ENERGY-INT 6

Communication Description

Software Version 01 (subject to alterations)

CONTENTS

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1 Introduction

The M-Bus (Meter Bus) is a new European standard for remote reading of meters. It can be used for all types of consumption meters and for various sensors and actuators.

This document does not deal with the M-Bus protocol in detail. Further information about this can be found on the Internet at www.m-bus.com.

The RS-232 communication module is a serial interface for communication with external devices, e.g. a PC.

2 Communication interfaces

SHARKY-HEAT is equipped with three communication interfaces:
- Optical ZVEI: In the ZVEI interface, a light pulse or a missing light pulse corresponds to each bit.
- M-BUS: M-Bus communication is over a two-wire line. This interface is an open-collector output, not a floating contact.
- RS-232: The module board contains a 3-pole terminal strip with terminals marked DAT, REQ and GND (ground). This connection can be used in conjunction with the HYD cable adapter for PC communication.

2.1 Communication priorities

Mutual influence between interfaces:

Interface	Priority
Optical ZVEI	1
M-Bus	2

Interface	Priority
Optical ZVEI	1
RS-232	2

The M-Bus and RS-232 interfaces can no longer be used during optical communication. Any communication in progress over the ZVEI interface is re-routed to the M-Bus when the M-Bus is detected.

2.2 Telegram formats

Communication complies with:
- IEC 870-5-1 Telecontrol equipment and systems; Transmission protocols; Section One - Transmission frame formats.

2.3 UART

Baud rates

- M-Bus: 300 and 2400 bauds (300 bauds: transmission in Interrupt Mode), no automatic baud rate switching
- RS-232:   300 and 2400 bauds
- ZVEI optical: 2400 bauds

Parity detection

to IEC 870-5-1; 8 data bits; parity even; 1 stop bit (8E1)

2.4 Protocol layer

1. IEC 870-5-1 corresponding to EN 1434-3
2. Data output (RSP_UD)
   a) Variable protocol
   b) Least Significant Byte first (Mode 1) for multi-byte variables
   c) All response telegrams also available for C1 errors

2.5 Connection set-up for optical ZVEI

To activate the optical ZVEI interface, a '0' - '1' bit pattern must be sent continuously at 2400 bauds for 2.2 s (= 480 bytes + $55 + 8 data bits + no parity + 1 stop bit). The actual communication can be started after a pause of 11 to 330 bit times (2400 bauds).

2.6 Connection set-up for M-Bus/RS-232

After connection to the M-Bus/RS-232, the MSP430 interface module needs max. 590 ms before it is ready for reliable communication. => A wait time of 590 ms must be observed between connection of the M-Bus/RS-232 and the start of communication.

2.7 Addressing

The meter can be addressed using two addressing variants: with a logic address (primary address) or by using a filter via its ex works identification (secondary address).

2.7.1 Selection (secondary address)

Request telegram:	68 0B 0B 68 53 FD 52 NN NN NN NN HH HH ID MM CS 16
Response:	E5 (only if filter matches)

Structure of filter:

4-byte BCD	NN (serial number)	$F digit joker
2-byte HST	HH (manufacturer code)	$FF byte joker
1-byte ID (Sharky: $28)	ID (ident. code)	$FF joker
1-byte SMED	MM (medium code)	$FF joker

After selection, the meter behaves as if it also had the primary address $FD and can therefore be operated via the primary address $FD (response always with own primary address).

2.7.2 Deselection

Request telegram:	10 40 FD CS 16
Response:	E5

To reliably end communication with the selected meter, the meter must be deselected. The primary address $FD then becomes free again and can be used for communication with another meter.

3   Reading the meter:

Procedure:
1. Define response – "Define response values"
2. Request response
3. Interpretation of data

3.1   Standard data reading (Application Reset 0)

Meter reading always uses a long frame with the following structure:

To make sure the standard value "0" (All) is obtained, an Application Reset should be carried out with subcode "0":

SND_UD: "68   04   04   68   **73/53**   **FD**   **50**   **00**   **CS**   16"

C-field: **73** or **53**

Address field: e.g. **FD** (equiv. to 254)

CI-field: **50**

Application Reset Subcode: **00**

"00" equiv. to "All" – (*see Appendix 1*)

or e.g. "20" equiv. to "Simple Billing"

Checksum: **CS**
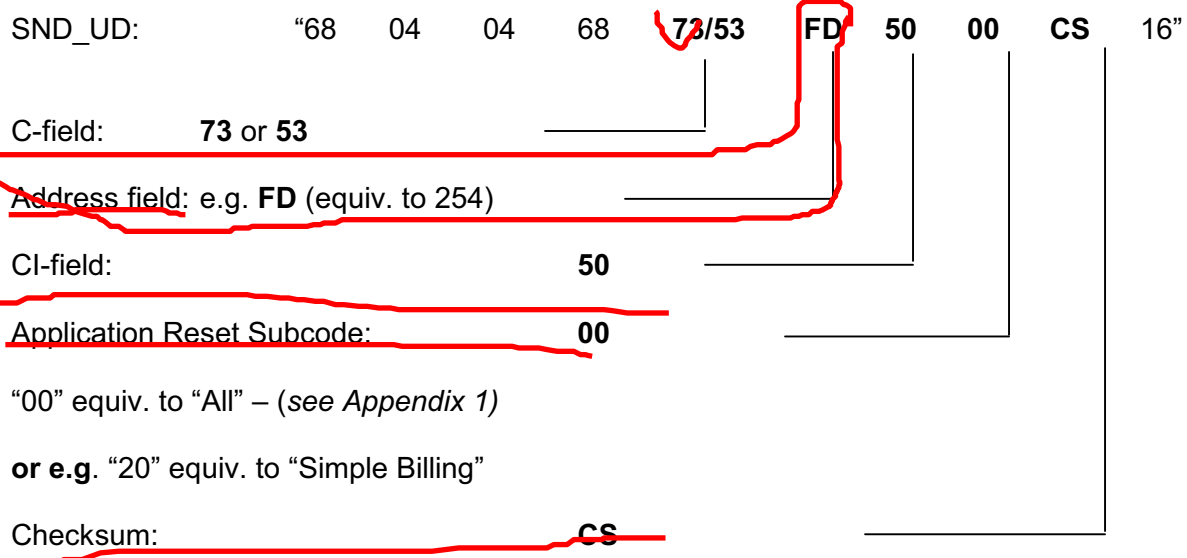
3.2   Request response

The following command must be sent to obtain a response from the meter:

Request telegram:		Response
REQ_UD2	10 7B AA CS 16	RSP_UD

3.3   Interpretation of data

The data received basically corresponds to the protocol structure of EN1434-3.
The unit definitions are contained in *Appendix 2*.

4 Customer telegram

Registers can be read or programmed direct in the meter using subtables.

The HYDRO-SET program from HYDROMETER can be used to set the customer telegram. This program can be downloaded at:

http://www.hydrometer.com/systeme/download.html

5 Parametrization of meter

The meter is equipped with a number of registers that can be set without breaking the calibration seal.

5.1 Structure of instruction set

Byte	Meaning	Description/content/value
	Header Long Frame (HLF)	
HLF 1	1st start character	$68
HLF 2	Long field	3 + x
HLF 3	Long field	3 + x
HLF 4	2nd start character	$68
HLF 5	C-field	$53 SND_UD
HLF 6	A-field	(Bus) address of meter
HLF 7	CI-field	$51 data send mode 1
	Variable Data Blocks (VDB)	
VDB 1.. VDB x		
	End of Long Frame (ALF)	
ALF 1	Checksum	
ALF 2	Stop character	$16

5.2 Date and time

The date and time can be changed with the following telegram:

Send:

   $68 $09 $09 $68 $53 $ FE $51 **$04 $6D [Date Time (4-Byte Mbus Type F)]** Check $16

Example: (15.05.2006):

         $68 $09 $09 $68 $53 $FE $51 $04 $6D $0F $0A $CF $05 $00 $16

Read: $E5

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5.3 New primary address

If VBD1 = $01 and VDB2 = $7A, VDB3 is used as new primary address.

Send: $68 $06 $06 $68 $53 $FE $51 **$01 $7A [Address]** Check $16

Example (address 5):

        $68 $06 $06 $68 $53 $FE $51 **$01 $7A $05** $22 $16

Read: $E5

Special cases:

A-field	Function	Use
$FD	Characters for secondary addressing	Secondary addressing
$FE	Broadcast (to all) with response	Only one meter connected
$FF	Broadcast (to all) without response	System-wide control

5.4 Serial number / customer number

The new meter number NNUM can be defined with the following telegram:
4-byte BCD

Send: $68 $09 $09 $68 $53 $FE $51 **$0C $79 NNUM Check** $16

Example (SN 12345678):

        $68 $09 $09 $68 $53 $FE $51 **$0C $79 $78 $56 $34 $12** $3B $16

Read: $E5

Note: The NNUM is part of the secondary address.

5.5 New reading date 1

If VBD1 = $44, VDB2 = $ED and VDB3 = $7E, VDB4 and VDB5 are used as new next reading date (data type F).

Send: $68 $10 $10 $68 $53 $FE $51 **[DATE] Check** $16

Example (01.05.2006) :

          $68 $10 $10 $68 $53 $FE $51 **$42 $EC $7E $C1 $05** $17 $16

Read: $E5

5.6 New reading date 2

If VBD1 = $84, VDB2 = $ED and VDB3 = $7E, VDB4 and VDB5 are used as new next reading date (data type F).

Send: $68 $10 $10 $68 $53 $FE $51 **[DATE] Check** $16

Example (31.12.2006) :

          $68 $11 $11 $68 $53 $FE $51 **$82 $01 $EC $7E $DF $0C** $7D $16

Read: $E5

5.7 Pulse input counter 1

If IMPIN1PL = 0, IMPCNT1 can be changed. This programming facility can be disabled by HYD!
4-byte BCD

Send: $68 $0B $0B $68 $53 $FE $51 **$8C $40 $FD $3A IMPCNT1** Check $16

Example (55667788):

          $68 $0B $0B $68 $53 $FE $51 **$8C $40 $FD $3A $88 $77 $66 $55** $5F $16

Read: $E5

5.8   Pulse input counter 2

If IMPIN2PL = 0, IMPCNT2 can be changed. This programming facility can be disabled by HYD!

4-byte BCD

Send: $68 $0B $0B $68 $53 $FE $51 **$8C $80 $40 $FD $3A IMPCNT1** Check $16

Example (66554433):

    $68 $0B $0B $68 $53 $FE $51 **$8C $80 $40 $FD 3A $33 $44 $55 $66** $57 $16

Read: $E5

5.9   Clearing operating hours

If NCLROTC = 0, ONTIME can be cleared in the field by communication.
3-byte BCD

Send: $68 $08 $08 $68 $53 $FE $51 **$0B $26 XX XX XX** Check $16

Example (clearing):

    $68 $08 $08 $68 $53 $FE $51 **$0B $26 $00 $00 $00** $D3 $16

Read: E5

5.10 Clearing error day counter

If NCLREDC = 0, ERRDAY can be cleared in the field by communication.
1-byte BCD

Send: $68 $06 $06 $68 $53 $FE $51 **$39 $27 XX** Check $16

Example (clearing):

    $68 $06 $06 $68 $53 $FE $51 **$39 $27 $00** $02 $16

Read: E5

5.11 Monthly values (last month)

The monthly memory with a capacity of 24 months is located in the EEPROM at address 0x2300 to 0x28FF, with 64 bytes per month.

Address	Month
0x2300	January of even year
0x2340	February of even year
0x2380	March of even year
0x23C0	April of even year
0x2400	May of even year
0x2440	June of even year
0x2480	July of even year
0x24C0	August of even year
0x2500	September of even year
0x2540	October of even year
0x2580	November of even year
0x25C0	December of even year
0x2600	January of odd year
0x2640	February of odd year
0x2680	March of odd year
0x26C0	April of odd year
0x2700	May of odd year
0x2740	June of odd year
0x2780	July of odd year
0x27C0	August of odd year
0x2800	September of odd year
0x2840	October of odd year
0x2880	November of odd year
0x28C0	December of odd year

Each entry has the following structure:

Value	Size	Type	Address
• Date	2 bytes	M-Bus type G	0
• Energy 1/10 display value	4 bytes	BCD	2
• Tariff energy 1 1/10 display value	4 bytes	BCD	6
• Tariff energy 2 1/10 display value	4 bytes	BCD	10
• Tariff definition 1	2 bytes	HY spec.	14
• Tariff definition 2	2 bytes	HY spec.	16
• Volume 1/10 display value	4 bytes	BCD	18
• Error day counter	1 byte	BCD	22
• Maximum monthly flow rate	3 bytes	BCD	23
• Maximum monthly power	4 bytes	BCD	27
• Day of maximum monthly flow rate	1 byte	hex	28
• Day of maximum monthly power	1 byte	hex	29
• Pulse counter 1	4 bytes	BCD	30
• Pulse counter 2	4 bytes	BCD	34
• IMPIN1DEF	1 byte	HY spec.	35
• IMPIN2DEF	1 byte	HY spec.	36
• ONTIME	3 bytes	BCD	39

5.11.1 Reading

Write read pointer to address

AppResSubCode 0xC0

Collect data (read pointer is always incremented by data block size)
- Check address, as possibly wrong if communication error
- Interpret response

5.11.2 Deletion

Deletion is not possible in the field, so do not write.

5.12 Deleting error log

The event memory with a capacity of 31 entries is located in the EEPROM at address 0x2284 to 0x22FF, with 4 bytes per entry. The administration data is located at address 0x2280.

Address	Value	Type
0x2280	Save next index	hex mask = 0x7C
0x2282	Delete last date	M-Bus type G
0x2284	Index 0	
0x2288	Index 1	
0x22FC	Index 30	

Each entry has the following structure:

Byte 1
Event byte

Mask	Source
0x01	RAM checksum error
0x02	Back-up power supply
0x04	Temperature measurement error
0x10	Change of PLEV
0xE0	Program start counter

Byte 2 and 3:
Date of saving (M-Bus data type G)

Byte 4 :

Bit	Source
0x1F	Hour
0x20	Leak at In1
0x40	Leak at In2
0x80	Data change

5.12.1 Reading

Write read pointer to address

AppResSubCode 0xC0

Collect data
- Check address, as possibly wrong if communication error
- Interpret response

5.12.2 Set read pointer

Send:

$68 $0D $0D $68 $53 $FE $51 $2F $0F **$00 $01 $6E $03 $03 AdrLo AdrHi $80**Check $16

Example (0x2300):

$68 $0D $0D $68 $53 $FE $51 $2F $0F **$00 $01 $6E $03 $03 $00 $23 $80** Check $16

Read: $E5

6 Appendix 1

Application Reset Subcode:

Application Reset Subcode	Telegram data
0 "All"	Current energy Current tariff energy 1 Current tariff energy 2 Current volume Current power Current flow rate Current forward temperature T_H Current return temperature T_C Current temperature difference Current operating hours Current date and time Reading date 1 (memory number = 1) • Energy • Volume • Tariff energy 1 • Tariff energy 2 • Date • Next reading date 1 Reading date 2 (memory number = 2) • Energy • Volume • Tariff energy 1 • Tariff energy 2 • Date • Next reading date 2 Pulse IN register • Current pulse input counter 1 • Current pulse input counter 2

1 "User data"	Current energy Current tariff energy 1 Current tariff energy 2 Current volume Current power Current flow rate Current forward temperature T_H Current return temperature T_C Current temperature difference Current operating hours Current date and time Reading date 1 (memory number = 1) • Energy • Volume • Tariff energy 1 • Tariff energy 2 • Date • Next reading date 1 Reading date 2 (memory number = 2) • Energy • Volume • Tariff energy 1 • Tariff energy 2 • Date • Next reading date 2 Reading date 1 last year (memory number = 3) • Energy • Volume • Tariff energy 1 • Tariff energy 2 • Date Reading date 2 last year (memory number = 4) • Energy • Volume • Tariff energy 1 • Tariff energy 2 • Date
2 "Simple billing"	As 1
3 "Enhanced billing"	Current energy Current volume Current flow rate Current forward temperature T_H Current return temperature T_C Current tariff energy 1 Current error day counter Current pulse input counter 1 Current pulse input counter 2 Tariff limit 2 reached

4 "Multi-tariff billing"	Current energy Current volume Current tariff energy 1 Current tariff energy 2 Current pulse input counter 1 Current operating hours Error day counter Current flow rate Current power Current forward temperature T_H Current return temperature T_C Date of last monthly memory Energy of last monthly memory Volume of last monthly memory Pulse counter 1 of last monthly memory Tariff energy 1 of last monthly memory Operating hours of last monthly memory Error day counter of last monthly memory
5 "Instanteous values"	Current energy Current tariff energy 1 Current tariff energy 2 Current volume Current power Current flow rate Current forward temperature T_H Current return temperature T_C Current operating hours Current error day counter

6
"Load management values for management"
	Proprietary data number:
	    4 -> $0F $04 SWVER READPTR READLEN Bytes
	
	• Application reset subcode = 0x60 makes
	  READPTR = 0x2900 and READLEN = maximum possible length
	• READPTR is automatically incremented by READLEN for every REQ_UD2

7 "Reserved"	As 1
8 "Installation and startup"	Current date and time ($04 $6D DTFZEIT) Next reading date 1 Next reading date 2

11
"Manufacturing"
	Proprietary data number:
	    4 -> $0F $04 SWVER READPTR *READLEN Bytes*
	
	• Application reset subcode = 0xB0 makes
	  READPTR = 0x200 and READLEN = maximum possible length
	• READPTR is automatically incremented by READLEN for every REQ_UD2

12 "Development"	As 11 without Init READPTR and READLEN
13 "Selftest"	Current energy Current date and time
14 "Reserved"	As 0
15 "Reserved"	RAMTEL

7   Appendix 2

M-Bus units:

	DIV	VIF	Unit
Current energy	0x0C	0x05	0.1 kWh
	0x0C	0x06	1 kWh
	0x0C	0x07	10 kWh
	0x0C	0x86 0x75	1 kWh * 10^{-1}
	0x0C	0x FB 0x81 0x72	1 MWh * 10^{-4}
	0x0C	0x FB 0x81 0x73	1 MWh * 10^{-3}
	0x0C	0x FB 0x81 0x74	1 MWh * 10^{-2}
	0x0C	0x0F	10 MJ
	0x0C	0x0E	1 MJ
	0x0C	0x0D	0.1 MJ
	0x0C	0x84 0x3D	10 kBtu
	0x0C	0x83 0x3D	1 kBtu
	0x0C	0x82 0x3D	0.1 kBtu
	0x0C	0xFB 0x0E	10 Mcal
	0x0C	0xFB 0x0D	1 Mcal
	0x0C	0xFB 0x0C	0.1 Mcal
Current volume	0x0C	0x12	0.1 l
	0x0C	0x13	1 l
	0x0C	0x14	10 l
Current flow rate	0x0B	0x3A	0.1 l/h
	0x0B	0x3B	1 l/h
	0x0B	0x3C	10 l/h
Current power	0x0C	0x2A	0.1 W
	0x0C	0x2B	1 W
	0x0C	0x2C	10 W
Current time	0x04	0x6D	Type F
Current forward temperature	0x0A	0x5A	0.1 ℃
Current return temperature	0x0A	0x5E	0.1 ℃
Current temperature difference	0x0A	0x62	0.1 ℃
Current tariff energy 1	0x8C 0x10	0x05	0.1 kWh
	0x8C 0x10	0x06	1 kWh
	0x8C 0x10	0x07	10 kWh
	0x8C 0x10	0x0F	10 MJ
	0x8C 0x10	0x0E	1 MJ
	0x8C 0x10	0x0D	0.1 MJ
	0x8C 0x10	0x84 0x3D	10 kBtu
	0x8C 0x10	0x83 0x3D	1 kBtu
	0x8C 0x10	0x82 0x3D	0.1 kBtu
	0x8C 0x10	0xFB 0x0E	10 Mcal
	0x8C 0x10	0xFB 0x0D	1 Mcal
	0x8C 0x10	0xFB 0x0C	0.1 Mcal

Current tariff energy 2	0x8C 0x20	0x05	0.1 kWh
	0x8C 0x20	0x06	1 kWh
	0x8C 0x20	0x07	10 kWh
	0x8C 0x20	0x0F	10 MJ
	0x8C 0x20	0x0E	1 MJ
	0x8C 0x20	0x0D	0.1 MJ
	0x8C 0x20	0x84 0x3D	10 kBtu
	0x8C 0x20	0x83 0x3D	1 kBtu
	0x8C 0x20	0x82 0x3D	0.1 kBtu
	0x8C 0x20	0xFB 0x0E	10 Mcal
	0x8C 0x20	0xFB 0x0D	1 Mcal
	0x8C 0x20	0xFB 0x0C	0.1 Mcal
Current operating hours	0x0B	0x26	h
Reading date 1 energy	0x4C	0x05	0.1 kWh
	0x4C	0x06	1 kWh
	0x4C	0x07	10 kWh
	0x4C	0x0F	10 MJ
	0x4C	0x0E	1 MJ
	0x4C	0x0D	0.1 MJ
	0x4C	0x84 0x3D	10 kBtu
	0x4C	0x83 0x3D	1 kBtu
	0x4C	0x82 0x3D	0.1 kBtu
	0x4C	0xFB 0x0E	10 Mcal
	0x4C	0xFB 0x0D	1 Mcal
	0x4C	0xFB 0x0C	0.1 Mcal
Reading date 1 volume	0x4C	0x12	0.1 l
	0x4C	0x13	1 l
	0x4C	0x14	10 l
Reading date 1 tariff energy 1	0xCC 0x10	0x05	0.1 kWh
	0xCC 0x10	0x06	1 kWh
	0xCC 0x10	0x07	10 kWh
	0xCC 0x10	0x0F	10 MJ
	0xCC 0x10	0x0E	1 MJ
	0xCC 0x10	0x0D	0.1 MJ
	0xCC 0x10	0x84 0x3D	10 kBtu
	0xCC 0x10	0x83 0x3D	1 kBtu
	0xCC 0x10	0x82 0x3D	0.1 kBtu
	0xCC 0x10	0xFB 0x0E	10 Mcal
	0xCC 0x10	0xFB 0x0D	1 Mcal
	0xCC 0x10	0xFB 0x0C	0.1 Mcal
Reading date 1 tariff energy 2	0xCC 0x20	0x05	0.1 kWh
	0xCC 0x20	0x06	1 kWh
	0xCC 0x20	0x07	10 kWh
	0xCC 0x20	0x0F	10 MJ
	0xCC 0x20	0x0E	1 MJ
	0xCC 0x20	0x0D	0.1 MJ
	0xCC 0x20	0x84 0x3D	10 kBtu
	0xCC 0x20	0x83 0x3D	1 kBtu
	0xCC 0x20	0x82 0x3D	0.1 kBtu
	0xCC 0x20	0xFB 0x0E	10 Mcal

	0xCC 0x20	0xFB 0x0D	1 Mcal
	0xCC 0x20	0xFB 0x0C	0.1 Mcal
Reading date 1 time	0x42	0x6c	Type G
Next reading date 1	0x42	0xEC 0x7E	Type G
Reading date 1 last year energy	0xCC 0x01	0x05	0.1 kWh
	0xCC 0x01	0x06	1 kWh
	0xCC 0x01	0x07	10 kWh
	0xCC 0x01	0x0F	10 MJ
	0xCC 0x01	0x0E	1 MJ
	0xCC 0x01	0x0D	0.1 MJ
	0xCC 0x01	0x84 0x3D	10 kBtu
	0xCC 0x01	0x83 0x3D	1 kBtu
	0xCC 0x01	0x82 0x3D	0.1 kBtu
	0xCC 0x01	0xFB 0x0E	10 Mcal
	0xCC 0x01	0xFB 0x0D	1 Mcal
	0xCC 0x01	0xFB 0x0C	0.1 Mcal
Reading date 1 last year volume	0xCC 0x01	0x12	0.1 l
	0xCC 0x01	0x13	1 l
	0xCC 0x01	0x14	10 l
Reading date 1 last year tariff energy 1	0xCC 0x11	0x05	0.1 kWh
	0xCC 0x11	0x06	1 kWh
	0xCC 0x11	0x07	10 kWh
	0xCC 0x11	0x0F	10 MJ
	0xCC 0x11	0x0E	1 MJ
	0xCC 0x11	0x0D	0.1 MJ
	0xCC 0x11	0x84 0x3D	10 kBtu
	0xCC 0x11	0x83 0x3D	1 kBtu
	0xCC 0x11	0x82 0x3D	0.1 kBtu
	0xCC 0x11	0xFB 0x0E	10 Mcal
	0xCC 0x11	0xFB 0x0D	1 Mcal
	0xCC 0x11	0xFB 0x0C	0.1 Mcal
Reading date 1 last year tariff energy 2	0xCC 0x21	0x05	0.1 kWh
	0xCC 0x21	0x06	1 kWh
	0xCC 0x21	0x07	10 kWh
	0xCC 0x21	0x0F	10 MJ
	0xCC 0x21	0x0E	1 MJ
	0xCC 0x21	0x0D	0.1MJ
	0xCC 0x21	0x84 0x3D	10 kBtu
	0xCC 0x21	0x83 0x3D	1 kBtu
	0xCC 0x21	0x82 0x3D	0.1 kBtu
	0xCC 0x21	0xFB 0x0E	10 Mcal
	0xCC 0x21	0xFB 0x0D	1 Mcal
	0xCC 0x21	0xFB 0x0C	0.1 Mcal
Reading date 1 last year time	0xC2 0x01	0x6c	Type G
Reading date 2 energy	0x8C 0x01	0x05	0.1 kWh
	0x8C 0x01	0x06	1 kWh

	0x8C 0x01	0x07	10 kWh
	0x8C 0x01	0x0F	10 MJ
	0x8C 0x01	0x0E	1 MJ
	0x8C 0x01	0x0D	0.1MJ
	0x8C 0x01	0x84 0x3D	10 kBtu
	0x8C 0x01	0x83 0x3D	1 kBtu
	0x8C 0x01	0x82 0x3D	0.1 kBtu
	0x8C 0x01	0xFB 0x0E	10 Mcal
	0x8C 0x01	0xFB 0x0D	1 Mcal
	0x8C 0x01	0xFB 0x0C	0.1 Mcal
Reading date 2 volume	0x8C 0x01	0x12	0.1 l
	0x8C 0x01	0x13	1 l
	0x8C 0x01	0x14	10 l
Reading date 2 tariff energy 1	0x8C 0x11	0x05	0.1 kWh
	0x8C 0x11	0x06	1 kWh
	0x8C 0x11	0x07	10 kWh
	0x8C 0x11	0x0F	10 MJ
	0x8C 0x11	0x0E	1 MJ
	0x8C 0x11	0x0D	0.1 MJ
	0x8C 0x11	0x84 0x3D	10 kBtu
	0x8C 0x11	0x83 0x3D	1 kBtu
	0x8C 0x11	0x82 0x3D	0.1 kBtu
	0x8C 0x11	0xFB 0x0E	10 Mcal
	0x8C 0x11	0xFB 0x0D	1 Mcal
	0x8C 0x11	0xFB 0x0C	0.1 Mcal
Reading date 2 tariff energy 2	0x8C 0x21	0x05	0.1 kWh
	0x8C 0x21	0x06	1 kWh
	0x8C 0x21	0x07	10 kWh
	0x8C 0x21	0x0F	10 MJ
	0x8C 0x21	0x0E	1 MJ
	0x8C 0x21	0x0D	0.1 MJ
	0x8C 0x21	0x84 0x3D	10 kBtu
	0x8C 0x21	0x83 0x3D	1 kBtu
	0x8C 0x21	0x82 0x3D	0.1 kBtu
	0x8C 0x21	0xFB 0x0E	10 Mcal
	0x8C 0x21	0xFB 0x0D	1 Mcal
	0x8C 0x21	0xFB 0x0C	0.1 Mcal
Reading date 2 time	0x82 0x01	0x6C	Type G
Next reading date 2	0x82 0x01	0xEC 0x7E	Type G
Reading date 2 last year energy	0x8C 0x02	0x05	0.1 kWh
	0x8C 0x02	0x06	1 kWh
	0x8C 0x02	0x07	10 kWh
	0x8C 0x02	0x0F	10 MJ
	0x8C 0x02	0x0E	1 MJ
	0x8C 0x02	0x0D	0.1 MJ
	0x8C 0x02	0x84 0x3D	10 kBtu
	0x8C 0x02	0x83 0x3D	1 kBtu
	0x8C 0x02	0x82 0x3D	0.1 kBtu
	0x8C 0x02	0xFB 0x0E	10 Mcal
	0x8C 0x02	0xFB 0x0D	1 Mcal

	0x8C 0x02	0xFB 0x0C	0.1 Mcal
Reading date 2 last year volume	0x8C 0x02	0x12	0.1 l
	0x8C 0x02	0x13	1 l
	0x8C 0x02	0x14	10 l
Reading date 2 last year tariff energy 1	0x8C 0x12	0x05	0.1 kWh
	0x8C 0x12	0x06	1 kWh
	0x8C 0x12	0x07	10 kWh
	0x8C 0x12	0x0F	10 MJ
	0x8C 0x12	0x0E	1 MJ
	0x8C 0x12	0x0D	0.1 MJ
	0x8C 0x12	0x84 0x3D	10 kBtu
	0x8C 0x12	0x83 0x3D	1 kBtu
	0x8C 0x12	0x82 0x3D	0.1 kBtu
	0x8C 0x12	0xFB 0x0E	10 Mcal
	0x8C 0x12	0xFB 0x0D	1 Mcal
	0x8C 0x12	0xFB 0x0C	0.1 Mcal
Reading date 2 last year tariff energy 2	0x8C 0x22	0x05	0.1 kWh
	0x8C 0x22	0x06	1 kWh
	0x8C 0x22	0x07	10 kWh
	0x8C 0x22	0x0F	10 MJ
	0x8C 0x22	0x0E	1 MJ
	0x8C 0x22	0x0D	0.1 MJ
	0x8C 0x22	0x84 0x3D	10 kBtu
	0x8C 0x22	0x83 0x3D	1 kBtu
	0x8C 0x22	0x82 0x3D	0.1 kBtu
	0x8C 0x22	0xFB 0x0E	10 Mcal
	0x8C 0x22	0xFB 0x0D	1 Mcal
	0x8C 0x22	0xFB 0x0C	0.1 Mcal
Reading date 2 last year time	0x82 0x02	0x6c	Type G
Error day counter	0x09	0xA7 0x18	Days
Pulse input 1	0x8C 0x40	0x05	0.1 kWh
	0x8C 0x40	0x06	1 kWh
	0x8C 0x40	0x07	10 kWh
	0x8C 0x40	0x0F	10 MJ
	0x8C 0x40	0x0E	1 MJ
	0x8C 0x40	0x0D	0.1 MJ
	0x8C 0x40	0x84 0x3D	10 kBtu
	0x8C 0x40	0x83 0x3D	1 kBtu
	0x8C 0x40	0x82 0x3D	0.1 kBtu
	0x8C 0x40	0xFB 0x0E	10 Mcal
	0x8C 0x40	0xFB 0x0D	1 Mcal
	0x8C 0x40	0xFB 0x0C	0.1 Mcal
	0x8C 0x40	0x12	0.1 l
	0x8C 0x40	0x13	1 l
	0x8C 0x40	0x14	10 l
	0x8C 0x40	0x15	100 l
	0x8C 0x40	0xFD 0x3A	No unit
Pulse input 2	0x8C 0x80	0x05	0.1 kWh

	0x40		
	0x8C 0x80 0x40	0x06	1 kWh
	0x8C 0x80 0x40	0x07	10 kWh
	0x8C 0x80 0x40	0x0F	10 MJ
	0x8C 0x80 0x40	0x0E	1 MJ
	0x8C 0x80 0x40	0x0D	0.1 MJ
	0x8C 0x80 0x40	0x84 0x3D	10 kBtu
	0x8C 0x80 0x40	0x83 0x3D	1 kBtu
	0x8C 0x80 0x40	0x82 0x3D	0.1 kBtu
	0x8C 0x80 0x40	0xFB 0x0E	10 Mcal
	0x8C 0x80 0x40	0xFB 0x0D	1 Mcal
	0x8C 0x80 0x40	0xFB 0x0C	0.1 Mcal
	0x8C 0x80 0x40	0x12	0.1 l
	0x8C 0x80 0x40	0x13	1 l
	0x8C 0x80 0x40	0x14	10 l
	0x8C 0x80 0x40	0x15	100 l
	0x8C 0x80 0x40	0xFD 0x3A	No unit
Current tariff def. 1	0x82 0x10	0x7F	Proprietary
Current tariff def. 2	0x82 0x20	0x7F	Proprietary
Latest monthly memory date	0xC2 0x02	0x6C	Type G
Latest monthly memory			
Latest monthly memory energy	0xCC 0x02	0x05	0.1 kWh
	0xCC 0x02	0x06	1 kWh
	0xCC 0x02	0x07	10 kWh
	0xCC 0x02	0x0F	10 MJ
	0xCC 0x02	0x0E	1 MJ
	0xCC 0x02	0x0D	0.1 MJ
	0xCC 0x02	0x84 0x3D	10 kBtu
	0xCC 0x02	0x83 0x3D	1 kBtu
	0xCC 0x02	0x82 0x3D	0.1 kBtu
	0xCC 0x02	0xFB 0x0E	10 Mcal
	0xCC 0x02	0xFB 0x0D	1 Mcal
	0xCC 0x02	0xFB 0x0C	0.1 Mcal
Latest monthly memory volume	0xCC 0x02	0x12	0.1 l
	0xCC 0x02	0x13	1 l

	0xCC 0x02	0x14	10 l
Latest monthly memory tariff energy 1	0xCC 0x12	0x05	0.1 kWh
	0xCC 0x12	0x06	1 kWh
	0xCC 0x12	0x07	10 kWh
	0xCC 0x12	0x0F	10 MJ
	0xCC 0x12	0x0E	1 MJ
	0xCC 0x12	0x0D	0.1 MJ
	0xCC 0x12	0x84 0x3D	10 kBtu
	0xCC 0x12	0x83 0x3D	1 kBtu
	0xCC 0x12	0x82 0x3D	0.1 kBtu
	0xCC 0x12	0xFB 0x0E	10 Mcal
	0xCC 0x12	0xFB 0x0D	1 Mcal
	0xCC 0x12	0xFB 0x0C	0.1 Mcal
Latest monthly memory tariff energy 2	0xCC 0x22	0x05	0.1 kWh
	0xCC 0x22	0x06	1 kWh
	0xCC 0x22	0x07	10 kWh
	0xCC 0x22	0x0F	10 MJ
	0xCC 0x22	0x0E	1 MJ
	0xCC 0x22	0x0D	0.1 MJ
	0xCC 0x22	0x84 0x3D	10 kBtu
	0xCC 0x22	0x83 0x3D	1 kBtu
	0xCC 0x22	0x82 0x3D	0.1 kBtu
	0xCC 0x22	0xFB 0x0E	10 Mcal
	0xCC 0x22	0xFB 0x0D	1 Mcal
	0xCC 0x22	0xFB 0x0C	0.1 Mcal
Latest monthly memory max. flow rate	0xDB 0x02	0x3A	0.1 l/h
	0xDB 0x02	0x3B	1 l/h
	0xDB 0x02	0x3C	10 l/h
Latest monthly memory max. power	0xDC 0x02	0x2A	0.1 W
	0xDC 0x02	0x2B	1 W
	0xDC 0x02	0x2C	10 W
Latest monthly memory tariff def. 1	0xC2 0x12	0x7F	Proprietary
Latest monthly memory tariff def. 2	0xC2 0x22	0x7F	Proprietary
Latest monthly memory error day counter	0xC9 0x02	0xA7 0x18	Days
Latest monthly memory pulse input 1	0xCC 0x42	0x05	0.1 kWh
	0xCC 0x42	0x06	1 kWh
	0xCC 0x42	0x07	10 kWh
	0xCC 0x42	0x0F	10 MJ
	0xCC 0x42	0x0E	1 MJ
	0xCC 0x42	0x0D	0.1 MJ
	0xCC 0x42	0x84 0x3D	10 kBtu
	0xCC 0x42	0x83 0x3D	1 kBtu
	0xCC 0x42	0x82 0x3D	0.1 kBtu

	0xCC 0x42	0xFB 0x0E	10 Mcal
	0xCC 0x42	0xFB 0x0D	1 Mcal
	0xCC 0x42	0xFB 0x0C	0.1 Mcal
	0xCC 0x42	0x12	0.1 l
	0xCC 0x42	0x13	1 l
	0xCC 0x42	0x14	10 l
	0xCC 0x42	0x15	100 l
	0xCC 0x42	0xFD 0x3A	No unit
Latest monthly memory pulse input 2	0x8C 0x80 0x40	0x05	0.1 kWh
	0xCC 0x82 0x40	0x06	1 kWh
	0xCC 0x82 0x40	0x07	10 kWh
	0xCC 0x82 0x40	0x0F	10 MJ
	0xCC 0x82 0x40	0x0E	1 MJ
	0xCC 0x82 0x40	0x0D	0.1 MJ
	0xCC 0x82 0x40	0x84 0x3D	10 kBtu
	0xCC 0x82 0x40	0x83 0x3D	1 kBtu
	0xCC 0x82 0x40	0x82 0x3D	0.1 kBtu
	0xCC 0x82 0x40	0xFB 0x0E	10 Mcal
	0xCC 0x82 0x40	0xFB 0x0D	1 Mcal
	0xCC 0x82 0x40	0xFB 0x0C	0.1 Mcal
	0xCC 0x82 0x40	0x12	0.1 l
	0xCC 0x82 0x40	0x13	1 l
	0xCC 0x82 0x40	0x14	10 l
	0xCC 0x82 0x40	0x15	100 l
	0xCC 0x82 0x40	0xFD 0x3A	No unit
Latest monthly memory operating hours	0xCB 0x02	0x26	h
Current tariff enable 1	0x81 0x10	0xFD 0x1A	Digital output
Current tariff enable 2	0x81 0x20	0xFD 0x1A	Digital output
Error status	0x02	0xFD 0x17	ZVERRBI; Leakage error
Leakage flow rate	0x0B	0xBA 0x69	0.1 l/h
	0x0B	0xBB 0x69	1 l/h
	0x0B	0xBC 0x69	10 l/h