Description of the M-BUS Protocol

Calec, AMTRON and AMBUS-Product Family

Table of Contents

References

Bibliography
[10] EN 1434 -3
[11] MBUS48. actual document of the M-Bus User Group   11. November 1998
      available for download from WWW.M-BUS.COM.

Glossary and abbreviations
M-Bus   Meter Bus as defined in the EN 1434
AMBUS   AMBUS is the name of Aquametro's M-Bus product line
M-Bus low level M-Bus commands specigfic to Aquametro products
$ the $-symbol is followed by hexadecimal number

1. Foreword

This document explains how to read the main parameters from AQUAMETRO meters by the M   -Bus interface or CALEC's optical interface. The latter uses the "M   -Bus" protocol, but not its physical interface. The aim of this document is to describe the access to the parameters for AMTRON,   AMBUS -IS (or -AS) and CALEC -MB; it is however not an exhaustive description of all the possibilities of communication with AQUAMETRO meters.

It is assumed that the reader is familia with the basics of M   -Bus communication described in EN 1434 and the document of the M-Bus User Group.

2. The M-Bus network

In the case of a network, Aquametro meters are connected in parallel to a four   -wire bus: two wires are used to power the meters with a low voltage supply (see the corresponding technical information) whil e the other two are used for the M-Bus connection itself. A central station (AMBUS -FA with or without PC or AMBUS -ZS with PC) connected to the network allows communication with the meters. In the following, the terms "master" (M) and "slave" (S) designate, respectively, the central station that reads data or sends a command, and the meter that communicates with it.

3. The basis of M-Bus communications

The communication is serial, usually with a baud rate of 2400. If the network does not permit this rate, a   ll or part of the network may be reduced to 300 Baud.

A byte consists of a start bit, 8 data bits (LSB first), an even parity bit and a stop bit.

The different bytes of a M   -Bus data string must be transmitted consecutively with no pauses (dead or idle time) between them, i.e. the stop bit of a preceding byte is immediately followed by the start bit of a following byte. If this requirement is not fulfilled, the data string will be considered prematurely closed and will be rejected. This point must be taken into consideration in particular if the communications program executes in a multi   -tasking environment such as Windows or Unix.

The communication has a master-slave structure in which a meter in the network only communicates if explicitly called upon to do so by the central station.

Each Amtron or Calec in a network is accessed by means of a primary or secondary address:

- The primary address (or bus number) is allocated at the time the network is put into service. It consists usually of a number between 1 and 250, but can remain at 0 (factory configuration) if the primary address is not used.
- The secondary address (or serial number) is fixed at the time of manufacture of the meter. It consists of eight digits and cannot be changed. A search algorithm ("wildcard search", not described here) allows automatic identification of all Aquametro meters in a network. The secondary address is preferentially used by the communication programs written by Aquametro.

Reading a meter takes place in two steps:

- The master   sends a data string of the type SND_UD (see later) that specifies a list of parameters that the addressed slave has to transmit, or an action that has to be taken. The slave acknowledges receipt by sending back the byte $E5 (ACK).
- The master sends a data string of the type REQ_UD2 which instructs the slave to furnish the selected parameters. The slave transmits these data by means of the RSP_UD type data string.

4. General structure of the SND_UD and RSP_UD data strings

4.1 General structure

These data strings are of the type "Long frame" or "Control frame" as defined in the EN1434 standard.

Bytes sent (M→S)	Comments
$68 **LL LL** $68	**LL**: 2 identical bytes
C_BYTE	Field C
ADR	Primary address. **ADR**=$FD if the address is secondary.
CI_BYTE	Field CI
AD4 AD3 AD2 AD1	Secondary address. (ADx=$FF if the address is primary)
$B4 $05	Manufacturer's code. $05B4 = "AMT"
VER MED ACC STAT SIG1 SIG2	6 bytes whose significance is beyond the scope of this document.
DIF1 DIFE1 VIF1 VIFE1 D11 ... D1n	First block of data (variable length)
	....
DIFm DIFEm VIFm VIFEm Dm1..Dmn	Last block of data (variable length).
CHK $16	Checksum and byte indicating end of data string.

Meanings:

- LL specifies the number of bytes included between C_BYTE (inclusive) and CHK (exclusive).
- CHK specifies the data string checksum, equal to the sum of the LL bytes from C_BYTE to the byte preceding CHK
- C_BYTE is $53 or $73 for a SND_UD data string, $08 for a RSP_UD data string.
- ADR specifies the primary address (or bus address).
- CI_BYTE is $51 for a SND_UD data string, $72 for a RSP_UD data string.
- AD4..AD1 are the four bytes of the secondary address (BCD LSByte first).
- DIF (Data Information Field): Codes the structure of the data. If the most significant bit of the DIF is 1, then the DIF is followed by a DIFE byte.
- VIF (Value Information Field): Codes the kind of data and its unit of measurement. If the most significant bit of the VIF is 1, then the VIF is followed by a VIFE byte.
- D11..D1n: n data bytes, LSByte first.

4.2 DIF coding

The four least significant bits of the DIF (Data Information Field) of each block encode the kind of data bytes that follow a VIF/VIFE, according to the following table:

DIF	Number of data bytes	Code of the data bytes (always LSB first)
$x0	none	no data available
$x1	1	binary or bit array (8 bits)
$x2	2	signed binary (16 bits), or date in G format.
$x3	3	signed binary (24 bits).
$x4	4	signed binary (32 bits), or date/time in F format.
$x5	4	floating point (IEEE 32 bits format).
$x6	6	signed binary (48 bits).
$x8	none	request for readout of a parameter
$xC	4	BCD (8 digits).
$xD	variable	ASCII text (in 'Pascal' format, reversed order)
others	see EN1434	not used by Aquametro devices.

4.2.1 Definition of the G format (coding the date)

first byte								second byte							
a2	a1	a0	j4	j3	j2	j1	j0	a6	a5	a4	a3	M3	M2	M1	M0

j4..j0 code the day (1..31), M3..M0 code the month (1..12), a6..a0 code the year (0..99)

4.2.2 Definition of the F format (coding the date and time).

first byte								second byte								third byte	fourth byte
0	0	n5	n4	n3	n2	n1	n0	0	0	0	h4	h3	h2	h1	h0	=byte1 format G	= byte2 format G

 h4..h0 code the hour (0..23), n5..n0 code the minute (0..59).

4.2.3 The IEEE32 format

The floating point coding format corresponds to the IEEE 32 bits code and is not described here.   It is used universally in current microprocessors, and adopted by practically all compilers.   Here the order of the bytes is simply inverted relative to the traditional representation, i.e. the byte for the expon ent is placed last. (See example in section 6.2.3).

5.   Applications of the SND_UD data string

5.1 General structure of the SND_UD. data string

This data string (Send User -Data) is sent by the master to the slave. The addressed slave replies with an ACK (single byte $E5), signifying receipt of the data string and that its syntax was correct. It does not necessarily mean that the command was correctly executed.

The 6 bytes VER..SIG2 are fixed at $FF.

5.1.1 Methods of addressing

- Primary addressing: ADR s pecifies the bus number (between 1 and 250). The four bytes AD4..AD1 all have values of $FF.
- Secondary addressing: ADR = $FD. The four bytes AD4..AD1 contain the secondary address.
- Point-to-point addressing: If there is only one slave physically connected to the master (e.g. in communication with an opto -head), the master may use point   -to-point addressing without the need to specify any address. In this mode ADR=$FE and AD4..AD1=$FF. If several slaves are present, discord results, and possibly a voltage breakdown of the M -Bus. In this case one must wait about two seconds (recovery time) before attempting a new communication.
- "Broadcast" addressing: This is a data string destined for all the meters in a network (e.g. sending the time). In this mode, ADR=AD4=..=AD1=$FF. There is no reply from any slave!

5.1.2 Usages of the SND_UD data string

There are four aplplications the SND_UD data string, although the standard does not impose this distinction:

- Selecting parameters that a slave shall send when instructed to do so. (by REQ_UD2),
- Writing a parameter or reconfiguring a meter (e.g.: changing primary address, adjusting the time ...),
- Changing baud rate,
- Sending specific data to the manufacturer of the slave.

5.2   Selection of parameters

Each block of data selects a parameter, but none of these blocks contains actual data. DIF is of the form $X8 (select for reading). Lists of DIF/VIF for each parameter are given in section 9, columns master →slave.

It is possible to select a complete group of parameters with DIF=$08, VIF=$7E. The contents of this group depends on the meter.

Example: The master informs the meter no. 56342211 that it will require data on totalized energy and volume. (Section 6 describes how reading of data is actually done):

> M→S: $68 $13 $13 $68 $53 $FD $51 $11 $22 $34 $56 $B4 $05 $FF $FF $FF $FF $FF $FF $08
>
> $06 $08 $15 $3C $16
>
> S→M: $E5   (Acknowledge)

5.3   Writing (replacing) a parameter

Considered here is how a parameter is written to the slave (e.g. date and time, primary address ...). The parameter is transmitted by the master in a data block in the body of a SND_UD data string. This block has the same structure as the block returned by the slave (in a RSP_UD data string) when this parameter is read.

Note: When the slave has received the command it replies with $E5 (ACK), which signifies simply that the data string has been received and that its syntax is correct, but not necessarily that it has executed the required command. It is therefore desirable to explicitly verify that the comm and has been carried out.

Example: The master sets the date and time (VIF=$6D) of a meter, with bus number 34, to 22 May 96, 10:48. (see section 4.2 on how the date and time are coded with format F):

M→S: $68 $15 $15 $68 $53 $22 $51 $FF $FF $FF $FF $B4 $05 $FF $FF $FF $FF $FF $FF $04

      $6D $30 $0A $16 $C5 $FB $16

S→M: $E5   (Acknowledge)

M→S: $68 $11 $11 $68 $53 $22 $51 $FF $FF $FF $FF $B4 $05 $FF $FF $FF $FF $FF $FF $08 $6C $E9 $16
      (Optional as a control: Selection of the Time/Date parameter)

S→M: $E5   (Acknowledge)

M→S: $10 $5B $22 $7D $16   (Optional as a control: REQ_UD2, see section 6).

S→M: $68 $15 $15 $68 $08 $22 $72 $09 $31 $54 $03 $B4 $05 $B0 $04 $D7 $98 $FF $FF $04 $6D

      $31 $0A $16 $C5 $8E $16   (22/05/96, 10:49.   OK !)

5.4   Changing the baud rate

The standard baud rate is 2400 baud. It is possible to modify this by replacing in the CI_BYTE byte of a SND_UD data string the value $51 with
- $B8 for communications at 300 baud
- $BB for communications at 2400 baud
- $BD for communications at 9600 baud

Although it is possible to issue a baud rate change command in just any SND_UD data string, it should be done specifically with one of the four modes of address (primary, secondary, point -to-point or broadcast - see section 5.1), according to the application.

Example 1:
Changing the baud rate of meter 34 to 300 baud:
M→S: $68 $03 $03 $68 $53 $22 $B8 $2D $16.   (Control Frame type, see EN1434)
S→M: $E5   (ACK, returned with the original baud rate before it is changed to 300 baud.)

Example 2:
Changing the baud rate of meter 03365901 to 2400 baud:
M→S: $68 $0F $0F $68 $53 $FD $BB $01 $59 $36 $03 $B4 $05 $FF $FF $FF $FF $FF $FF $FE $16
      (SND_UD of type Long frame, without selecting parameters).
S→M: $E5   (ACK, returned with the original baud rate before it is changed to 2400 baud.)

5.5   The "low level" communication

The EN1434 standard allows transfer of specific data to the manufacturer in a SND_UD data string. These data (xxxxx below) are consecutive to a $0F byte (termed MDH in the standar   d) placed at the beginning of a block (position 20 for Aquametro devices). The general structure of the so   -called "low level" data string (a term adopted by Aquametro for reasons of the subsidiary functions that these communications accomplish) is:

M→S: $68 LL LL $68 C_BYTE ADR CI_BYTE AD4...AD1 $B4 $05 $FF $FF $FF $FF $FF $FF
         $0F xxxxxxxxxxxx CHK $16

Depending on the communication, the slave may also reply "low level".

"Low level" communications to Aquametro meters allow, amongst other things:

- direct reading of internal memory
- writing to memory and resetting counters to zero (if the lock -bit is not set).
- writing of calibration values (temperature, analogue outputs...)
- executing reconfiguration functions (relays and analogue outputs, commentary field...)
- replacing the executable code (firmware) with a new version (Calec -MB).

Certain of these functions are implemented in programs written by AQUAMETRO.

Fraudulent manipulations however are avoided by setting the lock bit.

6.   Reading a meter

To read a meter, the master issues a REQ_UD2 command string to the slave. The slave replies in a RSP_UD data string, with the information previously selected by the master.

6.1 The REQ_UD2 data string

The REQ_UD2 data string (Request for User Data type 2) is a data string of the type "short   -frame", sent by the master. It is composed of 5 bytes, by which the master asks the slave to send the previously selected information. The structure of the data string is:

M→S: $10 $5B ADR CHK $16   where   ADR = Primary address,   CHK = ADR + $5B.
The ADR byte depend on address mode:

- Primary address: ADR specifies the bus number (between 1 and 250).
- Secondary address: ADR = $FD. The meter that is addressed must have been selected previously by a SND_UD communication in which its secondary address has been specified.
- Point-to-point address: ADR=$FE. (See the limitations on usage given in section 5).
- Broadcast addressing within REQ_UD2 message is a nonsense.

For primary and point -to-point addressing, sending first a SND_UD is unnecessary. If no parameter has been explicitly selected in a SND_UD communication, the slave will send at minimum the contents of its energy counter.

The receipt of a REQ_UD2 provokes a response from the slave in the form of a data string of type RSP_UD in which the requested parameters are coded - see the following section.

6.2.   The RSP_UD data string

With this type of data string (Respond with User -Data.- see general structure in section 4), the slave sends its data.

6.2.1 First part of data string

In the first part of the string (the first 19 bytes), the slave states its identity (bus and series numbers, manufacturer's code, type of meter and status).
- Bus number and series number: see section 4
- Manufacturer's code: $05B4 = "AMT" (AQUAMETRO). see section 4
- Meter type: This is coded in the byte VER (see section 4). For AMTRON this byte starts with 00 (MSB), for SAPHIR with 01 and for CALEC-MB with 10. Contact Aquametro for more detailed information.

- Status: The byte STAT (see se ction 4) gives information on the state of alarms and the status of the lock -bit . Coding of this byte is particular to Aquametro in respect to the framework proposed by EN1434.
    - bits 0 and 1:   reserved
    - bit 2 (weight 4):   Power-alarm (under or over powered)
    - bit 3 (weight 8):   Hardware error
    - bit 4 (weight 16):   1 if the lock-bit is not set.
    - bit 5 (weight 32):   Flow alarm (Namur break, overflow)
    - bit 6 (weight 64):   Temperature alarm (hardware or software)
    - bit 7 (weight 128):   Various (option alarm, RAM/ROM alarm).

6.2.2 Second part of data string

The order in which the blocks follow one another as well as the coding of the data and their respective units do not necessarily correspond to the order in which the selection was made or to the requested codings. Decoding is done in two steps:

- extraction of the blocks of data. These blocks are of variable length and therefore it is necessary to examine the structure of each one in order to determine its exact length (even if the information it contains is of no interest) so that the beginning of the next block can be exactly located. The presence or absence of DIFEs or VIFEs is revealed by the most significant bits of DIFs or VIFs.
- Decoding the information contained in each block. The four least significant bits of the DIF (Data Information Field) of each block encode the kind of data bytes that follow a VIF/VIFE, according to the table in section 4.2. A list of DIF/DIFE/VIF/VIFE parameters is given in section 9.

6.2.3 Example

Grouped reading of temperatures, power, flow rat e, date and hours in service for meter no. 03543109.

M→S: $68 $1D $1D $68 $53 $FD $51 $09 $31 $54 $03 $B4 $05 $FF $FF $FF $FF $FF $FF
        $08 $2E $08 $3D $08 $5B $08 $5F $08 $63 $08 $22 $08 $6D $34 $16 (SND_UD)
S→M: $E5 (ACK)
M→S: $10 $5B $FD $58 $16   (REQ_UD2)
S→M: $68 $38 $38 $68 $08 $C8 $72 $09 $31 $54 $03 $B4 $05 $B0 $04 $C9 $10 $FF $FF $03 $22 $9A $00
$00 $05 $2E $A0 $C8 $51 $46 $05 $3E $B4 $E3 $D7 $42 $05 $5B $90 $D3 $07 $43 $05 $5F $0E $AA $E7 $41
$05 $63 $9C $BC $D5 $42 $04 $6D $10 $09 $05 $C5 $77 $16

The above RSP_UD data string, which contains neither DIFEs nor VIFEs, decodes as follows:

- Bus number: 200, manufacturer's number: 03543109.
- It concerns a Calec -MB, option Tariff (VER = 10110000b)
- There is no alarm state, but the lock -bit is not set (STAT = 00010000b)
- Hours in service (coded in binary in 3 bytes. DIF/VIF = $03/$22) = 154   ($00009A)
- Power (in kW, coded in floating point. DIF/VIF=$05/$2E) = 13426.2
- Flow rate (in m³/h, coded in floating point) = 107.945
- Warm side temperature (in °C, bytes $4307D390, coded in floating point) = 135.82
- Cold side temperature (°C) = 28.95
- Temperature difference (K) = 106.87
- Date/time (coded with F format): 5 May 96, 09h 16 mn.

7. Readout of AMBUS-AS

AMBUS-AS is nothing else than an AMBUS -IS. Its particular application justifies its special name: its role is not to count pulses, but to transmit a binary state. Typical application: remote alarm control.

The reading of the state uses a "low -level" data string (see sections 5.1 and 5.5) with the following f ormat:

M→S: $68 $18 $18 $68 $53 ADR $51 AD4 AD3 AD2 AD1 $B4 $05 $FF $FF $FF $FF $FF $FF
        $0F $00 $00 $10 $01 CHK $16
S→M: $68 $13 $13 $68 $08 ADR $72 AD4 AD3 AD2 AD1 $B4 $05 VER MED ACC STAT SIG1
        SIG2 $0F $00 $10 PORTA CHK $16

The state is in the MS-bit of the PORTA byte:

0 means that input (NAMUR) is not active (I<1mA). 1 means that the input is active. (I>2mA).

8. Configuration modifications

8.1 Allocation of a bus address

Before installation into a network, all meters have the same primary addr   ess 0 (factory configuration), which poses no problem if secondary addressing is used. For communications using the primary address (bus number) however, the devices cannot all be connected to the network for they all have the same bus number.

The allocation of a bus number is achieved either with a point   -to-point link or by secondary addressing, using a SND_UD data string with DIF=$01, VIF=$7A, followed by a byte that encodes in binary the new bus number.

Example: Allocating the bus number 65 ($41) to a C alec-MB using point -to-point addressing.

M→S: $68 $12 $12 $68 $53 $FE $51 $FF $FF $FF $FF $B4 $05 $FF $FF $FF $FF $FF $FF
$01 $7A $41 $0D $16 (point -to-point protocol).

S→M: $E5   (Acknowledge).

M→S: $10 $5B $FD $58 $16   (verification).

S→M: $68 LL LL $68 $08 $41 $72 ......   (replies with its new bus address).

8.2 Reading/writing of identification text (CALEC-MB only)

M-Bus reading of identification text (max 40 characters) is only possible with F/W version 102 or upwards, writing only with version 103 or upwards. The characters (ASCII coded) are sent in reverse order. They are preceded by four bytes: The first three are DIF, VIF, VIFE ($0D, $FD, $11 resp.), the fourth codes the length of the ASCII string that follows (0 to 40. "Pascal" type structure).

Example 1:

Reading of Id-text of a Calec -MB by point -to-point addressing.

M→S: $68 $12 $12 $68 $53 $FE $51 $FF $FF $FF $FF $B4 $05 $FF $FF $FF $FF $FF $FF
$08 $FD $11$67 $16

S→M: $E5   (Acknowledge).

M→S: $10 $5B $FE $59 $16

S→M: $68 $38 $38 $68 $08 $00 $72 $99 $99 $99 $99 $B4 $05 $A8 $04 $0E $58 $FF $FF $0D $FD
$11 $25 $21 $20 $65 $69 $67 $72 $65 $6E $65 $27 $6C $20 $65 $64 $20 $65 $73 $69 $72
$74 $69 $61 $6D $20 $61 $4C $20 $3A $20 $42 $4D $2D $63 $65 $6C $61 $43 $DC $16

The 37 character text is: "Calec-MB : La maîtrise de l'énergie !".

Example 2:

writing the following Id-text: "AQUAMETRO AG":

M→S: $68 $1F $1F $68 $53 $FE $51 $FF $FF $FF $FF $B4 $05 $FF $FF $FF $FF $FF $FF
$0D $FD $11 $0C $47 $41 $20 $6F $72 $74 $65 $6D $61 $75 $71 $41 $CF $16

S→M: $E5   (Acknowledge).

Note: Sending a null string text ($0D $FD $11 $00) clears the Id -text.

8.3 Setting the Lock-bit

The Calec-MB has 3 protection levels:

- Level 0:   No data protection.
- Level 1:   Only data involved (directly or indirectly) in volume or energy calculations are protected.
- Level 2:   Level 1 + protection of data relative to calendar (Fixed dates ...).

The lock-bit is considered as set in level 1 or 2. The protection level can be incremented by an M-Bus command. This operation is not reversible !

The following data string, in low-level format, sets the lock-bit (AMTRON) or increments the protection level by one (CALEC-MB):

M→S: $68 $11 $11 $68 $53 $FE $51 $FF $FF $FF $FF $B4 $05 $FF $FF $FF $FF $FF $FF $0F $0A $6A $16

S→M: $E5   (Acknowledge).

8.4 Relay programming (Calec-MB only, non-exhaustive description)

Relay programming is achieved by sending for each relay a low-level SND_UD string with the following format:

M→S: $68 $18 $18 $68 $53 ADR $51 AD4 AD3 AD2 AD1 $B4 $05 $FF $FF $FF $FF $FF $FF

   $0F $03 **OFFS** $24 **PARM4 PARM3 PARM2 PARM1 FCT** CHK $16

S→M: Calec-MB answer, not described here.

Bytes ADR, AD1..AD4 and CHK are described in section 4.

OFFS = 9*(Relay number -1). Relay number is between 1 and 4 (or 6 if 3 option slots are available).

PARM1..**PARM4** code (unless otherwise mentioned) a floating point number (format IEEE 32 bits).

FCT: relay function. If LS-bit of FCT is set, state of the relay is inverted.

Relay Function	FCT	PARM1..PARM4	comment
none	$00	$FF $FF $FF $FF	Relay permanently open
Energy pulse	$20	Pulse value (floatint IEEE)	Unit: Wh
Volume pulse	$22	Pulse value (floating IEEE)	Unit: litres
Alarm (ON)	$40	$FF $FF $FF $FF	Relay closed if alarm set
Power threshold	$80	Threshold value (floating IEEE)	Unit: kW
Flow threshold	$82	Threshold value (floating IEEE)	Unit: m³/h
delta-T threshold	$88	Threshold value (floating IEEE)	Unit: K
cold side temp. threshold	$8A	Threshold value (floating IEEE)	Unit: °C
hot side temp. threshold	$8C	Threshold value (floating IEEE)	Unit: °C
Duration since last volume pulse.	$8E	Threshold value (floating IEEE)	Unit: seconds. Can be used as no-flow alarm.

8.5 Programming of analogue outputs (Calec-MB only)

For each output, 2 low-level SND_UD strings are issued as follow:

M→S: $68 $18 $18 $68 $53 ADR $51 AD4 AD3 AD2 AD1 $B4 $05 $FF $FF $FF $FF $FF $FF

   $0F $03 **OFFS** $24 **PARM4 PARM3 PARM2 PARM1 FCT** CHK $16

S→M: Calec-MB answer, not described here.

M→S: $68 $17 $17 $68 $53 ADR $51 AD4 AD3 AD2 AD1 $B4 $05 $FF $FF $ FF $FF $FF $FF

   $0F $03 **OFFS2** $24 **PARM8 PARM7 PARM6 PARM5** CHK2 $16

S→M: Calec-MB answer, not described here.

The bytes ADR, AD1..AD4, CHK and CHK2 are described in section 4.

OFFS = 9*(Output number -1).

OFFS2 = 9*(Output number -1)+5.

PARM1..**PARM4** code the lower threshold as a floating point number (format IEEE 32 bits).

PARM5..**PARM8** code the upper threshold as a floating point number (format IEEE 32 bits).

FCT: analogue output function.

Function		FCT	Unit	comment
none		$00		
Power	0..20 mA	$E0	kW	The 4..20mA option corresponds to FCT=$E1
flow	0..20 mA	$E2	m³/h	The 4..20mA option corresponds to FCT=$E3
delta-T	0..20 mA	$E8	K	The 4..20mA option corresponds to FCT=$E9
cold side temp.	0..20 mA	$EA	°C	The 4..20mA option corresponds to FCT=$EB
hot side temp.	0..20 mA	$EC	°C	The 4..20mA option corresponds to FCT=$ED

9. List of parameters

The lists below are not exhaustive. Among those not mentioned are parameters that are only of interest in particular applications (K -factor, date of manufacture, ma sking alarms...). Others exist only in special configurations (Cold - version, BDE, DTF ...). In such cases the appropriate lists will be included in a technical note.

9.1 List of parameters for Amtron-N, Amtron-NW, Saphir-N, AMBUS IS

Parameter	Data selectionl Master->Slave	Slave->Master	DRH length	Remark	R/W	AMTRON-N/NW Cold	AMTRON-NW Cold	SAPHIR-N	SAPHIR-NE	AMBUS-IS-E	AMBUS-IS-EV	AMBUS-IS-0	AMTRON-N-Solar [6]	Any VIF [5]
Energy	08 (01..0F)	03 VIF1	5	see VIF1	R	X	X			X	X			X	X
Energy-	28 (01..0F)	23 VIF1	5	see VIF1	R		X								X
Volume	08 (11..1F)	03 VIF2	5	see VIF2	R	X		X	X		X			X	X
Pulse without unit	08 6E	03 VIF5	5	see VIF5	R							X			X
Billing date	48 (6C..6D)	42 6D	6	type F [1]	R/W	X	X	X	X	X	X	X	X	X
Billing date E	48 (00..0F)	43 VIF1	5	VIF1	R	X	X			X	X			X	X
Billing date E-	68 (00..0F)	63 VIF1	5	VIF1	R		X								X
Billing date volume	48 (10..1F)	43 VIF2	5	VIF2	R	X		X	X		X			X	X
Billing date pulses	48 6E	43 VIF5	5	VIF5	R							X			X
Operating hours	08 (20..23)	03 22	5	binary 24	R	X	X	X	X	X	X	X		X
Power	08 (28..37)	05 2E	6	float, kW.	R	X	X			X	X			X
Peak Power	58 (28..37)	55 2E	6	float, kW [2]	R/W	X	X			X	X			X
Flow rate	08 (38..47)	05 3E	6	float, m³/h	R	X	X	X	X		X			X
Peak flow rate	58 (38..47)	55 3E	6	float, m³/h [2]	R/W	X	X	X	X		X			X
Supply temperature	08 (58..5B)	05 5B	6	float, °C	R	X	X			X				X
Return temperature	08 (5C..5F)	05 5F	6	float, °C	R	X	X			X				X
Delta-T	08 (60..63)	05 63	6	float, K	R	X	X			X				X
Date/Time	08 (6C..6D)	04 6D	6	type F	R/W	X	X	X	X	X	X	X		X
Serial number	08 78	0C 78	6	BCD 8 digits	R/W	X	X	X	X	X	X	X		X
Primary adress	08 7A	01 7A	3	binary 8	R/W	X	X	X	X	X	X	X		X
Energy high res.	08 00	06 VIF3	8	see VIF3	R	X	X			X	X			X
Energy high res.	28 00	26 VIF3	8	see VIF3	R		X							X
Volume high res.	08 10	06 VIF4	8	see VIF4	R	X		X	X		X			X
Pulses	--------------------	--------------------	-------	----------------	----	----	----	----	----	----	----	----		
Pulse value volume	08 (90..9F) 38	05 93 38	7	float (l), [4]	R/W	X	X	X	X		X			X
Pulse value energy	08 (80..8F) 38	05 VIF6 38	7	float kWh, [4]	R/W							X		X
Total:		25 parameters												

X Standard parameters if no data are selected
[1] The billing date in the AMTRON family contains date and time information.
  For setting june 1st as the billing date, may 30th, 23:59 must be programmed.
[2] May be reset by low level code
[3] The comment field can not be read out like in the CALEC
[4] Firmware 9 and higher. Caution: VIFE hex 38 wrong !!! should be hex 28! Ccorrected in Firmware 17 and higher
[5] Any VIF = 7E on version 15 and higher
[6] Firmware 20 and higher

Standard resolution E	VIF1 (before a 24-bit number).	High resolution E	VIF3 (value = 48-bit number)
1 kWh	06	0.001 Wh (1 mWh)	00
1 MJ	0E	1 J	08
Standard resolution V	**VIF2 (24-bit number).**	**High resolution V**	**VIF4 (value = 48-bit number)**
0.1 m³	15	0.001 l	10
Standard resolution IS - 0	**VIF5 (24-bit number).**	**High resolution IS-0**	
number without units	6E	does not apply	
Pulse value IS -E	VIF6 (float)		
1 kWh	86		
1 MJ	8E		

Table 1   DIF/ VIF of the AMTRON family up to FW 17 and 20

9.2. List of parameters characteristic to Calec-MB

Parameter	Data selectionl Master->Slave	Slave->Master	DRH length	Remark	R/W	Standard	BDE 4)	BDV 4)	TWIN-V	TWIN-E	DTF	ISPC	ANY-VIF
Energy 1	08 (01..0F)	04 VIF1	6..11	see VIF1	R/W	x			x	x	x	x	x
Pos energy (BDE)	08 (81..8F) 3B	04 VIF1 3B	7..12	see VIF1	R/W		x	x					x
Energy 2	88 40 (01..0F)	84 40 VIF1	7..12	see VIF1	R/W					x			x
Neg energy (BDE)	08 (81..8F) 3C	04 VIF1 3C	7..12	see VIF1	R/W		x	x					x
Energy 2 (DTF)	88 10 (01..0F)	84 10 VIF1	7..12	see VIF1	R/W						x		x
Volume 1	08 (11..1F)	04 VIF2	6..8	see VIF2	R/W	x	x		x	x	x	x	x
Pos Volume (BDV)	08 (91..9F) 3B	04 VIF2 3B	7..12	see VIF2	R/W			x					x
Volume 2	88 40 (11..1F)	84 40 VIF2	7..9	see VIF2	R/W				x	x		x	x
Neg Volume (BDV)	08 (91..9F) 3C	04 VIF2 3C	7..12	see VIF2	R/W			x					x
Volume 2 (DTF)	88 10 (11..1F)	84 10 VIF2	7..9	see VIF2	R/W						x		x
Billing date 1.	48 (6C..6D)	42 6C	6	type G, [1]	R/W	x	x	x	x	x	x	x	x
E1, Billing date 1	48 (00..0F)	44 VIF1	6..11	VIF1, [1]	R/W	x			x	x	x	x	x
E+, Billing date 1	48 (80..8F) 3B	44 VIF1 3B	7..12	VIF1, [1]	R/W		x	x					x
E2, Billing date 1	C8 40 (00..0F)	C4 40 VIF1	7..12	VIF1, [1]	R/W					x			x
E-, Billing date 1	48 (00..0F) 3C	44 VIF1 3C	7..12	VIF1, [1]	R/W		x	x					x
E2 (DTF), Billing date 1	C8 10 (00..0F)	C4 10 VIF1	7..12	VIF1, [1]	R/W						x		x
V2, Billing date 1	C8 40 (10..1F)	C4 40 VIF2	7..9	VIF2, [1]	R/W						x		x
Billing date 2.	88 01 (6C..6D)	82 01 6C	7	type G, [2]	R/W	x	x	x	x	x	x	x	
E1, Billing date 2	88 01 (00..0F)	84 01 VIF1	7..12	VIF1, [2]	R/W	x			x	x	x	x	
E+, Billing date 2	88 01(80..8F)3B	84 01 VIF1 3B	8..13	VIF1, [2]	R/W		x	x					
E2, Billing date 2	88 41 (00..0F)	84 41 VIF1	7..12	VIF1, [2]	R/W					x			
E-, Billing date 2	88 01(00..0F)3C	84 01 VIF1 3C	8..13	VIF1, [2]	R/W		x	x					
E2 (DTF), Billing date 2	88 11 (00..0F)	84 11 VIF1	7..12	VIF1, [2]	R/W						x		
V2, Billing date 2	88 41 (10..1F)	84 41 VIF2	7..9	VIF2, [2]	R/W							x	
Operating hours	08 (20..23)	03 22	5	binary 24	R	x	x	x	x	x	x	x	x
Power	08 (28..37)	05 2E	6	float, kW.	R	x	x	x	x	x	x	x	x
Power 2	88 40 (28..37)	85 40 2E	7	float, kW.	R					x			x
Flow rate	08 (38..47)	05 3E	6	float, m³/h	R	x	x	x	x	x	x	x	x
Flow rate 2	88 40 (38..47)	85 40 3E	7	float, m³/h	R					x		x	x
Supply temperature	08 (58..5B)	05 5B	6	float, °C	R	x	x	x	x	x	x	x	x
Peak supply temperature	58 (58..5B)	55 5B	6	°C, [3]	R/W	x	x	x	x	x	x	x	
Return temperature	08 (5C..5F)	05 5F	6	float, °C	R	x	x	x	x	x	x	x	x
Peak return temperature	58 (5C..5F)	55 5F	6	°C, [3]	R/W	x	x	x	x	x	x	x	
Delta-T	08 (60..63)	05 63	6	float, K	R	x	x	x	x	x	x	x	x
Peak Delta-T	58 (60..63)	55 63	6	K, [3]	R/W	x	x	x	x	x	x	x	
Date/Time	08 (6C..6D)	04 6D	6	type F	R/W	x	x	x	x	x	x	x	x
Secondary adress	08 78	0C 78	6	BCD 8	R/W	x	x	x	x	x	x	x	
Primäry adress	08 7A	01 7A	3	binary 8	R/W	x	x	x	x	x	x	x	
Comment	08 FD 11	0D FD 11 (0..28)	4..44	ASCII	R/W	x	x	x	x	x	x	x	
Energie1 high res.	08 00	06 VIF3	8	see VIF3	R	x			x	x	x	x	x
Energie+ high res. (BDE)	08 80 3B	06 VIF3 3B	9	see VIF3	R		x	x					x
Volume1 high res.	08 10	06 VIF4	8	see VIF4	R	x			x	x	x	x	x
Volume+ high res.(BDE)	08 90 3B	06 VIF4 3B	9	see VIF4	R		x	x					x
Energie2 high res.	88 40 00	86 40 VIF3	9	see VIF3	R					x			x

Parameter	Data selectionl Master->Slave	Slave->Master	DRH length	Remark	R/W	Standard	BDE 4)	BDV 4)	TWIN-V	TWIN-E	DTF	ISPC	ANY-VIF
Energie- high res. (BDE)	08 80 3C	06 VIF3 3C	9	see VIF3	R		x	x					x
Energie2 high res. (DTF)	88 10 00	86 10 VIF3	9	see VIF3	R						x		x
Volume2 high res.	88 40 10	86 40 VIF4	9	see VIF4	R					x	x		x
Volume- high res. (BDE)	08 90 3C	06 VIF4 3C	9	see VIF4	R		x	x					x
Volume2 high res. (DTF)	88 10 10	86 10 VIF4	9	see VIF4	R						x		x
Pulse value 1	08 (90..9F) 28	05 93 28	7	float (l)	R/W	x	x	x	x	x	x	x	x
Pulse value 2	08 (90..9F) 29	05 93 29	7	float (l)	R/W					x		x	x
Logger period (Day)	08 FD 27	01 FD 27	4	binary 8	R/W	x	x	x	x	x	x	x	
Integration period (Min)	08 (F0..F3) 27	01 F1 27	4	binary 8	R/W	x	x	x	x	x	x	x	
History 1	C8 01 7E	C2 01 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 2	88 02 7E	82 02 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 3	C8 02 7E	C2 02 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 4	88 03 7E	82 03 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 5	C8 03 7E	C2 03 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 6	88 04 7E	82 04 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 7	C8 04 7E	C2 04 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 8	88 05 7E	82 05 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 9	C8 05 7E	C2 05 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 10	88 06 7E	82 06 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 11	C8 06 7E	C2 06 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 12	88 07 7E	82 07 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 13	C8 07 7E	C2 07 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 14	88 08 7E	82 08 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
History 15	C8 08 7E	C2 08 6C ...	3..51	Logger array	R	x	x	x	x	x	x	x	
Access number.	08 FD 08	03 FD 08	6	binary 24	R	x	x	x	x	x	x	x	
Status Tariff input	88 10 FD 30	81 10 FD 30	5	Bit weight 2	R						x		x
Cumulated tariff time	88 10 FD(31..33)	83 10 FD 32	7	binary 24	R						x		x
Firmware version	08 FD 0E	01 FD 0E	4	binary 8	R	x	x	x	x	x	x	x	
Alarm Bytes	08 FD 17	02 FD 17	5	binary 16	R	x	x	x	x	x	x	x	
Alarm Mask	08 FD 18	02 FD 18	5	binary 16	R/W	x	x	x	x	x	x	x	
Manufaturing date	08 FD 0B	02 FD 0B	5	type G	R/W	x	x	x	x	x	x	x	
K-Faktor (#11)	08 (80..8F) 33	05 83 33	7	kWh/m³/K 5)	R	x	x	x	x	x	x	x	x
Total:		77 Parameters											

Table 2   General DIF / VIF for the CALEC family

X Standard parameters if no data are selected
[1] May also be activated by: M->S **48 7E**
[2] May also be activated by: M->S **88 01 7E**
[3] May also be activated by: M->S **58 7E**
[4] Firware Version 106 and higher
[5] k-factor only for input 1, ik-factor for input 2 can not be read

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Structure of a logger array (only if logger data are available)				R/W	Standard	BDE 4)	BDV 4)	TWIN-V	Twin-E	DTF	ISPC	AnyVIF
Loggerdate	History 1..15	82/C2 0x 6C ...	5 type G	R	x	x	x	x	x	x	x	
Logger energy 1	History 1..15	84/C4 0x VIF1	7 see VIF1	R	x				x	x	x	x
Logger energy 1	History 1..15	84/C4 0x VIF1 3B	8 see VIF1	R		x	x					
Logger energy 2	History 1..15	84/C4 4x VIF1	7 see VIF1	R					x			
Logger energy 2	History 1..15	84/C4 0x VIF1 3C	8 see VIF1	R		x	x					
Logger energy 2	History 1..15	84/C4 1x VIF1	7 see VIF1	R							x	
Logger volume 1	History 1..15	84/C4 0x VIF2	7 see VIF2	R	x							
Logger volume 2	History 1..15	84/C4 4x VIF2	7 see VIF2	R								x
Date Powerlogging	History 1..15	94/D4 0x AB 39	8 type F	R	x	x	x	x	x	x	x	
Loggermaxpower	History 1..15	95/D5 0x 2B	7 float (W)	R	x	x	x	x	x	x	x	
DatePowerlogging2	History 1..15	94/D4 4x AB 39	8 type F	R		x	x		x			
Loggermaxpower 2	History 1..15	95/D5 4x 2B	7 float (W)	R		x	x		x			
DateFlowlogging	History 1..15	94/D4 0x BB 39	8 type F	R	x			x		x		
LoggerFlow	History 1..15	95/D5 0x 3B	7 float (l/h)	R	x			x		x		
DateFlowlogging 2	History 1..15	94/D4 4x BB 39	8 type F	R								x
LoggerFlow 2	History 1..15	95/D5 4x 3B	7 float (l/h)	R								x
Total length of a logger record:					49	51	51	49	49	49	49	

Table 3 Logger data DIF/ VIF for the CALEC family

	Firmware 106 and higher	**FW 105 and lower**		**For all Firmwares**	
Standard resolution E	**VIF1 (before 32 bit number).**	**VIF1 (value 32-bit number).**		**High resolution E**	**VIF3 (value = 48-bit number)**
0.01 kWh	04	04		0.001 Wh (1 mWh)	00
0.1 kWh	05	05		0.001 Wh (1 mWh)	00
1 kWh	06	06		0.001 Wh (1 mWh)	00
0.01 MWh (10 kWh)	07	07		0.01 Wh	01
0.1 MWh	85 7D	87 77		0.1 Wh	02
1 MWh	86 7D	87 F7 77		1 Wh	03
0.01 GWh (10 MWh)	87 FD	87 F7 F7 77		0.01 kWh	04
0.1 GWh	85 FD 7D	87 F7 F7 F7 77		0.1 kWh	05
1 GWh	86 FD 7D	87 F7 F7 F7 F7 77		1 kWh	06
0.01 MJ (10 kJ)	0C	0C		1 J	08
0.1 MJ	0D	0D		1 J	08
1 MJ	0E	0E		1 J	08
0.01 GJ (10 MJ)	0F	0F		0.01 kJ	09
0.1 GJ	8D 7D	8F 77		0.1 kJ	0A
1 GJ	8E 7D	8F F7 77		1 kJ	0B
0.01 TJ (10 GJ)	8F 7D	8F F7 F7 77		0.01 MJ	0C
0.1 TJ	8D FD 7D	8F F7 F7 F7 77		0.1 MJ	0D
1 TJ	8E FD 7D	8F F7 F7 F7 F7 77		1 MJ	0E
Standard resolution V	**VIF1 (32 bit number).**	**VIF1 (value 32-bit number).**		**High resolution V**	**VIF3 (value = 48-bit number)**
0.01 l	11	11		0.001 l (1 ml)	10
0.1 l	12	12		0.001 l	10
1 l	13	13		0.001 l	10
0.01 m³ (10 l)	14	14		0.001 l	10
0.1 m³	15	15		0.001 l	10
1 m³	16	16		0.001 l	10
0.01 Ml (10 m³)	17	17		0.01 l	11
0.1 Ml (100 m³)	97 77	97 77		0.1 l	12
1 Ml (1000m³)	97 F7 77	97 F7 77		1 l	13

Table 4 DIF/VIF for coding the energy and volume units on the CALEC MB

10. Troubleshooting

The communication does not work !
Does it concern the complete network or one (or several) meter(s) in particular ?

If it is the complete network:
- Check the bus wiring, the AMBUS ↔ PC link, and use (at least provisionally) a PC compatible loaded with the read-out program (MBUSTOOL) written by Aquametro that runs under DOS.
- Check the voltage and current at the central station with the aid of a multime ter. The M-Bus voltage should lie between 24 and 36 VDC (polarity is immaterial), and the supply voltage between 12 and 24 VAC. These limits also apply to the meters positioned at the extremities of the network.
- Subdivide the main network into smaller networks by removing branches from it, and try to communicate with these sub-networks. (Max. 30 meters per sub-network).
- If the central station is an AMBUS -FA, check to see if the PC can at least communicate with its processor. The response to this question will facilitate diagnosis.
- Check the points 1, 2, 3, 4, 6, 8, 9, 10, 11, 15, 19, 20 given in the table below.
- Contact Aquametro.

In the case where one (or more) particular meter(s) do(es) not respond:
- If access to the meter is possible, make sure that it is powered (display present ?); read from the display its bus and series numbers, baud rate and access counter. It is also desirable to establish a point -to-point link, if possible with the meter disconnected from the bus.
- Exchange (at least provisionally) the meter with one that is known to function correctly in order to determine if the problem lies with the network or with the meter itself.
- If access to the meter is not possible, try to communicate with it from the central station using various baud rates. (The non-recommended rates 600, 1200, and 4800 baud should also be tried).
- Check the points 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 16, 17, 18 given in the table below.
- Contact Aquametro.

No	Origin or symptoms of the problem	Possible solutions
1	The PTC of the AMBUS-ZS or -FA has cut the electrical supply to the meters in the network due to an overload.	Disconnect the AMBUS from the 230V mains for about one minute, then reconnect. Contact Aquametro in case of recurrence.
2	Short circuit in the network. There is no supply or bus voltage.	Disconnect all meters from the network. If the short circuit persists, check the wiring. Otherwise reconnect the meters one by one, checking the network each time in order to locate the meter that provokes the short circuit.
3	Wrong meter bus voltage (24..36 VDC) and/or supply voltage (12..20 VAC).	Check the wiring (supply and M-Bus inverted?). Replace the network cable with one of larger cross -section (ohmic losses ?).
4	Broken cable. The supply and bus voltages are present at the central station but absent at the meters. Symptom: The PC can address the AMBUS-FA but not the rest of the network.	Check the cable by degrees. Check that the bus cable is properly screwed to the terminal of the AMBUS -ZS or -FA central station (possible source of bad contacts).
5	Non-correspondence of primary address.	Read the primary address from the display of the meter in question. Change to secondary addressing, modify the primary address of the meter, or address the "right" address.
6	Conflict of primary addresses. Reading out is not possible because of multiplicities in primary address.	Locate all meters with the same address and modify them, or change to secondary addressing.
7	Non-correspondence of secondary address.	Read the secondary address from the display of the meter in question and correct for it in the program.

No	Origin or symptoms of the problem	Possible solutions
8a	Non-correspondence of baud rate due to an error in configuration.	Read the baud rate from the display of the meter in question, correct for it in the program or modify the baud rate of the meter.
8b	Non-correspondence of baud rate due to a serial card having no quartz oscillator.	Change the serial card or the complete computer. A deviation of more than ±5% prevents communication.
9	Baud rate too high: Because of capacitances and inductances distributed throughout the M-Bus network, transmission cannot take place above a certain speed. (Check with an appropriate oscilloscope).	A baud rate of 9600 baud can be reduced to 2400 by simply disconnecting and then reconnecting the meter. Otherwise, an in situ point-to-point connection must be made in order to assign a new baud rate (300 baud) to it with the program.
10	Disregard of the timing of the M-Bus data string. (See section 3). Symptoms: Functions under DOS, but not under Windows; on certain computers but not on others ... (Check with an appropriate oscilloscope!)	- Rewrite the program in such a way that the computer's operating system does not disturb the synchronisation of the bytes, or run it on a faster computer, or reduce the baud rate of the complete network. - Use a program written by Aquametro and run it under DOS.
11	Disregard of the M-Bus prerequisites (parity, checksum, data string structures ...) → No slave replies.	- Locate the problem with the aid of a protocol/logic analyser and correct the program. - Use a program written by Aquametro.
12	A CALEC-MB functions with a point-to-point link to an opto-head, but not in the network.	Defective M-Bus interface.
13	A CALEC-MB in the network is read in situ by means of a point-to-point link with an opto-head.	Such a reading disturbs the complete network. Make sure that no-one reads by point-to-point during an M-BUS read-out.
14	The optical interface of a CALEC-MB placed under an intense artificial light can be dazzled, leading to perturbations in communications.	Move either the CALEC or the light source, or cover the interface with a strip of opaque adhesive tape.
15	Overload of the M-BUS network. The complete network does not function, but each sub-network (max. 30 meters) functions individually.	There are several possible causes. Examine the voltage on the bus by means of an oscilloscope. Replace the central station. Contact Aquametro.
16	The AMBUS-FA "sees" less meters than the computer to which it is attached.	Does the whole network have the same baud rate ? Is the FA saturated (FA-30, -60, -150) ?
17	A meter does not communicate, but reacts to commands to change the primary address, or date ...	The channel for transmitting is defective. Reception can be checked by sending a SND_UD data string and watching the display to see if the M-Bus access counter gets incremented (see user's manual).
18	Certain parameters can be read, while others can not.	Contact Aquametro specifying the parameter(s) that cannot be accessed, the meter type (AMTRON, SAPHIR or CALEC), the hardware version (Standard, Twin, Cold, ...) and the firmware version.
19	The computer sends RS232 signals of too weak amplitude for the AMBUS RS232 (passive) interface to function properly.	Certain computers (portables in particular) send signals that are too weak. Try on different computer or replace the serial card.
20	The RS232 cable is not good.	To connect (using RS232) an AMBUS to the DB9 input of a computer, a "modem" type cable is needed where the 9 poles (male and female) are connected "one-to-one".