

PRELIMINARY

HIGH-SPEED GATED IMAGE INTENSIFIER UNITS

C9016-2x, C9546, C9547 SERIES



▲Left: C9016-2x series + Controller, Center: C9546 series, Right: C9547 series

OVERVIEW

Image intensifiers (I. I.) are devices capable of intensifying an image at high gain and high-speed gating (electronic shutter operation). This allows them to capture "instantaneous images" of ultra-fast phenomena that occur in extremely short periods of time. Hamamatsu C9016-2x, C9546 and C9547 series image intensifier units consist of a compact head that integrates an image intensifier with a high-speed gate operation circuit and a remote controller.

Built-in image intensifiers are available with two standard photocathodes which are GaAsP photocathode and multialkali photocathode. The GaAsP photocathode is ideal for low-light-level imaging in the visible region such as for fluorescence observations. The multialkali photocathode on the other hand offers high sensitivity over a wider spectral response range from the UV through near IR region so observations can be made at various wavelengths.

A high-speed shutter camera can easily be configured by simply connecting the image intensifier head to the front of a CCD camera. Various types of CCD cameras can be optically connected through a relay lens or by fiber coupling for highly efficient light transmission from the image intensifier. CCD cameras with fiber optic window are available as options. Image intensifier gain can be adjusted from the remote controller or a PC (personal computer) through USB interface (Ver. 1.1 compatible with Windows 2000 / XP). Built-in over-light protection circuit allows using these image intensifier units without having to worry much about the input light level.

FEATURES

- **High Speed Gating**
C9016-2x Series: 20 ns ~
C9546 series: 3 ns ~
C9547-01/-02: 5 ns ~
C9547-03/-04: 10 ns ~
- **Gate Operation in Accordance with Input Gate Pulse Width and Its Repetition Rate**
- **Superior Shutter Ratio Even in UV region**
MCP gating: C9546, C9547 series
- **High Performance Image Intensifier**
High quantum efficiency: GaAsP model
Wide spectral response: Multialkali model
High resolution and High gain
- **Built-in Protective Circuit Prevents Damage from Excessive Light**

APPLICATIONS

- **Analysis of High-speed Phenomenon**
Engine combustion state
Plasma emission / Discharge / PIV / Flow / Spray and so on.
- **Imaging of Low-light-level Emission and Fluorescence**
Time resolved fluorescence imaging for dyed cell/tissue

HAMAMATSU

SPECIFICATIONS

| Parameter | | Type No. | C9016-21 C9546-01 C9547-01 | C9016-22 C9546-02 C9547-02 | C9016-23 C9546-03 C9547-03 | C9016-24 C9546-04 C9547-04 | Unit |
|---|--|-------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|---|
| Photocathode Sensitivity | Luminous Sensitivity (Typ.) | | 700 | | 230 | 150 | μA/lm |
| | Radiant Sensitivity [Ⓐ] (Typ.) | C9016-2x C9546 | 214 | | 53 | 47 | mA/W |
| | | C9547 | 192 | | | | |
| | Quantum Efficiency [Ⓐ] (Typ.) | C9016-2x C9546 | 50 | | 15 | 14 | % |
| C9547 | | 45 | | | | | |
| Photocathode | Effective Diameter | C9016-2x C9546 | 17 [Ⓑ] | | 17.5 [Ⓑ] | | mm |
| | | C9547 | 25 [Ⓒ] | | 25 [Ⓒ] | | |
| | | Window Material | Borosilicate glass | | Synthetic silica | | |
| | Photocathode Material | GaAsP | | Multialkali | | — | |
| | Spectral Response | 280 to 720 | | 185 to 900 | | nm | |
| Peak Wavelength | 530 | | 430 | | | | |
| Phosphor Screen | Window Material | FOP | | | | | — |
| | Phosphor Material [Ⓓ] | P43 | | | | | — |
| | Decay Time | See Figure 8 | | | | | — |
| Gain | Luminous Gain (Typ.) | C9016-2x | 2.2 × 10 ⁴ | 5.0 × 10 ⁶ | 1.1 × 10 ⁴ | 4.0 × 10 ⁶ | (lm/m ²)/lx |
| | | C9546 | 2.0 × 10 ⁴ | 3.0 × 10 ⁶ | 1.0 × 10 ⁴ | 2.4 × 10 ⁶ | |
| | | C9547 | | | | | |
| | Radiant Emittance Gain [Ⓐ] (Typ.) | C9016-2x | 1.4 × 10 ⁴ | 3.4 × 10 ⁶ | 6.8 × 10 ³ | 3.0 × 10 ⁶ | (W/m ²)/(W/m ²) |
| C9546 | | 1.3 × 10 ⁴ | 2.0 × 10 ⁶ | 6.2 × 10 ³ | 1.8 × 10 ⁶ | | |
| C9547 | | 1.2 × 10 ⁴ | 1.9 × 10 ⁶ | | | | |
| Equivalent Background Input (EBI) | Luminous (Typ.) | 3 × 10 ⁻¹² | | 1 × 10 ⁻¹¹ | | lm/cm ² | |
| | Radiant [Ⓐ] (Typ.) | 8 × 10 ⁻¹⁵ | | 3 × 10 ⁻¹⁴ | | W/cm ² | |
| Limiting Resolution (Typ.) | | 50 | 36 | 57 | 32 | Lp/mm | |
| Image Magnification | | 1 | | | | | — |
| Maximum Input | Luminous (Typ.) | 1.5 × 10 ⁻³ | 7.0 × 10 ⁻⁶ | 5.0 × 10 ⁻³ | 1.6 × 10 ⁻⁵ | lx | |
| Light Level [Ⓔ] | Radiant [Ⓐ] (Typ.) | 4.0 × 10 ⁻¹⁰ | 1.6 × 10 ⁻¹² | 8.0 × 10 ⁻¹⁰ | 2.4 × 10 ⁻¹² | W/cm ² | |
| Average of Max. Phosphor Screen Brightness | | 10 | | | | | cd/m ² |
| Power Requirement | | 100 to 240 | | | | | V |
| Power Consumption (Max.) | C9016-2x | 4.8 | | | | | W |
| | | C9546 | 6 | 8.4 | 6 | 8.4 | |
| | | C9547 | 7.2 | 10.8 | 7.2 | 10.8 | |
| Operating Ambient Temperature | | 0 to +40 | | | | | °C |
| Storage Temperature | | -20 to +50 | | | | | |
| Operating and Storage Humidity [Ⓔ] | | Below 70 | | | | | |

NOTE: ⒶAt wavelength of peak sensitivity

Ⓑ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.

Ⓒ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.

ⒹP-24 and P-46 phosphor screens are also available. ⒺDuring normal (continuous) mode at maximum gain ⒻNo condensation

Protective Functions

| Parameter | | C9016-2x | C9546 · C9547 |
|--|----------|--|---------------|
| Repetition Rate | Max. | 2 kHz | 30 kHz |
| | Display | Red LED is lit continuously * | |
| Shuts off operation during excessive light | | | |
| Excessive Light Protection | Warning | Red LED flashes * (on rear of head and remote controller operation panel) | |
| | Shut off | Red LED is lit continuously * (on rear of head and remote controller operation panel) | |
| Protection Circuit Reset | | Reset switch on the remote controller or sending command via USB interface | |

NOTE: * C9546 and C9547 series

The LED on near of head can be turned out by control software.

Controllable Functions

| Parameter | Remote Controller | | PC (software) | |
|------------------------------------|-------------------|-----------------------------|---------------|-----------------------------|
| | C9016-2x | C9546 [Ⓒ] C9547 | C9016-2x | C9546 [Ⓒ] C9547 |
| Gain Setting | Yes | Yes | Yes | Yes |
| Operation Mode Switching | Yes | Yes | Yes | Yes |
| Excessive Light Protection Display | Yes | Yes | Yes | Yes |
| Excessive Light Protection Reset | Yes | Yes | Yes | Yes |
| Excessive Gate Input Monitor | Yes | Yes | Yes | Yes |
| Integrated screen Current Monitor | No | No | No | Yes |

NOTE: ⒸThe control mode automatically switches to PC by connecting USB cable even if the remote controller is connected.

GATE SPECIFICATIONS

| Parameter | | C9016-2x | C9546 Series | C9547-01, -02 | C9547-03, -04 |
|-------------------|--------------------------------------|--|--|---------------|---------------|
| Operation Mode | Normal Mode | Continuous Mode | | | |
| | Gate Mode | Normally OFF, Turns ON when the gate signal is input | | | |
| Gate Signal Input | Level | C-MOS Positive logic | TTL Positive logic | | |
| | Input Impedance | 50 Ω | | | |
| | Pulse Width ^(A) | 20 ns to DC | 5 ns to DC | 8 ns to DC | 15 ns to DC |
| | Repetition Rate ^(B) (Max) | 2 kHz | 30 kHz | | |
| | when MCP is gated | — | 10 kHz | | |
| | Gate off Time | — | 20 μs Min. | | |
| Gate Output | Gate Time ^(A) | 20 ns to DC | 3 ns to DC | 5 ns to DC | 10 ns to DC |
| | Gate Rise Time (Typ.) | 15 ns | 2 ns | 3 ns | 8 ns |
| | Gate Fall Time (Typ.) | 15 ns | 3 ns | 4 ns | 10 ns |
| | Delay Time | 46 ns ± 2 ns | 36 ns ± 2 ns | | |
| | when MCP is gated | — | 86 ns ± 2 ns | | |
| Jitter (Max.) | 0.5 ns | | | | |
| Gate Time Monitor | Output Level | — | 2 V Positive logic (at 50 Ω termination) | | |
| | Pulse Width | — | Gate time (FWHM) | | |
| | Output Impedance | — | 50 Ω | | |

NOTE: (A) Please refer to Figure 1 and Figure 3.
 (B) Built-in protection circuit

Figure 1: C9016-2x Series
Gate Time Input / Output Characteristics

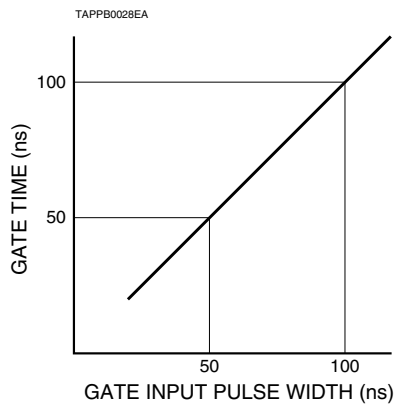


Figure 2: C9016-2x Series
Time Sequence

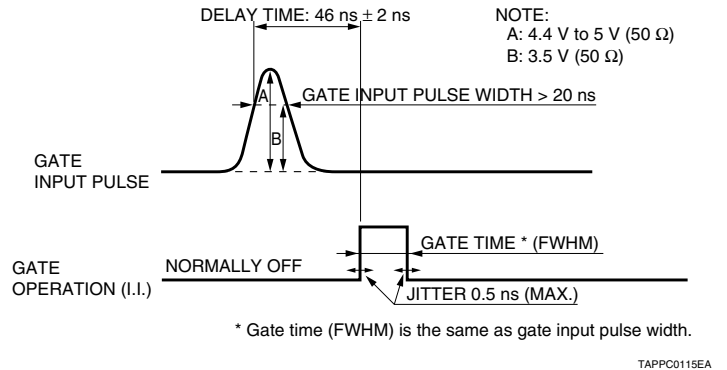


Figure 3: C9546 · C9547 Series
Gate Time Input / Output Characteristics

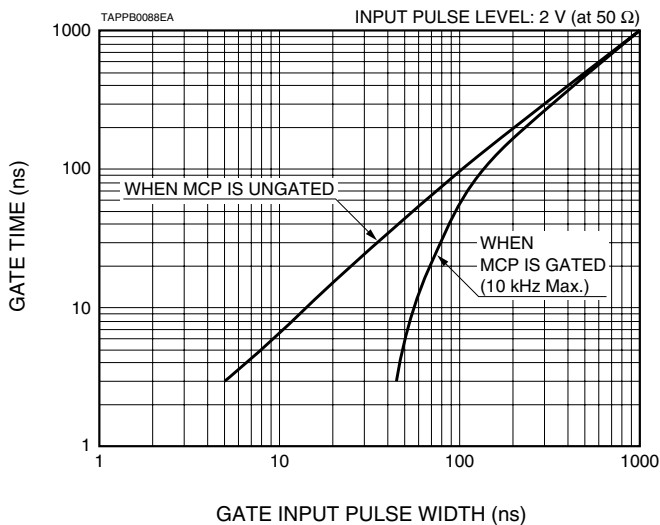
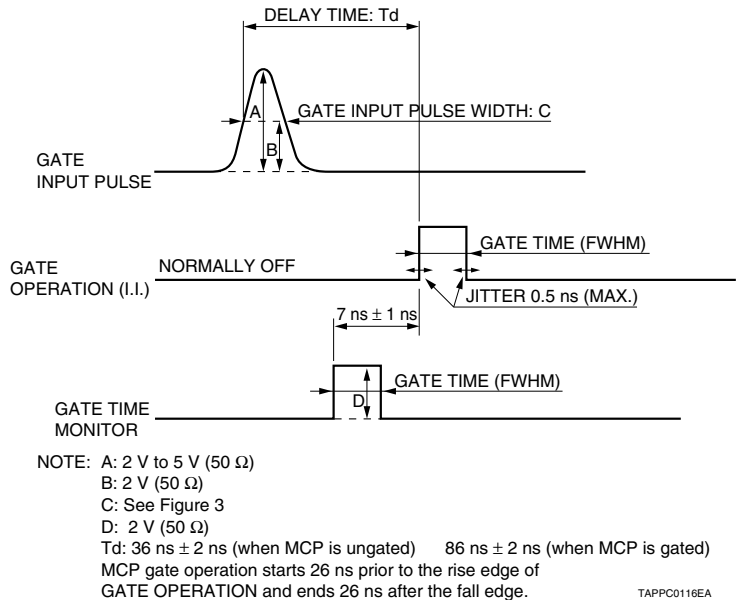


Figure 4: C9546 · C9547 Series
Time Sequence



CHARACTERISTICS

Figure 5: Typical Spectral Response

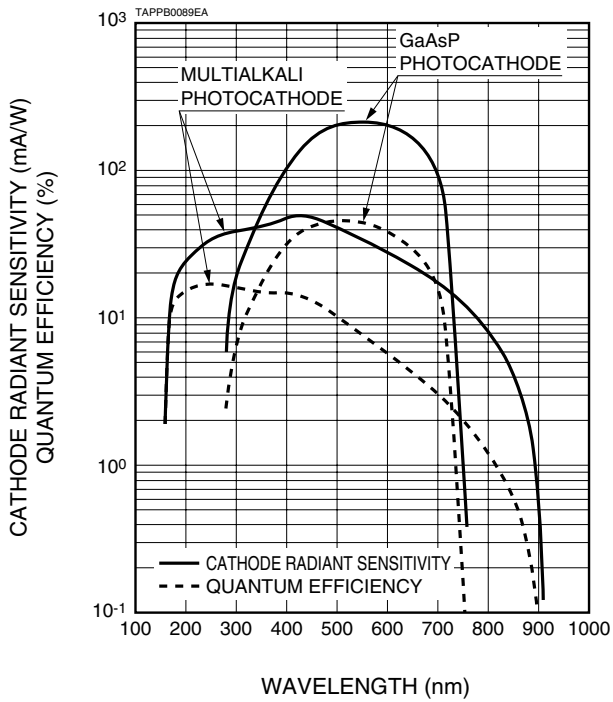


Figure 6: Typical Luminous Gain

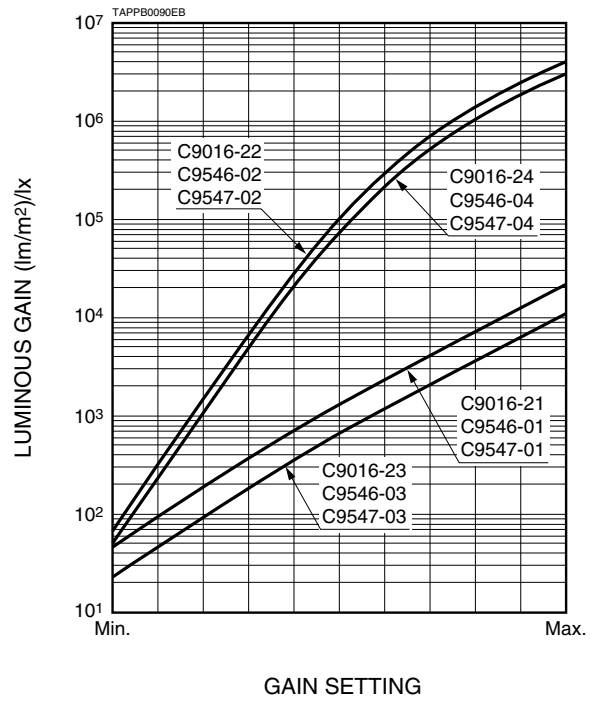


Figure 7: Typical Phosphor Screen Spectral Emission

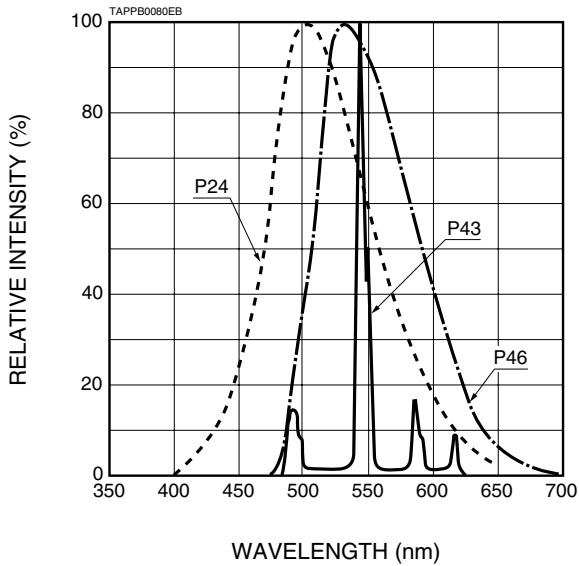
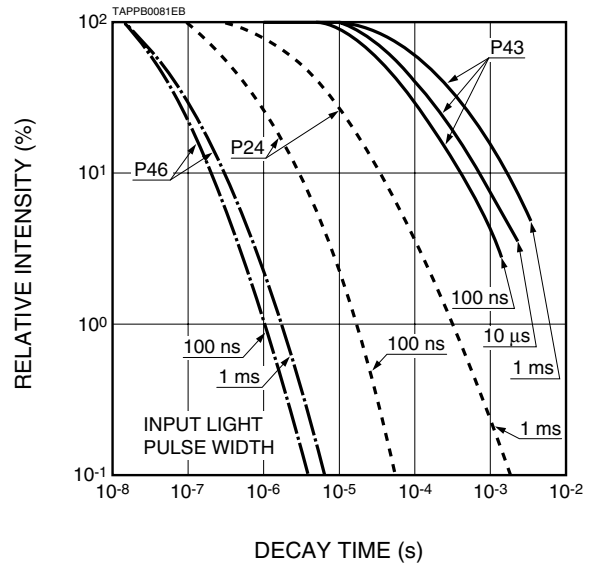


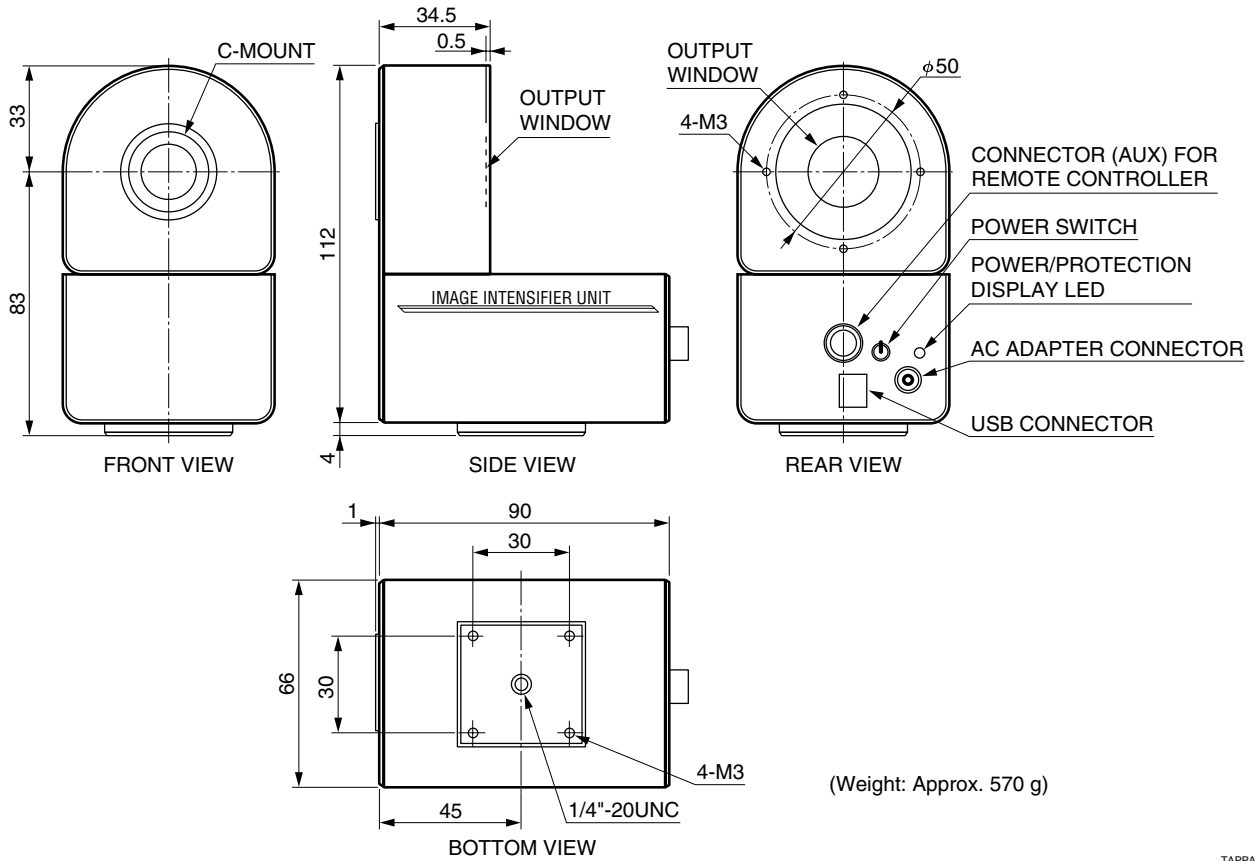
Figure 8: Typical Phosphor Screen Decay Characteristics



DIMENSIONAL OUTLINES (Unit: mm)

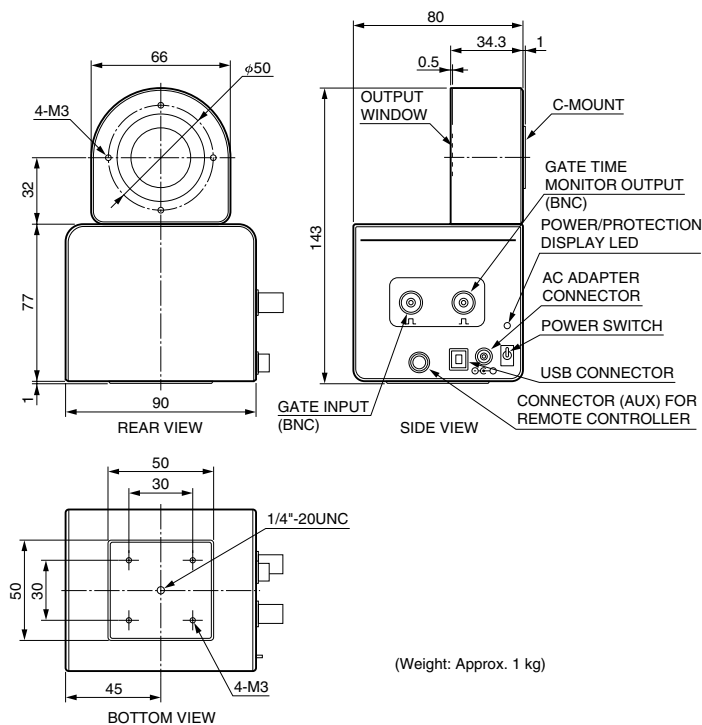
● Head

C9016-2x series



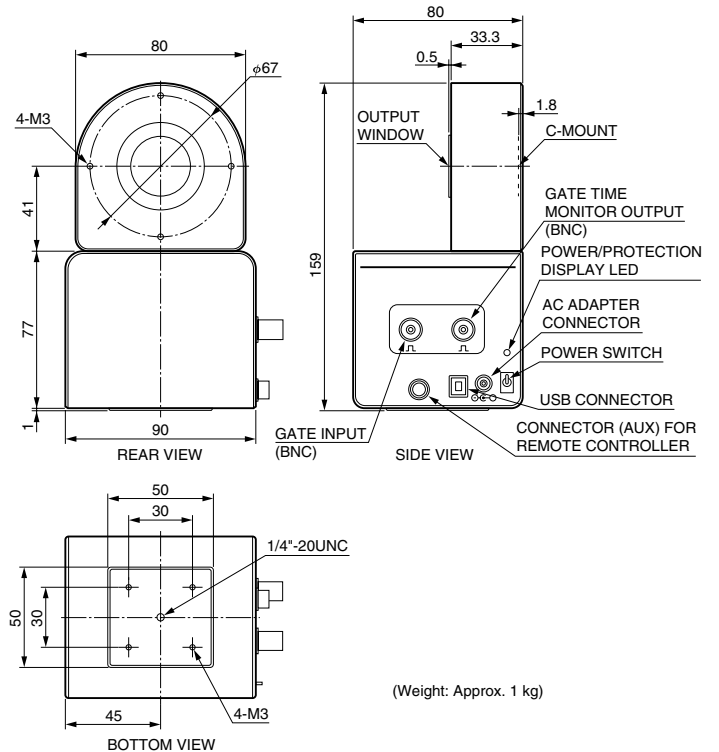
TAPPA0061EC

C9546 series



TAPPA0071EA

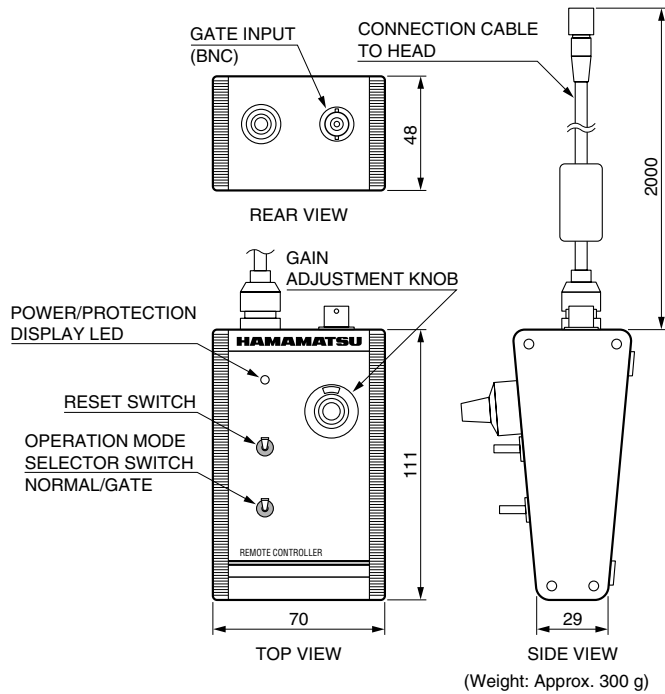
C9547 series



TAPPA0072EA

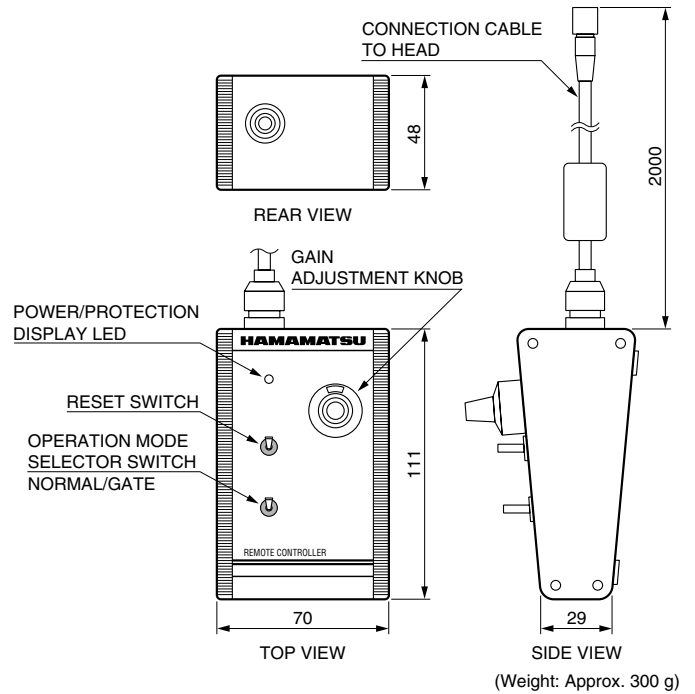
●Remote Controller

C9016-2x series



TAPPA0062EC

C9546, C9547 series



TAPPA0073EA

ACCESSORIES (SOLD SEPARATELY)

●C9018, C9018-01 CCD cameras with fiber optic window

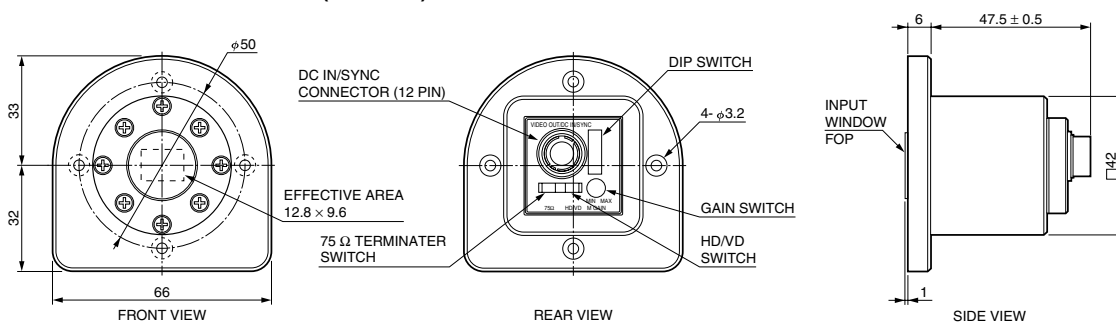
The C9018 series CCD cameras have a restart/reset function and are designed to read out images from C9016 and C9546 series image intensifier units. Fiber coupling allows more highly efficient image readout than lens coupling. The C9018 series cannot be used with C9547 series image intensifier units.

SPECIFICATIONS

| Parameter | C9018 | C9018-01 | Unit |
|---------------------------------|---|-----------|----------|
| Signal Systems | EIA | CCIR | — |
| Charge Accumulation | Frame storage / Field storage, switchable | | — |
| Effective Image Area (H × V) | 12.8 × 9.6 | | mm |
| Number of Pixels (H × V) | 768 × 494 | 752 × 582 | — |
| Resolution (Horizontal) | 570 | 560 | TV lines |
| Power Requirement | +9.0 to +16.0 | | V |
| Power Consumption | 1.6 | | W |
| Operating Ambient Temperature | 0 to +40 | | °C |
| Storage Temperature | -20 to +50 | | °C |
| Operating and Storage Humidity* | Below 70 | | % |
| Weight | 170 | | g |

NOTE: * No condensation

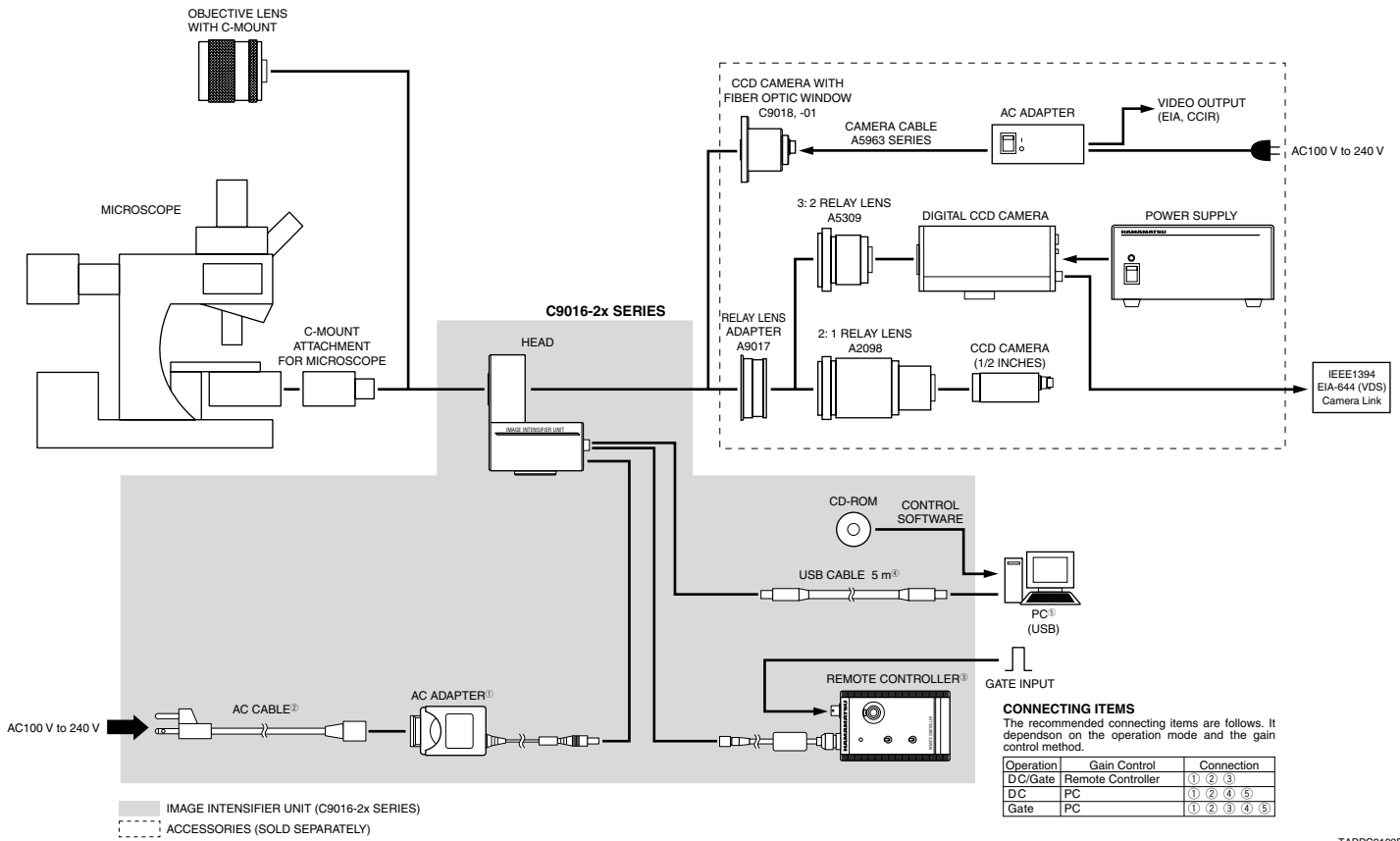
DIMENSIONAL OUTLINE (Unit: mm)



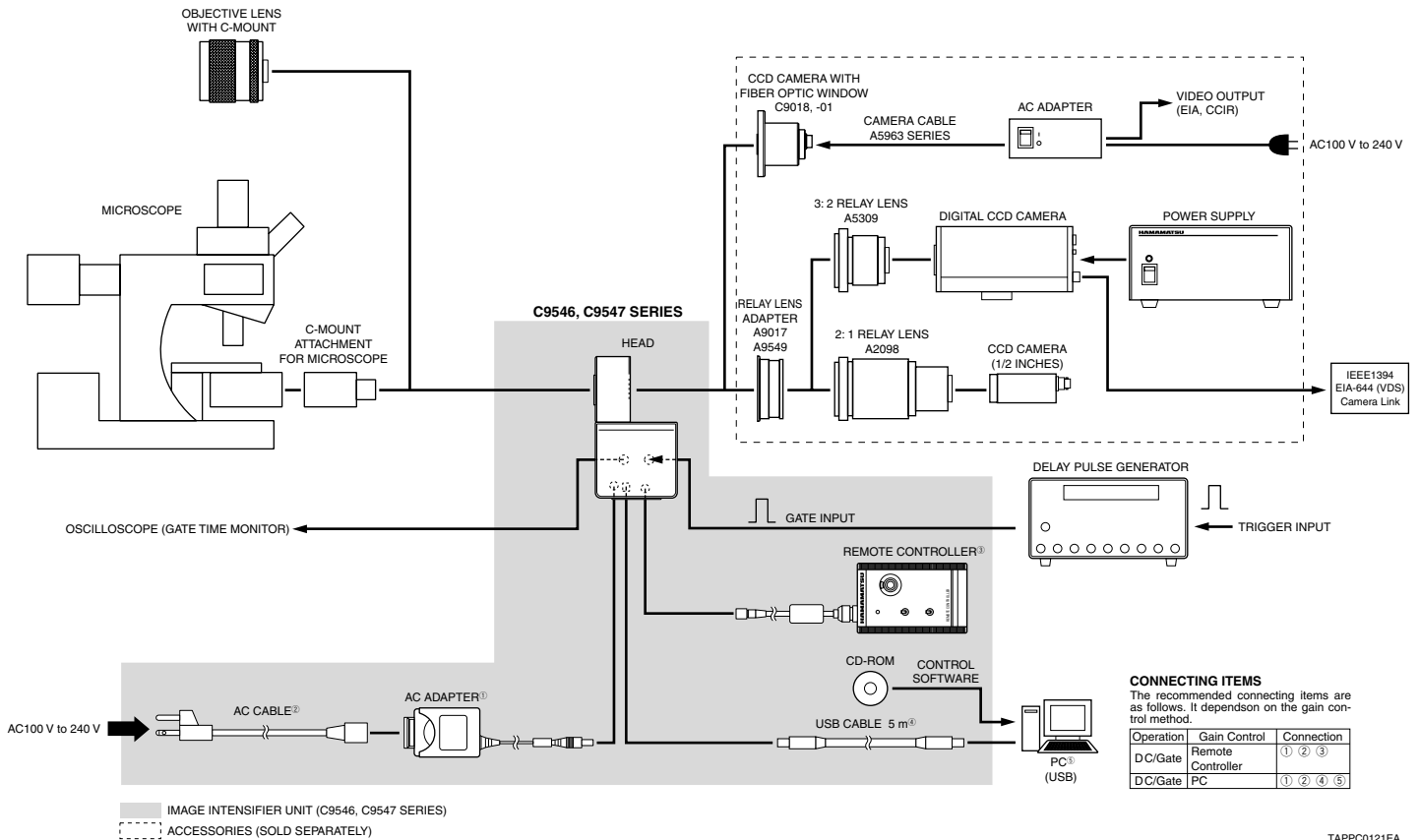
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SETUP EXAMPLE WITH OPTICAL ACCESSORIES

● C9016-2x Series



●C9546, C9547 Series



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