High sensitivity photomultiplier tube modules

(High sensitivity photocathode photomultiplier tubes)

HAMAMATSU

PHOTON IS OUR BUSINESS

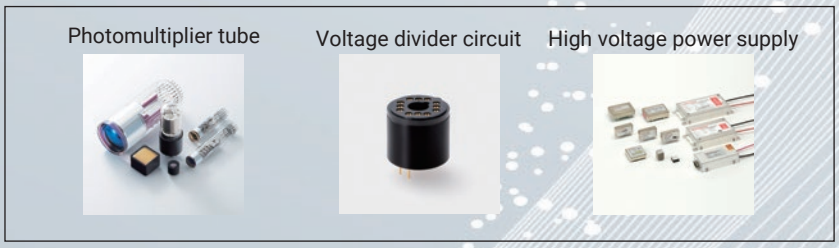
High sensitivity photomultiplier tube modules

Ultimate performance and beyond

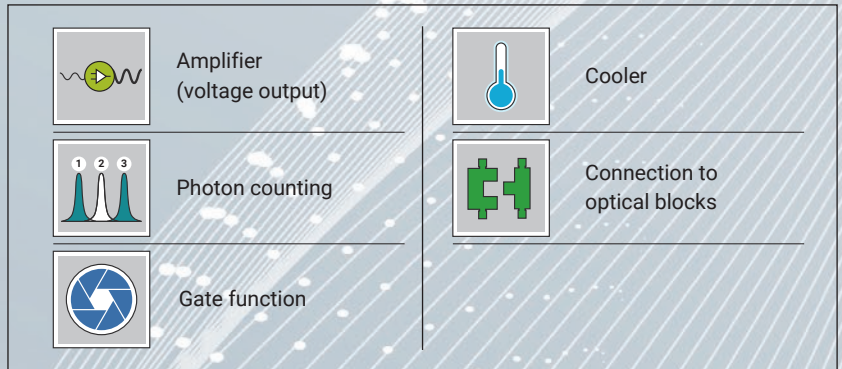
Photomultiplier tubes or PMT are known as extremely high-sensitivity detectors among the many types of optical sensors currently available. Photomultiplier tubes include models that utilize a crystalline semiconductor material as the photocathode to achieve even higher performance. Hamamatsu offers these high sensitivity photocathode photomultiplier tubes as versatile and easy-to-use detector modules.

What is a photomultiplier tube module?

A photomultiplier tube module or PMT module is basically a compact detector package consisting of a photomultiplier tube for converting light into electrical signals, a high-voltage power supply circuit for operating the photomultiplier tube and a voltage divider circuit for supplying voltage to each dynode of the photomultiplier tube. Our lineup of PMT modules include models with additional functions added to this basic package.



Additional functions



What is a photocathode?

A photocathode is an electrode that converts incident light into electrons. The spectral range and conversion efficiency of light that can be converted into electrons differ depending on the material used for the photocathode. There are more than 10 different types of photocathodes available for photomultiplier tubes.

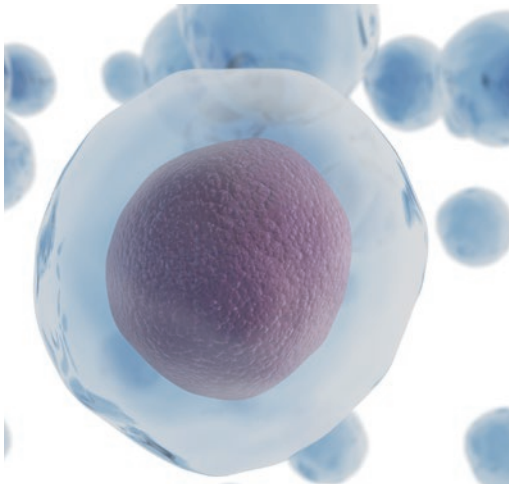
What is a high sensitivity photocathode photomultiplier tube?

These photomultiplier tubes utilize a crystalline semiconductor material such as GaAsP and GaAs for their photocathode. Compared to most other photomultiplier tubes that use alkali metals for their photocathode, crystalline photocathode photomultiplier tubes achieve more specific and superior characteristics.

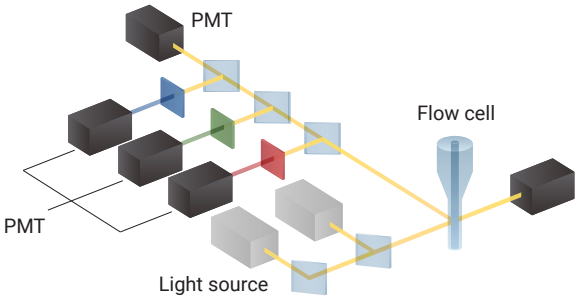
INDEX

Application examples

Flow cytometer

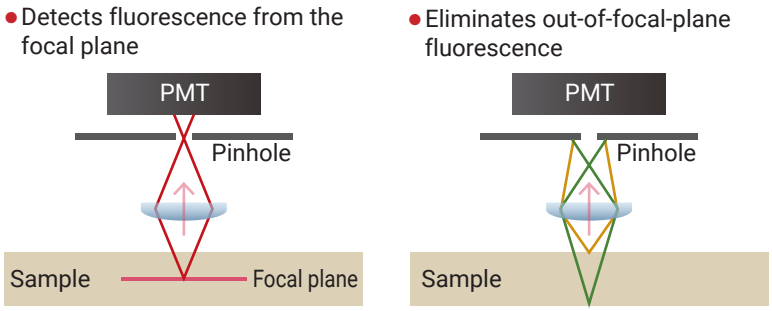


In flow cytometer, cells labeled with fluorescent material flow in a solution along a flow cell while moving at a certain interval.
A laser beam is then irradiated onto the cells and the scattered light from the cells and fluorescence from the fluorescent material are measured by a photomultiplier tube.
Various kinds of information are acquired from the scattered light and fluorescence such as cell surface antigens, cell cycles, 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, multi color analysis, high-speed operation, and compact flow systems.

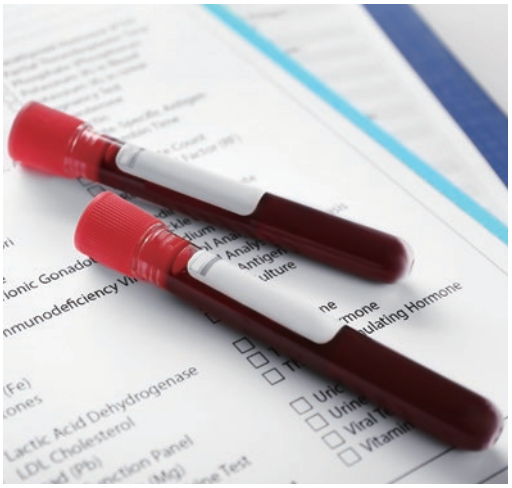


Laser scanning microscope

A Laser scanning microscope is a type of optical microscope for imaging a target object using a laser as the light source.
One distinct feature of laser confocal microscopes is the pinhole placed at the focus point. The pinhole eliminates light unnecessary for measurement so that only fluorescence very close to the focal plane of the sample can be detected. Due to this structure, laser confocal microscopes allow measurements with excellent optical resolution and resolving power in the depth direction.



Blood inspection

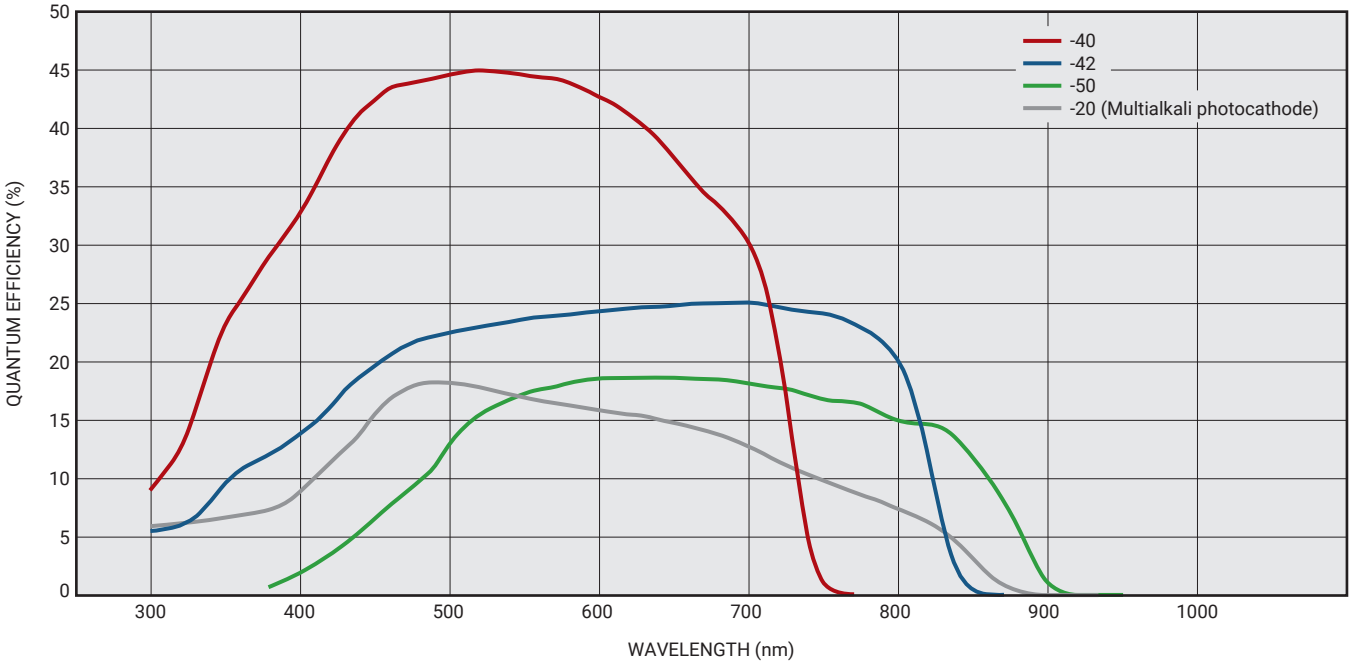


Blood contains antigens, namely substances that trigger an immune response specific to a disease or bacteria. Blood testing includes a method for finding disease or detecting bacteria and its extent or quantity by making use of a small amount of blood (plasma and serum) mixed with an antibody reagent that binds to the antigen to be assayed and then measuring the amount of luminescence that is emitted when the antibody reacts with the antigen.

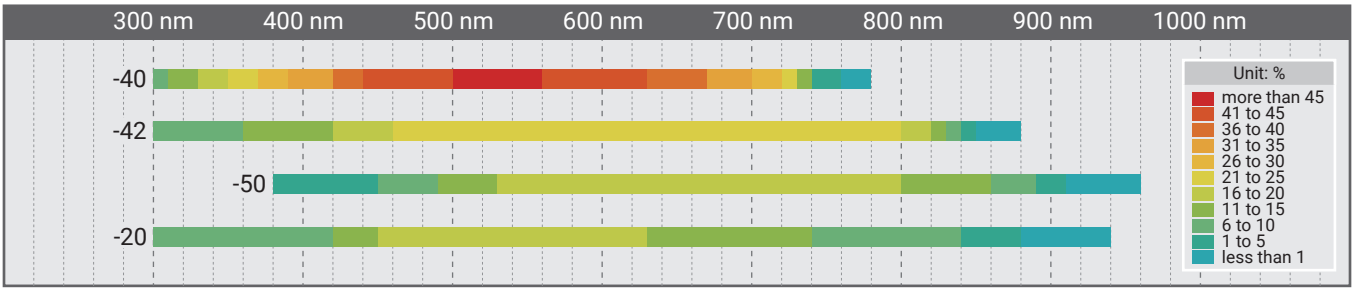
High sensitivity photocathode lineup

Photocathode lineup	GaAsP	Extended Red GaAsP	GaAs
Suffix	-40	-42	-50
Spectral response range (nm)	300 to 740	300 to 840	380 to 900
Peak quantum efficiency wavelength (nm)	520	660	630

Spectral response characteristics



Spectral response range color chart



The definition of spectral response range differs depending on the type of photocathode. The specified detection limit wavelength on the longer wavelength side differs between high sensitivity photocathodes (Type No. suffix: -40, -42, -50) and multialkali photocathodes (Type No. suffix: -20) as follows:
-40, -42, -50: Wavelength at which quantum efficiency drops to 10 % of the maximum value
-20: Wavelength at which radiant sensitivity decreases to 0.1 % of the maximum value

Type No. quick reference table

Type No.		H16200	H16201	H16204	H16722	H16721	H11706	H12056	H15460	H15461	H12310	H12311
Image												
Photo-cathode	GaAsP	○	○	○	○		○	○	○		○	
	Extended Red GaAsP	○	○	○	–		–	–	–		○	
	GaAs	○	○	○	○		–	–	–		–	
Feature		Compact			Internal cooler		Gate function		Large effective area		Multichannel	
Output type		Current output			Current output	PC*	Current output		Voltage output	Current output	Voltage output	
Availability of P type		○			○		○		–		–	
Page		P.05-P.06			P.07-P.08	P.09-P.10	P.11-P.12		P.13-P.14	P.15-P.16	P.17-P.18	

*PC: Photoncounting

Standard model

Photomultiplier tube modules H16200 series, H16201 series, H16204 series

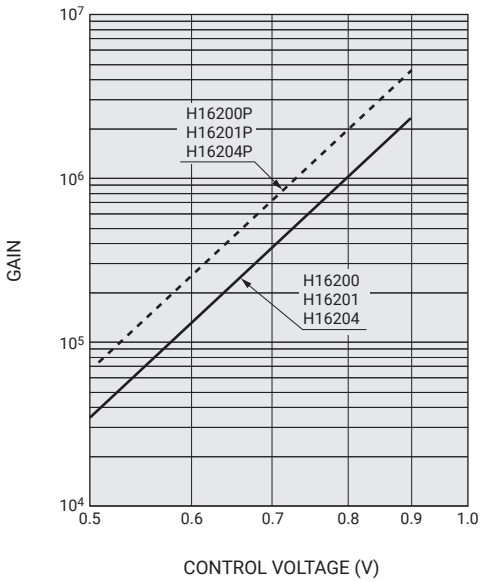
Specifications

(at +25 °C)

Parameter				-40	-42	-50	Unit
Input voltage				+11.5 to +15.5			V
Max. input voltage				+18			V
Max. input current ①				12			mA
Max. output signal current				40			μA
Max. control voltage ②				+0.9			V
Recommended control voltage adjustment range ②				+0.5 to +0.8			V
Effective area				ϕ5			mm
Spectral response				300 to 740	300 to 840	380 to 900	nm
Peak quantum efficiency wavelength				520	660	630	nm
Cathode	Quantum efficiency	at peak quantum efficiency wavelength	Min.	40	15	14	%
			Typ.	45	25	19	
		at 800 nm	Min.	—	12	11	
			Typ.	—	20	15	
	Radiant sensitivity	at peak quantum efficiency wavelength	Min.	168	80	70	mA/W
			Typ.	189	133	95	
		at 800 nm	Min.	—	78	71	
			Typ.	—	129	97	
Anode	Radiant sensitivity ③	at peak quantum efficiency wavelength	Min.	1.0×10^5	4.8×10^4	4.2×10^4	A/W
			Typ.	1.9×10^5	1.3×10^5	9.5×10^4	
		at 800 nm	Min.	—	4.7×10^4	4.3×10^4	
			Typ.	—	1.3×10^5	9.7×10^4	
	Dark current ③④		Typ.	3	3	4	nA
			Max.	10	11	12	
	P type Dark count ④⑤		Typ.	6000	6900	7500	s^{-1}
			Max.	18 000	20 700	22 500	
	Gain ③		Typ.	1.0×10^6			—
	P type Gain ③		Typ.	2.0×10^6			—
Rise time ③			Typ.	1.0			ns
Ripple noise ③⑥ (peak to peak)			Max.	0.6			mV
Settling time ⑦			Max.	0.2			s
Operating ambient temperature ⑧				+5 to +35			°C
Storage temperature ⑧				-20 to +50			°C
Weight				H16200: Approx. 76 / H16201: Approx. 100 / H16204: Approx. 106			g

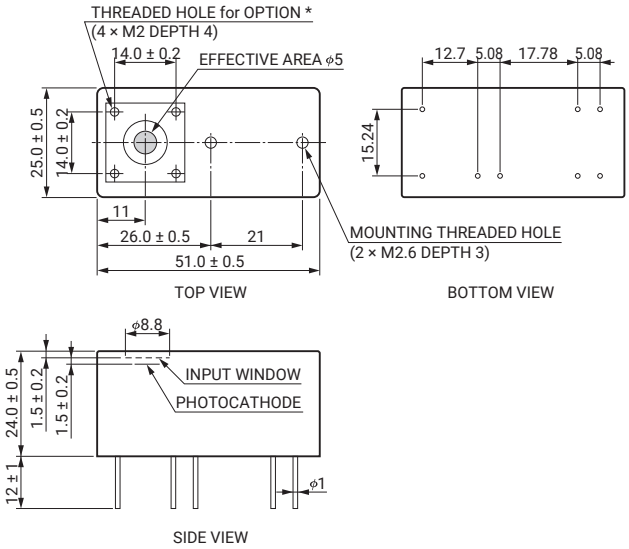
NOTE: ① Input voltage: +15 V, Control voltage: +0.8 V
② Input impedance: 30 kΩ
③ Control voltage: +0.8 V
④ After 30 min storage in darkness.
⑤ Plateau voltage = Control voltage
⑥ Cable: RG-174/U, Cable length: 450 mm, Load resistance: 1 MΩ, Load capacitance: 22 pF
⑦ The time required for the output to reach a stable level following a change in the control voltage from +0.8 V to +0.5 V.
⑧ No condensation

Gain

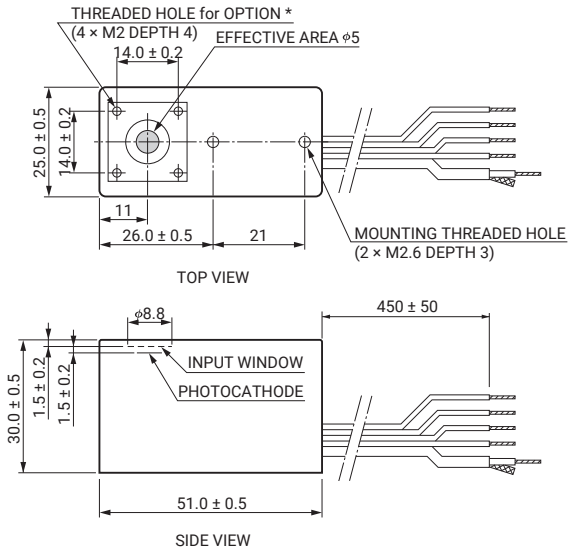


Dimensional outline (Unit: mm)

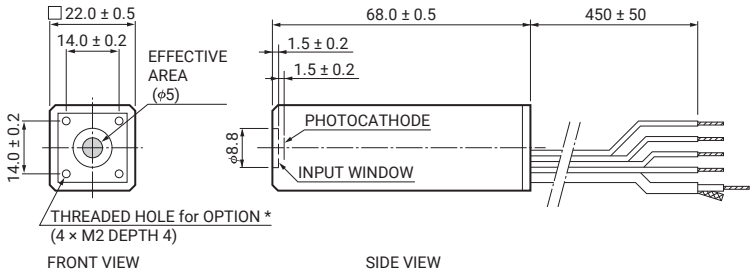
● H16200



● H16204



● H16201



* Option: Optical fiber adapter (E5776 / E5776-51), C-mount adapter (A9865)

Low dark current model

Photomultiplier tube modules H16722 series

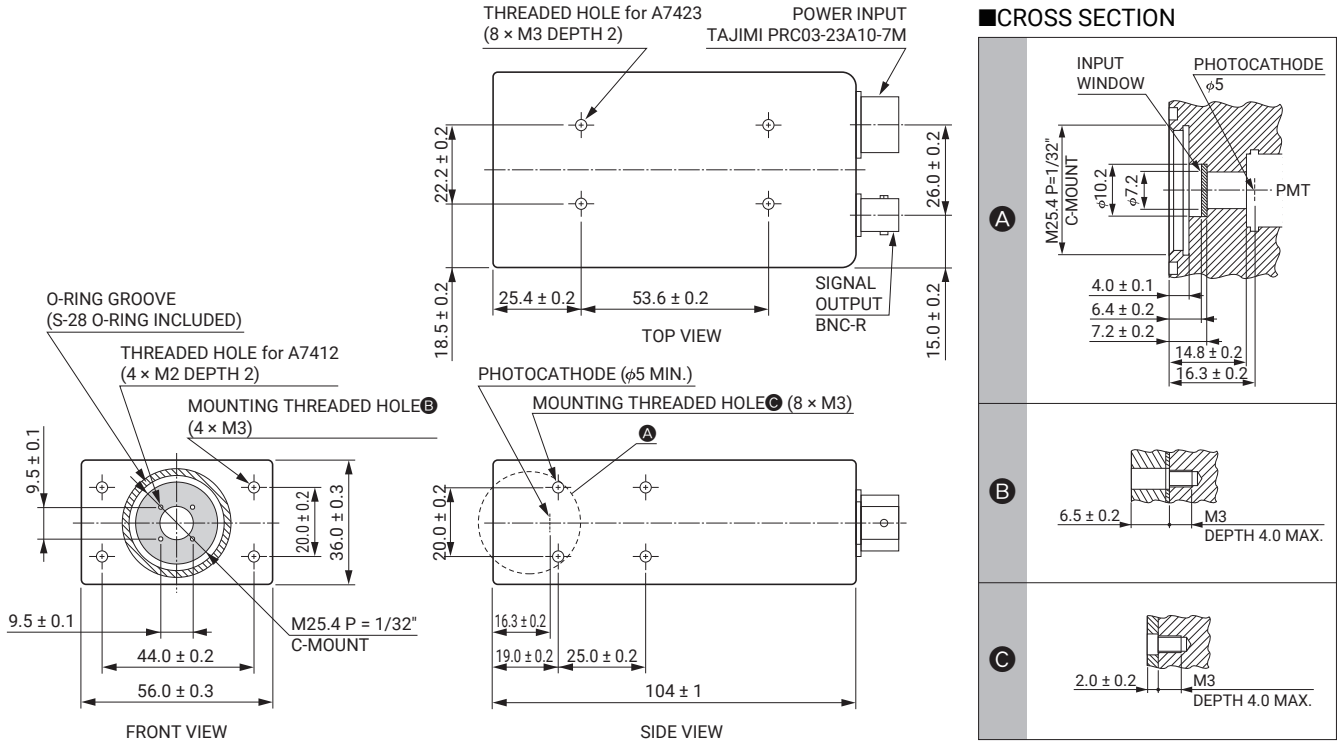
Specifications

(at +25 °C)

Parameter				-40	-50	Unit
Input voltage				+11.5 to +15.5		V
Main unit		Max. input voltage		+18		V
		Max. input current ①		30		mA
Thermoelectric cooler		Max. input voltage		2.6		V
		Max. input current		2.2		A
Max. output signal current				40		μA
Max. control voltage ②				+0.9		V
Recommended control voltage adjustment range ②				+0.5 to +0.8		V
Effective area				φ5		mm
Spectral response				300 to 740	380 to 900	nm
Peak quantum efficiency wavelength				520	630	nm
Cathode	Quantum efficiency	at peak quantum efficiency wavelength	Min.	40	14	%
			Typ.	45	19	
		at 800 nm	Min.	—	11	
			Typ.	—	15	
	Radiant sensitivity	at peak quantum efficiency wavelength	Min.	168	70	mA/W
			Typ.	189	95	
		at 800 nm	Min.	—	71	
			Typ.	—	97	
Anode	Radiant sensitivity ③	at peak quantum efficiency wavelength	Min.	1.0×10^5	4.2×10^4	A/W
			Typ.	1.9×10^5	9.5×10^4	
		at 800 nm	Min.	—	4.3×10^4	
			Typ.	—	9.7×10^4	
	Dark current ③④		Typ.	0.4	0.5	nA
			Max.	1.0	1.3	
	P type Dark count ④⑤		Typ.	100	125	s^{-1}
			Max.	300	375	
	Gain ③		Typ.	1.0×10^6		—
	P type Gain ③		Typ.	2.0×10^6		—
Rise time ③			Typ.	1.0		ns
Ripple noise ③⑥ (peak to peak)			Max.	0.6		mV
Settling time ⑦			Max.	0.2		s
Operating ambient temperature ⑧				+5 to +35		°C
Storage temperature ⑧				-20 to +50		°C
Weight				453		g
Cooling specifications ⑨		Cooling method		Thermoelectric cooling		—
		Max. cooling temperature (ΔT)		35		°C
		Time to reach Max. cooling temperature		Approx. 5		min

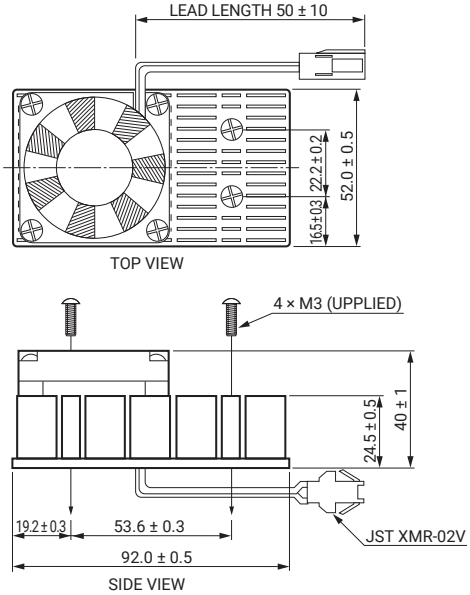
NOTE: ① Input voltage: +15 V, Control voltage: +0.8 V ② Input impedance: 100 kΩ ③ Control voltage: +0.8 V
④ After 30 min storage in darkness, PMT setting temperature 0 °C, used with C8137-02 and A7423
⑤ Plateau voltage = control voltage
⑥ Cable: RG-174/U, Cable length: 450 mm, Load resistance: 1 MΩ, Load capacitance: 14 pF
⑦ The 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.
⑧ No condensation
⑨ Input current to thermoelectric cooler: 2 A

Dimensional outline (Unit: mm)

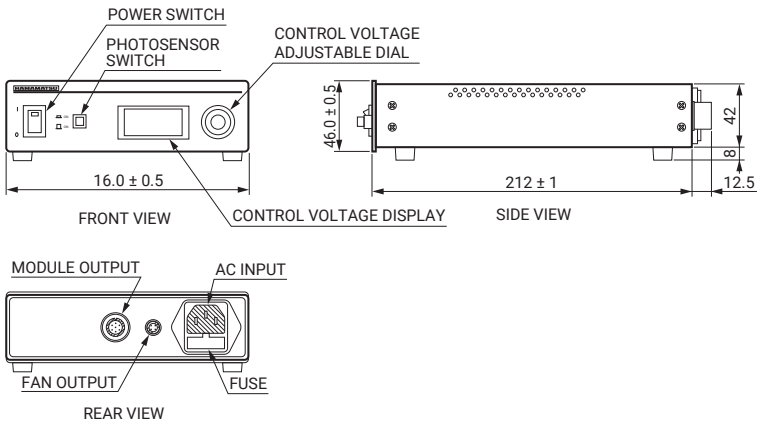


Options (Unit mm)

● Heatsink with Fan A7423



● Power supply unit with temperature control C8137-02



* The C8137 power supply is designed for the H16721, and the C8137-02 power supply is for the H16722.
* The C8137 front panel differs slightly from the above figure. (It has no control-voltage adjustment dial and display.)
* Supplied with a power cable, fan cable and AC cable.

Photon counting head low dark count model

Photon counting head H16721 series

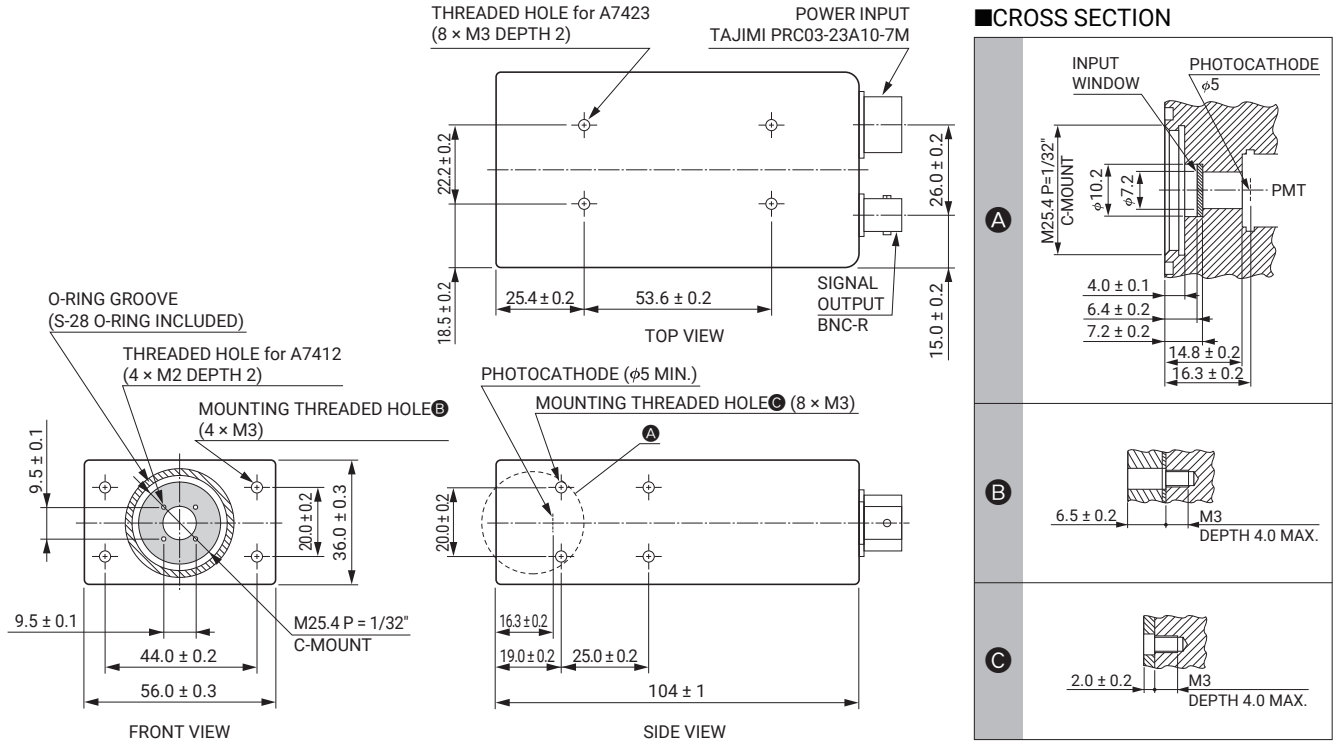
Specifications

(at +25 °C)

Parameter			-40	-50	Unit
Input voltage			+4.5 to +5.5		V
Main unit	Max. input voltage		+6		V
	Max. input current		50		mA
Thermoelectric cooler	Max. input voltage		2.6		V
	Max. input current		2.2		A
Effective area			φ5		mm
Spectral response			300 to 740	380 to 900	nm
Peak quantum efficiency wavelength			610	730	nm
Count sensitivity	400 nm		5.3×10^5	—	$s^{-1} \cdot pW^{-1}$
	500 nm		9.0×10^5	2.6×10^5	
	600 nm		10.3×10^5	4.5×10^5	
	700 nm		8.5×10^5	5.1×10^5	
	800 nm		—	4.8×10^5	
Count linearity ①			1.5×10^6	1.5×10^6	s^{-1}
Dark count ②		Typ.	100	125	s^{-1}
		Max.	300	375	
Pulse-pair resolution			70		ns
Output pulse width			30		ns
Output pulse height ③		Min.	3.0		V
		Typ.	3.6		
Recommended load resistance			50		Ω
Signal output logic			Positive logic		—
Operating ambient temperature ④			+5 to +35		°C
Storage temperature ④			-20 to +50		°C
Weight			Approx. 395		g
Cooling specifications ⑤	Cooling method		Thermoelectric cooling		—
	Max. cooling temperature (ΔT)		35		°C
	Time to reach Max. cooling temperature		Approx. 5		min

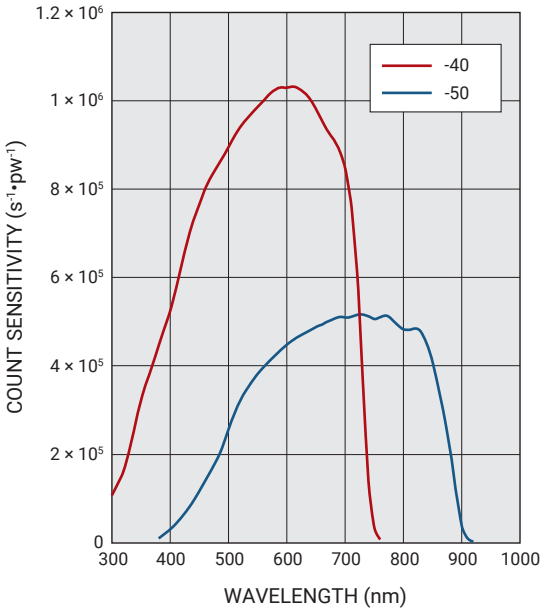
NOTE: ① Random pulse, at 10 % count loss: 10 %
② After 30 min storage in darkness, PMT setting temperatre 0 °C, used with C8137 and A7423
③ Cable: RG-174/U, Cable length: 450 mm, Input voltage: +5 V, Load resistance: 50 Ω
④ No condensation
⑤ Input current to thermoelectric cooler: 2 A

Dimensional outline (Unit: mm)



See page 08 for information on the optional heatsink with fan and power supply unit with temperture control

Count sensitivity



Option

Counting unit C8855-01

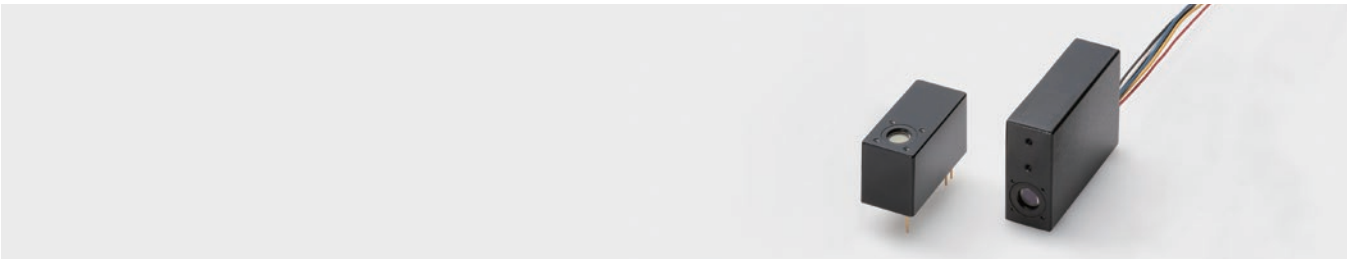
Photon counting measurement via USB connection

The C8855-01 is a counting unit with a USB interface port. The counter of the C8855-01 has two counter circuits (double counter method) capable of counting input signals with no dead time. The sample software that comes with the C8855-01 helps you to start measurement easily and quickly.

- USB (Type B) connection

Gate function model

Photomultiplier tube modules H11706-40, H12056-40



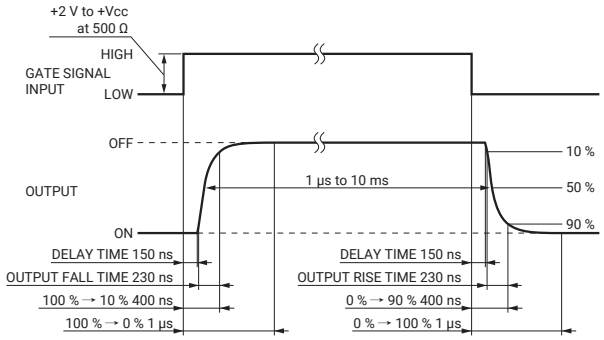
Specifications

(at +25 °C)

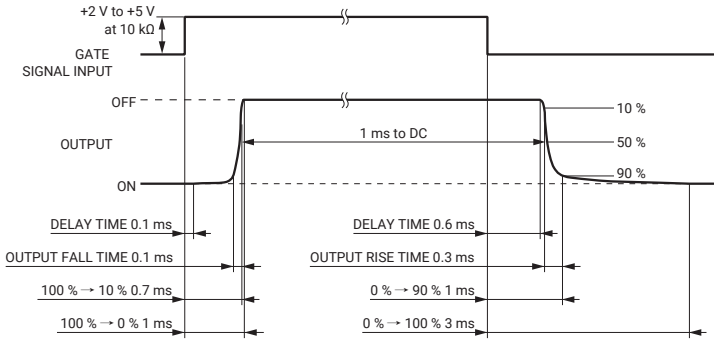
Parameter				H11706-40	H12056-40	Unit
Input voltage (Vcc)				+14.5 to +15.5	+4.5 to +5.5	V
Max. input voltage				+16	+5.5	V
Max. input current ①				10		mA
Max. output signal current ②				2	40	μA
Max. control voltage ②				+0.9		V
Recommended control voltage adjustment range ②				+0.5 to +0.8		V
Effective area				ϕ5		mm
Spectral response				300 to 740		nm
Peak quantum efficiency wavelength				520		nm
Cathode	Quantum efficiency	at peak quantum efficiency wavelength	Min.	40		%
			Typ.	45		
	Radiant sensitivity ③	at peak quantum efficiency wavelength	Min.	168		mA/W
			Typ.	189		
Anode	Radiant sensitivity ③	at peak quantum efficiency wavelength	Min.	1.0×10^5		A/W
			Typ.	1.9×10^5		
	Dark current ③④		Min.	3		nA
			Typ.	10		
	P type Dark count ④⑤		Typ.	6000		s^{-1}
			Max.	18 000		
	Gain ③		Typ.	1.0×10^6		—
	P type Gain ③		Typ.	2.0×10^6		—
Rise time ③				1.0		ns
Ripple noise ③⑥ (peak to peak)			Max.	0.8	0.6	mV
Settling time ⑦			Max.	0.2	10	s
Operating ambient temperature ⑧				+5 to +35		°C
Storage temperature ⑧				-20 to +50		°C
Weight				Approx. 135	Approx. 85	g
Gate specifications	Gate mode	Mode		Normally ON		—
		Gate width (FWHM)		1 μs to 10 ms	1 ms to DC	—
		Output rise time ⑨	Typ.	230 ns	0.3 ms	—
		Output fall time ⑩	Typ.	230 ns	0.1 ms	—
		Repetition rate ①⑪	Max.	10	0.3	kHz
		Switching ratio	Typ.	10^3		—
		Delay time	Typ.	0.15 μs	0.6 ms ⑨, 0.1 ms ⑩	—
	Gate signal input	Input low level	Min.	0	—	V
			Max.	+0.4	—	
		Input high level	Min.	+2.0	+2	V
			Max.	Vcc		
		Input impedance		500	10 000	Ω

NOTE: ① H11706...Input voltage: +15 V, Control voltage: +0.8 V, H12056...Input voltage: +5 V, Control voltage: +0.8 V
② H11706...Input impedance: 30 kΩ, H12056...Input impedance: 1 MΩ
③ Control voltage: +0.8 V ④ After 30 min storage in darkness. ⑤ Plateau voltage = Control voltage
⑥ Cable: RG-174/U, Cable length: 450 mm, Load resistance: 1 MΩ, Load capacitance: 14 pF
⑦ The 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.
⑧ No condensation ⑨ From OFF to ON ⑩ From ON to OFF ⑪ H11706...Gate width: 1 μs, H12056...Gate width: 1 ms

H11706 Gate operation mode

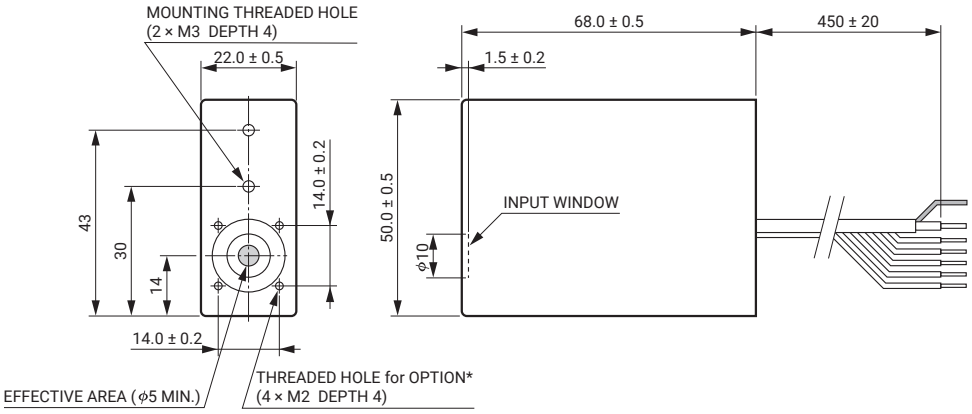


H12056 Gate operation mode



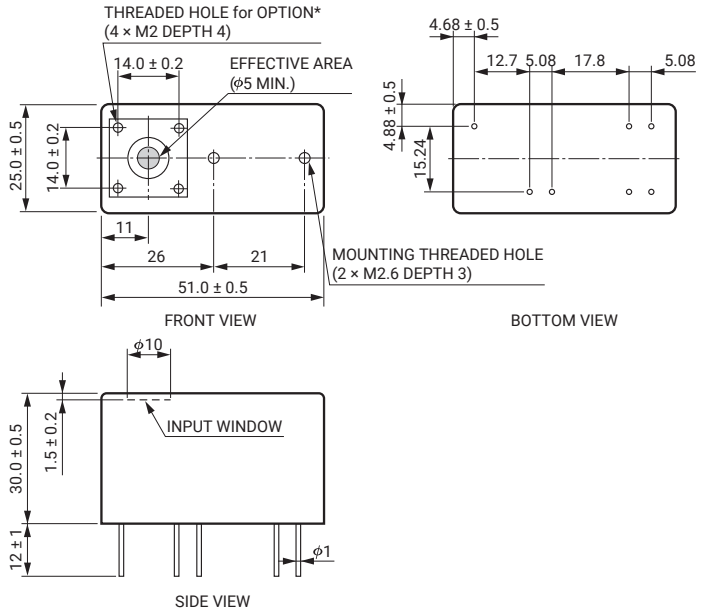
Dimensional outline (Unit: mm)

● H11706-40



* Option: Optical fiber adapter (E5776 / E5776-51), C-mount adapter (A9865)

● H12056-40



* Option: Optical fiber adapter (E5776 / E5776-51), C-mount adapter (A9865)

The H12056 series and H11706 series also include a lineup of alkali metal photocathodes. Please check out our website for details.

Large effective area model

Photomultiplier tube modules H15460 series (Voltage output)

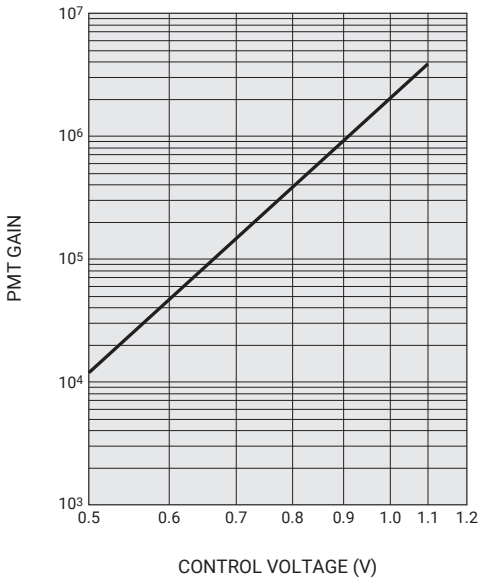
Specifications

(at +25 °C)

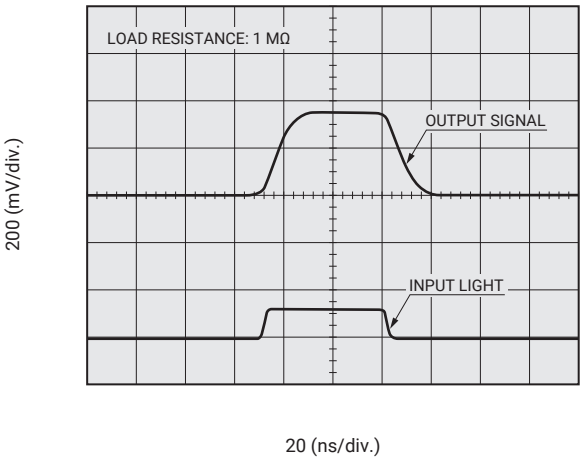
Parameter				H15460-40	Unit
Input voltage				±4.5 to ±5.5	V
Max. input voltage				±5.5	V
Max. input current ①				+26.5 / -23	mA
Max. output signal voltage ②				+2	V
Max. control voltage ③				+1.1	V
Recommended control voltage adjustment range ③				+0.5 to +1.0	V
Effective area				14 × 14	mm
Spectral response				300 to 740	nm
Peak quantum efficiency wavelength				520	nm
Cathode	Quantum efficiency	at peak quantum efficiency wavelength	Min.	40	%
			Typ.	45	
	Radiant sensitivity	at peak quantum efficiency wavelength	Min.	168	mA/W
			Typ.	189	
Anode ④	Radiant sensitivity		Min.	3.4	V/nW
			Typ.	7.5	
	Voltage output in darkness ⑤		Typ.	0.2	mV
			Max.	1	
	PMT Gain		Typ.	2.0×10^6	—
Frequency bandwidth			Typ.	DC to 30 MHz	—
Current-to-voltage conversion factor			Max.	0.02	V/μA
Output offset voltage			Typ.	±5	mV
Ripple noise (peak to peak) ④⑥			Max.	0.5	mV
Settling time ⑦			Max.	10	s
Operating ambient temperature ⑧				+5 to +50	°C
Storage temperature ⑧				-20 to +50	°C
Weight ⑨				98	g

NOTE: ① Input voltage: ±5 V, Control voltage: +1.0 V
② Input voltage: ±5 V, Averaged over any interval of 30 s maximum, Max pulse output signal voltage: +2 V, Load resistance: 10 kΩ
③ Input impedance 1 MΩ
④ Control voltage: +1.0 V
⑤ After 30 min storage in darkness. The actual output value in darkness is the sum of dark current and offset voltage.
⑥ Cable: RG-174/U, Cable length: 450 mm, Load resistance: 1 MΩ, Load capacitance: 22 pF
⑦ The time required for the output to reach a stable level following a charge in the control voltage from +1.0 V to +0.5 V.
⑧ No condensation
⑨ The cable can be changed to a cable terminated with a BNC connector. Its weight in that case is 12 grams heavier.

Gain (Typ.)

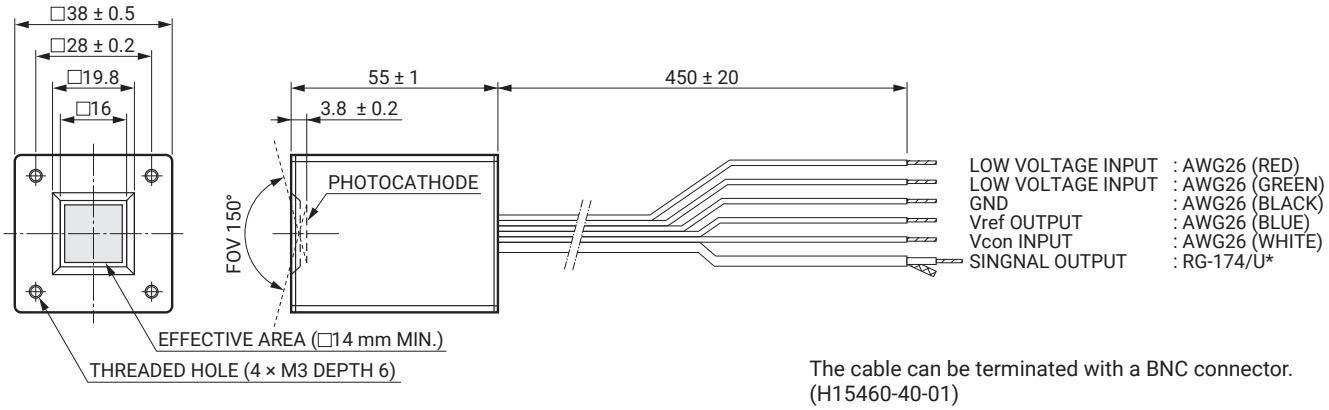


Output characteristics (Typ.)



Dimensional outline (Unit: mm)

● H15460-40



The cable can be terminated with a BNC connector.
(H15460-40-01)

Large effective area model

Photomultiplier tube modules H15461series (Current output)

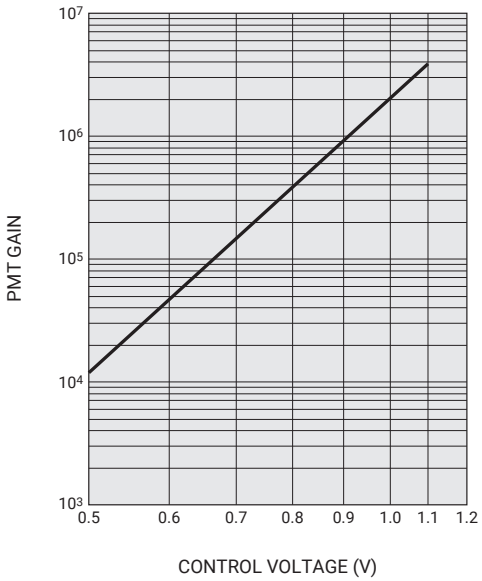
Specifications

(at +25 °C)

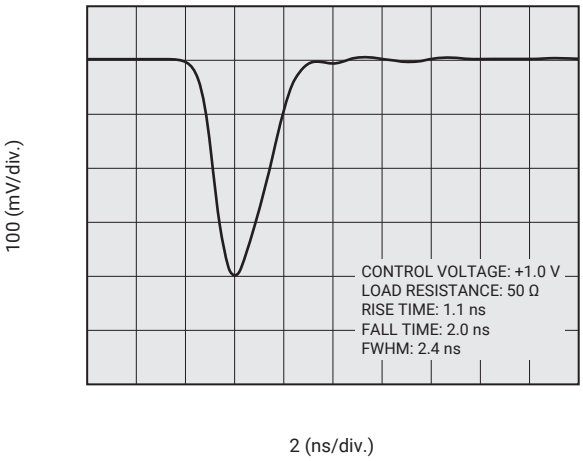
Parameter				H15461-40	Unit
Input voltage				+4.5 to +5.5	V
Max. input voltage				+5.5	V
Max. input current ①				+3.5	mA
Max. output signal voltage ②				100	μA
Max. control voltage ③				+1.1	V
Recommended control voltage adjustment range ③				+0.5 to +1.0	V
Effective area				14 × 14	mm
Spectral response				300 to 740	nm
Peak quantum efficiency wavelength				520	nm
Cathode	Quantum efficiency	at peak quantum efficiency wavelength	Min.	40	%
			Typ.	45	
	Radiant sensitivity	at peak quantum efficiency wavelength	Min.	168	mA/W
			Typ.	189	
Anode ④	Radiant sensitivity		Min.	1.7×10^5	A/W
			Typ.	3.8×10^5	
	Dark current ⑤		Typ.	10	nA
			Max.	50	
	PMT Gain		Typ.	2.0×10^6	—
Rise time			Typ.	1.1	ns
T.T.S.			Typ.	0.19	ns
Ripple noise ④⑥ (peak to peak)			Max.	0.2	mV
Settling time ⑦			Max.	10	s
Operating ambient temperature ⑧				+5 to +50	°C
Storage temperature ⑧				-20 to +50	°C
Weight ⑨				93	g

NOTE: ① Input voltage: +5 V, Control voltage: +1.0 V
② Input voltage: +5 V, Averaged over any interval of 30 s maximum, Max pulse output signal voltage: 0.1 mA
③ Input impedance: 1 MΩ
④ Control voltage: +1.0 V
⑤ After 30 min storage in darkness.
⑥ Cable: RG-174/U, Cable length: 450 mm, Load resistance: 1 MΩ, Load capacitance: 22 pF
⑦ The time required for the output to reach a stable level following a charge in the control voltage from +1.0 V to +0.5 V.
⑧ No condensation
⑨ The cable can be changed to a cable terminated with a BNC connector. Its weight in that case is 12 grams heavier.

Gain (Typ.)

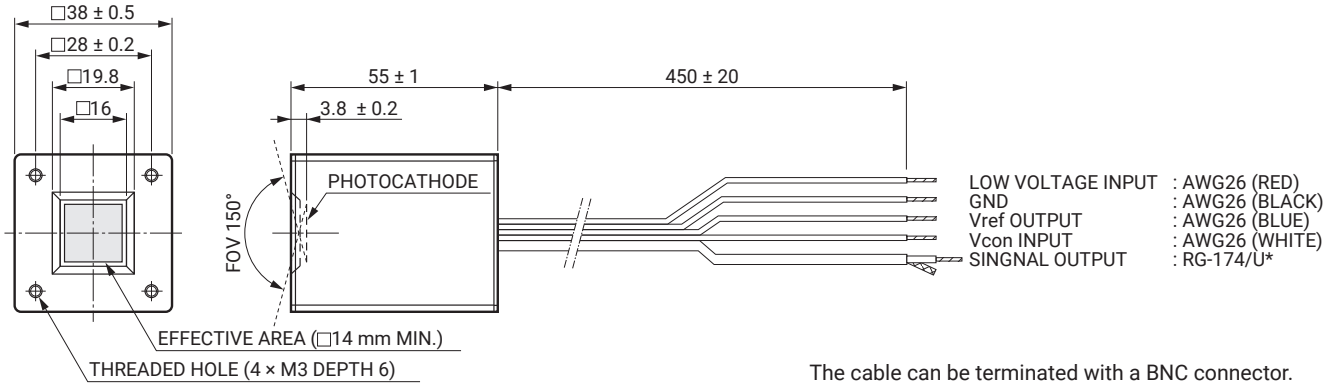


Output waveform



Dimensional outline (Unit: mm)

● H15461-40



The cable can be terminated with a BNC connector.
(H15461-40-01)

Multichannel model

Photomultiplier tube modules H12310 series, H12311 series

Specifications

(at +25 °C)

Parameter				H12310-40	H12311-40	H12310-42	H12311-42	Unit
Input voltage				+10.5 to +13.5				V
				±4.5 to ±5.5				V
Max. input voltage				+15				V
				±6				V
Max. input current ①②				+40				mA
				+110/-110				mA
Max. output signal voltage/ch ③				+0.4				V
Max. control voltage ④				+1.2				V
Recommended control voltage adjustment range ④				+0.5 to +1.1				V
Effective area/ch				0.8 × 5.0				mm
Number of channel				16				—
Channel pitch				1				mm
Spectral response				300 to 740		300 to 840		nm
Peak quantum efficiency wavelength				520		660		nm
Cathode	Quantum efficiency	at peak quantum efficiency wavelength	Min.	40		15		%
			Typ.	45		25		
		at 800 nm	Min.	—		12		
			Typ.	—		20		
	Radiant sensitivity	at peak quantum efficiency wavelength	Min.	168		80		mA/W
			Typ.	189		133		
		at 800 nm	Min.	—		77		
			Typ.	—		129		
Anode ②⑤	Radiant sensitivity	at peak quantum efficiency wavelength	Min.	8.4		4.0		V/nW
			Typ.	18.9		13.3		
		at 800 nm	Min.	—		3.9		
			Typ.	—		12.9		
	Voltage output in darkness ⑥		Typ.	0.05	0.005 ⑦	0.1	0.01 ⑦	mV
			Max.	0.15	0.015 ⑦	0.3	0.03 ⑦	
	PMT Gain		Typ.	1.0×10^6				—
	Cross-talk		Max.	2				%
Gain control for each channel	Range			1:0.01				/ch
	Step			256 (0 to 255)				Step/ch
Frequency bandwidth (-3 dB)				DC to 1 MHz				—
Current-to-voltage conversion factor				0.1				V/μA
Output offset voltage			Typ.	±2				mV
Ripple noise ②⑤⑧ (peak to peak)			Max.	1				mV
Settling time ⑨			Max.	2				s
Operating ambient temperature ⑩				+5 to +50	+5 to +35	+5 to +50	+5 to +35	°C
Storage temperature ⑩				-20 to +50				°C
Weight				434	680	434	680	g

NOTE: ① Input voltage: +12 V (High voltage power supply) ±5 V (Amplifier power supply), Control voltage: +1.0 V
② Gain adjustment step: 255 in darkness
③ Input voltage: +12 V / ±5 V, Averaged over any duration of 30 seconds maximum, Max. pulse output signal voltage: +3.5 V, Load resistance: 10 kΩ
④ Input impedance: 400 kΩ ⑤ Control voltage: +1.0 V
⑥ After 30 minutes storage in darkness. The actual output value in darkness is the sum of dark current and offset voltage.
⑦ Input current to thermoelectric cooler: 2.8 A, Heatsink: A14473, Fan: A14474
⑧ Ribbon cable, Cable length: 500 mm, Load resistance: 1 MΩ, Load capacitance: 14 pF
⑨ The time required for the output to reach a stable level following a change in the control voltage form +1.0 V to +0.5 V. ⑩No condensation

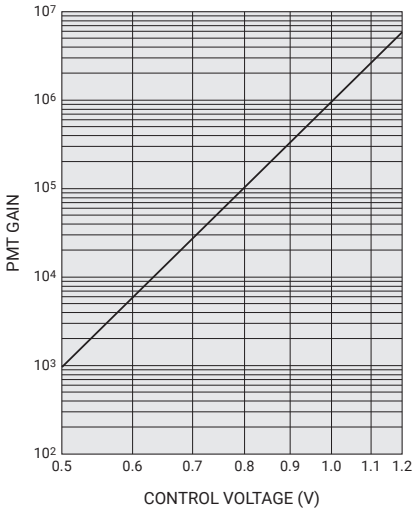
Specifications

(at +25 °C)

Parameter		H12311-40	H12311-42	Unit
Cooling specifications ⑩	Cooling method	Thermoelectric cooling		—
	Max. cooling temperature (ΔT)	25		°C
	Time to reach Max. cooling temperature	Approx. 10		min
	Max. input voltage for thermoelectric cooler	3.2		V
	Max. input current for thermoelectric cooler	4.0		A

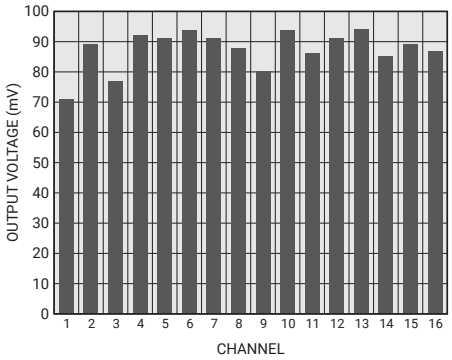
NOTE: ⑩ Input current to thermoelectric cooler: 2.8 A (used with Heatsink A14473 and fan A14474)

Gain (Typ.)

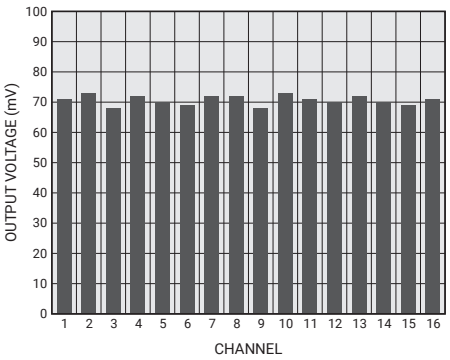


Example for gain adjustment function

● Before gain adjustment

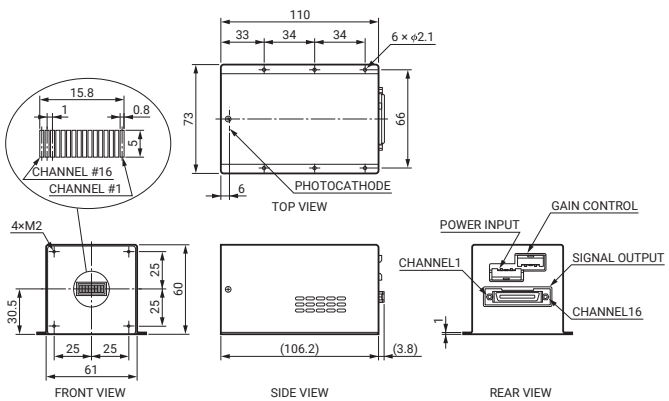


● After gain adjustment

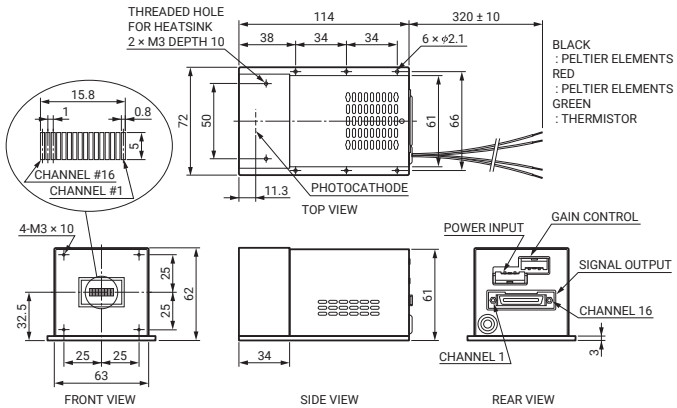


Dimensional outline (Unit: mm)

● H12310 series



● H12311 series



ACCESSORIES (Supplied)

	CONNECTOR	CABLE
GAIN CONTROL CABLE	XARP-06V [JST]	UL3385 [HITACHI]
POWER INPUT CABLE	XARP-07V [JST]	UL3385 [HITACHI]
SIGNAL OUTPUT CABLE	PCR-E36FA, PCS-E36LA [HTK]	7/0.127 25P VX-10SV, 20276SB [OKI]

The H12310 and H12311 are also available with photon counting heads. Please contact us for details.

Related products

Photomultiplier tube assembly H16566 series

Compact, lightweight assembly type with internal voltage divider circuit

The assembly type contains a voltage divider circuit, but does not include a high-voltage power supply circuit and is smaller and lighter than other PMT modules.
If you design your own power supply circuits, the assembly type is a good choice that offers greater flexibility in equipment design compared to other PMT modules.

- High sensitivity (GaAsP photocathode / GaAs photocathode)
- Compact, Light weight

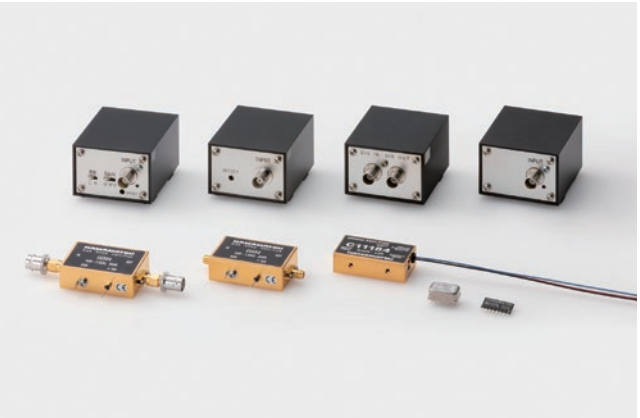
Power supplies for PMT modules C7169, C10709

Ensures stable PMT module operation

These power supplies are designed and optimized for our PMT modules. The C7169 provides a 5 V output, and the C10709 provides a 15 V output. Both can also be used as a gain adjustment controller.

Power supply and matching PMT modules

Type No.	PMT module type No.
C7169(15 V)	H11706, H16200, H16201, H16203
C10709(5 V)	H15460, H15461, H12056
Not suitable or not recommended	H12310, H12311, H16721, H16722



Amplifier units, Amplifier modules

Amplifiers for current output PMT modules

These amplifiers convert a signal fed directly from current output type PMT modules into a voltage signal. A wide product lineup is available to allow you to select the ideal amplifier for each PMT module and your application.

- A wide lineup of frequency bands

Optical fiber adapters for PMT modules E5776, E5776-51

Adapters for optical fiber cable input

This optical fiber adapter allows connection to an optical fiber cable which has FC or SMA connector.
Light from an optical fiber can be easily guided into a PMT module by installing this adapter to the light input side of the PMT module.

Power supply and matching PMT modules

Type No.	PMT module type No.
E5776 E5776-51	H16200, H16201, H16203, H16721, H16722, H11706, H12056
Not suitable or not recommended	H15460, H15461, H12310, H12311

Related products

Optical blocks for PMT module

Optical blocks simplify optical connections for low-light-level measurements

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.

Photon counting unit C9744

Allows easy photon counting measurement

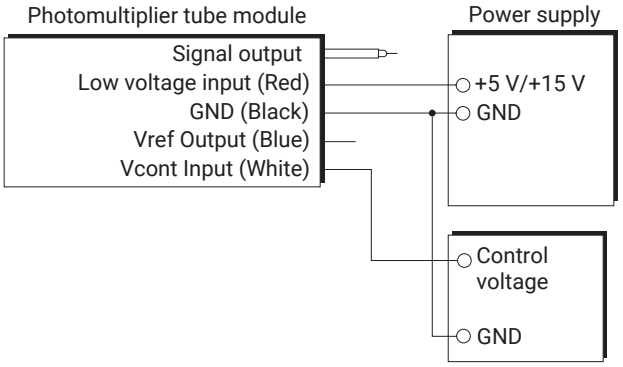
The photon counting unit C9744 converts single photoelectron pulses from a photomultiplier tube into digital signals of logic pulse by use of the built-in amplifier and discriminator circuits.
Photon counting can be easily performed by simply connecting a counter to the output of the photon counting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

Sensitivity adjustment method

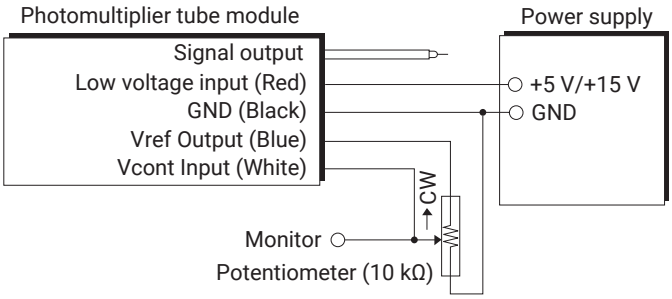
- Adjust the sensitivity by adjusting the control voltage.
- The reference voltage should be electrically isolated.
- When adjusting the sensitivity using a variable resistor, monitor the control voltage so that it does not exceed the maximum value.

● Current output type

● Voltage programming

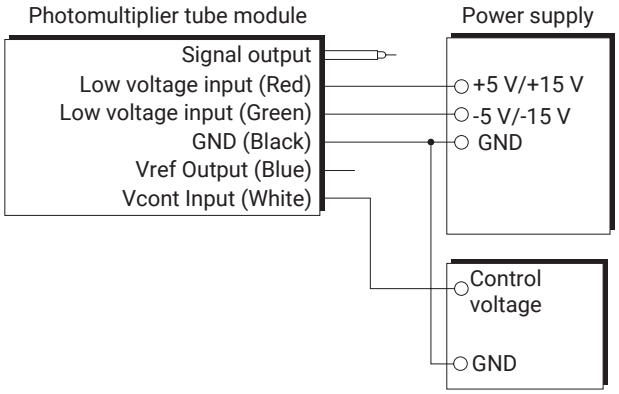


● Resistance programming

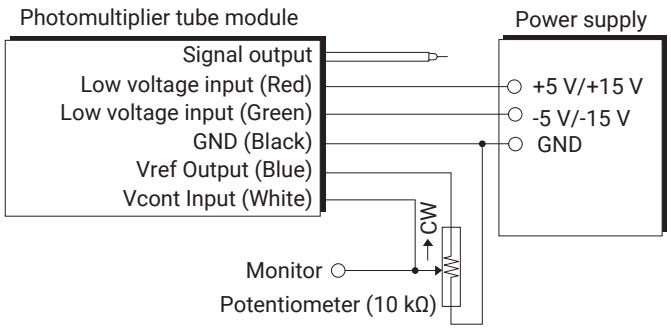


● Voltage output type

● Voltage programming

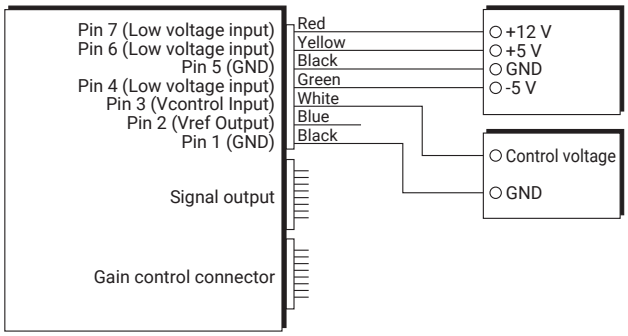


● Resistance programming

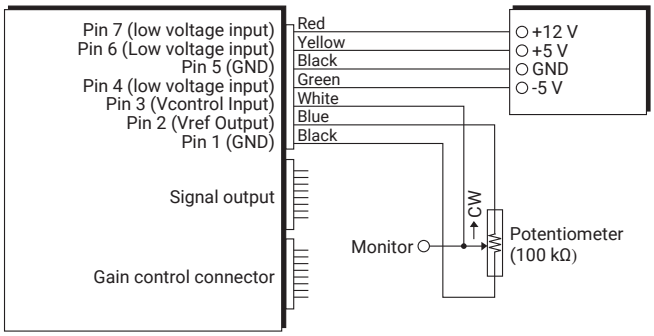


● H12310・H12311

● Voltage programming



● Resistance programming



Technical guide

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 radiant flux of the incident light, 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.
We attach spectral response data showing radiant sensitivity to individual photomultiplier tubes only when requested by the customer and we charge for this service.
If spectral response data is necessary, please request it before placing an order since the measurement takes a lot of time.

● Gain

Gain of photomultiplier tubes listed in this catalog is the anode output current divided by the cathode output current, which is obtained when at a specified control voltage is input.
A high voltage corresponding to the control voltage is input to a photomultiplier tube, so the higher the control voltage, the higher the gain will be.

● 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, which is in nearly proportion to the change in gain. However, the slope of the dark current versus the voltage curve becomes 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 of the photomultiplier tube or the surface of the circuit boards.
Most of dark current originates from thermionic emissions from the photocathode.
Cooling PMT modules is therefore very effective in reducing the dark current, but PMT modules should always be used within the specified operating ambient temperature range.
PMT modules with a cooler are designed to cool the built-in photomultiplier tube very efficiently, reducing the dark current in a short time.

● Spatial uniformity

When a light spot strikes a small area on a photocathode, the output value may vary depending on the position of light incident on the photocathode. This variation in the output value is called "spatial uniformity." Spatial uniformity is mainly caused by the irregular sensitivity of the photocathode itself and also by a non-uniform loss of electrons due to differences in the electron trajectories.
Spatial uniformity also depends on the wavelength of light. In general, if spatial uniformity affects measurements, the input light should be made to illuminate a wider area on the photocathode, or a diffuser plate should be placed in front of the photocathode.

● Temperature characteristics

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

● Drift and life characteristics

While operating a photomultiplier tube continuously over a long period of time, 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 characteristics.
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 important in measurements, operating the photomultiplier tube at an average anode current of 1 µA or less is recommended.

● Time response characteristics

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 (TTS).
These time response characteristics differ depending on the type of photomultiplier tube contained in PMT modules.
In the case of current-output PMT modules, in addition to the time response characteristics of the built-in photomultiplier tube itself, the signal load conditions have effects on the PMT module response speed.
When the load resistance to current-output PMT modules is made larger, the signal voltage increases but the response speed reduces.

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 is compact with low power consumption and delivers high DC characteristics and pulse linearity characteristics, 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 supplied to the entire photomultiplier tube and an active type divider circuit that supplies 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 output 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 of 1 MΩ and a load capacitance of 22 pF.

● Settling time

When the control voltage is changed, the high voltage supplied to the photomultiplier tube also changes, but there is a slight delay from the change in the control voltage.
The settling time is the time required for the photomultiplier tube supply voltage to reach the specified level after changing the control voltage.
At Hamamatsu Photonics, this settling time is measured usually by 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.

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

HAMAMATSU PHOTONICS K.K. **www.hamamatsu.com**

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

U.S.A.: HAMAMATSU CORPORATION: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218 E-mail: usa@hamamatsu.com
Germany: HAMAMATSU PHOTONICS DEUTSCHLAND GMBH.: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de
France: HAMAMATSU PHOTONICS FRANCE S.A.R.L.: 19 Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: infos@hamamatsu.fr
United Kingdom: HAMAMATSU PHOTONICS UK LIMITED: 2 Howard Court,10 Tewin Road, Welwyn Garden City, Hertfordshire, AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777 E-mail: info@hamamatsu.co.uk
North Europe: HAMAMATSU PHOTONICS NORDEN AB: Torshamnsgatan 35, 16440 Kista, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se
Italy: HAMAMATSU PHOTONICS ITALIA S.R.L.: Strada della Moia, 1 int. 6 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it
China: HAMAMATSU PHOTONICS (CHINA) CO., LTD.: 1201, Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn
Taiwan: HAMAMATSU PHOTONICS TAIWAN CO., LTD.: 13F-1, No.101, Section 2, Gongdao 5th Road, East Dist., Hsinchu City, 300046, Taiwan(R.O.C) Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw

Cat. No.TPMO1120E01
SEPT. 2023 IP