PEM735 - Modbus & Communication

Universal measuring device
Software version 2.00.xx

B 9310 0735

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

Photos: Bender archive

Table of Contents

1. Modbus register and communication

This Annex provides a complete description of the Modbus register (protocol version 6.0) for the PEM735 series to facilitate access to information. The keys which are adjustable for individual parameters are also listed.

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 PEM735 supports the 4-digit addressing scheme and the following Modbus functions:

1. Holding register for reading values
   (Read Holding Register; function code 0x03)
2. Register for DO status setup
   (Force Single Coil; function code 0x05)
3. Register for device programming
   (Preset Multiple Registers; function code 0x10)
4. General read reference
   (Read General Reference; function code 0x14)

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

Explanatory comments relating to the read reference (function code 0x14)
The Modbus function code "0x14" is used to access data from the

- Data recorder (DR log)
- Energy log
- Power quality log (PQ log)
- Waveform recorder (WFR log)

Data packet structure (function code 0x14)

Read reference request packet (master to PEM)		**Read reference response packet (PEM to master)**	
Slave address	1 byte	Slave address	1 byte
Function code (0 x 14)	1 byte	Function code (0 x 14)	1 byte
Byte count	1 byte	Byte count	1 byte
Sub-Req X, reference type (0x06)	1 byte	Sub-Res X, byte count	1 byte
Sub-Req X, File number	2 bytes	Sub-Res X, Reference type (0x06)	1 byte
Sub-Req X, Start address	2 bytes	Sub-Res X, Register data	NxN_0 byte
Sub-Req X, Register count	2 bytes	Sub-Res X+1…	
Sub-Req X+1…			
Error check	2 bytes	Error check	2 bytes

Table 1.1: Data packet structure (function code 0x14)

2. Basic values

2.1 U, I, P, Q, S, λ, phase angle, status DI/DO/RO

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

Register	Property	Description	Format	Description/ unit
0042	RO	S_{L2} 1)	Float	VA
0044	RO	S_{L3} 1)	Float	VA
0046	RO	S_{ges}	Float	VA
0048	RO	λ_{L1} 1)	Float	
0050	RO	λ_{L2} 1)	Float	
0052	RO	λ_{L3} 1)	Float	
0054	RO	λ_{ges}	Float	
0056	RO	f 2)	Float	Hz
0058	RO	U_4	Float	V
0060	RO	I_4	Float	A
0062	RO	3 I_0 [(I_1+I_2+I_3)]	Float	A
0064…0069	Reserved			
0070	RO	Phase angle U_{L1} or U_{L1L2}	UINT16	x 100, °
0071	RO	Phase angle U_{L2} or U_{L2L3}	UINT16	x 100, °
0072	RO	Phase angle U_{L3} or U_{L3L1}	INT16	x 100, °
0073	RO	Phase angle I_1	INT16	x 100, °
0074	RO	Phase angle I_2	INT16	x 100, °
0075	RO	Phase angle I_3	INT16	x 100, °
0076	RO	Status DI 3)	UINT16	
0077	RO	Status DO 4) and RO	UINT16	

Table 2.1: Basic measurements

Comments on table 2.1:

1) Only in the case of wye connection (WYE).

2) Register 0056 can be refreshed every 1 or 10 s (can be set with register 7031).

3) **Status register 0076**:
Represents the **status of the six digital inputs**
B0 B7 for DI1 DI8 (1 = active/closed; 0 = inactive/opened)

4) **Status register 0077:**
Represents the **status of the digital outputs**
B0…B3 for RO1…RO4 (1 = active/closed; 0 = inactive/opened)
B4…B5 for DO1…DO2 (1 = active/closed; 0 = inactive/opened)

General: The refreshing cycle of the basic values can be set via register 7030. This has an effect on the registers 0000…0060 and 0070…0075.

2.2 Alarm status

Register	Property	Description	Format	Description/ unit
0078	RO	Alarm status 1	UINT32	
0080	RO	Alarm status 2	UINT32	

The **alarm registers 0078 and 0080** indicate the various alarm states (1 = active, 0 = inactive). The following tables illustrate the details of the alarm registers:

2.2.1 Bit sequence register 0078

Bit No.	Alarm by event	Bit No.	Alarm by event	Bit No.	Alarm by event
B0	Setpoint 1	**B11**	Setpoint 12	**B22**	Setpoint 23
B1	Setpoint 2	**B12**	Setpoint 13	**B23**	Setpoint 24
B2	Setpoint 3	**B13**	Setpoint 14	**B24**	Setpoint 25
B3	Setpoint 4	**B14**	Setpoint 15	**B25**	Setpoint 26
B4	Setpoint 5	**B15**	Setpoint 16	**B26**	Setpoint 27
B5	Setpoint 6	**B16**	Setpoint 17	**B27**	Setpoint 28
B6	Setpoint 7	**B17**	Setpoint 18	**B28**	Setpoint 29
B7	Setpoint 8	**B18**	Setpoint 19	**B29**	Setpoint 30
B8	Setpoint 9	**B19**	Setpoint 20	**B30**	Setpoint 31
B9	Setpoint 10	**B20**	Setpoint 21	**B31**	Setpoint 32
B10	Setpoint 11	**B21**	Setpoint 22		

Table 2.2: Bit sequence alarm register (0078)

2.2.2 Bit sequence register 0080

Bit No.	Alarm by event	Bit No.	Alarm by event	Bit No.	Alarm by event
B0	Logic module 1	**B3**	Logic module 4	**B6**	Logic module 7
B1	Logic module 2	**B4**	Logic module 5	**B7**	Logic module 8
B2	Logic module 3	**B5**	Logic module 6	**B8…31**	Reserved

Table 2.3: Bit sequence alarm register (0080)

2.3 Pointer

Register	Property	Description	Format
0082	RO	SOE pointer [1)]	UINT32
0084	RO	PQ log pointer [2)]	UINT32
0086	RO	WFR1 log pointer [3)]	UINT32
0088	RO	WFR2 log pointer [3)]	UINT32
0090	RO	Incremental energy log pointer [4)]	UINT32
0092	RO	High speed DR1 pointer	UINT32
0094	RO	High speed DR2 pointer	UINT32
0096	RO	High speed DR3 pointer	UINT32
0098	RO	High speed DR4 pointer	UINT32
0100…0107	Reserved		
0108	RO	DR1 pointer	UINT32
0110	RO	DR2 pointer	UINT32
0112	RO	DR3 pointer	UINT32
0114	RO	DR4 pointer	UINT32
0116	RO	DR5 pointer	UINT32
0118	RO	DR6 pointer	UINT32
0120	RO	DR7 pointer	UINT32
0122	RO	DR8 pointer	UINT32
0124	RO	DR9 pointer	UINT32
0126	RO	DR10 pointer	UINT32
0128	RO	DR11 pointer	UINT32
0130	RO	DR12 pointer	UINT32
0132	RO	DR13 pointer	UINT32
0134	RO	DR14 pointer	UINT32
0136	RO	DR15 pointer	UINT32
0138	RO	DR16 pointer	UINT32
0140	RO	EN 50160 pointer [5)]	UINT32

0142	RO	Mains signalling voltage 1 triggers WFR pointer	UINT32
0144	RO	Mains signalling voltage 2 triggers WFR pointer	UINT32
0146	RO	Mains signalling voltage 3 triggers WFR pointer	UINT32
0148	Reserved		
0150	RO	Disturbing signal WFR pointer	UINT32
0152…0159	Reserved		

Table 2.4: Pointer

1) The **SOE pointer** points to the last entry added. The event log can store up to 1024 events. It works like a ring buffer according to the FIFO principle: The event 1025 overwrites the first value, event 1026 the second one and so on. The event log can be reset in the setup parameters.

2) The **PQ log pointer** points to the last entry added. The PQ event log can store up to 1024 events. It works like a ring buffer according to the FIFO principle: The 1025th event overwrites the first value, the 1026th the second and so on. The event log can be reset in the setup parameter menu (see).

3) The PEM735 features two waveform recorders (WFR). Each WFR has its own pointer that indicates the most recently added entry in each case. The value of the **WFR pointer** can be between 0 and 0xFFFFFFFF. As soon as the maximum value is reached, it starts again with 0. The energy log can always be reset via the communications interface. The value 0 means that no waveform recordings exist.

4) The value of the **interval energy log pointers** and of the 20 **data recorder pointers** can be between 0 and 0xFFFFFFFF. As soon as the maximum value is reached, it starts again with 0. The energy log can always be reset via the communications interface.

5) Register 42000 ff.

2.4 Timestamp

Register	Property	Description	Format	Description/ Unit
0160	RO	Timestamp real time (s) for data	UINT32	s
0162	RO	Timestamp real time (ms) for data	UINT16	ms
0163	RO	Timestamp frequency (s) [1)]	UINT32	s
0165	RO	Timestamp frequency (ms) [1)]	UINT16	ms
0166	RO	Timestamp Pst (s)	UINT32	s
0168	RO	Timestamp Pst (ms)	UINT16	ms
0169	RO	Timestamp Plt(s)	UINT32	s
0171	RO	Timestamp Plt (ms)	UINT16	ms
0172	RO	"flagged" voltage [2)]	UINT16	--
0173	RO	"flagged" current	UINT16	--
0174	RO	"flagged" frequency	UINT16	--
0175	RO	"flagged" Plt [3)]	UINT16	--
0176	RO	"flagged" Pst [3)]	UINT16	--
0177	Reserved			
0178	RO	Voltage dip counter	UINT32	--
0180	RO	Voltage swell counter	UINT32	--
0182	RO	Interruption counter	UINT32	--
0184	RO	Transient event counter	UINT32	--
0186	RO	Rapid voltage change counter	UINT32	--
0188	RO	Mains signalling voltage 1: event counter	UINT32	--
0190	RO	Mains signalling voltage 2: event counter	UINT32	--
0192	RO	Mains signalling voltage 3: event counter	UINT32	--
0194	RO	Total number of power quality events	UINT32	

Table 2.5: Timestamp

Comments table 2.5

1) Registers 0163…0165 can be refreshed every 1 or 10 s (can be set with register 7031).

2) "flagged" Plt and "flagged" Pst can be activated with register 7032 = 1.

3) "flagged" voltage can assume one of three values:

0 = no "flagged" voltage

1 = "flagged" voltage due to voltage dips, voltage swells and other events without interruptions

2 = "flagged" voltage due to an event with interruption

The following registers can be refreshed at the speed of 10, 50 or 150 cycles at 50 Hz (or 12, 60 or 180 cycles at 60 Hz), every 10 minutes or every 2 hours (basic value refreshing speed, set register 7030):

0000…0060

0070…0075

0160…0162

0166…0167

2.5 PQ measurements (deviation)

Deviation Δ_{UL} or Δ_{ULL}
U_{over}= Voltage swell deviation
U_{under} = Voltage dip deviation

The r.m.s. value U_{rms} can be applied to evaluate the voltage swell or voltage dip deviation as a percentage relating to U_{din}.

Voltage swell deviation = 0 for $U_{rms} < U_{din}$
Voltage swell deviation = $((U_{rms} - U_{din})/U_{din}) \times 100\ \%$ for $U_{rms} \geq U_{din}$

Voltage dip deviation = 0 for $U_{rms} > U_{din}$
Voltage dip deviation = $((U_{din} - U_{rms})/U_{din} \times 100\ \%$ for $U_{rms} \leq U_{din}$

The accuracy of the voltage measurement is 0.1 %.
The voltage swell deviation or voltage dip can be set as a Setpoint.

Frequency deviation $\Delta f = ((f - f_{nom})/f_{nom}) \times 100\ \%$

Register	Property	Description	Format	Unit
0200	RO	Voltage deviation ΔU_{L1} or ΔU_{L1L2}	Float	% 1)
0202	RO	Voltage deviation ΔU_{L2} or ΔU_{L2L3}	Float	%
0204	RO	Voltage deviation ΔU_{L3} or ΔU_{L3L1}	Float	%

Register	Property	Description	Format	Unit
0206	RO	Frequency deviation Δf	Float	Hz
0208	RO	u_2	Float	%
0210	RO	u_0	Float	%
0212	RO	Relative unbalance I_2 (negative system component)	Float	%
0214	RO	Relative unbalance I_0 (zero system component)	Float	%
0216	RO	U_1 (positive sequence component)	Float	V
0218	RO	U_2 (negative phase sequence)	Float	V
0220	RO	U_0 (zero sequence component)	Float	V
0222	RO	I_1 (positive sequence component)	Float	A
0224	RO	I_2 (negative sequence component)	Float	V
0226	RO	I_0 (zero sequence component)	Float	A
0228	RO	Short-term flicker (Pst) U_{L1} or U_{L1L2}	Float	--
0230	RO	Short-term flicker (Pst) U_{L2} or U_{L2L3}	Float	--
0232	RO	Short-term flicker (Pst) U_{L3} or U_{L3L1}	Float	--
0234	RO	Long-term flicker (Plt) U_{L1} or U_{L1L2}	Float	--
0236	RO	Long-term flicker (Plt) U_{L2} or U_{L2L3}	Float	--
0238	RO	Long-term flicker (Plt) U_{L3} or U_{L3L1}	Float	--
0240	RO	Voltage swell deviation ΔU_{L1} (wye connection)	Float	%
0242	RO	Voltage swell deviation ΔU_{L2} (wye connection)	Float	%
0244	RO	Voltage swell deviation ΔU_{L3} (wye connection)	Float	%
0246	RO	Voltage dip deviation ΔU_{L1} (wye connection)	Float	%

Register	Property	Description	Format	Unit
0248	RO	Voltage dip deviation ΔU_{L2} (wye connection)	Float	%
0250	RO	Voltage dip deviation ΔU_{L3} (wye connection)	Float	%
0252	RO	Voltage swell deviation ΔU_{L1L2} (delta connection)	Float	%
0254	RO	Voltage swell deviation ΔU_{L2L3} (delta connection)	Float	%
0256	RO	Voltage swell deviation ΔU_{L3L1} (delta connection)	Float	%
0258	RO	Voltage dip deviation ΔU_{L1L2} (delta connection)	Float	%
0260	RO	Voltage dip deviation ΔU_{L2L3} (delta connection)	Float	%
0262	RO	Voltage dip deviation ΔU_{L3L1} (delta connection)	Float	%

Table 2.6: PQ measurements (deviation)

Comments table 2.6:

1) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

3. Energy measurement

3.1 r.m.s. values

Total number of full waveforms

Register	Property	Description	Format	Unit
0300	RW	Active energy import	UINT32	kWh
0302	RW	Active energy export	UINT32	kWh
0304	RO	Active energy net amount	INT32	kWh
0306	RO	Total active energy	UINT32	kWh
0308	RW	Reactive energy import	UINT32	kvarh
0310	RW	Reactive energy export	UINT32	kvarh
0312	RO	Reactive energy net amount	INT32	kvarh
0314	RO	Total reactive energy	UINT32	kvarh
0316	RW	Apparent energy	UINT32	kVAh
0318…0324	Reserved			
0326	RO	Active energy import, fractional value	Float	Ws
0328	RO	Active energy export, fractional value	Float	Ws
0330	RO	Active energy net value	Float	Ws
0332	RO	Total active energy value	Float	Ws
0334	RO	Reactive energy import, fractional value	Float	vars
0336	RO	Reactive energy export value	Float	vars
0338	RO	Reactive energy net value	Float	vars
0340	RO	Total amount of reactive energy	Float	vars
0342	RO	Apparent energy	Float	VAs
0344…0350	Reserved			

Table 3.1: Energy measurement register(cycles)

Note:
After reaching the maximum value of 999.999.999 kWh/kvarh/kVAh, the measurement starts again with 0.

3.2 Fundamental component

Register	Property	Description	Format	Unit
0352	RW	Active energy import	UINT32	kWh
0354	RW	Active energy export	UINT32	kWh
0356	RW	Reactive energy import	UINT32	kvarh
0358	RW	Reactive energy export	UINT32	kvarh
0360…0366	Reserved			
0368	RO	Active energy import	Float	Ws
0370	RO	Active energy export	Float	Ws
0372	RO	Reactive energy import	Float	vars
0374	RO	Reactive energy export	Float	vars
0376…0382	Reserved			

Table 3.2: Energy measurement register (fundamental components)

3.3 Pulse counter

Register value: number of impulses x resolution of setting
Example: When the resolution of setting is 5 and the impulses counted are 400, the register value is 5 x 400 = 2000. In order to calculate the counted impulses, the register value has to be divided by the resolution of setting.
The counter registers have a maximum of 0…999,999,999 and will roll over to zero when it is reached.

Register	Property	Description	Format
0680	RW	Pulse counter DI1	UINT32
0682	RW	Pulse counter DI2	UINT32
0684	RW	Pulse counter DI3	UINT32
0686	RW	Pulse counter DI4	UINT32
0688	RW	Pulse counter DI5	UINT32
0690	RW	Pulse counter DI6	UINT32
0692	RW	Pulse counter DI7	UINT32
0694	RW	Pulse counter DI8	UINT32

Table 3.3: Pulse counter register

4. Harmonics

All registers for measured values of harmonics are newly set over an adjustable period of time. These can be set using the modbus register 7030.
Setting possibilities:
50 Hz 10, 50, 150 cycles, 10 minutes, 2 h
60 Hz 12, 60, 180 cycles, 10 minutes, 2 h.

4.1 PQ log: Fundamental component measurement

Measured values regarding the fundamental component f_0 are stored in the registers 0700…0750.

Register	Property	Description	Format	Unit
0700	RO	$U_{L1(f0)}$ [1] or $U_{L1L2\ (f0)}$ [2]	Float	V
0702	RO	$U_{L2\ (f0)}$ [1] or $U_{L2L3\ (f0)}$ [2]	Float	V
0704	RO	$U_{L3\ (f0)}$ [1] or $U_{L3L1\ (f0)}$ [2]	Float	V
0706	RO	Ø $U_{LN\ (f0)}$ [1] or Ø $U_{LL\ (f0)}$ [2]	Float	V
0708	RO	$I_{1(f0)}$	Float	A
0710	RO	$I_{2\ (f0)}$	Float	A
0712	RO	$I_{3(f0)}$	Float	A
0714	RO	Ø $I_{(f0)}$	Float	A
0716	RO	$U_{4\ (f0)}$	Float	V
0718	RO	$I_{4\ (f0)}$ [3]	Float	A
0720	RO	$P_{L1(f0)}$ [1]	Float	W
0722	RO	$P_{L2(f0)}$ [1]	Float	W
0724	RO	$P_{L3(f0)}$ [1]	Float	W
0726	RO	$P_{ges\ (f0)}$	Float	W
0728	RO	$Q_{L1\ (f0)}$ [1]	Float	var
0730	RO	$Q_{L2\ (f0)}$ [1]	Float	var

Register	Property	Description	Format	Unit
0732	RO	$Q_{L3\ (f0)}$ [1]	Float	var
0734	RO	$Q_{ges\ (f0)}$	Float	var
0736	RO	$S_{L1\ (f0)}$ [1]	Float	VA
0738	RO	$S_{L2\ (f0)}$ [1]	Float	VA
0740	RO	$S_{L3\ (f0)}$ [1]	Float	VA
0742	RO	$S_{ges\ (f0)}$	Float	VA
0744	RO	$\lambda_{L1\ (f0)}$ [1) 4)]	Float	
0746	RO	$\lambda_{L2\ (f0)}$ [1]	Float	
0748	RO	$\lambda_{L3\ (f0)}$ [1]	Float	
0750	RO	$\lambda_{ges\ (f0)}$	Float	

Table 4.1: Register fundamental component measurement

Comments table 4.1:

1) Only in the case of wye connection (WYE).

2) Only in the case of delta connection (DELTA).

3) I_4 input only, otherwise it is reserved

4) λ is the power factor related to the fundamental component. This is the cosine of the angle between the fundamental component of the voltage and the current.

4.2 PQ log: k-factor, THD, TOHD, TEHD

k-factor The k-factor refers to the capability of distorted currents to generate power loss in transformers, for example.

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

I_h = rms I of the harmonic No. h
h_{max} = number of the max. harmonic
h = harmonic No. h

THD **T**otal **H**armonic **D**istortion
TOHD **T**otal **O**dd **H**armonic **D**istortion
TEHD **T**otal **E**ven **H**armonic **D**istortion

Register	Property	Description	Format	Unit
0752	RO	k-factor I_1	Float	
0754	RO	k-factor I_2	Float	
0756	RO	k-factor I_3	Float	
0758	RO	k-factor I_4 [3]	Float	
0760	RO	THD_{UL1} [1] or THD_{UL1L2} [2]	Float	% or V [4] [5]
0762	RO	THD_{UL2} [1] or THD_{UL2L3} [2]	Float	% or V
0764	RO	THD_{UL3} [1] or THD_{UL3L1} [2]	Float	% or V
0766	RO	THD_{U4}	Float	% or V
0768	RO	THD_{I1}	Float	% or A
0770	RO	THD_{I2}	Float	% or A
0772	RO	THD_{I3}	Float	% or A
0774	RO	THD_{I4} [3] or reserved	Float	% or A
0776	RO	$TOHD_{UL1}$ [1] or $TOHD_{UL1L2}$ [2]	Float	% or V
0778	RO	$TOHD_{UL2}$ [1] or $TOHD_{UL2L3}$ [2]	Float	% or V
0780	RO	$TOHD_{UL3}$ [1] or $TOHD_{UL3L1}$ [2]	Float	% or V
0782	RO	$TOHD_{U4\,f(0)}$	Float	% or V
0784	RO	$TOHD_{I1}$	Float	% or A
0786	RO	$TOHD_{I2}$	Float	% or A
0788	RO	$TOHD_{I3}$	Float	% or A
0790	RO	$TOHD_{I4}$ [3] or reserved	Float	% or A
0792	RO	$TEHD_{UL1}$ [1] or $TEHD_{UL1L2}$ [2]	Float	% or V
0794	RO	$TEHD_{UL2}$ [1] or $TEHD_{UL2L3}$ [2]	Float	% or V
0796	RO	$TEHD_{UL3}$ [1] or $TEHD_{UL3L1}$ [2]	Float	% or V
0798	RO	$TEHD_{U4\,f(0)}$	Float	% or V
0800	RO	$TEHD_{I1}$	Float	% or A

Register	Property	Description	Format	Unit
0802	RO	THD_{I2}	Float	% or A
0804	RO	THD_{I3}	Float	% or A
0806	RO	THD_{I4} [3] or reserved	Float	% or A

Table 4.2: Register harmonic measurements

Note table 4.2:

1) Only in the case of wye connection (WYE).
2) Only in the case of delta connection (DELTA).
3) I_4-input, otherwise it is reserved.
4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.
5) Registers 7024 and 7025 specify, whether the register content is given in % or in V resp. A.

4.3 PQ log: Individual harmonic

The harmonics can be calculated as pure r.m.s. values (in V or A) or harmonic distortion (in %). You can specify this in the **registers 7024 and 7025**.

When the "harmonic distortion" has been selected, the calculation method can be specified in register **7026**. There are two options to **calculate** the **individual harmonic distortion:**

THD:

Calculation of an individual harmonic (related to the r.m.s. value of the fundamental component U_1 or I_1)

$$THD_{U(k)} = \frac{U_k}{U_1} \times 100\ \%$$

$$THD_{I(k)} = \frac{I_k}{I_1} \times 100\ \%$$

THF:

Harmonic factor calculation of an individual harmonic (THF, related to the total value U_{ges} resp. I_{ges})

$$THF_{U(k)} = \frac{U_k}{\sqrt{\sum_{k=1}^{63} U_k^2}} \times 100\ \%$$

$$THF_{I(k)} = \frac{I_k}{\sqrt{\sum_{k=1}^{63} I_k^2}} \times 100\ \%$$

Register	Property	Description	Format	Unit
0808	RO	U_{L1} [1] or U_{L1L2} [2] 2nd harmonic	Float	% or V [3]
0810	RO	U_{L2} [1] or U_{L2L3} [2] 2nd harmonic	Float	% or V
0812	RO	U_{L3} [1] or U_{L3L1} [2] 2ndharmonic	Float	% or V
0814	RO	U_4 2nd harmonic	Float	% or V
0816	RO	I_1 2nd harmonic	Float	% or A
0818	RO	I_2 2nd harmonic	Float	% or A
0820	RO	I_3 2nd harmonic	Float	% or A
0822	RO	I_4 2nd harmonic	Float	% or A
…				
1784	RO	U_{L1} [1] or U_{L1L2} [2] 63rd harmonic	Float	% or V
1786	RO	U_{L2} [1] or UL_{2L3} [2] 63rd harmonic	Float	% or V
1788	RO	U_{L3} [1] or U_{L3L1} [2] 63rd harmonic	Float	% or V
1790	RO	U_4 63rd harmonic	Float	% or V
1792	RO	I_1 63rd harmonic	Float	% or A
1794	RO	I_2 63rd harmonic	Float	% or A

1796	RO	I_3 63rd harmonic	Float	% or A
1798	RO	I_4 63rd harmonic	Float	% or A

Table 4.3: Individual harmonic

Comments table 4.3

1) Only in the case of wye connection (WYE).

2) Only in the case of delta connection (DELTA).

3) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

4.4 Interharmonic

Register	Property	Description	Format	Unit
1800	RO	TIHD $_{UL1}$ [1] or TIHD $_{UL1L2}$ [2]	Float	% [3]
1802	RO	TIHD $_{UL2}$ [1] or TIHD $_{UL2L3}$ [2]	Float	%
1804	RO	TIHD $_{UL3}$ [1] or TIHD $_{UL3L1}$ [2]	Float	%
1806	RO	TIHD$_{U4}$	Float	%
1808	RO	TIHD$_{I1}$	Float	%
1810	RO	TIHD$_{I2}$	Float	%
1812	RO	TIHD$_{I3}$	Float	%
1814	RO	TIHD$_{I4}$	Float	%
1816	RO	TOIHD $_{UL1}$ [1] or TOIHD $_{UL1L2}$ [2]	Float	%
1818	RO	TOIHD $_{UL2}$ [1] or TOIHD $_{UL2L3}$ [1]	Float	%
1820	RO	TOIHD $_{UL3}$ [1] or TOIHD $_{UL3L1}$ [2]	Float	%
1822	RO	TOIHD $_{U4}$	Float	%
1824	RO	TOIHD$_{I1}$	Float	%
1826	RO	TOIHD$_{I2}$	Float	%
1828	RO	TOIHD$_{I3}$	Float	%
1830	RO	TOIHD$_{I4}$	Float	%
1832	RO	TIHD $_{UL1}$ [1] or TIHD $_{UL1L2}$ [2]	Float	%

Register	Property	Description	Format	Unit
1834	RO	THD_{UL3} [1] or THD_{UL3L1} [2]	Float	%
1836	RO	THD_{U4}	Float	%
1838	RO	THD_{I1}	Float	%
1840	RO	THD_{I2}	Float	%
1842	RO	THD_{I3}	Float	%
1844	RO	THD_{I4}	Float	%
1846	RO	$TEIHD_{I4}$	Float	%
1848	RO	$IHD0_{UL1}$ [1] or $IHD0_{UL1L2}$ [2]	Float	% or V [4]
1850	RO	$IHD0_{UL2}$ [1] or $IHD0_{UL2L3}$ [2]	Float	% or V
1852	RO	$IHD0_{UL3}$ [1] or $IHD0_{UL3L1}$ [2]	Float	% or V
1854	RO	$IHD0_{U4}$	Float	% or V
1856	RO	$IHD0_{I1}$	Float	% or A
1858	RO	$IHD0_{I2}$	Float	% or A
1860	RO	$IHD0_{I3}$	Float	% or A
1862	RO	$IHD0_{I4}$	Float	% or A
1864	RO	$IHD1_{UL1}$ [1] or $IHD1_{UL1L2}$ [2]	Float	% or V
1866	RO	$IHD1_{UL2}$ [1] or $IHD1_{UL2L3}$ [2]	Float	% or V
1868	RO	$IHD1_{UL3}$ [1] or $IHD1_{UL3L1}$ [2]	Float	% or V
1870	RO	$IHD1_{U4}$	Float	% or V
1872	RO	$IHD1_{I1}$	Float	% or A
1874	RO	$IHD1_{I2}$	Float	% or A
1876	RO	$IHD1_{I3}$	Float	% or A
1878	RO	$IHD1_{I4}$	Float	% or A
1880	RO	$IHD2_{UL1}$ [1] or $IHD2_{UL1L2}$ [2]	Float	% or V
1882	RO	$IHD2_{UL2}$ [1] or $IHD2_{UL2L3}$ [2]	Float	% or V
1884	RO	$IHD2_{UL3}$ [1] or $IHD2_{UL3L1}$ [2]	Float	% or V

Register	Property	Description	Format	Unit
1886	RO	IHD2 $_{U4}$	Float	% or V
1888	RO	IHD2 $_{I1}$	Float	% or A
1890	RO	IHD2 $_{I2}$	Float	% or A
1892	RO	IHD2 $_{I3}$	Float	% or A
1894	RO	IHD2 $_{I4}$	Float	% or A
1896	RO	IHD3 $_{UL1}$ [1)] or IHD3 $_{UL1L2}$ [2)]	Float	% or V
1898	RO	IHD3 $_{UL2}$ [1)] or IHD3 $_{UL2L3}$ [2)]	Float	% or V
1900	RO	IHD3 $_{UL3}$ [1)] or IHD3 $_{UL3L1}$ [2)]	Float	% or V
1902	RO	IHD3 $_{U4}$	Float	% or V
1904	RO	IHD3 $_{I1}$	Float	% or A
1906	RO	IHD3 $_{I2}$	Float	% or A
1908	RO	IHD3 $_{I3}$	Float	% or A
1910	RO	IHD3 $_{I4}$	Float	% or A
…				
2856	RO	IHD63 $_{UL1}$ [1)] or IHD63 $_{UL1L2}$ [2)]	Float	% or V
2858	RO	IHD63 $_{UL2}$ [1)] or IHD63 $_{UL2L3}$ [2)]	Float	% or V
2860	RO	IHD63 $_{UL3}$ [1)] or IHD63 $_{UL3L1}$ [2)]	Float	% or V
2862	RO	IHD63 $_{U4}$	Float	% or V
2864	RO	IHD63 $_{I1}$	Float	% or A
2866	RO	IHD63 $_{I2}$	Float	% or A
2868	RO	IHD63 $_{I3}$	Float	% or A
2870	RO	IHD63 $_{I4}$	Float	% or A

Table 4.4: Interharmonic register

Comments table 4.4

1) Only in the case of wye connection (WYE).

2) Only in the case of delta connection (DELTA).

3) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

4) Registers 7024 and 7025 specify, whether the register content is given in % or in V resp. A.

5. Demand

"Demands" are defined as an average consumption over the last fixed demand period. The length of the period can be specified (register 7101…7103, see page 54).

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

The calculations of the predicted demand are optimised for a number of sliding windows (register 7103) of 1.

5.1 Present demand

Register	Property	Description	Format	Unit
3000	RO	Demand U_{L1} [1)]	Float	V
3002	RO	Demand U_{L2} [1)]	Float	V
3004	RO	Demand U_{L3} [1)]	Float	V
3006	RO	Ø Demand U_{LN} [1)]	Float	V
3008	RO	Demand U_{L1L2} [2)]	Float	V
3010	RO	Demand U_{L2L3} [2)]	Float	V
3012	RO	Demand U_{L3L1} [2)]	Float	V
3014	RO	Ø Demand U_{LL} [2)]	Float	V
3016	RO	Demand I_1	Float	A
3018	RO	Demand I_2	Float	A
3020	RO	Demand I_3	Float	A
3022	RO	Ø Demand I	Float	A

Register	Property	Description	Format	Unit
3024	RO	Demand U_4	Float	V
3026	RO	Demand I_4 [3)]	Float	A
3028	RO	Demand P_{L1} [1)]	Float	W
3030	RO	Demand P_{L2} [1)]	Float	W
3032	RO	Demand P_{L3} [1)]	Float	W
3034	RO	Demand P_{ges}	Float	W
3036	RO	Demand Q_{L1} [1)]	Float	var
3038	RO	Demand Q_{L2} [1)]	Float	var
3040	RO	Demand Q_{L3} [1)]	Float	var
3042	RO	Demand Q_{ges}	Float	var
3044	RO	Demand S_{L1} [1)]	Float	VA
3046	RO	Demand S_{L2} [1)]	Float	VA
3048	RO	Demand S_{L3} [1)]	Float	VA
3050	RO	Demand S_{ges}	Float	VA
3052	RO	Demand power factor λ_1 [1)]	Float	
3054	RO	Demand power factor λ_2 [1)]	Float	
3056	RO	Demand power factor λ_3 [1)]	Float	
3058	RO	Demand power factor λ_{ges}	Float	
3060	RO	Demand frequency *f*	Float	Hz

Table 5.1: Register: Present demands

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) I_4 input, otherwise it is reserved.

5.2 Power quality demand

Register	Property	Description	Format	Unit
3062	RO	Demand deviation ΔU_{L1} [1] or ΔU_{L1L2} [2]	Float	% [3]
3064	RO	Demand deviation ΔU_{L2} [1] or ΔU_{L2L3} [2]	Float	%
3066	RO	Demand deviation ΔU_{L3} [1] or ΔU_{L3L1} [2]	Float	%
3068	RO	Demand deviation Δf	Float	Hz
3070	RO	Demand voltage unbalance negative sequence component U_2	Float	-
3072	RO	Demand voltage unbalance zero sequence component U_0	Float	-
3074	RO	Demand current unbalance negative sequence component I_2	Float	-
3076	RO	Demand current unbalance zero sequence component I_0	Float	-

Table 5.2: Register Demand power quality

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

5.3 Harmonic demand

Register	Property	Description	Format	Unit
3078	RO	k-factor I_1	Float	--
3080	RO	k-factor I_2	Float	--
3082	RO	k-factor I_3	Float	--
3084	RO	k-factor I_4	Float	--
3086	RO	THD_{UL1} [1] or THD_{UL1L2} [2]	Float	% [4]
3088	RO	THD_{UL2} [1] or THD_{UL2L3} [2]	Float	%
3090	RO	THD_{UL3} [1] or THD_{UL3L1} [2]	Float	%

Register	Property	Description	Format	Unit
3092	RO	$THD_{U4\ f(0)}$	Float	%
3094	RO	THD_{I1}	Float	%
3096	RO	THD_{I2}	Float	%
3098	RO	THD_{I3}	Float	%
3100	RO	THD_{I4} [3]	Float	%
3102	RO	$TOHD_{UL1}$ [1] or $TOHD_{UL1L2}$ [2]	Float	%
3104	RO	$TOHD_{UL2}$ [1] or $TOHD_{UL2L3}$ [2]	Float	%
3106	RO	$TOHD_{UL3}$ [1] or $TOHD_{UL3L1}$ [2]	Float	%
3108	RO	$TOHD_{U4\ f(0)}$	Float	%
3110	RO	$TOHD_{I1}$	Float	%
3112	RO	$TOHD_{I2}$	Float	%
3114	RO	$TOHD_{I3}$	Float	%
3116	RO	$TOHD_{I4}$ [3]	Float	%
3118	RO	$TEHD_{UL1}$ [1] or $TEHD_{UL1L2}$ [2]	Float	%
3120	RO	$TEHD_{UL2}$ [1] or $TEHD_{UL2L3}$ [2]	Float	%
3122	RO	$TEHD_{UL3}$ [1] or $TEHD_{UL3L1}$ [2]	Float	%
3124	RO	$TEHD_{U4\ f(0)}$	Float	%
3126	RO	$TEHD_{I1}$	Float	%
3128	RO	$TEHD_{I2}$	Float	%
3130	RO	$TEHD_{I3}$	Float	%
3132	RO	$TEHD_{I4}$ [3]	Float	%
3134	RO	U_{L1} [1] or U_{L1L2} [2] 2nd harmonic	Float	% or V [5]
3136	RO	U_{L2} [1] or U_{L2L3} [2] 2nd harmonic	Float	% or V
3138	RO	U_{L3} [1] or U_{L3L1} [2] 2nd harmonic	Float	% or V

Register	Property	Description	Format	Unit
3140	RO	U_4 2nd harmonic	Float	% or V
3142	RO	I_1 2nd harmonic	Float	% or A
3144	RO	I_2 2nd harmonic	Float	% or A
3146	RO	I_3 2nd harmonic	Float	% or A
3148	RO	I_4 2nd harmonic	Float	% or A
…	…	…	…	…
4110	RO	U_{L1} 1) or U_{L1L2} 2) 63rd harmonic	Float	% or V
4112	RO	U_{L2} 1) or U_{L2L3} 2) 63rd harmonic	Float	% or V
4114	RO	U_{L3} 1) or U_{L3L1} 2) 63rd harmonic	Float	% or V
4116	RO	U_4 63rd harmonic	Float	% or V
4118	RO	I_1 63rd harmonic	Float	% or A
4120	RO	I_2 63rdharmonic	Float	% or A
4122	RO	I_3 63rd harmonic	Float	% or A
4124	RO	I_4 63rd harmonic	Float	% or A

Table 5.3: Register Harmonic demand

Comments table 5.3:

1) Only in the case of wye connection (WYE).
2) Only in the case of delta connection (DELTA).
3) I_4 input only, otherwise it is reserved.
4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.
5) Registers 7024 and 7025 specify, whether the register content is given in % or in V resp. A.

5.4 Power export demand

Register	Property	Description	Format	Unit
4126	RO	Export P_{L1} 1)	Float	W
4128	RO	Export P_{L2} 1)	Float	W

Register	Property	Description	Format	Unit
4130	RO	Export P_{L3} [1)]	Float	W
4132	RO	Export P_{ges}	Float	W
4134	RO	Export Q_{L1} [1)]	Float	var
4136	RO	Export Q_{L2} [1)]	Float	var
4138	RO	Export Q_{L3}	Float	var
4140	RO	Export Q_{ges} [1)]	Float	var

Table 5.4: Register power export demand

1) Only in the case of wye connection, otherwise reserved.

5.5 Predicted demand

Register	Property	Description	Format	Unit
4200	RO	Predicted demand U_{L1} [1)]	Float	V
4202	RO	Predicted demand U_{L2} [1)]	Float	V
4204	RO	Predicted demand U_{L3} [1)]	Float	V
4206	RO	Predicted demand U_{LN} Ø	Float	V
4208	RO	Predicted demand U_{L1L2} [2)]	Float	V
4210	RO	Predicted demand U_{L2L3} [2)]	Float	V
4212	RO	Predicted demand U_{L3L1} [2)]	Float	V
4214	RO	Ø Predicted demand U_{LL} [2)]	Float	V
4216	RO	Predicted demand I_1	Float	A
4218	RO	Predicted demand I_2	Float	A
4220	RO	Predicted demand I_3	Float	A
4222	RO	Predicted demand I Ø	Float	A
4224	RO	Predicted demand U_4	Float	V
4226	RO	Predicted demand I_4	Float	A

Register	Property	Description	Format	Unit
4228	RO	Predicted demand P_{L1} [1]	Float	W
4230	RO	Predicted demand P_{L2} [1]	Float	W
4232	RO	Predicted demand P_{L3} [1]	Float	W
4234	RO	Predicted demand P_{ges}	Float	W
4236	RO	Predicted demand Q_{L1} [1]	Float	var
4238	RO	Predicted demand Q_{L2} [1]	Float	var
4240	RO	Predicted demand Q_{L3} [1]	Float	var
4242	RO	Predicted demand Q_{ges}	Float	var
4244	RO	Predicted demand S_{L1} [1]	Float	VA
4246	RO	Predicted demand S_{L2} [1]	Float	VA
4248	RO	Predicted demand S_{L3} [1]	Float	VA
4250	RO	Predicted demand S_{ges}	Float	VA
4252	RO	Predicted demand λ_1	Float	-
4254	RO	Predicted demand λ_2	Float	-
4256	RO	Predicted demand λ_3	Float	-
4258	RO	Predicted demand λ_{ges}	Float	-
4260	RO	Predicted demand f	Float	Hz

Table 5.5: Register Predicted demand

1) **Only in the case wye connection,** otherwise the register is reserved.

2) **Only in the case of delta connection,** otherwise the register is reserved.

5.6 Maximum demand values

5.6.1 Maximum demand values: General

Register	Property	Description	Format	Unit
4300	RO	$U_{L1\ max}$ [1)]	Float	V
4302	RO	$U_{L2\ max}$ [1)]	Float	V
4304	RO	$U_{L3\ max}$ [1)]	Float	V
4306	RO	Ø $U_{LN\ max}$	Float	V
4308	RO	$U_{L1L2\ max}$ [2)]	Float	V
4310	RO	$U_{L2L3\ max}$ [2)]	Float	V
4312	RO	$U_{L3L1\ max}$ [2)]	Float	V
4314	RO	Ø $U_{LL\ max}$ [2)]	Float	V
4316	RO	$I_{1\ max}$	Float	A
4318	RO	$I_{2\ max}$	Float	A
4320	RO	$I_{3\ max}$	Float	A
4322	RO	Ø I_{max}	Float	A
4324	RO	$U_{4\ max}$	Float	V
4326	RO	$I_{4\ max}$ [3)]	Float	A
4328	RO	$P_{L1\ max}$ [1)]	Float	W
4330	RO	$P_{L2\ max}$ [1)]	Float	W
4332	RO	$P_{L3\ max}$ [1)]	Float	W
4334	RO	$P_{ges\ max}$	Float	W
4336	RO	$Q_{L1\ max}$ [1)]	Float	var
4338	RO	$Q_{L2\ max}$ [1)]	Float	var
4340	RO	$Q_{L3\ max}$ [1)]	Float	var
4342	RO	$Q_{ges\ max}$	Float	var
4344	RO	$S_{L1\ max}$ [1)]	Float	VA

Register	Property	Description	Format	Unit
4346	RO	$S_{L2\ max}$ [1]	Float	VA
4348	RO	$S_{L3\ max}$ [1]	Float	VA
4350	RO	$S_{ges\ max}$	Float	VA
4352	RO	λ1 max [1]	Float	-
4354	RO	λ2 max [1]	Float	-
4356	RO	λ3 max [1]	Float	-
4358	RO	λges max	Float	-
4360	RO	f_{max}	Float	Hz

Table 5.6: Register maximum demand values: General

1) **Only in the case wye connection,** otherwise the register is reserved.

2) **Only in the case of delta connection,** otherwise the register is reserved.

5.6.2 Maximum demand values: Power quality

Register	Property	Description	Format	Unit
4362	RO	max. demand ΔU_{L1} [1] or ΔU_{L1L2} [2]	Float	-
4364	RO	max. demand ΔU_{L2} [1] or ΔU_{L2L3} [2]	Float	-
4366	RO	max. demand ΔU_{L3} [1] or ΔU_{L3L1} [2]	Float	-
4368	RO	max. demand Δf	Float	Hz
4370	RO	max. demand voltage unbalance negative sequence component U_2	Float	-
4372	RO	max. demand zero sequence component U_0	Float	-
4374	RO	max. demand current unbalance negative sequence component I_2	Float	-
4376	RO	max. demand current unbalance zero sequence component I_0	Float	-

Table 5.7: Register maximum values power quality

1) Only in the case of wye connection.

2) Only in the case of delta connection.

5.6.3 Maximum demand values: Harmonics

Register	Property	Description	Format	Unit
4378	RO	max. demand k-factor I_1	Float	--
4380	RO	max. demand k-factor I_2	Float	--
4382	RO	max. demand k-factor I_3	Float	--
4384	RO	max. demand k-factor I_4	Float	--
4386	RO	max. demand THD_{UL1} [1] or THD_{UL1L2} [2]	Float	% [4]
4388	RO	max. demand THD_{UL2} [1] or THD_{UL2L3} [2]	Float	%
4390	RO	max. demand THD_{UL3} [1] or THD_{UL3L1} [2]	Float	%
4392	RO	max. demand $THD_{U4\ f(0)}$	Float	%
4394	RO	max. demand THD_{I1}	Float	%
4396	RO	max. demand THD_{I2}	Float	%
4398	RO	max. demand THD_{I3}	Float	%
4400	RO	max. demand THD_{I4} [3] or reserved	Float	%
4402	RO	max. demand $TOHD_{UL1}$ [1] or $TOHD_{UL1L2}$ [2]	Float	%
4404	RO	max. demand $TOHD_{UL2}$ [1] or $TOHD_{UL2L3}$ [2]	Float	%
4406	RO	max. demand $TOHD_{UL3}$ [1] or $TOHD_{UL3L1}$ [2]	Float	%
4408	RO	max. demand $TOHD_{U4\ f(0)}$	Float	%
4410	RO	max. demand $TOHD_{I1}$	Float	%
4412	RO	max. demand $TOHD_{I2}$	Float	%
4414	RO	max. demand $TOHD_{I3}$	Float	%
4416	RO	max. demand $TOHD_{I4}$ [3]	Float	%
4418	RO	max. demand $TEHD_{UL1}$ [1] or $TEHD_{UL1L2}$ [2]	Float	%
4420	RO	max. demand $TEHD_{UL2}$ [1] or $TEHD_{UL2L3}$ [2]	Float	%
4422	RO	max. demand $TEHD_{UL3}$ [1] or $TEHD_{UL3L1}$ [2]	Float	%

Register	Property	Description	Format	Unit
4424	RO	max. demand $TEHD_{U4\ f(0)}$	Float	%
4426	RO	max. demand $TEHD_{I1}$	Float	%
4428	RO	max. demand $TEHD_{I2}$	Float	%
4430	RO	max. demand $TEHD_{I3}$	Float	%
4432	RO	max. demand $TEHD_{I4}$ 3)	Float	%
4434	RO	max. demand $HD2_{UL1}$ 1) or $HD2_{UL1L2}$ 2)	Float	%
4436	RO	max. demand $HD2_{UL2}$ 1) or $HD2_{UL2L3}$ 2)	Float	%
4438	RO	max. demand $HD2_{UL3}$ 1) or $HD2_{UL3L1}$ 2)	Float	%
4440	RO	max. demand $HD2_{U4}$	Float	%
4442	RO	max. demand $HD2_{I1}$	Float	%
4444	RO	max. demand $HD2_{I2}$	Float	%
4446	RO	max. demand $HD2_{I3}$	Float	%
4448	RO	max. demand $HD2_{I4}$	Float	%
…	…	…	…	…
5410	RO	max. demand $HD63_{UL1}$ 1) or $HD63_{UL1L2}$ 2)	Float	%
5412	RO	max. demand $HD63_{UL2}$ 1) or $HD63_{UL2L3}$ 2)	Float	%
5414	RO	max. demand $HD63_{UL3}$ 1) or $HD63_{UL3L1}$ 2)	Float	%
5416	RO	max. demand $HD63_{U4}$	Float	%
5418	RO	max. demand $HD63_{I1}$	Float	%
5420	RO	max. demand $HD63_{I2}$	Float	%
5422	RO	max. demand $HD63_{I3}$	Float	%
5424	RO	max. demand $HD63_{I4}$	Float	%

Table 5.8: Register maximum demand values: Harmonics

Comments table 5.8:

1) Only in the case of wye connection (WYE).
2) Only in the case of delta connection (DELTA).
3) I_4 input, otherwise it is reserved.
4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

5.6.4 Maximum demand values: Power export

Register	Property	Description	Format	Unit
5426	RO	max. demand export P_{L1} 1)	Float	W
5428	RO	max. demand export P_{L2} 1)	Float	W
5430	RO	max. demand export P_{L3} 1)	Float	W
5432	RO	max. demand export P_{ges}	Float	W
5434	RO	max. demand export Q_{L1} 1)	Float	var
5436	RO	max. demand export Q_{L2} 1)	Float	var
5438	RO	max. demand export Q_{L3} 1)	Float	var
5440	RO	max. demand export Q_{ges}	Float	var

Table 5.9: Register maximum demand value power export

Note table 5.9:

1) Only in the case of wye connection, otherwise reserved.

5.7 Minimum demand values

5.7.1 Minimum demand values: General

Register	Property	Description	Format	Unit
5500	RO	min. demand U_{L1} 1)	Float	V
5502	RO	min. demand U_{L2} 1)	Float	V
5504	RO	min. demand U_{L3} 1)	Float	V
5506	RO	min. demand Ø U_{LN}	Float	V
5508	RO	min. demand U_{L1L2} 2)	Float	V

Register	Property	Description	Format	Unit
5510	RO	min. demand U_{L2L3} [2)]	Float	V
5512	RO	min. demand U_{L3L1} [2)]	Float	V
5514	RO	min. demand Ø U_{LL}	Float	V
5516	RO	min. demand I_1	Float	A
5518	RO	min. demand I_2	Float	A
5520	RO	min. demand I_3	Float	A
5522	RO	min. demand Ø I	Float	A
5524	RO	min. demand *U4*	Float	V
5526	RO	min. demand I_4 [3)]	Float	A
5528	RO	min. demand P_{L1} [1)]	Float	W
5530	RO	min. demand P_{L2} [1)]	Float	W
5532	RO	min. demand P_{L3} [1)]	Float	W
5534	RO	min. demand P_{ges}	Float	W
5536	RO	min. demand Q_{L1} [1)]	Float	var
5538	RO	min. demand Q_{L2} [1)]	Float	var
5540	RO	min. demand Q_{L3} [1)]	Float	var
5542	RO	min. demand Q_{ges}	Float	var
5544	RO	min. demand S_{L1} [1)]	Float	VA
5546	RO	min. demand S_{L2} [1)]	Float	VA
5548	RO	min. demand S_{L3} [1)]	Float	VA
5550	RO	min. demand S_{ges}	Float	VA
5552	RO	min. demand λ1	Float	-
5554	RO	min. demand λ2	Float	-

Register	Property	Description	Format	Unit
5556	RO	min. demand λ3	Float	-
5558	RO	min. demand λges	Float	-
5560	RO	min. demand *f*	Float	Hz

Table 5.10: Register minimum values general

Comments table 5.10:

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) I_4 input, otherwise it is reserved.

5.7.2 Minimum demand values: Power quality

Register	Property	Description	Format	Unit
5562	RO	min. demand deviation ΔU_{L1} [1] or ΔU_{L1L2} [2]	Float	% [3]
5564	RO	min. demand deviation ΔU_{L2} [1] or ΔU_{L2L3} [2]	Float	%
5566	RO	min. demand deviation ΔU_{L3} [1] or ΔU_{L3L1} [2]	Float	%
5568	RO	min. demand deviation Δf	Float	Hz
5570	RO	min. demand voltage unbalance negative sequence component U_2	Float	-
5572	RO	min. demand voltage unbalance zero sequence component U_0	Float	-
5574	RO	min. demand current unbalance negative sequence component I_2	Float	-
5576	RO	min. demand current unbalance zero sequence component I_0	Float	-

Table 5.11: Register minimum demand values power quality

1) Only in the case of wye connection (WYE).

2) Only in the case of delta connection (DELTA).

3) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

5.7.3 Minimum demand values: Harmonics

Register	Property	Description	Format	Unit
5578	RO	min. demand k-factor I_1	Float	--
5580	RO	min. demand k-factor I_2	Float	--
5582	RO	min. demand k-factor I_3	Float	--
5584	RO	min. demand k-factor I_4 [3]	Float	--
5586	RO	min. demand THD_{UL11} [1] or THD_{UL1L2} [2]	Float	% [4]
5588	RO	min. demand THD_{UL2} [1] or THD_{UL2L3} [2]	Float	%
5590	RO	min. demand THD_{UL3} [1] or THD_{UL3L1} [2]	Float	%
5592	RO	min. demand $THD_{U4\ f(0)}$	Float	%
5594	RO	min. demand THD_{I1}	Float	%
5596	RO	min. demand THD_{I2}	Float	%
5598	RO	min. demand THD_{I3}	Float	%
5600	RO	min. demand THD_{I4} [3]	Float	%
5602	RO	min. demand $TOHD_{UL1}$ [1] or $TOHD_{UL1L2}$ [2]	Float	%
5604	RO	min. demand $TOHD_{UL2}$ [1] or $TOHD_{UL2L3}$ [2]	Float	%
5606	RO	min. demand $TOHD_{UL3}$ [1] or $TOHD_{UL3L1}$ [2]	Float	%
5608	RO	min. demand $TOHD_{U4\ f(0)}$	Float	%
5610	RO	min. demand $TOHD_{I1}$	Float	%
5612	RO	min. demand $TOHD_{I2}$	Float	%
5614	RO	min. demand $TOHD_{I3}$	Float	%
5616	RO	min. demand $TOHD_{I4}$ [3]	Float	%
5618	RO	min. demand $TEHD_{UL1}$ [1] or $TEHD_{UL1L2}$ [2]	Float	%
5620	RO	min. demand $TEHD_{UL2}$ [1] or $TEHD_{UL2L3}$ [2]	Float	%
5622	RO	min. demand $TEHD_{UL3}$ [1] or $TEHD_{UL3L1}$ [2]	Float	%
5624	RO	min. demand $TEHD_{U4\ f(0)}$	Float	%

Register	Property	Description	Format	Unit
5626	RO	min. demand $TEHD_{I1}$	Float	%
5628	RO	min. demand $TEHD_{I2}$	Float	%
5630	RO	min. demand $TEHD_{I3}$	Float	%
5632	RO	min. demand $TEHD_{I4}$ [3]	Float	%
5634	RO	min. demand $HD2_{UL1}$ [1] or $HD2_{UL1L2}$ [2]	Float	%
5636	RO	min. demand $HD2_{UL2}$ [1] or $HD2_{UL2L3}$ [2]	Float	%
5638	RO	min. demand $HD2_{UL3}$ [1] or $HD2_{UL3L1}$ [2]	Float	%
5640	RO	min. demand $HD2_{U4}$	Float	%
5642	RO	min. demand $HD2_{I1}$	Float	%
5644	RO	min. demand $HD2_{I2}$	Float	%
5646	RO	min. demand $HD2_{I3}$	Float	%
5648	RO	min. demand $HD2_{I4}$	Float	%
…	…	…	…	…
6610	RO	min. demand $HD63_{UL1}$ [1] or $HD63_{UL1L2}$ [2]	Float	%
6612	RO	min. demand $HD63_{UL2}$ [1] or $HD63_{UL2L3}$ [2]	Float	%
6614	RO	min. demand $HD63_{UL3}$ [1] or $HD63_{UL3L1}$ [2]	Float	%
6616	RO	min. demand $HD63_{U4}$	Float	%
6618	RO	min. demand $HD63_{I1}$	Float	%
6620	RO	min. demand $HD63_{I2}$	Float	%
6622	RO	min. demand $HD63_{I3}$	Float	%
6624	RO	min. demand $HD63_{I4}$	Float	%

Table 5.12: Register minimum demand values: Harmonics

Comments table 5.12:

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) I_4-input only, otherwise it is reserved.

4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

5.7.4 Minimum demand value: Power export

Register	Property	Description	Format	Unit
6626	RO	min. demand export P_{L1} [1)]	Float	W
6628	RO	min. demand export P_{L2} [1)]	Float	W
6630	RO	min. demand export P_{L3} [1)]	Float	W
6632	RO	min. demand export P_{ges}	Float	W
6634	RO	min. demand export Q_{L1} [1)]	Float	var
6636	RO	min. demand export Q_{L2} [1)]	Float	var
6638	RO	min. demand export Q_{L3} [1)]	Float	var
6640	RO	min. demand export Q_{ges}	Float	var

Table 5.13: Register minimum demand values power export

1) Only in the case of wye connection, otherwise reserved.

5.7.5 Peak demand

Register	Property	Description	Format	Unit
6700…6705	RO	Peak demand P_{ges} of this month	see table 5.15, page 46	W
6706…6711	RO	Peak demand Q_{ges} of this month		var
6712…6717	RO	Peak demand S_{ges} of this month		VA
6718…6723	RO	Peak demand I_1 of this month		A
6724…6729	RO	Peak demand I_2 of this month		A
6730…6735	RO	Peak demand I_3 of this month		A

Register	Property	Description	Format	Unit
6736…6741	RO	Peak demand P_{ges} of last month	see table 5.15	W
6742…6747	RO	Peak demand Q_{ges} of last month		var
6748…6753	RO	Peak demand S_{ges} of last month		VA
6754…6759	RO	Peak demand THD_{I1} of this month		A
6760…6765	RO	Peak demand THD_{I2} of this month		A
6766…6771	RO	Peak demand THD_{I3} of this month		A

Table 5.14: Register peak demand

"of this month": since the last reset
"of last month": before the last reset
Reset: siehe „Clear/reset register“ auf Seite 59.

5.7.6 Peak demand data structure

Offset	Property	Description	Format	Note
+ 0	RO	Peak demand value	INT32	
+ 2	RO	High byte: year	UINT16	1…99 (year-2000)
	RO	Low byte: month		1…12
+ 3	RO	High byte: day	UINT16	1…28/29/30/31
	RO	Low byte: hour		0…23
+ 4	RO	High byte: minute	UINT16	0…59
	RO	Low byte: second		0…59
+ 5	RO	Milliseconds	UINT16	1…999

Table 5.15: Peak demand data structure

There are different mechanisms to change data from the current month to data from the previous month:

- **0**: Data transfer will happen at 00:00 of the last day of every month.
- **Other numeric value**: Data transfer will happen at a specific time. Coding according to the following formula:
  - (day x 100 + hour) where day = 1…28 and hour = 0…23.
    Example: Register entry 1512 indicates that the data transfer happens at 12:00 a.m. on the 15th of each month.
- **0xFFFF**: Data transfer does not happen automatically at a specific time, the register has to be reset manually. After the reset, the "maximum demand for the current month" becomes the "maximum demand since last reset"; The "maximum demand for the last month" becomes the "maximum demand before last reset".

See register 7081.

6. System parameters

6.1 Setup parameters

Register	Property	Description	Format	Range/unit
7000	RW	Transformation ratio, voltage transformer (primary side)	UINT32	1…1.000.000 (100*)
7002	RW	Transformation ratio, voltage transformer (secondary side)	UINT32	1…690 (100*)
7004	RW	Transformation ratio, measuring current transformer (primary side)	UINT32	1…30.000 (5*)
7006	RW	Transformation ratio, measuring current transformer (secondary side)	UINT32	1…5*
7008	RW	Transformation ratio, voltage transformer U_4 (primary side)	UINT32	1…1.000.000 (100*)
7010	RW	Transformation ratio, voltage transformer U_4 (secondary side)	UINT32	1…400 (100*)
7012	RW	Transformation ratio, measuring current transformer I_4 (primary side)	UINT32	1…30.000 (5*)
7014	RW	Transformation ratio, measuring current transformer I_4 (secondary side)	UINT32	1…5*
7016	RW	Wiring mode	UINT16	0 = WYE* 1 = DELTA 2 = DEMO
7017	RW	U_{nom} (secondary)	UINT16	100*…700 V (U_{LL})
7018	RW	f_{nom}	UINT16	0 = 50 Hz* 1 = 60 Hz
7019	RW	Power factor λ rule	UINT16	0*= IEC 1 = IEEE 2 = -IEEE

Register	Property	Description	Format	Range/unit
7020	RW	Calculation method *S*	UINT16	0* = vector 1 = scalar
7021	RW	Polarity I_1	UINT16	0* = normal 1 = reverse
7022	RW	Polarity I_2	UINT16	
7023	RW	Polarity I_3	UINT16	
7024	RW	Calculation of the individual harmonic (voltage)	UINT16	0*= Distortion (%) 1 = r.m.s. value (V)
7025	RW	Calculation of the individual harmonic (current)	UINT16	0*= Distortion (%) 1 = r.m.s. value (A)
7026	RW	Calculation of the harmonic distortion (HD calculation)	UINT16	0*= % of the fundamental component (THD) 1 = % of the r.m.s. value (THF)
7027	RW	Calculation of the harmonics in the form of subgroups	UINT16	0*= yes 1 = no
7028	RW	Determine the number of harmonics which are to be considered in the calculation of THD, TEHD and TOHD	UINT16	2…63*
7029	RW	Method for setting and resetting the DO and RO [1)]	UINT16	0 = disabled 1*= enabled
7030	RW	Refreshing cycle basic values [2)]	UINT16	0 = 10/12 cycles, 1*= 50/60 cycles, 2 = 150/180 cycles, 3 = 10 minutes, 4 = 2 hours
7031	RW	Refreshing cycle frequency	UINT16	0*= 1 s, 1 = 10 s
7032	RW	Flagging measured values [3)]	UINT16	0*= not activated, 1= activated, "flagged data" will not be recorded
7033…7035	Reserved			

Register	Property	Description	Format	Range/unit
7037	RW	Polarity I_4	UINT16	0* = normal 1 = reverse
7038	RW	EN 50160 Voltage level	UINT16	0*=Low voltage 1 = Medium voltage 2 = High voltage
7039		EN 50160: start day of a week		0* = Sun 1 = Mon … 6 = Sat
7040…7080	Reserved			

Table 6.1: Register parameter setup

Comments:

1) See register 9100 ff.

2) Sets the refreshing cycle for the registers 0…60, 70…75, 160…162, 166…167

3) Flagged data: Measurement values (measured or aggregated), which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

6.2 Setup: Clock and language

Register	Property	Description	Format	Unit/option
7081	RW	Set copy mechanism to take place at the end of the month[1)]	UINT16	0*, 0xFFFF
7082	RW	Backlight timeout	UINT16	0 = Display is always lit 1…60 min (3*)
7083	RW	Language	UINT16	0*= English
7084	RW	Time zone [2)]	UINT16	0…32 (26*)
7085	RW	IRIG-B time zone	INT16	-1440…+1440 (0*)
7086	RW	Clock source [1)]	UINT16	0=DI PPS 1=RTC 2=GPS 3=SNTP 4*=IRIG-B

Register	Property	Description	Format	Unit/option
7087	RW	Date format user interface	UINT16	0*=YYMMDD 1=MMDDYY 2=DDMMYY
7088…7100	Reserved			

Table 6.2: Register setup: Clock and language

Comments

[1)] When GPS or IRIG-B is selected, the RS-485 port 1 is automatically used for time synchronisation. When "DI" is selected, input DI8 is used for time synchronisation(1PPS GPS).

[2] **Register 7084**: key time zones without summertime

Key	Time zone	Key	Time zone
0	GMT – 12 h	**17**	GMT + 03:30 h
1	GMT – 11 h	**18**	GMT + 04 h
2	GMT – 10 h	**19**	GMT + 04:30 h
3	GMT – 09 h	**20**	GMT + 05 h
4	GMT – 08 h	**21**	GMT + 05:30 h
5	GMT – 07 h	**22**	GMT + 05:45 h
6	GMT – 06 h	**23**	GMT + 06 h
7	GMT – 05 h	**24**	GMT + 06:30 h
8	GMT – 04 h	**25**	GMT + 07 h
9	GMT – 03 h	**26**	GMT + 08 h
10	GMT – 03:30 h	**27**	GMT + 09 h
11	GMT – 02 h	**28**	GMT + 09:30 h
12	GMT – 01 h	**29**	GMT + 10 h
13	GMT	**30**	GMT + 11 h
14	GMT + 01 h	**31**	GMT + 12 h
15	GMT + 02 h	**32**	GMT + 13 h
16	GMT + 03 h		

*Table 6.3: **Register 7084**: key time zones without summertime*

6.3 Demand setup

Register	Property	Description	Format	Unit
7101	RW	Demand calculation mode	UINT16	0* = SLD[1)] 1 = SYNC DI
7102	RW	Window width for demand evaluation [2)]	UINT16	1…60 min, 15*
7103	RW	Number of windows for demand evaluation (sliding windows)	UINT16	1*…15
7104	RW	Dynamics of the Predicted demand [3)]	UINT16	70*…99
7105…7109	Reserved			

Table 6.4: Register demand setup

Comments:

1) SLD: synchronised for internal time basis

2) Period for demand evaluation = Number of windows x window width

3) A higher value allows higher sensitivity to trend changes.

6.4 Setup DI and DO

Register	Property	Description	Format	Unit
7110	RW	Function DI1	UINT16	0 = digital input 1 = impulse counter 2 = SYNC DI demand 3 = PPS SYNC
7111	RW	Function DI2	UINT16	
7112	RW	Function DI3	UINT16	
7113	RW	Function DI4	UINT16	
7114	RW	Function DI5	UINT16	
7115	RW	Function DI6	UINT16	
7116	RW	Function DI7	UINT16	
7117	RW	Function DI8	UINT16	

Register	Property	Description	Format	Unit
7118	RW	Debounce time DI1	UINT16	1…1000 ms (20*)
7119	RW	Debounce time DI2	UINT16	
7120	RW	Debounce time DI3	UINT16	
7121	RW	Debounce time DI4	UINT16	
7122	RW	Debounce time DI5	UINT16	
7123	RW	Debounce time DI6	UINT16	
7124	RW	Debounce time DI7	UINT16	
7125	RW	Debounce time DI8	UINT16	
7126	RW	Resolution of setting DI1	UINT32	1*…1.000.000
7128	RW	Resolution of setting DI2	UINT32	
7130	RW	Resolution of setting DI3	UINT32	
7132	RW	Resolution of setting DI4	UINT32	
7134	RW	Resolution of setting DI5	UINT32	
7136	RW	Resolution of setting DI6	UINT32	
7138	RW	Resolution of setting D7	UINT32	
7140	RW	Resolution of setting DI8	UINT32	
7142	RW	Mode DO1	UINT16	0*…6 [1)]
7143	RW	Mode DO2	UINT16	
7144	RW	Pulse width DO1	UINT16	0…6000 (x 0.1 s) 0 = Latch mode (10*)
7145	RW	Pulse width DO2	UINT16	
7146	RW	Pulse width RO1	UINT16	
7147	RW	Pulse width RO2	UINT16	
7148	RW	Pulse width RO3	UINT16	
7149	RW	Pulse width RO4	UINT16	
7150 …7159	Reserved			

Table 6.5: Register setup DI and DO

Comments table 6.5

1) 0*= Controlled via Modbus
1 = Pulsing for energy import (fundamental and harmonics)
2 = Pulsing for fundamental wave energy import
3 = Pulsing for harmonics energy import
4 = Pulsing for energy export (fundamental components and harmonics) (or as previously translated: energy export)
5 = Pulsing for fundamental wave energy export
6 = Pulsing for harmonics energy export

6.5 Energy measurement setup

Register	Property	Description	Format	Unit/option
7160	RW	Pulse constant for DO and RO	UINT16	0 = 1000 impulses/kWh 1 = 3200 impulses/kWh 2* = 5000 impulses/kWh 3 = 6400 impulses/kWh 4 = 12800 impulses/kWh
7161	RW	Pulse output kWh-LED	UINT16	0 = Switched off 1* = Pulsing for active energy (fundamentals and harmonics) 2 = Pulsing for fundamental wave active energy 3 = Pulsing for harmonics active energy
7162	RW	Pulse output LED kvarh	UINT16	0 = Switched off 1* = Pulsing for reactive energy (fundamentals and harmonics) 2 = Pulsing for fundamental wave reactive energy 3 = Pulsing for harmonics reactive energy

Table 6.6: Energy measurement setup

Comments:
Depending on the max. input rating applied (measured with the internal sensors of the device, "input rating"), the PEM offers the following possibilities for the setting of the pulse constant:

kVA (secondary side)	Pulse constant options (impulses/kWh)	Default setting
≤ 500	1000/3200/5000/6400/12800	1000
≤ 690	1000/3200/5000	1000
≤ 1900	1000/3200	1000
> 1900	1000	1000

Table 6.7: Pulse constant setting possibilities

6.6 Setup: Communication

Register	Property	Description	Format	Unit/option
7200	RW	Protocol interface 1 (RS-485)	UINT16	0* = Modbus 1 = Time sync.
7201	RW	Device address interface 1 (RS-485)	UINT16	1…247 (100*)
7202	RW	Baud rate interface 1 (RS-485)	UINT16	0 = 1200 1 = 2400 2 = 4800 3 = 9600* 4 = 19200 5 = 38,400
7203	RW	Interface 1 configuration (RS-485)	UINT16	0 = 8N2; 1 = 8O1 2* = 8E1; 3 = 8N1 4 = 8O2 ; 5 = 8E2
7204	RW	Protocol interface 2 (RS-485)	UINT16	0* = Modbus 1 = Gateway
7205	RW	Device address interface 2 (RS-485)	UINT16	1…247 (101*)

Register	Property	Description	Format	Unit/option
7206	RW	Baud rate interface 2 (RS-485)	UINT16	0 = 1200 1 = 2400 2 = 4800 3 = 9600* 4 = 19200 5 = 38,400
7207	RW	Interface 2 configuration (RS-485)	UINT16	0 = 8N2; 1 = 8O1 2* = 8E1; 3 = 8N1 4 = 8O2 ; 5 = 8E2
7208	RW	IP address Ethernet 1	UINT32	192.168.0.100* Contents of register for factory setting: 0xC0A00064
7210	RW	Subnet mask Ethernet 1	UINT32	255.255.255.0*
7212	RW	Standard gateway Ethernet 1	UINT32	192.168.0.1
7214	Reserved			
7215	RW	Synchronisation interval SNTP	UINT16	10…1440 (min) (60*)
7216	RW	IP address SNTP server	UINT32	191.0.0.6* Contents of register for factory setting: 0xBF000006
7218…7315	Reserved			

Table 6.8: Register setup: communcation

6.7 Clear/reset register

The entry 0xFF00 triggers the corresponding recorder (register 7400…7403) or clears the corresponding log.

Register	Property	Description	Format
7400	WO	Manual trigger WFR1	UINT16
7401	WO	Manual trigger WFR2	UINT16
7402	Reserved		
7403	WO	Manual trigger disturbing signal WFR	UINT16
7404	WO	Clear DR1 (high speed)	UINT16
7405	WO	Clear DR2 (high speed)	UINT16
7406	WO	Clear DR3 (high speed)	UINT16
7407	WO	Clear DR4 (high speed)	UINT16
7408…7411	Reserved		
7412	WO	Clear DR1 (standard)	UINT16
…			
7427	WO	Clear DR16 (standard)	UINT16
7428	WO	Clear WFR1	UINT16
7429	WO	Clear WFR2	UINT16
7430	Reserved		
7431	WO	Clear disturbing signal WFR	UINT16
7432	WO	Clear interval energy log	UINT16
7433	WO	Clear PQ log	UINT16
7434	WO	Clear event log	UINT16
7435	WO	Clear energy log	UINT16
7436	WO	Clear max/min log of this month	UINT16
7437	WO	Clear all max/min logs	UINT16
7438	WO	Clear peak demand log of the present month	UINT16
7439	WO	Clear all peak demands	UINT16
7440	WO	Clear counter DI1	UINT16
7441	WO	Clear counter DI2	UINT16

Register	Property	Description	Format
…	WO	…	UINT16
7446	WO	Clear counter DI7	UINT16
7447	WO	Clear counter DI8	UINT16
7448	Reserved		
7449	WO	Clear EN 50160 log	UINT16
7450	WO	Clear dip counter	UINT16
7451	WO	Clear voltage swell counter	UINT16
7452	WO	Clear voltage interruption counter	UINT16
7453	WO	Clear transient counter	UINT16
7454	WO	Clear rapid voltage change counter	UINT16
7455	WO	Clear mains signalling voltage, frequency 1 counter	UINT16
7456	WO	Clear mains signalling voltage, frequency 2 counter	UINT16
7457	WO	Clear mains signalling voltage, frequency 3 counter	UINT16
7458	WO	Clear all PQ counters	UINT16
7459…7461	Reserved		
7462	WO	Clear all logs (registers 7400…7458)	UINT16

Table 6.9: Clear/reset register

7. Setpoint

The PEM735 features 32 user-programmable control setpoints which provide extensive control by allowing a user to initiate an action in response to a specific event.

The first 24 (1…24) setpoints are **standard setpoints,** the other setpoints (25…32) are **high speed setpoints**. Standard setpoints are often used for triggers which continue over a long period, high speed setpoints, however, are used for fast reactions with a reduced range of functions (see note [2], table 7.1)
Typical applications for setpoints are: alarms, fault detection and power quality indication (PQ monitoring).

7.1 Setpoint setup parameters

Register	Property	Description		Format	
7600	RW	1st setpoint (standard)	Type [1]	UINT16	0 = disabled 1 = over setpoint 2 = under setpoint
7601	RW		Measured quantity[2]	UINT16	0*…162
7602	RW		Over setpoint	Float	0*
7604	RW		Under setpoint	Float	0*
7606	RW		Response delay [3]	UINT16	0*…9,999 s
7607	RW		Delay on release [4]	UINT16	0…9,999 s
7608	RW		Trigger 1 [5]	UINT16	0*…35
7609	RW		Trigger 2 [5]	UINT16	0*…35
…					

Register	Property	Description		Format	
7910	RW	32nd setpoint (high speed)	Type [1]	UINT16	0 = disabled 1 = over setpoint 2 = under setpoint
7911	RW		Measured quantity[2]	UINT16	0*…162
7912	RW		Over setpoint	Float	0*
7914	RW		Under setpoint	Float	0*
7916	RW		Response delay [3]	UINT16	0*…9.999
7917	RW		Delay on release [4]	UINT16	0…9.999
7918	RW		Trigger 1 [5]	UINT16	0*…35
7919	RW		Trigger 2 [5]	UINT16	0*…35

Table 7.1: Setup setpoint register

Comments table 7.1
The setpoints 1…24 are standard setpoints, the setpoints 25…32 are high speed setpoints.
1) Setpoint type: Specifies the type of evaluation (over setpoint or under setpoint) or is disabled.

2) **Measured quantity**: Specifies the measured quantities to be monitored; for standard setpoints all measurement quantities can be selected, for high speed setpoints only 1…18 apply.

7.2 Setpoint parameter "Measured quantity"

Key	Measured quantity	Scale/unit
0	-	-
1	U_{LN}	V
2	U_{LL}	V
3	I	A
4	U_4	V
5	I_4	A
6	Deviation $f_{\Delta n}$	Hz
7	P_{ges}	W
8	Q_{ges}	var
9	S_{ges}	VA
10	λ_{ges}	-
11	DI1	**Over setpoint**: Threshold will closed DI (DI = 1), Inactive limit will open DI (DI = 0) **Under setpoint**: Threshold will open DI (DI = 0), Inactive limit will close DI (DI = 1)
12	DI2	
13	DI3	
14	DI4	
15	DI5	
16	DI6	
17	DI7	
18	DI8	
19	Demand P_{ges}	W
20	Demand Q_{ges}	var
21	Demand S_{ges}	VA
22	Demand λ	-
23	Predicted demand P_{ges}	W
24	Predicted demand Q_{ges}	var
25	Predicted demand S_{ges}	VA

Key	Measured quantity	Scale/unit
26	Predicted demand λ_{ges}	
27	THD_U	100 %
28	$TOHD_U$	100 %
29	$TEHD_U$	100 %
30	THD_I	100 %
31	$TOHD_I$	100 %
32	$TEHD_I$	100 %
33	Unbalance U_2 (negative sequence)	100 %
34	Unbalance U_0 (zero sequence)	100 %
35	Unbalance I_2 (negative sequence)	100 %
36	Unbalance I_0 (zero sequence)	100 %
37	Deviation *U*	100 %
38	Phase reversal	
39	$HD2_U$	V or %
40	$HD2_I$	A or %
…		
161	$HD63_U$	V or %
162	$HD63_I$	A or %

Table 7.2: Key setpoint parameter "Measured quantity"

[3] **Response delay:** Specifies the minimum period that a threshold must have been violated before an action is triggered.
Each status change of a setpoint generates an event that is stored in the event log. The range of the response delay can be 0…9,999 seconds for standard setpoints. For high speed setpoints 0…9,999 cycles are possible.

[4] **Delay on release:** Specifies the minimum period that the setpoint return condition must have met before returning to normal condition.
Each status change of a setpoint generates an event that is stored in the event log. The range of the delay on release is 0…9,999 seconds for standard setpoints. For high speed setpoints 0…9,999 cycles are possible.

[5] **Setpoint trigger**: Specifies the action which is triggered when the setpoint is reached. This action includes "No Trigger" and "Trigger DOx".

Key	Action	Key	Action	Key	Action
0	—	**12**	Reserved	**24**	DR10
1	RO1	**13**	Reserved	**25**	DR11
2	RO2	**14**	Reserved	**26**	DR12
3	RO3	**15**	DR1	**27**	DR13
4	RO4	**16**	DR2	**28**	DR14
5	DO1	**17**	DR3	**29**	DR15
6	DO2	**18**	DR4	**30**	DR16
7	DR1 (high speed)	**19**	DR5	**31**	WFR1
8	DR2 (high speed)	**20**	DR6	**32**	WFR2
9	DR3 (high speed)	**21**	DR7	**33**	Reserved
10	DR4 (high speed)	**22**	DR8	**34**	Disturbing signal WFR
11	Reserved	**23**	DR9	**35**	Reserved

Table 7.3: Key setpoint parameter "Trigger"

8. Logic modules

8.1 Logic module register

Register	Property		Description	Format	
7920	RW	1st Logic module	Enable logic module	UINT16	0* = disabled 1 = enabled
7921	RW		Mode 1	UINT16	0* = AND 1 = OR 2 = NAND 3 = NOR
7922	RW		Mode 2	UINT16	
7923	RW		Mode 3	UINT16	
7924	RW		Source 1	UINT16	0*…32
7925	RW		Source 2	UINT16	
7926	RW		Source 3	UINT16	
7927	RW		Source 4	UINT16	
7928	RW		Trigger 1	UINT16	0*…34
7929	RW		Trigger 2	UINT16	
…					
7990	RW	8th Logic module	Enable logic module	UINT16	0* = disabled 1 = enabled
7991	RW		Mode 1	UINT16	0* = AND 1 = OR 2 = NAND 3 = NOR
7992	RW		Mode 2	UINT16	
7993	RW		Mode 3	UINT16	
7994	RW		Source 1	UINT16	0*…32
7995	RW		Source 2	UINT16	
7996	RW		Source 3	UINT16	
7997	RW		Source 4	UINT16	
7998	RW		Trigger 1	UINT16	0*…34
7999	RW		Trigger 2	UINT16	

Table 8.1: Logic module register

PEM735 provides 8 programmable logic modules for logical AND-, NAND-, OR- or NOR operations. Each logic module can link various set point conditions logically with each other.

Logical expression =

{(source 1 *[operation1]* **source 2)** *[operation 2]* **source 3}** *[operation 3]* **source 4**

Logic modules are programmed via the communication interface.

8.2 Key for the sources 1…4 (Logic modules)

Key	Source	Key	Source	Key	Source
0	—	**11**	DI1	**22**	Demand deviation Δf
1	U_{LN}	**12**	DI2	**23**	Predicted demand P_{ges}
2	U_{LL}	**13**	DI3	**24**	Predicted demand Q_{ges}
3	I	**14**	DI4	**25**	Predicted demand S_{ges}
4	U_4	**15**	DI5	**26**	Predicted demand deviation Δf
5	I_4	**16**	DI6	**27**	THDU
6	Deviation Δf	**17**	DI7	**28**	TOHDU
7	P_{ges}	**18**	DI8	**29**	TEHDU
8	Q_{ges}	**19**	Demand P_{ges}	**30**	THDI
9	S_{ges}	**20**	Demand Q_{ges}	**31**	TOHDI
10	λ_{ges}	**21**	Demand S_{ges}	**32**	TEHDI

Table 8.2: Keys for the sources 1…4 (logic modules)

8.3 Key for triggers (Logic modules)

Key	Action	Key	Action	Key	Action
0	—	**12**	Reserved	**24**	DR10
1	RO1	**13**	Reserved	**25**	DR11
2	RO2	**14**	Reserved	**26**	DR12
3	RO3	**15**	DR1	**27**	DR13
4	RO4	**16**	DR2	**28**	DR14
5	DO1	**17**	DR3	**29**	DR15
6	DO2	**18**	DR4	**30**	DR16
7	DR1 (high speed)	**19**	DR5	**31**	WFR1
8	DR2 (high speed)	**20**	DR6	**32**	WFR2
9	DR3 (high speed)	**21**	DR7	**33**	Reserved
10	DR4 (high speed)	**22**	DR8	**34**	Disturbing signal WFR
11	Reserved	**23**	DR9	**35**	Reserved

Table 8.3: Trigger keys (logic modules)

9. Data recorder setup

PEM735 features an internal memory of 80 MB and provides

- 4 high speed data recorders (high speed DR)
- 16 standard data recorders (standard DR)

Each of these recorders is capable of recording 16 parameters. The data recorders can only be programmed via the Modbus register. The differences between the standard DR and the high speed DR are, for example, the recording intervals and the measured quantities that can be recorded.

9.1 Setup parameters

The following setup parameters are supported:

No.	Parameters	Setting
1	Trigger mode	0* = disabled 1 = by timer 2 = by setpoint
2	Recording mode	**Standard DR** 0 = stop-when-full 1 = FIFO (ring memory) **High speed DR** 0 = stop-when-full
3	Number of records	0*…65535 (entries)
4	Recording depth	**Standard DR** 0…3,456,000 seconds (40 days) **High speed DR** 0.5…60 cycles
5	Number of measured quantities	0…16
6	Recording delay [1)]	**Standard DR** (Trigger mode "by timer" only) 0…43200 s (12 h) **High speed DR** --
7	Measured quantities 1…16 (see table 9.3)	**Standard DR** 0…1741 **High speed DR** 0…31

Table 9.1: Setup data recorder :

*The **data recorder is only enabled**, when the **parameters 1, 3…5 are all non-zero**!*

9.2 Data recorder setup register

Register	Prop.	Description		Format	Unit/option
8000	RW	High speed DR1	Trigger mode [1]	UINT16	0* = disabled 1 = triggered by timer 2 = triggered by setpoint
8001	RW		Recording mode	UINT16	0*= stop-when-full
8002	RW		Recording depth[2]	UINT16	0*…65535
8003	RW		Recording interval	UINT32	1*…120 (x 0.5 cycles)
8005	RW		Reserved		
8006	RW		Number of measured quantities [4]	UINT16	0…16*
8007	RW		Measured quantity 1	UINT16	0*…31
8008	RW		Measured quantity 2	UINT16	
8009	RW		Measured quantity 3	UINT16	
…	RW		…	UINT16	
8022	RW		Measured quantity 16	UINT16	
8023…8045	RW	High speed DR2		-	same structure as high speed DR1
8046…8068	RW	High speed DR3		-	
8069…8091	RW	High speed DR4		-	
8092…8183	Reserved				

Register	Prop.	Description		Format	Unit/option
8184	RW	Standard DR1	Trigger mode [1)]	UINT16	0* = disabled 1 = triggered by timer 2 = triggered by setpoint
8185	RW		Recording mode	UINT16	0*= stop-when-full 1 = FIFO (ring memory)
8186	RW		Recording depth[2)]	UINT16	0*…65535
8187	RW		Recording interval	UINT32	1…3,456,000 s (40 days)
8189	RW		Recording delay[3)]	UINT16	0*…43200 s (= 12 h)
8190	RW		Number of measured quantities [4)]	UINT16	0…16*
8191	RW		Measured quantity 1	UINT16	0*…1741
8192	RW		Measured quantity 2	UINT16	
8193	RW		Measured quantity 3	UINT16	
…	RW		…	UINT16	
8206	RW		Measured quantity 16	UINT16	
8207…8229	RW	DR2 (standard)		-	same structure as standard DR1
8230…8252	RW	DR3 (standard)		-	
8253…8275	RW	DR4 (standard)		-	
8276…8298	RW	DR5 (standard)		-	
8299…8321	RW	DR6 (standard)		-	
8322…8344	RW	DR7 (standard)		-	
8345…8367	RW	DR8 (standard)		-	
8368…8390	RW	DR9 (standard)		-	
8391…8413	RW	DR10 (standard)		-	
8414…8436	RW	DR11 (standard)		-	

Register	Prop.	Description	Format	Unit/option
8437…8459	RW	DR12 (standard)	-	same structure as Standard DR1
8460…8482	RW	DR13 (standard)	-	
8483…8505	RW	DR14 (standard)	-	
8506…8528	RW	DR15 (standard)	-	
8529…8551	RW	DR16 (standard)	-	

Table 9.2: Data recorder setup register

Comments:

1) High-speed data recorders can be triggered by a timer (the internal clock) or a setpoint. In trigger mode 2 when the setpoint becomes active, the recorder starts to record, and when the setpoint becomes inactive, the data recorder stops.

2) If the recording depth (number of measurements) is set to 0, the data recorder will be disabled.

3) Recording delay (standard DR only): In trigger mode 1 (triggered by timer), a fixed time can be set in seconds to delay the start of measurement. Example: "300" means that the measurement will be delayed by 300 seconds (5 minutes) after the timer period has elapsed. In order to obtain evaluable results, the time set for recording delay should be less than that of the recording interval.
For trigger mode 2, a delay cannot be set.

4) An overview of the possible measuring quantities for the data recorder is given in the following list: High speed DR can select the measuring quantities 1…31. If the number of measuring quantities is set to 0, the data recorder will be disabled.

Measuring quantity key for the data recorder

Key	Measured quantity (data recorder)	Factor/unit
1	U_{L1}	V
2	U_{L2}	V
3	U_{L3}	V
4	Ø U_{LN}	V
5	U_{L1L2}	V
6	U_{L2L3}	V
7	U_{L3L1}	V
8	Ø U_{LL}	V

Key	Measured quantity (data recorder)	Factor/unit
9	I_1	A
10	I_2	A
11	I_3	A
12	Ø I	A
13	U_4	V
14	I_4 (measured)	A
15	P_1	W
16	P_2	W
17	P_3	W
18	P_{ges}	W
19	Q_1	var
20	Q_2	var
21	Q_3	var
22	Q_{ges}	var
23	S_{L1}	VA
24	S_{L2}	VA
25	S_{L3}	VA
26	S_{ges}	VA
27	λ_{L1}	
28	λ_{L2}	
29	λ_{L3}	
30	λ_{ges}	
31	f	Hz
32	Demand U_{L1}	V
33	Demand U_{L2}	V
34	Demand U_{L3}	V
35	Ø Demand U_{LN}	V

Key	Measured quantity (data recorder)	Factor/unit
36	Demand U_{L1L2}	V
37	Demand U_{L2L3}	V
38	Demand U_{L3L1}	V
39	Ø Demand U_{LL}	V
40	Demand I_1	A
41	Demand I_2	A
42	Demand I_3	A
43	Ø Demand I	A
44	Demand U_4	V
45	Demand I_4 [1)]	A
46	Demand P_1	W
47	Demand P_2	W
48	Demand P_3	W
49	Demand P_{ges}	W
50	Demand Q_1	var
51	Demand Q_2	var
52	Demand Q_3	var
53	Demand Q_{ges}	var
54	Demand S_{L1}	VA
55	Demand S_{L2}	VA
56	Demand S_{L3}	VA
57	Demand S_{ges}	VA
58	Demand λ_1	
59	Demand λ_2	
60	Demand λ_3	
61	Demand λ_{ges}	
62	Demand f	Hz

Key	Measured quantity (data recorder)	Factor/unit
63	Demand deviation ΔU_{L1}	100 %
64	Demand deviation ΔU_{L2}	100 %
65	Demand deviation ΔU_{L3}	100 %
66	Demand deviation Δf	Hz
67	Demand unbalance U_2 (negative sequence component)	
68	Demand unbalance U_0 (zero sequence component)	
69	Demand unbalance I_2 (negative sequence component)	
70	Demand unbalance I_0 (zero sequence component)	
71	Demand k-factor I_1	
72	Demand k-factor I_2	
73	Demand k-factor I_3	
74	Demand k-factor I_4	
75	Demand THD_{UL1}	100 %
76	Demand THD_{UL2}	100 %
77	Demand THD_{UL3}	100 %
78	Demand THD_{U4}	100 %
79	Demand THD_{I1}	100 %
80	Demand THD_{I2}	100 %
81	Demand THD_{I3}	100 %
82	Demand THD_{I4}	100 %
83	Demand $TOHD_{UL1}$	100 %
84	Demand $TOHD_{UL2}$	100 %
85	Demand $TOHD_{UL3}$	100 %
86	Demand $TOHD_{U4}$	100 %
87	Demand $TOHD_{I1}$	100 %
88	Demand $TOHD_{I2}$	100 %
89	Demand $TOHD_{I3}$	100 %

Key	Measured quantity (data recorder)	Factor/unit
90	Demand $TOHD_{I4}$	100 %
91	Demand $TEHD_{UL1}$	100 %
92	Demand $TEHD_{UL2}$	100 %
93	Demand $TEHD_{UL3}$	100 %
94	Demand $TEHD_{U4}$	100 %
95	Demand $TEHD_{I1}$	100 %
96	Demand $TEHD_{I2}$	100 %
97	Demand $TEHD_{I3}$	100 %
98	Demand $TEHD_{I4}$	100 %
99	Demand $HD2_{UL1}$	V or %
100	Demand $HD2_{UL2}$	V or %
101	Demand $HD2_{UL3}$	V or %
102	Demand $HD2_{U4}$	V or %
103	Demand $HD2_{I1}$	A or %
104	Demand $HD2_{I2}$	A or %
105	Demand $HD2_{I3}$	A or %
106	Demand $HD2_{I4}$	A or %
107	Demand $HD3_{UL1}$	V or %
108	Demand $HD3_{UL2}$	V or %
109	Demand $HD3_{UL3}$	V or %
110	Demand $HD3_{U4}$	V or %
111	Demand $HD3_{I1}$	A or %
112	Demand $HD3_{I2}$	A or %
113	Demand $HD3_{I3}$	A or %
114	Demand $HD3_{I4}$	A or %
	…	
587	Demand $HD63_{UL1}$	V or %

Key	Measured quantity (data recorder)	Factor/unit
588	Demand $HD63_{UL2}$	V or %
589	Demand $HD63_{UL3}$	V or %
590	Demand $HD63_{U4}$	V or %
591	Demand $HD63_{I1}$	A or %
592	Demand $HD63_{I2}$	A or %
593	Demand $HD63_{I3}$	A or %
594	Demand $HD63_{I4}$	A or %
595	Peak demand U_{L1}	V
596	Peak demand U_{L2}	V
597	Peak demand U_{L3}	V
598	Ø Peak demand U_{LN}	V
599	Peak demand U_{L1L2}	V
600	Peak demand U_{L2L3}	V
601	Peak demand U_{L3L1}	V
602	Ø Peak demand U_{LL}	V
603	Peak demand I_1	A
604	Peak demand I_2	A
605	Peak demand I_3	A
606	Ø Peak demand I	A
607	Peak demand U_4	V
608	Peak demand I_4	A
609	Peak demand P_1	W
610	Peak demand P_2	W
611	Peak demand P_3	W
612	Peak demand P_{ges}	W
613	Peak demand Q_1	var
614	Peak demand Q_2	var

Key	Measured quantity (data recorder)	Factor/unit
615	Peak demand *Q3*	var
616	Peak demand Q_{ges}	var
617	Peak demand S_{L1}	VA
618	Peak demand S_{L2}	VA
619	Peak demand S_{L3}	VA
620	Peak demand S_{ges}	VA
621	Peak demand λ_1	
622	Peak demand λ_2	
623	Peak demand λ_3	
624	Peak demand λ_{ges}	
625	Peak demand *f*	Hz
626	Peak demand deviation ΔU_{L1}	100 %
627	Peak demand deviation ΔU_{L2}	100 %
628	Peak demand deviation ΔU_{L3}	100 %
629	Peak demand deviation Δf	Hz
630	Peak demand unbalance U_2 (negative sequence component)	
631	Peak demand unbalance U_0 (zero sequence component)	
632	Peak demand unbalance I_2 (negative sequence component)	
633	Peak demand unbalance I_0 (zero sequence component)	
634	Peak demand k-factor I_1	
635	Peak demand k-factor I_2	
636	Peak demand k-factor I_3	
637	Peak demand k-factor I_4	
638	Peak demand THD_{UL1}	100 %
639	Peak demand THD_{UL2}	100 %

Key	Measured quantity (data recorder)	Factor/unit
640	Peak demand $THD_{UL3\ max}$	100 %
641	Peak demand THD_{U4}	100 %
642	Peak demand THD_{I1}	100 %
643	Peak demand THD_{I2}	100 %
644	Peak demand THD_{I3}	100 %
645	Peak demand THD_{I4}	100 %
646	Peak demand $TOHD_{UL1}$	100 %
647	Peak demand $TOHD_{UL2}$	100 %
648	Peak demand $TOHD_{UL3}$	100 %
649	Peak demand $TOHD_{U4}$	100 %
650	Peak demand $TOHD_{I1}$	100 %
651	Peak demand $TOHD_{I2}$	100 %
652	Peak demand $TOHD_{I3}$	100 %
653	Peak demand $TOHD_{I4}$	100 %
654	Peak demand $TEHD_{UL1}$	100 %
655	Peak demand $TEHD_{UL2}$	100 %
656	Peak demand $TEHD_{UL3}$	100 %
657	Peak demand $TEHD_{U4}$	100 %
658	Peak demand $TEHD_{I1}$	100 %
659	Peak demand $TEHD_{I2}$	100 %
660	Peak demand $TEHD_{I3}$	100 %
661	Peak demand $TEHD_{I4}$	100 %
662	Peak demand $HD2_{UL1}$	V or %
663	Peak demand $HD2_{UL2}$	V or %
664	Peak demand $HD2_{UL3}$	V or %
665	Peak demand $HD2_{U4}$	V or %
666	Peak demand $HD2_{I1}$	A or %

Key	Measured quantity (data recorder)	Factor/unit
667	Peak demand $HD2_{I2}$	A or %
668	Peak demand $HD2_{I3}$	A or %
669	Peak demand $HD2_{I4}$	A or %
670	Peak demand $HD3_{UL1}$	V or %
671	Peak demand $HD3_{UL2}$	V or %
672	Peak demand $HD3_{UL3}$	V or %
673	Peak demand $HD3_{U4}$	V or %
674	Peak demand $HD3_{I1}$	A or %
675	Peak demand $HD3_{I2}$	A or %
676	Peak demand $HD3_{I3}$	A or %
677	Peak demand $HD3_{I4}$	A or %
	…	
1150	Peak demand $HD63_{UL1}$	V or %
1151	Peak demand $HD63_{UL2}$	V or %
1152	Peak demand $HD63_{UL3}$	V or %
1153	Peak demand $HD63_{U4}$	V or %
1154	Peak demand $HD63_{I1}$	A or %
1155	Peak demand $HD63_{I2}$	A or %
1156	Peak demand $HD63_{I3}$	A or %
1157	Peak demand $HD63_{I4}$	A or %
1158	min. demand U_{L1}	V
1159	min. demand U_{L2}	V
1160	min. demand U_{L3}	V
1161	Ø min. demand U_{LN}	V
1162	min. demand U_{L1L2}	V
1163	min. demand U_{L2L3}	V
1164	min. demand U_{L3L1}	V

Key	Measured quantity (data recorder)	Factor/unit
1165	Ø min. demand U_{LL}	V
1166	min. demand I_1	A
1167	min. demand I_2	A
1168	min. demand I_3	A
1169	Ø min. demand I	A
1170	min. demand U_4	V
1171	min. demand I_4	A
1172	min. demand P_1	W
1173	min. demand P_2	W
1174	min. demand P_3	W
1175	min. demand P_{ges}	W
1176	min. demand Q_1	var
1177	min. demand Q_2	var
1178	min. demand Q_3	var
1179	min. demand Q_{ges}	var
1180	min. demand S_{L1}	VA
1181	min. demand S_{L2}	VA
1182	min. demand S_{L3}	VA
1183	min. demand S_{ges}	VA
1184	min. demand λ_1	
1185	min. demand λ_2	
1186	min. demand λ_3	
1187	min. demand λ_{ges}	
1188	min. demand f	Hz
1189	min. demand deviation ΔU_{L1}	100 %
1190	min. demand deviation ΔU_{L2}	100 %
1191	min. demand deviation ΔU_{L3}	100 %

Key	Measured quantity (data recorder)	Factor/unit
1192	min. demand deviation Δf	Hz
1193	min. demand unbalance U_2 (negative sequence component)	
1194	min. demand unbalance U_0 (zero sequence component)	
1195	min. demand unbalance I_2 (negative sequence component)	
1196	min. demand unbalance I_0 (zero sequence component)	
1197	min. demand k-factor I_1	
1198	min. demand k-factor I_2	
1199	min. demand k-factor I_3	
1200	min. demand k-factor I_4	
1201	min. demand THD_{UL1}	100 %
1202	min. demand THD_{UL2}	100 %
1203	min. demand THD_{UL3}	100 %
1204	min. demand THD_{U4}	100 %
1205	min. demand THD_{I1}	100 %
1206	min. demand THD_{I2}	100 %
1207	min. demand THD_{I3}	100 %
1208	min. demand THD_{I4}	100 %
1209	min. demand $TOHD_{UL1}$	100 %
1210	min. demand $TOHD_{UL2}$	100 %
1211	min. demand $TOHD_{UL3}$	100 %
1212	min. demand $TOHD_{U4}$	100 %
1213	min. demand $TOHD_{I1}$	100 %
1214	min. demand $TOHD_{I2}$	100 %
1215	min. demand $TOHD_{I3}$	100 %
1216	min. demand $TOHD_{I4}$	100 %
1217	min. demand $TEHD_{UL1}$	100 %

Key	Measured quantity (data recorder)	Factor/unit
1218	min. demand $TEHD_{UL2}$	100 %
1219	min. demand $TEHD_{UL3}$	100 %
1220	min. demand $TEHD_{U4}$	100 %
1221	min. demand $TEHD_{I1}$	100 %
1222	min. demand $TEHD_{I2}$	100 %
1223	min. demand $TEHD_{I3}$	100 %
1224	min. demand $TEHD_{I4}$	100 %
1225	min. demand $HD2_{UL1}$	V or %
1226	min. demand $HD2_{UL2}$	V or %
1227	min. demand $HD2_{UL3}$	V or %
1228	min. demand $HD2_{U4}$	V or %
1229	min. demand $HD2_{I1}$	A or %
1230	min. demand $HD2_{I2}$	A or %
1231	min. demand $HD2_{I3}$	A or %
1232	min. demand $HD2_{I4}$	A or %
1233	min. demand $HD3_{UL1}$	V or %
1234	min. demand $HD3_{UL2}$	V or %
1235	min. demand $HD3_{UL3}$	V or %
1236	min. demand $HD3_{U4}$	V or %
1237	min. demand $HD3_{I1}$	A or %
1238	min. demand $HD3_{I2}$	A or %
1239	min. demand $HD3_{I3}$	A or %
1240	min. demand $HD3_{I4}$	A or %
	…	
1713	min. demand $HD63_{UL1}$	V or %
1714	min. demand $HD63_{UL2}$	V or %
1715	min. demand $HD63_{UL3}$	V or %

Key	Measured quantity (data recorder)	Factor/unit
1716	min. demand $HD63_{U4}$	V or %
1717	min. demand $HD63_{I1}$	A or %
1718	min. demand $HD63_{I2}$	A or %
1719	min. demand $HD63_{I3}$	A or %
1720	min. demand $HD63_{I4}$	A or %
1721	Active energy import $_{ges}$	kWh
1722	Active energy export $_{ges}$	kWh
1723	Active energy $_{ges}$	kWh
1724	Active energy net $_{ges}$	kWh
1725	Reactive energy import $_{ges}$	kvarh
1726	Reactive energy export $_{ges}$	kvarh
1727	Reactive energy $_{ges}$	kvarh
1728	Reactive energy net $_{ges}$	kvarh
1729	Apparent energy import	kVAh
1730	Active energy import$_{(f0)\ ges}$	kWh
1731	Active energy export$_{(f0)\ ges}$	kWh
1732	Reactive energy import$_{(f0)\ ges}$	kvarh
1733	Reactive energy export$_{(f0)\ ges}$	kvarh
1734	Active energy import$_{THD}$	kWh
1735	Active energy export$_{THD}$	kWh
1736	Short-term flicker Pst $_{UL1}$ or Pst $_{UL1L2}$	
1737	Short-term flicker Pst $_{UL2}$ or Pst $_{UL2L3}$	
1738	Short-term flicker Pst $_{UL3}$ or Pst $_{UL3L1}$	
1739	Long-term flicker Plt $_{UL1}$ or Plt $_{UL1L2}$	
1740	Long-term flicker Plt $_{UL2}$ or Plt $_{UL2L3}$	
1741	Long-term flicker Plt $_{UL3}$ or Plt $_{UL3L1}$	

Table 9.3: Measured quantity key for the data recorder

Note:

Energy parameters are of type INT32, all other parameters are of float type (single precision float type).

Each change to offset parameters (recording mode, recording depth, recording interval, recording delay, number of measuring quantities) deletes the data recorder and will set the pointer to 0.

9.3 Example of a recording with 16 measured quantities

PEM735 features 20 data recorders DR: 4 high speed data recorders HS-DR and 16 Standard data recorders DR.
Between the groups of data recorders there are 4 recorders whic are reserved:

Recorders 1…4:	HS DR
Recorders 5…8:	Reserved (cannot be used)
Recorders 9…24:	DR

In addition to the recorded measured quantities also a timestamp is included. Each measured quantity requires a 4-byte storage capacity, the timestamp requires an 8-byte storage capacity. The storage capacity for each data recorder is (n x 4 + 8) byte, in this case n means the number of the recorded measured quantities.

Byte	0	1	2	3	4	5	6	7	8	9	10	11
0	Measured quantity 1				Measured quantity 2				Measured quantity 3			
12	Measured quantity 4				Measured quantity 5				Measured quantity 6			
24	Measured quantity 7				Measured quantity 8				Measured quantity 9			
36	Measured quantity 10				Measured quantity 11				Measured quantity 12			
48	Measured quantity 13				Measured quantity 14				Measured quantity 15			
60	Measured quantity 16				Year	Month	Day	h	min	s	ms	

Table 9.4: Data recorder (format)

Read data recorder log

The Modbus function code 0x14 is used to read the data recorder log. To improve efficiency, it is recommended to read out several data recorder logs at a time.

1. Read recording depth and write down as "N".
2. Read present pointer "P" for the recorder to be read out and write down:
   - HS DR 1…4 (register 0092…0098)
   - DR 1…16 (register 0108…0138)
3. Setup of the Modbus request packet:
   - Data recorder number: number 1…4 (for HS DR) or 9…24 (for DR)
   - Recorder number: mod[(P-1) / N]

Consider the Modbus specification, in particular the setup of the function code 0x14.

If the recording mode is set to "FIFO" and the recording depth to "N", the newest data will be replaced by the oldest ones after "N" records have been recorded.

Example of reading out DR 1

Ensure that the data recorder is enabled.
Otherwise the data recorder log is 0.

Used registers = (number of measured quantities x 4 + 8)/2

Example: read DR1

Register	Description	Example value
8184	Trigger mode	1
8185	Recording mode	1
8186	Recording depth	100
8187	Recording interval	1
8189	Recording delay	0
8190	Number of measured quantities	16
8191	Measured quantity 1	1
8192	Measured quantity 2	2
8193	Measured quantity 3	3
…	…	…
8206	Measured quantity 16	16

Table 9.5: Read DR 1 (example)

1. Read the following registers:

DR1 pointer (register 0108) = P = 185
Recording depth (register 8186) = N = 100
Number of measured quantities (register 8190) = n = 16

Consequently, the number of the latest recording is:
mod[(P-1) / N] = mod[(185-1) / 100] = 84 (= 0x54)
Single recording size16 x 4 + 8 = 72 (used registers = 72/2 = 36 = 0x24)

Example: Request packets, response packets

Request packet (master to slave)		Response packet (slave to master)	
Unit ID	01	Unit ID	01
Function code 0x14	14	Function code 0x14	14
Subsequent byte number	07	Response data length	4A
Fixed as 0x06	06	Present recorder length	49

Request packet (master to slave)		Response packet (slave to master)	
File number	0009	Fixed as 0x06	06
Latest recording number	0054	Content	(example) 48 57 98 39 48 55 62 FA 48 57 88 29 48 56 D6 74 48 B9 C1 22 48 B9 BA 2B 48 BA AE A2 48 BA 0D FB 43 FA E9 48 43 F8 53 7A 43 FA D1 49 43 FA 04 AF 42 C2 9A 3A 40 80 CC B5 4C 52 C2 BE 4C 4E 5C B9 0E 08 1B 0E 20 09 00 00
Used registers (recording size/2)	0024		

Table 9.6: Example: Request packets, response packets

2. Send "Request packet": (Hex, without CRC): 01 14 07 06 00 09 00 54 00 24
3. Receive "Response packet" (Hex, without CRC): 01 14 4A 49 06 48 57 98 39 48 55 62 FA 48 57 88 29 48 56 D6 74 48 B9 C1 22 48 B9 BA 2B 48 BA AE A2 48 BA 0D FB 43 FA E9 48 43 F8 53 7A 43 FA D1 49 43 FA 04 AF 42 C2 9A 3A 40 80 CC B5 4C 52 C2 BE 4C 4E 5C B9 0E 08 1B 0E 20 09 00 00
4. Read the registers 8191…8206 for the measured quantities 1…16.

00 01 00 02 00 03 00 04 00 05 00 06 00 07 00 08 00 09 00 0A 00 0B 00 0C 00 0D 00 0E 00 0F 00 10

Refer to table 9.3 to divide the measured quantities with units into measurement data.

Element	Original data	Measurement data
Measured quantity 1	48 57 98 39	Float, 220768.8906250 V
Measured quantity 2	48 55 62 FA	Float, 218507.9062500 V
…		
Measured quantity 16	4C 4E 5C B9	Float, 54096612.0000000 W
Timestamp	0E 08 1B 0E 20 09 00 00	2014/8/27 14:32:09:000

10. Waveform recorder (WFR)

The PEM735 provides two waveform recorders (WFR) capable of recording independently from one another, which together can store 128 entries. Each WFR can record three-phase voltage and current signals as well as U_4 und I_4 at a time, at a maximum resolution of 513 samples per cycle.
Waveform recorders can be triggered by

- Setpoints
- Voltage dip/voltage swell
- Transient events
- Communication interface (manual)

During this process the **control via communications interface has the highest priority**. Other WFR triggers will be ignored until recording is completed.

Data are stored according to the FIFO principle (first in, first out). If 64 waveforms are reserved for this WFR, for example, the 65th waveform will overwrite the oldest one, etc.
WFR data is stored in a non-volatile memory and will not suffer any loss in the event of power failure.

The programming of the waveform recorder is only supported by the communications interface. The following setup parameters are supported:

No.	Parameters	Setting
1	Number of measurements	0…128 (entries)
2	Number of samples per cycle	16, 32, 64, 128, 256, 512 samples
3	Cycles per record	320, 160, 80, 40, 20 cycles
4	Number of cycles before the event	2…192 cycles

Register waveform recorder

Register	Property	Description		Format
8600	RW	WFR 1	Number of waveforms1)	0 … 128 (64*)
8601	RW		Quantity Samples per cycle 2)	0*= 16/640 1 = 32/320 2 = 64/160 3 = 128/80 4 = 256/40 5 = 512/20 [Samples per cycle/number of cycles]
8602	RW		Number of cycles before the event3)	2*…192 (16/640) 2* …96 (32/320) 2* …48 (64/160) 2* …24 (128/80) 2* …12 (256/40) 2* …6 (512/20) [Samples per cycle/number of cycles]
8603	RW	WFR 2	Number of waveforms 1)	0* … 128
8604	RW		Quantity Samples per cycle 2)	0*= 16/640 1 = 32/320 2 = 64/160 3 = 128/80 4 = 256/40 5 = 512/20 [Samples per cycle/number of cycles]
8605	RW		Number of cycles before the event3)	2*…192 (16/640) 2* …96 (32/320) 2* …48 (64/160) 2* …24 (128/80) 2* …12 (256/40) 2* …6 (512/20) [Samples per cycle/number of
8606	RW	Reserved	-	--

Register	Property	Description		Format
8607	RW	Transient recorder	Number of cycles before the event	2 …10 (5*)

Table 10.1: Register waveform recorder

[1] The total capacity of WFR1 and WFR 2 is 128 entries:

(Number of waveforms WFR 1 + number of waveforms WFR 2) ≤ 128

[2] The valid formats from the "Number of samples per cycle" and "Number of cycles" are:

16 x 640
32 x 320
64 x 160
128 x 80
256 x 40
512 x 20

3) The "Number of cycles before event" are limited. The possible entries in this register refer directly to the entry in register 8601 or 8604. Example:

Register entry in 8604: 5 — 512 samples per cycle
Register entry in 8605: — 2…6 possible

Changes to the setup parameters of the WFR will clear the waveform recorder and will set the WFR pointer to "0".

WFR1 pointer: register 0086
WFR2 pointer: register 0088

11. Energy log

Register	Property	Description		Format	Unit/option
8700	RW	Recording mode		UINT 16	0: disabled 1: stop-when-full 2: FIFO
8701	RW	Recording depth [1]		UINT 16	0*…65535
8702	RW	Recording interval		UINT 16	0 = 5 min* 1 = 10 min 2 = 15 min 3 = 30 min 4 = 60 min
8703	RW	Start time[2]	HiWord: year	UINT 16	0…99 (year - 2000)
			LoWord: month	UINT 16	1…12
8704	RW		HiWord: day	UINT 16	1…31
			LoWord: hour	UINT 16	0…23
8705	RW		HiWord: minute	UINT 16	0…59
			LoWord: second	UINT 16	0…59
8706	RW	Number of measured quantities		UINT 16	0*…5
8707	RW	Measured quantity 1		UINT 16	0* = active energy import (0.01 kWh) 1 = active energy export (0.01 kWh) 2 = reactive energy import (0.01 kvarh) 3 = reactive energy import (0.01 kvarh) 4 = apparent energy (0.01 kVAh)
8708	RW	Measured quantity 2		UINT 16	
8709	RW	Measured quantity 3		UINT 16	
8710	RW	Measured quantity 4		UINT 16	
8711	RW	Measured quantity 5		UINT 16	

Table 11.1: Register energy log

1) If the entry is "Number of recordings = 0", the energy log is disabled.

2) When the current time meets or exceeds the start-up time, the energy log starts to record.

*Any change of the **registers 8701…8711** will clear the WFR log and reset the pointer to 0.*

The energy log format is analogous to the data recorder format (see chapter 9.)

The recording values can also be read out in a similar way, as described in „Kapitel 9.3 Example of a recording with 16 measured quantities“. The following applies to the energy log:

- Pointer: register 0090
- Number of records: 25
- Each measurement entry requires a storage capacity of 28 bytes, irrespective of the configuration.

12. Setup PQ

12.1 Voltage swells, dips and interruptions

Register	Property	Description	Format	Note
8750	RW	Enabling monitoring of voltage swells, dips and interruptions	UINT16	0* = disabled 1 = enabled
8751	RW	Reference voltage for voltage swells, dips and interruptions	UINT16	0*= U_{din} (nominal) 1 = U_{sr} (slide reference voltage)
8752	RW	Swell threshold	UINT16	101…200 (x 0.01U_e) (110*)
8753	RW	Voltage dip threshold	UINT16	1…99 (x 0.01U_e) (90*)
8754	RW	Interruption threshold[1)]	UINT16	0…50 (x 0.01U_e) (10*)
8755	RW	Voltage swell hysteresis	UINT16	1…1000 (x 0.001U_e) (5*)
8756	RW	Voltage dip hysteresis	UINT16	
8757	RW	Voltage interruption hysteresis	UINT16	
8758	RW	Swell, dip and interruption trigger 1[2)]	UINT16	0…35 (31*)
8759	RW	Swell, dip and interruption trigger 2[2)]	UINT16	0*…35

Table 12.1: PQ log register: Voltage dips, swells, interruptions

Comments table 12.1

[1)] "Interruption voltage threshold" must be less than "Voltage dip threshold".

[2)] Voltage dips/swells and rapid voltage change trigger DO1/DO2 are only possible when DO1/DO2 have the function "Digital output" (register 7142, 7143)

Key for triggers see table 12.4.

12.2 Transients

Register	Property	Description	Format	Note
8760	RW	Voltage transient disturbances enabled	UINT16	0* = disabled 1= enabled
8761	RW	Transient voltage disturbances thresholds	UINT16	5…500 (x 0.01U_e) (50*)
8762	RW	Transient voltage disturbance trigger 1 [1)]	UINT16	0…6 and 31…35 (32*)
8763	RW	Transient voltage disturbance trigger 2 [1)]	UINT16	0*… 6 and 31…35

Table 12.2: PQ log register: Transients

Comments table 12.2

[1)] Trigger list

Voltage dips/swells and rapid voltage change trigger DO1/DO2 are only possible when DO1/DO2 have the function "Digital output" (register 7142, 7143).

Key for triggers see table 12.4.

12.3 Rapid voltage changes

Register	Property	Description	Format	Note
8764	RW	Rapid voltage changes monitoring	UINT16	0* = disabled 1= enabled
8765	RW	min. voltage change rate	UINT16	0…100 (x 0.01U_e/s) (5*)
8766	RW	min. settling time	UINT16	1…50 (x 0.1 s) (10*)
8767	RW	Min. voltage difference	UINT16	0…1000 (x 0.001 U_e) (10*)
8768	RW	Tolerance window, voltage (steady state)	UINT16	0…1000 (x 0.001 U_e) (1*)
8769	RW	Detection mode	UINT16	0*= steady state 1 = max. voltage change
8770	RW	Rapid voltage changes trigger 1 [1)]	UINT16	0…6 und 31*…35
8771	RW	Rapid voltage changes trigger 2 [1)]	UINT16	0*…6 and 31…35

Table 12.3: PQ log register: Rapid voltage changes

Comments table 12.3

[1)] Voltage dips/swells and rapid voltage change trigger DO1/DO2 are only possible when DO1/DO2 have the function "Digital output" (register 7142, 7143).

Key for triggers see table 12.4.

Trigger key (rapid voltage changes)

Key	Action	Key	Action	Key	Action
0	--	**12**	Reserved	**24**	DR 10
1	RO1	**13**	Reserved	**25**	DR 11
2	RO2	**14**	Reserved	**26**	DR 12
3	RO3	**15**	DR 1	**27**	DR 13
4	RO4	**16**	DR 2	**28**	DR 14
5	DO1	**17**	DR 3	**29**	DR 15
6	DO2	**18**	DR 4	**30**	DR 16
7	High speed DR 1	**19**	DR 5	**31**	WFR1
8	High speed DR 2	**20**	DR 6	**32**	WFR2
9	High speed DR 3	**21**	DR 7	**33**	Reserved
10	High speed DR 4	**22**	DR 8	**34**	Disturbing signal WFR
11	Reserved	**23**	DR 9	**35**	Reserved

Table 12.4: Trigger key (rapid voltage changes)

12.4 Mains signalling voltages

Register	Pro-perty	Description	Format	Note
8772	RW	Mains signalling voltage monitoring, frequency 1	UINT16	0* = disabled 1= enabled
8773	RW	Mains signalling voltage, frequency 1	UINT16	50 Hz: 600…30000 (x 0.1 Hz), 10000* 60 Hz: 700…30000 (x 0.1 Hz), 10000*

Register	Property	Description	Format	Note
8774	RW	Mains signalling voltage threshold, frequency 1	UINT16	3…1000 (x 0.001 U_e) 50* (x 0.001 U_e)
8775	RW	Mains signalling voltage transmission time, frequency 1	UINT16	1…120 s, 60* s
8776	RW	Mains signalling voltage monitoring, frequency 2	UINT16	0* = disabled 1 = enabled
8777	RW	Mains signalling voltage, frequency 2	UINT16	50 Hz: 600…30000 (x 0.1 Hz), 20000* 60 Hz: 700…30000 (x 0.1 Hz), 20000*
8778	RW	Mains signalling voltage threshold, frequency 2	UINT16	3…1000 (x 0.001 U_e) (50*)
8779	RW	Mains signalling voltage transmission time, frequency 2	UINT16	1…120 s, (60*)
8780	RW	Mains signalling voltage monitoring, frequency 3	UINT16	0* = disabled 1 = enabled
8781	RW	Mains signalling voltage, frequency 3	UINT16	50 Hz: 600…30000 (x 0.1 Hz), 30000* 60 Hz: 700 …30000 (x 0,1Hz), 30000*
8782	RW	Mains signalling voltage threshold, frequency 3	UINT16	3…1000 (x 0.001 U_e) (50*)
8783	RW	Mains signalling voltage transmission time, frequency 3	UINT16	1…120 s (60*)

Table 12.5: PQ log register: Mains signalling voltages

12.5 Flicker mode

Register	Property	Description	Format	Note
8784	RW	Flicker Mode	UINT16	0*= 120 V 1 = 230 V

Table 12.6: PQ log register: Flicker mode

13. RO/DO control

The control register of the digital outputs are implemented as Write-Only registers (WO) and can be controlled with the function code 0x05. In order to query the current DO status, the register **0077** has to be read out.

When **Register 7029 = 1** is selected, the PEM735 supports the execution of commands to the outputs in two steps (ARM before EXECUTING): Before sending an open or close command to one of the outputs, it must be enabled first. This is achieved by writing 0xFF00 to the appropriate RO/DO register. If an "Execute" command is not received within 15 seconds, the output will be disabled again.
Each command to be executed sent to an output that has not been enabled before, will be ignored by the PEM735 and returned as an exception code 0x04.

Register	Property	Description	Format	Note
9100	WO	Enable RO1 closed	UINT16	Writing 0xFF00
9101	WO	Execute RO1 closed	UINT16	Writing 0xFF00
9102	WO	Enable RO1 open	UINT16	Writing 0xFF00
9103	WO	Execute RO1 open	UINT16	Writing 0xFF00
9104	WO	Enable RO2 closed	UINT16	Writing 0xFF00
9105	WO	Execute RO2 closed	UINT16	Writing 0xFF00
9106	WO	Enable RO2 open	UINT16	Writing 0xFF00
9107	WO	Execute RO2 open	UINT16	Writing 0xFF00
9108	WO	Enable RO3 closed	UINT16	Writing 0xFF00
9109	WO	Execute RO3 closed	UINT16	Writing 0xFF00
9110	WO	Enable RO3 open	UINT16	Writing 0xFF00
9111	WO	Execute RO3 open	UINT16	Writing 0xFF00
9112	WO	Enable RO4 closed	UINT16	Writing 0xFF00
9113	WO	Execute RO4 closed	UINT16	Writing 0xFF00
9114	WO	Enable RO4 open	UINT16	Writing 0xFF00
9115	WO	Execute RO4 open	UINT16	Writing 0xFF00

Register	Property	Description	Format	Note
9116	WO	Enable DO1 closed	UINT16	Writing 0xFF00
9117	WO	Execute DO1 closed	UINT16	Writing 0xFF00
9118	WO	Enable DO1 open	UINT16	Writing 0xFF00
9119	WO	Execute DO1 open	UINT16	Writing 0xFF00
9120	WO	Enable DO2 closed	UINT16	Writing 0xFF00
9121	WO	Execute DO2 closed	UINT16	Writing 0xFF00
9122	WO	Enable DO2 open	UINT16	Writing 0xFF00
9123	WO	Execute DO2 open	UINT16	Writing 0xFF00

Table 13.1: RO/DO control register

14. Event log (SOE log)

14.1 Event log register

Register	Property	Description	Format
10000…10007	RO	Event 1	Data structure see table 14.2
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	
10088…10095	RO	Event 12	
…	…	…	
18176…18183	RO	Event 1023	
18184…18191	RO	Event 1024	

Table 14.1: Event log register

14.2 Event log data structure

Offset	Property	Description	Format	Note
+ 0	RO	Reserved	UINT16	
+1	RO	High byte: event classification	UINT16	see table 14.3
		Low byte: event sub classification		

Offset	Property	Description	Format	Note
+2	RO	High byte: year	UINT16	1…99 (year-2000)
		Low byte: month		1…12
+3	RO	High byte: day	UINT16	1…31
		Low byte: hour		0…23
+4	RO	High byte: minute	UINT16	0…59
		Low byte: second		0…59
+5	RO	Milliseconds	UINT16	0…999
+ 6, + 7	RO	Event value	INT32	-

Table 14.2: Event log data structure

Comments:

[1] 1024 SOE entries can be stored. The 1025th entry overwrites the first value, the 1026th the second one and so on (FIFO, ring memory). Therefore the last 1024 entries in each case (if available) can be read out.

[2] Calculation of the associated register:

Since the pointer on the latest entry is incremented beyond 1024, the following method is required in order to determine the start address of the latest recording.

Register number of N: 10,000 + 8 x [mod ((N-1)/1024)] with N = SOE entry

Example: SOE entry no.1050
10000 + 8 x [mod ((1049-1024)/1024)]
10000 + 8 x [25] = 10200

14.3 Event classification (SOE log)

Classification overview

Classification	Format	Description
1	INT 32	DI status change
2	INT 32	Function DO/RO
3	Float	Alarm
4	INT 32	Self-test
5	INT 32	Parameter configuration via communication interface or device button
6	INT 32	Trigger events
7	Float	Voltage over/under harmonics 2…63, active or reset
8	Float	Current over/under harmonics 2…63, active or reset

14.4 Event sub classification

Event classification	Event sub classification	Event value Unit Option	Description
1	1	1/0	DI1 closed/opened
	2	1/0	DI2 closed/opened
	3	1/0	DI3 closed/opened
	4	1/0	DI4 closed/opened
	5	1/0	DI5 closed/opened
	6	1/0	DI6 closed/opened
	7	1/0	DI7 closed/opened
	8	1/0	DI8 closed/opened

Event classifi-cation	Event sub classification	Event value Unit Option	Description
2	1	1/0	RO1 closed/opened via communications interface
	2	1/0	RO2 closed/opened via communications interface
	3	1/0	RO3 closed/opened via communications interface
	4	1/0	RO4 closed/opened via communications interface
	5	1/0	DO1 closed/opened via communications interface
	6	1/0	DO2 closed/opened via communications interface
	7	1/0	RO1 closed/opened via setpoint
	8	1/0	RO2 closed/opened via setpoint
	9	1/0	RO3 closed/opened via setpoint
	10	1/0	RO4 closed/opened via setpoint
	11	1/0	DO1 closed/opened via setpoint
	12	1/0	DO2 closed/opened via setpoint
	13	1/0	RO1 closed/opened due to voltage dip/swell
	14	1/0	RO2 closed/opened due to voltage dip/swell
	15	1/0	RO3 closed/opened due to voltage dip/swell
	16	1/0	RO4 closed/opened due to voltage dip/swell
	17	1/0	DO1 closed/opened due to voltage dip/swell
	18	1/0	DO2 closed/opened due to voltage dip/swell
	19	1/0	RO1 closed/opened due to transient event
	20	1/0	RO2 closed/opened due to transient event
	21	1/0	RO3 closed/opened due to transient event
	22	1/0	RO4 closed/opened due to transient event

Event classifi-cation	Event sub classification	Event value Unit Option	Description
2	23	1/0	DO1 closed/opened due to transient event
	24	1/0	DO2 closed/opened due to transient event
	25	1/0	RO1 closed/opened due to rapid voltage change
	26	1/0	RO2 closed/opened due to rapid voltage change
	27	1/0	RO3 closed/opened due to rapid voltage change
	28	1/0	RO4 closed/opened due to rapid voltage change
	29	1/0	DO1 closed/opened due to rapid voltage change
	30	1/0	DO2 closed/opened due to rapid voltage change
	31	1/0	RO1 closed/opened via device button
	32	1/0	RO2 closed/opened via device button
	33	1/0	RO3 closed/opened via device button
	34	1/0	RO4 closed/opened via device button
	35	1/0	DO1 closed/opened via device button
	36	1/0	DO2 closed/opened via device button
3	1	Trigger value	>-Setpoint U_{LN} exceeded
	2	Trigger value	>-Setpoint U_{LL} exceeded
	3	Trigger value	>-Setpoint I exceeded
	4	Trigger value	>-Setpoint U_4 exceeded
	5	Trigger value	>-Setpoint I_4 exceeded

Event classification	Event sub classification	Event value Unit Option	Description
3	6	Trigger value	>-Setpoint Δf exceeded
	7	Trigger value	>-Setpoint P_{ges} exceeded
	8	Trigger value	>-Setpoint Q_{ges} exceeded
	9	Trigger value	>-Setpoint S_{ges} exceeded
	10	Trigger value	>-Setpoint λ_{ges} exceeded
	11	1	Setpoint DI1 closed active
	12	1	Setpoint DI2 closed active
	13	1	Setpoint DI3 closed active
	14	1	Setpoint DI4 closed active
	15	1	Setpoint DI5 closed active
	16	1	Setpoint DI6 closed active
	17	1	Setpoint DI7 closed active
	18	1	Setpoint DI8 closed active
	19	Trigger value	>-Setpoint demand P_{ges} exceeded
	20	Trigger value	>-Setpoint demand Q_{ges} exceeded
	21	Trigger value	>-Setpoint demand S_{ges} exceeded
	22	Trigger value	>-Setpoint demand λ_{ges} exceeded
	23	Trigger value	>-Setpoint Predicted demand P_{ges} exceeded
	24	Trigger value	>-Setpoint Predicted demand Q_{ges} exceeded

Event classifi-cation	Event sub classification	Event value Unit Option	Description
3	25	Trigger value	>-Setpoint Predicted demand S_{ges} exceeded
	26	Trigger value	>-Setpoint Predicted demand λ_{ges} exceeded
	27	Trigger value	>-Setpoint THD_U exceeded
	28	Trigger value	>-Setpoint $TOHD_U$ exceeded
	29	Trigger value	>-Setpoint $TEHD_U$ exceeded
	30	Trigger value	>-Setpoint THD_I exceeded
	31	Trigger value	>-Setpoint $TOHD_I$ exceeded
	32	Trigger value	>-Setpoint $TEHD_I$ exceeded
	33	Trigger value	>-Setpoint voltage unbalance U_2 exceeded (negative sequence component)
	34	Trigger value	>-Setpoint voltage unbalance U_0 exceeded (zero sequence component)
	35	Trigger value	>-Setpoint current unbalance I_2 exceeded (negative sequence component)
	36	Trigger value	>-Setpoint current unbalance I_0 exceeded (zero sequence component)
	37	Trigger value x 100	>-Setpoint deviation voltage exceeded
	38	1	>-Setpoint phase reversal exceeded
	39…45	Reserved	
	46	Return value	>-Setpoint U_{LN} reset

Event classification	Event sub classification	Event value Unit Option	Description
3	47	Return value	>-Setpoint U_{LL} reset
	48	Return value	>-Setpoint I reset
	49	Return value	>-Setpoint U_4 reset
	50	Return value	>-Setpoint I_4 reset
	51	Return value	>-Setpoint Δf reset
	52	Return value	>-Setpoint P_{ges} reset
	53	Return value	>-Setpoint Q_{ges} reset
	54	Return value	>-Setpoint S_{ges} reset
	55	Return value	>-Setpoint λ_{ges} reset
	56	0	Setpoint "DI1 closed" reset
	57	0	Setpoint "DI2 closed" reset
	58	0	Setpoint "DI3 closed" reset
	59	0	Setpoint "DI4 closed" reset
	60	0	Setpoint "DI5 closed" reset
	61	0	Setpoint "DI6 closed" reset
	62	0	Setpoint "DI7 closed" reset
	63	0	Setpoint "DI8 closed" reset
	64	Return value	>-Setpoint "Demand P_{ges}" reset
	65	Return value	>-Setpoint "Demand Q_{ges}" reset

Event classification	Event sub classification	Event value Unit Option	Description
3	66	Return value	>-Setpoint "Demand S_{ges}" reset
	67	Return value	>-Setpoint "Demand λ_{ges}" reset
	68	Return value	>-Setpoint "Predicted demand P_{ges}" reset
	69	Return value	>-Setpoint "Predicted demand P_{ges}" reset
	70	Return value	>-Setpoint "Predicted demand S_{ges} " reset
	71	Return value	>-Setpoint "Predicted demand λ_{ges}" reset
	72	Return value	>-Setpoint "THD_U" reset
	73	Return value	>-Setpoint "$TOHD_U$" reset
	74	Return value	>-Setpoint "$TEHD_U$" reset
	75	Return value	>-Setpoint "THD_I" reset
	76	Return value	>-Setpoint "$TOHD_I$" reset
	77	Return value	>-Setpoint "$TEHD_I$" reset
	78	Return value	>-Setpoint "Voltage unbalance U_2" reset (negative sequence component)
	79	Return value	>-Setpoint "Voltage unbalance U_0" reset (zero sequence component)
	80	Return value	>-Setpoint "Current unbalance I_2" exceeded (negative sequence component)
	81	Return value	>-Setpoint "Current unbalance *I0*" exceeded (zero sequence component)

Event classification	Event sub classification	Event value Unit Option	Description
3	82	Return value	>-Setpoint "Voltage deviation" reset
	83	0	>-Setpoint "Phase reversal" reset
	84…90	Reserved	
	91	Trigger value	<-under setpoint U_{LN}
	92 2	Trigger value	<-under setpoint U_{LL}
	93	Trigger value	<-under setpoint I
	94	Trigger value	<-Under setpoint U_4
	95	Trigger value	<-Under I_4 setpoint
	96	Trigger value	<-Under setpoint Δf
	97	Trigger value	<-under setpoint P_{ges}
	98	Trigger value	<-under setpoint Q_{ges}
	99	Trigger value	<-under setpoint S_{ges}
	100	Trigger value	<-under setpoint λ_{ges}
	101	0	Setpoint DI1 opened active
	102	0	Setpoint DI2 opened active
	103	0	Setpoint DI3 opened active
	104	0	Setpoint DI4 opened active
	105	0	Setpoint DI5 opened active
	106	0	Setpoint DI6 opened active

Event classification	Event sub classification	Event value Unit Option	Description
3	107	0	Setpoint DI7 opened active
	108	0	Setpoint DI8 opened active
	109	Trigger value	<-under setpoint demand P_{ges}
	110	Trigger value	<-under setpoint demand Q_{ges}
	111	Trigger value	<-Under setpoint demand S_{ges}
	112	Trigger value	<-under setpoint demand λ_{ges}
	113	Trigger value	<-Under setpoint Predicted demand P_{ges}
	114	Trigger value	<-Under setpoint Predicted demand Q_{ges}
	115	Trigger value	<-Under setpoint Predicted demand S_{ges}
	116	Trigger value	<-Under setpoint Predicted demand λ_{ges}
	117	Trigger value	<-under setpoint THD_U
	118	Trigger value	<-under setpoint $TOHD_U$
	119	Trigger value	<-under setpoint $TEHD_U$
	120	Trigger value	<-under setpoint THD_I
	121	Trigger value	<-under setpoint $TOHD_I$
	122	Trigger value	<-under setpoint $TEHD_I$
	123	Trigger value	<-Under setpoint voltage unbalance U_2

Event classification	Event sub classification	Event value Unit Option	Description
3	124	Trigger value	<-Under setpoint voltage unbalance U_0
	125	Trigger value	<-Under setpoint current unbalance I_2 (negative sequence component)
	126	Trigger value	<-Under setpoint current unbalance I_0 (zero sequence component)
	127	Trigger value	<-Under setpoint voltage deviation
	128…135	Reserved	
	136	Return value	<-Setpoint U_{LN} reset
	137	Return value	<-Setpoint U_{LL} reset
	138	Return value	<-Setpoint I reset
	139	Return value	<-Setpoint U_4 reset
	140	Return value	<-Setpoint I_4 reset
	141	Return value	<-Setpoint deviation Δf reset
	142	Return value	<-Setpoint P_{ges} reset
	143	Return value	<-Setpoint Q_{ges} reset
	144	Return value	<-Setpoint S_{ges} reset
	145	Return value	<-Setpoint λ_{ges} reset
	146	1	Setpoint "DI1 open" reset
	147	1	Setpoint "DI2 open" reset
	148	1	Setpoint "DI3 open" reset
	149	1	Setpoint "DI4 open" reset
	150	1	Setpoint "DI5 open" reset
	151	1	Setpoint "DI6 open" reset
	152	1	Setpoint "DI7 open" reset
	153	1	Setpoint "DI8 open" reset

Event classification	Event sub classification	Event value Unit Option	Description
3	154	Return value	<-Setpoint "Demand P_{ges}" reset
	155	Return value	<-Setpoint "Demand P_{ges}" reset
	156	Return value	<-Setpoint "Demand S_{ges}" reset
	157	Return value	<-Setpoint "Demand λ_{ges}" reset
	158	Return value	<-Setpoint "Predicted demand P_{ges}" reset
	159	Return value	<-Setpoint "Predicted demand Q_{ges}" reset
	160	Return value	<-Setpoint "Predicted demand S_{ges}" reset
	161	Return value	<-Setpoint "Predicted demand λ_{ges}" reset
	162	Return value	<-Setpoint "THD_U" reset
	163	Return value	<-Setpoint "$TOHD_U$" reset
	164	Return value	<-Setpoint "$TEHD_U$" reset
	165	Return value	<-Setpoint "THD_I" reset
	166	Return value	<-Setpoint "$TOHD_I$" reset
	167	Return value	<-Setpoint "$TEHD_I$" reset
	168	Return value	<-Setpoint "Voltage unbalance U_2" reset (negative sequence component)
	169	Return value	<-Setpoint "Voltage unbalance U_0 " reset (zero system component)
	170	Return value	<-Setpoint "Current unbalance I_2" reset (negative sequence component)
	171	Return value	<-Setpoint "Current unbalance I_0" reset (zero sequence component)
	172	Return value	<-Setpoint "Voltage deviation" reset
	173	Reserved	

Event classifi-cation	Event sub classification	Event value Unit Option	Description
4	1	0	DSP fault
	2	0	AD fault
	3	Reserved	
	4	Reserved	
	5	0	NVRAM fault
	6	0	FRAM log fault
	7	0	System parameter fault
	8	0	Setpoint parameter fault
	9	0	Fault parameter data recorder
	10	0	Fault parameter waveform recorder
	11	0	Fault parameter PQ log
	12	0	Fault parameter energy log
	13	0	Fault parameter EN 50160 log
	14	Reserved	
	15	0	Fault parameter disturbing signal recorder
	16	Reserved	
	17	0	Fault internal parameter
	18	0	Fault parameter communication

Event classifi-cation	Event sub classification	Event value Unit Option	Description
5	1	0	Supply voltage on
	2	0	Supply voltage off
	3	0	Clock set via front panel
	4	0	Setup changed via device buttons
	5	Reserved	
	6	0	Communication parameter changed via device button
	7…9	Reserved	
	10	0	DI counter cleared via front panel
	11		Event log cleared via front panel
	12	0	PQ log cleared via device button
	13	0	Energy values cleared via front panel
	14	0	Data recorder cleared via front panel
	15	0	Waveform recorder cleared via front panel
	16	Reserved	
	17	Reserved	
	18	0	Energy log cleared via device buttons
	19	0	Max./Min. value log of this month cleared via front panel
	20	Reserved	
	21	0	Peak demand of this month cleared via front panel
	22…24	Reserved	

Event classification	Event sub classification	Event value Unit Option	Description
5	25	1…9	PQ event **cleared via device buttons:** 1: voltage dip counter 2: voltage swell counter 3: voltage interruption counter 4: transient counter 5: rapid voltage change counter 6: counter mains signalling voltage 1 7: counter mains signalling voltage 2 8: counter mains signalling voltage 3 9: all PQ events
	26	0	All logs and statistics cleared via device buttons
	27	0	Setup changed via communications interface
	28	0	Internal parameters set via communications interface
	29	0	Communication parameter set via communications interface
	30	0	Counter DI set via communications interface
	31	0	Event log set via communications interface
	32	Reserved	
	33	1…8	Counter DI cleared via communications interface
	34	0	Event log cleared via communications interface
	35	0	PQ log cleared via communications interface
	36	0	Energy values cleared via communications interface
	37	0	Data recorder cleared via communications interface
	38	0	Waveform recorder cleared via communications interface

Event classifi-cation	Event sub classification	Event value Unit Option	Description
5	39	Reserved	
	40	0	Transient log cleared via communications interface
	41	0	Energy log cleared via communications interface
	42	0	Max./Min. value log of this month cleared via communications interface
	43	0	All Max./Min. values cleared via communications interface
	44	0	Peak demand of this month cleared via communications interface:
	45	0	All peak demand values cleared via communications interface
	46	0	EN 50160 log cleared via communications interface
	47	Reserved	
	48	1…9	PQ log **cleared via communications interface**: 1: voltage dip counter 2: voltage swell counter 3: voltage interruption counter 4: transient counter 5: rapid voltage change counter 6: counter mains signalling voltage 1 7: counter mains signalling voltage 2 8: counter mains signalling voltage 3 9: all PQ events
	49	0	All logs and statistics cleared via device buttons
	50	Reserved	
	51	Reserved	

Event classification	Event sub classification	Event value Unit Option	Description
6	1	0	Waveform recording triggered by communications interface
	2	Setpoint 1…40	Waveform recording triggered by setpoint
	3	1…2	Waveform recording triggered by voltage dip/voltage swell
	4	1…2	Waveform recording triggered by transient
	5	1…2	Waveform recording triggered by rapid voltage change
	6	Setpoint 1…40	Data recorder (standard) triggered by setpoint
	7	0	Data recorder (standard) triggered by voltage dip/voltage swell
	8	Reserved	
	9	Reserved	
	10	Setpoint 1…40	Data recorder (high speed) triggered by setpoint
	11	0	Data recorder (high speed) triggered by voltage dip/voltage swell
	12 …22	Reserved	
	23	0	Unwanted signal recorder triggered by communications interface
	24	Setpoint 1…40	Unwanted signal recorder triggered by setpoint
	25	0	Disturbing signal recorder triggered by voltage dip/voltage swell
	26	0	Disturbing signal recorder triggered by transient disturbance
	27	0	Distrubing signal recorder triggered by rapid voltage change
	28	0	Disturbing signal recording finished

Event classifi-cation	Event sub classification	Event value Unit Option	Description
7	1	Trigger value	>-HD2$_U$ active
	…		
	62	Trigger value	>-HD63$_U$ active
	63	Return value	>-HD2$_U$ reset
	…		
	124	Return value	>-HD63$_U$ reset
	125	Trigger value	<-HD2$_U$ active
	…		
	186	Trigger value	<-HD63$_U$ active
	187	Return value	<-HD2$_U$ reset
	…		
	248	Return value	<-HD63$_U$ reset

Event classification	Event sub classification	Event value Unit Option	Description
8	1	Trigger value	>-HD2$_I$ active
	…		
	62	Trigger value	>-HD63$_I$ active
	63	Return value	>-HD2$_I$ reset
	…		
	124	Return value	>-HD63$_I$ reset
	125	Trigger value	<-HD2$_I$ active
	…		
	186	Trigger value	<-HD63$_I$ active
	187	Return value	<-HD2$_I$ reset
	…		
	248	Return value	<-HD63$_I$ reset

Table 14.3: Event classification

15. Max./Min. log

Log of the maximum and minimum values of the current and the last month

15.1 Maximum values of this month

Values since the last reset
Format: see table 15.5, page 134

Register	Property	Description	Factor/unit
20000…20005	RO	$U_{L1\ max}$ [1]	V
20006…20011	RO	$U_{L2\ max}$ [1]	V
20012…20017	RO	$U_{L3\ max}$ [1]	V
20018…20023	RO	Ø $U_{LN\ max}$ [1]	V
20024…20029	RO	$U_{L1L2\ max}$	V
20030…20035	RO	$U_{L2L3\ max}$	V
20036…20041	RO	$U_{L3L1\ max}$	V
20042…20047	RO	Ø $U_{LL\ max}$	V
20048…20053	RO	$I_{1\ max}$	A
20054…20059	RO	$I_{2\ max}$	A
20060…20065	RO	$I_{3\ max}$	A
20066…20071	RO	Ø I_{max}	A
20072…20077	RO	$U_{4\ max}$	V
20078…20083	RO	$I_{4\ max}$ [2] or reserved	A
20084…20089	RO	$P_{ges\ max}$	W
20090…20095	RO	$Q_{ges\ max}$	var
20096…20101	RO	$S_{ges\ max}$	VA
20102…20107	RO	λges max	
20108…20113	RO	f_{max}	Hz

Register	Property	Description	Factor/unit
20114…20119	RO	$THD_{UL1\ max}$ or $THD_{UL1L2\ max}$	% [3]
20120…20125	RO	$THD_{UL2\ max}$ or $THD_{UL2L3\ max}$	%
20126…20131	RO	$THD_{UL3\ max}$ or $THD_{UL3L1\ max}$	%
20132…20137	RO	$THD_{I1\ max}$	%
20138…20143	RO	$THD_{I2\ max}$	%
20144…20149	RO	$THD_{I3\ max}$	%
20150…20155	RO	Max. k-factor I_1	
20156…20161	RO	Max. k-factor I_2	
20162…20167	RO	Max. k-factor I_3	
20168…20173	RO	Max. k-factor I_4 [2] or reserved	
20174…20179	RO	Max. voltage unbalance U_2 (negative sequence component)	%
20180…20185	RO	Max. voltage unbalance U_0 (zero sequence component)	%
20186…20191	RO	Max. current unbalance I_2 (negative sequence component)	%
20192…20197	RO	Max. current unbalance I_0 (zero sequence component)	%

Table 15.1: Register maximum value log current month

Comments

1) In the case of delta connection, the registers 20000…20023 are reserved.

2) I_4 input only, otherwise it is reserved.

3) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

15.2 Min. values of this month

Values since the last reset

Format: see table 15.5, page 134

Register	Property	Description	Factor/unit
20200…20205	RO	$U_{L1\ min}$ [1]	V
20206…20211	RO	$U_{L2\ min}$ [1]	V
20212…20217	RO	$U_{L3\ min}$ [1]	V
20218…20223	RO	Ø $U_{LN\ min}$ [1]	V
20224…20229	RO	$U_{L1L2\ min}$ [2]	V
20230…20235	RO	$U_{L2L3\ min}$ [2]	V
20236…20241	RO	$U_{L3L1\ min}$ [2]	V
20242…20247	RO	Ø $U_{LL\ min}$ [2]	V
20248…20253	RO	$I_{1\ min}$	A
20254…20259	RO	$I_{2\ min}$	A
20260…20265	RO	$I_{3\ min}$	A
20266…20271	RO	Ø I_{min}	A
20272…20277	RO	$U_{4\ min}$	V
20278…20283	RO	$I_{4\ min}$ [3]	A
20284…20289	RO	$P_{ges\ min}$	W
20290…20295	RO	$Q_{ges\ min}$	var
20296…20301	RO	$S_{ges\ min}$	VA
20302…20307	RO	λges min	
20308…20313	RO	f_{min}	Hz
20314…20319	RO	$THD_{UL1\ min}$ [2] or $THD_{UL1L2\ min}$ [2]	% [4]
20320…20325	RO	$THD_{UL2\ min}$ [2] or $THD_{UL2L3\ min}$ [2]	%
20326…20331	RO	$THD_{UL3\ min}$ [1] or $THD_{UL3L1\ min}$ [2]	%

Register	Property	Description	Factor/unit
20332…20337	RO	$THD_{I1\ min}$	%
20338…20343	RO	$THD_{I2\ min}$	%
20344…20349	RO	$THD_{I3\ min}$	%
20350…20355	RO	Min. k-factor I_1	
20356…20361	RO	Min. k-factor I_2	
20362…20367	RO	Min. k-factor I_3	
20368…20373	RO	Min. k-factor I_4 [3)]	
20374…20379	RO	Min. voltage unbalance U_2 (negative sequence components)	%
20380…20385	RO	Min. voltage unbalance U_0 (zero sequence component)	%
20386…20391	RO	Min. current unbalance I_2 (negative sequence component)	%
20392…20397	RO	Min. current unbalance I_0 (zero sequence component)	%

Table 15.2: Register minimum values log current month

Comments

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) I_4 input only, otherwise it is reserved.

4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

15.3 Max. values of last month

Values **before** the last reset

Format: see table 15.5, page 134

Register	Property	Description	Factor/unit
20400…20405	RO	$U_{L1\ max}$ [1]	V
20406…20411	RO	$U_{L2\ max}$ [1]	V
20412…20417	RO	$U_{L3\ max}$ [1]	V
20418…20423	RO	Ø $U_{LN\ max}$ [1]	V
20424…20429	RO	$U_{L1L2\ max}$ [2]	V
20430…20435	RO	$U_{L2L3\ max}$ [2]	V
20436…20441	RO	$U_{L3L1\ max}$ [2]	V
20442…20447	RO	Ø $U_{LL\ max}$ [2]	V
20448…20453	RO	$I_{1\ max}$	A
20454…20459	RO	$I_{2\ max}$	A
20460…20465	RO	$I_{3\ max}$	A
20466…20471	RO	Ø I_{max}	A
20472…20477	RO	$U_{4\ max}$	V
20478…20483	RO	$I_{4\ max}$ [3]	A
20484…20489	RO	$P_{ges\ max}$	W
20490…20495	RO	$Q_{ges\ max}$	var
20496…20501	RO	$S_{ges\ max}$	VA
20502…20507	RO	λges max	
20508…20513	RO	f_{max}	Hz
20514…20519	RO	$THD_{UL1\ max}$ [1] or $THD_{UL1L2\ max}$ [2]	% [4]
20520…20525	RO	$THD_{UL2\ max}$ [1] or $THD_{UL2L3\ max}$ [2]	%
20526…20531	RO	$THD_{UL3\ max}$ [1] or $THD_{UL3L1\ max}$ [2]	%

Register	Property	Description	Factor/unit
20532…20537	RO	$THD_{I1\ max}$	%
20538…20543	RO	$THD_{I2\ max}$	%
20544…20549	RO	$THD_{I3\ max}$	%
20550…20555	RO	Max. k-factor I_1	
20556…20561	RO	Max. k-factor I_2	
20562…20567	RO	Max. k-factor I_3	
20568…20573	RO	Max. k-factor I_4 [3)]	
20574…20579	RO	Max. voltage unbalance U_2 (negative sequence component)	%
20580…20585	RO	Max. voltage unbalance U_0 (zero sequence component)	%
20586…20591	RO	Max. current unbalance I_2 (negative sequence component)	%
20592…20597	RO	Max. current unbalance I_0 (zero sequence component)	%

Table 15.3: Register maximum values log last month

Comments:

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) I_4 input only, otherwise it is reserved.

4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

15.4 Min. values last month

Values **before** the last reset

Format: see table 15.5, page 134

Register	Pro-perty	Description	Factor /unit
20600…20605	RO	$U_{L1\ min}$ [1]	V
20606…20611	RO	$U_{L2\ min}$ [1]	V
20612…20617	RO	$U_{L3\ min}$ [1]	V
20618…20623	RO	Ø $U_{LN\ min}$ [1]	V
20624…20629	RO	$U_{L1L2\ min}$ [2]	V
20630…20635	RO	$U_{L2L3\ min}$ [2]	V
20636…20641	RO	$U_{L3L1\ min}$ [2]	V
20642…20647	RO	Ø $U_{LL\ min}$ [2]	V
20648…20653	RO	$I_{1\ min}$	A
20654…20659	RO	$I_{2\ min}$	A
20660…20665	RO	$I_{3\ min}$	A
20666…20671	RO	Ø I_{min}	A
20672…20677	RO	$U_{4\ min}$	V
20678…20683	RO	$I_{4\ min}$ [3]	A
20684…20689	RO	$P_{ges\ min}$	W
20690…20695	RO	$Q_{ges\ min}$	var
20696…20701	RO	$S_{ges\ min}$	VA
20702…20707	RO	λges min	
20708…20713	RO	f_{min}	Hz
20714…20719	RO	$THD_{UL1\ min}$ [1] or $THD_{UL1L2\ min}$ [2]	% [4]
20720…20725	RO	$THD_{UL2\ min}$ [1] or $THD_{UL2L3\ min}$ [2]	%
20726…20731	RO	$THD_{UL3\ min}$ [1] or $THD_{UL3L1\ min}$ [2]	%

Register	Pro-perty	Description	Factor /unit
20732…20737	RO	$THD_{I1\ min}$	%
20738…20743	RO	$THD_{I2\ min}$	%
20744…20749	RO	$THD_{I3\ min}$	%
20750…20755	RO	Min. k-factor I_1	
20756…20761	RO	Min. k-factor I_2	
20762…20767	RO	Min. k-factor I_3	
20768…20773	RO	Min. k-factor I_4 [3)]	
20774…20779	RO	Min. voltage unb. U_2 (negative sequence component)	%
20780…20785	RO	Min. voltage unb. U_0 (zero sequence component)	%
20786…20791	RO	Min. current unb. I_2 (negative sequence component)	%
20792…20797	RO	Min. current unbalance I_0 (zero sequence component)	%

Table 15.4: Register minimum values last month

Comments:

1) Only in the case of wye connection, otherwise reserved.

2) Only in the case of delta connection, otherwise reserved.

3) I_4 input only, otherwise it is reserved.

4) Register content "%": 1.0 = 100 %; 0.95 = 95 % etc.

15.5 Data structure Max./Min. log

Offset	Property	Description	Format	Note
+ 0	RO	Max or min. value	Float	
+ 2	RO	High byte: year	UINT16	1…99 (year-2000)
	RO	Low byte: month		1…12
+ 3	RO	High byte: day	UINT16	1…31
	RO	Low byte: hour		0…23
+ 4	RO	High byte: minute	UINT16	0…59
	RO	Low byte: second		0…59
+ 5	RO	Milliseconds	UINT16	0…999

Table 15.5: Max./Min. log data structure

16. PQ log

16.1 PQ log register:

Register	Property	Description	Format
21000…21015	RO	PQ log: event 1	see table 16.2
21016…21031	RO	PQ log: event 2	
21032…21047	RO	PQ log: event 3	
21048…21063	RO	PQ log: Event 4	
21064…21079	RO	PQ log: event 5	
21080…21095	RO	PQ log: event 6	
21096…21111	RO	PQ log: event 7	
21112…21127	RO	PQ log: event 8	
21128…21143	RO	PQ log: event 9	
21144…21159	RO	PQ log: event 10	
21160…21175	RO	PQ log: event 11	
21176…21191	RO	PQ log: event 12	
…	…	…	
37368…37383	RO	PQ log: event 1024	

Table 16.1: PQ log register:

16.2 PQ log data structure

Offset	Property	Description	Format	Note
+ 0	RO	Reserved	UINT16	
+1	RO	High byte: PQ event classification	UINT16	1…4
		Low byte: PQ event sub classification		1…7
+2	RO	High byte: year	UINT16	1…99 (year-2000)
		Low byte: month		1…12
+3	RO	High byte: day	UINT16	1…31
		Low byte: hour		0…23
+4	RO	High byte: minute	UINT16	0…59
		Low byte: second		0…59
+5	RO	Milliseconds	UINT16	0…999
+ 6, + 7	RO	PQ event value 1	Float	-
+ 8, +9	RO	PQ event value 2	UINT32	Note [1]
+ 10, + 11	RO	PQ event value 3	Float	
+ 12, + 13	RO	PQ event value 4	Float	
+ 14, + 15	RO	PQ event value 5	Float	

Table 16.2: PQ log data structure

Note:

[1] 1024 PQ entries can be saved. Entry 1025 overwrites the first value, the 1026th the second one and so on (FIFO, ring memory). Therefore the last 1024 entries in each case (if available) can be read.

16.3 Sub classification PQ log

The device classifies the PQ logs into 4 classes which in turn are divided into sub classes.

The table shows the possible sub classifications.

PQ log classification	PQ log Sub classification	Event value number and format	PQ value Unit/option	Description
1. Voltage swell/voltage dip	1	1 (UINT32)	**Detection triggered on** Bit 0 = U_{L1} Bit 1 = U_{L2} Bit 2 = U_{L3}	Start of voltage swell
		2…5	Reserved	
	2	1 (Float)	Max. disturbance U_{LN} (in %)	End of voltage swell
		2 (UINT32)	Duration (ms)	
		3 (Float)	Max. disturbance U_{L1} (in %)	
		4 (Float)	Max. disturbance U_{L2} (in %)	
		5 (Float)	Max. disturbance U_{L3} (in %)	
	3	As in the case of sub classification 1		Start of voltage dip
	4	As in the case of sub classification 2		End of voltage dip
	5	As in the case of sub classification 1		Start of voltage interruption
	6	As in the case of sub classification 2		End of voltage interruption
	7	1 (UINT32)	**Direction** 0: on the supply side 1: on the load side	Cause of disturbance
		2 (UINT32)	**Reliability of statement** 0: low probability 1: medium probability 2: high probability	
		3…5	Reserved	

PQ log classification	PQ log Sub classification	Event value number and format	PQ value Unit/option	Description
2. Transient event	1	1 (Float)	Max. transient U (%)	Transient event was recorded
		2 (UINT32)	Duration (µs)	
		3 (Float)	Max. transient U_{L1} (%)	
		4 (Float)	Max. transient U_{L2} (%)	
		5 (Float)	Max. transient U_{L3} (%)	
3. Rapid voltage change	1	1 (Float)	Voltage change during steady-state condition (%)	Rapid voltage change U_{L1}
		2 (UINT32)	Duration (ms)	
		3 (Float)	Max. voltage change rate (% U_n / s)	
		4 (UINT32)	Direction of rapid voltage change 0: decreased 1: increased	
		5 (UINT32)	Reserved	
	2	As in the case of sub classification 1		Rapid voltage change U_{L2}
	3	As in the case of sub classification 1		Rapid voltage change U_{L3}

PQ log classi-fication	PQ log Sub classi-fication	Event value number and format	PQ value Unit/option	Description
4. Mains signalling voltage	1	1 (UINT32)	*f* (x 0.1 Hz)	Start mains signalling voltage, **frequency 1**
		2 (UINT32)	**Detection triggered on** Bit 0= Phase 1 Bit 1= Phase 2 Bit 2= Phase 3	
	2	1 (UINT32)	*f* (x 0.1 Hz)	End of mains signalling voltage, **frequency 1**
		2 (Float)	Max. signal U_{L1} (V)	
		3 (Float)	Max. signal U_{L2} (V)	
		4 (Float)	Max. signal U_{L3} (V)	
		5	Reserved	
	3	As in the case of sub classification 1		Start mains signalling voltage, **frequency 2**
	4	As in the case of sub classification 2		End of mains signalling voltage, **frequency 2**
	5	As in the case of sub classification 1		Start mains signalling voltage, **frequency 3**
	6	As in the case of sub classification 2		End of mains signalling voltage, **frequency 3**

Table 16.3: PQ sub classification key

17. EN 50160 log

The PEM 735 allows an evaluation according to the EN 50160 standard. These evaluations are available on the display of the device (graphical, to a limited extent) and also via a web application.
This standard aims to specify the evaluation criteria for the voltage quality in power supply systems with regard to frequency, voltage level, waveform and symmetry of line voltages.

The EN 50160 evaluations are stored in the PEM735 for a period of up to one year. The last saved data record can be found in the Modbus register 00140. Starting with the latest data record, you can read the last, the second last… etc. report, provided that the respective value has been written to the register 42000. The start and end time of the set interval can be found in the registers 42002 and 42004.

Irrespective of the type of distribution system, the assessment comprises the following points:

- Power frequency
- Supply voltage variations
- Rapid voltage changes
- Flicker severity
- Supply voltage unbalance
- Harmonic voltage
- Interharmonic voltage
- Mains signalling voltages on the supply voltage (ripple control signals)
- Interruptions
- Voltage dips
- Voltage swells
- Transient voltages

17.1 General

Register	Property	Description	Format	Unit/description
42000	RW	Number EN 50160 report log	UINT32	
42002	RO	Start time (local time)	UINT32	UNIX seconds[1)]
42004	RO	End time (local time)	UINT32	UNIX seconds

Table 17.1: Register EN 50160 General

Comments table 17.1

1) UNIX seconds: number of seconds since 01.01.1970, 0:00 h

17.2 Power frequency

Register	Property	Description	Format	Unit/ description
42006	RO	Result f_n over a measurement period (only for networks **with connection** to an interconnected system)	UINT32	0: ok 1: not ok
42008	RO	Number of measured values within the permitted thresholds	UINT32	without "flagged data"[1)]
42010	RO	Number of flagged measured values	UINT32	"flagged data"
42012	RO	Result f_n within the "broad" limits of the measurement period	UINT32	0: ok 1: not ok
42014	RO	Number of measured values which exceed the "broad" limits of the standard	UINT32	
42016	RO	Percentage of the measured values which are within the "broad" limits of the standard [2)]	Float	x 100 %
42018	RO	Result f_n within the "narrow" limits of the measurement period	UINT32	0: ok 1: not ok
42020	RO	Measured values the duration of which exceeds the "narrow" limits of the standard	UINT32	

42022	RO	Percentage of the measured values which are within the "narrow" limits of the standard	Float	x 100 %
42024	RO	Highest measured value during the measurement period	Float	Hz
42026	RO	Lowest measured value during the measurement period	Float	Hz

Table 17.2: Power frequency register

Comments table 17.2

1) Flagged measured values have not been considered.
Flagged data (flagged measured values): Measured values (measured or aggregated) which were flagged to indicate that they may be influenced by voltage interruptions, swells or dips.

2) Definition percentage: (Period with correct measured values)/(entire measurement period)
10 % are written as "0.10" to the register

Two tests are carried out to check that the power frequency is in accordance with EN 50160:

a.) The limit values in register 45002 (= positive deviation) and 45004 (= negative deviation) have to comply with at least register 45000 x 100 %.

b.) The limit values in register 45008 (= positive deviation) and 45010 (= negative deviation) have to comply with at least register 45006 x 100 %.

17.3 Supply voltage variations

Register	Property	Description	Format	Unit/ description
42028	RO	Result *supply voltage variations* during the measurement period	UINT32	0: ok 1: not ok
42030	RO	Number of correct measured values	UINT32	Without "flagged data"[1)]
42032	RO	Number of flagged measured values	UINT32	"flagged data"
42034	RO	Result *supply voltage variations* within the "wide" limits during the measurement period[2)]	UINT32	0: ok 1: not ok

Register	Property	Description	Format	Unit/ description
42036	RO	Number of measured values U_{L1} which exceed the "wide" limits of the standard	UINT32	Measured values
42038	RO	Number of measured values U_{L2} which exceed the "wide" limits of the standard	UINT32	Measured values
42040	RO	Number of measured values U_{L3} which exceed the "wide" limits of the standard	Float	Measured values
42042	RO	Percentage of the average values U_{L1} which are within the "wide" limits of the standard	Float	x 100 %
42044	RO	Persentage of the average values U_{L2} which are within the "wide" limits of the standard	Float	x 100 %
42046	RO	Percentage of the average values U_{L} which are within the "wide" limits of the standard	Float	x 100 %
42048	RO	Result *supply voltage variations* within the "narrow" limits during the measurement period [2)]	UINT32	
42050	RO	Number of measured values U_{L1} which exceed the "narrow" limits of the standard	UINT32	
42052	RO	Number of measured values U_{L2} which exceed the "narrow" limits of the standard	UINT32	
42054	RO	Number of measured values U_{L3} which exceed the "narrow" limits of the standard	UINT32	
42056	RO	Percentage of the average values *UL1* which are within the "narrow" limits of the standard	Float	x 100 %

Register	Property	Description	Format	Unit/ description
42058	RO	Percentage of the average values U_{L2} which are within the "narrow" limits of the standard	Float	x 100 %
42060	RO	Percentage of the average values U_{L} which are within the "narrow" limits of the standard	Float	x 100 %
42062	RO	Highest 10-minute mean value during the measurement period of U_{L1}	Float	V
42064	RO	Highest 10-minute mean value during the measurement period of U_{L2}	Float	V
42066	RO	Highest 10-minute mean value during the measurement period of U_{L3}	Float	V
42068	RO	Lowest 10-minute mean value during the measurement period of U_{L1}	Float	V
42070	RO	Lowest 10-minute mean value during the measurement period U_{L2}	Float	V
42072	RO	Lowest 10-minute mean value during the measurement period of U_{L3}	Float	V

Table 17.3: Supply voltage variations register

Comments page 145:

1) Flagged data: Measurement values (measured or aggregated) which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

2) The relevant registers: 45014 and 45016
minimum percentage to be met: 45012

3) The relevant registers: 45020 and 45022
minimum percentage to be met: 45018

17.4 Flicker

Register	Property	Description	Format	Unit/ note
42074	RO	Result *flicker* during the measurement period	UINT32	0: ok 1: not ok
42076	RO	Number of correct measured values	UINT32	Without "flagged data"[1)]
42078	RO	Number of flagged measured values	UINT32	"flagged data"
42080	RO	Number of measured values Plt_{UL1} which exceed the limits of the standard	UINT32	
42082	RO	Number of measured values Plt_{UL2} which exceed the limits of the standard	UINT32	
42084	RO	Number of measured values Plt_{UL3} which exceed the limits of the standard	UINT32	
42086	RO	Percentage of the average values Plt_{UL1} which are within the limits of the standard	Float	x 100 %
42088	RO	Percentage of the average values of Plt_{UL2} which are within the limits of the standard	Float	x 100 %
42090	RO	Percentage of the average values of Plt_{UL3} which are within the limits of the standard	Float	x 100 %

Register	Property	Description	Format	Unit/ note
42092	RO	Max. Plt_{UL1} during the measurement period	Float	Statistic of this week
42094	RO	Max. Plt_{UL2} during the measurement period	Float	
42096	RO	Max. Plt_{UL3} during the measurement period	Float	
42098	RO	Max. Plt_{UL1} during the measurement period	Float	
42100	RO	Max. Plt_{UL2} during the measurement period	Float	
42102	RO	Max. Plt_{UL3} during the measurement period	Float	
42104	RO	P95: Plt_{UL1}	Float	
42106	RO	P95: Plt_{UL2}	Float	
42108	RO	P95: Plt_{UL3}	Float	

Table 17.4: Register flicker

Comments table 17.4:

1) Flagged data: Measurement values (measured or aggregated) which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

17.5 Supply voltage unbalance

Register	Property	Description	Format	Unit/ description
42110	RO	Result *voltage unbalance* during the measurement period	UINT32	0: ok 1: not ok
42112	RO	Number of correct measured values	UINT32	Without "flagged data"[1)]
42114	RO	Number of flagged measured values	UINT32	"flagged data"

Register	Property	Description	Format	Unit/ description
42116	RO	Number of measured values which exceed the limits of the standard	UINT32	
42118	RO	Percentage of the average voltage unbalance values which are within the limits of the standard	Float	
42120	RO	Max. unbalance value during the measurement period	Float	
42122	RO	Min. unbalance value during the measurement period	Float	
42124	RO	P95: voltage unbalance	Float	

Table 17.5: Register unbalance of the supply voltage

Comments table 17.5

1) Flagged data: Measurement values (measured or aggregated) which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

17.6 Harmonic voltages

Register	Property	Description	Format	Unit/ note
42126	RO	Result *harmonics* during the measurement period	UINT32	0: ok 1: not ok
42128	RO	Number of correct measured values	UINT32	Without "flagged data"[1)]
42130	RO	Number of flagged measured values	UINT32	"flagged data"
42132	RO	Result Total Harmonic Distortion *THD* during the measurement period	UINT32	0: ok 1: not ok
42134	RO	Number of measured values THD_{UL1} which exceed the limits of the standard	UINT32	
42136	RO	Number of measured values THD_{UL2} which exceed the limits of the standard	UINT32	
42138	RO	Number of measured values THD_{UL3} which exceed the limits of the standard	UINT32	
42140	RO	Percentage of the measured values THD_{UL1} which are within the limits of the standard	Float	x 100 %
42142	RO	Percentage of the measured values THD_{UL2} which are within the limits of the standard	Float	x 100 %
42144	RO	Percentage of the measured values THD_{UL3} which are within the limits of the standard	Float	x 100 %
42146	RO	Result of the harmonic distortion 2^{nd} *harmonic* during the measurement period	UINT32	0: ok 1: not ok
42148	RO	Number of measured values $HD2_{UL1}$ which exceed the limits of the standard	UINT32	
42150	RO	Number of measured values $HD2_{UL2}$ which exceed the limits of the standard	UINT32	
42152	RO	Number of measured values $HD2_{UL3}$ which exceed the limits of the standard	UINT32	

Register	Property	Description	Format	Unit/ note
42154	RO	Percentage of the measured values $HD2_{UL1}$ which are within the limits of the standard	Float	x 100 %
42156	RO	Percentage of the measured values $HD2_{UL2}$ which are within the limits of the standard	Float	x 100 %
42158	RO	Percentage of the measured values $HD2_{UL3}$ which are within the limits of the standard	Float	x 100 %
…				
42468	RO	Result harmonic distortion *25th harmonic* during the measurement period	UINT32	0: ok 1: not ok
42470	RO	Number of measured values $HD25_{UL1}$ which exceed the limits of the standard	UINT32	
42472	RO	Number of measured values $HD25_{UL2}$ which exceed the limits of the standard	UINT32	
42474	RO	Number of measured values $HD25_{UL3}$ which exceed the limits of the standard	UINT32	
42476	RO	Percentage of the measured values $HD25_{UL1}$ which are within the limits of the standard	Float	x 100 %
42478	RO	Percentage of the measured values $HD25_{UL2}$ which are within the limits of the standard	Float	x 100 %
42480	RO	Percentage of the measured values $HD25_{UL3}$ which are within the limits of the standard	Float	x 100 %
42482	RO	Max. THD_{UL1}	Float	x 100 %
42484	RO	Max. THD_{UL2}	Float	x 100 %
42486	RO	Max. THD_{UL3}	Float	x 100 %
42488	RO	Min. THD_{UL1}	Float	x 100 %

Register	Property	Description	Format	Unit/ note
42490	RO	Min. THD_{UL2}	Float	x 100 %
42492	RO	Min. THD_{UL3}	Float	x 100 %
42494	RO	P95: THD_{UL1}	Float	x 100 %
42496	RO	P95: THD_{UL2}	Float	x 100 %
42498	RO	P95: THD_{UL3}	Float	x 100 %
42500	RO	Ø THD_{UL1}	Float	x 100 %
42502	RO	Ø THD_{UL2}	Float	x 100 %
42504	RO	Ø THD_{UL3}	Float	x 100 %
42506	RO	Max. $HD2_{UL1}$	Float	x 100 %
42508	RO	Max. $HD2_{UL2}$	Float	x 100 %
42510	RO	Max. $HD2_{UL3}$	Float	x 100 %
…	RO			
42644	RO	Max. $HD25_{UL1}$	Float	x 100 %
42646	RO	Max. $HD25_{UL2}$	Float	x 100 %
42648	RO	Max. $HD25_{UL3}$	Float	x 100 %
42650	RO	Min. $HD2_{UL1}$	Float	x 100 %
42652	RO	Min. $HD2_{UL2}$	Float	x 100 %
42654	RO	Min. $HD2_{UL3}$	Float	x 100 %
…	RO			
42788	RO	Min. $HD25_{UL1}$	Float	x 100 %
42790	RO	Min. $HD25_{UL2}$	Float	x 100 %
42792	RO	Min. $HD25_{UL3}$	Float	x 100 %
42794	RO	P95: $HD2_{UL1}$	Float	x 100 %
42796	RO	P95: $HD2_{UL2}$	Float	x 100 %
42798	RO	P95: $HD2_{UL3}$	Float	x 100 %
…				

Register	Property	Description	Format	Unit/ note
42932	RO	P95: $HD25_{UL1}$	Float	x 100 %
42934	RO	P95: $HD25_{UL2}$	Float	x 100 %
42936	RO	P95: $HD25_{UL3}$	Float	x 100 %
42938	RO	Ø $HD2_{UL1}$	Float	x 100 %
42940	RO	Ø $HD2_{UL2}$	Float	x 100 %
42942	RO	Ø $HD2_{UL3}$	Float	x 100 %
…	RO			x 100 %
43076	RO	Ø $HD25_{UL1}$	Float	x 100 %
43078	RO	Ø $HD25_{UL2}$	Float	x 100 %
43080	RO	Ø $HD25_{UL3}$	Float	x 100 %

Table 17.6: Harmonic voltages (register)

Comments table 17.6

1) Flagged data: Measurement values (measured or aggregated) which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

17.7 Interharmonic voltages

Register	Property	Description	Format	Unit/option
43082	RO	Number of correct measured values	UINT32	Without "flagged data"[1)]
43084	RO	Number of flagged measured values	UINT32	"flagged data"
43086	RO	Max. TIHD of U_{L1}	Float	x 100 %
43088	RO	Max. TIHD of U_{L2}	Float	x 100 %
43090	RO	Max. TIHD of U_{L3}	Float	x 100 %
43092	RO	Min. TIHD of U_{L1}	Float	x 100 %
43094	RO	Min. TIHD of U_{L2}	Float	x 100 %
43096	RO	Min. TIHD of U_{L3}	Float	x 100 %

Register	Property	Description	Format	Unit/option
43098	RO	P95: TIHD of U_{L1}	Float	x 100 %
43100	RO	P95: TIHD of U_{L2}	Float	x 100 %
43102	RO	P95: TIHD of U_{L3}	Float	x 100 %
43104	RO	Ø TIHD of U_{L1}	Float	x 100 %
43106	RO	Ø TIHD of U_{L2}	Float	x 100 %
43108	RO	Ø TIHD of U_{L3}	Float	x 100 %
43110	RO	Max. IHD2 of U_{L1}	Float	x 100 %
43112	RO	Max. IHD2 of U_{L2}	Float	x 100 %
43114	RO	Max. IHD2 of U_{L3}	Float	x 100 %
…				
43254	RO	Max. IHD25 of U_{L1}	Float	x 100 %
431256	RO	Max. IHD25 of U_{L2}	Float	x 100 %
43258	RO	Max. IHD25 of U_{L3}	Float	x 100 %
43260	RO	Min. IHD2 of U_{L1}	Float	x 100 %
43262	RO	Min. IHD2 of U_{L2}	Float	x 100 %
43264	RO	Min. IHD2 of U_{L3}	Float	x 100 %
…	RO			
43404	RO	Min. IHD25 of U_{L1}	Float	x 100 %
43406	RO	Min. IHD25 of U_{L2}	Float	x 100 %
43408	RO	Min. IHD25 of U_{L3}	Float	x 100 %
43410	RO	P95: IHD2 of U_{L1}	Float	x 100 %
43412	RO	P95: IHD2 of U_{L2}	Float	x 100 %
43414	RO	P95: IHD2 of U_{L3}	Float	x 100 %
…			Float	x 100 %
43554	RO	P95: IHD25 of U_{L1}	Float	x 100 %
43556	RO	P95: IHD25 of U_{L2}	Float	x 100 %
43558	RO	P95: IHD25 of U_{L3}	Float	x 100 %

Register	Property	Description	Format	Unit/option
43560	RO	Ø IHD2 of U_{L1}	Float	x 100 %
43562	RO	Ø IHD2 of U_{L2}	Float	x 100 %
43564	RO	Ø IHD2 of U_{L3}	Float	x 100 %
…	RO			
43704	RO	Ø IHD25 of U_{L1}	Float	x 100 %
43706	RO	Ø IHD25 of U_{L2}	Float	x 100 %
43708	RO	Ø IHD25 of U_{L3}	Float	x 100 %

Table 17.7: Register interharmonic voltages

Comments table 17.7:

[1)] Flagged data: Measurement values (measured or aggregated) which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

17.8 Mains signalling voltages

The supply system is temporarily used for the transmission of information. The frequencies for the transmission are locally defined.
The PEM735 can record the signal level for three different frequency ranges 60…3000 Hz (f_n = 50 Hz) or 70…3000 Hz (f_n = 60 Hz). For each of the three frequencies limits can be specified by the user.

Register	Property	Description	Format	Unit/ option
43710	RO	Result *mains signalling voltages* during the measurement period	UINT32	0: ok 1: not ok
43712	RO	Number of correct measured values	UINT32	Without "flagged data"[1)]
43714	RO	Number of flagged measured values	UINT32	"flagged data"
43716	RO	Result *mains signalling voltages, frequency range*1 during the measurement period	UINT32	0: ok 1: not ok

Register	Property	Description	Format	Unit/ option
43718	RO	Number of measured values of U_{L1} in the frequency range 1 which exceed the limits of the standard	UINT32	
43720	RO	Number of measured values of U_{L2} in the frequency range 1 which exceed the limits of the standard	UINT32	
43722	RO	Number of measured values of U_{L3} in the frequency range 1 which exceed the limits of the standard	UINT32	
43724	RO	Percentage of the measured values of U_{L1} in the frequency range 1 which are within the limits of the standard	Float	
43726	RO	Percentage of the measured values of U_{L2} in the frequency range 1 which are within the limits of the standard	Float	
43728	RO	Percentage of the measured values of U_{L3} in the frequency range 1 which are within the limits of the standard	Float	
43730	RO	Result *mains signalling voltages, frequency range 2* during the measurement period	UINT32	0: ok 1: not ok
43732	RO	Number of measured values of U_{L1} in the frequency range 2 which exceed the limits of the standard	UINT32	
43734	RO	Number of measured values of U_{L2} in the frequency range 2 which exceed the limits of the standard	UINT32	
43736	RO	Number of measured values of U_{L3} in the frequency range 2 which exceed the limits of the standard	UINT32	
43738	RO	Percentage of the measured values of U_{L1} in the frequency range 2 which are within the limits of the standard	Float	

Register	Property	Description	Format	Unit/ option
43740	RO	Percentage of the measured values of U_{L2} in the frequency range 2 which are within the limits of the standard	Float	
43742	RO	Percentage of the measured values of U_{L3} in the frequency range 2 which are within the limits of the standard	Float	
43744	RO	Result *mains signalling voltages,* frequency range 3 during the measurement period	UINT32	0: ok 1: not ok
43746	RO	Number of measured values of U_{L1} in the frequency range 3 which exceed the limits of the standard	UINT32	
43748	RO	Number of the measured values of U_{L2}, in the frequency range 3, which are within the limits of the standard	UINT32	
43750	RO	Number of the measured values of U_{L3}, in the frequency range 2, which are within the limits of the standard	UINT32	
43752	RO	Percentage of the measured values of U_{L1} in the frequency range 3 which are within the limits of the standard	Float	
43754	RO	Percentage of the measured values of U_{L2} in the frequency range 3 which are within the limits of the standard	Float	
43756	RO	Percentage of the measured values of U_{L3} in the frequency range 3 which are within the limits of the standard	Float	
43758	RO	Max. signal in the frequency range 1 U_{L1}	Float	
43760	RO	Max. signal in the frequency range 1 U_{L2}	Float	
43762	RO	Max. signal in the frequency range 1 U_{L3}	Float	

Register	Property	Description	Format	Unit/ option
43764	RO	Max. signal in the frequency range 2 U_{L1}	Float	
43766	RO	Max. signal in the frequency range 2 U_{L2}	Float	
43768	RO	Max. signal in the frequency range 2 U_{L3}	Float	
43770	RO	Max. signal in the frequency range 3 U_{L1}	Float	
43772	RO	Max. signal in the frequency range 3 U_{L2}	Float	
43774	RO	Max. signal in the frequency range 3 U_{L3}	Float	
43776	RO	Min. signal in the frequency range 1 U_{L1}	Float	
43778	RO	Min. signal in the frequency range 1 U_{L2}	Float	
43780	RO	Min. signal in the frequency range 1 U_{L3}	Float	
43782	RO	Min. signal in the frequency range 2 U_{L1}	Float	
43784	RO	Min. signal in the frequency range 2 U_{L2}	Float	
43786	RO	Min. signal in the frequency range 2 U_{L3}	Float	
43788	RO	Min. signal in the frequency range 3 U_{L1}	Float	
43790	RO	Min. signal in the frequency range 3 U_{L2}	Float	
43792	RO	Min. signal in the frequency range 3 U_{L3}	Float	

Register	Property	Description	Format	Unit/ option
43794	RO	P95: signal in the frequency range 1 U_{L1}	Float	
43796	RO	P95: signal in the frequency range 1 U_{L2}	Float	
43798	RO	P95: signal in the frequency range 1 U_{L3}	Float	
43800	RO	P95: signal in the frequency range 2 U_{L1}	Float	
43802	RO	P95: signal in the frequency range 2 U_{L2}	Float	
43804	RO	P95: signal in the frequency range 2 U_{L3}	Float	
43806	RO	P95: signal in the frequency range 3 U_{L1}	Float	
43808	RO	P95: signal in the frequency range 3 U_{L2}	Float	
43810	RO	P95: signal in the frequency range 3 U_{L3}	Float	

Table 17.8: Mains signalling voltages register

Comments table 17.8

1) Flagged data: Measurement values (measured or aggregated) which were flagged to indicate that the values may be influenced by interruptions, voltage swells or voltage dips.

17.9 Rapid voltage change

Register	Property	Description	Format	Unit/ description
43812	RO	Number of rapid voltage changes U_{L1}	UINT32	
43814	RO	Number of rapid voltage changes U_{L2}	UINT32	
43816	RO	Number of rapid voltage changes U_{L3}	UINT32	

Table 17.9: Rapid voltage change (register)

17.10 Voltage swells

Counter according to classifications

Register	Pro-perty	Description	Format	Unit/description
43818	RO	Voltage swell counter	UINT32	10 ms ≤ **duration** ≤ 500 ms 110 % < **voltage** < 120 %
43820	RO	Voltage swell counter	UINT32	500 ms ≤ **duration** ≤ 5000 ms 110 % < **voltage** < 120 %
43822	RO	Voltage swell counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 110 % < **voltage** < 120 %
43824	RO	Voltage swell counter	UINT32	60000 ms < **duration** 110 % < **voltage** < 120 %
43826	RO	Voltage swell counter	UINT32	10 ms ≤ **duration** ≤ 500 ms 120 % < **voltage** < 140 %
43828	RO	Voltage swell counter	UINT32	500 ms ≤ **duration** ≤ 5000 ms 120 % < **voltage** < 140 %
43830	RO	Voltage swell counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms / 120 % < **voltage** < 140 %)
43832	RO	Voltage swell counter	UINT32	60000 ms < **duration** 120 % < **voltage** < 140 %
43834	RO	Voltage swell counter	UINT32	10 ms ≤ **duration** ≤ 500 ms 140 % < **voltage** < 160 %

Register	Property	Description	Format	Unit/description
43836	RO	Voltage swell counter	UINT32	500 ms ≤ **duration** ≤ 5000 ms 140 % < **voltage** < 160 %
43838	RO	Voltage swell counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 140 % < **voltage** < 160 %
43840	RO	Voltage swell counter	UINT32	60000 ms < **duration** 140 % < **voltage** < 160 %
43842	RO	Voltage swell counter	UINT32	10 ms ≤ **duration** ≤ 500 ms 160 % < **voltage** < 200 %
43844	RO	Voltage swell counter	UINT32	500 ms ≤ **duration** ≤ 5000 ms 160 % < **voltage** < 200 %
43846	RO	Voltage swell counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 160 % < **voltage** < 200 %
43848	RO	Voltage swell counter	UINT32	60000 ms < **duration** 160 % < **voltage** < 200 %
43850	RO	Voltage swell counter	UINT32	10 ms ≤ **duration** ≤ 500 ms 200 % < **voltage**
43852	RO	Voltage swell counter	UINT32	500 ms ≤ **duration** ≤ 5000 ms 200 % < **voltage**
43854	RO	Voltage swell counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 200 % < **voltage**)
43856	RO	Voltage swell counter	UINT32	60000 ms < **duration** 200 % < **voltage**

Table 17.10: Voltage swell register (counter according to classifications)

17.11 Dips

Counter according to classifications

Register	Property	Description	Format	Unit/description
43858	RO	Voltage dip counter	UINT32	10 ms ≤ **duration** ≤ 200 ms U_{res}/U_n (%) < 5
43860	RO	Voltage dip counter	UINT32	200 ms ≤ **duration** ≤ 500 ms U_{res}/U_n (%) < 5
43862	RO	Voltage dip counter	UINT32	500 ms ≤ **duration** ≤ 1000 ms U_{res}/U_n (%) < 5
43864	RO	Voltage dip counter	UINT32	1000 ms ≤ **duration** ≤ 5000 ms U_{res}/U_n (%) < 5
43866	RO	Voltage dip counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms U_{res}/U_n (%) < 5
43868	RO	Voltage dip counter	UINT32	60000 ms < **duration** U_{res}/U_n (%) < 5
43870	RO	Voltage dip counter	UINT32	10 ms ≤ **duration** ≤ 200 ms 5 ≤ U_{res}/U_n (%) < 40
43872	RO	Voltage dip counter	UINT32	200 ms ≤ **duration** ≤ 500 ms 5 ≤ U_{res}/U_n (%) < 40
43874	RO	Voltage dip counter	UINT32	500 ms ≤ **duration** ≤ 1000 ms 5 ≤ U_{res}/U_n (%) < 40
43876	RO	Voltage dip counter	UINT32	1000 ms ≤ **duration** ≤ 5000 ms 5 ≤ U_{res}/U_n (%) < 40
43878	RO	Voltage dip counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 5 ≤ U_{res}/U_n (%) < 40
43880	RO	Voltage dip counter	UINT32	60000 ms < **duration** 5 ≤ U_{res}/U_n (%) < 40

Register	Property	Description	Format	Unit/description
43882	RO	Voltage dip counter	UINT32	10 ms ≤ **duration** ≤ 200 ms 40 ≤ U_{res}/U_n (%) < 70
43884	RO	Voltage dip counter	UINT32	200 ms ≤ **duration** ≤ 500 ms 40 ≤ U_{res}/U_n (%) < 70
43886	RO	Voltage dip counter	UINT32	500 ms ≤ **duration** ≤ 1000 ms 40 ≤ U_{res}/U_n (%) < 70
43888	RO	Voltage dip counter	UINT32	1000 ms ≤ **duration** ≤ 5000 ms 40 ≤ U_{res}/U_n (%) < 70
43890	RO	Voltage dip counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 40 ≤ U_{res}/U_n (%) < 70
43892	RO	Voltage dip counter	UINT32	60000 ms < **duration** 40 ≤ U_{res}/U_n (%) < 70
43894	RO	Voltage dip counter	UINT32	10 ms ≤ **duration** ≤ 200 ms 70 ≤ U_{res}/U_n (%) < 80
43896	RO	Voltage dip counter	UINT32	200 ms ≤ **duration** ≤ 500 ms 70 ≤ U_{res}/U_n (%) < 80
43898	RO	Voltage dip counter	UINT32	500 ms ≤ **duration** ≤ 1000 ms 70 ≤ U_{res}/U_n (%) < 80
43900	RO	Voltage dip counter	UINT32	1000 ms ≤ **duration** ≤ 5000 ms 70 ≤ U_{res}/U_n (%) < 80
43902	RO	Voltage dip counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 70 ≤ U_{res}/U_n (%) < 80
43904	RO	Voltage dip counter	UINT32	60000 ms < **duration** 70 ≤ U_{res}/U_n (%) < 80
43906	RO	Voltage dip counter	UINT32	10 ms ≤ **duration** ≤ 200 ms 80 ≤ U_{res}/U_n (%) < 90
43908	RO	Voltage dip counter	UINT32	200 ms ≤ **duration** ≤ 500 ms 80 ≤ U_{res}/U_n (%) < 90
43910	RO	Voltage dip counter	UINT32	500 ms ≤ **duration** ≤ 1000 ms 80 ≤ U_{res}/U_n (%) < 90

Register	Property	Description	Format	Unit/description
43912	RO	Voltage dip counter	UINT32	1000 ms ≤ **duration** ≤ 5000 ms 80 ≤ $\boldsymbol{U_{res}/U_n}$ (%) < 90
43914	RO	Voltage dip counter	UINT32	5000 ms ≤ **duration** ≤ 60000 ms 80 ≤ $\boldsymbol{U_{res}/U_n}$ (%) < 90
43916	RO	Voltage dip counter	UINT32	60000 ms < **duration** 80 ≤ $\boldsymbol{U_{res}/U_n}$ (%) < 90

Table 17.11: Voltage swell register(counter according to classifications)

17.12 Interruptions

Register	Property	Description	Format	Unit/ description
43918	RO	Number of voltage interruptions < 1 s	UINT32	
43920	RO	Number of voltage interruptions 1 s … < 3 minutes	UINT32	
43922	RO	Number of voltage interruptions > 3 minutes	UINT32	

Table 17.12: Voltage interruptions (register)

17.13 Transient voltage

Register	Property	Description	Format	Unit/ description
43924	RO	Number of transients in U_{L1}	UINT32	Current week
43926	RO	Number of transients in U_{L2}	UINT32	
43928	RO	Number of transients in U_{L3}	UINT32	

Table 17.13: Register transient voltage

17.14 EN 50160 log configuration

The voltage range can be set in register 7038:
0: low voltage (LV)
1: medium voltage(MV)
2: high voltage (HV)

For the register contents, the following applies:
1.0 = 100 %
0.95 = 95 % ect.

Register	Pro-perty	Description	Format	Factory setting
45000	RW	Frequency limit (tolerance)	Float	1.00
45002	RW	Frequency limit (positive deviation)	Float	1.04 x f_n
45004	RW	Frequency limit (positive deviation)	Float	0.94 x f_n
45006	RW	Frequency limit (strict tolerance limit)	Float	0.995
45008	RW	Frequency limit (positive deviation within narrow limits)	Float	1.01 x f_n
45010	RW	Frequency limit (negative deviation within narrow limits)	Float	0.99 x f_n
45012	RW	Voltage limit (tolerance)	Float	1.00

Register	Property	Description	Format	Factory setting
45014	RW	Voltage limit (positive deviation)	Float	LV: 1.1 MV/HV: 1.15
45016	RW	Voltage limit (negative deviation)	Float	0.85 x U_n
45018	RW	Voltage limit (narrow tolerance limits)	Float	LV: 0.95 MV/HV: 0.99
45020	RW	Voltage limit (positive deviation within narrow limits)	Float	1.1 x U_n
45022	RW	Voltage limit (strict limits negative deviation)	Float	0.9 x U_n
45024	RW	Flicker limit (tolerance)	Float	0.95
45026	RW	Flicker threshold	Float	1
45028	RW	Unbalance (tolerance)	Float	0.95
45030	RW	Unbalance (thresholds)	Float	0.02
45032	RW	Harmonic thresholds (tolerance)	Float	0.95
45034	RW	Harmonic thresholds (THD)	Float	0.08
45040	RW	Thresholds HD2	Float	LV/MV: 0.02 HV: 0.019
45042	RW	Thresholds HD3	Float	LV/MV: 0.05 HV: 0.03
45044	RW	Thresholds HD4	Float	0.01
45046	RW	Thresholds HD5	Float	LV/MV: 0.06 HV:0.05
45048	RW	Thresholds HD6	Float	0.005
45050	RW	Thresholds HD7	Float	LV/MV:0.05 HV: 0.04
45052	RW	Thresholds HD8	Float	0.005
45054	RW	Thresholds HD9	Float	LV/MV 0.015 HV: 0.013
45056	RW	Thresholds HD10	Float	0.005
45058	RW	Thresholds HD11	Float	LV/MV 0.035 HV: 0.03
45060	RW	Thresholds HD12	Float	0.005

Register	Property	Description	Format	Factory setting
45062	RW	Thresholds HD13	Float	LV/MV 0.03 HV: 0.025
45064	RW	Thresholds HD14	Float	0.005
45066	RW	Thresholds HD15	Float	0.005
45068	RW	Thresholds HD16	Float	0.005
45070	RW	Thresholds HD17	Float	0.02
45072	RW	Thresholds HD18	Float	0.005
45074	RW	Thresholds HD19	Float	0.005
45076	RW	Thresholds HD20	Float	0.005
45078	RW	Thresholds HD21	Float	0.005
45080	RW	Thresholds HD22	Float	0.005
45082	RW	Thresholds HD23	Float	0.015
45084	RW	Thresholds HD24	Float	0.005
45086	RW	Thresholds HD25	Float	0.015

Table 17.14: Register configuration EN 50160

18. Energy of harmonics

Register	Pro-perty	Description	Format	Unit
60400	RW	Active energy import $_{THD}$	UINT32	kWh
60402	RW	Reactive energy import $_{THD}$	UINT32	kvarh
60404	RW	Active energy export $_{THD}$	UINT32	kWh
60406	RW	Reactive energy export $_{THD}$	UINT32	kvarh
60408…60411	Reserved			
60412	RW	Active energy import $_{HD2}$	UINT32	kWh
60414	RW	Reactive energy import $_{HD2}$	UINT32	kvarh
60416	RW	Active energy export $_{HD2}$	UINT32	kWh
60418	RW	Reactive energy export $_{HD2}$	UINT32	kvarh
…				
60644	RW	Active energy import $_{HD31}$	UINT32	kWh
60646	RW	Reactive energy import $_{HD31}$	UINT32	kvarh
60648	RW	Active energy export $_{HD31}$	UINT32	kWh
60650	RW	Reactive energy export $_{HD31}$	UINT32	kvarh
60652…60659	Reserved			
60660	RO	Active energy import $_{THD}$	Float	Ws
60662	RO	Reactive energy import $_{THD}$	Float	vars
60664	RO	Active energy export $_{THD}$	Float	Ws
60666	RO	Reactive energy export $_{THD}$	Float	vars
60668…60671	Reserved			
60672	RO	Active energy import $_{HD2}$	Float	Ws
60674	RO	Reactive energy import $_{HD2}$	Float	vars
60676	RO	Active energy export $_{HD2}$	Float	Ws

Register	Pro-perty	Description	Format	Unit
60678	RO	Reactive energy export $_{HD2}$	Float	vars
…				
60904	RO	Active energy import $_{HD31}$	Float	Ws
60906	RO	Reactive energy import $_{HD31}$	Float	vars
60908	RO	Active energy export $_{HD31}$	Float	Ws
60910	RO	Reactive energy export $_{HD31}$	Float	vars

Table 18.1: Register energy of harmonics

19. Harmonic power

Register	Property	Description	Format	Unit
61000	RO	P_{THD}	Float	W
61002	RO	Q_{THD}	Float	var
61004	RO	$P_{L1\ (HD2)}$	Float	W
61006	RO	$P_{L2\ (HD2)}$	Float	W
61008	RO	$P_{L3\ (HD2)}$	Float	W
61010	RO	$P_{ges\ (HD2)}$	Float	W
61012	RO	$Q_{L1\ (HD2)}$	Float	var
61014	RO	$Q_{L2\ (HD2)}$	Float	var
61016	RO	$Q_{L3\ (HD2)}$	Float	var
61018	RO	$Q_{ges\ (HD2)}$	Float	var
61020	RO	$S_{L1\ (HD2)}$	Float	VA
61022	RO	$S_{L2\ (HD2)}$	Float	VA
61024	RO	$S_{L3\ (HD2)}$	Float	VA
61026	RO	$S_{ges\ (HD2)}$	Float	VA
…				
62468	RO	$P_{L1\ (HD63)}$	Float	W
62470	RO	$P_{L2\ (HD63)}$	Float	W
62472	RO	$P_{L3\ (HD63)}$	Float	W
62474	RO	$P_{ges\ (HD63)}$	Float	W
62476	RO	$Q_{L1\ (HD63)}$	Float	var
62478	RO	$Q_{L2\ (HD63)}$	Float	var
62480	RO	$Q_{L3\ (HD63)}$	Float	var
62482	RO	$Q_{ges\ (HD63)}$	Float	var

Register	Property	Description	Format	Unit
62484	RO	$S_{L1\ (HD63)}$	Float	VA
62486	RO	$S_{L2\ (HD63)}$	Float	VA
62488	RO	$S_{L3\ (HD63)}$	Float	VA
62490	RO	$S_{ges\ (HD63)}$	Float	VA

Table 19.1: Register harmonic power

20. Glossary and terms

Abbreviation/ term	Long form	Description
COMM	Communication	
Debounce time		Time period a signal must be pending at DI until it can be detected.
Demand		Also: present demand; average consumption values over the last fixed demand period
DI	Digital Input	Digital input (2.4 mA, DC 24 V)
Dip threshold		Voltage dip threshold
DMD	Present Demand	Present demand
DO	Digital Output	Digital output (max. 50 mA, max. 80 V)
DR	Data Recorder	Data recorder
FIFO	First In First Out	Ring memory: When the memory is full, the oldest entries will be overwritten by the new values.
Flagged data		Flagged measured values: Measurement results (measured or aggregated), which were flagged to indicate that the results may be influenced by interruptions, voltage swells or voltage dips.
Float		Floating point number, register size 4 bytes
Fund.	Fundamental	Fundamental wave
GB	Giga Byte	
GPS	Global Positioning System	
Harmonic factor		see THF

Abbreviation/ term	Long form	Description
HS	High speed	High speed
Interharmonic		Interharmonic between the (n-1)th and nth harmonic
k-factor		The k-factor refers to the capability of distorted currents to generate power loss in transformers, for example.
LCD	Liquid Crystal Display	
MB	Mega Byte	
P		Active power in kW
P95	Measured value of the 95^{th} percentile	95. percentile: 95 % of the values are less than or equal to this measured value.
Percentile:		Percentile rank divides the set of data into 100 equal parts.
Plt	Perceptibility unit long term	Long term flicker (2-hour value, cubic average of 12 Pst)
PPS	Pulse Per Second	Pulse per second
PQ	Power Quality	
Predicted demand		Extrapolated average power consumption values of the current period, which is not yet concluded
Pst	Perceptibility unit short term	Short term flicker; 10-minute value
Pulse width		Time during which DO or RO remains active
Q		Reactive power

Abbreviation/ term	Long form	Description
r.m.s. value		Square root of the arithmetic mean of the squares of the instantaneous values of a quantity taken over a given interval of time and a specified bandwidth.
Resolution of setting		Value which is written to the register per impulse; register content/resolution of setting = number of measured impulses
Ripple control signal		Mains signalling voltages on electrical low-voltage systems, called "ripple control signal", are a burst of signals, often applied at a non-harmonic frequency. Are intended for remote control of industrial equipment, revenue meters and other devices. f < 3 kHz;
rms	Root mean square	r.m.s. value
RO	Relay output	Relay output
S		Apparent power
SOE	Sequence Of Events	Events
Supply voltage unbalance		Unequal r.m.s. values of the line-to-line voltages (fundamental component) or the phase angles of consecutive line conductors; only apply to three-phase systems
Swell		Voltage swell
SYNC DI	Demand Sync Input	Digital input demand synchronisation
TEHD	Total Even Harmonic Distortion	Total even harmonic distortion
THD	Total Harmonic Distortion	Total harmonic distortion

Abbreviation/ term	Long form	Description
THF	Total Harmonic Factor	(= harmonic factor) Calculation of an individual harmonic factor related to the total r.m.s. value U_{ges} or I_{ges}
TOHD	Total Odd Harmonic Distortion	Total odd harmonic distortion
Transients		Short term voltage variations superimposed on the supply voltage
U_0		Zero sequence component
u_0		Zero sequence component (ratio expressed as a percentage) $u_0 = (U_0/U_1)$ x 100 %
U_0 / I_0		Zero sequence component voltage/current
U_0 / I_0 Unb		Unbalance zero sequence component voltage/ current
U_1		Positive sequence component
U_1 / I_1		Positive sequence component voltage/current
U_2		Negative sequence component
u_2		Negative sequence component ratio expressed as a percentage $u_2 = (U_2/U_1)$ x 100 %
U2 / I2		Negative sequence component voltage/current
U2 / I2 Unb		Negative sequence component unbalance voltage/current
U_{din}	Declared input voltage	Value calculated from the declared supply voltage on the basis of the transformer ratio.
UINT16	Unsigned integer 16 bit	Unsigned integer, register size 2 bytes (high byte, low byte)

Abbreviation/ term	Long form	Description
UINT32	Unsigned integer 32 bit	unsigned integer, register size 4 bytes (HiWord, LoWord)
unb	Unbalance	Unbalance
U_{res}	Residual voltage	Minimum value of $U_{rms(1/2)}$ {class A} recorded during a voltage dip or interruption; the residual voltage (related to the declared voltage) is expressed as a value in volts, as a percentage or per unit value.
$U_{rms(1)}$		Value of the r.m.s. voltage measured over one cycle and refreshed each cycle.
$U_{rms(1/2)}$	Half-cycle r.m.s. voltage	Value of the r.m.s. voltage refreshed each half-cycle (r.m.s. value measured over one cycle, commencing at a fundamental zero crossing)
U_{sr}	Sliding reference voltage	Sliding reference voltage, is prinicipally not used in low-voltage systems.
Voltage dip		Transitory reduction of the voltage below the specified threshold of 90 % of U_n with a hysteresis of 2 %; voltage interruptions are special voltage dips.
Voltage interruption (polyphase system)		Begins when the U_{rms} voltage on all measured channels falls below the voltage interruption threshold; ends when the U_{rms} voltage on any channel is equal to, or greater than, the interruption threshold plus the hysteresis. Typically, the voltage interruption thresholds are 5 % or 10 % of U_{din}; typically, the hysteresis is equal to 2 % of U_{din}.

Abbreviation/ term	Long form	Description
Voltage interruption (single-phase system)		Begins when the U_{rms} voltage falls below the voltage interruption threshold; ends when the U_{rms} voltage is equal to or greater than the voltage interruption threshold plus the hysteresis. Typically, the voltage interruption thresholds are 5 % or 10 % of U_{din}; typically, the hysteresis is equal to 2 % of U_{din}.
Voltage swell (polyphase system)		Begins when the U_{rms} voltage of at least one channel is above the swell threshold; ends when the U_{rms} voltage on all measured channels is equal to or below the swell threshold minus the hysteresis voltage. Typically, the swell thresholds are > 110 % of U_{din}; typically, the hysteresis is equal to 2 % of U_{din}.
Voltage swell (single-phase system)		Begins when the U_{rms} voltage rises above the swell threshold; ends when the U_{rms} voltage is equal to or below the swell threshold minus the hysteresis voltage. Typically, the swell thresholds are > 110 % of U_{din}; Typically, the hysteresis is equal to 2 % of U_{din}.
WF	Waveform	Waveform
WFR	Waveform recorder	Waveform recorder

INDEX

BENDER
The Power in Electrical Safety©

Bender GmbH & Co. KG
Postfach 1161 • 35301 Gruenberg • Germany
Londorfer Str. 65 • 35305 Gruenberg • Germany

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

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

Photos: Bender archive

BENDER Group