SENSOR SOLUTIONS

**3S-2IS**

# Dual Orientations
# Irradiance Sensor

## USER MANUAL

# USER MANUAL TABLE OF CONTENTS





Pinarcay OSB Mahallesi Organize Sanayi Tesisleri Teknokent Idare Binasi No: 7, D:1, 19100 Merkez / Corum / Türkiye
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## 1. Introduction

Dual Orientations Irradiance Sensor is a product of from the SEVEN meteorological sensors range of professional and intelligent measuring sensors with digital interface for environmental and industrial applications.

Figure 1 – Dual Orientations Irradiance Sensor

It is a weather station with measures of irradiance, temperature and wind speed. All measured meteorological data is transferred to dataloggers and receiver units via a 2-wire RS485 bus with Modbus RTU protocol.

The flexible design of the Dual Orientations Irradiance Sensor makes it possible to select external sensors according to the required parameters in meteorological applications.

SEVEN products use reliable and high-quality instruments to provide accurate meteorological information in environmental and industrial applications.

***Note:*** *SEVEN reserves the right to make changes in this entire document withhout prior notice.*

## 2. Dual Orientations Irradiance Sensor Installation

It is suggested that the system be operated at ground level to make sure that all components are working properly prior to installation. A general diagram of the progress of the installation steps is given below.

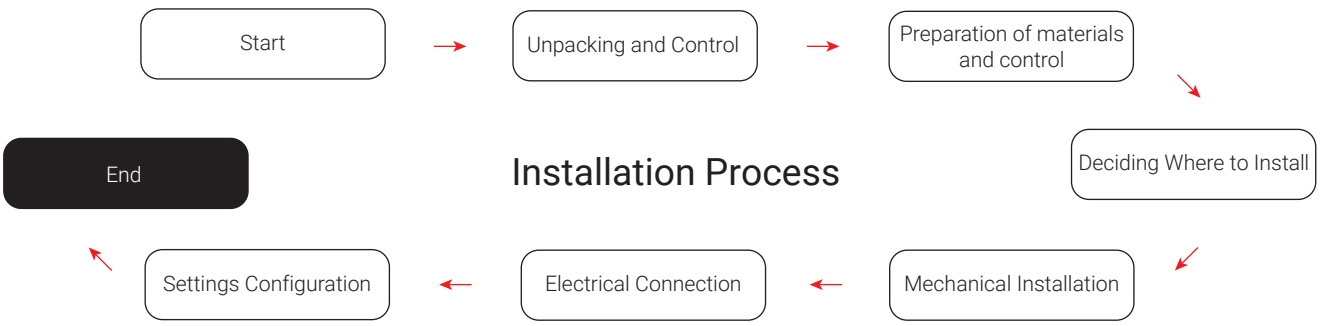


Figure 2 – Installation Process



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## 2.1. Unpacking and Control

Upon receipt of the product, it must be carefully checked whether the package content is complete. Seven Sensor Solutions must be contacted if any of the components are missing, damaged or defective.

| | | | | |
|---|---|---|---|---|
|  |  |  |  |  |
| A Qty 1 | B Qty 2 | C Qty 3 | D Qty 1 | E Qty 1 |
| Light Sigma Profile | Mounting Foot | Light Sigma Profile | Wind Speed Sensor Connection Sheet | Irradiance Sensor Support Sheet |
|  |  |  |  |  |
| F Qty 1 | G Qty 1 | a Qty 19 | b Qty 18 | c Qty 1 |
| Irradiance Sensor Connection Sheet | Ambient Temp. Sensor Connection Sheet | M6 x 12 Imbus Bolt | M6 T Channel Nut | Profile Cover |
|  |  |  |  | |
| d Qty 6 | e Qty 2 | f Qty 8 | g Qty 1 | |
| Hidden Corner Connection | M6 Fiber Nut | M6 x 30 Concrete Screw | M6 x 20 Butterfly Bolt | |

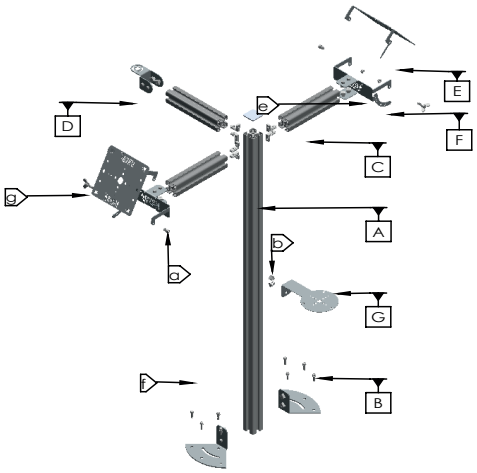


Figure 3 – Mounting Structure Packing List



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| A Qty 1 | B Qty 1 | C Qty 1 | D Qty 1 | E Qty 13 |
|---|---|---|---|---|
| Wind Direction Sensor | Wind Speed Sensor | Irradiance Sensor | M6 x 12 Imbus Bolt | M5 X 12 Imbus Bolt |

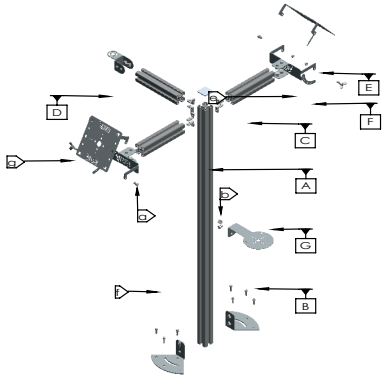


Figure 4 – Installation Process

***Note:*** *Quantity and content of the received material may be different based on customer confirmed order.*

## 2.2. Site Requirements and Considerations

When the Dual Orientations Irradiance Sensor is to be mounted on a rooftop, it should preferably be mounted on the prevailing wind side of the building. It should also be avoided to place the station near any heat source such as chimneys or ventilation.

The Dual Orientations Irradiance Sensor needs to be in the same direction and the same inclination as the solar panels. They should be positioned in the same or higher plane than the solar panels. The azimuth angle can be adjusted with a compass by rotating the mounting structure on its axis and the tilt angle can be adjusted with the protractor on the mounting structure.

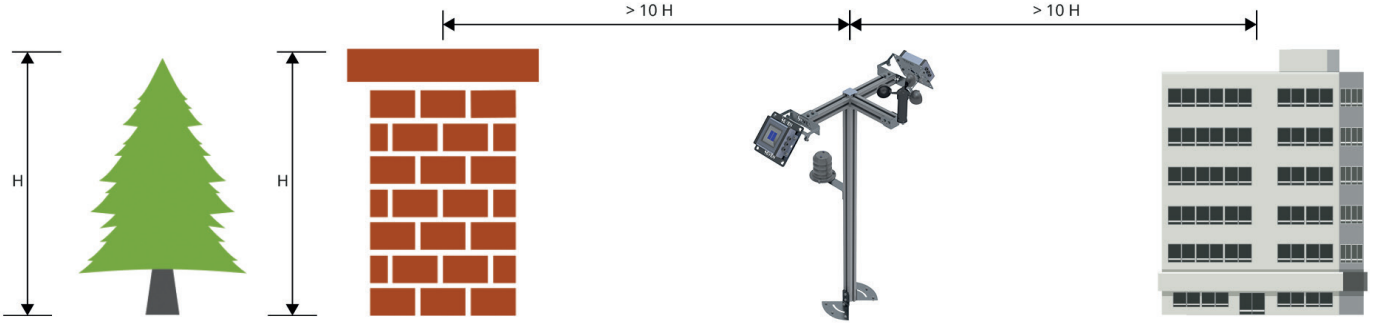


Figure 5 – Installation Site Selection

When the Dual Orientations Irradiance Sensor is to be mounted on a rooftop, it should preferably be mounted on the prevailing wind side of the building. It should also be avoided to place the station near any heat source such as chimneys or ventilation.

The Dual Orientations Irradiance Sensor needs to be in the same direction and the same inclination as the solar panels. They should be positioned in the same or higher plane than the solar panels. The azimuth angle can be adjusted with a compass by rotating the mounting structure on its axis and the tilt angle can be adjusted with the protractor on the mounting structure.



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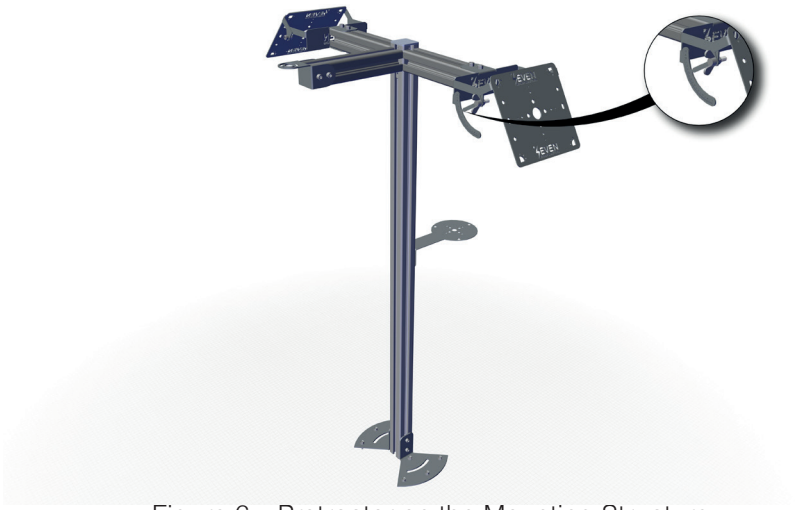


Figure 6 – Protractor on the Mounting Structure

***Note:*** *To facilitate the maintenance and cleaning of the Dual Orientations Irradiance Sensor must be installed in an easily accessible location, especially for rooftop projects.*

The Module Temperature Sensors must be installed at the exact midpoint of the solar panel. A sensor location should be chosen in the center of the cell closest to the exact midpoint of the module, avoiding the boundaries between cells. Module Temperature Sensors Installation Manual can be relieved for more detail.

## 2.3. Preparation of Materials to be Used in Installation

The materials needed during installation are provided by SEVEN. The user should only prepare the following hand tools and personal protective equipment.

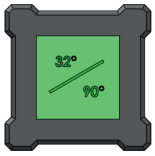
| Materials | | |
|---|---|---|
|  |  |  |
| Gloves | Meter | Drill |
|  |  |  |
| 6 mm Concrete Screw Drill Bit | Spirit Level | Digital Compass |

Figure 7 – Materials to be Used in Installation



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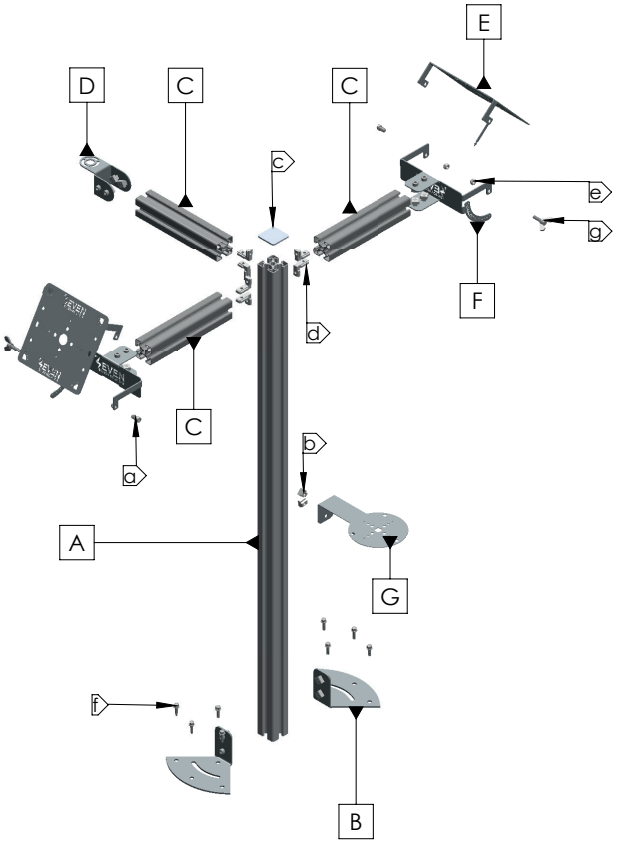
## 2.4. Installation

3S-2IS Dual Orientations Irradiance Sensor installation can be handled in 2 steps. Firstly, the **Dual Orientations Irradiance Sensor** mounting structure must be installed. Then the sensors must be fixed to the mounting structure. The installation can be easily completed by a qualified electrician by following SEVEN instructions.

### 2.4.1. Mounting Structure

The installation of the mounting structure in which the sensors are to be mounted is very simple and fast.




| No | Part Name | Definition | Qty |
|---|---|---|---|
| **A** | Light Sigma Profile | K8 - 40 x 40 x 1000 mm Aluminum | 1 |
| **B** | Mounting Foot | 3 mm Chrome | 2 |
| **C** | Light Sigma Profile | K8 - 40 x 40 x 200 mm Aluminum | 3 |
| **D** | Wind Speed Sensor Connection Sheet | 1,5 mm Chrome | 1 |
| **E** | Irradiance Sensor Connection Sheet | 2 mm Chrome | 2 |
| **F** | Irradiance Sensor Support Sheet | 1,5 mm Chrome | 2 |
| **a** | M6 x 12 Imbus Bolt | Stainless | 20 |
| **b** | M6 T Channel Nut | Stainless | 18 |
| **c** | Profile Cover | K8 - 40 x 40 mm Plastic | 1 |
| **d** | Hidden Corner Connection | 30 x 30 mm Aluminum | 6 |
| **e** | M6 Fiber Nut | Stainless | 4 |
| **f** | Concrete Screw | M6 x 30 mm | 8 |
| **g** | M6 x 20 Butterfly Bolt | Aluminum | 2 |



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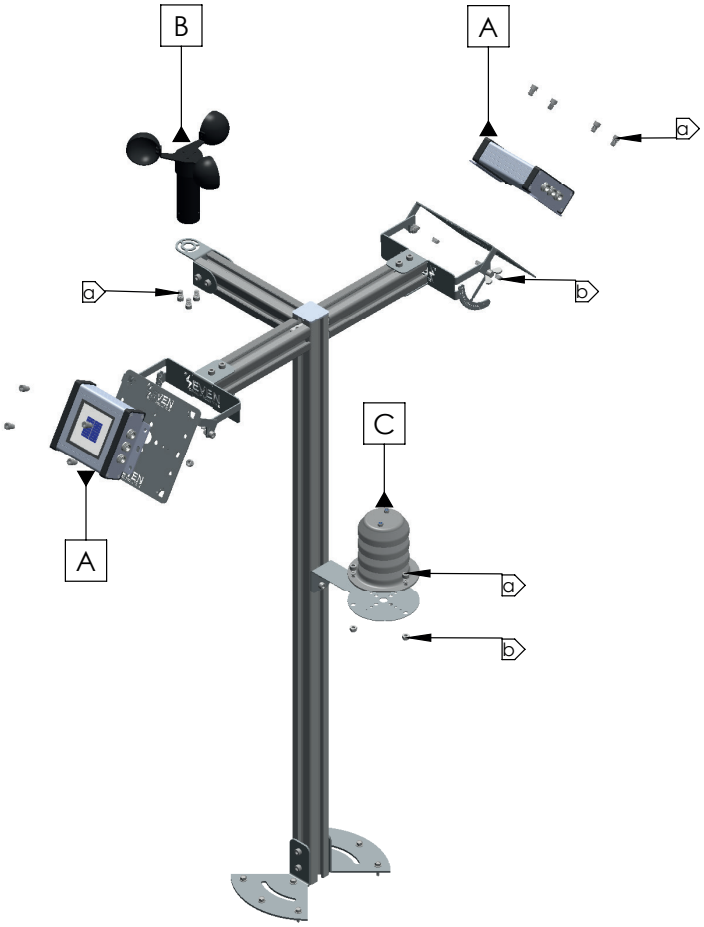
### 2.4.2. External Sensors

The external sensors must be fixed to the mounting structure as shown below, after the installation of the mounting structure is completed.




| No | Part Name | Definition | Qty |
|---|---|---|---|
| **A** | Irradiance Sensor | Aluminum | 2 |
| **B** | Wind Speed Sensor | Anodized Aluminum Housing – ABS Cup | 1 |
| **C** | Ambient Temperature Sensor | ABS | 1 |
| **a** | M6 x 12 Imbus Bolt | Stainless | 20 |
| **b** | M6 T Fiber Nut | Stainless | 18 |

## 2.5. Inspection and Maintenance

Dual Orientations Irradiance Sensor is not requiring any maintenance or changing of spare parts. However, the cleaning of the solar cell surface should be done periodically according to the standard which follow for site monitoring. The surface of the solar cell glass can be gently cleaned with a soft cloth and soapy water.

Fastener tightness and cable conditions, looking for damage, deterioration, or disconnection of sensors and electrical enclosures, soiling or displacement of optical sensors, evidence of moisture or vermin in enclosures, loose wiring connections, detachment of temperature sensors, embrittlement of attachments and other potential problems, should be checked periodically.



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***Note:*** *We recommend to use thread-locking fluid for fasteners.*

According to IEC 61724-1:2021, the monitoring system should be inspected at least annually and preferably at more frequent intervals.

## 3. Test and Calibration

SEVEN delivers all Dual Orientations Irradiance Sensors with calibration certificates.

Each irradiance sensor is calibrated under Class AAA Sun Simulator according to IEC 60904-2 and IEC 60904-4 standards by using a reference cell calibrated by Institute for Solar Energy Research (ISFH) in Germany.

Each irradiance sensor is tested under natural sunlight by using a reference cell calibrated by the Fraunhofer Institute for Solar Energy Systems ISE in Germany.

### 3.1. Recalibration

Recalibration of irradiance sensors according to IEC 61724-1 standard shall be conducted in a manner that minimizes downtime and sensor outages in order to prevent interruption of monitoring.

Effective methods may include:

• Exchanging installed sensors with new or recalibrated sensors

• Performing on-site recalibration of sensors where possible

• Providing redundant sensors and alternating laboratory recalibration schedules.

According to IEC 61724-1 standard, “for Class A systems, irradiance sensors shall be recalibrated once every 2 years, or more frequently per manufacturer recommendations. For Class B systems, recalibrate irradiance sensors according to manufacturer recommendations.”

The recommended recalibration period is at least once every 3 years from the installation of the irradiance sensors in the site.

## 4. Connections

External sensors are designed with the Plug & Run principle. The sensor connection box has waterproof and UV resistant connectors. Each external sensor has a different pin configuration, so wrong connection is not possible. The minimum bending radius at cables is 5 mm.

| Connector Assignment for External Sensors | |
|---|---|
| **Wind Speed Sensor** | 2 pin Connector |
| **Module Temperature Sensor** | 4 pin Connector |
| **Plane of Array Irradiance Sensor** | 6 pin Connector |
| **Ambient Temperature Sensor** | 5 pin Connector |



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The supply voltage for the Dual Orientations Irradiance Sensor is 12 - 30 V DC. Operation with a supply voltage of 24 V is recommended.

The Dual Orientations Irradiance Sensor has an electrically isolated, half-duplex, 2 wire RS485 interface for configuration, communication and the firmware update.

The communication and power cable of Dual Orientations Irradiance Sensor should be always laid separated from AC/DC cables.

***Note:*** *The installation and electrical connections of SEVEN sensors should be carried out by a qualified electrician.*

| Wire Assignment for Power & Communication | |
|---|---|
| **RS485 A / Data (+)** | Green |
| **RS485 B / Data (-)** | Yellow |
| **Positive Supply Voltage** | Brown |
| **Supply Voltage Ground** | White |

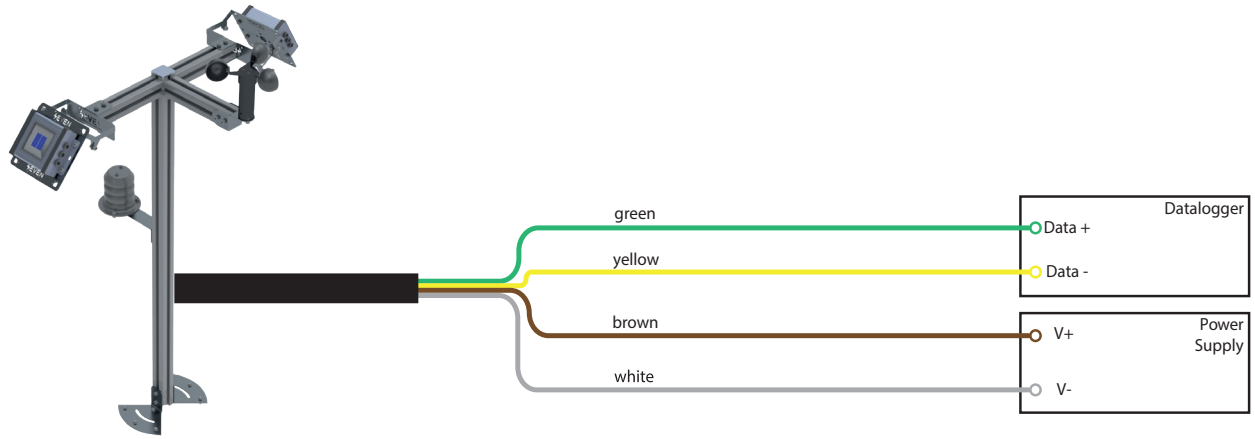


Figure 8 – Wire Assignment for Power & Communication

## 5. Configuration and Communication

Once the Dual Orientations Irradiance Sensor has been installed and connected correctly, the sensor begins autonomously to take measurements.

**Attention must be paid to the following points:**
• A measurement request should be made to the Dual Orientations Irradiance Sensor with the 3S-2IS Configuration Tool and it should be checked whether it correctly operation in the site.
• If several Modbus Device are operated on a network, a unique device ID must be assigned to each device.
Follow SEVEN instructions to configure the Dual Orientations Irradiance Sensor on dataloggers.



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## 5.1. 3S-2IS Configuration Tool

3S-2IS Configuration Tool is a software tool for testing communication and adjusting Modbus parameters on the Dual Orientations Irradiance Sensor. The 3S-2IS Configuration Tool can also be used to update the firmware of the Dual Orientations Irradiance Sensor.

A Windows® PC with a serial bus interface set as a serial COM port, 3S-2IS Configuration Tool software, and USB to RS485 Converter are required for configuration and testing purposes.

Download the software 3S-2IS Configuration Tool and install it on your computer. Download link is below.
https://www.sevensensor.com/files/3s-configuration-tool-v2.0.zip

***Note:*** If the serial COM port does not appear when the 3S-2IS Configuration Tool is connected to the computer via USB to RS485 Converter, the serial COM port driver must be updated.

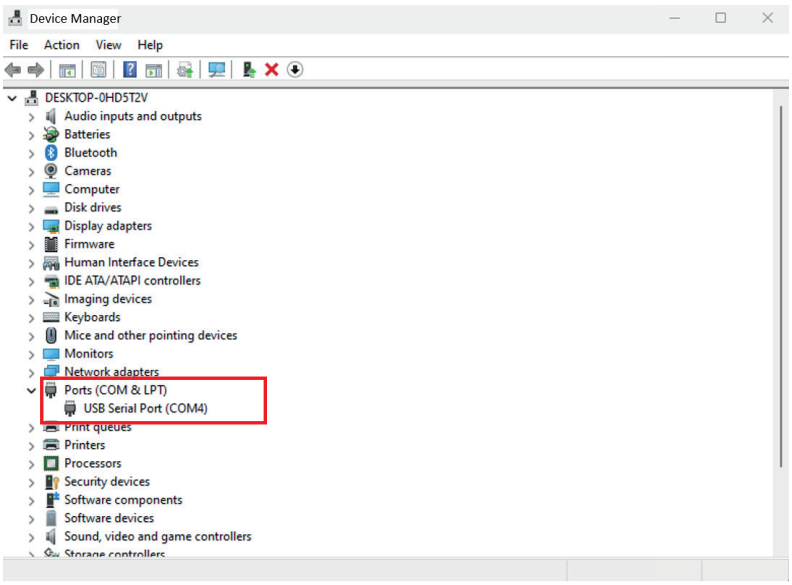


Figure 9 – Serial COM Port

***Note 2:*** *Make sure to always use the correct and current version of the 3S-2IS Configuration Tool for Dual Orientations Irradiance Sensor configuration.*

### 5.1.1. Establishing Connection

The 3S-IS and 3S-IS-LR Irradiance Sensors are connected to the computer via USB to RS485 Converter by making a cable connection as described in the “4. Connections” section. After launching the 3S-IS Configuration Tool, the following screen will appear.



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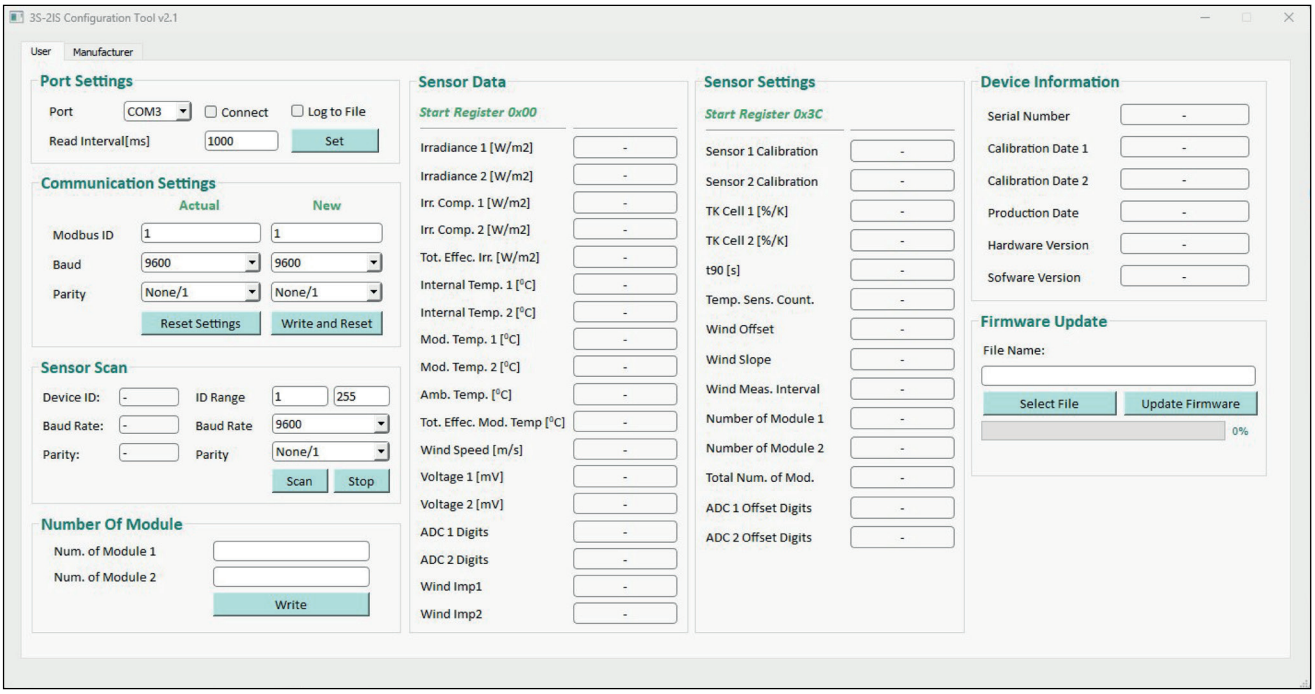


Figure 10 – 3S-IS Configuration Tool

Follow the steps below to connect to the Dual Orientations Irradiance Sensor with the 3S-2IS Configuration Tool.

- Select the serial COM port to which the USB to RS485 converter is connected.
- Enter the Modbus ID, Baud rate and Parity of the Dual Orientations Irradiance Sensor in the **"Actual"** section of the **"Communication Settings"**.
- Click on **"Connect"**.

***Note:*** *Factory defaults of the Irradiance Sensor: Modbus ID* ***1****, Baud rate* **9600***, Parity* **none/1***.*

Once the connection is successfully completed, the data received from the device will be displayed in the **"Sensor Data"** section. Irradiance Sensor details can be found in the **"Device Information"** section.

### 5.1.2. Change the Modbus Parameters

To change the Modbus parameters (Modbus ID, Baud rate and Parity) of the device, enter the values you want to assign in the **"New"** section of the **"Communication settings"** and click on **"Write and Reset"**.

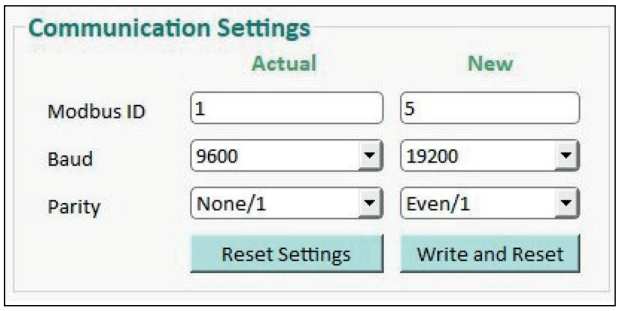


Figure 11 - Changing Modbus Parameters



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### 5.1.3. Find the Modbus Parameters

If Modbus parameters are changed and the connection cannot be established with the device, the following steps should be followed to find the Modbus parameters of the Dual Orientations Irradiance Sensor.

- Modbus parameters of device can be found with **"Scan"** button in the **"Port Settings"** section.

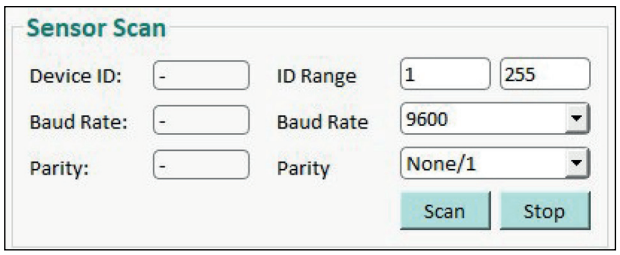


Figure 12 – Finding Modbus Parameters

- When the search is completed and the Modbus parameters of the device are found, a message **"Sensor Device is connected"** (as in Figure 13) will appear on the desktop. The found parameters are filled in automatically.

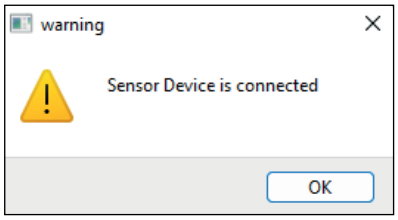


Figure 13 – Sensor Device is connected

- Reconnect with the **"Connect"** button.

### 5.1.4. Entering the Number of Modules

In the "Number of Modules" section, enter the number of panels for the two directions on the site and click **"Write"**.

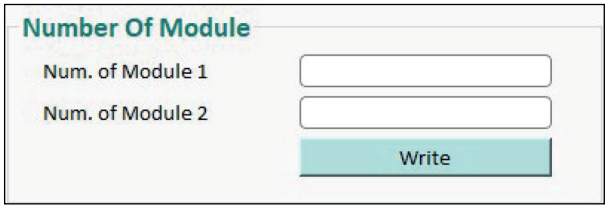


Figure 14 – Entering the Number of Modules

***Note:*** *Modbus parameters search can be stopped at any time with the* **"Stop Scan"** *button.*

### 5.1.5. Firmware Update

Dual Orientations Irradiance Sensor firmware can be updated by SEVEN depending product developments. SEVEN provides this updated firmware to users free of charge. If the Dual Orientations Irradiance Sensor firmware needs to be updated, the following steps should be followed.



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Figure 11 – Changing Modbus Parameters

• Clicking on the **"Select File"** button in the **"Firmware Update"** section, the current firmware file with the **".bin"** extension is selected.
• The firmware update is started with the **"Update Firmware"** button. The update process is confirmed in the pop-up message box and can be followed on the loading bar.

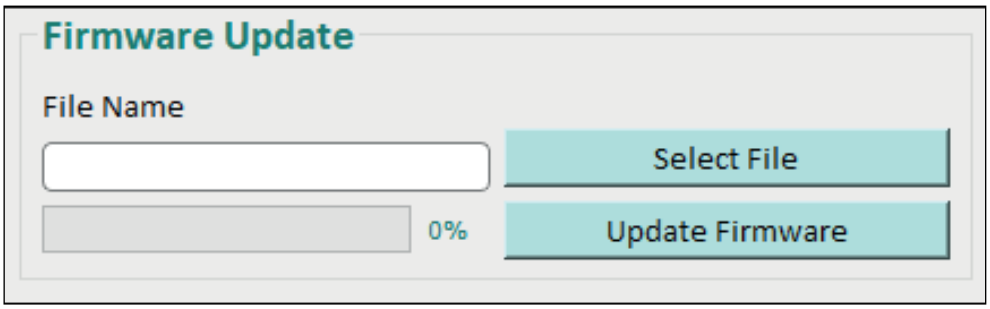


Figure 15 – Software Update Process

• After the firmware update process is completed, reconnection can be established clicking on the **"Connect"** button.

***Note:*** *Please contact SEVEN sales team for the current firmware version.*

## 5.2. Modbus RTU Specifications

### 5.2.1. Supported Bus Protocol

The Dual Orientations Irradiance Sensor is equipped with an RS-485 communication port that supports Modbus RTU commands. The Dual Orientations Irradiance Sensor can be configured to operate in different communication parameters. The table that follows describes each supported bus protocol.

| | |
|---|---|
| **Baud Rate** | 4800, 9600, 19200, 38400 |
| **Parity** | None, Even, Odd |
| **Stop Bit** | 1, 2 (only at None parity) |
| **Factory Default** | 9600 Baud, 8N1, address: 1 |

### 5.2.2. Supported Function Codes

The Dual Orientations Irradiance Sensor supports a specific subset of Modbus RTU commands. The table that follows lists each supported function code.

| | |
|---|---|
| **0x03** | Read Holding Registers |
| **0x04** | Read Input Registers |
| **0x46** | Read & Change Parameters |
| **0x08** | Diagnostics |

***Note:*** *All checksums of the Modbus protocol are omitted in this document. These checksums must always be calculated and sent during communication.*



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### 5.2.2.1. Read Holding Registers (0x03)

The 3S-IS and 3S-IS-LR Irradiance Sensors support a specific subset of Modbus RTU commands. The table that follows lists each supported function code.

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x03 |
| **Start Register** | 2 Byte (Big Endian) | see register table below |
| **End Register** | 2 Byte (Big Endian) | see register table below |

Slave Response:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x03 |
| **Number of Bytes** | 1 Byte | 0 to 255 (2xN) N = Number of Registers |
| **Data** | 2 Byte x N (Big Endian) | see register table below |

## Holding Register Map

The Dual Orientations Irradiance Sensor holding register map is based on the “SunSpec Alliance” communication standards.

| Start | End | Value | Type | Units | Scale Factor | Constant |
|---|---|---|---|---|---|---|
| 40000 | 40001 | SunSpec ID | uint32 | N/A | N/A | "SunS" |
| 40002 | 40002 | SunSpec Device ID | uint16 | N/A | N/A | 0x0001 |
| 40003 | 40003 | SunSpec Length | uint16 | Registers | N/A | 65 |
| 40004 | 40019 | Manufacturer | String (32) | N/A | N/A | "SevenSensor" |
| 40020 | 40035 | Model | String (32) | N/A | N/A | "3S-2IS" |
| 40036 | 40043 | Hardware Version | String (16) | N/A | N/A | "2.0" |
| 40044 | 40051 | Software Version | String (16) | N/A | N/A | "2.0" |
| 40052 | 40067 | Serial Number | String (32) | N/A | N/A | "23.12.345.65.0013" |
| 40068 | 40068 | Device ID | uint16 | N/A | N/A | 1 |
| Sunspec Device Model Measurement Registers | | | | | | |
| 40069 | 40069 | Block ID | int16 | N/A | N/A | 307 |
| 40070 | 40070 | Length | int16 | Registers | N/A | 11 |
| 40071 | 40071 | Air Temperature | int16 | °C | 0.1 | Measured |
| 40074 | 40074 | Wind Speed | int16 | m/s | 0.1 | Measured |
| Irradiance Model Registers | | | | | | |
| 40082 | 40082 | Block ID | int16 | N/A | 0 | 302 |
| 40083 | 40083 | Length | int16 | Registers | 0 | 5 |
| 40084 | 40084 | Plane of Array | uint16 | W/m² | 0.1 | Measured |
| 40085 | 40085 | Plane of Array 2 | Uint16 | W/m² | 0.1 | Measured |
| 40086 | 40086 | Diffuse Irradiance | uint16 | W/m² | 0 | N/A |
| 40087 | 40087 | Direct Irradiance | uint16 | W/m² | 0 | N/A |
| 40088 | 40088 | Total Effective Irradiance | uint16 | W/m² | 0 | Measured |



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| | | | | | | |
|---|---|---|---|---|---|---|
| **Back of Module Temperature Registers** | | | | | | |
| **40089** | **40089** | **Block ID** | int16 | N/A | N/A | **303** |
| **40090** | **40090** | **Length** | int16 | Registers | N/A | **3** |
| **40091** | **40091** | **Module Temperature**<br>**Total Effective Modul Temperature** | int16 | °C | 0.1 | **Measured** |
| **40092** | **40092** | **Modul Temp 1** | int16 | °C | 0.1 | **Measured** |
| **40093** | **40093** | **Modul Temp 2** | int16 | °C | 0.1 | **Measured** |
| **Device Model Measurement Registers** | | | | | | |
| **40093** | **40093** | **Block ID** | int16 | N/A | N/A | **308** |
| **40094** | **40094** | **Length** | int16 | Registers | N/A | **5** |
| **40095** | **40095** | **Total Effective Irradiance** | int16 | W/m² | 0.1 | **N/A** |
| **40096** | **40096** | **Modul Temp1** | int16 | °C | 0.1 | **Measured** |
| **40097** | **40097** | **Modul Temp2** | int16 | °C | 0.1 | **N/A** |
| **40098** | **40098** | **Wind Speed** | int16 | m/s | 0.1 | **Measured** |
| **40099** | **40099** | **Air Temperature** | int16 | °C | 0.1 | **Measured** |
| **Device Model Measurement Registers** | | | | | | |
| **40100** | **40100** | **End of SunSpec Block** | uint16 | N/A | N/A | **0xFFFF** |
| **40101** | **40101** | **Length** | uint16 | Registers | 0 | **0** |
| **40102** | **40102** | **Plane of Array**<br>**Total Effective Irradiance** | int16 | W/m² | 0.1 | **Measured** |
| **40103** | **40103** | **Module Temp1** | **int16** | **°C** | **0.1** | **Measured** |
| **40104** | **40104** | **Module Temp2** | int16 | °C | 0.1 | **Measured** |
| **40105** | **40105** | **Wind Speed** | int16 | m/s | 0.1 | **Measured** |
| **40106** | **40106** | **Air Temperature** | int16 | °C | 0.1 | **Measured** |
| **End of Block Registers** | | | | | | |
| **40107** | **40107** | **End of SunSpec Block** | uint16 | N/A | N/A | **0xFFFF** |
| **40108** | **40108** | **Length** | **uint16** | **Registers** | **0** | **0** |
| **Device Address Read/Write Register** | | | | | | |
| **40109** | **40109** | **Modbus ID – Write Register** | **uint16** | **N/A** | **N/A** | **1** |

### 5.2.2.2. Read Input Registers (0x04)

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x04 |
| **Start Register** | 2 Byte (Big Endian) | see register table below |
| **End Register** | 2 Byte (Big Endian) | see register table below |

Slave Resonse:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x04 |
| **Number of Bytes** | 1 Byte | 0 to 255 (2xN) N = Number of Registers |
| **Data** | 2 Byte x N (Big Endian) | see register table below |

**Input Register Map**

A common input register map has been created for all SEVEN Modbus devices. All data marked in bold in the common input register map below are defined for Dual Orientations Irradiance Sensor.

***Note:*** *Values marked as "raw data" are for information only and should not be used for serial applications.*



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The following Modbus data marked in bold can be read individually or in blocks.

| ID-Dec | ID-Hex | Value | Range | Resolution |
|---|---|---|---|---|
| **30000** | **0x00** | **Irradiance 1** | **0…1600 W/m²** | **0.1 W/m²** |
| **30001** | **0x01** | **Irradiance 2** | **0…1600 W/m²** | **0.1 W/m²** |
| **30002** | **0x02** | **Total Effective Compensated Irradiance** | **0…1600 W/m²** | **0.1 W/m²** |
| **30003** | **0x03** | **Temperature Compensated Irradiance 1** | **0…1600 W/m²** | **0.1 W/m²** |
| **30004** | **0x04** | **Temperature Compensated Irradiance 2** | **0…1600 W/m²** | **0.1 W/m²** |
| **30005** | **0x05** | **mV Value of Irradiance 1 (raw data)** | **-** | **0.01 mV** |
| **30006** | **0x06** | **Temperature Compensated Irradiance 1** | **0…1600 W/m²** | **0.1 W/m²** |
| **30007** | **0x07** | **Temperature Compensated Irradiance 2** | **0…1600 W/m²** | **0.1 W/m²** |
| **30008** | **0x08** | **Digit Value of the ADC 2 (raw data)** | **0…4096** | **1** |
| **30009** | **0x09** | **Internal Cell Temperature 1** | **-40…+85 °C** | **0.1°C** |
| **30010** | **0x0A** | **Internal Cell Temperature 2** | **-40…+85 °C** | **0.1°C** |
| **30011** | **0x0B** | **Module Temperature 1** | **-40…+85 °C** | **0.1°C** |
| **30012** | **0x0C** | **Total Effective Temperature Compansated Irradiance** | **0…1600 W/m²** | **0.1 W/m²** |
| **30013** | **0x0D** | **Total Effective Module Temperature** | **-40…+85 °C** | **1°C** |
| **30014** | **0x0E** | **Ambient Temperature** | **-40…+85 °C** | **0.1°C** |
| 30015 | 0x0F | Internal Temperature 1 | -40…+85 °C | 0.1°C |
| 30016 | 0x10 | Internal Temperature 2 | -40…+85 °C | 0.1°C |
| **30017** | **0x11** | **Wind Speed** | **0…40 m/s** | **0.1 m/s** |
| **30018** | **0x12** | **Wind sensor number of pulses since last modbus read out (high-word) (raw data)** | **Pulse** | **1** |
| **30019** | **0x13** | **Wind sensor number of pulses since last modbus read out (low-word) (raw data)** | **Cycle** | **1** |
| 30020 | 0x14 | Wind Direction | 0…359° | 1 |
| 30021 | 0x15 | Total Effective Module Temperature | -40…+85 °C | 0.1°C |
| 30022 | 0x16 | Module Temperature 1 | -40…+85 °C | 0.1°C |
| 30023 | 0x17 | Module Temperature 2 | -40…+85 °C | 0.1°C |
| 30024 | 0x18 | Daily Average Soiling Ratio | 0…100% | 0.1% |
| 30025 | 0x19 | Stable Data Counter | - | 1 |
| 30026 | 0x1A | Solar Noon Time Hour | Hour | 1 |
| 30027 | 0x1B | Solar Noon Time Minute | Minute | 1 |
| 30028 | 0x1C | Rain Gauge (Min) | | 0.1 mm/min |
| 30029 | 0x1D | Ambient Temperature | -40…+85 °C | 0.1°C |
| 30030 | 0x1E | Irradiance 3 | 0…1600 W/m² | 0.1 W/m² |
| 30031 | 0x1F | Irradiance 4 | 0…1600 W/m² | 0.1 W/m² |
| 30032 | 0x20 | Temperature Compensated Irradiance 3 | 0…1600 W/m² | 0.1 W/m² |
| 30033 | 0x21 | Temperature Compensated Irradiance 4 | 0…1600 W/m² | 0.1 W/m² |
| 30034 | 0x22 | mV Value of Irradiance 3 (raw data) | - | 0.01 mv |
| 30035 | 0x23 | mV Value of Irradiance 4 (raw data) | - | 0.01 mv |
| 30036 | 0x24 | Digit Value of the ADC 3 (raw data) | 0…4096 (raw data) | 1 |
| 30037 | 0x25 | Digit Value of the ADC 4 (raw data) | 0…4096 (raw data) | 1 |
| 30038 | 0x26 | Internal Cell Temperature 3 | -40…+85 °C | 0.1°C |
| 30039 | 0x27 | Internal Cell Temperature 4 | -40…+85 °C | 0.1°C |
| 30040 | 0x28 | Module Temperature 3 | -40…+85 °C | 0.1°C |
| 30041 | 0x29 | Module Temperature 4 | -40…+85 °C | 0.1°C |
| 30042 | 0x2A | Albedo | 0…1 | 0.001 |
| 30053 | 0x35 | Wind Speed | 0…40 m/s | 0.1 m/s |



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Additionally, the following internal data marked in bold can be read individually or in blocks.

| 30060 | 0x3C | Hardware Version | | Range |
|---|---|---|---|---|
| **30061** | **0x3D** | **Software Version** | | **Manufacturer Parameters Read Only** |
| **30062** | **0x3E** | **Calibration Value 1** | | |
| **30063** | **0x3F** | **Calibration Value 2** | | |
| **30064** | **0x40** | **Temperature Coefficient Value 1** | | |
| **30065** | **0x41** | **Temperature Coefficient Value 2** | | |
| **30066** | **0x42** | **ADC Offset Value 1** | | |
| **30067** | **0x43** | **ADC Offset Value 2** | | |
| **30068** | **0x44** | **Temperature Sensor Count** | | |
| **30069** | **0x45** | **Number of Module** | | |
| **30070** | **0x46** | **T90 value** | | |
| **30071** | **0x47** | **Wind Speed Offset Value** | | |
| **30072** | **0x48** | **Serial Number** | **Production Day** | |
| **30073** | **0x49** | | **Production Month** | |
| **30074** | **0x4A** | | **Production Year** | |
| **30075** | **0x4B** | | **Board Serial Number** | |
| **30076** | **0x4C** | | **Box Serial Number** | |
| **30077** | **0x4D** | | **Sensor Serial Number** | |
| **30078** | **0x4E** | **Production Date** | **Production Day** | |
| **30079** | **0x4F** | | **Production Month** | |
| **30080** | **0x50** | | **Production Year** | |
| **30081** | **0x51** | **Calibration Date 1** | **Calibration Day 1** | |
| **30082** | **0x52** | | **Calibration Month 1** | |
| **30083** | **0x53** | | **Calibration Year 1** | |
| **30084** | **0x54** | **Calibration Date 2** | **Calibration Day 2** | |
| **30085** | **0x55** | | **Calibration Month 2** | |
| **30086** | **0x56** | | **Calibration Year 2** | |
| 30087 | 0x57 | Calibration Date 3 | Calibration Day 3 | |
| 30088 | 0x58 | | Calibration Month 3 | |
| 30089 | 0x59 | | Calibration Year 3 | |
| 30090 | 0x5A | Calibration Date 4 | Calibration Day 4 | |
| 30091 | 0x5B | | Calibration Month 4 | |
| 30092 | 0x5C | | Calibration Year 4 | |
| **30110** | **0x6E** | **Module Rate 1** | | **User Parameters Read / Write** |
| **30111** | **0x6F** | **Module Rate 2** | | |
| **30112** | **0x70** | **Analog Sensor Selection** | | |
| **30113** | **0x71** | **Wind Speed Sensor Offset Value** | | |
| **30114** | **0x72** | **Wind Speed Sensor Slope High Value** | | |
| **30115** | **0x73** | **Wind Speed Sensor Slope Low Value** | | |
| **30116** | **0x74** | **Wind Speed Sensor Interval Value** | | |
| 30117 | 0x75 | Wind Direction Enable Selection | | |



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#### 5.2.2.3. Read & Change Parameters (0x46)

**Sub Function (0x04): Write Device Address**

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x04 |
| **New Address** | 1 Byte | 1 to 247 |

Slave Response:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x04 |
| **New Address** | 1 Byte | 1 to 247 |

**Sub Function (0x06): Write Communication Parameters**

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x06 |
| **New Baud Rate** | 1 Byte | 0 to 3, see table below |
| **New Parity / Stop Bit** | 1 Byte | 0 to 3, see table below |

Slave Response:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x06 |
| **New Baud Rate** | 1 Byte | 0 to 3, see table below |
| **New Parity / Stop Bit** | 1 Byte | 0 to 3, see table below |

***Note:*** *When the "Write Communication Parameters" command is used, the "Write Device Address" command must also be used before the restart communication command.*

**Communication Parameter Settings**

Additionally, the following internal data marked in bold can be read individually or in blocks.

| Baud Rate | Value | Parity / Stop Bit | Value |
|---|---|---|---|
| **4800** | **0** | **None/1** | 0 |
| **9600** | **1** | **None/2** | 1 |
| **19200** | **2** | **Odd** | 2 |
| **38400** | **3** | **Even** | 3 |



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## Sub Function (0x07): Read Hardware & Software Versions

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x07 |

Slave Response:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x07 |
| **Hardware Version** | 2 Byte (Little Endian) | 0 to 65535 |
| **Software Version** | 2 Byte (Little Endian) | 0 to 65535 |

## Sub Function (0x08): Read Serial Number - Production Date - Calibration Date

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x08 |

Slave Response:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x46 |
| **Sub Function Code** | 1 Byte | 0x08 |
| **Production Year** | 1 Byte | 0 to 99 |
| **Production Code** | 1 Byte | 0 to 99 |
| **Cell Serial Number** | 2 Byte (Little Endian) | 0 to 999 |
| **Board Serial Number** | 1 Byte | 0 to 99 |
| **Box Serial Number** | 1 Byte | 0 to 99 |
| **Sensor Serial Number** | 2 Byte (Big Endian) | 0 to 9999 |
| **Production Day** | 1 Byte | 1 to 31 |
| **Production Month** | 1 Byte | 1 to 12 |
| **Production Year** | 1 Byte | 0 to 99 |
| **Calibration Day 1** | 1 Byte | 1 to 31 |
| **Calibration Month 1** | 1 Byte | 1 to 12 |



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Slave Response:

| | | |
|---|---|---|
| **Calibration Year 1** | 1 Byte | 0 to 99 |
| **Calibration Day 2** | 1 Byte | 1 to 31 |
| **Calibration Month 2** | 1 Byte | 1 to 12 |
| **Calibration Year 2** | 1 Byte | 0 to 99 |
| **Calibration Day 3** | 1 Byte | 1 to 31 |
| **Calibration Month 3** | 1 Byte | 1 to 12 |
| **Calibration Year 3** | 1 Byte | 0 to 99 |
| **Calibration Day 4** | 1 Byte | 1 to 31 |
| **Calibration Month 4** | 1 Byte | 1 to 12 |
| **Calibration Year 4** | 1 Byte | 0 to 99 |

### 5.2.2.4. Diagnotics (0x08)

Master Request:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x08 |
| **Restart Code** | 4 Byte | 0x00000000 |

Slave Response:

| | | |
|---|---|---|
| **Address** | 1 Byte | 1 to 247 |
| **Function Code** | 1 Byte | 0x08 |
| **Restart Code** | 4 Byte | 0x00000000 |

## 6. Specifications

3S-2IS measures the Plane of Array Irradiance, Module & Ambient Temperature and Wind Speed. The Dual Orientations Irradiance Sensor provides these measurements as a digital output.

The Dual Orientations Irradiance Sensor must be used in combination with suitable power supply and a data acquisition system which uses the Modbus communication protocol via RS485. It is equipped with a RS485 communications port that supports a subset of Modbus RTU commands. Baud rates of 4800, 9600, 19200, and 38400 are supported. Holding and input registers are supported.

The Dual Orientations Irradiance Sensor should be powered from an external power supply. The power supply input is nominally rated for 24 V DC but can accept a voltage in the range of 12 to 30 V DC. The inputs are reverse polarity and surge protected. The power supply and RS485 bus are isolated from each other.

The instrument is classified according to IEC 61724-1 and should be used in accordance with the recommended practices of IEC, WMO and ASTM.



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## 6.1. Technical Specifications

| General Specifications | |
|---|---|
| **Measured Data** | Plane of Array Irradiance, Module & Ambient Temperature and Wind Speed. |
| **Standards** | Compliant to IEC 61724-1:2021 |
| **Digital Outputs** | RS485 up to 38400 Baud |
| **Communication Protocol** | Modbus RTU<br>*(Optional Modbus TCP/IP)* |
| **Output Rate** | 1/s |
| **Operating Temperature Range** | -40°C to +85°C |
| **Mounting Structure** | Aluminum & Stainless Steel |
| **Dimensions** | 630 x 860 x 1285 mm (W x L x H)<br>*(Height can be changed as per request)* |
| **Weight** | 5.8 kg |
| **IP Rating** | IP 54<br>*(Optional IP 67)* |
| **Power Supply** | 12 to 30 V DC |
| **Power Consumption** | 25 mA @ 24 V DC |
| **Electrical Connection** | 3 m LIYYC11Y PUR Cable, UV and weather resistant |
| **Galvanic Isolation** | 1000 V between power supply and RS485 Bus |
| **Origin** | TÜRKİYE |

## 6.2. Sensor Specifications

### Irradiance Sensor

| | |
|---|---|
| Sensor Type | Silicon Reference Cell (31 x 31 mm) |
| Range | 0 to 1600 W/m2 |
| Resolution | 0.1 W/m2 |
| Standard | Class A according to IEC 61724-1<br>Calibration according to IEC 60904 |

### Module & Ambient Temperature Sensors

| | |
|---|---|
| Sensor Type | PT1000 |
| Range | -40°C to +85°C |
| Accuracy | ± 0.1°C |
| Resolution | 0.1°C |
| Standard | Class A according to IEC 60751:2022 |

### Wind Speed Sensor

| | |
|---|---|
| Sensor Type | Cup Star Anemometer (Reed Relay) |
| Range | 0.9 to 40 m/s |
| Accuracy | ± 0.2 m/s or ± 2% of measuring value |
| Resolution | 0.1 m/s wind run |
| Threshold | 0.9 m/s |
| Standard | Compliant to IEC 61724-1:2021 |

## 7. Terms of Warranty

### Limited Sensor Warranty

SEVEN Sensor Solutions guarantees that its products comply with the specifications published by SEVEN, and are completely free from all manufacturer defects for a period of 2 years from the invoice date.



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### Solutions for The Manufacturing Defects

SEVEN commits to the clients to repair or replace the defective sensor if the problem is related to the production.

First; define the problem. Then, prepare a technical report and share the problem with SEVEN technical team, who will to work on resolving this problem.

Clients must return the defective item, part or component to SEVEN with handling shipping charges.

If SEVEN confirms that the sensor has a defect covered by the warranty, the repaired or replaced sensor will be warranted for the remainder of the original sensor warranty period.

### Warranty Limitations

• Before using the sensor, clients should determine the suitability of the sensor for its intended use. Thus, the clients assume all risk and responsibilities arising from misuse.
• SEVEN disclaims all responsibilities for any damages arising from the ordinary and improper use of the sensors.
• SEVEN does not warrant the following;

- Sensors subjected to misuse, negligence, improper storage, installation or accidental damage.
- Defects caused by improper or insufficient site preparation and maintenance of the site by the customer.
- Indirect damages resulting from loss or alteration of data and loss of profits or unrealized savings resulting from these damages.
- Any damage caused by the use of sensors with other than the original cables and accessories of the sensors.
- Damage caused by a lack of equipment inspections, lack of timely calibration, and lack of proper maintenance or cleaning.
- Damage caused by the unauthorized opening of the sensor case.
- Damage due to natural disasters such as; hail, hurricane storm, flooding, fire, lightning…etc.

### Warranty Limitations

Besides, SEVEN reserves the exclusive right to decide, whether a sensor is covered by the warranty or not. A sensor found damaged or defective under warranty may be either repaired or replaced, at the sole discretion of SEVEN. Should a sensor fail prematurely, the replacement sensor is warranted for the remainder of the original sensor warranty period.

## 8. Additional Documents and Software

The following documents and software can be downloaded from www.sevensensor.com or requested from SEVEN Sensor Solutions.

| | |
|---|---|
| User Manual | This document |
| Datasheet | Dual Orientations Irradiance Sensor brochure |
| 3S-2IS Configuration Tool | Windows® software for testing, firmware updates and configuration of the device |
| Firmware | Current device firmware |

## 9. Contact Details

Please feel free to contact us if you face any difficulties during installation or configuration.

| | |
|---|---|
| Address | Pinarcay OSB Mahallesi Organize Sanayi Tesisleri Teknokent Idare Binasi<br>No: 7, D:1, 19100 Merkez / Corum / Turkey |
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