

EKO

Beyond Accuracy.

PV-Blocks

PV evaluation system

May 2021

www.EKO-EU.com



PV evaluation systems

1. EKO Evaluation systems
2. New PV-Blocks evaluation system
 - PV-Blocks system modules
 - Configuration
 - Specifications
 - Software
3. Grid connected
4. Turn-key

1

PV module
evaluation systems

EKO PV Measurement solutions

- MP-180 (Cell)
- MP-160 / 165 (Module)
- MP-11 (Module string)
- PV-Blocks (Module)





MP-180

PV Cell evaluation system



MP-11

PV string performance evaluation. Portable IV checker (I/V STC)

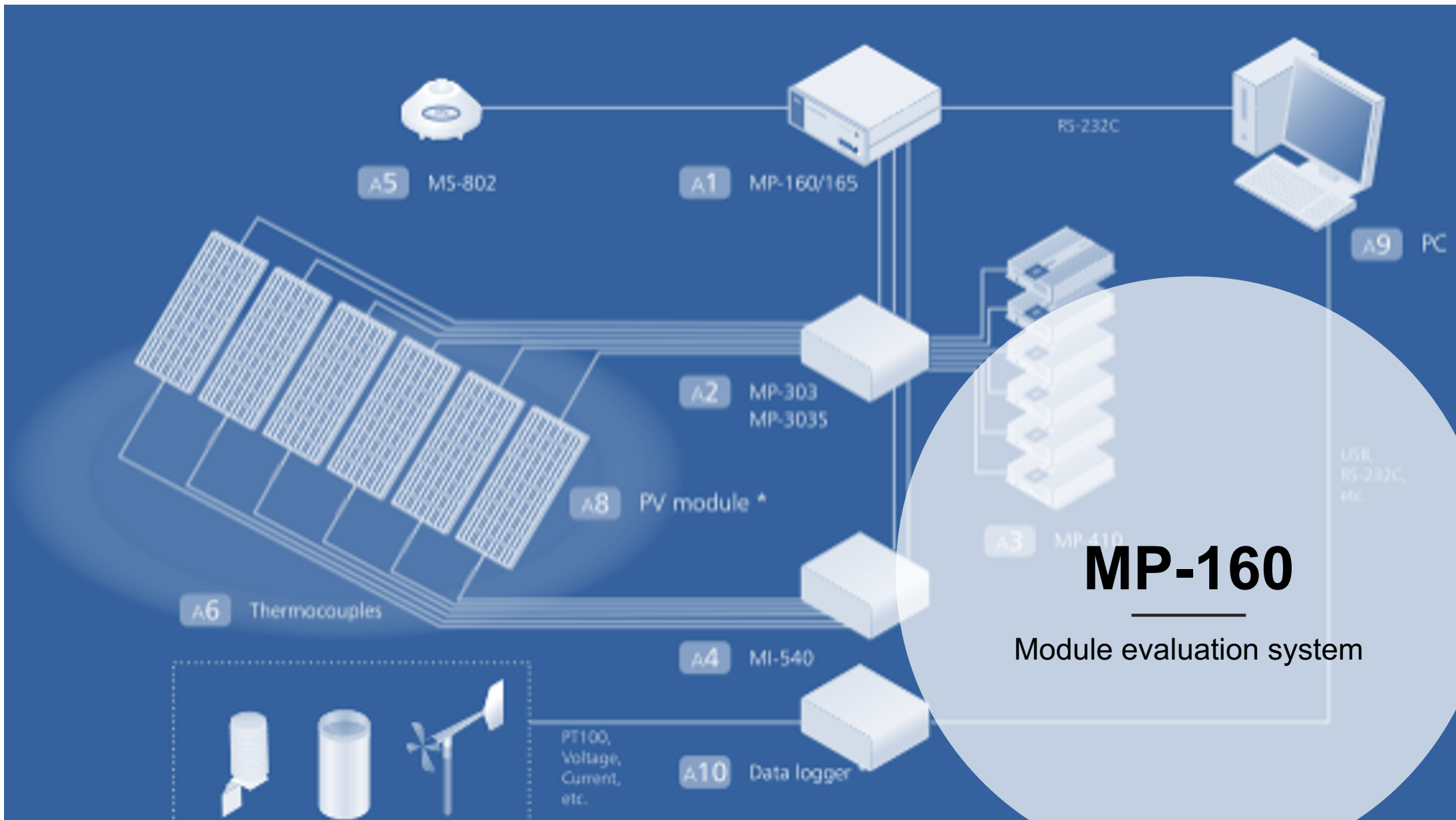
High power input range 18kW (1000V / 30A)

Quick measurement time (Capacitor method)

Auto measurement schedule

Sensor unit with data logger (Irr, PV Module temp)

PC operating / analysis software



MP-160

Module evaluation system

2

PV-Blocks PV
evaluation systems



EKO



PV Blocks
Powered by ReRa

Beyond Accuracy.

Introduction

PV Blocks modular research system for PV module performance evaluation outdoors



PV Module performance Outdoors



- Monitor performance outdoors (Mpp, Isc, Voc, IV, Tm STC, NOCT)
- Irradiance (GHI, Irr POA, DNI, DHI, Albedo, Spectral irradiance)
- Meteorological parameters (Ta, RH, P, Ws, Wd, Precipitation)

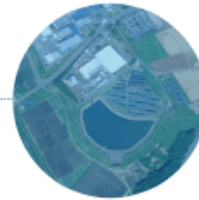
All data simultaneously measured and managed through one system

EKO

 TALKING POINT

EKO Instruments Mega Solar Parks

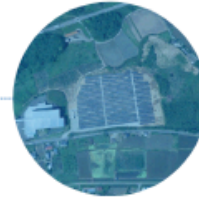
Since 2013, both PV parks not only contributed to be a great experimental platform for new developments, but also have a tremendous impact to the general ecological strategy of EKO.



Ami Solar Park

721

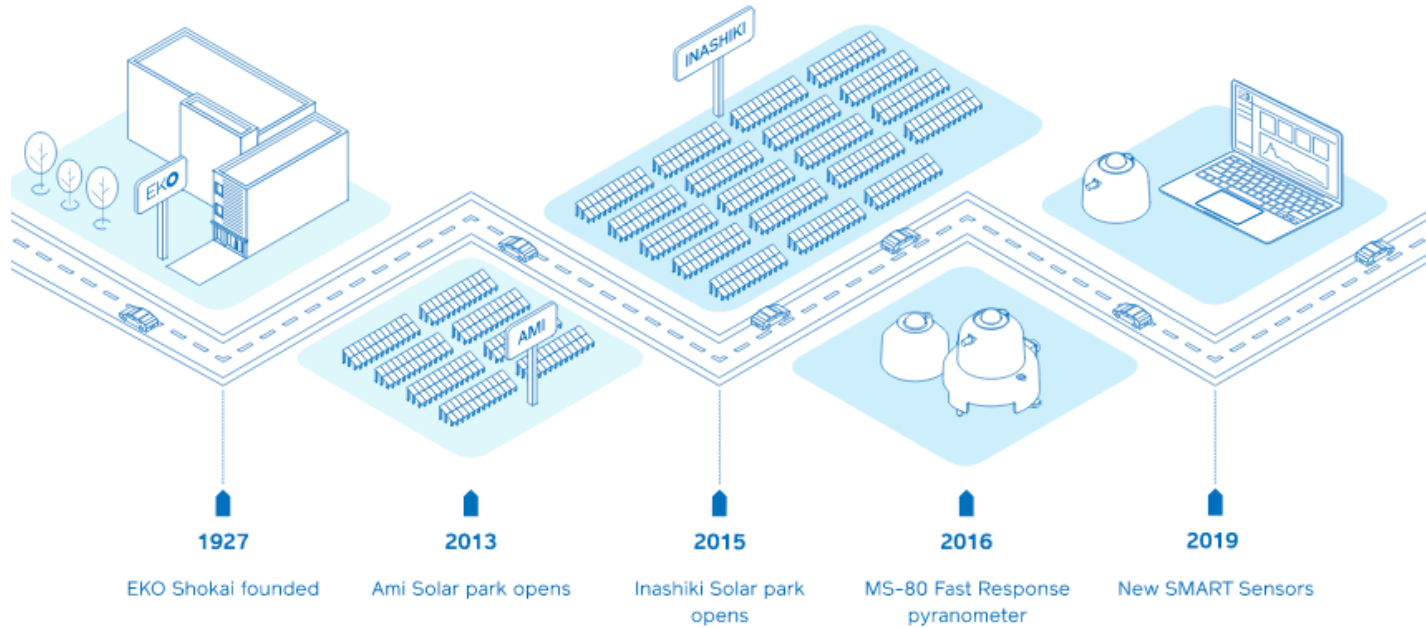
MWh/year



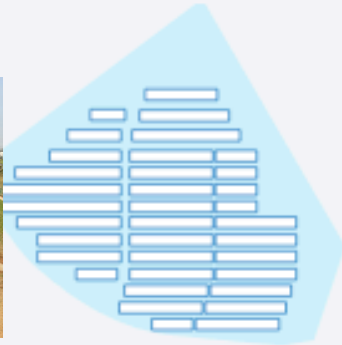
Inashiki Solar Park

2.050

MWh/year

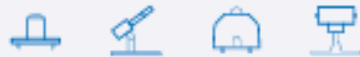


Ami Solar Park



Land Area:	16.290 m ²
PV cell capacity:	705 kW
Inverter capacity:	600 kW
N. of panels:	3.188

Tested sensors:



Inashiki Solar Park



Land Area:	28.500 m ²
PV cell capacity:	2020 kW
Inverter capacity:	1.250 kW
N. of panels:	7.560

Tested sensors:

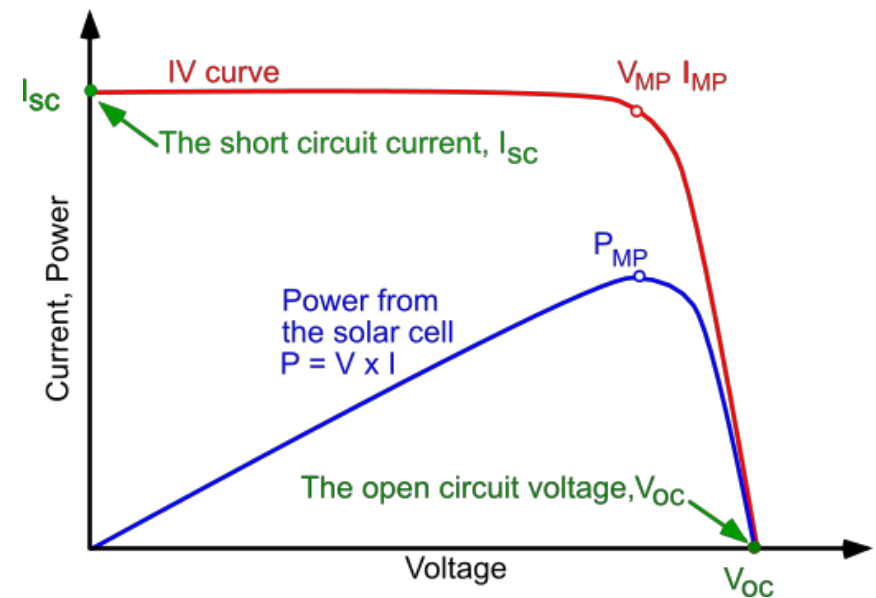


PV Module Performance

Environmental and atmospheric conditions

- IV (I_{sc} / V_{oc})
- V_p / I_{mp} / P_{max}
- T_{BP}
- Irr

STC is an industry-wide standard to indicate the performance of PV modules and specifies a **cell temperature of 25°C** and an **irradiance of 1000 W/m²** with an **air mass 1.5 (AM1.5)** spectrum. These correspond to the irradiance and spectrum of sunlight incident on a clear day upon a sun-facing 37°-tilted surface with the sun at an angle of 41.81° above the horizon.



PV-Blocks compliance

IEC standards:

- IEC 60904-1 – Part1 Measurement of photovoltaic current-voltage characteristics
- IEC 60891 – Procedures for temperature and irradiance corrections to measured I-V characteristics

IEC 60904-1

Measurement of photovoltaic current-voltage characteristics

“The irradiance measurements shall be made using a PV reference device packaged and calibrated in conformance with IEC 60904-2 or IEC 60904-6 or a pyranometer.”

PVBlocks can be connected to any of the mentioned reference devices

“The temperature of the reference device and the specimen shall be measured using instrumentation with an accuracy of ± 1 °C with repeatability of ± 0.5 °C.”

PVBlocks supports the measurement of Pt100 sensors and any digital temperature measurement device

“The measurement ranges of the data acquisition should be carefully chosen. If the test specimen is a module, the 4-wire connection should start at the terminals or connectors.”

The IV-Loads support a 4-wire connection.

IEC 60904-1

Measurement of photovoltaic current-voltage characteristics

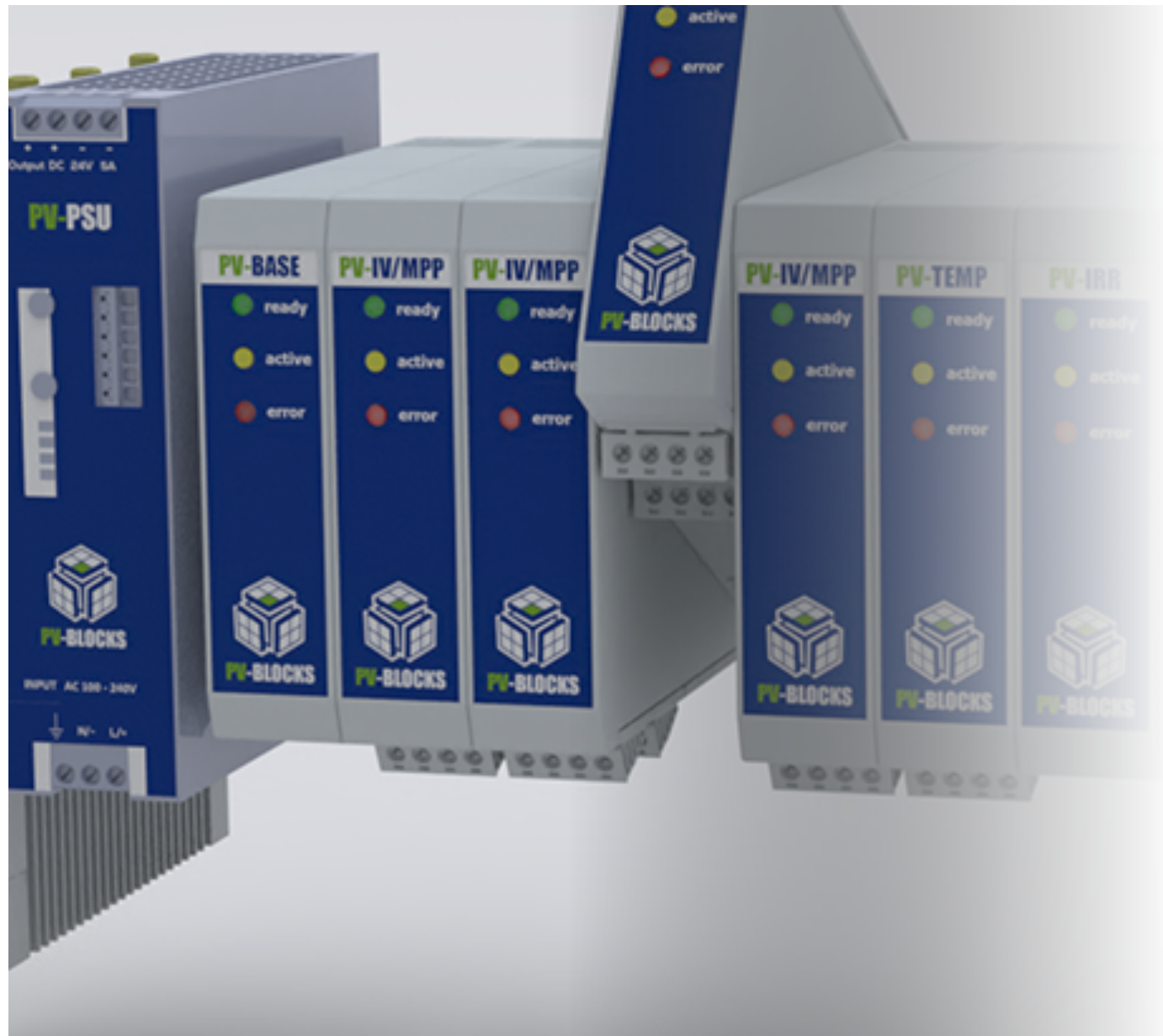
“Isc: the IV-curve is extrapolated to zero voltage provided that voltage drop is not higher than 3 % of the device open-circuit voltage and that there is a linear relationship between current and voltage.”

“Voltages and currents shall be measured using instrumentation with an accuracy of ± 0.2 % of the open-circuit voltage and short-circuit current using independent leads from the terminals of the specimen and keeping them as short as possible.”

Isc, Voc	± 0.2 % of Isc	± 0.2 % of Voc
10A, 40V	± 20 mA	± 80 mV
20A, 120V	± 40 mA	± 240 mV
5A, 20V	± 10 mA	± 40 mV
1A, 80V	± 2 mA	± 160 mV

PV-Blocks is a powerful modular system to test the latest PV module technology outdoors. It comprises an all-in-one solution for measuring IV-curves, maximum power point tracking and full support for irradiance and meteorological data.



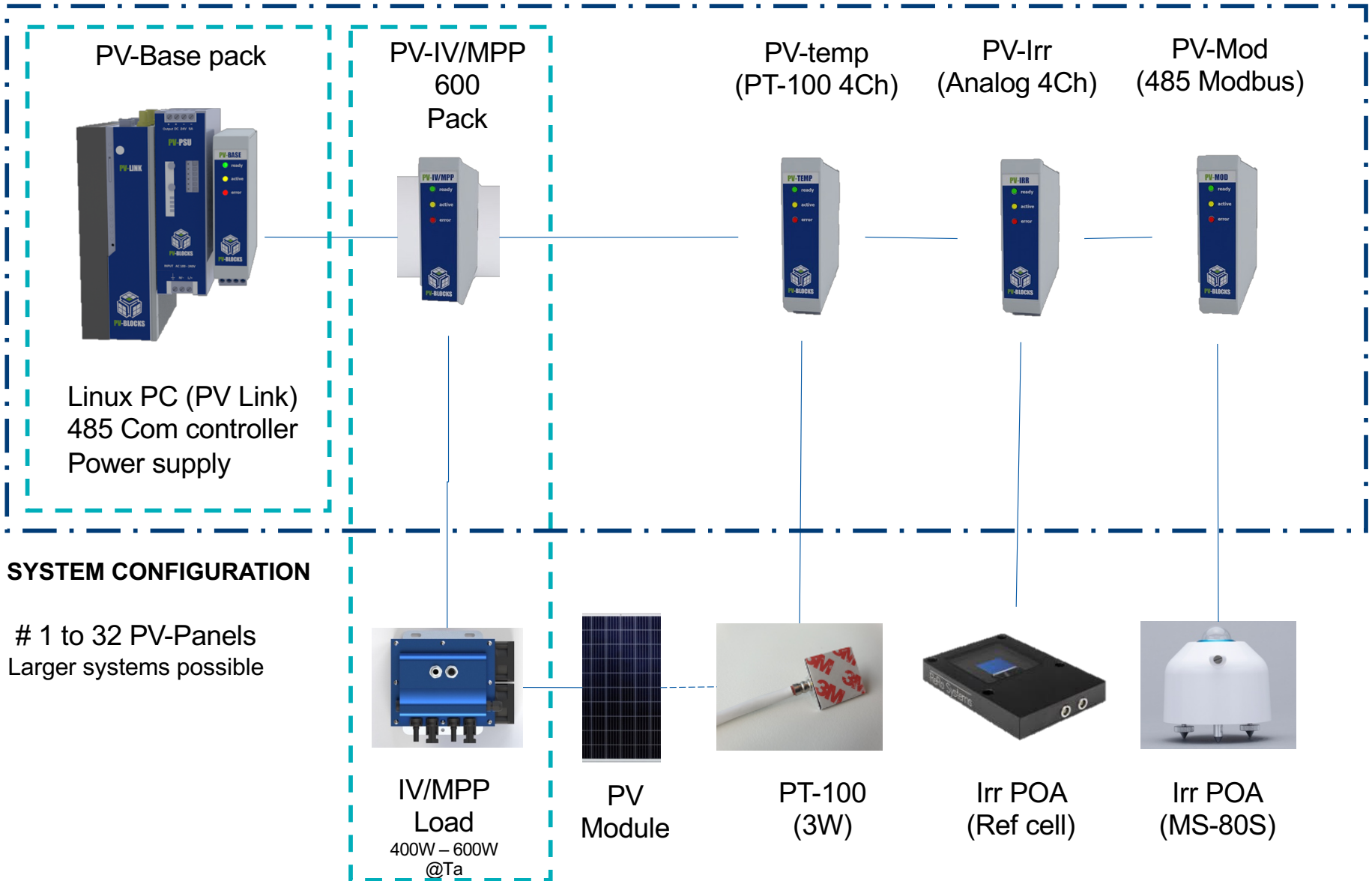


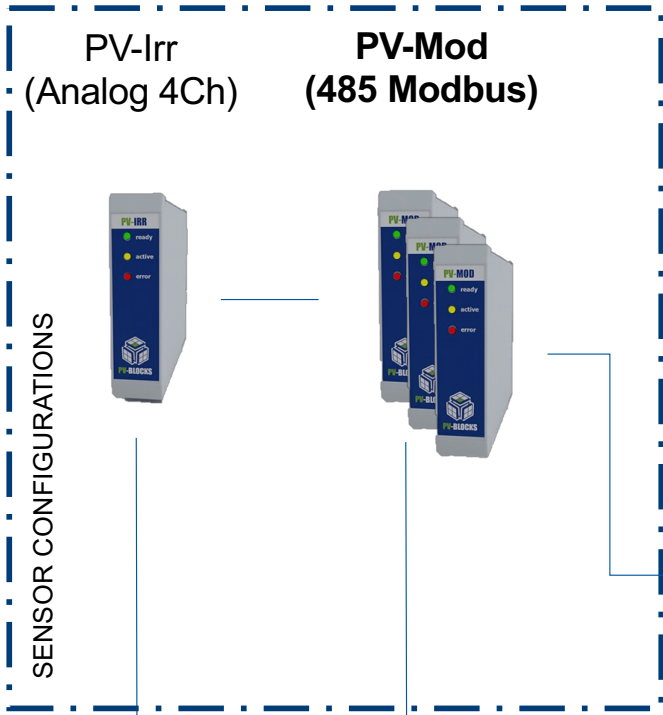
EKO PV-Blocks

The PV-Blocks system consists of different modules called 'PV-Blocks'.

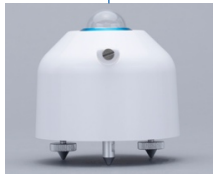
Each PV-Block is targeted to a different measurement task. This can be, for example a current/voltage measurement of the PV panel, the back-panel temperature, the in-plane irradiance or the output of a professional weather station.

Another important feature of the PV-Blocks is the direct integration of controllable loads (up to 600 Watt). These loads allow for full IV-curve measurements and positive voltage biasing.

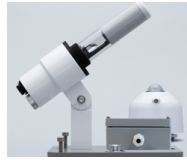




Irr POA
(Ref cell)



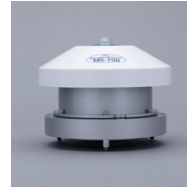
Irr POA
(MS-80S)



MS-90 PLus
Irr DNI
Irr DHI
Irr GHI



MS-80S Albedo
Irr GHI
Irr GHI_R



MS-711
Spectral Irr
(300-1100nm)



MS-712
Spectral Irr
(900-1700nm)



STR-21G-S2
Irr DNI
Irr DHI
Irr GHI



STR-21S-SA
Irr Total
Single Axis

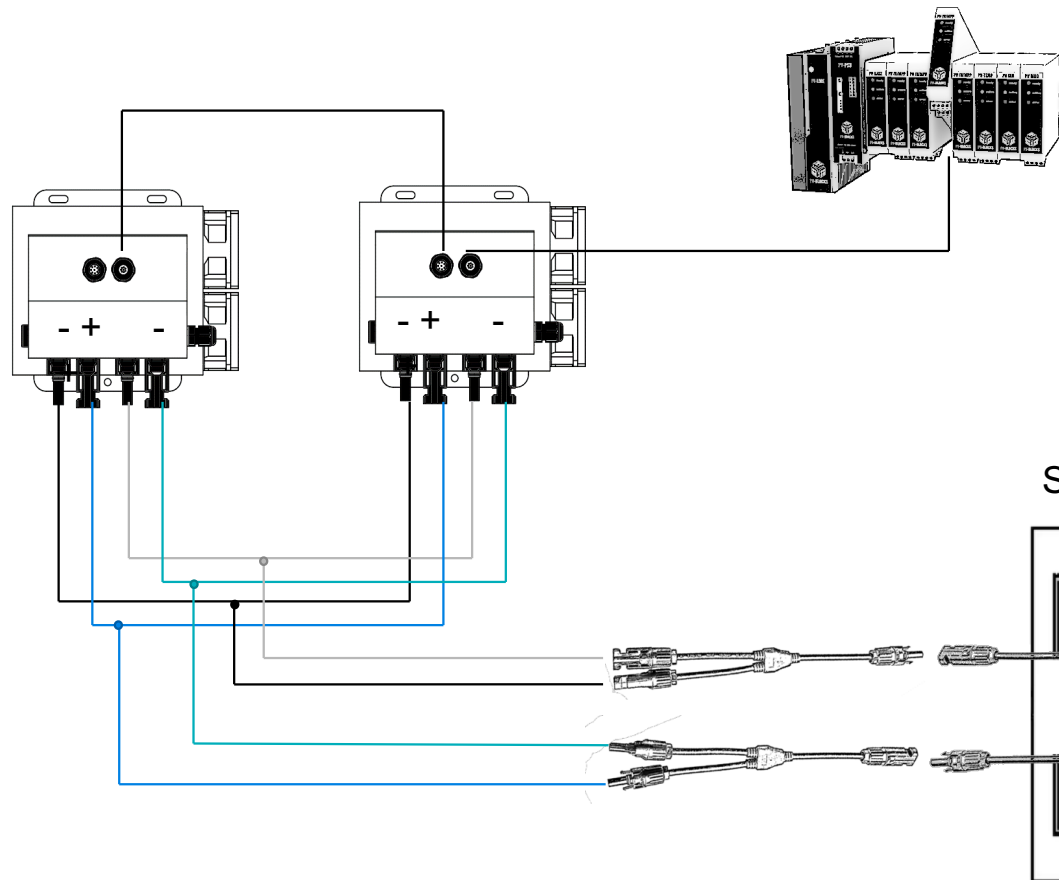


Metsens 500
Ta, P
RH, Ws
Wd



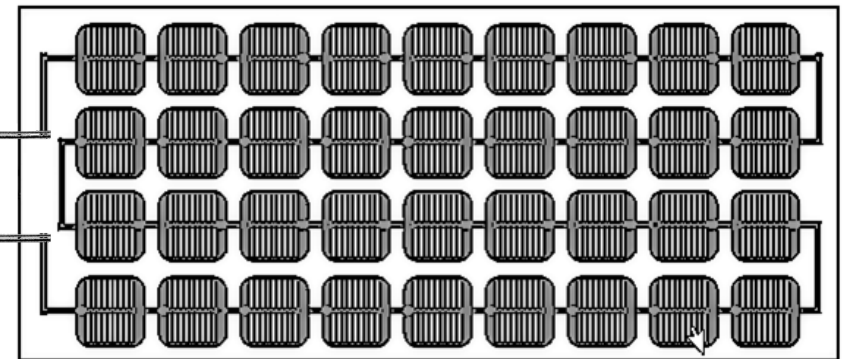
Pvmet 500
Ta, P
RH, Ws
Wd
Rain

High power option 1

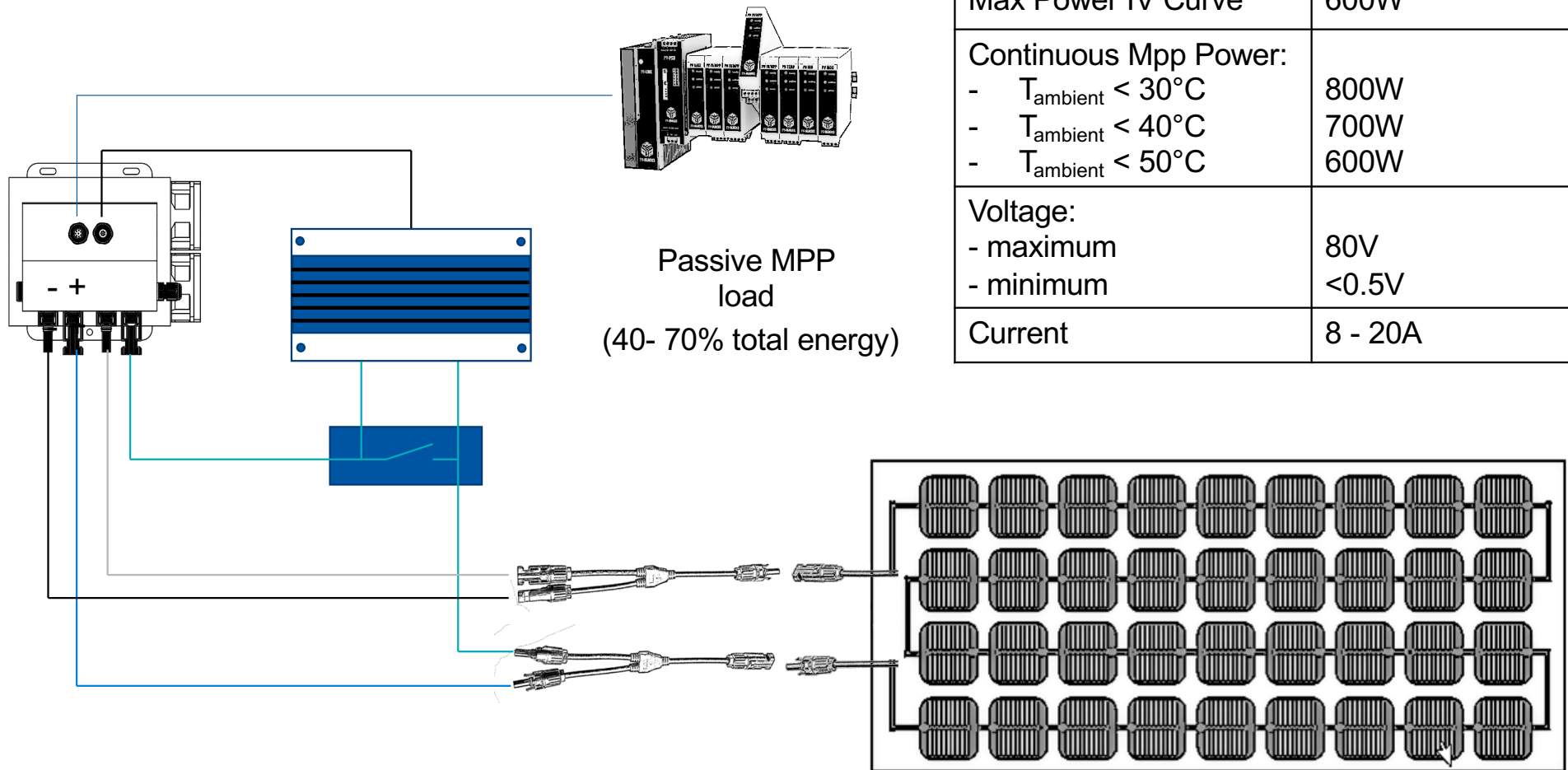


Parameter	Value
Max Power IV Curve	1200W
Continuous Mpp Power:	
- $T_{\text{ambient}} < 30^{\circ}\text{C}$	900W
- $T_{\text{ambient}} < 40^{\circ}\text{C}$	800W
- $T_{\text{ambient}} < 50^{\circ}\text{C}$	700W
Voltage:	
- maximum	80V
- minimum	<0.5V
Current	0 - 20A

Same voltage, double current



High power option 2



Parameter	Value
Max Power IV Curve	600W
Continuous Mpp Power:	
- $T_{\text{ambient}} < 30^{\circ}\text{C}$	800W
- $T_{\text{ambient}} < 40^{\circ}\text{C}$	700W
- $T_{\text{ambient}} < 50^{\circ}\text{C}$	600W
Voltage:	
- maximum	80V
- minimum	<0.5V
Current	8 - 20A



1. PV Base pack

- Each PV Blocks system contains the PV Base pack
- PV Base Pack comprises
 - Linux computer (PV-Link)
 - 24VDC power supply (PSU),
 - Logical bus control unit (PV BASE)
 - ethernet cable (10m).

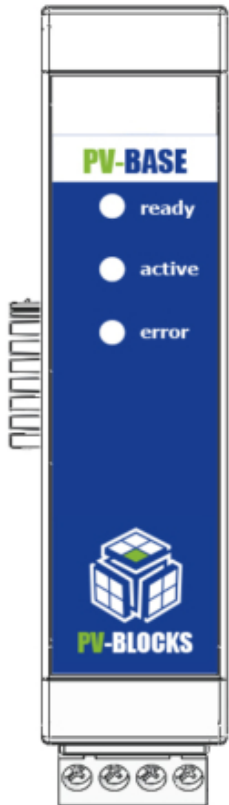


The control software is running on the PV Link computer and can be accessed using any internet browser. The software handles scheduling of measurements, storing of data in a local database, configuration of the system and connected devices. All data can be easily exported in the most common formats (CSV, etc..). A full user management system is available to control the access levels of different users.

On the computer there are multiple ethernet ports, for a direct connection to, a laptop and one to connect to the local network. This way the user is free in the selection of the interface. When only the local network is used, it is impossible for intruders to access any data.

To install the base pack, the user must simply mount the 3 units on a standard T35 DIN-rail and apply AC power (100 – 240VAC) to the power supply.

Specifications



PV base Pack

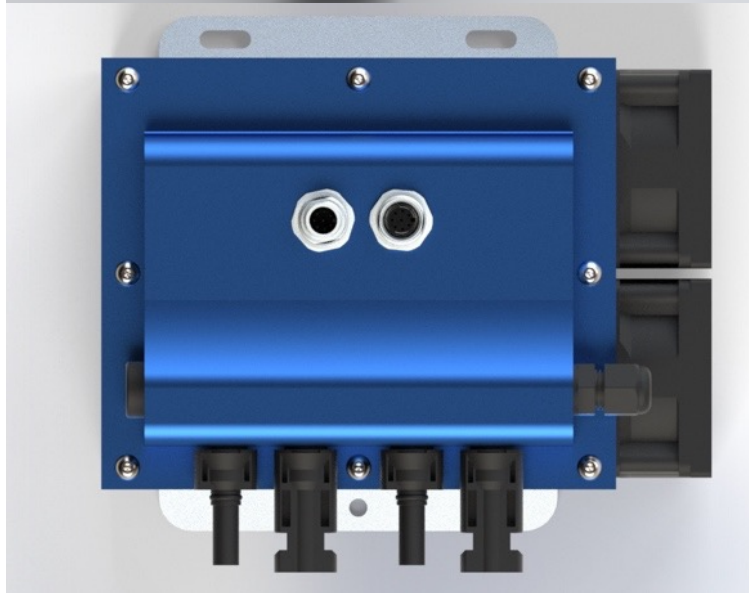
Input voltage	24 V DC
Input power max	
Interface	RS485

Power supply (PSU)

Input voltage range	100 V AC ... 240 V AC (-15 % ... +10 %)
Nominal output voltage	24 V DC
Nominal output current	5 A
Output power	120 W
Ambient temperature operation	-25°C ... 70°C

Computer (PV Link)

	Linux operating system / Web interface
Input voltage	9 ... 36 V DC
Input power max	
Memory	4 Gb
Storage	32 Gb SSD
Ambient temperature operation	-25°C ... 70°C

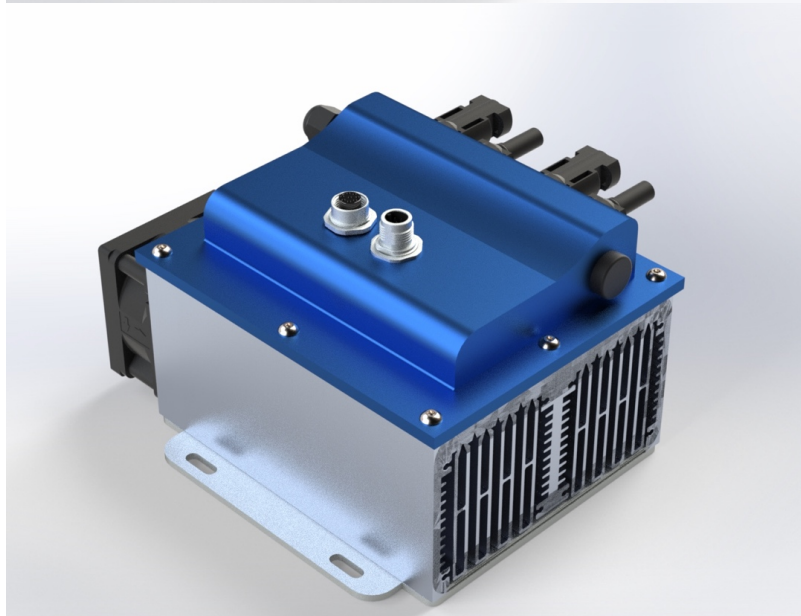
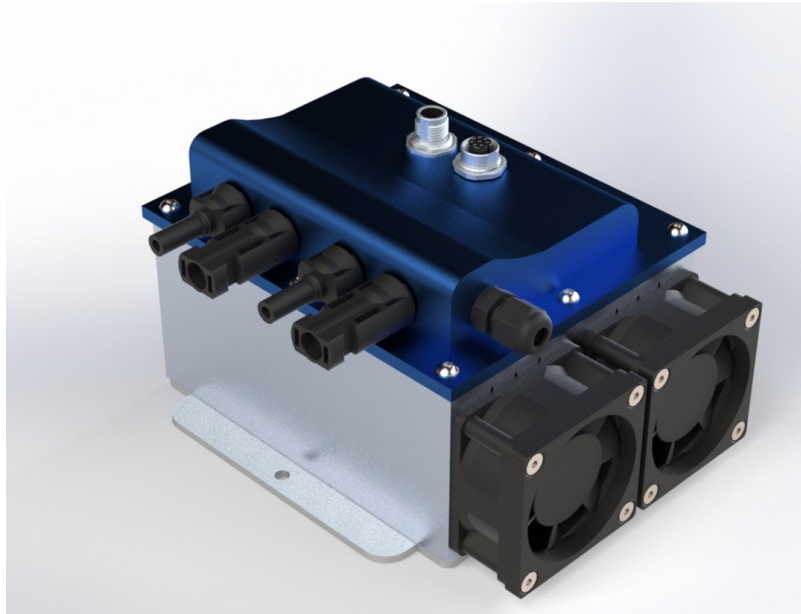


2. PV IV/MPP Pack

The PV IV/MPP Pack is used for the measurement of IV curves, MPP tracking and specific voltage biasing of PV Panels. The Load unit (IP 55) can be installed outdoors close to the PV module.

Key features:

- The PV IV/MPP Pack is used for the measurement of IV Curves, MPP tracking and specific voltage biasing of PV Panels.
- IV/MPP Load Block (Installed outdoors).
- IV measurement up to 600W (Multiple loads for larger capacity > 600W).
- Accurate MPP tracking (I_{mpp} / V_{mpp} / P_{mpp})
- 10 to 20 m heatsink measurement cable (between IV/MPP Block and heatsink), 4Wire connection to PV modules (MC-4 connector)
- The measurement speed of an IV curve can be set from 200ms, up to 30 seconds (50 to 200 points, can be extended but affects measurement time).



2. PV IV/MPP Pack

Range (Load)

- 0 - 600W
- 1 – 80 (Default) / 120V (Optional) / 200V (Optional)
- 0 - 20A

Fan unit

The IV/MPP load unit is actively cooled by forced air and has over temperature safety protection.

Input voltage	24 V DC
Communication modules	RS 485
Sweep time	0.2 – 30s
Curve direction	Isc – Voc – Isc
Resolution	24 Bits
ADC	Simultaneous
IV points	50, 100, 150, ...



4. PV TEMP

The PV TEMP block handles the measurement of up to 4 temperature sensors connected to the back plane of PV Panels.

Key features:

- Pt100 temperature measurement of PV panels and PV cells
- Up to 4 PT-100 sensors per PV TEMP block
- 3-wire connection

Specifications:

Input voltage	24 VDC
Busload	0.1
Sensor	Pt100
Connection	3-wire
Inputs	4
Accuracy	0.35°C with PT-100/3W



5. PV IRR

The PV IRR block handles the measurement of up to 4 analog irradiance sensors (Pyranometers and reference cells).

Key features:

- High resolution input for analog sensors: pyranometers, reference cells
- 4 dedicated analog inputs
- High impedance sensor ready

Specifications:

Input voltage	24 VDC
Busload	0.1
Analog input	0 – 100mV
Resolution	24 bits
Inputs	4
Accuracy	0.1 μ V



6. PV MOD

The PV MOD block can be used to integrate external instruments that support the MODBUS RTU protocol.

Key features:

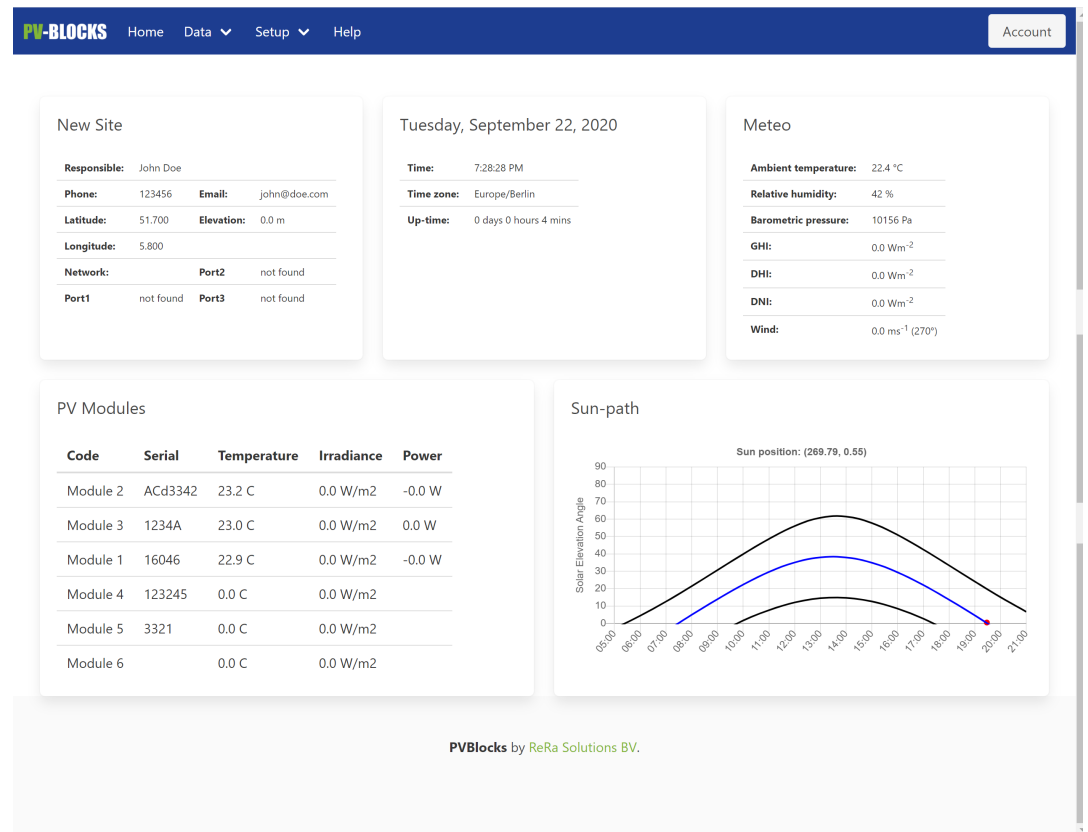
- Modbus RTU connection
- Integration of external EKO sensors (weather stations, DNI sensors, Pyranometers)

Specifications:

Input voltage	24 VDC
Input terminals (A/B)	4 (8 sensors of same type)
Supported sensors	EKO Smart sensors (80S / 60S / 40S), MS-711, MS-90-Plus+, Metsens500, PVmet500
MODBUS	RTU
Baudrate	≤ 115200

Software

Web-interface



Software

Functions

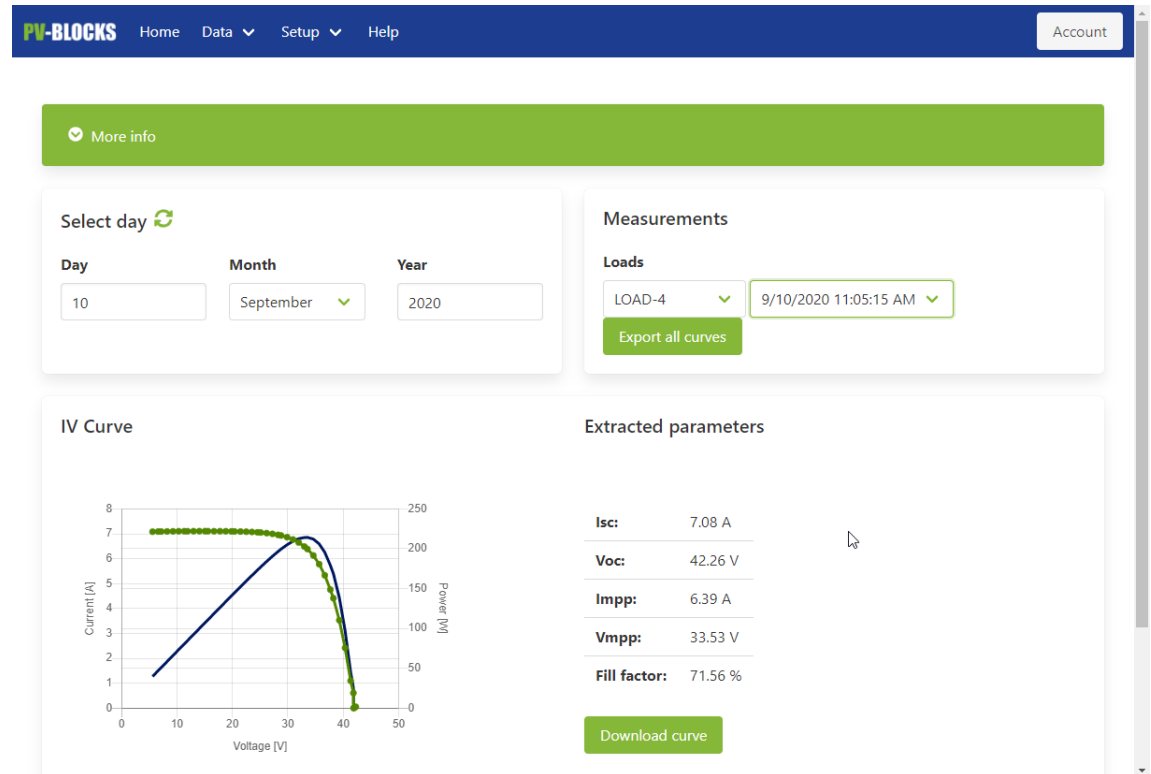
PV-Blocks user interface offers many functions to configure your measurements

Key features:

- Web-browser UI
- Home screen (system status, measurement data)
- IV measurement data, settings, index values (STC, NOCT)
- Measurement Scheduler (applicable for each single modules)
- Easy System configuration (auto detection of modules, define sensors to be combined with IV measurement)
- Automatic updates
- Phyton API for advanced user data management

IV Curve

For each PV module



PV Modules

Settings PV modules

PV-BLOCKS



PV Modules

More info

Manufacturer	Panel Code	Serial	Area	Power	Irradiance sensor
JWA	Module 2	ACd3342	1.3	280	
Sunpower	Module 3	1234A	0		
JA Solar	Module 1	16046	1.6	265	
ReRa	Module 4	123245	0	123	
ReRa 2	Module 5	3321	0		
ReRa 3	Module 6		0		

New

Scheduler

Settings PV modules

The screenshot shows the PV-BLOCKS web interface. At the top, there is a navigation bar with 'PV-BLOCKS' on the left and 'Home', 'Data', 'Setup', and 'Help' in the center. An 'Account' button is on the right. Below the navigation bar is a red banner with the text: 'The scheduler is paused, no measurements are taken. Go to System Setup / Scheduler to enable it.'

Scheduler

Enable scheduler **Scheduler**
The scheduler is now paused, no measurements are taken. Use the button to enable the scheduler.

Reset Scheduler **Reset**
To reset the scheduler, press the button. All scheduler settings will be reset and removed. Do this for example when a new PVBlock is installed.

IV-curves

PVBlock	Start	Stop	Mode	Curve Interval	
LOAD-1					
LOAD-2					
LOAD-3					
LOAD-4					
LOAD-5					
LOAD-6					
LOAD-7					
LOAD-8					

PVBlocks by ReRa Solutions BV.

Hardware configuration

Settings PV modules

The scheduler is paused, no measurements are taken. Go to System Setup / Scheduler to enable it.

Hardware configuration

Enable scheduler

Hardware configuration

The scheduler is now paused, no measurements are taken. Use the button to enable the scheduler.

Reset Base unit

Reset base unit

Whenever the system is malfunctioning resetting the base unit can provide a solution.

Scan PVBlocks

Scan PVBlocks

The hardware will scan itself to see if there are any new PVBlocks installed. Only use this when the hardware is modified or the first time the system is setup.

Send Trigger

Trigger measurements

This will send a trigger signal to the system, resulting in a synchronous measurement among all pvblocks. This only has to be used for testing purposes.

Direct control

Direct PVBlock control

This will allow for the direct control of the PVBlock modules.

Position	Label	PV-block	Unique ID
1	LOAD-1	IV-MPP	(3746994893856784658)link / Reset
2	LOAD-2	IV-MPP	(5548434744804695570)link / Reset
3	LOAD-3	IV-MPP	(3026418953477529618)link / Reset
4	LOAD-4	IV-MPP	(1376300046512852661)link / Reset
5	LOAD-5	IV-MPP	(9583660010928700690)link / Reset
6	LOAD-6	IV-MPP	(1347477008897650075)link / Reset
7	LOAD-7	IV-MPP	(1419534602935512168)link / Reset
8	LOAD-8	IV-MPP	(4323455646159970578)link / Reset
9	IV-MOD	PV-MOD	(4683743616340219410)link / Reset
10	Temperatures	PV-TEMP	(3674937299816732946)link / Reset ✓
11	Temperatures	PV-TEMP	(1109686948572427547)link / Reset ✓
12	Irradiances	PV-IRR	(6269010685182116882)link / Reset ✓

Save

Backup

Software updates

The screenshot shows a web interface for PV-BLOCKS. At the top, there is a dark blue navigation bar with the logo 'PV-BLOCKS' on the left and links for 'Home', 'Data', 'Setup', and 'Help' in the center. On the right side of the navigation bar is an 'Account' button. Below the navigation bar is a white content area with the title 'Backup'. Underneath the title, it says 'Available backups'. A table lists one backup with columns for 'Name', 'Date', 'Download', and 'Restore'. The backup name is a long alphanumeric string, the date is '21-Sep-2020 11:33:58', and the download link is 'Download Backup (5Mb)'. Below the table is a 'New backup' button. Further down, there are instructions: 'Upload backup from your device.' and 'Upload a backup from your computer so you can restore it.' At the bottom of the page, there is a footer that reads 'PVBlocks by ReRa Solutions BV.' and a small icon in the bottom right corner.

PV-BLOCKS Home Data Setup Help Account

Backup

Available backups

Name	Date	Download	Restore
psql-data-20200921-113355-d3b71249-bec4-4b3d-b71e-df68a01c5160.tar.gz	21-Sep-2020 11:33:58	Download Backup (5Mb)	

[New backup](#)

Upload backup from your device.

Upload a backup from your computer so you can restore it.

PVBlocks by ReRa Solutions BV.

API

Phyton

PV-Blocks user interface offers a Python based API to give maximum flexibility to create your own data interface

Key features:

- Run python scrips on a separate PC
- Generated Python script functions for easy integration
- Create your preferred data download scripts.



3

PV modules grid
connected

Grid connected



- Connect PV-Blocks to the grid with PV-Switch and PV-monitoring modules
- Irradiance (GHI, Irr POA, DNI, DHI, Albedo, Spectral irradiance)
- Meteorological parameters (Ta, RH, P, Ws, Wd, Precipitation)

All data simultaneously measured and managed through one system

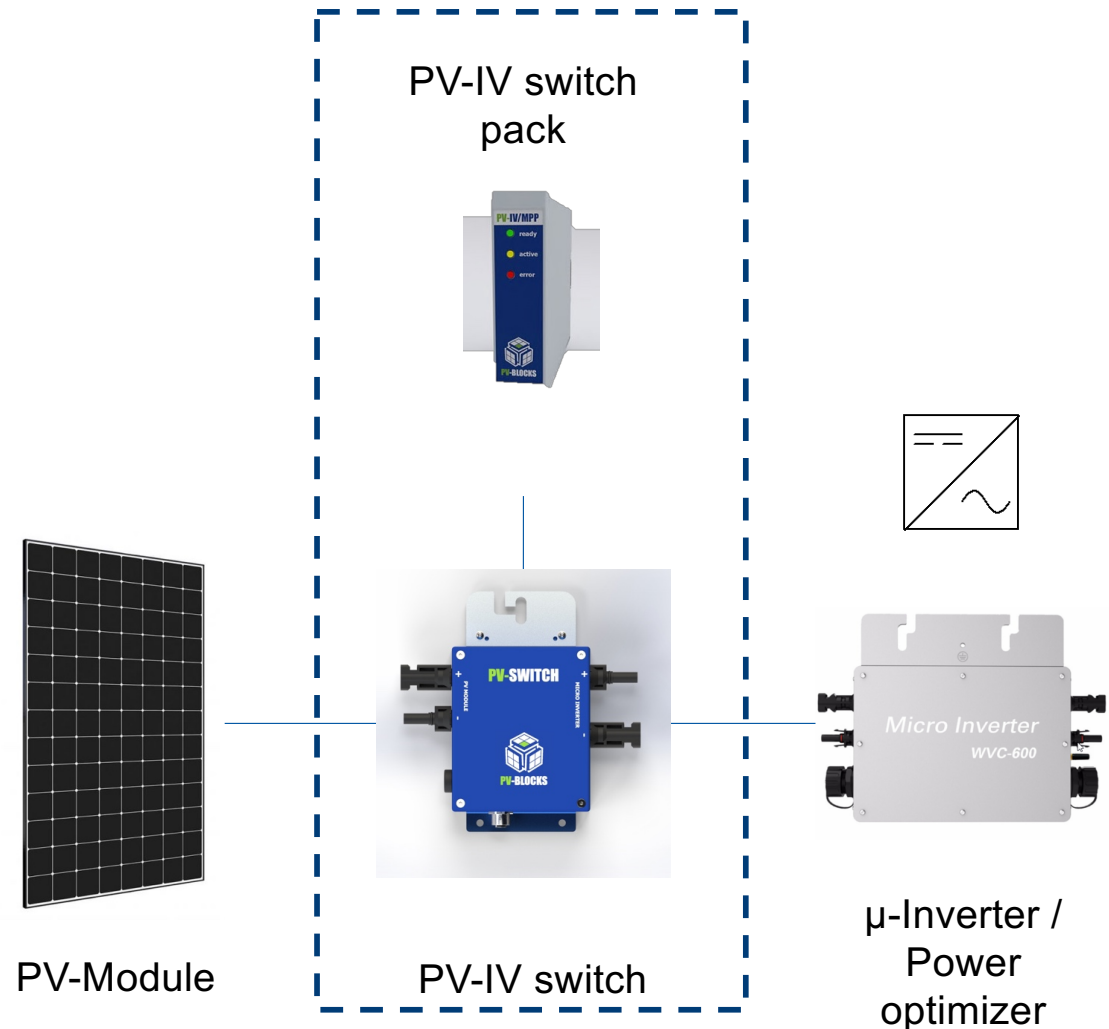
EKO

PV-Switch pack

(PV-IV/MPP + PV-Switch modules)

- Grid connected
- PV Module testing (IV / MPP*)
- Power 0 - 600W
- Voltage 0.5 – 80V
- Current 0 - 20A

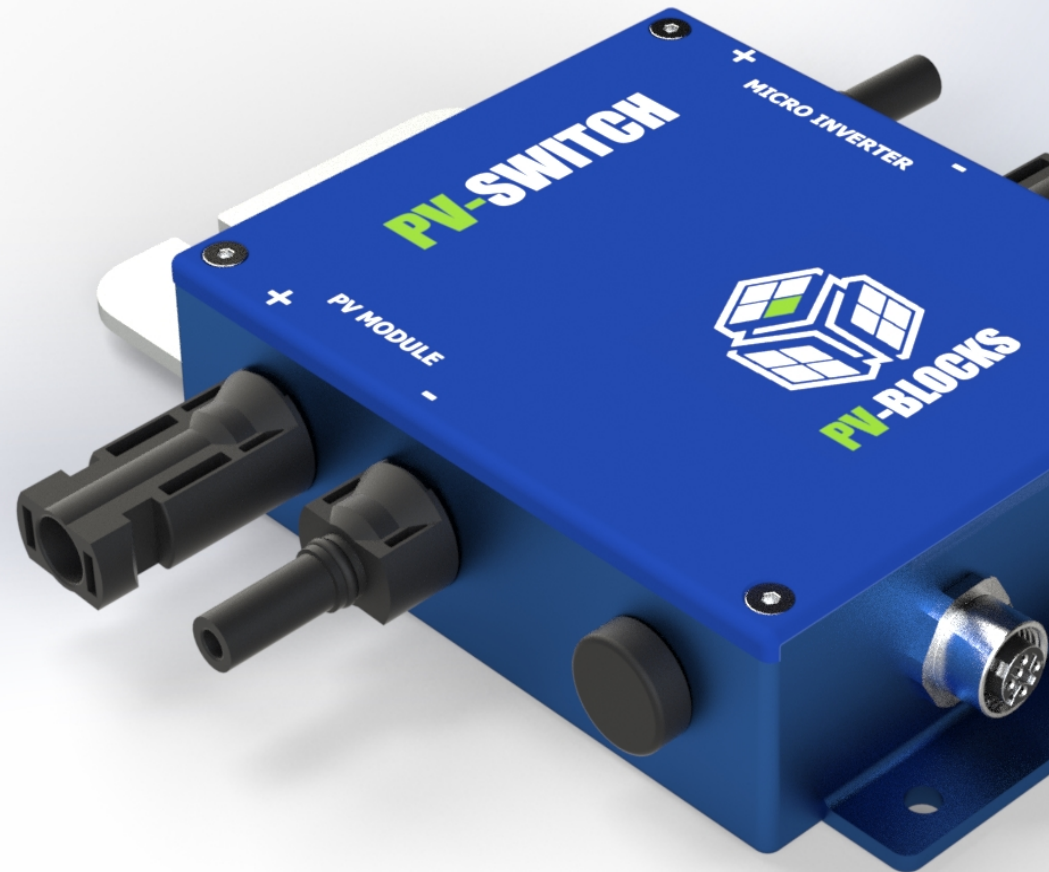
* μ -inverter



PV-Switch

Parameter	Value
Max Power IV Curve	600W < 30sec
Voltage: - maximum - minimum	80V <0.5V
Current	0 - 20A

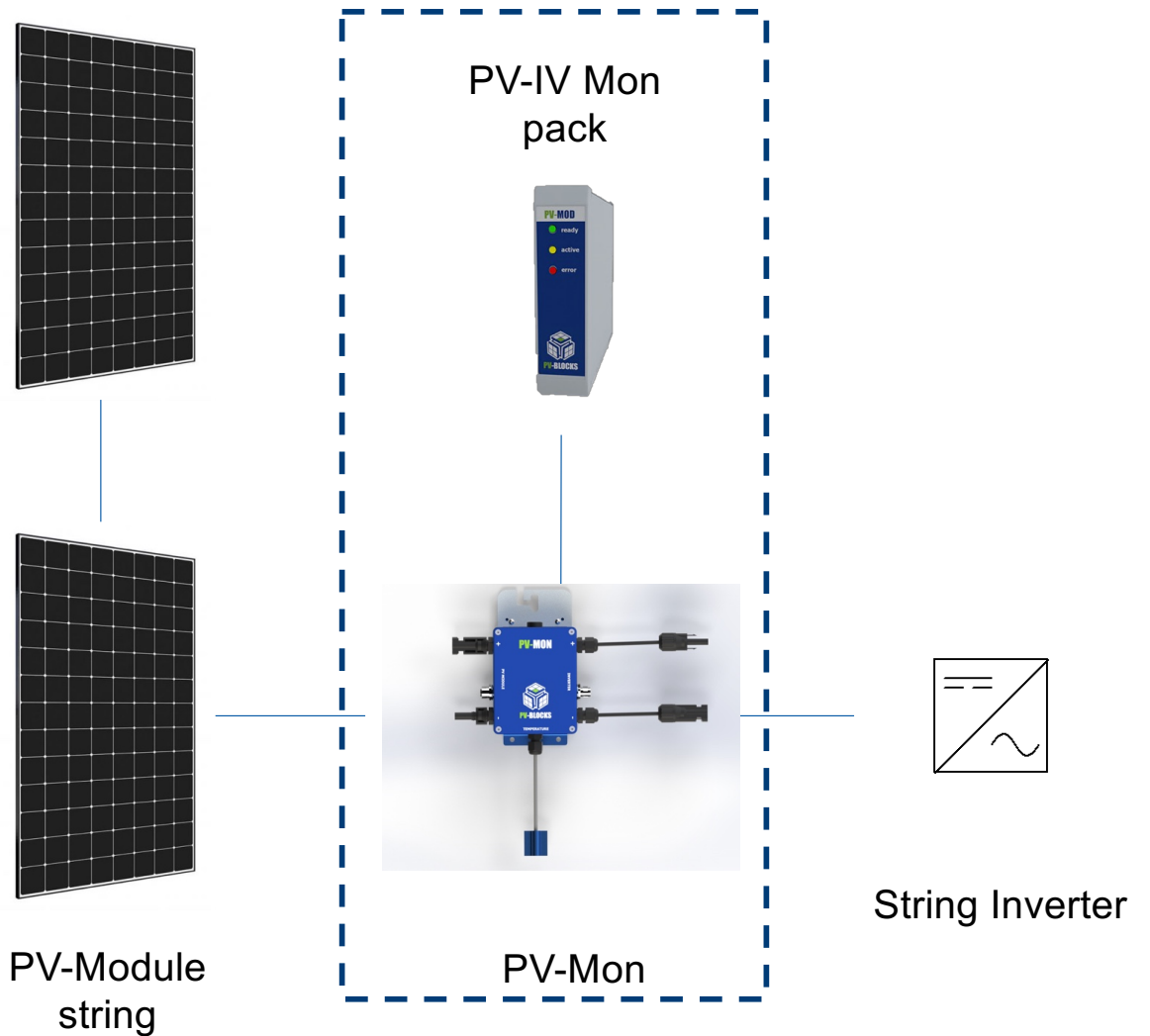
Parameter	Value
Voltage accuracy	< $\pm 0.1\%$ FS
Current accuracy	< $\pm 0.1\%$ FS
Complies to:	IEC 60904-1 IEC 60891
Voltage resolution	0.1 mV
Current resolution	0.01 mA



PV-Monitor pack

(PV-MOD + PV-Mon modules)

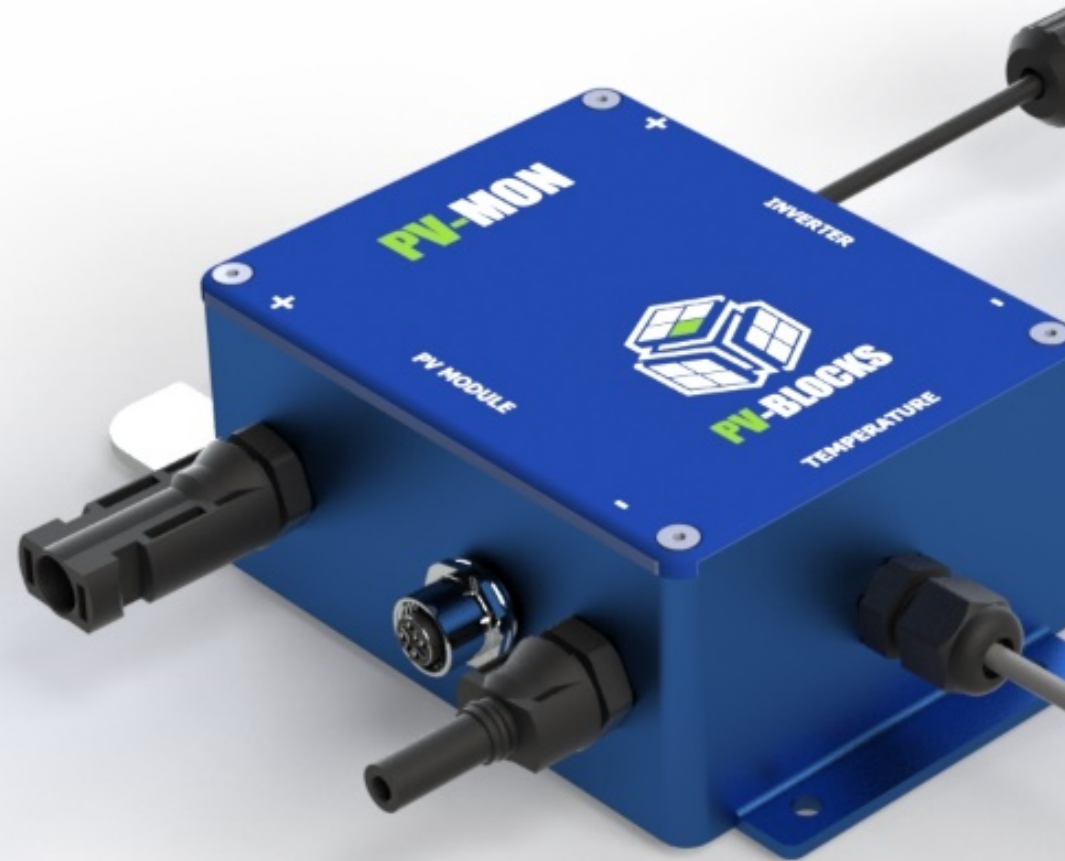
- Grid connected to string inverter
- PV Module string monitoring (I, V, P)
- Voltage 100 / 1000 / 1500 VDC
- Current 0 - 50A
- Module temperature monitoring
- Up to 8 units to one PV-MOD module



PV-Mon

Parameter	Value
Communication	Modbus 485 RTU
Voltage DC:	0 - 100V / 1000V / 1500V
Current	0 - 50A
Voltage accuracy	< $\pm 0.5\%$ FS
Current accuracy	< $\pm 0.5\%$ FS
Voltage resolution	1 mV / 15mV
Current resolution	10 mA/ 100mA

Parameter	Value
Pt100 connection	3 wire
Pt100 sensor	Class 1/3 DIN



4

Turn-key

Turn-key

Outdoor solution
Pre-configured



Configuration

Custom built system

EKO Offers system design and custom-built solutions

Key features:

- PV-Blocks modules integrated to IP-65 enclosure
- Pre-assembled and wired system
- PV-Blocks module and sensor settings
- Setting of calibration parameters

Note: Sensor cables, PV-Module cables need to be connected on site, installation of Main enclosure, load units, cables done by customer.

Thank you for
your attention

