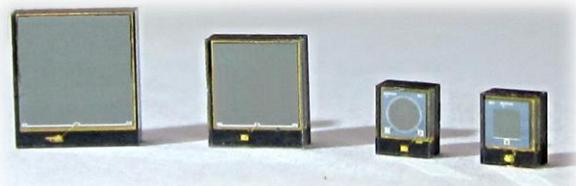


General Description

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 RGB-SiPMs are based on the AdvanSiD “N-on-P” silicon technology for detection of Red, Green, and Blue light. RGB-SiPMs have peak efficiency at 550 nm, with detection spectrum extending from 350 nm to 900 nm.

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



Features

- Red, Green, Blue light detection
- Superior breakdown voltage uniformity
- Low noise
- 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 | • Flow Cytometry |
| • Medical Imaging | • Biological Sensors |
| • Nuclear Medicine | • Analytical Instruments |
| • DNA Sequencing | • SEM Microscopy |
| • Homeland Security | • Confocal Microscopy |

Ordering Information

| Product Code | Description |
|--------------|---|
| ASD-RGB1S-P | 1x1 mm ² active area SiPM |
| ASD-RGB1C-P | 1.2 mm diameter circular active area SiPM |
| ASD-RGB3S-P | 3x3 mm ² active area SiPM |
| ASD-RGB4S-P | 4x4 mm ² active area SiPM |

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

RGB 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 + 4 | | 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-RGB1S-P | ASD-RGB1C-P | ASD-RGB3S-P | ASD-RGB4S-P |
| AA | Effective active area | 1x1 mm ² | 1.13 mm ² | 3x3 mm ² | 4x4 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 | 550 kΩ | | | |
| C | Cell capacitance | 90 fF | | | |
| τ _{RC} | Recharge time constant | 50 ns | | | |
| S _R | Spectral response range | 350 to 900 nm | | | |
| λ _p | Peak sensitivity wavelength | 550 nm | | | |
| PDE | Photon Detection Efficiency ⁽¹⁾ | 32.5 % | | | |
| BV | Breakdown voltage ⁽²⁾ | Typical: 27 V | Min: 25 V | Max: 29 V | |
| σBV | BV standard deviation ⁽³⁾ | 50 mV | | | |
| OV | Recommended Overvoltage range ⁽⁴⁾ | Min: 2 V | | Max: 4 V | |
| DCR | Dark Count Rate ⁽⁵⁾ | < 100 kHz/mm ² @ 2 V OV | | | < 200 kHz/mm ² @ 4 V OV |
| G | Gain ⁽⁶⁾ | 2.7×10 ⁶ | | | |
| BVTC | Breakdown Voltage Temperature Coefficient | 27 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 +4 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 ($\pm 2\sigma$) 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 +4 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.

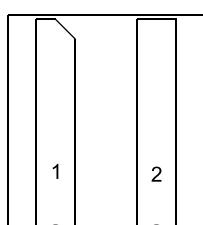
RGB SiPMs

Dimensional Outlines

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

| Product | Top View | Side View | Bottom View |
|---|----------|-----------|-------------|
| ASD-RGB1S-P SMD package for SiPM 1x1 mm ² active area size Material: Black FR4 + transparent epoxy layer CSP without castellation | | | |
| ASD-RGB1C-P SMD package for SiPM 1.2 mm circular active area size Material: Black FR4 + transparent epoxy layer CSP without castellation | | | |
| ASD-RGB3S-P SMD package for SiPM 3x3 mm ² active area size Material: Black FR4 + transparent epoxy layer SLIM PACKAGE | | | |
| ASD-RGB4S-P SMD package for SiPM 4x4 mm ² active area size Material: Black FR4 + transparent epoxy layer SLIM PACKAGE | | | |

Pins function



CSP bottom view



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

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 $T=20^{\circ}\text{C}$, 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>.

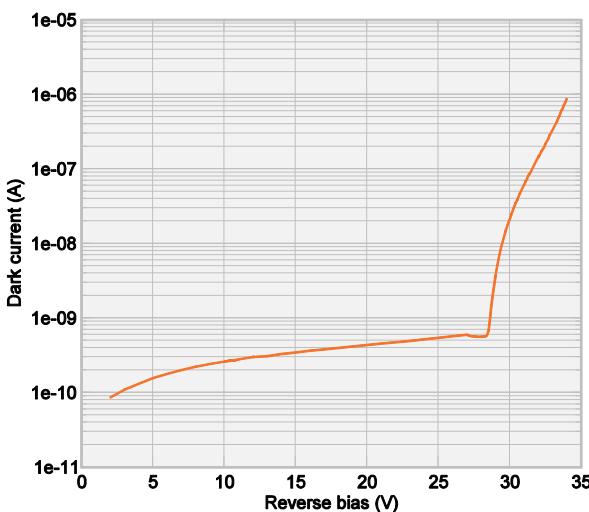


Fig.1 Typical reverse IV curve (ASD-RGB1S-P).

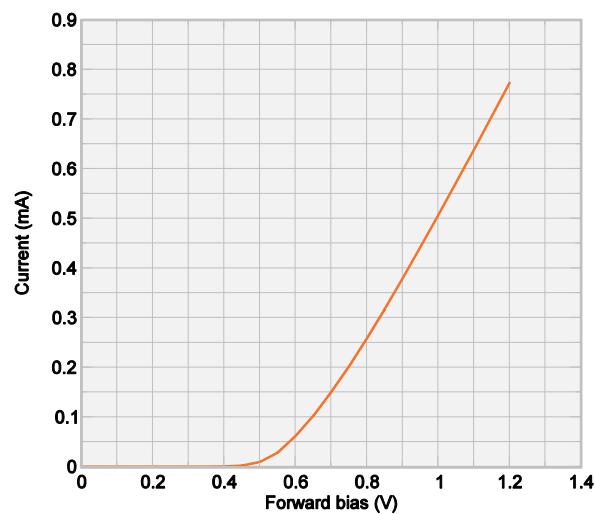


Fig.2 Typical forward IV curve (ASD-RGB1S-P).

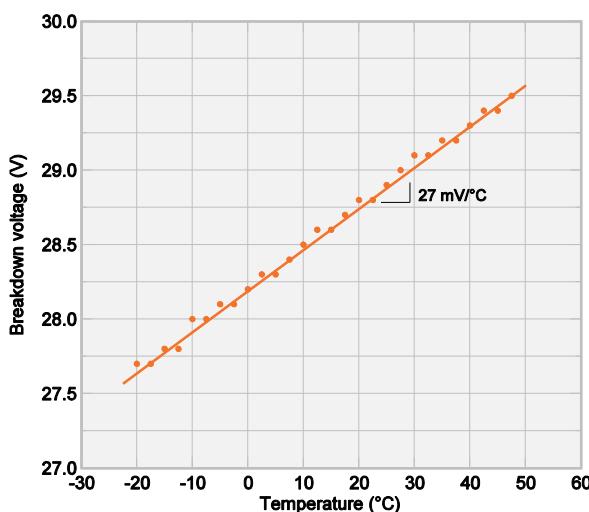


Fig.3 RGB-SiPMs breakdown voltage temperature dependence.

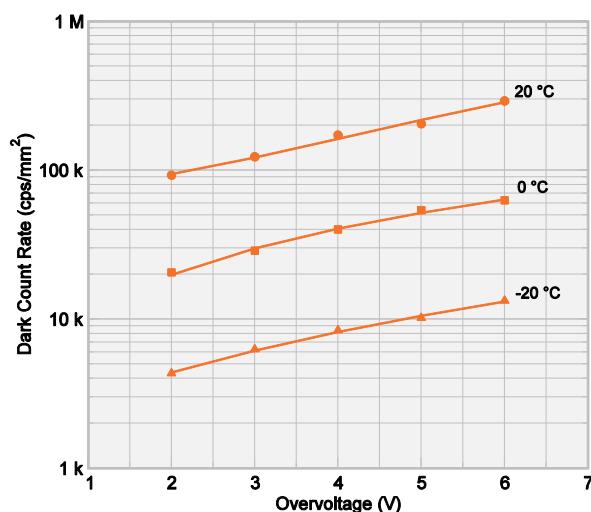


Fig.4 Dark count rate per square mm in RGB-SiPMs as a function of overvoltage and temperature. 0.5 p.e. threshold level. Primary dark count rate, not including afterpulse.

RGB SiPMs

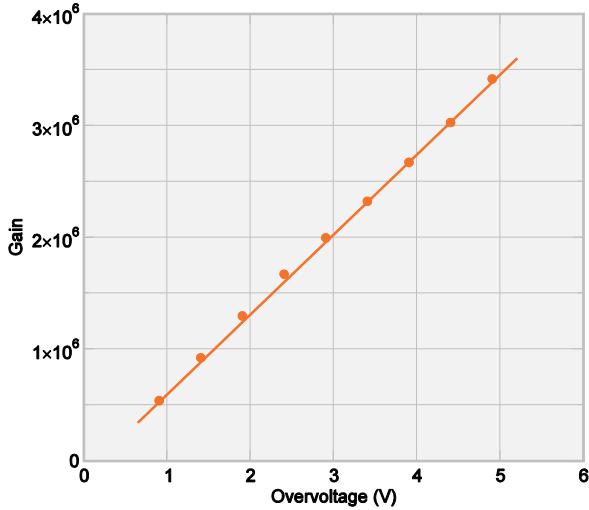


Fig.5 Gain of RGB-SiPMs as a function of overvoltage.

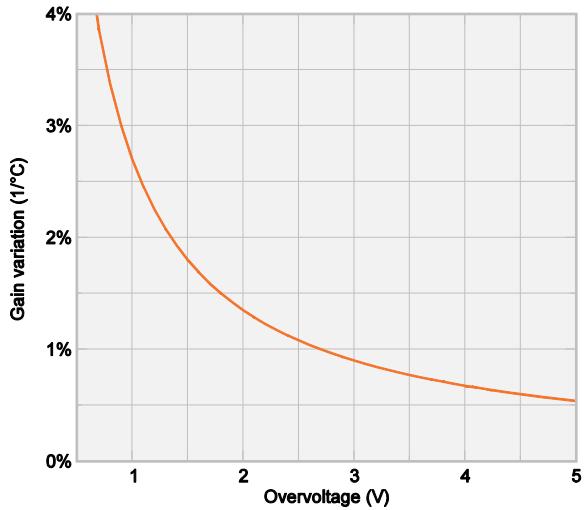


Fig.6 Relative variation of gain with temperature in RGB-SiPMs as a function of overvoltage.

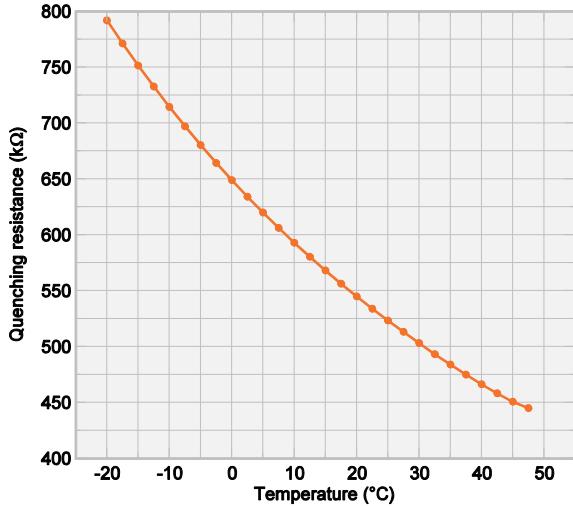


Fig.7 Temperature dependence of poly-silicon quenching resistance in RGB-SiPMs.

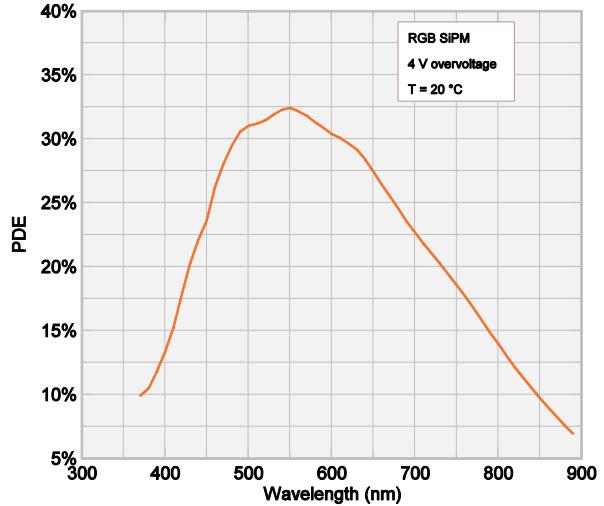


Fig.8 Photo detection efficiency (PDE) in RGB-SiPMs as a function of wavelength (crosstalk and afterpulse not included).

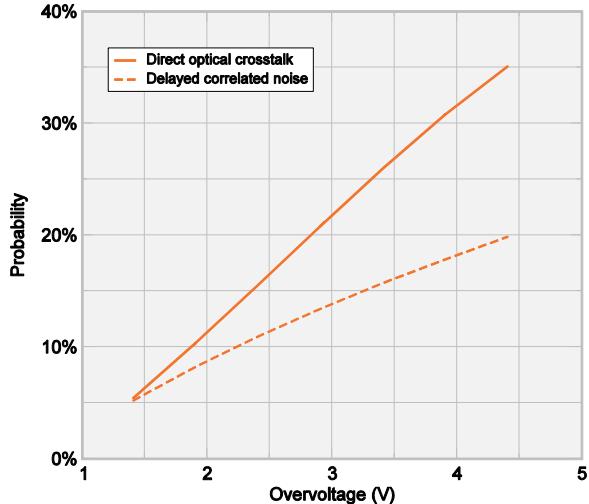


Fig.9 Correlated noise probability in RGB-SiPMs as a function of overvoltage. Delayed correlated noise includes delayed crosstalk and afterpulse.

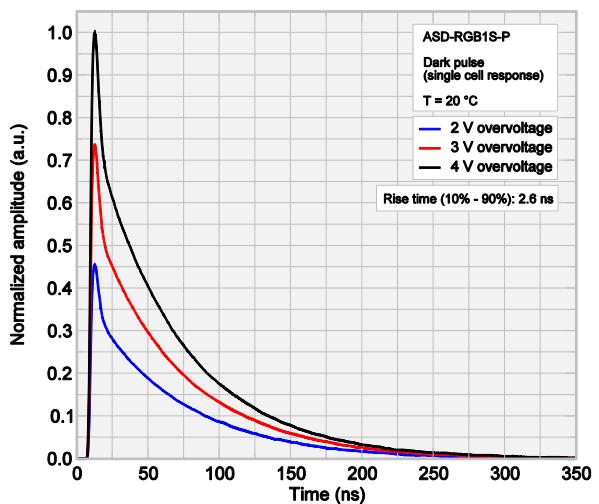
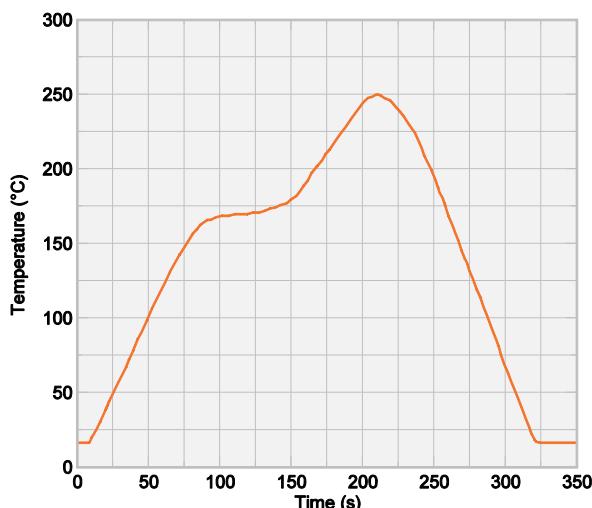


Fig.10 RGB-SiPM pulse shape (dark pulses, single cell response) at different overvoltage. Recharge time constant is 50 ns. Signals acquired with ASD-EP-EB-N.

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

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