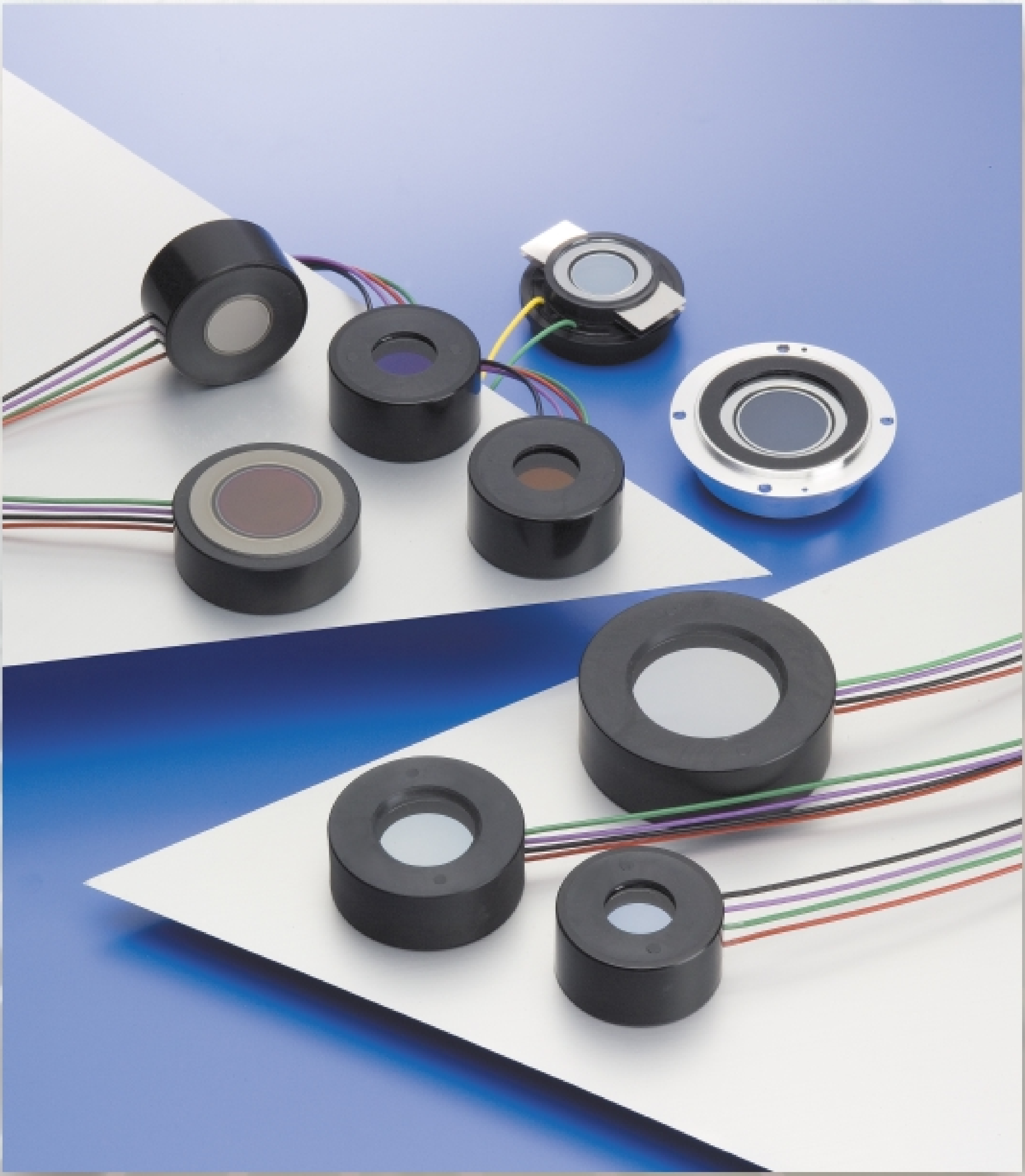
IMAGE INTENSIFIERS



HAMAMATSU

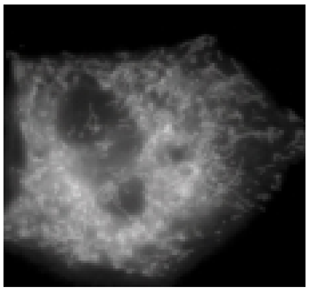
Image Intensifier

Image intensifiers (often abbreviated as I. I.) were primarily developed for nighttime viewing and surveillance under moonlight or starlight. Image intensifiers are capable of detecting and amplifying low-light-level images (weak emissions or reflected light) for bringing them into view as sharp contrast images. Image intensifier applications have spread from nighttime viewing to various fields including industrial product inspection and scientific research, especially when used with CCD cameras (intensified CCD or ICCD). Gate operation models are also useful for observation and motion analysis of high-speed phenomena (high-speed moving objects, fluorescence lifetime, bioluminescence and chemiluminescence images). Some major image intensifier applications are introduced here.

APPLICATION EXAMPLE

BIOTECHNOLOGY

Fluorescence imaging



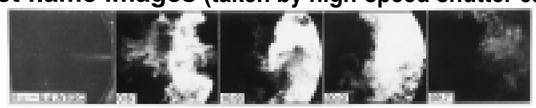
Mitochondria inside a nerve system culture cell NG108-15, specificity - labeled with fluorescent dye MITO TRACKER.

INDUSTRY

Observing engine combustion

Soot scattering images (taken by image intensifier)

Direct flame images (taken by high-speed shutter camera)

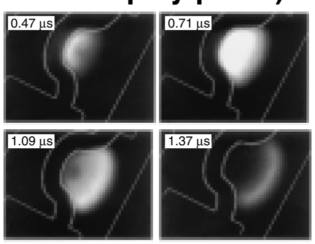


ATDC: After Top Dead Center, θ: Crank angle with respect to ATDC

How soot is generated can be observed by viewing low-level scattering light resulting from laser irradiation.

ELECTRONICS

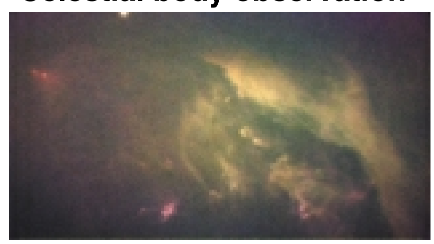
PDP (Plasma display panel) emission



Very-low plasma emission occurring over an ultra-short duration can be observed. (*Plasma emission is superimposed on the PDP electrode. Top left shows elapsed time after applying a voltage to the each others electrode.

ASTRONOMY

Celestial body observation



Star wind from the protostar L1551-IRS5 (red star at upper left), twinkling in yellowish green when it collides with surrounding gases.

Photo courtesy of National Astronomical Observatory in Japan/In cooperation with NHK (Nihon Hoso Kyokai)

OTHER-APPLICATIONS

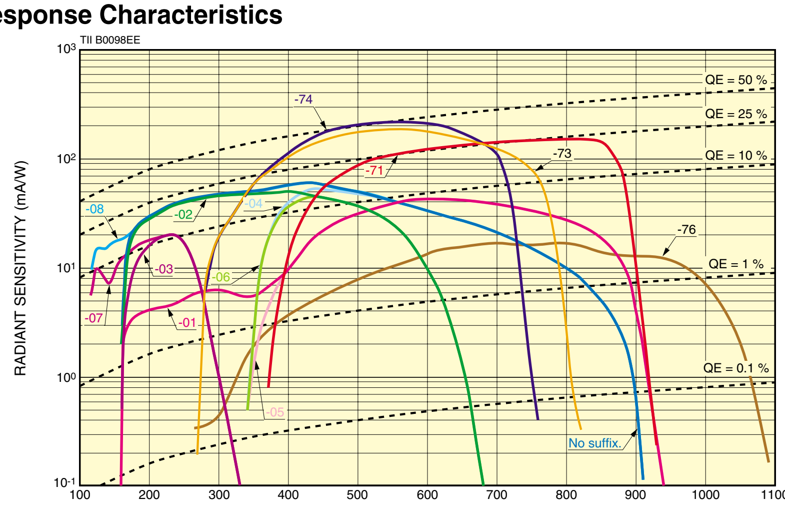
- **Low-light-level imaging**
- **Multi-channel spectroscopy**
- **High-speed motion analysis**
- **Bioluminescence or chemiluminescence imaging**
- **UV range imaging (Corona discharge observation)**

FEATURES

Feature 1 WIDE VARIATIONS

A wide variety of characteristics is presented including spectral response by choosing a photocathode and window material combination, photocathode size, the number of MCPs (gain) and gate time. You are sure to find the device that best matches your application from our complete lineup of standard or custom products.

■Spectral Response Characteristics



NOTE: Gate operation types may have slightly lower sensitivity in the ultraviolet region.

Feature 2 HIGH RESOLUTION

Clear, sharp images can be obtained with no chicken wire.

Feature 3 COMPACT AND LIGHTWEIGHT

Proximity-focused configuration is more compact and lightweight than inverter type.

Feature 4 NO DISTORTION

Images without distortion can be obtained even at periphery.

Feature 5 HIGH-SPEED GATE OPERATION

High-speed gated image intensifiers are available for imaging and motion analysis of high-speed phenomena.

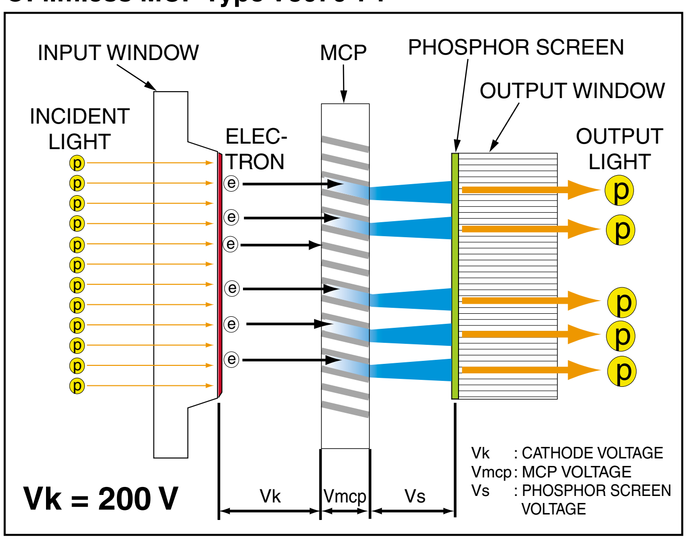
Feature 6 HIGH SENSITIVITY GaAsP PHOTOCATHODE

Excellent image intensification with an even higher signal-to-noise ratio is achieved by combining our filmless MCP fabrication technology with the high-sensitivity GaAsP photocathode that delivers a typical quantum efficiency of 50 % at 530 nm (see lower left graph).

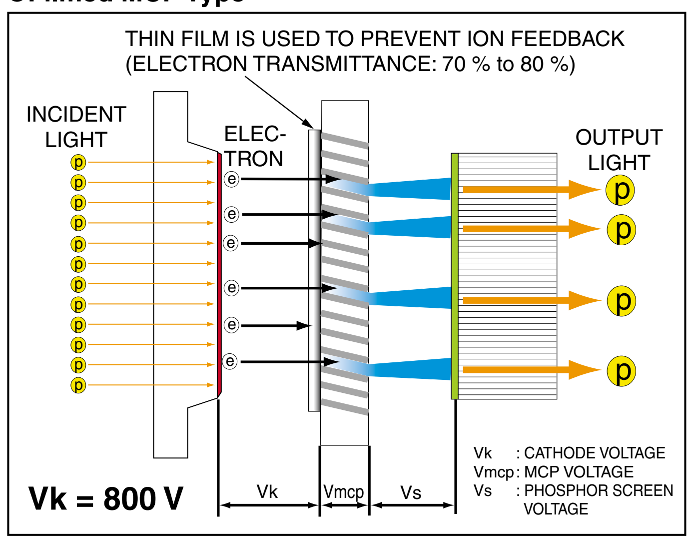
■STRUCTURE

In filmed image intensifiers having a GaAsP photocathode, a thin film is usually deposited over the surface of the MCP (microchannel plate) to prevent ion feedback. Our newly perfected fabrication method successfully eliminates this thin film while maintaining the same operating life as filmed image intensifiers. This filmless structure eliminates the loss of electrons passing through the MCP and therefore improves the signal-to-noise ratio more than 20 % compared to filmed image intensifiers.
This technology is now being applied to the GaAs photocathode fabrication process.

●Filmless MCP Type V8070-74



●Filmed MCP Type

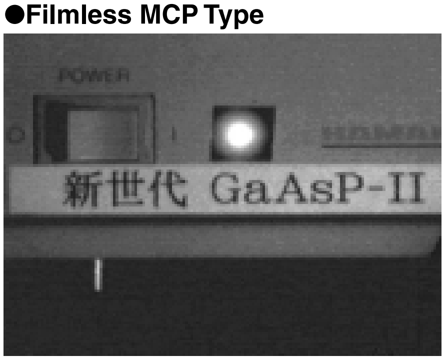


SN Ratio 20 % UP | **High Resolution 57 Lp/mm (Typ.)** | **Cathode Voltage 200 V**

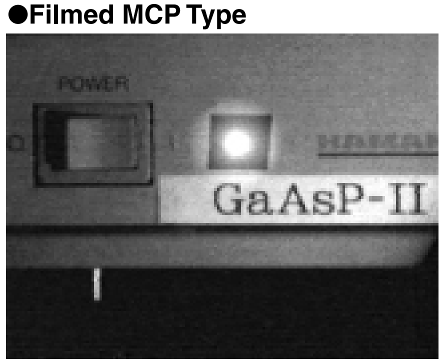
■Low "halo" effect

Minimizes the halo effect that makes annular light appear around bright spots.

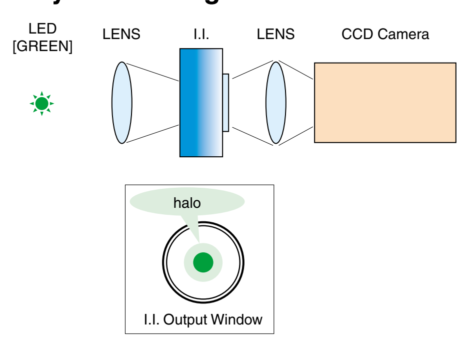
●Filmless MCP Type



●Filmed MCP Type



●System Configuration

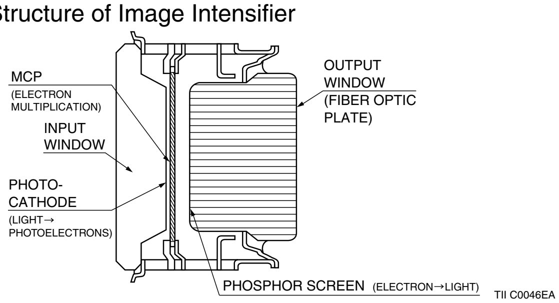


●STRUCTURE AND OPERATION

STRUCTURE

Figure 1 shows the structure of a typical image intensifier. A photocathode that converts light into photoelectrons, a microchannel plate (MCP) that multiplies electrons, and a phosphor screen that reconverts electrons into light are arranged in close proximity in an evacuated ceramic case. The close proximity design from the photocathode to the phosphor screen delivers an image with no geometric distortion even at the periphery.
Types of image intensifiers are often broadly classified by "generation". The first generation refers to image intensifiers that do not use an MCP and where the gain is usually no greater than 100 times. The second generation image intensifiers use MCPs for electron multiplication. Types using a single-stage MCP have a gain of about 10000, while types using a 3-stage MCP offer a much higher gain of more than 10 million.
A variety of photocathodes materials are currently in use. Of these, photocathodes made of semiconductor crystals such as GaAs and GsAsP are called "third generation". These photocathodes offer extremely high sensitivity. Among the first and second generation image intensifiers, there are still some inverter types in which an image is internally inverted by the electron lens, but these are rarely used now because of geometric distortion.

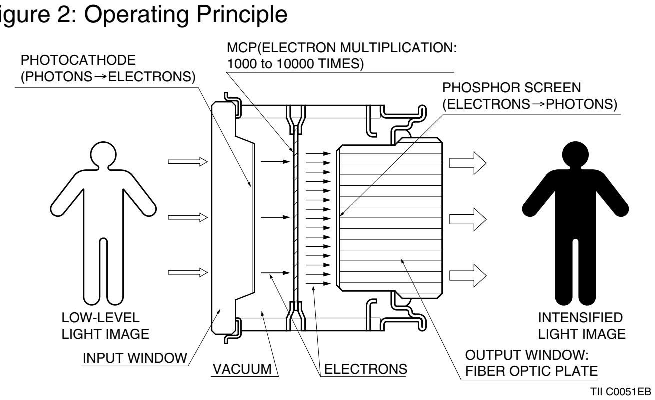
Figure 1: Structure of Image Intensifier



OPERATING PRINCIPLE

Figure 2 shows how light focused on the photocathode is converted into photoelectrons. The number of photoelectrons emitted at this point is proportional to the input light intensity. These electrons are then accelerated by a voltage applied between the photocathode and the MCP input surface (MCP-in) and enter individual channels of the MCP. Since each channel of the MCP serves as an independent electron multiplier, the input electrons impinging on the channel wall produce secondary electrons. This process is repeated hundreds of times by the potential gradient across the both ends of the MCP and a large number of electrons are in this way released from the output end of the MCP. The electrons multiplied by the MCP are further accelerated by the voltage between the MCP output surface (MCP-out) and the phosphor screen, and strike the photocathode which emits light according to the amount of electrons. Through this process, an input optical image is intensified about 10 000 times (in the case of a one-stage MCP) and appears as the output image on the phosphor screen.

Figure 2: Operating Principle

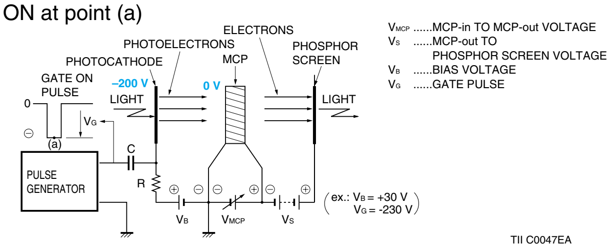


GATE OPERATION

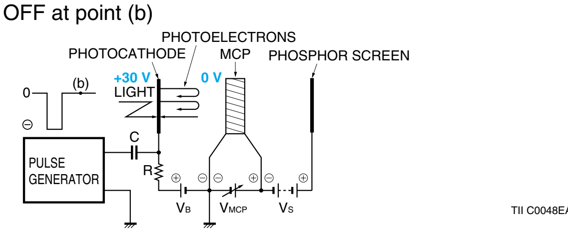
An image intensifier can be gated to open or close the optical shutter by varying the potential between the photocathode and the MCP-in. Figure 3 shows typical gate operation circuits.
When the gate is ON, the photocathode potential is lower than the MCP-in potential so the electrons emitted from the photocathode are attracted by this potential difference towards the MCP and multiplied there. An intensified image can then be obtained on the phosphor screen.
When the gate is OFF however, the photocathode has a higher potential than the MCP-in (reverse-biased) so the electrons emitted from the photocathode are forced to return to the photocathode by this reverse-biased potential and do not reach the MCP. In the gate OFF mode, no output image appears on the phosphor screen even if light is incident on the photocathode.
To actually turn on the gate operation, a high-speed, negative polarity pulse of about 200 volts is applied to the photocathode while the MCP-in potential is fixed. The width (time) of this pulse will be the gate time.
The gate function is very effective when analyzing high-speed optical phenomenon. Gated image intensifiers and ICCDs (intensified CCDs) having this gate function are capable of capturing instantaneous images of high-speed optical phenomenon while excluding extraneous signals.

Figure 3: Gate Operation Circuits

Gate ON at point (a)



Gate OFF at point (b)



PHOTON COUNTING MODE

SIT (silicon intensified target) cameras and image intensifiers using a one-stage MCP have been used in low-light-level imaging. However, these imaging devices cannot capture a clear image when the light level is lower than 10^{-5} lx. At such extremely low light levels, detecting light as an analog quantity is difficult due to limitations by the laws of physics, but detecting light by counting photons is more effective. Image intensifiers using a 3-stage MCP are ideal for photon counting.
Image intensifiers with a 3-stage MCP can be considered high-sensitivity image intensifiers. However, these have two operation modes, one of which is completely different from normal image intensifier operation. At light levels down to about 10^{-4} lx, these 3-stage MCP image intensifiers operate in the same way as normal image intensifiers by applying a low voltage to the MCP. A continuous output image can be obtained with a gray scale or gradation. This operation mode allows the 3-stage MCP to provide a lower gain of 10^2 to 10^4 and is called "analog mode".
On the other hand, when the light intensity becomes so low (below 10^{-5} lx) that the incident photons are separated in time and space, the photocathode emits very few photoelectrons and only one or no photoelectrons enter each channel of the MCP. Capturing a continuous image with a gradation is then no longer possible. In such cases, by applying about 2.4 kV to the 3-stage MCP to increase the gain to about 10^6, light spots (single photon spots) with approximately a 60 μm diameter corresponding to individual photoelectrons will appear on the output phosphor screen. The gradations of the output image are not expressed as a difference in brightness but rather as differences in the time and spatial density distribution of the light spots. Even at extremely low light levels when only a few light spots appear per second on the output phosphor screen, an image can be obtained by detecting each spot and its position, and integrating them into an image storage unit such as a still camera and video frame memory. The brightness distribution of this image is configured by the difference in the number of photons at each position. This operation is known as photon counting mode.

Since image intensifiers using a 3-stage MCP can operate in both analog mode and photon counting mode, they can be utilized in a wide spectrum of applications from extremely low light levels to light levels having motion images.

●GLOSSARY OF TERMS

Photocathode Sensitivity

Luminous Sensitivity: The output current from the photocathode per the input luminous flux from a standard tungsten lamp (color temperature: 2856 K), usually expressed in µA/lm (microamperes per lumen). Luminous sensitivity is a term originally for sensors in the visible region and is used in this catalog as a guideline for sensitivity.

Radiant Sensitivity: The output current from the photocathode per the input radiant power at a given wavelength, usually expressed in A/W (amperes per watt).

Quantum Efficiency (QE): The number of photoelectrons emitted from the photocathode divided by the number of input photons, generally expressed in % (percentage). The quantum efficiency and radiant sensitivity have the following relation at a given wavelength λ.

$$QE = \frac{S \times 1240}{\lambda} \times 100\ (\%)$$

S: Radiant sensitivity (A/W)
λ: Wavelength (nm)

Luminous Emittance

This is the luminous flux density emitted from a phosphor screen and is usually expressed in lm/m^2 (lumens per square meter). The luminous emittance from a completely diffused surface emitting an equal luminance in every direction is equivalent to the luminance (cd/m^2) multiplied by π.

Gain

Gain is designated by different terms according to the photocathode spectral response range. Luminous emittance gain is used for image intensifiers having sensitivity in the visible region. Radiant emittance gain and photon gain are used for image intensifiers intended to detect invisible light or monochromatic light so that light intensity must be expressed in units of electromagnetic energy

Photon gain is also used to evaluate image intensifiers using a P-47 phosphor (see Figure 5) whose emission spectrum is shifted from the relative visual sensitivity.

Luminous Gain: The ratio of the phosphor screen luminous emittance (lm/m^2) to the illuminance (lx) incident on the photocathode.

Radiant Emittance Gain: The ratio of the phosphor screen radiant emittance density (W/m^2) to the radiant flux density (W/m^2) incident on the photocathode. In this catalog, the radiant emittance gain is calculated using the radiant flux density at the wavelength of maximum photocathode sensitivity and the radiant emittance density at the peak emission wavelength (545 nm) of a P-43 phosphor screen.

Photon Gain: The ratio of the number of input photons per square meter at a given wavelength to the number of photons per square meter emitted from the phosphor screen.

MTF (Modulation Transfer Function)

When a black-and-white stripe pattern producing sine-wave changes in brightness is focused on the photocathode, the contrast on the output phosphor screen drops gradually as the stripe pattern density is increased. The relationship between this contrast and the stripe density (number of line-pairs per millimeter) is referred to as the MTF.

Limiting Resolution

The limiting resolution shows the ability to delineate image detail. This is expressed as the maximum number of line-pairs per millimeter on the photocathode (1 line-pair = a pair of black and white lines) that can be discerned when a black-and-white stripe pattern is focused on the photocathode. In this catalog, the value at 5 % MTF is listed as the limiting resolution.

EBI (Equivalent Background Input)

This indicates the input illuminance required to produce a luminous emittance from the phosphor screen, equal to that obtained when the input illuminance on the photocathode is zero. This indicates the inherent background level or lower limit of detectable illuminance of an image intensifier.

Shutter Ratio

The ratio of the brightness on the phosphor screen during gate ON to that during gate OFF, measured when a gated image intensifier is operated under standard conditions.

Dark Count

This indicates the noise level of an image intensifier using a 3-stage MCP when operated in the photon counting mode.

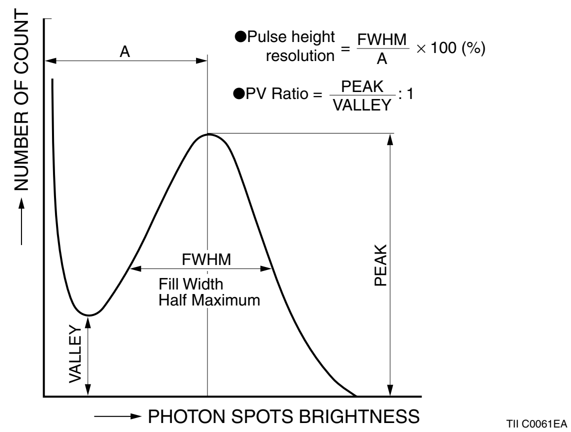
The dark count is usually expressed as the number of bright spots per square centimeter on the photocathode measured for a period of one second (S^{-1}/cm^2).

Cooling the photocathode is very effective in reducing the dark count. Usually, photocathodes (such as red-enhanced or extended red multialkali, GaAs and Ag-O-Cs) that tend to produce a large number of dark count at room temperatures should be cooled when used in the photon counting mode.

Pulse Height Distribution (PHD) on Phosphor Screen

Bright spots appear on the output phosphor screen when an image intensifier using a 3-stage MCP is operated in the photon counting mode. The pulse height distribution is a graph showing how many times a bright spot occurs on the phosphor screen, plotted as a function of brightness level (pulse height).

When an image intensifier is used with the MCP gain saturated, the brightness of each spot corresponding to each photoelectron is equalized on the phosphor screen to allow photon counting imaging. As noted in the graph below, the pulse height resolution and the P/V (peak-to-valley) ratio are used to indicate how the bright spots are aligned.

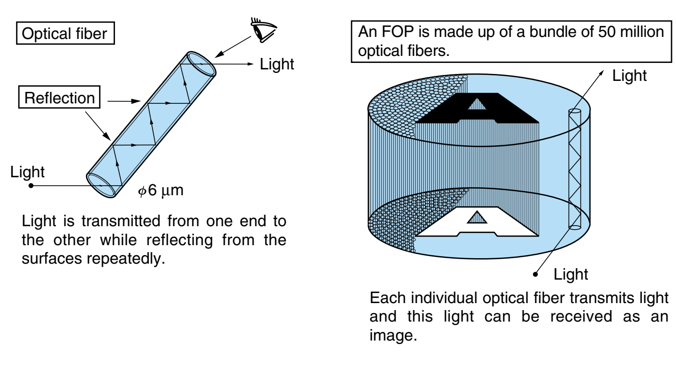


Fiber Optic Plate (FOP)

The FOP is an optical plate comprising some millions to hundreds of millions of glass fibers with 6 µm diameter, bundled parallel to one another.

The FOP is capable of transmitting an optical image from one surface to another without causing any image distortion.

■Structure of FOP



●SELECTION CRITERIA (Factors for making the best choice)

Items	Selectable Range	Description/Value
Effective Area ★Select the effective area that matches the readout method.	ϕ18 mm (13.5 mm × 10 mm) Ⓐ	The 25 mm (16 mm × 16 mm Ⓐ) and 40 mm diameter types transfer a larger amount of image information to a readout device coupled by using a reduction optical system such as a relay lens and tapered FOP. This lets you acquire high resolution images. The 18 mm diameter type (13.5 mm × 10 mm) is compatible with 1-inch CCDs.
	ϕ25 mm (16 mm × 16 mm) Ⓐ	
	ϕ40 mm	

Items	Window Type	Transmitting Wavelength	Features
Input Window ★Select the window according to the required sensitivity at short wavelengths.	Synthetic silica	160 nm or longer	Standard input window with high UV transmittance.
	Fiber optic Plate (FOP)	350 nm or longer	Optical element that transmits an optical image with high efficiency and no distortion. An image should be focused on the front surface of FOP.
	MgF_2	115 nm or longer	Alkali halide crystal that transmits VUV radiation yet offers low deliquescence.
	Borosilicate glass	300 nm or longer	Most common glass material used in the visible to near IR region. Not suitable for UV detection.

Items	Photocathode Type	Spectral Response	Features
Photocathode ★Select the photocathode according to the required sensitivity at long wavelengths.	Multialkali	Up to 900 nm	Made from 3 kinds of alkali metals, having high sensitivity from the UV through near IR region.
	Extended red multialkali	Up to 950 nm	Made from 3 kinds of alkali metals, having high sensitivity extending to 950 nm in the near IR region. Ideal for nighttime viewing.
	Bialkali	Up to 650 nm	Made from 2 kinds of alkali metals, having sensitivity from the UV to visible region. Background noise is low.
	Cs-Te	Up to 320 nm	Having sensitivity only in the UV region and almost insensitive to wavelengths longer than 320 nm and visible light. Often called "solar blind photocathode".
	GaAs	Up to 920 nm	Made from group Ⅲ-V crystal having high sensitivity from the visible to near IR region. Spectral response curve is nearly flat from 450 to 850 nm.
	GaAsP	Up to 720 nm	Made from group Ⅲ-V crystal having very high sensitivity in the visible region (quantum efficiency 50 % Typ. at 530 nm).
	InGaAs	Up to 1100 nm	Made from group Ⅲ-V crystal having high sensitivity at 1 μm. This photocathode is suitable for laser ranging application used by YAG laser.

Items	Selectable Range	Description/Value
MCP ★Select the number of stages according to the required gain.	1 stage	Gain: about 10^3
	2 stage	Gain: about 10^5
	3 stage	Gain: more than 10^6 (For photon counting imaging)

Items	Phosphor Type	Peak Emission Wavelength [nm]	10 % Decay Time	Relative Ⓒ Power Efficiency	Emission Color	NOTE
Phosphor Screen ★Select the decay time that matches the readout method and application, and the spectral emission that matches the read-out device sensitivity.	P20E	530	1 ms	1.3	Yellowish green	
	P24	500	3 μs to 40 μs Ⓑ	0.4	Green	
	P43	545	1 ms	1	Yellowish green	Typical decay time
	P46	530	0.2 μs to 0.4 μs Ⓑ	0.3	Yellowish green	Short decay time
	P47	430	0.11 μs	0.3	Purplish blue	Short decay time

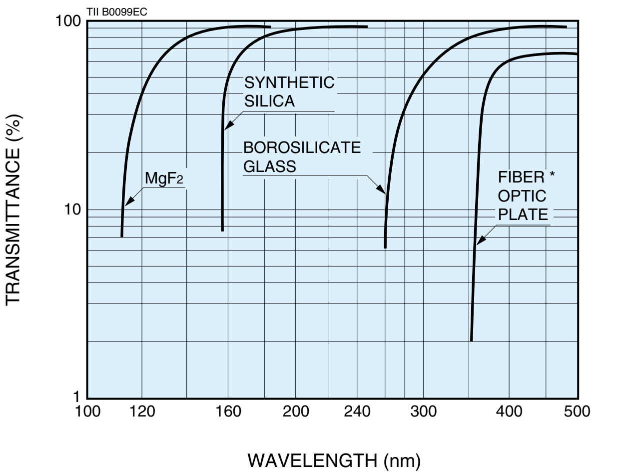
Items	Selectable Range	Description/Value
Output Window ★Select the window that matches the readout method.	Fiber optic plate (FOP)	Standard output window and ideal for direct coupling to a CCD with FOP input window, allowing highly efficient readout. If the phosphor screen is not at ground potential, a NESA (transparent conductive film) may be needed to prevent noise generated by a high voltage from getting into the CCD. When a relay lens is used, it should be focused on the edge of the FOP.
	Borosilicate glass	For relay lens readout. The relay lens should be focused on the phosphor screen surface.
	Taper fiber optic	The output image is reduced by tapered FOP. The tapered FOP is also suitable to connect a CCD camera with FOP window directly.
	Twisted fiber optics	FOP twisted 180 ° to invert an image. This output window is only for nighttime viewing applications where the output image is directly viewed by eye. Using a twisted fiber optics reduces the eyepiece length, making the nighttime viewing unit more compact.

Items	Selectable Range	Description/Value
Gate Time ★Select the gate time that matches the required time resolution.	200 ps Ⓓ	Mesh type (V5548U)
	250 ps Ⓓ	Metallic thick film type (V4323U, V6561U)
	5 ns (ϕ18 mm type)	Metallic thin film type
	10 ns (ϕ25 mm type)	
	20 ns (ϕ40 mm type)	

Ⓐ: at crystal photocathode
Ⓑ: Depends on the input pulse width. Refe to Figuer 6 on page 6.
Ⓒ: Relative value with output from P43 set as 1. Measured with 6 kV voltage applied.
Ⓓ: Shutter time: Defined as the rise time. The input gate pulse width should be at least twice the shutter time.

INPUT WINDOWS

Figure 4: Typical Transmittance of Window Materials



* Collimated transmission

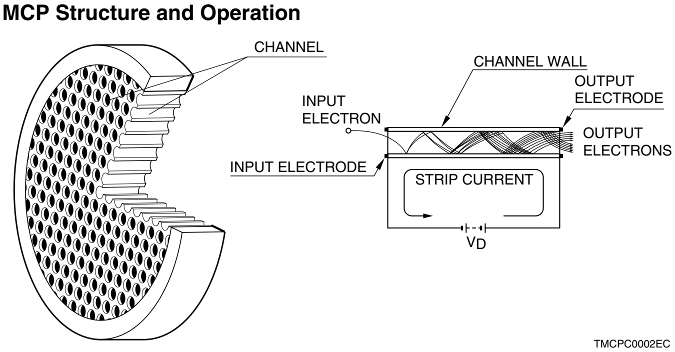
PHOTOCATHODE

A photocathode converts light into electrons. This conversion efficiency depends on the wavelength of light. The relationship between this conversion efficiency (photocathode radiant sensitivity or quantum efficiency) and wavelength is called the spectral response characteristic. (See spectral response characteristics on page 2.)

MCP (MICROCHANNEL PLATE)

An MCP is a secondary electron multiplier consisting of an array of millions of very thin glass channels (glass pipes) bundled in parallel and sliced in the form of a disk. Each channel works as an independent electron multiplier. When an electron enters a channel and hits the inner wall, secondary electrons are produced. These secondary electrons are then accelerated by the voltage (V_{MCP}) applied across the both ends of the MCP along their parabolic trajectories to strike the opposite wall where additional secondary electrons are released. This process is repeated many times along the channel wall and as a result, a great number of electrons are output from the MCP.
The dynamic range (linearity) of an image intensifier depends on the so-called strip current which flows through the MCP during operation. When a higher linearity is required, using a low-resistance MCP is recommended so that a large strip current will flow through the MCP.
The channel diameter of typical MCPs is 10 µm. High resolution type MCPs, however, use a 6 µm channel diameter.

MCP Structure and Operation



PHOSPHOR SCREEN

The phosphor screen generally absorbs ultraviolet radiation, electron beams or X-rays and emits light on a wavelength characteristic of that material. An image intensifier uses a phosphor screen at the output surface to convert the electrons multiplied by the MCP into light. Phosphor screen decay time is one of the most important factors to consider when selecting a phosphor screen type. When used with a high-speed CCD or linear image sensor, a phosphor screen with a short decay time is recommended so that no afterimage remains in the next frame. For nighttime viewing and surveillance, a phosphor with a long decay time is suggested to minimize flicker. Figure 5 shows typical phosphor spectral emission characteristics and Figure 6 shows typical decay characteristics.
We also supply phosphor screens singly for use in detection of ultraviolet radiation, electron beams and X-rays.

Figure 5: Typical Phosphor Spectral Emission Characteristics

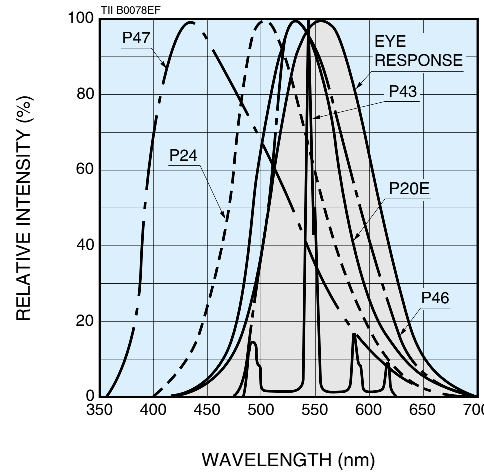
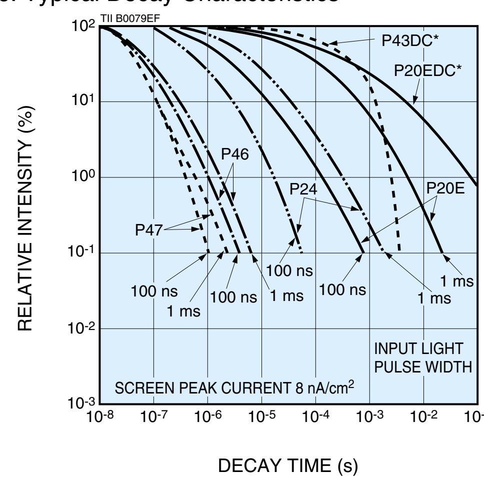


Figure 6: Typical Decay Characteristics



* Decay time obtained following to the continuous input light removal.

OUTPUT WINDOW MATERIAL

Please select the desired type according to the readout method.

GATE OPERATION

Most photocathodes have a high electrical resistance (surface resistance) and are not suited for gate operation when used separately. To allow gate operation at a photocathode, a low-resistance photocathode electrode (metallic thin film) is usually deposited between the photocathode and the incident window. Gate operation can be performed by applying a high-speed voltage pulse to the low-resistance photocathode electrode. Metallic thick films or mesh type electrodes are provided rather than metallic thin films since they offer an even lower surface resistance. The gate operation time is determined by the type of photocathode electrode.
Since the semiconductor crystals of the GaAs and GaAsP photocathodes themselves have low resistance, no photocathode electrode film needs to be deposited for gate operation.

●SELECTION GUIDE (by wavelength)

THIRD GENERATION

Suffix	Spectral Response Range (nm)	Wave-length of Peak Response (nm) Ⓐ	Input Window /Index of Refraction n Ⓑ	Photocathode	Standard Phosphor Screen	Standard Output Window	Effective Photo-cathode Area	13.5 mm × 10 mm	
							Gate Function Ⓒ	non	
							NOTE	High Quantum Efficiency	NIR High Sensitivity
							1 stage MCP Ⓔ	V8070	V7090
							2 stage MCP Ⓔ	V8070	V7090
-71	370 to 920	650 to 750	Borosilicate Glass /1.49*3	GaAs	P43	FOP	1 stage MCP		○
							2 stage MCP		○
-72	370 to 920	650 to 750	FOP/–	GaAs	P43	FOP	1 stage MCP		○ *
							2 stage MCP		○ *
-73	280 to 820	480 to 530	Borosilicate Glass /1.49*3	Enhanced Red GaAsP	P43	FOP	1 stage MCP	○ *	
							2 stage MCP	○ *	
-74	280 to 720	480 to 530	Borosilicate Glass /1.49*3	GaAsP	P43	FOP	1 stage MCP	○	
							2 stage MCP	○	
-75	350 to 720	480 to 530	FOP/–	GaAsP	P43	FOP	1 stage MCP	○ *	
							2 stage MCP	○ *	
-76	360 to 1100	700 to 800	Borosilicate Glass /1.49*3	InGaAs	P43	FOP	1 stage MCP		
							2 stage MCP		

SECOND GENERATION

Suffix	Spectral Response Range (nm)	Wave-length of Peak Response (nm) Ⓐ	Input Window /Index of Refraction n Ⓑ	Photocathode	Standard Phosphor Screen	Standard Output Window	Effective Photo-cathode Area	ϕ18 mm	
							Gate Function Ⓒ	non	
							NOTE	High Resolution	—
							1 stage MCP Ⓔ	V6886U	—
							2 stage MCP Ⓔ	—	V4170U
—	160 to 900	430	Synthetic Silica /1.46*1	Multialkali	P43	FOP	1 stage MCP	○	
							2 stage MCP		○
-01	160 to 950	600	Synthetic Silica /1.46*1	Extended Red Multialkali	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-02	160 to 650	400	Synthetic Silica /1.46*1	Bialkali	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-03	160 to 320	230	Synthetic Silica /1.51*2	Cs-Te	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-04	350 to 900	430	FOP/–	Multialkali	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-05	350 to 950	600	FOP/–	Extended Red Multialkali	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-06	350 to 650	430	FOP/–	Bialkali	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-07	115 to 320	230	MgF_2 /1.40 or 1.41 *2	Cs-Te	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *
-08	115 to 900	430	MgF_2 /1.40 or 1.41 *2	Multialkali	P43	FOP	1 stage MCP	○ *	
							2 stage MCP		○ *

NOTE: Ⓐ Wavelength used measure refractive index: *1: 589.6 nm, *2: 254 nm, *3: 588 nm Ⓑ Minimum gate time
Ⓒ Shutter time: Defined as the rise time. The input gate pulse width should be at least twice the shutter time.
Ⓓ Image intensifier with a 3-stage MCP capable of photon counting are also available. Feel free to contact our sales office.

TYPE NO. GUIDE

THIRD GENERATION

V○○○○ A–B–C D E F

Type No.

- A: Potting method
- B: Photocathode and input window
- C: Gate operation
- D: Number of MCPs
- E: Phosphor screen
- F: Output window

A (See dimensional drawing.)

Suffix	Potting Method
U	Input window is positioned inwards from the front edge of the case.
D	Input window protrudes from the front edge of the case. This type is ideal when using a Peltier cooling to reduce noise.

B

Suffix	Input Window	Photocathode
71	Borosilicate Glass	GaAs
72	FOP	GaAs
73	Borosilicate Glass	Enhanced Red GaAsP
74	Borosilicate Glass	GaAsP
75	FOP	GaAsP
76	Borosilicate Glass	InGaAs

C

Suffix	Gate Type
N	Non-Gate
G	Gatable (5 ns)

D

Suffix	Stage of MCP
1	1
2	2
3	3*

* Image intensifier with a 3-stage MCP capable of photon counting are also available.

E (Standard type is P43.)

Suffix	Phosphor Screen Material
0	P20E
3	P43
4	P24
6	P46
7	P47

13.5 mm × 10 mm				16 mm × 16 mm				Suffix
non	5 ns			non		5 ns		
1 µm Type	High Quantum Efficiency	NIR High Sensitivity	1 µm Type	High Quantum Efficiency	NIR High Sensitivity	High Quantum Efficiency	NIR High Sensitivity	
V8071	V8070	V7090	V8071	V9501	V9569	V9501	V9569	
V8071	V8070	V7090	V8071	V9501	V9569	V9501	V9569	
		○			○ *		○ *	-71
		○			○ *		○ *	
		○ *			○ *		○ *	-72
		○ *			○ *		○ *	
	○ *			○ *		○ *		-73
	○ *			○ *		○ *		
	○			○ *		○ *		-74
	○			○ *		○ *		
	○ *			○ *		○ *		-75
	○ *			○ *		○ *		
○ *			○ *					-76
○ *			○ *					

ϕ18 mm				ϕ25 mm				ϕ40 mm		Suffix
5 ns		250 ps Ⓓ	200 ps Ⓓ	non		10 ns		non	20 ns	
High Resolution	—	High-speed Gate	High-speed Gate	High Resolution	—	High Resolution	—	—	—	
V6887U	—	V4323U	V5548U	V7669U	—	V7670U	—	V5180U	V5181U	
—	V4183U	V6561U	—	—	V10308U	—	V10309U	V5182U	V5183U	
○		○ *	○	○		○		○ *	○ *	—
	○	○ *			○		○	○ *	○ *	
○ *		△	△	○ *		○ *		△	△	-01
	○ *	△			○ *		○ *	△	△	
○ *		△	△	○ *		○ *		△	△	-02
	○ *	△			○ *		○ *	△	△	
○ *		△	△	○ *		○ *		△	△	-03
	○ *	△			○ *		○ *	△	△	
○ *		—	—	○ *		○ *		△	△	-04
	○ *	—			○ *		○ *	△	△	
○ *		—	—	○ *		○ *		△	△	-05
	○ *	—			○ *		○ *	△	△	
○ *		—	—	○ *		○ *		△	△	-06
	○ *	—			○ *		○ *	△	△	
○ *		—	—	○ *		○ *		—	—	-07
	○ *	—			○ *		○ *	—	—	
○ *		—	—	○ *		○ *		—	—	-08
	○ *	—			○ *		○ *	—	—	

○...Standard product △...Please consult with our sales office. — ...Not available *: Manufactured upon receiving your order

F

Suffix	Output Window
0	Fiber Optic Plate
1	Fiber Optic Plate W/NESA (with Transparent Conductive Coating)
2	Borosilicate Glass

SECOND GENERATION

Hamamatsu second generation image intensifiers are classified by series type No. and suffix No. When you consult with our sales office about a product or place an order, please carefully refer to the characteristics listed in the spec table.

If you need custom devices (using a different window or phosphor screen material, low resistance MCP, transparent conductive film (NESA), special case potting), please let us know about your special requests.

V○○○○U – ○○

Series Type No. Suffix No.

When you need a device with a built-in power supply (input voltage: +2 V to +5 V), please specify a type No. "V○○○○P" instead of "V○○○○U". ("P" indicates a power supply is incorporated into the device.)

●CHARACTERISTICS

THIRD GENERATION

Type No. Effective Photocathode Area 13.5 mm × 10 mm	Type No. Effective Photocathode Area 16 mm × 16 mm	Suffix (Spectral Response Range)	Stage of MCP ①	Gate Function	Photocathode Material	Wavelength of Peak Response (nm) ②
V7090U/D	—	-71 (370 nm to 920 nm)	1	Both type are avairable	GaAs	600 to 750
			2			
		-72 (370 nm to 920 nm)	1			
			2			
—	V9569U/D	-71 (370 nm to 920 nm)	1	Both type are avairable	GaAs	600 to 750
			2			
		-72 (370 nm to 920 nm)	1			
			2			
V8070U/D	—	-73 (280 nm to 820 nm)	1	Both type are avairable	Enhanced Red GaAsP	480 to 530
			2			
		-74 (280 nm to 720 nm)	1		GaAsP	
			2			
		-75 (350 nm to 720 nm)	1			
			2			
—	V9501U/D	-73 (280 nm to 820 nm)	1	Both type are avairable	Enhanced Red GaAsP	480 to 530
			2			
		-74 (280 nm to 720 nm)	1		GaAsP	
			2			
		-75 (350 nm to 720 nm)	1			
			2			
V8071U/D	—	-76 (360 nm to 1100 nm)	1	Both type are avairable	InGaAs	700 to 800
			2			

SECOND GENERATION

Type No. Effective Photocathode Area ϕ18 mm	Type No. Effective Photocathode Area ϕ25 mm	Type No. Effective Photocathode Area ϕ40 mm	Suffix (Spectral Response Range)	Stage of MCP ①	Gate Function ②	Photocathode Material	Wavelength of Peak Response (nm) ②
V6886U	V7669U	—	Non-Suffix (160 nm to 900 nm) -04 (350 nm to 900 nm) -08 (115 nm to 900 nm)	1	×	Multialkali	430
V6887U	V7670U	—			○		
—	—	V5180U⑥			×		
V4323U⑤, V5548U⑤	—	V5181U⑥			○		
V4170U	V10308U	V5182U⑥		2	×		
V4183U, V6561U⑤	V10309U	V5183U⑥			○		
V6886U	V7669U	—	-01 (160 nm to 950 nm) -05 (350 nm to 950 nm)	1	×	Extended red Multialkali	600
V6887U	V7670U	—			○		
V4170U	V10308U	—		2	×		
V4183U	V10309U	—			○		
V6886U	V7669U	—	-02 (160 nm to 650 nm) -06 (350 nm to 650 nm)	1	×	Bialkali	[-02] 400 [-06] 430
V6887U	V7670U	—			○		
V4170U	V10308U	—		2	×		
V4183U	V10309U	—			○		
V6886U	V7669U	—	-03 (160 nm to 320 nm) -07 (115 nm to 320 nm)	1	×	Cs-Te	230
V6887U	V7670U	—			○		
V4170U	V10308U	—		2	×		
V4183U	V10309U	—			○		

Above characteristics are measured using a P43 phosphor screen.

NOTE: ① Image intensifiers with a 3-stage MCP capable of photon counting are also available. Feel free to contact our sales office.
② ○: available, ×: not available
③ Typical values measured at the wavelength of peak response (except -76 type measured at 1 μm)
④ Typical values measured at 20 °C
⑤ Models with a suffix number "-04" or "-08" are not available.
⑥ Models with a suffix number "-04" are available as custom products. However models with a suffix "-08" are not available.
⑦ V5181U only.

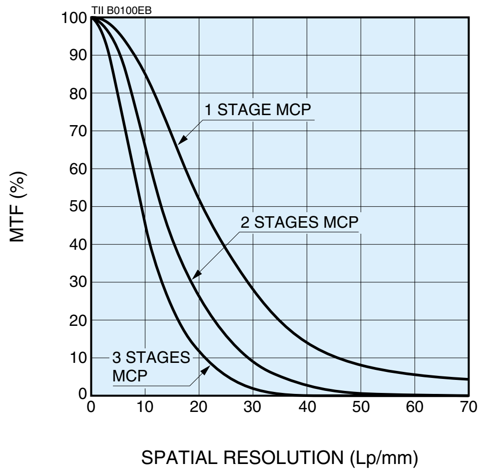
Photocathod Sensitivity: Luminous Sensitivity (µA/lm)	Radiant Sensitivity ③ (mA/W)	Quantum Efficiency (QE) ③ (%)	Gain: Luminous Gain [(lm/m²)/lx]	Radiant Emittance Gain ③ [(W/m²)/(W/m²)]	Equivalent Background Input (EBI) ④ (lm/cm²)	(W/cm²) ③	Limiting Resolution (Lp/mm)	Operation / Storage Ambient Temperature (°C)	Maximum Shock	Maximum Vibration
1200	181	27	3.6×10^{4}	1.1×10^{4}	2×10^{-11}	4×10^{-14}	57	-20 to +40 / -55 to +65	300 m/s² (30G), 18 ms	10 Hz to 55 Hz 0.7 mm (p-p)
			9.6×10^{6}	2.7×10^{6}			40			
900	134	20	2.7×10^{4}	8.3×10^{3}			57			
			7.2×10^{6}	2.0×10^{6}			40			
1100	147	22	3.3×10^{4}	9.0×10^{3}			50			
			8.8×10^{6}	2.2×10^{6}			32			
750	100	15	2.3×10^{4}	6.2×10^{3}			50			
			6.0×10^{6}	1.5×10^{6}			32			
800	192	45	2.5×10^{4}	1.3×10^{4}	3×10^{-12}	8×10^{-15}	57			
			5.7×10^{6}	3.0×10^{6}			40			
700	214	50	2.2×10^{4}	1.4×10^{4}			57			
			5.0×10^{6}	3.4×10^{6}			40			
600	150	35	1.9×10^{4}	1.0×10^{4}			57			
			4.3×10^{6}	2.4×10^{6}			40			
750	171	40	2.3×10^{4}	1.2×10^{4}			50			
			5.3×10^{6}	2.7×10^{6}			32			
650	192	45	2.0×10^{4}	1.3×10^{4}			50			
			4.6×10^{6}	3.1×10^{6}			32			
550	128	30	1.7×10^{4}	8.5×10^{3}			50			
			3.9×10^{6}	2.0×10^{6}			32			
250	8	1	7.0×10^{3}	4.6×10^{2}	3×10^{-10}	9×10^{-12}	57			
			1.6×10^{6}	1.1×10^{4}			40			

Photocathod Sensitivity: Luminous Sensitivity (µA/lm)	Radiant Sensitivity ③ (mA/W)	Quantum Efficiency (QE) ③ (%)	Gain: Luminous Gain [(lm/m²)/lx]	Radiant Emittance Gain ③ [(W/m²)/(W/m²)]	Equivalent Background Input (EBI) ④ (lm/cm²)	(W/cm²) ③	Limiting Resolution (Lp/mm)	Operation / Storage Ambient Temperature (°C)	Maximum Shock	Maximum Vibration
280	62	18	1.2×10^{4}	8.7×10^{3}	1×10^{-11}	3×10^{-14}	64	-20 to +40 / -55 to +65	300 m/s² (30G), 18 ms	10 Hz to 55 Hz 0.7 mm (p-p)
230	53	15	1.1×10^{4}	6.8×10^{3}						
170	60	17	1.2×10^{4}	8.7×10^{3}			36			
150	47	14	1.1×10^{4}	6.8×10^{3}			57 (36⑦)			
170	60	17	5×10^{6}	4×10^{6}			32			
150	47	14	4×10^{6}	3×10^{6}						
550	45	9.3	2.5×10^{4}	6.2×10^{3}	3×10^{-11}	2×10^{-14}	64			
350	42	8.7	2.1×10^{4}	5.3×10^{3}						
350	43	8.9	1×10^{7}	3×10^{6}			32			
250	40	8.3	8×10^{6}	2×10^{6}						
50	50	14	3.1×10^{3}	7×10^{3}	5×10^{-13}	5×10^{-16}	48			
40	40	12	2.5×10^{3}	5.9×10^{3}						
50	50	14	1×10^{6}	4×10^{6}			25			
40	40	12	1×10^{6}	3×10^{6}						
—	20	11	—	2.6×10^{3}	—	1×10^{-15}	40			
—	15	8	—	2×10^{3}						
—	20	11	—	1×10^{6}			22			
—	15	8	—	7.5×10^{5}						

●CHARACTERISTIC GRAPHS

Figure 7: MTF

Second Generation



Third Generation

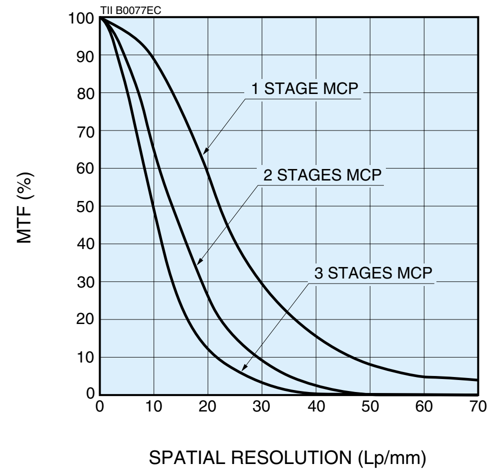


Figure 8: Luminous Gain vs. MCP Voltage (V8070 Series)

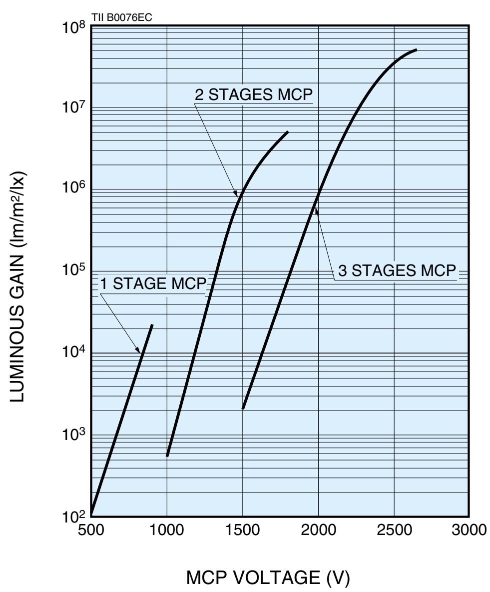


Figure 9: Equivalent Background Input (EBI) vs. Temperature

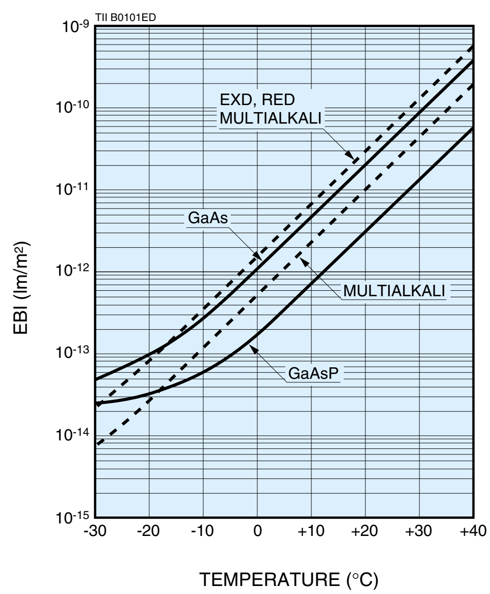


Figure 10: Photocathode Illuminance vs. Phosphor Screen Luminous Emittance

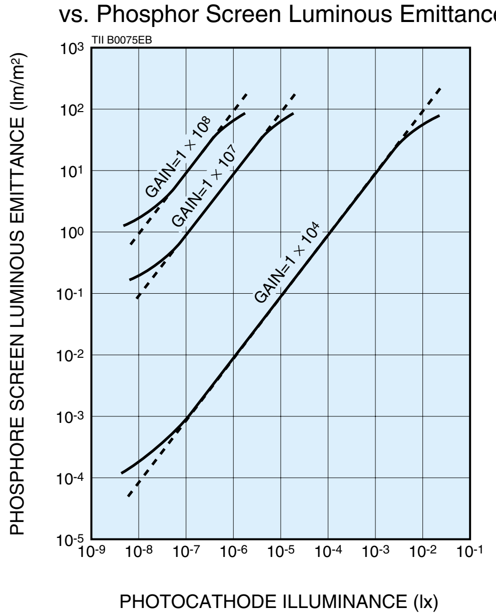
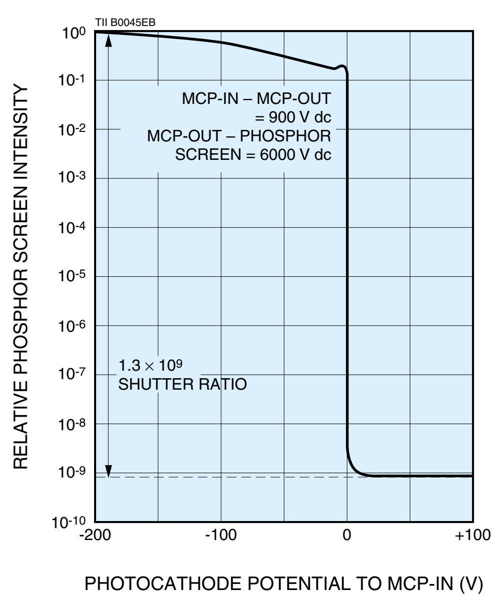


Figure 11: Shutter Ratio (color temperature: 2856 k)



Recommended Operation (Example)

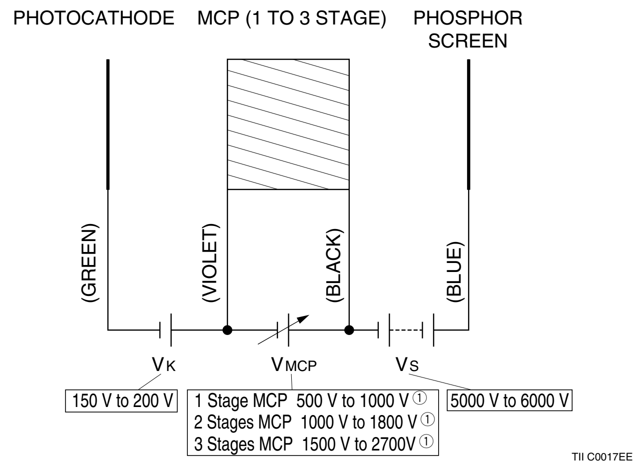
Normal Operation

Supply Voltage (See Figure 12.)

Photocathode – MCP-in (Vk) ....150 V to 200 V
MCP-in – MCP-out (V_{MCP})① ....1 Stage MCP 500 V to 1000 V
2 Stages MCP 1000 V to 1800 V
3 Stages MCP 1500 V to 2700 V
MCP-out – Phosphor Screen (Vs) ....5000 V to 6000 V

NOTE: ①The maximum supply voltage and recommended supply voltage for the MCP-in and MCP-out are noted on the test data sheet when the products is delivered. Please refer to the test data sheet for these values.

Figure 12: Normal Operation



NOTE: A compact high-voltage power supply is available. (See page 15.) Any electrode (for photocathode, MCP and phosphor screen) can be connected to ground potential.

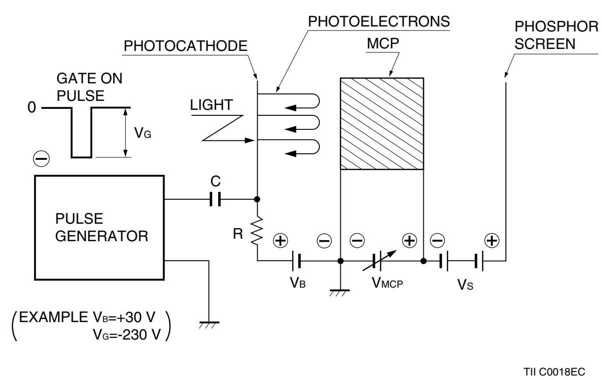
Gate Operation

There are two basic circuits for gate operation as shown in Figure 13 below. The supply voltages V_{MCP} and Vs are the same as those in normal operation. Gate operation is controlled by changing the bias voltage (V_B) between the photocathode and MCP-in.

Figure 13: Gate Operation

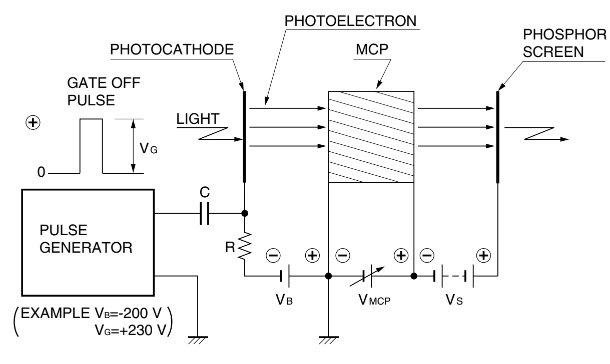
Normally-OFF mode

The V_B is constantly applied as a reverse bias to the photocathode, so no image appears on the phosphor screen. An image appears only when a gate pulse (V_G) is applied to the photocathode.



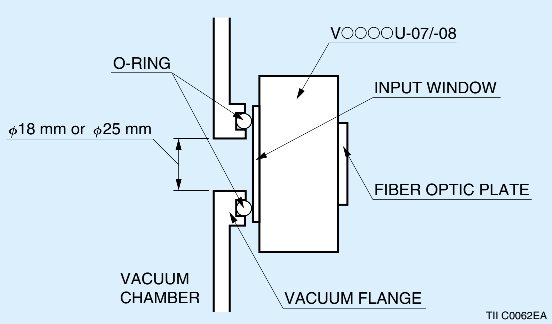
Normally-ON mode

The V_B is constantly applied as a forward bias to the photocathode, so an image is always seen on the phosphor screen during operation. The image disappears only when a gate pulse (V_G) is applied to the photocathode.



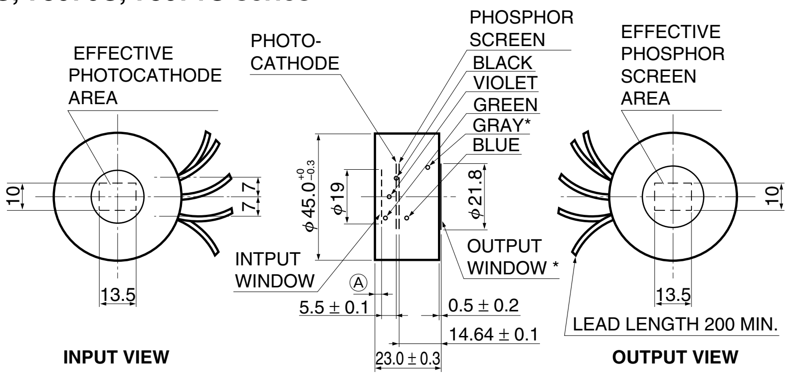
C, R: Chose the value in consideration of pulse width and repetition rate.
C: High voltage type.

Clamping method for using a vacuum chamber with the V○○○○U-07, -08



V7090U/D series, V8070U/D series, V8071U/D series

V7090U, V8070U, V8071U series

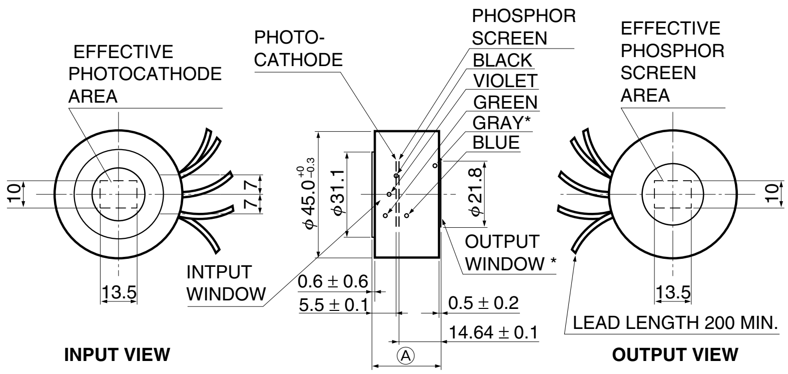


MCP	Ⓐ
1 srtage	1.9 ± 0.6
2 srtages	1.4 ± 0.6

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*
*ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)
CASE MATERIAL: POM (POLY OXY METHIYENE)

TII A0043ED

V7090D, V8070D, V8071D series



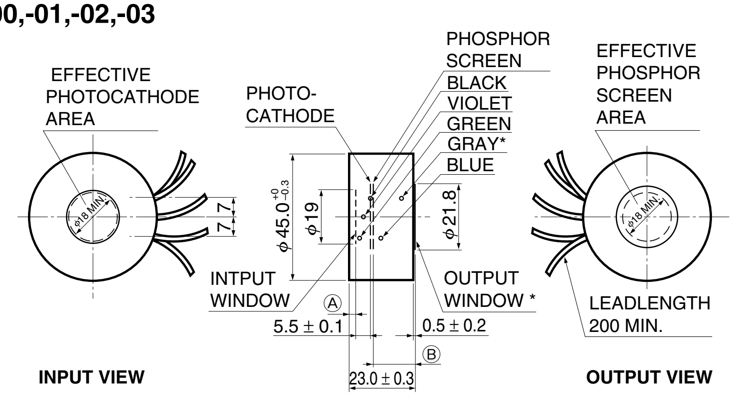
MCP	Ⓐ
1 srtage	21.1 ± 0.5
2 srtages	21.6 ± 0.5

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*
*ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)
CASE MATERIAL: POM (POLY OXY METHIYENE)

TII A0053ED

V6886U, V6887U, V4170U, V4183U series

Suffix :-00,-01,-02,-03

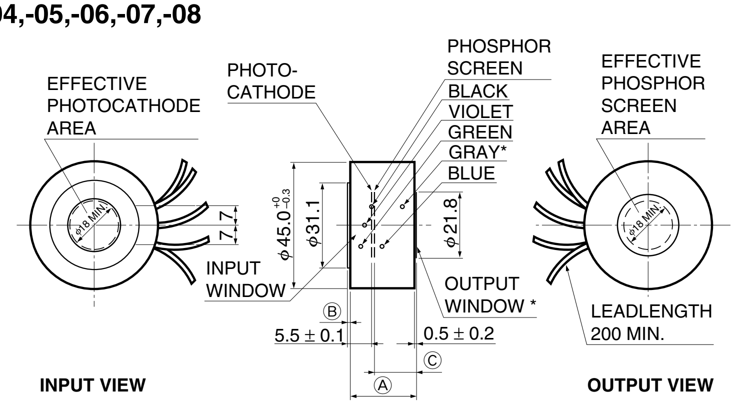


TYPE No.	Ⓐ	Ⓑ
V6886U, V6887U	2.0 ± 0.6	14.64 ± 0.1
V4170U, V4183U	1.6 ± 0.7	14.17 ± 0.1

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)* *ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)
CASE MATERIAL: POM (POLY OXY METHIYENE)

TII A0033EE

Suffix :-04,-05,-06,-07,-08

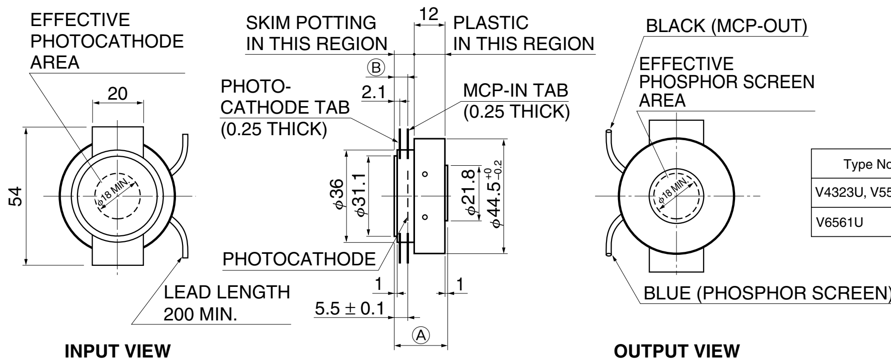


TYPE No.	Ⓐ	Ⓑ	Ⓒ
V6886U, V6887U	21.0 ± 0.5	$0.5^{+0.6}_{-0.5}$	14.64 ± 0.1
V4170U, V4183U	21.4 ± 0.6	$0.4^{+0.6}_{-0.4}$	14.17 ± 0.1

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)* *ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)
CASE MATERIAL: POM (POLY OXY METHIYENE)

TII A0034EE

V4323U, V5548U, V6561U series

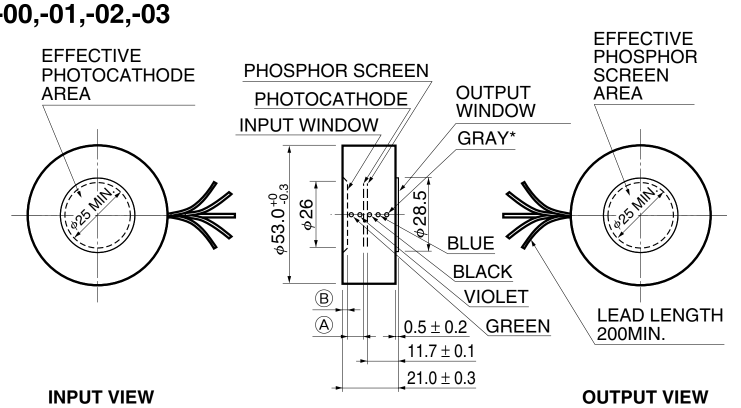


Type No.	Ⓐ	Ⓑ
V4323U, V5548U	21.1 ± 0.5	4.9
V6561U	21.4 ± 0.6	5.4

TII A0001EC

V7669U, V7670U, V10308U, V10309U series

Suffix :-00,-01,-02,-03



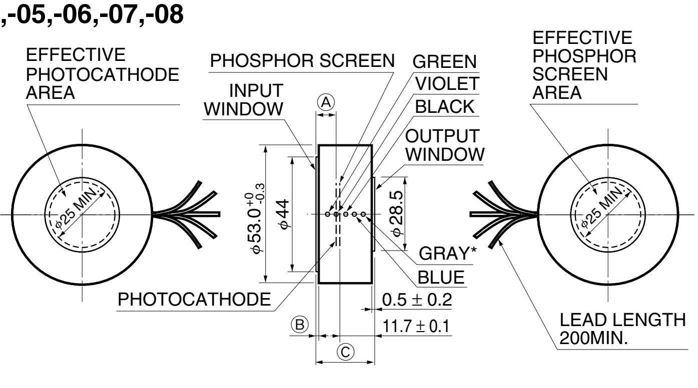
TYPE No.	Ⓐ	Ⓑ
V7669U, V7670U	5.94 ± 0.1	2.5 ± 0.6
V10308U, V10309U	5.53 ± 0.1	2.1 ± 0.7

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*
*ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)

CASE MATERIAL: POM (POLY OXY METHYIENE)

TII A0018EC

Suffix :-04,-05,-06,-07,-08



TYPE No.	Ⓐ	Ⓑ	Ⓒ
V7669U, V7670U	5.94 ± 0.1	0.5 ± 0.5	18.5 ± 0.5
V10308U, V10309U	5.53 ± 0.1	0.4 $^{+0.65}_{-0.4}$	18.9 ± 0.55

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*
*ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)

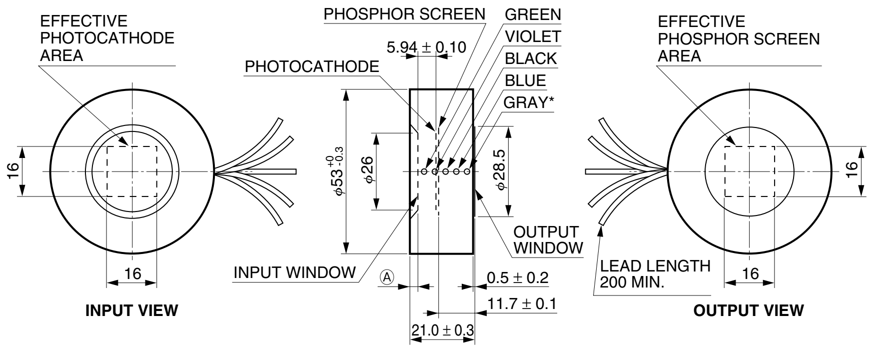
CASE MATERIAL: POM (POLY OXY METHYIENE)

TII A0046EB

DIMENSIONAL OUTLINES (Unit: mm)

V9501U, V9569U, V9501D, V9569D series

V9501U, V9569U series



MCP	Ⓐ
1 stage	2.4 ± 0.6
2 stage	2.0 ± 0.6

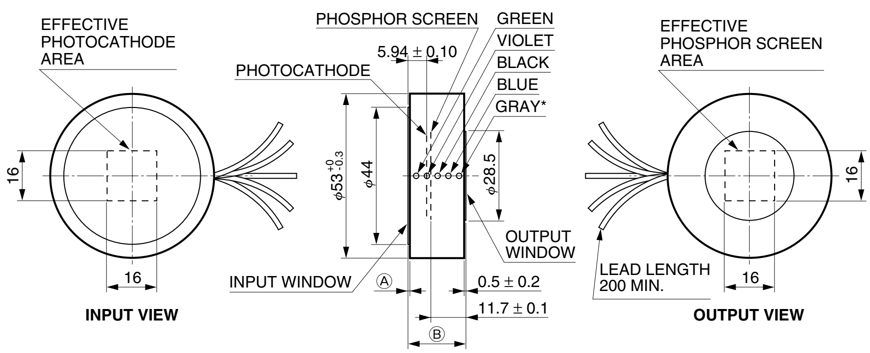
LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*

* ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)

CASE MATERIAL: POM (POLY OXY METHYIENE)

TII A0063EA

V9501D, V9569D series



MCP	Ⓐ	Ⓑ
1 stage	0.6 ± 0.6	18.6 ± 0.5
2 stage	0.5 ± 0.5	19.0 ± 0.5

LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*

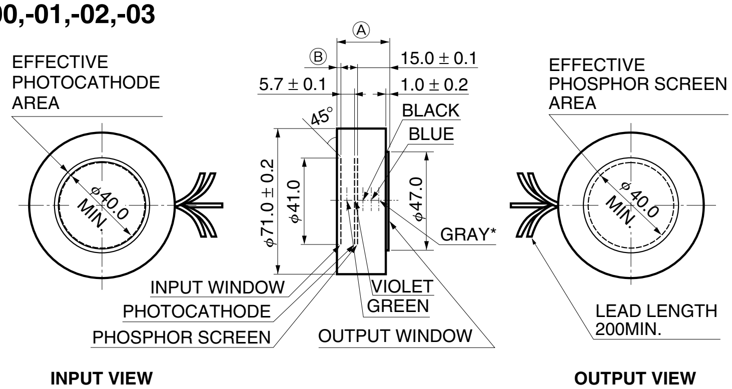
* ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)

CASE MATERIAL: POM (POLY OXY METHYIENE)

TII A0063EA

V5180U, V5181U, V5182U, V5183U series

Suffix :-00,-01,-02,-03



LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*

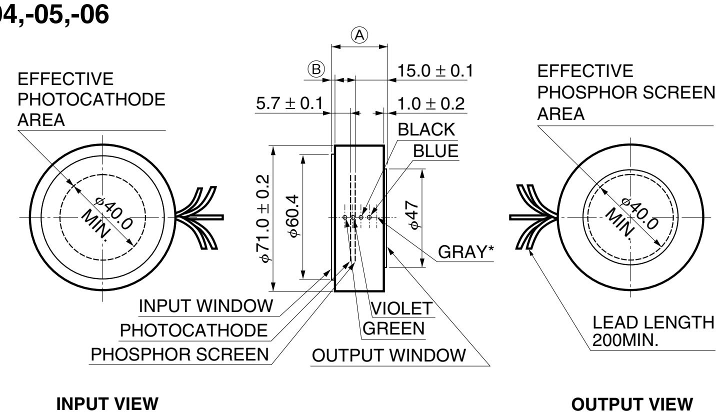
* ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)

CASE MATERIAL: POM (POLY OXY METHYIENE)

Type No.	Ⓐ	Ⓑ
V5180U, V5181U	24.0 ± 0.3	1.7 ± 0.6
V5182U, V5183U	24.5 ± 0.3	1.7 ± 0.7

TII A0014EE

Suffix :-04,-05,-06



LEAD (COVER: PTFE [Polytetrafluoroethylene])
GREEN (PHOTOCATHODE)
VIOLET (MCP-IN)
BLACK (MCP-OUT)
BLUE (PHOSPHOR SCREEN)
GRAY (NESA/GND)*

* ONLY WITH TRANSPARENT CONDUCTIVE COATING (NESA)

CASE MATERIAL: POM (POLY OXY METHYIENE)

Type No.	Ⓐ	Ⓑ
V5180U, V5181U	22.3 ± 0.5	0.8 ± 0.6
V5182U, V5183U	22.8 ± 0.5	0.8 ± 0.7

TII A0047EC

HANDLING PRECAUTIONS

- Do not apply excessive shocks or vibrations during transportation, installation, storage or operation. Image intensifiers are an image tube evacuated to a high degree of vacuum. Excessive shocks or vibrations may cause failures or malfunctions. For reshipping or storage, use the original package received from Hamamatsu.
- Never touch the input or output window with bare hands during installation or operation. The window may become greasy or electrical shocks or failures may result.
  Do not allow any object to make contact with the input or output window. The window might become scratched.
- Dust or dirt on the input or output window will appear as black blemishes or smudges. To remove dust or dirt, use a soft cloth to wipe the windows thoroughly before operation. If fingerprints or marks adhere to the windows, use a soft cloth moistened with alcohol to wipe off the windows. Never attempt cleaning any part of image intensifiers while it is in operation.
- Never attempt to modify or to machine any part of image intensifiers or power supplies.
- Do not store or use in harsh environments. If image intensifiers is left in a high-temperature, salt or acidic atmosphere for a long time, the metallic parts may corrode causing contact failure or a deterioration in the vacuum level.
- Image intensifiers are extremely sensitive optical devices. When applying the MCP voltage without using an excessive light protective circuit, always increase it gradually while viewing the emission state on the phosphor screen until an optimum level is reached.
- Do not expose the photocathode to strong light such as sunlight regardless of whether in operation or storage.
  Operating the image intensifiers while a bright light (e.g. room illumination) is striking the photocathode, might seriously damage the photocathode.
  The total amount of photocurrent charge that flows in the photocathode while light is incident during operation has an inverse proportional effect on photocathode life. This means that the amount of incident light should be kept as small as possible.
- Never apply the voltage to image intensifiers exceeds the maximum rating. Especially if using a power supply made by another company, check before making connections to the image intensifier, that the voltage appling to each electrode is correct.
  If a voltage in excess of the maximum rating is applied even momentarily, the image intensifier might fail and serious damage might occur.
- Use only the specified instructions when connecting an image intensifier to a high-voltage power supply module.
  If the connections are incorrect, image intensifiers might be instantly damaged after the power is turned on. Use high-voltage connectors or solder having a high breakdown voltage. When soldering, provide sufficient insulation at the solder joint by using electrical insulation tape capable of withstanding at least 10 kV or silicon rubber that hardens at room-temperature and withstands at least 20 kV/mm.

WARRANTY

Hamamatsu image intensifiers are warranted for one year from the date of delivery or 1000 hours of actual operation, whichever comes first. This warranty is limited to repair or replacement of the product. The warranty shall not apply to failure or defects caused by natural disasters, misused or incorrect usage that exceeds the maximum allowable ratings.
When ordering, please double-check all detailed information.

●SEPARATE POWER SUPPLIES

Hamamatsu offers various types of separate modular power supplies designed to provide the high voltages needed for image intensifier operation. These power supplies are compact, lightweight and operate on a low voltage input. Image intensifier gain is easily controlled by adjusting the control voltage for the MCP voltage or the control resistance. Please select the desired product that matches your application.

FOR DC OPERATION

Type No.	Input		MCP Control Voltage	Output						Ground ①	Features	Applicable I.I.
	Voltage	Max. Current		Photocathode–MCP-In		MCP-In–MCP-Out		MCP-Out–Phosphor Screen				
				Voltage	Max. Current	Voltage	Max. Current	Voltage	Max. Current			
	(V)	(mA)	(V)	(V)	(µA)	(V)	(µA)	(V)	(µA)			
C6706①	+15±1.5	60	+5 to +10	200	25	500 to 1000	20	6000	0.25 to 0.75	MCP-in	ABC (Automatic Brightness Control)	V6886U,V7669U V7090○-71-N1○○ V8070○-74-N1○○
C6706-20①	+12±1.2								0.1 to 1		Excess current (excess light) protective function	

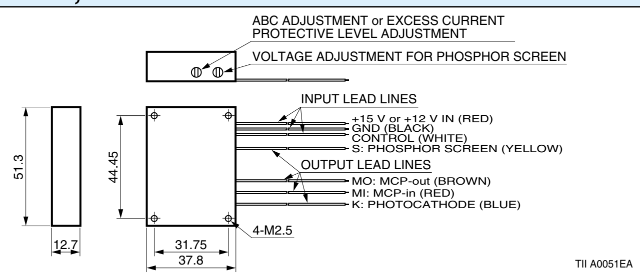
FOR GATE OPERATION (100 ns to DC operation at maximum repetition rate of 1 kHz)

Type No.	Input		MCP Voltage	Gate Signal Input Level		Output					Ground ①	Features	Applicable I.I.
	Voltage	Current	Control Voltage	Gate On Voltage	Gate Off Voltage	Photocathode–MCP-In	MCP-In–MCP-Out		MCP-Out–Phosphor Screen				
						Voltage	Voltage	Max. Current	Voltage	Max. Current			
	(V)	(mA Max.)	(V)	(V)	(V)	(V)	(V)	(µA)	(V)	(µA)			
C6083①	+10±0.5	200	+5 to +10	0 (TTL Low)	+5 (TTL High)	-200	500 to 1000	50	6000	0.05 to 5	MCP-in	ABC②	V6887U, V7670U, V5181U V7090○-71-G1○○ V8070○-74-G1○○

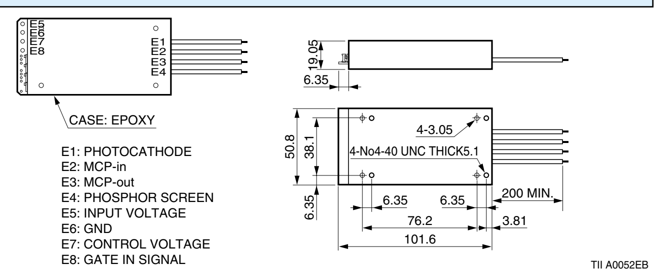
NOTE: ①Other ground terminal types and other input voltage types are also available. Please consult our sales office. ②ABC: Automatic Brightness Control

■Dimensional Outlines (Unit: mm)

C6706, -20



C6083



●RELATED PRODUCTS

EB-CCD

The EB-CCD is an entirely new type of high-sensitivity imaging device that employs the "Electron Bombardment (EB)" effect. This effect intensifies images by accelerating an electron image photoelectrically converted to strike the CCD while applying a high voltage. The EB-CCD has a simple structure and theoretically has no deterioration in the S/N ratio that usually occurs due to gain fluctuations. This means you get highly sensitive image acquisition along with a high S/N ratio.
Two types of EB-CCD are available depending on the readout method. One is the N7640 designed to operate at the TV scan rate. The other is the N7220 for slow scan readout. The EB-CCD is ideal for high-sensitivity video cameras in low-light-level applications where the sensitivity of ordinary CCD cameras is too low.
The N7220 slow scan type can detect images down to single-photon light levels.

■FEATURES

●**Long Life**

●**High S/N Ratio**

Captures high-quality images with high S/N ratio due to 100 % fill factor and high gain at first stage.

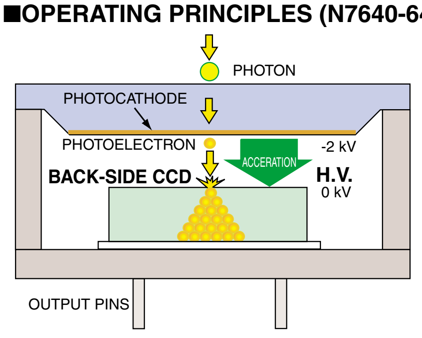
●**Highly stable operation against excessive light**

No image burn-in occurs if excessive light (ex. 100 lx for 3 minutes) is input.

■SPECIFICATIONS

Parameter	N7640-64	N7640-20	N7220-64	N7220-61	N7220-20	Unit
CCD Drive Method	FT		FFT			—
Photocathode	GaAsP	Multialkali	GaAsP	GaAs	Multialkali	—
Quantum Efficiency Ⓐ [Typ.]	50	15	50	23	15	%
Maximum Supply Voltage	-2	-6	-8			kV
Gain [Typ.]	300	700	1300			—
Effective Area (H × V)	9.2 × 6.8		12.2 × 12.2			mm
Number of Effective Pixels (H × V)	658 × 490		512 × 512			—
CCD Readout Frequency	14		1			MHz
Dimensions	ϕ53 × 16.5					mm

■OPERATING PRINCIPLES (N7640-64)



HIGH-SPEED GATED IMAGE INTENSIFIER UNITS

High-speed gated Image Intensifier (I.I.) unit comprises proximity focused I.I., high voltage power supply and gate driver circuit. Depending on application, a best gated I.I. unit can be selected from among various models.
The built-in I.I. is available with GaAsP photocathode or Multialkali photocathode The GaAsP photocathode type delivers very high quantum efficiency in visible region ideal for bio-/fluorescence imaging application under a microscope. The Multialkali photocathode type offers a wide spectral range from UV (Ultra Violet) to NIR (Near Infrared Region).
All of gated I.I. units can be operated and controlled from a remote controller or a PC (Personal Computer) via a USB interface controller. HAMAMTSU also provides suitable relay lenses or CCD camera with FOP window for C9016/C9546 series.
C9548 series is released newly. This gated I.I. unit is added on a built-in pulse generator function and then it can be operatable at 500 ns min burst operation.

SELECTION GUIDE

Type No.	C9016 Series				C9546 Series				C9547 Series				C9548 Series				Unit
Suffix No.	-01(-21)	-02(-22)	-03(-23)	-04(-24)	-01	-02	-03	-04	-01	-02	-03	-04	-01	-02	-03	-04	
Gate Time	100 µs (20 ns)				3 ns				5 ns		10 ns		10 ns				—
Gate Repetition Rate	100 Hz (2 kHz)				30 kHz				30 kHz				200 kHz				—
Effective Area	ϕ17 ①				ϕ17 ①				ϕ25 ②				ϕ25 ②				mm
Photocathode Material	GaAsP		Multialkali		GaAsP		Multialkali		GaAsP		Multialkali		GaAsP		Multialkali		—
Spectral Response	280 to 720		185 to 900		280 to 720		185 to 900		280 to 720		185 to 900		280 to 720		185 to 900		nm
Peek QE ③	50		18	17	50		15	14	45		15	14	45		15	14	%
MCP Stage	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	—
Built-in Pulse Generator Function	No				No				No				Yes				—

NOTE: ①Effective output area is 12.8 mm × 9.6 mm. Take the effective area of the camera and reduction rate of the relay lens to be used into account.
②Effective output area is 16 mm × 16 mm. Take the effective area of the camera and reduction rate of the relay lens to be used into account.
③Typical at peak wavelength.

ICCD CAMERA WITH HIGH-SPEED ELECTRONIC SHUTTER C10054 SERIES

The C10054 series is an easy to use compact camera housing an image intensifier fiber-coupled to a CCD, as well as a CCD drive circuit, high-voltage power supply and high-speed gate circuit. The C10054 series makes it easy to measure low-light-levels and capture images of various high-speed phenomena.
A wide lineup of 18 models are currently provided allowing you to select multialkali, GaAs or GaAsP photocathodes the number of MCPs.

SELECTION GUIDE

Signal System								Unit
Signal System	EIA	C10054-01	C10054-02	C10054-03	C10054-04	C10054-05	C10054-06	Unit
	CCIR	C10054-11	C10054-12	C10054-13	C10054-14	C10054-15	C10054-16	
	Progressive Scan	C10054-21	C10054-22	C10054-23	C10054-24	C10054-25	C10054-26	
Effective Imaging Area		12.8 × 9.6						mm
Photocathode Material		GaAsP		Multialkali		GaAs		—
Spectral Response		280 to 720		185 to 900		370 to 920		nm
Shutter Time (Min.)		5						ns
Shutter Repetition Frequency (Max.)		2						kHz
Stage of MCP		1	2	1	2	1	2	—

HAMAMATSU

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www.hamamatsu.com

Main Products

Electron Tubes
Photomultiplier Tubes
Light Sources
Microfocus X-ray Sources
Image Intensifiers
X-ray Image Intensifiers
Microchannel Plates
Fiber Optic Plates

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Si Photodiodes
Photo IC
PSD
InGaAs PIN Photodiodes
Compound Semiconductor Photosensors
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Optical Communication Devices
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Video Cameras for Measurement
Image Processing Systems
Streak Cameras
Optical Measurement Systems
Imaging and Analysis Systems

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