Opto-semiconductors

CONDENSED CATALOG

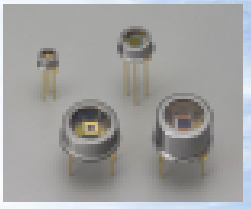
HAMAMATSU

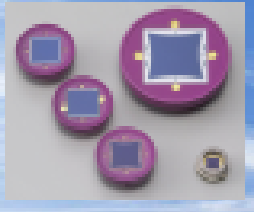
OPTO-SEMICONDUCTORS

Wide-ranging semiconductor device line-up to support the opto-electronics industry

Hamamatsu Photonics has developed and produced a variety of advanced photodetectors and related devices including application-specific products used in medical, analysis and scientific measurement fields. This development work is based on the concept of “Finding the interaction of light and matter” and is a never-ending quest. All of these fields require high-speed photodetectors capable of capturing very low level light. To respond to these needs, here at the Solid State Division of Hamamatsu Photonics we have improved the performance of our opto-semiconductor devices and made them highly integrated. These opto-semiconductor devices are manufactured by our uniquely developed semiconductor process technology and sophisticated mounting technology. Our extensive line-up of opto-semiconductor devices now covers a broad spectral range from the infrared to ultraviolet and further to high-energy particles, allowing use in applications including medical diagnosis, communications, general electronic products, etc. Here at Hamamatsu Photonics we will never cease challenging the future possibilities of light and opto-semiconductors.

Koei Yamamoto
Representative Director and Senior Managing Director
Director of Solid State Division
Hamamatsu Photonics K. K.



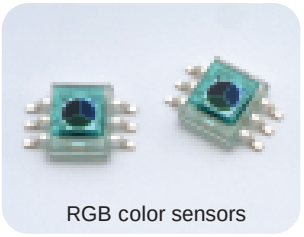


Contents

Applications of Hamamatsu opto-semiconductors

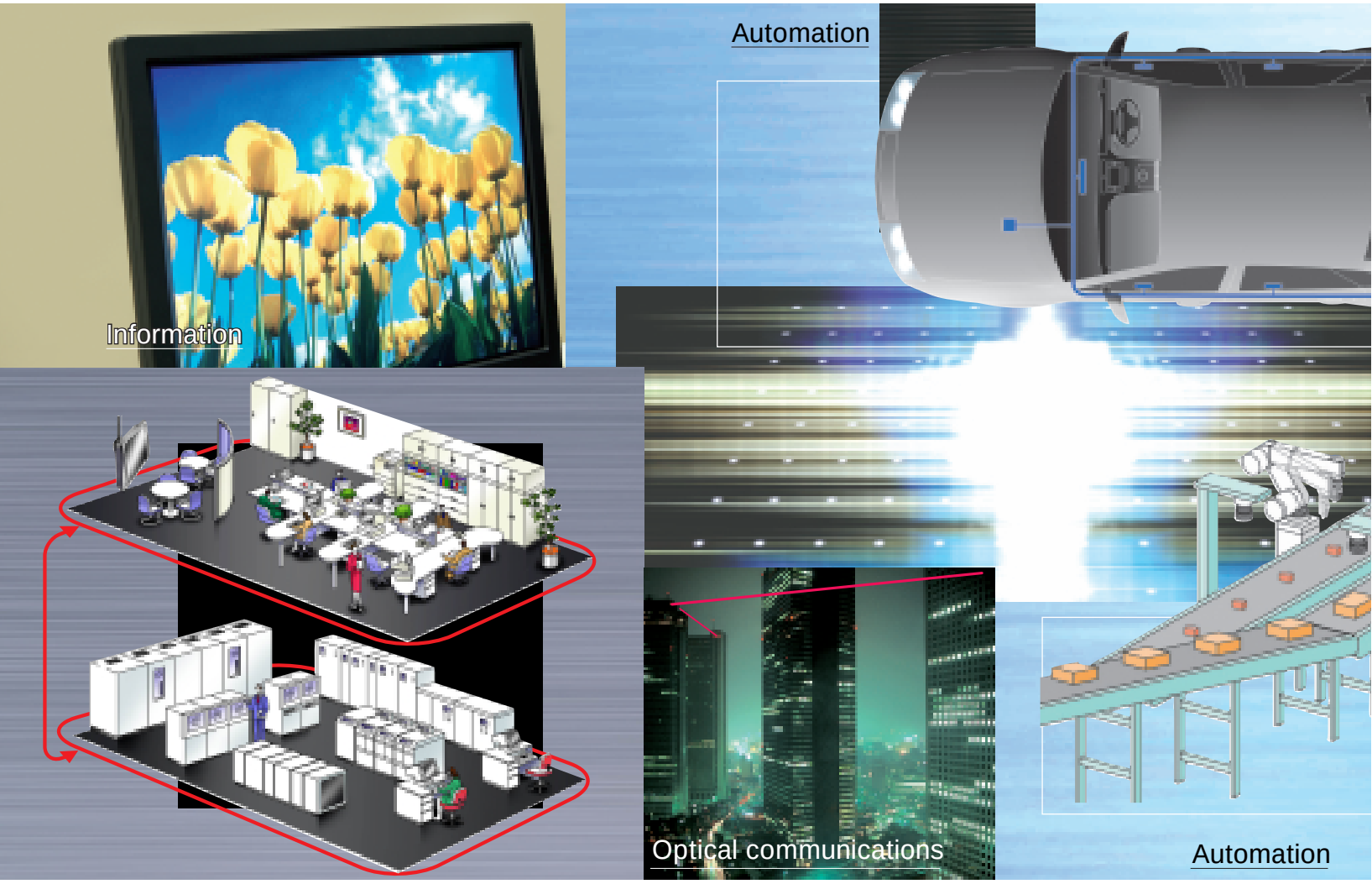
Since they first went on sale in 1958, opto-semiconductors from Hamamatsu Photonics have been used in a host of wide-ranging applications including communications, industrial products and general electronic products as well as the medical diagnosis and scientific fields.

LCD color adjustment
RGB color sensors we make are ideal for detecting LED backlight colors.


RGB color sensors

Automotive applications
Uses for our automotive related devices include in-vehicle LAN, ambient light level detection and day/night detection in auto light control, sun load sensors for auto air conditioning, laser radars, and multi-function jog dials.


Automotive related devices



Optical communications
Hamamatsu provides light transmitter and receiver devices for spatial light transmission as well as optical fiber communications.


Optical communication related devices


10 Gbps ROSA (XMD-MSA)

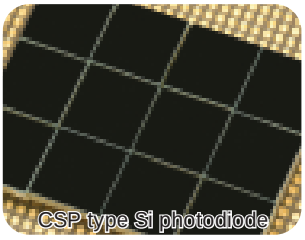
Industrial robotics
Infrared LED and Si PIN photodiode arrays are used to configure the encoders built into robots for position control.


Infrared LED

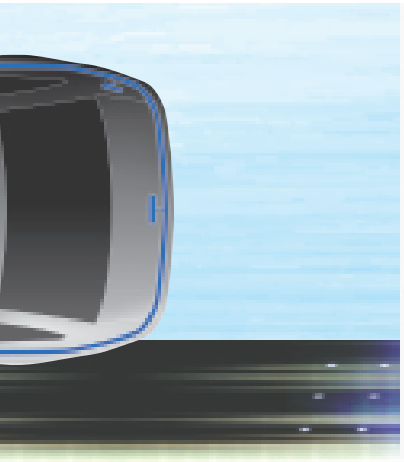
X-ray non-destructive inspection
Hamamatsu makes the X-ray flat panel sensors used for inspecting electrical circuits and other devices. These are widely used as X-ray non-destructive inspection sensors.

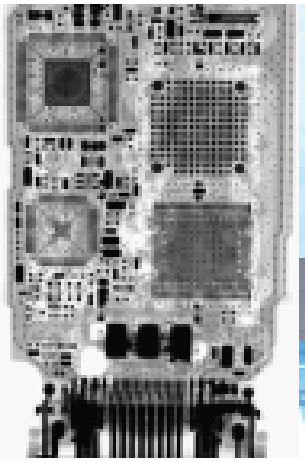
X-ray flat panel sensor

X-ray baggage inspection
Si photodiodes are widely used in the detector section of X-ray scanners.



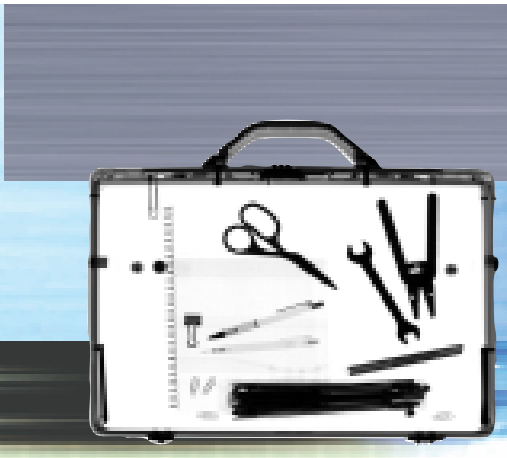
CSP type Si photodiode

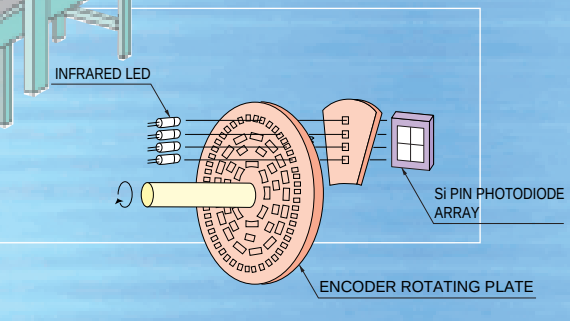


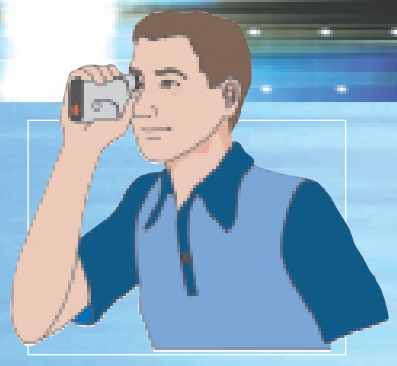


Measurement

X-ray image
of cellular phone (PCB)







Measurement

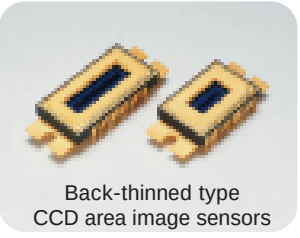
Industrial

Si PIN Photodiode arrays

Rangefinder
Surveying instruments used for distance require Si APDs and Si PIN photodiodes.

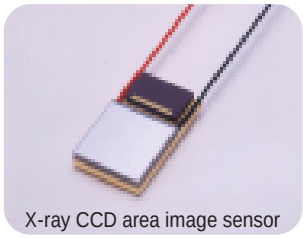
Si APD

Semiconductor manufacturing equipments
Hamamatsu back-thinned type CCD area image sensors are used for semiconductor manufacturing equipments.

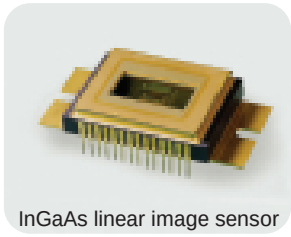


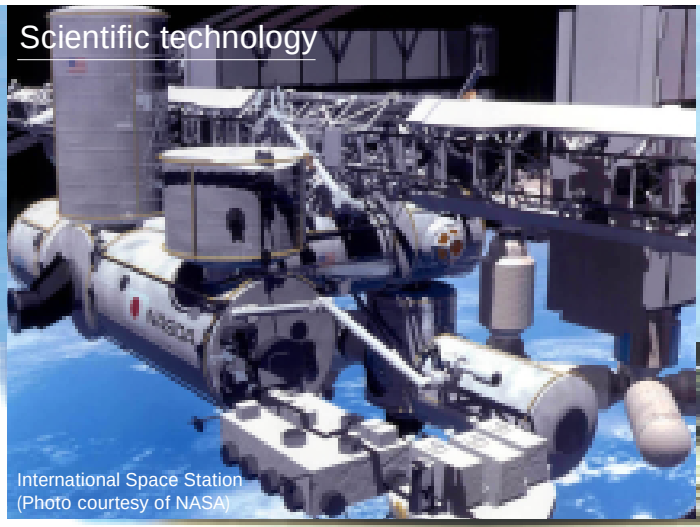
Back-thinned type
CCD area image sensors

Observation of outer galactic space
These CCD sensors are scheduled for use in the International Space Station. There they will help in mapping of X-ray celestial bodies in space and observe fluctuations in spatial phenomenon outside our galaxy.


X-ray CCD area image sensor

Detection of substances on asteroid surfaces
InGaAs linear image sensor we developed for near infrared spectrophotometry is mounted in the "HAYABUSA (falcon)" - Japan's asteroid explorer.


InGaAs linear image sensor



International Space Station
(Photo courtesy of NASA)

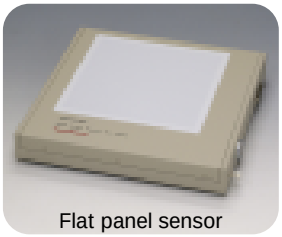
Asteroid explorer "HAYABUSA"
[by courtesy of JAXA (Japan Aerospace Exploration Agency)]

3D CT image for dental diagnosis.

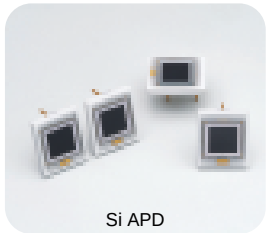
CMS project
(by courtesy of CERN)

Dental X-ray imaging
Front-illuminated CCD area image sensors and flat panel sensors are used for dental diagnosis panorama/cephalometric imaging and inline non-destructive inspection.


Front-illuminated type
CCD area image sensors


Flat panel sensor

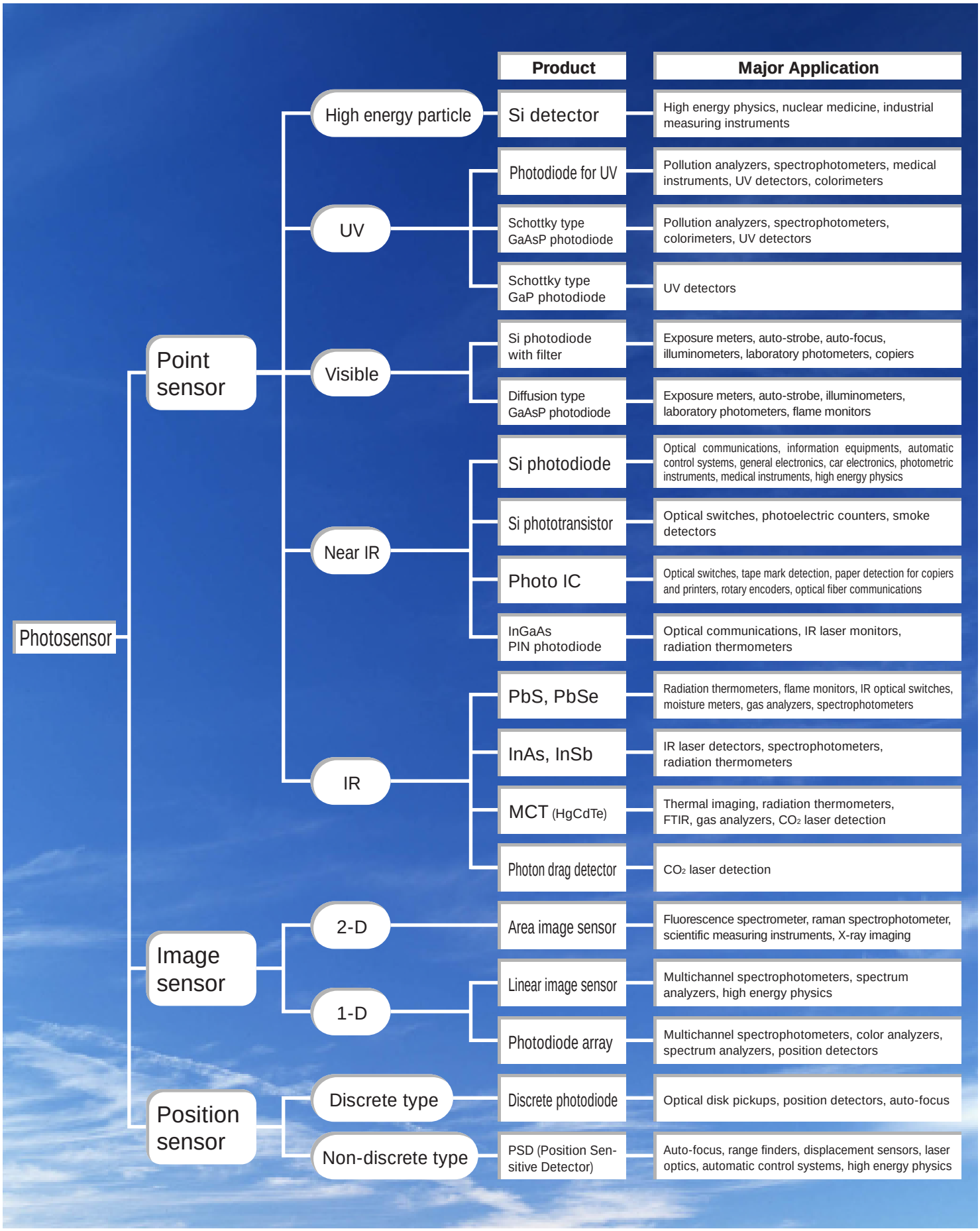
High energy particle detection
Our Si photodiodes, Si APD and Si stripe detectors are used in high energy physics projects (CMS, CERN, KEK, etc.).

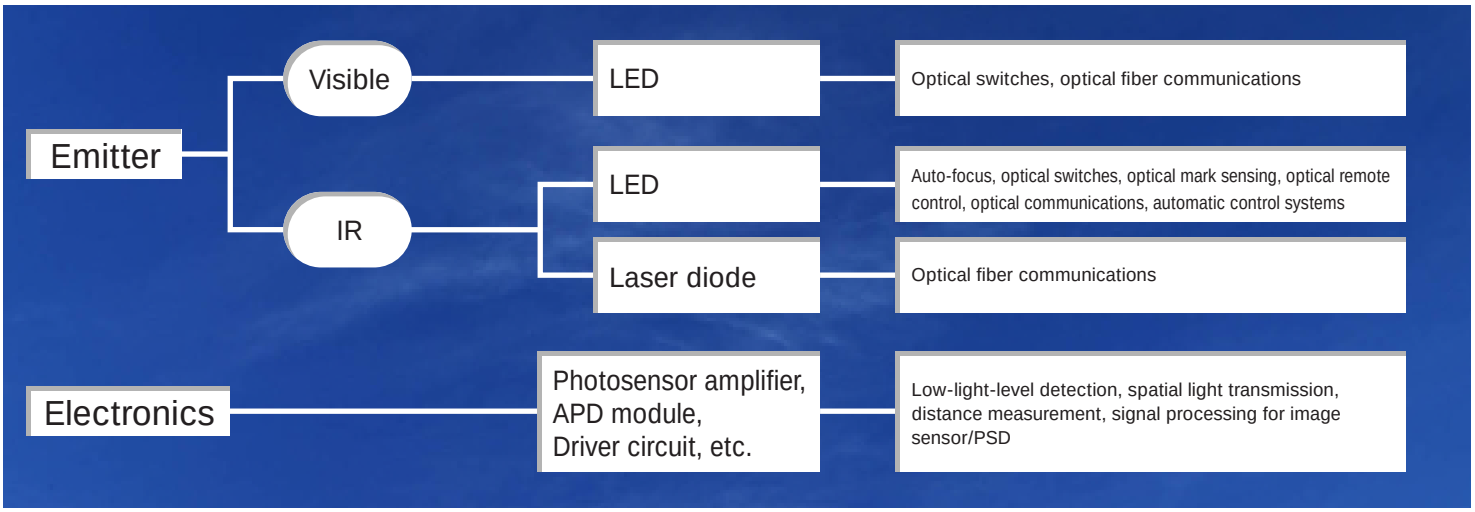

Si APD


Si strip detector

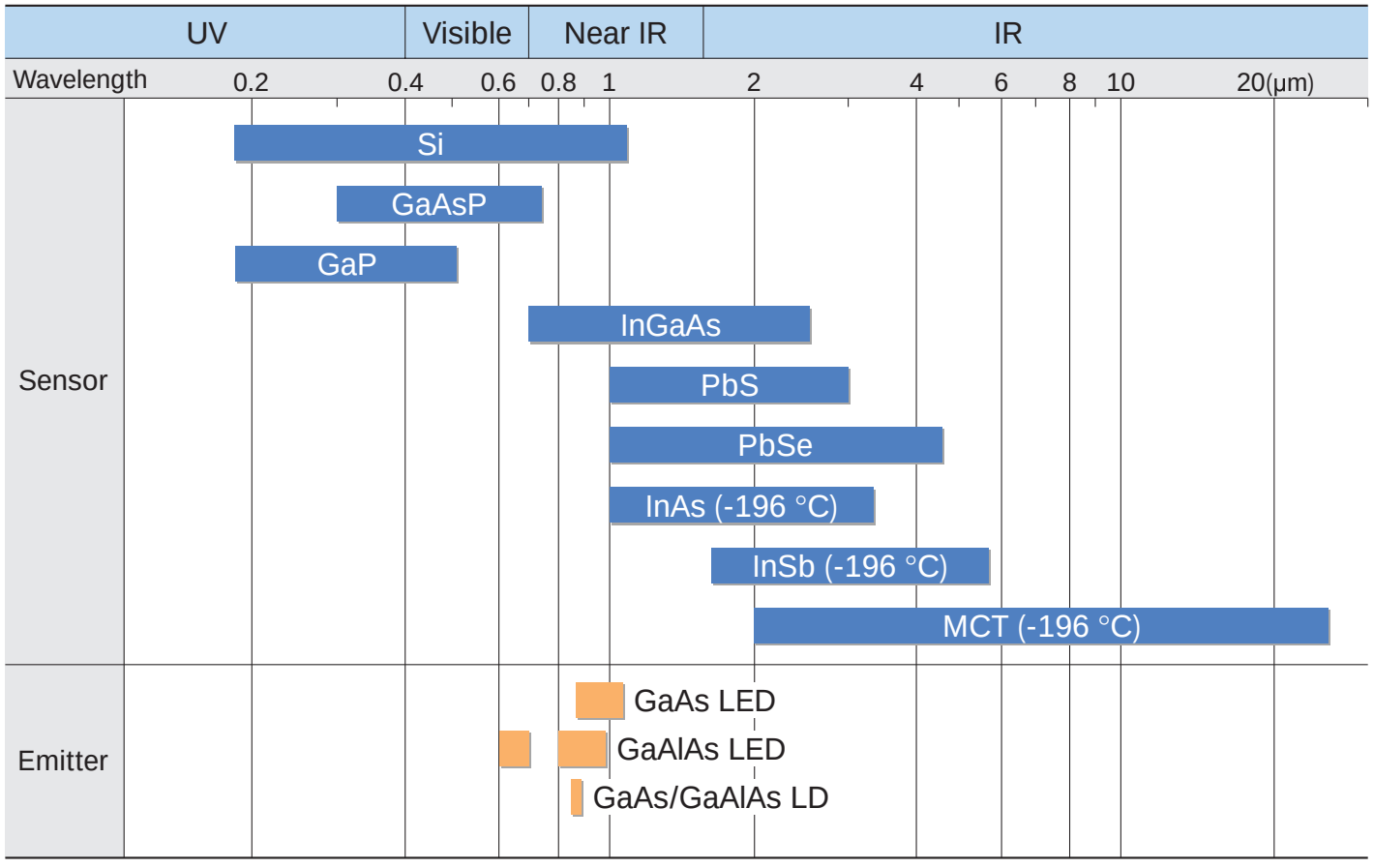
Selection Guide

Types and applications of Hamamatsu opto-semiconductors





Selection guide by wavelength



Opto-semiconductor manufacturing process

Design

We will respond to requests for custom devices. Please free to contact us.

- Electrical and optical characteristics
- Active area
- Number of elements
- Package

Our own advanced process technology delivers various photodiodes with outstanding characteristics.

● Wide spectral response range (UV to near IR) ● High sensitivity
● High reliability ● Low noise

■ Process technology examples

A variety of opto-semiconductors are manufactured by utilizing IC process technology.

PIN bipolar process

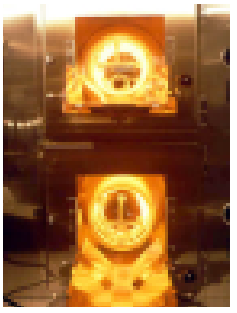
Allows fabricating high-speed photo IC by integrating a PIN photodiode and fast signal processing circuits into a single chip.

CMOS process

Our unique analog & digital circuit technology extracts the maximum performance from optical devices, to develop highly functional devices that will be useful in a broad range of application fields including measurement, medical diagnosis and security.

Wafer process

Wafer thermal process (Oxidation, impurity diffusion)

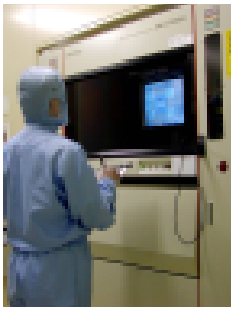


Wafer during thermal process

CVD (Chemical Vapor Deposition) for forming thin film on substrate

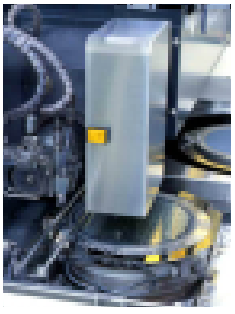
Photolithography process using mask aligner for circuit pattern exposure

Impurity diffusion by ion implantation

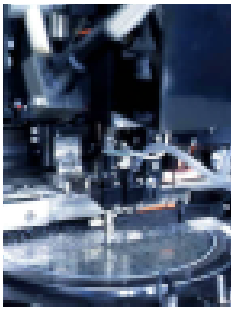


Electrode metallization using spattering equipment

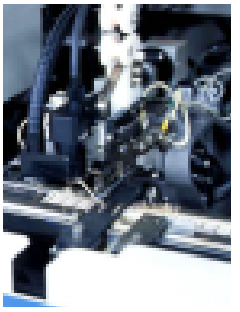
Assembly process



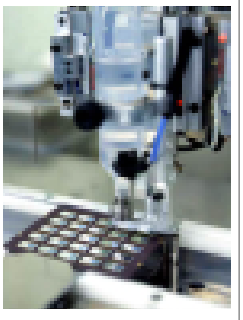
Dicing process for dicing a wafer into individual chips



Die bonding for placing and bonding diced chips onto package



Wire bonding



Automatic filling of potting resin onto chips

Plastic package

Resin molding process

Lead-frame trimming and forming process

Inspection

Device characteristics are evaluated by automatic tester.

We will respond to requests for various package assemblies.
We are also ready for mass production of low-cost packaging devices.

Package examples

● Metal package ● Ceramic package ● Plastic package
● Surface-mount type ● Receptacle type ● Pigtail type

■ Assembly technology examples

Axis alignment technology

Makes highly precise connection of optical communication devices to optical fibers.

Bump technology

This technology makes electrical interconnections to chips without using wire bonding and allows fabricating small, compact, yet highly reliable devices.

Core technologies of opto-semiconductors

By merging core technologies here at Solid State Division of Hamamatsu Photonics, we succeeded in developing and manufacturing a wide range of opto-semiconductors offering distinctive features.

Semiconductor process technologies

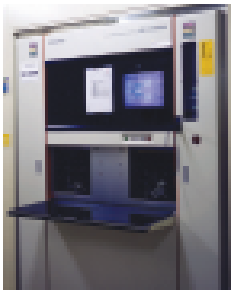
We manufacture diverse types of opto-semiconductors by using our own in-house semiconductor process technologies (including CMOS, NMOS, bipolar, PIN bipolar, compound semiconductor processes).

■ Si semiconductor process

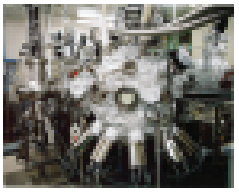
■ Compound semiconductor process

● Semiconductor process optimized for optical devices

Crystal growth
Thermal process
Insulation film formation
Etching
Miniaturlzation
Electrode formation



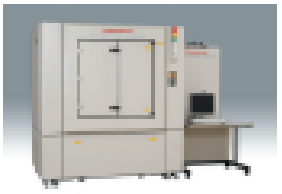
Spattering equipment (Electrode formation)



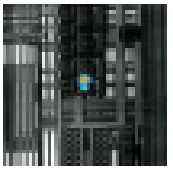
MBE equipment (crystal growth)

MOCVD equipment (crystal growth)

● Feedback to process by cutting-edge evaluation techniques



Semiconductor inspection equipment



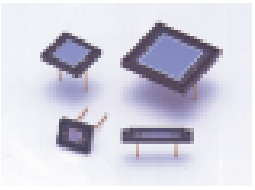
Failure analysis example by detecting light emission

Mounting / Package technologies

We offer opto-semiconductors in a variety of package styles to meet diverse and wide-ranging application needs.

Metal

Plastic

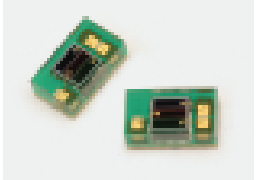


Ceramic

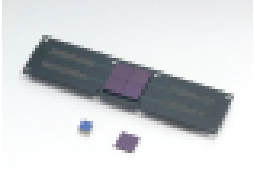
Surface mount type

Thin plastic

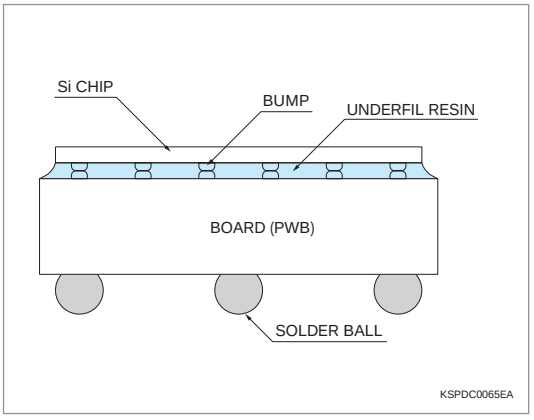
Square type metal



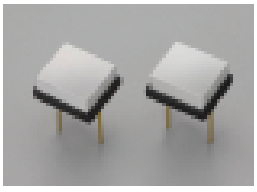
COB (Chip On Board)



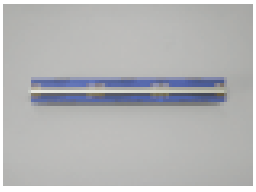
CSP (Chip Size Package)



Cross section of CSP



With scintillator



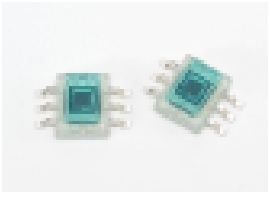
Long and narrow type

Dewar

CMOS technologies

CMOS is the focus of much attention as a promising technology for manufacturing highly integrated, high-speed opto-semiconductors. HAMAMATSU is actively developing CMOS sensors based on our unique analog CMOS technology developed in-house for various fields such as in-vehicle applications, general electronics and information processing as well as spectrophotometry and medical measurement. By integrating optical sensor devices with analog/digital circuit functions into products designed to meet market needs, our CMOS sensor devices will prove ideal for upgrading performance, lowering system costs and delivering more sophisticated functions.

■ Products using CMOS technology

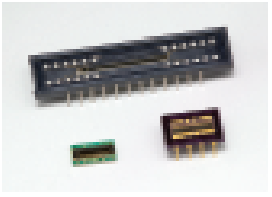


CMOS photo IC

Excellent mass production
·Merging packaging and production technologies

Compact

Low power consumption



CMOS image sensors

High sensitivity
·Uses APS (Active Pixel Sensor) method

Sophistication
·Internal AD converter
·Adjustable integration time per pixel

High-speed
·High-speed readout by simultaneously integrating charges in all pixels

X-ray flat panel sensors

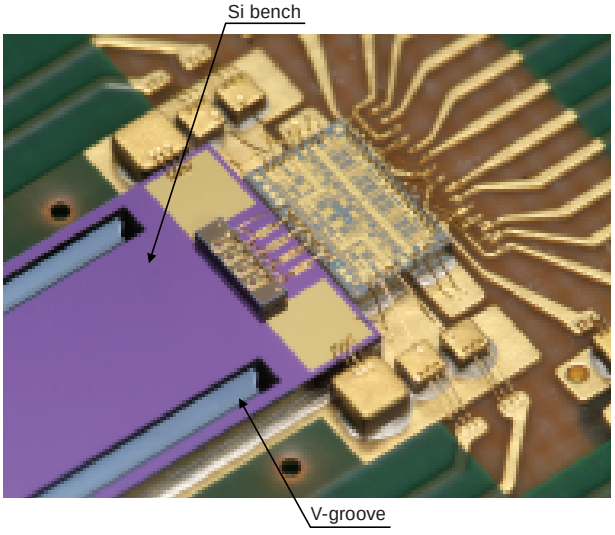
Special shape
·X-ray image sensors with large active area

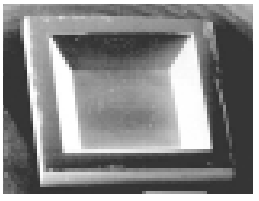
Photodiode arrays with amplifier

Flexible design
·Hybrid assembly with CMOS amps delivers maximum sensor performance.

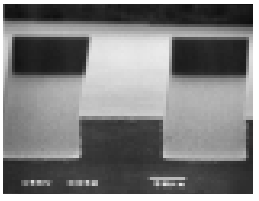
MEMS technologies

Silicon MEMS (Micro Electro Mechanical System) technologies are drawing attention as innovative technologies that enhance opto-semiconductor functions. We are developing diverse types of opto-semiconductor devices by using techniques including anisotropic wet etching, deep dry etching, wafer-wafer bonding, anodic bonding, and through-hole interconnection.

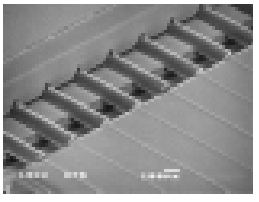




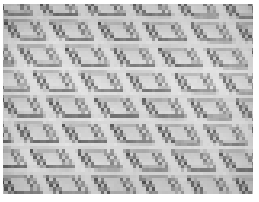
Anisotropic wet etching



Deep dry etching



Optical wave guide



Surface micromashine processing

Si Photodiodes

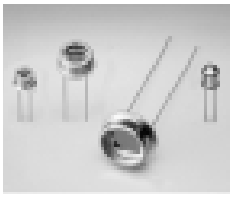
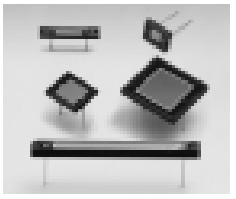
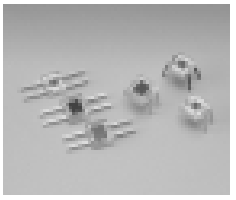
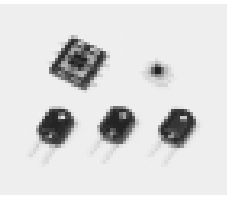
Product line-up used in diverse applications

- Used in wide applications covering optical fiber communications, cameras, copiers, analytical equipment and baggage inspection
- Available in various packages: metal, ceramic and plastic packages including surface mount types

Si photodiodes

Featuring high sensitivity and low dark current, these Si photodiodes are widely used for precision photometry (such as analytical instruments) and general photometry (such as visible range).

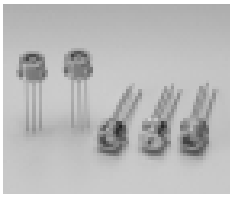
■ Product line-up
- For UV to near IR range
- For visible to near IR range
- For excimer laser detection
- For monochromatic light
- For visible range
- For RGB color sensor

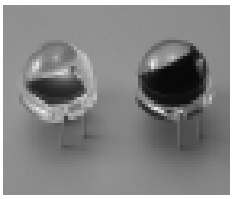





Si PIN photodiodes

Si PIN photodiodes deliver high-speed response when operated with a reverse bias and are widely used for optical communications and optical disk pickup, etc.

■ Product line-up
- Cut-off frequency: 1 GHz or more
- Cut-off frequency: 500 MHz to less than 1 GHz
- Cut-off frequency: 100 MHz to less than 500 MHz
- Cut-off frequency: 10 MHz to less than 100 MHz
- Miniature and thin plastic package type

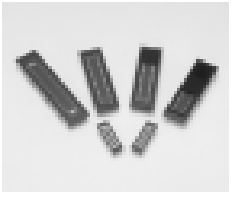
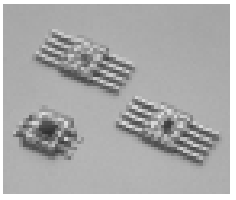
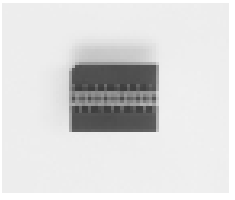
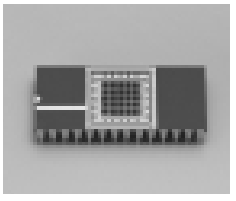




Si photodiode arrays

Si photodiode arrays consist of multiple elements formed in a linear or matrix arrangement in one package. These Si photodiode arrays are used in a wide range of applications such as laser beam position detection and spectrophotometry.

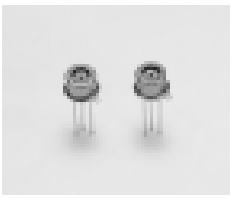
■ Applications
- Spectrophotometers
- Light position detection
- Laser beam axis alignment
- Incident angle detection
- 2-D photometry

Si photodiodes with preamp, TE-cooled type Si photodiode

Si photodiodes with preamp incorporate a photodiode and a preamplifier chip into the same package. This configuration makes them highly resistant to external noise and allows you to design more compact circuits.

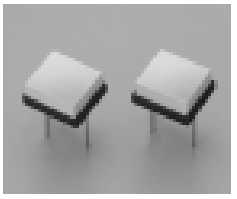
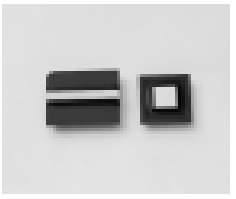
■ Product line-up
- For optical fiber communications
- For analytical instrument and precision measurement

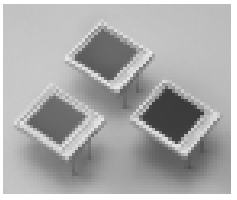



X-ray detectors

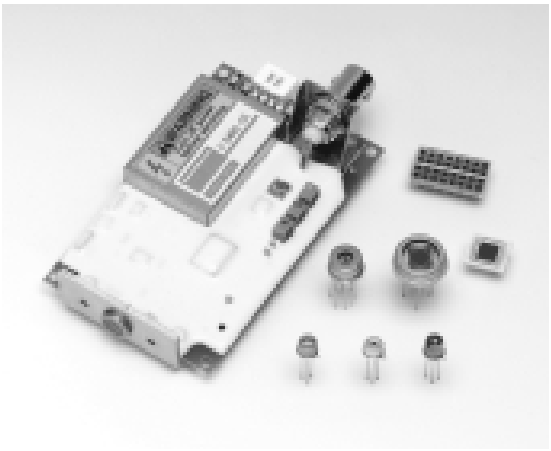
These X-ray detectors are comprised of a Si photodiode coupled to a scintillator and widely used for baggage inspection and non-destructive inspection.

■ Product line-up
- With scintillator
- Large active area type



APD



High-speed, high sensitivity photodiodes having a internal gain mechanism

The APD (avalanche photodiode) is a high sensitivity photodiode that operates at high speeds and high gain by applying a reverse bias. Delivers a higher S/N than PIN photodiodes and is widely used in optical rangefinders, spatial light transmission, scintillation detectors, etc.

Si APD

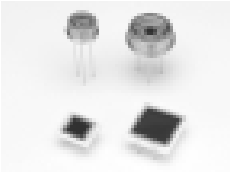
■ Product line-up

● NIR type

NIR (near infrared) type includes low bias voltage operation devices for 800 nm band, and low temperature coefficient devices.

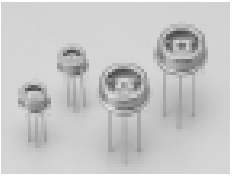
● Short wavelength type

These short-wavelength APDs are optimized for detection of UV to visible light. High gain can be obtained in short wavelength regions, making these APDs suitable for low-light-level measurements such as in analytical instrument.



● NIR high sensitivity type

NIR high sensitivity APDs are enhanced near infrared sensitivity devices for 900 nm and 1.06 µm bands.



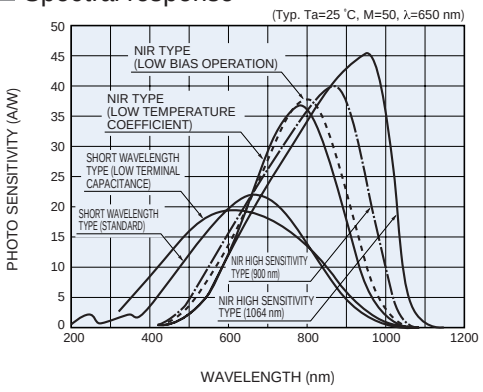
● Surface mount type

This surface-mount type APD is Si APD encapsulated in a surface mount ceramic package that ensures high reliability in the same wide operating temperature range (-20 to 85 ˚C) as metal package devices.

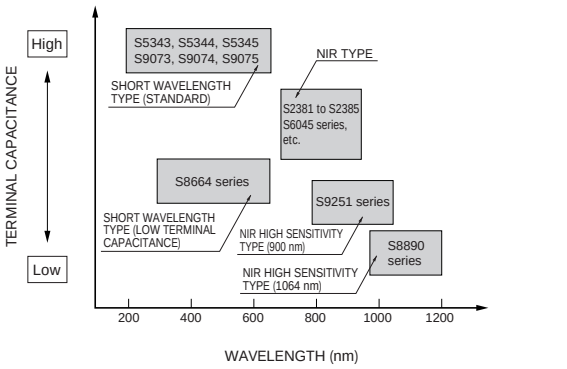
● Multi-element type

This quadrant APD with ϕ1 mm active area is designed to operate with a low bias. The quadrant format on one chip ensures uniform characteristics between elements. Single power supply operation allows easy connections. Applications include low-light-level detection and laser beam alignment.

Spectral response



Terminal capacitance vs. wavelength



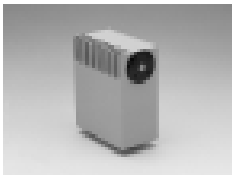
APD modules

Product line-up

- **Standard type**
  Available for near infrared and short wavelength applications, and also with FC connector coupling, etc.

- **High sensitivity type**
  High gain type for detection under low illuminance

- **High-speed type**
  Fast response type for pulsed light detection



- **TE-cooled type**
  High sensitivity APD module for low-light-level detection

Sensitivity vs. response speed

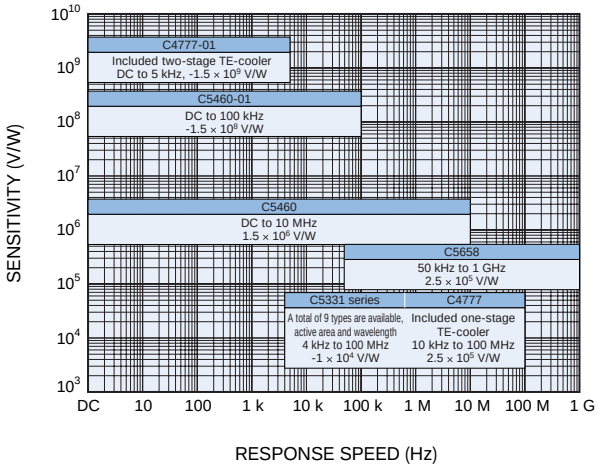
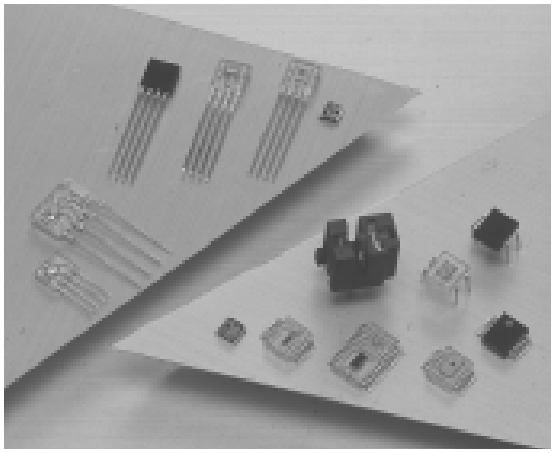


Photo IC



Highly functional devices integrating photodiode with signal processing circuits

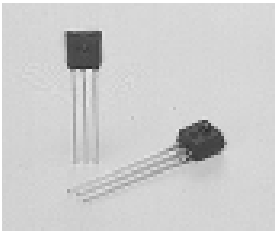
Compared to devices consisting of a discrete photodiode and an op-amp circuit, photo ICs offer the following features.

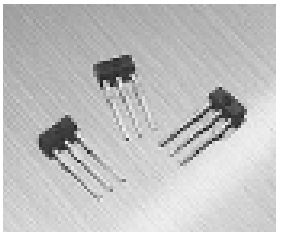
- Compact and light weight
- High resistance to electromagnetic induction noise
- High reliability

Schmitt trigger photo IC

Digital output

Digital-output photo ICs molded into a subminiature plastic package.





Light modulation photo IC

Digital output

Light modulation photo ICs allow reliable optical detection even under disturbance background light by detecting pulsed signals in synchronous mode. Asynchronous type is also provided.

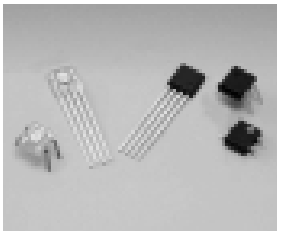


Photo IC for laser beam sync detection

Digital output

These photo ICs provide the start timing for laser beam scan in laser beam printers and digital copiers. Dual photodiode type is also provided that maintains stable output even if the laser power or ambient temperature fluctuates.

Photo IC for optical link

Digital output

These photo ICs are specifically developed as receivers and emitters for optical fiber communications. Digital output is obtained from these photo ICs when they detect red light emitted through a POF (Plastic Optical Fiber).

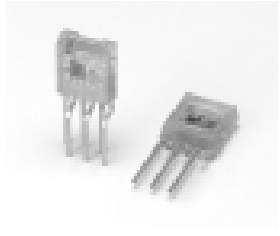


Photo IC for optical switch

Digital output

Functions needed for industrial optical switches are implemented into these photo ICs.

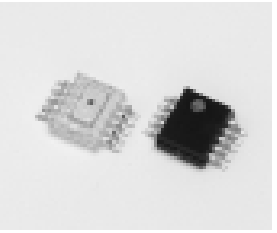
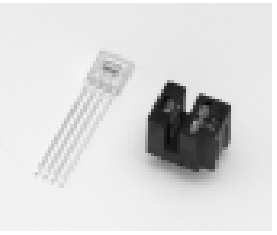


Photo IC/Module for encoder

Digital output

Linear encoders or rotary encoders having a 2-phase digital output can be configured by using this photo IC along with a codestrip or codewheel and a light source such as tungsten lamp or LED. Small package and high resolution encoder module is also available.



Light-to-frequency converter photo IC

Digital output

This is a photo IC that combines a photodiode and a current-to-frequency converter on a hybrid CMOS chip. Output is a square wave (50 % duty ratio) with frequency directly proportional to light intensity incident on the photodiode.

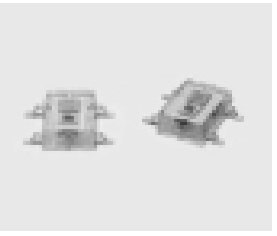
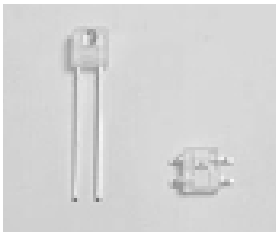
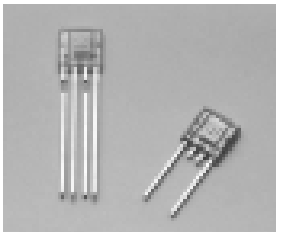


Photo IC diodes

Analog output

Photo IC diodes have two terminals like photodiodes and amplify the photocurrent generated by the input of light.





Related products

Phototransistors

Phototransistors amplify the current generated by the input of light. Compared to photodiodes, a large output current can be derived even from a small active area.

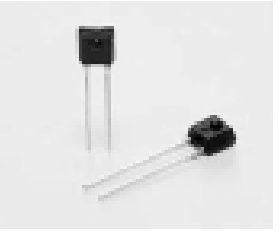
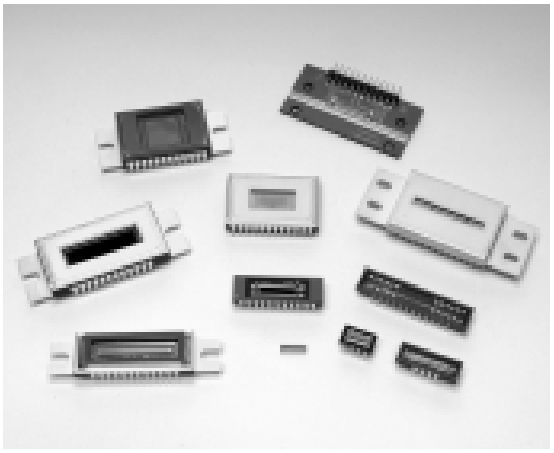


Image Sensors



A wide line-up of image sensors ideal for spectroscopy and measurement applications

HAMAMATSU provides various types of image sensors that cover a wide energy level and spectral response range from near infrared (NIR) at 2.6 µm through visible, ultraviolet, vacuum ultraviolet (VUV) down to soft X-rays and hard X-rays at several hundred keV.

CCD area image sensors

CCD area image sensors offer a high S/N and are ideal for low-light-level detection. Among CCD area image sensors, back-thinned types (for backside light input) offer high quantum efficiency even in the vacuum UV region. (Maximum QE more than 90 %)
Excellent sensitivity stability allows detection over a wide spectral range from visible light through X-rays.

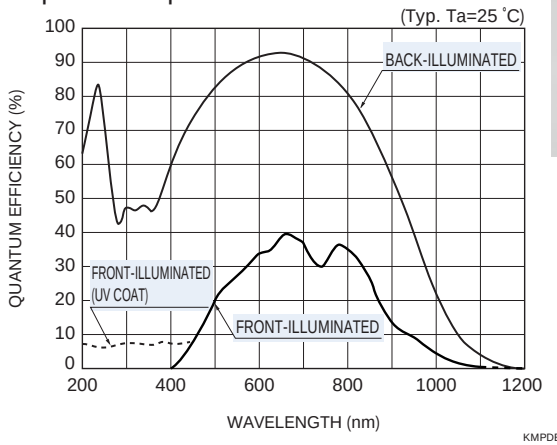
■ Front-illuminated type

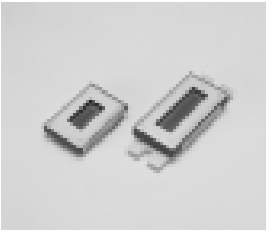
- For spectrophotometry
- Long integration type for spectrophotometry
- For scientific measurement
- For X-ray imaging

■ Back-thinned type

- For spectrophotometry
- High resolution type for spectrophotometry
- Large full well type for spectrophotometry
- For scientific measurement

■ Spectral response



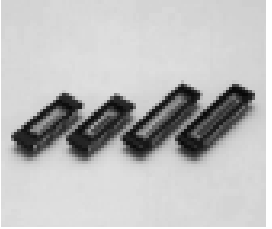


NMOS linear image sensors

NMOS linear image sensors feature a large active area of each photodiode, high UV sensitivity yet sufficiently low noise. Dedicated driver circuits and pulse generators are also available.

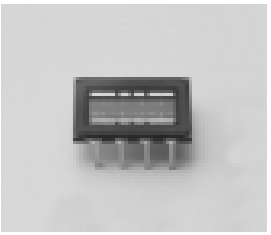
■ Product line-up

- Current output type (infrared enhanced type, FOP type and for X-ray detection)
- Voltage output type



CMOS linear image sensors

CMOS linear image sensors are self-scanning photodiode arrays integrated with a signal processing circuit.
These image sensors also incorporate a timing generator that produces clock pulses needed for driving the image sensor and can be easily operated by supplying a clock pulse, start pulse and 5 V supply.

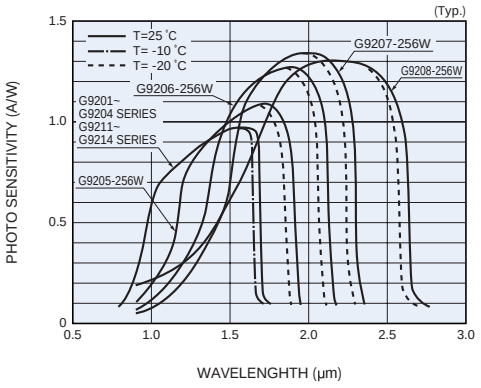


InGaAs linear image sensors

InGaAs image sensors are designed for detection and measurement in the near infrared region. The built-in readout CMOS circuit allows easy handling and operation.

■ Product line-up
- For spectrophotometry
- For DWDM monitor

■ Spectral response

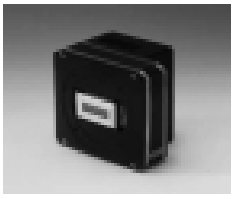


KIRDB0033EB

Related products

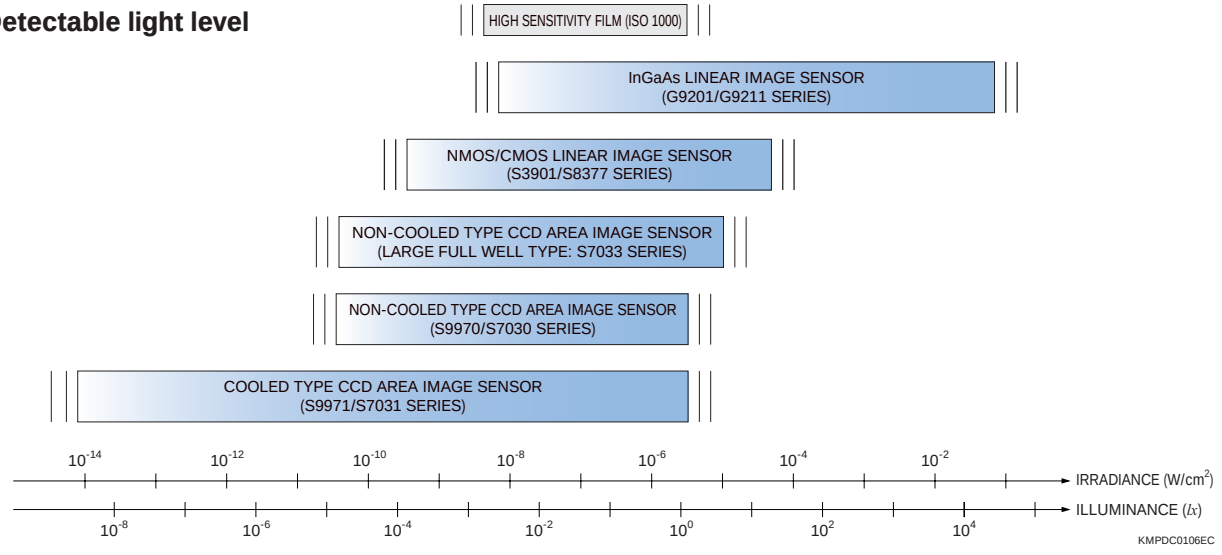
Multichannel detector heads

Operating an image sensor requires sophisticated signal processing. Hamamatsu multichannel detector heads contain an image sensor driver circuit that allows quick and easy operation of an image sensor by installing it into the socket on the front of the detector head. For InGaAs linear image sensors and CCD area image sensors, the dedicated controller C7557 is also provided.



■ Product line-up
- InGaAs multichannel detector head
- CCD multichannel detector head
- NMOS multichannel detector head

■ **Detectable light level**



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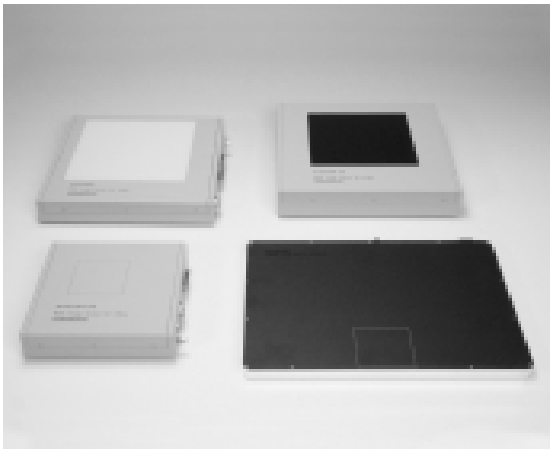
X-ray Flat Panel Sensors



Acquires real-time X-ray images

Flat panel sensors are digital X-ray image sensors newly developed as key devices for non-destructive inspection, digital radiography and other real-time X-ray imaging applications requiring high sensitivity and high image quality. Flat panel sensors consist of a sensor board and a control board, both assembled in a thin, flat and compact package.

Applications

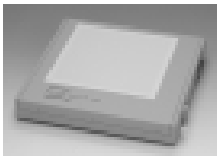
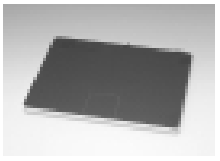
● Non-destructive inspection ● Digital X-ray photography
● Soft X-ray radiography ● Digital radiography, etc.

For non-destructive inspection


Type No.	Output	Number of pixels	Pixel size (μm)	Diagonal size (mm)	Frame rate *1 (frame/s)	Resolution (line pairs/mm)
C7921CA-02	Digital (12-bit)	1056 × 1056	50	75	4	8
C9321CA-02		1056 × 1056	50	75	8	8
C7942CA-02		2400 × 2400	50	170	2	8
C7943CA-02		1248 × 1248	100	176	7	5
C7921SK-05		1056 × 1056	50	75	4	8
C9321SK-05		1056 × 1056	50	75	8	8
C7942SK-05		2400 × 2400	50	170	2	8
C9312SK		2496 × 2304	50	170	8	9

*1: Single operation

For radiology

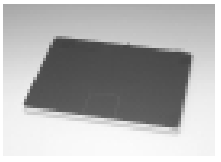



■ Product line-up
● High resolution type
● High flame rate type

Type No.	Output	Number of pixels	Pixel size (μm)	Diagonal size (mm)	Frame rate *2 (frame/s)	Resolution (line pairs/mm)
C9732DK	Digital (14-bit)	2400 × 2400	50	170	1	10
C9730DK		1056 × 1056	50	75	4	10
C9250DP	Digital (12-bit)	624 × 624	200	176	30	2.5
C9311DK		1248 × 1152	100	170	30	5

*2: Single operation

Low noise type

■ Features
● Active pixel CMOS sensor
● Low noise

Type No.	Output	Number of pixels	Pixel size (μm)	Diagonal size (mm)	Frame rate *3 (frame/s)	Noise (e^-)
C10013SK *4	Digital (12-bit)	1056 × 1056	50	75	4	80
C9728DK *4	Digital (14-bit)	1056 × 1056	50	75	3	80

*3: Single operation
*4: Application (X-ray energy range) C10013SK: for non-destructive inspection (20 to 150 kVp)
C9728DK: for diffraction (18 keV or less)

PSD (Position Sensitive Detectors)

Light spot position sensors used for distance measurements, etc.

PSDs (Position Sensitive Detectors) are comprised of a monolithic detector with no discrete elements and provide continuous position data by making use of the surface resistance of the photodiode. PSDs offer advantages such as high position resolution, high-speed response and reliability.

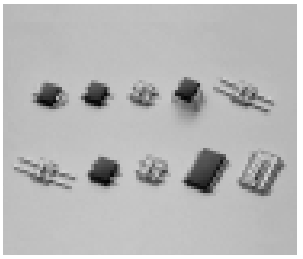
- Excellent position resolution
- Wide spectral response range
- High-speed response
- Simultaneously detects light intensity and the center of gravity position of the light spot
- High reliability

Applications

- Position and angle sensing
- Distortion and vibration measurements
- Lens reflection and refraction measurements
- Laser displacement sensing
- Optical remote control
- Optical rangefinders
- Optical switches
- Optical correction for camera shake
- 3-D shape measurement

One-dimensional PSD

■ Product line-up
- Visible-cut type for near infrared detection
- Red sensitivity enhanced type
- Microscopic light spot (LD beam, etc.) detection type
- Long, narrow type with an active area exceeding 30 mm

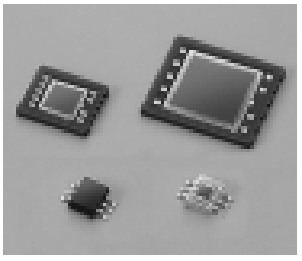


Plastic package

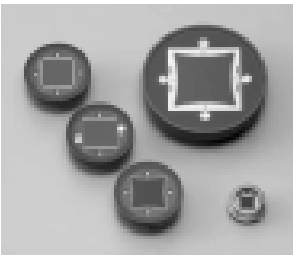
Metal/Ceramic package

Two-dimensional PSD

■ Product line-up
- Tetra-lateral type
  High-speed response and low dark current
- Duo-lateral type
  Small position detection error and high position resolution
- Pin-cushion type
  Tetra-lateral type with improved active area and electrodes having a position detection error as small as the duo-lateral type while still having the advantages of the tetra-lateral type



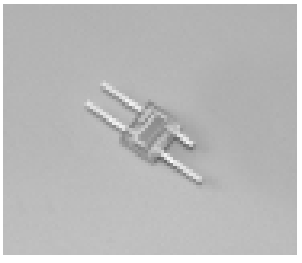
Surface mount type/Plastic package

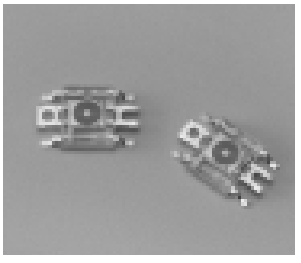


Ceramic/Metal package

Special type PSD

■ Product line-up
- 128-element PSD array
- Nonlinear output PSD
- Circular PSD for angle detection





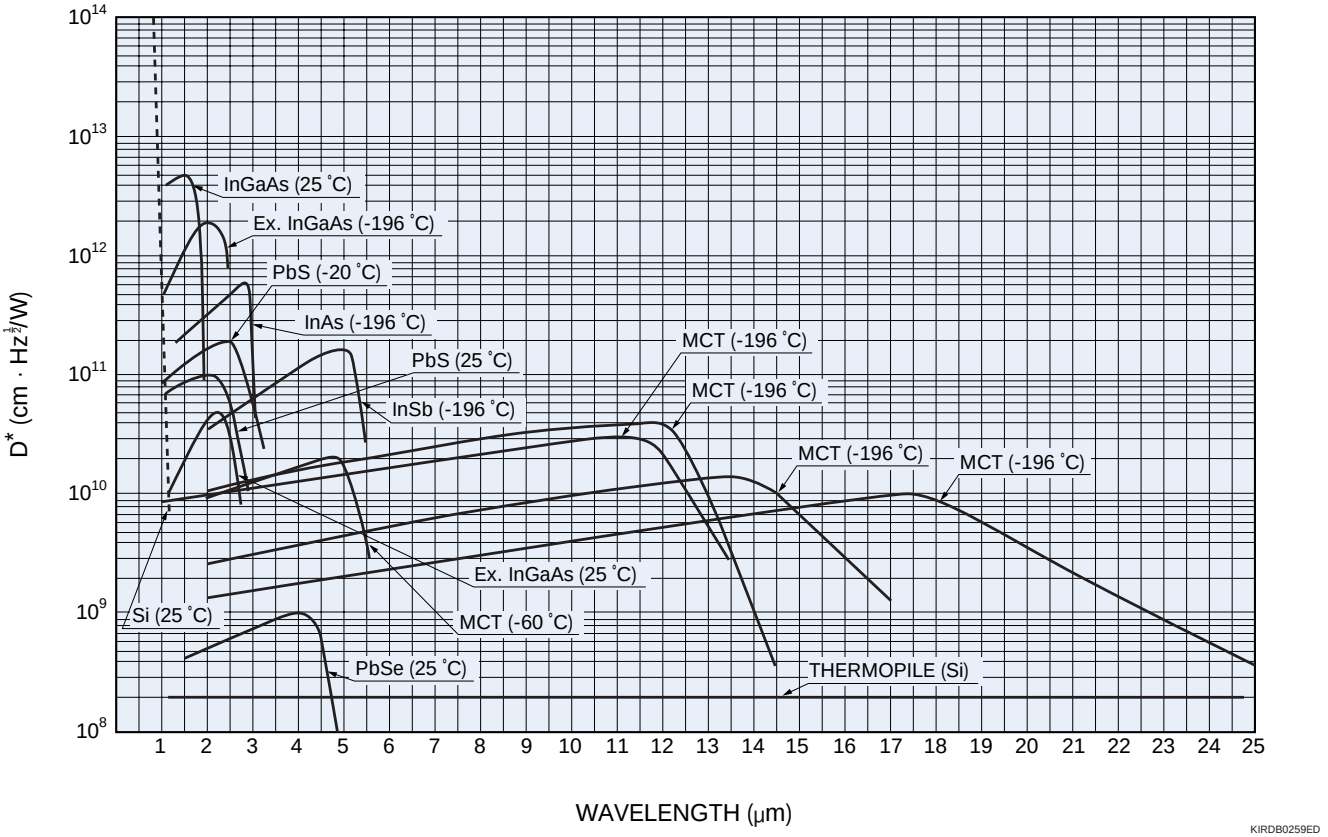
Infrared Detectors

Providing a variety of photosensors with different spectral response characteristics.

Infrared detectors are utilized in a wide range of fields such as industry, agriculture, medicine, physics, chemistry, astronomy, communications and remote sensing from space.

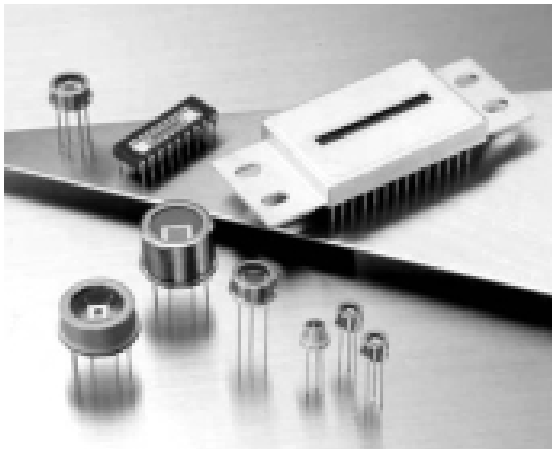
Product name		Spectral response range (μm) 0 5 10 15 20 25	Feature
Infrared detector			
InGaAs PIN photodiode		0.7 2.6	• NIR (near infrared) detectors that feature low noise and excellent frequency response characteristics.
PbS photoconductive detector		1 3.2	• Photoconductive detectors whose resistance decreases with the input of infrared light. • Can be used at room temperatures in a wide range of applications such as radiation thermometers and flame monitors
PbSe photoconductive detector		1.5 5.2	• Detects wavelengths up to 5.2 μm • Offers higher sensitivity at room temperatures compared to other detectors used in the same wavelength range. Suitable for a wide range of applications such as gas analyzers.
InSb photoconductive detector		1 6.7	• Detects wavelengths up to around 6.5 μm, with high sensitivity over long periods by thermoelectric cooling
InSb photovoltaic detector		1 5.5	• High speed and high sensitivity in so-called atmospheric window (3 to 5 μm)
InAs photovoltaic detector		1 3.8	• Covers a spectral response range close to PbS but offers higher response speed
MCT (HgCdTe) photoconductive detector		2 25	• Various types with different spectral response are provided by changing the HgTe and CdTe composition ratio. • Photoconductive detectors whose resistance decreases with the input of infrared light • Available with thermoelectric coolers, cryogenic dewars and Stirling coolers
MCT (HgCdTe) photovoltaic detector		1 13	• Excellent output linearity • High-speed response
Two-color detector	Si + PbS	0.2 3.1	• Wide spectral response range from UV to IR • Two-color detectors incorporate an infrared-transmitting Si photodiode mounted over a PbS detector, PbSe detector or InGaAs PIN photodiode along the same optical axis.
	Si + PbSe	0.2 5.1	
	Si + InGaAs	0.25 1.7	
Photon drag detector		10	• High-speed detector with high sensitivity in 10 μm band (for CO_2 laser detection) • Room temperature operation with high-speed response

Spectral response of compound semiconductor photosensors (typical example)



KIRDB0259ED

■ InGaAs PIN photodiodes



NIR (near infrared) detectors that feature low noise and excellent frequency response characteristics

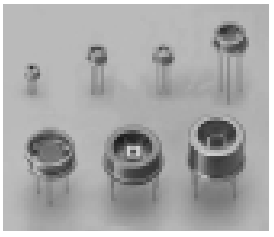
InGaAs PIN photodiodes are NIR detectors that feature high-speed response due to small terminal capacitance.
When cooled with a thermoelectric cooler, InGaAs PIN photodiodes exhibit very lower dark current to deliver even higher D* (Detectivity).

Applications

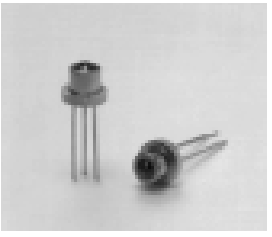
- Optical fiber communications
- Optical power meters
- Laser diode monitors
- Gas analyzers
- Moisture meters
- Other infrared detection, etc.

Standard type [0.9 to 1.7 µm (Non-cooled type)]

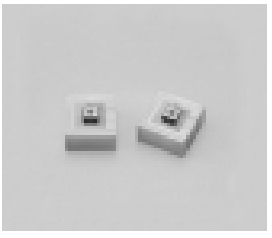
● Metal package .....
Hamamatsu InGaAs PIN photodiodes are available in various active area size (ϕ0.04 to ϕ5 mm).
TE-cooled type is also provided.

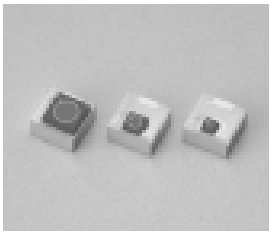


● Metal package with ball lens .....
This InGaAs PIN photodiode is encapsulated in a metal package with a ball lens that allows efficient coupling to an optical fiber.



● Surface mount type .....
These InGaAs PIN photodiodes are assembled on a small ceramic base originally developed for laser diode monitoring.

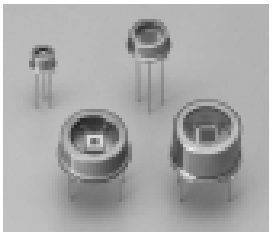




Long wavelength type .....

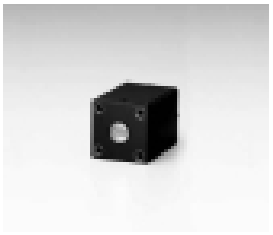
- Peak sensitivity wavelength: 1.75 µm [0.9 to 1.9 µm (Non-cooled type)]
- Peak sensitivity wavelength: 1.95 µm [0.9 to 2.1 µm (Non-cooled type)]
- Peak sensitivity wavelength: 2.30 µm [1.2 to 2.6 µm (Non-cooled type)]

TE-cooled type is also provided.

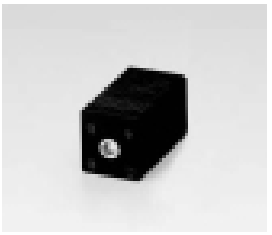


Infrared detector modules with preamp

These modules consist of an InGaAs PIN photodiode assembled with the matched preamplifier, and can operate simply by connecting a DC power supply.



Non-cooled type

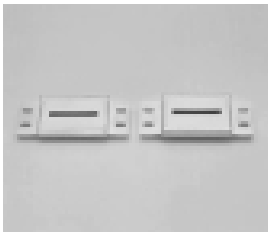


TE-cooled type

Metal dewar type

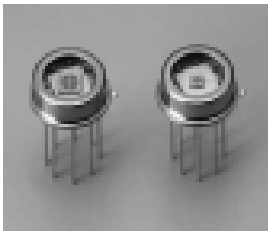
InGaAs linear image sensors

- For spectrophotometry
- For DWDM monitor



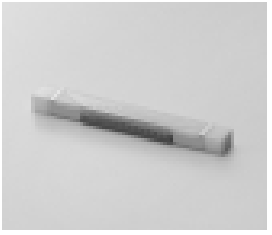
InGaAs photodiode arrays

Quadrant InGaAs photodiodes for position detection of light spot and 16-element linear arrays for NIR (near IR) spectrophotometry are provided.



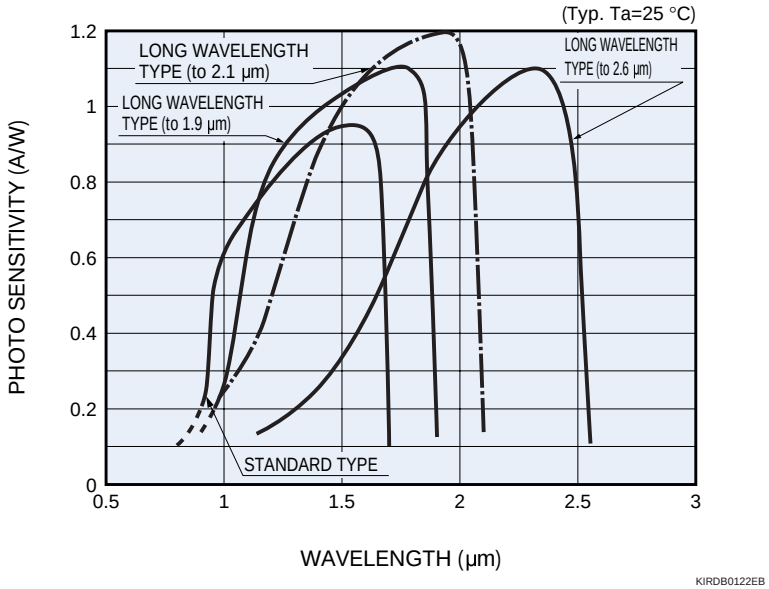
Quadrant element type

16-element array

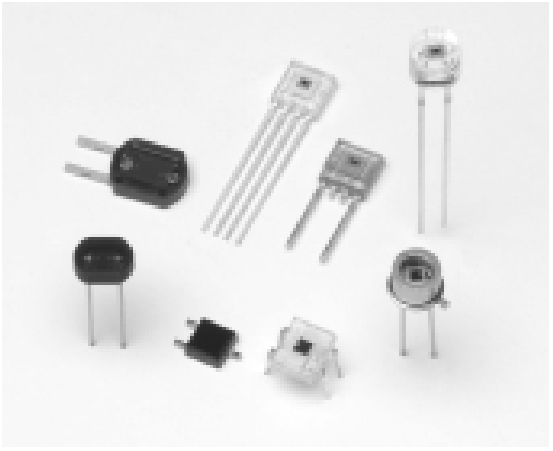


40-element array

Spectral response of InGaAs PIN photodiode



Visible Light Sensors



Spectral response close to that of the human eye

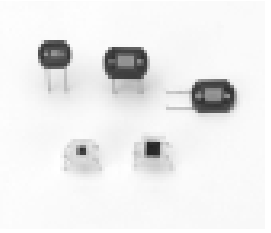
Photo IC

Amplified current output type requires no signal amplifier.

Si photodiodes

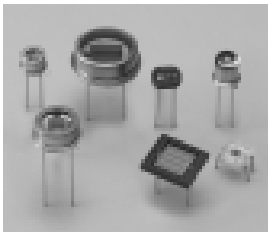
These Si photodiodes have sensitivity in the visible range.

■ Product line-up
- ● Filter type (general use)
- ● Filter type (CIE standard luminous spectral efficiency approximation)
- ● Filterless type



GaAsP photodiodes

Compound semiconductor photosensors whose spectral response approaches that of the human eye

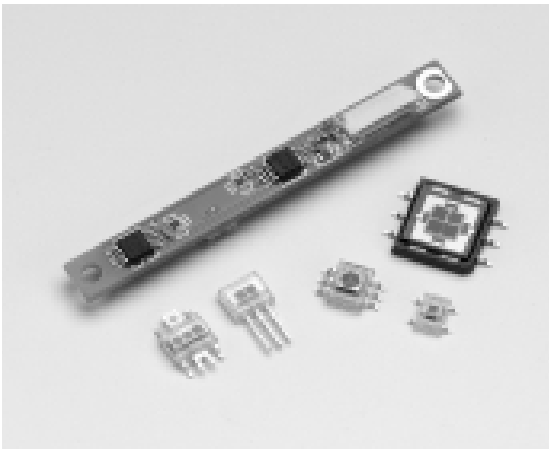


GaP photodiodes

Compound semiconductor photosensors whose spectral response approaches that of the human eye

Si photodiodes with internal visible compensation filter

Color Sensors



For LCD color monitoring and simple color detection

RGB color sensors

These photodiodes have an internal color filter. Available in monochrome or RGB type.

RGB color sensor modules

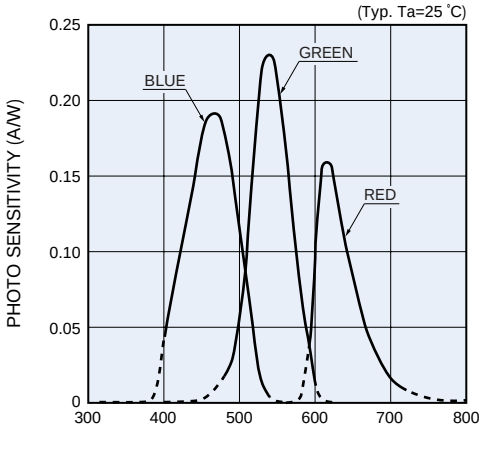
RGB color sensor module has been specifically developed for the power monitor of RGB-LEDs.

For RGB-LED power monitor

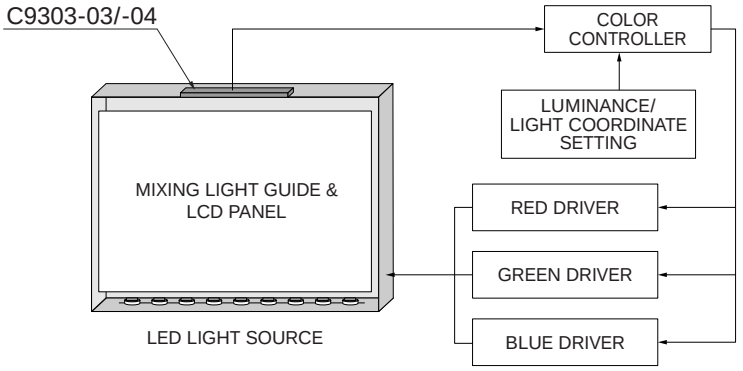
For object color measurement (Fiber reflect method)

Board for evaluation

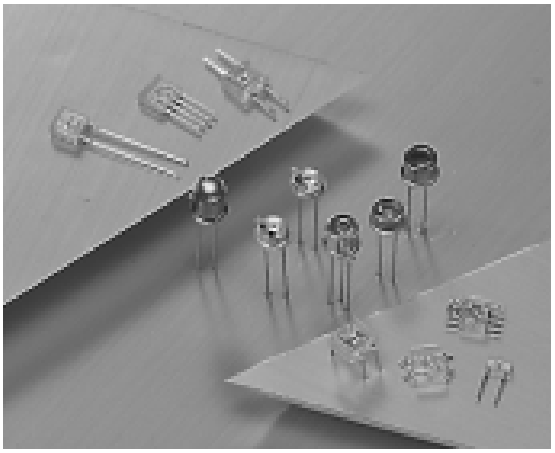
Spectral response (typical example: RGB color photodiode)



Application example of RGB color sensor module optical feedback of backlight for TFT-LCD



LED



LED used for optical communications, camera auto-focus, optical switches, etc.

Compared to laser diodes, LEDs offer advantages such as lower cost and longer life.
Hamamatsu Photonics has developed and produced various types of LEDs that enhance emission efficiency via a high output power LED chip mounted in a reflector (mirror) at the package base, which makes the light emitted from the chip edges reflect towards the front.

Applications

- Optical switches
- Optical fiber communications
- Spatial light transmission
- Auxiliary light sources for CCD imaging

For optical switch

Hamamatsu offers a full line of LED with various structures and package shapes ideal for optical switch design.

■ Product line-up

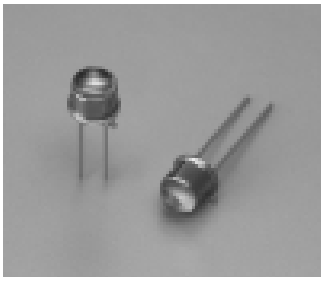
- Metal package with lens
- Metal package
- Resin-potted (with reflector · without reflector)
- Plastic package

For moisture and gas detection

Long wavelength LED with peak emission wavelengths at 1.3, 1.45 and 1.65 µm ideal for sensing water content or gas content

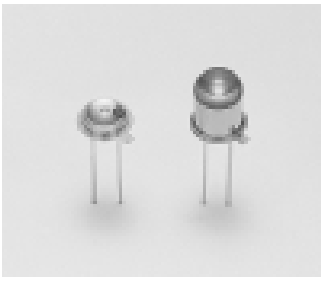
For encoder

An optimized lens shape allows these LED to emit a highly collimated beam instead of having to use a current confinement structure chip.



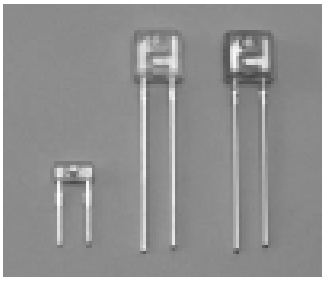
For spatial light transmission

High-speed, high output power LED developed for spatial light transmission Transmitter/receiver module for VICS (Vehicle Information and Communication System) is also available.



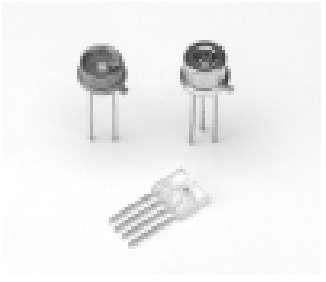
Miniature LED

These LEDs are high-power LEDs molded into a miniature, clear plastic package.



For optical link

These LEDs are suitable for 50 Mbps and 156 Mbps optical link. These are used with photo ICs for optical link.



Optical Communication Related Devices

High-speed devices available in various types of packages designed for optical fiber communications and spatial light transmission

Hamamatsu provides high-quality receiver/transmitter devices designed for long range, high-speed communications and short range, low-speed communications, as well as spatial light transmission.

For optical fiber communications (trunk line, broadcasting, high-speed LAN)

High-speed photodiodes and laser diodes housed in variety of packages are provided.

TOSA, ROSA

Hamamatsu provides a wide line-up of TOSA/ROSA devices from medium speeds on up to 10 Gbps.

Plastic housing

Metal housing

Metal package

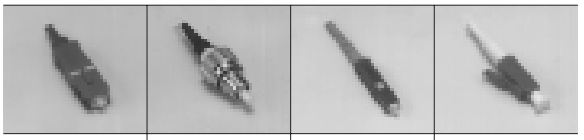
Flat window

With lens

Receptacle

Product			
Mounting style	Board		Panel
Connector	SC	FC	FC

Pigtail

Product	Photodiode/Laser diode						Laser diode (High power type)			
Mounting style										
	Coaxial		Board *		Panel *		Coaxial			
connector										
	SC	FC	SC	FC	SC	FC	SC	FC	MU *	LC *

* Mount type (on-board, panel-mount) and connectors (MU, LC) are available upon special request.

For optical fiber communications (factory automation, office automation, home network, automobile LAN)

These are light receivers and emitters suitable for medium to low speed optical links.

Photodiodes


Flat window


With lens

Photo IC, LED

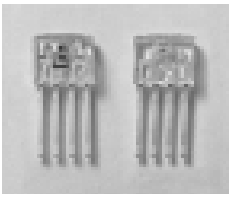


Photo IC / Red LED for optical link (POF)


Infrared LED (flat window)

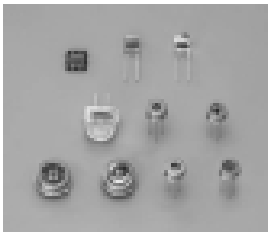

Infrared LED (with lens)

For spatial light transmission

Hamamatsu provides large area photodiodes and high-power LEDs suitable for spatial light transmission, as well as a light emitter/receiver module designed for vehicle-mounted VICS (Vehicle Information and Communication System).

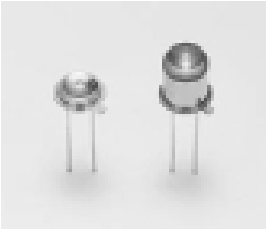
Photodiodes

Si PIN photodiode, Si PIN photodiode with preamp and Si APD are provided for spatial light transmission.



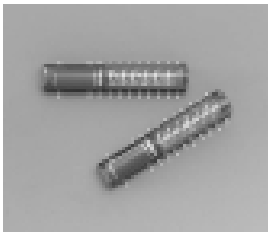
Infrared LED

These LEDs are high-power LED for spatial light transmission.



Light emitting/receiving module (for vehicle-mounted VICS)

Light emitting/receiving modules consist of an LED array and a photodiode in the same small package.



For optical power and wavelength monitor

These devices are used to monitor optical power or wavelengths of laser diodes or light traveling along an optical path.

Photodiodes, Linear image sonsors

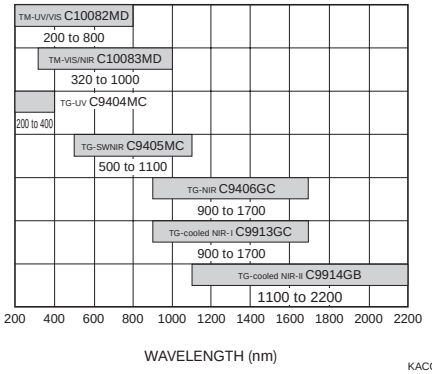
Mini-spectrometers

Integrating optical system, image sensor and circuit

Compact spectrometers with integrated optical system, image sensor and circuits by fabrication the grating section with micro-machining techniques

- High throughput due to transmission grating made of quartz
- Highly accurate optical characteristics
- No external power supply required: Uses USB bus power (Non-cooled type)
- Low noise measurement (Cooled type)
- Compact design for easy assembly
- Contains a wavelength conversion factor

■ Typical spectral response range



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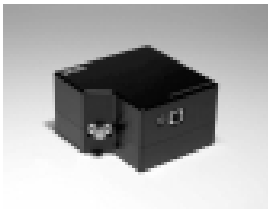
TM series (non-cooled type)



Type No.	Product type	Built-in image sensor	Spectral response range (nm)	Spectral resolution (Spectral response half width) (nm)	Application
C10082MD	TM-UV/VIS	CMOS linear image sensor S8378-1024Q	200 to 800	6	● Industrial color measurement ● Spectral evaluation of light sources ● Analysis of sunlight and illumination
C10083MD	TM-UV/VIS	CMOS linear image sensor S8378-1024Q	320 to 1000	8	

TG series (non-cooled type)

Type No.	Product type	Built-in image sensor	Spectral response range (nm)	Spectral resolution (Spectral response half width) (nm)	Application
C9404MC	TG-UV	CMOS linear image sensor S8378-512Q	200 to 400	3	● Fluorescence measurement ● Tooth decay analysis ● UV light source testing
C9405MC	TG-SWNIR	NMOS linear image sensor S8381-512Q	500 to 1100	5 (550 to 1100)	● Detection of saccharic acids in foods ● Taste analyzers ● LED testing
C9406GC	TG-NIR	InGaAs linear image sensor G9204-512D	900 to 1700	7	● Water content measurement ● Optical communication component testing ● Film thickness measurement

TG series (cooled type)

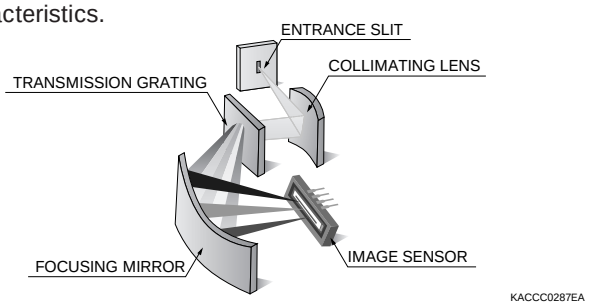
Type No.	Product type	Built-in image sensor	Spectral response range (nm)	Spectral resolution (Spectral response half width) (nm)	Application
C9913GC	TG-cooled NIR-I	InGaAs linear image sensor G9204-512S	900 to 1700	7	● Water content measurement ● Component analysis in food, agriculture fields, etc. ● Process control for chemical products
C9914GB	TG-cooled NIR-II	InGaAs linear image sensor G9206-02	1100 to 2200	8	

Options (Optical fiber for light input)

Type No.	Product name	Applicable mini-spectrometer	Specification
A9762-01	Fiber for UV/visible range (resistance to UV)	C9404MC (TG-UV) C10082MD (TM-UV/VIS) C10083MD (TM-VIS/NIR)	Core diameter 600 µm, N.A. 0.22, length 1.5 m, connectorized SMA905D at both ends
A9763-01	Fiber for visible /near infrared range	C9405MC (TG-SWNIR) C9406GC (TG-NIR) C9913GC (TG-cooled NIR-I) C9914GB (TG-cooled NIR-II)	Core diameter 600 µm, N.A. 0.22, length 1.5 m, connectorized SMA905D at both ends

Optical component layout (TM series)

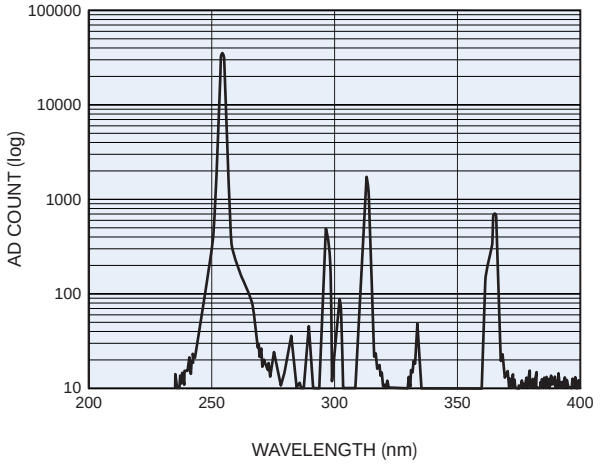
TM series mini-spectrometers use a transmission holographic grating made of quartz and precision optical components arranged on a rugged optical base, making it possible to deliver high throughput and highly accurate optical characteristics.



KACCC0287EA

Measurement example (line spectrum measurement)

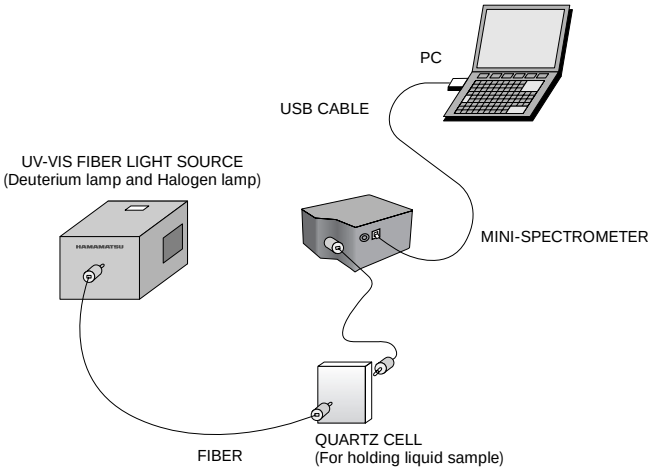
Line spectra from low-pressure mercury lamp were measured with C9404MC (TG-UV).



KACCB0081EA

Connection example (transmission light measurement)

Light to be measured is guided into the entrance port through an optical fiber and the spectrum measured with the built-in image sensor is output through the USB port to a PC for data acquisition. There are no moving parts inside the unit so stable measurements are obtained at all times. An optical fiber that guides light input from external sources allows a flexible measurement setup.



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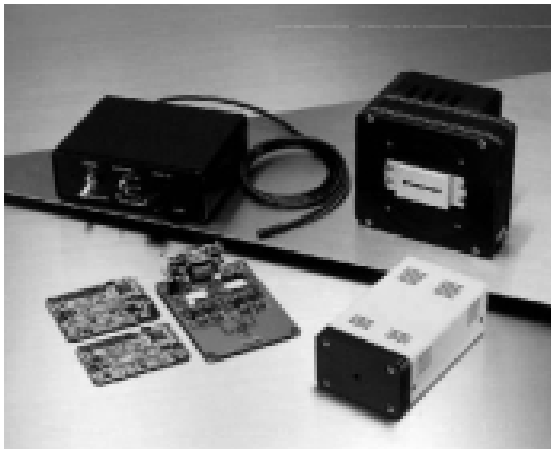
Opto-semiconductor modules



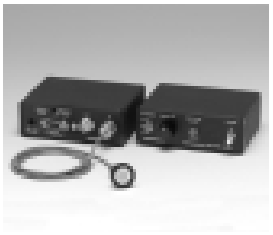
Application-specific circuits and modules used with opto-semiconductors

Custom opto-semiconductor assemblies are also available upon request. Please feel free to consult us with your specific needs.

Examples of assembly products

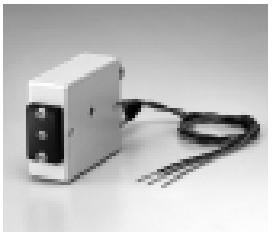
Photosensor amplifier

These photosensor amplifiers are current-to-voltage conversion amplifiers for amplifying photocurrent with low noise.



For low-light-level detection (with BNC connector)

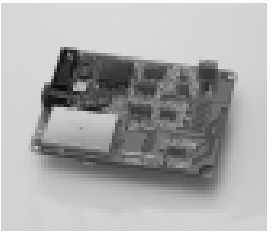
With optical fiber

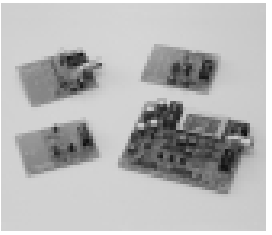


High-speed type

Circuit for Si photodiode

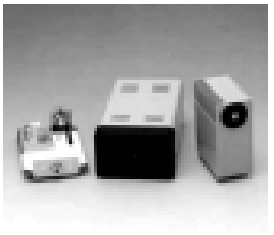
Offering circuit designs that make Si photodiodes both simple and convenient





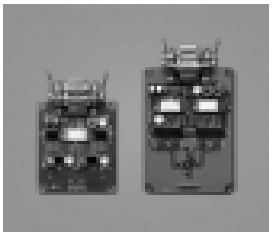
APD module

APD modules are high-speed, high-sensitivity photodetectors using an APD (avalanche photodiode). An APD, a low-noise amplifier and a bias power supply is assembled into a compact case. By simply connecting to a low voltage DC power supply, these APD modules allow optical measurements with a S/N dozens of times higher than PIN photodiodes.



PSD signal processing circuit

HAMAMATSU provides various types of signal processing circuits for evaluation of PSDs (Position Sensitive Detector).

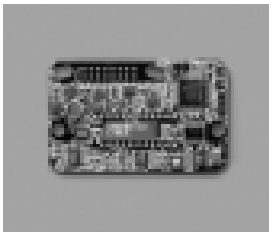


RGB color sensor module

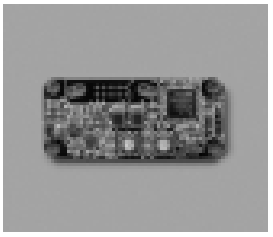
RGB color sensor module has been specifically developed for the power monitor of RGB-LEDs.

Driver circuit and pulse generator for NMOS linear image sensor

HAMAMATSU provides various types of driver circuits and pulse generators optimized for use with our NMOS linear image sensors.



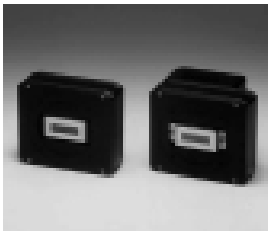
Driver circuit



Pulse generator

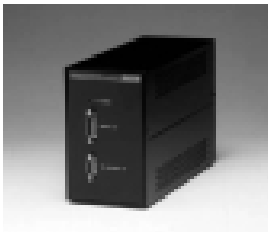
Multichannel detector head

Multichannel detector heads incorporate a driver circuit designed for various types of image sensors (CCD area image sensors, InGaAs linear image sensors), NMOS linear image sensors.



Peripheral product for image sensor

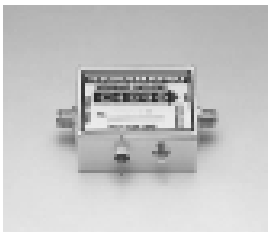
Multichannel detector head controller (for CCD area image sensor and InGaAs linear image sensor) and other peripheral products are provided.



Multichannel detector head controller

PIN photodiode amplifier (wide band)

HAMAMATSU provides a PIN photodiode amplifier (10 times) with a wide bandwidth (5 MHz to 1.5 GHz), high gain and flat gain spectrum.

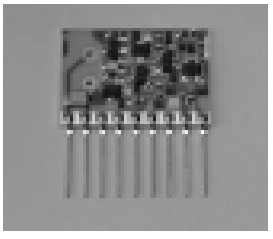


Pulsed laser diode module

HAMAMATSU provides a compact pulsed laser diode driver module integrated with L7055-02.

Charge amplifier

HAMAMATSU charge amplifier that features low noise is ideal for radiation and high energy particle detection.

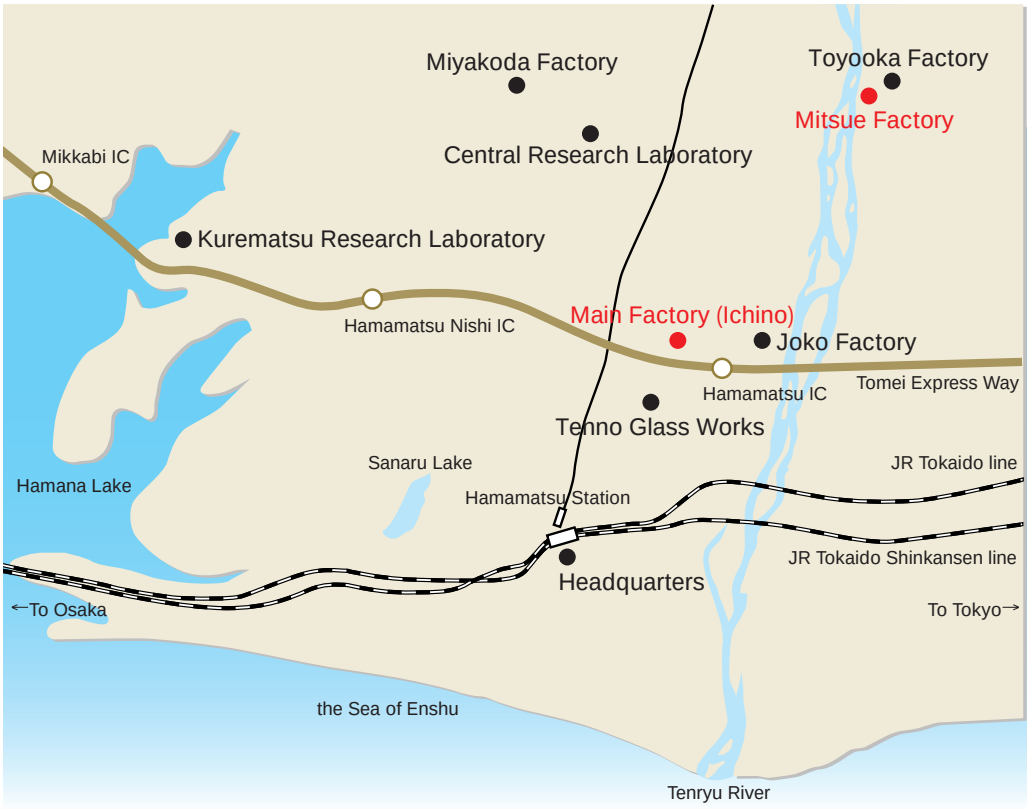


16 × 16 element photodiode array detector

16 × 16 element photodiode array detector is a 2-D detector using 256-element photodiode with visible sensitivity.

Factory/Research Laboratory/Domestic Sales

(Hamamatsu City Area Map)



Factories

- Opto-semiconductors : Main Factory (Ichino), Mitsue Factory
- Electron tube products: Toyooka Factory, Tenno Glass Works
  Beijing Hamamatsu Photon Techniques Ltd. (China)
- System products : Joko Factory, Miyakoda Factory
- Laser products : Miyakoda Factory

Laboratories

- Central Research Laboratory
- Tsukuba Research Laboratory
- Kurematsu Research Laboratory

Domestic Sales offices

- Tokyo branch office
- Osaka sales office
- Sendai sales office
- Tsukuba sales office

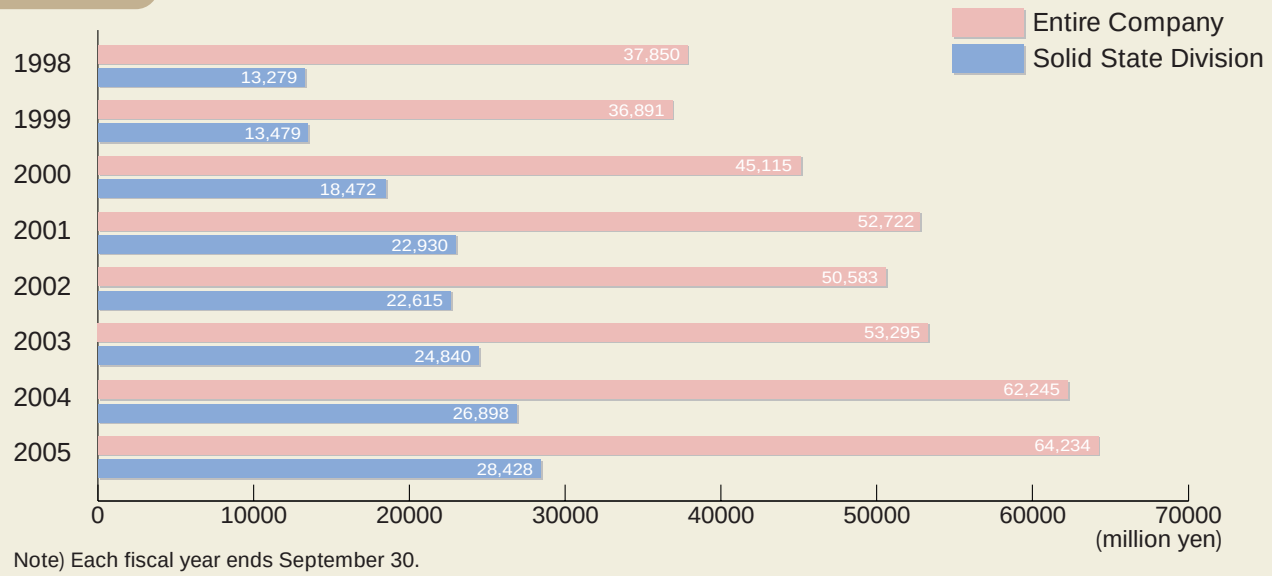
Solid State Division
Main Factory
(Ichino-cho, Hamamatsu City)

Solid State Division
Mitsue Factory

Organization Chart of Solid State Division

Administration		
General Affair		
Sales	The 1st Domestic Sales Dept.	
	The 2nd Domestic Sales Dept.	
	Export Sales Dept.	
	Sales Promotion Dept.	
Business Control		
Quality Control		
Research & Development	The 2nd Develop. Dept.	Opto-micro machine
	The 3rd, 5th Develop. Dept.	Integrated circuit
The 1st Mfg.	The 2nd Dept.	Photoconductive detector, IR detector
	The 11th Dept.	LED, Photodiode for infrared range
The 2nd Mfg.	The 3rd Dept.	General-purpose Si photodiodes, PSD
	The 30th Dept.	Special Si photodiode
The 3rd Mfg.	The 10th Dept., The 36th Dept.	Photo IC, Si photodiode PSD and LED with plastic package
The 4th Mfg.	The 34th Dept.	Image sensor
The 5th Mfg.	The 29th Dept.	Light measurement modules & units
	The 32nd Dept.	Photosensor assemblies
New Business Promotion	Optical communication device group	Optical communication module, Flat panel sensor
	Flat panel group	
Si Wafer Process		
Mitsue Mfg.	The 1st Assembly Dept.	Metal package assemblies
	The 2nd Assembly Dept.	Ceramic package assemblies
	The 3rd Assembly Dept.	Plastic package assemblies
	Auto. promotion Dept.	Production & Test equipment
Assembly		

Annual sales



Note) Each fiscal year ends September 30.

HAMAMATSU

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Main Products

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Image sensors
X-ray flat panel sensors
PSD
Infrared detectors
LED
Optical communication related devices
Automotive devices
Mini-spectrometers
High energy particle/X-ray detectors
Opto-semiconductor modules

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Imaging tubes
Light sources
Imaging and processing Systems

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Cat. No. KOTH0001E08
Jul. 2006 DN
Printed in Japan (3,500)