GOSSEN METRAWATT

A2000

Multifunctional Power Meter
Modbus Communications Protocol – Mod 1–

3-349-225-03
6/7.03

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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	

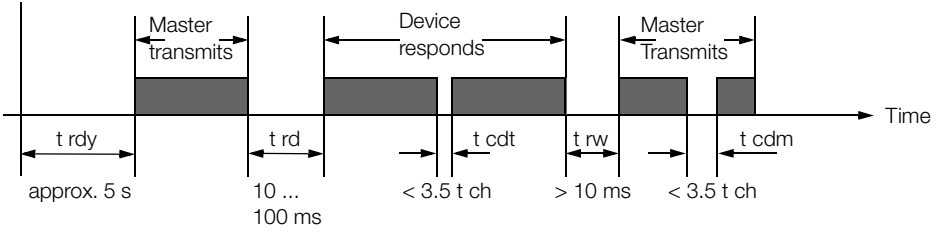

Figure 1 Basic Time Response

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:

```
/* ---------------------------------------------------------------------
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

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)

Error code

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

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
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	
	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**	read only
	A000h … A01Fh	U1	
	A100h … A11Fh	U2	
	A200h … A21Fh	U3	
	A300h … A31Fh	I1	
	A400h … A41Fh	I2	
	A500h … A51Fh	I3	

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} ... 10^{2}	dim.U= –1 ... 2	0 ... 9999	0 V ... 999.9 V ... 999.9 kV	dim. U (V)
Current	A	10^{-3} ... 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} ... 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} ... 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_{Σ}	0403h
$P1_{max}$	0404h
$P2_{max}$	0405h
$P3_{max}$	0406h
$P_{\Sigma\ max}$	0407h
Reactive power:	
Q1	0500h
Q2	0501h
Q3	0502h
Q_{Σ}	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_{Σ}		0603h
$S1_{max}$		0604h
$S2_{max}$		0605h
$S3_{max}$		0606h
$S_{\Sigma max}$		0607h
Power factors:		
PF1		0700h
PF2		0701h
PF3		0702h
PF_{Σ}	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] 1^{st} – 10^{th} preceding interval
[5] Max. interval value as of power-up or value reset (see see chapter 4.5 on page 26, 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 to be monitored (source)	0 ... 100	
Relay 2, hysteresis	1001h			
Relay 1, limit	1002h		–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 25
Pulse output 2, rate	1201h	1 / kWh (MWh)		
Pulse output 1, source	1300h		See chapter 4.4.4 on page 25	
Pulse output 2, source	1301h			
Analog outputs:		U/M of quantity to be output (source)	–9999 ... 9999	
Lower range limit 1	1400h			
Lower range limit 2	1401h			
Lower range limit 3	1402h			Lower range limit 3 / 4 = 0, if feature A1 is not included
Lower range limit 4	1403h			
Analog outputs:		U/M of quantity to be output (source)	–9999 ... 9999	
Upper range limit 1	1500h			
Upper range limit 2	1501h			
Upper range limit 3	1502h			Upper range limit 3 / 4 = 0, if feature A1 is not included
Upper range limit 4	1503h			
Analog ouptuts:			See chapter 4.4.3 on page 25	
Source 1	1600h			
Source 2	1601h			
Source 3	1602h			Source 3 / 4 = 0, if feature A1 is not included
Source 4	1603h			
Configuration 1	1604h		See chapter 4.4.2 on page 24	
Configuration 2	1605h			
Configuration 3	1606h			Configuration 3 / 4 = 0, if feature A1 is not included
Configuration 4	1607h			

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 1 = 1 s 2 = 2 s 3 = 3 s 4 = 5 s 5 = 8 s 6 = 15 s 7 = 25 s 8 = 40 s 9 = 1 min 10 = 2 min 11 = 3 min 12 = 5 min 13 = 8 min 14 = 15 min 15 = 30 min	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)	
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	

4.5 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 4.5.3 on page 28
	2100h	Measuring circuit	
	2101h	Miscellaneous	
Clear max. U/I	2400h	See next page	Write only
Clear max. powers		See next page	Write only
Max. powers	2500h		
Max. interval powers/FFT	2501h		
Clear energy meter	2600h	=55AAh	Write only
Set default parameters	2700h	=A965h	Write only, sets 1st and 2nd parameter set to default values, except for address (set – default, – user)
Analog outputs		± 2000 100 corresponds to 1 mA bzw. 0.5 V	Write only if source analog outputs = external Not with feature L2
Direct output value 1	2800h		
Direct output value 2	2801h		
Direct output value 3	2802h		
Direct output value 4	2803h		
Start / stop data logger	2900h	=55h: stop =AAh: start	Not with feature R1 Restart only after previous stop!

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 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 = 2100h)

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 R1is 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	
Represent. of reactive power	3800h		
per DIN 40110		0000h	$Q = \sqrt{S^2 - P^2}$
With sign		0010h	$Q = \frac{1}{TN} \cdot \int_0^{TN} U(t) \cdot J\left(t - \frac{TN}{4}\right) dt$ [2]
Compensating reactive power		0020h	
Voltage measuring range			
Primary phase voltage U_{tprim}	3B00h	1 ... 7500	= 100 V ... 750 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	0.1	= 5 A, 1 A
Display brightness	3F00h	(bit 0 to 2) 0 ... 7	0.5 brightness grades
Display filter	3F00h	(bit 3 to 7) 0 ... 30	Time constant in s

[1] Variant without data logger: no low tariff
[2] TN is the period duration of the basic frequency of U and/or I

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 ... 15	0	—	—

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 2nd harmonic	8302h		U3 2nd harmonic	8A02h	
...	...		...	...	
U3 15th harmonic	830Fh		U3 15th 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 2nd harmonic	8402h		I1 2nd harmonic	8B02h	
...	...		...	...	
I1 15th harmonic	840Fh		I1 15th 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 2nd harmonic	8502h		I2 2nd harmonic	8C02h	
...	...		...	...	
I2 15th harmonic	850Fh		I2 15th 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 2nd harmonic	8602h		I3 2nd harmonic	8D02h	
...	...		...	...	
I3 15th harmonic	860Fh		I3 15th 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

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 ... 13	See page 37, Data Logger, Sampling Interval
Current recording duration per window in trigger mode [1)]	9201h	8 ... 21	See page 37, Data Logger, Recording Duration
Trigger specification	9202h	00h ... 3Fh	See page 37, Data Logger, Trigger Specification
Selection and assignment of measured values to recording channels 1 to 12			See page 38, 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] Free Run
Number of 16 bit values per sample	9302h	0 ... 24	
Channel list assignments:			See page 38, 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 ... 1800	=0: [2]
Recording duration • of a window (in trigger mode) • max. duration (without triggering)	9312h+9313h	60 ... 345600	
Max. number of samples per window	9314h+9315h	0 ... 260000	

[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 37

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 39, Data Logger, Time Stamp Format
Time stamp for the last trigger	9407h ... 940Ch		See page 39, Data Logger, Time Stamp Format
Time stamp for the last sample	940Dh... 9412h		See page 39, Data Logger, Time Stamp Format
Sample position of the first trigger	9413h+9414h	0 ... 195000	
Sample position of the last trigger	9415h+9416h	0 ... 260000	≤ max. number
Position of the last sample	9417h+9418h	0 ... 260000	≤ max. number
Number of samples per transmission block	9419h	5 ... 120	Last block may have fewer samples
Number of transmission blocks per window	941Ah	1 ... 2170	
Data field data logger transmission block	9500h		Read only
1st measured value from 1st sample in the block	+0		5)
…	…		
Last measured value from 1st sample	+ x – 1		
1st measured value from 2nd sample	+ x 3)		
…	…		
Last measured value from last sample	+ 119 4)		
Window number Data block number	9900h 9901h	1 ... 99 0 ... 2169	For the request of WA = 94xxh and 95xxh

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

5) The less significant word is quoted first in the case of energy measurement values

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	=1: Alarm 1-trigger enable	
1	=1: Alarm 2-trigger enable	
2	=1: ext. trigger disabling deactivated	
3	=0: “one-time only” memory mode =1: “cyclical” memory mode	
5,4	=0.0: pre-trigger 00% =0.1: pre-trigger 25% =1.0: pre-trigger 50% =1.1: pre-trigger 75%	Position of the 1st 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} =1: phase 2 or U_{23} =2: phase 3 or U_{31} =3: sum of 3 phases =4: neutral conductor current	= L– for energies and LTHT mode = L+ = H– = H+ only if type of measured value = 2, 3 (current)	= 8: Current harmonics phase 1 = 9: Current harmonics phase 2 =10: Current harmonics phase 3 =12: Voltage distortion factor phase 1 =13: Voltage distortion factor phase 2 =14: Voltage distortion factor phase 3
8 ... 15	Type of measured value	=0: delta voltage =1: phase voltage =2: phase current =3: phase current (avg) =4: active power =5: reactive power =6: apparent power =7: power factor		=0: thd (Total harmonic distortion) =1: 1st harmonic . . . =15: 15th harmonic
		=8: frequency =9: active power interval =10: reactive power interval =11: apparent power interval	independent of phase number The last completed power interval is used in each case	
		=12: no measured value is assigned to this channel	≙ "OFF" If one recording channel is deactivated, the subsequent recording channels are likewise regarded as deactivated	
		=13: active energy =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:		read only
1st sampling value U1	A000h	
...	...	
32nd sampling value U1	A01Fh	
U2 – Sampling values:		read only
1st sampling value U2	A100h	
...	...	
32nd sampling value U2	A11Fh	
U3 – Sampling values:		read only
1st sampling value U3	A200h	
...	...	
32nd sampling value U3	A21Fh	
I1 – Sampling values:		read only
1st sampling value I1	A300h	
...	...	
32nd sampling value I1	A31Fh	
I2 – Sampling values:		read only
1st sampling value I2	A400h	
...	...	
32nd sampling value I2	A41Fh	
I3 – Sampling values:		read only
1st sampling value I3	A500h	
...	...	
32nd sampling value I3	A51Fh	

5 Product Support

When you need support, please contact:

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