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Mini-spectrometer

TF series | C13053MA

Compact and thin, built-in high-sensitivity CMOS image sensor

The mini-spectrometer TF series is a polychromator provided in a compact, thin case that houses optical elements, image sensor, and driver circuit. Spectrum data can be acquired by guiding measurement light into a mini-spectrometer through an optical fiber and transferring the measured results to a PC via the USB connection. The incorporation of a high-sensitivity CMOS image sensor maintains high sensitivity equivalent to that of a CCD and achieves low power consumption. Moreover, the trigger function that can be also used for short-term integration enables spectroscopic measurement of pulse emissions.
The product includes free evaluation software with functions for setting measurement conditions, acquiring and saving data, drawing graphs, and so on. Furthermore, the DLL function specifications are disclosed, so users can create their original measurement software programs.

Features

- **Compact, thin case**
- **High-sensitivity CMOS image sensor built in (high sensitivity equivalent to that of a CCD)**
- **With a trigger function**
- **High throughput using quartz transmission grating**
- **Highly accurate optical characteristics**
- **External power supply not necessary (USB bus powered)**
- **Installable in equipment**
- **Stores wavelength conversion factor*1 in internal memory**

Applications

- **Sugar content and acidity detection of foods**
- **Plastic sorting**
- **Thickness gauge**

*1: A conversion factor for converting the image sensor pixel number into a wavelength. A calculation factor for converting the A/D converted count into the input light level is not provided.

Optical characteristics

Parameter		Specification	Unit
Spectral response range		500 to 1100	nm
Spectral resolution (FWHM)*2	Typ.	2.5	nm
	Max.	3.5	
Wavelength reproducibility*3		-0.4 to +0.4	nm
Wavelength temperature dependence		-0.04 to +0.04	nm/°C
Spectral stray light*2 *4		-33 max.	dB

*2: When the slit in the table in "Structure" is used. The spectral resolution depends on the slit.
*3: Measured under constant light input conditions
*4: The ratio of the count measured when an 800 nm light is input to the count measured when an 800 ± 40 nm light is input.

Electrical characteristics

Parameter		Specification	Unit
A/D conversion		16	bit
Integration time		11 to 100000	µs
Interface		USB 2.0	-
USB bus power current consumption	Typ.	220	mA
	Max.	250	

Structure

Parameter	Specification	Unit
Dimensions (W × D × H)	80 × 60 × 12	mm
Weight	88	g
Image sensor	High-sensitivity CMOS linear image sensor	-
Number of pixels	512	pixels
Slit*5 (H × V)	25 × 250	µm
NA*6	0.22	-
Connector for optical fiber	SMA905	-

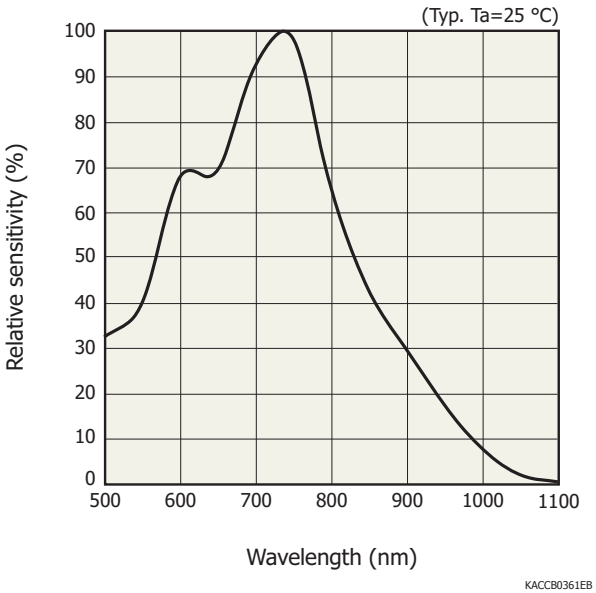
*5: Input slit aperture size
*6: Numeric aperture (solid angle)

Absolute maximum ratings

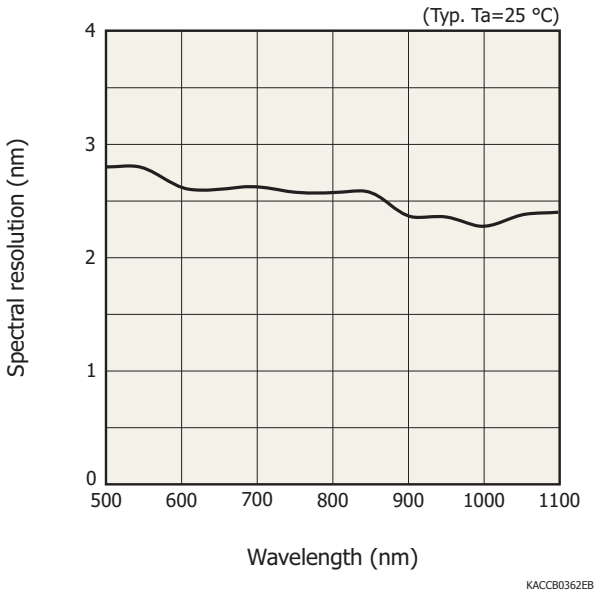
Parameter	Value	Unit
Operating temperature*7	+5 to +50	°C
Storage temperature*7	-20 to +70	°C

*7: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

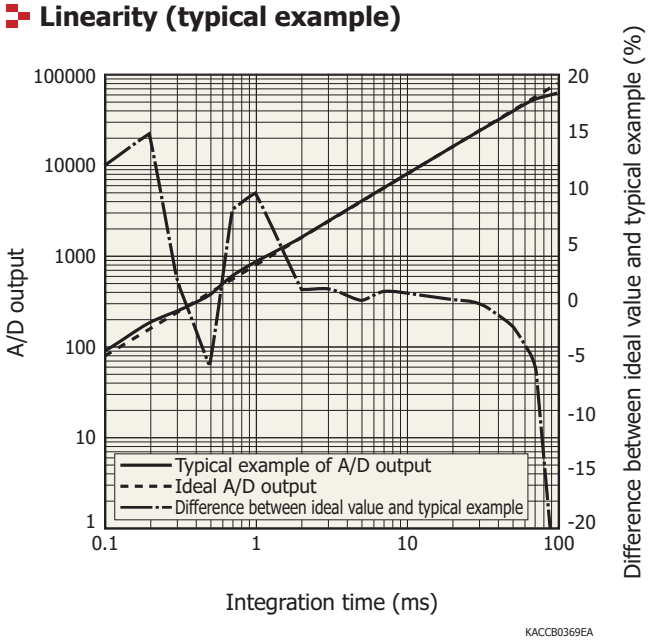
Spectral response



Spectral resolution vs. wavelength

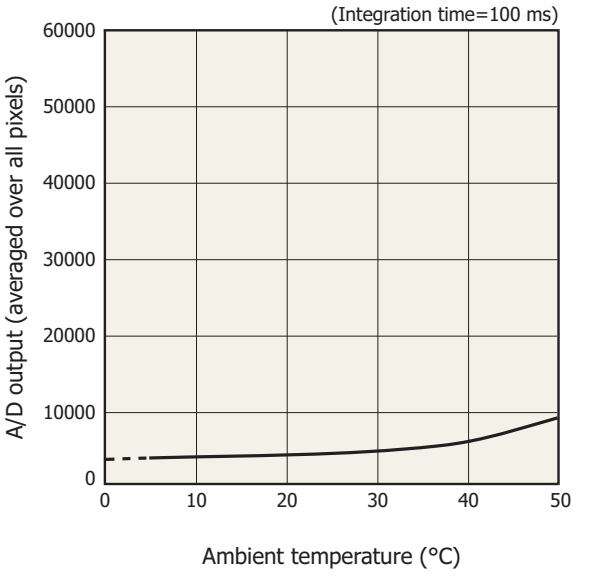


Linearity (typical example)



A/D output is the output with dark output subtracted when light is input. The difference between the ideal value and typical example contains a measurement error. The smaller the A/D output, the larger the measurement error.

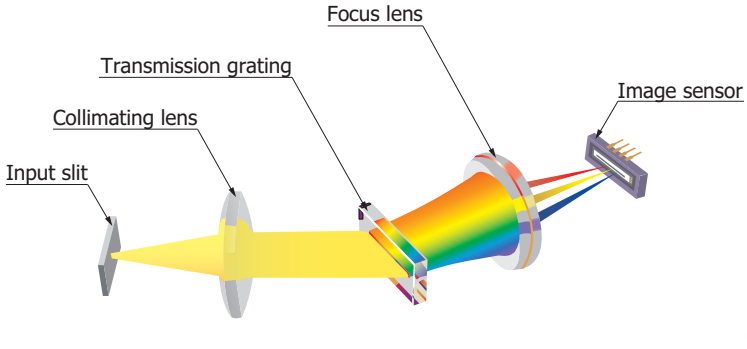
Dark output vs. temperature (typical example)



A/D output is the sum of the sensor and circuit offset outputs and the sensor dark output.

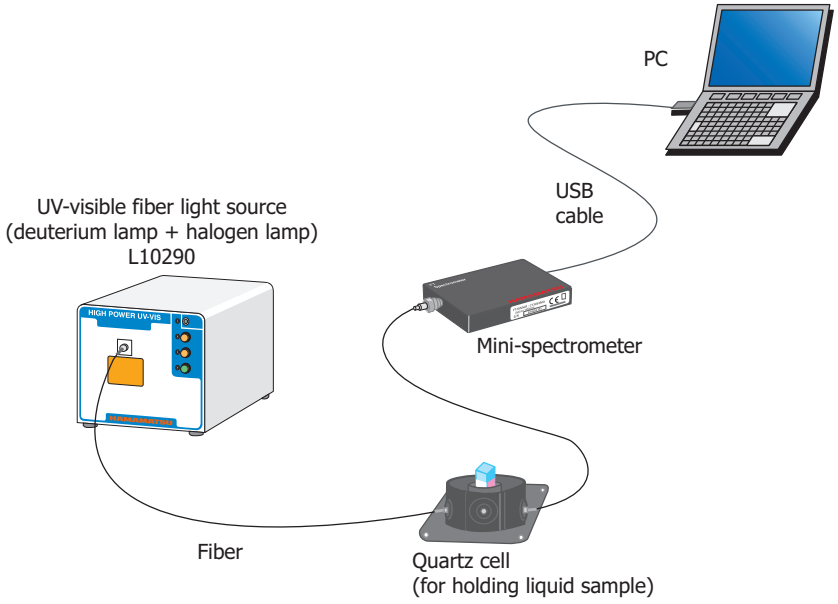
Optical component layout

The mini-spectrometer TF series employs a transmission holographic grating made of quartz and an optical system arranged on a robust optical base to produce high throughput and highly accurate optical characteristics.



Connection example (transmitted light measurement)

Spectrum data can be acquired by guiding measurement light into a mini-spectrometer through an optical fiber and transferring the measured results to a PC via the USB connection. Since there are no moving parts inside the device, constantly stable measurements can be expected. Moreover, the optical guiding section uses an optical fiber making connection to the measured object flexible.



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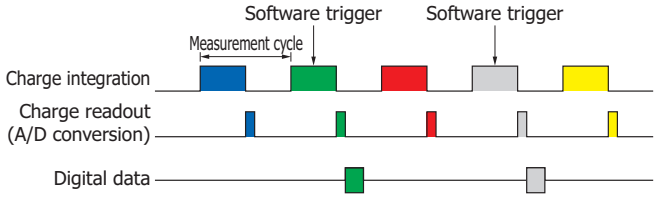
Trigger operation modes

In the C13053MA, the following trigger operation modes are available. You can switch between these modes from the evaluation software supplied with the C13053MA.

(1) Asynchronous data measurement at software trigger input

The first piece of digital data that is converted after a software trigger is applied from the PC is acquired.



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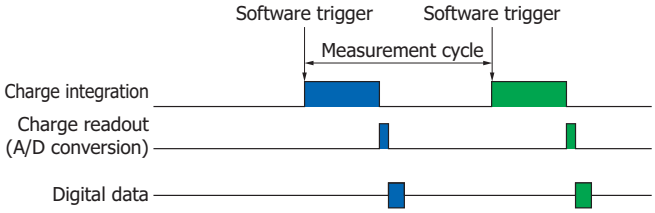
(2) Synchronous data measurement at software trigger input

Sensor operation (integration) starts when a software trigger is applied from the PC.



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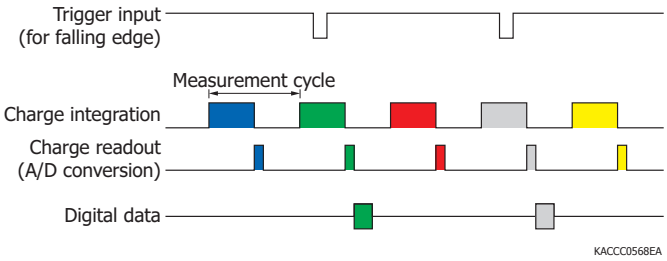
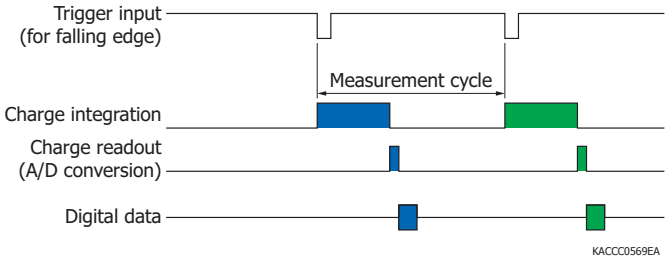
(3) Asynchronous data measurement at external trigger input

The first piece of digital data that is converted after an external trigger edge (rising or falling edge can be specified) is applied to the external trigger terminal is acquired.



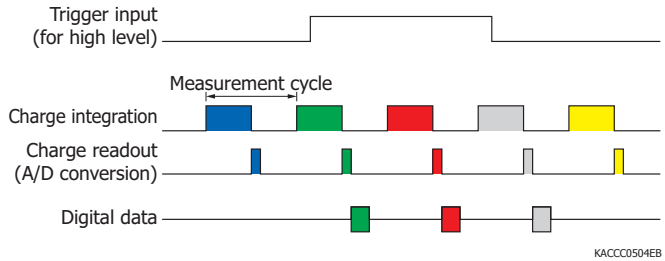
(4) Synchronous data measurement at external trigger input

Sensor operation (integration) starts when an external trigger edge (rising or falling edge can be specified) is applied to the external trigger terminal, and then the digital data is acquired.



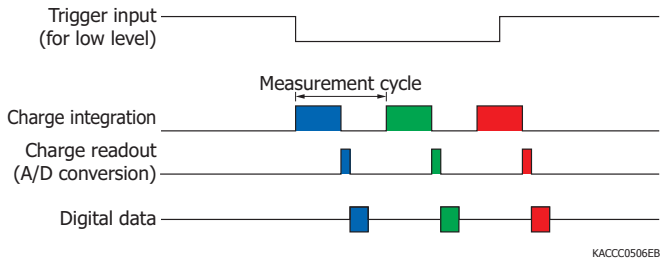
(5) Asynchronous data measurement at external trigger input level

Digital data is acquired when an external trigger (high level or low level can be specified) is applied to the external trigger terminal.



(6) Synchronous data measurement at external trigger input level

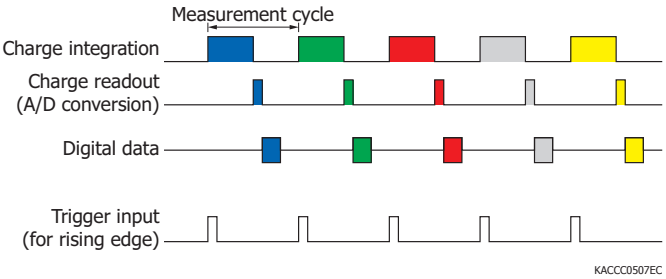
Sensor operation (integration) starts when a trigger (high level or low level can be specified) is applied to the external trigger terminal, and then the digital data is acquired.



In any of the modes 1 to 6, if the trigger input cycle is shorter than the measurement cycle of the spectrometer, the input trigger is ignored.

(7) External trigger signal output

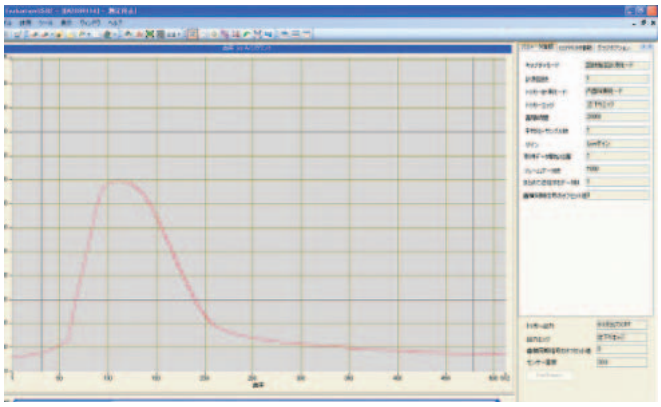
The start timing (pulse width: 10 µs) of integration can be output from the external trigger terminal (trigger output edge: rising or falling edge can be specified).



Evaluation software (accessory)

By installing the evaluation software (SpecEvaluationUSB2.exe)*8 into a PC, you can perform the following basic operations.

- Acquire and save measured data
- Set measurement conditions
- Module information acquisition (wavelength conversion factor, mini-spectrometer type, etc.)
- Display graphs
- Arithmetic functions
  Pixel number to wavelength conversion
  Calculation in comparison with reference data (transmittance, reflectance)
  Dark subtraction
  Gaussian approximation (peak position and count, FWHM)

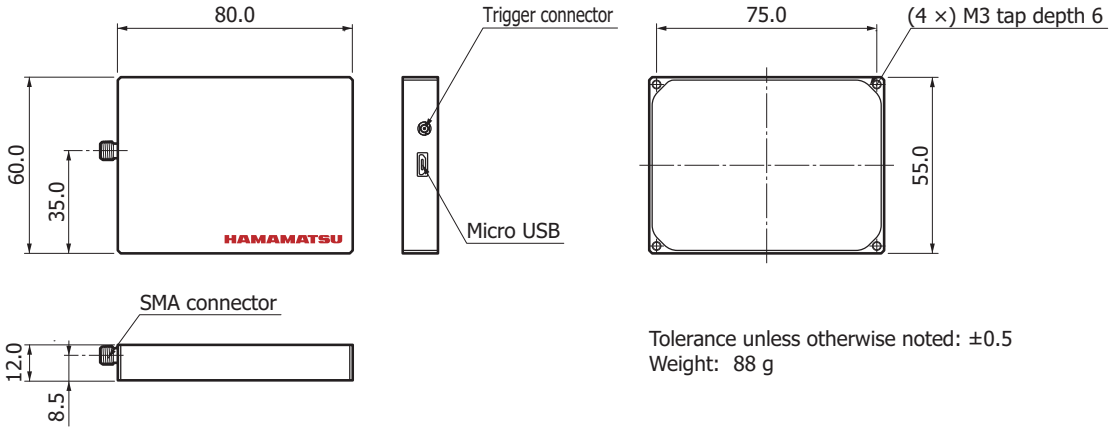


Note: Up to eight mini-spectrometers can be connected to a single PC.

*8: Compatible OS
Microsoft® Windows® 7 Professional SP1 (32-bit, 64-bit)
Microsoft® Windows® 8 Professional (32-bit, 64-bit)

A DLL for controlling the hardware is available.
Users can develop original measurement programs using the following development platform.
Microsoft® Visual Studio® 2008 (SP1) Visual C++®
Microsoft® Visual Studio® 2008 (SP1) Visual Basic®
Note: Microsoft, Windows, Visual Studio, Visual C++, and Visual Basic are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ±0.5
Weight: 88 g

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Accessories

· USB cable
· Dedicated software (evaluation software, sample software, DLL)

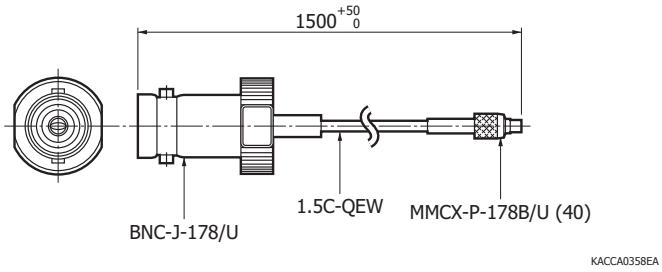
Options (sold separately)

· Input optical fiber

Type no.	Product name	Core diameter (µm)	Specification
A9762-01	Fiber for visible/near infrared range	600	NA=0.22, length=1.5 m, low cost With SMA905D connector on each end
A9763-05		400	NA=0.22, length=1.5 m, small bending radius at fiber section With SMA905D connector on each end

· Coaxial cable for external trigger input A12763

Dimensional outline (unit: mm)



Mini-spectrometer lineup

Type no.	Type		Spectral response range (nm)	Spectral resolution max. (nm)	Image sensor
C10082CA	Mini-spectrometer TM series	TM-UV/VIS-CCD High sensitivity	200 to 800	6	Back-thinned CCD image sensor
C10082CAH		TM-UV/VIS-CCD High resolution		1*	
C10082MD		TM-UV/VIS-MOS Wide dynamic range		6	CMOS linear image sensor
C10083CA		TM-VIS/NIR-CCD High sensitivity	320 to 1000	8 (λ=320 to 900 nm)	Back-thinned CCD image sensor
C10083CAH		TM-VIS/NIR-CCD High resolution		1* (λ=320 to 900 nm)	
C10083MD		TM-VIS/NIR-MOS Wide dynamic range		8	CMOS linear image sensor
C11697MB		TM-VIS/NIR-MOS-II Trigger-compatible		8	High-sensitivity CMOS linear image sensor
C9404CA	Mini-spectrometer TG series	TG-UV-CCD High sensitivity	200 to 400	3	Back-thinned CCD image sensor
C9404CAH		TG-UV-CCD High resolution		1*	
C9405CB		TG-SWNIR-CCD-II IR-enhanced	500 to 1100	5 (λ=550 to 900 nm)	IR-enhanced back-thinned CCD image sensor
C11713CA		TG-RAMAN-I High resolution	500 to 600	0.3*	Back-thinned CCD image sensor
C11714CB		TG-RAMAN-II High resolution	790 to 920	0.3*	IR-enhanced back-thinned CCD image sensor
C11482GA	Mini-spectrometer TG series	TG2-NIR Non-cooled type	900 to 1700	7	InGaAs linear image sensor
C9913GC		TG-cooled NIR-I Low noise (cooled type)		7	
C9914GB		TG-cooled NIR-II Low noise (cooled type)	1100 to 2200	8	
C11118GA		TG-cooled NIR-III Low noise (cooled type)	900 to 2550	20	
C13053MA	Mini-spectrometer TF series	TF-SWIR-MOS-II Compact, thin case	500 to 1100	3.5	High-sensitivity CMOS linear image sensor
C13054MA		TF-RAMAN Compact, thin case	790 to 920	0.4*	
C13555MA		TF-VIS-MOS-II Compact, thin case	340 to 830	3	
C11007MA	Mini-spectrometer RC series	RC-VIS-MOS Spectrometer module	340 to 780	9	CMOS linear image sensor
C11008MA		RC-SWNIR-MOS Spectrometer module	640 to 1050	8	IR-enhanced CMOS linear image sensor

* Typ.

For installation into mobile measuring equipment

Type no.	Type		Spectral response range (nm)	Spectral resolution max. (nm)	Image sensor
C11009MA	Mini-spectrometer RC series	RC-VIS-MOS Spectrometer head	340 to 780	9	CMOS linear image sensor
C11010MA		RC-SWNIR-MOS Spectrometer head	640 to 1050	8	IR-enhanced CMOS linear image sensor

For installation into mobile measuring equipment (ultra-compact)

Type no.	Type		Spectral response range (nm)	Spectral resolution max. (nm)	Image sensor
C11708MA	Mini-spectrometer MS series	MS-SWNIR-MOS Spectrometer head	640 to 1050	20	CMOS linear image sensor
C12666MA	Micro-spectrometer	Spectrometer head	340 to 780	15	CMOS linear image sensor
C12880MA		Spectrometer head	340 to 850	15	High-sensitivity CMOS linear image sensor

Related information

www.hamamatsu.com/sp/ssd/doc_en.html

■ Precautions
· Disclaimer
· Mini-spectrometers

■ Technical information
· Mini-spectrometers

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