Optical blocks are freely combinable modular units designed to facilitate optical connections that are usually difficult for low-light-level measurements. Hamamatsu provides various types of optical blocks that allow installation of optical components such as filters, mirrors, and lenses. Each optical block can be placed precisely and is easy to attach/detach yet excellent in light shielding. When used in combination with a Hamamatsu photomultiplier tube module, optical blocks allow low-light-level measurements even in an ordinary room environment.

**FEATURES**

- Easy to attach / detach
- No alignment required
- Excellent light-shielding effect
- Makes low-light-level measurement easy
- Easy connection to microscopes

**OVERVIEW**

**USING EXAMPLE**

- Connecting to a microscope
- PMT module
- Adapter block A10030-xx
- Filter block A10033-90
- Shutter block A10036
- Pinhole block A11027

**Integration**

- Mechanics
  - Holder
  - Stage
- Light shield
  - Darkroom environment
- Optics
  - Filter
  - Mirror
  - Lens
- Detector
  - PMT
  - Photodiode
  - Camera
<table>
<thead>
<tr>
<th>Photo</th>
<th>Product name / Type No.</th>
<th>Over view</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Adapter block A10030 series" /></td>
<td><strong>Adapter block A10030 series</strong></td>
<td>The A10030 series is an adapter block for connecting a PMT module to a V-groove type optical block.</td>
<td>4</td>
</tr>
<tr>
<td><img src="image2.png" alt="C-mount adapter block A10039" /></td>
<td><strong>C-mount adapter block A10039</strong></td>
<td>This block connects a device having C-mount to V-groove type optical blocks. The connection angle for the device and block is adjustable.</td>
<td>4</td>
</tr>
<tr>
<td><img src="image3.png" alt="Fiber adapter block A10037 series" /></td>
<td><strong>Fiber adapter block A10037 series</strong></td>
<td>Optical fiber cables with FC or SMA connectors can be connected to the blocks in the A10037 series. The lens assembled in the block collimates the light spread from the optical fiber.</td>
<td>5</td>
</tr>
<tr>
<td><img src="image4.png" alt="Beam expander block A10031" /></td>
<td><strong>Beam expander block A10031</strong></td>
<td>This optical block widens the diameter of a collimated beam of light to 2.5 times its original size or reduces the diameter to 1/2.5 times its original size.</td>
<td>5</td>
</tr>
<tr>
<td><img src="image5.png" alt="Joint block A10038 series" /></td>
<td><strong>Joint block A10038 series</strong></td>
<td>The A10038 series is a joint block for connecting one optical block to another. The joint is available in two types: MM (male-male) type and FF (female-female) type.</td>
<td>6</td>
</tr>
<tr>
<td><img src="image6.png" alt="Cuvette block A11971" /></td>
<td><strong>Cuvette block A11971</strong></td>
<td>This block is a small dark box specifically designed for cuvettes with an optical path length of 10 mm, and allows easy measurement of samples in combination with various optical blocks.</td>
<td>6</td>
</tr>
<tr>
<td><img src="image7.png" alt="Shutter block A10036" /></td>
<td><strong>Shutter block A10036</strong></td>
<td>The A10036 is a manual shutter block with a plate that is opened and closed by sliding it left and right. Light is sufficiently blocked so there will be no problem even at photon counting levels.</td>
<td>7</td>
</tr>
<tr>
<td><img src="image8.png" alt="ND filter block A10032 series" /></td>
<td><strong>ND filter block A10032 series</strong></td>
<td>A neutral density (ND) filter is included in this optical block to attenuate light levels. The ND filter is available in two types transmittance: 10 % type and 1 % type.</td>
<td>7</td>
</tr>
<tr>
<td><img src="image9.png" alt="Interchangeable filter block A10033-90" /></td>
<td><strong>Interchangeable filter block A10033-90</strong></td>
<td>The A10033-90 is a holder block for assembling a commercially available 15 mm diameter filter.</td>
<td>8</td>
</tr>
<tr>
<td><img src="image10.png" alt="Interchangeable dichroic block A10034-90" /></td>
<td><strong>Interchangeable dichroic block A10034-90</strong></td>
<td>This is a V-groove type holder block that allows installation of a commercially available dichroic mirror with a 45-degree incident angle.</td>
<td>9</td>
</tr>
<tr>
<td><img src="image11.png" alt="Beam splitter block A10035" /></td>
<td><strong>Beam splitter block A10035</strong></td>
<td>This optical block uses a cubic type half-mirror. Incident light is split into reflected and transmitted beams at a ratio of 1 to 1.</td>
<td>10</td>
</tr>
<tr>
<td><img src="image12.png" alt="Beam splitter block A10035-90" /></td>
<td><strong>Beam splitter block A10035-90</strong></td>
<td>The A10035-90 is a holder block designed to hold a 15 mm cubic type beam splitter.</td>
<td>10</td>
</tr>
<tr>
<td><img src="image13.png" alt="Pinhole block A11027" /></td>
<td><strong>Pinhole block A11027</strong></td>
<td>This is a holder block that can hold a commercially available, mount type pinhole. Light passing through the pinhole is collimated by the lens installed in the block and is output.</td>
<td>11</td>
</tr>
<tr>
<td><img src="image14.png" alt="Beam aligner block A10760" /></td>
<td><strong>Beam aligner block A10760</strong></td>
<td>This optical block is for using an infinity-corrected objective lens to guide laser light into an optical fiber with an attached FC connector or to collimate and transmit the beam from a fiber-optic cable.</td>
<td>12</td>
</tr>
<tr>
<td><img src="image15.png" alt="Tube lens block A10859 series" /></td>
<td><strong>Tube lens block A10859 series</strong></td>
<td>This block contains a focusing lens with a focal distance of 100 mm and is used for an infinity-corrected objective lens. Aberration is reduced due to the use of an achromatic lens.</td>
<td>13</td>
</tr>
<tr>
<td><img src="image16.png" alt="C-mount interchangeable filter block A11213 series" /></td>
<td><strong>C-mount interchangeable filter block A11213 series</strong></td>
<td>The A11213 series is a C-mount connection block for installing a commercially available 25 mm diameter filter or lens. This block allows angle adjustment and so is useful as a spacer or adapter that connects between C-mounts.</td>
<td>14</td>
</tr>
<tr>
<td><img src="image17.png" alt="C-mount adapter A9865" /></td>
<td><strong>C-mount adapter A9865</strong></td>
<td>This adapter is for connecting a PMT module to a optical block and an equipment with C-mount.</td>
<td>14</td>
</tr>
</tbody>
</table>
**CONNECTION EXAMPLES**

- Connection example using bifurcated optical fiber ........................................................................................................ 17
- Connection example using the beam expander block ........................................................................................................ 17
- Connecting to a microscope .................................................................................................................................................. 17
- Fluorescence detection (Confocal) ....................................................................................................................................... 18
- Connection example using an objective lens and the tube lens block ................................................................................... 18
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**COMPATIBLE PMT MODULE**

* In preparation for use with optical blocks, a C-mount adapter plate must be attached to the PMT module.
Please notify us of your need for this adapter when ordering.

---

**Connection**
- **C-mount interchangeable dichroic block**
  - **A11214**
  - The A11214 is a C-mount connection block for installing a dichroic mirror for use at a 45° angle of incidence.
  - Page: 15

- **Polarizer block**
  - **A11026**
  - This is a holder block designed for a polarizer.
  - Polarizing filters and waveplates are polarizing elements whose polarization characteristics change depending on direction and angle.
  - Page: 16
**Block Characteristics**

- **Adapter block A10030 series**

The A10030 series is an adapter block for connecting a PMT module to each block. The A10030 series adapter blocks have M4 and M3 screw holes for securing to an optical bench or optical stage.

**NOTE:** Avoid frequently attaching and detaching from PMT module.

**Compatible PMT Modules**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>H10720/H10721/H10722/H10723/H11900/H11901/H11902/H11903/H11526/H11706/H12056/H10682/H11890/H12386/H14600/H14601</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10030-01</td>
<td>H7826/H7827/H7828/H12775</td>
</tr>
<tr>
<td>A10030-02</td>
<td></td>
</tr>
</tbody>
</table>

**Specifications**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective Beam Size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10030-01</td>
<td>ø8 mm</td>
<td></td>
</tr>
<tr>
<td>A10030-02</td>
<td>ø12 mm*</td>
<td>Approx. 18 g</td>
</tr>
</tbody>
</table>

* When connected to other optical blocks, their effective optical path diameters take precedence.

**Dimensional Outlines (Unit: mm)**

A10030-01

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.0±0.1</td>
<td>27.0±0.1</td>
</tr>
</tbody>
</table>

A10030-02

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.0±0.1</td>
<td>27.0±0.1</td>
</tr>
</tbody>
</table>

- **C-mount adapter block A10039**

The A10039 connects a V-groove type optical block to a C-mount type optical block or a device with a C-mount. The A10039 also allows adjusting the connection angle.

**Specifications**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective Beam Size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10039</td>
<td>ø8 mm</td>
<td>Approx. 27 g</td>
</tr>
</tbody>
</table>

* Supplied: C-mount double female thread ring.

**Dimensional Outlines (Unit: mm)**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.0±0.1</td>
<td>27.0±0.1</td>
</tr>
</tbody>
</table>

How to connect a C-mount adapter block

1. Loosen the four screws on the adapter block and make sure the C-mount ring is separated about 1 mm from the adapter block body.
2. Insert the C-mount ring into the C-mount of the PMT module and turn the adapter block body clockwise until it stops.
3. Turn the adapter block body counterclockwise so that it is positioned at the desired angle and then tighten the four screws.

---

**NOTE:** Avoid frequently attaching and detaching from PMT module.
**Fiber adapter block A10037 series**

Optical fiber cables with FC or SMA connectors can be connected to the blocks in the A10037 series. The lens assembled in the block collimates the light spread from the optical fiber. The A10037/A10037-01 is suitable for use in the visible region (400 nm to 700 nm) and the A10037-10/A10037-11 for use in the UV region (200 nm to 400 nm).

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Recommended wavelength</th>
<th>Connector</th>
<th>Focal length</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10037</td>
<td>Visible</td>
<td>FC</td>
<td>10 mm</td>
<td>Approx. 17 g</td>
</tr>
<tr>
<td>A10037-01</td>
<td>UV</td>
<td>SMA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A10037-10</td>
<td>UV</td>
<td>FC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A10037-11</td>
<td>UV</td>
<td>SMA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Dimensional outlines (Unit: mm)**

When fiber core diameter is 100 µm and NA is 0.2

<table>
<thead>
<tr>
<th>Distance from Fiber Output End</th>
<th>Beam Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mm</td>
<td>Max. 4.9 mm</td>
</tr>
<tr>
<td>150 mm</td>
<td>Max. 5.4 mm</td>
</tr>
</tbody>
</table>

* In the case of the SMA connector type, the beam diameter depends on the position of the connected fiber cable end. The above values are measured when the fiber cable end is at the same position as the FC connector type.

---

**Beam expander block A10031**

This block widens the diameter of a collimated beam of light to 2.5 times its original size or reduces the diameter to 1/2.5 times its original size. This block has a C-mount thread for connecting to another device.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10031</td>
<td>φ8 mm</td>
<td>Approx. 43 g</td>
</tr>
</tbody>
</table>

* Supplied: C-mount double male thread ring.
** Designed for wavelength from 400 nm to 700 nm.

**Dimensional outlines (Unit: mm)**

---

Transmittance (Typical)

---

Incident light conditions
The A11971 cuvette block is a small dark box specifically designed for cuvettes with an optical path length of 10 mm. It allows easy measurement of samples in combination with other optical blocks. The base can be removed as needed.

NOTE: This cuvette block is very compact. If it falls over, the sample may leak from the cuvette, so we recommend securing the body of the block and/or using a capped cuvette.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Applicable cuvette size</th>
<th>Optical path length</th>
<th>Dimensional outline</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A11971</td>
<td>8 mm</td>
<td>10 mm</td>
<td>12.5 mm × 12.5 mm</td>
<td>56 mm (H)</td>
<td>Approx. 206 g</td>
</tr>
</tbody>
</table>

* Supplied: Block cap 2 pcs and Hex wrench S2.5

**Dimensional outlines (Unit: mm)**
Shutter block A10036

The A10036 is a manual shutter block with a plate that is opened and closed by sliding it left and right. Light is sufficiently blocked so there will be no problem even at photon counting levels.

NOTE: If you feel the shutter does not open and close smoothly, we recommend applying a small amount of an optical grease to the plate.

ND filter block A10032 series

A neutral density (ND) filter is included in this optical block to attenuate light levels.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10036</td>
<td>φ8 mm</td>
<td>Approx. 48 g</td>
</tr>
</tbody>
</table>

Dimensional outlines (Unit: mm)

Transmittance (Typical)

* Transmittance characteristics are typical values and may differ depending on the production lot.
Interchangeable filter block A10033-90

The A10033-90 is a holder block that allows you to insert an optical filter. The filter is held by the spacer ring and the retaining ring, and can be easily exchanged by using the accessory tool. The A11213 C-mount interchangeable filter block series (P.14) is also available. Filters with 25 mm diameters can be installed in these blocks.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Compatible filter size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10033-90</td>
<td>ø8 mm</td>
<td>Size: ø12.7 mm (1/2 inch) to ø15 mm (Max.)* (recommended: ø15 mm)</td>
<td>Approx. 24 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness: 1.5 mm to 5 mm</td>
<td></td>
</tr>
</tbody>
</table>

* Supplied: Screw ring tool, spacer ring, retaining ring, O-ring

**Dimensional outlines (Unit: mm)**

**Connection example: Fiber-optic single wavelength detection**

The lens inside the A10037 series fiber adapter block collimates the beam of the light signal emitted from the optical fiber. The A10033-90 filter block contains an optical filter that only allows a specific wavelength to pass. When dimming the beam, use ND filter block A10032 series.
The A10034-90 is a V-groove type holder block that allows installation of a dichroic mirror with a 45-degree incident angle, such as a commercially available sized dichroic mirror frequently used for microscopes. Hamamatsu also provides the A11214 C-mount interchangeable dichroic block. (p.15)

**NOTE:**
- Dichroic mirror for this block must be purchased separately. (Products by companies such as Edmund Optics Inc., SIGMAKOKI CO., LTD., and Thorlabs Inc. can be used.)
- Commercially available dichroic mirrors usually have markings to distinguish their front and back sides. Be careful to install dichroic mirrors in the A10034-90 in the correct direction.
- When installing a dichroic mirror, be careful to keep it clean and to avoid getting fingerprints on it.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Compatible dichroic mirror</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10034-90</td>
<td>8 mm</td>
<td>W x H: 25 mm to 26 mm (W) × 35 mm to 38 mm (H) Thickness: 0.9 mm to 1.1 mm (recommended 1 mm)</td>
<td>Approx. 139 g</td>
</tr>
</tbody>
</table>

* Supplied: Hex wrench S2.0

**Dimensional outlines (Unit: mm)**

**Connection example: Fiber-opic dual wavelength detection**

The lens inside the A10037 series fiber adapter block collimates the beam of the light signal emitted from the optical fiber. The dichroic mirror installed in the A10034-90 dichroic block reflects light below a certain wavelength and allows all light above that wavelength to pass. Finally, each of the two A10033-90 filter blocks extracts a specific wavelength so that the signal levels of the two separate wavelengths can be measured.
**Beam splitter block A10035**

The A10035 uses a cubic type half-mirror. Incident light is split into reflected and transmitted beams at a ratio of 1 to 1.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10035</td>
<td>ø8 mm</td>
<td>Approx. 63 g</td>
</tr>
</tbody>
</table>

* Designed for wavelength from 400 nm to 700 nm.

**Dimensional outlines (Unit: mm)**

NOTE: Light level is cut to approximately one third due to light absorption.

**Beam splitter block A10035-90**

The A10035-90 is a holder block designed to hold a 15 mm cubic type beam splitter. There are M3 screw holes in the bottom of the block for holding.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Applicable beam splitter size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10035-90</td>
<td>ø8 mm</td>
<td>15 mm x 15 mm x 15 mm cubic type</td>
<td>Approx. 55 g</td>
</tr>
</tbody>
</table>

* Supplied: Hex wrench 2 pcs (S0.89 and S1.5))

**Dimensional outlines (Unit: mm)**

NOTE: The beam splitter is not included.

*Products by companies such as Edmund Optics Inc. and SIGMAKOKI CO., LTD. can be used.*

*Be careful to install the beam splitter so that it faces in the correct direction.*

*When installing a beam splitter, be careful to keep it clean and to avoid getting fingerprints on it.*
Pinhole block A11027

The A11027 is a holder block for mounting a pinhole. The screws can be used to adjust the pinhole's position in the XY directions. The built-in lens collimates the light that passes through the pinhole and converges the light on a photodetector. There is a base attached to the holder block through the M3 screw holes in the bottom of the block. If necessary, this base can be removed and re-attached to the side of the block.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Applicable pinhole mount size</th>
<th>XY axis range of motion</th>
<th>Adjustment screw pitch</th>
<th>Focal length</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A11027</td>
<td>Size: φ16 mm Thickness: 1.58 mm to 1.6 mm</td>
<td>1.2 mm</td>
<td>0.25 mm</td>
<td>15 mm</td>
<td>Approx. 180 g (including the base)</td>
</tr>
</tbody>
</table>

* Supplied: Screw ring tool and hex wrench S2.5

**Dimensional outlines (Unit: mm)**

**Extended example of microscope**

Connecting the A11027 pinhole block to the C-mount port of a microscope configures a confocal optical system. Light passing through the pinhole is collimated by the lens in the block and is efficiently guided to the PMT module.
**Beam aligner block A10760**

**NOTE:** Objective lens and fiber-optic cable are not included.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Travels</th>
<th>Optical fiber connector</th>
<th>Compatible objective lens</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10760</td>
<td>1 mm</td>
<td>3 mm</td>
<td>FC</td>
<td>Approx. 420 g</td>
</tr>
</tbody>
</table>

* Use an infinity-corrected lens as the objective lens. Supplied: Hex wrench S3.0

**USING EXAMPLE 1: FOCUSING**

1. Remove the two cover screws using a Phillips-head screwdriver, and then remove the cover.
2. Use the hexagonal wrench that comes with the block to remove the two plate screws, and then remove the plate.
3. Attach an objective lens to the plate’s objective lens screw hole (M20.32 P0.706).
4. Reassemble the block by performing steps 1 and 2 in reverse, and then connect the block to other devices.

You can align the optical fiber by using the X-, Y-, and Z-axis adjustment screws. Only turn the Z-axis adjustment screw after you have loosenened the screws in step 1.

**USING EXAMPLE 2: COLLIMATOR**

**Technical guide**

**Pupil diameter and parfocal distance**

**Pupil diameter**

The diameter of the beam that is emitted from the pupil of an objective lens with a focal length f and a numerical aperture NA is given by:

Pupil diameter = 2 x f x NA

**Parfocal distance**

The parfocal distance is the distance from the objective mounting position of the objective lens to the sample at which the sample is in-focus. The A10760 is designed to be used with an objective lens whose parfocal distance is 45 mm.

**Dimensional outlines (Unit: mm)**
Tube lens block A10859 series

These are video lens blocks for use with the infinity-corrected objective lenses. It has a tube lens with a focal length of 100 mm to form an image. One side has a male C-mount thread, and the other side has a female C-mount thread. You can attach a device such as a camera to the side with the male thread. You can use a C-mount double male thread ring to connect the side with the female thread to the dark box. The tube lens block reduces aberration through the use of an achromatic lens.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Focal length</th>
<th>Effective beam size</th>
<th>Recommended sensor size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10859</td>
<td>100 mm</td>
<td>φ15 mm</td>
<td>1/3 inches or less</td>
<td>Approx. 130 g</td>
</tr>
<tr>
<td>A10859-01</td>
<td>φ24 mm</td>
<td>1/2 inches or less</td>
<td></td>
<td>Approx. 205 g</td>
</tr>
</tbody>
</table>

* Supplied: C-mount double male thread ring and hex wrench S1.5
* Designed for wavelength from 400 nm to 700 nm.

Transmittance (Typical)

**Dimensional outlines (Unit: mm)**

A10859

![Dimensional outlines](image)

A10859-01

![Dimensional outlines](image)

Technical guide

**Imaging lens**

The light from the sample is collimated by the infinity-corrected objective lens before it enters the imaging lens. The imaging lens focuses the image on the focal point.

**Magnification**

You can calculate the magnification from the imaging lens focal length (100 mm) and the focal length of the microscope's objective lens.

\[
\text{Magnification (M)} = \frac{\text{Imaging lens focal length}}{\text{Objective lens focal length}} = \frac{100}{\text{Objective lens focal length}}
\]

Example: When the objective lens focal length is 45 mm, the magnification is approximately 2.2 times.

**Distance between the imaging lens and the objective lens**

Even though the beam of light that passes from the infinity-corrected objective lens to the imaging lens is collimated, the distance between the lenses must still be kept below a certain limit. This limit (L) can be calculated from the specifications of the objective and imaging lenses and the effective area of the sensor.

\[
L (\text{mm}) = \frac{f_2 (\phi_2 - \phi_1)}{\phi}
\]

where \(\phi_1\) is the objective lens's exit pupil diameter (mm), \(f_1\) is the focal length (mm), \(\phi_2\) is the imaging lens effective diameter, \(f_2\) is the focal length (mm), \(\phi\) is the effective sensor area, and \(d\) is the observation area.

To avoid vignetting when using the A10859 with objective lens \((f_1 = 18\ mm, \ NA = 0.25)\) and a 1/3-inch video camera \((\phi = 6\ mm)\), keep the distance from the objective lens to the A10859 below 100 mm. At this distance, placing a dichroic mirror between the objective lens and the A10859 will not have much of an effect on the overall optical characteristics.
These C-mount threaded optical blocks are for installing commercial optical filters and lenses with 25 mm diameters. You can use it with the A11214 C-mount interchangeable dichroic block to measure fluorescence or perform other tasks. Because this block enables angle adjustment, it is also useful as a spacer between C-mounts and as a connection adapter.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Compatible filter size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A11213</td>
<td>φ20 mm</td>
<td>φ24 mm to φ25 mm (φ25 mm to φ25.4 mm recommended)</td>
<td>Approx. 29 g</td>
</tr>
<tr>
<td>A11213-01</td>
<td></td>
<td>Thickness: 5 mm (Max.) (2 mm to 5 mm recommended)</td>
<td>Approx. 30 g</td>
</tr>
</tbody>
</table>

* Supplied: Hex wrench S1.5

**Connection example: Single wavelength detection**

Only light at a specific wavelength passes through the optical filter assembled in the block and is detected by the PMT module.

**Connection example: Fiber-optic single wavelength detection**

Light emitted and spread from the optical fiber cable is collimated by the lens in the A10037 series fiber adapter block and is efficiently guided to the PMT module.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9865</td>
<td>φ8 mm</td>
<td>Approx. 7 g</td>
</tr>
</tbody>
</table>

**Dimensional outlines (Unit: mm)**

This adapter is for connecting a PMT module to a optical block or an equipment with C-mount.
C-mount interchangeable dichroic block A11214

This C-mount threaded optical block is for installing a dichroic mirror for use at a 45° angle of incidence. You can use typical dichroic mirrors that are commercially available for use with microscopes.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Effective beam size</th>
<th>Compatible dichroic mirror size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A11214</td>
<td>20 mm</td>
<td>25 mm to 26 mm (W) x 35 mm to 38 mm (H)</td>
<td>Approx. 84 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness: 0.9 mm to 1.1 mm (1 mm recommended)</td>
<td></td>
</tr>
</tbody>
</table>

* Supplied: Hex wrench S2.0

**Dimensional outlines (Unit: mm)**

Connection example: Fiber-optic dual / triple wavelength detection

The dichroic mirror assembled in the block reflects light at wavelengths shorter than a specific wavelength and transmits longer wavelength light. Furthermore, only light at a specific wavelength passes through the optical filter and is then detected by the PMT module.

**Dual wavelength detection**

- PMT MODULE
- C-MOUNT INTERCHANGEABLE FILTER BLOCK A11213
- C-MOUNT ADAPTER A9865
- C-MOUNT ADAPTER BLOCK A10037-xx
- C-MOUNT ADAPTER BLOCK A10039
- C-MOUNT ADAPTER A9865
- C-MOUNT ADAPTER BLOCK A11214
- FIBER ADAPTER BLOCK A10037-xx

**Triple wavelength detection**

- PMT MODULE
- C-MOUNT INTERCHANGEABLE FILTER BLOCK A11213
- C-MOUNT ADAPTER A9865
- C-MOUNT ADAPTER BLOCK A10037-xx
- C-MOUNT ADAPTER BLOCK A10039
- C-MOUNT ADAPTER BLOCK A11214

**NOTE:**

- Dichroic mirrors for this block must be purchased separately. (Products by companies such as Edmund Optics Inc., SIGMAKOKI CO., LTD. and Thorlabs Inc. can be used.)
- Commercially available dichroic mirrors usually have markings to distinguish their front and back sides. Be careful to install dichroic mirrors in the A11214 in the correct direction.
- When installing a dichroic mirror, be careful to keep it clean and to avoid getting fingerprints on it.

**Connection example:**

Fiber-optic dual / triple wavelength detection

The dichroic mirror assembled in the block reflects light at wavelengths shorter than a specific wavelength and transmits longer wavelength light. Furthermore, only light at a specific wavelength passes through the optical filter and is then detected by the PMT module.
Polarizing filters and waveplates are polarizing elements whose polarization characteristics change depending on direction and angle. The A11026 is a simple, course-movement holder block that can be used to adjust the direction and angle.

**NOTE:**
- The polarizing filter or waveplate is not included. (Products by companies such as Edmund Optics Inc., SIGMAKOKI CO., LTD. and Thorlabs Inc. can be used.)
- When installing a polarizing element, be careful to keep it clean and to avoid getting fingerprints on it.

| SPECIFICATIONS |
|-----------------|-----------------|----------------|-----------------|-----------------|
| Type No.        | Effective beam size | Applicable polarizing element size | Adjustable range | Angle scale |
| A11026          | 8 mm             | Diameter: 25 mm to 25.4 mm Thickness: 1 mm to 8 mm | 90° ① | 5° ① Intervals |
|                 |                  | Weight            |                | Approx. 55 g    |

① Can be rotated 90° or more by changing the angle adjustment screw position.
② Scale indicates adjustment intervals and does not indicate adjustable pitch.
Can be fixed at any desired angle within the adjustable range of 90°.

* Supplied: Hex wrench S1.5

**Dimensional outlines (Unit: mm)**
Connection example using the beam expander block

The A10031 beam expander block is designed to reduce a 20-mm beam of collimated light to a diameter of 8 mm, the size of the PMT module’s photocathode; however, the expander block’s use is not just limited to collimated light, it can also be used to converge divergent light. For example, if you use the beam expander block to receive the divergent light from an optical fiber, the signal level will be higher than if you had just used a PMT module.

Connecting to a microscope

The microscope port is designed so that the image is focused at 17.526 mm from the C-mount attachment location. When you connect a C-mount adapter to a commercially sold 10-mm C-mount ring (male to female), the approximate location of the image point is at the PMT module’s photocathode (as shown in the figure on the left).

If the light converges to a diameter of 1 mm or less at the image point, do not match the location of the image point to the location of the PMT module’s photocathode; instead, expose the photocathode to a defocused light beam with a diameter of 1 mm or more.

* L is the distance from the attached end of the PMT module to the photocathode.
Fluorescence detection (Confocal)

For detecting fluorescence, it is convenient to use a laser with an optical fiber output. If you intend to focus the laser up to the diffraction limit, use single-mode optical fiber. The infinity-corrected objective lens inside the beam aligner block collimates the light beam emitted from the optical fiber. In this situation, you can collect the light efficiently if you use an objective lens with an NA that is larger than that of the optical fiber. You can calculate the beam diameter from the optical fiber NA or the objective lens NA, whichever is smaller, and the focal length of the objective lens.

The laser is reflected by the dichroic mirror, passes through the objective lens in the dark box, and excites the sample. The excited fluorescence passes through the objective lens, dichroic mirror, and tube lens block and is focused on the position of the pinhole that is installed in the pinhole block. This creates the confocal optical system. The light that passes through the pinhole is collimated by the installed lens and is injected into the PMT module.

![Connection example using an objective lens and the tube lens block](TPMODEUG101.png)

Technical guide

The performance of the confocal optical system is determined by the size of the pinhole. The Airy disk (diameter) is used as the reference. The following equation is used to calculate the Airy disk. The system magnification is determined by the focal length of the observation-side objective lens and the focal length of the tube lens block.

\[
\text{Airy disk (diameter)} = 1.22 \times M \times \frac{\lambda}{\text{NA}}
\]

- \(M\): System magnification
- \(\lambda\): Fluorescence wavelength
- \(\text{NA}\): NA of the observation-side objective lens

* If the objective lens focal distance on the observation side is unknown, please contact the lens manufacturer.

If spatial resolution is important, use a pinhole whose size is close to the size of the Airy disk. If you are only measuring fluorescence intensity, make the pinhole larger than the Airy disk; this will lower the spatial resolution, but it will also increase the signal level.

Connection example using an objective lens and the tube lens block

An infinity-corrected objective lens is connected to the A10859 tube lens block with a microscope objective lens mount, which has threads for a M20.32 × 0.706 mm objective lens and a C-mount male thread. Next, the tube lens block is connected to an imaging camera, such as an EM-CCD camera. You can adjust the focus using the manual focusing ring on the tube lens block.

![Connection example diagram](TPMODEUG101.png)
**Imaging System Connection Example**

**Coaxial Incident Illumination Method**

Illuminate the sample with a fiber bundle connected to a xenon arc lamp. You can attach the fiber bundle easily by using a commercially available C-mount light guide mount. To excite the sample, put an excitation filter that matches its fluorescent dye into the A11213-01 C-mount interchangeable filter block. If the light from the fiber bundle is not diffused enough, you can illuminate the sample evenly by inserting a holographic or other type of diffuser.

The dichroic mirror reflects the excitation light. Then, the objective lens of the dark box focuses the light onto the sample, which is excited by the light. The fluorescence emitted from the sample passes through the dichroic mirror and the fluorescence filter and is focused onto the imaging camera by the lens inside the A10859-01 tube lens block.

**Transmitted Illumination Method**

This is an imaging example that uses transmitted illumination. The image of the sample is focused onto an imaging camera, such as a CCD camera, by an infinity-corrected objective lens and the A10859-01 tube lens block. A convenient way to illuminate the sample is to use a commercially available LED illuminator.
● Emission detection
Collimated light such as chemiluminescence and bioluminescence captured by an infinity-corrected lens is reduced to 1/2.5 by using the A10031 beam expander and is guided to the PMT module with an effective diameter of 8 mm. A filter block is added when detecting light at a specific wavelength.

● Example of connection to a mini-spectrometer
The laser beam emitted from the optical fiber is collimated by the infinity-corrected objective lens inside the A10760 beam aligner block. The dichroic mirror inside the A11214 C-mount interchangeable dichroic block reflects the collimated laser, which then passes through the objective lens in the dark box and illuminates the sample. The fluorescence from the excited sample is converged by the objective lens and then passes through the dichroic mirror inside the A11214. The fluorescence is then converged further by the A10031 beam expander block. The lens inside the fiber adapter block converges the light into the optical fiber and guides it to the mini-spectrometer, where it is measured. If you want to remove the excitation light, place the A10033 filter block between the beam expander block and the A10037 series fiber adapter block. The fiber adapter block does not have focusing capabilities, so we recommend that you connect the fiber adapter block and the mini-spectrometer with an optical fiber whose core diameter is at least 600 µm.

* There is a separate catalog for mini-spectrometers. Please refer to that catalog for more information.
Simultaneous measurement with a PMT module and an imaging camera

The following is an example of simultaneous measurement in which the two objective lens adapters are attached to the dark box. The lower (inverted) part excites the sample using laser light and measures the fluorescence of the sample using the PMT module. The upper (upright) part illuminates the observation area using a xenon arc lamp and uses an imaging camera to observe the observation area and the fluorescence signal.

A plano-convex lens and a fluorescence filter are installed in front of the PMT module to isolate the fluorescence. The plano-convex lens converges the beam of light. If this causes a problem in the fluorescence filter's wavelength shift, place the filter in front of the plano-convex lens.

So that there is no interference with the PMT module's measurement, use a wavelength for the imaging camera's illumination that is different from both the excitation wavelength and the fluorescence wavelength. For example, if you use a 488 nm laser, use a DM505 dichroic mirror for the PMT module and a 530 nm / 40 nm bandpass filter for the emission filter. On the imaging camera side, use a 600 nm longpass filter for illumination and put a laser-blocking filter in front of the camera.

*Example: Edmund optics
  • C-thread light guide mounting adapter
  • Fiber optic light guide adapter
  • C-Mounted cube beamsplitter
**CONNECTION EXAMPLES**

- **Fluorescence dye and connection examples**

  1. Fluorescence dye and connection examples

  ![Diagram 1](image1)

  ![Diagram 2](image2)

  ![Diagram 3](image3)

- **Transmittance**

  ![Graph A](image4)

  ![Graph B](image5)

  ![Graph C](image6)
Stabilized light sources for PMT L11494 series

The majority of these devices are LED light sources that have been developed for visual-sensitive compensation of PMTs and PMT modules. Because the amount of light generated by the LED is monitored and controlled by a photodiode, these devices always generate stable light of approximately 1 pW.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>L11494-430</th>
<th>L11494-470</th>
<th>L11494-525</th>
<th>L11494-660</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak wavelength of light</td>
<td>428</td>
<td>465</td>
<td>522</td>
<td>660</td>
<td>nm</td>
</tr>
<tr>
<td>FWHM</td>
<td>65</td>
<td>26</td>
<td>35</td>
<td>30</td>
<td>nm</td>
</tr>
</tbody>
</table>

**Spectral distribution of generated light (Typical)**

- **L11494-430**
- **L11494-470**
- **L11494-525**
- **L11494-660**

**Life characteristic**

**Temperature characteristic**

**Connection example**

* There is a separate catalog for stabilized light sources. Please refer to that catalog for more information.