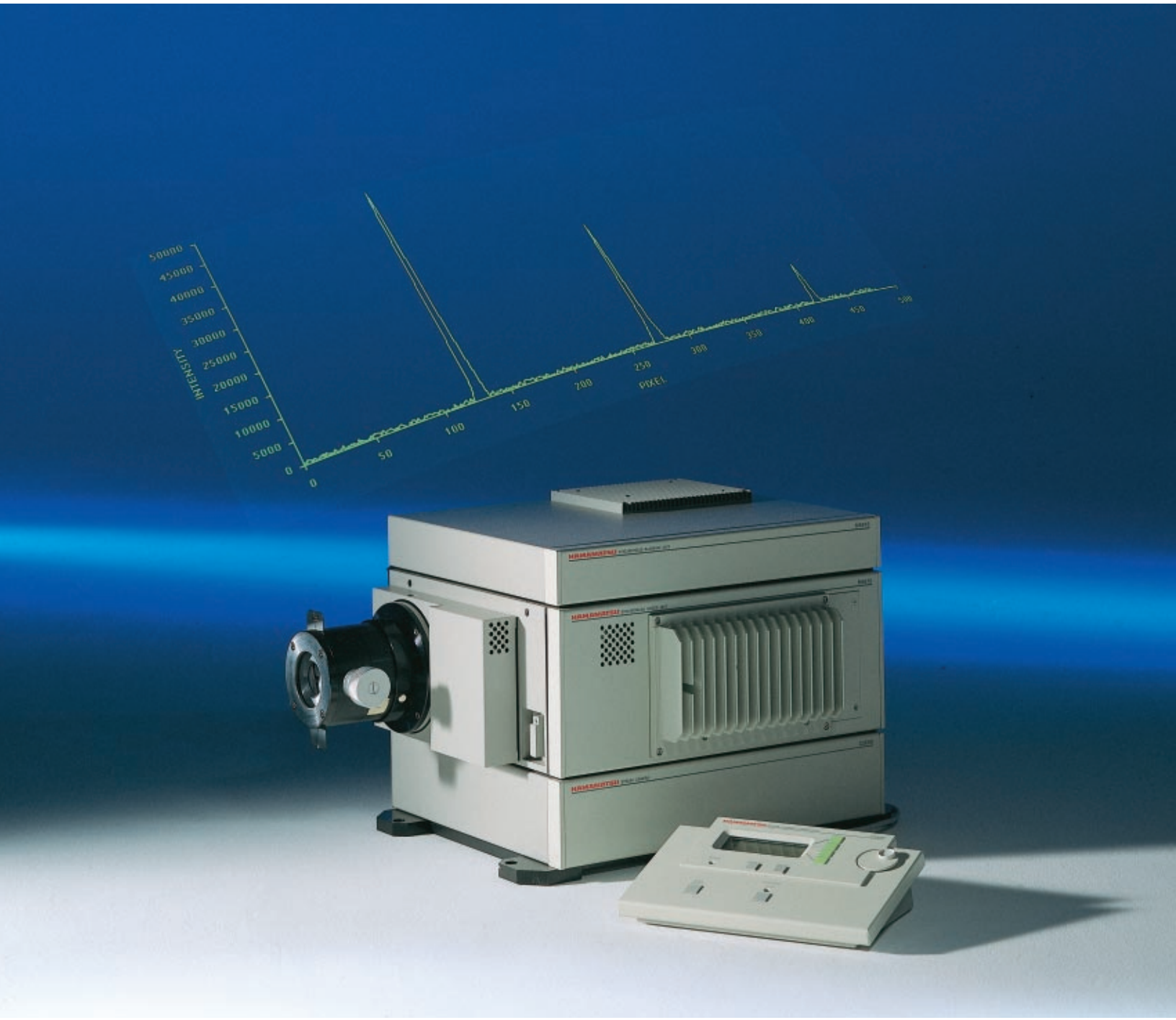
Universal Streak Camera C5680 Series



HAMAMATSU

Measurements Ranging From X-Ray to Near

Now you can select the functions you need to match a diverse range of light-emitting phenomena, giving you new options in flexibility

The streak camera is an ultra high-speed detector which captures light emission phenomena occurring in extremely short time periods. Not only can the streak camera measure intensity variations with superb temporal resolution, but it can also be used for simultaneous measurement of the spatial (or spectral) distribution.
The C5680 Streak Camera Series is a universal streak camera which incorporates all of the specialized technology and expertise HAMAMATSU has acquired in over 20 years of research. The streak tubes are manufactured on a regular production schedule at Hamamatsu to provide consistency and reliability. Special requests and custom designs are also available.

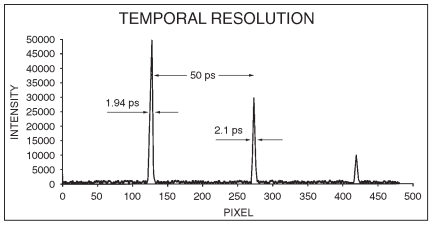
APPLICATIONS

- **Measurement of electron bunch for synchrotron and LINAC applications**
- **Research involving x-ray lasers, free electron lasers, and various other types of pulsed lasers**
- **Plasma light emission, radiation, laser ablasion, combustion and explosions**
- **Fluorescence lifetime measurement, transient absorption measurement, time-resolved Raman spectroscopy**
- **Optical soliton communications, response measurement with quantum devices**
- **Lidar Thomson scattering, laser distance measurement**

Infrared With a Temporal Resolution of 2 ps

FEATURES

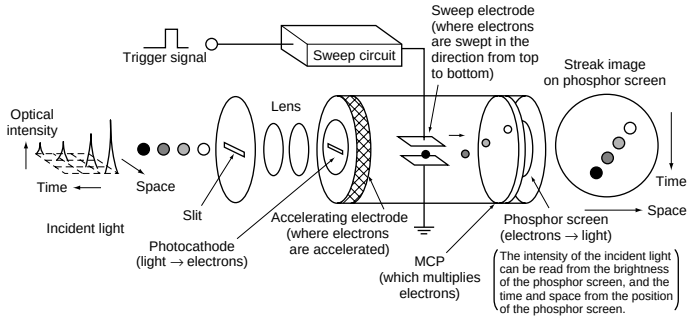
- **Temporal resolution of within 2 ps**
  A temporal resolution of 2 ps is achieved for both synchroscan and single shot.



▲CPM ring dye laser, etalon 50 ps

- **Several plug-in module, operating mode.**
- **Accommodates a diverse range of experimental setups from single light emitting phenomena to high-speed repeated phenomena in the GHz.**
- **Can be used in X-ray to near infrared fields**
  By selecting the appropriate streak tube (light sensor), the C5680 can be used in a wide range of measurement applications, from X-rays to near infrared light.
- **Simultaneous measurement of light intensity on temporal and spatial (wavelength) axes**
  Spectrograph can be placed in front of the streak camera, to convert the spatial axis to a wavelength axis. This enables changes in the light intensity to be measured over various wavelength (time-resolved spectroscopy).
- **Ultra-high sensitivity (detection of single photons)**
  The streak tube converts light into electrons which are then multiplied by an electron multiplier. This enables detection of extremely faint light (at the single-photon level).
  (See photon counting integration principle)
- **IEEE-488 (GP-IB) control**
  Computer control enables remote control and advanced measurements to be performed out using very simple operation.
- **Diverse selection of peripheral equipment**
  A full lineup of peripheral devices is available, including spectroscopes, optical trigger heads, and expansion units.

The operating principle of the streak camera



OPERATING PRINCIPLE

The light pulse to be measured is projected onto the slit and is focused by the lens into an optical image on the photocathode of the streak tube. Changing the temporal and spatial offset slightly each time, four light pulses, each with a different light intensity, are introduced through the slit and conducted to the photocathode.

Here, the photons are converted into a number of electrons proportional to the intensity of the incident light. The four light pulses are converted sequentially to electrons which are then accelerated and conducted towards the photocathode.

As the group of electrons created from the four light pulses passes between a pair of sweep electrodes, a high voltage is applied (see above), resulting in a high-speed sweep (the electrons are swept in the direction from top to bottom). The electrons are deflected at different times, and at slightly different angles in the perpendicular direction, and are then conducted to the MCP (micro-channel plate).

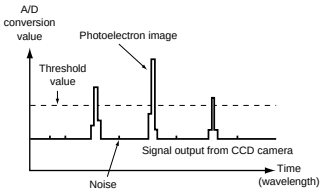
As the electrons pass the MCP, they are multiplied several thousands of times and are then bombarded against the phosphor screen, where they are converted back into light.

The fluorescence image corresponding to the first incident light pulse is positioned at the top of the phosphor screen, followed by the others, with images proceeding in descending order; in other words, the axis in the perpendicular direction on the phosphor screen serves as the temporal axis. The brightnesses of the various fluorescence images are proportional to the intensities of the corresponding incident light pulses. The positions in the horizontal direction on the phosphor screen correspond to the positions of the incident light in the horizontal direction.

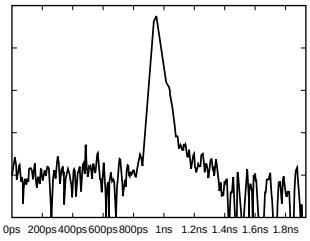
THE PRINCIPLE OF PHOTON COUNTING INTEGRATION

Photoelectrons given off from the photocathode of the streak tube are multiplied at a high integration rate by the MCP, and one photoelectron is counted as one intensity point on the phosphor screen. A threshold value is then used with this photoelectron image to clearly separate out noise.

Separation of Photoelectron Image and Noise



Photon Counting Integration

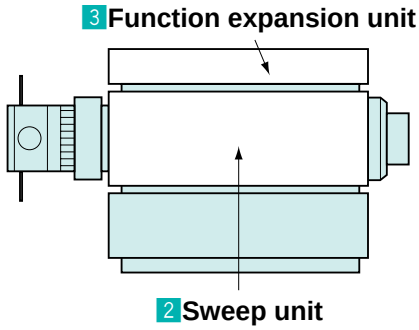


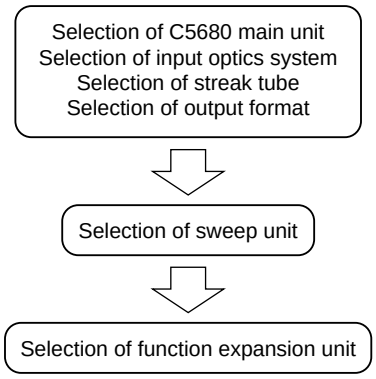
Light source: PLP (λ = 800 nm)
Integration time: 1 min.

Positions in the photoelectron image which are above the threshold value are detected and are integrated in the memory, enabling noise to be eliminated completely. This makes it possible to achieve data measurements with a high dynamic range and high S/N.

FUNCTION CONFIGURATION

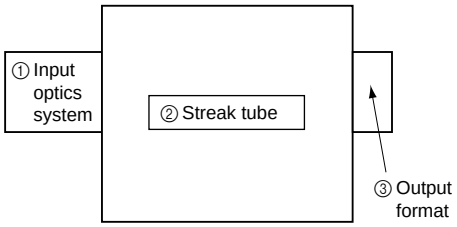
1 C5680 Main Unit (with power supply and camera controller)





SPECIFICATIONS

1 C5680 Main Unit



[Suffix (Model No.)]

One of the following suffixes is appended to the model number of the C5680, depending on the type of streak tube and output format used.

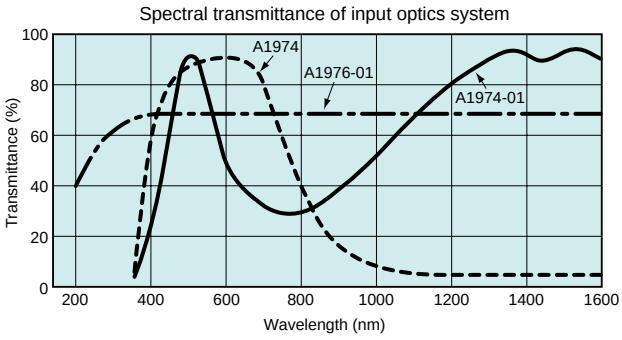
C5680–□□

	1	Accommodates 200 to 850 nm, 1 MCP
	2	Accommodates 300 to 1600 nm, 1 MCP
	3	Accommodates 115 to 850 nm, 1 MCP
2 Lens output type	4	Accommodates 200 to 900 nm, 1 MCP
3 Video output type	5	Accommodates 200 to 850 nm, 2 MCPs

① Input Optics System

Model Name	Spectral Transmission	Effective F Value	Image Multiplication Ratio	Slit Width	Slit Width Reading Precision	Overall Length
A1976-01	200 to 1600nm	5.0	1 : 1	0 to 5mm	5µm	98.2mm
A1974	400 to 900nm	1.2	1 : 1			159mm
A1974-01	400 to 1600nm	1.2	1 : 1			159mm
A1976-04	200 to 1600nm	3.5	1 : 1			98.2mm

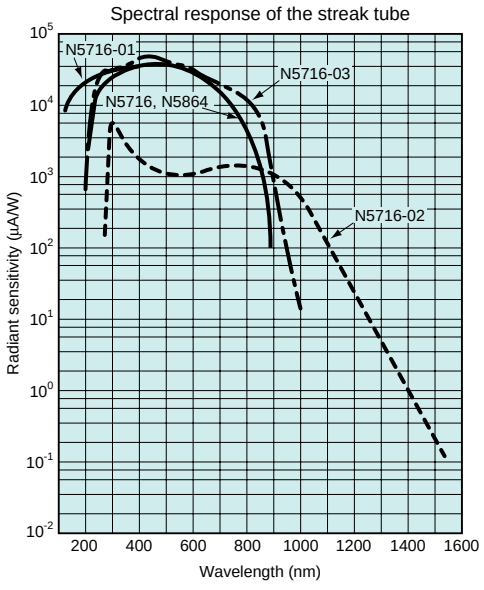
The A1974 and A1974-01 are optional units.



② Streak Tube

Model Name	Spectral Response Characteristic	Effective Photocathode Size	MCP Gain	Phosphor Screen	Spatial Resolution
N5716	200 to 850nm	• 0.15 × 5.22 mm Lens output type • 0.15 × 4.78 mm Video output type	3×10^3	• Photocathode characteristic P-43 • Fiber-optic output • Effective photocathode size • 18 mm	25 lp/mm or more centered on photocathode
N5716-02	300 to 1600nm				
N5716-01	115 to 850nm				
N5716-03	200 to 900nm				
N5864	200 to 850nm		6×10^5		

X-ray streak cameras designed for use with 10 eV to 10 keV can also be selected.



Units Allow Greater Flexibility in Applications

③ Output Formats

- **Lens output** ..... Magnification 1 : 0.7 (50 mm : 35 mm)
  Effective F value F/2.0
  F-mount

- **Video output** ... Signal format CCIR or RS-170
  Coupling method Fiber optics
  Resolution 768 × 493 or 756 × 581 pixels

④ Other 5680 Specifications

- Gate

Gating Method	Gate Extinction Ratio	Gate Time
MCP + horizontal blanking	1 : 10^6 min.	50 ns to continuous
MCP + horizontal blanking + photocathode	1 : 10^8 min.	50 ns to continuous

  - Gate trigger input ..... 3.5 to 5.0 V/50 Ω
  - Gate trigger delay time ..... 120 ns max.
  - Max. horizontal blanking repetition frequency ..... 2 MHz
  - Max. MCP gate repetition frequency ..... 10 kHz
  - Max. photocathode gate repetition frequency ..... 10 kHz

- Reset signal ..... Reset at 0 V
- Monitor out signal ..... 3.5 Vp-p (typ.)
- Interface ..... IEEE-488 (GP-IB)
- Status output ..... D sub-connector DB-25S, 16-bit parallel output, open collector
- Line voltage ..... 110/117/220/240 VAC, 50/60 Hz
- Power consumption ..... Approx. 180 VA

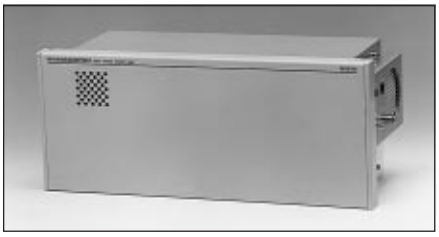
2 Sweep units (blanking type; built into main unit)

- **M5675 Synchroscan Unit**

Temporal resolution ..... Better than 2 ps at 800 nm (N5716-01)
Better than 3 ps at 800 nm (N5716-02)
Sweep range Video output type . 150 ps to 1/6 fs (fs: synchroscan frequency)
Lens output type ... 200 ps to 1/6 fs
Sweep range ..... 4 selectable range
Synchroscan frequency ..... Factory set within a range of 75 to 165 MHz
Synchronous frequency range .. fs ± 0.2 MHz (fs = synchroscan frequency)
Trigger jitter ..... Better than temporal resolution
Trigger signal input ..... –3 dBm to 17 dBm / 50 Ω

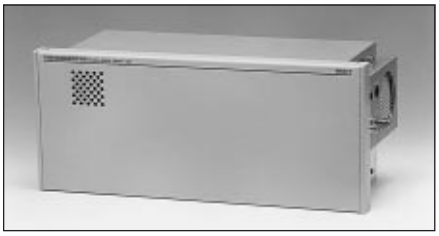
- **M5676 Fast Single Sweep Unit**

Temporal resolution ..... Better than 2 ps at 800 nm (1.5 ps typ.)
Sweep time Video output type .. 0.15, 0.5, 1, 2, 5, 10, 20, 50 ns/full screen
Lens output type ... 0.2, 0.5, 1, 2, 5, 10, 20, 50 ns/full screen
Trigger jitter ..... Better than 20 ps
Trigger delay ..... Approx. 13 ns (fastest range)
Maximum sweep repetition frequency ... 10 kHz max.
Trigger signal input ..... ± 5 V/50 Ω



- **M5677 Slow Single Sweep Unit**

Temporal resolution ..... Better than 50 ps
Sweep time ..... 5 ns to 1 ms/full screen
Trigger jitter ..... Better than temporal resolution
Trigger delay ..... Approx. 45 ns (fastest range)
Maximum sweep repetition frequency ... 2 MHz max. (fastest range)
Trigger signal input ..... ± 5 V/50 Ω



3 Function Expansion Units (connected to top of main unit)

- **M5678 Synchronous Blanking Unit**

(designed for use in conjunction with M5675 Synchroscan)

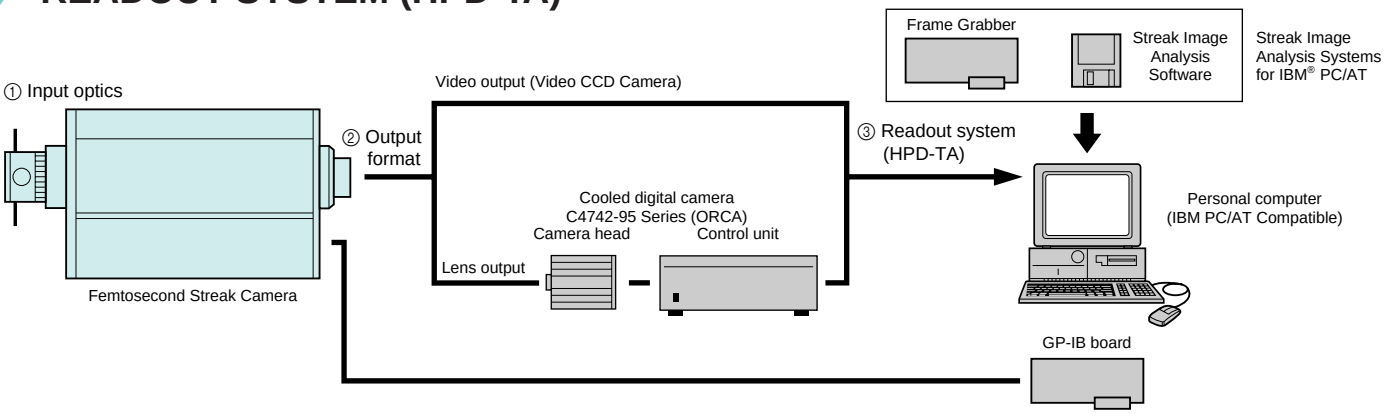
Synchroscan frequency ..... Factory set within a range of 75 to 165 MHz
Horizontal shift width ..... 2.5 or 11 mm (at phosphor screen)

- **M5679 Dual Time Base Extender Unit**

(Can be used in conjunction with all sweep units)

Sweep time ..... 100 ns to 100 ms/full screen
Maximum sweep repetition frequency ... 10 Hz max.
Trigger signal input ..... ± 5 V/50 Ω

READOUT SYSTEM (HPD-TA)



4 General Outline

The HPD-TA (Temporal Analyzer) is a high-performance digital data acquisition and control system specifically designed to read out images from the Hamamatsu streak camera's phosphor screen. It enables precise, quantitative acquisition and pre-analysis of two dimensional streak data that includes photon counting plus a full range of data correction and calibration possibilities. It possible to select the best camera for a given streak configuration and application. The camera is connected to an IBM-compatible PC/AT via a frame grabber board that can support real-time data transfer.

The HPD-TA allows the remote control of the C5680 via GPIB interface. The entire system is controlled through a powerful but user-friendly software application that runs on a Microsoft Windows platform.

* A read out system based on the Macintosh ® computer is also available.
Please consult with our sales office for more details.

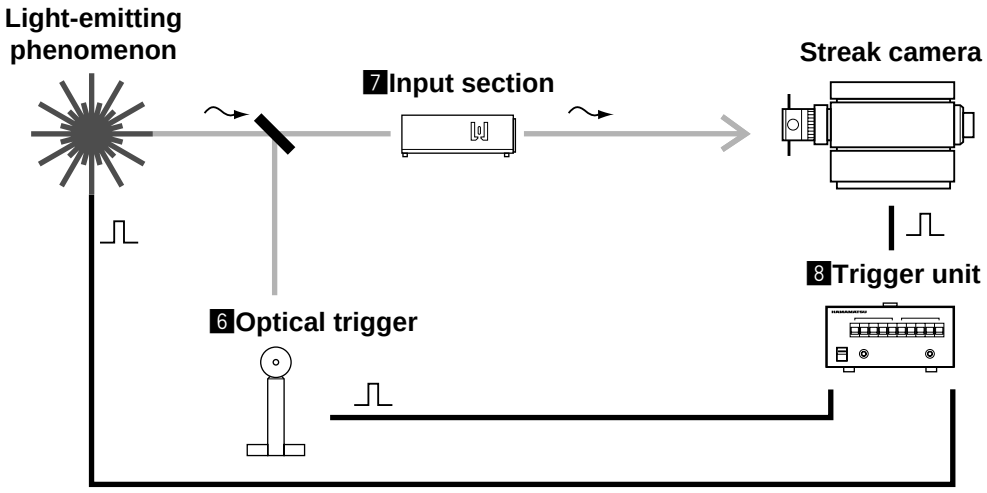
- **Functions & Specifications**

Items		Cooled CCD Version	Video Version
Camera Model		C4742-95 Series (ORCA)	Video CCD (CCIR or RS-170A)
Coupling Method		Relay lens	Fiber optics
Resolution		1280 × 1024 pixels	768 × 493 or 756 × 581 pixels
Dynamic range	Single frame	10 or 12 bits	8 bits
	Integration	16 bits	16 bits
Frame rate		9 Hz (normal) / 18 Hz (super pixel)	30 Hz
Superpixel mode		•	–
Subarray scan mode		•	–
Single exposure time		100 µs to 10 sec	40 or 33 ms
Analog integration		on chip / into memory	into memory
Photon counting		•	•
Dark correction		•	•
Shading correction		•	•
Curvature correction		•	•
Calibration		linear / nonlinear, both axes	linear / nonlinear, both axes
Multiple profiles		up to 10	up to 10
Data export (images)		Binary, TIFF, ASCII	Binary, TIFF, ASCII
Data export (profiles)		ASCII	ASCII
Streak camera interface		GPIB or StatusPort	GPIB or StatusPort
Other devices interface		GPIB	GPIB

5 Computer Environment

The HPD-TA requires an industry-standard Pentium-class (or compatible) PC with a 32-bit Microsoft Windows version. A fast, high-resolution graphics configuration is recommended. Depending on the streak camera system configuration, a number of PCI and/or ISA slots as well as a serial interface port may be occupied. (Please consult Hamamatsu for a detailed specification for a given case.)

PERIPHERAL EQUIPMENT



6 Optical Trigger (PIN diode head)

- **For C1083-01 Low Repetition Unit**

Spectral response	400 to 1100nm
Rise time	0.8ns
Dimensions/weight	Head: 100 (W) × 160 to 235 (H) × 50 (D) mm/400g
	Power supply unit: 100 (W) × 83(H) × 100 (D) mm/400g
Power supply	+45 V (battery)

- **For C1808-03 High Repetition Unit**

Minimum input level	500μW (f=91MHz, λ=610mm, FWHM<1ps)
Saturation output level	Approx. 1.5 Vp-p (50 Ω)
Frequency band	<100MHz
Power supply	INPUT Voltage range 100 to 240 V Input power supply frequency range 50/60 Hz

7 Input Section

- **C5094 and C5095 Spectroscopes**

	C5094	C5095
Optical layout	Czerny-Turner model (with toroidal mirror for aberration correction)	
Focal distance	250mm	500mm
F value	4	8
Incident light slit width	Variable between 10 to 2,000 μm	
Grating	Up to 3 can be installed simultaneously	
Reciprocal dispersion	2.5nm/mm	1.5nm/mm
	(when using 1200 gr/mm)	(when using 1200 gr/mm)
Wavelength resolution	< reciprocal dispersion × 0.06	

The following are needed in order to connect these units to the C5680:
- A spectroscope mounting table
- A spectroscope adaptor
- A light source for wavelength axis calibration (mercury lamp, etc.)

- **Fiber-optic Input Optics System (FC Connector)**

This fiber-optic input optics system can be connected in place of the incident light slit in the C5680.

- **Objective Lens**

Connecting a C-mount adaptor to the incident light slit section of the C5680 enables attachment of a C-mount objective lens. F-mount objective lenses can also be attached using an FC converter.

8 Trigger Units

• C1097-01 Delay Unit

This unit can be used to align the operation timing of the streak camera with the target phenomenon.
* The C1097-04, which has a GP-IB interface, is also available.

Variable delay range	0 to 31.96ns
Delay setting range	30, 60, 120, 250, 500ps, 1, 2 4, 8, 16ns
Minimum delay time	Approx. 12 ns
Maximum input voltage	30V
Power supply	AC85 to 250V
External dimensions/weight	215 (W) × 350 (D) × 102 (H) mm/3.4kg

• High-stability Delay Unit C6878

Used in combination with a synchroscan unit, this unit is used to adjust the delay times of trigger signals. In addition, the amount by which trigger signals are delayed is adjusted automatically, while monitoring the sweep signal, enabling stable acquisition of streak images over a long period of time.

Input signals	INPUT:	Input signal frequency range	75 to 100 MHz
		Input signal level	0 to +10 dBm
	REF.IN:	Input signal level	-10 to +10 dBm
Output signalsl	OUTPUT:	Output signal level	-3 to +10 dBm
Variable delay range	Phase angle in relation to input signal		360 degrees
Power supply	Input voltage range		100 to 240 V
	Input power supply frequency range		50/60 Hz
Power consumption	Approx. 28 VA		
External dimensions	261 (W) × 331 (D) × 98.5 (H) mm		

• C4547-01 Streak Trigger Unit

This creates gate trigger signals and streak trigger signals from an external trigger signal, and supplies them to the single sweep unit.
It is equipped with a divider function, enabling external trigger signals with a higher frequency than that of the sweep repetition frequency to be used.

Frequency band	10MHz to 200MHz
Input level	0 to 15dBm/50 Ω
Output signal level	3Vp-p/50 Ω
Output frequency	1 Hz to 100 kHz (variable)

• C6207 RF Up Converter Unit

This outputs an output signal of 100 MHz synchronized to the 10 MHz input signal.
Inputting reference output signals from a commercial frequency synthesizer enables stable synchroscan triggers to be obtained.

Input signal frequency	10MHz ± 10Hz
Input level	–10dBm to 0dBm/50 Ω
Output frequency	100MHz
Output signal level	3dBm/50 Ω (typ.)
Timing jitter	σ: 1 ps max.
Power supply	100/117/220/240VAC, 50/60Hz

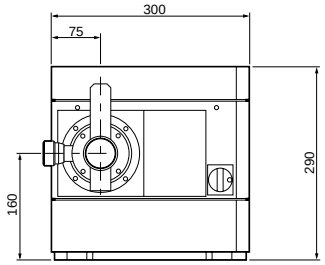
• Other

Numerous other peripheral devices are also available, such as the DG535 Digital Delay Generator and the Picosecond Light Pulser PLP Series. Please feel free to contact HAMAMATSU concerning these and other devices.

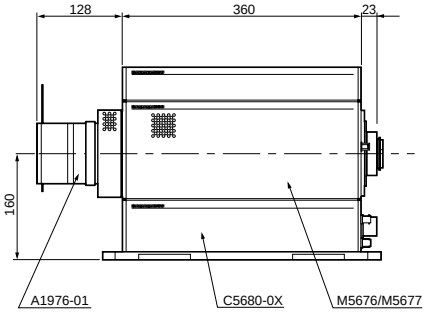
Universal Streak Camera C5680 Series

DIMENSIONAL OUTLINES (Unit: mm)

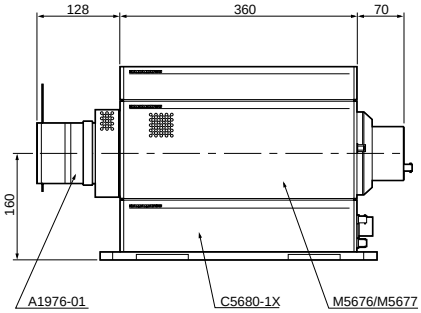
• **C5680 main unit (approx. 20 kg)**



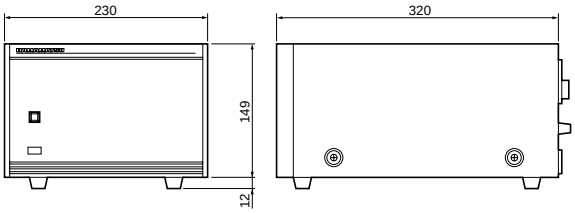
C5680-0X (lens output)



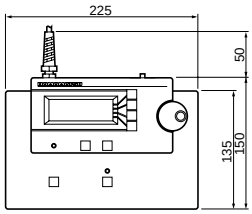
C5680-1X (video output)



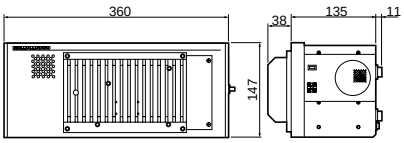
• **Power supply unit (approx. 10 kg)**



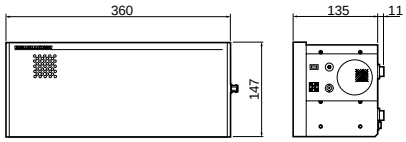
• **Remote control unit (approx. 1.2 kg)**



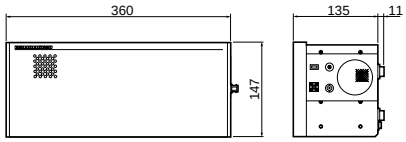
• **M5675 Synchroscan Unit (approx. 4.1 kg)**



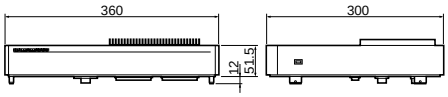
• **M5676 Fast Single Sweep Unit (approx. 2.4 kg)**



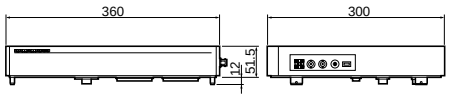
• **M5677 Slow Single Sweep Unit (approx. 2.2 kg)**



• **M5678 Synchronous Blanking Unit (approx. 3.4 kg)**



• **M5679 Dual Time Base Extender Unit (approx. 3.4 kg)**



RELATED PRODUCTS

• Synchroscan FESCA (C6860)

The newly developed Synchroscan FESCA achieves an ultra-high temporal resolution at a high repetition frequency of 75 to 100 MHz, synchronizing with repetitive optical phenomena. The integration of such repetitive phenomena makes it possible to detect and measure extremely weak signals in the IR region of up to 1600 nm using an S-1 streak tube.
Used in combination with the HPD-TA Streak Image Readout System, it provides full remote control of streak camera functions via a GPIB interface.

• FESCA-200 (C6138)

This is a streak camera which opens up new horizons in picosecond measurement, with a temporal resolution of 0.2 ps (200 fs). It is ideal for applications such as analyzing the energy relaxation in quantum well devices, analyzing dynamic chemical reactions at the molecular level, evaluating femtosecond lasers, and research involving optical solitons, where direct measurement of ultra high-speed phenomena is carried out in the sub-picosecond range.

• Streak Camera C2830

This streak camera offers two operation modes simply by switching the sweep unit: a fast single-sweep mode with a temporal resolution of better than 10 ps, and a slow single-sweep mode with a temporal resolution of better than 100 ps. A fiber-optic output streak tube enables direct connection to and readout from a fiber-optic input CCD camera.

• Framing Streak Camera C4187

This camera is designed for ultra high-speed photography, with a shutter speed of 50 ns, a frame rate of 3 million frames per second, and continuous shooting of up to eight frames. A dedicated readout system enables on-the-spot image and data analysis. In addition, the plug-in module can be replaced to allow the unit to be used as a streak camera with a temporal resolution of 10 ps.

TÜV CERT ISO 9001/ISO 13485 EN 46001 Certificate: 09 105 79045

HAMAMATSU

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Cat. No. SSCS 1046E04
AUG/2001 CR
Printed in Japan (500)