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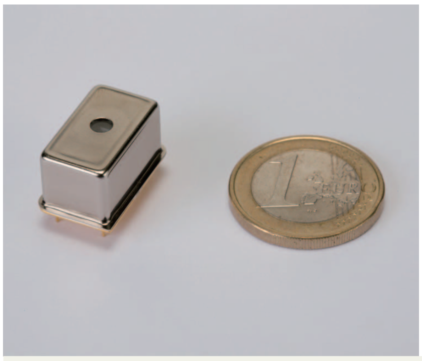


Micro-spectrometer

C12880MA

Finger-tip sized, ultra-compact spectrometer head supporting high sensitivity and long wavelength region

The C12880MA is a high-sensitivity, ultra-compact (finger-tip sized) spectrometer head that supports the long wavelength region (up to 850 nm). Hermetically sealed packaging provides improved humidity resistance. This product is suitable for integration into a variety of compact devices.

Features

- **Finger-tip size: 20.1 × 12.5 × 10.1 mm**
- **Weight: 5 g**
- **Spectral response range: 340 to 850 nm**
- **High sensitivity**
- **Spectral resolution: 15 nm max.**
- **Supports synchronized integration (electronic shutter function)**
- **Hermetic package: high reliability against humidity**
- **For integration into mobile measurement equipment**
- **Wavelength conversion factors*1 are listed on final inspection sheet.**

Applications

- **Food inspection**
- **Biometry (POC)**
- **Tester for lights, LEDs, etc.**
- **Water quality control monitors and other environment measuring instruments**
- **Various light level measurements**

*1: Conversion factors 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.

Structure

Parameter	Specification	Unit
Image sensor	High-sensitivity CMOS linear image sensor with slit	-
Number of pixels	288	pixels
Pixel size (H × V)	14 × 200	μm
Slit*2 (H × V)	50 × 500	μm
NA*3	0.22	-
Dimensions (W × D × H)	20.1 × 12.5 × 10.1	mm
Weight	5	g

*2: Entrance slit aperture size
*3: Numeric aperture (solid angle)

Absolute maximum ratings (Ta=25 °C unless otherwise noted)

Parameter	Symbol	Condition	Value	Unit
Supply voltage	Vs max		-0.3 to +6	V
Clock pulse voltage	V(CLK)		-0.3 to +6	V
Start pulse voltage	V(ST)		-0.3 to +6	V
Operating temperature	Topr	No dew condensation*4	+5 to +50	°C
Storage temperature	Tstg	No dew condensation*4	-20 to +70	°C

*4: 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.

Recommended terminal voltage (Ta=25 °C)

Parameter		Symbol	Min.	Typ.	Max	Unit
Supply voltage		Vs	4.75	5	5.25	V
Clock pulse voltage	High level	V(CLK)	Vs - 0.25	Vs	Vs + 0.25	V
	Low level		0	-	0.3	
Start pulse voltage	High level	V(ST)	Vs - 0.25	Vs	Vs + 0.25	V
	Low level		0	-	0.3	

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

Parameter	Symbol	Min.	Typ.	Max	Unit
Clock pulse frequency	f(CLK)	0.2	-	5	MHz
Video rate	VR	-	f(CLK)	-	Hz
Output impedance*5	Zo	-	150	-	Ω
Current consumption*6	I	-	20	-	mA

*5: Video signal output terminal (10-pin)
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 to the video output terminal so that the current flow is minimized.
*6: f(CLK)=5 MHz

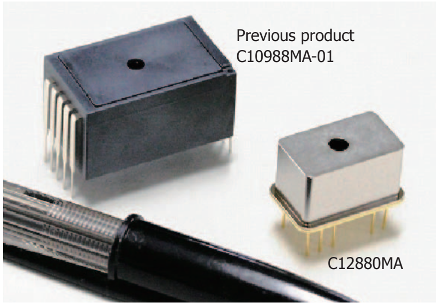
Electrical and optical characteristics [Ta=25 °C, Vs=5 V, V(CLK)=V(ST)=5 V]

Parameter	Symbol	Min.	Typ.	Max	Unit
Conversion efficiency	CE	-	50	-	$\mu V/e^-$
Dark output voltage*7	Vd	-	0.8	-	mV
Saturation output voltage*8	Vsat	-	4.3	-	V
Readout noise	Nr	-	1.8	-	mV rms
Output offset voltage	Vo	0.3	0.5	0.9	V
Spectral response range	λ	-	340 to 850	-	nm
Spectral resolution (FWHM)	-	-	12	15	nm
Wavelength reproducibility*9	λr	-0.5	-	+0.5	nm
Wavelength temperature dependence	λTd	-0.1	-	+0.1	nm/°C
Spectral stray light*10	SL	-	-	-25	dB

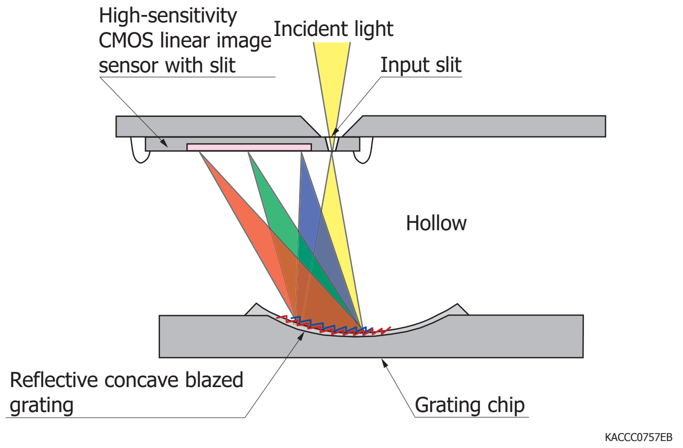
*7: Integration time=10 ms
*8: Relative value in reference to output offset voltage Vo
Example: When output offset voltage Vo is 0.5 V and saturation output voltage Vsat is 4.3 V, the saturation voltage at the video signal output terminal is 4.8 V.
*9: Measured under constant light input conditions
*10: The ratio of the count measured when a light spectrum (655 nm) is input to the count measured at that wavelength ± 40 nm.

Optical component layout

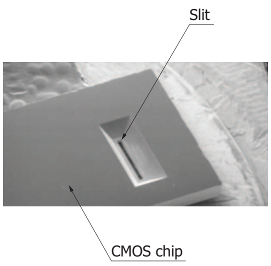
Besides a CMOS image sensor chip integrated with an optical slit by etching technology, the C12880MA employs a reflective concave blazed grating formed by nanoimprint. In addition, the glass used in the light path of the previous C10988MA-01 is not used in the C12880MA, making it extremely compact.



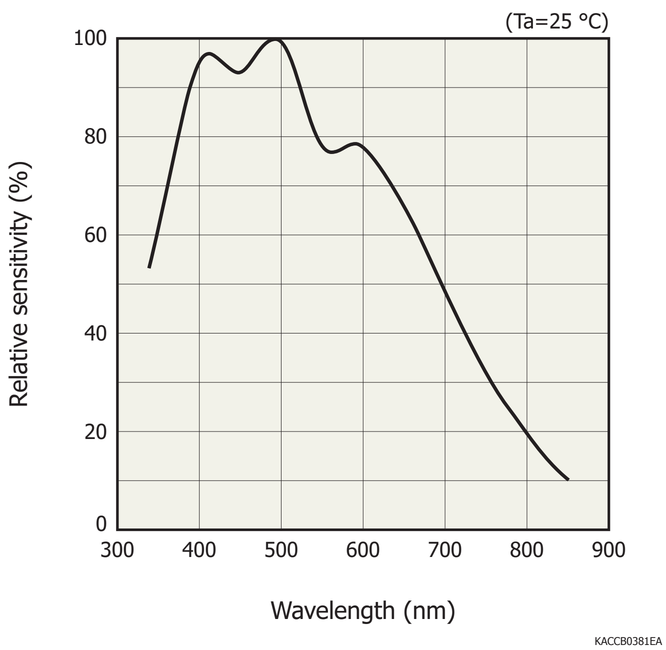
Structure



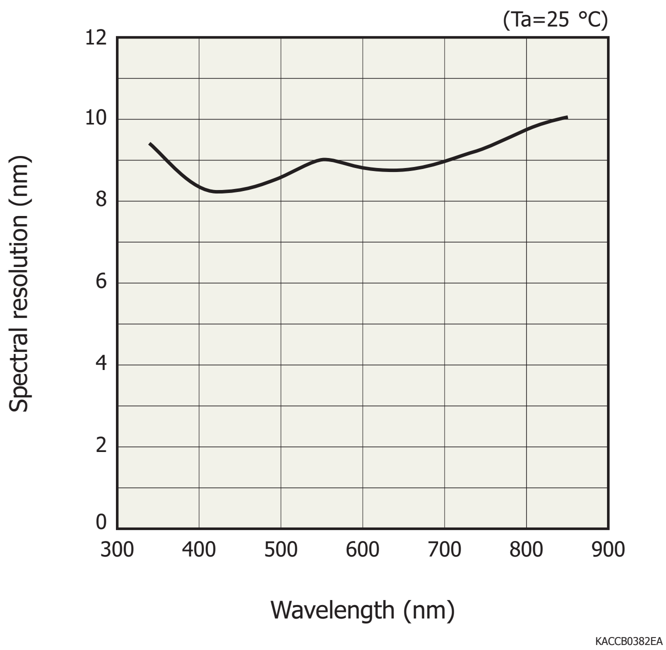
High-sensitivity CMOS linear image sensor with a slit [Incident light side (back of chip)]



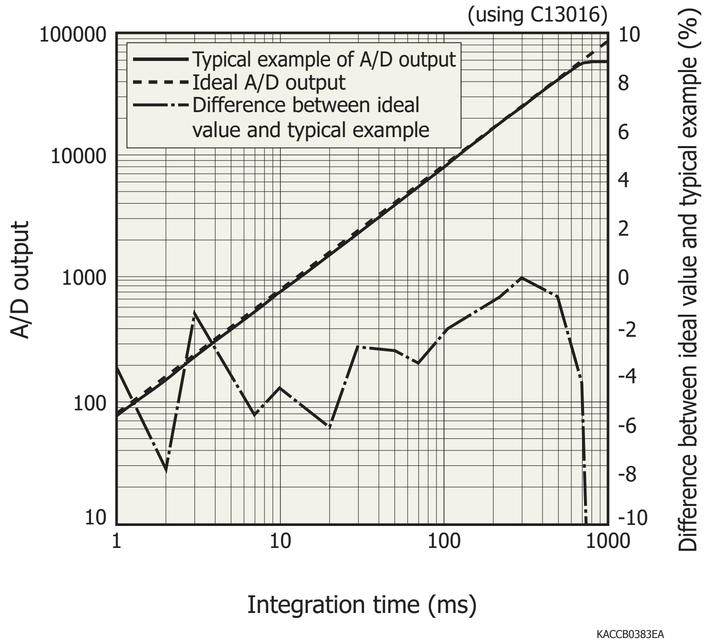
Spectral response (typical example)



Spectral resolution vs. wavelength (typical example)

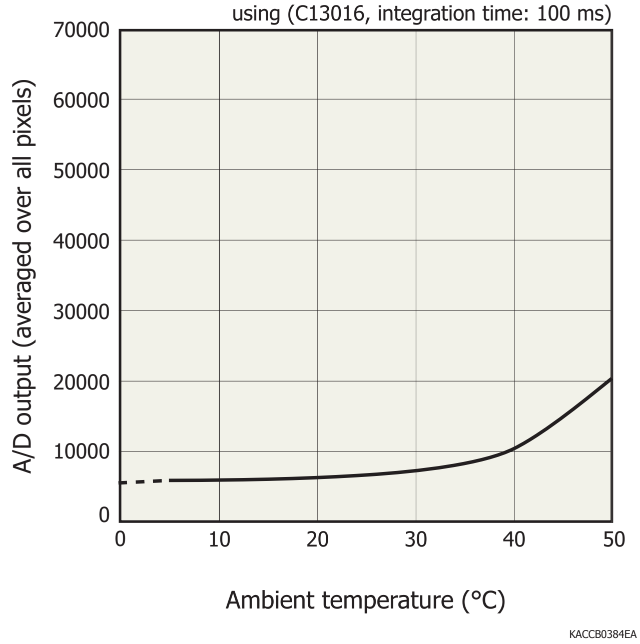


Linearity (typical example)



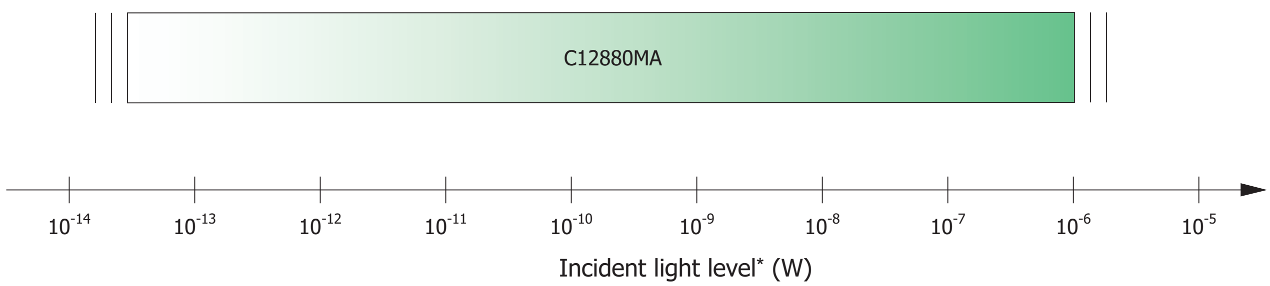
A/D output is the output with dark output is subtracted when light is input. The difference between the ideal value and typical example contains a measurement error. The smaller the A/D output, the larger the measurement error.

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.

Measurable incident light level



* Using C13016, input spot diameter 800 μm (λ=600 nm)

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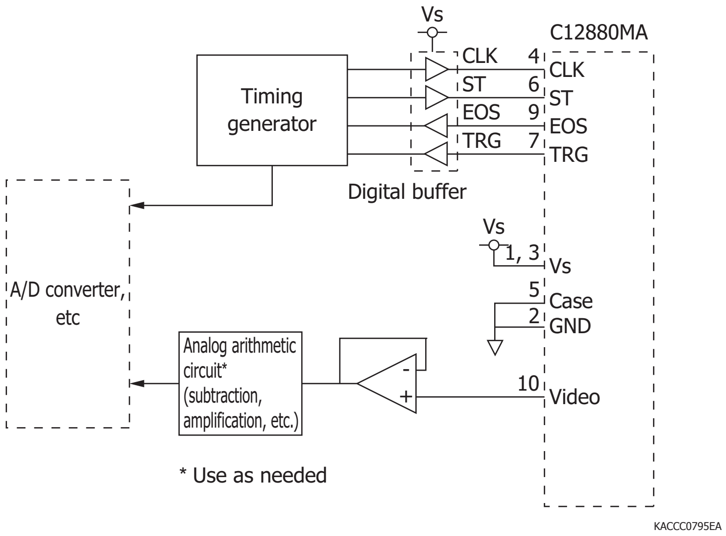
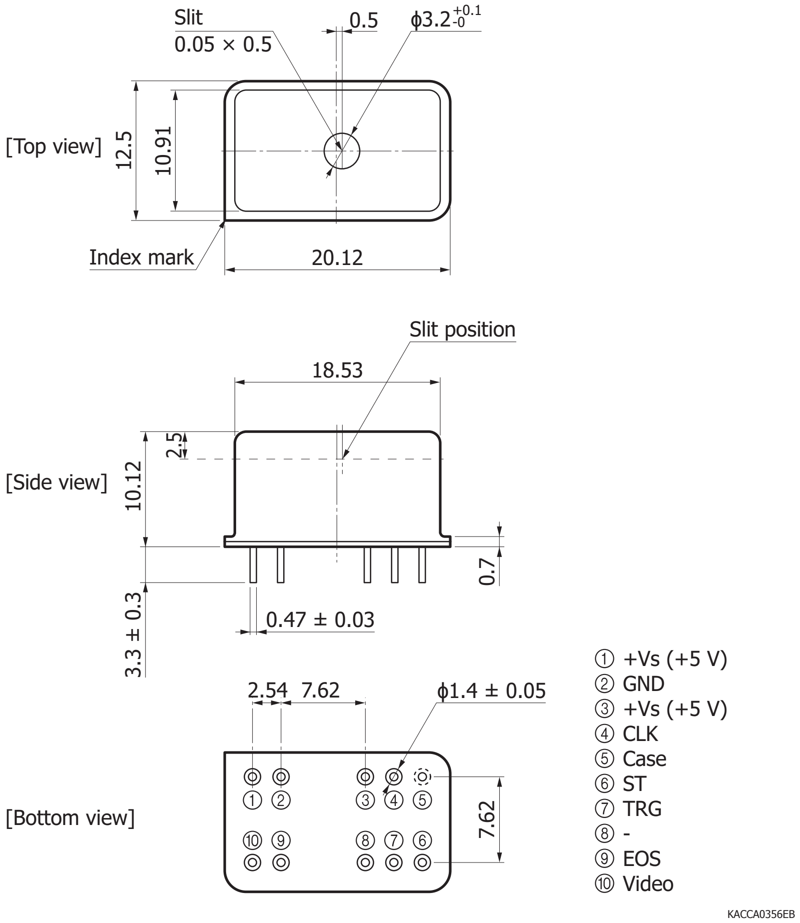
Recommended driver circuit example



Precautions

- The packaging of the C12880MA 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)



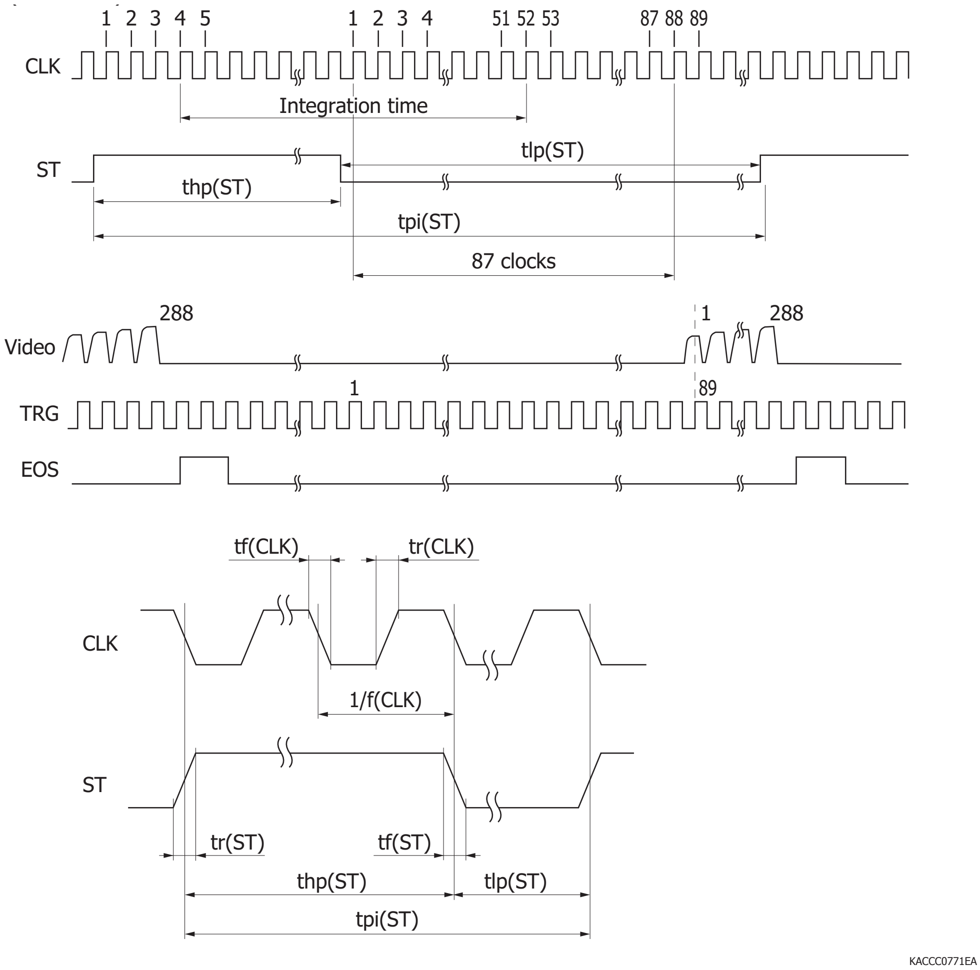
Pin connections

Make electrical connections to an external circuit using leads.

Pin no.	Symbol	Name	I/O	Description
1	+Vs	Supply voltage	I	Sensor power supply: 5 V
2	GND	Ground	-	Sensor ground
3	+Vs	Supply voltage	I	Sensor power supply: 5 V
4	CLK	Clock pulse	I	Sensor clock pulse
5	Case	Case	-	Case connection
6	ST	Start pulse	I	Sensor start pulse
7	TRG	Trigger pulse	O	Pulse for capturing sensor video signals
8	-	Fastening pin	-	Do not connect electrically.
9	EOS	End of scan	O	Sensor scan end
10	Video	Video output	O	Sensor video output

Note: Pin no. 5 and the case of the micro-spectrometer are at the same potential. Ensure that the case is not in contact with other potentials during use. Parts coming in contact with the case must be set at the same potential as pin no. 5 or insulated from other potentials.

Timing chart



Parameter	Symbol	Min.	Typ.	Max.	Unit
Start pulse cycle*11	tpi(ST)	381/f(CLK)	-	-	s
Start pulse high period*12	thp(ST)	6/f	-	-	s
Start pulse low period	tlp(ST)	375/f	-	-	s
Start pulse rise and fall times	tr(ST), tf(ST)	0	10	30	ns
Clock pulse duty	-	45	50	55	%
Clock pulse rise and fall times	tr(CLK), tf(CLK)	0	10	30	ns

*11: The shortest period required to output the video signals from all pixels.
*12: The integration time equals the high period of ST plus 48 CLK cycles.
The shift register starts operation at the rising edge of CLK immediately after ST goes low.
The integration time can be changed by changing the ratio of the high and low periods of ST.
If the first TRG pulse after ST goes low is counted as the first pulse, the Video signal should be acquired at the rising edge of the 89th TRG pulse.

Operation example

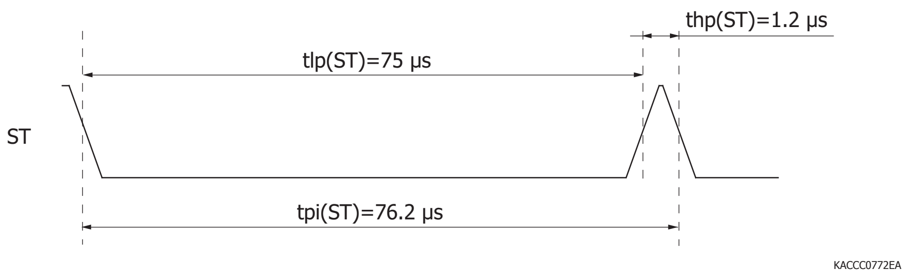
This is an operating example when the clock pulse frequency is set to maximum (video data rate is also set to maximum), the time per scan to minimum, and the integration time to maximum.

· Clock pulse frequency [f(CLK)] = Video data rate
= 5 MHz

· Start pulse cycle [tpi(ST)] = 381/f(CLK)
= 381/5 MHz
= 76.2 μs

· Low period of start pulse min. [tlp(ST)] = 375/f(CLK)
= 375/5 MHz
= 75 μs

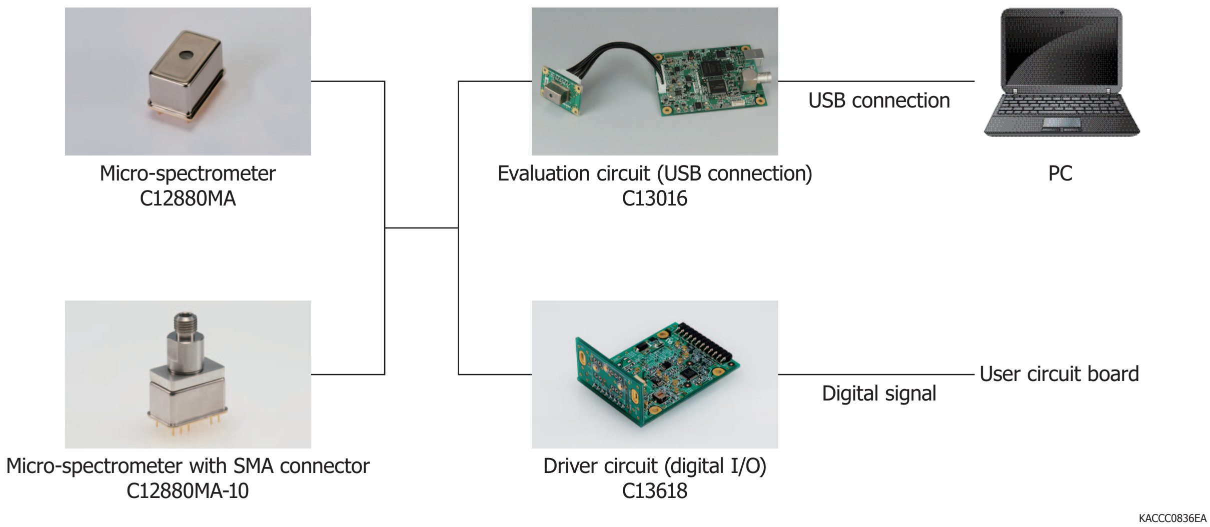
· High period of start pulse [thp(ST)] = Start pulse cycle [tpi(ST)] - Low period of start pulse min. [tlp(ST)]
= 76.2 μs - 75 μs
= 1.2 μs



Integration time is equal to the high period of start pulse + 48 cycles of clock pulses, so it will be 1.2 μs + 9.6 μs = 10.8 μs.

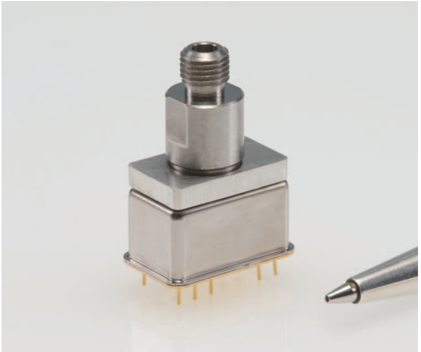
Selection chart

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

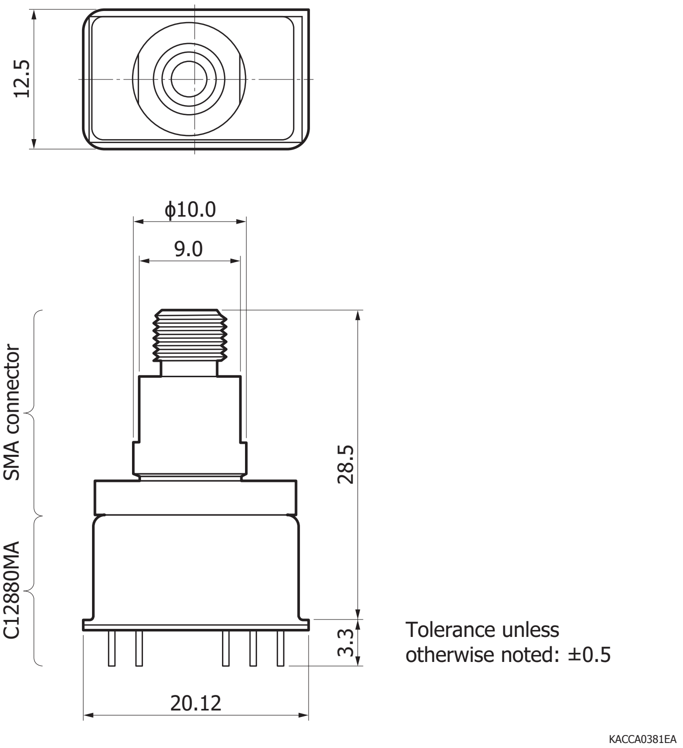


Micro-spectrometer with SMA connector C12880MA-10

The C12880MA-10 is a product in which an SMA connector is attached to the C12880MA. 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 C12880MA-10 is the same as those of the C12880MA except the connector section.



Dimensional outline (unit: mm)

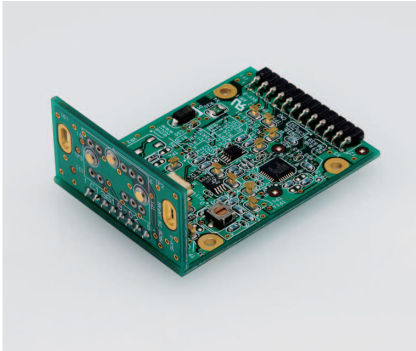


Options

Product name	Type no.	Core diameter (µm)	Specification
Fiber for UV/visible range (resistance to UV)	A9762-01	600	NA=0.22, length=1.5 m With SMA905D connector on each end
	A9762-05	400	

Driver circuit for micro-spectrometer C13618

The C13618 is a driver circuit that the C12880MA or C12880MA-10 can be mounted on. It has an A/D converter that can be used to obtain digital data (16-bit) by applying an external power supply and drive signal. Using this driver circuit with the user's circuit board having LVDS level and 3.3 V level I/O ports eliminates the need for designing analog circuits and video output conversion circuits.



Structure

Parameter	Specification	Unit
Applicable micro-spectrometers (sold separately)	C12880MA, C12880MA-10	-
A/D converter	AD7961 by Analog Devices	-
I/O terminal	Connector 801-87-012-20-002101 by PRECI-DIP	-
Number of I/O terminals	12	-
Dimensions	55 × 40 × 21.6	mm
Weight	14.3	g

Absolute maximum ratings

Parameter	Symbol	Condition	Value	Unit
Operating temperature	Topr	No dew condensation*13	+5 to +40	°C
Storage temperature	Tstg	No dew condensation*13	-20 to +70	°C

*13: 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.

Electrical characteristics (Ta=25 °C, Vs=SENSOR_ST=SENSOR_CLK=3.3 V)

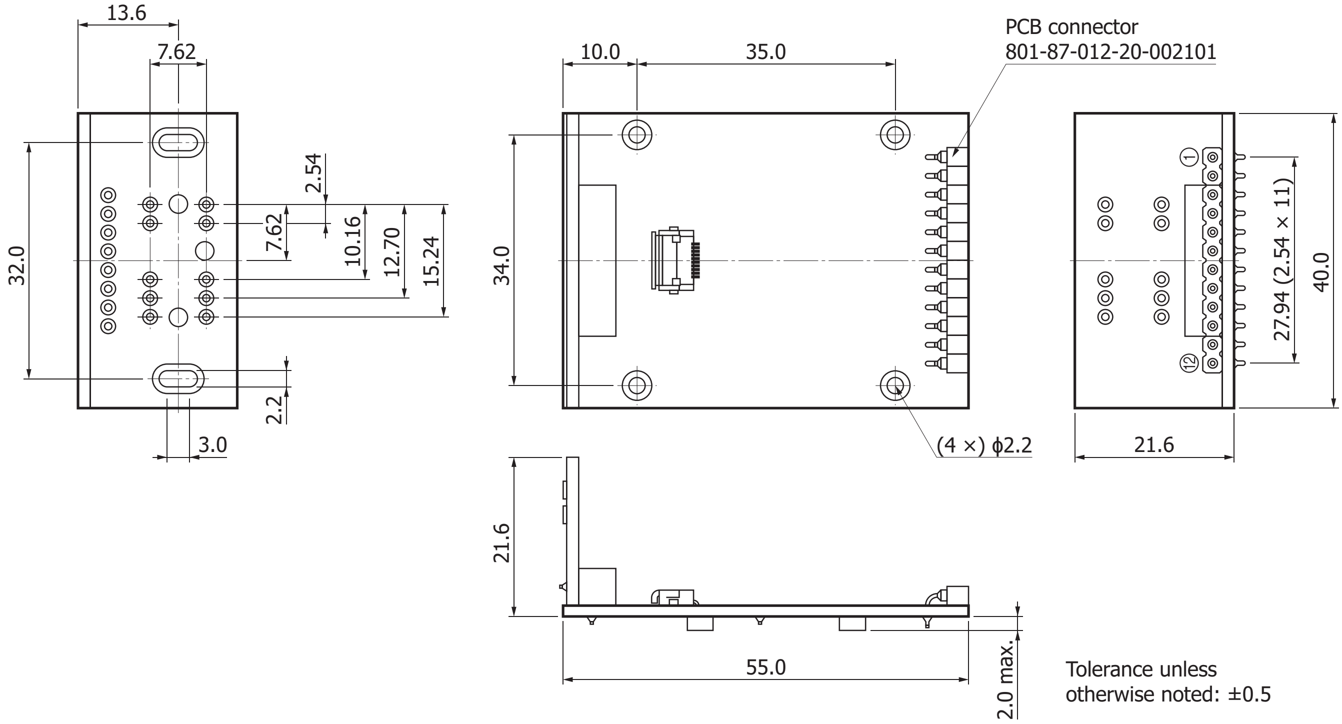
Parameter	Symbol	Min.	Typ.	Max.	Unit
Sensor clock frequency	SENSOR_CLK	0.2	-	5	MHz
A/D converter clock frequency	AD_CLK	-	250	300	MHz
Current consumption	Ic	-	150	200	mA

Recommended operating conditions (Ta=25 °C)

Parameter		Symbol	Min.	Typ.	Max.	Unit
Power supply		Vs	3.15	3.3	3.45	V
Sensor clock input signal	High level	SENSOR_CLK	3.15	3.3	3.45	V
	Low level		0	-	0.3	
Sensor start input signal	High level	SENSOR_ST	3.15	3.3	3.45	V
	Low level		0	-	0.3	
A/D converter output signal*14	Input voltage range	AD_CLK+, AD_CLK-	0.8	-	1.575	V
	Differential input voltage		0.1	-	0.65	

*14: AD_CLK+ and AD_CLK- are a pair of LVDS signals.

Dimensional outline (unit: mm)

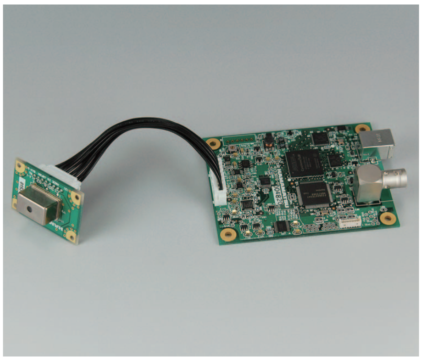


Pin connections

Pin no.	Symbol	Input/Output	Function
1	Vs	Input	Supply voltage
2	NC	-	-
3	SENSOR_CLK	Input	Clock pulse for C12880MA and C12880MA-10
4	SENSOR_ST	Input	Start pulse for C12880MA and C12880MA-10
5	SENSOR_TRG	Output	Trigger pulse for C12880MA and C12880MA-10
6	AD_CLK+	Input	Clock pulse for A/D converter
7	AD_CLK-		
8	AD_DCO+	Output	Buffered clock pulse of A/D converter
9	AD_DCO-		
10	AD_D+	Output	Data of A/D converter
11	AD_D-		
12	GND	-	Ground

Micro-spectrometer evaluation circuit C13016 (sold separately)

The C13016 is a circuit board designed to simply evaluate the characteristics of the micro-spectrometer C12880MA. The characteristics of the C12880MA can be evaluated using the evaluation software by connecting the C12880MA to a PC with a USB cable A9160 (AB type, sold separately)*15.



Features

- **Initial evaluation circuit for micro-spectrometer C12880MA**
- **Wavelength conversion factors of the micro-spectrometer can be input from a PC.*16**
- **High A/D resolution (16-bit)**
- **USB powered**

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

*16: Typical wavelength conversion factors are entered at the time of shipment of the C13016. To measure a spectrum with higher wavelength accuracy, it is necessary to input the wavelength conversion factors listed in the final inspection sheet that comes with each micro-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	5	MHz
Video rate	5	MHz
Integration time	11 to 1000000	μs

Structure

Parameter		Specification	Unit
Applicable spectrometer		C12880MA	-
Dimensions	Control board	90 × 70	mm
	Sensor board	30 × 44	mm

Absolute maximum ratings

Parameter	Condition	Value	Unit
Operating temperature	No dew condensation*17	+5 to +40	°C
Storage temperature	No dew condensation*17	-20 to +70	°C

*17: 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.

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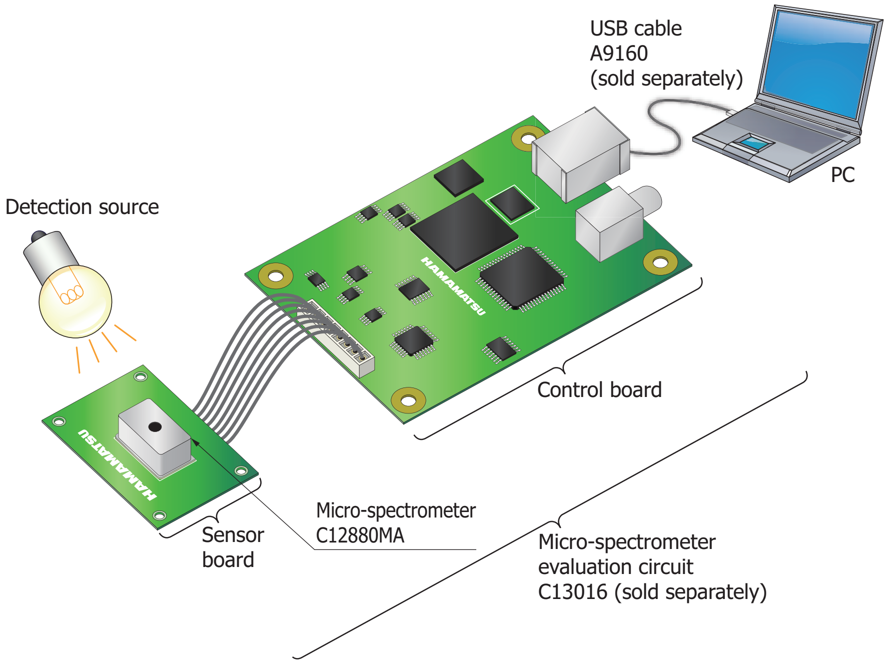
Connection example



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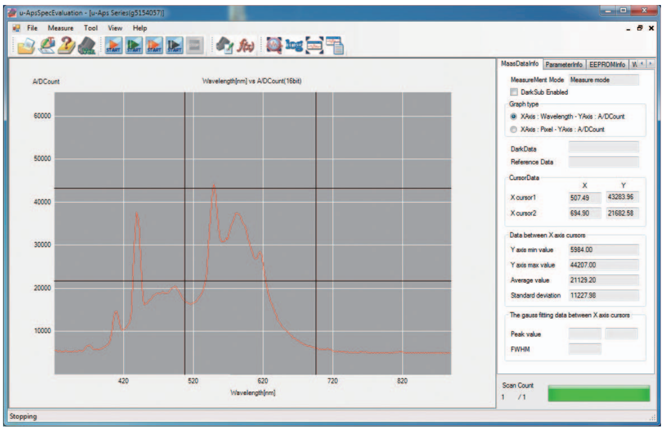
Evaluation software display example



Mini-spectrometer/micro-spectrometer lineup

Type no.	Series	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	Mini-spectrometer TM series	TM-UV/VIS-CCD High resolution	200 to 800	1*	Back-thinned CCD image sensor
C10082MD	Mini-spectrometer TM series	TM-UV/VIS-MOS Wide dynamic range	200 to 800	6	CMOS linear image sensor
C10083CA	Mini-spectrometer TM series	TM-VIS/NIR-CCD High sensitivity	320 to 1000	8 (λ=320 to 900 nm)	Back-thinned CCD image sensor
C10083CAH	Mini-spectrometer TM series	TM-VIS/NIR-CCD High resolution	320 to 1000	1* (λ=320 to 900 nm)	Back-thinned CCD image sensor
C10083MD	Mini-spectrometer TM series	TM-VIS/NIR-MOS Wide dynamic range	320 to 1000	8	CMOS linear image sensor
C11697MB	Mini-spectrometer TM series	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	Mini-spectrometer TG series	TG-UV-CCD High resolution	200 to 400	1*	Back-thinned CCD image sensor
C9405CB	Mini-spectrometer TG series	TG-SWNIR-CCD-II IR-enhanced	500 to 1100	5 (λ=550 to 900 nm)	IR-enhanced back-thinned CCD image sensor
C11713CA	Mini-spectrometer TG series	TG-RAMAN-I High resolution	500 to 600	0.3*	Back-thinned CCD image sensor
C11714CB	Mini-spectrometer TG series	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	Mini-spectrometer TG series	TG-cooled NIR-I Low noise (cooled type)	900 to 1700	7	InGaAs linear image sensor
C9914GB	Mini-spectrometer TG series	TG-cooled NIR-II Low noise (cooled type)	1100 to 2200	8	InGaAs linear image sensor
C11118GA	Mini-spectrometer TG series	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	Mini-spectrometer TF series	TF-RAMAN Compact, thin case	790 to 920	0.4*	High-sensitivity CMOS linear image sensor
C13555MA	Mini-spectrometer TF series	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	Mini-spectrometer RC series	RC-SWNIR-MOS Spectrometer module	640 to 1050	8	IR-enhanced CMOS linear image sensor

* Typ.

For installation into mobile measuring equipment

Type no.	Series	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	Mini-spectrometer RC series	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.	Series	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 series	Spectrometer head	340 to 780	15	CMOS linear image sensor
C12880MA	Micro-spectrometer series	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

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