

Mini-spectrometer

[TG series]

C9405CB



Enhanced near infrared sensitivity type

The C9405CB is a polychromator integrated with optical elements, an image sensor and a driver circuit. Light to be measured is guided into the entrance port of TG series through an optical fiber and the spectrum measured with the built-in image sensor is output from the USB port to a PC for data acquisition. Compared to the previous product, the C9405CB delivers even higher sensitivity in the near infrared region because it uses a back-thinned CCD image sensor with enhanced near infrared sensitivity. The C9405CB comes supplied with free evaluation software that allows setting measurement conditions, acquiring and saving data, and displaying graphs. Original measurement software can be designed on an end-user's side as DLL's function specification is disclosed.

Features

- **Enhanced near infrared sensitivity: about twice higher than previous type**
- **Improved etaloning characteristics**
- **High throughput due to transmission grating made of quartz**
- **Easy to install into equipment**
- **Wavelength conversion factor is recorded in internal memory*1**
- **Accepts external trigger input**

Applications

- **Detection of saccharic acids in foods**
- **Film thickness meter**

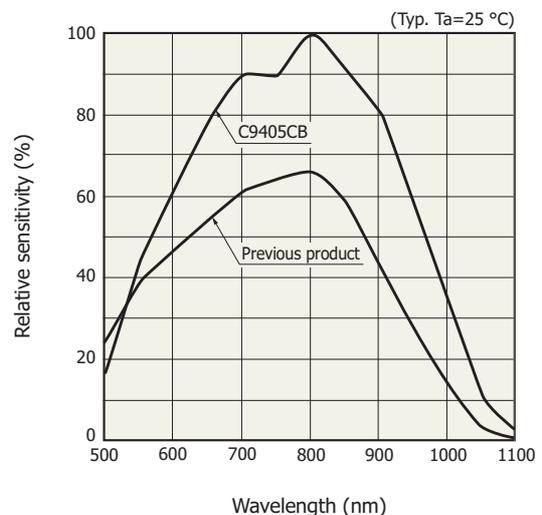
*1: A conversion factor for converting the image sensor pixel number into a wavelength is recorded in the module. A calculation factor for converting the A/D converted count into the input light intensity is not provided.

High sensitivity in near infrared region

Using a CCD image sensor with enhanced near infrared sensitivity, the C9405CB offers high sensitivity in the near infrared region, which is about 2 times higher than the previous product.

In particular, high sensitivity at wavelengths longer than 800 nm makes the C9405CB suitable for measurement of brix (sugar concentrations) and acidity in foods, where sensitivity from 800 to 1000 nm is required.

☑ Spectral response



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Optical characteristics

Parameter	Specification	Unit
Spectral response range	500 to 1100	nm
Spectral resolution (FWHM) ^{*2}	5 max. ($\lambda=550$ to 900 nm)	nm
Wavelength reproducibility ^{*3}	-0.2 to +0.2	nm
Wavelength temperature dependence	-0.02 to +0.02	nm/°C
Spectral stray light ^{*2 *4}	-35 max.	dB

*2: Depends on the slit opening. Values were measured with the slit listed in the table "Structure".

*3: Measured under constant light input conditions

*4: When monochromatic light of 800 nm 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.

Note: The C9405CB generates high-order light due to the structure, because the following condition is met:

$$\frac{\text{Upper limit of spectral response range}}{\text{Lower limit of spectral response range}} > 2$$

To eliminate this high-order light, use a long-pass filter with the C9405CB as needed.

Electrical characteristics

Parameter	Specification	Unit
A/D conversion	16	bit
Integration time	10 to 10000	ms
Interface	USB 1.1	-
Consumption current of USB bus power	150 max.	mA
External power supply	5	V
Consumption current of external power supply	0.8 max.	A

Structure

Parameter	Specification	Unit
Dimensions (W × D × H)	125.7 × 115.7 × 75	mm
Weight	670	g
Image sensor	IR-enhanced back-thinned type CCD image sensor (S11510-1006)	-
Number of pixels	1024	pixels
Slit ^{*5} (H × V)	70 × 800	μm
NA ^{*6}	0.22	-
Connector for optical fiber	SMA905D	-

*5: Entrance slit aperture size

*6: Numeric aperture (solid angle)

Absolute maximum ratings

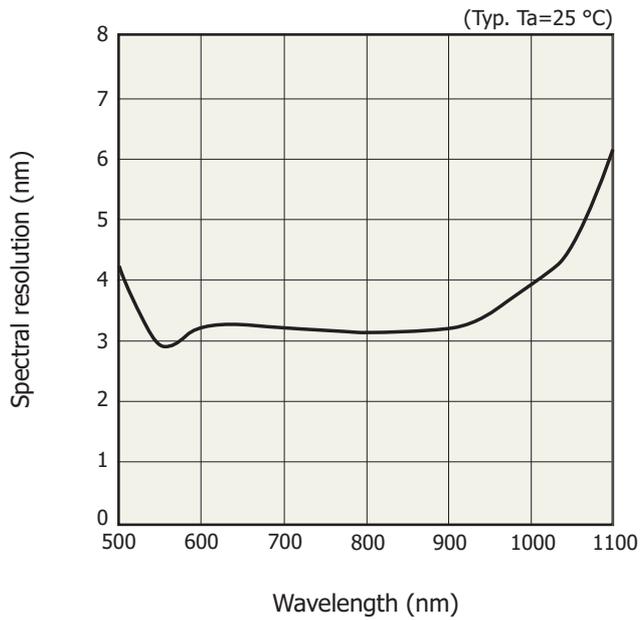
Parameter	Value	Unit
Operating temperature ^{*7}	+5 to +40	°C
Storage temperature ^{*7}	-20 to +70	°C

*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.

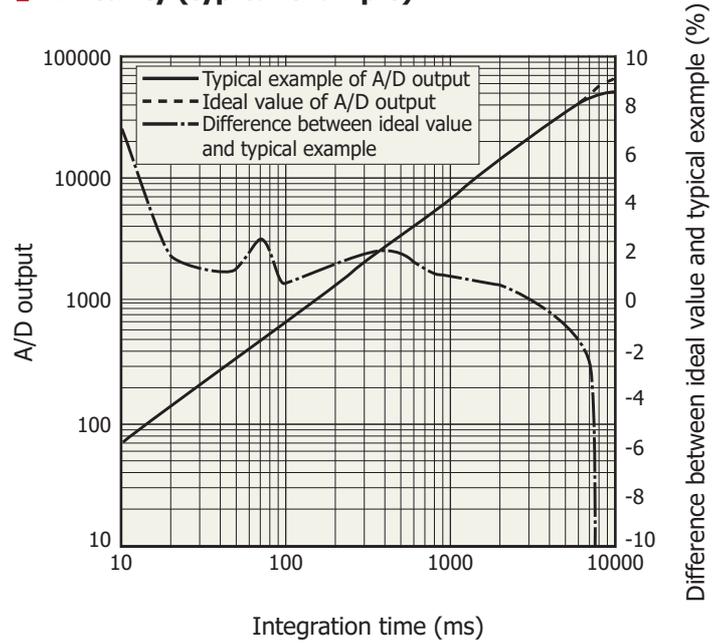
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.

Spectral resolution vs. wavelength



KACCB0220EA

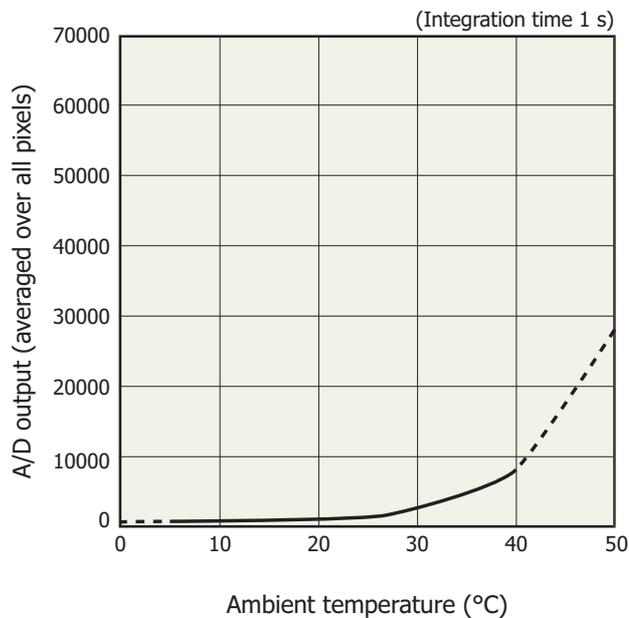
Linearity (typical example)



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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 (typical example)

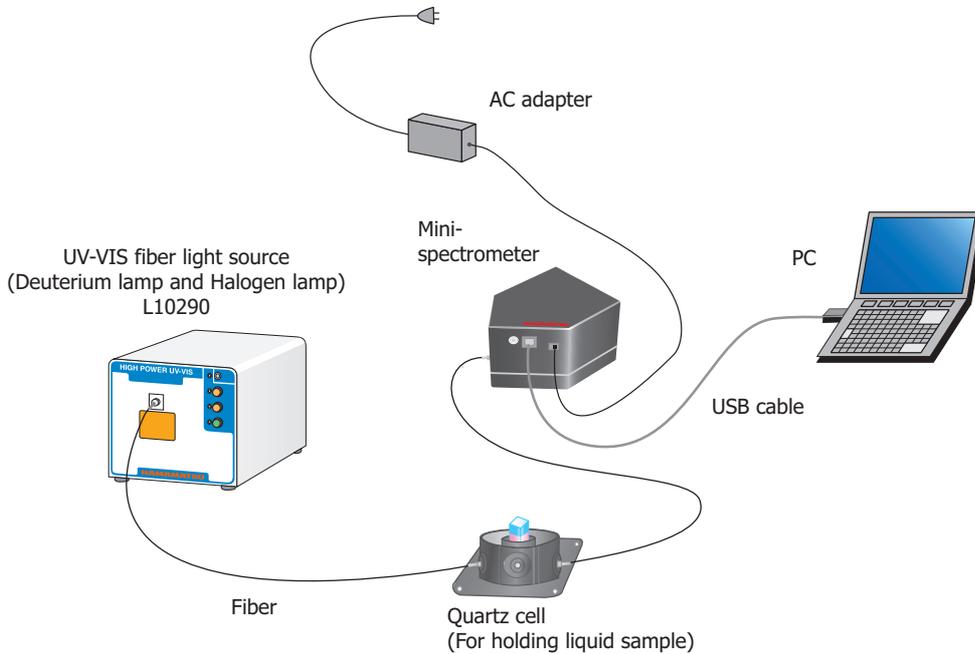


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A/D output is the sum of the sensor and circuit offset outputs and the sensor dark output.

Connection example (transmission light measurement)

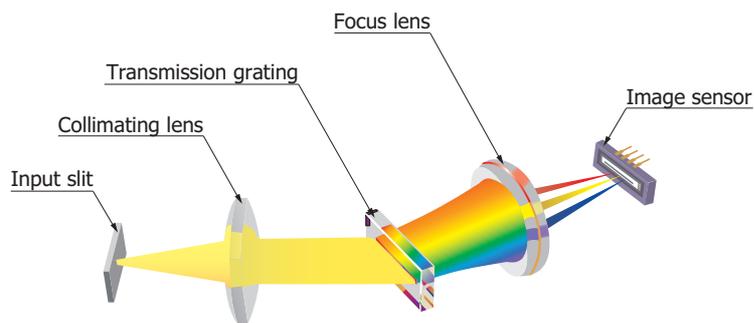
Light to be measured is guided into the entrance port of TG series through an optical fiber and the spectrum measured with the built-in image sensor is output through the USB port to a PC for data acquisition. There are no moving parts inside the unit so stable measurements are obtained at all times. An optical fiber that guides light input from external sources allows a flexible measurement setup.



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Optical component layout

TG series mini-spectrometers use a transmission holographic grating made of quartz and precision optical components arranged on a rugged optical base, making it possible to deliver high throughput and highly accurate optical characteristics.



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❑ Evaluation software package (supplied with unit)

Installing the evaluation software package (Spec Evaluation.exe)*8 into your PC allows running the following basic tasks:

- Measurement data acquisition and save
- Measurement condition setup
- Module information acquisition
(wavelength conversion factor, polychromator type, etc.)
- Graphic display
- Arithmetic operation
 - Pixel number to wavelength conversion
 - Comparison calculation with reference data
(transmittance, reflectance)
 - Dark subtraction
 - Gaussian approximation
(peak position and count, FWHM)

Note:

- Two or more mini-spectrometers can be connected and used with one PC simultaneously.
- The external trigger input function does not work with the evaluation software. If using an external trigger input or designing original application software, the user software must be configured to support that function.

*8: Compatible OS: Microsoft® Windows® 7 Professional SP1 (32-bit, 64-bit)
 Microsoft Windows 8 Professional (32-bit, 64-bit)
 Microsoft Windows 10 Professional (32-bit, 64-bit)

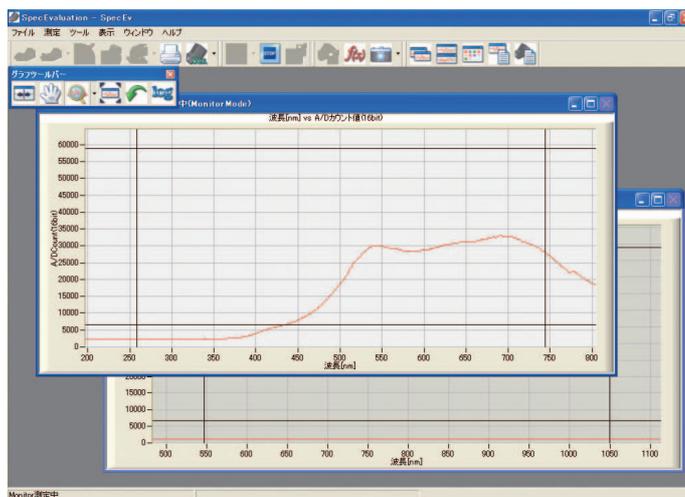
DLL for controlling hardware is also provided.

You can develop your own measurement programs by using a following software development environment.

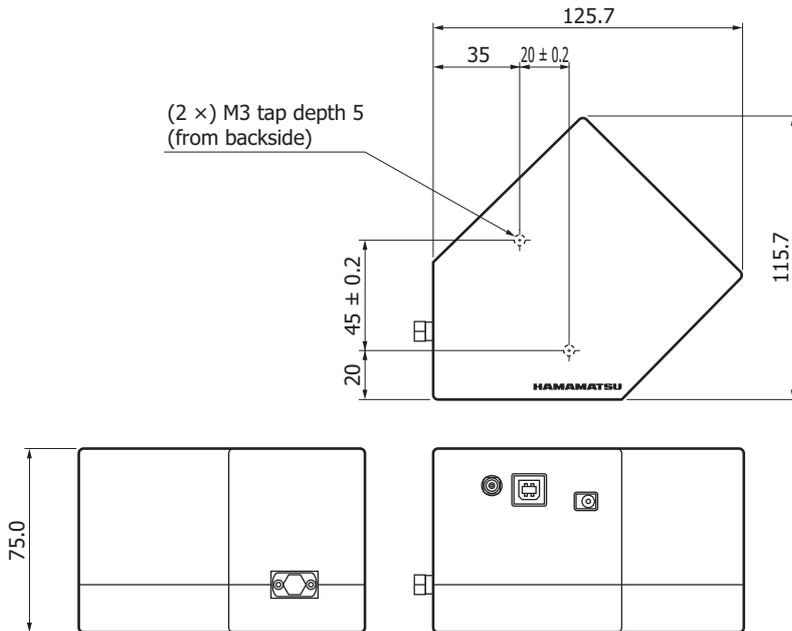
Microsoft Visual Studio® 2008 (SP1) Visual C++®

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 other countries.



Dimensional outline (unit: mm)



Tolerance unless otherwise noted: ±0.5
Weight: 670 g

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Accessories

- USB cable
- Dedicated software (evaluation software, sample software, DLL)
- AC adapter (for power supply)

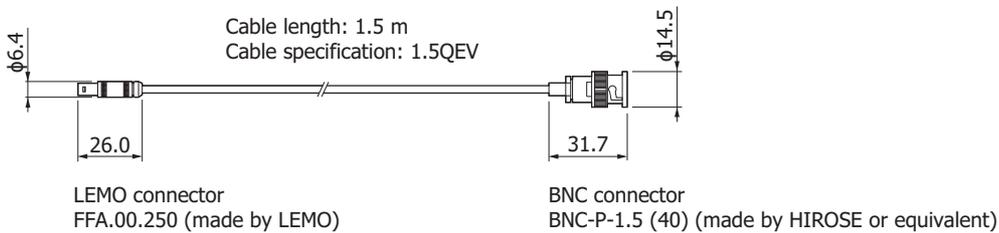
Options (sold separately)

- Optical fiber for light input

Type no	Product name	Applicable mini-spectrometer	Core diameter (μm)	Specification
A9763-01	Fiber for visible/near infrared range	C9405CB (TG-SWNIR-CCD-II)	600	NA=0.22, length 1.5 m, connectorized SMA905D at both ends

- Coaxial cable for external trigger input A10670

Dimensional outline (unit: mm)



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Mini-spectrometer lineup

Type no.	Type	Spectral response range (nm)													Spectral resolution max. (nm)	Image sensor		
		200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600				
C10082CA	TM-UV/VIS-CCD High sensitivity																6	Back-thinned CCD image sensor
C10082CAH	TM-UV/VIS-CCD High resolution		200 to 800														1*	
C10082MD	TM-UV/VIS-MOS Wide dynamic range																6	CMOS linear image sensor
C10083CA	TM-VIS/NIR-CCD High sensitivity																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	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																5 (λ=550 to 900 nm)	IR-enhanced back-thinned CCD image sensor
C11713CA	TG-RAMAN-I High resolution																0.3*	Back-thinned CCD image sensor
C11714CB	TG-RAMAN-II High resolution																0.3*	IR-enhanced back-thinned CCD image sensor
C11482GA	TG2-NIR Non-cooled type																7	InGaAs linear image sensor
C9913GC	TG-cooled NIR-I Low noise (cooled type)																7	
C9914GB	TG-cooled NIR-II Low noise (cooled type)																8	
C11118GA	TG-cooled NIR-III Low noise (cooled type)																20	
C13053MA	TF-SWIR-MOS-II Compact, thin case																3.5	High-sensitivity CMOS linear image sensor
C13054MA	TF-RAMAN Compact, thin case																0.4*	
C13555MA	TF-VIS-MOS-II Compact, thin case																3	
C11007MA	RC-VIS-MOS Spectrometer module																9	CMOS linear image sensor
C11008MA	RC-SWNIR-MOS Spectrometer module																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		
		200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600				
C11009MA	RC-VIS-MOS Spectrometer head																9	CMOS linear image sensor
C11010MA	RC-SWNIR-MOS Spectrometer head																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		
		200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600				
C11708MA	MS-SWNIR-MOS Spectrometer head																20	CMOS linear image sensor
C12666MA	Spectrometer head																15	CMOS linear image sensor
C12880MA	Spectrometer head																15	High-sensitivity CMOS linear image sensor

Related information

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

■ Precautions

- Disclaimer
- Mini-spectrometers

■ Technical information

- Mini-spectrometers

Information described in this material is current as of December 2017.

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