

SPACE GRADE MODULATOR

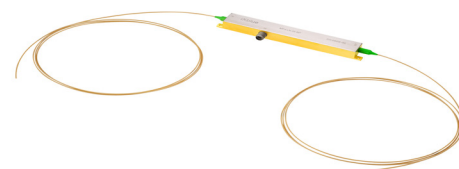
EM/NS-FM/FM/-MXER-LN-10

C-band 10 GHz Space Grade High Extinction Ratio Modulator

The MXER-LN-10 is an electro-optical amplitude modulator featuring a very high extinction ratio and a very wide bandwidth above 10 GHz. Its specific design relies on Exail "Magic Junction" (patent n° US2008193077) to achieve a very low insertion loss and high extinction ratio values.

The MXER-LN-10 is ready for space, and several Space Grades modulator versions are proposed.

An EM-/NS-FM-/FM/-MXER-LN-10 modulator version can be purchased to match the user application and space mission requirements.



Features

- Optical power up to 20 dBm
- High extinction ratio
- Low insertion losses
- Low V_{π}

Applications

- High pulse contrast
- Pulse-position modulation (PPM)
- Quantum Key Distribution (QKD)
- Lidar

Related Equipments

- MPZ C-Band phase modulators

MXER-LN-10 Performance Highlights

Parameter	Min	Typ	Max	Unit
Operating wavelength	1535	1550	1560	nm
Usable EO bandwidth	-	12	-	GHz
V_{π} RF @50 kHz	-	5.5	6	V
Insertion loss (without connector)	-	4	5	dB
RF port input impedance	-	50	-	Ω

Space Grade Modulator Versions and Definition ⁽¹⁾

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

⁽¹⁾ ○: apply, X: do not apply

⁽²⁾ Please refer to the MXER Series commercial data-sheet, <https://www.ixblue.com/wp-content/uploads/2022/01/MXER-LN%20SERIES.pdf>.

SPACE GRADE MODULATORS

EM-MXER-LN-10

Space Grade High Extinction Ratio 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}	-	10	12	-	GHz
Ripple S_{21}	ΔS_{21}	RF electrodes, $f < 10$ GHz	-	0.5	1	dB
Electrical return loss	S_{11}	RF electrodes, $f < 10$ GHz		-12	-10	dB
V_{π} RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	5.5	6	V
V_{π} DC	$V_{\pi_{DC}}$	DC electrodes	-	6.5	7	V
RF port input impedance	Z_{in-RF}	-	-	50	-	Ω
DC port input impedance	Z_{in-DC}	-	1	-	-	M Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	λ	-	1535	1550	1560	nm
Insertion loss	IL	Without connector ⁽¹⁾	-	4	5	dB
DC static extinction ratio	SER	Note ⁽²⁾	30	35	-	dB
Polarization extinction ratio	PER	Without connector	20	-	-	dB
Optical return loss	ORL	-	-40	-	-	dB
Chirp	-	-	-0.1	-	+0.1	-

⁽¹⁾ 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.

⁽²⁾ Measured with narrow source, linewidth ≤ 200 MHz.

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
Maximum RF input power (CW mode)	RF_{in}	-	+28	dBm
Bias voltage	DC_{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-MXER-LN-10

Space Grade High Extinction Ratio Modulator – Engineering Model

Interfaces and dimensions

Input fiber	Polarization maintaining 1550 nm - Corning PM 15-U25D - Length: typ. 1.5 meter
Output fiber	Polarization maintaining 1550 nm - Corning PM 15-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
Optical connectors orientation	Slow axis parallel to the connector key
Package size	110 x 15 x 9.7 mm ³
Mass	70 g
Package Lid	Laser marked
Materials	Low outgassing

Screening ⁽¹⁾

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

⁽¹⁾ Please refer to «00025954-A - MX & MXER Space Model - Screening Test and LAT.pdf» documentation.

Documentation

Acceptance Test Report
Interface Control Document
Certificate of Conformity
Handling Manual

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SPACE GRADE MODULATORS

NS-FM-MXER-LN-10

Space Grade High Extinction Ratio 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}	-	10	12	-	GHz
Ripple S_{21}	ΔS_{21}	RF electrodes, $f < 10$ GHz	-	0.5	1	dB
Electrical return loss	S_{11}	RF electrodes, $f < 10$ GHz		-12	-10	dB
V_{π} RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	5.5	6	V
V_{π} DC	$V_{\pi_{DC}}$	DC electrodes	-	6.5	7	V
RF port input impedance	Z_{in-RF}	-	-	50	-	Ω
DC port input impedance	Z_{in-DC}	-	1	-	-	M Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	λ	-	1535	1550	1560	nm
Insertion loss	IL	Without connector ⁽¹⁾	-	4	5	dB
DC static extinction ratio	SER	Note ^{(2), (3)}	30	35	-	dB
Polarization extinction ratio	PER	Without connector	20	-	-	dB
Optical return loss	ORL	-	-40	-	-	dB
Chirp	-	-	-0.1	-	+0.1	-

⁽¹⁾ 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.

⁽²⁾ Measured with narrow source, linewidth ≤ 200 MHz.

⁽³⁾ The modulator's ER is warranted in the range [0 °C , +70 °C]. Qualification has not been performed for the full operating temperature range [-30 °C , +70 °C].

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
Maximum RF input power (CW mode)	RF_{in}	-	+28	dBm
Bias voltage	DC_{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-MXER-LN-10

Space Grade High Extinction Ratio Modulator-New Space Flight Model

Interfaces and dimensions

Input fiber	Polarization maintaining 1550 nm – Corning PM 15-U25D – Length: typ. 1.5 meter
Output fiber	Polarization maintaining 1550 nm – Corning PM 15-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
	Space grade Mini-Avim® / Avim®
Optical connectors orientation	Slow axis parallel to the connector key
Package size	110 x 15 x 9.7 mm ³
Mass	70 g
Package Lid	Laser marked
Materials	Low outgassing

Screening ⁽¹⁾

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

⁽¹⁾ Please refer to «00025954-A - MX & MXER Space Model - Screening Test and LAT.pdf» documentation.

Qualification legacy

Sub-group	Test	Conditions
Mechanical	Sine vibrations	20 g
	Random vibrations	33.6 grms
	Shocks	1600 g
Radiations	Total Ion Dose	360 krad
	Total Non Ionizing Dose	E = 60 MeV, $\phi = 6 \times 10^{11}$ p+/cm ²
Thermal cycling	Ambient pressure	-40 °C / +85 °C, 500 cycles non-operational
	Vacuum	-30 °C / +70 °C, 20 cycles non-operational
Lifetest	Ageing	+85 °C, 1000 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-MXER-LN-10

SpaceGradeHighExtinctionRatioModulator – FlightModel

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}	-	10	12	-	GHz
Ripple S_{21}	ΔS_{21}	RF electrodes, $f < 10$ GHz	-	0.5	1	dB
Electrical return loss	S_{11}	RF electrodes, $f < 10$ GHz		-12	-10	dB
V_{π} RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	5.5	6	V
V_{π} DC	$V_{\pi_{DC}}$	DC electrodes	-	6.5	7	V
RF port input impedance	Z_{in-RF}	-	-	50	-	Ω
DC port input impedance	Z_{in-DC}	-	1	-	-	M Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	λ	-	1535	1550	1560	nm
Insertion loss	IL	Without connector ⁽¹⁾	-	4	5	dB
DC static extinction ratio	SER	Note ^{(2), (3)}	30	35	-	dB
Polarization extinction ratio	PER	Without connector	20	-	-	dB
Optical return loss	ORL	-	-40	-	-	dB
Chirp	-	-	-0.1	-	+0.1	-

⁽¹⁾ 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.

⁽²⁾ Measured with narrow source, linewidth ≤ 200 MHz.

⁽³⁾ The modulator's ER is warranted in the range [0 °C , +70 °C]. Qualification has not been performed for the full operating temperature range [-30 °C , +70 °C].

Absolute Maximum Ratings

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Parameter	Symbol	Min	Max	Unit
Maximum RF input power (CW mode)	RF_{in}	-	+28	dBm
Bias voltage	DC_{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-MXER-LN-10

Space Grade High Extinction Ratio Modulator – Flight Model

Interfaces and dimensions

Input fiber	Polarization maintaining 1550 nm – Corning PM 15-U25D – Length: typ. 1.5 meter
Output fiber	Polarization maintaining 1550 nm – Corning PM 15-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
	Space grade Mini-Avim® / Avim®
Optical connectors orientation	Slow axis parallel to the connector key
Package size	110 x 15 x 9.7 mm ³
Mass	70 g
Package Lid	Laser marked
Materials	Low outgassing

Screening ⁽¹⁾

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

⁽¹⁾Please refer to «00025954–A – MX & MXER Space Model – Screening Test and LAT.pdf» documentation.

Qualification legacy

Sub-group	Test	Conditions
Mechanical	Sine vibrations	20 g
	Random vibrations	33.6 grms
	Shocks	1600 g
Radiations	Total Ion Dose	360 krad
	Total Non Ionizing Dose	E = 60 MeV, $\phi = 6 \times 10^{11}$ p+/cm ²
Thermal cycling	Ambient pressure	–40 °C / +85 °C, 500 cycles non-operational
	Vacuum	–30 °C / +70 °C, 20 cycles non-operational
Lifetest	Ageing	+85 °C, 1000 h
Moisture	Damp heat	+85 °C, 85 % RH, 240 h

SPACE GRADE MODULATORS

FM-MXER-LN-10

Space Grade High Extinction Ratio Modulator – Flight Model

Flight Model Lot Acceptance Test (LAT) ⁽¹⁾

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]
Performances	Final functional test	Room temperature

⁽¹⁾ Please refer to «00025954-A – MX & MXER Space Model – Screening Test and LAT.pdf» documentation.

Documentation

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

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Mechanical Diagram and Pinout

[illegible]

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