

# Modbus/RTU interface SINEAX DM5000

## Content

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>EIA-RS-485 Standard .....</b>                                       | <b>2</b>  |
| 1.1      | Coding .....   | 2         |
| 1.2      | Connections.....   | 2         |
| 1.3      | Topology.....  | 2         |
| 1.4      | System requirements .....  | 2         |
| <b>2</b> | <b>Coding and addressing .....</b>                                     | <b>3</b>  |
| <b>3</b> | <b>Mapping.....</b>  | <b>4</b>  |
| 3.1      | Address space.....   | 4         |
| 3.2      | Used addresses.....  | 5         |
| 3.3      | Used Syntax .....  | 6         |
| <b>4</b> | <b>Device information .....</b>  | <b>7</b>  |
| 4.1      | Device identification .....  | 7         |
| <b>5</b> | <b>Measurements .....</b>  | <b>8</b>  |
| 5.1      | General instantaneous values.....                                      | 8         |
| 5.2      | System analysis.....   | 9         |
| 5.2.1    | Instantaneous values of harmonic analysis .....                        | 9         |
| 5.2.2    | Instantaneous values of imbalance analysis acc. Fortescue .....        | 10        |
| 5.2.3    | Instantaneous values of extended power analysis.....                   | 10        |
| 5.3      | Minimum / maximum values of system quantities.....                     | 11        |
| 5.4      | Minimum / maximum values of system analysis .....                      | 12        |
| 5.4.1    | Maximum values of harmonic analysis .....                              | 12        |
| 5.4.2    | Maximum values of imbalance analysis acc. Fortescue .....              | 13        |
| 5.4.3    | Maximum values of extended power analysis.....                         | 13        |
| 5.5      | Mean-values: Trend, Last values, minimum / maximum values .....        | 14        |
| 5.5.1    | Mean values of power (standard quantities), averaging interval t1..... | 14        |
| 5.5.2    | User-defined mean values, averaging interval t2.....                   | 14        |
| 5.5.3    | Bimetal current, averaging interval t3.....                            | 14        |
| 5.6      | Resetting of min/max values .....                                      | 15        |
| 5.7      | Present state of limit values .....                                    | 15        |
| 5.8      | Present state of monitoring functions .....                            | 15        |
| 5.9      | Summary alarm .....  | 15        |
| <b>6</b> | <b>Energy meters.....</b>  | <b>16</b> |
| 6.1      | Meter contents of standard quantities .....                            | 16        |
| 6.2      | Meter contents of user-defined quantities .....                        | 16        |
| 6.3      | Meter contents of digital inputs.....                                  | 17        |
| 6.4      | Present tariff of meters .....   | 17        |
| <b>7</b> | <b>Operating hour counters .....</b>                                   | <b>18</b> |
| <b>8</b> | <b>Remote interface .....</b>  | <b>19</b> |

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

## GMC INSTRUMENTS

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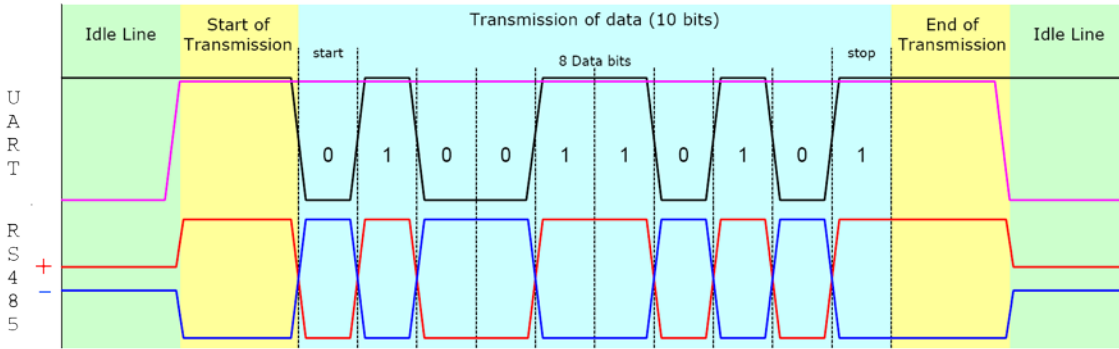


# 1 EIA-RS-485 Standard

The EIA-RS 485 standard defines the physical layer of the Modbus interface.

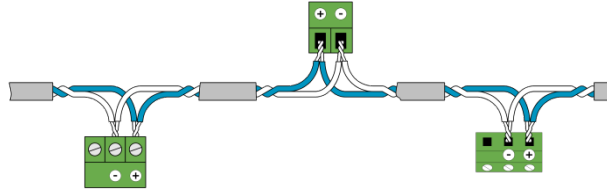
## 1.1 Coding

The data will be transferred serially via the 2-wire bus. The information is coded in NRZ code as a differential signal. The positive polarity signals a logical 1, the negative polarity signals a logical 0.

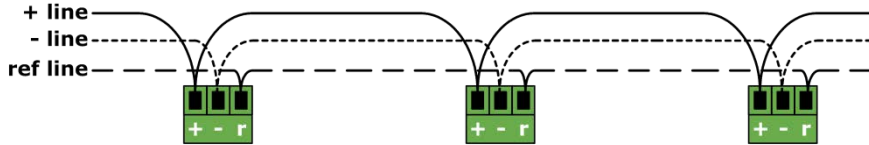


## 1.2 Connections

We recommend using a shielded and twisted two-wire bus cable. Shielding improves the electromagnetic compatibility (EMC). The notation of the wires A resp. B is contradictory depending on the information source.

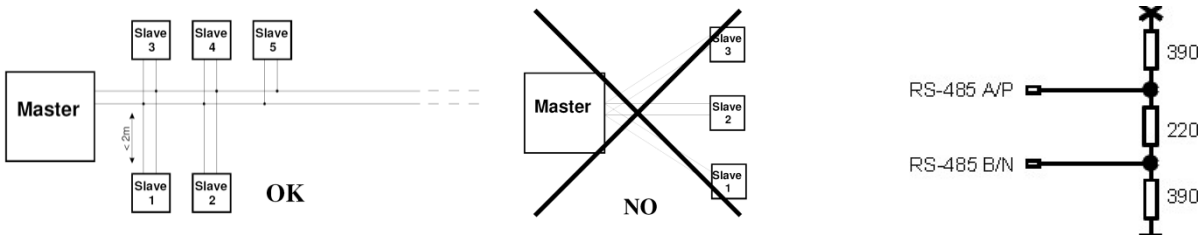


The potential difference of all bus members must not exceed  $\pm 7V$ . Therefore the use of a shield or of a third wire (ref line) for potential equalization is recommended.



## 1.3 Topology

On both ends of the bus cable a termination resistor must be provided. In addition to the bus termination resistors a resistor  $R_U$  (Pull-up) must be connected to the supply voltage and a resistor  $R_D$  (Pull down) to the reference potential. By means of these two resistors a defined idle state of the line is ensured if no bus member is sending data.



## 1.4 System requirements

- Cable : twisted 2-wire line, characteristic impedance 100 up to 130  $\Omega$ , min. 0.22mm<sup>2</sup> (24AWG)
- Cable length : maximum of 1'200m, depending on the transfer rate
- Members : maximum of 32 per segment
- Baud rate : 2'400, 4'800, 9'600, 19'200, 38'400, 57'600, 115'200 Baud
- Mode : 11 Bit format - 2 stop bits, no parity or 1 stop bit with odd/even parity  
10 Bit format - 1 stop bit, no parity (possible, but not in accordance with Modbus standard)

## 2 Coding and addressing

### Addressing

Modbus groups different data types as references. For addressing the data one have to know that Modbus starts the register numeration at 1, but the addressing at 0.

*Example: Measurement U1N on register address 102*

- Address declaration in value table (see chapter 5.1): (4x)102
- Real address: 102 (offset 1)
- Address used in telegram transmission: 101 (offset 0)

### Serializing

The Modbus specification defines the telegrams to be sequences of data bytes. For the correct serializing of the bytes (MSB or LSB First), the appropriate physical layer (RS485, Ethernet) is responsible. The RS485 (UART, COM) transmits the „Least Significant Bit“ first (LSB First) and adds the synchronization and parity bits (start bit, parity bit and stop bit).

|       |   |   |   |   |   |   |   |   |     |      |
|-------|---|---|---|---|---|---|---|---|-----|------|
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Par | Stop |
|-------|---|---|---|---|---|---|---|---|-----|------|

### 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 coils 100 up to 111 of device 17

| Byte | Request              |       | Answer        |             |
|------|----------------------|-------|---------------|-------------|
| 1    | Slave address        | 0x11  | Slave address | 0x11        |
| 2    | Function code        | 0x01  | Function code | 0x01        |
| 3    | Start address        | 0x00  | Byte count    | 0x02        |
| 4    | 99 = Coil 100        | 0x63  | Byte 1        | <b>0x53</b> |
| 5    | Number of registers: | 0x00  | Byte 2        | <b>0x03</b> |
| 6    | 100...111 => 12      | 0x0C  | Checksum      | crc_l       |
| 7    | Checksum             | crc_l | CRC16         | crc_h       |
| 8    | CRC16                | crc_h |               |             |

The start address of the request plus the bit position in the answer bytes 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 12 | Coil 11 | Coil 10 | Coil 9 |
|--------|------|-----------|---|---|---|---|---------|---------|---------|--------|
| Byte 2 | 0x03 | 00000011b | - | - | - | - | OFF     | OFF     | ON      | ON     |

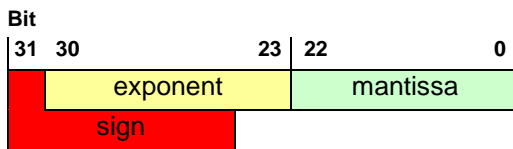
## Reading float numbers (REAL): Function 0x03, Read Holding Register

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.

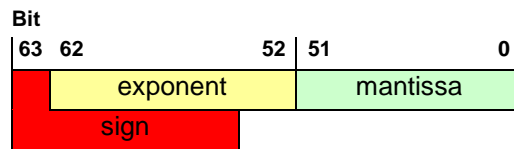
The IEEE 754 standard as the most often used standard for the representation of floating numbers is applied. 32 and 64 Bit numbers are used:

- The first register contains the bits 0 – 15
- The second register contains the bits 16 – 31
- The third register contains the bits 32 – 47
- The fourth register contains the bits 48 – 63

32-Bit Float (REAL32)



64-Bit Float (REAL64)



Example: Reading voltage U1N on register address 102 of device 17.

| Byte | Request                   |       | Answer        |       |
|------|---------------------------|-------|---------------|-------|
| 1    | Slave address             | 0x11  | Slave address | 0x11  |
| 2    | Function code             | 0x03  | Function code | 0x03  |
| 3    | Start address<br>(102-1)  | 0x00  | Byte Count    | 0x04  |
| 4    |                           | 0x65  | Byte 1        | 0xE8  |
| 5    | Number of registers:<br>2 | 0x00  | Byte 2        | 0x78  |
| 6    |                           | 0x02  | Byte 3        | 0x43  |
| 7    | Checksum<br>CRC16         | crc_l | Byte 4        | 0x6B  |
| 8    |                           | crc_h | Checksum      | crc_l |
| 9    |                           |       | CRC16         | crc_h |

| 0x436B |                     |   |   |   |   |   |   |   |  |   |   |   |   |   |   | 0xE878 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |
|--------|---------------------|---|---|---|---|---|---|---|--|---|---|---|---|---|---|--------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|
| 0      | 1                   | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1  | 1 | 0 | 1 | 0 | 1 | 1 | 1      | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |  |
| +      | Exponent: 134-127=7 |   |   |   |   |   |   |   | Mantissa=1.1101011110100001111000b=1,84303188323974609375d |   |   |   |   |   |   |        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |

➤  $U1N = +1,84303188323974609375 * 2^7 = 234,908V$

## 3 Mapping

### 3.1 Address space

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

| Space                 | Access              | Function code        |  |
|-----------------------|---------------------|----------------------|--|
| Coil / 0x             | readable / writable | 0x01<br>0x05<br>0x0F | Read Coil Status<br>Force Single Coil<br>Force Multiple Coils                            |
| Discrete input / 1x   | read only           | 0x02                 | Read Input Status <sup>1)</sup>  |
| Input register / 3x   | read only           | 0x04                 | Read Input Register <sup>1)</sup>  |
| Holding register / 4x | readable / writable | 0x03<br>0x06<br>0x10 | Read Holding Register<br>Force Single Register <sup>1)</sup><br>Preset Multiple Register |

1) not implemented

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

### 3.2 Used addresses

| 4x addresses | # Reg. | Description  | Access |
|--------------|--------|--|--------|
| 100 – 193    | 94     | Instantaneous values general                                   | R      |
| 850 – 885    | 36     | Instantaneous values of imbalance analysis acc. Fortescue      | R      |
| 900 – 947    | 48     | Instantaneous values of extended power analysis                | R      |
| 1000 – 1081  | 82     | Timestamps of minimum/maximum of instantaneous values          | R      |
| 1100 – 1181  | 82     | Minimum/maximum of instantaneous values                        | R      |
| 1200 – 1811  | 612    | Maximum values of harmonic analysis                            | R      |
| 1850 – 1865  | 16     | Maximum values of imbalance analysis acc. Fortescue            | R      |
| 1870 – 1909  | 40     | Timestamps of maximum values of extended power analysis        | R      |
| 1920 – 1959  | 40     | Maximum values of extended power analysis                      | R      |
| 2000 – 2099  | 100    | Power mean-values: Trend, last value, minimum / maximum value  | R      |
| 2150 – 2293  | 144    | User-defined mean-values: Trend, last value, minimum / maximum | R      |
| 2300 – 2323  | 24     | Bimetal current: Present value, timestamp and slave-pointer    | R      |
| 2600 – 2631  | 32     | Reading meter contents of standard quantities (REAL64)         | R      |
| 2640 – 2735  | 96     | Reading meter contents of user-defined quantities (REAL64)     | R      |
| 2740 – 2741  | 2      | Reading device operating hour counter                          | R      |
| 2742 – 2747  | 6      | Reading free operating hour counters 1...3                     | R      |
| 2750 – 2781  | 32     | Setting meter contents of standard quantities                  | W      |
| 2790 – 2885  | 48     | Setting meter contents of user-defined quantities              | W      |
| 2900 – 2915  | 16     | Setting analog outputs (remote control)                        | W      |
| 2940 – 3067  | 128    | Reading meter contents of digital inputs (REAL64)              | R      |
| 3080 – 3143  | 64     | Reading meter contents of digital inputs (REAL32)              | R      |
| 3160 – 3287  | 128    | Setting meter contents of digital inputs                       | W      |
| 4100 – 4115  | 16     | Reading meter contents of standard quantities (REAL32)         | R      |
| 4120 – 4167  | 48     | Reading meter contents of user-defined quantities (REAL32)     | R      |
| 4200 – 4229  | 30     | Instantaneous values THD/TDD                                   | R      |
| 4230 – 6209  | 1980   | Instantaneous values of harmonics                              | R      |
| 6250 – 6271  | 22     | Timestamps min/max values harmonic analysis                    | R      |
| 6300 – 6321  | 22     | Maximum values THD /TDD  | R      |
| 6326 – 8301  | 1976   | Maximum values harmonics                                       | R      |
| 8400 – 8655  | 256    | Reserved for CUx0000   | R      |

| 0x addresses | # Coils | Description                            | Access |
|--------------|---------|--|--------|
| 1 – 5        | 5       | Reset of min/max values group 1...5    | W      |
| 20           | 1       | Reset of summary alarm                 | W      |
| 30 – 32      | 3       | Reset of operating hour counters 1...3 | W      |
| 50 – 55      | 6       | Remote I/O                             | W      |
| 100 – 111    | 12      | State of limit values 1-12             | R      |
| 140 – 147    | 8       | State of monitoring functions 1...8    | R      |
| 170 – 171    | 2       | State of summary alarm                 | R      |
| 180          | 1       | State of energy meter tariff           | R      |

**Access:** R = readable, W = writable

### 3.3 Used Syntax

|                                       |  |
|---------------------------------------|--|
| <b>Address 4x / 0x</b>                | Start address of described data block (Register, Coil or Input Status)   |
| <b>Time</b>                           | 4x register address of a timestamp, typically of a minimum / maximum value   |
| <b>Value</b>                          | 4x register address of a measured value, typically for minimum / maximum values  |
| <b>Reset</b>                          | Coil 0x register address to reset a corresponding measured quantity  |
| <b>Name</b>                           | Unique name of a variable or structure   |
| <b>Type</b>                           | <p><b>Data type of variable</b></p> <p>UINT32: 32-bit integer without sign</p> <p>REAL32 (32-bit float)</p> <p>REAL64 (64-bit float)</p> <p>CHAR[.]:String with/without termination (NULL)</p> <p>TIME: seconds since 1970/1/1 (UINT32)</p> <p>COIL: Bit information</p>   |
| <b>Default</b>                        | Value when delivering, after a hardware reset or if quantity is not available  |
| <b>Description</b>                    | Description of the quantity  |
| 14   2L   3G   3P   3U   3A   4U   4O | <p>Availability of the measured quantities, depending on the connected system</p> <p><b>14</b> = single phase system or 4-wire balanced load</p> <p><b>2L</b> = two phase system (split phase)</p> <p><b>3G</b> = 3-wire balanced load</p> <p><b>3P</b> = 3-wire balanced load, phase shift (2U,1I) <b>available for AM3000 only</b></p> <p><b>3U</b> = 3-wire unbalanced load</p> <p><b>3A</b> = 3-wire balanced load, Aron connection</p> <p><b>4U</b> = 4-wire unbalanced load</p> <p><b>4O</b> = 4-wire unbalanced load, Open-Y connection</p> |

## 4 Device information

### 4.1 Device identification

The type of the connected device may be identified using the function **Report Slave ID (0x11)**.

| Device address | Function | CRC      |           |
|----------------|----------|----------|-----------|
| ADDR           | 0x11     | Low-Byte | High-Byte |

Device answer:

| Device address | Function | #Bytes | Device ID | Data1 | Data2 | CRC      |           |
|----------------|----------|--------|-----------|-------|-------|----------|-----------|
| ADDR           | 0x11     | 3      | <sid>     |       |       | Low-Byte | High-Byte |

|      |      |        |                                       |
|------|------|--------|---------------------------------------|
| 0x01 | 0x00 | VR660  | Temperature controller                |
| 0x02 | 0x00 | A200R  | Display unit temperature controller   |
| 0x03 | 0x01 | CAM    | Measurement unit power quantities     |
| 0x04 | 0xFF | APLUS  | Multifunctional display unit          |
| 0x05 | 0x00 | V604s  | Universal transmitter                 |
| 0x05 | 0x01 | VB604s | Universal transmitter                 |
| 0x05 | 0x02 | VC604s | Universal transmitter                 |
| 0x05 | 0x03 | VQ604s | Universal transmitter                 |
| 0x07 | 0x00 | VS30   | Temperature transmitter               |
| 0x08 | 0x00 | DM5S   | Multi-transducer DM5S                 |
| 0x08 | 0x01 | DM5F   | Multi-transducer DM5F                 |
| 0x0A | 0xFF | HW730  | Angular transmitter                   |
| 0x0B | 0xFF | AM1000 | Multifunctional display unit          |
| 0x0C | 0xFF | AM2000 | Multifunctional display unit          |
| 0x0D | 0xFF | AM3000 | Multifunctional display unit          |
| 0x0E | 0xFF | PQ3000 | Power quality display unit            |
| 0x0F | 0xFF | PQ5000 | Power quality measurement unit        |
| 0x10 | 0xFF | DM5000 | Measurement unit power quantities     |
| 0x11 | 0xFF | CU3000 | Multif. display unit with CODESYS     |
| 0x12 | 0xFF | CU5000 | Multif. measurement unit with CODESYS |
| 0x13 | 0xFF | PQ1000 | Power quality display unit            |

The value for Data2 is reserved for future extensions.

## 5 Measurements

### 5.1 General instantaneous values

| Address<br>4x | Name     | 14 | 2L | 3G | 3P | 3U | 3A | 4U | 4O | Type   | Description   |
|---------------|----------|----|----|----|----|----|----|----|----|--------|---|
| 100           | U        | ●  | ●  | -  | -  | ●  | -  | -  | -  | REAL32 | System voltage [V]                                    |
| 102           | U1N      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Voltage phase L1 to N [V]                             |
| 104           | U2N      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Voltage phase L2 to N [V]                             |
| 106           | U3N      | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Voltage phase L3 to N [V]                             |
| 108           | U12      | -  | -  | ●  | ●  | -  | ●  | ●  | ●  |        | Voltage phase L1 to L2 [V]                            |
| 110           | U23      | -  | -  | ●  | ●  | -  | ●  | ●  | ●  |        | Voltage phase L2 to L3 [V]                            |
| 112           | U31      | -  | -  | ●  | ●  | -  | ●  | ●  | ●  |        | Voltage phase L3 to L1 [V]                            |
| 114           | UNE      | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Zero displacement voltage in 4-wire systems [V]       |
| 116           | I        | ●  | -  | ●  | ●  | ●  | -  | -  | -  | REAL32 | System current [A]                                    |
| 118           | I1       | -  | ●  | -  | -  | -  | ●  | ●  | ●  |        | Current in phase L1 [A]                               |
| 120           | I2       | -  | ●  | -  | -  | -  | ●  | ●  | ●  |        | Current in phase L2 [A]                               |
| 122           | I3       | -  | -  | -  | -  | -  | ●  | ●  | ●  |        | Current in phase L3 [A]                               |
| 124           | I4 / IN  | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Neutral current [A]                                   |
| 126           | P        | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | Active power system [W]                               |
| 128           | P1       | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Active power phase 1 (L1 – N) [W]                     |
| 130           | P2       | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Active power phase 2 (L2 – N) [W]                     |
| 132           | P3       | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Active power phase 3 (L3 – N) [W]                     |
| 134           | Q        | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | Reactive power system [var]                           |
| 136           | Q1       | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Reactive power phase 1 (L1 – N) [var]                 |
| 138           | Q2       | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Reactive power phase 2 (L2 – N) [var]                 |
| 140           | Q3       | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Reactive power phase 3 (L3 – N) [var]                 |
| 142           | S        | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | Apparent power system S [VA]                          |
| 144           | S1       | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Reactive power phase 1 (L1 – N) [VA]                  |
| 146           | S2       | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Reactive power phase 2 (L2 – N) [VA]                  |
| 148           | S3       | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Reactive power phase 3 (L3 – N) [VA]                  |
| 150           | F        | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | System frequency [Hz]                                 |
| 152           | PF       | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | PF = P / S, Power factor system                       |
| 154           | PF1      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Power factor phase 1 (L1 – N)                         |
| 156           | PF2      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Power factor phase 2 (L2 – N)                         |
| 158           | PF3      | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Power factor phase 3 (L3 – N)                         |
| 160           | QF       | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | QF = Q / S, Reactive power factor system              |
| 162           | QF1      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Reactive power factor phase 1 (L1 – N)                |
| 164           | QF2      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Reactive power factor phase 2 (L2 – N)                |
| 166           | QF3      | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Reactive power factor phase 3 (L3 – N)                |
| 168           | LF       | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | sign(Q)·(1 – abs(PF)), Load factor system             |
| 170           | LF1      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Load factor phase 1 (L1 – N)                          |
| 172           | LF2      | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Load factor phase 2 (L2 – N)                          |
| 174           | LF3      | -  | -  | -  | -  | -  | -  | ●  | ●  |        | Load factor phase 3 (L3 – N)                          |
| 176           | U_MEAN   | -  | ●  | ●  | ●  | -  | ●  | ●  | -  | REAL32 | Average value of voltages (U1x+U2x+U3x)/3 [V]         |
| 178           | I_MEAN   | -  | ●  | -  | -  | -  | -  | ●  | ●  |        | Average value of currents (I1+I2+I3)/3 [A]            |
| 180           | UF12     | -  | -  | ●  | ●  | -  | ●  | ●  | ●  | REAL32 | Phase angle voltage U1-U2 [°]                         |
| 182           | UF23     | -  | -  | ●  | ●  | -  | ●  | ●  | ●  |        | Phase angle voltage U2-U3 [°]                         |
| 184           | UF31     | -  | -  | ●  | ●  | -  | ●  | ●  | ●  |        | Phase angle voltage U3-U1 [°]                         |
| 186           | DEV_UMAX | -  | ●  | ●  | ●  | -  | ●  | ●  | ●  | REAL32 | Max. deviation from the average value of voltages [V] |
| 188           | DEV_IMAX | -  | ●  | -  | -  | -  | ●  | ●  | ●  | REAL32 | Max. deviation from the average value of currents [A] |
| 190           | IMS      | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | REAL32 | Average value of currents with sign of P [A]          |
| 192           | IPE      | -  | -  | -  | -  | -  | -  | ●  | ●  | REAL32 | Earth current [A]                                     |



## 5.2 System analysis

### 5.2.1 Instantaneous values of harmonic analysis

| Address 4x | Name    | Type   | Description   |
|------------|---------|--------|---|
| 4200       | THD_U1N | REAL32 | Total Harmonic Distortion Voltage U1N [%]               |
| 4202       | THD_U2N |        | Total Harmonic Distortion Voltage U2N [%]               |
| 4204       | THD_U3N |        | Total Harmonic Distortion Voltage U3N [%]               |
| 4206       | THD_U12 | REAL32 | Total Harmonic Distortion Voltage U12 [%]               |
| 4208       | THD_U23 |        | Total Harmonic Distortion Voltage U23 [%]               |
| 4210       | THD_U31 |        | Total Harmonic Distortion Voltage U31 [%]               |
| 4212       | THD_UNE | REAL32 | Total Harmonic Distortion Voltage U31 [%] <sup>1)</sup> |
| 4214       | TDD_I1  | REAL32 | Total Demand Distortion current I1 [%]                  |
| 4216       | TDD_I2  |        | Total Demand Distortion current I2 [%]                  |
| 4218       | TDD_I3  |        | Total Demand Distortion current I3 [%]                  |
| 4220       | TDD_IN  | REAL32 | Total Demand Distortion current IN [%]                  |
| 4222       | THD_I1  | REAL32 | Total Harmonic Distortion current I1 [%]                |
| 4224       | THD_I2  |        | Total Harmonic Distortion current I2 [%]                |
| 4226       | THD_I3  |        | Total Harmonic Distortion current I3 [%]                |
| 4228       | THD_IN  | REAL32 | Total Harmonic Distortion current IN [%] <sup>1)</sup>  |

<sup>1)</sup> not implemented yet

- ▶ THD\_U: Harmonic content related to the fundamental of the RMS value of the voltage
- ▶ TDD\_I: Harmonic content related to the **rated value** of the current
- ▶ THD\_I: Harmonic content related to the fundamental of the RMS value of the current

| Address 4x | Name    | Type   | Description  |
|------------|---------|--------|--|
| 4234       | H2_U1N  | REAL32 | Voltage U1N: Content 2 <sup>nd</sup> harmonic [%]                |
| 4408       | H89_U1N |        | Voltage U1N: Content 89 <sup>th</sup> harmonic [%]               |
| 4414       | H2_U2N  | REAL32 | Voltage U2N: Content 2 <sup>nd</sup> harmonic [%]                |
| 4588       | H89_U2N |        | Voltage U2N: Content 89 <sup>th</sup> harmonic [%]               |
| 4594       | H2_U3N  | REAL32 | Voltage U3N: Content 2 <sup>nd</sup> harmonic [%]                |
| 4768       | H89_U3N |        | Voltage U3N: Content 89 <sup>th</sup> harmonic [%]               |
| 4774       | H2_U12  | REAL32 | Voltage U12: Content 2 <sup>nd</sup> harmonic [%]                |
| 4948       | H89_U12 |        | Voltage U12: Content 89 <sup>th</sup> harmonic [%]               |
| 4954       | H2_U23  | REAL32 | Voltage U23: Content 2 <sup>nd</sup> harmonic [%]                |
| 5128       | H89_U23 |        | Voltage U23: Content 89 <sup>th</sup> harmonic [%]               |
| 5134       | H2_U31  | REAL32 | Voltage U31: Content 2 <sup>nd</sup> harmonic [%]                |
| 5308       | H89_U31 |        | Voltage U31: Content 89 <sup>th</sup> harmonic [%]               |
| 5314       | H2_UNE  | REAL32 | Voltage UNE: Content 2 <sup>nd</sup> harmonic [%] <sup>1)</sup>  |
| 5488       | H89_UNE |        | Voltage UNE: Content 89 <sup>th</sup> harmonic [%] <sup>1)</sup> |
| 5494       | H2_I1   | REAL32 | Current I1: Content 2 <sup>nd</sup> harmonic [%]                 |
| 5668       | H89_I1  |        | Current I1: Content 89 <sup>th</sup> harmonic [%]                |
| 5674       | H2_I2   | REAL32 | Current I2: Content 2 <sup>nd</sup> harmonic [%]                 |
| 5848       | H89_I2  |        | Current I2: Content 89 <sup>th</sup> harmonic [%]                |
| 5854       | H2_I3   | REAL32 | Current I3: Content 2 <sup>nd</sup> harmonic [%]                 |
| 6028       | H89_I3  |        | Current I3: Content 89 <sup>th</sup> harmonic [%]                |
| 6034       | H2_IN   | REAL32 | Current IN: Content 2 <sup>nd</sup> harmonic [%] <sup>1)</sup>   |
| 6208       | H89_IN  |        | Current IN: Content 89 <sup>th</sup> harmonic [%] <sup>1)</sup>  |

<sup>1)</sup> not implemented yet

- ▶ Hi\_Uxy: Harmonic content of the voltage related to the fundamental 100 %
- ▶ Hi\_Ix: Harmonic content of the current related to the **rated** current
- ▶ At rated frequency 60Hz harmonics are available up to the 75<sup>th</sup> only, the other values are 0.0

### 5.2.2 Instantaneous values of imbalance analysis acc. Fortescue

| Address 4x | Name        | 14 | 2L | 3G | 3P | 3U | 3A | 4U | 4O | Type   | Description                           |
|------------|-------------|----|----|----|----|----|----|----|----|--------|---------------------------------------|
| 850        | UR1         | -  | -  | •  | -  | •  | •  | •  | -  | REAL32 | Voltage [V]: Positive sequence        |
| 852        | UR2         | -  | -  | •  | -  | •  | •  | •  | -  |        | Voltage [V]: Negative sequence        |
| 854        | U0          | -  | -  | -  | -  | -  | -  | •  | -  |        | Voltage [V]: Zero sequence            |
| 856        | IR1         | -  | -  | -  | -  | •  | -  | •  | •  | REAL32 | Current [A]: Positive sequence        |
| 858        | IR2         | -  | -  | -  | -  | •  | -  | •  | •  |        | Current [A]: Negative sequence        |
| 860        | I0          | -  | -  | -  | -  | -  | -  | •  | •  |        | Current [A]: Zero sequence            |
| 862        | UNB_UR2_UR1 | -  | -  | •  | -  | •  | •  | •  | -  | REAL32 | Imbalance factor voltage: UR2/UR1 [%] |
| 864        | UNB_IR2_IR1 | -  | -  | -  | -  | •  | -  | •  | •  |        | Imbalance factor current: IR2/IR1 [%] |
| 866        | UNB_U0_UR1  | -  | -  | -  | -  | -  | -  | •  | -  | REAL32 | Imbalance factor voltage: U0/UR1 [%]  |
| 868        | UNB_I0_IR1  | -  | -  | -  | -  | -  | -  | •  | •  |        | Imbalance factor current: I0/IR1 [%]  |

### 5.2.3 Instantaneous values of extended power analysis

| Address 4x | Name  | 14 | 2L | 3G | 3G | 3U | 3A | 4U | 4O | Type   | Description                                   |
|------------|-------|----|----|----|----|----|----|----|----|--------|---|
| 900        | P_H1  | •  | •  | •  | •  | •  | •  | •  | •  | REAL32 | Fundamental active power, system [W]          |
| 902        | P1_H1 | -  | •  | -  | -  | -  | -  | •  | •  |        | Fundamental active power, L1 [W]              |
| 904        | P2_H1 | -  | •  | -  | -  | -  | -  | •  | •  |        | Fundamental active power, L2 [W]              |
| 906        | P3_H1 | -  | -  | -  | -  | -  | -  | •  | •  |        | Fundamental active power, L3 [W]              |
| 908        | Q_H1  | •  | •  | •  | •  | •  | •  | •  | •  | REAL32 | Reactive power of fundamental, system [var]   |
| 910        | Q1_H1 | -  | •  | -  | -  | -  | -  | •  | •  |        | Reactive power of fundamental, phase L1 [var] |
| 912        | Q2_H1 | -  | •  | -  | -  | -  | -  | •  | •  |        | Reactive power of fundamental, phase L2 [var] |
| 914        | Q3_H1 | -  | -  | -  | -  | -  | -  | •  | •  |        | Reactive power of fundamental, phase L3 [var] |
| 924        | S_H1  | •  | •  | •  | •  | •  | •  | •  | •  | REAL32 | Fundamental apparent power, system [VA]       |
| 926        | S1_H1 | -  | •  | -  | -  | -  | -  | •  | •  |        | Fundamental apparent power, L1 [VA]           |
| 928        | S2_H1 | -  | •  | -  | -  | -  | -  | •  | •  |        | Fundamental apparent power, L2 [VA]           |
| 930        | S3_H1 | -  | -  | -  | -  | -  | -  | •  | •  |        | Fundamental apparent power, L3 [VA]           |
| 924        | D     | •  | •  | •  | •  | •  | •  | •  | •  | REAL32 | Distortion reactive power, system [var]       |
| 926        | D1    | -  | •  | -  | -  | -  | -  | •  | •  |        | Distortion reactive power, phase L1 [var]     |
| 928        | D2    | -  | •  | -  | -  | -  | -  | •  | •  |        | Distortion reactive power, phase L2 [var]     |
| 930        | D3    | -  | -  | -  | -  | -  | -  | •  | •  |        | Distortion reactive power, phase L3 [var]     |
| 932        | CPHI  | •  | •  | •  | •  | •  | •  | •  | •  | REAL32 | cos( $\varphi$ ) of fundamental, system       |
| 934        | CPHI1 | -  | •  | -  | -  | -  | -  | •  | •  |        | cos( $\varphi$ ) of fundamental, phase L1     |
| 936        | CPHI2 | -  | •  | -  | -  | -  | -  | •  | •  |        | cos( $\varphi$ ) of fundamental, phase L2     |
| 938        | CPHI3 | -  | -  | -  | -  | -  | -  | •  | •  |        | cos( $\varphi$ ) of fundamental, phase L3     |
| 940        | TPHI  | •  | •  | •  | •  | •  | •  | •  | •  | REAL32 | tan( $\varphi$ ) of fundamental, system       |
| 942        | TPHI1 | -  | •  | -  | -  | -  | -  | •  | •  |        | tan( $\varphi$ ) of fundamental, phase L1     |
| 944        | TPHI2 | -  | •  | -  | -  | -  | -  | •  | •  |        | tan( $\varphi$ ) of fundamental, phase L2     |
| 946        | TPHI3 | -  | -  | -  | -  | -  | -  | •  | •  |        | tan( $\varphi$ ) of fundamental, phase L3     |

### 5.3 Minimum / maximum values of system quantities

| Time<br>[TIME] | Value<br>[REAL32] | Name         | 14 | 2L | 3G | 3P | 3U | 3A | 4U | 4O | Description                    |
|----------------|-------------------|--------------|----|----|----|----|----|----|----|----|--------------------------------|
| 1000           | 1100              | U_MAX        | •  | •  | -  | •  | -  | -  | -  | -  | Maximum value of U [V]         |
| 1002           | 1102              | U1N_MAX      | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of U1N [V]       |
| 1004           | 1104              | U2N_MAX      | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of U2N [V]       |
| 1006           | 1106              | U3N_MAX      | -  | -  | -  | -  | -  | -  | •  | •  | Maximum value of U3N [V]       |
| 1008           | 1108              | U12_MAX      | -  | -  | •  | -  | •  | •  | •  | •  | Maximum value of U12 [V]       |
| 1010           | 1110              | U23_MAX      | -  | -  | •  | -  | •  | •  | •  | •  | Maximum value of U23 [V]       |
| 1012           | 1112              | U31_MAX      | -  | -  | •  | -  | •  | •  | •  | •  | Maximum value of U31 [V]       |
| 1014           | 1114              | UNE_MAX      | -  | -  | -  | -  | -  | -  | •  | •  | Maximum value of UNE [V]       |
| 1016           | 1116              | I_MAX        | •  | -  | •  | •  | -  | -  | -  | -  | Maximum value of I [A]         |
| 1018           | 1118              | I1_MAX       | -  | •  | -  | -  | •  | •  | •  | •  | Maximum value of I1 [A]        |
| 1020           | 1120              | I2_MAX       | -  | -  | -  | -  | •  | •  | •  | •  | Maximum value of I2 [A]        |
| 1022           | 1122              | I3_MAX       | -  | -  | -  | -  | •  | •  | •  | •  | Maximum value of I3 [A]        |
| 1024           | 1124              | IN_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of IN [A]        |
| 1026           | 1126              | P_MAX        | •  | •  | •  | •  | •  | •  | •  | •  | Maximum value of P [W]         |
| 1028           | 1128              | P1_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of P1 [W]        |
| 1030           | 1130              | P2_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of P2 [W]        |
| 1032           | 1132              | P3_MAX       | -  | -  | -  | -  | -  | -  | •  | •  | Maximum value of P3 [W]        |
| 1034           | 1134              | Q_MAX        | •  | •  | •  | •  | •  | •  | •  | •  | Maximum value of Q [var]       |
| 1036           | 1136              | Q1_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of Q1 [var]      |
| 1038           | 1138              | Q2_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of Q2 [var]      |
| 1040           | 1140              | Q3_MAX       | -  | -  | -  | -  | -  | -  | •  | •  | Maximum value of Q3 [var]      |
| 1042           | 1142              | S_MAX        | •  | •  | •  | •  | •  | •  | •  | •  | Maximum value of S [VA]        |
| 1044           | 1144              | S1_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of S1 [VA]       |
| 1046           | 1146              | S2_MAX       | -  | •  | -  | -  | -  | -  | •  | •  | Maximum value of S2 [VA]       |
| 1048           | 1148              | S3_MAX       | -  | -  | -  | -  | -  | -  | •  | •  | Maximum value of S3 [VA]       |
| 1050           | 1150              | F_MAX        | •  | •  | •  | •  | •  | •  | •  | •  | Maximum value of F [Hz]        |
| 1052           | 1152              | DEV_UMAX_MAX | -  | -  | •  | -  | •  | •  | •  | •  | Maximum value of DEV_UMAX [V]  |
| 1054           | 1154              | DEV_IMAX_MAX | -  | -  | -  | -  | •  | •  | •  | •  | Maximum value of DEV_IMAX [A]  |
| 1056           | 1156              | U_MIN        | •  | •  | -  | •  | -  | -  | -  | -  | Minimum value of U [V]         |
| 1058           | 1158              | U1N_MIN      | -  | •  | -  | -  | -  | -  | •  | •  | Minimum value of U1N [V]       |
| 1060           | 1160              | U2N_MIN      | -  | •  | -  | -  | -  | -  | •  | •  | Minimum value of U2N [V]       |
| 1062           | 1162              | U3N_MIN      | -  | -  | -  | -  | -  | -  | •  | •  | Minimum value of U3N [V]       |
| 1064           | 1164              | U12_MIN      | -  | -  | •  | -  | •  | •  | •  | •  | Minimum value of U12 [V]       |
| 1066           | 1166              | U23_MIN      | -  | -  | •  | -  | •  | •  | •  | •  | Minimum value of U23 [V]       |
| 1068           | 1168              | U31_MIN      | -  | -  | •  | -  | •  | •  | •  | •  | Minimum value of U31 [V]       |
| 1070           | 1170              | PF_MIN_QI    | •  | •  | •  | •  | •  | •  | •  | •  | min. power factor quadrant I   |
| 1072           | 1172              | PF_MIN_QIV   | •  | •  | •  | •  | •  | •  | •  | •  | min. power factor quadrant IV  |
| 1074           | 1174              | PF_MIN_QIII  | •  | •  | •  | •  | •  | •  | •  | •  | min. power factor quadrant III |
| 1076           | 1176              | PF_MIN_QII   | •  | •  | •  | •  | •  | •  | •  | •  | min. power factor quadrant II  |
| 1078           | 1178              | F_MIN        | •  | •  | •  | •  | •  | •  | •  | •  | Minimum value of F [Hz]        |
| 1080           | 1180              | IPE_MAX      | -  | -  | -  | -  | -  | -  | •  | •  | Maximum value of IPE [A]       |

- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.

## 5.4 Minimum / maximum values of system analysis

### 5.4.1 Maximum values of harmonic analysis

| Time [TIME] | Value [REAL32] | Name        | Description                                  |
|-------------|----------------|-------------|--|
| 6250        | 6300           | THD_U1N_MAX | max. THD value voltage U1N [%]               |
| 6252        | 6302           | THD_U2N_MAX | max. THD value voltage U2N [%]               |
| 6254        | 6304           | THD_U3N_MAX | max. THD value voltage U3N [%]               |
| 6256        | 6306           | THD_U12_MAX | max. THD value voltage U12 [%]               |
| 6258        | 6308           | THD_U23_MAX | max. THD value voltage U23 [%]               |
| 6260        | 6310           | THD_U31_MAX | max. THD value voltage U31 [%]               |
| 6262        | 6312           | THD_UNE_MAX | max. THD value voltage UNE [%] <sup>1)</sup> |
| 6264        | 6314           | TDD_I1_MAX  | max. TDD value current I1 [%]                |
| 6266        | 6316           | TDD_I2_MAX  | max. TDD value current I2 [%]                |
| 6268        | 6318           | TDD_I3_MAX  | max. TDD value current I3 [%]                |
| 6270        | 6320           | TDD_IN_MAX  | max. TDD value current IN [%] <sup>1)</sup>  |

| Time [TIME] | Value [REAL32] | Name        | Description   |
|-------------|----------------|-------------|---|
| 6250        | 6326           | H2_U1N_MAX  | Voltage U1N: Max. content 2 <sup>nd</sup> harmonic [%]                |
|             | 6500           | H89_U1N_MAX | Voltage U1N: Max. content 89 <sup>th</sup> harmonic [%]               |
| 6252        | 6506           | H2_U2N_MAX  | Voltage U2N: Max. content 2 <sup>nd</sup> harmonic [%]                |
|             | 6680           | H89_U2N_MAX | Voltage U2N: Max. content 89 <sup>th</sup> harmonic [%]               |
| 6254        | 6686           | H2_U3N_MAX  | Voltage U3N: Max. content 2 <sup>nd</sup> harmonic [%]                |
|             | 6860           | H89_U3N_MAX | Voltage U3N: Max. content 89 <sup>th</sup> harmonic [%]               |
| 6256        | 6866           | H2_U12_MAX  | Voltage U12: Max. content 2 <sup>nd</sup> harmonic [%]                |
|             | 7040           | H89_U12_MAX | Voltage U12: Max. content 89 <sup>th</sup> harmonic [%]               |
| 6258        | 7046           | H2_U23_MAX  | Voltage U23: Max. content 2 <sup>nd</sup> harmonic [%]                |
|             | 7220           | H89_U23_MAX | Voltage U23: Max. content 89 <sup>th</sup> harmonic [%]               |
| 6260        | 7226           | H2_U31_MAX  | Voltage U31: Max. content 2 <sup>nd</sup> harmonic [%]                |
|             | 7400           | H89_U31_MAX | Voltage U31: Max. content 89 <sup>th</sup> harmonic [%]               |
| 6262        | 7406           | H2_UNE_MAX  | Voltage UNE: Max. content 2 <sup>nd</sup> harmonic [%] <sup>1)</sup>  |
|             | 7580           | H89_UNE_MAX | Voltage UNE: Max. content 89 <sup>th</sup> harmonic [%] <sup>1)</sup> |
| 6264        | 7586           | H2_I1X_MAX  | Current I1: Max. content 2 <sup>nd</sup> harmonic [%]                 |
|             | 7760           | H89_I1X_MAX | Current I1: Max. content 89 <sup>th</sup> harmonic [%]                |
| 6266        | 7766           | H2_I2X_MAX  | Current I2: Max. content 2 <sup>nd</sup> harmonic [%]                 |
|             | 7940           | H89_I2X_MAX | Current I2: Max. content 89 <sup>th</sup> harmonic [%]                |
| 6268        | 7946           | H2_I3X_MAX  | Current I3: Max. content 2 <sup>nd</sup> harmonic [%]                 |
|             | 8120           | H89_I3X_MAX | Current I3: Max. content 89 <sup>th</sup> harmonic [%]                |
| 6270        | 8126           | H2_IN_MAX   | Current IN: Max. content 2 <sup>nd</sup> harmonic [%] <sup>1)</sup>   |
|             | 8300           | H89_IN_MAX  | Current IN: Max. content 89 <sup>th</sup> harmonic [%] <sup>1)</sup>  |

<sup>1)</sup> not implemented yet

- ▶ The maximum values of the harmonic analysis arise from monitoring the maximum values of THD resp. TDD. The maximum values of the individual harmonics are not monitored separately, but stored when a maximum value of THD or TDD is recognized. The image of the maximum harmonics therefore always corresponds to the associated THD resp. TDD.
- ▶ At rated frequency 60Hz only harmonics up to the 75<sup>th</sup> are available, the other values are 0.0
- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.

The individual harmonics are implemented as 32-bit float numbers (2 registers per value).

### 5.4.2 Maximum values of imbalance analysis acc. Fortescue

| Time [TIME] | Value [REAL32] | Name            | 14 | 2L | 3G | 3P | 3U | 3A | 4U | 4O | Description                |
|-------------|----------------|-----------------|----|----|----|----|----|----|----|----|----------------------------|
| 1850        | 1858           | UNB_UR2_UR1_MAX | -  | -  | ●  | -  | ●  | ●  | ●  | -  | max. imbalance UR2/UR1 [%] |
| 1852        | 1860           | UNB_IR2_IR1_MAX | -  | -  | -  | -  | -  | -  | ●  | ●  | max. imbalance IR2/IR1 [%] |
| 1854        | 1862           | UNB_U0_UR1_MAX  | -  | -  | -  | -  | ●  | -  | ●  | -  | max. imbalance U0/UR1 [%]  |
| 1856        | 1864           | UNB_I0_IR1_MAX  | -  | -  | -  | -  | -  | -  | ●  | ●  | max. imbalance I0/IR1 [%]  |

- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.

The imbalance maximum values are implemented as 32-bit float numbers (2 registers per value).

### 5.4.3 Maximum values of extended power analysis

| Time [TIME] | Value [REAL32] | Name          | 14 | 2L | 3G | 3P | 3U | 3A | 4U | 4O | Description                                     |
|-------------|----------------|---------------|----|----|----|----|----|----|----|----|---|
| 1870        | 1920           | P_MAX_H1      | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | Max. active power of fundamental, system [W]    |
| 1872        | 1922           | P1_MAX_H1     | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. active power of fundamental, phase L1 [W]  |
| 1874        | 1924           | P2_MAX_H1     | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. active power of fundamental, phase L2 [W]  |
| 1876        | 1926           | P3_MAX_H1     | -  | -  | -  | -  | -  | -  | ●  | ●  | Max. active power of fundamental, phase L3 [W]  |
| 1878        | 1928           | Q_MAX_H1      | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | Max. reactive power fundamental, system [var]   |
| 1880        | 1930           | Q1_MAX_H1     | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. reactive power fundamental, phase L1 [var] |
| 1882        | 1932           | Q2_MAX_H1     | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. reactive power fundamental, phase L2 [var] |
| 1884        | 1934           | Q3_MAX_H1     | -  | -  | -  | -  | -  | -  | ●  | ●  | Max. reactive power fundamental, phase L3 [var] |
| 1886        | 1936           | S_MAX_H1      | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | Max. apparent power of fundamental, system [VA] |
| 1888        | 1938           | S1_MAX_H1     | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. apparent power fundamental, phase L1 [VA]  |
| 1890        | 1940           | S2_MAX_H1     | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. apparent power fundamental, phase L2 [VA]  |
| 1892        | 1942           | S3_MAX_H1     | -  | -  | -  | -  | -  | -  | ●  | ●  | Max. apparent power fundamental, phase L3 [VA]  |
| 1894        | 1944           | D_MAX         | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | Max. distortion reactive power, system [var]    |
| 1896        | 1946           | D1_MAX        | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. distortion reactive power, phase L1 [var]  |
| 1898        | 1948           | D2_MAX        | -  | ●  | -  | -  | -  | -  | ●  | ●  | Max. distortion reactive power, phase L2 [var]  |
| 1900        | 1950           | D3_MAX        | -  | -  | -  | -  | -  | -  | ●  | ●  | Max. distortion reactive power, phase L3 [var]  |
| 1902        | 1952           | CPHI_MIN_QI   | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | min. cos( $\varphi$ ) quadrant I (*)            |
| 1904        | 1954           | CPHI_MIN_QIV  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | min. cos( $\varphi$ ) quadrant IV (*)           |
| 1906        | 1956           | CPHI_MIN_QIII | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | min. cos( $\varphi$ ) quadrant III (*)          |
| 1908        | 1958           | CPHI_MIN_QII  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | min. cos( $\varphi$ ) quadrant II (*)           |

(\*) min. cos( $\varphi$ ) of the system fundamental in all 4 quadrants

All values are implemented as 32-bit float numbers (2 registers per value).

- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.

## 5.5 Mean-values: Trend, Last values, minimum / maximum values

### 5.5.1 Mean values of power (standard quantities), averaging interval t1

| Name         | Trend    | Mean-value                 | Maximum        |                   | Minimum        |                   | Description                         |
|--------------|----------|----------------------------|----------------|-------------------|----------------|-------------------|-------------------------------------|
|              | [REAL32] | Last ..... - 4<br>[REAL32] | Time<br>[TIME] | Value<br>[REAL32] | Time<br>[TIME] | Value<br>[REAL32] |                                     |
| AVG_P_I_IV   | 2000     | 2010... 2018               | 2060           | 2080              | 2070           | 2090              | Mean-value P, quadrant I+IV [W]     |
| AVG_P_II_III | 2002     | 2020... 2028               | 2062           | 2082              | 2072           | 2092              | Mean-value P, quadrant II+III [W]   |
| AVG_Q_I_II   | 2004     | 2030... 2038               | 2064           | 2084              | 2074           | 2094              | Mean-value Q, quadrant I+II [var]   |
| AVG_Q_III_IV | 2006     | 2040... 2048               | 2066           | 2086              | 2076           | 2096              | Mean-value Q, quadrant III+IV [var] |
| AVG_S        | 2008     | 2050... 2058               | 2068           | 2088              | 2078           | 2098              | Mean-value S [VA]                   |

- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.
- ▶ For each of the standard quantities the mean-value for the last interval and the 4 previous values are provided.

### 5.5.2 User-defined mean values, averaging interval t2

| Name   | Trend    | Mean-value       | Maximum        |                   | Minimum        |                   | Description           |
|--------|----------|------------------|----------------|-------------------|----------------|-------------------|-----------------------|
|        | [REAL32] | Last<br>[REAL32] | Time<br>[TIME] | Value<br>[REAL32] | Time<br>[TIME] | Value<br>[REAL32] |                       |
| AVG_1  | 2150     | 2174             | 2198           | 2246              | 2222           | 2270              | Config. mean-value 1  |
| AVG_2  | 2152     | 2176             | 2200           | 2248              | 2224           | 2272              | Config. mean-value 2  |
| AVG_3  | 2154     | 2178             | 2202           | 2250              | 2226           | 2274              | Config. mean-value 3  |
| AVG_4  | 2156     | 2180             | 2204           | 2252              | 2228           | 2276              | Config. mean-value 4  |
| AVG_5  | 2158     | 2182             | 2206           | 2254              | 2230           | 2278              | Config. mean-value 5  |
| AVG_6  | 2160     | 2184             | 2208           | 2256              | 2232           | 2280              | Config. mean-value 6  |
| AVG_7  | 2162     | 2186             | 2210           | 2258              | 2234           | 2282              | Config. mean-value 7  |
| AVG_8  | 2164     | 2188             | 2212           | 2260              | 2236           | 2284              | Config. mean-value 8  |
| AVG_9  | 2166     | 2190             | 2214           | 2262              | 2238           | 2286              | Config. mean-value 9  |
| AVG_10 | 2168     | 2192             | 2216           | 2264              | 2240           | 2288              | Config. mean-value 10 |
| AVG_11 | 2170     | 2194             | 2218           | 2266              | 2242           | 2290              | Config. mean-value 11 |
| AVG_12 | 2172     | 2196             | 2220           | 2268              | 2244           | 2292              | Config. mean-value 12 |

- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.

### 5.5.3 Bimetal current, averaging interval t3

| Name | Value    | Maximum        |                   |    |    |    |    |    |    |    |    | Description                            |                                |                                |
|------|----------|----------------|-------------------|----|----|----|----|----|----|----|----|--|--------------------------------|--------------------------------|
|      | [REAL32] | Time<br>[TIME] | Value<br>[REAL32] | 14 | 2L | 3G | 3P | 3U | 3A | 4U | 4O |  |                                |                                |
| IB   | 2300     | 2308           | 2316              | •  | -  | •  | •  | -  | -  | -  | -  | Damped current in balanced systems [A] |                                |                                |
| IB1  | 2302     | 2310           | 2318              | -  | •  | -  | -  | •  | •  | •  | •  |  | Damped current in phase L1 [A] |                                |
| IB2  | 2304     | 2312           | 2320              | -  | •  | -  | -  | •  | •  | •  | •  |  |                                | Damped current in phase L2 [A] |
| IB3  | 2306     | 2314           | 2322              | -  | -  | -  | -  | •  | •  | •  | •  |  |                                |                                |

- ▶ Resetting of min/max values in groups, see [Resetting of min/max values](#)
- ▶ A timestamp "1.1.1970" indicates that the associated measurement is invalid.

## 5.6 Resetting of min/max values

Min/max values may be reset in groups via coils.

| Address 0x | Name    | Type | Group to be reset   |
|------------|---------|------|---|
| 1          | MM_RES1 | COIL | - Min/max of voltages, currents, frequency  |
| 2          | MM_RES2 | COIL | - Min/max of active, reactive, apparent power<br>- Min/max of fundamental and distortion reactive power<br>- Minimum values of load factors, $\cos\phi$ |
| 3          | MM_RES3 | COIL | - Min/Max values of power mean-values / configurable mean-values<br>- Bimetal slave pointers  |
| 4          | MM_RES4 | COIL | - Maximum of THD U/I, TDD I, individual harmonics   |
| 5          | MM_RES5 | COIL | - Maximum values of imbalance analysis  |

## 5.7 Present state of limit values

| Address 0x | Name       | Type | Description                           |           |
|------------|------------|------|---------------------------------------|-----------|
| 100        | LIMIT_ST1  | COIL | State of limit value 1 (0=OFF, 1=ON)  | read only |
| 101        | LIMIT_ST2  |      | State of limit value 2 (0=OFF, 1=ON)  |           |
| 102        | LIMIT_ST3  |      | State of limit value 3 (0=OFF, 1=ON)  |           |
| 103        | LIMIT_ST4  |      | State of limit value 4 (0=OFF, 1=ON)  |           |
| 104        | LIMIT_ST5  |      | State of limit value 5 (0=OFF, 1=ON)  |           |
| 105        | LIMIT_ST6  |      | State of limit value 6 (0=OFF, 1=ON)  |           |
| 106        | LIMIT_ST7  |      | State of limit value 7 (0=OFF, 1=ON)  |           |
| 107        | LIMIT_ST8  |      | State of limit value 8 (0=OFF, 1=ON)  |           |
| 108        | LIMIT_ST9  |      | State of limit value 9 (0=OFF, 1=ON)  |           |
| 109        | LIMIT_ST10 |      | State of limit value 10 (0=OFF, 1=ON) |           |
| 110        | LIMIT_ST11 |      | State of limit value 11 (0=OFF, 1=ON) |           |
| 111        | LIMIT_ST12 |      | State of limit value 12 (0=OFF, 1=ON) |           |

## 5.8 Present state of monitoring functions

| Address 0x | Name     | Type | Description   |           |
|------------|----------|------|---|-----------|
| 140        | MFUN_ST1 | COIL | State of monitoring function 1 (0=inactive, 1=active) | read only |
| 141        | MFUN_ST2 |      | State of monitoring function 2 (0=inactive, 1=active) |           |
| 142        | MFUN_ST3 |      | State of monitoring function 3 (0=inactive, 1=active) |           |
| 143        | MFUN_ST4 |      | State of monitoring function 4 (0=inactive, 1=active) |           |
| 144        | MFUN_ST5 |      | State of monitoring function 5 (0=inactive, 1=active) |           |
| 145        | MFUN_ST6 |      | State of monitoring function 6 (0=inactive, 1=active) |           |
| 146        | MFUN_ST7 |      | State of monitoring function 7 (0=inactive, 1=active) |           |
| 147        | MFUN_ST8 |      | State of monitoring function 8 (0=inactive, 1=active) |           |

## 5.9 Summary alarm

The summary alarm represents the over-all alarm state of the device. It is the AND combination of all defined monitoring functions enabled for the summary alarm and is active if at least one function is in the alarm state. The summary alarm is used for showing the alarm state on the display and can also activate a logic output (e.g. digital output or relay).

Via interface the summary alarm may be influenced as follows:

- **Resetting** the logic output of the summary alarm: The output will be reset even if there summary alarm is active.

| Address 0x | Name         | Type | Description   |
|------------|--------------|------|---|
| 170        | SA_STATE     | COIL | State of summary alarm (0=inactive, 1=active)                 |
| 171        | SA_RES_STATE | COIL | Logic output of summary alarm (0=inactive or reset, 1=active) |
| 20         | SA_RESET     | COIL | For <b>Resetting</b> the logic output of the summary alarm    |

## 6 Energy meters

Meter contents may be read in two different formats:

- REAL64 numbers (4 registers per value): High resolution
- REAL32 numbers (2 registers per value): Reduced resolution

All meter contents are scaled in the basic unit of the appropriate base quantity

### 6.1 Meter contents of standard quantities

| Reading<br>[REAL64] | Reading<br>[REAL32] | Writing<br>[REAL64] | Name        | 14 | 2L | 3G | 3G | 3U | 3A | 4U | 4O | Description                                 |
|---------------------|---------------------|---------------------|-------------|----|----|----|----|----|----|----|----|---|
| 2600                | 4100                | 2750                | P_I_IV_HT   | •  | •  | •  | •  | •  | •  | •  | •  | Active energy QI+IV, high tariff [Wh]       |
| 2604                | 4102                | 2754                | P_II_III_HT | •  | •  | •  | •  | •  | •  | •  | •  | Active energy QII+III, high tariff [Wh]     |
| 2608                | 4104                | 2758                | Q_I_II_HT   | •  | •  | •  | •  | •  | •  | •  | •  | Reactive energy QI+II, high tariff [varh]   |
| 2612                | 4106                | 2762                | Q_III_IV_HT | •  | •  | •  | •  | •  | •  | •  | •  | Reactive energy QIII+IV, high tariff [varh] |
| 2616                | 4108                | 2766                | P_I_IV_LT   | •  | •  | •  | •  | •  | •  | •  | •  | Active energy QI+IV, low tariff [Wh]        |
| 2620                | 4110                | 2770                | P_II_III_LT | •  | •  | •  | •  | •  | •  | •  | •  | Active energy QII+III, low tariff [Wh]      |
| 2624                | 4112                | 2774                | Q_I_II_LT   | •  | •  | •  | •  | •  | •  | •  | •  | Reactive energy QI+II, low tariff [varh]    |
| 2628                | 4114                | 2778                | Q_III_IV_LT | •  | •  | •  | •  | •  | •  | •  | •  | Reactive energy QIII+IV, low tariff [varh]  |

### 6.2 Meter contents of user-defined quantities

| Reading<br>[REAL64] | Reading<br>[REAL32] | Writing<br>[REAL64] | Name       | Description                        |
|---------------------|---------------------|---------------------|------------|------------------------------------|
| 2640                | 4120                | 2790                | METER1_HT  | User-defined meter 1, high tariff  |
| 2644                | 4122                | 2794                | METER2_HT  | User-defined meter 2, high tariff  |
| 2648                | 4124                | 2798                | METER3_HT  | User-defined meter 3, high tariff  |
| 2652                | 4126                | 2802                | METER4_HT  | User-defined meter 4, high tariff  |
| 2656                | 4128                | 2806                | METER5_HT  | User-defined meter 5, high tariff  |
| 2660                | 4130                | 2810                | METER6_HT  | User-defined meter 6, high tariff  |
| 2664                | 4132                | 2814                | METER7_HT  | User-defined meter 7, high tariff  |
| 2668                | 4134                | 2818                | METER8_HT  | User-defined meter 8, high tariff  |
| 2672                | 4136                | 2822                | METER9_HT  | User-defined meter 9, high tariff  |
| 2676                | 4138                | 2826                | METER10_HT | User-defined meter 10, high tariff |
| 2680                | 4140                | 2830                | METER11_HT | User-defined meter 11, high tariff |
| 2684                | 4142                | 2834                | METER12_HT | User-defined meter 12, high tariff |

| Reading<br>[REAL64] | Reading<br>[REAL32] | Writing<br>[REAL64] | Name       | Description                       |
|---------------------|---------------------|---------------------|------------|-----------------------------------|
| 2688                | 4144                | 2838                | METER1_NT  | User-defined meter 1, low tariff  |
| 2692                | 4146                | 2842                | METER2_NT  | User-defined meter 2, low tariff  |
| 2696                | 4148                | 2846                | METER3_NT  | User-defined meter 3, low tariff  |
| 2700                | 4150                | 2850                | METER4_NT  | User-defined meter 4, low tariff  |
| 2704                | 4152                | 2854                | METER5_NT  | User-defined meter 5, low tariff  |
| 2708                | 4154                | 2858                | METER6_NT  | User-defined meter 6, low tariff  |
| 2712                | 4156                | 2862                | METER7_NT  | User-defined meter 7, low tariff  |
| 2716                | 4158                | 2866                | METER8_NT  | User-defined meter 8, low tariff  |
| 2720                | 4160                | 2870                | METER9_NT  | User-defined meter 9, low tariff  |
| 2724                | 4162                | 2874                | METER10_NT | User-defined meter 10, low tariff |
| 2728                | 4164                | 2878                | METER11_NT | User-defined meter 11, low tariff |
| 2732                | 4166                | 2882                | METER12_NT | User-defined meter 12, low tariff |



### 6.3 Meter contents of digital inputs

| Reading<br>[REAL64] | Reading<br>[REAL32] | Writing<br>[REAL64] | Name     | Description                                   |
|---------------------|---------------------|---------------------|----------|---|
| 2940                | 3080                | 3160                | MX1_1_HT | Meter content input 1 (option 1), high tariff |
| 2944                | 3082                | 3164                | MX1_2_HT | Meter content input 2 (option 1), high tariff |
| 2948                | 3084                | 3168                | MX1_3_HT | Meter content input 3 (option 1), high tariff |
| 2952                | 3086                | 3172                | MX1_4_HT | Meter content input 4 (option 1), high tariff |
| 2956                | 3088                | 3176                | MX2_1_HT | Meter content input 1 (option 2), high tariff |
| 2960                | 3090                | 3180                | MX2_2_HT | Meter content input 2 (option 2), high tariff |
| 2964                | 3092                | 3184                | MX2_3_HT | Meter content input 3 (option 2) high tariff  |
| 2968                | 3094                | 3188                | MX2_4_HT | Meter content input 4 (option 2), high tariff |
| 3004                | 3112                | 3224                | MX1_1_NT | Meter content input 1 (option 1), low tariff  |
| 3008                | 3114                | 3228                | MX1_2_NT | Meter content input 2 (option 1), low tariff  |
| 3012                | 3116                | 3232                | MX1_3_NT | Meter content input 3 (option 1), low tariff  |
| 3016                | 3118                | 3236                | MX1_4_NT | Meter content input 4 (option 1), low tariff  |
| 3020                | 3120                | 3240                | MX2_1_NT | Meter content input 1 (option 2), low tariff  |
| 3024                | 3122                | 3244                | MX2_2_NT | Meter content input 2 (option 2), low tariff  |
| 3028                | 3124                | 3248                | MX2_3_NT | Meter content input 3 (option 2) low tariff   |
| 3032                | 3126                | 3252                | MX2_4_NT | Meter content input 4 (option 2), low tariff  |

► Digital inputs are available for device versions with appropriate input modules only

### 6.4 Present tariff of meters

The device supports two tariffs, high and low tariff. The same tariff is used for both, standard meters and free selectable meters. The tariff can be defined via digital input 0.1. The present state of this digital input therefore represents the active tariff.

| Reading<br>[COIL] | Name     | Description  | read only |
|-------------------|----------|--|-----------|
| 180               | DIGIN0_1 | <b>Tariff situation</b><br>0: high tariff<br>1: low tariff |           |

## 7 Operating hour counters

The operating hour counters have a resolution of [s]. This allow to measure operating times up to 136 years, whereby an overflow is excluded.

The operating hour counter of the device itself starts to count as soon as the power supply is applied to the device. The meter is designed as endless counter and can't be reset.

The resettable operating hour counters 1...3 count if the associated condition is fulfilled. Possible conditions are:

- always (power supply switched on)
- never (counter inactive)
- if a measured value goes above or below a certain limit value
- fulfilled monitoring function

| Reading<br>[UINT32] | Reset<br>[COIL] | Description | Description                              |
|---------------------|-----------------|-------------|--|
| 2740                | -               | OPR_CNTR    | Operating hour counter of the device [s] |
| 2742                | 30              | OPR_CNTR1   | Resettable operating hour counter 1 [s]  |
| 2744                | 31              | OPR_CNTR2   | Resettable operating hour counter 2 [s]  |
| 2746                | 32              | OPR_CNTR3   | Resettable operating hour counter 3 [s]  |

## 8 Remote interface

All relays or digital outputs **not used** for the normal device functionality may be used for other purposes. Driving is performed via the configuration interface, e.g. by means of a Modbus master software.

| Address 0x | Name    | Type | Description                 |            |
|------------|---------|------|-----------------------------|------------|
| 50         | STAT_O1 | COIL | State of digital output 0.1 | write only |
| 51         | STAT_O2 | COIL | State of digital output 0.2 |            |
| 52         | STAT_O3 | COIL | State of relay 1 (option 1) |            |
| 53         | STAT_O4 | COIL | State of relay 2 (option 1) |            |
| 54         | STAT_O5 | COIL | State of relay 1 (option 2) |            |
| 55         | STAT_O6 | COIL | State of relay 2 (option 2) |            |

► The relay outputs are available for device versions with appropriate relay modules only

### Analog outputs

| Address 4x | Name    | Type   | Description                     |            |
|------------|---------|--------|---------------------------------|------------|
| 2900       | AOUT1_1 | REAL32 | Analog output 1 (option 1) [mA] | write only |
| 2902       | AOUT1_2 | REAL32 | Analog output 2 (option 1) [mA] |            |
| 2904       | AOUT1_3 | REAL32 | Analog output 3 (option 1) [mA] |            |
| 2906       | AOUT1_4 | REAL32 | Analog output 4 (option 1) [mA] |            |
| 2908       | AOUT2_1 | REAL32 | Analog output 1 (option 2) [mA] |            |
| 2910       | AOUT2_2 | REAL32 | Analog output 2 (option 2) [mA] |            |
| 2912       | AOUT2_3 | REAL32 | Analog output 3 (option 2) [mA] |            |
| 2914       | AOUT2_4 | REAL32 | Analog output 4 (option 2) [mA] |            |

► Analog outputs are available for device versions with appropriate analog output modules only