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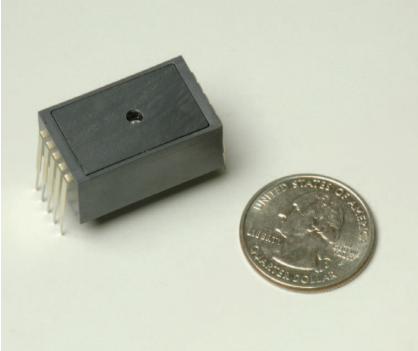
Mini-spectrometers



MS series | C10988MA-01 | C11708MA

Ultra-compact mini-spectrometer integrating MEMS and image sensor technologies

The MS series are thumb-sized (27.6 × 16.8 × 13 mm) spectrometer heads developed for installation into mobile measurement equipment by merging our MEMS and image sensor technologies.
The MS series uses a CMOS image sensor integrated with a light receiving slit. The internal optical system is comprised of a convex lens on which a grating is formed by nanoimprint.
The result is a remarkably small size less than one-third the volume of the RC series mini-spectrometers that have already been marketed.

Features

- **Thumb size: 27.6 × 16.8 × 13 mm**
- **Weight: 9 g**
- **Spectral response range: 340 to 750 nm (C10988MA-01)**
  640 to 1050 nm (C11708MA)
- **Spectral resolution: 14 nm (C10988MA-01)**
  20 nm (C11708MA)
- **Installation into mobile measurement equipment**
- **Wavelength conversion factor*1 is listed on final inspection sheet.**

Applications

C10988MA-01

- **Color monitoring for printers and printing machines**
- **Installation into large size display (Color control device)**

C11708MA

- **Fruit sugar content measurement / cereal taste test**
- **Component analysis**

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

Optical characteristics

Parameter	C10988MA-01	C11708MA	Unit
Spectral response range	340 to 750	640 to 1050	nm
Spectral resolution (FWHM)*2	14 max.	20 max.	nm
Wavelength reproducibility*3	-0.5 to +0.5		nm
Wavelength temperature dependence	-0.05 to +0.05		nm/°C
Spectral stray light*2 *4	-25 max.		dB

*2: Depends on the slit opening. Values were measured with the slit listed in the table "Structure / Absolute maximum ratings".
*3: Measured under constant light input conditions
*4: When monochromatic light of the following wavelengths is input, spectral stray light is defined as the ratio of the count measured at the input wavelength, to the count measured in a region of the input wavelength ±40 nm.
C10988MA-01: 550 nm, C11708MA: 850 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*5	-	Ω

*5: 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.

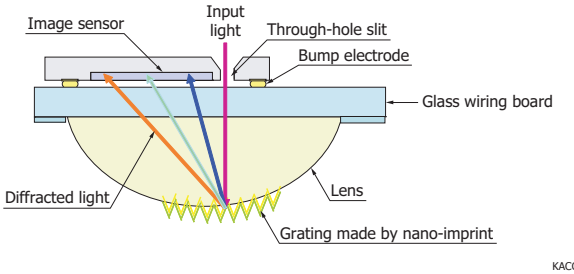
Structure / Absolute maximum ratings

Parameter	Value	Unit
Dimensions (W × D × H)	27.6 × 16.8 × 13	mm
Weight	9	g
Number of pixels	256	pixels
Pixel size (H × V)	12.5 × 1000	µm
Image sensor	CMOS linear image sensor	-
Slit*6 (H × V)	75 × 750	µm
NA*7	0.22	-
Operating temperature*8	+5 to +50	°C
Storage temperature*8	-20 to +70	°C

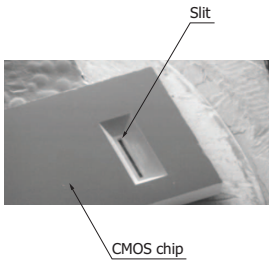
*6: Entrance slit aperture size
*7: Numeric aperture (solid angle)
*8: No dew condensation
When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration 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 (C10988MA-01)

Besides a CMOS image sensor chip integrated with an optical slit by etching, the C10988MA-01 employs a grating that is formed on a convex lens by nano-imprint. This has made the unit very compact.

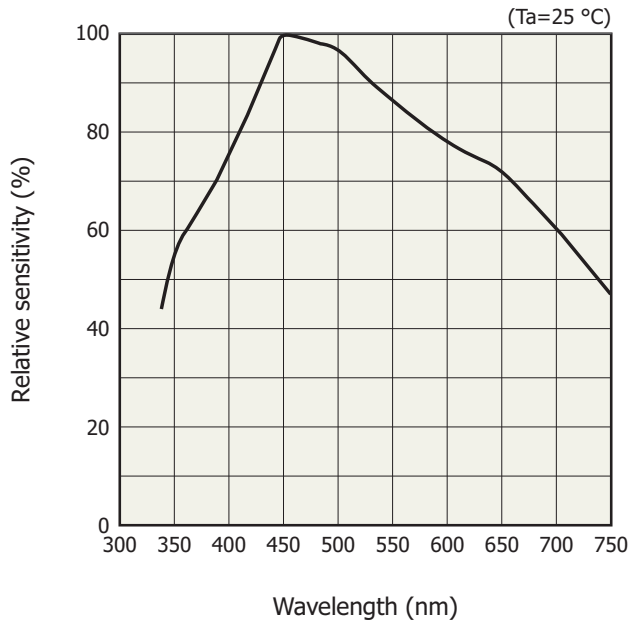


CMOS chip (back)

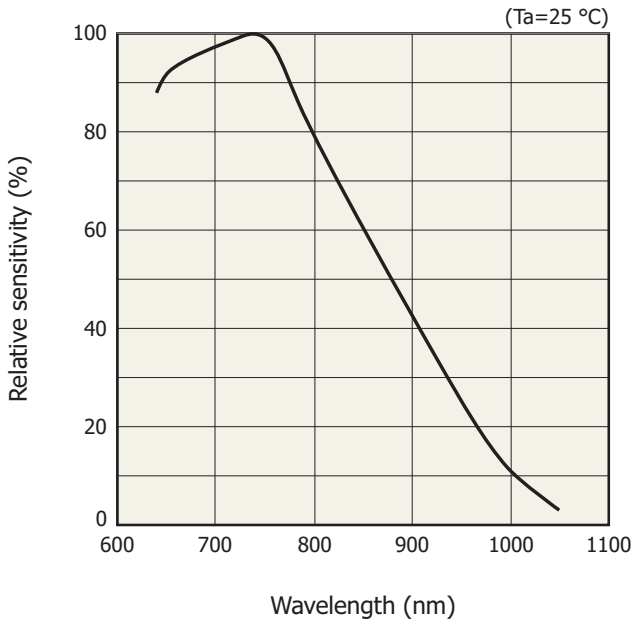


Spectral response (typical example)

C10988MA-01



C11708MA



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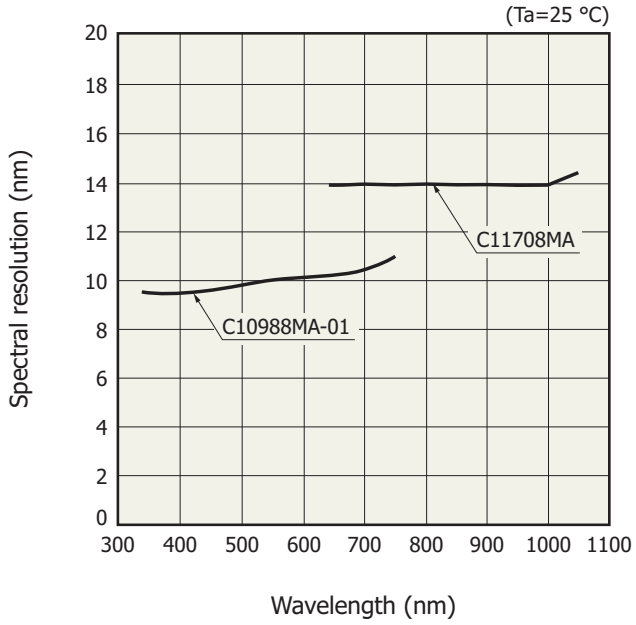
Spectral resolution vs. wavelength (typical example)



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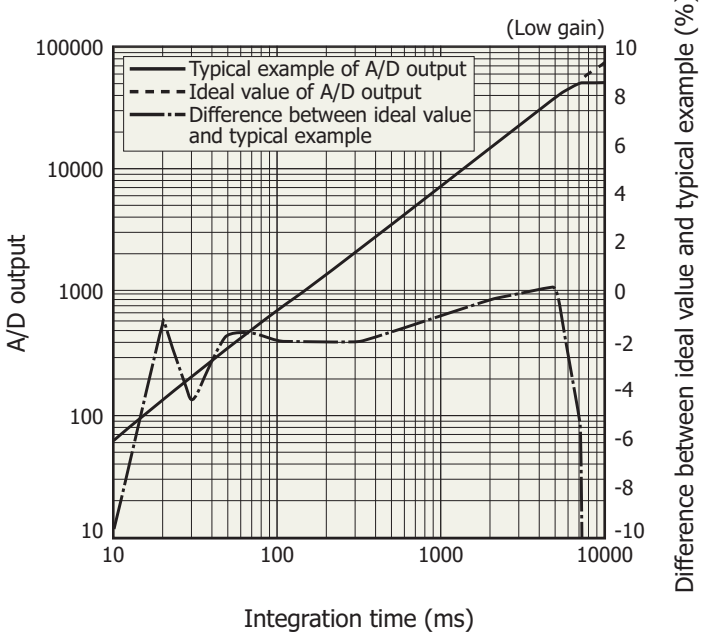
Linearity (measured with C11351, typical example)



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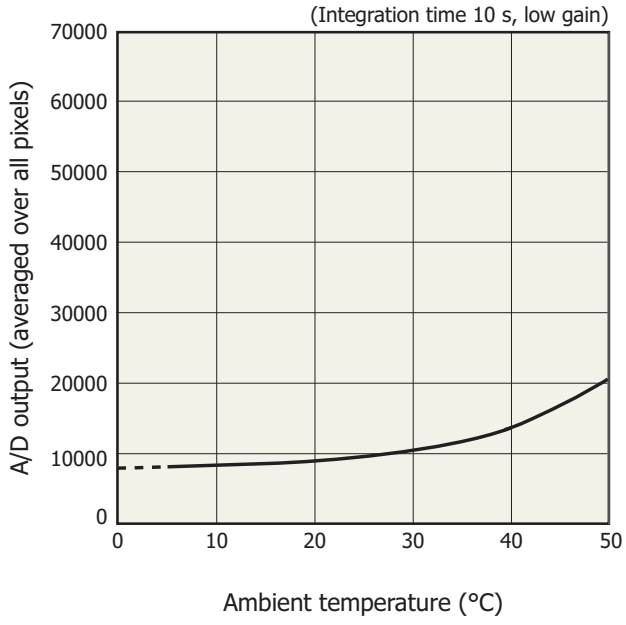
A/D output is the output with dark output is subtracted when light is input. The difference between the ideal value and typical example contains a measurement error. The smaller the A/D output, the larger the measurement error.

Dark output vs. ambient temperature (measured with C11351, typical example)



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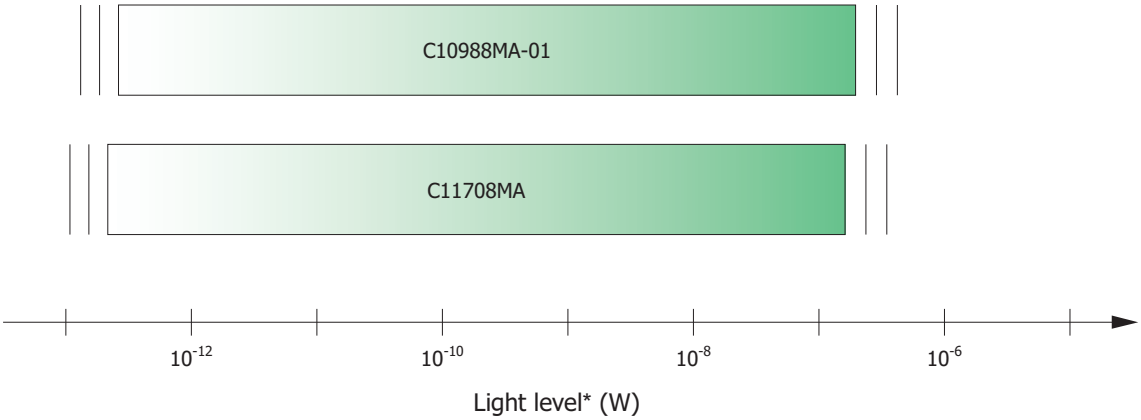
A/D output is the sum of the sensor and circuit offset outputs and the sensor dark output.

Measurable optical power



* Input spot diameter: 800 µm (C10988MA-01: λ=550 nm, C11708MA: λ=850 nm)

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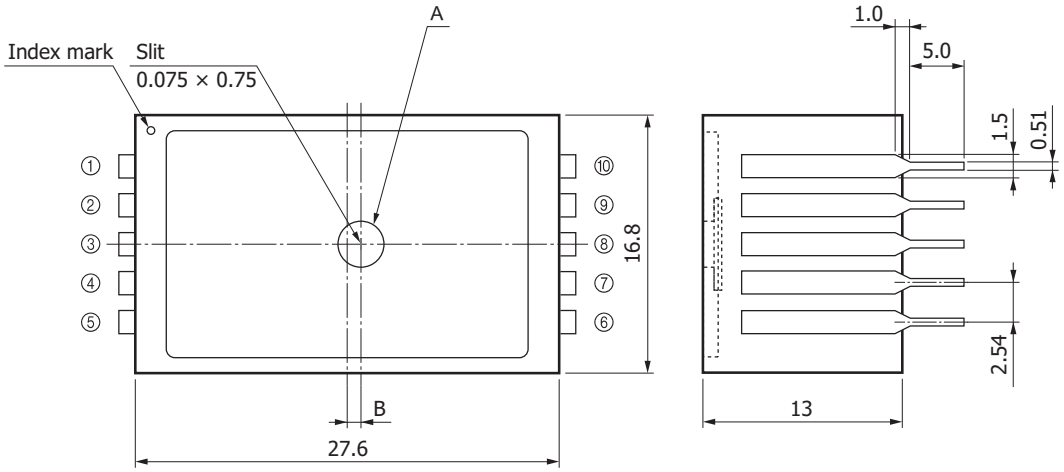
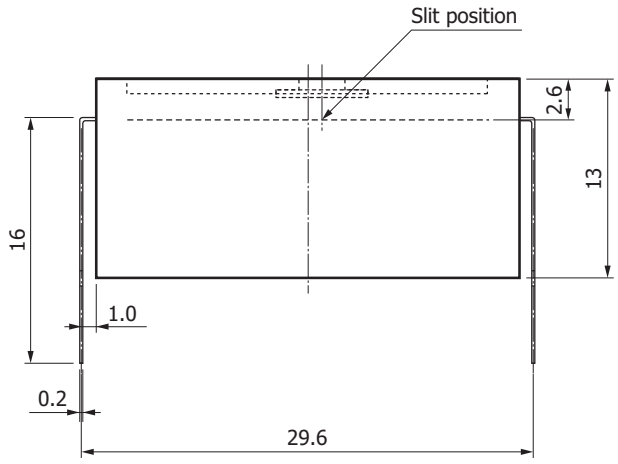
Dimensional outline (unit: mm, tolerance unless otherwise noted: ±0.2)





① CLK
② GND
③ NC
④ ST
⑤ NC
⑥ Gain
⑦ EOS
⑧ NC
⑨ Vdd
⑩ Video

Weight: 9 g

	C10988MA-01	C11708MA
A	ϕ3	ϕ2.8
B	0.75	0.5

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Electrical connections with an external circuit

Make electrical connections to an external circuit using the lead pins.

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

Precation for use

· If external force is repeatedly applied to the lead pins, this may damage the lead pins.
When installing this product in locations subject to vibration, secure it with resin or a holder, etc.
(Recommended resin: KE347B, etc. made by Shin-Etsu Chemical Co., Ltd.)
· The sensor may be damaged by soldering, so be careful of the soldering temperature and time.
As a general guide, finish soldering within 3.5 seconds at 370 °C or less when soldering by hand, or within 10 seconds at 260 °C or less when using a solder bath.

CMOS image sensor

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]

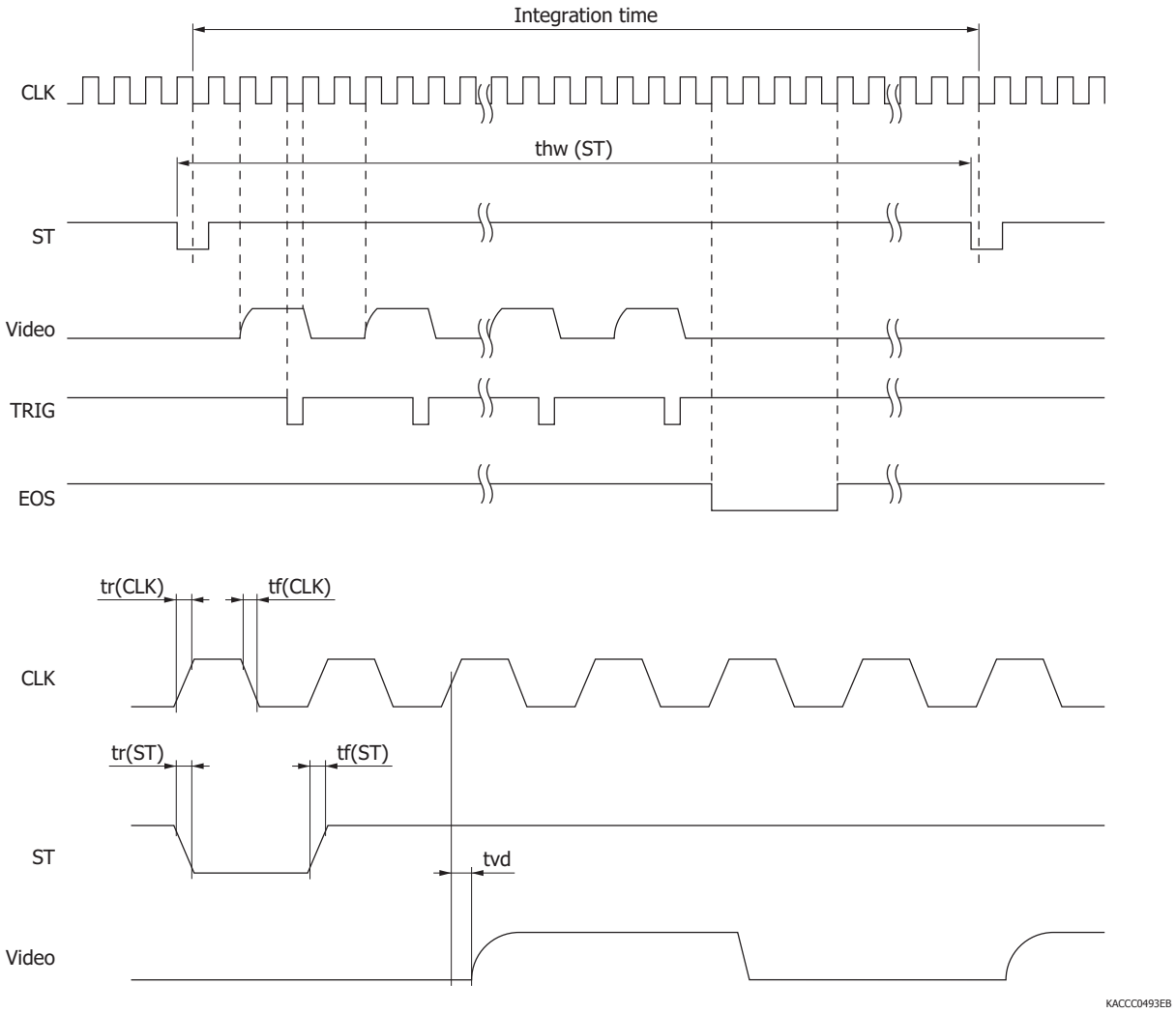
Parameter		Symbol	Min.	Typ.	Max.	Unit
Clock pulse frequency		f(CLK)	1	-	800	kHz
Power consumption	High gain	P	-	-	60	mW
	Low gain		-	-	60	

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	
Feedback capacitance of charge amplifier*9	High gain	Cf	-	1.4	-	pF
	Low gain		-	4.8	-	
Saturation output voltage*10	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	

*9: Gain=5 V (low gain), Vg=0 V (high gain)
*10: Difference from Vo

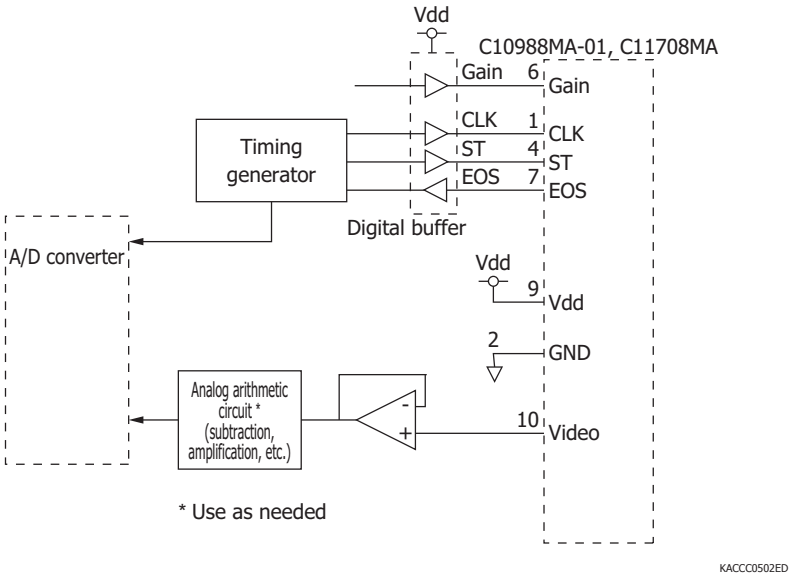
Timing chart



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

Recommended driver circuit example



Evaluation circuit C11351 for mini-spectrometer MS series

The C11351 is a circuit board designed to simply evaluate characteristics of mini-spectrometer MS series. By using the C11351 with the MS series (sold separately) and a USB cable A9160 (AB type; sold separately), the MS series characteristics can be evaluated with the evaluation software*11.

Features

- **Initial evaluation circuit for mini-spectrometer MS series**
- **Wavelength conversion factors of MS series can be input from PC*12**
- **High A/D resolution (16 bits)**
- **Powered only via USB port**

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

*12: A typical wavelength conversion factor for converting the image sensor pixel number into a wavelength is recorded in C11351. 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 C10988MA-01 or C11708MA.

Note: Since the C11351 is an evaluation circuit for the MS series, the DLL function specifications are not available to users.
Microsoft and Windows are either registerd trademarks or trademarks of Microsoft Corporation in the United States and 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

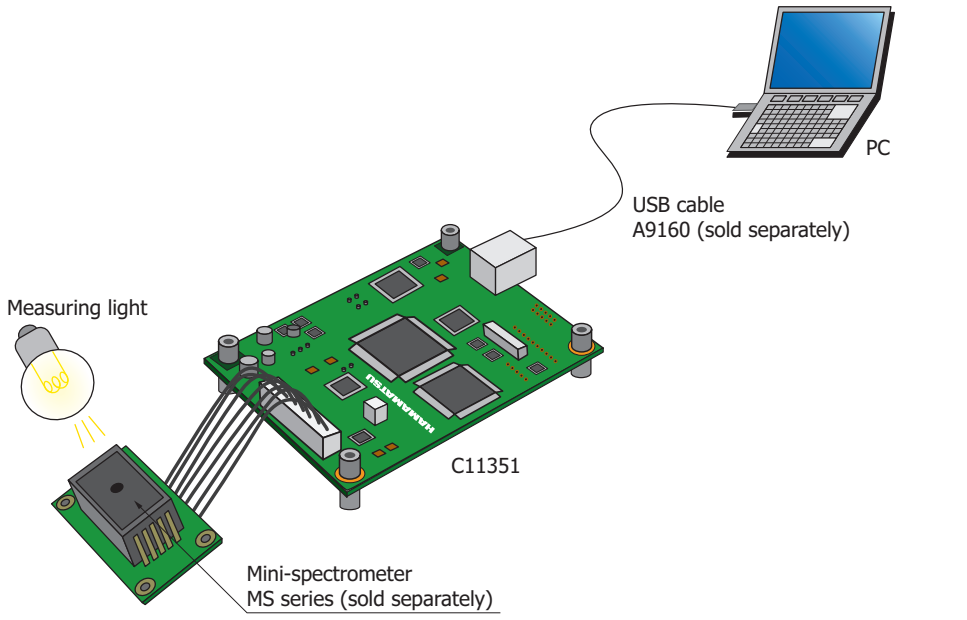
Structure / Absolute maximum ratings

Parameter		Specification	Unit
Applicable mini-spectrometer		C10988MA-01, C11708MA	-
Dimensions	Control board	80 × 60	mm
	Sensor board	30 × 44	mm
Operation 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



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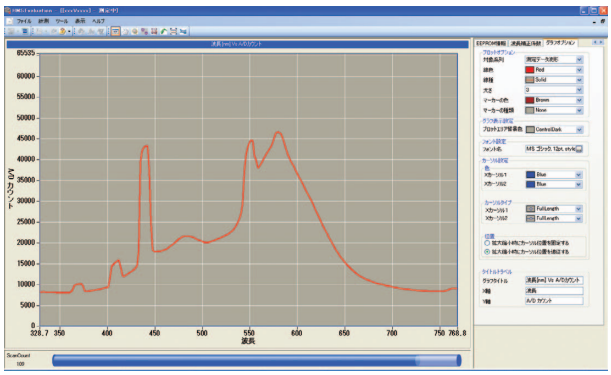
Evaluation software



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	200 to 800	1*	Back-thinned CCD image sensor
C10082MD	TM-UV/VIS-MOS Wide dynamic range	200 to 800	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	320 to 1000	1* (λ=320 to 900 nm)	Back-thinned CCD image sensor
C10083MD	TM-VIS/NIR-MOS Wide dynamic range	320 to 1000	8	CMOS linear image sensor
C11697MB	TM-VIS/NIR-MOS-II Trigger-compatible	320 to 1000	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	200 to 400	1*	Back-thinned CCD image sensor
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)	900 to 1700	7	InGaAs linear image sensor
C9914GB	TG-cooled NIR-II Low noise (cooled type)	1100 to 2200	8	InGaAs linear image sensor
C11118GA	TG-cooled NIR-III Low noise (cooled type)	900 to 2550	20	InGaAs linear image sensor
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*	High-sensitivity CMOS linear image sensor
C13555MA	TF-VIS-MOS-II Compact, thin case	340 to 830	3	High-sensitivity CMOS linear image sensor
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	Micro-spectrometer / Spectrometer head	340 to 850	15	High-sensitivity CMOS linear image sensor

Related information

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

■ Precautions
・Disclaimer

■ Technical information
・Mini-spectrometers

Information described in this material is current as of February, 2016.
Product specifications are subject to change without prior notice due to improvements or other reasons. This document has been carefully prepared and the information contained is believed to be accurate. In rare cases, however, there may be inaccuracies such as text errors. Before using these products, always contact us for the delivery specification sheet to check the latest specifications.
The product warranty is valid for one year after delivery and is limited to product repair or replacement for defects discovered and reported to us within that one year period. However, even if within the warranty period we accept absolutely no liability for any loss caused by natural disasters or improper product use.
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HAMAMATSU www.hamamatsu.com

HAMAMATSU PHOTONICS K.K., Solid State Division
1126-1 Ichino-cho, Higashi-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, N.J. 08807, U.S.A., Telephone: (1) 908-231-0960, Fax: (1) 908-231-1218
Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49) 8152-375-0, Fax: (49) 8152-265-8
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
United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, United Kingdom, Telephone: (44) 1707-294888, Fax: (44) 1707-325777
North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46) 8-509-031-00, Fax: (46) 8-509-031-01
Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy, Telephone: (39) 02-93581733, Fax: (39) 02-93581741
China: Hamamatsu Photonics (China) Co., Ltd.: B1201, Jiaming Center, No.27 Dongsanhuan Beilu, Chaoyang District, Beijing 100020, China, Telephone: (86) 10-6586-6006, Fax: (86) 10-6586-2866

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