



PEM353



Universal measuring device

Software version: 1.00.00

Hardware version: 1.00



Bender GmbH & Co. KG

Londorfer Str. 65 • 35305 Gruenberg • Germany

Postfach 1161 • 35301 Gruenberg • Germany

Tel.: +49 6401 807-0 • Fax: +49 6401 807-259

E-Mail: info@bender.de • www.bender.de

© Bender GmbH & Co. KG

All rights reserved.

Reprinting only with permission of the publisher.

Subject to change!

Photos: Bender archive.

Table of Contents

1. Important information	9
1.1 How to use this manual	9
1.2 Technical support: Service and support	10
1.2.1 First level support	10
1.2.2 Repair service	10
1.2.3 Field service	10
1.3 Training courses	11
1.4 Delivery conditions	11
1.5 Inspection, transport and storage	11
1.6 Warranty and liability	12
1.7 Disposal	12
2. Safety instructions	13
2.1 General safety instructions	13
2.2 Work on electrical installations	13
2.3 Intended use	14
3. Device description	15
3.1 Scope of delivery	15
3.2 Product description	15
3.3 Areas of application	15
3.4 Functions	16
3.5 Compatibility with Bender Gateways	18
3.6 Variants	19
3.7 Application example	20
4. Installation	21
4.1 Dimension diagram	21
4.2 Mounting in a front panel	22

4.3	Removing from a front panel	22
5.	Connection	23
5.1	Overview of the terminals	24
5.2	Overview of the wiring diagrams	25
5.3	Wiring diagrams direct connection (without potential transformers)	26
5.3.1	1P2W L-N	26
5.3.2	1P2W L-L	27
5.3.3	1P3W with 2 measuring current transformers	28
5.3.4	3P3W with 3 measuring current transformers	29
5.3.5	3P3W with 2 measuring current transformers (Aron circuit)	30
5.3.6	3P4W with 3 (4) measuring current transformers	31
5.4	Wiring diagrams with potential transformers (medium and high voltage)	32
5.4.1	3P3W	32
5.4.2	3P4W with 3 potential transformers	33
5.5	Supply voltage	34
5.6	Measuring voltage inputs	34
5.7	Connection via measuring current transformers, normative requirements	34
5.8	Communication interface (RS-485)	34
5.9	Digital inputs	34
5.10	Digital outputs	35
6.	Commissioning	37
6.1	Before switching on	37
6.2	Switching on	37
6.3	After switching on (configuration)	38
7.	Operation	39
7.1	Getting to know the operating elements	39
7.2	LED indication	40
7.2.1	Pulse LED	40
7.2.2	Comm. LED	40

7.3	Navigation	40
7.4	Standard display	41
7.5	Data display	41
7.5.1	Detail page "U/I"	41
7.5.2	Detail page "Power"	43
7.5.3	Detail page "Energy"	43
7.5.4	Detail page "Demand"	44
7.5.5	Detail page "Harmonics"	45
7.5.6	Detail page "Max./Min."	47
7.5.7	Detail page "TOU"	49
7.5.8	Detail page "I/O"	49
7.5.9	Detail page "SOE"	49
8.	Setup	51
8.1	Setup: Overview diagram menu	51
8.2	Setup: setting options	53
9.	Inputs and outputs	61
9.1	Digital inputs (DI)	61
9.2	Digital outputs (DO)	62
9.3	Energy Pulsing display	62
10.	Power and energy	65
11.	Demand DMD	67
12.	Power Quality	69
12.1	Voltage and current phase angles	69
12.2	Harmonic distortion	69
12.2.1	Harmonic	69
12.2.2	THDf and THDr	70
12.2.3	TDD - Total Demand Distortion	70
12.2.4	k-factor	70
12.2.5	Crest factor	70
12.2.6	Measured values of the harmonics	71

12.3	Unbalance	72
13.	Setpoints	73
14.	Log	77
14.1	Max./Min. log	77
14.2	Peak demand log	79
14.3	Monthly energy log	80
14.4	Event log (SOE log)	81
15.	Time of Use (TOU)	83
15.1	Tariff switch according to a fixed schedule	85
15.2	Tariff switch by changing the status of the DI	86
15.3	Querying the schedule status	86
16.	Modbus Register Map	87
16.1	Basic measured values	88
16.2	Energy measurement	93
16.2.1	Energy meters and tariffs (present measured values)	93
16.2.2	Monthly energy log (Energy Log)	96
16.2.3	Interval energy measurement (EN Period)	98
16.2.4	Pulse counter digital inputs	98
16.3	Power Quality	99
16.4	Harmonics currents	100
16.5	Harmonics voltages	101
16.6	Demand	102
16.7	Predicted demand	102
16.8	Peak demand of this month	103
16.9	Peak demand of last month	104
16.10	Max./Min. log	106
16.10.1	Maximum values of this month	106
16.10.2	Minimum values of this month	108
16.10.3	Maximum values of last month	110
16.10.4	Minimum values of last month	112

16.10.5	Max./Min. log data structure	114
16.11	Setup parameters (basic)	114
16.12	Setup (inputs and outputs)	119
16.13	Setup (communication)	120
16.14	Setup (setpoints)	121
16.15	TOU setup	123
16.15.1	Setup schedules register	123
16.15.2	Season	124
16.15.3	Daily profiles	127
16.15.4	Alternate days	129
16.16	Time setting	131
16.17	Clearing logs and meters	132
16.18	Event log (SOE log)	134
16.19	DOx control	143
16.20	Universal measuring device information	144
17.	PEM353-N	147
17.1	Daily and monthly logs (freeze logs)	147
17.1.1	Daily freeze log	147
17.1.2	Monthly freeze log	149
17.2	Data recorders DR	151
17.2.1	DR setup parameters	151
17.2.2	Key to measured quantities used for data recorders DR	152
17.2.3	Factory settings data recorders	158
17.2.4	Reading out the data recorders	160
17.2.5	Data structure data recorders	160
18.	Technical data	161
18.1	Tabular data	161
18.2	Standards and certifications	164
18.3	Ordering details	165
INDEX	167

1. Important information

1.1 How to use this manual







This manual is intended for **qualified personnel** working in electrical engineering and electronics!

Always keep this manual within easy reach for future reference.

To make it easier for you to understand and revisit certain sections in this manual, we have used symbols to identify important instructions and information.

The meaning of these symbols is explained below:

 DANGER	<p>This signal word indicates that there is a high risk of danger that will result in death or serious injury if not avoided.</p>
 WARNING	<p>This signal word indicates a medium risk of danger that can lead to death or serious injury if not avoided.</p>
 CAUTION	<p>This signal word indicates a low-level risk that can result in minor or moderate injury or damage to property if not avoided.</p>
	<p>This symbol denotes information intended to assist the user in making optimum use of the product.</p>

1.2 Technical support: Service and support

For commissioning and troubleshooting Bender offers you:

1.2.1 First level support

Technical support by phone or e-mail for all Bender products

- Question about specific customer applications
- Commissioning
- Troubleshooting

Telephone: +49 6401 807-760*
Fax: +49 6401 807-259
In Germany only: 0700BenderHelp (Tel. and Fax)
E-mail: support@bender-service.de

1.2.2 Repair service

Repair, calibration, update and replacement service for Bender products

- Repair, calibration, testing and analysing Bender products
- Hardware and software update for Bender devices
- Delivery of replacement devices for faulty or incorrectly delivered Bender devices
- Extended warranty for Bender devices with in-house repair service resp. replacement devices at no extra cost

Telephone: +49 6401 807-780** (technical issues)
+49 6401 807-784**, -785** (commercial issues)
Fax: +49 6401 807-789
E-mail: repair@bender-service.de

Please send the devices for **repair** to the following address:

Bender GmbH, Repair-Service,
Londorfer Straße 65,
35305 Gruenberg

1.2.3 Field service

On-site service for all Bender products

- Commissioning, parameter setting, maintenance, troubleshooting for Bender products

- Analysis of the electrical installation in the building (power quality test, EMC test, thermography)
- Practical training courses for customers

Telephone: +49 6401 807-752**, -762 **(technical issues)
+49 6401 807-753** (commercial issues)
Fax: +49 6401 807-759
E-mail: fieldservice@bender-service.de
Internet: www.bender.de

*Available from 7.00 a.m. to 8.00 p.m. on 365 days of the year (CET/UTC+1)

**Mo-Thu 7.00 a.m. - 8.00 p.m., Fr 7.00 a.m. - 13.00 p.m

1.3 Training courses

Bender is happy to provide training regarding the use of test equipment. The dates of training courses and workshops can be found on the Internet at www.bender-de.com -> Know-how -> Seminars.

1.4 Delivery conditions

The conditions of sale and delivery set out by Bender apply.

For software products, the "Softwareklausel zur Überlassung von Standard- Software als Teil von Lieferungen, Ergänzung und Änderung der Allgemeinen Lieferbedingungen für Erzeugnisse und Leistungen der Elektroindustrie" (software clause in respect of the licensing of standard software as part of deliveries, modifications and changes to general delivery conditions for products and services in the electrical industry) set out by the ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie e.V., (German Electrical and Electronic Manufacturers' Association) also applies.

Conditions of sale and delivery can be obtained from Bender in printed or electronic format.

1.5 Inspection, transport and storage

Inspect the packaging and equipment packaging for damage, and compare the contents of the package with the delivery documents. In the event of damage in transit, please contact Bender immediately.

The devices must only be stored in areas where it is protected from dust, humidity and spray or dripping water, and in which the specified storage temperatures can be assured.

1.6 Warranty and liability

Warranty and liability claims in the event of injury to persons or damage to property are excluded if they can be attributed to one or more of the following causes:

- Improper use of the device.
- Incorrect mounting, commissioning, operation and maintenance of the device.
- Failure to observe the instructions in this operating manual regarding transport, commissioning, operation and maintenance of the device.
- Unauthorised changes to the device made by parties other than the manufacturer.
- Non-observance of technical data.
- Repairs carried out incorrectly and the use of replacement parts or accessories not approved by the manufacturer.
- Catastrophes caused by external influences and force majeure.
- Mounting and installation with device combinations not recommended by the manufacturer.

This operating manual, especially the safety instructions, must be observed by all personnel working on the device. Furthermore, the rules and regulations that apply for accident prevention at the place of use must be observed.

1.7 Disposal

Abide by the national regulations and laws governing the disposal of this device. Ask your supplier if you are not sure how to dispose of the old equipment.

The directive on waste electrical and electronic equipment (WEEE directive) and the directive on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS directive) apply in the European Community. In Germany, these policies are implemented through the "Electrical and Electronic Equipment Act" (ElektroG). According to this, the following applies:

- Electric and electronic equipment are not to be included in household waste.
- Batteries and accumulators are not to be included in household waste but must be disposed of in accordance with the regulations.
- Old electrical and electronic equipment from users other than private households which was introduced to the market after 13th August 2005 must be taken back by the manufacturer and disposed of properly.

For more information on the disposal of Bender devices, refer to our website at www.bender-de.com -> Service & support.

2. Safety instructions

2.1 General safety instructions

Part of the device documentation in addition to this manual is the enclosed " Safety instructions for Bender products".

2.2 Work on electrical installations



Only **qualified personnel** are permitted to carry out the work necessary to install, commission and run a device or system.



Risk of fatal injury due to electric shock!

Touching live parts of the system carries the risk of:

- An electric shock
- Damage to the electrical installation
- Destruction of the device

Before installing and connecting the device, make sure that the installation has been de-energised. Observe the rules for working on electrical installations.

Refer to the rated and supply voltage values as specified in the technical data!

If the device is being used in a location outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. European standard EN 50110 can be used as a guide.

2.3 Intended use

The PEM353 is suitable for use in 2-, 3- and 4-wire systems and in their respective versions as TN, TT and IT systems.

The current measurement inputs of the PEM353 are always connected via external .../ 1 A or .../5 A measuring current transformers. In principle, measurements in medium and high-voltage systems are carried out via potential transformers.

Use for the intended purpose also includes:

- Device-specific settings compliant with local equipment and operating conditions
- Adhering to the manual

Any other use than that described in this manual is regarded as improper.

3. Device description

3.1 Scope of delivery

- 1 x PEM353
- 1 x safety instructions for Bender products (multilingual)
- 1 x quick-start guide (manual for download at www.bender.de/en/service-support/downloads)
- 1 x rubber seal
- 4 x retaining clips

3.2 Product description

The digital universal measuring device PEM353 is used to record and display measured quantities of an electricity supply network, and make them available via the communication interface.

The range of measurements extends from voltages and currents to power and energy meters to measured quantities of the voltage quality, such as THD and the individual harmonics up to the 31st order.

The PEM353 is suitable for use in 2-, 3- and 4-wire systems and in their respective versions as TN, TT and IT systems. This allows monitoring single and polyphase systems. With its standardised dimensions of 96 x 96 mm, the device is intended for front panel mounting.

3.3 Areas of application

- Modern indicating instrument for electrical quantities, e.g. as a replacement for analogue indicating instruments
- Power quality monitoring
- Limit value monitoring (setpoints) with alarm forwarding
- Measurement and monitoring of the N conductor
- Energy and power measurement, e.g. as part of energy data monitoring

3.4 Functions

1. Measurement of electrical quantities such as
 - Phase voltages (individually + Σ) U_{L1}, U_{L2}, U_{L3} in V
 - Line-to-line voltages (individually + Σ) $U_{L1L2}, U_{L2L3}, U_{L3L1}$ in V
 - Phase currents (individually + Σ) I_1, I_2, I_3 in A
 - Neutral current I_n (calculated) in A
 I_4 (measured, PEM353-N only) in A
 - Residual current I_r (calculated, PEM353-N only) in A
 - Frequency f in Hz
 - Power per phase conductor (individually + Σ) P in kW, Q in kvar, S in kVA
 - Displacement factor (individually + Σ) $\cos(\varphi)$
 - Power factor (individually + Σ) λ
 - Active and reactive energy import (individually + Σ) in kWh, kvarh
 - Active and reactive energy export (individually + Σ) in kWh, kvarh
 - Voltage phase angle (LN or LL, individually) in $^\circ$
 - Current phase angle (individually) in $^\circ$
 - Voltage unbalance in %
 - Current unbalance in %
 - Harmonic distortion (THD, TOHD, TEHD) for U and I
 - k-factor for I
 - Crest factor for I
 - Total demand distortion (TDD) for I
2. Energy meters
 - Accuracy class of the active energy acc. to IEC 62053-22: 0.5 S
 - LED (pulse) for active or reactive energy
 - 2 pulse outputs (PEM353-P only)
 - Total phase and individual phase energy metering
 - Import, export, net and total per active and reactive energy
 - Total apparent energy
 - Up to 4 pulse counters (e.g. gas, water, air, heat)
3. Times of Use for energy measurement
 - Up to 8 tariffs
 - Tariff switching via digital inputs or

- Tariff switching according to schedule, 2 schedules
- Total phase and individual phase energy metering per tariff
 - Import and export per active and reactive energy
 - Total apparent energy
- Peak demand of the total phase power (P, Q, S) per tariff
- 4. Energy meter log - 12 monthly values
 - Total phase energy metering
 - Import, export, net and total per active and reactive energy
 - Apparent energy
 - Total phase energy metering per tariff
 - Import and export per active and reactive energy
 - Total apparent energy
- 5. Load data for total phase power (P, Q, S) and currents
 - Configurable sliding average values/averaging (demand)
 - Demand forecasts of the next average value
 - Peak demand log with timestamp
 - Total phase power and currents (P, Q, S)
 - Total phase power per tariff (P, Q, S)
- 6. Log for max. and min. values for 45 measured quantities with timestamp
- 7. Limit value monitoring by means of setpoints and alarm forwarding
 - 9 parametrisable monitoring points (setpoints)
 - 25 measured quantities to choose from
 - Alerting via display and/or digital outputs (DO)
 - Monitoring for limit value violation (over/under limit value)
 - Hysteresis adjustable
- 8. Event log (SOE log)
 - 100 entries with timestamp, resolution 1 ms
 - Changes to setup, setpoints and DI/DO
 - System messages
 - Limit value violations
- 9. Load data log: daily and monthly values (PEM353-N only)
 - Daily log
 - 60 days (2 months)
 - Total phase energy per active, reactive and apparent energy
 - Peak demands of total phase power (P, Q, S)

- Monthly log
 - 36 months (3 years)
 - Total phase energy per active, reactive and apparent energy
 - Monthly peak demands of total phase power with timestamp (P, Q, S)

10. Data recorders (PEM353-N only)

- 5 recorders with up to 16 channels each
- Channel selection from 328 measured quantities
- Interval configurable: 60 s to 40 days
- Recording time e.g. 100 days at a 15-minute interval

11. Easy and convenient operation

- Large backlit graphic display
- Display password protection
- Standard display with 4 selectable measured quantities

12. Other functions

- Connection fault detection (frequency, voltage/current failure, wrong polarity of measuring current transformer, rotating field)
- Operating hours counter

13. Communication interface and protocols

- Galvanically isolated RS-485 interface (1,200 to 38,400 bit/s)
- LED for communication activities
- Modbus RTU protocol
- BACnet MS/TP
- DNP

3.5 Compatibility with Bender Gateways

Bender Gateways provide advanced functions for the PEM353. In addition to visualisation, these also include convenient parameter setting and configuration via the web browser. Parameter setting and configuration via gateway goes far beyond the setting options on the display, as it includes many functions that would otherwise only be accessible via the communication interface.

For further information on Bender Gateways, please refer to our [homepage](#).

Whether the PEM353 is supported by a Bender Gateway depends on the respective firmware version. You can find a [compatibility list](#) on our homepage.

3.6 Variants

Property	PEM353	PEM353-P	PEM353-N
Voltage inputs (L1, L2, L3)	AC 230/400 V; 45...65 Hz		
Supply voltage	95...250 V; DC, AC 47...440 Hz		
Digital inputs	4		
Digital outputs	2 relay outputs	2 solid-state pulse outputs	2 relay outputs
Communication interface	RS-485 (Modbus RTU, BACnet MS/TP, DNP)		
Current inputs (I_1, I_2, I_3)	5 A		
I_4	—	—	5 A
Accuracy class for 5 A	0.5 S		
Accuracy class for 1 A	1		
Logs	Event log (SOE log) Max./Min. log Peak demand log Energy meter log (monthly values)		
Data recorders	—	—	5
Load data log (daily and monthly values)	—	—	X
Language	English		

3.7 Application example

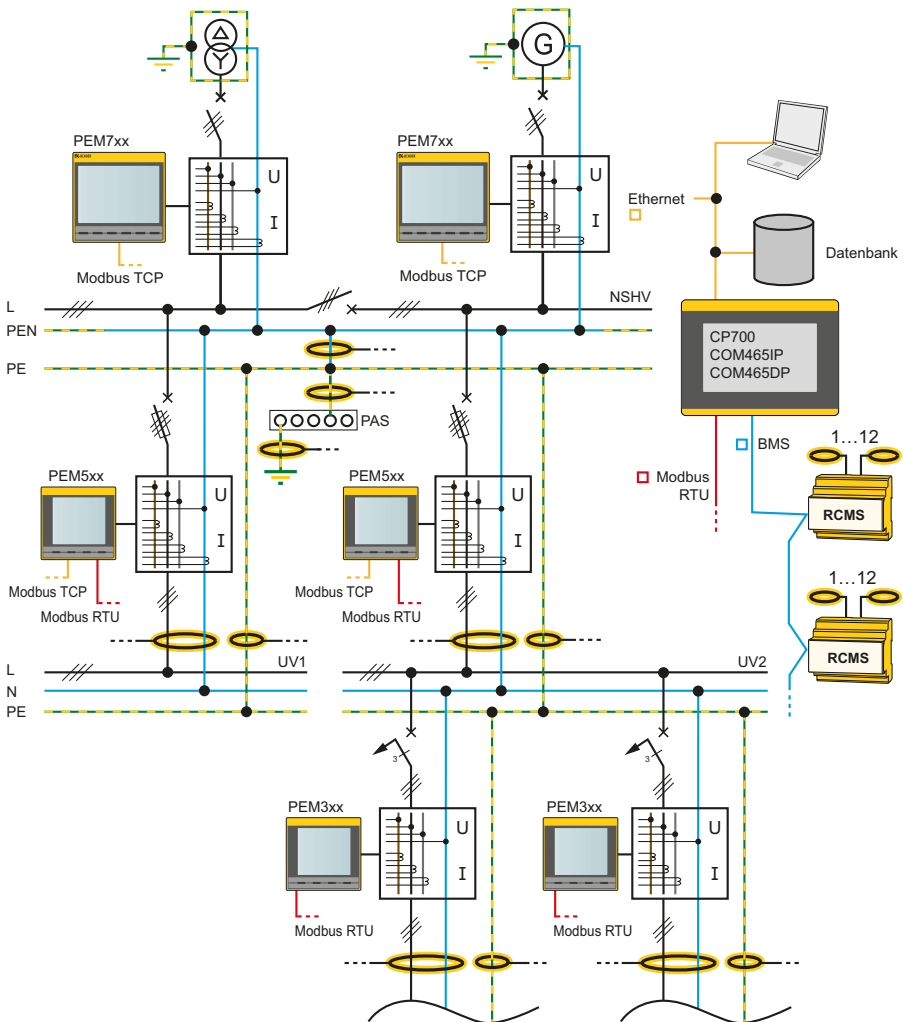


Fig. 3.1: Application example

4. Installation



This manual is intended for **qualified personnel** working in electrical engineering and electronics!



Risk of fatal injury due to electric shock!

Touching live parts of the system carries the risk of:

- An electric shock
- Damage to the electrical installation
- Destruction of the device

Before installing and connecting the device, make sure that the installation has been de-energised. Observe the rules for working on electrical installations.

Refer to the rated and supply voltage values as specified in the technical data!

4.1 Dimension diagram

The dimensions comply with DIN IEC 61554:2002-08

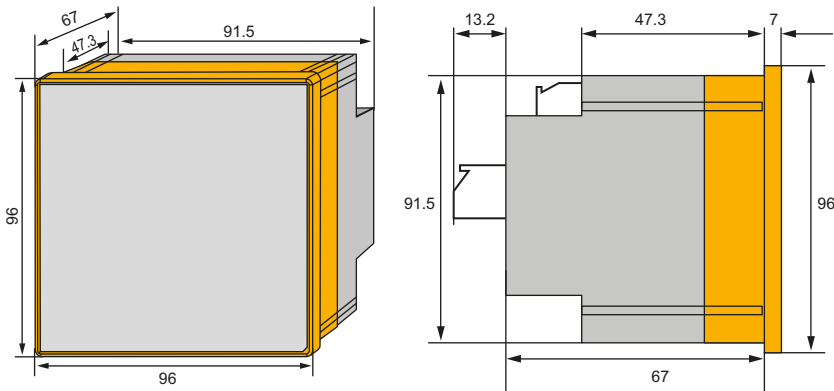


Fig. 4.1: Dimension diagram PEM353

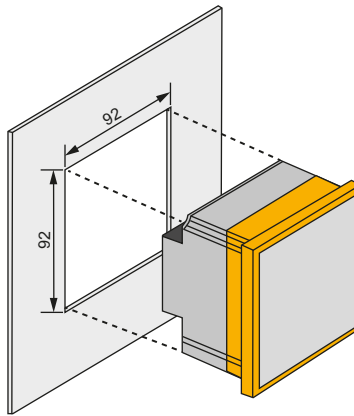


Fig. 4.2: Dimension diagram PEM353 (panel cutout)

4.2 Mounting in a front panel

Provide a mounting opening of 92 mm x 92 mm (max. permissible dimensions 92.8 x 92.8 mm). Consider the mounting depth of the device and the space required for terminal connection.

1. Mount the rubber seal on the back of the device.
2. Insert the device into the mounting opening of the front panel.
3. Place the four retaining clips over the device corners from behind.
4. Push the retaining clips tightly against the front plate.
5. Check the device to ensure that it is firmly installed.

The device is installed.

4.3 Removing from a front panel

The device is installed and connected. Follow the instructions in "chapter 5. Connection".

1. Remove the connections from the terminal blocks or remove the terminal blocks from the device.
2. Unlatch the retaining clips by carefully bending them outwards. Remove all four retaining clips.
3. Remove the device from the front panel.

The device is removed.

5. Connection



Only **qualified personnel working in electrical engineering and electronics** are permitted to carry out the work necessary to install, commission and run a device or system.



DANGER

Risk of fatal injury due to electric shock!

Touching live parts of the system carries the risk of:

- An electric shock
- Damage to the electrical installation
- Destruction of the device

Before installing and connecting the device, make sure that the **installation** has been **de-energised**. Observe the rules for working on electrical installations.

Refer to the rated and supply voltage values as specified in the technical data!

5.1 Overview of the terminals

The connections are located on the back of the device.

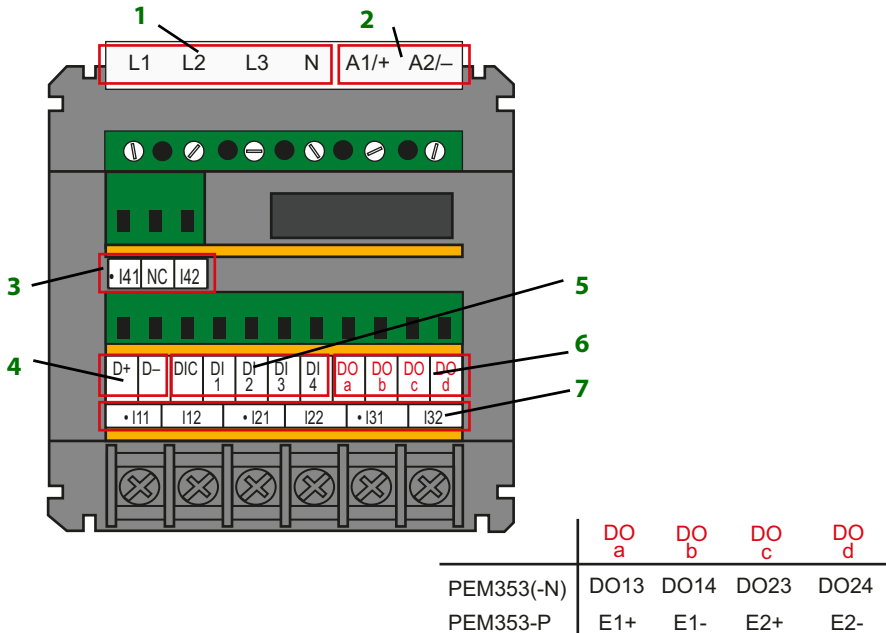


Fig. 5.1: Wiring diagram PEM353

Legend to wiring diagram PEM353

1	Measuring voltage inputs: The measuring leads should be protected with appropriate fuses.
2	Supply voltage: Power protection by a quick-response 6 A fuse. If supplied from an IT system, both lines must be protected by a fuse.
3	Measuring current inputs I_4 (optional)
4	RS-485 bus connection
5	Digital inputs
6	Digital outputs (N/O contacts)
7	Measuring current inputs $I_{1...3}$

5.2 Overview of the wiring diagrams

The following connection configurations are supported:

Direct connection (without potential transformers)

- 1P2W LN
- 1P2W LL
- 1P3W
- 3P3W with 3 measuring current transformers
- 3P3W with 2 measuring current transformers (Aron)
- 3P4W

With potential transformers (e.g. in medium and high-voltage systems)

- 3P3W with a 3-phase potential transformer
- 3P4W with three potential transformers

5.3 Wiring diagrams direct connection (without potential transformers)

5.3.1 1P2W L-N

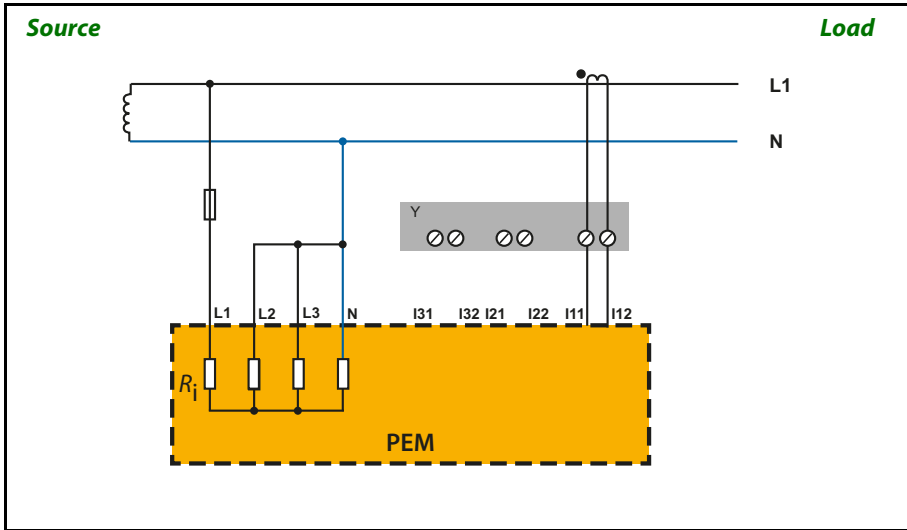


Fig. 5.2: Connection diagram one-phase 2-wire system

Y Disconnect terminal of the measuring current transformers



When using this wiring, the wiring mode (Setup > Basic > Wiring Mode) must be set to **1P2W L-N**.

5.3.2 1P2W L-L

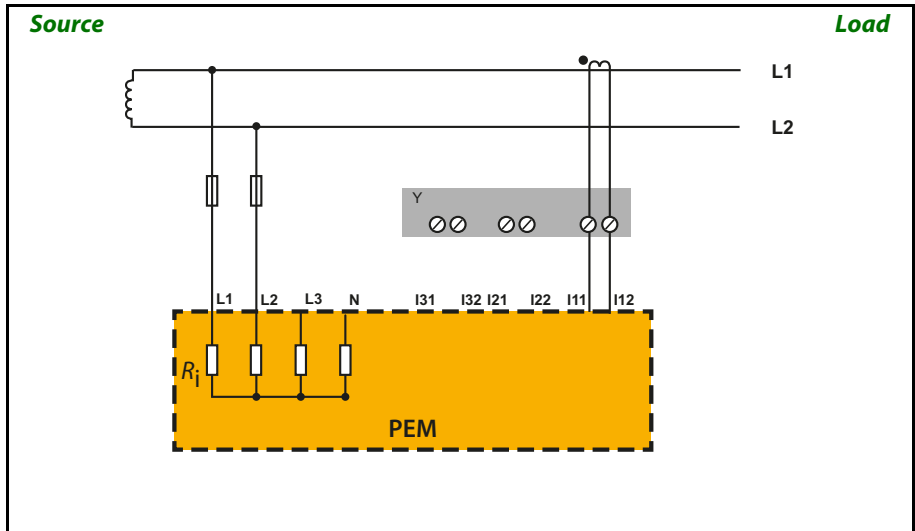



Fig. 5.3: Connection diagram one-phase 2-wire system

Y *Disconnect terminal of the measuring current transformers*

 *When using this wiring, the wiring mode (Setup > Basic > Wiring Mode) must be set to **1P2W L-L**.*

5.3.3 1P3W with 2 measuring current transformers

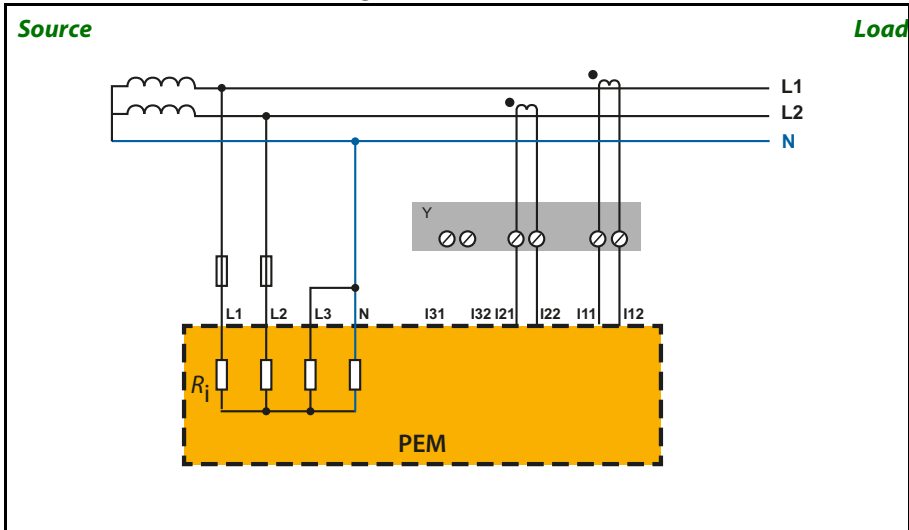


Fig. 5.4: Connection diagram one-phase 3-wire system

Y *Disconnect terminal of the measuring current transformers*



*When used in a 3-wire system, the wiring mode (Setup > Basic > Wiring Mode) must be set to **1P3W**.*

5.3.4 3P3W with 3 measuring current transformers

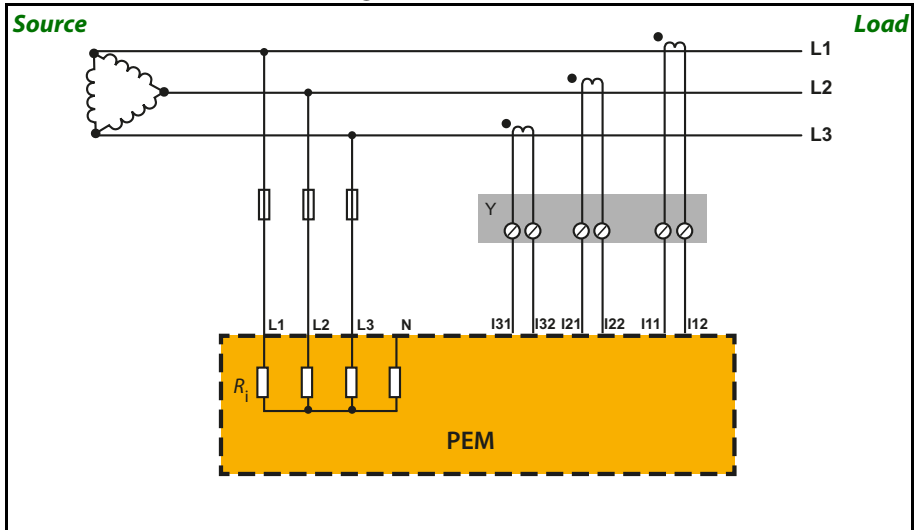


Fig. 5.5: Connection diagram with 3 measuring current transformers

Y Disconnect terminal of the measuring current transformers

i When used in a 3-wire system, the wiring mode (Setup > Basic > Wiring Mode) must be set to **3P3W**.

5.3.5 3P3W with 2 measuring current transformers (Aron circuit)

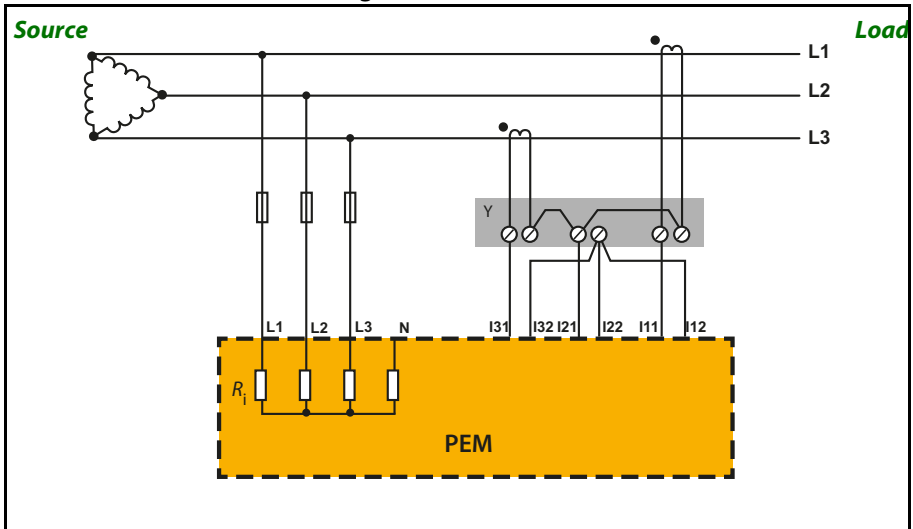




Fig. 5.6: Connection diagram 3P3W with 2 measuring current transformers (Aron circuit)

Y *Disconnect terminal of the measuring current transformers*

- 

When used in a 3-wire system, the wiring mode (Setup > Basic > Wiring Mode) must be set to **3P3W**.
- 

With this circuit variant, the **measurement uncertainty** of the current is **greater** for **L2** than for currents L1 and L3 measured directly by the measuring current transformers.

5.3.6 3P4W with 3 (4) measuring current transformers

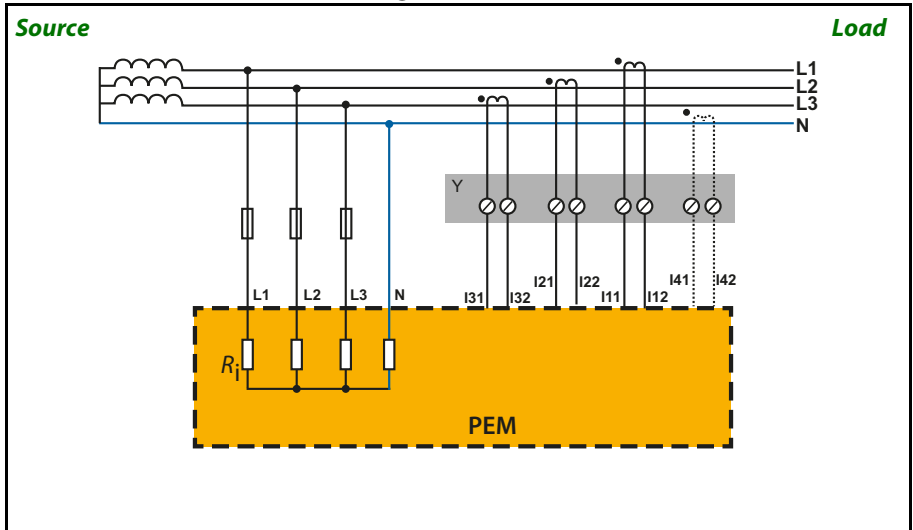


Fig. 5.7: Connection diagram 3P4W with 3 (4) measuring current transformers

Y Disconnect terminal of the measuring current transformers
I₄ Measurement I_4 for PEM353-N only

When using this wiring, the wiring mode (Setup > Basic > Wiring Mode) must be set to **3P4W**.

5.4 Wiring diagrams with potential transformers (medium and high voltage)

5.4.1 3P3W

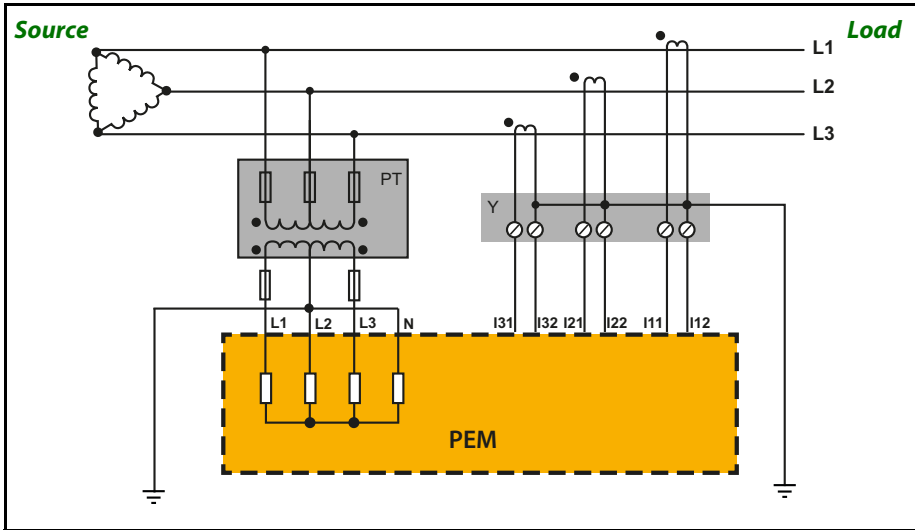


Fig. 5.8: Connection diagram three-phase 3-wire system

Y
PT

Disconnect terminal of the measuring current transformers
The transformation ratio in the PEM353 can be set by specifying the primary and secondary transformation ratio. Odd ratios can also be configured.



*When used in a 3-wire system, the wiring mode (Setup > Basic > Wiring Mode) must be set to **3P3W**.*

5.4.2 3P4W with 3 potential transformers

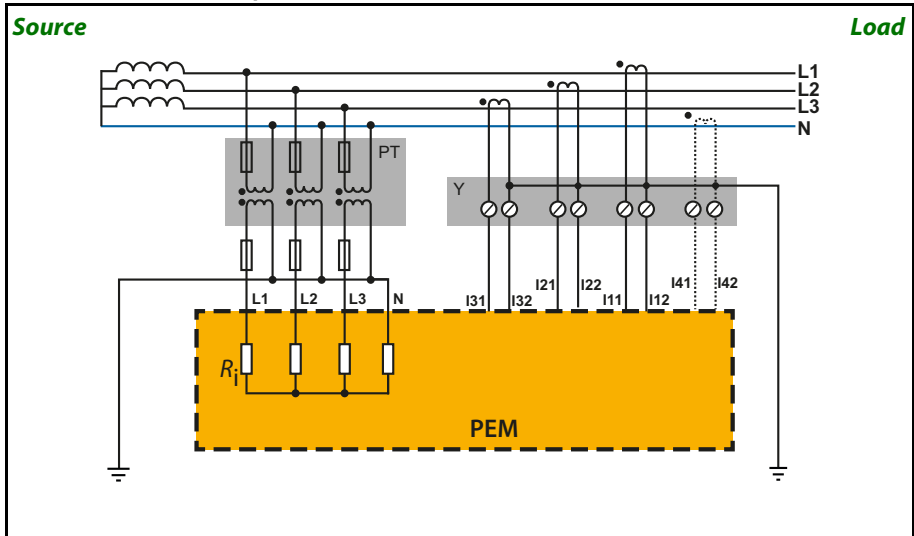


Fig. 5.9: Connection diagram three-phase 4-wire system
(e.g. TN-S system)

Y
I₄
PT

Disconnect terminal of the measuring current transformers
Measurement I₄ for PEM353-N only
The transformation ratio in the PEM353 can be set by specifying the primary and secondary transformation ratio. Odd ratios can also be configured.



*When using this wiring, the wiring mode (Setup > Basic > Wiring Mode) must be set to **3P4W**.*

5.5 Supply voltage

Provide power protection by a quick-response 6 A fuse.
Connect the PEM353 to the supply voltage (terminals A1/+ and A2/-).



A single-pole supply voltage must be protected by a fuse; if the device is powered by an IT system, all poles must be protected.

5.6 Measuring voltage inputs

Protect the measuring voltage inputs by a fuse (e.g. 2 A) with sufficient separability for the measuring point.

Connect the measuring voltage inputs according to the selected connection configuration.

5.7 Connection via measuring current transformers, normative requirements

Provide a suitable shorting block for each current measurement input (in the wiring diagrams: disconnect terminal of the measuring current transformers "Y").

Connect the current measurement inputs according to the selected connection configuration.



Current measurement inputs must not be "protected" by fuses. The current measurement inputs must not be earthed in low-voltage applications. IEC 60364-5-55 (edition 2.2) chapter 557.5.3.1

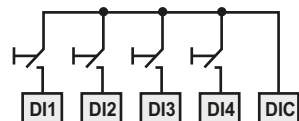
5.8 Communication interface (RS-485)

The connection to the RS-485 bus is carried out via terminals D+ and D-. Up to 32 devices can be connected to the bus. The maximum cable length for all devices connected to the RS-485 bus is 1200 m.

5.9 Digital inputs

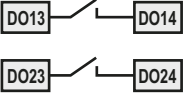
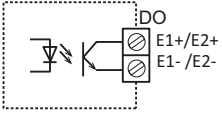
The universal measuring device PEM353 provides 4 digital inputs. The inputs are supplied by a galvanically isolated DC 24 V (DIC) voltage. An external circuit providing at least a current I_{\min} of 1 mA is required for triggering the inputs.

Connect the auxiliary circuit to the terminal of the digital input used (DI1...4) and to DIC.



5.10 Digital outputs

PEM353(-N) features 2 configurable outputs (N/O relay),
 PEM353-P features 2 pulse outputs ("Solid State Relay").

	PEM353 PEM353-N (2 relay contacts)	Rated operational voltage	AC 250 V	DC 30 V
		Rated operational current	5 A	5 A
	PEM353-P (2 solid-state con- tacts) Maximum cable length: 30 m	Rated operational voltage		DC 30 V
		Rated operational current		30 mA

6. Commissioning



Only **qualified personnel** are permitted to carry out the work necessary to install, commission and run a device or system.



DANGER

Risk of fatal injury due to electric shock!

Touching live parts of the system carries the risk of:

- An electric shock
- Damage to the electrical installation
- Destruction of the device

Before installing and connecting the device, make sure that the **installation** has been **de-energised**. Observe the rules for working on electrical installations.

Refer to the rated and supply voltage values as specified in the **technical data!**

6.1 Before switching on

Before switching on, check the following:

1. Does the supply voltage correspond to the specifications on the nameplate?
2. Is the secondary current of the measuring current transformers less than or equal to the specifications on the nameplate?
3. Is the nominal system voltage or the potential transformer secondary voltage less than or equal to the specifications of the nominal voltage on the nameplate?

6.2 Switching on

Connect the supply voltage.

6.3 After switching on (configuration)

After connecting the supply voltage, carry out at least the following steps:

1. Set language, time and date
(see "chapter 8. Setup" > Clock)
2. Configure the communication interface
(see "chapter 8. Setup" > Comm.)
3. Make wiring settings
(see "chapter 8. Setup" > Basic)
 - Connection configuration: Observe the necessary settings for the selected connection configuration.
 - Transformation ratio of the potential transformers (optional)
 - Transformation ratio of the current transformers

7. Operation

7.1 Getting to know the operating elements

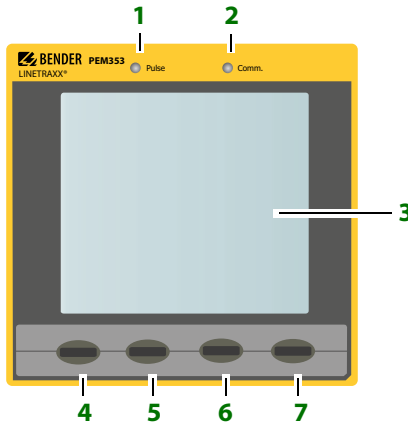


Fig. 7.1: Operating elements

Legend of the operating elements

No.	Element	Description
1	Pulse LED (red)	Indication of energy pulsing
2	Comm. LED (green)	Indication of communication activity
3	Display	LCD graphic display
4	Button 1	The function of the buttons varies depending on the context. The meaning of the buttons is always shown on the display above the corresponding button.
5	Button 2	
6	Button 3	
7	Button 4	

7.2 LED indication

The universal measuring device features two LEDs on the front panel: "Pulse" (red) and "Comm." (green).

7.2.1 Pulse LED

The "Pulse" LED is used when the EN PULSE function is activated. This can be set in the setup menu using the buttons on the front or via the communication interface (Setup > Main > LED EN Pulse). The LED flashes every time a certain amount of energy is measured.

For more details, refer to page 62.

7.2.2 Comm. LED

Indication of active communication with other devices.

7.3 Navigation

The four buttons on the front of the device are used to navigate through the individual pages and views of the contents. The settings are also made with these buttons.



The present meanings of the buttons are always shown above the buttons in the bottom line of the display.

The detail page of the section, which can consist of several subpages, opens from the standard display by pressing a button (button 2: "U/I" area and button 3: "Power" area). Another area can be set from the standard display using the arrow buttons (buttons 1 and 4) (Energy, Demand, Harmonics, Max./Min., TOU, I/O, SOE and Setup). Use the arrow buttons to scroll through the subpages and "Esc" to exit the subpages and detail pages.

The individual subpages are numbered consecutively (top line, right).

Arrows	Scroll through a list, change cursor position
Esc	Exit menu
Enter	Activate menu
OK	Confirm entry
Cancel	Reject entry
Browse	Scroll through the settings in read-only mode

7.4 Standard display

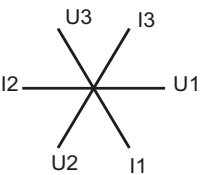
The standard display is the page to which the device returns from each menu after an adjustable time. The standard display shows the present measured values for 4 parameters in plain text. These parameters can be freely selected (see page 56). If any button is pressed in the standard display, navigation to the non-changeable menus begins as described above (chapter 7.3).

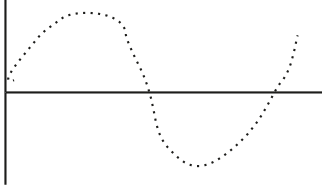
If the display has gone dark, it can be illuminated again by pressing any button.

7.5 Data display

The following sections provide an overview of the retrievable data. They are sorted according to the individual detail pages.

7.5.1 Detail page "U/I"

Subpage No.	First line	Second line	Third line	Fourth line
"Standard display"	Main 1st	Main 2nd	Main 3rd	Main 4th
1	U_{L1}	U_{L2}	U_{L3}	$\emptyset U_{LN}$
2	U_{L1L2}	U_{L2L3}	U_{L3L1}	$\emptyset U_{LL}$
3	I_1	I_2	I_3	$\emptyset I$
4	$I_n^{1)}$	$[I_4]^{2)}$	$[I_r]^{2) 3)}$	
5	f			
6	Phase angle U_{L1}	Phase angle U_{L2}	Phase angle U_{L3}	
7	Phase angle I_1	Phase angle I_2	Phase angle I_3	
8	Phasor diagram 			

Subpage No.	First line	Second line	Third line	Fourth line
9	Waveform U_{L1}			
10	Waveform U_{L2}			
11	Waveform U_{L3}			
12	Waveform I_1			
13	Waveform I_2			
14	Waveform I_3			
15	Operating hours counter			
16 ⁴⁾	$U_{L1(f_0)}$	$U_{L2(f_0)}$	$U_{L3(f_0)}$	
17 ⁴⁾	$I_1(f_0)$	$I_2(f_0)$	$I_3(f_0)$	

Tab. 7.1: Detail page "U/I"

Notes Tab. 7.1

- 1) I_n is the calculated current on the N conductor; r.m.s. value of $(I_1 + I_2 + I_3)$
- 2) for PEM353-N only
- 4) „Fundamental“ (top line of the display):
- 4) „Fundamental“ (top line of the display): value refers to the fundamental f_0

7.5.2 Detail page "Power"

Subpage No.	First line	Second line	Third line	Fourth line
1	P_{tot}	Q_{tot}	S_{tot}	λ_{tot}
2	P_{L1}^*	P_{L2}^*	P_{L3}^*	P_{tot}
3	Q_{L1}^*	Q_{L2}^*	Q_{L3}^*	Q_{tot}
4	S_{L1}^*	S_{L2}^*	S_{L3}^*	S_{tot}
5	λ_{L1}^*	λ_{L2}^*	λ_{L3}^*	λ_{tot}
6	Displacement factor $\cos(\varphi)_{L1}^*$	Displacement factor $\cos(\varphi)_{L2}^*$	Displacement factor $\cos(\varphi)_{L3}^*$	Displacement factor $\cos(\varphi)_{Ltot}^*$
7 ¹⁾	$P_{L1}(f_0)$	$P_{L2}(f_0)$	$P_{L3}(f_0)$	$P_{tot}(f_0)$

Tab. 7.2: Detail page "Power"

Note Tab. 7.2:

- * Display only when applicable.
- 1) „Fundamental“ (top line of the display): value refers to the fundamental f_0

7.5.3 Detail page "Energy"

Subpage No.	First line	Second line	Third line	Fourth line
1	Total active energy	Total reactive energy	Apparent energy	
2	Active energy import	Active energy export	Net active energy	Total active energy
3	Reactive energy import	Reactive energy export	Net reactive energy	Total reactive energy
4	Total apparent energy			

Tab. 7.3: Detail page "Energy"

7.5.4 Detail page "Demand"

Subpage No.		First line	Second line	Third line
		Peak demand P Timestamp	Peak demand Q Timestamp	Peak demand S Timestamp
Max.	1	Peak demand P Timestamp	Peak demand Q Timestamp	Peak demand S Timestamp
	2	Peak demand I_1 Timestamp	Peak demand I_2 Timestamp	Peak demand I_3 Timestamp
Pres.	1	Present demand P	Present demand Q	Present demand S
	2	Present demand I_1	Present demand I_2	Present demand I_3
Pred.	1	Predicted peak demand P	Predicted peak demand Q	Predicted peak demand S
	2	Predicted peak demand I_1	Predicted peak demand I_2	Predicted peak demand I_3

Tab. 7.4: Detail page "Demand"

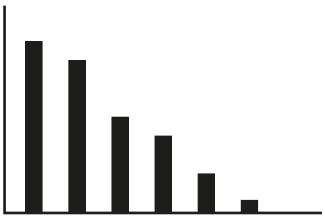
Notes Tab. 7.4:

Max = maximum value

Pres = present

Pred = predicted

7.5.5 Detail page "Harmonics"

Subpage No.		First line	Second line	Third line
		THD _{UL1}	THD _{UL2}	THD _{UL3}
Basic	1 (THD _U)	THD _{UL1}	THD _{UL2}	THD _{UL3}
	2 (THD _I)	THD _{I1}	THD _{I2}	THD _{I3}
	3 (TDD)	TDD _{I1}	TDD _{I2}	TDD _{I3}
	4 (k-factor)	k-factor I_1	k-factor I_2	k-factor I_3
	5 (Crest factor)	Crest factor I_1	Crest factor I_2	Crest factor I_3
	6 (Unbalance)	Unbalance I	Unbalance U	
	7 (Unbalance U)	Positive sequence component U1	Negative sequence component U2	Zero sequence component U0
	8 (Unbalance I)	Positive sequence component I1	Negative sequence component I2	Zero sequence component I0
Graph	1	TOHD _{UL1}		
	2	TOHD _{UL2}		
	3	TOHD _{UL3}		
	4	TOHD _{I1}		
	5	TOHD _{I2}		
	6	TOHD _{I3}		
L1	1 (TOHD)	TOHD3...15 for U and I		
	2 (TOHD)	TOHD17...29 for U and I		
	3 (TOHD)	TOHD31 for U and I		
	4 (TEHD)	TEHD2...14 for U and I		
	5 (TEHD)	TEHD16...28 for U and I		
	6 (TEHD)	TEHD30 for U and I		

Subpage No.		First line	Second line	Third line
L2	1 (TOHD)	TOHD3...15 for <i>U</i> and <i>I</i>		
	2 (TOHD)	TOHD17...29 for <i>U</i> and <i>I</i>		
	3 (TOHD)	TOHD31 for <i>U</i> and <i>I</i>		
	(TEHD)	TEHD2...14 for <i>U</i> and <i>I</i>		
	(TEHD)	TEHD16...28 for <i>U</i> and <i>I</i>		
	(TEHD)	TEHD30 for <i>U</i> and <i>I</i>		
L3	1 (TOHD)	TOHD3...15 for <i>U</i> and <i>I</i>		
	2 (TOHD)	TOHD17...29 for <i>U</i> and <i>I</i>		
	3 (TOHD)	TOHD31 for <i>U</i> and <i>I</i>		
	(TEHD)	TEHD2...14 for <i>U</i> and <i>I</i>		
	(TEHD)	TEHD16...28 for <i>U</i> and <i>I</i>		
	(TEHD)	TEHD30 for <i>U</i> and <i>I</i>		

Tab. 7.5: Detail page "Harmonics"

7.5.6 Detail page "Max./Min."

Subpage No.		First line	Second line	Third line	Fourth line
		$U_{L1 \max}$ Timestamp	$U_{L2 \max}$ Timestamp	$U_{L3 \max}$ Timestamp	$\emptyset U_{LN \max}$ Timestamp
Max.	U/I	1 $U_{L1 \max}$ Timestamp	$U_{L2 \max}$ Timestamp	$U_{L3 \max}$ Timestamp	$\emptyset U_{LN \max}$ Timestamp
		2 $U_{L1L2 \max}$ Timestamp	$U_{L2L3 \max}$ Timestamp	$U_{L3L1 \max}$ Timestamp	$\emptyset U_{LL \max}$ Timestamp
		3 $I_1 \max$ Timestamp	$I_2 \max$ Timestamp	$I_3 \max$ Timestamp	$\emptyset I_1 \max$ Timestamp
		4 f_{\max} Timestamp	$I_n \max$ Timestamp	$I_4 \max^{1)}$ Timestamp	$I_r \max^{1)}$ Timestamp
	Power	1 $P_{L1 \max}$ Timestamp	$P_{L2 \max}$ Timestamp	$P_{L3 \max}$ Timestamp	$P_{\text{tot} \max}$ Timestamp
		2 $Q_{L1 \max}$ Timestamp	$Q_{L2 \max}$ Timestamp	$Q_{L3 \max}$ Timestamp	$Q_{\text{tot} \max}$ Timestamp
		3 $S_{L1 \max}$ Timestamp	$S_{L2 \max}$ Timestamp	$S_{L3 \max}$ Timestamp	$S_{\text{tot} \max}$ Timestamp
		4 $\lambda_1 \max$ Timestamp	$\lambda_2 \max$ Timestamp	$\lambda_3 \max$ Timestamp	$\lambda_{\text{tot} \max}$ Timestamp
	Harmonics	1 THD $U_{L1 \max}$ Timestamp	THD $U_{L2 \max}$ Timestamp	THD $U_{L3 \max}$ Timestamp	
		2 THD $I_1 \max$ Timestamp	THD $I_2 \max$ Timestamp	THD $I_3 \max$ Timestamp	
		3 Max. k-factor L1 Timestamp	Max. k-factor L2 Timestamp	Max. k-factor L3 Timestamp	
		4 Max. crest factor L1 Timestamp	Max. crest factor L2 Timestamp	Max. crest factor L3 Timestamp	
		5 Max. current unbalance Timestamp	Max. voltage unbalance Timestamp		

Subpage No.		First line	Second line	Third line	Fourth line	
Min.	U/I	1	$U_{L1 \text{ min}}$ Timestamp	$U_{L2 \text{ min}}$ Timestamp	$U_{L3 \text{ min}}$ Timestamp	$\emptyset U_{LN \text{ min}}$ Timestamp
		2	$U_{L1L2 \text{ min}}$ Timestamp	$U_{L2L3 \text{ min}}$ Timestamp	$U_{L3L1 \text{ min}}$ Timestamp	$\emptyset U_{LL \text{ min}}$ Timestamp
		3	$I_1 \text{ min}$ Timestamp	$I_2 \text{ min}$ Timestamp	$I_3 \text{ min}$ Timestamp	$\emptyset I \text{ min}$ Timestamp
		4	f_{min} Timestamp	$I_n \text{ min}$ Timestamp	$I_4 \text{ min}^{1)}$ Timestamp	$I_r \text{ min}^{1)}$ Timestamp
	Power	1	$P_{L1 \text{ min}}$ Timestamp	$P_{L2 \text{ min}}$ Timestamp	$P_{L3 \text{ min}}$ Timestamp	$P_{\text{tot min}}$ Timestamp
		2	$Q_{L1 \text{ min}}$ Timestamp	$Q_{L2 \text{ min}}$ Timestamp	$Q_{L3 \text{ min}}$ Timestamp	$Q_{\text{tot min}}$ Timestamp
		3	$S_{L1 \text{ min}}$ Timestamp	$S_{L2 \text{ min}}$ Timestamp	$S_{L3 \text{ min}}$ Timestamp	$S_{\text{tot min}}$ Timestamp
		4	$\lambda_1 \text{ min}$ Timestamp	$\lambda_2 \text{ min}$ Timestamp	$\lambda_3 \text{ min}$ Timestamp	$\lambda_{\text{tot min}}$ Timestamp
	Harmonics	1	THD $U_{L1 \text{ min}}$ Timestamp	THD $U_{L2 \text{ min}}$ Timestamp	THD $U_{L3 \text{ min}}$ Timestamp	
		2	THD $I_1 \text{ min}$ Timestamp	THD $I_2 \text{ min}$ Timestamp	THD $I_3 \text{ min}$ Timestamp	
		3	Min. k-factor L1 Timestamp	Min. k-factor L2 Timestamp	Min. k-factor L3 Timestamp	
		4	Min. crest factor L1 Timestamp	Min. crest factor L2 Timestamp	Min. crest factor L3 Timestamp	
		5	Min. current unbalance Timestamp	Min. voltage unbalance Timestamp		

Tab. 7.6: Detail page "Max./Min."

Notes Tab. 7.6

¹⁾ for PEM353-N only

7.5.7 Detail page "TOU"

(Time of Use)

The Time of Use (TOU) has to be configured via the communication interface (see Modbus register from page 83). The events can be called up on the device.

Subpage no.		First line	Second line	Third line
Standard display TOU		Active energy import	Active energy export	
Tariff 1	1 (kWh)	Active energy import	Active energy export	
	2 (kvarh)	Reactive energy import	Reactive energy export	
	3 (kVAh)	Total apparent energy		
	4 (peak demand)	P Timestamp	Q Timestamp	S Timestamp
Tariff 2...8	1 (kWh)	Active energy import	Active energy export	
	2 (kvarh)	Reactive energy import	Reactive energy export	
	3 (kVAh)	Total apparent energy		
	4 (peak demand)	P Timestamp	Q Timestamp	S Timestamp

Tab. 7.7: Detail page "TOU"

7.5.8 Detail page "I/O"

Display of the switching states of the digital inputs and outputs

Display	First line	Second line	Third line	Fourth line
DI status 1/3	DI1	DI2	DI3	DI4
Pulse counter 2/3	Number of DI1 pulses	Number of DI2 pulses	Number of DI3 pulses	Number of DI4 pulses
DO status 3/3	DO1	DO2		

Fig. 7.2: Detail page I/O

7.5.9 Detail page "SOE"

(Sequence of events, event log)

The device can store up to 100 events. These events can be called up on the device.

8. Setup

To enter the setup mode, scroll through the menu in the bottom line of the display using the arrow buttons until "Setup" appears. Activate the setup by pressing the "Setup" button.

You can return to the display mode automatically after an adjustable time without pressing a button or immediately by manually pressing the "ESC" button.



*To change parameters you must first **enter the password**. (Factory setting: 0000)*

8.1 Setup: Overview diagram menu

The following diagram will help you navigate through the setup menus.

[Browse](#)

View configuration

[Enter Password](#)

The configuration can be changed after entering the correct password.

Setup	
Browse / Enter Password	
Basic	Wiring Mode, PT Primary, PT Secondary, CT Primary, CT Secondary, I4 Primary, I4 Secondary, PF convention, kVA calculation, CT1...3 polarity, THD calculation method, Demand Period, No. of windows, Predicted response, EN pulse constant, LED EN pulse, EN Period, kvarh Calc., On Time Threshold
Comm.	COM1...2: Protocol, Unit ID, Baud rate, Data format
Setpoints	Group 1...9: Type, Parameter, OverLimit, UnderLimit, ActiveDelay, InactiveDelay, Trigger 1...2
I/O	Digital Input: Function, Debounce, Pulse weight DO Pulse width: DO1, DO2 DO Function
Display	Timeout, Contrast, Language, Delimiter, Main 1...4, Setpoint LCD Alarm
Clock	Time, Date, Date format
Maintenance	Password Setup, Clear registers, Clear all data, DO control
Information	Firmware, Update, Modbus, BACnet MSTP, DNP, Serial number

Fig. 8.1: Setup menu overview

8.2 Setup: setting options

The table illustrates the messages shown on the display, their meaning and the setting options.

Display entry Level 1 Level 2	Parameter	Description	Setting options	Factory settings
	Browse	Read access to the settings, no changes possible.	—	
	Password	The configuration can be changed after entering the correct password.	0000...9999	0000
Basic				
	Wiring mode	Select wiring mode	DEMO, 1P2W L-N 1P2W L-L 1P3W 3P3W 3P4W	3P4W
	PT Primary	Select PT transformation ratio (primary side)	1... 1000000 V	100 V
	PT Secondary	Select PT transformation ratio (secondary side)	1...690 V	100 V
	CT Primary	Select CT transformation ratio (primary side)	1...30000 A	5 A
	CT Secondary	Select CT transformation ratio (secondary side)	1...5 A	5 A
	I4 Primary	For PEM353-N only	1...30000 A	5 A
	I4 Secondary		1...5 A	5 A
	PF Convention	Power factor rule ¹⁾	IEC, IEEE, -IEEE	IEC
	kVA Calc.	S calculation method ²⁾	Vector, scalar	Vector
	I1 Polarity	Set I_1 measuring current transformer polarity	Normal/ Reversed	Normal
	I2 Polarity	Set I_2 measuring current transformer polarity		
	I3 Polarity	Set I_3 measuring current transformer polarity		

Display entry Level 1 Level 2	Parameter	Description	Setting options	Factory settings
	THD Calc.	Total harmonic distortion (THDf) or distortion factor (THDr)	THDf, THDr	THDf
	DMD Period	Set the measurement period for demand measurement	1...60 min	15 min
	No. of Windows	Set the number of sliding windows	1...15	1
	Predicted Response	Dynamics of the demand prediction 70 = low dynamics, slow adjustment to trend changes 99 = high dynamics, faster adjustment to trend changes	70...99	70
	EN Pulse Const	Number of LED pulses per amount of energy	1000, 3200	1000
	LED EN Pulse	Enable kWh or kvar energy pulsing	Disabled, kWh, kvarh	Disabled
	EN Period	Time interval for interval energy meters ³⁾	5...60 min	60 min
	kvarh Calc.	Calculation method for reactive energy	RMS, Fund,	RMS
	OT Threshold	Load current response value from which the operating hours counter counts ⁴⁾	0.001...1 x I prim	0.001
Comm.				
	Configure communication interface 1			
	Protocol	Communication standard of the serial interface	Modbus BACnet MS/TP DNP	Modbus
	Unit ID	Set address for measuring device	1-247	100
	Baud rate	Set baud rate	1200/2400/ 4800/9600/ 19200/38400 bps	9600
	Data Format	Parity bit configuration	8N2/8O1/8E1/ 8N1/8O2/8E2	8E1
	INST	For BACnet MS/TP only		
	MAXMAS			
	LOCK			

Display entry Level 1 Level 2	Parameter	Description	Setting options	Factory settings
Setpoints				
Group1...9	Type	Disabled Value exceeded Below value	Disabled Over Under	
	Parameter	Monitored measured value	see Tab. 13.1	
	OvLim	Upper limit		
	UnLim	Lower limit		
	ActiveDelay	Active delay		
	InactiveDelay	Inactive delay		
	Trigger 1	Setpoint switches DO	none DO1 DO2	
Trigger 2				
I/O	Configure inputs/outputs			
Digital Input DI				
Function	Set DI function			
	DI1...4	Set function DI1...4; Tariff switch (for DI1...3 only)	0 = digital input 1 = pulse counter 3 = tariff switch	0
Debounce	Minimum time that DI... must remain active or inactive for the status to be validated			
	D1...4	Set debounce for DI1...4	1...9999 ms	20 ms
Pulse Weight	Specifies by how much the counter is increased for each pulse			
	DI1...4		1...1000000	1
Digital Output DO				
Pulse Width	Defines the minimum pulse width or the latch mode of the DO			
	DO1...2 RO	Set pulse width DO1...2	0...6000 (x 0.1 s) 0 = latch mode	10

Display entry Level 1 Level 2	Parameter	Description	Setting options	Factory settings
Function	DO1	Set DO function	Remote control/Alarm kWh import kWh export kWh total kvarh import kvarh export kvarh total	Remote control/Alarm
	DO2			
Setpoints				
Group1...9	Type	Disabled Value exceeded Below value	Disabled Over Under	
	Parameter	Monitored measured value	see Tab. 13.1	
	OvLim	Upper limit		
	UnLim	Lower limit		
	ActiveDelay	Active delay		
	InactiveDelay	Inactive delay		
	Trigger 1	Setpoint switches DO...	none DO1 DO2	
Trigger 2				
Display				
	Timeout	Time until the display goes dark or returns to standard display	0...60 (minutes) 0: display always on	5
	Contrast	Display contrast	0...9	5
	Language	System language	English	English
	Delimiter	Decimal separator Option 1: decimal point (1,23) Option 2: Decimal comma (1,23)	Option 1/ option 2	Option 1
	Main 1...4 5)	Measured values that are shown on the standard display		
	SP LCD Alarm	Setpoint alarm signalled by flashing display lighting	On Off	On

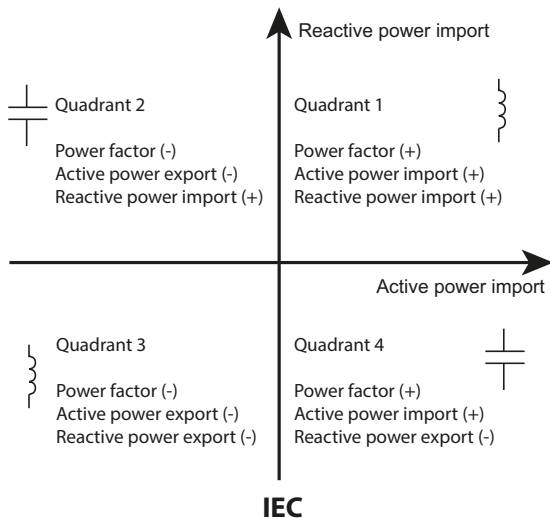
Display entry Level 1 Level 2	Parameter	Description	Setting options	Factory settings
Clock				
	Time	Set present time	HH:MM:SS	
	Date	Set present date	(20)YYMMDD	
	Date format	Select date format for timestamp and for the display	YYMMDD MMDDYY DDMMYY	YYMMDD
Maintenance				
Password setup	New Password	Enter new password		
	Confirm Password	Confirm new password		
Clear Registers ⁶⁾	Energy			
	Present	Clear present energy measurement and present log	Yes/No	No
	History	Clear stored monthly logs	Yes/No	No
	Demand			
	Present Max	Clear present peak demand log (since last reset)	Yes/No	No
	All	Clear all peak demand values and logs	Yes/No	No
	Max./Min.			
	Present	Clear present Max./Min. log (since last reset)	Yes/No	No
	All	Clear all Max./Min. logs	Yes/No	No
	Operating Time			
	Reset	Clear operating hours counter	Yes/No	No
	Pulse counter			
	All	Clear all pulse counters	Yes/No	No
	DI1	Clear pulse counter for DI...	Yes/No	No
	DI2		Yes/No	No
	DI3		Yes/No	No
	DI4		Yes/No	No
	SOE Logs			
	Clear SOE	Clear event log	Yes/No	No

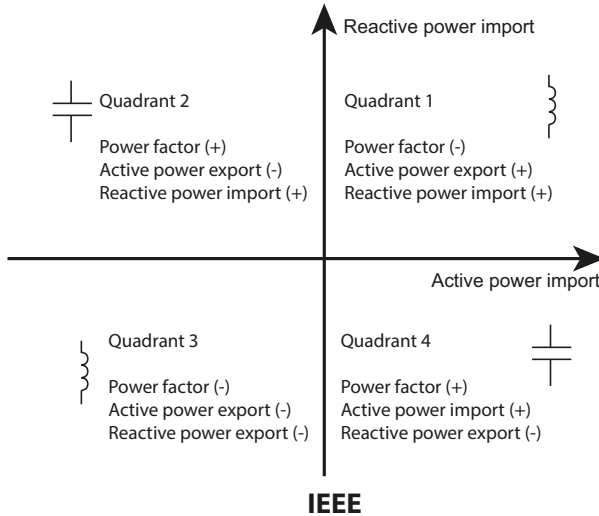
Display entry Level 1 Level 2	Parameter	Description	Setting options	Factory settings
Clear all Data		Clear all of the above data	Yes/No	No
DO Control	DO1	Defines the state of the DO ⁷⁾	Normal On Off	Normal
	DO2			Normal
Information				
	Firmware	Firmware version	—	
	Update	Date of last firmware update		
	Modbus	Modbus protocol version		
	BACnet MS/TP	BACnet MS/TP protocol version		
	DNP	DNP protocol version		
	SN	Device serial number		

Tab. 8.1: Setup adjustment possibilities

Notes for Tab. 8.1

- ¹⁾ Power factor λ rules





"IEEE" and "-IEEE" differ only by the reversed signs.

2) There are two different ways to calculate the apparent power S :

Vector method V:	Scalar method S:
$S_{\text{tot}} = \sqrt{P_{\text{tot}}^2 + Q_{\text{tot}}^2}$	$S_{\text{tot}} = S_{L1} + S_{L2} + S_{L3}$

Choose the calculation method:

Vector = vector method

Scalar = scalar method

When the load is symmetrical (with regard to active and reactive power), the two methods provide identical results.

Vector method: If the load is not symmetrically distributed between the 3 phases, the vector method first accumulates all active and reactive power and then calculates the apparent power (graphic vector addition). The focus here is on the three-phase system as a whole.

Scalar method: The apparent power for each of the 3 phases is calculated separately and then the values are added together to give the total. The focus here is on the three phases individually and the apparent power transmitted in the three phases.

3) Interval energy meters (EN Period) are reset at the end of each interval.

- 4) The response value can be 0.1...100 % of "I prim". I prim takes into account the connected external measuring current transformer:

$$I_{\text{prim}} = 5 \text{ A} \times \frac{CT_{\text{primary}}}{CT_{\text{secondary}}}$$

- 5) List of standard display options:

$U_{L1...3}, \emptyset U_{LN}, U_{L1L2...L3L1}, \emptyset U_{LL}, I_{1...3}, \emptyset I, P, Q, S, \lambda, f$, active energy import, active energy export, total active energy, active energy import tariff T1...4, demand $I_{1...3}$, demand P, demand Q, demand S, $P_{(f0)}, \lambda_{(f0)}, I_4, THD_{UL1...3}, I_r$

- 6) Present: present log
History: all stored registers without present log
- 7) Normal = internal control, e.g. via setpoints

On = enables the DO

Off = disables the DO

"On" and "Off" can be used for the installation test, for example.



For proper operation of the DO via setpoints, "Normal" must be selected here!

9. Inputs and outputs

9.1 Digital inputs (DI)

The device provides four digital inputs which are internally operated with DC 24 V, have a sampling frequency of 1000 Hz and feature a programmable debounce time.

The following functions can be used:

- Digital inputs are typically used for monitoring external states. The switching states of the digital inputs can be read from the LC display or on the connected system components. Changes in external states are stored as events in the event log (SOE log) with a resolution of 1 ms.
- Pulse counter: programmable step size (pulse weight) and information regarding water, air, gas, electricity and district heating.
- Time of Use: 2 different schedules can be configured. For more details, refer to chapter 15.

DI setup parameters

Setup parameter	Description	Option
Dlx Function	Each DI can be used as status input or pulse counter; A tariff switch is only possible for DI1...3	0= status input 1 = pulse counter 2 = tariff switch
Dlx Debounce	Minimum period that the DOLx must remain in active or inactive state to validate the state	1...1000 (20)* ms
Dlx Pulse weight	When set to "Pulse counter": Specifies by how much the counter is increased for each pulse	1*...1000000

Tab. 9.1: DI setup parameters

9.2 Digital outputs (DO)

The device features two digital outputs. These differ depending on the device:

PEM353	Relay outputs
PEM353-N	Relay outputs
PEM353-P	Pulse outputs

Digital outputs are generally used for alerting when a setpoint is triggered, for load control, for decoupling energy counting pulses or for remote-controlled applications.

Examples:

1. Operation via buttons on the front panel (siehe „Setup“ auf Seite 51.)
2. Operation via communication interface
3. Alerting when a setpoint is triggered, see chapter 13.
4. Energy pulsing

9.3 Energy Pulsing display

The LED pulse output on the front of the device is used for kWh or kvarh display when the EN PULSE function is enabled. This can be set in the setup menu using the buttons on the front panel or via the communication interface. The LED flashes every time a certain amount of energy is converted.

Possible settings:

Register 6036	Display reactive or active energy
Register 6035	Setting pulse variant
	1000 pulses per kxh or.
	3200 pulses per kxh with $x = W$ or var
	(depending on entry in register 6036)

These "kxh" refer to the measured energy without considering the used potential transformer or measuring current transformer. To find out what a single pulse means, the ratios of the measuring current transformers and the measuring potential transformers must also be calculated.

Pulse display example

The following is configured or are used:

Register 6036 active energy

Register 6035 1000 pulses per kWh (= 1 pulse/Wh)

CTs 100 A : 5 A (= 20)

PTs 11 kV : 100 V (= 110)

The actual current is therefore 20 times, the actual voltage 110 times greater than the measured value. This means that the actual energy (20 x 110 =) is 2200 times greater than the pulse display:

1 pulse signals an energy consumption of 2200 Wh = 2.2 kWh.

Pulse constant EN Pulse CNST:1000 or 3200 pulses kWh or kvarh

PEM353-P

Instead of the two relay outputs, the PEM353-P device variant has two solid-state pulse outputs which can be used for kWh and kvarh pulsing, among other things. Energy pulsing is typically used for accuracy tests.

10. Power and energy

The following measured values are available:

Parameter	L1	L2	L3	Σ	\emptyset
P	x	x	x	x	—
Q	x	x	x	x	—
S	x	x	x	x	—
λ	x	x	x	x	—
f	x	—	—	—	—

Energy meters

Basic energy parameters include:

- Active energy (import*, export*, net energy and total energy in kWh)
- Reactive energy (import*, export*, net energy and total energy in kvarh)
- Apparent energy (S_{tot} in kVAh)

* also tariff-related

The maximum value that can be displayed is $\pm 100,000,000.0$. When the maximum value is reached, the register jumps back to 0. A manual reset as well as a manual change of the meter value can be carried out password-protected via the software and the buttons on the front panel.

11. Demand DMD

"Demands" are defined as average consumption values of the last concluded demand period. The length of the period can be determined (register 6029...6031, see page 115).

In contrast, the "Predicted demands" are defined as average consumption values projected in real time for the present period, which is not yet concluded. Predicted demands provide information about the amount of demand values to be expected. Depending on the signal applied the predictions are more or less accurate.

The following present measured demand values and predicted demands are provided:

- Currents (I_1, I_2, I_3)
- Total active power P_{tot} , reactive power Q_{tot} and apparent power S_{tot}

Furthermore, the following is provided:

- Peak demand values of this/last month:
 - Currents (I_1, I_2, I_3)
 - Total active power P_{tot} , reactive power Q_{tot} and apparent power S_{tot}
 - Total active power P_{tot} , reactive power Q_{tot} and apparent power S_{tot} only for the times during which the individual energy meters were active

The **duration of the sliding window** can be adjusted using the buttons on the front panel or via the communication interface. A new demand value is provided at the end of a sliding window. The following options are available:

1...60 minutes

In addition to the duration, the number of **sliding windows** used to calculate a demand value must also be set between 1...15.

A demand value is the average value of a measured value over the period "number of sliding windows x duration of the sliding window".

Example 1

Duration of a sliding window = 1 minute

Number of sliding windows for one demand value = 15

Result: A new demand value is provided once per minute as an average value over the last 15 minutes.

Example 2

Duration of a sliding window = 15 minutes

Number of sliding windows for one demand value = 1

Result: A new demand value is only provided every 15 minutes as an average value over 15 minutes.

12. Power Quality

12.1 Voltage and current phase angles

Phase angle analysis is used to determine the angle between the voltages and currents of the three phase conductors.

12.2 Harmonic distortion

The device provides an analysis of:

- All harmonics up to the 31st order
 - Total Harmonic Distortion (THD)
 - Even Total Harmonic Distortion (TEHD)
 - Odd Total Harmonic Distortion (TOHD)
- Harmonic content related to the fundamental component of the demand current (TDD)
- k-factor
- Crest factor

12.2.1 Harmonic

The harmonic components are evaluated if a current of at least 0.1 % I_{nom} (without considering CTs) flows. At an I_{nom} of 5 A the minimum current is 5 mA.

All parameters are available on the display or via the communication interface.

12.2.2 THDf and THDr

THDf (Total harmonic distortion) and THDr (distortion factor)

$$\text{THDf} = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{I_1} \times 100 \% \quad \text{THDr} = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{\sqrt{\sum_{h=1}^{\infty} I_h^2}} \times 100 \%$$

with h = harmonic order
 I_1 = r.m.s. value of the fundamental
 I_h = r.m.s. value of the h^{th} harmonic

The type of harmonic calculation is defined in **register 6028**:

0* = THDf (factory setting), 1 = THDr

12.2.3 TDD - Total Demand Distortion

The **total demand distortion** (TDD) is defined as the ratio of the r.m.s. value of the harmonic currents I_h to the demand maximum of the fundamental current I_L .

$$\text{TDD} = \frac{\sqrt{\sum_{h=1}^{31} I_h^2}}{I_L}$$

with
 h = harmonic order
 I_h = r.m.s. value of the h^{th} harmonic
 I_L = r.m.s. value of the peak demand fundamental current

12.2.4 k-factor

k-factor calculation:

$$\text{k-Faktor} = \frac{\sum_{h=1}^{h_{\max}} (I_h h)^2}{\sum_{h=1}^{h_{\max}} (I_h)^2}$$

I_h = Effektivwert I der h -ten Harmonischen
 h_{\max} = Nummer größte Harmonische
 h = h -te Harmonische

A k-factor of 1.0 indicates a linear load (no harmonics). The higher the k-factor the greater the heating effect by the harmonics.

12.2.5 Crest factor

Crest factor calculation:

$$C = |X|_{\text{peak}} / X_{\text{rms}}$$

12.2.6 Measured values of the harmonics

The following measured values are supported:

	L1 or L1L2	L2 or L2L3	L3 or L3L1
Harmonics voltage	THD	THD	THD
	TEHD	TEHD	TEHD
	TOHD	TOHD	TOHD
	2 nd harmonic	2 nd harmonic	2 nd harmonic

	31 st harmonic	31 st harmonic	31 st harmonic
Harmonics current	THD	THD	THD
	TEHD	TEHD	TEHD
	TOHD	TOHD	TOHD
	TDD	TDD	TDD
	TEDD	TEDD	TEDD
	TODD	TODD	TODD
	k-factor	k-factor	k-factor
	Crest factor	Crest factor	Crest factor
	2 nd harmonic	2 nd harmonic	2 nd harmonic

	31 st harmonic	31 st harmonic	31 st harmonic

Tab. 12.1: Overview of measured values harmonics

12.3 Unbalance

The device can measure voltage and current unbalances.

The following calculation method is applied:

$$\text{Voltage unbalance} = U_2/U_1 \times 100 \%$$

$$\text{Current unbalance} = I_2/I_1 \times 100 \%$$

- with
- U1 = positive sequence component voltage
 - U2 = negative sequence component voltage
 - I1 = positive sequence component current
 - I2 = negative sequence component current

13. Setpoints

The device features 9 user-programmable control setpoints which provide extensive control by allowing a user to initiate an action in response to a specific condition. Setpoints can be programmed via the **communication interface** or in the setup.

Operation of the setpoints

Setpoints only respond when the tripping limit value (...Lim) is violated for the defined minimum period (Active Delay). Shorter limit value violations are ignored. This also applies to the inactive delay.

">" setpoints

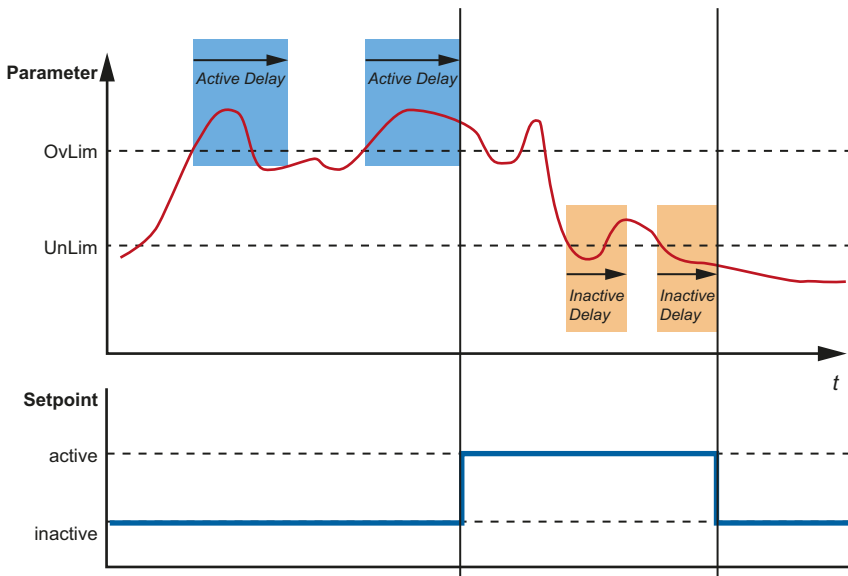


Fig. 13.1: Exceeding the set value trips the setpoint

"<" setpoints

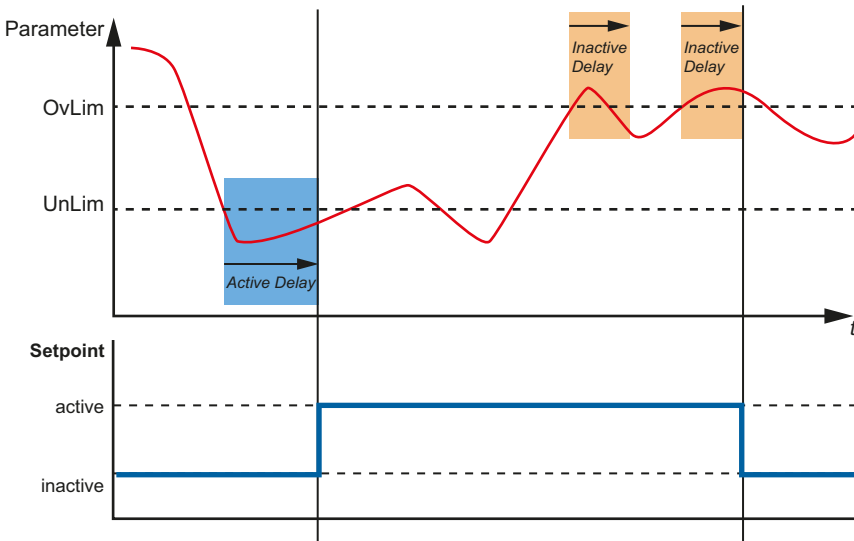


Fig. 13.2: Falling below the set value trips the setpoint

The following **setup parameters** are available:

1. **Setpoint type:** defines the type of operation (over value = ">" setpoint, under value = "<" setpoint, deactivated).
2. **Setpoint parameters**

Key	Parameter	Factor; Unit
0	—	—
1	U_{LN}	V
2	U_{LL}	V
3	I	A
4	I_n (calculated)	A
5	f	Hz
5	P_{tot}	W
7	Q_{tot}	var

Key	Parameter	Factor; Unit
8	S_{tot}	VA
9	λ_{tot}	
10	Demand P_{tot}	W
11	Demand Q_{tot}	var
12	Demand S	VA
13	Predicted demand P_{tot}	W
14	Predicted demand Q_{tot}	var
15	Predicted demand S	VA
16	THD _U	x 100 %
17	TOHD _U	x 100 %
18	TEHD _U	x 100 %
19	THD _I	x 100 %
20	TOHD _I	x 100 %
21	TEHD _I	x 100 %
22	Voltage unbalance	x 100 %
23	Current unbalance	x 100 %
24	Phase reversal	
25	I_4 (PEM353-N only)	A

Tab. 13.1: Setpoint parameters

3. Setpoint limit (OvLim)

">" setpoint: response threshold value

"<" setpoint: release threshold value

4. Setpoint limit (UnLim)

">" setpoint: release threshold value

"<" setpoint: response threshold value



">" setpoint

The measured value must

- exceed the setpoint limit (OvLim) in order to be activated (response threshold value) and
- fall below the setpoint limit (UnLim) in order to be deactivated (release threshold value).

"<" setpoint

The measured value must

- fall below the setpoint limit (UnLim) in order to be activated (response threshold value) and
- exceed the setpoint limit (OvLim) in order to be deactivated (release threshold value).

5. **Active Delay:** Specifies the minimum period that a threshold value must have been violated before an action is triggered. Each state change of a setpoint generates an event that is stored in the event log. The active delay is specified in seconds and can range between 0 and 9,999 seconds.
6. **Inactive Delay:** Specifies the minimum period that a value must meet the conditions for the return to normal state. Each state change of a setpoint generates an event that is stored in the event log. The inactive delay is specified in seconds and can range between 0 and 9,999 seconds.
7. **Setpoint trigger:** Specifies what action is carried out when the setpoint is reached. This action includes "No Trigger" and "Trigger DOx".

Key	Action
0	None (no trigger)
1	Close DO1 (trigger DO1)
2	Close DO2 (trigger DO2)
Others	Reserved

14. Log

Event in the event of a voltage interruption, the memory contents are not lost. Storage works according to the FIFO principle (first in, first out): The present month overwrites the oldest stored month.

14.1 Max./Min. log

The PEM353 stores each new maximum and minimum value of this month and last month. The stored values are listed in the table below.

This month		Last month	
Maximum values	Minimum values	Maximum values	Minimum values
$U_{L1} \text{ max}$	$U_{L1} \text{ min}$	$U_{L1} \text{ max}$	$U_{L1} \text{ min}$
$U_{L2} \text{ max}$	$U_{L2} \text{ min}$	$U_{L2} \text{ max}$	$U_{L2} \text{ min}$
$U_{L3} \text{ max}$	$U_{L3} \text{ min}$	$U_{L3} \text{ max}$	$U_{L3} \text{ min}$
$\emptyset U_{LN} \text{ max}$	$\emptyset U_{LN} \text{ min}$	$\emptyset U_{LN} \text{ max}$	$\emptyset U_{LN} \text{ min}$
$U_{L1L2} \text{ max}$	$U_{L1L2} \text{ min}$	$U_{L1L2} \text{ max}$	$U_{L1L2} \text{ min}$
$U_{L2L3} \text{ max}$	$U_{L2L3} \text{ min}$	$U_{L2L3} \text{ max}$	$U_{L2L3} \text{ min}$
$U_{L3L1} \text{ max}$	$U_{L3L1} \text{ min}$	$U_{L3L1} \text{ max}$	$U_{L3L1} \text{ min}$
$\emptyset U_{LL} \text{ max}$	$\emptyset U_{LL} \text{ min}$	$\emptyset U_{LL} \text{ max}$	$\emptyset U_{LL} \text{ min}$
$I_1 \text{ max}$	$I_1 \text{ min}$	$I_1 \text{ max}$	$I_1 \text{ min}$
$I_2 \text{ max}$	$I_2 \text{ min}$	$I_2 \text{ max}$	$I_2 \text{ min}$
$I_3 \text{ max}$	$I_3 \text{ min}$	$I_3 \text{ max}$	$I_3 \text{ min}$
$\emptyset I \text{ max}$	$\emptyset I \text{ min}$	$\emptyset I \text{ max}$	$\emptyset I \text{ min}$
$P_{L1} \text{ max}$	$P_{L1} \text{ min}$	$P_{L1} \text{ max}$	$P_{L1} \text{ min}$
$P_{L2} \text{ max}$	$P_{L2} \text{ min}$	$P_{L2} \text{ max}$	$P_{L2} \text{ min}$
$P_{L3} \text{ max}$	$P_{L3} \text{ min}$	$P_{L3} \text{ max}$	$P_{L3} \text{ min}$
$P_{\text{tot}} \text{ max}$	$P_{\text{tot}} \text{ min}$	$P_{\text{tot}} \text{ max}$	$P_{\text{tot}} \text{ min}$
$Q_{L1} \text{ max}$	$Q_{L1} \text{ min}$	$Q_{L1} \text{ max}$	$Q_{L1} \text{ min}$
$Q_{L2} \text{ max}$	$Q_{L2} \text{ min}$	$Q_{L2} \text{ max}$	$Q_{L2} \text{ min}$

This month		Last month	
Maximum values	Minimum values	Maximum values	Minimum values
$Q_{L3 \text{ max}}$	$Q_{L3 \text{ min}}$	$Q_{L3 \text{ max}}$	$Q_{L3 \text{ min}}$
$Q_{\text{tot max}}$	$Q_{\text{tot min}}$	$Q_{\text{tot max}}$	$Q_{\text{tot min}}$
$S_{L1 \text{ max}}$	$S_{L1 \text{ min}}$	$S_{L1 \text{ max}}$	$S_{L1 \text{ min}}$
$S_{L2 \text{ max}}$	$S_{L2 \text{ min}}$	$S_{L2 \text{ max}}$	$S_{L2 \text{ min}}$
$S_{L3 \text{ max}}$	$S_{L3 \text{ min}}$	$S_{L3 \text{ max}}$	$S_{L3 \text{ min}}$
$S_{\text{tot max}}$	$S_{\text{tot min}}$	$S_{\text{tot max}}$	$S_{\text{tot min}}$
$\lambda_1 \text{ max}$	$\lambda_1 \text{ min}$	$\lambda_1 \text{ max}$	$\lambda_1 \text{ min}$
$\lambda_2 \text{ max}$	$\lambda_2 \text{ min}$	$\lambda_2 \text{ max}$	$\lambda_2 \text{ min}$
$\lambda_3 \text{ max}$	$\lambda_3 \text{ min}$	$\lambda_3 \text{ max}$	$\lambda_3 \text{ min}$
$\lambda_{\text{tot max}}$	$\lambda_{\text{tot min}}$	$\lambda_{\text{tot max}}$	$\lambda_{\text{tot min}}$
f_{max}	f_{min}	f_{max}	f_{min}
Max. voltage unbalance	Min. voltage unbalance	Max. voltage unbalance	Min. voltage unbalance
Max. current unbalance	Min. current unbalance	Max. current unbalance	Min. current unbalance
THD $U_{L1 \text{ max}}$ or THD $U_{L1L2 \text{ max}}$	THD $U_{L1 \text{ min}}$ or THD $U_{L1L2 \text{ min}}$	THD $U_{L1 \text{ max}}$ or THD $U_{L1L2 \text{ max}}$	THD $U_{L1 \text{ min}}$ or THD $U_{L1L2 \text{ min}}$
THD $U_{L2 \text{ max}}$ or THD $U_{L2L3 \text{ max}}$	THD $U_{L2 \text{ min}}$ or THD $U_{L2L3 \text{ min}}$	THD $U_{L2 \text{ max}}$ or THD $U_{L2L3 \text{ max}}$	THD $U_{L2 \text{ min}}$ or THD $U_{L2L3 \text{ min}}$
THD $U_{L3 \text{ max}}$ or THD $U_{L3L1 \text{ max}}$	THD $U_{L3 \text{ min}}$ or THD $U_{L3L1 \text{ min}}$	THD $U_{L3 \text{ max}}$ or THD $U_{L3L1 \text{ max}}$	THD $U_{L3 \text{ min}}$ or THD $U_{L3L1 \text{ min}}$
THD $I_1 \text{ max}$	THD $I_1 \text{ min}$	THD $I_1 \text{ max}$	THD $I_1 \text{ min}$
THD $I_2 \text{ max}$	THD $I_2 \text{ min}$	THD $I_2 \text{ max}$	THD $I_2 \text{ min}$
THD $I_3 \text{ max}$	THD $I_3 \text{ min}$	THD $I_3 \text{ max}$	THD $I_3 \text{ min}$
$I_4 \text{ max}$	$I_4 \text{ min}$	$I_4 \text{ max}$	$I_4 \text{ min}$
$I_n \text{ max}$	$I_n \text{ min}$	$I_n \text{ max}$	$I_n \text{ min}$
Crest factor $I_1 \text{ max}$	Crest factor $I_1 \text{ min}$	Crest factor $I_1 \text{ max}$	Crest factor $I_1 \text{ min}$
Crest factor $I_2 \text{ max}$	Crest factor $I_2 \text{ min}$	Crest factor $I_2 \text{ max}$	Crest factor $I_2 \text{ min}$
Crest factor $I_3 \text{ max}$	Crest factor $I_3 \text{ min}$	Crest factor $I_3 \text{ max}$	Crest factor $I_3 \text{ min}$
k-factor $I_1 \text{ max}$	k-factor $I_1 \text{ min}$	k-factor $I_1 \text{ max}$	k-factor $I_1 \text{ min}$

This month		Last month	
Maximum values	Minimum values	Maximum values	Minimum values
k-factor $I_{2 \max}$	k-factor $I_{2 \min}$	k-factor $I_{2 \max}$	k-factor $I_{2 \min}$
k-factor $I_{3 \max}$	k-factor $I_{3 \min}$	k-factor $I_{3 \max}$	k-factor $I_{3 \min}$

Tab. 14.1: Measured values in Max./Min. log for this month and last month

Monthly self-read time (Max./Min. log)

The self-read mechanism for the Max./Min. log is determined by the content of **register 6033**.

- 0: Data transfer takes place at 00:00 h of the first day of each month.
- 0xFFFF: Data transfer does not happen automatically at a specific time, it only happens when 0xFF00 is written to **register 9605**. This changes the data of the "Max./Min. log of this month" to the values of the "Max./Min. log of last month"; the "Max./Min. log of this month" is determined again from this date.
- Other numeric value: Data transfer takes place independently at a different time. Encoding according to the following formula:
Time = (day x 100 + hour) where day = 1...28 and hour = 0...23.

14.2 Peak demand log

The PEM353 stores the peak demand of the last month and of this month with timestamp for I_1 , I_2 , I_3 , P_{tot} , Q_{tot} and S_{tot} . The peak demands for P_{tot} , Q_{tot} and S_{tot} are determined separately for the times during which one of the 8 available tariffs (T1...T8) was active (differentiated rating).

All values can be accessed through the front panel buttons (TOU menu) as well as the communication interface.

The changeover between this month and last month (automatic self-read time) is carried out using the procedure (register 6033) described in chapter 11.

This month	Last month
Peak demand I_1	Peak demand I_1
Peak demand I_2	Peak demand I_2
Peak demand I_3	Peak demand I_3
Peak demand P_{tot}	Peak demand P_{tot}

This month	Last month
Peak demand Q_{tot}	Peak demand Q_{tot}
Peak demand S_{tot}	Peak demand S_{tot}
Peak demand P_{tot} (T1...8)	Peak demand P_{tot} (T1...8)
Peak demand Q_{tot} (T1...8)	Peak demand Q_{tot} (T1...8)
Peak demand S_{tot} (T1...8)	Peak demand S_{tot} (T1...8)

Monthly self-read time (peak demand log)

The self-read mechanism for the peak demand log is described by the content of **register 6033**.

- 0: Data transfer takes place at 00:00 h of the first day of each month.
- 0xFFFF: Data transfer does not happen automatically at a specific time, it only happens when 0xFF00 is written to **register 9603**. By doing this, the data of the "Peak demand of this month" become the values of the "Peak demand of last month"; the "Peak demand of this month" is determined again from this date.
- Other numeric value: Data transfer takes place independently at a different time. Encoding according to the following formula:
Time = (day x 100 + hour) where day = 1...28 and hour = 0...23.

14.3 Monthly energy log

Energy values for the present month (not yet ended) and the last 12 months are stored. The following measured values are stored:

Active energy	Active energy import	Active energy export	Net active energy	Active energy Total
	Active energy import (T 1...8)	Active energy export (T 1...8)		
Reactive energy	Reactive energy import	Reactive energy export	Net reactive energy	Reactive energy Total
	Reactive energy import (T 1...8)	Reactive energy export (T 1...8)		
	Reactive energy Q1	Reactive energy Q2	Reactive energy Q3	Reactive energy Q4
Apparent energy	Apparent energy			

Tab. 14.2: Overview of the stored energy values

Monthly self-read time (monthly energy log)

The self-read mechanism for the monthly energy log is determined by the content of **register 6034**.

- 0: Data transfer takes place at 00:00 h of the first day of each month.
- Other numeric value: Data transfer takes place independently at a different time.
Encoding according to the following formula:
Time = (day x 100 + hour) where day = 1...28 and hour = 0...23.

14.4 Event log (SOE log)

The device can store up to 100 events. Storage works according to the FIFO principle (first in, first out): The 101st event overwrites the first entry, the 102nd the second etc. Possible events:

- Failure supply voltage
- Setpoint state change
- Switching operations of the DO
- State changes of the digital inputs
- Setup changes
- Schedule switch in the TOU

Each event record includes the event classification, the relevant parameter values and a timestamp in 1 ms resolution.

All events can be retrieved via the display and the communication interface.

The event log can be cleared using the buttons on the front panel or via the communication interface.

15. Time of Use (TOU)

This function is used when electricity costs vary throughout the day and/or year (night, weekends, holidays, season...).

Up to 8 different tariffs can be configured (only via the communication interface). The registers of the meter readings are described at chapter 16.2.

The device provides 2 complete schedules between which can be switched at a predefined time or on command (write to register 7008: 0xFF00). The following individual settings are possible for each of the two schedules:

- Up to 12 seasons
- Up to 20 daily profiles with up to 12 periods each (minimum length of a period: 15 minutes)
- Up to 90 holidays and alternate days

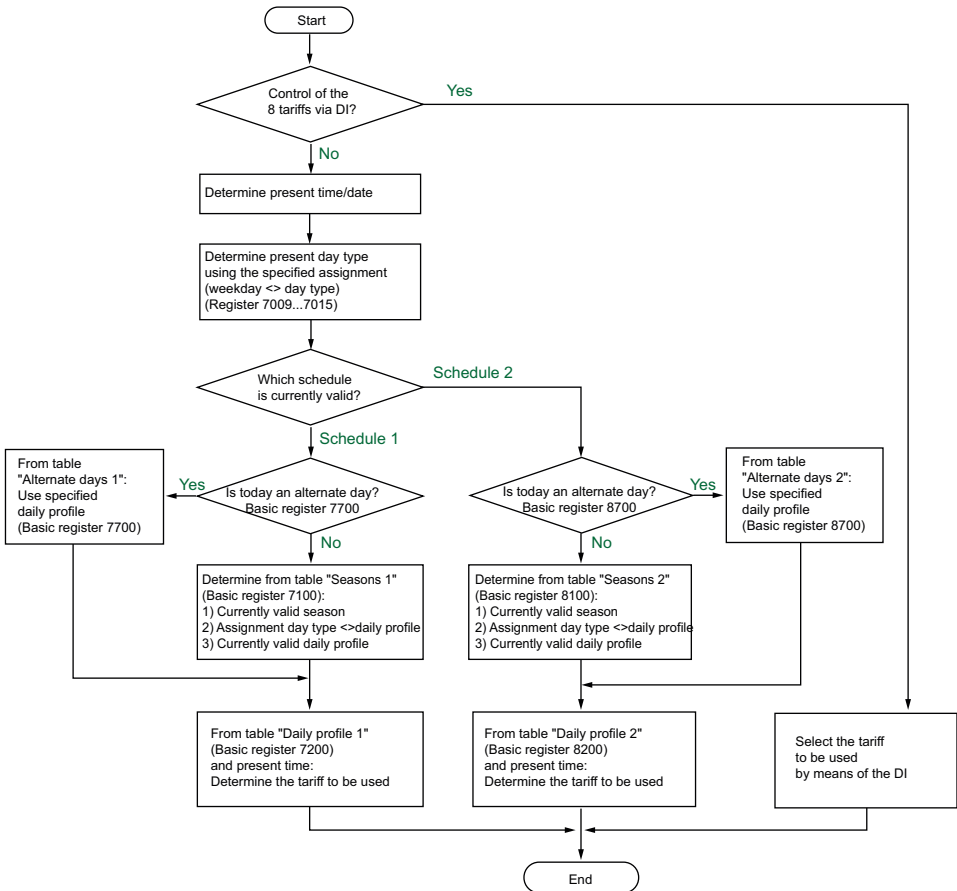
Specification for both schedules:

- 3 day types (e.g. weekday, Saturday, Sunday)

Switching between the tariffs can be based on

- a fixed schedule
- a status change of the digital inputs DI1...3

The following diagram provides an overview of how the device chooses the tariff to be used:



Each schedule switch is stored as an event in the **event log** (SOE log) with a timestamp (resolution 1 ms).

The following information can be stored for each tariff:

- Import and export of active, reactive and apparent energy per phase
- Import and export of total active, reactive and apparent energy,
- Peak demand of this month and last month for P, Q, S

15.1 Tariff switch according to a fixed schedule

The following setup parameters are available:

Setup parameter	Definition
Daily profile Start address 7200 (schedule 1) Start address 8200 (schedule 2)	A daily profile defines the times during the day at which the system switches to a tariff that is also defined here. A total of 20 daily profiles can be defined for each schedule.
Season Start address 7100 (schedule 1) Start address 8100 (schedule 2)	The "Seasons" tables define the date on which the assignment day type-daily profile number is redefined. A maximum of 12 seasons can be defined for each schedule. The first season always starts from January 01.
Alternate days Start address 7700 (schedule 1) Start address 8700 (schedule 2)	A day can be defined as an alternate day (example: May 01). Each table of alternate days can define a maximum of 90 such days. One of the 20 daily profiles can be assigned to each alternate day. Daily profiles defined in the list of alternate days always have priority.
Day types Registers 7009...7015 (together for schedules 1 and 2)	Here, the basic assignment of weekday - day type is defined. This assignment is only made once for all weeks and for both schedules.
Switching time automatic: register 7006 manual: register 7008	Specifies the time at which a tariff switch should take place.
Schedule state Registers 7000...7005	Requests which tariff schedule is currently active.

Tab. 15.1: Overview of tariff schedule setup parameters

15.2 Tariff switch by changing the status of the DI

Up to 3 DI (DI1...3 only) can be used to select to which of the 8 possible tariffs the values should be added.



Once DI1 is configured for the tariff switch, all automatic tariff schedules are ignored.

The registers of DI1...3 encode the selected tariff binary. This results in the number of possible adjustable tariffs: If more than two tariffs are required, DI2 must additionally be configured for the tariff switch; if there are 5 and more different tariffs, DI3 is also required for switching.

Bit DI3	Bit DI2	Bit DI1	Tariff
0	0	0	1
0	0	1	2
0	1	0	3
0	1	1	4
1	0	0	5
1	0	1	6
1	1	0	7
1	1	1	8

Tab. 15.2: Encoding of the tariffs by the DI1...3

Example DI settings

DI1 = digital input or energy pulse counter,

DI2 = tariff switch

Since DI1 is not configured for the tariff switch, **the tariffs are switched according to the specified schedule.** The setting for DI2 is ignored.

15.3 Querying the schedule status

After setting up the schedules, the present status can be queried via the communication interface (registers 7000...7005). Further registers for tariffs:

- Date and time of automatic schedule switching (to the exact hour, register 7006)
- Manual switching of the schedule by writing 0xFF00 to register 7008

16. Modbus Register Map

This chapter provides a complete description of the Modbus register map for the PEM353 series to facilitate the access to information. In general, the registers are implemented as Modbus Read Only Registers (RO = read only) with the exception of the DO control registers, which are implemented as Write Only Registers (WO = write only). The PEM353 supports the following Modbus functions:

1. For reading out values:
Read Holding Register; Function code 0x03
2. For setting DO status:
Force Single Coil; Function code 0x05
3. For writing values:
Preset Multiple Registers; Function code 0x10

Register formats used:

Float	IEEE754 32-bit (single precision floating point number)
INT16	Signed 16-bit integer
INT32	Signed 32-bit integer
UINT16	Unsigned 16-bit integer
UINT32	Unsigned 32-bit integer

For a complete Modbus protocol specification, please visit <http://www.modbus.org>.

16.1 Basic measured values

Register	Property	Description	Format	Scale/unit
0000	RO	$U_{L1}^{1)}$	Float	V
0002	RO	$U_{L2}^{1)}$	Float	
0004	RO	$U_{L3}^{1)}$	Float	
0006	RO	$\emptyset U_{LN}$	Float	
0008	RO	U_{L1L2}	Float	
0010	RO	U_{L2L3}	Float	
0012	RO	U_{L3L1}	Float	
0014	RO	$\emptyset U_{LL}$	Float	
0016	RO	I_1	Float	A
0018	RO	I_2	Float	
0020	RO	I_3	Float	
0022	RO	$\emptyset I$	Float	
0024	RO	$P_{L1}^{1)}$	Float	W
0026	RO	$P_{L2}^{1)}$	Float	
0028	RO	$P_{L3}^{1)}$	Float	
0030	RO	P_{tot}	Float	
0032	RO	$Q_{L1}^{1)}$	Float	var
0034	RO	$Q_{L2}^{1)}$	Float	
0036	RO	$Q_{L3}^{1)}$	Float	
0038	RO	Q_{tot}	Float	
0040	RO	$S_{L1}^{1)}$	Float	VA
0042	RO	$S_{L2}^{1)}$	Float	
0044	RO	$S_{L3}^{1)}$	Float	
0046	RO	S_{tot}	Float	

Register	Property	Description	Format	Scale/unit
0048	RO	$\lambda_{L1}^{1)}$	Float	—
0050	RO	$\lambda_{L2}^{1)}$	Float	
0052	RO	$\lambda_{L3}^{1)}$	Float	
0054	RO	λ_{tot}	Float	
0056	RO	f	Float	Hz
0058	RO	Phase angle U_{L1N} or U_{L1L2} (3P3W)	Float	°
0060	RO	Phase angle U_{L2N} or U_{L2L3} (3P3W)	Float	
0062	RO	Phase angle U_{L3N} or U_{L3L1} (3P3W)	Float	
0064	RO	Phase angle I_1	Float	
0066	RO	Phase angle I_2	Float	
0068	RO	Phase angle I_3	Float	
0070	RO	I_n (calculated)	Float	A
0072	RO	I_4 (measured)	Float	
0074	RO	Displacement factor $\cos \varphi$ L1	Float	—
0076	RO	Displacement factor $\cos \varphi$ L2	Float	
0078	RO	Displacement factor $\cos \varphi$ L3	Float	
0080	RO	Displacement factor total	Float	—
0082...0094	Reserved			
0096	RO	Status digital inputs ²⁾	UINT16	
0097	Reserved			
0098	RO	Status digital outputs ³⁾	UINT16	
0099	Reserved			
0100	RO	Setpoint status ⁴⁾	UINT16	
0101	RO	Wiring diagnostic status ⁵⁾	UINT16	
0102	RO	SOE log pointer ⁶⁾	UINT32	
0104	RO	Operating hours counter ⁷⁾	UINT32	0.1 h
0106...0111	Reserved			—

Register	Property	Description	Format	Scale/unit
0112	RO	$P_{L1(f0)}$	Float	W
0114	RO	$P_{L2(f0)}$	Float	
0116	RO	$P_{L3(f0)}$	Float	
0118	RO	$P_{tot(f0)}$	Float	
0120	RO	P_{THD}	Float	
0122	RO	Pointer data recorder 1 ⁸⁾	UINT32	—
0124	RO	Pointer data recorder 2 ⁸⁾	UINT32	
0126	RO	Pointer data recorder 3 ⁸⁾	UINT32	
0128	RO	Pointer data recorder 4 ⁸⁾	UINT32	
0130	RO	Pointer data recorder 5 ⁸⁾	UINT32	
0132...0148	RO	Reserved		
0150	RO	$U_{L1(f0)} / U_{L1L2(f0)}$ ⁹⁾	Float	V
0152	RO	$U_{L2(f0)} / U_{L2L3(f0)}$ ⁹⁾	Float	
0154	RO	$U_{L3(f0)} / U_{L3L1(f0)}$ ⁹⁾	Float	
0156	RO	$I_{1(f0)}$ ⁹⁾	Float	A
0158	RO	$I_{2(f0)}$ ⁹⁾	Float	
0160	RO	$I_{3(f0)}$ ⁹⁾	Float	
0162	RO	U1 (positive sequence component U) ¹⁰⁾	Float	V
0164	RO	U2 (negative sequence component U) ¹⁰⁾	Float	
0166	RO	U0 (zero sequence component U) ¹⁰⁾	Float	
0168	RO	I1 (positive sequence component I) ¹⁰⁾	Float	A
0170	RO	I2 (negative sequence component I) ¹⁰⁾	Float	
0172	RO	I0 (zero sequence component I) ¹⁰⁾	Float	
0174	RO	I_r (residual current) ⁸⁾	Float	

Tab. 16.1: Basic measured values

Notes Tab. 16.1:

- 1) Only in the case of wye connection.
- 2) **Status register 0096:**
Represents the **status of the four digital inputs**
B0...B3 for DI1...DI4 (1 = active/closed; 0 = inactive/open)
- 3) **Status register 0098:**
Represents the **status of the two digital outputs**
B0 for DO1 (1 = active/closed; 0 = inactive/open)
B1 for DO2 (1 = active/closed; 0 = inactive/open)
- 4) **Status register 0100** indicates the different setpoints (1 = active, 0 = inactive) . .

Bit in register 0100	Status	Bit in register 0082	Status
B0	Setpoint 1	B5	Setpoint 6
B1	Setpoint 2	B6	Setpoint 7
B2	Setpoint 3	B7	Setpoint 8
B3	Setpoint 4	B8	Setpoint 9
B4	Setpoint 5	B9...15	Reserved

Tab. 16.2: Bit sequence status setpoints (0100)

- 5) The diagnostic register 0101 shows wiring errors. In 3P4W and 3P3W mode, there is an error detection feature that detects voltage problems already during the PEM353 setup phase.
The diagnosis is based on the following assumptions:
 - Voltage/current rotating field is equal
 - The measured active energy is assumed as the related active energy and is > 0 W
 - The wiring of the measuring inputs (current and voltage) is correct

Status register 0101 (1 = feature fulfilled, 0 = feature not fulfilled)

Bit	Parameter	3P3W	3P4W
00	Summary bit (set when one of bits 1...15 is set)	x	x
01	Frequency deviation outside 45...65 Hz	x	x
02	$U < 10\%$ of PT primary voltage (register 6000)	—	x
03	$I < 10\%$ of CT primary current (register 6004)	x	x
04	Reserved	—	—
05	Reserved	—	—
06	The voltage rotating field rotates anticlockwise.	—	x

Bit	Parameter	3P3W	3P4W
07	The current rotating field rotates anticlockwise.	x	x
08	The total active power is negative.	—	x
09	The active power on L1 is negative.	—	x
10	The active power on L2 is negative.	—	x
11	The active power on L3 is negative.	—	x
12	Measuring current transformer 1 polarity may be reversed.	—	x
13	Measuring current transformer 2 polarity may be reversed.	—	x
14	Measuring current transformer 3 polarity may be reversed.	—	x
15	Reserved	—	—

- 6) The SOE log pointer points to the last entry added. The event log works like a ring buffer according to the FIFO principle: If the pointer has reached the value 0xFFFFFFFF, the next event resets the pointer to 0x00000000 (overflow). The event log can be cleared in the setup parameters (write 0xFF00 to register 9609) or using the device buttons (Setup > Maintenance > Clear Registers). The SOE log can store a maximum of 100 events.
- 7) Time during which the device has measured a higher current than the threshold value set in register 6049 on any phase on the secondary side (i.e. without CTs).
- 8) for PEM353-N only
- 9) When wiring mode "1P2W L-N" or "1P2W L-L" is selected, the registers are reserved.
- 10) When wiring mode "1P2W L-N", "1P2W L-L" or "1P3W" is selected, the registers are reserved.

16.2 Energy measurement



After reaching the maximum value of 999,999,999 kWh/kvarh/kVAh, the measurement will roll over to 0 (overflow).

16.2.1 Energy meters and tariffs (present measured values)

Register Σ L1...3	Register L1	Register L2	Register L3	Property	Energy meters	Description	Format	Unit	
0500	0620	0740	0860	RW	Global	Active energy import	INT32	0.1 x kWh	
0502	0622	0742	0862	RW		Active energy export	INT32		
0504	0624	0744	0864	RO		Net active energy	INT32		
0506	0626	0746	0866	RO		Total active energy	INT32		
0508	0628	0748	0868	RW		Reactive energy import	INT32	0.1 x kvarh	
0510	0630	0750	0870	RW		Reactive energy export	INT32		
0512	0632	0752	0872	RO		Net reactive energy	INT32		
0514	0634	0754	0874	RO		Total reactive energy	INT32		
0516	0636	0756	0876	RW		Apparent energy	INT32	0.1 x kVAh	
0518	0638	0758	0878	RW		Reactive energy Q1	INT32	0.1 x kvarh	
0520	0640	0760	0880	RW		Reactive energy Q2	INT32		
0522	0642	0762	0882	RW		Reactive energy Q3	INT32		
0524	0644	0764	0884	RW		Reactive energy Q4	INT32		
0526	0646	0766	0886	RW		Tariff 1	Active energy import	INT32	0.1 x kWh
0528	0648	0768	0888	RW			Active energy export	INT32	
0530	0650	0770	0890	RW			Reactive energy import	INT32	0.1 x kvarh
0532	0652	0772	0892	RW	Reactive energy export		INT32		
0534	0654	0774	0894	RW	Apparent energy		INT32	0.1 x kVAh	

Register Σ L1...3	Register L1	Register L2	Register L3	Property	Energy meters	Description	Format	Unit
0536	0656	0776	0896	RW	Tariff 2	Active energy import	INT32	0.1 x kWh
0538	0658	0778	0898	RW		Active energy export	INT32	
0540	0660	0780	0900	RW		Reactive energy import	INT32	0.1 x kvarh
0542	0662	0782	0902	RW		Reactive energy export	INT32	
0544	0664	0784	0904	RW		Apparent energy	INT32	0.1 x kVAh
0546	0666	0786	0906	RW	Tariff 3	Active energy import	INT32	0.1 x kWh
0548	0668	0788	0908	RW		Active energy export	INT32	
0550	0670	0790	0910	RW		Reactive energy import	INT32	0.1 x kvarh
0552	0672	0792	0912	RW		Reactive energy export	INT32	
0554	0674	0794	0914	RW		Apparent energy	INT32	0.1 x kVAh
0556	0676	0796	0916	RW	Tariff 4	Active energy import	INT32	0.1 x kWh
0558	0678	0798	0918	RW		Active energy export	INT32	
0560	0680	0800	0920	RW		Reactive energy import	INT32	0.1 x kvarh
0562	0682	0802	0922	RW		Reactive energy export	INT32	
0564	0684	0804	0924	RW		Apparent energy	INT32	0.1 x kVAh
0566	0686	0806	0926	RW	Tariff 5	Active energy import	INT32	0.1 x kWh
0568	0688	0808	0928	RW		Active energy export	INT32	
0570	0690	0810	0930	RW		Reactive energy import	INT32	0.1 x kvarh
0572	0692	0812	0932	RW		Reactive energy export	INT32	
0574	0694	0814	0934	RW		Apparent energy	INT32	0.1 x kVAh

Register Σ L1...3	Register L1	Register L2	Register L3	Property	Energy meters	Description	Format	Unit
0576	0696	0816	0936	RW	Tariff 6	Active energy import	INT32	0.1 x kWh
0578	0698	0818	0938	RW		Active energy export	INT32	
0580	0700	0820	0940	RW		Reactive energy import	INT32	0.1 x kvarh
0582	0702	0822	0942	RW		Reactive energy export	INT32	
0584	0704	0824	0944	RW		Apparent energy	INT32	0.1 x kVAh
0586	0706	0826	0946	RW	Tariff 7	Active energy import	INT32	0.1 x kWh
0588	0708	0828	0948	RW		Active energy export	INT32	
0590	0710	0830	0950	RW		Reactive energy import	INT32	0.1 x kvarh
0592	0712	0832	0952	RW		Reactive energy export	INT32	
0594	0714	0834	0954	RW		Apparent energy	INT32	0.1 x kVAh
0596	0716	0836	0956	RW	Tariff 8	Active energy import	INT32	0.1 x kWh
0598	0718	0838	0958	RW		Active energy export	INT32	
0600	0720	0840	0960	RW		Reactive energy import	INT32	0.1 x kvarh
0602	0722	0842	0962	RW		Reactive energy export	INT32	
0604	0724	0844	0964	RW		Apparent energy	INT32	0.1 x kVAh

Tab. 16.3: Register of energy meters and tariffs (present measured values)

16.2.2 Monthly energy log (Energy Log)

Register	Property	Energy meters	Description	Format	Value/unit	
0980	RW	Global	Month ¹⁾	INT16	0*...12	
0981	RO		HiByte: year (0...99) LoByte: month (1...12)	INT16	Timestamp (20YY/MM/DD hh:mm:ss) ²⁾	
0982	RO		HiByte: Day (1...31) LoByte: hour (0...23)	INT16		
0983	RO		HiByte: minute (0...59) LoByte: second (1...59)	INT16		
0984	RW		Active energy import	INT32	0.1 x kWh	
0986	RW		Active energy export	INT32		
0988	RO		Net active energy	INT32		
0990	RO		Total active energy	INT32		
0992	RW		Reactive energy import	INT32	0.1 x kvarh	
0994	RW		Reactive energy export	INT32		
0996	RO		Net reactive energy	INT32		
0998	RO		Total reactive energy	INT32		
1000	RW		Apparent energy	INT32	0.1 x kVAh	
1002	RW		Reactive energy Q1	INT32	0.1 x kvarh	
1004	RW		Reactive energy Q2	INT32		
1006	RW		Reactive energy Q3	INT32		
1008	RW		Reactive energy Q4	INT32		
1010	RW		Tariff 1	Active energy import	INT32	0.1 x kWh
1012	RW			Active energy export	INT32	
1014	RW			Reactive energy import	INT32	0.1 x kvarh
1016	RW	Reactive energy export		INT32		
1018	RW	Apparent energy		INT32	0.1 x kVAh	
1020	RW	Tariff 2	Active energy import	INT32	0.1 x kWh	
1022	RW		Active energy export	INT32	0.1 x kvarh	
1024	RW		Reactive energy import	INT32		
1026	RW		Reactive energy export	INT32		
1028	RW		Apparent energy	INT32	0.1 x kVAh	

Register	Property	Energy meters	Description	Format	Value/unit
1030	RW	Tariff 3	Active energy import	INT32	0.1 x kWh
1032	RW		Active energy export	INT32	
1034	RW		Reactive energy import	INT32	0.1 x kvarh
1036	RW		Reactive energy export	INT32	
1038	RW		Apparent energy	INT32	0.1 x kVAh
1040	RW	Tariff 4	Active energy import	INT32	0.1 x kWh
1042	RW		Active energy export	INT32	
1044	RW		Reactive energy import	INT32	0.1 x kvarh
1046	RW		Reactive energy export	INT32	
1048	RW		Apparent energy	INT32	0.1 x kVAh
1050	RW	Tariff 5	Active energy import	INT32	0.1 x kWh
1052	RW		Active energy export	INT32	
1054	RW		Reactive energy import	INT32	0.1 x kvarh
1056	RW		Reactive energy export	INT32	
1058	RW		Apparent energy	INT32	0.1 x kVAh
1060	RW	Tariff 6	Active energy import	INT32	0.1 x kWh
1062	RW		Active energy export	INT32	
1064	RW		Reactive energy import	INT32	0.1 x kvarh
1066	RW		Reactive energy export	INT32	
1068	RW		Apparent energy	INT32	0.1 x kVAh
1070	RW	Tariff 7	Active energy import	INT32	0.1 x kWh
1072	RW		Active energy export	INT32	
1074	RW		Reactive energy import	INT32	0.1 x kvarh
1076	RW		Reactive energy export	INT32	
1078	RW		Apparent energy	INT32	0.1 x kVAh
1080	RW	Tariff 8	Active energy import	INT32	0.1 x kWh
1082	RW		Active energy export	INT32	
1084	RW		Reactive energy import	INT32	0.1 x kvarh
1086	RW		Reactive energy export	INT32	
1088	RW		Apparent energy	INT32	0.1 x kVAh

Tab. 16.4: Monthly energy log register (Energy Log)

Notes Tab. 16.4:

- 1) This register represents the month that has been read out. In addition to the present month, the last 12 months are available. Register content 0 = this month, 1 = last month, 2 = two months back, etc. To read out the data of a certain month, the correct value for this month must be written into register 980.
- 2) The timestamp shows when the period for each stored month log ended; for the present month, it shows the present date and time since the recording has not finished yet.

The monthly log of the present month (not yet ended) can still be modified. Stored concluded monthly logs, however, can only be read out.

16.2.3 Interval energy measurement (EN Period)

The final values of the energies counted in the last completed interval (EN Period) can be read out here.

Register	Property	Description	Format	Unit
1100	RW	Active energy import	INT32	0.1 kWh
1102	RW	Active energy export	INT32	
1104	RW	Reactive energy import	INT32	0.1 kvarh
1106	RW	Reactive energy export	INT32	
1108	RW	Apparent energy	INT32	0.1 kVAh

Tab. 16.5: Interval energy measurement register (EN Period)

16.2.4 Pulse counter digital inputs

Register	Property	Description	Format	Unit
1200	RW	DI1 pulse counter	UINT32	0...1,000,000,000 DIx pulse counter = pulse counter x pulse width
1202	RW	DI2 pulse counter	UINT32	
1204	RW	DI3 pulse counter	UINT32	
1206	RW	DI4 pulse counter	UINT32	

Tab. 16.6: Register of pulse counter digital inputs

16.3 Power Quality

Register	Property	Description	Format	Unit
1300	RO	TDD ₁₁	Float	—
1302	RO	TDD ₁₂	Float	
1304	RO	TDD ₁₃	Float	
1306	RO	TODD ₁₁	Float	
1308	RO	TODD ₁₂	Float	
1310	RO	TODD ₁₃	Float	
1312	RO	TEDD ₁₁	Float	
1314	RO	TEDD ₁₂	Float	
1316	RO	TEDD ₁₃	Float	
1318	RO	k-factor I_1	Float	
1320	RO	k-factor I_2	Float	
1322	RO	k-factor I_3	Float	
1324	RO	Crest factor I_1	Float	
1326	RO	Crest factor I_2	Float	
1328	RO	Crest factor I_3	Float	
1330	RO	Voltage unbalance	Float	
1332	RO	Current unbalance	Float	

Tab. 16.7: Power quality register

16.4 Harmonics currents

Register	Property	Description	Format	Unit	
1400	RO	THD ₁₁	Float	—	
1402	RO	THD ₁₂	Float		
1404	RO	THD ₁₃	Float		
1406	RO	TOHD ₁₁	Float		
1408	RO	TOHD ₁₂	Float		
1410	RO	TOHD ₁₃	Float		
1412	RO	TEHD ₁₁	Float		
1414	RO	TEHD ₁₂	Float		
1416	RO	TEHD ₁₃	Float		
1418	RO	HD02 ₁₁	Float		
1420	RO	HD02 ₁₂	Float		
1422	RO	HD02 ₁₃	Float		
...					
1592	RO	HD31 ₁₁	Float		
1594	RO	HD31 ₁₂	Float		
1596	RO	HD31 ₁₃	Float		

Tab. 16.8: Harmonics currents register

16.5 Harmonics voltages

Register	Property	Description	Format	Unit	
1600	RO	THD _{UL1} or THD _{UL1L2}	Float	—	
1602	RO	THD _{UL2} or THD _{UL2L3}	Float		
1604	RO	THD _{UL3} or THD _{U3L1}	Float		
1606	RO	TOHD _{UL1} or TOHD _{UL1L2}	Float		
1608	RO	TOHD _{UL2} or TOHD _{UL2L3}	Float		
1610	RO	TOHD _{UL3} or TOHD _{UL3L1}	Float		
1612	RO	TEHD _{UL1} or TEHD _{UL1L2}	Float		
1614	RO	TEHD _{UL2} or TEHD _{UL2L3}	Float		
1616	RO	TEHD _{UL3} or TEHD _{UL3L1}	Float		
1618	RO	HD02 _{UL1} or HD02 _{UL1L2}	Float		
1620	RO	HD02 _{UL2} or HD02 _{UL2L3}	Float		
1622	RO	HD02 _{UL3} or HD02 _{UL3L1}	Float		
...					
1792	RO	HD31 _{UL1} or HD31 _{UL1L2}	Float		
1794	RO	HD31 _{UL2} or HD31 _{UL2L3}	Float		
1796	RO	HD31 _{UL3} or HD02 _{UL3L1}	Float		

Tab. 16.9: Harmonics voltages register

16.6 Demand

Register	Property	Description	Format	Scale/unit
3000	RO	Demand I_1	Float	A
3002	RO	Demand I_2	Float	A
3004	RO	Demand I_3	Float	A
3006	RO	Demand P_{tot}	Float	W
3008	RO	Demand Q_{tot}	Float	var
3010	RO	Demand S_{tot}	Float	VA

Tab. 16.10: Demands register

16.7 Predicted demand

Register	Property	Description	Format	Scale/unit
3200	RO	Predicted demand I_1	Float	A
3202	RO	Predicted demand I_2	Float	A
3204	RO	Predicted demand I_3	Float	A
3206	RO	Predicted demand P_{tot}	Float	W
3208	RO	Predicted demand Q_{tot}	Float	var
3210	RO	Predicted demand S_{tot}	Float	VA

Tab. 16.11: Predicted demand register

16.8 Peak demand of this month

Register	Property	Energy meters	Description	Format	Unit
3400...3405	RO	Global	Peak demand I_1 of this month	See data structure Tab. 16.14	A
3406...3411	RO		Peak demand I_2 of this month		A
3412...3417	RO		Peak demand I_3 of this month		A
3418...3423	RO		Peak demand P of this month		W
3424...3429	RO		Peak demand Q of this month		var
3430...3435	RO		Peak demand S of this month		VA
3436...3441	RO	Tariff 1	Peak demand P of this month		W
3442...3447	RO		Peak demand Q of this month		var
3448...3453	RO		Peak demand S of this month		VA
3454...3459	RO	Tariff 2	Peak demand P of this month		W
3460...3465	RO		Peak demand Q of this month		var
3466...3471	RO		Peak demand S of this month		VA
3472...3477	RO	Tariff 3	Peak demand P of this month		W
3478...3483	RO		Peak demand Q of this month		var
3484...3489	RO		Peak demand S of this month		VA
3490...3495	RO	Tariff 4	Peak demand P of this month		W
3498...3502	RO		Peak demand Q of this month		var
3503...3507	RO		Peak demand S of this month		VA
3508...3513	RO	Tariff 5	Peak demand P of this month		W
3514...3519	RO		Peak demand Q of this month		var
3520...3525	RO		Peak demand S of this month		VA
3526...3531	RO	Tariff 6	Peak demand P of this month		W
3532...3537	RO		Peak demand Q of this month		var
3538...3543	RO		Peak demand S of this month		VA
3544...3549	RO	Tariff 7	Peak demand P of this month		W
3550...3555	RO		Peak demand Q of this month		var
3556...3561	RO		Peak demand S of this month		VA

Register	Property	Energy meters	Description	Format	Unit
3562...3567	RO	8	Peak demand P of this month	See data structure Tab. 16.14	W
3568...3573	RO		Peak demand Q of this month		var
3574...3579	RO		Peak demand S of this month		VA

Tab. 16.12: Register of peak demand this month

16.9 Peak demand of last month

"Last month" is the period before the last self-read time.

Register	Property	Energy meters	Description	Format	Unit
3600...3605	RO	Global	Peak demand I_1 of last month	See data structure Tab. 16.14	A
3606...3611	RO		Peak demand I_2 of last month		A
3612...3617	RO		Peak demand I_3 of last month		A
3618...3623	RO		Peak demand P of last month		W
3624...3629	RO		Peak demand Q of last month		var
3630...3635	RO		Peak demand S of last month		VA
3636...3641	RO	Tariff 1	Peak demand P of last month		W
3642...3647	RO		Peak demand Q of last month		var
3648...3653	RO		Peak demand S of last month		VA
3654...3659	RO	Tariff 2	Peak demand P of last month		W
3660...3665	RO		Peak demand Q of last month		var
3666...3671	RO		Peak demand S of last month		VA
3672...3677	RO	Tariff 3	Peak demand P of last month		W
3678...3683	RO		Peak demand Q of last month		var
3684...3689	RO		Peak demand S of last month		VA
3690...3695	RO	Tariff 4	Peak demand P of last month		W
3698...3702	RO		Peak demand Q of last month	var	
3703...3707	RO		Peak demand S of last month	VA	

Register	Property	Energy meters	Description	Format	Unit
3708...3713	RO	Tariff 5	Peak demand P of last month	See data structure Tab. 16.14	W
3714...3719	RO		Peak demand Q of last month		var
3720...3725	RO		Peak demand S of last month		VA
3726...3731	RO	Tariff 6	Peak demand P of last month		W
3732...3737	RO		Peak demand Q of last month		var
3738...3743	RO		Peak demand S of last month		VA
3744...3749	RO	Tariff 7	Peak demand P of last month		W
3750...3755	RO		Peak demand Q of last month		var
3756...3761	RO		Peak demand S of last month		VA
3762...3767	RO	Tariff 8	Peak demand P of last month		W
3768...3773	RO		Peak demand Q of last month		var
3774...3779	RO		Peak demand S of last month		VA

Tab. 16.13: Register of peak demand last month

Peak demand data structure

Offset	Description	Note
+ 0	HiWord: year	1...99 (year-2000)
	LoWord: month	1...12
+ 1	HiWord: day	1...28/29/30/31
	LoWord: hour	0...23
+2	HiWord: minute	0...59
	LoWord: second	0...59
+ 3	Millisecond	0...999
+4...+5	Peak demand value	

Tab. 16.14: Peak demand data structure

16.10 Max./Min. log

16.10.1 Maximum values of this month

Register	Property	Description	Format	Unit
4000...4005	RO	$U_{L1 \text{ max}}$	See data structure Tab. 16.19	V
4006...4011	RO	$U_{L2 \text{ max}}$		
4012...4017	RO	$U_{L3 \text{ max}}$		
4018...4023	RO	$\emptyset U_{LN \text{ max}}$		
4024...4029	RO	$U_{L1L2 \text{ max}}$		
4030...4035	RO	$U_{L2L3 \text{ max}}$		
4036...4041	RO	$U_{L3L1 \text{ max}}$		
4042...4047	RO	$\emptyset U_{LL \text{ max}}$		
4048...4053	RO	$I_1 \text{ max}$		A
4054...4059	RO	$I_2 \text{ max}$		
4060...4065	RO	$I_3 \text{ max}$		
4066...4071	RO	$\emptyset I \text{ max}$		W
4072...4077	RO	$P_{L1 \text{ max}}$		
4078...4083	RO	$P_{L2 \text{ max}}$		
4084...4089	RO	$P_{L3 \text{ max}}$		
4090...4095	RO	$P_{\text{tot max}}$		
4096...4101	RO	$Q_{L1 \text{ max}}$		var
4102...4107	RO	$Q_{L2 \text{ max}}$		
4108...4113	RO	$Q_{L3 \text{ max}}$		
4114...4119	RO	$Q_{\text{tot max}}$		VA
4120...4125	RO	$S_{L1 \text{ max}}$		
4126...4131	RO	$S_{L2 \text{ max}}$		
4132...4137	RO	$S_{L3 \text{ max}}$		
4138...4143	RO	$S_{\text{tot max}}$		

Register	Property	Description	Format	Unit
4144...4149	RO	$\lambda_{1 \max}$	See data structure Tab. 16.19	—
4150...4155	RO	$\lambda_{2 \max}$		
4156...4161	RO	$\lambda_{3 \max}$		
4162...4167	RO	$\lambda_{\text{tot} \max}$		
4168...4173	RO	f_{\max}		Hz
4174...4179	RO	$I_n \max$ (calculated)		A
4180...4185	RO	THD _{UL1} max or THD _{UL1L2} max		
4186...4191	RO	THD _{UL2} max or THD _{UL2L3} max		
4192...4197	RO	THD _{UL3} max or THD _{UL3L1} max		
4198...4203	RO	THD _{I1} max		
4204...4209	RO	THD _{I2} max		
4210...4215	RO	THD _{I3} max		
4216...4221	RO	k-factor $I_1 \max$		
4222...4227	RO	k-factor $I_2 \max$		
4228...4233	RO	k-factor $I_3 \max$		
4234...4239	RO	Crest factor $I_1 \max$		
4240...4245	RO	Crest factor $I_2 \max$		
4246...4251	RO	Crest factor $I_3 \max$		
4252...4257	RO	Max. voltage unbalance		
4258...4263	RO	Max. current unbalance		
4264...4269	RO	$I_4 \max$	A	
4270...4275	RO	$I_r \max$	A	

Tab. 16.15: Maximum values of this month

16.10.2 Minimum values of this month

Register	Property	Description	Format	Unit
4300...4305	RO	U_{L1} min	See data structure Tab. 16.19	V
4306...4311	RO	U_{L2} min		
4312...4317	RO	U_{L3} min		
4318...4323	RO	$\emptyset U_{LN}$ min		
4324...4329	RO	U_{L1L2} min		
4330...4335	RO	U_{L2L3} min		
4336...4341	RO	U_{L3L1} min		
4342...4347	RO	$\emptyset U_{LL}$ min		
4348...4353	RO	I_1 min		A
4354...4359	RO	I_2 min		
4360...4365	RO	I_3 min		
4366...4371	RO	$\emptyset I$ min		
4372...4377	RO	P_{L1} min		W
4378...4383	RO	P_{L2} min		
4384...4389	RO	P_{L3} min		
4390...4395	RO	P_{tot} min		
4396...4401	RO	Q_{L1} min		var
4402...4407	RO	Q_{L2} min		
4408...4413	RO	Q_{L3} min		
4414...4419	RO	Q_{tot} min		
4420...4425	RO	S_{L1} min	VA	
4426...4431	RO	S_{L2} min		
4432...4437	RO	S_{L3} min		
4438...4443	RO	S_{tot} min		

Register	Property	Description	Format	Unit	
4444...4449	RO	λ_1 min	See data structure Tab. 16.19	—	
4450...4455	RO	λ_2 min			
4456...4461	RO	λ_3 min			
4462...4467	RO	λ_{tot} min			
4468...4473	RO	f_{min}			Hz
4474...4479	RO	I_n min (calculated)			A
4480...4485	RO	THD _{UL1} min or THD _{UL1L2} min			
4486...4491	RO	THD _{UL2} min or THD _{UL2L3} min			
4492...4497	RO	THD _{UL3} min or THD _{UL3L1} min			
4498...4503	RO	THD _{I1} min			
4504...4509	RO	THD _{I2} min			
4510...4515	RO	THD _{I3} min			
4516...4521	RO	k-factor I_1 min			
4522...4527	RO	k-factor I_2 min			
4528...4533	RO	k-factor I_3 min			
4534...4539	RO	Crest factor I_1 min			
4540...4545	RO	Crest factor I_2 min			
4546...4551	RO	Crest factor I_3 min			
4552...4557	RO	Min. voltage unbalance			
4558...4563	RO	Min. current unbalance			
4564...4569	RO	I_4 min	A		
4570...4575	RO	I_r min	A		

Tab. 16.16: Minimum values of this month

16.10.3 Maximum values of last month

Register	Property	Description	Format	Unit
4600...4605	RO	U_{L1} max	See data structure Tab. 16.19	V
4606...4611	RO	U_{L2} max		
4612...4617	RO	U_{L3} max		
4618...4623	RO	$\emptyset U_{LN}$ max		
4624...4629	RO	U_{L1L2} max		
4630...4635	RO	U_{L2L3} max		
4636...4641	RO	U_{L3L1} max		
4642...4647	RO	$\emptyset U_{LL}$ max		
4648...4653	RO	I_1 max		A
4654...4659	RO	I_2 max		
4660...4665	RO	I_3 max		
4666...4671	RO	$\emptyset I_{max}$		W
4672...4677	RO	P_{L1} max		
4678...4683	RO	P_{L2} max		
4684...4689	RO	P_{L3} max		
4690...4695	RO	P_{tot} max		
4696...4701	RO	Q_{L1} max		var
4702...4707	RO	Q_{L2} max		
4708...4713	RO	Q_{L3} max		
4714...4719	RO	Q_{tot} max		
4720...4725	RO	S_{L1} max	VA	
4726...4731	RO	S_{L2} max		
4732...4737	RO	S_{L3} max		
4738...4743	RO	S_{tot} max		

Register	Property	Description	Format	Unit
4744...4749	RO	$\lambda_{1 \max}$	See data structure Tab. 16.19	—
4750...4755	RO	$\lambda_{2 \max}$		
4756...4761	RO	$\lambda_{3 \max}$		
4762...4767	RO	$\lambda_{\text{tot} \max}$		
4768...4773	RO	f_{\max}		Hz
4774...4779	RO	$I_n \max$ (calculated)		A
4780...4785	RO	THD _{UL1} max or THD _{UL1L2} max		
4786...4791	RO	THD _{UL2} max or THD _{UL2L3} max		
4792...4797	RO	THD _{UL3} max or THD _{UL3L1} max		
4798...4803	RO	THD _{I1} max		
4804...4809	RO	THD _{I2} max		
4810...4815	RO	THD _{I3} max		
4816...4821	RO	k-factor $I_1 \max$		
4822...4827	RO	k-factor $I_2 \max$		
4828...4833	RO	k-factor $I_3 \max$		
4834...4839	RO	Crest factor $I_1 \max$		
4840...4845	RO	Crest factor $I_2 \max$		
4846...4851	RO	Crest factor $I_3 \max$		
4852...4857	RO	Max. voltage unbalance		
4858...4863	RO	Max. current unbalance		
4864...4869	RO	$I_4 \max$	A	
4870...4875	RO	$I_r \max$	A	

Tab. 16.17: Maximum values of last month

16.10.4 Minimum values of last month

Register	Property	Description	Format	Unit
4900...4905	RO	U_{L1} min	See data structure Tab. 16.19	V
4906...4911	RO	U_{L2} min		
4912...4917	RO	U_{L3} min		
4918...4923	RO	$\emptyset U_{LN}$ min		
4924...4929	RO	U_{L1L2} min		
4930...4935	RO	U_{L2L3} min		
4936...4941	RO	U_{L3L1} min		
4942...4947	RO	$\emptyset U_{LL}$ min		
4948...4953	RO	I_1 min		A
4954...4959	RO	I_2 min		
4960...4965	RO	I_3 min		
4966...4971	RO	$\emptyset I$ min		
4972...4977	RO	P_{L1} min		W
4978...4983	RO	P_{L2} min		
4984...4989	RO	P_{L3} min		
4990...4995	RO	P_{tot} min		
4996...5001	RO	Q_{L1} min		var
5002...5007	RO	Q_{L2} min		
5008...5013	RO	Q_{L3} min		
5014...5019	RO	Q_{tot} min		
5020...5025	RO	S_{L1} min	VA	
5026...5031	RO	S_{L2} min		
5032...5037	RO	S_{L3} min		
5038...5043	RO	S_{tot} min		

Register	Property	Description	Format	Unit
5050...5049	RO	λ_1 min	See data structure Tab. 16.19	—
5050...5055	RO	λ_2 min		
5056...5061	RO	λ_3 min		
5062...5067	RO	λ_{tot} min		Hz
5068...5073	RO	f_{min}		
5074...5079	RO	I_n min (calculated)		A
5080...5085	RO	THD _{UL1} min or THD _{UL1L2} min		
5086...5091	RO	THD _{UL2} min or THD _{UL2L3} min		
5092...5097	RO	THD _{UL3} min or THD _{UL3L1} min		
5098...5103	RO	THD _{I1} min		
5104...5109	RO	THD _{I2} min		
5110...5115	RO	THD _{I3} min		
5116...5121	RO	k-factor I_1 min		
5122...5127	RO	k-factor I_2 min		
5128...5133	RO	k-factor I_3 min		
5134...5139	RO	Crest factor I_1 min		
5140...5145	RO	Crest factor I_2 min		
5146...5151	RO	Crest factor I_3 min		
5152...5157	RO	Min. voltage unbalance		
5158...5163	RO	Min. current unbalance		
5164...5169	RO	I_4 min	A	
5170...5175	RO	I_r min	A	

Tab. 16.18: Minimum values of last month

16.10.5 Max./Min. log data structure

Offset	Property	Description	Note
+ 0	RO	HiWord: year	1...99 (year-2000)
	RO	LoWord: month	1...12
+ 1	RO	HiWord: day	1...28/29/30/31
	RO	LoWord: hour	0...23
+ 2	RO	HiWord: minute	0...59
	RO	LoWord: second	0...59
+ 4...+5	RO	Max. or Min. value	

Tab. 16.19: Max./Min. log data structure

16.11 Setup parameters (basic)

* = factory settings

Register	Property	Description	Format	Range/unit
6000	RW	PT primary side ¹⁾	UINT32	1...1,000,000 V; 100* V
6002	RW	PT secondary side	UINT32	1...690 V; 100* V
6004	RW	CT primary side	UINT32	1...30,000 A; 5* A
6006	RW	CT secondary side	UINT32	1...5 A; 5* A
6008	RW	Reserved	UINT32	
6010	RW	Reserved	UINT32	
6012	RW	I_4 primary side	UINT32	1...30,000 A; 5* A
6014	RW	I_4 secondary side	UINT32	1...5 A; 5* A
6016	RW	Reserved	UINT32	
6018	RW	Reserved	UINT32	
6020	RW	Wiring mode	UINT16	0 = Demo 1 = 1P2W L-N 2 = 1P2W L-L 3 = 1P3W 4 = 3P3W 5 = 3P4W*
6021	RW	Power factor λ rule	UINT16	0 = IEC* 1 = IEEE 2 = -IEEE

Register	Property	Description	Format	Range/unit
6022	RW	Calculation method S	UINT16	0 = vector* 1 = scalar
6023	RW	Current transformer L1 polarity	UINT16	0 = normal* 1 = reversed
6024	RW	Current transformer L2 polarity	UINT16	0 = normal * 1 = reversed
6025	RW	Current transformer L3 polarity	UINT16	0 = normal * 1 = reversed
6026	RW	Reserved	UINT16	
6027	RW	Reserved	UINT16	
6028	RW	THD calculation ²⁾	UINT16	0 = THDf* 1 = THDr
6029	RW	Demand measurement period	UINT16	1, 2, 3, 5, 10, 15*, 60 minutes
6030	RW	Number of sliding windows	UINT16	1*...15
6031	RW	Dynamics of the demand prediction	UINT16	70*...99 (High value = high dynamics, but also high sensitivity to noise)
6032	RW	Method for setting and resetting the DO and RO ³⁾	UINT16	0* = disabled 1 = enabled
6033	RW	Self-read time for the peak demand log and the Max./Min. log ⁴⁾	UINT16	0 = beginning of the month 0xFFFF* = manual Other value = automatic
6034	RW	Self-read time for the monthly energy log ⁵⁾	UINT16	0*
6035	RW	Energy pulse constant	UINT16	0 = 1000 pulses/kxh 1 = 3200 pulses/kxh
6036	RW	LED energy pulses	UINT16	0 = disabled 1 = active energy 2 = reactive energy
6037	RW	Screen dark after	UINT16	0...60 minutes; 5*
6038	RW	Language	UINT16	1 = English
6039	RW	Date format (on display)	UINT16	0* = YYMMDD 1 = MMDDYY 2 = DDMMYY
6040	RW	Decimal separator	UINT16	0 = . (decimal point) 1 = , (decimal comma)

Register	Property	Description	Format	Range/unit
6041	RW	Monthly freeze self-read time (monthly log/freeze log) ⁵⁾	UINT16	0*
6042	RW	Daily freeze self-read time (daily log/freeze log) ⁶⁾	UINT16	0*
6043	RW	Standard display (1 st measured quantity) ⁷⁾	UINT16	0...36, 7*
6044	RW	Standard display (2 nd measured quantity) ⁷⁾	UINT16	0...36, 11*
6045	RW	Standard display (3 rd measured quantity) ⁷⁾	UINT16	0...36, 12*
6046	RW	Standard display (4 th measured quantity) ⁷⁾	UINT16	0...36, 15*
6047	RW	EN Period ⁸⁾	UINT16	5...60* min
6048	RW	Setpoint alarm signalled by flashing display lighting	UINT16	0 = return 1 = enabled
6049	RW	Load current response value from which the operating hours counter counts ⁹⁾	UINT16	1*...1000 (x 0.1 % I prim)
6050	RW	Calculation method for reactive energy	UINT16	0 = rms 1 = fund (refers to the fundamental)
6051	RW	DNP polling object ¹⁰⁾	UINT16	0...65535, 0x3F*

Tab. 16.20: Setup parameters (basic)

Notes Tab. 16.20

- 1) Potential transformer primary side/Potential transformer secondary side ≤ 10,000
- 2) THDf = refers to the fundamental f_0
THDr = refers to the r.m.s. value (distortion factor)

$$\text{THDf} = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{I_1} \times 100 \% \quad \text{THDr} = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{\sqrt{\sum_{h=1}^{\infty} I_h^2}} \times 100 \%$$

with I_1 = r.m.s. value of the fundamental, I_h = r.m.s. value of the h^{th} harmonic

- 3) see register 9100 ff.
- 4) 0: Data transfer takes place at 00:00 h of the first day of each month.
0xFFFF: Data transfer does not happen automatically at a specific time, but only by writing 0xFF00 to register 9603 (peak demand) or to register 9605 (Max./Min. log). By doing this, the data of the "Peak demand of this month" become the values of the "Peak demand of last month"; the "Peak demand of this month" is determined again from this date. The same applies to the Max./Min. log.
Other numeric value: Data transfer takes place independently at a different time. Encoding according to the following formula:
Time = (day x 100 + hour) where day = 1...28 and hour = 0...23.
Example: 1512 = data transfer at 12:00 h on the 15th of each month
- 5) 0: Data transfer/Freeze log takes place at 00:00 h of the first day of each month.
Other numeric value: Data transfer takes place independently at a specific time. Encoding according to the following formula:
Time = (day x 100 + hour) where day = 1...28 and hour = 0...23.
Example: 1512 = data transfer at 12:00 h on the 15th of each month
- 6) 0 = freeze log takes places daily at 00:00 h
Other numeric value: Freeze log takes place independently at a specific time. Encoding according to the following formula:
Time = (hour x 100 + minute) where hour = 0...23 and minute = 0...59.
Example: 1512 = data transfer daily at 15:12 h

7) Key for measured values 1...4 on the standard display

Key	Parameter	Key	Parameter	Key	Parameter	Key	Parameter
0	U_{L1}	10	I_3	20	Import active energy, tariff 1	30	$P_{tot} (f_0)$
1	U_{L2}	11	$\emptyset I$	21	Import active energy, tariff 2	31	Total displacement factor
2	U_{L3}	12	P_{tot}	22	Import active energy, tariff 3	32	I_4
3	$\emptyset U_{LN}$	13	Q_{tot}	23	Import active energy, tariff 4	33	THD U_{L1}
4	U_{L1L2}	14	S_{tot}	24	Demand I_1	34	THD U_{L2}
5	U_{L2L3}	15	λ_{tot}	25	Demand I_2	35	THD U_{L3}
6	U_{L3L1}	16	f	26	Demand I_3	36	I_r
7	$\emptyset U_{LL}$	17	Active energy import	27	Demand P		
8	I_1	18	Active energy export	28	Demand Q		
9	I_2	19	Total active energy	29	Demand S		

8) If EN Period is changed, the previous recording of the interval energy meter is reset.

9)

$$I_{prim} = 5 \text{ A} \times \frac{CT_{primary}}{CT_{secondary}}$$

The register content corresponds to % values of I_{prim}

where 1 = 0.1 %

1000 = 100 %)

10) Overview of the "DNP Polling Objects"

Bit	Object description	Setting options
B00	Object 1: Binary Inputs	0 = return 1 = enabled*
B01	Object 10: Binary Output	
B02	Object 20: 32-bit Binary Counters	
B03	Object 20: 16-bit Binary Counters	
B04	Object 30: Analog Inputs Primary Readings	
B05	Object 40: Analog Output Status	
B06	Reserved	

16.12 Setup (inputs and outputs)

Setup register (inputs and outputs)

Register	Property	Description	Format	Unit
6200	RW	DI1 function	UINT16	0* = digital input 1 = pulse counter 2 = tariff switch
6201	RW	DI2 function	UINT16	
6202	RW	DI3 function	UINT16	
6203	RW	DI4 function	UINT16	0* = digital input 1 = pulse counter
...	Reserved			
6208	RW	DI1 debounce time	UINT16	1...9999 ms; 20* ms
6209	RW	DI2 debounce time	UINT16	
6210	RW	DI3 debounce time	UINT16	
6211	RW	DI4 debounce time	UINT16	
...	Reserved			
6216	RW	DI1 pulse width	UINT32	1*...1,000,000
6218	RW	DI2 pulse width	UINT32	
6220	RW	DI3 pulse width	UINT32	
6222	RW	DI4 pulse width	UINT32	
...	Reserved			

Register	Property	Description	Format	Unit
6230	RW	DO1 function	UINT16	0* = remote control/setpoint 1 = kWh import 2 = kWh export 3 = kWh total
6231	RW	DO2 function	UINT16	4 = kvarh import 5 = kvarh export 6 = kvarh total
...	Reserved			
6236	RW	DO1 pulse width	UINT16	0...6000 (x 0.1 s); 10* 0 = latch mode
6237	RW	DO2 pulse width	UINT16	

Tab. 16.21: Setup register (inputs and outputs)

16.13 Setup (communication)

Register	Property	Description	Format	Value
6400	RW	COM1	Protocol	UINT16 0* = Modbus RTU 1 = BACnet MS/TP 3 = DNP
6401	RW		Device address	UINT16 1...247 (100*)
6402	RW		Baud rate	UINT16 0 = 1200 1 = 2400 2 = 4800 3 = 9600* 4 = 19200 5 = 38400 bps
6403	RW		Parity bit configuration	UINT16 0 = 8N2 1 = 8O1 2 = 8E1* 3 = 8N1 4 = 8O2 5 = 8E2

Tab. 16.22: Setup (communication)

16.14 Setup (setpoints)

Register	Property	Description	Format	Unit	
6500	RW	Setpoint 1	Setpoint type	UINT16	0 = disabled 1 = ">" setpoint 2 = "<" setpoint
6501	RW		Parameters ¹⁾	UINT16	0...32
6502	RW		Upper limit ²⁾	Float	0*
6504	RW		Lower limit ²⁾	Float	0*
6506	RW		Active delay	UINT16	0...9999 s; 10*
6507	RW		Inactive delay	UINT16	
6508	RW		Trigger action 1 ³⁾	UINT16	0...4
6509	RW		Trigger action 2 ³⁾	UINT16	
...		...			
6580	RW	Setpoint 9	Setpoint type	UINT16	0 = disabled 1 = ">" setpoint 2 = "<" setpoint
6581	RW		Parameters ¹⁾	UINT16	0...32
6582	RW		Upper limit	Float	0*
6584	RW		Lower limit	Float	0*
6586	RW		Active delay	UINT16	0...9999 s; 10*
6587	RW		Inactive delay	UINT16	
6588	RW		Trigger action 1	UINT16	0...4
6589	RW		Trigger action 2	UINT16	

Tab. 16.23: Setup register (setpoints)

Notes Tab. 16.23

1) Setpoint parameter key

Key	Parameter	Key	Parameter	Key	Parameter
0	—	10	Present demand P_{tot}	20	TOHD _I
1	U_{LN}	11	Present demand Q_{tot}	21	TEHD _I
2	U_{LL}	12	Present demand S_{tot}	22	Voltage unbalance
3	I	13	Predicted demand P_{tot}	23	Current unbalance
4	I_n	14	Predicted demand Q_{tot}	24	Rotating field
5	f	15	Predicted demand S_{tot}	25	I_4
6	P_{tot}	16	THD _U	26...29	Reserved
7	Q_{tot}	17	TOHD _U	30	I_r
8	S_{tot}	18	TEHD _U	31	U2
9	λ	19	THD _I	32	U0

- 2) "**>**" **setpoint**: The measured value must exceed the upper limit to become active (response threshold value) and fall below the lower limit to become inactive (release threshold value).
 "**<**" **setpoint**: The measured value must fall below the lower limit to become active (response threshold value) and exceed the upper limit to become inactive (release threshold value).
- 3) Trigger action key

Key	Parameter
0	—
1	DO1 closed
2	DO2 closed
Others	Reserved

16.15 TOU setup

Refer also to chapter 15.

16.15.1 Setup schedules register

Register	Property	Description	Format	Range/Option
Status register				
7000	RO	Currently active tariff	UINTEGER	0...7 (T1...T8)
7001	RO	Currently active season	UINTEGER	0...11 (season 1...12)
7002	RO	Currently active period of the daily profile	UINTEGER	0...11 (period 1...12)
7003	RO	Currently active daily profile	UINTEGER	0...19 (profile 1...20)
7004	RO	Currently active day type	UINTEGER	0 = day type 1 1 = day type 2 2 = day type 3 3 = alternate day
7005	RO	Currently active schedule	UINTEGER	0 = schedule 1 1 = schedule 2
Switching between schedules				
7006	RW	Automatic switching time of the schedule ¹⁾	UINTEGER32	Tab. 16.25
7008	WO	Manual switching of the schedule	UINTEGER	0xFF00
Assignment weekday to day types				
7009	RW	Sunday setup	UINTEGER	0* = day type 1 1 = day type 2 2 = day type 3
7010	RW	Monday setup	UINTEGER	
7011	RW	Tuesday setup	UINTEGER	
7012	RW	Wednesday setup	UINTEGER	
7013	RW	Thursday setup	UINTEGER	
7014	RW	Friday setup	UINTEGER	
7015	RW	Saturday setup	UINTEGER	

Tab. 16.24: Setup schedules register

Notes Tab. 16.24

- 1) If DI1 is configured for the tariff switch, the schedules are ignored and instead the status of the DI is used for the tariff switch.

Register content 0xFFFFFFFF deactivates the automatic tariff switch.

Data structure switching time:

Byte 3	Byte 2	Byte 1	Byte 0
Year - 2000 (0...37)	Month (1...12)	Day (1...31)	Hour (0...23)

Tab. 16.25: Data structure switching time

16.15.2 Season

There are two sets of setup parameters (one for schedule 1, one for schedule 2).

The respective register address is the start address + offset. 12 seasons can be defined for each schedule.

Start address schedule 1: register 7100.

Start address schedule 2: register 8100.

Offset	Property	Description	Format	Range/Option	
0	RW	Season 1	Start date ¹⁾	UINT16	0x0101
1	RW		Weekday 1 daily profile	UINT16	0...19
2	RW		Weekday 2 daily profile	UINT16	
3	RW		Weekday 3 daily profile	UINT16	
4	RW	Season 2	Start date ²⁾	UINT16	HiByte: month LoByte: day
5	RW		Weekday 1 daily profile	UINT16	0...19
6	RW		Weekday 2 daily profile	UINT16	
7	RW		Weekday 3 daily profile	UINT16	
8	RW	Season 3	Start date ²⁾	UINT16	HiByte: month LoByte: day
9	RW		Weekday 1 daily profile	UINT16	0...19
10	RW		Weekday 2 daily profile	UINT16	
11	RW		Weekday 3 daily profile	UINT16	

Offset	Property	Description	Format	Range/Option
12	RW	Season 4	Start date ²⁾	HiByte: month LoByte: day
13	RW		Weekday 1 daily profile	0...19
14	RW		Weekday 2 daily profile	
15	RW		Weekday 3 daily profile	
16	RW	Season 5	Start date ²⁾	HiByte: month LoByte: day
17	RW		Weekday 1 daily profile	0...19
18	RW		Weekday 2 daily profile	
19	RW		Weekday 3 daily profile	
20	RW	Season 6	Start date ²⁾	HiByte: month LoByte: day
21	RW		Weekday 1 daily profile	0...19
22	RW		Weekday 2 daily profile	
23	RW		Weekday 3 daily profile	
24	RW	Season 7	Start date ²⁾	HiByte: month LoByte: day
25	RW		Weekday 1 daily profile	0...19
26	RW		Weekday 2 daily profile	
27	RW		Weekday 3 daily profile	
28	RW	Season 8	Start date ²⁾	HiByte: month LoByte: day
29	RW		Weekday 1 daily profile	0...19
30	RW		Weekday 2 daily profile	
31	RW		Weekday 3 daily profile	
32	RW	Season 9	Start date ²⁾	HiByte: month LoByte: day
33	RW		Weekday 1 daily profile	0...19
34	RW		Weekday 2 daily profile	
35	RW		Weekday 3 daily profile	

Offset	Property	Description	Format	Range/Option
36	RW	Season 10	Start date ²⁾	HiByte: month LoByte: day
37	RW		Weekday 1 daily profile	0...19
38	RW		Weekday 2 daily profile	
39	RW		Weekday 3 daily profile	
40	RW	Season 11	Start date ²⁾	HiByte: month LoByte: day
41	RW		Weekday 1 daily profile	0...19
42	RW		Weekday 2 daily profile	
43	RW		Weekday 3 daily profile	
44	RW	Season 12	Start date ²⁾	HiByte: month LoByte: day
45	RW		Weekday 1 daily profile	0...19
46	RW		Weekday 2 daily profile	
47	RW		Weekday 3 daily profile	

Tab. 16.26: Data structure schedule (season)

- 1) The start date for season 1 is always January 01. This cannot be modified.
- 2) Start date: The start date of a season must always be later than the start date of the previous season. Register content 0xFFFF deactivates the respective season and all following seasons.

16.15.3 Daily profiles

Daily profiles register (of schedules 1 and 2)

Register schedule 1	Register schedule 2	Property	Description	Format
7200...7223	8200...8223	RW	Daily profile 1	See daily profile data structure Tab. 16.28
7224...7247	8224...8247	RW	Daily profile 2	
7248...7271	8248...8271	RW	Daily profile 3	
7272...7295	8272...8295	RW	Daily profile 4	
7296...7319	8296...8319	RW	Daily profile 5	
7320...7343	8320...8343	RW	Daily profile 6	
7344...7367	8344...8367	RW	Daily profile 7	
7368...7391	8368...8391	RW	Daily profile 8	
7392...7415	8392...8415	RW	Daily profile 9	
7416...7439	8416...8439	RW	Daily profile 10	
7440...7463	8440...8463	RW	Daily profile 11	
7464...7487	8464...8487	RW	Daily profile 12	
7488...7511	8488...8511	RW	Daily profile 13	
7512...7535	8512...8535	RW	Daily profile 14	
7536...7559	8536...8559	RW	Daily profile 15	
7560...7583	8560...8583	RW	Daily profile 16	
7584...7607	8584...8607	RW	Daily profile 17	
7608...7631	8608...8631	RW	Daily profile 18	
7632...7655	8632...8655	RW	Daily profile 19	
7656...7679	8656...8679	RW	Daily profile 20	

Tab. 16.27: Daily profiles register

Setup (daily profile data structure)

Offset	Property	Period		Format	Value
0	RW	1	Start time ¹⁾	UINT16	0x0000
1	RW		Tariff to be used	UINT16	0...7 (T1...T8)
2	RW	2	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
3	RW		Tariff to be used	UINT16	0...7 (T1...T8)
4	RW	3	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
5	RW		Tariff to be used	UINT16	0...7 (T1...T8)
6	RW	4	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
7	RW		Tariff to be used	UINT16	0...7 (T1...T8)
8	RW	5	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
9	RW		Tariff to be used	UINT16	0...7 (T1...T8)
10	RW	6	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
11	RW		Tariff to be used	UINT16	0...7 (T1...T8)
12	RW	7	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
13	RW		Tariff to be used	UINT16	0...7 (T1...T8)
14	RW	8	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
15	RW		Tariff to be used	UINT16	0...7 (T1...T8)
16	RW	9	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
17	RW		Tariff to be used	UINT16	0...7 (T1...T8)
18	RW	10	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
19	RW		Tariff to be used	UINT16	0...7 (T1...T8)
20	RW	11	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
21	RW		Tariff to be used	UINT16	0...7 (T1...T8)

Offset	Property	Period		Format	Value
22	RW	12	Start time ²⁾	UINT16	HiByte: hour (0...23) LoByte: minute (0...59)
23	RW		Tariff to be used	UINT16	0...7 (T1...T8)

Tab. 16.28: Daily profile data structure

Notes Tab. 16.28:

- 1) The start time for period 1 is 00:00 h and cannot be modified.
- 2) Register content 0xFFFF terminates the settings of the daily profile. The corresponding period ends at 23:59 h.

The minimum interval for a period is 15 minutes.

The start time of a period must always be later than the start time of the previous period.

16.15.4 Alternate days

Alternate days are, for example, holidays. They have a higher priority than seasons and specify the daily profile to be used. For the two schedules 1 and 2, the alternative days must be determined individually. The register address is the start address + offset.

Start address schedule 1 = 7700

Start address schedule 2 = 8700

Setup (data structure alternate days)

Offset	Property	Description		Format	Value
0	RW	Alternate day 1	Date	UINT32	See data structure Tab. 16.30
2	RW		Daily profile	UINT16	0...19
3	RW	Alternate day 2	Date	UINT32	See data structure Tab. 16.30
5	RW		Daily profile	UINT16	0...19
6	RW	Alternate day 3	Date	UINT32	See data structure Tab. 16.30
8	RW		Daily profile	UINT16	0...19
...					

Offset	Property	Description	Format	Value	
261	RW	Alternate day 88	Date	UINT32	See data structure Tab. 16.30
263	RW		Daily profile	UINT16	0...19
264	RW	Alternate day 89	Date	UINT32	See data structure Tab. 16.30
266	RW		Daily profile	UINT16	0...19
267	RW	Alternate day 90	Date	UINT32	See data structure Tab. 16.30
269	RW		Daily profile	UINT16	0...19

Tab. 16.29: Setup (data structure alternate days)

Data structure alternate day date

Byte 3	Byte 2	Byte 1	Byte 0
Reserved	Year - 2000 (0...37)	Month (1...12)	Day (1...31)

Tab. 16.30: Data structure alternate day date

Alternate days can also be programmed as recurring dates by writing "0xFF" to the corresponding byte for month and/or year.

16.16 Time setting

There are two time register formats supported by the PEM353:

1. Year/Month/Day/Hour/Minute/Second Register 9000...9002
2. UNIX time Register 9004

When sending the time via Modbus, care should be taken to only write one of the two time register sets. All registers within a time register set must be written in a single transaction.

If all the registers **9000...9004** are set, both timestamp registers will be updated to reflect the new time specified in the UNIX time register set. Time specified in the first display format will be ignored.

Optionally, register **9003** displays milliseconds. When broadcasting time, the function code has to be set to 0x10 (Preset Multiple Register). Incorrect date or time values will be rejected by the universal measuring device.

Register	Property	Description	Format	Note
9000	RW	Year and month	UINT16	HiWord: Year - 2000 LoWord: month (1...12)
9001	RW	Day and hour	UINT16	HiWord: day (1...28/29/30/31) LoWord: hour (0...23)
9002	RW	Minute and second	UINT16	HiWord: minute (0...59) LoWord: second (0...59)
9003	RW	Millisecond	UINT16	0...999
9004	RW	UNIX time	UINT32	Time in seconds elapsed since January 01, 1970 (00:00:00 h) (0...4102444799)

Tab. 16.31: Timestamp register

16.17 Clearing logs and meters

Register	Property	Description	Format	Content
9600	WO	Clear all concluded logs of the monthly energy log ¹⁾	UINT16	Write 0xFF00 to the register to trigger the described action
9601	WO	Clear all energy logs ²⁾	UINT16	
9602	WO	Clear energy log of this month ³⁾	UINT16	
9603	WO	Clear present peak demand (since last reset) ⁴⁾	UINT16	
9604	WO	Clear all demand values ⁵⁾	UINT16	
9605	WO	Clear present Max./Min. log (since last reset) ⁶⁾	UINT16	
9606	WO	Clear all Max./Min. logs ⁷⁾	UINT16	
9607	WO	Clear operating hours counter ⁸⁾	UINT16	
9608	WO	Clear all measured values ⁹⁾	UINT16	
9609	WO	Clear SOE event log	UINT16	
9610	WO	Clear DI1 pulse counter	UINT16	
9611	WO	Clear DI2 pulse counter	UINT16	
9612	WO	Clear DI3 pulse counter	UINT16	
9613	WO	Clear DI4 pulse counter	UINT16	
Reserved				
9618		Clear all pulse counters	UINT16	

Tab. 16.32: "Clear" register

Notes Tab. 16.32

- 1) Writing 0xFF00 to register 9600 clears all concluded logs of the monthly energy log. The present, not yet concluded monthly log is not cleared.
- 2) Clears the total phase and individual phase energy registers
- 3) Clears the energy log of the present month

- 4) The clearing behaviour depends on the settings in register 6033:
When register 6033 = automatic is set
 Clears the present peak demand, the peak demand of last month is not changed.
When register 6033 = manual is set
 The present peak demand is written to the registers of the "Peak demand of last month". Afterwards, the present peak demand is cleared.
- 5) All demand registers and logs are cleared (present demand, peak demand of this month and last month).
- 6) The clearing behaviour depends on the settings in register 6033:
When register 6033 = automatic is set
 Clears only the present Max./Min. log, the Max./Min. log of last month is not changed.
When register 6033 = manual is set
 The present Max./Min. log is written to the "Max./Min. log of last month". Afterwards, the present Max./Min. log is cleared.
- 7) Clears the Max./Min. logs of this month and last month.
- 8) Operating hours counter: Time during which the device has measured more than 100 mA on any phase (secondary side, i.e. without considering the measuring current transformers).
- 9) Executes the actions determined for registers 9600...9607 and 9610...9615. In addition, the PEM353-N clears the daily and monthly logs (freeze logs).

For PEM353-N only

Clearing the data recorders

Register	Property	Description	Format	Content
9619	WO	Clear data recorder 1	UINT16	Write 0xFF00 to the register to trigger the described action
9620	WO	Clear data recorder 2	UINT16	
9621	WO	Clear data recorder 3	UINT16	
9622	WO	Clear data recorder 4	UINT16	
9623	WO	Clear data recorder 5	UINT16	
9624	WO	Clear all data recorders	UINT16	

16.18 Event log (SOE log)

Each event entry occupies 8 registers, as shown in the following table. The internal data structure of the event log is listed in Tabelle 16.34.

Register	Property	Description	Format
10000...10007	RO	Event 1	See Tab. 16.34
10008...10015	RO	Event 2	
10016...10023	RO	Event 3	
10024...10031	RO	Event 4	
10032...10039	RO	Event 5	
10040...10047	RO	Event 6	
10048...10055	RO	Event 7	
10056...10063	RO	Event 8	
10064...10071	RO	Event 9	
10072...10079	RO	Event 10	
10080...10087	RO	Event 11	
	...		
10792...10799	RO	Event 100	

Tab. 16.33: Event log (SOE log)

Event data structure (SOE log)

The internal data structure of the 8 registers belonging to each event in the SOE log is described in the table below.

Offset	Property	Description
+0	RO	HiByte: event classification LoByte: event sub-classification (see Tabelle 16.35)
+1	RO	HiByte: year-2000 LoByte: month (1...12)
+2	RO	HiByte: day (0...31) LoByte: hour (1...23)
+3	RO	HiByte: minute (0...59) LoByte: second (0...59)
+4	RO	Millisecond (0...999)

Offset	Property	Description
+5	RO	HiByte: Reserved LoByte: Status
+6...+7	RO	Event value

Tab. 16.34: Event data structure

Event classification (SOE log)

Event classification	Event sub-classification	Status	Event value	Meaning
1 (DI)	1	1/0		Digital input 1 closed/open
	2	1/0		Digital input 2 closed/open
	3	1/0		Digital input 3 closed/open
	4	1/0		Digital input 4 closed/open
	5	Reserved		
	6	Reserved		
2 (DO)	1	1/0		Digital output 1 closed/open via Modbus access
	2	1/0		Digital output 2 closed/open via Modbus access
	3...10	Reserved		
	11	1/0		Digital output 1 closed/open via setpoint
	12	1/0		Digital output 2 closed/open via setpoint
	13...20	Reserved		
	21	1/0		Digital output 1 closed/open via front panel operation
	22	1/0		Digital output 2 closed/open via front panel operation
	23...30	Reserved		
	31	0		Digital output 1 open after "Pulse width DO1" (register 6236) has elapsed
	32	0		Digital output 2 open after "Pulse width DO2" (register 6237) has elapsed
	33...34	Reserved		

Event classification	Event sub-classification	Status	Event value	Meaning
3 (Setpoint)	1	1/0	Trigger value	Status 1 = ">" setpoint U_{LN} exceeded Status 0 = return
	2	1/0	Trigger value	Status 1 = ">" setpoint U_{LL} exceeded Status 0 = return
	3	1/0	Trigger value	Status 1 = ">" setpoint I exceeded Status 0 = return
	4	1/0	Trigger value	Status 1 = ">" setpoint I_n exceeded Status 0 = return
	5	1/0	Trigger value	Status 1 = ">" setpoint f exceeded Status 0 = return
	6	1/0	Trigger value	Status 1 = ">" setpoint P_{tot} exceeded Status 0 = return
	7	1/0	Trigger value	Status 1 = ">" setpoint Q_{tot} exceeded Status 0 = return
	8	1/0	Trigger value	Status 1 = ">" setpoint S_{tot} exceeded Status 0 = return

Event classification	Event sub-classification	Status	Event value	Meaning
3 (Setpoint)	9	1/0	Trigger value	Status 1 = ">" setpoint λ_{tot} exceeded Status 0 = return
	10	1/0	Trigger value	Status 1 = ">" setpoint demand P_{tot} exceeded Status 0 = return
	11	1/0	Trigger value	Status 1 = ">" setpoint demand Q_{tot} exceeded Status 0 = return
	12	1/0	Trigger value	Status 1 = ">" setpoint demand S_{tot} exceeded Status 0 = return
	13	1/0	Trigger value	Status 1 = ">" setpoint predicted demand P_{tot} exceeded Status 0 = return
	14	1/0	Trigger value	Status 1 = ">" setpoint predicted demand Q_{tot} exceeded Status 0 = return
	15	1/0	Trigger value	Status 1 = ">" setpoint predicted demand S_{tot} exceeded Status 0 = return
	16	1/0	Trigger value	Status 1 = ">" setpoint THD_U exceeded Status 0 = return
	17	1/0	Trigger value	Status 1 = ">" setpoint $TOHD_U$ exceeded Status 0 = return
	18	1/0	Trigger value	Status 1 = ">" setpoint $TEHD_U$ exceeded Status 0 = return
	19	1/0	Trigger value	Status 1 = ">" setpoint THD_I exceeded Status 0 = return
	20	1/0	Trigger value	Status 1 = ">" setpoint $TOHD_I$ exceeded Status 0 = return
	21	1/0	Trigger value	Status 1 = ">" setpoint $TEHD_I$ exceeded Status 0 = return
	22	1/0	Trigger value	Status 1 = ">" setpoint unbalance U exceeded Status 0 = return
23	1/0	Trigger value	Status 1 = ">" setpoint unbalance I exceeded Status 0 = return	
24	1/0	Trigger value	Status 1 = ">" setpoint rotating field active Status 0 = return	

Event classification	Event sub-classification	Status	Event value	Meaning
3 (Setpoint)	25	1/0	Trigger value	Status 1 = ">" setpoint I_4 exceeded Status 0 = return
	26...31	Reserved		
	32	1/0	Trigger value	Status 1 = ">" setpoint I_r active Status 0 = return
	33	1/0	Trigger value	Status 1 = ">" setpoint U_2 (negative sequence component) active Status 0 = return
	34	1/0	Trigger value	Status 1 = ">" setpoint U_0 (zero sequence component) active Status 0 = return
	35...40	Reserved		
	41	1/0	Trigger value	Status 1 = below "<" setpoint U_{LN} Status 0 = return
	42	1/0	Trigger value	Status 1 = below "<" setpoint U_{LL} Status 0 = return
	43	1/0	Trigger value	Status 1 = below "<" setpoint I Status 0 = return
	44	1/0	Trigger value	Status 1 = below "<" setpoint I_n Status 0 = return
	45	1/0	Trigger value	Status 1 = below "<" setpoint f Status 0 = return
	46	1/0	Trigger value	Status 1 = below "<" setpoint P_{tot} Status 0 = return
	47	1/0	Trigger value	Status 1 = below "<" setpoint Q_{tot} Status 0 = return
	48	1/0	Trigger value	Status 1 = below "<" setpoint S_{tot} Status 0 = return
	49	1/0	Trigger value	Status 1 = below "<" setpoint λ_{tot} Status 0 = return
	50	1/0	Trigger value	Status 1 = below "<" setpoint demand P_{tot} Status 0 = return
	51	1/0	Trigger value	Status 1 = below "<" setpoint demand Q_{tot} Status 0 = return
52	1/0	Trigger value	Status 1 = below "<" setpoint demand S_{tot} Status 0 = return	

Event classification	Event sub-classification	Status	Event value	Meaning
3 (Setpoint)	53	1/0	Trigger value	Status 1 = below "<" setpoint predicted demand P_{tot} Status 0 = return
	54	1/0	Trigger value	Status 1 = below "<" setpoint predicted demand Q_{tot} Status 0 = return
	55	1/0	Trigger value	Status 1 = below "<" setpoint predicted demand S_{tot} Status 0 = return
	56	1/0	Trigger value	Status 1 = below "<" setpoint THD U Status 0 = return
	57	1/0	Trigger value	Status 1 = below "<" setpoint TOHD U Status 0 = return
	58	1/0	Trigger value	Status 1 = below "<" setpoint TEHD U Status 0 = return
	59	1/0	Trigger value	Status 1 = below "<" setpoint THD I Status 0 = return
	60	1/0	Trigger value	Status 1 = below "<" setpoint TOHD I Status 0 = return
	61	1/0	Trigger value	Status 1 = below "<" setpoint TEHD I Status 0 = return
	62	1/0	Trigger value	Status 1 = below "<" setpoint unbalance U Status 0 = return
	63	1/0	Trigger value	Status 1 = below "<" setpoint unbalance I Status 0 = return
	64	1/0	Trigger value	Status 1 = below "<" setpoint I_4 Status 0 = return
	65...68		Reserved	
	69	1/0	Trigger value	Status 1 = ">" setpoint I_r active Status 0 = return
	70	1/0	Trigger value	Status 1 = "<" setpoint U2 (negative sequence component) active Status 0 = return
71	1/0	Trigger value	Status 1 = "<" setpoint U0 (zero sequence component) active Status 0 = return	

Event classification	Event sub-classification	Status	Event value	Meaning
4 (Diagnosis)	1	1	0	System parameter fault
	2	1	0	Internal device fault
	3	1	0	Tariff schedule parameter fault
	4	1	0	Memory fault
5 (Operation)	1	1	0	Supply voltage on
	2	2	0	Supply voltage off
	3	0	0	Present energy log cleared via front panel operation ¹⁾
	4	0	0	Stored energy log cleared via front panel operation ²⁾
	5	0	0	Peak demand of this month cleared via front panel operation
	6	0	0	Present demand, present peak demand and peak demand of the previous month cleared via front panel operation
	7	0	0	Max./Min. value log of this month cleared via front panel operation
	8	0	0	All Max./Min. value logs cleared via front panel operation
	9	0	0	All logs cleared via front panel operation ³⁾
	10	0	0	SOE event log cleared via front panel operation
	11	0	x = 1...4	Dlx pulse counter cleared via front panel operation
	12	0		All Dlx pulse counters cleared via front panel operation
	13	0		Device operating time cleared via front panel operation
	14	0	0	Time set via front panel operation
	15	0	0	Setup changed via front panel operation
	16...29	Reserved		
30	0	0	All energy logs cleared via communication ⁴⁾	

Event classification	Event sub-classification	Status	Event value	Meaning	
5 (Operation)	31	0	0	Energy log of this month cleared via communication ⁵⁾	
	32	0	0	Concluded monthly energy logs cleared via communication ⁶⁾	
	33	0	0	Peak demand of this month cleared via communication	
	34	0	0	Present demand, present peak demand and peak demand of the previous month cleared via communication	
	35	0	0	Max./Min. log of this month cleared via communication	
	36	0	0	All Max./Min. value logs cleared via communication	
	37	0	0	All logs cleared via communication ³⁾	
	38	0	0	SOE event log cleared via communication	
	39	0	x = 1...4	Dlx pulse counter cleared via communication	
	40	0	0	All DI pulse counters cleared via communication	
	41	0	0	Device operating time cleared via communication	
	42	Reserved			
	43	0	0	Setup changed via communication	
	44	0	0	Energy meters were set via communication	
	45	0	0	Scheduled tariffs (T1...T8) were set via communication	
	46	0	1...4	Tariff schedule has been switched ⁷⁾	
	47	0	x = 1...5	DRx log cleared via communication	
48			All data recorder logs cleared via communication		

Tab. 16.35: Event classification

- 1) Clear register from "chapter 16.2.1 Energy meters and tariffs (present measured values)" and "chapter 16.2.2 Monthly energy log (Energy Log)" (only this month)
- 2) Clear register of the concluded energy logs(chapter 16.2.2) (except this month)
- 3) Clear all energy meters and tariffs (see footnote 1), peak demand and Max./Min. logs, device operating time, DI pulse counters
For PEM353-N only: clear also data recorders, daily and monthly logs (freeze logs)
- 4) Clear register for energy measurement (chapter 16.2) (except this month)

- 5) Clear monthly energy log of the present month (chapter 16.2.2, register content 0980 = 0)
- 6) Clear all concluded energy logs of the last months (chapter 16.2.2, register content 0980 = 1...12)
- 7) Tariff schedule has been switched with the following event values:

Entry	Description
1	Manual switching from schedule 1 to schedule 2
2	Manual switching from schedule 2 to schedule 1
3	Automatic switching from schedule 1 to schedule 2
4	Automatic switching from schedule 2 to schedule 1

16.19 DOx control

The control registers of the digital outputs are implemented as Write-Only registers (WO) and can be controlled with the function code 0x05 or 0x10. In order to query the current DO status, **register 0098** has to be read out.

When **register 6032 = 1** is set, the PEM353 supports the execution of commands on the outputs in two steps (**Arm Before Executing**): Before sending an open or close command to one of the outputs, it must be "armed" first. This is achieved by writing 0xFF00 to the respective DO register. If the armed output does not receive a command to be executed within 15 seconds, this output will be disarmed again and will not be available for adjustment.

If a command to be executed is sent to an output which has not been "armed" previously, the PEM353 ignores the command and instead returns it as exception code 0x04.



*When **register 6032 = 0** is set, "arming" is not necessary: Writing 0xff00 to an "Execute" register will immediately "arm" the DO. However, if an attempt is made to bring a DO to the state in which it already is, an exception code will also be generated.*

Control register digital outputs (DO)

Register	Property	Format	Description
9100	WO	UINT16	Arm DO1 close
9101	WO	UINT16	Execute DO1 close
9102	WO	UINT16	Arm DO1 open
9103	WO	UINT16	Execute DO1 open
9104	WO	UINT16	Arm DO2 close
9105	WO	UINT16	Execute DO2 close
9106	WO	UINT16	Arm DO2 open
9107	WO	UINT16	Execute DO2 open
9108...9165	Reserved		

Tab. 16.36: Control register digital outputs (DO)

16.20 Universal measuring device information

Register	Property	Description	Format	Note
9800... 9819	RO	Model ¹⁾	UJNT16	
9820	RO	Software version	UJNT16	E.g.: 10000 = V1.00.00
9821	RO	Protocol version	UJNT16	E.g.: 40 = V4.0
9822	RO	Date of software update (year-2000)	UJNT16	E.g.: 080709 = July 9, 2008
9823	RO	Date of software update: month	UJNT16	
9824	RO	Date of software update: day	UJNT16	
9825	RO	Serial number		
9827...9828	Reserved			
9829	RO	Feature code	Bit map	Bit 0...2: 010 = I ₄ Storage bit 6 : 0 = without flash 1 = with flash Basic functions bit 7...8: 00 = 4xDI + 2x DO 01 = — 10 = 4x DI + 2x RO Other bits: Reserved

Tab. 16.37: Universal measuring device information

- 1) The universal measuring device model appears in registers 9800...9819. An encoding example is given in the table below using the "PEM353" by way of example.

Register	Value (Hex)	ASCII
9800	0x50	P
9801	0x45	E
9802	0x4D	M
9803	0x33	3
9804	0x35	5
9805	0x33	3
9806...9819	0x20	Null

Tab. 16.38: ASCII encoding of "PEM353"

17. PEM353-N

17.1 Daily and monthly logs (freeze logs)

Energy and demand values can be stored automatically at a specified time ("freeze logs").

Storage capacity daily log: 60 days (2 months)

Storage capacity monthly log: 36 months (3 years)

Both the setting of the log time and the log contents can only be accessed via the communication interface.

17.1.1 Daily freeze log

The following parameters are stored in the daily log for each freeze log:

- Total active energy
- Total reactive energy
- Total apparent energy
- Peak demand P_{tot}
- Peak demand Q_{tot}
- Peak demand S_{tot}

Each of these 60 freeze logs has a timestamp (time of storage).

Setting the storage time (register 6042)

- 0 = freeze log every day at 00:00 h
- Not 0: time = (hour x 100 + minute) where hour = 0...23 and minute = 0...59

Example: 1612 = every day at 16:12 h

Daily freeze log register

Register	Property	Description	Format	Factor	Unit
12000	RW	Index ¹⁾	INT16	1...60	
12001	RO	HiByte: year-2000 LoByte: month (1...12)	INT16	—	
12002	RO	HiByte: day (0...31) LoByte: hour (1...23)	INT16		
12003	RO	HiByte: minute (0...59) LoByte: second (0...59)	INT16		
12004	RO	Total active energy	INT32	x 0.1	kWh
12006	RO	Total reactive energy	INT32	x 0.1	kvarh
12008	RO	Total apparent energy	INT32	x 0.1	kVA
12010	RO	Peak demand P_{tot}	Float	x 1	W
12012	RO	Peak demand Q_{tot}	Float	x 1	var
12014	RO	Peak demand S_{tot}	Float	x 1	VA

Tab. 17.1: Daily freeze log register

- 1) To retrieve the values of a certain day from registers 12001...12014, a value $N = 1...60$ must be written to register 12000. The value N determines the day: 1 = previous day, 2 = two days back, etc.

If an invalid value is written to the register ($N = 0$ or > 60), exception code 0x03 will be returned.

If all registers 12001...12014 of one day return the value "0", the entry is invalid or no more entries have been stored (e.g. in case of a new device).

It is recommended to start with $N = 1$ on the first readout of the daily log and end with $N = 60$ (or with the first invalid return value). On each following day, the values of the newest entry at that time can be simply retrieved with $N = 1$.

17.1.2 Monthly freeze log

The following parameters are stored in the monthly log:

- Total active energy
- Total reactive energy
- Total apparent energy
- Peak demand P_{tot}
- Peak demand Q_{tot}
- Peak demand S_{tot}

Each of these 30 freeze logs has a timestamp. In addition, the peak demand values have their own timestamp (time of occurrence).

Setting the storage time (register 6041)

- 0 = freeze log at 00:00 h on the 1st of each month
- Not 0: time = (day x 100 + hour) where day = 0...28 and hour = 0...23

Example: 1612 = at 16:00 h on the 16th of each month

Monthly freeze log register

Register	Property	Description	Format	Factor	Unit
12500	RW	Index ¹⁾	INT16	1...36	
12501	RO	HiByte: year-2000 LoByte: month (1...12)	INT16	—	
12502	RO	HiByte: day (0...31) LoByte: hour (1...23)	INT16		
12503	RO	HiByte: minute (0...59) LoByte: second (0...59)	INT16		
12504	RO	Total active energy	INT32	x 0.1	kWh
12506	RO	Total reactive energy	INT32	x 0.1	kvarh
12508	RO	Total apparent energy	INT32	x 0.1	kVA
12510...12515	RO	Peak demand P_{tot}	Note ²⁾		
12516...12521	RO	Peak demand Q_{tot}			
12522...12527	RO	Peak demand S_{tot}			

Tab. 17.2: Monthly freeze log register

Notes Tab. 17.2

- 1) To retrieve the values of a certain day from registers 12501...12527, a value $N = 1 \dots 36$ must be written to register 12000. The value N determines the month: 1 = previous month, 2 = two months back, etc.

If an invalid value is written to the register ($N = 0$ or > 36), exception code 0x03 will be returned.

If all registers 12501...12527 of one day return the value "0", the entry is invalid or no more entries have been stored (e.g. in case of a new device).

It is recommended to start with $N = 1$ on the first readout of the monthly log and end with $N = 36$ (or with the first invalid return value). In each following month, the values of the newest entry at that time can be simply retrieved with $N = 1$.

- 2) Peak demand data structure

Offset	Description	Note
+ 0	HiWord: year	1...99 (year-2000)
	LoWord: month	1...12
+ 1	HiWord: day	1...28/29/30/31
	LoWord: hour	0...23
+2	HiWord: minute	0...59
	LoWord: second	0...59
+ 3	Millisecond	0...999
+4...+5	Peak demand value	

Tab. 17.3: Peak demand data structure

17.2 Data recorders DR

There are 5 data recorders DR1...5 which can record up to 16 parameters each. Event in the event of a voltage interruption, the memory contents are not lost. Data recorders can only be programmed and read out via the communication interface.

17.2.1 DR setup parameters

No.	Setup parameter	Value/Option	Factory setting
1	Trigger mode	0 = disabled 1 = by timer	1
2	Recording mode	0 = stop-when-full 1 = FIFO (First-In-First-Out)	1
3	Number of records	1...10,000 entries	5760
4	Recording interval	60...3,456,000 s (40 days)	900
5	Recording delay ¹⁾	0...43,200 s (12 h)	0
6	Number of measured quantities	0...16	16
7	Measured quantities 1...16	0...331 (see chapter 17.2.2)	

Tab. 17.4: Setup data recorders



The data recorder is only enabled when the parameters 1...4 are all non-zero!

¹⁾ "Recording delay":

In trigger mode 1, a fixed time can be set in seconds to delay the start of measurement (triggered by timer). Example: "300" means that the recording will be delayed by 5 minutes after being triggered by the timer. In order to obtain evaluable results, the time set for the recording delay should be less than that of the recording interval.

17.2.2 Key to measured quantities used for data recorders DR

16 measured quantities per data recorder can be selected from the table below:

Key	Measured quantity (data recorder)	Factor/unit
	Present measured value	
1	U_{L1}	V
2	U_{L2}	V
3	U_{L3}	V
4	$\emptyset U_{LN}$	V
5	U_{L1L2}	V
6	U_{L2L3}	V
7	U_{L3L1}	V
8	$\emptyset U_{LL}$	V
9	I_1	A
10	I_2	A
11	I_3	A
12	$\emptyset I$	A
13	P_1	W
14	P_2	W
15	P_3	W
16	P_{tot}	W
17	Q_1	var
18	Q_2	var
19	Q_3	var
20	Q_{tot}	var
21	S_{L1}	VA
22	S_{L2}	VA
23	S_{L3}	VA
24	S_{tot}	VA
25	λ_{L1}	

Key	Measured quantity (data recorder)	Factor/unit
26	λ_{L2}	
27	λ_{L3}	
28	λ_{tot}	
29	f	Hz
30	Phase angle U_{L1} / phase angle U_{L1L2}	°
31	Phase angle U_{L2} / phase angle U_{L2L3}	°
32	Phase angle U_{L3} / phase angle U_{L3L1}	°
33	Phase angle I_1	°
34	Phase angle I_2	°
35	Phase angle I_3	°
36	I_n (calculated)	A
37	I_4 (measured)	A
38	reserved	
39	reserved	
40	reserved	
	Power Quality	
41	P_{L1}	W
42	P_{L2}	W
43	P_{L3}	W
44	P_{tot}	W
45	THD P_{tot}	
46	TDD I_1	
47	TDD I_2	
48	TDD I_3	
49	TOHD I_1	
50	TOHD I_2	
51	TOHD I_3	

Key	Measured quantity (data recorder)	Factor/unit
52	TEHD I_1	
53	TEHD I_2	
54	TEHD I_3	
55	k-factor I_1	
56	k-factor I_2	
57	k-factor I_3	
58	Crest factor I_1	
59	Crest factor I_2	
60	Crest factor I_3	
61	Unbalance U	
62	Unbalance I	
63	THD _{L1L2} or THD _{L1}	
64	THD _{L2L3} or THD _{L2}	
65	THD _{L3L1} or THD _{L3}	
66	TOHD _{L1L2} or TOHD _{L1}	
67	TOHD _{L2L3} or TOHD _{L2}	
68	TOHD _{L3L1} or TOHD _{L3}	
69	TEHD _{L1L2} or TEHD _{L1}	
70	TEHD _{L2L3} or TEHD _{L2}	
71	TEHD _{L3L1} or TEHD _{L3}	
72	HD02 _{UL1L2} or HD02 _{L1}	
73	HD02 _{UL2L3} or HD02 _{L2}	
74	HD02 _{UL3L1} or HD02 _{L3}	
75	HD03 _{UL1L2} or HD03 _{L1}	
76	HD03 _{UL2L3} or HD03 _{L2}	
77	HD03 _{UL3L1} or HD03 _{L3}	
...	...	

Key	Measured quantity (data recorder)	Factor/unit
159	HD31 _{UL1L2} or HD31 _{L1}	
160	HD31 _{UL2L3} or HD31 _{L2}	
161	HD31 _{UL3L1} or HD31 _{L3}	
162	THD _{I1}	
163	THD _{I2}	
164	THD _{I3}	
165	TOHD _{I1}	
166	TOHD _{I2}	
167	TOHD _{I3}	
168	TEHD _{I1}	
169	TEHD _{I2}	
170	TEHD _{I3}	
171	HD02 _{I1}	
172	HD02 _{I2}	
173	HD02 _{I3}	
...		
258	HD31 _{I1}	
259	HD31 _{I2}	
260	HD31 _{I3}	
	Energy measurement	
261	DI1 pulse counter	
262	DI2 pulse counter	
263	DI3 pulse counter	
264	DI4 pulse counter	
265	DI5 pulse counter	
266	DI6 pulse counter	
267	Active energy import	Wh
268	Active energy export	Wh

Key	Measured quantity (data recorder)	Factor/unit
269	Net active energy	Wh
270	Total active energy	Wh
271	Reactive energy import	varh
272	Reactive energy export	varh
273	Net reactive energy	varh
274	Total reactive energy	varh
275	Apparent energy	VAh
276	Reactive energy Q1	varh
277	Reactive energy Q2	varh
278	Reactive energy Q3	varh
279	Reactive energy Q4	varh
280	Import active energy, tariff 1	Wh
281	Export active energy, tariff 1	Wh
282	Import reactive energy, tariff 1	varh
283	Export reactive energy, tariff 1	varh
284	Apparent energy, tariff 1	VAh
285	Import active energy, tariff 2	Wh
286	Export active energy, tariff 2	Wh
287	Import reactive energy, tariff 2	varh
288	Export reactive energy, tariff 2	varh
289	Apparent energy, tariff 2	VAh
290	Import active energy, tariff 3	Wh
291	Export active energy, tariff 3	Wh
292	Import reactive energy, tariff 3	varh
293	Export reactive energy, tariff 3	varh
294	Apparent energy, tariff 3	VAh
295	Import active energy, tariff 4	Wh
296	Export active energy, tariff 4	Wh

Key	Measured quantity (data recorder)	Factor/unit
297	Import reactive energy, tariff 4	varh
298	Export reactive energy, tariff 4	varh
299	Apparent energy, tariff 4	VAh
300	Import active energy, tariff 5	Wh
301	Export active energy, tariff 5	Wh
302	Import reactive energy, tariff 5	varh
303	Export reactive energy, tariff 5	varh
304	Apparent energy, tariff 5	VAh
305	Import active energy, tariff 6	Wh
306	Export active energy, tariff 6	Wh
307	Import reactive energy, tariff 6	varh
308	Export reactive energy, tariff 6	varh
309	Apparent energy, tariff 6	VAh
310	Import active energy, tariff 7	Wh
311	Export active energy, tariff 7	Wh
312	Import reactive energy, tariff 7	varh
313	Export reactive energy, tariff 7	varh
314	Apparent energy, tariff 7	VAh
315	Import active energy, tariff 8	Wh
316	Export active energy, tariff 8	Wh
317	Import reactive energy, tariff 8	varh
318	Export reactive energy, tariff 8	varh
319	Apparent energy, tariff 8	VAh
	Demand measured values	
320	Present demand I_1	A
321	Present demand I_2	A
322	Present demand I_3	A
323	Present demand P_{tot}	W

Key	Measured quantity (data recorder)	Factor/unit
324	Present demand Q_{tot}	var
325	Present demand S_{tot}	VA
326	$I_{1 \text{ max}}$ of the present demand period	A
327	$I_{2 \text{ max}}$ of the present demand period	A
328	$I_{3 \text{ max}}$ of the present demand period	A
329	$P_{\text{ max}}$ of the present demand period	W
330	$Q_{\text{ max}}$ of the present demand period	var
331	$S_{\text{ max}}$ of the present demand period	VA
332	Present residual current	
	I_r	A

Tab. 17.5: Key to measured quantities for the data recorders

17.2.3 Factory settings data recorders

Parameter	DR1	DR2	DR3	DR4	DR5
Trigger mode	Timer				
Recording mode	FIFO				
Number of records	5760				
Recording interval	900				
Recording delay	0				
Number of measured quantities	15	16	16	15	16
Measured quantity 1	Active energy import	U_{L1L2}	U_{L1}	THD _{UL1} / THD _{UL1L2}	Tariff 1: active energy import
Measured quantity 2	Active energy export	U_{L2L3}	U_{L2}	THD _{UL2} / THD _{UL2L3}	Tariff 1: active energy export
Measured quantity 3	Total active energy	U_{L3L1}	U_{L3}	THD _{UL3} / THD _{UL3L1}	Tariff 1: reactive energy import
Measured quantity 4	Net active energy	$\emptyset U_{LL}$	$\emptyset U_{LN}$	THD _{I1}	Tariff 1: reactive energy export

Parameter	DR1	DR2	DR3	DR4	DR5
Measured quantity 5	Reactive energy import	I_1	P_{L1}	THD ₁₂	Tariff 2: active energy import
Measured quantity 6	Reactive energy export	I_2	P_{L2}	THD ₁₃	Tariff 2: active energy export
Measured quantity 7	Total reactive energy	I_3	P_{L3}	TDD ₁₁	Tariff 2: reactive energy import
Measured quantity 8	Net reactive energy	$\emptyset I$	Q_{L1}	TDD ₁₂	Tariff 2: reactive energy export
Measured quantity 9	Total apparent energy	I_n (calculated)	Q_{L2}	TDD ₁₃	Tariff 3: active energy import
Measured quantity 10	Demand P_{tot}	P_{tot}	Q_{L3}	k-factor I_1	Tariff 3: active energy export
Measured quantity 11	Demand Q_{tot}	Q_{tot}	S_{L1}	k-factor I_2	Tariff 3: reactive energy import
Measured quantity 12	Demand S_{tot}	S_{tot}	S_{L2}	k-factor I_3	Tariff 3: reactive energy export
Measured quantity 13	Demand I_1	λ_{tot}	S_{L3}	Crest factor I_1	Tariff 4: active energy import
Measured quantity 14	Demand I_2	f	λ_{L1}	Crest factor I_2	Tariff 4: active energy export
Measured quantity 15	Demand I_3	Unbalance U	λ_{L2}	Crest factor I_3	Tariff 4: reactive energy import
Measured quantity 16	—	Unbalance I	λ_{L3}	—	Tariff 4: reactive energy export

Tab. 17.6: Factory settings data recorders

17.2.4 Reading out the data recorders

Register	Property	Description	Format
20000...20037	RO	Log data recorder 1	see Tab. 17.8
20038...20075	RO	Log data recorder 2	
20076...20113	RO	Log data recorder 3	
20114...20151	RO	Log data recorder 4	
20152...20189	RO	Log data recorder 5	

Tab. 17.7: ata recorders register

17.2.5 Data structure data recorders

Offset	Property	Description	Format	Note
+ 0	RW	Pointer data recorders	UINT32	
+2	RO	HiWord: year LoWord: month	UINT16	1...99 (year-2000) 1...12
+ 3	RO	HiWord: day LoWord: hour	UINT16	1...28/29/30/31 0...23
+4	RO	HiWord: minute LoWord: second	UINT16	0...59 0...59
+5	RO	Millisecond	UINT16	0...999
+6...+7	RO	Parameter 1	Float	
+8...+9	RO	Parameter 2	Float	
+10...+11	RO	Parameter 3	Float	
...				
+36...+37	RO	Parameter 16	Float	

Tab. 17.8: Data structure data recorders

Notes Tab. 17.8

Writing a number "n" into the pointer register of the corresponding data recorder displays the data of the nth data point of this recorder in the following 35 registers, if they have already been recorded.

Writing a pointer value pointing to a **recorder data set** that is either already overwritten or has not been recorded yet will generate an exception response with the error code (0x03) as defined by the Modbus protocol.

18. Technical data

18.1 Tabular data

Insulation coordination acc. to IEC 60664-1/IEC 60664-3

Definitions

Measuring circuit 1 (IC1).....	(L1, L2, L3, N)
Measuring circuit 2 (IC2).....	(•I11, I12, •I21, I22, •I31, I32, •I41, 42)
Supply circuit (IC3).....	(A1/+ , A2/-)
Output circuit 1 (IC4)	
PEM353-N, PEM353.....	(D013, D014)
PEM353-P.....	(E1+ , E1-)
Output circuit 2 (IC5)	
PEM353-N, PEM353.....	(D023, D024)
PEM353-P.....	(E2+ , E2-)
Control circuit 1 (IC6).....	(D1C, D11, D12, D13, D14)
Control circuit 2 (IC7).....	(D+ , D-)
Overvoltage category	
IC1, IC3.....	III
IC2, IC4, IC5, IC6.....	II
Pollution degree.....	2
Rated voltage	
IC1.....	AC 277 V U_{LN} / 480 V U_{LL}
IC2.....	AC 300 V
IC3.....	AC/DC 250 V
IC4, IC5	
PEM353, PEM353-N.....	AC 250 V
PEM353-P.....	DC 30 V
IC6.....	DC 30 V
Rated insulation voltage	
IC1 / (IC2 . . . 7).....	500 V
IC2 / (IC3 . . . 7).....	320 V
IC3 / (IC4 . . . 7).....	320 V
IC4 / (IC5 . . . 7).....	320 V
IC5 / (IC6 . . . 7).....	320 V
IC6 / IC7.....	32 V

Rated impulse voltage

IC1 / (IC2...7)	4 kV
IC2 / (IC3...7)	4 kV
IC3 / (IC4...7)	4 kV
IC4 / (IC5...7)	4 kV
IC5 / (IC6...7)	4 kV
IC6 / IC7	800 V

Safe separation (reinforced insulation) between

IC1 / (IC2...7)	overvoltage category III, 300 V
IC2 / (IC3...7)	overvoltage category II, 300 V
IC3 / (IC4...7)	overvoltage category III, 300 V
IC4 / (IC5...7)	overvoltage category II, 300 V
IC5 / (IC6...7)	overvoltage category II, 300 V

Voltage test (routine test) acc. to IEC 61010-1:

IC1 / (IC2...7)	AC 2.0 kV, 1 minute
IC2 / (IC3...7)	AC 2.0 kV, 1 minute
IC3 / (IC4...7)	AC 2.0 kV, 1 minute
IC4 / (IC5...7)	AC 2.0 kV, 1 minute
IC5 / (IC6...7)	AC 2.0 kV, 1 minute

Supply voltage

Supply voltage	AC/DC 95...250 V ($\pm 10\%$)
Frequency range	DC, 47...440 Hz
Power consumption	< 5 VA

Measuring voltage inputs

Nominal voltage $U_{L1,L2,L3}$	230 V
Nominal voltage $U_{L1L2,L2L3,L3L1}$	400 V
Measuring range.....	10 V... 200 % U_n
Internal resistance $U_{L1-N,L2-N,L3-N}$	> 12 M Ω
Transformation ratio of the measuring voltage transformer	
Primary	1...1,000,000 V
Secondary	1...690 V
Max. transformation ratio	10,000

Measuring current transformer inputs

I_{nom}	5 A
Measuring range	0.1 ... 200 % I_{nom}
Load	< 0.15 VA
Overload range.....	2 x I_{nom} permanent, 20 x $I_{nom} \leq 1$ s
Transformation ratio of the measuring current transformer	
Primary	1 ... 30000 A
Secondary	1 ... 5 A

Accuracies (OMV = of measured value/OFS = of full-scale value)

Phase voltage $U_{L1-N,L2-N,L3-N}$	± 0.2 % OMV, +0.05 % OFS
Current $I_{1, 2, 3}$	± 0.2 % OMV, +0.05 % OFS
Neutral current I_4 (PEM353-N)	± 0.2 % OMV
Frequency f	± 0.02 Hz
Phasing	$\pm 1^\circ$
Active power, reactive power.....	± 0.5 % OMV, +0.05 % OFS
Power factor λ	± 0.5 %
Measurement of the active energy acc. to DIN EN 62053-22 (VDE 0418 part 3-22)	
Accuracy class with 5 A measuring current transformers	0.5 S
Accuracy class with 1 A measuring current transformers	1 S
Measurement of the voltage r.m.s. values.....	acc. to DIN EN 61557-12 (VDE 0413-12), chapter 4.7.6
Measurement of the phase current r.m.s. values	acc. to DIN EN 61557-12 (VDE 0413-12), chapter 4.7.5
Frequency measurement	acc. to DIN EN 61557-12 (VDE 0413-12), chapter 4.7.4

Interface

Interface: Protocol	RS-485: Modbus RTU, BACnet MS/TP, DNP
Baud rate	1.2 ... 38.4 kbit/s
Cable length	0 ... 1200 m
Recommended cable (shielded)	J-Y(St)Y min. 2 x 0.8

Switching elements

Outputs	2 N/O contacts
Operating principle	N/O operation
PEM353-N, PEM353.....	
Relay contacts, N/O operation, AC 250 V or DC 30 V	5 A
Minimum current I_{min}	1 mA at AC/DC ≥ 10 V
PEM353-P.....	
Pulse output	max. DC 30 V, max. 30 mA
Cable length	≤ 30 m

Inputs.....	4 common galv. isolated digital inputs
I_{\min}	1 mA
U_{D1}	DC 24 V

Environment/EMC

EMC	IEC 61326-1
Operating temperature.....	-25...+55 °C
Classification of climatic conditions acc. to IEC 60721 (stationary use)	3K6
Classification of mechanical conditions acc. to IEC 60721 (stationary use)	3M4
Range of use	< 2000 m

Connection

Connection type.....	screw-type terminals, plug-in connector
----------------------	---

Other

Degree of protection, installation	IP20
Degree of protection, front (with rubber seal)	IP54
Weight	≤ 350 g

18.2 Standards and certifications

The specified standards take into account the edition valid until 11.2017 unless otherwise indicated.

PEM353 was designed in accordance with the following standards:

DIN EN 62053-22 (VDE 0418 Part 3-22)

Electricity metering equipment (a.c.) - Particular requirements - Part 22: Static meters for active energy (classes 0.2 S and 0.5 S) (IEC 62053);

DIN EN 61557-12 (VDE 0413-12)

Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. - Equipment for testing, measuring or monitoring of protective measures – Part 12: Performance measuring and monitoring devices (PMD)

DIN IEC 61554:2002-08

Panel mounted equipment – Electrical measuring instruments – Dimensions for panel mounting (IEC 61554:1999)

18.3 Ordering details

Type	Article number
<p>PEM353-N 4 DI, 2 RO, RS-485 (Modbus RTU) 5 A Class 0.5 S for operation with 5 A measuring current transformers Class 1 S for operation with 1 A measuring current transformers 277 V U_{LN} / 480 V U_{LL} 45...65 Hz I4 4 MB memory Supply: 95...250 V; DC, AC 47...440 Hz English</p>	B93100353
<p>PEM353-P 4 DI, 2 solid-state pulse outputs, RS-485 (Modbus RTU) 5 A Class 0.5 S for operation with 5 A measuring current transformers Class 1 S for operation with 1 A measuring current transformers 277 V U_{LN} / 480 V U_{LL} 45...65 Hz Supply: 95...250 V; DC, AC 47...440 Hz English</p>	B93100354
<p>PEM353 4 DI, 2 RO, RS-485 (Modbus RTU) 5 A Class 0.5 S for operation with 5 A measuring current transformers Class 1 S for operation with 1 A measuring current transformers 277 V U_{LN} / 480 V U_{LL} 45...65 Hz Supply: 95...250 V; DC, AC 47...440 Hz English</p>	B93100355

INDEX

A

Apparent power, calculation 59
Application example 20
Areas of application 15

B

Back-up fuses 23, 37

C

Commissioning 37
Communication interface 34
Connection 23
Connection diagram

- 1P2W L-L 27
- 1P2W L-N 26
- 1P3W 28
- 3P3W (Aron circuit) 30
- 3P3W with 3 measuring current transformers 29
- 3P3W with PT 32
- 3P4W 31
- 3P4W with PT 33
- Three-phase 4-wire system 33

Control

- Digital outputs 143

Crest factor 70

D

Data display 41
Data recorders

- Measured quantity key 152

Demand 67

Demand DMD 67

Demand, duration measuring period 67

Detail page

- "Demand" 44
- "Energy" 43
- "Harmonics" 45
- "I/O" 51
- "Max./Min." 47
- "Power" 43
- "SOE" 49
- HARMONICS 46
- U/I 41

Detail page "TOU" 49

Detail page "U/I" 41

Device features 19

Digital inputs 34

Digital inputs (DI) 61

Digital output

- Modbus control 143

Digital outputs 35

Digital outputs (DO) 62

Dimension diagram 21

Display mode

- Data display 41

E

Energy Pulsing

- Display 62
- LED indication 40

Event

- Classification 135
- Log 81
- Modbus register 134

F

Front panel mounting 22
Front view 21
Functional description 21
Functions 16

H

Harmonics 69
How to use this manual 9

I

Inputs, digital 34
Installation 21
Intended use 14

K

k-factor 45, 70

L

LED indication 40
Log
- Max./Min. 77
- Monthly energy log 80
- Peak demand 79
- SOE log 81

M

Measuring current transformer inputs 34
Measuring voltage inputs 34
Modbus
- Basic measured values 88
- Energy measurement 93
- Event log 134
- Measuring device information 144
- Register Map 87
- Setup parameter 114
- SOE log 134
Mounting in a front panel 22

N

Navigation 40

O

Operating elements 39
Operation 39

P

Panel cutout 22
Phase angle
- Current 69
- Voltage 69
Power and energy 65
Power factor rules 58
Power Quality 69
Product description 15

R

Removing from a front panel 22

S

Scope of delivery 15
Self-read time 79
Service 10
Set demand period 67
Setpoints 73
Setup 51
- Overview menu 52
- Setting options 53—58
Sliding Window 67
SOE log
- Modbus 134
Standard display 41
Supply voltage 34
Support 10

T

TDD 70

Technical data 161
TEHD 69, 75
Terminals 24
THD 45
THDf 70
THDr 70
TOHD 45, 69, 75
Total harmonic distortion 45
TOU 83
Training courses 11

U

Unbalance 72

V

Variants 19

W

Wiring diagrams 25
Work activities on electrical installations 13
Workshops 11



Bender GmbH & Co. KG

Londorfer Str. 65 • 35305 Gruenberg • Germany

Postfach 1161 • 35301 Gruenberg • Germany

Tel.: +49 6401 807-0 • Fax: +49 6401 807-259

E-Mail: info@bender.de • www.bender.de

© Bender GmbH & Co. KG

All rights reserved.

Reprinting only with permission of the publisher.

Subject to change!

Photos: Bender archive.



BENDER Group