

SIPhoDiAS



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

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D4.3: Fabrication & characterization of Gen-1 photodetector module (public version)

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PURPOSE AND STRUCTURE OF THE DOCUMENT

This deliverable reports the high-speed microwave photodiode module developed in H2020-SPACE-SIPHODIAS project by ALBIS. 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 photodiode developed by ALBIS in the frames of H2020-SPACE-SIPHODIAS project, is a high speed microwave photodiode module applicable to direct optical-to-electrical conversion of RF-modulated optical signals and is designed to deliver a bandwidth of 40 GHz. The optical input is supplied through a single-mode 9/125 mm fiber pigtail. The RF output of the device is provided through a K-connector. The photodiode inside this module is a high performance Albis InGaAs p-i-n photodiode, designed to operate in the wavelength region from 1260 to 1620 nm.

The module specifications have been defined in collaboration with Thales Alenia Space (Toulouse) and are aligned with the requirements of microwave photonic payloads that deploy RF down conversion in the Ka and Q-bands.

2. SPECIFICATIONS

The specifications listed below are preliminary and will be updated following the completion of the module full functional test (FFT), which is in progress. The specifications that have already been verified by test are marked as “confirmed”.

2.1. Opto-electronic specifications

Parameter	Symbol	Condition	Target			Unit	Notes
			Min	Typ	Max		
Operating wavelength	λ		1.54		1.58	μm	confirmed
DC Responsivity	R	$V_{\text{DC}} = 3.0 \text{ V}$	0.5	0.6		A/W	At 1550 nm confirmed
Polarization dependent loss	PDL				0.05	dB	to be confirmed.
Bandwidth	$f_{3\text{dB}}$	$V_{\text{DC}} = 3.0 \text{ V}$	35			GHz	-3dB electrical confirmed
Response flatness	$S_{12,p-p}$	$f = f_{\text{op}}$			± 0.5	dB	within bandwidth confirmed
Electrical return loss	S_{11}			-5		dB	within bandwidth confirmed
Damage threshold PD	P_{max}			13		dBm	to be confirmed
Operating optical input	P_{opt}				+10	mW	to be confirmed
Maximal forward current	I_{F}				1	mA	to be confirmed
Operating voltage	V_{DC}		3.0		5.0	V	confirmed

Dark current	I_D	$V_{DC} = 3.0 \text{ V}$			20	nA	BOL confirmed
Optical return loss	S_{22}		30			dB	confirmed

2.2. Mechanical and environmental specifications

Parameter	Symbol	Condition	Target			Unit	Notes
			Min	Typ	Max		
Operating temperature	T_{op}		-15		75	°C	to be confirmed
Storage temperature	T_{stg}		-40		90	°C	to be confirmed
Hermetic sealing	-		Yes				to be confirmed
Vacuum	-		$<10^{-6}$			Bar	
Leak rate	-				5^{-8}	atm.cc/s	for He
Electrical output impedance	$R_{F_{out}}$			50		Ω	confirmed
Electrical output interface	-		K-connector				confirmed
Optical input interface	P_{opt}		SMF pigtail				confirmed
Optical termination	-		FC/APC				confirmed
Pigtail length	-			1.0		m	confirmed
Package size	$L \times W \times H$		14.9x9x9			mm	confirmed
Mass	-			8	10	g	Without fiber pigtail and FC/APC connector confirmed

3. Module outline and characterization

Figure 1 shows the fully assembled and packaged photodiode prototype.

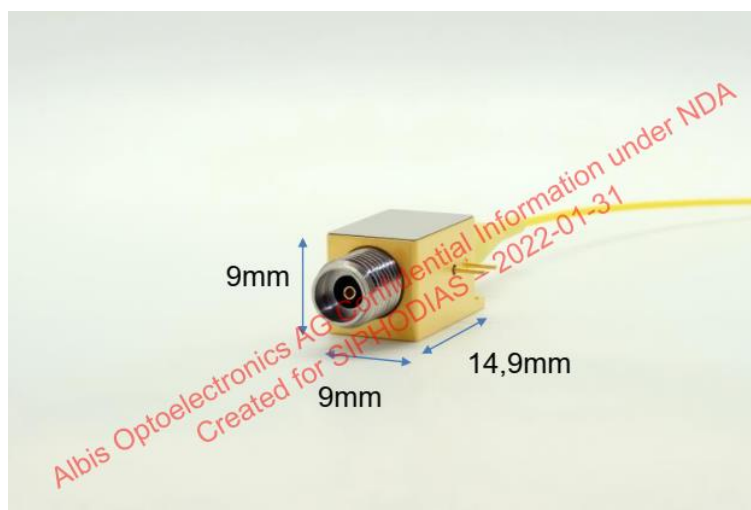


Figure 1 Packaged photodiode prototype by ALBIS.

Figure 2 shows the resulting S12 and S11 of the packaged photodiode at an optical wavelength of $\lambda = 1550\text{nm}$ and a reverse bias voltage $V_r = -5.0\text{V}$. The S12 transfer function is flat from 0 GHz to nearly 40 GHz. Above 40 GHz, the frequency response shows a steep drop. Therefore, the bandwidth of the device is most probably not limited by the sub-assembly including the photodiode or the package parasitic but due to the limitation to use a space qualified K-connector which is specified up to 40 GHz. The electrical return loss S11 is better than -10 dB up to about 25 GHz and remains below -4 dB up to 40 GHz demonstrating good broadband RF matching.

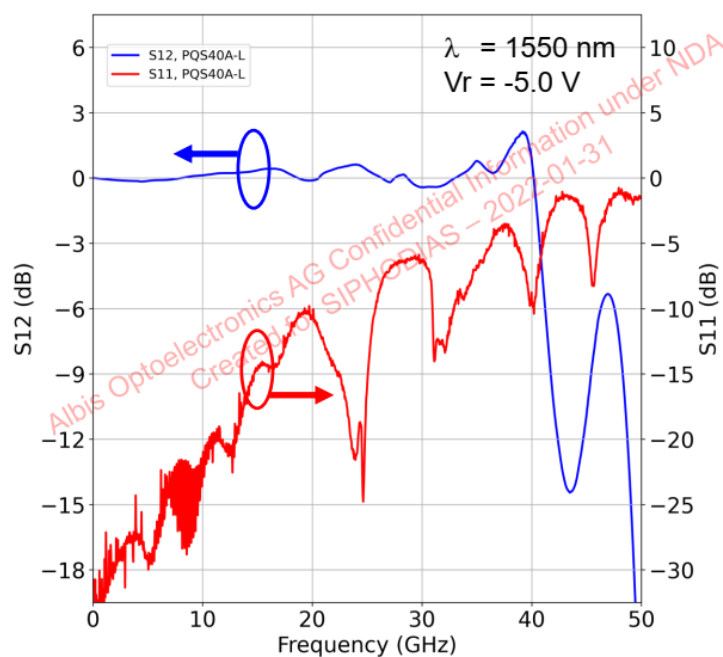


Figure 2. S-parameter measurement of the packaged photodiode prototype.

4. Conclusion

This report has presented the high speed microwave photodiode module developed by ALBIS in the frames of H2020-SIPHODIAS project. The information is intended for public release.

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