GOSSEN METRAWATT

A2000

Multifunctional Power Meter
Communications Protocol per EN 60870

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1 Overview of Telegrams (Commands) to the A2000 as per EN 60870

Telegrams to the A2000	**Applies to following data** (where parameter index PI = ..h)	**Response from the A2000** (via → ... record)	**Comments**
Execute **instrument reset** → via abbreviated record	Execute hardware reset	None	See chap. 5.1, page 10
Most important measured values and errors (cyclical data) transmitted → via abbreviated record	U, I, W, P, Q, PF, f dep. upon 4 or 3-wire configuration	→ full record	See chap. 5.2, page 10
Events data for **error analysis** transmitted → via abbreviated record	Values exceeded or fallen short of, pole reversal, HW error	error messages, limit value statuses → full record	See chap. 5.3, page 12
All measured values transmitted → via control record	$U_{\curlywedge}$, $U_{\triangle}$, I_{AVG}, P, Q, S, PF, f, E_P, E_Q, E_{INTP}, E_{INTQ} → PI = 00h ... 0Fh	→ full record	See chap. 5.4, page 15
Output parameters transmitted → via control record acknowledgement → full record	**Relays:** hysteresis, limit values, source, configuration **Analog outputs:** start and end values, source, configuration **S0 pulse outputs** → PI = 10h ... 1Fh	→ full record	See chap. 5.5, page 16
Control commands acknowledge → via full record **Statuses** transmitted → via control record	Delete measurement and max. values, set analog outputs, read out relay/S0 status → PI = 20h ... 2Fh	→ full record	See chap. 6.5, page 27
Instrument specifications transmitted → via control record	Software version, connection type, voltage/current range, display brightness, ... → PI = 30h ... 3Fh	→ full record	See chap. 6.6, page 30
Real-time clock values transmission → via control record acknowledge → via full record	read out and set real-time clock → PI = 90h ... 9Fh	→ full record	See chap. 6.8, page 34

The contents of the telegrams (commands) vary, and various types of telegrams are used depending upon content and signal direction.

see chap. 2, page 5 regarding abbreviated, full and control records
see chap. 3.2, page 7 regarding contents of the function field (FF).

2 Telegram Types: Abbreviated, Control and Full Records

All telegrams, whether in the query or the response direction, consist of one of three different types of records, which vary from one another in their basic structure. Use of these records is defined for each available interface function for the A2000. Structure and use of the record types are described below.

2.1 Abbreviated Records

Abbreviated records are transmitted in the query direction (from the master)

- in order to communicate brief commands to the instruments (e.g. reset).
- in order to query important data from the instruments (e.g. events data).

Abbreviated records are transmitted in the response direction (from the A2000).

- in order to acknowledge queries which do not require any response data.

Abbreviated Record Layout:

Char. No.	Content	Meaning		Comment
1	10h	Start bit	(SB)	special for abbreviated-records
2		Function field	(FF)	compare chap. 3.2, page 7
3	0 ... FAh, FFh	Instrument address	(IA)	***Addr*** or 255, compare chap. 3.1, page 7
4	00h	Instrument address high-byte		
5	(GA) + (FF)	Checksum	(CS)	= instrument address + function field (FF)
6	16h	End mark		common to all record types

2.2 Control Records

Control Record Layout:

Control records are only transmitted in the query direction from the A2000, and allow for the querying of all data which cannot be queried with abbreviated records, because they require more detailed specification.

Control Record Layout:

Char. No.	Content	Meaning		Comment
1	68h	Start bit	(SB1)	
2	03h	Length	(L1)	= number of characters starting with FF up to and excl. checksum
3	03h	Length (repeat)	(L2)	
4	68h	Start bit (repeat)	(SB2)	
5		Function field	(FF)	compare chap. 3.2, page 7
6	0 ... FAh	Instrument address	(IA)	***Addr*** or 255, compare chap. 3.1, page 7
7	00h	Instrument address high-byte		
8		Parameter index	(PI)	compare chap. 3.3, page 8

Char. No.	Content	Meaning		Comment
9	(IA) + (FF) + (PI)	Checksum	(CS)	The checksum is arrived at by means of a byte by byte summation of all characters starting with the function field (FF) up to and excluding the checksum (CS).
10	16h	End mark	(EM)	

2.3 Full Records

Full records are used by the A2000:

- in order to transmit commands and parameters to the instrument.
- in order to download data from the instrument.

Full Record Layout:

Char. No.	Content	Meaning		Comment
1	68h	Start bit	(SB1)	
2	4 + n	Length	(L1)	Number of characters starting with function field up to and excl. checksum
3	4 + n	Length (repeat)	(L2)	
4	68h	Start bit (repeat)	(SB2)	
5		Function field	(FF)	compare chap. 3.2, page 7
6	0 ... FAh, FFh	Instrument address	(IA)	***Addr*** or 255, compare chap. 3.1, page 7
7	00h	Instrument address high-byte		
8		Parameter index	(PI)	compare chap. 3.3, page 8
9 ... 8 + n		n Characters user data, information field		
9 + n		Checksum	(CS)	The checksum is arrived at by means of a byte by byte summation of all characters starting with the instrument address up to and including the last data byte without overflow summation.
10 + n	16h	End Mark	(EM)	

Gray areas represent the primary data included within the protocol see chap. 3, page 7.

3 Primary Data Included within the Protocol – GA, FF, PI, DB

3.1 Instrument Address (IA)

- Length: 2 bytes
- High byte = 00h
- Low byte = 0 ... 250, individual instrument address range = interface address ***Addr***.
- 255, all instruments connected to a single bus can be queried simultaneously with this address. Data and commands transmitted to this address are uploaded to all instruments, but no acknowledgement is transmitted to the master.

3.2 Function Field (FF)

The function field includes

- For abbreviated records: actual user information which has been predefined bit by bit and which varies depending upon direction (query or response).
- For control and full records: direction and control information for the transmitted data block.

Structure of the function field:

	MSB							LSB	
Function		1	FCB	FCV	2^3	2^2	2^1	2^0	Primary to secondary station
Field	RES	PRM							
		0	ACD	DFC	Function				Secondary to primary station
bit	7	6	5	4	3	2	1	0	

Function Field Coding (FF) for the Query Direction:

Bit No.	Function	Value	Telegram Type	Comments
3 ... 0	Function (abbreviated record)	0h	SEND / CONFIRM	Normalizing the connecting layer of the secondary station
		9h	REQUEST / RESPOND	Querying the condition of the connecting layer
		4h	SEND / NO REPLAY [1)]	Reset instrument
		Ah	REQUEST / RESPOND	**Class 1:** request events data from instrument
		Bh	REQUEST / RESPOND	**Class 2:** request cycle data from instrument
3 ... 0	Function (control /full record)	3h	SEND / CONFIRM [1)]	Transmit data to instrument
		Bh	REQUEST / RESPOND	Request data from instrument (with PI)

Bit No.	Function	Value	Telegram Type	Comments
4	FCV: Telegram sequence-bit valid			
5	FCB: Telegram sequence-bit	[2]		
6	PRM: Direction-bit	1h (fix)		Primary to secondary station
7	RES			Reserved

[1] Functions 4 h and 3h support broadcast
[2] The telegram sequence-bit is not evaluated

Function Field Coding (FF) for the Response Direction:

Bit No.	Function	Value	Telegram Type	Comments
3 ... 0	Function	0h	CONFIRM	ACK: positive acknowledgement
		1h	CONFIRM	NACK: negative acknowledgement; message not accepted
		8h	RESPOND	Send data to the master
		Bh	RESPOND	Condition of the connecting layer or access request
4	DFC: Data flow control	0		Job completed, instrument ready
		1		Instrument not ready for this job, repeat job if applicable
5	ACD: Access request	0		No error occurred
		1		Error occurred (query events data)
6	RMP: Direction-bit	0h (fix)		Secondary to primary station
7	RES	0h (fix)		Reserved

3.3 Parameter Index (PI)

The type of data to be transmitted is determined by means of the parameter index. The parameter index groups encompass data related to functions, as well as instrument parameter settings.
The parameter indexes documented in chap. 6, page 17 are the only indexes which can be queried in the A2000. All others are acknowledged with an error message.

- Example: PI = 00h queries phase voltage, PI = 01h queries delta voltage, and PI = 02h queries phase current, etc.

3.4 Data Block Length and Format (DB)

Length and format are variable and are dependent upon 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	LS byte first	Number without sign
± 15 bits	LS byte first, two's complement representation	Number with sign
32 bits	LS byte first	Number without sign
± 31 bits	LS byte first, two's complement representation	Number with sign
8 / 16 bits	LS byte first	Bit array

4 Telegram Validity – Units and Data Ranges

The A2000 checks the characters of the received telegram in accordance with the following tables:

Abbreviated Records:

Char. No.	Criterion
1	10h
2	FF = valid function coding, see chap. 3.2, page 7
3	Address ***Addr*** or 255, see chap. 3.1, page 7
4	00h
5	PS = Addr or 255 + FF
6	16h

Control and Full Records:

Char. No.	Criterion
1	68h
2	Note length of CS and end mark
3	Character 3 = Character 2
4	68h
5	FF, compare "Structure of the function field:", page 7
6	Interface address ***Addr*** or 255, compare chap. 3.1, page 7
7	00h
8	PI = valid parameter index, see chap. 3.3, page 8
. . .	Data block
Length + 5	PS = byte summation without overflow for all characters starting with function field up to and excluding checksum
Length + 6	16h

If incorrect values for FF and PI are received by the host computer, the instrument responds with a NACK. If the user data do not lie within their specified ranges, the instrument responds with an abbreviated record including a flagged ACD bit. The "invalid value" bit is flagged in error status word 2.

5 Telegram Contents (commands)

5.1 Reset Instrument

The addressed instrument executes a hardware reset (similar to brief interruption of auxiliary power supply.

Example: instrument address = 250

Query from master (abbreviated record):

10h	44h	FAh	00h	3Eh	16h
SZ	FF	GA low	GA high	PS	EZ

Response from A2000:

none

5.2 Request Class 2 Data Class 2

The most important measurement and output data from the A2000 are included in a single packet. Cyclical queries for these values can thus be executed in a compact fashion (abbreviated record query).

Example: instrument address = 250

Query from master (abbreviated record):

10h	7Bh	FAh	00h	75h	16h
SZ	FF	GA low	GA high	PS	EZ

Response from A2000 (full record): (compare chap. 2.3)

68h	21h	21h	68h	08h	FAh	00h	22h	Data bloc	14h	16h
SZ	L	L	SZ	FF	GA low	GA high	PI	19 or 29 characters	PS	EZ

5.2.1 Class 2 Data

The class 2 data block is selected from the 0xh PI group (parameter index), and is dependent of the selected measurement configuration: 4-wire or 3-wire system.
The 29 characters included in the cycle data have the following format for 4-wire configuration:

Bit No.	Content	Format	Comment	
9, 10	FCh, 08h	± 15 bits	Uph1 = 230.0 V	Assumption: Dim. U = –1 compar chap. 6.2, page 20
11, 12	0Bh, 09h	± 15 bits	Uph2 = 231.5 V	
13, 14	FAh, 08h	± 15 bits	Uph3 = 229.8 V	
15, 16	ECh, 13h	± 15 bits	Iph1 = 5.100 A	Assumption: Dim. I = –3 compare chap. 6.2, page 20
17, 18	E7h, 13h	± 15 bits	Iph2 = 5.095 A	
19, 20	71h, 13h	± 15 bits	Iph3 = 4.977 A	
21, 22	95h, 04h	± 15 bits	P1 = 1173 W	Assumption: Dim. P = –0 compare chap. 6.2, page 20
23, 24	9Bh, 04h	± 15 bits	P2 = 1179 W	
25, 26	61h, 04h	± 15 bits	P3 = 1121 W	
27, 28	00h, 00h	± 15 bits	Q1 = 0 W	
19, 30	00h, 00h	± 15 bits	Q2 = 0 W	
31, 32	E3h, 00h	± 15 bits	Q3 = 227 W	
33	100	± 7 bits	PF1 = 1.00	
34	100	± 7 bits	PF2 = 1.00	
35	98	± 7 bits	PF3 = 0.98	
36, 37	8Ah, 13h	16 bits	Frequency = 50.02 Hz	

The 19 characters included in the cycle data have the following format for 3-wire configuration:

Bit No.	Content	Format	Comment	
9, 10	9Dh, 0Fh	± 15 bits	U12 = 399.9 V	Assumption: Dim. U = –1 compar chap. 6.2, page 20
11, 12	9Bh, 0Fh	± 15 bits	U23 = 399.5 V	
13, 14	8Eh, 0Fh	± 15 bits	U31 = 398.2 V	
15, 16	ECh, 13h	± 15 bits	Iph1 = 5.100 A	Assumption: Dim. I = –3 compare chap. 6.2, page 20
17, 18	E7h, 13h	± 15 bits	Iph2 = 5.095 A	
19, 20	71h, 13h	± 15 bits	Iph3 = 4.977 A	
21, 22	7Dh, 0Dh	± 15 bits	P_{Σ} = 3453 W	Assumption: Dim. P = –0 compare chap. 6.2, page 20
23, 24	4Fh, 01h	± 15 bits	Q_{Σ} = 335 VA	
25	100	± 7 bits	$Pf_{\Sigma} = 0.995 \approx 1{,}00$	
26, 27	8Ah, 13h	16 bits	Frequency = 50.02 Hz	

5.3 Request Class 1 Data

Events data are summarized in 2 words and include all instrument error messages and alarms.
They can be queried with an abbreviated record in order to identify a specific error or alarm.
This request can be made in an asynchronous fashion, if the operator request bit (group alarm) was previously flagged within the function field (FF) of any given response telegram.

Example: instrument address = 250

Query from master (abbreviated record):

10h	7Ah	FAh	00h	74h	16h
SZ	FF	GA low	GA high	PS	EZ

Response from A2000 (full record, compare chap. 2.3):

68h	08h	08h	68h	08h	FAh	00h	21h	2 x FSW	23h	16h
SZ	L	L	SZ	FF	GA low	GA high	PI	FSW 1 / 2 (4 char.)	PS	EZ

The 4 characters in the events data block are bit arrays which are combined into error status words 1 and 2. These 4 characters can also be read by querying data with the parameter index: PI = 21h.

Error Status Word 1 (measuring circuit), Read Only

Char.	Bit No.	Value	Meaning	Comment
1.	0	1	U1 < 0.7 % of measuring range or none	
	1	1	U2 < 0.7 % of measuring range or none	
	2	1	U3 < 0.7 % of measuring range or none	
	3	1	I1 < 0.8 % of measuring range or none	
	4	1	I2 < 0.8 % of measuring range or none	
	5	1	I3 < 0.8 % of measuring range or none	
	6	1	DC offset too large (bits 0 ... 5 indicate channel) [1)]	Defective measuring input
	7	1	Frequency < 40 Hz or none	
2.	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	Instrument not calibrated	Re-calibration required

[1)] If bit 6 = 1., bits 0 through 5 have a different meaning

see chap. 3.2, page 7 regarding the content of the function field (FF)

Error Status Word 2 (various), Read only (write bit 0, 1)

Char.	Bit No.	Value	Meaning	Comment
3.	0	1	Alarm 1 (relay 1) active	[1]
	1	1	Alarm 2 (relay 2) active	[1]
	2	1	Condition for alarm 1 fulfilled	not stored to memory
	3	1	Condition for alarm 2 fulfilled	not stored to memory
	4	1	3-wire connection in following order: L1, L3, L2	0 after correction and instrument restart
	5	0		
	6	0		
	7	0		
4.	8	1	Defective measuring input	0 after error correction
	9	1	Invalid parameter value, value not accepted	0 after value has been read
	10	0		
	11	1	Power failure at real-time clock, indicated time incorrect	0 after real-time has been written (PI = 90h, 91h)
	12	1	Real-time clock error	0 after error correction
	13	1	Faulty parameter setting from EEPROM	0 after error correction
	14	1	Faulty meter reading from EEPROM	0 after error correction
	15	1	Defective EEPROM	

[1] Bit 0, 1 = 1 – writing event resets alarm message 1, 2 (required for alarm memory mode)

5.4 Request Data from A2000

All values, parameters, configurations, conditions, instrument identification etc. can be queried with this form of communication. The data are queried individually by means of the parameter index (PI).
A complete list of all parameter indexes is included in chapter chap. 6.

- Example: **Requesting the 3 phase currents and their peak values**

Query from master (control record, compare chap. 2.2):

68h	04h	04h	68h	7Bh	FAh	00h	02h	77h	16h
SZ	L	L	SZ	FF	GA low	GA high	PI	PS	EZ

Response from instrument (full record, compare chap. 2.3):

68h	10h	10h	68h	08h	FAh	00h	00h
SZ	L	L	SZ	FF	GA low	GA high	PI

ECh	13h	E7h	13h	71h	13h	F5h	13h	F0h	13h	98h	13h	84h	16h
												PS	EZ

12 data byte

Under the assumption that DIM.I = –3, the 12 characters included in the data block (ECh, 13h, E7h, 13h, 71h, 13h, F5h, 13h, F0h, 13h, 98h, 13h) result in the following current values, as described in chap. 6.2, page 20 (Units of Measurement Values) and chap. 3.4, page 9 (Data Block Format):

The multiplier for current is, for example 10^{-3} $\rightarrow$ unit = 0.001 A

Iph1 = ECh, 13h $\Rightarrow$ Iph1 = 13ECh = 5100
When multiplied by the unit, the resulting value for Iph1 is = 5.100 A

The following applies as well:

Iph2 = E7h, 13h $\Rightarrow$ Iph2 = 5.095 A
IPh3 = 71h, 13h $\Rightarrow$ Iph3 = 4.977 A
$I1_{max}$ = F5h, 13h $\Rightarrow$ $I1_{max}$ = 5.109 A
$I2_{max}$ = F0h, 13h $\Rightarrow$ $I2_{max}$ = 5.104 A
$I3_{max}$ = 98h, 13h $\Rightarrow$ $I3_{max}$ = 5.016 A

5.5 Transmit Data to the A2000

All parameters, configurations and operating conditions which can be changed by the operator, can be set with this type of communication. The data are queried individually by means of the parameter index (PI). A complete list of parameter indexes is included in chapter chap. 6.

No protection is provided against overwriting data. The LOCK switch position is irrelevant.

The transmitted value is checked by the A2000 as regards its setting range. If the value is not within the allowable range, it is not stored to memory – bit 9, "invalid value", is flagged in error status word 2, and the "operator request" bit is flagged in the function field of the abbreviated acknowledgement record.

- Example: **Configuration of the analog outputs**

Output type –20 ... 20 mA	02h
Phase 1:	
Source value 1: delta voltage	00h
Source value 2: phase voltage	10h
Source value 3: phase current	20h
Source value 4: frequency	80h

Response is given by positive acknowledgement → Writing sucessfully completed

Write command:

68h	0C	0C	68h	73h	FA	00h	16h	00h	10h	20h	80h	02h	02h	02h	02h	3B	16H
SZ	L	L	SZ	FF	GA low	GA high	PI	8 data bytes								PS	EZ

Acknowledgement:

10h	20h	FA	00h	1A	16H
SZ	FF	GA low	GA high	PS	EZ

see chap. 3.2, page 7 regarding the content of the function field (FF)

6 Data and Corresponding Parameter Index

In addition to the parameter index (PI) for the individual data, the format and the length of the data blocks in the full record are also important for the querying of data from, or the transmission of data to the A2000. See also column „Number of Characters“ in the overview table (chap. 6.1). The sequence and contents of the characters in the data block can be determined from the “Format” column in the parameters tables, as well as from chap. 3.4, page 9.

6.1 Overview (PI = 00h ... 95h)

Main Group	PI	Number of Characters	Value	Comment
0			**Measured Values**	read only
	00h	12	Phase voltages	
	01h	12	Delta voltages	
	02h	12	Phase currents	
	03h	12	Averaged phase currents	
	04h	16	Active powers	
	05h	16	Reactive powers	
	06h	16	Apparent powers	
	07h	16	Power factors	
	08h	32	Energy meter	
	09h	24	Interval active powers	
	0Ah	24	Interval reactive powers	
	0Bh	24	Interval apparent powers	
	0Dh	8	Neutral conductor currents	
	0Fh	2	Line frequency	
1			**Limit Values**	
	10h	8	Relay hysteresis / limit	
	11h	4	Relay source / configuration	
	12h	4	Pulse output rate	
	13h	2	Pulse output source	
	14h	8	Analog output lower range limit	not for Feature L2
	15h	8	Analog output upper range limit	not for Feature L2
	16h	8	Analog output source / configuration	not for Feature L2
	18h	1	Pulse output length	
	1Dh	4	Analog input: Lower range limit/offset	
	1Eh	4	Analog input: Upper range limt	
	1Fh	2	Analog input: Configuration	

Main Group	PI	Number of Characters	Value	Comment
2			**Control Commands / Status Queries**	
	20h	2	Control status	
	21h	4	Error status	read only
	24h	2	Max. voltages, delete currents	write only
	25h	3	Max. powers / delete FFT	write only
	26h	2	Delete energy meter	write only
	27h	2	Set standard parameters	write only
	28h	8	Control analog outputs	not for Feature L2
	29h	1	Data logger start / stop	not for Feature R1
	2Ah	1	Trigger interval	write only
	2Fh	8	Measured values analog input	Read only, write deletes both maximum values
3			**Device Specification**	
	30h	1	Device ID	read only
	31h	1	Equipped with	read only
	32h	4	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	4	Low tariff time interval	only for Feature R1
	39h	1	Frequency source	
	38h	1	Type of measurement for reactive power	
	3Bh	4	Voltage measuring range	
	3Ch	4	Current measuring range	
	3Fh	1	Display brightness/filter	

Main Group	PI	Number of Characters	Value	Comment
8			**Harmonic waves, FFT**	read only
	80h	24	THD / fundamental wave	
	81h	32	U1 THD / distortion factors	
	82h	32	U2 THD / distortion factors	
	83h	32	U3 THD / distortion factors	
	84h	32	I1 THD / harmonic waves	
	85h	32	I2 THD / harmonic waves	
	86h	32	I3 THD / harmonic waves	
	87h	24	Maximum values THD / fundamental wave	
	88h	32	Maximaum values U1 THD / distortion factors	
	89h	32	Maximum values U2 THD / distortion factors	
	8Ah	32	Maximum values U3 THD / distortion factors	
	8Bh	32	Maximum values I1 THD / harmonic waves	
	8Ch	32	Maximum values I2 THD / harmonic waves	
	8Dh	32	Maximum values I3 THD / harmonic waves	
9			**Real-time Clock / Data Logger**	only for Feature R1
	90h	3	Time	
	91h	4	Date	
	92h	15	Setup parameters for data logger	
	93h	23	Current recording setup	read only
	94h	34	Current setup of a recording window	read only
	95h	223 ... 243	Recording data of transmission block	read only
A			**Sampling Values**	
	A0	64	U1	read only
	A1	64	U2	read only
	A2	64	U3	read only
	A3	64	I1	read only
	A4	64	I2	read only
	A5	64	I3	read only
	A6	1	freeze/update sampling values	

6.2 Units, Ranges and Resolution of Measured Values

These data apply to all telegram contents, both for measured values and for parameters.
The multipliers (position of decimal points, „dim“ parameters) are established by entering the primary measuring ranges (compare PI = 3Bh, 3Ch) and can be read with PI = 32h.

Measuring Quantity	Basic Unit	Multiplier Range	Corresponding Value of the „dim“ Parameter PI = 32h	Value Range of Data Field	Physical Value Range	Display Resolution comp. 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)
Voltage distortion factor	%	0.1	—	0 ... 1000	0 ... 100.0 %	0.1 %
Current, current harmonic wave	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)

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

The parameter index PI = 00h extends up to 0Fh for measured values. Measured values can only be read. Writing of measured values is not possible.

PI	Measured Values	Format
00h	Phase voltages:	
	U1	16 bits
	U2	16 bits
	U3	16 bits
	$U1_{max}$	16 bits
	$U2_{max}$	16 bits
	$U3_{max}$	16 bits
01h	Delta voltages:	
	U12	16 bits
	U23	16 bits
	U31	16 bits
	$U12_{max}$	16 bits
	$U23_{max}$	16 bits
	$U31_{max}$	16 bits
02h	Phase currents:	
	I1	16 bits
	I2	16 bits
	I3	16 bits
	$I1_{max}$	16 bits
	$I2_{max}$	16 bits
	$I3_{max}$	16 bits

PI	Measured Values	Format
03h	Averaged phase currents:	
	$I1_{avg}$	16 bits
	$I2_{avg}$	16 bits
	$I3_{avg}$	16 bits
	$I1_{avg\ max}$	16 bits
	$I2_{avg\ max}$	16 bits
	$I3_{avg\ max}$	16 bits
04h	Active power:	
	P1	± 15 bits
	P2	± 15 bits
	P3	± 15 bits
	P_{Σ}	± 15 bits
	$P1_{max}$	± 15 bits
	$P2_{max}$	± 15 bits
	$P3_{max}$	± 15 bits
	$P_{\Sigma\ max}$	± 15 bits
05h	Reactive power:	
	Q1	16 bits
	Q2	16 bits
	Q3	16 bits
	Q_{Σ}	16 bits
	$Q1_{max}$	16 bits
	$Q2_{max}$	16 bits
	$Q3_{max}$	16 bits
	$Q_{\Sigma\ max}$	16 bits

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

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

[1] To obtain the PF, multiply the result (± 7 bits) by 0.01.
[2] Active energy exports are displayed with a negative sign in the L123 mode. All energy values are positive in the LTHT mode
[3] Current interval
[4] 1. – 10. Interval before
[5] Max. interval value since switching on or reset of the value, see chap. 6.5, page 27, PI=25h

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

PI	Parameter	Format	Unit	Value Range	Comment
10h	Relay 1 hysteresis	16 bits	Unit of quantity to be monitored (source)	0 ... 9999	
	Relay 2 hysteresis	16 bits			
	Relay 1 limit	± 15 bits		–1999 ... 9999	
	Relay 2 limit	± 15 bits			
11h	Relay 1 source	8 bits		see chap. 6.4.3, page 25	
	Relay 2 source	8 bits			
	Relay 1 configuration	8 bits		see chap. 6.4.1, page 24	
	Relay 2 configuration	8 bits			
12h	Pulse output 1 rate	16 bits	1 / kWh	0 ... 5000	Unit see chap. 6.4.4, page 26
	Pulse output 2 rate	16 bits	1 / kWh		
13h	Pulse output 1 source	8 bits		see chap. 6.4.4, page 26	
	Pulse output 2 source	8 bits			
14h	Analog outputs:		Unit of quantity to be monitored (source)	–1999 ... 9999	Lower range limit 3 / 4 = 0 Where characteristic A1 does not apply Lower range limit 3 / 4 are not read or written where Feature A3
	Lower range limit 1	± 15 bits			
	Lower range limit 2	± 15 bits			
	Lower range limit 3	± 15 bits			
	Lower range limit 4	± 15 bits			
15h	Analog outputs:		Unit of quantity to be monitored (source)	–1999 ... 9999	Upper range limit 3 / 4 = 0 Characteristic A1 Upper range limit 3 / 4 are not read or written where Feature A3
	Upper range limit 1	± 15 bits			
	Upper range limit 2	± 15 bits			
	Upper range limit 3	± 15 bits			
	Upper range limit 4	± 15 bits			

PI	Parameter	Format	Unit	Value Range	Comment
16h	Analog outputs:				
	Source 1	8 bits		See chap. 6.4.3, page 25	Source 3 / 4 = 0, if not Characteristic A1 Source 3 / 4 are not read or written where Feature A3
	Source 2	8 bits			
	Source 3	8 bits			
	Source 4	8 bits			
	Configuration 1	8 bits		See chap. 6.4.2, page 25	Configuration 3 / 4 = 0, if not Characteristic A1 Configuration 3 / 4 are not read or written where Feature A3
	Configuration 2	8 bits			
	Configuration 3	8 bits			
	Configuration 4	8 bits			
18h	Pulse length	8 bits		0 ... 7	0.1 s ... 0.8 s
1Dh	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 –200 °C fixed
	Lower range limit 1	± 15 bits			
	Lower range limit 2				
1Eh	Analog inputs		depending on configuration	depending on configuration	not with PT1000 Upper range limit 850 °C fixed
	Upper range limit 1	± 15 bits			
	Upper range limit 2				
1Fh	Analog inputs		depending on configuration	see chap. 6.4.5, page 26	
	Configuration 1	8 bits			
	Configuration 2				

6.4.1 Relay Configuration (PI = 11h)

Bit No.	Value	Meaning	Function
0	0	low	Low/high alarm function
	1	high	
1	0	nonstore	Alarm memory
	1	store	
2	0	depending on DIP switch	Alarm release
	1	always vacant	
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

6.4.2 Analog Output Configuration (PI = 16h)

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 ... 7	0		No function

6.4.3 Relay and Analog Output Sources (PI = 11h or 16h)

Bit No.	Value	Meaning	Function
0 ... 3	000	Phase 1 or 1→2	Phase number of the 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 for source value = 2, 3 (current)
	101	For all 3 phases	only for relays (PI = 11h)
4 ... 7	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 intervalic active power [1)]	
	1010	Total intervalic reactive power [1)]	
	1011	Total intervalic apparent power [1)]	
	1100	External value (can be controlled via interface)	

[1)] The current interval (– 0) is used for the relay output, the interval (–1) is used for the analog output

6.4.4 Pulse Output Source (PI = 13h)

Bit No.	Value	Meaning	Function
3 ... 0	000	Phase 1 or 1→2	Phase number of the source value
	001	Phase 2 or 2→3	
	010	Phase 3 or 3→1	
	011	Sum	
4	0	Active energy	Type of source value
	1	Reactive energy	
5	0	Import	
	1	Export	
6	0	Pulses per kWh	
	1	Pulses per MWh	
7	0	High tariff	
	1	Low tariff	

6.4.5 Configuration of Analog Input (PI = 1Fh)

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, 7	—	—	no function

6.5 Control Commands and Status Queries (PI = 20h ... 29h)

Control commands and status queries are included in parameter index group 20h ... 2Fh.

PI	Parameter	Format	Value Range	Comment
20h	A2000 control status	16 bits	see next page	
21h	A2000 error status	2x 16 bits		read only, compare events data chap. 5.3, page 12
24h	$U \triangle_{max}$ clear	Bit array with 2 x 8 bits	See next page: Command, Peak Voltage Values, ...	write only
	U_{max} clear			
	I_{max} clear			
	$I_{avg\ max}$ clear			
25h	P_{max} clear	Bit array with 3 x 8 bits	See next page: Command, Peak Power Values, ...	write only
	Q_{max} clear			
	S_{max} clear			
	PF_{max} clear			
	$P_{int\ max}$ clear			
	$Q_{int\ max}$ clear			
	$S_{int\ max}$ clear			
	FFT clear			
26h	Clear energy meter	16 bits	=55AAh	write only
27h	Set default parameters	16 bits	=A965h	write only, sets 1st and 2nd parameter sets to default values, excl. address (Set – default, – user)
28h	Analog outputs		± 2000 100 corresponds to 1 mA or 0.5 V, respectively	write only if source analog outputs = external not for Feature L2
	Direct output value 1	± 15 bits		
	Direct output value 2	± 15 bits		
	Direct output value 3	± 15 bits		
	Direct output value 4	± 15 bits		
29h	Data logger start / stop	8 bits	=55h: Stop =AAh: Start	Restart only after previous stop!
2Ah	Trigger interval	8 bits	=AAh: Trigger	write only
2Fh	Analog inputs		same as in the display, without taking the decimal point into account	Read only. Writing on any value deletes both maximum values.
	Measured value 1	± 15 bits		
	Measured value 2	± 15 bits		
	Maximum measured value 1	± 15 bits		
	Maximum measured value 2	± 15 bits		
	Status	16 bits	see chap. 6.5.3	

6.5.1 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	can only be set via interface, if source = external
9	0 / 1	Relay 2 active / inactive	can only be set via interface, if source = external
10 ... 15	0	—	

6.5.2 Delete Maximum Voltages, Currents, Powers (PI = 24h, 25h)

Command: Peak Voltage Values, Reset 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	—
0	1	$I1_{max} = 0$
1	1	$I2_{max} = 0$
2	1	$I3_{max} = 0$
3	0	$I_{N\,max} = 0$
4	1	$I1_{avg\,max} = 0$
5	1	$I2_{avg\,max} = 0$
6	1	$I3_{avg\,max} = 0$
7	0	$I_{N\,avg\,max} = 0$

Command: Peak Power Values, Reset Power Factors (PI = 25h)

Bit No.	Value	Function
0	1	$P1_{max} = 0$
1	1	$P2_{max} = 0$
2	1	$P3_{max} = 0$
3	1	$P\Sigma1_{max} = 0$
4	1	$Q1_{max} = 0$
5	1	$Q2_{max} = 0$
6	1	$Q3_{max} = 0$
7	1	$Q\Sigma1_{max} = 0$
0	1	$S1_{max} = 0$
1	1	$S2_{max} = 0$
2	1	$S3_{max} = 0$
3	1	$S\Sigma_{max} = 0$
4	1	$PF1_{max} = 0$
5	1	$PF2_{max} = 0$
6	1	$PF3_{max} = 0$
7	1	$PF\Sigma1_{max} = 0$
0	1	$P_{int\,max} = 0$
1	1	$Q_{int\,max} = 0$
2	1	$S_{int\,max} = 0$
3	1	Max. FFT = 0
4 ... 7		not in use

6.5.3 Status of Analog Inputs (PI = 2Fh)

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	—	

6.6 Instrument Specifications (PI = 30h ... 3Fh)

PI	Parameter	Format	Value Range	Comment
30h	Device identification	8 bits	A2h	read only
31h	Equipped with	8 bits	see variants	read only
32h	Measured value - dimension			read only – determined from primary voltage and current measuring ranges (PI = 3Bh, 3Ch)
	Dim. U	± 7 bits	– 1 … 2	
	Dim. I	± 7 bits	– 3 … 2	
	Dim. P	± 7 bits	– 1 … 8	
	Dim. E	± 7 bits	– 1 … 8	
33h	3-L/4-L/3L-1/3L13/4L13 connection	8 bits	55h/AAh/33h/CCh/66h	
34h	Energy synchronizing interval	8 bits	0.1 ... 60	= external, 1 ... 60 minutes
35h	Software version	8 bits	0 ... 255	read only
36h	Energy meter mode	8 bits		Mode Low tariff active
			00h	L123 by time setting [1]
			04h	LTHT by time setting [1]
			08h	L123 with synchronizing input
			0Ch	LTHT with synchronizing input
37h	Low tariff time periods			only active, if feature R1
	Start time, minutes	8 bits	0 ... 59	
	Start time, hours	8 bits	0 ... 23	
	End time, minutes	8 bits	0 ... 59	
	End time, hours	8 bits	0 ... 23	
38h	Representation of reactive power	8 bits	see “Representation of Reactive Power (PI = 38h)” on page 31	
39h	Frequency source	8 bits	00h	All phases are taken into account
			40h	Synchronization only in relation to voltages
3Bh	Voltage measuring range			
	U_{tprim}	100 V/16 bits	– 600 ... 0 / 1 ... 8000	= 100 V ... 700 V / 100 V ... 800 kV
	U_{tsek}	1 V/16 bits	100 ... 500	= 100 V ... 500 V
3Ch	Current measuring range			
	I_{tprim}	1 A, 5 A/16 bits	0.1 ... 30000	= 1 A, 5 A ... 150000 A
	I_{tsek}	bit 0	0.1	= 5 A, 1 A
		bit 1 ... 7	—	—
		bit 8 ... 15	– 100 ... 100	0.900 ... 1.100 adjustment
3Fh	Display brightness	bits 0 ... 2	0 ... 7	0.5 brightness levels
	Display filter	bits 3 ... 7	0 ... 30	time constant in sec.

[1] For version without data logger: no low tariff

Equipment (PI = 31h)

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

Representation of Reactive Power (PI = 38h)

Value	Representation	Comment
00h	per DIN 40110	$Q = \sqrt{S^2 - P^2}$
10h	with sign	$Q = \frac{1}{TN} \cdot \int_0^{TN} U(t) \cdot J\left(t - \frac{TN}{4}\right) dt$ [1)]
20h	Equalizing reactive power	
30h	with sign	Power factor same as Ferraris meters

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

6.7 FFT, Harmonics (PI = 80h ... 86h)

PI	Parameter	Format	Comment	PI	Parameter	Format	Comment
80h	**Instantaneous Values THD/ Fundamental Wave:** I1 THD	16 bits	read only	87h	**Maximum Values THD/ Fundamental Wave:** I1 THD	16 bits	read only
	I1 Fundamental wave	16 bits			I1 Fundamental wave	16 bits	
	I2 THD	16 bits			I2 THD	16 bits	
	I2 Fundamental wave	16 bits			I2 Fundamental wave	16 bits	
	I3 THD	16 bits			I3 THD	16 bits	
	I3 Fundamental wave	16 bits			I3 Fundamental wave	16 bits	
	U1 THD	16 bits			U1 THD	16 bits	
	U1 Fundamental wave	16 bits			U1 Fundamental wave *	16 bits	
	U2 THD	16 bits			U2 THD	16 bits	
	U2 Fundamental wave	16 bits			U2 Fundamental wave *	16 bits	
	U3 THD	16 bits			U3 THD	16 bits	
	U3 Fundamental wave	16 bits = 24 bytes			U3 Fundamental wave *	16 bits = 24 bytes	
81h	**Instantaneous Values U1 THD/ Harmonic Waves:** U1 THD	16 bits	read only	88h	**Maximum Values U1 THD/ Harmonic Waves:** U1 THD	16 bits	read only
	U1 Fundamental wave	16 bits			U1 Fundamental wave *	16 bits	
	U1 2nd Harmonic wave	16 bits			U1 2nd Harmonic	16 bits	
	...	...			...	...	
	U1 15th Harmonic wave	16 bits = 32 bytes			U1 15th Harmonic	16 bits = 32 bytes	
82h	**Instantaneous Values U2 THD/ Harmonic Waves:** U2 THD	16 bits	read only	89h	**Maximum Values U2 THD/ Harmonic Waves:** U2 THD	16 bits	read only
	U2 Fundamental wave	16 bits			U2 Fundamental wave *	16 bits	
	U2 2nd Harmonic	16 bits			U2 2nd Harmonic	16 bits	
	...	...			...	...	
	U2 15th Harmonic	16 bits = 32 bytes			U2 15th Harmonic	16 bits = 32 bytes	

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

PI	Parameter	For-mat	Comment	PI	Parameter	For-mat	Comment
83h	**Instantanous Values U3 THD/ Harmonic Waves:** U3 THD	16 bits	read only	8Ah	**Maximum Values U3 THD/ Harmonic Waves:** U3 THD	16 bits	read only
	U3 Fundamental wave	16 bits			U3 Fundamental wave *	16 bits	
	U3 2nd Harmonic	16 bits			U3 2nd Harmonic	16 bits	
	...	...			...	...	
	U3 15th Harmonic	16 bits = 32 bytes			U3 15th Harmonic	16 bits = 32 bytes	
84h	**Instantenous Values I1 THD/ Harmonic Waves:** I1 THD	16 bits	read only	8Bh	**Maximum Values I1 THD/ Harmonic Waves:** I1 THD	16 bits	read only
	I1 Fundamental wave	16 bits			I1 Fundamental wave	16 bits	
	I1 2nd Harmonic	16 bits			I1 2nd Harmonic	16 bits	
	...	...			...	...	
	I1 15th Harmonic	16 bits = 32 bytes			I1 15th Harmonic	16 bits = 32 bytes	
85h	**Instantenous Values I2 THD/ Harmonic Waves:** I2 THD	16 bits	read only	8Ch	**Maximum Values I2 THD/ Harmonic Waves:** I2 THD	16 bits	read only
	I2 Fundamental wave	16 bits			I2 Fundamental wave	16 bits	
	I2 2nd Harmonic	16 bits			I2 2nd Harmonic	16 bits	
	...	...			...	...	
	I2 15th Harmonic	16 bits = 32 bytes			I2 15th Harmonic	16 bits = 32 bytes	
86h	**Instantenous Values I3 THD/ Harmonic Waves:** I3 THD	16 bits	read only	8Dh	**Maximum Values I3 THD/ Harmonic Waves:** I3 THD	16 bits	read only
	I3 Fundamental wave	16 bits			I3 Fundamental wave	16 bits	
	I3 2nd Harmonic	16 bits			I3 2nd Harmonic	16 bits	
	...	...			...	...	
	I3 15th Harmonic	16 bits = 32 bytes			I3 15th Harmonic	16 bits = 32 bytes	

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

6.8 Real-Time Clock / Data Logger (PI = 90h ... 9Fh) Value ranges with 512 kB memory

PI	Parameter	Format	Value Range	Comment
90h	Seconds	8 bits	0 ... 59	Recording restarts RTC
	Minutes	8 bits	0 ... 59	
	Hours	8 bits	0 ... 23	
91h	Day	8 bits	1 ... 31	Recording restarts RTC
	Month	8 bits	1 ... 12	
	Year	8 bits	0 ... 99	
	Millennium	8 bits	19 ... 20	
92h	Data Logger, parameter settings			
Info field	Sampling interval	8 bits	0 ... 19	See page 37 Data Logger, Sampling Interval
	Current recording duration for one window in trigger mode [1]	8 bits	8 ... 24	See page 37 Data Logger, Recording Duration
	Trigger specification	8 bits	00h ... 3Fh	See page 37 Data Logger, Trigger Specification
	Selection and assignment of measured values to recording channels 1 through 12			See page 38 Data Logger, Selection and Assignment of Measured Values
	Channel 1	8 bits		
	Channel 2	8 bits		
	Channel 3	8 bits		
	Channel 4	8 bits		
	Channel 5	8 bits		
	Channel 6	8 bits		
	Channel 7	8 bits		
	Channel 8	8 bits		
	Channel 9	8 bits		
	Channel 10	8 bits		
	Channel 11	8 bits		
	Channel 12	8 bits		

[1] Not valid for recording without trigger

PI	Parameter	Format	Value Range	Comment
93h	Data Logger, general configuration for recording memory			read only
Info field	Number of avail. windows (v)	8 bits	1 ... 99	
	Number of windows used or % occupancy of logger	8 bits %/8 bits	1 ... v, 100 0 ... 100	Trigger mode * Free run
	Number of 16 bit values per sample	8 bits	0 ... 24	
	Channel assignments:			See page 38 Data Logger, Selection and Assignment of Measured Values
	Channel 1	8 bits		
	Channel 2	8 bits		
	Channel 3	8 bits		
	Channel 4	8 bits		
	Channel 5	8 bits		
	Channel 6	8 bits		
	Channel 7	8 bits		
	Channel 8	8 bits		
	Channel 9	8 bits		
	Channel 10	8 bits		
	Channel 11	8 bits		
	Channel 12	8 bits		
	Trigger 1 – source	8 bits	00h ... C5h	See page 25 Relay and Analog Output Sources (PI = 11h or 16h)
	Trigger 2 – source	8 bits	00h ... C5h	
	Sampling interval	1 s/16 bits	0,0,1 ... 43200	=0: [2] 0.3 s ... 12 h; 20864 ≙ 24 h
	Recording duration • of one window (in trigger mode) • max. duration (without triggering)	1 s/32 bits	60 ... 3.12 x 10^9	1 min ... 99 years
	Max. number of samples per window	32 bits	0 ... 260754	

[1] In trigger mode: Number of windows used since start of logging, 100 after first overwrite
[2] Interval dependent upon measuring frequency, 16 or 32 periods, compare page 37 Data Logger, Sampling Interval

PI	Parameter	Format	Value Range	Comment
94h	Data logger, specific parameters of a recording window			read only
PE head	Window number	8 bits	1 ... v	[3]
Info field	Time stamp for first trigger	6 x 8 bits		See page 39 Data Logger, Time Stamp Format
	Time stamp for last trigger	6 x 8 bits		See page 39 Data Logger, Time Stamp Format
	Time stamp for last sample	6 x 8 bits		See page 39 Data Logger, Time Stamp Format
	Sample position for first trigger	32 bits	0 ... 195566	
	Sample position for last trigger	32 bits	0 ... 260754	< max. number
	Position of last sample	32 bits	0 ... 260754	< max. number, number of samples – 1
	Number of samples per data transmission block	8 bits	5 ... 120	last block may have fewer samples
	Number of data transmission blocks per window	16 bits	1 ... approx. 2200	
95h	Data field Data Logger transmission block			read only
PE head	Window number Data block number	8 bits 16 bits	1 ... 99 0 ... 2169	
Info field	First measured value for the first sample in the block	16 bits		2 x t x s signs are transmitted [4]
	…	…		
	Last measured value for the first sample	16 bits		The less significant word is quoted first in the case of energy measured values.
	First measured value for the second sample	16 bits		
	…	…		
	Last measured value for the last samples	16 bits		

[3] 1 = Window number = 1: oldest window; v = current window
[4] t = Number of recording channels in use; s = number of samples per data transmission block

6.8.1 Data Logger, Sampling Interval

Index	Interval	Index	Interval	Index	Interval	Index	Interval
0	1 meas. cycle *	2	1 second	8	1 minute	14	1 hour
1	2 meas. 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 periods

6.8.2 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

6.8.3 Data Logger, Trigger Specification

Bit No.	Function	Comments
0...2	0: no trigger 1: Alarm 1 trigger 2: Alarm 2 trigger 3: Alarm 1 and 2 trigger 4: no trigger and logger start via Sync input 5: Alarm 1 trigger and trigger lock via Sync input 6: Alarm 2 trigger and trigger lock via Sync input 7: Alarm 1 and 2 trigger and trigger lock via Sync input	
3	=0: memory mode “one time only” =1: memory mode “cyclical”	
5,4	=0,0: pre-trigger 00% =0,1: pre-trigger 25% =1,0: pre-trigger 50% =1,1: pre-trigger 75%	Position of first triggers in % relative to number of sampling steps per window
6	=0	not in use
7	=0	not in use

6.8.4 Data Logger, Selection and Assignment of Measured Values

For recording channels 1 - 12 in the channel list:
Recording is performed with all channels starting with channel 1 and up to the first channel in the list flagged ⏏ "OFF". All subsequent entries to the list are disregarded!

Bit No.	Function	Coding (1)	Comments	Coding (2)
0 ... 3	Phase number for the measured value	=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: Intervalic active power =10: Intervalic reactive power =11: Intervalic apparent power	independent of phase number The latest competed intervalic power is used in each case	
		=12: no measured value assigned to this channel	⏏ "OFF" If one recording channel is deactivated, the subsequent recording channels are also regarded as deactivated	
		=13: active energy =14: reactive energy		

6.8.5 Data Logger, Time Stamp Format

Byte No.	Content	Format	Byte No.	Content	Format
1	seconds	8 bit binary	4	day (of month)	8 bit binary
2	minutes	8 bit binary	5	month	8 bit binary
3	hours	8 bit binary	6	decade & year	8 bit binary

6.9 Sampling values

PI	Value	WA	Comment
A0	**U1 – Sampling Values:** 1st Sampling value U1 ... 32nd Sampling value U1	 ±15 bits ... ±15 bits = 64 bytes	read only
A1	**U2 – Sampling Values:** 1st Sampling value U2 ... 32nd Sampling value U2	 ±15 bits ... ±15 bits = 64 bytes	read only
A2	**U3 – Sampling Values:** 1st Sampling value U3 ... 32nd Sampling value U3	 ±15 bits ... ±15 bits = 64 bytes	read only
A3	**I1 – Sampling Values:** 1st Sampling value I1 ... 32nd Sampling value I1	 ±15 bits ... ±15 bits = 64 bytes	read only
A4	**I2 – Sampling Values:** 1st Sampling value I2 ... 32nd Sampling value I2	 ±15 bits ... ±15 bits = 64 bytes	read only
A5	**I3 – Sampling Values:** 1st Sampling value I3 ... 32nd Sampling value I3	 ±15 bits ... ±15 bits = 64 bytes	read only
A6	Sampling values freeze = 55h update = AAh	8 Bit	

7 Product Support Industrial Division

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