HAMAMATSU
PHOTON IS OUR BUSINESS

Mini-spectrometer

Micro series | C12666MA

Fingertip size, ultra-compact spectrometer head integrating MEMS and image sensor technologies

The C12666MA is an ultra-compact (Fingertip size) spectrometer head developed based on our MEMS and image sensor technologies. The adoption of a newly designed optical system has achieved a remarkably small size, less than half the volume of the previous mini-spectrometer MS series (C10988MA-01). In addition, the employment of hermetic packaging has improved humidity resistance.
This product is suitable for integration into a variety of devices, such as integration into printers and hand-held color monitoring devices that require color management. It is also suitable for applications that collaborate with portable devices, such as smartphones and tablets.

Features

- **Fingertip size: 20.1 × 12.5 × 10.1 mm**
- **Weight: 5 g**
- **Spectral response range: 340 to 780 nm**
- **Spectral resolution: 15 nm max.**
- **Hermetic package: High reliability against humidity**
- **Installation into mobile measurement equipment**
- **Wavelength conversion factor*1 is listed on final inspection sheet**

Applications

- **Color monitoring for printers and printing machines**
- **Testers for lights and LEDs**
- **Color adjustment of various large size displays**
- **Water quality control monitors and other environment measuring instruments**
- **Measuring instruments that use portable devices such as smartphones and tablets**

*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		Value	Unit
Spectral response range		340 to 780	nm
Spectral resolution (FWHM)	Typ.	12	nm
	Max.	15	
Wavelength reproducibility*2		-0.5 to +0.5	nm
Wavelength temperature dependence		-0.1 to +0.1	nm/°C
Spectral stray light*3		-25	dB

*2: Measured under constant light input conditions
*3: Spectral stray light = 10 × log (Tl/Th)
Th: output signal when a light spectrum at a certain wavelength is input
Tl: output signal at that wavelength ± 40 nm

Electrical characteristics

Parameter	Min.	Typ.	Max.	Unit
Supply voltage	4.75	5	5.25	V
Power consumption	-	30	-	mW
Video rate	0.25	-	200	kHz
Output impedance	-	150 *4	-	Ω

*4: An increase in the current consumption at the video output terminal also increases the chip temperature and so causes the dark current to rise. To avoid this, connect a buffer amplifier for impedance conversion to the video output terminal so that the current flow is minimized. As the buffer amplifier, use a JFET or CMOS input operational amplifier of optical input impedance.

Structure

Parameter	Specification	Unit
Dimensions (W × D × H)	20.1 × 12.5 × 10.1	mm
Weight	5	g
Slit*5 (H × V)	50 × 750	µm
NA*6	0.22	-
Image sensor (H × V)	CMOS linear image sensor with a slit	-
Number of pixels	256	pixels
Pixel size (H × V)	12.5 × 1000	µm

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

Absolute maximum ratings

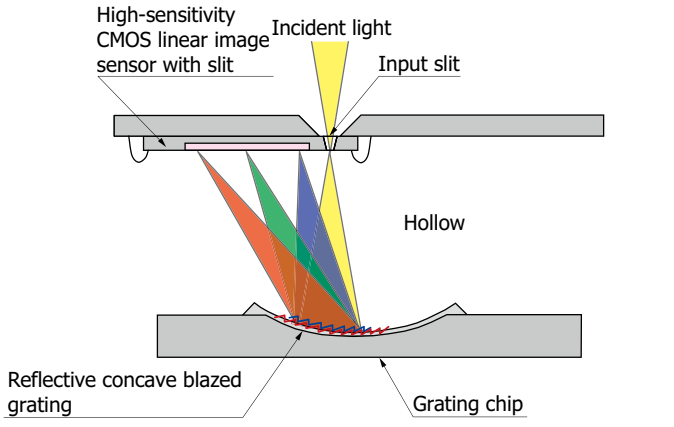
Parameter	Value	Unit
Operating temperature*7	+5 to +50	°C
Storage temperature*7	-20 to +70	°C

*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.

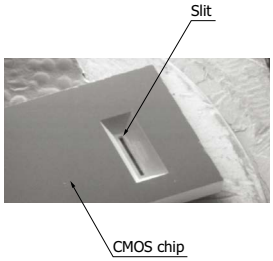
Optical component layout

Besides a CMOS image sensor chip integrated with an optical slit by etching technology, the C12666MA employs a reflective concave blazed grating formed by nanoimprint. In addition, the glass used in the light path of the previous C10988MA-01 is not used in the C12666MA, making it extremely compact.

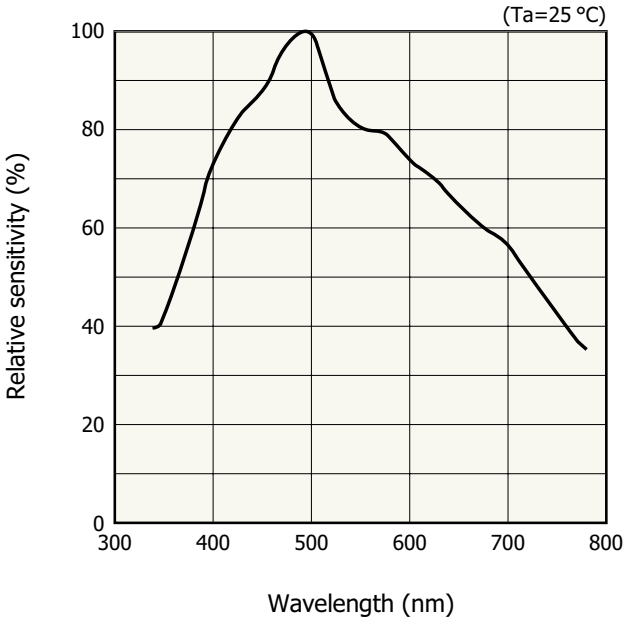
Structure



CMOS linear image sensor with a slit [Incident light side (back of chip)]

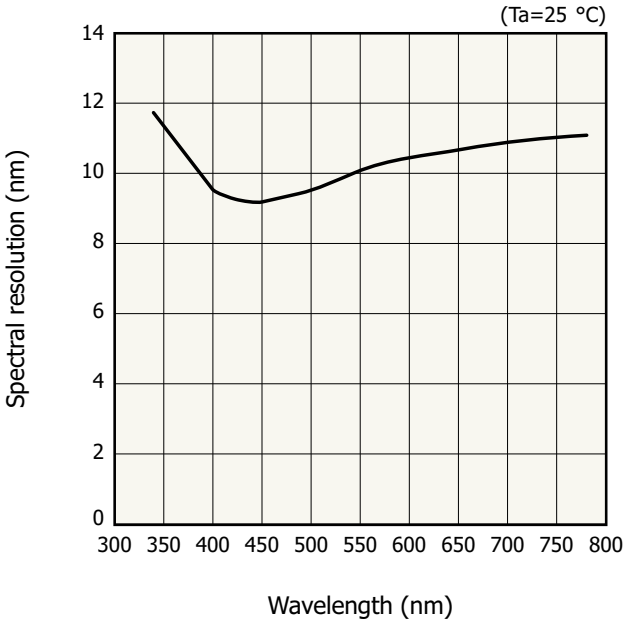


Spectral response (typical example)



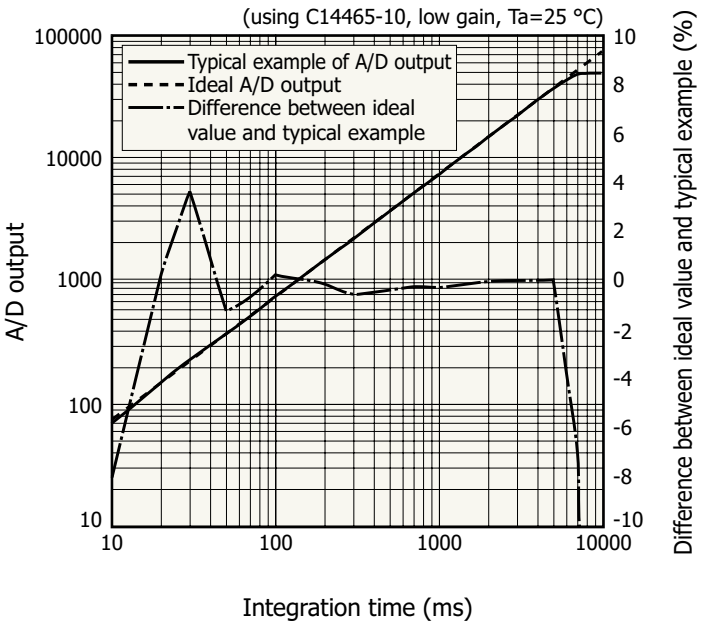
KACCB0350EB

Spectral resolution vs. wavelength (typical example)



KACCB0351EA

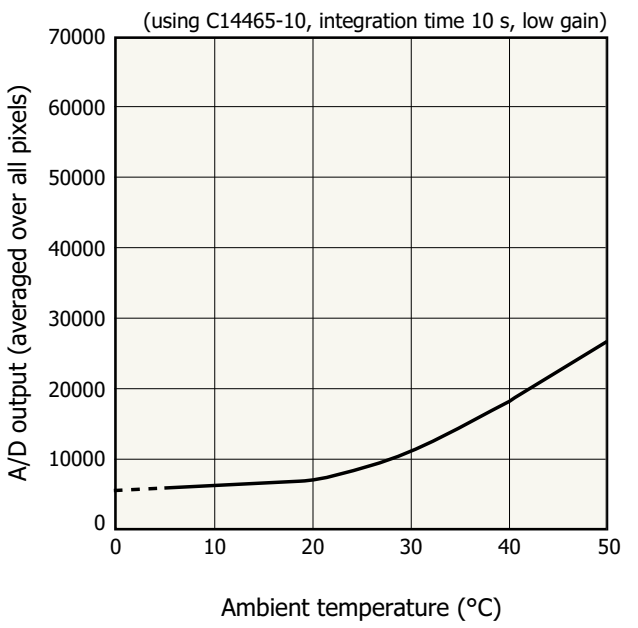
Linearity (typical example)



A/D output is the output with dark output is 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.

KACCB0352EC

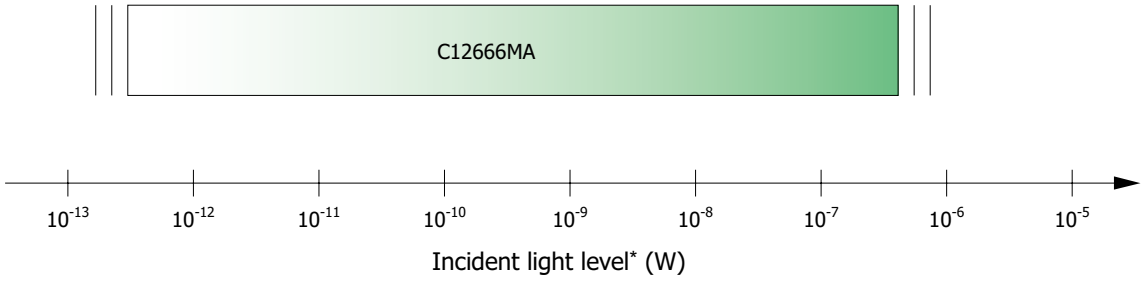
Dark output vs. ambient temperature (typical example)



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

KACCB0354EC

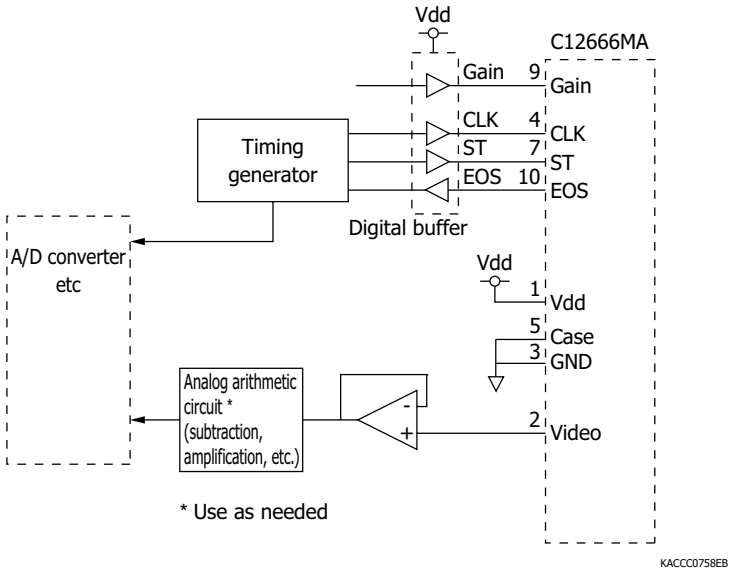
Measurable incident light level



* Input spot diameter: 800 µm (λ=550 nm)

KACCB354EA

Recommended driver circuit example

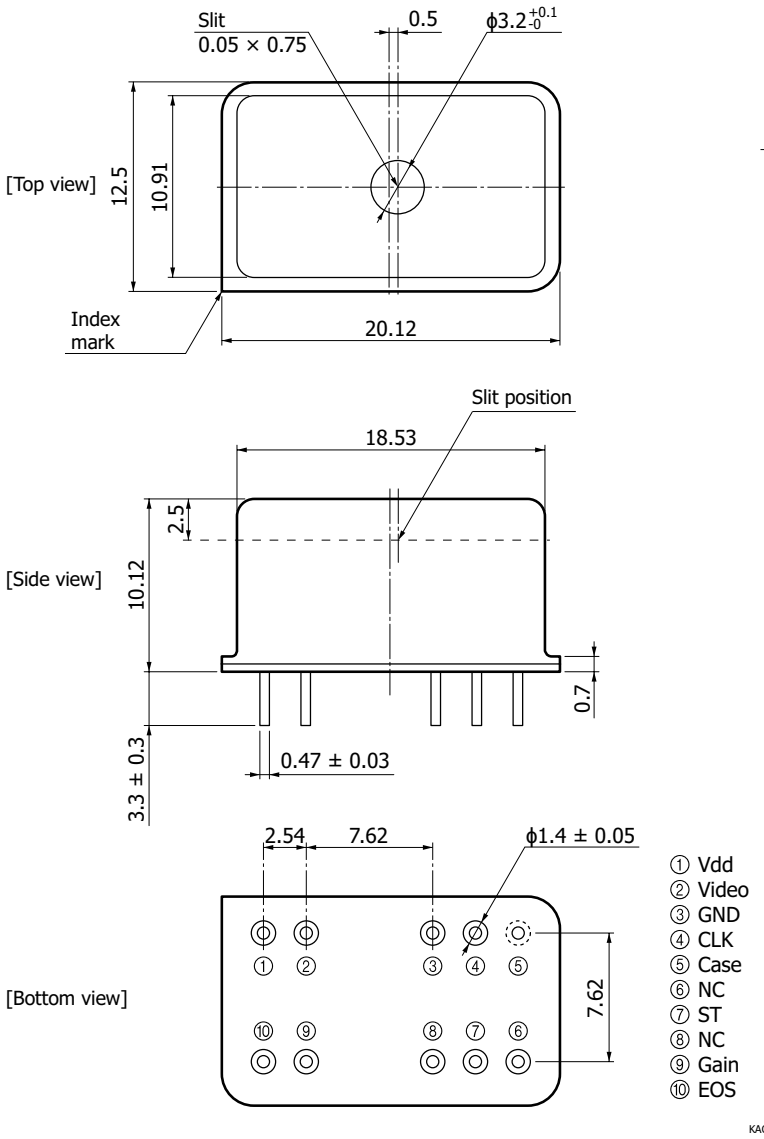


KACCC0758EB

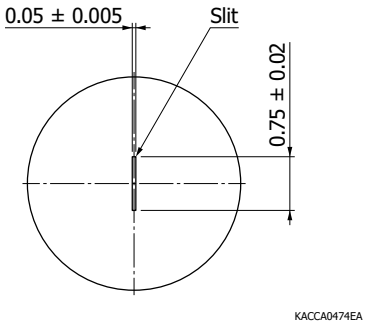
Precautions

· The packaging of C12666MA is electrically conductive, so be careful when designing the circuit to avoid short circuit caused by contact with a circuit pattern.
· If external force is repeatedly applied to the lead pins, this may damage the lead pins.
· To prevent damage due to soldering, be careful of the soldering temperature and time.
As a general guide, finish soldering within 3.5 seconds at 350 °C or less when soldering by hand, or within 10 seconds at 260 °C or less when using a solder bath.

Dimensional outline
(unit: mm, tolerance unless otherwise noted: ±0.2)



Enlarged view of slit (unit: mm)



Pin connections

Make electrical connections to an external circuit using leads.

Pin no.	Symbol	Name	I/O	Description
1	Vdd	Supply voltage	I	Image sensor power supply: 5 V
2	Video	Video output	O	Video output signal
3	GND	Ground	-	Sensor ground
4	CLK	Clock pulse	I	Sensor scan sync signal
5	Case	Case	-	Case connection terminal
6	NC		-	No connection
7	ST	Start pulse	I	Start pulse
8	NC		-	No connection
9	Gain	Gain	I	Image sensor: Gain setting
10	EOS	End of scan	O	Sensor scan end signal

Note: Pin no. 9 is pulled up internally to Vdd via 10 kΩ.
Do not pull-up or pull-down the gain setting using an external circuit. For low gain, leave the pin open or connect to Vdd. For high gain, connect to GND.

Internal CMOS image sensor specifications

Recommended terminal voltage

Parameter		Symbol	Min.	Typ.	Max.	Unit
Supply voltage		Vdd	4.75	5	5.25	V
Gain selection terminal voltage	High gain	Gain	0	-	0.4	V
	Low gain		Vdd - 0.25	Vdd	Vdd + 0.25	V
Clock pulse voltage	High level	V(CLK)	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	V
Start pulse voltage	High level	V(ST)	Vdd - 0.25	Vdd	Vdd + 0.25	V
	Low level		0	-	0.4	V

Electrical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V]

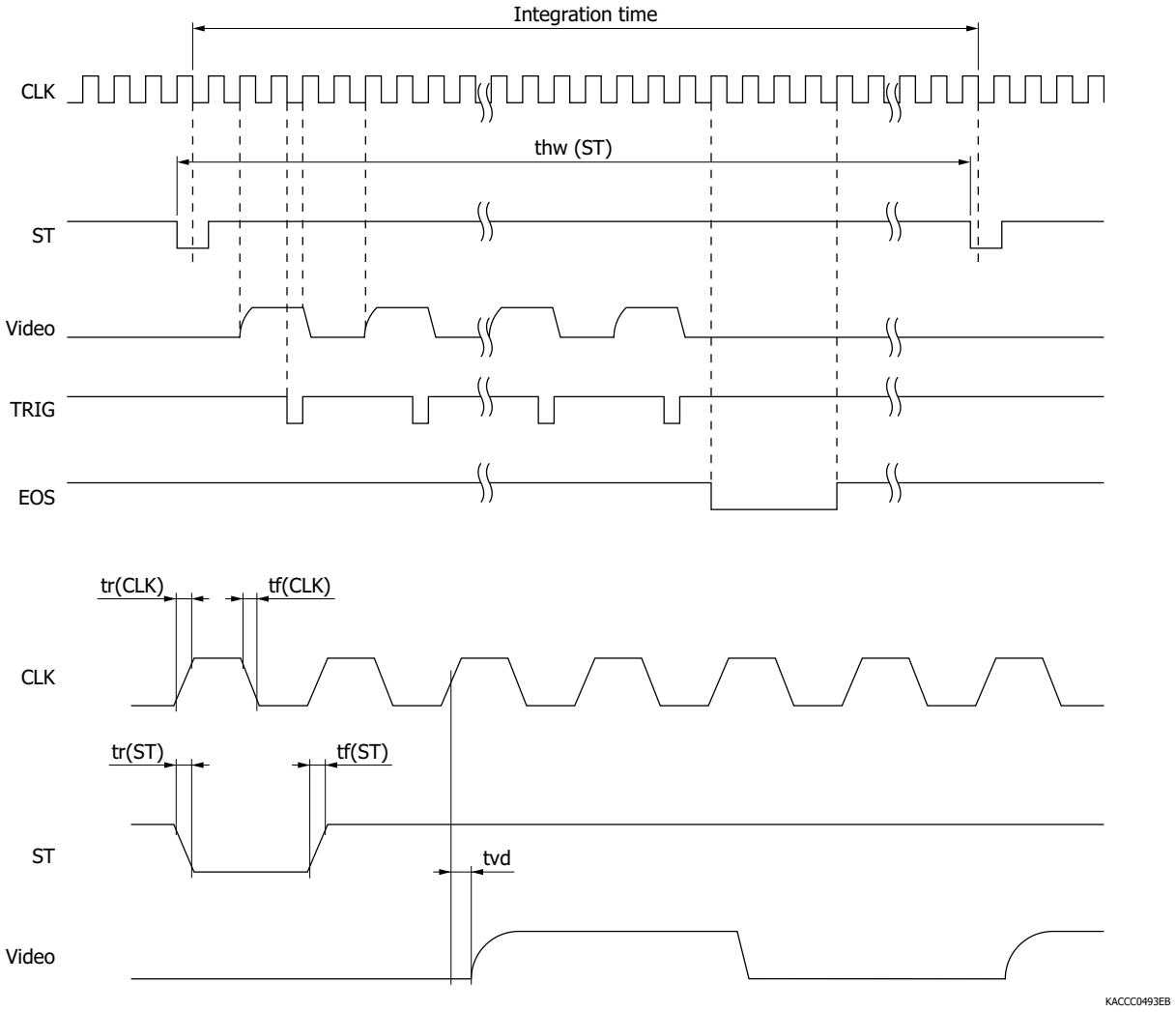
Parameter		Symbol	Min.	Typ.	Max.	Unit
Clock pulse frequency		f(CLK)	1	-	800	kHz
Power consumption	High gain	P	-	-	60	mW
	Low gain		-	-	60	

Electrical and optical characteristics [Ta=25 °C, Vdd=5 V, V(CLK)=V(ST)=5 V]

Parameter		Symbol	Min.	Typ.	Max.	Unit
Dark current	High gain	ID	-	0.02	0.08	pA
	Low gain		-	0.02	0.08	
Output offset voltage	High gain	Vo	0.15	0.35	0.55	V
	Low gain		0.15	0.35	0.55	
Charge amplifier feedback capacitance*8	High gain	Cf	-	1.4	-	pF
	Low gain		-	4.8	-	
Saturation output voltage*9	High gain	Vsat	2.3	2.8	3.3	V
	Low gain		1.4	1.7	2.0	
Readout noise	High gain	Nr	-	0.3	0.5	mV rms
	Low gain		-	0.2	0.4	

*8: Gain=5 V (low gain), Vg=0 V (high gain)
*9: Voltage difference relative to Vo

Timing chart

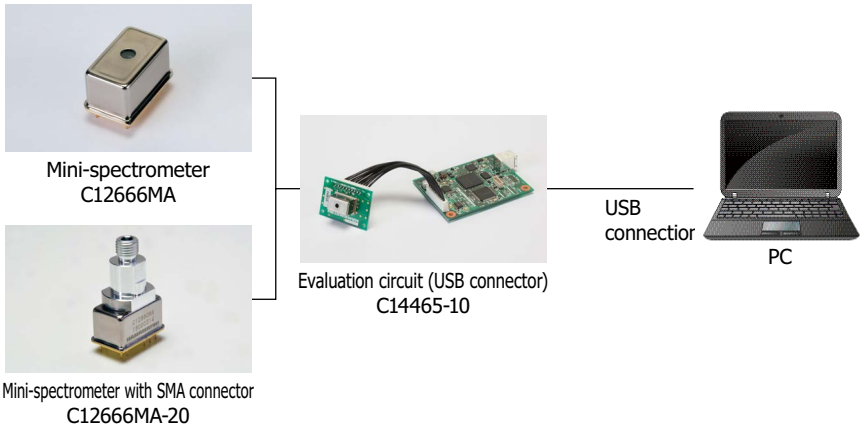


Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse high period	thw(ST)	1030/f(CLK)	-	-	s
Start pulse rise/fall times	tr(ST), tf(ST)	0	20	30	ns
Clock pulse duty ratio	-	45	50	55	%
Clock pulse rise/fall times	tr(CLK), tf(CLK)	0	20	30	ns
Video delay time	tvd	-	20	-	ns

Note: The clock pulse should be set from high to low just once when the start pulse is low. The internal shift register starts operating at this timing.
The integration time is determined by the start pulse intervals. However, since the charge integration of each pixel is carried out between the signal readout of that pixel and the next signal readout of the same pixel, the start time of charge integration differs depending on each pixel. In addition, the next start pulse cannot be input until signal readout from all pixels is completed.
Video output is 1/4 of the clock pulse frequency.

Selection chart

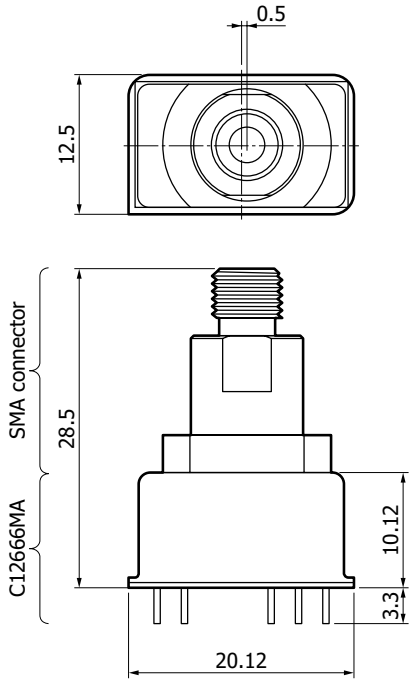
A mini-spectrometer with SMA connector (for optical fiber connection), an evaluation circuit, and a driver circuit are available as related products for the mini-spectrometer (micro series).



Mini-spectrometer with SMA connector C12666MA-20

The C12666MA-20 is a product in which an SMA connector is attached to the C12666MA. It has an optical system inside the connector that can be connected with an optical fiber (single core, NA=0.22) with an SMA connector. The specifications of the C12666MA-20 is the same as those of the C12666MA except the connector section.

Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ±0.2

KACCA0507EA

Options

Product name	Type no.	Core diameter (μm)	Specification
Fiber for UV/visible range (resistance to UV)	A16962-01	600	NA=0.22, length=1.5 m With SMA905D connector on each end

Mini-spectrometer evaluation circuit C14465-10 (sold separately)

The C14465-10 is a circuit board designed to simply evaluate the characteristics of the mini-spectrometer. The characteristics of the mini-spectrometer can be evaluated using the evaluation software by connecting the mini-spectrometer to a PC with a USB cable A9160 (AB type, sold separately)*10.

Features

- **Initial evaluation circuit for mini-spectrometer*11**
- **Wavelength conversion factors of the mini-spectrometer can be input from a PC.*12**
- **High A/D resolution (16-bit)**
- **USB powered**

*10: Compatible OS:
Microsoft Windows 8.1 Professional (32-bit, 64-bit)
Microsoft Windows 10 Professional (32-bit, 64-bit)

*11: The C14465-10 is a modified version of the C14465 evaluation circuit for the previous mini-spectrometer MS series (C10988MA-01, C11708MA). Only the sensor board has been modified. If you already have the C14465, you only have to purchase the C14465-03 (the sensor board for mini-spectrometers) to evaluate C12666MA mini-spectrometers.

*12: A typical wavelength conversion factor is entered at the time of shipment of the C14465-10. To measure a spectrum with higher wavelength accuracy, it is necessary to input the wavelength conversion factor listed in the final inspection sheet that comes with each mini-spectrometer.

Note: Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries.

Electrical characteristics

Parameter	Specification	Unit
Interface	USB 2.0	-
A/D conversion	16	bit
Clock pulse frequency	800	kHz
Video rate	200	kHz
Integration time	5 to 10000	ms

Structure

Parameter		Specification	Unit
Applicable spectrometer		C12666MA	-
Dimensions	Control board	80 × 60	mm
	Sensor board	30 × 44	mm

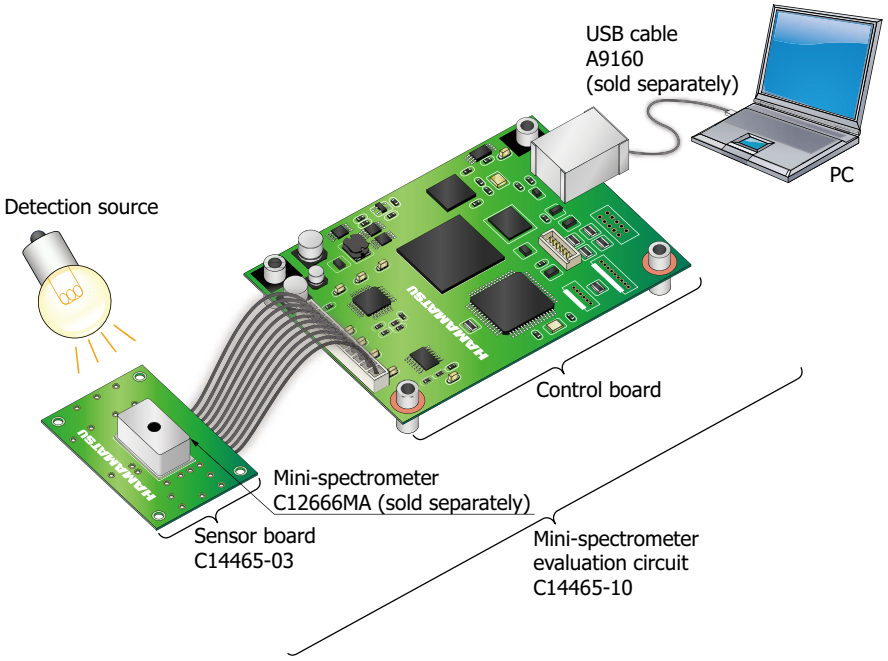
Absolute maximum ratings

Parameter	Value	Unit
Operating temperature*13	+5 to +40	°C
Storage temperature*13	-20 to +70	°C

*13: 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.

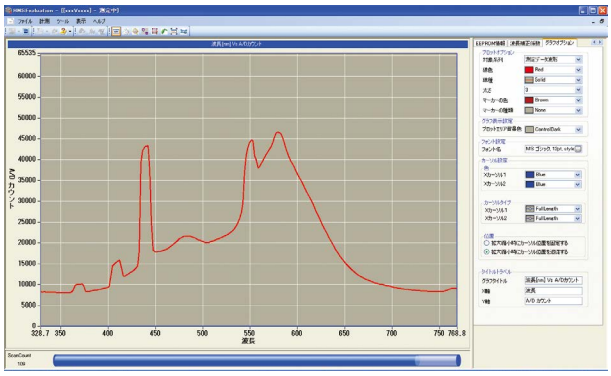
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Connection example



KACCC0759ED

Evaluation software display example



Related information

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

■ Precaution
· Disclaimer

■ Technical information
· Mini-spectrometers

HAMAMATSU www.hamamatsu.com

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 PHOTONICS TAIWAN 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

Cat. No. KACC1216E15 Mar. 2025 DN