

# Mini-spectrometer TG series C9404MC, C9405MC

Integrating optical system, image sensor and circuit



HAMAMATSU TG series mini-spectrometers are polychromators integrated with optical elements and an image sensor. 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. C9404MC and C9405MC are palm-top-size units and operate on USB bus power. Two models are available to cover different spectral ranges: C9404MC (TG-UV-MOS) and C9405MC (TG-SWNIR-MOS). The TG series comes with sample software, device driver and DLL that let you easily set measurement conditions and acquire, save and graphically display the spectrum data.

### Features

- High throughput due to transmission grating made of quartz
- Highly accurate optical characteristics
- No external power supply required: Uses USB bus power
- Compact design for easy assembly
- Wavelength conversion factor \*1 is recorded in internal memory

### Applications

- |   |                        |
|---|------------------------|
| C9404MC (TG-UV-MOS)                     |                        |
| ● Fluorescence measurement              | ● Tooth decay analysis |
| ● UV light source testing               |                        |
| C9405MC (TG-SWNIR-MOS)                  |                        |
| ● Detection of saccharic acids in foods |                        |
| ● Taste analyzers                       | ● LED testing          |

\*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.

■ Mini-spectrometer line-up

Type No.	Type	Spectral response range (nm)											Spectral resolution Max. (nm)	Image sensor					
		200	400	600	800	1000	1200	1400	1600	1800	2000	2200							
C10082CA	TM series	TM-UV/VIS-CCD High sensitivity															6	Back-thinned type 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 type CCD image sensor
C10083CAH		TM-VIS/NIR-CCD High resolution	320 to 1000														1*		
C10083MD		TM-VIS/NIR-MOS Wide dynamic range																8	CMOS linear image sensor
C9404CA	TG series	TG-UV-CCD High sensitivity	200 to 400														3	Back-thinned type CCD image sensor	
C9404CAH		TG-UV-CCD High resolution															1*		
C9404MC		TG-UV-MOS Wide dynamic range																3	CMOS linear image sensor
C9405CA		TG-SWNIR-CCD High sensitivity				500 to 1100												5 (λ=550 to 900 nm)	Back-thinned type CCD image sensor
C9405MC	TG-SWNIR-MOS Wide dynamic range				500 to 1100												5 (λ=550 to 1100 nm)	NMOS linear image sensor	
C9406GC	TG series	TG-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		
C9914GB		TG-cooled NIR-II Low noise (cooled type)					1100 to 2200										8		
C9407MA	RC series	RC-VIS-MOS Spectrometer module	340 to 780														9	CMOS linear image sensor	

\* Typ.

■ OEM model

Type No.	Type	Spectral response range (nm)											Spectral resolution Max. (nm)	Image sensor			
		200	400	600	800	1000	1200	1400	1600	1800	2000	2200					
C9409MA	RC series RC-VIS-MOS Spectrometer head	340 to 780														9	CMOS linear image sensor

## Specifications

Parameter	TG-UV-MOS	TG-SWNIR-MOS	Unit
	C9404MC	C9405MC	
Number of pixels	512		pixels
Spectral response range	200 to 400	500 to 1100	nm
Spectral resolution Max. (Spectral response half width) *2	3	5 *3	nm
Wavelength reproducibility *4	±0.1	±0.2	nm
Wavelength temperature dependence	0.02		nm/°C
Spectral stray light *2, *5	-35	-35	dB
Broadband stray light *2, *6	-27	-27	dB
Slit *7	140 (H) × 500 (V)	70 (H) × 2500 (V)	µm
A/D conversion	16		bit
Integration time	5 to 10000		ms
Optical NA *8	0.11	0.22	-
Image sensor	CMOS linear image sensor (S8378-512Q)	NMOS linear image sensor (S8381-512Q)	-
Connector for optical fiber	SMA905D		-
Interface	USB1.1		-
Current consumption *9	100	100	mA
Operating temperature *10	+5 to +40		°C
Storage temperature	-20 to +70		°C
Dimensions	40 (W) × 106 (D) × 86 (H)		mm

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

\*3:  $\lambda=550$  to 1100 nm

\*4: Measured under constant light input conditions.

\*5: 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  $\pm 20$  nm (C9404MC) or  $\pm 40$  nm (C9405MC).

C9404MC: 300 nm, C9405MC: 800 nm

\*6: This is the ratio of the transmittance measured with light passing through the following optical filters to the transmittance measured in the blocking region.

C9404MC: WG320, C9405MC: RG850

\*7: Entrance slit aperture size

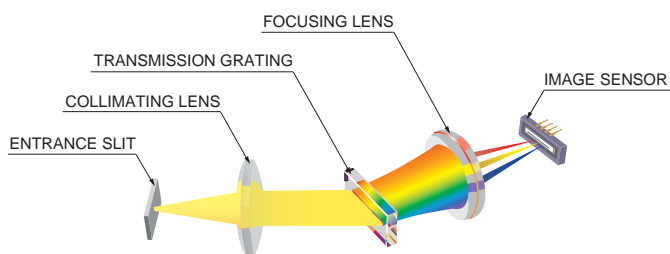
\*8: Numerical aperture (solid angle)

\*9: USB bus power

\*10: No condensation

## 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.

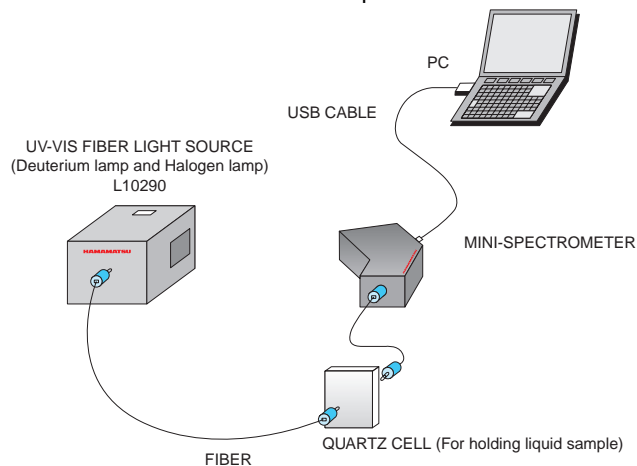


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## Connection example

(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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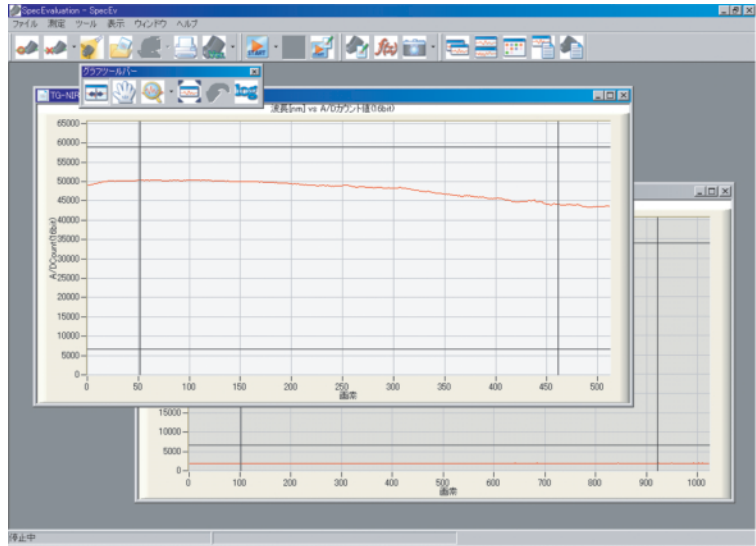
■ **Dedicated software package (supplied with unit)**

Installing the dedicated software package (containing sample software, device driver, DLL)\*11 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
  - Dark subtraction
  - Comparison calculation with reference data  
(transmittance, reflectance)
  - Gaussian approximation  
(peak position and count, FWHM)

Note: Two or more mini-spectrometers can be connected and used with one PC simultaneously.

\*11: Compatible OS: Microsoft Windows Professional Edition 2000 (SP3 or later) and XP (SP1a or later)



Device driver and DLL for controlling hardware are also provided.

You can develop your own measurement programs by using a software development environment that includes Microsoft Visual C++ and Visual Basic.\*12 The DLL provides functions such as USB port open/close, measurement condition setup, measurement data and module information acquisition.

\*12: Operation of the device driver and DLL has been verified only with Microsoft Visual C++® and Visual Basic®.

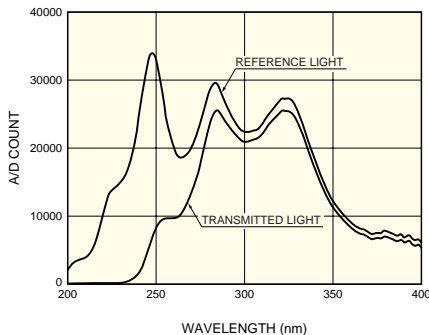
Microsoft Visual C++ and Microsoft Visual Basic are either registered trademarks or trademarks of Microsoft Corporation in the United States.

■ **Measurement examples**

(1) **Transmittance measurement**

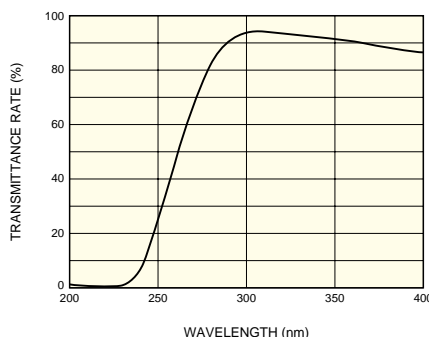
Transmittance of 1 mm thick optical window plate was measured with C9404MC (TG-UV-MOS).

· Measurement value



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· Calculation result

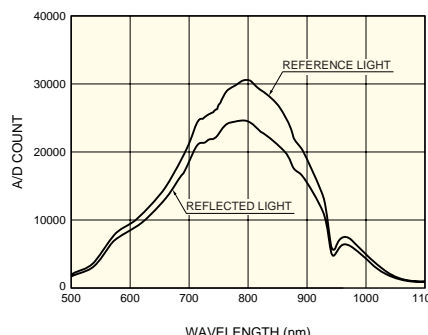


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(2) **Reflectance measurement**

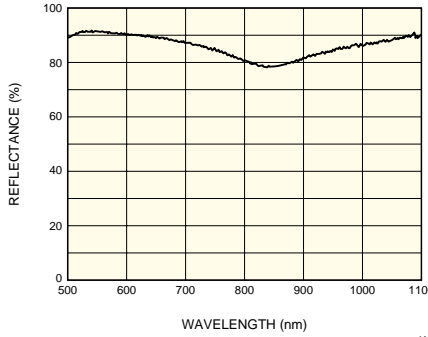
Spectral reflectance of reflecting mirror was measured with C9405MC (TG-SWNIR-MOS).

· Measurement value



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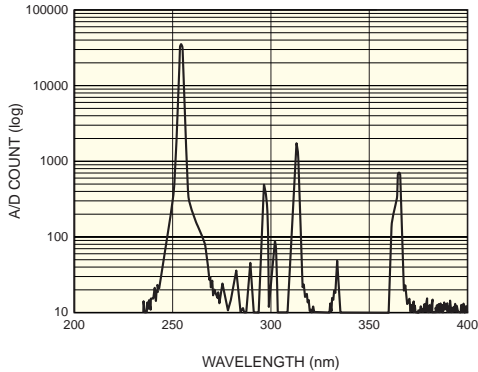
· Calculation result



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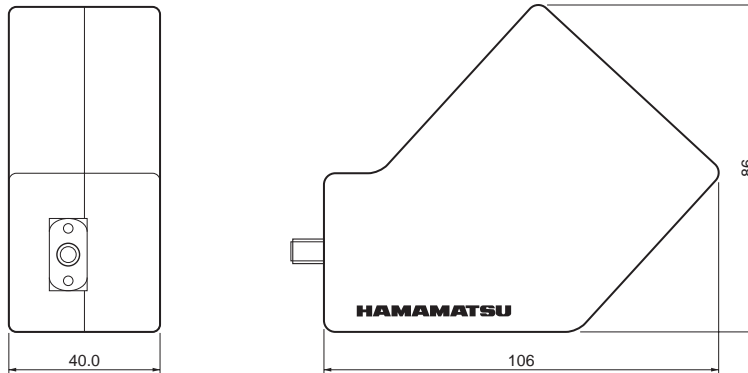
### (3) Line spectrum measurement

Line spectra from low-pressure mercury lamp were measured with C9404MC (TG-UV-MOS).



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### ■ Dimensional outline (unit: mm)



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### ■ Accessories

- USB cable
- Dedicated software (sample software, device driver, DLL)

### ■ Options (sold separately)

Optical fibers for light input

Type. No	Product name	Applicable mini-spectrometer	Specification
A9762-01	Fiber for UV/visible range (resistance to UV)	C9404MC (TG-UV-MOS)	Core diameter 600 μm, N.A.=0.22, length 1.5 m, connectorized SMA905D at both ends
A9763-01	Fiber for visible/near infrared range	C9405MC (TG-SWNIR-MOS)	