GOSSEN METRAWATT

A2000

Multifunctional Power Meter
Modbus Communications Protocol – Mod2–

3-349-129-03
6/7.03

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Abbreviations and their meanings:

BA	Bit address
CRC	Cyclical redundancy check
DA	Device address
DB	Data block length = n x 2 (bytes)
EC	Exception code
FC	Function code
FF	Function field
m	Number of bytes
MR	Measuring range
MSB	Most significant bit
n	Number of words
PI	Parameters index

1 Overview of Telegrams (commands) to the A2000 in Accordance with Modbus

Utilized Functions:

Code	Modbus Function	Application
05	Force single coil	CPU reset
07	Read exception status	Query: device OK?
03	Read holding registers	Data query
16	Preset multiple registers	A2000 parameters configuration

1.1 Modbus Telegram Format (general)

Typical Message Frame:

Start	ADDRESS	FUNCTION	DATA	CRC	END
T1-T2-T3-T4	8 bit	8 bit	n x 8 bit	16 bit	T1-T2-T3-T4

T1-T4: waiting times

2 The Address Field

- Address range: 0 ... 247 (currently, addresses 3, 5, 7 and 16 cannot be used).
- Slave address range: 1 ... 247
- The master writes the slave address of the slave with which it wants to communicate to the address field.
  When responding, the slave writes its own address to the address field so that the master knows where the answer is coming from.
- Address 0 is reserved for messages which are transmitted to all slaves (broadcast).
  Functions 05h and 10h support broadcast.

3 The Function Field

- When the master sends a query, it tells the slave what to do.
- The slave returns the same code in the event of an error-free response.
- If an error occurs, the MSB in the error code is set to one. Additionally, the slave adds an error code to the data field which informs the master which error has occurred.

3.1 Errors

There are 4 events which may result from a query (other than broadcast messages):

- The slave receives in an error-free fashion, processes the query normally and returns a response.
- The slave does not receive the query (faulty communications), and does not return a response. The master may generate a timeout as a result.
- The slave receives the message but detects a transmission error (parity, CRC). No response is returned (may result in timeout).
- The slave receives in an error-free fashion, but is unable to process the query. The slave responds with an exception, in order to inform the master which error has occurred.

Exceptions include 2 fields which differentiate them from normal messages:

- Function code field:

  The function code is normally returned. In the case of an exception, the MSB in the function code is set to 1 (e.g. query 01h is followed by response 81h).

- Data field:

  The data field does not contain any data, as would be the case with normal responses. Instead, it contains the exception code which describes the error in detail.

Example: **Error-Free Communications**

Query from master:

F0	03	00	2F	00	01	A0	E2
GA	FF	PI high	PI–1 low	n high	n low	CRC low	CRC high

Response from A2000:

F0	03	02	00	A2	44	28
GA	FF	m	DB high	DB low	CRC low	CRC high

Example: **Incorrect Parameter Entry**

Query from master:

F0	10	00	2F	00	01	02	00	A2	29	E2
GA	FF	PI high	PI–1 low	n high	n low	m	DB high	DB low	CRC low	CRC high

This address may not be written to. Error message 02 is generated as a result.

Response from A2000:

F0	90	02	9C	32
GA	FF	EC	CRC low	CRC high

The A2000 supports the following exception codes:

Code	Name
01	ILLEGAL FUNCTION
02	ILLEGAL DATA ADDRESS
03	ILLEGAL DATA VALUE

3.2 CRC Generation

- CRC field = 2 bytes (16 bits)
- The CRC is generated by the transmitting device and is attached to the message.
- The receiving device calculates the CRC value during receipt, and compares it with the transmitted value.

Positioning of the CRC value within the message:

Addr	Func	Data Count	Data	Data	Data	Data	CRC Lo	CRC Hi

4 RTU Character Frame

With parity check:

Start	1	2	3	4	5	6	7	8	Par	Stop

Without parity check:

Start	1	2	3	4	5	6	7	8	Stop	Stop

5 Data and Message Transmission

5.1 Reading and Writing Word by Word

Example: Reading

Query from master:

GA	FF	PI high	PI–1 low	n high	n low	CRC low	CRC high
	03					XX	XX

Response from A2000:

GA	FF	m	DB	CRC low	CRC high
	03		m Sign	XX	XX

Example: Writing

Telegram:

GA	FF	PI high	PI–1 low	n high	n low	m	DB	CRC low	CRC high
	10h						m sign	XX	XX

Response from A2000:

GA	FF	PI high	PI–1 low	n high	n low	CRC low	CRC high
	10h					XX	XX

5.2 Device Reset

Example: Device address F0h = 240d (except broadcast)

Query from master:

F0	05	00	00	00	00	D8	EB
GA	FC	BA	BA	DB	DB	CRC low	CRC high

Response from A2000:

none

5.3 Query: Device OK?

The queried device responds with the function field only.

Example: Device address = 240

Query from master:

F0	07	04	72
GA	FF	CRC low	CRC high

1st response from A2000:

F0	07	00	73	C3
GA	FF	DB	CRC low	CRC high

2nd response from A2000:

F0	07	80	72	63
GA	FF	DB	CRC low	CRC high

If one bit has been set in the event data, the slave responds with exception status 80h. In all other cases the slave responds with 00h.

1st response: No error status bit is set (event data → PI 21h)

2nd response: At least 1 error status bit is set (event data → PI 21h)

5.4 Cycle Data

Requesting cycle data:

Example: Device address = 240d

Query from master:

F0h	03h	00h	21h	00h	0Fh	40h	E5h
GA	FF	PI high	PI–1 low	n high	n low	CRC low	CRC high

Response from A2000:

F0h	03h	1Eh	DB	87h	23h
GA	FF	m	30 char.	CRC low	CRC high

Positioning of the cycle data within the data block

5.4.1 Cycle Data for “4-Wire” Configuration

The cycle data block includes a selection from PI group 0xh (parameters index), and is independent of the selected measuring connection configuration, e.g. 4L or 3L (4-wire or 3-wire system).
The 30 characters included in the cycle data have the following format for the “4L” configuration:

Char. No.	Content	Format	Comment
1	FFh		Unused byte
2, 3		16 bit	Frequency
4		± 7 bit	PF3
5		± 7 bit	PF2
6		± 7 bit	PF1
7, 8		16 bit	Q3
9, 10		16 bit	Q2
11, 12		16 bit	Q1
13, 14		± 15 bit	P3
15, 16		± 15 bit	P2
17, 18		± 15 bit	P1
19, 20		16 bit	Iph3
21, 22		16 bit	Iph2
23, 24		16 bit	Iph1
25, 26		16 bit	Uph3
27, 28		16 bit	Uph2
29, 30		16 bit	Uph1

5.4.2 Cycle Data for “3-Wire” Configuration

The 30 characters included in the cycle data have the following format for the “3L” configuration:

Char. No.	Content	Format	Comment
1 ... 11	FFh		Unused bytes
12, 13		16 bit	Frequency
14		± 7 bit	PFΣ
15, 16		16 bit	QΣ
17, 18		± 15 bit	PΣ
19, 20		16 bit	Iph3
21, 22		16 bit	Iph2
23, 24		16 bit	Iph1
25, 26		16 bit	U31
27, 28		16 bit	U23
29, 30		16 bit	U12

5.5 Event Data

Requesting event data:

Query from master:

F0h	03h	00h	20h	00h	02h	D0h	E0h
GA	FF	PI high	PI–1 low	n high	n low	CRC low	CRC high

Response from A2000:

F0h	03h	04h	Error status word 1		Error status word 2		33h	3Ch
GA	FF	m	high	low	high	low	CRC low	CRC high

Error status word 1 (measuring circuit), read only

Bit No.	Value	Meaning	Comment
0	1	U1 overflow	
1	1	U2 overflow	
2	1	U3 overflow	
3	1	I1 overflow	
4	1	I2 overflow	
5	1	I3 overflow	
6	1	Frequency > 70 Hz	At none of the 6 measurement inputs
7	1	Device is not calibrated	Re-calibration required
8	1	U1 < 0.7% of measuring range or non-existent	
9	1	U2 < 0.7% of measuring range or non-existent	
10	1	U3 < 0.7% of measuring range or non-existent	
11	1	I1 < 0.8% of measuring range or non-existent	
12	1	I2 < 0.8% of measuring range or non-existent	
13	1	I3 < 0.8% of measuring range or non-existent	
14	1	DC offset too large (bits 0 to 5 identify channel)	Defective measurement input
15	1	Frequency < 40 Hz / non-existent	At none of the 6 measurement inputs

Error status word 2 (miscellaneous), read only (write bit 0, 1)

Bit No.	Value	Meaning	Comment
0	1	Defective measurement input	0 after error has been corrected
1	1	Illegal parameter, value not accepted	0 after reading
2	0		
3	1	Real-time clock power failure, incorrect real-time value	0 after write to RTC, PI = 90h, 91h
4	1	Defective real-time clock	0 after error has been corrected
5	0	Incorrect setup parameter from EEPROM	0 after error has been corrected
6	0	Incorrect meter reading from EEPROM	0 after error has been corrected
7	0	Defective EEPROM	0 after error has been corrected
8	1	Alarm 1 (relay 1) active	1)
9	1	Alarm 2 (relay 2) active	1)
10	1	Condition for alarm 1 fulfilled (is not saved to memory)	
11	1	Condition for alarm 2 fulfilled (is not saved to memory)	
12	1	3-wire connection with following sequence: L1, L3, L2	0 after correction and after device is switched back on
13	0		
14	0		
15	0		

[1] Bit 8, 9 = 1 - write resets alarm 1, 2 (required for alarm memory mode)

6 Data and Associated Parameters Index PI

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

6.1 Addressing of Values and Parameter

The start address is identified as PI (parameters index) in the following tables. Indirect addressing of the data area is accomplished via the parameters index (pointer at start address). The parameters index corresponds to register addressing, i.e. register 1 is addressed with 00h and so forth. The length of the data area (number of registers to be read / written) is indicated in the column “Number of words“ in the Overview Table (chapter 6.3).

Example: Read in delta voltage (device address = 240d):

Delta voltages are read in via parameters index 01h.

As demonstrated by the measured value table, this data block includes 6 measured values with 16 bits each.

Thus: n = 6

Query from master:

F0h	03h	00h	00h	00h	06h	D0h	E9h
GA	FF	PI high	PI–1 low	n high	n low	CRC low	CRC high

Response from A2000:

F0h	03h	0Ch	DB	EBh	45h
GA	FF	m	12 Char.	CRC low	CRC high

6.2 Data Block Length and Format (DB)

Length and format are variable depending on PI and FF.
Transmitted values have the following format:

8 bits		Number without sign
± 7 bits	Two’s complement representation	Number with sign
16 bits	MS byte first	Number without sign
± 15 bits	MS byte first, two’s complement representation	Number with sign
32 bits	MS byte first	Number without sign
± 31 bits	MS byte first, two’s complement representation	Number with sign
8 / 16 bits	MS byte first	Bit array

6.3 Overview (PI = 00h bis 99h)

Main Group	PI	Number of Words	Value	Comment
0			**Measured values**	Read only
	00h	6	Phase voltages	
	01h	6	Delta voltages	
	02h	6	Phase currents	
	03h	6	Averaged phase currents	
	04h	8	Active power	
	05h	8	Reactive power	
	06h	8	Apparent power	
	07h	8	Power factors	
	08h	16	Energy meters	
	09h	12	Interval active power	
	0Ah	12	Interval reactive power	
	0Bh	12	Interval apparent power	
	0Dh	4	Neutral conductor currents	
	0Fh	1	Line frequency	
1			**Limit Values**	
	10h	4	Relay hysteresis / limit	
	11h	2	Relay source / configuration	
	12h	2	Pulse output rate	
	13h	1	Pulse output source	
	14h	4	Analog output lower range limit	Not for Feature L2
	15h	4	Analog output upper range limit	Not for Feature L2
	16h	4	Analog output source / configuration	Not for Feature L2

Main Group	PI	Number of Words	Value	Comment
2			**Control commands / status queries**	
	20h	1	Control status	
	21h	2	Error status	Read only
	22h	15	Cycle data	Read only
	24h	1	Max. voltages, delete currents	Write only
	25h	2	Max. powers / delete FFT	Write only
	26h	1	Delete energy meter	Write only
	27h	1	Set standard parameters	Write only
	28h	4	Control analog outputs	Not for Feature L2
	29h	1	Data logger start / stop	Only for Feature R1
3			**Device specification**	
	30h	1	Device ID	Read only
	31h	1	Equipped with	Read only
	32h	2	Measured value dimensions	Read only
	33h	1	Connection type	
	34h	1	Synchronizing interval	
	35h	1	Software version	Read only
	36h	1	Energy meter mode	
	37h	2	Low tariff time interval	Only for Feature R1
	38h	1	Type of measurement for reactive power	
	3Bh	2	Voltage measuring range	
	3Ch	2	Current measuring range	
	3Fh	1	Display brightness/display filter	

Main Group	PI	Number of Words	Value	Comment
8			**Harmonic waves, FFT**	Read only
	80h	12	THD / fundamental wave	
	81h	16	U1 THD / distortion factors	
	82h	16	U2 THD / distortion factors	
	83h	16	U3 THD / distortion factors	
	84h	16	I1 THD / harmonic waves	
	85h	16	I2 THD / harmonic waves	
	86h	16	I3 THD / harmonic waves	
	87h	12	Maximum values THD / fundamental wave	
	88h	16	Maximum values U1 THD / distortion factors	
	89h	16	Maximum values U2 THD / distortion factors	
	8Ah	16	Maximum values U3 THD / distortion factors	
	8Bh	16	Maximum values I1 THD / harmonic waves	
	8Ch	16	Maximum values I2 THD / harmonic waves	
	8Dh	16	Maximum values I3 THD / harmonic waves	
9			**Real-time Clock / Data Logger**	Not for Feature R1
	90h	2	Time	
	91h	2	Date	
	92h	8	Setup parameters data logger	
	93h	14	Current setup of recording	Read only
	94h	17	Current setup of a recording window	Read only
	95h	122	Transmission block of record data	Read only
	99h	2	Selection recording window, transmission block	
A			**Sampling Values**	Read only
	A0	32	U1	
	A1	32	U2	
	A2	32	U3	
	A3	32	I1	
	A4	32	I2	
	A5	32	I3	

6.4 Measured Value Units of Measure, Measured Value Ranges and Resolution

The data below are valid for all telegram 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 PI = 3Bh, 3Ch) and can be read with PI = 32h.

Measured Quantity	Basic Unit of Measure	Multiplier Range	Corresponding Value for “dim” Parameter PI = 32h	Data Field Value Range	Overall Physical Value Range	Display Resolution compare: PI = 32h
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)

6.5 Table of Measured Values (PI = 00h ... 0Fh)

For measured values the parameter index PI = 00h extends to 0Fh. Measured values can only be read, writing is not possible.

PI	Measured Values	Format
00h	Phase voltages:	
	$U3_{max}$	16 bit
	$U2_{max}$	16 bit
	$U1_{max}$	16 bit
	U3	16 bit
	U2	16 bit
	U1	16 bit
01h	Delta voltages:	
	$U31_{max}$	16 bit
	$U23_{max}$	16 bit
	$U12_{max}$	16 bit
	U31	16 bit
	U23	16 bit
	U12	16 bit
02h	Phase currents:	
	$I3_{max}$	16 bit
	$I2_{max}$	16 bit
	$I1_{max}$	16 bit
	I3	16 bit
	I2	16 bit
	I1	16 bit
03h	Averaged phase currents:	
	$I3_{avg\ max}$	16 bit
	$I2_{avg\ max}$	16 bit
	$I1_{avg\ max}$	16 bit
	$I3_{avg}$	16 bit
	$I2_{avg}$	16 bit
	$I1_{avg}$	16 bit
04h	Active power:	
	$P_{\Sigma\ max}$	± 15 bit
	$P3_{max}$	± 15 bit
	$P2_{max}$	± 15 bit
	$P1_{max}$	± 15 bit
	P_{Σ}	± 15 bit
	P3	± 15 bit
	P 2	± 15 bit
	P 1	± 15 bit
05h	Reactive power:	
	$Q_{\Sigma\ max}$	16 bit
	$Q3_{max}$	16 bit
	$Q2_{max}$	16 bit
	$Q1_{max}$	16 bit
	Q_{Σ}	16 bit
	Q3	16 bit
	Q2	16 bit
	Q1	16 bit

PI	Measured Values		Format
06h	Apparent power:		
	$S_{\Sigma max}$		16 bit
	$S3_{max}$		16 bit
	$S2_{max}$		16 bit
	$S1_{max}$		16 bit
	S_{Σ}		16 bit
	S3		16 bit
	S2		16 bit
	S1		16 bit
07h	Power factors:		
	$PF_{\Sigma min}$		± 7 bit
	$PF3_{min}$		± 7 bit
	$PF2_{min}$		± 7 bit
	$PF1_{min}$	PF<0: PF capacitive [1]	± 7 bit
	PF_{Σ}	PF>0: PF inductive [1]	± 7 bit
	PF3		± 7 bit
	PF2		± 7 bit
	PF1		± 7 bit
08h	Energy meter: [2]		
	Mode L123	Mode LTHT	
	$E_{Q\Sigma}$	$E_{Q\Sigma H+}$	32 bit
	E_{Q3}	$E_{Q\Sigma H-}$	32 bit
	E_{Q2}	$E_{Q\Sigma L+}$	32 bit
	E_{Q1}	$E_{Q\Sigma L-}$	32 bit
	$E_{P\Sigma}$	$E_{P\Sigma H+}$	± 31 / 32 bit
	E_{P3}	$E_{P\Sigma H-}$	± 31 / 32 bit
	E_{P2}	$E_{P\Sigma L+}$	± 31 / 32 bit
	E_{P1}	$E_{P\Sigma L-}$	± 31 / 32 Bit

PI	Measured Values		Format
09h	$P_{Int\Sigma}$	[3]	1 x ± 15 bit
	$P_{Int\Sigma}$	[4]	10 x ± 15 bit
	$P_{Int\Sigma}$	[5]	1 x ± 15 bit
0Ah	$Q_{Int\Sigma}$	[3]	1 x 16 bit
	$Q_{Int\Sigma}$	[4]	10 x 16 bit
	$Q_{Int\Sigma}$	[5]	1 x 16 bit
0Bh	$S_{Int\Sigma}$	[3]	1 x 16 bit
	$S_{Int\Sigma}$	[4]	10 x 16 bit
	$S_{Int\Sigma}$	[5]	1 x 16 bit
0Dh	Neutral conductor currents		
	$I_{N\ avg\ max}$		16 bit
	$I_{N\ avg}$		16 Bit
	$I_{N\ max}$		16 Bit
	I_N		16 Bit
0Fh	Line frequency		0 bit

[1] Multiply the result (± 7 bits) 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] Max. interval value as of power-up or value reset (see chapter 6.7 on page 22, PI=25h)
[4] 10^{th} to 1^{st} preceding interval
[5] Current interval

6.6 Table for Relay, Pulse and Analog Output Quantities (PI = 10h ... 1Fh)

PI	Parameter	Format	Unit of Measure	Value Range	Comment
10h	Relay 2, limit	± 15 bit	U/M of quantity to be monitored (source)	–10000 ... 9999	Selected range limits dependent upon relays, observe source!
	Relay 1, limit	± 15 bit			
	Relay 2, hysteresis	16 bit		0 ... 100	
	Relay 1, hysteresis	16 bit			
11h	Relay 2, configuration	8 bit		See chapter 6.6.1 on page 20	
	Relay 1, configuration	8 bit			
	Relay 2, source	8 bit		See chapter 6.6.3 on page 21	
	Relay 2, source	8 bit			
12h	Pulse output 2, rate	16 bit	1 / kWh	0 ... 5000	
	Pulse output 1, rate	16 bit	1 / kWh		
13h	Pulse output 2, source	8 bit		See chapter 6.6.4 on page 22	
	Pulse output 1, source	8 bit			
14h	Analog outputs:		U/M of quantity to be output (source)	–19999 ... 9999	Lower range limit 3 / 4 = 0 if feature A1 is not included
	Lower range limit 4	± 15 bit			
	Lower range limit 3	± 15 bit			
	Lower range limit 2	± 15 bit			
	Lower range limit 1	± 15 bit			
15h	Analog outputs:		U/M of quantity to be output (source)	–19999 ... 9999	Upper range limit 3 / 4 = 0 if feature A1 is not included
	Upper range limit 4	± 15 bit			
	Upper range limit 3	± 15 bit			
	Upper range limit 2	± 15 bit			
	Upper range limit 1	± 15 bit			
16h	Analog outputs:			See chapter 6.6.2 on page 20	Configuration 3 / 4 = 0 if feature A1 is not included
	Configuration 4	8 bit			
	Configuration 3	8 bit			
	Configuration 2	8 bit			
	Configuration 1	8 bit			
	Source 4	8 bit		See chapter 6.6.3 on page 21	Source 3 / 4 = 0 if feature A1 is not included
	Source 3	8 bit			
	Source 2	8 bit			
	Source 1	8 bit			

6.6.1 Relay Configuration (PI = 11h)

Bit No.	Value	Meaning	Function
0	0	low	Low / high alarm function
	1	high	
1	0	non-store	Alarm memory
	1	store	
2	0	Depends upon DIP switch	Alarm enabling
	1	Always open	
3	0		No function
4 ... 7	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

6.6.2 Analog Output Configuration (PI = 16h)

Bit No.	Value	Meaning	Function
0, 1	0.0	4 ... 20 mA (2 ... 10 V)	Output type
	0.1	0 ... 20 mA (0 ... 10 V)	
	1.0	–20 ... 20 mA (–10 ... 10 V)	
2 ... 7	0		No function

6.6.3 Source Code for Alarm (relay) and Analog Outputs (PI = 11h or 16h)

Bit No.	Value	Meaning	Function
0 ... 3	0	Phase 1 or 1→2	Phase number of source value (no function for frequency)
	1	Phase 2 or 2→3	
	2	Phase 3 or 3→1	
	3	Sum	
	4	Neutral conductor current	Only for source value = 2, 3 (current)
	5	For all 3 phases	Only for relay (PI = 11h)
4 ... 7	0	Delta voltage	Type of source value
	1	Phase voltage	
	2	Phase current	
	3	Phase current, averaged	
	4	Active power	
	5	Reactive power	
	6	Apparent power	
	7	Power factor	
	8	Frequency [1)]	
	9	Total active power interval [2)]	
	10	Total reactive power interval [2)]	
	11	Total apparent power interval [2)]	
	12	External value (control via interface is possible)	

[1)] Frequency value independent of phase number
[2)] Power interval values independent of phase number
Current interval is used for alarm output,
previously concluded interval is used for analog output.

6.6.4 Source Code for Pulse Output (PI = 13h)

Bit No.	Value	Meaning	Function
3 ... 0	0	Phase 1 or 1→2	Phase number of source value (no function for frequency)
	1	Phase 2 or 2→3	
	2	Phase 3 or 3→1	
	3	Sum	
4	0	Active energy	Type of source value
	1	Reactive energy	
5	0	Import	Type of source value
	1	Export (for active energy only)	
6	0	Pulses per kWh	
	1	Pulses per MWh	
7	0	High tariff	
	1	Low tariff	

6.7 Control Commands and Status Queries (PI = 20h ... 2Fh)

Control commands and status queries are summarized in parameters index groups 20h ... 2Fh.

PI	Parameter	Format	Value Range	Comment
20h	A2000 control status	16 bit	See next page	
21h	A2000 error status	2x 16 bit		Read only, comp. with event data in chapter 5.5 on page 9
22h	Cycle data	30 bytes		See chapter 5.4 on page 8.
24h	$U \triangle_{max}$ clear	bit array: 16 bit	See page 24 Bit array: reset peak values for voltage, ...	Write only
	U_{max} clear			
	I_{max} clear			
	$I_{avg\ max}$ clear			
25h	MaxFFT clear	4 bytes	See page 24 Bit array: reset peak values for active reactive and apparent power, ...	Write only
	$P_{int\ max}$ clear			
	$Q_{int\ max}$ clear			
	$S_{int\ max}$ clear			
	P_{max} clear			
	Q_{max} clear			
	S_{max} clear			
	PF_{min} clear			
26h	Energy clear all	16 bit	=55AAh	Write only

PI	Parameter	Format	Value Range	Comment
27h	Set default parameters	16 bit	=A965h	Write only, sets 1st and 2nd parameter sets to default values. Interface settings remain unchanged.
28h	Analog outputs		± 2000 100 corresponds to 1 mA or 0.5 V	If source = external
	Direct output value 4	± 15 bit		
	Direct output value 3	± 15 bit		
	Direct output value 2	± 15 bit		
	Direct output value 1	± 15 bit		
29h	Start / stop data logger	16 bit	=0055h: stop =00AAh: start	Restart only possible after previous stop!

A2000 Control Status (PI = 20h)

Bit No.	Value	Function	Comment
0 ... 6	0		
7	1	Pulse input active	Read only
8	0 / 1	Relay 1 active / inactive	If source = external
9	0 / 1	Relay 2 active / inactive	If source = external
10 ... 15	0		

A2000 Error Status (PI = 21h)

See event data in chapter 5.5 on page 9.

Bit array: reset peak values for voltage and current (PI = 24h)

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	0	$I_{N\,max} = 0$
12	1	$I1_{avg\,max} = 0$
13	1	$I2_{avg\,max} = 0$
14	1	$I3_{avg\,max} = 0$
15	0	$I_{N\,avg\,max} = 0$

Bit array: reset peak values for active, reactive and apparent power, as well as for power factor and interval power (PI = 25h)

Bit No.	Value	Function
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	0	not in use
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	$PF1_{min} = 0$
13	1	$PF2_{min} = 0$
14	1	$PF3_{min} = 0$
15	1	$PF\Sigma_{min} = 0$

6.8 Device Specifications

PI	Parameter	Format	Value Range	Comment
30h	Device ID	16 bit	00A2h	Read only
31h	Equipped with	16 bit	See product variants	Read only
32h	Measured Value - Dimension			Read only – determined by primary voltage and current measuring ranges (PI = 3B, 3Ch)
	Dim. E in Wh	± 7 bit		
	Dim. P in W	± 7 bit		
	Dim. I in A	± 7 bit		
	Dim. U in V	± 7 bit		
33h	3-L/4-L/3L-1/3L13/4L13 connection	16 bit	0055h/00AAh/0033h/00CCh/0066h	
34h	Energy synchronizing interval	16 bit	0.1 ... 60	= external, 1 ... 60 minutes
35h	Software version	16 bit	0 ... 255	Read only
36h	Energy meter mode	16 bit		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
37h	Low tariff time interval			Only active if feature R1 is included
	LT_Stop: hours	8 bit	0 ... 23	
	LT_Stop: minutes	8 bit	0 ... 59	
	LT_Start: hours	8 bit	0 ... 23	
	LT_Start: minutes	8 bit	0 ... 59	
38h	Represent. of reactive power	16 bit		
	per DIN 40110		0000h	$Q=\sqrt{S^2-P^2}$
	with sign		0010h	$Q=\frac{1}{TN}\cdot\int_0^{TN}U(t)\cdot J\left(t-\frac{TN}{4}\right)dt$ *)
	Compensating reactive power		0020h	
3Bh	Voltage measuring range			
	U_{tsec}	1 V/16 bit	100 ... 500	= 100 V ... 500 V
	U_{torim}	100 V/16 bit	1... 7500	= 100 V ... 750 kV
3Ch	Current measuring range			
	I_{tsec}	/16 bit	0.1	= 5 A, 1 A
	I_{torim}	1A, 5 A /16 bit	0.1 ... 30000	= 1 A, 5 A ... 150000 A
3Fh	Display brightness	bit 0 ... 2	0 ... 7	0.5 brightness levels
	Display filter	bit 3 ... 7	0 ... 30	Time constant

*) TN is the period duration of the basic frequency of U or I, respectively.

Product Variants (PI = 31h)

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 synchronizing input	S1
3	1	Equipped with LON interface	L1
4	1	Equipped with data logger	R1
5	1	Equipped with clock	R1
6	1	Profibus model	L2
7 ... 15	0	Reserved	

6.9 FFT, Harmonics (PI = 80h ... 8Dh)

PI	Parameter	Format	Comment	PI	Parameter	Format	Comment
80h	**Instantaneous values THD/ fundamental wave:** I1 THD	16 bit	read only	87h	**Maximum values THD/ fundamental wave:** I1 THD	16 bit	read only
	I1 fundamental wave	16 bit			I1 fundamental wave	16 bit	
	I2 THD	16 bit			I2 THD	16 bit	
	I2 fundamental wave	16 bit			I2 fundamental wave	16 bit	
	I3 THD	16 bit			I3 THD	16 bit	
	I3 fundamental wave	16 bit			I3 fundamental wave	16 bit	
	U1 THD	16 bit			U1 THD	16 bit	
	U1 fundamental wave	16 bit			U1 fundamental wave *	16 bit	
	U2 THD	16 bit			U2 THD	16 bit	
	U2 fundamental wave	16 bit			U2 fundamental wave *	16 bit	
	U3 THD	16 bit			U3 THD	16 bit	
	U3 fundamental wave	16 bit = 24 byte			U3 fundamental wave *	16 bit = 24 byte	
81h	**Instanteneous values U1 THD/ harmonic waves:** U1 15th harmonic	16 bit	read only	88h	**Maximum values U1 THD/ harmonic waves:** U1 15th harmonic	16 bit	read only
	U1 14th harmonic	16 bit			U1 14th harmonic	16 bit	
	...	...			...	16 bit	
	U1 1st fundamental wave	16 bit			U1 fundamental wave	...	
	U1 THD	16 bit = 32 byte			U1 THD	16 bit = 32 byte	
82h	**Instanteneous values U2 THD/ harmonic waves:** U2 15th harmonic	16 bit	read only	89h	**Maximum values U2 THD/ harmonic waves:** U2 15th harmonic	16 bit	read only
	U2 14th harmonic	16 bit			U2 14th harmonic	16 bit	
	...	...			...	16 bit	
	U2 1st harmonic	16 bit			U2 fundamental wave	...	
	U2 THD	16 bit = 32 byte			U2 THD	16 bit = 32 byte	

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

PI	Parameter	For-mat	Comment	PI	Parameter	For-mat	Comment
83h	**Instanteneous values U3 THD/ harmonic waves:** U3 15th harmonic	16 bit	read only	8Ah	**Maximum values U3 THD/ harmonic waves:** U3 15th harmonic	16 bit	read only
	U3 14th harmonic	16 bit			U3 14th harmonic	16 bit	
	...	...			...	16 bit	
	U3 fundamental wave	16 bit			U3 fundamental wave	...	
	U3 THD	16 bit = 32 byte			U3 THD	16 bit = 32 byte	
84h	**Instanteneous values I1 THD/ harmonic waves:** I1 15th harmonic	16 bit	read only	8Bh	**Maximum values I1 THD/ harmonic waves:** I1 15th harmonic	16 bit	read only
	I1 14th harmonic	16 bit			I1 14th harmonic	16 bit	
	...	...			...	16 bit	
	I1 fundamental wave	16 bit			I1 fundamental wave	...	
	I1 THD	16 bit = 32 byte			I1 THD	16 bit = 32 byte	
85h	**Instanteneous values I2 THD/ harmonic waves:** I2 15th harmonic	16 bit	read only	8Ch	**Maximum values I2 THD/ harmonic waves:** I2 15th harmonic	16 bit	read only
	I2 14th harmonic	16 bit			I2 14th harmonic	16 bit	
	...	...			...	16 bit	
	I2 fundamental wave	16 bit			I2 fundamental wave	...	
	I2 THD	16 bit = 32 byte			I2 THD	16 bit = 32 byte	
86h	**Instanteneous values I3 THD/ harmonic waves:** I3 15th harmonic	16 bit	read only	8Dh	**Maximum values I3 THD/ harmonic waves:** I3 15th harmonic	16 bit	read only
	I3 14th harmonic	16 bit			I3 14th harmonic	16 bit	
	...	...			...	16 bit	
	I3 fundamental wave	16 bit			I3 fundamental wave	...	
	I3 THD	16 bit = 32 byte			I3 THD	16 bit = 32 byte	

6.10 Real-Time Clock / Data Logger

PI	Character Number	Parameter	Format	Setting Range	Comment
90h		Real-time clock: time			
Info Field	1	XX	8 bit	XX	Write restarts RTC
	2	Hours	8 bit	0 ... 23	
	3	Minutes	8 bit	0 ... 59	
	4	Seconds	8 bit	0 ... 59	
91h		Real-time clock: date	8 bit	1 ... 31	
Info Field	1	Millennium	8 bit	19 ... 20	Write restarts RTC
	2	Year	8 bit	0 ... 99	
	3	Month	8 bit	1 ... 12	
	4	Day	8 bit	1 ... 31	
92h		Data logger, setup parameters			
Info Field	1	XX	8 bit		
		Selection and assignment of measured values to recording channels 1 to 12			See page 33
	2	Channel 12	8 bit		
	3	Channel 11	8 bit		
	4	Channel 10	8 bit		
	5	Channel 9	8 bit		
	6	Channel 8	8 bit		
	7	Channel 7	8 bit		
	8	Channel 6	8 bit		
	9	Channel 5	8 bit		
	10	Channel 4	8 bit		
	11	Channel 3	8 bit		
	12	Channel 2	8 bit		
	13	Channel 1	8 bit		
	14	Trigger specification	8 bit	00h ... 3Fh	See page 32
	15	Recording duration	8 bit	8 ... 21	See page 32
	16	Sampling interval	8 bit	0 ... 13	See page 32

PI	Character Number	Parameter	Format	Setting Range	Comment
93h		Data logger, general configuration for recording memory			Read only
Info Field	1	XX	8 bit	XX	
	2 ... 5	Max. number of samples per window	32 bit	0 ... 260000	
	6 ... 9	Recording duration per window in trigger mode	1 s / 32 bit	60 ... 345600	
	6 ... 9	Maximum recording duration without triggering	1 s / 32 bit	60 ... 345600	
	10, 11	Sampling interval	1 s / 16 bit	0,0,1 ... 1800	=0: [1]
	12	Trigger 2 – source	8 bit	00h ... C5h	
	13	Trigger 1 – source Channel list assignments:	8 bit	00h ... C5h	
	14	Channel 12	8 bit		
	15	Channel 11	8 bit		
	16	Channel 10	8 bit		
	17	Channel 9	8 bit		
	18	Channel 8	8 bit		
	19	Channel 7	8 bit		
	20	Channel 6	8 bit		
	21	Channel 5	8 bit		
	22	Channel 4	8 bit		
	23	Channel 3	8 bit		
	24	Channel 2	8 bit		
	25	Channel 1	8 bit		
	26	Number of 16 bit values per sample	8 bit	0 ... 24	
	27	Number or utilized windows or data logger occupancy level as percentage	8 bit	1 ... v, 100 or 0 ... 100	Trigger mode [2] Free run
	28	Number of available windows (v)	8 bit	1 ... 99	

[1] Interval depends upon measuring frequency, 16 or 32 system periods (see also chapter 6.10.1 on page 32).
[2] In trigger mode: number of windows used since data logger start-up; 100 after first overwrite

PI	Character Number	Parameter	Format	Setting Range	Comment
94h		Data logger, specific parameters for a recording window			Read only
Info Field	1, 2	Number of transmission blocks per window	16 bit	1 ... 2170	May have fewer samples
	3	Number of samples per transmission block	8 bit	5 ... 120	≥ last block
	4 ... 7	Position of the last sample	32 bit	0 ... 260000	≤ max. number
	8 ... 11	Sample position of the last trigger	32 bit	0 ... 260000	≤ max. number
	12 ... 15	Sample position of the first trigger	32 bit	0 ... 195000	
	16 ... 21	Time stamp for the last sample	6 x 8 bit	–	
	22 ... 27	Time stamp for the last trigger	6 x 8 bit	–	
	28 ... 33	Time stamp for the first trigger	6 x 8 bit	–	
	34	Window number	8 bit	1 ... v	[3]
95h		Data field data logger transmission block			Read only
Info Field	n ... 240 – nb [4]	Invalid characters (FFh)			[6]
	239, 240 – (s × t × 2 – 2) [5]	Last measured value from last sample			
	...	...			
	239, 240 – t × 2 [5]	1st measured value from 2nd sample			
	239, 240 – (t × 2 – 2) [5]	Last measured value from 1st sample			
	239, 240	1st measured value from 1st sample in the block			
	241, 242	Data block number	16 bit	1 ... 2170	
	243	Window number	8 bit	1 ... v	
	244	number of valid bytes = nb	8 bit	220 ... 240	
99h		Window index and data block number			Write only
Info Field	1, 2	Window index	16 bit	1 ... v	
	3, 4	Data block number	16 bit		

[3] 1 = window number = oldest window, v = current window
[4] nb = number of valid bytes = s × t × z
[5] t = number of utilized recording channels, s = number of samples per transmission block
[6] The more significant word is quoted first in the case of energy measurement values

6.10.1 Data Logger Sampling Interval

Index	Interval	Index	Interval	Index	Interval	Index	Interval
0	1 measuring cycle *	2	1 second	8	1 minute	14	1 hour
1	2 measuring cycles *	3	2 seconds	9	2 minutes	15	2 hours
		4	5 seconds	10	5 minutes	16	4 hours
		5	10 seconds	11	10 minutes	17	8 hours
		6	15 seconds	12	15 minutes	18	12 hours
		7	30 seconds	13	30 minutes	19	24 hours

* 1 measuring cycle ≙ 16 system periods

6.10.2 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

6.10.3 Data Logger Trigger Specification

Bit No.	Function	Comment
0	=1: Alarm 1 trigger enabled	
1	=1: Alarm 2 trigger enabled	
2	=1: external trigger disabling deactivated	
3	=0: “one-time only” memory mode =1: “cyclical” memory mode	
5, 4	=0.0: 00% pre-trigger =0.1: 25% pre-trigger =1.0: 50% pre-trigger =1.1: 75% pre-trigger	Position of the 1st trigger as a percentage in relation to the number of sampling operations per window
6 ... 7	=0	not in use

6.10.4 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 ... 3	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 for type of measured value = 2, 3 (current)	= 8: Current harmonic waves phase 1 = 9: Current harmonic waves phase 2 =10: Current harmonic waves phase 3 =12: Voltage distortion factor phase 1 =13: Voltage distortion factor phase 2 =14: Voltage distortion factor phase 3
4 ...7	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	independen of phase number The latest 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		

* The last concluded interval is used.

6.10.5 Data Logger Time Stamp Format

Byte No.	Content	Format	Byte No.	Content	Format
1	Decade + year	8 bit binary	4	Hours	8 bit binary
2	Month	8 bit binary	5	Minutes	8 bit binary
3	Day of the month	8 bit binary	6	Seconds	8 bit binary

6.11 Sampling Values

PI	Value	WA	Comment
A0	**U1 – Sampling values:** 32nd sampling value U1 ... 1st sampling value U1	 ±15 bit ... ±15 bit = 32 words	read only
A1	**U2 – Sampling values:** 32nd sampling value U2 ... 1st sampling value U2	 ±15 bit ... ±15 bit = 32 words	read only
A2	**U3 – Sampling values:** 32nd sampling value U3 ... 1st sampling value U3	 ±15 bit ... ±15 bit = 32 words	read only
A3	**I1 – Sampling values:** 32nd sampling value I1 ... 1st sampling value I1	 ±15 bit ... ±15 bit = 32 words	read only
A4	**I2 – Sampling values:** 32nd sampling value I2 ... 1st sampling value I2	 ±15 bit ... ±15 bit = 32 words	read only
A5	**I3 – Sampling values:** 32nd sampling value I3 ... 1st sampling value I3	 ±15 bit ... ±15 bit = 32 words	read only

7 Product Support

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