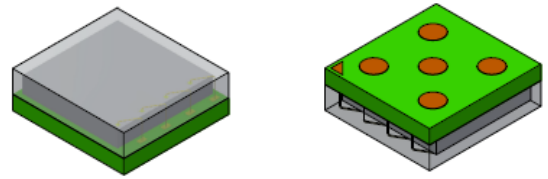


AFBR-S4N33P012M

HDR NUV-MT Silicon Photomultiplier



Description

The Broadcom® AFBR-S4N33P012M is a monolithic Silicon Photomultiplier (SiPM) array used for ultra-sensitive precision measurements of single photons. This SiPM is based on the NUV-MT technology which combines high photodetection efficiency (PDE) with low dark count rate and low cross-talk. With an SPAD pitch of 18 μm and a short recharge time, the HDR (high dynamic range) NUV-MT SiPM provides a high dynamic range.

The active area of 3 x 3 mm² is sub-segmented into a 2 x 2 matrix of four independent channels. Each sub-channel has an active area of 1.5 x 1.5 mm².

Larger areas can be covered by tiling multiple AFBR-S4N33P012M SiPMs.

The encapsulation for good mechanical stability and robustness is realized by an epoxy clear mold compound, which is highly transparent down to UV wavelengths, resulting in a broad response in the visible light spectrum with high sensitivity towards the blue and near-UV region of the light spectrum.

Features

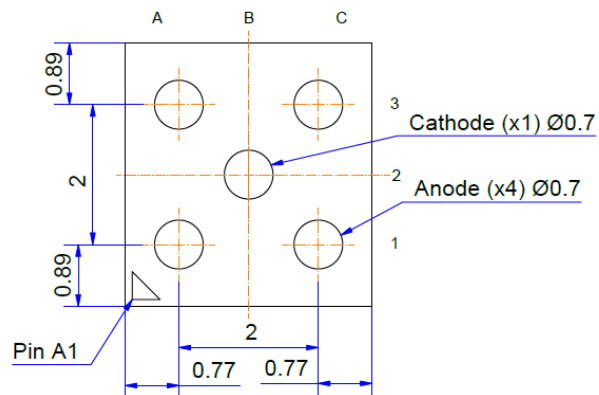
- High PDE (40% at 420 nm)
- High dynamic range (27339 SPADs)
- Low noise
- 4-side tileable, with high fill factors
- Cell pitch 18 μm
- Highly transparent epoxy protection layer
- Operating temperature range from -20°C to $+60^{\circ}\text{C}$
- Excellent uniformity of breakdown voltage and gain between devices
- RoHS, CFM, and REACH compliant

Applications

- Fluorescence Detection
- Microscopy
- Flow Cytometry
- X-Ray and Gamma Ray Detection
- Photon Counting X-Ray Detection
- Safety and Security
- Physics Experiments
- Cherenkov Detection

Pad Layout

Figure 2: Pad Layout



Pad	Function
A1	Anode 1
C1	Anode 2
C3	Anode 3
A3	Anode 4
B2	Cathode

The AFBR-S4N33P012M has 5 signal pads.
The pad layout is displayed in Figure 2.

NOTE:

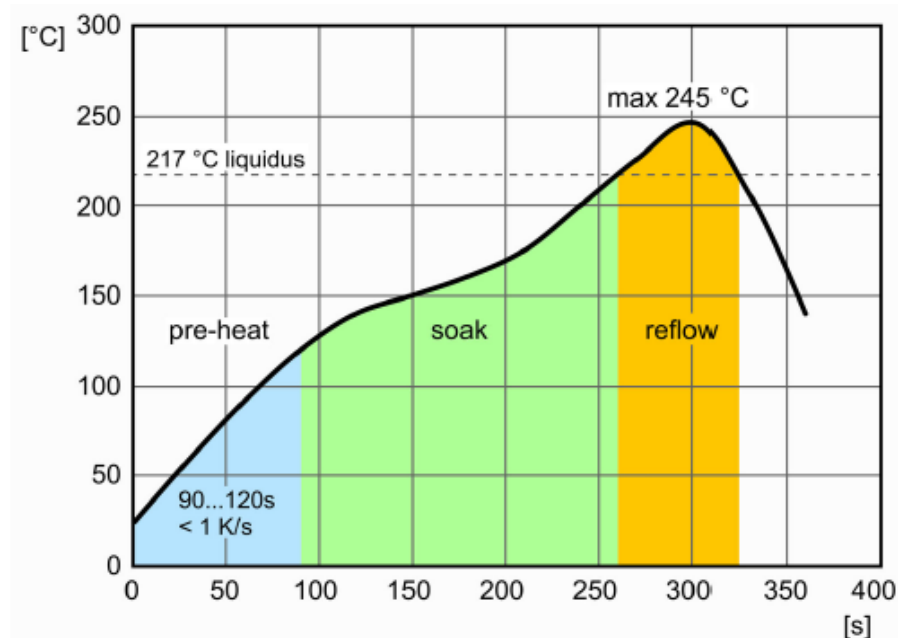
1. Dimensions: mm.

Regulatory Compliance Table

Feature	Test Method	Performance
Electrostatic discharge (ESD) to the electrical pins, Human Body Model (contact ESD)	JESD22-A114	See Absolute Maximum Ratings
Electrostatic discharge (ESD) to the electrical pins, Charged Device Model	JESD22-C101F	See Absolute Maximum Ratings
Restriction of hazardous substances directive	RoHS Directive 2011/65/EU Annex II	Certified compliant

Reflow Soldering Diagram

Figure 4: Recommended Reflow Soldering Profile



Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause damage to the devices. Limits apply to each parameter in isolation. Absolute maximum ratings are those values beyond which damage to the device may occur if these limits are exceeded for other than a short period of time.

Parameter	Symbol	Min.	Max.	Unit
Storage Temperature	T_{SG}	-20	+60	°C
Operating Temperature ^a	T_A	-20	+60	°C
Soldering Temperature ^{b,c}	T_{SOLD}		245	°C
Lead Soldering Time ^{b,c}	t_{SOLD}		60	s
Electrostatic Discharge Voltage Capability HBM	ESD_{HBM}		2	kV
Electrostatic Discharge Voltage Capability CDM	ESD_{CDM}		500	V
Operating Over Voltage	V_{OV}		16	V

- Biased at constant voltage = 12V above breakdown
- The tile is reflow solderable according to the solder diagram shown in Figure 3.
- The moisture level definition (MLD) is according to MSL 5. The floor life is 48 hours at 30°C and 60% relative humidity. No baking is required before soldering unless the floor life is exceeded. For more details on soldering and handling, refer to the Broadcom AFBR-S4NxxPyy4M: NUV-MT Handling and Soldering application note (AFBR-S4NxxPyy4M-AN).

Single Device Specification

Features measured at 25°C unless otherwise specified.

Geometric Features

Parameter	Symbol	Value	Unit
Package outer dimensions	PD	3.54 x 3.77	mm ²
Full active area	FAA	3.0 x 3.0	mm ²
Channel active area	CAA	1.5 x 1.5	mm ²
Micro cell pitch	L _{CELL}	18	μm
Number of micro cells on full SiPM	N _{CELLS}	27339	—

Optical and Electrical Features

Features measured at 12V OV and 25°C unless otherwise specified.

Parameter	Symbol	Min	Typical ¹	Max	Unit	Reference Plots
Spectral range	λ	250	—	900	nm	—
Peak sensitivity wavelength	λ_{PK}	—	420	—	nm	—
Breakdown Voltage	V _{BD}	—	32.5	—	V	—
Temperature coefficient of breakdown voltage	$\Delta V_{BD}/\Delta T$	—	30	—	mV/°C	—
Photo detection efficiency ^{1,2}	PDE	—	40	—	%	—
Dark current (FAA)	I _D	—	40	—	nA	—
Dark count rate per element ³ (FAA)	DCR _{FAA}	—	810	—	kcps	—
Dark count rate per channel ³ (CAA)	DCR _{CAA}	—	200	—	kcps	—
Dark count rate per unit area	DCR _{mm2}	—	90	—	kcps/mm ²	—
Gain	G	—	1.3	—	x10 ⁶	—
Optical crosstalk	P _{XTALK}	—	3	—	%	—
After pulsing probability	P _{AD}	—	< 1	—	%	—
Recharge time constant	T _{FALL}	—	18	—	ns	—
Nominal terminal capacitance ⁴ (on CAA)	C _T	—	100	—	pF	—
Temperature coefficient of gain ⁵	$\Delta G/\Delta T$	—	tbd	—	x10 ⁴ /°C	—

¹ Measured at 12V OV.

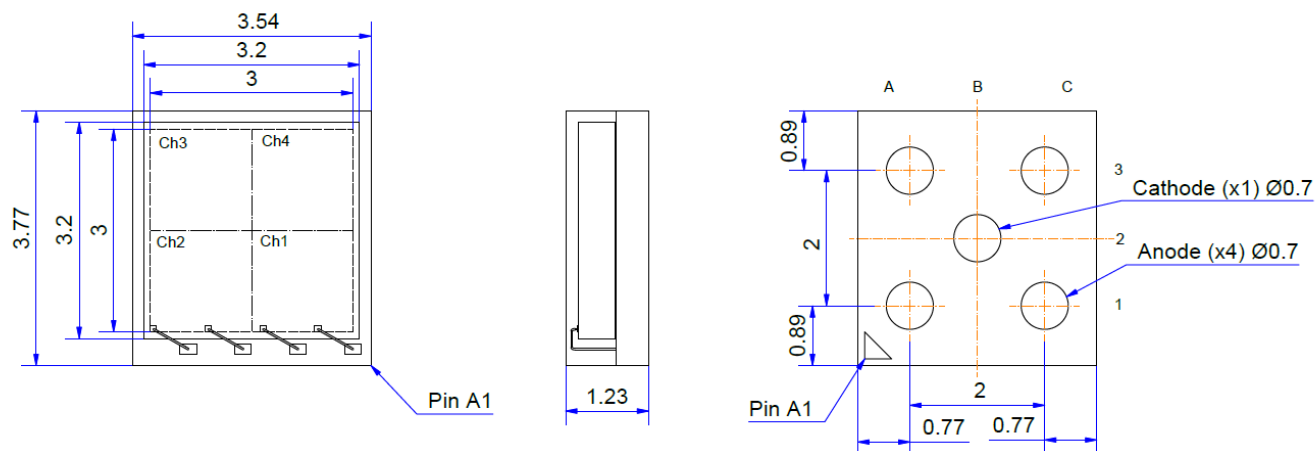
² Measured at peak sensitivity wavelength. Measurement does not include correlated noise, such as after-pulsing or optical cross-talk.

³ Measured at 0.5 p.e. amplitude. Measurement does not include delayed correlated events.

⁴ Measured using input sine wave with f = 200 kHz and V_{in} = 500 mV.

⁵ Calculated from gain dependence on V and breakdown voltage temperature coefficient: $dG/dT = dG/dV \times dV_{BD}/dT$.

Mechanical Data – Package Outline



NOTES:

- 1) Dimensions are in millimeters.
- 2) Nominal values rounded to two decimal places - Suppression of following zeros.

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