3S-TP-MB-A

Thermopile Pyranometer

USER MANUAL

USER MANUAL TABLE OF CONTENTS

Pinarcay OSB Mahallesi 11. Cadde, No: 35, Corum Organize Sanayi Bolgesi 19200 Merkez / Corum / Türkiye
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1. Introduction

Thermopile Pyranometer is a product from the SEVEN meteorological sensors range of professional and intelligent measuring sensors with digital interface for environmental and photovoltaic system.

Figure 1 - Thermopile Pyranometer

The SEVEN pyranometer 3S-TP-MB-A is designed to meet the **"ISO 9060:2018 fast-response and spectrally flat Class A"** and **"IEC 61724-1:2021 Class A monitoring"** standards. Equipped with cutting-edge thermopile detector and diffuser technology, this high-precision device features **low zero-offset** behavior and the **lowest non-stability** characteristics. Falling into the **fast-response and spectrally flat** sub-categories, the SEVEN pyranometer offers low-zero-offset behavior, maximizing measurement accuracy. This advanced technology device is ideal for meeting the highest standards in solar energy system performance monitoring.

The SEVEN pyranometer also includes a humidity sensor and two temperature sensors. These additional features ensure multi-parameter environmental monitoring, allowing for precise adjustments and accurate readings under varying conditions. The integrated sensors contribute to the device's overall reliability and performance, making it a robust solution for solar energy system, meteorology and to be used in different applications assessments.

Measured irradiance, humidity and temperature data are transmitted to data loggers and other receiving units via serial RS485 interface with Modbus RTU protocol.

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

Note: SEVEN has the right to make modifications on this documentation without notice.

2. Thermopile Pyranometer 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.

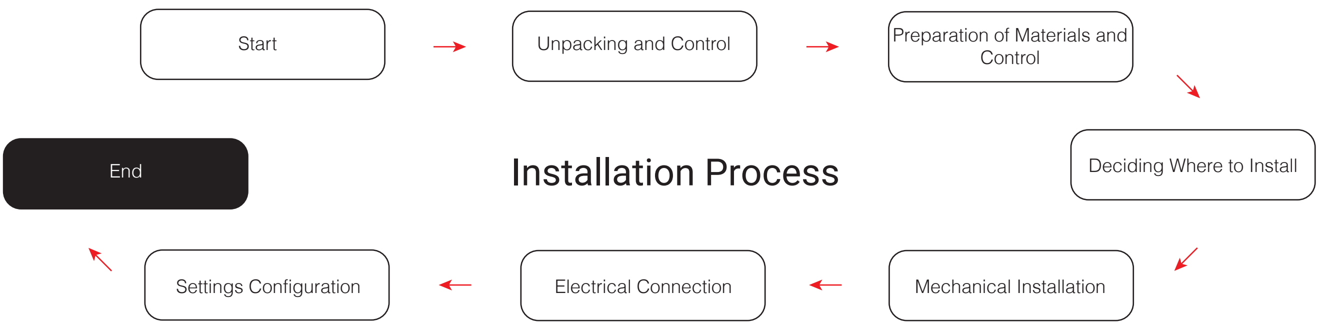

Figure 2 – Installation Process

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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.

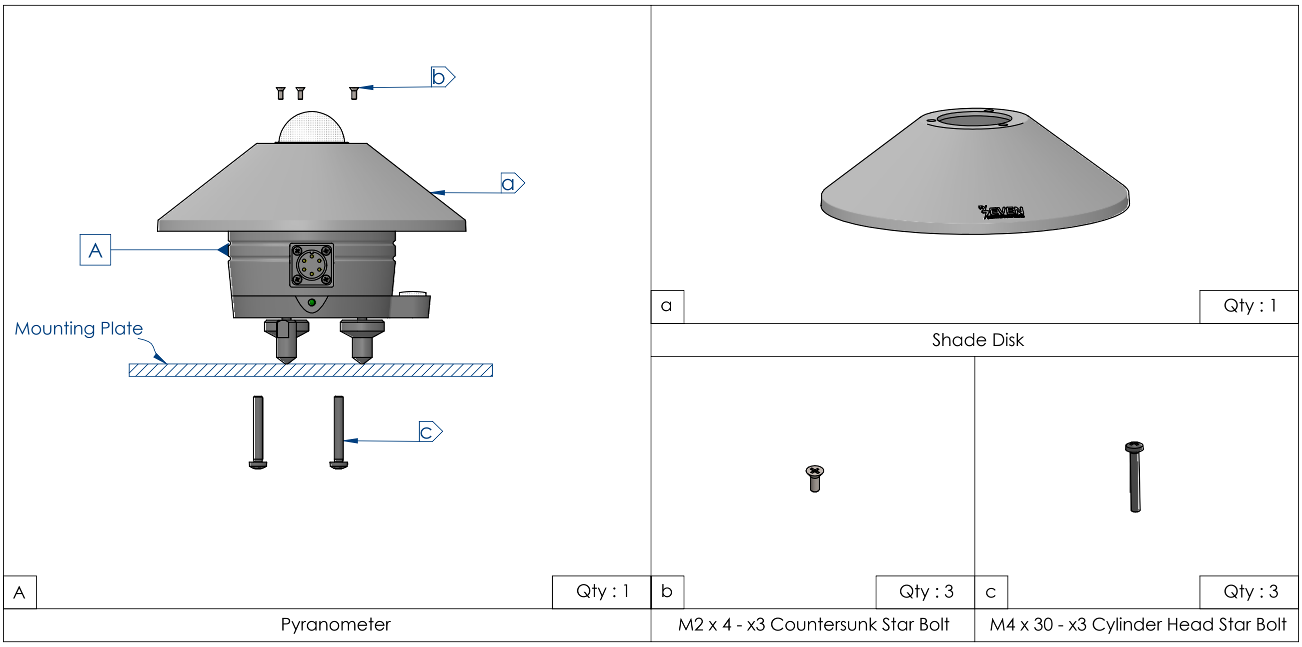

Figure 3 - Thermopile Pyranometer Packing List

2.2. Site Requirements and Considerations

Each site is different and has its own unique challenges. For this reason, the installation of the product may differ for each site. First of all, the location where the product will be installed must be determined. The chosen location should be free from shading, ensuring that buildings, trees, and other structures do not cast shadows on the sensor at any time of the day. Additionally, the pyranometer must have an unobstructed 180° view of the sky above it to accurately measure solar irradiance.

For Global Horizontal Irradiance (GHI) measurement with a Thermopile Pyranometer, the location should be chosen to ensure that obstacles do not exceed 5 degrees above the horizon line. This 5-degree limit corresponds to a minimum distance from the instrument to the obstacle of 10 times the obstacle's height. This means that the Thermopile Pyranometer should be placed at least 10 times the height of any obstruction or shading source.

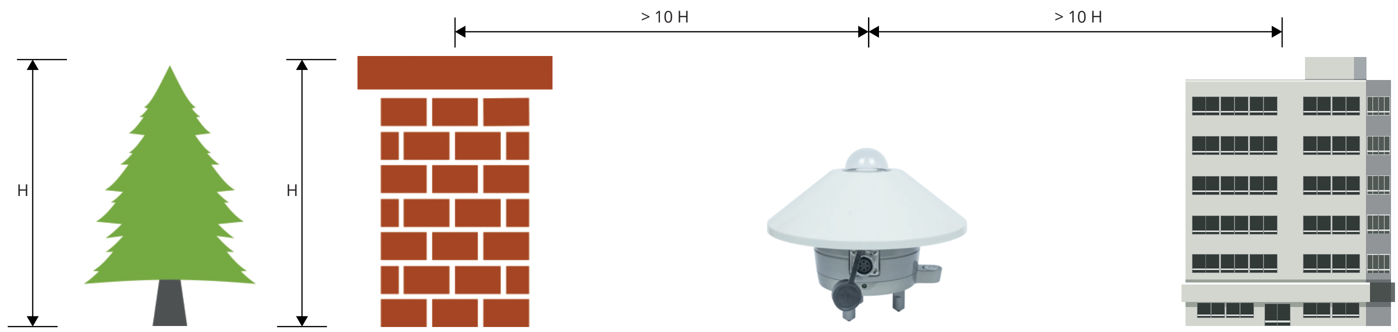

Figure 4 - Installation for Thermopile Pyranometer

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It should also be placed away from surfaces with high heat sources, as such radiation can cause measurement deviations. The device should not be placed near light-colored walls or other objects that reflect sunlight or emit shortwave radiation. The pyranometer should be kept within the specified operating temperature range and as far as possible from humid environments, ensuring that the sensor remains dry. A dry environment that maintains the operating temperature range will help the accuracy and longevity of the device.

If the Thermopile Pyranometer set is to be mounted on a rooftop, the station should be placed away from any heat sources such as chimneys or ventilation systems.

For POA irradiance measures the Thermopile Pyranometer needs to be in the same direction and the same inclination as the solar panels. It should be positioned in the same or higher plane than the solar panels. The azimuth angle can be adjusted with an angle meter.

When it comes to electrical and data logging considerations, it is important to use high-quality, UV-resistant cables and securely fasten them to prevent physical damage. Positioning the data logger in a protected area within the recommended cable length from the pyranometer ensures reliable data recording at the required sampling rate.

To obtain accurate and reliable measurements from your pyranometer, it is essential to choose a suitable location and consider environmental and operational conditions. Following these guidelines, derived from the ISO 9060:2018 and IEC 61724-1:2021 standards, will help ensure optimal performance and the long life of your instrument. For more details, you can refer to specific sections of the **ISO 9060:2018 and IEC 61724-1:2021 standards** along with this guide.

⚠ **Note:** To facilitate the maintenance and cleaning of the Thermopile Pyranometer, the Thermopile Pyranometer must be installed in an easily accessible location, especially for rooftop projects.

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

Materials	
	
Gloves	Cleaning Wipes
	
Angle Meter	Drill

Figure 5 - Materials to be Used in Installation

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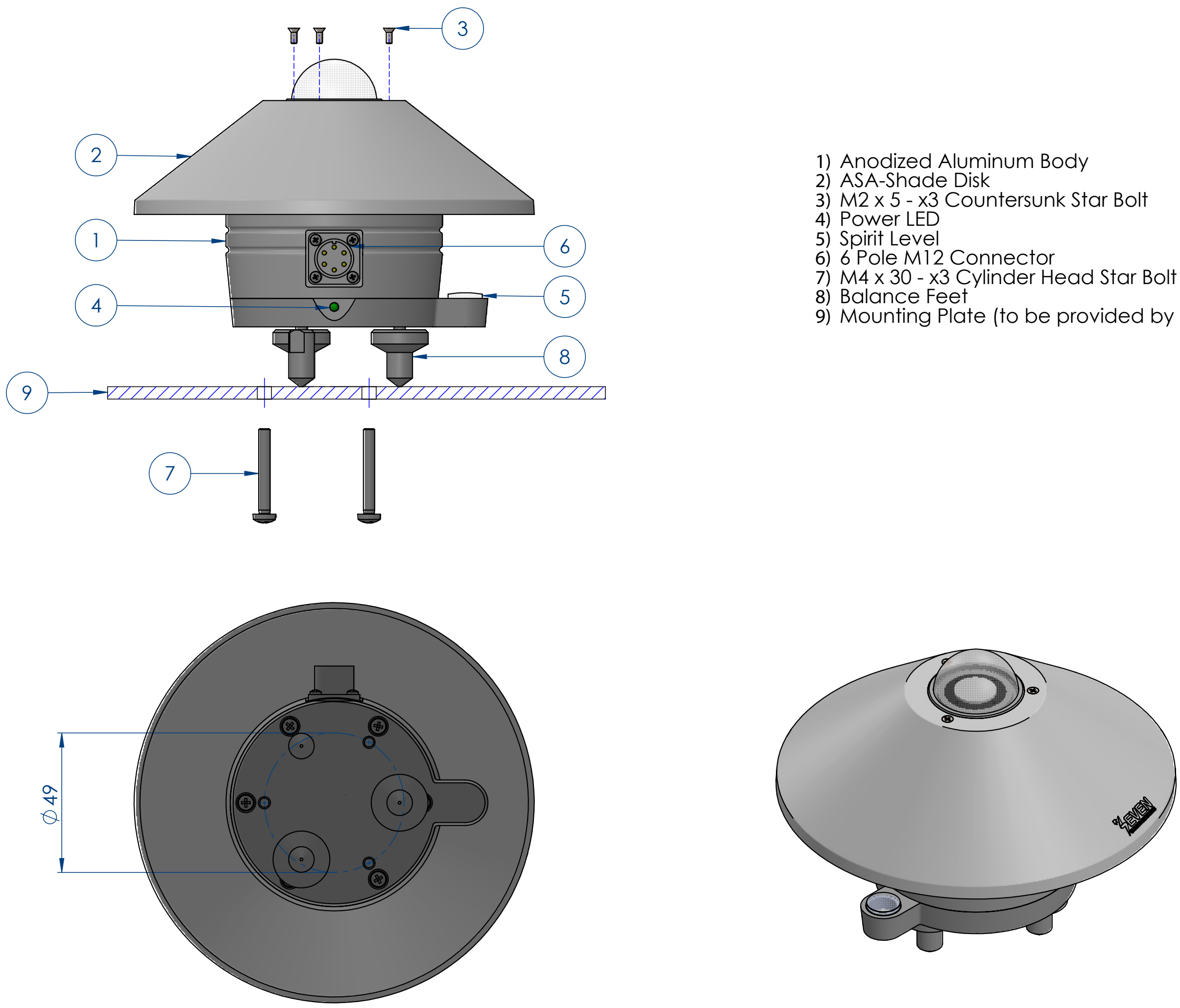
2.3. Installation

Thermopile Pyranometer installation can be easily completed by a qualified electrician by following SEVEN instructions.

2.3.1. Installation for Measuring Global Irradiance



1) Anodized Aluminum Body
2) ASA-Shade Disk
3) M2 x 5 - x3 Countersunk Star Bolt
4) Power LED
5) Spirit Level
6) 6 Pole M12 Connector
7) M4 x 30 - x3 Cylinder Head Star Bolt
8) Balance Feet
9) Mounting Plate (to be provided by the user)

Figure 6 - Installation for Measuring GHI

- Make sure that you received all the metarial mentioned in Figure 3 and that your installation location meets the requirements under “2.2. Site Requirements and Considerations” before starting the installation.
- Remove the shade disk before starting the mounting.
- To align the pyranometer horizontally, make adjustments by rotating the leveling feet until at least half of the spirit level bubble is in the inner ring.
- Complete the mounting of the pyranometer by fastening the screws using a drill as shown in the figure 6.
- Reinstall the shade disk on the pyranometer.
- Fix the cables in the appropriate area.

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2.3.2. Installation for Measuring POA Irradiance

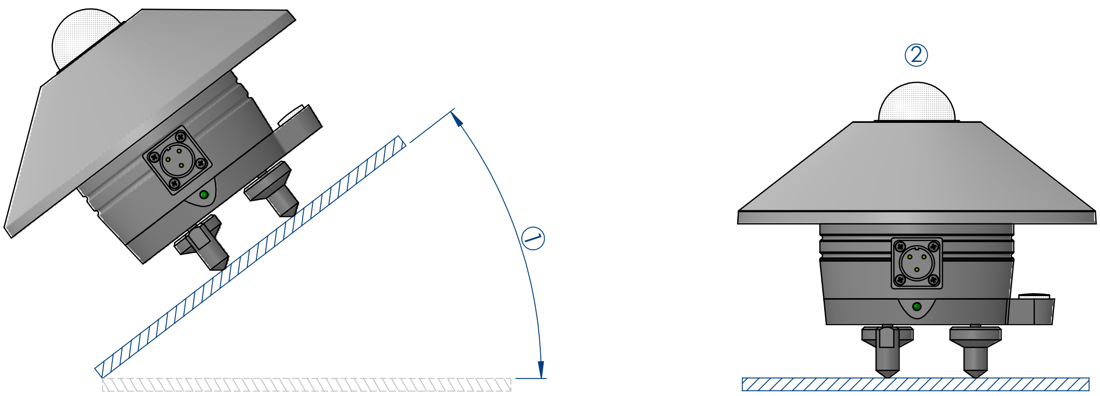

Figure 7 - Installation for Measuring POA

- In a photovoltaic system, the pyranometer is mounted at the same zenith angle, azimuth angle and tilt angle as the panels.
- The pyranometer shade disk must be removed.
- The pyranometer must be placed on a horizontal surface.
- With the help of the pyranometer feet and the angle meter, the sensor is moved to the desired azimuth and zenith angles.
- Fix the pyranometer on the same inclined surface as the modules.
- The pyranometer shade disk must be reinstalled.
- The pyranometer connector is turned downwards. (To prevent water from entering the connector)
- Fix the cables in the appropriate area.

2.4. Inspection and Maintenance

Thermopile Pyranometer is not requiring any maintenance or changing of spare parts. However, the cleaning of the dome glass surface should be done periodically according to the standard which is followed for site monitoring.

According to IEC 61724-1:2021, the monitoring system should be inspected at least annually and preferably at more frequent intervals. Regular maintenance and follow-up steps should be followed according to the ISO/IEC 9901 standard.

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

2.4.1. Daily Routine

During inspections, the dome glass of the device is usually wiped clean and dry. If there are deposits such as frozen snow, glazed frost, frost, or lime, it is common practice to gently clean them using a deicing liquid. It is also common practice to check for condensation inside the domes and to ensure that the sensing surfaces are in good condition. Additionally, checking for any deterioration in the domes, diffusers, and seals is important, especially for new devices. If deposits form on the dome glass, gently clean them by blowing off material that is not fully adhered to the surface, wiping with a soft cloth without a support frame, or wetting the surface. Care should be taken to avoid scratching the optical surfaces. Abrasive cleaning methods can alter the transmission of the optics.

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2.4.2. Weekly Routine

The humidity of the Thermopile Pyranometer should be monitored. If it is used in an area with high humidity and large temperature variations, the humidity inside the sensor may increase. When the humidity rises, you may see fogging inside the Dome Glass, you should contact SEVEN technical service.

2.4.3. Monthly Routine

Inspection of the azimuth and tilt angles (in the horizontal position by using the spirit level) is typically carried out monthly. Check that the solar visor is securely fastened. It is common practice to pay attention to the transmission and amplification of the signals. A check that the data acquisition system clock is keeping the correct time (usually ±10 s is sufficient) is another common practice.

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

2.4.4. Yearly Routine

After a usage of one year, all electrical connections and cables should be checked. If the Shade Disk is dirty, it should be cleaned, but if it is damaged, SEVEN technical supports should be contacted.

2.4.5. Two and Five-Yearly Routine

At the end of 2 years, Thermopile Pyranometer sensitivity should be checked. At the end of 5 years, SEVEN technical supports should be contacted for recalibration.

3. Test and Calibration

SEVEN delivers the Thermopile Pyranometer with a calibration certificate.

The SEVEN Thermopile Pyranometer is calibrated under a 1000 W/m2 Class AAA solar simulator and indoors in a calibration facility designated according to the international standard ISO 9847.

Your SEVEN Pyranometer should be recalibrated according to the IEC 91724-1:2021 standard every 2 years after being deployed in the field to verify solar radiation measurements. However, we recommend recalibration at least every 5 years.

SEVEN provides solar sensor calibrations in accordance with the international standard defined by ISO 9847 appendix A1 in the recalibration methods applied to its products.

Please contact SEVEN for more information on recalibration and calibration procedures.

4. Connection

The voltage supply for the Thermopile Pyranometer is 12 - 30 V DC. Operation with a voltage supply of 24 V is recommended.

When the sensor is connected, see whether power is supplied to the pyranometer by the LED indicator under the connector. If the LED is green, there is power, if not, there is no power to the sensor.

The Thermopile Pyranometer has an electrically isolated, half-duplex, 3 wire RS485 interface for configuration, communication and the firmware update.

The communication and power cable of Thermopile Pyranometer 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.

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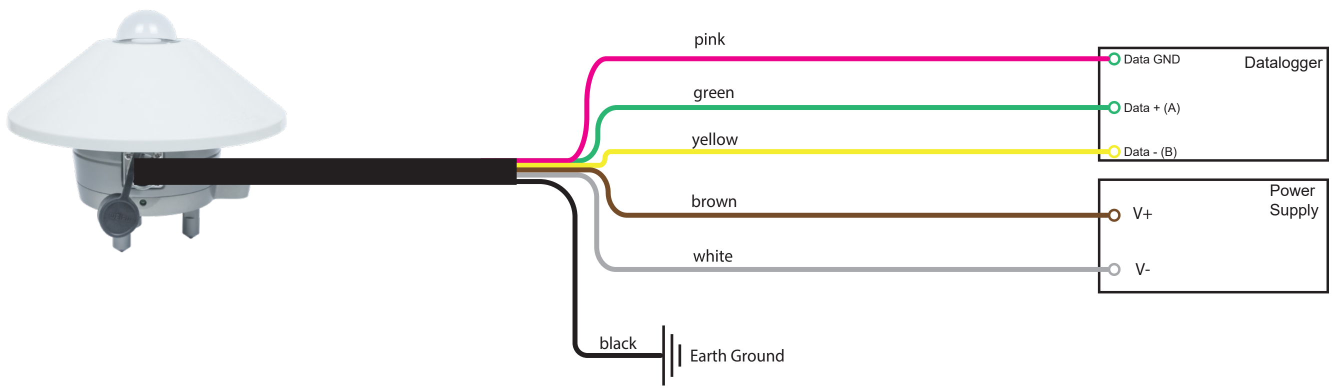
Wire Assignment for Power & Communication	
RS485 A / Data (+)	Green
RS485 B / Data (-)	Yellow
Data Ground	Pink
Power Supply (+)	Brown
Power Supply (-)	White
Earth Ground	Black



5. Configuration and Communication

Once the Thermopile Pyranometer has been correctly installed and connected according to the "5.1. 3S-TP-MB Configuration Tool," the sensor will autonomously start taking measurements.

Attention must be paid to the following points:

- A measurement request should be made to the Thermopile Pyranometer with the 3S-TP-MB Configuration Tool and it should be checked whether it correctly operates in the site.

- If several Modbus Device are operated on a network, a unique device ID must be assigned to each device.

5.1. 3S-TP-MB Configuration Tool

3S-TP-MB Configuration Tool is a software tool for testing communication and adjusting Modbus parameters on the Thermopile Pyranometer. The 3S-TP-MB Configuration Tool can also be used to update the firmware of the Thermopile Pyranometer.

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

Check the 3S-TP-MB Configuration Tool User Manual for more details.

https://www.sevensensor.com/files/d/en/3S-Pyranometer_Configuration_Tool_v1.0.pdf

5.2. Modbus RTU Specifications

5.2.1. Supported Bus Protocol

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

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

5.2.2. Supported Function Codes

The Thermopile Pyranometer 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
0x09	Reset Communication Command

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

5.2.2.1. Read Holding Registers (0x03)

The 3S-TP-MB-A 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

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Holding Register Map

The Thermopile Pyranometer holding register map is based on the **“Sunspec Alliance”** communication standards. All data marked in bold below are defined for the Pyranometer.

Start	End	Value	Type	Units	Scale Factor	Constant
40000	40001	sunspecs ID	uint32	N/A	N/A	"Suns'"
40002	40002	sunspecs 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-TP-MB-A"
40036	40043	Hardware Version	String (16)	N/A	N/A	"1.0"
40044	40051	Software Version	String (16)	N/A	N/A	"1.0"
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	uint16	N/A	N/A	307
40070	40070	Length	uint16	Registers	N/A	11
40071	**40071**	**Air Temperature – (Internal Temperature)**	**int16**	**°C**	**0.1**	**Measured**
40072	**40072**	**Relative Humidity**	**uint16**	**%**	**1**	**Measured**
40073	40073	Barometric Pressure	uint16	hPa	1	N/A
40074	40074	Wind Speed	uint16	m/s	1	N/A
40075	40075	Wind Direction	uint16	°	1	N/A
40076	40076	Rain Gauge (Hour)	uint16	mm/hour	0.1	N/A
40077	40077	Snow	uint16	inches	N/A	N/A
40078	40078	PPT Type	uint16	inches	N/A	N/A
40079	40079	Electric Field	uint16	V/m	N/A	N/A
40080	40080	Surface Wetness	uint16	KOhms	N/A	N/A
40081	40081	Soil Moisture	uint16	%	N/A	N/A
Irradiance Model Registers						
40082	40082	Block ID	uint16	N/A	N/A	302
40083	40083	Length	uint16	Registers	N/A	5
40084	**40084**	**Plane of Array** **Global Horizontal Irradiance**	**uint16**	**W/m²**	**1**	**Measured**
40085	40085	Plane of Array 2	uint16	W/m²	1	N/A
40086	40086	Diffuse Irradiance	uint16	W/m²	N/A	N/A
40087	40087	Direct Irradiance	uint16	W/m²	N/A	N/A
40088	**40088**	**Total Effective Irradiance**	**uint16**	**W/m²**	**N/A**	**Measured**

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Start	End	Value	Type	Units	Scale Factor	Constant
Back of Module Temperature Registers						
40089	40089	Block ID	uint16	N/A	N/A	303
40090	40090	Length	uint16	Registers	N/A	9
40091	40091	Module Temp Effective Module Temp	int16	°C	0.1	N/A
40092	**40092**	**Module Temp 1-(Sensor Temperature)**	**int16**	**°C**	**0.1**	**Measured**
40093	40093	Module Temp 2	int16	°C	0.1	N/A
40094	40094	Module Temp 3	int16	°C	0.1	N/A
40095	40095	Module Temp 4	int16	°C	0.1	N/A
40096	40096	Module Temp 5	int16	°C	0.1	N/A
40097	40097	Module Temp 6	int16	°C	0.1	N/A
40098	40098	Module Temp 7	int16	°C	0.1	N/A
40099	**40099**	**Internal Temperature**	**int16**	**°C**	**0.1**	**Measured**
Device Model Measurement Registers						
40100	40100	Block ID	uint16	N/A	N/A	308
40101	40101	Length	uint16	Registers	N/A	5
40102	**40102**	**Plane of Array**	**uint16**	**W/m^2**	**0.1**	**Measured**
40103	**40103**	**Module Temp – (Sensor Temperature)** **Module Temp 1**	**int16**	**°C**	**0.1**	**Measured**
40104	**40104**	**Ambient Temp (Internal Temperature)** **Module Temp 2**	**int16** **uint16**	**°C**	**0.1** **1**	**Measured**
40105	40105	Wind Speed	int16	m/s	0.1	N/A
40106	**40106**	**Air Temperature – (Sensor Temperature)**	**uint16**	**°C**	**N/A**	**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 Response:

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

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Input Register Map

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

ID-Dec	ID-Hex	Value	Range	Resolution
30002	0x02	Temperature Compensated Irradiance	0…4000 W/m^2	0.1 W/m^2
30006	0x06	Internal Relative Humidity	0…+100 %	0.1 %
30007	0x07	Internal Temperature	-40…+85 °C	0.1 °C
30008	0x08	Sensor Temperature	-40…+150 °C	0.1 °C
30009	0x09	Signal in mV Generated by Thermopile	0 – 100 mV	0.01 mV

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

<table>
<tr><th>ID-Dec</th><th>ID-Hex</th><th colspan="2">Value</th><th>Range</th></tr>
<tr><td>30301</td><td>0x12D</td><td colspan="2">Hardware Version</td><td rowspan="16">Manufacturer Parameters
Read Only</td></tr>
<tr><td>30302</td><td>0x12E</td><td colspan="2">Software Version</td></tr>
<tr><td>30304</td><td>0x130</td><td colspan="2">Sensitivity Value</td></tr>
<tr><td>30342</td><td>0x156</td><td rowspan="6">Serial Number</td><td>Production Year</td></tr>
<tr><td>30343</td><td>0x157</td><td>Production Code</td></tr>
<tr><td>30344</td><td>0x158</td><td>Cell Serial Number</td></tr>
<tr><td>30345</td><td>0x159</td><td>Board Serial Number</td></tr>
<tr><td>30346</td><td>0x15A</td><td>Box Serial Number</td></tr>
<tr><td>30347</td><td>0x15B</td><td>Sensor Serial Number</td></tr>
<tr><td>30348</td><td>0x15C</td><td rowspan="3">Production Date</td><td>Production Day</td></tr>
<tr><td>30349</td><td>0x15D</td><td>Production Month</td></tr>
<tr><td>30350</td><td>0x15E</td><td>Production Year</td></tr>
<tr><td>30351</td><td>0x15F</td><td rowspan="3">Calibration Date</td><td>Calibration Day</td></tr>
<tr><td>30352</td><td>0x160</td><td>Calibration Month</td></tr>
<tr><td>30353</td><td>0x161</td><td>Calibration Year</td></tr>
</table>

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	0x046
Start Register	1 Byte	0x04
End Register	1 Byte	1 to 247

Slave Response:

Address	1 Byte	1 to 247
Function Code	1 Byte	0x046
Number of Bytes	1 Byte	0x04
Data	1 Byte	1 to 247

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Sub Function (0x06): Write Communication Parameters
Master Request:

Address	1 Byte	1 to 247
Function Code	1 Byte	0x046
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	0x046
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.

Sub Function (0x06): Write Communication Parameters

Parameter changes will take effect after restart of the sensor by power on reset or restart communication command.

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

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

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Revision 0.0 / **Created** 27.02.2025

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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Restart Communication Command (0x09)

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. Troubleshooting

If the SEVEN Thermopile Pyranometer output signals are absent or incorrect, your sensor is not working properly. There are points you need to check first;

1. Check that the 24V voltage supplied to the sensor is correct. (The LED indicator can be checked.)
2. Check that the sensor's cable connections are made correctly.
3. Check that the configuration of the sensor is correct.
4. Check the glass dome for any contamination, fogging, scratches or foreign objects.
5. Check that there is no shadowing or obstruction to irradiance reception at the position of the sensor.
6. Check that the mounting angle of the sensor has not shifted.
7. If it is not one of the above problems or you cannot solve it, you can contact SEVEN Technical Service.

7. Additional Documents and Software

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

Datasheet https://www.sevensensor.com/files/d/en/3S-TP-MB-A_Thermopile_Pyranometer.pdf
3S-TP-MB Configuration Tool https://www.sevensensor.com/files/d/en/3S-Pyranometer_Configuration_Tool_v1.0.pdf

8. Contact Details

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

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