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AdvanSiD
Advanced Silicon Detectors

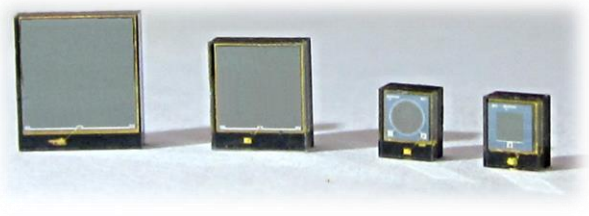
NUV SiPMs
Chip Scale Package (CSP)

NUV SiPMs

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.

Chip Scale Package (CSP) plastic SMD package provides a cost-effective solution to achieve greater board density and high performances.



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**
- **CSP Nickel free**

Application

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

Ordering Information

Product Code	Description
ASD-NUV1S-P	1x1 mm^2 active area SiPM
ASD-NUV1C-P	1.2 mm diameter circular active area SiPM
ASD-NUV3S-P	3x3 mm^2 active area SiPM
ASD-NUV4S-P	4x4 mm^2 active area SiPM

S indicates square SiPM; C indicates circular SiPM; P indicates plastic chip scale package (CSP).

NUV SiPMs

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-P	ASD-NUV1C-P	ASD-NUV3S-P	ASD-NUV4S-P
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			
n_{epoxy}	Refractive index of epoxy resin(7)	1.5115 (@ 589 nm, 23°C, uncured)			
T_{epoxy}	Spectral transmission of epoxy resin(7)	> 97% @ 1000 – 1600 nm ; > 99% @ 400 – 1000 nm			

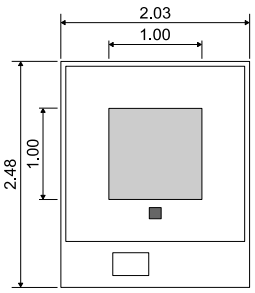
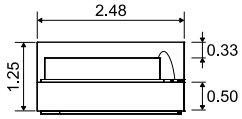
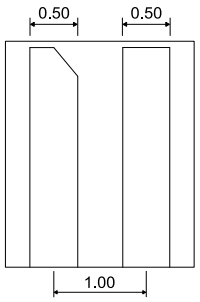
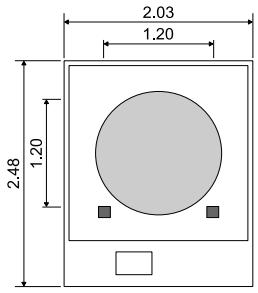
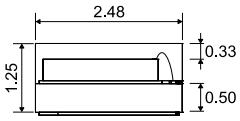
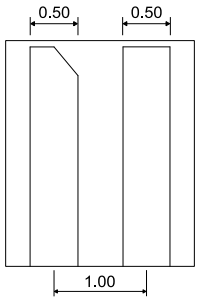
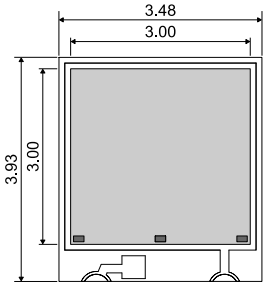
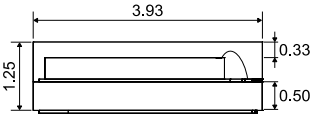
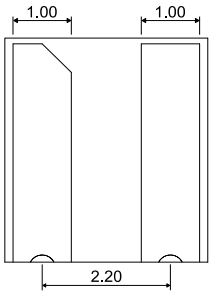
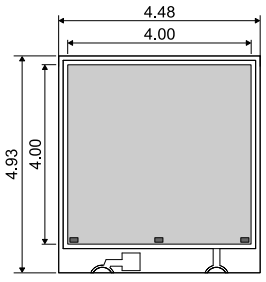
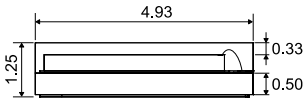
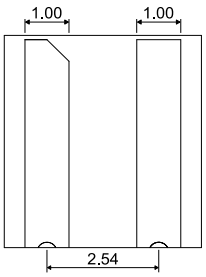
(1) Measured at peak sensitivity wavelength ($\lambda = \lambda_p$) at +6 V overvoltage (not including afterpulse and crosstalk).
(2) Refer to the data provided with each shipped product.
(3) BV of SiPMs belonging to a same production lot is within 200 mV (±2σ) from mean BV value.
(4) Operating voltage (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.
(7) To be used as a guide only, not as a specification. Reported data is not guaranteed.

Information in this datasheet is believed to be reliable. However, no responsibility is assumed for possible inaccuracies or omissions. Specification are subject to change without notice.

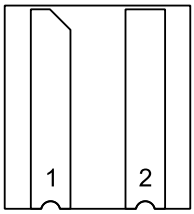
NUV SiPMs

Dimensional Outlines

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

Product	Top View	Side View	Bottom View
ASD-NUV1S-P SMD package for SiPM 1x1 mm² active area size Material: Black FR4 + transparent epoxy layer			
ASD-NUV1C-P SMD package for SiPM 1.2 mm circular active area size Material: Black FR4 + transparent epoxy layer			
ASD-NUV3S-P SMD package for SiPM 3x3 mm² active area size Material: Black FR4 + transparent epoxy layer **SLIM PACKAGE**			
ASD-NUV4S-P SMD package for SiPM 4x4 mm² active area size Material: Black FR4 + transparent epoxy layer **SLIM PACKAGE**			

Pins function



CSP bottom view

N°	Name	Function
1	K	SiPM Cathode
2	A	SiPM Anode

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 parameters can be found on the *Introduction to SiPMs* available at http://advansid.com/resources/the-silicon-photmultiplier.

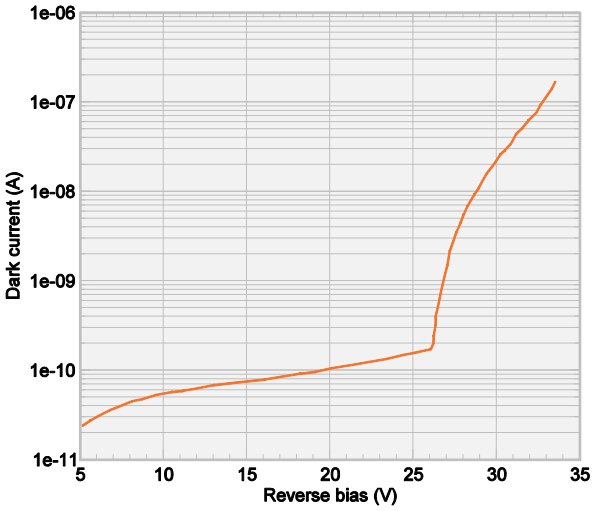


Fig.1 Typical reverse IV curve (ASD-NUV1S-P).

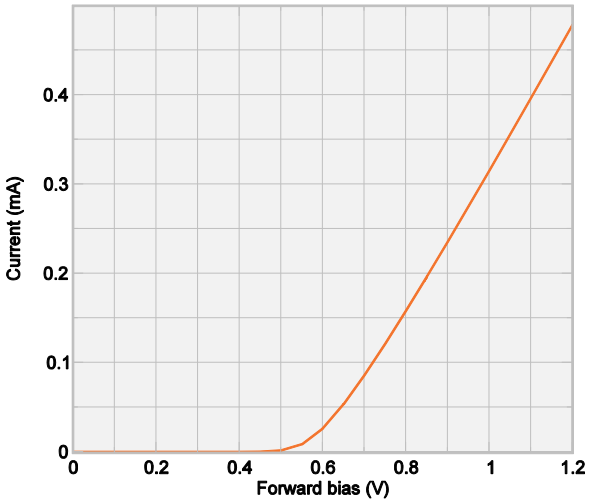


Fig.2 Typical forward IV curve (ASD-NUV1S-P).

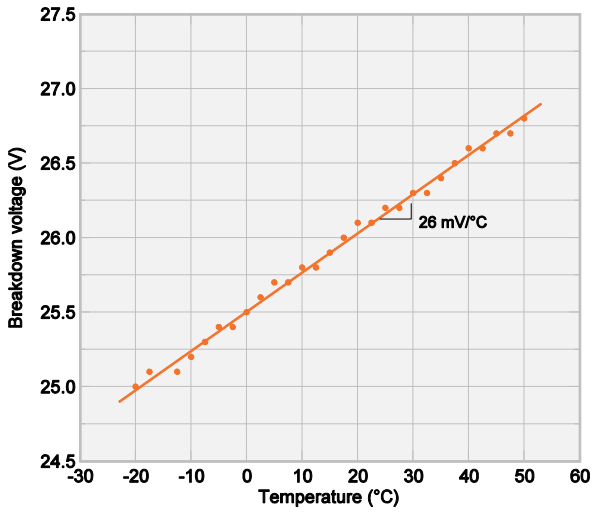


Fig.3 NUV-SiPMs breakdown voltage temperature dependence.

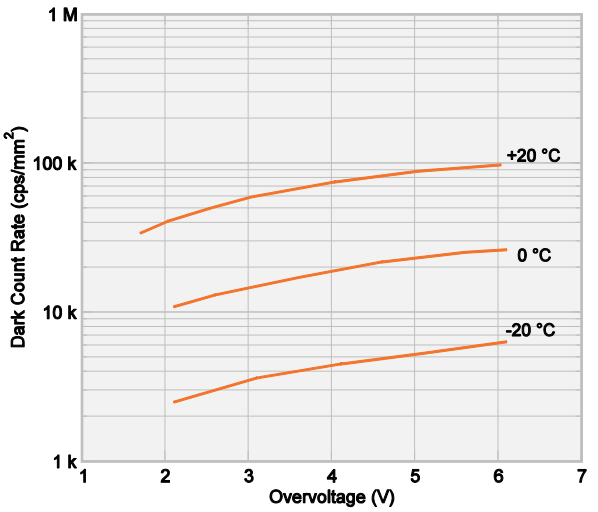


Fig.4 Dark count rate per square mm in NUV-SiPMs as a function of overvoltage and temperature.

NUV SiPMs

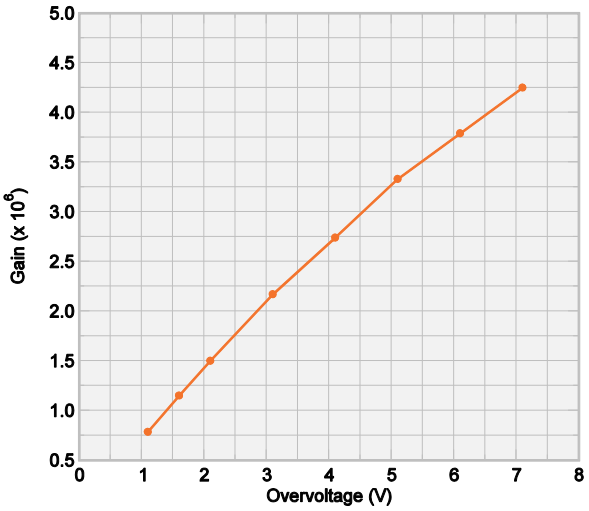


Fig.5 Gain of NUV-SiPMs as a function of overvoltage.

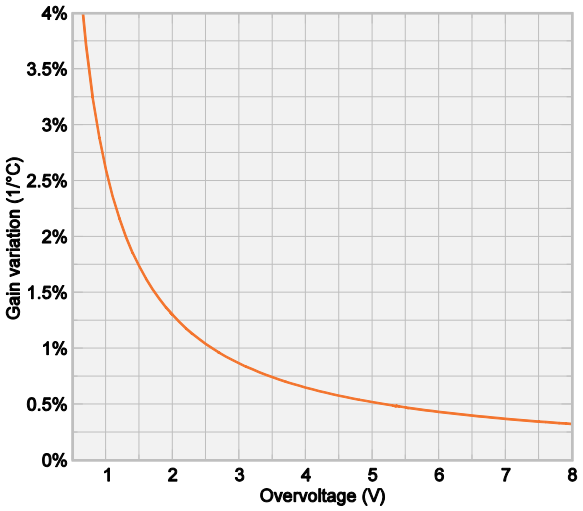


Fig.6 Relative variation of gain with temperature in NUV-SiPMs as a function of overvoltage.

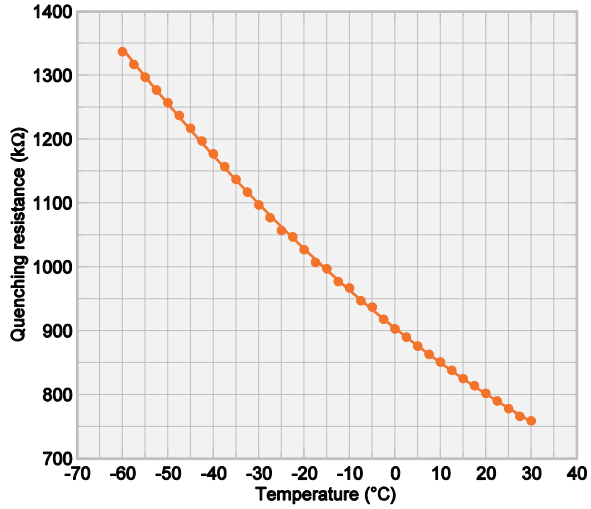


Fig.7 Temperature dependence of poly-silicon quenching resistance in NUV-SiPMs.

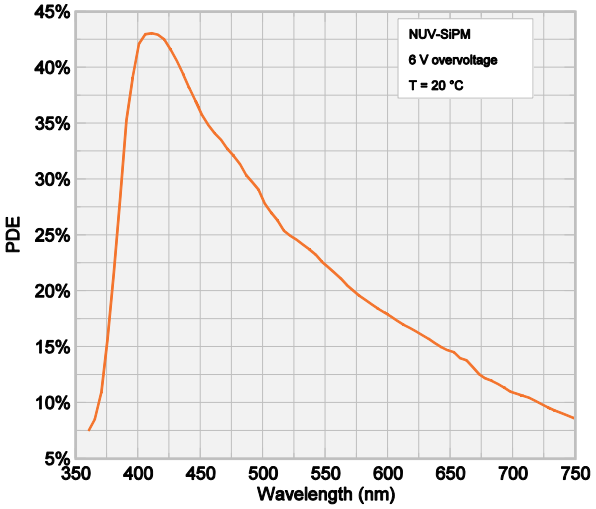


Fig.8 Photo detection efficiency (PDE) in NUV-SiPMs as a function of wavelength (crosstalk and afterpulse not included).

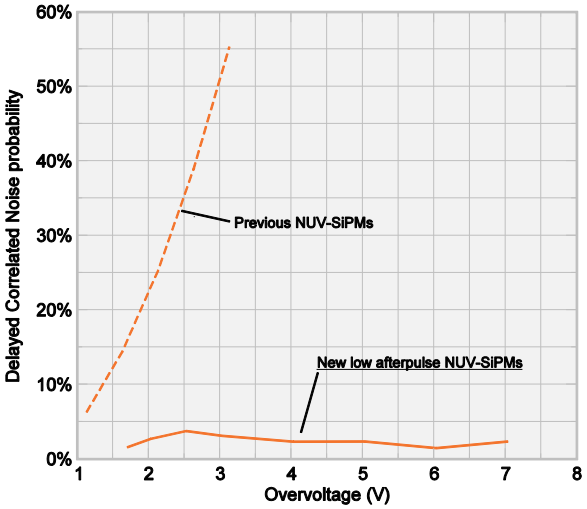


Fig.9 Delayed correlated noise probability (delayed crosstalk and afterpulse) in NUV-SiPMs.

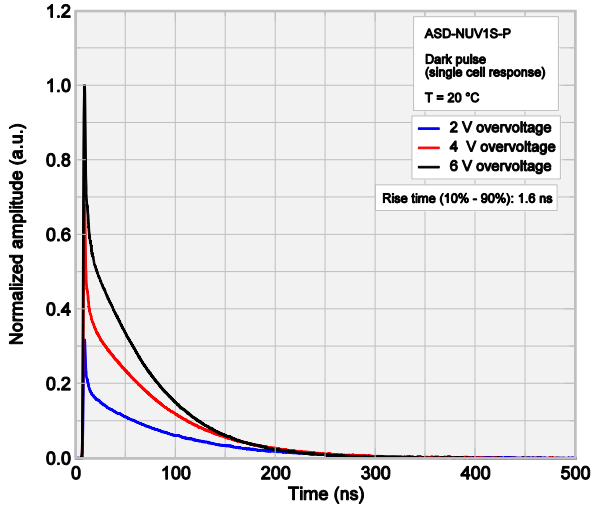
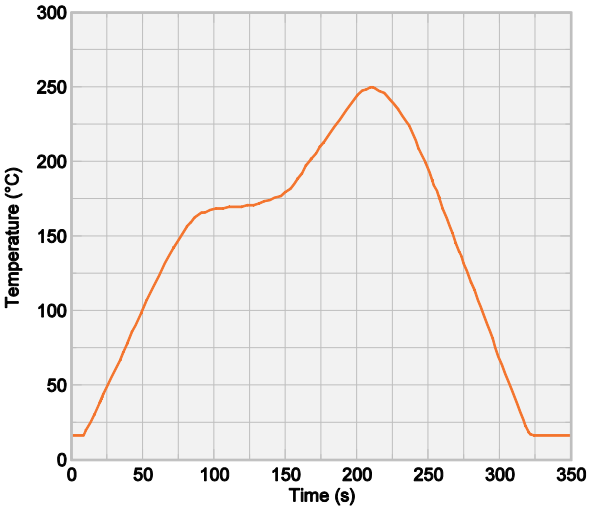


Fig.10 NUV-SiPM pulse shape (dark pulses, single cell response) at different overvoltage. Recharge time constant is 70 ns. Signals acquired with ASD-EP-EB-N.

Recommended Reflow Soldering Profile



The reflow soldering must be performed within 24 hours once the device has been removed from package and stored in a 25°C and <60% RH ambient conditions. The reflow soldering profile is recommended for Pb-free solder such as Tin-Silver-