8. Modbus Register Map

This chapter provides a complete description of the Modbus register (protocol version 6.0) for the PEM533 series to facilitate access to information. In general, the registers are implemented as Modbus Read Only Registers (RO = read only) with the exception of the DO control registers, which are implemented as Write Only Registers (WO = write only).
PEM533 supports the 6-digit addressing scheme and the following Modbus functions:

1. Holding register for reading values
   (Read Holding Register; function code 0x03)
2. Register for setting the DO status
   (Force Single Coil; function code 0x05)
3. Register for device programming
   (Preset Multiple Registers; function code 0x10)

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

8.1 Basic measurements

Register	Property	Description	Format	Scale/ unit
0000	RO	U_{L1} 1)	UINT32	×100, V 2)
0002	RO	U_{L2} 1)	UINT32	×100, V
0004	RO	U_{L3} 1)	UINT32	×100, V
0006	RO	Ø U_{LN}	UINT32	×100, V
0008	RO	U_{L1L2}	UINT32	×100, V
0010	RO	U_{L2L3}	UINT32	×100, V
0012	RO	U_{L3L1}	UINT32	×100, V
0014	RO	Ø U_{LL}	UINT32	×100, V
0016	RO	*I1*	UINT32	×1000, A
0018	RO	*I2*	UINT32	×1000, A
0020	RO	*I3*	UINT32	×1000, A
0022	RO	Ø *I*	UINT32	×1000, A

Register	Property	Description	Format	Scale/ unit
0024	RO	P_{L1} 1)	INT32	×1000, kW
0026	RO	P_{L2} 1)	INT32	×1000, kW
0028	RO	P_{L3} 1)	INT32	×1000, kW
0030	RO	P_{ges}	INT32	×1000, kW
0032	RO	Q_{L1} 1)	INT32	×1000, kvar
0034	RO	Q_{L2} 1)	INT32	×1000, kvar
0036	RO	Q_{L3} 1)	INT32	×1000, kvar
0038	RO	Q_{ges}	INT32	×1000, kvar
0040	RO	S_{L1} 1)	INT32	×1000, kVA
0042	RO	S_{L2} 1)	INT32	×1000, kVA
0044	RO	S_{L3} 1)	INT32	×1000, kVA
0046	RO	S_{ges}	INT32	×1000, kVA
0048	RO	λ_{L1} 1)	INT16	×1000, -
0049	RO	λ_{L2} 1)	INT16	×1000, -
0050	RO	λ_{L3} 1)	INT16	×1000, -
0051	RO	λ_{ges}	INT16	×1000, -
0052	RO	*F*	UINT16	×100, Hz
0053	RO	*I4*	UINT32	x1000, A
0055…0064	Reserved			
0065	RO	Voltage unbalance	UINT16	x1000
0066	RO	Current unbalance	UINT16	x1000
0067	RO	Displacement factor L1	INT16	x1000
0068	RO	Displacement factor L2	INT16	x1000
0069	RO	Displacement factor L3	INT16	x1000
0070	RO	Phase angle $_{U}L1$	UINT16	x100, °
0071	RO	Phase angle $_{U}L2$	UINT16	x100, °
0072	RO	Phase angle $_{U}L3$	UINT16	x100, °

Register	Property	Description	Format	Scale/ unit
0073	RO	Phase angle I_1	UINT16	x100, °
0074	RO	Phase angle I_2	UINT16	x100, °
0075	RO	Phase angle I_3	UINT16	x100, °
0076…0079	Reserved			
0080	RO	Status digital inputs [3]	UINT16	
0081	RO	Status digital outputs [4]	UINT16	
0082	RO	Alarm [5]	UINT16	
0083	RO	SOE Pointer [6]	UINT32	
0085…0119	Reserved			

Table 8.1: Basic measurements

Notes:

1) Only in the case of wye connection.

2) "x 100, V" means that the voltage value returned in the register is 100 times the actual measured value (therefore, the value of the register must be divided by 100 to obtain the measuring value).

3) **Status register 0080**:
Represents the **states of the two digital inputs**
B0 B5 for DI1 DI6 (1 = active/closed; 0 = inactive/open)

4) Status register 0081:
Represents the **states of the two digital outputs**
B0 for DO1 (1 = active/closed; 0 = inactive/open)
B1 for DO2 (1 = active/closed; 0 = inactive/open)

5) The **alarm register 0082** indicates the various alarm states (1 = active, 0 = inactive).
Table 8.2 on page 56 illustrates details of the alarm register.

Bit in register 0082	Alarm event
B0…B2	Reserved
B3	Setpoint 1
B4	Setpoint 2
B5	Setpoint 3
B6	Setpoint 4
B7	Setpoint 5
B8	Setpoint 6
B9	Setpoint 7
B10	Setpoint 8
B11	Setpoint 9
all other bits	Reserved

Table 8.2: Bit sequence alarm register (0082)

6) The SOE pointer points to the last entry added. The event log can store up to 64 events. It works like a ring buffer according to the FIFO principle: The 65rd value overwrites the first value, the 66th the second one and so on. The event log can be reset in the setup parameter menu (see page 42).

8.2 Energy measurement

Register	Property	Description	Format	Unit
0200	RW	Active energy import	UINT32	kWh
0202	RW	Active energy export	UINT32	kWh
0204	RO	Active energy net amount	INT32	kWh
0206	RO	Total active energy	UINT32	kWh
0208	RW	Reactive energy import	UINT32	kvarh
0210	RW	Reactive energy export	UINT32	kvarh
0212	RO	Reactive energy net amount	INT32	kvarh
0214	RO	Total reactive energy	UINT32	kvarh
0216	RW	Apparent energy	UINT32	kVAh

Table 8.3: Energy measurements

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

8.3 Harmonic measurements

Register	Property	Description	Format	Unit
0400…0402	Reserved			
0403	RO	k-factor I_1	UINT16	x10
0404	RO	k-factor I_2	UINT16	x10
0405	RO	k-factor I_3	UINT16	x10
0406	RO	$TEHD_{UL1}$	UINT16	x10,000
0407	RO	$TEHD_{UL2}$	UINT16	x10,000
0408	RO	$TEHD_{UL3}$	UINT16	x10,000
0409	RO	$TEHD_{I1}$	UINT16	x10,000
0410	RO	$TEHD_{I2}$	UINT16	x10,000
0411	RO	$TEHD_{I3}$	UINT16	x10,000
0412	RO	$TOHD_{UL1}$	UINT16	x10,000
0413	RO	$TOHD_{UL2}$	UINT16	x10,000
0414	RO	$TOHD_{UL3}$	UINT16	x10,000
0415	RO	$TOHD_{I1}$	UINT16	x10,000
0416	RO	$TOHD_{I2}$	UINT16	x10,000
0417	RO	$TOHD_{I3}$	UINT16	x10,000
0418	RO	THD_{UL1}	UINT16	x10,000
0419	RO	THD_{UL2}	UINT16	x10,000
0420	RO	THD_{UL3}	UINT16	x10,000
0421	RO	THD_{I1}	UINT16	x10,000
0422	RO	THD_{I2}	UINT16	x10,000
0423	RO	THD_{I3}	UINT16	x10,000
0424	RO	U_{L1} 2^{nd} harmonic	UINT16	x10,000
0425	RO	U_{L2} 2^{nd} harmonic	UINT16	x10,000
0426	RO	U_{L3} 2^{nd} harmonic	UINT16	x10.000

Register	Property	Description	Format	Unit
0427	RO	I_1 2nd harmonic	UINT16	x10,000
0428	RO	I_2 2nd harmonic	UINT16	x10,000
0429	RO	I_3 2nd harmonic	UINT16	x10,000
…	RO	…	UINT16	x10.000
0598	RO	U_{L1} 31st harmonic	UINT16	x10,000
0599	RO	U_{L2} 31st harmonic	UINT16	x10,000
0600	RO	U_{L3} 31st harmonic	UINT16	x10,000
0601	RO	I_1 31st harmonic	UINT16	x10,000
0602	RO	I_2 31st harmonic	UINT16	x10,000
0603	RO	I_3 31st harmonic	UINT16	x10,000

Table 8.4: Harmonic measurements

8.4 Demand

Register	Property	Description	Format	Unit
1000	RO	Demand U_{L1}	INT32	x100, V
1002	RO	Demand U_{L2}	INT32	x100, V
1004	RO	Demand U_{L3}	INT32	x100, V
1006	RO	Ø Demand U_{LN}	INT32	x100, V
1008	RO	Demand U_{L1L2}	INT32	x100, V
1010	RO	Demand U_{L2L3}	INT32	x100, V
1012	RO	Demand U_{L3L1}	INT32	x100, V
1014	RO	Ø Demand U_{LL}	INT32	x100, V
1016	RO	Demand I_1	INT32	x1000, A
1018	RO	Demand I_2	INT32	x1000, A
1020	RO	Demand I_3	INT32	x1000, A
1022	RO	Ø Demand I	INT32	x1000, A
1024	RO	Demand P_{L1}	INT32	x1000, kW
1026	RO	Demand P_{L2}	INT32	x1000, kW
1028	RO	Demand P_{L3}	INT32	x1000, kW
1030	RO	Demand P_{ges}	INT32	x1000, kW
1032	RO	Demand Q_{L1}	INT32	x1000, kvar
1034	RO	Demand Q_{L2}	INT32	x1000, kvar
1036	RO	Demand Q_{L3}	INT32	x1000, kvar
1038	RO	Demand Q_{ges}	INT32	x1000, kvar
1040	RO	Demand S_{L1}	INT32	x1000, kVA
1042	RO	Demand S_{L2}	INT32	x1000, kVA
1044	RO	Demand S_{L3}	INT32	x1000, kVA
1046	RO	Demand S_{ges}	INT32	x1000, kVA
1048	RO	Demand λ_1	INT32	x1000
1050	RO	Demand λ_2	INT32	x1000

Register	Property	Description	Format	Unit
1052	RO	Demand λ_3	INT32	x1000
1054	RO	Demand λ_{ges}	INT32	x1000
1056	RO	Demand *f*	INT32	x100, Hz
1058	RO	Demand voltage unbalance	INT32	x1000
1060	RO	Demand current unbalance	INT32	x1000
1062	RO	Demand THD_{UL1}	INT32	x10,000
1064	RO	Demand THD_{UL2}	INT32	x10.000
1066	RO	Demand THD_{UL3}	INT32	x10,000
1068	RO	Demand THD_{I1}	INT32	x10,000
1070	RO	Demand THD_{I2}	INT32	x10,000
1072	RO	Demand THD_{I3}	INT32	x10,000

Table 8.5: Register demands

8.5 Extreme values per demand measurement time frame

8.5.1 Maximum values demand

Register	Property	Description	Format	Unit
1400	RO	$U_{L1\ max}$	INT32	x100, V
1402	RO	$U_{L2\ max}$	INT32	x100, V
1404	RO	$U_{L3\ max}$	INT32	x100, V
1406	RO	Ø $U_{LN\ max}$	INT32	x100, V
1408	RO	$U_{L1L2\ max}$	INT32	x100, V
1410	RO	$U_{L2L3\ max}$	INT32	x100, V
1412	RO	$U_{L3L1\ max}$	INT32	x100, V
1414	RO	Ø $U_{LL\ max}$	INT32	x100, V
1416	RO	$I_{1\ max}$	INT32	x1000, A
1418	RO	$I_{2\ max}$	INT32	x1000, A

Register	Property	Description	Format	Unit
1420	RO	$I_{3\ max}$	INT32	x1000, A
1422	RO	Ø I_{max}	INT32	x1000, A
1424	RO	$P_{L1\ max}$	INT32	x1000, kW
1426	RO	$P_{L2\ max}$	INT32	x1000, kW
1428	RO	$P_{L3\ max}$	INT32	x1000, kW
1430	RO	$P_{ges\ max}$	INT32	x1000, kW
1432	RO	$Q_{L1\ max}$	INT32	x1000, kvar
1434	RO	$Q_{L2\ max}$	INT32	x1000, kvar
1436	RO	$Q_{L3\ max}$	INT32	x1000, kvar
1438	RO	$Q_{ges\ max}$	INT32	x1000, kvar
1440	RO	$S_{L1\ max}$	INT32	x1000, kVA
1442	RO	$S_{L2\ max}$	INT32	x1000, kVA
1444	RO	$S_{L3\ max}$	INT32	x1000, kVA
1446	RO	$S_{ges\ max}$	INT32	x1000, kVA
1448	RO	$\lambda_{1\ max}$	INT32	x1000
1450	RO	$\lambda_{2\ max}$	INT32	x1000
1452	RO	$\lambda_{3\ max}$	INT32	x1000
1454	RO	$\lambda_{ges\ max}$	INT32	x1000
1456	RO	f_{max}	INT32	x100, Hz
1458	RO	max. voltage unbalance	INT32	x1000
1460	RO	max. current unbalance	INT32	x1000
1462	RO	$THD_{UL1\ max}$	INT32	x10.000
1464	RO	$THD_{UL2\ max}$	INT32	x10.000
1466	RO	$THD_{UL3\ max}$	INT32	x10.000
1468	RO	$THD_{I1\ max}$	INT32	x10.000
1470	RO	$THD_{I2\ max}$	INT32	x10.000
1472	RO	$THD_{I3\ max}$	INT32	x10,000

Fig. 8.1: Maximum values per demand period

8.5.2 Minimum values demand

Register	Property	Description	Format	Unit
1600	RO	$U_{L1\ min}$	INT32	x100, V
1602	RO	$U_{L2\ min}$	INT32	x100, V
1604	RO	$U_{L3\ min}$	INT32	x100, V
1606	RO	Ø $U_{LN\ min}$	INT32	x100, V
1608	RO	$U_{L1L2\ min}$	INT32	x100, V
1610	RO	$U_{L2L3\ min}$	INT32	x100, V
1612	RO	$U_{L3L1\ min}$	INT32	x100, V
1614	RO	Ø $U_{LL\ min}$	INT32	x100, V
1616	RO	$I_{1\ min}$	INT32	x1000, A
1618	RO	$I_{2\ min}$	INT32	x1000, A
1620	RO	$I_{3\ min}$	INT32	x1000, A
1622	RO	Ø I_{min}	INT32	x1000, A
1624	RO	$P_{L1\ min}$	INT32	x1000, kW
1626	RO	$P_{L2\ min}$	INT32	x1000, kW
1628	RO	$P_{L3\ min}$	INT32	x1000, kW
1630	RO	$P_{ges\ min}$	INT32	x1000, kW
1632	RO	$Q_{L1\ min}$	INT32	x1000, kvar
1634	RO	$Q_{L2\ min}$	INT32	x1000, kvar
1636	RO	$Q_{L3\ min}$	INT32	x1000, kvar
1638	RO	$Q_{ges\ min}$	INT32	x1000, kvar
1640	RO	$S_{L1\ min}$	INT32	x1000, kVA
1642	RO	$S_{L2\ min}$	INT32	x1000, kVA
1644	RO	$S_{L3\ min}$	INT32	x1000, kVA
1646	RO	$S_{ges\ min}$	INT32	x1000, kVA
1648	RO	$\lambda_{1\ min}$	INT32	x1000
1650	RO	$\lambda_{2\ min}$	INT32	x1000
1652	RO	$\lambda_{3\ min}$	INT32	x1000

Register	Property	Description	Format	Unit
1654	RO	$\lambda_{ges\ min}$	INT32	x1000
1656	RO	f_{min}	INT32	x100, Hz
1658	RO	min. voltage unbalance	INT32	x1000
1660	RO	min. current unbalance	INT32	x1000
1662	RO	$THD_{UL1\ min}$	INT32	x10.000
1664	RO	$THD_{UL2\ min}$	INT32	x10.000
1666	RO	$THD_{UL3\ min}$	INT32	x10,000
1668	RO	$THD_{I1\ min}$	INT32	x10,000
1670	RO	$THD_{I2\ min}$	INT32	x10,000
1672	RO	$THD_{I3\ min}$	INT32	x10,000

Table 8.6: Minimum values per demand period

8.6 Peak demand

The value of the peak demand register is the actual value x 1,000, that means, to obtain a value in kW, kVA or kvar, the value of the register has to be divided by 1000.

8.6.1 Peak demand this month

Register	Property	Description	Format	
1800…1804	RO	Peak demand *P* of this month	see Table 8.9 on page 64	x1000, kW
1805…1809	RO	Peak demand *Q of this month*		x1000, kvar
1810…1814	RO	Peak demand *S* of this month		x1000, kVA
1815…1819	RO	Peak demand I_1 of this month		x1000, A
1820…1824	RO	Peak demand I_2 of this month		x1000, A
1825…1829	RO	Peak demand I_3 of this month		x1000, A

Table 8.7: Peak demand of this month

8.6.2 Peak demand last month

Register	Property	Description	Format	
1850…1854	RO	Peak demand *P* last month	see Table 8.9 on page 64	x1000, kW
1855…1859	RO	Peak demand *Q* last month		x1000, kvar
1860…1864	RO	Peak demand *S last month*		x1000, kVA
1865…1869	RO	Peak demand I_1 last month		x1000, A
1870…1874	RO	Peak demand I_2 last month		x1000, A
1875…1879	RO	Peak demand I_3 last month		x1000, A

Table 8.8: Peak demand last month

Peak demand data structure

Offset	Property	Description	Format	Note
+ 0	RO	Peak demand value	INT32	
+ 2	RO	HiWord: Year	UINT16	1…99 (year-2000)
	RO	LoWord: Month		1…12
+ 3	RO	HiWord: Date: Day	UINT16	1…28/29/30/31
	RO	LoWord: Hour		0…23
+ 4	RO	HiWord: Minute	UINT16	0…59
	RO	LoWord: Second		0…59

Table 8.9: Peak demand data structure

8.7 Max/Min log

8.7.1 Maximum log of this month

Register	Eigenschaft	Beschreibung	Format	Einheit
2000…2004	RO	$U_{L1\ max}$	see Table 8.14 on page 71	x100, V
2005…2009	RO	$U_{L2\ max}$		x100, V
2010…2014	RO	$U_{L3\ max}$		x100, V
2015…2019	RO	Ø $U_{LN\ max}$		x100, V
2020…2024	RO	$U_{L1L2\ max}$		x100, V
2025…2029	RO	$U_{L2L3\ max}$		x100, V
2030…2034	RO	$U_{L3L1\ max}$		x100, V
2035…2039	RO	Ø $U_{LL\ max}$		x100, V
2040…2044	RO	$I_{1\ max}$		x1000, A
2045…2049	RO	$I_{2\ max}$		x1000, A
2050…2054	RO	$I_{3\ max}$		x1000, A
2055…2059	RO	Ø I_{max}		x1000, A
2060…2064	RO	$P_{L1\ max}$		x1000, kW
2065…2069	RO	$P_{L2\ max}$		x1000, kW
2070…2074	RO	$P_{L3\ max}$		x1000, kW
2075…2079	RO	$P_{ges\ max}$		x1000, kW
2080…2084	RO	$Q_{L1\ max}$		x1000, kvar
2085…2089	RO	$Q_{L2\ max}$		x1000, kvar
2090…2095	RO	$Q_{L3\ max}$		x1000, kvar
2096…2099	RO	$Q_{ges\ max}$		x1000, kvar
2100…2104	RO	$S_{L1\ max}$		x1000, kVA
2105…2109	RO	$S_{L2\ max}$		x1000, kVA
2110…2114	RO	$S_{L3\ max}$		x1000, kVA
2115…2119	RO	$S_{ges\ max}$		x1000, kVA

Register	Eigenschaft	Beschreibung	Format	Einheit
2120…2124	RO	$\lambda_{1\ max}$	see Table 8.14 on page 71	x1000
2125…2129	RO	$\lambda_{2\ max}$		x1000
2130…2134	RO	$\lambda_{3\ max}$		x1000
2135…2139	RO	$\lambda_{ges\ max}$		x1000
2140…2144	RO	f_{max}		x100, Hz
2145…2149	RO	min. voltage unbalance		x1000
2150…2154	RO	min. current unbalance		x1000
2155…2159	RO	$THD_{UL1\ max}$		x10.000
2160…2164	RO	$THD_{UL2\ max}$		x10.000
2165…2169	RO	$THD_{UL3\ max}$		x10.000
2170…2174	RO	$THD_{I1\ max}$		x10.000
2175…2179	RO	$THD_{I2\ max}$		x10.000
2180…2184	RO	$THD_{I3\ max}$		x10.000

Table 8.10: Max log of this month

8.7.2 Min log of this month

Register	Property	Description	Format	
2300…2304	RO	$U_{L1\ min}$	see Table 8.14 on page 71	x100, V
2305…2309	RO	$U_{L2\ min}$		x100, V
2310…2314	RO	$U_{L3\ min}$		x100, V
2315…2319	RO	Ø $U_{LN\ min}$		x100, V
2320…2324	RO	$U_{L1L2\ min}$		x100, V
2325…2329	RO	$U_{L2L3\ min}$		x100, V
2330…2334	RO	$U_{L3L1\ min}$		x100, V
2335…2339	RO	Ø $U_{LL\ min}$		x100, V
2340…2344	RO	$I_{1\ min}$		x1000, A
2345…2349	RO	$I_{2\ min}$		x1000, A
2350…2354	RO	$I_{3\ min}$		x1000, A

Register	Property	Description	Format	
2355…2359	RO	Ø I_{min}	see Table 8.14 on page 71	x1000, A
2360…2364	RO	$P_{L1\ min}$		x1000, kW
2365…2369	RO	$P_{L2\ min}$		x1000, kW
2370…2374	RO	$P_{L3\ min}$		x1000, kW
2375…2379	RO	$P_{ges\ min}$		x1000, kW
2380…2384	RO	$Q_{L1\ min}$		x1000, kvar
2385…2389	RO	$Q_{L2\ min}$		x1000, kvar
2390…2395	RO	$Q_{L3\ min}$		x1000, kvar
2396…2399	RO	$Q_{ges\ min}$		x1000, kvar
2400…2404	RO	$S_{L1\ min}$		x1000, kVA
2405…2409	RO	$S_{L2\ min}$		x1000, kVA
2410…2414	RO	$S_{L3\ min}$		x1000, kVA
2415…2419	RO	$S_{ges\ min}$		x1000, kVA
2420…2424	RO	$\lambda_{1\ min}$		x1000
2425…2429	RO	$\lambda_{2\ min}$		x1000
2430…2434	RO	$\lambda_{3\ min}$		x1000
2435…2439	RO	$\lambda_{ges\ min}$		x1000
2440…2444	RO	f_{min}		x100, Hz
2445…2449	RO	min. voltage unbalance		x1000
2450…2454	RO	min. current unbalance		x1000
2455…2459	RO	$THD_{UL1\ min}$		x10,000
2460…2464	RO	$THD_{UL2\ min}$		x10,000
2465…2469	RO	$THD_{UL3\ min}$		x10,000
2470…2474	RO	$THD_{I1\ min}$		x10,000
2475…2479	RO	$THD_{I2\ min}$		x10,000
2480…2484	RO	$THD_{I3\ min}$		x10,000

Table 8.11: Min log of this month

8.7.3 Max log of last month

Register	Property	Description	Format	
2600…2604	RO	$U_{L1\ max}$	see Table 8.14 on page 71	x100, V
2605…2609	RO	$U_{L2\ max}$		x100, V
2610…2614	RO	$U_{L3\ max}$		x100, V
2615…2619	RO	Ø $U_{LN\ max}$		x100, V
2620…2624	RO	$U_{L1L2\ max}$		x100, V
2625…2629	RO	$U_{L2L3\ max}$		x100, V
2630…2634	RO	$U_{L3L1\ max}$		x100, V
2635…2639	RO	Ø $U_{LL\ max}$		x100, V
2640…2644	RO	$I_{1\ max}$		x1000, A
2645…2649	RO	$I_{2\ max}$		x1000, A
2650…2654	RO	$I_{3\ max}$		x1000, A
2655…2659	RO	Ø I_{max}		x1000, A
2660…2664	RO	$P_{L1\ max}$		x1000, kW
2665…2669	RO	$P_{L2\ max}$		x1000, kW
2670…2674	RO	$P_{L3\ max}$		x1000, kW
2675…2679	RO	$P_{ges\ max}$		x1000, kW
2680…2684	RO	$Q_{L1\ max}$		x1000, kvar
2685…2689	RO	$Q_{L2\ max}$		x1000, kvar
2690…2695	RO	$Q_{L3\ max}$		x1000, kvar
2696…2699	RO	$Q_{ges\ max}$		x1000, kvar
2700…2704	RO	$S_{L1\ max}$		x1000, kVA
2705…2709	RO	$S_{L2\ max}$		x1000, kVA
2710…2714	RO	$S_{L3\ max}$		x1000, kVA
2715…2719	RO	$S_{ges\ max}$		x1000, kVA

Register	Property	Description	Format	
2720…2724	RO	$\lambda_{1\ max}$	see Table 8.14 on page 71	x1000
2725…2729	RO	$\lambda_{2\ max}$		x1000
2730…2734	RO	$\lambda_{3\ max}$		x1000
2735…2739	RO	$\lambda_{ges\ max}$		x1000
2740…2744	RO	f_{max}		x100, Hz
2745…2749	RO	max. voltage unbalance		x1000
2750…2754	RO	max. current unbalance		x1000
2755…2759	RO	$THD_{UL1\ max}$		x10,000
2760…2764	RO	$THD_{UL2\ max}$		x10,000
2765…2769	RO	$THD_{UL3\ max}$		x10,000
2770…2774	RO	$THD_{I1\ max}$		x10,000
2775…2779	RO	$THD_{I2\ max}$		x10,000
2780…2784	RO	$THD_{I3\ max}$		x10,000

Table 8.12: Max log of last month

8.7.4 Min log last month

Register	Property	Description	Format	
2900…2904	RO	$U_{L1\ min}$	see Table 8.14 on page 71	x100, V
2905…2909	RO	$U_{L2\ min}$		x100, V
2910…2914	RO	$U_{L3\ min}$		x100, V
2915…2919	RO	$Ø\ U_{LN\ min}$		x100, V
2920…2924	RO	$U_{L1L2\ min}$		x100, V
2925…2929	RO	$U_{L2L3\ min}$		x100, V
2930…2934	RO	$U_{L3L1\ min}$		x100, V
2935…2939	RO	$Ø\ U_{LL\ min}$		x100, V
2940…2944	RO	$I_{1\ min}$		x1000, A
2945…2949	RO	$I_{2\ min}$		x1000, A
2950…2954	RO	$I_{3\ min}$		x1000, A

Register	Property	Description	Format	
2955…2959	RO	Ø I_{min}	see Table 8.14 on page 71	x1000, A
2960…2964	RO	$P_{L1\ min}$		x1000, kW
2965…2969	RO	$P_{L2\ min}$		x1000, kW
2970…2974	RO	$P_{L3\ min}$		x1000, kW
2975…2979	RO	$P_{ges\ min}$		x1000, kW
2980…2984	RO	$Q_{L1\ min}$		x1000, kvar
2985…2989	RO	$Q_{L2\ min}$		x1000, kvar
2990…2995	RO	$Q_{L3\ min}$		x1000, kvar
2996…2999	RO	$Q_{ges\ min}$		x1000, kvar
3000…3004	RO	$S_{L1\ min}$		x1000, kVA
3005…3009	RO	$S_{L2\ min}$		x1000, kVA
3010…3014	RO	$S_{L3\ min}$		x1000, kVA
3015…3019	RO	$S_{ges\ min}$		x1000, kVA
3020…3024	RO	$\lambda_{1\ min}$		x1000
3025…3029	RO	$\lambda_{2\ min}$		x1000
3030…3034	RO	$\lambda_{3\ min}$		x1000
3035…3039	RO	$\lambda_{ges\ min}$		x1000
3040…3044	RO	f_{min}		x100, Hz
3045…3049	RO	min. voltage unbalance		x1000
3050…3054	RO	min. current unbalance		x1000
3055…3059	RO	$THD_{UL1\ min}$		x10,000
3060…3064	RO	$THD_{UL2\ min}$		x10,000
3065…3069	RO	$THD_{UL3\ min}$		x10,000
3070…3074	RO	$THD_{I1\ min}$		x10,000
3075…3079	RO	$THD_{I2\ min}$		x10,000
3080…3084	RO	$THD_{I3\ min}$		x10,000

Table 8.13: Memory minimum values last month

Max/Min log data structure

Offset	Property	Description	Format	Note
+ 0	RO	Max resp. Min value	INT32	
+ 2	RO	HiWord: Year	UINT16	1…99 (year-2000)
	RO	LoWord: Month		1…12
+ 3	RO	HiWord: Date: Day	UINT16	1…28/29/30/31
	RO	LoWord: Hour		0…23
+ 4	RO	HiWord: Minute	UINT16	0…59
	RO	LoWord: Second		0…59

Table 8.14: Max*/Min log data structure*

8.8 Setup parameters

Register	Property	Description	Format	Range/unit
6000	RW	Voltage transformer ratio	UINT16	1*…2200
6001	RW	Measuring current transformer ratio	UINT16	1*…6000 (current input 5 A) 1*…30000 (current input 1 A)
6002	RW	Wiring mode	UINT16	0 = WYE* 1 = DELTA 2 = DEMO
6003	RW	Device address Modbus RTU	UINT16	1…247 (100*)
6004	RW	Modbus RTU baud rate	UINT16	0 = 1200 1 = 2400 2 = 4800 3 = 9600* 4 = 19200
6005	RW	Modbus RTU parity	UINT16	0 = 8N2; 1 = 8O1 2 = 8E1* ; 3 = 8N1 4 = 8O2 ; 5 = 8E2
6006…6014	Reserved			
6015	RW	Power factorλ rule	UINT16	B1B0: 00* = IEC 01= IEEE 10 = -IEEE
6016	RW	Calculation method *S*	UINT16	B1B0: 00* = vector 01 = scalar
6017	RW	Polarity measuring current transformer L1	UINT16	0* = normal 1 = reversed
6018	RW	Polarity measuring current transformer L2	UINT16	0* = normal 1=reversed
6019	RW	Polarity measuring current transformer L3	UINT16	0=normal 1=reversed
6020	RW	Demand measurement period	UINT16	1, 2, 3, 5, 10, 15*, 60 minutes
6021	RW	Number of sliding windows	UINT16	1*…15
6022…6045	Reserved			

Register	Property	Description	Format	Range/unit
6046	RW	Setpoints DI1/ DI2	See “Digital input setpoint data structure (register 6046, 6047 and 6048)” on page 74.	
6047	RW	Setpoints DI3 / DI4		
6048	RW	Setpoints DI5 / DI6		
6049…6071	Reserved			
6072…6080	RW	Setpoint 1	See “Control setpoints data structure” on page 75.	
6081…6089	RW	Setpoint 2		
6090…6098	RW	Setpoint 3		
6099…6107	RW	Setpoint 4		
6108…6016	RW	Setpoint 5		
6117…6125	RW	Setpoint 6		
6126…6134	RW	Setpoint 7		
6135…6143	RW	Setpoint 8		
6144…6152	RW	Setpoint 9		
6153…6271	Reserved			
6272	RW	Enable energy pulse	UINT16	0* = disabled 1 = enabled
6273	RW	Pulse constant	UINT16	0* = 1000 imp/kxh
6274	RW	Read time	UINT16	0*
6275…6289	Reserved			
6290	WO	Clear all energy registers	UINT16	Writing 0xFF00 to the register clears the energy values
6291	WO	Clear event log	UINT16	Writing 0xFF00 to the register resets the pointer of the event log to 0
6292	WO	Clear demand of this month	UINT16	Writing 0xFF00 to the register clears the demand values of this month
6293	WO	Clear Max/Min log	UINT16	Writing 0xFF00 to the register clears the values of the Max/Min log
6294…6329	Reserved			

Table 8.15: Setup parameters

8.8.1 Digital input setpoint data structure (register 6046, 6047 and 6048)

Digital inputs DI1 and DI2

DI2				DI1		
Bit	15…10	9	8	7…2	1	0
Triggers digital output	Reserved	DO2	DO1	Reserved	DO2	DO1

Table 8.16: Register 6046

Digital inputs DI3 and DI4

DI4				DI3		
Bit	15…10	9	8	7…2	1	0
Triggers digital output	Reserved	DO2	DO1	Reserved	DO2	DO1

Table 8.17: Register 6047

Digital inputs DI5 and DI6

DI6				DI5		
Bit	15…10	9	8	7…2	1	0
Triggers digital output	Reserved	DO2	DO1	Reserved	DO2	DO1

Table 8.18: Register 6048

Example:
If register 6046 contains a value of 0x101, it means the following:
After being enabled

- DI1 controls output DO2
- DI2 controls output DO1.

Control setpoints data structure

Offset	Property	Description	Format	Range/options
+ 0	RW	Type	UINT16	0 = disabled 1 = over setpoint 2 = under setpoint
+ 1	RW	Parameters [1)]	UINT16	1…16
+ 2	RW	Threshold value exceeded	INT32	/
+ 4	RW	Value below release threshold	INT32	/
+ 6	RW	Response threshold value delay delay	UINT16	0…9999 (s)
+ 7	RW	Release threshold value delay	UINT16	0…9999 (s)
+ 8	RW	Trigger [2)]	UINT16	0…21

Table 8.19: Control setpoints data structure

Comments relating to the table above

[1)] Parameter

Key	Parameters	Scale/ unit	Key	Parameters	Scale/ unit
0	—	—	9	$THED_U$	x10,000
1	U_{LN}	x100, V	10	$THED_I$	x10,000
2	U_{LL}	x100, V	11	$TOHD_U$	x10,000
3	I	x 1,000, A	12	$TOHD_I$	x10,000
4	P_{ges}	x1,000, kW	13	Demand P_{ges}	x1,000, kW
5	S_{ges}	x1,000, kvar	14	Demand Q_{ges}	x1,000, kvar
6	λ_{ges}	x1,000	15	Demand S_{ges}	x1,000, kVA
7	THD_U	x10,000	16	Ø Demand I	x1,000, A
8	THD_I	x10,000			

Table 8.20: Setpoint parameter

[2] Trigger

Key	0	1	2	3…21
Action	/	DO1	DO2	Reserved

Table 8.21: Setpoint trigger

8.9 Event log (SOE log)

Each SOE event occupies 8 registers, as shown in the following table. The internal data structure of the event log is listed in Table 8.23 on page 77.

Register	Property	Description	Format
10000…10007	RO	Event 1	see Table 8.23 on page 77
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	
…			
10504…10511	RO	Event 64	

Table 8.22: Event log (SOE log)

Event data structure (SOE log)

The following table describes the internal data structure of the 8 registers which belong to each event in the SOE log.

Offset	Property	Description
+ 0	RO	Reserved
+ 1	RO	Event classification (see Table 8.24 on page 82)
+ 2	RO	HiWord: Year-2000 LoWord: Month (1…12)
+ 3	RO	HiWord: Day (0…31) LoWord: Hour (1…23)
+ 4	RO	HiWord: Minute (0…59) LoWord: Second (0…59)
+ 5	RO	Millisecond (0…999)
+ 6	RO	HiWord: Event value
+ 7	RO	LoWord: Event value

Table 8.23: Event data structure

Event classification (SOE log)

Event classification	Event sub-classification	Event value option	Description
1	1	1/0	Digital input 1 closed/open
	2	1/0	Digital input 2 closed/open
	3	1/0	Digital input 3 closed/open
	4	1/0	Digital input 4 closed/open
	5	1/0	Digital input 5 closed/open
	6	1/0	Digital input 6 closed/open
2	1	1/0	Digital output 1 closed/open by Modbus access
	2	1/0	Digital output 2 closed/open by Modbus access
	3…4	Reserved	
	5	1/0	Digital output 1 closed/open by setpoint
	6	1/0	Digital output 2 closed/open by setpoint
	7…8	Reserved	
	9	1/0	Digital output 1 closed/open by button on the front

Event classification	Event sub-classification	Event value option	Description
2	10	1/0	Digital output 2 closed/open by button on the front
	11…14	Reserved	
	15	1/0	Digital output 1 closed/open by DI setpoint
	16	1/0	Digital output 2 closed/open by DI setpoint
	17…18	Reserved	
3	1	Trigger value x 100	>-Setpoint U_{LN} exceeded
	2	Trigger value x 100	>-Setpoint U_{LL} exceeded
	3	Trigger value x 1000	>-Setpoint *I* exceeded
	4	Trigger value	>-Setpoint P_{ges} exceeded
	5	Trigger value	>-Setpoint Q_{ges} exceeded
	6	Trigger value x 1000	>-Setpoint λ_{ges} exceeded
	7	Trigger value x 10,000	>-Setpoint THD_U exceeded
	8	Trigger value x 10,000	>-Setpoint THD_I exceeded
	9	Trigger value x 10,000	>-Setpoint $TEHD_U$ exceeded
	10	Trigger value x 10,000	>-Setpoint $TEHD_I$ exceeded
	11	Trigger value x 10,000	>-Setpoint $TOHD_U$ exceeded
	12	Trigger value x 1000	>-Setpoint $TOHD_I$ exceeded
	13	Trigger value x 1000	>-Setpoint demand P_{ges} exceeded
	14	Trigger value x 1000	>-Setpoint demand Q_{ges} exceeded
	15	Trigger value x 1000	>-Setpoint demand S_{ges} exceeded
	16	Trigger value x 100	>-Setpoint demand *I* exceeded
	17	Return value x 100	>-Setpoint U_{LN} return

Event classification	Event sub-classification	Event value option	Description
3	18	Return value x 100	>-Setpoint U_{LL} return
	19	Return value x 1000	>-Setpoint *I* return
	20	Return value	>-Setpoint P_{ges} return
	21	Return value	>-Setpoint Q_{ges} return
	22	Return value x 1000	>-Setpoint λ_{ges} return
	23	Return value x 10,000	>-Setpoint THD_U return
	24	Return value x 10.000	>-Setpoint THD_I return
	25	Return value x 10.000	>-Setpoint $TEHD_U$ return
	26	Return value x 10.000	>-Setpoint $TEHD_I$ return
	27	Return value x 10.000	>-Setpoint $TOHD_U$ return
	28	Return value x 1000	>-Setpoint $TOHD_I$ return
	29	Return value x 1000	>- Setpoint demand P_{ges} return
	30	Return value x 1000	>-Setpoint demand Q_{ges} return
	31	Return value x 1000	>-Setpoint demand S_{ges} return
	32	Return value x 100	>-Setpoint demand*Ireturn*
	33	Trigger value x 100	Under <-Setpoint U_{LN}
	34	Trigger value x 100	Under <-Setpoint U_{LL}
	35	Trigger value x 1000	Under <-Setpoint *I*
	36	Trigger value	Under <-Setpoint P_{ges}
	37	Trigger value	Under <-setpoint Q_{ges}
	38	Trigger value x 1000	Under <-Setpoint λ_{ges}

Event classification	Event sub-classification	Event value option	Description
3	39	Trigger value x 10.000	Under <-Setpoint THD_U
	40	Trigger value x 10.000	Under <-Setpoint THD_I
	41	Trigger value x 10.000	Under <-Setpoint $TEHD_U$
	42	Trigger value x 10.000	Under <-Setpoint $TEHD_I$
	43	Trigger value x 10.000	Under <-Setpoint $TOHD_U$
	44	Trigger value x 1000	Under <-Setpoint $TOHD_I$
	45	Trigger value x 1000	Under <-Setpoint demand P_{ges}
	46	Trigger value x 1000	Under <-Setpoint demand Q_{ges}
	47	Trigger value x 1000	Under <-Setpoint demand S_{ges}
	48	Trigger value x 100	Under <-Setpoint demand *I*
	49	Return value x 100	<-Setpoint U_{LN} return
	50	Return value x 100	<-Setpoint U_{LL} return
	51	Return value x 1000	<-Setpoint *I* return
	52	Return value	<-Setpoint P_{ges} return
	53	Return value	<-Setpoint Q_{ges} return
	54	Return value x 1000	<-Setpoint λ_{ges} return
	55	Return value x 10.000	<-Setpoint THD_U return
	56	Return value x 10.000	<-Setpoint THD_I return
	57	Return value x 10.000	<-Setpoint $TEHD_U$ return
	58	Return value x 10.000	<-Setpoint $TEHD_I$ return

Event classification	Event sub-classification	Event value option	Description
3	59	Return value x 10,000	<-Setpoint $TOHD_U$ return
	60	Return value x 1000	<-Setpoint $TOHD_I$ return
	61	Return value x1000	<-Setpoint demand P_{ges} return
	62	Return value x1000	<-Setpoint demand Q_{ges} return
	63	Return value x 1000	<-Setpoint demand S_{ges} return
	64	Return value x 100	<-Setpoint demand *I* return
	65	Bit 31	Shows which DO is being triggered by DI setpoint 0 = open 1 = closed
		Bits 16…30	Shows which DI is being triggered by DO 1 = DI1 2 = DI2 3 = DI3 4 = DI4 5 = DI5 6 = DI6
		Bits 2…15	Reserved
		Bits 0…1	Shows which DO is being triggered by the associated DI: Bit 0 = DO1/ Bit 1 = DO2
	66…69	Reserved	
4	1	0	Supply voltage on
	2	0	Supply voltage off
	3	0	Setup changed via device buttons
	4	0	Setup changed via communications
	5	0	Counter DI cleared via communication
	6	0	Event log cleared via device buttons
	7	0	Event log cleared via communications
	8	0	Energy values cleared via device buttons
	9	0	Energy values cleared via communications
	10	0	Peak demand of this month cleared via device buttons
	11	0	Peak demand of this month cleared via communications

Event classification	Event sub-classification	Event value option	Description
4	12	0	Max/Min value log of this month cleared via device buttons
	13	0	Max/Min log of this month cleared via communications
	14	Reserved	
5	1…6	Reserved	
6	1…17	Reserved	

Table 8.24: Event classification

8.10 Time setting

There are two time register formats supported by PEM533:

1. Year/Month/Day/Hour/Minute/Secondregister 9000…9002
2. UNIX-timeregister 9004

When sending the time via Modbus communications, care should be taken to only write one of the two time register sets. All registers within a time register set must be written in a single transaction.
If all the registers **9000…9004** are set, both timestamp registers will be updated to reflect the new time specified in the UNIX time register set. Time specified in the first display format will be ignored.
Optionally, the register **9003** displays milliseconds. When broadcasting time, the function code has to be set to 0x10 (Preset Multiple Register). Incorrect date or time values will be rejected by the measuring device.

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

Table 8.25: Timestamp register

8.11 DOx 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 **0081** have to be read out.
PEM533 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 activated first. This is achieved by writing 0xFF00 to the appropriate DO register. If an "Execute" command is not received within 15 seconds, the output will be deactivated again.
Each command that is to be sent to an output not being activated before will be ignored by the PEM533 and instead will be returned as exception code 0x04.

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

Table 8.26: Digital output control register

8.12 Universal measuring device information

Register	Property	Description	Format	Note
9800… 9819	RO	Model*	UINT16	see Table 8.28 on page 85
9820	RO	Software version	UINT16	e.g.: 10000 = V1.00.00
9821	RO	Protocol version	UINT16	e.g.: 40 = V4.0
9822	RO	Software update date (year-2000)	UINT16	e.g.: 080709 = July 9, 2008
9823	RO	Software update date: Month	UINT16	
9824	RO	Software update date: Date: day	UINT16	
9825	RO	Serial number		
9827…9829	Reserved			
9830	RO	Measuring current input	UINT16	1 / 5 (A)
9831	RO	U_S	UINT16	100/400 (V)

Table 8.27: Measuring device information

* The model of the universal measuring device is included in the registers 9800…9819. A coding example is given in the table below using the "PEM533" by way of example.

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

Table 8.28: ASCII coding of "PEM533"