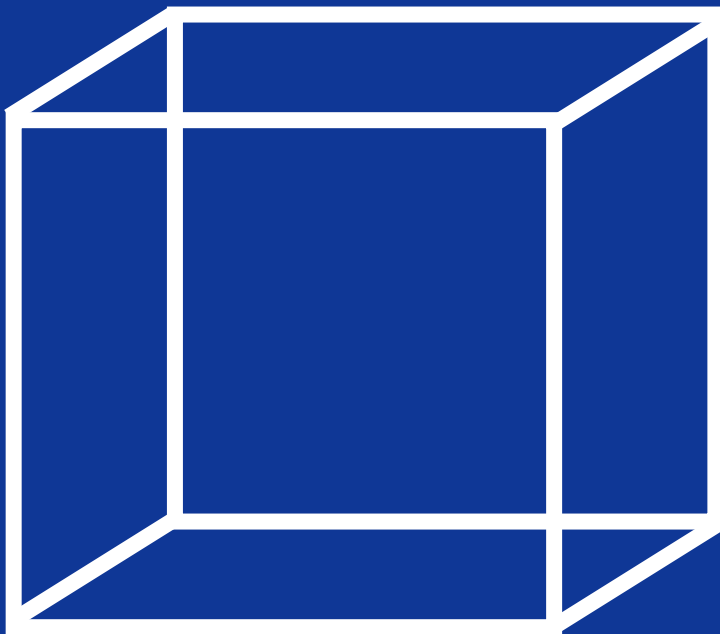


# C-Box-S1

Smart Processing Interface

For MS-90 Plus+ system



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## 2. Important User Information

Thank you for using EKO Products

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument. Keep this manual at safe and handy place for whenever it is needed.

For any questions, please contact us at one of the EKO offices given below:

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### 2-1. Contact Information

#### EKO INSTRUMENTS CO., LTD.

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	The Netherlands	

##### North America Region

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sales-usa@eko-instrumentments.com	95 South Market Street, Suite 300	Tel: +1 408-977-7751
	San Jose, CA 95113 USA	Fax: +1 408-977-7741

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### 2-2. Warranty and Liability

For warranty terms and conditions, contact EKO or your distributor for further details.

EKO guarantees that the product delivered to customer has been verified, checked and tested to ensure that the product meets the appropriate specifications. The product warranty is valid only if the product has been installed and used according to the directives provided in this instruction manual.

In case of any manufacturing defect, the product will be repaired or replaced under warranty. However, the warranty does not apply if:

- Any modification or repair was done by any person or organization other than EKO service personnel.
- The damage or defect is caused by not respecting the instructions of use as given on the product brochure or the instruction manual.

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## 2-3. About Instruction Manual

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This manual was issued: 2024/07/10

Version Number: 2.0\_0.1

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## 2-4. Environment

### 1. WEEE Directive 2002/96/EC

This product is subjected to WEEE Directive 2002/96/EC and should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product(s) to a designated recycle collection point.

Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

### 2. RoHS Directive 2002/95/EC

EKO Instruments has completed a comprehensive evaluation of its product range to ensure compliance with RoHS Directive 2002/95/EC regarding maximum concentration values for substances. As a result all products are manufactured using raw materials that do not contain any of the restricted substances referred to in the RoHS Directive 2002/95/EC at concentration levels in excess of those permitted under the RoHS Directive 2002/95/EC, or up to levels allowed in excess of these concentrations by the Annex to the RoHS Directive 2002/95/EC.

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## 2-5. CE Declaration



IMPORTANT USER INFORMATION

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### DECLARATION OF CONFORMITY

We: EKO Instruments Europe B.V.  
Lulofsstraat 55, U 28, Den Haag  
2521 AL Den Haag

The Netherlands

Declare under our sole responsibility that the product:

Product Name : Control box for the MS-90 DNI sensor  
Model No. : C-BOX-S1

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

Harmonized standards:

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

Following the provisions of the directive:

EMC-directive : 89/336/EEC  
Amendment to the above directive : 93/68/EEC

Date : 01-02-2020

Position of Authorized Signatory : Technical Director

Name of Authorized Signatory : C.H. Hoogendijk

## 3. Safety Information

EKO Products are designed and manufactured with consideration for safety; however, please make sure to read and understand this instruction manual thoroughly to be able to operate the instrument safely in the correct manner.



### WARNING CAUTION

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



### 3-1. WARNING/CAUTION

#### 1. Installation

- Do not install C-BOX-S1 / MS-90 Plus+ in a place, which it may get under water.
- Make sure the instruments are installed in a location where they are easily accessible for maintenance, or it may lead to unexpected accidents and injury.
- Although this product is designed to meet EMC Directive compliance requirements, it may not fully satisfy its primary specification/performance when using this product near following locations where strong electromagnetic wave is generated. Please pay attention to the installation environment.

Outdoor: High voltage power line, power receiver/distribution facility, etc.

Indoor: Large-size chiller, large rotation device, microwave, etc.

#### 2. Power Supply

- Always make sure to check the power supply voltage and type (AC/DC) before connecting and powering ON the instruments.
- Use with fuse 0.5A connected in series on the power supply cable. Depending on the power supply connected, large current may flow when the internal malfunction occurs, and may lead to generating heat and fire.

#### 3. Instruction Manual

- In this instruction manual contains basic and important operation information for the use of the C-BOX-S1 for the MS-90 DNI sensor.
- Read this instruction manual and understand the contents well before operating C-BOX-S1.
- Also, keep this instruction manual in handy location in case you need it.

## 4. Introduction

The C-BOX-S1 smart processing interface provides different functions for sensor control and data processing of the different sensors provided with MS-90 Plus+ system. MS-90 Plus+ tracker less system has unique properties to measure the DNI, GHI, DHI.

The C-BOX-S1 has a built in GPS receiver and is used as part of the MS-90 Plus+ sensor system. By using this device, the MS-90 analogue voltage output peaks correspondent to DNI are detected and converted to digital. With an additional MS-80SH pyranometer a turnkey system can be configured to measure DNI, GHI and DHI over Modbus. Optionally a second MS-80SH pyranometer can be combined to measure the albedo.

Through the Modbus 485 communication line, it is possible to connect with any PV monitoring devices or datalogger, which have a RS-485 serial interface and provide MODBUS serial communication.

The signal converter is integrated in an IP65 enclosure for outdoor installation. The settings for the measurements and communication can be changed by using the EKO C-BOX-S1 setup software.

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### 4-1. Main Functions

MS-90 Plus+ is a turnkey system to measure DNI, GHI and DHI over Modbus 485 RTU.



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## 4-2. Package Contents

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

Table 4-1 Package Contents (C-Box-S1)

Standard Items	Qty.	Remarks
C-BOX-S1 Main Unit	1	C-BOX-S1-Modbus 485 with GPS
Extension Cable (optional)	1	Standard Length: 1.5 for connection to MS-80SH
MS-90 Cable (optional)	1	Standard Length: 1.5 for connection to MS-90
Factory settings report	1	When supplied with sensors

Table 4-2 Package Contents (MS-90 Plus+ system)

Standard Items	Qty.	Remarks
C-BOX-S1 Main Unit	1	C-BOX-S1-Modbus 485 with GPS
Extension Cable	1	Standard Length: 1.5 for connection to MS-80SH
MS-90 Cable	1	Standard Length: 1.5 for connection to MS-90
Factory settings report	1	
MS-90 DNI sensor + Base mounting plate	1	
MS-80SH + signal cable	1	Standard Length: 10m for communication and power supply
Mounting screws for C-Box-S1	1	



## 5. Getting Started

### 5-1. Parts Name

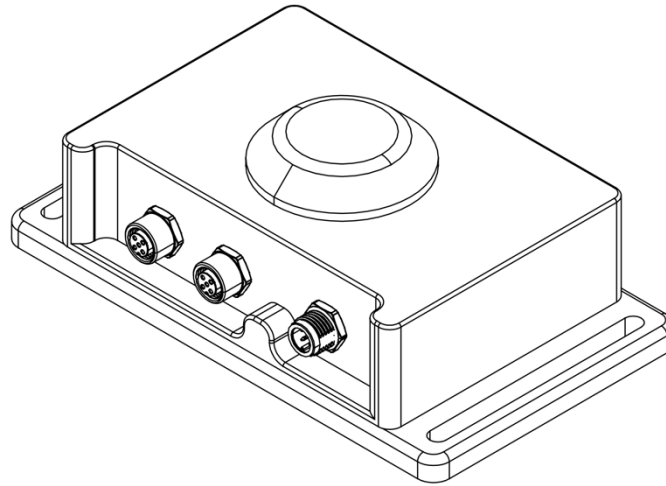


Figure 5-1-1. C-BOX-S1 Parts Name

Standard Items	Qty.	Remarks
GPS Receiver	1	C-BOX-S1-Modbus 485 with GPS
Pyranometer input	1	For MS-80SH
DNI sensor input	1	For MS-90
(Modbus / Power supply) output	1	

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## 5-2. System Overview

The C-BOX-S1 Smart Processing Interface is used to build a sensor system to measure multiple irradiance components. Below figure describe the system configuration of MS-90 Plus+.

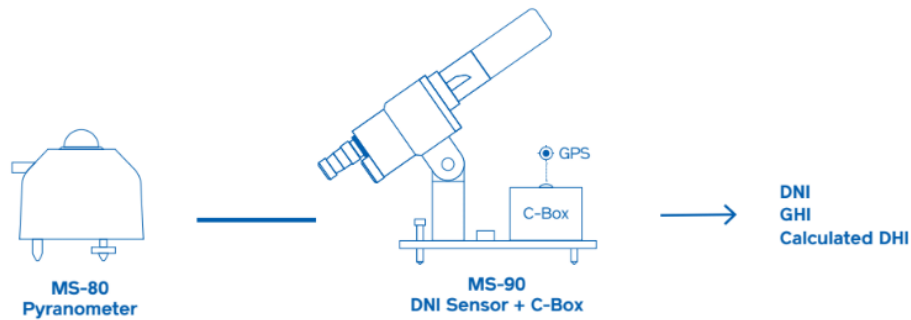


Figure 5-2-1. MS-90 Plus+ system (with MS-80SH sensor)

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## 5-3. Installation

The ideal mounting position is a place without any obstructions such as buildings, trees, and mountains, however it might be difficult to find such location. As a general rule the sensors should have a clear horizon above 5°. The setup location should be easily accessible for periodic maintenance of glass dome cleaning, desiccant replacement, etc. Avoid surrounding towers, poles, walls or billboards with bright colors that can reflect solar radiation onto the sensors.

For is installation of the sensors MS-90 DNI sensor and MS-80SH pyranometer check out the online manuals at [EKO-EU.com](http://EKO-EU.com).

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## 5-4. Settings

### 1. Wiring

The system will be delivered with all sensor parameters preset.



Disconnect from power source before installation and maintenance to avoid any damage to electronics or sensors.

Connect all cables to the sensors and data acquisition system.

1. Connect the C-BOX-S1 to data logger via Modbus RTU
2. Connect the MS-90 DNI sensor signal cable to the sensor (1.5m cable)
3. Connect the MS-80SH Pyranometer signal cable to the sensor (1.5m cable)
4. Connect the Main Unit power supply

### 2. Connections

To extend the cable lifetime, prevent that the cables are not directly exposed to direct sun light or rain/wind. Cables can be placed in a cable conduit. Cable vibrations will potentially cause noise in the output signal. Fasten the cable so that the cable does not swing or move by wind blowing. Exposure of the signal cable to excessive electromagnetic emissions can cause noise in the output signal as well. Therefore the cable should be lined at a safe distance from a potential source generating EMC noise, such as an AC power supply, high voltage lines or telecom antenna.

#### Output Modbus 485 mode

Table 5-3-1. Connections C-BOX-S1-Modbus 485 (Output)

5 Pin connector / wire Color	Function
1. Brown	12V – 24VDC Supply voltage
2. White	Supply voltage 0
3. Blue	Modbus (+) / A
4. Black	Modbus (-) / B
5. Grey	Modbus ground

C-BOX-S1 can connect to a system that communicates with Modbus 485 RTU. Connection of C-BOX-S1 to the RS-485 communication network is shown below. The Master represents the data-logging device [such as PC], and the slaves represent devices such as the C-BOX-S1. Connect the + and – for the master to [A] and [B]. Also at the end of the network, connect a 120Ω termination resistor.

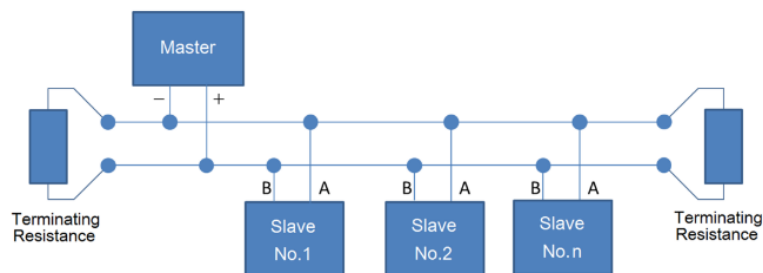


Figure 5-4-3. Connections of C-BOX-S1 in a Modbus 485 network

## 5-5. Operating

When powering the C-BOX-S1 it will always start up in Modbus mode. After powering the C-BOX-S1 while connected to the MS-90 DNI sensor, the mirror will start automatically turning. Upon startup of the C-BOX-S1, the detector voltage output will build up due to internal charging of a capacitor from the MS-90 sensor circuit, this voltage will slowly adapt to the irradiance conditions after approximately 1 minute.

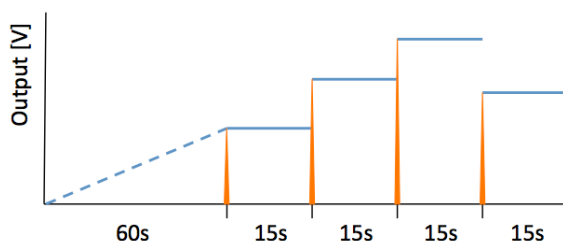


Figure 5-5-1. C-BOX-S1 analog output signal

## 5-6. Irradiance measurements

The DNI measurements are taken every 15 seconds based on the rotation speed of the mirror. Global Irradiance (GHI) measurements are measured every 1 second

For a system configured with MS-90 DNI and MS-80SH pyranometer and operated in Modbus mode the three irradiance components (DNI, GHI, DHI) will be measured.

The pyranometer (GHI) signal is converted into irradiance based on the sensitivity figure which is factory preset. Hence the diffuse irradiance (DHI) is calculated based on the DNI and GHI.

$$\text{Irr}_{\text{DHI}} = \text{Irr}_{\text{GHI}} - (\text{Irr}_{\text{DNI}} \cdot \text{Cos } \vartheta)$$

- $\text{Irr}_{\text{DHI}}$  = Calculated diffuse horizontal irradiance [W/m<sup>2</sup>]  
 $\text{Irr}_{\text{GHI}}$  = Global Horizontal Irradiance [W/m<sup>2</sup>]  
 $\text{Irr}_{\text{DNI}}$  = Direct Normal Irradiance [W/m<sup>2</sup>]  
 $\text{Cos } \vartheta$  = Zenith angle (°)

# 6. Modbus communication

## 6-1. Communication

Pin / wire Color	Function
Communication standard	RS-485
Protocol	Modbus Slave RTU
Communication speed	9600 Default
Data length	8bits
Node address	1 Default / can be changed with EKO software (MS-90 Plus+ productpage <a href="http://www.eko-instruments.com">www.eko-instruments.com</a> )
Stop bit	1
Parity bit	None

## 6-2. Registers

Address	Label	Format	Description
0	MB_FW_VERSION	16 bit WORD	Firmware version
1	MB_SERIAL	16 bit WORD	Serial number
2	MB_SENSOR_MODEL	16 bit WORD	Sensor model
3	MB_BOARD_TEMPERATURE	16 bit WORD	PCB Temperature * 10
4	MB_MSX0	FLOAT	MS80 Global irradiance
6	MB_DNI	FLOAT	DNI
10	MB_NTC	FLOAT	MS80 Temperature
12	MB_DIFF	FLOAT	Diffuse
14	MB_TIMESTAMP	32 bit	Timestamp from GPS
18	MB_GPS_SATS	16 bit WORD	Amount of visible GPS satellites
22	MB_CF0	FLOAT	MS-80 calibration value
32	MB_CF5	FLOAT	MS-90 calibration value
34	MB_LAT	FLOAT	Latitude
36	MB_LON	FLOAT	Longitude
40	MB_ELEVATION	FLOAT	Sun elevation
42	MB_AZIMUTH	FLOAT	Sun azimuth

# 7. Specification

## 7-1. Main Unit

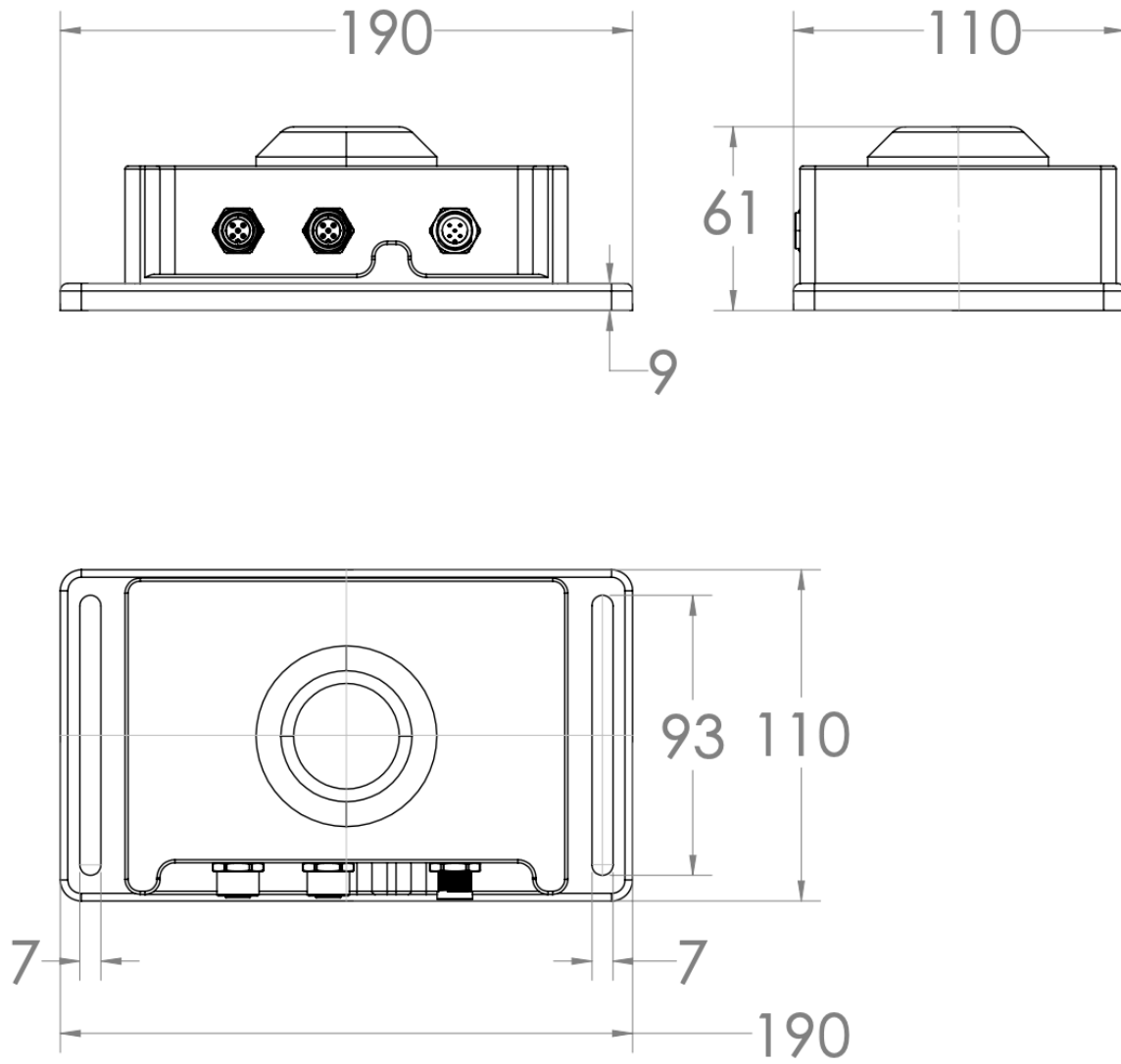
Table 8-1. C-Box-S1 Main Unit Specification

Characteristics	Details	
Input Signals	EKO MS-90 DNI sensor	Analog pulse 0 to 2V
	EKO MS-80SH Pyranometer	Digital input Modbus
Communication Method	RS-485 (Modbus RTU)	
Temperature Response (-20~50°C)	< 0.2%	
Operating Temperature Range	-40 to +80°C	
Operating Humidity Range	≤ 95% RH (no condensation)	
Response Time	1s	
Power Supply	12 - 24VDC	
Average Power Consumption	0.5W	
Dimensions (L / W / H)	125 x 60 x 80 mm	
Weight (kg)	0.5	
Ingress protection	IP 65	

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## 7-2. Dimensions

Dimensions (mm)







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