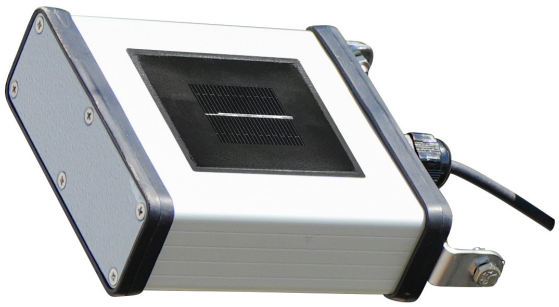
SEVEN SENSOR SOLUTIONS



3S-ALBEDO

Albedometer

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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Revision 0.0 / **Created** 21.02.2025

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.

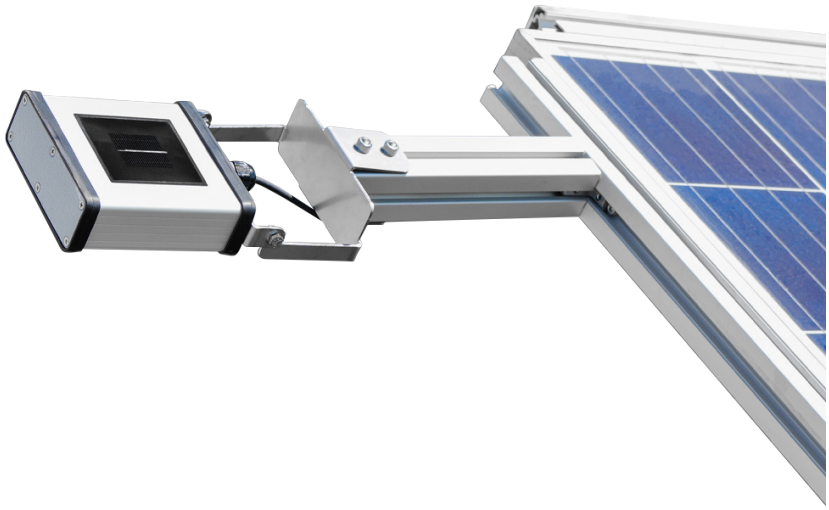


Figure 1 - Albedometer

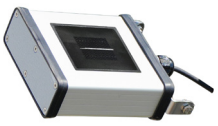
The albedometer consists of two cells; the front cell measures the plane of array irradiance, while the rear cell measures the reflected irradiance. It is used for calculating the performance ratio and measuring solar albedo. Solar albedo is the ratio of reflected irradiance to plane of array irradiance. 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 designation used for the albedometer is 3S-Albedo.

The 3S-Albedo is designed for professional use in photovoltaic plants with bifacial panels. 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.

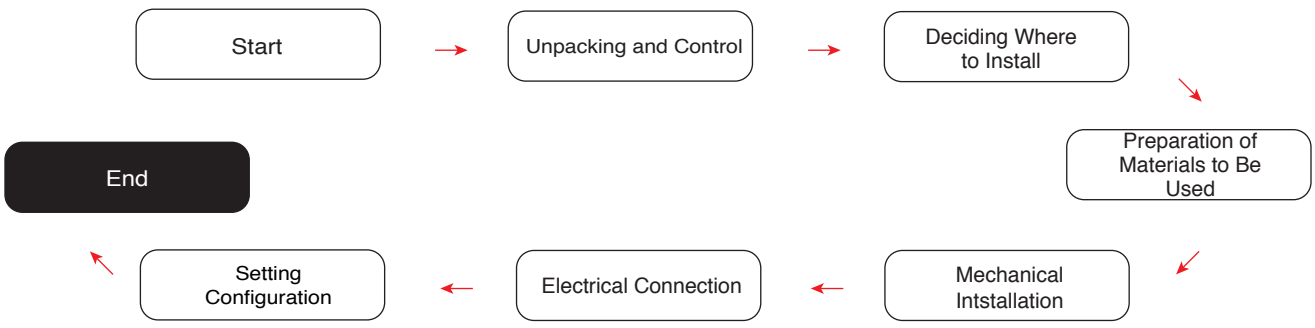


Figure 2 - Installation Process

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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.

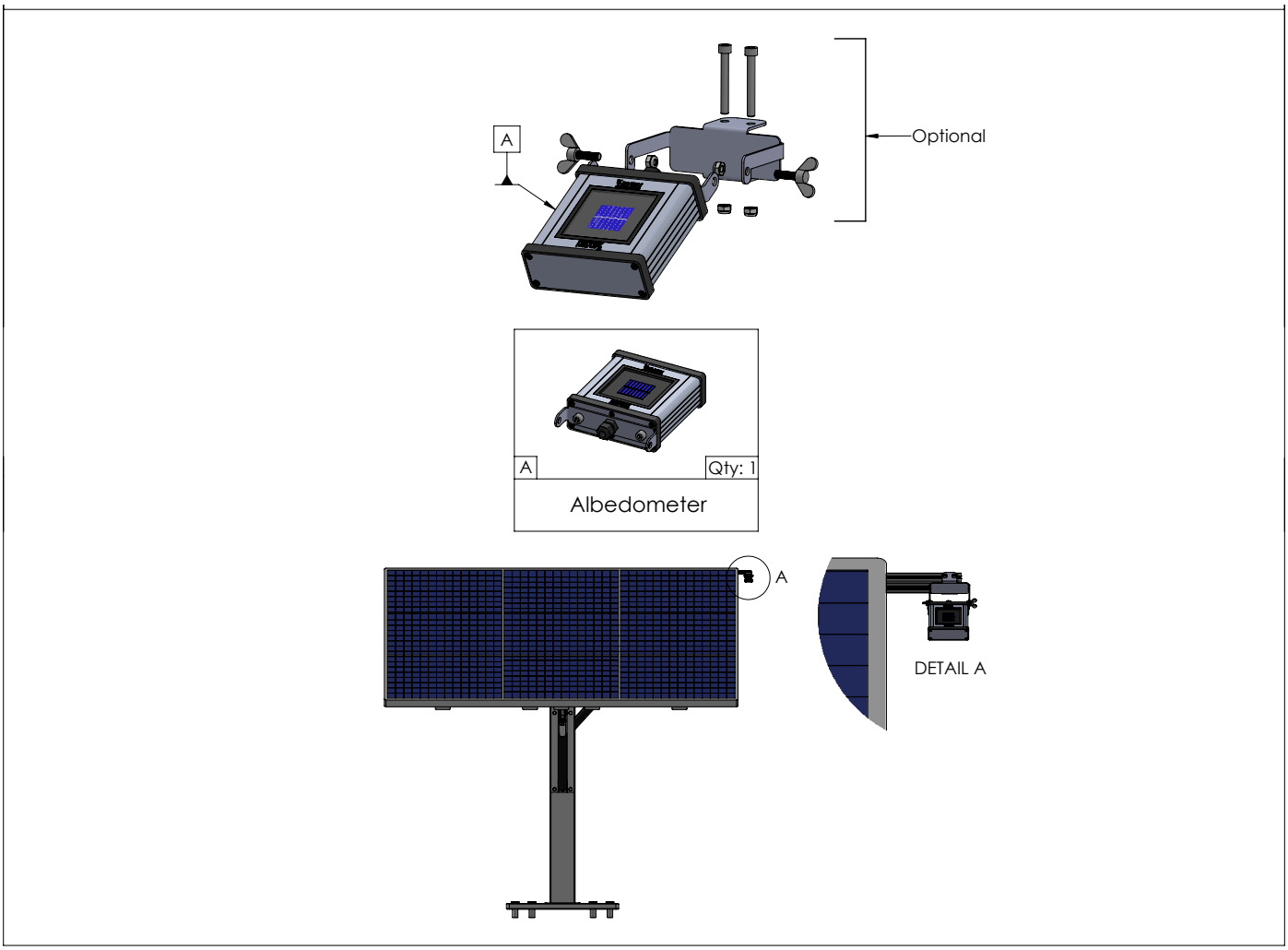

Figure 3 - Packing List

Note: *Optional connection 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.*

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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 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 Installation

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

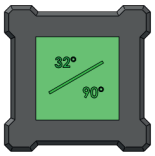
<table>
<tr><th colspan="4">Materials</th></tr>
<tr><td>  </td><td>  </td><td colspan="2">  </td></tr>
<tr><td>Gloves</td><td>Meter</td><td colspan="2">Drill</td></tr>
<tr><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>6 mm Concrete Screw Drill Bit</td><td>M6 Nut and Bolt</td><td>Steel Drill Bit</td><td>Spirit Level</td></tr>
</table>

Figure 4 - Materials to be Used in Installation

2.4. Installation

The albedometer installation can be done as follows.

1. 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. Step

2 Pcs M6 screws and M6 nuts should be used to fix the albedometer.

3. Step

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

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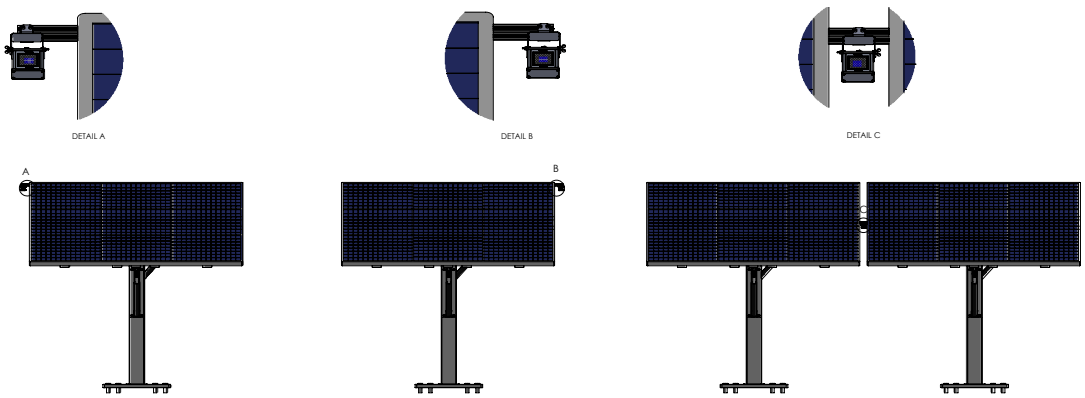

Option 1 **Option 2** **Option 3**

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

2.5. Inspection and Maintenance

The albedometer does not require any maintenance or replacement of spare parts. However, the cleaning of both of the solar cell surface should be done periodically according to the standard followed 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 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.*

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

3. Calibration

SEVEN delivers all 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.

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:

-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, 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 of SEVEN for class B systems is at least once every 3 years from the installation of the irradiance sensors in the site.

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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.*

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

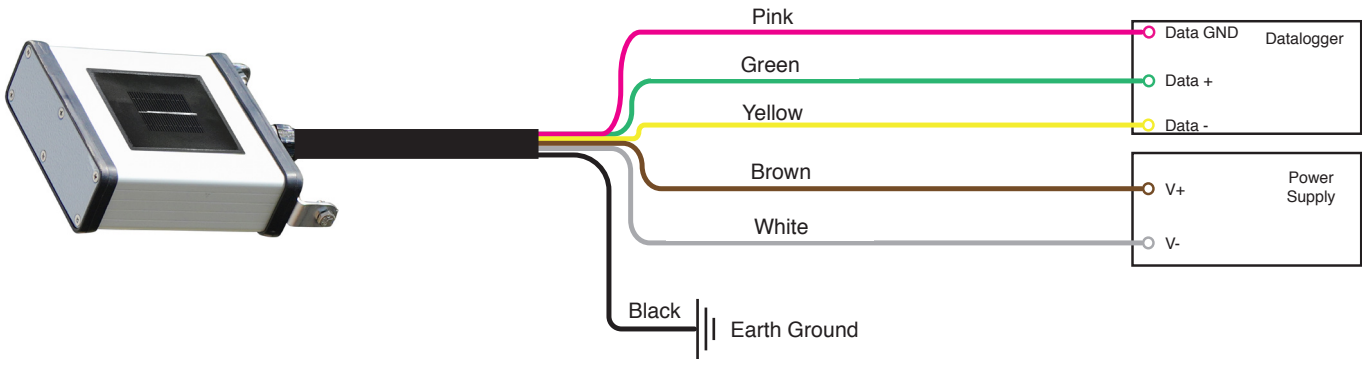

Figure 4 - Wire Assignment for Power & Communication

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.

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_v2.0.pdf

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5.2. Modbus RTU Specifications

5.2.1. Supported Bus Protocol

The following register adresses apply to Software 2 and Software 3 (SW2 & SW3). 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 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 albedometer supports a specific subset of Modbus RTU commands. The table that follows lists each supported function code.

0x03	Read Holding Registers	*(Read Holding Registers)*
0x04	Read Input Registers	*(Read Input Registers)*
0x46	Read & Change Parameters	*(Read & Change Parameters)*
0x08	Reset Communication Command	*(Reset Communication Command)*

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 to 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 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 the register table below

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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 Adresi	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-Albedo"
40036	40043	Hardware Version	String (16)	N/A	N/A	"Device Hardware Version"
40044	40051	Software Version	String (16)	N/A	N/A	"Device Software Version"
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
Irradiance Model Registers						
40082	40082	Block ID	uint16	N/A	0	302
40083	40083	Length	uint16	Register	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
Device Model Measurement Registers						
40100	40100	Block ID	uint16	N/A	N/A	308
40101	40101	Length	uint16	Register	Register	5
40102	40102	Albedo	uint16	N/A	0.01	Measured Value
40103	40103	Module Temperature Module Temperature 1	int16	N/A	0.1	Measured Value
40104	40104	Module Temperature 2	int16	°C	0.1	Measured Value
40105	40105	Wind Speed	uint16	m/s	0.1	Measured Value
40106	40106	Ambient Temperature	int16	°C	0.1	Measured Value
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 (ID)	1 Bayt	1 - 247
Function Code	1 Bayt	0x04
Start Register	2 Bayt (Big Endian)	see the register table below
Number of Registers	2 Bayt (Big Endian)	see the register table below

Slave Response:

Address (ID)	1 Bayt	1 - 247
Function Code	1 Bayt	0x04
Number of Bytes	1 Bayt	0 - 255 (2xN) N = Number of Registers
Data	2 Bayt x N (Big Endian)	see the 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
30000	**0x00**	**Irradiance 1**	**0…1600 W/m²**	**0.1 W/m²**
30001	**0x06**	**Irradiance 2**	0…1600 W/m²	**0.1 W/m²**
30006	**0x0C**	**Temperature Compensated Irradiance 1**	0…1600 W/m²	**0.1 W/m²**
30007	**0x0F**	**Temperature Compensated Irradiance 2**	0…1600 W/m²	0.1°C
30014	**0x0E**	**Albedo**	0...1	0.01
30015	**0x0F**	**Internal Cell Temperature 1**	-40…+85 °C	0.1°C
30016	**0x10**	**Internal Cell Temperature 2**	-40…+85 °C	0.1°C

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 Value 2**		
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**	**Üretim Tarihi**	**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**	

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5.2.2.3. Read & Change Parameters (0x46)

Sub Function (0x04): Write Device Address

Master Request:

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

Slave Response:

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

Sub Function (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.*

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Communication Parameter Settings

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

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

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

Sub Function (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

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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 Byte (Little Endian)	0 - 999
Board Serial Number	1 Byte	0 - 99
Box Serial Number	1 Byte	0 - 99
Sensor Serial Number	2 Byte (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

5.2.2.4. Restart Communication Command (0x08)

Master Request:

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

Slave Response:

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

6. Contact Details

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

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E-mail	teknik@sevensensor.com
Website	www.sevensensor.com