HAMAMATSU

PHOTON IS OUR BUSINESS

HIGH-SPEED GATED IMAGE INTENSIFIER UNIT

HIGH-SPEED GATED IMAGE INTENSIFIER UNIT

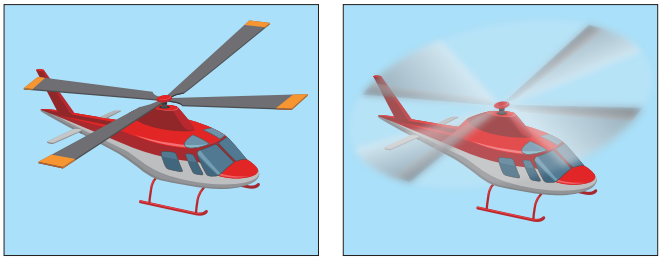
The image intensifier unit is an image intensifying unit with a gate operation that can capture images of high-speed phenomena, by connecting the unit with a camera. The gate operation refers to a function that is equivalent to the shutter operation with conventional cameras, except that operation is performed electrically, thereby achieving a gating time measured in units of nanoseconds.
The unit is also capable of intensifying incident light by several thousand to several million times, facilitating observations of faint luminous phenomena.
The wide range of photocathodes available support a broad range of imaging requirements, from ultraviolet to near infrared wavelength regions.

Upgrading a camera system on hand to a high sensitivity and high-speed shutter camera

Captures "instantaneous image" of high-speed phenomena

High-speed gated image intensifier units (hereafter gated I.I. units) are able to capture an "instantaneous image" of high-speed phenomena occurring within extremely short time durations by means of "gate operation (shutter operation)". Gate operation is basically the same function as a camera shutter, but gated I.I. units perform this operation electronically in a minimum gate time of 1/300 000 000th of a second.
Another feature is that background light and excitation light outside the measurement time can be eliminated by synchronizing the gate operation with a laser pulse or other signal.

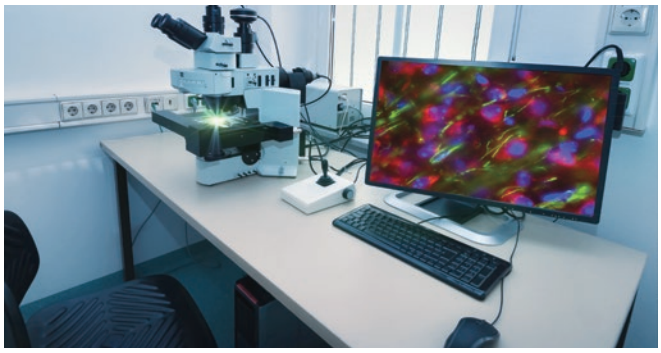
Example of gate operation



With gate operation　　No gate operation

Observes faint low level light

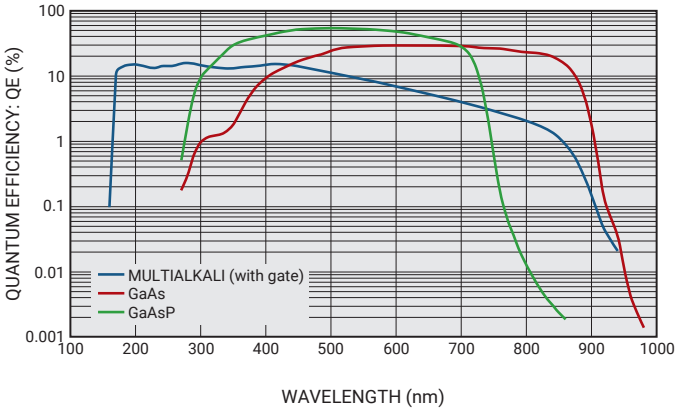
Gated I.I. units have an internal image enhancement function that allows visualizing low-level light images invisible to the human eye.
As the gate time becomes faster, less light is available so this image enhancement function is essential for gate operation.
Image enhancement is achieved by the built-in MCP (microchannel plate) which is available in 1-stage and 2-stage types to meet application needs.



Views images in the UV or near infrared regions

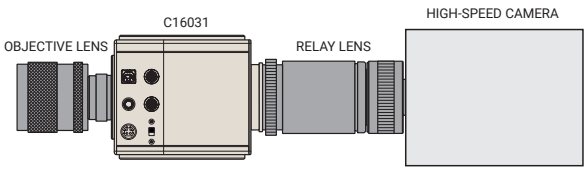
Image intensifiers used in gated I.I. units cover a wide spectral range to allow imaging at desired wavelengths over a broad range from the UV to near infrared.

Image intensifier spectral response characteristics



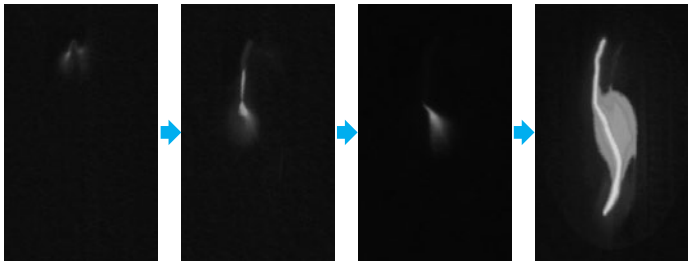
Configurations

1. Capturing images of high-speed phenomena

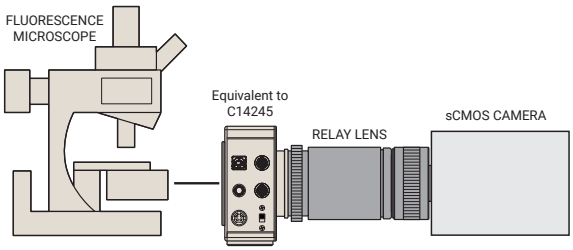


Example of captured images:
Observation of micro-discharge phenomenon (refer to page 20)

The change of an electric discharge phenomenon over time can be observed.

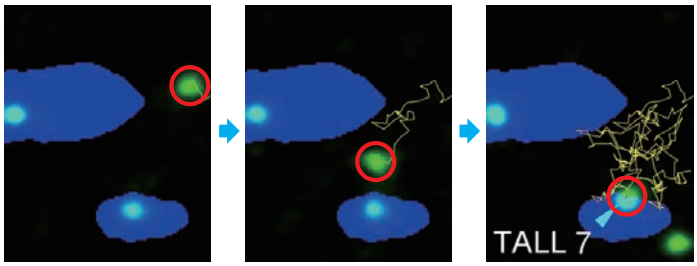


2. 1 Molecular fluorescence observation



Example of captured images:
SFMI (Single Florescent Molecule Tracking (refer to page 21)

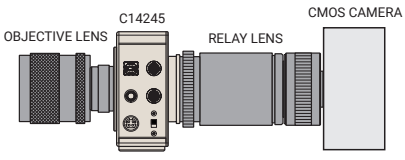
The luminescence of fluorescent labeled molecules can be captured and molecular movements can be tracked.



* TALL (Temporary Arrest of LateraL diffusion)

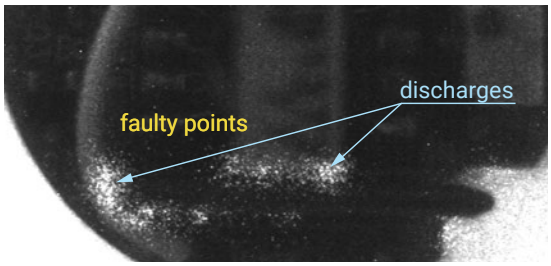
Photo courtesy of Okinawa Institute of Science and Technology Graduate University
Membrane Cooperativity Unit Dr. Akihiro Kusumi, Dr. Taka-aki Tsunoyama

3. Capturing images of invisible region



Example of captured images:
Observation of electric discharge phenomenon in invisible region (refer to page 22)

Electric discharge from printed circuit boards that are not visible to eyes can be verified.

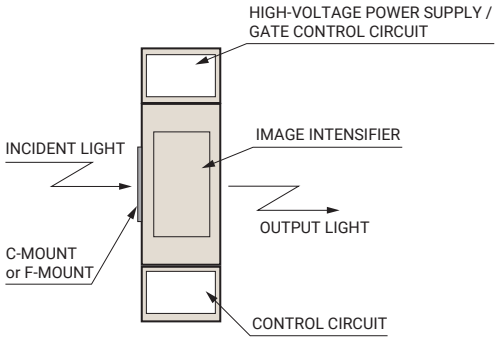


Principle

Internal structure

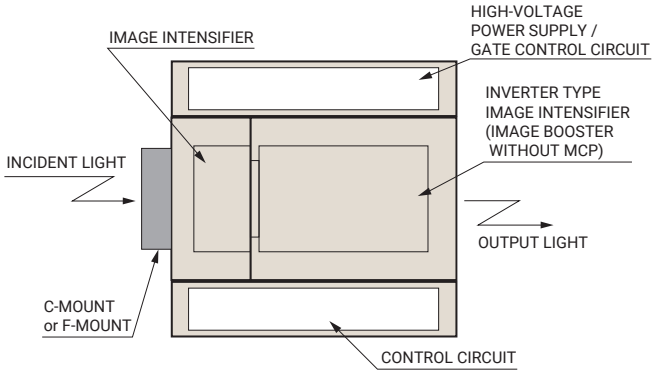
HIGH-SPEED GATED IMAGE INTENSIFIER UNIT

A proximity focused image intensifier, high-voltage power supply and gate driver circuit are integrated into a compact unit. A CMOS camera, a high-speed camera, or a similar device may be selected as the camera.



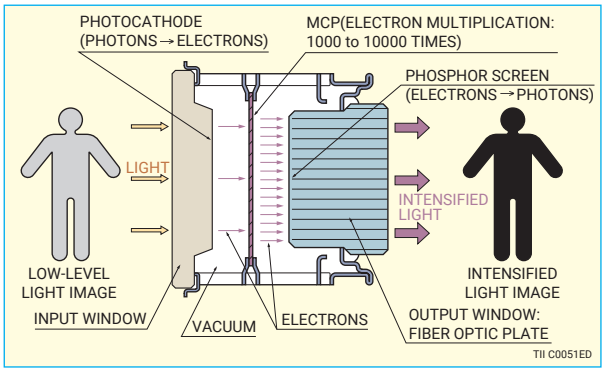
HIGH-SPEED GATED IMAGE INTENSIFIER UNIT FOR HIGH-SPEED CAMERA

This is a high-speed gated image intensifier unit consisting of an image intensifier linked with an inverter-type image intensifier, which is capable of deriving high luminance output images. The unit is recommended for use when capturing high-speed images at 300 frames per second or greater.

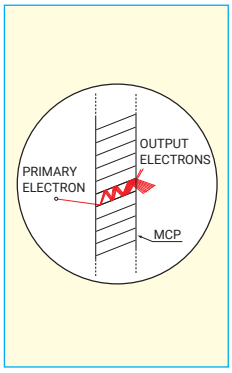


Proximity focused image intensifier

The image intensifier is an imaging device capable of intensifying faint images by several thousand to tens of thousand times.
Faint images entering the image intensifier is converted into photoelectrons on the photocathode. Photoelectrons enter the microchannel plate (MCP) and impacts the internal wall of the MCP dozens of times. Secondary electrons are discharged from wall surfaces when impacts occur. Electrons are multiplied by several times to a few thousand times with a 1-stage MCP type unit, while a dual stage MCP type unit can multiply electrons by dozens of times to a few hundred thousand times, which then strike on the phosphor screen to present an intensified image.



Proximity focused image intensifier structure



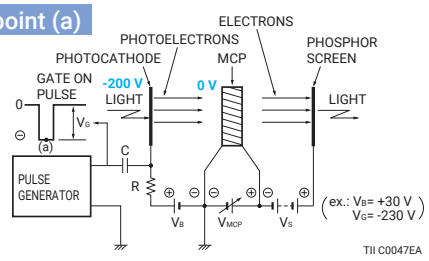
Electron multiplication at MCP

Gate operation

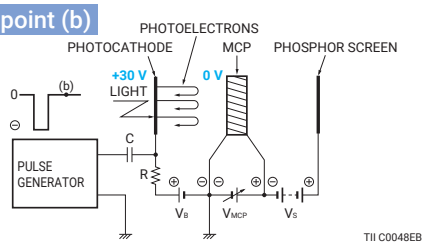
The gate operation is performed by changing the electric potential of the photocathode and MCP-in. The electric potential at the photocathode is lower than the electric potential on MCP-in when the gate is in the ON state, thus electrons discharged from the photocathode enters the MCP with positive electric potential. Images multiplied by the MCP, as well as the optical output from the phosphor screen, are acquired in this operating state.
When the gate is in the OFF state, on the other hand, the electric potential on the photocathode is greater than the photoelectric potential on the MCP-in, thus electrons discharged from the photocathode is pulled back onto the photocathode that is charged with positive electric potential and they do not reach the MCP.
Therefore the situation with the gate in the OFF state would be such that there is absolutely no image output even when incident light is present.

Gating operation (Proximity focused image intensifier)

Gate ON at point (a)



Gate OFF at point (b)



Hints to selecting products

Use the following guidelines to select a high-speed gated image intensifier unit having features and specifications ideal for your measurements. The six items listed below are very important for selecting the right product. Select the product you need by using a combination of these six items.

Item	Description	Selection method
Image frames rate of readout camera	This is an element that determines whether or not an image booster is necessary. As the image frame rate of a camera is increased, sufficient images will no longer be derived with the level of light output from the image intensifier alone, and as a result, an image booster becomes necessary in order to obtain a greater light output level.	Image frame rate of camera · 1000 frames/s or more: A booster is necessary. Select the C16031 series · 300 to 1000 frames/s: The use of a booster is recommended. C16031 series is recommended.
Input surface/ effective surface size (effective area)	There are two types of input surface/output surface sizes, namely ϕ18 mm and ϕ25 mm. The effective area of a photocathode is selected based on the effective element size of the readout camera.	Effective area of ϕ18 mm input surface/output surface · Multialkali photocathode … ϕ18 mm · GaAsP/GaAs photocathode … 12.8 mm × 9.6 mm Effective area of ϕ25 mm input surface/output surface · Multialkali photocathode … ϕ25 mm · GaAsP/GaAs photocathode … 16.0 mm × 16.0 mm
Photocathode (wavelength detection range)	Incident light that enters the photocathode is converted into photoelectrons by the photocathode. The fluctuation of images can be reduced with greater conversion efficiency (quantum efficiency) for conversion of incident light into photoelectrons. It is important to select a photocathode based on the luminescence light emission wavelength of the measurement target.	What is the wavelength of the light of the imaging target? · A broad range that spans from ultraviolet region to near infrared region … Multialkali photocathode · Near infrared region at the center … GaAs photocathode · Visible region at the center … GaAsP photocathode
MCP (image intensity)	The electron multiplying function of the MCP offers varying degrees of image intensity, based on the MCP gain setting and the number of MCP stages. The minimum object illumination of ordinary CMOS cameras is about 0.1 lx, however, the 1-stage MCP type has an image intensifying capacity of about ten thousand times, which makes it possible to capture images with illumination of about 1×10^{-5} lx. The dual stage MCP type has an image intensifying capacity of about one million times, which makes it possible to capture images with illumination of about 1×10^{-7} lx. Make selections based on the light intensity of the observation target, as well as the measurement environment.	· 1-stage MCP...10 000 times (typ.) · 2-stage MCP...1 million times (typ.) · 1 Molecular fluorescence observation...2-stage MCP · single-photon detection...2-stage MCP Figures described above are rough standards. Consult us separately for details, as various conditions such as light intensity, gating time, image intensity (gain), lens, image capturing device and the like are all relevant.
Phosphor (luminescence and persistence characteristics)	Electrons multiplied by the MCP are once again converted into light by the phosphor screen. It is necessary to select a phosphor screen with short light persistence time in order to observe high-speed phenomena.	· Gating time of under 1 ms … P46 recommended · Gating time of 1 ms and over … P43 recommended · Image frame rate of camera 300 frames/s or more … P46 recommended
Gate functions	The gate operation ON time control and repetition frequency control by gate trigger input are available as gate functions. An “instantaneous image” of a phenomenon that occurred within the gate ON time can be capture. Shorter gating time derives images with less movement, but images become darker since the light intensity decreases. The repetition frequency of the gate operation can be synchronized, according to the repetition of the measurement target, as well as image frame rate of the output camera.	· High-speed time resolution by gate operation … Gate function available · Ordinary time resolution of camera … Gate function not available * The maximum repetition frequency of 30 kHz for the C14245 series is not for high-speed cameras, but it is a standard for acquiring multiple exposure images by combining with a camera of lower image frame rates.

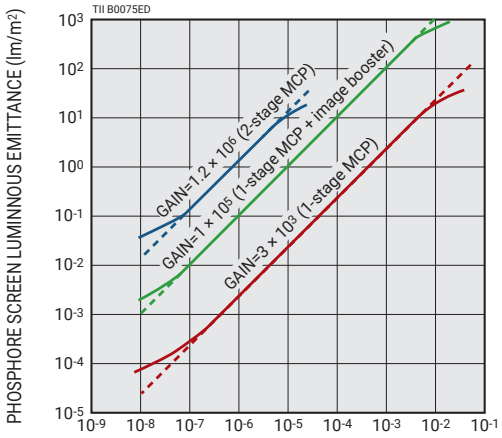
Selection Guide

Image frames rate of readout camera

This is an element that determines whether or not an image booster is necessary.
As the image frame rate of a camera is increased, sufficient images will no longer be derived with the level of light output from the image intensifier alone, and as a result, an image booster becomes necessary in order to obtain a greater light output level.

Image frames rate	Booster
1000 frames / second or more	Required
300 to 1000 frames / second	Recommended
300 frames / second or more less	Unnecessary

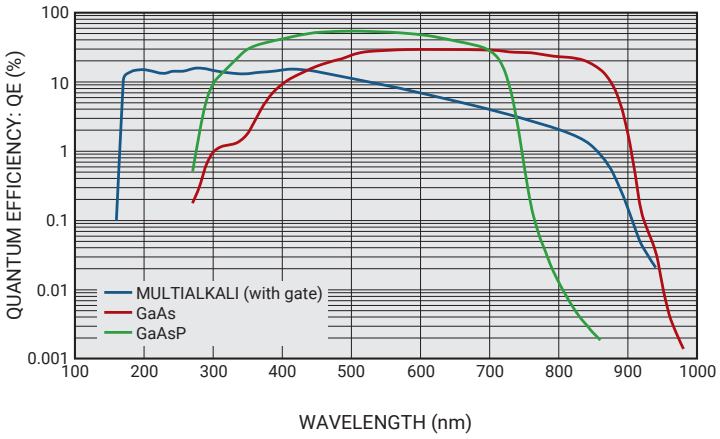
●Photocathode illuminance vs. Phosphor screen luminous emittance (Multialkali photocathode, P46)



Wide spectral response, High quantum efficiency (QE)

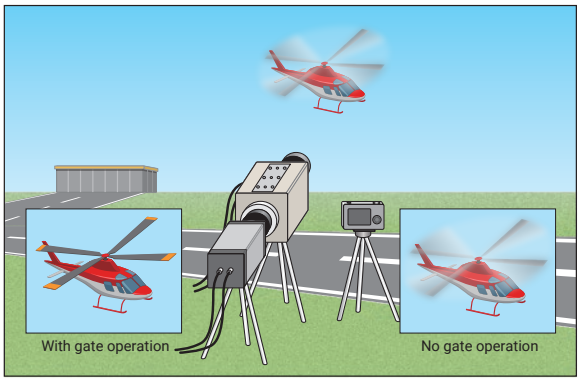
Enhanced photocathode sensitivity allows capturing high quality images with minimum flicker.
GaAsP photocathode is recommended for the visible range, and GaAs photocathode for the near infrared range.

Photocathode	Features
MULTIALKALI	UV to near-infrared sensitivity
GaAs	Uniform and high sensitivity from the visible to near-infrared region
GaAsP	Very high sensitivity in the visible region



High-speed gate imaging

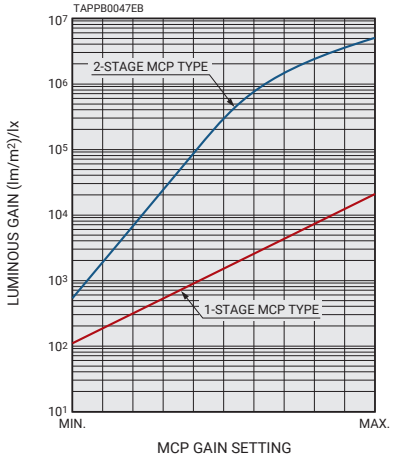
When changes in the event are occurring at an extremely fast rate, images can be captured in very short time units.
This makes it possible to analyze high-speed phenomena in greater detail.



Using 2-stage MCP

The 2-stage MCP enables imaging bio- or chemi-luminescence at extremely low light levels, or monitoring living things under dark conditions.
The 2-stage MCP offers image intensification (gain) approximately 100 times higher than that of the 1-stage MCP, enabling high-sensitivity detection.

●Gain characteristics (GaAs PHOTOCATHODE, P43)



Phosphor screen

High-speed camera supporting model adopts the P46 with shorter persistence characteristics.

Phosphor type	Peak emission	10 % Decay time	Relative power efficiency	Emission color	Note
P43	545 nm	1 ms	1	Yellowish green	Standard
P46	510 nm	0.2 µs to 0.4 µs	0.3	Green	Short decay time

Is camera frame rate (300 to)1000 frames / second or more ?

YES

High-speed camera supporting model

1-stage MCP	C16031-211/ -311

P7

NO

Measurement wavelengths?

UV to near IR range or UV range

(185 nm to 900 nm)

Ultraviolet region to near infrared region imaging model

1-stage MCP	C14245-11111/ -11112/ -21111/ -21113/ -31111/ -31113
2-stage MCP	C14245-11211/ -11212/ -21211/ -21213/ -31211/ -31213

P9

Visible range

(280 nm to 720 nm)

Visible region imaging model

1-stage MCP	C14245-12111/ -12112/ -22111/ -22113/ -32111/ -32113
2-stage MCP	C14245-12211/ -12212/ -22211/ -22213/ -32211/ -32213

P11

Visible to near IR range

(370 nm to 920 nm)

Visible region to near infrared region imaging model

1-stage MCP	C14245-13111/ -13112/ -23111/ -23113/ -33111/ -33113
2-stage MCP	C14245-13211/ -13212/ -23211/ -23213/ -33211/ -33213

P13

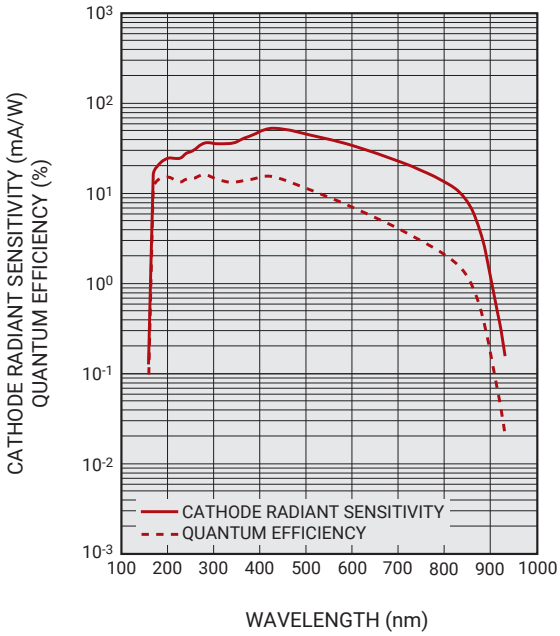
High-speed camera supporting model

C16031-211/ -311

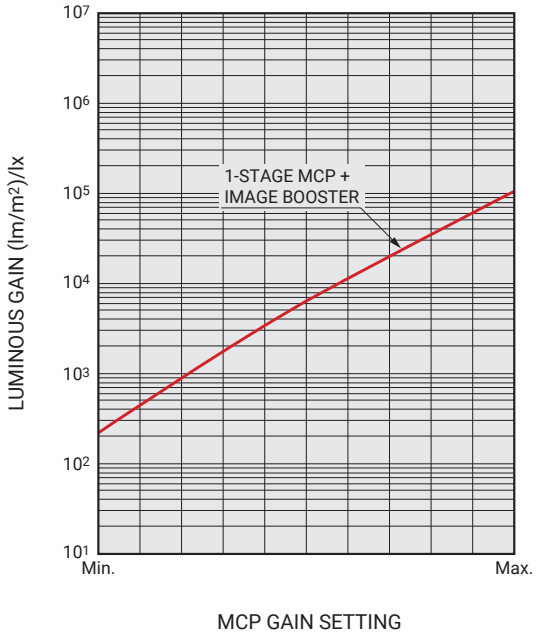
- The lack of light intensity can be resolved by raising the image frame rate of high-speed cameras .
- A multialkali photocathode is adopted to support imaging centering around visible region.
- A broad range of sensitivity spanning from ultraviolet region to near infrared region.
- Analyses of high-speed luminous phenomena.
- Measurement of faint light imaging.
- Observation of high-speed moving object.

Characteristic

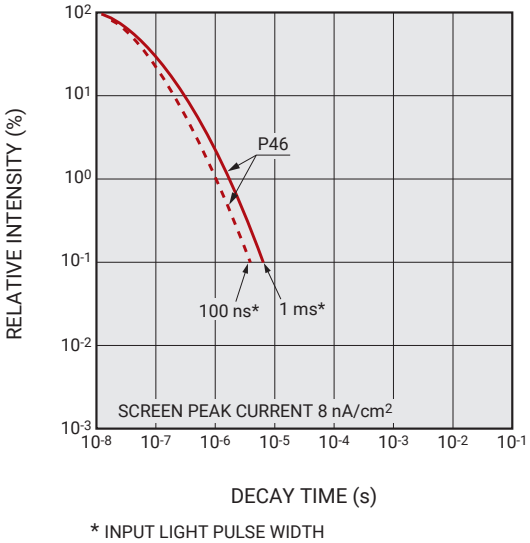
Spectral response (Typ.)



Gain (Typ.)

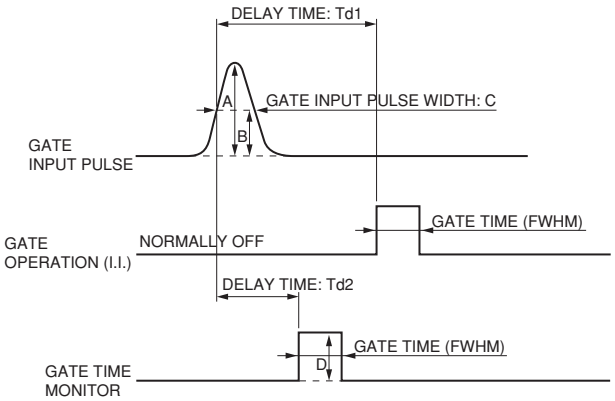


Typical decay characteristics



* INPUT LIGHT PULSE WIDTH

Time sequence



NOTE:
A: 2 V to 5 V (50 Ω)
B: 2 V (50 Ω)
C: GATE TIME of I.I. + 10 ns
D: 2 V (50 Ω)
Td1: 60 ns
Td2: 40 ns

Type number guide

C16031-211-A1

Series type No. A B C D

A: Input diameter and input mount of I.I.

Suffix	Input diameter	Input mount
2	25 mm	C-mount
3	25 mm	F-mount

B: Photocathode types

Suffix	Photocathode
1	Multialkali

C: Phosphor types and output windows

Suffix	Phosphor types	Output windows
1	P46	FOP

D: Specified destinations of AC adapters

Suffix	Stage of MCP
A1	Japan
A2	USA
A3	EU

Specifications

Parameter		C16031		Unit
		-211	-311	
Input	Lens mount	C-mount	F-mount	–
	Surface size	ϕ25 Ⓐ		mm
	Window	Silica		–
	Photocathode	Multialkali		–
Number of MCP stages		1		Stage
Output	Phosphor screen	P46		–
	Window	FOP		–
Spectral response range		185 to 900		nm
Cathode luminous sensitivity	Typ.	230		μA/lm
	Min.	150		
Cathode radiation sensitivity Ⓑ		53		mA/W
Cathode quantum efficiency Ⓑ		15		%
Luminous gain	Typ.	1.0×10^5		(lm/m²)/lx
	Min.	5.0×10^4		
EBI Ⓒ	Typ.	2×10^{-9}		lm/cm²
	Max.	8×10^{-9}		
Central limitting resolution	Typ.	38		Lp/mm
	Min.	28		
Image magnification		0.67		–
Operating mode	Continuous mode	Available		–
	Gate mode Ⓓ	Available		–
Gate signal input and gating time monitor output	Gate minimum ON time	10		ns
	Gate maximum repetition	200		kHz
	Gate connector terminals	BNC		–
	gate signal level	TTL		–
	Gate signal polarity	Positive logic		–
	Gate terminal impedance	50		Ω
	Gate operation delay time Ⓔ	60		ns
	Gating time monitor delay time Ⓔ	40		ns
Protective functions		Excessive light protection shutoff Ⓕ, gate frequency limit Ⓖ		–
Power supply voltage (using AC adapter)		AC 100 to 240		V
Power consumption	Max.	5		W
Control method		PC Ⓗ / Remote controller		–
Operating ambient temperature		0 to +40		°C
Storage temperature		-20 to +50		°C
Operating ambient humidity and storage humidity		Below 70 Ⓘ		%

NOTE: Ⓐ Effective area: Φ25 mm
Ⓑ Standard value for the radiation sensitivity with maximum sensitivity wavelength
Ⓒ Typical value at 20 °C.
Ⓓ Gate ON time is variable with the pulse width of the gate signal input.
Ⓔ Delay time with respect to gate signal input.
Ⓕ The image intensifier operation is stopped in the event the phosphor screen average current exceeds the preset level.
Ⓖ The gate operation is stopped in the event the maximum gate repetition frequency is exceeded.
Ⓗ The supported OS is Windows 10. Controls performed using the software accessory via USB2.0 interface.
Ⓘ No condensation

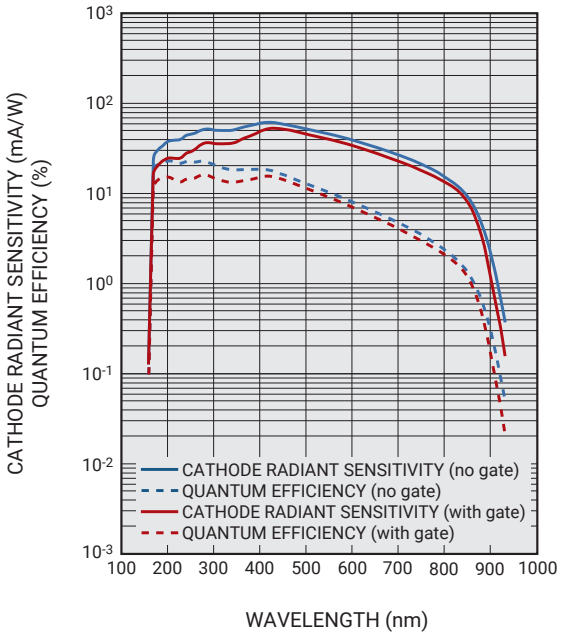
UV to NIR imaging model

C14245-11111/ -11112/ -11211/ -11212/ -21111/ -21113/ -21211/ -21213/ -31111/ -31113/ -31211/ -31213

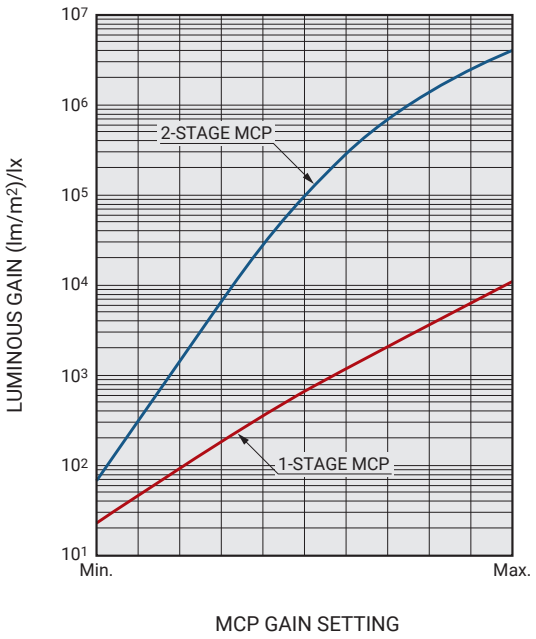
- A multialkali photocathode is adopted to support imaging centering around visible region.
- A broad range of sensitivity spanning from ultraviolet region to near infrared region.
- Analyses of high-speed luminous phenomena.
- Measurement of faint light imaging.
- Observation of high-speed moving object.

Characteristic

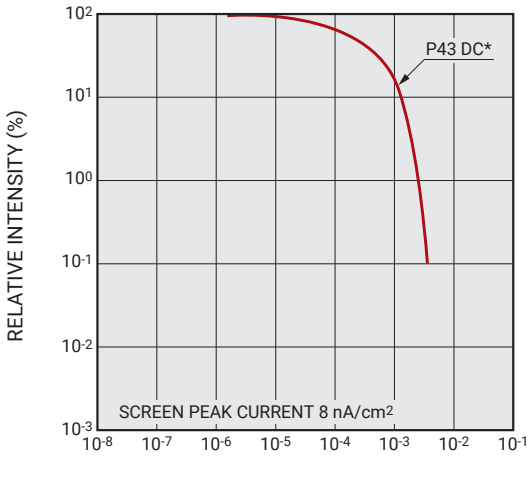
Spectral response (Typ.)



Gain (Typ.)

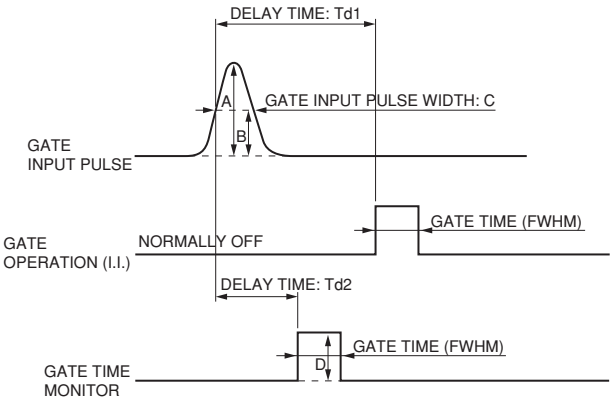


Typical decay characteristics



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

Time sequence



NOTE:
A: 2 V to 5 V (50 Ω)
B: 2 V (50 Ω)
C: GATE TIME of I.I. + 10 ns
D: 2 V (50 Ω)
Td1: 50 ns
Td2: 35 ns

Type number guide

C14245-11111-A1

Series type No. A B C D E F

A: Input diameter and input mount of I.I.

Suffix	Input diameter	Input mount
1	18 mm	C-mount
2	25 mm	C-mount
3	25 mm	F-mount

B: Photocathode types

Suffix	Photocathode
1	Multialkali

C: Number of MCPs

Suffix	Stage of MCP
1	1
2	2

D: Phosphor types and output windows

Suffix	Phosphor types	Output windows
1	P43	FOP

E: Gate characteristics

Suffix	Minimum gate time	Maximum repetition frequency
1	—	No gate
2	3 ns	30 kHz (Only when ϕ18 is selected)
3	5 ns	30 kHz (Only when ϕ25 is selected)

F: Specified destinations of AC adapters

Suffix	Stage of MCP
A1	Japan
A2	USA
A3	EU

Specifications

Parameter		C14245								Unit
		-11111	-11112	-11211	-11212	-21111 -31111	-21113 -31113	-21211 -31211	-21213 -31213	
Input	Lens mount	C-mount (-1xxxx Series/-2xxxx Series) / F-mount (-3xxxx Series)								—
	Surface size	ϕ18 Ⓐ				ϕ25 Ⓑ				mm
	Window	Silica								—
	Photocathode	Multialkali								—
Number of MCP stages		1		2		1		2		Stage
Output	Phosphor screen	P43								—
	Window	FOP								—
Spectral response range		185 to 900								nm
Cathode luminous sensitivity	Typ.	280	230	170	150	280	230	170	150	μA/lm
	Min.	150		100		150		100		
Cathode radiation sensitivity Ⓒ		62	53	60	47	62	53	60	47	mA/W
Cathode quantum efficiency Ⓒ		18	15	17	14	18	15	17	14	%
Luminous gain	Typ.	1.2×10^4	1.1×10^4	5.0×10^6	4.0×10^6	1.2×10^4	1.1×10^4	5.0×10^6	4.0×10^6	(lm/m²)/lx
	Min.	7.0×10^3		1.0×10^6		7.0×10^3		1.0×10^6		
EBI Ⓓ	Typ.	1.0×10^{-11}								lm/cm²
	Max.	4.0×10^{-11}								
Central limitting resolution	Typ.	64		57		64		57		Lp/mm
	Min.	51		45		51		45		
Image magnification		1								—
Operating mode	Continuous mode	Available								—
	Gate mode Ⓔ	N/A	Available	N/A	Available	N/A	Available	N/A	Available	—
Gate signal input and gating time monitor output	Gate minimum ON time	—	3	—	3	—	5	—	5	ns
	Gate maximum repetition	—	30	—	30	—	30	—	30	kHz
	Gate connector terminals	—	BNC	—	BNC	—	BNC	—	BNC	—
	gate signal level	—	TTL	—	TTL	—	TTL	—	TTL	—
	Gate signal polarity	—	Positive logic	—	Positive logic	—	Positive logic	—	Positive logic	—
	Gate terminal impedance	—	50	—	50	—	50	—	50	Ω
	Gate operation delay time Ⓕ	—	50	—	50	—	50	—	50	ns
	Gating time monitor delay time Ⓕ	—	35	—	35	—	35	—	35	ns
Protective functions		Excessive light protection shutoff Ⓖ, gate frequency limit Ⓗ								—
Power supply voltage (using AC adapter)		AC 100 to 240								V
Power consumption	Max.	5								W
Control method		PC Ⓘ / Remote controller								—
Operating ambient temperature		0 to +40								°C
Storage temperature		-20 to +50								°C
Operating ambient humidity and storage humidity		Below 70 Ⓙ								%

NOTE: Ⓐ Effective area: Φ18 mm
Ⓑ Effective area: Φ25 mm
Ⓒ Standard value for the radiation sensitivity with maximum sensitivity wavelength
Ⓓ Typical value at 20 °C.
Ⓔ Gate ON time is variable with the pulse width of the gate signal input.
Ⓕ Delay time with respect to gate signal input.
Ⓖ The image intensifier operation is stopped in the event the phosphor screen average current exceeds the preset level.
Ⓗ The gate operation is stopped in the event the maximum gate repetition frequency is exceeded.
Ⓘ The supported OS is Windows 10. Controls performed using the software accessory via USB2.0 interface.
Ⓙ No condensation

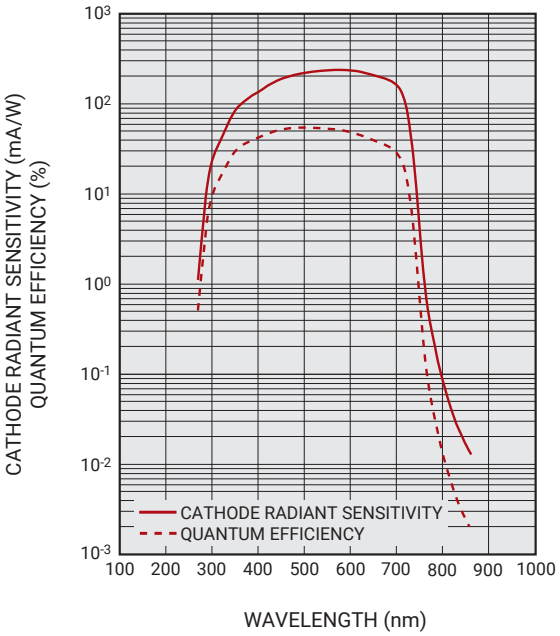
Visible region imaging model

C14245-12111/ -12112/ -12211/ -12212/ -22111/ -22113/ -22211/ -22213/ -32111/ -32113/ -32211/ -32213

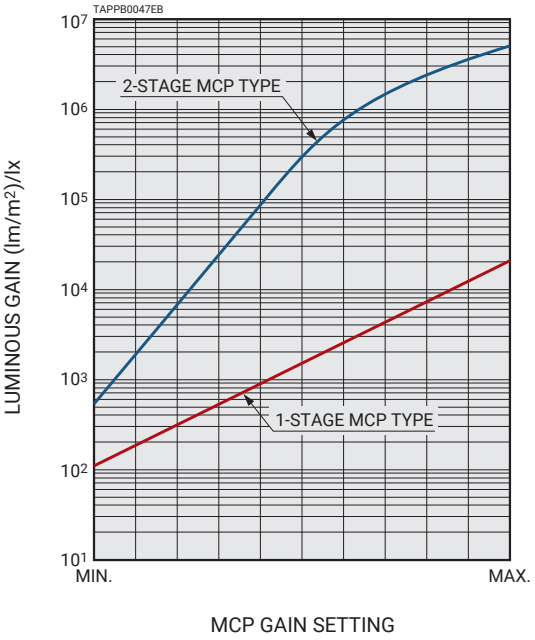
- A GaAsP photocathode is adopted to support imaging centering around visible region.
- High quantum efficiency in visible region.
- Analyses of high-speed luminous phenomena.
- Measurement of faint light imaging.
- Observation of high-speed moving object.

Characteristic

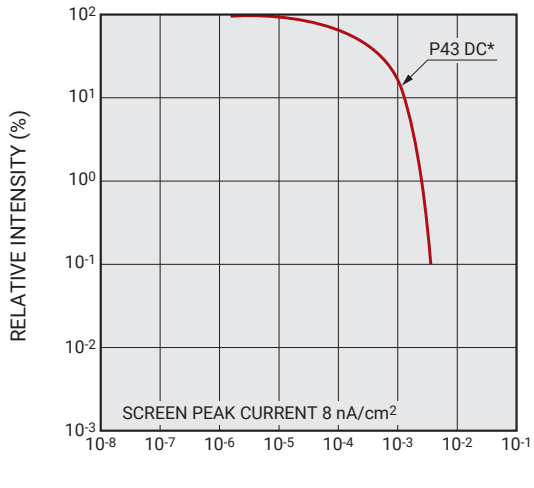
Spectral response (Typ.)



Gain (Typ.)

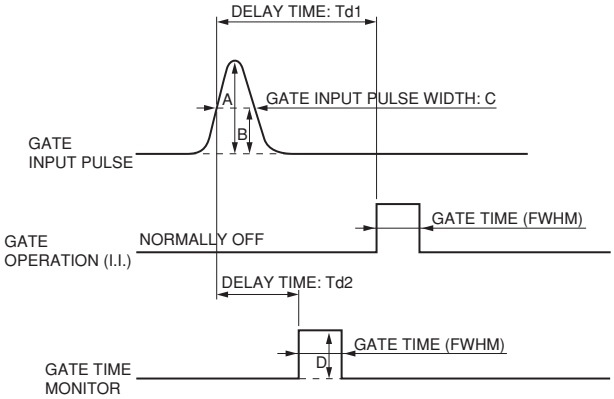


Typical decay characteristics



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

Time sequence



NOTE:
A: 2 V to 5 V (50 Ω)
B: 2 V (50 Ω)
C: GATE TIME of I.I. + 10 ns
D: 2 V (50 Ω)
Td1: 50 ns
Td2: 35 ns

Type number guide

C14245-12111-A1

Series type No. A B C D E F

A: Input diameter and input mount of I.I.

Suffix	Input diameter	Input mount
1	18 mm	C-mount
2	25 mm	
3	25 mm	F-mount

B: Photocathode types

Suffix	Photocathode
2	GaAsP

C: Number of MCPs

Suffix	Stage of MCP
1	1
2	2

D: Phosphor types and output windows

Suffix	Phosphor types	Output windows
1	P43	FOP

E: Gate characteristics

Suffix	Minimum gate time	Maximum repetition frequency
1	—	No gate
2	3 ns	30 kHz (Only when ϕ18 is selected)
3	5 ns	30 kHz (Only when ϕ25 is selected)

F: Specified destinations of AC adapters

Suffix	Stage of MCP
A1	Japan
A2	USA
A3	EU

Specifications

Parameter		C14245								Unit
		-12111	-12112	-12211	-12212	-22111 -32111	-22113 -32113	-22211 -32211	-22213 -32213	
Input	Lens mount	C-mount (-1xxxx Series/-2xxxx Series) / F-mount (-3xxxx Series)								—
	Surface size	ϕ18 Ⓐ				ϕ25 Ⓑ				mm
	Window	Borosilicate glass								—
	Photocathode	GaAsP								—
Number of MCP stages		1		2		1		2		Stage
Output	Phosphor screen	P43								—
	Window	FOP								—
Spectral response range		280 to 720								nm
Cathode luminous sensitivity	Typ.	700								μA/lm
	Min.	400								
Cathode radiation sensitivity Ⓒ		214								mA/W
Cathode quantum efficiency Ⓒ		50								%
Luminous gain	Typ.	2.2×10^4		5.0×10^6		2.2×10^4		5.0×10^6		(lm/m²)/lx
	Min.	1.0×10^4		1.0×10^6		1.0×10^4		1.0×10^6		
EBI Ⓓ	Typ.	3.0×10^{-12}								lm/cm²
	Max.	3.0×10^{-11}								
Central limitting resolution	Typ.	64		57		57		51		Lp/mm
	Min.	51		45		45		40		
Image magnification		1								—
Operating mode	Continuous mode	Available								—
	Gate mode Ⓔ	N/A	Available	N/A	Available	N/A	Available	N/A	Available	—
Gate signal input and gating time monitor output	Gate minimum ON time	—	3	—	3	—	5	—	5	ns
	Gate maximum repetition	—	30	—	30	—	30	—	30	kHz
	Gate connector terminals	—	BNC	—	BNC	—	BNC	—	BNC	—
	gate signal level	—	TTL	—	TTL	—	TTL	—	TTL	—
	Gate signal polarity	—	Positive logic	—	Positive logic	—	Positive logic	—	Positive logic	—
	Gate terminal impedance	—	50	—	50	—	50	—	50	Ω
	Gate operation delay time Ⓕ	—	50	—	50	—	50	—	50	ns
	Gating time monitor delay time Ⓕ	—	35	—	35	—	35	—	35	ns
Protective functions		Essive light protection shutoff Ⓖ, gate frequency limit Ⓗ								—
Power supply voltage (using AC adapter)		AC 100 to 240								V
Power consumption	Max.	5								W
Control method		PC Ⓘ / Remote controller								—
Operating ambient temperature		0 to +40								°C
Storage temperature		-20 to +50								°C
Operating ambient humidity and storage humidity		Below 70 Ⓙ								%

NOTE: Ⓐ Effective area: 12.8 mm × 9.6 mm
Ⓑ Effective area: 16 mm × 16 mm
Ⓒ Standard value for the radiation sensitivity with maximum sensitivity wavelength
Ⓓ Typical value at 20 °C.
Ⓔ Gate ON time is variable with the pulse width of the gate signal input.
Ⓕ Delay time with respect to gate signal input.
Ⓖ The image intensifier operation is stopped in the event the phosphor screen average current exceeds the preset level.
Ⓗ The gate operation is stopped in the event the maximum gate repetition frequency is exceeded.
Ⓘ The supported OS is Windows 10. Controls performed using the software accessory via USB2.0 interface.
Ⓙ No condensation

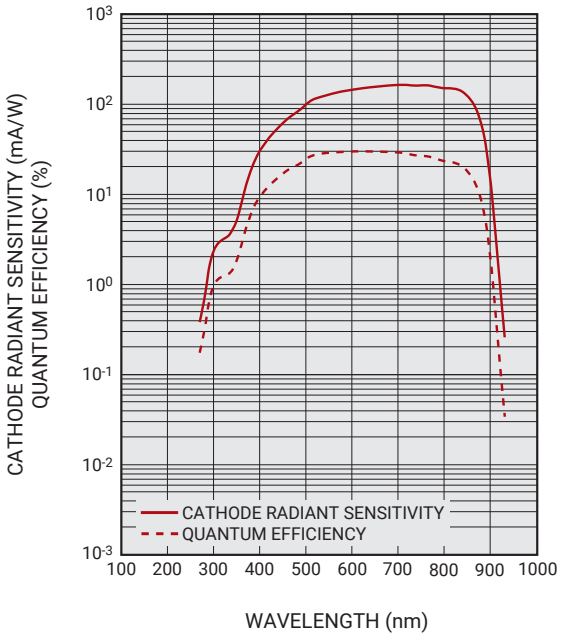
Visible region to to NIR imaging model

C14245-13111/ -13112/ -13211/ -13212/ -23111/ -23113/ -23211/ -23213/ -33111/ -33113/ -33211/ -33213

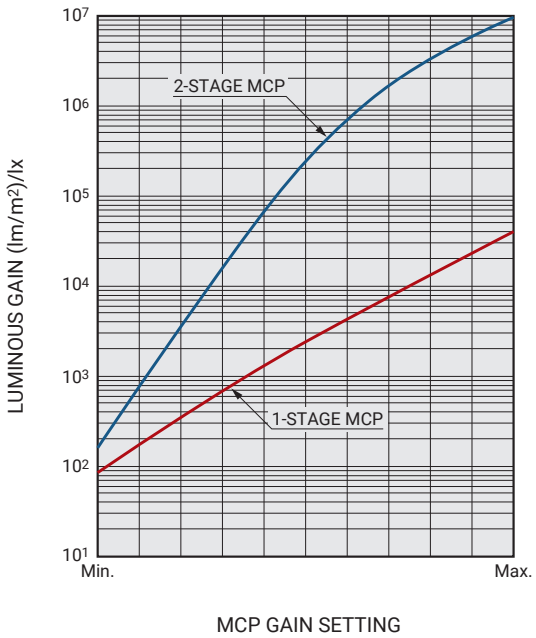
- A GaAs photocathode is adopted to support imaging in visible region to near infrared region.
- High sensitivity in visible region to near infrared region.
- Analyses of high-speed luminous phenomena.
- Measurement of faint light imaging.
- Observation of high-speed moving object.

Characteristic

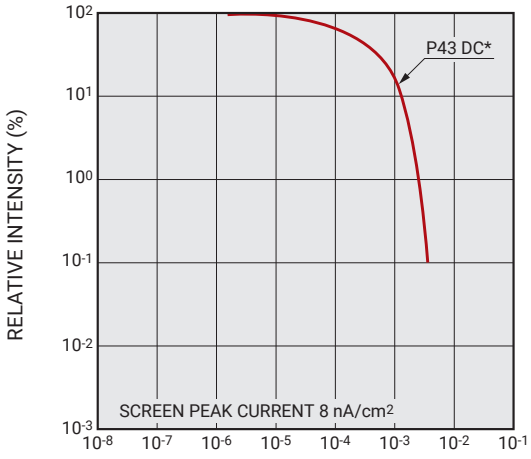
Spectral response (Typ.)



Gain (Typ.)

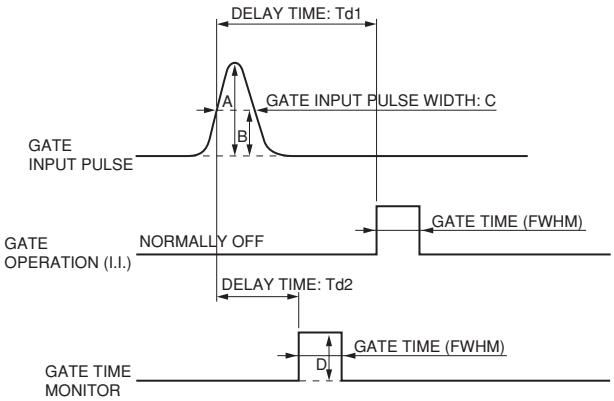


Typical decay characteristics



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

Time sequence



NOTE:
A: 2 V to 5 V (50 Ω)
B: 2 V (50 Ω)
C: GATE TIME of I.I. + 10 ns
D: 2 V (50 Ω)
Td1: 50 ns
Td2: 35 ns

Type number guide

C14245-13111-A1

Series type No. A B C D E F

A: Input diameter and input mount of I.I.

Suffix	Input diameter	Input mount
1	18 mm	C-mount
2	25 mm	C-mount
3	25 mm	F-mount

B: Photocathode types

Suffix	Photocathode
3	GaAs

C: Number of MCPs

Suffix	Stage of MCP
1	1
2	2

D: Phosphor types and output windows

Suffix	Phosphor types	Output windows
1	P43	FOP

E: Gate characteristics

Suffix	Minimum gate time	Maximum repetition frequency
1	—	No gate
2	3 ns	30 kHz (Only when ϕ18 is selected)
3	5 ns	30 kHz (Only when ϕ25 is selected)

F: Specified destinations of AC adapters

Suffix	Stage of MCP
A1	Japan
A2	USA
A3	EU

Specifications

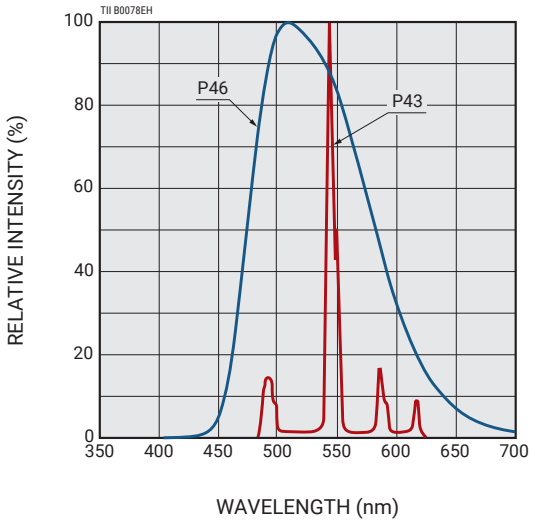
Parameter		C14245								Unit
		-13111	-13112	-13211	-13212	-23111 -33111	-23113 -33113	-23211 -33211	-23213 -33213	
Input	Lens mount	C-mount (-1xxxx Series/-2xxxx Series) / F-mount (-3xxxx Series)								—
	Surface size	ϕ18 Ⓐ				ϕ25 Ⓑ				mm
	Window	Borosilicate glass								—
	Photocathode	GaAs								—
Number of MCP stages		1		2		1		2		Stage
Output	Phosphor screen	P43								—
	Window	FOP								—
Spectral response range		370 to 920								nm
Cathode luminous sensitivity	Typ.	1500								μA/lm
	Min.	1000								
Cathode radiation sensitivity Ⓒ		170								mA/W
Cathode quantum efficiency Ⓒ		30								%
Luminous gain	Typ.	4.0×10^4		9.6×10^6		4.0×10^4		9.6×10^6		(lm/m²)/lx
	Min.	1.0×10^4		1.0×10^6		1.0×10^4		1.0×10^6		
EBI Ⓓ	Typ.	2.0×10^{-11}								lm/cm²
	Max.	5.0×10^{-11}								
Central limitting resolution	Typ.	64		57		57		51		Lp/mm
	Min.	51		45		45		40		
Image magnification		1								—
Operating mode	Continuous mode	Available								—
	Gate mode Ⓔ	N/A	Available	N/A	Available	N/A	Available	N/A	Available	—
Gate signal input and gating time monitor output	Gate minimum ON time	—	3	—	3	—	5	—	5	ns
	Gate maximum repetition	—	30	—	30	—	30	—	30	kHz
	Gate connector terminals	—	BNC	—	BNC	—	BNC	—	BNC	—
	gate signal level	—	TTL	—	TTL	—	TTL	—	TTL	—
	Gate signal polarity	—	Positive logic	—	Positive logic	—	Positive logic	—	Positive logic	—
	Gate terminal impedance	—	50	—	50	—	50	—	50	Ω
	Gate operation delay time Ⓕ	—	50	—	50	—	50	—	50	ns
	Gating time monitor delay time Ⓕ	—	35	—	35	—	35	—	35	ns
Protective functions		Essive light protection shutoff Ⓖ, gate frequency limit Ⓗ								—
Power supply voltage (using AC adapter)		AC 100 to 240								V
Power consumption	Max.	5								W
Control method		PC Ⓘ / Remote controller								—
Operating ambient temperature		0 to +40								°C
Storage temperature		-20 to +50								°C
Operating ambient humidity and storage humidity		Below 70 Ⓙ								%

NOTE: Ⓐ Effective area: 12.8 mm × 9.6 mm
Ⓑ Effective area: 16 mm × 16 mm
Ⓒ Standard value for the radiation sensitivity with maximum sensitivity wavelength
Ⓓ Typical value at 20 °C.
Ⓔ Gate ON time is variable with the pulse width of the gate signal input.
Ⓕ Delay time with respect to gate signal input.
Ⓖ The image intensifier operation is stopped in the event the phosphor screen average current exceeds the preset level.
Ⓗ The gate operation is stopped in the event the maximum gate repetition frequency is exceeded.
Ⓘ The supported OS is Windows 10. Controls performed using the software accessory via USB2.0 interface.
Ⓙ No condensation

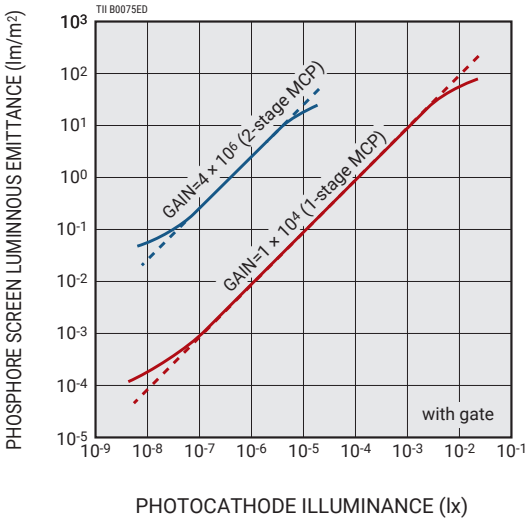
Common specification

Common characteristics

Phosphor screen spectral emission



Photocathode illuminance vs. Phosphor screen luminous emittance (Multialkali photocathode, P43)



Precaution for handling

- The image intensifier (I.I.) is an image tube with a high level of vacuum.
  Do not subject the tube to a strong impact or vibration when transporting, storing or in actual use. That can cause malfunction.
  Use the authorized packing material used
  when the product was sent from us to transport and store the product.
- Never touch the input window or output window directly with bare hands while handling or operating the product. That can cause contamination, electric shock or malfunction.
  Furthermore, do not allow any object to come into contact with the input window or the output window. That can cause scratches.
- Thoroughly wipe the input window or the output window with a soft cloth or the like before use, since contaminants adhering to these windows will appear as a black flaws or stains in images. Use a soft cloth soaked with alcohol to wipe off any fingerprint or finger marks adhering on the surface. Furthermore, never perform such a procedure while operating the product.
- Never modify the base unit.
- Pay attention to the storage and operating environment conditions such as the temperature and humidity. This is particularly the case when leaving the product in a salty or acidic atmosphere of high temperature for prolonged period of time, as that can cause contact failures due to metal corrosion or fail to keep vacuum.
- Avoid exposing the photocathode to strong light such as the sun, regardless of whether the product is in operation or in storage.
  Operating the product that is exposed to bright light (for instance an indoor lighting) can potentially damage the photocathode. Furthermore, the relationship between the total charge of photoelectric current conducted by incident light during operations and the life of the product is inversely proportional.
- Instead of setting the gain low and increasing the incident light amount, raise the gain setting and reduce the incident light as much as possible to adjust phosphor screen luminance.

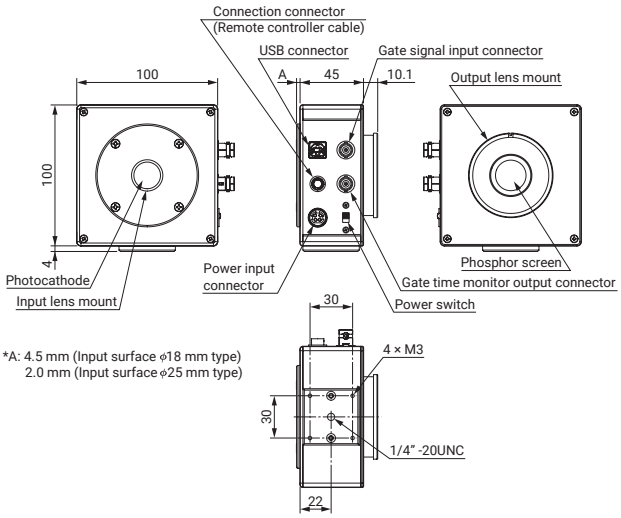
Product Warranty

The warranty period of the base unit is one year from the delivery date.
In the event any malfunction that can be attributed to manufacturing issues during the covered period will be repaired or replaced free of charge.
Such services may be provided for a fee, however, in cases that correspond to descriptions provided below.
(1) Any malfunction arising from misuse caused by the user failing to follow descriptions of the instruction manual, or malfunction caused by carelessness.
(2) Any malfunction arising from an electrical or mechanical modification of the product.
(3) Any malfunction that is caused or induced by a natural disaster or other force majeure.
(4) Partial deterioration of sensitivity of image intensifier (ghosting).
The limit of coverage by this warranty shall be the delivery of a replacement for this product.

Dimensions (Unit: mm)

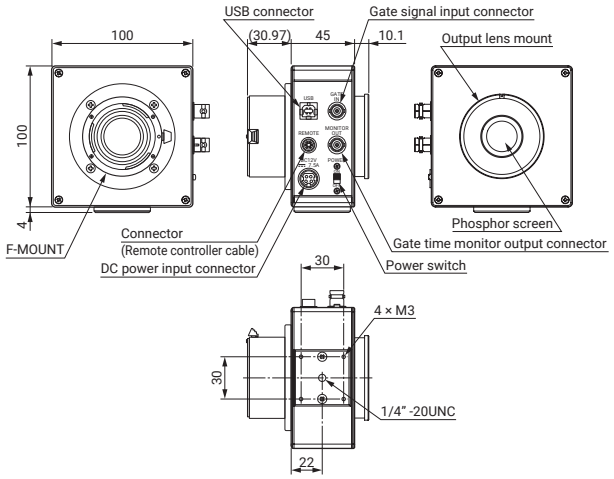
●C14245 Series

C-mount type



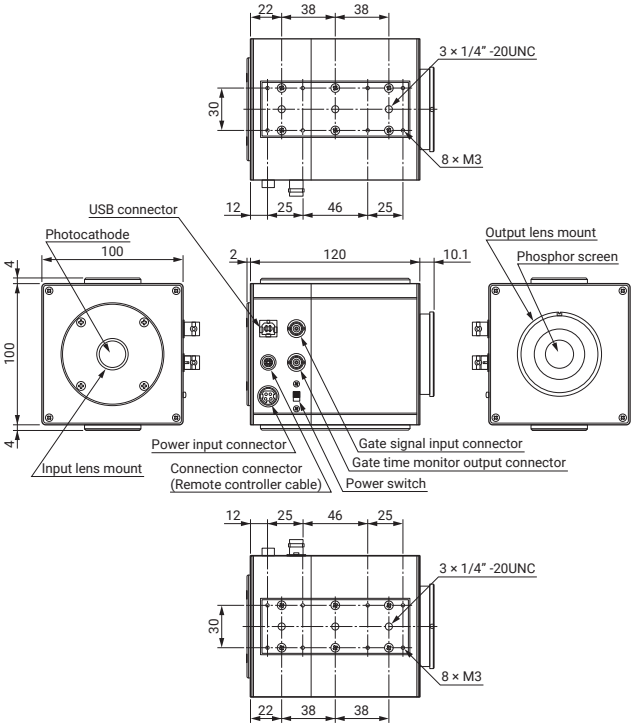
*A: 4.5 mm (Input surface ϕ18 mm type)
2.0 mm (Input surface ϕ25 mm type)

F-mount type

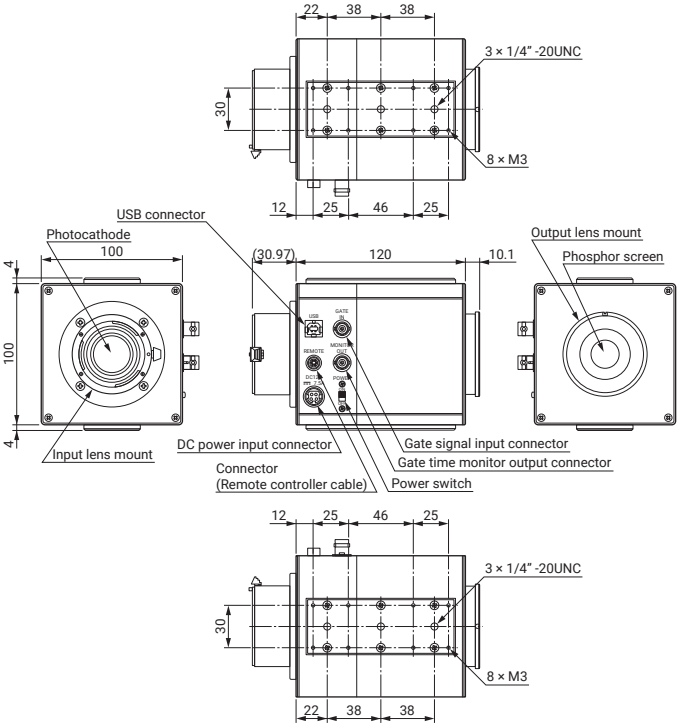


●C16031 Series

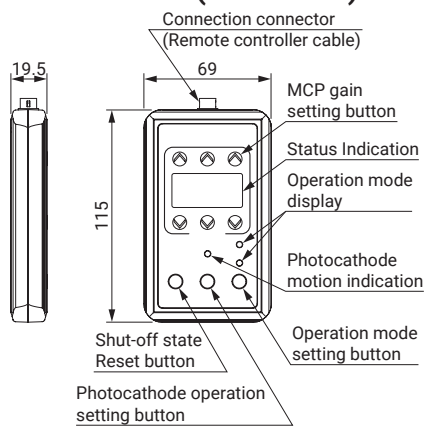
C-mount type



F-mount type

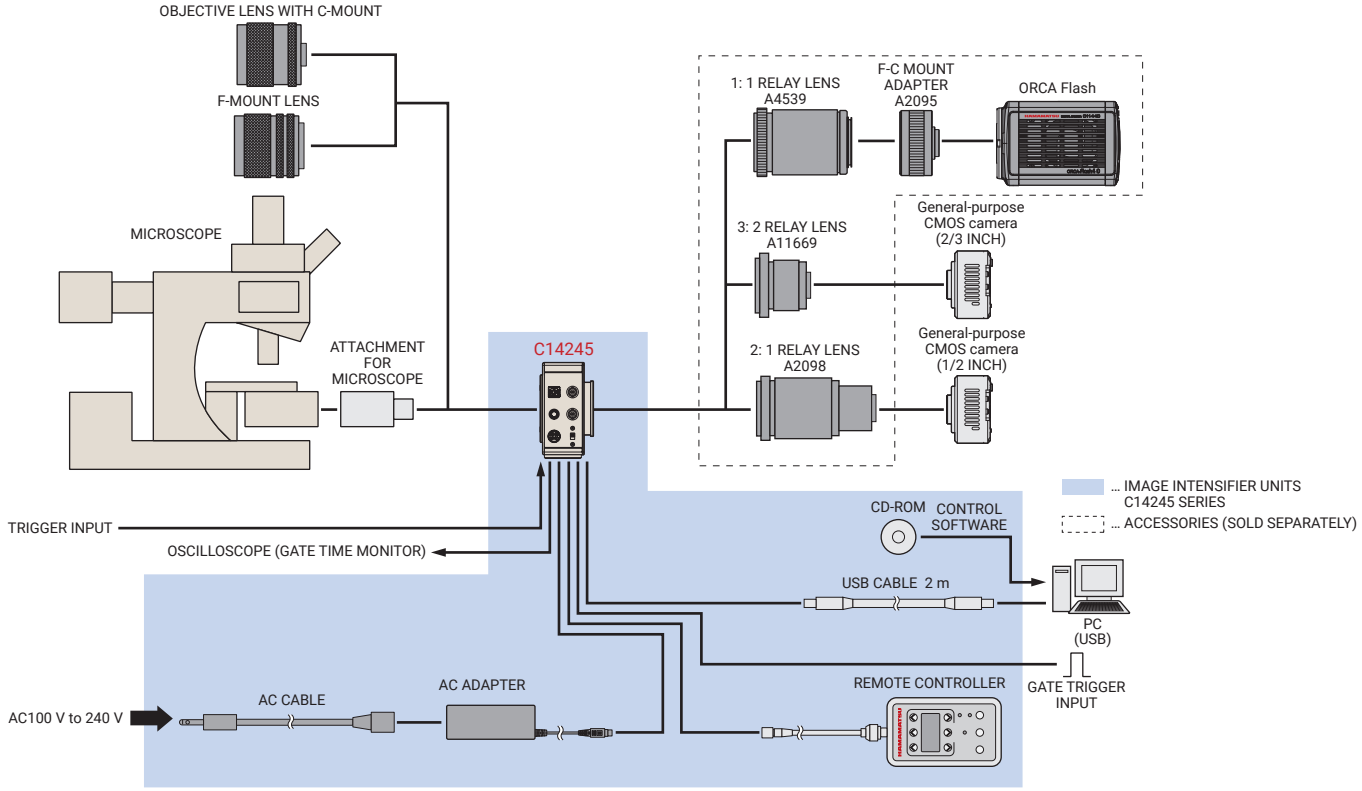


●Controller (Common)



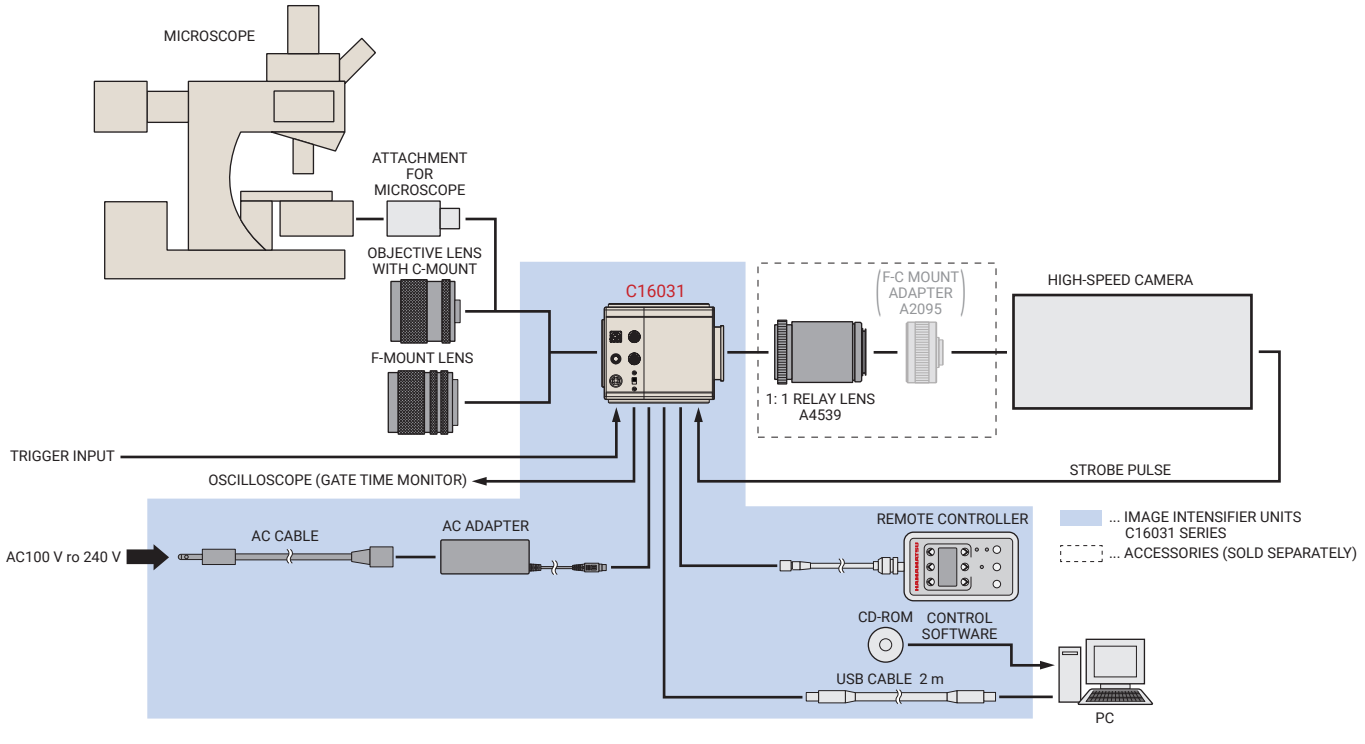
Readout device selection guide

●C14245 Series



TAPPC0109EG

●C16031 Series

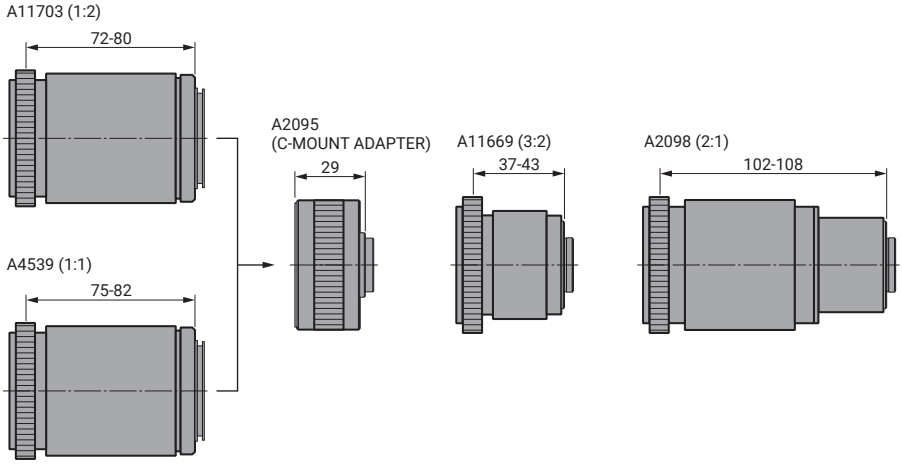


TII C0072ED

Related products

Relay lens

Select a lens that is suitable for the effective area of the I.I., as well as the sensor size of the readout camera.



Type No. (ratio)	Output mount	Weight (g)
A11703 (1:2)	F-MOUNT	450
A4539 (1:1)	F-MOUNT	400
A2095 (–)	C-MOUNT	80
A11669 (3:2)	C-MOUNT	200
A2098 (2:1)	C-MOUNT	460

Digital CMOS camera ORCA-spark

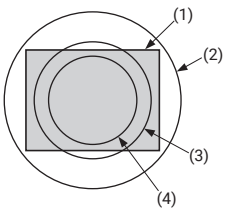
ORCA-spark is a high resolution and highly sensitive digital CMOS camera adopting a CMOS sensor of 2.3 million pixels (1920 (H) × 1200 (V), picture element size □5.6 µm).
A low readout noise of 6.6 electrons is achieved and facilitates image capturing with a superior signal to noise ratio, even with dark targets. Since the camera is fitted with a global shutter, adjusting timing of exposure time of the camera with the high-speed gating time is easy.

Connection configuration example
(C14245 + A4539 + A2095 + ORCA-Spark)

Precautions when selecting a relay lens

Vignetting or darkening around the edge of the imaging area may occur depending on the camera and relay lens used. When selecting a relay lens, be sure to check the image area size of the camera and relay lens magnification.

Imaging area



(Example)
The effective imaging area of the C14245-1xxxx series (input surface size: 18 mm diameter) when used with a relay lens (A4539/A11669/A2098) is as follows:

(1) Image area of camera: 12.8 mm x 9.6 mm (16 mm diagonally, 1-inch size)
(2) Output surface size when connected to the A4539 (1:1): 18 mm diameter
(3) Output surface size when connected to the A11669 (3:2): 12 mm diameter (Vignetting occurs on the right and left sides of the screen)
(4) Output surface size when connected to the A2098 (2:1): 9 mm diameter (Vignetting occurs around the edge of the screen)

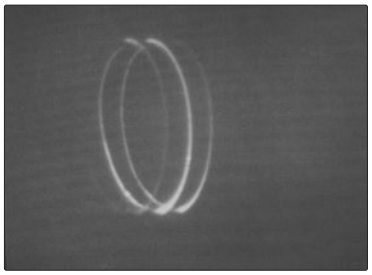
Application Note

01 Observation of pulsed light propagation through optical fiber

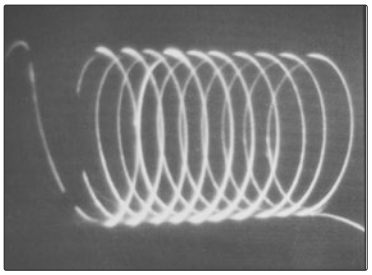
This is what pulsed laser light passing through an optical fiber looks like when observed with a high-speed gated image intensifier.
This allows verifying the distance that the light pulse travels after emission per the gate time.

* Unsheathed optical fiber was used to observe light pulse from external side.
* Optical fiber refractive index: 1.5

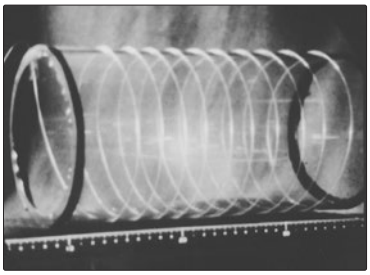
Example images



Gate time: 3 ns



Gate time: 100 ns

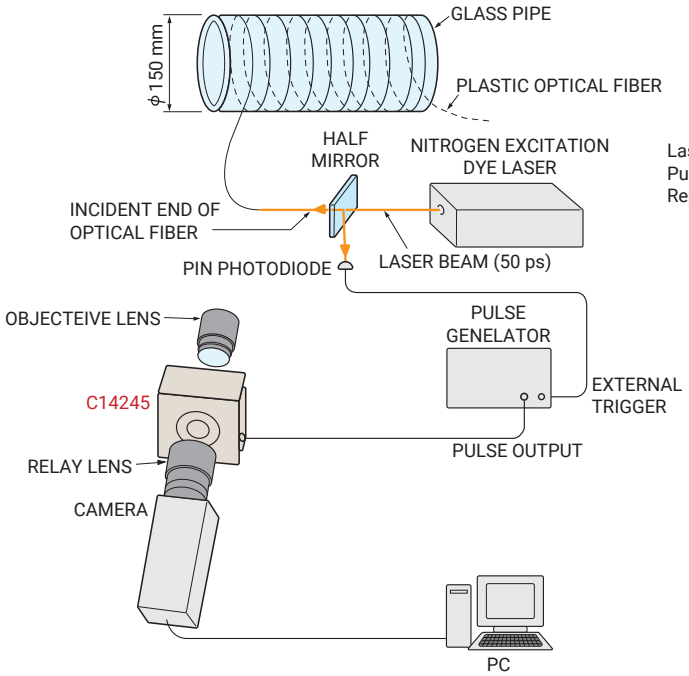


External view of fiber optic cable used in this test

Image at 3 ns gate time: Image shows light moved 60 cm.
Image at 100 ns gate time: Light has moved 20 m, so entire fiber is emitting light.

Imaging system configuration

Pulsed laser light is guided into the fiber optic cable wound around a glass pipe. A high-speed gated image intensifier is used to capture an image of pulsed light passing through to optical fiber optic. The image captured with the gated image intensifier is then read out with a camera.
To control the gate time (shutter speed), pulsed light is split by a beamsplitting mirror into two paths. A PIN photodiode detects light on one path and generates a trigger signal for input to a pulse generator. This pulse generator provides a TTL signal output for the high-speed gated image intensifier power supply.



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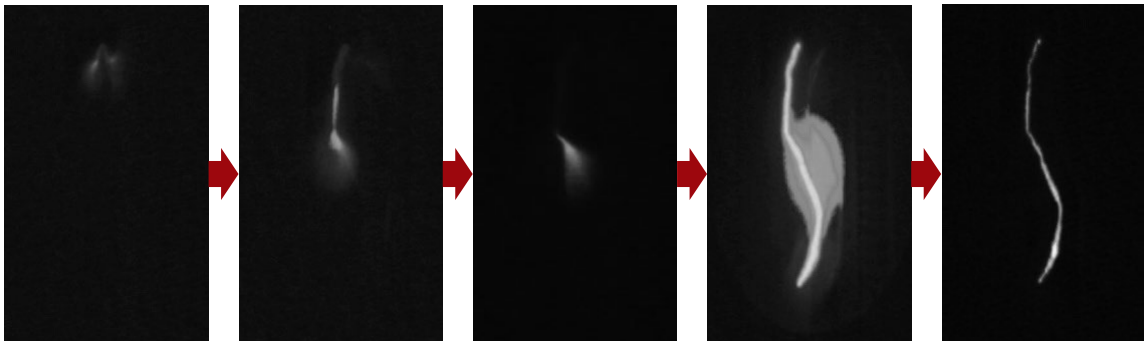
02 Observation of micro-discharge phenomenon

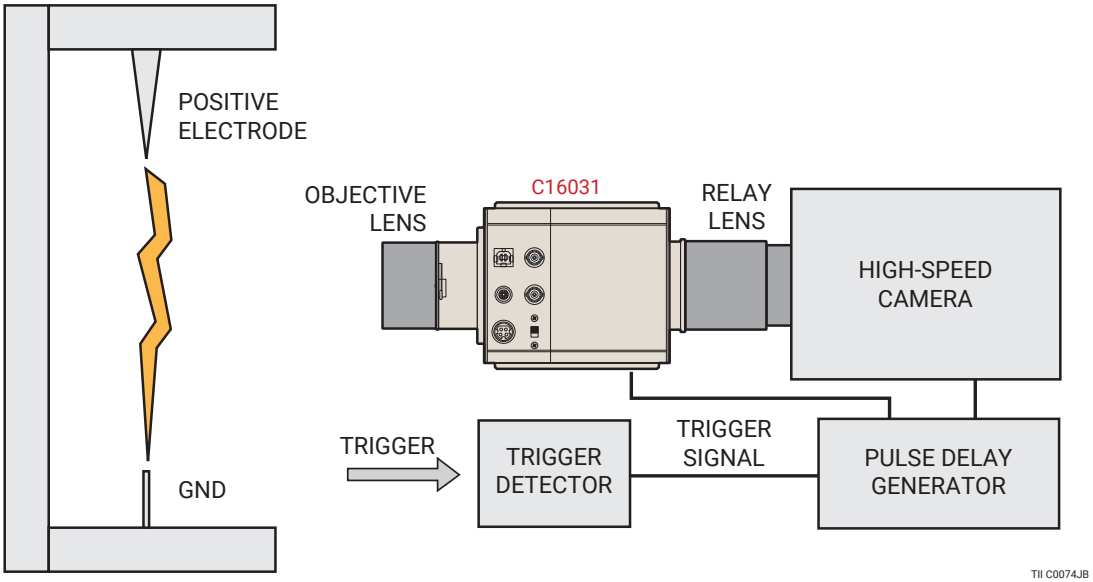
Changes in a micro-discharge phenomenon were observed by connecting a gated image intensifier unit to a high-speed camera that captures images at 500 000 frames per second.
Capturing a high-speed phenomenon at faint light emissions is usually impossible with a camera operating at a low frame rate, because low frame rates do not provide enough time resolution. However, merely increasing the frame rate (less exposure time) reduces the input light level and makes the acquired images
darker and unsatisfactory.
We succeeded in capturing clear images of very weak light emission at a high frame rate by combining a high-speed camera with a high-speed gated image intensifier unit that contains a proximity focused image intensifier coupled to an inverter type intensifier and provides high brightness output.

Example images



Imaging system configuration

The camera is synchronized based on a trigger signal generated just prior to a discharge phenomenon, and the trigger signal is input to the gated image intensifier unit so that the gate opens only during the time the discharge phenomenon occurs.

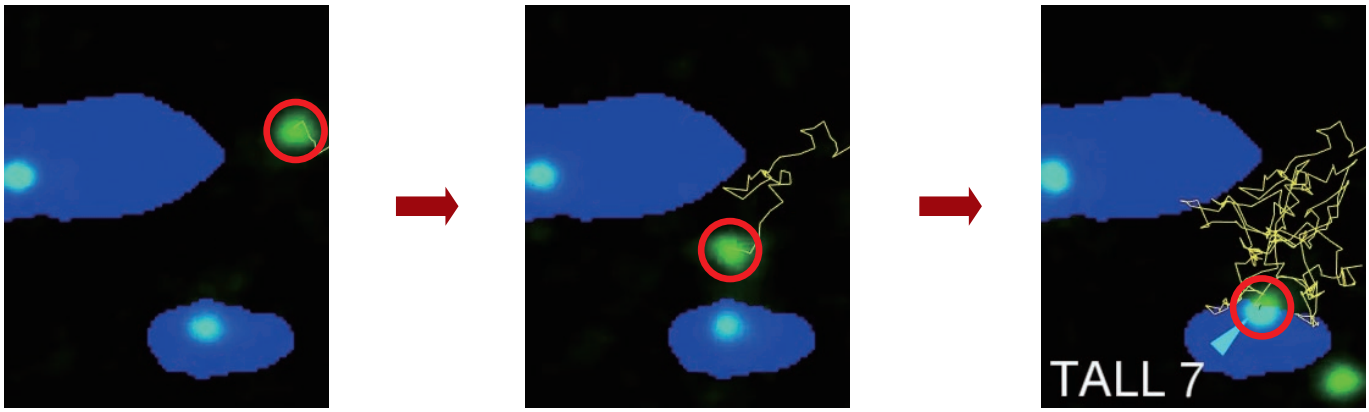


Application Note

03 Observation of single cell membrane protein molecule group

A scene from an observation conducted on the movement of identifiers placed on individual proteins (molecules) in cell membranes with fluorescent molecules, using a gate I.I. unit. Faint light emitted by fluorescent molecules are captured to verify how the proteins tagged with identifiers move.

Example images



* TALL (Temporary Arrest of LateraL diffusion)

Imaging system configuration

A laser beam is radiated on cells to observe fluorescence using a fluorescence microscope.
The digital CMOS camera ORCA-Flash is used for the read out of the C14245.

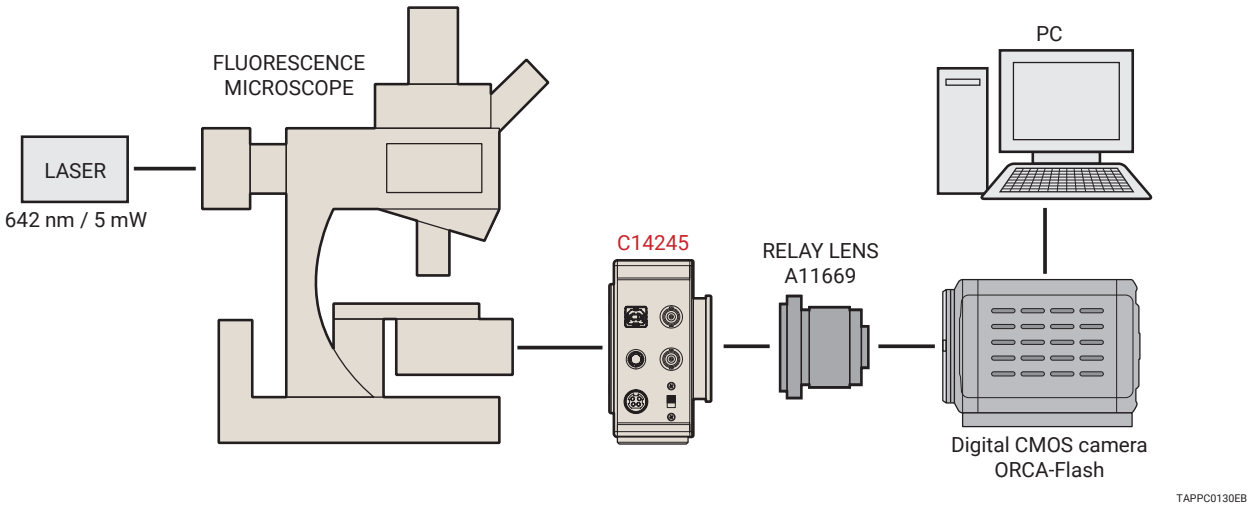
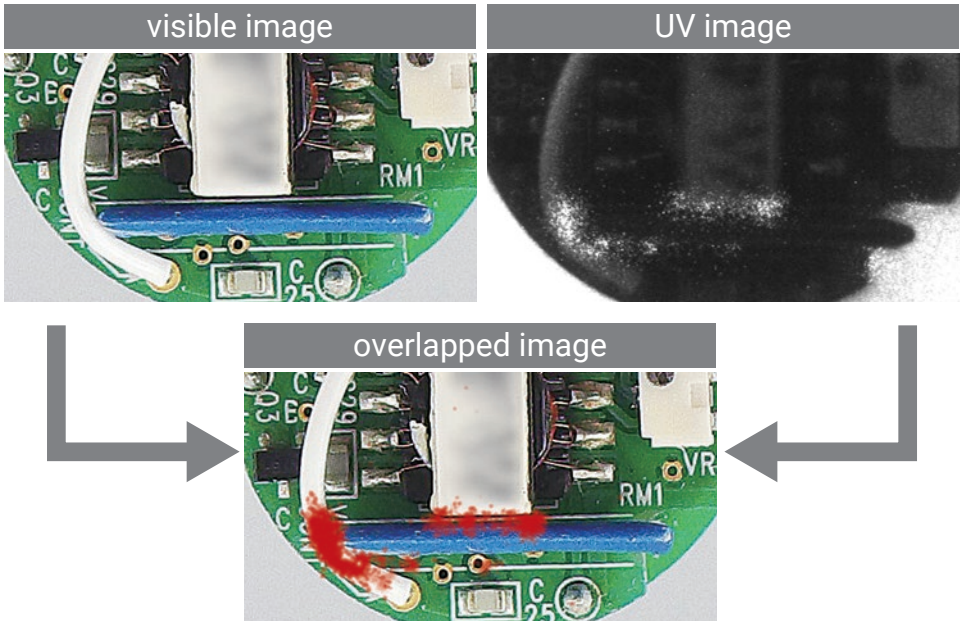


Photo courtesy of Okinawa Institute of Science and Technology Graduate University Membrane Cooperativity Unit
Dr. Akihiro Kusumi, Dr. Taka-aki Tsunoyama

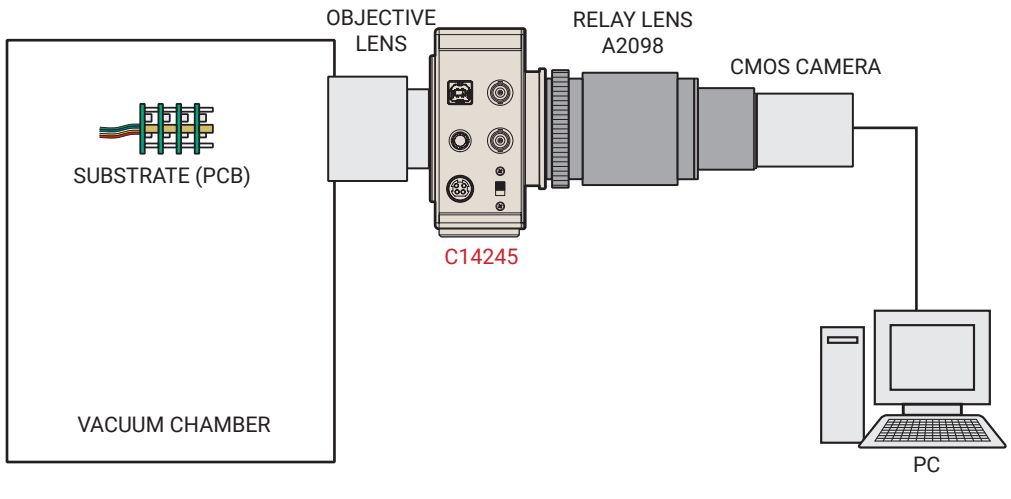
04 Observation of electric discharge phenomenon on a printed circuit board

Electric discharge phenomenon due to insulation defect of the printed circuit board was observed using a gate I.I. unit. Capturing images of electrical discharge phenomenon makes it possible to verify where and how electrical discharges are occurring.

Example images



Imaging system configuration



Information on demonstration offers

Hamamatsu Photonics lends out demonstration equipment to customers for the purpose of examinations, prior to their purchase of a high-speed gated I.I. unit.

Please feel free to contact us and we would be happy to offer our proposals about combination of suitable equipment.

Please direct your inquiries via the QR code indicated to the left or by accessing the URL described below, if a product demonstration is desired.

https://www.hamamatsu.com/jp/en/product/optical-sensors/image-sensor/image-intensifier-unit.html

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