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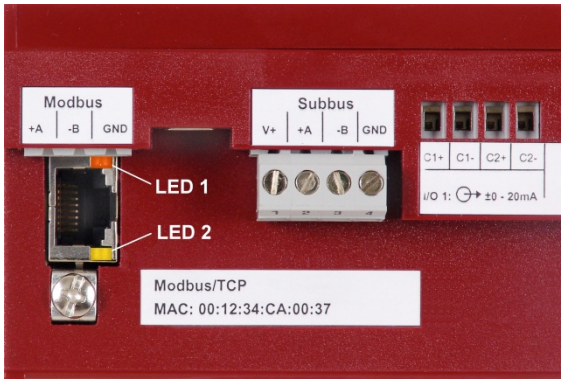
1. Bus connection

1.1 Connection

Before devices can be connected to an existing Ethernet network, you have to ensure that they will not disturb the normal network service. The rule is:

None of the devices to connect is allowed to have the same IP address than another device already installed

The factory setting of the IP address of CAM is: 192.168.1.101



The standard RJ45 connector serves for direct connecting an Ethernet cable. If the PC is directly connected to the device a cross-wired cable must be used.

To prevent possible EMC problems the shield of the cable can be connected to earth via screw connector.

The network installation of the devices is done by means of the CB-Manager software. As soon as all devices have a unique network address they may be accessed by means of a suitable Modbus master client.

- Interface: RJ45 connector, Ethernet 100BaseTX
- Mode: 10/100 MBit/s, full / half duplex, Auto-negotiation
- Protocols: Modbus/TCP, NTP

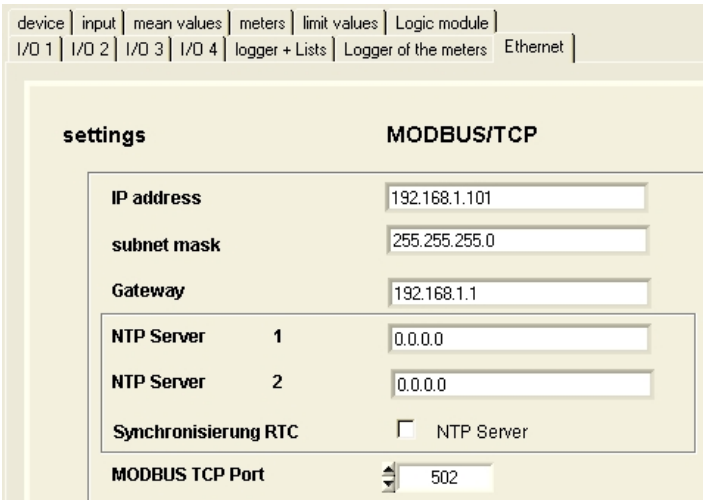
Function of the LEDs

LED 1 (orange)	▪ ON as soon as a network connection exists ▪ Flashing when data is transmitted via Ethernet connection
LED 2 (yellow)	▪ Flashing with 1 Hz: Start-up part 1 (boot loader) ▪ Flashing with 0.5Hz: Start-up part 2 (operating system and device services) ▪ ON during Modbus/TCP communication with the device

1.2 Network installation using the CB-Manager software

The setting of the network parameters of the device may be done via a local interface (USB and RS485) or directly via the Ethernet interface.

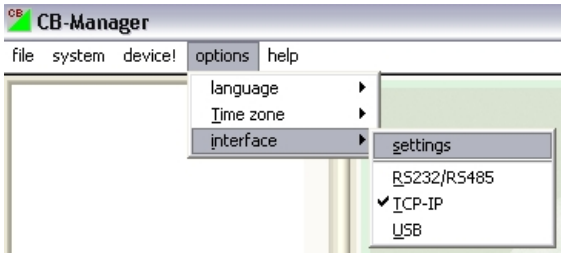
Installation via a local interface



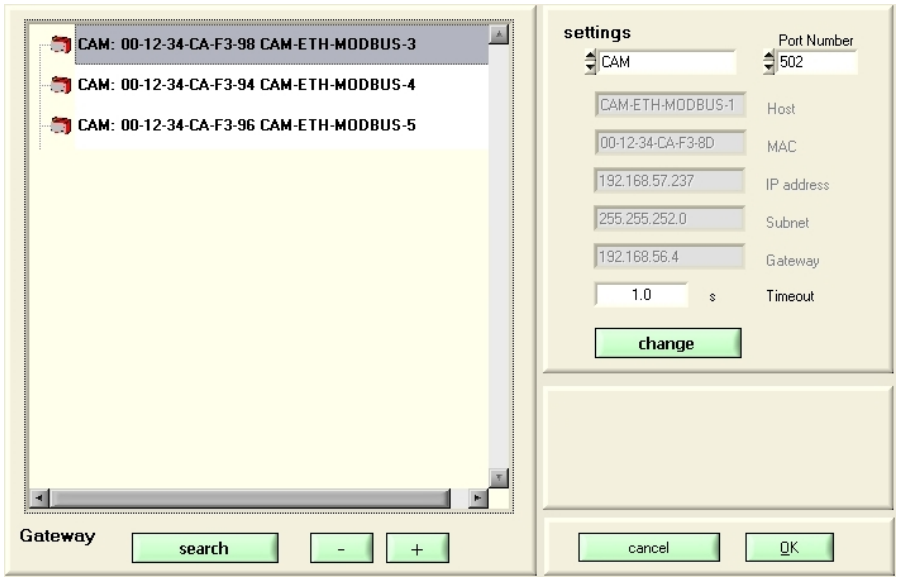
The network settings are part of the device configuration (register "Ethernet") and have to be arranged with the network administrator:

- ***IP address***: This one must be **unique**, i.e. may be assigned in the network only once.
- ***Subnet mask***: Defines how many devices are directly addressable in the network. This setting is equal for all the devices.
- ***Gateway***: Is used to resolve addresses during communication between different networks. Should contain a valid address within the own network.

Installation via Ethernet interface



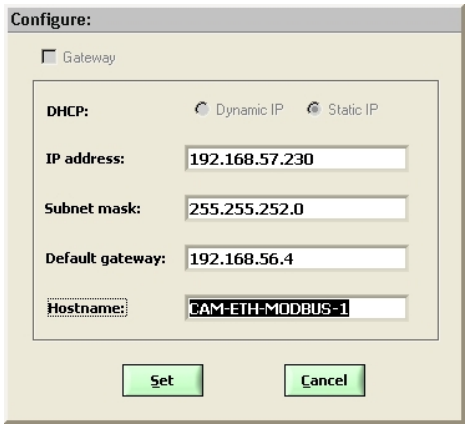
Select "settings" under options | interface. The interface type has to be set to "TCP-IP".



Devices in the local network

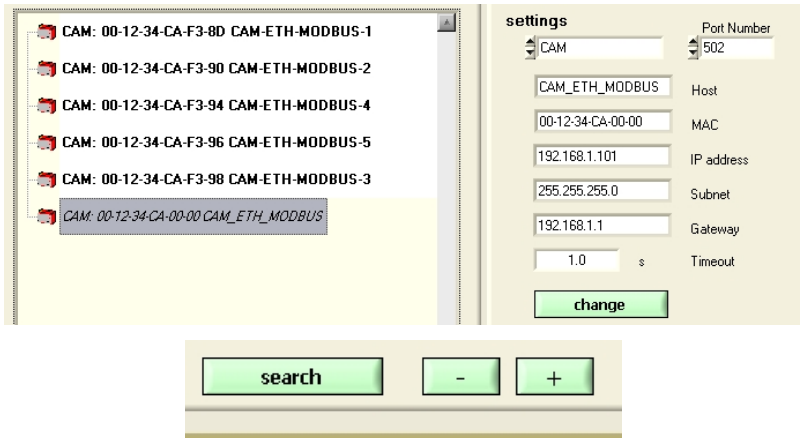
Set settings to "CAM". All devices connected in the local network will be searched using a UDP broadcast telegram, which identifies the devices by means of their MAC address. A clear identification of each device is possible by means of its unique MAC address, which is shown on the device (see chapter 1.1).

Now to each device a **unique** network address must be assigned. To do so select a device from the list and click on "**change**".



The following settings have to be arranged with the network administrator:

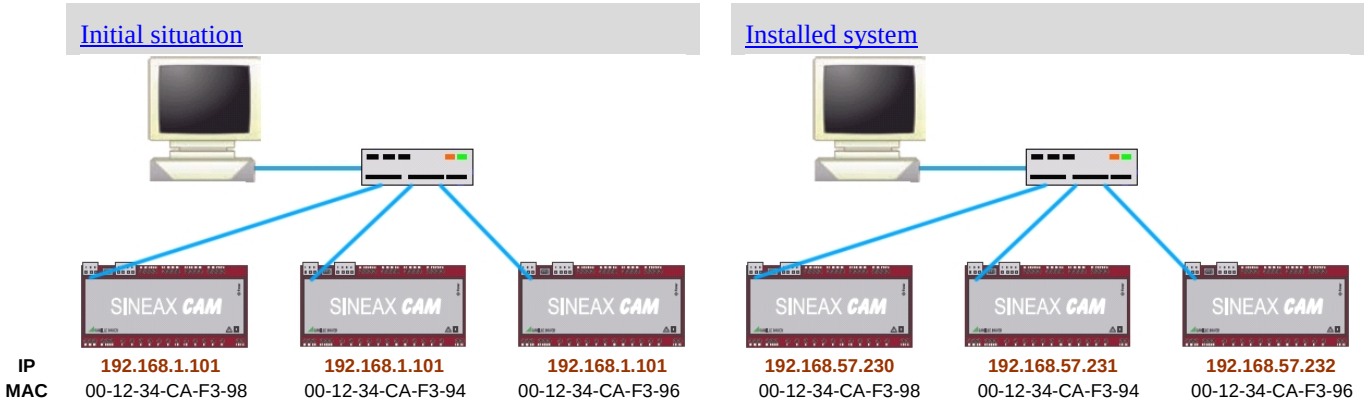
- ***IP address***: This one must be **unique**, i.e. may be assigned in the network only once.
- ***Subnet mask***: Defines how many devices are directly addressable in the network. This setting is equal for all the devices.
- ***Default gateway***: Is used to resolve addresses during communication between different networks. Should contain a valid address within the own network.
- ***Hostname***: Individual designation for each device. Helps to identify the device in the device list.



Devices outside the local network

Devices which are not in the same network as the PC (e.g. in the Internet) can not be found and have to be added manually to the device list by means of [+]. To each entry you have to assign a unique IP and MAC address, which are different from the initial value. Otherwise it's not possible to add further entries.

The setting of the network parameters must be performed before mounting the device. As an alternative this may be done in the destination network via a local interface or via Ethernet.



1.3 Time synchronization via NTP protocol

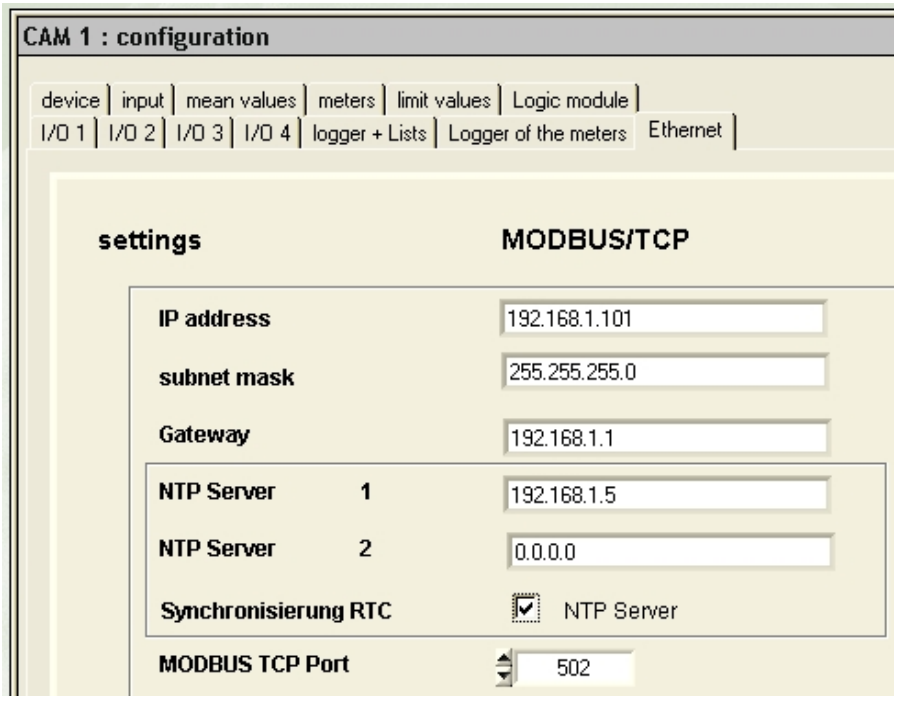
For the *time synchronization* via Ethernet *NTP* (Network Time Protocol) is the standard. Corresponding time servers are used in computer networks, but are also available for free via Internet. Using NTP it's possible to hold all devices on a common time base.

Two different NTP servers may be defined. If the first server is not available the second server is used for trying to synchronize the time. Adjusting of the clock is performed once every 24h. If no time synchronization is desired, to both NTP servers the address 0.0.0.0 should be assigned.

The setting of the addresses is done by means of the CB-Manager software. The NTP data is arranged in the register "Ethernet" of the device configuration.

Activation

To activate the time synchronization via NTP, the "Synchronisation RTC" must be checked by means of the checkbox.



1.4 TCP ports for data transmission

TCP ports

The TCP communication is done via so-called ports. The number of the used port allows determining the type of communication. As a standard Modbus/TCP communication is performed via TCP port 502, NTP uses port 123. However, the port for the Modbus/TCP telegrams may be modified. You may provide a unique port to each of the devices, e.g. 503, 504, 505 etc., for an easier analysis of the telegram traffic. The setting of the Modbus TCP port is done as shown above. Independent of these setting a communication via port 502 is always supported. The device allows at least 5 connections to different clients at the same time.

Firewall

Due to security reasons nowadays each network is protected by means of a firewall. When configuring the firewall you have to decide which communication is desired and which have to be blocked. The TCP port 502 for the Modbus/TCP communication normally is considered to be unsafe and is very often disabled. This may lead to a situation where no communication between networks (e.g. via Internet) is possible.

2. Coding and addressing

The basics of the **MODBUS®** communication are summarized in the document **"Modbus Basics. PDF"**
(see provided Doku-CD or on our website http://www.camillebauer.com)

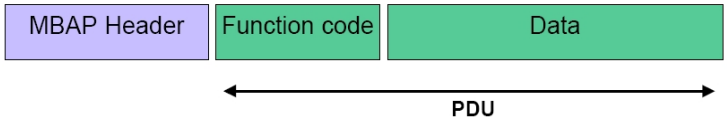
Addressing

Modbus groups different data types as references. The telegram functions 03_H (Read Holding Register) and 10_H (Preset Multiple Registers) e.g. use register addresses starting at 40001. The reference 4xxxx is implicit, i.e. is given by the used telegram function. Therefore for addressing the leading 4 is omitted. Another specialty in Modbus telegrams is, that the register numeration starts at 1, but the addressing starts at 0.

Example: Measurement U1N on register address 40102

- Address declaration (see chapter 5.1): 40102
- Real address: 102 (offset 1)
- Address used in telegram: 101 (offset 0)

Telegrams



The information to transmit is the same for Modbus/TCP as for Modbus/RTU telegrams, displayed in green above. The addressing of the devices is done by means of the IP address and replaces the previous Modbus address. Therefore the Modbus slave address is set to 0xFF. The check sum is dropped, because the security of the transmission is assured on TCP communication level. In the following examples the MBAP header bytes are not shown.

Reading bit information: Function 0x01, Read Coil Status

Bits are represented within a byte in a conventional way, MSB (Bit 7) on the most left and LSB (Bit 0) most right (0101'1010 = 0x5A = 90).

Example: Reading Coil 1 up to 14

Byte	Request	
1	Slave address	0xFF
2	Function code	0x01
3	Start address 0 = Coil 1	0x00
4		0x00
5	Number of registers:	0x00
6	1…14 => 14	0x0E

Answer	
Slave address	0xFF
Function code	0x01
Byte count	0x02
Byte 1	**0x53**
Byte 2	**0x2B**

The start address of the request plus the bit position in the answer byte 0 corresponds to the coil address. Started bytes are filled with zeros.

	Hex	Binary	Coil 8	Coil 7	Coil 6	Coil 5	Coil 4	Coil 3	Coil 2	Coil 1
Byte 1	0x53	01010011b	OFF	ON	OFF	ON	OFF	OFF	ON	ON

	Hex	Binary	-	-	Coil 14	Coil 13	Coil 12	Coil 11	Coil 10	Coil 9
Byte 2	0x2B	00101011b	-	-	ON	OFF	ON	OFF	ON	ON

Reading byte information

Modbus does not know a data type Byte or Character (see address space). Strings or byte arrays will be mapped into holding registers (2 bytes per register) und transferred as „Character streams“.

Example: Device description text on address 42095 and following (terminated by 0)

Byte	Request		Answer		
1	Slave address	0xFF	Slave address	0xFF	
2	Function code	0x03	Function code	0x03	
3	Start address: (2095-1)	0x08	Byte count	0x04	
4		0x2E	Byte 1	**0x41**	‚A‘
5	Number of registers: 2	0x00	Byte 2	**0x43**	‚C‘
6		0x02	Byte 3	**0x00**	0
7			Byte 4	**0x4D**	‚M‘

Example: IP address of the Ethernet card on addresses 44900 and 44901

Byte	Request		Answer		
1	Slave address	0xFF	Slave address	0xFF	
2	Function code	0x03	Function code	0x03	
3	Start address: (4900-1)	0x13	Byte count	0x0C	
4		0x23	Byte 1	**0x87**	135
5	Number of registers: 2	0x00	Byte 2	**0x39**	57
6		0x02	Byte 3	**0xC0**	192
7			Byte 4	**0xA8**	168

- IP address: **192.168.57.135**

Reading single registers: Function 0x03, Read Holding Register

Register or words will be transferred in accordance with the „Big Endian“ format.

Example: Reading the phase voltage THD on register addresses 40191 up to 40193

Byte	Request		Answer		
1	Slave address	0xFF	Slave address	0xFF	
2	Function code	0x03	Function code	0x03	
3	Start address (191-1)	0x00	Byte count	0x06	
4		0xBE	Byte 1	**0x00**	Hex. Dec.
5	Number of registers: 3	0x00	Byte 2	**0x13**	THD U1N= 0x0013: 19 ‰ = 1,9%
6		0x03	Byte 3	**0x00**	
7			Byte 4	**0x18**	THD U2N=0x0018: 24 ‰ = 2,4%
8			Byte 5	**0x00**	
9			Byte 6	**0x1A**	THD U3N=0x001A: 26 ‰ = 2,6%

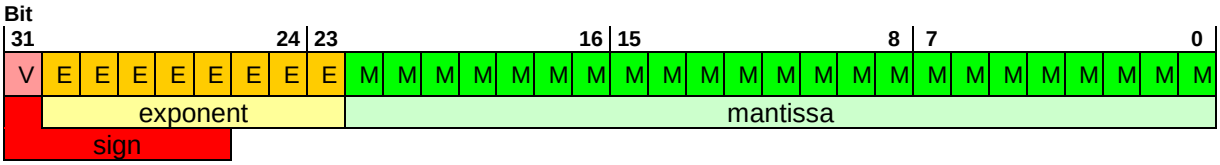
The THD values are directly scaled in tenths of a percent.

Reading float numbers (REAL): Function 0x03, Read Holding Register

There is no representation for floating point numbers in the Modbus specification. But as a matter of principle any desired data structure can be casted to a sequence of 16Bit registers.

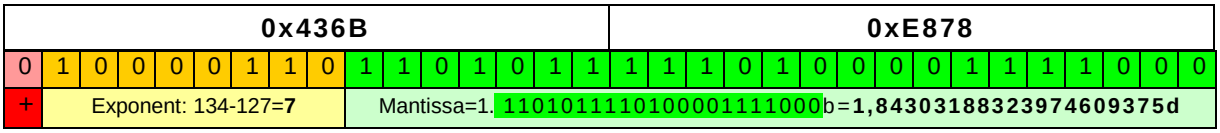
The IEEE 754 standard as the most often used standard for the representation of floating numbers is normally applied.

- The first register contains the bits 0 – 15 of the 32 bit number (bit 0…15 of the mantissa).
- The second register contains the bits 16 – 31 of the 32 bit number (sign, exponent and bit 16-22 of the mantissa).



Example: Reading voltage U1N on register address 40102 of device 17.

Byte	Request		Answer	
1	Slave address	0x11	Slave address	0x11
2	Function code	0x03	Function code	0x03
3	Start address (102-1)	0x00	Byte count	0x04
4		0x65	Byte 1	**0xE8**
5	Number of registers:	0x00	Byte 2	**0x78**
6	2	0x02	Byte 3	**0x43**
7			Byte 4	**0x6B**



- **U1N** = +1,843031883239746093750 * 2^{7} **= 234,908V**

3. Mapping

Address space

The address space may be divided in 4 address spaces in accordance with the 4 data types.

Space	r / w	Address range	Function code	
Coil	readable writable	00001 – 09999	0x01 0x05 0x0F	Read Coil Status Force Single Coil [1)] Force Multiple Coils
Discrete input	read only	10001 – 19999	0x02	Read Input Status
Input register	read only	30001 – 39999	0x04	Read Input Register [1)]
Holding register	readable writable	40001 – 49999	0x03 0x06 0x10	Read Holding Register Force Single Register [1)] Preset Multiple Register

1) not implemented

To reduce the number of commands the device image has been mapped using „Holding register“ if possible.
Information normally addressed as a single bit are implemented as „Coil“ or „Discrete input“.

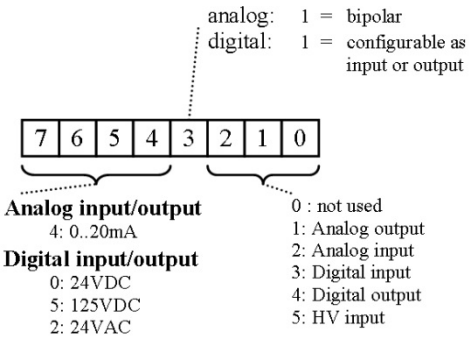
Segments

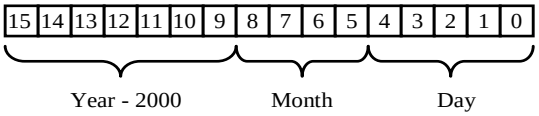
Address	Description	Allowed function codes	
40001 – 40017	Device information	0x03	Read Holding Register
40100 – 40187	General instantaneous values		
40190 – 40196	Instantaneous values harmonic analysis		
40200 – 40493	Instantaneous values of harmonics		
40500 – 40667	Minimum / Maximum values		
40670 – 40984	Maximum values THD, TDD and harmonics		
40990 – 41021	Instantaneous values of system analysis		
41030 – 41173	Mean values, interval time t_1		
41180 – 41323	Mean values, interval time t_2		
41330 – 41345	Instantaneous values analog input		
41362 – 41369	Instantaneous values analog output		
42956 – 42956	Instantaneous values limit values		
43917 – 43924	Instantaneous values logic functions		
46000 – 46119	Free assembled Modbus image		
41400 – 41459	Meter contents + scaling factors of I/O meters	0x03 0x10	Read Holding Register Preset Multiple Register
41460 – 41485	Meter contents + scaling factor standard meters		
41550 – 41562	RTC		
41600 – 41602	Simulation mode		
42000 – 42015	Serial numbers device, bus card, I/Os		
42020 – 42121	Parameters security system / general		
42200 – 42215	Measurement input parameters		
42420 – 42493	I/O parameters		
42600 – 42663	Mean value parameters		
42700 – 42955	Limit value parameters + state information		
43100 – 43920	Logic module parameters		
44300 – 44301	tariff allocation I/O meters		
44900 – 44911	Parameters of the Ethernet bus card		
46200 – 46259	Parameters of the free Modbus image		
10003 – 10014	Digital inputs	0x02	Read Input Status
00001 – 00014 01025	Present state of relays and digital outputs Present meter tariff	0x01	Read Coil Status
00001 – 00014 00500 – 00541 00670 – 00676 01030 – 01077 01400 – 01423 01460 – 01471	Relays + digital outputs Reset of minimum / maximum values Reset maximum values THD, TDD, harmonics Reset minimum/maximum of mean-values Reset of I/O meters Reset of standard meters	0x0F	Force Multiple Coils

Used syntax

Address	Start address of described data blocks (Register, Coil or Input Status)
Time	Register address of a timestamp, typically a minimum / maximum value
Value	Register address of a measured quantity, typically a minimum / maximum value
Reset coil	Coil register address to reset a corresponding measured quantity
Name	Unique name of a variable or structure
Data type	Data type of variable U: unsigned INT: integer with 8, 16 or 32 Bit REAL (float) CHAR[..] TIME: seconds since 1.1.1970
#	Offset from the start address in the unit of the data type, for byte information: low byte 0, high byte 1
Default	Value when delivering or following a hardware reset
Description	Exact description of variable
14 2L 3G 3U 4U	Availability of the measured quantities, depending on the connected system 14 =Single phase system or 4-wire balanced load 2L =two phase system (split phase) 3G =3-wire balanced load 3U =3-wire unbalanced load or 3-wire unbalanced load Aron 4U =4-wire unbalanced

4. Device information

Address	Name	Data type	#	Default	Description
40001	HW_IO_CONF	UINT8	0	255	I/O module 1 
			1	255	I/O module 2 as module 1
			2	255	I/O module 3 as module 1
			3	255	I/O module 4 as module 1
40003	HW_DISPLAY	UINT8	0	0	*Value* *Meaning* 0 not used 1 small display 2 external display via Subbus
			1	255	0 nicht verwendet 1 Ethernet (IEC61850) 2 Ethernet (Modbus/TCP) 3 Ethernet (PROFINET)
40004	HW_OPTIONS	UINT16	0	0xD0	*Bit* *Meaning* 0 Logger 1 and 2 1 Operator list 2,3 not used 4 Real time clock (RTC) 5 Flash 6 Relays 7 Neutral measurement 8 Subbus works as Repeater (NLB995) 9-11 Frequency range version 000: 45-65Hz 001: 10-70Hz 010: 10-140Hz 12 Current inputs 0: Standard inputs (0…5A) 1: Rogowski current inputs (0…5V)
40005	NLB_NR	UINT16	0	0	NLB number (non-official versions)
40006	FV_INPUT	UINT16	0	0x0106	Firmware version measurement part (0x0106 = 1.06)
40007	FV_OUTPUT	UINT16	0	0x0137	Firmware version analysis unit (0x0137 = 1.37)
40008	FV_COM	UINT16	0	0x0000	Firmware version communication unit
40009	FV_MODUL	UINT16	0	0x0102	Firmware version module 1 (0x0102 = 1.02)
			1	0x0102	Module 2 as module 1
			2	0x0102	Module 3 as module 1
			3	0x0102	Module 4 as module 1
40013	FV_DISPLAY	UINT16	0	0x0000	Firmware version small display
			1	0x0000	Firmware version external display
40015	HW_FREQ	UINT16	0	5000	Calibration frequency (5000 = 50.00Hz)
40016	CFG_DIGIO	UINT16	0	0	Configuration of digital IO modules (**writable !!!**) *Bit* *Meaning (0 = input, 1 = output)* 0 Module 1 1 Module 2 2 Module 3 3 Module 4
40017	OPTION_EN	UINT128	0	0	Code for activating options

Address	Name	Data type	#	Default	Description
42000	SERIAL_NR	UINT32	0	0	Serial number / consecutive number of the basic device High register:  Low register: consecutive production number
42002			1	0	Serial number bus card (as basic device)
42004			2	0	Serial number module 1 (as basic device)
42006			3	0	Serial number module 2 (as basic device)
42008			4	0	Serial number module 3 (as basic device)
42010			5	0	Serial number module 4 (as basic device)
42012			6	0	Serial number small display unit (as basic device)
42014			7	0	Serial number large display unit (as basic device)

5. Measurements

5.1 General instantaneous values

Starting from version 1.32 of the analysis firmware an 8 byte timestamp is provided for „general instantaneous values”.

Address	Name	Description
40096	TIME_SECONDS	Seconds since 1.1.1970
40098	TIME_MICROSECONDS	Microseconds of the timestamp

Address	Name	14	2L	3G	3U	4U	Data type	#	Default	Description
40100	U	●	●	-	-	-	REAL	0	0.0	System voltage
40102	U1N	-	●	-	-	●		1	0.0	Voltage phase L1 to N
40104	U2N	-	●	-	-	●		2	0.0	Voltage phase L2 to N
40106	U3N	-	-	-	-	●		3	0.0	Voltage phase L3 to N
40108	U12	-	-	●	●	●		4	0.0	Voltage phase L1 to L2
40110	U23	-	-	●	●	●		5	0.0	Voltage phase L2 to L3
40112	U31	-	-	●	●	●		6	0.0	Voltage phase L3 to L1
40114	UNE	-	-	-	-	●		7	0.0	Zero displacement voltage in 4-wire systems
40116	I	●	-	●	-	-	REAL	0	0.0	System current
40118	I1	-	●	-	●	●		1	0.0	Current in phase L1
40120	I2	-	●	-	●	●		2	0.0	Current in phase L2
40122	I3	-	-	-	●	●		3	0.0	Current in phase L3
40124	IN	-	●	-	-	●		4	0.0	Neutral current
40126	IB	●	-	●	-	-		5	0.0	Bimetal current in balanced load systems
40128	IB1	-	●	-	●	●		6	0.0	Bimetal current in phase L 1
40130	IB2	-	●	-	●	●		7	0.0	Bimetal current in phase L2
40132	IB3	-	-	-	●	●		8	0.0	Bimetal current in phase L3
40134	P	●	●	●	●	●	REAL	0	0.0	Active power system (P = P1 + P2 + P3)
40136	P1	-	●	-	-	●		1	0.0	Active power phase 1 (L1 – N)
40138	P2	-	●	-	-	●		2	0.0	Active power phase 2 (L2 – N)
40140	P3	-	-	-	-	●		3	0.0	Active power phase 3 (L3 – N)
40142	Q	●	●	●	●	●	REAL	0	0.0	Reactive power system (Q = Q1 + Q2 + Q3)
40144	Q1	-	●	-	-	●		1	0.0	Reactive power phase 1 (L1 – N)
40146	Q2	-	●	-	-	●		2	0.0	Reactive power phase 2 (L2 – N)
40148	Q3	-	-	-	-	●		3	0.0	Reactive power phase 3 (L3 – N)
40150	S	●	●	●	●	●	REAL	0	0.0	Apparent power system S
40152	S1	-	●	-	-	●		1	0.0	Apparent power phase 1 (L1 – N)
40154	S2	-	●	-	-	●		2	0.0	Apparent power phase 2 (L2 – N)
40156	S3	-	-	-	-	●		3	0.0	Apparent power phase 3 (L3 – N)
40158	F	●	●	●	●	●	REAL	0	0.00	System frequency
40160	PF	●	●	●	●	●	REAL	0	0.0	Active power factor system PF = P / S
40162	PF1	-	●	-	-	●		1	0.0	Active power factor phase L1 (L1 – N)
40164	PF2	-	●	-	-	●		2	0.0	Active power factor phase L2 (L2 – N)
40166	PF3	-	-	-	-	●		3	0.0	Active power factor phase L3 (L3 – N)
40168	QF	●	●	●	●	●	REAL	0	0.0	Reactive power factor system QF = Q / S
40170	QF1	-	●	-	-	●		1	0.0	Reactive power factor phase L1 (L1 – N)
40172	QF2	-	●	-	-	●		2	0.0	Reactive power factor phase L2 (L2 – N)
40174	QF3	-	-	-	-	●		3	0.0	Reactive power factor phase L3 (L3 – N)
40176	LF	●	●	●	●	●	REAL	0	0.0	Load factor system LF = sign(Q)·(1 – abs(PF))
40178	LF1	-	●	-	-	●		1	0.0	Load factor L1 (L1 – N)
40180	LF2	-	●	-	-	●		2	0.0	Load factor L2 (L2 – N)
40182	LF3	-	-	-	-	●		3	0.0	Load factor L3 (L3 – N)
40184	U_MEAN	-	●	-	●	●	REAL	0	0.0	Average value of voltages (U1N+U2N+U3N)/3
40186	I_MEAN	-	●	-	●	●		1	0.0	Average value of currents (I1+I2+I3)/3

5.2 Instantaneous values of the harmonic analysis

Address	Name	14	2L	3G	3U	4U	Data type	#	Default	Description
40190	UNB_U	-	-	-	-	•	UINT16	0	0	Unbalance factor
40191	THD_U1X	U	U1N	U12	U12	U1N	UINT16	0	0	Total Harmonic Distortion
40192	THD_U2X	-	U2N	U23	U23	U2N		1	0	Total Harmonic Distortion
40193	THD_U3X	-	-	U31	U31	U3N		2	0	Total Harmonic Distortion
40194	TDD_I1	I	I1	I	I1	I1	UINT16	0	0	Total Demand Distortion
40195	TDD_I2	-	I2	-	I2	I2		1	0	Total Demand Distortion
40196	TDD_I3	-	-	-	I3	I3		2	0	Total Demand Distortion

These values are unsigned 16 bit numbers (1 quantity per register). 1000 corresponds to 100 %.

THD Harmonic content related to the fundamental of the RMS value of the voltage.
TDD Harmonic content related to the **nominal** current.

The above measurements are also available as floating point numbers, see **chapter 5.6**

5.3 Instantaneous values of the harmonics

Address	Name	14	2L	3G	3U	4U	Data type	#	Default	Description
40200	H2_U1X	U	U1N	U12	U12	U1N	UINT16	0	0	Content of the 2nd voltage harmonic
	…							…		…
	H50_U1X							48	0	Content of the 50th voltage harmonic
40249	H2_U2X	-	U2N	U23	U23	U2N	UINT16	0	0	Content of the 2nd voltage harmonic
	…							…		…
	H50_U2X							48	0	Content of the 50th voltage harmonic
40298	H2_U3X	-	-	U31	U31	U3N	UINT16	0	0	Content of the 2nd voltage harmonic
	…							…		…
	H50_U3X							48	0	Content of the 50th voltage harmonic
40347	H2_I1X	I	I1	I	I1	I1	UINT16	0	0	Content of the 2nd current harmonic
	…							…		…
	H50_I1X							48	0	Content of the 50th current harmonic
40396	H2_I2X	-	I2	-	I2	I2	UINT16	0	0	Content of the 2nd current harmonic
	…							…		…
	H50_I2X							48	0	Content of the 50th current harmonic
40445	H2_I3X	-	-	-	I3	I3	UINT16	0	0	Content of the 2nd current harmonic
	…							…		…
	H50_I3X							48	0	Content of the 50th current harmonic

These values are unsigned 16-Bit numbers (1 value per register). 1000 corresponds to 100 %.

Hi_UXX Harmonic content of the voltage related to the fundamental 100 %
Hi_IXX Harmonic content of the current converted to the rated current

5.4 Minimum / maximum values of system quantities

Time	Value	Reset coil	Name	Data type	#	Default	Description
40500	40584	500	U_MAX	TIME / REAL	0	1.1.2000 / 0.0	Maximum value U
40502	40586	501	U1N_MAX		1	1.1.2000 / 0.0	Maximum value U1N
40504	40588	502	U2N_MAX		2	1.1.2000 / 0.0	Maximum value U2N
40506	40590	503	U3N_MAX		3	1.1.2000 / 0.0	Maximum value U3N
40508	40592	504	U12_MAX		4	1.1.2000 / 0.0	Maximum value U12
40510	40594	505	U23_MAX		5	1.1.2000 / 0.0	Maximum value U23
40512	40596	506	U31_MAX		6	1.1.2000 / 0.0	Maximum value U31
40514	40598	507	UNE_MAX		7	1.1.2000 / 0.0	Maximum value UNE
40516	40600	508	I_MAX	TIME / REAL	0	1.1.2000 / 0.0	Maximum value I
40518	40602	509	I1_MAX		1	1.1.2000 / 0.0	Maximum value I1
40520	40604	510	I2_MAX		2	1.1.2000 / 0.0	Maximum value I2
40522	40606	511	I3_MAX		3	1.1.2000 / 0.0	Maximum value I3
40524	40608	512	IN_MAX		4	1.1.2000 / 0.0	Maximum value IN
40526	40610	513	IB_MAX		5	1.1.2000 / 0.0	Maximum value IB
40528	40612	514	IB1_MAX		6	1.1.2000 / 0.0	Maximum value IB1
40530	40614	515	IB2_MAX		7	1.1.2000 / 0.0	Maximum value IB2
40532	40616	516	IB3_MAX		8	1.1.2000 / 0.0	Maximum value IB3
40534	40618	517	P_MAX	TIME / REAL	0	1.1.2000 / 0.0	Maximum value P
40536	40620	518	P1_MAX		1	1.1.2000 / 0.0	Maximum value P1
40538	40622	519	P2_MAX		2	1.1.2000 / 0.0	Maximum value P2
40540	40624	520	P3_MAX		3	1.1.2000 / 0.0	Maximum value P3
40542	40626	521	Q_MAX	TIME / REAL	0	1.1.2000 / 0.0	Maximum value Q
40544	40628	522	Q1_MAX		1	1.1.2000 / 0.0	Maximum value Q1
40546	40630	523	Q2_MAX		2	1.1.2000 / 0.0	Maximum value Q2
40548	40632	524	Q3_MAX		3	1.1.2000 / 0.0	Maximum value Q3
40550	40634	525	S_MAX	TIME / REAL	0	1.1.2000 / 0.0	Maximum value S
40552	40636	526	S1_MAX		1	1.1.2000 / 0.0	Maximum value S1
40554	40638	527	S2_MAX		2	1.1.2000 / 0.0	Maximum value S2
40556	40640	528	S3_MAX		3	1.1.2000 / 0.0	Maximum value S3
40558	40642	529	F_MAX	TIME / REAL		1.1.2000 / 0.0	Maximum value F
40560	40644	530	U_MIN	TIME / REAL	0	1.1.2000 / 0.0	Minimum value U
40562	40646	531	U1N_MIN		1	1.1.2000 / 0.0	Minimum value U1N
40564	40648	532	U2N_MIN		2	1.1.2000 / 0.0	Minimum value U2N
40566	40650	533	U3N_MIN		3	1.1.2000 / 0.0	Minimum value U3N
40568	40652	534	U12_MIN		4	1.1.2000 / 0.0	Minimum value U12
40570	40654	535	U23_MIN		5	1.1.2000 / 0.0	Minimum value U23
40572	40656	536	U31_MIN		6	1.1.2000 / 0.0	Minimum value U31
40574	40658	537	PF_MIN_IN_L	TIME / REAL	0	1.1.2000 / 0.0	min. cos(φ) Inc./inductive
40576	40660	538	PF_MIN_IN_C		1	1.1.2000 / 0.0	min. cos(φ) Inc./capacitive
40578	40662	539	PF_MIN_OUT_L		2	1.1.2000 / 0.0	min. cos(φ) Outg./inductive
40580	40664	540	PF_MIN_OUT_C		3	1.1.2000 / 0.0	min. cos(φ) Outg./capacitive
40582	40666	541	F_MIN	TIME / REAL		1.1.2000 / 75.	Minimum value of F

By setting Coil 500…541 (Reset) the appropriate maximum resp. minimum value with timestamp will be reset.

5.5 Maximum values of THD, TDD and harmonics

Register	Reset coil	Name	Data type	#	Default	Description
40670	670	UNB_U_TIME	TIME	0	1.1.2000	Time
40672		UNB_U_MAX	UINT16	0	0	max. unbalance factor
40673	671	H_U1X_TIME	TIME	0	1.1.2000	Time
40675		THD_U1X_MAX	UINT16	0	0	max. THD phase 1
		H2_U1X_MAX		1	0	max. content of 2nd voltage harmonic phase 1
		…		…		…
		H50_U1X_MAX		49	0	max. content of 50th voltage harmonic phase 1
40725	672	H_U2X_TIME	TIME		1.1.2000	Time
40727		THD_U2X_MAX	UINT16	0	0	max. THD phase 3
		H2_U2X_MAX		1	0	max. content of 2nd voltage harmonic phase 2
		…		…		…
		H50_U2X_MAX		49	0	max. content of 50th voltage harmonic phase 2
40777	673	H_U3X_TIME	TIME	0	1.1.2000	Time
40779		THD_U3X_MAX	UINT16	0	0	max. THD phase 3
		H2_U3X_MAX		1	0	max. content of 2nd voltage harmonic phase 3
		…		…		…
		H50_U3X_MAX		49	0	max. content of 50th voltage harmonic phase 3
40829	674	H_I1X_TIME	TIME	0	1.1.2000	Time
40831		TDD_I1X_MAX	UINT16	0	0	max. THD phase 1
		H2_I1X_MAX		1	0	max. content of 2nd current harmonic phase 1
		…		…		…
		H50_I1X_MAX		49	0	max. content of 50th current harmonic phase 1
40881	675	H_I2X_TIME	TIME	0	1.1.2000	Time
40883		TDD_I2X_MAX	UINT16	0	0	max. THD phase 2
		H2_I2X_MAX		1	0	max. content of 2nd current harmonic phase 2
		…		…		…
		H50_I1X_MAX		49	0	max. content of 50th current harmonic phase 2
40933	676	H_I3X_TIME	TIME	0	1.1.2000	Time
40935		TDD_I3X_MAX	UINT16	0	0	max. THD phase 3
		H2_I3X_MAX		1	0	max. content of 2nd current harmonic phase 3
		…		…		…
		H50_I3X_MAX		49	0	max. content of 50th current harmonic phase 3

These values are unsigned 16-Bit numbers (1 value per register). 1000 corresponds to 100 %.
By setting coils **670…676** the appropriate maximum values with timestamp will be reset.

Hi_UXX_MAX Harmonic content of the voltage related to the fundamental 100 %
Hi_IXX_MAX Harmonic content of the current related to the nominal current

5.6 Instantaneous values of the system analysis

Since version 1.37 of the analysis firmware the following measurements of the system analysis are available

Address	Name	14	2L	3G	3U	4U	Data type	Default	Description
40990	UR1	-	-	-	-	●	REAL	0.0	Voltage [V]: Positive sequence
40992	UR2	-	-	-	-	●		0.0	Voltage [V]: Negative sequence
40994	U0	-	-	-	-	●		0.0	Voltage [V]: Zero sequence
40996	IR1	-	-	-	●	●	REAL	0.0	Current [A]: Positive sequence
40998	IR2	-	-	-	●	●		0.0	Current [A]: Negative sequence
41000	I0	-	-	-	-	●		0.0	Current [A]: Zero sequence
41002	UNB_UR2_UR1	-	-	-	-	●	REAL	0.0	Unbalance factor voltage: UR2/UR1 [%]
41004	UNB_IR2_IR1	-	-	-	●	●		0.0	Unbalance factor current: IR2/IR1 [%]
41006	UNB_U0_UR1	-	-	-	-	●		0.0	Unbalance factor voltage: U0/UR1 [%]
41008	UNB_I0_IR1	-	-	-	-	●		0.0	Unbalance factor current: I0/IR1 [%]
41010	THD_U1X	U	U1N	U12	U12	U1N	REAL	0.0	Total Harmonic Distortion Ux
41012	THD_U2X	-	U2N	U23	U23	U2N		0.0	Total Harmonic Distortion Ux
41014	THD_U3X	-	-	U31	U31	U3N		0.0	Total Harmonic Distortion Ux
41016	TDD_I1	I	I1	I	I1	I1	REAL	0.0	Total Demand Distortion Ix
41018	TDD_I2	-	I2	-	I2	I2		0.0	Total Demand Distortion Ix
41020	TDD_I3	-	-	-	I3	I3		0.0	Total Demand Distortion Ix

THD Harmonic content related to the fundamental of the RMS value of the voltage.
TDD Harmonic content related to the **nominal** current.

- THD and TDD are also available as 16-bit integer values, see chapter 5.2
- The maximum values of TDH/TDD are available as 16-bit integer values only, see chapter 5.5

5.7 Mean values and trend with interval time t1

#	Mean val.	Trend	Maximum			Minimum		
NAME	REAL	REAL	TIME	REAL[value]	Reset	TIME	REAL [value]	Reset
AVG1.1	41030	41054	41078	41102	1030	41126	41150	1054
AVG1.2	41032	41056	41080	41104	1031	41128	41152	1055
AVG1.3	41034	41058	41082	41106	1032	41130	41154	1056
AVG1.4	41036	41060	41084	41108	1033	41132	41156	1057
AVG1.5	41038	41062	41086	41110	1034	41134	41158	1058
AVG1.6	41040	41064	41088	41112	1035	41136	41160	1059
AVG1.7	41042	41066	41090	41114	1036	41138	41162	1060
AVG1.8	41044	41068	41092	41116	1037	41140	41164	1061
AVG1.9	41046	41070	41094	41118	1038	41142	41166	1062
AVG1.10	41048	41072	41096	41120	1039	41144	41168	1063
AVG1.11	41050	41074	41098	41122	1040	41146	41170	1064
AVG1.12	41052	41076	41100	41124	1041	41148	41172	1065

5.8 Mean values and trend with interval time t2

#	Mean val.	Trend	Maximum			Minimum		
NAME	REAL	REAL	TIME	REAL[value]	Reset	TIME	REAL [value]	Reset
AVG2.1	41180	41204	41228	41252	1042	41276	41300	1066
AVG2.2	41182	41206	41230	41254	1043	41278	41302	1067
AVG2.3	41184	41208	41232	41256	1044	41280	41304	1068
AVG2.4	41186	41210	41234	41258	1045	41282	41306	1069
AVG2.5	41188	41212	41236	41260	1046	41284	41308	1070
AVG2.6	41190	41214	41238	41262	1047	41286	41310	1071
AVG2.7	41192	41216	41240	41264	1048	41288	41312	1072
AVG2.8	41194	41218	41242	41266	1049	41290	41314	1072
AVG2.9	41196	41220	41244	41268	1050	41292	41316	1074
AVG2.10	41198	41222	41246	41270	1051	41294	41318	1075
AVG2.11	41200	41224	41248	41272	1052	41296	41320	1076
AVG2.12	41202	41226	41250	41274	1053	41298	41322	1077

5.9 Instantaneous values of analog inputs

Address	Name	Data type	#	Default	Description
41330	AIN1	REAL	0	0	Analog input value 1.1
			1	0	Analog input value 1.2
41334	AIN2	REAL	0	0	Analog input value 2.1
			1	0	Analog input value 2.2
41338	AIN3	REAL	0	0	Analog input value 3.1
			1	0	Analog input value 3.2
41342	AIN4	REAL	0	0	Analog input value 4.1
			1	0	Analog input value 4.2

5.10 Instantaneous values of analog outputs

Address	Name	Data type	#	Default	Description
41362	AOUT1	UINT16	0	0	Analog output 1.1 16'384 corresponds to 100% of the **hardware** limit (20mA)
			1	0	Analog output 1.2 as 1.1
41364	AOUT2	UINT16	0	0	Analog output 2.1 as 1.1
			1	0	Analog output 2.2 as 1.1
41366	AOUT3	UINT16	0	0	Analog output 3.1 as 1.1
			1	0	Analog output 3.2 as 1.1
41368	AOUT4	UINT16	0	0	Analog output 4.1 as 1.1
			1	0	Analog output 4.2 as 1.1

5.11 Measurements of the free Modbus image

The following memory area contains the measured quantities which have been freely assembled as a Modbus image. Thus sequence and content are user defined.

These up to 60 measurements can be read using one Modbus telegram only.

Address	Name	Data type	Default	Description
46000	FREE_MB_VAL	REAL[60]	0.0	Measurements in floating point format. Sequence and measurement as defined by the user.

5.12 Present state of limit values

Address	Name	Data type	#	Default	Description
42956	LIMIT_STATE	BYTE[8]	0	0	*Bit* *Meaning* 0 State of limit value 1 (0=OFF, 1=ON) 1 State of limit value 2 2 State of limit value 3 3 State of limit value 4 4 State of limit value 5 5 State of limit value 6 6 State of limit value 7 7 State of limit value 8
			1	0	As above, but state of limit value 9...16
			2	0	As above, but state of limit value 17...24
			3	0	As above, but state of limit value 25...32
			4	0	As above, but state of limit value 33...40
			5	0	As above, but state of limit value 41...48
			6	0	As above, but state of limit value 49...56
			7	0	As above, but state of limit value 57...64

5.13 Present state of logic functions

For all logic functions an initial value is defined. This initial value corresponds to the normal case, i.e. **no alarm** or **event not occurred**. If the result of the logic function (*LOGIC_FUNC*) is unlike the initial value, an exception is present, i.e. **alarm** or **event occurred**. In this case, delayed by a switch-in or dropout delay, an action is initiated. This is indicated by setting the corresponding bits in *LOGIC_STAT* and is independent of the state of the initial value.

If a logic function can be acknowledged, subsequent an action may be reset by a definable procedure, e.g. to switch off an alarm horn. Depending on the selected procedure this can be done for single logic functions or for all functions at the same time. So it's e.g. possible to selectively acknowledge functions by setting the appropriate bits in *LOGIC_RESET*. For which logic functions actions have been reset may be seen from the corresponding bits in *RESET_STAT*. If a bit is set, the associated logic function has been acknowledged.

Address	Name	Data type	#	Default	Description
43917	LOGIC_RESET	INT32	0	0	**Acknowledge of alarms (events) - Write only** *Bit* *corresponding function* 0 Logic function LS 1 1 Logic function LS 2 ... ... 30 Logic function LS 31 31 Logic function LS 32
43919	LOGIC_FUNC	UINT32	0	0	**Present state of logic function LSx** *Assignment as LOGIC_RESET*
43921	LOGIC_STAT	UINT32	0	0	**State of alarm/event monitoring** *Assignment as LOGIC_RESET*
43923	RESET_STAT	UINT32	0	0	**Reset state of alarm/event monitoring** *Assignment as LOGIC_RESET*

5.14 Present state of relays

Address	Name	Data type	#	Default	Description
1	RELAY1	COIL	0	0	State relay 1
2	RELAY2	COIL	0	0	State relay 2

5.15 Present state of digital outputs

Address	Name	Data type	#	Default	Description
3	DIGOUT1.1	COIL	0	0	Present state digital output1.1
4	DIGOUT1.2	COIL	0	0	Present state digital output1.2
5	DIGOUT1.3	COIL	0	0	Present state digital output1.3
6	DIGOUT2.1	COIL	0	0	Present state digital output2.1
7	DIGOUT2.2	COIL	0	0	Present state digital output2.2
8	DIGOUT2.3	COIL	0	0	Present state digital output2.3
9	DIGOUT3.1	COIL	0	0	Present state digital output3.1
10	DIGOUT3.2	COIL	0	0	Present state digital output3.2
11	DIGOUT3.3	COIL	0	0	Present state digital output3.3
12	DIGOUT4.1	COIL	0	0	Present state digital output4.1
13	DIGOUT4.2	COIL	0	0	Present state digital output4.2
14	DIGOUT4.3	COIL	0	0	Present state digital output4.3

5.16 Present state of digital inputs

Address	Name	Data type	#	Default	Description
10003	DIGIN1.1	DISCRETE INPUT	0	0	Present state digital input1.1
10004	DIGIN1.2	DISCRETE INPUT	0	0	Present state digital input1.2
10005	DIGIN1.3	DISCRETE INPUT	0	0	Present state digital input1.3
10006	DIGIN2.1	DISCRETE INPUT	0	0	Present state digital input2.1
10007	DIGIN2.2	DISCRETE INPUT	0	0	Present state digital input2.2
10008	DIGIN2.3	DISCRETE INPUT	0	0	Present state digital input2.3
10009	DIGIN3.1	DISCRETE INPUT	0	0	Present state digital input3.1
10010	DIGIN3.2	DISCRETE INPUT	0	0	Present state digital input3.2
10011	DIGIN3.3	DISCRETE INPUT	0	0	Present state digital input3.3
10012	DIGIN4.1	DISCRETE INPUT	0	0	Present state digital input4.1
10013	DIGIN4.2	DISCRETE INPUT	0	0	Present state digital input4.2
10014	DIGIN4.3	DISCRETE INPUT	0	0	Present state digital input4.3

6. Meters

6.1 Tariff of meters

Address	Name	Data type	#	Default	Description
1025	CNT_TARIF	COIL	0	0	Tariff situation (writable) *Value* *Meaning* 0 High tariff 1 Low tariff

6.2 Contents of the I/O meters

Value	Reset-Coil	Name	Data type	#	Default	Description
41400	1400	CNTR_AD_11	UINT32	0	0	Meter DIGIO / AIN 1.1 High tariff
41424	1412			1	0	Meter DIGIO / AIN 1.1 Low tariff
41402	1401	CNTR_AD_12	UINT32	0	0	Meter DIGIO / AIN 1.2 High tariff
41426	1413			1	0	Meter DIGIO / AIN 1.2 Low tariff
41404	1402	CNTR_D_13	UINT32	0	0	Meter DIGIO 1.3 High tariff
41428	1414			1	0	Meter DIGIO 1.3 Low tariff
41406	1403	CNTR_AD_21	UINT32	0	0	Meter DIGIO / AIN 2.1 High tariff
41430	1415			1	0	Meter DIGIO / AIN 2.1 Low tariff
41408	1404	CNTR_AD_22	UINT32	0	0	Meter DIGIO / AIN 2.2 High tariff
41432	1416			1	0	Meter DIGIO / AIN 2.2 Low tariff
41410	1405	CNTR_D_23	UINT32	0	0	Meter DIGIO 2.3 High tariff
41434	1417			1	0	Meter DIGIO 2.3 Low tariff
41412	1406	CNTR_AD_31	UINT32	0	0	Meter DIGIO / AIN 3.1 High tariff
41436	1418			1	0	Meter DIGIO / AIN 3.1 Low tariff
41414	1407	CNTR_AD_32	UINT32	0	0	Meter DIGIO / AIN 3.2 High tariff
41438	1419			1	0	Meter DIGIO / AIN 3.2 Low tariff
41416	1408	CNTR_D_33	UINT32	0	0	Meter DIGIO 3.3 High tariff
41440	1420			1	0	Meter DIGIO 3.3 Low tariff
41418	1409	CNTR_AD_41	UINT32	0	0	Meter DIGIO / AIN 4.1 High tariff
41442	1421			1	0	Meter DIGIO / AIN 4.1 Low tariff
41420	1410	CNTR_AD_42	UINT32	0	0	Meter DIGIO / AIN 4.2 High tariff
41444	1422			1	0	Meter DIGIO / AIN 4.2 Low tariff
41422	1411	CNTR_D_43	UINT32	0	0	Meter DIGIO 4.3 High tariff
41446	1423			1	0	Meter DIGIO 4.3 Low tariff

By setting Coil 1400...1423 the appropriate meter will be reset.

6.3 Scaling factors of the I/O meters

Value	Name	Data type	#	Default	Description
41448	CNTR_EXP_AD_11	UINT16	0	0	Scaling factor DIGIO / AIN 1.1
41449	CNTR_EXP _AD_12	UINT16	0	0	Scaling factor DIGIO / AIN 1.2
41450	CNTR_EXP _D_13	UINT16	0	0	Scaling factor DIGIO 1.3
41451	CNTR_EXP _AD_21	UINT16	0	0	Scaling factor DIGIO / AIN 2.1
41452	CNTR_EXP _AD_22	UINT16	0	0	Scaling factor DIGIO / AIN 2.2
41453	CNTR_EXP _D_23	UINT16	0	0	Scaling factor DIGIO 2.3
41454	CNTR_EXP _AD_31	UINT16	0	0	Scaling factor DIGIO / AIN 3.1
41455	CNTR_EXP _AD_32	UINT16	0	0	Scaling factor DIGIO / AIN 3.2
41456	CNTR_EXP _D_33	UINT16	0	0	Scaling factor DIGIO 3.3
41457	CNTR_EXP _AD_41	UINT16	0	0	Scaling factor DIGIO / AIN 4.1
41458	CNTR_EXP _AD_42	UINT16	0	0	Scaling factor DIGIO / AIN 4.2
41459	CNTR_EXP _D_43	UINT16	0	0	Scaling factor DIGIO 4.3

The units of the meters can be derived from the unit of the corresponding inputs.

6.4 Meter contents of standard quantities

Value	Reset coil	Description	Data type	#	Default	Description
41460	1460	CNTR_P_INC	UINT32	0	0	Active energy meter P incoming High tariff
41472	1466			1	0	Active energy meter P incoming Low tariff
41462	1461	CNTR_P_OUT	UINT32	0	0	Active energy meter P outgoing High tariff
41474	1467			1	0	Active energy meter P outgoing Low tariff
41464	1462	CNTR_Q_IND	UINT32	0	0	Reactive meter Q inductive High tariff
41476	1468			1	0	Reactive meter Q inductive Low tariff
41466	1463	CNTR_Q_CAP	UINT32	0	0	Reactive meter Q capacitive High tariff
41478	1469			1	0	Reactive meter Q capacitive Low tariff
41468	1464	CNTR_Q_INC	UINT32	0	0	Reactive meter Q incoming High tariff
41480	1470			1	0	Reactive meter Q incoming Low tariff
41470	1465	CNTR_Q_OUT	UINT32	0	0	Reactive meter Q outgoing High tariff
41482	1471			1	0	Reactive meter Q outgoing Low tariff
41485		CNTR_TARIF	UINT16			Tariff situation (0= High tariff, 1=Low tariff) [1)]

By setting Coil 1460...1471 the appropriate meter will be reset. The unit of active energy meters is [Wh] resp. [var] for reactive energy meters.

[1)] Starting from version 1.39 the tariff situation is present for easier access to metering data

6.5 Scaling of the meters

The scaling factor is an unsigned 16-bit integer number. It is used to scale the meter contents to the appropriate physical unit. It includes as well the conversion for possibly connected primary transformers.

Physical meter content = Meter content * 10^{x} [Wh or varh]

Example: $P_{incoming}$ = 12056; CNTR_EXP_xxx = 4

Meter content: 12056×10^{4} [Wh] $= 12056 \times 10^{6} \times 10^{-2}$ [Wh] = **120.56 [MWh]**

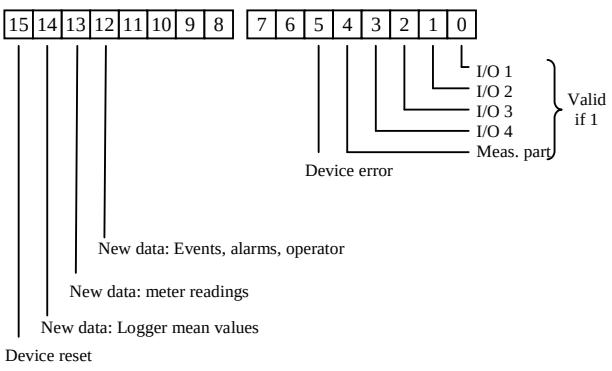
[MWh] 2 post decimal positions

7. Parameters and settings

7.1 Security system

Address	Name	Data type	#	Default	Description
42020	WR_PROTECT	UINT16	0	0x5AA5	Write protection *Value* *Meaning* 0x5AA5 inactive 0xA55A active
42021	USR_RIGHTS	UINT16	0	0	Access rights user 1 *Bit* *Meaning* *Bit* *Description* 0 Configuration 6 Manipulation lists 1 Real time clock 7 Disturbance recorder 2 Limit values 8 Adjustment analog inputs 3 Min / Max values 9 Simulations 4 Meter, Tariff situation 10 Alarm acknowledgement 5 Manipulation logger
42022			1	0	Access rights user 2 (as user 1)
42023			2	0	Access rights user 3 (as user 1)
42024	PW_ADMIN	CHAR[20]	0	„admin“	Encoded Password administrator
42034	PW_USERS	CHAR[20]	0	„user1“	User identification user 1
42044			1	„user1“	Password user 1
42054			2	„user2“	User identification user 2
42064			3	„user2“	Password user 2
42074			4	„user3“	User identification user 3
42084			5	„user3“	Password user 3
42094	WRP_MODTCP	UINT16	0	0x0000	Bit0: No write access via Modbus/TCP interface (Device answers with error code 0x01H)

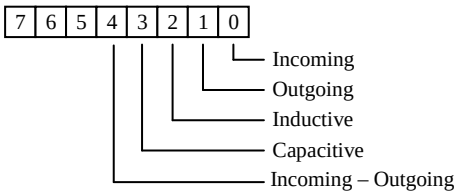
7.2 General parameters

Address	Name	Data type	#	Default	Description
42095	DEV_DESC	CHAR[48]	0	„CAM“	Device description
42119	DEV_STATUS	UINT16	0	0	Device status 
42120	DEV_TEMP	UINT16	0	0	Device temperature
42121	DEV_USER	UINT16	0	0	User (0: device, 1: admin, 2: user 1, 3: user 2, 4: user 3)

7.3 Parameters of the measurement input

Address	Name	Data type	#	Default	Description
42200	INPUT_CFG	UINT8	0	0x04	System *Value* *Meaning* 0x00 Single phase 0x05 Split phase 0x01 3-wire, balanced load 0x11 3-wire, balanced load, U = U12 0x21 3-wire, balanced load, U = U23 0x31 3-wire, balanced load, U = U31 0x13 3-wire, unbalanced load 0x03 3-wire, unbalanced load, Aron 0x02 4-wire, balanced load 0x04 4-wire, unbalanced load 0x14 4-wire, unbalanced load, Open-Y
			1	0x0A	Settings *Bit* *Meaning* *0* *1* 0, 1 Freq. measurement via 0 Voltage 1 Current 2 Automatic 2 Sampling freq. adaptive fixed 3 Rotation sense left-hand right-hand 4 Quadrants electrical mathematical 5 Input measurement normal interrupted 6 Frequency meas. filtered fast
42201	MAIN_FREQ	UINT16	0	5000	Rated frequency in 1/100 Hz
42202	IN_VOLTAGE	REAL	0	400.0	Rated voltage primary (L-L)
42204			1	400.0	Rated voltage secondary (L-L)
42206	IN_CURRENT	REAL	0	5.0	Rated current primary
42208			1	5.0	Rated current secondary
42210	IN_VOLT_MAX	REAL	0	480.0	Maximum voltage secondary (L-L)
42212	IN_CURR_MAX	REAL	0	6.0	Maximum current secondary
42214	EFF_MEAN_TP	UINT16	0	8	RMS averaging over 2, 3, 4, 8, 16, 32, 64, 128…1024 cycles
42215	IB_MEAN_TP	UINT16	0	15	Low-pass time constant for bimetal current [min]

7.4 Parameters of mean values

Address	Name	Data type	#	Default	Description
42600	MEAN_BAS_T1	UINT16[12]	0	[0,0,0…	Base of the 12 measurements for interval time t1 *Value* *Meaning* 0 not used 1 General instantaneous values 2 THD, TDD 16 analog inputs AIN 19 digital inputs with HT (DIH) and LT(DIL)
42612	MEAN_IND_T1	UINT16[12]	0	[0,0,0…	Index of the 12 measurements for interval time t1 *Base* *Index* *1* *2* *16* 0 U UNB_U AIN1.1 1 U1N THD_U1X AIN1.2 2 U2N THD_U2X AIN2.1 3 U3N THD_U3X AIN2.2 4 U12 TDD_I1X AIN3.1 5 U23 TDD_I2X AIN3.2 6 U31 TDD_I3X AIN4.1 7 UNE AIN4.2 8 I 9 I1 10 I2 11 I3 12 IN 13 IB 14 IB1 15 IB2 16 IB3 17 P 18 P1 19 P2 20 P3 21 Q 22 Q1 23 Q2 24 Q3 25 S ... ... 43 Imean etc. (see table general instantaneous values) For base 1 and 16 (Data type real) the index must be multiplied by 2.
42624	MEAN_ATT_T1	CHAR[12]	0	[0,0,0…	Attributes of mean values 
42630	MEAN_SYN_T1	UINT16	0	0	Synchronization of interval *Value* *Meaning* 0 without 1 via digital input 1.1 2 via digital input 1.2 etc.
42631	MEAN_INT_T1	UINT16	0	900	time interval t1 in seconds
42632	MEAN_BAS_T2	UINT16[12]	0	[0,0,0…	Base of 12 measurements with interval time t2 (see 42600)
42644	MEAN_OFF_T2	UINT16[12]	0	[0,0,0…	Index of 12 measurements for interval time t2 (see 42612)
42656	MEAN_ATT_T2	UINT16[12]	0	[0,0,0…	Attributes of mean values (see 42624)
42662	MEAN_SYN_T2	UINT16	0	0	Synchronization of interval (see 42630)
42663	MEAN_INT_T2	UINT16	0	900	time interval t2 in seconds

7.5 Parameters of limit values

Address	Name	Data type	Default	Description
42700	LIMIT_BASE	UINT16[64]	0	Base of the measurand *value* *meaning* 0 not used 1 general instantaneous values 2 THD, TDD 13 t1: mean values MEAN1 / Trend mean values TRM1 14 t2: mean values MEAN2 / Trend mean values TRM2 16 analog inputs AIN
42764	LIMIT_OFFSET	UINT16[64]	0	Index of the measurand *Base* *Index* *1* *2* *13* *14* *16* 0 U UNB_U MEAN1_1 MEAN2_1 AIN1.1 2 U1N THD_U1X MEAN1_2 MEAN2_2 AIN1.2 4 U2N THD_U2X MEAN1_3 MEAN2_3 AIN2.1 6 U3N THD_U3X MEAN1_4 MEAN2_4 AIN2.2 8 U12 TDD_I1X MEAN1_5 MEAN2_5 AIN3.1 10 U23 TDD_I2X MEAN1_6 MEAN2_6 AIN3.2 12 U31 TDD_I3X MEAN1_7 MEAN2_7 AIN4.1 14 UNE MEAN1_8 MEAN2_8 AIN4.2 16 I MEAN1_9 MEAN2_9 18 I1 MEAN1_10 MEAN2_10 20 I2 MEAN1_11 MEAN2_11 22 I3 MEAN1_12 MEAN2_12 24 IN TRM1_1 TRM2_1 26 IB TRM1_2 TRM2_2 28 IB1 TRM1_3 TRM2_3 30 IB2 TRM1_4 TRM2_4 32 IB3 TRM1_5 TRM2_5 34 P TRM1_6 TRM2_6 36 P1 TRM1_7 TRM2_7 38 P2 TRM1_8 TRM2_8 40 P3 TRM1_9 TRM2_9 42 Q TRM1_10 TRM2_10 44 Q1 TRM1_11 TRM2_11 46 Q2 TRM1_12 TRM2_12 48 Q3 50 S ... ... 86 Imean (see table general instantaneous values) For base 2 the index must be divided by 2.
42828	LIMIT_ON	INT[64]	0	Limit values for state ON Related to the configured maximum value of the measurand (100% = 16'384)
42892	LIMIT_OFF	INT[64]	0	Limit values for state OFF Related to the configured maximum value of the measurand (100% = 16'384)

- Upper limit value (monitoring of a rise over a limit value): LIMIT_ON > LIMIT_OFF

- Lower limit value (monitoring of a fall below a limit value): LIMIT_ON < LIMIT_OFF

- Hysteresis corresponds to the difference between LIMIT_ON and LIMIT_OFF

Example:
Rated current 100/1A with 50% over range, I1>120A should be monitored, hysteresis 5A

100% = 16'384 is related to 150A (100A +50%)

▶ LIMIT_ON = 16'384 x 120 / 150 = 13'107

▶ LIMIT_OFF = 16'384 x (120-5) / 150 = 12'561

7.6 Parameters of the real time clock

Address	Name	Data type	Default	Description
41550	RTC_TIME	TIME	0	UTC time in seconds since 1st of January 1970, Date range: 1.1.2005 …
41552	EV_TIME	UINT32	0	UTC time of last event
41554	RTC_SYNC	UINT16	0	Synchronization *Value* *Meaning* 0 no synchronization 1 via measurement input 2 via HV input 3, 4, 5 via digital input 1.1 / 1.2 / 1.3 6, 7, 8 via digital input 2.1 / 2.2 / 2.3 9, 10, 11 via digital input 3.1 / 3.2 / 3.3 12, 13, 14 via digital input 4.1 / 4.2 / 4.3 15 via time server (Bus card)
41555	RTC_INTERVAL	UINT32	0	Synchronization interval [s] for external time emitter
41557	RTC_AJUST	REAL	0	Clock adjustment in seconds per day + Clock is too slow - Clock goes ahead
41559	OPERATION_TIME	UINT32	0	Operating hours counter [h]
41561	NTP_UPDATE	UINT32	0	UTC time of last time synchronization via NTP

Setting the clock

Special care must be taken when putting the clock back. Present logger or list data may lie then in the future. The same happens if for test purposes the time is put forward and then back again.
In both cases no new data will be logged until the time of the last event is reached again.

7.7 Parameters of the Ethernet bus card

Address	Name	Data type	#	Default	Description
44900	TCP_IP	UINT8[4]	0	101	IP address of the Ethernet card (default: 192.168.1.101)
			1	1	
			2	168	
			3	192	
44902	TCP_SUBNET	UINT8[4]	0	255.255.255.0	Subnet mask
44904	TCP_GATEWAY	UINT8[4]	0	192.168.1.1	Gateway address
44906	TCP_NTP1	UINT8[4]	0	0.0.0.0	IP address NTP server 1
44908	TCP_NTP2	UINT8[4]	0	0.0.0.0	IP address NTP server 2
44910	TCP_PORT	UINT16	0	502	Alternative Modbus/TCP port

7.8 Parameters of the analog inputs

Address	Name	Data type	#	Default	Description
42420	AIN1.1	UINT16	0	0	Unit
		INT16	0	0	Trimming Gain ± 16'384 = ± 20mA
		INT16	0	0	Trimming Offset ± 16'384 = ± 20mA
		INT16	0	0	Input values for 0% (100% = 16'384)
			1	16'384	Input value for 100%
		REAL	0	0	Physical value for 0%
			1	16'384	Physical value for 100%
		UINT16	0	0	time constant input low-pass filter [0…5000] in 1/100 s
42430	AIN1.2				Analog input 1.2 as 1.1
42440	AIN2.1		0	0	Analog input 2.1 as 1.1
42450	AIN2.2		1	0	Analog input 2.2 as 1.1
42460	AIN3.1		0	0	Analog input 3.1 as 1.1
42470	AIN3.2		1	0	Analog input 3.2 as 1.1
42480	AIN4.1		0	0	Analog input 4.1 as 1.1
42490	AIN4.2		1	0	Analog input 4.2 as 1.1

7.9 Parameters of the digital inputs

Address	Name	Data type	#	Default	Description
42420	DIGIO1.1	UINT16	0	0	Unit
		UINT32	0	0	Number of pulses per energy unit
		UINT32	0	0	reserved
		UINT8	0	100	Minimum pulse length in ms
			1	0	*Bit* *Meaning* *0* *1* 0 Signal types state Edge 1 Polarity falling rising 2 Tariff switching OFF ON
42426	DIGIO1.2				Digital input 1.2 as 1.1
42432	DIGIO1.3				Digital input 1.3 as 1.1
42440	DIGIO2.1		0		Digital input 2.1 as 1.1
42446	DIGIO2.2		1		Digital input 2.2 as 1.1
42452	DIGIO2.3		2		Digital input 2.3 as 1.1
42460	DIGIO3.1		0		Digital input 3.1 as 1.1
42466	DIGIO3.2		1		Digital input 3.2 as 1.1
42472	DIGIO3.3		2		Digital input 3.3 as 1.1
42480	DIGIO4.1		0		Digital input 4.1 as 1.1
42486	DIGIO4.2		1		Digital input 4.2 as 1.1
42492	DIGIO4.3		2		Digital input 4.3 as 1.1

7.10 Parameters of the HV module (always module 4)

Address	Name	Data type	#	Default	Description
42480	HVIN	UINT16	0	0	Unit
		UINT32	0	0	Number of pulses per energy unit
		UINT32	0	0	reserved
		UINT8	0	100	Minimum pulse length in ms
				1	*Bit* *Meaning* *0* *1* 0 Signal types state Edge
		UINT16	0	5000	Synchronization rated frequency in 1/100 Hz

7.11 Parameters of the digital outputs

Address	Name	Data type	#	Default	Description
42420	DIGIO1.1	UINT16	0	0	reserved
		UINT16	0	0	Base of measurand *Value* *Meaning* 0 not used 7 Standard meter 8 I/O meter
		UINT32	0	0	Index of measurand *Base* *Index* *7* *8* 0 P Incoming High tariff Meter I/O 1.1 High tariff 2 P Outgoing High tariff Meter I/O 1.2 High tariff 4 Q Inductive tariff Meter I/O 1.3 High tariff 6 Q Capacitive High tariff Meter I/O 2.1 High tariff 8 Q Incoming High tariff Meter I/O 2.2 High tariff 10 Q Outgoing High tariff Meter I/O 2.3 High tariff 12 P Incoming Low tariff Meter I/O 3.1 High tariff 14 P Outgoing Low tariff Meter I/O 3.2 High tariff 16 Q Inductive Low tariff Meter I/O 3.3 High tariff 18 Q Capacitive Low tariff Meter I/O 4.1 High tariff 20 Q Incoming Low tariff Meter I/O 4.2 High tariff 22 Q Outgoing Low tariff Meter I/O 4.3 High tariff 24 Meter I/O 1.1 Low tariff 26 Meter I/O 1.2 Low tariff 28 Meter I/O 1.3 Low tariff 30 Meter I/O 2.1 Low tariff 32 Meter I/O 2.2 Low tariff 34 Meter I/O 2.3 Low tariff 36 Meter I/O 3.1 Low tariff 38 Meter I/O 3.2 Low tariff 40 Meter I/O 3.3 Low tariff 42 Meter I/O 4.1 Low tariff 44 Meter I/O 4.2 Low tariff 46 Meter I/O 4.3 Low tariff
		UINT32	0	1	Pulse rate in Wh or varh
		UINT16	0	100	▪ Used as pulse output *Bit* *Meaning* 0..7 Minimum pulse width [1..255 ms] 8 0: pulse output 9,10 not used ▪ Used as limit output (via logic module) *Bit* *Meaning* 0..7 not used 8 1: state change 9 0: falling edge, 1: rising edge 10 not used ▪ Used as self-monitoring signal *Bit* *Meaning* 0..7 Delay of self-monitoring signal [1..255 s] 8 not used 9 0: low active, 1: high active signaling 10 1: Used for device self-monitoring
42426	DIGIO1.2				Digital output 1.2 as 1.1
42432	DIGIO1.3				Digital output 1.3 as 1.1
42440	DIGIO2.1		0		Digital output 2.1 as 1.1
42446	DIGIO2.2		1		Digital output 2.2 as 1.1
42452	DIGIO2.3		2		Digital output 2.3 as 1.1
42460	DIGIO3.1		0		Digital output 3.1 as 1.1
42466	DIGIO3.2		1		Digital output 3.2 as 1.1
42472	DIGIO3.3		2		Digital output 3.3 as 1.1
42480	DIGIO4.1		0		Digital output 4.1 as 1.1
42486	DIGIO4.2		1		Digital output 4.2 as 1.1
42492	DIGIO4.3		2		Digital output 4.3 as 1.1

7.12 Parameters of the analog outputs

Address	Name	Data type	#	Default	Description
42420	AOUT1.1	UINT8	0	0	Characteristic *Bit* *Meaning* 0 quadratic 1 inverted 2 linear
			1	0	Range limits output quantity Bit 0..3: lower range limit (% related to 16'384) 0: 0% 1: -5% 2: -10% 3 : -15% 4: -20% Bit 4..7: upper range limit: (% related to 16'384) 0: 0% 1: 105 2: 110% 3: 115% 4: 120%
		UINT16	0	0	Base of the measurand *Value* *Meaning* 0 not used 1 General present measurements 2 THD, TDD 13 Mean values t1 14 Mean values t2
		UINT16	0	0	Index of measurements *Base* *Index* *1* *2* *13* *14* 0 U UNB_U 1 U1N THD_U1X 2 U2N THD_U2X 3 U3N THD_U3X 4 U12 TDD_I1X 5 U23 TDD_I2X 6 U31 TDD_I3X 7 UNE 8 I 9 I1 10 I2 11 I3 12 IN AVG1.1 AVG2.1 13 IB AVG1.2 AVG2.2 14 IB1 AVG1.3 AVG2.3 15 IB2 AVG1.4 AVG2.4 16 IB3 AVG1.5 AVG2.5 17 P AVG1.6 AVG2.6 18 P1 AVG1.7 AVG2.7 19 P2 AVG1.8 AVG2.8 20 P3 AVG1.9 AVG2.9 21 Q AVG1.10 AVG2.10 22 Q1 AVG1.11 AVG2.11 23 Q2 AVG1.12 AVG2.12 24 Q 25 S 26 S1 27 S2 28 S3 29 F etc. (see table general present measurements) For base 1, 13 and 14 (data type real) the index must be multiplied by 2.
		INT16	0	0	Value of input quantity for 0% (100% = 16'384)
			1	8'162	Value of input quantity for kink point
			2	16'384	Value of input quantity for 100%
		INT16	0	0	Value of output quantity for 0% (20mA = 16'384)
			1	8'162	Value of output quantity for kink point
			2	16'384	Value of output quantity for 100%
		UINT16	0	0	Time constant low-pass output filter [0…5000] in 1/100s
42430	AOUT1.2				Analog output 1.2 as 1.1
42440	AOUT2.1		0		Analog output 2.1 as 1.1
42450	AOUT2.2		1		Analog output 2.2 as 1.1
42460	AOUT3.1		0		Analog output 3.1 as 1.1
42470	AOUT3.2		1		Analog output 3.2 as 1.1
42480	AOUT4.1		0		Analog output 4.1 as 1.1
42490	AOUT4.2		1		Analog output 4.2 as 1.1

7.13 Parameters of the free Modbus image

Here the measurements of the Modbus image and the sequence of the measurements within the image can be freely defined.

Address	Name	Data type	#	Default	Description
46200	FREE_MB_SRC	UINT16[60]	0	0	*Low byte: Base of the 1st measurement* *Value* *Meaning* 0 not used 1 General instantaneous values 13 Mean values t1 14 Mean values t2 40 System analysis *High byte: Index of the 1st measurement* *Base* *Index* *1* *13* *14* *40* 0 U MEAN1.1 MEAN2.1 UR1 2 U1N MEAN1.2 MEAN2.2 UR2 4 U2N MEAN1.3 MEAN2.3 U0 6 U3N MEAN1.4 MEAN2.4 IR1 8 U12 MEAN1.5 MEAN2.5 IR2 10 U23 MEAN1.6 MEAN2.6 I0 12 U31 MEAN1.7 MEAN2.7 UNB_UR2_UR1 14 UNE MEAN1.8 MEAN2.8 UNB_IR2_IR1 16 I MEAN1.9 MEAN2.9 UNB_U0_UR1 18 I1 MEAN1.10 MEAN2.10 UNB_I0_IR1 20 I2 MEAN1.11 MEAN2.11 THD_U1x 22 I3 MEAN1.12 MEAN2.12 THD_U2x 24 IN TRM1_1 TRM2_1 THD_U3x 26 IB TRM1_2 TRM2_2 TDD_I1 28 IB1 TRM1_3 TRM2_3 TDD_I2 30 IB2 TRM1_4 TRM2_4 TDD_I3 32 IB3 TRM1_5 TRM2_5 34 P TRM1_6 TRM2_6 36 P1 TRM1_7 TRM2_7 38 P2 TRM1_8 TRM2_8 40 P3 TRM1_9 TRM2_9 42 Q TRM1_10 TRM2_10 44 Q1 TRM1_11 TRM2_11 46 Q2 TRM1_12 TRM2_12 48 Q3 50 S 52 S1 54 S2 56 S3 58 F 60 PF 62 PF1 64 PF2 66 PF3 68 QF 70 QF1 72 QF2 74 QF3 76 LF 78 LF1 80 LF2 82 LF3 84 Umean 86 Imean
			1 … 59		*2nd measurement, parameters as [0]* … *60th measurement, parameters as [0]*

8. Simulation mode

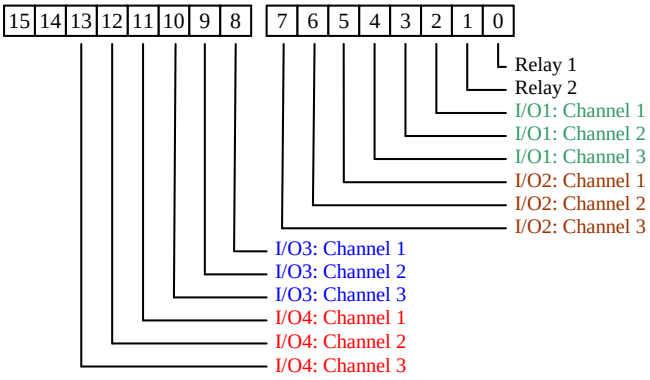
The simulation mode allows simulating the values of analog / digital outputs or the states of logical functions of the logic module. It's intended for testing of subsequent circuits during commissioning.

There are two possibilities to stop the simulation mode:
- Setting the register SIM_MOD to 0
- Switching off the auxiliary power

Address	Name	Data type	Default	Description
41600	SIM_MOD	UINT16	0	Simulation mode (0 = OFF) *Bit meaning* 0 not used 1 Logic functions 2 Analog outputs 3 Digital outputs + Relays
41601	SIM_OUT1	UINT16	0	Bit mask for simulation (see below)
41602	SIM_OUT2	UINT16	0	Bit mask for simulation (see below)

8.1 Simulation of digital outputs and relay states

Start:

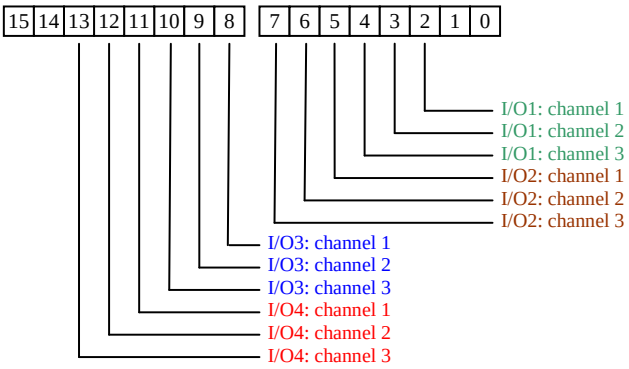
Address	Name	Value
41600	SIM_MOD	8
41601	SIM_OUT1	Which digital output channels should be simulated ? 
41602	SIM_OUT2	Not used

Setting states: For all selected channels in SIM_OUT1 a state can be simulated

Address	Name	Data type	Dedicated digital output
1	RELAY1	COIL	State relay 1
2	RELAY2	COIL	State relay 2
3	DIGOUT1.1	COIL	Present state digital output1.1
4	DIGOUT1.2	COIL	Present state digital output1.2
5	DIGOUT1.3	COIL	Present state digital output1.3
6	DIGOUT2.1	COIL	Present state digital output2.1
7	DIGOUT2.2	COIL	Present state digital output2.2
8	DIGOUT2.3	COIL	Present state digital output2.3
9	DIGOUT3.1	COIL	Present state digital output3.1
10	DIGOUT3.2	COIL	Present state digital output3.2
11	DIGOUT3.3	COIL	Present state digital output3.3
12	DIGOUT4.1	COIL	Present state digital output4.1
13	DIGOUT4.2	COIL	Present state digital output4.2
14	DIGOUT4.3	COIL	Present state digital output4.3

8.2 Simulation of analog outputs

Start:

Address	Name	Value
41600	SIM_MOD	4
41601	SIM_OUT1	Which analog output channels should be simulated ? 
41602	SIM_OUT2	Not used

Setting output values: For all selected channels in SIM_OUT1 a value can be simulated

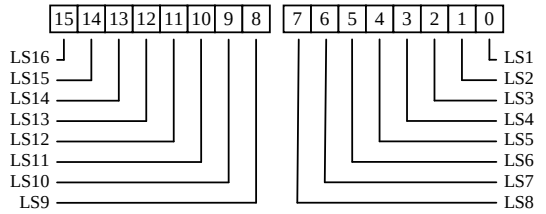
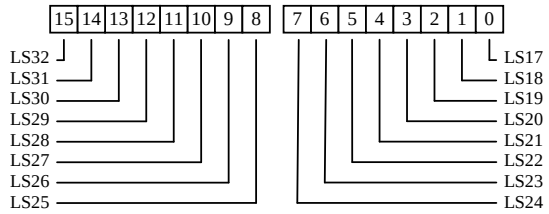
Address	Name	Data type	Dedicated analog output
41362	AOUT1	UINT16	Analog output I/O1.1
41363			Analog output I/O1.2
41364	AOUT2	UINT16	Analog output I/O2.1
41365			Analog output I/O2.2
41366	AOUT3	UINT16	Analog output I/O3.1
41367			Analog output I/O3.2
41368	AOUT4	UINT16	Analog output I/O4.1
41369			Analog output I/O4.2

16’384 corresponds to 100% of the **hardware** upper range limit (20mA).

8.3 Simulation of logic functions

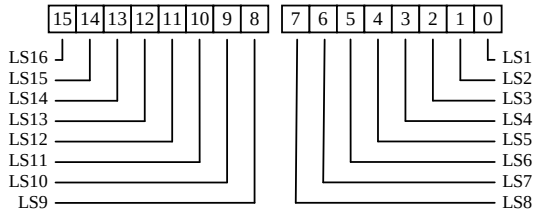
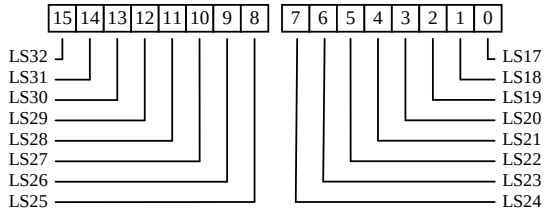
These will work starting from firmware version 1.06 of the analysis part and CB-Manager version 1.03

Start:

Address	Name	Value
41600	SIM_MOD	2
41601	SIM_OUT1	Which logic functions should be simulated ? 
41602	SIM_OUT2	Which logic functions should be simulated ? 

Logic functions not used in the logic module can't be simulated.

Setting logical states: For all selected channels in SIM_OUT1 or SIM_OUT2 a state can be simulated

Address	Name	Data type	Value
43919	LOGIC_FUNC1	UINT16	Value of logic functions LS1...LS16 
43920	LOGIC_FUNC2	UINT16	Value of logic functions LS17...LS32 

9. Remote I/O

The Modbus master can use all relays or digital outputs which **haven't been used** for the device functionality for own purposes.

This feature is supported starting from version 1.06 of the analysis part.

Address	Name	Data type	Dedicated digital output
1	RELAY1	COIL	State relay 1
2	RELAY2	COIL	State relay 2
3	DIGOUT1.1	COIL	Present state digital output1.1
4	DIGOUT1.2	COIL	Present state digital output1.2
5	DIGOUT1.3	COIL	Present state digital output1.3
6	DIGOUT2.1	COIL	Present state digital output2.1
7	DIGOUT2.2	COIL	Present state digital output2.2
8	DIGOUT2.3	COIL	Present state digital output2.3
9	DIGOUT3.1	COIL	Present state digital output3.1
10	DIGOUT3.2	COIL	Present state digital output3.2
11	DIGOUT3.3	COIL	Present state digital output3.3
12	DIGOUT4.1	COIL	Present state digital output4.1
13	DIGOUT4.2	COIL	Present state digital output4.2
14	DIGOUT4.3	COIL	Present state digital output4.3

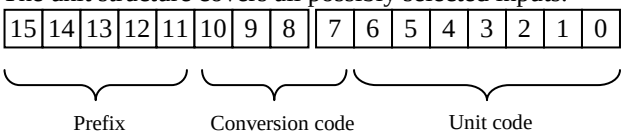
APPENDIX A

UNITS

The units deliver information about what a measured quantity is representing. So the kind of a measurement as well as its scaling is defined. The following structure covers all possible units. This definition is valid for the values of the appropriate MODBUS registers, which describe a unit. Visualization software can derive the correct measurement display from it.

Applications:
- Analog inputs: Measurand or meter unit
- Digital inputs: Meter unit

The unit structure covers all possibly selected inputs:



SI-Prefixes

Code	Name	Symbol	power
10= 01010b	*Yotta*	Y	10^{24}
9 = 01001b	*Zetta*	Z	10^{21}
8 = 01000b	Exa	E	10^{18}
7 = 00111b	Peta	P	10^{15}
6 = 00110b	Tera	T	10^{12}
5 = 00101b	Giga	G	10^{9}
4 = 00100b	Mega	M	10^{6}
3 = 00011b	Kilo	k	10^{3}
2 = 00010b	Hekto	h	10^{2}
1 = 00001b	Deka	da	10^{1}
0 = 00000b	-	-	10^{0}

Code	Name	Symbol	power
-1 = 11111b	Dezi	D	10^{-1}
-2 = 11110b	Zenti	C	10^{-2}
-3 = 11101b	Milli	M	10^{-3}
-4 = 11100b	Mikro	µ	10^{-6}
-5 = 11011b	Nano	N	10^{-9}
-6 = 11010b	Pico	P	10^{-12}
-7 = 11001b	Femto	F	10^{-15}
-8 = 11000b	Atto	A	10^{-18}
-9 = 10111b	*Zepto*	Z	10^{-21}
-10 = 10110b	*Yocto*	y	10^{-24}

Special case: Coding for decibel
For that the prefix code is used: 10000b = 20 * log(X/X0)
10001b = 10 * log(X/X0)

Unit code

Code	Description	Unit	
1	no unit		-
2	length	Meter	m
3	mass	Gram *)	G
4	time	Seconds	s
5	current	Ampere	A
6	temperature	Kelvin	K
7	Amount of substance	Mol	mol
8	luminous intensity	Candela	Cd
9	plane angle	*(61850: Grad)*	rad
10	plane angle	Radiant	rad
11	solid angle	Steradiant	sr
21	absorbed dose	Gray	Gy
22	activity	Becquerel	Bq
23	relative temperature		°C
24	dose equivalent	Sievert	Sv
25	electric capacitance	Farad	F
26	electric charge		As
27	electric conductance	Siemens	1/Ω
28	electric inductivity	Henry	H
29	electric potential	Volt	V
30	electric resistance	Ohm	Ω
31	energy	Joule	Ws
32	force	Newton	N
33	frequency	Hertz	Hz
34	illuminance	Lux	lx
35	luminous flux	Lumen	lm
36	magnetic flux	Weber	Wb
37	magnetic flux density	Tesla	T
38	power	Watt	W
39	pressure		N/m^2
41	area		m^2
42	volume		m^3
43	velocity		m/s
44	acceleration		m/s^2
45	volume rate		m^3/s
46	fuel efficiency		m/m^3
47	moment of mass		M
48	density	*)	g/m^3
49	viscosity		m^2/s
50	thermal conductivity		W/m K
51	heat capacity		J/K
52	concentration		ppm
53	rotational speed		s^{-1}
54	angular velocity		rad s^{-1}

Code	Description	Unit	
61	apparent power		VA
62	active power	Watt	W
63	reactive power		Var
64	phase angle		rad
65	power factor cos phi		-
66	volt seconds		Vs
67	volts squared		V^2
68	amp seconds		As
69	amps squared		A^2
70	amps squared time		A^2s
71	apparent energy		VAs
72	active energy		Ws
73	reactive energy		vars
74	magnetic flux	Weber	V/Hz
80	specific electrical resistance	Ohmmeter	Ωm
81	magnetic induction		A/m
82	current density		A/m^2
83	molar mass		g/mol
84	molar volume		m^3/mol
85	molar heat capacity		J/mol
86	electric charge	Coulomb	C
87	electric field strength		V/m
88	irradiation		J/m^2
89	energy flux density		W/m^2
90	radiant intensity		W/sr
91	radiance		$W/sr*s^2$
92	luminance		cd/m^2
93	quantity of light		lm*s
94	luminous exposure		lx*s
95	lens power	Dioptre	1/m
96	radiant flux		W
97	sound pressure		N/m^2
98	sound intensity		W/m^2
99	permeability		H/m
100	mechanical stress		N/m^2
101	torque	Newton meter	Nm
102	spring rate		N/m
103	volume throughput		m^3*s

*) The SI unit would be kg. But instead of kg g is used, because kilo is coded by the prefix.

Conversion code

The SI prefix is always related to the first unit (e.g. km/h)

The conversion code 0 represents the unit which is mentioned in the table of the unit codes.

Physical quantity	Code	Unit			Physical quantity	Code	Unit	
Temperature	0	Kelvin	K	⇔	**Heat capacity**	0	Kelvin	J/K
	1	Celsius	°C			1	Celsius	J/°C
	2	Fahrenheit	°F			2	Fahrenheit	J/°F
	3	Rankine	°R			3	Rankine	J/°R
Plane angle	0	Radiant	rad	⇔	**Angular velocity**	0		rad/s
	1	Grad	1°			1		°/s
	2	Minutes	1’			⇳		
	3	Seconds	1’’		**Angular acceleration**	0		rad / s^2
	4	Gon	gon			1		° / s^2
	5	Cent. degree	1^g					
	6	Cent. minute	1^c					
	7	Cent. second	1^{cc}					
Force	0	Newton	N	⇔	**Torque**	0	Newton meter	Nm
	1	Pond	p			1	Pondmeter	pm
	2	Dyn	dyn					
	3	pound-force	lbf					
	4	poundal	pdl					
Mass	0	Gram	g		**Pressure**	0		N/ m^2
	1	Ton	t			1	Pascal	Pa
	2	metr. carat	Kt			2	Bar	bar
	3	pound	lb			3		Torr
	4	ounce	oz			4	techn. atm.	at
	5	ton				5	phys. atm.	atm
	6	long ton				6	Meter water column	m WS
	7	short ton				7	Millimeter mercury column	mm HG
Luminous intensity	0	Candela	cd	⇔	**Luminance**	0		cd / m^2
						1	Stilb	sb
						2	Apostilb	asb
magnetic induction	0		A/m		**magnetic flux**	0	Weber	Wb
	1	Oersted	Oe			1	Maxwell	M
Induction	0	Tesla	T					
	1	Gauss	G					
					Ionic dose	0	C / kg	
						1	Roentgen	
without unit	0	-	-		**Energy dose**	0	Gray	Gy
	1	Relation	-			1	Rad	rd
	2	Percent	%		**Activity**	0	Becquerel	Bq
	3	Parts per Million	ppm			1	Curie	Ci
	15	invalid	-					

Physical quantity	Code	Unit			Physical quantity	Code	Unit	
mechanical stress	0 1 2		N/ m^2 p/ mm^2 p/ cm^2		**Surface tension**	0 1		N/m dyn/cm
Length	0 1 2 3 4 5 6 7	Meter inch foot yard mile Nautical mile Angström Light year	m in ft yd Mi Sm Å lj	⇔ ⇗ ⇙	**Area**	0 1 2 3 4 5 6 7	 square inch square foot square yard square mile Ar Hectare Barn	m^2 in^2 ft^2 yd^2 mi^2 a ha b
Volume	0 1 2 3 4 5 6 7 8 9	 cubic inch cubic foot cubic yard cubic mile Litre gallon (UK) gallon (US) barrel bushels	m^3 in^3 ft^3 yd^3 mi^3 l gal gal	⇔	**Volume meter**	0 1 2 3 4 5 6 7	 cubic inch cubic foot cubic yard cubic mile Litre gallon (UK) gallon (US)	m^3s in^3s ft^3s yd^3s mi^3s ls gal*s gal*s
Power	0 1 2 3 4 5 6	Watt Horse power	W J/s PS cal/s eV/s cal/h pm/s	⇔	**Energy**	0 1 2 3 4 5 6 7	Watt seconds Joule calorie Elektron volt Erg brit. term. unit Watt hour	Ws J PSh cal eV erg btu Wh
Reactive power	0		Var	⇔	**Reactive energy**	0 7		vars varh
Apparent power	0		VA	⇔	**Apparent energy**	0 7		VAs VAh
Luminous flux	0		lm	⇔	**Quantity of light**	0 7		lm*s lm*h
electric current	0		A	⇔	**electric charge**	0 7		As Ah
Time	0 1 2 3 4 5 ⇳	Seconds Minutes Hours Day Month Year	s min h d Mt Y	⇔	**Velocity** ⇳	0 1 2 3 4 5 6	 Knots	m/s m/min m/h m/d m/Mt m/Y kn
Frequency	0 1 2 3 4 5		Hz 1/min 1/h 1/d 1/Mt 1/Y		**Acceleration**	0 1 2 3 4 5		m/s^2 m/min^2 m/h^2 m/d^2 m/Mt^2 m/Y^2

Yellow marked are those units, which may be directly converted into the depending unit (e.g. P ⇔ E)