K29-B60919K

HAMAMATSU

MINI-SPECTROMETERS

TG-CCD Series (C9404CA, C9404CAH, C9405CC)
HARDWARE INSTRUCTION MANUAL

Doc Version 1.11

Hamamatsu Photonics K.K. 1126-1, Ichino-cho, Higashi-ku, Hamamatsu-City, 435-8558, Japan, Telephone : 81-53-434-3311

SOLID STATE DIVISION

To use the product safely

To use this product correctly and safely, always comply with the precautions listed below. We are not liable for any damage resulting from failure to comply with the precautions and instructions in this manual.

The following safety alert symbols and signal words are used in this manual to indicate degree of hazard.

DANGER

"DANGER" indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

"WARNING" indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

"CAUTION" indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury or damage to the equipment.

Introduction

Thank you for purchasing a Hamamatsu TG-CCD series mini-spectrometer (also called "this product"). This instruction manual explains how you can use this product and how to install, connect and operate it. To use this product safely and correctly, read this manual carefully before use and comply with the instructions.

Before using the TG series mini-spectrometer

- When using this product please be sure to stay within the maximum ratings and comply with all caution items to avoid possible trouble or accidents. We are constantly making every effort to improve product quality and reliability but this does not guarantee complete safety when using this product. In particular, when this product is to be used in equipment or systems which might cause personal injury, fatal accident or damage to property if handled improperly, be sure to implement safety measures that take potential problems fully into account. In such applications, we bear no responsibility for problems or damage arising from use of this product.

- After unpacking, first check that all items are included (see the list below). If an item is missing or damaged, contact us immediately without using this product.

- The contents of this manual are subject to change without prior notice due to product improvement, etc.

- Reproduction or copying of this manual is prohibited without permission of Hamamatsu Photonics.

- If this manual is lost or damaged, immediately contact our sales office to ask for an additional copy.

This product is supplied with the following items:

Mini-spectrometer main unit	1
AC adaptor	1
CD-ROM	1
USB cable (1.5m)	1
Inspection sheet	1
‘About handling manual for HAMAMATSU miniature spectrometer’	1

WARNING

■Stop using if an abnormal condition occurs.
If smoke, unusual odors, abnormal noise or heat are noticed while operating this product, immediately stop using it. Continuous operation under such abnormal conditions may cause fire or electrical shock. Immediately turn off the PC connected to this product and then unplug the USB cable. After making sure that no abnormal condition has disappeared, contact our sales office. Never attempt to repair on your own since it is dangerous.

■Do not apply vibrations or shocks to this product.
Excessive shocks or vibrations may damage the internal components or adversely affect their adjustments, causing fire or electrical shock.

■Always connect this product to a USB port and a supplied AC adaptor.
This product is designed to connect to a USB port on a PC and a supplied AC adaptor. Fire or electrical shock may result if used at a voltage higher than the regulated voltage.

■Do not disassemble this product.
Do not remove any covers on this product. Touching the internal parts or changing their adjustments may cause malfunctions, fire or electrical shock.

■Do not allow any object or water to penetrate inside.
If flammable objects, pieces of metal or water penetrate inside this product, they may cause fire or electrical shock.

■Handle the cables properly.
Avoid placing any heavy objects on the cable or bringing a heater close to the cable. Do not pull on the cable itself when disconnecting it. Doing so might damage the cable and cause fire or electrical shock.

Table of contents

CAUTION

Before using this product, be sure to read the following precautions to ensure correct and safe use.

■This product is high-precision optical equipment !

Do not apply any excessive vibrations or shocks to this product.
Avoid using or storing this product in outdoor locations exposed to excessive dust or dampness. The optical connector has an open aperture through which dust and damp might directly enter and affect the internal optical components. To prevent this, a cap is attached to the optical connector when shipped from our factory. Keep this cap attached until you connect an optical fiber cable to this connector. When connecting the optical fiber cable, clean the ferrule of the optical fiber cable.
Never insert any pointed or protruding object into the optical connector, since the internal optical components might be damaged.

■Do not use organic solvent such as thinner and acetone for cleaning.

Use a soft dry cloth to wipe the surface of this product clean.
Keep the optical connector away from dust and dampness as explained above, so that you do not have to clean it.

■Install the evaluation software in your PC only after you accept the terms in the "Software license agreement".

Never connect this product to the PC before installing the evaluation software. Otherwise, the software installation may fail. (See the description of "Installing the software" in the separate " Mini Spectrometer Software Instruction Manual " for how to install the software.)

■Power to this product is supplied from the USB port on the PC and attached AC adaptor.

Due to the USB specifications, the maximum power that can be supplied from one USB port is limited to 5 V, 500mA. **If connecting two or more units to one USB port through a hub, use a hub with power supply.** Typical current consumption of the Hamamatsu TG series mini-spectrometers is shown below.

Mini-spectrometer model	Current consumption (mA)
TG-UV CCD(C9404CA,C9404CAH)	100
TG-SWNIR CCD(C9405CC)	100

■Power saving function and screensaver

Depending on the PC model, the power supplied from the USB port might be interrupted when the power saving function or screensaver is activated. In this case, this product also stops operation and might create problems when the PC returns from power saving or screensaver mode.
If power to your PC is interrupted in this same way while connected to this product, **disable the power saving function and screensaver.** (For PC functions and settings, see the PC operation manual.)
The evaluation software contained on the supplied CD-ROM has a function that allows you to temporarily change the PC settings when the software starts up.

■Precautions on handling the acquired data

This product uses a 1024-pixel linear image sensor that detects the light spectrum formed by the grating. The data acquired with the PC is A/D converted data that corresponds to the analog output from each pixel of the image sensor. **The evaluation software (supplied on the CD-ROM) saves the same A/D conversion data that corresponds to each pixel.** To calibrate each pixel of the image sensor according to the wavelength axis, see the description of "Notes on the saved text data" in the separate " Mini Spectrometer Software Instruction Manual ".

■This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Overview

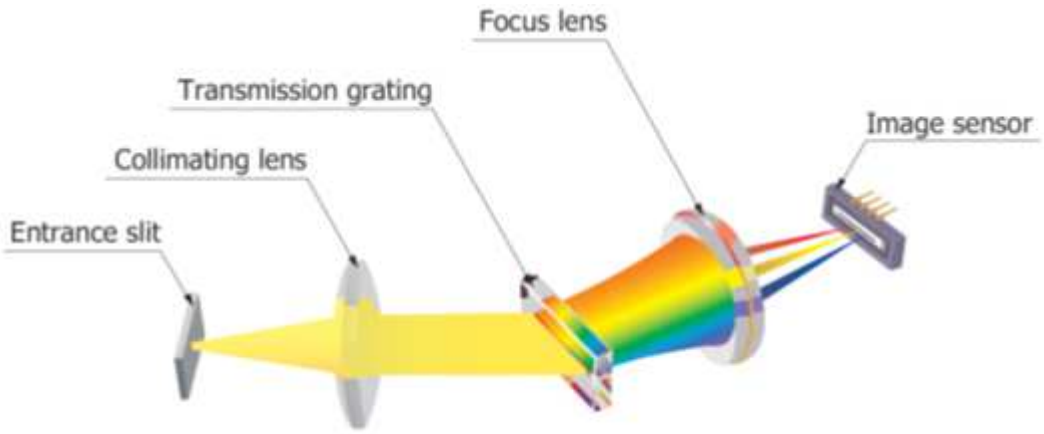
Hamamatsu TG-CCD series mini-spectrometers are polychromators integrated with optical elements and an image sensor circuit into a compact module. Two models of the TG series are available to cover different spectral ranges: UV(C9404CA). The table below shows the TG series model names and spectral response range. C9404CAH as high resolution type for above C9404CA also is available.
For TG-SWNIR, high sensitivity and near-infrared wavelength is C9405CC.

Mini-spectrometer model	Spectral response range (nm)
TG-UV CCD (C9404CA, C9404CAH)	200 to 400
TG-SWNIR CCD (C9405CC)	500 to 1100

Light to be measured is guided into the entrance port of the mini-spectrometer through an optical fiber and the spectrum is detected with the built-in image sensor. The spectrum data is then output from the USB port to a PC for data acquisition and analysis. Parameter information such as coefficients for converting the image sensor pixel numbers to the wavelengths is internally stored in the module. This can also be taken into the PC via the USB cable. The TG series mini-spectrometer comes with evaluation software that lets you set measurement conditions, acquire and save spectrum data, and display it graphically. Basic measurements can be easily and quickly carried out with this software. Also supplied are a driver software package and a DLL file usable with Visual C++ and Visual Basic, allowing you to develop your own measurement programs.

Internal configuration

The following illustration shows the schematic diagram of a Hamamatsu TG-CCD series mini-spectrometer. The function of each element used in the TG-CCD series is explained below.



■ **Entrance slit**
This is an aperture through which light to be measured is guided inside. In most cases, the light to be measured is guided by an optical fiber connected to the entrance slit.

■ **Collimating lens**
The light passing through the entrance slit usually spreads at a definite angle. The collimating lens collimates this light and guides it onto the transmission grating.

■ **Transmission grating**
The Transmission grating disperses the light guided through the collimating lens according to the wavelength and lets light of the same wavelength pass at the same diffraction angle. This is the so-called wavelength dispersing element.

■ **Focus lens**
This lens forms an image of the light, which has passed through the transmission grating while being dispersed at the specific diffraction angles according to the wavelengths, onto the linearly arranged pixels of the image sensor that sequentially cover a spectral range from short to long wavelengths.

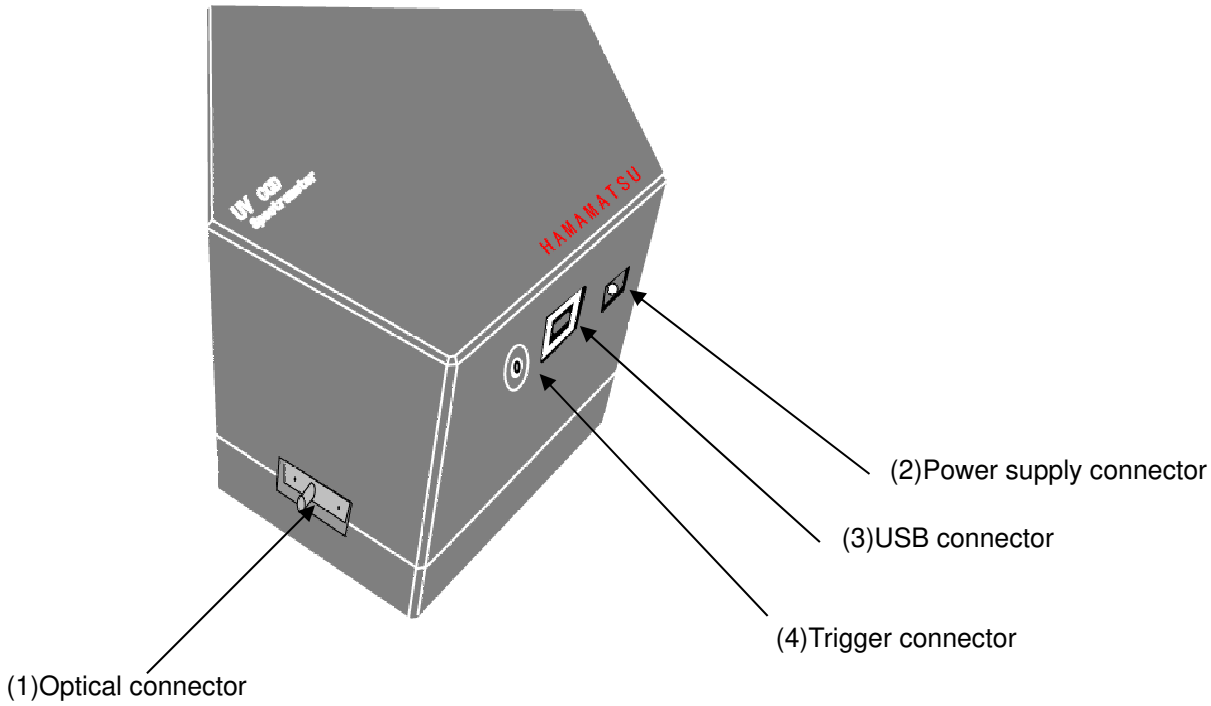
■ **Image sensor**
Converts the spectral data of light, which has been produced in the path between the entrance slit and the focus lens, into electrical signals.

Part name and description

Part names and functions of this product are described below.

■Mini-spectrometer main body

Contains optical elements used to disperse light into a spectrum and an image sensor circuit.



(1)Optical connector

This is the SMA905D receptacle. The optical fiber cable for guiding measurement light into the mini-spectrometer plugs in here. The entrance slit is located just inside this optical connector.
A cap is attached to this optical connector when shipped.

(2)Power supply connector

This is an AC adaptor jack. Use the supplied AC adaptor to make the connection for the external power supply.

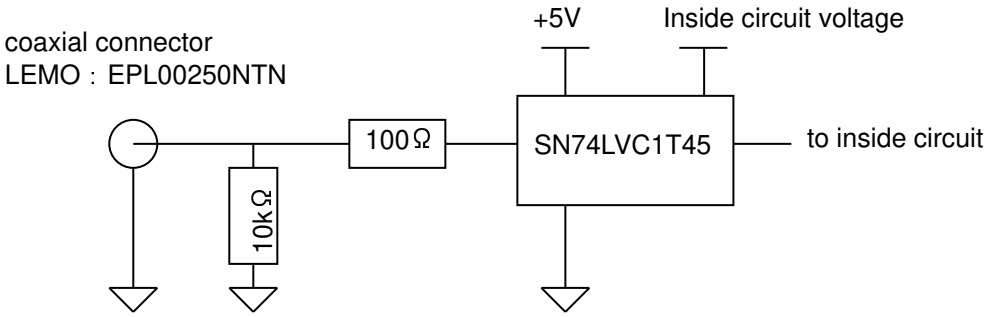
(3)USB connector

This is a USB B receptacle for connection to a PC. Use the supplied USB cable to make the connection.

(4)Trigger connector

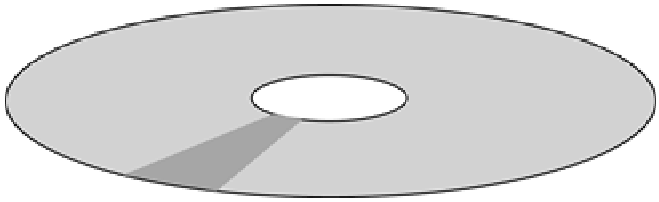
This is a coaxial connector receptacle for the external trigger function. In case of using external trigger function, connect the coaxial cable and input the external trigger signal.(0 - 5V)

Electrical circuit inside the mini-spectrometer is as follows.



■CD-ROM

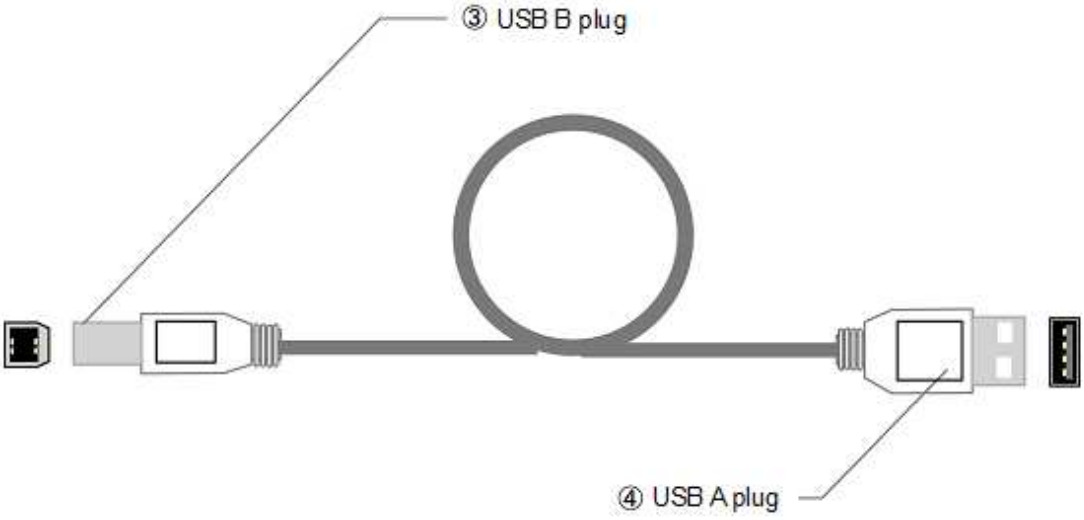
Contains related software and documents such as this instruction manual.



See the description of "Installing the software" in the separate " Mini Spectrometer Software Instruction Manual " for how to install the software.

■USB cable (1.5 m)

Use this USB cable to connect the mini-spectrometer to the PC.



（1）USB B plug

Connect this plug to the USB port of the mini-spectrometer.

（2）USB A plug

Connect this plug to the USB port of the PC.

■AC adaptor

Use this AC adaptor to connect the mini-spectrometer to the external power supply.

(1) **output　plug**

Connect this plug to the power supply connector of the mini-spectrometer.

(2) **Input　plug**

Connect this plug to the outlet for commercial power supply (AC100-240V 50/60Hz).

Connecting/disconnecting the mini-spectrometer

The following procedures explain how to make connections to the mini-spectrometer.

Use the USB cable to connect the mini-spectrometer to your PC. Spectral data of the light that entered the mini-spectrometer through the optical fiber cable is transferred to the PC via this USB cable.
External power supply is needed to drive the mini-spectrometer.

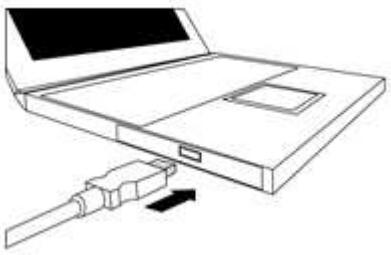
■Connecting the cables

CAUTION:
Always first install the evaluation software before connecting the mini-spectrometer to the PC. Otherwise, the software may not be installed.
(See the description of "Installing the software" in the separate " Mini Spectrometer Software Instruction Manual " for how to install the software.)

■ Procedure

(1) Connect the output plug of the supplied AC adaptor to the power supply connector of the mini-spectrometer. Connect the input plug of the AC adaptor to the outlet for commercial power supply (AC100-240V 50/60Hz).

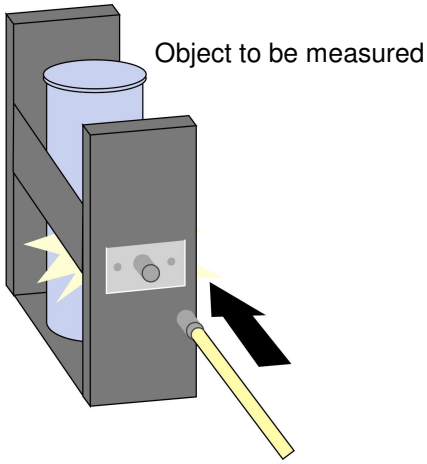
(2) Insert the USB A plug of the USB cable (supplied) into the USB port of the PC.



(3) Insert the USB B plug of the USB cable (supplied) into the USB connector on the mini-spectrometer.

(4) Remove the cap from the optical connector and attach one end of an optical fiber cable to the optical connector. (The end of the optical fiber cable should be cleaned before making this connection.) See the description in "C. Suitable optical fiber cables" in Appendix (p. 19) for selecting an optical fiber cable.

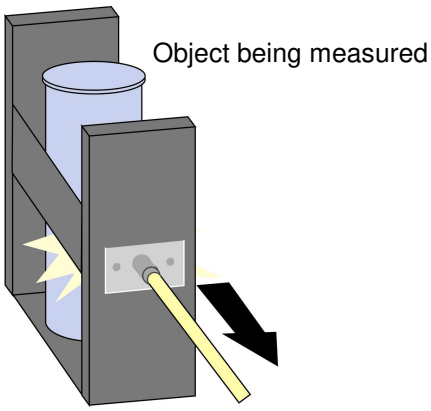
(5) Connect the other end of the optical fiber cable to the object (light) to be measured.



■ Disconnecting the cables

(1) Quit the mini-spectrometer software (evaluation software installed from the CD-ROM or user's own software).

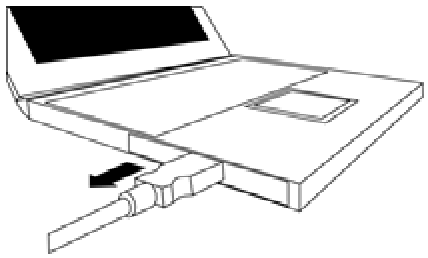
(2) Remove the optical fiber from the object (light) being measured.



(3) Remove the optical fiber cable from the optical connector of the mini-spectrometer and reattach the cap to the optical connector.

(4) Unplug the USB cable from the USB connector on the mini-spectrometer.

(5) Unplug the USB cable from the USB port of the PC.



(6) Disconnect the output plug of the AC adaptor from the power supply connector of the mini-spectrometer. Disconnect the input plug of the AC adaptor from the outlet for commercial power supply (AC100-240V 50/60Hz).

Warranty and repair

■ Warranty

When using this product please be sure to stay within the maximum ratings and comply with all caution items to avoid possible trouble or accidents. We are constantly making every effort to improve product quality and reliability but this does not guarantee complete safety when using this product. In particular, when this product is to be used in equipment or systems which might cause personal injury, fatal accident or damage to property if handled improperly, implement safety measures that take potential problems fully into account.

This product is warranted for a period of one year from the date of delivery. If you should find any failure in the workmanship and notify us within this warranty period, we will repair or replace it at our option, free of charge. (The warranty is limited to repair or replacement.) However, even if within the warranty period the warranty shall not apply to failures in cases where the product has been damaged by accidents such as natural or man-made disasters, or misused (including modification, incorrect handling without regard to the precautions, installation locations, applications, usage, storage and disposal described in this manual). Please acknowledge that we bear no liability for any problems caused by these cases.

■ Repair

If a failure is found or you suspect possible trouble, contact us with the specific problem and detailed description of the trouble, as well as the product model number and production number (serial number). We will make every effort to repair the product in as short a time as possible. In the following cases, however, the repair might require additional time and extra costs or might be refused.

(1) The product was purchased a long time ago.
(2) The maintenance parts used in the product are not in current production.
(3) The product was modified or altered.
(4) The product was severely damaged.

Appendix

A. Specifications

Parameter	TG-UV CCD		TG-SWNIR CCD	Unit
	C9404CA	C9404CAH	C9405CC	
Number of pixels	1024			-
Spectral response range	200 to 400		500 to 1100	nm
Wavelength resolution (FWHM) *1	3max.	1(typ.)	5max (550～900nm)	nm
Wavelength reproducibility *2	-0.1 to +0.1		-0.2 to +0.2	nm
Wavelength temperature dependence	-0.02 to +0.02			nm/°C
Spectral stray light *1, *3	-35max.		-35max.	dB
Slit *4	140(H)×500(V)	10(H)×1000(V)	70 (H)×800(V)	μm
AD conversion	16			bit
Integration time	10 to 10000			msec
Optical NA	0.11		0.22	-
Image sensors	Back-thinned CCD Image sensors			-
	S10420-1006-01		S16010-1006	
Optical fiber connector	SMA905D			-
Interface	USB 1.1			-
Current consumption (USB bus power)	100max.			mA
External power supply for driving	5			V
Operating temperature *5	+5 to +40			°C
Storage temperature	-20 to +70			°C
Dimensions	115.7 × 125.7 × 75			mm
weight	670			g

*1: Measured with the slit specified in this table. The wavelength resolution depends on the slit size.
*2: Measured under constant light input conditions.
*3: 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 ± 20 nm(C9404CA, C9404CAH) C9404CA/CAH: 300 nm C9405CC : 800nm
*4: Entrance slit aperture size
*5: Numerical aperture (solid angle)
*6: No condensation

Applicable standards

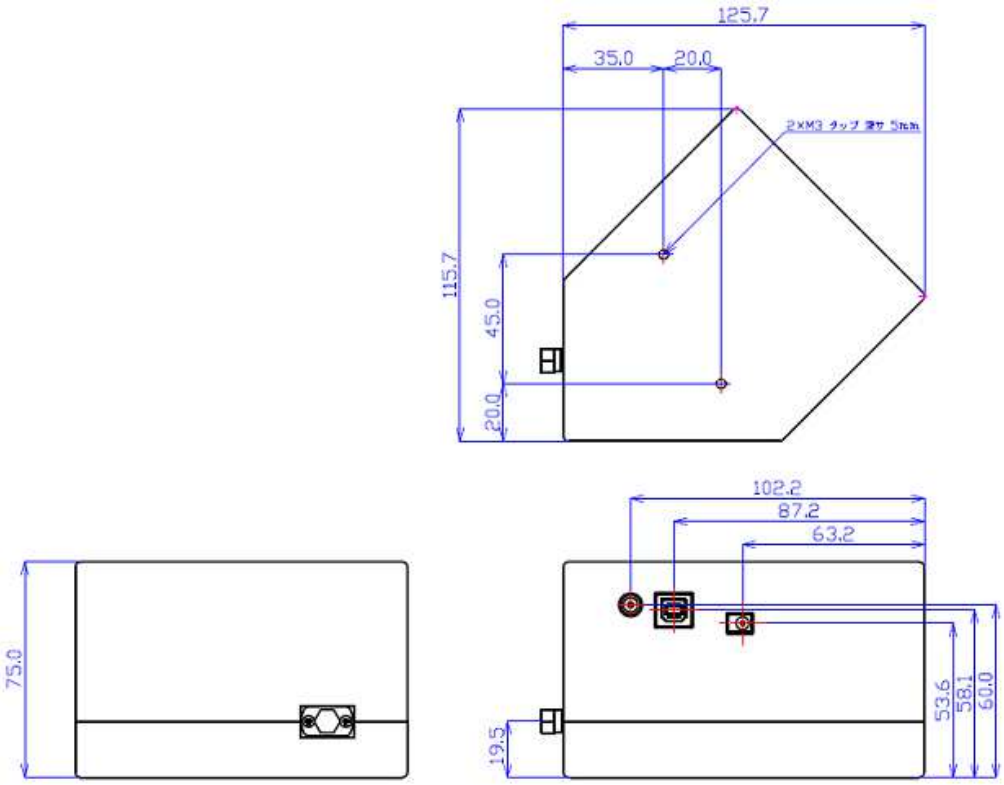
EMC	EN61326-1:2006 Group 1 Class B
SAFETY	EN61010-1 : 2010

NOTE: Use the USB cable (1.5 m) and AC adaptor (Ferrite core attachment items to a DC line) comes with this product.

Specifications of AC adaptor

item	specifications
specified input voltage and frequency	AC100V-240V 50Hz/60Hz
specified output voltage/ current	DC5.0V 2.0A
input current	0.28A less than (AC100VIN/AC240VIN 50/60Hz DC0A) （at 25 degree）
cable length between spectrometer and AC adaptor body	1200±100mm
cable length between AC adaptor body and outlet	1830±50mm
dimensional outline	50.6(W) x 75.0(D) x 29.8(H) mm
weight	96g±10g
acquired safety standard	Electrical Appliance and Materials Safety Law UL60950-1 EN60950
EMI	VCCI class B，FCC class B，CISPR 22 class B

B. Dimensional outlines (Unit: mm)



C. Suitable optical fiber cables

The following conditions are required for optical fiber cables used to connect to mini-spectrometers.

■ Optical fiber cables should have high transmittance in the spectral response range of the mini-spectrometer to be used or the spectral output range of the object (light) to be measured. This ensures more efficient and reliable measurement.

■ Optical fiber cables should have an optical NA (numerical aperture) of about 0.2 that optically matches the TG series mini-spectrometers. (Optical fiber with about 0.1 NA is available for C9404CA/CAH .) Adequate performance cannot be obtained if the NA differs significantly from these values.

■ Optical fiber should have a core diameter sufficiently larger than the width of the input slit of the mini-spectrometer. Measurement reproducibility is adversely affected if the core diameter is less than 3 times the width of the input slit.
An optical fiber with a larger core diameter is recommended when using a mini-spectrometer whose input slit height is larger than the core diameter of the optical fiber. This is because the larger the core diameter, the greater the amount of light that enters the mini-spectrometer for measurement, as long as the light flux density at the input end of the optical fiber is uniform.

■ The protective tube surrounding the optical fiber should have a good light shielding.
If the protective tube does not have good light shielding, then ambient light might penetrate inside the optical fiber as stray light and adversely affect measurement.

As optional accessories for the TM series mini-spectrometers, Hamamatsu provides optical fiber cables carefully selected to meet the above-mentioned conditions.

Type No.	Product name	Mini-spectrometer	Specifications
A15362-01	Optical fiber for UV/visible range (resistance to UV)	TG-UV CCD (C9404CA,C9404CAH)	Core diameter 600 µm, N.A.=0.22 Length 1.5 m, with SMA905D connector at both ends
A15362-02	Optical fiber for UV/visible range (resistance to UV)	TG-UV CCD (C9404CA,C9404CAH)	Core diameter 800 µm, N.A.=0.22 Length 1.5 m, with SMA905D connector at both ends
A15363-01	Optical fiber for visible/near infrared range	TG-SWNIR CCD (C9405CC)	Core diameter 600 µm, N.A.=0.22 Length 1.5 m, with SMA905D connector at both ends
A15363-02	Optical fiber for visible/near infrared range	TG-SWNIR CCD (C9405CC)	Core diameter 800 µm, N.A.=0.22 Length 1.5 m, with SMA905D connector at both ends

Refer to the following recommendations when selecting accessory optical fibers.

■ TG-UV CCD(C9404CA, C9404CAH)
We recommend using A15362-01 for most applications.

■ TG-SWNIR CCD(C9405CC)
We recommend using A15363-0 for most applications.
The A15363-02 may be used in applications requiring increased light input to the mini-spectrometer.

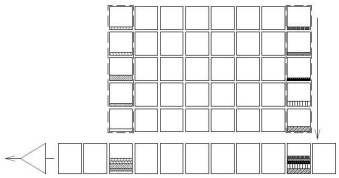
Use the A15362-02 or A15363-02 if a larger core diameter is needed due to the light source, object to be measured or the measurement system.

D. Image sensors

Optical information is dispersed into a spectrum by the grating. The spectrum is then linearly focused by the focusing lens onto a linear image sensor that converts light into an electrical signal at each wavelength of the spectrum.
The TG-CCD uses a back-thinned type CCD image sensor specially designed for spectrophotometry based on our long experience in image sensor technologies.
The image sensor outputs a photoelectric signal from each pixel at a certain time interval. This time interval is called "integration time" during which the photoelectric signal is accumulated in each pixel. The output signal level can therefore be optimized by adjusting the integration time. For example, even at low light levels, lengthening the integration time increases the output signal to a level where the signal can be easily processed.

· **Line binning**

Signal charges of CCD image sensor are accumulated in the potential well of each pixel in accordance with the integration time. When integration time finishes, signal charges are accumulated in each pixel in the second dimension as shown in figure below. Because shift registers both in vertical and horizontal are clocked separately, image sensor can be operated by so-called binning. TG-CCD series use line binning to add signal charges in the vertical direction.
In line binning signal charges can be added after converted by turns into the corresponding pixel in horizontal shift register with impressing the clock of shift registers in vertical and stopping the clock in horizontal.
By using the line binning it is enable to get the equivalent signal which one dimensional sensor with longer photo sensitive area in vertical can get. Further because readout of output is performed at a time, mixing of noise accompanied with readout can be minimized.

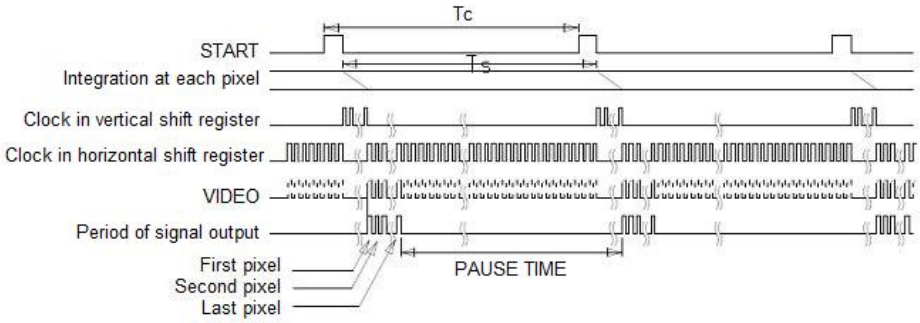


line binning

· readout timing

Charges read out from CCD image sensor by line binning are converted to output portion clocking the shift register.
In this method, the repetition time (Tc) equals the integration time (Ts). So the integration time set in the software supplied with the product matches the repetition time (Tc).
It takes about 1.1 ms to convert the signal from vertical shift register by line binning.
Signal readout from horizontal shift register is set to 2μs/pixel, so the readout time (Tr) can be expressed as follows:

$$Tr = 1.1\ ms + 2\ \mu s/pixel \times 1024\ pixel = 3.2msec$$

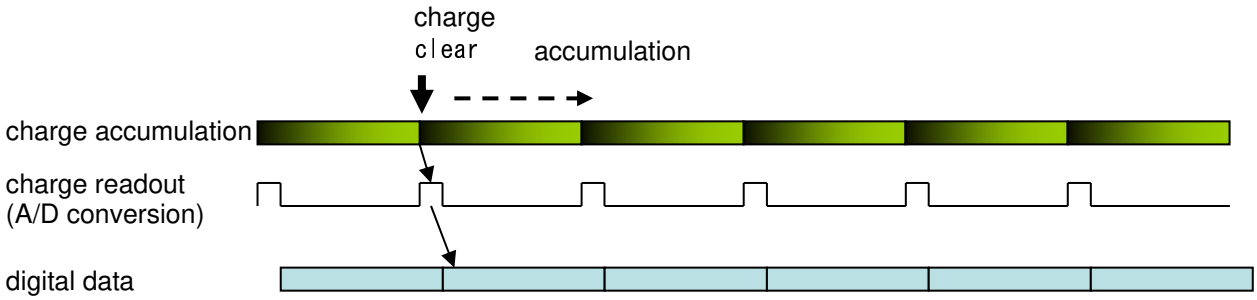


Repetition time (Tc) = Integration time (Ts) = Readout time(Tr)+Pause time
Timing chart

E. External trigger

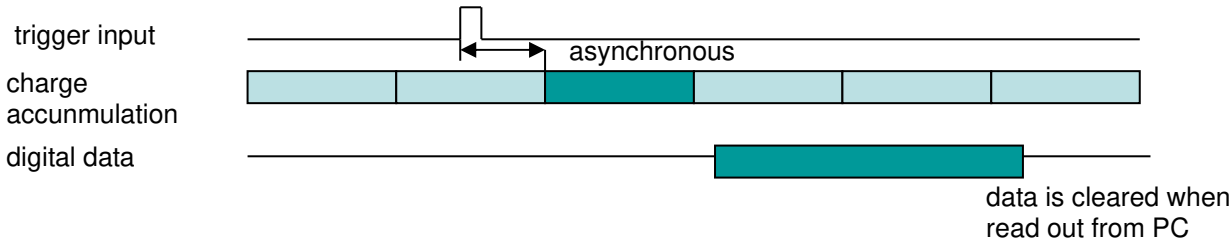
■ Free-run operation (normal operation mode)

Operating procedure of image sensor in normal operation mode is described as follows.
When light enters an image sensor, an electrical charge is generated in each pixel of the image sensor according to the incident light intensity. This charge accumulates in each pixel during the integration time and is cleared to zero during readout. This means that the charge must be read out before accumulating a newly generated charge.
In mini-spectrometer, this cycle of
"charge accumulation → charge readout (A/D conversion) → digital data hold"
repeats continuously.
Digital data after A/D conversion is continuously updated with data obtained in the last integration time. When a data request is received from the PC, the mini-spectrometer sends the most recent data at that point to the PC. Typical free-run operation mode is illustrated as follows.



■ Operation mode 1 during external trigger input

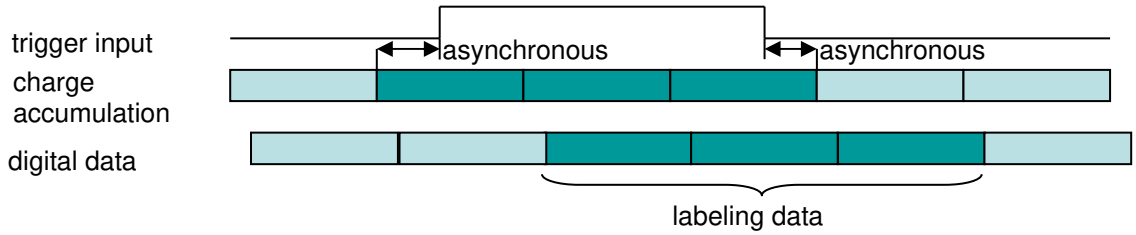
Operation mode 1 during external trigger input (data hold by trigger input) is illustrated as follows.
Though mini-spectrometer drives on free-run operation same as normal operation mode, the data to be held is controlled by trigger input. The mini-spectrometer internally holds digital data accumulated in the integration time that begins just after a trigger input edge (rising or falling edge selectable) is detected. This data being held is then reset when it is read out from the PC. If the next trigger is input while the data is still being held, then the data is updated to new digital data.



■ Operation mode 2 during external trigger input

Operation mode 2 during external trigger input (labeling to the digital data accumulated during trigger 〔gate〕 input) is illustrated as follows.

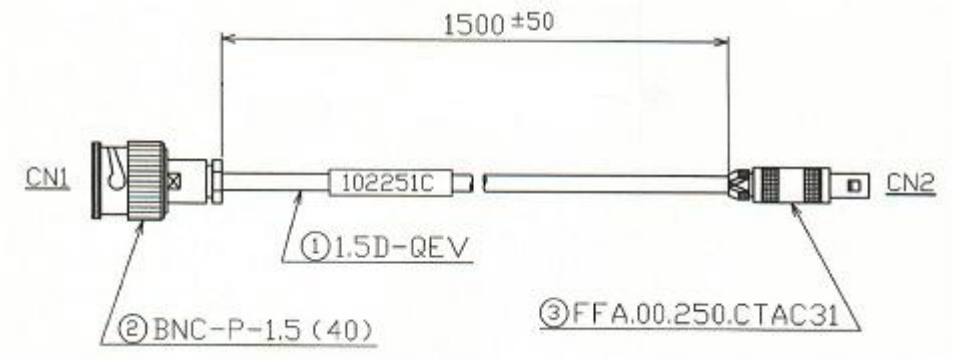
Though mini-spectrometer drives on free-run operation same as normal operation mode, this operation mode attaches a label to digital data during the gate period for external trigger input. When a trigger (High level or Low level selectable) is input, a label corresponding to data accumulated during trigger input is attached to the digital data. When each digital data is read out from the PC, that label information is obtained at the same time.



As the accessory for the external trigger input, a coaxial cable which has connector to fit the trigger connector receptacle of this mini-spectrometer on one end and BNC connector on the other end is prepared.

Accessory : coaxial cable A10670

CABLE：1.5DQEV(FUJIKURA)、FFA.00.250(LEMO)、BNC-P-1.5（40）（HIROSE)



Release Notes

Version number	Revision date	Description
K29-B60919 Doc Version 1.0	Nov. 2010	First edition
K29-B60919A Doc Version 1.1	Mar. 2011	Added C9405CB Changed AC adaptor image Changed AC adaptor specifications Changed Dimensional outlines (Unit: mm)
K29-B60919B Doc Version 1.2	Jun. 2011	Changed A. Specifications Changed AC adaptor image
K29-B60919C Doc Version 1.3	Dec. 2012	Added applicable standards
K29-B60919D Doc Version 1.4	Apr. 2013	Deleted the part of words such as class Ⅰ apparatus "of" IEC61010 " To use the product safely". Changed Accessory
K29-B60919E Doc Version 1.5	Jun. 2013	Changed address
K29-B60919F Doc Version 1.6	Sep. 2014	Changed Internal configuration Changed supplied with the following items Changed Dimensional outlines (Unit: mm) Changed Electrical circuit Deleted C9405CA Changed A. Specifications
K29-B60919G Doc Version 1.7	Feb. 2016	Changed Applicable standards Changed Specifications of AC adaptor
K29-B60919H Doc Version 1.8	Dec. 2016	Changed address
K29-B60919I Doc Version 1.9	Nov. 2017	Changed E.External trigger
K29-B60919J Doc Version 1.10	May. 2019	Changed C. Suitable optical fiber cables.
K29-B60919K Doc Version 1.11	Aug. 2020	Changed C9405CB to C9405CC. Added explanation about FCC rules to "CAUTION".

HAMAMATSU www.hamamatsu.com

HAMAMATSU PHOTONICS K.K., Solid State Division
1126-1 Ichino-cho, Higashi-ku, Hamamatsu City, 435-8558 Japan, Telephone: (81) 53-434-3311, Fax: (81) 53-434-5184
U.S.A.: Hamamatsu Corporation: 360 Foothill Road, Bridgewater, N.J. 08807, U.S.A., Telephone: (1) 908-231-0960, Fax: (1) 908-231-1218
Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone: (49) 8152-375-0, Fax: (49) 8152-265-8
France: Hamamatsu Photonics France S.A.R.L.: 19, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone: 33-(1) 69 53 71 00, Fax: 33-(1) 69 53 71 10
United Kingdom: Hamamatsu Photonics UK Limited: 2 Howard Court, 10 Tewin Road, Welwyn Garden City, Hertfordshire AL7 1BW, United Kingdom, Telephone: (44) 1707-294888, Fax: (44) 1707-325777
North Europe: Hamamatsu Photonics Norden AB: Torshamnsgatan 35 16440 Kista, Sweden, Telephone: (46) 8-509-031-00, Fax: (46) 8-509-031-01
Italy: Hamamatsu Photonics Italia S.r.l.: Strada della Moia, 1 int. 6, 20020 Arese (Milano), Italy, Telephone: (39) 02-93581733, Fax: (39) 02-93581741
China: Hamamatsu Photonics (China) Co., Ltd.: B1201, Jiaming Center, No.27 Dongsanhuan Beilu, Chaoyang District, Beijing 100020, China, Telephone: (86) 10-6586-6006, Fax: (86) 10-6586-2866