

# Mini-spectrometer TG series C9406GC, C9913GC, C9914GB

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. Non-cooled type and cooled type are provided. Non-cooled type is a palmtop-size unit and operates on USB bus power. Cooled type allows accurate measurement with low noise by cooling the image sensor. Two models are available: C9913GC (TG-cooled NIR-I) and C9914GB (TG-cooled NIR-II). 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
- G9406GC: No external power supply required (Uses USB bus power) \*1
- Low noise measurement (Cooled type)
- Compact design for easy assembly
- Wavelength conversion factor \*2 is recorded in internal memory

\*1: C9913GC, C9914GB: Each requires 5 V and 12 V power supplies.

\*2: 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

#### C9406GC (TG-NIR)

- Water content measurement
- Optical communication component testing
- Film thickness measurement

#### C9913GC (TG-cooled NIR-I), C9914GB (TG-cooled NIR-II)

- Water content measurement
- Component analysis in food, agriculture fields, etc.
- Process control for chemical products

■ Mini-spectrometer line-up

Type No.	Type	Spectral response range (nm)											Spectral resolution Max. (nm)	Image sensor		
C10082CA	TM series	TM-UV/VIS-CCD [High sensitivity]	200 to 800											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]	200 to 800											6	CMOS linear image sensor	
C10083CA		TM series	TM-VIS/NIR-CCD [High sensitivity]	320 to 1000											8 (λ=320 to 900 nm)	Back-thinned type CCD image sensor
C10083CAH			TM-VIS/NIR-CCD [High resolution]	320 to 1000											1* (λ=320 to 900 nm)	
C10083MD			TM-VIS/NIR-MOS [Wide dynamic range]	320 to 1000											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]	200 to 400											1*	Back-thinned type CCD image sensor	
C9404MC		TG-UV-MOS [Wide dynamic range]	200 to 400											3	CMOS linear image sensor	
C9405CA		TG series	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)	
C9406GC			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	
C9409MA	RC series	RC-VIS-MOS [Spectrometer head]	340 to 780											9	CMOS linear image sensor

**Specifications**

## Non-cooled type

Parameter	TG-NIR	Unit
	C9406GC	
Number of pixels	512	pixels
Spectral response range	900 to 1700	nm
Spectral resolution Max. (Spectral response half width) *3	7	nm
Wavelength reproducibility *4	±0.2	nm
Wavelength temperature dependence	0.02	nm/°C
Spectral stray light *3, *5	-35	dB
Broadband stray light *3, *6	-30	dB
Slit *7	70 (H) × 500 (V)	μm
A/D conversion	16	bit
Integration time	5 to 10000	ms
Optical NA *8	0.22	-
Image sensor	InGaAs linear image sensor (G9204-512D)	-
Connector for optical fiber	SMA905D	-
Interface	USB1.1	-
Current consumption *9	250	mA
Operating temperature *10	+5 to +40	°C
Storage temperature	-20 to +70	°C
Dimensions	40 (W) × 106 (D) × 86 (H)	mm

## Cooled type

Parameter	TG-cooled NIR-I	TG-cooled NIR-II	Unit
	C9913GC	C9914GB	
Number of pixels	512	256	pixels
Spectral response range	900 to 1700	1100 to 2200	nm
Spectral resolution *3 (Spectral response half width)	7	8	nm
Wavelength reproducibility *4	±0.2	±0.4	nm
Wavelength temperature dependence	0.02	0.04	nm/°C
Spectral stray light *3, *5	-35	-35	dB
Broadband stray light *3, *6	-30	-30	dB
Slit *7	70 (H) × 500 (V)	70 (H) × 250 (V)	μm
A/D conversion	16		bit
Integration time	5 to 10000		ms
Optical NA *8	0.22	0.22	-
Image sensor	InGaAs linear image sensor (G9204-512S)	InGaAs linear image sensor (G9206-02)	-
Image sensor cooling temperature	-5	-20	°C
Connector for optical fiber	SMA905D		-
Interface	USB1.1		-
USB bus power current consumption	250	250	mA
Power supply for cooling element (Max.) *11	5/1.8	5/2.8	V/A
Power supply for cooling fan *11	12/0.2		V/A
Operating temperature *10	+5 to +35 (+5 to +30 *12)		°C
Storage temperature	-20 to +70		°C
Dimensions	142 (W) × 218 (D) × 80 (H)		mm

\*3: Depends on the slit opening. Values were measured with the slit opening listed in the table.

\*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 ±40 nm.  
C9406GC/C9913GC: 1300 nm, C9914GB: 1650 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.  
C9406GC/G9913GC: LP1400 (SPECTROGON), C9914GB: LP1700 (SPECTROGON)

\*7: Entrance slit aperture size

\*8: Numerical aperture (solid angle)

\*9: USB bus power

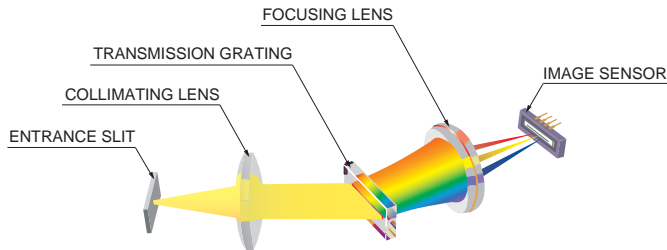
\*10: No condensation

\*11: Maximum value in steady state. Note that inrush current flows at start-up.

\*12: For controllable cooling temperature

## Optical component layout

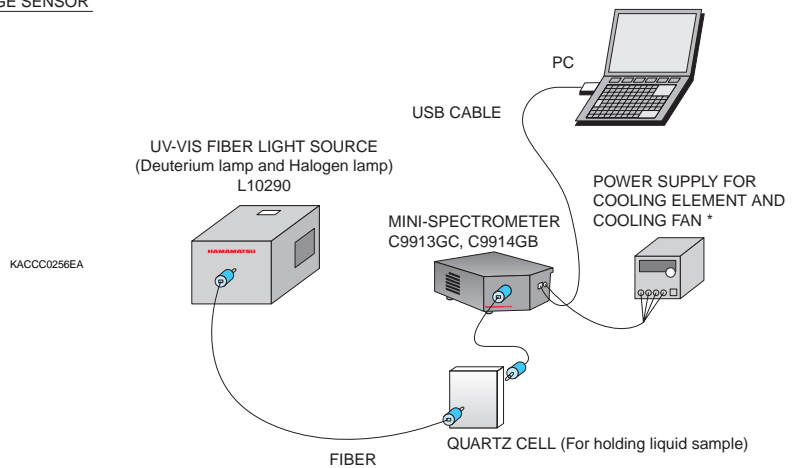
TG series mini-spectrometers use a transmission holographic grating made of quartz and precision optical components arranged on a rugged optical base, making it possible to deliver high throughput and highly accurate optical characteristics.



## 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.



\* External power supply should be prepared by the user.  
C9406GC: No external power supply required (Uses USB bus power)

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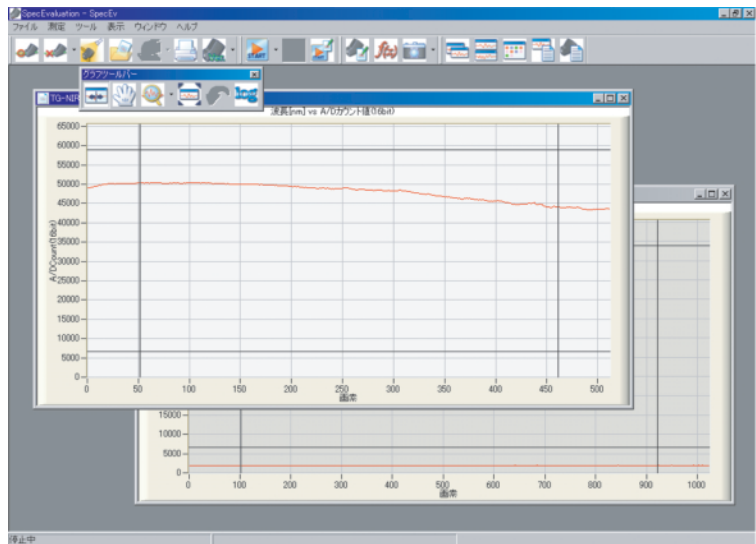
## Dedicated software package (supplied with unit)

Installing the dedicated software package (containing sample software, device driver, DLL)\*<sup>13</sup> 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.

\*13: 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.

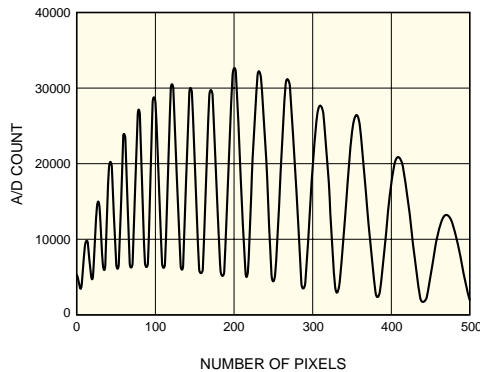
You can develop your own measurement programs by using a software development environment that includes Microsoft Visual C++ and Visual Basic.\*<sup>14</sup> The DLL provides functions such as USB port open/close, measurement condition setup, measurement data and module information acquisition.

\*14: 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 example

· Film thickness measurement (white light interferometry)  
 Thickness of 10 μm thick food wrapping film (polyvinylidene chloride) was measured with C9406GC (TG-NIR).



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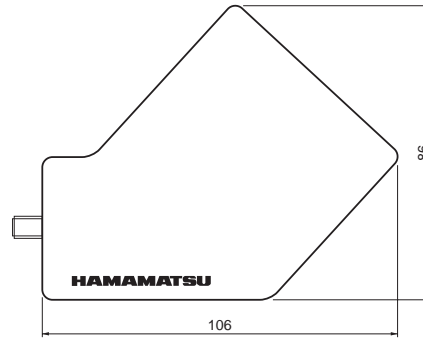
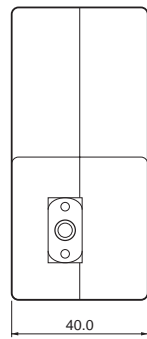
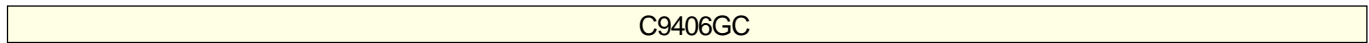
## Note:

Principle of film thickness measurement:

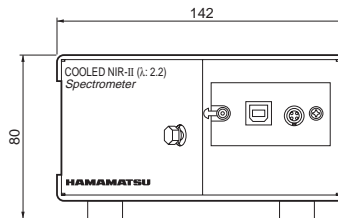
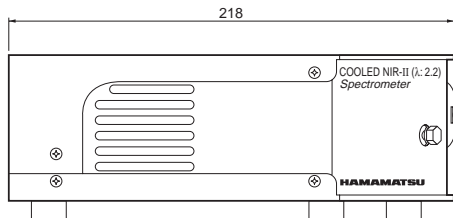
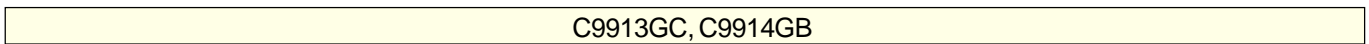
In film thickness measurement utilizing white light interferometry, an interference spectrum resulting from internal reflections between the front and back surfaces of a film is obtained.

The film thickness can then be determined by calculation from the spectral peak count, wavelength range, refractive index of film and incident light angle.

## ■ Dimensional outline (unit: mm)



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## ■ Accessories

- USB cable
- Dedicated software (sample software, device driver, DLL)
- Connector for connection to cooling element and cooling fan power supply (C9913GC, C9914GB)

## ■ Options (sold separately)

Optical fibers for light input

Type. No	Product name	Specification
A9763-01	Fiber for visible/ near infrared range	Core diameter 600 μm, N.A.=0.22, length 1.5 m, connectorized SMA905D at both ends

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