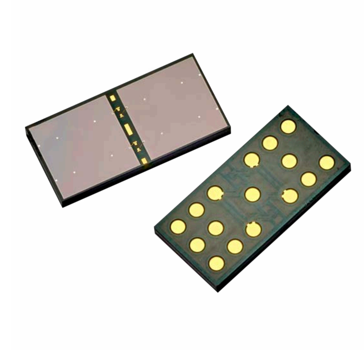
Data Sheet

AFBR-S4N66P024M

2×1 NUV-MT Silicon Photomultiplier Array

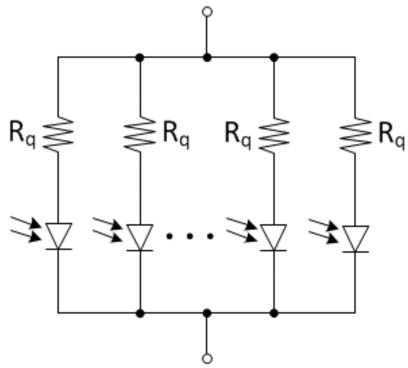


Description

The Broadcom® AFBR-S4N66P024M is a Silicon Photomultiplier (SiPM) array used for ultra-sensitive precision measurements of single photons. Two 6 mm × 6 mm SiPMs are arranged in a 2×1 element array with a pitch of 7 mm. Larger areas can be covered with a SiPM-pitch of 7 mm by tiling multiple AFBR-S4N66P024M arrays. The passivation layer is a clear epoxy mold compound (EMC) highly transparent down to UV wavelengths. This results in a broad response in the visible light spectrum with high sensitivity towards blue and near-UV region of the light spectrum. The array is best suited for the detection of low-level pulsed light sources, especially for detection of Cherenkov or scintillation light from the most common organic (plastic) and inorganic scintillator materials (for example, LSO, LYSO, BGO, NaI, CsI, BaF, LaBr). This product is lead-free and RoHS compliant.

Block Diagram

Figure 1: AFBR-S4N66P024M Block Diagram of Single SiPM Element



Features

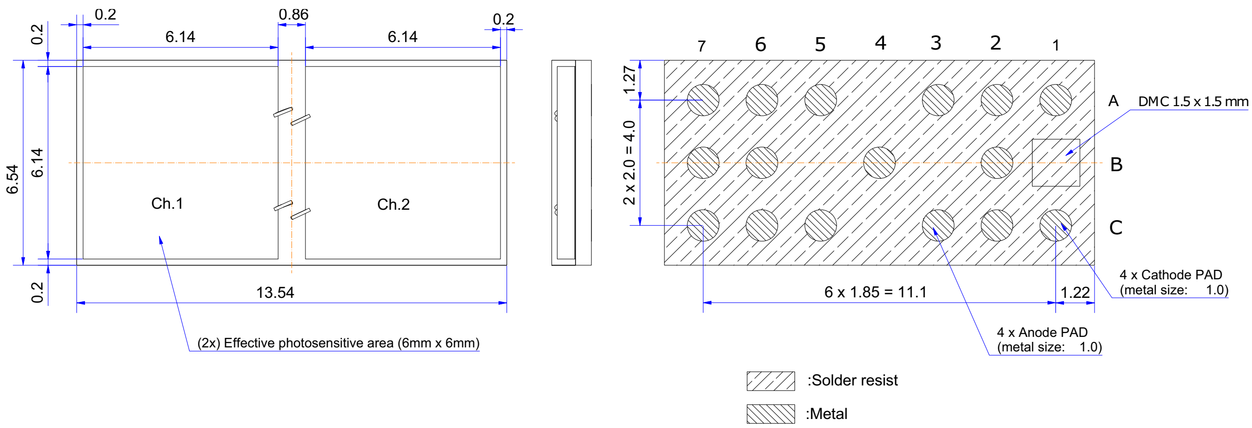
- 2×1 SiPM array
- Array size 13.54 mm × 6.54 mm
- High PDE (63% at 420 nm)
- Excellent SPTR and CRT
- Excellent uniformity of breakdown voltage
- Excellent uniformity of gain
- Four-side tilable, with high fill factors
- Cell pitch 40 µm
- Highly transparent epoxy protection layer
- Operating temperature range from 0°C to +60°C
- RoHS, CFM, and REACH compliant

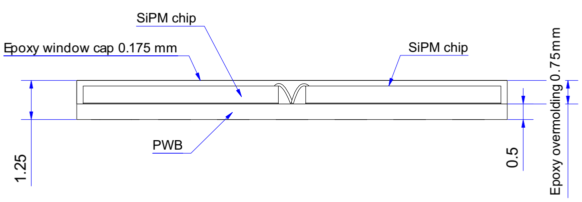
Applications

- X-ray and gamma ray detection
- Gamma ray spectroscopy
- Safety and security
- Nuclear medicine
- Positron emission tomography
- Life sciences
- Flow cytometry
- Fluorescence - luminescence measurements
- Time-correlated single photon counting
- High energy physics
- Astrophysics

Mechanical Drawing and Pin Layout

Figure 2: Package Drawing with Dimensions

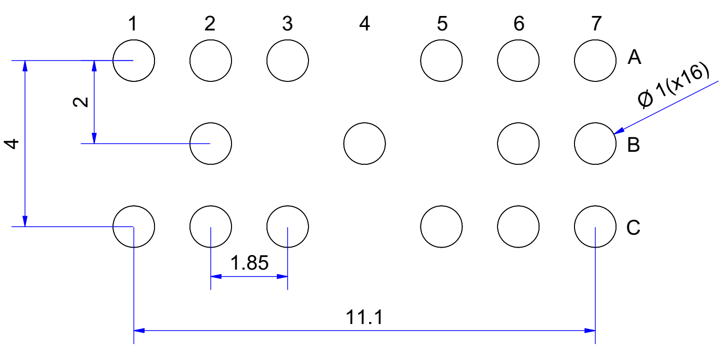




PAD CONNECTION	PAD NO.
Ch.1 cathode common	A1,C1
Ch1 anode common	A3,C3
Ch.2 anode common	A5,C5
Ch.2 cathode common	A7,C7
Not connected	A2,B2,C2,B4,A6,B6,C6,B7

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

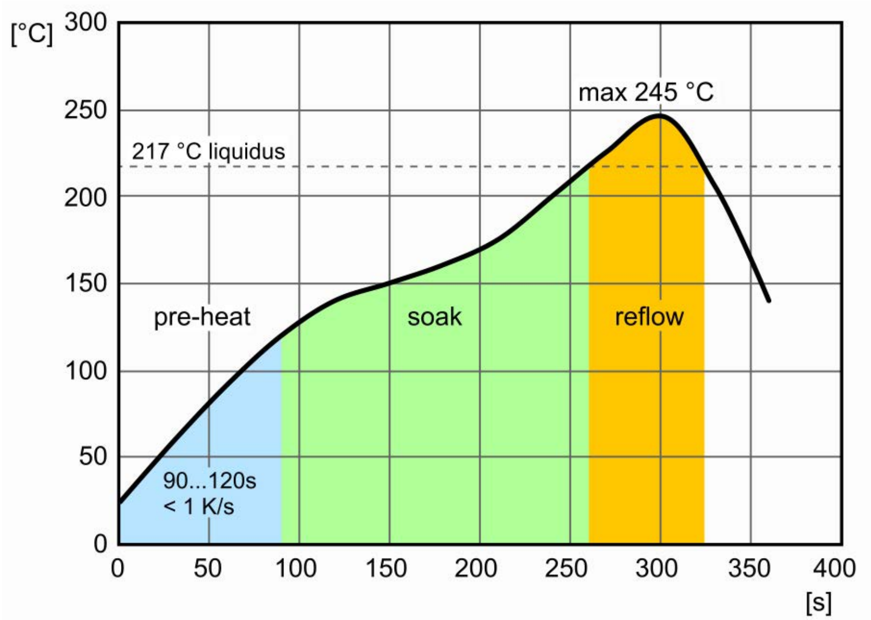
Figure 3: Recommended Landing Pattern Diagram



Note: Dimensions are in millimeters.

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.	Units
Storage Temperature	T_{STG}	–20	+80	°C
Operating Temperature[a]	T_A	0	+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

a. Biased at constant voltage = 12V above breakdown.

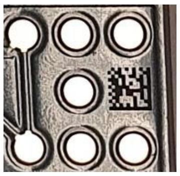
b. The AFBR-S4N66P024M is reflow-solderable according to solder diagram as shown in Figure 4.

c. Baking at 125°C for 16 hours is mandatory prior to soldering. MLD is according to MSL 6 with a floor life of 4 hours at 30°C and 60% relative humidity.

Device Identification

Each device can be identified and tracked by a unique data matrix code (DMC) on the back of the PCB. The code is structured as follows: YYWWNNNNNN (Y – year, W – week, N – running number). An example DMC is shown in Figure 5.

Figure 5: Example Data Matrix Code for Device Identification



Device Specification

Features measured at 25°C unless otherwise specified.

Geometric Features

Parameter	Symbol	Value	Units
Device area	DA	13.54 × 6.54	mm^2
Total active area	AA	6 × 6 × 2	mm^2
Element active area	EAA	6 × 6	mm^2
Micro cell pitch	L_{cell}	40	µm
Number of micro cells per element	N_{cells}	22428	—

Optical and Electrical Features

Values are measured at 12V above breakdown.

Parameter	Symbol	Min.	Typ.[a]	Max.	Units	Reference Plots
Spectral range	λ	360	—	900	nm	Figure 6
Peak sensitivity wavelength	λ_{PK}	—	420	—	nm	Figure 6
Photo detection efficiency	PDE at λ_{PK}	—	63	—	%	Figure 7
Dark current per element	I_D	—	8.6	—	µA	Figure 8
Dark count rate per unit area[b]	DCR/mm^2	—	125	—	kcps	Figure 9
Dark count rate per element	DCR	—	4.4	—	Mcps	Figure 9
Gain	G	—	7.3	—	$\times 10^6$	Figure 10
Optical crosstalk[c]	P_{Xtalk}	—	23	—	%	Figure 11
Afterpulsing probability	P_{AP}	—	< 1	—	%	
Recharge time constant	τ_{fall}	—	55	—	ns	Figure 12
Breakdown Voltage	V_{BD}	—	32.5	—	V	Figure 8
Nominal terminal capacitance per element[d]	C_T	—	1550	—	pF	
Temperature coefficient of breakdown voltage (23…27°C)	$\Delta V_{BR}/\Delta T$	—	30	—	mV/°C	
Temperature coefficient of gain (23…27°C)[e]	$\Delta G/\Delta T$	—	1.46	—	$\times 10^4$/°C	

a. Typical values are measured at 12V above breakdown

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

c. Calculated as the sum of direct, delayed crosstalk, and after-pulsing probabilities.

d. Measured at 40V using input sine wave with f = 200 kHz and V_{in} = 500 mV.

e. Calculated from gain dependence on V and breakdown voltage temperature coefficient: $\Delta G/\Delta T = \Delta G/\Delta V \times \Delta V_{BR}/\Delta T$.

Reference Plots

Typical features measured at 25°C unless otherwise specified.

Figure 6: PDE vs. Wavelength at 12V OV

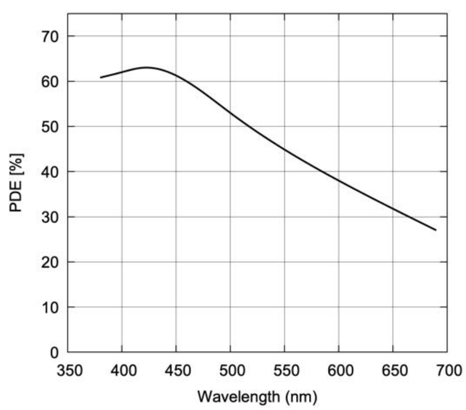


Figure 7: PDE vs. OV at 420 nm

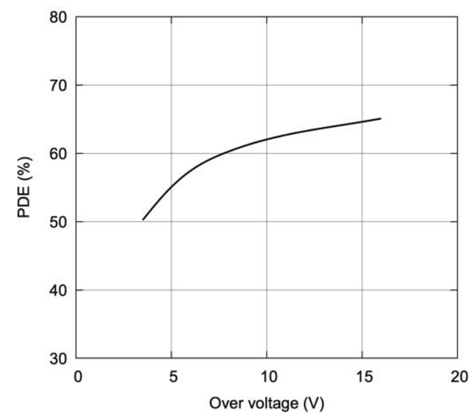


Figure 8: Reverse IV Curve in Dark Conditions

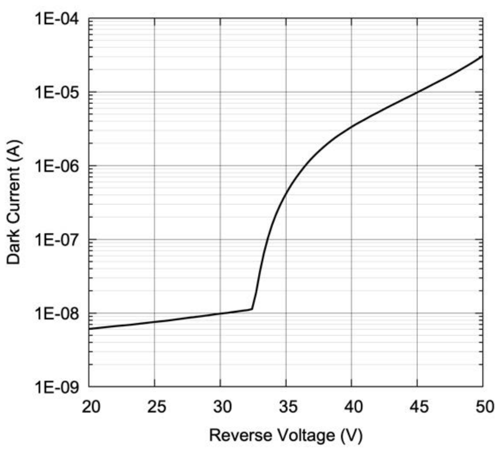


Figure 9: Dark Count Rate vs. Overvoltage

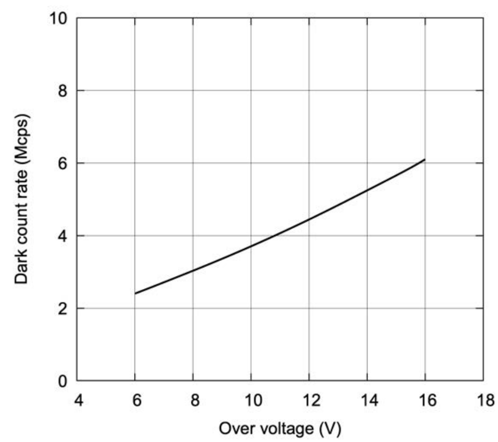


Figure 10: Gain vs. Overvoltage

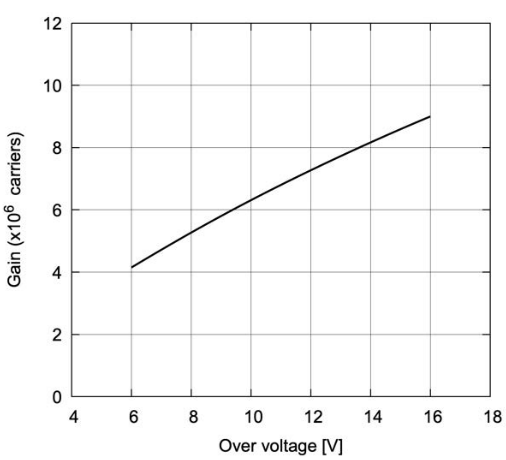


Figure 11: Total Correlated Noise vs. Overvoltage

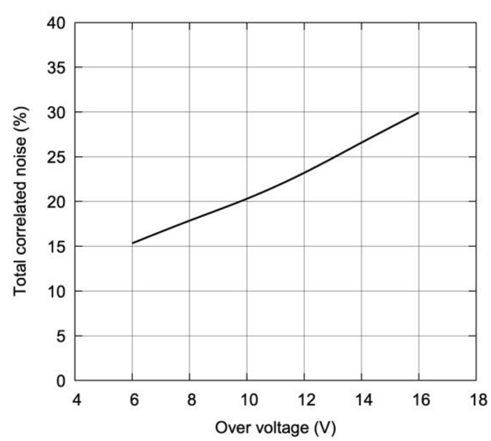


Figure 12: Typical Pulse Waveform in Response of a Picosecond Laser-Pulse on a Load Impedance of 25Ω and Applied Bias of 12V above Breakdown