SENSOR SOLUTIONS

3S-ALBEDO & 3S-ALBEDO-2T

ALBEDOMETER

USER MANUAL

USER MANUAL TABLE OF CONTENTS

Pinarcay OSB Mah. Organize Sanayi 11. Cadde No:35 Merkez / Corum / Türkiye
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1. Introduction

Albedometer is a product from the SEVEN meteorological sensor range, consisting of professional and intelligent measurement sensors with a digital interface designed for environmental and industrial applications.

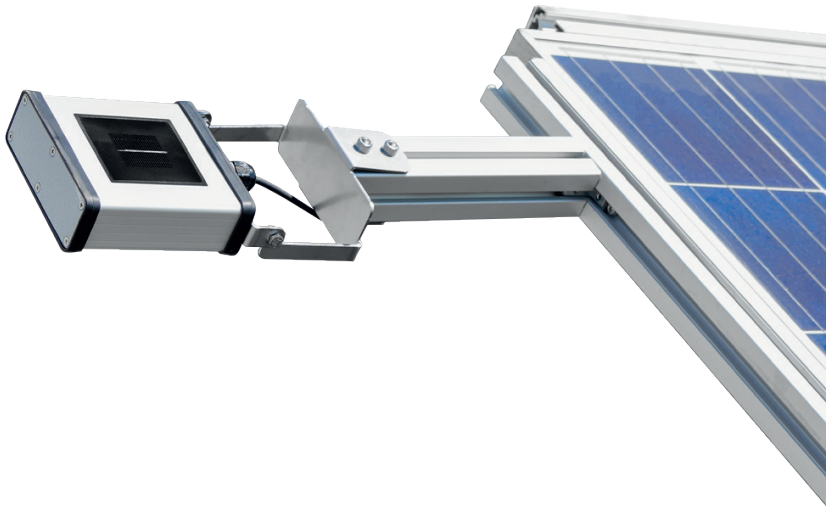


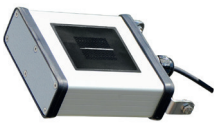
Figure 1 - Albedometer

The albedometer consists of two cells; the front cell measures the plane of array irradiance, while the rear cell measures the reflected irradiance. It is used for calculating the performance ratio and measuring solar albedo. Solar albedo is the ratio of reflected irradiance to plane of array irradiance. All measured meteorological data are transmitted to dataloggers and receiver units via a 3-wire RS485 bus with Modbus RTU protocol.

The albedometer is specially designed according to the requirements of PV plant monitoring systems based on the IEC 61724-1 standard.

Note: *SEVEN reserves the right to make changes to this entire document without prior notice.*

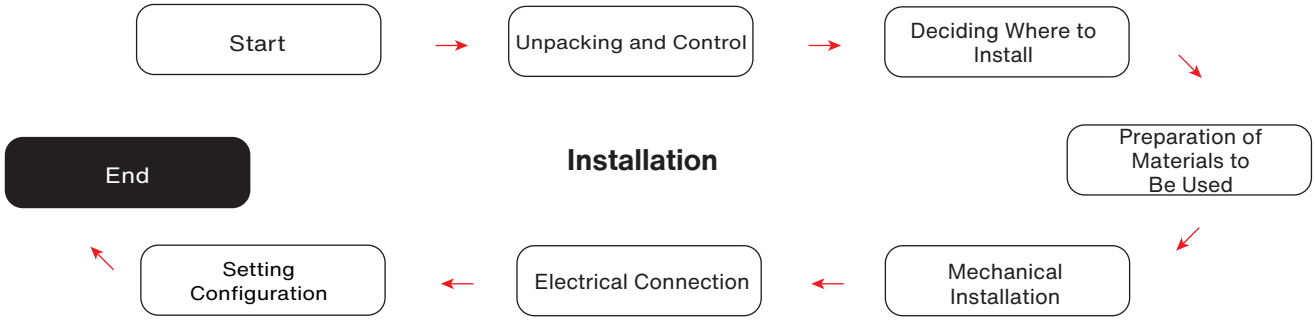
The model used for the albedometer **3S-ALBEDO** or **3S-ALBEDO-2T.**



The 3S-ALBEDO or 3S-ALBEDO-2T Albedometer is designed for professional use in photovoltaic plants with bifacial panels. 2 PT1000 Module Temperature Sensors can be connected to the 3S-ALBEDO-2T model. All measured meteorological data are transmitted to dataloggers and receiver units via a 3-wire RS485 interface with Modbus RTU protocol.

2. Albedometer Installation

It is suggested that the system be operated 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.



Scheme 1 - 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.

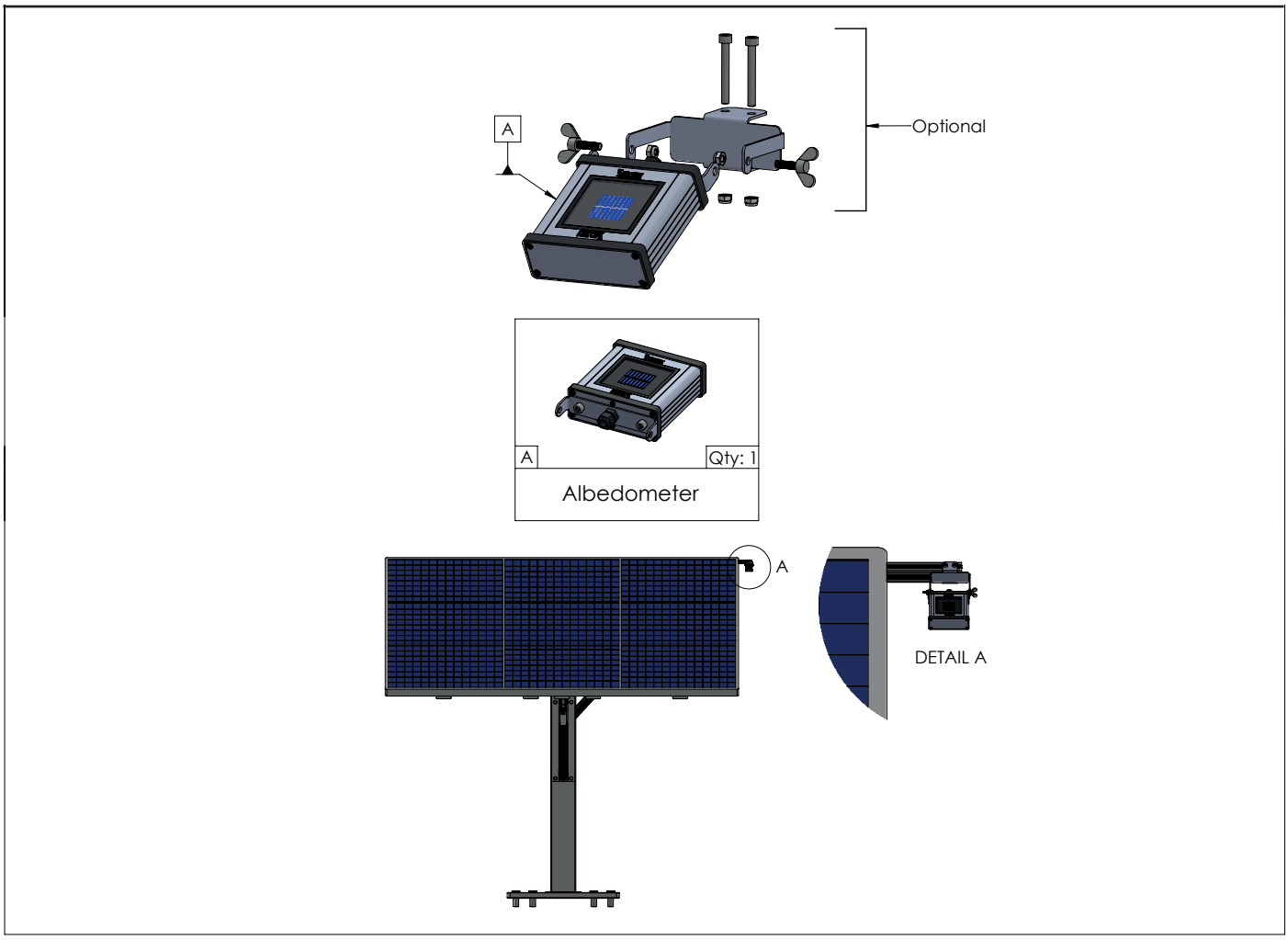

Figure 2 - 3S-Albedo

If the 3S-ALBEDO-2T model has been purchased, the following products should be included in addition to the package contents:
- Module Temperature Sensor x 2
- Self-Adhesive Cable Clips
- Plastic Black Clamps

		
A Qty: 2	B Qty: 8	C Qty: 8
Module Temperature Sensor	Self-Adhesive Cable Clips	Plastic Black Clamps

Figure 3 - 3S-MT-PT1000

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Note: *Optional products brackets can be offered on request. You can contact SEVEN Sensor Solutions for further information.*

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

2.2. Site Requirements and Considerations

Each site is different and has its own unique challenges. Therefore, the installation of the product may differ at each site. First of all, it should be decided where the product will be installed.

The albedometer should be placed at a distance of at least 10 times the height of any obstacle or shading source.

The Albedometer needs to be in the same direction and the same inclination as the solar panels.

The placement of albedometers aligned with the solar panels should be chosen so as to represent the albedo of the area. The placement of albedometer in the same direction as the solar panels should be mounted at a **minimum height of 1 meter** to allow sufficient field of view for radiation reflected from the ground. They should not be shaded by nearby structures, including plants, panels, or panel structures, within a **±80-degree field of view.** Shadowing caused by the albedo measurement device and its support structure should be minimized.

If the expected surface variations exist across the site, use an appropriate number of sensors and sampling methodologies to capture these variations effectively.

There should not be any object at the bottom of the albedometer that may interfere with the reflected irradiance.

2.3. Preparation of Materials to be Used in the Installation

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

Materials			
			
Gloves	Meter	Drill	
			
6mm Magnetic Nut Adapter	M6 Nut Screw	Steel Drill Bit	Spirit Level

Figure 4 - Materials Used in Installation

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2.4. Installation

The albedometer installation can be done as follows.

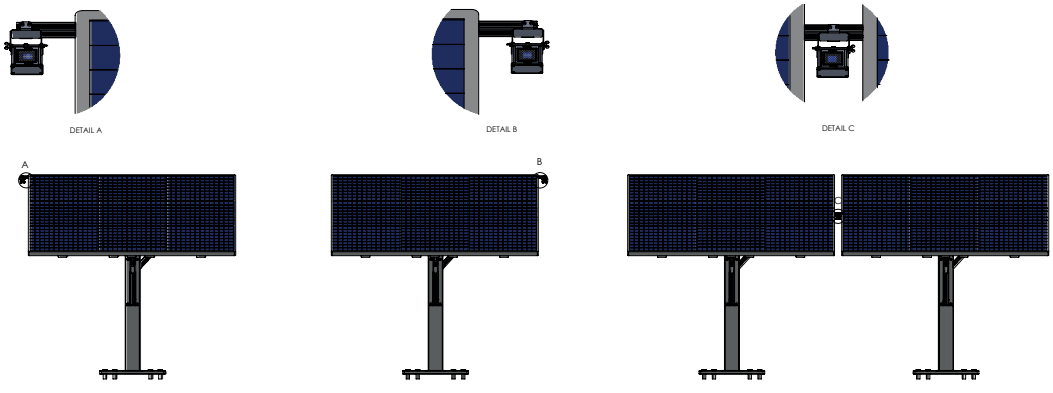
Note: *If the 3S-ALBEDO-2T model has been purchased, you can download the 3S-MT- PT1000 User Manual for Module Temperature Sensor installation:*
https://www.sevensensor.com/files/d/en/Module_Temperature_Sensor_User_Manual.pdf

1st Step	2nd Step	3rd Step
The position of the albedometer must be adjusted using the spirit level. The angle of inclination should be the same as the solar panels. The albedometer should be positioned with the side labeled **"Rear Side"** facing the ground	2 Pcs M6 screws and M6 nuts should be used to fix the albedometer.	The albedometer should be fixed in the area by the appropriate hand tools.

Don't miss the 'Rear Side" position!
*It should be positioned so that the **"Rear Side"** label is on the bottom of the box.*

Figure 5 - Albedometer Rear Side Position

Note: *The albedometer can be installed using three different mounting options, depending on field conditions and the field designer's planning.*



1st Option **2nd Option** **3rd Option**

Note: *Proper grounding is required for safe and accurate operation of the sensors; otherwise, performance issues and device damage may occur.*

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2.5. Inspection and Maintenance

The albedometer does not require any maintenance or replacement of spare parts. However, the cleaning of both solar cells surface should be done periodically according to the standard followed for site monitoring. The surface of the solar cells 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 sensors, evidence of moisture or vermin in enclosures, loose wiring connections, embrittlement of attachments and other potential problems, should be checked periodically.

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

3. Calibration

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

SEVEN delivers all albedometers with calibration certificates. Each albedometer 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.

Recalibration of albedometers 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:

- Replacement of 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, albedometers shall be recalibrated once every 2 years, or more frequently per manufacturer recommendations. For Class B systems, recalibrate albedometers according to manufacturer recommendations.

The recommended recalibration period of SEVEN for class B systems is at least once every 3 years from the installation of the sensors in the site.

4. Connections

The supply voltage for the Albedometer sets is 12 - 30 V DC. Operation with a supply voltage of 24 V is recommended. The albedometer communication and power cable should always be laid separately from the AC/DC cables.

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

Note: *Compliance to IEC 61000-4-2 (ESD) and IEC 61000-4-5 (Surge) standards.*

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

Power and Communication Information	
Signal Ground	Red
RS485 A/Data (+)	Green
RS485 B/Data (-)	Yellow
Power (+)	Brown
Power (-)	White
Protective Earth	Black

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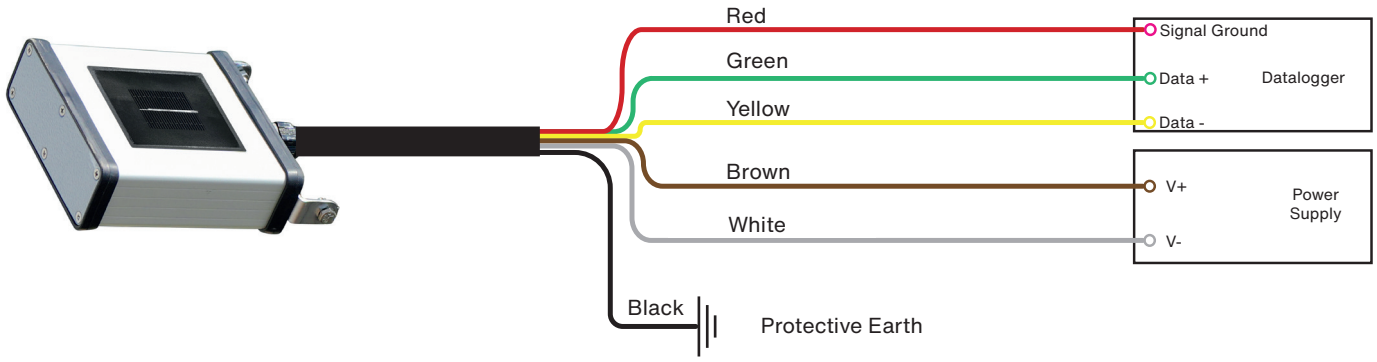

Figure 6 - Cable Assignment for Power and Communication

5. Communication

Once the Albedometer 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 Albedometer (3S-Albedo) with the 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. The Baud Rate and Parity should be the same.

5.1. 3S-Albedo Configuration Tool

3S-Albedo Configuration Tool is a software tool for testing communication and adjusting Modbus parameters of the 3S-Albedo. A Windows® PC with a serial bus interface set as a serial COM port, 3S-Albedo Configuration Tool software,and USB to RS485 Converter are required for configuration and testing purposes.

Follow the instructions in the 3S-Albedo Configuration Tool User Manual:
https://www.sevensensor.com/files/d/en/3S-Albedometer_Configuration_Tool_v3.0.pdf

5.2. Modbus RTU Technical Specifications

5.2.1. Supported Bus Protocol

The following register adresses apply to Software 4 (SW4). If you are using a different version of the software, please download the corresponding Modbus Map from the following link:

https://www.sevensensor.com/download

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

Baud	4800, 9600, 19200, 38400
Parity	None, Even, Odd
Stop Bit	1, 2 (Only at None Parity)
Factory Settings	9600, 8N1, address: 1

5.2.2. Supported Function Codes

The albedometer supports a specific subset of Modbus RTU commands. The table that follows lists each supported function code.

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0x03	Read Holding Registers	*(Holding Kayıt Adresleri Okuma)*
0x04	Read Input Registers	*(Input Kayıt Adresleri Okuma)*
0x46	Read & Change Parameters	*(Parametreleri Okuma ve Değiştirme)*
0x08	Reset Communication Command	*(Haberleşmeyi Yeniden Başlat)*

Note: *The checksum (CRC) of the Modbus protocol is omitted in this document. The checksum should always be calculated and sent during communication*

5.2.2.1. Read Holding Registers (0x03)

Master Request:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x03
Start Register	2 Byte(Big Endian)	see the register table below
Number of Registers	2 Byte(Big Endian)	see the register table below

Slave Response:

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

Holding Register Map

Albedometer holding register map is based on the **"SunSpec Alliance"** communication standards. The following register addresses are defined for the Albedometer.

Start	End	Value	Type	Units	Scale Factor	Constant
40000	40001	SunSpec Address	uint32	N/A	N/A	"SunS"
40002	40002	SunSpec Address	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	Device Model	String (32)	N/A	N/A	"3S-Albedo"
40036	40043	Hardware Version	String (16)	N/A	N/A	"Cihaz Donanım Sürümü"
40044	40051	Software Version	String (16)	N/A	N/A	"Cihaz Yazılım Sürümü"
40052	40067	Serial Number	String (32)	N/A	N/A	"23.12.345.65.0013"
40068	40068	Device Address (ID)	uint16	N/A	N/A	1
Irradiance Model Registers						
40082	40082	Block ID	uint16	N/A	0	302
40083	40083	Length	uint16	Value	0	5
40084	**40084**	**Plane of Array** **Plane of Array 1**	**uint16**	**W/m²**	**1**	**Measured Value**
40085	**40085**	**Plane of Array 2**	**uint16**	**W/m²**	**1**	**Measured Value**
40086	40086	Diffuse Irradiance	uint16	W/m²	N/A	N/A
40087	40087	Direct Irradiance	uint16	W/m²	N/A	N/A
40088	**40088**	**Albedo**	**uint16**	**N/A**	**N/A**	**Measured Value**
Module Temperature Model Registers						
40089	40089	Block ID	uint16	N/A	N/A	303
40090	40090	Length	uint16	Value	N/A	9
40091	**40091**	Module Temperature Effective Module Temperature	int16	°C	**0.1**	N/A

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40092	**40092**	**Module Temperature 1**	**int16**	**°C**	**0.1**	**Measured Value**
40093	**40093**	**Module Temperature 2**	**int16**	**°C**	**0.1**	**Measured Value**
40094	40094	Module Temperature 3	int16	°C	0.1	N/A
40095	40095	Module Temperature 4	int16	°C	0.1	N/A
40096	40096	Module Temperature 5	int16	°C	0.1	N/A
40097	40097	Module Temperature 6	int16	°C	0.1	N/A
40098	40098	Module Temperature 7	int16	°C	0.1	N/A
40099	40099	Module Temperature 8 Ambient Temperature (SH)	int16	°C	0.1	N/A
Device Model Measurement Registers						
40100	40100	Block ID	uint16	N/A	N/A	308
40101	40101	Length	uint16	Value	Value	5
40102	40102	Albedo	uint16	N/A	0.01	N/A
40103	40103	Module Temperature Module Temperature 1	int16	°C	0.1	N/A
40104	40104	Module Temperature 2	int16	°C	0.1	N/A
40105	40105	Wind Speed	uint16	m/s	0.1	N/A
40106	40106	Ambient Temperature	int16	°C	0.1	N/A
End of Block Registers						
40107	40107	End of SunSpec Block	uint16	N/A	N/A	0xFFFF
40108	40108	Length	uint16	Value	0	0
Device Address Read/Write Register						
40109	40109	Device Address (ID)	uint16	N/A	N/A	1

5.2.2.2. Reading Input Registers (0x04)

Master Request:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x04
Start Register	2 Bytes (Big Endian)	See the register table below
Number of Registers	2 Bytes (Big Endian)	See the register table below

Slave Response:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x04
Number of Bytes	1 Byte	0 - 255 (2xN) N = Number of Registers
Data	2 Bytes x N (Big Endian)	See the register table below

Input Register Map

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

ID-Dec	ID-Hex	Value	Range	Resolution
3000**0**	0x00	Irradiance 1	0...1600 W/m²	0.1 W/m²
3000**1**	0x06	Irradiance 2	0...1600 W/m²	0.1 W/m²
3000**6**	0x0C	Temperature Compensated Irradiance 1	0...1600 W/m²	0.1 W/m²
3000**7**	0x0F	Temperature Compensated Irradiance 2	0...1600 W/m²	0.1°C
3001**4**	0x0E	Albedo	0...1	0.01
3001**5**	0x0F	Internal Temperature 1	-40...+85 °C	0.1°C
3001**6**	0x10	Internal Temperature 2	-40...+85 °C	0.1°C
3002**2**	0x16	Module Temperature Sensor 1	-40...+85 °C	0.1°C
3002**3**	0x17	Module Temperature Sensor 2	-40...+85 °C	0.1°C

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

ID-Dec	ID-Hex	Value		Range
30301	0x12D	Hardware Version		Manufacturer Parameters
30302	0x12E	Software Version		
30304	0x130	Calibration Value 1		
30305	0x131	Calibration Value 2		
30310	0x136	Temperature Coefficient Value 1		
30311	0x137	Temperature Coefficient Value 2		
30323	0x143	ADC Offset Value1		
30324	0x144	ADC Offset Value2		
30329	0x149	T90 Value		
30342	0x156	Serial Number	Production Year	
30343	0x157		Production Code	
30344	0x158		Cell Serial Number	
30345	0x159		Board Serial Number	
30346	0x15A		Box Serial Number	
30347	0x15B		Sensor Serial Number	
30348	0x15C	Production Date	Production Day	
30349	0x15D		Production Month	
30350	0x15E		Production Year	
30351	0x15F	Calibration Date 1	Calibration Day 1	
30352	0x160		Calibration Month 1	
30353	0x161		Calibration Year 1	
30354	0x162	Calibration Date 2	Calibration Day 2	
30355	0x163		Calibration Month 2	
30356	0x164		Calibration Year 2	

5.2.2.3. Read and Change Parameters (0x46)

Sub Function (0x04): Write Device Address

Master Request:

Address (ID)	1 Byte	1 - 247
Function Code	1 Bayt	0x46
Sub Function Code	1 Bayt	0x04
New Address (ID)	1 Bayt	1 - 247

Slave Response:

Adres (ID)	1 Bayt	1 - 247
Function Code	1 Bayt	0x46
Sub Function Code	1 Bayt	0x04
New Address (ID)	1 Bayt	1 - 247

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Sub Function Code (0x06): Write Communication Parameters

Master Request:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x46
Sub Function Code	1 Byte	0x06
New Baud Rate	1 Byte	0 - 3, See the table below
New Parity/Stop Bit	1 Byte	0 - 3, See the table below

Slave Response:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x46
Sub Function Code	1 Byte	0x06
New Baud Rate	1 Byte	0 - 3, See the table below
New Parity/Stop Bit	1 Byte	0 - 3, See the 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

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

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

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

Master Request:

Address	1 Byte	1 - 247
Function Code	1 Byte	0x46
Sub Function Code	1 Byte	0x07

Slave Response:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x46
Address (ID)	1 Byte	0x07
Hardware Version	2 Bytes (Little Endian)	0 - 65535
Software Version	2 Bytes (Little Endian)	0 - 65535

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

Master Request:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x46
Sub Function Code	1 Byte	0x08

Slave Response:

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

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5.2.2.4. Restart Communication Command (0x08)

Master Request:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x09
Restart Code	4 Bytes	0x00000000

Slave Response:

Address (ID)	1 Byte	1 - 247
Function Code	1 Byte	0x09
Restart Code	4 Bytes	0x00000000

6. Contact Details

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

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