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Mini-spectrometer

[**TG series**] | C9405CC

Enhanced near infrared sensitivity type

The C9405CC 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 C9405CC delivers even higher sensitivity in the near infrared region because it uses a back-thinned CCD image sensor with enhanced near infrared sensitivity. The C9405CC 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**

[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.

Applications

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

High sensitivity in near infrared region

Using a CCD image sensor with enhanced near infrared sensitivity, the C9405CC 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 C9405CC suitable for measurement of brix (sugar concentrations) and acidity in foods, where sensitivity from 800 to 1000 nm is required.

⊠ **Spectral response**

(Typ. Ta=25 °C)
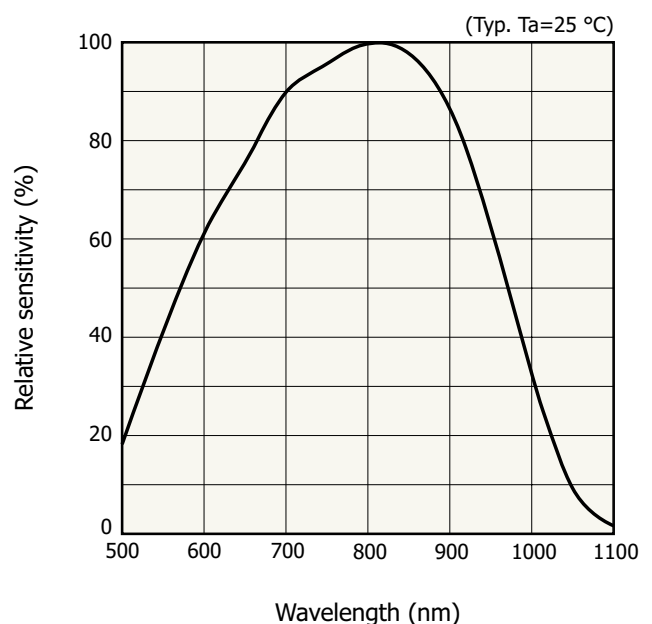
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Optical characteristics

Parameter		Specification	Unit
Spectral response range		500 to 1100	nm
Spectral resolution (FWHM)*2	Typ.	4 (λ=550 to 900 nm)	nm
	Max.	5 (λ=550 to 900 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 C9405CC 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 C9405CC 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 (S16010-1006)	-
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

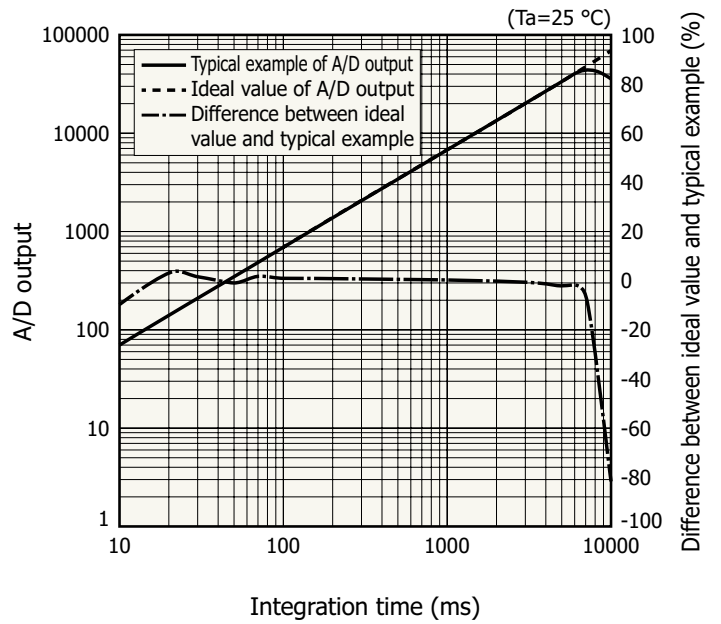| Parameter	Value	Unit
Operating temperature*7	+5 to +40	°C
Storage temperature*7	-20 to +70	°C

*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.

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Spectral resolution vs. wavelength

(Typ. Ta=25 °C)

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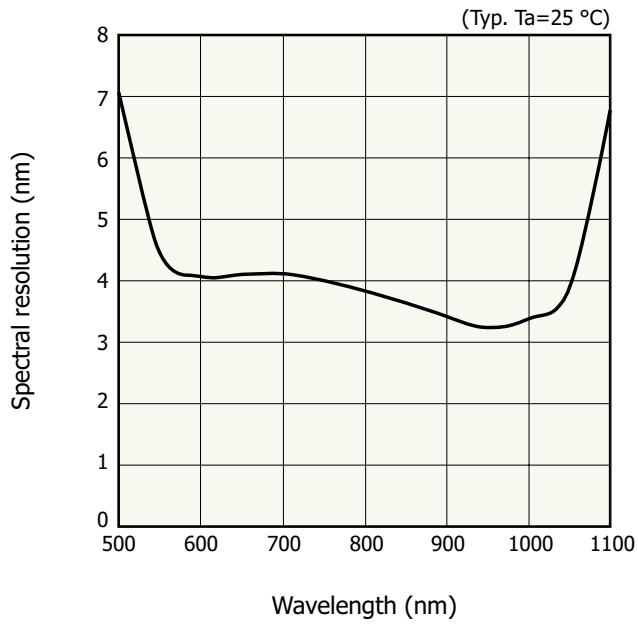
Linearity (typical example)

(Ta=25 °C)

- Typical example of A/D output
- Ideal value of A/D output
- Difference between ideal value and 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.
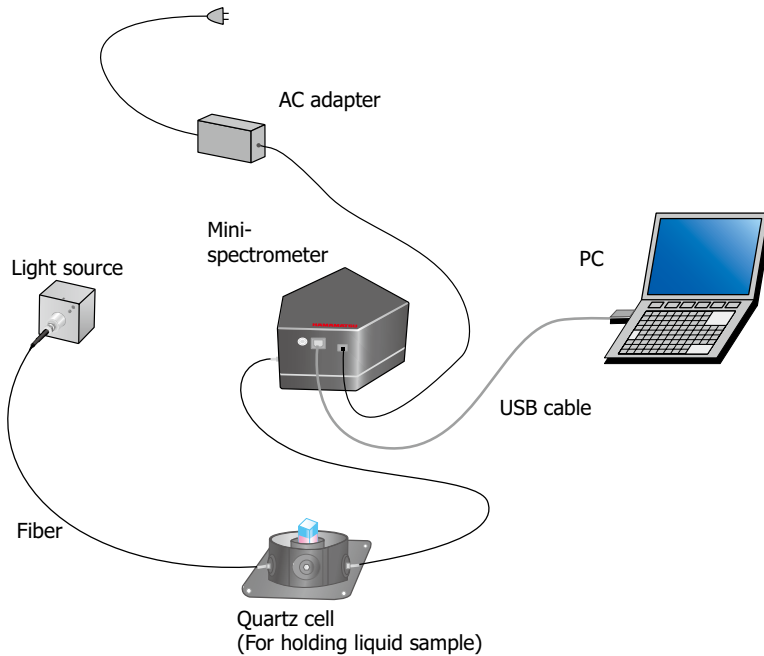
Dark output vs. ambient temperature (typical example)

(Integration time=1 s)

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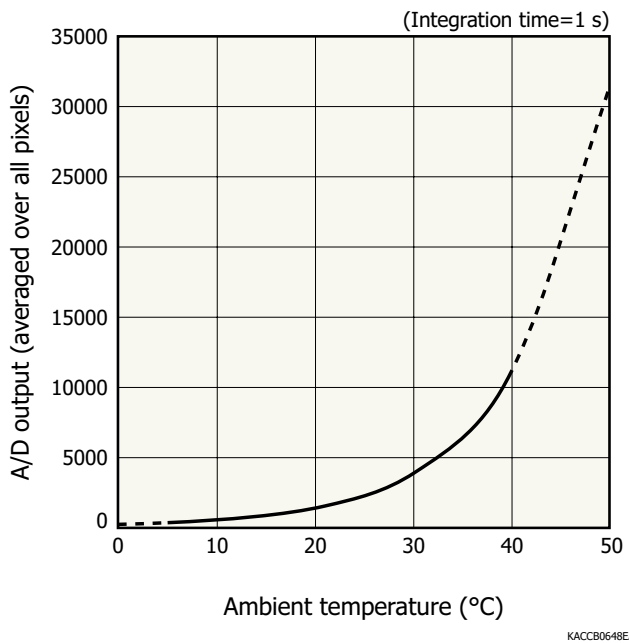
A/D output is the sum of the sensor and circuit offset outputs and the sensor dark output.

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.

AC adapter

Light source

Mini-spectrometer

PC

USB cable

Fiber

Quartz cell
(For holding liquid sample)

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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.

Focus lens

Transmission grating

Image sensor

Collimating lens

Input slit
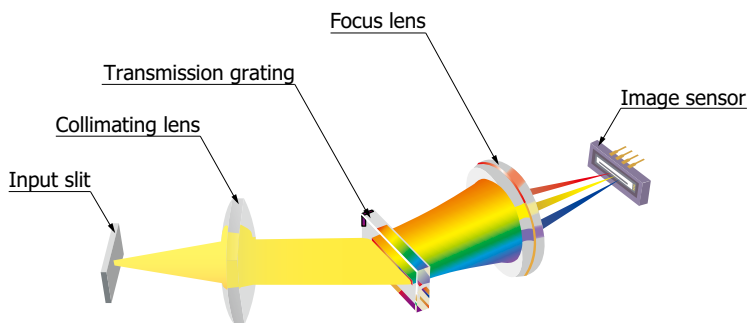
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Evaluation software package (supplied with unit)

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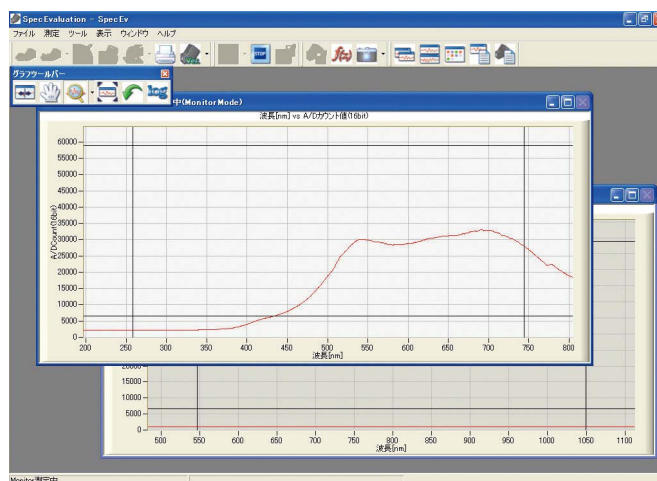
Note:
· Two or more mini-spectrometers can be connected and used
  with one PC simultaneously.
· The external trigger input function does not work with the evaluation software. If using an external trigger input or designing original
  application software, the user software must be configured to support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

[8]: Compatible OS: Microsoft Windows 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 registerd trademarks or trademarks of Microsoft
      Corporation in the United States and other countries.

Dimensional outline (unit: mm)
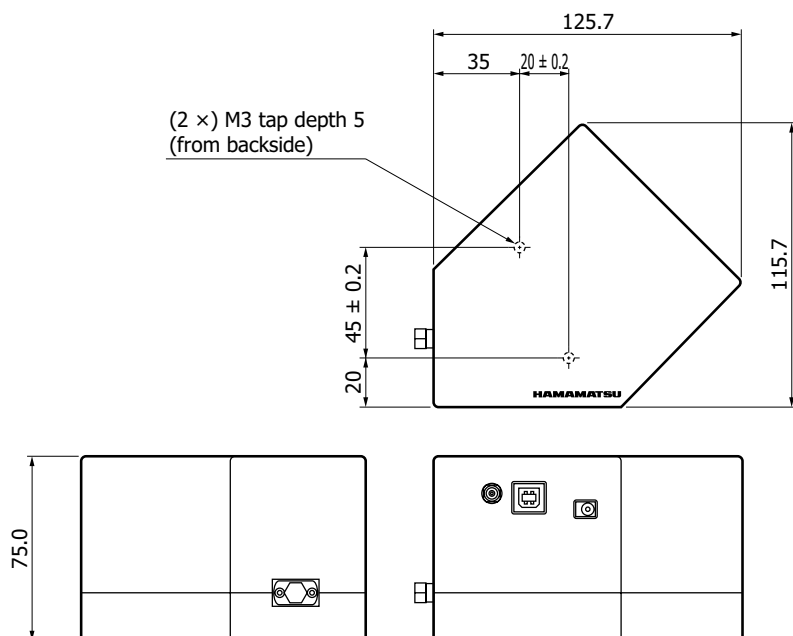
Tolerance unless otherwise noted: ±0.5
Weight: 670 g

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▶ Accessories

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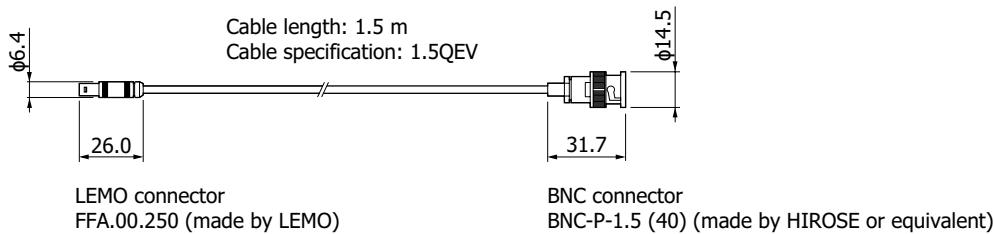· AC adapter (for power supply)

▶ Options (sold separately)

· Optical fiber for light input

Type no	Product name	Applicable mini-spectrometer	Core diameter (μm)	Specification
A16963-01	Fiber for visible/near infrared range	C9405CC (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)

Cable length: 1.5 m
Cable specification: 1.5QEV

φ6.4   26.0   φ14.5   31.7

LEMO connector
FFA.00.250 (made by LEMO)

BNC connector
BNC-P-1.5 (40) (made by HIROSE or equivalent)

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▶ 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 March 2024.

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. Copying or reprinting the contents described in this material in whole or in part is prohibited without our prior permission.