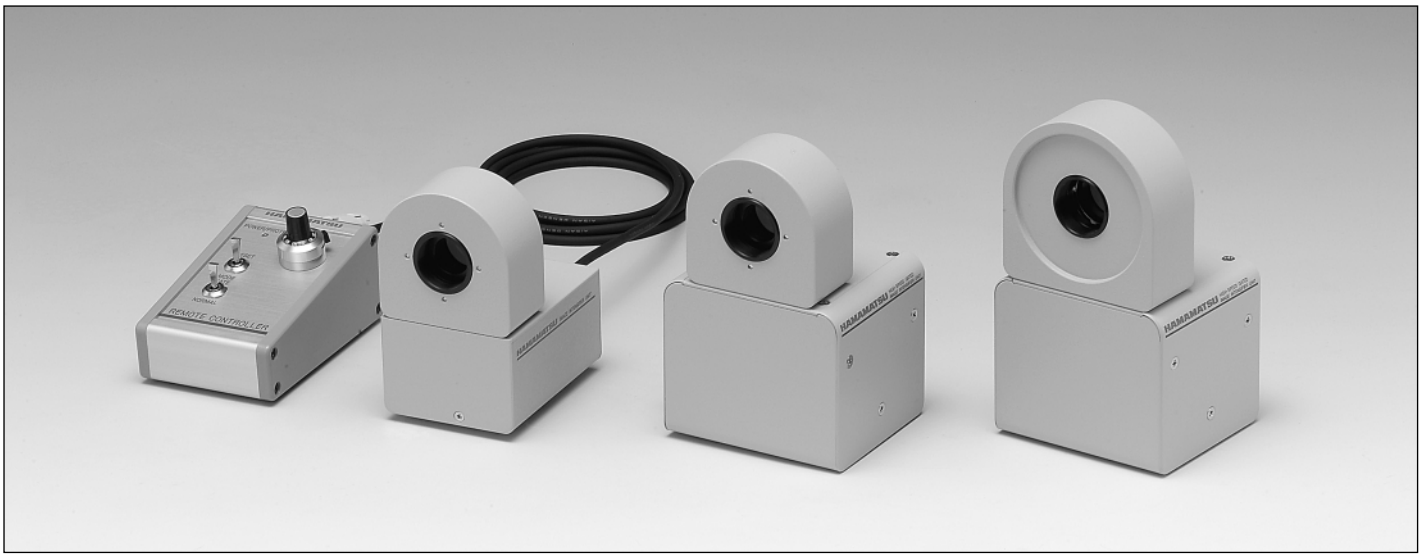
PRELIMINARY

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 ultrafast 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 C9547	2.0×10^4	3.0×10^6	1.0×10^4	2.4×10^6	
	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 Light Level Ⓔ	Luminous (Typ.)		1.5×10^{-3}	7.0×10^{-6}	5.0×10^{-3}	1.6×10^{-5}	lx
	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 *	
Excessive Light Protection		Shuts off operation during excessive light	
	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 Ⓐ	20 ns to DC	5 ns to DC	8 ns to DC	15 ns to DC
	Repetition Rate Ⓑ (Max)	2 kHz	30 kHz		
	when MCP is gated	—	10 kHz		
	Gate off Time	—	20 µs Min.		
Gate Output	Gate Time Ⓐ	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: ⒶPlease refer to Figure 1 and Figure 3.
ⒷBuilt-in protection circuit

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

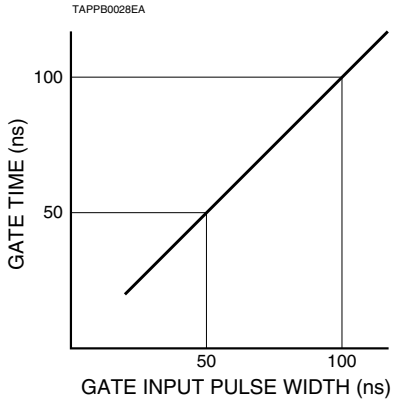
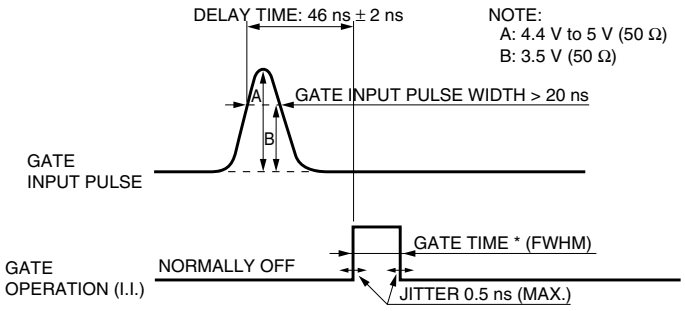


Figure 2: C9016-2x Series
Time Sequence



* Gate time (FWHM) is the same as gate input pulse width.

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

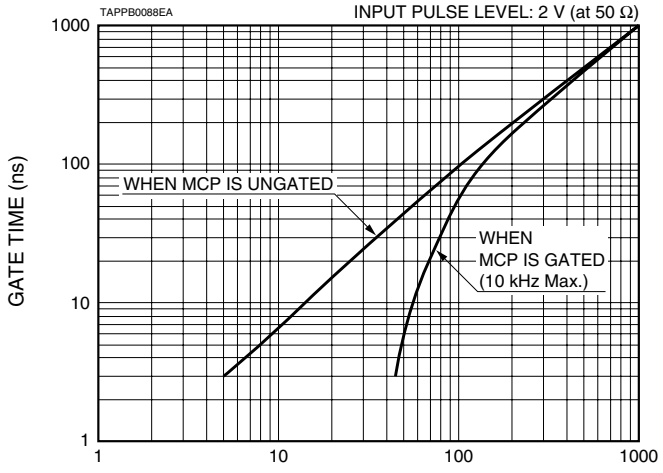
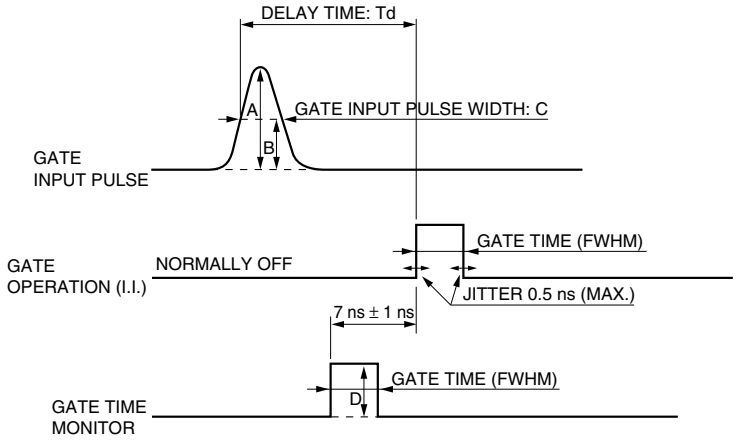


Figure 4: C9546 · C9547 Series
Time Sequence



NOTE: A: 2 V to 5 V (50 Ω)
B: 2 V (50 Ω)
C: See Figure 3
D: 2 V (50 Ω)
Td: 36 ns ± 2 ns (when MCP is ungated) 86 ns ± 2 ns (when MCP is gated)
MCP gate operation starts 26 ns prior to the rise edge of
GATE OPERATION and ends 26 ns after the fall edge.

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CHARACTERISTICS

Figure 5: Typical Spectral Response

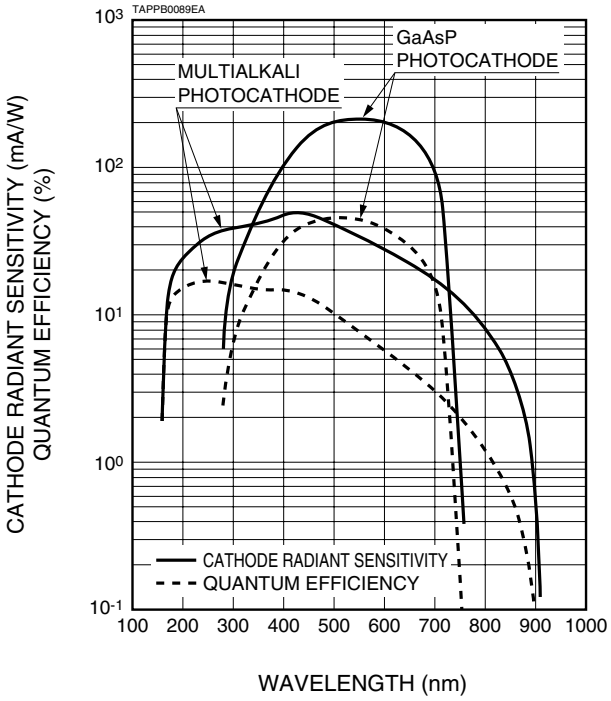


Figure 6: Typical Luminous Gain

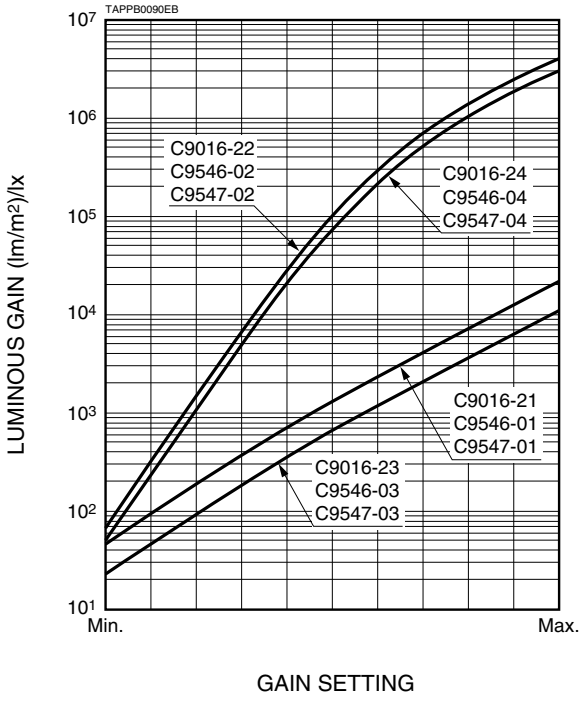


Figure 7: Typical Phosphor Screen Spectral Emission

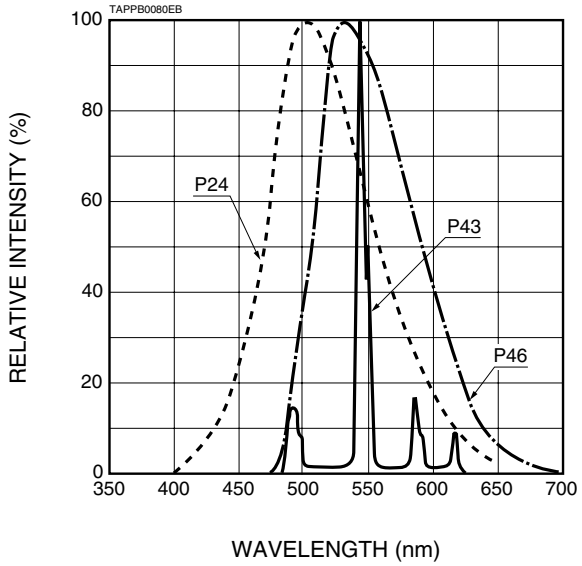
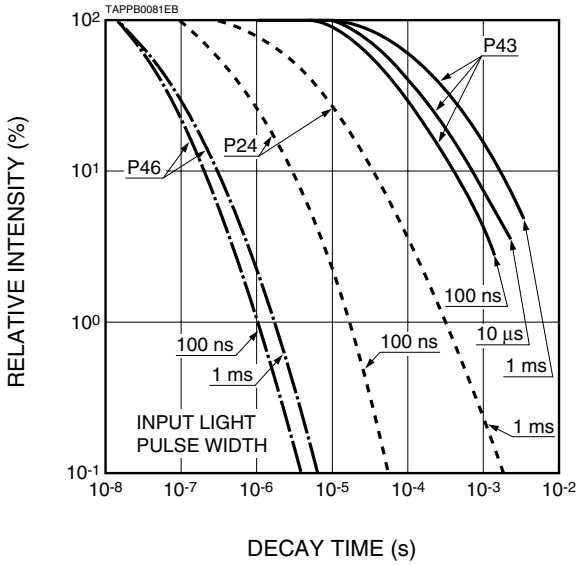


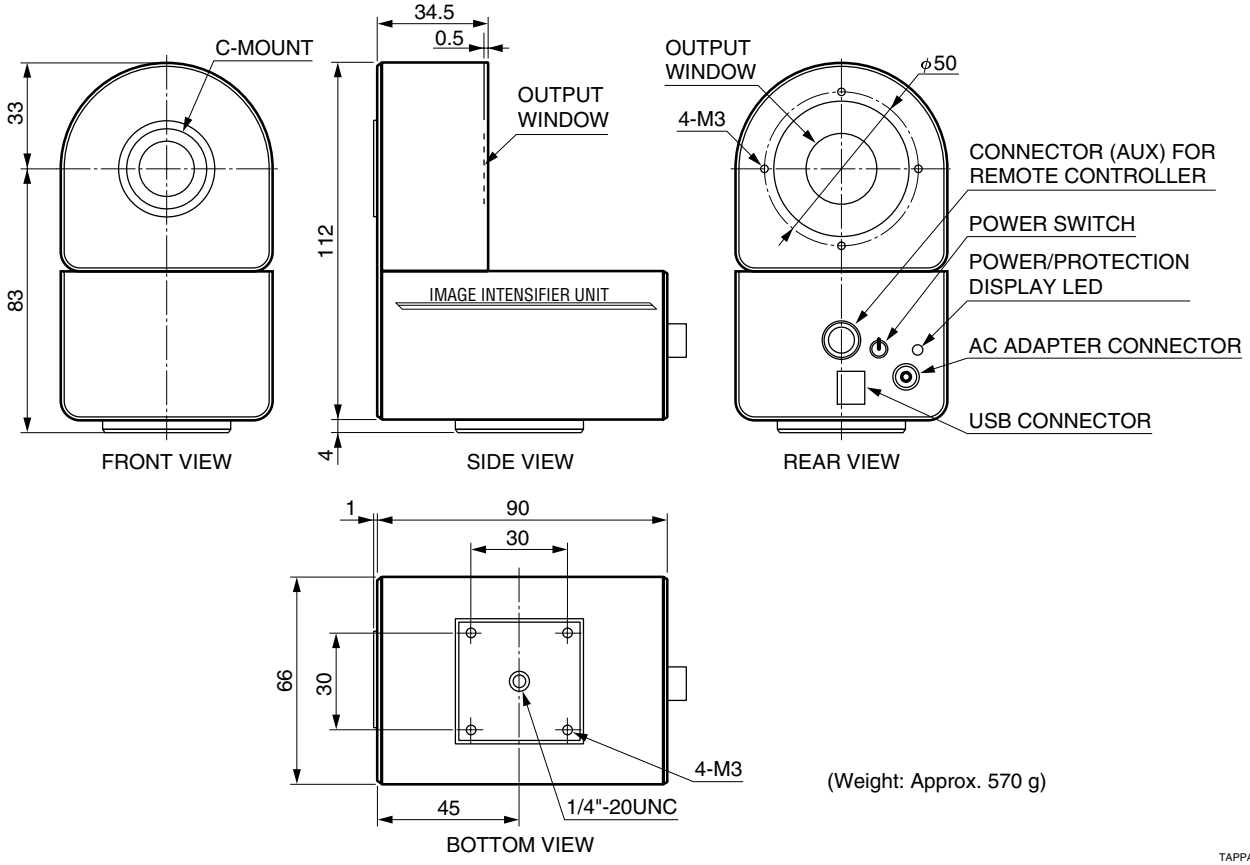
Figure 8: Typical Phosphor Screen Decay Characteristics



DIMENSIONAL OUTLINES (Unit: mm)

●Head

C9016-2x series



(Weight: Approx. 570 g)

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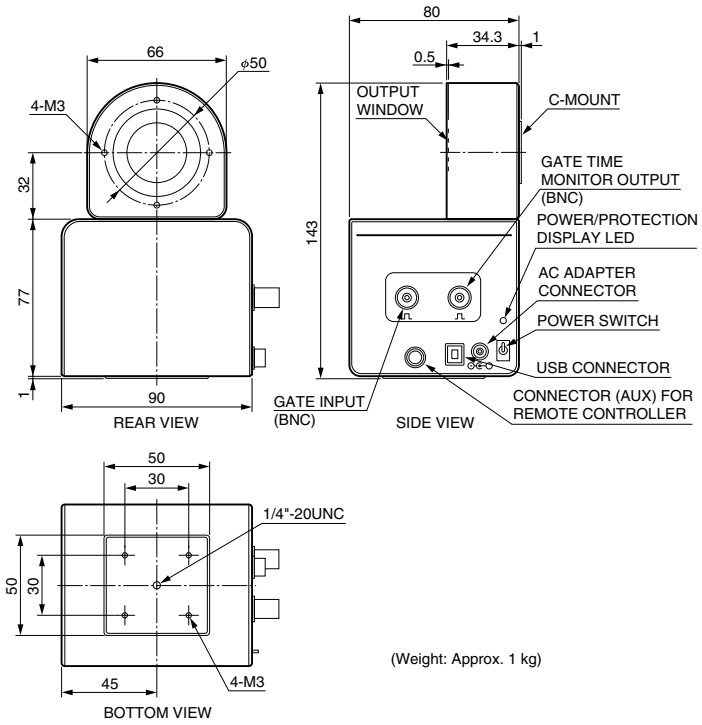
C9546 series



(Weight: Approx. 1 kg)

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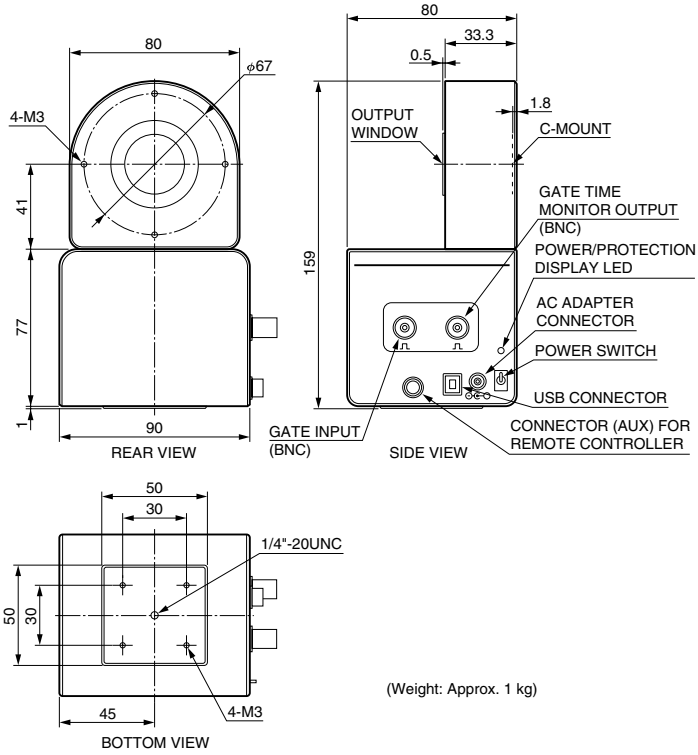
C9547 series



(Weight: Approx. 1 kg)

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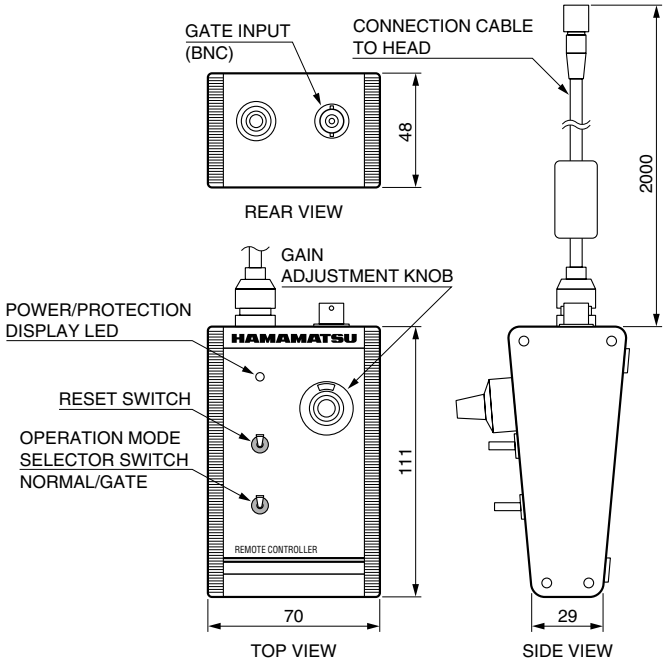
●Remote Controller

C9016-2x series



(Weight: Approx. 300 g)

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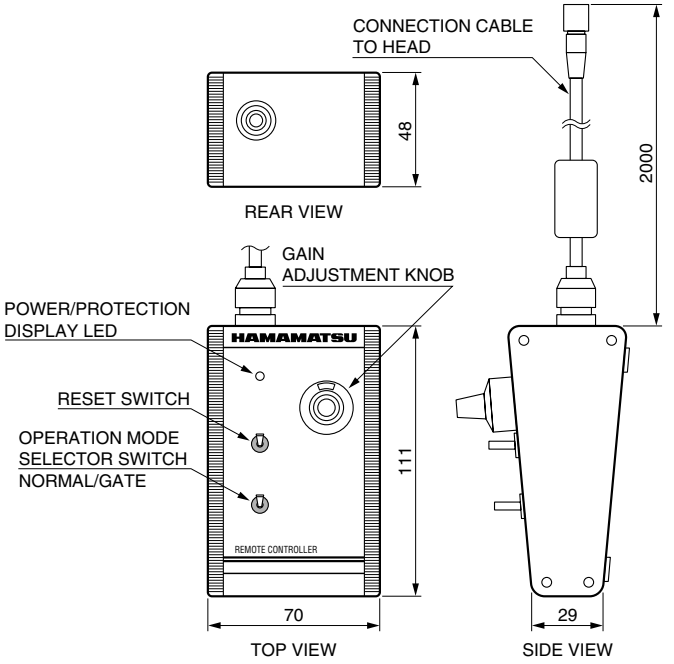
C9546, C9547 series



(Weight: Approx. 300 g)

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ACCESSORIES (SOLD SEPARATELY)

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

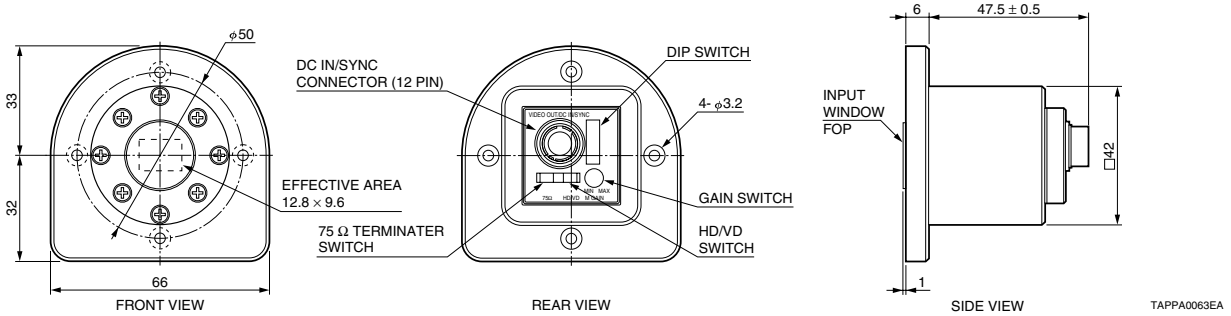
The C9018 series CCD cameras have a restart/reset function and are designed to read out images from C9016 and C9546 series image intensifier units. Fiber coupling allows more highly efficient image readout than lens coupling. The C9018 series cannot be used with C9547 series image intensifier units.

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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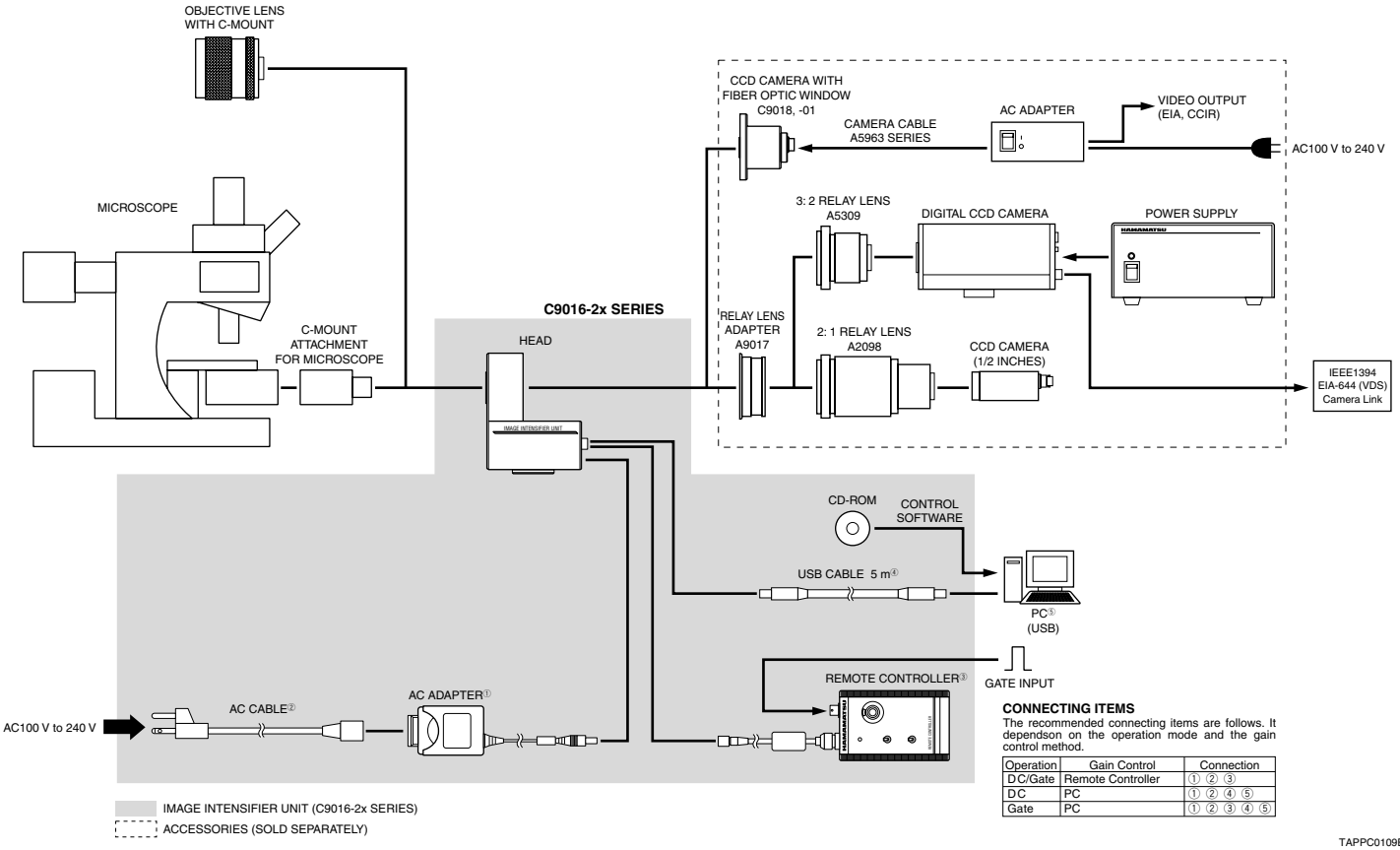
SETUP EXAMPLE WITH OPTICAL ACCESSORIES

●C9016-2x Series



CONNECTING ITEMS

The recommended connecting items are follows. It dependson on the operation mode and the gain control method.

Operation	Gain Control	Connection
DC/Gate	Remote Controller	① ② ③
DC	PC	① ② ④ ⑤
Gate	PC	① ② ③ ④ ⑤

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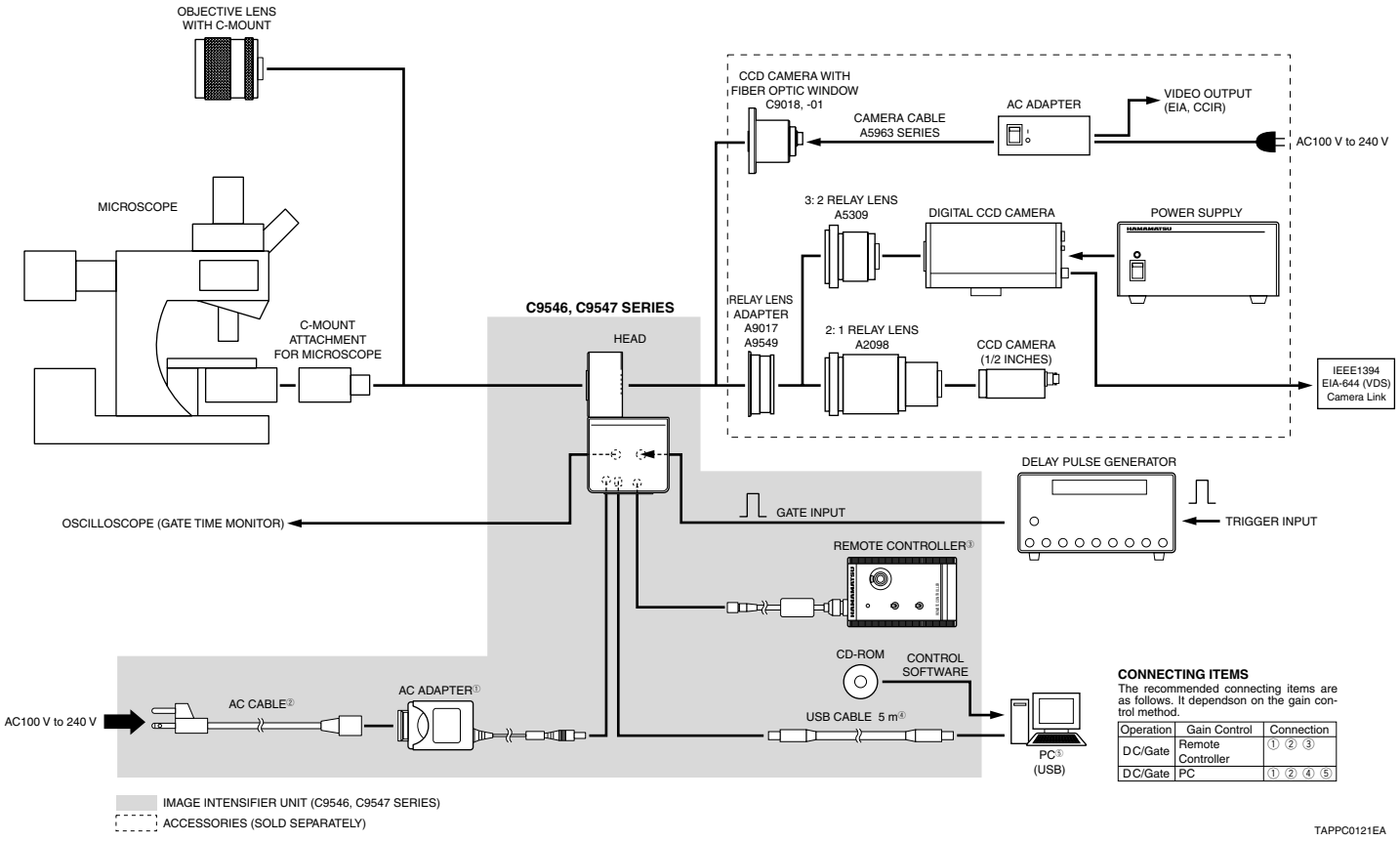
●C9546, C9547 Series



CONNECTING ITEMS

The recommended connecting items are as follows. It dependson on the gain control method.

Operation	Gain Control	Connection
DC/Gate	Remote Controller	① ② ③
DC/Gate	PC	① ② ④ ⑤

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