GOSSEN METRAWATT

TCP/IP

Interface for Multi-Tariff Meters U228X-W4 and U238X-W4

3-349-937-03
4/3.17

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1 General

1.1 Modbus TCP

Modbus TCP is a variant of Modbus RTU. Basically it's a Modbus RTU package packed into a TCP/IP sequence. The Modbus RTU frame is rendered routable on the Internet through the use of the TCP/IP standard. And thus with suitable configuration, it's no longer necessary to have all Modbus slaves in the same subnet. In contrast, all salves are physically connected to a single bus in the case of Modbus RTU.

Definition of terms: The Modbus slave is the meter, and is also called a server because it contains the data. The Modbus master is the PC or a summator, and is also known as a Modbus client.

1.2. Electrical Connection

The meter is connected to the network by means of a commercially available network cable with RJ45 plug. The other end of the network cable is wired to an Ethernet switch which establishes the connection to the rest of the network.

1.3 TCP/IP Meter Configuration

The default settings for the device's network configuration are as follows:

IP address: 192.168.1.253
Subnet mask: 255.255.255.0
Gateway: 0.0.0.0
User name: admin
Password: admin

(The address of your Internet router can be entered under gateway, but this is not necessary.)

The IP address can be reset to the default setting directly at the device via the menu (see section 5).

The IP address is set via the meter's web interface as described below. If your network also uses IP address 192.168.1.x, you don't have to make any changes at your PC. However, you'll have to rule out the possibility that any other device is already using this IP address. You can check this, for example, with the ping command. ***Do not*** yet connect the meter to your network, but first open a DOSBox. Enter the following command to the DOSBox:

"Ping 192.168.1.253"

Then press the enter key. If the following response appears 4 times:

"Request Timeout"

you can continue. If, on the other hand, the following message appears:

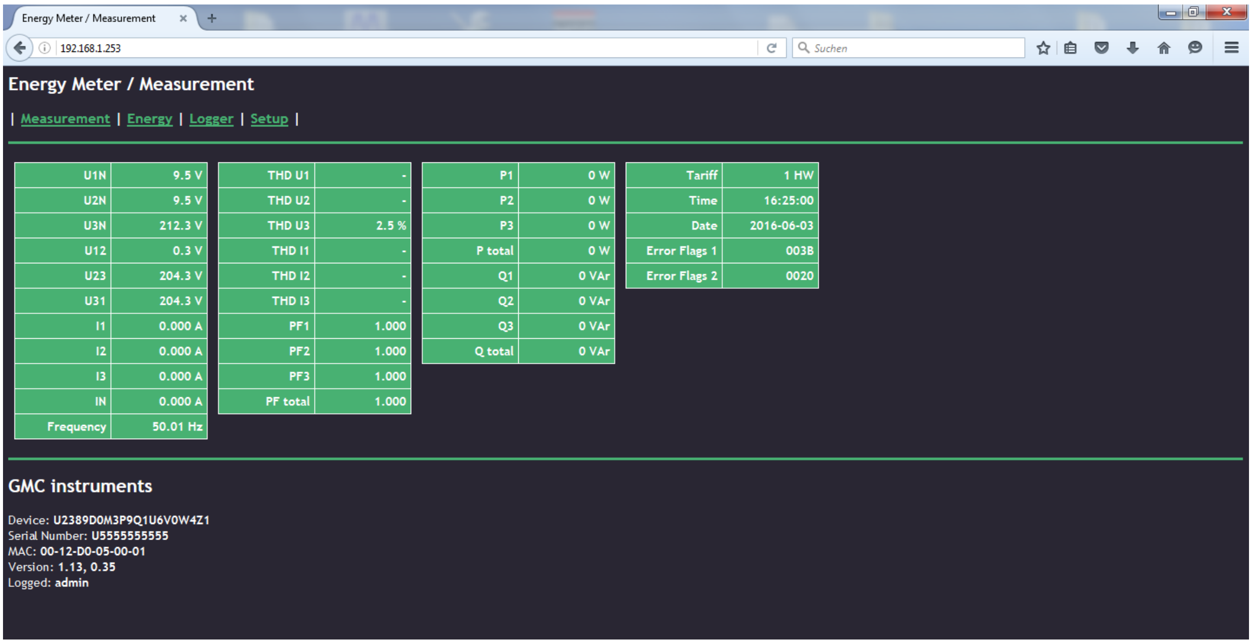
"Reply from 192.168.1.253: Bytes=....."

temporarily disconnect the device with this IP address from your network and execute the ping command once again. If the respective device cannot be disconnected or if you don't know which device is using this IP address, disconnect the PC from the network and connect it directly to the meter.

If your network uses an address range other than 192.168.1.x, the address range must be adapted in the meter. The address range of your configuration PC must first of all be changed to the range shown above to this end. The procedure depends upon your operating system. Instructions can be found in the Internet, for example by searching for "change IP address".

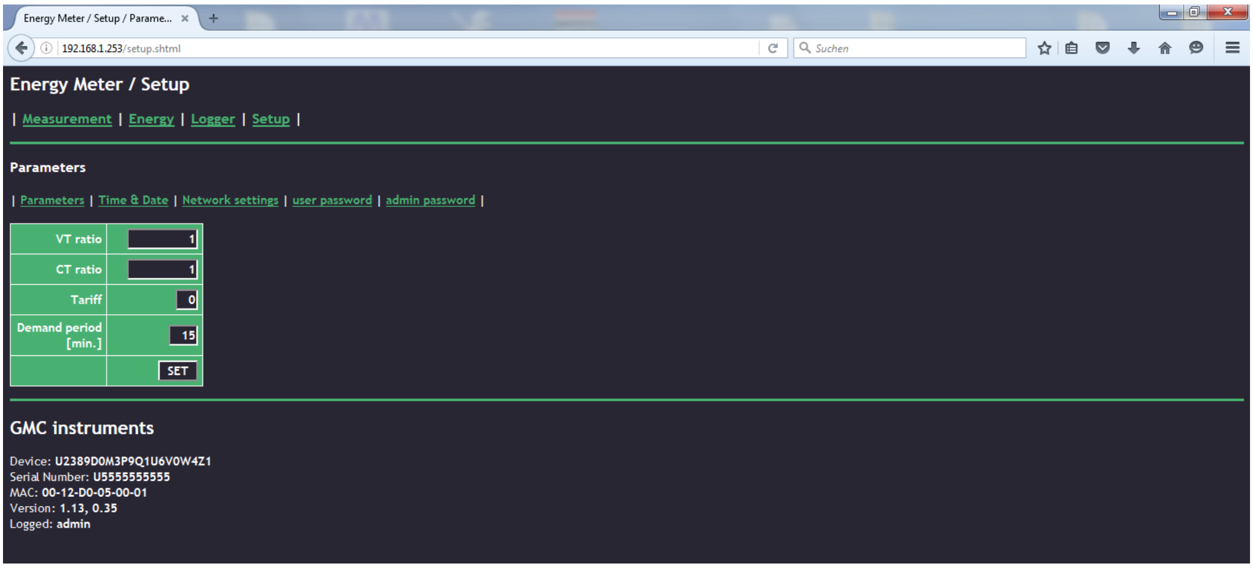
When the above listed conditions have been fulfilled and the meter is being supplied with electrical power, connect the meter to your network or PC by means of a network cable (see above).

Start your Internet browser and enter the following address: 192.168.1.253. After pressing the enter key, you'll first have to log on to the meter. User name and password are both initially set to "admin" (default setting). After entering the password and clicking "OK", the following page should appear:



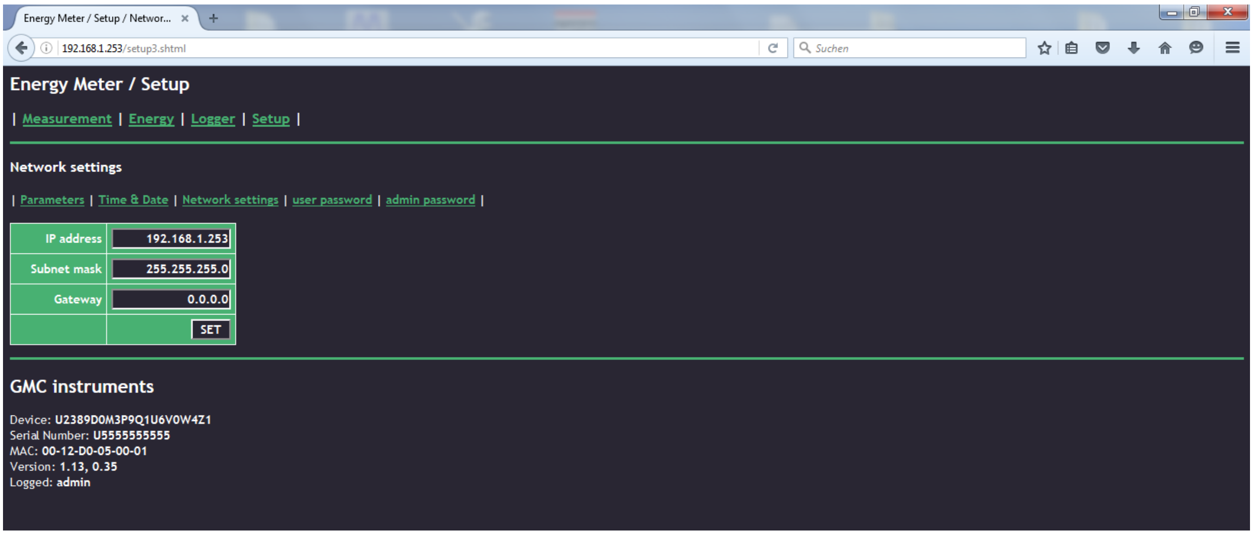
This display shows current measured values, the tariff, date and time, and the error flags. Click "Setup" in order to access the dialog for setting the IP address.

The following page appears:



Meter parameters can be changed here if applicable (depending on meter variant), time can be set, and the passwords and the IP address can be changed. Click "Network settings" to change the IP address.

The IP address can be changed in the page which then appears:



Click into the “IP address” field and change the address to your network’s IP address range. **Note:** After clicking “SET”, the meter’s TCP/IP module is automatically restarted and the address becomes immediately active. This means that you immediately have to use the newly selected address. If another IP address range is used, the range also has to be changed at your PC again in order to gain access to the meter.

If you want to use more than one meter, it thus makes good sense to first of all configure all of the meters correspondingly. **Note:** Each IP address may only be assigned once!

1.4 Firmware Update

As of version V1.0, the energy meters with TCP/IP interface are equipped with BACnet functionality. In order to be able to use BACnet on older devices, the firmware has to be updated.

Download the GMC-I update tool from our website at www.ecs-4.com to this end.
Connect the meter to the PC via an Ethernet cable and fill out the following fields:

– **IP address:** Enter the current device IP address (can be changed via web server).
– **admin password:** Enter your administrative password (default: admin).
– Click the **FIRMWARE UPDATE** button.

Please wait until the update procedure has been completed and do not interrupt communication!

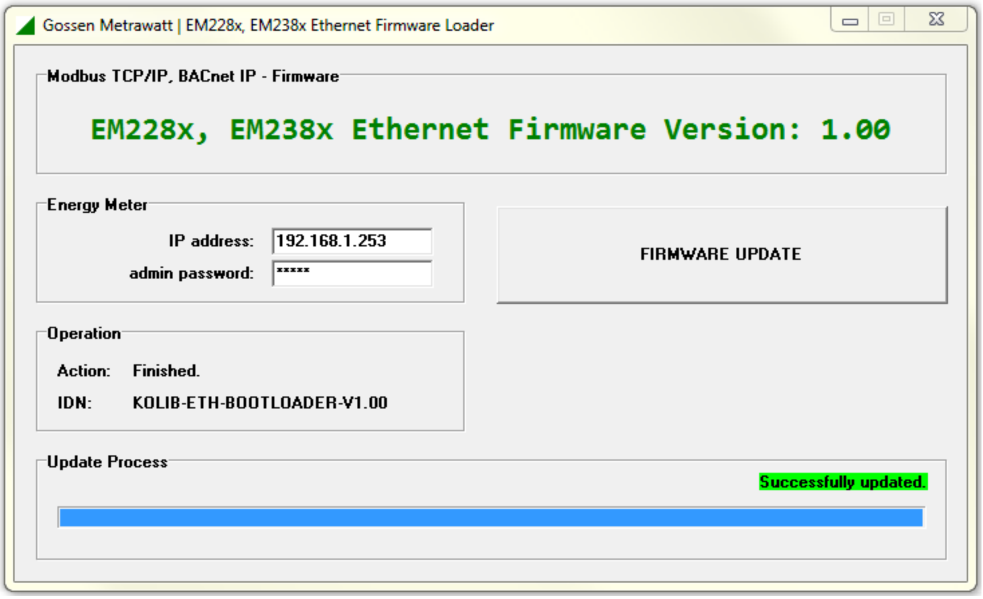


Figure 1: GMC-I Update Tool V1.00, Successfully Updated

If the update doesn't start, please check the following:

– An incorrect password is indicated by means of a corresponding message.
– Other errors can usually be traced back to an incorrectly entered IP address.
– The PC must be in the same subnet.
– With some PCs, the required type of connection is disabled in the case of a simultaneous WiFi connection: if applicable, try another PC or deactivate the adapter.

Note: As is the case with all firmware updates, this procedure is not entirely without risk. During the update there's no valid interface firmware. The devices' energy metering function is not impaired, but in extreme cases the interface function may be lost. Please contact our technical support department with any questions or in the event that problems should occur.

1.5 Technical Details

The meter supports 10 and 100 MBit/s in full and half-duplex. The corresponding setting is entered automatically. In a 1 GBit/s network, the corresponding port at the switch is configured automatically to 10 or 100 MBit/s.
The TCP/IP connection supports HP Auto-MDIX, which means that crossover network cables are unnecessary – the meter can be connected to a switch as well as to a PC with normal patch cables.

2 Modbus TCP Protocol

2.1 Introduction

Modbus RTU is a protocol for distances of up to 1200 meters. Transmission speed has to be reduced as distance increases in order to assure functional stability. This applies to all of the devices connected to the same bus, i.e. all devices must use the lower speed – those close to the Modbus master as well. Up to 247 devices can be addressed on the Modbus. Remote access to the meters over distances of several kilometers is only possible with special converters.

The TCP/IP protocol, well-known through its use on the Internet, can also be used to access devices at even further distances. In order to avoid having to create an entirely new standard, the already established Modbus RTU protocol is minimally modified and then transmitted as a “payload” via the TCP/IP protocol. With corresponding enabling, this makes it possible to access the meter from any PC anywhere in the world.

2.2 OSI Model

The OSI model is a reference model for network protocols. It defines 7 layers within which all data transmission takes place. Each layer has precisely defined interfaces to the next higher and next lower layers (except for layers 1 and 7 because there’s no further layer below 1 or above 7). The higher level doesn’t see how the lower levels are transmitting data.

Order of the layers (the highest level is at the top):

7 Application layer
6 Presentation layer
5 Session layer
4 Transport layer
3 Network layer
2 Data link layer
1 Physical layer

Layer 1 defines the physical interface, for example the utilized plugs and cables and how the bits to be transmitted are coded.

Layer 2 is the data link layer. The data stream is subdivided into blocks within this layer and a checksum is added for the detection of faulty blocks. A globally unique MAC address is used in order to address the recipient.

As the utilized interface, the Ethernet standard defines exactly how layers 1 and 2 must be laid out.

Layer 3 is the network layer. It regulates routing of the data packets through the various subnets. The Internet protocol (IP) is used for addressing – and the so-called IP address is added.

Layer 4 is the transport layer. It’s used for segmentation of the data stream, and in order to prevent network congestion. Addressing takes place here as well – port addresses are added. Port 80 is especially well known due to its use on the Internet (“surfing”). Modbus TCP is executed via port 502, which is reserved to this end.

Layers 5 and 6 are not used for Modbus TCP.

Layer 7 is the application layer. The Modbus RTU packets are transported within this layer.

2.3 Excursus regarding Modbus RTU

In order to explain the layout of the Modbus TCP packets, the layout of the Modbus RTU packets will first be briefly considered.

2.3.1 Layout of Modbus RTU Frames

According to the specification, Modbus RTU frames always have the same layout:
(All numbers are decimal numbers unless otherwise specified.)

Device Address	Function Code	Data	CRC
8-bit (commonly 0 ... 247)	8-bit	n x 8-bit (n = 0 ... 252)	16-bit

And thus the maximum size of a Modbus frame is 256 bytes.

2.3.2 Function Code

The Modbus specification defines various function codes (FC). The following three function codes are used for Modbus TCP by the U228x-, U238x meter range:

Function Code	Meaning	Use
3	Read words (read holding registers)	Read parameters
4	Read values (read input register)	Read measured values
16	Write words (write multiple registers)	Write parameters

2.3.3 Data

The data to be transmitted are contained in this part of the frame. In requests from the master to the slave, the data are always 16-bit words and the high byte is always transmitted first.
If applicable and depending on the function code, responses from the slave contain the number of the following 16-bit data words as a byte value.

2.3.4 CRC Calculation (cyclic redundancy check)

The calculation is carried out over all of a frame’s characters, except for those of the CRC byte. The low CRC byte (CRC LByte) is the first in the frame, followed by the high byte (CRC Hbyte). The recipient of the frame also calculates the CRC and compares it with the received CRC.
The CRC is not used for Modbus TCP, and is only explained here for the sake of completeness.

2.3.5 Frame Details of the Various Function Codes

Function Code 03 – Read Parameters:

Request Master > slave

Address	Function Code	Data				CRC
		Start address		Number of Registers		
Addr.	03	High byte	Low byte	High byte	Low byte	CRC16

Re-sponse Slave > master

Address	Function Code	Data		CRC
		Number of Data Bits	Information	
Addr.	03	N (8-bit)	N/2 register	CRC16

Function Code 04 – Read Measured Values:

Request Master > slave

Address	Function Code	Data				CRC
		Start address		Number of Registers		
Addr.	04	High byte	Low byte	High byte	Low byte	CRC16

Re-sponse Slave > master

Address	Function Code	Data		CRC
		Number of Data Bits	Information	
Addr.	04	N (8-bit)	N/2 register	CRC16

Function Code 16 – Write Parameters:

Request Master > slave

Address	Function Code (hex)	Data						CRC
		Start Address		Number of Registers		Number of Bytes	Infor-mation	
Addr.	10h	Hi	Lo	Hi	Lo	N	N bytes	CRC16

Re-sponse Slave > master

Address	Function Code (hex)	Data				CRC
		Start Address		Number of Registers		
Addr.	10h	Hi	Lo	Hi	Lo	CRC16

2.3.6 Error Handling

When the recipient of a frame detects an error, a corresponding error frame is sent to the master.

Address	Function Code	Data	Checksum	
			Low byte	High byte
11h	FC + 80h	Error code	CRC16	

The received function code is returned with set MSB (**m**ost **s**ignificant **b**it). This corresponds to an addition of 80h. The error code indicates an operating or a program error. The following error codes are supported:

Error Code	Description
01	The utilized function code is not supported.
02	The utilized register address is impermissible. The register is invalid or write protected.
03	Some of the utilized data values are not within the permissible range, e.g. invalid number of registers.

2.4 From Modbus RTU to Modbus TCP

As a result of the mode of operation defined in the OSI model, the recipient's application layer directly sees the Modbus commands transmitted by the sender – layers further down are quasi-transparent and Modbus TCP doesn't have to deal with them.

In order to progress from Modbus RTU to Modbus TCP, the Modbus RTU protocol is adapted slightly:

- CRC16 is omitted because data transmission is already assured by the OSI layers further down.
- The rest, i.e. the function code and the data, are called the "protocol data unit" (PDU).

Due to addressing via IP addresses (or MAC addresses), the address from the Modbus RTU protocol wouldn't actually be necessary anymore in the case of Modbus TCP. But it's retained in order to address the individual slaves where Modbus TCP to Modbus RTU converters are used (bridges, routers, gateways). These converters have only a single address within the Modbus TCP network, but they can address up to 247 Modbus RTU slaves.
The RTU address is disregarded in pure Modbus TCP networks. Depending on recommendation, it should be either 0, 1 or 255. This address is ignored in this Modbus TCP meter and can take on any value. It's called the "unit identifier" and is included in the "Modbus application protocol" (MBAP) header. This header precedes the PDU.

The following is also included in the MBAP header:

- Length, i.e. the number of bytes which follow (2 bytes)
- The "protocol identifier" (2 bytes) – always 0 in the Modbus TCP protocol
- The "transaction identifier" (2 bytes)

The transaction identifier is a number which is generated by the Modbus TCP client (master). It's transmitted unchanged in the response by the Modbus TCP server (slave, in this case the meter). It's used to assure correct allocation of received to transmitted data packets.

And thus a complete Modbus TCP packet is laid out as follows:

MBAP				**PDU**	
Transaction identifier (2 bytes)	**Protocol identifier (2 bytes)**	**Length (2 bytes)**	**Unit identifier (1 byte)**	**Function code (1 byte)**	**Data (x bytes)**

Example 1: Request the selected current transformer ratio (CT) at register address 10000 of the device with address 18 (in the example: 1000:1):

Modbus RTU (values in hexadecimal format):

Request:

Meter Address	**Function Code**	**Start Address**		**Number of Registers**		**CRC**	
		High byte	**Low byte**	**High byte**	**Low byte**	**Low byte**	**High byte**
12	03	27	10	00	01	8D	D8

Response:

Meter Address	**Function Code**	**Number of Data Bits**	**Information**		**CRC**	
			High byte	**Low byte**	**Low byte**	**High byte**
12	03	02	**03**	**E8**	3D	39

The same request and response in Modbus TCP (values in hexadecimal format):

Request:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 06	01	03	27 10 00 01

Response:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 05	01	03	02 **03 E8**

Example 2: Request THD values for phase voltages L1 ... L3 at register addresses 8 … 10 of the device with address 24:

Modbus RTU (values in hexadecimal format):

Request:

Meter Address	**Function Code**	**Start Address**		**Number of Registers**		**CRC**	
		High byte	**Low byte**	**High byte**	**Low byte**	**Low byte**	**High byte**
18	04	00	08	00	03	33	C0

Response:

Meter Address	**Function Code**	**Number of Data Bits**	**Information**	**CRC**	
				Low byte	**High byte**
18	04	08	**00 15 00 80 00 25**	E5	33

The same request and response in Modbus TCP (values in hexadecimal format):

Request:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function Code**	**Data**
00 02	00 00	00 06	01	04	00 08 00 03

Response:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function Code**	**Data**
00 02	00 00	00 09	01	03	**00 15 00 80 00 25**

The THD values for the voltages are thus (with Modbus RTU as well as with Modbus TCP):
THD (L1) = (0x0015) = 0.021
THD (L2) = (0x0080) = 0.128
THD (L3) = (0x0025) = 0.037

Example 3: Set the voltage transformer ratio at register address 10100 of the device with address 17 to 500:1.

Modbus RTU (values in hexadecimal format):

Command:

Meter Address	**Function Code**	**Start Address**		**Number of Registers**		**Number of Bytes**	**Information**	**CRC**	
		High byte	**Low byte**	**High byte**	**Low byte**			**Low byte**	**High byte**
11	10	27	74	00	01	02	**01 F4**	36	31

Response:

Meter Address	**Function Code**	**Start Address**		**Number of Registers**	**CRC**	
		High byte	**Low byte**		**Low byte**	**High byte**
11	10	27	74	00 01	49	F7

The same command and response in Modbus TCP (values in hexadecimal format):

Command:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 09	01	10	27 74 00 01 02 **01 F4**

Response:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 06	01	10	27 74 00 01

3 Modbus TCP Address Space

All register addresses in this document are zero-based, and are thus transmitted directly via the interface as they're listed in the tables. Conversion is consequently unnecessary.

3.1 Address Overview

Address	Number of Registers	Description	Access
0-14	15	Voltage	R
100-110	11	Current	R
200-216	17	Power	R
300-313	14	Total energy (all tariffs)	R
400-414	15	Energy, active tariff	R
500-510	11	Operating hours, date and time of the last reset and the last cutoff date	R
600-613	14	Energy, tariff 1	R
700-713	14	Energy, tariff 2	R
800-813	14	Energy, tariff 3	R
900-913	14	Energy, tariff 4	R
1000-1013	14	Energy, tariff 5	R
1100-1113	14	Energy, tariff 6	R
1200-1213	14	Energy, tariff 7	R
1300-1313	14	Energy, tariff 8	R
1400-1411	12	Energy, tariff 1, on cutoff date	R
1500-1511	12	Energy, tariff 2, on cutoff date	R
1600-1611	12	Energy, tariff 3, on cutoff date	R
1700-1711	12	Energy, tariff 4, on cutoff date	R
1800-1811	12	Energy, tariff 5, on cutoff date	R
1900-1911	12	Energy, tariff 6, on cutoff date	R
2000-2011	12	Energy, tariff 7, on cutoff date	R
2100-2111	12	Energy, tariff 8, on cutoff date	R
2200-2211	12	Resettable energy, tariff 1	R
2300-2311	12	Resettable energy, tariff 2	R
2400-2411	12	Resettable energy, tariff 3	R
2500-2511	12	Resettable energy, tariff 4	R
2600-2611	12	Resettable energy, tariff 5	R
2700-2711	12	Resettable energy, tariff 6	R
2800-2811	12	Resettable energy, tariff 7	R
2900-2911	12	Resettable energy, tariff 8	R
3000-3035	36	Features	R
3100-3115	16	Operating logbook, last entry	R
3200-3215	16	Operating logbook, previous entry	R
3300-3315	16	Operating logbook, next entry	R
3400-3431	32	Load profile, last entry	R
3500-3531	32	Load profile, previous entry	R
3600-3631	32	Load profile, next entry	R
3700-3701	2	Version	R
10000	1	CT	R/W
10100	1	VT	R/W
10400	1	Load profile integrating period	R/W
10500	1	Tariff	R/W
10600-10603	4	Device clock	R/W
10700-10703	4	Date and time of next reset	R/W
10800-10803	4	Date and time of next cutoff date	R/W

Access: R = **r**ead, W = **w**rite

Note: All registers within the address range of 3000 to 10800 can only be read and written block by block with fixed length.

This is a device-specific limitation for the assurance of the data consistency of the parameters and the data within this address range. All other registers can also be read proportionately in accordance with the Modbus specification.

3.2 Variable Types

Standard Variable Types	
	UINT8 8-bit integer, no leading sign SINT8 8-bit integer, with leading sign UINT16 16-bit integer, no leading sign SINT16 16-bit integer, with leading sign UINT32 32-bit integer, no leading sign SINT32 32-bit integer, with leading sign

3.3 Format Types

3.3.1 Format Type 1 (voltage, current, power)

This format consists of two components:

- Mantissa (SINT16)
- Exponent (SINT8), the exponent is saved to the exponent register's low byte.

Exponent register:

High byte = 0	Low byte = exponent

*Variable value = mantissa * 10 ^ exponent*

U/M of the variables:	Voltage	V
	Current	A
	Power	W or VA or VAr depending on the type of power

Example: A voltage exponent of -1 and a voltage value of 2309 is read as:

Mantissa register:	09h	05h
Exponent register:	0	FFh

2309 * 10 ^ (-1) = 230.9 V

Comment: If the mantissa has a value of 8000h, this means that the variable is undefined.

3.3.2 Format Type 2 (energy)

Calibratable energy values are saved as UINT32 values.

Mantissa:

UINT32

The primary energy value is always transmitted.

Primary energy factor:	UINT32	
Exponent:	High byte = 0	Low byte = exponent

Includes primary energy in watt hours for all meter types (regardless of energy type):

*Primary energy [Wh/varh] = mantissa * primary energy factor*

or

*Primary energy [Wh/varh] = mantissa * (10 ^ exponent)*

Example: calculation of primary active energy (import and export) of the active tariff

Active energy import [Wh] = mantissa (address 400, UINT32) * factor (address 408, UINT32)
Active energy export [Wh] = mantissa (address 402, UINT32) * factor (address 408, UINT32)

3.3.3 Format Type 3 (frequency)

Is used for frequency and is defined as follows:

Mantissa (UINT16)

Variable value = mantissa * 0.01 [Hz]

Example: a frequency mantissa of 5002 is read as
Frequency register:

13h	**8Ah**

5002*0.01=50.02 Hz

3.3.4 Format Type 4 (power factor)

Is used for power factor and is defined as follows:

Mantissa (SINT16)

Variable value = mantissa / 1000

Example: a power-factor mantissa of 985 is read as

Power factor register:

03h	**D9h**

985/1000=0.985

3.3.5 Format Type 5 (THD)

Is used for THD and is defined as follows:

Mantissa (UINT16)

Variable value = mantissa / 1000

3.3.6 Format Type 6 (error status flags 1)

This register contains the following error bits:

MSB **LSB**

NoCal		I3Hi	I2Hi	I1Hi	U3Hi	U2Hi	U1Hi		DCerr	I3Lo	I2Lo	I1Lo	U3Lo	U2Lo	U1Lo

Error Bit	Description
U1Lo	U1 < 75% Un
U2Lo	U2 < 75% Un
U3Lo	U3 < 75% Un
I1Lo	I1 < start-up
I2Lo	I2 < start-up
I3Lo	I3 < start-up
DC err	DC offset too high
	Unused
U1Hi	U1 > 120% Un
U2Hi	U2 > 120% Un
U3Hi	U3 > 120% Un
I1Hi	Maximum value for I1 exceeded
I2Hi	Maximum value for I2 exceeded
I3Hi	Maximum value for I3 exceeded
	Unused
NoCal	Device not calibrated

3.3.7 Format Type 7 (error status flags 2)

This register contains the following error bits:

MSB **LSB**

									NRUM	FRUM		FSYNC	FHi	FLo	FNo

Error Bit	Description
FNo	No frequency synchronization
FLo	Frequency < 40 Hz
FHi	Frequency > 70 Hz
FSYNC	Cumulative frequency error
	Unused
FRUM	Incorrect direction of rotation
NRUM	No direction of rotation detected
	Unused
	Unused
	Unused
	Unused
	Unused
	Unused
	Unused
	Unused
	Unused

3.3.8 Format Type 8 (RTC structure)

Structure of the Modbus frame (date and time):

Seconds	Minutes	Hours	Day	Month	Year low	Year high	0

Data bytes

Variable	Format
Seconds	UINT8
Minutes	UINT8
Hours	UINT8
Day	UINT8
Month	UINT8
Year	UINT16

Example for requesting date and time:

Request:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 06	01	03	29 68 00 04

Response:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 0B	01	03	08 **02 06 0C 0B 07 E0 07 00**

This corresponds to 12:06:02 p.m. on 11 July 2016.

In the following, the clock will be set to 12:15:00 p.m. on 11 July 2016:

Command:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 0F	01	10	29 68 00 04 08 **00 0F 0C 0B 07 E0 07 00**

Response:

MBAP				**PDU**	
Transaction identifier	**Protocol identifier**	**Length**	**Unit identifier**	**Function code**	**Data**
00 02	00 00	00 06	01	10	29 68 00 04

3.3.9 Format Type 9 (interface hardware and firmware versions)

Format for hardware (HW) and firmware (FW) versions of the Modbus interface:

HW-MSB	HW-LSB	FW-MSB	FW-LSB

Variable	Format
HW-MSB	UINT8
HW-LSB	UINT8
FW-MSB	UINT8
FW-LSB	UINT8

Example: HW version = 13, FW version = 45

Variable	Value
HW-MSB	1
HW-LSB	3
FW-MSB	4
FW-LSB	5

3.3.10 Format Type 10 (operating logbook entry)

The structure consists of 32 bytes.

Logger Structure Definition

Byte Index	Variable	Format
0	Index entry	UINT16
2	Event code	UINT8
3	Parameter (1)	UINT8
4	Parameter (2)	UINT8
5	Parameter (3)	UINT8
6	Parameter (4)	UINT8
7	Parameter (5)	UINT8
8	Parameter (6)	UINT8
9	Parameter (7)	UINT8
10	Operating hours	UINT32
14	Event time stamp	Format type 8
22 … 31	Reserve	------

Event codes:

Event Code Beginning	Event Code End	Description	Parameter
00h		Status OK	
01h	81h	Current overload	Phase number (par 1)
02h	82h	Phase voltage too high	Phase number (par 1)
03h	83h	No frequency synchronization	
04h	84h	Frequency too low	
05h	85h	Frequency too high	
06h	86h	Incorrect phase sequence	
07h	87h	Unknown phase sequence	
08h	88h	Meter not calibrated	
09h	89h	Phase voltage too low	Phase number (par 1)
0Ah	8Ah	Analog error: DC offset too large	
0Bh	8Bh	Energy error: faulty energy status	
0Ch	8Ch	Internal communication error	
40h		Date/time changed	New time saved (format type 8 in parameters 1 ... 7)
48h		CT changed	New CT value saved (par 1)
49h		VT changed	New VT value saved (par 1)
60h		Reset has occurred, date and time have **not** been saved.	
61h		Supply power to meter was interrupted.	
68h		The energy value has been reconstructed from cyclical backups.	

3.3.11 Format Type 11 (load profile entry)

The structure consists of 64 bytes.

Byte Index	Variable	Format
0	Index entry	UINT16
2	Active tariff	UINT8
3	Exponent for energy	SINT8
4	Active energy import from all phases (mantissa)	UINT32
8	Active energy export to all phases (mantissa)	UINT32
12	Reactive energy import from all phases (mantissa)	UINT32
16	Reactive energy export to all phases (mantissa)	UINT32
20	Two additional decimal places for active energy import (mantissa 2)	UINT8
21	Two additional decimal places for active energy export (mantissa 2)	UINT8
22	Two additional decimal places for reactive energy import (mantissa 2)	UINT8
23	Two additional decimal places for reactive energy export (mantissa 2)	UINT8
24	Load profile status 1	Format 11a
26	Load profile status 2	Format 11b
28	Time stamp	Format 8
36	Load profile interval (1, 2, 3, 4, 5, 10, 15, 30, 60 min.)	UINT8
37 … 63	Reserve	1 byte

Note: All energy values are calculated as follows:

Display accuracy:

Energy = mantissa * 10 ^ exponent register [Wh] or [VArh]

Increased accuracy:

Energy = mantissa * 10 ^ exponent register + mantissa 2 * 10 ^ (exponent_for_energy-2) [Wh] or [VArh]

Calibratable energy is always saved to memory: the CT and VT values must be subsequently multiplied in the case of feature Q1 (adjustable CT and VT values, calibratable secondary energy).

Example:

Mantissa 1 of 4561 and mantissa 2 of 24 and exponent +3 is read as:

Mantissa 1 register:	00h	00h	11h	D5h
Mantissa 2 register:	00h	18h		
Exponent register:	03h			

4561 * 10 ^ (3) + 24 * 10 ^ (1) = 4,561,240 Wh

3.3.12 Format Type 11a (load profile status 1)

This bit field identifies which events occurred during the integrating period:

MSB **LSB**

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit	Description
0	Current 1 has exceeded the maximum value
1	Current 2 has exceeded the maximum value
2	Current 3 has exceeded the maximum value
3	Maximum value for U1 exceeded
4	Maximum value for U2 exceeded
5	Maximum value for U3 exceeded
6	No frequency synchronization possible
7	Frequency too low
8	Frequency too high
9	Incorrect phase sequence
10	Phase sequence unknown
11	Device is not calibrated
12	Analog error: DC offset too large
13	Energy error: faulty energy status
14	Internal communication error
15	The energy value has been reconstructed from cyclical backups.

Load profile status 1: bits 0 ... 15 come from the operating logbook for events which have occurred during the load profile interval.

3.3.13 Format Type 11b (load profile status 2)

This bit field identifies which events occurred during the integrating period:

MSB **LSB**

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Status bit	*Description*
0	Shortened integrating period (not started/ended synchronous to clock time)
1	Started after a reset
2	End of the period due to tariff change
3	End of the period due to clock time change
4	-
5	-
6	-
7	-
8	-
9	-
10	-
11	-
12	-
13	-
14	-
15	-

If the load profile logger entry is incomplete (after reset, tariff change or time change), this is indicated by the “incomplete load profile interval” status bit.

If a reset has occurred, for example in the case of a restart after a power failure, this is indicated in the first load profile entry by means of the “reset occurred” status bit (and incomplete load profile logger interval). If the tariff is changed, the current load profile logger value (asynchronous entry) at the point in time of the tariff change is saved with the information “tariff change”. A new load profile interval is then started with the new tariff. As a result, no energy values can be lost (the entry after the tariff change and the next entry are flagged with the “incomplete load profile interval” status bit).

If time is changed, the current load profile logger value (asynchronous entry) is saved with the “time changed – asynchronous load profile entry” status bit with the previous time stamp, after which a new load profile logger period is started with the new time. As a result, no energy values can be lost (the entry after the tariff change and the next entry are flagged with the “incomplete load profile interval” status bit).

3.3.14 Format Type 12 (device information)

The structure consists of 72 bytes.

Byte Index	Variable	Format
0 … 10	Features	UINT8[11]
11 … 18	Serial number (of the main device)	UINT8 [8]
19	Calibration date	UINT8
20	Calibration month	UINT8
21	Calibration year	UINT16
23 … 24	Reserve	
25	Firmware version	UINT16
27 … 31	Reserve	
32 … 63	Product information	UINT8[32]
64 … 70	M-Bus reserve	UINT8[7]
71	Unused	

Features:

Byte Index	Feature	Explanation
0	D	0: Gossen-Metrawatt
1	Res	Reserve
2	Res	Reserve
3	H	Auxiliary voltage, not for meters with 4 standard width units (0 = none)
4	P	Calibration 0: with MID 9: with MID + calibration certificate
5	Q	CT / VT 0: 1 1: adjustable 9: CT / VT fixed in the purchase order
6	U	Operating voltage 3: 100 V / 110 V 5: 2-wire 230 V 6: 400 V 7: 500 V
7	V	Pulse output 0: none 1: 1000 pulses/kWh, 24 V, pulse width: 30 ms, interpulse period: > 30 ms 2: S0, programmable, 24 V, pulse width: 30 ms, interpulse period: > 30 ms 3: 1000 pulses/kWh, 230 V, pulse width: 30 ms, interpulse period: > 30 ms 4: S0, programmable, 230 V, pulse width: 30 ms, interpulse period: > 30 ms 7: 100 pulses/kWh, 24 V, pulse width: 130 ms, interpulse period: > 130 ms 8: 1000 pulses/kWh, 24 V, pulse width: 130 ms, interpulse period: > 130 ms 9: Customer-specific order, 24 V
8	W	Bus interface 0: none 1: LON 2: MBus 4: TCP/IP 7: Modbus RTU
9	Z	Load profile 0: no load profile 1: with load profile
10	S	Special variant (always 0)

Serial number:

0^{th} byte	**1^{st} byte**	**2^{nd} byte**	**3^{rd} byte**		**4^{th} byte**		**5^{th} byte**		**6^{th} byte**		**7^{th} byte**	
CHAR	CHAR	BCD	BCD	BCD	BCD	BCD	BCD	BCD	BCD	BCD	BCD	Reserve
“Z”	“B”	1	2	3	4	5	0	0	0	0	1	

The serial number consists of two letters and 10 digits (BCD format).

In the above example: ZB1234500001

Firmware version:

0^{th} byte		**1^{st} byte**	
0	BCD	BCD	BCD
0	2	5	6

The firmware version consists of 3 digits (BCD format).

In the above example: FW version 2.56

Product information:

Text-based information with 32 characters – defined by the manufacturer.

4 Variables in the Address Space

All register addresses in this document are zero-based, and are thus transmitted directly via the interface as they're listed in the tables. No conversion is required.

4.1 Address Space with Flexible Addressing (Modbus standard)

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
0	Voltage at the primary side between phases L1 and L2	1	1	4	Mantissa, exponent at address 12	
1	Voltage at the primary side between phases L2 and L3	1	1	4	Mantissa, exponent at address 12	
2	Voltage at the primary side between phases L3 and L1	1	1	4	Mantissa, exponent at address 12	
3	Mean value of voltage between phases at the primary side	1	1	4	Mantissa, exponent at address 12	
4	Primary phase voltage L1 to N	1	1	4	Mantissa, exponent at address 12	
5	Primary phase voltage L2 to N	1	1	4	Mantissa, exponent at address 12	
6	Primary phase voltage L3 to N	1	1	4	Mantissa, exponent at address 12	
7	Mean value of phase voltages at the primary side	1	1	4	Mantissa, exponent at address 12	
8	Primary phase voltage THD, L1 to N	1	5	4		
9	Primary phase voltage THD, L2 to N	1	5	4		
10	Primary phase voltage THD, L3 to N	1	5	4		
11	Frequency	1	3	4		
12	Voltage exponent	1	SINT8	4	Exponent in the low byte	
13	Error status flags 1	1	6	4		
14	Error status flags 2	1	7	4		
100	L1 phase current at the primary side	1	1	4	Mantissa, exponent at address 108	
101	L2 phase current at the primary side	1	1	4	Mantissa, exponent at address 108	
102	L3 phase current at the primary side	1	1	4	Mantissa, exponent at address 108	
103	Mean value of phase currents at the primary side	1	1	4	Mantissa, exponent at address 108	
104	Current in the N conductor at the primary side	1	1	4	Mantissa, exponent at address 108	
105	Phase L1 current THD	1	5	4		
106	Phase L2 current THD	1	5	4		
107	Phase L3 current THD	1	5	4		
108	Current exponent	1	SINT8	4	Exponent in the low byte	
109	Error status flags 1	1	6	4		
110	Error status flags 2	1	7	4		
200	Active power P1 at the primary side	1	1	4	Mantissa, exponent at address 212	

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
201	Active power P2 at the primary side	1	1	4	Mantissa, exponent at address 212	
202	Active power P3 at the primary side	1	1	4	Mantissa, exponent at address 212	
203	Active power Ptot at the primary side	1	1	4	Mantissa, exponent at address 212	
204	Reactive power Q1 at the primary side	1	1	4	Mantissa, exponent at address 212	
205	Reactive power Q2 at the primary side	1	1	4	Mantissa, exponent at address 212	
206	Reactive power Q3 at the primary side	1	1	4	Mantissa, exponent at address 212	
207	Reactive power Qtot at the primary side	1	1	4	Mantissa, exponent at address 212	
208	Phase 1 power factor	1	4	4		
209	Phase 2 power factor	1	4	4		
210	Phase 3 power factor	1	4	4		
211	Total power factor	1	4	4		
212	Power exponent at the primary side	1	SINT8	4	Exponent in the low byte	
213	Secondary active power, all phases	1	1	4	Mantissa, exponent at address 214	
214	Secondary power exponent	1	SINT8	4	Exponent in the low byte	
215	Error status flags 1	1	6	4		
216	Error status flags 2	1	7	4		
300	Active energy import, total (all tariffs)	2	2	4	Mantissa (see format type 2)	1.8.0
302	Active energy export, total (all tariffs)	2	2	4	Mantissa (see format type 2)	2.8.0
304	Reactive energy import, total (all tariffs)	2	2	4	Mantissa (see format type 2)	3.8.0
306	Reactive energy export, total (all tariffs)	2	2	4	Mantissa (see format type 2)	4.8.0
308	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
310	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
311	Energy type	1	UINT16	4	Energy values type, 0 = secondary, 1 = primary	
312	Error status flags 1	1	6	4		
313	Error status flags 2	1	7	4		
400	Active energy import of the active tariff	2	2	4	Mantissa (see format type 2)	
402	Active energy export of the active tariff	2	2	4	Mantissa (see format type 2)	
404	Reactive energy import of the active tariff	2	2	4	Mantissa (see format type 2)	
406	Reactive energy export of the active tariff	2	2	4	Mantissa (see format type 2)	
408	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
410	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
411	Energy type	1	UINT16	4	Energy values type, 0 = secondary, 1 = primary	
412	Active tariff	1	UINT16	4	Active tariff (1 ... 8)	
413	Error status flags 1	1	6	4		

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
414	Error status flags 2	1	7	4		
500	Operating hours	2	UINT32	4		
502	Operating hours since last reset	1	UINT16	4		
503	Point in time of last cutoff date	4	8	4		
507	Point in time of last reset	4	8	4		
600	Tariff 1, active energy import	2	2	4	Mantissa (see format type 2)	1.8.1
602	Tariff 1, active energy export	2	2	4	Mantissa (see format type 2)	2.8.1
604	Tariff 1, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.1
606	Tariff 1, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.1
608	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
610	Energy exponent	1	SINT8	4	Exponent in the low byte	
611	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
612	Error status flags 1	1	6	4		
613	Error status flags 2	1	7	4		
700	Tariff 2, active energy import	2	2	4	Mantissa (see format type 2)	1.8.2
702	Tariff 2, active energy export	2	2	4	Mantissa (see format type 2)	2.8.2
704	Tariff 2, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.2
706	Tariff 2, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.2
708	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
710	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
711	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
712	Error status flags 1	1	6	4		
713	Error status flags 2	1	7	4		
800	Tariff 3, active energy import	2	2	4	Mantissa (see format type 2)	1.8.3
802	Tariff 3, active energy export	2	2	4	Mantissa (see format type 2)	2.8.3
804	Tariff 3, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.3
806	Tariff 3, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.3
808	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
810	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
811	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
812	Error status flags 1	1	6	4		
813	Error status flags 2	1	7	4		
900	Tariff 4, active energy import	2	2	4	Mantissa (see format type 2)	1.8.4
902	Tariff 4, active energy export	2	2	4	Mantissa (see format type 2)	2.8.4
904	Tariff 4, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.4
906	Tariff 4, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.4
908	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
910	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
911	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
912	Error status flags 1	1	6	4		
913	Error status flags 2	1	7	4		
1000	Tariff 5, active energy import	2	2	4	Mantissa (see format type 2)	1.8.5
1002	Tariff 5, active energy export	2	2	4	Mantissa (see format type 2)	2.8.5
1004	Tariff 5, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.5
1006	Tariff 5, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.5
1008	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1010	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1011	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1012	Error status flags 1	1	6	4		
1013	Error status flags 2	1	7	4		
1100	Tariff 6, active energy import	2	2	4	Mantissa (see format type 2)	1.8.6
1102	Tariff 6, active energy export	2	2	4	Mantissa (see format type 2)	2.8.6
1104	Tariff 6, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.6
1106	Tariff 6, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.6
1108	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1110	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1111	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1112	Error status flags 1	1	6	4		
1113	Error status flags 2	1	7	4		
1200	Tariff 7, active energy import	2	2	4	Mantissa (see format type 2)	1.8.7
1202	Tariff 7, active energy	2	2	4	Mantissa (see format	2.8.7

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
	export				type 2)	
1204	Tariff 7, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.7
1206	Tariff 7, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.7
1208	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1210	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1211	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1212	Error status flags 1	1	6	4		
1213	Error status flags 2	1	7	4		
1300	Tariff 8, active energy import	2	2	4	Mantissa (see format type 2)	1.8.8
1302	Tariff 8, active energy export	2	2	4	Mantissa (see format type 2)	2.8.8
1304	Tariff 8, reactive energy import	2	2	4	Mantissa (see format type 2)	3.8.8
1306	Tariff 8, reactive exergy export	2	2	4	Mantissa (see format type 2)	4.8.8
1308	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1310	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1311	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1312	Error status flags 1	1	6	4		
1313	Error status flags 2	1	7	4		
1400	Active energy import, tariff 1, on cutoff date	2	2	4	Mantissa (see format type 2)	
1402	Active energy export, tariff 1, on cutoff date	2	2	4	Mantissa (see format type 2)	
1404	Reactive energy import, tariff 1, on cutoff date	2	2	4	Mantissa (see format type 2)	
1406	Reactive energy export, tariff 1, on cutoff date	2	2	4	Mantissa (see format type 2)	
1408	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1410	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1411	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1500	Active energy import, tariff 2, on cutoff date	2	2	4	Mantissa (see format type 2)	
1502	Active energy export, tariff 2, on cutoff date	2	2	4	Mantissa (see format type 2)	
1504	Reactive energy import, tariff 2, on cutoff date	2	2	4	Mantissa (see format type 2)	
1506	Reactive energy export, tariff 2, on cutoff date	2	2	4	Mantissa (see format type 2)	
1508	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
1510	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1511	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1600	Active energy import, tariff 3, on cutoff date	2	2	4	Mantissa (see format type 2)	
1602	Active energy export, tariff 3, on cutoff date	2	2	4	Mantissa (see format type 2)	
1604	Reactive energy import, tariff 3, on cutoff date	2	2	4	Mantissa (see format type 2)	
1606	Reactive energy export, tariff 3, on cutoff date	2	2	4	Mantissa (see format type 2)	
1608	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1610	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1611	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1700	Active energy import, tariff 4, on cutoff date	2	2	4	Mantissa (see format type 2)	
1702	Active energy export, tariff 4, on cutoff date	2	2	4	Mantissa (see format type 2)	
1704	Reactive energy import, tariff 4, on cutoff date	2	2	4	Mantissa (see format type 2)	
1706	Reactive energy export, tariff 4, on cutoff date	2	2	4	Mantissa (see format type 2)	
1708	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1710	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1711	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1800	Active energy import, tariff 5, on cutoff date	2	2	4	Mantissa (see format type 2)	
1802	Active energy export, tariff 5, on cutoff date	2	2	4	Mantissa (see format type 2)	
1804	Reactive energy import, tariff 5, on cutoff date	2	2	4	Mantissa (see format type 2)	
1806	Reactive energy export, tariff 5, on cutoff date	2	2	4	Mantissa (see format type 2)	
1808	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1810	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1811	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
1900	Active energy import, tariff 6, on cutoff date	2	2	4	Mantissa (see format type 2)	
1902	Active energy export, tariff 6, on cutoff date	2	2	4	Mantissa (see format type 2)	
1904	Reactive energy import,	2	2	4	Mantissa (see format	

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
	tariff 6, on cutoff date				type 2)	
1906	Reactive energy export, tariff 6, on cutoff date	2	2	4	Mantissa (see format type 2)	
1908	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
1910	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
1911	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2000	Active energy import, tariff 7, on cutoff date	2	2	4	Mantissa (see format type 2)	
2002	Active energy export, tariff 7, on cutoff date	2	2	4	Mantissa (see format type 2)	
2004	Reactive energy import, tariff 7, on cutoff date	2	2	4	Mantissa (see format type 2)	
2006	Reactive energy export, tariff 7, on cutoff date	2	2	4	Mantissa (see format type 2)	
2008	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2010	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2011	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2100	Active energy import, tariff 8, on cutoff date	2	2	4	Mantissa (see format type 2)	
2102	Active energy export, tariff 8, on cutoff date	2	2	4	Mantissa (see format type 2)	
2104	Reactive energy import, tariff 8, on cutoff date	2	2	4	Mantissa (see format type 2)	
2106	Reactive energy export, tariff 8, on cutoff date	2	2	4	Mantissa (see format type 2)	
2108	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2110	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2111	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2200	Resettable active energy import, tariff 1	2	2	4	Mantissa (see format type 2)	
2202	Resettable active energy export, tariff 1	2	2	4	Mantissa (see format type 2)	
2204	Resettable reactive energy import, tariff 1	2	2	4	Mantissa (see format type 2)	
2206	Resettable reactive energy export, tariff 1	2	2	4	Mantissa (see format type 2)	
2208	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2210	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2211	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
2300	Resettable active energy import, tariff 2	2	2	4	Mantissa (see format type 2)	
2302	Resettable active energy export, tariff 2	2	2	4	Mantissa (see format type 2)	
2304	Resettable reactive energy import, tariff 2	2	2	4	Mantissa (see format type 2)	
2306	Resettable reactive energy export, tariff 2	2	2	4	Mantissa (see format type 2)	
2308	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2310	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2311	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2400	Resettable active energy import, tariff 3	2	2	4	Mantissa (see format type 2)	
2402	Resettable active energy export, tariff 3	2	2	4	Mantissa (see format type 2)	
2404	Resettable reactive energy import, tariff 3	2	2	4	Mantissa (see format type 2)	
2406	Resettable reactive energy export, tariff 3	2	2	4	Mantissa (see format type 2)	
2408	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2410	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2411	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2500	Resettable active energy import, tariff 4	2	2	4	Mantissa (see format type 2)	
2502	Resettable active energy export, tariff 4	2	2	4	Mantissa (see format type 2)	
2504	Resettable reactive energy import, tariff 4	2	2	4	Mantissa (see format type 2)	
2506	Resettable reactive energy export, tariff 4	2	2	4	Mantissa (see format type 2)	
2508	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2510	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2511	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2600	Resettable active energy import, tariff 5	2	2	4	Mantissa (see format type 2)	
2602	Resettable active energy export, tariff 5	2	2	4	Mantissa (see format type 2)	
2604	Resettable reactive energy import, tariff 5	2	2	4	Mantissa (see format type 2)	
2606	Resettable reactive energy export, tariff 5	2	2	4	Mantissa (see format type 2)	
2608	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	

Register Address	Name	Length (words)	Format Type	FC	Description	OBIS
2610	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2611	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2700	Resettable active energy import, tariff 6	2	2	4	Mantissa (see format type 2)	
2702	Resettable active energy export, tariff 6	2	2	4	Mantissa (see format type 2)	
2704	Resettable reactive energy import, tariff 6	2	2	4	Mantissa (see format type 2)	
2706	Resettable reactive energy export, tariff 6	2	2	4	Mantissa (see format type 2)	
2708	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2710	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2711	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2800	Resettable active energy import, tariff 7	2	2	4	Mantissa (see format type 2)	
2802	Resettable active energy export, tariff 7	2	2	4	Mantissa (see format type 2)	
2804	Resettable reactive energy import, tariff 7	2	2	4	Mantissa (see format type 2)	
2806	Resettable reactive energy export, tariff 7	2	2	4	Mantissa (see format type 2)	
2808	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2810	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2811	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	
2900	Resettable active energy import, tariff 8	2	2	4	Mantissa (see format type 2)	
2902	Resettable active energy export, tariff 8	2	2	4	Mantissa (see format type 2)	
2904	Resettable reactive energy import, tariff 8	2	2	4	Mantissa (see format type 2)	
2906	Resettable reactive energy export, tariff 8	2	2	4	Mantissa (see format type 2)	
2908	Primary energy factor	2	UINT32	4	Primary energy [Wh/varh] = mantissa * factor	
2910	Energy exponent	1	SINT8	4	Secondary or primary depending on energy type	
2911	Energy type	1	5	4	Energy values type, 0 = secondary, 1 = primary	

4.2 Address Space with Fixed Block Size

Register Address	Name	Fixed Length (words)	Format Type	FC	Description
3000	Features	36	12	4	Device options and information
3100	Operating logbook, last entry	16	10	4	
3200	Operating logbook, previous entry	16	10	4	
3300	Operating logbook, next entry	16	10	4	
3400	Load profile, last entry	32	11	4	
3500	Load profile, previous entry	32	11	4	
3600	Load profile, next entry	32	11	4	
3700	HW and FW versions	2	9	4	Interface HW and FW versions
10000	Current transformer ratio (CT)	1	UINT16	16 / 3	Limit values exist for VT x CT
10100	Voltage transformer ratio (VT)	1	UINT16	16 / 3	Limit values exist for VT x CT
10400	Load profile integrating period	1	UINT16	16 / 3	Selectable settings: 1, 2, 3, 4, 5, 10, 15, 30, 60 (minutes)
10500	Tariff selection	1	UINT16	16 / 3	Tariff selection: 1 … 8 or 0 0 means that hardware tariff selection is active. **Observe section 6.2.**
10600	Device clock time at the meter	4	8	16 / 3	
10700	Date and time for resetting	4	8	16 / 3	
10800	Date and time of the cutoff date	4	8	16 / 3	

5 BACnet IP

5.1 General

BACnet (**b**uilding **a**utomation and **c**ontrol **n**etworks) is a network protocol for building automation.

Insofar as the specified standards (defined BIBBs) are adhered to within the BACnet, compatibility can be assured for communication amongst devices from various manufacturers.

Which services and procedures have to be supported at the server and client sides in order to fulfill a given system requirement is defined in the so-called BIBB (BACnet interoperability building block).

Energy meters included in the EM228x and EM238x series support the BACnet Smart Sensor (B-SS) device type with the following BIBBs: DS-RP-B, DM-DDB-B and DM-DOB-B. The following BIBBs are also supported: DS-WP-B, DS-RPM-B and DM-TS-B.

- Vendor name: GMC-I Messtechnik GmbH
- Vendor ID: 881
- Product name: ENERGYMID Energy Meter
- Product model number: EM2281, EM2289, EM2381, EM2387, EM2389

Key for table below

R/W R = read only, R/W = read or write
NV Value is stored in non-volatile memory.
The value will be still available if the meter experiences a power loss.
Units Lists the units of measure included in a register.

5.2 Device Object

Property	R / W	NV	Value returned	Additional information
Object_Identifier	R/W	NV	Gerät <n>	n is the BACnet device ID. It corresponds to a decimal number within a range of 1 to 4,193,999. This can be changed via the interface or the web server. The default value upon shipment from the factory is the number 881,000 + the 16-bit part of the MAC address, in order to reduce the possibility of conflicts when several devices are installed.
Object_Type	R	NV	8 : Object Device	
Object_Name	R/W	NV	<Object_Name>	The object name can be changed and is limited to 64 characters. The default value is “GMC-I Energy Meter – <BACnet Device ID>”.
System_Status	R	NV	0 : Operational	
Vendor_Name	R	NV	GMC-I Messtechnik GmbH	
Vendor_Identifier	R	NV	881	
Model_Name	R	NV	EM2389 Energy Meter W4 U6 Q1 M3 Z1	EM2281, EM2289, EM2381, EM2387, EM2389
Serial_Number	R	NV	U5555555555	
Firmware_Revision	R	NV	<Current interface firmware version>	“x.yy” is the firmware version of the TCP/BACnet interface card.
Application_Software_Version	R	NV	<Current main firmware version>	“x.yy” is the firmware version of the meter’s PCB.
Location	R/W	NV	<Location>	The location description field is limited to 64 characters. The default value is “location not defined”.
Description	R/W	NV	<Description>	The description field is limited to 64 characters. The default value is “GMC-I Energy Meter”.
Protocol_Version	R	NV	1	
Protocol_Revision	R	NV	12	
Protocol_Services_Supported	R	NV	I Am, Who Is, I Have, Who Has, Read Property, Read Property Multiple, Write Property, Time Synchronization	
Protocol_Object_Types_Supported	R	NV	Device, Analog Input	
Object_List	R	NV	Device, AI0, AI1, AI2, AI3, AI4, ... AI78	
Max_APDU_Length_Supported	R	NV	1476	
Segmentation_Supported	R	NV	3 : None	
Local_Date	R			Is set via BACnet time synchronization
Local_Time	R			Is set via BACnet time synchronization
APDU_Timeout	R	NV	3000	
Number_Of_APDU_Retries	R	NV	3	
Device_Address_Binding	R	NV	None	
Database_Revision	R	NV	0	Is increased by 1 each time the device configuration is changed.

5.3 Analog Input Objects

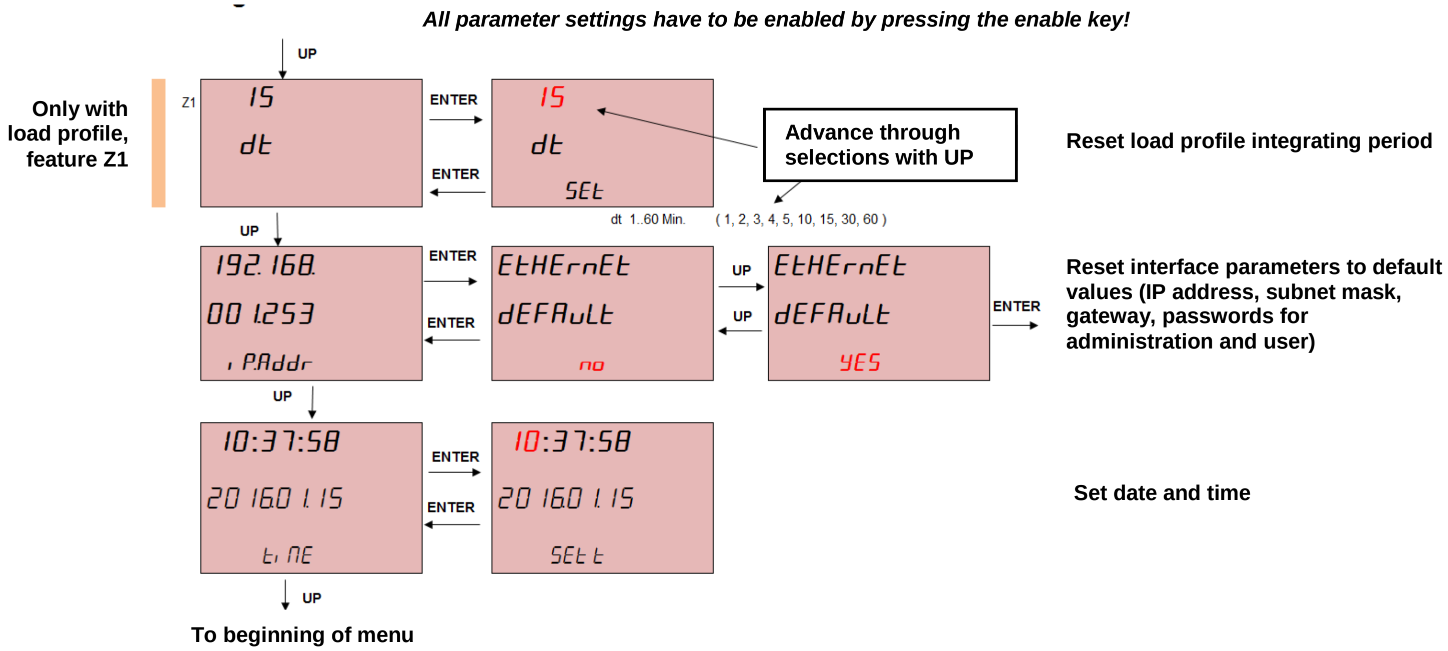
Property	R / W	NV	Value returned	Additional information
Object_Identifier	R	NV	Analog_Input <AI>	AI is the index of the analog input object (0, 1, 2 ...)
Object_Type	R	NV	0 : Object Analog Input	
Object_Name	R	NV	Name of the register	Example: "U1N"
Present_Value	R		Value of the register	Example: "230.0"
Units	R		U/M of the register	Example: "Volts"
Description	R	NV	Description of the register	Example: "primary phase voltage L1 to N"
Status_Flags	R		In_Alarm, Fault, Overridden, Out_Of_Service	
Out_Of_Service	R		False, True	False = Present_Value is valid True = Present_Value is invalid
Event_State	R	NV	Normal	

Object	Object_Name	Description	Units	Additional information
		Voltmeter		
AI0	U12	Voltage at the primary side between phases L1 and L2	V	
AI1	U23	Voltage at the primary side between phases L2 and L3	V	
AI2	U31	Voltage at the primary side between phases L3 and L1	V	
AI3	Uavg	Mean value of voltage between phases at the primary side	V	
AI4	U1N	Primary phase voltage L1 to N	V	
AI5	U2N	Primary phase voltage L1 to N	V	
AI6	U3N	Primary phase voltage L1 to N	V	
AI7	UavgN	Mean value of phase voltages at the primary side	V	
AI8	ThdU1	Primary phase voltage THD, L1 to N	%	
AI9	ThdU2	Primary phase voltage THD, L1 to N	%	
AI10	ThdU3	Primary phase voltage THD, L1 to N	%	
AI11	Freq	Frequency	Hz	
		Ammeter		
AI12	I1	L1 phase current at the primary side	A	
AI13	I2	L2 phase current at the primary side	A	
AI14	I3	L3 phase current at the primary side	A	
AI15	IAvg	Mean value of phase currents at the primary side	A	
AI16	IN	N conductor current at the primary side (calculated)	A	
AI17	ThdI1	Phase L1 current THD	%	
AI18	ThdI2	Phase L2 current THD	%	
AI19	ThdI3	Phase L3 current THD	%	
		Power Meter		
AI20	Wat1	Active power P1 at the primary side	W	
AI21	Wat2	Active power P2 at the primary side	W	
AI22	Wat3	Active power P3 at the primary side	W	
AI23	WatTot	Active power Ptot at the primary side	W	
AI24	VAr1	Reactive power Q1 at the primary side	VAr	
AI25	VAr2	Reactive power Q2 at the primary side	VAr	
AI26	VAr3	Reactive power Q3 at the primary side	VAr	
AI27	VArTot	Reactive power Qtot at the primary side	VAr	
AI28	PwrFact1	Phase L1 power factor	Power	

			Factor	
AI29	PwrFact2	Phase L2 power factor	Power Factor	
AI30	PwrFact3	Phase L3 power factor	Power Factor	
AI31	PwrFactTot	Total power factor	Power Factor	
		Energy Meter		
AI32	WhPosTot	Active energy import, total (all tariffs)	Wh	
AI33	WhNegTot	Active energy export, total (all tariffs)	Wh	
AI34	VArhPosTot	Reactive energy import, total (all tariffs)	VArh	
AI35	VArhNegTot	Reactive energy export, total (all tariffs)	VArh	
AI36	WhPosActTariff	Active energy import of the active tariff	Wh	
AI37	WhNegActTariff	Active energy export of the active tariff	Wh	
AI38	VArhPosActTariff	Reactive energy import of the active tariff	VArh	
AI39	VArhNegActTariff	Reactive energy export of the active tariff	VArh	
AI40	ActiveTariff	Active tariff		
AI41	EnergyFlowHours	Operating hours	Hours	
AI42	PowerUpHours	Operating hours since last reset	Hours	
AI43	WhPosT1	Tariff 1, active energy import	Wh	
AI44	WhNegT1	Tariff 1, active energy export	Wh	
AI45	VArhPosT1	Tariff 1, reactive energy import	VArh	
AI46	VArhNegT1	Tariff 1, reactive energy export	VArh	
AI47	WhPosT2	Tariff 2, active energy import	Wh	
AI48	WhNegT2	Tariff 2, active energy export	Wh	
AI49	VArhPosT2	Tariff 2, reactive energy import	VArh	
AI50	VArhNegT2	Tariff 2, reactive energy export	VArh	
AI51	WhPosT3	Tariff 3, active energy import	Wh	
AI52	WhNegT3	Tariff 3, active energy export	Wh	
AI53	VArhPosT3	Tariff 3, reactive energy import	VArh	
AI54	VArhNegT3	Tariff 3, reactive energy export	VArh	
AI55	WhPosT4	Tariff 4, active energy import	Wh	
AI56	WhNegT4	Tariff 4, active energy export	Wh	
AI57	VArhPosT4	Tariff 4, reactive energy import	VArh	
AI58	VArhNegT4	Tariff 4, reactive energy export	VArh	
AI59	WhPosT5	Tariff 5, active energy import	Wh	
AI60	WhNegT5	Tariff 5, active energy export	Wh	
AI61	VArhPosT5	Tariff 5, reactive energy import	VArh	
AI62	VArhNegT5	Tariff 5, reactive energy export	VArh	
AI63	WhPosT6	Tariff 6, active energy import	Wh	
AI64	WhNegT6	Tariff 6, active energy export	Wh	
AI65	VArhPosT6	Tariff 6, reactive energy import	VArh	
AI66	VArhNegT6	Tariff 6, reactive energy export	VArh	
AI67	WhPosT7	Tariff 7, active energy import	Wh	
AI68	WhNegT7	Tariff 7, active energy export	Wh	
AI69	VArhPosT7	Tariff 7, reactive energy import	VArh	
AI70	VArhNegT7	Tariff 7, reactive energy export	VArh	
AI71	WhPosT8	Tariff 8, active energy import	Wh	
AI72	WhNegT8	Tariff 8, active energy export	Wh	
AI73	VArhPosT8	Tariff 8, reactive energy import	VArh	
AI74	VArhNegT8	Tariff 8, reactive energy export	VArh	
AI75	CT	Current transformer ratio (CT)		
AI76	VT	Voltage transformer ratio (VT)		
AI77	Status1	Status 1 Flags		See section 3.3.6, “Format Type 6”
AI78	Status2	Status 2 Flags		See section 3.3.7, “Format Type 7”

6 Control and Display Functions

Parameter Settings Overview (excerpt from operating instructions 3-349-868-03, supplement including TCP/IP parameter settings)



7 Application Notes

7.1 Notes regarding Initial Start-Up

- Refer to section 2 regarding the possible necessity of changing the IP address.
- **In the case of type U2x89 U3 meters (4-wire meters with phase voltage of 57.7 / 63.5 V), neither the interface function, load profile logging (with Z1 only) nor device background illumination work during single phase operation. Other meter functions are not impaired.**
- If the tariff change will be triggered via the interface, this must take place once after pressing the enable key (see section 6.2 below).

7.2 Tariff Change via Interface

- The currently selected energy metering tariff can be viewed in register 414.
- The interface can specify a tariff by writing a value of 1 to 8 to register 10500, in which case the hardware tariff input is ignored.
- If a value of 0 (default value) is written to register 10500, the meter's tariff is specified via the tariff input.
- **However, in order to initially specify the tariff via the interface (value of 1 to 8 at address 10500) after previous hardware control (indicated by a value of 0 at register address 10500), the enable key on the device must first be pressed and the key must not appear at the device display. The setting is otherwise ignored by the device!**
- As long as a fixed tariff is selected in register 10500 (a value of 1 to 8), the tariff can always be changed via the interface.
- Entering a value of 0 to the register address makes it possible to switch back to hardware control.

7.3 Operating Logbook and Load Profile

The operating logbook and the load profile are read out sequentially from the latest to the oldest entry. The procedure is as follows:

- By reading **exactly** 16 words (operating logbook) or 32 words (load profile) from register address 3100 or 3400 respectively, the last (newest) entry is read in its entirety.
- Subsequently, the next oldest entry is always retrieved by reading **exactly** 16 or 32 words from address 3200 or 3500 respectively.
- Previously retrieved values can be read out once again by reading **exactly** 16 or 32 words from address 3300 or 3600 respectively, for example in the case of transmission problems etc.

Contents of the operating logbook:

- Events are logged with time stamp.
- Events are logged once again when they disappear, and their disappearance is indicated.
- Parameters: Relevant parameters are also logged depending on the event.

Load profile function:

- At the end of each integrating period, all 4 energy values for the current tariff are saved to memory with enhanced accuracy along with time stamp and status.
- The integrating period is always ended synchronous to clock time, unless an event starts a new period (e.g. tariff change, time change).
- The status represents a cumulative view of events which have occurred during the integrating period.
- Incomplete integrating periods are identified.
- In the case of a tariff change or a time change, the integrating period is interrupted, the value is stored along with the old tariff or time and a new period is started.

7.4 Cutoff Date Meter

The date and time at which the meter readings will be “frozen” can be preselected by writing a entry to register address10800, i.e. the current energy value status is copied to a special data range and can be read out later (cutoff date energy values).
The point in time at which cutoff date energy values were recorded can be found at addresses 503 to 506, and the energy values for tariffs 1 to 8 in resisters 1400 to 2111 (see table 4.1).
The following rules apply to the specification of a cutoff date:

- Point in time in the future: cutoff date energy values are updated at this point in time.
- Point in time in the past: no updating of cutoff date energy values.
- Current date, time of day in the past: current device time and cutoff date energy values are saved to memory.
- An entry of 0 to day, month or year functions as a placeholder: the cutoff date energy values are updated on each corresponding date.
- Everything in date and time set to 0 (placeholder): cutoff date via device clock, every day at midnight, initial recording immediately.

7.5 Resettable Meter

Similar to the cutoff date meter, meter readings are saved and the respective differential value (= current value - value at the time of resetting) is determined.
The date and time at which the meter readings will be reset can be preselected by writing a value to register address 10700.
The point in time at which resetting has occurred can be found at addresses 507 to 510, and the energy values for tariffs 1 to 8 in resisters 2200 to 2911 (see table 4.1).
The following rules apply to the specification of a reset time point:

- Point in time in the future: reset at this point in time.
- Point in time in the past: no resetting of energy values.
- Current date, time of day in the past: immediate reset with current device clock time.
- An entry of 0 to day, month or year functions as a placeholder: the energy values are reset on each corresponding date.
- Everything in date and time set to 0 (placeholder): reset via device clock, every day at midnight, initial reset immediately.

8 Product Support

If required please contact:

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