HAMAMATSU
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Mini-spectrometer

TG series | C9406GC, C9913GC, C9914GB

For near IR, 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 supplied with evaluation software that allows setting measurement conditions, acquiring and saving data, and displaying graphs. DLL is also supplied as accessory items to allow the users to configure their own measurement software.

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: C9913GC, C9914GB)**
- **Compact design for easy assembly**
- **Wavelength conversion factor*2 is recorded in internal memory**

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**

*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 level is not provided.

Optical characteristics

Parameter	TG-NIR	TG-cooled NIR-I	TG-cooled NIR-II	Unit
	C9406GC	C9913GC	C9914GB	
Spectral response range	900 to 1700	900 to 1700	1100 to 2200	nm
Spectral resolution (FWHM)*3	7 max.	7 max.	8 max.	nm
Wavelength reproducibility*4	-0.2 to +0.2	-0.2 to +0.2	-0.4 to +0.4	nm
Wavelength temperature dependence	-0.02 to +0.02	-0.02 to +0.02	-0.04 to +0.04	nm/°C
Spectral stray light*3 *5	-35 max.			dB

*3: Depends on the slit opening. Values were measured with the slit listed in the table "Structure / Absolute maximum ratings".
*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

Electrical characteristics

Parameter	C9406GC	C9913GC	C9914GB	Unit
A/D conversion	16			bit
Integration time	5 to 10000		5 to 1000	ms
Interface	USB 1.1			-
Current consumption of USB bus power	250 max.			mA

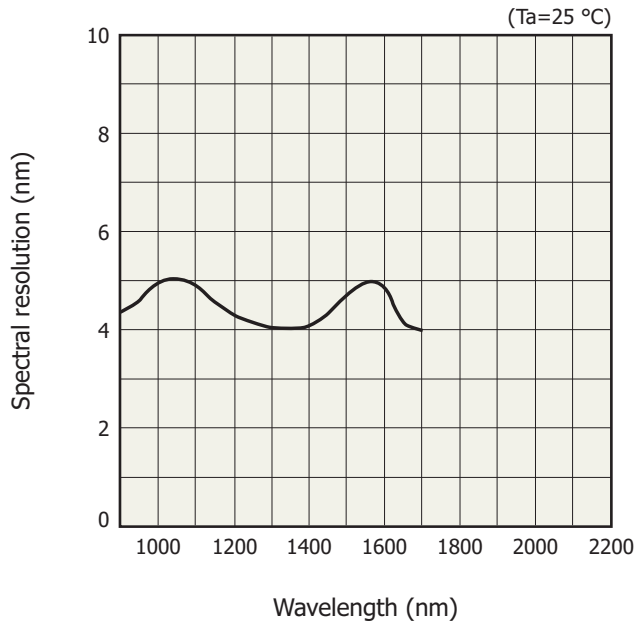
Structure / Absolute maximum ratings

Parameter	C9406GC	C9913GC	C9914GB	Unit
Dimensions (W × D × H)	38.5 × 106 × 86	142 × 218 × 80		mm
Weight	270	1700	1700	g
Image sensor	InGaAs linear image sensor (G9204-512D)	TE-cooled type InGaAs linear image sensor (G9204-512S)	TE-cooled type InGaAs linear image sensor	-
Number of pixels*6	512	512	256	pixels
Slit*7 (H × V)	70 × 500	70 × 500	70 × 250	µm
NA*8	0.22			-
Connector for optical fiber	SMA905D			-
Operating temperature*9	+5 to +40	+5 to +35 (+5 to +30*10)		°C
Storage temperature*9	-20 to +70			°C
Power supply for cooling element max.*11	-	5/1.8	5/2.8	V/A
Power supply for cooling fan	-	12/0.2		V/A

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.
*6: No defective pixel (at low gain). Defective pixels are those whose electrical and optical characteristics do not meet our specifications.
*7: Entrance slit aperture size
*8: Numeric aperture (solid angle)
*9: No condensation
*10: For controllable cooling temperature
*11: Maximum value in steady state. Note that inrush current flows at start-up.
The connector for connection to cooling element and cooling fan power supply is attached (C9913GC, C9914GB).

Spectral resolution vs. wavelength (typical example)

C9406GC



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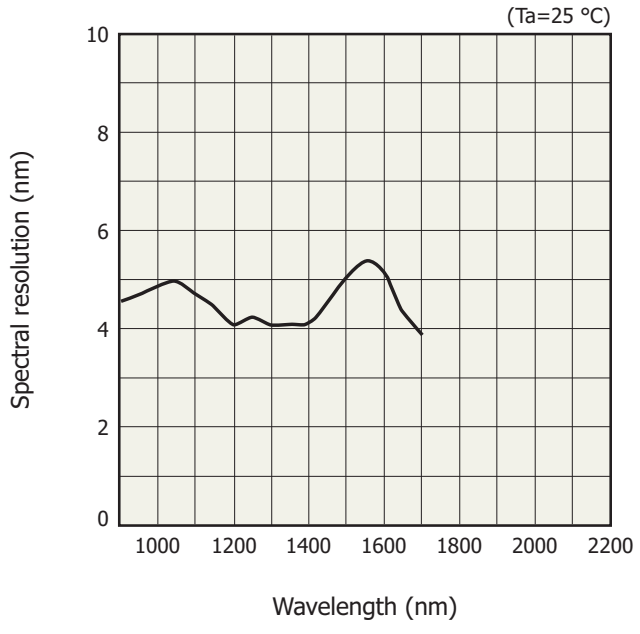
C9913GC



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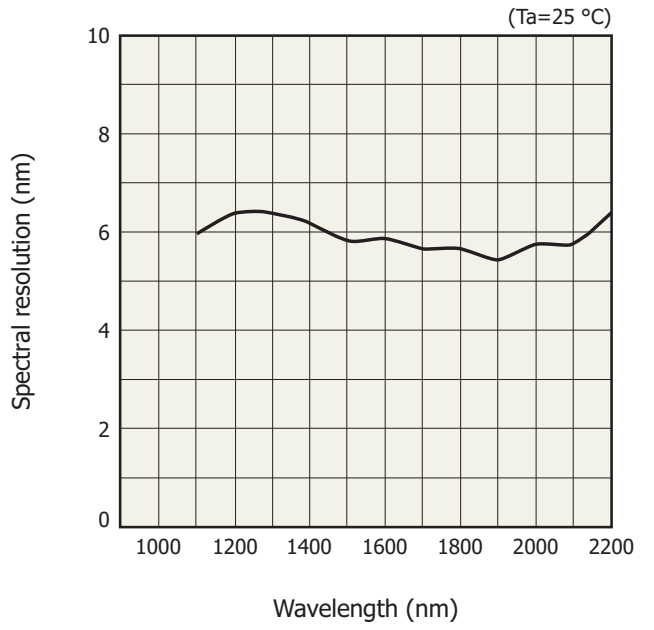
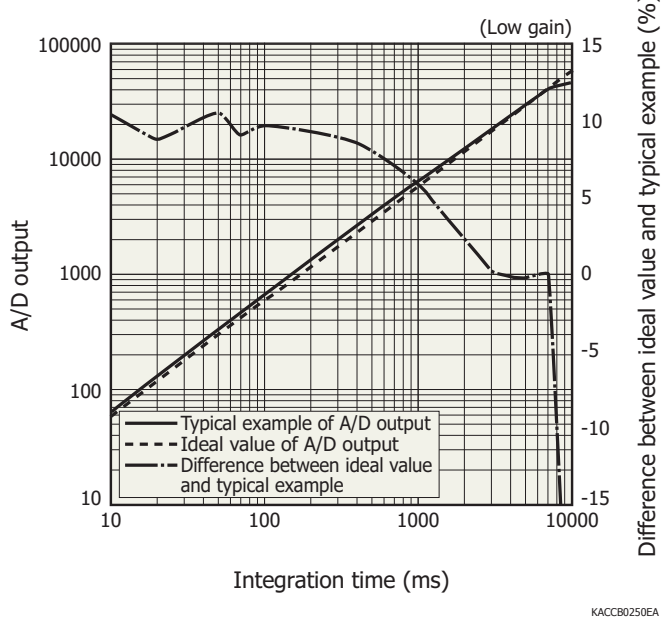
C9914GB

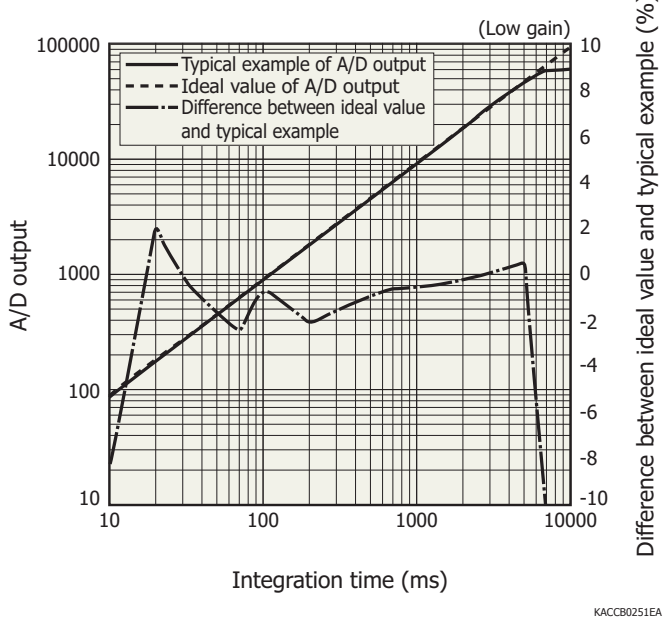


Linearity (typical example)

C9406GC

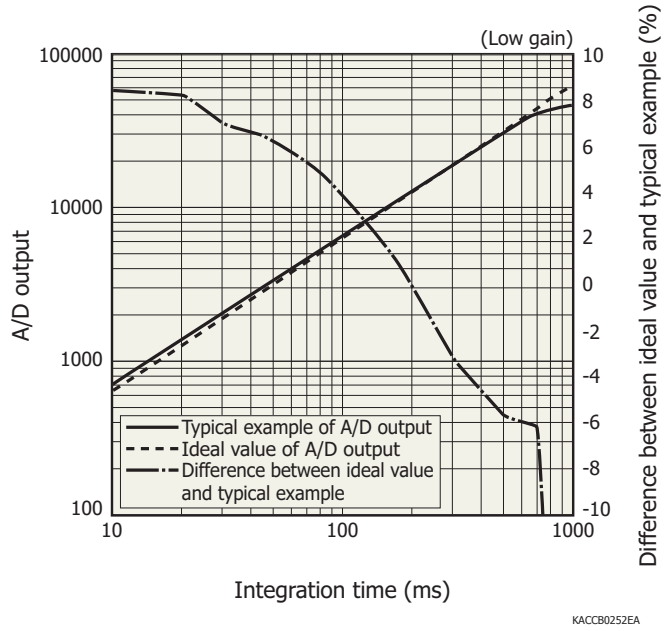


C9913GC



Note: 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.

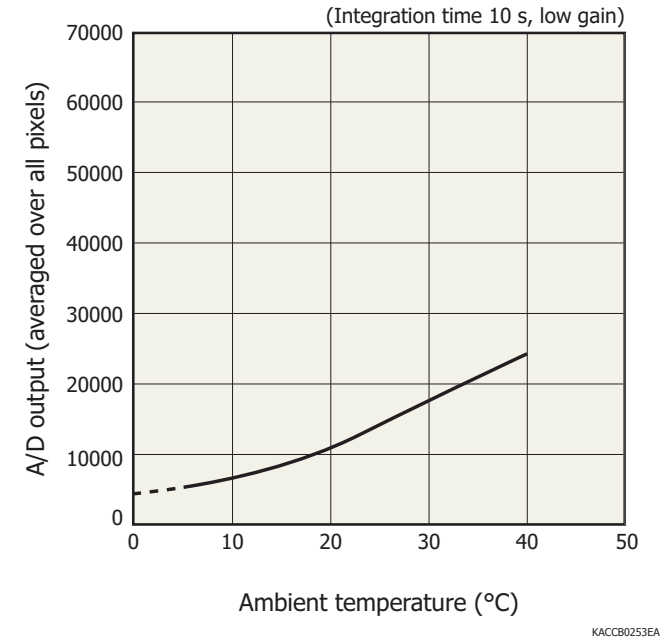
C9914GB



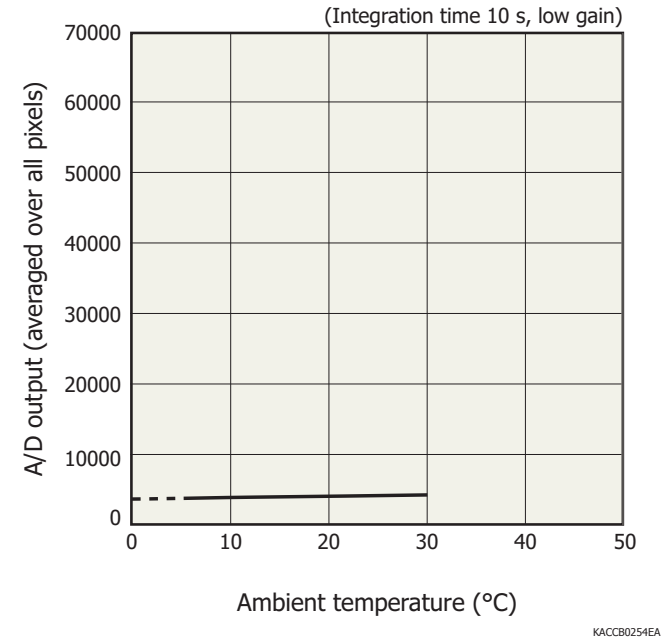
Note: A/D output is the output with dark output is subtracted when light is input. The difference between the ideal value and typical example contains a measurement error. The smaller the A/D output, the larger the measurement error.

Dark output vs. ambient temperature (typical example)

C9406GC

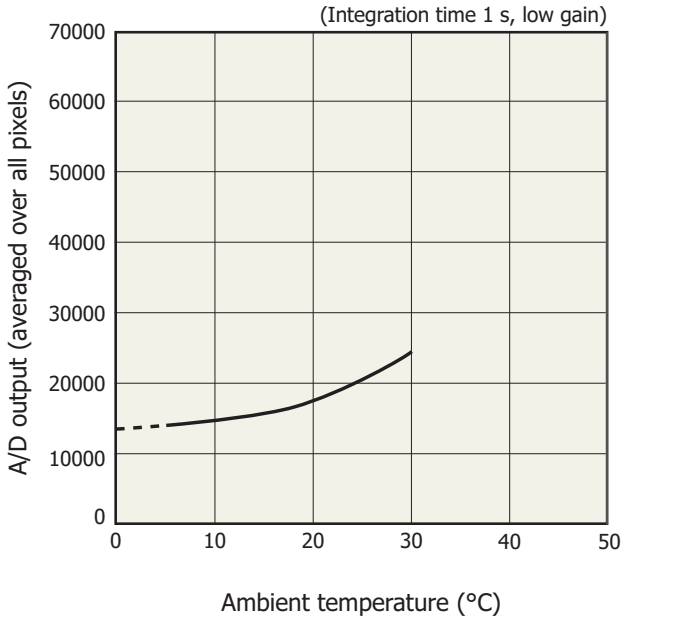


C9913GC



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

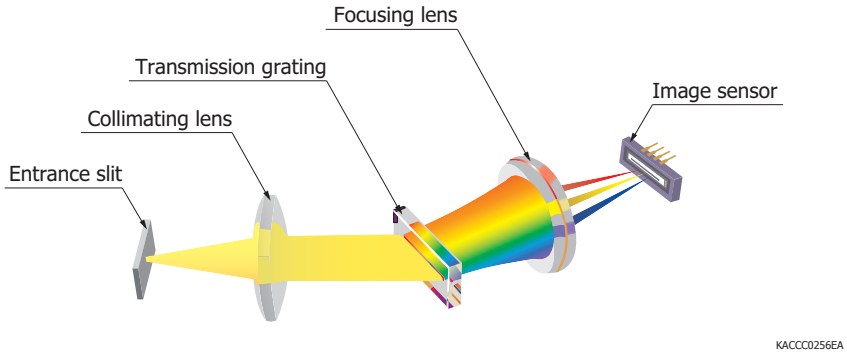
C9914GB



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

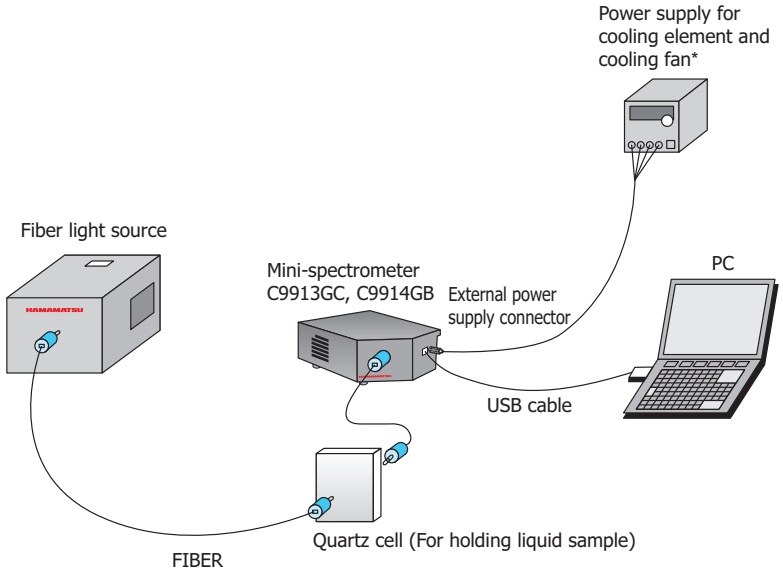
Optical component layout

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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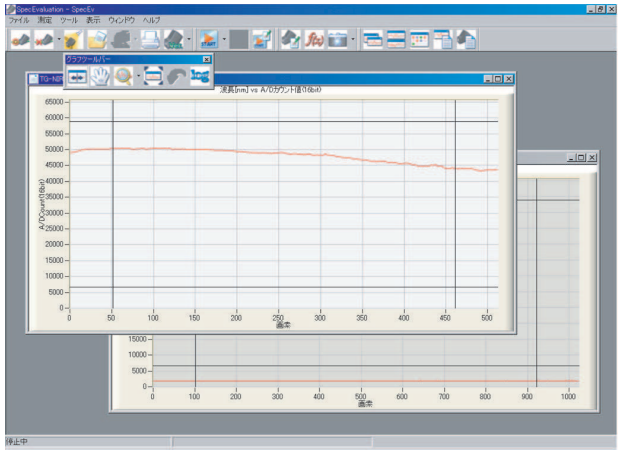
Evaluation software package (supplied with unit)

Installing the evaluation software package (Spec Evaluation.exe)*12 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.

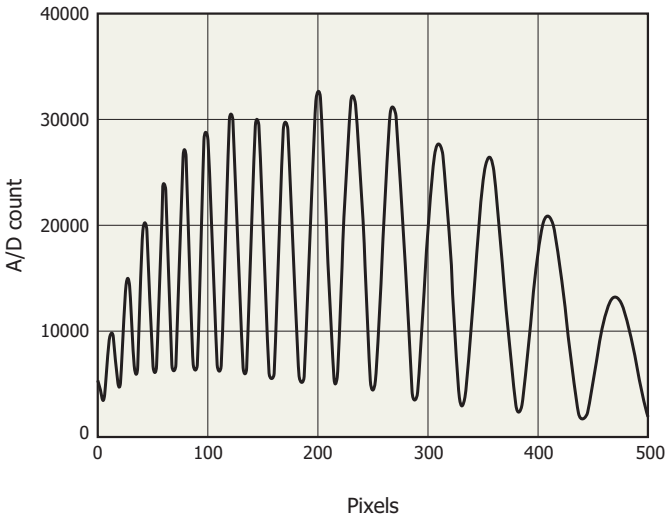
*12: Compatible OS: Microsoft® Windows® XP Professional SP3 (32-bit)*13
Microsoft® Windows® Vista Business SP1 (32-bit)*13
Microsoft® Windows® 7 Ultimate SP1 (32-bit)*13
Microsoft® Windows® 7 Ultimate SP1 (64-bit)*13

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++®*13
Microsoft® Visual Studio® 2008 (SP1) Visual Basic®*13
*13: 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.

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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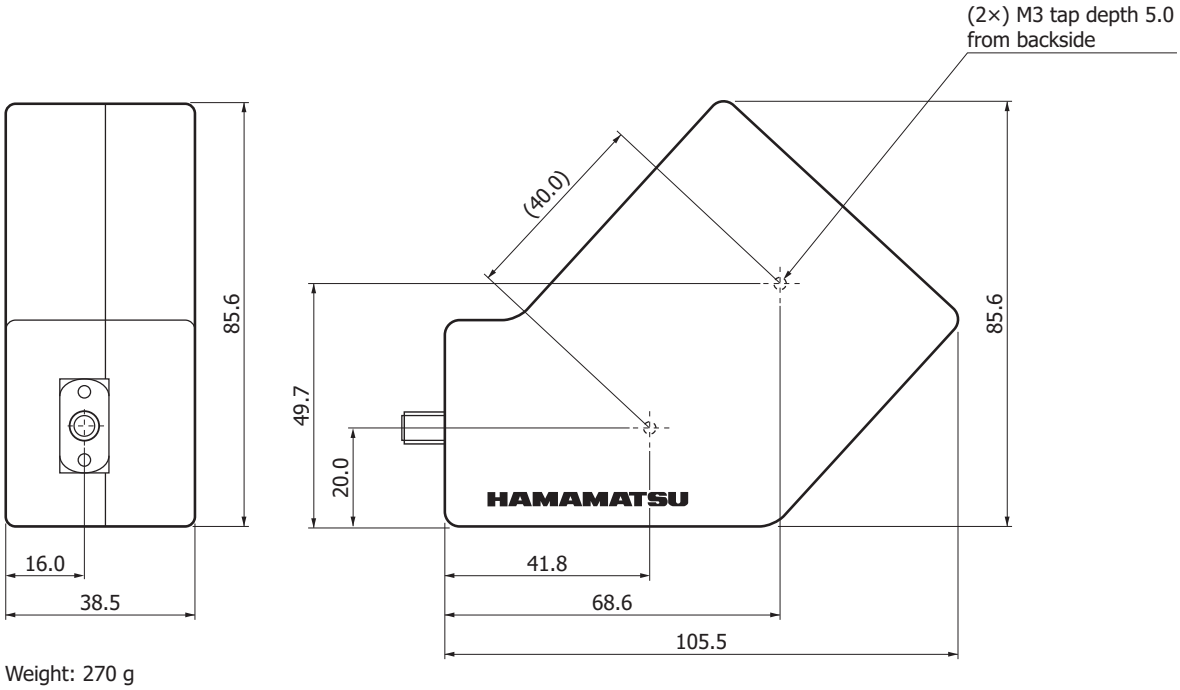
Note:
Principle of film thickness measurement:
In film thickness measurement utilizing white light interferometry, an interference spectrum resulting from internal reflections between the front and back surfaces of a film is obtained.
The film thickness can then be determined by calculation from the spectral peak count, wavelength range, refractive index of film and incident light angle.

Dimensional outline (unit: mm, tolerance unless otherwise noted: ±0.5)

C9406GC



Weight: 270 g

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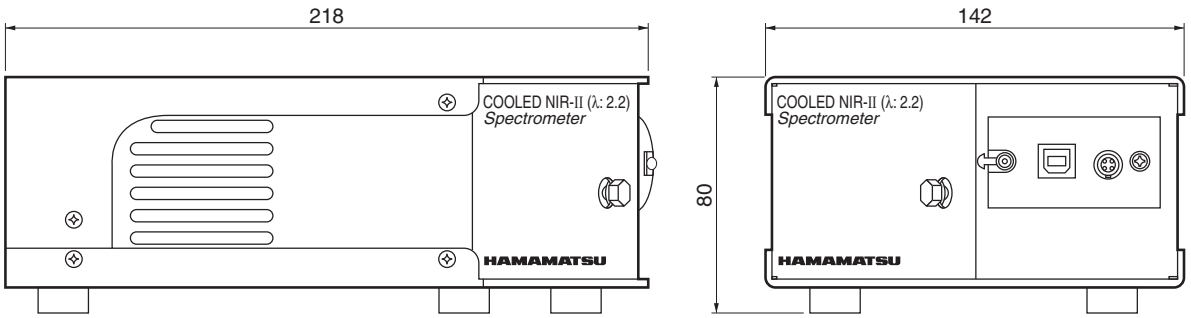
C9913GC, C9914GB



Weight: 1.7 kg

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Accessories

- USB cable
- Dedicated software (evaluation software, sample software, DLL)
- External power supply connector [made by LEMO S.A.: FGG0B304CLAD56 (only available in C9913GC and C9914GB)]

Options (sold separately)

Optical fibers for light input

Type no.	Product name	Specification
A9763-01	Optical fiber for visible/near infrared range	Core diameter 600 µm, NA=0.22, length 1.5 m, connectorized SMA905D at both ends

CE

The C9406GC, C9913GC, and C9914GB conform to the European EMC directives.
(applied standard: EN 61326-1 Class B)

Mini-spectrometer lineup

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 series	TM-UV/VIS-CCD High resolution	200 to 800	1*	Back-thinned type CCD image sensor
C10082MD	TM series	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 series	TM-VIS/NIR-CCD High resolution	320 to 1000	1* (λ=320 to 900 nm)	Back-thinned type CCD image sensor
C10083MD	TM series	TM-VIS/NIR-MOS Wide dynamic range	320 to 1000	8	CMOS linear image sensor
NEW C11697MA	TM series	TM-VIS/NIR-MOS-II Trigger-compatible	320 to 1000	8	CMOS image sensor with amp array
C9404CA	TG series	TG-UV-CCD High sensitivity	200 to 400	3	Back-thinned type CCD image sensor
C9404CAH	TG series	TG-UV-CCD High resolution	200 to 400	1*	Back-thinned type CCD image sensor
NEW C9405CB	TG series	TG-SWNIR-CCD-II IR-enhanced	500 to 1100	5 (λ=550 to 900 nm)	IR-enhanced back-thinned CCD image sensor
NEW C11713CA	TG series	TG-RAMAN-I High resolution	500 to 600	0.3*	Back-thinned type CCD image sensor
NEW C11714CA	TG series	TG-RAMAN-II High resolution	790 to 920	0.3*	Back-thinned type CCD image sensor
C9406GC	TG series	TG-NIR Non-cooled type	900 to 1700	7	InGaAs linear image sensor
C9913GC	TG series	TG-cooled NIR-I Low noise (cooled type)	900 to 1700	7	InGaAs linear image sensor
C9914GB	TG series	TG-cooled NIR-II Low noise (cooled type)	1100 to 2200	8	InGaAs linear image sensor
C11118GA	TG series	TG-cooled NIR-III Low noise (cooled type)	900 to 2550	20	InGaAs linear image sensor
C11007MA	RC series	RC-VIS-MOS Spectrometer module	340 to 780	9	CMOS linear image sensor
C11008MA	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.	Type		Spectral response range (nm)	Spectral resolution max. (nm)	Image sensor
C11009MA	RC series	RC-VIS-MOS Spectrometer head	340 to 780	9	CMOS linear image sensor
C11010MA	RC series	RC-SWNIR-MOS Spectrometer head	640 to 1050	8	IR-enhanced CMOS linear image sensor

Ultra-compact type for installation into mobile measuring equipment

Type no.	Type		Spectral response range (nm)	Spectral resolution max. (nm)	Image sensor
C10988MA	MS series	MS-VIS-MOS Spectrometer head	340 to 750	14	CMOS linear image sensor
NEW C11708MA	MS series	MS-SWNIR-MOS Spectrometer head	640 to 1050	20	CMOS linear image sensor

Information described in this material is current as of March, 2012.
Product specifications are subject to change without prior notice due to improvements or other reasons. Before assembly into final products, please contact us for the delivery specification sheet to check the latest information.
Type numbers of products listed in the delivery specification sheets or supplied as samples may have a suffix "(X)" which means preliminary specifications or a suffix "(Z)" which means developmental 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.

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