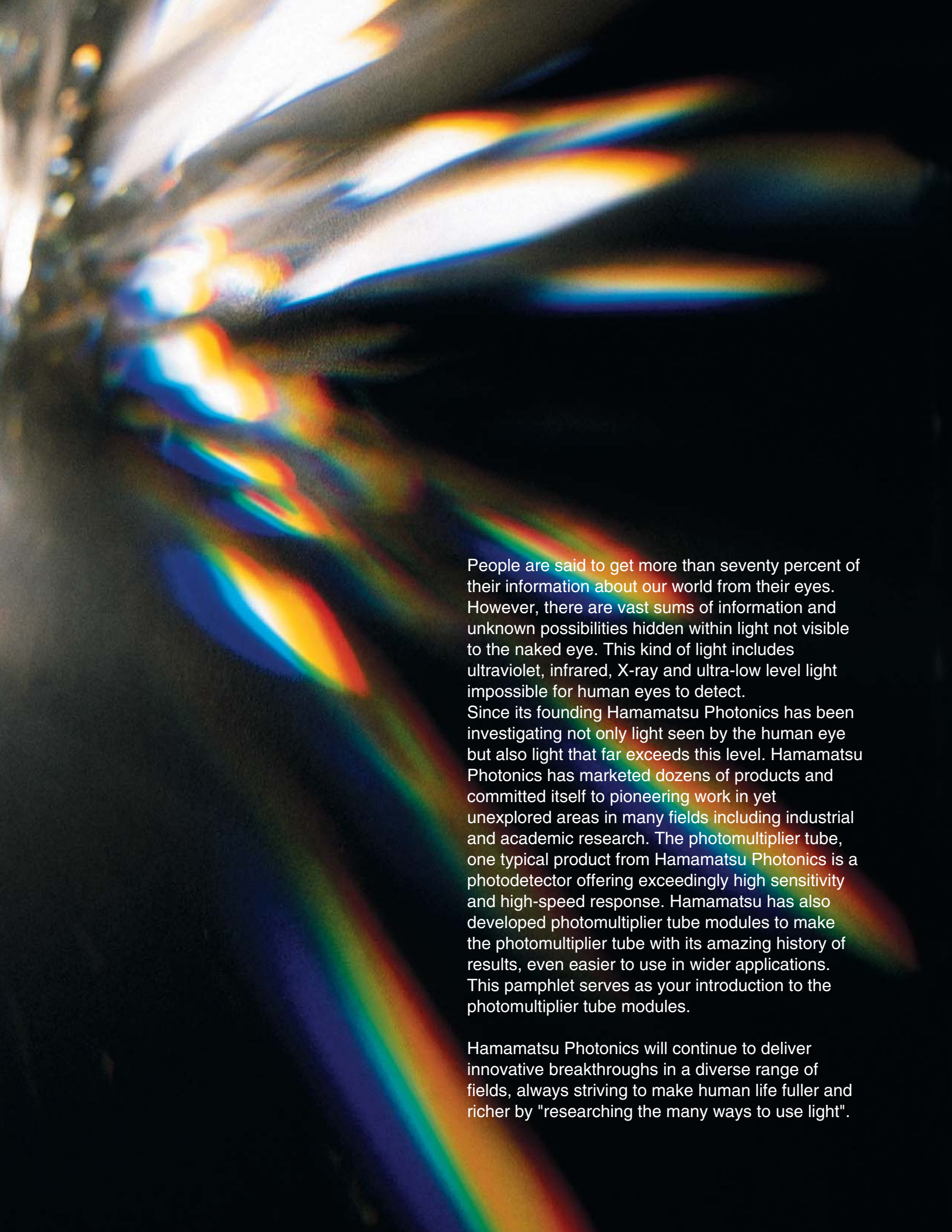
HAMAMATSU

PHOTON IS OUR BUSINESS

PHOTOMULTIPLIER TUBE MODULES

HAMAMATSU PHOTONICS K.K.



People are said to get more than seventy percent of their information about our world from their eyes. However, there are vast sums of information and unknown possibilities hidden within light not visible to the naked eye. This kind of light includes ultraviolet, infrared, X-ray and ultra-low level light impossible for human eyes to detect.
Since its founding Hamamatsu Photonics has been investigating not only light seen by the human eye but also light that far exceeds this level. Hamamatsu Photonics has marketed dozens of products and committed itself to pioneering work in yet unexplored areas in many fields including industrial and academic research. The photomultiplier tube, one typical product from Hamamatsu Photonics is a photodetector offering exceedingly high sensitivity and high-speed response. Hamamatsu has also developed photomultiplier tube modules to make the photomultiplier tube with its amazing history of results, even easier to use in wider applications. This pamphlet serves as your introduction to the photomultiplier tube modules.

Hamamatsu Photonics will continue to deliver innovative breakthroughs in a diverse range of fields, always striving to make human life fuller and richer by "researching the many ways to use light".

Contents

Type No. Simplified chart

Hamamatsu offers a full lineup of photomultiplier tube (PMT) modules adaptable to various kinds of applications and measurements. Now you can make the best choice from among our PMT modules available with diverse device characteristics and shapes, analog or digital outputs, CPU and interfaces for control and data transfer with computers and even gating function.

Function / Type	Current output	With gate function	With cooler	Voltage output
Micro PMT	 H12402/12403 P.8			
Metal package PMT	 ○ H10720/H10721 H11900/H11901 P.10	 ○ H11526/H12056 H11706 P.12 P.13	 ○ H7422 P.11	 ○ H10722/H11902 H10723/H11903 P.21 P.22
Side-on PMT	 H9305/H13320 P.14		 H7844 P.16	 H9306/H9307 P.23
	 H11461 P.15			 H11462 P.23
Head-on PMT	 H7826 P.17			 H7827 P.24
	 H10425 H10426 P.17 P.18	 H13661 P.18	 H13543 P.20	 H10492 H10493 P.24 P.25
	 H11411 H11432 P.19			

○ ... Products are applicable to "optical blocks for PMT modules". For more information, see P.34 or individual catalog.

What is PMT module

The PMT module is basically comprised of a photomultiplier tube to convert light into electrical signals, a high-voltage power supply circuit, and a voltage divider circuit to distribute the optimum voltage to each dynode, all assembled into a single compact case. In addition to these basic PMT modules, Hamamatsu also provides modules having various additional functions such as signal processing, cooling and interface to PC.

Photon counting

	With gate function	CPU + I/F	With cooler	Type
 H12406 P.9				Micro PMT
 H10682 P.26		 H11890 P.28	 H7421 P.27	Metal package PMT
 H12386 P.26				
 H12525 P.28	 H8259 P.29			Side-on PMT
 H7828 P.29				Head-on PMT
 H11870 P.30 H11123 P.31	 H13467 P.30	 H9319 P.31		

Constitution examples

Examples of how to use PMT modules and related products are shown below according to the type of measurement.

The cable ends of the cable output types do not have connectors such as BNC connectors. We can install a connector (extra charge) if needed. Please specify the type of connector along with the cable length when placing your order.

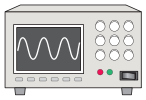
Connecting to ammeters


Current output type


Commercial ammeter

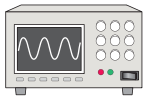
Connecting to oscilloscopes


Current / Voltage output type


Commercial oscilloscope


Current output type

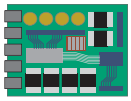

Amplifier unit (P.32)

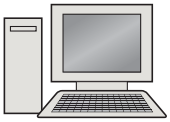

Commercial oscilloscope

Using AD converters


Current output type


Amplifier unit (P.32)


Commercial ADC board

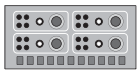


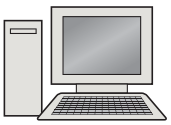
Time-correlated single photon counting


Current output type


Amplifier unit (P.32)


Commercial CFD


Commercial TAC



Photon counting

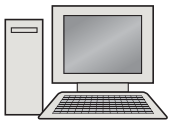

Photon counting head

Commercial counter


Photon counting head

RS-232C

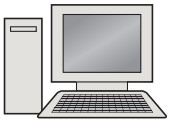
USB




Photon counting head


Counting unit (P.33)

USB




Current output type selected for photon counting


Photon counting unit (P.33)

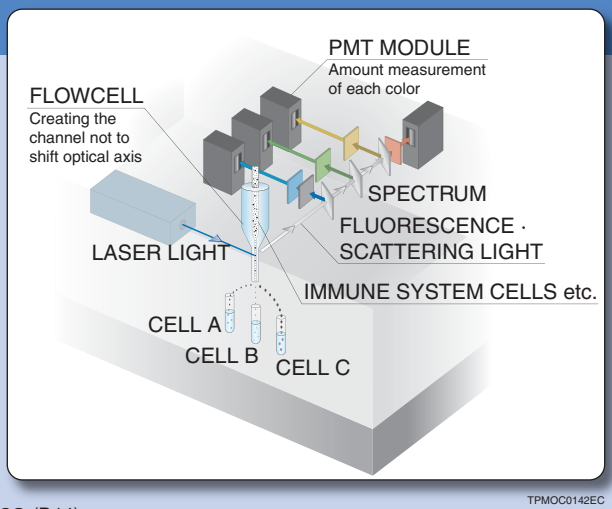

Counting unit (P.33)

USB

Application examples

Flowcytometers

In a flowcytometers, cells labeled with fluorescent material flow in a solution along a flow cell while moving at a certain interval. A laser beam is then irradiated onto the cells and the scattered light from the cells and fluorescence from the fluorescent material are measured by a photomultiplier tube. Various kinds of information are acquired from the scattered and fluorescence such as cell surface antigens, cell periods, number of cells, immunity functions and reticulocytes, and the cells can also be separated from each other. Rapid advances are recently being made in irradiation by multiple lasers, 6-channel color analysis, high-speed operation, and compact flow systems.



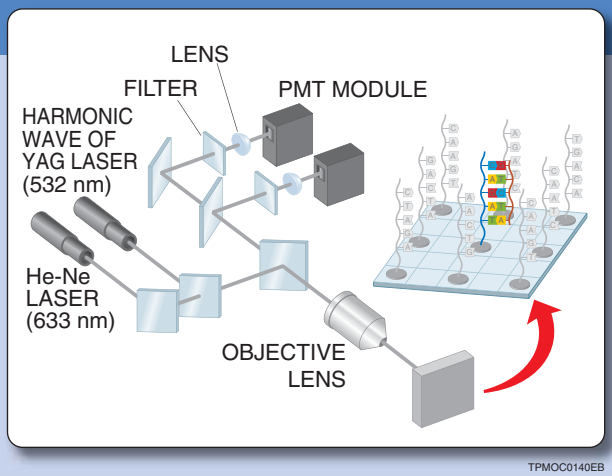
TPMOC0142EC

Vital characteristics
- **High-speed response**
- **High quantum efficiency**

PMT modules
- **H11900/H11901 series** (P.10)
- **H10720/H10721 series** (P.10)
- **H9305/H13320 series** (P.14)

DNA chip reader

A DNA chip reader is used to analyze colossal amounts of genetic information. The DNA chip is a substrate on which a large amount of DNA is arrayed usually by a method using semiconductor lithographic technology, or a method dispensing the DNA onto a slide glass using a high-precision robot. On the DNA chip, hybridization is performed on the DNA labeled by a fluorescent dye. The DNA chip is then scanned by laser beam and by measuring the fluorescent intensity of the hybridized DNA spot, the genetic information is acquired from among the targeted DNA.
(Hybridization is process to link 2 chains of DNA each having a complementary base.)



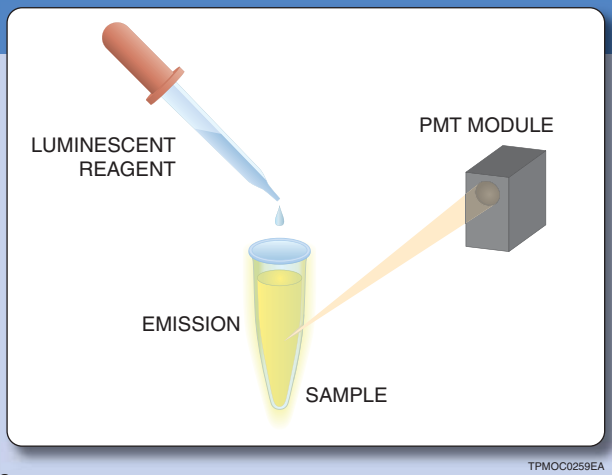
TPMOC0140EB

Vital characteristics
- **High-speed response**
- **High quantum efficiency**

PMT modules
- **H9305/H13320 series** (P.14)

Blood inspection

Blood includes the antigen, which is the material causes immune reaction, of individual disease or bacteria which the person has. There is a blood inspection method which can decide that the subject has a disease or bacteria to what extent by reacting small amount of blood with an antibody as a reagent which bonds with specific antigen and measuring its amount of luminescence. While the study in order to improve efficiency of bonding or emission has been advanced, there has been also a demand to decrease the amount of sample used to measure. In order to achieve such demand, photomultiplier tubes are used as the detector which can perform single photon counting.



TPMOC0259EA

Vital characteristics
- **Wide dynamic range**
- **High sensitivity**

PMT modules
- **H10682-110** (P.26)
- **H10721-110** (P.10)

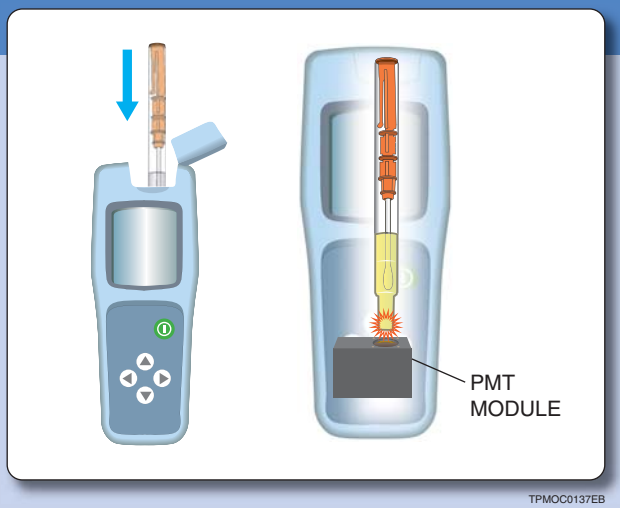
Application examples

Hygiene monitor

The hygiene monitor is also called an ATP analyzer. This device extracts the ATP held in bacteria and cells and makes measurements by causing a reaction with the luminous reagent in the ATP using the firefly's light emission principle. This hygiene monitor is used for making purity checks at restaurants and factories producing foods, etc. In the test, the surface of the object for inspection is wiped with a cotton swab and the extent of dirt or contamination immediately found just by inserting the swab in the sanitary monitor. A great feature of the hygiene monitor is that the photon counting method allows highly sensitive measurements using just an extremely small amount of sample material.

Vital characteristics
- **Compact and light weight**
- **Low power consumption**

PMT modules
- **H7828** (P.29)



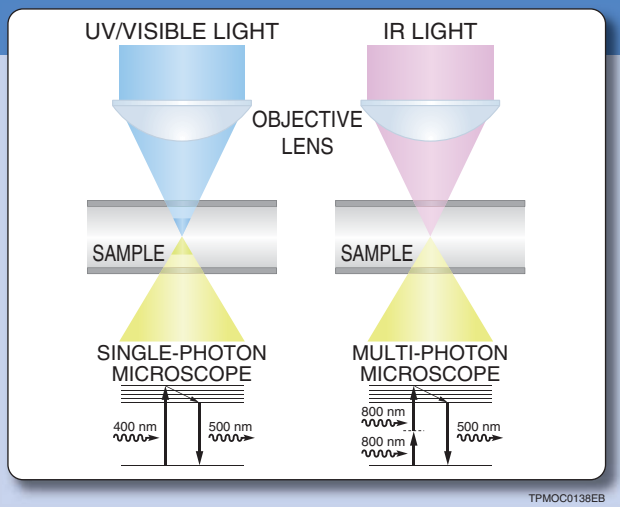
TPMOC0137EB

Multi-photon microscope

In this method, fluorescent molecules can be excited with near infrared light by letting the molecules absorb two photons almost simultaneously, and the resulting visible to UV fluorescence is observed. The cross sectional area absorbing the two photons is extremely small, so nearly all the fluorescence must be detected as a signal at any position from the focal point. Other advantages are that nearly twice the wavelength is used compared to excitation by one photon. This not only means that unwanted effects from scattering and background noise inside the sample due to excitation light are drastically reduced but also that damage to cells from UV light is minimized.

Vital characteristics
- **High quantum efficiency**

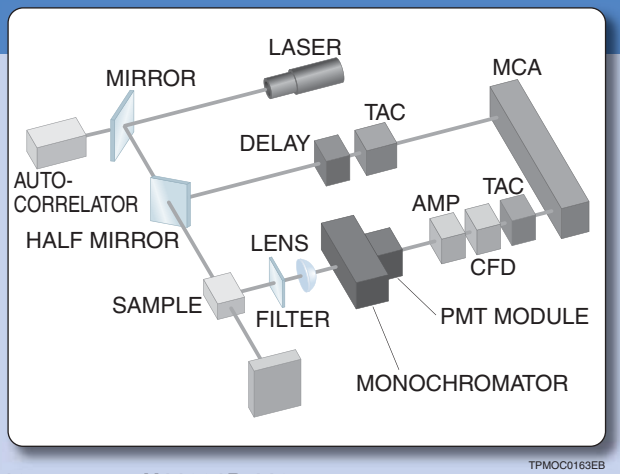
PMT modules
- **H7422-40** (P.11)
- **H9305-03** (P.14)



TPMOC0138EB

Time-correlated single photon counting

Time-correlated single photon counting is used to measure low-level light emitted from a sample when excited with a pulsed laser, based on the theory that a histogram obtained by repeatedly measuring the single photon many times at a slightly delayed timing represents a waveform of the emitted light. Electrical signals produced by a laser driver are slightly delayed and used as trigger signals while the PMT module detects the light emission from a sample. The PMT module output pulse signals are then input to a time-to-amplitude converter (TAC) that produces an electrical pulse in proportion to the time difference between a light detection signal and a trigger signal. A multichannel analyzer (MCA) creates a frequency distribution of the output signals from the TAC, to obtain a waveform of the light emission of the sample.



TPMOC0163EB

Vital characteristics
- **High-speed response**
- **High gain**

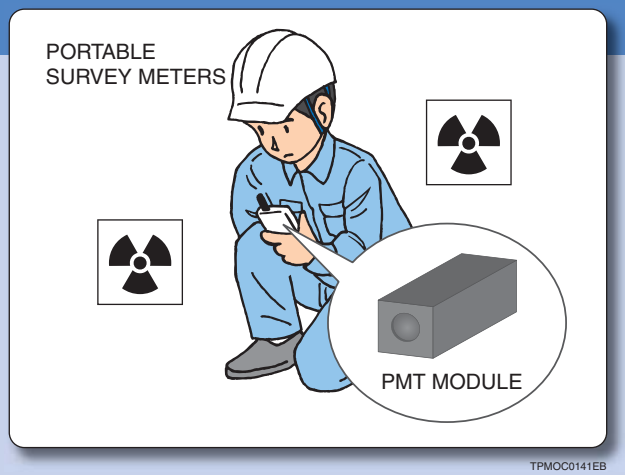
PMT modules
- **H10721P-110** (P.10)
- **H11901P-110** (P.10)
- **H7422P series** (P.11)

Portable survey meters

Portable radiation measurement devices or survey meters are essential for detecting radioactive substances for public safety in customs inspections, nuclear power plants, and hospitals, etc. Among various radiation measurement devices, the most sensitive type uses a combination of photomultiplier tube and scintillator and offers sensitivity ranging from several ten to hundreds of times higher than Geiger-Müller counters (GM counters). Photomultiplier tubes used in this application must be compact, rugged, and easily coupled to scintillators, and also have low power consumption.

Vital characteristics
- **Compact and light weight**
- **Low power consumption**
- **Vibration-resistant**

PMT modules
- **H10720-110/H10721-110** (P.10)
- **H7826** (P.17)



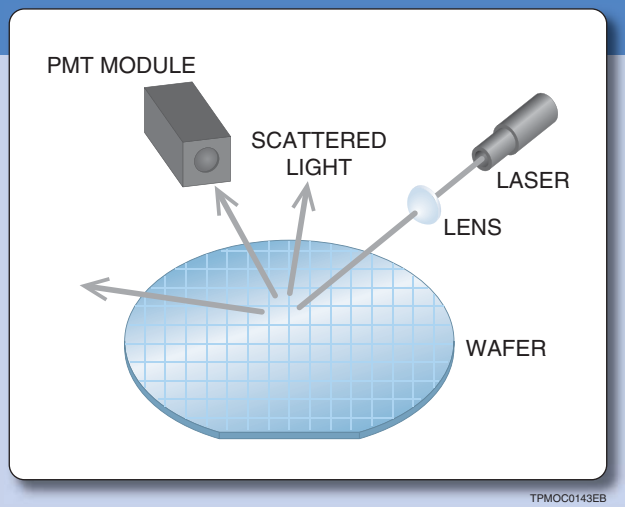
TPMOC0141EB

Semiconductor wafer inspection systems

These systems find defects on semiconductor wafers, by scanning a laser beam onto the wafer and then detecting the resulting scattered light to find any debris, dirt or damage on the wafer surface. Advances in semiconductor technology have made lithographic lines on wafers even finer so that even smaller defects must now be detected making these inspection devices an essential tool.

Vital characteristics
- **High-speed response**
- **Wide dynamic range**

PMT modules
- **H10721 series** (P.10)
- **H11901 series** (P.10)



TPMOC0143EB

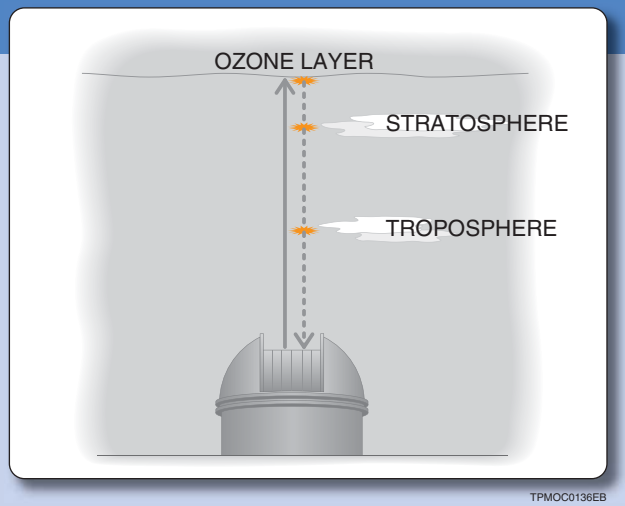
Laser radar

One use of laser radar (often called "LIDAR*") is making atmospheric measurements. A laser beam is emitted into the atmosphere and the light scattered by the "atmospheric molecules" and "suspended elements" then detected. The scattered light is absorbed by "trace gases" during its return and is therefore extremely faint. These "trace gases, and the distribution and concentration of suspended elements" can be analyzed by measuring this faint light. Lidar is actually used in measurements of aerosol and ozone concentrations, CO_2, SO_2 and NOx concentrations, wind velocity and also the extent of visibility.

* LIDAR: LIght Detection And Ranging

Vital characteristics
- **Gated operation**
- **Less after pulse**

PMT modules
- **H11526 series** (P.12)
- **H11870-01** (P.30)



TPMOC0136EB

Micro PMT modules H12402 series
Micro PMT modules H12403 series

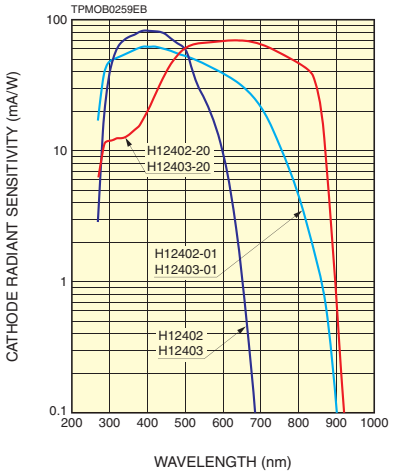
▲(Left) H12403 series,
(Right) H12402 series

(at +25 °C)

Parameter		H12402 H12403	H12402-01 H12403-01	H12402-20 H12403-20	Unit
Spectral response		300 to 650	300 to 850	300 to 920	nm
Effective area		3 (X) × 1 (Y)			mm
Input voltage		+4.5 to +5.5			V
Recommended control voltage adjustment range		+0.5 to +1.0 (Max. +1.15)	+0.5 to +1.1 (Max. +1.15)		V
Gain ①	Typ.	2.0 × 10^6	3.5 × 10^5	7.5 × 10^5	—
Maximum average output signal current		5			μA
Dark current ①	Typ.	0.3		3	nA
Settling time ②	Max.	10			s
Operating ambient temperature		+5 to +50			°C

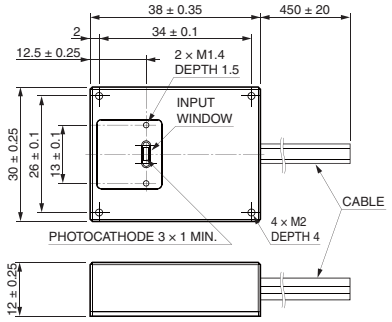
①Control voltage +0.9 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)

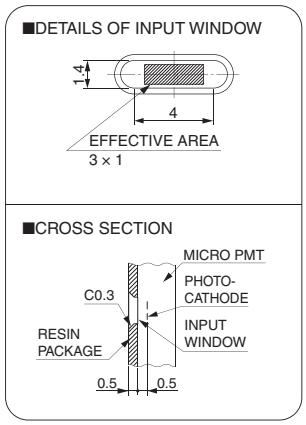
■H12402 series



LOW VOLTAGE INPUT (+5 V) : AWG26 (RED)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT : AWG26 (WHITE)
SIGNAL OUTPUT : RG-174/U

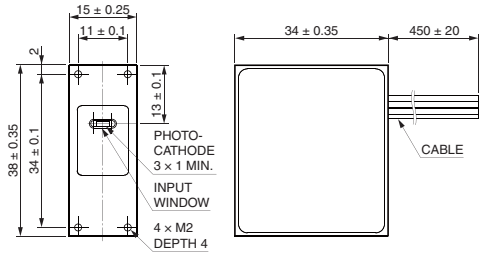
Weight: 42 g

TPMOA0083EB



TPMHA0590EB

■H12403 series



LOW VOLTAGE INPUT (+5 V) : AWG26 (RED)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT : AWG26 (WHITE)
SIGNAL OUTPUT : RG-174/U

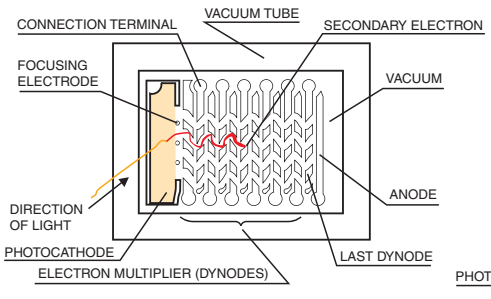
Weight: 52 g

TPMOA0084EB

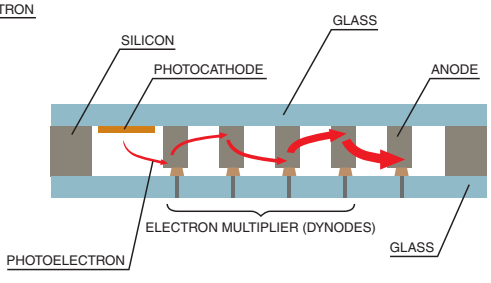
Full-scale Micro PMT image!

Micro PMT works on the same vacuum tube technology and principle as conventional PMTs and so can deliver the same performance as conventional PMT yet in a compact and light-weight

■ Micro PMT internal structure



[TOP VIEW]



[SECTIONAL VIEW]

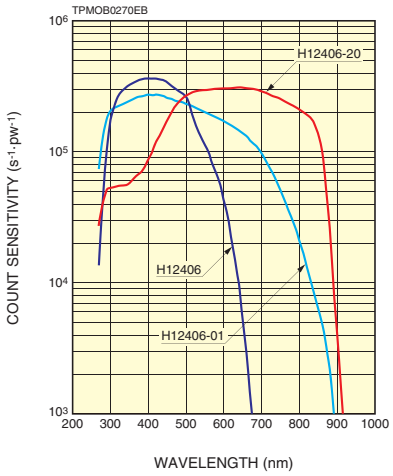
Micro PMT photon counting heads H12406 series

Photon counting

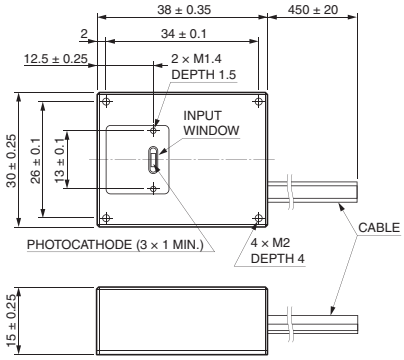
(at +25 °C)

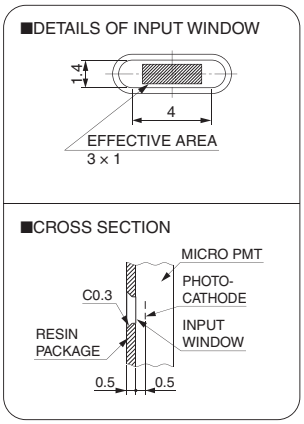
Parameter		H12406	H12406-01	H12406-20	Unit
Spectral response		300 to 650	300 to 850	300 to 920	nm
Effective area		3(X) × 1(Y)			mm
Input voltage		+4.75 to +5.25			V
Count linearity		5.0×10^6			s^{-1}
Dark count	Typ.	10	100	500	s^{-1}
Pulse-pair resolution		20			ns
Output pulse width		10			ns
Output pulse height	Min.	+2.0 (Load resistance 50 Ω)			V
Recommended load resistance		50			Ω
Operating ambient temperature		+5 to +50			°C

●Count sensitivity



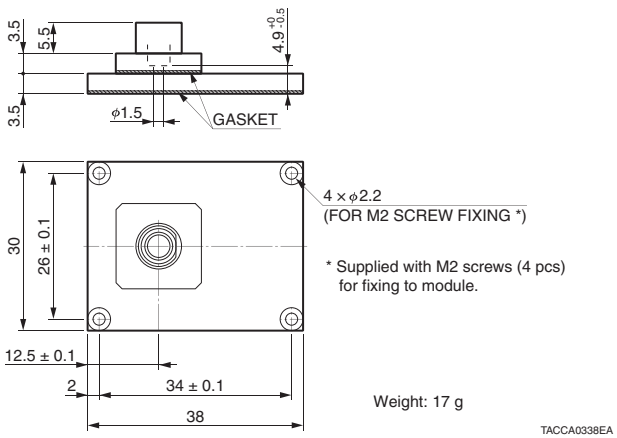
●Dimensional outline (Unit: mm)



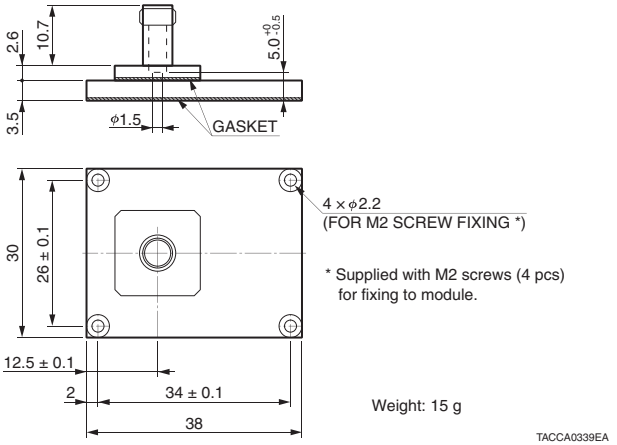


■OPTION

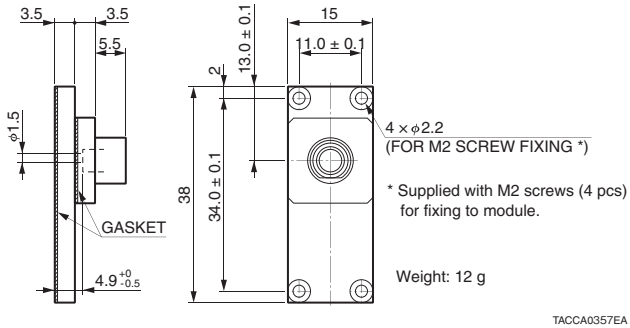
●E13561 (FC type)



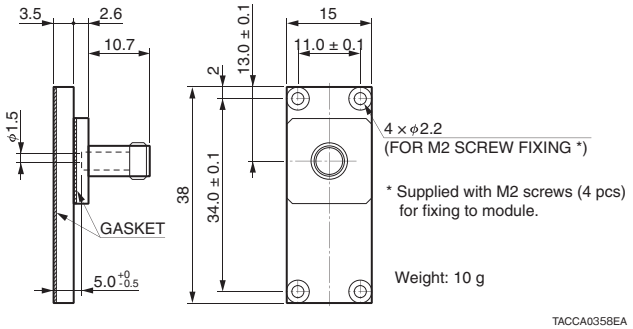
●E13562 (SMA type)



●E13563 (FC type)



●E13564 (SMA type)



* E13561 and E13562 are the exclusive options for H12402/H12406 series, E13563 and E13564 are the exclusive options for H12403 series.

Current output

Photosensor modules H10720 series
Photosensor modules H11901 series

Settling time **10** s | **+3** V to **+5** V operating

▲(Left) H10720 series,
(Right) H10721 series

(at +25 °C)

Parameter		H10720-110 H10721-110 H10720P-110 H10721P-110	H10720-113 H10721-113 H10720P-113 H10721P-113	H10720-210 H10721-210 H10720P-210 H10721P-210	H10720-01 H10721-01 H10720P-01 H10721P-01	H10720-04 H10721-04 H10720P-04 H10721P-04	H10720-20 H10721-20	Unit
Spectral response		230 to 700	185 to 700	230 to 700	230 to 870	185 to 870	230 to 920	nm
Effective area		ϕ8						mm
Input voltage		+2.8 to +5.5						V
Maximum input current ①		2.7 (Dark condition)						mA
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)						V
Gain ①	Typ.	2.0×10^6						—
Maximum average output signal current		100						μA
Dark current ①	Typ.	1	1	1	1	1	10	nA
P type Dark count ①	Typ.	50	50	50	600	600	—	s^{-1}
Settling time ②	Max.	10						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

Photosensor modules H11900 series
Photosensor modules H11901 series

Settling time **0.2** s | **+15** V operating

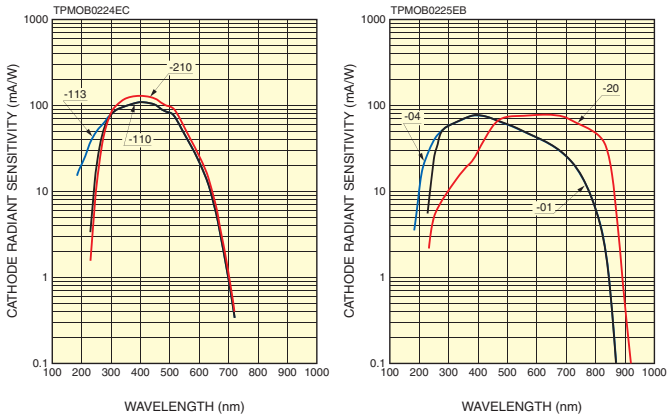
▲(Left) H11900 series,
(Right) H11901 series

(at +25 °C)

Parameter		H11900-110 H11901-110 H11900P-110 H11901P-110	H11900-113 H11901-113 H11900P-113 H11901P-113	H11900-210 H11901-210 H11900P-210 H11901P-210	H11900-01 H11901-01 H11900P-01 H11901P-01	H11900-04 H11901-04 H11900P-04 H11901P-04	H11900-20 H11901-20	Unit
Spectral response		230 to 700	185 to 700	230 to 700	230 to 870	185 to 870	230 to 920	nm
Effective area		ϕ8						mm
Input voltage		+11.5 to +15.5						V
Maximum input current ①		12 (Dark condition)						mA
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)						V
Gain ①	Typ.	2.0×10^6						—
Maximum average output signal current		100						μA
Dark current ①	Typ.	1	1	1	1	1	10	nA
P type Dark count ①	Typ.	50	50	50	600	600	—	s^{-1}
Settling time ②	Max.	0.2						s
Operating ambient temperature		+5 to +50						°C

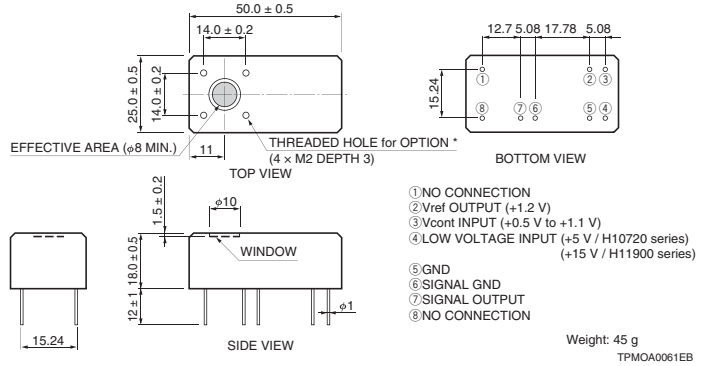
①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)

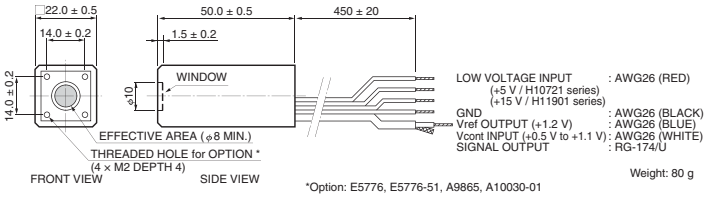
■H10720/H11900 series



Weight: 45 g

TPMOA0061EB

■H10721/H11901 series



Weight: 80 g

*Option: E5776, E5776-51, A9865, A10030-01

TPMOA0062EA

Photosensor modules H7422 series Cooler

Heatsink with fan (A7423)
sold separately

(at +25 °C)

Parameter		H7422-40	H7422-50	H7422P-40	H7422P-50	Unit
Spectral response		300 to 720	380 to 890	300 to 720	380 to 890	nm
Effective area		φ5				mm
Input voltage		+11.5 to +15.5				V
Recommended control voltage adjustment range		+0.5 to +0.8 (Max. +0.9)				V
Gain ①	Typ.	5.0×10^5	5.0×10^5	1.0×10^6	1.0×10^6	—
Maximum average output signal current		2				μA
Dark current (at 0 °C) ①	Typ.	0.4	0.5	0.4	0.5	nA
Dark count (at 0 °C)	Typ.	—		100	125	s^{-1}
Settling time ②		0.2				s
Operating ambient temperature		+5 to +35				°C

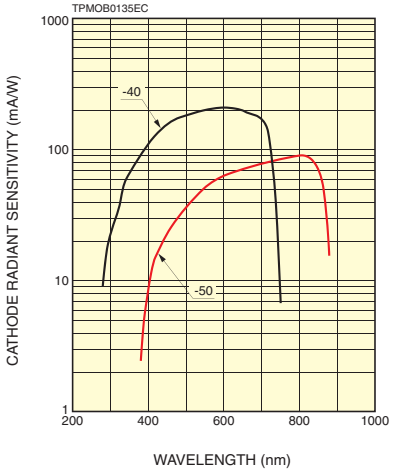
①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

Cooling specifications

Cooling method	Thermoelectric cooling	—
Max. cooling temperature (ΔT)	35	°C
Cooling time	Approx. 5	min
Over light protection*	10	μA

* We also provide "A type" that over light protective function works at 50 μA.

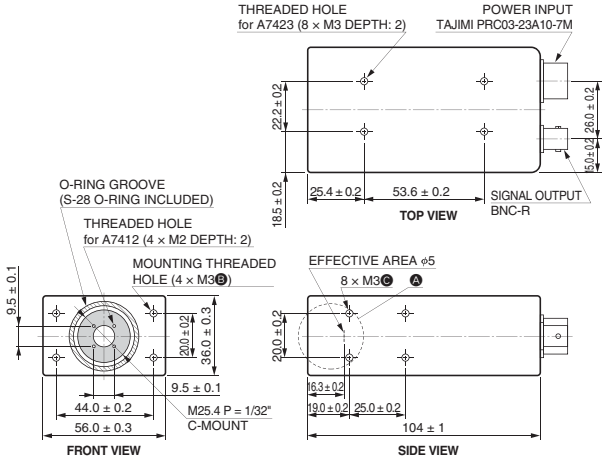
●Spectral response

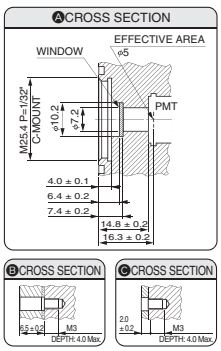


●Option

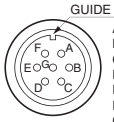
- Heatsink with fan A7423
- Single cable E1168-05
- Optical fiber adapter (FC type) A7412
- C-mount adapter A7413
- Power supply unit with temperature control (AC100 V to 240 V input) C8137-02
- Power supply unit with temperature control (+12 V input, on-board type) M13414

●Dimensional outline (Unit: mm)





Weight: 400 g



A: THERMISTOR 1
B: THERMISTOR 2
C: THERMOELECTRIC COOLER +
D: THERMOELECTRIC COOLER –
E: LOW VOLTAGE INPUT (+15 V)
F: CONTROL VOLTAGE INPUT (+0.5 V to +0.8 V)
G: GND

TAJIMI PRC03-23A10-7M

TPMOA0024ED

Current output

Photosensor modules H11526 series

Gate **100** ns | Settling time **2** s

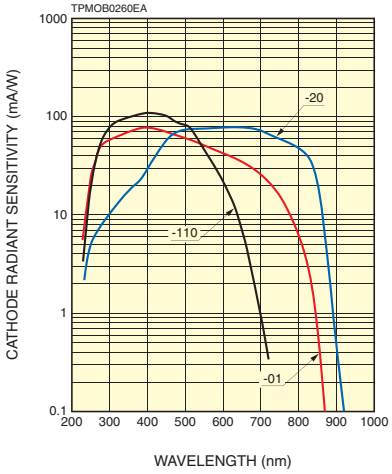
(at +25 °C)

Parameter		H11526-110-NN H11526-110-NF	H11526-01-NN H11526-01-NF	H11526-20-NN H11526-20-NF	Unit
Spectral response		230 to 700	230 to 870	230 to 920	nm
Effective area		ϕ8			mm
Input voltage		+14.5 to +15.5			V
Recommended control voltage adjustment range		+0.4 to +0.9 (Max. +0.9)			V
Gain ①	Typ.	2.0×10^6			—
Maximum average output signal current		100			μA
Dark current ①	Typ.	1	1	10	nA
Settling time ②		2			s
Operating ambient temperature		+5 to +45			°C

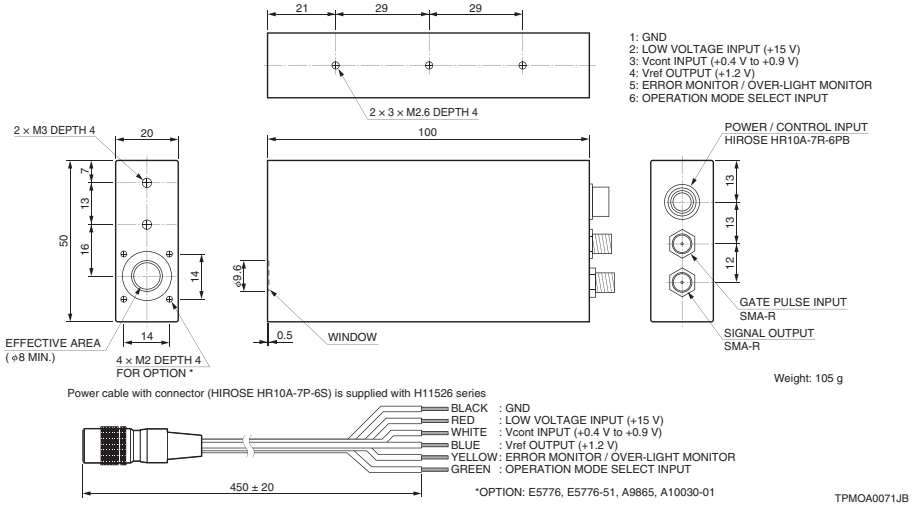
①Control voltage +0.8 V

②The time required for the output to reach a stable level following a change in the control voltage from +0.8 V to +0.4 V

●Spectral response



●Dimensional outline (Unit: mm)



TPMOA0071JB

Photosensor modules H12056 series

Gate **10** ms | Settling time **10** s

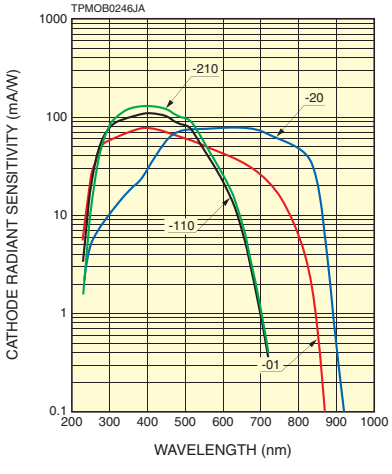
(at +25 °C)

Parameter		H12056-110 H12056P-110	H12056-210 H12056P-210	H12056-01 H12056P-01	H12056-20	Unit
Spectral response		230 to 700		230 to 870	230 to 920	nm
Effective area		ϕ8				mm
Input voltage		+4.5 to +5.5				V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)				V
Gain ①	Typ.	2.0×10^6				—
Maximum average output signal current		100				μA
Dark current ①	Typ.	1	1	1	10	nA
P type Dark count ①	Typ.	50	50	600	—	s^{-1}
Settling time ②		10				s
Operating ambient temperature		+5 to +50				°C

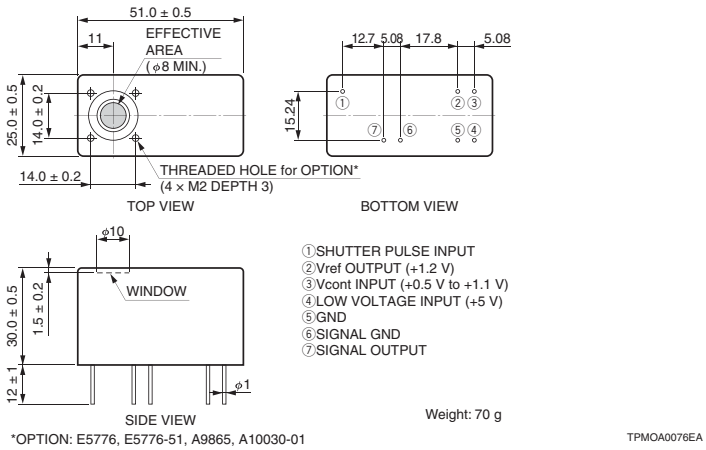
①Control voltage +1.0 V

②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



TPMOA0076EA

Photosensor modules H11706 series

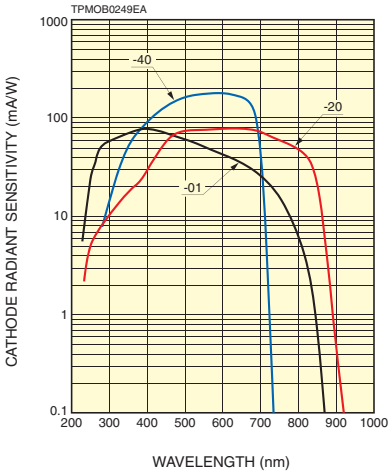
Gate 1 µs | Settling time 0.2 s

(at +25 °C)

Parameter		H11706-01 H11706P-01	H11706-20	H11706-40 H11706P-40	Unit
Spectral response		230 to 870	230 to 920	300 to 720	nm
Effective area		φ8		φ5	mm
Input voltage		+14.5 to +15.5			V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)		+0.5 to +0.8 (Max. +0.9)	V
Gain ①	Typ.	2.0×10^6		5.0×10^5	—
Maximum average output signal current		100		2	µA
Dark current ①	Typ.	1	10	5	nA
P type Dark count ①	Typ.	600	—	6000	s^{-1}
Settling time		0.2 ②		0.2 ③	s
Operating ambient temperature		+5 to +50		+5 to +35	°C

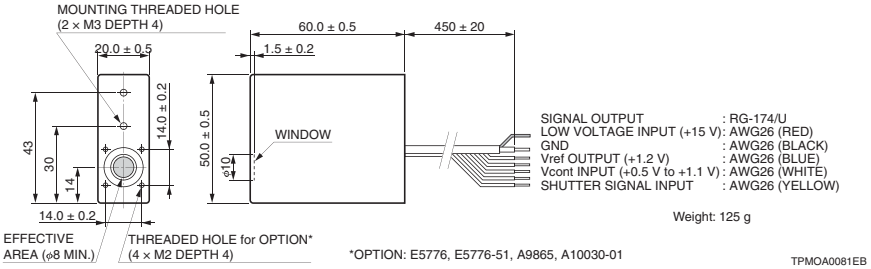
①H11706-01, H11706P-01, H11706-20: control voltage +1.0 V
H11706-40, H11706P-40: control voltage +0.8 V
②The time required for the output to reach a stable lebel following a change in the control voltage from +1.0 V to +0.5 V.
③The time required for the output to reach a stable lebel following a change in the control voltage from +0.9 V to +0.5 V.

●Spectral response

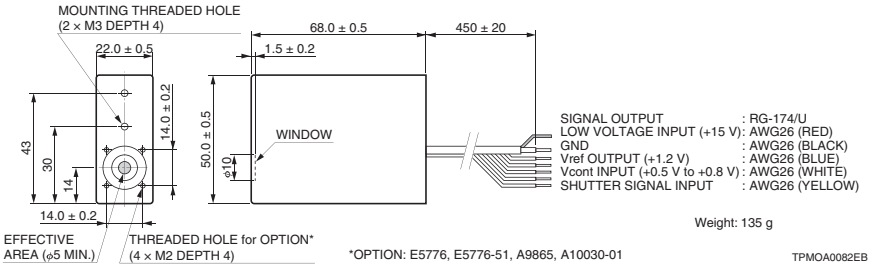


●Dimensional outline (Unit: mm)

■H10706-01/-20



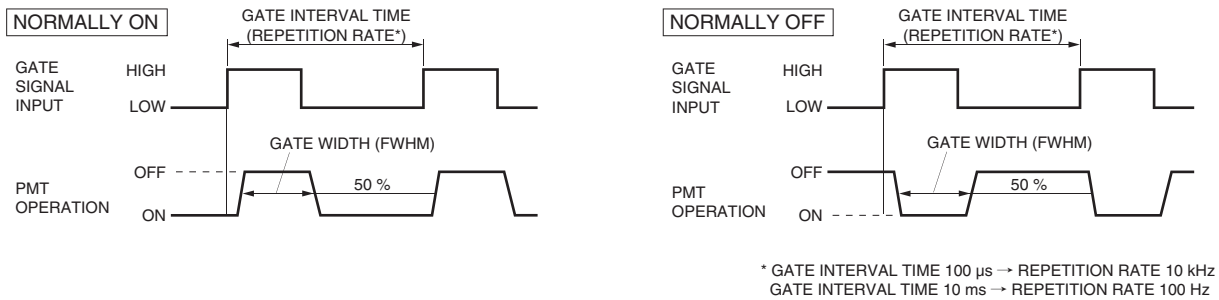
■H10706-40



●Gate characteristics

Parameter			H11526-xx-NN	H11526-xx-NF	H11706	H12056	Unit
Gate mode	Mode		Normally ON	Normally OFF	Normally ON	Normally ON	—
	Gate width (FWHM)		100 ns to DC		1 µs to 10 ms	10 ms to DC	—
	Repetition rate	Max.	10		10	0.07	kHz
	Switching ratio	Typ.	10^6		10^3	10^3	—
Gate signal	Input HIGH level		+3.5 to +5		+2 to +15	+2 to +5	V
	Input impedance		10		0.5	10	kΩ

●Gate operation mode



* GATE INTERVAL TIME 100 µs → REPETITION RATE 10 kHz
GATE INTERVAL TIME 10 ms → REPETITION RATE 100 Hz

TPMOC0260EA

Current output

Photosensor modules H9305 series

+15 V operating

(at +25 °C)

Parameter		H9305-01	H9305-02	H9305-03	H9305-13	H9305-04	H9305-05	Unit
Spectral response		185 to 750	185 to 900	185 to 900	185 to 900	185 to 830	185 to 650	nm
Effective area (X × Y)		3.7 × 13.0						mm
Input voltage		+11.5 to +15.5						V
Recommended control voltage adjustment range		+0.25 to +1.0 (Max. +1.2)						V
Gain ①	Typ.	5.8×10^6	4.0×10^6	4.0×10^6	4.0×10^6	3.5×10^6	7.5×10^6	—
Maximum average output signal current		10						μA
Dark current ①	Typ.	1	1	2	3	0.1	0.5	nA
Settling time ②	Max.	10						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

Photosensor modules H13320 series

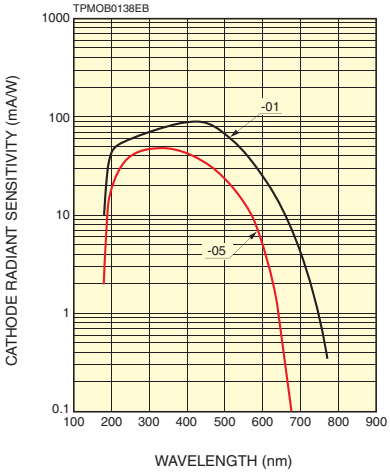
+3 V to +5 V operating

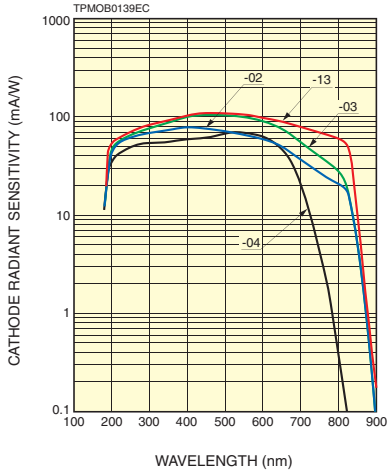
(at +25 °C)

Parameter		H13320-01	H13320-02	H13320-03	H13320-13	H13320-04	H13320-05	Unit
Spectral response		185 to 750	185 to 900	185 to 900	185 to 900	185 to 830	185 to 650	nm
Effective area (X × Y)		3.7 × 13.0						mm
Input voltage		+2.8 to +5.5						V
Recommended control voltage adjustment range		+0.25 to +1.0 (Max. +1.2)						V
Gain ①	Typ.	5.8×10^6	4.0×10^6	4.0×10^6	4.0×10^6	3.5×10^6	7.5×10^6	—
Maximum average output signal current		10						μA
Dark current ①	Typ.	1	1	2	3	0.1	0.5	nA
Settling time ②	Max.	14						s
Operating ambient temperature		+5 to +50						°C

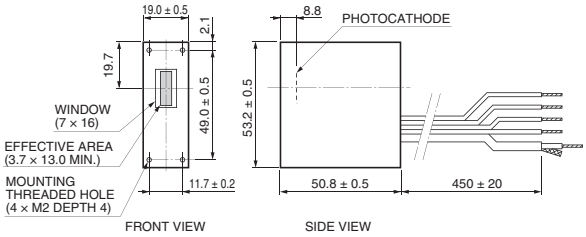
①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response





●Dimensional outline (Unit: mm)



LOW VOLTAGE INPUT (+5 V / H13320 SERIES): AWG26 (RED)
(+15 V / H9305 SERIES)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT (+0.25 V to +1.0 V) : AWG26 (WHITE)
SIGNAL OUTPUT : RG-174/U

Weight: 110 g

TPMOA0013JH

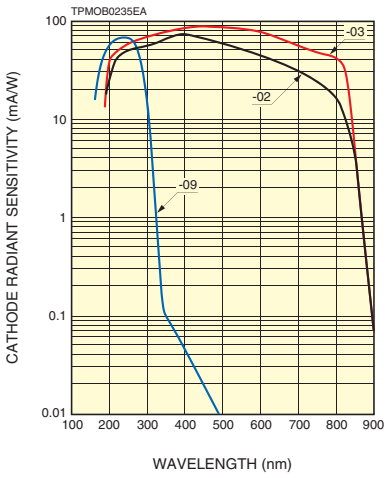
Photosensor modules H11461 series

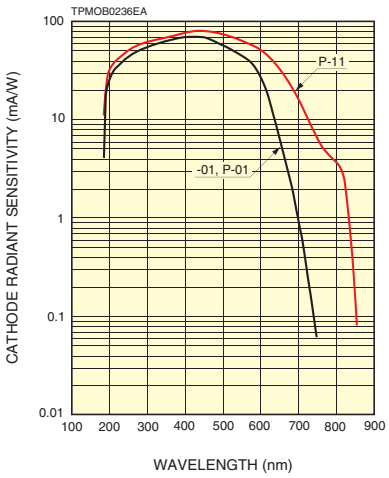
(at +25 °C)

Parameter		H11461-01	H11461-02	H11461-03	H11461-09	H11461P-01	H11461P-11	Unit
Spectral response		185 to 710	185 to 900	185 to 900	160 to 320	185 to 710	185 to 850	nm
Effective area (X × Y)		4 × 20						mm
Input voltage		+4.5 to +5.5						V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.2)						V
Gain ①	Typ.	1.2×10^7	1.0×10^7	9.5×10^6	1.0×10^7	1.2×10^7	3.5×10^6	—
Maximum average output signal current		100						μA
Dark current ①	Typ.	0.2	3	10	1	0.1	0.2	nA
Dark count ①	Typ.	—	—	—	—	30	80	s^{-1}
Settling time ②	Max.	14						s
Operating ambient temperature		+5 to +50						°C

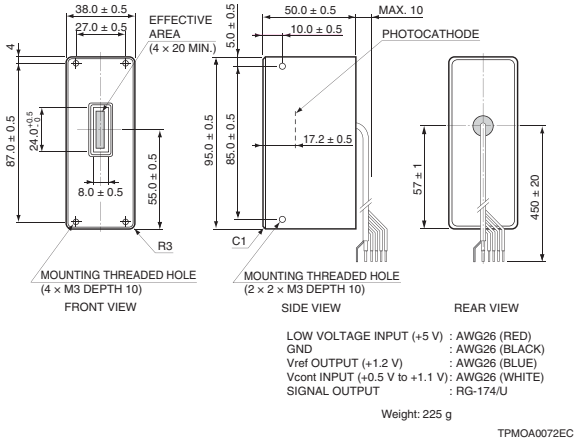
①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response





●Dimensional outline (Unit: mm)



Photosensor module with thermoelectric cooler H7844

Cooler

(at +25 °C)

Parameter		H7844	Unit
Spectral response		185 to 900	nm
Effective area (X × Y)		10 × 14	mm
Input voltage		+11.5 to +15.5	V
Recommended control voltage adjustment range		+0.3 to +1.1	V
Gain ①	Typ.	1.0×10^7	—
Maximum average output signal current		58	μA
Dark current ①	Typ.	0.1	nA
Settling time ②	Max.	0.2	s
Operating ambient temperature		+5 to +40	°C

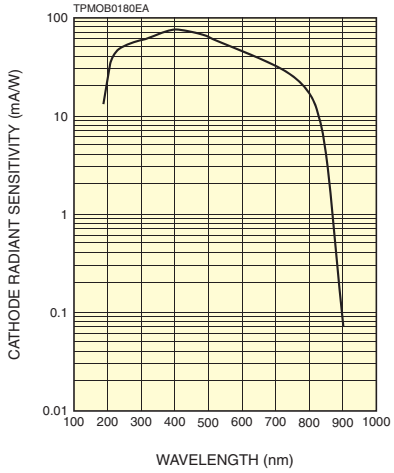
①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

Cooling specifications

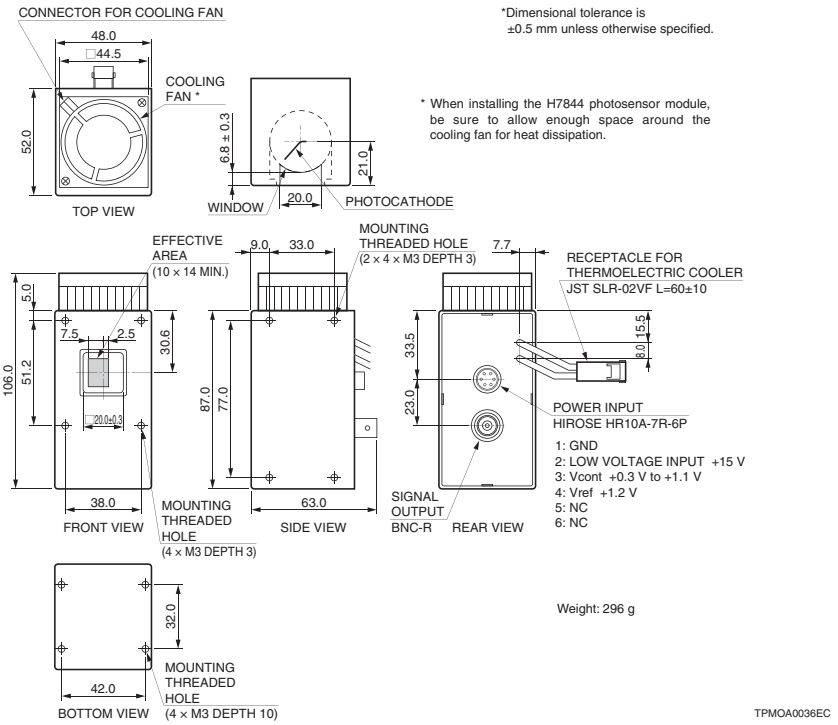
Cooling method		Thermoelectric cooling	—
Max. cooling temperature (ΔT) ③④		20	°C
Cooling time ③		Approx. 3	min

③Input current to thermoelectric cooler = 2.1 A ④Photocathode temperature difference from ambient

●Spectral response



●Dimensional outline (Unit: mm)



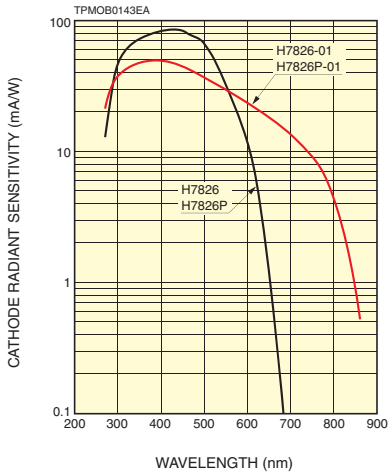
Photosensor modules H7826 series

(at +25 °C)

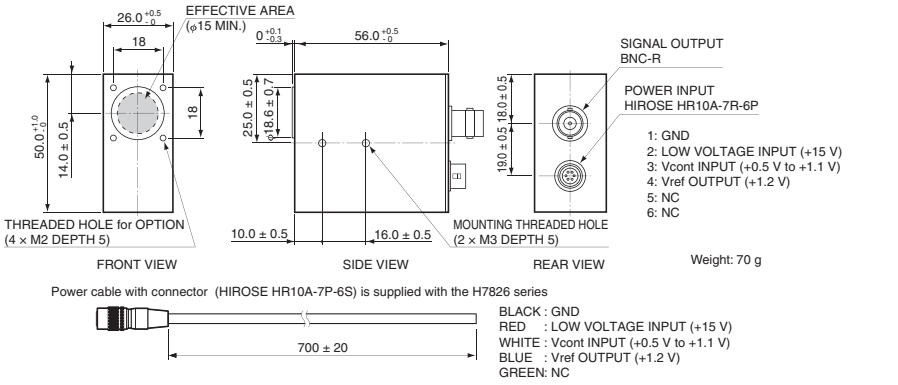
Parameter		H7826	H7826-01	H7826P	H7826P-01	Unit
Spectral response		300 to 650	300 to 850	300 to 650	300 to 850	nm
Effective area		ϕ15				mm
Input voltage		+11.5 to +15.5				V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.2)				V
Gain ①	Typ.	5.5×10^5	2.5×10^5	1.8×10^6	1.0×10^6	—
Maximum average output signal current		100				μA
Dark current ①	Typ.	3		3		nA
Dark count	Typ.	—		200	2000	s^{-1}
Settling time ②	Max.	0.2				s
Operating ambient temperature		+5 to +45				°C

①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



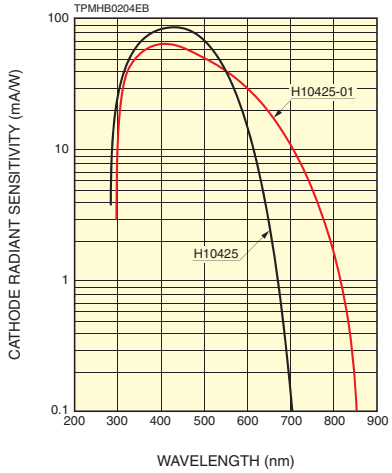
Photosensor modules H10425 series

(at +25 °C)

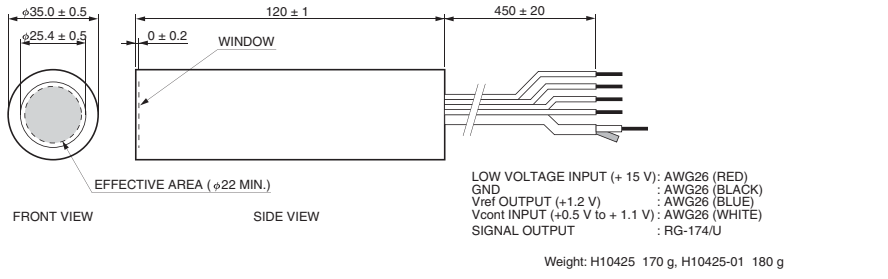
Parameter		H10425	H10425-01	Unit
Spectral response		300 to 650	300 to 850	nm
Effective area		ϕ22		mm
Input voltage		+11.5 to +15.5		V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.2)		V
Gain ①	Typ.	2.0×10^6	5.0×10^5	—
Maximum average output signal current		100		μA
Dark current ①	Typ.	3		nA
Settling time ②	Max.	10		s
Operating ambient temperature		+5 to +50		°C

①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



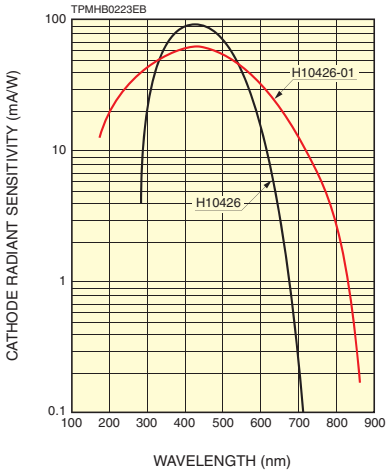
Photosensor modules H10426 series

(at +25 °C)

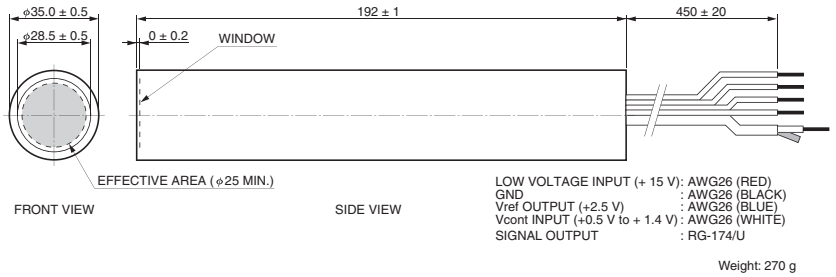
Parameter		H10426	H10426-01	Unit
Spectral response		300 to 650	185 to 850	nm
Effective area		φ25		mm
Input voltage		+11.5 to +15.5		V
Recommended control voltage adjustment range		+0.5 to +1.4 (Max. +1.5)		V
Gain ①	Typ.	2.1×10^6	5.3×10^5	—
Maximum average output signal current		100		μA
Dark current ①	Typ.	2	3	nA
Settling time ②	Max.	10		s
Operating ambient temperature		+5 to +50		°C

①Control voltage +1.0 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



Weight: 270 g

TPMOA0047EB

High speed photosensor module H13661

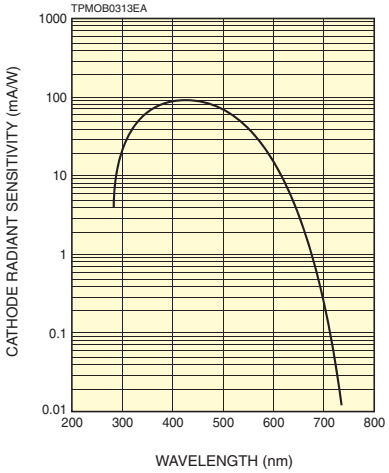
Rise time **230** ps | **Positive output**

(at +25 °C)

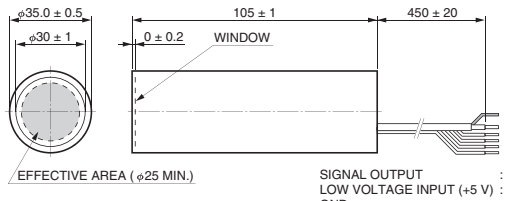
Parameter		H13661	Unit
Spectral response		300 to 650	nm
Effective area		φ25	mm
Input voltage		+4.8 to +5.5	V
Recommended control voltage adjustment range		+1.8 to +2.2 (Max. +2.3)	V
Gain ①	Typ.	3.1×10^4	—
Maximum average output signal current		100	μA
Dark current ①	Typ.	1	nA
Settling time ②	Max.	10	s
Operating ambient temperature		+5 to +50	°C

①Control voltage +2.2 V
②The time required for the output to reach a stable level following a change in the control voltage from +2.2 V to +1.8 V

●Spectral response



●Dimensional outline (Unit: mm)



Weight: 101 g

TPMOA0100EA

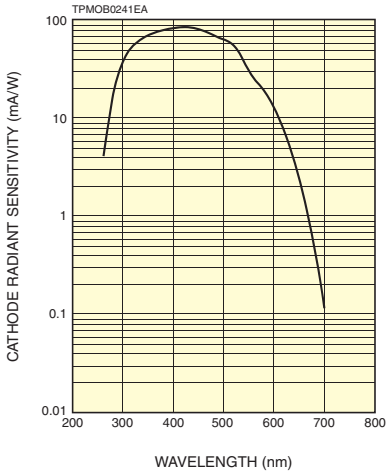
Photomultiplier tube module H11411

(at +25 °C)

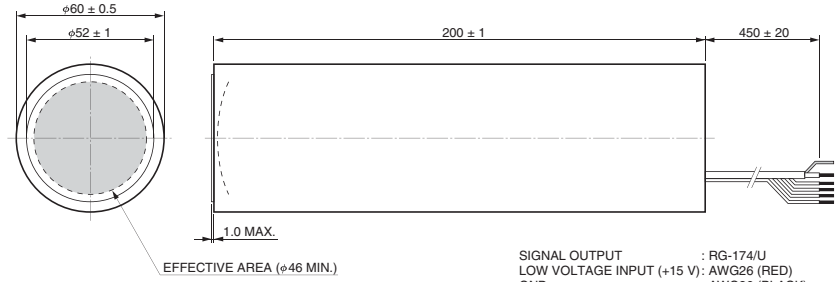
Parameter		H11411	Unit
Spectral response		300 to 650	nm
Effective area		φ46	mm
Input voltage		+11.5 to +15.5	V
Recommended control voltage adjustment range		+0.5 to +1.8 (Max. +1.9)	V
Gain ①	Typ.	3.3×10^6	—
Maximum average output signal current		200	μA
Dark current ①	Typ.	6	nA
Settling time ②	Max.	10	s
Operating ambient temperature		+5 to +50	°C

①Control voltage +1.75 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



Weight: 560 g

TPMOA0074EB

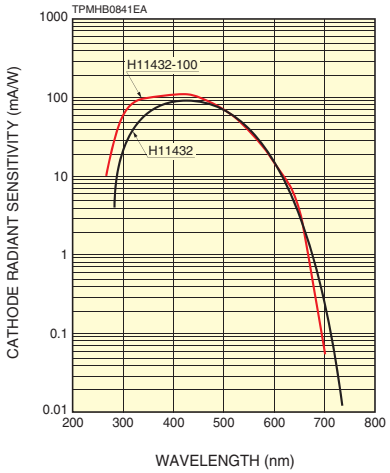
Photomultiplier tube modules H11432 series

(at +25 °C)

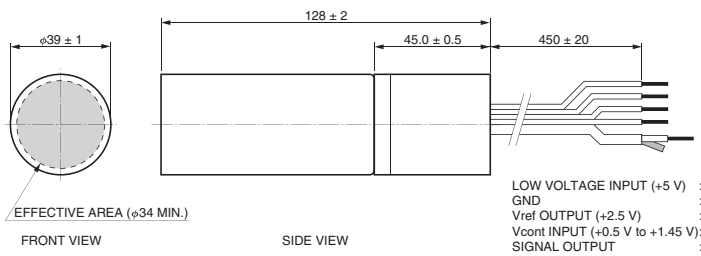
Parameter		H11432	H11432-100	Unit
Spectral response		300 to 650		nm
Effective area		φ34		mm
Input voltage		+4.5 to +5.5		V
Recommended control voltage adjustment range		+0.5 to +1.45 (Max. +1.5)		V
Gain ①	Typ.	5.0×10^5		—
Maximum average output signal current		100		μA
Dark current ①	Typ.	10		nA
Settling time ②	Max.	10		s
Operating ambient temperature		+5 to +50		°C

①Control voltage +1.3 V
②The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



Weight: 135 g

TPMHA0566EB

Photosensor modules H13543 series

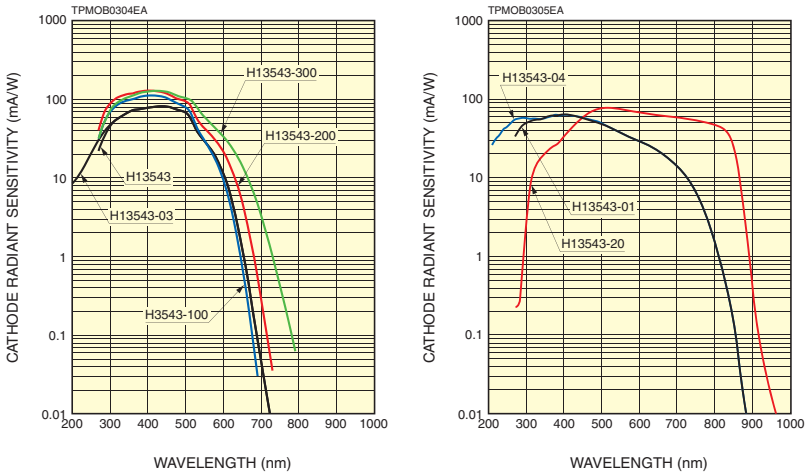
Square photocathode

(at +25 °C)

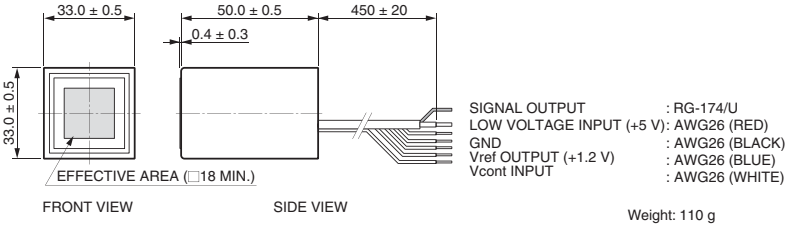
Parameter		H13543	H13543-01	H13543-03	H13543-04	H13543-20	H13543-100	H13543-200	H13543-300	Unit
Spectral response		300 to 650	350 to 880	185 to 650	185 to 880	300 to 920	300 to 650	300 to 650	300 to 700	nm
Effective area (X × Y)		18 × 18								mm
Input voltage		+4.5 to +5.5								V
Recommended control voltage adjustment range		+0.4 to +0.8 (Max. +0.9)								V
Gain ①	Typ.	2.0×10^6	2.0×10^6	2.0×10^6	1.0×10^6	2.0×10^6	1.0×10^6	1.0×10^6	2.0×10^6	—
Maximum average output signal current		100								μA
Dark current ①	Typ.	2	10	2	10	20	2	2	2	nA
Settling time ②	Max.	10								s
Operating ambient temperature		+5 to +50								°C

①Control voltage +0.8 V
②The time required for the output to reach a stable level following a change in the control voltage from +0.8 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



Weight: 110 g

TPMOA0099EA

Photosensor modules H10722 series

Settling time **10** s | **±5** V operating

(at +25 °C)

Parameter		H10722-110	H10722-113	H10722-210	H10722-01	H10722-04	H10722-20	Unit
Spectral response		230 to 700	185 to 700	230 to 700	230 to 870	185 to 870	230 to 920	nm
Effective area		ϕ8						mm
Input voltage		±4.5 to ±5.5						V
Maximum input current		+6.2 / -3.5 (Dark condition)						mA
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)						V
Photomultiplier tube gain ①	Typ.	2.0×10^6						—
Frequency bandwidth		DC to 20 kHz						—
Current-to-voltage conversion factor		1						V/µA
Maximum output signal voltage		+4 (Load resistance 10 kΩ)						V
Voltage output depending on PMT dark current ①	Typ.	1	1	1	1	1	10	mV
Settling time ②	Max.	10						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V
② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

Photosensor modules H11902 series

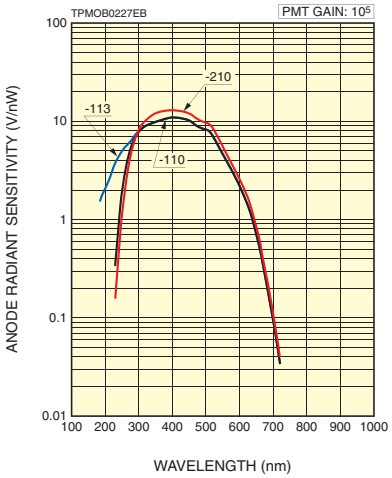
Settling time **0.2** s | **±15** V operating

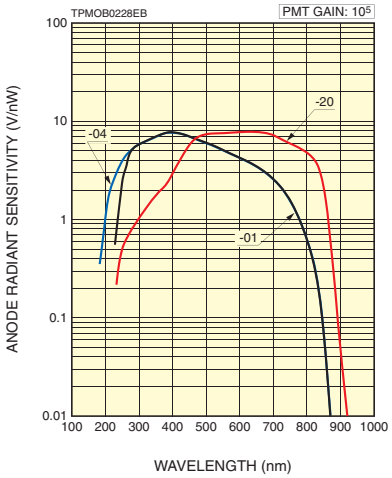
(at +25 °C)

Parameter		H11902-110	H11902-113	H11902-210	H11902-01	H11902-04	H11902-20	Unit
Spectral response		230 to 700	185 to 700	230 to 700	230 to 870	185 to 870	230 to 920	nm
Effective area		ϕ8						mm
Input voltage		±11.5 to ±15.5						V
Maximum input current		+13 / -1 (Dark condition)						mA
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)						V
Photomultiplier tube gain ①	Typ.	2.0×10^6						—
Frequency bandwidth		DC to 20 kHz						—
Current-to-voltage conversion factor		1						V/µA
Maximum output signal voltage		+10 (Load resistance 10 kΩ)						V
Voltage output depending on PMT dark current ①	Typ.	1	1	1	1	1	10	mV
Settling time ②	Max.	0.2						s
Operating ambient temperature		+5 to +50						°C

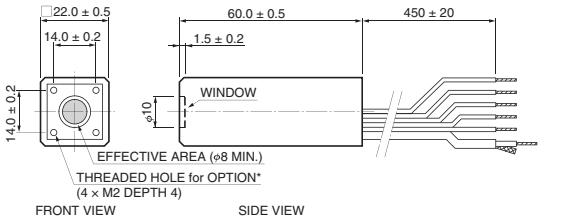
①Control voltage +1.0 V
② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response





●Dimensional outline (Unit: mm)



LOW VOLTAGE INPUT (+5 V / H10722 SERIES) (+15 V / H11902 SERIES) : AWG26 (RED)
LOW VOLTAGE INPUT (-5 V / H10722 SERIES) (-15 V / H11902 SERIES) : AWG26 (GREEN)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT (+0.5 V to +1.1 V) : AWG26 (WHITE)
SIGNAL OUTPUT : RG-174/U

Weight: 90 g

*OPTION: E5776, E5776-51, A9865, A10030-01

TPMOA0063EB

Photosensor modules H10723 series

Settling time **10** s | **±5** V operating

(at +25 °C)

Parameter		H10723-110	H10723-113	H10723-210	H10723-01	H10723-04	H10723-20	Unit
Spectral response		230 to 700	185 to 700	230 to 700	230 to 870	185 to 870	230 to 920	nm
Effective area		ϕ8						mm
Input voltage		±4.5 to ±5.5						V
Maximum input current		+6.2 / -3.5 (Dark condition)						mA
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)						V
Photomultiplier tube gain ①	Typ.	2.0×10^6						—
Frequency bandwidth		DC to 200 kHz						—
Current-to-voltage conversion factor		0.1						V/μA
Maximum output signal voltage		+4 (Load resistance 10 kΩ)						V
Voltage output depending on PMT dark current ①	Typ.	0.1	0.1	0.1	0.1	0.1	1	mV
Settling time ②	Max.	10						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V
② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

Photosensor modules H11903 series

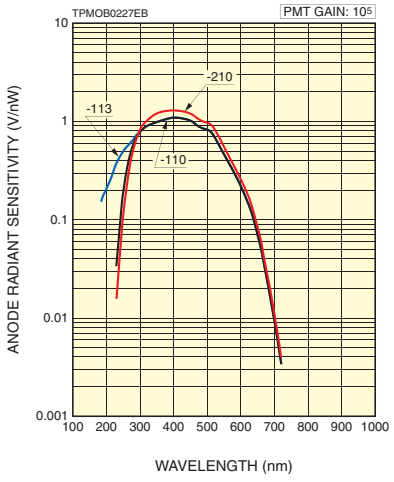
Settling time **0.2** s | **±15** V operating

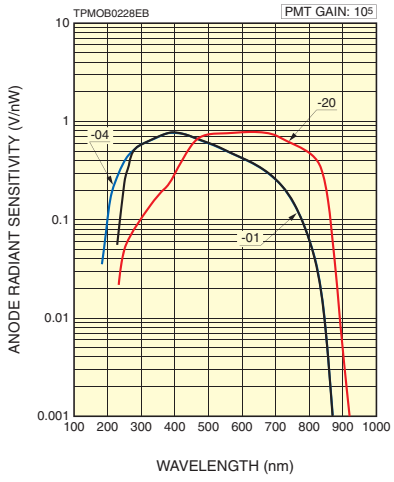
(at +25 °C)

Parameter		H11903-110	H11903-113	H11903-210	H11903-01	H11903-04	H11903-20	Unit
Spectral response		230 to 700	185 to 700	230 to 700	230 to 870	185 to 870	230 to 920	nm
Effective area		ϕ8						mm
Input voltage		±11.5 to ±15.5						V
Maximum input current		+20 / -8 (Dark condition)						mA
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.1)						V
Photomultiplier tube gain ①	Typ.	2.0×10^6						—
Frequency bandwidth		DC to 200 kHz						—
Current-to-voltage conversion factor		0.1						V/μA
Maximum output signal voltage		+10 (Load resistance 10 kΩ)						V
Voltage output depending on PMT dark current ①	Typ.	0.1	0.1	0.1	0.1	0.1	1	mV
Settling time ②	Max.	0.2						s
Operating ambient temperature		+5 to +50						°C

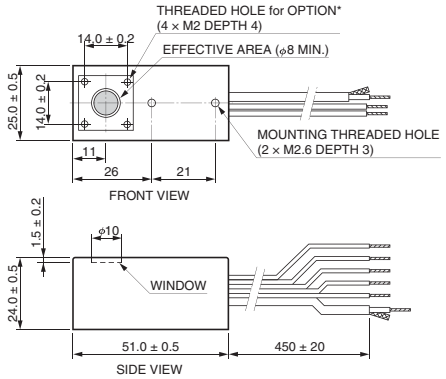
①Control voltage +1.0 V
② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response





●Dimensional outline (Unit: mm)



LOW VOLTAGE INPUT (+5 V / H10723 SERIES) (+15 V / H11903 SERIES)	: AWG26 (RED)
LOW VOLTAGE INPUT (-5 V / H10723 SERIES) (-15 V / H11903 SERIES)	: AWG26 (GREEN)
GND	: AWG26 (BLACK)
Vref OUTPUT (+1.2 V)	: AWG26 (BLUE)
Vcont INPUT (+0.5 V to +1.1 V)	: AWG26 (WHITE)
SIGNAL OUTPUT	: RG-174/U

Weight: 90 g

*OPTION: E5776, E5776-51, A9865, A10030-01

TPMOA0064EB

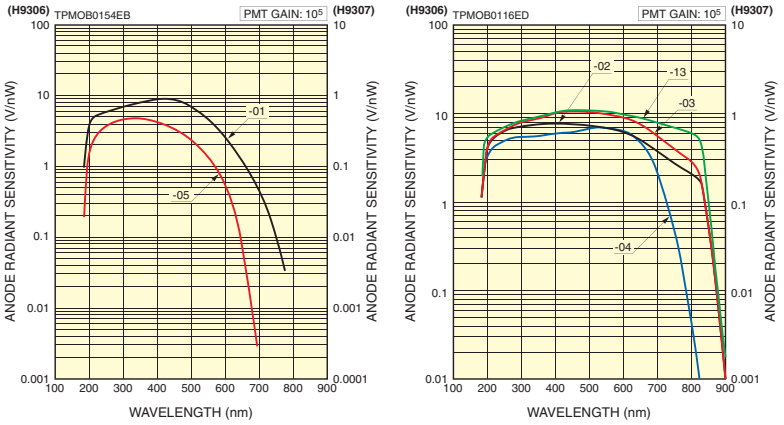
Photosensor modules H9306 series
Photosensor modules H9307 series

(at +25 °C)

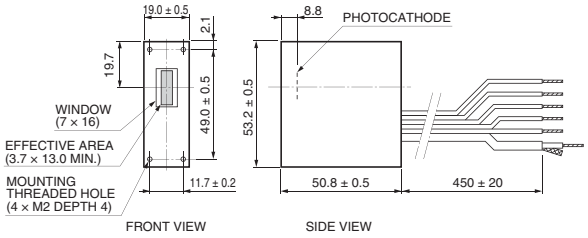
Parameter			H9306-01 H9307-01	H9306-02 H9307-02	H9306-03 H9307-03	H9306-13 H9307-13	H9306-04 H9307-04	H9306-05 H9307-05	Unit
Spectral response			185 to 750	185 to 900	185 to 900	185 to 900	185 to 830	185 to 650	nm
Effective area (X × Y)			3.7 × 13.0						mm
Input voltage			±11.5 to ±15.5						V
Recommended control voltage adjustment range			+0.25 to +1.0 (Max. +1.2)						V
Photomultiplier tube gain ①		Typ.	5.8 × 10^6	4.0 × 10^6	4.0 × 10^6	4.0 × 10^6	3.5 × 10^6	7.5 × 10^6	—
Frequency bandwidth			H9306 series: DC to 20, H9307 series: DC to 200						kHz
Current-to-voltage conversion factor			H9306 series: 1, H9307 series: 0.1						V/µA
Maximum output signal voltage			H9306 series: +10, H9307 series: +1 (Load resistance 10 kΩ)						V
Voltage output depending on PMT dark current ①	H9306	Typ.	1	1	2	3	0.1	0.5	mV
	H9307	Typ.	0.1	0.1	0.2	0.3	0.01	0.05	
Settling time ②		Max.	10						s
Operating ambient temperature			+5 to +50						°C

①Control voltage +1.0 V ② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



LOW VOLTAGE INPUT (+15 V) : AWG26 (RED)
LOW VOLTAGE INPUT (-15 V) : AWG26 (GREEN)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT (+0.25 V to +1.0 V): AWG26 (WHITE)
SIGNAL OUTPUT : RG-174/U

Weight: 110 g

TPMOA0013JG

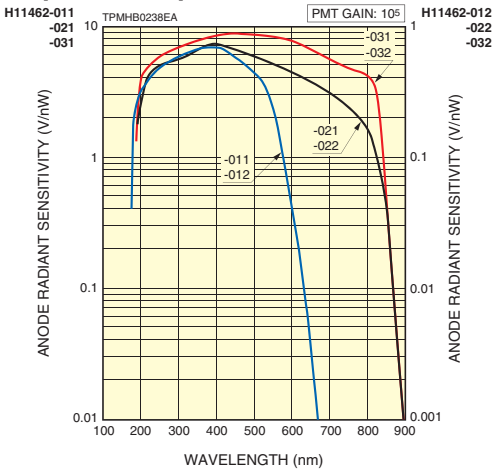
Photosensor modules H11462 series

(at +25 °C)

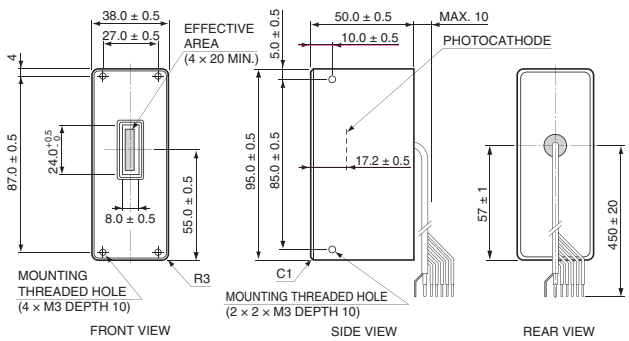
Parameter		H11462-011	H11462-012	H11462-021	H11462-022	H11462-031	H11462-032	Unit
Spectral response		185 to 710		185 to 900		185 to 900		nm
Effective area (X × Y)		4 × 20						mm
Input voltage		±4.5 to ±5.5						V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.2)						V
Photomultiplier tube gain ①	Typ.	1.2 × 10^7		1.0 × 10^7		9.5 × 10^6		—
Frequency bandwidth (DC to)		20	200	20	200	20	200	kHz
Current-to-voltage conversion factor		1	0.1	1	0.1	1	0.1	V/µA
Maximum output signal voltage		+4 (Load resistance 10 kΩ)						V
Voltage output depending on PMT dark current ①	Typ.	0.2	0.02	3	0.3	10	1	mV
Settling time ②	Max.	14						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V ② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



LOW VOLTAGE INPUT (+5 V) : AWG26 (RED)
LOW VOLTAGE INPUT (-5 V) : AWG26 (GREEN)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT (+0.5 V to +1.1 V) : AWG26 (WHITE)
SIGNAL OUTPUT : RG-174/U

Weight: 225 g

TPMOA0073EC

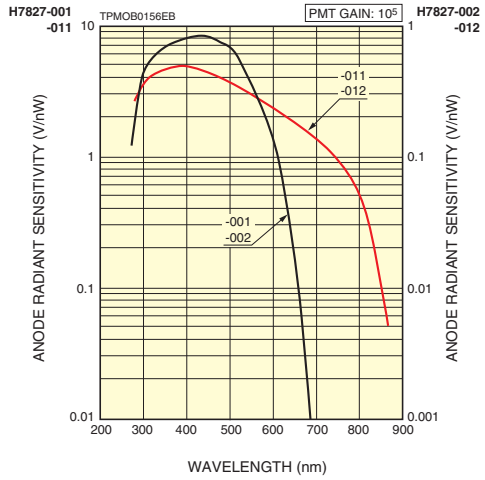
Photosensor modules H7827 series

(at +25 °C)

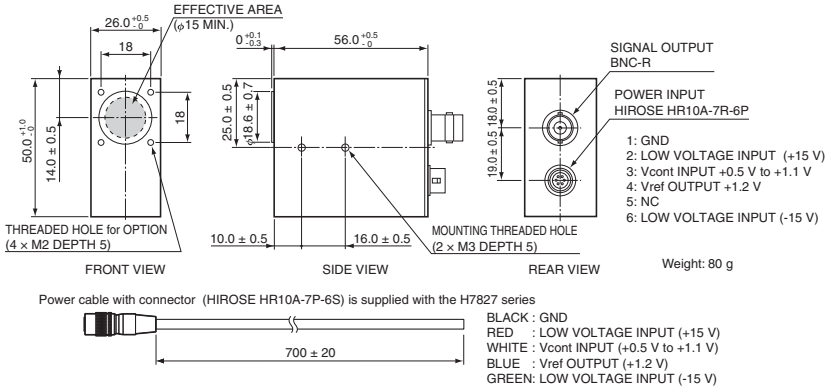
Parameter		H7827-001	H7827-002	H7827-011	H7827-012	Unit
Spectral response		300 to 650		300 to 850		nm
Effective area		ϕ15				mm
Input voltage		±11.5 to ±15.5				V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.2)				V
Photomultiplier tube gain ①	Typ.	5.5 × 10^5		2.5 × 10^5		—
Frequency bandwidth (DC to)		20	200	20	200	kHz
Current-to-voltage conversion factor		1	0.1	1	0.1	V/μA
Maximum output signal voltage		+10 (Load resistance 10 kΩ)				V
Voltage output depending on PMT dark current ①	Typ.	3	0.3	3	0.3	mV
Settling time ②	Max.	0.2				s
Operating ambient temperature		+5 to +45				°C

①Control voltage +1.0 V ② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



TPMOA0023ED

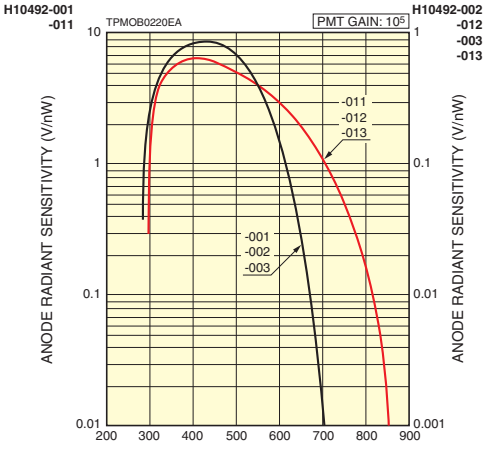
Photosensor modules H10492 series

(at +25 °C)

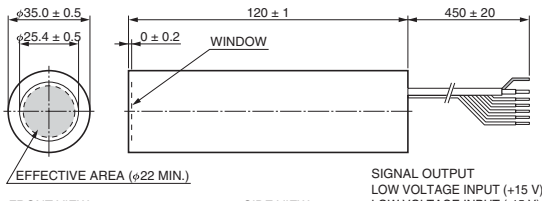
Parameter		H10492-001	H10492-002	H10492-003	H10492-011	H10492-012	H10492-013	Unit
Spectral response		300 to 650			300 to 850			nm
Effective area		ϕ22						mm
Input voltage		±11.5 to ±15.5						V
Recommended control voltage adjustment range		+0.5 to +1.1 (Max. +1.2)						V
Photomultiplier tube gain ①	Typ.	2.0 × 10^6			5.0 × 10^5			—
Frequency bandwidth (DC to)		20	200	8000	20	200	8000	kHz
Current-to-voltage conversion factor		1	0.1	0.1	1	0.1	0.1	V/μA
Maximum output signal voltage		-001/-002/-011/-012: +10 (Load resistance 10 kΩ), -003/-013: +10 (Load resistance 500 Ω) +5 (Load resistance 50 Ω)						V
Voltage output depending on PMT dark current ①	Typ.	3	0.3	0.3	3	0.3	0.3	mV
Settling time ②	Max.	10						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V ② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



SIGNAL OUTPUT : RG-174/U
LOW VOLTAGE INPUT (+15 V) : AWG26 (RED)
LOW VOLTAGE INPUT (-15 V) : AWG26 (GREEN)
GND : AWG26 (BLACK)
Vref OUTPUT (+1.2 V) : AWG26 (BLUE)
Vcont INPUT (+0.5 V to +1.1 V) : AWG26 (WHITE)

Weight: H10492-001/-002/-003 170 g
H10492-011/-012/-013 180 g

TPMOA0059EB

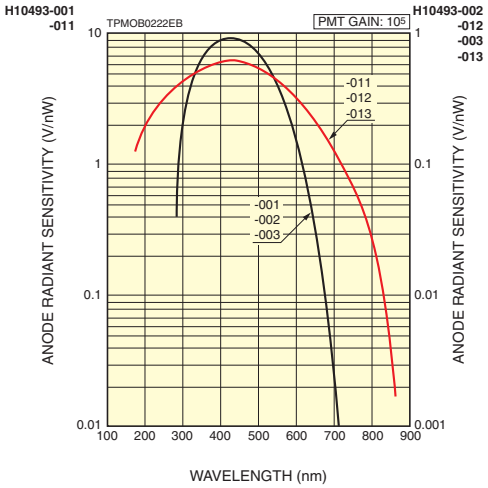
Photosensor modules H10493 series

(at +25 °C)

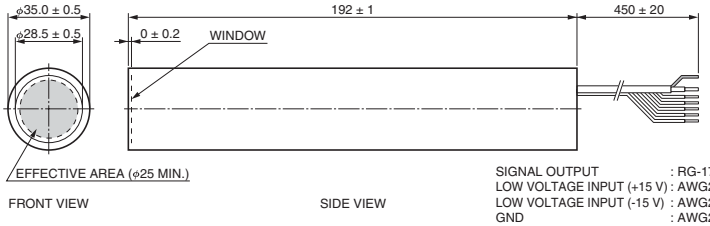
Parameter		H10493-001	H10493-002	H10493-003	H10493-011	H10493-012	H10493-013	Unit
Spectral response		300 to 650			185 to 850			nm
Effective area		ϕ25						mm
Input voltage		±11.5 to ±15.5						V
Recommended control voltage adjustment range		+0.5 to +1.4 (Max. +1.5)						V
Photomultiplier tube gain ①	Typ.	2.1×10^6			5.3×10^5			—
Frequency bandwidth (DC to)		20	200	8000	20	200	8000	kHz
Current-to-voltage conversion factor		1	0.1	0.1	1	0.1	0.1	V/μA
Maximum output signal voltage		-001/-002/-011/-012: +10 (Load resistance 10 kΩ), -003/-013: +10 (Load resistance 500 Ω) +5 (Load resistance 50 Ω)						V
Voltage output depending on PMT dark current ①	Typ.	2	0.2	0.2	3	0.3	0.3	mV
Settling time ②	Max.	10						s
Operating ambient temperature		+5 to +50						°C

①Control voltage +1.0 V ② The time required for the output to reach a stable level following a change in the control voltage from +1.0 V to +0.5 V

●Spectral response



●Dimensional outline (Unit: mm)



SIGNAL OUTPUT : RG-174/U
LOW VOLTAGE INPUT (+15 V) : AWG26 (RED)
LOW VOLTAGE INPUT (-15 V) : AWG26 (GREEN)
GND : AWG26 (BLACK)
Vref OUTPUT (+2.5 V) : AWG26 (BLUE)
Vcont INPUT (+0.5 V to +1.4 V) : AWG26 (WHITE)

Weight: 270 g

TPMOA0060EB

Photon counting heads H10682 series
Photon counting heads H12386 series

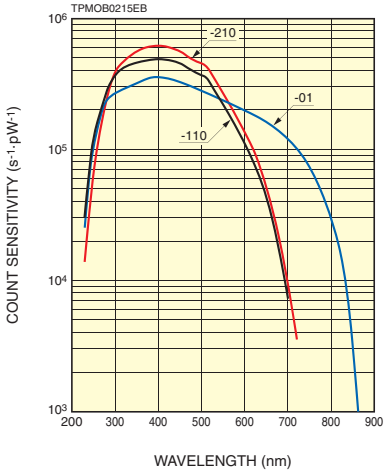
▲H10682 series

▲H12386 series

(at +25 °C)

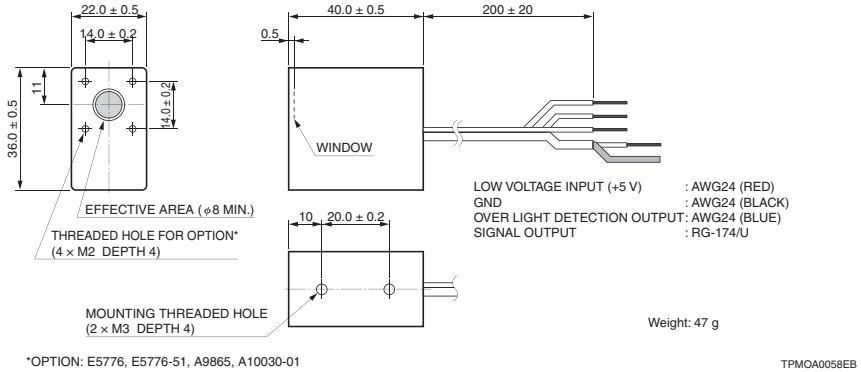
Parameter		H10682-110 H12386-110	H10682-210 H12386-210	H10682-01 H12386-01	Unit
Spectral response		230 to 700	230 to 700	230 to 870	nm
Effective area		ϕ8			mm
Input voltage		+4.75 to +5.25			V
Count linearity		5.0×10^6			s^{-1}
Dark count	Typ.	50	50	600	s^{-1}
Pulse-pair resolution		20			ns
Output pulse width		10			ns
Output pulse Height	Min.	+2.0 (Load resistance 50 Ω), +4.0 (Un-terminated)			V
Recommended load resistance		50			Ω
Operating ambient temperature		+5 to +40			°C

●Count sensitivity



●Dimensional outline (Unit: mm)

■H10682 series

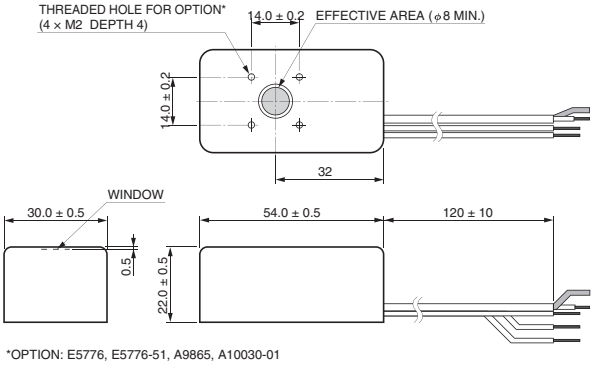


Weight: 47 g

*OPTION: E5776, E5776-51, A9865, A10030-01

TPMOA0058EB

■H12386 series



*OPTION: E5776, E5776-51, A9865, A10030-01

Weight: 61 g

TPMOA0090EA

Photon counting heads H7421 series Cooler

Heatsink with fan (A7423)
sold separately

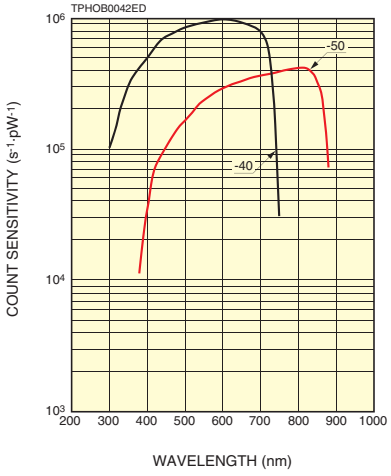
(at +25 °C)

Parameter		H7421-40	H7421-50	Unit
Spectral response		300 to 720	380 to 890	nm
Effective area		φ5		mm
Input voltage		+4.5 to +5.5		V
Count linearity		1.5×10^6		s^{-1}
Dark count (at 0 °C)	Typ.	100	125	s^{-1}
Pulse-pair resolution		70		ns
Output pulse width		30		ns
Output pulse Height	Min.	+3.0		V
Recommended load resistance		50		Ω
Operating ambient temperature		+5 to +35		°C

Cooling specifications

Cooling method	Thermoelectric cooling	—
Max. cooling temperature (ΔT)	35	°C
Cooling time	Approx. 5	min

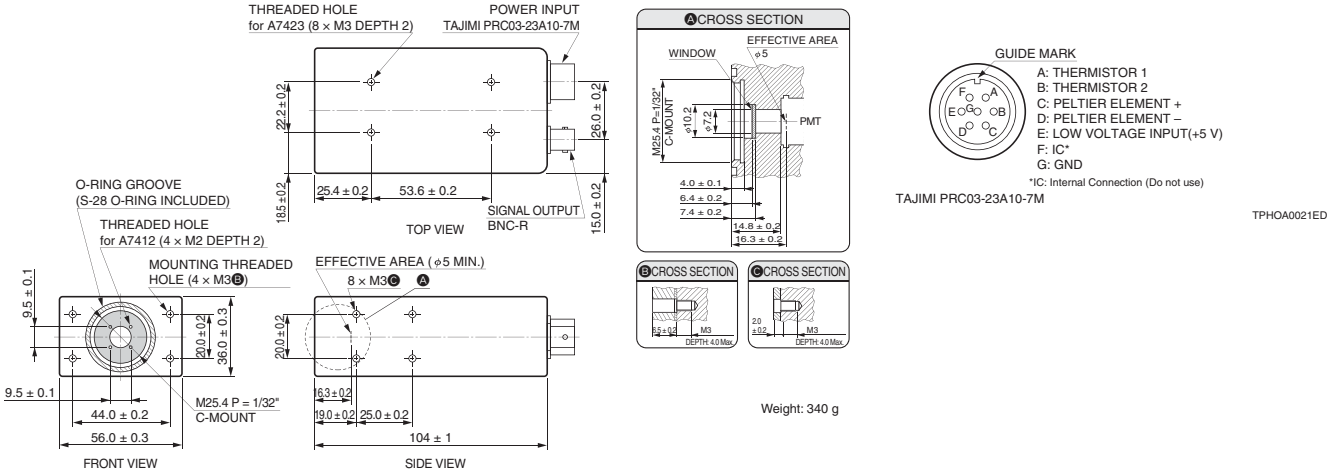
●Count sensitivity



●Option

- Heatsink with fan A7423
- Single cable E1168-05
- Optical fiber adapter (FC type) A7412
- C-mount adapter A7413
- Power supply unit with temperature control (AC100 V to 240 V input) C8137
- Power supply unit with temperature control (+12 V input, on-board type) M13413

●Dimensional outline (Unit: mm)



Photon counting heads H11890 series

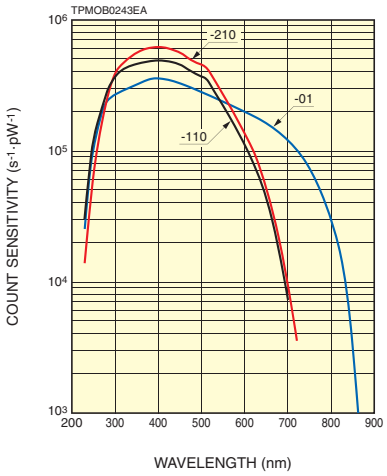
CPU+I/F

(at +25 °C)

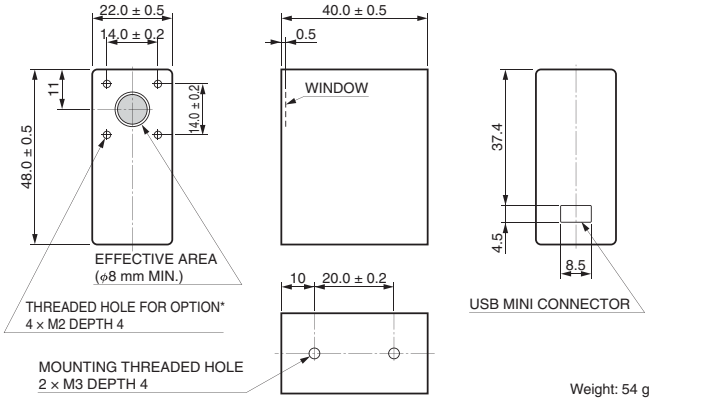
Parameter		H11890-110	H11890-210	H11890-01	Unit
Spectral response		230 to 700	230 to 700	230 to 870	nm
Effective area		ϕ8			mm
Input voltage		USB Bus power			—
Count linearity		5.0×10^6 (with function of linearity correction: 2.0×10^7)			s^{-1}
Dark count	Typ.	50	50	600	s^{-1}
Pulse-pair resolution		20			ns
Counter gate time		1 to 10000			ms
Interface ①		USB2.0			—
Compatible OS ②		Windows® 7 Pro, 8 Pro			—
Operating ambient temperature		+5 to +40			°C

①Conform to in RS-232C ②Sample program supplied

●Count sensitivity



●Dimensional outline (Unit: mm)



Weight: 54 g

*OPTION: E5776, E5776-51, A9865, A10030-01

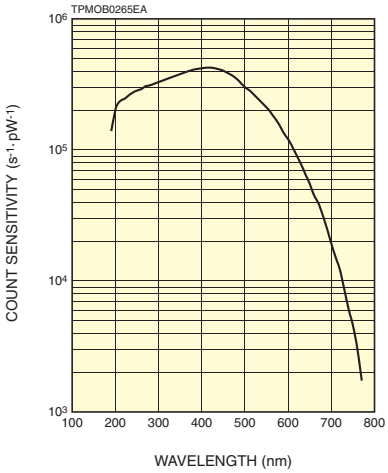
TPMOA0075EC

Photon counting head H12525-01

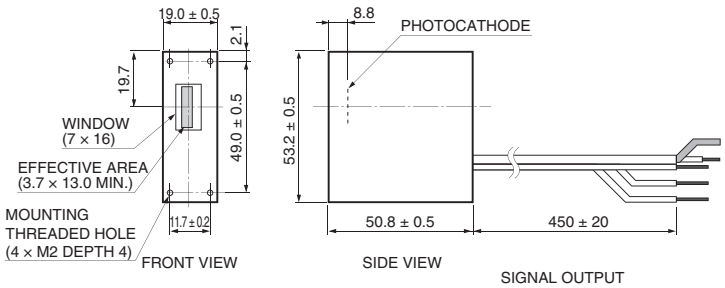
(at +25 °C)

Parameter		H12525-01	Unit
Spectral response		185 to 750	nm
Effective area (X × Y)		3.7 × 13.0	mm
Input voltage		+4.75 to +5.25	V
Count linearity		2.0×10^6	s^{-1}
Dark count	Typ.	50	s^{-1}
Pulse-pair resolution		20	ns
Output pulse width		10	ns
Output pulse Height	Min.	+2.0 (Load resistance 50 Ω), +4.0 (Un-terminated)	V
Recommended load resistance		50	Ω
Operating ambient temperature		+5 to +50	°C

●Count sensitivity



●Dimensional outline (Unit: mm)



SIGNAL OUTPUT : RG-174/U
LOW VOLTAGE INPUT (+5 V) : AWG26 (RED)
GND : AWG26 (BLACK)
OVER LIGHT DETECTION OUTPUT: AWG26 (BLUE)

Weight: 110 g

TPMOA0089EC

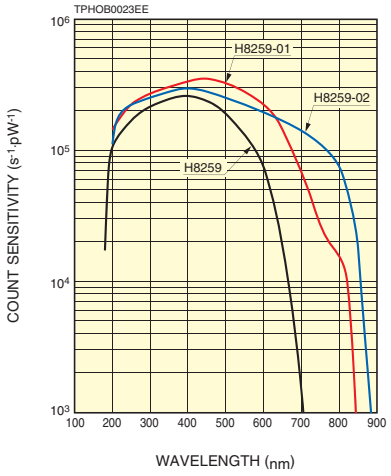
Photon counting heads H8259 series

Gate 50 µs

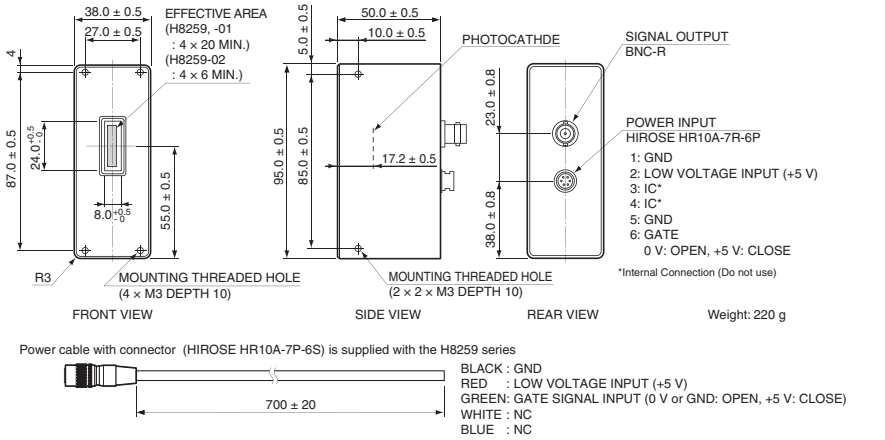
(at +25 °C)

Parameter		H8259	H8259-01	H8259-02	Unit
Spectral response		185 to 680	185 to 850	185 to 900	nm
Effective area (X × Y)		4 × 20		4 × 6	mm
Input voltage		+4.5 to +5.5			V
Count linearity		2.5×10^6			s^{-1}
Dark count	Typ.	30	80	400	s^{-1}
Gate width (FWHM)		50 µs to DC (Normally ON)			—
Repetition rate	Max.	10			kHz
Pulse-pair resolution		35			ns
Output pulse width		30			ns
Output pulse Height	Min.	+2.0 (Load resistance 50 Ω)			V
Recommended load resistance		50			Ω
Operating ambient temperature		+5 to +40			°C

●Count sensitivity



●Dimensional outline (Unit: mm)



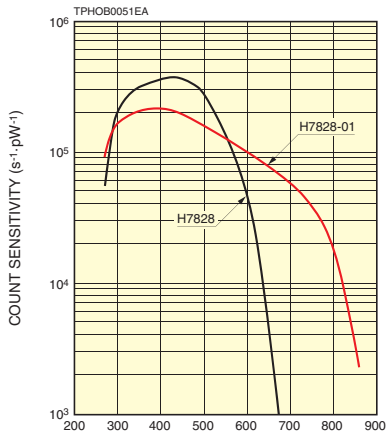
TPHOA0027EF

Photon counting heads H7828 series

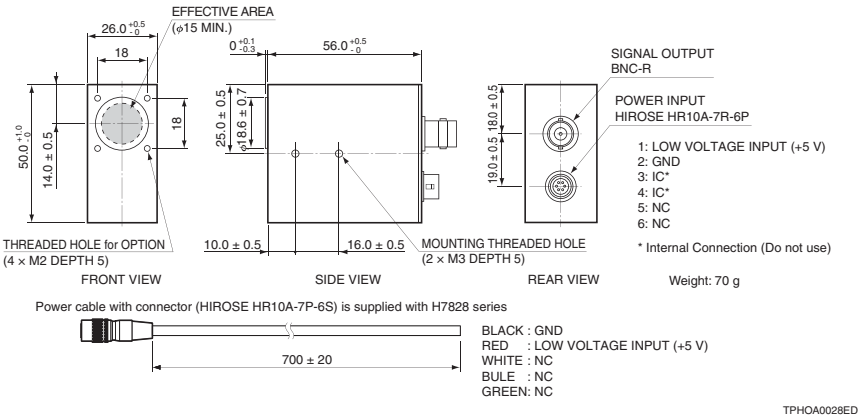
(at +25 °C)

Parameter		H7828	H7828-01	Unit
Spectral response		300 to 650	300 to 850	nm
Effective area		φ15		mm
Input voltage		+4.5 to +5.5		V
Count linearity		1.5×10^6		s^{-1}
Dark count	Typ.	200	2000	s^{-1}
Pulse-pair resolution		70		ns
Output pulse width		30		ns
Output pulse Height	Min.	+3.0 (Load resistance 50 Ω)		V
Recommended load resistance		50		Ω
Operating ambient temperature		+5 to +40		°C

●Count sensitivity



●Dimensional outline (Unit: mm)



TPHOA0028ED

Photon counting heads H11870 series
Photon counting heads H13467 series

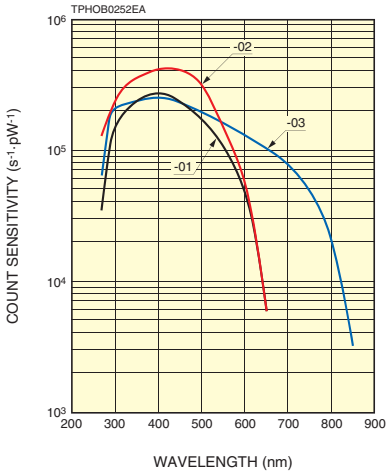
(at +25 °C)

▲H11870 series

▲H13467 series

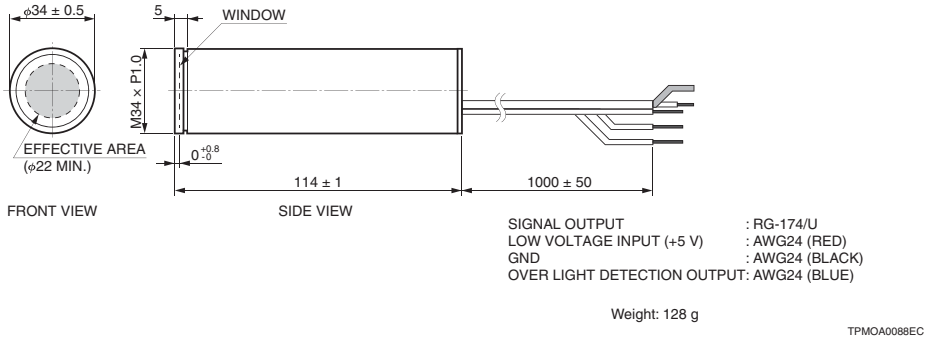
Parameter		H11870-01 H13467-01	H11870-02 H13467-02	H11870-03 H13467-03	Unit
Spectral response		300 to 650	300 to 650	300 to 850	nm
Effective area		ϕ22			mm
Input voltage		+4.75 to +5.25			V
Count linearity		6.0×10^6			s^{-1}
Dark count	Typ.	15	60	5000	s^{-1}
Pulse-pair resolution		18			ns
Output pulse width		9			ns
Output pulse Height	Min.	+2.0 (Load resistance 50 Ω), +4.0 (Un-terminated)			V
Recommended load resistance		50			Ω
Operating ambient temperature		+5 to +40			°C

●Count sensitivity



●Dimensional outline (Unit: mm)

■H11870 series

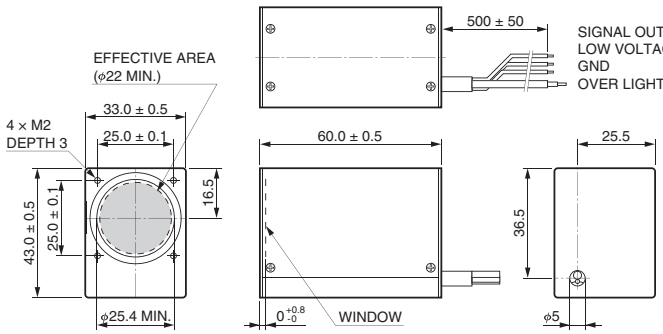


SIGNAL OUTPUT : RG-174/U
LOW VOLTAGE INPUT (+5 V) : AWG24 (RED)
GND : AWG24 (BLACK)
OVER LIGHT DETECTION OUTPUT: AWG24 (BLUE)

Weight: 128 g

TPMOA0088EC

■H13467 series



SIGNAL OUTPUT : RG-174/U
LOW VOLTAGE INPUT (+5 V) : AWG24 (RED)
GND : AWG24 (BLACK)
OVER LIGHT DETECTION OUTPUT: AWG24 (BLUE)

Weight: 111 g

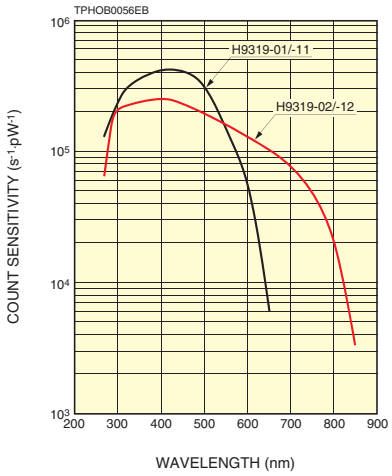
TPMOA0092EB

Photon counting heads H9319 series CPU+I/F

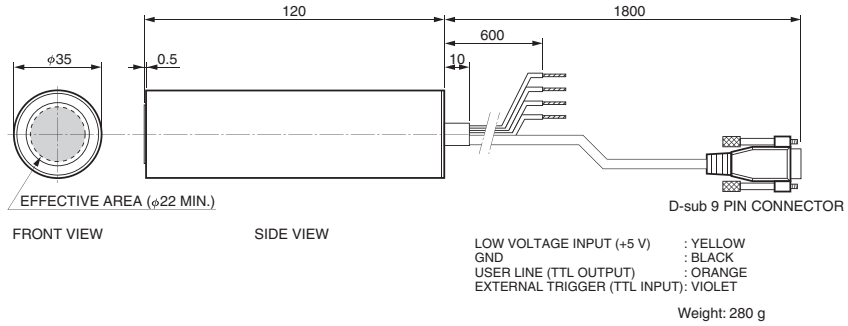
(at +25 °C)

Parameter		H9319-01	H9319-11	H9319-02	H9319-12	Unit
Spectral response		300 to 650		300 to 850		nm
Effective area		ϕ22				mm
Input voltage		+4.75 to +5.25				V
Count linearity		20 × 10^6				s^{-1}
Dark count	Typ.	150		10000		s^{-1}
Counter gate time		10 to 1000				ms
Input signal (External trigger input)		TTL level signal				—
Output signal (User line output)		TTL level signal				—
Interface		RS-232C				—
Sample program		yes	no	yes	no	—
Operating ambient temperature		+5 to +50				°C

●Count sensitivity



●Dimensional outline (Unit: mm)



Weight: 280 g

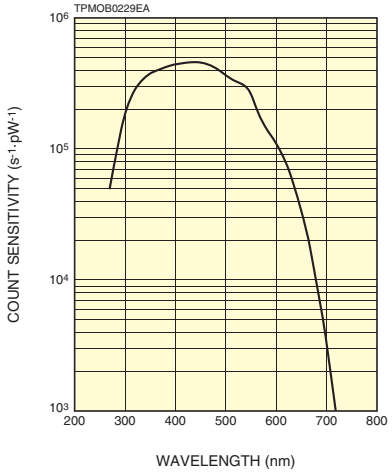
TPMOA0032EB

Photon counting head H11123

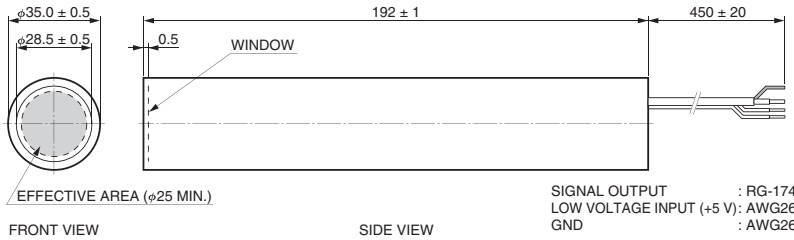
(at +25 °C)

Parameter		H11123	Unit
Spectral response		300 to 650	nm
Effective area		ϕ25	mm
Input voltage		+4.75 to +5.25	V
Count linearity		5.0 × 10^6	s^{-1}
Dark count	Typ.	100	s^{-1}
Pulse-pair resolution		20	ns
Output pulse width		10	ns
Output pulse Height	Min.	+2.0 (Load resistance 50 Ω), +4.0 (Un-terminated)	V
Recommended load resistance		50	Ω
Operating ambient temperature		+5 to +40	°C

●Count sensitivity



●Dimensional outline (Unit: mm)



Weight: 260 g

TPMOA0065EB

Related products

Power supplies for PMT modules C7169, C10709

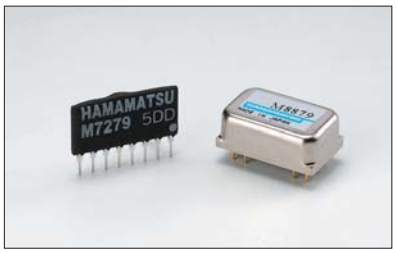
The C7169 and C10709 are power supply units for photomultiplier tube modules. Input voltage and control voltage for photomultiplier tube modules can be supplied by this power supply unit alone.

Parameter		C7169	C10709	Unit
Output voltage		±15	±5	V
Output current	Max.	0.3 (+15 V), 0.2 (-15 V)	2.0 (+5 V), 0.2 (-5 V)	A
Control voltage Ⓐ (variable voltage range)		+0.25 to +1.8		V
Applicable products		H7826, H7827, H7844, H9305, H9306 H9307, H10425, H10426, H10492 H10493, H11411, H11526, H11706 H11900, H11901, H11902, H11903	H10720, H10721, H10722, H10723 H11432, H11461, H11462, H12056 H12402, H12403, H13320, H13543	—
Output connector		Binding post		—
Input voltage		AC 100 to AC 240		V

ⒶAdjust within the recommended control voltage range for the photosensor module being used.

Amplifier units, Amplifier modules

These are amplifier units and amplifier modules for photomultiplier tubes and current output type PMT modules.
Output signal from photomultiplier tubes can be directly input into these amplifiers.



Type No.	Frequency bandwidth (-3 dB)	Current-to-voltage conversion factor	Signal input polarity (Output)	Signal connector		Supply voltage (V)
				Input	Output	
C7319	DC to 20 kHz DC to 200 kHz (Switchable)	0.1 V/μA, 1 V/μA 10 V/μA (Switchable)	Positive / Negative (Inverting)	BNC-R		±5 to ±15
C12419	DC to 1 MHz	1 V/μA	Positive / Negative (Inverting)	BNC-R		±15
C9999	DC to 10 MHz	50 mV/μA	Positive / Negative (Non-inverting)	BNC-R		±5
C9999-01		10 mV/μA	Positive / Negative (Inverting / Non-inverting)			
C6438	DC to 50 MHz	0.5 mV/μA	Positive / Negative (Non-inverting)	BNC-R		±5
C6438-01		25 mV/μA	Positive / Negative (Non-inverting)			
C6438-02		5 mV/μA	Positive / Negative (Inverting / Non-inverting)			
C9663	DC to 150 MHz	4 mV/μA	Positive / Negative (Non-inverting)	BNC-R		±5
C11184	DC to 300 MHz	1.25 mV/μA	Positive / Negative (Non-inverting)	MCX-R (MCX-BNC adapter is supplied)		±5
C5594-12	50 kHz to 1.5 GHz	3.15 mV/μA	Positive / Negative (Non-inverting)	SMA-P	SMA-R	+12 to +16
C5594-22				SMA-R	SMA-R	
C5594-44				BNC-R	BNC-R	
M7279	DC to 10 MHz	10 mV/μA	Positive / Negative (Non-inverting)	On-board mounting		±5 to ±6.5
M8879	DC to 150 MHz	4 mV/μA	Positive / Negative (Non-inverting)	On-board mounting		±5 to ±6

Photon counting unit C9744

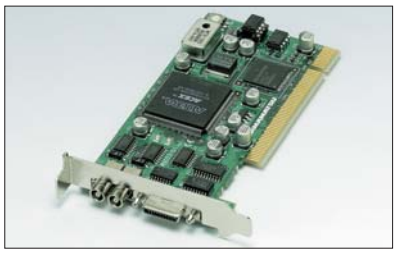
The photon counting unit C9744 converts single photoelectron pulses from a photomultiplier tube into digital signals of logic pulse by use of the built-in amplifier and discriminator circuits. Photon counting can be easily performed by simply connecting a counter to the output of the photon counting unit.
The C9744, which incorporates a prescaler (division by 10), can perform measurement with an excellent output linearity up to 10^7 s^{-1}.

Parameter	Description / Value		Unit
Input impedance	50		Ω
Discrimination level (input conversion)	-0.4 to -16		mV
Required PMT gain	3×10^6		—
Prescaler	÷1	÷10	—
Count linearity	4×10^6	1×10^7	s^{-1}
Pulse-pair resolution	25	10	ns
Output pulse width	10	Depends on count rate	ns
Output pulse	CMOS, positive logic		—
Connector	Input / output: BNC-R, Power: DIN-R (6 pin) Ⓐ		—
Supply voltage	+5.0 V, 130 mA / -5.0 V, 50 mA		—

ⒶSupplied with a cable (1.5 m) attached to the mating plug.

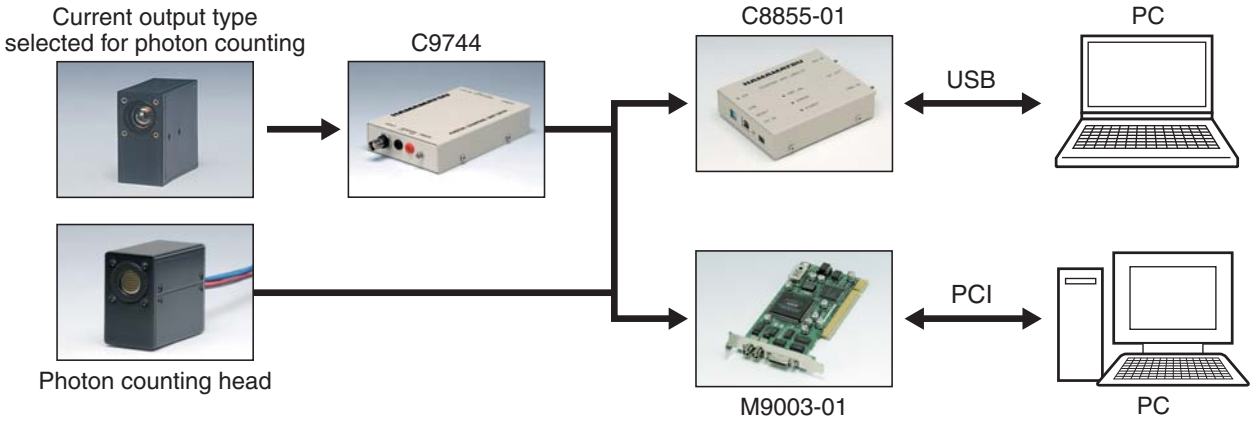
Counting unit C8855-01, Counting board M9003-01

The C8855-01 is a counting unit with a USB interface and M9003-01 is a counting board that is PCI bus add-in type. Both products have two counter circuits (double counter method) capable of counting input signals with no dead time. The C8855-01 is supplied with sample software and therefore you can start measurement as soon as the C8855-01 is delivered.



Parameter	C8855-01	M9003-01	Unit
Number of input signals	1	2	ch
Signal input level	CMOS positive logic	TTL positive logic	—
Signal pulse width	8 or longer		ns
Input impedance	50 Ω	50 Ω (at SW ON), 100 kΩ (at SW OFF)	—
Max. count rate	50		MHz
Internal counter gate time	50 µs to 10 s	50 ns to 12.75 µs	—
Trigger method	Software / External trigger		—
External trigger signal	TTL negative logic		—
OS	Windows® 7/8/8.1/10 Professional		—
Data transfer method / transfer quantity	—	DMA transfer / 64 M bytes MAX.	—
Supply voltage	+7 V / 500 mA Max. (AC adapter included)	PCI standard	—

■Example of connections for photon counting measurement



Optical blocks for PMT module

Optical blocks are precision units that contain or can contain optical components such as bandpass filters and dichroic mirrors. These blocks are specially designed for low-light-level measurements using PMT modules. Their optical components are precisely arranged to ensure complete light shielding. They can be easily attached/detached by thumbscrews allowing optical blocks to be freely combined as needed. Optical blocks can be assembled in combination with light sources such as lasers or microscope objective lenses to create confocal optical systems or fluorescence microscopes.

▲Optical block combinations

■Lineup

C-mount adapter A9865

This adapter connects a PMT module to C-mount threaded optical blocks. This adapter can also be connected to a device with C-mount.

Adapter block A10030-01

The A10030-01 is an adapter block for connecting a PMT module to a V-groove type optical block.

Fiber adapter block A10037 series

This block connects to optical fibers with a FC/SMA connector. The lens assembled in the block collimates the light spreading from the optical fiber.

Filter block A10033-90

The A10033-90 is a holder block for assembling a commercially available 15 mm diameter filter.

C-mount adapter block A10039

This block connects a device having C-mount to V-groove type optical blocks. The connection angle for the device and block is adjustable.

Pinhole block A11027

This is a holder block that can hold a commercially available, mount type pinhole. Light passing through the pinhole is collimated by the lens installed in the block and is output.

C-mount interchangeable filter block A11213 series

The A11213 series is a C-mount connection block for installing a commercially available 25 mm diameter filter or lens. This block allows angle adjustment and so is useful as a spacer or adapter that connects between C-mounts.

C-mount interchangeable dichroic block A11214

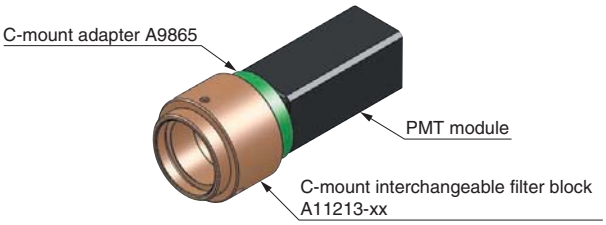
The A11214 is a C-mount connection block for installing a commercially available dichroic mirror having a 45 degree incident angle, 1 mm thickness, and dimensions of 26 × 38 mm.

* Other types of optical blocks are also available besides the products listed here. For more details please refer to the individual catalogs or access our web site.

■Connection example

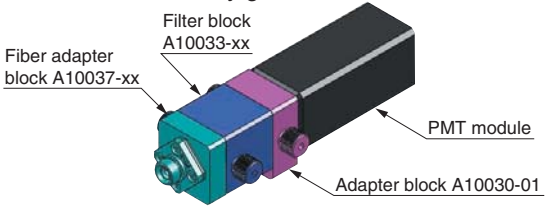
●Single wavelength detection with C mount

Optical filter within the block passes only light at a specific wavelength which is then detected by the PMT module.



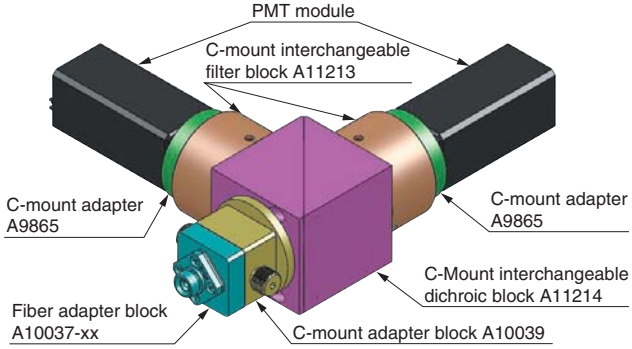
●Fiber-optic single wavelength detection

Light emitted and spreading from an optical fiber cable is collimated by the lens within the A10037 series fiber adapter block and so is effectively guided to the PMT module.



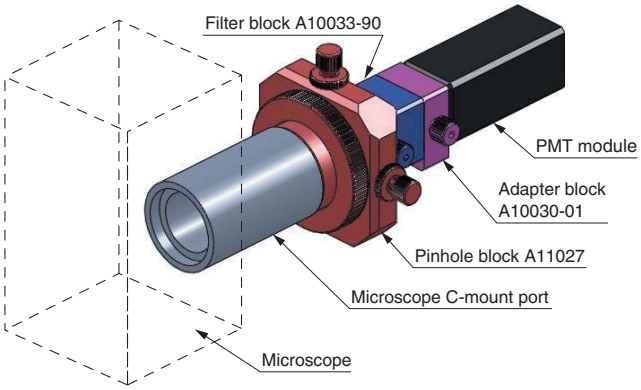
●Fiber-optic dual wavelength detection

The dichroic mirror within the block reflects light shorter than a certain wavelength and passes light longer than that wavelength. The optical filters further pass only light at a specific wavelength which is then detected by PMT modules.



●Extended example of microscope

Connecting the A11027 pinhole block to the C-mount port of a microscope configures a confocal optical system. Light passing through the pinhole is collimated by the lens in the block and is efficiently guided to the PMT module.



Stabilized light sources L11416, L11494 series

The L11416 and L11494 series are LED light sources mainly designed for adjusting the sensitivity of PMT (photomultiplier tubes) and PMT modules. The L11416 series is a test tube type easily mounted in lab devices such as for blood sampling, while the L11494 series is a plate type designed to be placed on a sample stage.
Stable continuous light of approximately 1 pW is always output because the LED emission power is controlled by monitoring with a photodiode.

▲Left: L11494, Right: L11416

■Features

●High stability even at photon counting level

■Specifications

●L11416 series

Parameter		L11416-470	L11416-525	L11416-555	L11416-590	Unit
Peak emission wavelength		465	522	555	592	nm
Spectral half width		26	35	30	18	nm
Light emission power		1 ± 0.5 Ⓐ				pW
Emission stability (0 °C to +50 °C)		±2 Max.				%
Battery		Button battery SR41 or equivalent				—
Battery service Life	Min.	24				h
Operating ambient temperature / humidity Ⓑ		0 °C to +50 °C / below 85 %				—
Storage temperature / humidity Ⓑ		-20 °C to +60 °C / below 85 %				—
Weight		13				g

ⒶAdjusted by using a 22 mm effective diameter photon counting head placed at a position 5 mm away from the L11416. ⒷNo condensation

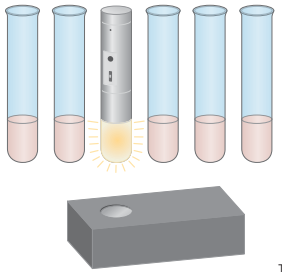
●L11494 series

Parameter		L11494-430	L11494-470	L11494-525	L11494-660	Unit
Peak emission wavelength		428	465	522	660	nm
Spectral half width		65	26	35	30	nm
Light emission power		High: 1 ± 0.5, Low: 0.01 ± 0.005 Ⓒ				pW
Emission area		φ7.0				mm
Emission stability (0 °C to +50 °C)		±2 Max.				%
Battery		Button battery SR41 or equivalent				—
Battery service life	Min.	10	24			h
Operating ambient temperature / humidity Ⓓ		0 °C to +50 °C / below 85 %				—
Storage temperature / humidity Ⓓ		-20 °C to +60 °C / below 85 %				—
Weight		23				g

ⒸAdjusted by using an 8 mm effective diameter photon counting head placed in direct contact with the L11494. ⒹNo condensation

■Image during use

●L11416



TACCC0172EA

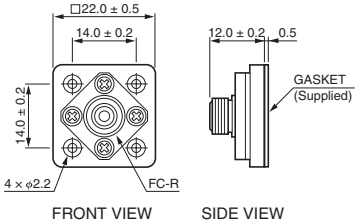
●L11494

TACCC0150EB

Optical fiber adapters for PMT modules E5776, E5776-51

This optical fiber adapter allows connection to an optical fiber cable which has FC or SMA connector. Guiding the light with an optical fiber can be easily performed by fixing this adapter to incident surface of photomultiplier tube module.

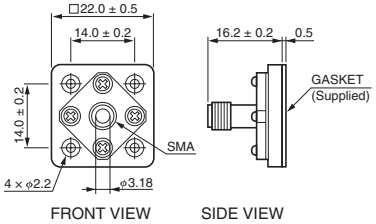
E5776 (FC type)



* Supplied with M2 screws (4 pcs) for fixing to module

TACCA0055EC

E5776-51 (SMA type)



* Supplied with M2 screws (4 pcs) for fixing to module

TACCA0239EC

Connectable PMT modules: H10682, H10720, H10721, H10722, H10723, H11526, H11706
H11890, H11900, H11901, H11902, H11903, H12056, H12386

* When bandpass filter or the like are required between optical fiber and module, it is recommended to use the fiber adapter block A10037 series (P.34), which includes the lens that can collimate diffused light from an optical fiber.

General Characteristics

Photocathode radiant sensitivity and quantum efficiency

Radiant sensitivity is the photoelectric current generated from the photocathode when struck by light at a given wavelength, divided by the incident radiant power, and expressed in A/W (amperes per watt). Quantum efficiency (QE) is the number of photoelectrons emitted from the photocathode divided by the number of incident photons and is usually expressed as a percent. Cathode radiant sensitivity is one factor in determining signal-to-noise (S/N) characteristics and detection limit of measurement systems, and is used to calculate signal-to-noise ratio (S/N ratio) and noise equivalent power (NEP) representing a lower detection limit.

Measurement of radiant sensitivity requires a sophisticated system using a spectrophotometer and also takes a lot of time. Because of this, we only attach spectral response data showing radiant sensitivity to the photomultiplier tube when specially requested by the customer and we charge for this service. Cathode radiant sensitivity cannot be measured once the photomultiplier tube is assembled as a module. If radiant sensitivity data is necessary, please request it when placing an order.

Luminous sensitivity

Cathode luminous sensitivity is the photoelectric current generated from the photocathode when a photomultiplier tube receives light flux from a tungsten filament lamp operated at a distribution temperature of 2856 K. Anode luminous sensitivity is the anode output current per incident light flux on the photocathode of a photomultiplier tube when a specific high voltage is applied. The light flux is lowered to an appropriate level by using a neutral density filter.

Luminous sensitivity data is measured and listed in the test sheet prior to shipment except for some types of PMT modules. Luminous sensitivity is particularly useful when comparing PMT modules having a similar spectral response range.

Blue sensitivity index and red/white ratio

Although different from absolute spectral response characteristics, the blue sensitivity index and the red/white ratio are often used for simple comparison of photomultiplier tube spectral response.

Blue sensitivity index is the photoelectric current generated from the photocathode when a blue filter is interposed in the same measurement system as used to measure cathode luminous sensitivity. Blue sensitivity index is an essential parameter in scintillation counting because the NaI(Tl) scintillators frequently used in scintillation counting, produce light emissions close to the blue spectrum when transmitted through a blue filter. Blue sensitivity index is not represented in lumens because the light flux once transmitted through a blue filter cannot be expressed in lumens.

Red/white ratio is used for comparing the sensitivity of photomultiplier tubes having a spectral response extending to the near infrared region. Like blue sensitivity index, the red/white ratio is also measured with the measurement system used for cathode luminous sensitivity, but a red to infrared filter is interposed. Red/white ratio is defined as the ratio of the cathode sensitivity measured with a red to infrared filter, to the cathode luminous sensitivity when measured without a filter.

Gain

Gain of PMT modules listed in this catalog is the ratio of anode output current to cathode output current, measured at specified values of control voltage. Gain depends directly on the high voltage applied to the photomultiplier tube, which is adjusted by a control voltage.

Dark current

A small amount of output current appears from a PMT module even when operated in a completely darkness. This output current is called "dark current". Dark current varies with the control voltage in proportion to the change in gain. However, the slope of the dark current versus the voltage curve becomes less and less steep as the control voltage is decreased. This dark current at a low control voltage is mainly comprised of leakage current generated on the glass stem and lead pins or the surface of the circuit boards. When a PMT module is operated at a normal high voltage, most of dark current originates from thermionic emissions, especially those from the photocathode. Cooling the module is therefore very effective in reducing the dark current. Hamamatsu PMT modules are designed to exhibit low dark current when used within the specified operating temperature range. However, in applications where dark current is a critical factor, using a PMT module with a built-in cooler is recommended.

Spatial uniformity

When a spot light strikes the photocathode of a photomultiplier tube, the photoelectric sensitivity may vary depending on the photocathode position. This variation in sensitivity is called "spatial uniformity". Spatial uniformity is caused by the irregular sensitivity of the photocathode itself and also by a non-uniform loss of electrons while focused and multiplied by the dynodes after being emitted from different positions on photocathode. Spatial uniformity also depends on the light wavelength. In general, head-on photomultiplier tubes provide better spatial uniformity than side-on tubes. To reduce the adverse effects of spatial uniformity on measurement, the input light must be made to illuminate a wider area on the photocathode or a diffuser plate must be placed in front of the photocathode.

Temperature characteristics

The sensitivity and dark current (dark count) of photomultiplier tubes change with the ambient temperature. The rate of this change (temperature coefficient) depends on the light wavelength. As the ambient temperature decreases, the sensitivity increases in the ultraviolet to visible region while it tends to decrease in the longer wavelength region. As temperature decreases, dark current also decreases because the thermionic emission of electrons is reduced.

Drift and life characteristics

While operating a photomultiplier tube continuously over a long period, the anode output current may vary slightly over time, even though the operating conditions have been kept constant. In this kind of anode current behavior, the stability over a short operating time is called the drift characteristic, while the stability over an extended period of time is called the life characteristic. Both drift and life characteristics differ according to the type of photomultiplier tubes and the magnitude of anode current drawn from the photomultiplier tube. When stability is of prime importance, operating the tube at an average anode current of 1 µA or less is recommended.

Time response characteristics

The time response characteristics of photomultiplier tubes are very important when measuring high-speed signals. Time response characteristics are usually evaluated in terms of electron transit time, rise time and electron transit time spread (T.T.S.). These characteristics differ depending on the type of photomultiplier tube contained in the PMT module and must be carefully selected to meet the application. In addition to the time response characteris-

tics of photomultiplier tubes, the signal load conditions have effects on PMT module response speeds, particularly on the current-output PMT modules. As the load resistance is made larger, the response speeds of the current-output PMT modules reduce.

Signal-to-noise characteristics

When observing the output waveform of a photomultiplier tube, fluctuations (AC components) can be seen in the signal components. This is so-called "shot noise" resulting from fluctuations in the photoemission and electron multiplication processes.
Since the effects of DC dark current can be largely eliminated, shot noise is the dominant factor in determining the signal-to-noise ratio (S/N ratio) in low-light-level measurement.
To minimize the shot noise and obtain a better S/N ratio, note the following points.

1. Use a photomultiplier tube that has as high a quantum efficiency as possible on the wavelength range to be measured.
2. Design the optical system for better light collection efficiency so that the incident light is guided to the photomultiplier tube with minimum loss.
3. Narrow the measuring system bandwidth as much as possible, as long as no problem occurs in the measurment.

Power Supply Circuit Characteristics

Power supply circuit

There are mainly two types of power supply circuits used in Hamamatsu PMT modules. One type is the Cockcroft-Walton circuit. The other is an active type divider circuit combined with the Cockcroft-Walton circuit.

Cockcroft-Walton circuit

The Cockcroft-Walton circuit is a voltage booster circuit with an array of series-connected diodes, and with capacitors connected at each of the alternate connection points. When a reference voltage is applied to this circuit, voltage potentials boosted 1 time, 2 times, 3 times ... (multiplied by integers) are applied to the dynodes of the photomultiplier tube. This circuit delivers good linearity in both DC and pulsed currents while maintaining low power consumption, and allows designing a compact circuit, but the settling time becomes temporarily long.

Active type divider circuit combined with Cockcroft-Walton circuit

This circuit consists of a Cockcroft-Walton circuit that generates a voltage applied to the entire photomultiplier tube and an active type divider circuit that applies a voltage to each dynode. In the active type divider circuit, transistors are used in place of voltage-dividing resistors for the last few dynodes. This method prevents the dynode-to-dynode voltage from being affected by the photomultiplier tube signal current, allowing good linearity to be obtained up to 60 to 70% of the voltage divider circuit current. This circuit also features short settling time compared to when only a Cockcroft-Walton circuit is used.

Ripple noise

Switching noise may get into the output signal of PMT modules by induction since high-voltage power supplies in PMT modules use a switching power supply. This induced noise is called "ripple noise". Although Hamamatsu PMT modules are designed to minimize this ripple noise, taking the following measures will reduce it even further.

1) Place a low-pass filter after the signal output from the PMT module.
2) Increase the control voltage to raise the photomultiplier tube gain and lower the amplifier gain.

At Hamamatsu Photonics, ripple noise is measured with a signal load resistance 1 MΩ and a load capacitance of 22 pF.

Settling time

When the control voltage for a PMT module is changed, the high voltage applied to the photomultiplier tube also changes, but has a slight delay due to the timing of the control voltage input. The settling time is the time required to reach the specified level of high voltage after changing the control voltage. At Hamamatsu Photonics, this settling time is measured when changing the control voltage from +1.0 V to +0.5 V.

Voltage output type PMT modules

Using as a charge amplifier

Voltage output type PMT modules incorporate an operational amplifier that converts a current output from the photomultiplier tube into a voltage output. The operational amplifier has feedback resistance and capacitance, and also serves as a simple charge amplifier allowing pulse measurements such as in scintillation counting applications.

Photosensor Module with Gate Function

Gate operation

When the primary excitation light from a strong light sources enters a photomultiplier tube, the signal processing system may saturate, causing adverse effects on the measurement. A mechanical shutter could be used to shut off such primary light. However, mechanical shutters are limited in terms of high-speed operation and service life. In contrast, gate operation is effective in serving as an electronic shutter to gate off excessive light, by changing the dynode voltage in the photomultiplier tube. The electronic shutter operates at high speeds with a high extinction ratio. There are two methods of gate operation. In one method the photomultiplier tube is normally off and turns on when a gate signal is input. In the other method, the photomultiplier tube is normally on and turns off when a gate signal is input.

Gate noise

High-speed gate pulses must be input to perform high-speed gate operation. When a gate pulse is input to a photomultiplier tube, induced noise is generated and appears in the anode signal due to interelectrode capacitance. This is called gate noise. Reducing the gate pulse voltage or noise canceling techniques are effective to some extent in decreasing this gate noise, but cannot completely eliminate it. So it is necessary to increase the photomultiplier tube gain or use the photomultiplier tube with high gain.

Switching ratio

This is the ratio of the photomultiplier tube outputs when the gate is tuned on and off at a constant light level incident on the photocathode. For example, while normally off operation, if the gate-off output is 1 nA and the gate-on output is 10 μA, the switching ratio is 1 nA to 10 μA or expressed as $1 : 10^4$.

Photon Counting Head

Principle of photon counting

When light intensity becomes extremely low, light can be counted as individual photons. Photomultiplier tubes are ideal for photon counting because they exhibit excellent time resolution, high gain and yet low noise. In low-light-level measurement, photon counting has advantages over the analog detection method. For example, noise pulses can be easily separated, and high stability and a high S/N ratio obtained.

Quantum efficiency

The most important characteristic in photon counting is the photocathode quantum efficiency. The probability of photoelectron emission when a single photon strikes the photocathode is called the photocathode quantum efficiency. Since the number of photoelectrons emitted per photon is one or zero, the quantum efficiency is defined as the ratio of the number of photoelectrons emitted from the photocathode to the number of photons incident on the photocathode over a unit of time. There are various types of photocathodes. It is essential to choose the photocathode that provides the highest quantum efficiency at the wavelength to be measured.

Detection efficiency

Detection efficiency is the ratio of the number of counted pulses (photomultiplier tube output pulses) to the number of incident photons. The "count sensitivity" listed in this catalog is related to this detection efficiency.

Correction of count loss

Theoretically, the maximum count rate is a reciprocal of pulse-pair resolution (ability to discriminate between successive pulses). However, since chemiluminescence and bioluminescence occur randomly, the detected signal pulses may overlap each other, causing a counting loss or error. Considering the probability of pulse overlap, the maximum effective count rate would be 1/10 th of the theoretical rate. This count loss of overlapped pulses can be corrected by the following equation.

$$N = \frac{n}{1-n \cdot t}$$

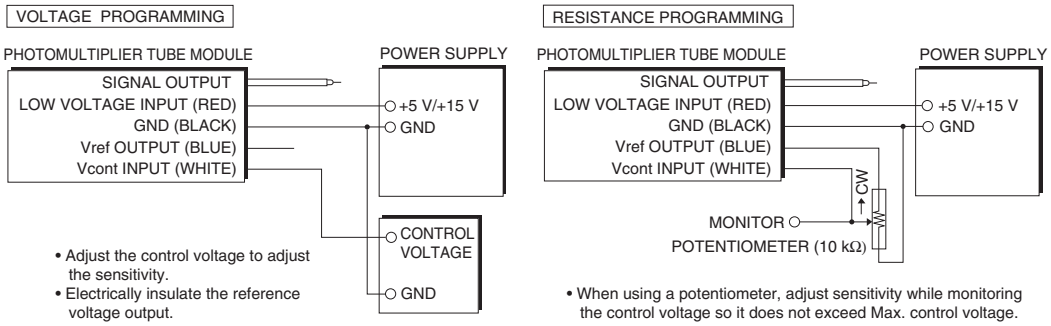
N : True count rate

n : Measured count rate

t : Pulse resolution

Sensitivity adjustment method

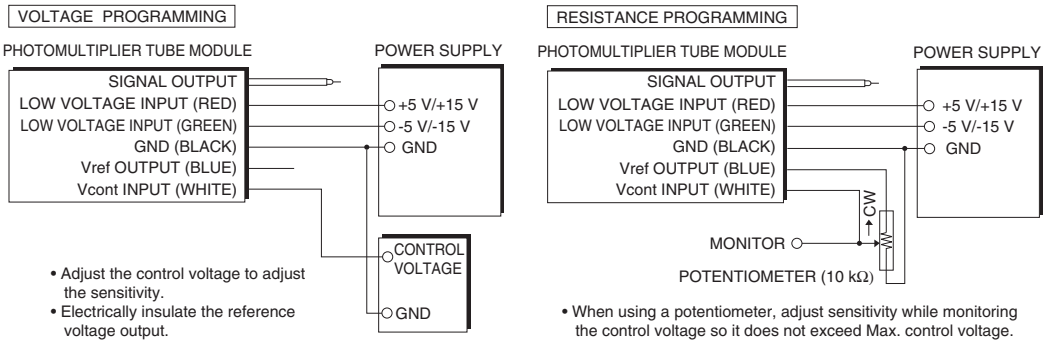
●Current output type



Low voltage input	Conforming product Type No.
+5 V	H10720, H10721, H11432, H11461, H12056, H12402, H12403, H13320, H13543, H13661
+15 V	H7826, H7844, H9305, H10425, H10426, H11411, H11526, H11706, H11900, H11901

* The power supply for photomultiplier tube modules(P.32) is available.

●Voltage output type



Low voltage input	Conforming product Type No.
±5 V	H10722, H10723, H11462
±15 V	H7827, H9306, H9307, H10492, H10493, H11902, H11903

* The power supply for photomultiplier tube modules(P.32) is available.

Safety precautions

WARNING

Subject to local technical requirements and regulations, availability of products included in this promotional material may vary. Please consult with our sales office.

Some products listed in this catalog generate a high voltage internally. Be sure to observe the following safety measures and take sufficient precautions to prevent possible electrical shocks.

- Always turn off the power before moving, installing and inspecting the products or connecting/disconnecting the cables and connectors.
- Do not modify any part of the product and do not open the housing case. Malfunctions or electrical shocks might result and the products might overheat, smoke or catch fire.

Handling precautions

Take the following precautions when handling PMT modules.

- Do not expose the photocathode of PMT modules to excessive light such as sunlight. If exposed, noise will increase and photocathode sensitivity will deteriorate.
- Do not touch the light input window with bare hands. Dirt and grime on the window causes loss of optical transmittance. If the window becomes soiled with dirt or grime, wipe it clean using alcohol.
- Helium will penetrate through silica (quartz) glass windows and increase noise. Avoid using or storing those PMT modules in an atmosphere where helium is present.
- Carefully check that the power supply output voltage and polarity are correct.
- Do not apply strong vibrations or impacts to PMT modules.
- Do not apply a strong tightening force to localized sections.
- Do not let moisture or dust penetrate inside.
- Consult with us if you must take special countermeasures against tough conditions such as high temperatures, high humidity or strong magnetic fields.
- When designing equipment using or incorporating products listed in this catalog, install safety interlocks (breakers, etc.) to prevent accidents from electrical shocks or excessive light input, etc.

Warranty

Hamamatsu PMT modules and related products are warranted to the original purchaser for a period of one year after delivery. The warranty is limited to repair or replacement of defective products due to defects in workmanship or materials used in their manufacture.
Even if within the warranty period, the warranty shall not apply to failures due to misuse, mishandling, modification by the customer, or accidents such as natural or manmade disasters.
The customer should inspect and test all products as soon as they are delivered.

Ordering Information

This catalog lists PMT modules and related products currently available from Hamamatsu Photonics. Please select those products that best match your design specifications. Delivery time depends on the type of product. Some are already in stock but some require extra delivery time. If you do not find the exact product you want in this catalog, feel free to contact our sales office nearest you. We will modify our current products or design new types to meet your specific needs.

MEMO

HAMAMATSU

HAMAMATSU PHOTONICS K.K., Electron Tube Division
314-5, Shimokanzo, Iwata City, Shizuoka Pref., 438-0193, Japan
Telephone: (81)539/62-5248, Fax: (81)539/62-2205
www.hamamatsu.com

Main Products

Electron Tubes
Photomultiplier Tubes
Photomultiplier Tube Modules
Microchannel Plates
Image Intensifiers
Xenon Lamps / Mercury Xenon Lamps
Deuterium Lamps
Light Source Applied Products
Laser Applied Products
Microfocus X-ray Sources
X-ray Imaging Devices

Opto-semiconductors
Si photodiodes
APD
Photo IC
Image sensors
PSD
Infrared detectors
LED
Optical communication devices
Automotive devices
X-ray flat panel sensors
Mini-spectrometers
Opto-semiconductor modules

Imaging and Processing Systems
Cameras / Image Processing Measuring Systems
X-ray Products
Life Science Systems
Medical Systems
Semiconductor Failure Analysis Systems
FPD / LED Characteristic Evaluation Systems
Spectroscopic and Optical Measurement Systems

Laser Products
Semiconductor lasers
Applied products of semiconductor lasers
Solid state lasers

REVISED APR. 2017

Information in this catalog is believed to be reliable. However, no responsibility is assumed for possible inaccuracies or omission. Specifications are subject to change without notice. No patent rights are granted to any of the circuits described herein.
© 2017 Hamamatsu Photonics K.K.

Sales Offices

Japan:
HAMAMATSU PHOTONICS K.K.
325-6, Sunayama-cho, Naka-ku,
Hamamatsu City, Shizuoka Pref. 430-8587, Japan
Telephone: (81)53-452-2141, Fax: (81)53-456-7889
E-mail: intl-div@hq.hpk.co.jp

China:
HAMAMATSU PHOTONICS (CHINA) Co., Ltd.
Main Office
1201 Tower B, Jiaming Center, 27 Dongsanhuan Beilu,
Chaoyang District, 100020 Beijing, China
Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866
E-mail: hpc@hamamatsu.com.cn

Shanghai Branch
4905 Wheelock Square, 1717 Nanjing Road West,
Jingan District, 200040 Shanghai, China
Telephone: (86)21-6089-7018, Fax: (86)21-6089-7017

Taiwan:
HAMAMATSU PHOTONICS TAIWAN Co., Ltd.
Main Office
8F-3, No.158, Section2, Gongdao 5th Road,
East District, Hsinchu, 300, Taiwan R.O.C.
Telephone: (886)03-659-0080, Fax: (886)07-811-7238
E-mail: info@tw.hpk.co.jp

Kaohsiung Office
No.6, Central 6th Road, K.E.P.Z. Kaohsiung 806,
Taiwan R.O.C.
Telephone: (886)07-262-0736, Fax: (886)07-811-7238

U.S.A.:
HAMAMATSU CORPORATION
Main Office
360 Foothill Road, Bridgewater, NJ 08807, U.S.A.
Telephone: (1)908-231-0960, Fax: (1)908-231-1218
E-mail: usa@hamamatsu.com

California Office
2875 Moorpark Ave. San Jose, CA 95128, U.S.A.
Telephone: (1)408-261-2022, Fax: (1)408-261-2522
E-mail: usa@hamamatsu.com

Chicago Office
4711 Golf Road, Suite 805, Skokie, IL 60076, U.S.A.
Telephone: (1)847-825-6046, Fax: (1)847-825-2189
E-mail: usa@hamamatsu.com

Boston Office
20 Park Plaza, Suite 312, Boston, MA 02116, U.S.A.
Telephone: (1)617-536-9900, Fax: (1)617-536-9901
E-mail: usa@hamamatsu.com

United Kingdom:
HAMAMATSU PHOTONICS UK Limited
Main Office
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

South Africa Office:
9 Beukes Avenue, Highway Gardens, Edenvale, 1609,
South Africa
Telephone/Fax: (27)11-609-0367

France, Portugal, Belgium, Switzerland, Spain:
HAMAMATSU PHOTONICS FRANCE S.A.R.L.
Main Office
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

Swiss Office
Dornacherplatz 7 4500 Solothurn, Switzerland
Telephone: (41)32-625-60-60, Fax: (41)32-625-60-61
E-mail: swiss@hamamatsu.ch

Belgian Office
Axisparc Technology, rue Andre Dumont 7 1435
Mont-Saint-Guibert, Belgium
Telephone: (32)10 45 63 34, Fax: (32)10 45 63 67
E-mail: info@hamamatsu.be

Spanish Office
C. Argenters, 4 edif 2 Parque Tecnológico del Vallés
08290 Cerdanyola (Barcelona), Spain
Telephone: (34)93 582 44 30, Fax: (34)93 582 44 31
E-mail: infospain@hamamatsu.es

Germany, Denmark, The Netherlands, Poland:
HAMAMATSU PHOTONICS DEUTSCHLAND GmbH
Main Office
Arzbergerstr. 10, D-82211 Herrsching am Ammersee,
Germany
Telephone: (49)8152-375-0, Fax: (49)8152-265-8
E-mail: info@hamamatsu.de

Danish Office
Lautruphøj 1-3, DK-2750 Ballerup, Denmark
Telephone: (45)70-20-93-69, Fax: (45)44-20-99-10
Email: info@hamamatsu.dk

Netherlands Office
Televisieweg 2, NL-1322 AC Almere, The Netherlands
Telephone: (31)36-5405384, Fax: (31)36-5244948
E-mail: info@hamamatsu.nl

Poland Office
02-525 Warsaw, 8 St. A. Boboli Str., Poland
Telephone: (48)22-646-0016, Fax: (48)22-646-0018
E-mail: poland@hamamatsu.de

North Europe and CIS:
HAMAMATSU PHOTONICS NORDEN AB
Main Office
Torshamnsgatan 35 16440 Kista, Sweden
Telephone: (46)8-509 031 00, Fax: (46)8-509 031 01
E-mail: info@hamamatsu.se

Russian Office
11, Christoprudny Boulevard, Building 1, Office 114,
101000, Moscow, Russia
Telephone: (7)495 258 85 18, Fax: (7)495 258 85 19
E-mail: info@hamamatsu.ru

Italy:
HAMAMATSU PHOTONICS ITALIA S.r.l.
Main Office
Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy
Telephone: (39)02-935-81-733, Fax: (39)02-935-81-741
E-mail: info@hamamatsu.it

Rome Office
Viale Cesare Pavese, 435, 00144 Roma, Italy
Telephone: (39)06-50513454, Fax: (39)02-935-81-741
E-mail: inforoma@hamamatsu.it

Quality, technology and service are part of every product.

TPMO0011E02
APR. 2017 IP
(2000)