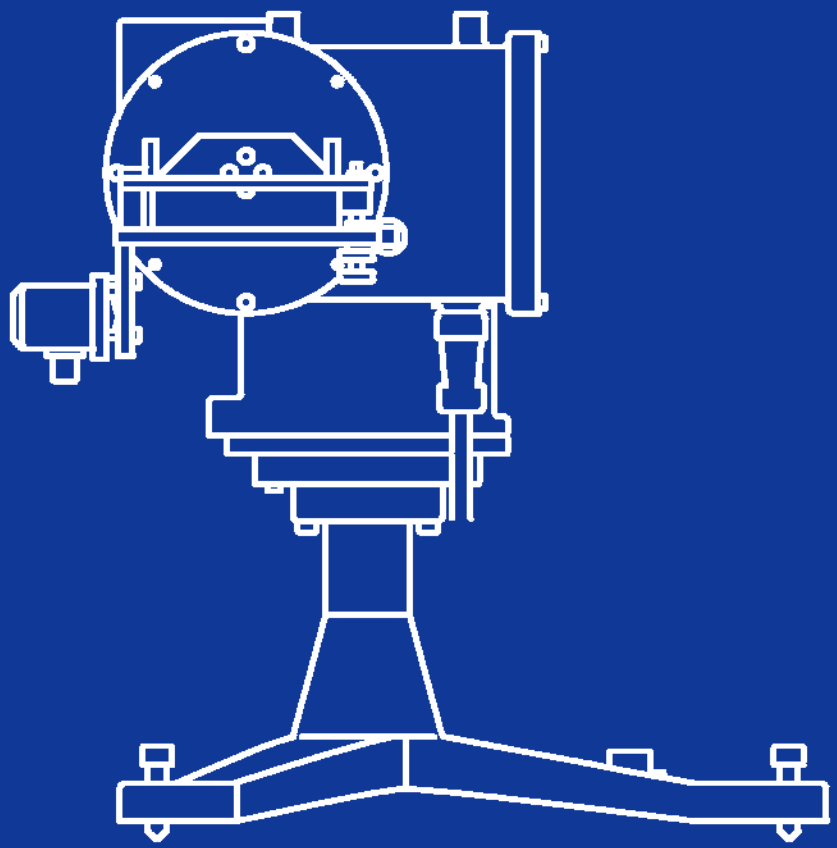
INSTRUCTION MANUAL

Sun Tracker Series

STR-21G
STR-22G
STR-32G



EKO

1. Index

1. Index 1
2. Important User Information 2
2-1.Contact Information 2
2-2.Warranty and Liability 2
2-3.About Instruction Manual 3
2-4.Environment 3
2-5. CE Declaration 4
3. Safety Information 5
3-1.WARNING/CAUTION 5
3-2.HIGH VOLTAGE WARNING 6
4. Introduction 7
4-1.Main Features 8
4-2.Package Contents 9
5. Getting Started 10
5-1.Parts Name and Descriptions 10
5-2.Setup 13
5-3.Installation 17
5-4. Sun Sensor Adjustments 21
6. Software 23
6-1. Installation and Uninstallation 23
6-2. Select a COM port number of RS232C 27
6-3. Setting Latitude, Longitude, Date and Time 27
7. Measurement Principle 29
8. Maintenance & Troubleshooting 30
8-1. Maintenance 30
8-2. Troubleshooting 31
8-3. Event Log 33
9. Specification 35
9-1. Sun Tracker 35
9-2. Firmware and Software 36
9-3. Dimensions 37
9-4. Communication Cable and Power Supply Cable 39
9-5. Accessories List 41
APPENDIX 44
A-1. STR-32-T Full-Size Tripod Assembly 44
A-2. Shading Ball Assembly & Setup 46
A-3. Mounting Pyrheliometer MS-57 on Sun Tracker 53
A-4. Mounting DNI Spectroradiometer on Sun Tracker 54
A-5. Alignment for More Precise Sun Tracking 57
A-6. Commands List 60
A-7. Packing Procedure for Sun Tracker 63

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
info@eko.co.jp

EKO INSTRUMENTS Co., Ltd.
1-21-8 Hatagaya, Shibuya-ku
Tokyo, 151-0072 Japan

Tel: +81 (3) 3469-6713
Fax: +81 (3) 3469-6719

Europe, Middle East, Africa, South America Region

www.eko-eu.com
info@eko-eu.com

EKO INSTRUMENTS Europe B.V.
Lulofsstraat 55, Unit 32,
2521 AL, Den Haag, The Netherlands

Tel: +31 (0)70 3050117
Fax: +31 (0)70 3840607

North America Region

www.eko-usa.com
info@eko-usa.com

EKO INSTRUMENTS USA Inc.
95 South Market Street, Suite 300
San Jose, CA 95113 USA

Tel: +1 408-977-7751
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

Copy Rights Reserved by EKO INSTRUMENTS CO., TLD. Making copies of whole or part of this document without permission from EKO is prohibited.

This manual was issued: 2018/01/30

Version Number: 7

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

CE

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 Sun Tracker
Model No.: STR-21G, STR-22G, STR-21G (DC24V), STR-22G (DC24V), STR-32G (DC24V)

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

Harmonized standards:

EN 61326-1:2006 Class B (Emission)
EN 61326-1:2006 (Immunity)

Following the provisions of the directive:

EMC-directive : 2004/108/EC
Low Voltage Directive : 2006/95/EC

Date: Mar. 01, 2012

Position of Authorized Signatory: Deputy 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 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.

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

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 maximum load capacity of the Installation Base or Mast needs to correspond with the total weight of the Sun Tracker assembly. After installation always check if the tracker is firmly mounted to the base or mast. Without fastening the instrument securely, in case of gale or earthquake etc. the tracker may drop causing severe injury or damage.
- The tracker system should be easily accessible. Accidents or injury may occur if the tracker is installed in a site where it is hard to perform maintenance.
- This instrument does not have a stall position function. Make sure the Sun Tracker is balanced with sensors mounted when it is not powered. The detent torque for non-powered Sun Tracker is about 5Nm for STR-21G/22G and 10Nm for STR-32G.
- The installation procedure provided on attached Quick Start Guide is an easy-step procedure. Depending on the installation location and environment, the Sun Tracker may not restart tracking the sun automatically in case of power supply reset if the Sun Tracker is installed with approximate orientation. It is highly recommended to follow the installation procedures on this manual in chapters [5-2. Setup] and [5-3. Installation] with accurate “True North/South” orientation and “Horizontal Leveling” for long-term and more precise measurements.
- When installing the Sun Tracker in the area between 23.4° north latitude and 23.4° south latitude, it is necessary to install in accurate position. Follow the instructions on [A-7. Alignment for More Precise Sun Tracking] in this manual.
- When installing the Shading Ball Assembly on the Sun Tracker, the setup base should have certain heights; follow the instructions on [5-2. Setup] section, [4. Shadow Ball Assembly] in this manual for preparing the setup base.

2. Approaching to the Instrument

- During installation or servicing always switch off the mains power. Pay attention, the sun tracker contains rotating parts that may cause severe injury or accident to your body when your body and/or clothing get caught.
- The Sun Trackers do not have any automatic stop safety mechanism, but can only be stopped by disconnecting the main power.

3. Transportation of Sun Tracker

The Sun Tracker is packaged up-side-down to prevent it from getting damages from the impacts during transportation. When transporting the Sun Tracker to measuring sites and shipping back to EKO for maintenance or in case of repair, follow the procedure described in the section [A-6. Packaging Procedure for Sun Tracker] for packing the Sun Tracker.

3-2. HIGH VOLTAGE WARNING

Power Supply

- To prevent electric shock or electronic damage by lightning or surge, make sure the earth cable or power plug is connected to ground.
- Check the supply voltage corresponding to the voltage requirements of the sun tracker (100 – 230 VAC or 24 DC)

4. Introduction

EKO Instruments high precision STR Sun Tracker models STR-21G, STR-22G and STR-32G provide high tracking reliability, enhanced functionality with fully automated set up procedure through a built in GPS receiver. The compact sun trackers are perfectly suited to support all kinds of measurement sensors to measure Global, Diffuse and Direct Radiation. The STR-21G and 22G Sun Tracker comes with a small tripod that offers a stable surface for the measurement equipment and adjustable pyrheliometer mount for the fine alignment. Besides, various mounting kits are available to accommodate the MS pyranometer series or other types of pyrheliometers.

The latest heavy duty Sun Tracker STR-32G is capable to take the highest load and maximum performance to support EKO's the spectral measurement solutions to measure the spectral global, diffuse and direct component. Although it has a 4 times higher load capacity (60Nm / 60kg), there is no changes to the body size. In combination with the heavy duty full-size tripod (optional), a very robust solution is offered for the most demanding applications on earth.

From sun rise to sun set the compact EKO Sun-Tracker guarantees accurate sun tracking and pointing of the attached solar sensors. The 2-axis tracker automatically adjusts to the sun's position by the sun sensor closed-loop control system, even if the tracker is not oriented or leveled properly. When the sun is absent the sun tracker will follow the solar path by accurately calculating its position. As soon as the sun appears the radiometers will be in the proper position to capture radiation.

Next to the basic sun tracking function, the STR-series can be fully controlled through the so called open command protocol, which gives the flexibility to monitor and control its position by sending the operating commands. By using a PC or data logger with RS-232 serial interface the sun tracker can be easily accessed.

When AC power is not available on site, a 24 VDC power version EKO Sun Tracker can be used, and its power can be supplied from a battery system, such as solar power. Due to its efficient motor / Harmonic Drive® design the power consumption is only 20W for STR-21G/22G and 25W for STR-32G. Harmonic-Drive® is one of the most reliable zero backlash drive systems which doesn't require any maintenance.

4-1. Main Features

1. Accurate Pointing

The STR-series is controlled by two individual sun tracking modes which can work simultaneously (Sun-sensor mode and Calculation mode). In the Sun-sensor Mode, a quadrant Si-photodiode detector with 30 degrees field will detect the sun and will compensate for misalignment of the sun tracker caused by set up. Since the offset in most cases is a static offset, the misalignment can be easily corrected within the sensor field of view. When clouds obscure the sun, the STR follows the solar path by calculation and open loop positioning. In general the tracking mode will automatically be switched depending on the solar radiation conditions, to maintain the highest tracking accuracy possible.

2. Simple Installation

The STR-series has a built in GPS (Global Positioning System), which acquires all necessary parameters (latitude, longitude, date and time) for automatic initialization and sun tracking without the need for setting up by a PC. However a PC can be used to set up the sun tracker manually.

3. High Durability

HarmonicDrive® which is a “Direct Drive” zero back-lash gear system to drive the shaft. Due to its high working efficiency the motor can be relatively small, low power but gives a high output torque on the shaft. Drive systems using belts can create backlash and the belt may break or loosen in a low temperature environment, however HarmonicDrive® has no such disadvantage and offers a long-term durability and will be maintenance free.

4. Control Functions

The STR series are easily accessible through the RS-232 serial interface using the open command protocol. By using simple commands the position of the tracker can be monitored or GPS time can be used for synchronizing PC or data logger time. Through the open command protocol the tracker can also be used as positioner.

4-2. Package Contents

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

Standard equipments of STR-21G, STR-22G and STR-32G are shown below.

Table 4-1. List of Standard Supply

Equipment	Quantity	STR-21G / 22G	STR-32G
Sun Tracker	1	STR-21G/22G	STR-32G
Sun Sensor	1	With sensor cable, already attached on Sun Tracker	
Pyrheliometer mounting assembly	1	Already attached on Sun Tracker	Optional
Tripod	1	Already attached to Sun Tracker	Optional
Power supply cable	1	AC or DC type Cable length: 10m	
Communication cable	1	Cable length: 3m*	
Cable Tie	3	Weather Resistance Bands 250 x 4.8mm	
Cable Tie Fixing Part	1	Already attached on the STR Body	
Instruction Manual & Setup software	1	CD-ROM	
Instruction Manual	1	✓	✓
Inspection Report	1	✓	✓
Quick Start Guide	1	✓	✓
Mounting bolts	1 bag	M8 x 80mm bolts: 3pcs Plain washer: 6pcs Spring washer: 3pcs Nuts: 3pcs	M12 x 100 bolts: 3pcs Plain washer: 6pcs Spring washer: 3pcs Nuts: 3pcs (applicable only when optional full-size tripod is ordered)
Pad plates	3pcs	Place underneath the level adjusting screws on tripod	----

*For different lengths of communication cable, please see [9-4. Specification], [9-5. Accessories List]

5. Getting Started

5-1. Parts Name and Descriptions

Each part name and its main functions are described below.

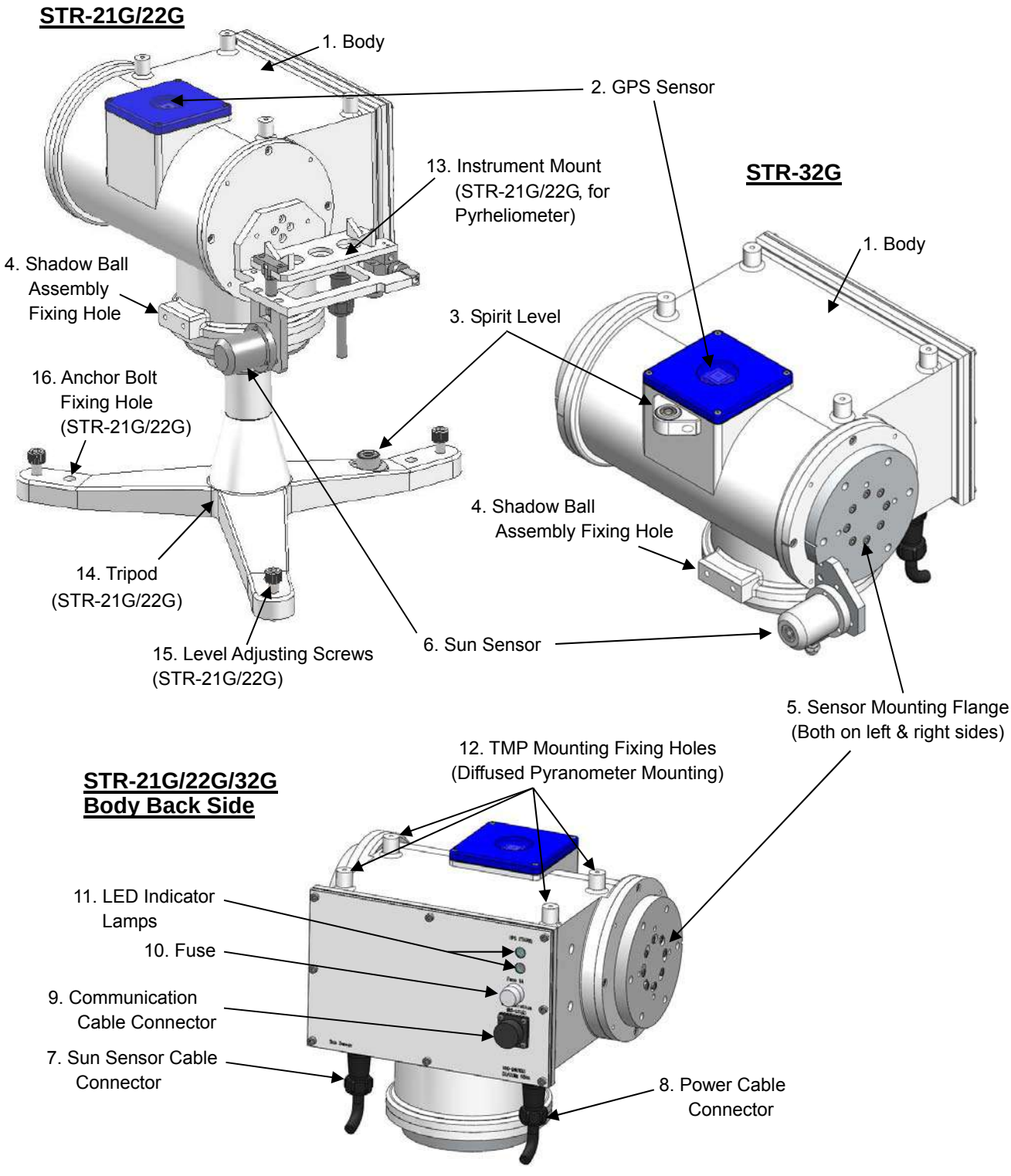


Figure 5-1. STR-21G/22G/32G Name of each part

1. Body

Power supply, driving mechanism, and electronic board accommodated inside the tracker.

2. GPS Sensor

Sensor for automatic set up by retrieving latitude, longitude, date and time parameters. This GPS function can be enabled/disabled from the attached software (default setting is GPS mode).

3. Spirit Level

The spirit level is used for checking the horizontal position of the Sun Tracker. STR-21G/22G has the spirit level on the Instrument tripod, and STR-32G has the spirit level on the Body by GPS sensor.

4. Shadow Ball Assembly Fixing Holes

Screw holes for attaching the shadow ball assembly, which is used for the diffused radiation measurements.

5. Sensor Mounting Flange

Sensor is mounted to this flange, which is applicable to various configuration of system to meet various measurement needs. EKO offers special mounting assemblies for different sensor models, such as pyrheliometer and spectroradiometer with collimating tube; contact EKO for further details.

6. Sun Sensor

Sun-sensor is mounted to improve the sun tracking accuracy. Usually the Sun Sensor is already attached on the sensor mount and aligned in the appropriate position thus it is not necessary to re-adjust at the installation.

When a special sensor mount is used or the Sun Sensor is replaced, the Sun Sensor will require alignment. For detail instruction of how to align the Sun Sensor, please see [5-4. Setup].

7. Sun Sensor Cable Connector

Connects the Sun-Sensor to the sun tracker main unit.

8. Power Cable Connector

The power cable is connected to provide power to the Sun Tracker.

There are two types, AC power supply version or DC power supply version Sun Tracker available.

9. Communication Cable Connector

Used when setting or controlling the Sun tracker by using a PC or data logger.

10. Fuse

Safety fuse (2A).

11. LED Indicator

LED indicate the power supply and GPS status

12. Mounting Plate Fixing Holes

Screw holes to fix the top mounting plates (for single pyranometer: TMP-S-xxx, for double unit: TMP-D-xxx) or spectroradiometer (TMP-WISER)

13. Sensor Mount (STR-21G/22G)

Sensor mount for pyrheliometer (MS-57) with Sun Sensor is attached to STR-21G/22G.

14. Tripod STR-21G/22G

Tripod with level adjustment screws, anchor bolt holes (fixing holes, uses M8 anchor bolts), and spirit level. Mounting base (tripod) for STR-32G is optional. See [9-5. Accessories List] and contact EKO for further details.

15. Level Adjusting Screw

Leveling Screw to adjust the Sun Tracker in horizontal position.

16. Anchor Bolt Fixing Hole

Sun Tracker is fixed to the setup base by using fixing bolts through these fixing holes.

5-2. Setup

1. Location & Setup Conditions

Since Pyrheliometers and DNI Spectroradiometer measure direct solar radiation by tracking the sun, install the tracker in a place where nothing obstructs the view of the sensors.

The ideal mounting position for Sun Tracker is a location which has a free 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 (Sensor cleaning, check for level and cable condition, etc.) of the Sun Tracker and mounted instrument(s).
- Avoid to place the Sun tracker in the area of surrounding objects e.g. towers, poles, walls or billboards with bright colors that can reflect solar radiation onto the pyranometer.

2. Orientation

Sun Tracker must be installed orientated in North / South direction.

There are 2 methods for installing the Sun Tracker: Easy-step installation using compass provided on Quick Start Guide, and precise installation by determining the True North/True South direction provided below.

By determining the direction of north/south, prepare the setup base as instructed in the next step [3. Preparation of Setup Base].

NOTE: On this manual, the installation instruction is described in the case of installing the Sun Tracker in Northern Hemisphere. When installing the Sun Tracker in the Southern Hemisphere, the installation would be based on South/True South direction.

1) How to Determine the Orientation by Easy-Step Installation
   Determine the orientation by using compass.

   Caution: Depending on the location (latitude/longitude) and environment of the installation site, the Sun Tracker may not restart tracking the sun automatically when using this method for installation and the Sun Tracker power supply is reset. For a long-term measurements and accurate measurements, it is highly recommended to determine the true north/south by following below installation method.
   For example, when the Sun Tracker is installed in North America west coast, which is an area with large difference (deviation) between the magnetic north and true north, the Sun Tracker may not be able to track the sun in stable manner when the power supply is reset due to the sun sensor going out of the range for field of view.
   Also, in the low latitude area, between 23.4° north latitude and 23.4° south latitude, the sun elevation may become near 90°. This Sun Tracker operates using only the calculation mode for azimuth angle in such sun elevation range as high 87° ~ 90°, and only the elevation angle is operated using sun sensor mode. This is because the Sun Tracker cannot track the sun by using only the sun sensor since the azimuth angle rotates at near 180° at around culmination time.

Since the calculation mode is used for azimuth angle, the sun tracking accuracy is depended on the installation setup (orientation and horizontal level). Therefore it is necessary to setup the Sun Tracker in accurate orientation by following below instruction and adjust the horizontal level as precise as possible. For more precise sun tracking, see [A-7. Alignment for More Precise Sun Tracking].

2) How to Determine the Precise True-North/South Direction

True-North/South is a direction to the North/South Pole of the Earth.

The North/South pointed by magnetic needle of compass is called magnetic north/south. Magnetic north/south has a deviation from a few degrees to more than ten degrees from True-North/South. Since this deviation differs by areas, it is recommended to check the deviation of magnetic north at your measurement site in advance. When installing the tracker, search for True-North/South by correcting the deviation of magnetic north/south.

There are following other methods to setup the Sun Tracker in the True North-South line:

(1) Using a geographical Map by determining the direction by referencing an object on an accurate terrain map. By referencing a mountain, a building, or a tower which can be seen in far location from the installation site, figure out the direction of the object from the site on an accurate terrain map (such as Google Map), the accurate north/south direction can be determined by using protractor.

(2) Determine the South from the sun position at culmination time.

Culmination time, the time when the sun passes the true south, can be found from scientific chronology. Such information is often provided on local astronomical observatory websites.

Based on the provided culmination time, observe the shade direction using a straight stick standing in perpendicular position or holding down a string with weight.

3. Preparation of Setup Base

Prepare a setup base with fixing holes for the anchor bolts (STR-21G/22G: M8, STR-32G: M12) as shown below. Make sure that the mounting base can hold total weight of the Sun Tracker itself and the sensors mounted on the Sun Tracker.

The anchor bolts must be attached to hold the Sun Tracker on the setup base (see figure 5-2). To avoid unexpected accidents or damage due to strong wind or gale, make sure to fasten the tripod on the stage or ground securely.

STR-32G does not come with standard tripod; therefore use a custom tripod or mounting base (optional EKO full-size tripod: STR-32-T).

Note: For assembly of the EKO full size tripod see [A-1 STR-32-T Full-Size Tripod Assembly].

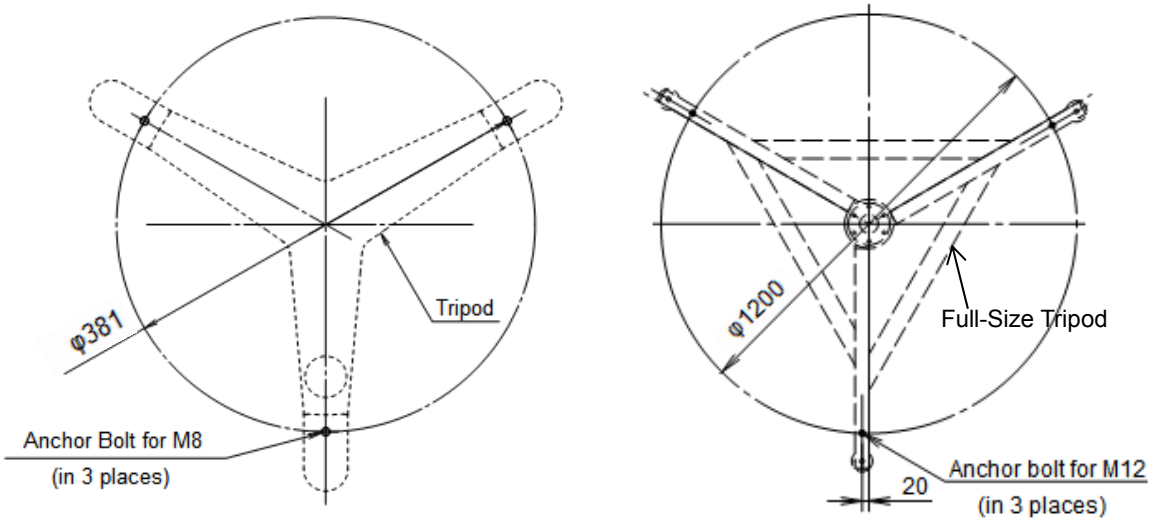


Figure 5-2. Anchor bolt position
(Left: STR-21G/22G, Right: STR-32G with optional full-size tripod)

STR-32G mounting flange interface: (Fixing bolts size: M8 x 20mm, 6pcs)

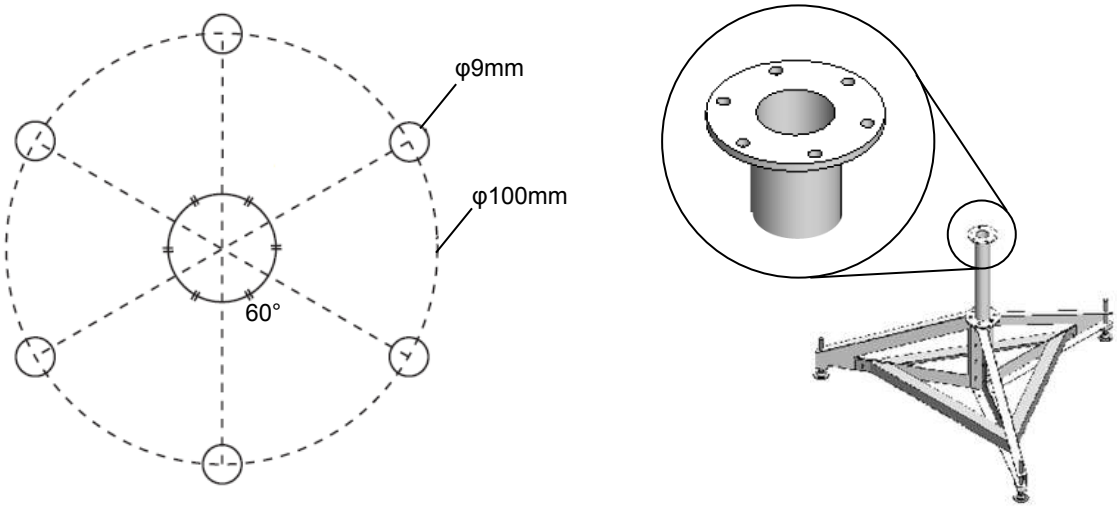


Figure 5-3. STR-32G Fixing Holes

4. Shadow Ball Assembly

For diffuse radiation measurement the Shading Ball Assembly (Single Type: MB-12-1, Double Type: MB-12-2) needs to be mounted on the Sun Tracker. See [9-5. Accessories List] for the assembly drawing.

If the optional Shading Ball is used, the arm of the Sun Tracker will be positioned at -15° after sunset and in stand-by condition. When the Shading Ball is attached to STR-21G/22G, the tip of the arm may touch the ground, thus place the Sun Tracker on a setup base which is higher than 100mm.

In case of STR-32G, place the Sun Tracker on a setup base/tripod which is higher than 300mm to avoid the tip of the arm touching the ground when the Sun Tracker is on stand-by condition. The optional large tripod is designed so that the tip of the arm will not touch the ground during stand-by.

For how to assemble and setup the Shading Ball Assembly, see [A-2. Shading Ball Assembly & Setup]

When the Shading Ball is attached, the Sun Tracker gets a higher wind load; make sure to fasten the Sun Tracker with anchor bolts in three places to prevent the Sun Tracker from falling or changing position.
Since the Shading Ball follows the sun movement; make sure there are no obstructions within 2m diameter around the Sun Tracker.

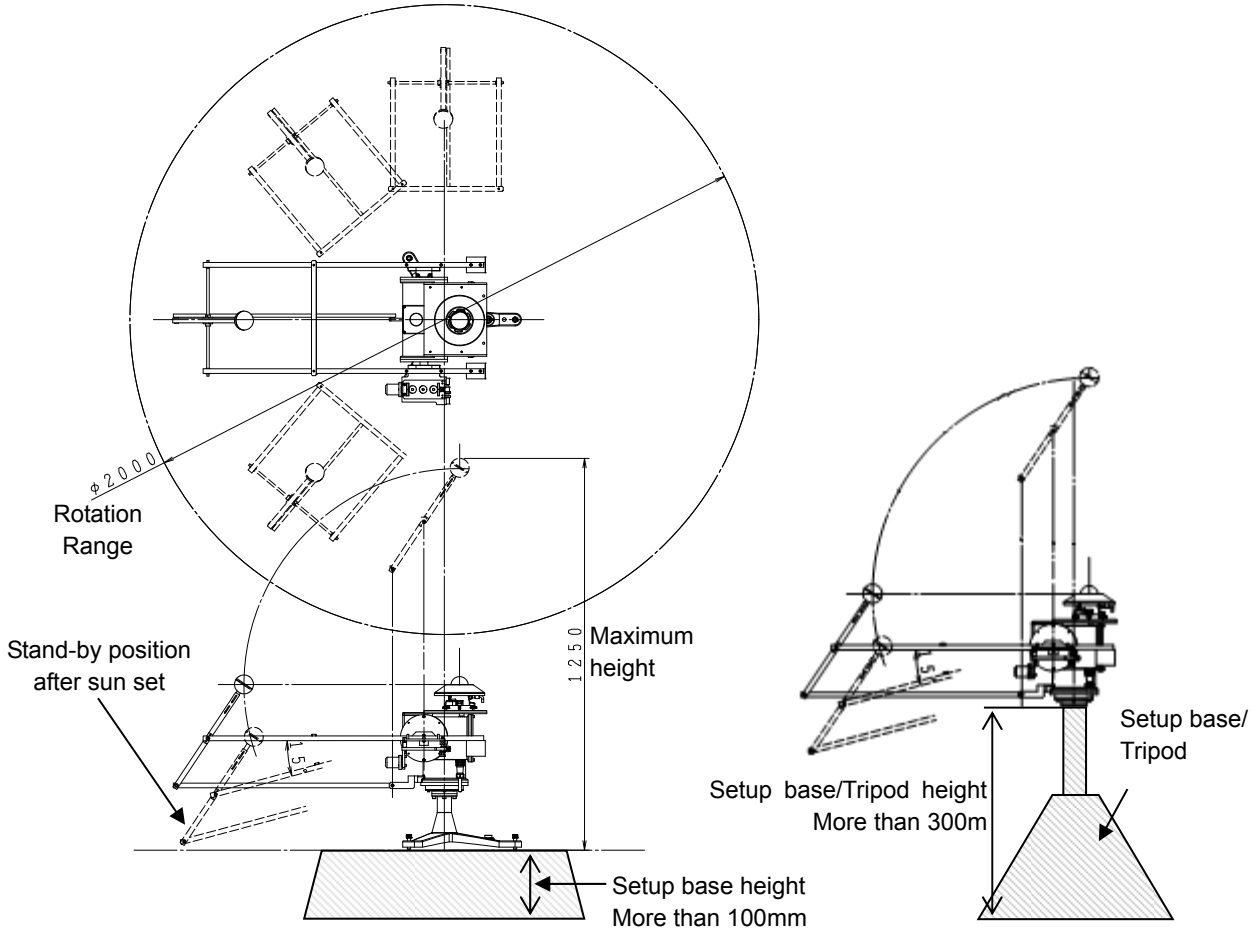


Figure 5-4. Shadow ball setup requirements
(Left: STR-21G/22G, Right: STR-32G)

5-3. Installation

1. Mounting the Sun Tracker

Installing STR-21G/22G:

Install the leg with the spirit level of the mounting base in the north (true north direction*). Right underneath the level adjusting screws, place the pad plates.

Adjust the leveling screws while checking the bubble in the spirit level fits into the center of the circle. When the adjustment is completed, fasten the Sun Tracker tightly by using fixing holes for anchor bolt and three M8 anchor bolts.

*Above installation describes the installation in the Northern hemisphere. For how to determine the true north, see [5-2. Setup], [2. Orientation] "2) How to Determine the Precise True-North/South Direction".

If the Sun Tracker is installed in Southern hemisphere, the direction of spirit level will be in the true south direction.

At the time of shipment the STR-21G/22G tripod is mounted at the correct origin position (mounting base with spirit level is positioned towards north).

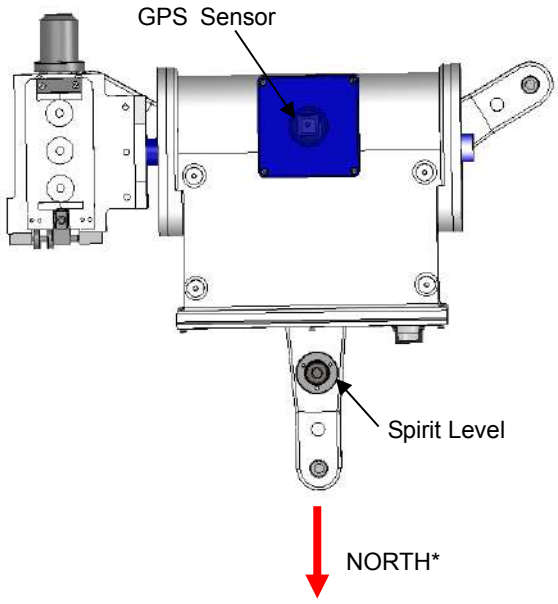


Figure 5-5. Spirit Level Position (STR-21G/22G Top View)

Installing STR-32G (Installed with EKO optional large tripod):

Install the Sun Tracker so that the spirit level on GPS body and the origin position mark on the azimuth shaft are facing south (when installing in Southern hemisphere, the origin position marks should be facing north).

Attach the STR-32G Body to the optional large tripod or custom setup with M8 x 20mm bolts (with plain washer and spring washer in 6 places) securely.
Adjust the tripod (optional) or custom setup level while checking the bubble in the spirit level fits into the center of the circle. Once the leveling is completed, fasten the tripod or custom setup with three anchor bolt (M12) securely.

Note: There are groove marks on the body matched with the marks on shaft and mounting flange to indicate the Sun Tracker is in the origin position. In case the GPS window does not point towards south, it means the Sun Tracker is not in the origin position. To reposition the Sun Tracker body to the origin position, connect the power cable to the power connector. When the power is turned on, the Sun Tracker body will return to the origin position and stops for 2 seconds; remove the power connector during this moment.

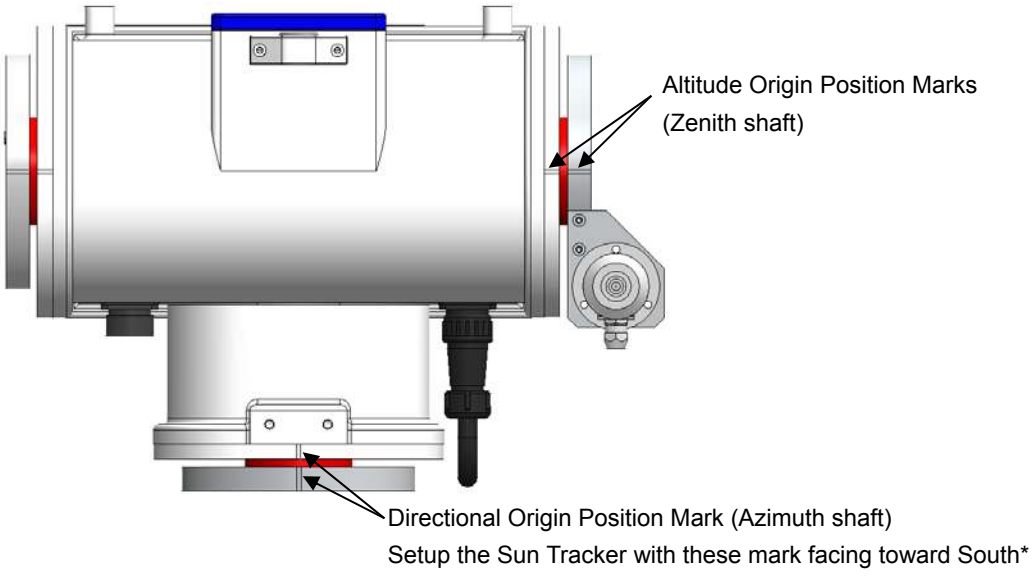


Figure 5-6. Origin Position Groove Marks (STR-32G Front View)

NOTE: Recommended to setup in accurate direction and leveled position

The Sun Sensor has +/- 15° field of view. As long as the sun is in this field of view range, the Sun Tracker is available to track the sun accurately with the Sun Sensor and the learning tracking function. However in order to prevent defects from time and setup errors and to maintain a stable and long-term tracking, setup the Sun Tracker as accurate as possible.
When setting up a pyranometer on top of the sun tracker for diffused radiation measurements, make sure to adjust the level accurately so that the sensor (pyranometer) will not tilt.

2. Mounting Shading Ball Assembly and Sensor(s)

When using a Shading Ball Assembly, install first before attaching sensor(s). For installing the Shading Ball Assembly and Pyranometer (s), go to Appendix [A-2. Shading Ball Assembly & Setup].

Mount the measurement instrument (such as pyrheliometer) on the mounting assembly securely
See [A-3. Mounting Pyrheliometer MS-57 on Sun Tracker] for how to mount EKO Pyrheliometer MS-57.
*To mount sensors other than MS-57, please refer to each instrument manual.

3. Connecting Cables

Insert the Sun Sensor cable connector from the Sun Sensor in the correct manner and tighten the lock-nut. See Fig.5-7 for how to wrap the sun sensor cable around on the Sun Tracker so that the cable will not get caught on the setup base and so on.

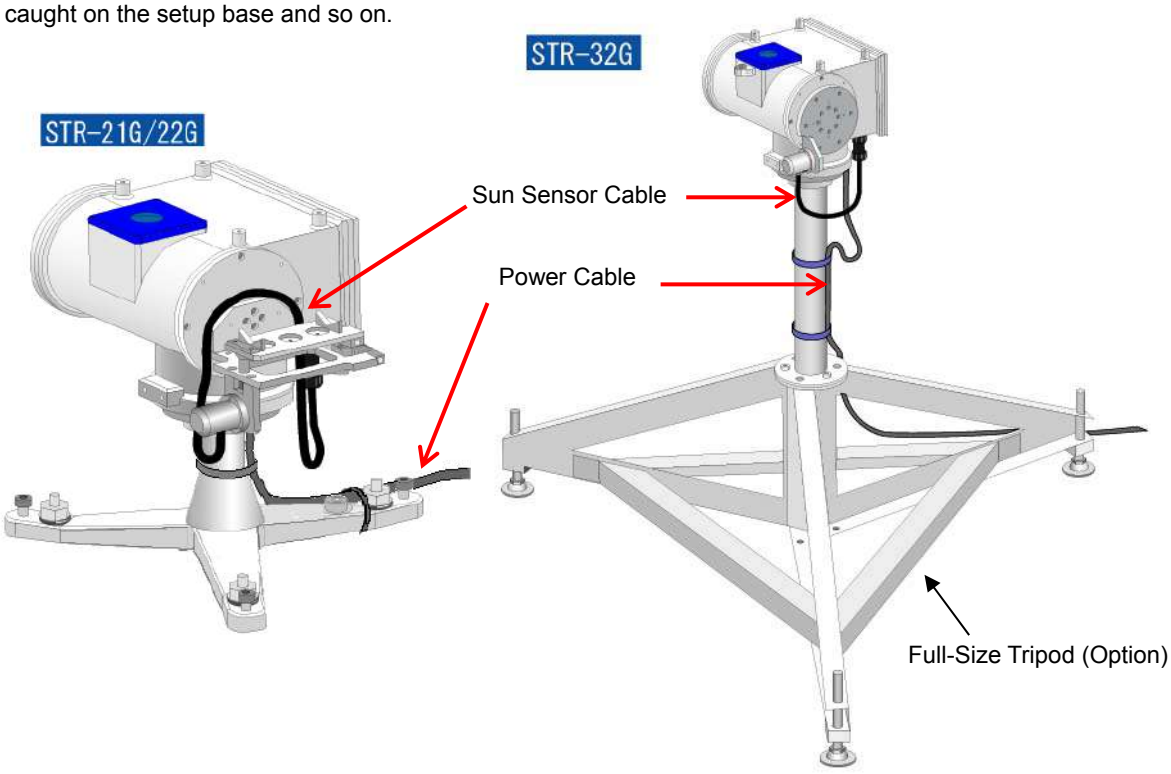
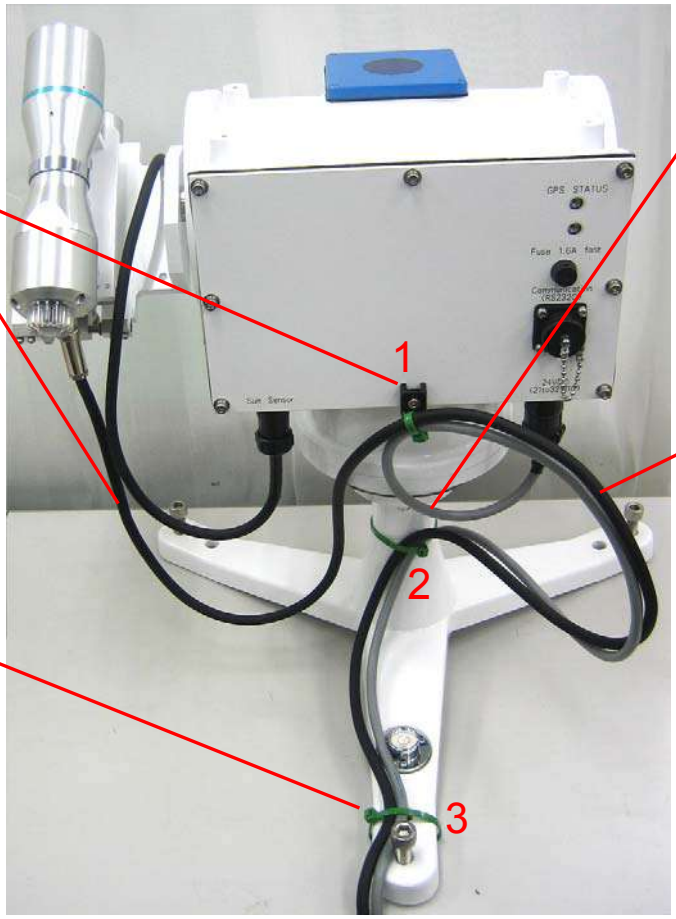


Figure 5-7A. Cables on the Sun Tracker (Left: STR-21G/22G, Right: STR-32G)



Cable Tie Fixing Part

Fix the Sensor Cable from the Pyrheliometer attached on the arm at 40 to 45cm position to the already attached Cable Tie Fixing Part at “1” position with the cable tie along with power supply cable.

Fix the power supply cable and sensor cable as short as possible for the positions between “2” and “3” positions.

Fix the Power Supply Cable at 20cm from the connector to the Cable Tie Fixing Part at “1” position along with the Sensor Cable.

From the “1” to “2” positions, fix the Power Supply Cable and Sensor Cable at bottom of the tripod with cable tie, giving 40 to 45cm length. If the cables are too long, they may get caught on anchor bolt and lead to causing malfunctions.

Figure 5-7B. Fixing Power Supply Cable and Sensor Cable (STR-21G/22G)

Connect the power supply cable to the power connector on the Sun Tracker Body. The LED indicator on the back side of Sun Tracker Body will light.

There are 5 key grooves on the connector which can be inserted only in one way. Once the connector is inserted correctly, the lock-nut will make a click sound.

Make sure the cable is connected to a grounded socket.

When the power is turned on, the Sun Tracker will move to the original position which detects the 0 (zero) azimuth-angle (True South) and 0 (zero) elevation-angle (Horizontal), then it starts tracking the sun.

4. Receiving GPS Data

When the Sun Tracker power is turned on, the GPS function is already activated by default setting. Depending on the setup environment, it will normally take approximately 5 minutes to complete the initialization procedure and retrieving GPS data. Until the GPS data are retrieved, the “Red” and “Green” LED indicator on the Sun Tracker blink as it searches for signal. Once the GPS data is received completely, the “Green” LED indicator lamp lights.

The tracker is now ready for operation and will automatically follow the sun. The time settings will be automatically updated to keep the Sun Tracker in absolute position.

If the “Red“ and “Green” LED lamps keep blinking for a while, disconnect the power supply connector once and reconnect, or connect the Sun Tracker to PC and check the GPS status from the software.

In case of any problem occurred with the GPS function, “Red” LED lamp lights on; in this case, follow above procedure to check the GPS status.

Table 5-1. LED Indications for GPS status

LED Lamp Indication	GPS Status
Red & Green LED lamps blinking	Searching GPS signal
Green LED	Receiving GPS signal, Normal operation
Red LED	GPS Abnormal condition

5. Check Sun Tracker Movement

Make sure the Sun Tracker is following the sun path properly, and attached sensor(s) is(are) aligned properly.

6. Sensor Alignment

On a sunny day, adjust the alignment of the sensor mount by using the adjusting screws to make the sun-spot to be in the center of the sensor target.

For example how to mount EKO Pyrheliometer MS-57, see [A-3. Mounting Pyrheliometer MS-57 on Sun Tracker]

Depending on the sensor(s) to be mounted, mounting and adjusting method vary; please refer to each sensor(s) instruction manual or any document provided from EKO in case of custom orders.

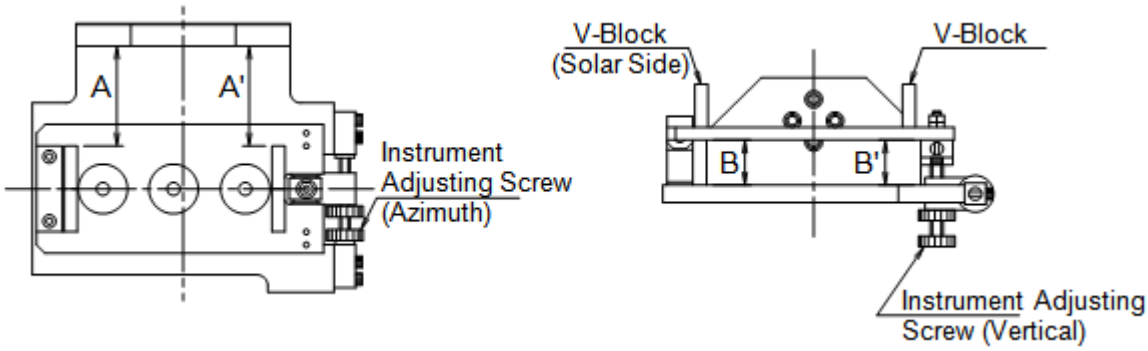
5-4. Sun Sensor Adjustments

If the Sun Tracker is purchased with the standard instrument mount, the sun sensor is already setup in our factory, adjustment of the sensor by user is not necessary at the installation. However, when an optional instrument mount (such as DNI Spectroradiometer) is installed or the Sun Sensor is replaced with a new one, the Sun Sensor must be aligned in a proper position as described below.

Adjust the sun sensor when the sky is clear and the direct solar irradiance is high.

1. STR-21G/22G

(1) Adjust the instrument mount. See Figure 5-xx below and adjust the distance of A and A' to be the same as that of B and B' by using instrument adjusting screws.



Instrument Mount Top View Instrument Mount Side View

Figure 5-8. STR-21G/22G Standard Instrument Mount

(2) Adjust the shadows of upper V-Block to be overlapped to lower V-Block by turning the adjusting screw of the sun sensor. When the adjustment of sun sensor is completed, fix the sun sensor with adjusting screws.

2 STR-32G

Sun sensor adjustment for STR-32G can be different depending on the type of instruments to be mounted.

In this section explains how to adjust the Sun Sensor when DNI spectroradiometers (MS-711/MS-710 & MS-712 with collimation tube STR-32-CT710 & STR-32-CT712; see [9-5. Accessories List]) are mounted on the STR-32G.

For how to mount the mounting plates (STR-32-P and STR-32-S) and the spectroradiometers with collimation tubes (MS-711/MS-710 & MS-712 with STR-32-CT710 & STR-32-CT712), see [A-4. Mounting DNI Spectroradiometer on Sun Tracker].

(1) Remove the Sun Sensor

Remove the Sun Sensor and the Sun Sensor plate. Keep the screws (3 sets of M4x25, plain washers, and spring washers) as they will be used again to mount the Sun Sensor in later steps.

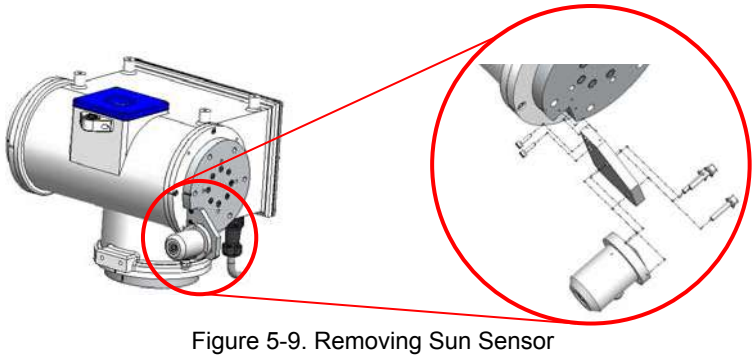


Figure 5-9. Removing Sun Sensor

(2) Attach the Sun Sensor on the Mounting Plate

After the mounting plate for DNI Spectroradiometer (STR-32-P) is setup on STR-32G, attach the Sun Sensor at the bottom of STR-32-P as shown in red circle in the below figure with the screws (3 sets of M4x25, plain washers, and spring washers) which were removed in the step (1).

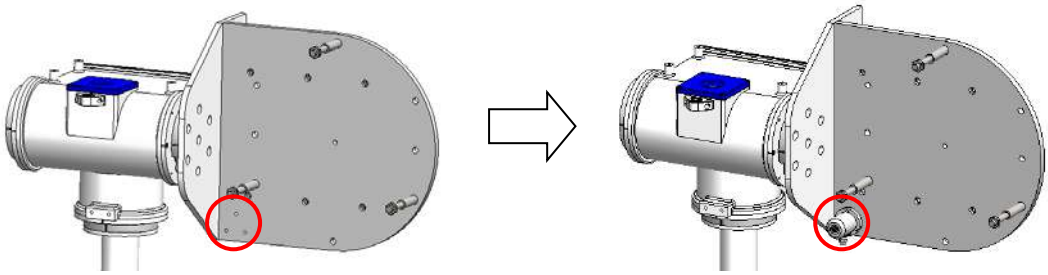


Figure 5-10. Attaching Sun Sensor

(3) Adjust Sun Sensor

In order to take accurate measurements, the collimation tube on the spectroradiometer must be properly aligned to the sun direction.

After the mounting plates, spectroradiometers and the collimation tubes are setup on the STR-32G according to [A-3. Mounting DNI Spectroradiometers on Sun Tracker], the Sun Sensor is adjusted by adjusting the 3 screws behind the Sun Sensor with reference of the sight spot which is attached on the collimation tube. On a sunny day, sun light is irradiated through the sight spot on the target. Adjust the Sun Sensor so that the sun light irradiates on the center of this sight spot target (Figure 5-11 & Figure 5-12). Make sure the Sun Sensor screws in three positions do not get loosen after the sight spot is aligned.

(Example) When the sight spot is not irradiating the target properly as shown on Figure 5-11, adjust the Sun Sensor screws (on behind the Sun Sensor) (A) and (B) in clockwise direction.

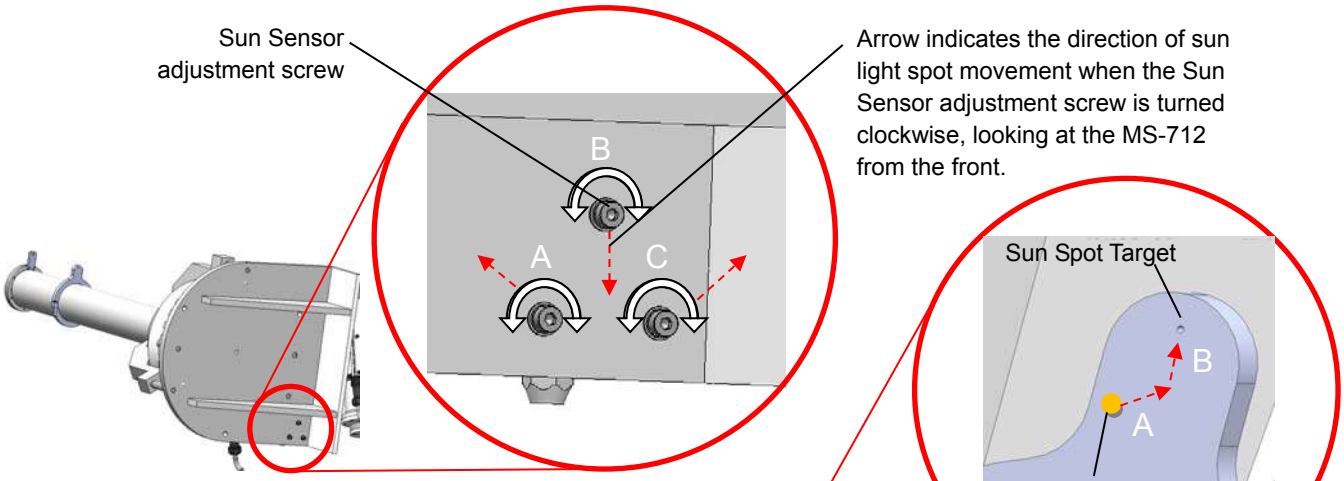


Figure 5-11. Sun Sensor Adjusting screws
(View from Sun Sensor back side)

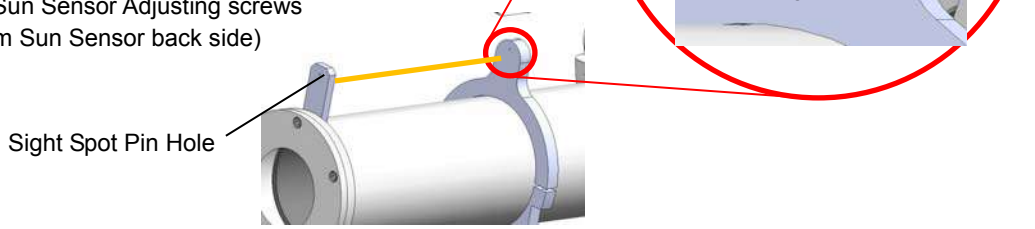


Figure 5-12. Sun Light Spot and Target
(View from MS-712 front side)

NOTE: When installing instruments other than DNI spectroradiometer described above and for detailed instructions, see the instruction manual for the instrument to be mounted, or follow the instructions if provided separately by EKO.

6. Software

When operating the Sun Tracker in GPS mode, it does not require to setup the latitude, longitude, date and time manually. In order to enter the latitude, longitude, date and time information of the setup site in a manual mode, a PC is needed.

6-1. Installation and Uninstallation

1. Software Installation

1) Turn ON the PC power and inset the software installation CD into the CD disk drive as the desk top of the window is indicated on screen.

2) Access the installation disk from [STR-21G,22G,32G_SetupSoftware_Ver3.3.4.0_Installer] → [English], and click the “Setup.exe” inside this file to start the installer.

3) Wizard window for the installation will appear; click [Next >] button to go to the next step.

Figure 6-1. Installation Wizard Start Window

4) Below “Software License Agreement” window will appear. Select “I accept the terms in the license agreement” and click [Next >] button

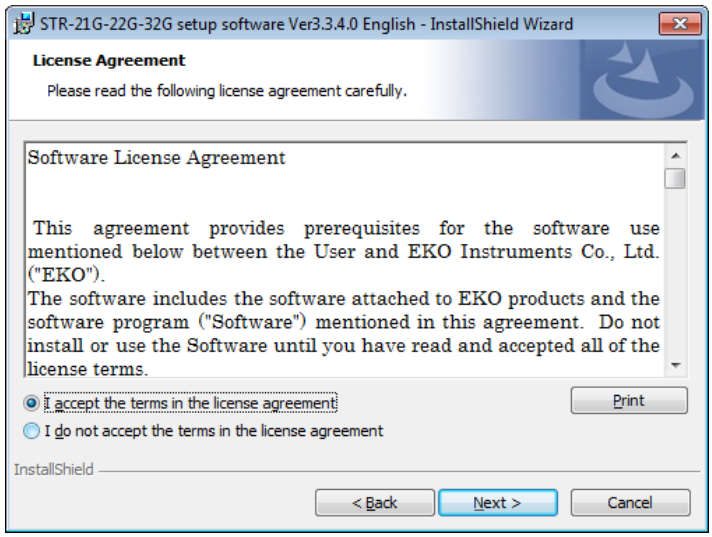


Figure 6-2. License Agreement Window

5) “Destination Folder” window appears. If the software is installed in “C:¥EKO” folder, click [Next >] button to go forward. If installing in different folder, click [Change…] button to select a desired folder.

NOTE: When changing the installation folder and using a PC with Windows Vista/7/8 for Operation System, UAC (User Account Control) function will be activated. Trying to access and install and/or save data in a folder which OS is controlling the folder access, it may cause problems. “C:¥Program Files”, “C:¥ProgramData”, “C:¥Windows”, and system drive route folder “C:¥” are examples of the controlled folders. When changing the installation folder, make sure to select a folder other than mentioned above.

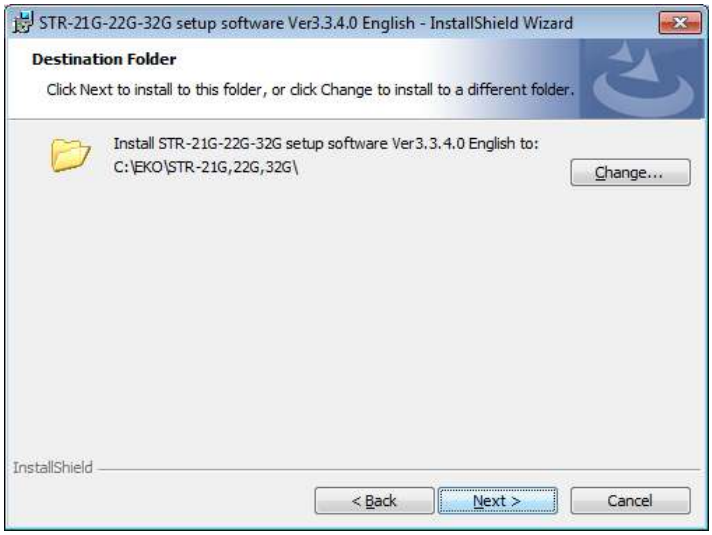


Figure 6-3. Destination Folder Setting

6) Installation confirmation window appears. Confirm the destination folder and click [Install] button to go forward.

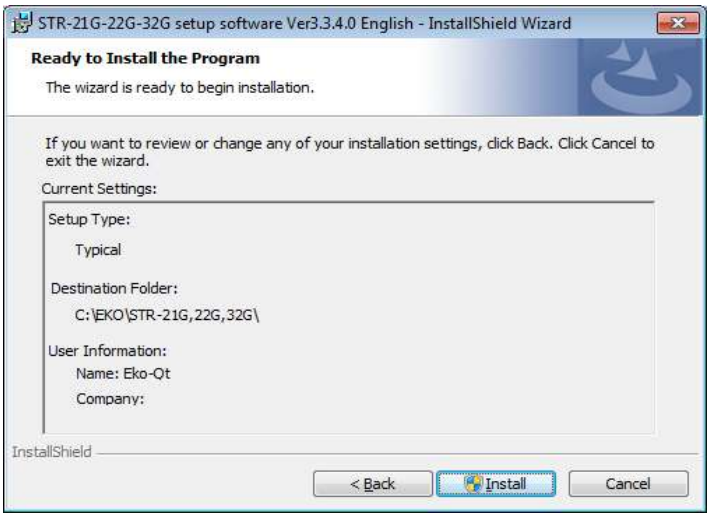


Figure 6-4. Installation Confirmation Window

7) After a while, the screen gets dark and “User Account Control” window appears. Clicking [Yes] button will start installation.

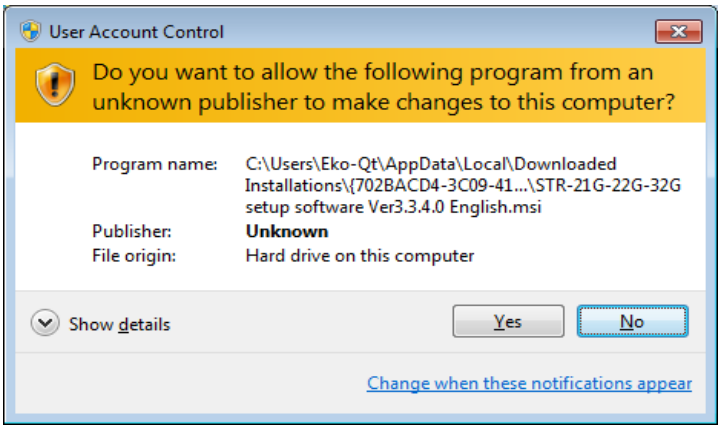


Figure 6-5. User Account Control Window

8) Once the installation is completed, below window appears. Click [Finish] button to close the installation wizard window.

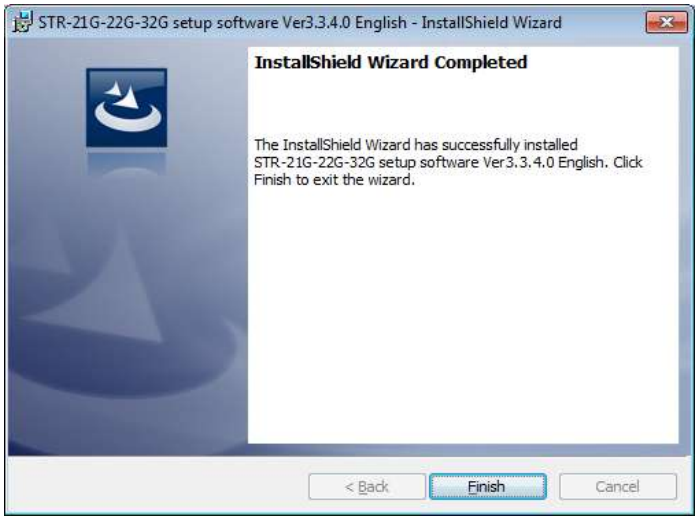


Figure 6-6. Wizard Complete Window

9) When the installation is complete, shortcut icon is created on the desk top. If clicked on “create shortcut in start menu”, below shortcut icon is created.

Figure 7-7. Shortcut Icon

2. Software Uninstallation

There are 2 ways for uninstalling the software from PC.

1) Uninstalling from [Program and Features]

Access in the order of: [Control Panel] → [Program] → [Program and Features] by clicking. Select the program to be deleted. Popup menu will appear by right-clicking on the deleting item; select “Uninstall (U)”.

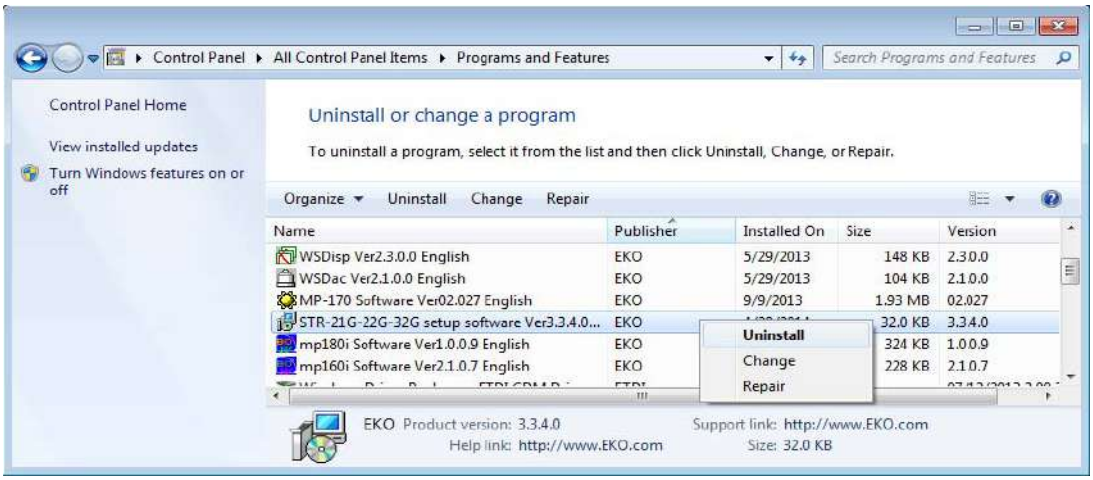


Figure 6-8. Uninstalling from “Program and Features”

2) Uninstalling from Install Disk

Just like when the software was installed, access from CD-ROM to start-up the Setup.exe for the software to be uninstalled.

Follow the messages indicated on this window and if the software is already installed, “Modify”, “Repair”, and “Remove” are shown on the window as options.

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

Follow the guide messages and the installed software is uninstalled.

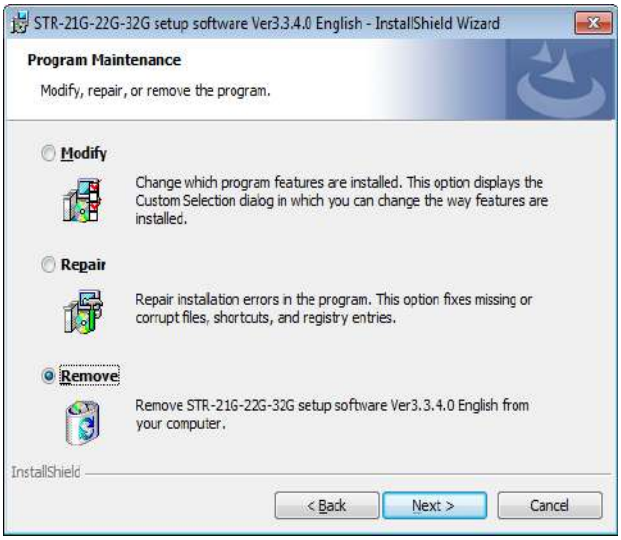


Figure 6-9. Program Maintenance Window

6-2. Select a COM port number of RS232C

(1) Remove the connector cap attached on the Sun Tracker body and connect the attached communication cable from the Sun Tracker to RS232C port of PC. Turn ON the Sun Tracker power. Insert the cable connector in the correct direction and tighten the coupling nut.

(2) By double-clicking “STRConfig”, the below dialog window will appear.

Figure 6-10. Port Selecting Dialog

(3) Select a COM port number of RS232C on the PC which is connected with the communication cable and click “OK”. Then the following screen for setting the software will appear. You can stop this operation by clicking “Cancel” button.

.

6-3. Setting Latitude, Longitude, Date and Time

When the installed software is started, following window appears for setting the latitude, longitude, date and time.

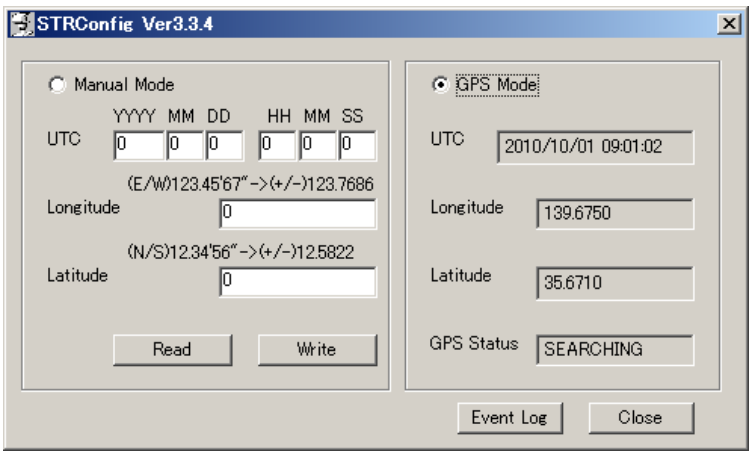


Figure 6-11. Setting screen

1. GPS Mode

When the “GPS Mode” radio button is clicked, the date, time, latitude and longitude information are acquired automatically by the GPS sensor. When the GPS can receive the positioning information, the “GPS Status” indicates as “GOOD”. When the Sun Tracker power is connected or when searching for the positioning information, the status is indicated as “SEARCHING”; when there is a problem with GPS function, the status is indicated as “ERROR”.

2. Manual Mode

When the “Manual Mode” radio button is clicked, any desired values can be entered for the date, time, latitude, and longitude. As the mode is switched from GPS to Manual, the data received with GPS are reflected to the Manual mode as well.
To enter desired data values, enter UTC (Coordinate Universal Time) for time, East longitude as plus (+) and West as minus (-), North latitude as plus (+) and South as minus (-) in degree down to the decimal point. The values are entered in “Degree” unit.

After completed entering the information and click “Write” button, the entered information is written in the Sun Tracker internal clock and nonvolatile memory. The written information can also be retrieved by clicking “Read” button.

If the Sun Tracker does not respond when clicking these buttons, check to 1) make sure that the power to the Sun Tracker is turned on, and 2) make sure that the correct COM port is selected as described in the above section [1. Install Software] then repeat the same procedure.

To quit the software, click the “Close” button.
Remove the communication cable from the Tracker and attach a connector cap. Make sure to attach the connector cap in order to prevent causing defects from rain and mechanical damages.

Sun Tracker is setup with GPS mode as default when the power is connected for the first time.
If power is disconnected while the Sun Tracker is setup with Manual mode, it will start with manual mode after the power is reconnected.

7. Measurement Principle

1. Calculation Principle of Sun Position

By using the sun positioning calculation (abbreviation calculation formula) issued by Japan Coastal Guard Intelligent Department, the EKO Sun Tracker points the instrument mount towards the sun direction (calculation mode). When the weather is clear, Sun Tracker corrects and learns the differences in positions between the sun sensor and calculation.

2. Principle of GPS

GPS is a short for Global Positioning System; this system accurately determines the position of itself on earth by using the satellite. This is one of the military technologies developed by the US Military; by using the radio waves which is transmitted by the satellite which are distributed out in approximately 30 bases on the orbit around the earth. Latitude, longitude, and altitude can be determined with error with just few centimeters to a few hundred centimeters.

3. Principle of Harmonic Drive®

Basically, the Harmonic Drive® -- which was developed to take advantage of the elastic dynamics of metal -- is generally made up of just three components: a wave generator, a flexspline and a circular spline.

The wave generator is a component having small ball bearings built into the outer circumference of the elliptical cam. The inside raceway of the bearings is fixed to the cam while the outer raceway is subjected to elastic deformation via the ball bearings. The wave generator is usually attached to the input shaft.

The flexpline is a thin cup-shaped metal rim component with external teeth. The bottom of the flexspline (cup bottom) is called the diaphragm. The diaphragm is usually attached to the output shaft.

The circular spline is a rigid steel ring with internal teeth. The circular spline has two teeth more than the flexpline and is usually fixed to a casing.

(1) The flexspline is deflected by the wave generator into an elliptical shape causing the flexspline teeth to engage with those of the circular spline at the major axis of the wave generator ellipse, with the teeth completely disengaged across the minor axis of the ellipse.

(2) When the wave generator is rotated clockwise with the circular spline fixed, the flexspline is subjected to elastic deformation and its tooth engagement position moves by turns relative to the circular spline.

(3) When the wave generator rotates 180 degrees clockwise, the flexspline moves counterclockwise by one tooth relative to the circular spline.

(4) When the wave generator rotates one revolution clockwise (360 degrees), the flexspline moves counterclockwise by two teeth relative to the circular spline because the flexspline has two fewer teeth than the circular spline. In general terms, this movement is treated as output power.

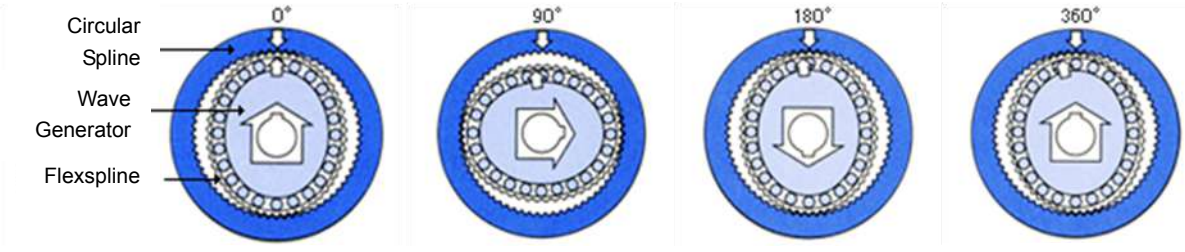


Figure 7-1. Principle of Harmonic Drive®

*Footnote: http://www.hds.co.jp/HDS_hp_english/english/principle/index.html

8. Maintenance & Troubleshooting

8-1. Maintenance

To maintain accurate measurement, it is recommended to regularly check the status of the Sun tracker. When the Sun Tracker is installed in a location where it is difficult to do maintenance, it may invite unexpected accidents and/or injury; please be very careful when working on maintenance.

Table 8-1. Maintenance

Maintenance Item	Frequency	How to	Effect
Sun Sensor front window cleaning	Monthly	If the Sun Sensor front window is dirty, wipe off the dirt with soft cloth.	If the Sun Sensor window is dirty, it will affect on the Sun Sensor operation, and cannot follow the sun accurately.
Check cable condition	Monthly	Make sure the sensor output cable, etc. attached to the Sun Tracker are not tangled anywhere.	If the cable is disconnected, the Sun Tracker may not function properly and lead to damage of the Sun Tracker. If the cable is damaged, it will be subject to noise or electric leakage will occur.
Check spirit level	Monthly	Check the horizontal level of the tracker by using the spirit level. Make sure that the mounted sensor is pointing to the sun properly by checking the target of the instrument.	If the sun tracker is not leveled properly, it may not point to the sun direction correctly or will lose accuracy.

8-2. Troubleshooting

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

Table 8-2. Troubleshooting

Failure	Action
Sun Tracker is not moving at all	Check the power supply voltage. The voltage should be AC100V to 240V (DC24V +/-10% for optional DC power supplied Sun Tracker).
	Check the latitude, longitude, date and time of the site by using the setting software and communication cable.
	Make sure the Sun Tracker is balanced with sensors mounted when it is not powered. With unbalanced condition, the Sun Tracker arms will rotate according to the load and the body will not operate properly. The retaining torque for non-powered Sun Tracker is about 5Nm for STR-21G/22G and 10Nm for STR-32G.
The Sun Tracker does not move in the elevation-angle direction	When the instrument mount is tilted down below -20° or tilted up above 95°, the limiter function becomes active; thus the Sun Tracker does not move in elevation-angle direction. Unplug the power cable once and readjust the instrument mount in leveled position by hands then turn on the power again. When readjusting the instrument mount, make sure to move slowly as the internal gear may break if it is moved too quickly.
Not tracking the sun	See the section [5-2. Setup] and [5-3. Installation] and check the Sun Tracker is installed properly. STR-21G/22G: Tripod leg with spirit level should be pointing North (northern hemisphere) STR-32G: Origin position marks on the Sun Tracker Body should be facing towards South (northern hemisphere) *In southern hemisphere, the STR-21G/22G spirit level pointing South, STR-32G origin position marks on Sun Tracker Body facing towards North.
	When the sun elevation angle exceeds 87 degrees angle during the calculation mode, the Sun Sensor is not used and the Sun Tracker will operate only by the calculation mode. Sun Tracker may not point to the accurate direction of the sun if the sum of errors from setup (orientation and leveling) and the input parameters (latitude, longitude, and time) become large. Check and make sure the Sun Tracker is setup properly.

Table 8-2. Troubleshooting – Continued

Failure	Action
The Sun Sensor does not point to the sun correctly. A sunspot of the sensor target becomes gradually out of alignment.	When the Sun Tracker is just installed, the learning tracking function has not accumulated enough data for accurate operation yet. As the Sun Sensor detects the sun, the Sun Sensor mode becomes active and data gets accumulated gradually. A few minutes after switching to the Sun Sensor mode, the learning tracking function starts to operate accurately.
	If the sensor target gets out of alignment although the Sun Tracker is operating in stable condition, there may be some misalignment due to mechanical cause. Tune the adjusting screw of the instrument mount to set a sun-spot at center of the target.
	See the section [5-3. Installation] and check to make sure that the sun sensor cable is connected properly.
Hearing abnormal sounds	When the adjusting screws are not locked with locknut properly, it may make sounds by the vibration of motor. Make sure to lock the locknut after the Sun Sensor is properly aligned.
GPS sensor does not receive the latitude, longitude, date and time information	Depending on the setup location, the GPS sensor may not operate properly. Check the surroundings and make sure there are no objects, such as large buildings and trees, to block the GPS signals. If there are anything which blocks signals (such as metal parts), remove such items from the Sun Tracker surroundings.
The Sun Tracker and PC are not communicating	Check the COM port settings and make sure that the SUN Tracker is properly connected through the RS232C serial cable to the PC.

8-3. Event Log

Error status of the tracker called “event log” can be downloaded by using the attached setup software.

Non-volatile memory is installed in the Sun Tracker Body, and it records the information, such as the time of power-on, time adjustment, and error occurrence, automatically with date and time, and these records are called “Event Log”.

The main purpose of keeping the records of Event Log in the Sun Tracker is for EKO service personnel to trace back the Sun Tracker’s activities to investigate the trouble cause in case a malfunction occurs with Sun Tracker. Thus there is no need for user to download the Event Log periodically.

In case malfunction occurs with Sun Tracker during operation, please refer to [8-2. Troubleshooting] and contact EKO for further assistance. If EKO service personnel request for Event Log, follow the below instruction for downloading.

1. Start up the Software

Start the software “STRConfig_V33x.exe” and the screen shown on Fig. 6-2 will appear.

2. Select a File for Storage

By clicking “Event Log” button, the event logs recorded on the internal memory in the Sun Tracker Body is downloaded to the PC. The following screen for selecting storage file will be displayed.

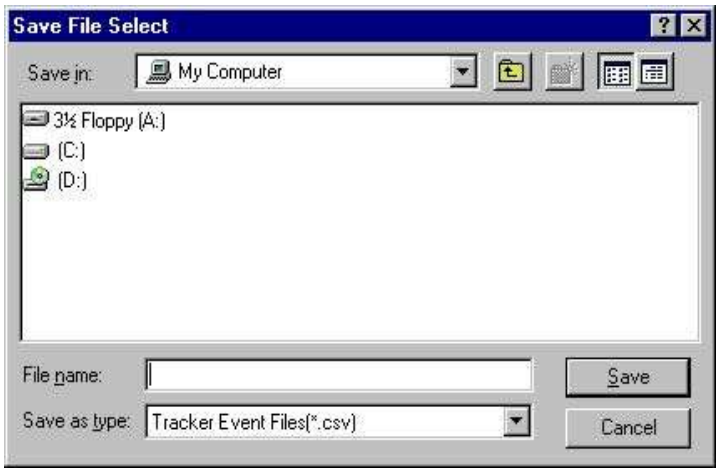


Figure 8-1. Storage file selecting screen

3. Enter File Name

Event log will be stored in the CSV: Comma Separation Variable form of ASCII format.
Specify a file name and add “csv” extension.

4. Save

Click “SAVE” button to save the event log.

5. Delete/Save Memory

After the event log file is saved, a dialog window appears, asking whether to delete or keep the records in the Sun Tracker Body.

Select either delete (Yes) or keep (No).

Figure 8-2. Erase Tracker Memory

You can easily check an obtained event log by using spreadsheet software such as Microsoft™ “Excel”.

Event log will be recorded at the time when events occurred and terminated. If errors are recovered automatically, only a comma will be recorded.

The latest event is recorded on the top line and older events follow. Up to 1,000 events can be recorded and when the memory exceeds this capacity, the events are overwritten from the oldest record.

Format of event log is “YYYY/MM/DD,HH:MM:SS,,, (description of event),,,”.

The following Table 8-3 shows the description of event log recorded in the log.

Table 8-3. Description of events

PWRON	Power on
WDTRST	Restart by watchdog resetting
RTCERR	Real time clock trouble
LOWPWR	Lower power voltage (<20.5V)
XORG	Failure in searching azimuth axis origin
XMOT	Azimuth axis motor trouble (Lost steps found by origin sensor)
XSENS	Software detected azimuth axis more than +/-360° in Sun Sensor mode
XOFF	Software detected azimuth axis more than +/-360° in calculation mode
YORG	Failure in searching elevation-angle axis origin
YSENS	Software detected elevation-angle axis less than 0° or more than 90° in sun sensor mode
YOFF	Software detected elevation- angle axis less than 0°or more than 90° in calculation mode
YHLIM	Zenith limit of-elevation-angle axis is detected
YLLIM	Horizontal limit of elevation-angle axis is detected
YMOT	Elevation-angle axis motor trouble (The origin sensor detected step-loss)
SSENS	Sun Sensor error (Abnormal operation detected on the Sun Sensor due to noise during the stand-by condition at tight)
RTCCHG	Updating real time clock (When setting a clock, the former time and changed time will be recorded.)

9. Specification

9-1. Sun Tracker

Table 9-1. Sun Tracker Specification

Models		Single Arm: STR-21G	Double Arm: STR-22G	High Torque & Double Arm: STR-32G
Motor		Stepping motor		
Motor driving mode		Harmonic Drive®*		
Pointing Accuracy		<0.01° (Solar Elevation: 0 ~ 87°)		
Angle Resolution		0.009°		0.000375°
Torque		12 Nm	24(12+12) Nm	60(30+30) Nm
Payload		7kg balanced	15kg balanced	60kg balanced
Tracking accuracy of Sun Sensor mode		0.01°		
Sun Sensor Field of View		±15°		
GPS Sensor measurement accuracy		Horizontal Position: Below 15m (2drms). GPS Positioning		
GPS Sensor positioning start time		~5 min. (depends on the receiving condition.)		
Temperature range		-40~+50℃ (-30 ~ +50℃ at cold start)		
IP Class		IP65		
Communication		RS-232C, 9600bps, 8N1		
Power requirement	AC Type	100-240VAC, 50/60Hz, 20W		100-240VAC, 50/60Hz, 25W
	DC Type	24V(21 ~ 32VDC), 20W		24V(21 ~ 32VDC), 25W
Fuse	AC Type	2A (ϕ5x20mm)		
	DC Type	1.6A Fast Acting (ϕ5x20mm)		
Size (WxDxH)		430 x 380 x 440mm	430 x 380 x 440mm	430 x 380 x 249mm
Weight		14.5 kg (with Tripod)	15.5 kg (with Tripod)	15 kg (Body only)

*HarmonicDrive® is registered trademark of Harmonic Drive Systems Inc.

9-2. Firmware and Software

Table 9-2. Firmware Specifications

Configuration mode	Calculation mode/ Sun-sensor mode, automatically switched.
Solar position calculation	Developed by Japan Coast Guard, Dept of Hydrography
Method of sun tracking	Tracking starts when the solar elevation-angle is -5° in Calculation mode. Tracking mode changes to Sun-sensor mode when the direct solar irradiance is more than the threshold value of Sun-Sensor. Tracking mode changes into calculation mode when the direct solar irradiance is less than the threshold value of Sun-Sensor. When the sun goes down to -5°, the tracker waits at elevation-angle of -15°, azimuth-angle of 0° (South).
Threshold value of Sun-sensor	It is determined by corresponding air mass automatically.
Learning tracking function	Offset for elevation-angle and azimuth-angle are calculated in every one second. The latest 60 data are averaged and stored as offset.
Threshold value of learning tracking function	It is determined by corresponding air mass automatically.
Accuracy of real time clock	+/- 2ppm, (at 25℃)
Back-up battery life	3,650 days (power-on), 1000 days (power-off)

Table 9-3. Software Specification

	Details	
Software Version	3.xx	
Firmware Version	4.xx(21G/22G) 5.xx(32G)	
Applicable OS	Microsoft Windows Vista/7/8/8.1/10	
Operation Environment	CPU: Memory: HHD Capacity: Display Resolution: Interface:	Pentium/Celeron equivalent, 100MHz or more 64MB or more 300MB or more 1024 x 768 dot or more RS-232C should be available
Program Name	STRconfg	
Software Function	Setting and reading of latitude, longitude, date and time. Event logging.	
Measurement Items	Latitude, longitude, date and time, event log records	

9-3. Dimensions

1. STR-21G/22G

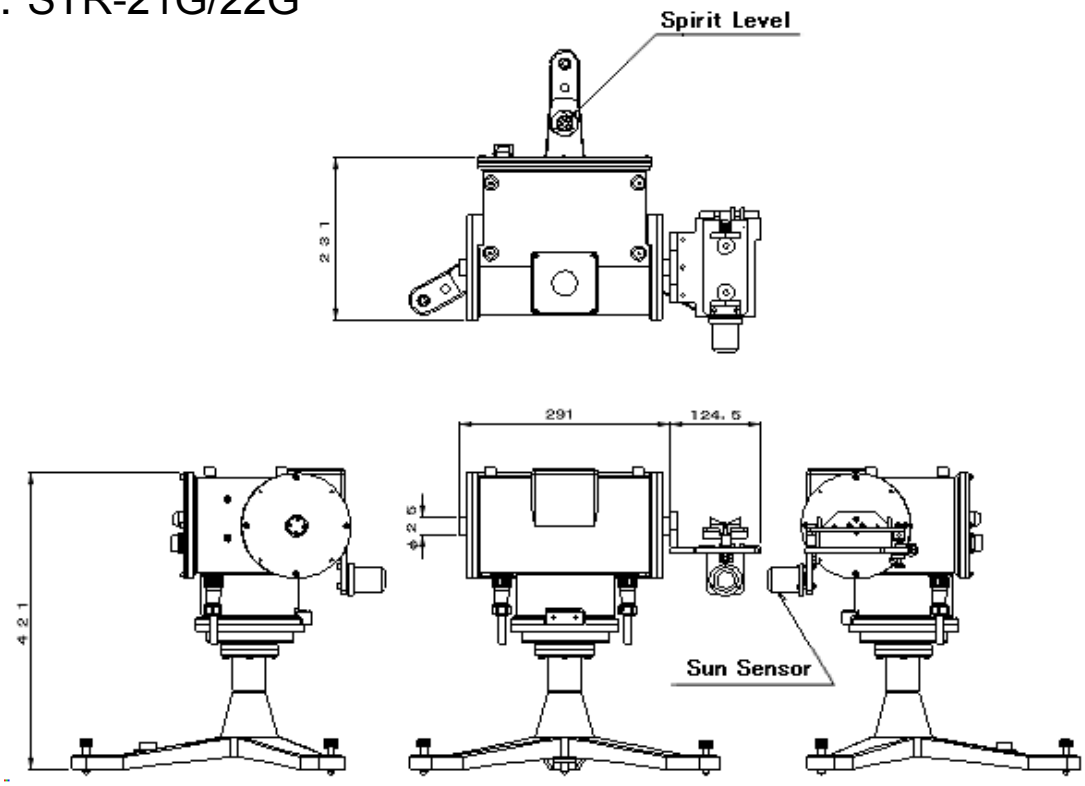


Figure 9-1. Dimension for STR-21G/22G

2. STR-32G

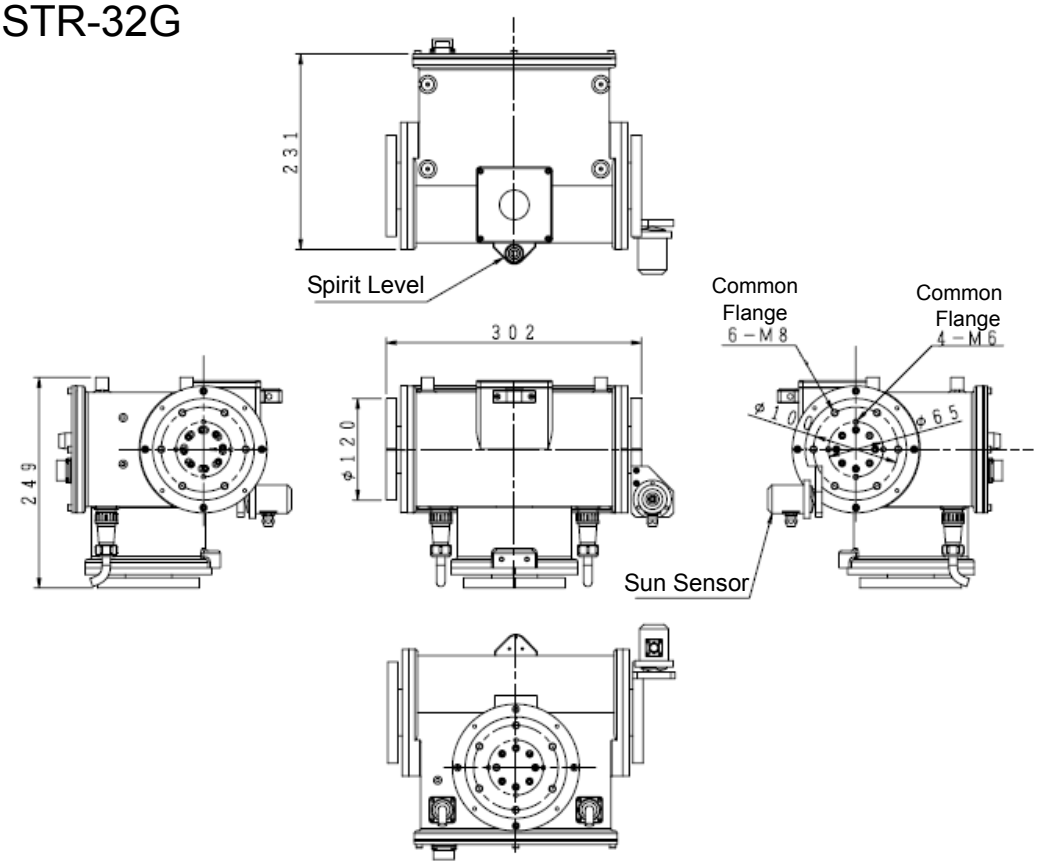


Figure 9-2. Dimension for STR-32G

3. Mounting Flanges

The flanges on Sun Tracker, both arms and the STR-32G bottom part for attaching to full-sized or custom tripod are all in same dimensions.

When the origin position marks on the arm flange is aligned, it represents that the altitude axis is in leveled position. When the origin position marks on the bottom part of STR-32G is aligned, it represents that the directional axis is facing towards the South (North if the Sun Tracker is installed in southern hemisphere). (See [5-3. Installation], [Installing STR-32G (Installed with EKO optional large tripod)])

STR-21G/22G Mounting Flanges

Azimuth-Axis

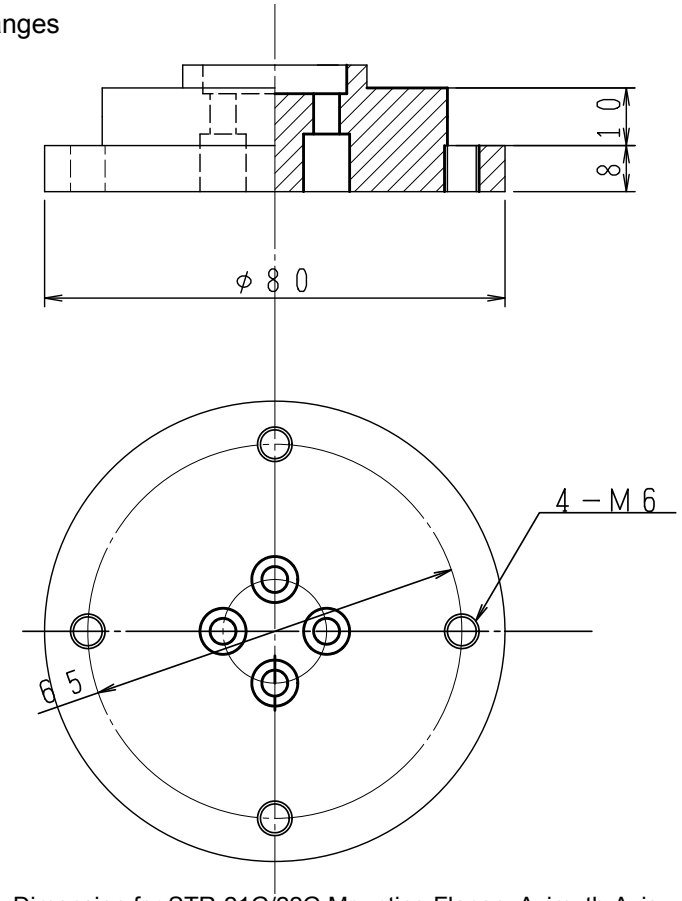


Figure 9-3. Dimension for STR-21G/22G Mounting Flange: Azimuth-Axis

Zenith-Axis

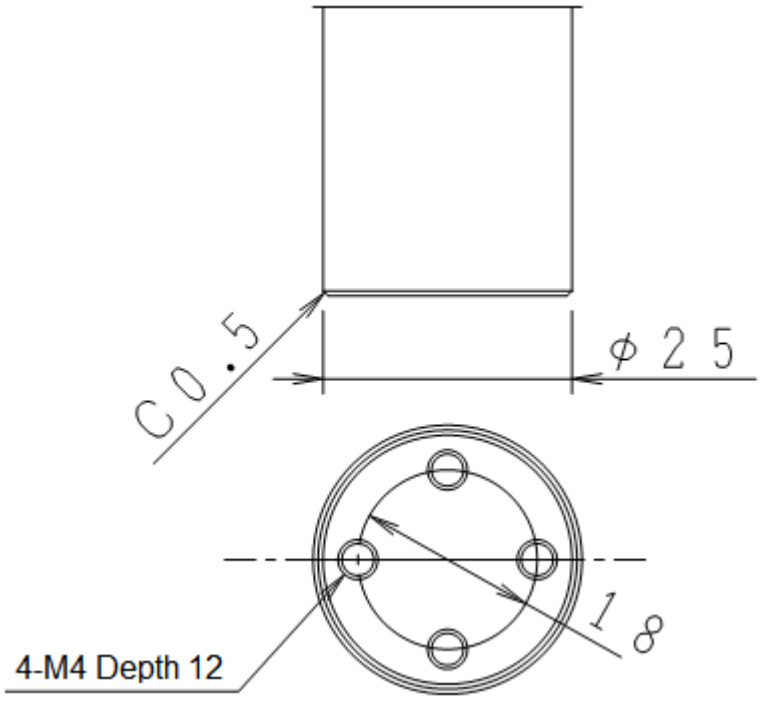


Figure 9-4. Dimension for STR-21G/22G Sensor Mounting Flange: Zenith-Axis

STR-32G Tripod Mounting Flange

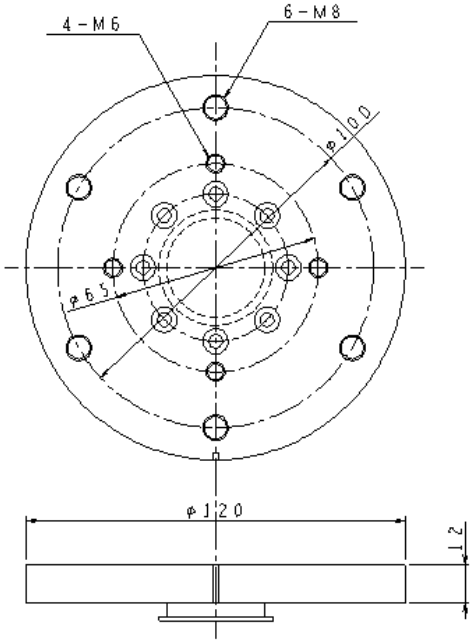


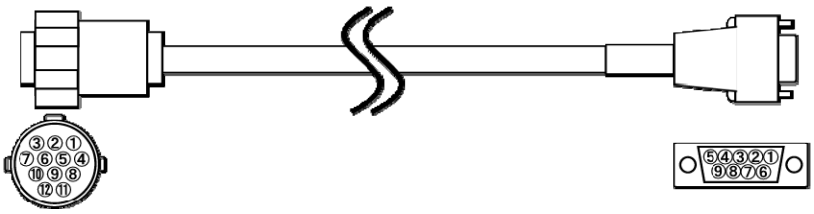
Figure 9-5. Dimension for STR-32G Tripod Mounting Flange

9-4. Communication Cable and Power Supply Cable

Table 9-4. Cable Specifications

Cables		Details	
Output Cable		Material:	MVVS
		Diameter:	0.3 mm^2 x 4 pins
		Outer Diameter:	Φ6 mm
		Cable end	See below figures
Power Cable	AC Type	Material:	OE-100
		Diameter:	0.75 mm^2 x 3 pins
		Outer Diameter:	Φ5.7 mm
		Cable end	See below figures
	DC Type	Material:	MVVS
		Diameter:	0.75 mm^2 x 2 pins
		Outer Diameter:	Φ5.7 mm
		Cable end	See below figures
Communication Cable		RS-232C, 4 pins, 0.3m^2	

1. Communication Cable



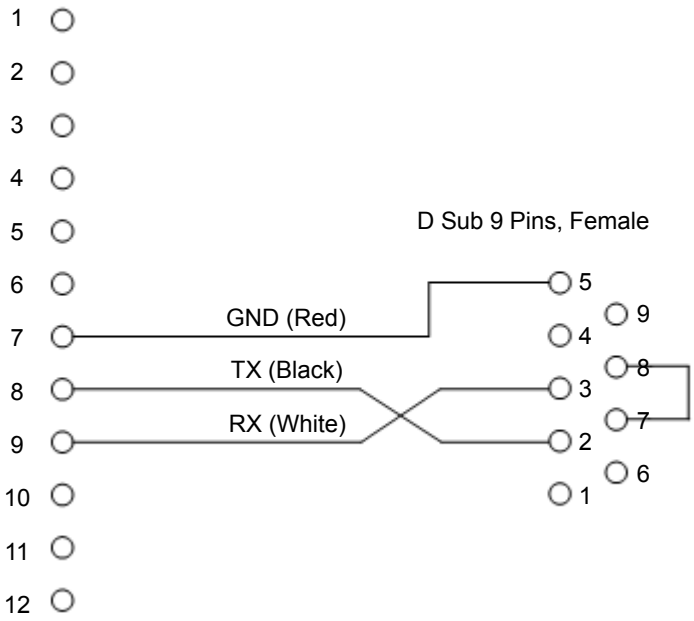
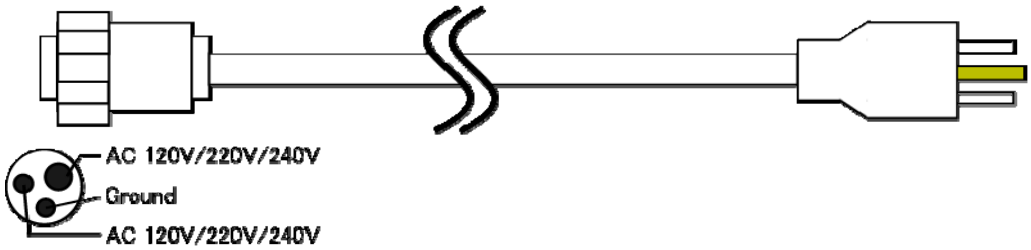


Figure 9-6. Communication Cable Image & Pin Assignment

*Communication cable can be extended up to 15m

2. AC Power Cable



3. DC Power Cable

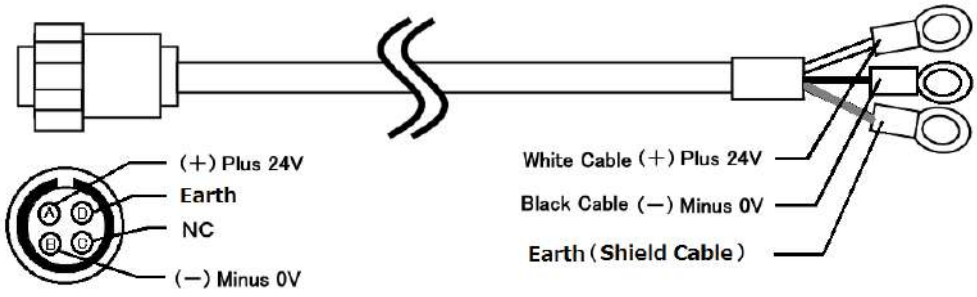


Figure 9-7. Power Supply Cables

9-5. Accessories List

For different application of the Sun Tracker, EKO has following optional accessories. The structural image of these optional accessories on Sun Tracker, please see the following page.

Table 9-5. Options

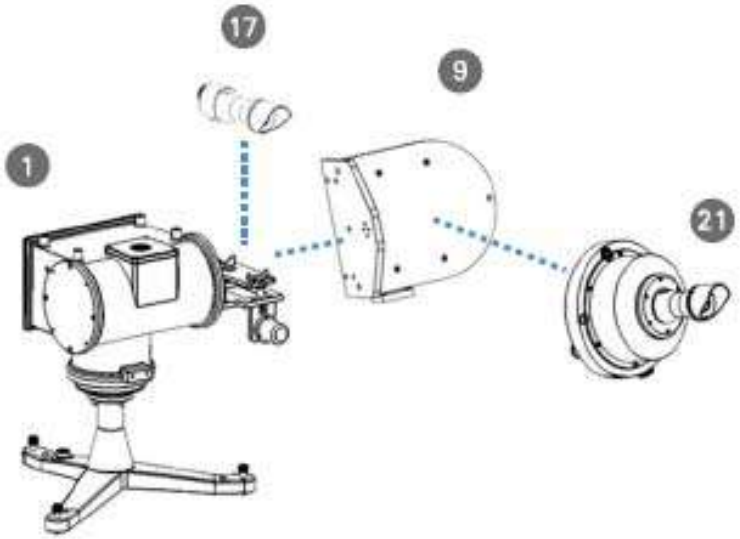
Option Items	Item No.	Descriptions
Notebook Computer	---	For setup
Communication Cable	---	RS-232C: 5m, 10m
TMP-S-XXX	4	For Diffuse solar radiation measurement (1 unit Pyranometer)*
TMP-DP-XXX	5	For Diffuse solar radiation measurement (2 units Pyranometers)*
TMP-WISER	6	For Diffuse solar radiation measurement (for MS-711/710, MS-712)
STR-22-SMP	7	Mounting for Normal Incident Pyranometer
STR-22-AD	8	Mounting for Pyrheliometer
STR-22-P	9	STR-21G/22G Mounting Plate for MS-700 DNI (Primary)
STR-22-S	10	STR-22G Mounting Plate for MS-700 DNI (Secondary)
STR-32-P	11	STR-32G Mounting Plate for MS-712 (Primary)
STR-32-S	12	STR-32G Mounting Plate for MS-711/MS-710 (Secondary)
STR-32-T	13	Tripod for STR-32G
MB-12-1	14	STR-22G Shading Ball Assembly for Pyranometer (Single Type)
MB-12-2	15	STR-22G Shading Ball Assembly for Pyranometer (Dual Type)
MB-13-2	16	STR-32G Shading Ball Assembly for WISER (MS-711/MS-710, MS-712)
MS-57	17	Pyrheliometer
MS-802, MS-402, MS-410, MS-802F, MS-402F,MS-80, MS-80A, MS-80M, MS-60,MS-60A,MS-60M	18	Pyranometer
MS-711	20	VIS-NIR Spectroradiometer
MS-712	20	NIR Spectroradiometer
MS-700 DNI	21	DNI Spectroradiometer
STR-32-CT712	22	Collimation Tube for MS-712
STR-32-CT711	23	Collimation Tube for MS-711/710
MD-81-10	24	STR-21G Shading Disk Assembly for Pyranometer (MS-80 Single Type)
MB-82-10	25	STR-22G Shading Ball Assembly for Pyranometer (MS-80 Single Type)
MB-82-20	26	STR-22G Shading Ball Assembly for Pyranometer (MS-80 Dual Type)

*Contact EKO for details

1. STR-21G/22G Configuration

STR-21G Configuration

①STR-21G Body



STR-22G Configuration

②STR-22G Body

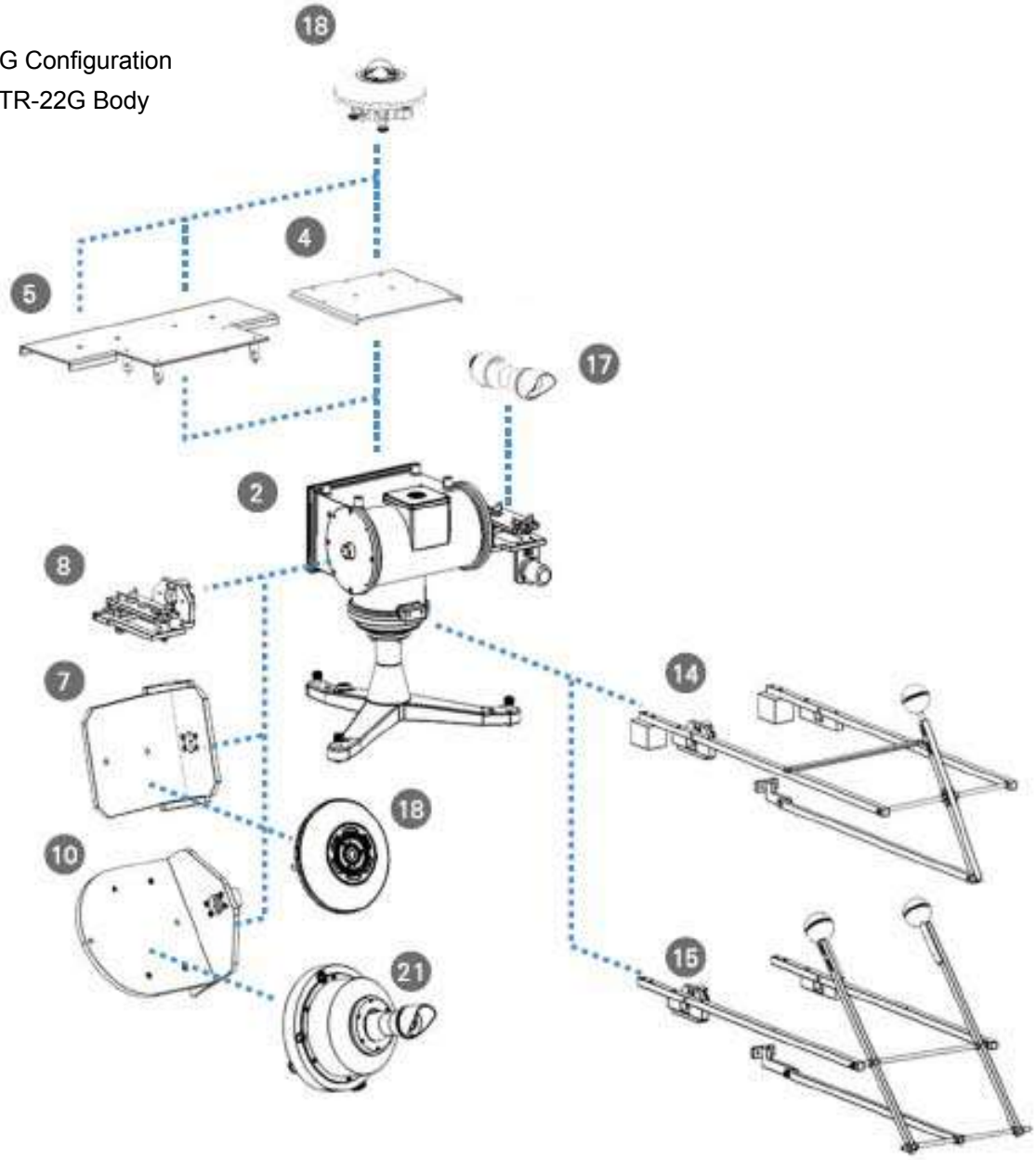


Figure 9-8. STR-21G/22G Configuration

2. STR-32G Configuration

③ STR-32G Body (③a : Body, ③b : Sun Sensor)

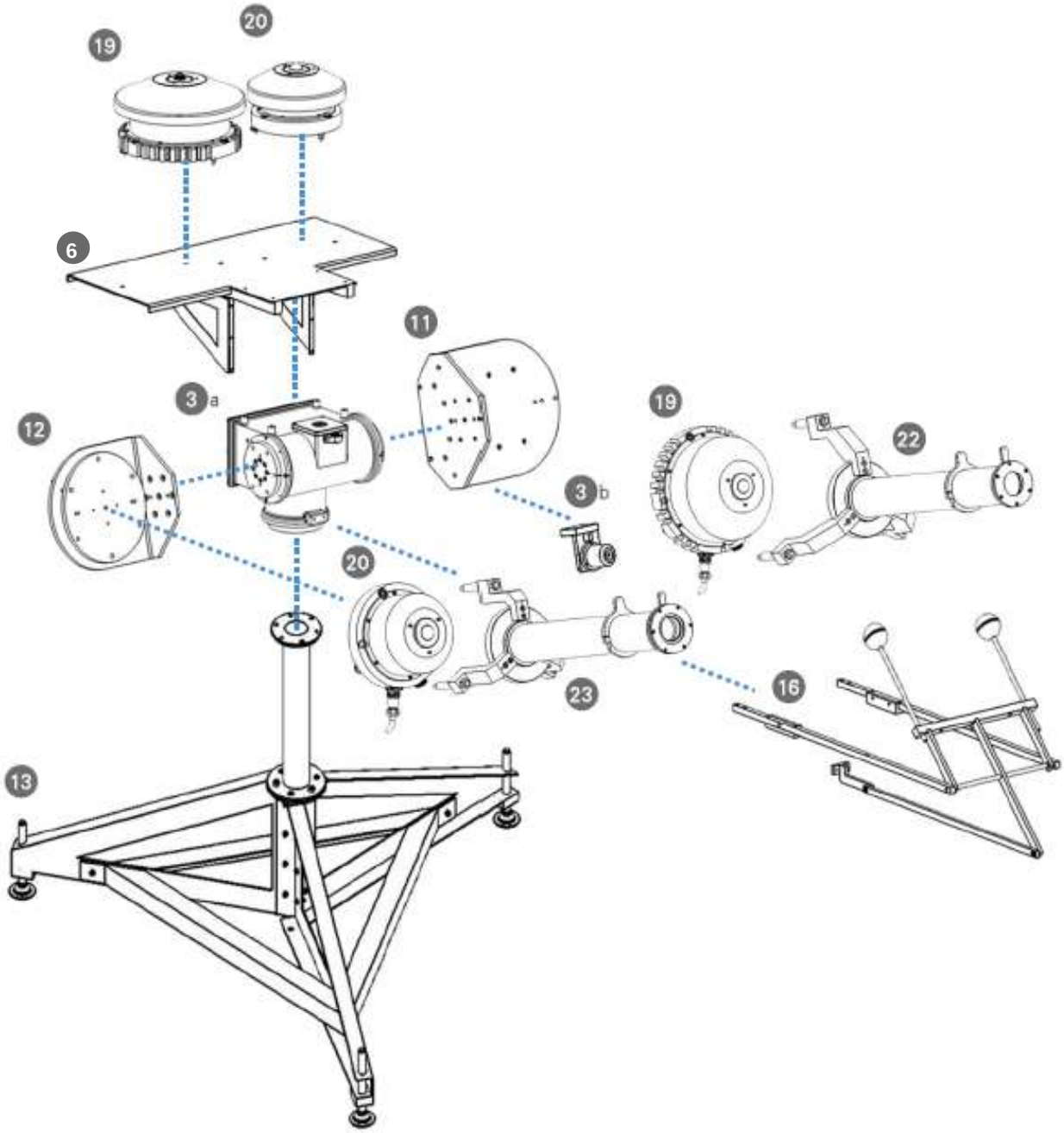


Figure 9-9. STR-32G Configuration

APPENDIX

A-1. STR-32-T Full-Size Tripod Assembly

1. Checking for Parts

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

Table A-1. Main Parts

Name of Parts	Quantity
Legs	3
Support Bars	3
Connection Plate	1
Leveling Screws	3
Pole	1

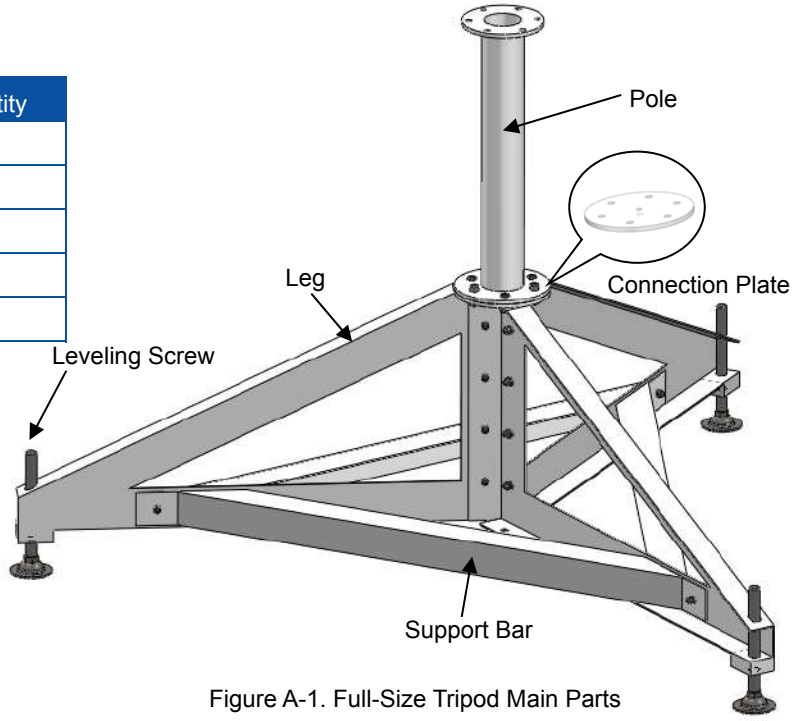


Figure A-1. Full-Size Tripod Main Parts

Table A-2. Bolts, nuts, etc.

Image	Parts Name	Size	Quantity
	Hex socket head cap bolt (with nut, plain washer, spring washer)	M6×15	12 sets
		M8×20	3 sets
		M6×20	3 sets
		M8×25	3 sets
	Hex socket head cap bolt (with plain washer and spring washer)	M8×20	6 sets

2. Assembling

(1) Attach the legs with M6x15 bolts (12 places) as shown belo

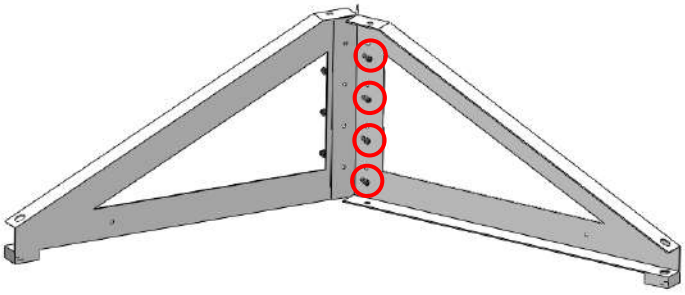


Figure A-2. Assembling Legs

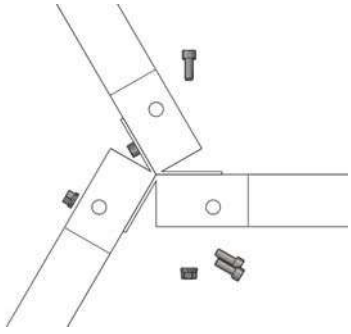


Figure A-3. Legs View from Top

(2) Attach support bars with M6x20 bolts (3 places)

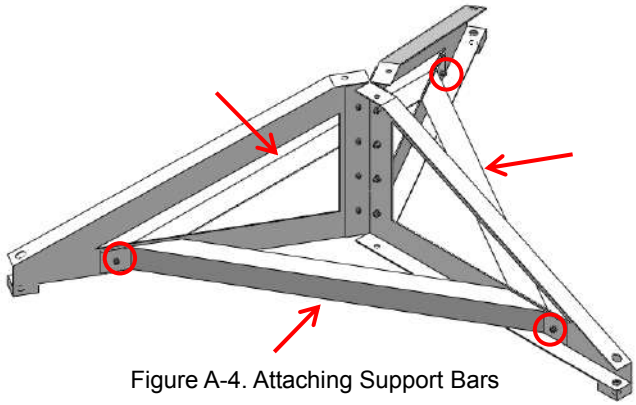


Figure A-4. Attaching Support Bars

(3) Place the connection plate as shown on the right, fix with M8x20 in three places. Attach the leveling screws at the end of each leg.

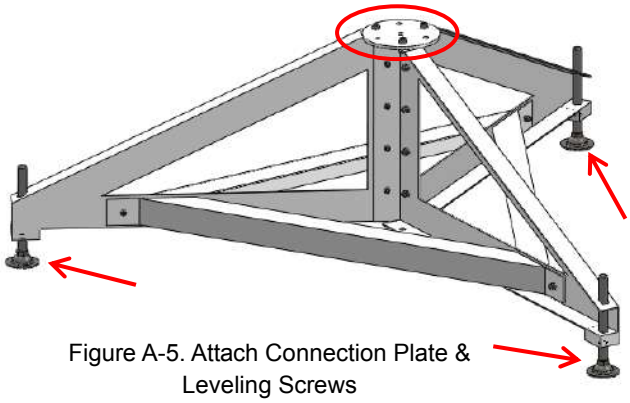


Figure A-5. Attach Connection Plate & Leveling Screws

(4) Place the pole on top of the connection plate, fasten with M8x25 bolt in three places. Make sure all screws are fixed tight.

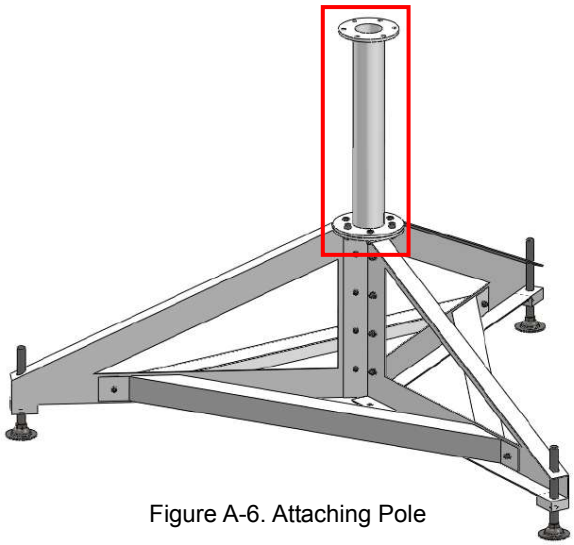
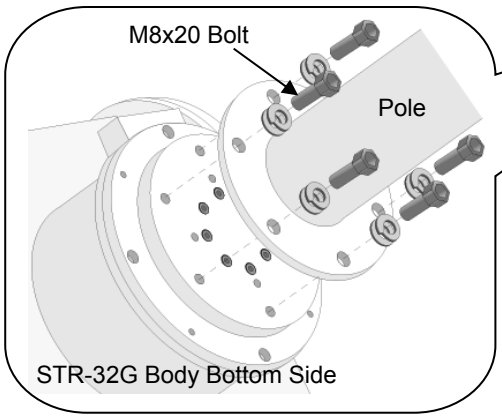


Figure A-6. Attaching Pole

(5) Fix the Sun Tracker STR-32G on the full-size tripod with M8x20 bolts in six places as shown below.



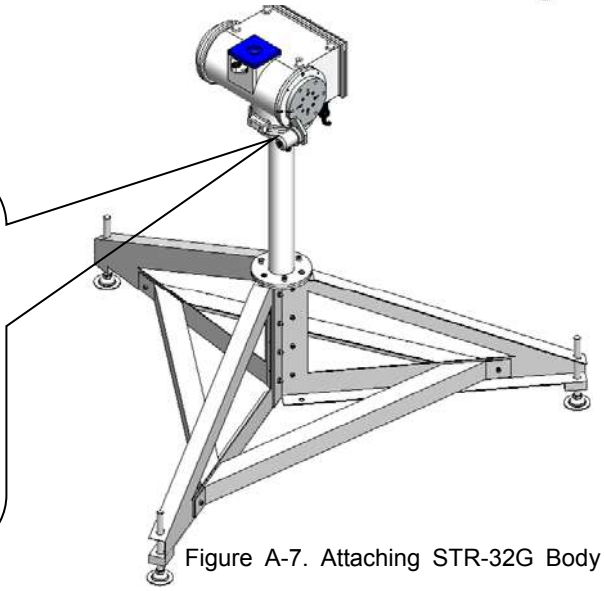


Figure A-7. Attaching STR-32G Body

A-2. Shading Ball Assembly & Setup

In this section explains how to assemble and setup the Shading Ball Assembly (MB-12-1 or MB-12-2) and Pyranometer(s) (MS-802, MS-802F, MS-402, or MS-402F) on the Sun Tracker.

1. Preparation

Make sure the Sun Tracker is in the origin point when setting up the shading ball assembly. (For how to reposition the Sun Tracker to the origin position, refer to [5-3. Installation], [1.Mounting the Sun Tracker].
Shading ball assembly setup should be done on a sunny day as it requires shade of shading ball itself to make fine alignment at the last step.

For assembling the Shading Ball, prepare the following tools:

- Hexagon wrench 1.5 (for set screws)
- Hexagon wrench 2.5 (for M3 screws)
- Hexagon wrench 3 (for M4 screws)
- Hexagon wrench 4 (for M6 screws)

2. Parts List

Before starting to assemble the shading ball, make sure there are no missing parts by checking the following parts list Table A-3 and Table A-4.
All the necessary screws, washer, bolts, and nuts are already attached to the parts in appropriate position.

Table A-3. Parts list: Single and Dual Shading Ball assembly parts

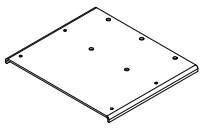
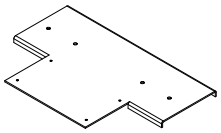
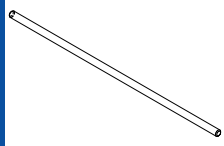
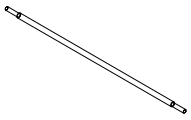
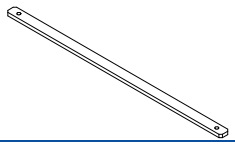
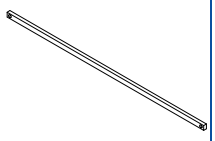
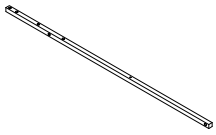
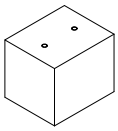
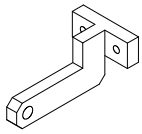
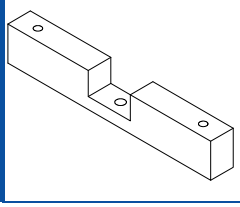
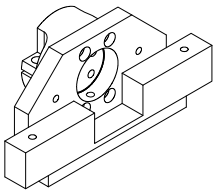
	Part No.	Parts Image	Qty.	Part No.	Parts Image	Qty.	Part No.	Parts Image	Qty.
Single Type	①		1	②		1	③		
Double Type	①		1	②A ②B		2		1	

Table A-4. Parts List: Common Parts

	Part No.	Parts Image	Qty.	Part No.	Parts Image	Qty.	Part No.	Parts Image	Qty.
Common Parts	④		1	⑤		1	⑥		1
	⑦		2	⑧		2	⑨		1
	⑩		1	⑪		1	⑫		1

*When the shading ball assembly is purchased at the same time as Sun Tracker, the parts 8, 9, and 10 will be already attached to Sun Tracker before shipment.

3. Shading Ball with Pyranometer Setup Procedure

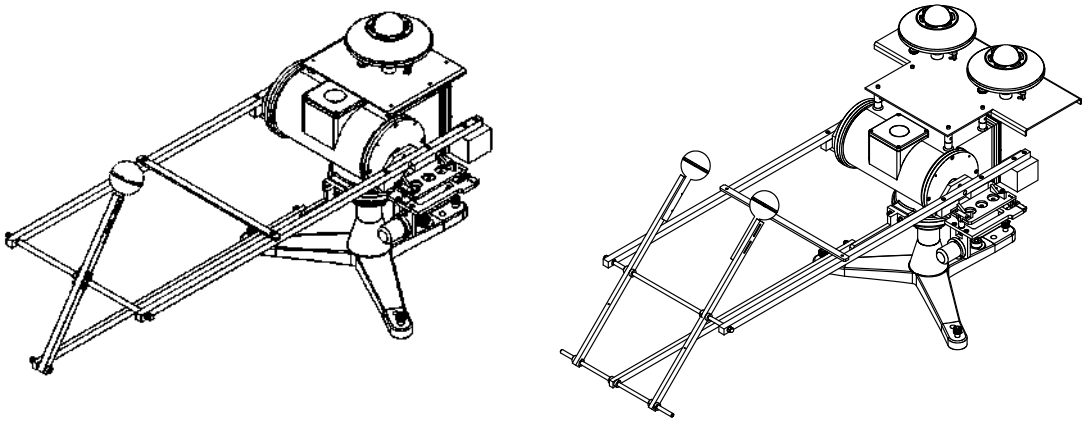


Figure A-8. Shading Ball with Pyranometer (Left: Single Type, Right: Dual Type)

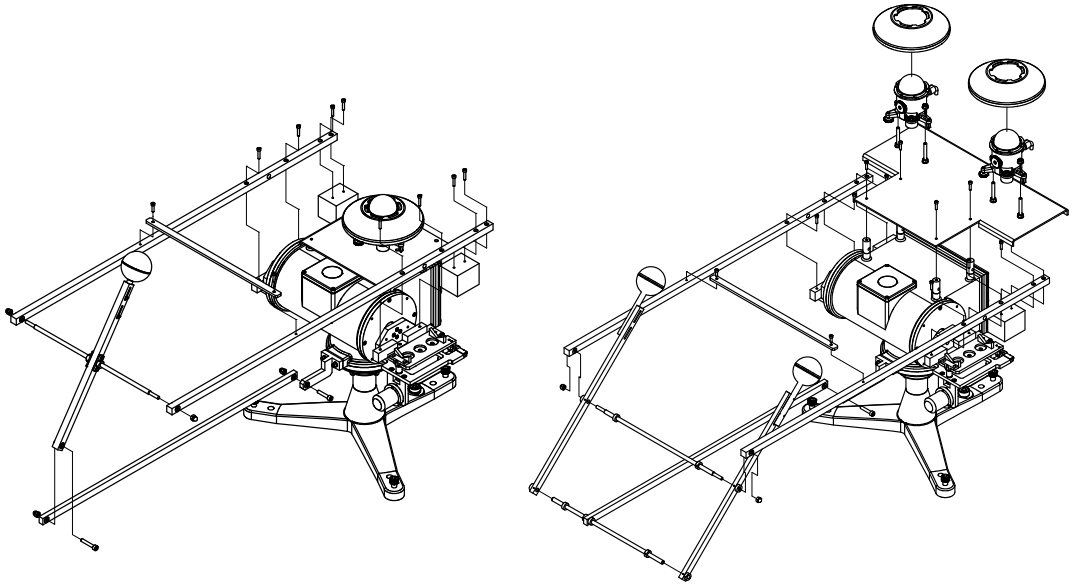
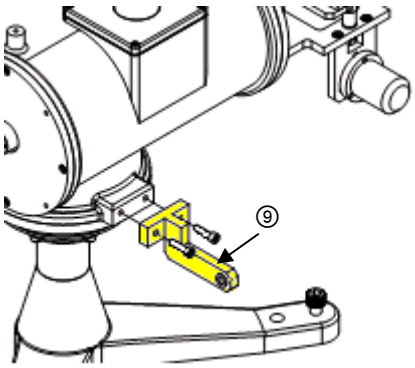


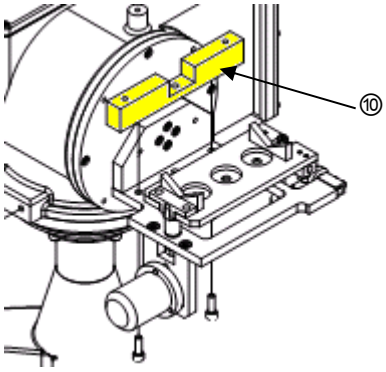
Figure A-9. Shading Ball with Pyranometer: Exploded View (Left: Single Type, Right: Dual Type)

Shading Ball Assembling Procedure

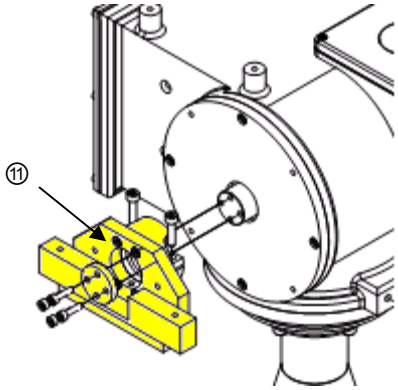
Steps (1) through (6) are common for both Single and Double Type Shading Ball Assembly.



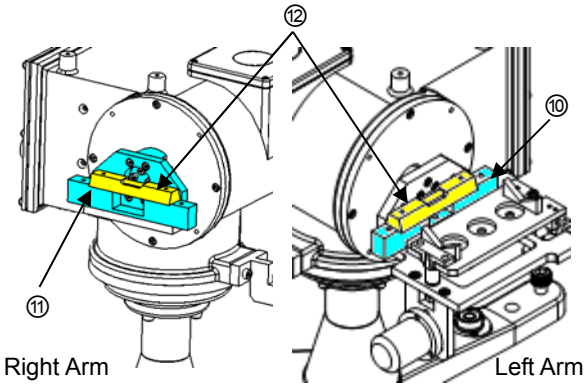
(1) Attach part ⑨ with two CAP screws(M5x20mm).



(2) Attach part ⑩ with two CAP screws (M5×15mm).

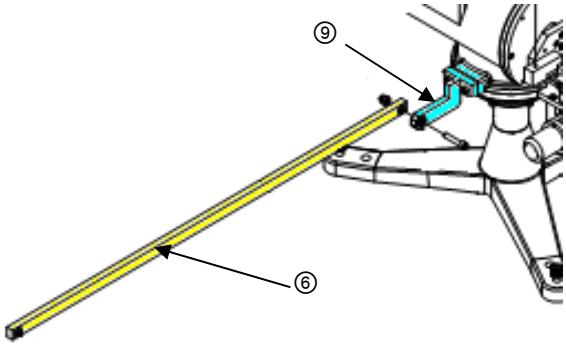


(3) Fix the part ⑪ to the Sun Tracker axis with two CAP screws (M5x20mm) from the above and with four CAP screws (M4x15mm) from the side.



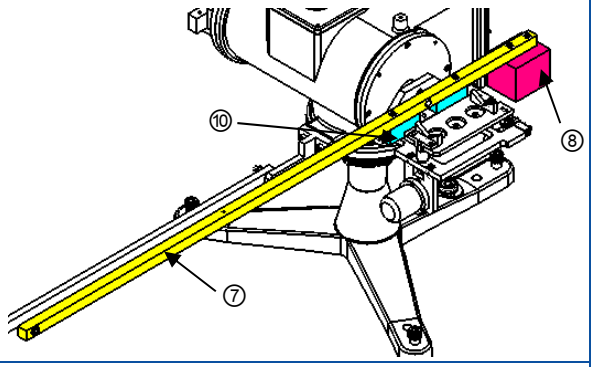
(4) Position the arm axis to the origin position in the altitude direction. Place the part ⑫ (spirit level) on the parts ⑩ and ⑪, check the level. Loosen the CAP screws which are fixing these parts and adjust the level as necessary, so that the air bubble in the spirit level comes to the center. Once these parts are leveled, fasten the parts ⑩ and ⑪ securely.

*If these parts are fasten too loose, it may lead to defects and/or mis-measurements.



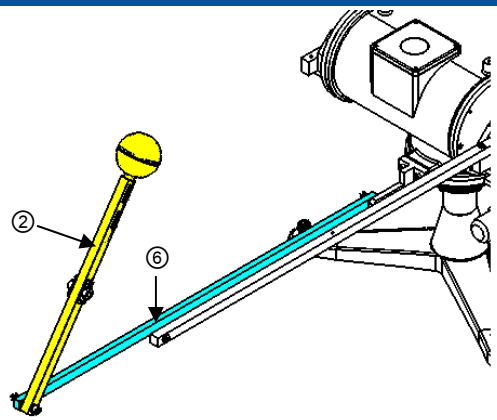
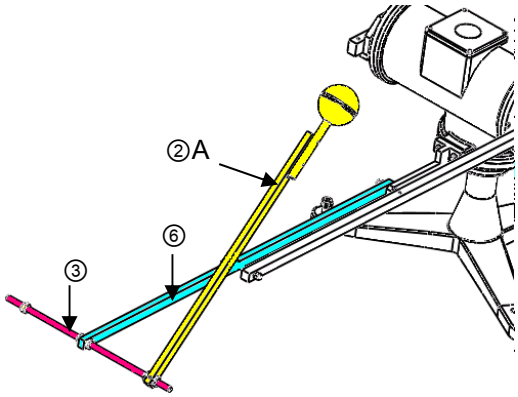
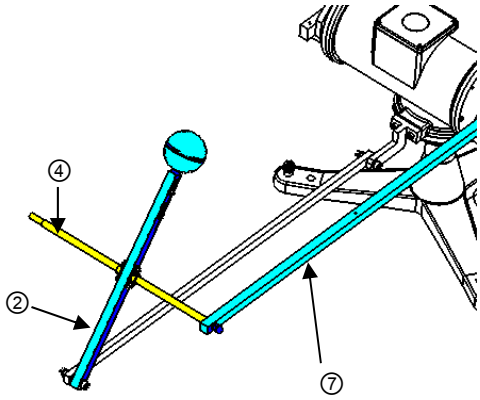
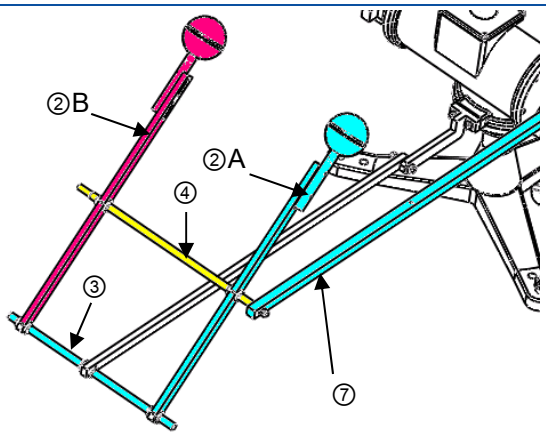
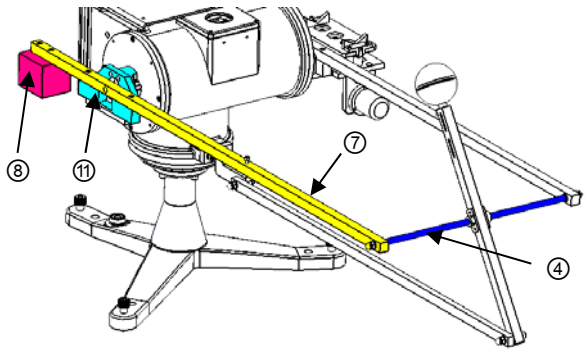
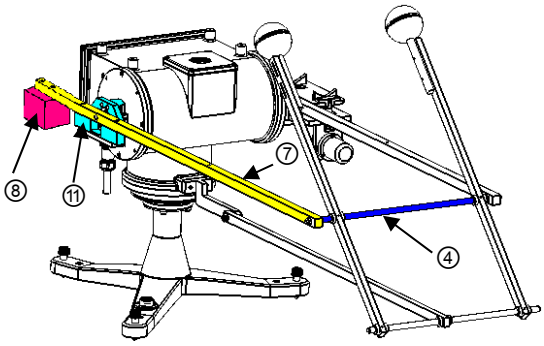
(5) Remove the screw (M6x30mm) and nut from the part ⑨ and attach the part ⑨ to part ⑥ with removed screw and nut. Make sure the part ⑥ can be rotated smoothly.

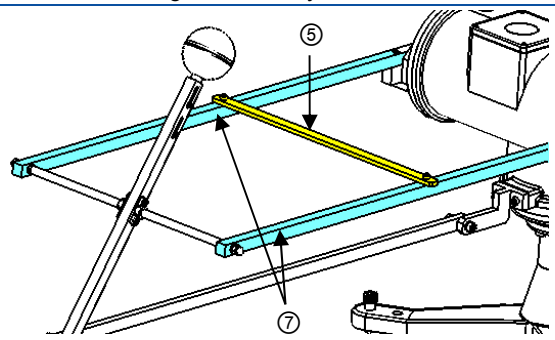
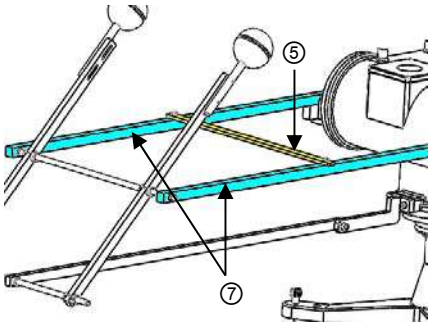
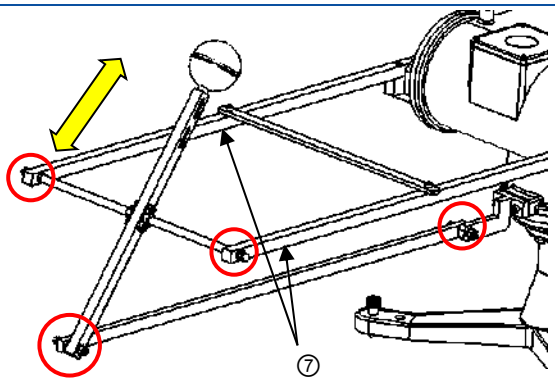
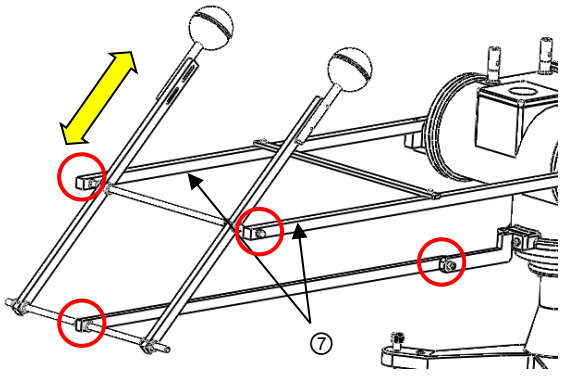
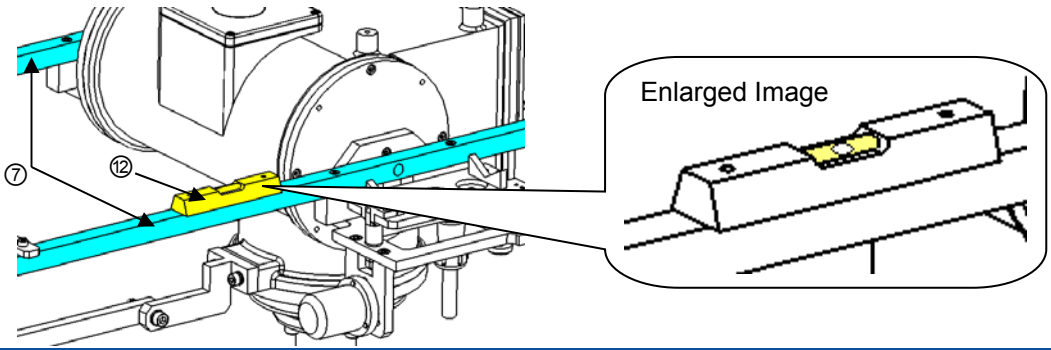
*If the screw is too loose, the parts will fall apart, yet fastening too tight will create excess load to the parts during operation and may lead to damaging the instrument. Be careful with tightening the screw of these parts.

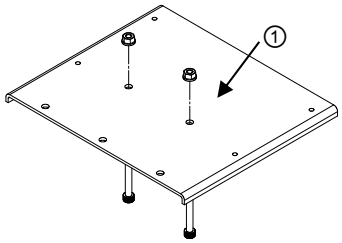
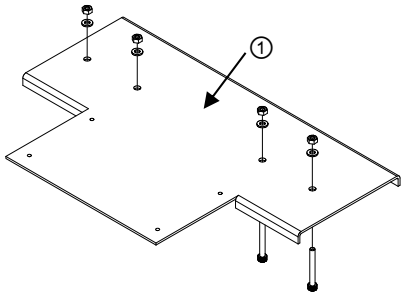
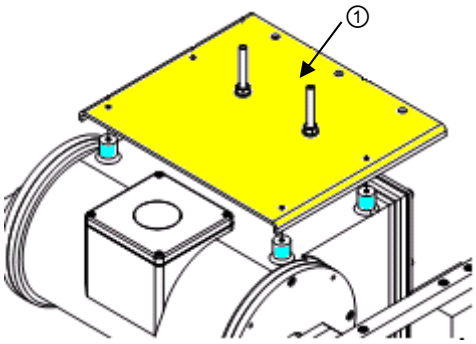
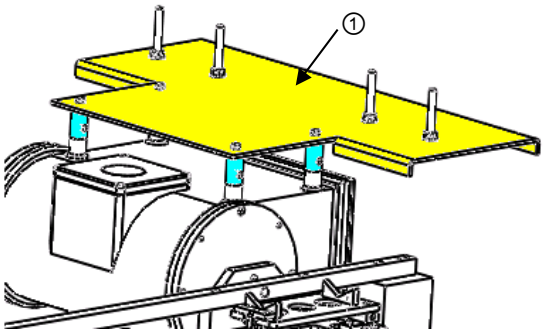
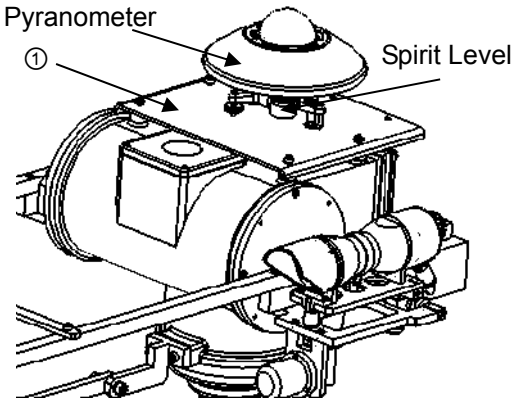
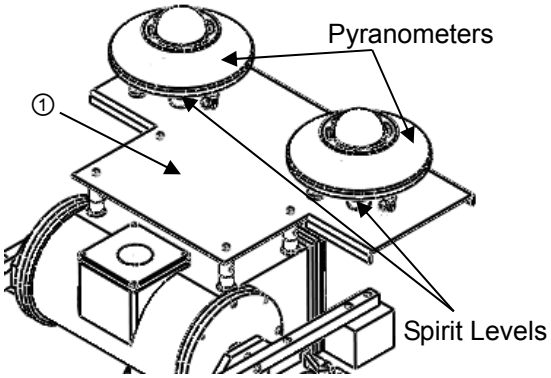


(6) Remove two screws (M4x18mm) from the part ⑩ and fasten the part ⑩ to the part ⑦ with removed screws securely.

Remove two screws (M4x18mm) from the part ⑧ and fasten the part ⑧ to the part ⑦ with removed screws securely.

Single Type	Double Type
	
(7) Remove the screw (M6x35mm) and nut from the part ② at the opposite end from the shading ball. Attach the part ② to part ⑥ with removed screw and nut so that the shading ball will be leaning towards the Sun Tracker Body.	(7) Loosen four set screws (M3x3mm) attached at the tip of the part ⑥ and insert the part ③. Loosen the four set screws (M3x3mm) attached at the center and the tip of part ②A and insert the part ③ through the tip of the part ②A.
	
(8) Remove the fixing nut from one side of part ④ and loosen four set screws (M3x3mm) at the center of part ② then insert the part ④ through part ②. Fix the part ④ to part ⑦ with removed fixing nut. *Fasten the set screws (M3x3mm) lightly as they will be adjusted later.	(8) Remove the fixing nut from both ends of the part ④ and insert the part ④ through ②A; attach the part ④ to part ⑦ with removed fixing nut. Loosen the set screws at the center and the tip of part ②B and insert the part ④ through ②B. *Fasten the set screws (M3x3mm) lightly as they will be adjusted later.
	

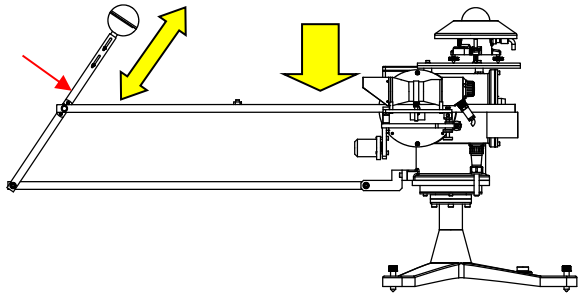
Single Type	Double Type
(9) Remove the fixing nut on the other side of the part ④ and attach it to the part ⑦ with removed fixing nut. Remove two screws (M4x18mm) on the part ⑪ and attach the part ⑪ to the part ⑦ with removed fixing nut securely. Remove two screws (M4x18mm) from the part ⑧ and attach the part ⑧ to the part ⑦ with removed fixing nut securely.	(9) Attach the part ④ to part ⑦ with the fixing nut removed in step (8). Remove two screws (M4x18mm) from the part ⑪ and attach the part ⑪ to part ⑦ with removed screws securely. Remove two screws (M4x18mm) from the part ⑧ and attach the part ⑧ to the part ⑦ with removed screws securely.
	
(10) Remove two screws (M4x12mm) from the part ⑦ and attach the part ⑦ to the part ⑤ with removed screws securely.	
	
(11) Without connecting the power cable, move the part ⑦ in up and down direction. Fasten the screws placed in red marked position; make sure the arms will move smoothly without any extra force. *If the screw is too loose, the parts will fall apart, yet fastening too tight will create excess load to the parts during operation and may lead to damaging the instrument. Be careful with tightening the screw of these parts.	
	
(12) Place the part ⑫ (spirit level) on the part ⑦ and check the level on both arms; make sure the air bubble is in the center.	

Single Type	Double Type
	
(13) Insert the mounting bolts for the pyranometer through the holes placed in the center of part ① from the bottom, and fasten them with washers and nuts.	
	
(14) Remmove four screws (M4x12mm) from the screw holes (blue part) on top of the Sun Tracker body; attach the part ① with removed screws securely. *Make sure the part ① is placed in the correct direction.	
	
(15) Place the pyranometer(s) in the appropriate direction on the part ① and adjust its (their) spirit level(s) then fasten the nuts.	

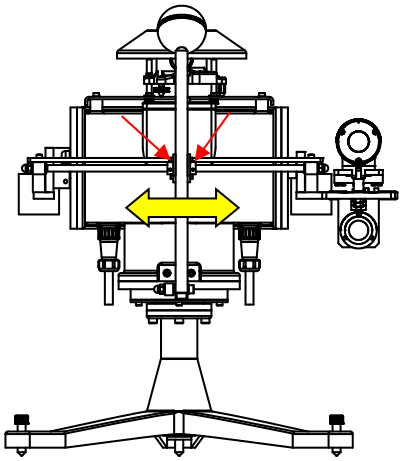
4. Final Adjustment of Shading Assembly

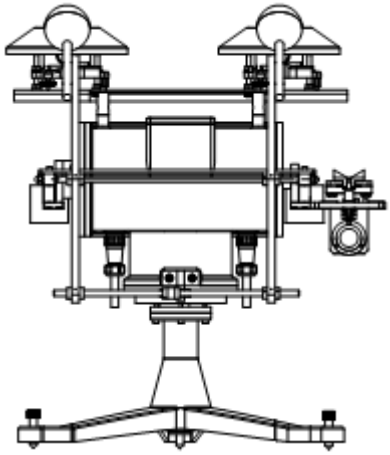
1) Connect the power cable to the connector on Sun Tracker. After 1~2 seconds Sun Tracker searches for the origin point, pull out the power cable and stop the Sun Tracker in the origin point position.

2) Check the parts No.6 are horizontally leveled on both sides (left & right side of Sun Tracker arms)

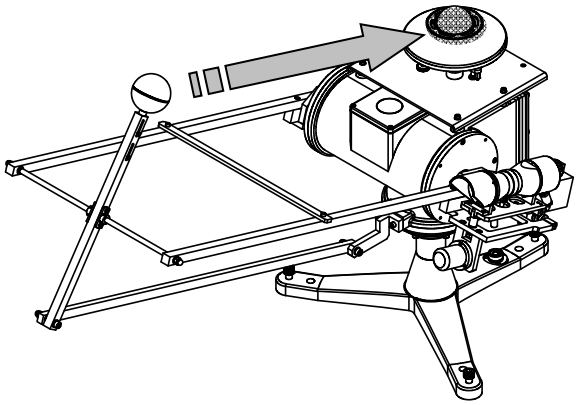


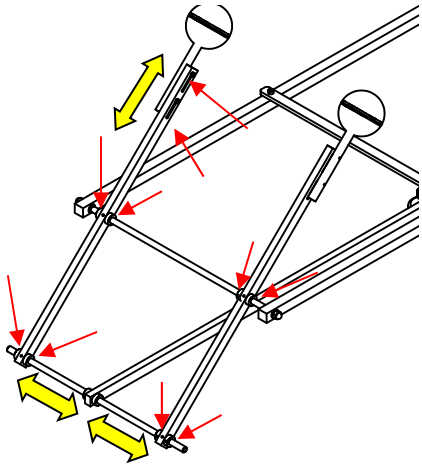
3) Visually check the position of shading ball; adjust the height and side positions making sure it covers the pyranometer dome when it is looked from the front position.





4) Insert the power cable to the connector, and check and make adjustment so that the shading ball makes the shadow on the glass dome evenly.



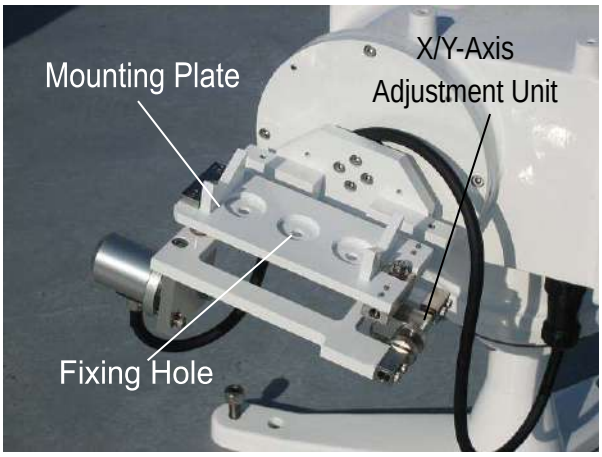


5) Check the position of shading ball shadow position as the Sun Tracker is tracking the sun; adjust the shading ball position as necessary.

6) After the adjustment is completed, fasten the screws securely

A-3. Mounting Pyrheliometer MS-57 on Sun Tracker

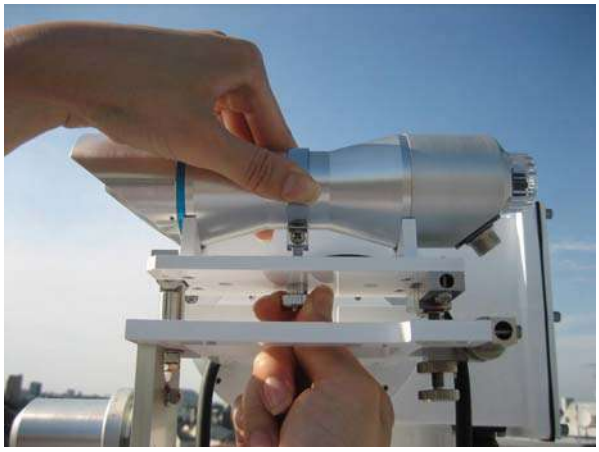
In this application the MS-57 is mounted on the EKO Sun Tracker STR-21G/22G for Direct Normal Incident (DNI) measurements.



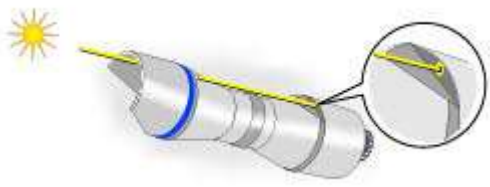
1) When mounting the MS-57 on Sun Tracker, use the fixing hole in the middle of the mounting plate.

2) Remove the knurling nut from the MS-57 mounting screw by hand. (Above picture shows condition the knurling nut is removed.)

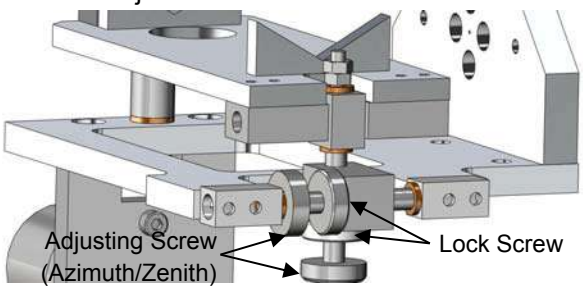
3) Place the MS-57 on the Sun Tracker mounting plate. Insert the mounting screw through the mounting plate center hole.



4) Attach the knurling nut which was removed earlier back on the mounting screw; tighten so the MS-57 is fixed securely.



XY Axis Adjustment Unit



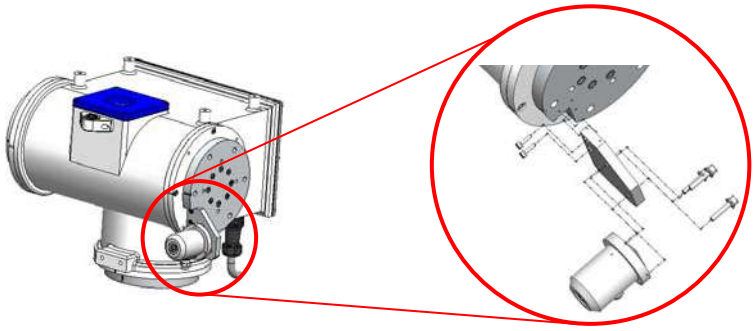
5) As the Sun Tracker is operating, align the sight spot on the MS-57 by using the XY Axis Adjustment Unit. Loosen the lock screws then use the adjusting screws for Zenith and Azimuth directions to align the sight spot to hit the target groove. After the alignment is done, tighten the lock screws.

For connecting output cable and taking measurements, see Pyrheliometer MS-57 Instruction Manual.

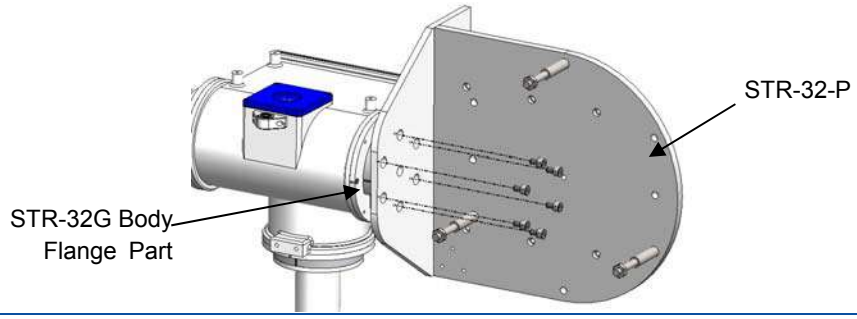
A-4. Mounting DNI Spectroradiometer on Sun Tracker

In this application the DNI Spectroradiometers (MS-711/MS-710 and MS-712 with collimation tubes STR-32-CT710 and STR-32-CT712) are mounted on the EKO Sun Tracker STR-32G for Spectral Direct Normal Incidence (DNI) measurements.

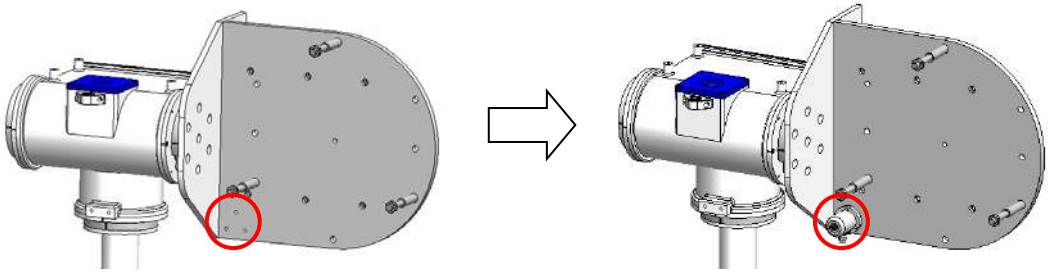
1. Mounting Instruments



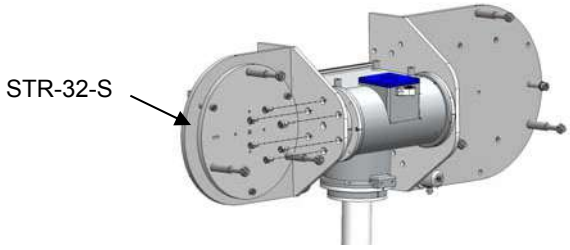
1) Remove the Sun Sensor and the Sun Sensor plate. Keep the screws (3 sets of M4x25, plain washers, and spring washers) as they will be used again to mount the Sun Sensor in later steps.



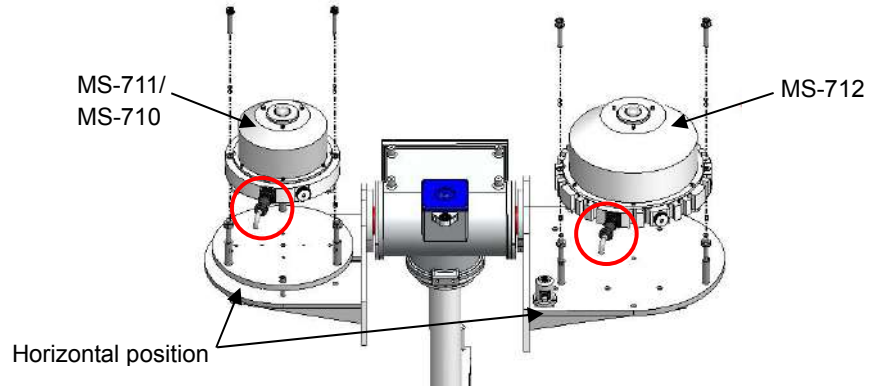
2) Attach the STR-32-P to the flange part of STR-32G body and fix with 8×15 (6pcs).



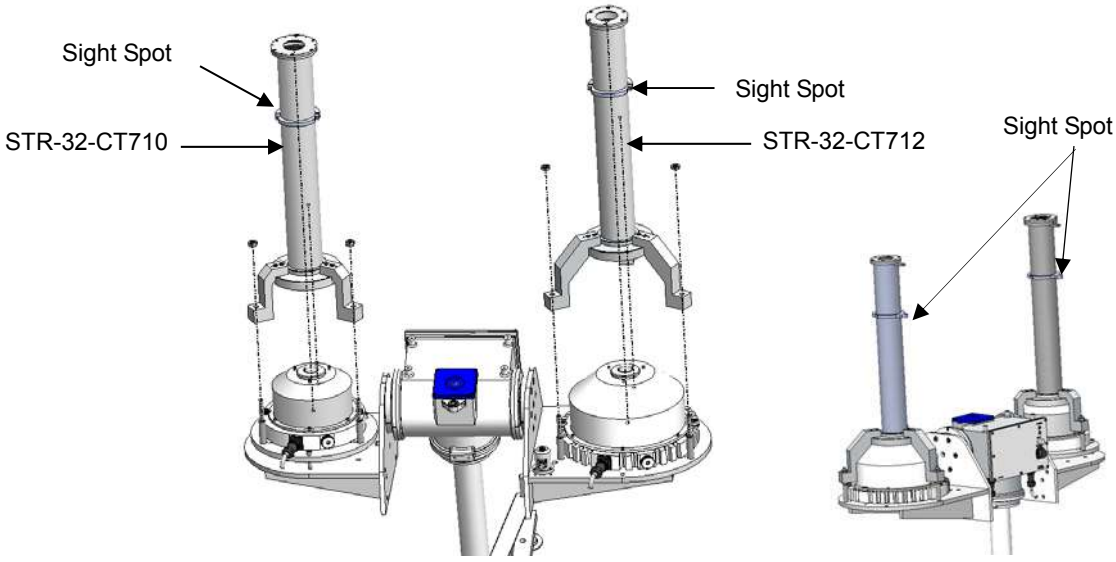
3) Attach the Sun Sensor at the bottom of STR-32-P as shown in red circle in the below figure with the screws (3 sets of M4x25, plain washers, and spring washers) which were removed in the step (1)



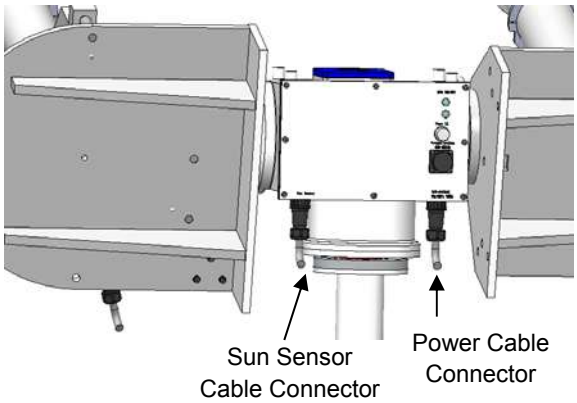
4) Attach the mounting plate STR-32-S on the secondary arm on the STR-32G body with M8x15 (6pcs).



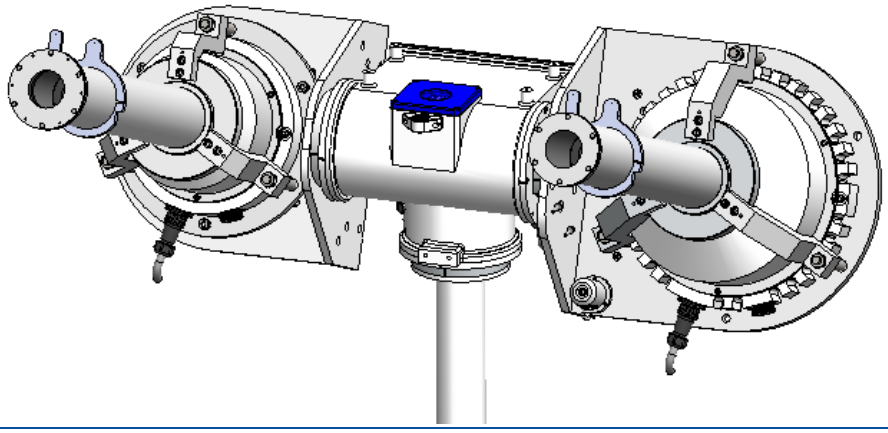
5) Remove the leveling screws from the bottom of spectroradiometers (MS-711/MS-710 and MS-712). Rotate the mounting plate manually so that the plates are positioned in horizontal position then attach the spectroradiometers (M8x50 & plain washers). Make sure the connectors (marked with red circle) for Spectroradiometers are facing bottom when the sensors are pointing toward the sun direction.



6) Attach the collimation tubes (STR-32-CT710 and STR-32-CT712) to the spectroradiometers with M10 nuts; make sure the sight spot part will be positioned at the top when the collimation tubes pointing towards the sun direction.



7) Connect the Sun Sensor cable then power cable. For detailed instructions for the cable connections, see [5-3. Installation], [3. Connecting Cable].



8) The mounting plates (STR-32-P & STR-32-S), spectroradiometers (MS-711/MS-710 & MS-712), and collimation tubes (STR-32-CT710 & STR-32-CT712) are now mounted on STR-32G.

9) Lastly, the sight spot for the DNI Spectroradiometers are adjusted.
The sight spot on the collimation tube (STR-32-CT712) for the Sun Sensor side (primary arm), see [5-4. Sun Sensor Setting], [2. STR-32G].
The sight spot on the collimation tube (STR-32-CT710) for the secondary arm side is adjusted by using the tilting plate which is attached to the mounting plate (STR-32-S).

2. Adjusting Sight Spot by Tilting Plate

Make sure the tilting plate is adjusted after the Sun Sensor setting is completed.
The tilting plate position can be adjusted by using the 3 adjusting bolts with supporting bolt in the center.
Adjust the tilting plate with same method as the adjusting Sun Sensor to bring the sun light spot to the center of sight spot target. (Figure A-10). If it is difficult to rotate the screws, loosen them once by turning anticlockwise.
Make sure the adjusting bolts in three positions do not get loosen after the sight spot is aligned.

For long-term measurements, check the sight spot alignment at least once a day after the setup.

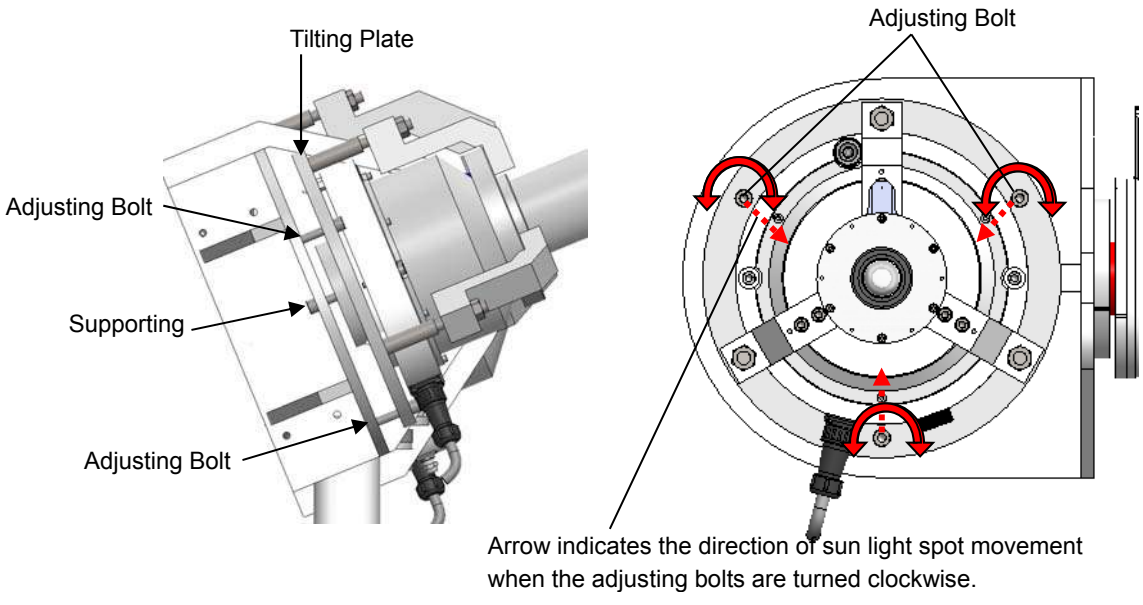


Figure A-10. Adjusting Bolts for Tilting Plate

A-5. Alignment for More Precise Sun Tracking

In the low latitude area, between 23.4° north latitude and 23.4° south latitude, the sun elevation may become near 90°. This Sun Tracker operates using only the calculation mode for azimuth angle in such sun elevation range as high 87° ~ 90°, and only the elevation angle is operated using sun sensor mode. This is because the Sun Tracker cannot track the sun by using only the sun sensor since the azimuth angle rotates at near 180° at around culmination time.

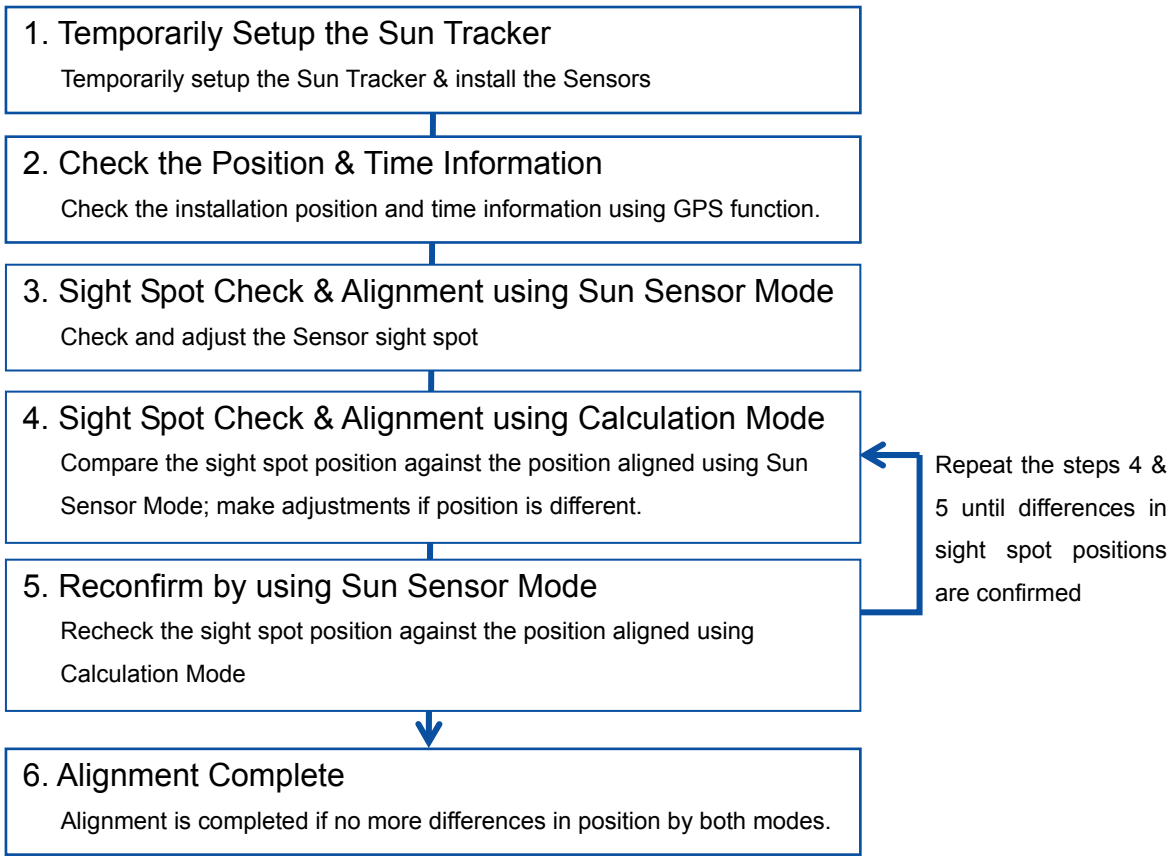
Since the calculation mode is used for azimuth angle, the sun tracking accuracy depends on the installation setup (orientation and horizontal level); therefore, the Sun Tracker precise orientation setup and horizontal level adjustments become very critical.

To increase the sun tracking accuracy in such condition, align the Sun Tracker setup by following below instruction.

This procedure must be performed under a clear sunny day, which sight spot on Pyrheliometer or Collimator Tube for Spectroradiometer can be used.

NOTE) If the sun Tracker is already installed in position, anchor bolt is fixed and cannot move the position of tripod, this adjustment cannot be applied.

1. Installation Procedure Flow



2. Installation Procedure

1) Temporary Setup the Sun Tracker, Install the Sensors

1. Prepare the setup base by confirming the orientation of the installation site according to the [5-2. Setup].
2. Follow the steps [1. Mounting the Sun Tracker] and [2. Mounting Shading Ball Assembly and Sensor (s)] in the section [5-3. Installation] to temporarily install the Sun Tracker; however, do not fix the Sun Tracker with anchor bolts since the Sun Tracker position may need to be adjusted by moving the whole tripod position. If the anchor bolt positions are already determined, reopen the anchor bolts holes after this alignment is performed.

   NOTE) At this step, make sure to setup the Sun Tracker in position with precise orientation and horizontal level.
3. Follow the instructions [A-3. Mounting Pyrheliometer MS-57 on Sun Tracker] or [A-4. Mounting DNI Spectroradiometer on Sun Tracker] to install the sensors on the Sun Tracker.

2) Check the Installation Site Position & Time Information

1. Follow the steps [3. Connecting Cables] and [4. Receiving GPS Data] in section [5-3. Installation] to connect the power supply cable and acquire the latitude/longitude and time information via GPS.
2. In case the installation site is in difficult location to receive GPS data, or LED indications on the Sun Tracker Body shows “Red” and determined there is problem with GPS data receiving, the installation site position and time information can be entered on software manually.

   Install the software following the instruction in [6-1. Installation and Uninstallation]. Setup the COM port according to [6-2. Select a COM Port number of RS232C] by connecting the Sun Tracker and PC using communication cable then enter the accurate latitude/longitude, and time information in the software as described in [6-3. Setting Latitude, Longitude, Date, and Time].

3) Sight Spot Check & Alignment using Sun Sensor Mode

1. At the step [5. Check Sun Tracker Movement] in section [5-3. Installation], check the Sun Tracker movement to make sure it is following the sun correctly, and the sight spot on the mounted sensor (pyrheliometer or collimation tube for spectroradiometers) are aligned properly.
2. If the sight spot is not aligned correctly, adjust the sight spot position following the instructions on [A-3. Mounting Pyrheliometer MS-57 on Sun Tracker] or [A-4. Mounting DNI Spectroradiometer on Sun Tracker].

4) Sight Spot Check & Alignment using Calculation Mode

1. After the sight spot is adjusted using the sun sensor mode, reset the learning function for the calculation mode by pulling out the power cable connector from the Sun Tracker body.
2. Plug the power cable connector again and start up the Sun Tracker. Let the Sun Tracker track the sun with calculation mode by making the sensor mode ineffective.

   At this time, learning function will become effective approximately 1 minute after the power is turned on, thus it is necessary to quickly make sun sensor function ineffective. To make the sun sensor mode ineffective, either to pull out the sun sensor cable out of the connector on Sun Tracker body or cover the sun sensor window with hand to block the sun light incident to the sun sensor.
3. Check for any difference in sight spot position between the positions aligned using sun sensor mode and calculation mode.
4. If different position is confirmed, DO NOT touch the X/Y-Axis Adjustment Unit or the Adjusting Bolts on Tilting Plate, but move the whole Sun Tracker body including the tripod to align the sight spot.

5) Reconfirm Sight Spot Position using Sun Sensor Mode

1. Use the sun sensor mode again to reconfirm there is no shift in sigh spot position from the calculation mode alignment.
2. If the sight spot position matches, alignment is completed.
   However, if the sight spot position is shifted again, repeat the steps 4 and 5 until sight spot position matches.

6) Alignment Complete

Lastly, check the horizontal level once again, and securely fix the Sun Tracker on the setup base using anchor bolts.

A-6. Commands List

By connecting the Sun Tracker Body and PC with attached communication cable and using appropriate terminal software downloaded to the PC, information from the Sun Tracker can be acquired through sending specific commands to the Sun Tracker.
Below provides the required conditions and commands.

Communication:	RS-232C
Baud Rate:	9600bps
Data Bit:	8bit
Parity:	None
Stop Bit:	1bit
Delimiter:	[CR] is only Carriage Return (0D)hex, [LF] Line Feed (0A)hex is not needed Differentiate the comma and decimal point as indicated.

1. Command asking for Firmware Version Number

VER[CR]	(Sending command)
3.00, OK[CR]	(Receiving Character String)

2. Command for Date and Time Setting

TM, 2003, 03, 18, 02, 23, 00[CR] (Sending Command)

- 00 — Second (2 digits)
- 23 — Minute (2 digits)
- 02 — Hour (2 digits)
- 18 — Date (2 digits)
- 03 — Month (2 digits)
- 2003 — Year (4 digits)

Enter the time with Greenwich Time (Month ~ Second can be entered with zero suppression)

OK[CR]/ERR[CR] (Receiving Character String)

3. Reading Command for Date and Time

TM[CR] (Sending Command)

2003, 03, 18, 02, 23, 05, OK[CR] (Receiving Character String)

- 2003: Year (4 digits)
- 03: Month (2 digits)
- 18: Date (2 digits)
- 02: Hour (2 digits)
- 23: Minute (2 digits)
- 05: Second (2 digits)

The time will be indicated with Greenwich Time (The received characters are not zero suppressed)

4. Command for Setting Location Information (Latitude, Longitude, etc.)

LO, 139.67500, 35.67100[CR] (Sending Command: example of longitude & latitude of Tokyo)

- 139.67500: Longitude
- 35.67100: Latitude

OK[CR]/ERR[CR] (Receiving Character String)

5. Command for Reading Location Information

LO[CR] (Sending Command)

+139.67500, +35.67100[CR] OK[CR] (Sending Command: example of longitude & latitude of Tokyo)

- +139.67500: Longitude
- +35.67100: Latitude

- This is an output of fixed field range.
- Always received with ± symbol at the head of the line.
- Received characters do not get zero suppression.

Ex.) When 1.2°E and 3.4°S, the result will be the following:
+001.20000, -03.40000, OK[CR]

6. Command for Reading the Current Direction of Angle

MR[CR] (Sending Command)

+057.555, +35.289, OK[CR] (Receiving Character String, When Azimuth: 57.555°, Altitude: 35.289°)

Azimuth Altitude

- This is an output of fixed field range.
- Always received with ± symbol at the head of the line.
- Received characters do not get zero suppression.

7. Command for Reading Current Calculated Location

CR[CR] (Sending Command)

+057.555, +35.289, OK[CR] (Receiving Character String, When Azimuth: 57.555°, Altitude: 35.289°)

Azimuth Altitude

The response will be the same as above “MR” command.

NOTE) If the response is OK, it means the command is accepted. If the command did not get accepted, it will indicate the error.

8. Command for Returning to Origin Position

MO[CR] (Sending Command)

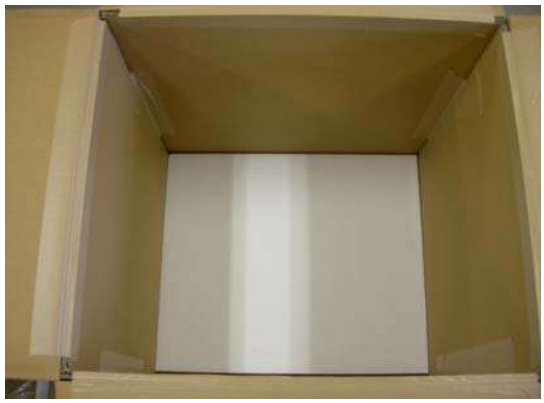
OK[CR] (Receiving Character String)

✧ Origin Position: Azimuth = In case of northern hemisphere, after receiving the command, True-South, altitude angle = 0 degree (horizontal position), the Sun Tracker will return to the origin position once then starts to track the sun right away.

A-7. Packing Procedure for Sun Tracker

When transporting the Sun Tracker to measuring sites, shipping back to EKO for maintenance or in case of repair, package the Sun Tracker with following procedure:

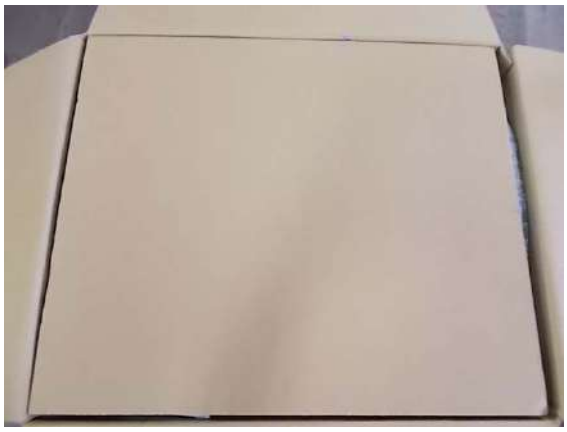
1) In a cardboard box which is little larger than the Sun Tracker, place a cushion material such as Styrofoam on the bottom of the box for reinforcement.



2) Adjust the Instrument Mount and Sun Sensor to horizontal position, and place the Sun Tracker in the box in “up-side-down” position. When inserting the Sun Tracker in the box, use cushions materials around the Sun Tracker so that the Sun Tracker will be positioned in the center of the box.

3) Making sure the Sun Tracker body, Instrument Mount, Sun Sensor, and Tripod will not directly contact the box; fill the gaps between the Sun Tracker and the box with cushion materials to fix the Sun Tracker in position.

4) At last, cover the Sun Tracker Tripod with cushion materials and hold it in position; close the inside lid.



5) Seal the box with tape securely, and packaging is complete.

It is recommended to place labels indicating “Handle with Care” and “This Side Up” on the box to prevent rough and improper handlings during the transportation.

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
95 South 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 32,
2521 AL, Den Haag,
The Netherlands
P. +31 (0)70 3050117
F. +31 (0)70 3840607
info@eko-eu.com
www.eko-eu.com