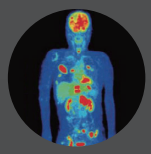
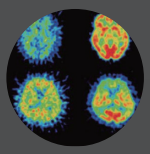
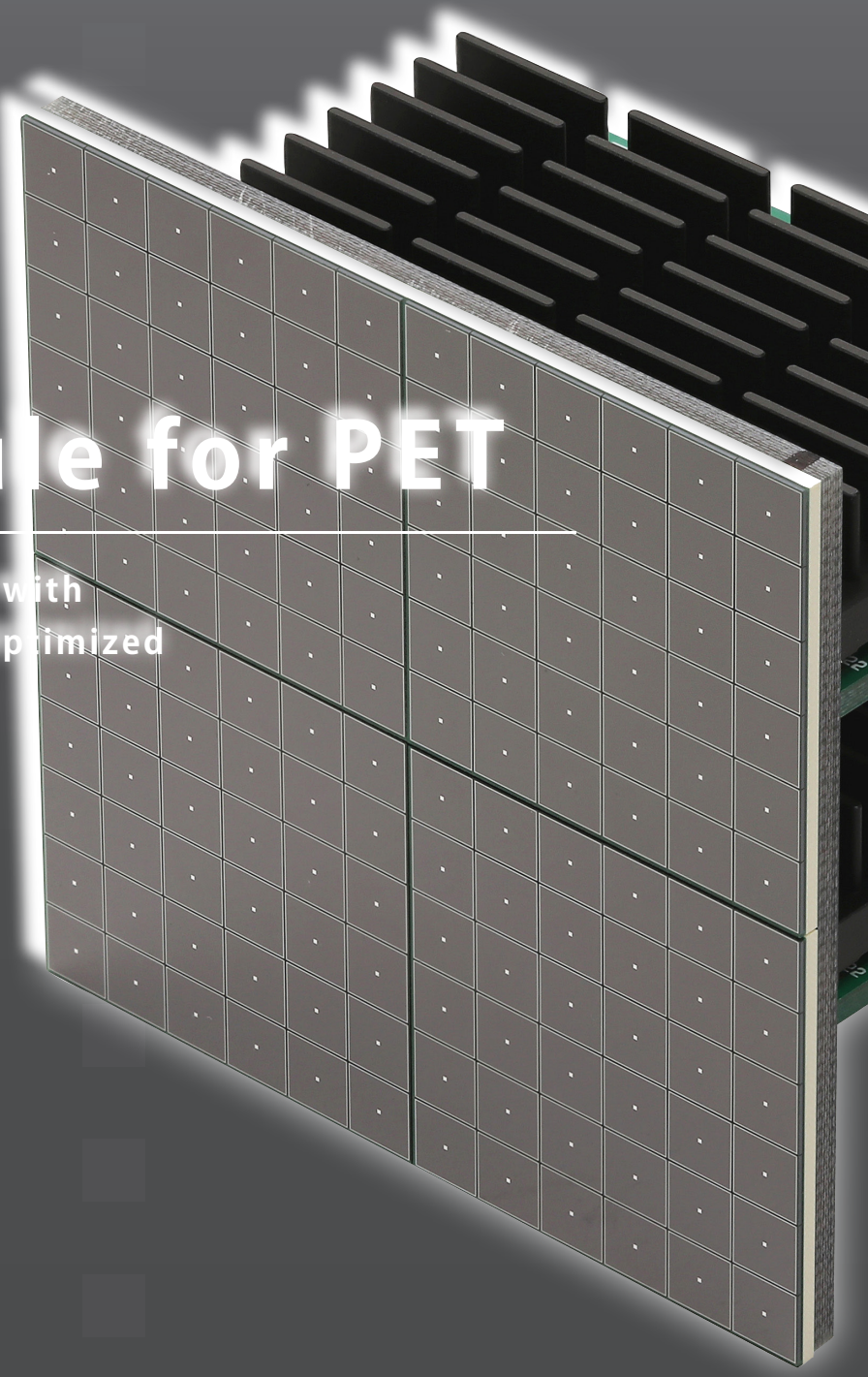
MPPC module for PET

By combining our MPPC device with circuit technologies, we offer optimized modules and circuits for PET.







HAMAMATSU

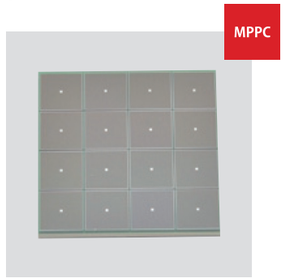
PHOTON IS OUR BUSINESS

DETECTOR

MPPC array

MPPC®
Multi-Pixel Photon Counter

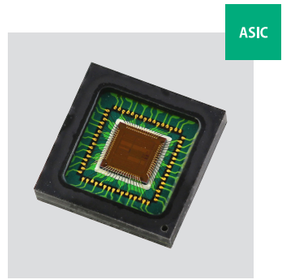
The MPPC is one of the devices called silicon photomultipliers (SiPM). The S14161 series is an MPPC (SiPM) array for precision measurement. It inherits the superb low afterpulse characteristics of its predecessor and further provides lower crosstalk and lower dark count. This MPPC array uses through silicon via (TSV) to minimize non-sensitive portions around the photosensitive area.



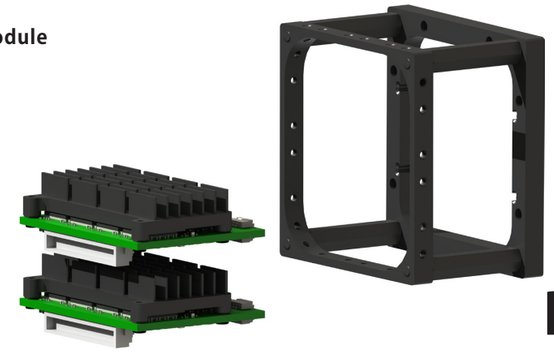
Features
- Reduced crosstalk and dark count (compared to previous products)
- Low afterpulses
- Outstanding photon counting capability (outstanding photon detection effeciency against incident photons)
- Excellent uniformity
- Low voltage operation

ASIC

An ASIC optimized for the MPPC and lutecium scintillator in the MPPC module was specifically designed. This ASIC along with TDC, FPGA, and other signal processing circuits necessary for TOF-PET is mounted on a compact circuit board. This is incorporated in the PET module.



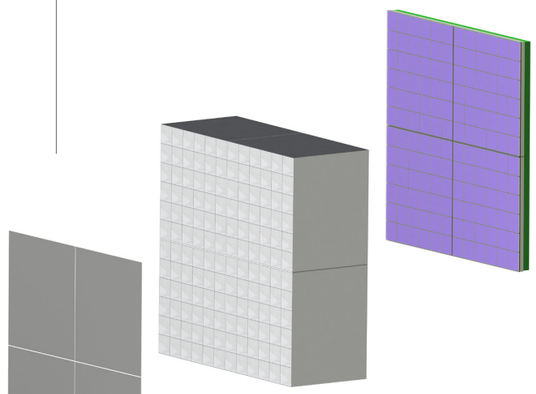
Features
- Designed specifically for the PET module
- Low power consumption
- 18 ch/chip



MPPC + LYSO + ASIC + Power

PET module

Hamamatsu PET modules consist of MPPC arrays, scintillators, and ASICs. Each part has optimum specifications for PET. Using these modules can make your PET device development more efficient. Further, Hamamatsu provides not only the light detection section but also latter-stage circuits and interface boards. Depending on your needs, you can also purchase these parts separately.



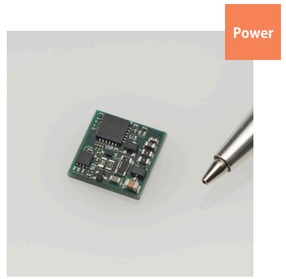
SCINTILLATOR

The lutecium scintillator features high light emission yields and fast decay time. Combining this scintillator with the MPPC enables the construction of excellent PET imaging systems, such as TOF-PET.

Features
- High light output
- Superior time resolution
- No deliquescence unlike CsI

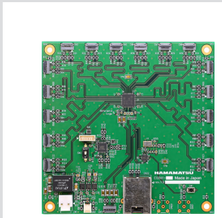
POWER SUPPLY

The power supply is for driving the MPPC. It contains a temperature compensation function to keep the MPPC operation stable.
A single power supply can run multiple MPPC arrays.



PERIPHERAL CIRCUIT

The power supply unit and peripheral circuits (sold separately) are for running the PET module properly.



PET module

These modules are installed in a PET device. These integrate an MPPC, scintillator, and ASIC board.

MPPC + LYSO + ASIC + Power

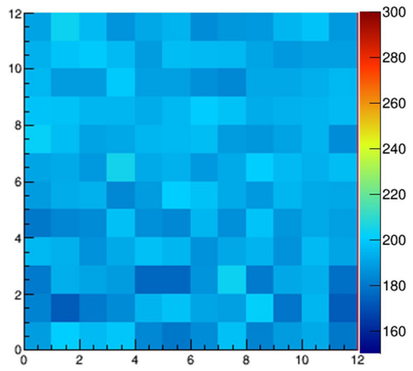
Type no.	C13500-4075YC-12
Photo	
Scintillator size/ch	4 × 4 mm (12 × 12 ch)
MPPC size/ch	4 × 4 mm, 75 µm pitch (12 × 12 ch)
Count rate	< 500 kcps
CRT (FWHM)	< 210 ps
Power consumption	2.6 W

Features 1

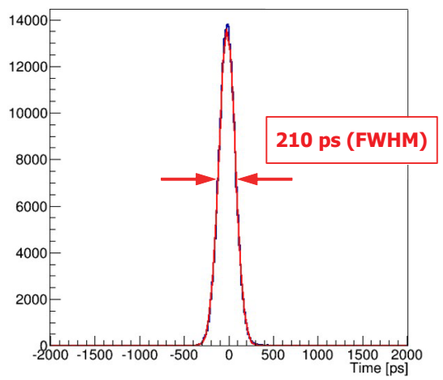
Excellent time resolution: 210 ps

- CRT (FWHM): 210 ps
- CRT variation (12 × 12 ch): ±15 ps max.

■ 2D map of CRT



■ Histogram of CRT

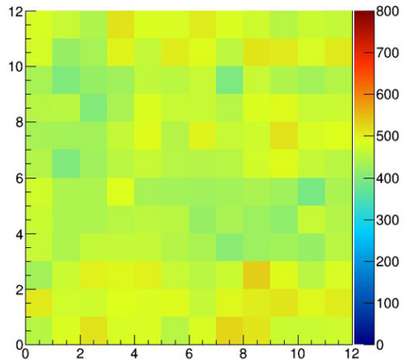


Features 2

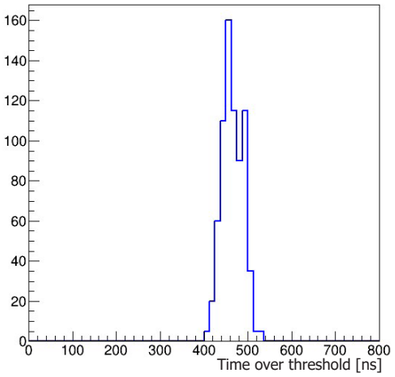
Outputs energy information of all channels

As the energy information of the PET module is processed using time over threshold, it is output as time information.

■ 2D map of energy peak (511 keV)



■ Histogram of energy peak (511 keV)

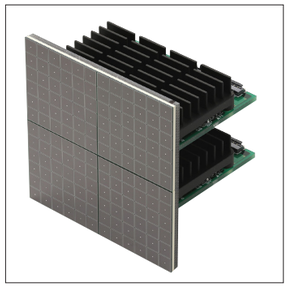


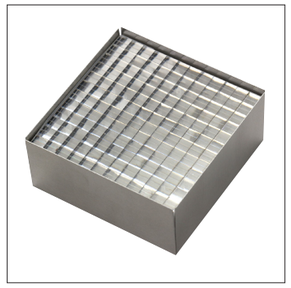
Features 3

Customizable for OEM

Customization is possible according to your needs.
Consult with your nearest Hamamatsu sales office.

Examples:
- MPPC
- Scintillator
- MR compatible
- Structure





■ Absolute maximum ratings

Parameter	Condition	C13500-4075YC-12	Unit
Supply voltage		+24	V
Operating temperature	No dew condensation	+15 to +35	°C
Storage temperature	No dew condensation	0 to +50	°C

■ Specifications (Typ. Ta=25 °C, Vs=+24 V, unless otherwise noted)

Parameter	Condition	C13500-4075YC-12	Unit
Count rate		< 500 kcps	-
CRT (FWHM)23		< 210	ps
Power consumption		2.6	W
Power supply	Using C13502-02	+24	V

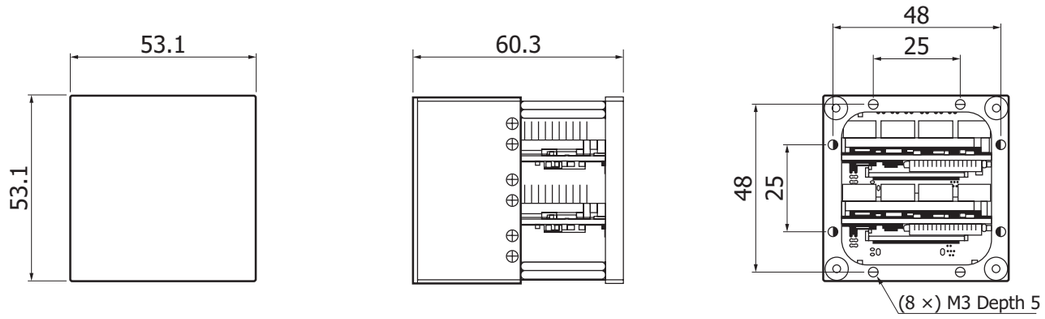
• Scintillator

Parameter	C13500-4075YC-12	Unit
Material	LYSO	-
Dimensions/ch	4.1 × 4.1 × 20	mm
Number of channels	144 (12 × 12)	ch
Element pitch	4.2	mm

• MPPC

Parameter	C13500-4075YC-12	Unit
Type	TSV (through silicon via)	-
Photosensitive area/ch	4 × 4	mm
Pixel pitch	75	μm
Number of channels	144 (12 × 12)	ch
Element pitch	4.2	mm

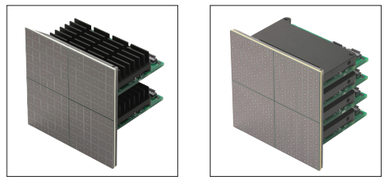
■ Dimensional outlines (unit: mm)



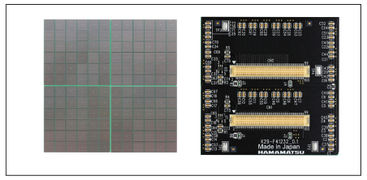
PET module without scintillator

MPPC + ASIC + Power

We can also provide only the MPPC array and ASIC board (without the scintillator). Contact us for details.



Without scintillator



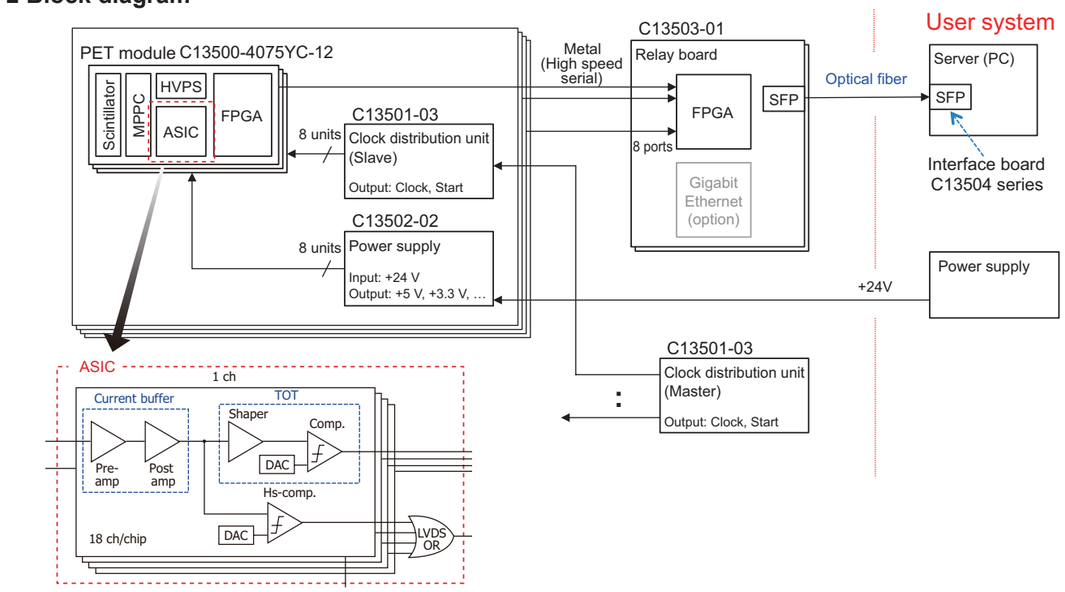
MPPC array board

Peripheral circuit and power supply

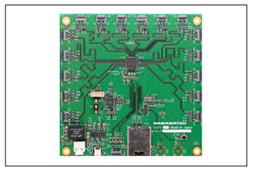
PERIPHERAL CIRCUIT

These are peripheral devices for running the PET module and peripheral circuits for generating output.

■ Block diagram



Clock distribution unit C13501-03

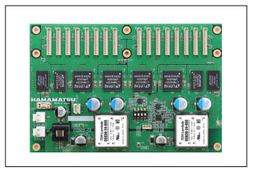


The C13501-03 provides sync signals that the PET module requires. It can distribute to eight signal processing units. It is also possible to distribute to up to 128 units by using several C13501-03s. The C13501-03 is designed on the assumption that it is connected to the PET module C13500 series.

Features

- Output signal: LVDS
- Distributes to 16 units

Power supply C13502-02

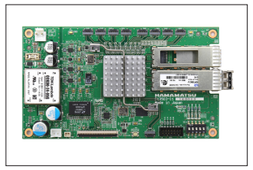


This unit is able to provide a power supply that is required for the PET module. The C13502-02 can distribute power to eight PET modules. This unit is the ideal power source to operate the PET module C13500 series.

Features

- The power supply is delivered to the PET module.
- Distributes to 16 signal processing units

Relay board C13503-01

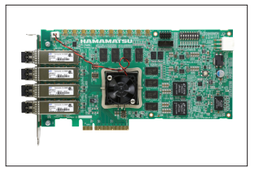


This C13503-01 gathers measurement data from PET module C13500 series and outputs data to PC via an optical fiber with high-speed data transfer.

Features

- High-speed interface
  10 Gbps (SFP)
  3 Gbps (Metal)
- Connects to 8 PET modules as cascade line

Interface board C13504 series

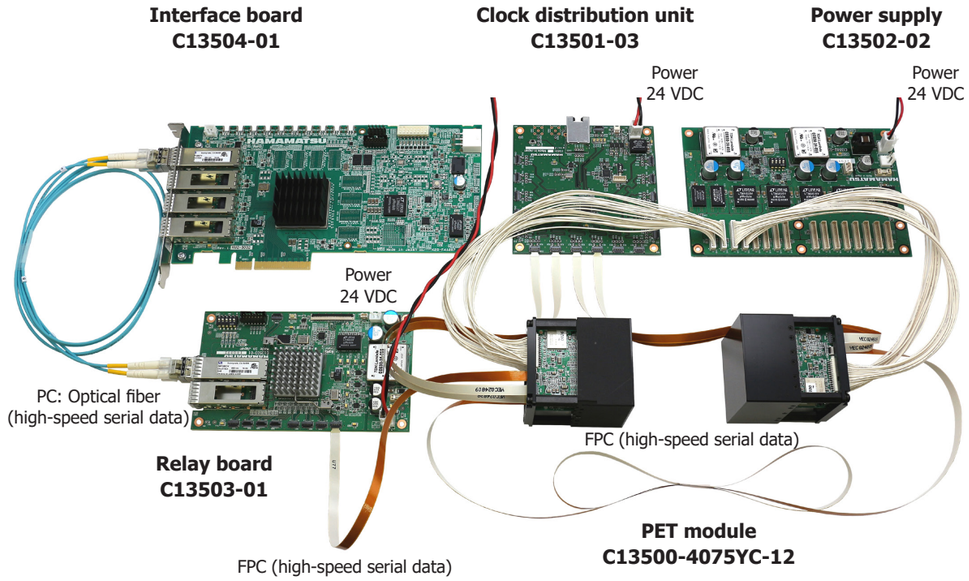


The C13504 series attach to the PCIe connector on a PC and easily collect measurement data in a PC with high-speed data transfer by connecting C13503-01.

Features

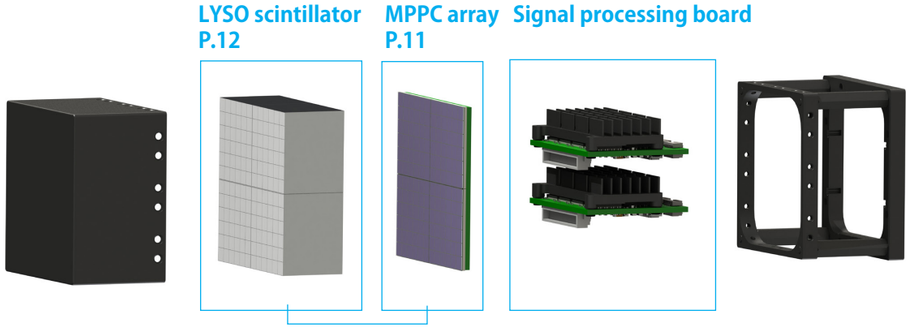
- High-speed optical interface
  C13504-01: 10 Gbps (SFP) cage × 2
  C13504-02: 10 Gbps (SFP) cage × 4
- DDR4 memory 8 GB (C13504-02)
- Windows 10 (64-bit), CentOS 6.7 (64-bit)

■ Connection example



Component lineup

Hamamatsu Photonics not only sells modules but also components.



MPPC array

MPPC

These are MPPC arrays for PET.

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

■ Specifications (Ta=25 °C, Vover=2.7 V)

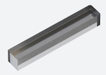
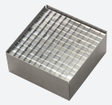
Parameter		S14161 -3050HS-04/-08	S14161 -4050HS-06	S14161 -6050HS-04	Unit
Spectral response range		270 to 900			nm
Peak sensitivity wavelength		450			nm
Photon detection efficiency at λp*1		50			%
Dark current	Typ.	0.6	1.1	2.5	μA
	Max.	1.8	3.3	7.5	
Terminal capacitance		500	900	2000	pF
Gain		2.5×10^6			-
Breakdown voltage		38			V
Recommended operating voltage		V_{BR} + 2.7			V
Temperature coefficient		34			mV/°C

*1: Photo detection efficiency does not include crosstalk or afterpulses.
Note: The above characteristics were measured at the operating voltage that yields the listed gain.
(See the data attached to each product.)

LYSO scintillator

LYSO

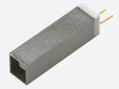
We also accept orders for individual LYSO scintillator arrays.

Type no.		Number of channels (ch)	Size/channel (mm)	Adhesive type
	J13059-3220YN	1 × 1	3.14 × 3.14 × 20	-
	J13059-3220YR-04	4 × 4	3.14 × 3.14 × 20	Reflective film
	J13059-3220YR-08	8 × 8	3.14 × 3.14 × 20	Reflective film
	J13427-1820YR-14	13 × 13 + 14 × 14	1.76 × 1.76 × 10 (2 layers)	Reflective film

MPPC with LYSO scintillator

MPPC + LYSO

These devices have LYSO scintillator arrays coupled to MPPC arrays.

Type no.		Scintillator			Built-in MPPC array	
		Number of channels (ch)	Size/channel (mm)	Channel pitch (mm)	Number of channels (ch)	Pixel pitch (μm)
	S13900-3220LR	1	3.14 × 3.14 × 20	-	1	50
	S13900-3220YR-04	4 × 4	3.14 × 3.14 × 20	3.2	4 × 4	50
	S13900-3220YR-08	8 × 8	3.14 × 3.14 × 20	3.2	8 × 8	50
	S13901-1820YR-14	13 × 13 14 × 14	1.76 × 1.76 × 10	1.8	8 × 8	50

Scintillator specifications

■ Specifications example (LYSO scintillator)

Parameter	Value	Unit
Density	7.2	g/cm^3
Effective atomic number	60	-
Attenuation length	1.2	cm
Decay constant	40	ns
Maximum emission	420	nm
Light yield (NaI:Tl=100%)	75	-
Refractive index	1.81	-
Energy resolution ^{137}Cs	8 to 10	%
Absorbed γ-ray irradiation dose (Radiation hardness)	10^8	rad (%/cm)
Hygroscopicity	No	-
Hardness	5.8	Moh
Cleavage	None	-

■ Comparison chart

Material	Density (g/cm^3)	Light yield (NaI=100 %)	Decay (ns)	Application
LYSO	7.25	80	41	PET, HEP
NaI:Tl	3.67	100	230	γ-ray, X-ray
CsI	4.53	120	1050	X-ray CT
CWO ($CdWO_4$)	7.68	40	5000	X-ray CT
BGO ($Bi_4Ge_3O_{12}$)	7.13	12	300	PET, HEP
PWO ($PbWO_4$)	8.20	1.3	10	HEP
GAGG	6.63	140	88	HEP

Power supply for MPPC

Power

Bias power supply with built-in high precision temperature compensation for MPPCs

Type no.		Mount	Stability (ppm/°C)	Temperature sensor	Voltage boost (MR compatibility)
	C11204-01	Pin	±10	Analog	Inductor (No)
	C11204-03	Pin	±30	Analog	External (Yes)
	C11204-04	Surface	±30	Digital	External (Yes)

■ Electrical characteristics (C11204-01, typ. Ta=25 °C, Vs=+5 V, unless otherwise noted)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	Vs		4.75	5	5.25	V
Current consumption	Icc	Vo=72 V, no load	-	20	-	mA
Output voltage	Vo	No load	-	20 to 90	-	V
Output current	Io		0	-	2	mA
Ripple noise[*1]	Vn	Vo=72 V, no load	-	0.1	0.2	mVp-p
Setting precision	-	Vo=72 V, no load	-	±10	-	mV
Setting resolution	-		-	1.8	-	mV
Temperature stability	-	25 ± 10 °C Vo=72 V, no load	-	±10	-	ppm/°C
Interface	-		Serial communication (UART)			-

*1: Using the recommended circuit.

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PHOTON IS OUR BUSINESS

Date.

No.

HAMAMATSU

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China: HAMAMATSU PHOTONICS (CHINA) CO., LTD.: 1201, Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn
Taiwan: HAMAMATSU PHOTONICS TAIWAN CO., LTD.: 13F-1, No.101, Section 2, Gongdao 5th Road, East Dist., Hsinchu City, 300046, Taiwan(R.O.C) Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw

KACC0011E09 Jun. 2023