Image Intensifiers (I.I.: Image Intensifiers)

Image intensifiers (often abbreviated as I.I.) are imaging devices capable of detecting and amplifying very low level light. Image intensifiers are used in a wide range of applications, including imaging of micro-discharges in the invisible regions and observation of high-speed phenomena.

**Application examples**

**Biotechnology**

**Fluorescence imaging**

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

**Industry**

**Observation of discharges occurring on a printed circuit board**

Visualization of discharges caused by poor insulation in the printed circuit board allows finding the faulty points.

**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 (Nippon Hoso Kyokai)
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. Light focused on the photocathode is converted into photoelectrons. These electrons then enter each channel of the MCP where they are multiplied by the potential gradient across both ends of the MCP and are released from the output end of the MCP. The electrons multiplied by the MCP then strike the phosphor screen that emits light according to the amount of electrons. Through this process, an input optical image is intensified about 10000 times (in the case of a one-stage MCP) and appears as the output image on the phosphor screen.

Gate operation

An image intensifier can be gated to open or close the electronic shutter by varying the potential between the photocathode and the MCP-in. When the gate is ON, the photocathode potential is lower than the MCP-in so the electrons emitted from the photocathode enter the MCP at a positive potential. 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 so the electrons emitted from the photocathode are forced to return to the photocathode at the positive 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. High-speed gated image intensifiers (see page 16) are designed to operate in high-speed gated mode that allows capturing instantaneous images of high-speed phenomena and so is very effective in analyzing high-speed phenomena.
Selection guide

Image intensifiers are available with various characteristics that can be selected by a combination of the components such as photocathodes and window materials. This selection guide describes the components of image intensifiers and the criteria for selecting an image intensifier that best matches your application.

1. Select an image intensifier with sensitivity optimized for objects (light) to be observed

The input window and photocathode must be selected according to the wavelength and intensity of light to be observed. To obtain an intensified image with a high SN ratio, select a photocathode with high sensitivity in the measurement wavelength range.

### Photocathode

Select a photocathode with the required S/N ratio and a spectral response that matches the wavelength to be observed.

<table>
<thead>
<tr>
<th>Type</th>
<th>Feature</th>
<th>Photocathode type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-Te (-03)</td>
<td>Solar blind spectral response with no sensitivity in the visible region (wavelength longer than 320 nm)</td>
<td>Alkali Photocathodes</td>
</tr>
<tr>
<td>High sensitivity Cs-Te (V13716)</td>
<td>Cs-Te photocathode with enhanced UV sensitivity</td>
<td></td>
</tr>
<tr>
<td>Bialkali (-02)</td>
<td>UV to visible sensitivity and low noise</td>
<td></td>
</tr>
<tr>
<td>Multialkali (No suffix)</td>
<td>UV to near-infrared sensitivity</td>
<td></td>
</tr>
<tr>
<td>GaAs (-71)</td>
<td>Uniform and high sensitivity from the visible to near-infrared region</td>
<td>Semiconductor Photocathodes</td>
</tr>
<tr>
<td>GaAsP (-74)</td>
<td>Very high sensitivity in the visible region</td>
<td></td>
</tr>
<tr>
<td>Extended Red GaAsP (-73)</td>
<td>GaAsP photocathode with extended red sensitivity</td>
<td></td>
</tr>
</tbody>
</table>

### Input window

The borosilicate glass is used for GaAs and GaAsP photocathodes, and synthetic silica is used for alkali photocathodes.

### MCP

Image intensification depends on the number of MCP stages. Select a 1-stage or 2-stage MCP according to the light intensity and measurement environment of objects to be observed.

<table>
<thead>
<tr>
<th>Number of MCP</th>
<th>Image intensification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electron multiplication (gain): about $10^3$</td>
</tr>
<tr>
<td>2</td>
<td>Electron multiplication (gain): about $10^5$</td>
</tr>
</tbody>
</table>

**NOTE:** The above graph shows spectral response data (quantum efficiency vs. wavelength) of various photocathodes combined with an input window of borosilicate glass (-71/-73/-74) or synthetic silica (no suffix/-02/-03). Quantum efficiency (QE) is the number of photoelectrons emitted from the photocathode divided by the number of incident photons and is generally expressed as a percent (%). Quantum efficiency and radiant sensitivity have the following relationship at a given wavelength.

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

where $S$ is the radiant sensitivity in A/W at a given wavelength and $\lambda$ is the wavelength in nm (nanometers).
2 Select an image intensifier with a time resolution high enough to capture objects to be observed

Photocathode electrode

Gate operation is determined by the photocathode electrode materials. To allow high-speed gate operation, some of our alkali photocathode image intensifiers use a metallic thin film electrode deposited between the photocathode and the input window, so select from among them (see page 5) when gate operation is needed. Image intensifiers using a GaAs or GaAsP photocathode have a gate function, except for the V6833P and V7090P that contain a power supply.

3 Select an image intensifier compatible with the readout device and method

Select an image intensifier that matches the performance and specifications of the image readout device to be used. The following describes the components of an image intensifier related to readout devices and an important point to consider when selecting them.

Effective area

Alkali photocathode image intensifiers have an effective area of 18 mm or 25 mm in diameter. GaAs and GaAsP photocathode image intensifiers have an effective area of 13.5 mm × 10 mm (input window diameter: 18mm) or 16 mm × 16 mm (input window diameter: 25 mm).

Output window

It is necessary to select an output window that efficiently couples to the readout device.

<table>
<thead>
<tr>
<th>Type</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber optic plate (FOP)</td>
<td>Ideal for direct coupling to a CCD/CMOS camera with an FOP window, allowing highly efficient image readout.</td>
</tr>
<tr>
<td>Borosilicate glass</td>
<td>Suitable for image readout using a relay lens.</td>
</tr>
<tr>
<td>Inverting concave fiber optics</td>
<td>Select this type when viewing the output image directly with eyes.</td>
</tr>
</tbody>
</table>

Phosphor screen

Select a phosphor screen compatible with the readout device sensitivity and method.

<table>
<thead>
<tr>
<th>Phosphor type</th>
<th>Peak emission</th>
<th>10 % Decay time</th>
<th>Relative power efficiency</th>
<th>Emission color</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>P43</td>
<td>545 nm</td>
<td>1 ms</td>
<td>1</td>
<td>Yellowish green</td>
<td>Standard</td>
</tr>
<tr>
<td>P46</td>
<td>510 nm</td>
<td>0.2 µs</td>
<td>0.3</td>
<td>Green</td>
<td>Short decay time</td>
</tr>
</tbody>
</table>

The decay time of P46 varies depending on the input pulse width. The relative power efficiency is a value relative to the power efficiency of P43 measured at a supply voltage of 6 kV and normalized to 1.

POINT Phosphor screen decay characteristics

Phosphor screen decay characteristics must be considered when coupling to an image readout device. When used with a high-speed readout CCD/CMOS 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 applications, a phosphor screen with a longer decay time is suggested to minimize flicker.
GaAs and GaAsP photocathode image intensifiers

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Spectral response range (nm)</th>
<th>Wavelength range of peak QE (nm)</th>
<th>Photocathode</th>
<th>Effective photocathode area (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V7090</td>
<td>370 to 920</td>
<td>600 to 700</td>
<td>GaAs</td>
<td>13.5 × 10</td>
</tr>
<tr>
<td>V9569</td>
<td>280 to 820</td>
<td>480 to 530</td>
<td>Extended red GaAsP</td>
<td>13.5 × 10</td>
</tr>
<tr>
<td>V8070</td>
<td>280 to 720</td>
<td>480 to 530</td>
<td>GaAsP</td>
<td>16 × 16</td>
</tr>
<tr>
<td>V9501</td>
<td>280 to 720</td>
<td>480 to 530</td>
<td>GaAsP</td>
<td>16 × 16</td>
</tr>
<tr>
<td>V6833P</td>
<td>370 to 920</td>
<td>600 to 700</td>
<td>GaAs</td>
<td>φ17.5</td>
</tr>
<tr>
<td>V6833P-G</td>
<td>370 to 920</td>
<td>600 to 700</td>
<td>GaAs</td>
<td>φ17.5</td>
</tr>
<tr>
<td>V7090P</td>
<td>370 to 920</td>
<td>600 to 700</td>
<td>GaAs</td>
<td>φ17.5</td>
</tr>
</tbody>
</table>

The output window of standard products is a fiber optic plate coated with P43 phosphor material.

Alkali photocathode image intensifiers

If you cannot find what you need from our standard products, please contact us with your custom requests (output window, phosphor screen material, low-resistance MCP, potting method, etc.).

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective photocathode area (mm)</th>
<th>Number of MCP</th>
<th>Gate function (ns)</th>
<th>Suffix</th>
<th>Spectral response range (nm)</th>
<th>Wavelength of peak response (nm)</th>
<th>Photocathode</th>
</tr>
</thead>
<tbody>
<tr>
<td>V6886U</td>
<td>φ18</td>
<td>1 stage MCP</td>
<td>Non</td>
<td>—</td>
<td>160 to 900</td>
<td>430</td>
<td>Multi-alkali</td>
</tr>
<tr>
<td>V4170U</td>
<td></td>
<td>2 stages MCP</td>
<td>-02</td>
<td>160 to 650</td>
<td>400</td>
<td>Bialkali</td>
<td></td>
</tr>
<tr>
<td>V6887U</td>
<td></td>
<td>1 stage MCP</td>
<td>-03</td>
<td>160 to 320</td>
<td>230</td>
<td>Cs-Te</td>
<td></td>
</tr>
<tr>
<td>V4183U</td>
<td></td>
<td>2 stages MCP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V7669U</td>
<td>φ25</td>
<td>1 stage MCP</td>
<td>Non</td>
<td></td>
<td>160 to 900</td>
<td>430</td>
<td>Multi-alkali</td>
</tr>
<tr>
<td>V10308U</td>
<td></td>
<td>2 stages MCP</td>
<td>-02</td>
<td>160 to 650</td>
<td>400</td>
<td>Bialkali</td>
<td></td>
</tr>
<tr>
<td>V7670U</td>
<td></td>
<td>1 stage MCP</td>
<td>-03</td>
<td>160 to 320</td>
<td>230</td>
<td>Cs-Te</td>
<td></td>
</tr>
<tr>
<td>V10309U</td>
<td></td>
<td>2 stages MCP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The V6833P, V6833P-G and V7090P contain a power supply (input voltage: +2 V to +3 V). These are limited in selecting the number of MCPs and the gate function as noted below.

- **Number of MCPs**
  - The number of MCP stages can be selected from 1 or 2, except for the following types that contain a power supply.
  - V6833P, V6833P-G, V7090P: Only 1-stage MCP is available.

- **Gate function**
  - The gate function with a gate time of 5 ns can be selected, except for the following types that contain a power supply.
  - V6833P, V7090P: No gate function is available.
  - V6833P-G: Only auto-gating is available.
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. Electrons entering an MCP are repeatedly multiplied by secondary emission within each channel and are released from the output end of 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 dynamic range is required, a low-resistance MCP is preferable.

Fiber optic plate (FOP)
An FOP is an optical device made up of a bundle of a few millions to hundreds of millions of optical fibers with a diameter of several micrometers.
An FOP is capable of transmitting an optical image from one surface to another without causing any image distortion.

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).

Quantum efficiency (QE)
The number of photoelectrons emitted from the photocathode divided by the number of input photons, generally expressed in % (percentage). The higher the quantum efficiency, the better the photoelectric conversion efficiency.

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).

Luminous emittance
This is the luminous flux density emitted from a phosphor screen and is usually expressed in lm/m² (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/m²) multiplied by π.

Gain
Gain is a measure of how much an image is intensified. It is designated by different terms according to the wavelength and properties of light as described below.
• Gain of image intensifiers with sensitivity in the visible range
  1. Luminous gain
     The ratio of the phosphor screen luminous emittance (lm/m²) to the illuminance (lx) incident on the photocathode.
  2. Gain of image intensifiers for invisible light or single wavelength light
     1. Radiant emittance gain
        The ratio of the phosphor screen radiant emittance density (W/m²) to the radiant flux density (W/m²) 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 P43 phosphor screen.
     2. 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.
### Characteristics

#### GaAs and GaAsP photocathode image intensifiers

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective photocathode area</th>
<th>Suffix</th>
<th>Stage of MCP</th>
<th>Spectral response range (nm)</th>
<th>Peak radiation sensitivity spectral response range (nm)</th>
<th>Luminous sensitivity (µA/lm)</th>
<th>Radiant sensitivity (mA/W)</th>
<th>Quantum efficiency (QE) (%)</th>
<th>Peak quantum efficiency spectral response range (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V7090 - V9569</td>
<td>13.5 mm x 10 mm 16 mm x 16 mm</td>
<td>-71 2</td>
<td>1 2</td>
<td>370 to 920 700 to 800</td>
<td>700 to 800 1000 1500</td>
<td>— 170 —</td>
<td>— 170 30 600 to 700</td>
<td>480 to 530</td>
<td></td>
</tr>
<tr>
<td>V8070 - V9501</td>
<td>13.5 mm x 10 mm 16 mm x 16 mm</td>
<td>-73</td>
<td>1</td>
<td>280 to 820 530 to 580 400 800</td>
<td>400 700 214 38</td>
<td>50 480 to 530</td>
<td>— 170 30 600 to 700</td>
<td>480 to 530</td>
<td></td>
</tr>
<tr>
<td>V8070 - V9501</td>
<td>13.5 mm x 10 mm 16 mm x 16 mm</td>
<td>-74</td>
<td>1</td>
<td>280 to 720 530 to 580 400 700</td>
<td>400 700 214 38</td>
<td>50 480 to 530</td>
<td>— 170 30 600 to 700</td>
<td>480 to 530</td>
<td></td>
</tr>
<tr>
<td>V8070 - V9501</td>
<td>13.5 mm x 10 mm 16 mm x 16 mm</td>
<td>-74</td>
<td>2</td>
<td>280 to 720 530 to 580 400 700</td>
<td>400 700 214 38</td>
<td>50 480 to 530</td>
<td>— 170 30 600 to 700</td>
<td>480 to 530</td>
<td></td>
</tr>
<tr>
<td>V6833P, V7090P</td>
<td>—</td>
<td>No suffix</td>
<td>1</td>
<td>370 to 920 700 to 800 1000 1500</td>
<td>— 170 —</td>
<td>— 170 30 600 to 700</td>
<td>480 to 530</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V6833P-G</td>
<td>—</td>
<td>No suffix</td>
<td>1</td>
<td>370 to 920 700 to 800 1000 1500</td>
<td>— 170 —</td>
<td>— 170 30 600 to 700</td>
<td>480 to 530</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Alkali photocathode image intensifiers

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective photocathode area</th>
<th>Suffix</th>
<th>Stage of MCP</th>
<th>Spectral response range (nm)</th>
<th>Peak wavelength (nm)</th>
<th>Luminous sensitivity (µA/lm)</th>
<th>Radiant sensitivity (mA/W)</th>
<th>Quantum efficiency (QE) (%)</th>
<th>Peak quantum efficiency spectral response range (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V6886U - V7669U</td>
<td>18 mm</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 900</td>
<td>430</td>
<td>150 280</td>
<td>—</td>
<td>62</td>
<td>— 18 410</td>
</tr>
<tr>
<td>V6887U - V7670U</td>
<td>18 mm</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 900</td>
<td>430</td>
<td>150 230</td>
<td>—</td>
<td>53</td>
<td>— 15 410</td>
</tr>
<tr>
<td>V4170U - V10308U</td>
<td>18 mm</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 900</td>
<td>430</td>
<td>100 170</td>
<td>—</td>
<td>60</td>
<td>— 17 410</td>
</tr>
<tr>
<td>V4183U - V10309U</td>
<td>18 mm</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 900</td>
<td>430</td>
<td>100 150</td>
<td>—</td>
<td>47</td>
<td>— 14 410</td>
</tr>
<tr>
<td>V6886U - V7669U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 650</td>
<td>400</td>
<td>20 50</td>
<td>—</td>
<td>50</td>
<td>— 14 380</td>
</tr>
<tr>
<td>V6887U - V7670U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 650</td>
<td>400</td>
<td>20 40</td>
<td>—</td>
<td>40</td>
<td>— 12 380</td>
</tr>
<tr>
<td>V4170U - V10308U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 650</td>
<td>400</td>
<td>20 50</td>
<td>—</td>
<td>50</td>
<td>— 14 380</td>
</tr>
<tr>
<td>V4183U - V10309U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 650</td>
<td>400</td>
<td>20 40</td>
<td>—</td>
<td>40</td>
<td>— 12 380</td>
</tr>
<tr>
<td>V6886U - V7669U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 320</td>
<td>230</td>
<td>—</td>
<td>—</td>
<td>10 32</td>
<td>5.4 17 220</td>
</tr>
<tr>
<td>V6887U - V7670U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 320</td>
<td>230</td>
<td>—</td>
<td>—</td>
<td>10 22</td>
<td>5.4 12 220</td>
</tr>
<tr>
<td>V4170U - V10308U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 320</td>
<td>230</td>
<td>—</td>
<td>—</td>
<td>10 32</td>
<td>5.4 17 220</td>
</tr>
<tr>
<td>V4183U - V10309U</td>
<td>25 mm</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 320</td>
<td>230</td>
<td>—</td>
<td>—</td>
<td>10 22</td>
<td>5.4 12 220</td>
</tr>
<tr>
<td>V13716U</td>
<td>—</td>
<td>No suffix</td>
<td>1</td>
<td>160 to 320</td>
<td>230</td>
<td>—</td>
<td>—</td>
<td>48 59</td>
<td>26 32 220</td>
</tr>
<tr>
<td>V13716U</td>
<td>—</td>
<td>No suffix</td>
<td>2</td>
<td>160 to 320</td>
<td>230</td>
<td>—</td>
<td>—</td>
<td>48 59</td>
<td>26 32 220</td>
</tr>
</tbody>
</table>

* The phosphor screen of standard products is P43 coated on an FOP output window. Please contact us for other phosphor screens and output windows.

**Note:**
1. Photocathode area other than effective area is not guaranteed.
2. Effective photocathode area: 17.5 mm
3. Auto gating function
4. Typical values measured at the wavelength of peak response
5. Typical values measured at 20 °C
6. Values measured using a P43 phosphor screen.

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...Type No. suffix differs depending on the potting method. See page 5 for details.
### Operating Ambient Temperature
-20 °C to +40 °C

### Storage Ambient Temperature
-55 °C to +60 °C

### Maximum Shock
300 m/s² (30 G), 18 ms

### Maximum Vibration
10 Hz to 55 Hz, 0.35 mm (p-p)

<table>
<thead>
<tr>
<th>Gate function</th>
<th>Luminous gain ([(\text{lm/}m^2)/\text{lx}])</th>
<th>Radiant emittance gain ([(\text{W/m}^2)/(\text{W/m}^2)])</th>
<th>Equivalent background input (EBI) ((\text{lm/cm}^2))</th>
<th>Limiting resolution (\phi 18) (Lp/mm)</th>
<th>Limiting resolution (\phi 25) (Lp/mm)</th>
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<th>Gate function</th>
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<th>Radiant emittance gain ([(\text{W/m}^2)/(\text{W/m}^2)])</th>
<th>Equivalent background input (EBI) ((\text{lm/cm}^2))</th>
<th>Limiting resolution (\phi 25) (Lp/mm)</th>
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<tr>
<td>—</td>
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<td>(3.8 \times 10^3)</td>
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<td>(1.0 \times 10^5)</td>
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<tr>
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<td>(3.0 \times 10^5)</td>
<td>—</td>
<td>(1.0 \times 10^5)</td>
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</table>
Figure 1: MTF

Alkali photocathode image intensifiers

GaAs and GaAsP photocathode image intensifiers

Figure 2: Luminous gain vs. MCP voltage (V8070 series)

Figure 3: Equivalent background input (EBI) vs. Temperature

Figure 4: Photocathode illuminance vs. Phosphor screen luminous emittance

Figure 5: Shutter ratio (color temperature: 2856 k)
Recommended operation (Example)

Normal operation

Supply voltage (See Figure 6.)

Photocathode – MCP-in (V_k) ............................................. 150 V to 200 V
MCP-in – MCP-out (V_{MCP}) ............................... 1 stage MCP 500 V to 1000 V
................................................................. 2 stages MCP 1000 V to 2000 V
MCP-out – Phosphor screen (V_s) ......................... 5000 V to 6000 V

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

Gate operation

There are two basic circuits for gate operation as shown in Figure 7 below. The supply voltages V_{MCP} and V_s 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 7: 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.
V7090U/D series, V8070U/D series (Effective photocathode area: 13.5 mm x 10 mm)

V7090U, V8070U series

INPUT VIEW

OUTPUT VIEW

V7090D, V8070D series

INPUT VIEW

OUTPUT VIEW

V6886U, V6887U, V4170U, V4183U series, V13716

Suffix: Non, -02, -03
V9501U/D series, V9569U/D series (Effective photocathode area: 16 mm × 16 mm)

V9501U, V9569U series

V9501D, V9569D series

V7669U, V7670U, V10308U, V10309U series

Suffix: Non, -02, -03
**Dimensional outlines (Unit:mm)**

### V6833P, V6833P-G (Built-in power supply)

INPUT VIEW

- **Effective Photocathode Area**: 17.5 MIN.
- **Photocathode (GaAs)**: 5.5 ± 0.1, 1.0 ± 0.1
- **Phosphor Screen Area**: 31.0 ± 0.2
- **Input Voltage**: (+2 V to +3 V)

OUTPUT VIEW

- **Effective Photocathode Area**: 17.5 MIN.
- **Photocathode (GaAs)**: 5.5 ± 0.1, 1.0 ± 0.1
- **Phosphor Screen Area**: 31.0 ± 0.2
- **Input Voltage**: (+2 V to +3 V)

**Housing Material**: POM [Polyoxymethylene]

---

### V7090P (Built-in power supply)

INPUT VIEW

- **Effective Photocathode Area**: 1.6 ± 0.15
- **Photocathode**: 0.63 ± 0.1, 5.5 ± 0.1, 19.8 ± 0.5
- **Output Window**: 0.8 ± 0.15

OUTPUT VIEW

- **Effective Photocathode Area**: 17.5 MIN.
- **Photocathode**: 6.8 ± 0.15
- **Input Voltage**: (+2 V to +3 V)

**Housing Material**: POM [Polyoxymethylene]
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 applying 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.

DISPOSAL METHOD

When disposing of the used image intensifier, take appropriate measures in compliance with applicable regulations regarding waste disposal and correctly dispose of it yourself, or entrust disposal to a licensed industrial waste disposal company.

In any case, be sure to comply with the regulations in your country, state, region or province to ensure the used image intensifier is disposed of legally and correctly.
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**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>C6706-010</td>
<td>+15±1.5</td>
<td>60</td>
<td>-200</td>
<td>500 to 1000</td>
<td>20</td>
<td>6000</td>
<td>0.25 to 0.75</td>
<td>ABC (Automatic Brightness Control)</td>
<td>V6886U, V7689U, V7090, -7, -N1.</td>
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<td>C6706-210</td>
<td>+12±1.2</td>
<td>+5 to +10</td>
<td>1000 to 2000</td>
<td>100</td>
<td>0.05 to 5</td>
<td>Excess current (excess light) protective function</td>
<td>V13716</td>
<td></td>
<td></td>
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<tr>
<td>C8499-020</td>
<td>+10±0.5</td>
<td>150</td>
<td>-200</td>
<td>500 to 1000</td>
<td>20</td>
<td>6000</td>
<td>0.25 to 0.75</td>
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<td>V4170U, V10308U, V7090, -7, N2.</td>
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<tr>
<td>C8499-220</td>
<td>-15±1.5</td>
<td>-200</td>
<td>500 to 1000</td>
<td>20</td>
<td>6000</td>
<td>0.25 to 0.75</td>
<td>ABC (Automatic Brightness Control)</td>
<td>V8070, -7, N2.</td>
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**FOR GATE OPERATION (100 ns to DC operation at maximum repetition rate of 1 kHz)**

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<th>Type No.</th>
<th>Voltage (V)</th>
<th>Current (mA Max.)</th>
<th>MCP control voltage (V)</th>
<th>Gate on voltage (V)</th>
<th>Gate off voltage (V)</th>
<th>Phosphor screen – MCP-in Voltage (V)</th>
<th>MCP-in – MCP-out Voltage (V)</th>
<th>MCP-out – Phosphor screen Voltage (V)</th>
<th>Max. Current (µA)</th>
<th>Features</th>
<th>Applicable I.I.</th>
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<tr>
<td>C6083-010</td>
<td>10±0.5</td>
<td>200</td>
<td>+5 to +10</td>
<td>0 (TTL Low)</td>
<td>+5 (TTL High)</td>
<td>-200</td>
<td>500 to 1000</td>
<td>50</td>
<td>6000</td>
<td>0.05 to 5</td>
<td>ABC</td>
</tr>
<tr>
<td>C6083-020</td>
<td>+10±0.5</td>
<td>200</td>
<td>+5 to +10</td>
<td>0 (TTL Low)</td>
<td>+5 (TTL High)</td>
<td>-200</td>
<td>1000 to 2000</td>
<td>50</td>
<td>6000</td>
<td>0.05 to 5</td>
<td>ABC</td>
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**NOTE:** ① Other ground terminal types and other input voltage types are also available. Please consult our sales office. ② ABC: Automatic Brightness Control

**Dimensional outlines (Unit: mm)**

<table>
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<tr>
<th>C6706-010, -210</th>
<th>C8499-020, -220</th>
<th>C6083-010, -020</th>
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</thead>
</table>

**Housing case for I.I. A10505**

A10505 is a Housing case for easy to use 45mm outer diameter of Image Intensifier (output window: FOP, MCP: 1 stage). It is available for 1 stage MCP type of V7090U/D, V8070U/D, V8071U/D, V6886U and V6887U series. Input: C-mount, Output: Hamamatsu’s relay lens mount. Screw hole for a tripod can be used for holding.

**Dimensional outlines (Unit: mm)**

1/4”–20 UNC DEPTH 8

M5X1 ORIGINAL RELAY LENS MOUNT

MATERIAL: ALUMINIUM
WEIGHT : 250 g
### High-speed gated image intensifier units

High-speed gated Image Intensifier (I.I.) unit comprises 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, multialkali photocathode or GaAs 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). The GaAs photocathode type has high sensitivity from visible region to NIR. All of gated I.I. units can be operated and controlled from a remote controller or a PC (Personal Computer) via the USB interface.

Input: C-mount, Output: Hamamatsu's relay mount. Screw hole for a tripod can be used for holding.

#### SELECTION GUIDE

<table>
<thead>
<tr>
<th>Type No.</th>
<th>C9546-01, -02</th>
<th>C9546-03, -04</th>
<th>C9546-05, -06</th>
<th>C9547-01, -02</th>
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<td>φ25 ②</td>
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<td>280 to 720</td>
<td>185 to 900</td>
<td>370 to 920</td>
<td>280 to 720</td>
<td>185 to 900</td>
<td>370 to 920</td>
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<td>Multalkali</td>
<td>GaAs</td>
<td>GaAsP</td>
<td>Multalkali</td>
<td>GaAs</td>
<td>—</td>
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</table>

**NOTE:**
① Effective 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.
② Effective 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.

### High-speed gated image intensifier units C10880-03C/-03F/-13C/-13F

No lighting required during imaging with High-speed camera

Image intensifiers (I.I.) are devices capable of intensifying an image at high gain and high-speed gating (electronic shutter operation). The C10880 series is an image intensifier unit which is suitable for High-speed camera application. It has a built-in pulse generator to allow multi-exposure (burst) operation.

By using a relay lens, the C10880 series can be easily connected to various High-speed cameras. The image intensifier gain, gate width and delay time can be controlled and set from a PC through the RS-232C interface. (The image intensifier gain can also be controlled and set from the remote controller.)

#### Features
- **Maximum repetition frequency:** 200 kHz
- **Built-in pulse generator**
- **Multi-exposure**
- **Built-in low distortion image booster** (C10880-13C/C10880-13F)
- **High-speed gating:** 10 ns minimum
- **High performance image intensifier**
  - Wide spectral response range from UV to near IR: Multalkali photocathode type.
  - High linearity compatible with high frame rate: Image booster included.
Main Products

Electron Tubes
- Photomultiplier tubes
- Photomultiplier tube modules
- Microchannel plates
- Image intensifiers
- Xenon lamps / mercury-xenon lamps
- Deuterium lamps
- Light source applied products
- Laser applied products
- Microfocus X-ray sources
- X-ray imaging devices

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

Imaging and Processing Systems
- Cameras / image processing measuring systems
- X-ray products
- Life science systems
- Medical systems
- Semiconductor failure analysis systems
- FPD / LED characteristic evaluation systems
- Spectroscopic and optical measurement systems

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

Sales Offices

Japan:
HAMAMATSU PHOTONICS K.K.
325-6, Sunayama-cho, Naka-ku,
Hamamatsu City, Shizuoka Pref., 438-8578, Japan
Telephone: (81)53-452-2141, Fax: (81)53-466-7889
E-mail: intl-div@hq.hpk.co.jp

China:
HAMAMATSU PHOTONICS (CHINA) Co., Ltd.
Main Office
1201 Tower B, Jiaming Center, 27 Dongsanhuan Beiul,
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.
Main Office
8F-3, No.158, Section 2, Gongda 5th Road,
East District, Hsinchu, 300, Taiwan R.O.C.
Telephone: (886)3-659-0081, Fax: (886)3-659-0081
E-mail: info@hamamatsu.com.tw

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

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

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

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

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

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

France, Portugal, Belgium, Switzerland, Spain:
HAMAMATSU PHOTONICS FRANCE S.A.R.L.
Main Office
19, Rue du Saule Trau, Parc du Moulin de Massy,
91882 Massy Cedex, France
Telephone: (33)69 53 71 00, Fax: (33)69 53 71 10
E-mail: info@hamamatsu.fr

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

Belgian Office
Axisparc Technology, rue Andre Dumont 7
1420 Choulers-Saint-Gébier, Belgium
Telephone: (32)10 45 63 34, Fax: (32)10 45 63 67
E-mail: info@hamamatsu.be

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

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

Danish Office
Lastrupgud 1-3, DK-2750 Ballerup, Denmark
Telephone: (45)70 20 93 68, Fax: (45)44 20 99 10
E-mail: info@hamamatsu.dk

Netherlands Office
Transistorstraat 7, NL-1322 CJ Almere, The Netherlands
Telephone: (31)36-5463084, Fax: (31)36-5244948
E-mail: info@hamamatsu.nl

Poland Office
10 Ciołka Street, RN 126-127 01-402 Warsaw, Poland
Telephone: (48)22-646-0016, Fax: (48)22-646-0018
E-mail: poland@hamamatsu.de

Israel Office (Hamamatsu Photonics Israel Ltd.)
Haboshil 6, Building C, 4672201 Herzliya, Israel
E-mail: Info@hamamatsu.co.il

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

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

Italy:
HAMAMATSU PHOTONICS ITALIA S.r.l.
Main Office
Viale Cesare Pavese, 435, 00144 Roma, Italy
Telephone: (39)06-50 51 34 54
E-mail: inforoma@hamamatsu.it

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