

HAMAMATSU

MINI-SPECTROMETERS

TG Series (C9406GC)

TG-COOLED Series (C9913GC, C9914GB)

TM Series (C10082MD, C10083MD)

TG-CCD Series (C9404CA, C9404CAH, C9405CC)

TM-CCD Series (C10082CA, C10082CAH, C10083CA, C10083CAH)

TG-RAMAN Series (C11713CA, C11714CA, C11714CB)

SOFTWARE INSTRUCTION MANUAL

Version 1.12

Introduction

Thank you for purchasing this Hamamatsu mini-spectrometer.

This instruction manual describes the software used with Hamamatsu mini-spectrometers. Most of this manual describes the evaluation software that comes supplied with the mini-spectrometer. For information about how to use the mini-spectrometer and how to install, connect and operate it, refer to the separate "Hardware Instruction Manual". To use the mini-spectrometer safely and correctly, read both manuals carefully before use and comply with the instructions.

CAUTION

Hamamatsu RC Series mini-spectrometer do not operate with this evaluation software.

Likewise, the TG series, TG-COOLED, TM, TG-CCD and TM-CCD Series mini-spectrometers do not operate with the evaluation software for RC Series. Be sure to use the evaluation software that matches the mini-spectrometer you are using.

Moreover, it is recommended not to run the evaluation software before the evaluation software CD-ROM Ver10.XX.XXXX(X is arbitrary number) for TG series, TG-COOLED and TM series and the evaluation software before the evaluation software CD-ROM Ver10.XX.XXXX(X is arbitrary number) for RC series simultaneously with this evaluation software. Whenever the relevant evaluation software exists, please install this evaluation software after uninstalling it. In case the evaluation software for TG series, TG-COOLED and TM series should exist at the same time with its for RC series, it is recommended to install the evaluation software by using CD-ROM after Ver11.XX.XXXX for both series.

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Installing the software

Components to be installed

The application CD-ROM supplied with the mini-spectrometer contains device drivers, evaluation software, documents for each mini-spectrometer, and development files that you will need when creating your own software. These are grouped by function and stored as several different components. You can specify which components should be installed in your PC.

To operate the mini-spectrometer, you must install the "EvaluationSoftware" component. Device drivers and evaluation software will also be installed when you install the "EvaluationSoftware" component. Using the evaluation software, you can easily operate the mini-spectrometer to immediately begin making measurements.

Other components for documents and development files are not mandatory to install. However, those files will be needed when you want to know more detailed information about mini-spectrometer operation or to create your own application software. If the hard disk of your PC has enough free space, we recommend installing all the components.

The contents of these components are described below. Refer to them when you install the components.

● EvaluationSoftware

This component contains the device drivers and evaluation software. You must install this component in your PC to operate the mini-spectrometer.

The device drivers are files needed to recognize the mini-spectrometer when it is connected to the PC.

The device drivers must therefore be installed before operating the mini-spectrometer from the PC.

When you connect the mini-spectrometer to the PC after installing the "EvaluationSoftware" component, the device driver will be automatically installed.

The evaluation software is a free software package supplied with a mini-spectrometer. It is designed to perform the basic operations of the mini-spectrometer easily. Upon installing the evaluation software, you can immediately start measurement using the mini-spectrometer, for example, to acquire data, draw the data graph in real time, and save the data. When two or more mini-spectrometers are connected to the same PC, this evaluation software also allows simultaneous operations.

● TG Series Document

This component contains a document for the TG series mini-spectrometer. The current version includes the following document.

"K29-B60910 TG Hardware Instrution Manual.pdf"

● TG-COOLED Series Document

This component contains a document for the TG-COOLED series mini-spectrometer. The current version includes the following document.

"K29-B60912 TG-COOLED Hardware Instrution Manual.pdf"

● TM Series Document

This component contains a document for the TM series mini-spectrometer. The current version includes the following document.

"K29-B60914 TM Hardware Instrution Manual.pdf"

● TG-CCD Series Document

This component contains a document for the TG-CCD series mini-spectrometer. The current version includes the following document.

"K29-B60919 TG-CCD series Hardware Instrution Manual.pdf"

● TM-CCD Series Document

This component contains a document for the TM-CCD series mini-spectrometer. The current version includes the following document.

"K29-B60916 TM-CCD series Hardware Instrution Manual.pdf"

- **TG-RAMAN Series Document**

This component contains a document for the TG-RAMAN series mini-spectrometer. The current version includes the following document.

"K29-B61079 TG-Raman series Hardware Instrution Manual.pdf"

- **Features and Specifications Document**

This component contains a document for mini-spectrometer technical information. The current version includes the following document.

"Mini-spectrometer_Features and Specifications.pdf"

- **Common**

Common documents concerning the Spectrometer of each series are stored in this component.

Following file is included in the current version.

"K29-B60923 QuickStartGuideToMini-Spectrometers.pdf"

- **DeveloperTools**

This component contains development files for those users who want to develop their own application software. The current version includes the following files.

- Driver & DLL files

"winusb1.1TGTm.inf"	...	Mini-spectrometer setup information file
"winusb1.1TGTm.cat"	...	Mini-spectrometer security catalog file
" winusbcoinstaller2.dll "	...	Driver control file
" WdfCoInstaller01009.dll "	...	Driver control file
"specu1b.dll"	...	Mini-spectrometer driver

- Files for Visual C++

"K29-B60925 SpectrometerFunctionSpecifications.pdf"	...	Mini-spectrometer DLL function specifications (Visual C++)
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- Files for Visual Basic

"K29-B60927 SpectrometerFunctionSpecificationsForVB.pdf"	...	Mini-spectrometer DLL function specifications (Visual Basic)
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- Files for Visual C#

" K32-B60231 SpectrometerFunctionSpecificationsForC#.pdf"	...	Mini-spectrometer DLL function specifications (Visual C#)
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Installing the software

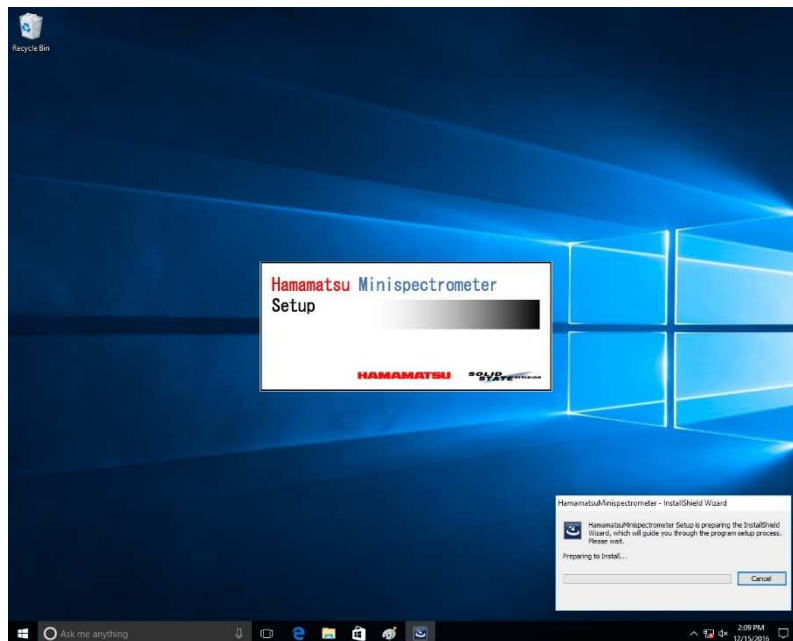
NOTE: Install the software into your PC only after you accept the terms in the "[Software license agreement](#)".

NOTE: Installing the evaluation software requires you to log in as a user with administrator rights.

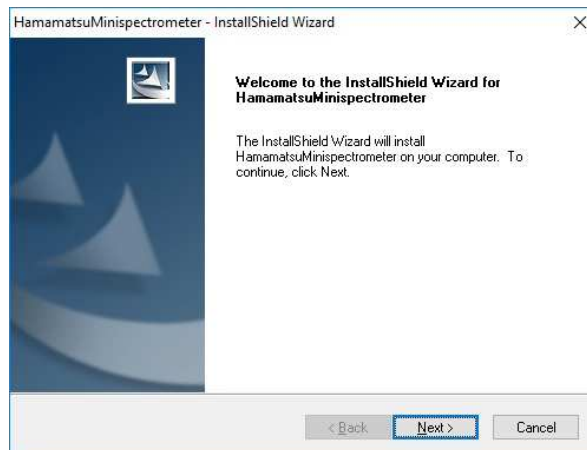
To install the software, always follow the procedure below.

[When installing the evaluation software into your PC for the first time]

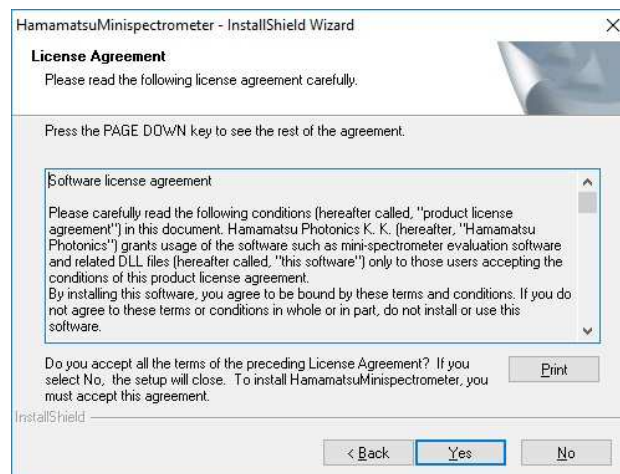
- (1) Insert the supplied CD-ROM into the CD-ROM drive of your PC. (At this point, the mini-spectrometer should not be connected to the PC.)
- (2) When the auto run for the CD is enabled, installation of the evaluation software automatically starts after inserting the CD-ROM into the CD-ROM drive. If the auto run is disabled, click "Start" > "Run". In the Run dialog box that appears, type "*drive*:\Setup.exe" (*drive* is the drive letter of your CD-ROM), for example, type "D:\Setup.exe" when the CD-ROM drive is "D". Then click [OK].
- (3) The Installer starts.



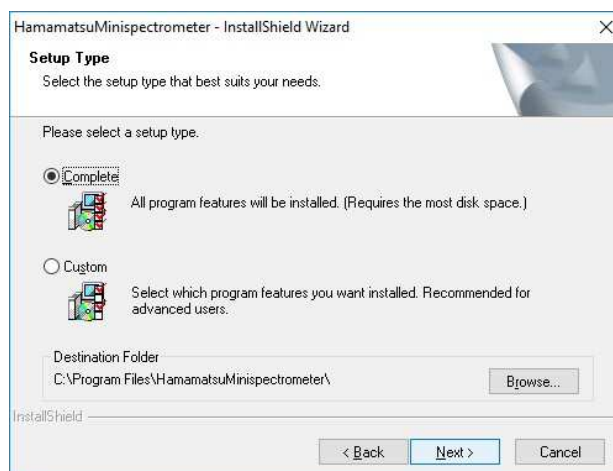
- (4) Click [Next] to continue.



- (5) When the license agreement screen appears, read through the contents carefully. If you accept the agreement, click [Yes].
NOTE: You may not install this software unless you accept the terms of the license agreement.



- (6) Select the components you want to install.
Selecting "Complete" install all components contained on the CD-ROM.
Selecting "Custom" allows you to select the components to install.
Select "Complete" in most cases.
TIP: For detailed information on each component, see ["Components to be installed"](#).



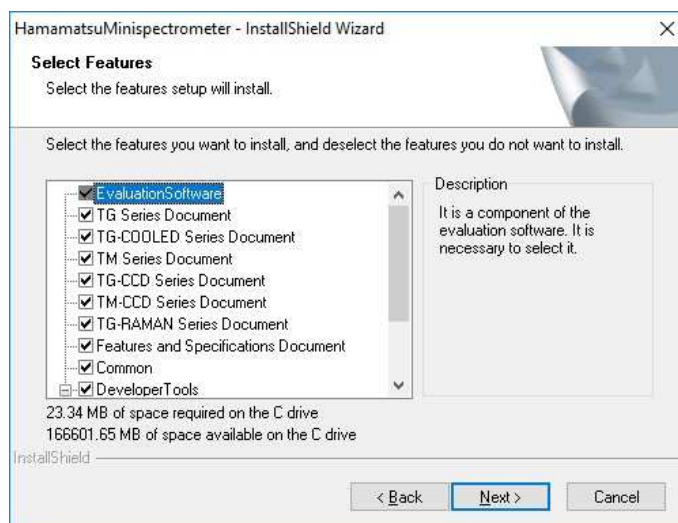
[When you selected "Custom"]

Select the components you want to install by placing a check mark and click [Next].

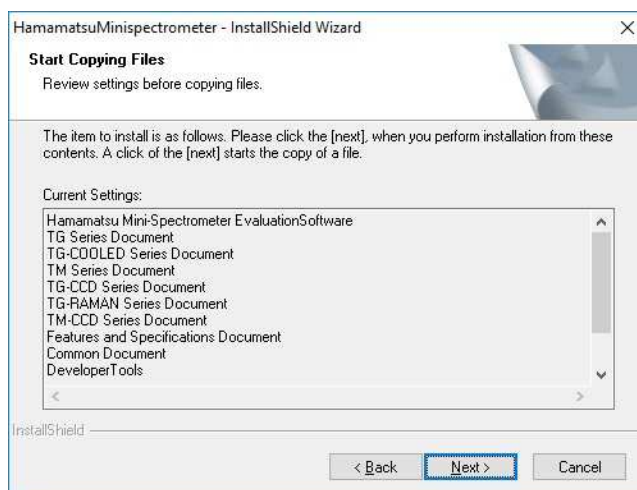
NOTE: You must select "EvaluationSoftware". (You cannot clear the " EvaluationSoftware " check box.)

TIP: For detailed information on each component, see [“Components to be installed”](#).

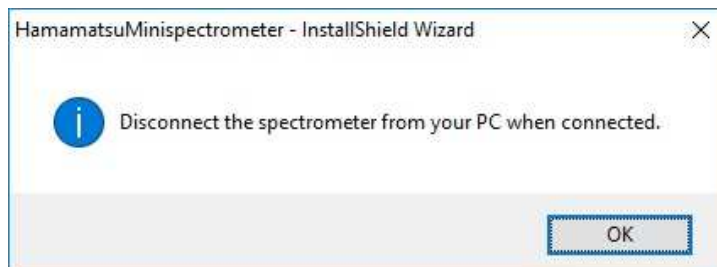
TIP: Components you do not select here can be added after software installation. For detailed information, see [“Changing the software functions \(adding/removing the components\)”](#).



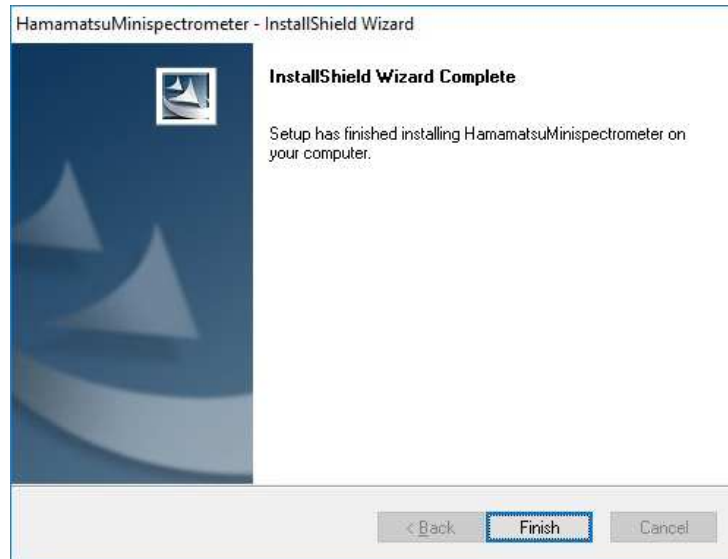
- (7) This confirmation screen appears before you start copying files. It shows a list of the components that will be installed. Click [Next] to continue.



- (8) If the mini-spectrometer is connected to the PC, disconnect the mini-spectrometer from the PC and then click [OK].



(9) The following screen appears when the installation is complete. Click [Finish].



Next, install the device driver.

- * If you connect each sort of mini-spectrometer to the PC for the first time, install the device driver for each sort of mini-spectrometer.
- * If you connect two or more mini-spectrometers to the PC, repeat the same procedure to install the device driver for each mini-spectrometer.
- * If you re-connect mini-spectrometer to the another USB port of PC, repeat the same procedure to install the device driver through each USB port.

When the mini-spectrometer is connected with PC, the driver is automatically installed.

Changing the installed software functions (adding/removing the components)

You can change the software functions by adding components that are not yet installed or removing the components already installed.

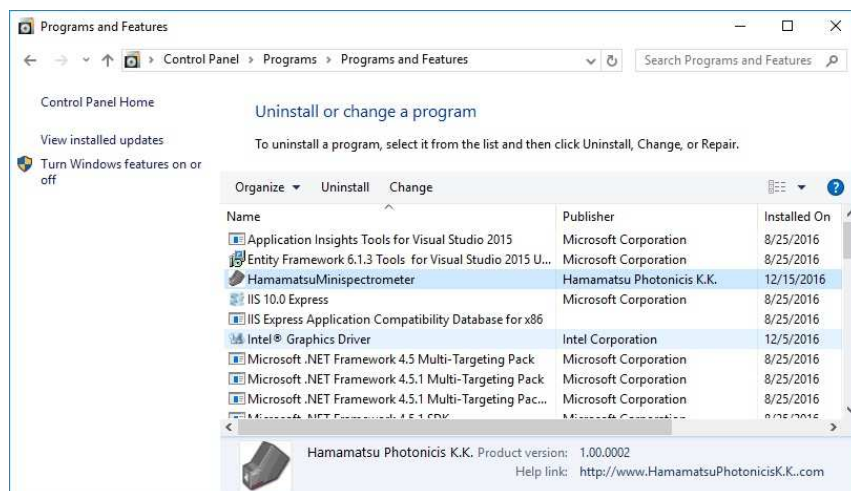
To change the software functions, always follow these steps.

(1) Click [Start], then select [Settings] > [Control Panel] to open the Control Panel.

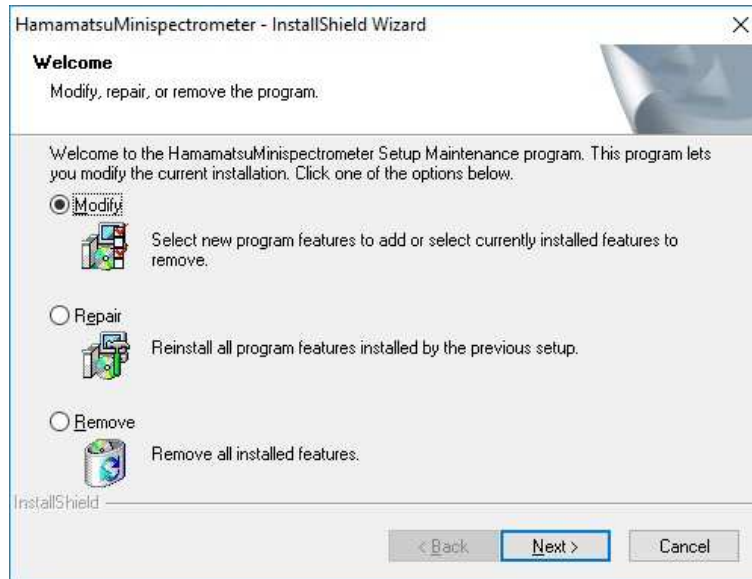
(2) In the Control Panel, select [Uninstall a Program].



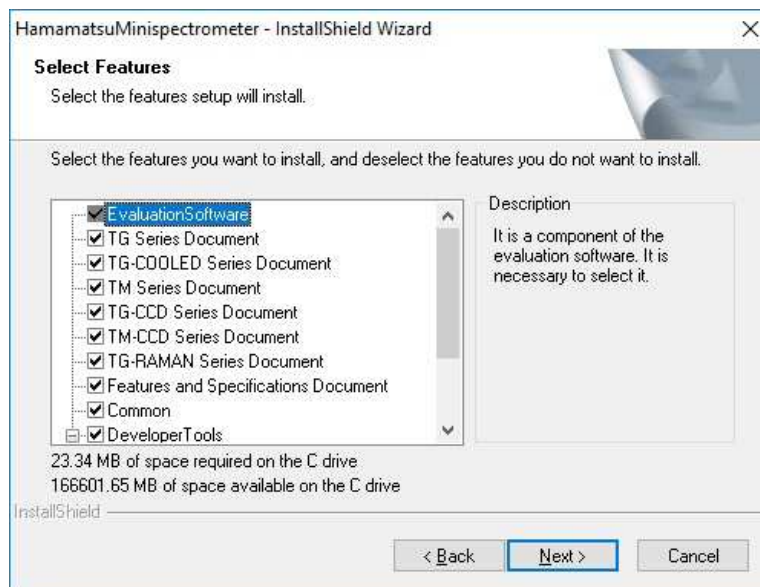
(3) In the "Add or Remove Programs" screen, select "Hamamatsu Minispectrometer" and click the [Change] button.



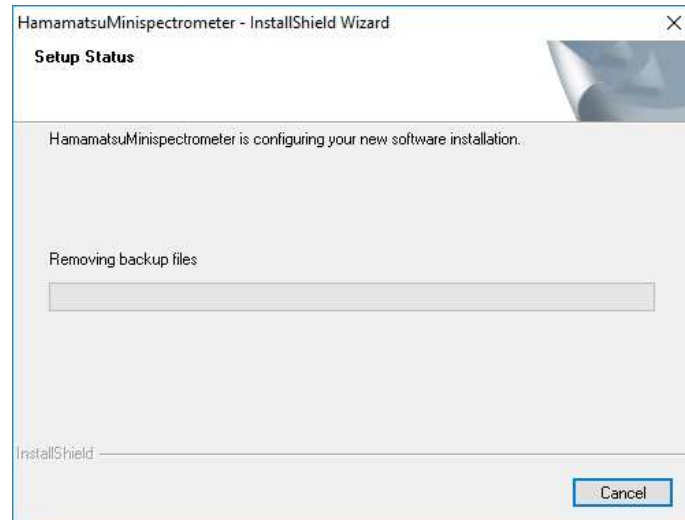
- (4) Select [Modify] and click [Next].



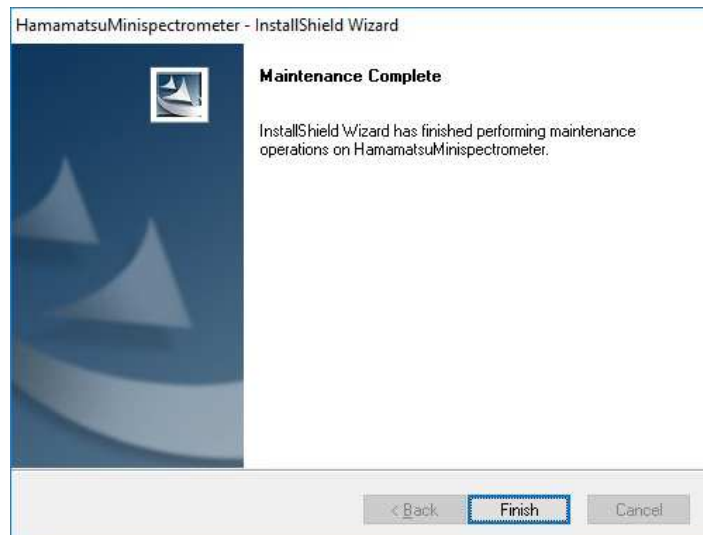
- (5) The following screen appears for selecting the software functions. Select the components you want to install by placing a checkmark. Items with a check mark will be installed, and items with no check mark will be removed or will not be installed. After selecting the desired components, click [Next] to continue.



(6) Maintenance starts.



(7) The following screen appears when maintenance is complete. Click [Finish].



Repairing the installed software functions

If for any reason an error occurs in the installed components, you can repair it. For example, if an essential file has been deleted, repairing the software functions reinstalls the deleted file automatically.

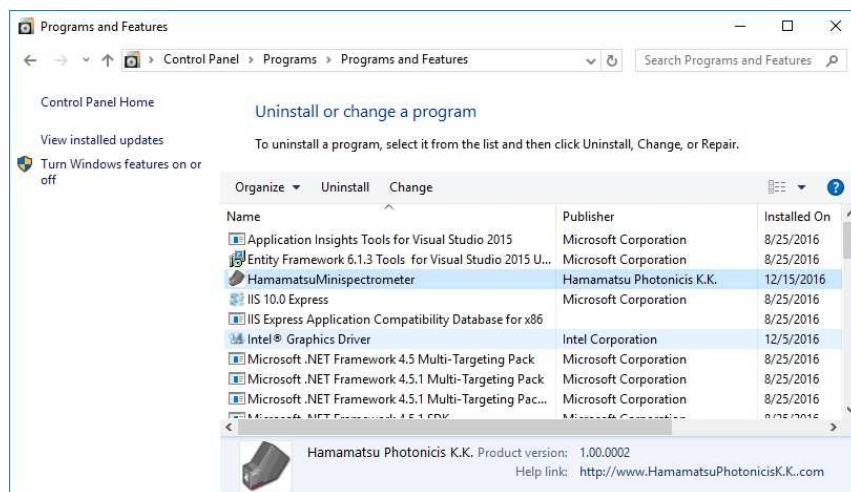
To repair the software functions, always follow these steps.

(1) Click [Start], then select [Settings] > [Control Panel] to open the Control Panel.

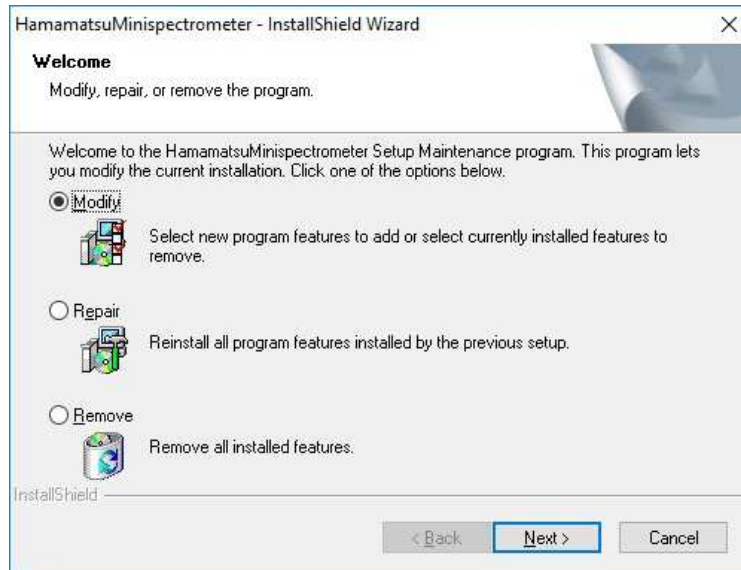
(2) In the Control Panel, select [Uninstall a Program].



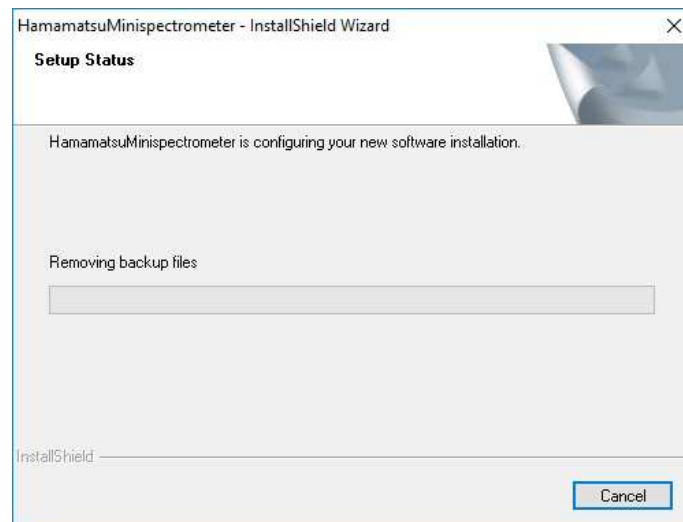
(3) In the "Add or Remove Programs" screen, select "Hamamatsu Minispectrometer" and click the [Change] button.



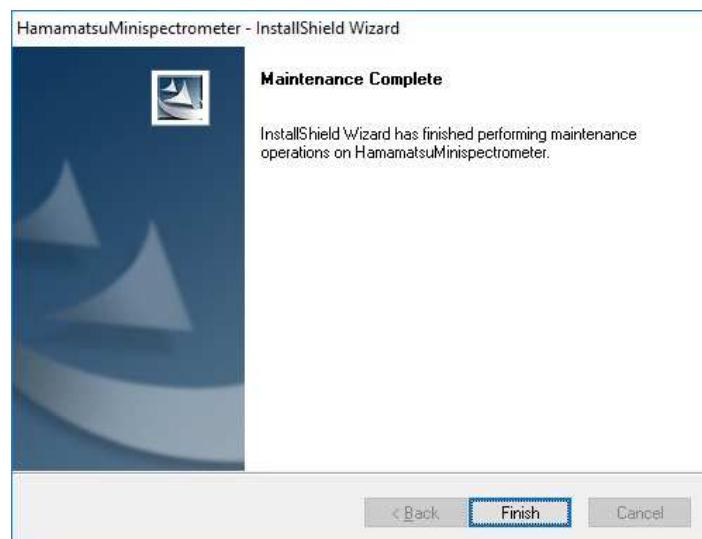
(4) Select [Repair] and click [Next].



(5) Maintenance starts.



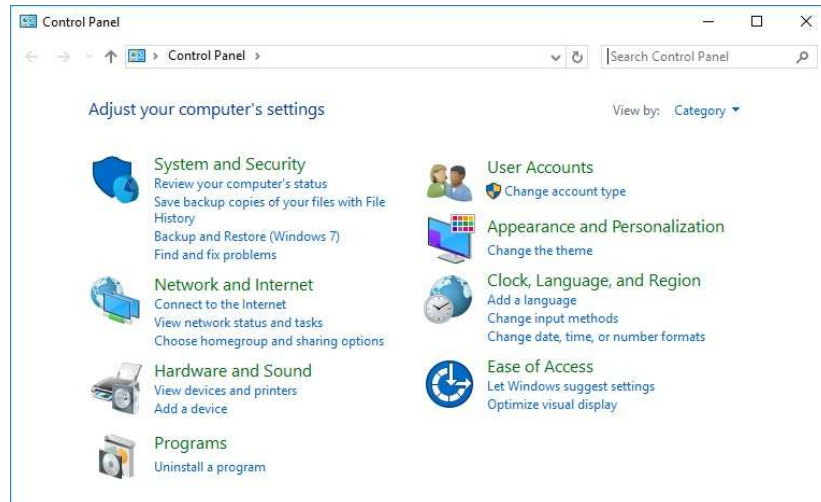
(6) The following screen appears when maintenance is complete. Click [Finish].



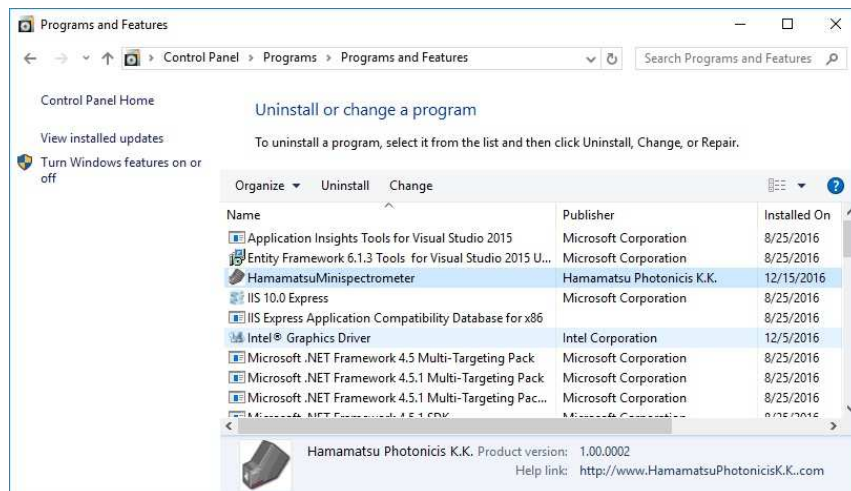
Uninstalling the software

Uninstalling the software removes all the components installed in your PC.
When uninstalling, please go after this software and all kinds' instruction manual end.
If you want to uninstall the software, always use the following procedure.
(The device drivers will also be uninstalled along with the software.)

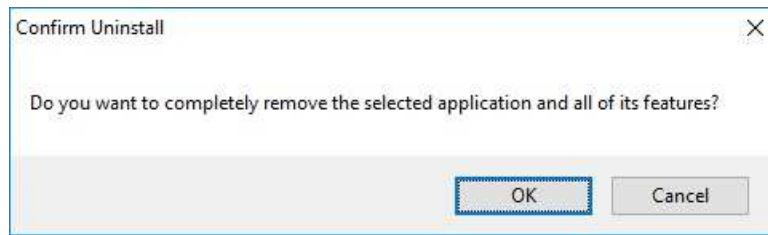
- (1) Click [Start], then select [Settings] > [Control Panel] to open the Control Panel.
- (2) In the Control Panel, select [Uninstall a Program].



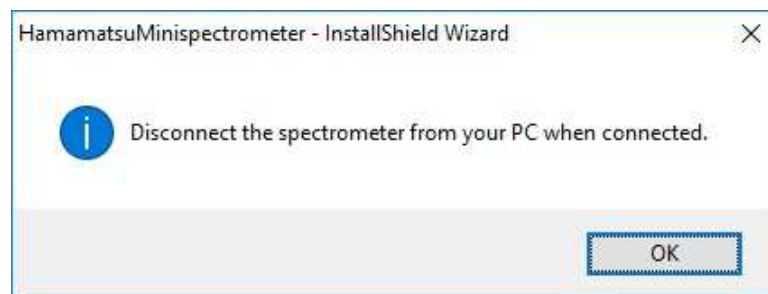
- (3) In the "Add or Remove Programs" screen, select "Hamamatsu Minispectrometer" and click the [Uninstall] button.



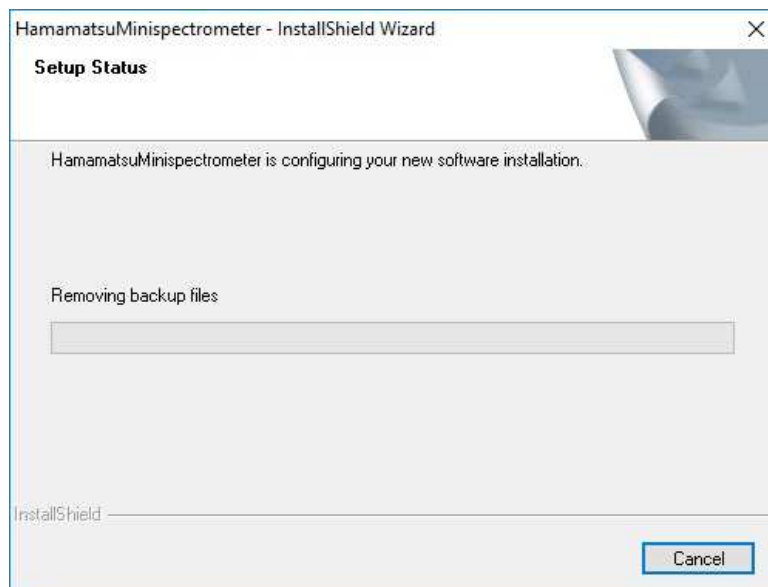
(4) The following confirmation dialog box appears. Click [OK] to continue.



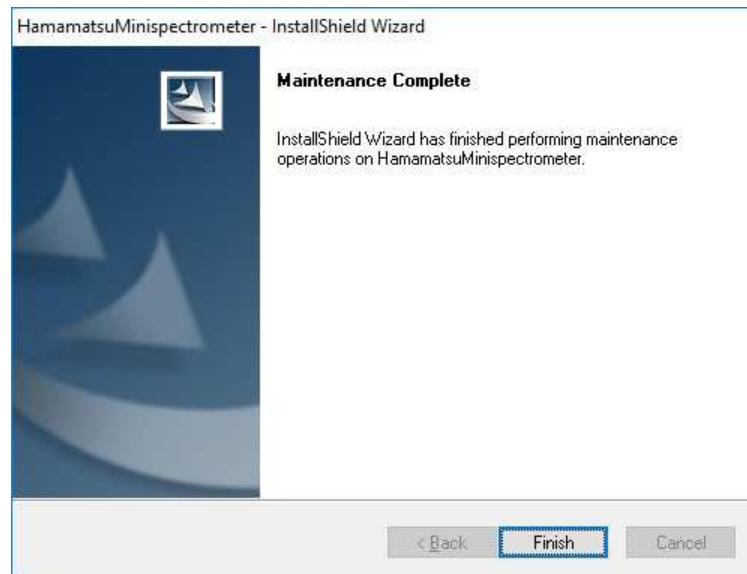
(5) If the mini-spectrometer is connected to the PC, disconnect it from the PC and click [OK].



(6) Uninstallation starts.



- (7) The following screen appears when uninstallation is complete. Click [Finish].



- (8) The following screen appears asking if you want to restart the PC. Select [Yes, I want to restart my computer now] and click [Finish].



Evaluation software

Overview

□ About the evaluation software

Hamamatsu mini-spectrometers (hereafter, mini-spectrometers) are designed to connect to a PC via the USB 1.1 interface. From the PC, you can easily operate mini-spectrometers while transferring measurement data to the PC.

The evaluation software is a free software package supplied with a mini-spectrometer and lets you easily perform the basic mini-spectrometer operations. After installing the evaluation software, you can immediately start measurement using the mini-spectrometer to acquire spectrum data, draw data graphs in real time, and save the data. When two or more mini-spectrometers are connected to the same PC, this evaluation software also allows simultaneous operations.

The evaluation software is compatible with all the following models of Hamamatsu TG series, TG-COOLED series, TG-RAMAN series and TM, TG-CCD, TM-CCD series mini-spectrometers.

(As of Oct. 2005)

Mini-spectrometer model	Spectral response range (nm)
TG-NIR (C9406GC)	900 to 1700
TG-UV CCD(C9404CA,C9404CAH)	200 to 400
TG-SWNIR CCD(C9405CC)	500 to 1100
TG-COOLED NIR-I (C9913GC)	900 to 1700
TG-COOLED NIR-II (C9914GB)	1100 to 2200
TG-RAMAN(C11713CA)	500 to 600
TG-RAMAN(C11714CA,C11714CB)	790 to 920
TM-UV/VIS (C10082MD)	200 to 800
TM-VIS/NIR (C10083MD)	320 to 1000
TM-UV/VIS CCD (C10082CA,C10082CAH)	200 to 800
TM-VIS/NIR CCD (C10083CA,C10083CAH)	320 to 1000

This evaluation software performs the basic mini-spectrometer operations. It is intended for evaluation purposes only. If you want to assemble it into your own system or configure measurement apparatus using a desired arithmetic operation, then you must create your own application software that meets your needs. When creating your own application software, see "[Creating your own application software](#)" of this manual or the separate "Function Specifications" manual.

□ System requirements

Evaluation software operation has been verified on the following systems. Operation on other systems is not guaranteed.

OS	Microsoft Windows 10 Pro 32bit, 64bit
.NET Framework	.NET Framework 3.5
Monitor	XGA(1024×768) or higher standards

To run this evaluation software, you must use a PC that meets the above system requirements. Although there are no other special requirements, we recommend using a PC with a high performance CPU and memory with a large capacity. You should keep this in mind when operating two or more mini-spectrometers simultaneously.

□ Limit on the number of connectable mini-spectrometers

USB supports simultaneous connection of up to 127 devices to a single PC. However, the maximum number of mini-spectrometers that can operate correctly is determined by hardware factors. For example, as an absolute requirement, there is an upper limit on the current consumption of the USB power. Because of this, increasing the number of mini-spectrometers will cause the current consumption to exceed the upper limit. So you must take into account the total current consumption when two or more mini-spectrometers are connected. In this case, we recommend connecting the mini-spectrometers via a powered USB hub that supplies its own power. With the evaluation software, up to 8 spectroscopes can be connected. For information on the current consumption of each mini-spectrometer, refer to the "Hardware Instruction Manual".

What the evaluation software does

Here is a quick reference of what this evaluation software does with the PC and mini-spectrometer.

● Measurement modes

The evaluation software operates in four measurement modes: Measure mode, Monitor mode, Dark mode and Reference mode. The table below shows what you can do in each mode.

Mode	Use to:	Features
Monitor mode	Monitor measurement data without saving it.	Graphically displays "pixel count vs. A/D output count" data in real time.
		Graphically displays "wavelength vs. A/D output count" data in real time.
		Cannot save measurement data.
		Performs dark subtraction.
		Displays reference data.
		Cannot set the number of measurement scans. (No limit on scan count).
Measure mode	Acquire and save measurement data.	Graphically displays "pixel count vs. A/D output count" data in real time.
		Graphically displays "wavelength vs. A/D output count" data in real time.
		Saves measurement data.
		Performs dark subtraction.
		Displays reference data.
		Specifies the number of measurement scans (up to 3000 scans).
Dark mode	Acquire data to perform dark subtraction	Graphically displays "pixel count vs. A/D output count" data in real time.
		Graphically displays "wavelength vs. A/D output count" data in real time.
		Saves measurement data.
Reference mode	Acquire reference data.	Graphically displays "pixel count vs. A/D output count" data in real time.
		Graphically displays "wavelength vs. A/D output count" data in real time.
		Saves measurement data.

● Arithmetic functions

The evaluation software also has the following arithmetic functions.

Function	Description
Dark subtraction	Acquires dark data and subtracts it from measurement data. Displays measurement data after dark subtraction.
Reference data measurement and display	Measures reference data and displays it graphically.
Gaussian fitting	Fits data in a specified range to Gaussian function.
Absorbance display	Absorbance can be displayed from measured dark offset value and reference data.

- **Limitations**

Parameter settings for measurement have the following limitations.

Parameter	Setting range
Integration time ^{*1}	5 ms to 10000 ms (specified in 0.001 ms steps)
Gain ^{*2}	High/Low (not selectable with some models)
Scan count (Number of scans)	Depends on the memory size and operation of your PC. (Not limited during Monitor mode)

- **Measurement data save**

Measurement data acquired during Measure mode, Dark mode and Reference mode can be stored.

Function	Description
Saves file in csv format	Saved data can be loaded with Microsoft Excel.

^{*1} For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.

^{*2} For a definition and description of gain, refer to the separate technical manual. To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

Using the evaluation software to make measurements

The following explains a simple procedure for making measurements with the evaluation software.
To make more sophisticated measurements, see the sections referred to in **TIP**.

□ Starting a measurement

[When using the TG-COOLED series]

When using the TG-COOLED series, connect the mini-spectrometer to an external power supply. Make sure the connections are correct and then turn on the external power supply.

See the description of "Connecting/disconnecting the mini-spectrometer" in the "Hardware Instruction Manual" to make the correct connections.

[When using the TG-CCD, TG-RAMAN, TM-CCD series]

When using the TG-CCD, TG-RAMAN, TM-CCD series, connect the mini-spectrometer to an AC adaptor.

See the description of "Connecting/disconnecting the mini-spectrometer" in the "Hardware Instruction Manual" to make the correct connections.

(1) Make the connections.

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

See the description of "Connecting/disconnecting the mini-spectrometer" in the "Hardware Instruction Manual" to make the correct connections.

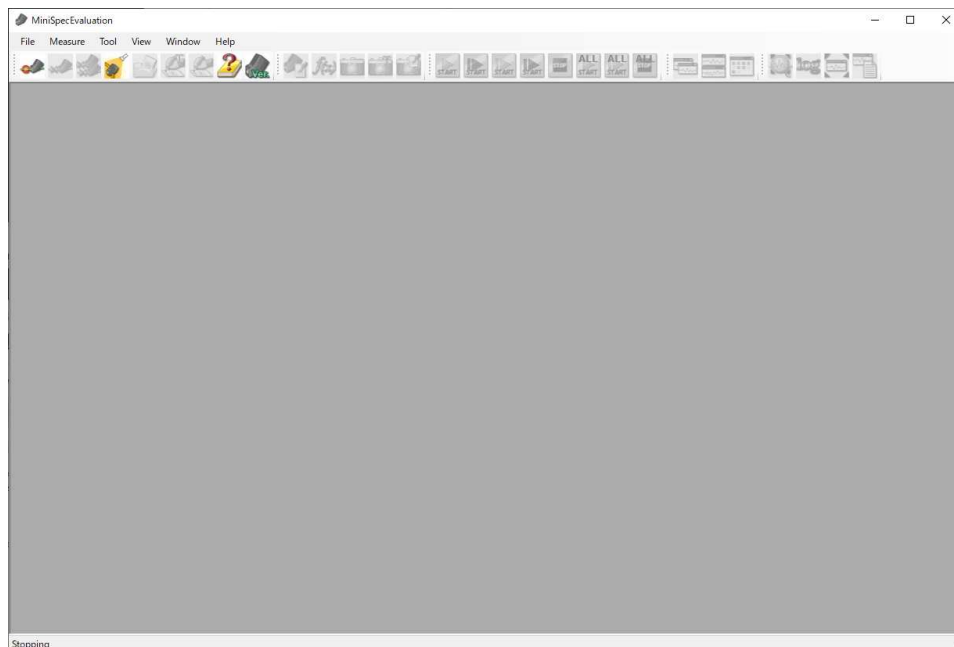
(2) Start the evaluation software.

After making the connections, start the evaluation software.




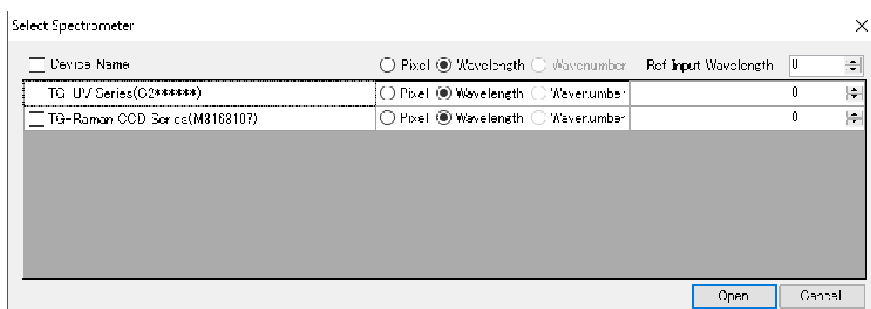
Double-click the short-cut icon on the desktop or select "Programs" > "HamamatsuMinispectrometer" > "EvaluationSoftware" > "SpecEvaluation" from the Windows Start menu.

The evaluation software starts and the following main window appears.



(3) Open the mini-spectrometer.

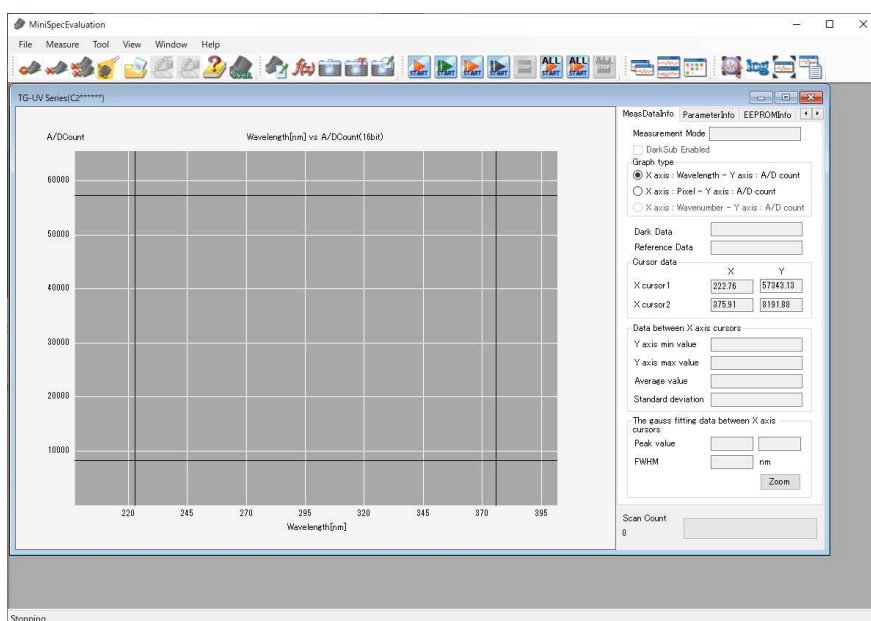
Click the  button on the Main tool bar or select "Open spectrometer" from the "File" menu in the main window.
The "Select Spectrometer" dialog box appears.



You must open (select) the mini-spectrometer you are going to use. Only the mini-spectrometer selected here can be controlled from the software.

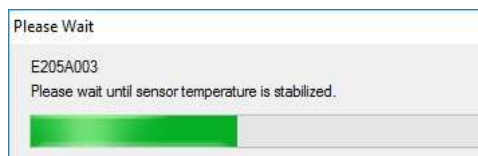
To open the mini-spectrometer, select it from the "Spectrometer (Unit ID)" drop-down list. You can also select the graph type by clicking the option button in the "Type of graph" group box. The "X axis: Wavelength [nm] - Y axis: A/D Count" option button is selected by default. The following procedures are explained assuming that this option button is selected. After selecting the mini-spectrometer, click the [Open] button.

When the selected mini-spectrometer is successfully opened, a graph window then appears as shown below.



If you want to open two or more mini-spectrometers, use the same procedure to open each one. The number of graph windows equal to the number of mini-spectrometers you have opened is displayed.


NOTE: The following message might appear when you open a mini-spectrometer of the TG-COOLED series.



The TG-COOLED series mini-spectrometer thermo-electrically cools the sensor to keep it at a constant temperature. After the power is turned on, it will take time until the sensor temperature becomes stable. Measurement cannot be performed during this cooling period. The above message disappears when the cooling temperature becomes stable. You can then start making measurements.

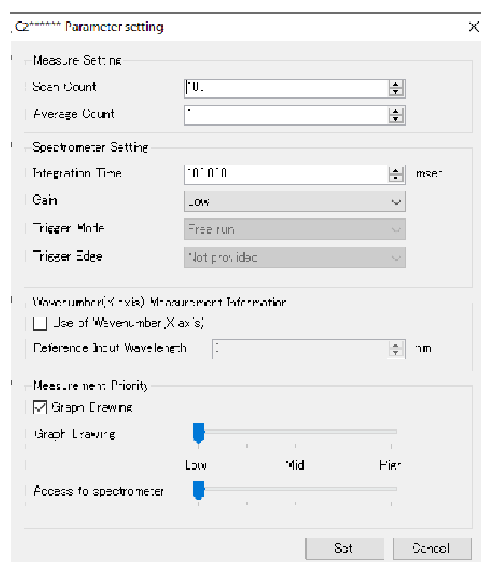
TIP: See also "[Evaluation software window](#)".

(4) Set the measurement parameters.

Click the  button on the Function toolbar or select "Parameter" from the "Tool" menu in the main window. The "Set Parameters" dialog box appears.

Set the parameters as needed and click the [Set] button.

(Default settings are as follows: Integration time^{*1} = 100 msec, Gain^{*2} = Low, Averaging = 1 scan, Trigger = Internal trigger mode)



TIP: See also "[Set Parameters](#)" dialog box.

^{*1} For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.


^{*2} For a definition and description of gain, refer to the separate technical manual. To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

(5) Start measurement.

The evaluation software operates in four modes: Measure mode, Monitor mode, Dark mode and Reference mode. This step explains Monitor mode - the most simple measurement mode. Monitor mode only acquires and displays measurement data graphically without storing it in the memory.

TIP: See "[Measurement modes](#)" for detailed information on other modes.




To start measurement in Monitor mode, click the  button on the Measure toolbar or select "Start Monitor mode" from the "Measure" menu in the main window. Measurement then starts.

TIP: The evaluation software includes several arithmetic functions useful for measurement. For more details on the arithmetic functions, see the description in "[Arithmetic functions](#)".

(6) Stop measurement.



To stop measurement, click the  button on the Measure toolbar or select "Stop" from the "Measure" menu in the main window. Measurement then stops.

□ Ending the measurement

(1) Quit the evaluation software

Select "Exit" from the "File" menu in the main window. The evaluation software then ends.

(2) Disconnect the devices

Disconnect the mini-spectrometer from the PC by referring to the description in "Connecting/disconnecting the mini-spectrometer" in the "Hardware Instruction Manual".

Evaluation software window

This section explains the basic elements that make up the evaluation software windows.

□ Main window

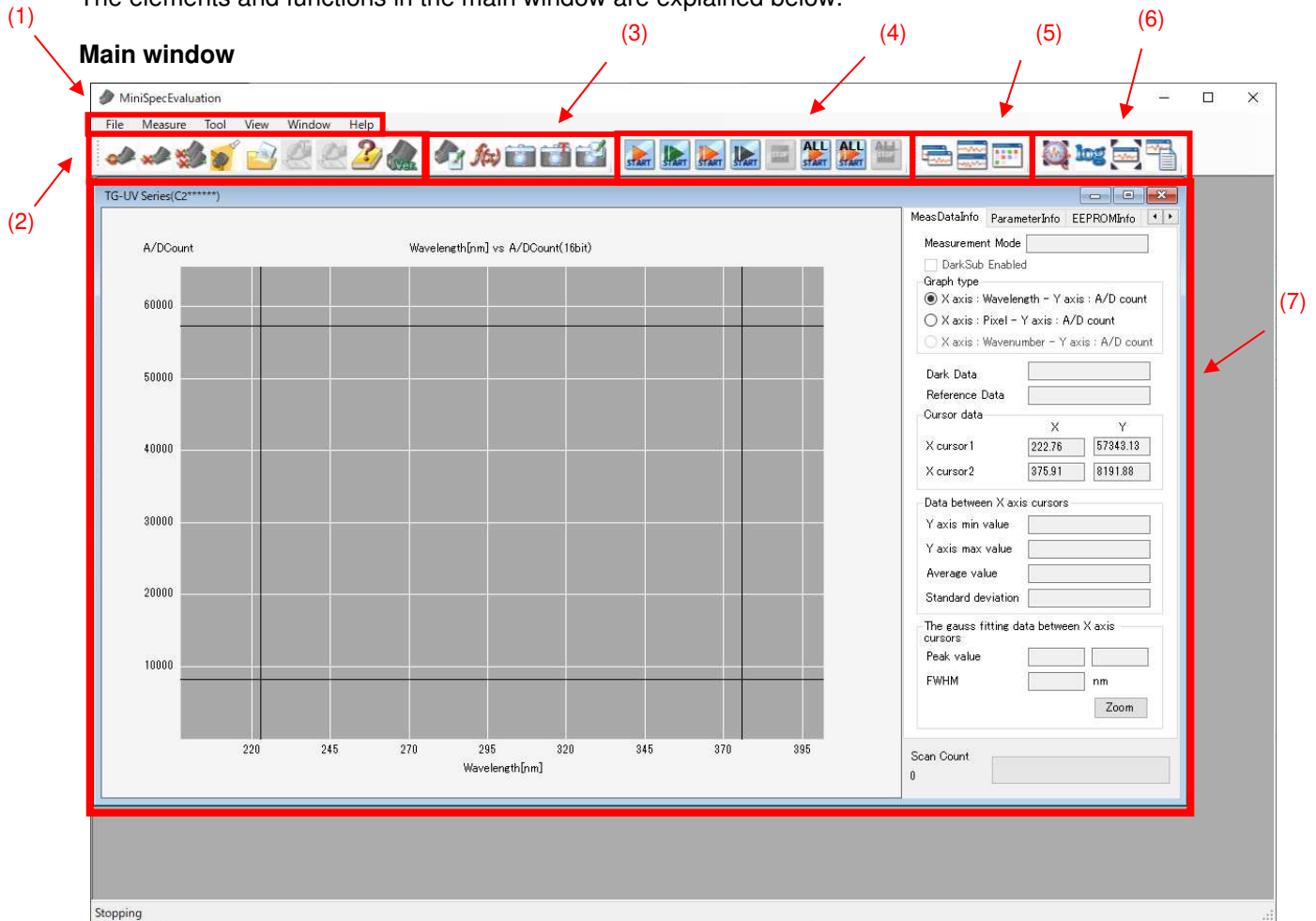
The main window contains a menu bar and various toolbars.

A small down arrow (▼) next to a toolbar button indicates there are more similar commands. Select the desired command from the list that appears by clicking the ▼ button. Each toolbar can be dragged to any position in the window, or can be hidden or redisplayed using the "View" menu on the menu bar.

The main window displays the number of graph windows that is equal to the number of mini-spectrometers you have opened.













The elements and functions in the main window are explained below.








Main window



(1) Menu bar

The menu bar at the top of the main window has several menus: "File", "Measure", "Tool", "View" and "Help". Each menu contains commands grouped by task. The table below shows what each menu does.

Menu	Command		Use to:	Toolbar button	
File	Open spectrometer		Open connected spectrometer.	Main toolbar	
	Close spectrometer		Close connected spectrometer.	Main toolbar	
	Close all spectrometers		Close all spectrometers.	Main toolbar	
	Update list		Update or refresh list of connected spectrometers.	Main toolbar	
	Load data file		Load dark data and reference data files.	Main toolbar	
	Save text data		Save acquired measurement data in text format.	Main toolbar	
	Save image data		Save displayed image.	Main toolbar	
	Exit		Exit application.		—
Measure	Start Monitor mode		Start measurement in Monitor mode.	Measurement toolbar	
	Start Measure mode		Start measurement in Measure mode.	Measurement toolbar	
	Start Dark mode		Start dark measurement.	Measurement toolbar	
	Start Reference mode		Start reference data measurement.	Measurement toolbar	
	Stop		Stop measurement.	Measurement toolbar	
	Start All Monitor mode		Start measurement in Monitor mode with all the opened spectro meters.	Measurement toolbar	
	Start All Measure mode		Start measurement in Measure mode with all the opened spectro meters.	Measurement toolbar	
	All Stop		Stop measurement with all the opened spectro meters.	Measurement toolbar	
Tool	Set parameters		Set measurement parameters.	Function toolbar	
	Arithmetic		Use arithmetic function.	Function toolbar	
	Copy	As image data	Copy image data to clipboard.	Function toolbar	
		As text data	Copy text data to clipboard.	Function toolbar	
		Set clipboard	Make clipboard settings.	Function toolbar	
Graph	Auto zoom		Use auto zoom.	Graph toolbar	
	Log scale		Change vertical axis to log scale.	Graph toolbar	

	Reset graph	Reset graph display area to initial state.	Graph toolbar	
	Graph information	Display graph information	Graph toolbar	
View	Status bar	Show or hide Status bar.		_____
	Main toolbar	Show or hide Main toolbar.		_____
	Measurement toolbar	Show or hide Measurement toolbar.		_____
	Function toolbar	Show or hide Function toolbar.		_____
	Window toolbar	Show or hide Window toolbar.		_____
	Graph toolbar	Show or hide Graph toolbar.		_____
Window	Cascade	Display graph windows so they overlap and the title bar of each window is visible.	Window toolbar	
	Tile	Display graph windows vertically or horizontally so they do not overlap.	Window toolbar	
	Arrange icons	Arrange graph windows when in icon mode.	Window toolbar	
Help	System	Display system information and settings.	Main toolbar	
	Version	Display software version information.	Main toolbar	

(2) Main toolbar

The Main toolbar contains icon buttons for opening/closing mini-spectrometers, updating the list of connected mini-spectrometers, loading/saving data and checking the software version.



(3) Function toolbar

This toolbar contains icon buttons for setting parameters and arithmetic operations, and capturing (copying) image/text data to clipboard.



(4) Measure toolbar

The Measure toolbar contains icon buttons for starting/stopping measurement and setting measurement conditions.



(5) Window toolbar

This toolbar contains icon buttons for displaying graph windows



(6) Graph toolbar

The Graph toolbar contains icon buttons for moving a displayed spectrum, zooming in/out a graph

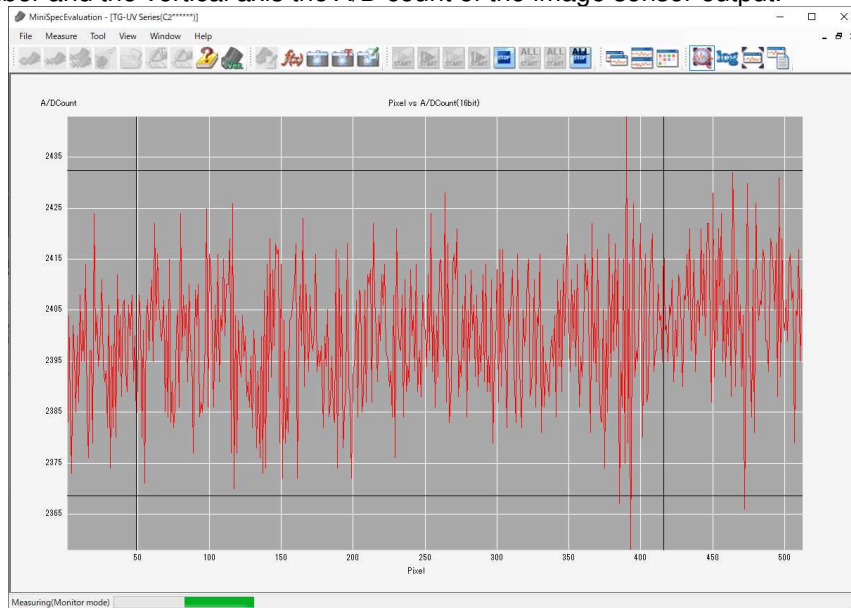


(7) Graph window

Displays measurement data graphically. The graph type can be selected from the following two formats.

○Pixel vs. A/D count graph

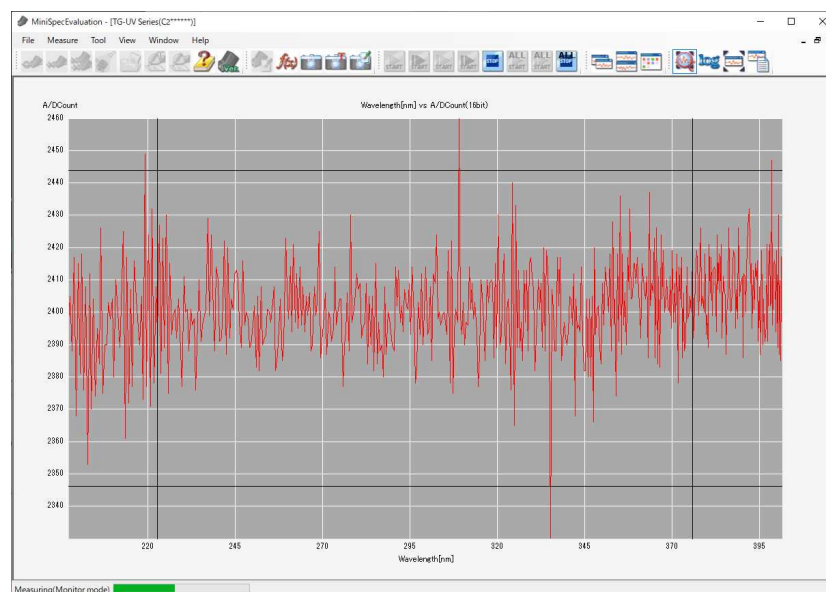
This graph displays row data obtained from the image sensor. The horizontal axis represents the pixel number and the vertical axis the A/D count of the image sensor output.



○Wavelength [nm] vs. A/D Count graph

This is a graph with the horizontal axis converted from pixel number to wavelength based on the row data obtained from the image sensor. The horizontal axis represents the pixel number, and the vertical axis the A/D count of the image sensor output. The horizontal axis is generated by polynomial approximation that was obtained in advance from calibration results obtained using an absolute reference light source. The vertical axis represents the A/D count of the image sensor output.

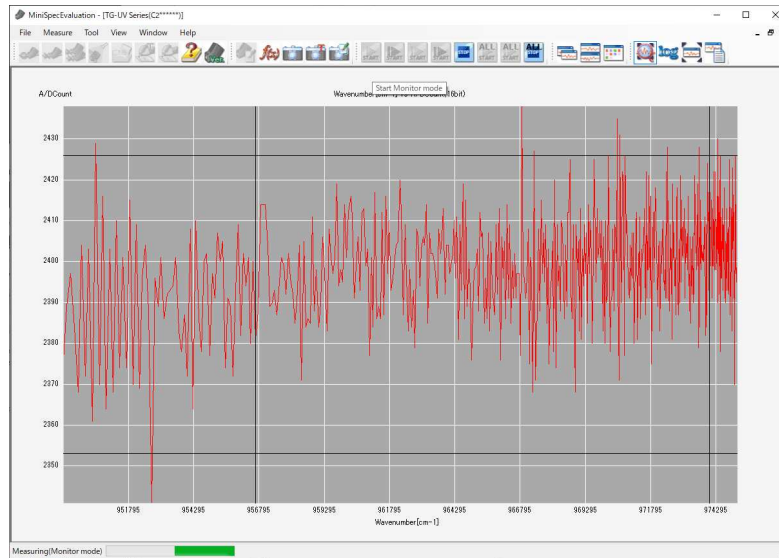
TIP: For detailed information on polynomial approximation, see "[Notes on the saved text data](#)".



○Wavenumber [cm-1] vs. A/D Count graph


This is a graph in which the horizontal axis is converted from pixels to wave numbers based on raw data Obtained from image sensors. The horizontal axis is generated from the values obtained in the same way as for the Wavelength [nm] vs. A / DCount graph, according to the following formula. The vertical axis shows the A / D count value of the image sensor output.

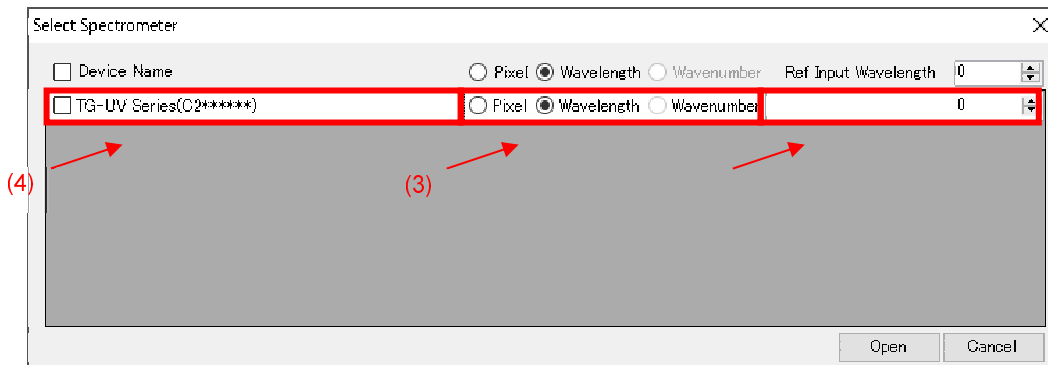
$$\text{Wavenumber} = \frac{10^7}{\text{Reference input wavelength}} - \frac{10^7}{\text{Wavelength}}$$



□ **Select Spectrometer" dialog box**

Use the "Select Spectrometer" dialog box to open (select) the mini-spectrometer you want to use. Only the mini-spectrometer(s) selected here can be controlled from the software.

The "Select Spectrometer" dialog box appears by clicking the  button on the Main toolbar or selecting "Open spectrometer" from the "File" menu in the main window. You can also specify here the type of the graph to be displayed.



(1) Spectrometer (Unit ID)

Select the mini-spectrometer you are going to use, from the drop-down list box that shows mini-spectrometers currently connected to the PC.

If you want to select all connected mini-spectrometers, use a check in [Device Name].

(2) Type of graph

Select the graph type to display data. The "Wavelength" is selected by default. If the mini-spectrometer's wavelength information is invalid, the "Pixel " will be selected.

Select the desired graph type by clicking the option button. Select the upper radio button to target all spectrometers.

(3) Using Reference input wavelength


Enter the value of the reference input wavelength to be used. If the value of the reference input wavelength is 1 or more, [Wavenumber] can be selected.

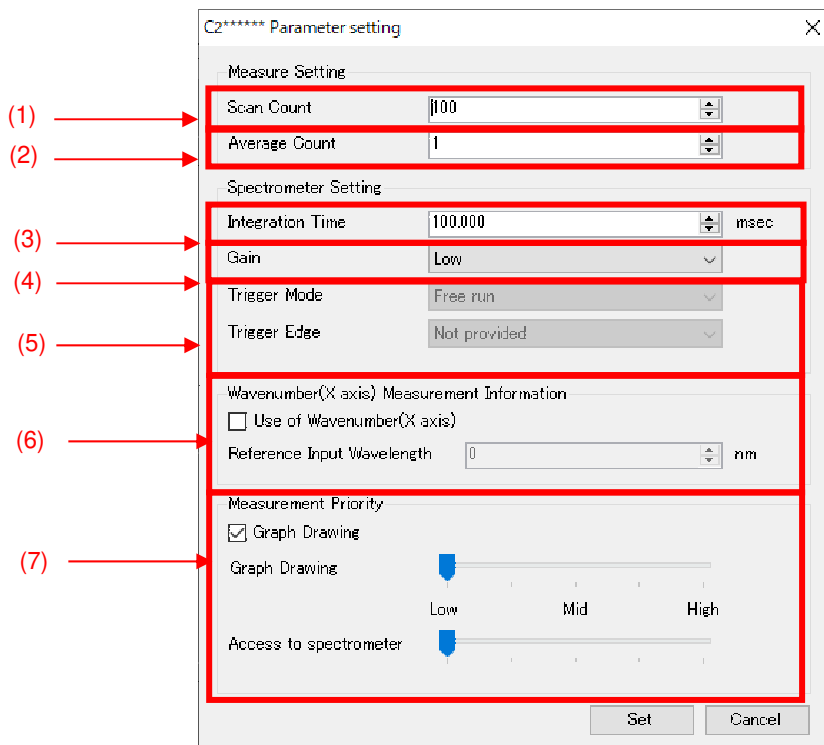
Use the edit box at the top to cover all spectrometers.

TIP: For detailed information on opening (selecting) the mini-spectrometer, see "[Opening/closing a mini-spectrometer and updating the list of mini-spectrometers](#)".

□ Set Parameters" dialog box

The "Set Parameters" dialog box allows you to set various parameters that control mini-spectrometer operation.

This dialog box appears by clicking the  button on the Function toolbar or selecting "Parameter" from the "Tool" menu in the main window. Here you can set the integration time^{*1}, gain^{*2}, averaging count, etc. Note that some parameters cannot be set depending on the mini-spectrometer model.



(1) Scan count

Specify the number of data to be saved. The setting range is from 1 to 5000 scans. However, the upper bound changes according to the performance of PC used. You can select the desired count from the drop-down list of the combo box that appears by clicking the small down arrow (▼). You can also directly enter a desired count from the keyboard, even if it is not listed in the combo box.

(2) Averaging

The evaluation software will display one profile (spectrum data) after averaging the data over the specified number of scans.

Specify the averaging count in the range from 1 to 255. You can select the desired count from the drop-down list of the combo box that appears by clicking the small down arrow (▼). You can also directly enter a desired count from the keyboard, even if it is not listed in the combo box.

note: If averaging function is selected with shorter integration time, (about shorter than 20 msec: depends on the performance of PC connected) mini-spectrometer may have a trouble in its operation taking

(3) Integration time

Specify the integration time in the range from 5 msec to 10 sec, in 0.001 msec steps. You can select the desired time from the drop-down list of the combo box that appears by clicking the small down arrow (▼). You can also directly enter a desired time from the keyboard, even if it is not listed in the combo box.

(4) Gain

Select the gain (High or Low) from the drop-down list.

Some mini-spectrometer models do not have the gain adjustment function, so this is disabled.

extraordinary longer measuring time. In this case enter the number of scans for averaging as 1.

(5) Trigger

This specifies the trigger mode for data acquisition. There are the three following modes in a trigger mode. Moreover, when labeling data is displayed with a trigger signal, a graph is displayed in orange.

• Free-run operation (normal operation mode)

Operating procedure of image sensor in normal operation mode is described as follows.

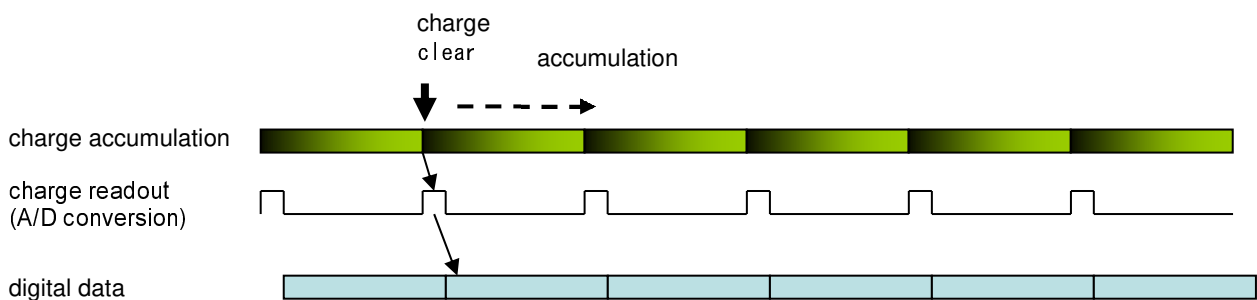
When light enters an image sensor, an electrical charge is generated in each pixel of the image sensor according to the incident light intensity. This charge accumulates in each pixel during the integration time and is cleared to zero during readout. This means that the charge must be read out before 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.

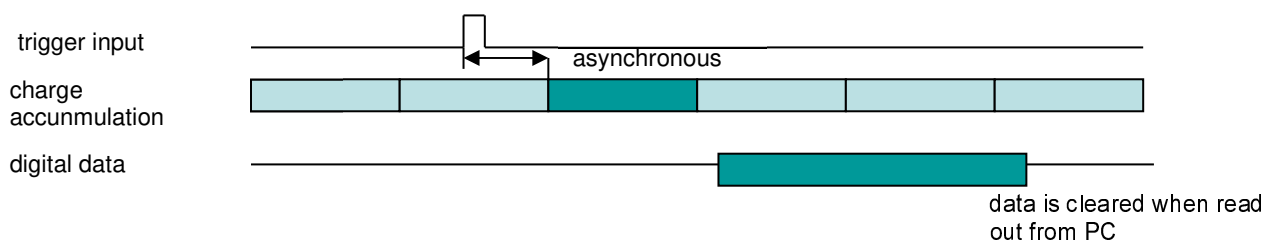


• Operation mode 1 during external trigger input

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.

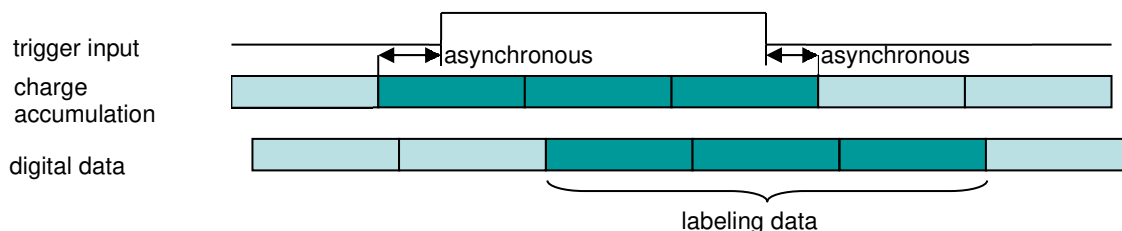
This data being held is then reset when it is read out from the PC. If the next trigger is input while the data is still being held, then the data is updated to new digital data.



• 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.



(6) kayser(X axis) Measurement Information

Set the reference input wavelength used for displaying the wave number. The specifiable values are from 0 to 9999 nm. Click the ▼ on the right side of the combo box to display the prepared values, from which you can select. Specifying a numerical value greater than 0 enables wavenumber axis display.

(7) Measurement operation priority

The priority of image drawing and communication with the mini-spectrometer can be selected. Both of these are preset to "Low" by default. When changing this setting, use the mouse to drag the slider. The higher the priority, the greater the percentage used for the processing. If the priority is set too high, the evaluation software processing takes up most of the CPU processing capability, causing problems with the OS operation. In worst cases the PC might lock up, so use caution. Using a PC with higher specs increases the CPU capability so that the evaluation software processing can be executed at a higher priority.

In most applications, using the default setting (Low) will not cause any problem.


^{*1}:For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.

^{*2} For a definition and description of gain, refer to the separate technical manual.

To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

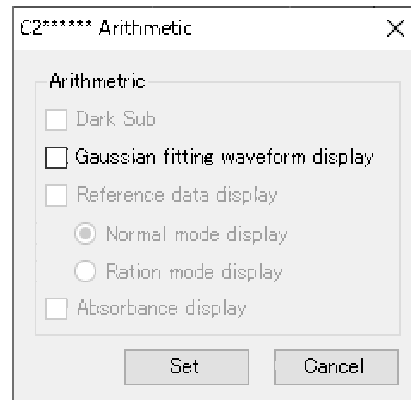
□ "Arithmetic Functions" dialog box

This dialog box allows you to enable or disable various arithmetic functions used for measurement.

This dialog box appears by clicking the  button on the Function toolbar or selecting "Arithmetic" from the "Tool" menu in the main window.

Available functions are dark subtraction, Gaussian function fitting and display, and reference data display (normal mode or ratio mode). Mark the check box for the function you want to use.

TIP: For detailed information on arithmetic functions, see "[Arithmetic functions](#)".

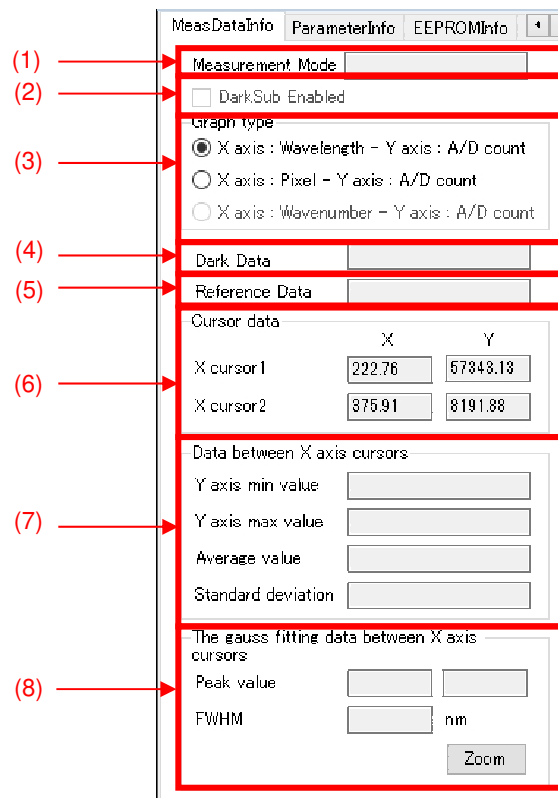


□ "Graph Information/Settings" dialog box

The "Graph Information/Settings" dialog box shows information on the currently active graph and also allows making detailed graph settings.

This dialog box appears by clicking the  button on the Graph toolbar or selecting "Graph information" from the "Tool" menu in the main window.

[Measurement Info] tab



(1) Mode

Shows the currently selected measurement mode.

TIP: For detailed information on measurement modes, see "[Measurement modes](#)".

(2) DarkSub Enable

Disp darksub status.

(3) Select graph type

Allows selecting the graph type that is displayed in the graph window.
Click the option button for the desired graph type.

(4) Dark data

Shows information on the currently retained dark data.
Shows "Data nothing" if no dark data is retained.

(5) Reference data

Shows information on the currently retained reference data.
Shows "Data nothing" if no reference data is retained.

(6) Cursor data

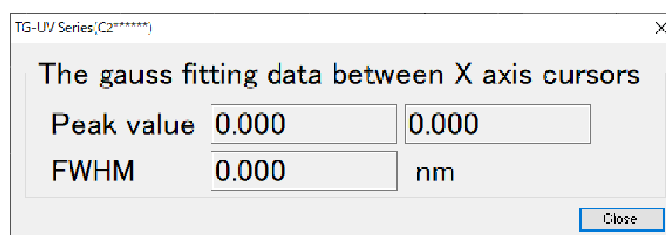
Shows the data at each cursor position displayed on the graph window.

(7) Data between X-axis cursors

Shows typical statistical data in the area enclosed by graph cursors

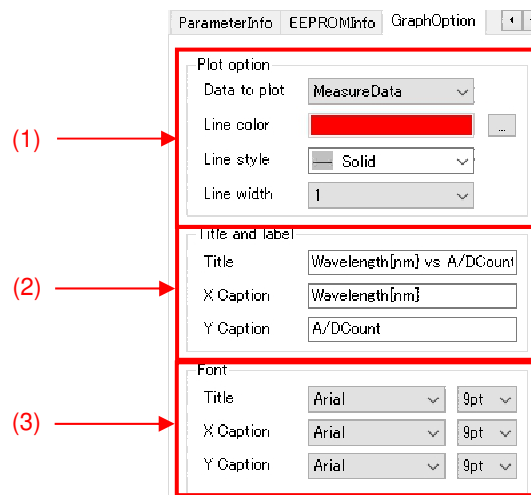
(8) Gaussian fitting data between X-axis cursors

Shows Gaussian fitting data information when the "Gaussian fitting waveform display" check box in the "Arithmetic Functions" dialog box is selected. You can enlarge the data by clicking on the zoom button.



TIP: For detailed information on the Gaussian fitting waveform display, see "[Gaussian fitting waveform display](#)".

[Graph Option] tab



(1) Plot option

Allows setting the line color, width and marker that are used to draw a waveform in the graph window.

Select the desired setting from each drop-down list that appears by clicking the down arrow (▼).

(2) Title and labels

Allows setting the title and labels for the graph.

Enter the title and labels as needed from the keyboard.

(3) Font

Set the font and font size of the title and axis label.

[Parameter Info] tab

ParameterInfo	EEPROMInfo	GraphOption	◀	▶
Scan Count	<input type="text" value="100"/>			
Average Count	<input type="text" value="1"/>			
Integration Time[msec]	<input type="text" value="100.000"/>			
Gain	<input type="text" value="Low"/>			
Trigger Mode	<input type="text" value="Free run"/>			
Trigger Edge	<input type="text" value="Not provided"/>			
Reference Input Wavelength[nm]	<input type="text"/>			

Shows the current parameter settings that you have set in the "Set Parameters" dialog box.

[EEPROM Info] tab

The screenshot shows the 'EEPROMInfo' tab with the following fields and values:

Field	Value
UnitID	C2*****
SensorName	S8878-5120
SerialNumber	***13***

Below these fields is a section titled 'Wavelength conversion coefficients' containing the following fields and values:

Field	Value
A0	1.966741082E+002
A1	5.627047270E-001
A2	-7.283092146E-004
A3	2.491058073E-006
A4	-4.972044719E-009
A5	8.266030221E-012

Shows EEPROM information on the mini-spectrometer.

(1) Unit ID

Shows the unit ID number of the mini-spectrometer on the active graph window.

(2) Sensor name

Shows the name of the image sensor installed in the mini-spectrometer on the active window.

(3) Serial No.

Shows the serial number of the mini-spectrometer on the active graph window.

(4) Wavelength conversion coefficients

Shows the wavelength conversion coefficients used by the mini-spectrometer on the active graph window.


Opening/closing a mini-spectrometer and updating the list of mini-spectrometers

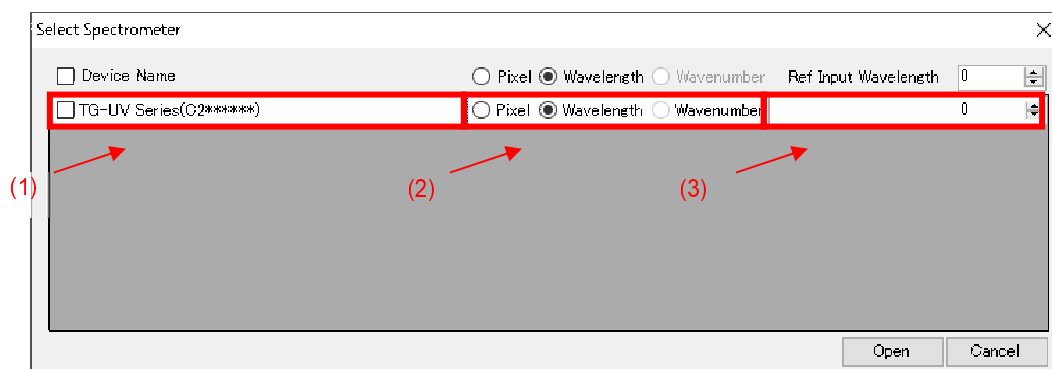
When this evaluation software starts up, it recognizes the mini-spectrometers connected to the PC via the USB cables, and makes a list of mini-spectrometers. To use a mini-spectrometer in this list, you must first open (select) it. To stop using the mini-spectrometer, you need to close it. If you have connected a mini-spectrometer after starting the evaluation software, then update or refresh the list.

This section explains how to open/close a mini-spectrometer and how to update the list of mini-spectrometers.

□ Opening a mini-spectrometer

This section explains how to open (select) a mini-spectrometer. Only the mini-spectrometer(s) selected here can be controlled from the software.

Click the  button on the Main toolbar or select "Open spectrometer" from the "File" menu in the main window. The "Select Spectrometer" dialog box appears to open (select) a mini-spectrometer. You can also specify here the type of the graph to display.



(1) Spectrometer (Unit ID)

Select the mini-spectrometer you are going to use, from the drop-down list box that shows mini-spectrometers currently connected to the PC.

If you want to select all connected mini-spectrometers, use a check in [Device Name].

(2) Type of graph

Select the graph type to display data. The "Wavelength" is selected by default. If the mini-spectrometer's wavelength information is invalid, the "Pixel" will be selected.

Select the desired graph type by clicking the option button. Select the upper radio button to target all spectrometers.

(3) Using Reference input wavelength


Enter the value of the reference input wavelength to be used. If the value of the reference input wavelength is 1 or more, [Wavenumber] can be selected.


Use the edit box at the top to cover all spectrometers.

□ Closing a mini-spectrometer

To stop using a mini-spectrometer, you must close it as explained below. You can close only the mini-spectrometer for the active graph window or close all mini-spectrometers at one time.

To close only the mini-spectrometer for the active graph window (top title bar highlighted in dark blue),


click the  button on the Main toolbar or select "Close spectrometer" from the "File" menu in the main window. The graph window that has been active will disappear and the mini-spectrometer with the corresponding unit ID number will close.

To close all mini-spectrometers that are open, click the  button on the Main toolbar or select "Close all spectrometers" from the "File" menu in the main window. All graph windows that have been displayed will disappear and all mini-spectrometers will close.

□ Updating the list of mini-spectrometers

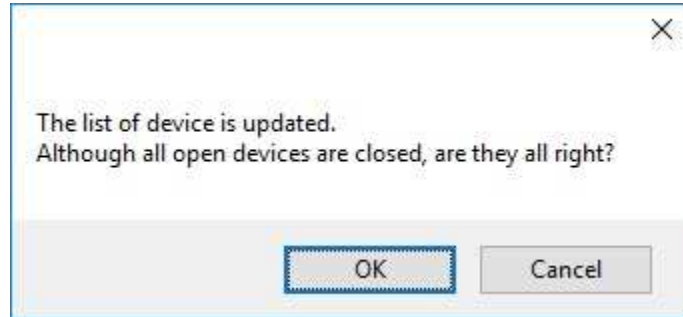
If a mini-spectrometer was connected after starting the evaluation software, then you must update or refresh the list of mini-spectrometers.



To update the list, click  button on the Main toolbar or select "Update list" from the "File" menu in the main window. The following dialog box then appears asking if you want to update the list.

Clicking [OK] will close all mini-spectrometers that are open and then update the list by recognizing the mini-spectrometers connected to the PC via the USB cables.

After this operation, you must again open the desired mini-spectrometers.



Measurement modes


The evaluation software operates in four measurement modes: Measure mode, Monitor mode, Dark mode and Reference mode. This section describes how to use each mode and what you can do in each mode.

□ Monitor mode measurement

Monitor mode only displays the measurement data graphically without storing it in the memory. This mode is ideal when you want to check the output data in real-time by displaying it on a graph or want to monitor the output data over extended periods of time.

- **To start:**



Click the  button on the Measurement toolbar or select "Start Monitor mode" from the "Measure" menu in the main window.

- **To stop:**



Click the  button or select "Stop" from the "Measure" menu in the main window.


□ Measure mode measurement

Measure mode allows you to display the measurement data graphically and to store it in the memory. Use this mode to check the output data in real-time while displaying it on a graph and then store it in the hard disk for data analysis after measurement.

Measurement data is constantly stored in the memory during measurement and all data is then saved temporarily in the hard disk after the measurement. The amount of data that can be retained depends on the memory size of the PC. In other words, the upper limit is determined by the memory size of your PC.

- **To start measurement:**




Click the  button on the Measurement toolbar or select "Start Measure mode" from the "Measure" menu in the main window.

- **To stop measurement:**

Measurement automatically stops when the specified scan count is reached. But you can stop the measurement any time before the specified scan count is reached. To stop the measurement, click the



 button or select "Stop" from the "Measure" menu in the main window.

The data that has been measured up to that point will be effective.

□ Dark mode measurement

The output of the mini-spectrometer is the sum of a signal proportional to the input light intensity, the circuit offset value, and the image sensor dark current. The term "dark" component referred to here includes the circuit offset value and image sensor dark output, which are independent of input light intensity.


The dark subtraction function becomes available after measuring dark data in Dark mode. We strongly recommend that you measure this dark data just after this evaluation software starts. When the integration time^{*1} or gain^{*2} setting is changed, the dark data also varies. So you must measure new dark data again when using the dark subtraction function.

^{*1} For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.

^{*2} For a definition and description of gain, refer to the separate technical manual. To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

- **To start measurement:**




Click the  button on the Measurement toolbar or select "Start Dark mode" from the "Measure" menu in the main window.

- **To stop measurement:**

Dark measurement automatically stops when the specified scan count is reached. But you can stop the measurement any time before the specified scan count is reached. To stop the measurement, click the



 button or select "Stop" from the "Measure" menu in the main window.


The data that has been measured up to that point will be effective. Dark data will then be created by averaging the obtained data.

☐ **Reference mode measurement**

This mode allows you to measure reference data that is used as comparison criterion. After measuring this reference data, both measurement data and reference data can be displayed. When the integration time^{*1} or gain^{*2} setting is changed, the measurement conditions vary as well. So you must measure the new reference data again when using the reference data.

- **To start measurement:**




Click the  button on the Measurement toolbar or select "Start Reference mode" from the "Measure" menu in the main window.

- **To stop measurement:**

Measurement automatically stops when the specified scan count is reached. But you can stop the measurement any time before the specified scan count is reached. To stop the measurement, click the



 button or select "Stop" from the "Measure" menu in the main window.

The data that has been measured up to that point will be effective. Reference data will then be created by averaging the obtained data.

^{*1} For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.

^{*2} For a definition and description of gain, refer to the separate technical manual. To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

Graph manipulation

Each graph window can be enlarged, displayed in a log scale or moved to any position in the main window. This section explains the functions and features of such graph manipulation tools, and also how to use them.

The graph manipulation tools are available on the Graph toolbar or from the "Tool" menu in the main window.



Graph toolbar

□ Moving the graph cursors

Two graph cursors (sampling lines) are provided on each of the X and Y axes. Using these graph cursors, you can check the data on the cursors or specify the area to perform arithmetic operations. The graph cursor information is displayed in the "Graph Information" dialog box.

TIP: For details on the "Graph Information/Setting" dialog box, see ["Graph Information/Setting" dialog box](#).

□ Zooming

To observe details of a waveform (spectrum), you may want to enlarge the area of interest. This evaluation software has three zoom functions that can be selected as needed.

• Window zoom


The window zoom enlarges an area specified with the mouse.

The rectangle of the alternate long and short dash line which will appear if a mouse is moved where the right button of a mouse is clicked on Graph Window is adjusted with a mouse, and the expansion range is specified.

• Auto zoom

The auto zoom automatically adjusts the scale of the vertical axis so that the graph is always set to the maximum to minimum range of the measurement data.




To enable the auto zoom function, click the  button on the Graph toolbar or select "Auto zoom" from the "Tool" menu in the main window.

□ Displaying the vertical axis in log scale

The vertical axis of each graph can be changed to log scale as needed.




Click the  button on the Graph toolbar or select "Log scale" from the "Tool" menu in the main window.

□ Resetting the graph display to initial state

Changes you made to graph display such as by "zooming" or "moving the display position" can be reset to the initial state.




Click the  button on the Graph toolbar or select "Reset graph" from the "Tool" menu in the main window.

□ Graph information

Show graph information.



Click the  button on the Graph toolbar or select "Graph information" from the "Tool" menu in the main window.

Arithmetic functions

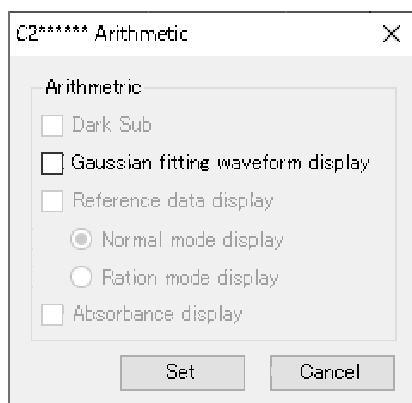
This evaluation software provides useful arithmetic functions that can be used during measurement. This section explains what these functions are and how to use them.

The following arithmetic functions are available.

Function		Description
Dark subtraction		Subtracts dark data (acquired beforehand) from the currently measured data. This function is not available if dark data has not yet been acquired.
Reference data display	Normal mode display	Displays reference data along with the currently measured data. This function is not available when reference data has not yet been acquired.
	Ratio mode display	Displays the ratio of the measurement data (transmittance, reflectance) to reference data. This ratio is calculated as follows: Currently measured data profile / Reference data profile \times 100 This function is not available if reference data has not yet been acquired.
Gaussian fitting waveform display		Performs Gaussian fitting on the area specified between the cursor lines and displays the Gaussian fit data along with the currently measured data.

Note : When the integration time and the gain changed, the whole data is cleared, so please measure once again.

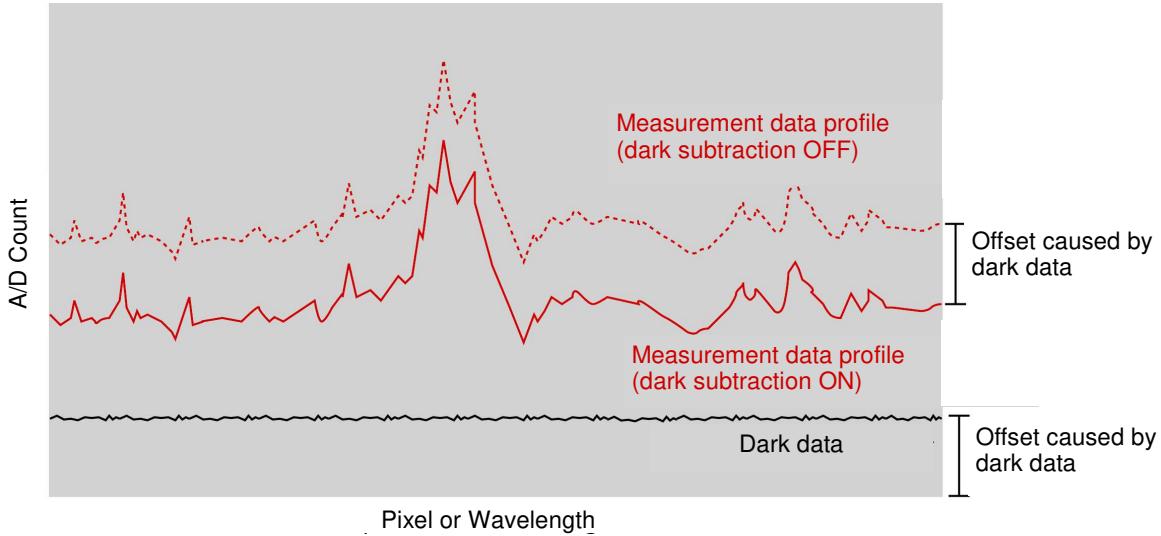
The above functions are enabled or disabled in the following dialog box that appears when you select "Arithmetic" from the "Tool" menu in the main window. If an item is grayed out, this means it cannot currently be used.



NOTE: When the "Ratio mode display" option is selected as the reference data display, you cannot enable the "Gaussian fitting waveform display". If you select the "Ratio mode display" option while the "Gaussian fitting waveform display" is enabled (ON), then the "Gaussian fitting waveform display" will be disabled (OFF).

☐ Dark subtraction

Using the premeasured dark data, this function subtracts the offset caused by the dark data from the currently measured data profile and displays the result graphically. The graph below shows data profiles measured with the dark subtraction enabled (ON) and disabled (OFF).



☐ Gaussian fitting waveform display

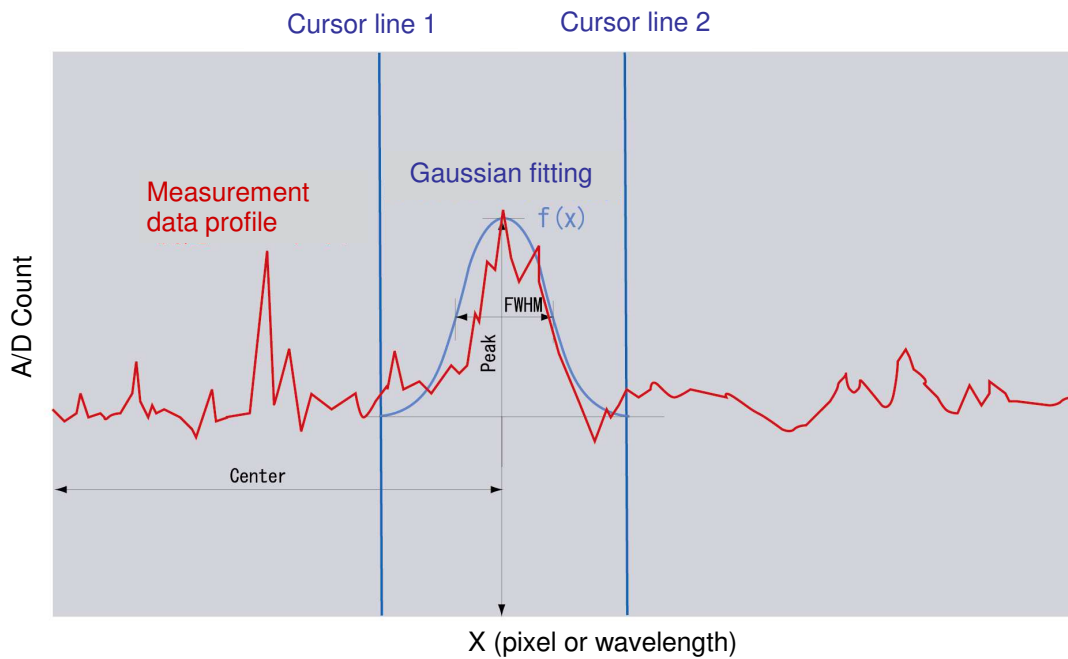
Performs Gaussian fitting on the area specified between the cursor lines and displays the Gaussian fit data along with the currently measured data. The following Gaussian function is used for Gaussian fitting.

$$f(x) = C_0 + C_1x + C_2 \exp\left\{-\left(\frac{x - C_3}{C_4}\right)^2\right\}$$

Here, C_0 to C_4 are coefficients obtained by Gaussian fitting, and x represents the horizontal axis value (pixel or wavelength).

This function is useful for finding an accurate peak position on the measured spectrum. An example is shown below. The red plot represents the currently measured data profile and the blue plot represents the Gaussian fit data calculated in the area specified between the blue cursor lines.

When this function is enabled (ON), the Gaussian fit data is displayed in the "Graph Information/Settings" dialog box as needed.



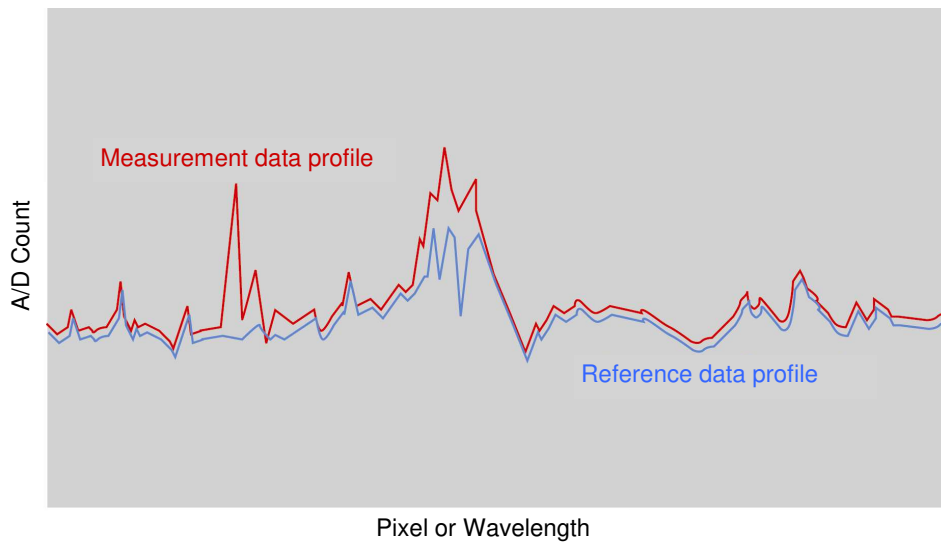
MeasDataInfo		ParameterInfo		EEPROMInfo	
Measurement Mode					
<input type="checkbox"/> DarkSub Enabled					
Graph type					
<input checked="" type="radio"/> X axis : Wavelength - Y axis : A/D count					
<input type="radio"/> X axis : Pixel - Y axis : A/D count					
<input type="radio"/> X axis : Wavenumber - Y axis : A/D count					
Dark Data					
Reference Data					
Cursor data					
	X	Y			
X cursor-1	222.76	5313.13			
X cursor-2	875.81	8191.88			
Data between Y axis cursors					
Y axis min value					
Y axis max value					
Average value					
Standard deviation					
The gauss fitting data between X axis cursors					
Peak value					
FWHM		nm			
Zoom					

□ Displaying the reference data

This function displays the currently measured data profile along with premeasured reference data profile. There are two methods for reference data display: Normal mode display and ratio mode display.

• Normal mode display

Displays reference data and measurement data simultaneously. An example is shown below. The blue plot represents the reference data profile and the red plot represents the currently measured data profile. The reference data profile is shown in blue on the actual software display. This function is useful for comparing currently measured spectrum data with reference data to see how it changes.

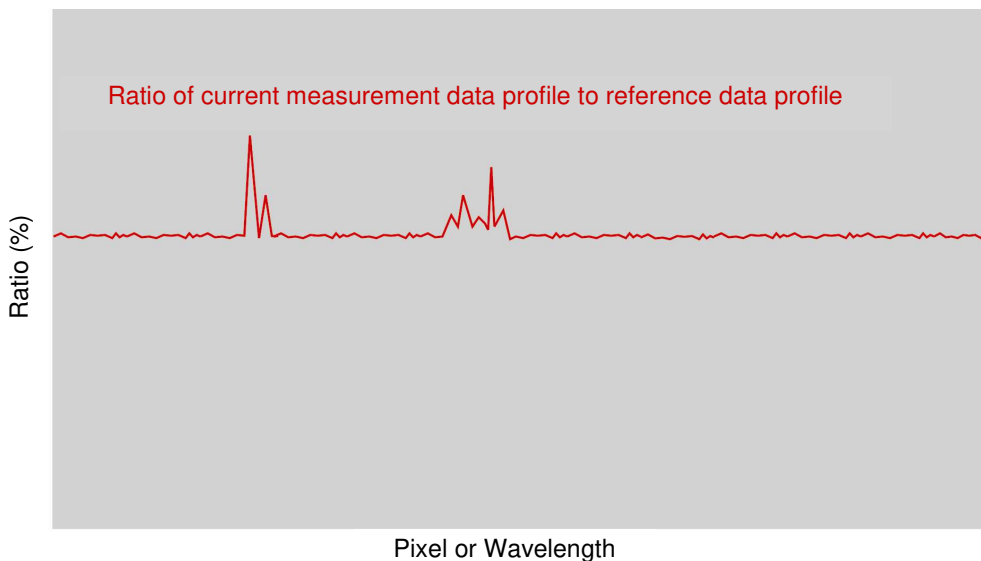


- Ratio mode display

Displays a data profile indicating the ratio of current measurement data profile (transmittance or reflectance) to reference data profile. This ratio profile is defined as follows:

$$\text{Ratio profile} = \text{Currently measured data profile} / \text{Reference data profile} \times 100 [\%]$$

The ratio mode display is useful for checking the transmission or reflection ratio versus the reference data. The graph below shows a ratio profile created from the profile data shown above in the normal mode.



□ Displaying the absorbance data

The absorbance data is displayed using the dark offset value and the reference profile measured in advance. The absorbance is calculated according to the following formula.

$$\text{Absorbance} = -\log_{10} \frac{AD \text{ count} - \text{dark offset}}{\text{Reference profile} - \text{dark offset}}$$

Copying the data to clipboard


The clipboard is an area of main memory that temporarily stores cut or copied data. When a character string or an image specified on the screen is copied or cut, it is temporarily stored on the clipboard. The data stored on the clipboard can be pasted into another application.

This evaluation software allows you to copy the last measurement data to the clipboard. You can copy two types of data to the clipboard: graph image data and text data. Using this function, you can insert a graph image into a document created by Microsoft Word or paste data on an Excel worksheet.

This section explains how to copy data to the clipboard.


☐ Copying as image data



Click the  button on the Function toolbar or select "Copy" > "As image data" from the "Tool" menu in the main window.

☐ Copying as text data




Click the  button on the Function toolbar or select "Copy" > "As text data" from the "Tool" menu in the main window. Text data will be copied to the clipboard according to the setting you made in the "Clipboard Settings" dialog box.

☐ Making the clipboard settings

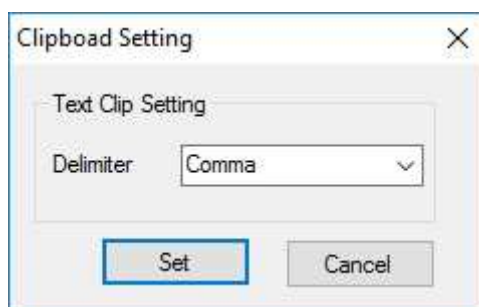
The "Clipboard Settings" dialog box allows you to make settings for copying data to the clipboard.



The "Clipboard Settings" dialog box appears by clicking the  button on the Function toolbar or selecting "Copy" > "Set clipboard" from the "Tool" menu in the main window.

• Text Clip

On the Text Clip, you can select a delimiter type used to copy text data. When pasting the copied data on an Excel worksheet, the delimiter will automatically separate the data series.




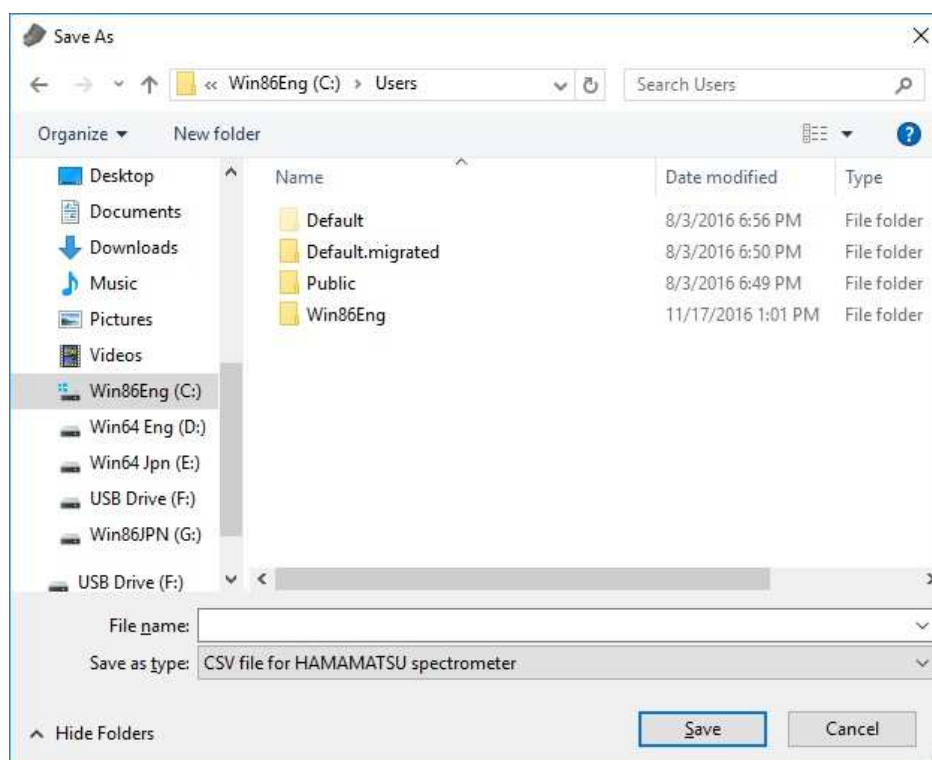
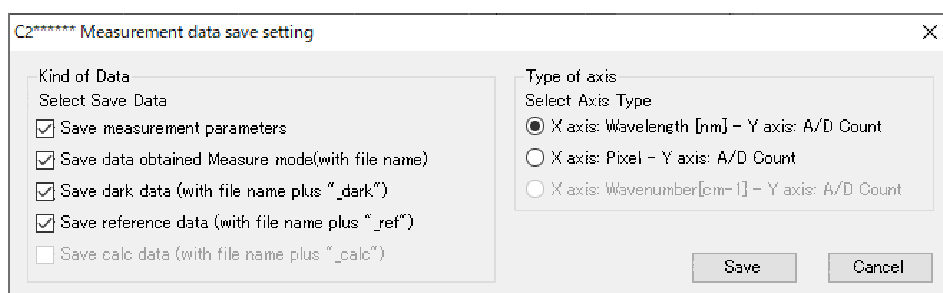
Saving the measurement data

This evaluation software allows you to save measurement data in a file as text data or image data. Data type, file format and precautions when saving the data are explained below.

☐ Saving the text data

Measurement data acquired in other than Monitor mode can be saved in a file as text data. The text data is stored in CSV format and so can be easily read by Microsoft Excel for graphic and arithmetic processing.

To save text data, click the  button on the Measurement toolbar or select "Save text data" from the "File" menu in the main window. Dialog displayed, please specify the type of data, and horizontal axis data. The following dialog box then appears. Specify the location to save the data and file name. Then click the [Save] button.



□ Text data files

There are 5 text data files that respectively store data acquired in Measure, Dark and Reference modes, and also the measurement parameters (integration time^{*1}, gain^{*2}, etc.), arithmetic data. The former 3 files are CSV format files and the measurement parameter file is a TXT file. The arithmetic data is a CSV file that records the arithmetic data (dark subtraction, ratio with reference, absorbance) specified in the "Arithmetic functions". Whether or not to save these data files can be specified in the "Data type to save" group box in the above dialog box.

The table below shows examples of files that can be created when data is saved.

File name specified in File name box	File name	File is created when:	Contents
<i>File_name</i>	<i>File_name.csv</i>	Data was measured in Measure mode.	Measurement data
	<i>File_name_dark.csv</i>	Dark data was measured in Dark mode.	Dark data
	<i>File_name_ref.csv</i>	Reference data was measured in Reference mode.	Reference data
	<i>File_name.txt</i>	Any of the above files was created.	Parameters used to measure data
	<i>File_name_calc.csv</i>	Arithmetic function was used.	Arithmetic data

Example: If you save all data under a file name of "test" after making measurements in Dark, Reference and Measure modes, the following 4 files are created.

File name	Contents
test.csv	Measurement data
test_dark.csv	Dark data
test_ref.csv	Reference data
test.txt	Parameters during measurement
Test_calc.csv	Arithmetic data

Data format of each file is shown below.

The first row in each CSV file indicates the pixel number or wavelength, depending on which was selected as the horizontal axis data form. In addition, the second column of each CSV file shows the average value of each measurement (each row) up to the third decimal place.

File_name.csv

Pixel ,	Average ,	1 ,	2	3	4	...	MAX_SCAN-1 ,	MAX_SCAN	LF
1,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
2,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
3,	XXX ,	XXX ,		XXX ,	XXX ,	...	XXX ,	XXX	LF
...	...	...	...	...	...	...	XXX ,	XXX	LF
511,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
512,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
ExternalTrigger		Trigger							LF

XXX ... A/D count value acquired during measurement
 MAX_SCAN ... Scan count you specified
 LF ... Line feed
 Trigger ... Trigger signal input flag

^{*1} For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.

^{*2} For a definition and description of gain, refer to the separate technical manual. To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

File_name_dark.csv

Pixel ,	Average ,	1 ,	2	3	4	...	MAX_SCAN-1 ,	MAX_SCAN	LF
1,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
2,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
3,	XXX ,	XXX ,		XXX ,	XXX ,	...	XXX ,	XXX	LF
...	...	...	...	...	...	...	XXX ,	XXX	LF
511,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
512,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
ExternalTrigger		Trigger							LF

XXX ... A/D count value acquired during measurement
MAX_SCAN ... Scan count you specified
LF ... Line feed
Trigger ... Trigger signal input flag

File_name_ref.csv

Pixel ,	Average ,	1 ,	2	3	4	...	MAX_SCAN-1 ,	MAX_SCAN	LF
1,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
2,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
3,	XXX ,	XXX ,		XXX ,	XXX ,	...	XXX ,	XXX	LF
...	...	...	...	...	...	...	XXX ,	XXX	LF
511,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
512,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	...	XXX ,	XXX	LF
ExternalTrigger		Trigger							LF

XXX ... A/D count value acquired during measurement
MAX_SCAN ... Scan count you specified
LF ... Line feed
Trigger ... Trigger signal input flag

File_name.txt

```

Integration = XXX
Gain = X
Averaging = X
TriggerMode= X
TriggerEdge= X
WavelengthRange_Upper = XXXXX
WavelengthRange_Lower = XXXXX
productID = XXXXXXXX
SensorName = XXXXXXXX
MeasDate = XXXX/XX/XX
a0 = X.XXXXXXXXXXXE±XX
a1 = X.XXXXXXXXXXXE±XX
a2 = X.XXXXXXXXXXXE±XX
a3 = X.XXXXXXXXXXXE±XX
a4 = X.XXXXXXXXXXXE±XX
a5 = X.XXXXXXXXXXXE±XX
ReferenceInputWavelength = XXX

```

Item	Meaning
Integration	Integration time ^{*1} [msec]
Gain	Gain ^{*2}
Averaging	Scan count (number of samples) to perform averaging
TriggerMode	Trigger Mode
TriggerEdge	Trigger Edge
WavelengthRange_Upper	Wavelength range (upper limit)
WavelengthRange_Lower	Wavelength range (lower limit)
productID	Product ID
SensorName	Sensor name
MeasDate	Measurement date
a0	Zero-order coefficient of quintic equation for pixel-to-wavelength conversion
a1	1st-order coefficient of quintic equation for pixel-to-wavelength conversion
a2	2nd-order coefficient of quintic equation for pixel-to-wavelength conversion
a3	3rd-order coefficient of quintic equation for pixel-to-wavelength conversion
a4	4th-order coefficient of quintic equation for pixel-to-wavelength conversion
a5	5th-order coefficient of quintic equation for pixel-to-wavelength conversion
ReferenceInputWavelength	Reference input wavelength

^{*1} For a definition and description of integration time, refer to "D. Image sensors" in the separate "Hardware Instruction Manual" and technical manual.

^{*2} For a definition and description of gain, refer to the separate technical manual. To check whether your mini-spectrometer has the gain adjustment function, see the separate "Hardware Instruction Manual".

File_name_calc.csv

Pixel ,	Average ,	1 ,	2	3	4	.. MAX_SCAN-1 ,	MAX_SCAN,	(Wavelength)	LF
1,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	.. XXX ,	XXX,	(YYY)	LF
2,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	.. XXX ,	XXX,	(YYY)	LF
3,	XXX ,	XXX ,		XXX ,	XXX ,	.. XXX ,	XXX,	(YYY)	LF
...	...	...	...	...	...	.. XXX ,	XXX,	(YYY)	LF
511,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	.. XXX ,	XXX,	(YYY)	LF
512,	XXX ,	XXX ,	XXX ,	XXX ,	XXX ,	.. XXX ,	XXX,	(YYY)	LF
ExternalTrigger		Trigger							LF

XXX ... A/D count value acquired during measurement
YYY ...Wavelength by wavelength calibration coefficient
MAX_SCAN ... Scan count you specified
LF ... Line feed
Trigger ...Trigger signal input flag

□ Notes on the saved text data

This mini-spectrometer uses a multi-element (for example, 512 pixels) linear image sensor that detects a spectrum formed by the grating. The data acquired at each pixel corresponds to each wavelength of the spectrum and is A/D converted in proportion to the light intensity. When saving this data with the evaluation software, you can specify the horizontal axis scale as pixels or wavelengths.

The following quintic equation can be used to calculate which pixel corresponds to the wavelength axis.

$$wavelength[nm] = a_0 + a_1 pix + a_2 pix^2 + a_3 pix^3 + a_4 pix^4 + a_5 pix^5$$

where $pix(1-)$ is any pixel of the image sensor.

The value calculated with this equation is not always an integer. When discussed with only the values simply calculated from the approximate expression, a slight difference might appear when comparing the calculated values with the wavelengths of known line spectra.

Each coefficient of a_0 to a_5 is stored in the measurement parameter file when the measurement data is saved. For more details, see the description in "[Text data files](#)".


□ Notes on the saved arithmetic data

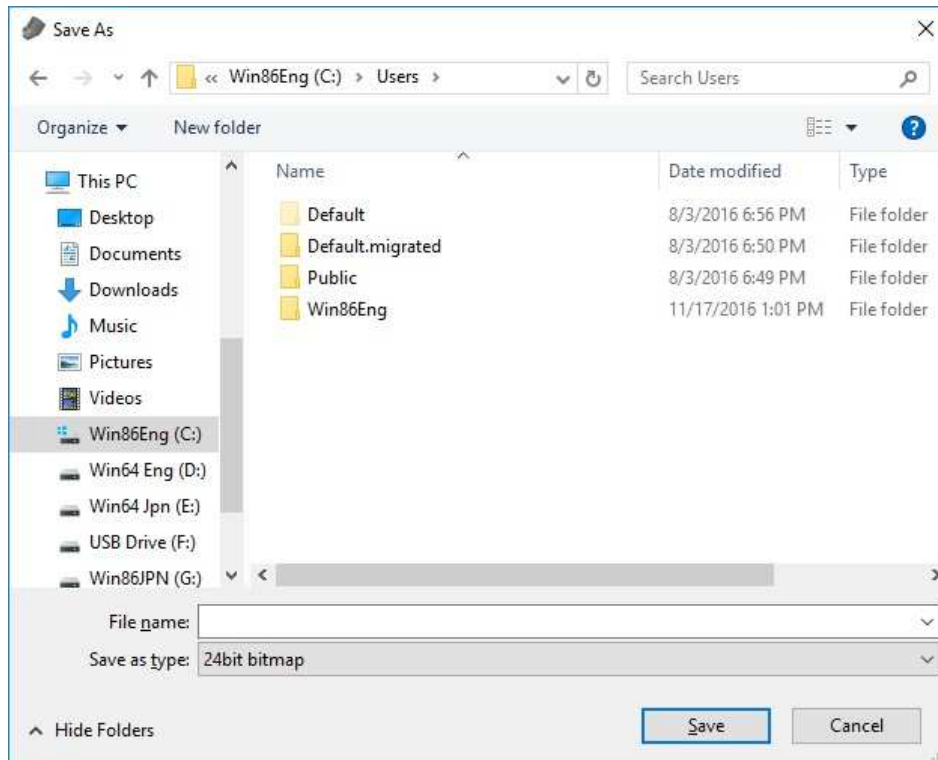
The data corresponding to the arithmetic function selected from "Dark subtraction", "Reference ratio" and "Absorbance" specified in the "[Arithmetic functions](#)" section is output to the third decimal place. When "Wavenumber" is selected as the saved data format, the wavelength corresponding to the last column is displayed.

The points to keep in mind of the data output for each calculation data are described below.

Data type	留意点
Dark subtraction	If the result of the operation is a negative number, 1 is displayed. Please refer to the " Dark subtraction " section for the calculation method. * If the reference ratio display function is also selected, the reference ratio data is output using the dark-subtracted measurement data and dark-subtracted reference data.
Reference ratio	The result of the operation is displayed as a percentage. For the calculation method, refer to the section " Displaying the reference data ". * If the dark subtraction function is also selected, the reference ratio data will be output using the dark subtraction measurement data and dark subtraction reference data.
Absorbance	If the result of the operation is a negative number, 0 is displayed. For the calculation method, refer to the section " Displaying the absorbance data ".

Saving the image data


To save text data, click the  button on the Measurement toolbar or select "Save image data" from the "File" menu in the main window. The following dialog box then appears. Specify the location to save the data, enter the file name, and click the [Save] button. Image data is stored in a 24-bit bitmap format.

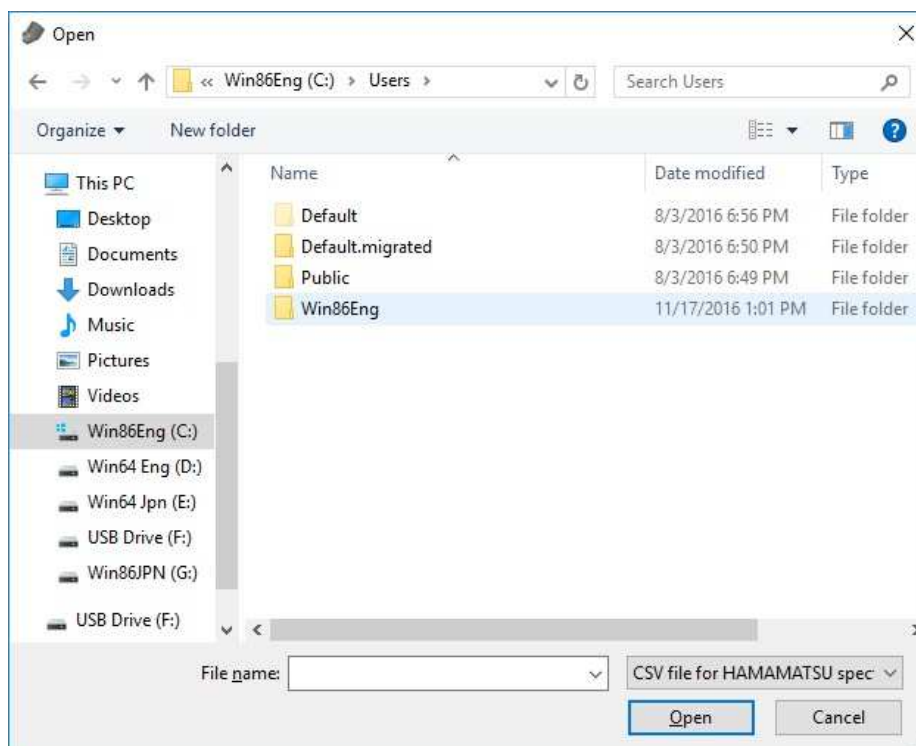
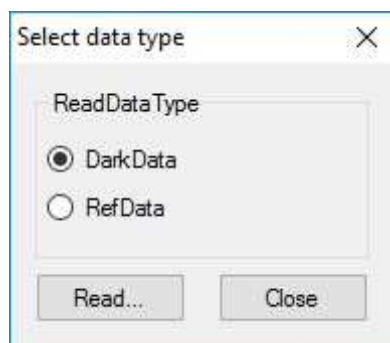


Loading a measurement data file

Data that was measured with the evaluation software and saved in text files can be loaded as reference data or dark data. You can then use the loaded reference or dark data with the arithmetic functions. This section explains the data type and format that can be loaded and also the procedure to load the data. For more details on the arithmetic functions, see the description in "[Arithmetic functions](#)".

□ To load a measurement data file

Click the  button on the Main toolbar or select "Load data file" from the "File" menu in the main window. The following dialog box then appears. Select the file name and data type, and click the [Open] button.



□ Loadable data type

You can load text data files with an extension ".csv" that contain data measured with the evaluation software and then saved in a CSV format. (Measurement parameter files with an extension ".txt" cannot be loaded.) If the horizontal axis for the loading data is wavelength, then the software automatically checks whether it matches the wavelength information of the currently selected mini-spectrometer. The data cannot be loaded unless it matches the wavelength information.


Other operations

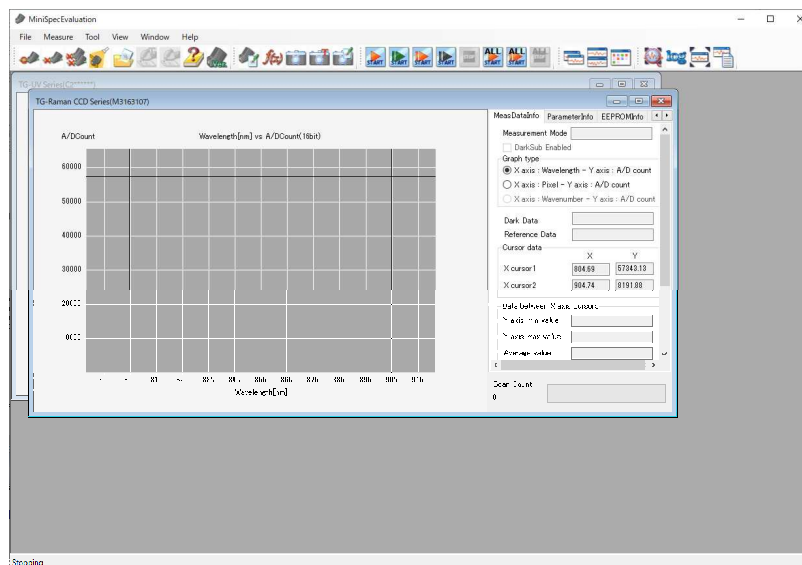
□ Displaying the graph windows

Like other Windows applications, you can resize each graph window by using the [Minimize] or [Maximize] button on the right side of the title bar or by dragging the window border or corner. You can also use the [Close (x)] button on the title bar to close the window. (This is the same as using the "Close spectrometer" toolbar button or command. See ["Closing a mini-spectrometer"](#).)


Graph windows can also be arranged in the following three ways.

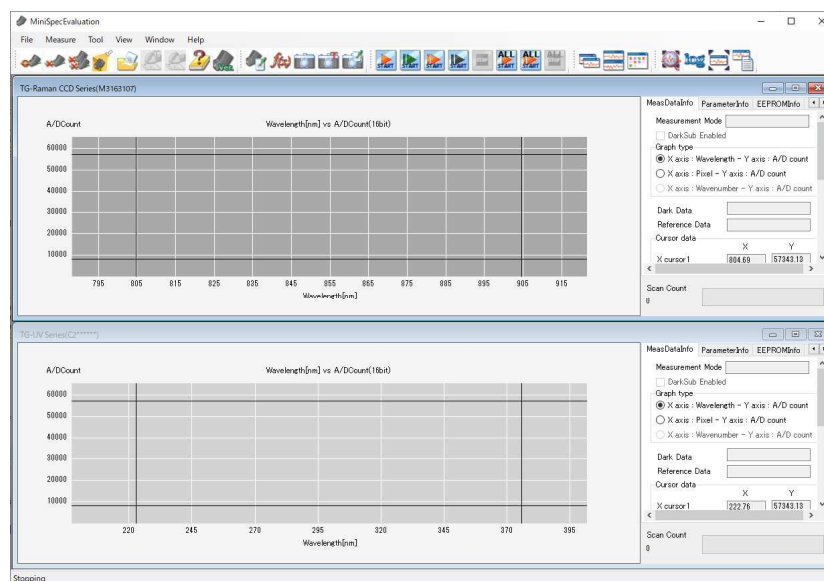
- **Cascading graph windows**

Click the  button on the Window toolbar or select "Cascade" from the "Window" menu in the main window. Graph windows are rearranged so that they overlap and the title bar of each window is visible, as shown below.




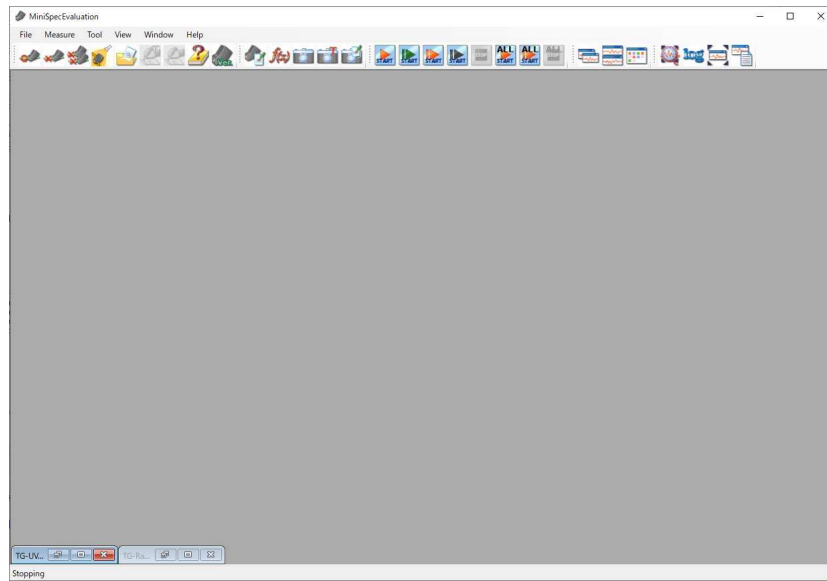
- **Tiling graph windows**

Click the  button on the Window toolbar or select "Tile" from the "Window" menu in the main window. Graph windows are rearranged vertically or horizontally so that they do not overlap, as shown below.



- **Arranging the icons**


Click the  button on the Window toolbar or select "Arrange icons" from the "Window" menu in the main window. Graph windows are reduced to icons and arranged on the bottom of the main window as shown below.

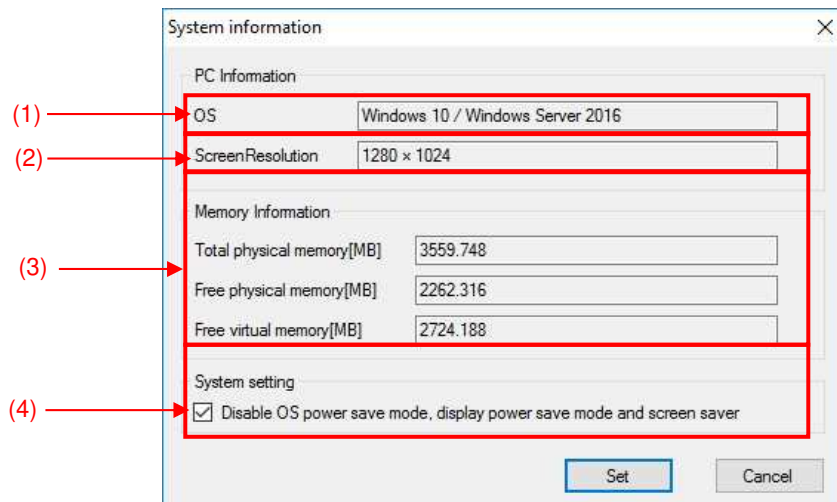


□ Help menu

The "Help" menu displays the system information on the PC or the version information of the mini-spectrometer software. You can also change the system settings as needed.

● Displaying or setting the system information

Click the  button on the Main toolbar or select "System" from the "Help" menu in the main window. The "System Information/Settings" dialog box then appears.



· PC system information display

- (1) OS
Shows the version of the OS (operating system).
- (2) Resolution
Shows the currently set monitor resolution.
XGA (1024×768) or higher resolution is recommended in order to use this evaluation software.
- (3) Memory
 - Total physical memory
Memory size actually installed in the PC
 - Available physical memory
Available size of physical memory
 - Available virtual memory
Available size of virtual memory

TIP: For details on system requirements for the evaluation software, see "[System requirements](#)".


· PC system settings

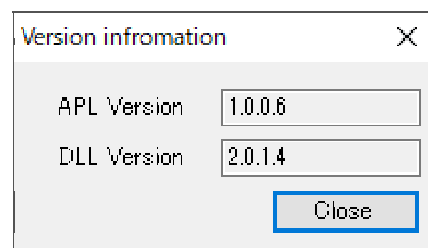
- (4) Disable power save mode, screen saver mode and monitor power save mode
Select this check box when you want to disable the power save mode of the PC.
Selecting this check box disables the power scheme settings you made in the "Power Options Properties" dialog box that appears by clicking "Start" > "Control Panel" > "Power Options".

When PC power save mode is activated, the power to the USB port might be interrupted depending on the PC model. This will cause errors in the mini-spectrometer operation since it operates from the USB bus power. In particular, if using a laptop PC to continuously operate the mini-spectrometer, select the above check boxes as needed to enable the power save modes.

The power scheme settings and power supply method to the USB differ depending on the PC model. Refer to the PC user manual to verify them.

Version information

To check the software version, click the  button on the Main toolbar or select "Version" from the "Help" menu in the main window. The following screen then appears.



This screen shows the following information.

- APL Version Version number of mini-spectrometer evaluation software
- DLL Version Version number of DLL for mini-spectrometer

Evaluation software error message list

If an error occurs, the evaluation software immediately displays the error code and message.

The table below shows the error codes and their meaning.

Messages in parentheses () are the error names defined in the "specu1b.dll" file. For more details on these errors, refer to the separate "Function Specifications" manual.

Error code	Meaning
ERROR1	The target spectrometer does not exist. (INVALID_HANDLE_VALUE)
ERROR2	Specified device handle is invalid. (USBDEV_INVALID_HANDLE)
ERROR3	Failed to access the specified spectrometer. (USBDEV_UNSUCCESS)
ERROR4	Specified value is invalid. (USBDEV_INVALID_VALUE)
ERROR5	Specified parameter is invalid. (USBDEV_INVALID_PARAMETER)
ERROR5	Specified USB device handle is invalid. (USBDEV_CHECK_INVALID)
ERROR6	Spectrometer is disconnected. (USBDEV_CHECK_REMOVE)
ERROR7	Cannot recognize the spectrometer due to other errors. (USBDEV_CHECK_OTHER)
ERROR8	Transferred data does not match the specified size. (USBDEV_BULK_SIZE_ERROR)
ERROR9	Data read request failed. (USBDEV_BULK_READ_ERROR)
ERROR10	Specified integration time is longer than the upper limit. (USBDEV_TIME_OVER_ERROR)
ERROR11	Specified integration time is shorter than the lower limit. (USBDEV_TIME_UNDER_ERROR)
ERROR12	Failed to set the integration time. (USBDEV_TIME_SET_ERROR)
ERROR13	Failed to set the gain. (USBDEV_SET_GAIN_ERROR)
ERROR14	Failed to acquire temperature sensor data. (USBDEV_GET_TEMP_ERROR)
ERROR15	Failed to set the trigger (mode/edge). (USBDEV_SET_TRIGGER_ERROR)
ERROR16	Failed to access the EEPROM in spectrometer. (USBDEV_RW_EEP_ERROR)
ERROR17	AC adaptor was disconnected. (USBDEV_ADC_OUTPUT_ERROR)

Creating your own application software

NOTE: Install the device driver and DLL into your PC only after you accept the terms in the "[Software license agreement](#)".

Overview

Hamamatsu provides the DLL and device driver to assist you in creating your own application software that runs on Windows and controls the Hamamatsu mini-spectrometer.

This section explains how to create your own application software that runs on Windows.

Application development system requirements

☐ **System requirements for device drivers and libraries**

Device driver and library operation is verified on the following systems. Operation on other systems is not guaranteed.

OS	Microsoft Windows 10 Pro 32bit, 64bit
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To run the device driver and DLL, you must use a PC that meets the above system requirements. Although there are no other special requirements, we recommend using a PC with a high performance CPU and memory sufficient for acquiring measurement data.

☐ **Windows application development requirements**

Windows application development using this DLL is intended for the following application development tools. Operation of this DLL with other development tools is not guaranteed.

Development Tool	Microsoft Visual Studio 2008 (SP1) Visual C++
	Microsoft Visual Studio 2008 (SP1) Visual Basic
	Microsoft Visual Studio 2008 (SP1) C#

□ About development files

To create your own application software, you will need several development files. For your convenience, the necessary development files are stored in the "DeveloperTools" folder on the CD-ROM supplied with the mini-spectrometer. These files can also be copied into a specified folder in your PC by installing the "DeveloperTools" component at the same time that you install the evaluation software. Below is a list of development files we provide. Prepare these files before you develop application software for mini-spectrometers.

○ Driver & DLL files

"winusb1.1TGTm.inf"	... Mini-spectrometer setup information file
"winusb1.1TGTm.cat"	... Mini-spectrometer security catalog file
"winusbcoinstaller2.dll "	... Driver control file
"WdfCoInstaller01009.dll "	... Driver control file
"specu1b.dll"	... Mini-spectrometer driver

○ Visual C++ files

"K29-B60925 SpectrometerFunctionSpecifications.pdf"	... Mini-spectrometer DLL function specifications (Visual C++)
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○ Visual Basic files

"K29-B60927 SpectrometerFunctionSpecificationsForVB.pdf"	... Mini-spectrometer DLL function specifications (Visual Basic)
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○ C# files

"K32-B60231 SpectrometerFunctionSpecificationsForC#.pdf"	... Mini-spectrometer DLL function specifications (C#)
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TIP: For the description of how to install each component, see "[Installing the software](#)".

Application development using Microsoft Visual Studio 2008 (SP1) Visual C++

The following describes the basics for developing an application using Microsoft Visual C++.

- (1) First create a new Visual C++ project.
- (2) The following files are required to develop an application using Microsoft Visual C++.
Copy these files from the CD-ROM that came with the mini-spectrometer or from the "Developer Tools" folder in your PC, and paste them into the file where the project is stored.

File name	Description
specu1b.dll	Mini-spectrometer DLL file

- (3) Open the project with Visual C++.

The above procedure now allows using the procedures provided in the specu1b.dll from the Visual C++ project. For details on each procedure, refer to the separate "Function Specifications" manual.

NOTE: For general topics on how to use DLL with Visual C++, see the Microsoft help information.

Application development using Microsoft Visual Studio 2008 (SP1) Visual Basic

The following describes the basics for developing an application using Microsoft Visual Basic

- (1) First create a new Visual Basic project.
- (2) The following files are required to develop an application using Microsoft Visual Basic
Copy these files from the CD-ROM that came with the mini-spectrometer or from the "Developer Tools" folder in your PC, and paste them into the file where the project is stored.

File name	Description
specu1b.dll	Mini-spectrometer DLL file

- (3) Open the project with Visual Basic.

The above procedure now allows using the procedures provided in the specu1b.dll from the Visual Basic project. For details on each procedure, refer to the separate "Function Specifications" manual.

NOTE: For general topics on how to use DLL with Visual Basic, see the Microsoft help information.

Application development using Microsoft Visual Studio 2008 (SP1) C#

The following describes the basics for developing an application using Microsoft C#

- (1) First create a new C# project.
- (2) The following files are required to develop an application using Microsoft C#
Copy these files from the CD-ROM that came with the mini-spectrometer or from the "Developer Tools" folder in your PC, and paste them into the file where the project is stored.

File name	Description
specu1b.dll	Mini-spectrometer DLL file

- (3) Open the project with C#.

The above procedure now allows using the procedures provided in the specu1b.dll from the C# project. For details on each procedure, refer to the separate "Function Specifications" manual.

NOTE: For general topics on how to use DLL with C#, see the Microsoft help information.

Application development using other development tools

Application development using other development tools is also explained below. However, operation of applications created with these tools is not guaranteed.

Borland C++ Builder is a powerful programming tool using C++ language.

For details on how to use the DLL library file created for Visual C++, see the C++ Builder help information.

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Release notes

Version number	Revision date	Description
K29-B60921	Oct.2010	First Edition
K29-B60921A	Mar.2011	Added C9405CB
K29-B60921B	May.2011	Added the Environment Microsoft(R) Windows 7 32bit, 64bit Changed Windows application development tool Microsoft Visual Studio 2008 (SP1) Changed Driver & DLL files
K29-B60921C	Jun.2011	Added TG-RAMAN series Changed window image Delete print function
K29-B60921D	May.2012	Added a description of the Evaluation software Outline Added a description of the Creating your own application software Overview
K29-B60921E	Jun.2013	Changed address
K29-B60921F	Apr.2014	Changed picture of a screen Changed system requirements Changed software function
K29-B60921G	Sep.2014	Changed system requirements Changed system requirements for device drivers and libraries Added explanation in trigger mode Deleted C9404MC,C9405MC,C9405CA Changed Text data files
K29-B60921H	Jan.2015	Added C11714CB
K29-B60921I	Dec.2016	Changed system requirements Changed system requirements for device drivers and libraries Changed address
K29-B60920J	Apr.2020	Changed system requirements for Evaluation software Changed application development environment requirements Changed window image Added explanation about absorbance display Added explanation about wave number display Delete description about Windows8. Changed Windows application development tool Added error code(USBDEV_INVALID_PARAMETER).
K29-B60920K	Aug.2020	Changed C9405CB to C9405CC
K29-B60920L	2020.Dec	Changed the description about the number of USB connections. Changed the description about measurement parameter output. Added explanation about arithmetic data output. Screen capture image change. Fixed some typos.

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