

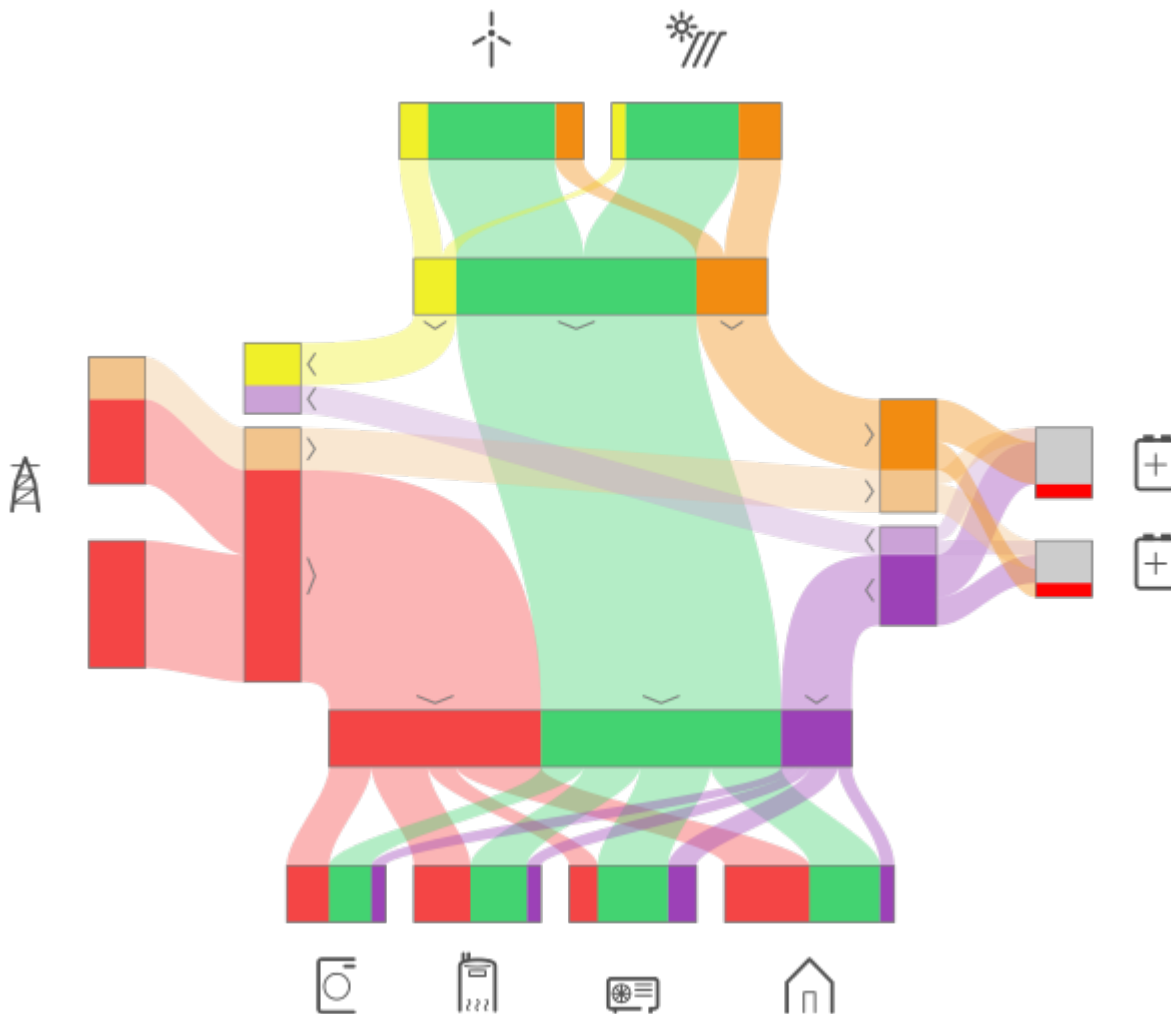
## **HEMS MANUAL**

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# HEMS Introduction

Home Energy Management System (HEMS) is a system for:

- monitoring electricity flows at home (consumption, production and storage),
- control of key consumers,
- optimizing consumption in terms of reducing consumption and using cheaper energy to ensure the same comfort with lower costs.



## HEMS Controller

It consists of an HEMS master controller ([MC-230](#)).

## Power sensors

The measurement of electrical power and energy of all energy sources and main electrical consumers is provided by single-phase ([PM1-E-D](#)) and three-phase ([PM3-I-D](#)) power sensors which are connected directly to HEMS master controller [MC-230](#). It supports:

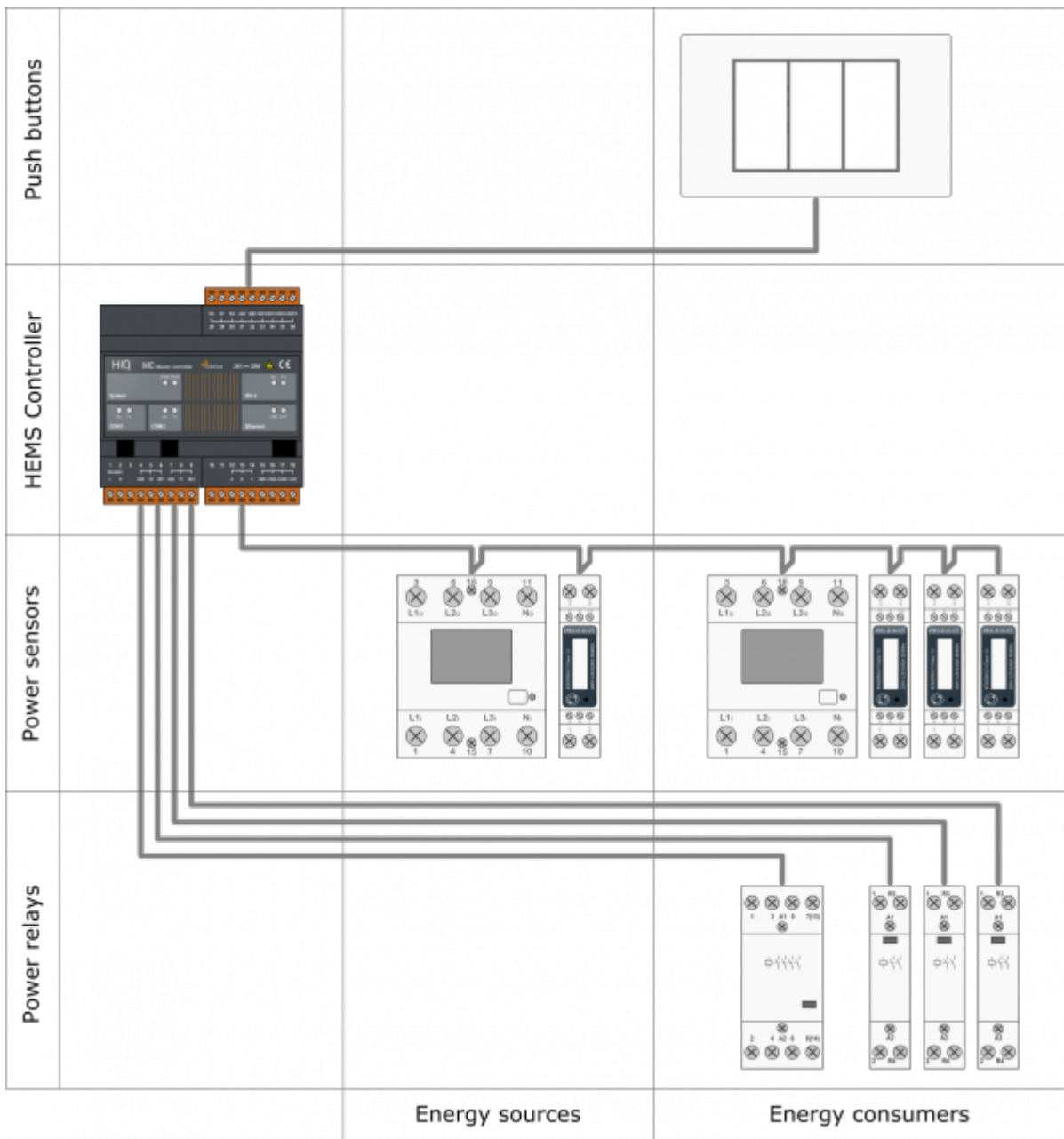
- **1 grid** power sensor
- up to **3** sensors for local power **plants** (PV, Wind, Cogeneration, Generator, etc)
- up to **2** local **storage** systems (home battery)
- up to **4** managed **consumers** (electrical heating, electrical water heater, washing machine, tumble dryer, ...)

## Power relays

Are used for control of managed consumers. Power relays are toggling power supply or enabling signal for the operation of the device. They are controlled directly from HEMS master controller [MC-230](#).

## Push buttons

Are used for manual control of managed devices. Push buttons are directly wired HEMS master controller [MC-230](#).



# SAFETY INSTRUCTIONS



Use the following safety guidelines to ensure your own personal safety and to protect your equipment and working environment from potential damage.

**NOTICE:** All applicable local and national codes that regulate the installation and operation of the equipment must be strictly followed.

**NOTICE:** Installation and electrical connection of the equipment must be carried out by qualified and authorized personnel.

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Notices which require special attention are highlighted with following symbols:

-  **WARNING** - which indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.
-  **CAUTION** - which indicates that minor to medium personal injury or property damage can result if proper precautions are not taken.

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This product can only function correctly if it is transported, stored, set up and installed correctly, and operated and maintained as recommended according to manufacturer's instructions.



**WARNING:** Failure to comply with manufacturer's safety and installation instructions or applicable codes and standards can result in damage to equipment or serious injury to personnel.



**WARNING:** Before installing, servicing or repairing electrical equipment power source must be disconnected.

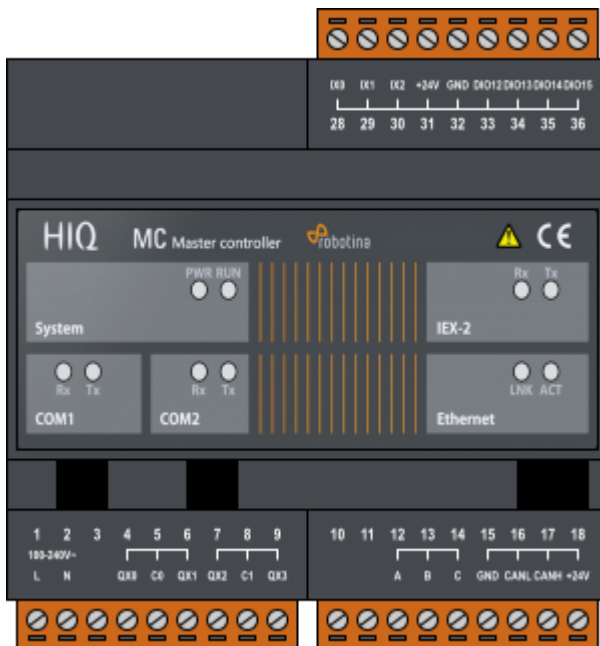


**CAUTION:** Don't try to open the device, any interference or change may impact device's properties and significantly affect safety.

- The device must be installed inside electrical enclosure where it cannot endanger people or environment.
- During operation, device must not be exposed to high temperature, high humidity, excessive dust, corrosive gases, vibration or shock.
- All connected wires must comply with manufacturer's specifications.
- For installation use only tools and equipment with non-conducting handles.
- Sufficient ventilation space has to be assured around device for proper operation.
- The manufacturer does not undertake any liability for material or personal damage resulting from use or handling which is not in accordance with the manufacturer's safety instructions.

# HEMS G2 controller

## Advanced HEMS controller



Model number:	<b>MC-230</b>
Mounting:	DIN rail, 6M, 106mm
Dimensions:	106x108x58mm

## Features

- Sources and consumers measurements:
  - 1 x Grid
  - 3 x Local power plants (PV, wind, cogeneration,...)
  - 2 x Storage system (battery)
  - 4 x Consumers
- Load management
  - 4 x Consumers
  - Manual control
  - Manual override timer
  - Weekly timetable, 15 min resolution

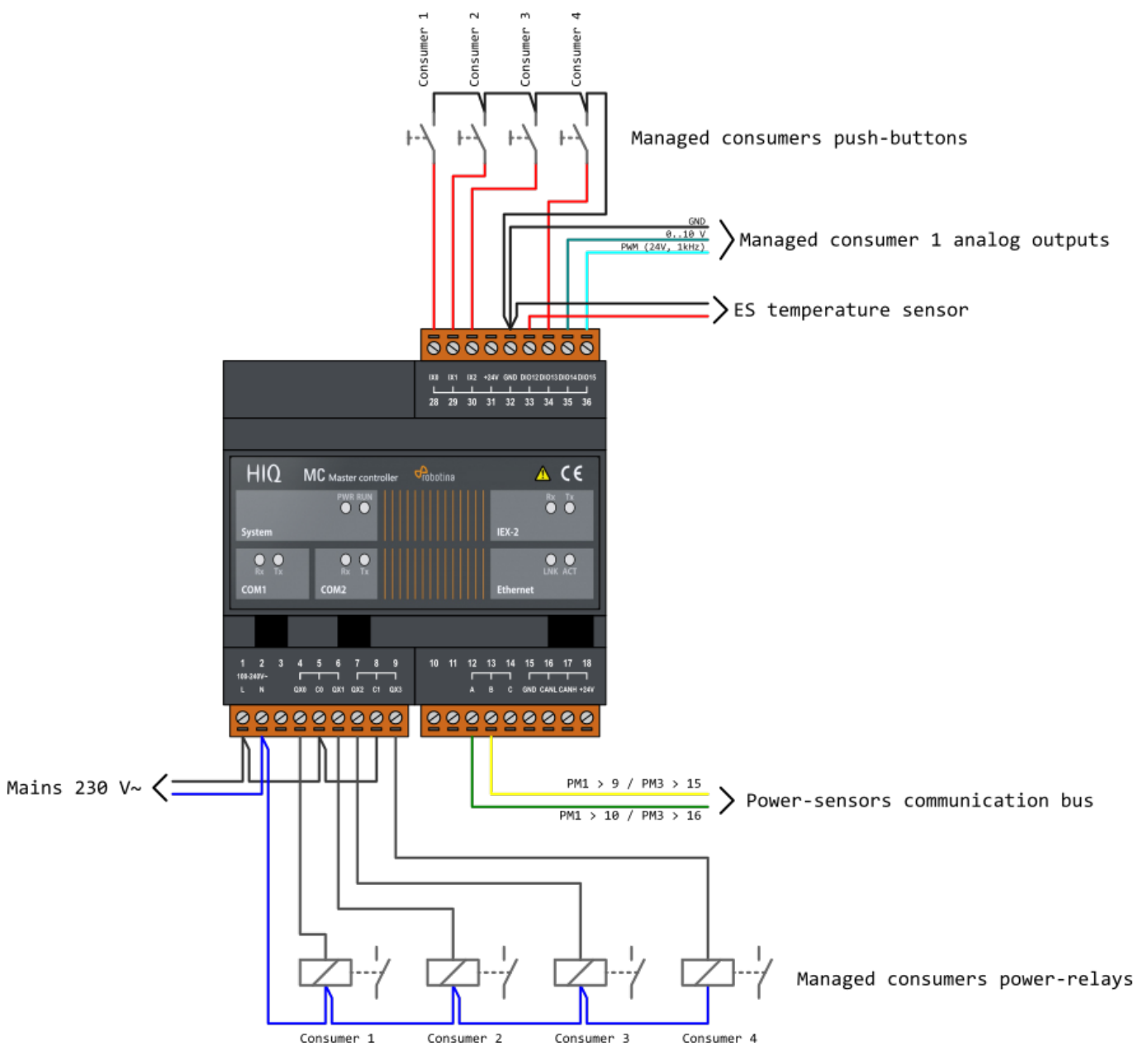
## Safety standards

EN 50081-1, EN 61000-6-2, EN 61131-1, EN 61131-2, EN 61000-3-2, EN 61000-3-3

# Technical specification

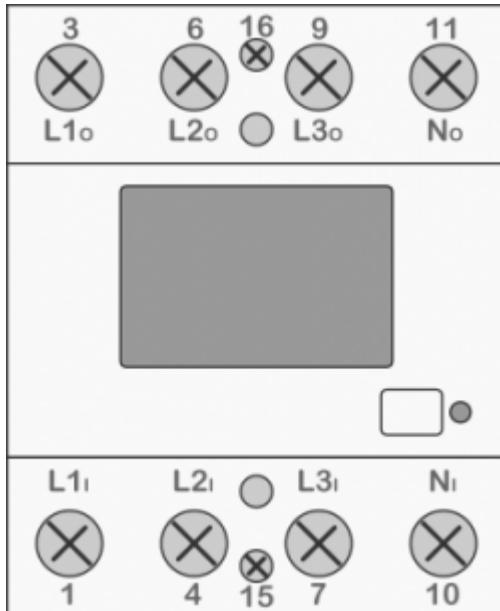
Relay outputs:	8A/250V
Communication:	Ethernet, 2x RS232, 1x RS485, IEX-2 bus
Nominal power rating:	243V(100-240VAC)
Power consumption:	typ. 1W (no load), 10W max
Power output:	24V 200mA (IEX-2 + terminals)
Ingress protection:	IP20
Operating temperature:	0..45°C
Storage temperature:	-20..75°C
Relative humidity:	0..95% n/c

## Terminals



# Three phase power-sensor

## Three phase power-sensor



Model number:	<b>PM3-I-D</b>
Connect to:	<a href="#">MC-230</a> RS485 power sensor bus A - B
Mounting:	DIN rail, 3M, 53 mm
Dimensions:	53 × 84 × 66 mm
<b>Used for measuring power and energy of</b>	
✓	three-phase energy sources
✓	three-phase energy consumers

## Applications

- Digital multi-function power-sensor for 3-phase sources or consumers

## Features

- Three phase direct connection up to 80 A
- Serial RS485 communication
- Display LCD 7+1 digit
- Multi-functional front LED

## General description

The PM-3-IQ is intended for energy measurements in three-phase electrical power network and can be used in residential, industrial and utility applications. Power-sensor measures energy directly in 4-wire networks according to the principle of fast sampling of voltage and current signals.

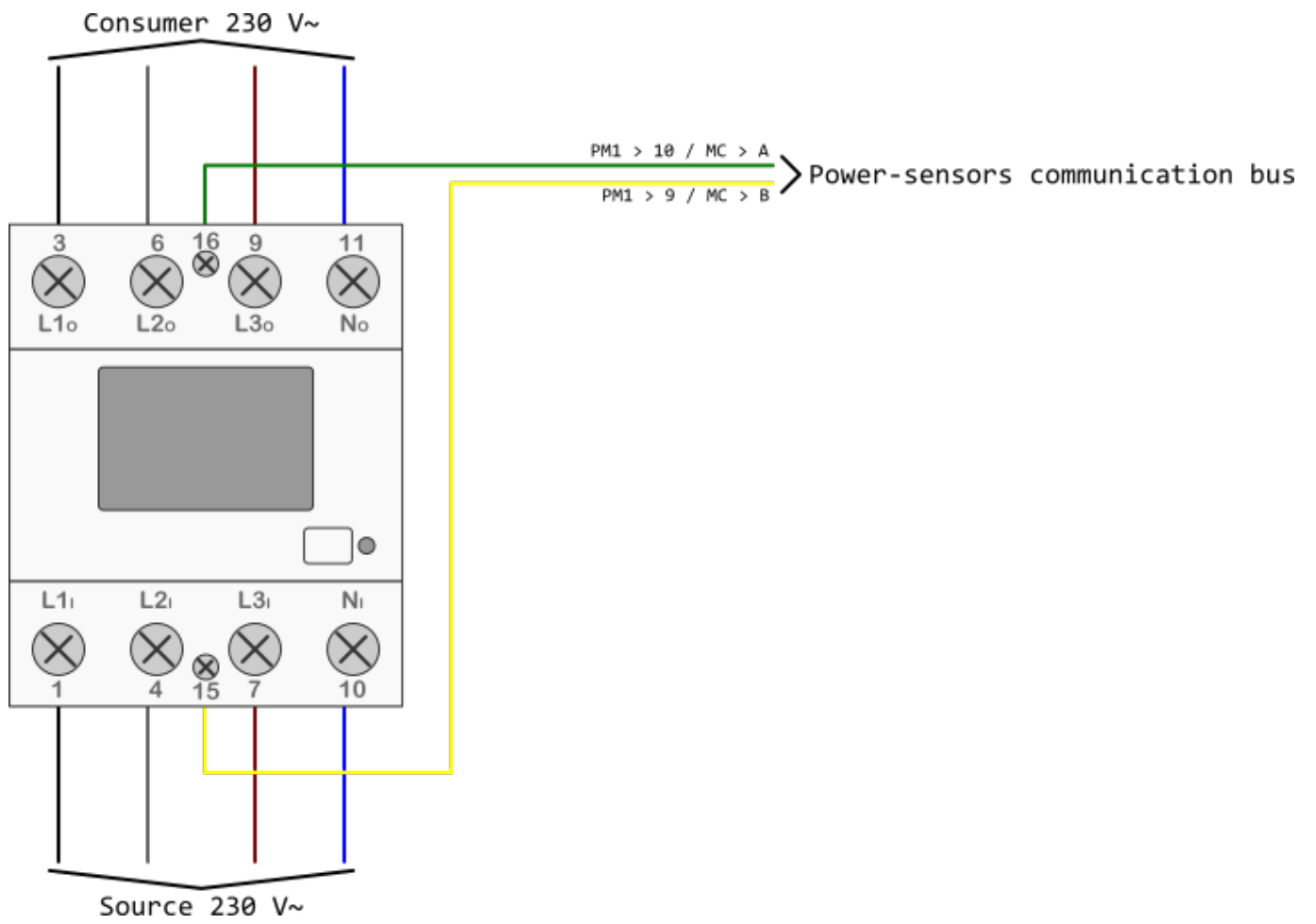
Connecting terminals can be sealed up against non-authorized access with protection covers. They are built to be fastened according to EN 60715 standard. Power-sensor has built-in RS485 serial communication with the MODBUS protocol which enables data transmission and thus connection of the measuring places into the network for the control and management with energy.



## Technical specifications

Nominal voltage	230 VAC (-20..+15%)
Power connector	2,5 .. 16 mm <sup>2</sup>
Reference current	5 A
Maximum current	80 A
Operational frequency range	50 or 60 Hz
Internal power consumption	< 8 VA
Communication type	RS485(half-duplex)
Communication protocol	Modbus RTU
<b>Accuracy</b>	
Active energy (Wh)	Class 1 IEC 62053-21
	class B EN 50470-3
	±1.5% from I <sub>min</sub> to I <sub>tr</sub>
	±1% from I <sub>tr</sub> to I <sub>max</sub>
<b>Ambient conditions and Safety</b>	
Dust/water protection	IP50
Operating temp. range	-25 ... 55°C
Indoor sensor	yes
Protection class	II
<b>EC Directives conformity</b>	
EC Directive on Measuring Instruments 2014/32/EU	
EC Directive on EMC 2014/30/EU	
EC Directive on Low Voltage 2014/35/EU	
EC Directive WEEE 2002/96/EC	

# Connection



# Manual

PM3-I-D Technical Documentation

# Single phase power-sensor

## Single phase power-sensor



Model number:	<b>PM1-E-D</b>
	<a href="#">MC-230</a>
Connect to:	RS485 power sensor bus A - B
Mounting:	DIN rail, 1M, 18 mm
Dimensions:	18 × 62 × 119 mm
<b>Used for measuring power and energy of</b>	
✓	single-phase energy sources
✓	single-phase energy consumers

## Applications

- Digital multi-function power-sensor for single phase networks

## Features

- DIN rail mounting with direct connection up to 45A
- Compact design in a single module 18mm wide
- Seal-able cover(phase and neutral terminals)

## General description

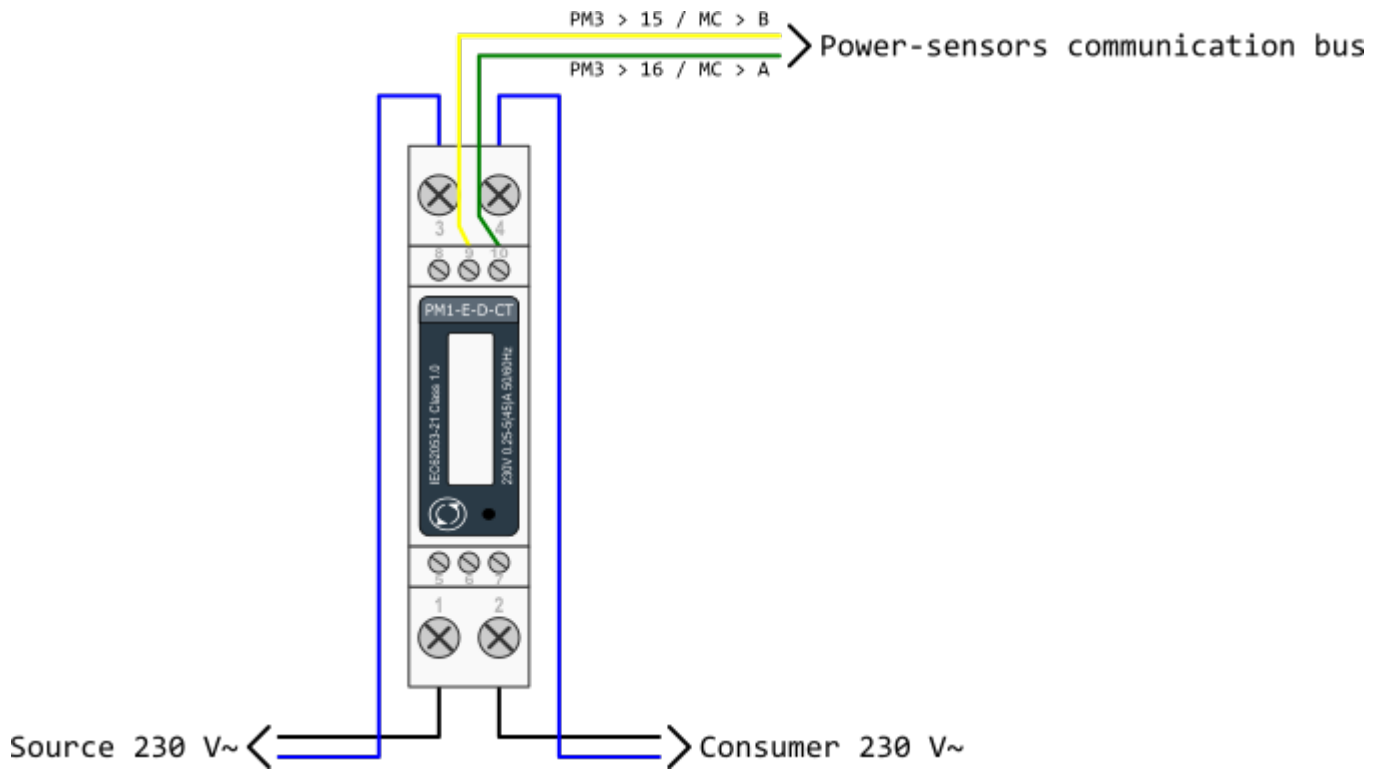
The PM1-E-D series is an advanced single phase energy monitoring solution with built-in configuration push button and LCD data displaying, particularly indicated for active energy and other parameters metering and for cost allocation. Housing for DIN-rail mounting, IP51 protection degree, direct connection up to max 45A.

## Technical specifications

<b>Energy Measurements</b>	
Imported/Exported active energy	0 to 99999.99 kWh
Imported/Exported reactive energy	0 to 99999.99 kVARh
Total active energy	0 to 99999.99 kWh
Total reactive energy	0 to 99999.99 kVARh
<b>Measured Inputs</b>	
Nominal Voltage Input	(Ph+N) 176 to 276V
Max Continuous Voltage	120% of nominal
Nominal Input Current	5(45)A
Max Continuous Current	120% of nominal
Frequency	50Hz ( $\pm 10\%$ )
<b>Accuracy</b>	
Voltage	0.5% of range maximum
Current	0.5% of nominal
Frequency	0.2% of mid-frequency
Power factor	1% of unity (0.01)
Active power (W)	$\pm 1\%$ of range maximum
Reactive power (VAR)	$\pm 1\%$ of range maximum
Apparent power (VA)	$\pm 1\%$ of range maximum
Active energy (Wh)	Class 1 IEC 62053-21
Reactive energy (VARh)	$\pm 1\%$ of range maximum
<b>Modbus (RS485 Output for Modbus RTU &amp; Pulsed Output)</b>	
Baud rate	1200, 2400, 4800, 9600.
Parity	none / odd / even
Stop bits	1 or 2
RS485 network address	1 to 247
<b>Reference Conditions of Influence Quantities</b>	
Ambient temperature	23°C $\pm 1^\circ\text{C}$
Input waveform	50 or 60Hz $\pm 2\%$
Input waveform	Sinusoidal (distortion factor < 0.005)
Auxiliary supply voltage	Nominal $\pm 1\%$
Auxiliary supply frequency	Nominal $\pm 1\%$
Auxiliary supply waveform (if AC)	Sinusoidal (distortion factor < 0.05)
Magnetic field of external origin	Terrestrial flux
<b>Environment</b>	
Operating temperature	-25°C to +55°C
Storage temperature	-40°C to +70°C
Relative humidity	0 to 95%, non-condensing
Altitude	Up to 3000m
Warm up time	1 minute
Vibration	10Hz to 50Hz, IEC 60068-2-6, 2g
Shock	30g in 3 planes
<b>Mechanics</b>	
DIN rail dimensions	18mm x 90mm (WxH) per DIN 43880

Mounting	DIN rail (DIN 43880)
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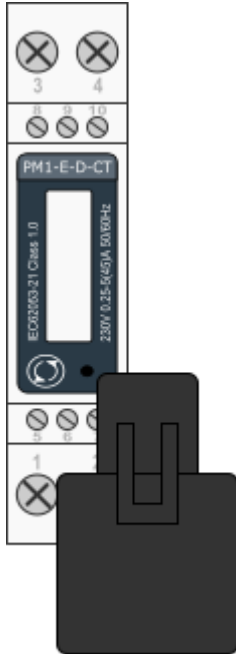
# SDM120 Wiring



[sdm120\\_series\\_datasheet.pdf](#)  
[sdm120\\_protocol.pdf](#)

# Single phase power-sensor

## 1-phase power-sensor, current transformer



Model number:	<b>PM1-E-D-CT</b>
Connect to:	<a href="#">MC-230</a> RS485 power sensor bus A - B
Mounting:	DIN rail, 1M, 18 mm
Dimensions:	18 × 62 × 119 mm
<b>Used for measuring power and energy of</b>	
✓	single-phase energy sources
✓	single-phase energy consumers

## Applications

- Digital multi-function power sensor for single phase networks

## Features

- DIN rail mounting with 50A current transformer
- Compact design in a single module 18mm wide
- Seal-able cover(phase and neutral terminals)

## General description

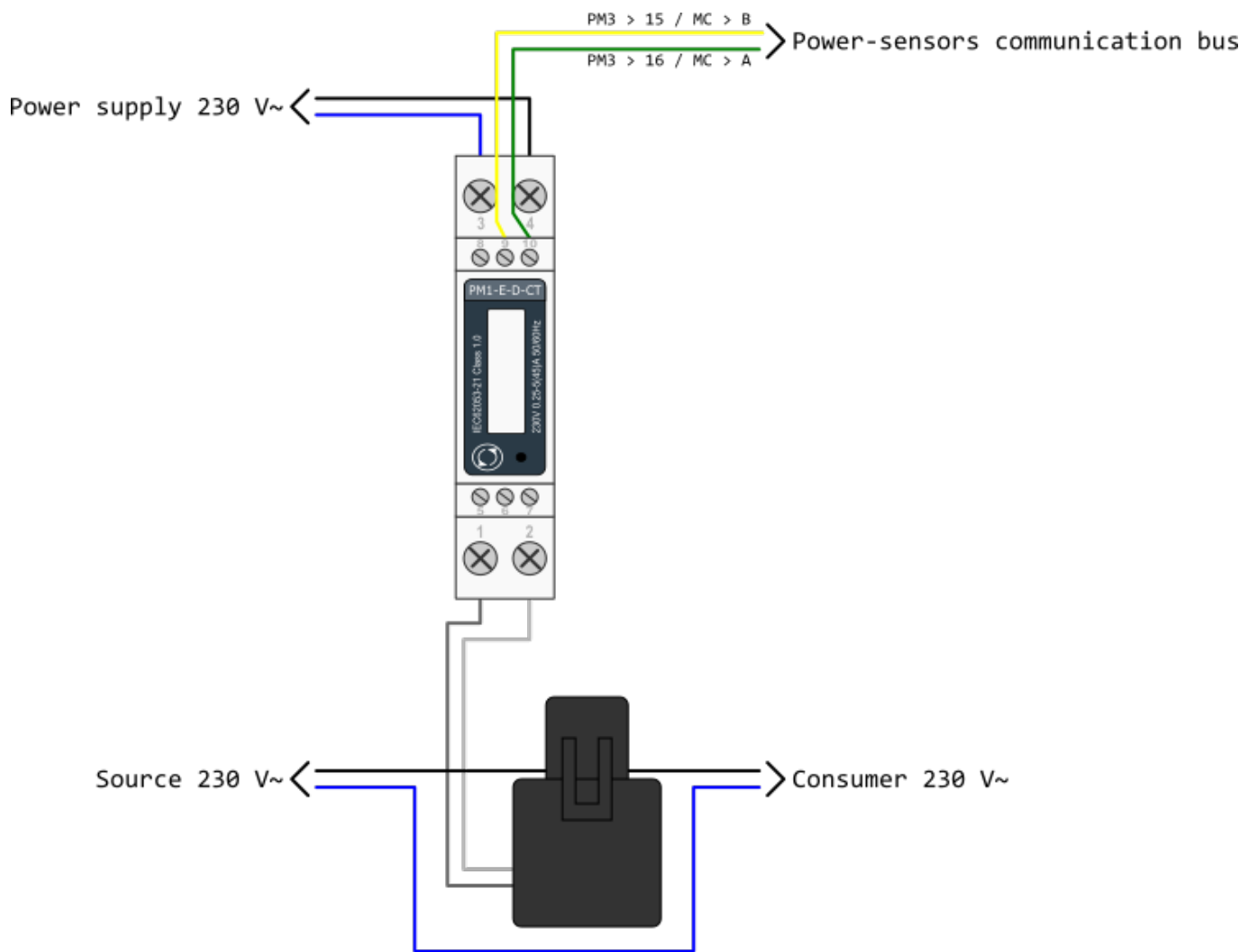
The PM1-E-D series is an advanced single phase energy monitoring solution with built-in configuration push button and LCD data displaying, particularly indicated for active energy and other parameters metering and for cost allocation. Housing for DIN-rail mounting, IP51 protection degree, direct connection up to max 45A.

## Technical specifications

Technical Data	
Operating Humidity	≤ 75%

Storage Humidity	≤ 95%
Operating Temperature	-20°C - +50°C
Storage Temperature	-30°C - +70°C
International Standard	IEC 62053-21
Accuracy	Class 1
Mounting	DIN rail (DIN 43880)
Sealing	IP51 Indoor
Nominal Voltage Input	(Ph+N) 230V AC (176-276V AC)
Max Continuous Voltage	120% of nominal
AC Voltage Withstand	4KV for 1 minute
Impulse Voltage Withstand	6KV-1.2μS
Current Input	0.25-5A(6)A AC RMS
Operational Current Range	0.4% Ib-I <sub>max</sub>
Over current withstand	20I <sub>max</sub> for 0.01s
Nominal Input Current Burden	0.5VA
Frequency	50Hz(±10%)
Power Consumption	≤ 2W/10VA/phase
<b>Accuracy</b>	
Voltage, Current	0.5%
Frequency	0.2% of Mid-Frequency
Power Factor	1% of Unity (0.01)
Active Power, Apparent Power	≤ 1% of Range Maximum
Reactive Power	≤ 1% of Range Maximum
Reactive Energy (Varh)	Class 2
Active Energy (Wh)	Class 1
<b>Modbus</b>	
Bus Type	RS485 (Semi-Duplex)
Protocol	Modbus RTU
Baud Rate	1200/2400/4800/9600bps
Address Range	1-247
Max. Bus Loading	64pcs
Communication Distance	1000 Meters
Parity	EVEN/ODD/NONE
Data Bit	8
Stop Bit	1

# SDM120 Terminals



[sdm120ct\\_series\\_datasheet.pdf](#)  
[sdm120ct\\_protocol.pdf](#)



# Current transformer

## Split core current transformer 50A



- Split core
- Safe operation
- Mini in size
- Very easy mounting
- Wide inner window

Model number:	<b>CT1-E-50</b>
Connect to:	<a href="#">PM-1-E-CT</a> terminals 1 -2
Mounting:	on wire
Dimensions:	41 × 24 × 27 mm

## General description





The CT1-E-50 split core current transformer is designed for fast and easy installation. The split core design permits non-contact current measurements through magnetic field induction without requiring that the primary wire be taken off line and disconnected for CT installation. This method permits a safer easy and portable current measurement. An internal precision burden resistor across the secondary winding of the CT provides a safe low voltage output and permits safe opening of the secondary circuit.

## Technical specifications

Frequency	50-60 Hz
Rated current	50 A
Accuracy	±1% from 20% to 120% of rated current
Phase angle	less than 2 degrees at 50% of rated current
Insulation voltage	600 VAC
Maximum primary voltage	5000 VAC (insulated conductor)
Dielectric strength	2.5 kV/1mA/1min
Operating temperature	-15 to 60°C
Operating humidity	< 85 %
Case material	PC/UL94-V0
Bobin	PBT
Core	Permalloy
Internal structure	Epoxy
Leads	UL 1015, Twisted pair, 22 AWG

# ES (temperature sensors)

## Digital temperature sensors

Technical specifications	
Operating temperature range	-55°C to +100°C (0°C to +50°C for -W)
Measuring error	max. $\pm 2^{\circ}\text{C}$ (-55°C to +100°C)
	max. $\pm 0.5^{\circ}\text{C}$ (-10°C to +85°C)
	typ. $\pm 0.2^{\circ}\text{C}$ (-10°C to +85°C)
Connect to	<a href="#">MC-230</a>
	terminals GND - IO12 for ES-B connect red and black to GND and yellow to IO12
Order code	
<b>ES</b>	heat-shrink tubing, 2m wire
	
<b>ES-A</b>	aluminum housing IP 67, 5m wire
	
<b>ES-W-OW-WHITE</b>	white plastic housing, terminals
<b>ES-W-OW-IVORY</b>	ivory plastic housing, terminals
	
<b>ES-B</b>	steel tube housing IP 67, 2m wire
	

# HEMS G2 Configurator

## home

Basic system overview.



### 1. Grid

>	From grid	Tariff (LO, HI, D-LO, D-HI) and power from grid in W Imported energy by tariff in Wh
<	To grid	Power exported to grid in W Exported energy in Wh

### 2. Plants

<	Produced	Produced power in W and energy in Wh
>	Consumed	Consumed power in W and energy in Wh

### 3. Storage systems

<	Sourced	Power in W and energy in Wh sourced from storage (battery)
>	Stored	Power in W and energy in Wh stored (to battery)

**bargraph and %<sup>1</sup>** SOC Battery State Of Charge

### 4. Consumers

>	Consumed	Consumed power in W and energy in Wh
[ ]	Status	Output status for managed consumers
<b>bargraph<sup>2</sup></b>	Analog out	Analog output value
<b>click</b>	Toggle	Click in frame toggles managed consumers output

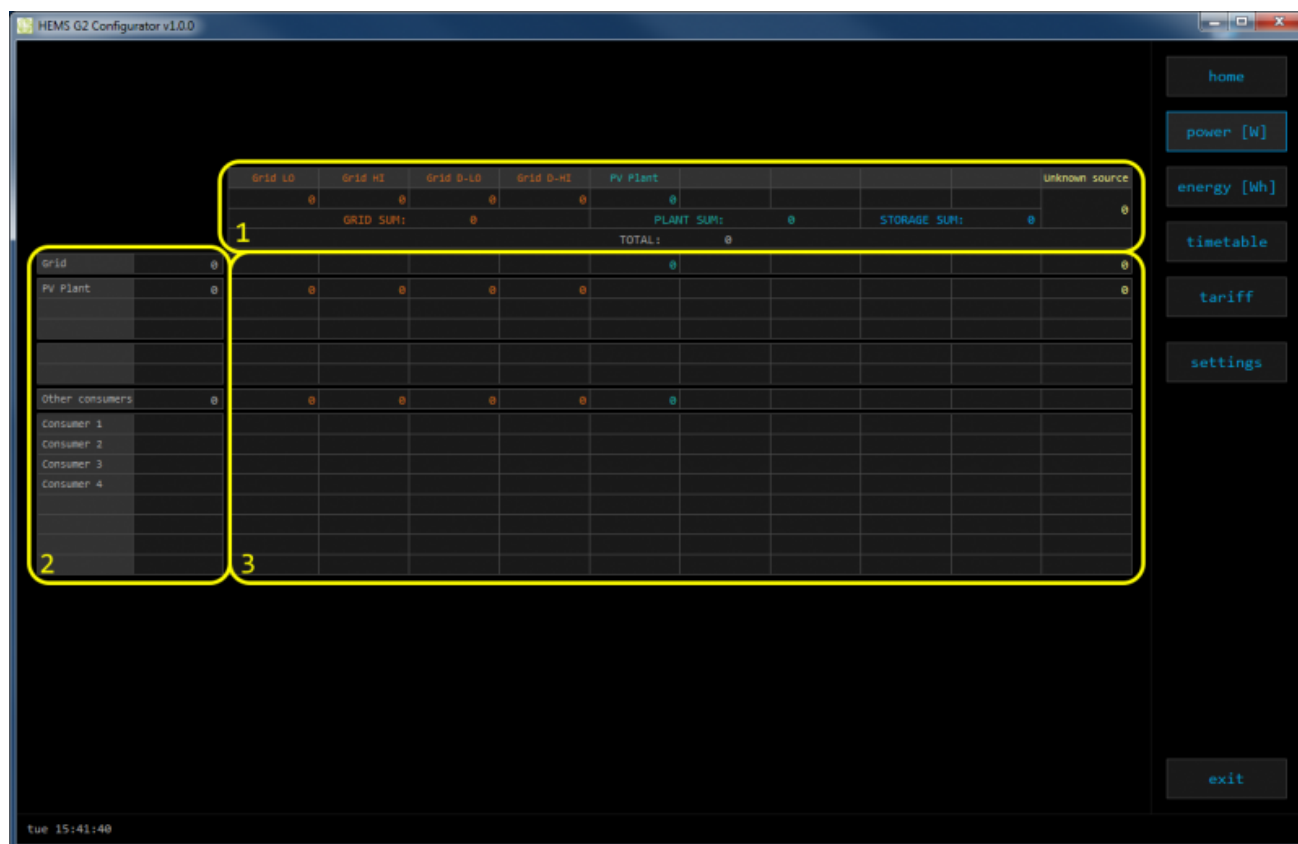
<b>long-press</b> <sup>2</sup>	Set analog	Long press on first consumer pops-up dialog for analog value set
<b>5. Unknown source</b>		
>	Sourced	Power in W and energy in Wh from unknown source
⚠ Accumulate also all differences caused by power-sensor inaccuracy		
<b>6. Other consumers</b>		
>	Consumed	Consumed power in W and energy in Wh by other (not measured) consumers

<sup>1</sup> only for eStore

<sup>2</sup> only for first managed consumer

# power

Overview of current power distribution by source / consumer.



## 1. Sourced power

Sourced power for each source

Sums per source type

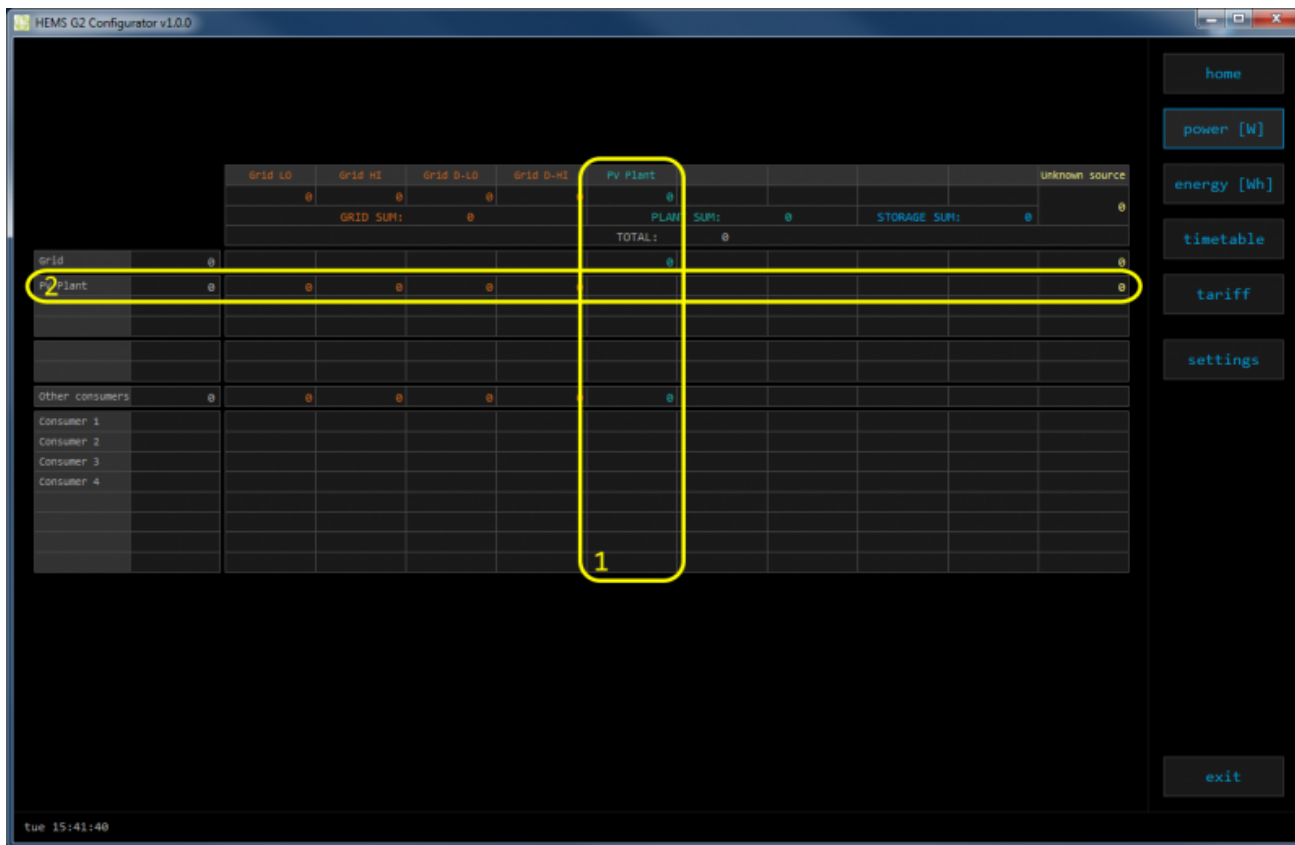
Total of all sourced power

## 2. Consumed power

Power for each consumer

## 3. Power distribution

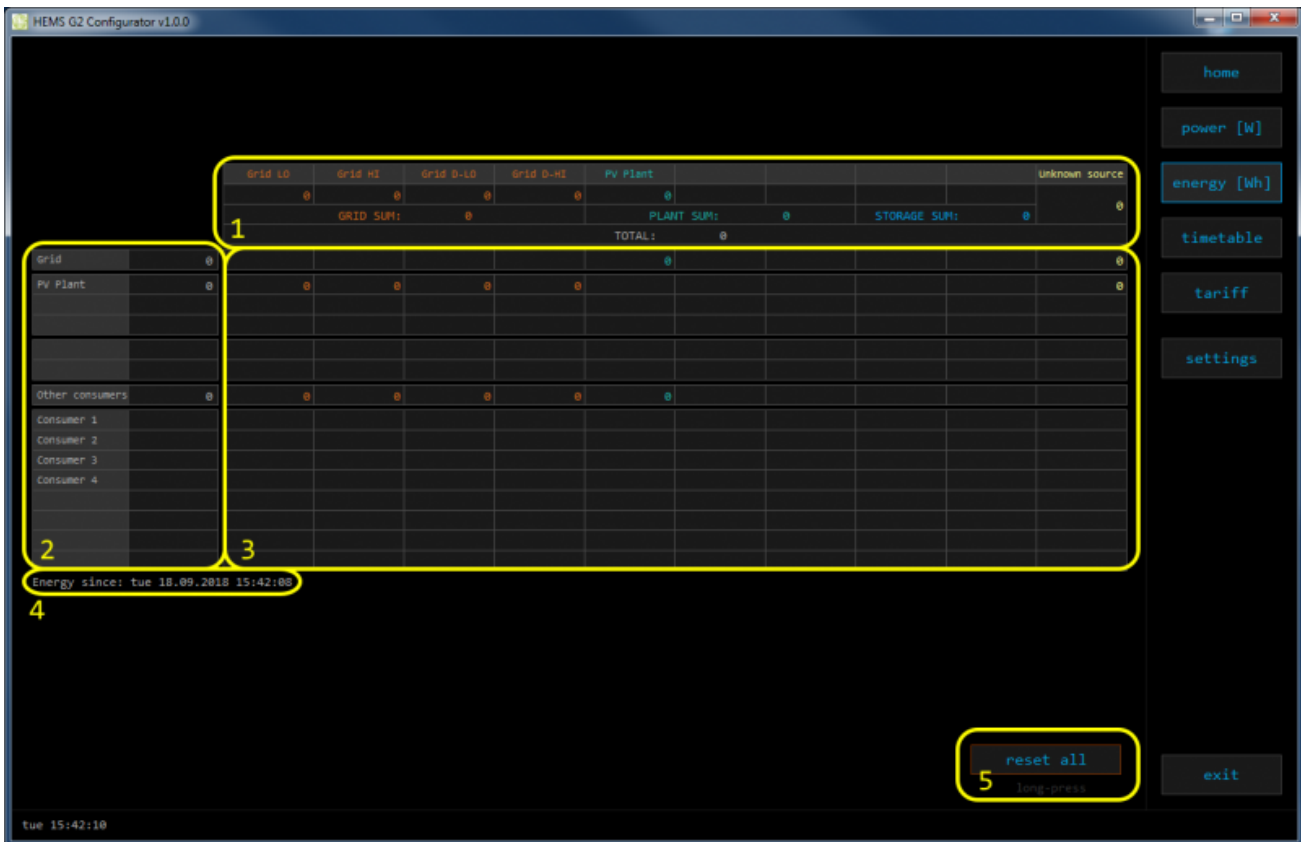
Partial distributed power



<b>1. Sourced power distribution</b>
How sourced power is consumed by each consumer
<b>2. Consumed power distribution</b>
Who sources consumed power

# energy

Energy overview of a given time distributed by sources / consumers.



## 1. Sourced energy

Sourced energy for each source

Sums per source type

Total of all sourced energy

## 2. Consumed energy

Energy for each consumer

## 3. Energy distribution

Partial distributed energy

## 4. Energy since

Date and time since energy is recorded

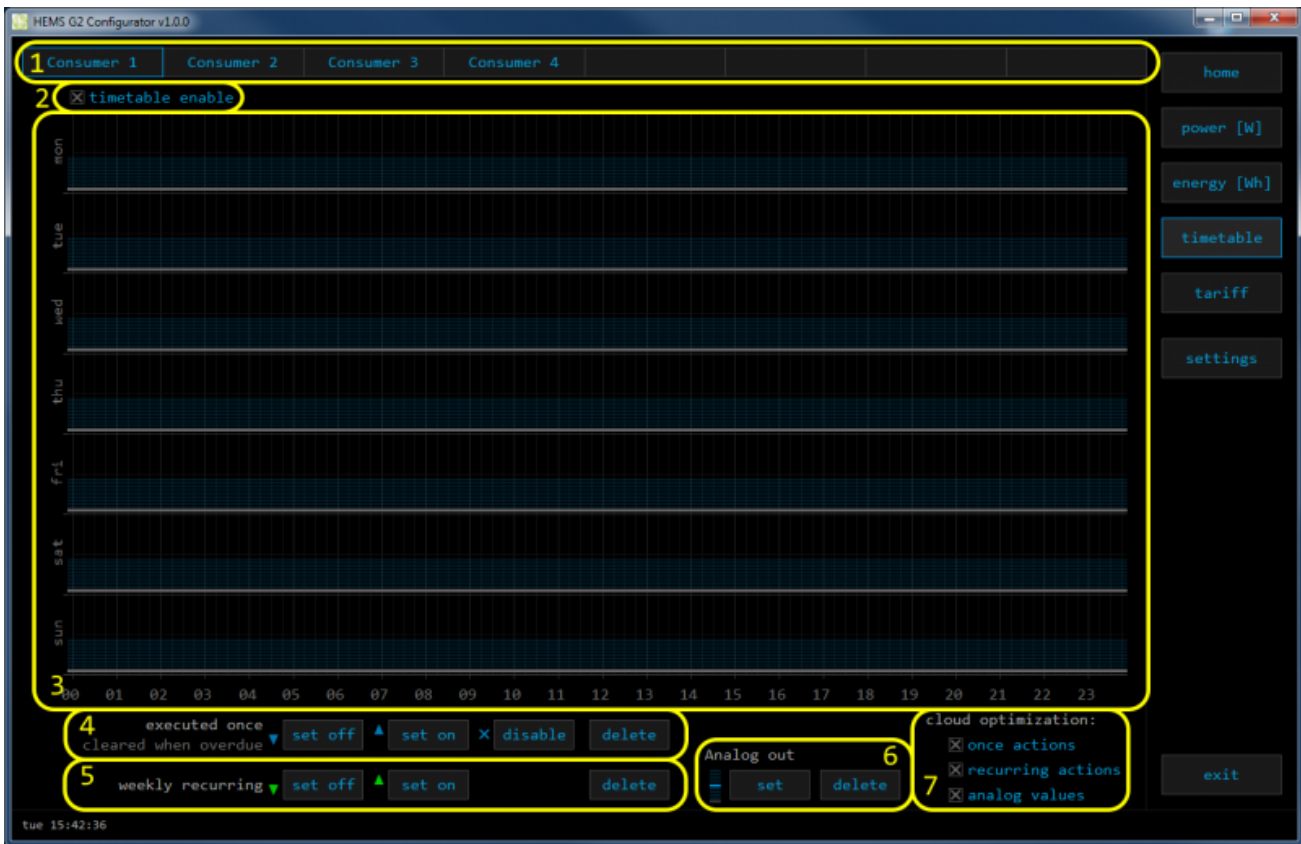
## 5. Reset all

Long-press to reset all energy counters



# timetable

Weekly timetable for managed consumers.



## 1. Managed load menu

Switch between managed loads

## 2. Enable checkbox

When un-checked timetable is not executed

## 3. Events grid

Events displayed in weekly grid (15 min resolution)

Click to select time and set event by clicking buttons below

## 4. Once actions (top priority timetable actions)

Actions are executed and then automatically cleared.

“Disable” action will just disable recurring action.

## 5. Recurring actions (low priority actions)

Actions are executed each week.

## 6. Analog out

Action to set analog output. Analog actions are recurring.

## 7. Cloud optimization

When enabled (checked) cloud optimization is enabled.

# tariff

Weekly tariff timetable for grid energy per tariff distribution.



## 1. Tariff grid

Graphical weekly timetable with tariffs.

Click to select term, click-and-drag to select multiple terms.

## 2. Low tariff

Set low tariff for selected terms.

## 3. High tariff

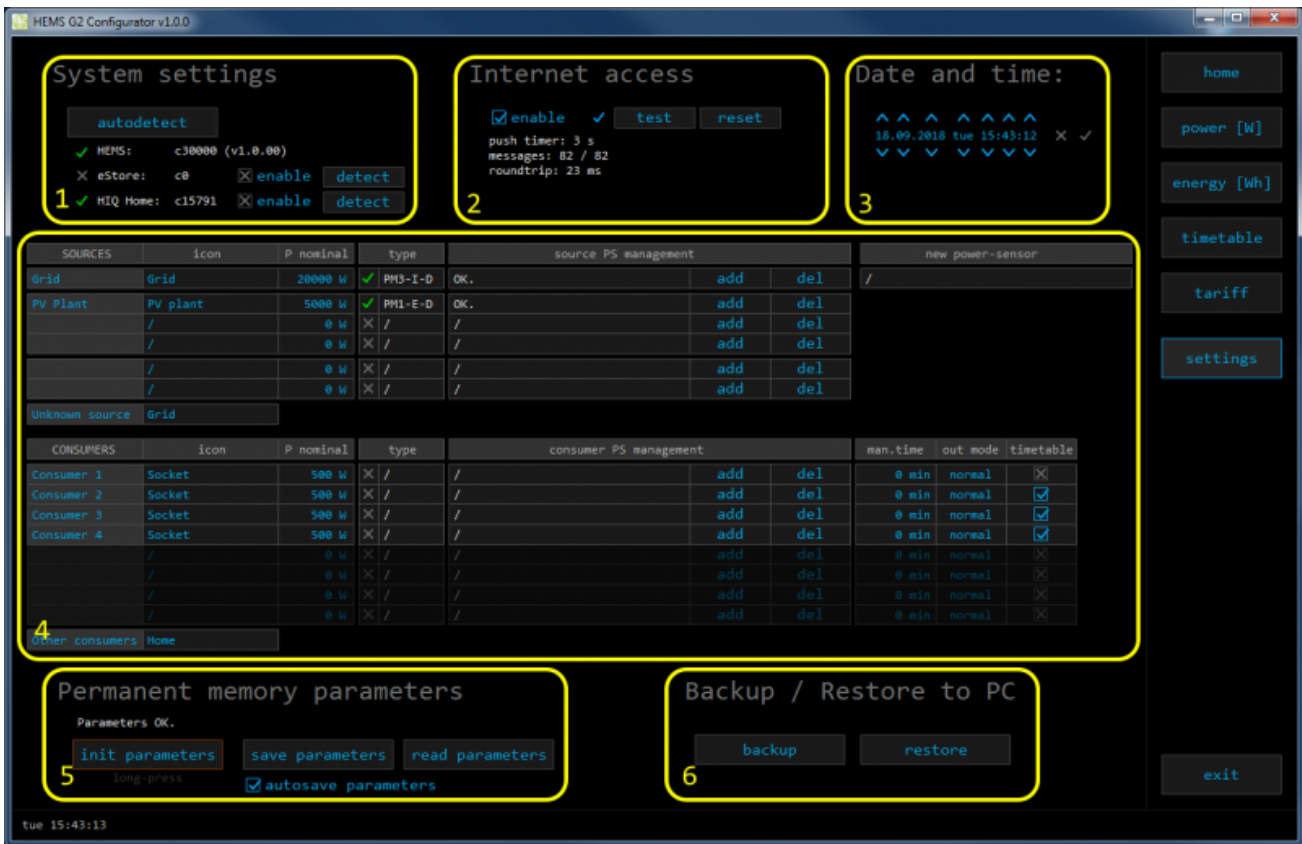
Set high tariff for selected terms.

## 4. Dynamic

Set dynamic tariff for selected terms. Dynamic tariff is superposed to LT or HT.

# settings

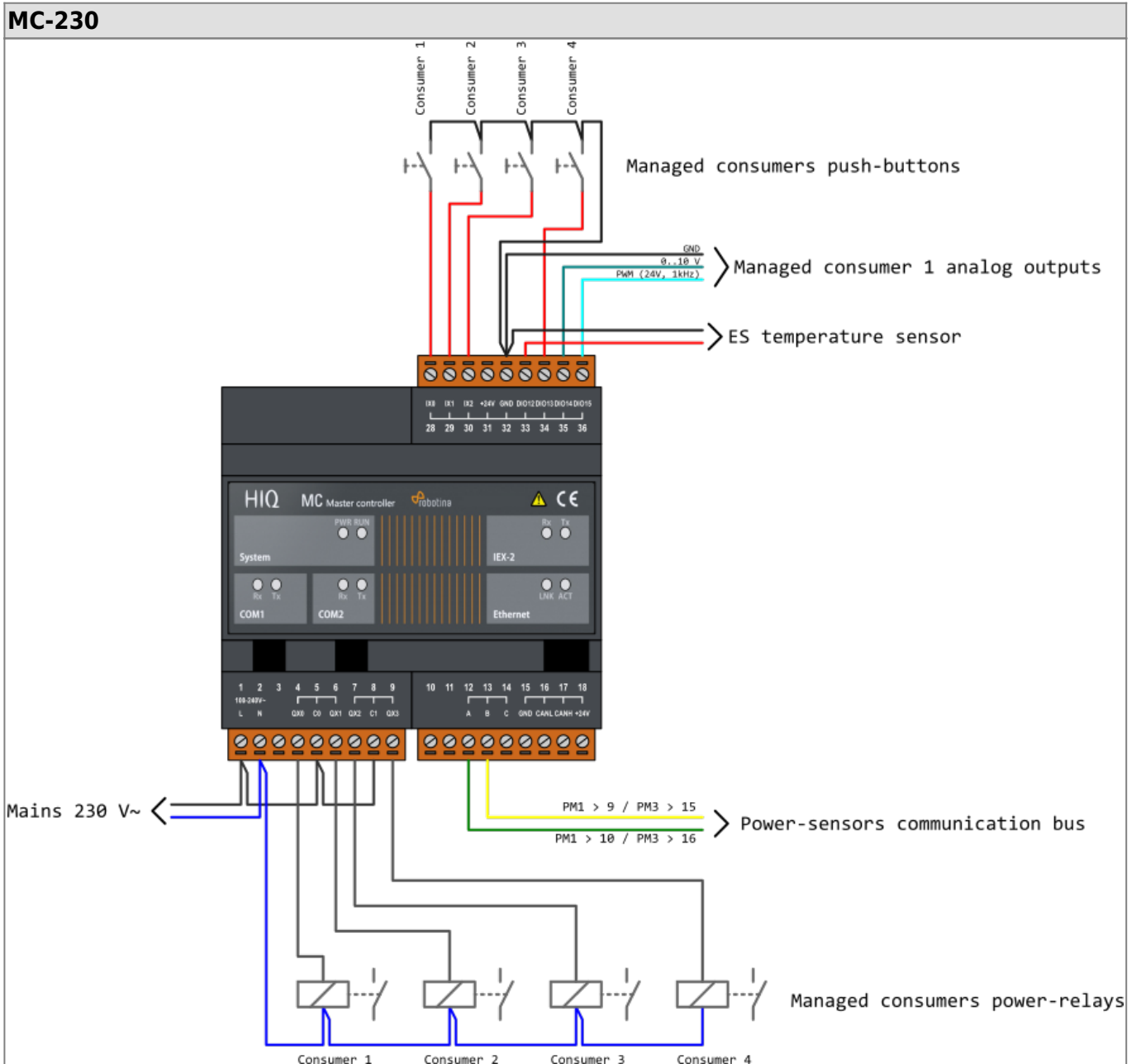
Easy and intuitive system setup.

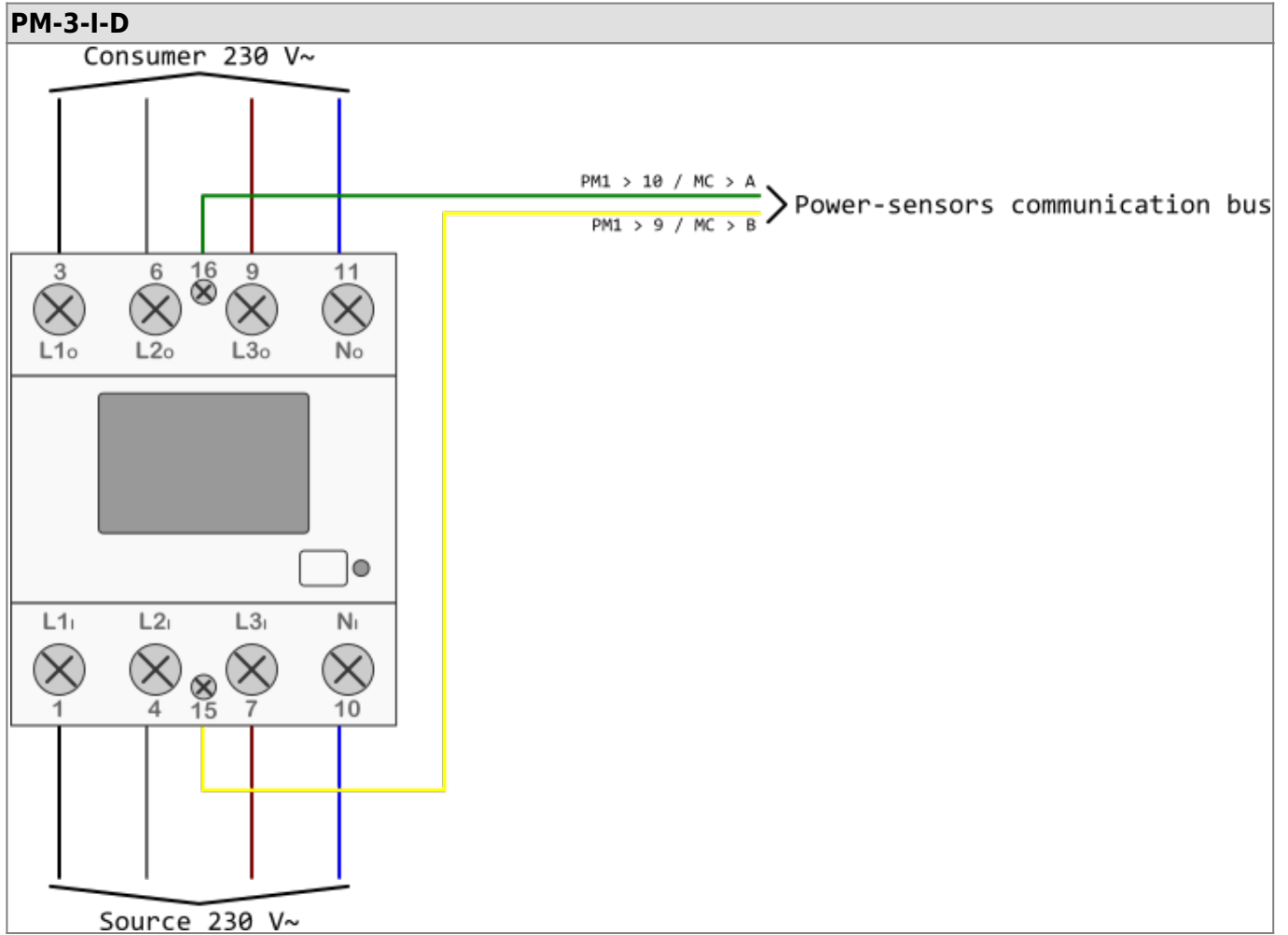


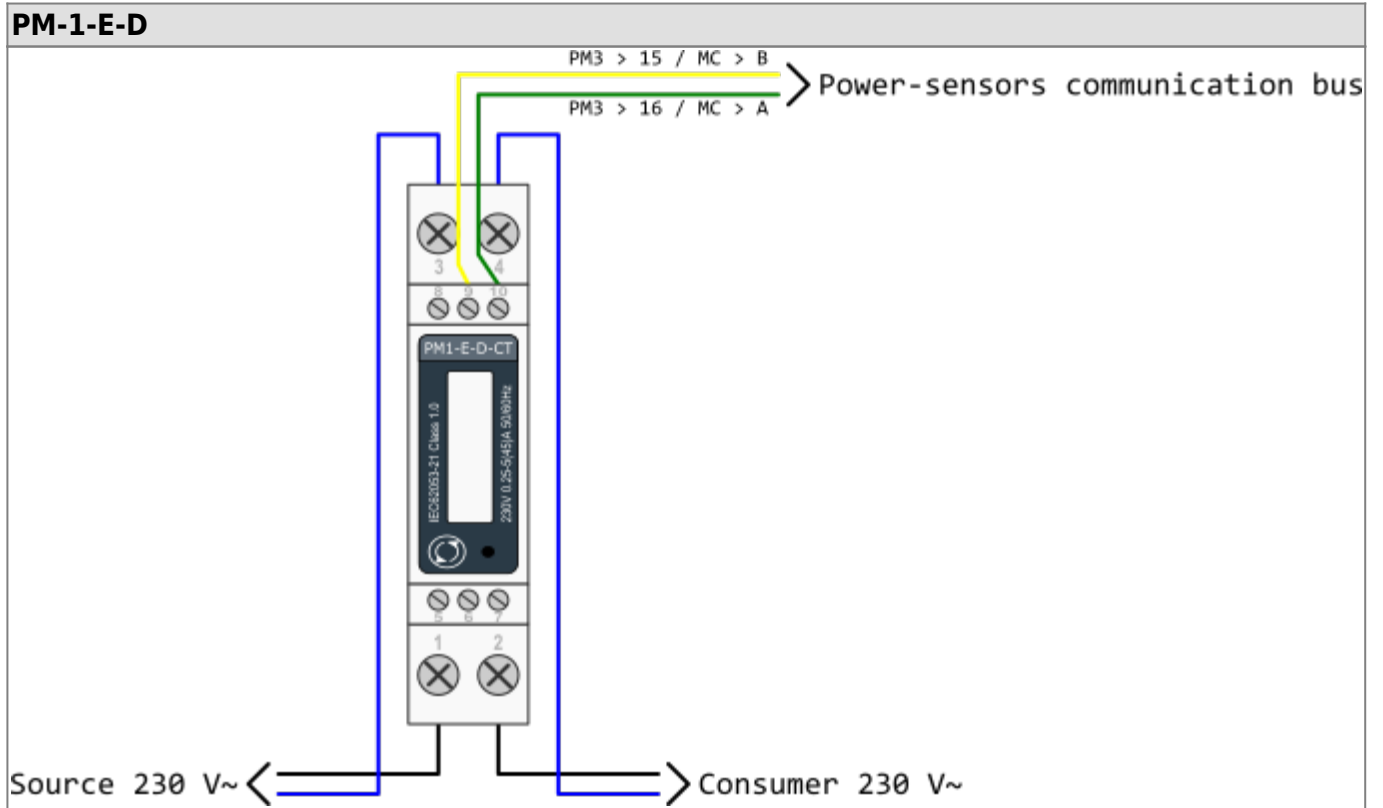
1. System settings		
	[ autodetect ]	Click to find HEMS G2 in local network
eStore	C.....	eStore serial number (automatically detected or can be entered manually).
	[ ] enable	When checked HEMS will read Grid, first plant and first Storage directly from eStore (so there is no need to duplicate power-sensor).
	[detect]	eStore address is cleared and new eStore can be detected.
HIQ Home	C.....	HIQ Home serial number (automatically detected or can be entered manually).
	[ ] enable	When checked HEMS will read Grid power and energy from HIQ Home (so there is no need to duplicate power-sensor).
	[detect]	HIQ Home address is cleared so new can be detected.
2. Internet access		
	[ ] enable	When checked HEMS is automatically connected to HIQ Universe cloud service. Connection is initialized by HEMS system and uses UDP packets on port 8442.
	[test]	New "push" message is sent to server and roundtrip time is rechecked.
	[reset]	Clear messages counts and roundtrip time
	push timer	Timer in s for send "push" message to server

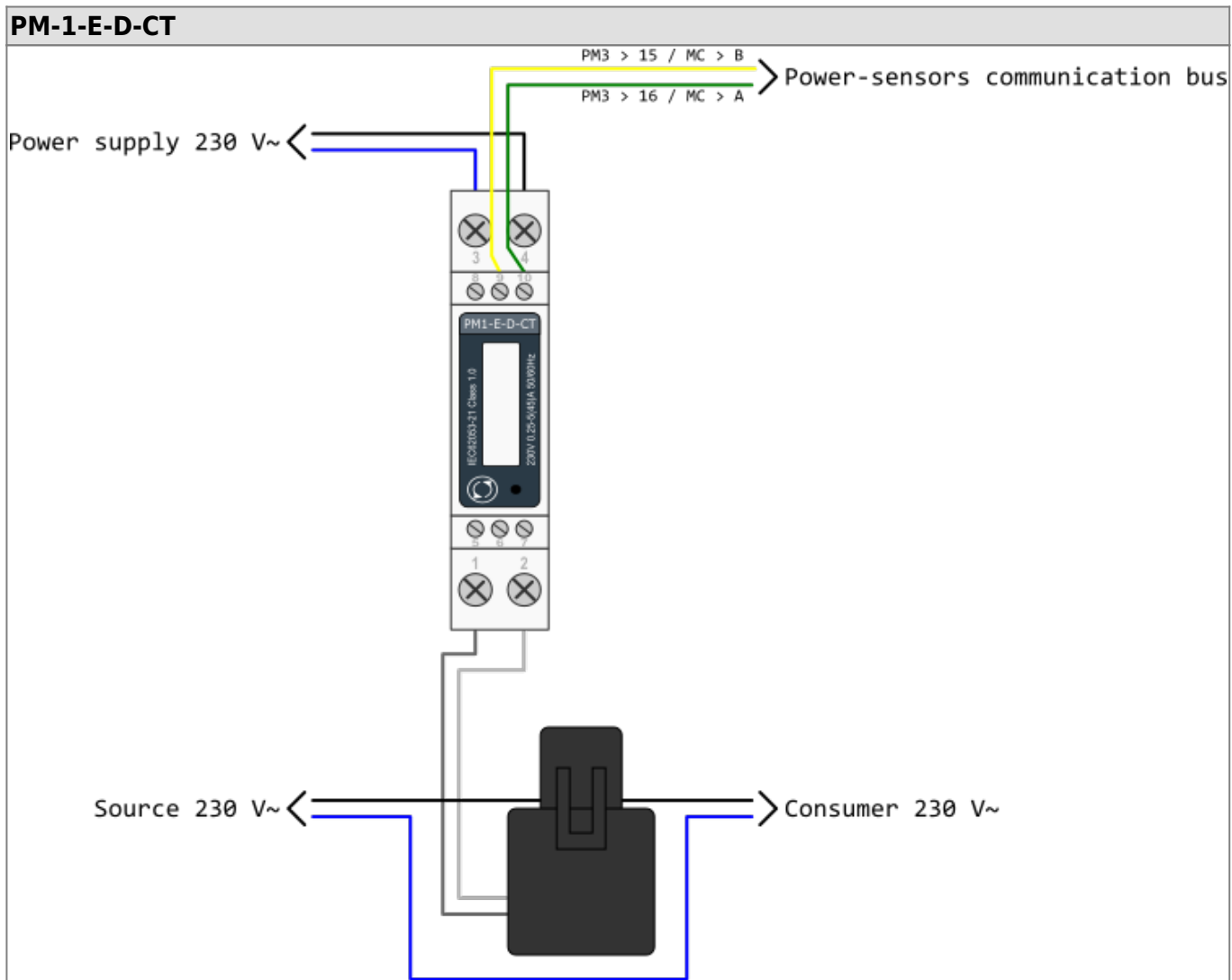
messages	Sent "push" messages / responses counters	
roundtrip	Time in ms between sent push message and response.	
<b>3. Date and time</b>		
Δ v	increment / decrement date or time field	
x	cancel changes	
✓	accept changes	
<b>4. Sources and Consumers settings table</b>		
SOURCES	source name	
icon	source icon	
P nominal	source nominal power	
type	source power-sensor type	
source PM management	source power-sensor management	
	message	messages regarding source power-sensor
	add	associate new power-sensor to source
	del	disassociate power-sensor from source & configure it as new power-sensor
new power-sensor	power-sensor configured as new one detected	
CONSUMERS	consumer name	
icon	consumer icon	
P nominal	consumer nominal power	
type	consumer power-sensor type	
consumer PM management	consumer power-sensor management	
	message	messages regarding consumer power-sensor
	add	associate new power-sensor to consumer
	del	disassociate power-sensor from consumer & configure it as new power-sensor
man. time	manged consumer manual override timer	
out mode	manged consumer output mode (normal or inverted)	
timetable	manged consumer timetable execution enabled	
<b>5. Permanent memory parameters</b>		
[init parameters]	init all parameters to default value	
[save parameters]	save all parameters to permanent memory	
[read parameters]	read all parameters from permanent memory	
[ ] autosave parameters	parameters will be automatically saved to permanent memory in 15 minutes after last parameter change	
<b>6. Backup / Restore to PC</b>		
[backup]	backup all parameters to PC	
[restore]	restore all parameters from PC backup	

# HEMS G2 wiring









Example of HEMS G2 wiring diagram:

[hems\\_g2.pdf](#)

Example done with [Elwin](#) by 3xM.

Archive file:

[20180924125415\\_hems\\_g2.zip](#)

Custom library components:

[components.zip](#)



# Commissioning

## Mounting

Mount the main controller MC-230, PM1-E-D and PM3-I-D electricity sensors, fuses, power relays and push-buttons to a suitable location.

## Wiring

Wire all elements **except** communication with single-phase **PM1-E-D sensors**.

Connect the MC-230 to the home LAN.

## Configuration

[Install and run](#)

HEMS G2 Configurator

on your PC.

Go to the “**settings**” page.

With the “**autodetect**” button, the application will locate the controller in the local network.

Enter **names**, select **icons**, and set the **nominal power** for all sources and consumers.

## Adding electricity sensor

### One-phase sensor PM-1-E-D

- **Connect** communication bus (to only one power-sensor)
- In HIQ Configurator counter should appear as “new power-sensor”
- Press and hold the push-button on the power-sensor until it appears **-SEt-** on display
- In HIQ Configurator click on the “**add**” button next to the source or consumer that the sensor is measuring

### Three-phase sensor PM3-I-D

- Communication bus with the power-sensor should already be connected
- Press and hold the push-button on the sensor until it appears “**COnf Add**” on display
- In HIQ Configurator counter should appear as “new power-sensor”
- Click on the “**add**” button next to the device that the sensor is measuring

## Removing the power-sensor

### One-phase sensors PM-1-E-D

- Make sure the “new power-sensor” is empty
- Press the button on power-sensor until **-Set-** appears on display
- In HEMS Configurator press **“del”** button next to the sensor
- After a few seconds, the sensor should appear as the “new power-sensor”
- If desired, the sensor can be removed or it can be assigned to another device.

### Three-phase power-sensor

- Make sure the “new power-sensor” is empty
- In HEMS Configurator press **“del”** button next to the sensor
- After a few seconds, the sensor should will appear as the “new power-sensor”
- If desired, the sensor can be removed or it can be assigned to another device.

## Setting device management features

For each managed consumer we can set:

- **man. time:** the time is in minutes for the manual override. It serves to ensure that the user can ensure a minimum validity of the manual switchover
- **out mode:** it can be normal (the output is turned on means the device is working) or inverted (the device is working when the output is off)
- **timetable checkbox:** allows to enable or disable the timetable for each device.

## Enable power-sensor from compatible systems

HEMS will automatically detect compatible

- battery systems eStore and
- home automation systems HIQ Home

which are in the same local network.

Only the first system is detected, if there are more than one it is necessary to enter the serial number of the desired system manually.

if **eStore** is **enabled**, HEMS will read:

- **grid** power-sensor
- power-sensor for the **first PV Plant** and
- power-sensor of the **first storage** system

From the **enabled HIQ Home** system, HEMS will automatically read the **grid** power-sensor.

## **internet access**

If enabled, the system will automatically establish access to the HIQ Universe web service. Communication with the server is automatically established so that the controller sends the push message to the server, and the server can then access the controller on the given path. The UDP type of internet packets on the output port 8442 is used. If communication is not established automatically, check the access from the local network to the Internet and the router settings.

## **date and time**

The date and time is used to operate the timetables, so it's important that they are always set up properly. We do this with arrows (up and down at date / time fields) and confirm the entry by clicking on the ok mark. Press x to cancel changes.

## **permanent memory**

Saving parameters to the permanent memory, after changing the settings, it is necessary since at startup HEMS always reads parameters from the permanent memory.

## **backup / restore to PC**

HEMS Configurator allows you to backup and restore all parameters to pc.