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AdvanSiD
Advanced Silicon Detectors

NUV SiPMs
TO Metallic Package

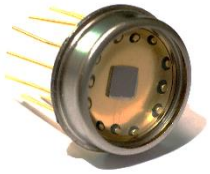
General Description

The Silicon PhotoMultiplier (SiPM) is an innovative solid-state silicon detector with single photon sensitivity. SiPMs are a valid alternative to photomultiplier tubes (PMT detectors). The main benefits of this detector are: high gain, extremely good timing performance, low operative voltage, insensitivity to magnetic field and high integration level.

ASD-NUV SiPMs are based on the AdvanSiD "P-on-N" silicon technology for detection of Near Ultraviolet Light. NUV-SiPMs have peak efficiency at 420nm, with detection spectrum extending from 350nm to 900nm.

Metallic TO18
Glass Window

Metallic TO18
Glob Top Silicone Resin



Metallic TO8
Glass Window

Application

- High Energy Physics
- Flow Cytometry
- Medical Imaging
- Biological Sensors
- Nuclear Medicine
- Analytical Instruments
- DNA Sequencing
- SEM Microscopy
- Homeland Security
- Confocal Microscopy

Features

- **Near Ultra Violet light detection**
- **Low noise**
- **Afterpulsing probability < 4 %**
- **Dark Count Rate < 100 kHz/mm^2**
- **Superior breakdown voltage uniformity**
- **Excellent temperature stability**
- **Detection of extremely faint light**
- **Very high gain (10^6)**
- **Extremely good timing performance**
- **Insensitive to magnetic fields**
- **Not damaged by ambient light**
- **Small and compact**

Ordering Information

Product Code	Description
ASD-NUV1S-M	1x1 mm^2 active area SiPM – TO18
ASD-NUV1S-MG	1x1 mm^2 active area SiPM – TO18
ASD- NUV1C-M	1.2 mm circular active area SiPM – TO18
ASD- NUV1C-MG	1.2 mm circular active area SiPM – TO18
ASD- NUV3S-M	3x3 mm^2 active area SiPM – TO8
ASD- NUV4S-M	4x4 mm^2 active area SiPM – TO8

S indicates square SiPM; C indicates circular SiPM;
M indicates metallic package with glass window;
MG indicates metallic package with glob top.

Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
T_A	Operating Temperature Range	-25	+40	°C
T_s	Storage temperature	-40	+60	°C
T_{sol}	Lead temperature (solder) 5s		+250	°C
M_{VW}	Max voltage working range	Breakdown Voltage + 6		V

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

Geometrical, Electrical, and Optical Typical Characteristics (T_a = 20 °C)

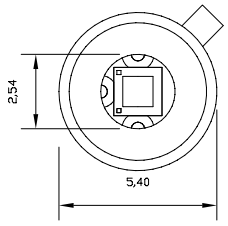
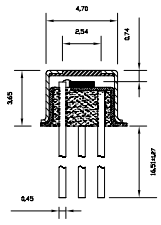
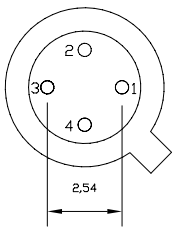
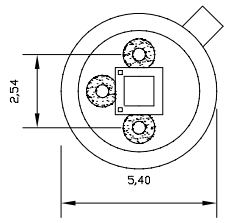
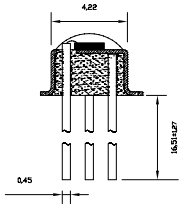
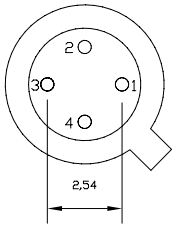
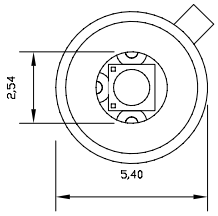
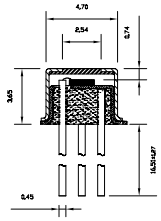
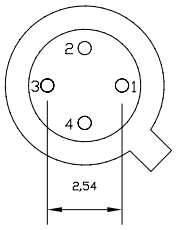
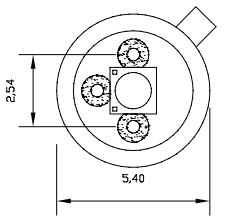
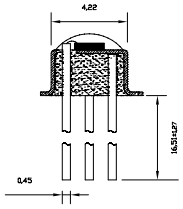
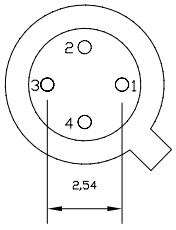
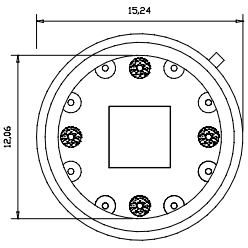
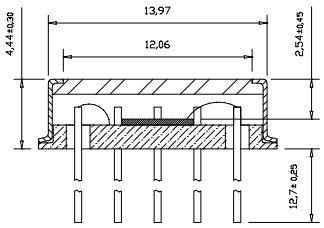
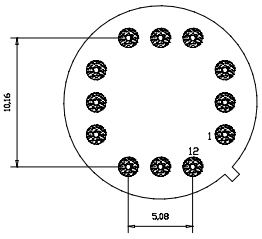
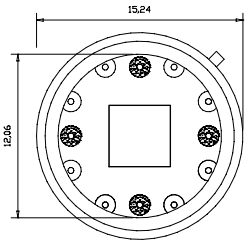
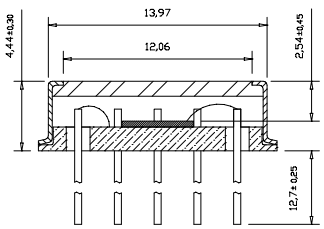
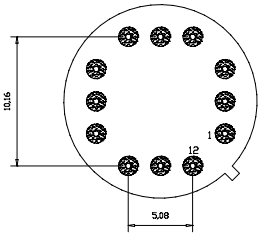
Symbol	Parameter	Product			
		ASD-NUV1S-M/MG	ASD-NUV1C-M/MG	ASD-NUV3S-M	ASD-NUV4S-M
AA	Effective active area	1×1 mm^2	1.13 mm^2	3×3 mm^2	4×4 mm^2
N	Cell count	625	673	5520	9340
CS	Cell size (pitch)	40 µm × 40 µm			
FF	Cell fill-factor	60 %			
RQ	Quenching resistance	800 kΩ			
C	Cell capacitance	90 fF			
τ_{RC}	Recharge time constant	70 ns			
S_R	Spectral response range	350 to 900 nm			
λ_p	Peak sensitivity wavelength	420 nm			
PDE	Photon Detection Efficiency (1)	43 %			
BV	Breakdown voltage(2)	Typical: 26 V	Min: 24 V	Max: 28 V	
σBV	BV standard deviation(3)	50 mV			
OV	Recommended Overvoltage range(4)	Min: 2 V		Max: 6 V	
DCR	Dark Count Rate(5)	< 50 kHz/mm^2 @ 2 V OV		< 100 kHz/mm^2 @ 6 V OV	
G	Gain(6)	3.6×10^6			
BVTC	Breakdown Voltage Temperature Coefficient	26 mV/°C			

(1) Measured at peak sensitivity wavelength ($\lambda = \lambda_p$) at +6 V overvoltage (not including afterpulse and crosstalk).
(2) Refer to the data provided with each shipped product.
(3) BV of SiPMs belonging to a same production lot is within 200 mV (±2σ) from mean BV value.
(4) Operating voltage (SiPM bias) is BV + OV, to be applied in reverse mode, i.e., $V_{AK} < 0$ (see "Pins Function" section).
(5) 0.5 p.e. threshold level at 20 °C (primary dark count rate; not including afterpulse).
(6) Measured at 20 °C at +6 V overvoltage.

NUV SiPMs

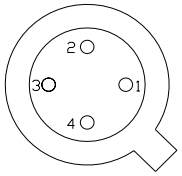
Dimensional Outlines

Units = mm, Mechanical tolerance = ±0.15 mm unless otherwise noted.

Product	Top View	Side View	Bottom View
ASD-NUV1S-M TO18 4 pins with glass window cap for SiPM 1x1 mm^2 active area size Material: Kovar			
ASD-NUV1S-MG TO18 4 pins with glob top for SiPM 1x1 mm^2 active area size Material: Kovar			
ASD-NUV1C-M TO18 4 pins with glass window cap for SiPM 1.13 mm^2 active area size Material: Kovar			
ASD-NUV1C-MG TO18 4 pins with glob top for SiPM 1.13 mm^2 active area size Material: Kovar			
ASD-NUV3S-M TO8 12 pins with glass window cap for SiPM 3x3 mm^2 active area size Material: Kovar			
ASD-NUV4S-M TO8 12 pins with glass window cap for SiPM 4x4 mm^2 active area size Material: Kovar			

Pins function

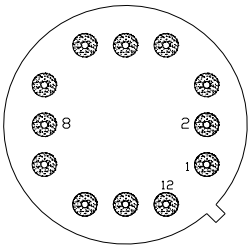
ASD-RGB1S-M/MG, ASD-RGB1C-M/MG
TO18 Metallic Package



Bottom view

N°	Name	Function
1	K	SiPM Cathode
3	A	SiPM Anode
2,4		Not connected

ASD-RGB3S-M, ASD-RGB4S-M
TO8 Metallic Package



Bottom view

N°	Name	Function
8	K	SiPM Cathode
2	A	SiPM Anode
1, 3-7, 9-12		Not connected

Device Characteristics

This section reports typical SiPM reverse and forward I/V curves and the dependences on overvoltage, temperature, and wavelength of most relevant device parameters. Refer to the data accompanying each shipped product for more detailed information.

All measurements are performed in a tight-light climatic chamber at T=20°C, unless otherwise noted.

SiPM output signals are amplified with ASD-EP-EB-N or ASD-EP-EB-PZ evaluation boards and acquired with fast oscilloscopes; the digitized data is then processed with dedicated PC programs.

Explanation of SiPM working principle and details on SiPM properties and parameters can be found on the guide *"Introduction to SiPMs"* available at http://advansid.com/resources/the-silicon-photmultiplier.

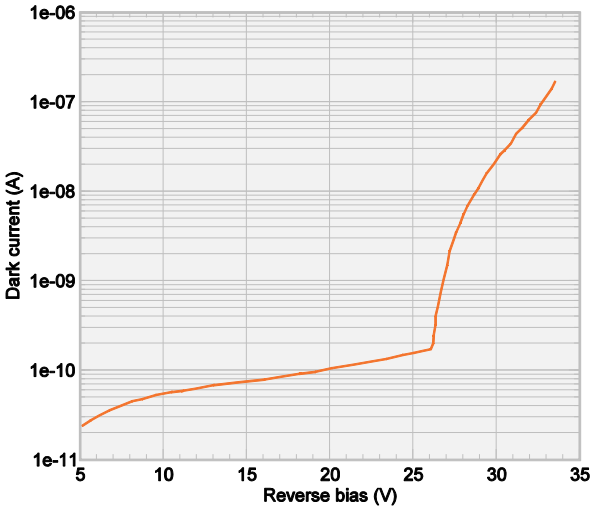


Fig.1 Typical reverse IV curve (ASD-NUV1S-M).

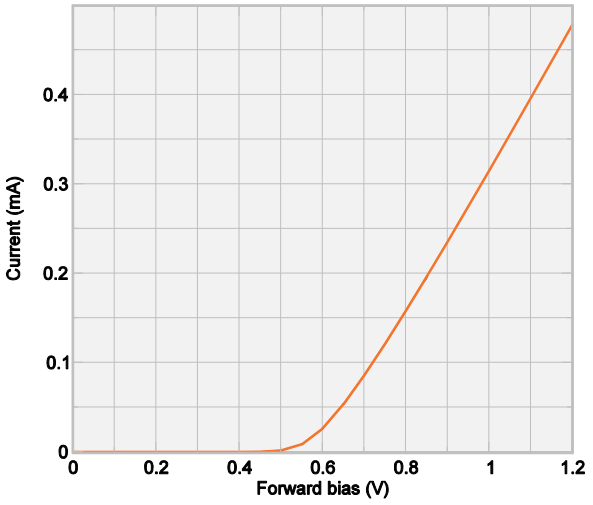


Fig.2 Typical forward IV curve (ASD-NUV1S-M).

NUV SiPMs

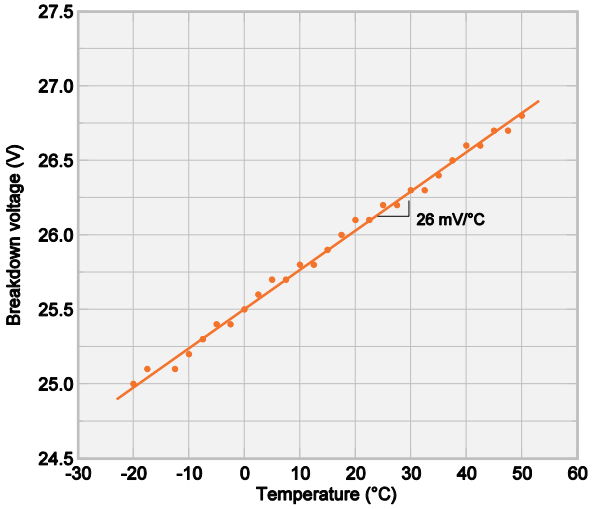


Fig.3 NUV-SiPMs breakdown voltage temperature dependence.

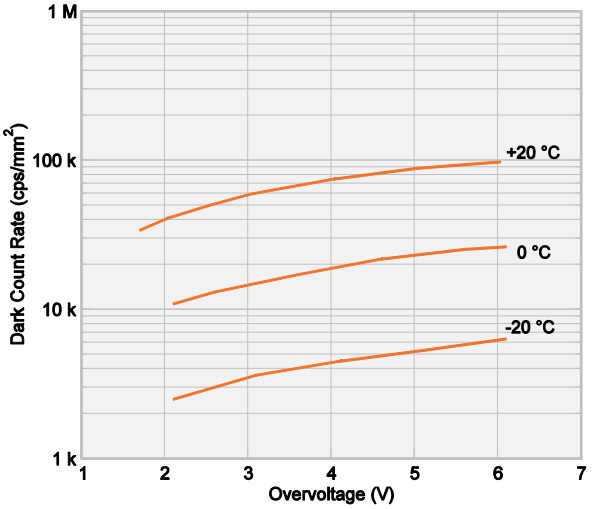


Fig.4 Dark count rate per square mm in NUV-SiPMs as a function of overvoltage and temperature.

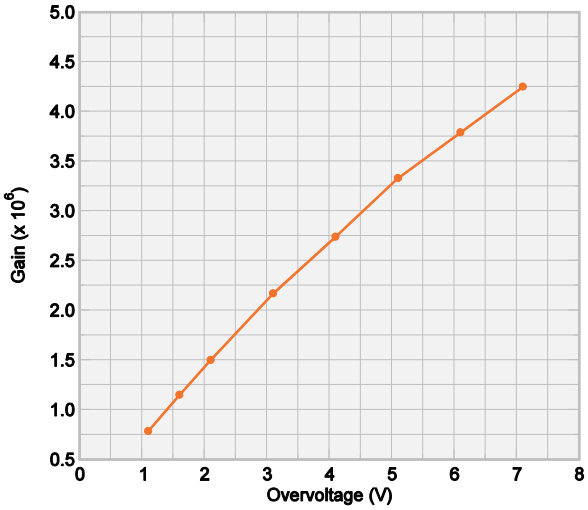


Fig.5 Gain of NUV-SiPMs as a function of overvoltage.

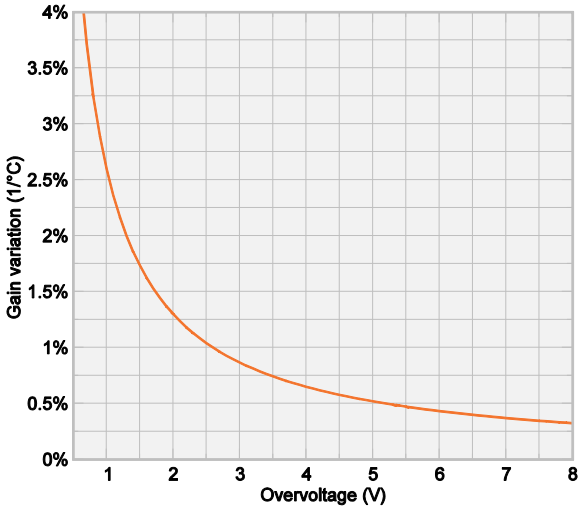


Fig.6 Relative variation of gain with temperature in NUV-SiPMs as a function of overvoltage.

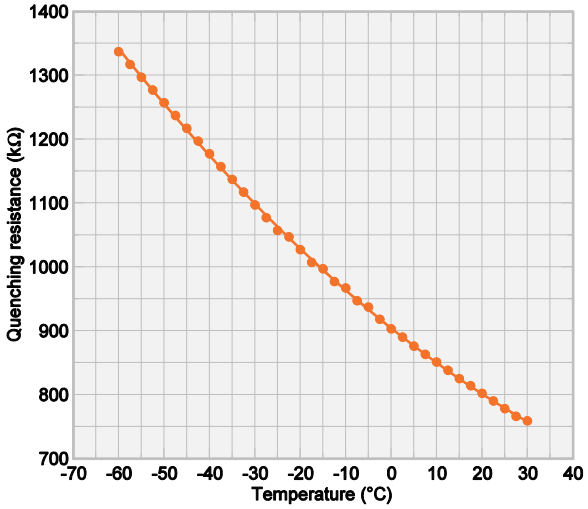


Fig.7 Temperature dependence of poly-silicon quenching resistance in NUV-SiPMs.

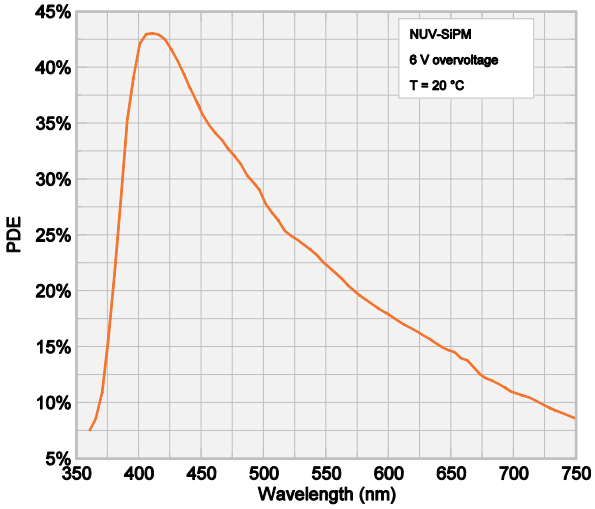


Fig.8 Photo detection efficiency (PDE) in NUV-SiPMs as a function of wavelength (crosstalk and afterpulse not included).

NUV SiPMs

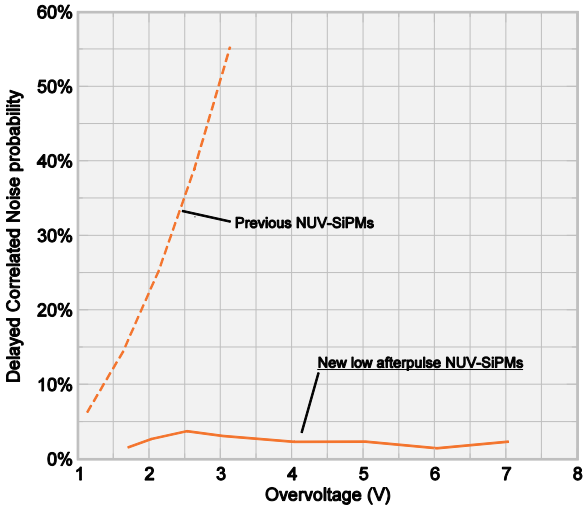


Fig.9 Delayed correlated noise probability (delayed crosstalk and afterpulse) in NUV-SiPMs.

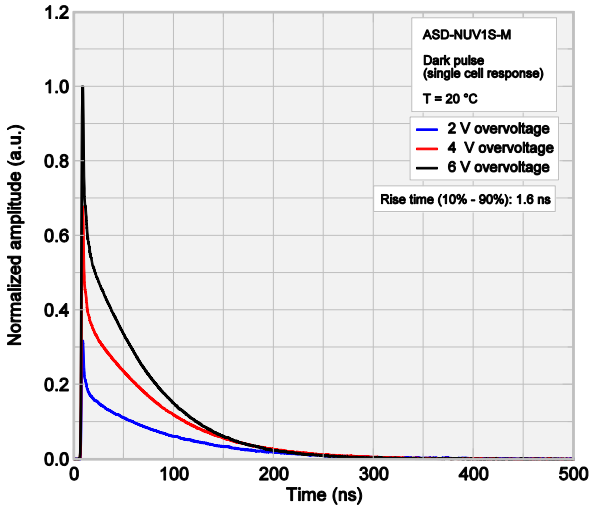


Fig.10 NUV-SiPM pulse shape (dark pulses, single cell response) at different overvoltage. Recharge time constant is 70 ns. Signals acquired with ASD-EP-EB-N.