DATASHEET

BIOMEDICAL SOLUTIONS

SPCM-AQ4C

Single Photon Counting Module Array

Overview

The SPCM-AQ4C is a 4-channel photon counting card capable of detecting single photons of light over the wavelength range from 400 nm to 1060 nm. Each channel is independent from the others.

The SPCM-AQ4C uses a unique silicon avalanche photodiode (SliK™) that has a circular active area with a peak photon detection efficiency exceeding 60% at 650nm.

Each photodiode is both thermo-electrically cooled and temperature controlled, ensuring stabilized performance despite changes in the ambient temperature. The SPCM-AQ4C card uses an improved circuit with a peak count rate >4 M c/s for short bursts of time on all 4 channels and a count rate of 1.5 M c/s for continuous operation. There is a "dead time" of 50 nanoseconds (ns) between pulses.

The SPCM-AQ4C requires +2 Volt, +5 Volt, and +30 Volt power supplies. The output of each channel – a TTL pulse that is 4.5 Volts high (into a 50 Ω load) and 25 ns wide – is available at the card edge behind the circuit board. Each TTL pulse corresponds to a detected photon. All input and output signals are available at the card connector.

To avoid a degradation of the module linearity and stability, the heat sink temperature should be kept between 5˚C and 40˚ C during operation.

Saturation

The count decreases at higher incoming light levels. The count at which the output rate starts to decrease is called the saturation point. As an extreme example, if the module is exposed to intense light, the count rate will fall to zero. Consequently, in certain applications, some tests should be performed by the operator to ensure that a low count rate is not caused by detector saturation. Precautions should be taken to avoid any excessive light level that will damage the SPCM.

Applications

- Single molecule detection
- High throughput DNA sequencing
- LIDAR
- Photon correlation spectroscopy
- Astronomical observation
- Optical range finding
- Adaptive optics
- Ultra sensitive fluorescence
- Particle sizing

Key Features and Benefits

- Peak photon detection efficiency at 650 nm: 60% typical
- Afterpulsing probability 0.5%
- Gated input
- TTL output
- FC fiber connector mounted and aligned on each detector
- 4 channels in one package
- Self-contained APD module with integrated electronics

PerkinElmer® precisely.

SPCM-AQ4C

Fiber connection option

The SPCM-AQ4C has an "FC" fiber-optic receptacle pre-aligned to the optical detector. Optical fibers with an FC connector on one end are available separately (see Fiber Type Ordering Guide on page 7). The photon detection efficiency is typically 60% at 650nm.

Fiber shielding

When used with optical fibers, both the fiber and the connector shrouds must be completely opaque; if not, stray light will increase the count rate. The SPCM-QCX pigtails conform to this requirement (see Fiber Type Ordering Guide on page 7).

Gating function

A gating function is provided with each channel. It is useful when looking for a signal that occurs only in a small timeframe window. Also, in some applications the background light flux is higher than the signal. In this case, the gating option could be used to improve the S/N ratio by opening a window only when the light signal is present. The output of the module is enabled when a TTL low level is applied to the module gate input. Gated count rate is = n-1. The module is gated "OFF" when a TTL high level signal is applied to the gate input.

Light emission during photon detection

One peculiarity of silicon avalanche photodiodes is that as an incoming photon is detected, a small amount of light is emitted from the avalanche region. The light emitted has a broad spectral distribution. In most cases, this is not a problem. However, it can cause some confusion if another detector is monitoring light, or if the optical system is such that light emitted from the SPCM-AQ4C is reflected back on itself. If these photons return more than 30 ns after the initial event, they will be detected.

Safety

The SPCM-AQ4C contains a **high voltage power supply**. All internal settings are pre-set; there are no user adjustments.

Units which appear defective or have suffered mechanical damage should not be used because of possible electrical shorting of the high-voltage power supply.

Warranty

A standard 12-month warranty following shipment applies. Any warranty is null and void if the module case has been opened.

ESD warning

Modules should only be handled at an ESD safe work station.

Table 1. **Specifications SPCM-AQ4C at 22˚C, all models, unless otherwise indicated**

Note: *At power on and 40˚C
**At maximum count rate

Parameter		Minimum	Typical	Maximum	Units
Supply currents:	at +2 V		1.0	4.0* 3.0**	Amps Amps
	at +5 V		0.20	1.0**	Amps
	at +30 V		0.01	0.04**	Amps
Maximum power consumption	at +2 V		2	6**	Watts
	at +5 V		1	5**	Watts
	at +30 V		0.3	1.2**	Watts
Supply voltages		1.95 4.75 29	2 5 30	2.05 5.25 31	V V V
Operating temperature (heatsink)		5		40	˚C
Photon detection efficiency (per channel)	at 400nm	1	2.5		%
	at 650nm	45	60		%
	at 830nm	35	45		%
	at 1060nm	1	2		%
Average Pd variation per channel at constant heat sink temperature (6 hrs at 25°C)			±1	±3	%
Average Pd variation per channel at 5°C to 40°C heat sink temperature			±4	±10	%
Dark count (per channel)				500	Counts/Sec.
Average dark count variation per channel at constant heat sink temperature (6 hours at 25˚C)				±10	%
Average dark count variation per channel at 5˚C to 40˚C heat sink temperature				±20	%
Dead time (Count rates below 5 Mc/s) nanoseconds			50		ns
Output pulse width			25		ns
Maximum count rate (per channel)	Continuous		1.5		Mc/s
	500ms duration, 25% duty cycle		4		Mc/s
Afterpulsing probability			0.3	0.5	%
Gate threshold voltage (at V_{Sup}= 5V)					
	Low level (sink 5mA) = Gate On		0	0.4	V
	High level = Gate Off		3.5	5.25	V
Gate turn-on delay before first edge of true output pulse			60	75	ns
Gate turn-off delay for minimum last output pulse width of 10ns			4	15	ns
Linearity correction factor [7] See fig. 3					
	at 200 kc/s		1.01	1.10	
	at 1 Mc/s		1.08	1.15	
	at 1.5 Mc/s		1.12	1.20	

Absolute maximum ratings

Parameter		Maximum	Units
Supply voltage	+2 V	2.1	V
	+5 V	5.5	V
	+30V	31.5	V
Mean count rate, continuous (per channel)		2	Mc/s
Peak count rate, at 25% duty cycle to 500ms (per channel)		5	Mc/s
Peak light intensity (per channel)	Maximum 10^4 photon/pulse and pulse width less than 1ns		
Temperature: -45˚ to 50˚C storage, 5˚C to 40˚C operating heat sink.			

Operating Instructions

1. Connection to incorrect voltage or reverse voltage may destroy the module. If such damage occurs, the warranty becomes invalid.
2. These modules are not qualified for shock or vibration other than normal instrumentation environments.
3. The module dissipates a mean power of 3.5W, and a maximum power of 14W at high count rate and 40° C. Adequate heat sinking must be provided by clamping the module to a suitable heat sink via the holes in the module base. For the specification performance, the module case temperature must not exceed 40° C.
4. Bi-stability of the dark count: On a small percentage of delivered modules, bi-stability of the dark count has been observed. Research indicates that this bi-stability is probably due to transitions at a single impurity site between a low energy and a high energy state. The phenomenon is seen as an abrupt change in the dark count rate, e.g. 350 to 390 c/s, and the dark count switches between the two states at a rate dependent on the detector temperature. Multilevel switching has also been observed, where more than one impurity site is switching.
5. Long-term bi-stability is related to fundamental semiconductor physics and is outside PerkinElmer's control. Warranty claims will not be entertained against bi-stability alone. Warranty claims will only be considered if the high level of the dark count exceeds the maximum level in the specification.
6. In the dark, the module generates random counts that follow a Poisson distribution. In a Poissonian process, the standard deviation is equal to the square root of the average counts. In this specification, the "dark count variation" refers to the stability of the average count of the module.
7. When connecting power to the module, good grounding techniques must be observed. All ground connections for the +30V and +5V supplies should connect through a single point on the user's interface. All ground pins on the card edge connector should be used. The +2V grounds should be connected together at a single point, but should be seperate and isolated from the grounds of the other supplies.
8. The actual photon rate could be calculated using the following equation, as indicated below:

$$ACTUALCOUNTRATE_{Photons} = \frac{(OUTPUT\ \ ModuleCountRate \times CORRECTIONFACTOR\ @\ the\ Module\ CountRate) - DARK\ COUNT\ Module}{PHOTON\ DETECTION\ EFFICIENCY\ Module}$$

The theoretical value, at low count rate, of the Correction Factor follows this equation:

$$Correction\ Factor = \frac{1}{1 - (t_d \times C_R)}$$

Where: t_d = Module Dead Time

C_R = Output Count Rate

The deviation from an ideal linear system is another way of looking at the saturation effect. The following equations show how to calculate this departure from the linearity:

$$LINEARITY = \left[\frac{OUTPUT\ ModuleCountRate}{(PHOTONS\ Actual\ Count\ Rate \times PHOTON\ DETECTION\ EFFICIENCY\ Module) + DARK\ COUNT\ Module}\right]^{-1}$$

$$= \left[\frac{1}{Correction\ Factor}\right]^{-1}$$

Card edge connector parameters

The electrical connections to the card edge connector are shown below. Each connector has 72 contacts, 36 on each side. The contact spacing is 0.100".

Mating connector is *Sullins Electronics Corp, P/N EZC36DCAN, 801 E. Mission Rd., San Marcos, CA. 92069 888-774-3100*

Http://www.edgecards.com/dsww100.php

Any equivalent connector may be used.

Card edge connector

Component Side

Contact #	Value
1	+2 V
3	+2 V
5	+30 V
7	2 V GROUND
9	TTL OUT 0
11	GROUND
13	GATE 0
15	GROUND
17	+5 V
Key Slot	
19	+2 V
21	+2 V
23	+30 V
25	2V GROUND
27	TTL OUT 1
29	GROUND
31	GATE 1
33	GROUND
35	+5 V
37	+2 V
39	+2 V
41	+30 V
43	2 V GROUND
45	TTL OUT 2
47	GROUND
49	GATE 2
51	GROUND
53	+5 V
55	+2 V
57	+2 V
59	+30 V
61	2 V GROUND
63	TTL OUT 3
65	GROUND
67	GATE 3
69	GROUND
71	+5 V

Card edge connector

Solder Side

Contact #	Value
2	NC
4	NC
6	NC
8	2 V GROUND
10	NC
12	NC
14	NC
16	NC
18	NC
Key Slot	
20	NC
22	NC
24	NC
26	2 V GROUND
28	NC
30	NC
32	NC
34	NC
36	NC
38	NC
40	NC
42	NC
44	2 V GROUND
46	NC
48	NC
50	NC
52	NC
54	NC
56	NC
58	NC
60	NC
62	2 V GROUND
64	NC
66	NC
68	NC
70	NC
72	NC

Figure 1. **Detector scan without FC fiber adaptor**

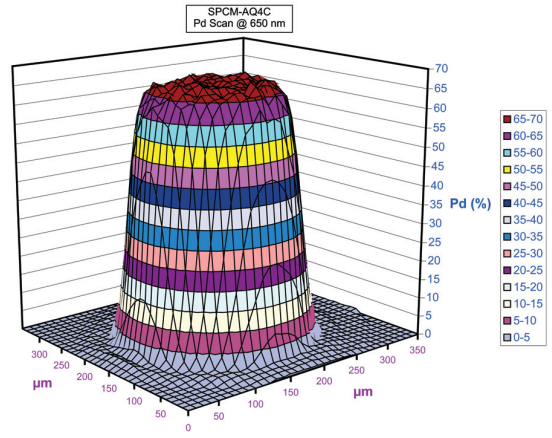


Figure 2. **Photon detection efficiency (pd) vs. wavelength**

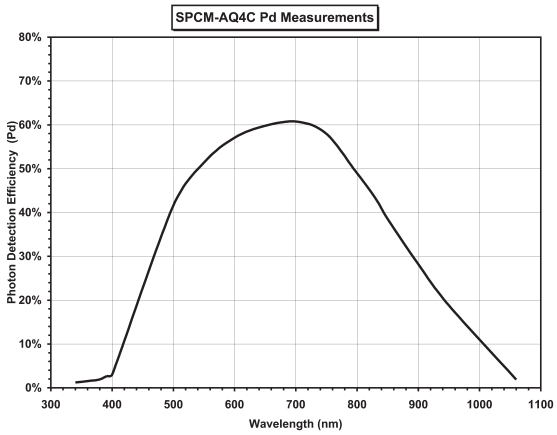


Figure 3. **Typical correction factor**

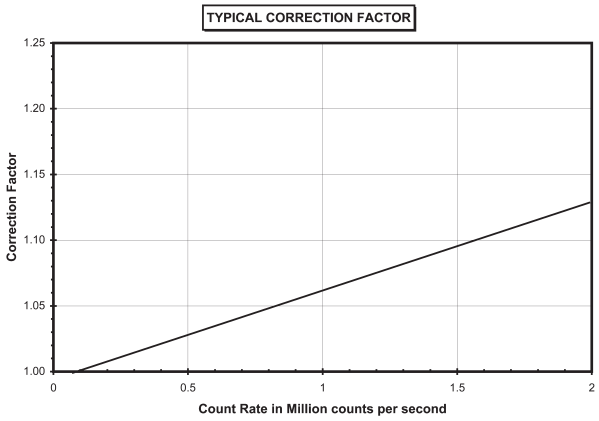


Figure 4. **Optical power vs. number of photons**

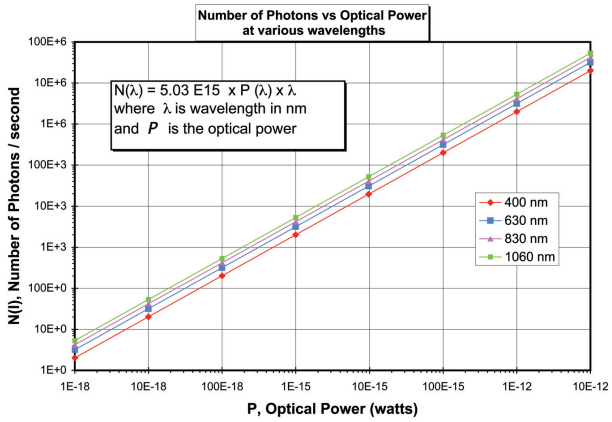
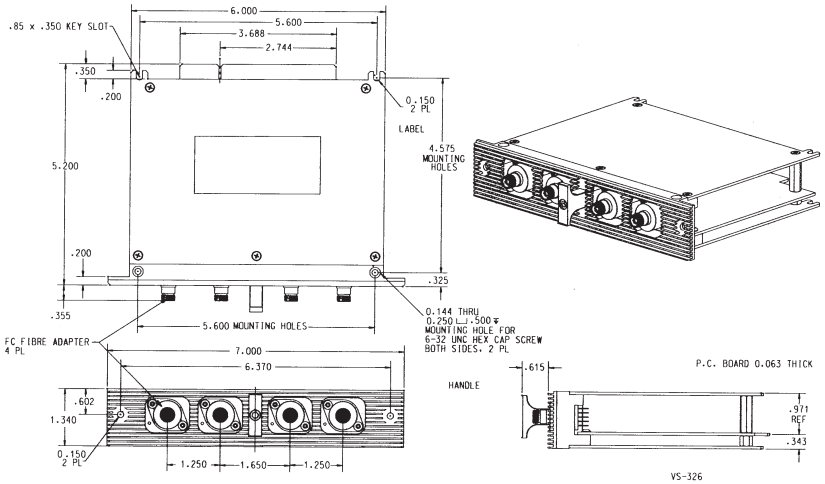


Figure 5. **Mechanical dimensions**



Fiber type ordering guide

Part Number	Fiber Type	Diameter			Numerical Aperture
		Core	Cladding	Outer	
SPCM-QC4	Single Fiber Multimode	62.5µm	125µm	2.5mm	0.29
SPCM-QC6	Single Fiber Multimode	100µm	140µm	2.5mm	0.27
SPCM-QC9	Single Fiber Multimode	As SPCM-QC6 but FC connector on free end			

Please contact PerkinElmer Optoelectronics for other fiber configurations.

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With a broad customer base in all major markets, built on ninety years of solid trust and cooperation with our customers, PerkinElmer is recognized as a reliable partner that delivers high quantity, customized, and superior "one-stop" solutions. Our products - from single photocells to complex x-ray inspection systems - meet the highest quality and environmental standards.

Our worldwide Centers of Excellence, along with our Customer and Technical Support teams, always work with you to find the best solutions for your specific needs.

PerkinElmer Optoelectronics

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So contact us and put PerkinElmer's expertise to work in your demanding applications. We will show how our innovations will help you deliver the perfect product.

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Appendix I

Declaration of Conformity

Declaration stating that PerkinElmer has conformed to CSA (Canadian Standards Association) which provides the right to bear the CSA mark on this product.

This product is eligible to bear the CSA mark with adjacent indicator 'C' and 'US'.

Products:

CLASS 8721 84 ELECTRICAL EQUIPMENT FOR LABORATORY USE – Certified to US standards
CLASS 8721 04 LABORATORY EQUIPMENT – Electrical.

Four channel photon counting module SPCM-AQ4C , rated 2 Vdc, 4.0 A; rated 5 Vdc, 1.0 A ; rated 30 Vdc, 0.04 A, Continuous operation, installation category l, pollution degree 2

APPLICABLE REQUIREMENTS:

CAN/CSA-C22.2 No. 1010.1-92 (R1999) – Safety requirements for electrical equipment for measurement, control, and laboratory use, part 1: General requirements
CAN/CSA-C22.2 No. 1010.1B-92 – Amendment 2:1997 to CAN/CSA 22.2 No. 101.1-92, Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements
UL std no. 61010A-1 – Electrical equipment for laboratory use ; part 1:General requirements

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This product is eligible to bear the CE mark in accordance with:

EN 61326:1997 Electrical equipment for measurement, control and laboratory use
EN 61010-1:2001 Safety requirements for electrical equipment for measurement, control and laboratory use
This product has been tested as per the following standards:

- Emission CISPR 11
- IEC 61000-4-2 ESD
- IEC 61000-4-3 Radiated susceptibility
- IEC 61000-4-4 Burst
- IEC 61000-4-5 Surge
- IEC 61000-4-6 Conducted susceptibility
- IEC 61000-4-11 Voltage dips and interruptions