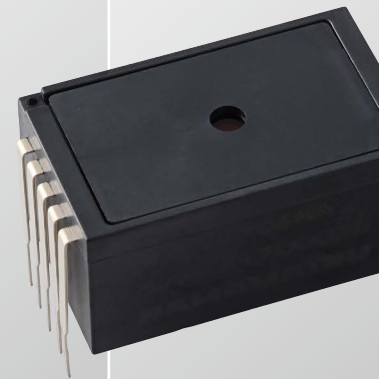


Compact spectrometers with built-in Hamamatsu image sensor, optical element, etc.

Mini-spectrometers



Related product



FTIR engine

Portable NIR spectroscopic module



MEMS-FPI spectrum sensors

Ultra-compact near infrared spectrum sensor with MEMS-FPI tunable filter

Mini- spectrometers



We have more than 20 different mini-spectrometers for the ultraviolet to near infrared regions.



What are mini-spectrometers?

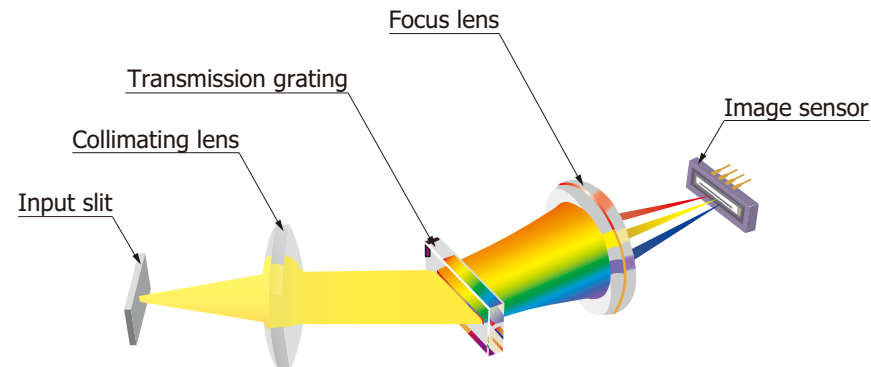
Mini-spectrometers are small spectrometers (polychromators) with an integrated optical system, image sensor, and driver circuit. They are portable devices that make them possible to do real-time measurement on-site.



Applications

- Color measurement
- Sugar content measurement
- Film thickness measurement
- Plastic screening
- Fluorescence measurement
- Environmental analysis
- Mobile measuring devices

● Example of mini-spectrometer optical system



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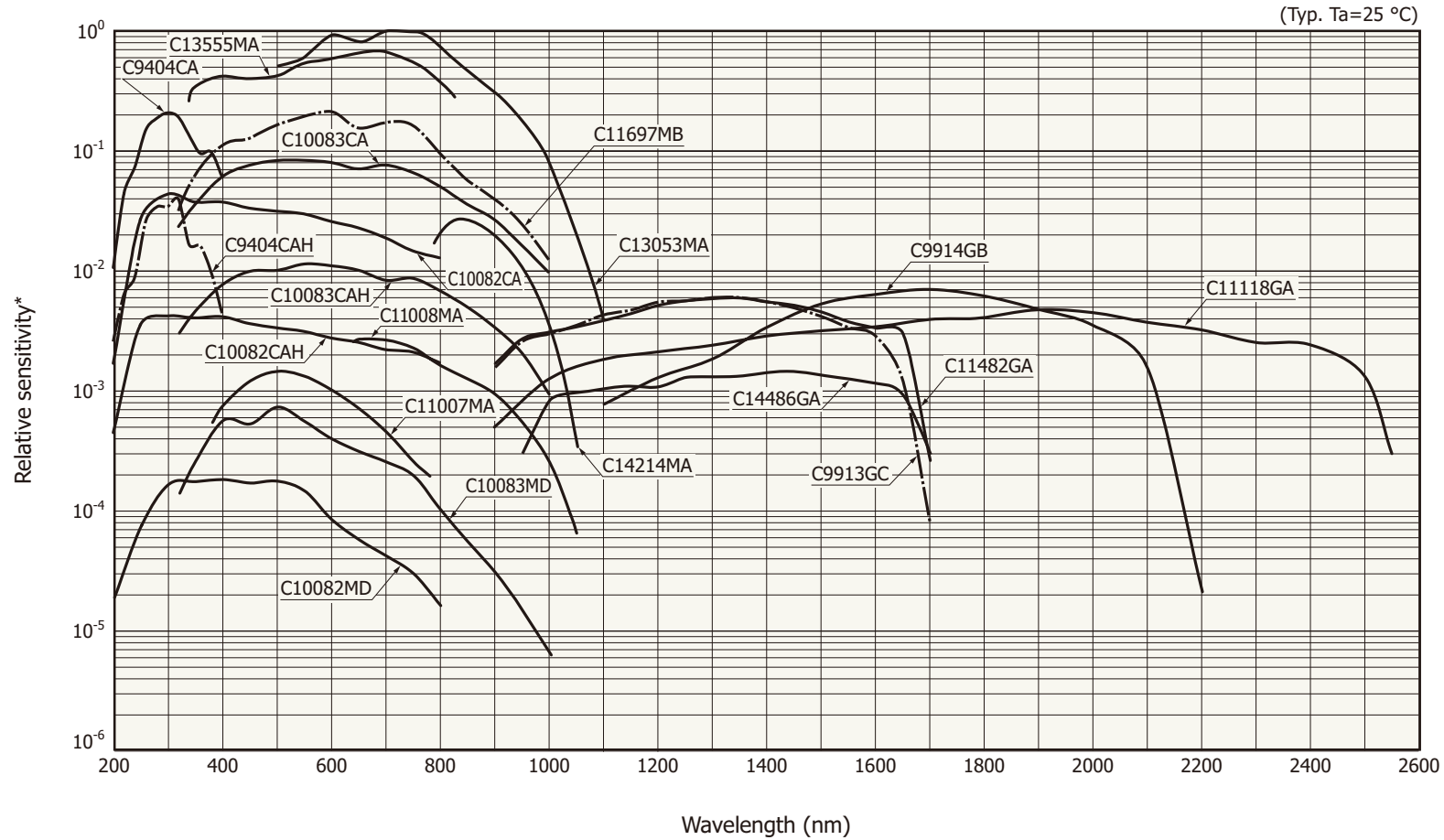


Ultra-small spectrometer heads (without a driver circuit) are also available.

Series	Products	Spectral response range (nm)																			
		UV	Visible				Near infrared														
		200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600							
For ultraviolet range	High sensitivity C10082CA High resolution C10082CAH Wide dynamic range C10082MD	200 to 800																			
	High sensitivity C9404CA High resolution C9404CAH	200 to 400																			
For visible range	High sensitivity C10083CA High resolution C10083CAH Wide dynamic range C10083MD High sensitivity C11697MB	320 to 1000																			
	High sensitivity C13555MA	340 to 830																			
	Wide dynamic range C11007MA	340 to 780																			
For visible to near infrared range	High near IR sensitivity C9405CC High sensitivity C13053MA	500 to 1100																			
	Wide dynamic range C11008MA	640 to 1050																			
For near infrared range	Non-cooled type C11482GA Cooled type C9913GC	900 to 1700																			
	Cooled type C9914GB	1100 to 2200																			
	Cooled type C11118GA	900 to 2550																			
	Compact type C14486GA	950 to 1700																			
For Raman spectroscopy	High resolution C14214MA	790 to 1050																			

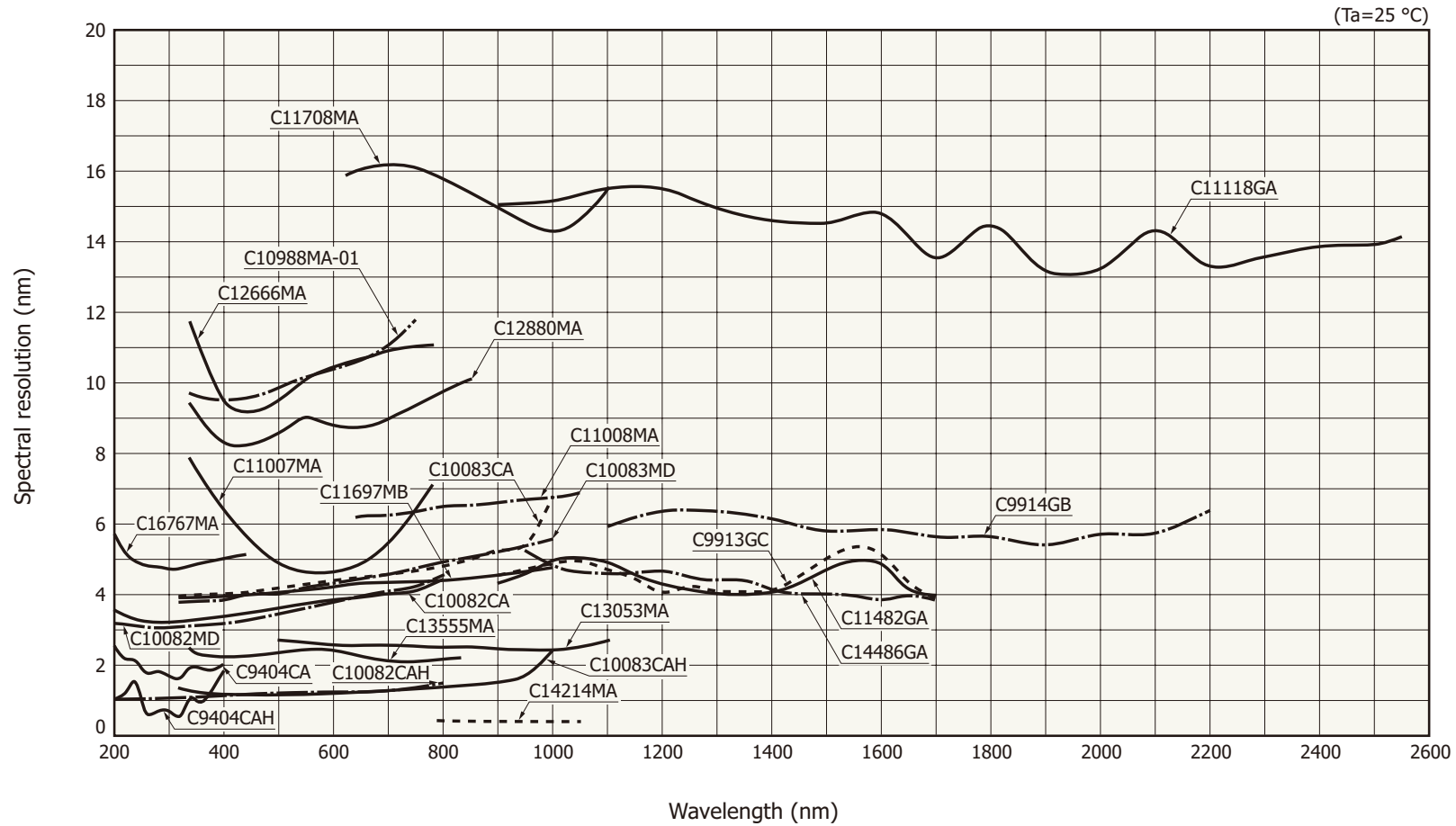
Note: See [P.12](#) for details on spectrometer heads.

Spectral response



* A/D count when constant light level enters optical fiber
(Fiber core diameter: 600 μm , assuming no attenuation in optical fiber)






Spectral resolution vs. wavelength (typical example)



KACCB0139EP







For ultraviolet range

This type of products has sensitivity in the ultraviolet range.

Type no.	Type	Spectral response range (nm)						Spectral resolution typ. (nm)	S/N max.	External power supply	Internal image sensor	Size (mm)	Photo
		UV	Visible			Near infrared							
		200	400	600	800								
C10082CA	High sensitivity	200 to 800						4	446 : 1	+5 V	Back-thinned CCD S10420-1106-01	95 × 92 × 76	
C10082CAH	High resolution	200 to 800						1	446 : 1	+5 V	Back-thinned CCD S10420-1106-01	95 × 92 × 76	
C10082MD	Wide dynamic range	200 to 800						4	4390 : 1	Not required (USB bus power only)	CMOS linear image sensor S8378-1024Q	94 × 90 × 55	
C9404CA	High sensitivity	200 to 400						2	446 : 1	+5 V	Back-thinned CCD S10420-1006-01	125.7 × 115.7 × 75	
C9404CAH	High resolution	200 to 400						1	446 : 1	+5 V	Back-thinned CCD S10420-1006-01	125.7 × 115.7 × 75	




For visible range

This type of products is suitable for measurement in the visible range.

Type no.	Type	Spectral response range (nm)							Spectral resolution typ. (nm)	S/N max.	External power supply	Internal image sensor	Size (mm)	Photo
		UV	Visible			Near infrared								
		200	400	600	800	1000								
C10083CA	High sensitivity		320 to 1000						5	446 : 1	+5 V	Back-thinned CCD S10420-1106-01	95 × 92 × 76	
C10083CAH	High resolution		320 to 1000						1	446 : 1	+5 V	Back-thinned CCD S10420-1106-01	95 × 92 × 76	
C10083MD	Wide dynamic range		320 to 1000						5	4390 : 1	Not required (USB bus power only)	CMOS linear image sensor S8378-1024Q	94 × 90 × 55	
C11697MB	High sensitivity		320 to 1000						5	260 : 1	Not required (USB bus power only)	High-sensitivity CMOS linear image sensor S11639	94 × 90 × 55	
C13555MA	High sensitivity		340 to 830						2.3	230 : 1	Not required (USB bus power only)	High-sensitivity CMOS linear image sensor	80 × 60 × 12	
C11007MA	Wide dynamic range		340 to 780						6	4390 : 1	Not required (USB bus power only)	CMOS linear image sensor S8378-256N	55 × 100 × 48	






For visible to near infrared range

This type of products has a wide spectral response range.

Type no.	Type	Spectral response range (nm)							Spectral resolution typ. (nm)	S/N max.	External power supply	Internal image sensor	Size (mm)	Photo
		UV		Visible			Near infrared							
		200	400	600	800	1000	1200							
C9405CC	High near IR sensitivity			500 to 1100					4	446 : 1	+5 V	Back-thinned CCD S16010-1006	125.7 × 115.7 × 75	
C13053MA	High sensitivity			500 to 1100					2.5	230 : 1	Not required (USB bus power only)	High-sensitivity CMOS linear image sensor	80 × 60 × 12	
C11008MA	Wide dynamic range			640 to 1050					6.5	4390 : 1	Not required (USB bus power only)	CMOS linear image sensor	55 × 100 × 48	


For near infrared range

This type of products has sensitivity in the near infrared range.

Type no.	Type	Spectral response range (nm)											Spectral resolution typ. (nm)	S/N max.	External power supply	Internal image sensor	Size (mm)	Photo	
		Near infrared																	
		800	1000	1200	1400	1600	1800	2000	2200	2400	2600								
C11482GA	Non-cooled type													5	7700 : 1	Not required (USB bus power only)	InGaAs linear image sensor G9204-512DA	38.5 × 106 × 86	
C9913GC	Cooled type													5	6100 : 1	+5 V, +12 V	InGaAs linear image sensor G9204-512SA	142 × 218 × 82	
C9914GB	Cooled type													6	6100 : 1	+5 V, +12 V	InGaAs linear image sensor	142 × 218 × 82	
C11118GA	Cooled type													15	7700 : 1	+5 V, +12 V	InGaAs linear image sensor G9208-256WB-02	142 × 218 × 82	
C14486GA	Compact type													5	6900 : 1	Not required (USB bus power only)	InGaAs linear image sensor	80 × 60 × 12	







For Raman spectroscopy

These mini-spectrometers are a high resolution type suitable for Raman spectroscopy.

Type no.	Type	Spectral response range (nm)					Spectral resolution typ. (nm)	S/N max.	External power supply	Internal image sensor	Size (mm)	Photo
		UV	Visible		Near infrared							
		200	400	600	800	1000						
C14214MA	High resolution					790 to 1050	0.4	230 : 1	Not required (USB bus power only)	High-sensitivity CMOS linear image sensor	100 × 60 × 12	

Spectrometer heads

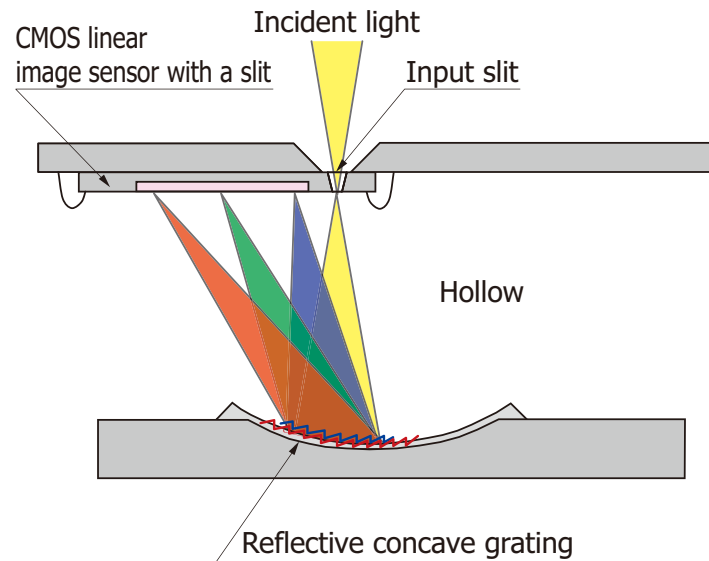
The small spectrometer heads (without a driver circuit) have a built-in optical system and image sensor.

Type no.	Type	Spectral response range (nm)						Spectral resolution typ. (nm)	S/N max.	Internal image sensor	Size (mm)	Photo
		UV	Visible			Near infrared						
		200	400	600	800	1000						
C16767MA	For ultraviolet range	190 to 440						5.5	293 : 1	High sensitivity CMOS linear image sensor	20.1 × 12.5 × 10.1	
C12666MA	Wide dynamic range	340 to 780						12	5300 : 1	CMOS linear image sensor	20.1 × 12.5 × 10.1	
C12880MA	High sensitivity	340 to 850						12	291 : 1	High sensitivity CMOS linear image sensor	20.1 × 12.5 × 10.1	
C11708MA	For near IR	640 to 1050						15	5300 : 1	CMOS linear image sensor	27.6 × 16.8 × 13	
C11009MA	Wide dynamic range	340 to 780						6	5600 : 1	CMOS linear image sensor S8378-256N	28 × 28 × 28	
C11010MA	Wide dynamic range	640 to 1050						6.5	5600 : 1	CMOS linear image sensor	35 × 28 × 20	

Optical system in the compact spectrometer heads

In the C12666MA, C12880MA, and C16767MA, we use a CMOS image sensor with a slit integrated by etching, and a reflective concave grating made by nanoimprint.

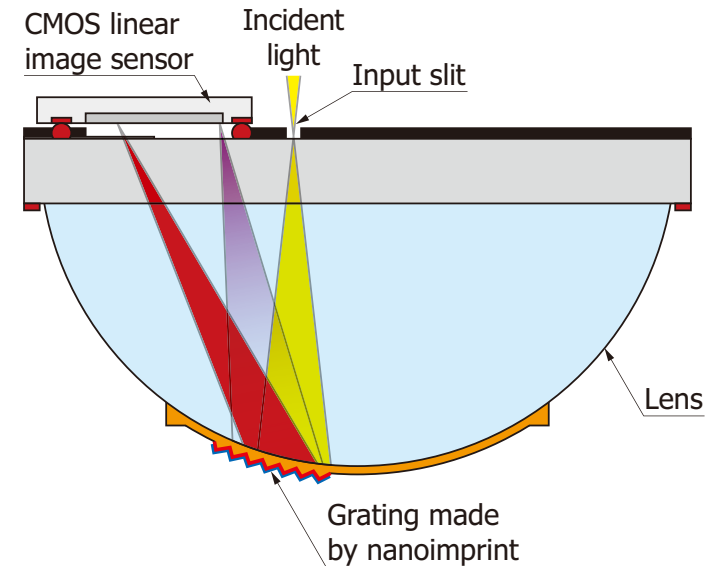
C12666MA, C12880MA, C16767MA



KACCC1035EB

The metal package provides high humidity resistance. Low cost is achieved because it is a hollow type.

C11708MA



KACCC0922EC

The glass used does not expand easily with rising temperatures, so the temperature dependency of the wavelength is extremely small.

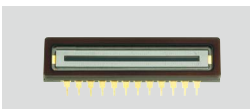
Mini-spectrometer Technology

In mini-spectrometers, we use MOEMS (micro-opto-electro-mechanical-systems) technology, combining an image sensor / optical system and MEMS.

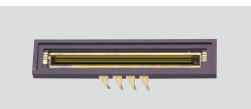
MOEMS technology

Image sensor

- Uses one of Hamamatsu image sensor lineup to support various wavelengths
- Available with custom design



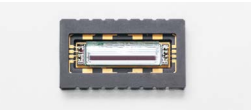
▲ CCD image sensor



▲ High-sensitivity CMOS linear image sensor



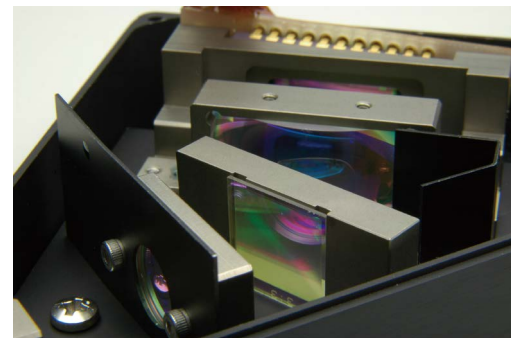
▲ TE-cooled InGaAs linear image sensor



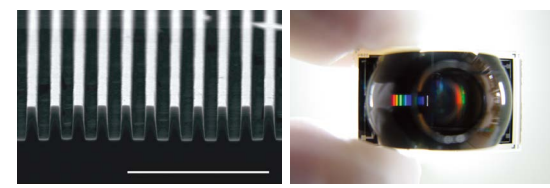
▲ IR-enhanced CMOS linear image sensor

Optical system

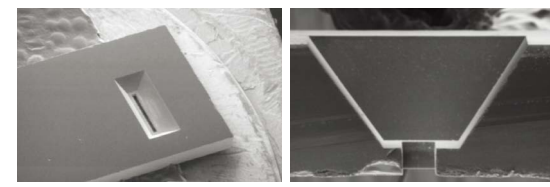
- Optical design suitable for spectrometers
- Optical simulation



MEMS



▲ Grating that uses nanoimprint



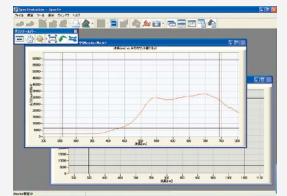
▲ Image sensor with a through-hole slit



Software

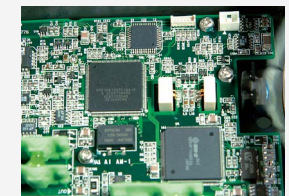
Supports various communication interfaces (e.g., USB)

Evaluation software available ▶



Circuit

- Unique driver circuit
- Evaluation circuit available for spectrometer heads

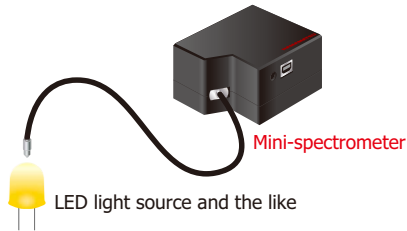


Mini-spectrometer

Application examples

Mini-spectrometers can be incorporated into a variety of devices and are used in a wide range of applications.

Color measurement (e.g., LED light source)



KACCC0796EA

A mini-spectrometer is used to perform spectral measurement and inspect LEDs or the like.

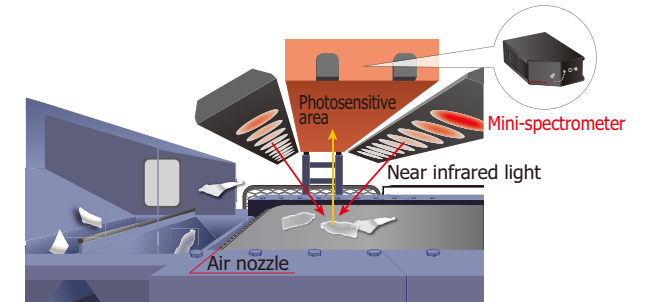
Sugar content measurement



KACCC0797EA

Absorbance is used in applications such as handy brix meters, which measure sugar content.

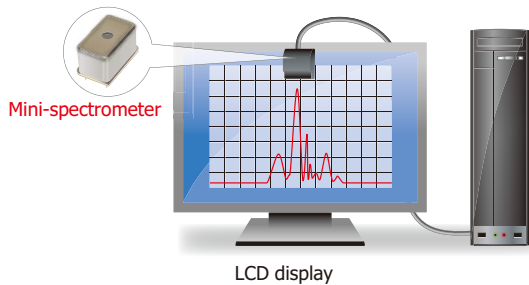
Plastic screening



KACCC0601EB

Plastic screening is performed by using the fact that when near infrared light is directed at plastic, the wavelengths that are absorbed varies depending on the material.

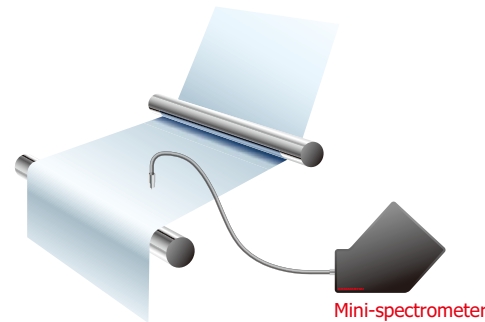
Display color measurement



KACCC0599EC

The emission spectrum of LCDs is monitored with a micro-spectrometer.

Film thickness measurement



KACCC0600EB

White light interferometry is used to measure the spectrum peak count, film refractive index, and film thickness from the light incident angle.

Environmental analysis



KACCC0798EB

Mini-spectrometers are used in environmental analysis of water, soil, and the like.

For mini-spectrometers
Accessories

We offer accessories for mini-spectrometers (sold separately).

Input optical fibers A16962 series, A16963 series

UV/visible optical fiber (UV resistant) and visible/NIR optical fiber are available. Note that the fiber is incorporated in the mini-spectrometers C11009MA and C11010MA.

Type no.	Product name	Core diameter (μm)	Minimum bend radius (mm)	Specification
A16962-01	Ultraviolet/visible optical fiber (UV resistant)	600	132	NA=0.22 1.5 m in length, with SMA905D connector on each end Operating temperature: 0 to +60 °C Storage temperature: -10 to +70 °C
A16962-02		800	176	
A16963-01	Visible/near infrared optical fiber	600	132	
A16963-02		800	176	

External trigger coaxial cables A10670, A12763

Cable	Applicable mini-spectrometers	Length (m)
A10670	C9404CA, C9404CAH, C10082CA, C10082CAH, C10082MD, C10083CA, C10083CAH, C10083MD, C11118GA, C11697MB, C11482GA	1.5
A12763	C13555MA, C13053MA, C14486GA, C14214MA	

2 W xenon flash lamp modules L13651 series



These lamp modules integrate a 2 W xenon flash lamp with a power supply and trigger socket, and are designed to extract maximum performance from the lamp.

Features

- Compact: 42 × 42 × 37 mm
- Operates on 5 V mobile battery
- Long life: 1 × 10⁹ flash
- Repetition rate: 1250 Hz max.
- Broad spectrum: UV region to middle IR region

[Note: We offer a catalog of xenon flash lamps.](#)

FT-NIR spectroscopic module that can be incorporated into portable analytical instruments

FTIR engine



FTIR ENGINE

What is an FTIR engine?

Compact FT-NIR spectroscopic module that can be incorporated into portable analytical instruments



The Fourier transform infrared spectrometer (FTIR) engine is compact enough to carry in just one hand. A Michelson optical interferometer and control circuit are built into a palm-sized case. Spectrum and absorbance can be measured by connecting a PC via USB.

Features

- Compact: palm size
- Optical fiber incident type
- High S/N
- Suitable for diffusion reflection measurement and absorbance measurement
- Spectral response range: 1100 to 2500 nm
- Real-time measurement on-site

Applications

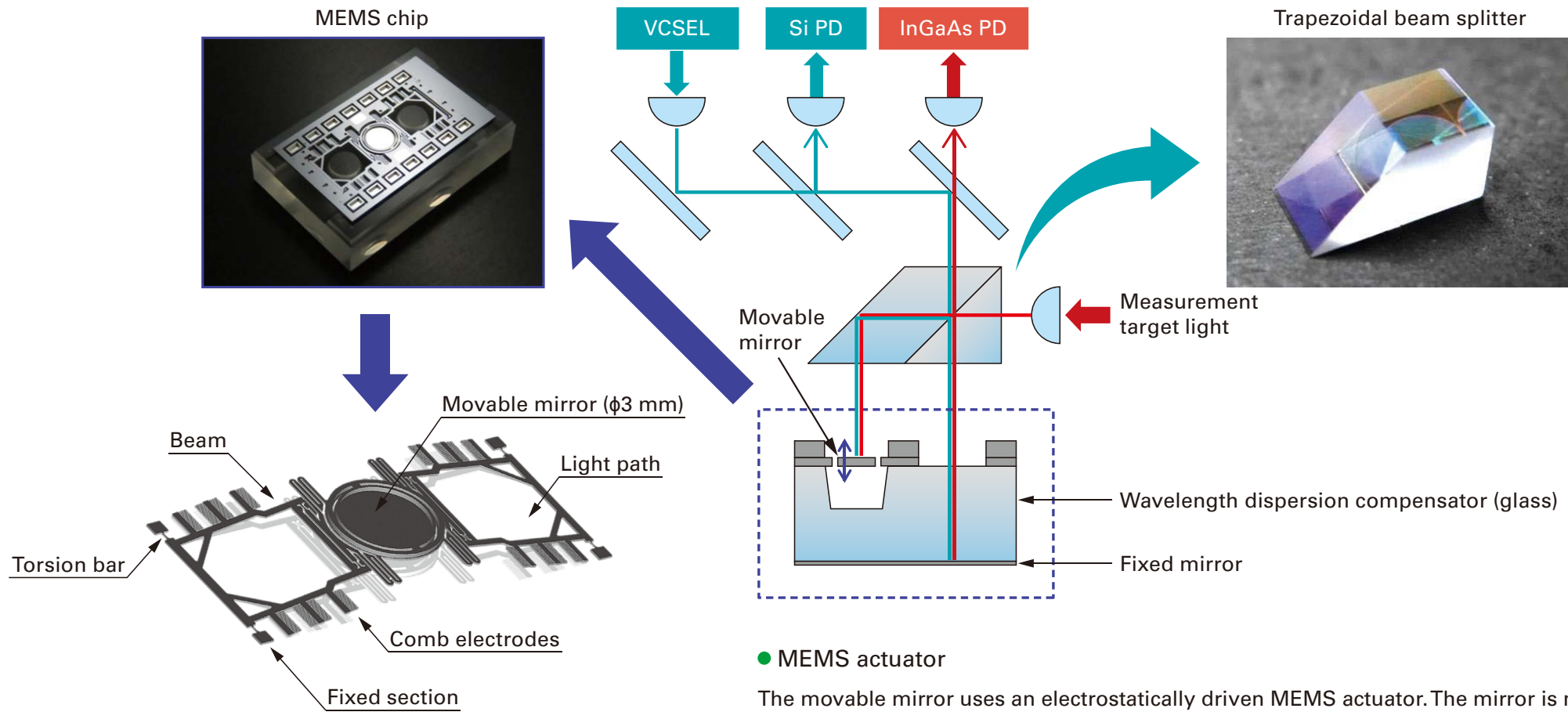
- Process analysis
- Material inspection
- Farm product inspection
- Plastic screening
- Concrete strength measurement
- Film thickness measurement
- Medical and health care equipment

Type no.	Spectral response range (nm)										Spectral resolution (nm)	
	Near infrared											
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600		
C15511-01											1100 to 2500	5.7 typ. (λ=1533 nm)

Optical system

The optical interferometer of the FTIR engine consists of a MEMS chip, as well as the light input section, beam splitter, fixed mirror, and photodetector.

Optical system of FTIR engine



● MEMS actuator

The movable mirror uses an electrostatically driven MEMS actuator. The mirror is moved up and down in parallel by applying voltage to comb electrodes.

Ultra-compact near infrared spectrum sensors that integrate MEMS-FPI tunable filter and photosensor

MEMS-FPI spectrum sensors

SPECTRUM SENSORS
MEMS-FPI

MEMS-FPI spectrum sensors



MEMS-FPI spectroscopic module
(MEMS-FPI spectrum sensor built-in)

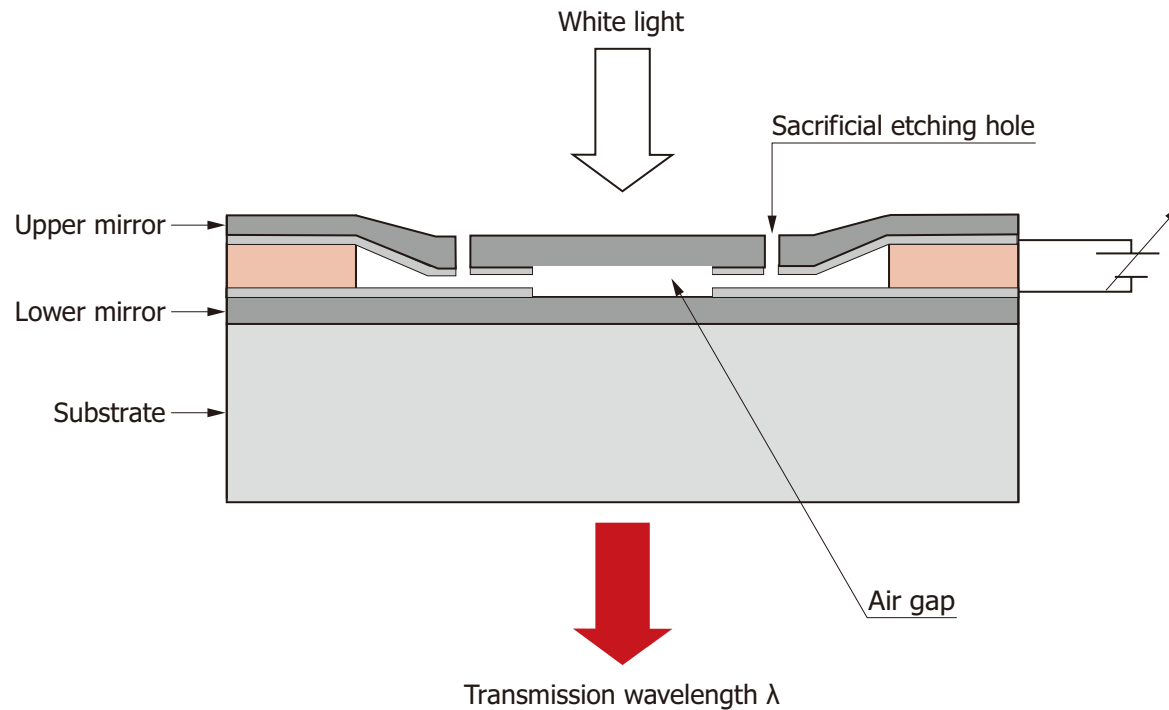
What are MEMS-FPI spectrum sensors?

Ultra-compact near infrared spectrum sensors that integrate MEMS-FPI tunable filter and photosensor

The MEMS-FPI spectrum sensor is an ultra compact sensor, containing an InGaAs PIN photodiode and an MEMS-FPI (Fabry-Perot Interferometer) tunable filter that is capable of changing the transmission wavelength by changing the applied voltage, all in one package.

MEMS-FPI tunable filter cross section

By applying voltage between the upper mirror and lower mirror of the MEMS-FPI tunable filter, it is possible to adjust the air gap by electrostatic attractive force, and change the transmission wavelength.



KIRDC0109EB

Lineup

We offer several types with different spectral response ranges.



Features

- Built-in Hamamatsu InGaAs PIN photodiode single device chip
- Ultra-compact: TO-5 package
- Ultra-lightweight: 1 g
- Hermetically sealed package: High reliability in high humidity environment
- Built-in thermistor
- Built-in band-pass filter for cutting off wavelengths outside the spectral response range

Applications

- Moisture detection
- Food inspection
- Farm product inspection
- Plastic screening
- Textile identification
- Installation into mobile measuring devices

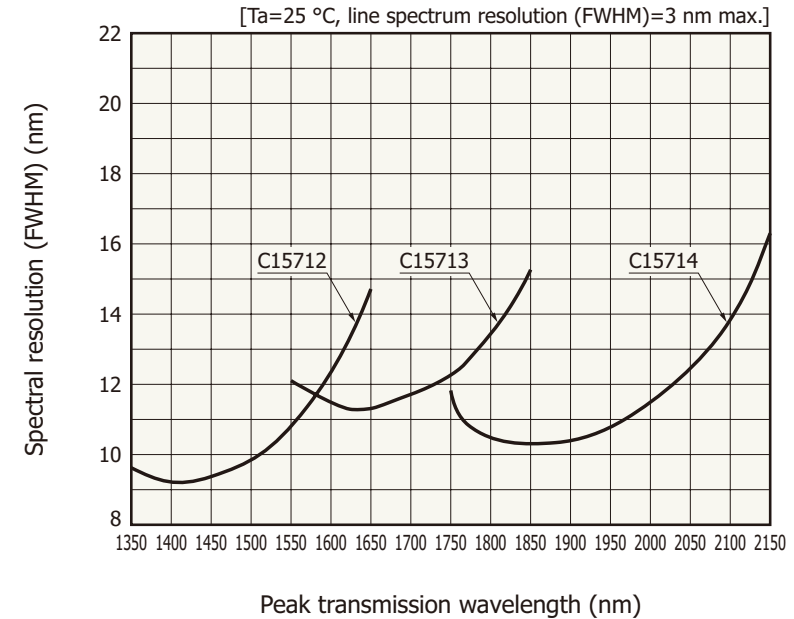
Type no.	Spectral response range (nm)								Spectral resolution (full width at half maximum) max. (nm)	Dark current max. (nA)	Photosensitive area (mm)
	Near infrared										
	800	1000	1200	1400	1600	1800	2000	2200			
C14272			1350 to 1650	█					18	10	φ0.3
C13272-03				1550 to 1850	█				20	100	φ0.3
C14273					1750 to 2150	█			22	150	φ0.3

MEMS-FPI spectroscopic modules

These compact modules have a built-in MEMS-FPI spectrum sensor and light source.



● Spectral resolution vs. peak transmission wavelength (typical example)






KACCB0624EA

MEMS-FPI spectroscopic module	Built-in sensor	Spectral response range (nm)							Spectral resolution (full width at half maximum) max. (nm)	
		Near infrared								
		800	1000	1200	1400	1600	1800	2000	2200	
C15712	C14272			1350 to 1650	█					18
C15713	C13272-03				1550 to 1850	█				20
C15714	C14273					1750 to 2150	█			22

Compact spectrometers for near infrared range

We offer a wide variety of compact spectrometers for the near infrared region.

Product name	Type no.	Spectral response range (nm)										Features	Spectroscopic technology	Spectral resolution (nm)	Size (mm)	Photo		
		Near infrared																
		800	1000	1200	1400	1600	1800	2000	2200	2400	2600							
FTIR engine	C15511-01												1100 to 2500	High precision measurement, high wavelength accuracy	MEMS-FTIR	5.7 typ. ($\lambda=1533$ nm)	49 × 57 × 76	
MEMS-FPI spectroscopic module	C15712 C15713 C15714												1350 to 1650 1550 to 1850 1750 to 2150	Compact, suitable for portable devices, excellent high-volume producibility, built-in light source	Fabry-Perot	22 max. (C15714, $\lambda=2150$ nm)	74 × 32 × 16	
Mini-spectrometer	C14486GA												950 to 1700	High-speed measurement, high sensitivity	Grating	5.0 typ.	80 × 60 × 12	

- [Disclaimer](#)
- [Mini-spectrometers / Precautions](#)

www.hamamatsu.com

- Information described in this material is current as of April 2024.
- Product specifications are subject to change without prior notice due to improvements or other reasons. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.

HAMAMATSU PHOTONICS K.K.

KACC0002E29 Apr. 2024 DN

HAMAMATSU PHOTONICS K.K., Solid State Division

1126-1 Ichino-cho, Chuo-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81)53-434-3311, Fax: (81)53-434-5184

U.S.A.: HAMAMATSU CORPORATION: 360 Foothill Road, Bridgewater, NJ 08807, U.S.A., Telephone: (1)908-231-0960, Fax: (1)908-231-1218

Germany: HAMAMATSU PHOTONICS DEUTSCHLAND GMBH: Arzbergerstr. 10, 82211 Herrsching am Ammersee, Germany, Telephone: (49)8152-375-0, Fax: (49)8152-265-8 E-mail: info@hamamatsu.de

France: HAMAMATSU PHOTONICS FRANCE S.A.R.L.: 19 Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: (33)1 69 53 71 00, Fax: (33)1 69 53 71 10 E-mail: infos@hamamatsu.fr

United Kingdom: HAMAMATSU PHOTONICS UK LIMITED: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire, AL7 1BW, UK, Telephone: (44)1707-294888, Fax: (44)1707-325777 E-mail: info@hamamatsu.co.uk

North Europe: HAMAMATSU PHOTONICS NORDEN AB: Torshamnsgatan 35, 16440 Kista, Sweden, Telephone: (46)8-509-031-00, Fax: (46)8-509-031-01 E-mail: info@hamamatsu.se

Italy: HAMAMATSU PHOTONICS ITALIA S.R.L.: Strada della Moia, 1 int. 6 20044 Arese (Milano), Italy, Telephone: (39)02-93 58 17 33, Fax: (39)02-93 58 17 41 E-mail: info@hamamatsu.it

China: HAMAMATSU PHOTONICS (CHINA) CO., LTD.: 1201, Tower B, Jiaming Center, 27 Dongsanhuan Beilu, Chaoyang District, 100020 Beijing, P.R. China, Telephone: (86)10-6586-6006, Fax: (86)10-6586-2866 E-mail: hpc@hamamatsu.com.cn

Taiwan: HAMAMATSU PHOTONICSTAIWAN CO., LTD.: 13F-1, No.101, Section 2, Gongdao 5th Road, East Dist., Hsinchu City, 300046, Taiwan(R.O.C) Telephone: (886)3-659-0080, Fax: (886)3-659-0081 E-mail: info@hamamatsu.com.tw