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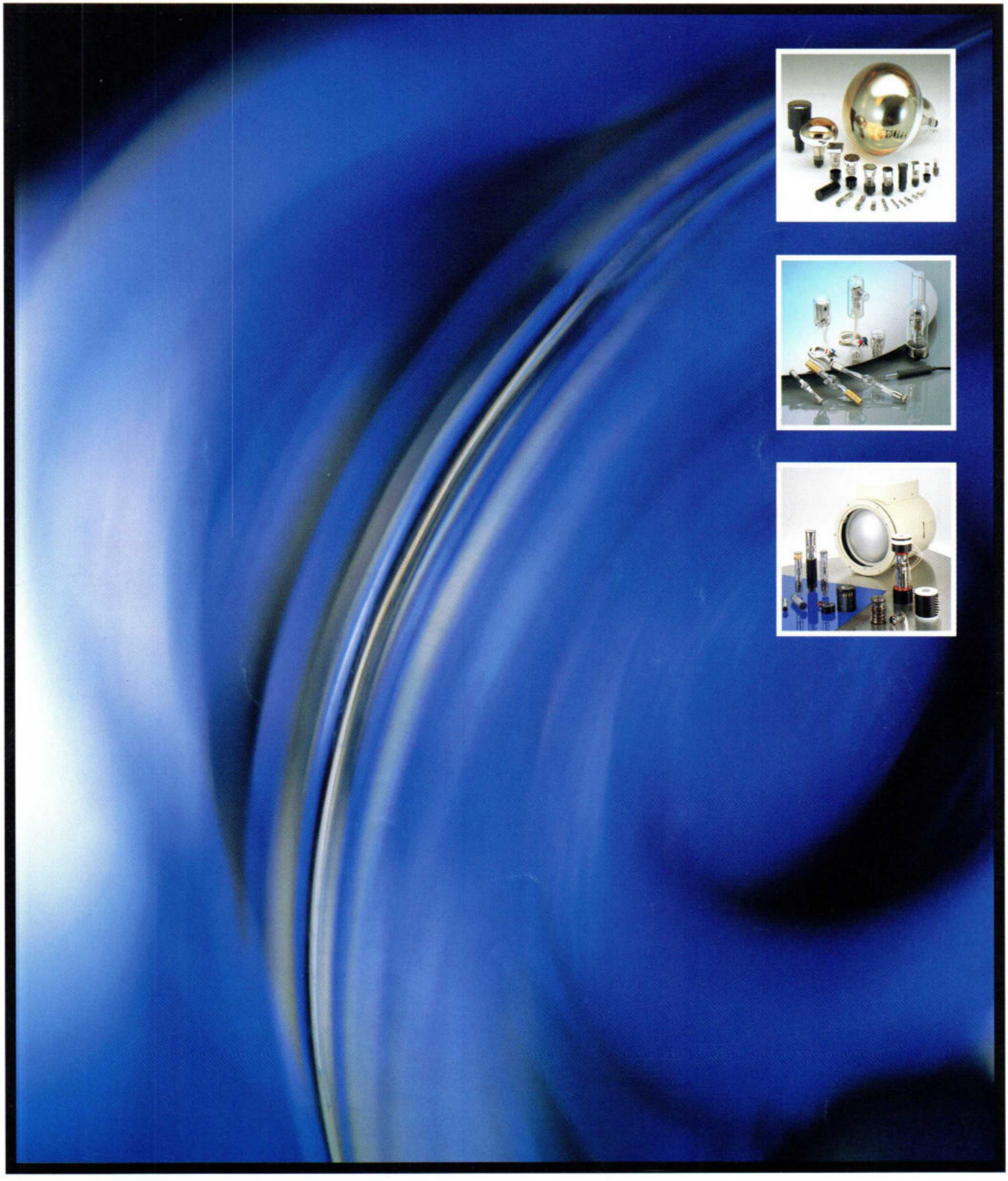
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HAMAMATSU

Electron Tube Products
CONDENSED CATALOG

Photomultiplier Tube/Light Source/Camera Tubes/Image Intensifier/Streak tube/Microchannel Plate



Selection Guide

Hamamatsu Photonics, a leading company in photonics technology, is engaged in the study and applications of light and light-related phenomena.

The Electron Tube Center, a part of Hamamatsu Photonics K.K. supports the progress in the most advanced photonics technologies, for example, ultra-high sensitivity and ultra-high speed metrology. The Electron Tube Center has developed and manufactured a variety of photonic devices and systems. They are widely used in spectroscopy, semiconductor industry, bio-technology and scientific research as well as in medical equipment such as diagnostic imaging systems and blood analyzers. This condensed catalog introduces major products available from Hamamatsu Photonics Electron Tube Center. For further information, please contact our sales office.



Selection Guide by Wavelength

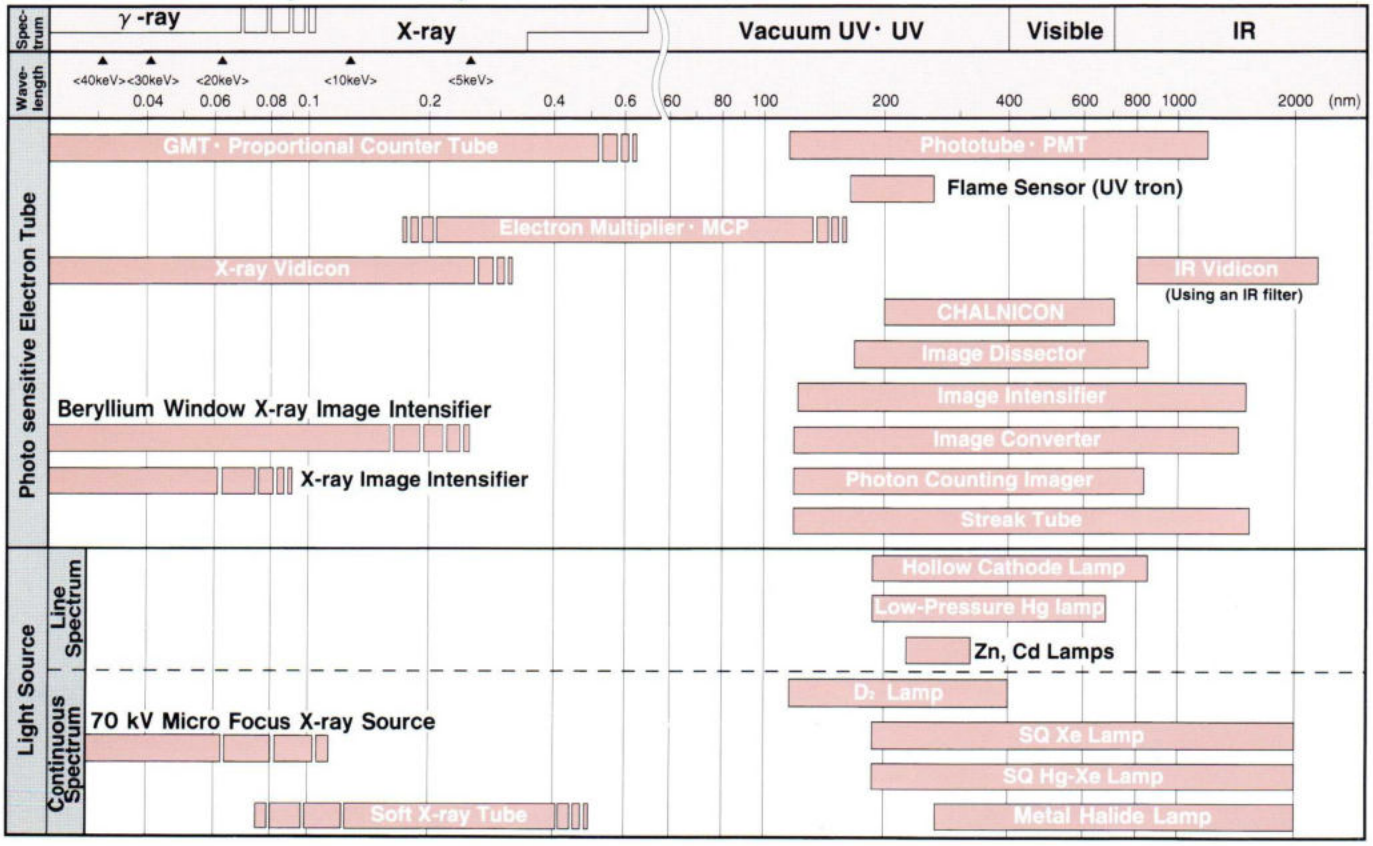


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Photomultiplier Tubes	Super high sensitivity, Low noise, High speed response, Wide variety	Spectroscopy, High energy physics, Medical use, Space, Pollution monitoring, etc.	2
Phototubes	High speed response, Low noise, Excellent linearity, Sensitive to UV	UV monitoring, Laser measurement, Spectroscopy, etc.	6
Flame Sensors (UV TRON®)	Highly reliable sensor only responding to UV.	Flame detection, Flame monitor, etc.	6
Electron Multipliers	Detection of electrons, ions, charged particles, vacuum UV and soft X-ray.	Mass spectroscopy, Solid surface analysis, etc.	7
GM (Geiger-Müller) Tubes	Compact radiation counter tubes for γ-ray and high energy β-ray	Pocket surveymeters, etc.	7
Proportional Counter Tubes	Radiation counter tubes for energy and dose measurement of X-ray and γ-ray	Fluorescent X-ray analyzer, Fluorescent film thickness measuring equipment, Sulfur meters, etc.	7
Vidicons	TV camera tubes for IR, X-ray and UV.	Nondestructive inspection, Industrial TV camera, image processing, moisture imaging etc.	8
CHALNICON®	Low dark current, Excellent color balance, High sensitivity, For visible range, etc.	Medical TV camera, Security or special observation, Radiation-resistant use, etc.	8
Image Intensifiers	Image intensification more than 10^4	Night time viewing, UV observation, Astronomical observation, etc.	9
Image Converters	Invisible to visible conversion	Laser and LED observation, IR microscope, Semiconductor wafer inspection, etc.	9
Photon Counting Imagers	Ultra high sensitivity imaging tubes which use photon counting technology.	Ultra high sensitivity microscope system, Low light level astronomical observation system, etc.	9
X-ray Image Intensifier	Large area imaging tube which converts the very weak X-ray image into visible image.	Medical X-ray diagnostic system, non-destructive inspection, etc.	10
Streak Tubes	Ultra-high speed photodetector with picosecond temporal resolution.	Raman spectroscopy, Measurement of explosion and impulse wave, Evaluation of laser, Analysis of laser fusion, etc.	10
Image Dissectors	No lag, Random-access scanning, etc.	Displacement measurement, Random-access camera, Laser scanning microscope	10
Microchannel Plates (MCP)	2-D detection and multiplication of electrons, ions, charged particles, Vacuum UV, soft X-ray, etc.	Image intensifier, CRT, Mass spectroscopy, ESCA, etc.	12

■ Applied Product	Features	Applications	Page
High Speed Gate Image Intensifier Unit	It can obtain the still image of very fast phenomena at any timing.	Analysis of high speed light emission phenomenon, Ultra low-light level imaging & observation of high speed moving object.	11
CCD Camera with Fiber Optic Window	High resolution CCD camera with fiber optic input window.	For the read-out of high speed gate image intensifier unit.	11
Built-in High Speed Electronic Shutter ICCD Camera Unit.	High speed phenomena is taken at high sensitivity with 1/10,000,000 shutter speed.	Analysis of high speed light emission phenomenon, Ultra low-light level imaging & observation of high speed moving object.	11

■ Optical Component	Features	Applications	Page
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Fiber Optic Plates with X-ray Scintillator	X-ray imaging device that provides higher sensitivity and resolution.	Dental Diagnosis, Mammography, Non-destructive inspection of semiconductor devices	12

■ Functional Material	Features	Applications	Page
Capillary Plates	2-D regular array of glass tubes with a uniform pore diameter and superior linearity.	Flow control, Optical or X-ray collimator, differentialpressure exhaust window, Particle filter, etc.	13

■ Light Source	Features	Applications	Page
Hollow Cathode Lamps	Emitting characteristic line spectrum of each element.	Atomic absorption analysis.	13
Deuterium Lamps	Continuous ultraviolet spectrum.	Spectroscopy, Fluorospectrophotometer, Liquid chromatography, Wafer process, etc.	14
Super-Quiet Xenon Lamps-Continuous Mode	Continuous spectrum from ultraviolet to visible and infrared. Similar to sunlight.	Spectrophotometer, Liquid chromatography, Fluorospectorohotometer, Phosphorospectrophotometer, etc.	15
Super-Quiet Mercury-Xenon Lamps	Continuous spectrum from ultraviolet to infrared including strong mercury line spectra.	Light sources for semiconductor photolithography, UV curing, Interferometers, etc.	15
Super-Quiet Xenon Flash Lamps	Continuous spectrum from ultraviolet to visible and infrared. Pulse operation.	Spectroscopy, Medical inspection, Photosensitive material processing, High-speed camera light source, etc.	16
UV Spot Light Source	Flexible light-guide allows UV illumination on confined area.	Gluing and fixation of optical and electronic parts using UV curing resin.	16
Metal Halide Lamp	Approx. 4 times of luminous efficiency of xenon or halogen lamps.	OHP, LCD projector, Light source for optical fiber, Color printer, Microscope and General light illumination.	17
Pen Type Low-Pressure Mercury Lamps	Line spectra in mainly ultraviolet region	Wavelength calibration for spectroscope, Chromatography, Fluorospectrophotometer, etc.	17
Micro Focus X-ray Source	Micro focusing feature of 10 μm will allow the sample enlargement of more than 50 times without any image deterioration.	Non-destructive X-ray inspection system, Multi-layers PCS X-ray inspection system and X-ray analysis system.	17

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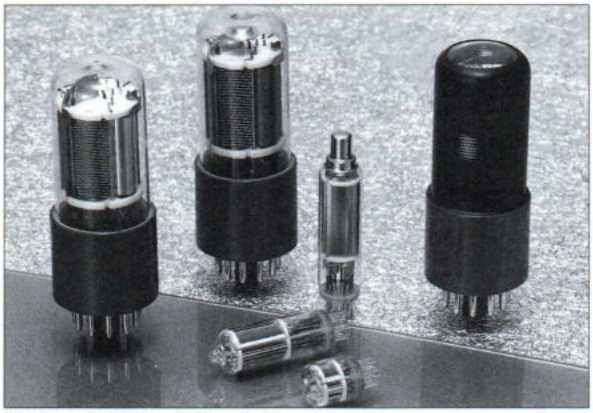
* This catalog provides general information and data regarding Hamamatsu major electron tube products. For more specific information please refer to our sectional catalogs or individual product data sheets which are available from our sales office or Hamamatsu representative. If the values shown on the specification sheet is not given as min. or max., it is typical (or medium) value.

Side-on Photomultiplier Tubes

at 25°C

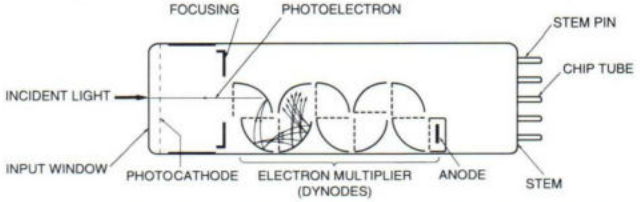
Type No.	Diameter (mm)	Length Max. (mm)	Spectral Response: Range (nm)	Spectral Response: Peak Wavelength λp (nm)	Cathode Sensitivity: Luminous (μA/lm)	Cathode Sensitivity: Radiant at λp (mA/W)	Anode to Cathode Supply Voltage (Vdc)	Anode Sensitivity: Luminous (A/lm)	Anode Sensitivity: Radiant at λp (A/W)	Current Amplification Typ.	Anode Dark Current (after 30min.) Typ. (nA)	Max. Supply Voltage (Vdc)
R5757	φ13 (1/2″)	65	115 to 195	130	–	21	1000	–	2.1×10^4	1.0×10^6	0.5	1250
R5959			115 to 320	200		55			3.8×10^5	7.0×10^5		
R1657		52	160 to 320			40 (at 254nm)			1.0×10^5 (at 254nm)	2.5×10^6		
R427		65										
R1414		50	185 to 650	340	40	48		300	3.6×10^5	7.5×10^6		
R3810		25										
R300		65										
R5785		50	185 to 700	420	100	80		500	4.0×10^5	5.0×10^6	1	
R4457P			185 to 830	530	200	70		1000	3.5×10^5		**20cps	
R3811		25	185 to 850		150	45		200	5.9×10^4	1.3×10^6	1	
R3823		50	185 to 900	600	350	70		2000	4.0×10^5	5.7×10^6		
R1259	φ28 (1-1/8″)	94	115 to 195	120	–	26 (at 122nm)	1000	–	3.1×10^4 (at 122nm)	1.2×10^6	1	1250
R1220			115 to 320	190	–	40 (at 254nm)		–	4.0×10^5 (at 254nm)	1.0×10^7		
R166UH			160 to 320	200	–	40 (at 254nm)		–	4.0×10^5 (at 254nm)			
R106			160 to 650	340	40	48		300	3.6×10^5	7.5×10^5		
R106UH					60	60		1500	1.5×10^6	2.5×10^7		
1P28			185 to 650		40	48		400	4.8×10^5	1.0×10^7	5	
R212								300	3.6×10^5	7.5×10^6	1	
R4332			160 to 750	420	120	91		1200	9.1×10^5	1.0×10^7	5	
931A			300 to 650	400	40	48		400	4.8×10^5		10	
931B					55	60		600	6.6×10^5	1.1×10^7	5	
1P21					40	48		250	3.0×10^5	6.25×10^6	1	
R105								400	4.8×10^5	1.0×10^7	2	
R1527			185 to 680	390	60	60			4.0×10^5	6.7×10^6	0.1	
1P28A			185 to 700	340		56		300	2.8×10^5	5.0×10^6	5	
R4220			185 to 710	410	100	70		1200	8.4×10^5	1.2×10^7	0.2	
R3788			185 to 750	420	120	90			9.0×10^5	1.0×10^7	5	
R2693		90	185 to 650	375	50	62		300	3.7×10^5	6.0×10^6	0.5	
R2368			185 to 850	420	150	64		200	8.3×10^4	1.3×10^6	5	
R4632		94		430	200	80		700	2.8×10^5	3.5×10^6	**50cps	
R955			160 to 900	400	250	74		2500	7.4×10^5	1.0×10^7	3	
R928			185 to 900									
R2949					200	68		2000	6.8×10^5		**300cps	
R1477-06				450	375	80			4.2×10^5	5.3×10^6	3	
R3896					525	90		5000	8.6×10^5	9.5×10^6	10	
R636-10			185 to 930	300 to 800	550	62	1250	250	2.8×10^4	4.5×10^5	0.1 (at 10A/lm)	1500
R2658			185 to 1010	400	100	1 (at 1μm)		16	160 (at 1μm)	1.6×10^5	1	
R5108			400 to 1200	800	25	2.2		7.5	660	3.0×10^5	350 (at 4A/lm)	
R1923	φ38 (1-1/2″) Dome Window Type	76.4*	300 to 800	530	300	89	1250	15	4.4×10^3	5.0×10^4	1	2000

* The length from the top of the tube to the end of the chip tube (exhaust glass pipe), excluding the length of the leads and temporary base.
**Dark counts per second.



Side-on Photomultiplier Tubes

●Operation Principle of Photomultiplier Tubes (Cross-Section of Head-on PMT)



When light enters a photocathode, the photocathode emits photoelectrons into the vacuum, These photoelectrons are then directed by the focusing electrode voltages towards the electron multiplier where electrons are multiplied by the process of secondary emission. The multiplied electrons are collected by the anode as an output signal. Because of secondary-emission multiplication, photomultiplier tubes are uniquely sensitive among photosensitive devices currently used to detect radiant energy in the ultraviolet, visible, and near infrared regions. The photomultiplier tube also features fast time response and low noise.

Head-on Photomultiplier Tubes

at 25°C

Type No.	Diameter (mm)	Length Max. (mm)	Spectral Response: Range (nm)	Spectral Response: Peak Wavelength λp (nm)	Cathode Sensitivity: Luminous (μA/lm)	Cathode Sensitivity: Radiant at λp (mA/W)	Anode to Cathode Supply Voltage (Vdc)	Anode Luminous Sensitivity (A/lm)	Current Amplification Typ.	Anode Dark Current (after 30min.) Typ. (nA)	Anode Pulse Rise Time (ns)	Max. Supply Voltage (Vdc)
R2496	ϕ10 (3/8″)	56.5	160 to 650	420	95	76	1250	100	1.1×10^6	5.0	0.8	1500
R1635			300 to 650									
R1894			300 to 850		120	51		50	4.2×10^5	2		
R1081	ϕ13 (1/2″)	86*	115 to 200	140	–	9.8 (at 122nm)	2000	9.8×10^2 A/W (at 122nm)	1.0×10^5	0.03	1.8	2250
R759		86	160 to 320	210		20 (at 254nm)	1000	1.0×10^4 A/W (at 254nm)	5.0×10^5	0.3	2.5	1250
R647			300 to 650	420	100	76		100	1.0×10^6	1		
R760			160 to 650							1		
R1463			185 to 850		120	51		120		4		
R3478	ϕ19 (3/4″)	80	300 to 650	420	115	88	1700	200	1.7×10^6	30	1.3	1800
R1166		103			105	85	1000	100	9.5×10^5	1	2.5	1250
R1450					115	88	1500	200	1.7×10^6	3	1.8	1800
R2801				375	45	55	1250	300	6.7×10^6	**15cps	2.2	1500
R1617			300 to 850	420	120	51	1000	120	1.0×10^6	4	2.5	1250
R632			400 to 1200	800	20	1.9	1250	10	5.0×10^5	150 (at 4A/lm)	2.2	1500
R1535	ϕ25 (1″)	113	300 to 650	420	115	88	1500	300	2.6×10^6	10	2.4	1800
R1924		57.5			90	85	1000	100	1.1×10^6	3	2.0	1250
R3550				375	50	60			2.0×10^6	**20cps		
R5070		60.5	300 to 900	420	230	65			4.3×10^5	3		
R1459	ϕ28 (1-1/8″)	127	115 to 200	140	–	9.8 (at 122nm)	2000	9.8×10^2 A/W (at 122nm)	1.0×10^5	0.03	9	2500
R431S		107	160 to 320	210		20 (at 254nm)	1000	1.0×10^4 A/W (at 254nm)	5.0×10^5	0.3	12	1500
R6095		127	300 to 650	420	95	88		200	2.1×10^6	2	4	
R3998-02		75			90	85		120	1.3×10^6		3.4	
R1355		113			95	88	1500	200	2.1×10^6	10	2.0	1900
R1282		112		375	40	51	2000	400	1.0×10^7	5	9	2500
R374		127	185 to 850	420	150	64	1000	80	5.3×10^5	3	15	1500
R5929			300 to 900		230	65		180	7.8×10^5	5		
R2228				650	200	40		150	7.5×10^5	8		
R316			400 to 1200	800	20	1.9	1250	10	5.0×10^5	1000 (at 4A/lm)	10	
R980	ϕ38 (1-1/2″)	116	300 to 650	420	100	90	1000	35	3.7×10^5	3	2.8	1250
R580		127			95	88	1250	100	1.1×10^6	3	2.7	1750
R1387		116	300 to 850		150	64	1000	50	3.3×10^5	4	2.8	1250
7102			400 to 1200	800	25	2.4	1250	5	2.0×10^5	1500 (at 4A/lm)	2.2	1500
R6231	ϕ51 (2″)	113	300 to 650	420	110	95	1000	30	2.7×10^5	2	5.0	1500
R1306		137									7.0	
R1828-01		192			90	85	2500	1800	2.0×10^7	50	1.3	3000
R2083		136			80	80	3000	200	2.5×10^6	100	0.7	3500
R5496							2500	1000	1.3×10^7		1.5	3000
R331-05		141			90	85	1500	120	1.3×10^6	18 cpm (Background noise)	2.6	2500
R329-02		142						100	1.1×10^6	6	2.6	2700
R464		141			50	50	1000	300	6.0×10^6	**5cps	13	1500
R375		127	160 to 850		150	64		80	5.3×10^5	5	9.0	

* The length from the input window to the end of the chip tube (exhaust glass pipe), excluding the length of the leads and temporary base.
** Dark counts per second.

●Applications

Spectroscopy	UV/Visible/IR Spectrophotometer, Atomic Absorption Spectrophotometer, Photoelectric Emission Spectrophotometer, Fluorescence Spectrophotometer, Raman Spectroscopy, Chromatography, etc.
Medical Applications	Radioimmunoassay, Fluorescence Immunoassay, Gamma Camera Positron CT, Liquid Scintillation Counter, X-ray Phototimer, etc.
High Energy Physics	Hodoscope, TOF Counter, Cherenkov Counter, Calorimeter, Air Shower Counter, etc.
Biotechnology	Cell Sorter, Fluorometer, etc.
Pollution Monitoring	Dust Counter, Turbidmeter, Door Monitor, etc.
Resource Inquiry	Oil Well Logging, etc.
Process Control	Thickness Meter, Laser Scanner, etc.
Photography and Printing	Color Scanner, Flying Spot Scanner, etc.
Others	Laser Radar, Measurement of Astronomical X-ray, Plasma Observation, etc.



Head-on Photomultiplier Tubes

Head-on Photomultiplier Tubes

at 25℃

Type No.	Diameter (mm)	Length Max. (mm)	Spectral Response Range (nm)	Spectral Response Peak Wavelength λp (nm)	Cathode Sensitivity Luminous (μA/lm)	Cathode Sensitivity Radiant at λp (mA/W)	Anode to Cathode Supply Voltage (Vdc)	Anode Luminous Sensitivity (A/lm)	Current Amplification Typ.	Anode Dark Current (after 30min.) Typ. (nA)	Anode Pulse Rise Time (ns)	Max. Supply Voltage (Vdc)
R550		147	300 to 850	420	150	64		100	6.7×10^5	10	9.0	
R649	φ51 (2″)	141			120	51	1000	800	6.7×10^6	200 cps***	13	1500
R669		127	300 to 900	650	230	50		75	3.3×10^5	7	9.0	
R943-02		104	160 to 930	300~800	600	71	1500	300	5.0×10^5	20 cps*** (at-20℃)	3.0	2200
R6232	φ60	101.5*	300 to 650	420	110	95	1000	30	2.7×10^5	2	6.0	1500
R6091	φ76 (3″)	152			90	85	1500	450	5.0×10^6	10	2.6	2500
R1307		150			110	95	1000	30	2.7×10^5	2	8.0	1500
R6233		123									6.0	
R1911		114*			100	90	1500		3.0×10^5	5	11	1800
R2238		69.5*			60	65	1250		5.0×10^5		5.5	1500
R877	φ127 (5″)	194			80	80	1250	40	5.0×10^5	10	10	
R1250		281			70	72	2000	1000	1.4×10^7	50	2.5	3000

Hemispherical Envelope Photomultiplier Tubes

R5912	φ202(8″)	290	300 to 650	420	80	76	1500	800	1.0×10^7	50	3.0	2500
R3600-02	φ508(20″)	683			60	65	2000	600		200	10	

Special Envelope Photomultiplier Tubes

R2248	9.8×9.8	56.5	300 to 650	420	95	76	1250	100	1.1×10^6	5	0.8	1500
R2102	13.5×13.5	86			100		1000		1.0×10^6		2.5	1250
R2497	26×26	112.5*			115	88	1500	300	2.6×10^6	50	2.4	1800
R1548	24×24	85			80	76	1250	200	2.5×10^6	20	1.8	1750
R6234-01	60/Ⓐ Hexagon	101.5*			110	95	1000	30	2.7×10^5	2	6.0	1500
R6236-01	60×60	101*										
R6235-01	76 Hexagon	101.5										
R6237-01	76×76	101.5*										
R1612	88×40	148			70	72			4.3×10^5	4	13	1250

Microchannel Plate Photomultiplier Tube [Effective Area φ11mm dia.]

R3809U-50	φ45	70.2	160 to 850	430	150	60	−3000	30	2.0×10^5	0.2	0.15	−3400
R3809U-51			160 to 900	600	350	40		70		1.0		

Microchannel Plate Photomultiplier Tube with Gated Type [Effective Area φ10mm dia.]

R5916U-50	φ55	71.5	160 to 850	430	150	60	−3000	30	2.0×10^5	0.2	0.18	−3400

Photomultiplier Tube for High Magnetic Environment

R5505	φ25	54.5	300 to 650	420±50	80	76	2000	40	5.0×10^5	5	1.5	2300
R5946	φ39	65						80	1.0×10^6		1.9	
R5924	φ52				70	72		700	1.0×10^7	30	2.5	
R5542	φ76	70								80	2.9	

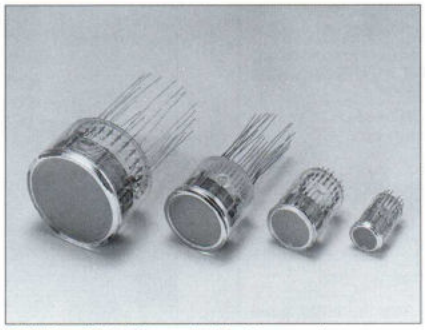
Position Sensitive Photomultiplier Tubes

R2486-02	φ76(3″)	89.2**	300 to 650	420	80	72	1250	8	1.0×10^5	20	5.5	1300
R2487-02	78×78	103.2**										
R3292-02	φ130	133								40	6.0	

Ⓐ The regular hexagonal input window of 68mm in diagonal.
* The length from the input window to the end of the chip tube (exhaust glass pipe), excluding the length of the leads and temporary base.
** The length from the input window to the position signal output circuit board.
*** Values averaged per second.



MCP-PMT



PMT for High Magnetic Environment



Position Sensitive PMT

Metal Package Photomultiplier Tube

R5600U series is the world smallest photomultiplier tube made into TO-8 metal package.

at 25°C

Type No.	Diameter (mm)	Length Max. (mm)	Spectral Response: Range (nm)	Spectral Response: Peak Wavelength λp (nm)	Cathode Sensitivity: Luminous (μA/lm)	Cathode Sensitivity: Radiant at λp (mA/W)	Supply Voltage (Vdc)	Anode Luminous Sensitivity (A/lm)	Current Amplification Typ.	Anode Dark Current (after 30min.) Typ. (nA)	Anode Pulse Rise Time (ns)	Max. Supply Voltage (Vdc)
R5600U	φ15.9	11.5	300 to 650	420	70	70	800	21	3.0×10^5	0.5	0.65	1000
R5600U-01			300 to 820		100	52		30		1.0		
R5600U-03			185 to 650		70	70		21		0.5		
R5600U-04			185 to 820		100	52		30		1.0		
R5600U-06		13.0	160 to 650		70	70		21		0.5		

"P" types (ex.R5600P-suffix) selected for Photon Counting are available.

Photo Sensor Module

H5773/H5783/H5784 series is a new type of photo sensor which combines metal package PMT and high voltage power supply into one package. H5784 series have a low noise amplifier.

at 25°C

Type No.	Spectral Response: Range (nm)	Spectral Response: Peak Wavelength λp (nm)	Radiant at 420nm (at +0.8V) Note1	Anode Dark Current (at +0.8V) Note2	Anode Pulse Rise Time (at +0.8V) (ns)	Supply Voltage (Vdc)	Recommended Control Voltage Range (V)	Max. Supply Voltage (Vdc)	Max. Output Note3	Configuration
H5773	300 to 650	430	21	0.5	0.65	+11.5 to +15.5	+0.25 to +0.95	+18	100	PC-board mounting type
H5773-01	300 to 820		15	1.0						
H5773-03	185 to 650		21	0.5						
H5773-04	185 to 820		15	1.0						
H5773-06	185 to 650		21	0.5						
H5783	300 to 650	430	21	0.5	0.65	+11.5 to +15.5	+0.25 to +0.95	+18	100	Cable output type
H5783-01	300 to 820		15	1.0						
H5783-03	185 to 650		21	0.5						
H5783-04	185 to 820		15	1.0						
H5783-06	185 to 650		21	0.5						
H5784	300 to 650	430	21	±3	–	±11.5 to ±15.5	+0.25 to +0.95	±18	10	Cable output type
H5784-01	300 to 820		15	±3						
H5784-03	185 to 650		21	±3						
H5784-04	185 to 820		15	±3						
H5784-06	185 to 650		21	±3						

"P" type (ex.H5783P-suffix) is available for H5773 & H5783 series. Incorporated PMT is selected for Photon Counting.

Note1: H5773/H5783 series···(μA/nW) H5784 series···(V/nW)

Note2: H5773/H5783 series···(nA) H5784 series···Output Offset (mV)

Note3: H5773/H5783 series···(μA) H5784 series···(V)

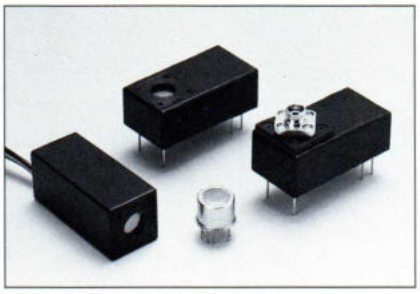
Photo Sensor Module

H5700 series is compact low light level detector module with built-in cockcroft-walton high voltage power supply and 13 mm diameter side-on photomultiplier into aluminum case. H5701/H5702 series further include amplifier which converts the PMT output current into voltage. The series features high sensitivity, low power consumption and excellent linearity.

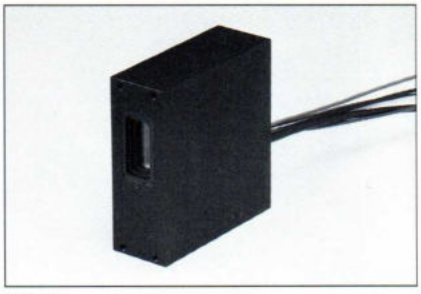
H5700 series is a current output type while H5701/H5702 series is a voltage output type.



LEFT: R5600 RIGHT: R5600U



LEFT: H5783 CENTER: H5773
RIGHT: H5773 with Fiber Adaptor
FRONT: R5600



H5700

Phototubes

at 25°C

Type No.	Figure	Spectral Response		Radiant Sensitivity at λp	Dark Current Max.	Operating Voltage	Max. Anode Supply Voltage
		Range (nm)	Peak Wavelength λp (nm)	(mA/W)	(pA)	(Vdc)	(Vdc)
R727	φ21mm Head-on	185 to 650	340	70	2.0	15	100
R5764	φ15mm Head-on	160 to 200	165	3			
R765		160 to 320	240	20	1.0		
R1228		185 to 320					

Biplanar Phototube/For Pulsed Laser Observation

at 25°C

Type No.	Spectral Response		Anode Supply Voltage	Luminous Sensitivity	Dark Current Max.	Rise Time	Fall Time	Max. Anode Supply Voltage
	Range (nm)	Peak Wavelength λp (nm)	(Vdc)	(μA/lm)	(nA)	(ps)	(ps)	(Vdc)
R1193U-51	300 to 1100	750	2500	20	50	270	100	2500
-52	185 to 650	340		50				
-53	300 to 850	400		80				
-54	115 to 320	200		15mA/W (at 254nm)				
-55*	180 to 350	220		15μA/W (at 248nm)			130	
R1328U-51	300 to 1100	750	2000	20	100	60	55	2000
-52	185 to 650	340		50				
-53	300 to 850	400		80				
-54	115 to 320	200		15mA/W (at 254nm)				

* For waveform observation of excimer laser

High-Voltage Power Supply C3463-50 for Biplanar Phototubes

The C3463-50 is a high-voltage power supply specifically designed for biplanar phototubes. It provides a maximum of 2.5kV and is supplied with a high voltage cable (E1168).

ND Filter E3331 for R1193U-55 Biplanar Phototube

The E3331 ND (neutral density) filter is provided for measurement of ArF (193nm) or KrF (248nm) excimer laser. It easily fits onto the R1193U-55 biplanar phototube and allows high laser power to directly enter the phototube.

Flame Sensors (UV TRON®)

at 25°C

Type No.	Spectral Response range (nm)	Maximum Ratings		Recommended Operating Condition		Characteristics (at 25°C)		
		Average Discharge Current (mA)	Operating Temperature (°C)	Operating Voltage (Vdc)	Average Discharge Current Max. (mA)	Discharge Starting Voltage Max. (Vdc)	Discharge Sustaining Voltage (Vdc)	Sensitivity Ⓐ (cpm)
R2868*	185 to 260	1	-20 to +60	325±25	0.1	280	185	5000
R1753-01		3	-20 to +125		0.3	260		10000
R259							220	600
R259-01	185 to 300	5			0.5		200	200

* The driving circuit C3704 series are available for the R2868.

Ⓐ Wavelength :200nm, Light intensity :10pW/cm²



Photo Tubes



Flame Sensors (UV TRON®)

Electron Multipliers

at 25°C

Type No.	Dynode				Characteristics			Anode to All Ohter Electrode Capacitance (pF)	Maximum Ratings				
	Number of Stage	Structure	Material	Radiation Opening (mm)	Supply Voltage (Vdc)	Current Amplification	Rise Time (ns)		Anode of First Dynode Voltage (Vdc)	Anode to Last Dynode Voltage (Vdc)	Ⓐ Average Anode Current (μA)	Operating Vacuum Level (Pa)	Operating Vacuum Level (torr)
R474	16	Box-and-Grid	Cu-BeO	8×6	2400	1×10^6	9.3	5.0	4000	350	10	1.3×10^{-2}	1×10^{-4}
R515								4.0					
R596				12×10			10	9.0		400			
R595	20				3000	4×10^7	12	9.0	5000				
R2362	23	Mesh	Cu-BeO	ϕ20	3450	5×10^5	3.5	23	4000	350			

- Types with large opening of 58mm (R2363) and 105mm (R2364) in diameter are also available.
- Super-compact type R4146 is also available.

Ⓐ Average over any interval of 30 seconds maximum

GM (Geiger-Müller) Tubes

at 25°C

Type No.	Dimensions Max. (mm)	Effective Length Min. (mm)	Filling Gas	Capacitance of Anode to Cathode (pF)	Starting Voltage Max. (V)	Plateau Voltage (V)	Plateau Slope Max. (%/V)	Ⓐ Background Max. (cpm)	Life Expectancy (counts)	Equivalent Tube
Compact GM Counter Tubes										
D3372	ϕ6.2×37	16	He,Ne,Halogen	3	380	500 to 650	0.15	2	5×10^{10} (4500cps)	Philips 18509
D3553	ϕ6.2×27	8		2.5	400	500 to 600	0.3	1	1×10^{10} (3200cps)	Philips 18529
D3517	ϕ6.2×24	5								–
High-Sensitivity GM Counter Tubes										
D4345	ϕ25×235	170	He,Ne,Halogen	9	420	500 to 650	0.15	80	1×10^{10} (1000cps)	–

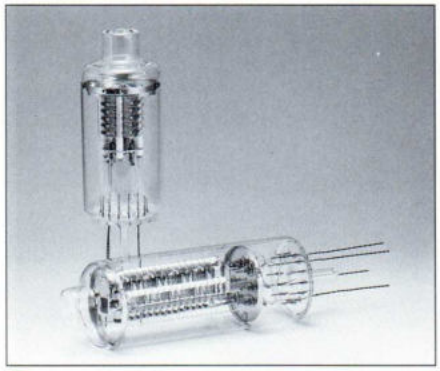
Ⓐ Shield with 50mm Pb and 3mm Al

Proportional Counter Tubes

at 25°C

Type No.	Dimensions (mm)	Effective Area (mm)	Filling Gas	Path Length (mm)	Operating Voltage Range (Vdc)	Recommended Operating Voltage (Vdc)	Ⓐ Energy Resolution (%)	Capacitance (pF)
D1286	ϕ38×120	20×20	$Ne+CO_2$	30	1200 to 1400	1300	19	2.5

Ⓐ Measured with ^{55}Fe source (5.9keV)



Electron Multipliers



Compact GM Counter Tubes



Proportional Counter Tubes

Vidicons

at 25°C

Type No.	Applications	Features	Diameter mm(inch) / Length(mm)	Method: Focusing	Method: Deflection	Dark Current (nA)	Sensitivity: Signal Current (nA)	Sensitivity: Faceplate Illuminance (lx)	Limiting Resolution at Center (TV lines)	Lag after 3TV fields (%)
Infrared Vidicons										
N2634 N2634-01	Night Surveillance, Scientific Surveys, Temperature Measurement, Infrared Laser Monitoring, Semiconductor Inspection, Moisture Imaging	Wavelength Range 400 to 1800nm	18 (2/3) / 103	Electromagnetic	Electromagnetic	5	150	(On IR filter) 10lx	550	40
N2635 N2635-50		Wavelength Range 400 to 2000nm					60			25
N2606 N2606-01 N2606-02	Semiconductor Inspection, Optical Fiber Inspection in Optical communications, Night Surveillance, Scientific Surveys, Temperature Measurement, Moisture Imaging	High resolution Wavelength Range 400 to 1900nm	25 (1) / 159				250	(On IR filter) 10lx	700	60
N2606-06		High resolution Wavelength Range 400 to 2200nm				12			650	
N2606-40		Moisture Imaging (1940nm)				–	2nA/μW (Measured through 1.94μm filter)			
N4585	Infrared laser monitoring	1300 to 1600nm				8	180	(On IR filter) 10lx		
X-ray Vidicons										
N603	Nondestructive X-ray Inspection, X-ray Topography	Beryllium Faceplate, High Resolution	25 (1) / 159	Electromagnetic	Electromagnetic	1	100	100R/min. (30kVp)	380	25
N400		Beryllium Faceplate, Wide Field of View	38(1-1/2) / 195				200		600	30

CHALNICON® /High-Sensitivity Camera Tubes

at 25°C

Type No. Ⓐ	Applications	Diameter mm(inch) / Length(mm)	Method: Focusing	Method: Deflection	Dark Current (nA)	Sensitivity: Signal Current (nA)	Sensitivity: Faceplate Illuminance (lx)	Limiting Resolution at Center (TV lines)	Lag after 3TV fields (%)
N3111 (X)·(D)/E5001 (X)·(D)	Industrial TV camera X-ray TV camera for Medical	25 (1) / 159	Electromagnetic	Electromagnetic	0.7	160	0.5	900	25
N3114 (X)·(D)/E5063 (X)·(D)								850	10
N3124/E5197A	Compact Industrial TV camera X-ray TV camera for Medical	18 (2/3) / 103	Electrostatic		0.5		1	750	5
N3113 (D)/E6061 (D)			Electromagnetic					700	
N3127	Radiation-tolerant Use		Electrostatic			70		360	
N3128						150		600	
N4716			Electromagnetic					750	
N6068		25 (1) / 159			0.7		0.5	850	10

Ⓐ The suffix letters, (X) and (D), indicate recommended applications: (X) for X-ray TV cameras; (D) for general-purpose industrial use. They are mainly differentiated according to the spurious signal specifications.



Vidicons



CHALNICON®

Image Intensifiers

at 25°C

Type No.	Spectral Response		Photocathode		Phosphor Screen		High Voltage Power Supply	Photocathode Radiant Sensitivity	Limiting Resolution (Center) Typ.	Distortion Typ.	Gain	
	Range (nm)	Peak Wavelength (nm)	Effective Diameter Min. (mm)	Window Ⓐ Material / Thickness (mm)	Effective Diameter Min. (mm)	Window Ⓐ Material / Thickness (mm)		(mA/W)	(lp/mm)	(%)	Luminous (lm/m²/lx)	Radiant Ⓑ (W/m²/W/m²)
Inverter Types												
V1366P	350 to 910	750	ϕ25	F/3.3	ϕ25	F/7	Included	50 (at 800nm)	30	5	6×10^4	–
V3843U			ϕ20		ϕ13		Option		50	4	250	
Proximity Focused Types												
V5255U	160 to 850	430	ϕ11.3	Q/4.9	ϕ11.3	F	Option	60Ⓑ	30	0	1.2×10^4	8.7×10^3
V2697U			ϕ18	Q/5.5	ϕ18							
V3063U*								47Ⓑ			1.1×10^4	6.8×10^3
V4323U**											1.0×10^4	
V5548U**								60Ⓑ			1.2×10^4	8.7×10^3
V4170U									25		5.0×10^5	4.0×10^6
V4183U*								47Ⓑ			4.0×10^6	3.0×10^6
V3346U			ϕ25	Q/5.9	ϕ25			60Ⓑ	30		1.2×10^4	8.7×10^3
V3347U*								47Ⓑ			1.1×10^4	6.8×10^3
V5180U			ϕ40	Q/5.7	ϕ40			60Ⓑ			1.2×10^4	8.7×10^3
V5181U*								47Ⓑ			1.1×10^4	6.8×10^3
V4136U			6.6×8.8	Q/5.5	6.6×8.8			60Ⓑ	32		7.0×10^3	5.1×10^3

Ⓐ F: Fiber optic Q: Synthetic silica Ⓑ at peak wavelength

- For proximity-focused types, other spectral responses are also available.

* Nano second gating is possible.

** Subnano second gating is possible.

- The V4136U is designed for fiber-coupling to CCD cameras for high-resolution TV cameras.
- 1 (lm/m²/lx) = 1 (ft-L/ft-c)

Image Converters

at 25°C

Type No.	Spectral Response		Photocathode		Phosphor Screen		Limiting Resolution (Center) Typ.	Distortion Typ.	Conversion index	Gain
	Range (nm)	Peak Wavelength (nm)	Effective Diameter Min. (mm)	Window Ⓐ Material / Thickness (mm)	Effective Diameter Min. (mm)	Window Ⓐ Material / Thickness (mm)	(lp/mm)	(%)	(cd/m²/lx)	Radiant Ⓑ (W/m²/W/m²)
V1365	300 to 1600	800	ϕ11	B/1.55	ϕ11	B/1.5	60	14	30	–

Ⓐ B: Borosilicate glass Ⓑ at peak wavelength

Photon Counting Imagers

At ultra-low light levels, it is difficult to detect and measure light as an analog quantity and the technique of detecting light as particles (photons) is more effective. However, the signal resulting from individual photons is so weak that an image cannot be obtained directly from the photon signal. The photon counting imager is a ultra-high sensitivity imaging tube that can detect individual photons at such ultra-low light levels. It provides position information of the incident photons to create an image.

at 25°C

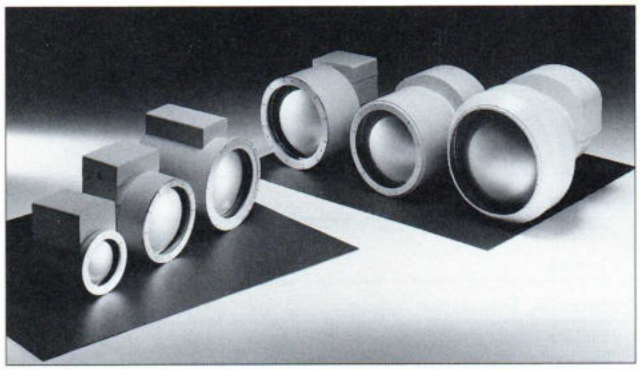
Type No.	Spectral Response		Photocathode		Phosphor Screen		Cathode Radiant Sensitivity at 400mm	Analog Mode	Photon Counting Mode	Distortion	Gain	
	Range (nm)	Peak Wavelength (nm)	Effective Diameter Min. (mm)	Window Ⓐ Material / Thickness (mm)	Effective Diameter Min. (mm)	Window Ⓐ Material / Thickness (mm)	(mA/W)	(lp/mm)	(lp/mm)	(%)	Luminous (lm/m²/lx)	Radiant Ⓑ (W/m²/W/m²)
Inverter Types												
V2025U	300 to 650	380	ϕ15	B/1.5	ϕ15	F	70	18	15	5	10^3 to 5×10^6	1×10^7
V2025U-13	160 to 850			Q/1.5			60				5×10^3 to 10^7	9×10^6
Proximity Focused Types												
V5102U	160 to 850	430	ϕ18	Q/5.5	ϕ18	F	60Ⓑ	20	–	0	7.2×10^7	5.2×10^7
V5103U							47Ⓑ				6.4×10^7	4.1×10^7

Ⓐ B: Borosilicate glass F: Fiber optic Q: Synthetic silica Ⓑ at peak wavelength

- V5103U is capable for nano second gate operation.
- 1 (lm/m²/lx) = 1 (ft-L/ft-c)

X-ray Image Intensifiers

X-ray image intensifiers are large diameter imaging tubes that convert low-contrast images into visible light images, and are used in medical X-ray TV systems and non-destructive X-ray inspection systems. Due to a newly developed CsI input phosphor screen, Hamamatsu X-ray image intensifiers provide high DQE (quantum detection efficiency) and high-quality images. Furthermore, the use of an aluminum input window and the improvement in the output phosphor screen achieve a very high contrast. In particular, the high definition types offer superior spatial resolution that assures an exceptionally clear image even for microstructures in a stomach mucous membrane that has previously been obtained only with high-sensitivity photographic film. In addition, the combination of new input/output phosphor screens and an electron lens designed by computer simulation allows high-quality images even in the digital imaging method.



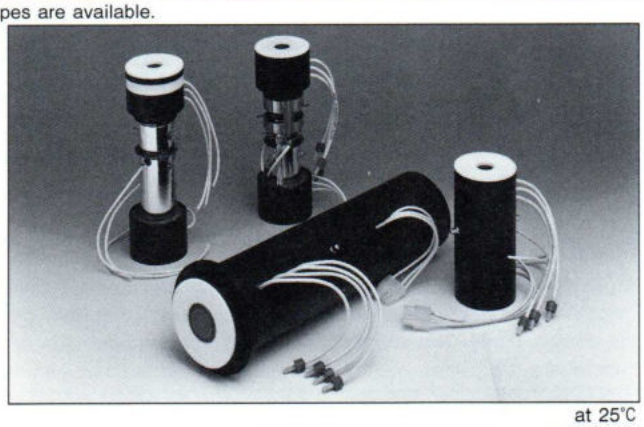
at 25°C

Type No.	Input Window			Output Window		Limiting Resolution	Conversion Factor		Contrast Ratio	QDE	Distortion	Background Max.
	Effective Diameter Typ. (mm)	Input Phosphor Screen Material	Window Material Thickness	Effective Diameter Typ. (mm)	Input Phosphor Screen Material	(lp/cm)	(cd/m²)/(μC/kg·s)	(cd/m²)/(mR/s)		(%)	(%)	(cd/m²)
V5445P	φ150	CsI	Beryllium	φ25.0	P-20	65	200	50	20 : 1	–	5	0.02
V3732P (6",4")	φ150	CsI	Aluminum	φ14.5	P-20	46	700	180	20 : 1	60	5	0.02
	φ105					60	–	–	–		–	–
V5914P (9")	φ220	CsI	Aluminum	φ20	P-20	44	1100	280	25 : 1	60	5.5	0.02
V2465P (9",6",4.5")	φ213	CsI	Aluminum	φ20	P-20	44	1400	350	25 : 1	60	5	0.02
	φ155					50	–	–			–	–
	φ115					60	–	–			–	–
High Definition V3733P (12",9",7")	φ293	CsI	Aluminum	φ60	P-20	70	180	45	35 : 1	60	10	0.02
	φ235					75	–	–	–		–	–
	φ185					83	–	–	–		–	–
High Definition V5213P (16",12",9",7")	φ360	CsI	Aluminum	φ60	P-20	55	250	65	35 : 1	60	14.5	0.02
	φ293					65	–	–	–		–	–
	φ235					70	–	–	–		–	–
	φ185					80	–	–	–		–	–

* Variant models such as integral power supply types and μ metal housing types are available.

Streak Tubes

The streak tube is an ultra-high speed photodetector which is capable of capturing ultra-short events on the scale of picoseconds. It can measure not only changes in light intensity with respect to time but also one-dimensional spatial information. For example, it can be used for time-resolved spectroscopy, spatially time-resolved measurement, and so on.
Hamamatsu offers a wide variety of streak tubes. They are suitable for a wide range of applications with sensitivity from the X-ray to the ultraviolet, visible and near infrared range.



at 25°C

Type No.	Spectral Response		Effective Photocathode Area Min.	Effective Phosphor Screen Area Min.	Photocathode Sensitivity			Temporal Resolution	Limiting Resolution (Center)	Gain
	Range (nm)	Peak Wavelength λp (nm)		(mm)	Luminous (μA/lm)	Radiant at 240nm (mA/W)	Radiant at 820nm (mA/W)	(ps)	(lp/mm)	MCP (at 900V)
N4320	200 to 900	420	0.07×6	φ15	150	10	7	<20	40	5×10^3
N5716			0.5×6					<2	50	
N3373			φ3					<0.6	75	

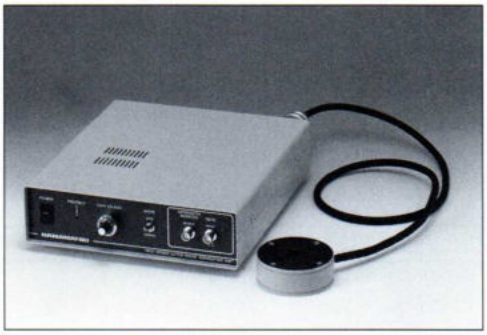
Image Dissectors/No Lag; For High-speed Tracking and Displacement Measurement

Unlike general camera tubes, the image dissector can offer no lag because it does not use the storage effect. it is possible to carry out random-access scanning by which any point on the photocathode can be read out at high-speed. at 25°C

Type No.	Diameter mm(inch)	Effective Photocathode Diameter (mm)	Ⓐ Focusing Method / Ⓑ Deflection Method	Absolute Maximum Ratings		Typical Characteristics						
				Photocathode Current Density (nA/mm²)	Anode Current (μA)	Photocathode Sensitivity (μA/lm)	Anode Sensitivity (nA/lx)	Electron Amplification	Amplitude Response (%)	Distortion (%)	S/N rms (10lx, Δf=100kHz) (dB)	Aperture Diameter (μm)
N1070-01	25(1)	φ16	M/M	30	10	150	47	1×10^6	65 (800 TV Lines/inch)	±2.5	10	φ20
N2730	25(1)	φ15	S/M	10	10	150	46000	5×10^6	50 (50 TV Lines/inch)	±2.5	30 (at1lx)	φ400

Ⓐ M: Electromagnetic focus S: Electrostatic focus Ⓑ M: Electromagnetic deflection

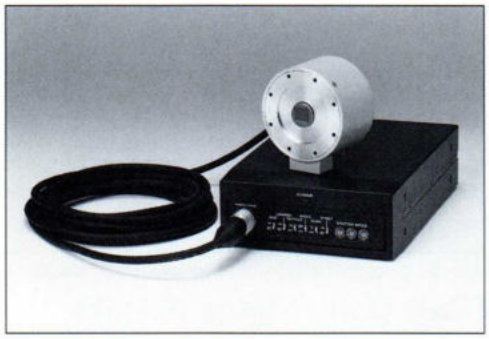
High Speed Gate Image Intensifier Unit



C2925-01, C4078-01, C4273 & C4274 are the high speed gate image intensifier unit developed for low light level high speed phenomena imaging.
Simply coupling the CCD camera at the unit head, it works as a high speed shutter camera. It can take a still image of any timing of high speed phenomena. It can be used for the applications such as observation of bioluminescence or discharge phenomena, and any other fast moving phenomena.

Parameter	C2925-01	C4078-01	C4273	C4274	Unit
Built-in Image Intensifier Characteristics					
Cathode Sensitivity	150				μA/lm (Typ.)
Luminous Emittance Gain	7.0×10^3	1.0×10^6	7.0×10^3	1.0×10^6	lm/m^2/lx (Min.)
Limiting Resolution	23	20	23	20	lp/mm (Min.)
Effective Diameter	ϕ17.5				mm
Function Mode/Protection					
Operation Mode	Normal Mode/Gate Mode				–
Excessive Incident Light Protection	YES		NO		–
Gate Signal Input					
Level	TTL, Positive Logic (5Vp-p Max.)				–
Input Impedance	50				Ω
Pulse Width	10 to DC		100 to DC		ns
Repetition Frequency	10 (with Limiting Circuit)				kHz (Max.)
Gate Output					
Gate Time	3 to DC		100 to DC		ns

CCD Camera with Fiber Optic Window



C5895 series employs high resolution CCD camera with fiber optic plate as an input window. It is designed for the read-out device for the fiber optic output image such as an image intensifier. Compared to the conventional lens coupling, it reduces the light loss so that the sensitivity can be increased by a factor of 3 to 10 times.

Parameter		C5895	C5895-01	Unit
Output Signal Method		EIA	CCIR	–
Image Area		12.8×9.6 (1 inch)		mm
Resolution	Horizontal	570	560	TV Lines
	Vertical	485 (2:1 interlace)	575 (2:1 interlace)	TV Lines

Built-in High Speed Electronic Shutter ICCD Camera Unit



Conventional high speed shutter camera had some limitation in taking a low light level image since the input light level reduces in proportion to the shutter speed. Accordingly, it can take the image only under high illumination other than strong light emmissive objects. This ICCD unit employs the image intensifier carrying high speed shutter function (minimum shutter speed of 100ns.) so that it makes high sensitivity and fast time resolving image aquisition for the fast phenomena possible. The unit contains AGC and high incident light protection functions so that it allows fail-safe operation.

Difference Among Each Camera Unit

Parameter	C4336 Series	C4206 Series	C4077 Series
Image Area	12.8mm×9.6mm (1 inch)	12.8mm×9.6mm (1 inch)	8.8mm×6.6mm (2/3 inch)
Minimum Photocathode Illumination	2×10^{-5} lx	4×10^{-7} lx	4×10^{-5} lx
Limiting Resolution	400 TV Lines	380 TV Lines	350 TV Lines

Microchannel Plates (MCP)

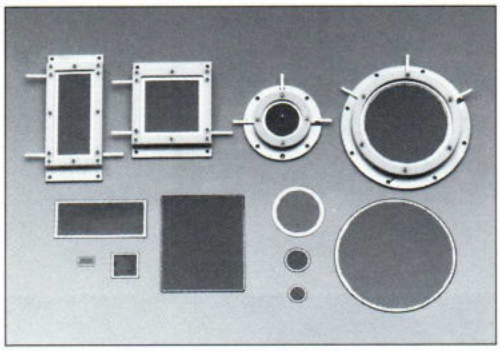
The microchannel plate (MCP) consists of a two-dimensional array of millions of very-small diameter glass capillaries (6 μm to 25 μm) fused together and sliced in the shape of a thin disk. These capillaries are called channels and act as independent electron multipliers. The MCP can be used for the two-dimensional detection and amplification of electrons, ions, etc.

at 25°C

Type No.	Dimension		Channel			Electrode Material	Electrical Characteristics Ⓐ				Maximum Ratings	
	Disk Diameter (mm)	Effective Diameter (mm)	Diameter (μm)	Bias Angle θ(°)	Open Area Ratio (%)		Current Gain	Plate Resistance (MΩ)	Dark Current (A/cm²)	Linear Output Signal	Applied Voltage (V)	Ambient Temperature (°C)
Circular MCPs												
F1094-09	φ24.9	φ20.0	10	5	60	Inconel or Ni-Cr	10^4 or More	50 to 500	5×10^{-13} or Less	7% of the strip current	1000	-50 to +70
F1552-09	φ32.8	φ27.0		12				30 to 300				
F1217-01	φ50.0	φ42.0	12	5, 8				10 to 200				
F1942-04	φ86.7	φ77.0	25	8				10 to 100			1200	
Rectangular MCPs												
F2805-03	60×60	53×53	20	8	60	Inconel or Ni-Cr	10^4 or More	20 to 120	5×10^{-13} or Less	7% of the strip current	1200	-50 to +70
F1943-02	88×38	81×31	15					20 to 200			1100	

Ⓐ at 1kv

MCP Assemblies



MCP assemblies are easy-to-use electron and ion detectors with integral leads for voltage application and signal readout devices. Various types of readout devices can be chosen according to applications.

■Applications

●Analytical Instrument
- High-speed Line Width Measurement
- **FIM, AP-FIM**
- **ESCA**
- **MASS SPECTROSCOPY**
- **TOF-MS**
- **LEED, MEED etc.**

●Electron Tubes
- **Image Intensifier**
- **High-speed Response PMT**
- **Streak Tubes**

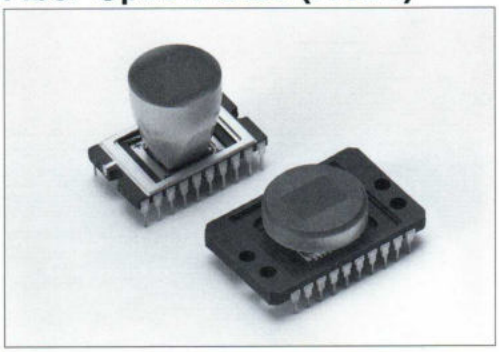
●Space
- **Plasma Ion Detection**
- **Soft X-ray, VUV Detection**

●High Energy Physics
- **Various Ion Detection**
- **Electron, Positron Detection**
- **High Energy Particle Detection**
- **X-ray Detection**

Assembly Type		MCP	Effective Diameter (mm)	No. of MCP	Readout Device*
Demountable Type	Non-demountable Type				
F2222	F1094	F1094-01	φ17	1 to 3	Single anode Phosphor screen Multianode High-speed detection anode CR-chain anode
F2226	–	F1942-04	φ75		
F2813	–	F1943-02	80×30		
F2814	–	F2805-03	50×50		

*Depending on the type of assembly, some readout devices may not be combined. So, please consult Hamamatsu sales office.

Fiber Optic Plates (F.O.P.)



The fiber optic plate (FOP) is an optical image transmitting element consisting of a large number of optical fibers bundled and fused in the form of a plate, in which each of the thin optical fibers (core diameter: 3 to 25 μm) with high refractive index is covered with clad glass with low refractive index.

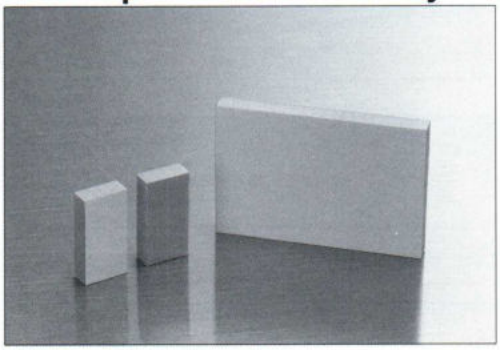
■Applications

Optical windows for image intensifiers, CRT, imaging tubes and CCD.

Type	Numeric Aperture (N.A)	Fiber Size (μm)	Transmittance* [Collimated(%)]	Resolution (lp/mm)
J3182	1.0	6	73	102
J3280	0.35	25	68	28.5
J3281	0.55			
J3282	0.88			

* λ=550nm, thickness=3.0mm, including the surface reflection.

Fiber Optic Plate with X-ray Scintillator (F.O.S)



Fiber Optic Plate with X-ray scintillator (FOS) is an X-ray imaging device for the next generation that provides higher sensitivity and resolution than currently used phosphor screen. The FOS also allows real-time digital radiography when directly coupled to a CCD.

■Applications

●Dental diagnosis ●Mammography
●Non-destructive inspection of semiconductor devices

Type No.	Scintillator Type	Outer Dimension (mm)	Effective Area (mm)	Thickness (mm)	Relative Light Output (% Min.) Ⓐ	Resolution (lp/mm Min.)
J6144	$Gd_2O_2S(Tb)$	30×20	28×18	3	120	14
J6671	CsI(Tl)		27×17	3	105	22
J6676	$Gd_2O_2S(Tb)$	50×50	48×48	3	120	14
J6677	CsI(Tl)		47×47	3	105	22

Ⓐ Relative values, with 100% being equal to the light output from conventional sensitizer paper.

Capillary Plates



The capillary plate is a glass plate with a thickness of 0.4 to several tens of millimeters. It is comprised of a two-dimensional regular array of glass tubes with inner diameters ranging from a few to several hundred microns. Each glass tube has excellent linearity and accuracy, thus being useful in a wide range of applications including use in optical guide and flow control.

■Applications

- ●Flow control and measurement equipment
- ●Optical and x-ray collimator
- ●Differential-pressure exhaust window
- ●Window material for VUV and X-ray
- ●Particle filter

Type No.	Outer Dimension (mm)	Effective Dimension (mm)	Capillary diameter D (μm)	Thickness L (mm)	L/D
J5022-01	φ5	φ0.8	12	1.0	83
J5022-21	φ87	φ77	25		40
J5022-19	60×60	53×53	20		50

Hollow Cathode Lamps/For atomic absorption analysis

Single-element Lamps :L233 Series (1.5" dia.), L1788 Series (2" dia. for Perkin-Elmer) :L2433 Series (S-H Method for Background Correction)

Elements		Type No. (suffix)	Analysis Lines (nm)
⊙ Ag	Silver	-47NB	328.07 * 338.28
⊙ Al	Aluminum	-13NB	309.27 * 396.15
⊙ As	Arsenic	-33NQ	193.70 * 197.20
⊙ Au	Gold	-79NQ	242.80 * 267.59
⊙ B	Boron	-5NQ	249.68 } * 249.77 }
⊙ Ba	Barium	-56NB	553.55 *
⊙ Be	Beryllium	-4NQ	234.86 *
⊙ Bi	Bismuth	-83NQ	223.06 * 306.77
⊙ Ca	Calcium	■-20NQ	422.67 *
⊙ Cd	Cadmium	-48NQ	228.80 *
⊙ Co	Cobalt	■-27NQ	240.73 * 346.58
⊙ Cr	Chromium	-24NB	357.87 * 425.44
Cs	Cesium	-55NB	852.11 *
⊙ Cu	Copper	-29NB	324.75 * 327.40
⊙ Dy	Dysprosium	-66NB	404.59 * 421.17
⊙ Er	Erbium	-68NB	400.79 * 415.11
⊙ Eu	Europium	-63NB	459.40 * 462.72
⊙ Fe	Iron	■-26NQ	248.33 * 371.99
⊙ Ga	Gallium	■-31NQ	287.42 * 294.36
Gd	Gadolinium	-64NB	407.87 * 422.58
⊙ Ge	Germanium	■-32NQ	265.16 *
⊙ Hf	Hafnium	■-72NQ	286.64 * 307.29

Elements		Type No. (suffix)	Analysis Lines (nm)
Hg	Mercury	■-80NQ	253.65 *
⊙ Ho	Holmium	-67NB	410.38 * 416.30
In	Indium	-49NB	303.94 * 325.61
Ir	Iridium	-77NQ	208.88 * 266.47
⊙ K	Potassium	-19NB	766.49 * 769.90
⊙ La	Lanthanum	-57NB	357.44 550.13 *
⊙ Li	Lithium	-3NB	610.36 670.78 *
Lu	Lutetium	-71NB	328.17 331.21 *
⊙ Mg	Magnesium	■-12NQ	285.21 *
⊙ Mn	Manganese	■-25NQ	279.48 * 403.08 *
⊙ Mo	Molybdenum	-42NB	313.26 * 320.88
⊙ Na	Sodium	-11NB	589.00 * 589.59
Nb	Niobium	-41NB	334.91 * 405.89
Nd	Neodymium	-60NB	463.42 492.45 *
⊙ Ni	Nickel	-28NQ	232.00 * 341.48
Os	Osmium	■-76NQ	290.90 * 305.86
⊙ Pb	Lead	-82NQ	217.00 * 283.30
⊙ Pd	Palladium	-46NQ	244.79 * 247.64
Pr	Praseodymium	-59NB	495.13 * 513.34
⊙ Pt	Platinum	■-78NQ	265.95 * 299.80
Rb	Rubidium	-37NB	780.02 * 794.76
Re	Rhenium	-75NB	346.05 * 346.47

Elements		Type No. (suffix)	Analysis Lines (nm)
Rh	Rhodium	-45NB	343.49 *
⊙ Ru	Ruthenium	-44NB	349.89 *
⊙ Sb	Antimony	-51NQ	217.58 * 231.15
Sc	Scandium	-21NB	390.74 391.18 *
⊙ Se	Selenium	-34NQ	196.03 *
⊙ Si	Silicon	■-14NQ	251.61 * 288.16
⊙ Sm	Samarium	-62NB	429.67 * 484.17
⊙ Sn	Tin	-50NQ	224.61 * 286.33
⊙ Sr	Strontium	-38NB	460.73 *
Ta	Tantalum	■-73NQ	271.47 * 275.83
Tb	Terbium	-65NB	431.88 432.64 *
⊙ Te	Tellurium	-52NQ	214.27 *
⊙ Ti	Titanium	-22NB	364.27 * 365.35
Tl	Thallium	■-81NQ	276.78 * 377.57
Tm	Thulium	-69NB	371.79 * 410.58
⊙ V	Vanadium	-23NB	306.64 318.40 *
W	Tungsten	■-74NQ	255.14 * 400.87
⊙ Y	Yttrium	-39NB	410.23 * 412.83
⊙ Yb	Ytterbium	-70NB	346.43 398.79 *
⊙ Zn	Zinc	-30NQ	213.86 * 307.59
Zr	Zirconium	-40NB	360.12 * 468.78
D_2	Deuterium	-1DQ	240.00 (peak)

* The most sensitive absorption line of each element.
■ For the type No. of the L233, L2433 series, the last suffix is "NU" instead of "NQ" except that the L2433-26 (Fe) is designated L2433-26NQ.
⊙ marks indicate the L2433 series lamps. D_2 is available only for L233 series.

Multi-element Lamps*: L733 Series (1.5" dia.), L1788 Series (2" dia. for Perkin-Elmer)

Elements	Type No.	Type No. (suffix)
Na-K	Sodium Potassium	-201NB
Ca-Mg	Calcium Magnesium	■-202NQ
Si-Al	Silicon Aluminum	■-203NQ
Fe-Ni	Iron Nickel	-204NQ
Sr-Ba	Strontium Barium	-205NB
Al-Ca-Mg	Aluminum Calcium Magnesium	■-321NQ
Ca-Mg-Zn	Calcium Magnesium Zinc	-322NQ

* Absorption lines comply with the wavelengths of single-element lamps.
■ For the L733 series, the last suffix is "NU" instead of "NQ".



Hollow Cathode Lamps

Deuterium Lamps

L2D2 Lamps

at 25°C

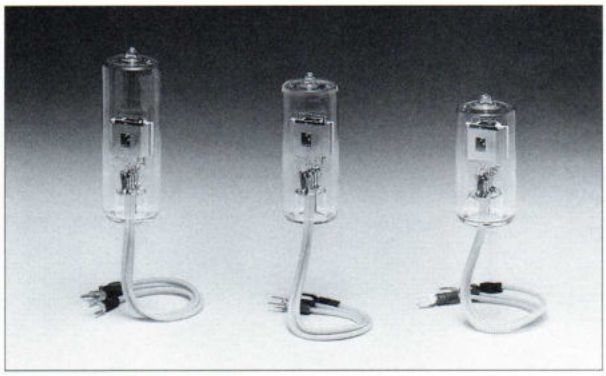
Series	Type No.	Aperture Size (mm)	Spectral Distribution (nm)	Required Discharge Starting Voltage Min. (Vdc) Ⓐ	Lamp Current (mAdc)	Lamp Voltage Typ. (Vdc)	Output Stability: Drift Max. (%/h)	Output Stability: Fluctuation Max. (%p-p)	Heater Ratings: Warm-up Voltage (Vdc, ac)	Heater Ratings: Warm-up Current Typ. (Adc, ac)	Heater Ratings: Warm-up Time Min. (s)	Heater Ratings: Operating Voltage (Vdc)	Heater Ratings: Operating Current Typ. (Adc)	Guaranteed Life (h) Ⓑ
L2-4000 Series	L6565	1.0	185 to 400	350	300 ± 30	80	±0.3	0.05	2.5±0.25	4	20	1.0±0.1	1.8	4000
	L6566								3.0±0.3	5		0 to 1	0 to 1.6	
L2-2000 Series	L6301	0.5	185 to 400	400	300 ± 30	80	±0.3	0.05	2.5±0.25	4	20	1.0±0.1	1.8	2000
	L6302	1.0		350										
	L6303	0.5		400								1.7±0.2	3.3	
	L6304	1.0		350										
	L6305	0.5		400					3.0±0.3	5		0 to 1	0 to 1.6	
	L6306	1.0		350										
	L6307	0.5		400					10±1	0.8		2.5 to 6.0	0.3 to 0.6	
	L6308	1.0		350										
	L6309	0.5		400						1.2		7.0±0.5	1.0	
	L6310	1.0		350										
	L6311	0.5		400	300±10				12 to 15	0.5 to 0.55		0	0	
	L6312	1.0		350										

Deuterium Lamps

at 25°C

Type No.	Window Material	Spectral Distribution (nm)	Required Discharge Starting Voltage Min. (Vdc) Ⓐ	Lamp Current (mAdc)	Lamp Voltage Typ. (Vdc)	Output Stability: Drift Max. (%/h)	Output Stability: Fluctuation Max. (%p-p)	Heater Ratings: Warm-up Voltage (Vdc, ac)	Heater Ratings: Warm-up Current Typ. (Adc, ac)	Heater Ratings: Warm-up Time Min. (s)	Heater Ratings: Operating Voltage (Vdc)	Heater Ratings: Operating Current Typ. (Adc)	Guaranteed Life (h)
HB(High-Brightness) Types (Indirectly Heated Cathode)													
L2196	Synthetic Silica	160 to 400	350	300±30	80	±0.5	0.05	10±1	1.2	20	7.0±0.5	1	1500 Ⓑ
L2541	UV Glass (0.4mmt)	185 to 400											
SQ(Super-Quiet) Types (Indirectly Heated Cathode)													
L1626	Synthetic Silica	160 to 400	350	300±30	80	±0.5	0.05	10±1	1.2	20	7.0±0.5	1	2000 Ⓑ
L2526	UV Glass (0.4mmt)	185 to 400											1500 Ⓑ
L1636	Synthetic Silica	160 to 400						2.5±0.25	4		1.7±0.2	3.3	2000 Ⓑ
L1729	UV Glass (0.4mmt)	185 to 400											1500 Ⓑ
DH(Directly-Heated) Types													
L544	Fused Silica	160 to 400	350	300±30	80	±0.5	0.1	10±1	0.8	20	3.5±0.5	0.3	1000 Ⓒ
L1128	Fused Silica												
L879	MgF_2	115 to 400											300 Ⓔ
L613	UV Glass (0.8mmt)	185 to 400						2.5±0.25	4		1.0±0.1	1.8	1000 Ⓒ
L879-01	MgF_2	115 to 400											300 Ⓔ
HP (High Performance • High Power • High Precision) types													
L4505-50	UV Glass (0.4mmt)	185 to 400	370	300±10	85	±0.5	0.05	12 to 15	0.5 to 0.55	20	– Ⓓ	– Ⓓ	1500 Ⓑ
L4510-50	UV Glass (0.4mmt)		350		80								

Ⓐ A starting voltage of higher than these values is required to trigger the lamp discharge. It is recommended for secure triggering to apply a voltage between 500 and 600V. The maximum rating is 650V.
Ⓑ The life end is defined when the UV region intensity falls to 50% of its initial value or when fluctuation exceeds 0.05%p-p.
Ⓒ The life end is defined when the UV region intensity falls to 50% of its initial value or when fluctuation exceeds 0.1%p-p.
Ⓓ The lamp is designed such that during operation the discharge current flows into the heater to maintain the cathode temperature at an optimum level. It is therefore unnecessary to supply the heater with external power for heating.
Ⓔ Estimated Life
* In order to maximize the lamp performances, we recommend to operate the lamp along with exclusive power supply made by HAMAMATSU.



L2D2 Lamps



Deuterium Lamps

Super-Quiet Xenon Lamps

at 25°C

Type No.	Power Consumption (W)	Arc Length (mm)	Window Material	Spectral Distribution (nm)	Lamp Current (Adc)	Lamp Voltage (Vdc)	Output Stability (after 20 min.)		Life	
							Drift Max. (%/h)	Fluctuation Max. (%)	Ⓐ Guaranteed (h)	Average (h)
L2173	35	1.0	Fused Silica	185 to 2000	3.5±0.5	11	±0.5	±0.5	1000	2000
L2193			Ozone-free Sicila	220 to 2000						
L2174	75	1.3	Fused Silica	185 to 2000	5.4±0.5	15				
L2174-01										
L2174-02										
L2194			Ozone-free Sicila	220 to 2000						
L2194-01										
L2194-02										
L2175	150	2.5	Fused Silica	185 to 2000	7.5±0.5	20			1200	2500
L2195			Ozone-free Sicila	220 to 2000						
L2273		2.0 (GS)	Fused Silica	185 to 2000	8.5±0.5	18			1800	3000
L2274			Ozone-free Sicila	220 to 2000						
L2479	300	3.0	Fused Silica	185 to 2000	15.0±1.0	20			1000	2000
L2480			Ozone-free Sicila	220 to 2000						

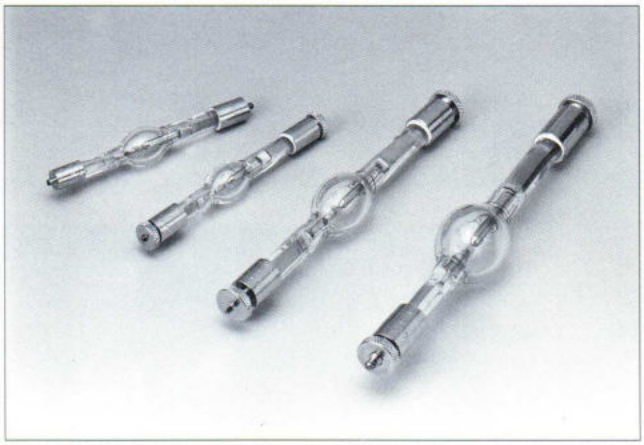
Ⓐ The life end is defined as the time when the radiant intensity falls to 50% of its initial value or when the output fluctuation exceeds 1%p-p.
* In order to maximize the lamp performances, we recommend to operate the lamp along with exclusive power supply made by HAMAMATSU.

Super-Quiet Mercury-Xenon Lamps

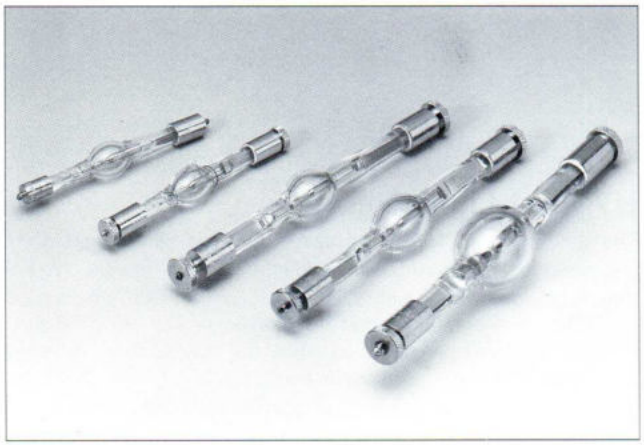
at 25°C

Type No.	Power Consumption (W)	Arc Length (mm)	Window Material	Spectral Distribution (nm)	Lamp Current (Adc)	Lamp Voltage (Vdc)	Output Stability (after 20 min.)		Life	
							Drift Max. (%/h)	Fluctuation Max. (%)	Ⓐ Guaranteed (h)	Average (h)
L2421	50	1.0	Fused Silica	185 to 2000	3.5±0.5	14	±0.5	±1.0	500	1000
L2481	75				5.4±0.5	15				
L2481-01										
L2481-02										
L2422	100	1.3			5.5±0.5	18				
L2422-01										
L2422-02										
L2482	150	1.7			7.5±0.5	20			1000	2000
L2423	200	2.0			8.0±0.5	23				
L2423-01										
L2570			Ozone-free Silica	220 to 2000						
L2570-01										
L2483	350	2.5	Fused Silica	185 to 2000	14.0±1.0	25			500	1000
L2424	500	3.0			20.0±1.0					

Ⓐ The life end is defined as the time when the radiant intensity falls to 50% of its initial value or when the output fluctuation exceeds ±1%.



Super-Quiet Xenon Lamps



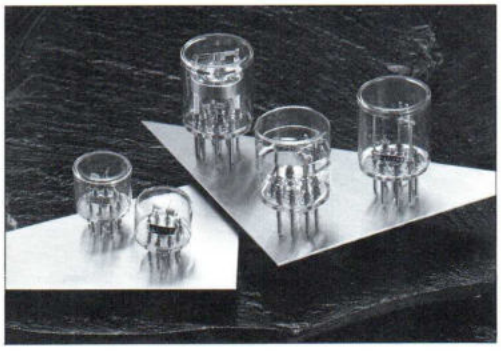
Super-Quiet Mercury-Xenon Lamps

Super-Quiet Xenon Flash Lamps

at 25°C

Type No.	Arc Size (mm)	Window Material	Spectral Distribution (nm)	Recommend Supply Voltage (Vdc)	Trigger Voltage (kV)	Max. Average Power (W)	Max. Input Energy per Flash (J/Flash)	Repetition Rate Max. (Hz)	Output Stability Ⓐ Output Ⓑ Fluctuation Max. (%)	Ⓐ Guaranteed Life Min. (Number of Flashes)
26mm Diameter SQ (Super-Quiet) Types										
L2187	8.0	Synthetic Silica	160 to 2000	700 to 1000	5 to 7	15	0.15	100	2.5	1.2×10^9
L2188		UV Glass	185 to 2000							
L2189		Borosilicate	240 to 2000							
L2358	3.0	Synthetic Silica	160 to 2000	700 to 1000	5 to 7	15	0.15	100	2.5	1.2×10^9
L2359		UV Glass	185 to 2000							
L2360		Borosilicate	240 to 2000							
L2435	1.5	Synthetic Silica	160 to 2000	700 to 1000	5 to 7	15	0.15	100	3.5	1.2×10^9
L2436		UV Glass	185 to 2000							
L2437		Borosilicate	240 to 2000							
20mm Diameter HQ (High-Quality) Types										
L4644	3.0	UV Glass	185 to 2000	700 to 1000	5 to 7	10	0.10	100	3.0	1×10^9
L4646										
L4645		Borosilicate	280 to 2000							
L4647			240 to 2000							
High-Power Types (Built-in Reflector Types)										
L4633	1.5	Borosilicate	240 to 2000	700 to 1000	5 to 7	15	0.15	100	5	5×10^8
L4634										

Ⓐ Measured under the following conditions. Supply voltage: 1000V, Main capacitor Cm: 0.1μF, Repetition rate: 50Hz
Ⓑ (Max. radiant output-Min. radiant output/Average radiant output)×100(%)
* Various trigger sockets and exclusive power supplies are available.
SQ types are available in 22mm & 28mm bulb diameter as well.
HQ types are available in 20mm bulb diameter as well.



Xenon Flash Lamp Module(HQ Type)

The xenon flash lamp module puts high stability xenon flash lamp (option), power supply and trigger socket into one unit for easy use and compact in its size as 1/4 of volume (comparison to other Hamamatsu models). No extra internal wiring is required thus simple to built into the system.

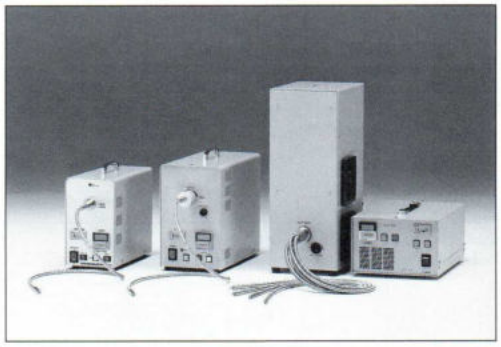


UV Spot Light Source

The light source for UV curing resin. It employs Hg-Xe lamp, which has high UV irradiation, and high quality cold mirror, which reflects only UV radiation, thus it provide low thermal radiation UV light. It, also, employs fiber bundle guide for light output so that UV irradiation can be limited to the area required. Various configurations, area size and numbers of bundle of fiber, are prepared to meet the various applications.

The lamp is supplied in cartridge configuration with pre-aligned for optical axis, which allows easy lamp mount.

Various external functions such as on-off, manual/auto shutter, etc., as standard. Hamamatsu offers this UV spot light source in series of 100W, 200W and 500W.



Metal Halide Lamp

Metal halide lamp provide approx. 4 times of luminous efficiency than xenon or halogen lamps. It also overcomes the problem of short life due to compact short arc gap. The color temperature is very close to it of day light which is suited for the use in light source of various projectors, color printer and microscope as well as general illumination purpose.



Type No.	Overall Max. (mm)	Lamp Power (W)	Lamp Voltage (Vac)	Lamp Current (Aac)	Luminous Flux (lm)	Luminous Efficiency (lm/W)	Color Temperature (K)	Arc Gap (mm)	Average Life (h)
L4342	78	150	80	1.9	11400	76	7500	5.0	3000
L6046	85	250	70	3.6	20000	80	6000	4.0	1000
L5431	140	575	95	6.1	49000	85	6000	7.0	3000

Pen Type Low-Pressure Mercury Lamps/UV to Visible line spectra

The L937 series lamps are compact pen-shape low-pressure mercury lamps which produce a highly pure line spectra with good stability and repeatability. These features make them useful in wavelength calibration for monochromators, ozone detectors, chromatographs, as well as in ozone generation, sterilizing lamps and water pollution analyzers.
These lamps also feature an easy-to-use, single-ended configuration and are available with ozone generating or ozoneless types. Specially designed power supplies are also available.



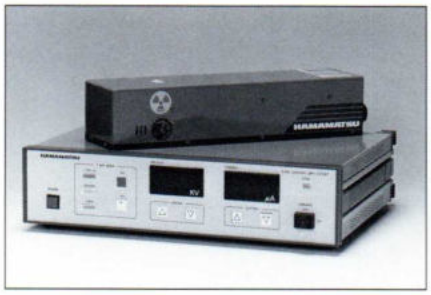
at 25°C

Type No.	Glass Material	Dimensions					Weight (including cable)	Characteristics					
		Outer Bulb Diameter of Discharge Area (mm)	Bulb Length of Discharge Area (mm)	Overall Length (mm)	Outer Diameter of Handle Section (mm)	Cable Length (mm)	(g)	Discharge Starting Voltage (Vrms)	Discharge Current (Lamp Current) (mArms)	Discharge Maintaining Voltage (Lamp Voltage) (Vrms)	Radiant Output Intensity at 254 nm (μW/cm^2/nm at lm)	Optimum Operating Temperature Range (°C)	Life Min. (h) Ⓐ
L937-01	Quartz Glass	ϕ6.5	25	85	ϕ10	445	37	800	18	200	2.5	40 to 55	5000
L937-02	Quartz Glass		54	114			38	900		270	5		
L937-03	Vycor Glass (Ozoneless)	ϕ9	25	89	ϕ13		47	800		200	2		
L937-04	Vycor Glass (Ozoneless)		57	117			49	900		270	4		
L937-05	Vycor Glass (Ozoneless)		25	73	ϕ11	225	12	800		200	2		

Ⓐ The life end is defined as the time when the radiant intensity falls to 50% of its initial value.
The C940 series power supplies are also available.

70kV Micro Focus X-ray Source

L5486 series, 70kV micro focus X-ray source, employs a micro focus X-ray tube having 10 μm focus length and is natural air-cooled X-ray source. Since its X-ray focus length is as small as 10 μm, it is almost like a point source. Therefore, it doesn't de-focus even the sample image is enlarged. It is suited for high resolution enlarged X-ray transmissive imaging for micro-defect or non-destructive internal observation by combinated with high sensitivity X-ray camera.



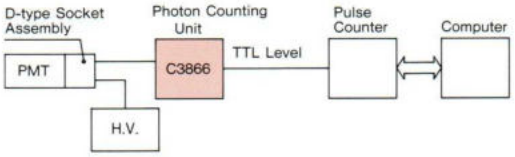
Photon Counting Heads H6180, H5920, H6240 Series

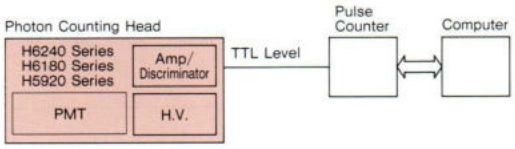
H6180 series is a compact photon counting head adding a high voltage power supply into a conventional photon counting head, but still making the total length shorter. The high voltage to the PMT and the discrimination voltage are pre-adjusted, therefore, it can be ready to perform the photon counting measurement by simply providing 5V power and connecting to a pulse counter.

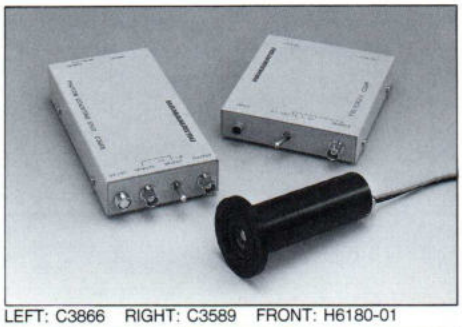
Photon Counting Unit C3866

The C3866 converts the output pulse from a photomultiplier tube into a 5V digital signal. Connecting a pulse counter to the C3866 allows photon counting with a high S/N ratio. Also, because of the built-in prescaler (division by 10), the C3866 can be operated without using a high-speed counter.

SET UP EXAMPLES







LEFT: C3866 RIGHT: C3589 FRONT: H6180-01

Photon Counter C5410

The C5410 Photon Counter includes an amplifier, discriminator and high-voltage power supply. By simply connecting a photomultiplier tube inserted into a D-type socket assembly, photon counting measurement can be made without any other troublesome setup.

The C5410 has added a time-resolved measurement function with no dead time which exists in the conventional single-gate measurement function. The large liquid crystal screen on the main unit allows display and analysis of the measured data. In addition, the RS232C interface facilitates connection to a commercially available computer, thus permitting data transfer and computer control for the main unit.



C5410 (PMT and socket assembly will be sold separately as an option.)

Accessories for Photomultiplier Tubes

In addition to the products listed below, Hamamatsu provides a variety of accessories for photomultiplier tubes. Please contact our sales office for more information.

Socket Assembly Series

Operating a photomultiplier tube requires a voltage divider. For easy and reliable use of photomultiplier tubes, Hamamatsu provides a complete line of socket assemblies which integrate a photomultiplier tube socket and a voltage divider into a compact package. The socket assemblies are classified into three types by function: the D type containing only a voltage divider; the DA type further including a preamplifier; the DP type having a voltage divider and a high-voltage power supply.



Magnetic Shield Case E989 Series

The E989 series magnetic shield cases were developed to protect photomultiplier tubes from the influence of magnetic fields. The E989 series is made of permalloy, a material of very high permeability (approximately 10^5). The magnetic field intensity within the shield case with respect to the external magnetic field can be attenuated down to 1/1000 to 1/10000, thus assuring stable output of photomultiplier tubes.



High-Voltage Power Supplies

A variety of high-voltage power supplies are available, ranging from bench-top types to modular types which can be mounted on a PC board. In addition, newly added to our product line are miniature high-voltage modules designed for compact equipment. They are smaller than one-sixth the cubic size of the conventional modular power supplies.

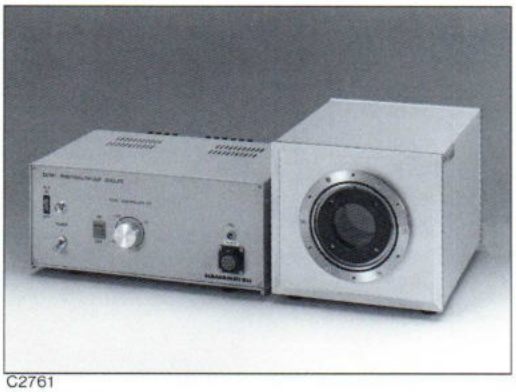


Thermoelectric Coolers C2761, C2773

Regardless of the presence of incident light, thermionic electrons are emitted from the photocathode and dynodes of a photomultiplier tube. This is a major factor that produces dark current. Therefore, cooling the photomultiplier tube can reduce these thermionic emissions and improve the S/N ratio.

The C2761 is a thermoelectric cooler using Peltier elements that allow temperature settings in the range from -30°C to 0°C. The housing is designed to minimize the infulence of external electrostatic or magnetic field.

The C2773 thermoelectric cooler is also provided for exclusive use with an MCP-PMT.



C2761

CE Marking

This catalog contains products which are subject to CE Marking of European Union Directives. For further details, please consult HAMAMATSU sales offices.

MEMO

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