HAMAMATSU

PHOTON IS OUR BUSINESS

MPPC®

Multi-Pixel Photon Counter

Photosensors with excellent photon-counting capability

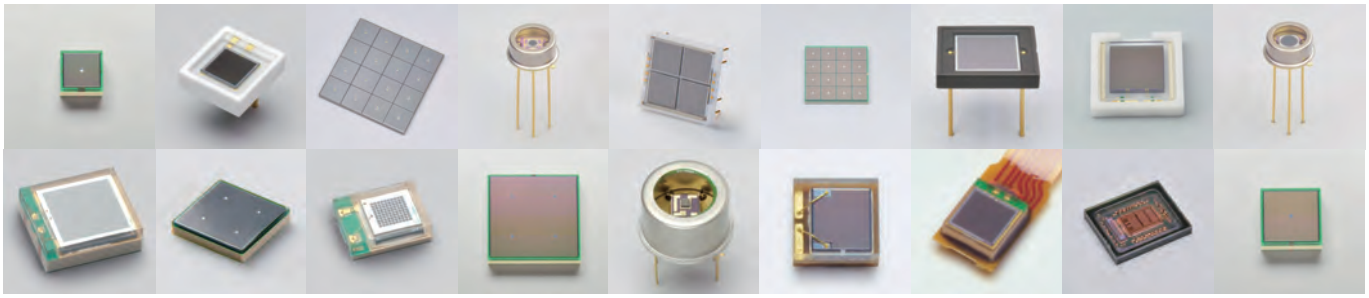
CONTENTS

Oct. 2022

What is MPPC® ?

MPPC®
Multi-Pixel Photon Counter

The MPPC (multi-pixel photon counter) is a type of photosensor called SiPM (silicon photomultiplier). It is a photon-counting device using multiple APD (avalanche photodiode) pixels operating in Geiger mode. Although essentially an opto-semiconductor device, it has excellent light receiving capability and can be used in various applications for detecting extremely weak light at the photon counting level.
The MPPC operates on low voltage and features high gain, high photon detection efficiency, high-speed response, excellent time resolution, and wide spectral response range. It achieves the high-level performance required in photon counting. It is also immune to magnetic fields, highly resistant to mechanical shocks and the like, and will not suffer from “burn-in” by incident light saturation, which are advantages unique to solid-state devices.



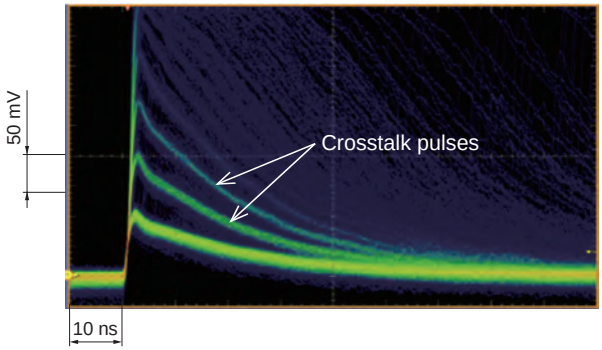
• Features of MPPC

When an MPPC detects photons, the output may contain false signals, namely afterpulse and crosstalk, that are separate from the output pulses of the incident photons. Hamamatsu MPPC maintains high photon detection efficiency while featuring low afterpulse, low crosstalk, and low dark count.

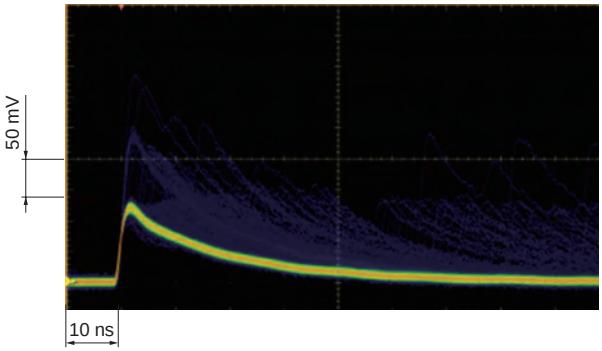
FEATURE 1 Low crosstalk

The pixel that detects photons may affect other pixels, making them produce pulses separate from output pulses. This phenomenon is called crosstalk. MPPC employs a structure that suppresses the occurrence of crosstalk.

■ **Previous product (3 × 3 mm, 50 µm pitch)**



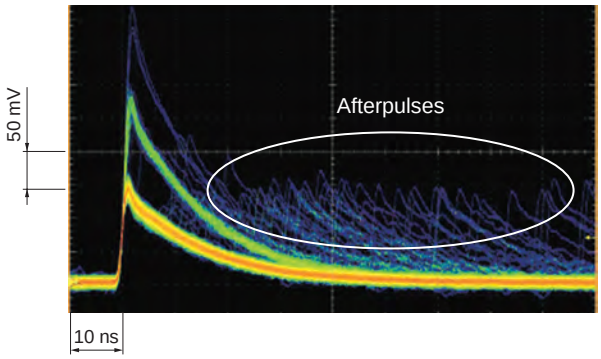
■ **Current product S13360-3050CS (3 × 3 mm, 50 µm pitch)**



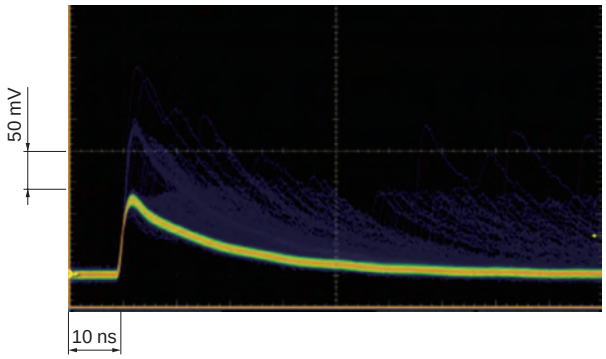
FEATURE 2 Low afterpulses

While an MPPC detects photons, delayed signals may be output separately from the output pulses. These signals are called afterpulses. Hamamatsu MPPC has low afterpulses.

■ **Previous product (3 × 3 mm, 50 µm pitch)**



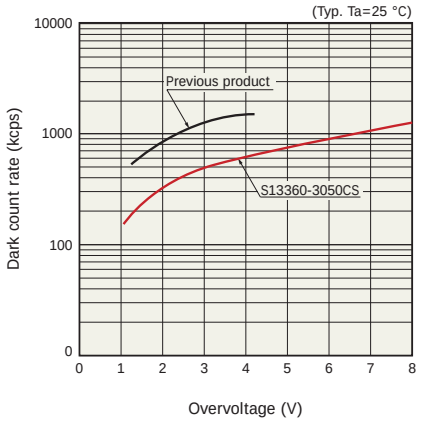
■ **Current product S13360-3050CS (3 × 3 mm, 50 µm pitch)**



FEATURE 3 Low dark count, high gain, high photon detection efficiency

Improvements in materials and wafer process technology have reduced the dark count down to approximately half that of previous products.

■ **Dark count rate vs. overvoltage**



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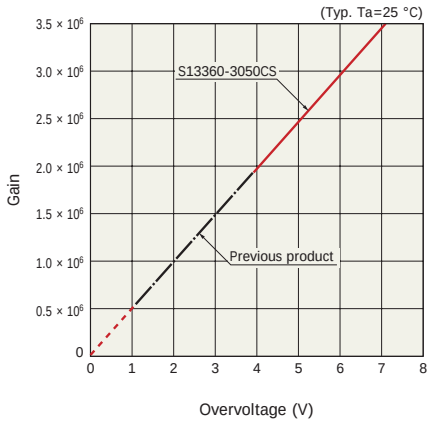
■ **Gain vs. overvoltage**



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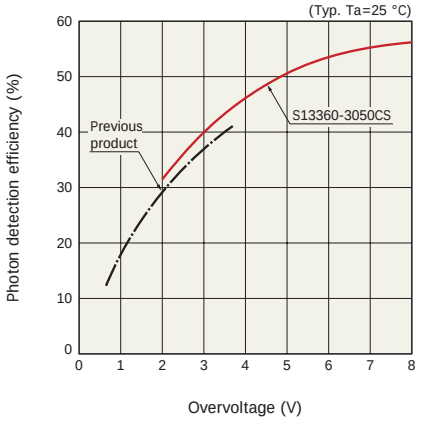
■ **Photon detection efficiency vs. overvoltage**



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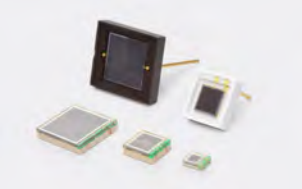
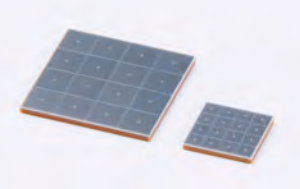
MPPC lineup

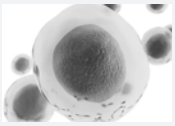
Hamamatsu offers a lineup of MPPCs that support a spectral range from vacuum ultraviolet (VUV) to near infrared (NIR), and also offers various element types, including multi-channel and thermoelectric cooling.
Choose from products suitable for various applications, including academic or research purposes, analytical equipment, PET scanners, and LiDAR.



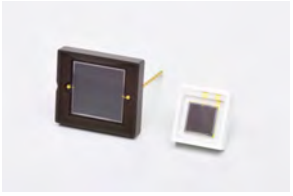
Single-channel MPPC



Multi-channel MPPC

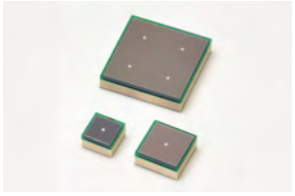
Measurement wavelength \ Applications	Academic research 	Measuring instruments (Flow cytometers, Microscopes, etc.) 	PET scanners 	LiDAR 
VUV/UV	P.26 For academic research experiments			
VIS	P.9~ For wide dynamic range S14160 series 		P.12 For PET scanners S14160 / S14161 series 	
	P.13~ For precision measurement S13360 / S13362 series 			
	P.19~ For precision measurement (TSV type) S13360 / S13361 series 			
VIS to NIR		P.21~ For visible light S14420 / S14422 series 		
NIR				P.25~ For near infrared S15639-1325PS

• Package option

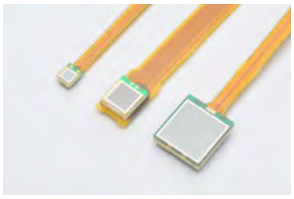


Ceramic package

Metal package



Surface mount

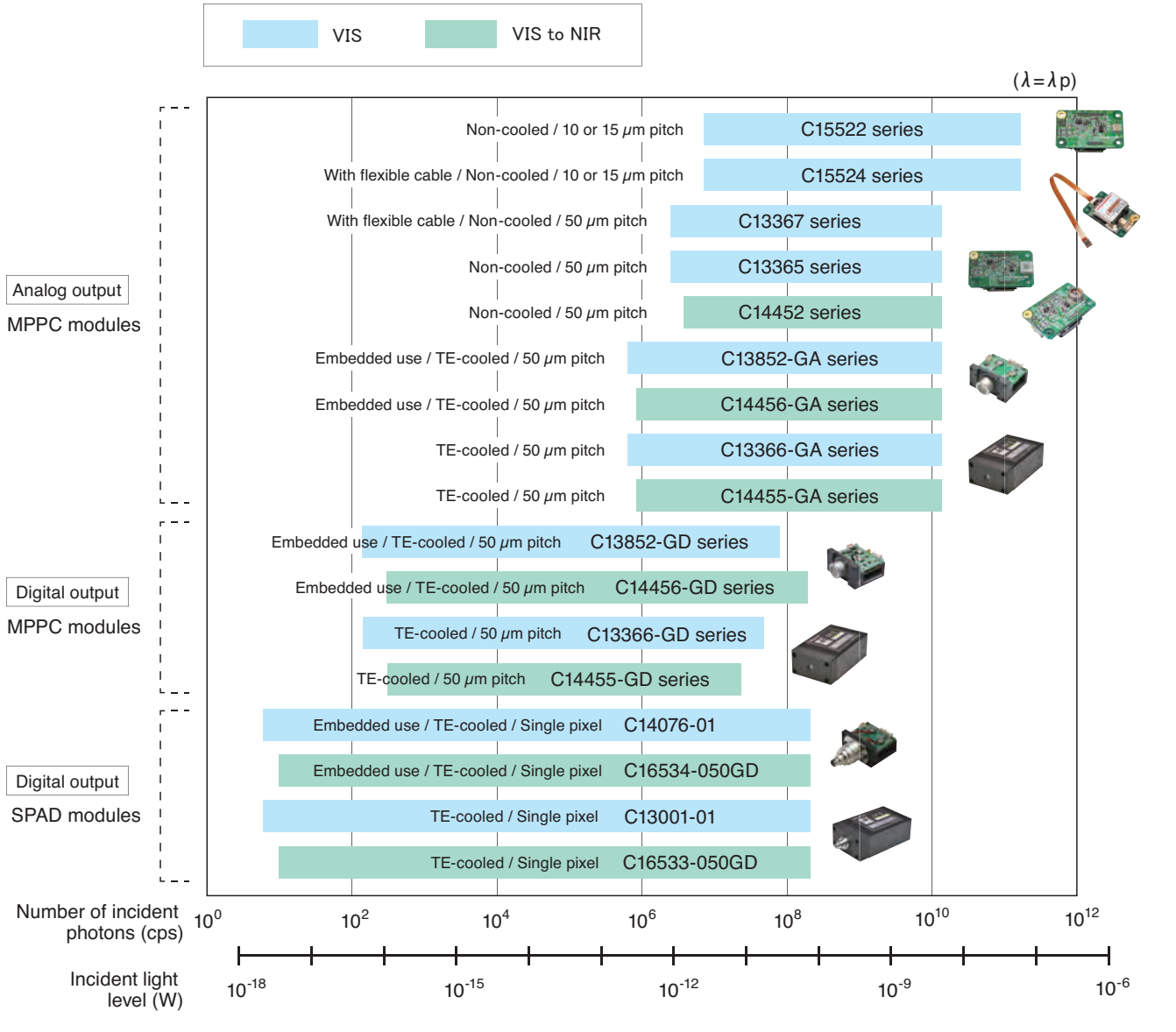


With flexible cable

Contents / Measurement wavelength	MPPC			Package options				Module type (MPPC module)
	Page no.	Type no.	Channel type	Ceramic package	Metal package	Surface mount	With flexible cable	
VUV/UV	Please consult us about VUV/UV MPPC.							
VIS	P.9	S14160 series	Single-channel			✓	✓ Option	✓
	P.12	S14161 series	Multi-channel			✓		
	P.13	S13360 series	Single-channel	✓	✓	✓	✓	✓
	P.17	S13362 series	TE-cooled Single-channel		✓			✓
	P.19	S13360 series (TSV type)	Single-channel			✓		
		S13361 series	Multi-channel			✓		✓
VIS to NIR	P.21	S14420 series	Single-channel		✓			✓
	P.23	S14422 series	TE-cooled Single-channel		✓			✓
NIR	P.25	S15639-1325PS	Single-channel	✓		✓	✓ Option	

MPPC modules / SPAD modules lineup

MPPC modules and SPAD modules are light detection modules with a built-in MPPC or SPAD. In addition to the detector, it is equipped with an amplifier and bias circuit, so all it needs is a power supply to perform measurement. These modules can be integrated into various devices or used for simple evaluation. We offer various product types, including low dark count cooled modules, uncooled modules with a temperature compensation function, and array modules with multi-channel MPPC. We also provide custom-made products to meet customer specifications.



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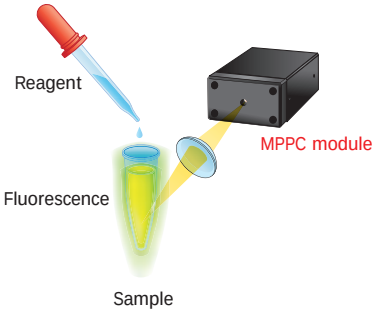
• Application examples

Fluorescence measurement



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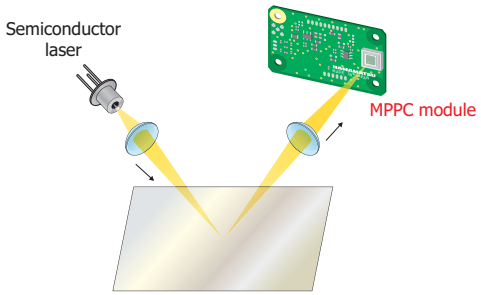
Major characteristics:
High photon detection efficiency, low afterpulse

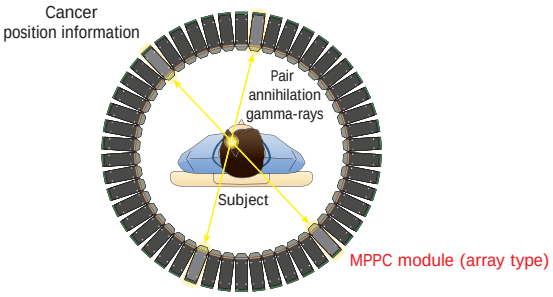
Surface inspection



KACCC1155EA

Major characteristics:
High-speed response, wide dynamic range

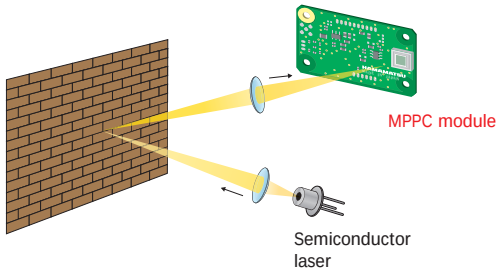
Scintillation measurement



KACCC0598EA

Major characteristics:
High photon detection efficiency, wide dynamic range

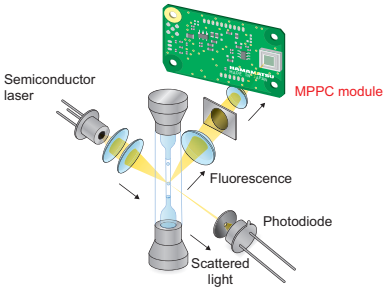
Distance measurement



KACCC1156EA

Major characteristics:
High-speed response, wide dynamic range

Flow cytometry



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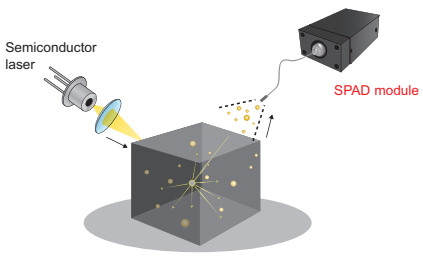
Major characteristics:
Wide dynamic range, high photon detection efficiency

Particle measurement



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Major characteristics:
High photon detection efficiency, low afterpulse

Product information

- VIS MPPC
- VIS to NIR MPPC
- NIR MPPC

VIS MPPC

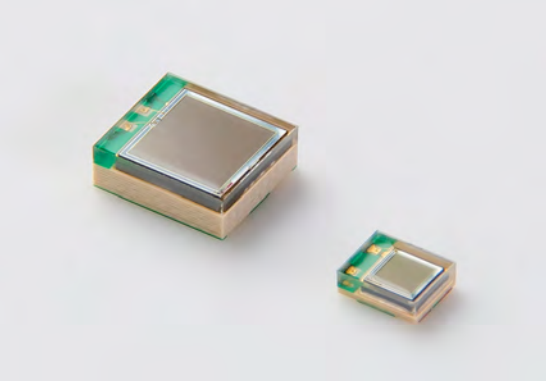
For wide dynamic range

S14160 series

ACADEMIC MEASUREMENT

FEATURES

- Small pixel pitch (10 µm / 15 µm)
- Wide dynamic range
- Low operating voltage (V_{BR}=38 V typ.)



APPLICATIONS

- High energy physics experiments
- Flow cytometers
- DNA sequencers
- Environmental analysis

Structure

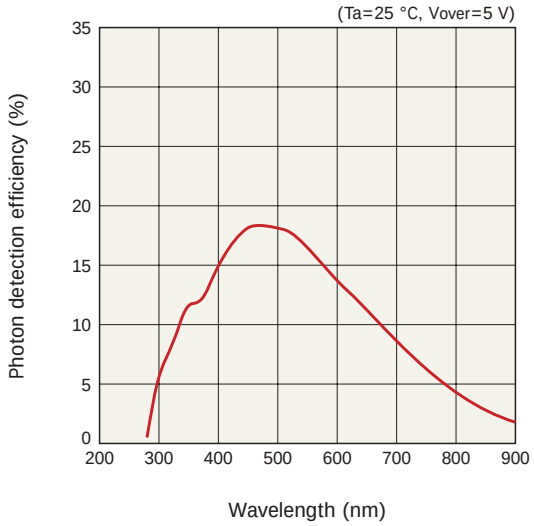
Type no.		Number of channel (ch)	Package	Pixel pitch (µm)	Effective photosensitive area (mm)	Number of pixels	Fill factor (%)
S14160	-1310PS	1	Surface mount type	10	1.3 × 1.3	16663	31
	-3010PS				3.0 × 3.0	89984	
	-1315PS			15	1.3 × 1.3	7284	49
	-3015PS				3.0 × 3.0	39984	

Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count	
					Typ. (kcps)	Max. (kcps)
S14160	-1310PS	18	38	100	120	360
	-3010PS			530	700	2100
	-1315PS	32		100	120	360
	-3015PS			530	700	2100

■ Photon detection efficiency vs. wavelength (typical example)

S14160-1310PS/-3010PS



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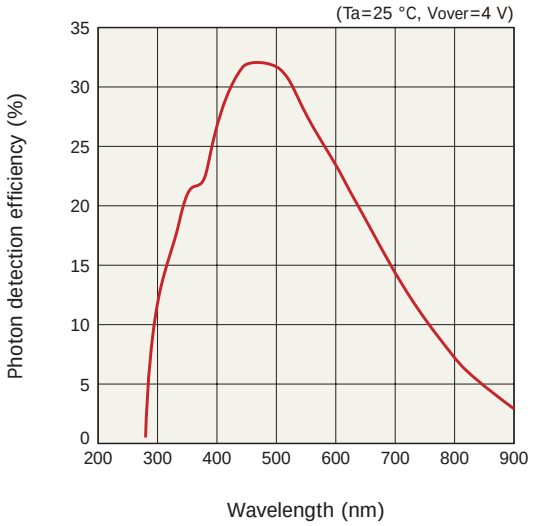
S14160-1315PS/-3015PS



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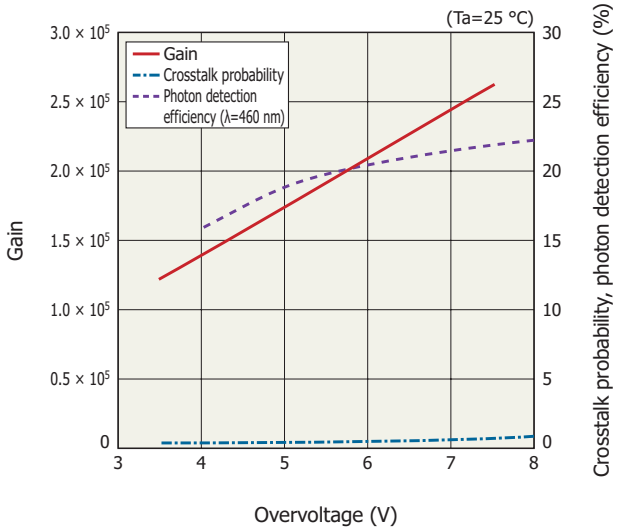
■ Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)

S14160-1310PS/-3010PS



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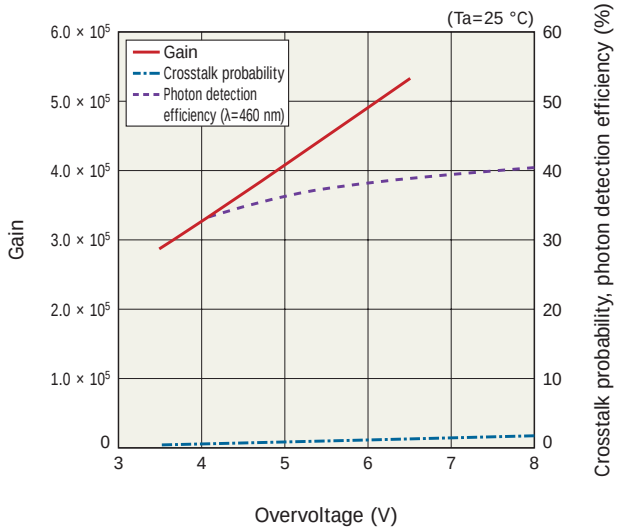
S14160-1315PS/-3015PS



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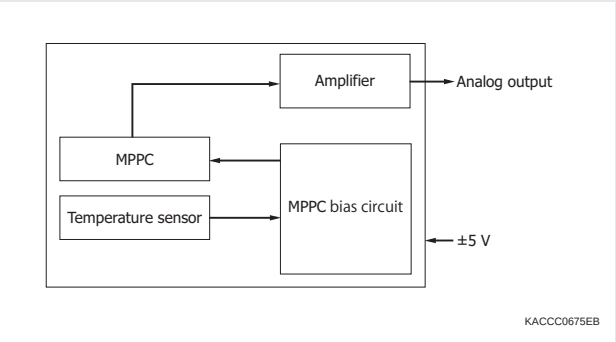
Module type

MPPC module C15522 series

■ **Features**

- Built-in VIS MPPC
  (S14160 series: 10 µm / 15 µm pixel pitch)
- Built-in temperature compensation circuit
- Analog output

■ **Block diagram**



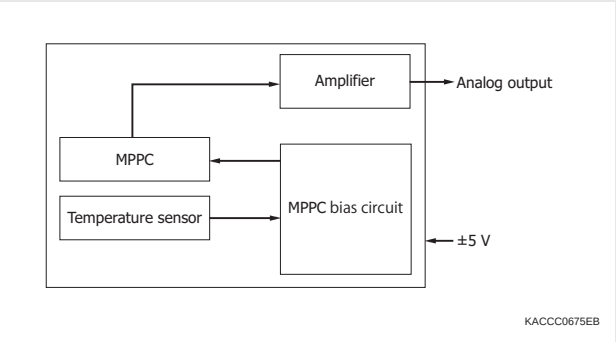
Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (µm)	Photosensitive area (mm)	Number of pixels
C15522	-1310SA	Analog	Non-cooled	S14160-1310PS	10	1.3 × 1.3	16663
	-3010SA			S14160-3010PS		3.0 × 3.0	89984
	-1315SA			S14160-1315PS	15	1.3 × 1.3	7284
	-3015SA			S14160-3015PS		3.0 × 3.0	39984

MPPC module C15524 series

■ **Features**

- Equipped with VIS MPPC
  (S14160 series: 10 µm / 15 µm pixel pitch)
- With a flexible cable
- Built-in temperature compensation circuit
- Analog output

■ **Block diagram**



Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (µm)	Photosensitive area (mm)	Number of pixels
C15524	-1310SA	Analog	Non-cooled	S14160-1310PS	10	1.3 × 1.3	16663
	-3010SA			S14160-3010PS		3.0 × 3.0	89984
	-1315SA			S14160-1315PS	15	1.3 × 1.3	7284
	-3015SA			S14160-3015PS		3.0 × 3.0	39984

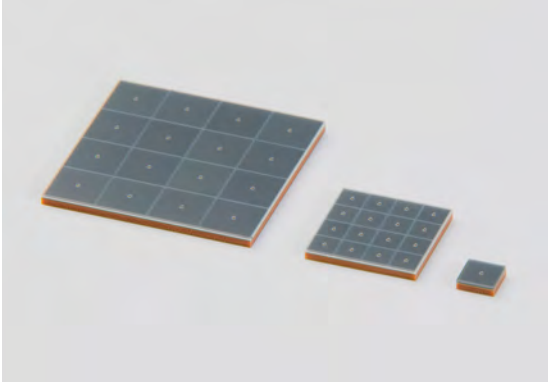
For PET scanners

S14160 / S14161 series

PET

FEATURES

- Higher PDE (50% at λp, Vop=V_{BR} + 2.7 V)
- Small dead space in effective photosensitive area
- Low operating voltage (V_{BR}=38 V typ.)
- Resistance to a magnetic field environment



APPLICATIONS

- PET scanners
- Radiation monitors

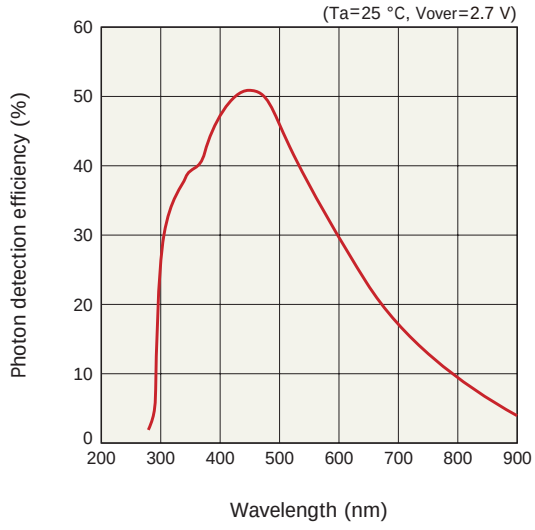
Structure

Type no.		Number of channels (ch)	Package	Pixel pitch (μm)	Effective photosensitive area (mm)	Number of pixels/ch	Fill factor (%)
S14160	-3050HS	1	Surface mount type	50	3.0 × 3.0	3531	74
	-4050HS				4.0 × 4.0	6331	
	-6050HS				6.0 × 6.0	14331	
S14161	-3050HS-04	16 (4 × 4)			3.0 × 3.0	3531	
	-3050HS-08	64 (8 × 8)			3.0 × 3.0	3531	
	-4050HS-06	36 (6 × 6)			4.0 × 4.0	6331	
	-6050HS-04	16 (4 × 4)			6.0 × 6.0	14331	

Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage V_{BR} (V)	Terminal capacitance Ct (pF)	Dark count	
					Typ.(μA)	Max.(μA)
S14160/ S14161	-3050HS	50	38	500	0.6	1.8
	-3050HS-04					
	-3050HS-08					
	-4050HS			900	1.1	3.3
	-4050HS-06					
	-6050HS			2000	2.5	7.5
	-6050HS-04					

Photon detection efficiency vs. wavelength (typical example)



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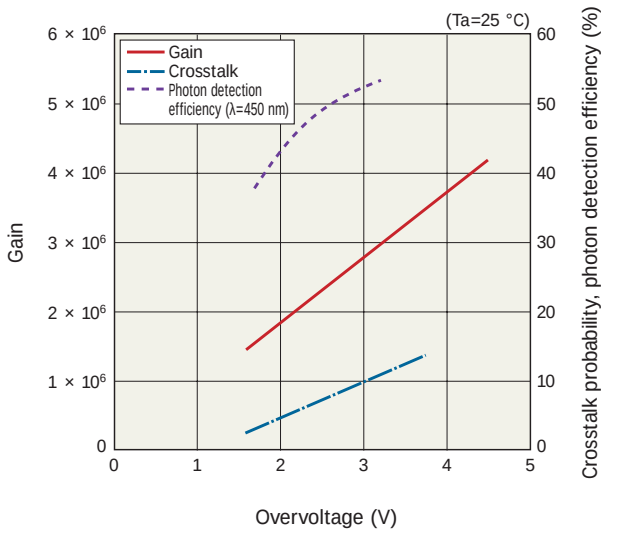
Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)



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VIS MPPC

For precision measurement

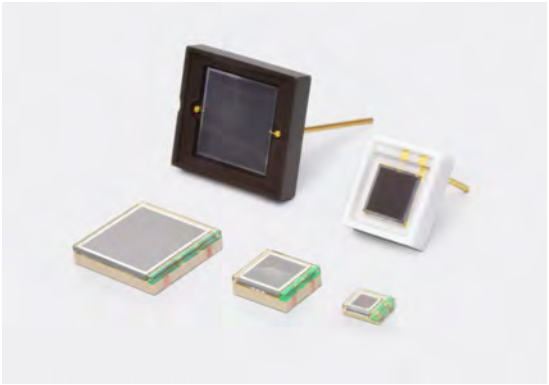
S13360 series


ACADEMIC


MEASUREMENT

FEATURES

- Wide variety of products
- Operates at room temperature



APPLICATIONS

- Fluorescence measurement
- Laser microscopes
- Flow cytometers
- DNA sequencers
- Environmental analysis
- Academic research

Structure

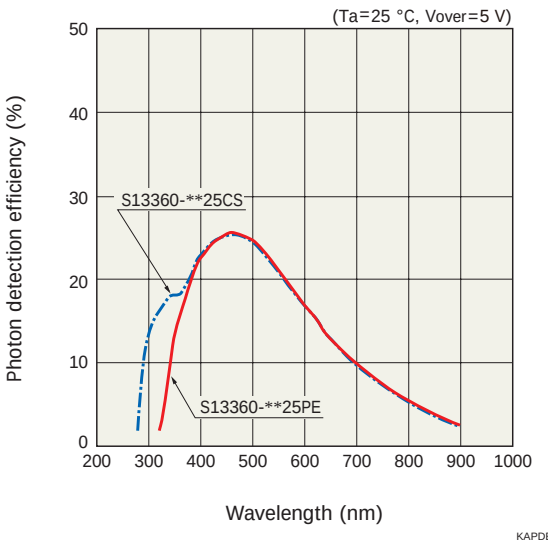
Type no.		Number of channel (ch)	Package	Pixel pitch (µm)	Effective photosensitive area (mm)	Number of pixels	Fill factor (%)
S13360	-1325PE	1	Surface mount type	25	1.3 × 1.3	2668	47
	-3025CS		Ceramic		3.0 × 3.0	14400	
	-3025PE		Surface mount type				
	-6025CS		Ceramic		6.0 × 6.0	57600	
	-6025PE		Surface mount type				
	-1350PE		Surface mount type	50	1.3 × 1.3	667	74
	-3050CS		Ceramic		3.0 × 3.0	3600	
	-3050PE		Surface mount type				
	-6050CS		Ceramic		6.0 × 6.0	14400	
	-6050PE		Surface mount type				
	-1375PE		Surface mount type	75	1.3 × 1.3	285	82
	-3075CS		Ceramic		3.0 × 3.0	1600	
	-3075PE		Surface mount type				
	-6075CS		Ceramic		6.0 × 6.0	6400	
	-6075PE		Surface mount type				

■ Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count	
					Typ. (kcps)	Max. (kcps)
S13360	-1325PE	25	53 ± 5	60	70	210
	-3025CS			320	400	1200
	-3025PE					
	-6025CS			1280	1600	5000
	-6025PE					
	-1350PE	40		60	90	270
	-3050CS			320	500	1500
	-3050PE					
	-6050CS			1280	2000	6000
	-6050PE					
	-1375PE	50		60	90	270
	-3075CS			320	500	1500
	-3075PE					
	-6075CS			1280	2000	6000
	-6075PE					

■ Photon detection efficiency vs. wavelength (typical example)

Pixel pitch: 25 µm



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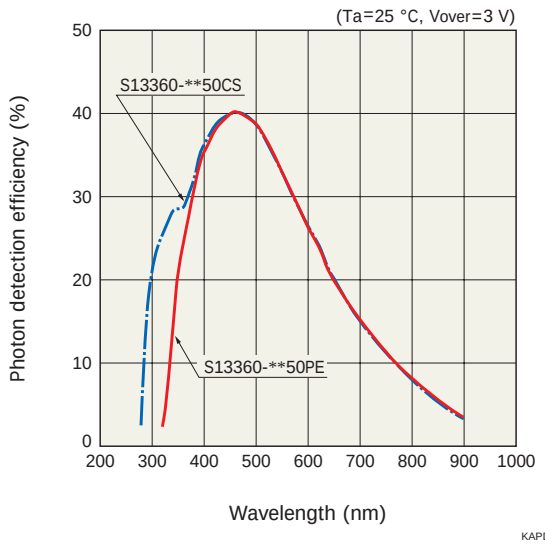
Pixel pitch: 50 µm



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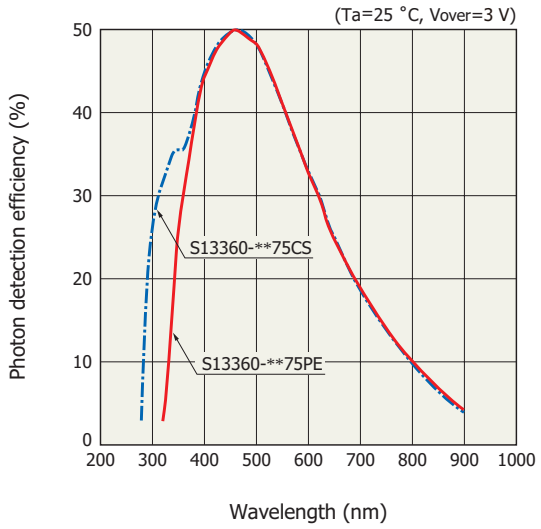
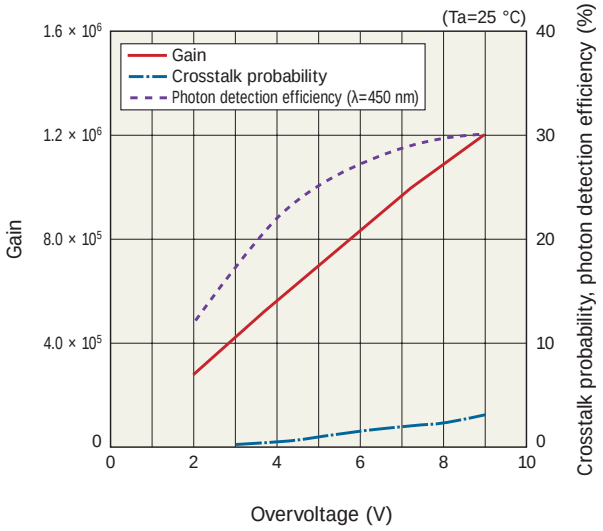
Pixel pitch: 75 µm



KAPDB0585EA

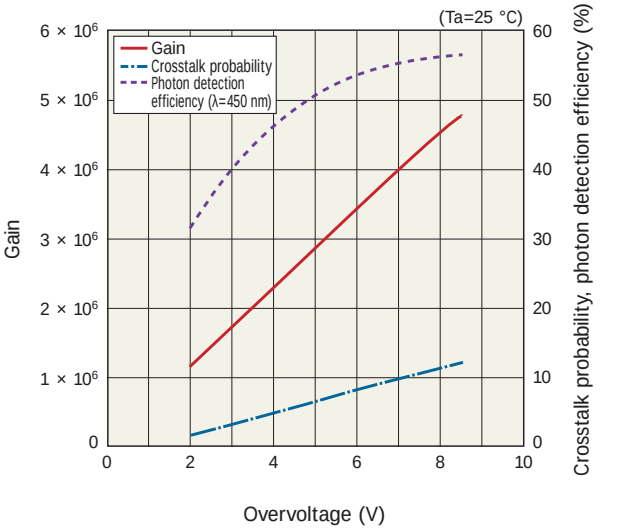
■ Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)

Pixel pitch: 25 µm



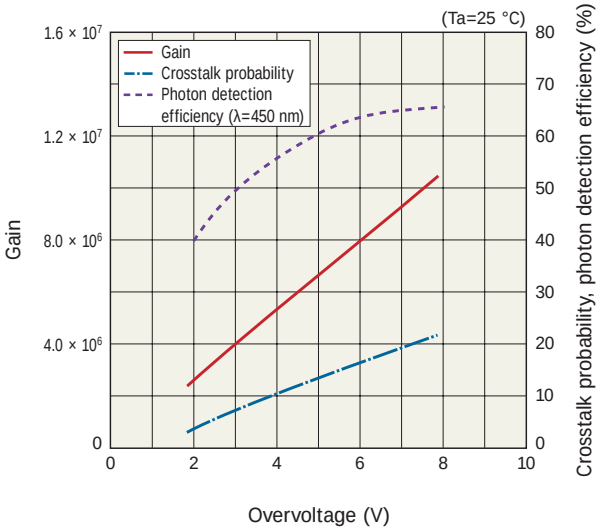
KAPDB0595EA

Pixel pitch: 50 µm



KAPDB0587EA

Pixel pitch: 75 µm



KAPDB0596EA

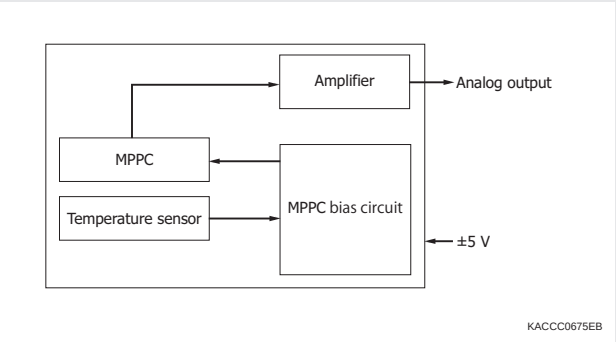
Module type

MPPC module C13365 series

Features

- Built-in VIS MPPC (S13360 series)
- Built-in temperature compensation circuit
- Analog output

Block diagram



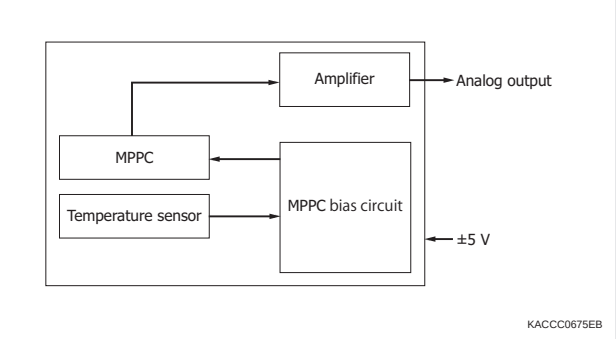
Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (µm)	Photosensitive area (mm)	Number of pixels
C13365	-3050SA	Analog	Non-cooled	S13360-3050CS	50	3.0 × 3.0	3600
	-6050SA			S13360-6050CS		6.0 × 6.0	14400

MPPC module C13367 series

Features

- Equipped with VIS MPPC (S13360 series) with a flexible cable
- Built-in temperature compensation circuit
- Analog output

Block diagram



Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (µm)	Photosensitive area (mm)	Number of pixels
C13367	-1350EA	Analog	Non-cooled	S13360-1350PE	50	1.3 × 1.3	667
	-3050EA			S13360-3050PE		3.0 × 3.0	3600
	-6050EA			S13360-6050PE		6.0 × 6.0	14400

VIS MPPC

For precision measurement (cooled type)

S13362 series


ACADEMIC

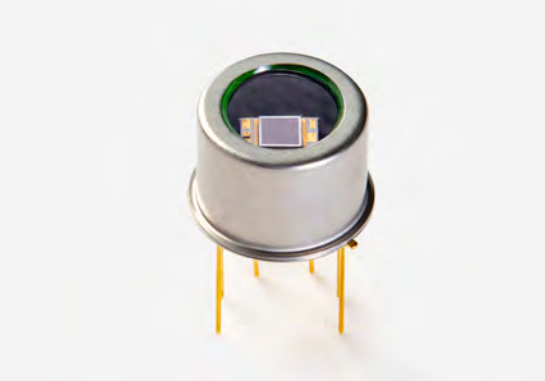

MEASUREMENT

FEATURES

- Operation possible with simple readout circuit
- Low dark count: 1/20 that of non-cooled type (Tchip=-10 °C)

APPLICATIONS

- Scattered light measurement
- Fluorescence measurement
- Flow cytometers
- Laser microscopes



Structure

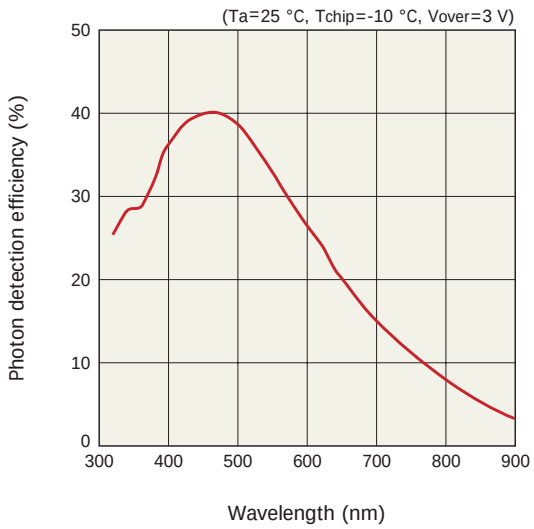
Type no.		Number of channel (ch)	Package	Pixel pitch (μm)	Effective photo-sensitive area (mm)	Number of pixels	Fill factor (%)	Cooling
S13362	-1350DG	1	Metal (TO-8)	50	1.3 × 1.3	667	74	Two-stage TE-cooled
	-3050DG				3.0 × 3.0	3600		

Electrical and optical characteristics (Typ. Ta=25 °C, Tchip=-10 °C, unless otherwise noted)

Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count		Recommended TE-cooler tempera-ture (°C)	Thermistor resistance (kΩ)	Thermistor B constant (K)
					Typ. (kcps)	Max. (kcps)			
S13362	-1350DG	40	51.1 ± 5	60	5	25	-10	9*1	3410*2
	-3050DG			320	13	72			

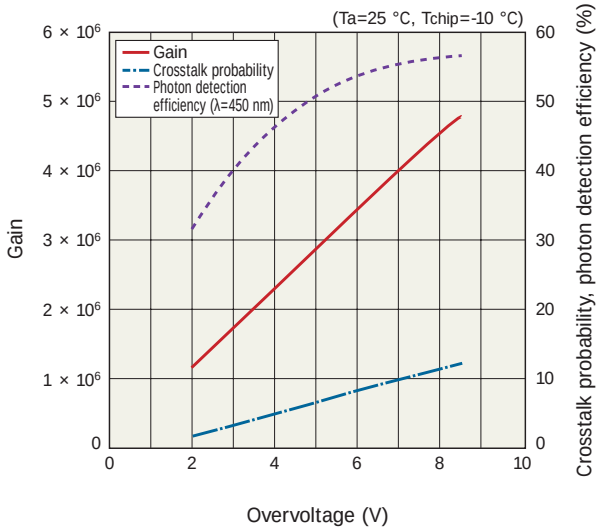
*1: Thermistor temperature=25 °C *2: T1=25 °C, T2=50 °C

Photon detection efficiency vs. wavelength (typical example)



KAPDB0604EA

Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)



KAPDB0589EB

Module type

MPPC module C13366/C13852 series

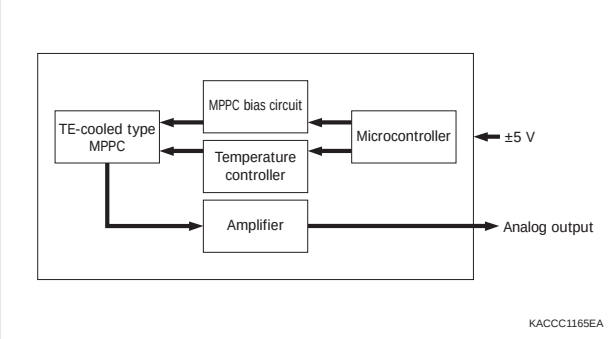
Features

- Built-in VIS MPPC (S13362 series: cooled type)
- Built-in temperature control function
- Low dark count
- Compact and lightweight (C13852 series)
- Analog output / digital output types available

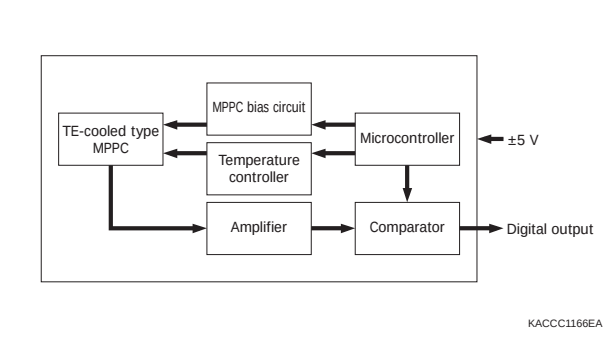
C13366 series
(for evaluation)

C13852 series
(for embedded use)

Block diagram (analog output type)



Block diagram (digital output type)



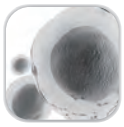
Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (μm)	Photosensitive area (mm)	Number of pixels
C13366	-1350GA	Analog	TE-cooled	S13362-1350DG	50	1.3 × 1.3	667
	-3050GA			S13362-3050DG		3.0 × 3.0	3600
	-1350GD	Digital		S13362-1350DG		1.3 × 1.3	667
	-3050GD			S13362-3050DG		3.0 × 3.0	3600
C13852	-1350GA	Analog	TE-cooled Compact	S13362-1350DG	50	1.3 × 1.3	667
	-3050GA			S13362-3050DG		3.0 × 3.0	3600
	-1350GD	Digital		S13362-1350DG		1.3 × 1.3	667
	-3050GD			S13362-3050DG		3.0 × 3.0	3600

VIS MPPC

For precision measurement (TSV type)

S13615 / S13360 / S13361 series


ACADEMIC


MEASUREMENT

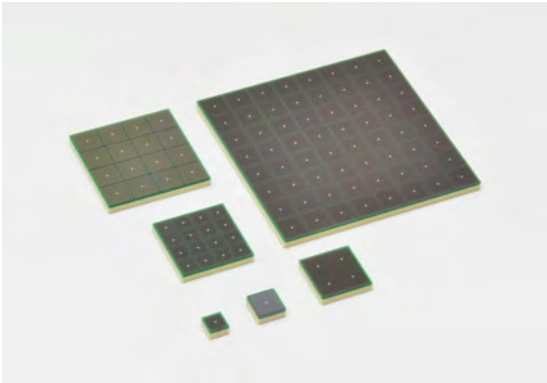

P E T

FEATURES

- Compact chip size package as a result of eliminating dead space

APPLICATIONS

- Space research
- High energy physics experiments
- PET scanners
- Environmental analysis



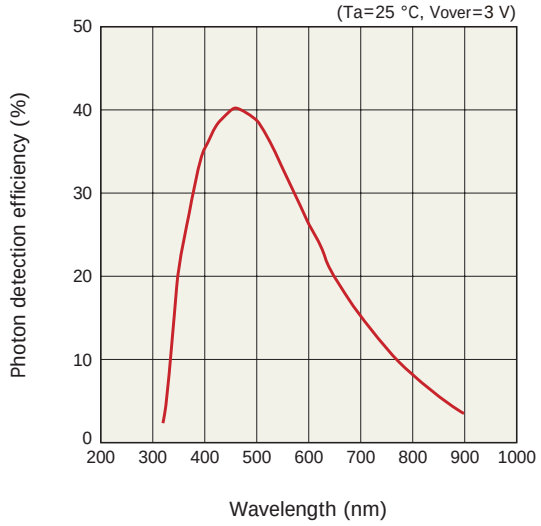
Structure

Type no.		Number of channels (ch)	Package	Pixel pitch (μm)	Effective photosensitive area/ch (mm)	Number of pixels/ch	Fill factor (%)
S13360	-2050VE	1	Surface mount type	50	2.0 × 2.0	1584	74
	-3050VE				3.0 × 3.0	3584	
	-6050VE				6.0 × 6.0	14336	
S13361	-2050NE-08	8 × 8	Surface mount type		2.0 × 2.0	1584	
	-2050AE-08		With connector				
	-3050NE-04	4 × 4	Surface mount type		3.0 × 3.0	3584	
	-3050AE-04		With connector				
	-3050NE-08	8 × 8	Surface mount type				
	-3050AE-08		With connector				
	-6050NE-04	4 × 4	Surface mount type		6.0 × 6.0	14336	
	-6050AE-04		With connector				

Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

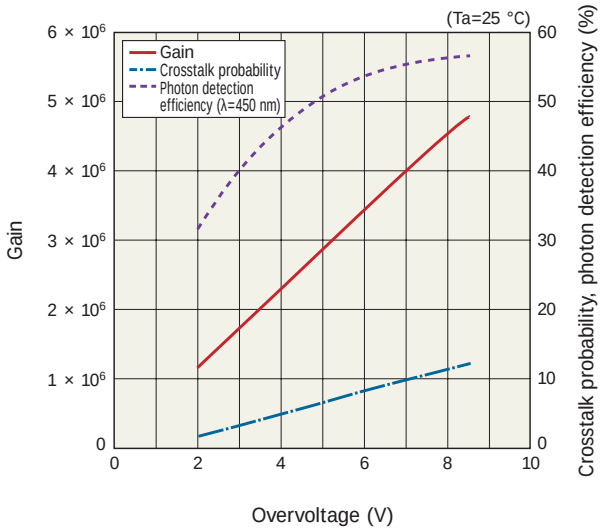
Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count	
					Typ. (kcps)	Max. (kcps)
S13360	-2050VE	40	53 ± 5	140	300	900
	-3050VE			320	500	1500
	-6050VE			1300	2000	6000
S13361	-2050NE-08			140	300	900
	-2050AE-08					
	-3050NE-04			320	500	1500
	-3050AE-04					
	-3050NE-08					
	-3050AE-08					
	-6050NE-04			1300	2000	6000
	-6050AE-04					

■ Photon detection efficiency vs. wavelength (typical example)



KAPDB0600EA

■ Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)



KAPDB0588EA

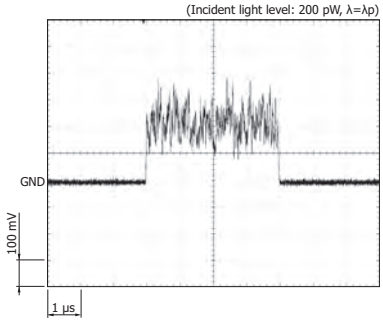
▶ Module type

MPPC module C13368-3050EA-16, C13369-3050EA-04

■ Features

- Built-in VIS MPPC array
- Built-in temperature compensation circuit

■ Measurement example (analog output)



Type no.	Output	Type	Built-in MPPC array			
			Type no.	Number of channels (ch)	Pixel pitch (µm)	Photosensitive area/ch (mm)
C13368-3050EA-16	Analog	Non-cooled	S13363-3050NE-16	1 × 16	50	3.0 × 3.0
C13368-3050EA-04			S13361-3050NE-04	4 × 4	50	3.0 × 3.0

VIS to NIR MPPC

For visible light

S14420 series

MEASUREMENT

FEATURES

- High photon detection efficiency: 40% (λ=600 nm, Vop=V_{BR} + 5 V)

APPLICATIONS

- Flow cytometers
- Laser microscopes
- Fluorescence measurement

Structure

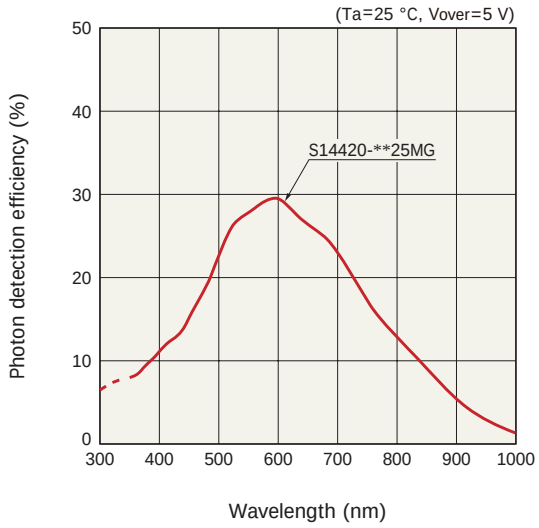
Type no.		Number of channel (ch)	Package	Pixel pitch (μm)	Effective photosensitive area (mm)	Number of pixels	Fill factor (%)
S14420	-1525MG	1	Metal (TO-5)	25	ϕ 1.5	2876	63
	-1550MG			50		724	81
	-3025MG			25	ϕ 3.0	11344	63
	-3050MG			50		2836	81

Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count	
					Typ. (kcps)	Max. (kcps)
S14420	-1525MG	30	42 ± 5	90	380	1000
	-1550MG	40				
	-3025MG	30		350	1600	4000
	-3050MG	40				

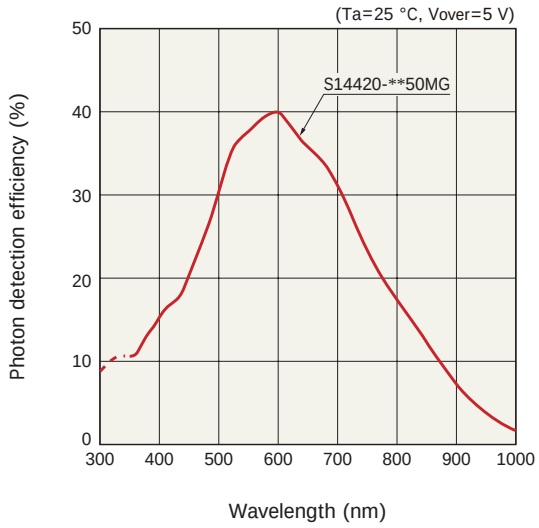
Photon detection efficiency vs. wavelength (typical example)

Pixel pitch: 25 μm



KAPDB0597EB

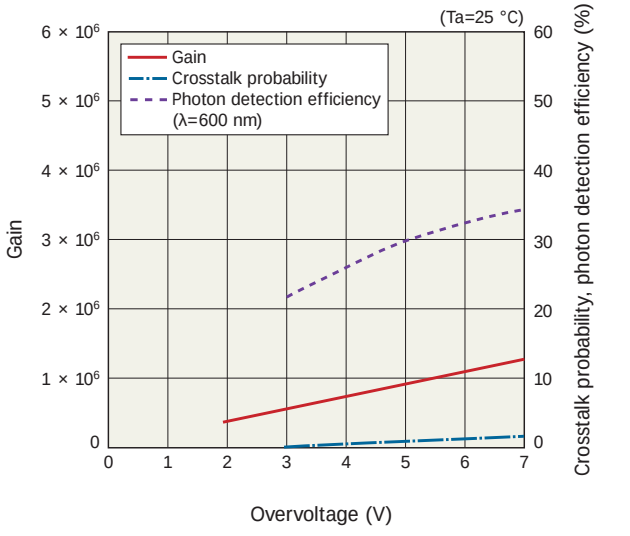
Pixel pitch: 50 μm



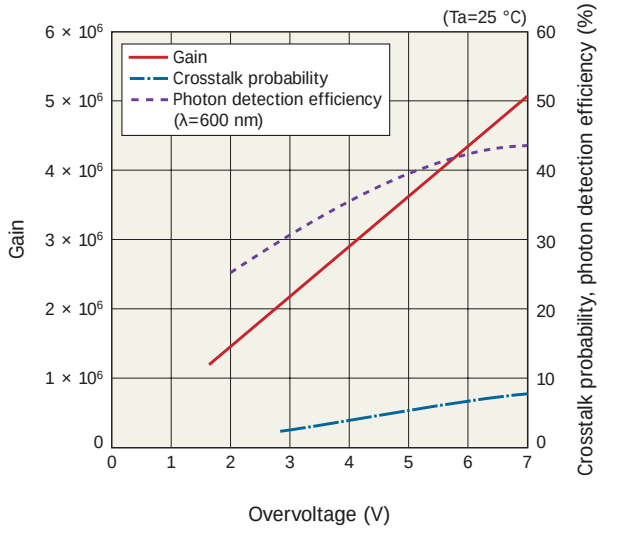
KAPDB0598EB

■ Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)

Pixel pitch: 25 µm



Pixel pitch: 50 µm



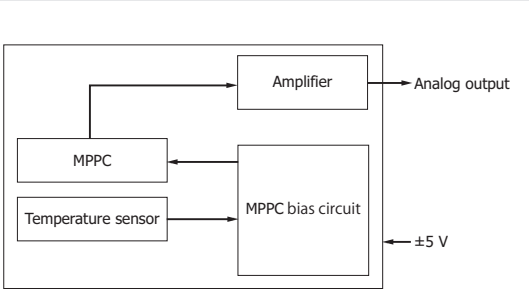
▶ Module type

MPPC module C14452 series

■ **Features**

- Built-in VIS to NIR MPPC (S14420 series)
- Built-in temperature compensation circuit
- Analog output

■ **Block diagram**



Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (µm)	Photosensitive area (mm)	Number of pixels
C14452	-1550GA	Analog	Non-cooled	S14420-1550MG	50	ϕ 1.5	724
	-3050GA			S14420-3050MG		ϕ 3.0	2836

VIS to NIR MPPC

For visible light (cooled type)

S14422 series

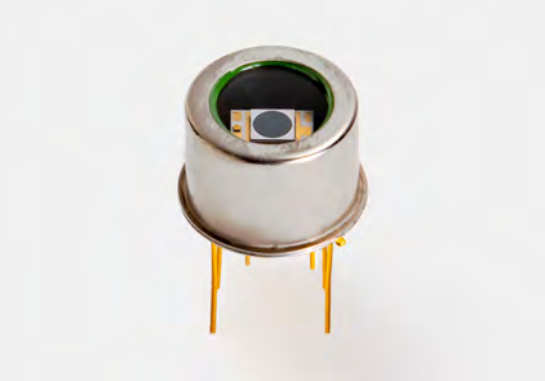
MEASUREMENT

FEATURES

- High photon detection efficiency: 40% (λ=600 nm, Vop=V_{BR} + 5 V, 50 µm pitch)
- Low dark count: 1/10 that of non-cooled type (Tchip=-10 °C)

APPLICATIONS

- Flow cytometers
- Laser microscopes
- Fluorescence measurement



Structure

Type no.		Number of channel (ch)	Package	Pixel pitch (µm)	Effective photo-sensitive area (mm)	Number of pixels	Fill factor (%)	Cooling
S14422	-1525DG	1	Metal (TO-8)	25	ϕ 1.5	2876	63	Two-stage TE-cooled
	-1550DG			50		724	81	
	-3025DG			25	ϕ 3.0	11344	63	
	-3050DG			50		2836	81	

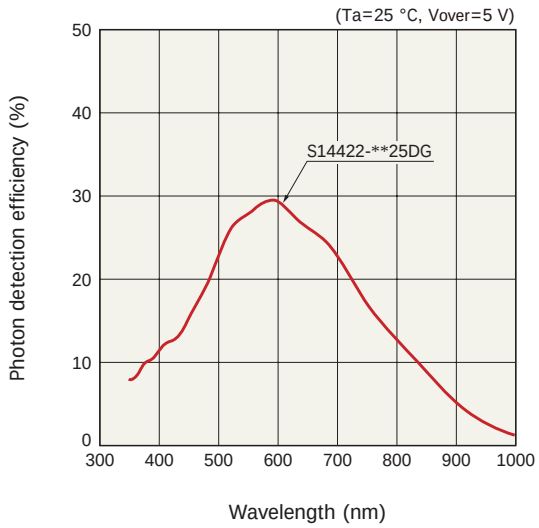
Electrical and optical characteristics (Typ. Ta=25 °C, Tchip=-10 °C, unless otherwise noted)

Type no.		Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count Typ. (kcps)	Dark count Max. (kcps)	Recommended TE-cooler temperature (°C)	Thermistor resistance (kΩ)	Thermistor B constant (K)
S14422	-1525DG	30	40.5 ± 5	90	35	140	-10	9*1	3410*2
	-1550DG	40							
	-3025DG	30		350	90	350			
	-3050DG	40							

*1: Thermistor temperature=25 °C *2: T1=25 °C, T2=50 °C

Photon detection efficiency vs. wavelength (typical example)

Pixel pitch: 25 µm



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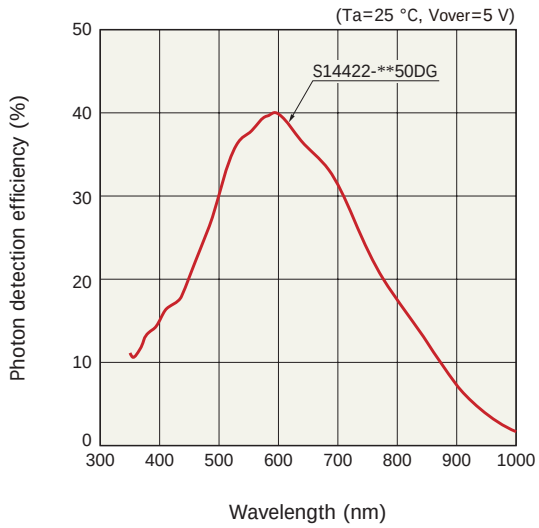
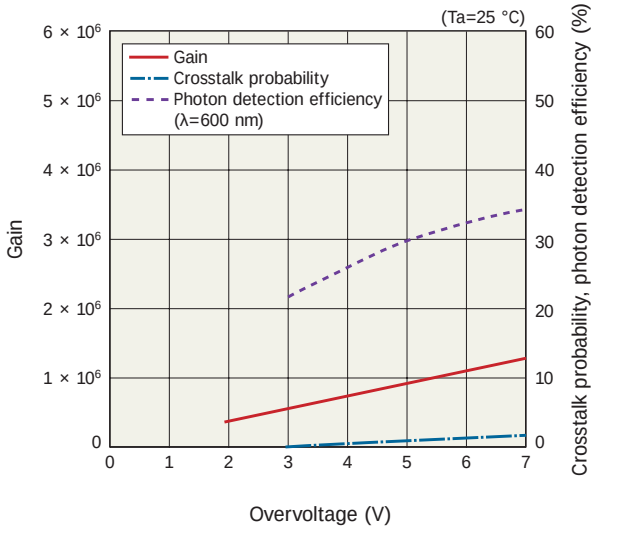
Pixel pitch: 50 µm



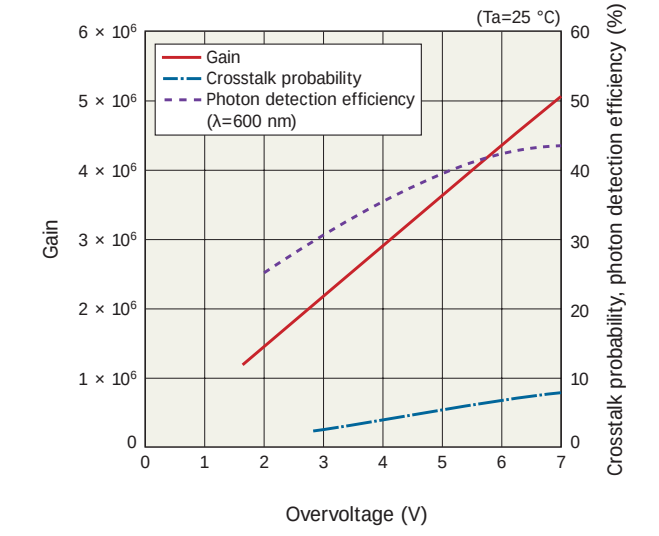
KAPDB0559EB

■ Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)

Pixel pitch: 25 µm



Pixel pitch: 50 µm



▶ Module type

MPPC module C14455/C14456 series

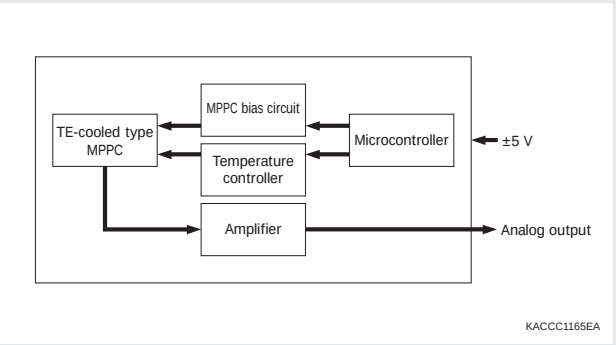
■ **Features**

- Built-in VIS to NIR MPPC (S14422 series: cooled type)
- Built-in temperature control function
- Low dark count
- Compact and lightweight (C14456 series)
- Analog output / digital output types available

C14455 series
(for evaluation)

C14456 series
(for embedded use)

■ **Block diagram (analog output type)**



Type no.		Output	Type	Built-in MPPC			
				Type no.	Pixel pitch (µm)	Photosensitive area (mm)	Number of pixels
C14455	-1550GA	Analog	TE-cooled	S14422-1550DG	50	ϕ 1.5	724
	-3050GA			S14422-3050DG		ϕ 3.0	2836
	-1550GD	Digital		S14422-1550DG		ϕ 1.5	724
	-3050GD			S14422-3050DG		ϕ 3.0	2836
C14456	-1550GA	Analog	TE-cooled Compact	S14422-1550DG	50	ϕ 1.5	724
	-3050GA			S14422-3050DG		ϕ 3.0	2836
	-1550GD	Digital		S14422-1550DG		ϕ 1.5	724
	-3050GD			S14422-3050DG		ϕ 3.0	2836

NIR MPPC

For near infrared

S15639-1325PS NEW

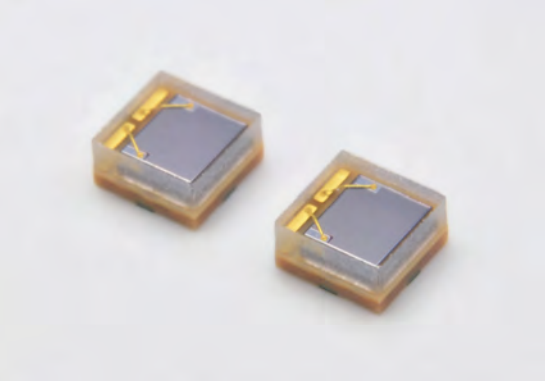
LiDAR

FEATURES

- High photon detection efficiency: 9% (λ=905 nm, V_R=V_{BR} + 14 V)
- Small package

APPLICATIONS

- Distance measurement (e.g., LiDAR)



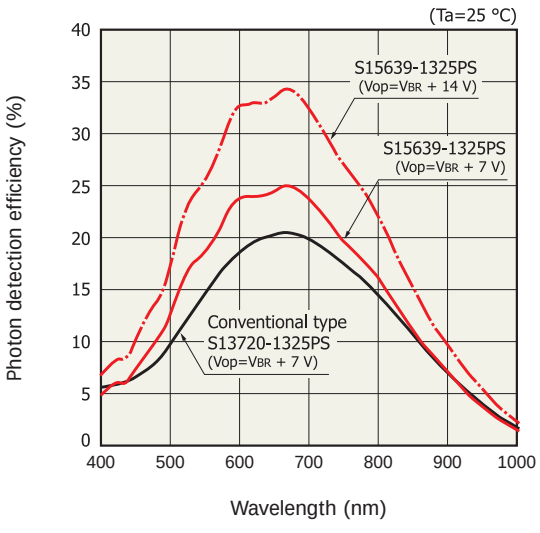
Structure

Type no.	Number of channel (ch)	Package	Pixel pitch (μm)	Effective photosensitive area (mm)	Number of pixels
S15639-1325PS	1	Surface mount type	25	1.1 (H) × 1.3 (V)	2120

Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.	Photon detection efficiency λ=905 nm (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Dark count	
				Typ. (kcps)	Max. (kcps)
S15639-1325PS	9	42	42	700	2000

Photon detection efficiency vs. wavelength (typical example)



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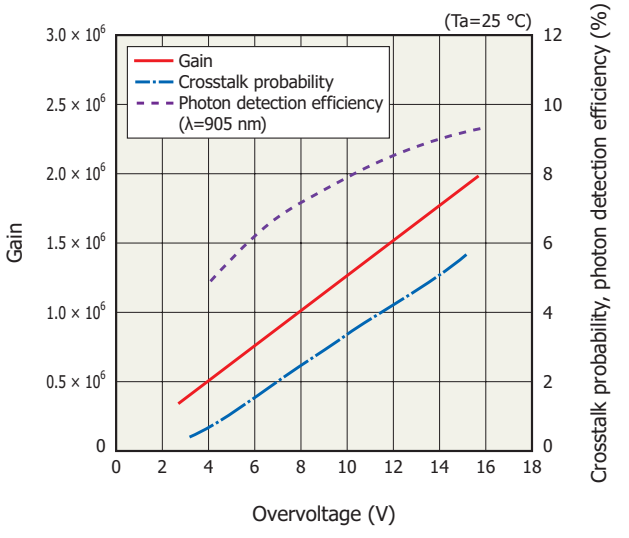
Gain, crosstalk probability, photon detection efficiency vs. overvoltage (typical example)



KAPDB0633EA

Special MPPCs for academic research

ACADEMIC

VIS MPPC

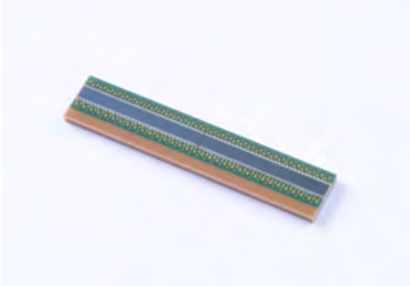
MPPC for fiber tracker S13552

FEATURES

- Developed for SciFi tracker in LHCb
- One-dimensional 128-element MPPC array
- Surface mount type

APPLICATIONS

- High energy physics experiment



Structure

Type no.	Number of channels (ch)	Package	Pixel pitch (μm)	Number of pixels / channel	Fill factor (%)
S13552	128 (1 × 64 ch, 2chips)	Surface mount	57.5 × 62.5	104	78

Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.	Photon detection efficiency λ=λp (%)	Breakdown voltage (V)	Terminal capacitance (pF)	Vop variation between channels in one product		Dark count	
				Typ. (kcps)	Max. (kcps)	Typ. (kcps)	Max. (kcps)
S13552	47	53 ± 5	320	0.4	1	60	300

VUV/UV MPPC

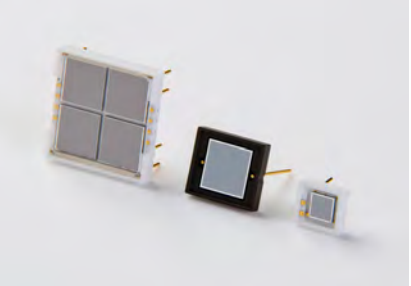
MPPC for dark matter research and neutrino experiments

FEATURES

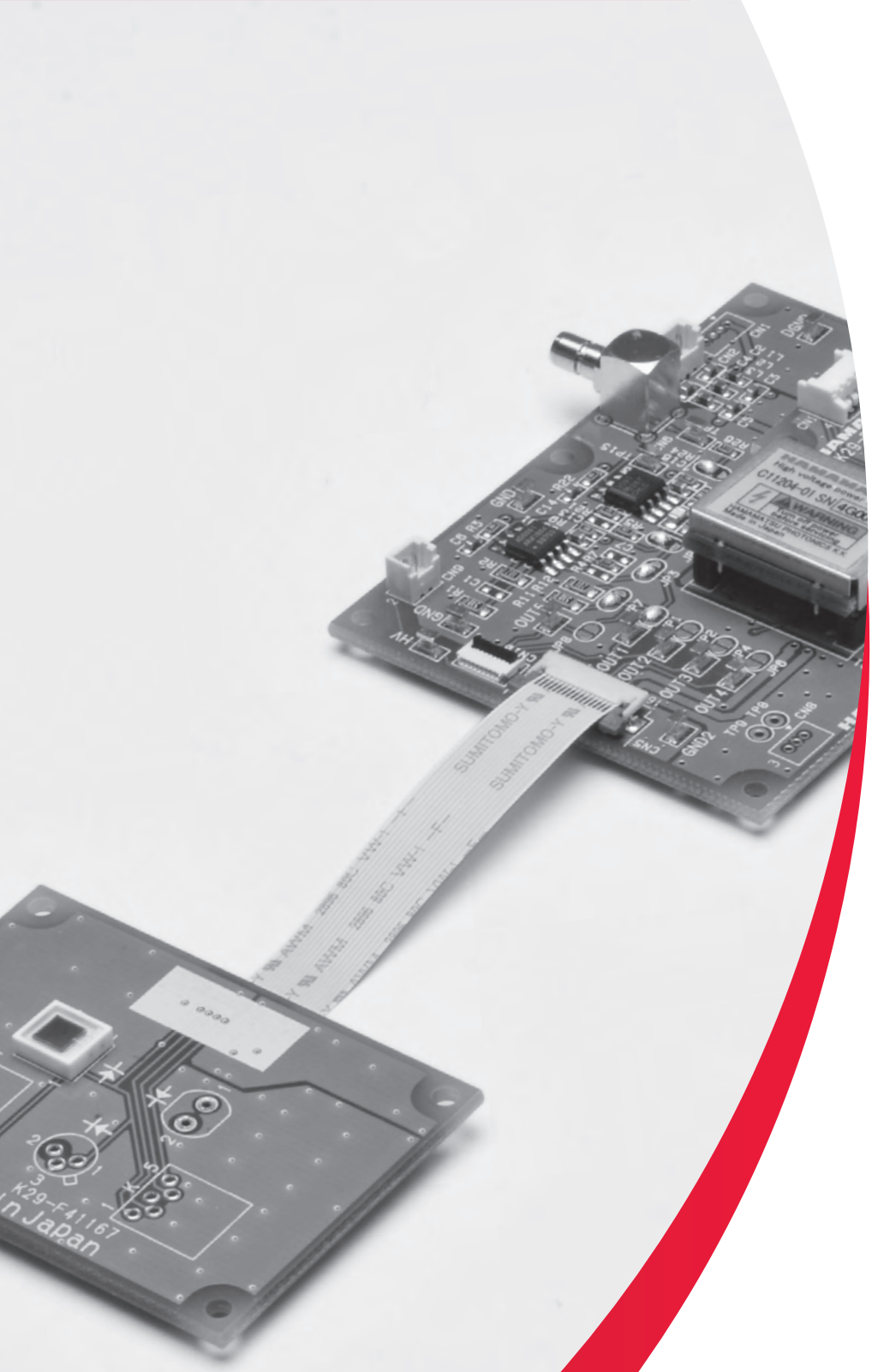
- High sensitivity to scintillation light of liquid xenon and liquid argon
- Suitable operation at cryogenic conditions

APPLICATIONS

- Scintillation light detection of liquid argon and liquid xenon for academic research experiments



For more details about MPPCs for academic research, please consult us.



Related products

Power supplies for MPPC

These are high-voltage power supplies that are optimized for driving MPPCs. Since they have a temperature compensation function, MPPCs can be driven stably even in environments subject to temperature changes.

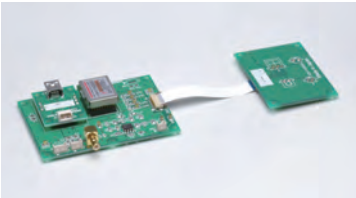
■ Features

- Superb temperature stability: ±10 ppm/°C (C11204 series)
- Finely adjustable resolution: 1.8 mV steps (C11204 series)
- Serial interface (C11204 series)
- Output voltage adjustment using a control voltage (C14156)

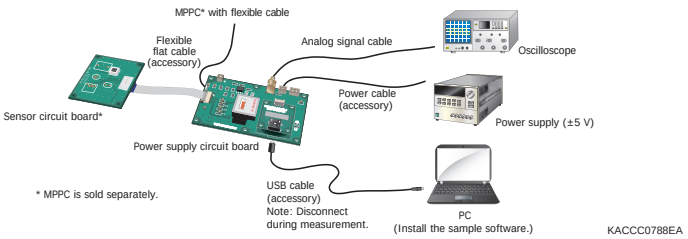
Product name	Photo	Type no.	Output voltage (V)	Dimensions (mm)	Type
Power supply for MPPC		C11204-01	20 to 90	19.4 (H) × 17.0 (V) × 6.7 (D)	Pin type
		C11204-02	20 to 90	11.5 (H) × 11.5 (V) × 2.0 (D)	Surface mount type
		C14156	0 to 80	7.0 (H) × 7.0 (V) × 2.0 (D)	Compact Low price

Driver circuits for MPPC

These are driver circuits for evaluating the MPPC. They consist of a power supply circuit board and a sensor circuit board. The power supply circuit board is equipped with a power supply for MPPC (with temperature compensation function). The sensor circuit board has an MPPC socket for leads, which allows MPPCs to be mounted.



■ Connection example



Product name	Photo	Type no.	Compatible MPPC*1	Integrated power supply	Output
Driver circuit for MPPC		C12332-02	For non-cooled MPPC (S13360 series)	C11204-01	Analog
		C14450	For non-cooled MPPC (S14420 series)	C11204-01	Analog
		C14191	For non-cooled MPPC (S15639 series)*2	C11204-01	Analog
		C14488	For non-cooled MPPC (S13360 series)	C14156	Analog

*1: MPPC is sold separately.
*2: Only MPPC with flexible cable (custom-made) can be connected.

Photon counting image sensors (PCI)

■ Features

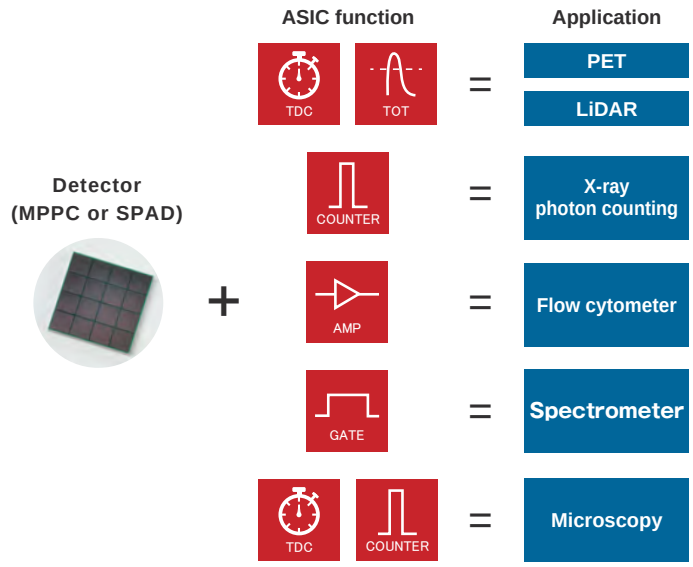
- MPPC (or SPAD) and ASIC in 1 package by hybrid connection
- Product lineup for various applications
- Evaluation board available (sold separately)

1D PCI

2D PCI

Please consult us for more details.

■ Sensor structure and suitable applications

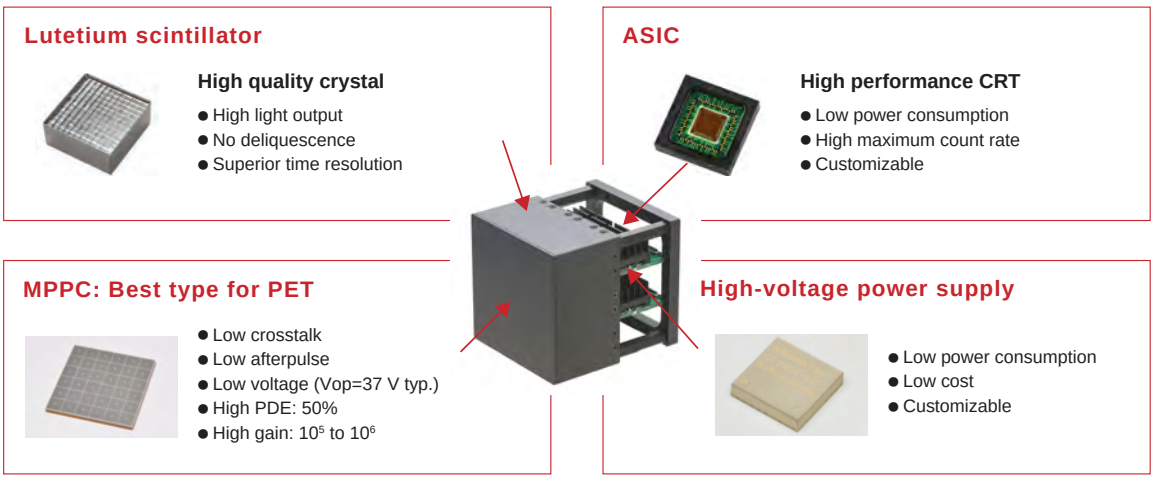


MPPC module for PET C13500 series

■ Features

- Built-in VIS MPPC (S14160 series)
- Included functions necessary for TOF-PET
- Timing resolution (FWHM): 210 ps
- Built-in temperature compensation circuit
- Digital interface: high-speed serial

■ Structure



SPAD modules

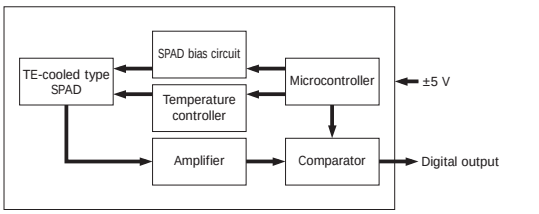
Photon counting modules that can detect extremely low-level light. It consists of a TE-cooled SPAD (single photon avalanche diode), amplifier, comparator, bias circuit, and temperature controller. You can simply supply external power (±5 V) to use these modules.

* For more details about SPAD, see P.32

■ Features

- High sensitivity
- Extremely low dark count: 7 cps typ. (VIS type)
- Low afterpulse
- Built-in temperature control function
- Digital output

■ Block diagram



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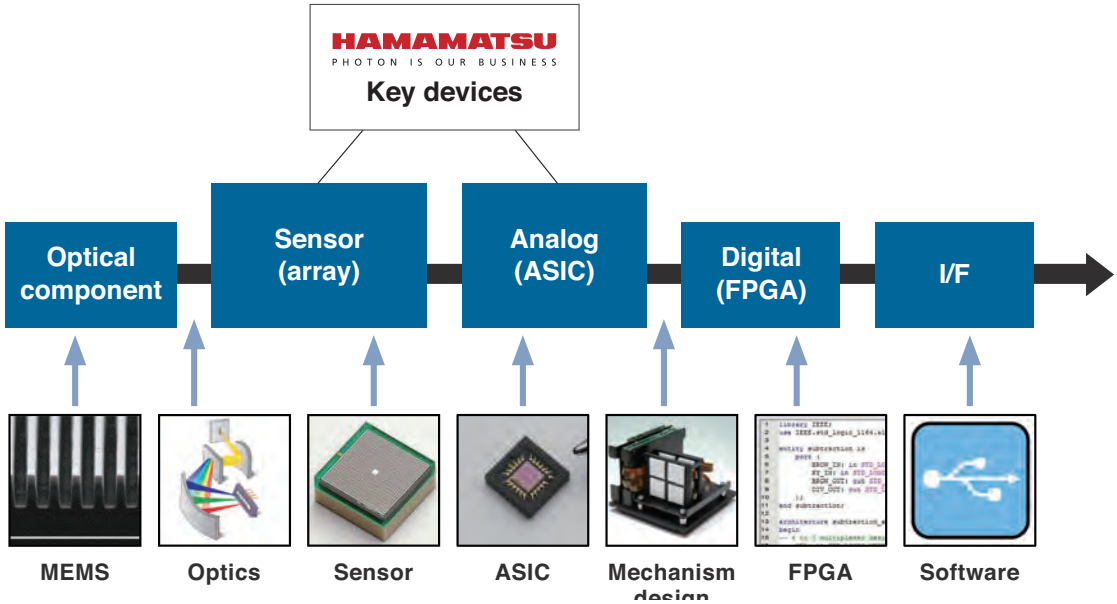
Product name	Photo	Type no.	Built-in sensor	Photosensitive area size (μm)	Spectral response range (nm)	Output	Type
VIS SPAD modules		C11202-050	TE-cooled SPAD	ϕ50	320 to 900	Digital	-
		C11202-100		ϕ100	320 to 900		-
		C13001-01		-	370 to 900		Fiber coupling
		C14076-01		-	370 to 900		Fiber coupling Embedded use
VIS to NIR SPAD modules		C16531-050GD		ϕ50	400 to 1000	Digital	-
		C16531-100GD		ϕ100	400 to 1000		-
		C16533-050GD		-	400 to 1000		Fiber coupling
		C16534-050GD		-	400 to 1000		Fiber coupling Embedded use

Customized modules

Hamamatsu can provide the most suitable module product by combining its vast sensor lineup with optical technologies, circuit technologies, and software technologies.

■ Hamamatsu flexibility

We offer customization by combining elemental technologies. Each key component suitable for an application can be selected, and compactly integrated in a small module.



■ Process for developing a custom module

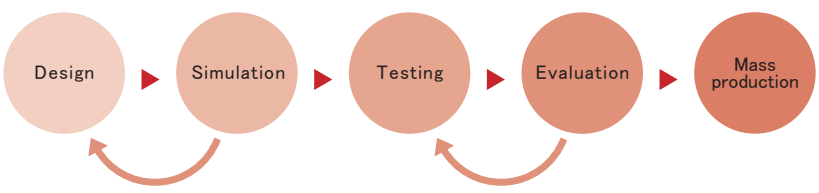
Requests from the customer »» 01 Functionality and performance that the customer wants to achieve 02 External dimensions 03 Price

▼

Assessment of the specifications »»

Sensor	Optics	Circuit	Software
You can select from a wide lineup of products or have a new device developed.	Suitable optical designs (for lenses, mirrors, filters, etc.) that are based on vast experience	Unique Hamamatsu analog and digital circuit designs that can handle low light levels (we can handle circuit design and pattern design)	We have the flexibility to design firmware for microcontrollers, FPGAs, DSPs, etc., as well as application software.

▼



Operating principle of MPPC

Photon counting

Light has the properties of both a particle and a wave. When the light level becomes extremely low, light behaves as discrete particles (photons) allowing us to count the number of photons. Photon counting is a technique for measuring the number of individual photons.
The MPPC is suitable for photon counting since it offers an excellent time resolution and a multiplication function having a high gain and low noise. Compared to ordinary light measurement techniques that measure the output current as analog signals, photon counting delivers a higher S/N and higher stability even in measurements at very low light levels.

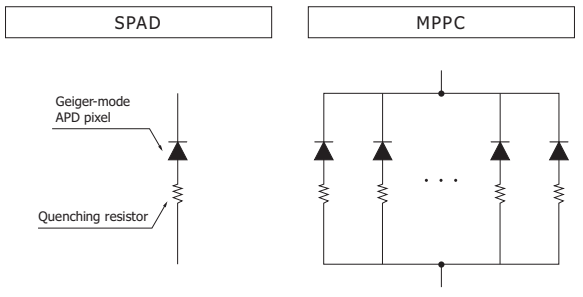
Geiger mode and quenching resistor

When an APD is operated at a reverse voltage higher than its breakdown voltage, a saturated output inherent to the APD device occurs (Geiger discharge) by input of light regardless of whether the light level is high or low. The condition where an APD operates at this voltage level is called Geiger mode. Geiger mode allows obtaining a large output by way of discharge even when detecting a single photon. Once Geiger discharge begins, it continues for as long as the electric field in the APD is maintained.
To halt a Geiger discharge and detect the next photon, an external circuit outside the APD must lower the operating voltage. One specific example for halting the Geiger discharge is a technique using a so-called quenching resistor connected in series with the APD. This quickly stops avalanche multiplication in the APD because a drop in the operating voltage occurs when the output current caused by the Geiger discharge flows in the quenching resistor. The output current caused by Geiger discharge is a pulse waveform with a sharp rise time, while the output current when Geiger discharge is halted by the quenching resistor is a pulse waveform with a relatively slow fall time.

Configuration

The structures of SPAD and MPPC are shown below.
SPAD is configured with one pixel, in which a Geiger mode APD and a Quenching resistor are combined as one set. MPPC is configured with a plurality of pixels, in which said SPADs are arranged in plural numbers and electrically connected in parallel.

■ Configuration of SPAD and MPPC



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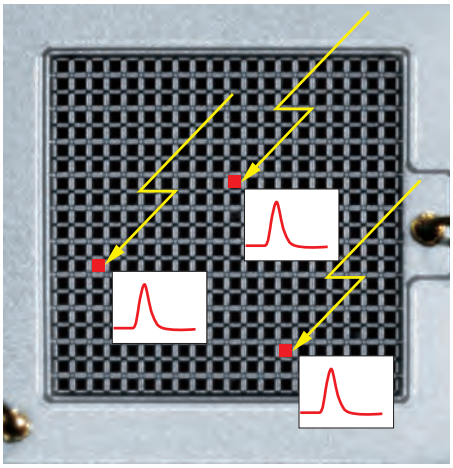
■ Illustration of an MPPC counting photons



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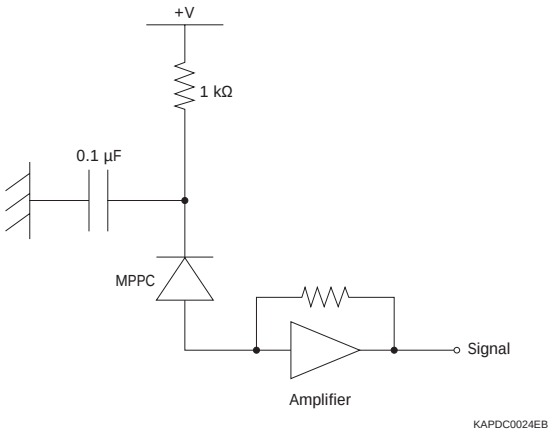
Basic operation

Each pixel in the MPPC outputs a pulse at the same amplitude when it detects a photon. Pulses generated by multiple pixels are output while superimposed onto each other. For example, if four photons are incident on different pixels and detected at the same time, then the MPPC outputs a signal whose amplitude equals the height of the four superimposed pulses.
Each pixel outputs only one pulse and this does not vary with the number of incident photons. So the number of output pulses is always one regardless of whether one photon or two or more photons enter a pixel at the same time. This means that MPPC output linearity gets worse as more photons are incident on the MPPC such as when two or more photons enter one pixel. This makes it essential to select an MPPC having enough pixels to match the number of incident photons.

For the MPPC readout circuit, a current-to-voltage amplifier can be used as with previous semiconductor devices. The MPPC outputs high-speed pulse signals, but because the gain of the MPPC itself is high, there is no need to greatly increase the gain on the circuit side. This has the advantage of more freedom in circuit design.

■ Basic connection diagram



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