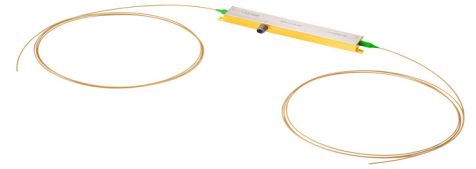


SPACE GRADE MODULATOR

# EM/NS-FM/FM/-NIR-MPX-LN-0.1

## 1000 nm band 300 MHz Space Grade Phase Modulator

The NIR-MPX-LN-0.1 phase is an electro-optical phase modulator featuring a wide bandwidth from DC to more than 300 MHz. Like all Exail Near InfraRed (NIR) modulators, the NIR-MPX-LN-0.1 uses a proton exchanged based waveguide process that confers them an unparalleled stability even when operating at high optical power and over a wide range of temperatures. The NIR-MPX-LN-0.1 phase modulator comes with high Polarization Extinction Ratio (PER) and Low Insertion Loss (LIL).



The NIR-MPX-LN-0.1 is ready for space, and several Space Grades modulator versions are proposed. An EM-/NS-FM-/FM-/NIR-MPX-LN-0.1 modulator version can be purchased to match the user application and space mission requirements.

This Commercial-off-the-shelf (COTS) modulator has been already submitted to a thorough qualification and has been embedded into satellites (TRL9).

### NIR-MPX-LN-0.1 Performance Highlights

#### Features

- TRL9 modulator
- Harsh environment qualification
- Optical power up to 20 dBm
- High impedance
- Low insertion losses
- Low  $V\pi$

Parameter	Min	Typ	Max	Unit
Operating wavelength	950	1060	1150	nm
Usable EO bandwidth	-	300	-	MHz
$V\pi$ RF @50 kHz	-	1.5	2	V
Insertion loss (without connector)	-	2.5	4	dB
RF port input impedance	-	10 000	-	$\Omega$

#### Applications

- Interferometric based sensors
- Laser combining
- Pound-Drever-Hall locking (PDH)
- Optical comb

### Space Grade Modulator Versions and Definition <sup>(1)</sup>

#### Related Equipments

- NIR-MX intensity modulators

Modulator grade		Terrestrial	Engineering	New-Space	Flight Model
		Grade	Model	Flight Model	FM
		TG <sup>(2)</sup>	EM	NS-FM	
	Flight compatibility	X	X	O	O
Assembly	Space compatible raw material	X	O	O	O
	Batch unicity	X	X	X	O
	Space compatible assembly process	X	X	O	O
Test	Screening test	Partial	Partial	O	O
	Space qualification test	X	X	O	O
	Lot acceptance test	X	X	X	O
	Qualification program	X	X	X	O
Documentation	Acceptance test report	O	O	X	X
	Interface control document	X	O	O	O
	Certificate of conformity	X	O	O	O
	Screening test report	X	X	O	O
	Lot acceptance test report	X	X	X	O
	Handling manual	O	O	O	O

<sup>(1)</sup> O: apply. X: do not apply

<sup>(2)</sup> Please refer to the NIR-MPX and NIR-MPZ Series commercial data-sheet, <https://www.ixblue.com/wp-content/uploads/2022/01/nir-mpxmpz-Inseries.pdf>.

## EM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - Engineering Model

The engineering model is flight representative in form, fit and function. The engineering models are used for functional qualification, except redundancy verification, failure survival demonstration and parameter drift checking. The EM is also used for final validation of test facilities. (ECSS-E-10-02A).

## Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Electro-optical (EO) bandwidth	$S_{21}$	-	100	150	-	MHz
Usable bandwidth	$t_r / t_f$	-		300	-	MHz
$V_{\pi}$ RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	1.5	2	V
RF port input impedance	$Z_{in-RF}$	-	-	10 000	-	$\Omega$

## Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	$\lambda$	-	950	1060	1150	nm
Insertion loss	IL	Without connector <sup>(1)</sup>	-	2.5	4	dB
Polarization extinction ratio	PER	Without connector	20	-	-	dB
Optical return loss	ORL	-	-40	-45	-	dB

<sup>(1)</sup> Consider an extra-loss up to 0.4 dB for each FC/APC commercial grade optical connector, and up to 0.5 dB for each Mini-Avim® and Avim® optical connector.

## Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Modulation voltage range	$E_{V_{in}}$	-20	+20	V
Optical input power (CW mode)	$OP_{in}$	-	+20	dBm
Operating temperature (no applied derating)	OT	+0	+70	°C
Storage temperature	ST	-40	+85	°C

## SPACE GRADE MODULATORS

# EM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - Engineering Model

### Interfaces and dimensions

Input fiber	Polarization maintaining 980 nm - Corning/Fujikura PM 98-U25D - Length: typ. 1.5 meter
Output fiber	Polarization maintaining 980 nm - Corning/Fujikura PM 98-U25D - Length: typ. 1.5 meter
Fibers jacket	1 mm PEEK loose tube
Input RF connector	Female K
Optical connectors (optional)	No connector
	Commercial grade FC/APC / Mini-Avim® / Avim®
	Space grade Mini-Avim® / Avim®
Optical connectors orientation	Slow axis parallel to the connector key
Package size	110 x 15 x 9.7 mm <sup>3</sup>
Mass	46 g
Package Lid	Laser marked
Materials	Low outgassing

### Screening

Test	Conditions
Thermal cycling	EOM non-operational -40 °C / +85 °C
Final tests after screening	Room temperature

### Documentation

Acceptance Test Report

Interface Control Document

Certificate of Conformity

Handling Manual

## SPACE GRADE MODULATORS

# NS-FM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - New-Space Flight Model

The New Space Flight Model (NS-FM) are the modulators dedicated to fly, based on qualification heritage (available on demand). The New-Space Flight Model are modulators that are used for the confirmation of key performances and interface, including unit mounting scheme and thermal characteristics. These modulators are identical to flight hardware, it is sampled from flight model lot after screening test. Those modulators are not evaluated with a Lot Acceptance Test.

### Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Electro-optical (EO) bandwidth	$S_{21}$	-	100	150	-	MHz
Usable EO bandwidth	$t_r / t_f$	-	-	300	-	MHz
$V_{\pi}$ RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	1.5	2	V
RF port input impedance	$Z_{in-RF}$	-	-	10 000	-	$\Omega$

### Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	$\lambda$	-	950	1060	1150	nm
Insertion loss	IL	Without connector <sup>(1)</sup>	-	2.5	4	dB
Polarization Extinction ratio	PER	Without connector	20	-	-	dB
Optical return loss	ORL	-	-40	-45	-	dB

<sup>(1)</sup> Consider an extra-loss up to 0.4 dB for each FC/APC commercial grade optical connector, and up to 0.5 dB for each Mini-Avim® and Avim® optical connector.

### Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Modulation voltage range	$EV_{in}$	-20	+20	V
Optical input power (CW mode)	$OP_{in}$	-	+20	dBm
Operating temperature (no applied derating)	OT	-30	+70	°C
Storage temperature	ST	-40	+85	°C

## SPACE GRADE MODULATORS

# NS-FM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - New-Space Flight Model

### Interfaces and dimensions

Input fiber	Polarization maintaining 980 nm - Corning/Fujikura PM 98-U25D - Length: typ. 1.5 meter
Output fiber	Polarization maintaining 980 nm - Corning/Fujikura PM 98-U25D - Length: typ. 1.5 meter
Fibers jacket	1 mm PEEK loose tube
Input RF connector	Female K
Optical connectors (optional)	No connector Commercial grade FC/APC / Mini-Avim® / Avim® Space grade Mini-Avim® / Avim®
Optical connectors orientation	Slow axis parallel to the connector key
Package size	110 x 15 x 9.7 mm <sup>3</sup>
Mass	46 g
Package Lid	Laser marked
Materials	Low outgassing

### Screening

Test	Conditions
Initial tests before screening	Room temperature
Thermal cycling	EOM non operational -40 °C / +85 °C
Burn-in	EOM operational +70 °C
Thermal cycling	EOM operational -30 °C / +70°C
Final tests after screening	Room temperature

### Qualification legacy

Sub-group	Test	Conditions
Mechanical	Sine vibrations	20 g
	Random vibrations	33.6 grms
	Shocks	1300 g
Radiations	Total Ion Dose	360 krad
	Total Non Ionizing Dose	E = 60 MeV, $\phi = 6 \times 10^{11}$ p+/cm <sup>2</sup>
Thermal cycling	Ambient pressure	-40 °C / +85 °C, 500 cycles non-operational
	Vacuum	-40 °C / +65 °C, 20 cycles non-operational
Lifetest	Ageing	+85 °C, 2000 h
Moisture	Damp heat	+85 °C, 85 % RH, 240 h

### Documentation

Interface Control Document - Certificate of Conformity

Screening test report - Handling Manual

Other documents available on request (Test plan, DML, DPL, DCL, ABCL, MFC...)

## SPACE GRADE MODULATORS

# FM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - Flight Model

The Flight Model (FM) are the modulators dedicated to fly; these are tested to acceptance-level testing (LAT Lot Acceptance Tests corresponding to a relaxed qualification tests program). (ECSS-E-10-02A).

### Electrical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Electro-optical (EO) bandwidth	$S_{21}$	-	100	150	-	MHz
Usable EO bandwidth	$t_r / t_f$	-	-	300	-	MHz
$V_{\pi}$ RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	1.5	2	V
RF port input impedance	$Z_{in-RF}$	-	-	10 000	-	$\Omega$

### Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	$\lambda$	-	950	1060	1150	nm
Insertion loss	IL	Without connector <sup>(1)</sup>	-	2.5	4	dB
Polarization Extinction ratio	PER	Without connector <sup>(1)</sup>	20	-	-	dB
Optical return loss	ORL	-	-40	-45	-	dB

<sup>(1)</sup> Consider an extra-loss up to 0.4 dB for each FC/APC commercial grade optical connector, and up to 0.5 dB for each Mini-Avim® and Avim® optical connector.

### Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min	Max	Unit
Modulation voltage range	$EV_{in}$	-20	+20	V
Optical input power (CW mode)	$OP_{in}$	-	+20	dBm
Operating temperature (no applied derating)	OT	-30	+70	°C
Storage temperature	ST	-40	+85	°C

## SPACE GRADE MODULATORS

# FM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - Flight Model

### Interfaces and dimensions

Input fiber	Polarization maintaining 980 nm - Corning/Fujikura PM 98-U25D - Length: typ. 1.5 meter
Output fiber	Polarization maintaining 980 nm - Corning/Fujikura PM 98-U25D - Length: typ. 1.5 meter
Fibers jacket	1 mm PEEK loose tube
Input RF connector	Female K
Optical connectors (optional)	No connector Commercial grade FC/APC / Mini-Avim® / Avim® Space grade Mini-Avim® / Avim®
Optical connectors orientation	Slow axis parallel to the connector key
Package size	110 x 15 x 9.7 mm <sup>3</sup>
Mass	46 g
Package Lid	Laser marked
Materials	Low outgassing

### Screening

Test	Conditions
Initial tests before screening	Room temperature
Thermal cycling	EOM non operational -40 °C / +85 °C
Burn-in	EOM operational +70 °C
Thermal cycling	EOM operational -30 °C / +70 °C
Final tests after screening	Room temperature

### Qualification legacy

Sub-group	Test	Conditions
Mechanical	Sine vibrations	20 g
	Random vibrations	33.6 grms
	Shocks	1300 g
Radiations	Total Ion Dose	360 krad
	Total Non Ionizing Dose	E = 60 MeV, $\phi = 6 \times 10^{11}$ p+/cm <sup>2</sup>
Thermal cycling	Ambient pressure	-40 °C / +85 °C, 500 cycles non-operational
	Vacuum	-40 °C / +65 °C, 20 cycles non-operational
Lifetest	Ageing	+85 °C, 2000 h
Moisture	Damp heat	+85 °C, 85 % RH, 240 h

## SPACE GRADE MODULATORS

# FM-NIR-MPX-LN-0.1

## 300 MHz Phase Modulator - Flight Model

### Flight Model Lot Acceptance Test (LAT)

Proposition of Lot Acceptance Test sequence - on request modification available

Sub-group	Test	Conditions
Mechanical	Vibration test	25 grms 1 min/axis - 1 axis (out of plane)
Thermal cycling	Non-operating temperature test	EOM non operational [-35 °C ; +60 °C]
	Operating temperature test	EOM operational [+10 °C; +20 °C; +55 °C]

### Documentation

Interface Control Document

Certificate of Conformity

Screening & LAT test report

Handling Manual

Other documents available on request (Test plan, DML, DPL, DCL, ABCL, MFC...)

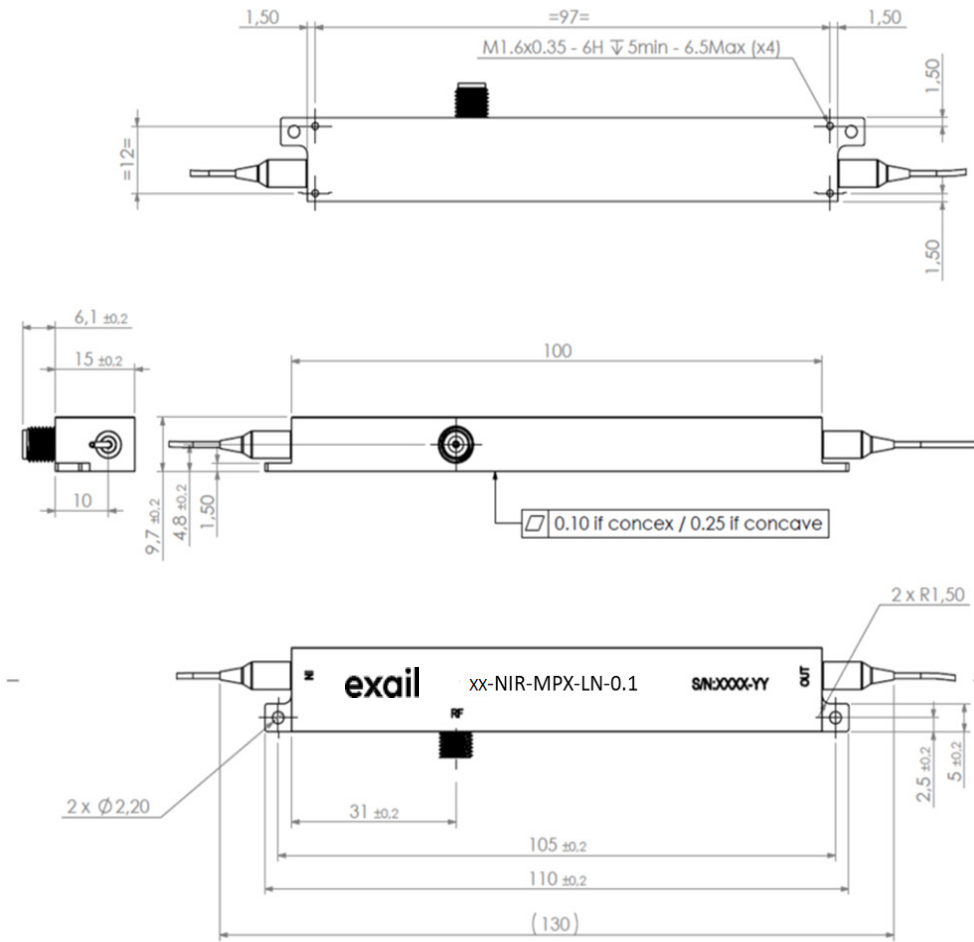
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# SPACE GRADE MODULATORS

## Mechanical Diagram and Pinout

All measurements in mm



EM / NS-FM / FM

Input connector: 00 (bare fiber), FA (FC/APC), AV (AVIM®), MAV (Mini-AVIM®)

Output connector: 00 (bare fiber), FA (FC/APC), AV (AVIM®), MAV (Mini-AVIM®)

□ -NIR-MPX-LN-0.1-00-P-P - □ - □

### About us

Exail Photonics produces specialty optical fibers and Bragg gratings based fiber optics components and provides optical modulation solutions based on the company lithium niobate (LiNbO<sub>3</sub>) modulators and RF electronic modules.

Exail Photonics serves a wide range of industries: sensing and instruments, defense, telecommunications, space and fiber lasers as well as research laboratories all over the world.

Exail reserves the right to change, at any time and without notice, the specifications, design, function or form of its products described herein. All statements, specification, technical information related to the products herein are given in good faith and based upon information believed to be reliable and accurate at the moment of printing. However, Exail provides no warranty (whether express or implied or statutory) as to the description, sufficiency, accuracy or completeness, merchantability or fitness for a particular purpose of any information or specification detailed herein. No liability is assumed for any inaccuracies and/or as a result of use of the products. The user must validate all parameters for each application before any use and he shall assume all risks and responsibilities in connection with the use of the products.