

Near Ultraviolet (NUV) SiPMs

Silicon photomultipliers (SiPMs) from First Sensor are innovative solid-state silicon detectors with single photon sensitivity. SiPMs are a valid alternative to photomultiplier tubes. The main benefits of these detectors are high gain, extremely good timing performance and low operating voltage. They are insensitive to magnetic field and have a high integration level. The detectors are optimized for Near Ultraviolet (NUV) light detection.



Features

- NUV light detection from 350 to 900 nm (peak efficiency at 420 nm)
- Afterpulsing probability <4 %
- Dark Count Rate <100 kHz/mm²
- Superior breakdown voltage uniformity
- Excellent temperature stability
- Detection of extremely faint light
- Very high gain (10⁶)
- Extremely good timing performance
- Insensitive to magnetic fields
- Not damaged by ambient light
- Small and compact
- Nickel free Chip Scale Package (CSP)

Applications

- High energy physics
- Medical imaging
- Nuclear medicine
- Homeland security
- Analytical instruments

Certificates

- RoHS compliant (2011/65/EU)

Near Ultraviolet (NUV) SiPMs

Absolute maximum ratings ⁽¹⁾

| Parameter | Min. | Max. | Unit |
|---|------|----------------------|------|
| Operating temperature (T_A) | -25 | +40 | °C |
| Storage temperature (T_S) | -40 | +60 | °C |
| Lead temperature (solder) 5 s (T_{sol}) | | +250 | °C |
| Voltage working range (MVW) | | Breakdown voltage +6 | V |

Typical characteristics

| Parameter | Product | | | |
|---|---|----------------------|-----------------------|-----------------------|
| | SiPM-NUV1S-SMD | SiPM-NUV1C-SMD | SiPM-NUV3S-SMD | SiPM-NUV4S-SMD |
| Effective active area | (1×1) mm ² | 1.13 mm ² | (3×3) mm ² | (4×4) mm ² |
| Cell count | 625 | 673 | 5520 | 9340 |
| Cell size (pitch) | 40 μm × 40 μm | | | |
| Cell fill-factor | 60 % | | | |
| Quenching resistance | 800 kΩ | | | |
| Cell capacitance | 90 fF | | | |
| Recharge time constant | 70 ns | | | |
| Spectral response range | 350 ... 900 nm | | | |
| Peak sensitivity wavelength | 420 nm | | | |
| Photon detection efficiency ⁽²⁾ | 43 % | | | |
| Breakdown voltage (BV) ⁽³⁾ | typ. 26 V, min. 24 V, max. 28 V | | | |
| BV standard deviation ⁽⁴⁾ | 50 mV | | | |
| Recommended overvoltage range (OV) ⁽⁵⁾ | min: 2 V, max: 6 V | | | |
| Dark count rate ⁽⁶⁾ | <50 kHz/mm ² @ 2 V OV, <100 kHz/mm ² @ 6 V OV | | | |
| Gain ⁽⁷⁾ | 3.6×10 ⁶ | | | |
| Breakdown voltage temperature coefficient | 26 mV/°C | | | |
| Refractive index of epoxy resin ⁽⁸⁾ | 1.5115 (@ 589 nm, 23 °C, uncured) | | | |
| Spectral transmission of epoxy resin ⁽⁸⁾ | >97% @ 1000 ... 1600 nm ; >99% @ 400 ... 1000 nm | | | |

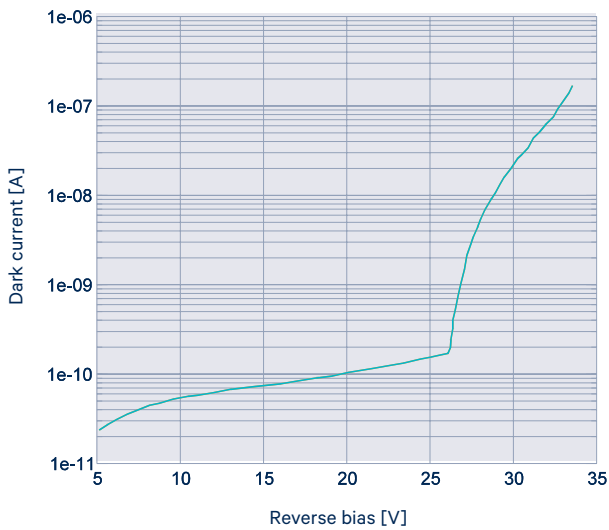
Specification notes

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

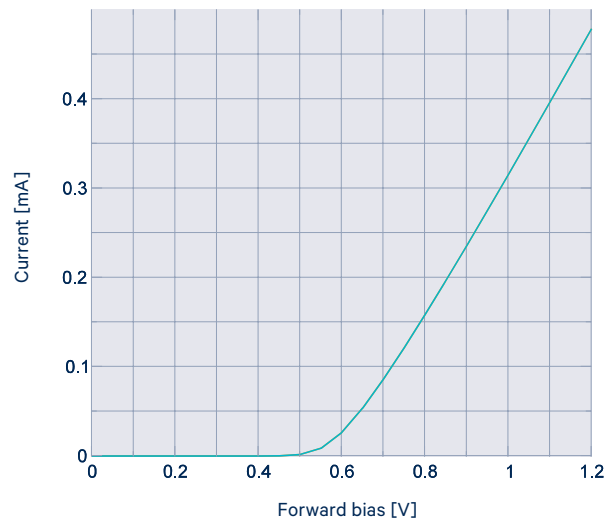
Near Ultraviolet (NUV) SiPMs

Device characteristics ^(9, 10)

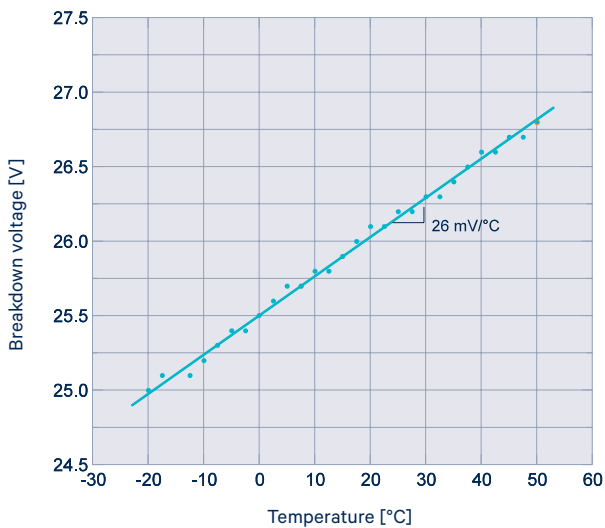
Typical reverse IV curve (SiPM-NUV1S-SMD)



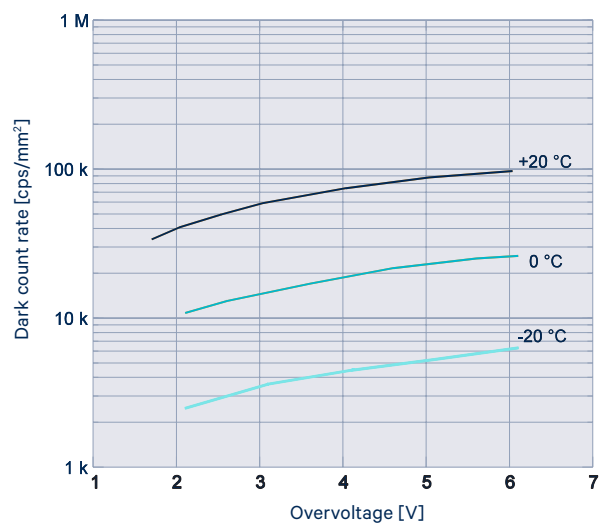
Typical forward IV curve (SiPM-NUV1S-SMD)



Breakdown voltage temperature dependence



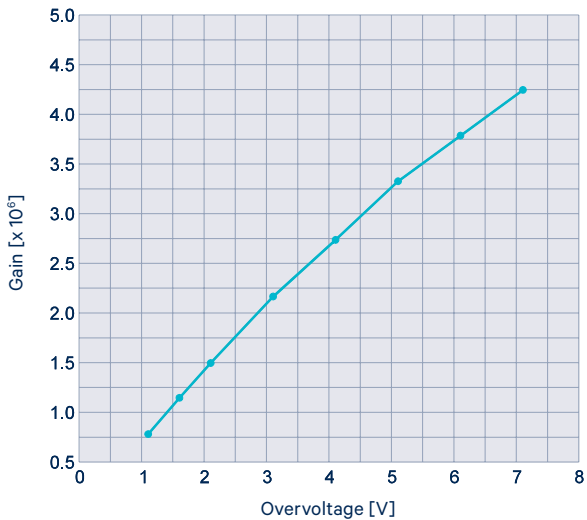
Dark count rate as fct of overvoltage and temperature



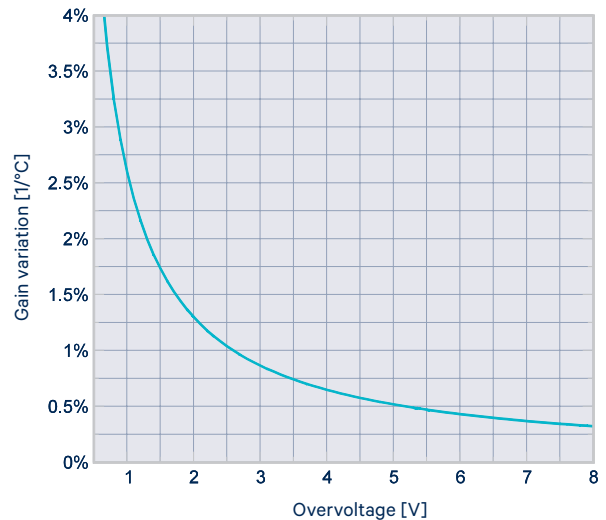
Near Ultraviolet (NUV) SiPMs

Device characteristics (cont.) ^(9, 10)

Gain as fct of overvoltage



Relative variation of gain with temperature as fct of overvoltage



Temperature dependence of poly-silicon quenching resistance

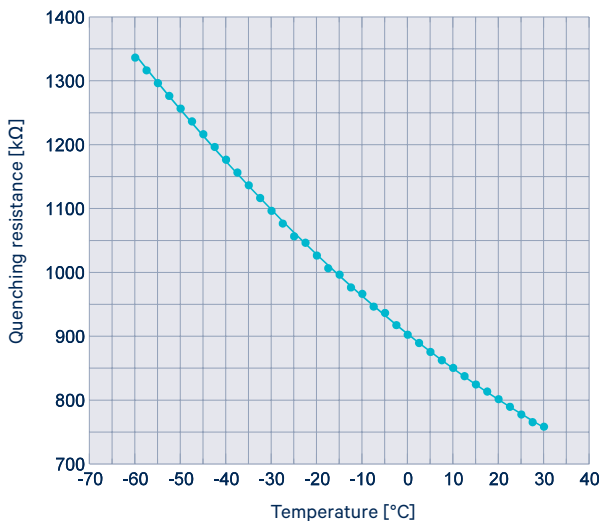
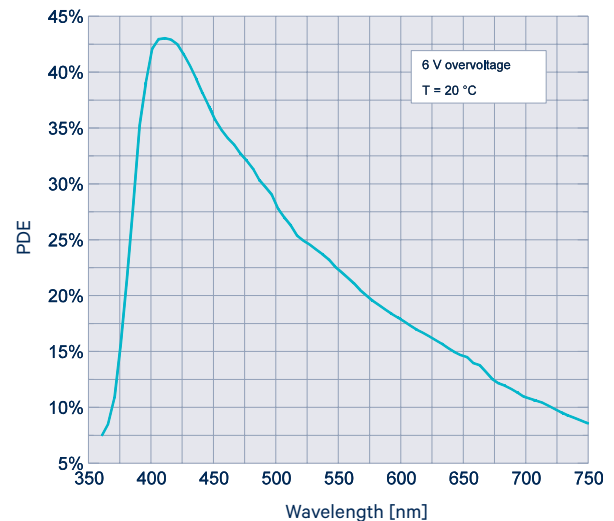


Photo detection efficiency (PDE) as fct of wavelength (crosstalk and afterpulse not included)

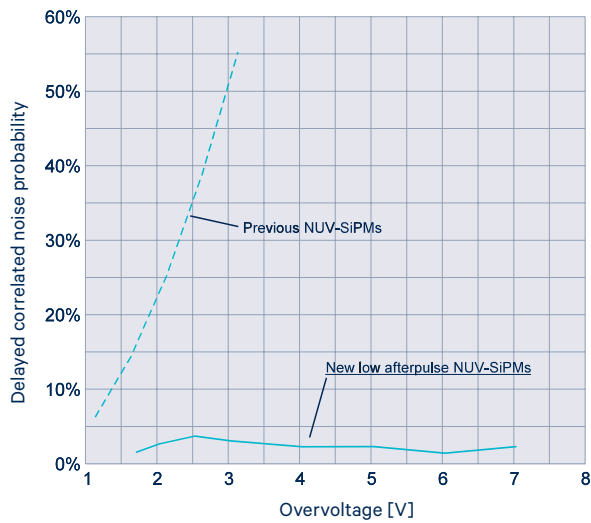


Near Ultraviolet (NUV) SiPMs

Device characteristics (cont.) ^(9, 10)

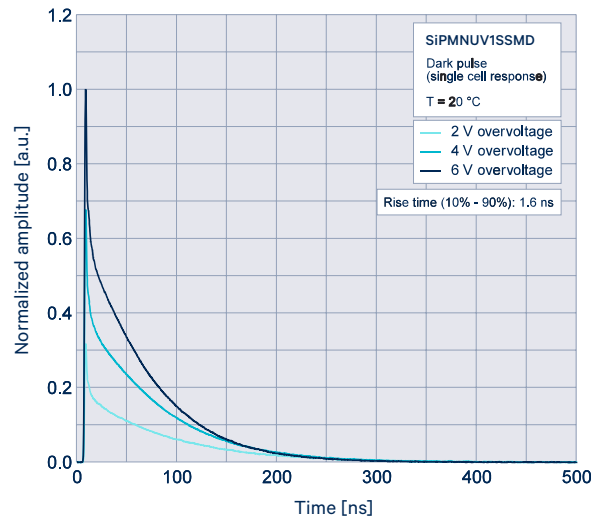
Delayed correlated noise probability

(delayed crosstalk and afterpulse)



Pulse shape at different overvoltage

(recharge time constant is 70 ns)



Specification notes

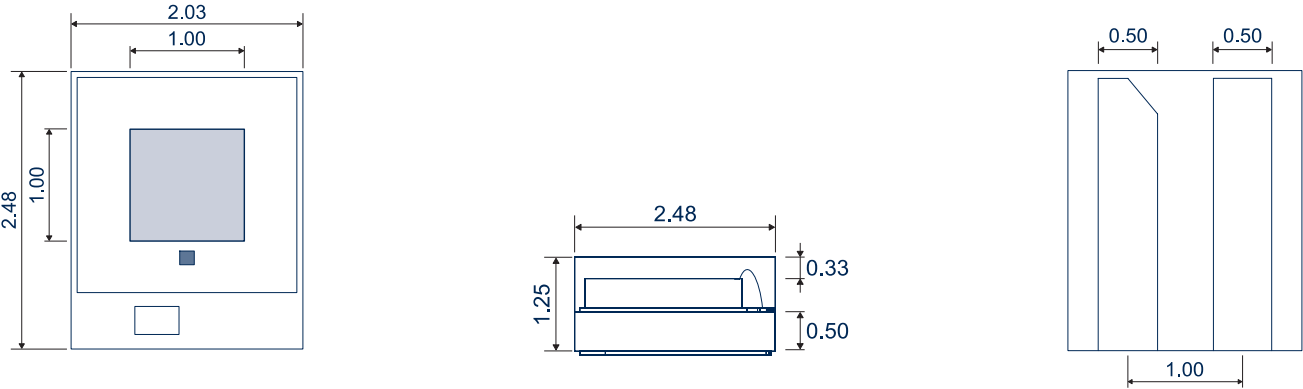
(9) $T_A = 20\text{ °C}$

(10) Refer to the data accompanying each shipped product for more detailed information.

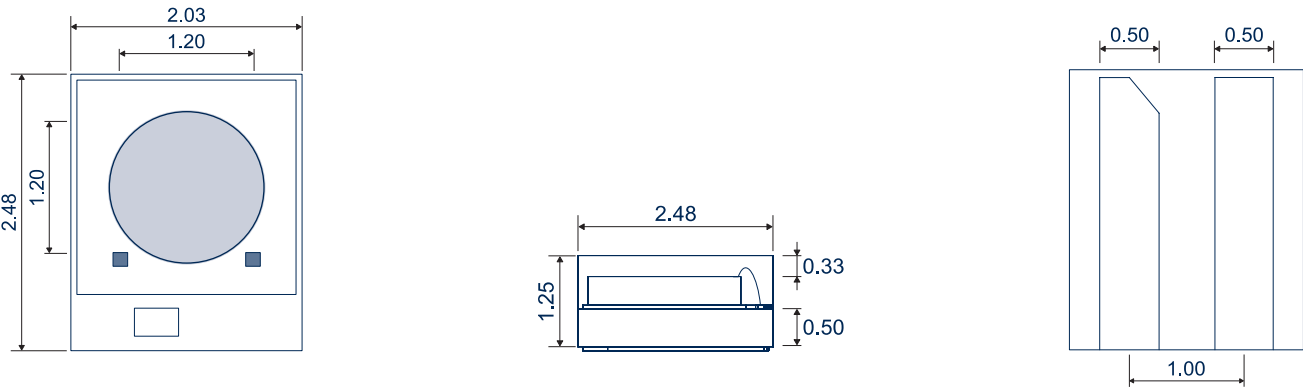
Near Ultraviolet (NUV) SiPMs

Physical dimensions

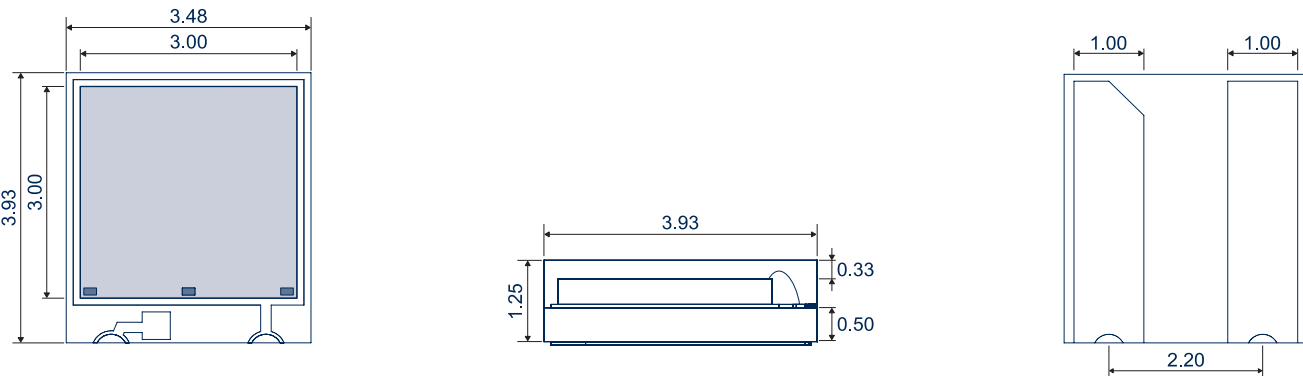
SiPM-NUV1S-SMD



SiPM-NUV1C-SMD



SiPM-NUV3S-SMD



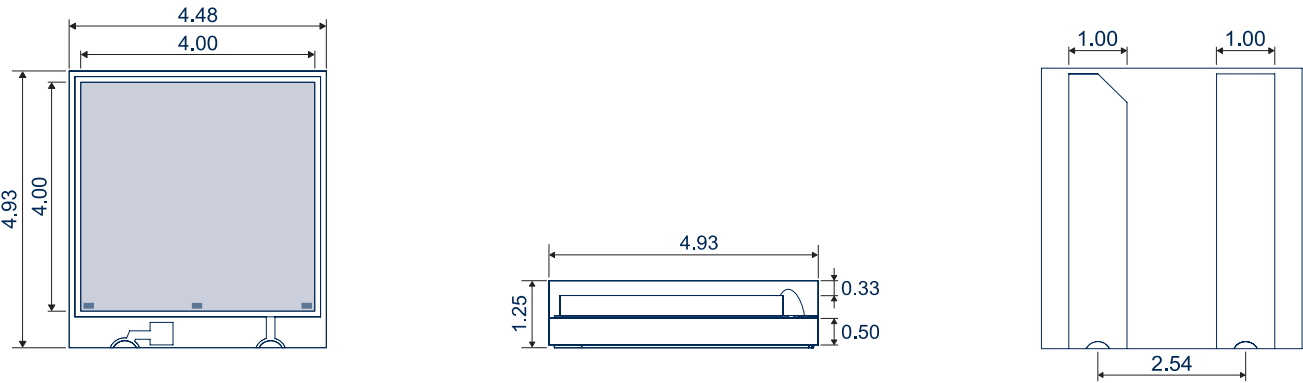
Material: Black FR4, transparent epoxy layer

dimensions in mm, mechanical tolerance ± 0.15 mm unless otherwise noted

Near Ultraviolet (NUV) SiPMs

Physical dimensions

SiPM-NUV4S-SMD

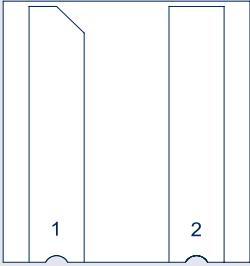



Material: Black FR4, transparent epoxy layer

dimensions in mm, mechanical tolerance ± 0.15 mm unless otherwise noted

Electrical connection

CSP bottom view

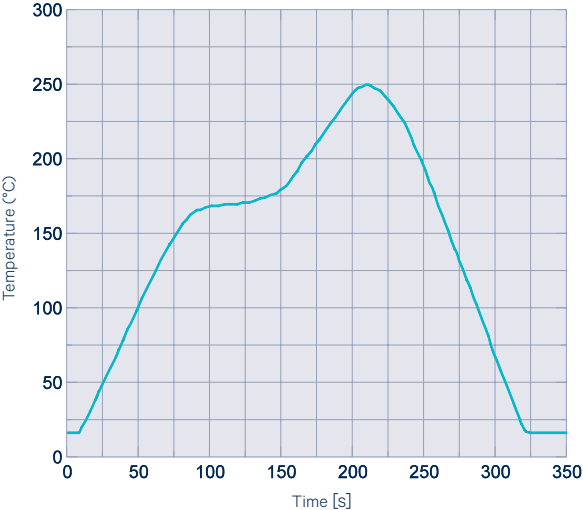




| Pin | Name | Function |
|-----|------|----------|
| 1 | K | Cathode |
| 2 | A | Anode |

Near Ultraviolet (NUV) SiPMs

Reflow soldering profile ⁽¹¹⁾



Specification notes

(11) 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-Copper (SAC). The peak temperature must not exceed 250 °C.

Ordering information

| Order # | Series | Range | Active area | Housing |
|----------|--------|------------------------|---|------------------------------|
| 50162801 | SiPM- | NUV [Near Ultraviolet] | 1S | (1x1) mm ² square |
| 50162802 | | | 1C | Ø 1.2 mm circular |
| 50162803 | | | 3S | (3x3) mm ² square |
| 50162804 | | | 4S | (4x4) mm ² square |
| | | | -SMD [Plastic chip scale package (CSP)] | |