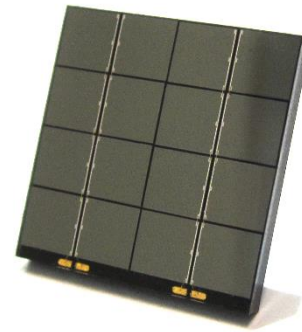


## General Description

High fill-factor, 16 channels hybrid array with 3x3 mm<sup>2</sup> or 4x4 mm<sup>2</sup> active area silicon photomultipliers (SiPMs) with common anode bias connection and independent cathodes readout.

AdvanSiD hybrid arrays feature the new low-afterpulse NUV-SiPMs that are based on the “P-on-N” silicon junction technology for the detection of Near Ultraviolet Light. NUV-SiPMs have peak efficiency at 420 nm, with detection spectrum extending from 350 nm to 900 nm.

The 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.



## Features

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

## 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-NUV3S-P-4x4TD	4x4 array of 3x3 mm <sup>2</sup> active area SiPMs
ASD-NUV4S-P-4x4TD	4x4 array of 4x4 mm <sup>2</sup> active area SiPMs

S indicates square SiPM; P indicates plastic chip scale package (CSP); TD indicates tile with die-to-die wire bonding.

## Hybrid TD Arrays 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 ( $T_a=20^\circ\text{C}$ )

Symbol	Parameter	Product		
		ASD-NUV3S-P-4x4TD		ASD-NUV4S-P-4x4TD
AA	Effective active area	3x3x16 mm <sup>2</sup>		4x4x16 mm <sup>2</sup>
Ch	Channels (SiPMs)	16		16
S	SiPM size	3x3 mm <sup>2</sup>		4x4 mm <sup>2</sup>
P	SiPM pitch	3.2 mm		4.2 mm
N	Cell number	5520 /channel		9340 /channel
FF <sup>A</sup>	Array fill-factor	83.5 %		87.3 %
CS	Cell size (pitch)	40 $\mu\text{m}$ x 40 $\mu\text{m}$		
FF	Cell fill-factor	60 %		
RQ	Quenching resistance	800 k $\Omega$		
C	Cell capacitance	90 fF		
$\tau_{RC}$	Recharge time constant	70 ns		
$S_R$	Spectral response range	350 to 900 nm		
$\lambda_p$	Peak sensitivity wavelength	420 nm		
PDE	Photon Detection Efficiency <sup>(1)</sup>	43 %		
BV	Breakdown voltage <sup>(2)</sup>	Typical: 26 V	Min: 24 V	Max: 28 V
$\sigma_{BV}$	BV standard deviation <sup>(3)</sup>	50 mV		
$\Delta BV$	BV uniformity <sup>(4)</sup>	< 0.4 V		
OV	Recommended Overvoltage range <sup>(5)</sup>	Min: 2 V	Max: 6 V	
DCR	Dark Count Rate <sup>(6)</sup>	< 50 kHz/mm <sup>2</sup> @ 2 V OV	< 100 kHz/mm <sup>2</sup> @ 6 V OV	
G	Gain <sup>(7)</sup>	3.6x10 <sup>6</sup>		
BVTC	Breakdown Voltage Temperature Coefficient	26 mV/°C		
$n_{\text{epoxy}}$	Refractive index of epoxy resin <sup>(8)</sup>	1.5115 (@ 589 nm, 23°C, uncured)		
$T_{\text{epoxy}}$	Spectral transmission of epoxy resin <sup>(8)</sup>	> 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 product. Special selection of devices based on BV available upon request.
- (3) BV of SiPMs belonging to a same production lot is within 200 mV ( $\pm 2\sigma$ ) from mean BV value.
- (4) Maximum difference in the BV of the SiPMs in each array.
- (5) Overvoltage: excess bias beyond BV.
- (6) 0.5 p.e. threshold level at 20 °C and +6 V overvoltage (primary dark count rate not including afterpulse).
- (7) Measured at 20 °C at +6 V overvoltage.
- (8) 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.

# Hybrid TD Arrays NUV-SiPMs

## Dimensional Outlines and Channels Numbering

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

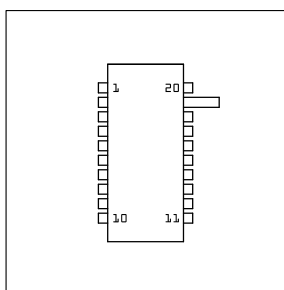
Product	Top View	Side View	Bottom View
<b>ASD-NUV3S-P-4x4TD</b> 4x4 SiPMs array 3x3 mm <sup>2</sup> active area SiPMs 3.2 mm SiPM pitch 120 um gap between SiPM dies Material: FR4 + transparent epoxy layer			
<b>ASD-NUV4S-P-4x4TD</b> 4x4 SiPMs array 4x4 mm <sup>2</sup> active area SiPMs 4.2 mm SiPM pitch 120 um gap between SiPM dies Material: FR4 + transparent epoxy layer			

## SiPMs Bias and Read-out

TD type arrays feature front side die-to-die wire bonding. The SiPM dies are grouped in columns and interconnected through the front bond pads. Common bias terminals are available for each column of the array. Each SiPM of the array (channel) is independently read-out from the back side of the dies.

- ➔ SiPMs in NUV “TD” type arrays feature common anode bias
- ➔ Independent cathode read-out - Negative output signals

## Pin-out



Array bottom view

Pin number	Name	Channel	Pin number	Name	Channel
1	K4	Ch.4	11	A1	Ch.1,5,9,13
2	K3	Ch.3	12	A2	Ch.2,6,10,14
3	K8	Ch.8	13	K14	Ch.14
4	K7	Ch.7	14	K13	Ch.13
5	K12	Ch.12	15	K10	Ch.10
6	K11	Ch.11	16	K9	Ch.9
7	K16	Ch.16	17	K6	Ch.6
8	K15	Ch.15	18	K5	Ch.5
9	A3	Ch.3,7,11,15	19	K2	Ch.2
10	A4	Ch.4,8,12,16	20	K1	Ch.1

A = Anode  
K = Cathode

# Hybrid TD Arrays NUV-SiPMs

## Connector

JAE 0.8 mm pitch IL-WX series.

One pin header connector mounted on the back of the module (part number JAE IL-WX-20P-VF-BE).

One receptacle (socket) provided with each shipped SiPM array (part number JAE IL-WX-20S-VF-BE).

SMT mounting of sockets should follow constructor's indications.

Datasheet and mechanical information available at [this link](#) (JAE website).

### General Specifications (JAE IL-WX-20P-VF-BE)

Parameter	Value	Unit
Number of contacts	20	-
Rated current	0.5	A
Dielectric withstanding voltage	500 (1 minute)	V (AC rms)
Insulation resistance	100 (min)	MΩ
Contact resistance	20 (max)	mΩ
Operating temperature range	-40 to +85	°C

## Device Characteristics

This section reports 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>.

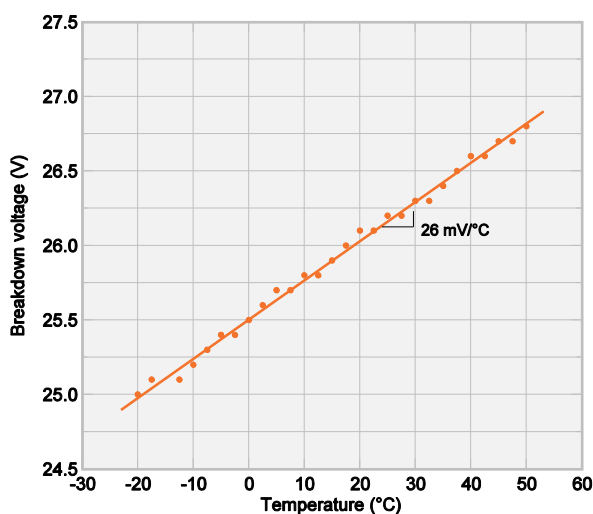


Fig.1 NUV-SiPMs breakdown voltage temperature dependence.

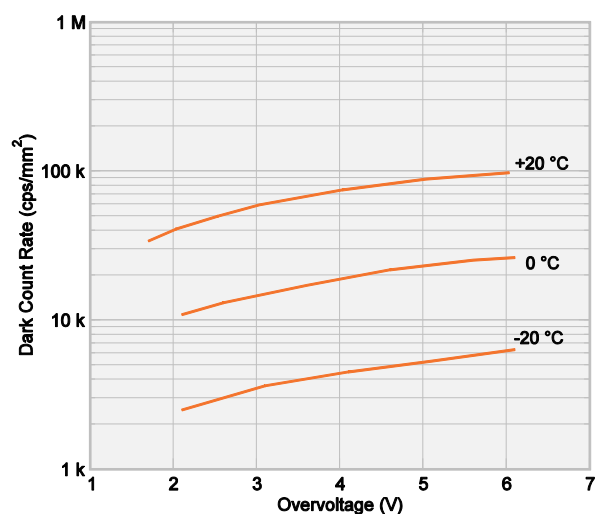
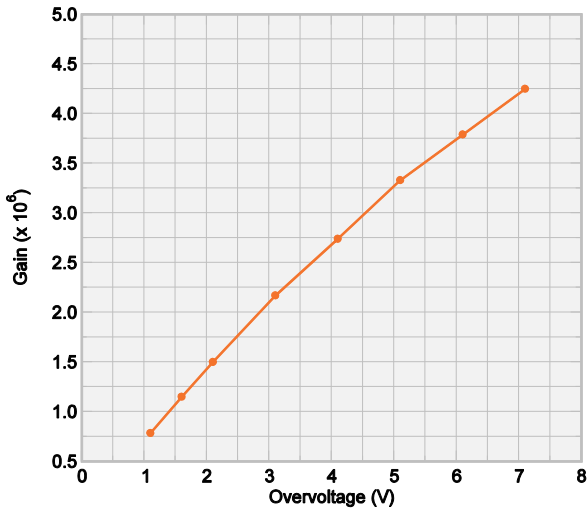
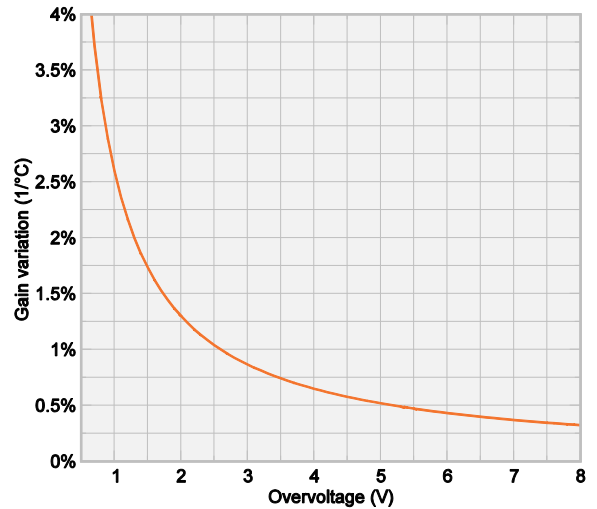


Fig.2 Dark count rate (per mm<sup>2</sup>) in low-afterpulse NUV-SiPMs as a function of overvoltage and temperature.

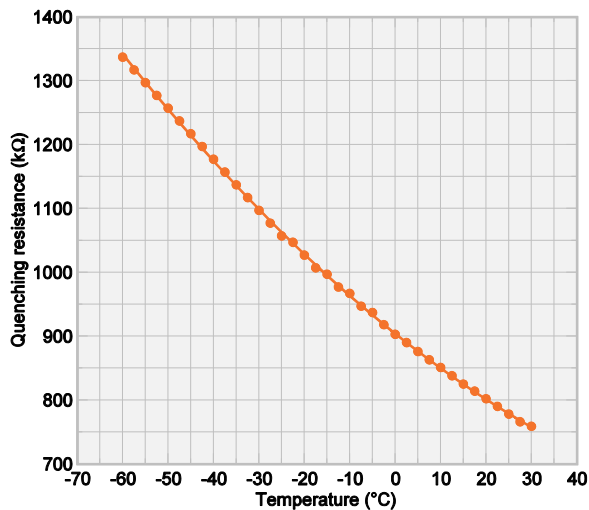
# Hybrid TD Arrays NUV-SiPMs



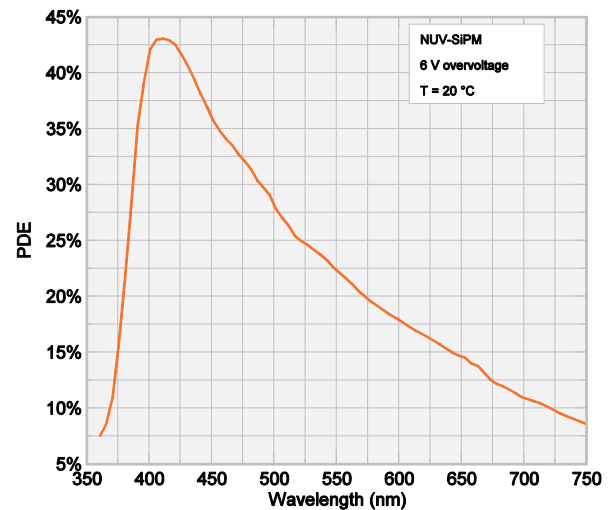
**Fig.3** Gain of NUV-SiPMs as a function of overvoltage.



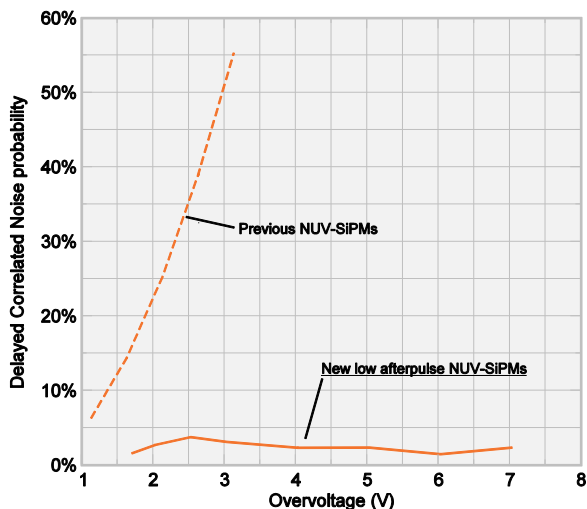
**Fig.4** Relative variation of gain with temperature in NUV-SiPMs as a function of overvoltage.



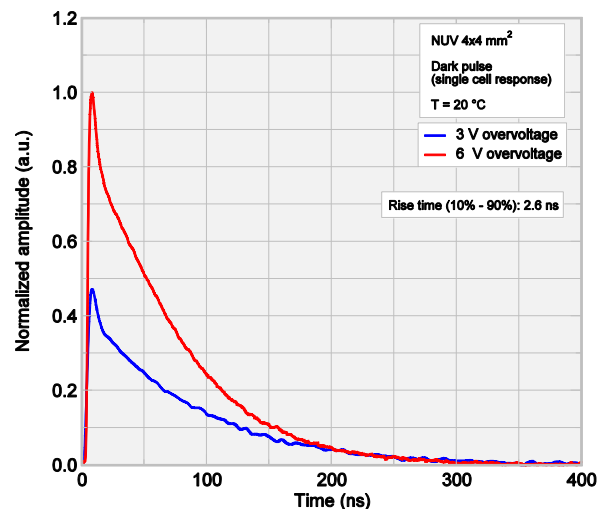
**Fig.5** Temperature dependence of poly-silicon quenching resistance in NUV-SiPMs.



**Fig.6** 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. Signals acquired with ASD-EP-EB-N.