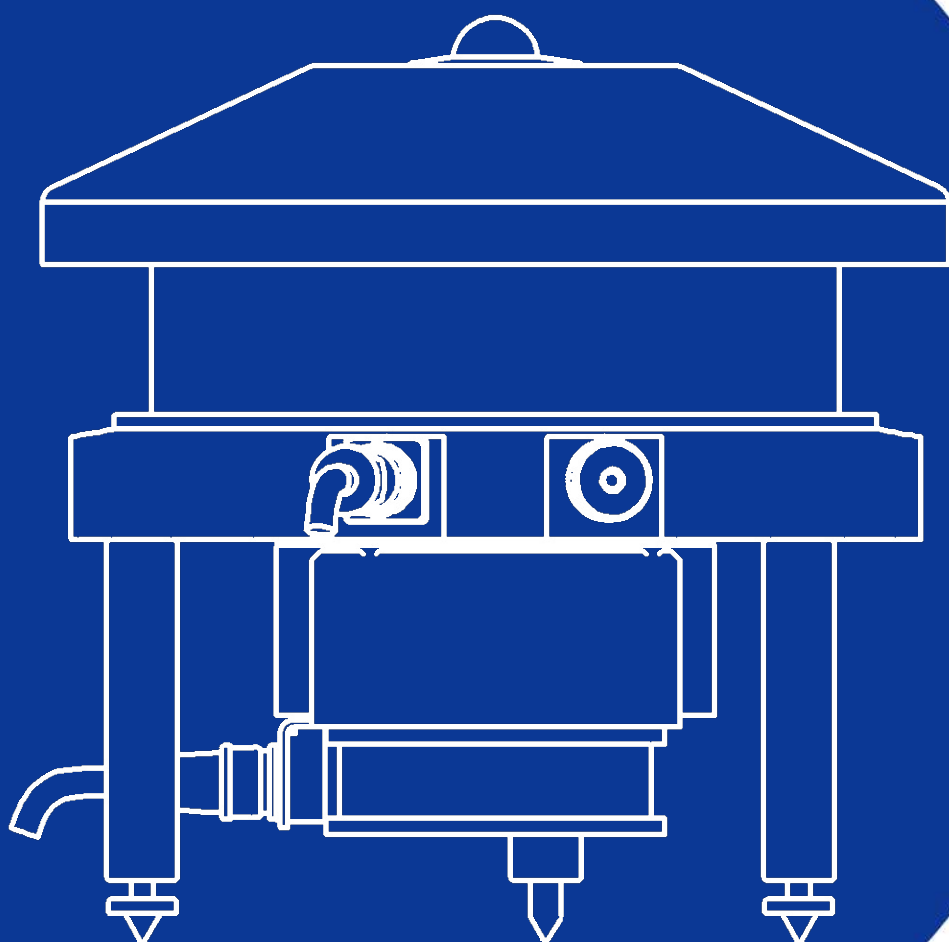


Grating Spectroradiometer
NIR

MS-713



EKO

1. Index

1. Index	1
2. Important User Information	3
2-1. Contact Information	3
2-2. Warranty and Liability	3
2-3. About Instruction Manual	4
3. Safety Information	5
3-1. WARNING	5
3-2. HIGH/LOW TEMPERATURE WARNING	6
4. Introduction	7
4-1. Main Features	8
4-2. Package Contents	9
4-3. Consumable Items	10
5. Getting Started	11
5-1. Parts Name and Descriptions	11
5-2. Setup Location	13
6. Software	16
6-1. Installation and Uninstallation	16
6-2. Data File Format	21
7. Measurement Software (WSDac)	23
7-1. Starting Measurement Software WSDac	23
7-2. Before Starting Measurement	24
7-3. Start Measurement	26
7-4. Measurement Data Display	28
7-5. Graph Setting	29
7-6. Graph Copy	30
7-7. Print	30
7-8. Version Information	30
8. Data Analysis Software (CSVDisp)	31
8-1. Starting Data Analysis Software CSVDisp.exe	31
8-2. Start Folder View	32
8-3. Show Measurement Data	32
8-4. Data Setting	36
8-5. Graph Setting	37
8-6. Data Saving	38
8-7. Graph Copy	39
8-8. Print	39
8-9. Version Information	39
9. Maintenance & Troubleshooting	40
9-1. Maintenance	40
9-2. Calibration Method	41
9-3. Troubleshooting	41
10. Specification	42
10-1. Sensor Specifications	42

10-2. Software	44
10-3. Cables	45
10-4. Dimensions	47
10-5. Accessories List	49

2. Important User Information

Thank you for using EKO Products

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument. Keep this manual at safe and handy place for whenever it is needed.

For any questions, please contact us at one of the EKO offices given below:

2-1. Contact Information

EKO INSTRUMENTS CO., LTD.

Asia, Oceania Region

www.eko.co.jp	EKO INSTRUMENTS Co., Ltd.	
info@eko.co.jp	1-21-8 Hatagaya, Shibuya-ku	Tel: +81 (3) 3469-6711
	Tokyo, 151-0072 Japan	Fax: +81 (3) 3469-6719

Europe, Middle East, Africa, South America Region

www.eko-eu.com	EKO INSTRUMENTS Europe B.V.	
info@eko-eu.com	Lulofsstraat 55, Unit 28,	Tel: +31 (0)70 3050117
	2521 AL, Den Haag, The Netherlands	Fax: +31 (0)70 3840607

North America Region

www.eko-usa.com	EKO INSTRUMENTS USA Inc.	
info@eko-usa.com	111 North Market Street, Suite 300	Tel: +1 408-977-7751
	San Jose, CA 95113 USA	Fax: +1 408-977-7741

2-2. Warranty and Liability

For warranty terms and conditions, contact EKO or your distributor for further details.

EKO guarantees that the product delivered to customer has been verified, checked and tested to ensure that the product meets the appropriate specifications. The product warranty is valid only if the product has been installed and used according to the directives provided in this instruction manual.

In case of any manufacturing defect, the product will be repaired or replaced under warranty. However, the warranty does not apply if:

- Any modification or repair was done by any person or organization other than EKO service personnel.
- The damage or defect is caused by not respecting the instructions of use as given on the product brochure or the instruction manual.

2-3. About Instruction Manual

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This manual was issued: 2019/07/29

Version Number: 5

3. Safety Information

EKO Products are designed and manufactured with consideration for safety; however, please make sure to read and understand this instruction manual thoroughly to be able to operate the instrument safely in the correct manner.



WARNING CAUTION

Attention to user; pay attention to the instructions given on the instruction manual with this sign.



HIGH TEMPERATURE WARNING

Touching or getting close to the device may lead to burn.



LOW TEMPERATURE WARNING

Touching or getting close to the device may lead to frostbite.



3-1. WARNING

1. Setup and Operation

- Installation base or mast should have enough load capacity to set the Grating Spectroradiometers MS-713. Fix MS-713 securely to the base or mast with bolts and nuts. Carefully install the computer as well. The instrument/computer may drop due to gale or earthquake and vibration, and may invite unexpected accidents.
- Do not use this instrument in different use other than its original purpose.
- Do not disassemble, modify or touch inside this instrument.
- Do not place this instrument in places where humidity and/or dusts exist, extreme difference in temperature of over specification range, near object which emits strong magnetic energy or electric wave. These conditions may cause damages to the instrument.
- Make sure to install this instrument where maintenance can be performed safely.
- Ventilation unit is attached to this instrument. Touching this instrument while the ventilation is running, it may lead to accidents and injury. Turn off the power before touching the ventilation unit.

2. Power Supply

- Do not touch the terminals and power plug with wet hands. This will lead to electric shocks and leakages.
- Check the voltage and provided power type (AC, DC) to make sure they are suitable for the instrument specification before turning the power on.
- Use only the attached cables. Using any other cables may lead to electric shocks or leakages.

EKO Instruments will not be held responsible in case of accidents or measurement accuracy by using cables other than specified by EKO.

3. Handling

- Hold the bottom part of the instrument firmly when carrying this instrument.
- Holding the cover, glass dome or any other part of this instrument can lead to damage or dropping instrument.
- Be careful with handling the glass dome.



3-2. HIGH/LOW TEMPERATURE WARNING



1. Temperature of the Sensor Part

- The spectrometer inside this instrument is temperature controlled to enhance the measurement accuracy. Therefore, the housing of this instrument becomes higher or lower than the outer temperature. Always use gloves for when touching the housing; touching with bare hands may lead to burn or frostbite.

4. Introduction

The Grating Spectroradiometer MS-713 is developed for measuring solar spectrum outdoor, and it is a unique all weather concept instrument which can be used in various fields such as meteorology, photovoltaic and agriculture.

Solar spectrum changes various ways depending on the season, the time of day, and the regional air mass and atmospheric composition. In response to changes in the spectrum, the power generation performance of multi-junction solar cells such as concentrating solar cells significantly change, and the growth conditions of crops differ. Detailed and quantitative understanding of the sunlight spectrum using a spectroradiometer makes it possible to analyze the relationship between device performance, crop growth, etc. and the spectrum.

MS-713 can measure the near infrared region in the wavelength range of 900 nm to 2,500 nm.

By using MS-713 in combination with MS-711, it is possible to seamlessly measure a broad wavelength range from 300nm to 2,500nm (MS-711 has a visible/ near infrared region between wavelength range of 300nm and 1,100nm, MS-713 measures the near infrared region from wavelength 900nm to 2,500nm.)

MS-713 has succeeded to control the temperature of the spectrometer at constant to suppress the temperature change in spectrometer, which will greatly affects the measurement uncertainty, allowing maintaining a high performance over a wide operation temperature range. In addition, MS-713 is has better resistances to mechanical vibration and external force compared to optical fiber type spectrometer due to optimal designs of diffuser and optical components. Therefore, it provides improved stability for continuously measuring outdoor, and excellent robustness in transportation for cyclic measurements.

MS-713 have a separate power supply and can be controlled through RS232 / 422 by a PC or data logger. The PC software provide different fuctions for operating, data management and visualisation.

4-1. Main Features

1. All-Weather

Using our technology cultivated through the design, manufacture and sale of weather observation equipment used outdoors such as pyranometers, we also have our grating spectroradiometers as all-weather products. MS-713 can be used for a long-term outdoor measurement.

2. Wide Measurement Range

By combining the MS-711 (300nm to 1,100nm) and MS-713(900nm to 2,500nm), it is possible to measure a wide wavelength range from 300nm to 2,500nm.

3. Operating Software

The operating software has different measurement functions, to make either a “single measurement” or “scheduled measurement” which takes periodical measurements every day.

This software allows to display multiple spectral data in one graph, as well as to review details of one spectral data and so on.

These software have the functions of resampling and saving the wavelength interval of spectrum data every 1 nm, automatically calculating various operation values, and combining with the spectrum data of MS-711 and MS-713.

4-2. Package Contents

Check the package contents first; if any missing item or damage is noticed, please contact EKO immediately.

Table 4-1. Package Contents

Standard Items	Qty.	Remarks
Sensors	1	
Power supply unit	1	
Set of Sensor fixing screws	1	Bolts: M8 x 230, Washers, Nuts (2pcs/set)
Fuse (for spare)	2	φ5.2x20, 250V, 2A
Sensor cable	1	Standard Length : 10m
Ventilation power supply cable	1	Standard Length : 10m
AC Adapter	1	Cable length : 1.5m
AC power supply cable	1	Length : 2m
RS-232C cable	1	Length : 1.5m
CD-ROM	1	Software (WSDac_V5.0.x.x.exe and WSDisp_V5.0.x.x.exe) Instruction Manual
Calibration Certificate	1	
Instruction Manual	1	

4-3. Consumable Items

MS-713 contains following consumable items. These items are not covered under warranty.

Table 4-2. Consumable Items

Standard Items	Qty.	Remarks
Silica Gel	Approx. 6g	Particle size: 2 to 3mm Replace when the color changed to red.
Fuse	1	φ5.2x20, 250V, 2A
Ventilation	1	[Specification of Ventilation] Model: 9WG1212H101-E Manufacturer: SANYO DENKI Size: 120 x 120 x 38mm Rated voltage: 12V Rated current: 0.38A Maximum air flow: 2.8 m ³ /min. Maximum static pressure: 70.4 Pa Expected Life: 100000hr / 60°C IP Class: IP55 No ribs Frame Materials: Aluminum [Specification of Terminal] Housing Model: 03T-JWPF-VSLE-S Contact Model: SWPT-001T-P025 Manufacturer: J.S.T.MFG.CO.,LTD.

5. Getting Started

5-1. Parts Name and Descriptions

Each part name and its main functions are described below.

Table 5-1 and Figure 5-1 describe the sensor parts, and Table 5-2 and Figure 5-2 describe the power supply parts.

1. Sensor

Table 5-1. Names and functions of Sensor Part

	Name	Function
1	Spirit Level	Used for leveling the sensor base horizontally, adjust the two leveling screws to place a bubble in the center of the circle.
2	Fixing Holes	Used for fixing the instrument in leveled position. Fix the sensor for safety.
3	Diffuser	The diffuser diffuses the incident light from sky hemisphere, and it compensates the intensity of the incident light to comply with cosine characteristics.
4	Quartz Dome	Dome protects the sensor inside from soiling and effects from rain and wind, and it enhances the cosine characteristics which incident from the sky hemisphere..
5	Sensor/Power Supply Cable Connector	Connect Sensor/Power Supply Cable. Transmit power signal from power supply to sensor. Connector part is waterproofed.
6	Drying Cartridge	Used for keeping inside the sensor dry. It is necessary to replace it periodically when the desiccant color change.
7	Cover	Prevents from sensor's internal temperature increasing by solar radiation.
8	Leveling Screws	To set the sensor in horizontal position, adjust 2 screws as monitoring the spirit level.
9	Heatsink	Effectively releases the heat generated during temperature controlling the spectrometer inside the MS-713.
10	Waterproof Ventilation	Effectively releases the heat generated during temperature controlling the spectrometer inside the MS-713.
11	Ventilation Power Supply Connector	Connect ventilation power supply cable



Figure 5-1. Parts Name and Function (Sensor)

2. Power Supply

Table 5-2. Names and functions of power supply

	Name	Function																																																	
1	Power Switch	When the power switch is pushed to right side, power is ON, to left side power is OFF.																																																	
2	Connector Strip Block	<table><tr><th colspan="2">Terminal block</th><th>Wire Color</th><th>Wire #</th><td rowspan="10">(DC GND)</td></tr><tr><td>1</td><td>TXD+(RS-422)</td><td>Brown</td><td>1</td></tr><tr><td>2</td><td>TXD-(RS-422)</td><td>Red</td><td>2</td></tr><tr><td>3</td><td>RXD+(RS-422)</td><td>Orange</td><td>3</td></tr><tr><td>4</td><td>RXD-(RS-422)</td><td>Yellow</td><td>4</td></tr><tr><td>5</td><td>Digital GROUND</td><td>Green</td><td>5</td></tr><tr><td>6</td><td>Supply power +5V</td><td>Gray/Blue</td><td>6</td></tr><tr><td>7</td><td>Supply power ground</td><td>White/Yellow Green</td><td>7</td></tr><tr><td>8</td><td>Peltier Control +16V</td><td>Black</td><td>8</td></tr><tr><td>9</td><td>Peltier Control Ground</td><td>Pink</td><td>9</td></tr><tr><td>10</td><td>EARTH</td><td>Black</td><td>10</td><td>(DC GND)</td></tr></table>				Terminal block		Wire Color	Wire #	(DC GND)	1	TXD+(RS-422)	Brown	1	2	TXD-(RS-422)	Red	2	3	RXD+(RS-422)	Orange	3	4	RXD-(RS-422)	Yellow	4	5	Digital GROUND	Green	5	6	Supply power +5V	Gray/Blue	6	7	Supply power ground	White/Yellow Green	7	8	Peltier Control +16V	Black	8	9	Peltier Control Ground	Pink	9	10	EARTH	Black	10	(DC GND)
Terminal block		Wire Color	Wire #	(DC GND)																																															
1	TXD+(RS-422)	Brown	1																																																
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7	Supply power ground	White/Yellow Green	7																																																
8	Peltier Control +16V	Black	8																																																
9	Peltier Control Ground	Pink	9																																																
10	EARTH	Black	10	(DC GND)																																															
3	Connector for PC	Connect RS-232C cable to PC.																																																	
4	Fuse Holder	Set 2A fuse.																																																	
5	AC Power Connector	Voltage range is AC100 to 240V, frequency is 50 / 60Hz.																																																	
6	Grounding Terminal	Use this terminal when AC power supply is not grounded.																																																	

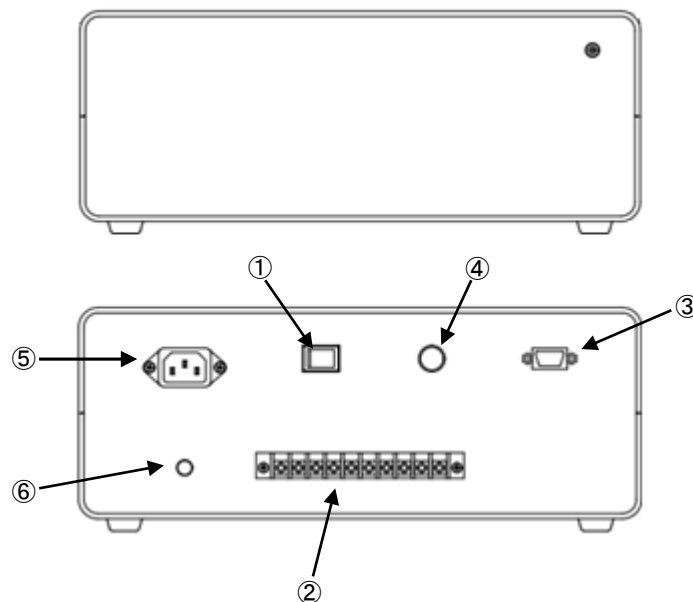


Figure 5-2. Parts Name and Function (Power Supply Part)

5-2. Setup Location

1. Location

In order to obtain representative measurements from spectroradiometers, several criteria with respect to setup and mounting of the instruments have to be considered*:

The ideal mounting position for the spectroradiometer is a location which has a full hemispheric field-of-view without any obstructions (such as buildings, trees, and mountain). In practice, it might be difficult to find such locations. Therefore, some practical recommendations on how to minimize undesired effects of reflecting or obstructing surfaces are given next:

- Select a mounting position which it is free from obstructions at 5° above horizon.
- The setup location should be easily accessible for periodic maintenance (quartz dome cleaning, desiccant replacement, etc.).
- Avoid surrounding towers, poles, walls or billboards with bright colors that can reflect solar radiation onto the spectroradiometer.

2. Installing at Horizontal or tilted Positions

(1) Prepare Installation Base

Check the installation base where the MS-713 has to be mounted and make sure it has two fixing holes with the appropriate pitch. The pitch sizes of the fixing holes are as follows (in mm):

Table 5-3. Fixing Hole Pitch and Bolt Size

	MS-713
Fixing Hole Pitch	280mm
Fixing Bolt Size	M8 x 230mm

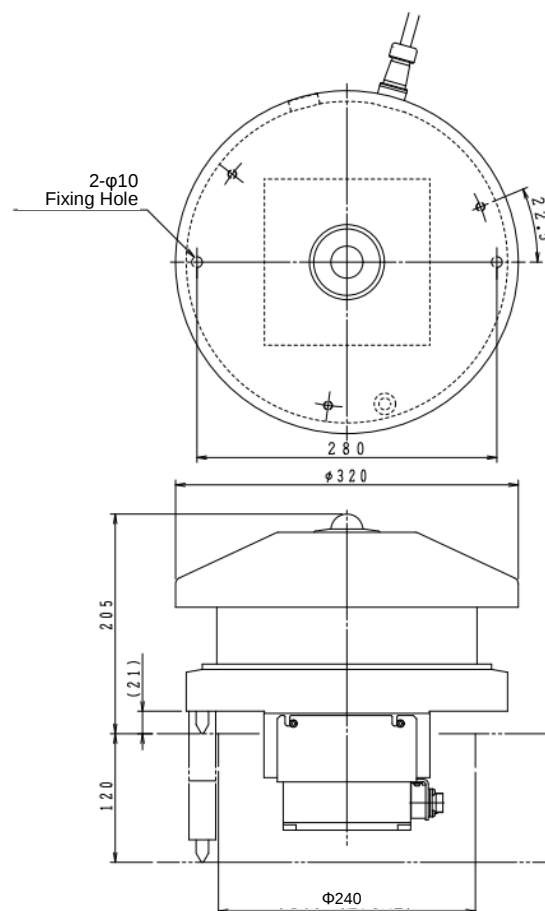


Figure 5-3. Dimension

(2) Setup the MS-713 Sensor

Setup the sensor with the signal cable connector facing the nearest Earth's pole.

In the Northern hemisphere, the connector should be orientated North, in the Southern hemisphere, the connector should be orientated South.

(3) Leveling

Adjust the sensors in a horizontal position by using the 2 leveling screws and observing the air bubble in the spirit level while manipulating the leveling screws. The instrument is leveled horizontally if the air bubble is in the center ring. Once the instrument is leveled properly, fix the instrument with mounting bolts.

In case the sensor is mounted on a tilted plane, preferably the sensor is mounted on the leveling screws to thermally isolate the sensor from the mounting platform.

If the sensor is not leveled properly, the readings are affected by cosine and azimuth errors. Periodically check the spirit level and adjust its position if necessary.

(4) Adjust Height

To take measurements by setting up the MS-713 side by side, the sensor surface must be adjusted to the same height level.

(5) Cover

Place the Cover on the instrument and fasten with 3 screws (M3).

(6) Connect Sensor Cable

Connect the sensor cable connector to the sensors and the Y-terminals to the terminal block of the power supply according to the table below.

Make sure the sensor connector part is securely connected so that moisture will not enter the connector. Also fasten the cable with such as band strip so that it will not be blown by wind

If the sensors are setup on Sun Tracker, make sure to have sufficient length of cable for rotation movement.

Use + screw driver to connect the cable to lug terminals on the power supply, make sure the cable numbers and the terminal numbers match.

NOTE: The power supply can't be used in an unprotected outdoors environment, as it can only be used in a dry environment.

Table 5-4. Terminal block layout and Wire colors

	Terminal block	Wire Color	Wire #	
1	TXD+ (RS-422)	Brown	1	
2	TXD- (RS-422)	Red	2	
3	RXD+ (RS-422)	Orange	3	
4	RXD- (RS-422)	Yellow	4	
5	Digital GROUND	Green	5	
6	Supply power +5V	Gray/Blue	6	
7	Supply power ground	White/Yellow Green	7	(DC GND)

8	Peltier Control +16V	Black	8	(DC GND)
9	Peltier Control Ground	Pink	9	
10	EARTH	Black	10	

(7) Connect Power Supply

Connect the one end of power cable to AC power supply connector at the rear of power supply. Then connect the other end of power cable to the socket properly. Make sure that provided power is AC100-240V, 50/60Hz, 50VA.

(8) Connect Communication Cable

Connect the PC COM port and the RS-232C connector at the back of the power supply with RS-232C cable. When connecting, insert the connector which has ferrite core to the power supply.

6. Software

This software is exclusively used for measuring and processing the data acquired by MS-713. It is used for taking measurements and analyzing data. Below describes the system configuration.

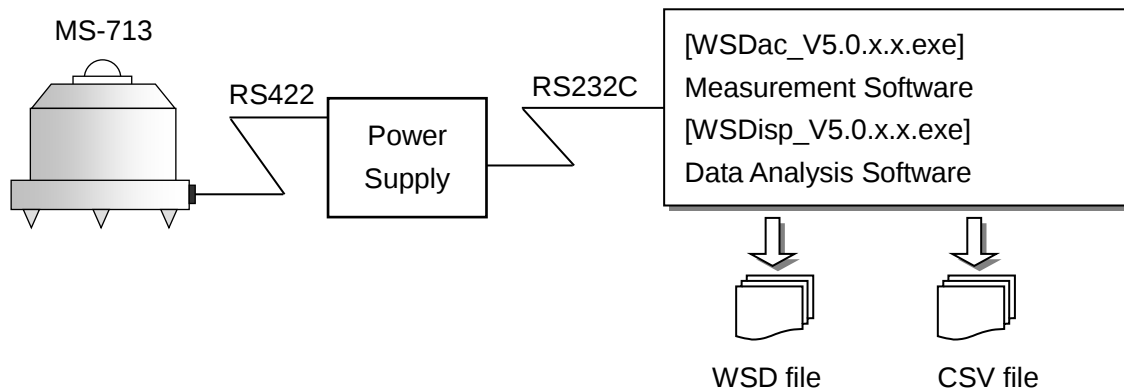


Figure 6-1. Outline of Software

6-1. Installation and Uninstallation

1. Installation

NOTE: Make sure to install the software on a PC which has administrative and/or installation authority.

- 1) Power ON the PC and insert the installation disk to the CD disk drive while the Windows desktop screen is displayed.
- 2) Start the installer by clicking the "Setup.exe" which is included in the Installation Disk.
- 3) Installation Wizard window appears. To go to the next step, click [Next].



Figure 6-2. Installation Wizard Startup Window

- 4) "License Agreement" window appears; select "I accept the terms in the license agreement" then click [Next] button to go to the next step.

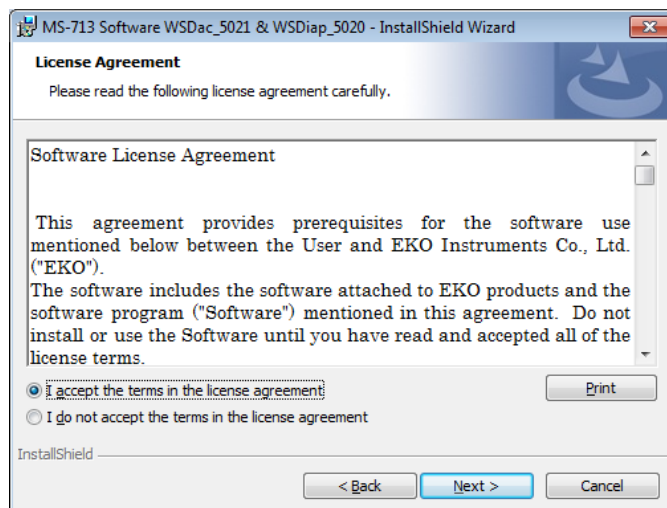


Figure 6-3. License Agreement Window

- 5) "Destination Folder" window appears. If the software will be installed in the "C:\EKO" folder, click [Next] button to go to the next step. To change the destination folder, click [Change...] button and select the appropriate folder.



Figure 6-4. Destination Folder Window

NOTE: When changing the installing folder, User Account Control function becomes active. Installing and/or data uploading in the folder which OS is restricting the access authority may generate problems. There are "C:\Program Files", "C:\ProgramData", "C:\Windows", and system drive route folder "C:\\" for such folder with restrictions. Avoid these folders when changing the destination folder.

- 6) “Ready to Install the Program” window appears. Confirm the destination folder and if okay, click [Install] button to go to next step.



Figure 6-5. Install Window

- 7) After a while, the PC display goes dark and “User Account Control” dialog window appears. Click [Yes] button to start the software installation.

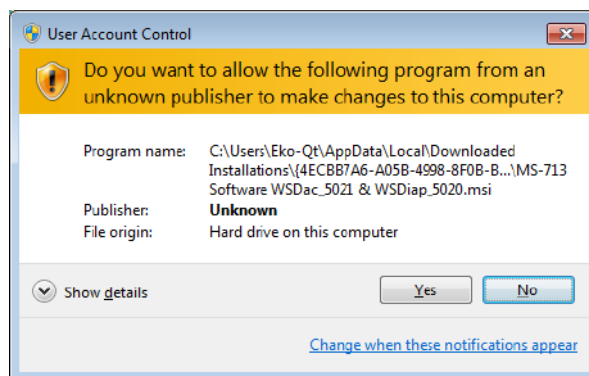


Figure 6-6. User Account Control Window

- 8) As the installation is completed, the following window appears. Click [Finish] button to close the installation window.

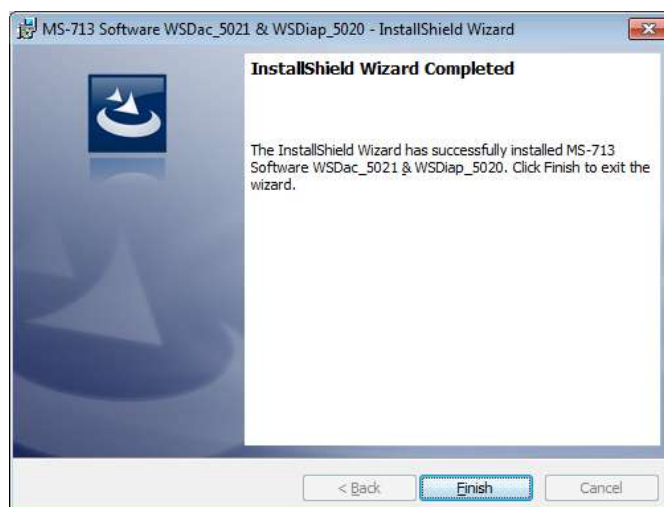


Figure 6-7. Installation Complete Window

- 9) When the installation is completed, a shortcut icon as shown below will be created on the desktop, as well as under the Start Menu, “All Programs” → “EKO” → “WISER”.

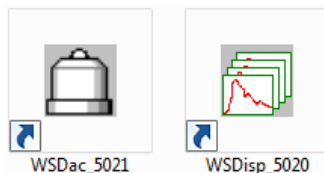


Figure 6-8. Software Shortcut Icon

2. Uninstallation

There are 2 ways to uninstall the software.

- 1) Uninstalling from the “Programs and Features”

Access by clicking “Control Panel” → “Program and Features”. Select the program to be uninstalled and right click; the popup menu will appear. Select “Uninstall”.

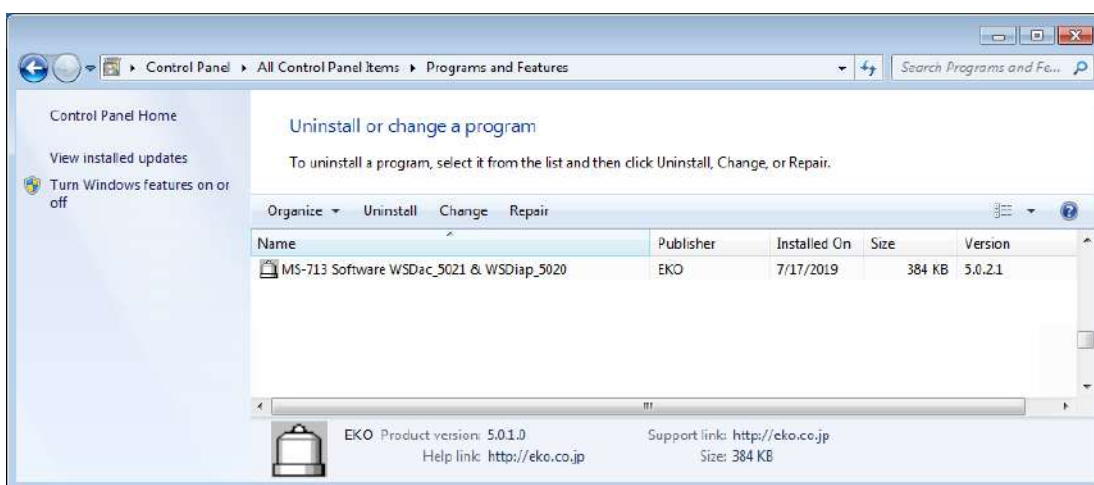


Figure 6-9. Uninstalling from “Programs and Features”

Following message appears; to uninstall, click [Yes] button. The software will disappear from the “Programs and Features” list and confirms the software has been uninstalled.

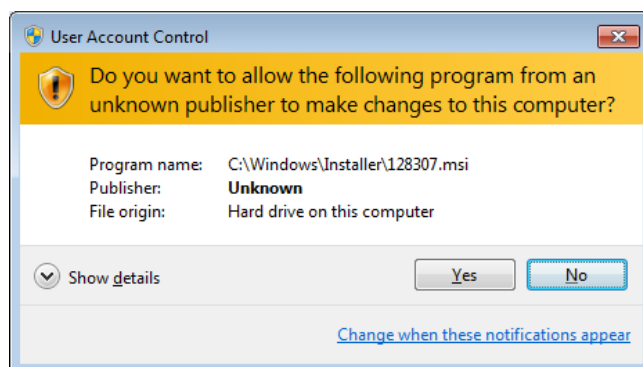


Figure 6-10. User Account Control Window

2) Uninstalling from Installation Disk

Just like when the software was installed, startup the software to be uninstalled from the CD-ROM.

Proceed according to the messages appear on the window. If the software is already installed, there appear the options as “Modify”, “Repair” and “Remove”.

Select “Remove” from this window and click [Next] button.

Follow the messages on each step will result in uninstalling the software.



Figure 6-11. Uninstalling from CD-ROM

6-2. Data File Format

The following data file formats are available for this software.

Table 6-1. File Format

	File format	Binary/ASCII	Wavelength increment
a	ESM file	Binary	Specified as spectroradiometers
b	CSV file	ASCII	Specified as spectroradiometers
c			1nm interval

1. WSD File (Binary Data)

WSD format data file is composed as binary data. Only the spectral radiation data of the wavelength interval according to spectroradiometers specifications is saved in WSD file.

2. CSV File (ASCII)

CSV file is composed as ASCII format data. The spectral radiation data of wavelength interval according to the spectroradiometers specification can be saved in CSV file, as well as the spectral radiation data which wavelength interval sampled at 1nm. The CSV file data is easily converted to other formats, including Microsoft Excel.

[Measured Value of CSV Data File and Calculated Value of CSV Data File]

This software can save the CSV data file of measured value which radiation is output for each wavelength, as well as the CSV data file of calculated value which output the calculation result.

[Measured Value of CSV Data File]

Radiation data of each wavelength is saved. This file contains the instrument data (MS-711, MS-712, MS-713, or Merge) which is selected ahead of time. See "CSV Format Data" in section "7-2 Before Starting Measurements"

Table 6-2. Example of Measurement Value of CSV Output (Original Wavelength Pitch):

Common for WSDac and WSDisp					Measured Date
Data	2018/12/20			2010/12/20	
Time	9:00:00			9:01:00	Measured Time
Memo	EKO WISER				Data Memo
Sensor	MS-711	MS-713	MERGE	MS-711	Instrument
Exposure Time(msec)	500	30		500	Exposure Time
Sensor Temp.(deg)	25	25		24.7	Internal Temperature
Power[V]	5.9	5		5.9	Applied Voltage
Wavelength (nm)	Irradiance (W/m ² /um)	Irradiance (W/m ² /um)	Irradiance (W/m ² /um)	Irradiance (W/m ² /um)	
:	:	:	:	:	
946.53	119.71		124.6	125.9	
947.31	110.3		127.99	93.65	
947.83		131.61	131.52		
948.1	140.11		132.52	133.84	
948.89	132.65		133.93	130.54	

Measured Wavelengths

MS-711 Radiation Data

MS-713 Radiation Data

Merged Radiation Data

Data acquired in one time measurement (Marked Blue)

[Calculated Value of CSV Data File]

The calculated value of CSV data file can be saved with data such as PAR (Photosynthetically Active Radiation), PPFD (Photosynthetic Photon Flux Density), ILLUMINANCE, Integral (interval integrated value) that are calculated out from the data in each calculated intervals. The PAR/PPFD are calculated from the data between 400 to 700nm and Illuminance is calculated by multiplying the standard relative luminosity curve to the data between 380 and 780nm. Integral (interval integrated value) will be the integrated value in the specified wavelength interval. Either one will be the calculation result of data which was linearly interpolated with 1nm pitch.

Table 6-3. Example of Calculated Value CSV Output, only WSDisp

2010/5/8				
Time	PAR(W/m ²)	PPFD(umol/m ² /s)	ILLUMINANCE(lx)	Integral[300-1800](W/m ²)
7:00:00	25.49	117.8	5935.9	138.2
7:01:00	25.5	117.8	5937.1	139.5
7:02:00	25.46	117.7	5931.2	131.7

Measured Date & Time

PAR Data

PPFD Data

ILLUMINANCE Data

Radiation Integrated Data

7. Measurement Software (WSDac)

WSDac.exe is measurement software, and it has main function of data measurement, including the scheduled measurement.

Scheduled measurement takes measurement automatically repeated daily at a certain time frame and in time interval which are setup in advance then save the data in WSD file. In each data measurement, the most appropriate exposure time is automatically setup by the software and takes and save the spectrum data.

NOTE: When taking measurements by switching multiple units of MS-713 on one computer, make sure to do the following:

- Restart the software each time the instrument is switched. If the software is not restarted, the calibration value saved from the previous measurements will be used, and the measurement will not be accurate.
- Change the folder for saving. With this software, the multiple data of the same model type instrument cannot be saved in a same folder.

NOTE: To use the merge function in data analysis software for the measured data, measurement should be taken with one of the following combination using WSDac.

- MS-711 + MS-712
- MS-711 + MS-713
- MS-710 + MS-712
- MS-710 + MS-713

7-1. Starting Measurement Software WSDac

As the "WSDacV3.0.x.x.exe" is started, the Fig.7-1 Window is displayed.

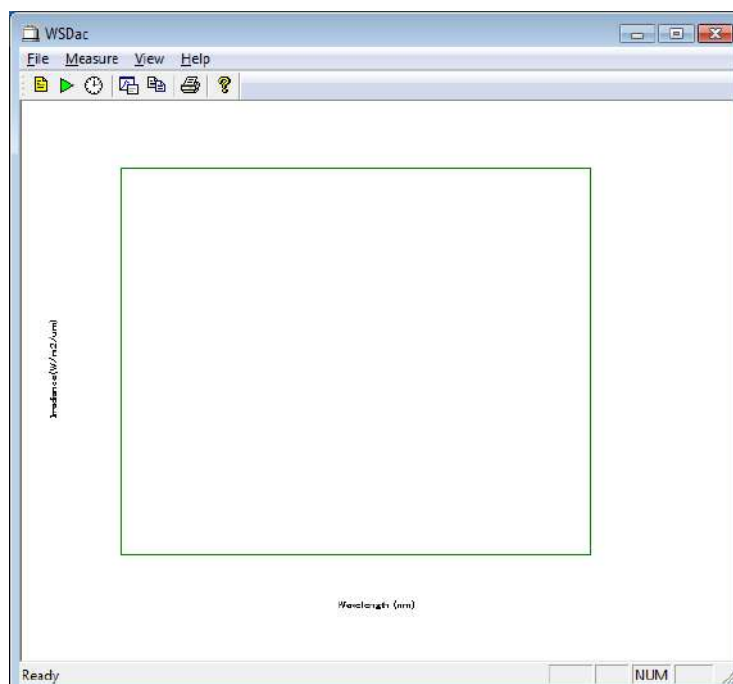


Figure 7-1. WSDac.exe Main Window

7-2. Before Starting Measurement

Before starting the measurement, setup the measurement condition. Go to [Measure → Measurement Settings] from the tool bar or click the [Configuration] button located at the top (Figure 7-2) then the [Measurement Settings] window will be displayed as shown on Figure 7-3.



Figure 7-2. Configuration Button

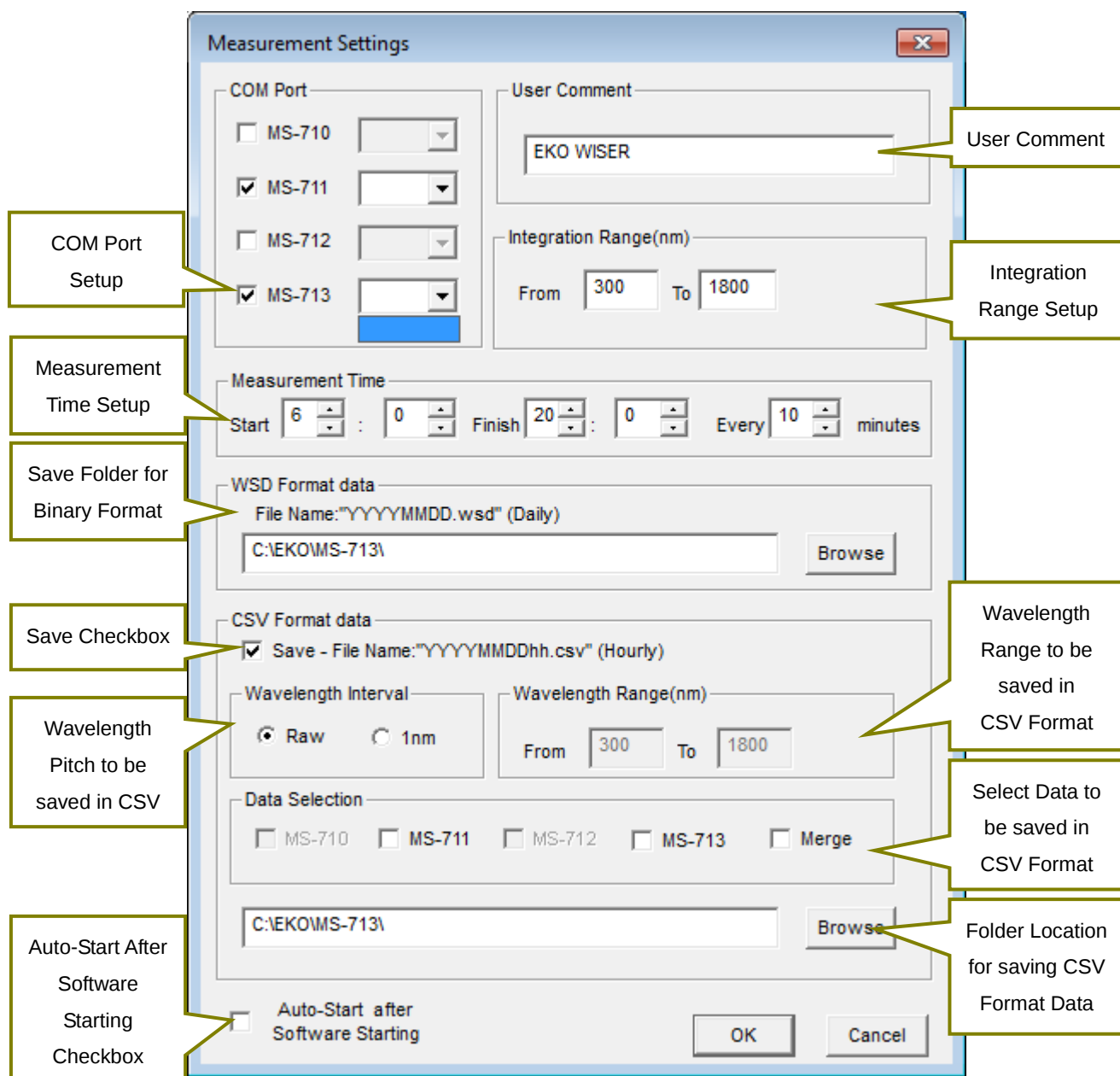


Figure 7-3. Measurement Setup Window

Table 7-1. Measurement Setup Window Functions

Functions	Description
[COM Port Setup]	Select a COM Port which is connected to the instrument to be controlled.
[User Comment]	Save the measurement data with attached memo which is entered in this box.
[Integration Range]	Indicates the specified integration value interval on the measurement data graph window.
[Measurement Time]	Measurement will be taken in the specified interval during the measurement start time to the end time.
[WSD Format Data]	A folder can be selected to save the Binary format spectrum data. Click [Browse] button to select a folder for data to be saved. When the data is taken, the file name will be saved with the measured date [YYYYMMDD.WSD] (YYYY: Year, MM: Month, and DD: Day)
[CSV Format Data]	A folder can be selected to save the CSV format spectrum data.
[Save] Checkbox	By checking this checkbox, measurement data in each time interval are saved in CSV format file. The file name will be the date and time of the measurement, such as [YYYYMMDDhh.WSD] (YYYY: Year, MM: Month, DD: Day, and hh: Time).
Wavelength Pitch	By selecting the "Raw", the data is saved with the unique wavelength pitch of the instrument itself. By selecting "1nm", the data is saved as linearly interpolated in 1nm pitch.
Wavelength Range	The data will be saved in CSV format data in the wavelength range which is specified; this is effective only when the Wavelength Pitch is setup with "1nm".
Data Selection	Saves the data of the instrument which is selected. When measuring the MS-711 and MS-713 at the same time, the combined data of MS-711 and MS-713 can be saved by selecting "Merge."
Folder for Saving CSV Format Data	Click [Browse] button to specify the folder for data to be saved. For CSV format file will create a Year folder [YYYY] automatically under the specified folder to save the data.
[Auto-Start After Software Starting]	By checking the checkbox, the measurement will be automatically started as the software is started up with the condition setup in the last measurement condition.

When clicking [OK] button shown at the bottom of the window, the data save folder setup is completed.

7-3. Start Measurement

There are Manual Measurement, which takes just one measurement, and Interval Measurement, which takes measurement by specified interval.

To start a manual measurement, go to [Measure → Start Manual Measurement] from the tool bar or click the [Manual Measurement Start] button located at the top (Figure 7-4); the [Manual Measurement Running] window is displayed as shown on the Figure 7-5.

To start Interval Measurement, go to [Measure → Start Interval Measurement] from the tool bar or click the [Start] button (Figure 7-6) located at the top; the [Interval Measurement] window is displayed as shown on Figure 7-7.

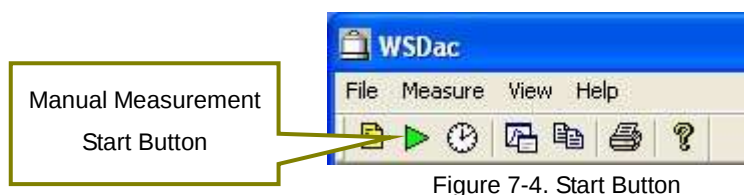


Figure 7-4. Start Button



Figure 7-5. Interval Measurement Window

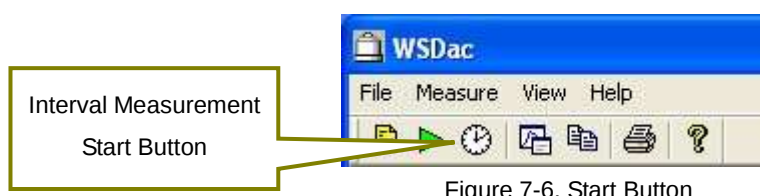


Figure 7-6. Start Button



Figure 7-7. Interval Measurement Window

Table 7-2. Measurement Start Functions

Functions	Descriptions
Current Time	The current time is displayed.
Instrument Status	The statuses of the measuring instruments are displayed. The Table 7-2 describes the meaning of each message and status, and how to deal with the statuses.
Abort Button	Terminates the manual or interval measurement.

Table 7-3. Messages Displayed on the Interval Measurement Dialog Window

Messages	Statuses	Actions
Error (Opening COM Port failed)	Cannot open the setup communication port.	Check the measurement settings.
Getting the sensor information	Software retrieving the sensor information. Normal condition	No action necessary
Error (Communication with the sensor failed)	No responses from the instrument	Check the communication cable and power supply of the instrument.
Error (Getting the sensor information failed)	The communication is unstable.	Check the communication cable for disconnection and cable condition.
Error (Getting the calibration value failed)		
Error (Sensor Name)	A sensor which is different from the setup is connected.	Check the communication port and the corresponding instrument.
READY	Completed the measurement preparation.	No action necessary.
Measuring	Displayed during the measurement is taken.	No action necessary.
Retrying measurement	The measurement failed, but retrying to start measurement.	Check communication cable and power supply of the instrument.
Measurement failed	Displayed when the measurement is retried for 3 times and measurement failed.	
Measurement OK	Measurement was done successfully.	No action necessary.

Application Log File (YYYY(Year).LOG)

The YYYY(Year).LOG file is created in the same folder as WSD files saving folder, which was setup in the measurement setup for Measurement software WSDac. This file records the information such as application start-up, measurement start, measurement error, file processing error. (Table 7-3)

Table 7-4. Contents Indicated in Application Log File

Message	Condition
APP START	Measurement Software startup
APP CLOSE	Measurement Software exit
INT.MEAS START	Started Interval Measurement
INT.MEAS STOP	Ended Interval Measurement
ERROR MEAS THREAD CREATE	Internal Error (Measurement Thread startup failed)
ERROR WSD LOAD	Existing WSD file uploading for adding data failed
ERROR MS710 MEAS	MS710 Measurement failed.
ERROR MS711 MEAS	MS711 Measurement failed.
ERROR MS712 MEAS	MS712 Measurement failed.
ERROR MS713 MEAS	MS713 Measurement failed.
ERROR WSD SAVE	WSD File Saving failed.
ERROR CSV SAVE	CSV File Saving failed.

7-4. Measurement Data Display

By taking a measurement, the Measurement Data display window shows the graph (Fig. 7-8). This graph is updated per each measurement.

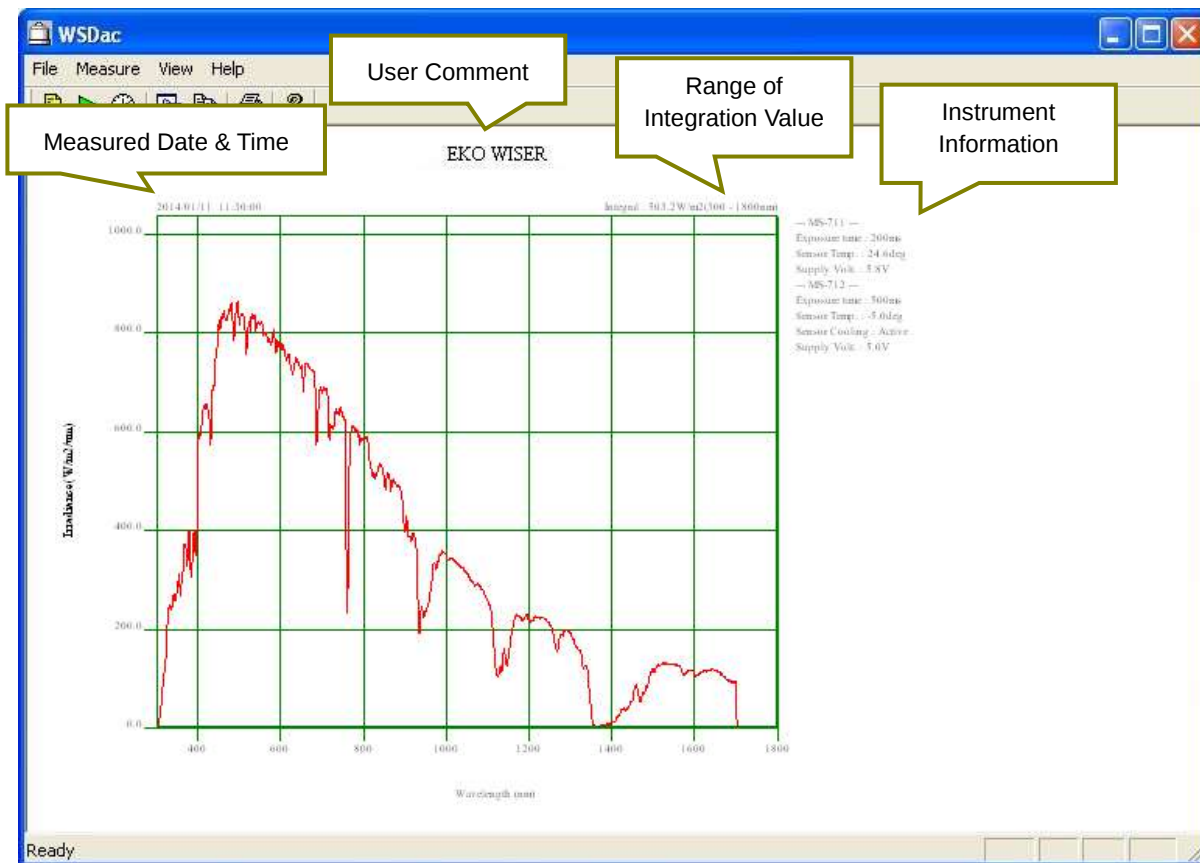


Figure 7-8. Measurement Data Display Window

Table 7-5. Measurement Data Display Functions

Functions	Descriptions
[Measured Date & Time]:	The date and time of the displayed measurement taken.
[User Comment]:	Displays the [User Comment] entered in the Measurement Setting.
[Range of Integration Value]:	Displays the spectrum radiation integration value (W/m ²) within the wavelength range which is setup in [Integration Range] in the Measurement Setting.
[Instrument Information]:	Displays the information of [Buildup Time (Exposure Time)], [Sensor Temperature], [Power Supply Voltage], and [Sensor Cooler Drive (MS-712 or MS-713)]

7-5. Graph Setting

When specifying the graph axis and color of line on the displayed graph, use the [Graph] button. Either go to [View → Graph Settings] from the tool bar or click the [Graph] button (Figure 7-9) located at the top, the [Graph Settings] window will display as shown on Figure 7-10.

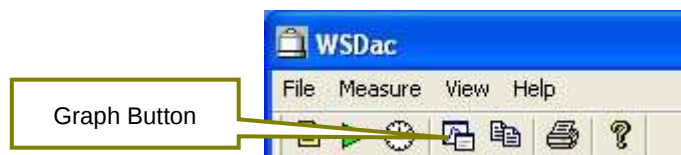


Figure 7-9. Graph Button

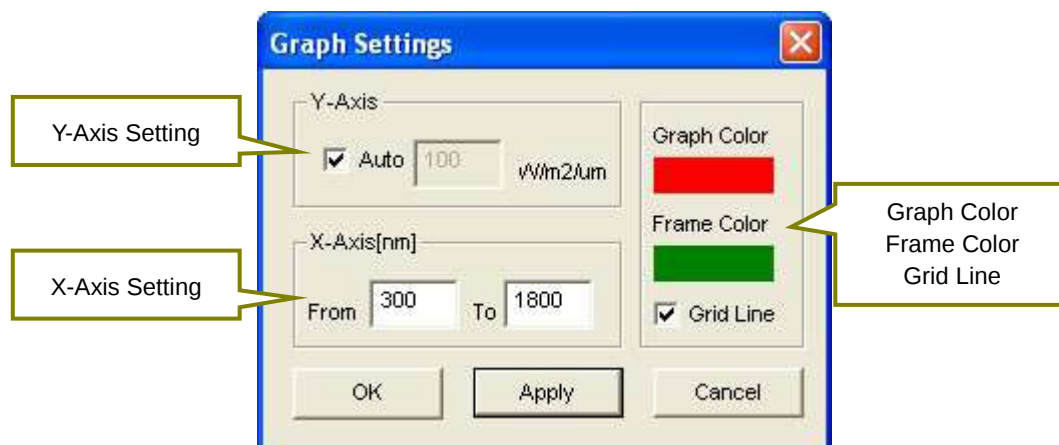


Figure 7-10. Graph Settings Window

Table 7-6. Graph Setting Functions

Functions	Descriptions
[Y-Axis Setting]:	By checking the “Auto” checkbox, the Y-Axis scale is automatically setup. By removing check from the “Auto” checkbox, the maximum value of Y-Axis can be specified
[X-Axis Setting]:	Specify the X-Axis wavelength range to be displayed on graph.
[Graph Color, Frame Color, and Grid Line]:	By clicking the colored area, the color selection dialog window will be displayed, and the graph and frame color can be specified as desired. The grid line of the graph can be shown or not shown by checking or un-checking the [Grid Line] checkbox.
[OK, Apply, Cancel] Buttons:	By clicking the [OK] button, the Graph Setting window will disappear and go back to the graph display window. Clicking [Apply] button will allow the user to see the changes on the graph with the Graph Setting window still opened.

[Cancel] button can cancel the setting changes on the Graph Setting.

7-6. Graph Copy

This function copies the graph image displayed on the window on to clip board. Go to [View → Copy] from the tool bar or click the [Copy] button (Figure 7-11) at the top to make copy of the graph.

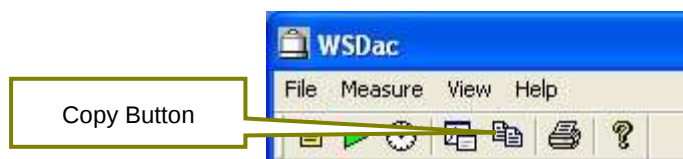


Figure 7-11. Copy Button

7-7. Print

This function prints the graph image displayed on the window. Go to [File → Print] from the tool bar or click the [Print] button (Figure 7-12) at the top to print the graph.

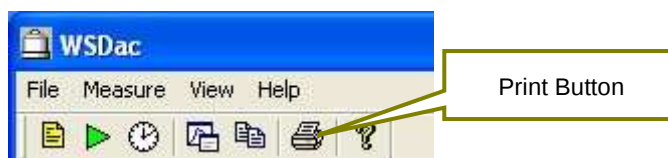


Figure 7-12. Print Button

Also, to see the print preview condition, go to [File → Print Preview] from the tool bar. Printer can be setup from [File → Printer Setup] on the tool bar.

7-8. Version Information

The software version information can be displayed. Go to [Help → About WSDac...] from the tool bar or click the [?] button (Figure 7-13) at the top to see the software version information.

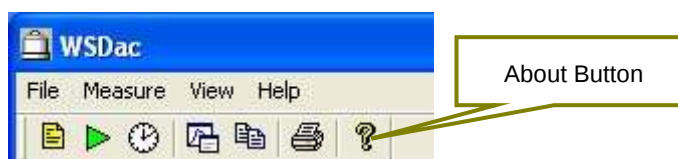


Figure 7-13. About Button

8. Data Analysis Software (CSVDisp)

WSDisp.exe is data analysis software, and it has main function to view the measured data (WSD) and save as CSV format files.

8-1. Starting Data Analysis Software CSVDisp.exe

As the CSVDisp is started, the Figure 8-1 Window is displayed.

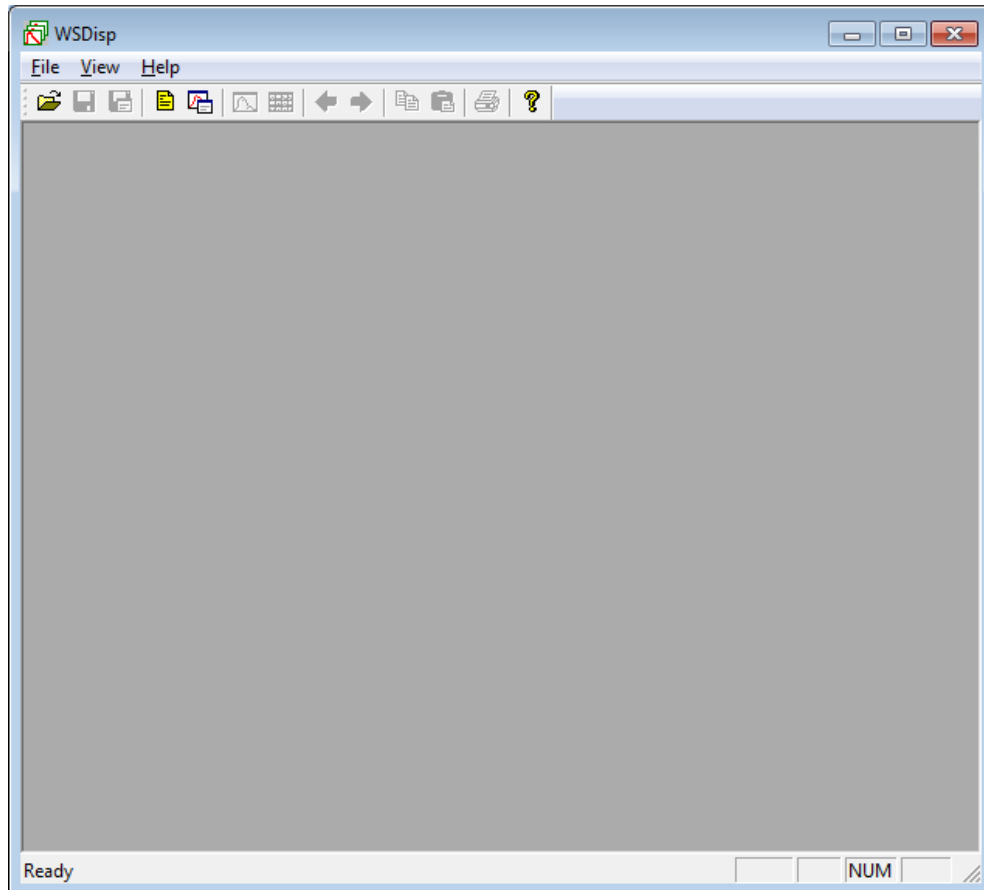


Figure 8-1. WSDips_V3.0.x.x.exe Window

8-2. Start Folder View

Go to [File → Open...] from the tool bar or click the [Open] button located at the top of the window (Fig. 8-2). When the file selecting dialog window appears, select a measurement data file and click [Open] button to show the data.

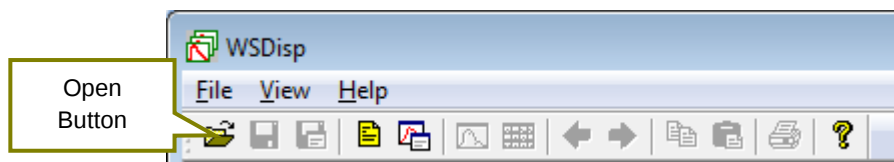


Figure 8-2. Open Button for Measurement Data Files

8-3. Show Measurement Data

1. Displaying Data List

After the measurement data is uploaded, "Tiled Data Window" appears as shown on Figure 8-3.

Only on this window, the data can be deleted by selecting data, then right click → Delete.

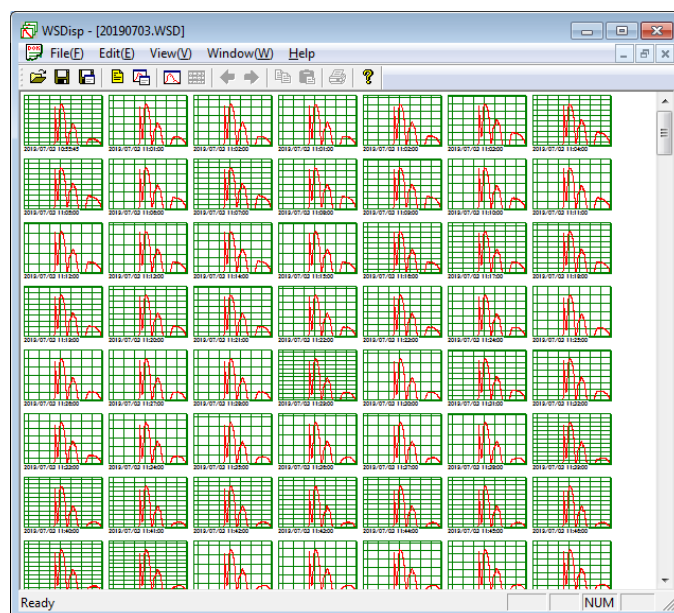


Figure 8-3. Tiled Data Window

2. Viewing Data Details

Double click the data shown on the Tiled Data window, or go to [View → Selected Data] on the tool bar, or clicking the [Selected Data] button (Figure 8-4) will display the "Tiled Data window" as shown on Figure 8-5.

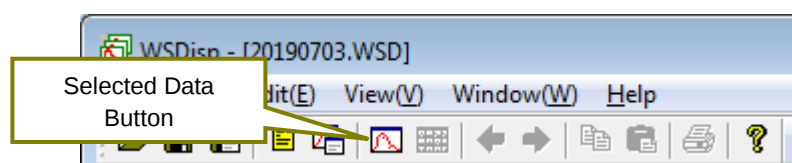


Figure 8-4. Selected Data Button

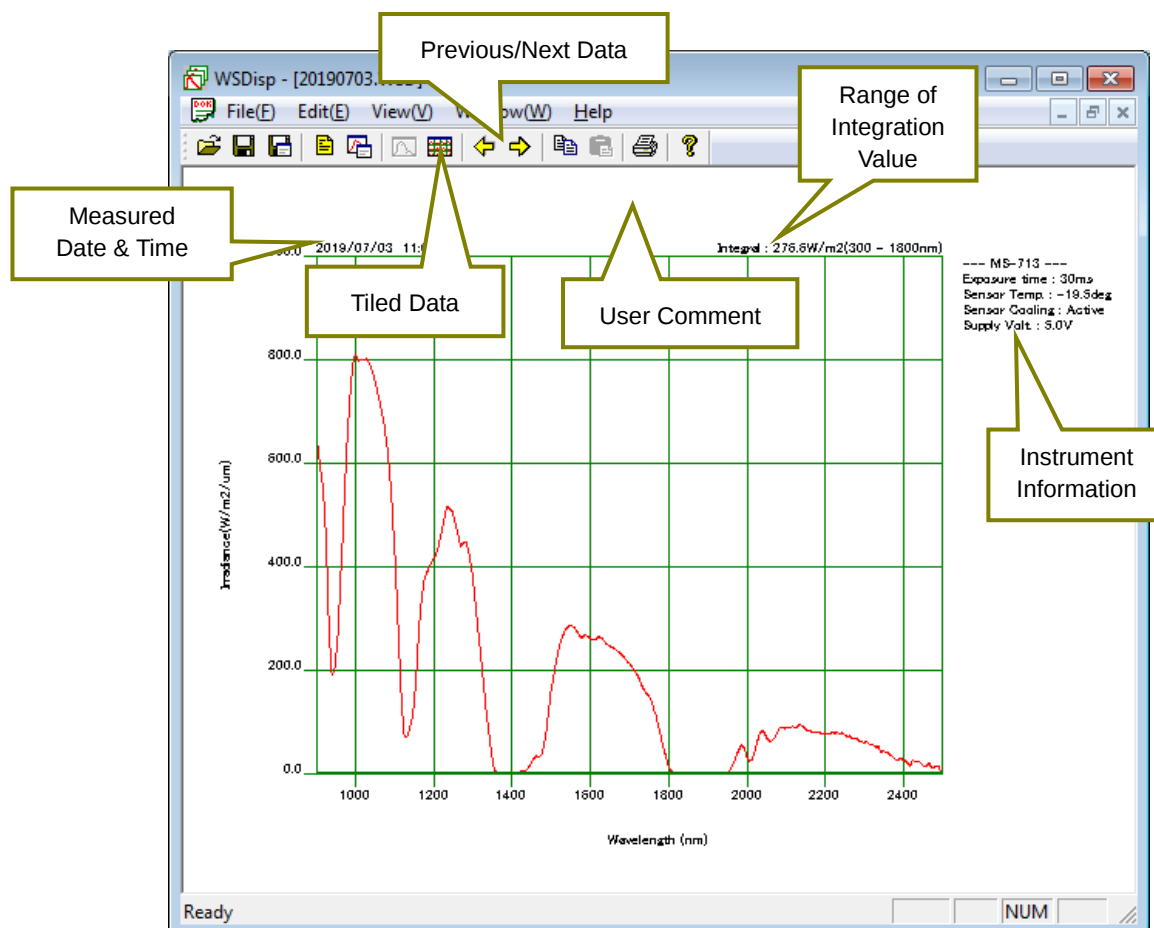


Figure 8-5. Measured Data Details Window

- [Previous/Next Data]:** By clicking these buttons, the data previous or next to the data currently shown is displayed. Arrow keys (←/→) on the keyboard can be also used to for this function.
- [Tile Data]:** The display window can be switched back to the Tiled Data window by clicking this button. Double clicking the displayed graph can also switch to the Tiled Data window.
- [Measured Date & Time]:** The date and time of the displayed measurement taken.
- [User Comment]:** Displays the [User Comment] entered in the Measurement Setting.
- [Range of Integration Value]:** Displays the spectrum intensity integration value (W/m^2) within the wavelength range which is setup in [Integration Range] in the Measurement Setting.
- [Instrument Information]:** Displays the information of [Buildup Time (Exposure Time)], [Sensor Temperature], [Power Supply Voltage], and [with/without Sensor Cooled Drive]

3. Displaying Specific Wavelength Data

Left clicking the mouse on the graph displayed on the graph displaying window, a cross-cursor appears as shown on Figure 8-6, and the value of the point where cross-cursor intersection is located is displayed on the right bottom of the graph. The cross-cursor moves as left clicking and moving the mouse; the values of each intersection position are shown at the right bottom of the graph.

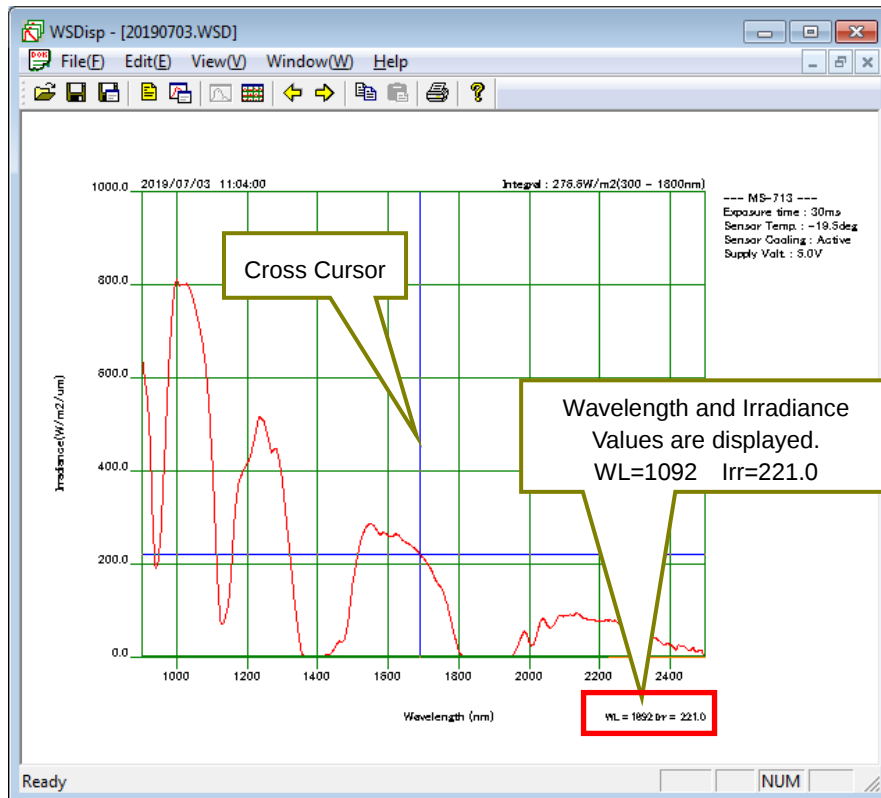


Figure 8-6. Displaying Specific Value on Graph

4. Displaying Multiple Selected Data

When selecting multiple data in a sequential range, first left click the first data in the range then as pressing the [Shift] key, click the last data in the range. The data can be selected as shown on the Figure 8-7. Also by using [Ctrl] key, the desired multiple data can be selected.

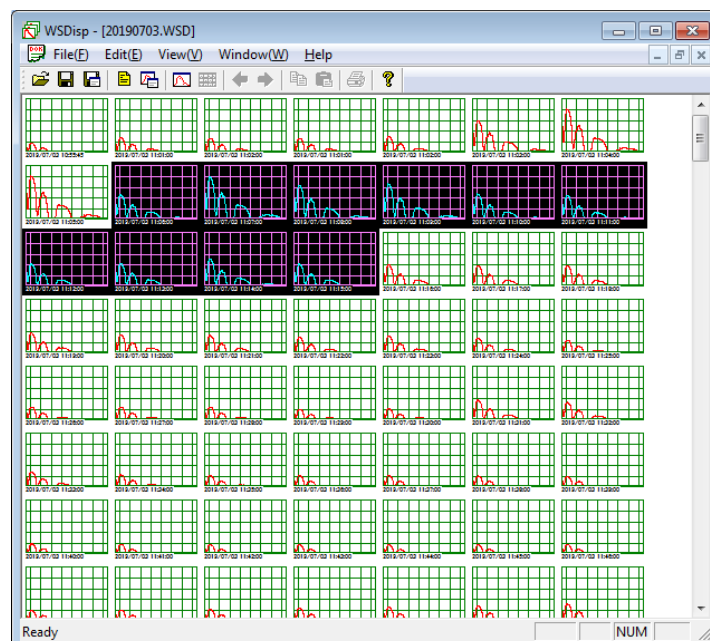


Figure 8-7. Selecting Multiple Data

As the multiple data are selected, right click the mouse and select [Spectral Data] from the dropdown list. The data are displayed in superimposed condition as shown on Figure 8-8.

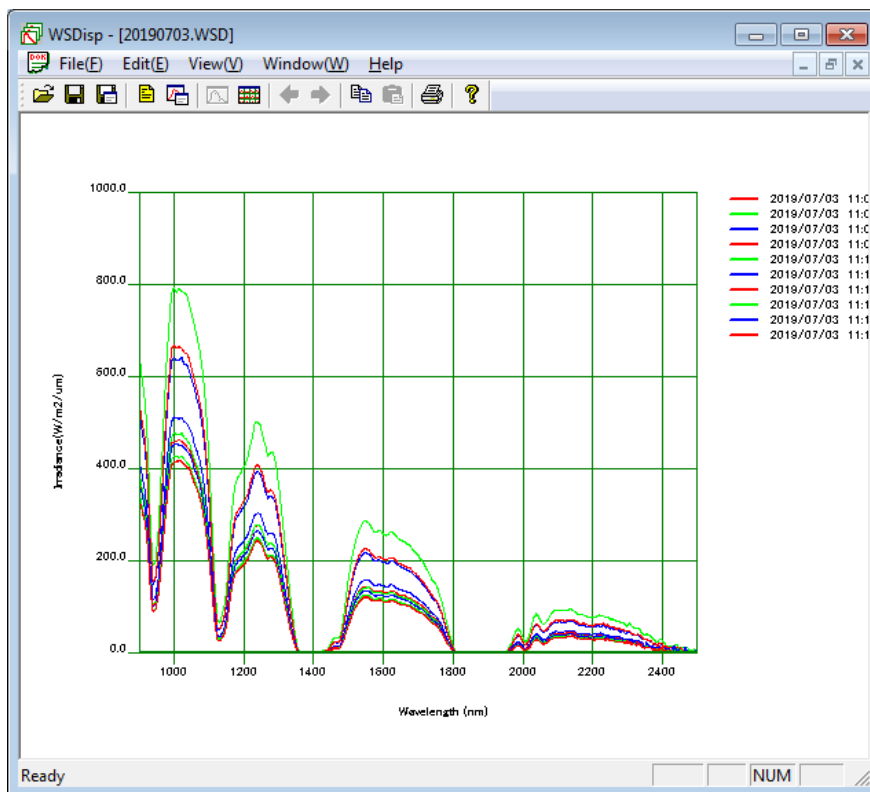


Figure 8-8. Superimposed Graph for Displaying Multiple Data

There are 10 colors for graphing: Red, Orange, Yellow, Yellow Green, Green, Light Green, Light Blue, Blue, Navy and Purple, registered as default colors. If more than 10 data are selected, the colors are repeated. Graph colors can be freely changed by opening the WSDisp.ini file as text editor and editing each RGB values of the [COLOR TABLE]. Also by adding the number of lines, more than 10 colors can be registered.

WSDisp.ini File

```

:
[COLOR_TABLE]
#LINE_COLOR001=R,G,B
LINE_COLOR001=255,0,0
LINE_COLOR002=255,94,25
LINE_COLOR003=251,236,53
LINE_COLOR004=128,255,0
LINE_COLOR005=0,255,0
LINE_COLOR006=0,255,128
LINE_COLOR007=0,255,255
LINE_COLOR008=0,128,255
LINE_COLOR009=0,0,255
LINE_COLOR010=128,0,255

```

5. Deleting Data

The data can be deleted on the tiled data list window by selecting data → right click → delete.

However, the data will not be completely deleted from the WSD file just by this procedure. In order to delete the original data, it is required to select “Save” from the File menu. Note that the original data will not recover by overwriting the file to save. If the original data is an important data, it is recommended to select “Save as...” to save with different name.

8-4. Data Setting

In order to setup the range or pitch of wavelength for saving data in CSV format, contents of the data to be saved (MS-711, MS-713, or to merge), or setup the integration range, click the [Data Settings] button. Go to [File → CSV Settings] from the tool bar or click the [Start] button (Figure 8-9) located at the top then the [CSV Settings] window is displayed as shown on Figure 8-10.

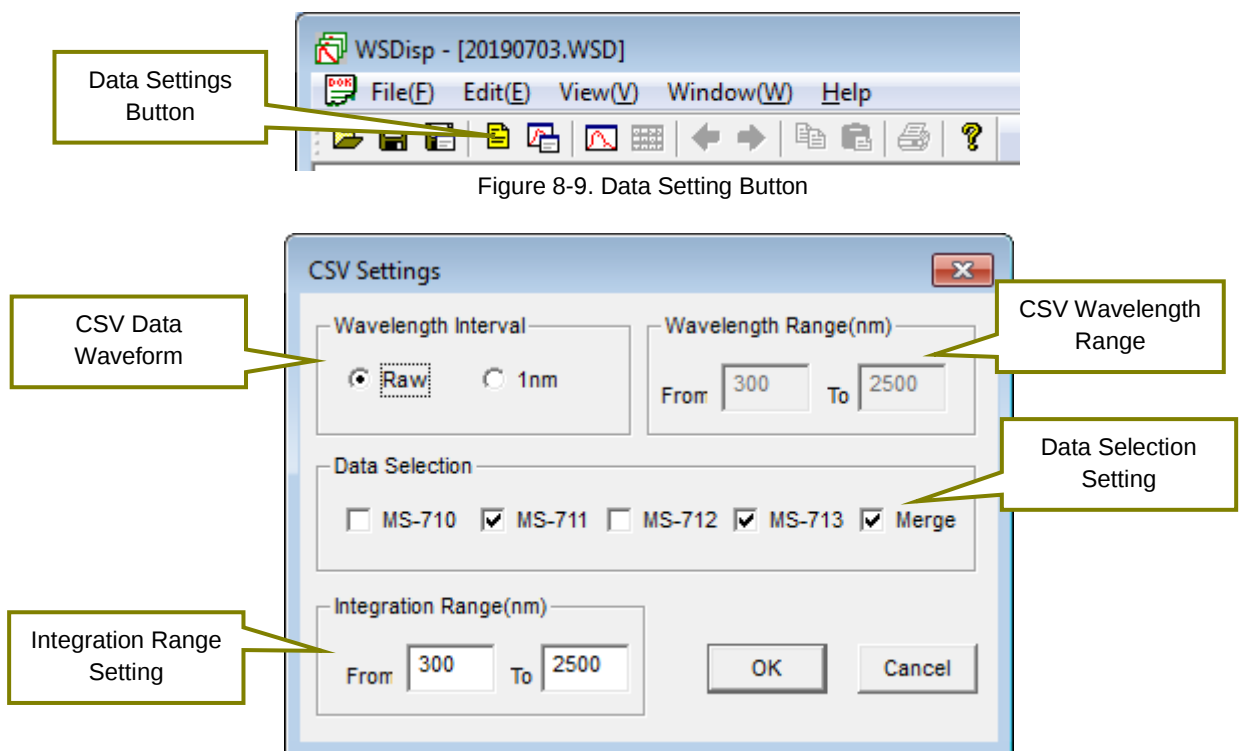


Figure 8-10. CSV Settings Dialog Window

- [CSV Data Waveform]:** Specify the wavelength pitch for when the [Saving Measurement Value in CSV Format]. By selecting the “Raw”, the data is saved with the unique wavelength pitch of the instrument itself. By selecting “1nm”, the data is saved as linearly interpolated in 1nm pitch.
- [CSV Wavelength Range (nm)]:** Specify the wavelength range for [Saving Measurement Value in CSV Format]; this is effective only when the Wavelength Pitch is setup with “1nm”.
- [Data Selection]:** Saves the data of the instrument which is selected for [Saving Measurement Value in CSV Format]. When measuring the MS-711 and MS-713 at the same time, the combined data of MS-711 and MS-713 can be saved by selecting “Merge.”
- [Integration Range]:** Specify the integration range for [Saving Measurement Value in CSV Format]. Also display the specified range of integrated value on the Selected Data display window, and the range becomes the integrated value of the saving CSV calculated value.

8-5. Graph Setting

When specifying the graph axis and color of line on the displayed graph, click the [Graph] button. Go to [View → Graph Settings] from the tool bar or click the [Graph] button (Figure 8-11) located at the top then the [Graph Settings] window will display as shown on Figure 8-12.

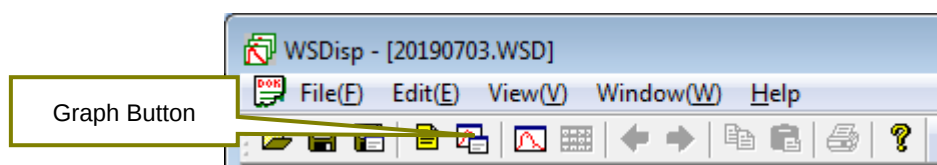


Figure 8-11. Graph Button

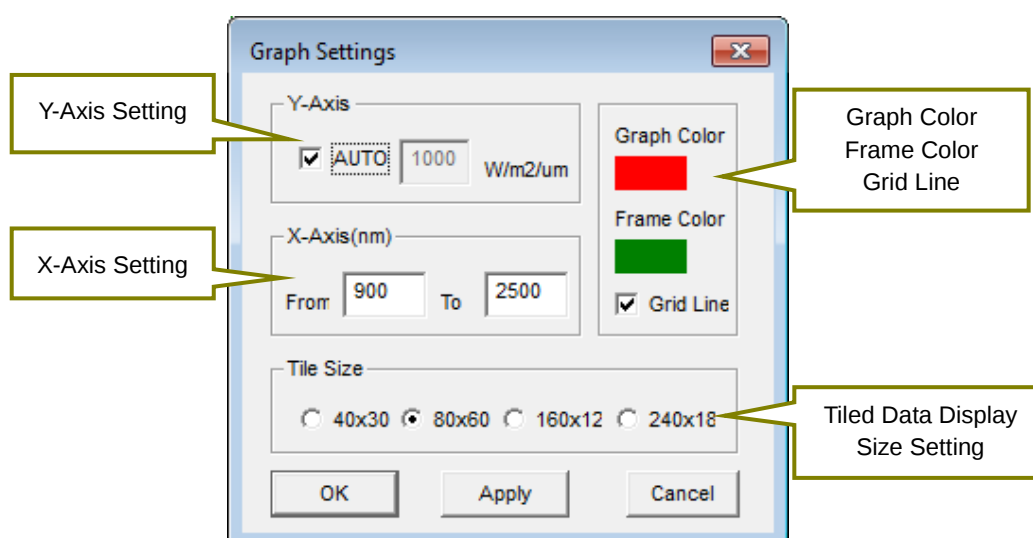


Figure. 8-12. Graph Settings Window

- [Y-Axis Setting]:** By checking the “Auto” checkbox, the Y-Axis scale is automatically setup. By removing check from the “Auto” checkbox, the maximum value of Y-Axis can be specified
- [X-Axis Setting]:** Specify the X-Axis wavelength range to be displayed on graph.
- [Graph Color, Frame Color, and Grid Line]:** By clicking the colored area, the color selection dialog window will be displayed, and the graph and frame color can be specified as desired. The grid line of the graph can be shown or not shown by checking or un-checking the [Grid Line] checkbox.
- [Tiled Data Display Size Setting]:** Setup the size of the one measurement data to be displayed on the Tiled Data display window.
- [OK, Apply, Cancel] Buttons:** By clicking the [OK] button, the Graph Setting window will disappear and go back to the graph display window.
Clicking [Apply] button will allow the user to see the changes on the graph with the Graph Setting window still opened.
[Cancel] button can cancel the setting changes on the Graph Setting.

8-6. Data Saving

To save one or more measured data (WSD Format), to save desired measured data or calculated data in CSV format, either go to [File] (Figure 8-13) in toolbar or use the [Save] button at the top (Figure 8-14).

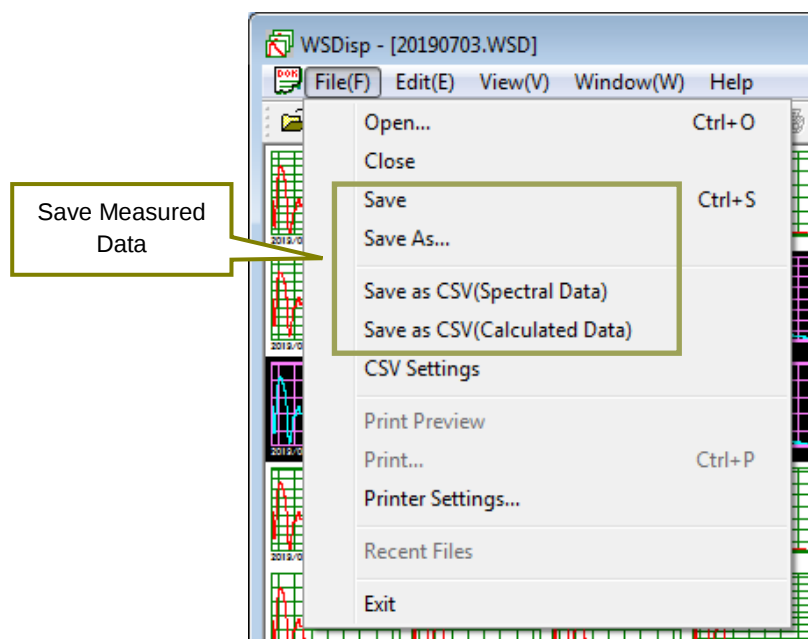


Figure 8-13. Data Saving from Toolbar

[Save]:	Save the measured data (WSD Format) with same name as the original file name.
[Save As...]:	Save the measured data (WSD Format) with different name as the original file.
[Save Measured Value as CSV Format]:	Save the measured time, comment, data comment, sensor type, exposure time, applied voltage on sensor, and spectrum data per specified wavelength pitch of the selected measurement data in CSV format.
[Save Calculated Value as CSV Format]:	Save the data of PAR (W/m^2), PPFD ($\mu mol/m^2/s$), ILLUMINANCE (lx), and integral (W/m^2) per each measured time of the selected measurement data in CSV format,

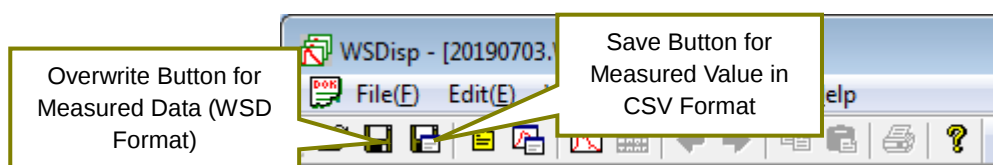


Figure 8-14. Save from the Icons

[Save Measurement Data]:	Save the measurement data (WSD format file) with same name as the original file name.
[Save Measurement Value as CSV Format]:	Save the measured time, comment, data comment, sensor type, exposure time, applied voltage on sensor, and spectrum data per specified wavelength pitch of the selected measurement data in CSV format.

NOTE: If the CSV converted data is lined more than 256, error message may appear when the file is opened, depending on the spreadsheet software type. If such error message appears, convert into CSV when there are less than 256 data lines.

8-7. Graph Copy

The image of the displayed graph can be copied on the clipboard. Go to [View → Copy] from the toolbar or click the [Copy] button (Fig. 8-15) at the top.

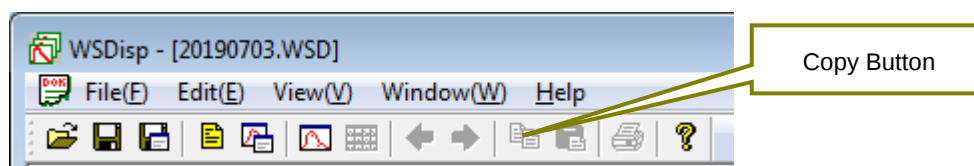


Figure 8-15. Copy Button

8-8. Print

This function prints the graph image displayed on the window. Go to [File → Print] from the tool bar or click the [Print] button (Fig. 8-16) at the top to print the graph.



Figure 8-16. Print Button

Also, to see the print preview condition, go to [File → Print Preview] from the tool bar. Printer can be setup from [File → Printer Setup] on the tool bar.

8-9. Version Information

The software version information can be displayed. Go to [Help → About WSDisp...] from the tool bar or click the [?] button (Fig. 8-17) at the top to see the software version information.

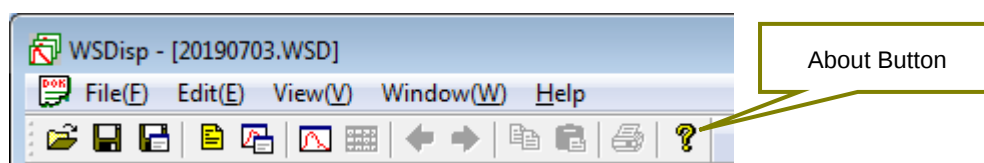


Figure 8-17. About Button

9. Maintenance & Troubleshooting

9-1. Maintenance

To maintain accurate measurement, it is recommended to check and do the following:

Table 9-1. Maintenance

Maintenance Item	Frequency	How To	Effect
Clean Quartz Dome	Several times per week	Remove soil from the quartz dome with air blower or soft cloth and alcohol.	Transmittance will change and sensitivity decreases when the quartz dome is soiled.
Check Ventilation Condition	Several times per week	Check and make sure the ventilation is working. If any objects such as leaves are caught in the fan, stop the operation and remove them.	Measurement may be impacted due to inefficient heat release and not being able to control temperature. This also may lead to damaging ventilation, ventilation power supply and/or sensor.
Check Glass Dome Condition	Weekly	Check for any crack or scratches on the glass dome.	May lead to water leakage inside the sensor and cause damages to the sensor.
Check Sensor Horizontal Position	Weekly	Adjust the spirit level on the sensor to keep it in horizontal position.	If the sensor is not leveled horizontally, measurements will be inaccurate by affecting on cosine/azimuth response.
Check Cable Condition	Weekly	Check the condition of sensor and communication cables, making sure they are connected properly, and they do not have any excess tensions	A disconnected cable may cause abnormal measurement values and operation mistakes. Damaged cables may also have risks of noise or electric shock.
Check Sensor Fixing	Weekly	Make sure the sensor is securely fixed on the mounting base.	Sensor may drop and cause damages and/or injury.
Check Silica Gel and Replace	Weekly	Check the color of the silica gel. If the silica gel color is changed, replace them. Turn the drying cartridge in anti-clockwise to remove. Replace with new silica gel on a clear day with less humidity.	Moisture gets inside the sensor while it is used for a long period of time. Moisture saturated silica gel will lead to condensation and may cause decrease of output and damage.
Recalibration	Every 2 years	To maintain the best possible measurement accuracy, it is recommended to recalibrate the sensor every 2 years. Contact EKO for more details and requests for a recalibration and maintenance service.	Sensitivity of the sensor changes by aging and may lead to taking inaccurate measurements.

9-2. Calibration Method

It is recommended to recalibrate the instrument once every 2 years. For further information about the calibration and recalibration, please contact EKO.

The spectroradiometer is calibrated against a NIST (National Institute of Standards and Technology) traceable tungsten-halogen OL-FEL standard lamp at a distance of 50 cm. The standard lamp has a known spectrum and the absolute irradiance is calibrated at several wavelengths. By measuring the spectroradiometer's detector responsivity in counts as a function of the irradiance at corresponding wavelengths, the sensitivity of each photo diode array pixel is converted into absolute units ($\text{W/m}^2/\mu\text{m}$).

The calibration function is determined by averaging 10 single measurements, measured separately for several different wavelength intervals each with a fixed exposure time. This is to use optimal output characteristics of the detector. Finally the calibration function is uploaded to the spectroradiometer firmware for automatic conversion of measured count into absolute units.

The spectroradiometer is provided with a calibration certificate indicating the measurement uncertainty. The combined uncertainty of the calibration function for each wavelength interval is based on individual uncertainties contributed by the standard lamp, calibration set-up and spectroradiometer performance properties.

9-3. Troubleshooting

Check the following items in case of trouble with the instrument. If any questions should remain, contact EKO for further technical support.

Table 9-2. Troubleshooting

Failure	Action
- Cannot operate from PC. - The data cannot be acquired.	The cable connections for PC, power supply, and/or sensor part may be connected incorrectly. 1) Check if the connection between PC and power supply, and power supply and sensor. 2) Check if the power of PC and power supply is turned on. 3) Check the fuse which is in the fuse box on the power supply rear panel; make sure it is not blown. If the fuse is blown, replace with the new fuse which is specified on [Table 11-3. Power Supply Specification]. 4) Check if the COM port connected to PC is correct. 5) Reboot the PC and check the communications and see if PC operation recovers successfully. 6) Remove anything which could cause the noise for power supply cable and sensor cable.
- The measured value is abnormal - S/N value of acquired data is not good. - Measured value is very low.	1) Shutter, spectrometer or PCB could be defected. In case there are any damages or malfunctions, please call EKO for assistance 2) If multiple MS-713 are connected to one PC to operate, make sure to restart the software each time the instrument is switched. Check if the dome is clean. Refer to the chapter "Maintenance"
- The software is operating abnormal.	The PC and software could be defected. Reboot the PC then retry the software.

10. Specification

10-1. Sensor Specifications

1. Sensor Specification

Table 10-1. Sensor Specification

Items	MS-713
Wavelength	900 to 2500nm
Wavelength Interval	1.2 to 2.2nm
Spectral Resolution	<20nm
Wavelength Accuracy	±2nm
Temperature Dependency	Within ±5%
Operating Temperature	-30 to +50°C
Temperature Control (Ta: Ambient Temperature)	Light Receiving Element Part: -20°C±0.5°C (Ta = -30 to +50°C)
Exposure time	1msec to 30msec
Cosine Response	Less than ±5% (within 80°)
Dome material	Synthetic Quartz
Communication	RS422 (between sensor and power supply unit)
Power supply	16VDC/5VDC
Maximum Power Consumption	95W
Dimension (Including cover & dome)	320(φ)×325(H) mm
Weight (Sensor Part)	11kg

Table 10-2. Definitions of Terms

Terms	Definitions
Wavelength Range	Range of wavelength which can be measured
Wavelength Interval	Interval of wavelength for measuring data
Wavelength Resolution	Full width at half-maximum when emission line is input
Wavelength Accuracy	Accuracy of wavelength
Cosine Response	Difference from the theoretical value ($\cos \theta$) at zenith angle of 0° to 80°
Temperature Dependency	Tolerance of change in output when ambient temperature changes between -30°C to +50°C.
Exposure Time	Shutter open time.

2. Power Supply Unit

Table 10-3. Power Supply Specification

Items	MS-713
Power supply (Standard)	Input : 100~240V, 50/60Hz Output : 16VDC(80W), 5VDC(15W)
Maximum Power Consumption	190W (When DC output 95W)
Fuse	φ5.2x20, 250V, 2A
Communication	RS232C(between power supply and PC)
Operating conditions	Temperature: 0 to +40°C, Humidity: 0~90%RH (No condensation)
Dimension	320(W) x 220(D) x 120(H) mm
Weight	1kg

3. Ventilation Unit

Table 10-4. Ventilation Unit Specification

Items	Details
Model Number	9WG1212H101-E
Manufacturer	SANYO DENKI
Dimensions	120 x 120 x 38mm
Frame Material	Aluminum
Rated Voltage	12V
Rated Current	0.38 A
Operating Voltage Range	7 to 13.8 V
Maximum Air Flow	2.8 m ³ /min.
Maximum Static Pressure	70.4 Pa
Expected Lifetime	100000hr / 60°C
Operating Environment	Temperature:-20 to +70°C
IP Classification	IP55
Terminals	Housing Model No.: 03T-JWPF-VSLE-S Contact Model No.: SWPT-001T-P025 Manufacturer: J.S.T.MFG.CO.,LTD.
AC Adapter	Input: 100-240VAC Output 12VDC, 1A Model No. UIA312-12-EIAJ-4 Manufacturer: Unifive

10-2. Software

Table 10-5. Software Specifications

	Details	
Applicable OS	Microsoft Windows XP/Vista/7/8/10	
Operation Environment	CPU: Memory: HHD Capacity: Display Resolution: Interface:	Pentium 1GHz or more More than 1GB More than 20GB More than 1024 x 768 CD-ROM Drive, RS-232C port
Software Name/Versions	Measurement Software:	WSDac, Version: 5.0.x.x
	Data Analysis Software:	WSDisp, Version: 5.0.x.x
Software Function	Data Measurement (Continuous measurement, single measurement) Data Saving (CSV format) Data Graphing	

10-3. Cables

Table 10-6. Cable Specifications

Cable Name	Details	
Sensor Cable	Cable Type :	MVVS
	Diameter:	0.5mm ² x 12pins
	Outer Diameter:	Φ10.4mm
	Cable end:	Y Terminal (1.25Y-4)
	Cable Length:	10m

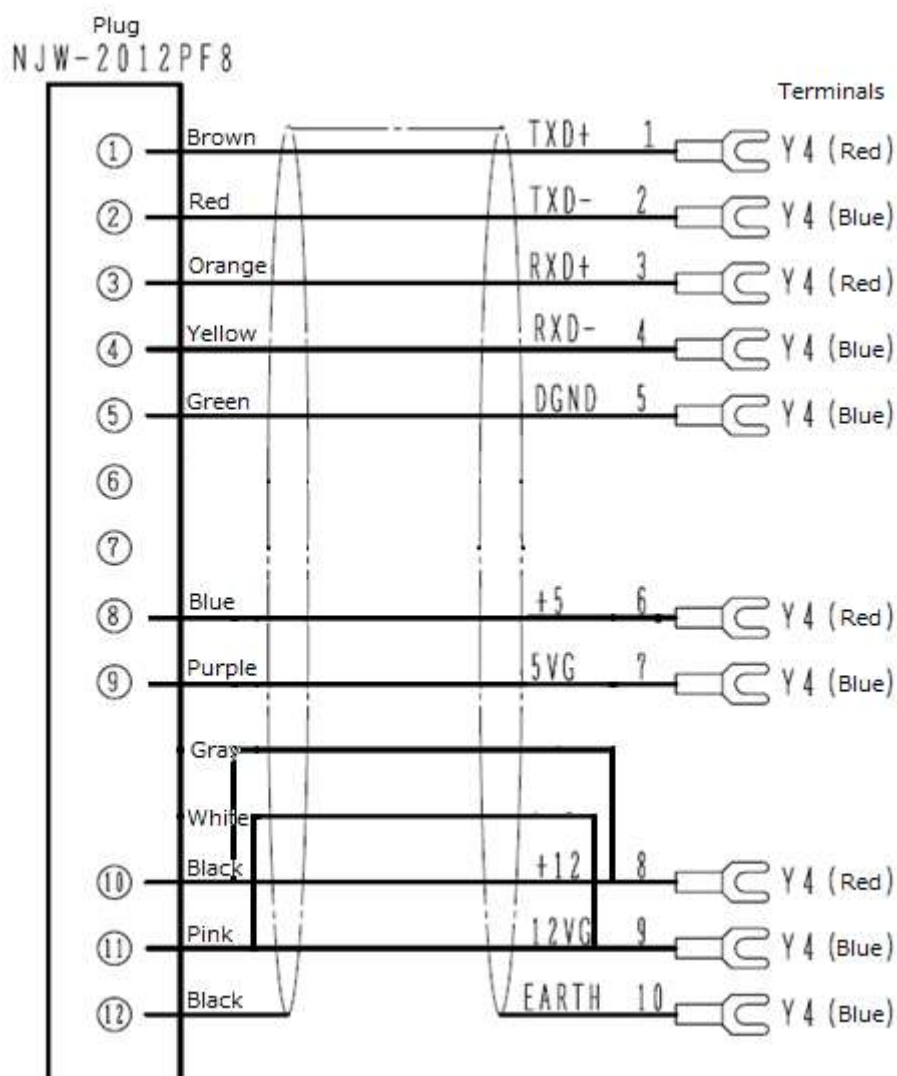


Figure 10-1. Sensor Cable Connections

Table 10-7. Ventilation Unit Power Supply Cable

Cable Name	Details	
Ventilation Unit Power Supply Cable	Cable Type :	VCTF
	Diameter:	0.75mm ² x 3C
	Outer Diameter:	φ4.8mm
	Cable ends:	AD Adapter side: THB387-3P Ventilation Unit side: NJW-163-PF
	Cable Length:	10m

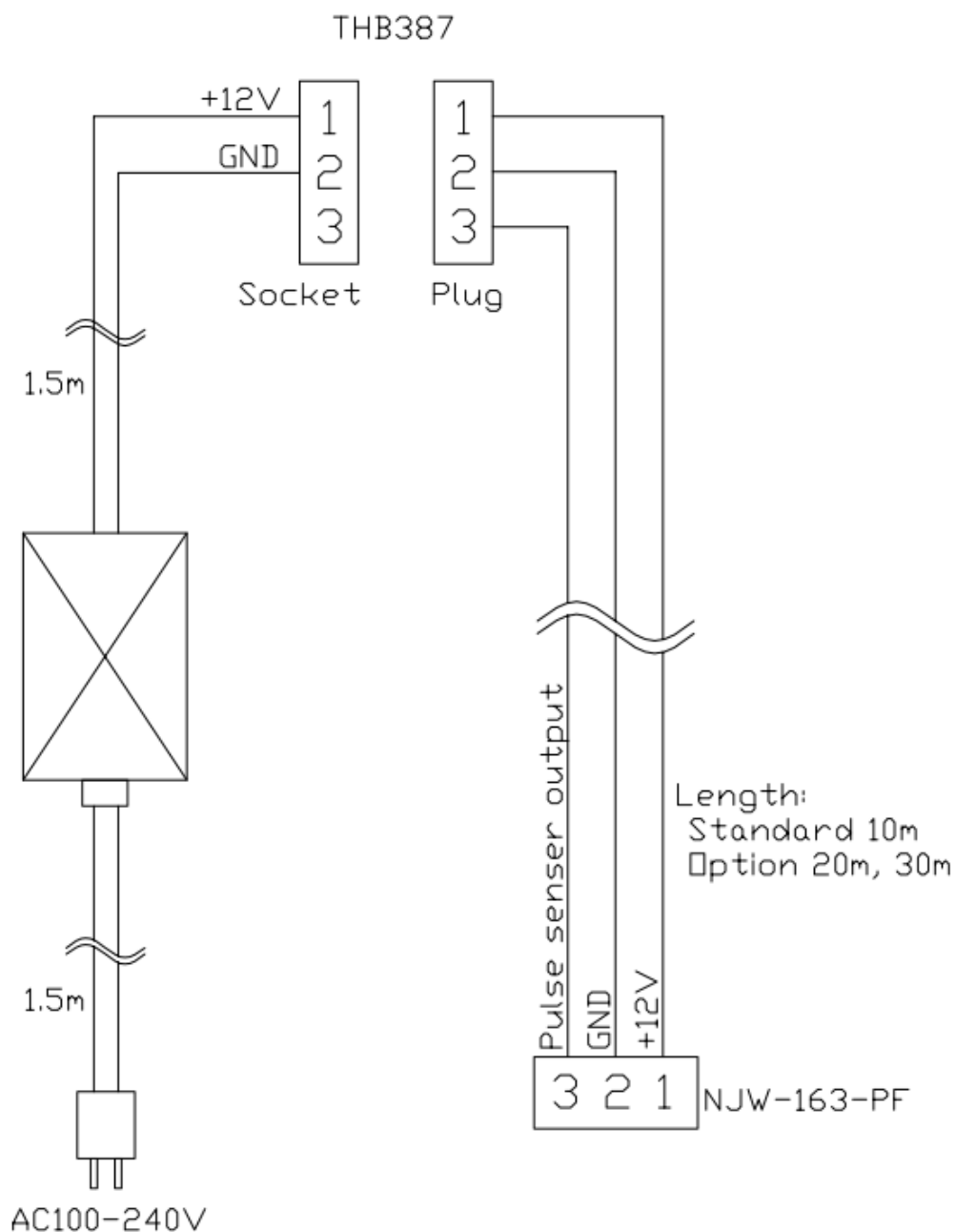


Figure 10-2. Ventilation Unit Power Supply Cable Connections

10-4. Dimensions

1. Sensor Part

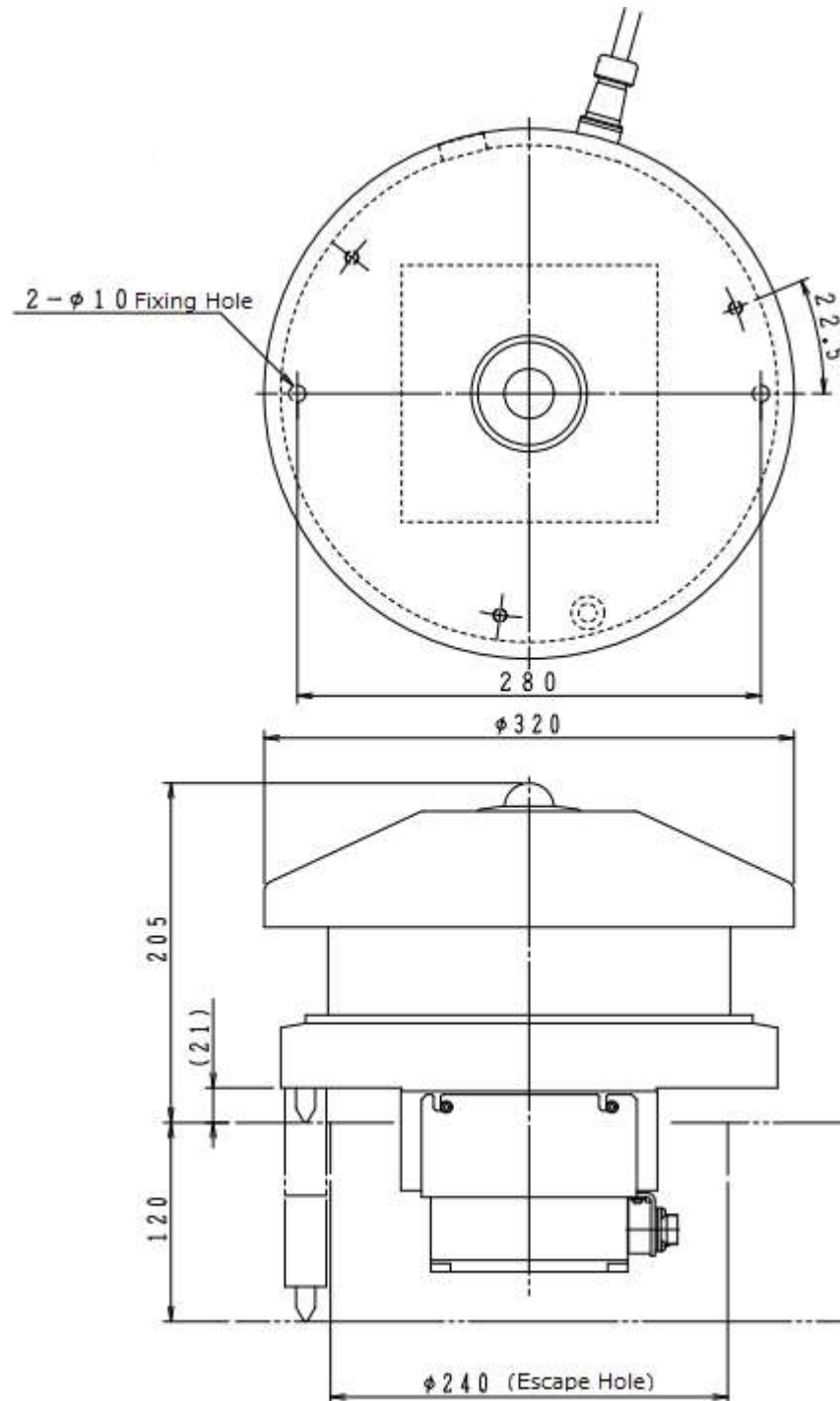


Figure 10-3. Sensor Part Dimensions

2. Power Supply

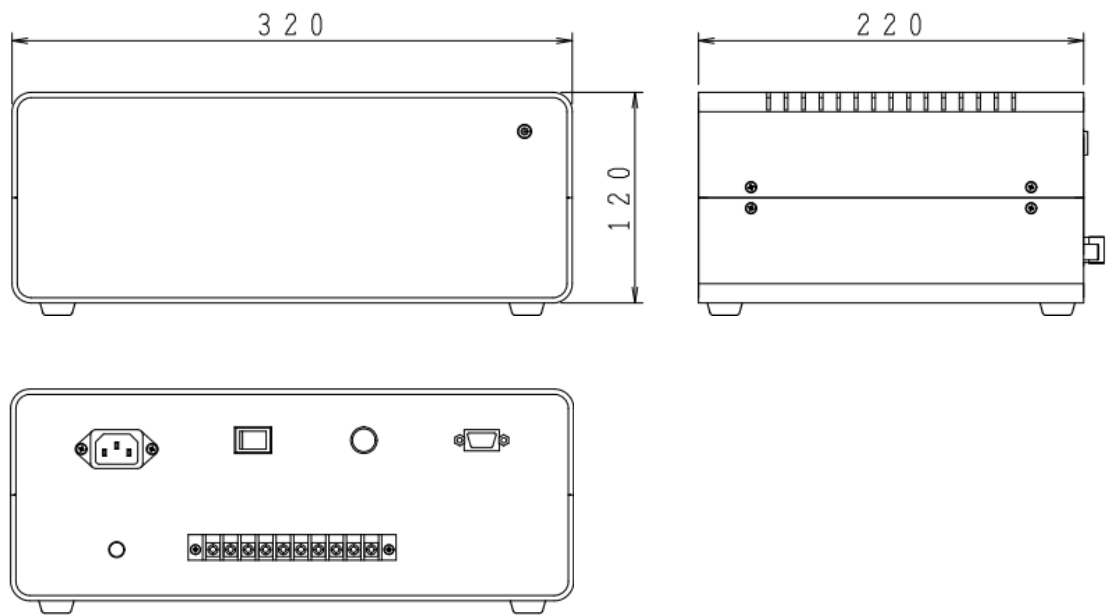


Figure 10-4. MS-713 Power Supply

10-5. Accessories List

Table 10-8. Accessories List

Standard Items	Remarks
Sensor Cable	Extension: 20m, 30m, 50m
Ventilation Power Supply Cable	Extension: 20m, 30m
Silica Gel	500g
Spare Fuse	φ5.2x20, 250V, 2A
Spare Ventilation	[Specification of Ventilation] Model: 9WG1212H101-E Manufacturer: SANYO DENKI Size: 120 x 120 x 38mm Rated voltage: 12V Rated current: 0.38A Maximum air flow: 2.8m³/min. Maximum static pressure: 70.4 Pa Expected Life: 100000hr / 60°C IP Class: IP55 No ribs Frame Materials: Aluminum [Specification of Terminal] Housing Model: 03T-JWPF-VSLE-S Contact Model: SWPT-001T-P025 Manufacturer: J.S.T.MFG.CO.,LTD.



EKO Asia, Oceania

1-21-8 Hatagaya,
Shibuya-ku, Tokyo
151-0072 Japan
P. +81.3.3469.6711
F. +81.3.3469.6719
info@eko.co.jp
www.eko.co.jp

EKO North America

111 North Market Street,
Suite 300, San Jose,
CA 95113, USA
P. +1-408-977-7751
F. +1-408-977-7741
info@eko-usa.com
www.eko-usa.com

**EKO Europe,
Middle East, Africa,
South America**

Lulofsstraat 55, Unit 28,
2521 AL, Den Haag,
The Netherlands
P. +31 (0)70 3050117
F. +31 (0)70 3840607
info@eko-eu.com
www.eko-eu.com