high output voltage
- Flat gain
- Gain & crossing point adjustments
- High quality eye diagram

#### Modulation format

- NRZ, RZ
- QPSK
- DPSK



### PuLse DRIVER

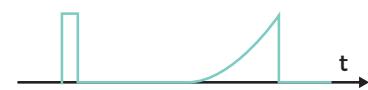


#### Key Features

- Medium output voltage
- Short to long pulse widths
- Square and Gaussian pulses
- Arbitrary waveforms

#### Modulation format

- Pulse generation
- Pulse picking
- Pulse shaping



# BIAS CONTROLLERS

## Modulators-matching components

Exail's Modulator Biars Controllers are a product range of automatic bias controllers specially designed to lock the operating point of  $\text{LiNbO}_3$  Mach-Zehnder modulators and ensure a stable operation over time and environmental conditions.



### Analog modulation Scheme

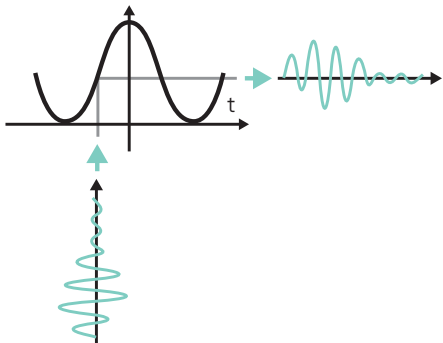


#### Key Features

- Dither-less operation
- QUAD+ & QUAD-
- High sensitivity
- USB remote control

#### Modulation format

- RF Over Fiber (RFoF)
- Linear modulation
- Optical communications



### DiGital modulation Scheme

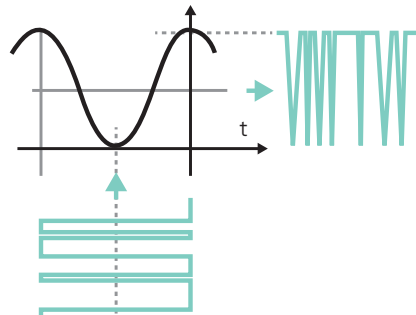


#### Key Features

- MIN, MAX, QUAD+ & QUAD-
- Any other operating points
- High sensitivity
- USB remote control

#### Modulation format

- NRZ, RZ
- QPSK, DPSK
- OFDM, CS-SSB



### Pulse modulation Scheme

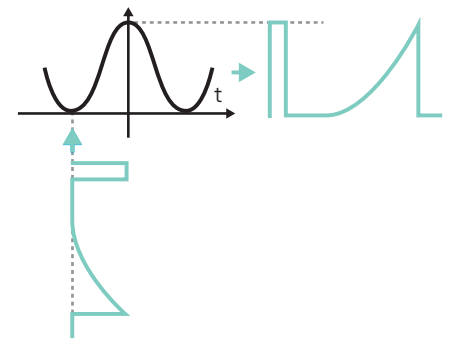


#### Key Features

- MIN & MAX
- High pulse contrast
- High stability over time
- USB remote control

#### Modulation format

- Pulse generation
- Pulse picking
- Pulse shaping



# MODBOXES

## Complete modulation systems

Exail's ModBoxes are custom turn-key Modulation Units and Transmitters. They incorporate a complete dedicated modulation stage with power supply, control electronics and optional laser source with receiver. ModBoxes can be tailored to accommodate a broad variety of applications: pulse picking or generation, spectral broadening, analog modulation and all formats of digital communications.



### Analog Optical Transmitter



#### Key Features

- Linear transmission
- High linearity
- Wide bandwidth components
- Low RIN laser and dither-less MBC
- High harmonics suppression

#### Modulation format

- RF Over Fiber (RFoF)
- Linear modulation
- Optical communications
- [S] optical device measurement
- DP-CS-SSB generation
- Receiver test

### Optical Reference Transmitter



#### Key Features

- 850 nm, CWDM & LAN-WDM, C-Band
- QPSK up to 64 Gbauds
- PAM-4 up to 56 Gbauds
- NRZ up to 56 Gb/s
- DPSK up to 28 Gb/s

#### Modulation format

- Space com / Data Com / Long Haul
- 100 GE and 400 GE in data centers
- Receiver test
- Transmission system test
- Receiver frequency test
- [S] optical device measurement

### Optical Pulse Shaper Laser Front-End



#### Key Features

- 30 ps to 100 ns Pulse Generation
- Arbitrary waveform optical pulses
- To 125  $\mu$ J pulse energy
- Extremely low jitter
- 60 dB optical pulse contrast

#### Modulation format

- Laser cutting
- Inertial confinement fusion
- Interaction of intense light with matter
- Laser plasma interaction
- Laser implosion
- Interaction of ion beam with HP laser



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