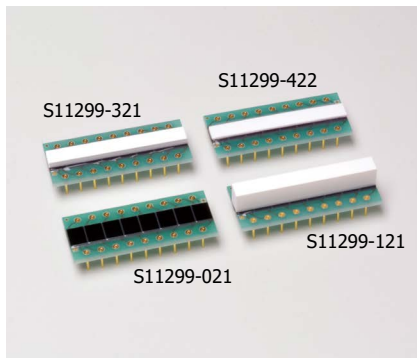


16-element Si photodiode arrays



S11299 series

Back-illuminated photodiode arrays for X-ray non-destructive inspection, slender board type

The S11299 series is a back-illuminated type 16-element photodiode array specifically designed for non-destructive X-ray inspection. It has improved sensitivity uniformity and smaller photodiode element variations compared to our previous product (S5668 series). The back-illuminated photodiode array is also simple to handle and easily couples to scintillators without having to worry about wire damage because there are no bonding wires and photosensitive areas on the back side. The S11299 series is compatible with dual energy imaging because it can be used in combination with our S11212 series [board size: 25.4 (W) × 20.0 (H) mm] to configure an upper and lower two layer structure capable of simultaneous detection of high and low X-rays.

Features

- Spectral response range: 340 to 1100 nm (S11299-021)
- Element size: 1.175 (W) × 2.0 (H) mm/one element
- Element pitch: 1.575 mm (× 16 pixels)
- Mounted on board size: 25.4 (W) × 10.2 (H) mm
- Long and narrow format by multiple arrays
- Supports dual energy imaging
(When used in an upper and lower two-layer combination. See page 7.)

Applications

- X-ray non-destructive inspection, etc.

Selection guide

Type no.	Scintillator			Application example
	Type	Afterglow	Crosstalk	
S11299-021	None*	-	-	General photometry
S11299-121	CsI(Tl)	Large	Low	X-ray non-destructive inspection of slow-moving objects (baggage inspection, etc.)
S11299-321	GOS ceramic	Small	Low	X-ray non-destructive inspection of fast-moving objects (baggage inspection, etc.)
S11299-422	Phosphor sheet	Small	May occur.	X-ray non-destructive inspection (at low X-ray energy)

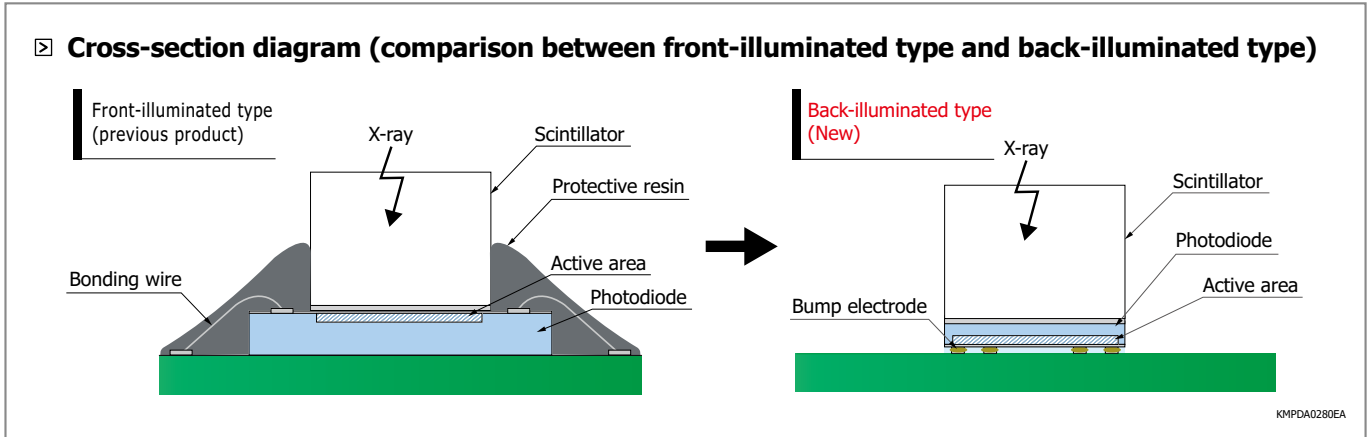
* This photodiode array as it is does not function as an X-ray detector.
An appropriate scintillator or phosphor sheet should be added at user's side.

Precautions

CsI(Tl) scintillator of the S11299-121 has deliquescence. Avoid storing or using the S11212-121 at high humidity.

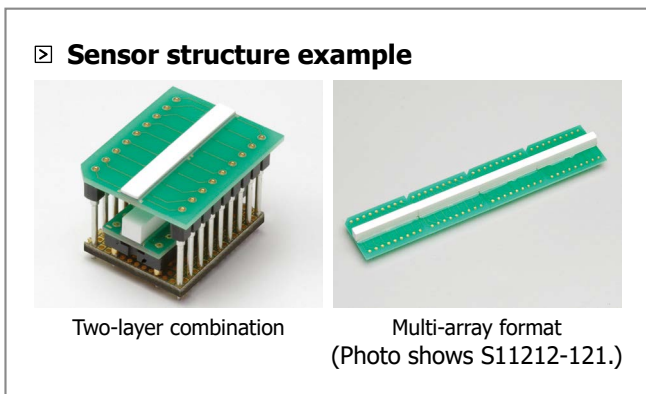
Feature 01 Back-illuminated type

The S11299 series photodiode arrays have a back-illuminated type structure. This structure uses no fragile easily-broken bonding wires since the photodiode array output terminals are directly connected by bump bonding to the electrodes on the board. This structure is robust since the board wiring is laid out within the board. The photodiode surface for coupling the scintillator has no bonding wires or photosensitive areas, so there is less risk of damaging the photodiode array. The S11299 series is also resistant to effects from temperature cycle and so ensures high reliability.



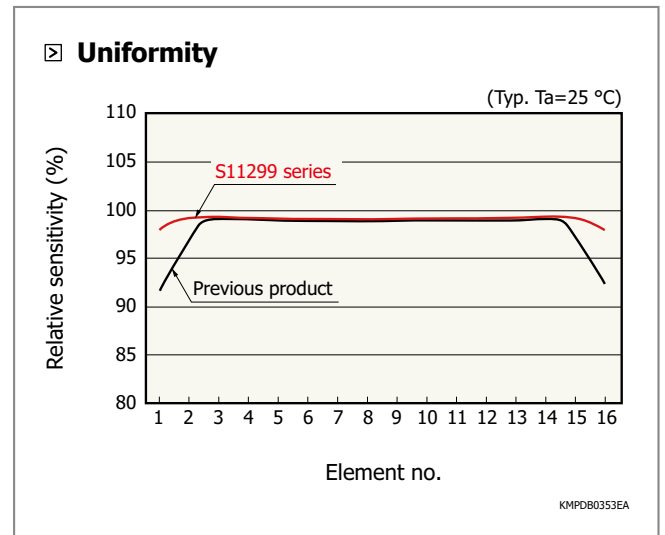
Feature 02 Multiple applications

The S11299 series supports dual energy imaging. To simultaneously detect high energy X-rays and low energy X-rays, the S11299 series is designed so that two photodiode arrays, each with a different scintillator, are combined in an upper and lower two-layer format. Arranging two or more S11299 series photodiode arrays in a row in close proximity also forms a line sensor that allows measurement of long objects.



Feature 03 Superb uniformity

Our unique sensor design minimizes variations in sensitivity between photodiode elements as well as at the sensor ends. The S11299 series offers significantly improved sensitivity uniformity compared to our previous product (S5668 series) and so provides optimal X-ray images.



Absolute maximum ratings

Parameter	Symbol	S11299-021	S11299-121/-321/-422	Unit
Reverse voltage	V _R Max.	10	10	V
Operating temperature*1	T _{opr}	-20 to +60	-10 to +60	°C
Storage temperature*1	T _{stg}	-20 to +80	-20 to +70	°C

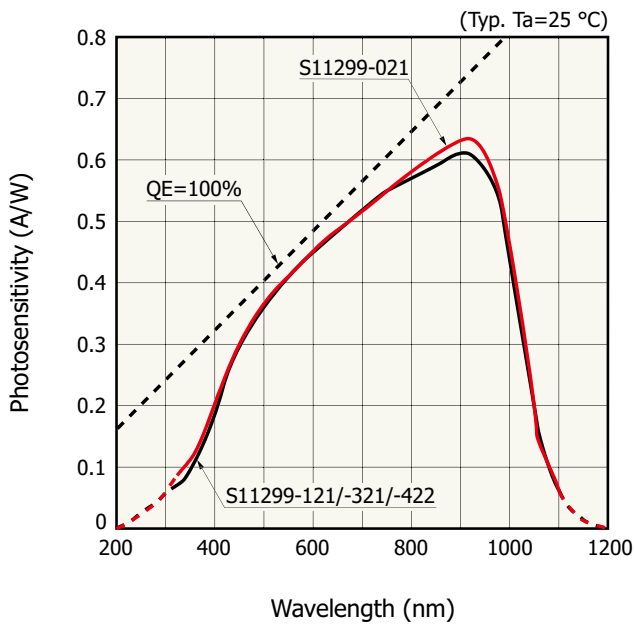
*1: No condensation

Electrical and optical characteristics (T_a=25 °C, per element, S11299-021 characteristics except X-ray sensitivity)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Spectral response range	λ		-	340 to 1100	-	nm
Peak sensitivity wavelength	λ_p		-	920	-	nm
Photo sensitivity	S	$\lambda=540$ nm	380	420	460	mA/W
		$\lambda=\lambda_p$	550	610	670	
X-ray sensitivity	I _{scX}	*2	S11299-021	-	-	nA
			S11299-121	-	6.0	
			S11299-321	-	3.5	
			S11299-422	-	3.0	
Dark current	I _D	V _R =10 mV	-	5	30	pA
Rise time	t _r	V _R =0 V, R _L =1 k Ω 10 to 90%, $\lambda=658$ nm	-	6.5	-	μ s
Terminal capacitance	C _t	V _R =0 V, f=10 kHz	30	40	50	pF

* These are reference (X-ray tube voltage 120 kV, tube current 1.0 mA, aluminum filter t=6 mm, distance 830 mm). X-ray sensitivity depends on the X-ray equipment operating and setup conditions.

Spectral response (characteristics without scintillator)

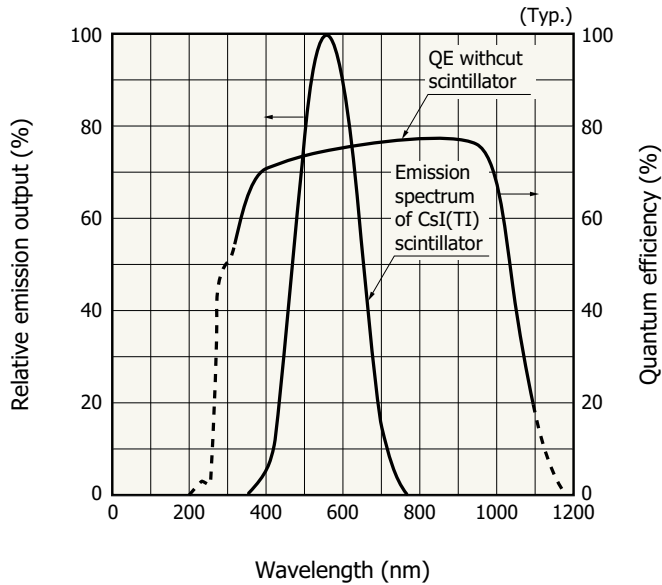


Spectral response characteristics of the S11299-121/-321/-422 include the transmittance and reflectance of the adhesive resin used to bond a scintillator.

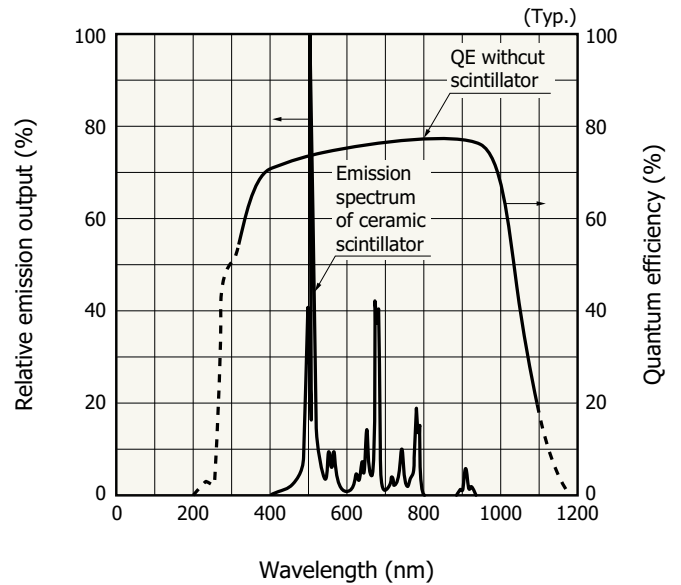
KMPD80351EC

■ Emission spectrum of scintillator and spectral response

S11299-121



S11299-321

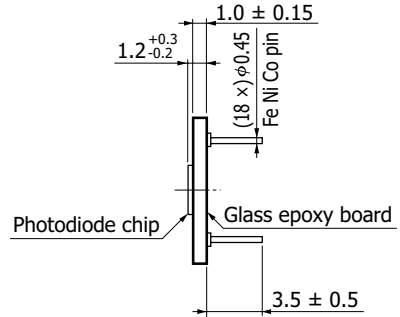
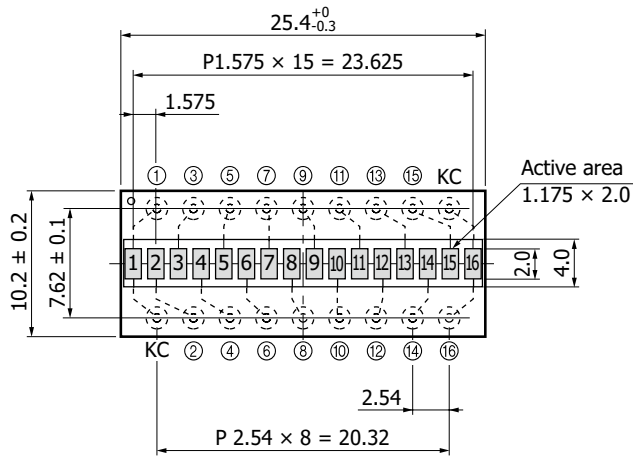


■ Scintillator specifications

Parameter	Condition	CsI(Tl)	Ceramic	Unit
Peak emission wavelength		560	512	nm
X-ray absorption coefficient	100 keV	10	7	cm ⁻¹
Refractive index	at peak emission wavelength	1.7	2.2	-
Decay constant		1	3	μs
Afterglow	100 ms after X-ray turn off	0.3	0.01	%
Density		4.51	7.34	g/cm ³
Color		Transparent	Light yellow-green	-
Sensitivity non-uniformity		±10	±5	%

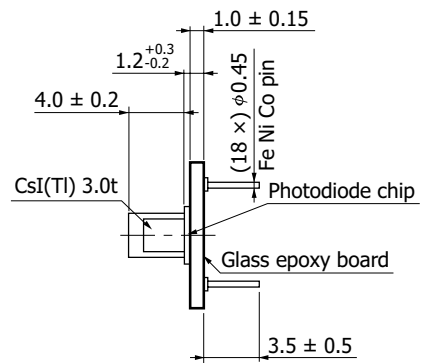
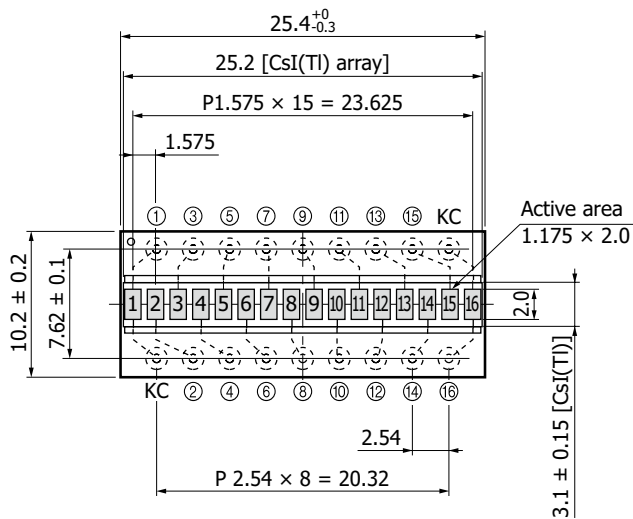
Dimensional outlines (unit: mm, tolerance: ± 0.1 mm unless otherwise noted)

S11299-021



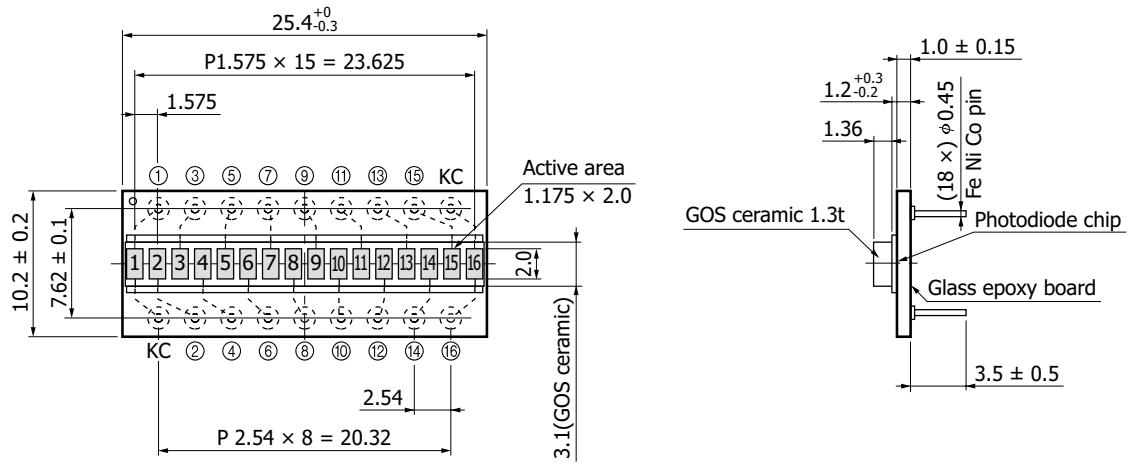
KMPDA0272EB

S11299-121



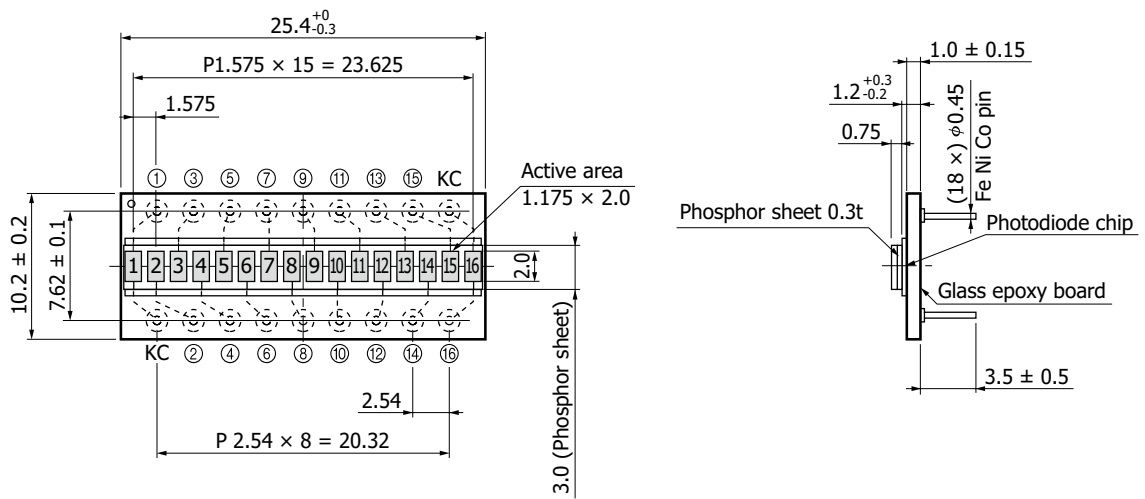
KMPDA0276EC

S11299-321



KMPDA0277EB

S11299-422



KMPDA0278EB

Lineup of Si photodiode arrays for X-ray non-destructive inspection

Scintillator	Type no.	Number of elements	Element pitch (mm)	Element size (mm)	Board size (mm)	Suitable X-ray energy	Photo
None*	S11212-021*	16	1.575	1.175 (W) × 2.0 (H)	25.4 (W) × 20.0 (H)	-	
	S11299-021*				25.4 (W) × 10.2 (H)		
CsI(Tl)	S11212-121				25.4 (W) × 20.0 (H)	High-energy	
	S11299-121				25.4 (W) × 10.2 (H)		
GOS ceramic	S11212-321				25.4 (W) × 20.0 (H)	High-energy	
	S11299-321				25.4 (W) × 10.2 (H)		
Phosphor sheet	S11212-422				25.4 (W) × 20.0 (H)	Low-energy	
	S11299-422				25.4 (W) × 10.2 (H)		

* These photodiode arrays as they are do not function as X-ray detectors. Appropriate scintillators or phosphor sheets should be added at user's side.

The S11212/S11299 series are also compatible with other scintillators than those listed in the above table (custom made devices). Please consult our sales office.

Combination examples (for dual energy imaging)

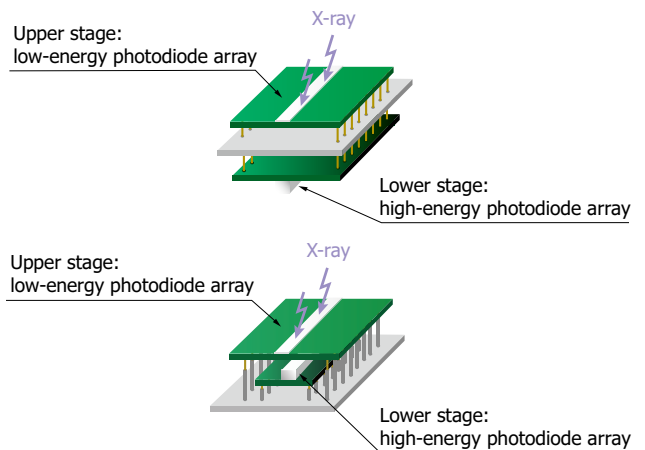
Dual energy imaging is a technique that acquires and superimposes two types of data in a single scan by using X-rays at two different energy levels (high energy and low energy). Two photodiode arrays with scintillators are used: one at the upper stage and the other at the lower stage. The upper stage is used for low energy detection, and the lower stage for high energy detection. Arranging two or more of these devices in a row also forms a line sensor for dual energy imaging.

① This combination uses the S11212 series in both upper and lower stages.

- [Upper stage] S11212-422 + [Lower stage] S11212-121
- [Upper stage] S11212-422 + [Lower stage] S11212-321

② This combination uses the S11212 series in the upper stage and the S11299 series in the lower stage

- [Upper stage] S11212-422 + [Lower stage] S11299-121
- [Upper stage] S11212-422 + [Lower stage] S11299-321



Note: For details on the S11212 series, refer to the S11212 series datasheet.

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

■ Precautions

- Disclaimer
- Metal, ceramic, plastic package products

Information described in this material is current as of June 2021.

Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use. Copying or reprinting the contents described in this material in whole or in part is prohibited without our prior permission.

HAMAMATSU

www.hamamatsu.com

HAMAMATSU PHOTONICS K.K., Solid State Division

1126-1 Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81)53-434-3311, Fax: (81)53-434-5184

U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, N.J. 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218, E-mail: usa@hamamatsu.com

Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8, E-mail: info@hamamatsu.de

France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10, E-mail: infos@hamamatsu.fr

United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777, E-mail: info@hamamatsu.co.uk

North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01, E-mail: info@hamamatsu.se

Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41, E-mail: info@hamamatsu.it

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.: 8F-3, No. 158, Section2, Gongdao 5th Road, East District, Hsinchu, 300, Taiwan R.O.C. Telephone: (886)3-659-0080, Fax: (886)3-659-0081, E-mail: info@hamamatsu.com.tw