SIPhoDiAS

Space-grade Opto-electronic Interfaces for Photonic Digital and Analogue Very-high-throughput Satellite payloads

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HISTORY OF CHANGES

ISSUE / SUBMISSION DATE	Page / section	Nature of change and reason
1.0 (28/02/2022)	-	-
2.0 (14/04/2022)		Figure 2 updated

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PURPOSE AND STRUCTURE OF THE DOCUMENT

This deliverable reports the high-bandwidth GaAs Mach-Zehnder Modulator (MZM) module developed in H2020-SPACE-SIPHODIAS project by aXenic. The deliverable is structured as a preliminary datasheet and presents the module specifications, the actual hardware implementation and the characterization data. The report is intended for public release.

1. DESCRIPTION

The MZM developed by aXenic in the frame of the H2020-SPACE-SIPHODIAS project, is a high bandwidth electro-optic modulator integrated in GaAs applicable to microwave-photonic mixing of optical local oscillators and high-frequency RF signals. The MZM is designed to deliver a bandwidth of 40 GHz. The optical input and output are supplied through polarization maintaining single-mode fibers. The RF input of the device is provided through SMPM connectors.

The module specifications have been defined in collaboration with Thales Alenia Space and are aligned with the requirements of microwave photonic payloads that operate in the Ka (30 GHz) and V (50 GHz) frequency bands.

2. SPECIFICATIONS

2.1. Opto-electronic specifications

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Optical Insertion Loss	IL				7	dB
RF Electrode Vpi	V_π	DC		4.6	5.5	V
Electrical to Optical Response	E/O S_{21}	S_{21}, 3dB Point	40		50	GHz
Electrical Return Loss	E/E S_{11}	S_{11}, DC-60GHz	8			dB
Optical Return Loss	RL		30			dB
Electrical to Optical Flatness [2]	E/O S_{21}	0.15 – 30GHz			$\pm$0.8	dB
Extinction Ratio	ER	Low Frequency	20	23		dB
Bias Electrode Vpi	Vpi			7.5	10	V
Quadrature Control Point	V_{ctrl}		0	2	4	V

Notes:

1. λ = 1550 nm, T = 25°C
2. EO Flatness (ripple) is the deviation in measured S21 from a smooth 3rd order polynomial fit.

2.2. Mechanical and environmental specifications

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Case Temperature	T_{case}		-15		+75	°C
Relative Humidity[1]	RH	Non-Condensing	5		85	%
Wavelength Range	λ		1520	1550	1580	nm
Substrate Bias Voltage [2]	V_{sub}		5.0	10.0	12.0	V
Quadrature Control Bias Voltage [3]	V_{ctrl}		-10.0	5	10.0	V
Null Control Bias Voltage [3]	V_{ctrl}		-5.0	0	5.0	V

Notes:

1. The substrate bias must be applied first and not exceeded by other bias voltages.
2. The control bias can be varied to achieve the best measurement conditions.

3. Module outline and characterization

Figure 1 shows the fully assembled and packaged modulator prototype. This modulator is well-adapted for folded packaging (RF connector on one side and I/O fibers on the other side).

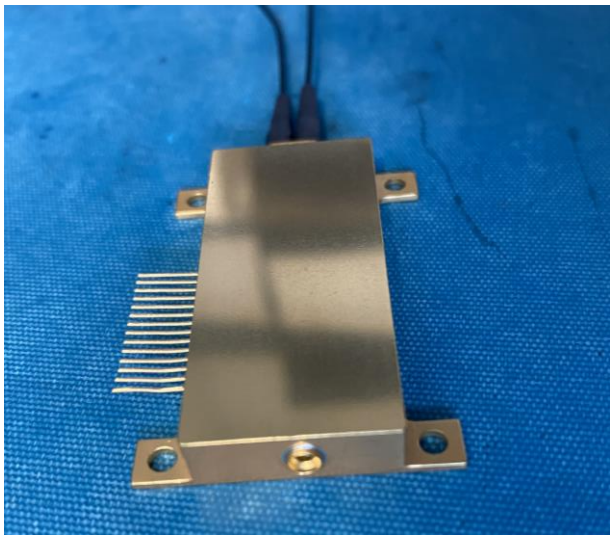

Figure 1 Packaged GaAs MZM prototype by aXenic

Figure 2 shows the frequency response of two modulator variants featuring different active lengths. The responses show that a 3 dB bandwidth of 40 GHz would be feasible in a compact MZM chip form factor that will allow array integration. The longer chip design shows a steeper roll-off but with recovery around 50GHz attributable to improvements in the RF structure. Combined with the lower baseline Vπ due to the longer RF interaction, this amounts to a lower dynamic drive-power requirement at 50GHz.

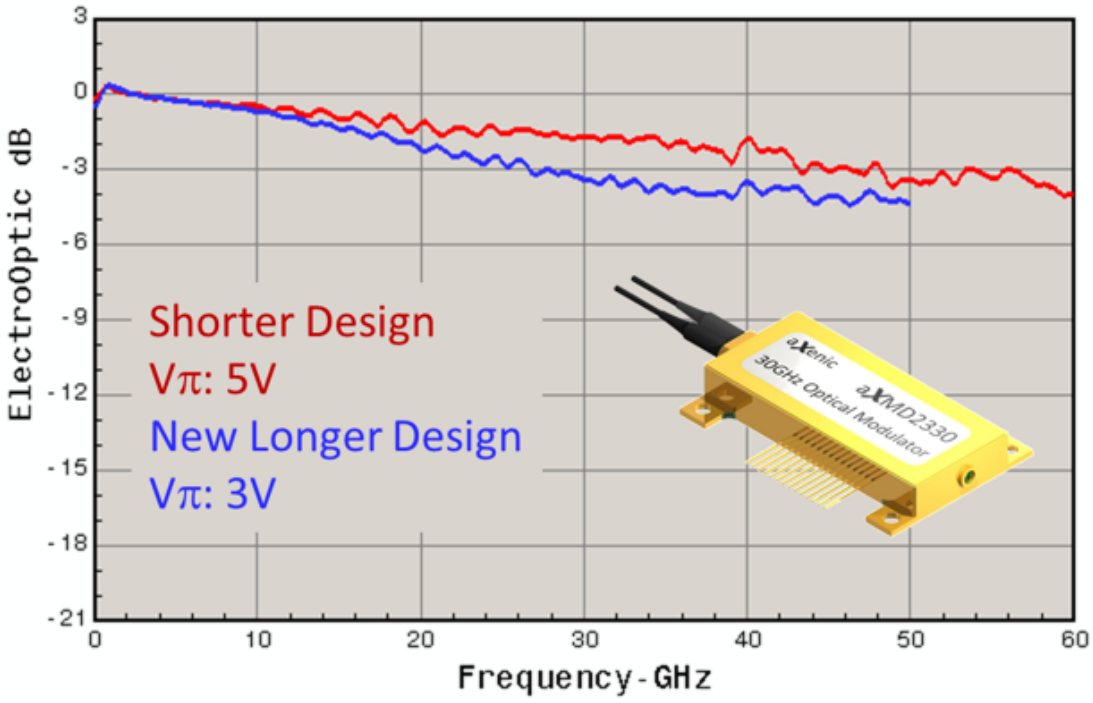

Figure 2. S-parameter measurement of the packaged photodiode prototype.

4. Conclusion

This report has presented the first-generation high bandwidth GaAs MZM module developed by aXenic in the frames of H2020-SIPHODIAS project. The information is intended for public release.

LIST OF FIGURES