



INSTRUCTION MANUAL

Grating Spectroradiometer

VIS-NIR MS-700

VIS-NIR MS-700 DNI

Software Version Number: SPDac3.5.xx/SPMan3.3.xx

Firmware Version Number: 3.1x

Manual Version Number: 3



EKO INSTRUMENTS CO., LTD.

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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

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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: 2014/06/04

Version Number: 3

2-4. Environment

1. WEEE Directive 2002/96/EC (Waste Electrical and Electronic Equipment)

This product is not subjected to WEEE Directive 2002/96/EC however it should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product(s) to designated collection points.

Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

2. RoHS Directive 2002/95/EC

EKO Instruments has completed a comprehensive evaluation of its product range to ensure compliance with RoHS Directive 2002/95/EC regarding maximum concentration values for substances. As a result all products are manufactured using raw materials that do not contain any of the restricted substances referred to in the RoHS Directive 2002/95/EC at concentration levels in excess of those permitted under the RoHS Directive 2002/95/EC, or up to levels allowed in excess of these concentrations by the Annex to the RoHS Directive 2002/95/EC.

2-5. CE Declaration



IMPORTANT USER INFORMATION



DECLARATION OF CONFORMITY

We: EKO INSTRUMENTS CO.,
LTD 1-21-8 Hatagaya
Shibuya-ku, Tokyo
151-0072 JAPAN

Declare under our sole responsibility that the product:

Product Name: Spectroradiometer
Model No.: MS-700, MS-700 DNI

To which this declaration relates is in conformity with the following
harmonized standards of other normative documents:

Harmonized standards:

EN 61326-1:2006 Class A (Emission)
EN 61326-1:2006 (Immunity)
EN 61000-4-2 EN 61000-4-3
EN 61000-4-4 EN 61000-4-5
EN 61000-4-6 EN 61000-4-11

Following the provisions of the directive:

EMC-directive: 2004/108/EC
Low Voltage Directive: 2006/95/EC
Amendment to the above directive: 93/68/EEC

Date: April 5, 2012

Position of Authorized Signatory: General Manager of Quality Assurance Dept.

Name of Authorized Signatory: Shuji Yoshida

Signature of Authorized Signatory: Shuji Yoshida

3. Safety Information

EKO products are designed and manufactured under the consideration of the safety precautions. Please make sure to read and understand this instruction manual thoroughly in order to be able to operate the instrument safely and in the correct manner.



WARNING CAUTION

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



HIGH VOLTAGE WARNING

High voltage is used; pay special attention to instructions given on this instruction manual with this sign to prevent electric leakage and/or electric shocks.



3-1. WARNING/CAUTION

1. Setup

- The installation base or mast should have enough load capacity for the instrument to be mounted. Fix the spectroradiometer securely to the base, mast or Sun tracker with bolts and nuts; otherwise, the instrument may drop due to gale or earthquake which may lead to unexpected accidents.
- The setup location should be easily accessible for periodic maintenance (glass dome cleaning, desiccant replacement, etc.).

2. Handling

- When carrying this instrument, hold the bottom part of the main housing only. Holding any other parts, such as cable, cover, dome or collimating tube, can damage the instrument or lead to accidental drop of the instrument.
- Be careful with glass domes when handling instruments. Strong impact to this part may damage the glass and may cause injuries by broken glass parts.



3-2. HIGH VOLTAGE WARNING

1. Power Supply

Check the supply voltage which must correspond to the voltage requirements of the spectroradiometer (100 – 230 VAC).

4. Introduction

The all weather grating spectroradiometer MS-700 and MS-700 DNI are designed to be used for continuous outdoor observation. EKO offers two different models, respectively MS-700 to measure the global solar distribution and MS-700 DNI to measure the direct spectral component. Ideally the MS-700 DNI Spectroradiometer is used in combination with the STR-Sun tracker series and the MS-56 pyrheliometer, but many more configurations are possible.

The compact all weather MS-700 spectroradiometer is unique in many ways. For various research applications it is used as the reference instruments for spectral irradiance measurements outdoors. Like the MS-700 the MS-700 DNI spectroradiometer cover the spectral range from 350 – 1050nm. Due to the advanced spectroradiometer design, it guarantees a stable output over time. Inside the MS-700 body, the detector unit is being maintained at a fixed temperature to maximize performance over a wide operating temperature range.

The spectroradiometers have a separate power control unit with RS-232/422 serial communication interface to be controlled by a PC or data logger. When operated by a PC, the operating software offers advanced functionality for data retrieval, visualization and data-management. It is also possible to create your personal control software using the so called open command protocol, which gives the flexibility to monitor and control the spectroradiometer with the same control functionality embedded into your existing system.

4-1. Main Features

1. All Weather Concept

MS-700 and MS-700 DNI solar spectroradiometers are designed to be used as the spectral measurement standard in any outdoors environment around the world.

2. Durability

The dome, diffuser, grating and photodiode array are embedded in MS-700/700 DNI to maximize the performance and guarantee durability.

3. Adaptive Measurement

The detector exposure time will be automatically adapted between 10ms to 5sec to optimize the signal to noise ratio, which makes the MS-700/700 DNI suitable to measure during fluctuating solar irradiance conditions.

4. Advanced Control and Analysis Software

The SPDAC software has several advanced control functions. In addition to the manual measurement mode the “scheduled measurement” mode automatically controls the measurement period during the day. It is possible to automatically perform periodical measurement and store the data of the specified time every day. With the SPMAN analysis software the measured spectral data can be visualized simultaneously. The software automatically converts and stores a data files with 1 or 5nm wavelength interval. Besides the integrated quantities of the following action spectra, PAR (Photosynthetic Active Radiation, W/m^2) and PPFD (Photosynthetic photon flux density, $\mu mol/m^2/s$) and illuminance (lux) can be calculated through the software.

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

Equipment	Quantity	Remarks
MS-700 Sensor	1 unit	
Fixing screws	1 set	MS-700: M8 x 75mm (2 sets of bolt, washer, and nuts included) MS-700 DNI: M8 x 65mm (2 sets of bolt, washer, and nuts included)
Power supply / control unit	1 unit	
Sensor cable	1	10m (Standard length)
AC power cable	1	2m
RS-232C cable	1	1.5m
Software CD-ROM	1	SPDac.exe and SPMAN.exe software, Instruction Manual in PDF
Instruction manual	1	

Table 4-2. Packaging contents when mounting assembly for MS-700DNI is purchased. All common items mentioned in the table above are included.

Equipment	Quantity	Remarks
MS-700 DNI Sensor	1 unit	Collimating tube fixed to the sensor
MS-700 DNI Side Mounting assembly	1 set	To mount the MS-700 DNI on STR-21G or STR-22G STR-22-PP700: Primary (with Sun Sensor) side STR-22-PS700: Secondary (without Sun Sensor) side
Mounting assembly fixing screws	4pcs	Primary side mounting assembly: M4 x 15mm Secondary side mounting assembly: M4 x 20mm
Tools for MS-700 DNI	1 set	Hexagon wrench 3 (for M4 screw) Hexagon wrench 4 (for M5 screw) Nut driver (for M8 nut)

*When STR-21G/22G is purchased at the same time, the mounting assembly and the fixing screws will be mounted on Sun Tracker before shipment

5. Getting Started

5-1. Parts Name and Descriptions

The names and functions of each component are as follows.

1. Spectroradiometer

Table 5-1. Names and functions of the various sensor parts

	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	Mounting holes	Mounting holes are used to attach the sensor to the mounting platform,
3	Diffuser	Provides a proper cosine response of the incident radiation.
4	Glass dome	Protects the optical diffuser for precipitation and soiling effects.
5	Sensor cable connector	Power and control cable between the spectroradiometer and control unit.
6	Drying Cartridge	Drying cartridge contains silica gel to protect against moisture.
7	Sun screen	The sun screen minimizes the heat load by solar radiation.
8	Leveling screws	Used for leveling the sensor in horizontal position.
9	*Collimator Tube	This tube guides the direct incident to the sensor part
10	*Heater	Heater to prevent the effect of condensation on Quartz window.
11	*Quartz Window	Prevents dusts and water to enter inside the tube.

**Only for MS-700 DNI*

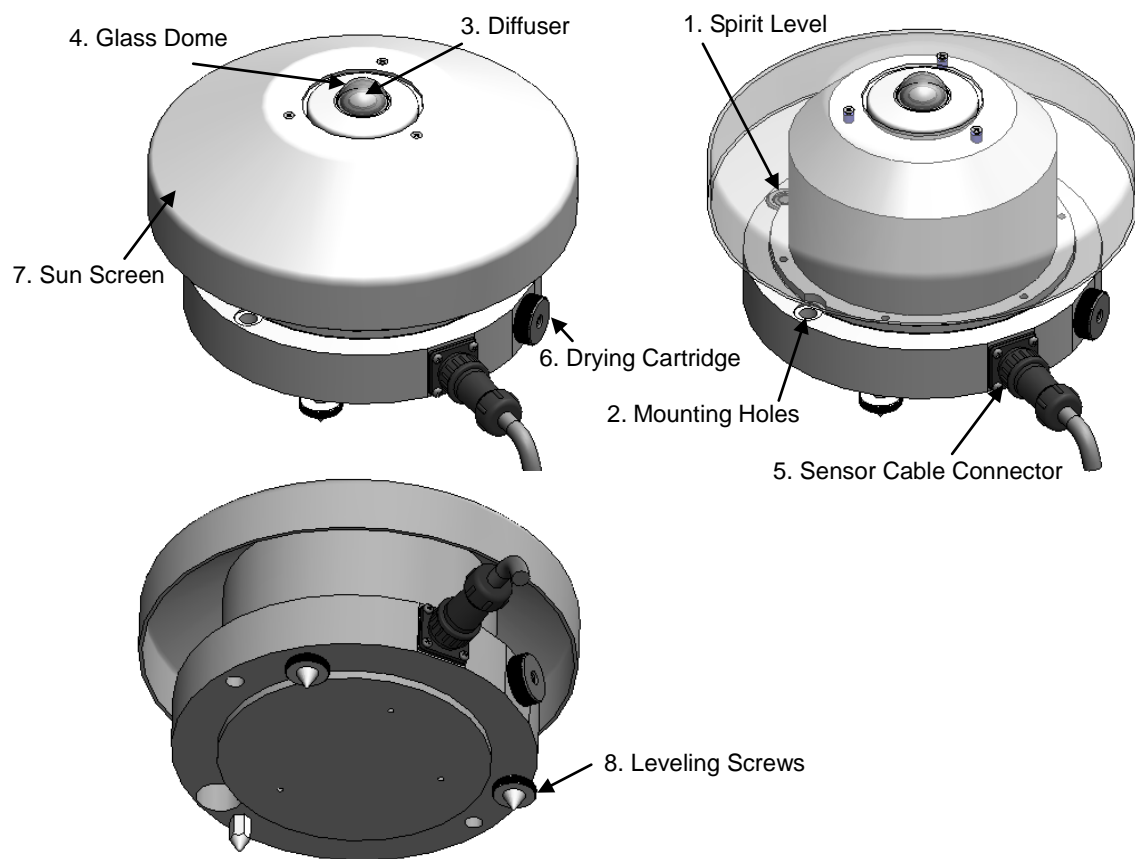


Figure 5-1. MS-700 Parts Name

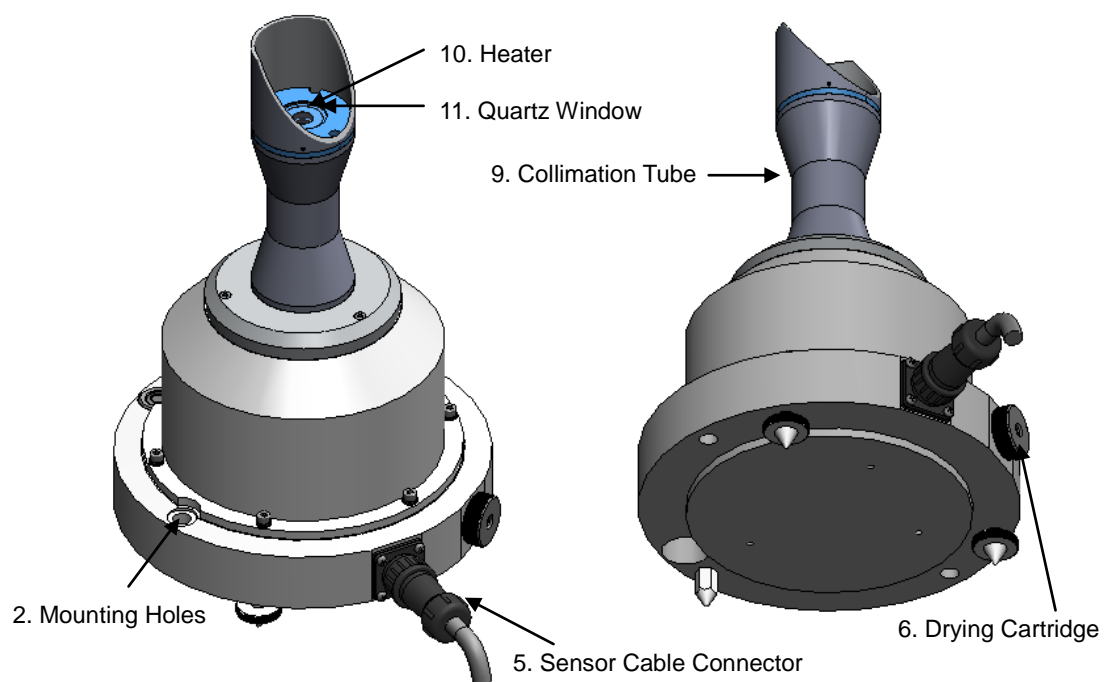


Figure 5-2. MS-700DNI Parts Name

2. Power Supply

Table 5-2. Names and functions of power supply

	Name	Function																																																										
1	Power switch	Power ON / OFF																																																										
2	Terminal Block	<table><tr><th colspan="2">Terminal block</th><th>Wire Color</th><th>Wire #</th><td></td></tr><tr><td>1</td><td>TXD+(RS-422)</td><td>Brown</td><td>1</td><td></td></tr><tr><td>2</td><td>TXD-(RS-422)</td><td>Red</td><td>2</td><td></td></tr><tr><td>3</td><td>RXD+(RS-422)</td><td>Orange</td><td>3</td><td></td></tr><tr><td>4</td><td>RXD-(RS-422)</td><td>Yellow</td><td>4</td><td></td></tr><tr><td>5</td><td>Digital GROUND</td><td>Green</td><td>5</td><td></td></tr><tr><td>6</td><td>Supply power 12V</td><td>Gray</td><td>6</td><td></td></tr><tr><td>7</td><td>Supply power ground</td><td>White</td><td>7</td><td>(DC GND)</td></tr><tr><td>8</td><td>Peltier Control +</td><td>Black</td><td>8</td><td></td></tr><tr><td>9</td><td>Peltier Control -</td><td>Pink</td><td>9</td><td>(DC GND)</td></tr><tr><td>10</td><td>EARTH</td><td>Black</td><td>10</td><td></td></tr></table>				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 12V	Gray	6		7	Supply power ground	White	7	(DC GND)	8	Peltier Control +	Black	8		9	Peltier Control -	Pink	9	(DC GND)	10	EARTH	Black	10	
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9	Peltier Control -	Pink	9	(DC GND)																																																								
10	EARTH	Black	10																																																									
3	RS-232C connector	Connect RS-232C cable to PC.																																																										
4	Fuse holder	2A fuse.																																																										
5	AC power connector	Power requirement : AC100 – 240V, 50/60Hz, 50VA																																																										

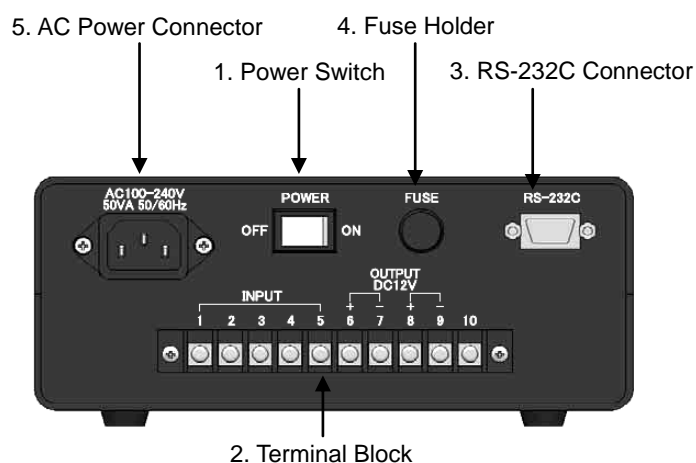


Figure 5-3. Power Supply Parts Name

5-2. Set-up

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 (glass dome cleaning, desiccant replacement, etc.).
- Avoid surrounding towers, poles, walls or billboards with bright colors that can reflect solar radiation onto the spectroradiometer.

2. Installation

Installing at Horizontal or tilted Positions (MS-700)

(1) Prepare Installation Base

Check the installation base where the spectroradiometer 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 for MS-700

	MS-700
Fixing Hole Pitch	180 mm
Fixing Bolt Size	M8 x 75mm

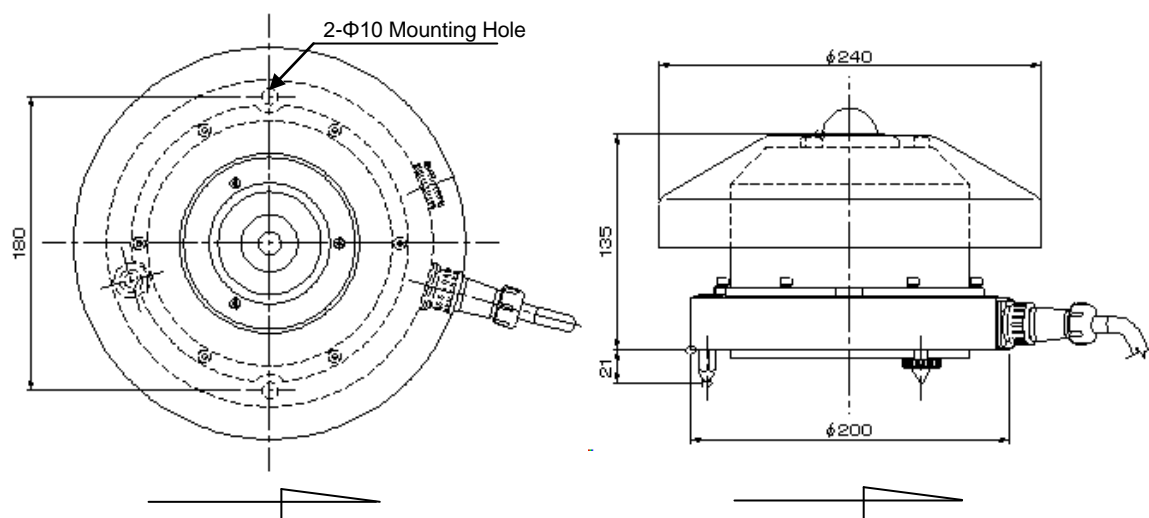


Figure 5-4. MS-700 Dimension

(2) Setup the Spectroradiometer

Setup the spectroradiometer 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 spectroradiometer 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 MS-700 is mounted on a tilted plane, preferably the MS-700 is mounted on the leveling screws to thermally isolate the spectroradiometer body from the mounting platform.

If the spectroradiometer 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) Sun Screen

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

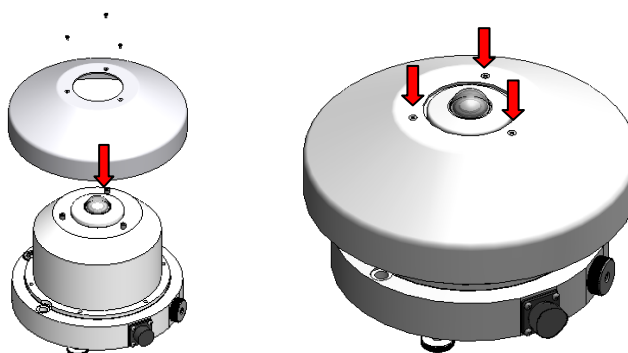


Figure 5-5. MS-700 Sun Screen

(5) Connect Sensor Cable

Connect the sensor cable connector to the spectroradiometer and the pig tail terminals to the terminal block of the power supply according to the table below.



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 12V	Gray	6
7	Supply power ground	White	7
8	Peltier Control +	Black	8
9	Peltier Control -	Pink	9
10	EARTH	Black	10

(6) 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.

(7) RS-232C

Connect the PC COM port and the RS-232C connector at the back of the power supply with RS-232C cable.

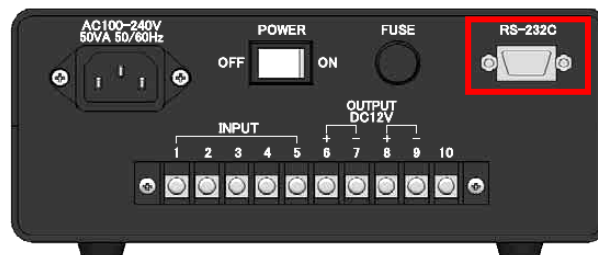


Figure 5-6. RS-232C Connector

Installing the MS-700 DNI on the Sun Tracker

In order to install the MS-700 DNI spectroradiometer on the EKO Sun Tracker STR-21G/22G a special mounting plate is required.

(1) Setup Sun Tracker

Setup the Sun Tracker. See Sun Tracker Series Instruction Manual.

(2) Preparation of Mounting Assembly

Depending on the mounting position on the Sun Tracker (primary side / secondary side), a different type of mounting plate is needed. If the MS-700 DNI is installed on STR-21G, mounting plate for primary side (with Sun Sensor), if the MS-700 DNI is installed on STR-22G, mounting plate for secondary side (without Sun Sensor) will be attached as standard accessory with the MS-700 DNI spectroradiometer.

Table 5-5 Fixing Hole Pitch and Bolt Size for MS-700 DNI

	MS-700 DNI
Fixing Hole Pitch	180 mm
Fixing Bolt Size	M8 x 65mm

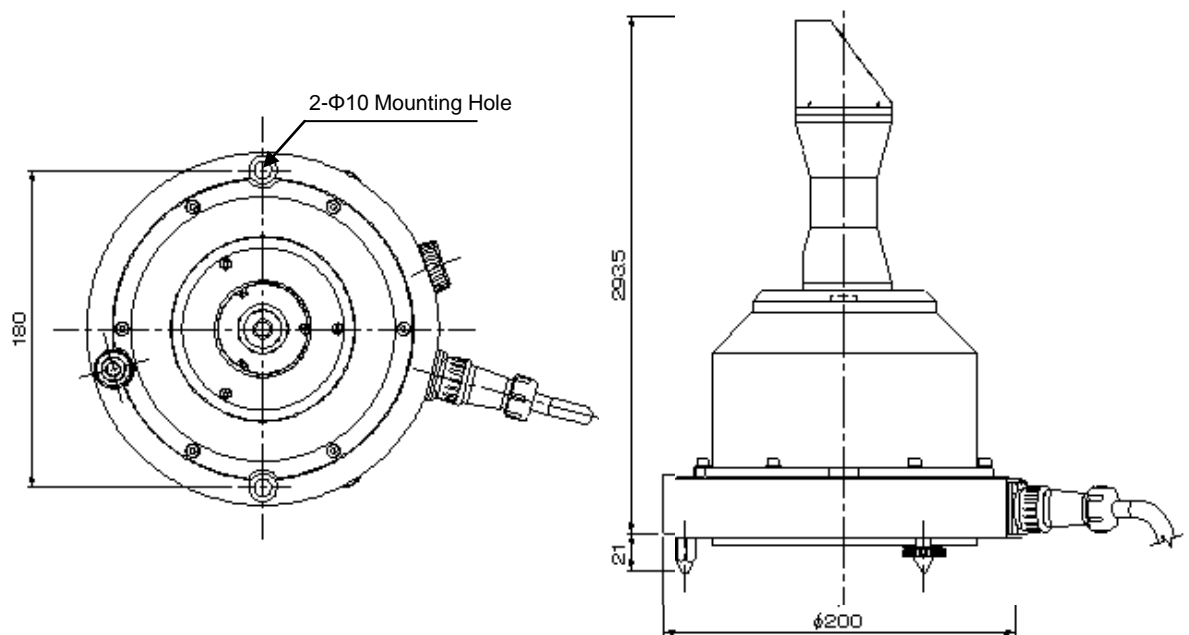


Figure 5-7. MS-700 DNI Dimension

(3) Mounting Plate Setup

When the EKO Sun Tracker STR-21G/22G is purchased at the same time the MS-700 DNI, the mounting plate is already setup on the Sun Tracker before shipment. Skip this section and go to (4) Spectroradiometer Setup.

To setup on the EKO Sun Tracker STR-21G/22G:

At first, position the Sun Tracker STR-21G/22G in origin position.

When the Sun Tracker power is turned on by connecting the power cable, the Sun Tracker body will return to the origin position and stops the movement for about 2 seconds then starts to follow the sun.

Pull out the power cable while the Sun Tracker body is at the origin position then pull out the Sun Sensor cable from the connector.

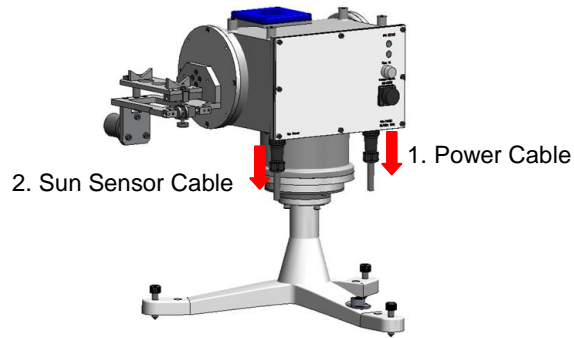


Figure 5-8. Order of removing cables

[Prepare the following tools] *These tools are included with mounting assembly package

One of each:

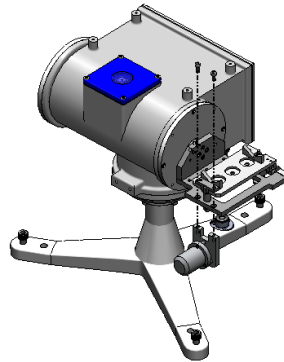
Hexagon wrench 3 (for M4 screws)

Hexagon wrench 4 (for M5 screws), and Nut Driver (for M8 nut)

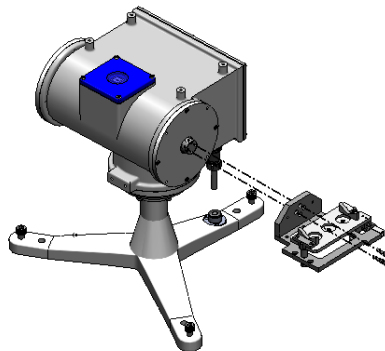
To setup the mounting plate on primary side (with Sun Sensor), follow steps A.

To setup the mounting plate on secondary side (without Sun Sensor), follow steps B

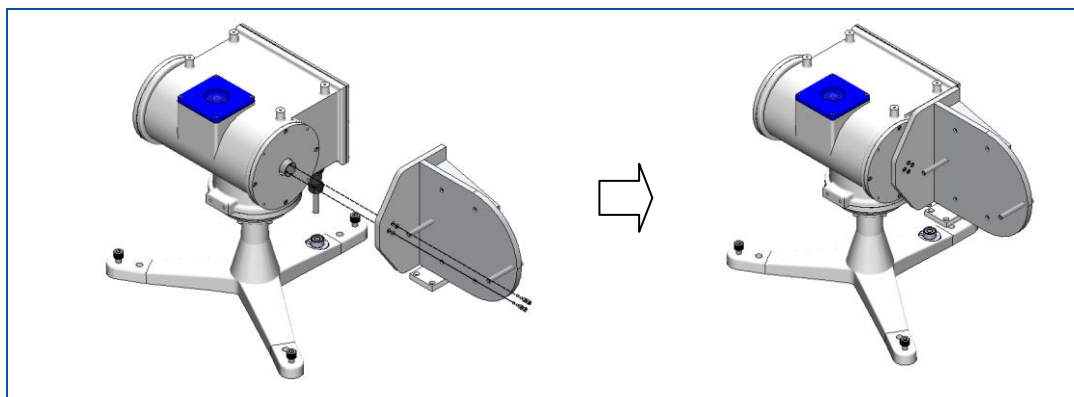
A. To setup the mounting plate on primary side (with Sun Sensor)



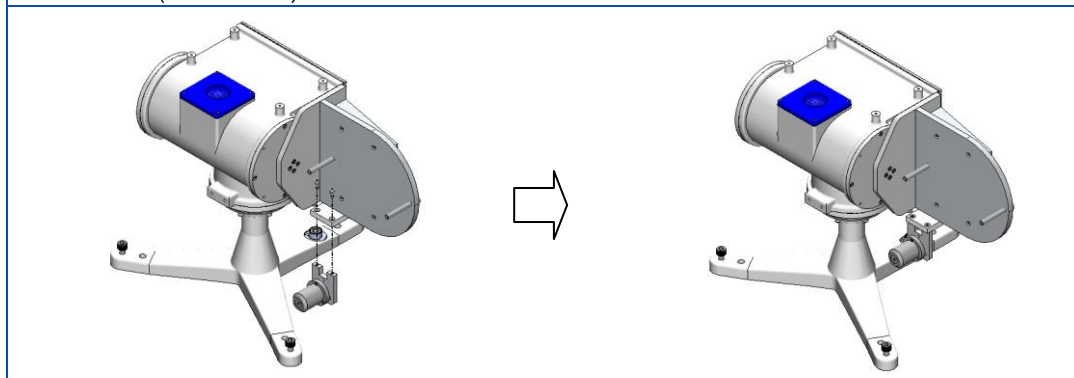
- 1) If the Sun Tracker already has Pyrheliometer mounting setup, remove the Sun Sensor by loosening the Sun Sensor fixing screws (M5 x 10mm). *Make sure to keep the removed screws.



- 2) Remove the mounting assembly fixing screws (M4 x 15mm) from the Sun Tracker shaft and remove the Pyrheliometer mounting assembly. *Make sure to keep the removed screws.



- 3) Attach the MS-700 DNI mounting plate to the Sun Tracker shaft with mounting assembly fixing screws (M4 x 15mm).



- 4) Attach the Sun Sensor on the mounting plate with Sun Sensor fixing screws (M5 x 10mm).

B. To setup the mounting assembly on secondary side (without Sun Sensor)

Round Plate

1) Insert the mounting plate holder in the Sun Tracker shaft; fasten with the 4 screws (M4 x 20mm) and a round plate to hold the mounting plate in a place from the inside.
DO NOT fasten these 4 screws too tight at this point; make sure the mounting plate can be easily rotated.

1. Sun Sensor Cable 2. Power Cable

2) Insert the Sun Sensor connector then insert power cable for the Sun Tracker; Sun Tracker will be in tracking mode and will try to find the solar position.

Shadow

Pointing to Sun direction NOT properly.

Pointing to Sun direction properly.

3) Adjust the mounting plate angle so that the shadow of the mounting screw (M8 x 75mm) for MS-700 DNI does not appear on the plate as shown on above image.

4) Tighten the 4 screws (M4 x 20mm) on the round plate. Then tighten the screws (M5) for the mounting plate.

(4) MS-700 DNI Setup

Remove the leveling screws attached on the bottom of the MS-700 DNI.

NOTE: During this process, DO NOT hold the collimation tube part. Holding or giving stress on this part will lead to damaging the instrument.

Insert screws (M8 x 65mm) through the mounting holes on the sides of MS-700 DNI to fasten the MS-700 DNI on the mounting plate with nut driver (for M8 nut) so the power connector will face the ground.

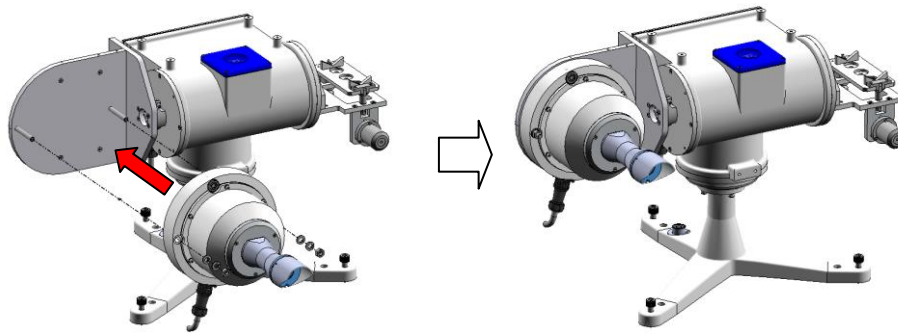


Figure 5-8. MS-700 DNI Setup Image: Before & After

(5) Sight Spot Adjustment

In order to take accurate measurements, MS-700 DNI sensor must be properly aligned to the sun direction. On a sunny day, sun light is irradiated through sight spot on the target on MS-700 DNI collimation tube. Adjust the Sun Sensor so that the sun light irradiates on the center of this sight spot target (Figure 5-10 and 5-11). If the screw does not turn, loosen the screws in three positions in counterclockwise then make adjustments. Make sure the Sun Sensor screws in three positions do not get loosen after the Sight Spot is aligned. When the Sun Tracker is used for a long period of time for measurement, check the Sight Spot alignment for at least one day after the setup.

Example:

When the Sight Spot is not irradiating the target properly as shown on Figure 5-5, adjust the Sun Sensor adjusting screws (on behind the Sun Sensor) (C) and (B) in clockwise direction.

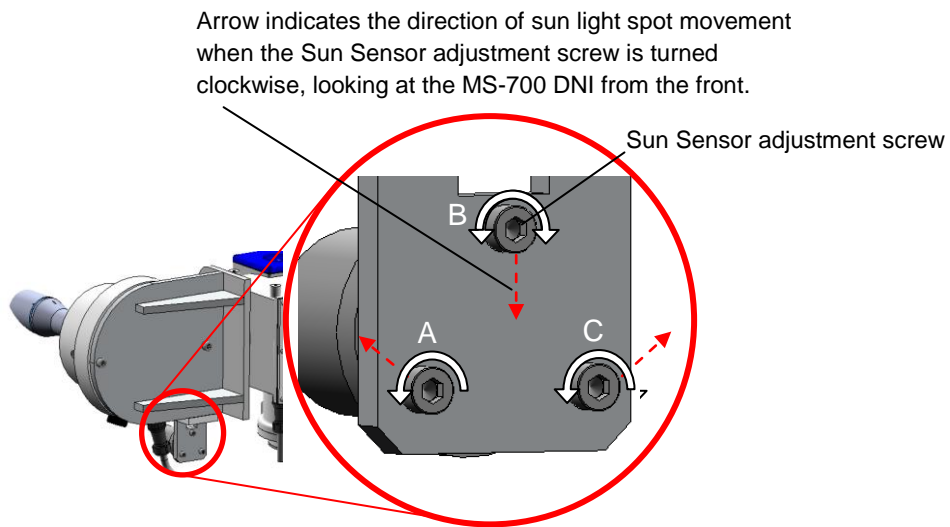


Figure 5-10. Sun Sensor Adjusting Screws
(View from Sun Sensor back side)

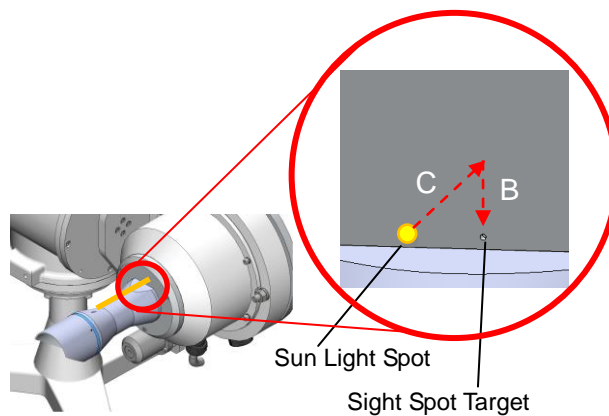


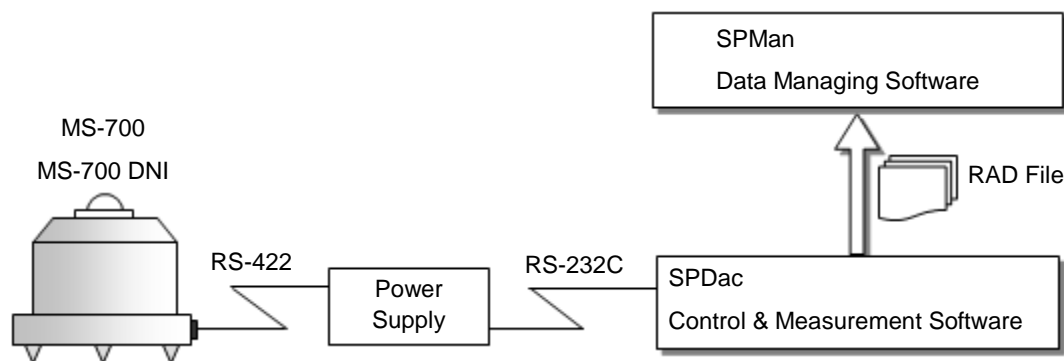
Figure 5-11. Sun Light Spot and Target
(View from MS-700 DNI front side)

To connect sensor cable, setup power supply and communication cable, go to section [5-2. Setup/2. Installation , Installing at Horizontal or Tilted Positions (MS-700)] steps (6) Connect Sensor cable

6. Software

SPDac (Spectral Data Acquisition) and SPMAN (Spectral Manager) is exclusively used for the measurement control and processing of the data acquired by the MS-700/700 DNI.

Fig.6-1 shows the data flow.



SPDac software is the control and measurement software that includes periodic measurement of the MS-700/700 DNI via RS-232C communication, and creates a data file (RAD file) described in section 6-4.

SPMAN software is the data managing software. SPMAN loads RAD data file that is created by SPDac. It has functions of graphing, data format converting and data calculations.

SPDac and SPMAN software selects Japanese/English displaying language automatically by checking language settings in Windows.

Notes: This software is designed to manage with one unit of MS-700 or MS-700 DNI.

1. When using multiple MS-700/700 DNI spectroradiometers with one PC
The sensitivity of MS-700/700 DNI which is connected and turned ON is set when the software is started.
When replacing the MS-700/700 DNI with another MS-700/700 DNI, turn on MS-700/700 DNI and re-start the software each time.
Creating individual folder for each spectroradiometer is recommended.
2. PC time settings
Set the time-zone and local time of the PC based on the measurement site.

6-1. Installation and Uninstallation

1. Installation

Copy all files from the CD-ROM to a designated folder on a hard disk

2. Uninstallation

To uninstall the software, delete all files that were copied at installation (described above). Since the software does not use any system files (DLL etc.), uninstallation will be completed only by deleting files.

6-2. SPDac (Measurement) Software Operations

SPDac software is the basic control software that includes the scheduled measurement function to operate the spectroradiometer in a continuous mode. Depending on the solar irradiance conditions the exposure time will be automatically adapted by SPDac for each individual measurement.

1. Start SPDac Software

After establishing the connection between the radiometer and PC, the COM Port window will automatically appear after starting SPDac software, shown in picture 6-1.

Select COM port number of the PC then click [OK].

Communication error window will appear when;

- (1) No cable has been connected between the Spectroradiometer and PC
- (2) The spectroradiometer power is switched off
- (3) No communication port can be addressed from Windows

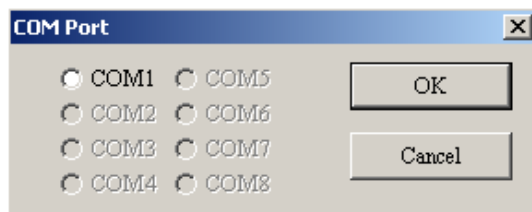


Figure 6-1. COM Port window



Figure 6-2. Communication error window

Figure 6-3. SPDac window will appear when the radiometer communication was established.

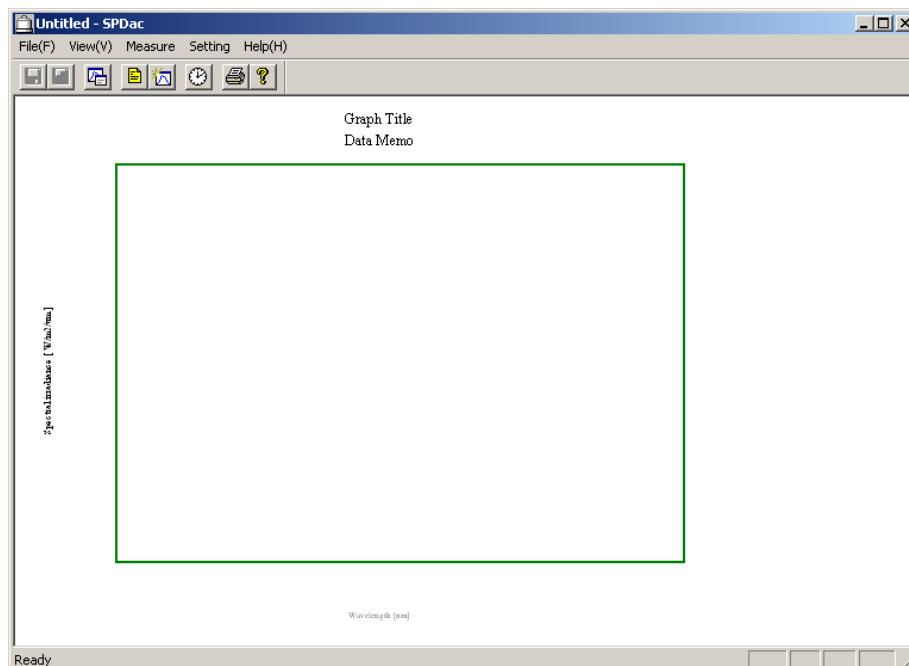


Figure 6-3. SPDac window

2. File Menu

The following functions are available from the File menu (Figure 6-4.).

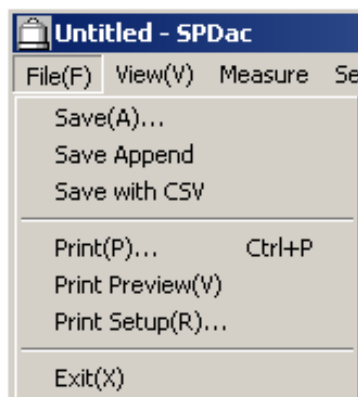


Figure 6-4. File menu

(1) Save

Save data displayed on a window as RAD file (see Table 6-1).

Figure 6-5 Data Memo window will appear after specifying a file name.

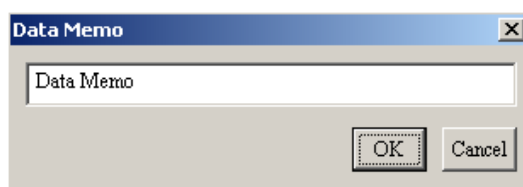


Figure 6-5. Data Memo window

Data Memo function stores measurement memorandum (parameters etc.) to header of RAD file with unlimited characters. To save data, click [OK]. To abort data saving, click [Cancel].

Existing RAD file cannot be overwritten. New data file should be assigned with unique file name.

(2) Save Append

Append data displayed on screen to existing RAD file as Binary (Data type “a” in Table 6-1).

(3) Save with CSV

Save data displayed on screen as CSV format (Data type “b” or “c” in Table 6-1). Select b or c file types from “CSV setting” under Setup Menu.

(4) Printing

Print out the data displayed on screen.

(5) Print Preview

Display printing preview of data displayed on screen.

(6) Printer setup

Setup printer for printing out graphs.

(7) Exit

Exit SPDac software.

3. View Menu

The following functions are available from the Figure 6-6. View menu.

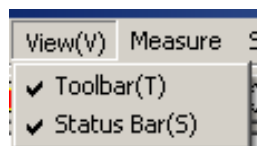


Figure 6-6. View menu

(1) Tool bar

Select appear/hide the tool bar shown on Figure 6-7. Tool bar.



Figure 6-7. Tool bar

The tool bar has functions of; Saving a working file, Appending a working file, Setting of graph, Setting of measurement, Measurement, Printing out a working file and Displaying software information, version and copyright.

(2) Status bar

Select appear/hide of status bar shown on Figure 6-8. Status bar.

The status bar displays contents of the tool bar, current status, and so on.



Figure 6-8. Status bar

4. Measure Menu

The following functions are available from the Figure 6-9. Measure menu.

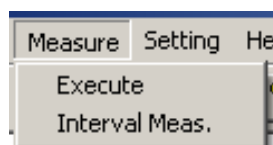


Figure 6-9. Measure

(1) Execute

Execute a single measurement; see Figure 6-10 how the Measure window appears when a measurement starts.

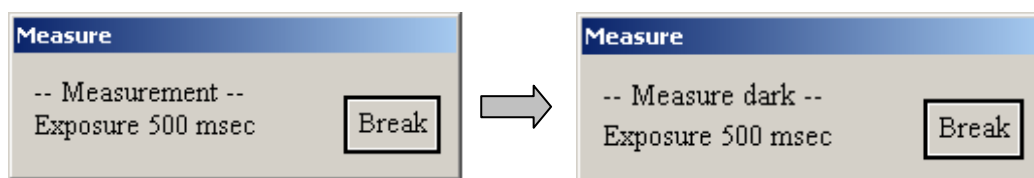


Figure 6-10. Measure

“Measurement” indicates the measuring status during the irradiance measurement.

“Measure dark” indicates the measuring status of a dark current when the shutter is closed.

After a measurement a graph of spectral irradiance will be displayed, see Figure 6-11

The integrated values (W/m^2), PAR (Photosynthetic Active Radiation, W/m^2 , 400-700nm), Photon ($\mu mol/m^2/s$, 400-700nm) and Illuminance (lux) (400-700nm) will be displayed in real time.

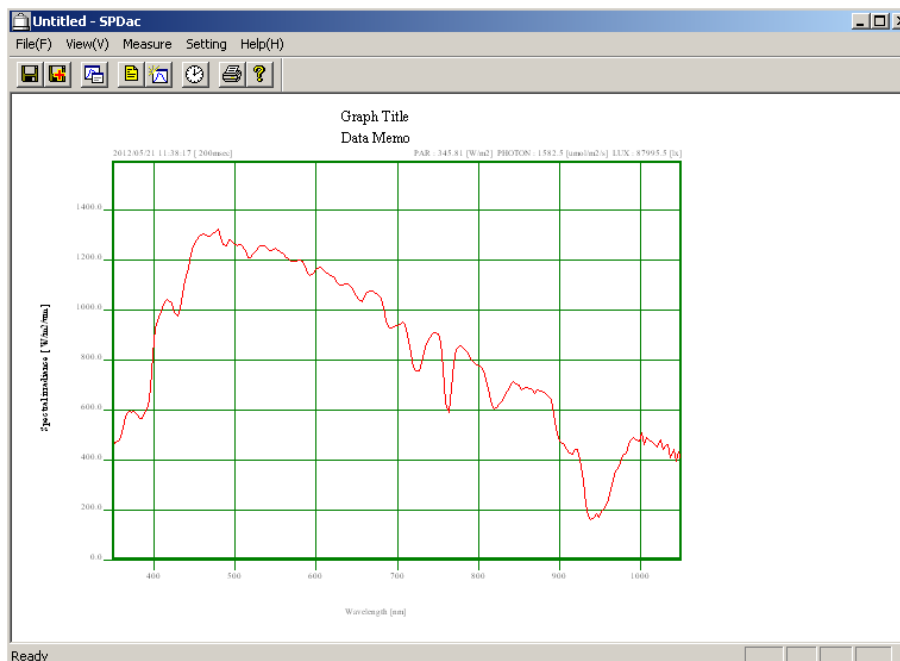


Figure 6-11. Graph of spectral

Date, time, and exposure time will be displayed on left-top of the screen.

See the section 7-5-2 for Graph title and the section 7-2-1 for Data Memo.

(2) Interval measurement

Interval measurement setting window will appear for entering [Start Time], [Stop Time], [Measurement Interval], [File Name] and [Data Memo] information.

In an interval measurement, measurements are taken from [start time] to [Stop time] of the day in [measurement interval] automatically based on PC time. After starting SPDac software, measurement will continue until SPDac software is stopped. RAD format data file will be stored to a folder assigned on File name menu.

Figure 6-12. Interval measurement setting window

Data file is stored automatically by interval measurement assigned with File name settings as followings:

[User define]: Click [Ref.] of [User define] to assign the file name.

[Automatic]: Clicking [Ref.] of [Automatic] to assign the folder that a data will be stored.

[Automatic] file name will be created as XYYMMDD.RAD format as followings;

XX: Type of instrument VS: MS-700/700 DNI

YYMMDD: Year, month and day of measurement

Example:	File name	VS110225.RAD
	Instrument	MS-700
	Date of measurement	February 25, 2011

[Data Memo] is a memorandum function that can be defined as a part of the file (RAD file). The memo can be freely chosen by the user.

To save data in CSV format while taking measurement, check “CSV Auto Save”. Assign data folder by clicking [Ref] button on “Save As...” window.

The file name will be saved in “YYYYMMDDhhmm.csv” format per every measurement. The “YYYYMMDDhhmm” indicates the year, month, date, hour and minutes. For example, the measurement data taken on August 22, 2011 at 10:25am with MS-700/700 DNI is written as “201108221025.CSV” automatically.

NOTE: When saving files in CSV file format directly, the wavelength step and wavelength range can be selected in “CSV Setting” under Setup menu. These information cannot be changed after measurement, so setup before taking measurements.

To beep at each measurement, place a check on [beep] checkbox.

Place a check on [Auto Start] checkbox to start the interval measurement at the same time the software is started.

When this function is registered, the interval measurement can be restarted as the PC is restarted.

After these setting are completed, press [Start]. Then Interval measurement window will appear and wait for start time.

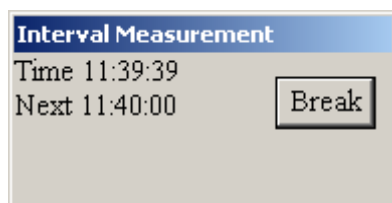


Figure 6-13. Interval measurement break window

To finish Figure 6-13 Interval measurement, click [Break].

5. Setting Menu

The following functions are available from the Figure 6-14 Setting menu.

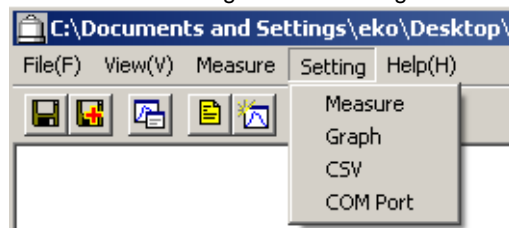


Figure 6-14 Setting menu

(1) Measurement

Exposure time can be adjusted according to Figure 6-15. Measurement settings window.

By checking [Auto], exposure time will be adjusted automatically by the software.

Exposure time is opening interval of the electronically controlled shutter, and equals the time the detector will be exposed to irradiance. For clear weather or a high intensity measurement, the exposure time should be set short to avoid over-range of a measurement. For a cloudy sky or low intensity measurement, the exposure time should be set long to avoid obtaining low S/N ratio data. By setting [Auto], the optimal exposure time will be automatically selected by the software.

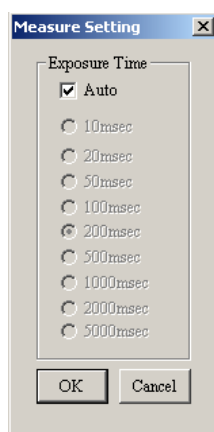


Figure 6-15. Measurement settings

(2) Graph

Graph settings are adjustable according to Figure 6-16. Graph settings window. Graph title, Horizontal (X) and Vertical (Y) axis, Showing grid, line colors and markers on/off are selectable.

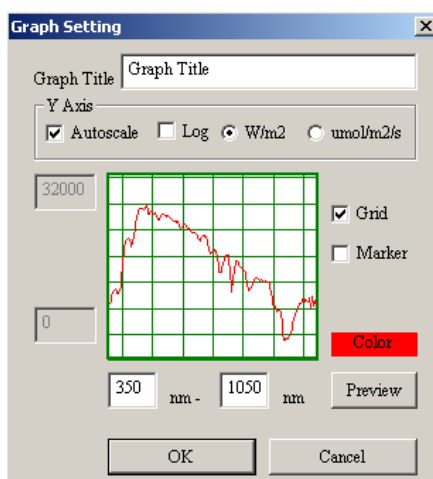


Figure 6-16. Graph settings

[Graph Title]	A title of a graph. The title will be displayed on a screen and print out. It won't be a part of the RAD file.
[Autoscale]	To set value of Y-axis as automatic scale, check [Autoscale] ON for Y-axis. To set upper and lower limit by user, check [Auto scale] checkbox.
[Log]	To set value of Y-axis as Log scale, check [Log] checkbox.
[W/m ²]	To set value of Y-axis as radiation (W/m ²), check [W/m ²] radio button.
[$\mu\text{mol/m}^2/\text{s}$]	To set value of Y-axis as Photon ($\mu\text{mol/m}^2/\text{s}$), check [$\mu\text{mol/m}^2/\text{s}$] radio button.
<u>X-Axis setting</u>	Begin and end wavelength will be set by user from Graph setting screen. Wavelength range of graph is 350 to 1050nm.
[Grid]	To show a grid of a graph, check [Grid] checkbox. Grids will be set automatically.
[Marker]	To display data by line with markers, check [Marker] checkbox.
[Color]	Colors of line and markers are set.
[Preview]	To display a graph as setup on the graph settings, click [Preview] button.

(3) CSV

Data Settings can be stored in CSV format by setting the interval of wavelength (W/L Step) and wavelength range (W/L Area).

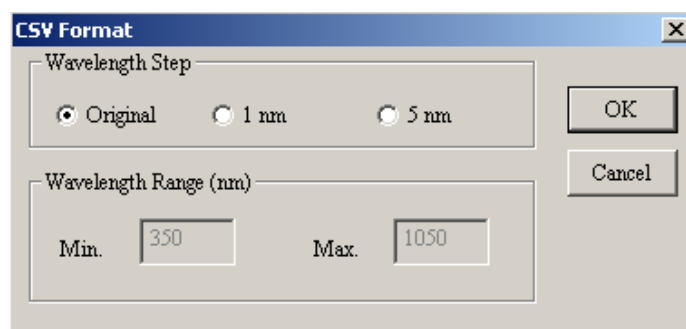


Figure 6-17 CSV Format

(4) COM port

COM port can be set according to Figure 6-18. Port settings window.

Change the COM port setting by using this function while the software is operating.

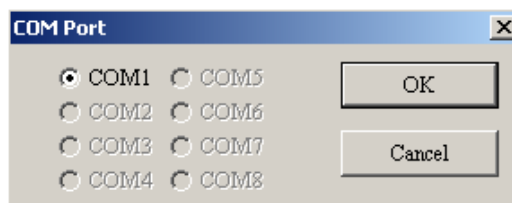


Figure 6-18. Port settings

6. Help Menu

The following functions are available from the Figure 6-19. Help menu.

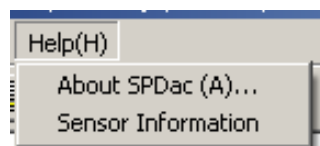


Figure 6-19. Help menu

(1) Software version information

The software version information is displayed on Figure 6-20. Software version information window.

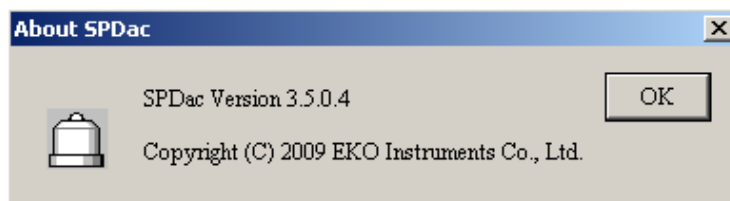


Figure 6-20. Software version information window

(2) Sensor information

Internal parameter, etc. are displayed at Figure 6-21. Sensor information window.

Coefficients C0 to C4 are wavelength parameters of optical detector.

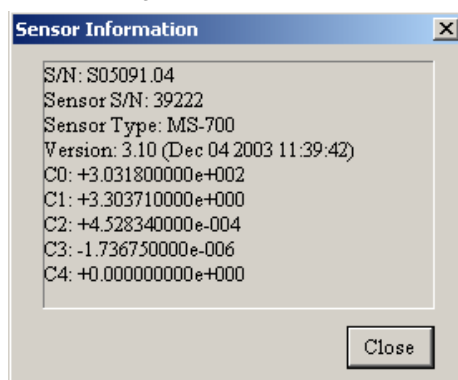


Figure 6-21. Sensor information

6-3. SPMAN (Data Managing) Software Operations

SPMan software is software for data managing applications. The basic function are, graphical display, data format conversion, and calculating data.

Spectral data will be displayed in all data files (Catalog View) or one specific data (Detail View).

RAD data file (Binary) will be converted to CSV (Comma Separation Variable) ASCII format by data conversion function. The integrated values for PAR (W/m^2), Photon ($\mu\text{mol/m}^2/\text{s}$) and Illuminance (lux) can be obtained by the calculating function.

1. Start SPMAN Software

After starting [SPMan.exe], Figure 6-22. File list will appear. Select RAD file to be managed.

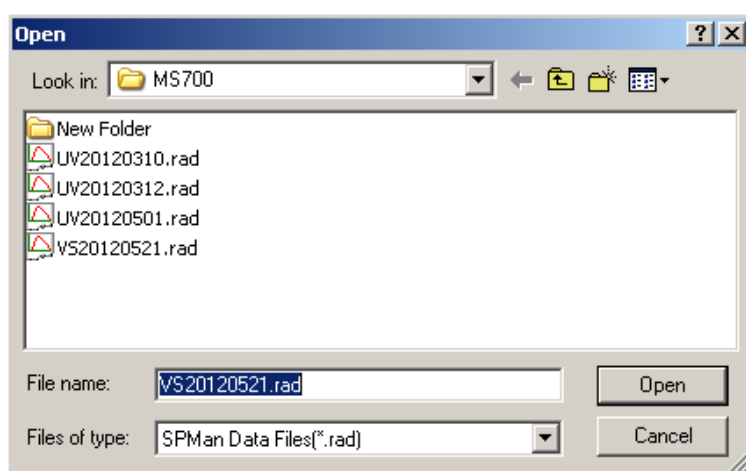


Figure 6-22. File list

Figure 6-23. SPMAN screen will appear after a file is selected.

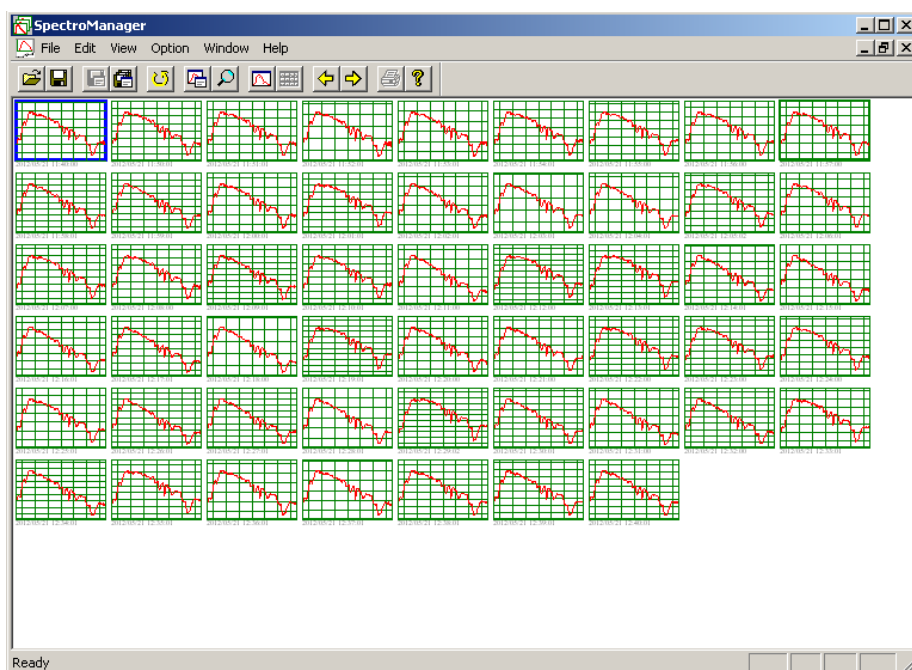


Figure 6-23. SPMAN screen

To display one graph, double-click a graph in Catalog View window (Detail View).

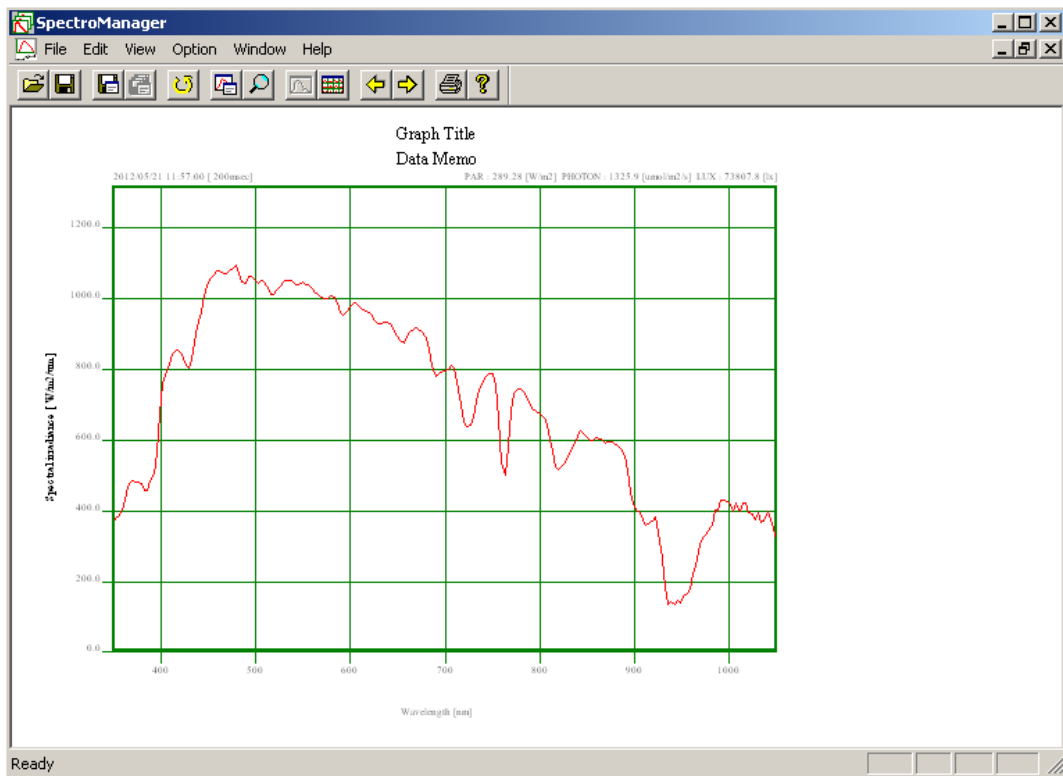


Figure 6-24. Detail view

2. File Menu

The following functions are available from the Figure 6-25. File menu.

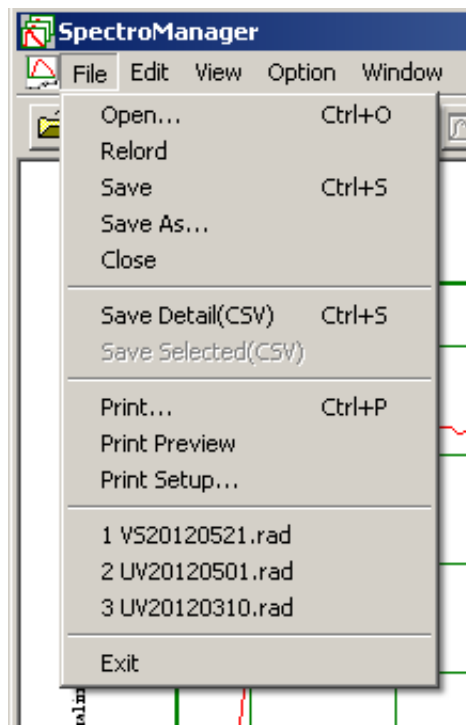


Figure 6-25. File menu

(1) Open

Load RAD file into SPMAN software. RAD file data has format "a" in Table.6-1.

(2) Reload

Reload all data that is displaying in a RAD data file.

When RAD files are saved sequentially during schedule measurement on SPDac and processed on SPMAN software, the data saved at latest can be reloaded in SPMAN by using the [Reload] function.

(3) Save

Save a displaying data as over write mode.

(4) Save as

Save a displaying data as user specified name.

(5) Close

Close current data.

(6) Save Detail [CSV]

Save a displaying data (Detail View) as CSV format. Setup the "Wave Length Step", "Unit", "Area", "File Name Type" and "Save Location" then click [OK] button.

(7) Save Selected [CSV]

Save the selected data of Catalog View screen as CSV file format. Setup the "Wave Length Step", "Unit", "Area", "File Name Type", and "Save Location". When [OK] button is clicked, the data selected from the displayed list will be saved in CSV format files.

To select data from Catalog View screen, click a spectral graph. The blue cursor indicates all data selected. To select multiple data, click data with pressing CTRL key or click on multiple data as holding down the SHIFT key until all the selected data are selected. To select all data on the screen, click [Select All] in [Edit] (see next section).

(8) Print

Print out data on the screen.

(9) Print preview

Display preview of data on the screen.

(10) Printing setup

Open the printer setting for connected printer.

(11) Exit

Finish SPMAN software.

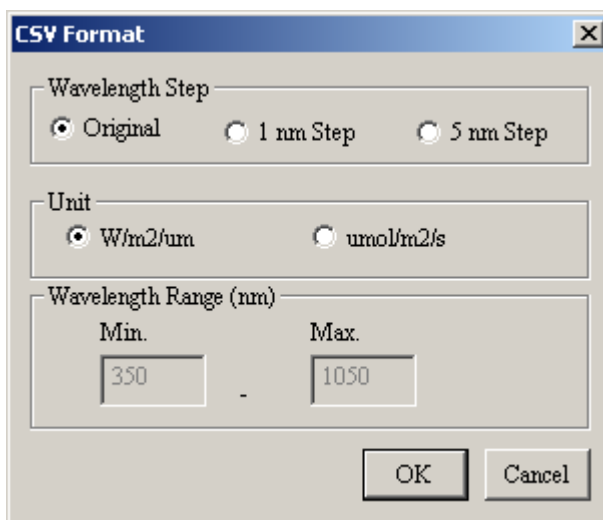


Figure 6-26 CSV Format

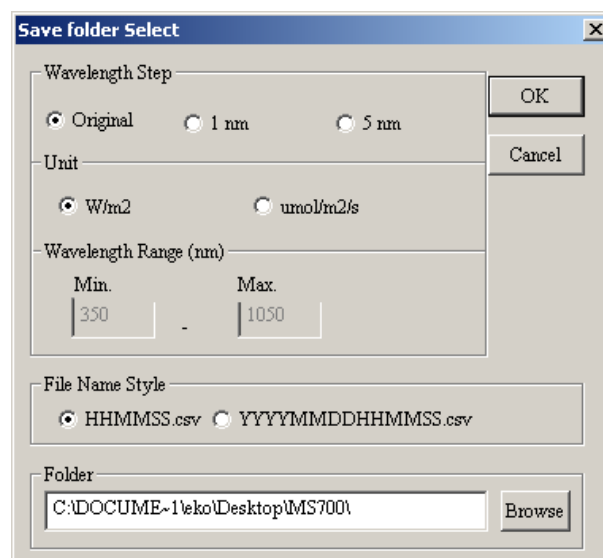


Figure 6-27 Save Folder

3. Edit Menu

The following functions are available from the Figure 6-28. Edit menu.

(1) Select all

Select all data of working RAD data file on Catalog View screen.

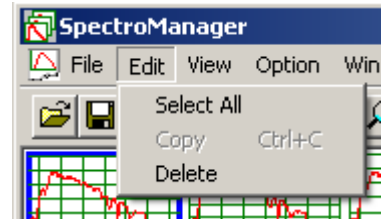


Figure 6-28. Edit menu

(2) Copy

To copy current Catalog View screen to the Clip Board, select [Copy]. A data send to the Clip Board is applicable for other application as Bitmap data by pasting.

(3) Delete

Delete selected data from RAD data file on Catalog View screen.

4. View Menu

The following functions are available from the Figure 6-29. View menu.

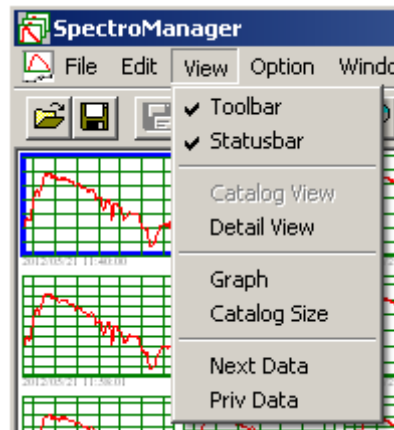


Figure 6-29. View menu

(1) Tool bar

Select either to show/hide the tool bar shown on Figure 6-30.



Figure 6-30. Tool bar

1	Open	6	Graph setting	11	Next Data
2	Save as	7	Catalog Size	12	Print
3	Save Detail [CSV]	8	Detail View	13	Help
4	Save Selected [CSV]	9	Catalog View		
5	Reload	10	Previous Data		

(2) Status bar

Select “show” or “hide” the status bar shown in Figure 6-31. The status bar indicates the measurement status.



Figure 6-31. Status bar

(3) Catalogue view

Set screen mode to display all files of a RAD data file.

To select data from Catalog view screen, double-click the spectral graph or click on [Detail View] on the tool bar. The blue frame indicates the selected data.

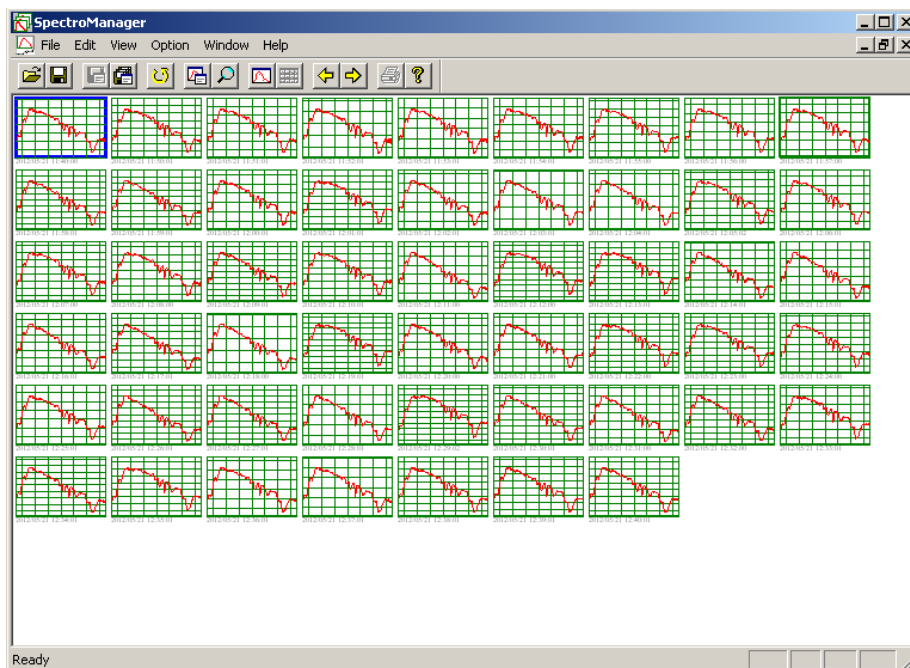


Figure 6-32. Catalogue view screen

(4) Detail view

The selected data of RAD data file will be displayed as shown on Figure 6-33.

To change a graph window into the Catalog view window, double-click the graph or click [Catalog View] on the tool bar.

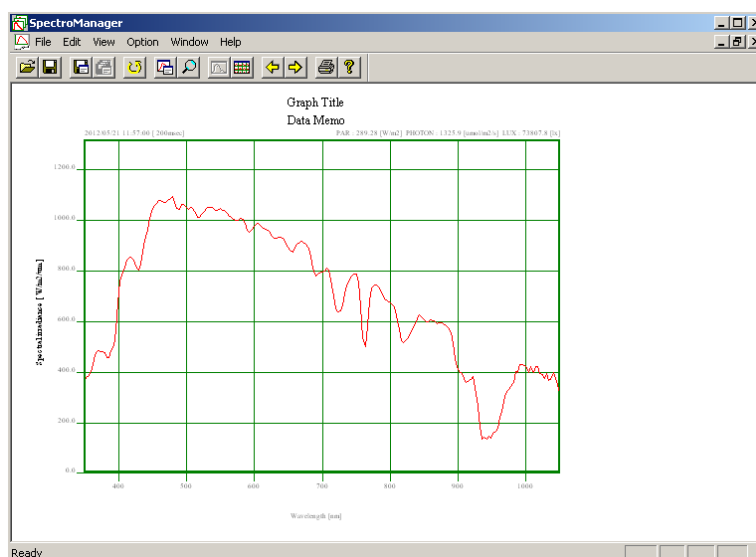


Figure 6-33. Detail

(5) Graph

Graph title, scales of X and Y axis, grid line or line color can be setup from Figure 6-34 graph setting screen.

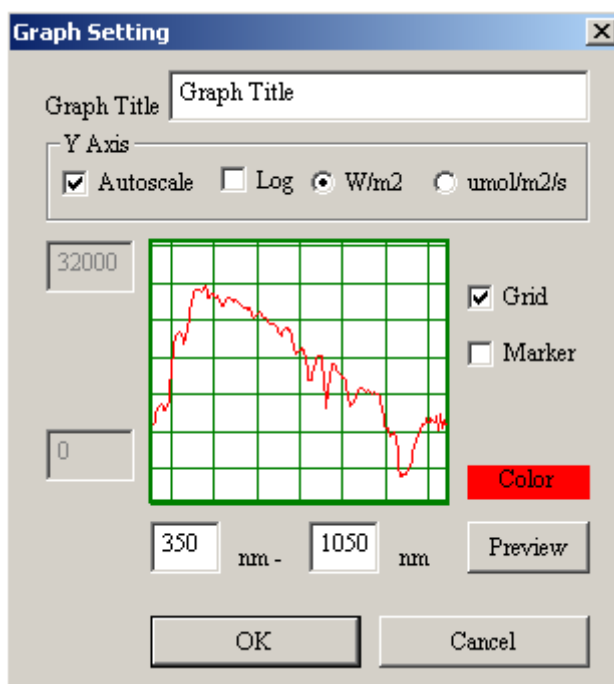


Figure 6-34. Graph setting

[Graph Title]	The title will be displayed on a screen and print out.
[Autoscale]	To set value of Y-axis as automatic scale, check [Autoscale] ON for Y-axis. To set upper and lower limit by user, check [Auto scale] checkbox.
[Log]	To set value of Y-axis as Logarithmic scale, check [Log] checkbox.
[W/m ²]	To set value of Y-axis as radiation (W/m ²), check [W/m ²] radio button.
[umol/m ² /s]	To set value of Y-axis as Photon (μmol/m ² /s), check [umol/m ² /s] radio button.
<u>X-Axis setting</u>	Starting and finishing wavelength will be set by user from Graph setting screen. Wavelength range of graph is 350 to 1050nm for MS-700/700DNI.
[Grid]	To show a grid of a graph, check [Grid] checkbox. Grids are set automatically.
[Marker]	To display data by line with markers, check [Marker] checkbox.
[Color]	Colors of line and markers are set.
[Preview]	To display a graph as set on the graph settings, click [Preview] button.

(6) Catalogue size

To set graph size of Catalog view, check a pixel size to be displayed at Figure 6-35

(7) Next data

Display next data, which was measured at the time right after the spectrum data in operation.

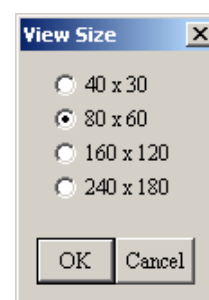


Figure 6-35. Catalogue size

(8) Previous data

Display previous data, which was measured at the time right after the spectrum data in operation.

5. Option Menu

The following functions are available from the Figure 6-36 option menu.

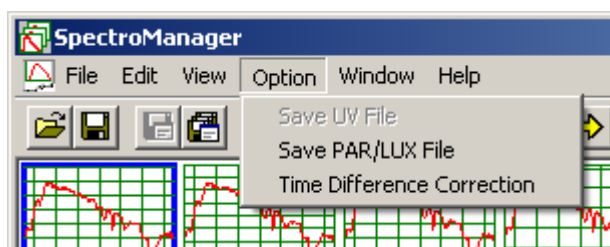


Figure 6-36. Option menu

- (1) Save PAR, Photon and Illuminance file

This is the calculation value for PAR, Photon, and Illuminance (400-700nm for each) from a current data file. The calculated value will be saved as CSV format.

- (2) Time Difference Correction

The recorded time uses UTC (Coordinated Universal Time). The UTC is the international standard time similar to the GMT (Greenwich Mean Time).

When PC setup time zone does not match with the time zone of measured data and opened with this software, it may show different time than the actual measured time. This is because the saved time is recorded by the UTC time, which is converted from the local time of the PC time zone setup. For example, data taken in Japan at noon (12:00AM) is displayed on a PC, which is setup with US time zone (UTC -8 hours), will show data as taken at 4:00AM.

To avoid such confusion, use the "Time difference Correction" function. In this case, set the time difference correction by -8:00 as UTC time difference.

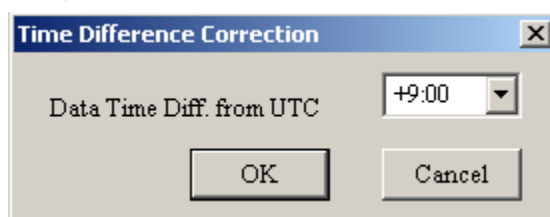


Figure 6-37. Time Difference

6. Window Menu

The following functions are available from the Figure 6-38 window menu.

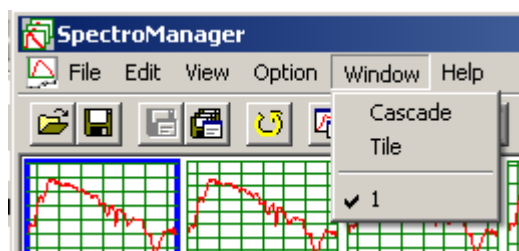


Figure 6-38. Window menu

- (1) Cascade

Multi RAD file data will be displayed as cascade style.

- (2) Tile

Multi RAD file data will be displayed as tile style.

7. Help Menu

The following functions are available from the Figure 6-39 Help menu.

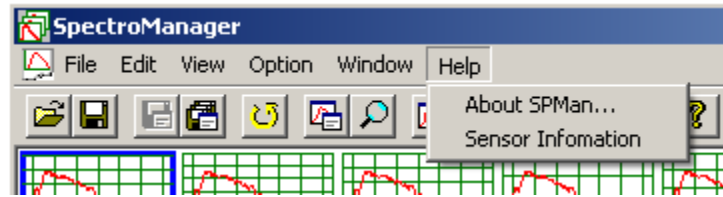


Figure 6-39. Help menu

(1) Version information

Software version will be displayed at Figure 6-40 version information.

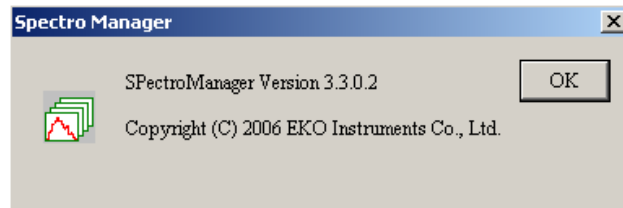


Figure 6-40. Version information

(2) Sensor information

Software information will be displayed at Figure 6-41 sensor information.

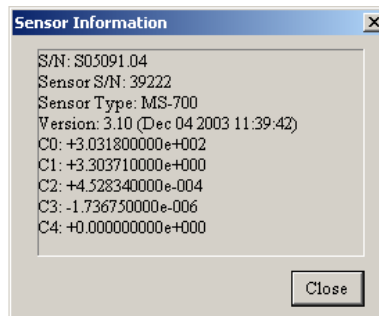


Figure 6-41. Sensor information

6-4. Data File Format

Data files are created as follows;

Table 6-1. File format

	File format	Binary/ASCII	Wavelength increment
a	RAD file	Binary	Specified as an instrument
b	CSV file	ASCII	Specified as an instrument
c			1nm or 5nm

1. RAD File (Binary data)

RAD files record spectral irradiance in a wavelength increment defined by the radiometer as binary format.

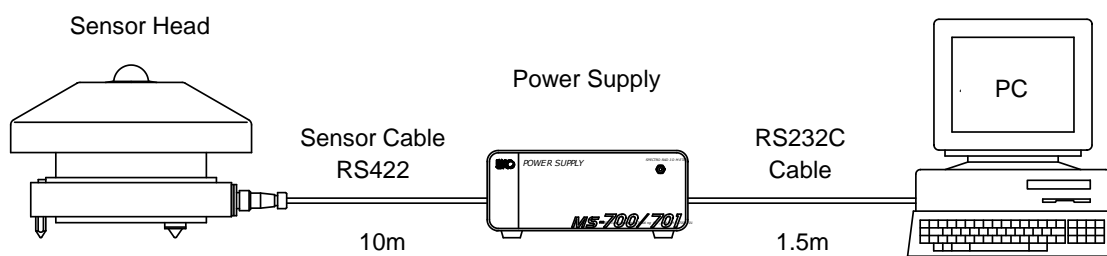
2. CSV File (ASCII)

CSV files record spectral irradiance in a wavelength increment defined by the radiometer, 1nm or 5nm as ASCII format. Those data can be opened by using Excel.

7. Measurement Principle

7-1. Measurement Principle

Block diagram of the MS-700/700DNI is shown below.



*PC is not included.

Figure 7-1. Block diagram

The sensor consists of a dome, a diffuser, a shutter, a grating spectrometer with a photodiode array, and temperature control unit to keep the temperature stable of the optical system and control unit.

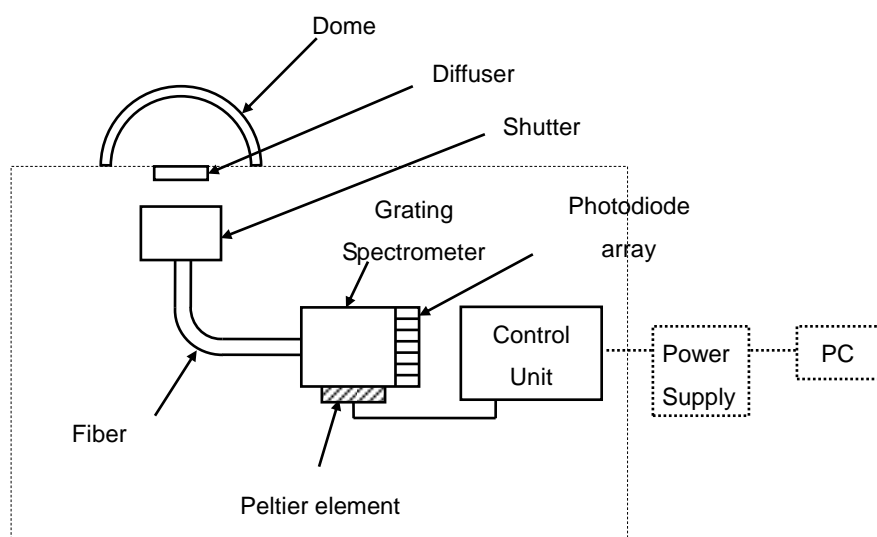


Figure 7-2. The sensor head configuration

8. Maintenance & Troubleshooting

8-1. Maintenance

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

Table 8-1. Maintenance

Maintenance Item	Frequency	How To	Effect
Clean Glass Dome / window	Several times per week (at least once per week)	Keep the glass dome / window clean by wiping it with a soft cloth and alcohol.	If the glass dome / window gets soiled (by accumulation of dirt) the detector output will be affected due to a change in transmittance. This dirt can either be removed manually (using a soft cloth and alcohol) or it is washed off by rain (self cleaning effect).
Check Glass Dome / window Condition	Weekly	Check for cracks and scratches on the glass dome / window and the rim.	May lead to water leakage due to rain/dew which causes damage of the detector inside the spectroradiometer.
Check Spirit Level Bubble (MS-700)	Weekly	Verify if the spectroradiometer is leveled by checking the bubble is in the center ring of spirit level. (When the spectroradiometer is setup in horizontal position)	If a spectroradiometer in the horizontal measurement position is not leveled correctly an additional cosine/azimuth error will be introduced.
Check Sight Spot (MS-700 DNI)	Weekly	Verify if the spectroradiometer is positioned properly by checking the sight spot on the collimation tube.	If a spectroradiometer position is not leveled correctly, it causes error to the measurements.
Check Cable Condition	Weekly	Verify if the cable connector is properly connected, tightened to the instrument, and how cable is lined; make sure the cable is not swinging by wind.	A disconnected cable will cause sporadic reading errors or failure of operation. If the cable is damaged, it may lead to noise or electric shock (ventilator AC power cable).
Check Setup Base Condition	Weekly	Check if the instrument is tightened properly to the mounting base plate and the base plate and/or table is securely fastened in a proper condition.	Loose instruments and/or mounting plates can lead to damages of the instruments and/or injury.
Check Silica Gel	Weekly	Verify that the color of the silica gel is dark blue (dark blue = okay). If the color of the silica gel turns into a reddish color then replace it with new silica gel.	With moisture saturated silica gel gives condensation inside the dome which leads to a lower detector output or damage.
Recalibration	Every 2 years	To maintain the best possible measurement accuracy, regular recalibration of the spectroradiometer is recommended. Contact EKO for more details and requests for a recalibration and maintenance service.	Due to natural aging of materials the detector properties of the spectroradiometer can change in time which affects the sensor sensitivity.

8-2. Calibration Method

It is recommended to recalibrate the instrument once every 1~2 years. For further information about the calibration and recalibration, please contact EKO.

The spectroradiometer is calibrated against a NIST 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 MS-700 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 3 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 MS-700 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.

8-3. Troubleshooting

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

Failure	Action
<ul style="list-style-type: none">- PC operation does not work.- The data can't be acquired.	<p>The cable connections for PC, power supply, and/or sensor part could be connected incorrectly.</p> <ol style="list-style-type: none">1) Check the connection between PC and power supply, and power supply and sensor.2) Check if the PC power and power supply are on.3) Check the fuse which is in the fuse box at the power supply rear panel. Make sure it is not blown.4) Check if the COM port connected to PC properly.5) Reboot the PC and check if the PC communications and operations are recovered.
<ul style="list-style-type: none">- The measured value is abnormal- S/N value of acquired data is not good.	<ol style="list-style-type: none">1) The exposure time could be inappropriate. Check if the exposure time is set as "automatic" at the "measurement menu/measurement settings" of SPDac.exe.2) When using multiple units of MS-700/700DNI on one PC, make sure to restart the software each time the spectroradiometer is switched. <p>Check if the dome is clean. Refer to the chapter "Maintenance"</p>
<ul style="list-style-type: none">- The software is operating abnormal.	<p>The PC and/or software could be defected.</p> <p>Reboot the PC and restart the software.</p>

9. Specification

9-1. Main Unit

Table 9-1. Sensor Specification

Sensor head	MS-700	MS-700 DNI
Wavelength range	350 - 1050nm	
Wavelength interval	3.3nm	
Optical resolution FWHM	10nm	
Wavelength accuracy	<0.3nm	
Temperature dependency	+/-1.0% (-20 to +50°C)	
Temperature control	25 +/- 5 °C controlled	
Cosine response	7% (Zenith angle : 0 to 80°)	---
Aperture Angle	---	5°
Slope Angle	---	1°
Stray light	0.15%	
Exposure time	10msec - 5sec Automatic adjustment (1 minute min. measurement interval)	
Window material	Filter glass	Quartz glass (Window for tube)
Communication	RS-422 (Between sensor head and power supply)	
Communication cable length	10 m (Optional max. 30m)	
Power requirement	12VDC, 50VA (from the power supply)	
Operating temperature	-20 to +50°C	
Dimension (Sensor head)	200(φ)×175(H) mm (With sun screen: 240(φ)×175(H) mm)	200(φ)×300(H) mm
Weight (Sensor head)	4kg	4.5kg

Table 9-2. Power Supply Unit Specification

Power supply	Remarks
Input	AC100-240V, 50/60Hz, 50VA
Output	DC12V
Communication	RS-232C (between power supply and PC)
Operating environment	Temperature : 0-40°C, Humidity : 0-90(%)RH *No condensation
Dimension	200(W) x 140 (D) x 80(H) mm
Weight	1kg

9-2. Software

Table 9-3. PC requirements

	Details
Operation Environment	CPU: Pentium 200MHz or more Memory: 32MB or more Hard Disk: 10GB or more Display: 1024 x 768 or more Others: CD-ROM drive
Communication Interface	RS232C

Table 9-4. Software Specifications

	Details
Applicable OS	Microsoft, Windows 2000/XP/Vista/7(32bit)
Software Names	Control and data acquisition: SPDac_Vxxxx.exe Data managing: SPMAN_Vxxxx.exe
Software Functions	SPDac_Vxxxx.exe Measurement: One shot or schedule measurement Exposure time: Automatic or manual setting Data display: Graph setting; unit, wavelength etc. Data save: "RAD" or CSV format SPMAN_Vxxxx.exe Data display: Detail or catalog view Graph setting: Unit, wavelength etc. Data save: CSV format Data calculation: PAR, Photon, illuminance

9-3. Output Cables & Ventilation Unit Power Cables

Table 9-5. Cable Specifications

Cables	Details	Terminal		Wire Color	Output
		Color	No.		
Sensor Cable	Material: MVVS	Red	1	Brown	TXD+(RS-422)
	Diameter: 0.5mm ² x 12 pins	Blue	2	Red	TXD-(RS-422)
	Outer Diameter: φ10.4mm	Red	3	Orange	RXD+(RS-422)
	Connector	Blue	4	Yellow	RXD-(RS-422)
	Diameter: φ26.5mm		5	Green	Digital GROUND
	Cable end: Y Terminal (1.25Y-4)		6	Gray	Supply power 12V
			7	White	Supply power ground
		Red	8	Black	Peltier Control +
		Blue	9	Pink	Peltier Control –
			10	Black	EARTH (Shield)
Power Cable	KP300KS16A 2.5M VCTF0.75 Black, AC power cable with plug				
Communication Cable	RS-232C (Cross)				

9-4. Dimensions

1. MS-700

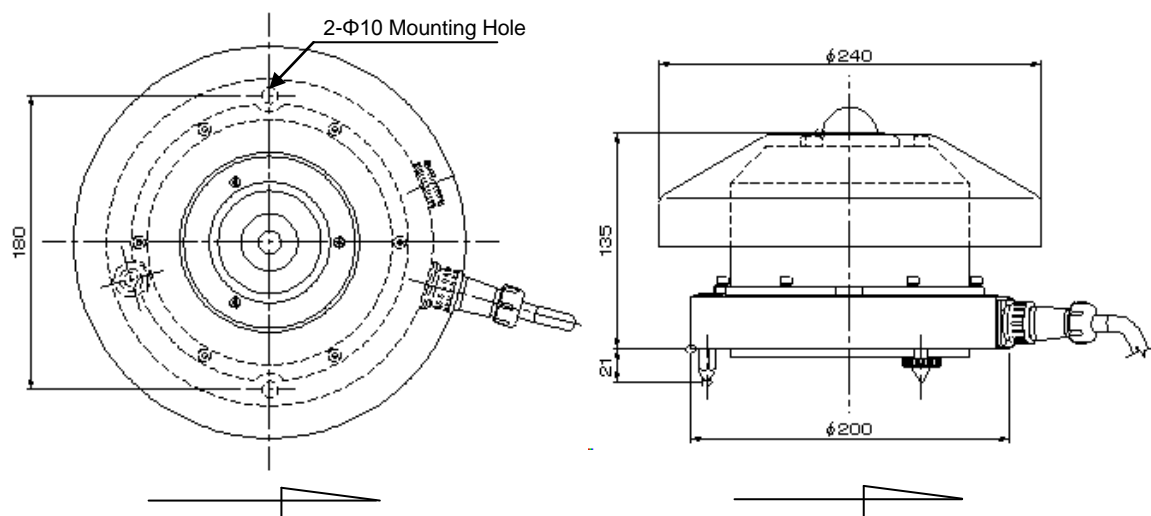


Figure 9-1. MS-700 Dimension

2. MS-700 DNI

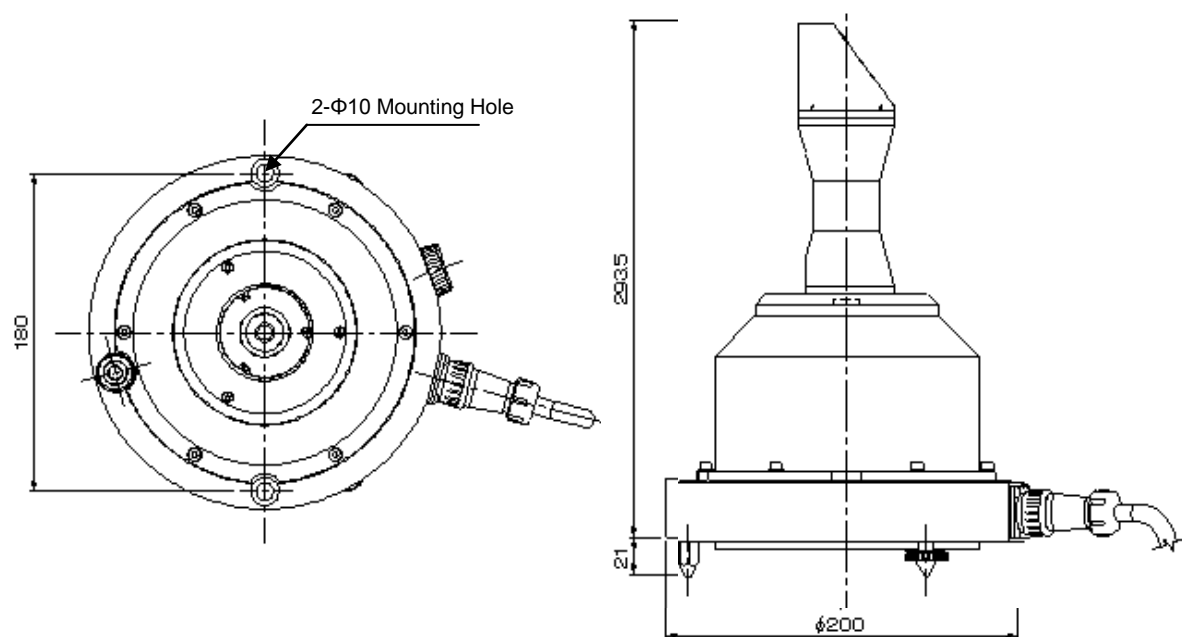


Figure 9-2. MS-700DNI Dimension

3. Power Supply

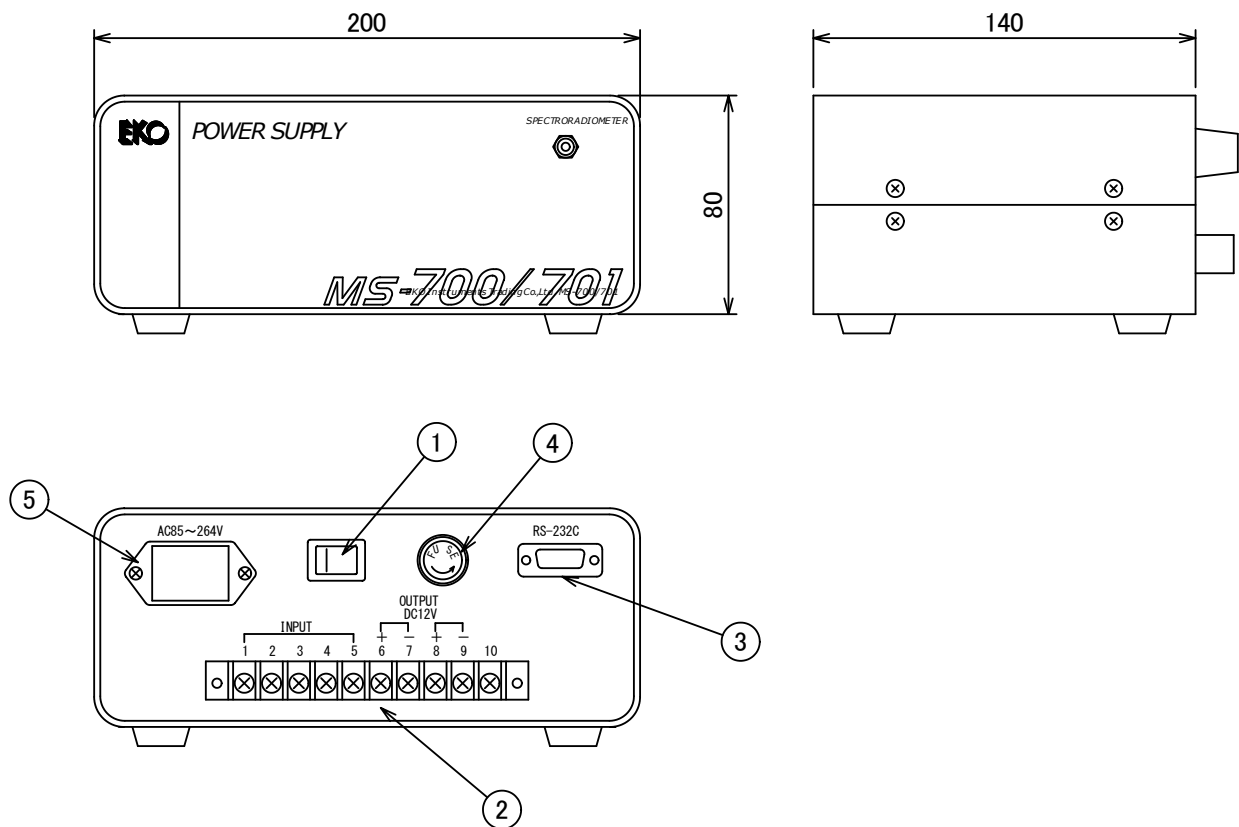


Figure 9-3 Power Supply Dimension

9-5. Accessories List

Option Items	Remarks
STR-22-PP700	Mounting Plate for MS-700DNI (primary side)
STR-22-PS700	Mounting Plate for MS-700DNI (secondary side)
Sensor cable	Cable lengths 20m, 30m
STR-21G	Single arm Sun Tracker
STR-22G	Double arm Sun Tracker



Japan: www.eko.co.jp

Europe: www.eko-eu.com

USA: www.eko-usa.com