GOSSEN METRAWATT

# A2000

**Multifunctional Power Meter**
**Modbus Communications Protocol –** *Ɲod 1–*

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## 1 General

Interface connection is described in operating instructions 3-348-981-03.
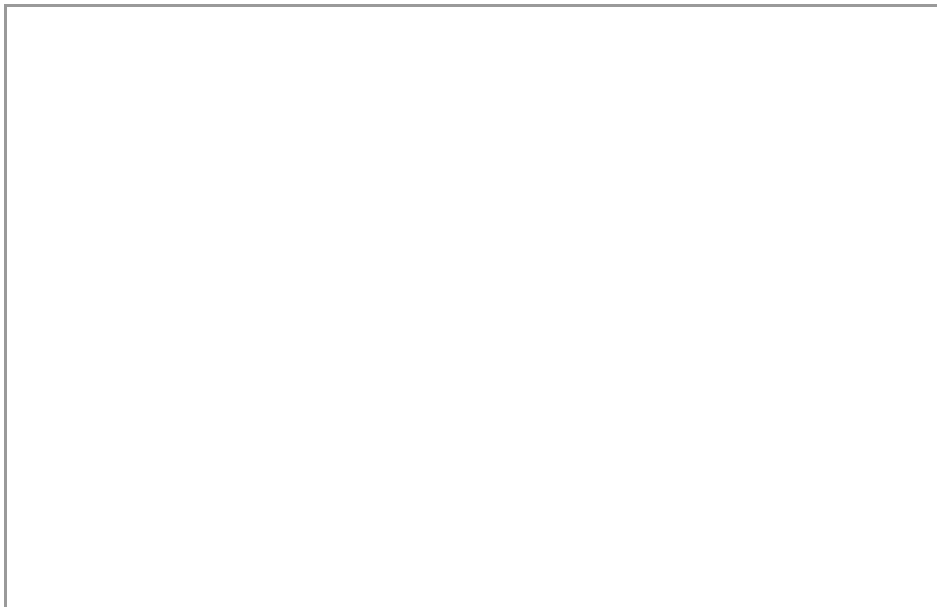
### 1.1 Interface Configuration

The A2000 power meter is equipped with a serial interface with the following configuration:

- Modes RS-232 and RS-485, (2-wire)
- Baud rate 1200, 2400, 4800, 9600, 19200 bd, (adjustable via front operating panel)
- Format 8 data bits, 1 parity bit, 1 stop bit
- Parity even, odd, space or none (adjustable via front operating panel)

### 1.2 Communication Protocol

The Modbus protocol is used for communication between the field control level and the device level.
The RTU mode and conformity class 0 (read and write words) are utilized by the A2000.

### 1.3 Primary Function

A master-slave protocol is used with a permanently assigned master (master computer) and up to 255 slaves (devices).
Communication takes place in the half-duplex operating mode, i.e. a device connected to the master computer only becomes active (i.e. responds):

- If it receives a valid frame addressed to itself
- If the specified minimum response delay time (t rd) has expired, allowing the master computer enough time to become ready to receive

The master computer may not become active again until:

- It receives a valid response frame from the addressed device and the specified waiting period after completion of the response frame (t rw) has expired
- The specified maximum response delay time (t rd) has expired
- The specified character delay time has expired (t cdt = pause between 2 character transmissions). This waiting time also applies for the receipt of invalid and incomplete responses!

#### 1.4 Time response

| | | | |
|---|---|---|---|
| Ready to transmit / receive after power-up | t rdy | approx. 5 s | |
| Character delay time (A2000 transmitter) | t cdt | < 3,5 t ch | (2 ms at 19.2 kbd) |
| Character delay time (master) | t cdm | < 3,5 t ch | (2 ms at 19.2 kbd) |
| Response delay time (A2000 transmitter) | t rd | 10 ... 100 ms | |
| Query waiting time after A2000 response (master) | t rw | > 10 ms | |
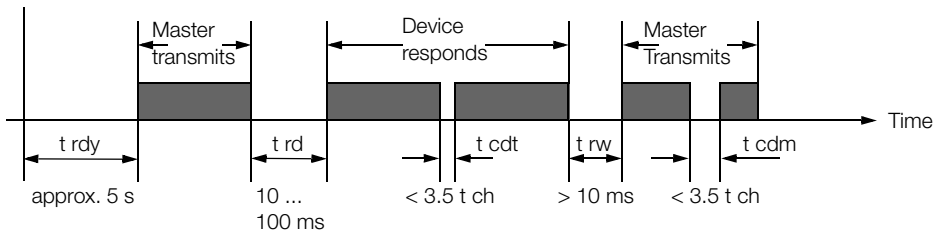


*Figure 1   Basic Time Response*

Character time = time for transmitting one character      t ch          0.57 ms at 19.2 kbd

## 2    Frame Types and Layout

### 2.1   Basic Layout

| Number of Characters | Meaning | Comment |
|---|---|---|
| 1 | Slave address (0 ... 255) | 0 = to all (only where function code = 5, 16) |
| 1 | Function code | See chapter 2.3 on page 6 |
| n | Data | See chapter 2.4 on page 7 and chapter 2.6 on page 9 |
| 1 | Error check (CRC-16 low byte) | See chapter 2.5 on page 7 |
| 1 | Error check (CRC-16 high byte) | |
| (4) | Waiting time, no characters are transmitted | See chapter 2.2 on page 6 |

### 2.2   Waiting Time
- Waiting time is equal to the time it would take to transmit 4 characters.
- Waiting time serves to delineate the beginning and the end of the frame, because no explicit length specification is included in the frame.
- A frame is considered finished when waiting time has expired.
- If, for any reason, transmission of a frame is interrupted for a period which exceeds waiting time, the frame is considered finished. The first character after the interruption is interpreted as the first character of a new frame (both parts of the frame are rejected due to error check failures for this reason).

### 2.3   Function Code
The following function codes (FC) are supported:

| Function Code | Meaning | Application |
|---|---|---|
| 3 | Read words | For reading values and parameters |
| 5 | Write single bit | Only for resetting the A2000 |
| 7 | Read status | Query: „A2000 o.k.?" |
| 16 | Write words | For writing parameters |

### 2.4 Data

Refer to chapter 2.6, chapter 3.2 and chapter 4 for details concerning the data field in the frame.
- Data used with Modbus are always 16 bit words.
- The high byte is transmitted first.

### 2.5 Error Check

Correct transmission of the frame is assured by means of the CRC-16 cyclical redundancy check. Both CRC-16 characters are generated as follows, based upon all of the characters included in the frame (slave address to last data byte):

1 Presetting of a 16 bit register (CRC-16 register) with FFFFh

2 Exclusive OR linking of the low bytes in the CRC-16 register to the frame's character, results to CRC-16 register

3 Shift the CRC-16 register one bit to the right,
   A "0" is added and the displaced, least significant bit (LSB) is saved

4 Where LSB = 0, continue as of step 5.
   Where LSB = 1, establish exclusive OR linking of the CRC-16 registers to A001h.

5 Repeat steps 3 and 4 until a total of 8 shifts to the right have occurred.
   At this point, one of the frame's characters has been processed.

6 Execute steps 2 through 5 for each of the frame's remaining characters.

7 The content of the CRC-16 register, preceded by the low byte, is added to the frame after all of the frame's characters have been processed.

For example, programming in C would result in the following code:

```c
/* ----------------------------------------------------------------
crc_16()                          calculate the crc_16 error check field
Input parameters:     buffer:     string to calculate CRC
                      length:     bytes number of the string
Return value:                     CRC value.
----------------------------------------------------------------- */
unsigned int crc_16 (unsigned char *buffer, unsigned int length) {
   unsigned int i, j, lsb, tmp, crc = 0xFFFF;
   for ( i = 0; i < length; i++ ) {
      tmp = (unsigned char) *buffer++;
      crc ^= tmp;
      for ( j = 0; j < 8; j++ ) {
         lsb = crc & 0x0001;
         crc >>= 1;
         if ( lsb != 0 ) crc ^= 0xA001;
      }
   }
   return (crc);
}
```

### 2.6 Support Frames

### 2.6.1 Read Words (FC = 3)

Query from Master:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (1 to 255) |
| 2 | FC = 3 |
| 3 | Word address (high byte) |
| 4 | Word address (low byte) |
| 5 | Number of words (high byte) |
| 6 | Number of words (low byte) |
| 7 | CRC-16 (low byte) |
| 8 | CRC-16 (high byte) |

Response from Slave:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (1 to 255) |
| 2 | FC = 3 |
| 3 | Number of characters (n) |
| 4 | Word data (n/2 words) |
| ... | Respective high byte first |
| ... | ... |
| 4 + n | CRC-16 (low byte) |
| 5 + n | CRC-16 (high byte) |

If the word address does not exist in the A2000, or if the number of words is too great, the A2000 transmits an "error response" with corresponding error code (see also chapter 2.7 on page 13).

### 2.6.2 Reset (FC = 5)

Query from Master:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (0 to 255) |
| 2 | FC = 5 |
| 3 | Bit address (high byte) = 0 |
| 4 | Bit address (low byte) = 0 |
| 5 | Bit data (high byte) = 0 |
| 6 | Bit data (low byte) = 0 |
| 7 | CRC-16 (low byte) |
| 8 | CRC-16 (high byte) |

Response from Slave:

| | |
|---|---|
| | Not possible |

Transmission of a request to all slaves is possible (slave address = 0).

The "write single bit function" is used exclusively for restarting the A2000.

If the bit address is not 0, or if it is not deleted, the A2000 transmits an "error response" with corresponding error code (see also chapter 2.7 on page 13).

### 2.6.3 Query „A2000 o.k.?" (FC = 7)

Query from Master:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (1 to 255) |
| 2 | FC = 7 |
| 3 | CRC-16 (low byte) |
| 4 | CRC-16 (high byte) |

Response from Slave:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (1 to 255) |
| 2 | FC = 7 |
| 3 | Status |
| 4 | CRC-16 (low byte) |
| 5 | CRC-16 (high byte) |

Bit 4 is set in the status if no write tasks (FC = 16) are currently possible.
Bit 5 is set if an error has occurred (operator prompt, read error status).
Other bits are set to 0.

### 2.6.4  Write Words (FC = 16)

Query from Master:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (0 to 255) |
| 2 | FC = 16 |
| 3 | Word address (high byte) |
| 4 | Word address (low byte) |
| 5 | Number of words (high byte) |
| 6 | Number of words (low byte) |
| 7 | Number of characters (n) |
| 8 | Word data (n/2 words) |
| ... | respective high byte first |
| ... | ... |
| 8 + n | CRC-16 (low byte) |
| 9 + n | CRC-16 (high byte) |

Response from Slave:

| Character No. | Meaning |
|---|---|
| 1 | Slave address (1 to 255) |
| 2 | FC = 16 |
| 3 | Word address (high byte) |
| 4 | Word address (low byte) |
| 5 | Number of words (high byte) |
| 6 | Number of words (low byte) |
| 7 | CRC-16 (low byte) |
| 8 | CRC-16 (high byte) |

Transmission of a request to all slaves is possible (slave address = 0), in which case no response ensues from the slaves.
If the word address does not exist in the A2000, if the number of words is too great or if the contained data is invalid, the A2000 transmits an "error response" with corresponding error code (see also chapter 2.7 on page 13).

### 2.7 Error Handling

If the slave address does not exist, if a parity error has occurred, if the error check fails (CRC-16 false) or if the function code is not supported, the slave does not send a response.

If the A2000 is incapable of executing the request although the frame is formally correct, it generates an error response in the error code of which (character 3) the reason for non-execution is specified.
The error response can be recognized by the returned function code in which the most significant bit is set.

**Error response**

**Error code**

| Character No. | Meaning |
|---|---|
| 1 | Slave address (1 to 255) |
| 2 | FC + 80h |
| 3 | Error code |
| 4 | CRC-16 (low byte) |
| 5 | CRC-16 (high byte) |

| Value | Meaning |
|---|---|
| 2 | Impermissible address |
| 3 | Impermissible data content |
| 6 | Currently no write tasks possible |
| 9 | Number of words is too great |
| 10 | Writing impermissible |
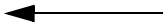
## 3 Reading and Writing Data

### 3.1 Addressing

All A2000 setup parameters and data are assigned to address groups according to functional relationships. The high byte of the word address (WA) constitutes this address group on account of the other implemented interface protocols. Apart from the interface setting, the A2000 can be operated completely via the bus interface.

A complete list of all parameters and data is included in chapter 4.

### 3.2 Data Formats

- All Modbus data are principally represented as words (16 bits) or double words (32 bits).
- When double words are transmitted, the most significant word is transmitted first.
- Measured values, limit values, setup values, etc. are transmitted as integer values with + or -signs (2 part complement, ±15 bits).
- Quantities which have an internal format of ±7 bits, are extended with + or -sign to ±15 bits.
- Energy meter readings and memory positions of the data logger are transmitted as long values with + or -sign (2 part complement, ±31 bits).
- Configurations, control and status quantities are bit arrays or similar (for details see chapter 4).

### 3.3 Writing Parameters

Example: Set the lower range limit of analog output 2 to 200 V
(assumption dim.U = –1) device address of A2000 is 5

Request from Master:

| Char.-No. | Value | Meaning |
|-----------|-------|---------|
| 1 | 05h | Device address |
| 2 | 10h | Function code = write words |
| 3 | 14h | Word address (WA), see chapter 4.4 |
| 4 | 01h | |
| 5 | 00h | Number of words = 1 |
| 6 | 01h | |
| 7 | 02h | Number of characters = 2 times 1 |
| 8 | 07h | Lower range limit (2000) |
| 9 | D0h | |
| 16 | C2h | CRC-16 |
| 17 | ECh | |

Response from Slave (if no error has occurred):

| Char.-No. | Value | Meaning |
|-----------|-------|---------|
| 1 | 05h | Device address |
| 2 | 10h | Function code = write words |
| 3 | 14h | Word address (WA), |
| 4 | 01h | |
| 5 | 00h | Number of words = 1 |
| 6 | 01h | |
| 7 | 54h | CRC-16 |
| 8 | 7Dh | |

### 3.4 Reading Parameters

Example: Read in the 3 phase currents of the A2000 with address 3 (assumption dim.I = 2)

Query from Master:

| Char.-No. | Value | Meaning |
|-----------|-------|---------|
| 1 | 03h | Device Address |
| 2 | 03h | Function code = read words |
| 3 | 02h | Word address (WA) see chapter 4.3 |
| 4 | 00h | |
| 5 | 00h | Number of words = 3 |
| 6 | 03h | |
| 7 | 05h | CRC-16 |
| 8 | 91h | |

Response from Slave (if no error has occurred):

| Char.-No. | Value | Meaning |
|-----------|-------|---------|
| 1 | 03h | Device address |
| 2 | 03h | Function code = read words |
| 3 | 06h | Number of characters = 2 times 3 |
| 4 | 06h | Current phase 1 = 157.9 kA |
| 5 | 2Bh | |
| 6 | 06h | Current phase 2 = 156.3 kA |
| 7 | 1Bh | |
| 8 | 06h | Current phase 3 = 159.2 kA |
| 9 | 38h | |
| 12 | 6Eh | CRC-16 |
| 13 | 88h | |

## 4 Data and Parameters with associated Word Addresses WA

### 4.1 Overview

The data and parameters of the A2000 are assigned to address groups. Values and/or parameters of identical type have consecutive addresses so that they can be jointly accessed and/or described with one query (see also chapter 2.6.1).

| Main Groups | Word Address (WA) | Value | Comment |
|---|---|---|---|
| 0 | | **Measured values** | read only |
| | 0000h … 0005h | Phase voltages | |
| | 0100h … 0105h | Delta voltages | |
| | 0200h … 0205h | Phase currents | |
| | 0300h … 0305h | Phase currents, averaged | |
| | 0400h … 0407h | Active powers | |
| | 0500h … 0507h | Reactive powers | |
| | 0600h … 0607h | Apparent powers | |
| | 0700h … 0707h | Power factors | |
| | 0800h … 080Fh | Energy meters | |
| | 0900h … 090Bh | Interval active powers | |
| | 0A00h … 0A0Bh | Interval reactive powers | |
| | 0B00h … 0B0Bh | Interval apparent powers | |
| | 0D00h … 0D03h | Neutral conductor currents | |
| | 0F00h | Line frequency | |
| 1 | | **Limit values** | |
| | 1000h … 1003h | Relay hysteresis / limit | |
| | 1100h … 1103h | Relay source / configuration | |
| | 1200h, 1201h | Pulse output rate | |
| | 1300h, 1301h | Pulse output source | |
| | 1400h … 1403h | Analog output lower range limit | not with feature L2 |
| | 1500h … 1503h | Analog output upper range limit | not with feature L2 |
| | 1600h … 1607h | Analog output source / configuration | not with feature L2 |
| | 1800 | Pulse output length | |
| | 1D00 … 1D01 | Analog input: Lower range limit/offset | |
| | 1E00 … 1E01 | Analog input: Upper range limt | |
| | 1F00 … 1F01 | Analog input: Configuration | |

| Main Groups | Word Address (WA) | Value | Comment |
|---|---|---|---|
| 2 | | **Control Commands / Status Queries** | |
| | 2000h | Control status | |
| | 2100h, 2101h | Error status | read only |
| | 2400h | Delete max. voltages, currents | write only |
| | 2500h, 2501h | Delete max. powers / FFT | write only |
| | 2600h | Delete energy meters | write only |
| | 2700h | Set standard parameters | write only |
| | 2800h … 2803h | Actuate analog outputs | not with feature L2 |
| | 2900h | Data logger Start / Stop | not with feature R1 |
| | 2A00h | Trigger interval | write only |
| | 2F00 … 2F03 | Measured values analog input | Read only, write deletes both maximum values |
| 3 | | **Device Specification** | |
| | 3000h | Device identity code | read only |
| | 3100h | Equipped with | read only |
| | 3200h … 3203h | Measured value dimensions | read only |
| | 3300h | Terminal type | |
| | 3400h | Synchronizing interval | |
| | 3500h | Software version | read only |
| | 3600h | Energy meter modus | |
| | 3700h … 3703h | Low tariff time interval | only with feature R1 |
| | 3800h | Type of reactive power measurement | |
| | 3900h | Frequency source | |
| | 3B00h, 3B01h | Voltage measuring range | |
| | 3C00h, 3C01h | Current measuring range | |
| | 3F00h | Display brightness/Display filter | |

| Main Groups | Word Address (WA) | Value | Comment |
|---|---|---|---|
| 8 | | **Harmonic waves, FFT** | read only |
| | 8000h … 800Bh | THD / fundamental wave | |
| | 8100h … 810Fh | U1 THD / distortion factors | |
| | 8200h … 820Fh | U2 THD / distortion factors | |
| | 8300h … 830Fh | U3 THD / distortion factors | |
| | 8400h … 840Fh | I1 THD / harmonic waves | |
| | 8500h … 850Fh | I2 THD / harmonic waves | |
| | 8600h … 860Fh | I3 THD / harmonic waves | |
| | 8700h … 870Bh | Maximum values THD / fundamental wave | |
| | 8800h … 880Fh | Maximum values U1 THD / distortion factors | |
| | 8900h … 890Fh | Maximum values U2 THD / distortion factors | |
| | 8A00h … 8A0Fh | Maximum values U3 THD / distortion factors | |
| | 8B00h … 8B0Fh | Maximum values I1 THD / harmonic waves | |
| | 8C00h … 8C0Fh | Maximum values I2 THD / harmonic waves | |
| | 8D00h … 8D0Fh | Maximum values I3 THD / harmonic waves | |
| 9 | | **Real time clock / Data logger** | only with feature R1 |
| | 9000h … 9002h | Time | |
| | 9100h … 9103h | Date | |
| | 9200h … 920Eh | Setup parameter data logger | |
| | 9300h … 9315h | Current setup of recording | read only |
| | 9400h … 941Ah | Current setup of a recording window | read only |
| | 9500h … 956Dh … 9577h | Record data transmission block | read only |
| | 9900h, 9901h | Selection recording window, transmission block | |
| A | | **Sampling values** | |
| | A000h … A01Fh | U1 | read only |
| | A100h … A11Fh | U2 | read only |
| | A200h … A21Fh | U3 | read only |
| | A300h … A31Fh | I1 | read only |
| | A400h … A41Fh | I2 | read only |
| | A500h … A51Fh | I3 | read only |
| | A600h | freeze/update sampling values | |

## 4.2 Measured Value Units of Measure, Measured Value Ranges and Resolution

The data below are valid for all frame content, for measured values as well as for parameters. The multipliers (decimal point position, „dim" parameter) are established upon entry of the primary measuring ranges (compare WA = 3B00h, 3C00h) and can be read with WA = 3200h … 3203h.

| Measured Quantity | Basic Unit of Measure | Multiplier Range | Corresponds to Value for „dim" Parameter | Data Field Value Range | Physical Value Range | Display Resolution |
|---|---|---|---|---|---|---|
| Line frequency | Hz | 0.01 | — | 4000 ... 7000 | 40.00 ... 70.00 Hz | 0.01 Hz |
| Power factor | 1 | 0.01 | — | −100 … 0 … +100 | 1.00 … cap 0 … ind 1.00 | 0.01 |
| Voltage | V | $10^{-1} \ldots 10^{2}$ | dim.U = −1 ... 2 | 0 ... 9999 | 0 V ... 999.9 V ... 999.9 kV | dim. U (V) |
| Voltage distortion factor | % | 0.1 | — | 0 ... 1000 | 0 ... 100.0 % | 0.1 % |
| Current, current harmonic wave | A | $10^{-3} \ldots 10^{2}$ | dim.I = −3 ... 2 | 0 ... 9999 | 0 A ... 9.999 A ... 999.9 kA | dim. I (A) |
| Power, interval power | W, VA, VAr | $10^{-1} \ldots 10^{8}$ | dim.P = −1 ... 8 | −9999 … 0 … 9999 | 0 ... 999.9 W / VA / VAr ... 999.9 GW / GVA / GVAr | dim. P (W) |
| Energy meter | Wh, VArh | $10^{-1} \ldots 10^{8}$ | dim.E = −1 ... 8 | −99999999 … 0 … 999999999 | 0 ... 99999999.9 Wh / VArh ... 99999999.9 GWh / GVArh | dim. E (Wh) |

### 4.3 Table of Measured Values

Measured values can only be read, writing is not possible.

| Measured values | WA |
|---|---|
| Phase voltages: | |
| U1 | 0000h |
| U2 | 0001h |
| U3 | 0002h |
| $U1_{max}$ | 0003h |
| $U2_{max}$ | 0004h |
| $U3_{max}$ | 0005h |
| Delta voltages: | |
| U12 | 0100h |
| U23 | 0101h |
| U31 | 0102h |
| $U12_{max}$ | 0103h |
| $U23_{max}$ | 0104h |
| $U31_{max}$ | 0105h |
| Phase currents: | |
| I1 | 0200h |
| I2 | 0201h |
| I3 | 0202h |
| $I1_{max}$ | 0203h |
| $I2_{max}$ | 0204h |
| $I3_{max}$ | 0205h |

| Measured Values | WA |
|---|---|
| Averaged phase currents: | |
| $I1_{avg}$ | 0300h |
| $I2_{avg}$ | 0301h |
| $I3_{avg}$ | 0302h |
| $I1_{avg\,max}$ | 0303h |
| $I2_{avg\,max}$ | 0304h |
| $I3_{avg\,max}$ | 0305h |
| Active power: | |
| P1 | 0400h |
| P2 | 0401h |
| P3 | 0402h |
| $P_{\Sigma}$ | 0403h |
| $P1_{max}$ | 0404h |
| $P2_{max}$ | 0405h |
| $P3_{max}$ | 0406h |
| $P_{\Sigma\,max}$ | 0407h |
| Reactive power: | |
| Q1 | 0500h |
| Q2 | 0501h |
| Q3 | 0502h |
| $Q_{\Sigma}$ | 0503h |
| $Q1_{max}$ | 0504h |
| $Q2_{max}$ | 0505h |
| $Q3_{max}$ | 0506h |
| $Q_{\Sigma\,max}$ | 0507h |

| Measured values | | WA |
|---|---|---|
| Apparent power: | | |
| S1 | | 0600h |
| S2 | | 0601h |
| S3 | | 0602h |
| $S_\Sigma$ | | 0603h |
| $S1_{max}$ | | 0604h |
| $S2_{max}$ | | 0605h |
| $S3_{max}$ | | 0606h |
| $S_{\Sigma\,max}$ | | 0607h |
| Power factors: | | |
| PF1 | | 0700h |
| PF2 | | 0701h |
| PF3 | | 0702h |
| $PF_\Sigma$ | PF<0: capacitive [1] | 0703h |
| $PF1_{min}$ | PF>0: inductive [1] | 0704h |
| $PF2_{min}$ | | 0705h |
| $PF3_{min}$ | | 0706h |
| $PF_{\Sigma\,min}$ | | 0707h |
| Energy meter: [2] | | |
| L123 mode | LTHT mode | |
| $E_{P1}$ | $E_{P\Sigma L-}$ | 0800h + 0801h |
| $E_{P2}$ | $E_{P\Sigma L+}$ | 0802h + 0803h |
| $E_{P3}$ | $E_{P\Sigma H-}$ | 0804h + 0805h |
| $E_{P\Sigma}$ | $E_{P\Sigma H+}$ | 0806h + 0807h |
| $E_{Q1}$ | $E_{Q\Sigma L-}$ | 0808h + 0809h |
| $E_{Q2}$ | $E_{Q\Sigma L+}$ | 080Ah + 080Bh |
| $E_{Q3}$ | $E_{Q\Sigma H-}$ | 080Ch + 080Dh |
| $E_{Q\Sigma}$ | $E_{Q\Sigma H+}$ | 080Eh + 080Fh |

| Measured values | | WA |
|---|---|---|
| $P_{Int\,\Sigma\,current}$ | [3] | 0900h |
| $P_{Int\,\Sigma\,expired}$ | [4] | 0901h … 090Ah |
| $P_{Int\,\Sigma\,max}$ | [5] | 090Bh |
| $Q_{Int\,\Sigma\,current}$ | [3] | 0A00h |
| $Q_{Int\,\Sigma\,expired}$ | [4] | 0A01h … 0A0Ah |
| $Q_{Int\,\Sigma\,max}$ | [5] | 0A0Bh |
| $S_{Int\,\Sigma\,current}$ | [3] | 0B00h |
| $S_{Int\,\Sigma\,expired}$ | [4] | 0B01h … 0B0Ah |
| $S_{Int\,\Sigma\,max}$ | [5] | 0B0Bh |
| Neutral conductor current | | |
| $I_N$ | | 0D00h |
| $I_{N\,max}$ | | 0D01h |
| $I_{N\,avg}$ | | 0D02h |
| $I_{N\,avg\,max}$ | | 0D03h |
| Line frequency | | 0F00h |

[1] Multiply the result by 0.01 to obtain the PF
[2] Active energy values are represented as negative numbers in the L123 mode.,
All energy values are positive in the LTHT mode.
[3] Current interval
[4] 1st – 10th preceding interval
[5] Max. interval value as of power-up or value reset (see see chapter 4.5 on page 27, WA = 2501h)

## 4.4 Table for Relay, Pulse and Analog Output Quantities

| Parameter | WA | Unit of Measure | Value Range | Comment |
|---|---|---|---|---|
| Relay 1, hysteresis | 1000h | U/M of quantity | 0 ... 9999 | |
| Relay 2, hysteresis | 1001h | to be monitored | | |
| Relay 1, limit | 1002h | (source) | –1999 ... 9999 | |
| Relay 2, limit | 1003h | | | |
| Relay 1, source | 1100h | | See chapter 4.4.3 on page 25 | |
| Relay 2, source | 1101h | | | |
| Relay 1, configuration | 1102h | | See chapter 4.4.1 on page 24 | |
| Relay 2, configuration | 1103h | | | |
| Pulse output 1, rate | 1200h | 1 / kWh (MWh) | 0 ... 5000 | U/M see chapter 4.4.4 on page 26 |
| Pulse output 2, rate | 1201h | 1 / kWh (MWh) | | |
| Pulse output 1, source | 1300h | | See chapter 4.4.4 on page 26 | |
| Pulse output 2, source | 1301h | | | |
| Analog outputs: | | | | |
| Lower range limit 1 | 1400h | U/M of quantity | –9999 ... 9999 | Lower range limit 3 / 4 = 0, if feature A1 is not included |
| Lower range limit 2 | 1401h | to be output | | |
| Lower range limit 3 | 1402h | (source) | | Lower range limit 3 / 4 are not read or written where Feature A3 |
| Lower range limit 4 | 1403h | | | |
| Analog outputs: | | | | |
| Upper range limit 1 | 1500h | U/M of quantity | –9999 ... 9999 | Upper range limit 3 / 4 = 0, if feature A1 is not included |
| Upper range limit 2 | 1501h | to be output | | |
| Upper range limit 3 | 1502h | (source) | | Upper range limit 3 / 4 are not read or written where Feature A3 |
| Upper range limit 4 | 1503h | | | |
| Analog ouputs: | | | | |
| Source 1 | 1600h | | See chapter 4.4.3 on page 25 | Source 3 / 4 = 0, if feature A1 is not included |
| Source 2 | 1601h | | | |
| Source 3 | 1602h | | | Source 3 / 4 are not read or written where Feature A3 |
| Source 4 | 1603h | | | |
| Configuration 1 | 1604h | | See chapter 4.4.2 on page 24 | Configuration 3 / 4 = 0, if feature A1 is not included |
| Configuration 2 | 1605h | | | |
| Configuration 3 | 1606h | | | Configuration 3 / 4 are not read or written where Feature A3 |
| Configuration 4 | 1607h | | | |
| Pulse length | 1800h | | 0 ... 7 | 0.1 s ... 0.8 s |

| Parameter | WA | Unit of Measure | Value Range | Comment |
|---|---|---|---|---|
| Analog inputs | | depending on configuration | depending on configuration | @ PT1000: Offset of measurement Format: Offset (in °C) *90 or Offset (in °F) *50 |
| Lower range limit 1 | 1D00 | | | |
| Lower range limit 2 | 1D01 | | | Lower range limit –200 °C fixed |
| Analog inputs | | depending on configuration | depending on configuration | not with PT1000 Upper range limit 850 °C fixed |
| Upper range limit 1 | 1E00 | | | |
| Upper range limit 2 | 1E01 | | | |
| Analog inputs | | depending on configuration | see chapter 4.4.5 on page 26 | |
| Configuration 1 | 1F00 | | | |
| Configuration 2 | 1F01 | | | |

### 4.4.1 Relay Configuration (WA = 1102h, 1103h)

| Bit No. | Value | Meaning | Function |
|---|---|---|---|
| 0 | 0 | low | low- / high alarm functions |
| | 1 | high | |
| 1 | 0 | nonstore | Alarm memory |
| | 1 | store | |
| 2 | 0 | Depends upon DIP switch | Alarm enabling |
| | 1 | Always open | |
| 3 | 0 | | No function |
| 4 ... 15 | 0 ... 15 | 0 = none      9 = 1 min<br>1 = 1 s      10 = 2 min<br>2 = 2 s      11 = 3 min<br>3 = 3 s      12 = 5 min<br>4 = 5 s      13 = 8 min<br>5 = 8 s      14 = 15 min<br>6 = 15 s      15 = 30 min<br>7 = 25 s<br>8 = 40 s | Alarm delay |

### 4.4.2 Configuration of Analog Output (WA = 1604h … 1607h)

| Bit No. | Value | Meaning | Function |
|---|---|---|---|
| 0 ... 1 | 00 | 4 ... 20 mA (2 ... 10 V) | Output type |
| | 01 | 0 ... 20 mA (0 ... 10 V) | |
| | 10 | –20 ... 20 mA (–10 ... 10 V) | |
| | 11 | –10 ... 10 mA (–5 ... 5 V) | |
| 2 ... 15 | 0 | | No function |

### 4.4.3 Source for Relay and Analog Outputs (WA = 1100h, 1101h bzw. 1600h … 1603h)

| Bit No. | Value | Meaning | Function |
|---------|-------|---------|----------|
| 0 … 7 | 000 | Phase 1 or 1→2 | Phase number of source value (no function for frequency) |
| | 001 | Phase 2 or 2→3 | |
| | 010 | Phase 3 or 3→1 | |
| | 011 | Sum | |
| | 100 | Neutral conductor current | only with source value = 2, 3 (current) |
| | 101 | for all 3 phases | only for relay (WA = 1100h) |
| 8 … 15 | 0000 | Delta voltage | Type of source value |
| | 0001 | Phase voltage | |
| | 0010 | Phase current | |
| | 0011 | Averaged phase current | |
| | 0100 | Active power | |
| | 0101 | Reactive power | |
| | 0110 | Apparent power | |
| | 0111 | Power factor | |
| | 1000 | Frequency | |
| | 1001 | Total active power interval [1] | |
| | 1010 | Total reactive power interval [1] | |
| | 1011 | Total apparent power interval [1] | |
| | 1100 | External value (Control via interface possible) | |

[1] The current interval (- 0) is used for relay output. Interval (-1) is used for analog output

### 4.4.4 Source for Pulse Output (WA = 1300h, 1301h)

| Bit No. | Value | Meaning | Function |
|---------|-------|---------|----------|
| 0 ... 3 | 000 | Phase 1 or 1→2 | Phase number of source value |
|  | 001 | Phase 2 or 2→3 |  |
|  | 010 | Phase 3 or 3→1 |  |
|  | 011 | Sum |  |
| 8 | 0 | Active energy | Type of source value |
|  | 1 | Reactive energy |  |
| 9 | 0 | Import |  |
|  | 1 | Export |  |
| 10 | 0 | Pulses per kWh |  |
|  | 1 | Pulses per MWh |  |
| 11 | 0 | High tariff |  |
|  | 1 | Low tariff |  |

### 4.4.5 Configuration of Analog Input (WA = 1F00h, 1F01h)

| Bit No. | Value | Meaning | Function |
|---------|-------|---------|----------|
| 0, 1 | 00 | 4 ... 20 mA / 2 ... 10 V / 0 °C | Input type |
|  | 01 | 0 ... 20 mA / 0... 10 V / 0 °F |  |
|  | 10 | −20 ... 20 mA / −10 ... 10 V / 0 °C |  |
|  | 11 | −10 ... 10 mA / −5 ... 5 V / 0 °F |  |
| 2 | 0 | Standard signal 20 mA/10 V | Input type |
|  | 1 | Temperature sensor Pt1000 |  |
| 3 | — | — | no function |
| 4, 5 | 00 | 0 places behind the decimal point / integral degrees | Decimal point, resolution |
|  | 01 | 1 place behind the decimal point / tenths of degree |  |
|  | 10 | 2 places behind the decimal point / integral degrees |  |
|  | 11 | 3 places behind the decimal point / tenths of degree |  |
| 6 ... 15 | — | — | no function |

## 4.5    Control Commands and Status Queries

| Parameter | WA | Value Range | Comment |
|---|---|---|---|
| Control status A2000 | 2000h | See next page | |
| Error status A2000 | | | Read only, compare with event data in chapter 4.5.4 on page 29 |
| | 2100h | Measuring circuit | |
| | 2101h | Miscellaneous | |
| Clear max. U/I | 2400h | See next page | Write only |
| Clear max. powers | | | Write only |
| Max. powers | 2500h | See next page | |
| Max. interval powers/FFT | 2501h | | |
| Clear energy meter | 2600h | =55AAh | Write only |
| Set default parameters | 2700h | =A965h | Write only, sets 1$^{st}$ and 2$^{nd}$ parameter set to default values, except for address (set – default, – user) |
| Analog outputs | | | |
| Direct output value 1 | 2800h | ± 2000 100 corresponds to 1 mA bzw. 0.5 V | Write only if source analog outputs = external |
| Direct output value 2 | 2801h | | |
| Direct output value 3 | 2802h | | Not with feature L2 |
| Direct output value 4 | 2803h | | |
| Start / stop data logger | 2900h | =55h: stop =AAh: start | Not with feature R1 Restart only after previous stop! |
| Trigger interval | 2A00h | =AAh: Trigger | Write only |
| Analog inputs | | | |
| Measured value 1 | 2F00h | same as in the display, without taking the decimal point into account | Nur lesen. Beim Schreiben auf beliebige Werte werden beide Maximalwerte gelöscht. |
| Measured value 2 | 2F01h | | |
| Maximum measured value 1 | 2F02h | | |
| Maximum measured value 2 | 2F03h | | |
| Status | 2F04h | see chapter 4.5.3 | |

### 4.5.1 Control Status A2000 (WA = 2000h)

| Bit No. | Value | Function | Comment |
|---|---|---|---|
| 0 ... 6 | 0 | — | |
| 7 | 0 / 1 | Pulse input inactive / active | Read only |
| 8 | 0 / 1 | Relay 1 active / inactive | Write only if source relay = external |
| 9 | 0 / 1 | Relay 2 active / inactive | |
| 10 ... 15 | 0 | — | |

### 4.5.2 Clear Maximum Voltages, Currents, Powers

**Reset command word peak values for voltage, current (WA = 2400h)**

| Bit No. | Value | Function |
|---|---|---|
| 0 | 1 | $U12_{max} = 0$ |
| 1 | 1 | $U23_{max} = 0$ |
| 2 | 1 | $U31_{max} = 0$ |
| 3 | 0 | — |
| 4 | 1 | $U1_{max} = 0$ |
| 5 | 1 | $U2_{max} = 0$ |
| 6 | 1 | $U3_{max} = 0$ |
| 7 | 0 | — |
| 8 | 1 | $I1_{max} = 0$ |
| 9 | 1 | $I2_{max} = 0$ |
| 10 | 1 | $I3_{max} = 0$ |
| 11 | 1 | $I_{N\,max} = 0$ |
| 12 | 1 | $I1_{avg\,max} = 0$ |
| 13 | 1 | $I2_{avg\,max} = 0$ |
| 14 | 1 | $I3_{avg\,max} = 0$ |
| 15 | 1 | $I_{N\,avg\,max} = 0$ |

**Reset command word peak values for powers, power factors**

| WA | Bit No. | Value | Function |
|---|---|---|---|
| 2500h | 0 | 1 | $P1_{max} = 0$ |
| | 1 | 1 | $P2_{max} = 0$ |
| | 2 | 1 | $P3_{max} = 0$ |
| | 3 | 1 | $P\Sigma_{max} = 0$ |
| | 4 | 1 | $Q1_{max} = 0$ |
| | 5 | 1 | $Q2_{max} = 0$ |
| | 6 | 1 | $Q3_{max} = 0$ |
| | 7 | 1 | $Q\Sigma_{max} = 0$ |
| | 8 | 1 | $S1_{max} = 0$ |
| | 9 | 1 | $S2_{max} = 0$ |
| | 10 | 1 | $S3_{max} = 0$ |
| | 11 | 1 | $S\Sigma_{max} = 0$ |
| | 12 | 1 | $PF1_{max} = 0$ |
| | 13 | 1 | $PF2_{max} = 0$ |
| | 14 | 1 | $PF3_{max} = 0$ |
| | 15 | 1 | $PF\Sigma_{max} = 0$ |
| 2501h | 0 | 1 | $P_{int\,max} = 0$ |
| | 1 | 1 | $Q_{int\,max} = 0$ |
| | 2 | 1 | $S_{int\,max} = 0$ |
| | 3 | 1 | Max. FFT = 0 |
| | 4 ... 15 | | — |

### 4.5.3 Status of Analog Inputs (WA = 2F04h)

| Bit No. | Value | Meaning | Comment |
|---|---|---|---|
| 0 | 1 | Measured value 1 fallen short of and/or sensor short circuit | Momentary state, indicated as lower or upper lines |
| 1 | 1 | Measured value 2 fallen short of and/or sensor short circuit | |
| 2, 3 | 0 | — | |
| 4 | 1 | Measured value 1 exceeded and/or sensor break | |
| 5 | 1 | Measured value 2 exceeded and/or sensor break | |
| 6, 7 | 0 | — | |
| 8 | 1 | Measured value 1 fallen short of and/or sensor short circuit | Accumulated state, can be deleted in the same way as maximum values. |
| 9 | 1 | Measured value 2 fallen short of and/or sensor short circuit | |
| 10, 11 | 0 | — | |
| 12 | 1 | Measured value 1 exceeded and/or sensor break | |
| 13 | 1 | Measured value 2 exceeded and/or sensor break | |
| 14, 15 | 0 | — | |

### 4.5.4 Error Status
Error status word measuring circuit (WA = 2100h)

| Bit No. | Value | Meaning | Comment |
|---|---|---|---|
| 0 | 1 | U1 < 0.7 % of measuring range or non-existent | |
| 1 | 1 | U2 < 0.7 % of measuring range or non-existent | |
| 2 | 1 | U3 < 0.7 % of measuring range or non-existent | |
| 3 | 1 | I1 < 0.8 % of measuring range or non-existent | |
| 4 | 1 | I2 < 0.8 % of measuring range or non-existent | |
| 5 | 1 | I3 < 0.8 % of measuring range or non-existent | |
| 6 | 1 | DC offset too large (bits 0 to 5 identify channel) [1] | Defective measuring input |
| 7 | 1 | Frequency < 40 Hz and/or no signal | |
| 8 | 1 | U1 overflow | |
| 9 | 1 | U2 overflow | |
| 10 | 1 | U3 overflow | |
| 11 | 1 | I1 overflow | |
| 12 | 1 | I2 overflow | |
| 13 | 1 | I3 overflow | |
| 14 | 1 | Frequency > 70 Hz | |
| 15 | 1 | Device is not calibrated | Re-calibration required |

[1] If bit 6 = 1, bits 0 to 5 have a different meaning

Error status word Miscellaneous (WA = 2101h)

| Bit No. | Value | Meaning | Comment |
|---|---|---|---|
| 0 | 1 | Alarm 1 (relay 1) active | [1] |
| 1 | 1 | Alarm 2 (relay 2) active | [1] |
| 2 | 1 | Condition for alarm 1 fulfilled | is not saved to memory |
| 3 | 1 | Condition for alarm 2 fulfilled | is not saved to memory |
| 4 | 1 | 3-wire connection with following sequence: L1, L3, L2 | 0 after correction and after device is switched back on |
| 5 | 0 | | |
| 6 | 0 | | |
| 7 | 0 | | |
| 8 | 1 | Defective measuring input | 0 after error has been corrected |
| 9 | 1 | Inadmissible parameter value, value not accepted | 0 after reading |
| 10 | 0 | | |
| 11 | 1 | Real-time clock power failure, incorrect time | 0 after writing real time (WA = 9000h, 9100h) |
| 12 | 1 | Defective real-time clock | 0 after error has been corrected |
| 13 | 1 | Incorrect setup parameter in EEPROM | 0 after error has been corrected |
| 14 | 1 | Incorrect meter reading in EEPROM | 0 after error has been corrected |
| 15 | 1 | Defective EEPROM | |

[1] Alarm message is reset in alarm memory mode by writing

## 4.6 Device Specifications

| Parameter | WA | Value Range | | Comment |
|---|---|---|---|---|
| Device ID | 3000h | A2h | | Read only |
| Equipped with | 3100h | See product variants | | Read only |
| Measured value – Dimension | | | | Read only – determined by primary voltage and current measuring ranges (WA = 3B00h, 3C00h) |
| Dim. U | 3200h | – 1 … 2 | | |
| Dim. I | 3201h | – 3 … 2 | | |
| Dim. P | 3202h | – 1 … 8 | | |
| Dim. E | 3203h | – 1 … 8 | | |
| 3-L/4-L/3L-1/3L13/4L13 connection | 3300h | 55h/AAh/33h/CCh/66h | | |
| Energy synchronizing interval | 3400h | 0,1 … 60 | | = external, 1 to 60 minutes |
| Software version | 3500h | 0 … 255 | | Read only |
| Energy meter mode | 3600h | | | Mode Low tariff active |
| | | 0000h | | L123 by time setting [1] |
| | | 0004h | | LTHT by time setting [1] |
| | | 0008h | | L123 with synchronizing input |
| | | 000Ch | | LTHT with synchronizing input |
| Low tariff time interval | | | | Only active if feature R1 is included |
| LT_Start: minutes | 3700h | 0 … 59 | | |
| LT_Start: hours | 3701h | 0 … 23 | | |
| LT_Stop: minutes | 3702h | 0 … 59 | | |
| LT_Stop: hours | 3703h | 0 … 23 | | |
| Representation of reactive power | 3800h | See "Representation of Reactive Power (PI = 38h)" on page 32 | | |
| Frequency source | 3900h | 0000h | | All phases are taken into account |
| | | 0040h | | Synchronization only in relation to voltages |
| Voltage measuring range | | | | |
| Primary phase voltage $U_{tprim}$ | 3B00h | – 600 … 0 / 1 … 8000 | | = 100 V … 700 V / 100 V … 800 kV |
| Secondary phase voltage $U_{tsec}$ | 3B01h | 100 … 500 | | = 100 V … 500 V |
| Current measuring range | | | | |
| Primary phase current $I_{tprim}$ | 3C00h | 0.1 … 30000 | | = 1 A, 5 A … 150 kA |
| Secondary phase current $I_{tsec}$ | 3C01h | Bit 0 | 0.1 | = 5 A, 1 A |
| | 3C01h | Bit 1 … 7 | — | — |
| | 3C01h | Bit 8 … 15 | – 100 … 100 | 0.900 … 1.100 adjustment |
| Display brightness | 3F00h | Bit 0 … 2 | 0 … 7 | 0.5 brightness grades |
| Display filter | 3F00h | Bit 3 … 7 | 0 … 30 | Time constant in s |

[1]) Variant without data logger: no low tariff

### 4.6.1 Product Variants (WA = 3100h)

| Bit No. | Value | Function | Feature |
|---------|-------|----------|---------|
| 0 | 1 | Equipped with analog outputs 3 and 4 | A1 |
| 1 | 1 | Equipped with S0 outputs | P1 |
| 2 | 1 | Equipped with asynchronous input | S1 |
| 3 | 1 | Equipped with LON interface | L1 |
| 4 | 1 | Equipped with data logger | R1 |
| 5 | 1 | Real-time clock | R1 |
| 6 | 1 | Profibus model | L2 |
| 7 | 1 | Equipped with analog inputs | A3 |

### 4.6.2 Representation of Reactive Power (PI = 38h)

| Value | Representation | Comment |
|-------|----------------|---------|
| 0000h | per DIN 40110 | $Q = \sqrt{S^2 - P^2}$ |

| Value | Representation | Comment |
|-------|----------------|---------|
| 0010h | with sign | $$Q = \frac{1}{TN} \cdot \int_{0}^{TN} U(t) \cdot J\left(t - \frac{TN}{4}\right) dt$$ <br><br> 1) |
| 0020h | Equalizing reactive power | |
| 0030h | with sign | Power factor same as Ferraris meters |

[1]) TN is the period duration of the basic frequency of U or I, respectively.

## 4.7 FFT, Harmonics

| Parameter | WA | Comment | Parameter | WA | Comment |
|---|---|---|---|---|---|
| **Instantaneous values THD/ fundamental wave:** I1 THD | 8000h | Read only | **Maximum values THD/ fundamental wave:** I1 THD | 8700h | Read only |
| I1 fundamental wave | 8001h | | I1 fundamental wave | 8701h | |
| I2 THD | 8002h | | I2 THD | 8702h | |
| I2 fundamental wave | 8003h | | I2 fundamental wave | 8703h | |
| I3 THD | 8004h | | I3 THD | 8704h | |
| I3 fundamental wave | 8005h | | I3 fundamental wave | 8705h | |
| U1 THD | 8006h | | U1 THD | 8706h | |
| U1 fundamental wave | 8007h | | U1 fundamental wave * | 8707h | |
| U2 THD | 8008h | | U2 THD | 8708h | |
| U2 fundamental wave | 8009h | | U2 fundamental wave * | 8709h | |
| U3 THD | 800Ah | | U3 THD | 870Ah | |
| U3 fundamental wave | 800Bh | | U3 fundamental wave * | 870Bh | |
| **Instantaneous values U1 THD/ harmonic waves:** U1 THD | 8100h | Read only | **Maximum values U1 THD/ harmonic waves:** U1 THD | 8800h | Read only |
| U1 fundamental wave | 8101h | | U1 fundamental wave * | 8801h | |
| U1 $2^{nd}$ harmonic | 8102h | | U1 $2^{nd}$ harmonic | 8802h | |
| ... | ... | | ... | ... | |
| U1 $15^{th}$ harmonic | 810Fh | | U1 $15^{th}$ harmonic | 880Fh | |
| **Instantaneous values U2 THD/ harmonic waves:** U2 THD | 8200h | Read only | **Maximum values U2 THD/ harmonic waves:** U2 THD | 8900h | Read only |
| U2 fundamental wave | 8201h | | U2 fundamental wave * | 8901h | |
| U2 $2^{nd}$ harmonic | 8202h | | U2 $2^{nd}$ harmonic | 8902h | |
| ... | ... | | ... | ... | |
| U2 $15^{th}$ harmonic | 820Fh | | U2 $15^{th}$ harmonic | 890Fh | |

\* As the maximum value would invariably be 100 % in this case, the minimum value is established instead for the voltage fundamental wave.

| Parameter | WA | Comment | Parameter | WA | Comment |
|---|---|---|---|---|---|
| **Instantaneous values U3 THD/ harmonic waves:** U3 THD | 8300h | Read only | **Maximum values U3 THD/ harmonic waves:** U3 THD | 8A00h | Read only |
| U3 fundamental wave | 8301h | | U3 fundamental wave * | 8A01h | |
| U3 2$^{nd}$ harmonic | 8302h | | U3 2$^{nd}$ harmonic | 8A02h | |
| ... | ... | | ... | ... | |
| U3 15$^{th}$ harmonic | 830Fh | | U3 15$^{th}$ harmonic | 8A0Fh | |
| **Instantaneous values I1 THD/ harmonic waves:** I1 THD | 8400h | Read only | **Maximum values I1 THD/ harmonic waves:** I1 THD | 8B00h | Read only |
| I1 fundamental wave | 8401h | | I1 fundamental wave | 8B01h | |
| I1 2$^{nd}$ harmonic | 8402h | | I1 2$^{nd}$ harmonic | 8B02h | |
| ... | ... | | ... | ... | |
| I1 15$^{th}$ harmonic | 840Fh | | I1 15$^{th}$ harmonic | 8B0Fh | |
| **Instantaneous values I2 THD/ harmonic waves:** I2 THD | 8500h | Read only | **Maximum values I2 THD/ harmonic waves:** I2 THD | 8C00h | Read only |
| I2 fundamental wave | 8501h | | I2 fundamental wave | 8C01h | |
| I2 2$^{nd}$ harmonic | 8502h | | I2 2$^{nd}$ harmonic | 8C02h | |
| ... | ... | | ... | ... | |
| I2 15$^{th}$ harmonic | 850Fh | | I2 15$^{th}$ harmonic | 8C0Fh | |
| **Instantaneous values I3 THD/ harmonic waves:** I3 THD | 8600h | Read only | **Maximum values I3 THD/ harmonic waves:** I3 THD | 8D00h | Read only |
| I3 fundamental wave | 8601h | | I3 fundamental wave | 8D01h | |
| I3 2$^{nd}$ harmonic | 8602h | | I3 2$^{nd}$ harmonic | 8D02h | |
| ... | ... | | ... | ... | |
| I3 15$^{th}$ harmonic | 860Fh | | I3 15$^{th}$ harmonic | 8D0Fh | |

\* As the maximum value would invariably be 100 % in this case, the minimum value is established instead for the voltage fundamental wave.

## 4.8 Real-Time Clock / Data Logger
### Value ranges with 512 kB memory

| Parameter | WA | Value Range | Comment |
|---|---|---|---|
| Seconds | 9000h | 0 … 59 | Write restarts RTC |
| Minutes | 9001h | 0 … 59 | |
| Hours | 9002h | 0 … 23 | |
| Day | 9100h | 1 … 31 | Write restarts RTC |
| Month | 9101h | 1 … 12 | |
| Year | 9102h | 0 … 99 | |
| Millennium | 9103h | 19 … 20 | |
| Data logger, setup parameters | | | |
| Sampling interval | 9200h | 0 … 19 | See page 39, Data Logger, Sampling Interval |
| Current recording duration per window in trigger mode [1] | 9201h | 8 … 24 | See page 39, Data Logger, Recording Duration |
| Trigger specification | 9202h | 00h … 3Fh | See page 40, Data Logger, Trigger Specification |
| Selection and assignment of measured values to recording channels 1 to 12 | | | See page 41, Data Logger, Selection and Assignment of Measured Values |
| Channel 1 | 9203h | | |
| Channel 2 | 9204h | | |
| Channel 3 | 9205h | | |
| Channel 4 | 9206h | | |
| Channel 5 | 9207h | | |
| Channel 6 | 9208h | | |
| Channel 7 | 9209h | | |
| Channel 8 | 920Ah | | |
| Channel 9 | 920Bh | | |
| Channel 10 | 920Ch | | |
| Channel 11 | 920Dh | | |
| Channel 12 | 920Eh | | |

[1] not valid for recordings without trigger

| Parameter | WA | Value Range | Comment |
|---|---|---|---|
| Data logger, general configuration for recording memory | | | Read only |
| Number of available windows (v) | 9300h | 1 ... 99 | |
| Number or utilized windows or data logger occupancy level as percentage | 9301h | 1 ... v, 100 bzw. 0 ... 100 | Trigger mode [1]<br>Free Run |
| Number of 16 bit values per sample | 9302h | 0 ... 24 | |
| Channel list assignments: | | | See page 41, Data Logger, Selection and Assignment of Measured Values |
| Channel 1 (Trace 1) | 9303h | | |
| Channel 2 | 9304h | | |
| Channel 3 | 9305h | | |
| Channel 4 | 9306h | | |
| Channel 5 | 9307h | | |
| Channel 6 | 9308h | | |
| Channel 7 | 9309h | | |
| Channel 8 | 930Ah | | |
| Channel 9 | 930Bh | | |
| Channel 10 | 930Ch | | |
| Channel 11 | 930Dh | | |
| Channel 12 | 930Eh | | |
| Trigger 1 – source | 930Fh | 00h ... 0C05h | See page 25, Source for Relay and Analog Outputs (WA = 1100h, 1101h bzw. 1600h ... 1603h) |
| Trigger 2 – source | 9310h | 00h ... 0C05h | |
| Sampling interval | 9311h | 0,0,1 ... 43200 | =0: [2] 0.3 s ... 12 h; 20864 $\triangleq$ 24 h |
| Recording duration<br>• of a window (in trigger mode)<br>• max. duration (without triggering) | 9312h+9313h | 60 ... 3.12 x 10$^9$ | 1 min ... 99 years |
| Max. number of samples per window | 9314h+9315h | 0 ... 260754 | |

[1] In trigger mode: number of windows utilized since start of data logger; 100 after first overwriting
[2] Interval depends on measuring frequency: 16 or 32 system periods, compare chapter 4.8.1 on page 39

| Parameter | WA | Value Range | Comment |
|---|---|---|---|
| Data logger, specific parameters for a recording window | | | Read only |
| Window number | 9400h | 1 ... v | |
| Time stamp for the first trigger | 9401h ... 9406h | | See page 42, Data Logger, Time Stamp Format |
| Time stamp for the last trigger | 9407h ... 940Ch | | See page 42, Data Logger, Time Stamp Format |
| Time stamp for the last sample | 940Dh... 9412h | | See page 42, Data Logger, Time Stamp Format |
| Sample position of the first trigger | 9413h+9414h | 0 ... 195566 | |
| Sample position of the last trigger | 9415h+9416h | 0 ... 260754 | < max. number |
| Position of the last sample | 9417h+9418h | 0 ... 260754 | < max. number, number of samples – 1 |
| Number of samples per transmission block | 9419h | 5 ... 120 | Last block may have fewer samples |
| Number of transmission blocks per window | 941Ah | 1 ... approx. 2200 | |
| Data field data logger transmission block | 9500h | | Read only |
| $1^{st}$ measured value from $1^{st}$ sample in the block | +0 | | The less significant word is quoted first in the case of energy measurement values |
| … | … | | |
| Last measured value from $1^{st}$ sample | + x – 1 | | |
| $1^{st}$ measured value from $2^{nd}$ sample | + x [3] | | |
| … | … | | |
| Last measured value from last sample | + 119 [4] | | |
| Window number | 9900h | 1 ... 99 | For the request of WA = 94xxh and 95xxh |
| Data block number | 9901h | 0 ... 2169 | |

[3] Number of 16 bit values per sample WA = 9302h
[4] „Number of 16 bit values per sample" multiplied by „Number of samples per transmission block" – 1   (WA = 9302h, 9419h)
   i.e. total number of words is 120 maximum

### 4.8.1  Data Logger, Sampling Interval

| Index | Interval | Index | Interval | Index | Interval |
|-------|----------|-------|----------|-------|----------|
| 0 | 1 measuring cycle * | 2 | 1 seconds | 14 | 1 hour |
| 1 | 2 measuring cycle * | 3 | 2 seconds | 15 | 2 hours |
| | | 4 | 5 seconds | 16 | 4 hours |
| | | 5 | 10 seconds | 17 | 8 hours |
| | | 6 | 15 seconds | 18 | 12 hours |
| | | 7 | 30 seconds | 19 | 24 hours |

\* 1 measuring cycle ≙ 16 system periods

### 4.8.2  Data Logger, Recording Duration

| Index | Recording Duration | Index | Recording Duration | Index | Recording Duration |
|-------|--------------------|-------|--------------------|-------|--------------------|
| 8 | 1 minute | 14 | 1 hour | 19 | 1 day |
| 9 | 2 minutes | 15 | 2 hours | 20 | 2 days |
| 10 | 5 minutes | 16 | 4 hours | 21 | 4 days |
| 11 | 10 minutes | 17 | 8 hours | 22 | 7 days |
| 12 | 15 minutes | 18 | 12 hours | 23 | 14 days |
| 13 | 30 minutes | | | 24 | 31 days |

### 4.8.3 Data Logger, Trigger Specification

| Bit No. | Function | Comment |
|---------|----------|---------|
| 0...2 | 0: no trigger<br>1: Alarm 1 trigger<br>2: Alarm 2 trigger<br>3: Alarm 1 and 2 trigger<br>4: no trigger and logger start via Sync input<br>5: Alarm 1 trigger and trigger lock via Sync input<br>6: Alarm 2 trigger and trigger lock via Sync input<br>7: Alarm 1 and 2 trigger and trigger lock via Sync input | |
| 3 | =0: "one-time only" memory mode<br>=1: "cyclical" memory mode | |
| 5,4 | =0.0: pre-trigger 00%<br>=0.1: pre-trigger 25%<br>=1.0: pre-trigger 50%<br>=1.1: pre-trigger 75% | Position of the 1$^{st}$ trigger as a percentage in relation to the number of sampling operations per window |
| 6 ... 15 | =0 | not in use |

### 4.8.4 Data Logger, Selection and Assignment of Measured Values

to recording channels 1 through 12 in the channel list:
Starting with channel 1, all channels are recorded up to the first channel for which ≙ "OFF"
has been entered to the channel list. None of the channels after this point in the list are taken into
consideration!

| Bit No. | Function | Coding (1) | Comment | Coding (2) |
|---------|----------|-----------|---------|-----------|
| 0 ... 7 | Measured value phase number | =0: phase 1 or $U_{12}$ | = L− for energies and LTHT mode | = 8: Current harmonics phase 1 |
| | | =1: phase 2 or $U_{23}$ | = L+ | = 9: Current harmonics phase 2 |
| | | =2: phase 3 or $U_{31}$ | = H− | =10: Current harmonics phase 3 |
| | | =3: sum of 3 phases | = H+ | =12: Voltage distortion factor phase 1 |
| | | =4: neutral conductor current | only if type of measured value = 2, 3 (current) | =13: Voltage distortion factor phase 2 |
| | | | | =14: Voltage distortion factor phase 3 |
| 8 ... 15 | Type of measured value | =0: delta voltage | | =0: thd (Total harmonic distortion) |
| | | =1: phase voltage | | =1:   1st harmonic |
| | | =2: phase current | | . |
| | | =3: phase current (avg) | | . |
| | | =4: active power | | . |
| | | =5: reactive power | | =15: 15th harmonic |
| | | =6: apparent power | | |
| | | =7: power factor | | |
| | | =8: frequency | independent of phase number | |
| | | =9: active power interval | The last completed power interval is used in each case | |
| | | =10: reactive power interval | | |
| | | =11: apparent power interval | | |
| | | =12: no measured value is assigned to this channel | ≙ "OFF" <br> If one recording channel is deactivated, the subsequent recording channels are likewise regarded as deactivated | |
| | | =13: active energy <br> =14: reactive energy | | |

### 4.8.5 Data Logger, Time Stamp Format

| Word | Contents | Word | Contents |
|------|----------|------|----------|
| 1 | seconds | 4 | day (of the month) |
| 2 | minutes | 5 | month |
| 3 | hours | 6 | decade + year |

## 4.9 Sampling Values

| Value | WA | Comment |
|---|---|---|
| **U1 – Sampling values:**<br>1st sampling value U1<br><br>...<br><br>32nd sampling value U1 | A000h<br><br>...<br><br>A01Fh | read only |
| **U2 – Sampling values:**<br>1st sampling value U2<br><br>...<br><br>32nd sampling value U2 | A100h<br><br>...<br><br>A11Fh | read only |
| **U3 – Sampling values:**<br>1st sampling value U3<br><br>...<br><br>32nd sampling value U3 | A200h<br><br>...<br><br>A21Fh | read only |
| **I1 – Sampling values:**<br>1st sampling value I1<br><br>...<br><br>32nd sampling value I1 | A300h<br><br>...<br><br>A31Fh | read only |
| **I2 – Sampling values:**<br>1st sampling value I2<br><br>...<br><br>32nd sampling value I2 | A400h<br><br>...<br><br>A41Fh | read only |
| **I3 – Sampling values:**<br>1st sampling value I3<br><br>...<br><br>32nd sampling value I3 | A500h<br><br>...<br><br>A51Fh | read only |
| Sampling values<br>freeze = 0055h<br>update = 00AAh | A600h | |

### 5 Product Support Industrial Division

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