

SPACE GRADE MODULATOR

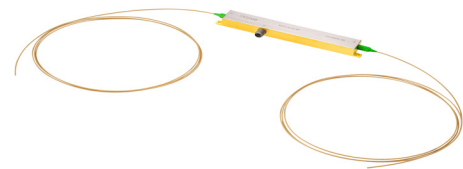
EM/NS-FM/FM/-MPX-LN-05

C-band 5 GHz Space Grade Phase Modulators

The MPX-LN-05 phase is an electro-optical phase modulator featuring a wide bandwidth up to 5GHz. Designed using state-of-the-art and proven lithium niobate technology, the MPX-LN-05 phase modulators are easy to operate and to integrate.

The MPX-LN-05 is ready for space, and several Space Grades modulator versions are proposed.
An EM-/NS-FM-/FM/-MPX-LN-05 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).



Features

- TRL9 modulator
- Harsh environment qualification
- Optical power up to 20 dBm
- 50 Ω impedance
- Low insertion losses
- Low V_π

Applications

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

Related Equipments

- MX intensity modulators

MPX-LN-05 Performance Highlights

Parameter	Min	Typ	Max	Unit
Operating wavelength	1530	1550	1580	nm
Usable EO bandwidth	3.5	4	5	GHz
V _π RF @50 kHz	-	6	7	V
Insertion loss (without connector)	-	2.5	3.5	dB
RF port input impedance	-	50	-	Ω

Space Grade Modulator Versions and Definition ⁽¹⁾

Modulator grade		Terrestrial Grade TG	Engineering Model EM	New-Space Flight Model del 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 Heritage	X	X	○	○
	Lot acceptance test	X	X	X	○
	Qualification program	X	X	X	○
Documentation	Acceptance test report	○	○	○	○
	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

SPACE GRADE MODULATORS

EM-MPX-LN-05

5 GHz 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}	-	3.5	4	5	GHz
Ripple S_{21}	-	-	-	0.5	1	dB
Electrical return loss	S_{11}	Up to 5 GHz	-	-12	-10	dB
V_{π} RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	6	7	V
RF port input impedance	Z_{in-RF}	-	-	50	-	Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	λ	-	1530	1550	1580	nm
Insertion loss	IL	Without connector ⁽¹⁾	-	2.5	3.5	dB
Optical return loss	ORL	-	-40	-45	-	dB

⁽¹⁾ Consider an extra-loss up to 0.2 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
RF input power	EP_{in}	--	+28	dBm
Optical input power (CW mode)	OP_{in}	-	+20	dBm
Operating temperature (no applied derating)	OT	+0	+70	°C
Storage temperature	ST	-40	+85	°C

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SPACE GRADE MODULATORS

EM-MPX-LN-05

5 GHz Phase Modulator – Engineering Model

Interfaces and dimensions

Input fiber	Polarization maintaining 1550 nm - Corning/Fujikura PM 15-U25D - Length: typ. 1.5 meter
Output fiber	Polarization maintaining 1550 nm - Corning/Fujikura 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 / 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

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

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NS-FM-MPX-LN-05

5 GHz 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}	-	3.5	4	5	GHz
Ripple S_{21}	-	-	-	0.5	1	dB
Electrical return loss	S_{11}	Up to 5 GHz	-	-12	-10	dB
V_{π} RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	6	7	V
RF port input impedance	Z_{in-RF}	-	-	50	-	Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	λ	-	1530	1550	1580	nm
Insertion loss	IL	Without connector ⁽¹⁾	-	2.5	3.5	dB
Optical return loss	ORL	-	-40	-45	-	dB

⁽¹⁾ Consider an extra-loss up to 0.2 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
RF input power	EP_{in}	--	+28	dBm
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-MPX-LN-05

5 GHz Phase Modulator – New-Space Flight Model

Interfaces and dimensions

Input fiber	Polarization maintaining 1550 nm – Corning/Fujikura PM 15-U25D – Length: typ. 1.5 meter
Output fiber	Polarization maintaining 1550 nm – Corning/Fujikura 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 / 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 ³
Mass	70 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, $\phi = 6 \times 10^{11} \text{ p}^+/\text{cm}^2$
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...)

FM-MPX-LN-05

5 GHz 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}	-	3.5	4	5	GHz
Ripple S_{21}	-	-	-	0.5	1	dB
Electrical return loss	S_{11}	Up to 5 GHz	-	-12	-10	dB
V_{π} RF @50 kHz	$V_{\pi_{RF\ 50\ kHz}}$	RF electrodes	-	6	7	V
RF port input impedance	Z_{in-RF}	-	-	50	-	Ω

Optical Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Crystal	-	-	Lithium Niobate X-Cut Y-Prop			
Operating wavelength	λ	-	1530	1550	1580	nm
Insertion loss	IL	Without connector ⁽¹⁾	-	2.5	3.5	dB
Optical return loss	ORL	-	-40	-45	-	dB

⁽¹⁾ Consider an extra-loss up to 0.2 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
RF input power	EP_{in}	--	+28	dBm
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-MPX-LN-05

5 GHz Phase Modulator – Flight Model

Interfaces and dimensions

Input fiber	Polarization maintaining 1550 nm – Corning/Fujikura PM 15-U25D – Length: typ. 1.5 meter
Output fiber	Polarization maintaining 1550 nm – Corning/Fujikura 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 / 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 ³
Mass	70 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, $\phi = 6 \times 10^{11} \text{ p}^+/\text{cm}^2$
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

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5 GHz 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]
Performances	Final functional test	Room temperature

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...)

Mechanical Diagram and Pinout

[illegible]

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