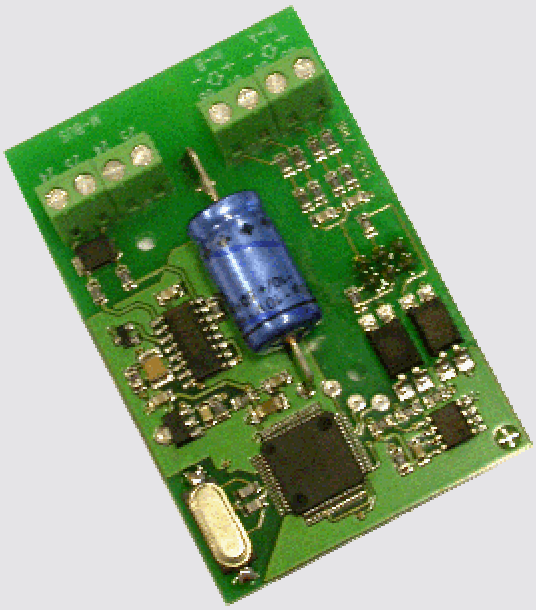
Technical Description

M-Bus Slave for MULTICAL® 401



Kamstrup

Kamstrup A/S
Industrivej 28, Stilling
DK-8660 Skanderborg
TEL: +45 89 93 10 00
FAX: +45 89 93 10 01
E-MAIL: energi@kamstrup.dk
WEB: www.kamstrup.com

Contents

1 Introduction

The present instructions describe the use of the new M-Bus Slave for MULTICAL®401 with full secondary addressing function.

1.1 Description

M-Bus is a bus system which is well suited for communication with heat meters. The system consists of an M-Bus Master and one or several M-Bus Slaves.

The M-Bus Slave module has been specially developed for MULTICAL®401. Communication on the M-Bus is effected by voltage modulation from M-Bus Master to M-Bus Slave and current modulation from M-Bus Slave to M-Bus Master through a standard two-wire cable.

The bus system fulfils the demands of the standards EN 1434-3, prEN 13757-2, and prEN 13757-3.

1.2 Communication on the M-Bus

Communication on the M-Bus is asynchronous serial bit transmission (EN 60870-5-1) in half duplex mode, which means that communication on the M-Bus can be transmitted one way at a time only.

Communication consists of 1 start bit, 8 data bits, 1 parity bit (even) and 1 stop bit.

Transmission speeds are 300 baud, 2400 baud, or 9600 baud. When the M-Bus Slave receives a message from the M-Bus Master the speed is autodetected and the reply is returned at the same baud rate.

The signal quality complies with section 3.6 of ISO 7480.

2 M-Bus Slave for MULTICAL® 401

It is easy to mount an M-Bus Slave in a MULTICAL®401, you simply insert it in the module area.

No special configuration of meter or module is necessary as the system is self-configuring.

2.1 Construction

The M-Bus Slave is constructed as a module that fits perfectly into MULTICAL®401.

The module is supplied through the M-Bus. The M-Bus Slave is galvanically separated from MULTICAL®401 communicating with it through optocouplers.

The M-Bus Slave automatically collects consumption data from the heat meter every hour and all data every twelve hours. Furthermore, data is collected from the heat meter at reset/start, after communication with the M-Bus Master as well as upon receipt of a manual call from MULTICAL®401.

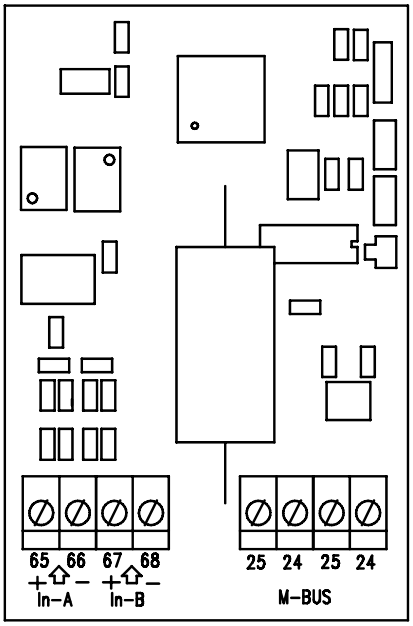
In order to reset the M-Bus Slave you decouple the M-Bus for some time (minimum one min.). The M-Bus Slave will collect new data from the heat meter if the M-Bus Master sends either a normalization (SND_NKE) or an application reset command to the M-Bus Slave.

Normalization (SND_NKE) means that the M-Bus Slave collects consumption data from the heat meter (like after a standard reading as well as every hour)

Application reset means that the M-Bus Slave collects all M-Bus relevant data from the meter (like after reset, reception of a manual call as well as every twelve hours).

The M-Bus Slave uses the display set-up of the heat meter for adding unit, decimal point position and number of decimals to the values of the M-Bus telegram so that they match the values read from the heat meter display.

The M-Bus connection is independent of polarity and consists of two sets of terminals. Apart from the M-Bus connections the module has two pulse inputs, which can be used for reading other volume meters, e.g. cold water meters.



M-Bus connection

Terminal 24	M-Bus connection
Terminal 25	M-Bus connection

Pulse inputs

Terminal 65	Pulse input A/In-A (+)
Terminal 66	Pulse input A/In-A (-)
Terminal 67	Pulse input B/In-B (+)
Terminal 68	Pulse input B/In-B (-)

2.2 Mounting

In order to mount the M-Bus Slave in MULTICAL®401 you open the meter, insert the M-Bus Slave in the module area, mount the M-Bus cables and close the meter again. Having mounted the M-Bus cables the M-Bus Slave must have time to collect data from the meter before you try to establish communication. We recommend that you wait minimum 30 seconds before starting communication with the M-Bus Slave.

The M-Bus Slave saves these data in its own memory and will from now on be ready to communicate on the M-Bus within approx. 6 sec. when the supply is switched on. After short-time failures in the M-Bus supply (‹ 1 sec.) the M-Bus Slave will usually be ready to communicate again within less than three seconds when the supply is switched on again.

At start-up the M-Bus Slave will try to collect data from the meter every 30 sec. until it has received correct data. I.e. if the M-Bus Slave has been without current for approx. one minute and is mounted in a MULTICAL®401 it will initiate itself.

We recommend that you switch off the whole M-Bus system before mounting new M-Bus Slaves. The M-Bus system should not be switched on again until mounting has been completed. This means that all M-Bus Slaves will be reset.

M-Bus Slaves can be mounted without switching off the M-Bus system. In order to secure that the M-Bus ID numbers of the meter are read into the M-Bus Slave, an "Application reset" command can be sent to all M-Bus Slaves after mounting. It is important that the M-Bus Slave is mounted in the meter before connecting the M-Bus cable to the M-Bus Slave.

If customer numbers, primary M-Bus address, or other meter data/set-ups are changed on the meter itself e.g. through the optical eye, it can take up to twelve hours until these numbers have been updated in the M-Bus Slave. This can be remedied by either switching off the M-Bus supply to the M-Bus Slave (approx. 1 minute), or by a manual call to the meter itself.

A manual call is effected by keeping the front plate button of MULTICAL® 401 activated for more than approx. 15 sec. until the text "Call" appears from the display. This prompts the M-Bus Slave to read all data from the meter writing "Ok" in the display when finished in acknowledgement of data having been updated. If the "Ok" fails to appear in the display within approx. 30 seconds, the manual call was not successful and a new manual call must be attempted.

Manual calls must not be effected until 30 sec. after having connected the M-Bus supply (e.g. by mounting the M-Bus Slave) as the M-Bus Slave collects data automatically, and as a manual call may conflict with the communication between the M-Bus Slave and MULTICAL® 401.

2.3 Addressing types

In order for the M-Bus system to function with several connected M-Bus Slaves it must be possible to distinguish between the individual M-Bus Slaves. This is managed by means of the following M-Bus identification numbers of each M-Bus Slave:

- Primary address: 001..250, as well as special addresses 0, 253, 254 and 255
- Customer numbers: 8 last digits 00000000 .. *99999999*
- Manufacturer ID: always 2C2Dh for "KAM" for Kamstrup M-Bus Slaves
- Version ID: always 02h for M-Bus Slave for MULTICAL® 401
- Device type ID: 04h for meter in return or 0Ch for meter in forward pipe
- Fabrication number: Serial number, 8 digits 00000000 .. *99999999*

When the M-Bus Master sends a message via the M-Bus some or all of the above-mentioned ID numbers of the M-Bus Slave are included in the message (format). Therefore, only the M-Bus Slave with the addressed ID numbers will reply.

Manufacturer ID and version ID have been permanently encoded in the M-Bus Slave and cannot be changed. The M-Bus Slave reads the rest of the M-Bus identification numbers from the meter.

2.3.1 Primary addressing

MULTICAL® 401 has a separate register for the primary address.

If the register contains a value between 0 and 250, the M-Bus Slave will consider this value the primary address. If the value is higher than 250 the M-Bus Slave will consider the three last digits of the customer number of MULTICAL® 401 the primary address.

The register value of MULTICAL®401 is set to *999* from the factory, which means that the three last digits of the customer number will be the primary address of meter and M-Bus Slave. If the three last digits of the customer number encoded in MULTICAL®401 exceed 250 (e.g. 345) the first digit will be ignored and the address of the M-Bus Slave will be determined by the last two digits only (e.g. 45).

If the customer number is changed either through the M-Bus or direct on MULTICAL®401 e.g. via the optical eye, the primary address of the M-Bus Slave is changed correspondingly as long as the primary address register of MULTICAL®401 exceeds the value 250.

If, on the other hand, a valid primary address between 001 and 250 is entered either through the M-Bus or direct on MULTICAL®401 e.g. via the optical eye, the M-Bus Slave will consider this one the primary address.

Changing the primary address does not influence the customer number of the meter.

In connection with primary addressing of M-Bus Slaves two or several M-Bus Slaves on one M-Bus cannot have the same primary address. In connection with secondary addressing or enhanced secondary addressing, however, it is possible to distinguish between M-Bus Slaves with the same primary address on the same M-Bus.

The normal addressing range of an M-Bus Slave is 001 .. 250.

Furthermore, there are four special addresses with the following functions,

Address 000 : Ordinary primary address, reserved for non-configured M-Bus Slaves.

Address 253 : Used for secondary addressing. Only the M-Bus Slave that accepts the address replies.

Address 254 : All M-Bus Slaves will reply to this address. The address must be used in systems with one connected M-Bus Slave only e.g. for test.

Address 255 : No M-Bus Slaves will reply to this address but they will all receive the message. This address makes it possible e.g. to change the baud rate of a whole system at a time sending one telegram. NB! The baud rate, however, is autodetected (baud 9600, baud 2400 or baud 300)

2.3.2 Secondary addressing

The M-Bus Slave for MULTICAL® 401 supports secondary addressing.

In connection with secondary addressing the M-Bus Slave is selected via the primary address 253 with its 8 byte long complete M-Bus ID, consisting of:

- The 8 last digits of the customer number (4 bytes)
- Manufacturer ID = ASCII characters "KAM" for Kamstrup encoded with the value 2C2Dh (2 bytes)
- Version / generation ID number = 02h for this type of M-Bus Slave (1 byte)
- Device type ID (previous medium) = 04h for heat meter with return volume measurement or 0Ch for heat meter with forward volume measurement (1 byte).

These 8 bytes make out the secondary address of the M-Bus Slave. The individual bytes can be replaced by wildcard characters. See section 2.3.4: *Wildcard characters*.

Selection of M-Bus Slave via secondary address (and deselection of the remaining M-Bus Slaves):

Start character	68h
L-field	0Bh
L-field	0Bh
Start character	68h
C-field	53h
A-field	FDh
CI-field	52h
ID no. LSB	37 or FF, BCD e.g. customer number = 4118737
ID no.	87 or FF
ID no.	11 or FF
ID no. MSB	04 or FF
Man. ID LSB	2Dh or FFh, KAM encoded with 2C2Dh
Man. ID MSB	2Ch or FFh
Version ID	02h or FFh
Device ID	04h or 0Ch or FFh
Check sum	XXh
Stop character	16h

As long as the M-Bus Slave remains selected it will reply to the primary address 253, which is dedicated to secondary addressing. The M-Bus Slave is deselected by either sending a new selection via the primary address 253 with a secondary address which is different from the address of the M-Bus Slave (whereby another M-Bus Slave may be selected), or by sending a normalization SND_NKE to the primary address 253.

2.3.3 Enhanced secondary addressing

As the customer number of the meter can be changed by the user either through the M-Bus or direct on the meter e.g. via the optical eye, more than one M-Bus Slave with the same secondary address may occur on the M-Bus.

The secondary address of the M-Bus Slave can therefore be extended by the eight-digit BCD "fabrication number" (4 bytes), which is identical with the eight lowest digits of the meter's serial number. This number is unique for each MULTICAL® 401 and cannot be changed after production.

In connection with enhanced secondary addressing the M-Bus Slave is selected by adding the "fabrication number" as an ordinary data record with DIF = 0Ch (for 4 bytes, 8 digit BCD) and VIF = 78h (for Fabrication number) to the selection telegram after the secondary address.

When an M-Bus Slave has been selected via enhanced secondary address, it will reply to primary address 253, like in connection with ordinary secondary addressing. Correspondingly the M-Bus Slave is deselected by either sending a new selection via primary address 253 with an (enhanced or ordinary) secondary address which is different from that of the M-Bus Slave (whereby another M-Bus Slave may be selected), or by sending a normalization SND_NKE to primary address 253.

Selection of M-Bus Slave via enhanced secondary address (and deselection of the remaining M-Bus Slaves)

Start character	68h
L-field	11h
L-field	11h

Start character	68h
C-field	53h
A-field	FDh
CI-field	52h
ID no. LSB	37 or FF, e.g. customer number = 4118737
ID no.	87 or FF
ID no.	11 or FF
ID no. MSB	04 or FF
Man. ID LSB	2Dh or FFh, KAM encoded with 2C2Dh
Man. ID MSB	2Ch or FFh
Version ID	02h or FFh
Device ID	04h or 0Ch or FFh
Record	0Ch DIF : 4 bytes, 8 digit BCD
Fabricat. no.	78h VIF : Fabrication no. (series number), e.g. 2500176
Fabr. no. LSB	76 or FF
Fabr. no.	01 or FF
Fabr. no.	50 or FF
Fabr. no. MSB	02 or FF
Check sum	XXh
Stop character	16h

2.3.4 Wildcard characters

Part of or all digits of the secondary and enhanced secondary addresses of the M-Bus Slave can be replaced by wildcard characters. The M-Bus Slave will not compare the wildcard characters to the corresponding digits of its own secondary and enhanced secondary addresses and the M-Bus Slave will be selected if only the rest of the characters match.

The 8 digits of the customer number as well as the 8 digits of the "fabrication number" (= series number) can be replaced by the wildcard character Fh separately.

The binary values "Manufacturer ID" (2 bytes), "Version / generation ID" (1 byte) as well as "Device type ID" (1 byte) of the secondary address can in bytes be replaced by the wildcard value FFh.

The values of DIF = 0Ch (for 4 bytes, 8 digit BCD) and VIF = 78h (for Fabrication number) in connection with enhanced secondary addressing cannot be replaced by wildcard values.

By means of wildcard characters (BCD Fh) and values (binary FFh) an M-Bus Master can relatively quickly scan the M-Bus for connected M-Bus Slaves without knowing the primary, secondary or enhanced secondary addresses of the M-Bus Slaves in advance.

This is called wildcard search and is fully supported by the M-Bus Slave for MULTICAL®401.

2.4 Physical features

The bus is independent of polarity.

Each M-Bus Slave has a maximum current consumption of 1 unit load (1.5 mA).

R_{in} = 410 Ω

C_{in} = 0.5 nF.

Maximum resistance in cable = 29 Ω/ 180 nF per pair

3 Data Communication

The M-Bus concept comprises various relevant formats and commands for communication between an M-Bus Master and an M-Bus Slave mounted in MULTICAL® 401.

3.1 Formats on the M-Bus

The M-Bus protocol comprises the following telegram / message format types:

Single character

Ack. = E5h

Short frame

Start = 10h
C-Field
A-Field
Check sum
Stop = 16h

Control frame

Start = 68h
L-Field = 3
L-Field = 3
Start = 68h
C-Field
A-Field
CI-Field
Check sum
Stop = 16h

Long frame

Start = 68h
L-Field = N + 3
L-Field = N + 3
Start = 68h
C-Field
A-Field
CI-Field
User data (N = 0..252 bytes)
Check sum
Stop = 16h

Meaning of the individual characters:

C-FIELD:
- 40h : SND_NKE
- 08h : RSP_UD
- 53h : SND_UD (FCB=0)
- 73h : SND_UD (FCB=1)
- 5Bh : REQ_UD2 (FCB=0)
- 7Bh : REQ_UD2 (FCB=1)

NB! The FCB-bit is not used but the M-Bus Slave accepts both FCB=0 and FCB=1

A-FIELD:
- XXh : Primary address of the M-Bus Slave encoded via MULTICAL® 401
- FDh : (253) Primary address of the M-Bus Slave in connection with secondary addressing
  The M-Bus Slave replies to RSP_UD, still with its own primary address however
- FEh : (254) Test address, to which all M-Bus Slaves will reply
  Using this address only one M-Bus Slave can be connected
- FFh : (255) Common address, through which all M-Bus Slaves can receive data from the M-Bus Master, but no replies will be returned

CI-FIELD: 50h : Application reset, (re-) initialisation of application level

51h : Normal transmission of SND_UD, send data (M-Bus Master to M-Bus Slave)

52h : Opening for secondary addressing required (selection of M-Bus Slaves)

72h : Respond in variable structure

B8h : Baud rate change to 300 baud

BBh : Baud rate change to 2400 baud

BDh : Baud rate change to 9600 baud

3.2 M-Bus Master for M-Bus Slave

Any communication on the M-Bus is initiated by the M-Bus Master, after which the addressed M-Bus Slave replies. Fundamentally there are two different communication sequences (from M-Bus Master to M-Bus Slave):

Send -› Confirm (SND / CON)

Request -› Response (REQ / RSP)

In connection with Send -› Confirm (SND / CON) the M-Bus Master sends a command or data to the M-Bus Slave, which sends an acknowledgement (ACK) in reply. The acknowledgement just means that the M-Bus Slave has received the telegram without errors, it has not necessarily accepted the content.

In connection with Request -› Response (REQ / RSP) the M-Bus Master sends a request to the M-Bus Slave which sends a telegram with the last read meter data in reply.

The M-Bus Slave supports the data format "Mode 1" only, which means that all multi-byte data values to and from the M-Bus Slave are sent with the least significant byte (LSB) first.

The M-Bus Slave does not use the FCB / FCV bit in C-Field, but accepts both FCB / FCV bit = 0 and 1.

The M-Bus Slave does not use DFC (Data Flow Control) / ACD (Access Demand) bits, i.e. both of these bits will always have the value 0 in the C-Field from the M-Bus Slave.

The individual M-Bus telegrams from M-Bus Master to M-Bus Slave and from M-Bus Slave to M-Bus Master, which are suppported, can be described as follows,

REQ_UD2 : Short frame. Request for data from M-Bus Slave.

Start character	10h
C-field	5Bh
A-field	XXh or FDh
Check sum	XXh
Stop character	16h

SND_NKE : Short frame. Normalizes the M-Bus Slave.

Start character	10h
C-field	40h
A-field	XXh or FDh
Check sum	XXh
Stop character	16h

SND_UD : Long frame, C-field = 53h (FCB=0) or 73h (FCB=1)

Data to the M-Bus Slave.

Start character	68h
L-field	XXh length of field = number of data bytes N + 3
L-field	XXh length of field repeated
Start character	68h
C-field	53h (FCB=0) or 73h (FCB=1) = SND_UD
A-field	XXh or FDh
CI-field	XXh 51h = send data, 52h = create secondary address
Data byte 1	XX
Data byte 2	XX
Data byte 3	XX
Data byte 4	XX
:	:
:	:
:	:
Data byte N	XX
Check sum	XXh
Stop character	16h

3.3 M-Bus Slave to M-Bus Master

RSP_UD : Long frame.

Data to M-Bus Master. See telegram later.

CON_ACK : Single control character.

Data format from M-Bus Master received correctly.

Single control char. E5h

The communication proceeds in the following sequences:

1. REQ_UD2 -> RSP_UD

When collection of heat meter data from the M-Bus Slave is required, REQ_UD2 is sent from the M-Bus Master. The M-Bus Slave checks the request and if in order the M-Bus Slave returns RSP_UD, which is heat meter data packed according to the M-Bus format RSP_UD. Consumption data can be up to one hour old. As soon as RSP_UD has been sent from the M-Bus Slave, new data is collected from the heat meter. Thus completely new data can be collected by sending REQ_UD2 to the same M-Bus Slave twice, or SND_NKE followed by REQ_UD2.

- As it normally takes 3 to 5 seconds to collect data from MULTICAL, there ought to be at least that interval (we recommend minimum 10 seconds) between two successive requests to the M-Bus Slave to be sure to receive new data. The M-Bus Slave will also reply whilst collecting data, however, but with a mixture of new and previous data until all new data have been read.

A time limit has been encoded in the M-Bus Slave to the effect that the slave always waits minimum 28 seconds between two successive data readings from the meter. I.e. no matter how often data is collected from the M-Bus Slave, it will maximum take approx. 30 seconds to update meter data, which complies with the updating time of MULTICAL® 401 which is 28 seconds.

2. SND_NKE -› CON_ACK

The M-Bus Master normalizes the M-Bus Slave by means of SND_NKE and the M-Bus Slave accepts to have received the message correctly by replying CON_ACK. The normalization prompts the M-Bus Slave to collect consumption data from the meter. A SND_NKE to the primary address will also deselect the M-Bus Slave if the M-Bus Slave has been selected by secondary or enhanced secondary addressing.

3. SND_UD -› CON_ACK

The M-Bus Master wants to send data to the M-Bus Slave or select / deselect the M-Bus Slave via secondary or enhanced secondary addressing. The M-Bus Slave confirms that the SND_UD telegram was correctly received by means of CON_ACK. The acknowledgement just means that the M-Bus Slave has received the telegram without errors, it is no guarantee of the M-Bus Slave having accepted the content.

Therefore, the M-Bus Slave will also send the acknowledgement CON_ACK upon receipt of an SND_UD command at a new baud rate although it ignores the content as the M-Bus Slave has automatic baud rate detection.

3.4 Data telegram

The following data is transferred from MULTICAL®401:

Serial number – Energy – Volume – Hour counter – Tforward– Treturn – Tdiff. – Power – Peak power – Flow – Peak flow – In-A – In-B – Date/Time – Energy* - Volume* - Peak power* - Peak flow* - In-A* - In-B* - Target date* - Info – TAR2 – TL2 – TAR3 – TL3 – TAR2* - TAR3* - Program number – Config number – Meter type/revision number – Module type/revision number.

* Target date data

3.5 Reading data from and entering data into MULTICAL® 401

The M-Bus Slave reads data from MULTICAL®401 in blocks of max. 50 bytes at a time. Depending on the situation reading proceeds according to one of the following two sequences,

1. Total reading of all M-Bus related data from MULTICAL®401.
2. Reading of current consumption values and time (subset of total reading).

3.5.1 Total reading

The M-Bus Slave carries out a total reading,

- After reset,
- After a manual call,
- After having entered data into MULTICAL®401 via the M-Bus,
- 12 hours after the latest total reading

3.5.2 Reading consumption data

Furthermore, the M-Bus Slave reads current consumption values and time in the following situations,

- having received a SND_NKE (M-Bus normalization)
- having received a REQ_UD2 (M-Bus data request)
- one hour after the latest reading of consumption values

The duration of a total reading is minimum approx. 12 seconds and longer if MULTICAL®401 is busy and, therefore, does not reply to one or two block readings at the first attempt.

The duration of a reading of current consumption values and time is minimum approx. 3 seconds and longer if MULTICAL®401 is busy and, therefore, does not reply to one or two block readings at the first attempt.

If a reading takes place whilst the M-Bus Slave is reading data from MULTICAL®401, the result will be a mixture of new and previous data. All data of one block, however, will always be simultaneous and valid, but either new or previous. As the last data block is always time and date as far as both total and consumption data readings are concerned, it appears from this block whether data have been updated, you just compare the times of the latest and previous readings.

In other words, if the time has been updated since the latest M-Bus reading, the rest of the data have also been updated. As the time is sent with just one minute's resolution, however, different reading values may appear within that minute.

4 Programming of MULTICAL® 401

The following data can be sent to the M-Bus Slave (with CI-field = 51h) and thereby be changed in MULTICAL®401:

- Primary M-Bus address (1 byte binary)
- Customer number (M-Bus ID number) = part of secondary address (4 bytes - 8 BCD digits)
- Date and time (4 bytes, binary coded as data type F, according to prEN13757-3 Annex A)
- Pulse counters A and B (2 x 4 bytes, binary)

Selecting the M-Bus Slave via secondary address or enhanced secondary address as well as application reset are obtained by sending a SND_UD telegram from M-Bus Master to M-Bus Slave with CI-field = 52h (selection of M-Bus Slaves) and CI-field = 50h (application reset) respectively.

The M-Bus Slave will also send an acknowledgement (CON_ACK) upon the receipt of set baud rate telegrams (CI-field = B8h .. BFh) but will ignore the content as the M-Bus Slave has automatic baud rate detection.

The individual telegrams for writing data into the M-Bus Slave are as follows,

4.1 Primary M-Bus address

Start character	68h
L-field	06h
L-field	06h
Start character	68h
C-field	53h (FCB=0) or 73h (FCB=1)
A-field	XXh or FDh
CI-field	51h
Record	01h DIF : 1 byte, binary
Address	7Ah VIF : Address
Primary address	XXh XX = 01h .. FAh for primary address = 1 .. 250
Check sum	XXh
Stop character	16h

4.2 Customer number (M-Bus ID no.) = part of secondary M-Bus address

Start character	68h
L-field	09h
L-field	09h
Start character	68h
C-field	53h (FCB=0) or 73h (FCB=1)
A-field	XXh or FDh
CI-field	51h
Record	0Ch DIF : 4 bytes, 8 digit BCD
Customer no.	79h VIF : ID number, e.g. customer no.: 31672106
ID no. LSB	06 BCD

ID no.	21 BCD
ID no.	67 BCD
ID no. MSB	31 BCD
Check sum	XXh
Stop character	16h

4.3 Date and time

Start character	68h
L-field	09h
L-field	09h
Start character	68h
C-field	53h (FCB=0) or 73h (FCB=1)
A-field	XXh or FDh
CI-field	51h
Record	04h DIF : 4 bytes, compound data type F
Date and time	6Dh VIF : Date and time, e.g. 02-09-04 13:10 standard time, valid
Date, time LSB	0Ah IV, 0, MI5, MI4, MI3, MI2, MI1, MI0
Date, time	2Dh SU, HY1, HY0, H4, H3, H2, H1, H0
Date, time	82h Y2, Y1, Y0, D4, D3, D2, D1, D0
Date, time MSB	09h Y6, Y5, Y4, Y3, M3, M2, M1, M0
Check sum	XXh
Stop character	16h

4.4 Pulse counters A and B

Start character	68h
L-field	12h
L-field	12h
Start character	68h
C-field	53h (FCB=0) or 73h (FCB=1)
A-field	XXh or FDh
CI-field	51h
Record	84h DIF : 4 bytes binary, DIFE follows
Pulse counter A	40h DIFE : sub unit no. = 1 (input A)
Volume	14h VIF : volume in 10-2 m³ (= 10 l), e.g. 001258.73 m3
vol. A LSB	B1h
vol. A	EBh
vol. A	01h
vol. A MSB	00h

Record	84h DIF : 4 bytes binary, DIFE follows
Pulse counter B	80h DIFE : sub unit no. LSB = 0, DIFE follows
	40h DIFE : sub unit no. MSB = 1 => unit no. = 2 (input B)
Volume	14h VIF : volume i 10-2 m³ (= 10 l), e.g. 000732.94 m³
vol. B LSB	4Eh
vol. B	1Eh
vol. B	01h
vol. B MSB	00h
Check sum	XXh
Stop character	16h

4.5 Application Reset

During application reset (re-) the M-Bus Slave initialises its M-Bus application protocol layer, which means

- reset of the access number, which is enclosed in RSP_UD and is incremented by one after each RSP_UD
- reading of all M-Bus related data of MULTICAL®401

The M-Bus Slave does not carry out a total reset like after "power-on".

Start character	68h
L-field	04h
L-field	04h
Start character	68h
C-field	53h (FCB=0) or 73h (FCB=1)
A-field	XXh or FDh
CI-field	50h
Subcode	00h Application Reset subcode, is not interpreted by the slave
Check sum	XXh
Stop character	16h

5 Protocol

The same commands apply using foreign M-Bus Masters and/or software. The M-Bus Slave supports the commands mentioned in this description only.

5.1 RSP_UD data

Complete description of reply from the M-Bus Slave (RSP_UD) upon request from the M-Bus Master (REQ_UD2):

DIF - Data Information Field, **VIF** - Value Information Field

Start	68 hex	
L-field	BE hex	length of 190 bytes
L-field	BE hex	length of 190 bytes
Start	68 hex	
C-field	08 hex	code for RSP_UD
A-field	6A hex	M-Bus Slave address (e.g. address = 106)
CI-field	72 hex	code for variable data structure starting with LSB (mode 1)
ID-no.	06 BCD	e.g. customer-no. = 31672106 Data head start
ID-no.	21 BCD	
ID-no.	67 BCD	
ID-no.	31 BCD	
Manufact.	2D hex	ID for Kamstrup A/S (KAM)
Manufact.	2C hex	
Version	02 hex	Version ID always = 2 for M-Bus Slave for MULTICAL® 401
Device ID	xx hex	heat meter (xx=04 for return pipe, xx=0C for forward pipe)
Access	xx hex	Is incremented by one after each RSP_UD. xx=00 after reset
Status	xx hex	Error message. xx=00 means no errror. See section 5.5.
Signature	00 hex	Not used
Signature	00 hex	End of data head
Record	0C hex	DIF: 4 bytes, 8 digit BCD
Fabricat. no.	78 hex	VIF: Fabrication no. (series no. of MC401), e.g. 2500176
	76 BCD	
	01 BCD	
	50 BCD	
	02 BCD	
Record	04 hex	DIF : 4 bytes binary
Energy	xx hex	VIF : energy, e.g. xx=0F (for 10 MJ), xx=06 (for kWh)
	B1 hex	e.g. 000137.45 GJ or 13745 kWh
	35 hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Volume	xx hex	VIF : volume, e.g. xx=14 (for 10 litres in resolution)

	10 hex	Example: 000258.72 m3
	65 hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Hour counter	22 hex	VIF : hours (on time)
	C6 hex	Example: 00012486 hours
	30 hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Temp.forward	59 hex	VIF : forward temperature in 0.01°C
	70 hex	Example: 000077.92 °C
	1E hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Temp.return	5D hex	VIF : return temperature in 0.01°C
	CD hex	Example: 00027.65 °C
	0A hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Temp.diff.	61 hex	VIF : temperature difference in 0.01 K
	A3 hex	Example: 000050.27 K
	13 hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Power	xx hex	VIF : power, e.g. xx=2D (for 0.1 kW resolution)
	12 hex	Example: 27.4 kW
	01 hex	
	00 hex	
	00 hex	
Record	14 hex	DIF : 4 bytes binary, maximum value
Peak power	xx hex	VIF : power, e.g. xx=2D (for 0.1 kW resolution)
	AB hex	Example: 68.3kW
	02 hex	
	00 hex	
	00 hex	
Record	04 hex	DIF : 4 bytes binary
Flow	xx hex	VIF : flow, e.g. xx=3B (for l/h resolution)

	59 hex	Example: 345 l/h
	01 hex	
	00 hex	
	00 hex	
Record	14 hex	DIF : 4 bytes binary, maximum value
Peak flow	xx hex	VIF : flow, e.g. xx=3B (for l/h resolution)
	17 hex	Example: 791 l/h
	03 hex	
	00 hex	
	00 hex	
Record	84h	DIF : 4 bytes binary, DIFE follows
Pulse counter A	40h	DIFE : sub unit no. = 1 (input A)
Volume	xx h	VIF : volume, e.g. xx=14 (for 10^{-2} m³ resolution)
	B1h	Example: 001258.73 m3
	EBh	
	01h	
	00h	
Record	84h	DIF : 4 bytes binary, DIFE follows
Pulse counter B	80h	DIFE : sub unit no. LSB = 0, DIFE follows
	40h	DIFE : sub unit no. MSB = 1 => unit no. = 2 (input B)
Volume	xx h	VIF : volume, e.g. xx=14 (for 10^{-2} m³ resolution)
	4Eh	Example: 000732.94 m³
	1Eh	
	01h	
	00h	
Record	04h	DIF : 4 bytes, compound data type F
Date and time	6Dh	VIF : Date and time, e.g. 02-09-04 13:10 std. tid, valid
	0Ah	IV, 0, MI5, MI4, MI3, MI2, MI1, MI0
	2Dh	SU, HY1, HY0, H4, H3, H2, H1, H0
	82h	Y2, Y1, Y0, D4, D3, D2, D1, D0
	09h	Y6, Y5, Y4, Y3, M3, M2, M1, M0
Record	44 hex	DIF : 4 bytes binary, historic (storage no. = 1)
Reading energy	xx hex	VIF : energy, e.g. xx=0F (for GJ), xx=06 (for kWh)
	xx hex	
	xx hex	
	xx hex	
	xx hex	
Record	44 hex	DIF : 4 bytes binary, historic (storage no. = 1)
Read volume	xx hex	VIF : volume, e.g. xx=14 (for 10^{-2} m³ resolution)
	xx hex	
	xx hex	
	xx hex	

	xx hex	
Record	54 hex	DIF : 4 bytes binary, hist. (storage no. = 1), max. value
Read pk. power	xx hex	VIF : power, e.g. xx=2D (for 0.1 kW resolution)
	xx hex	
	xx hex	
	xx hex	
	xx hex	
Record	54 hex	DIF : 4 bytes binary, hist. (storage no. = 1), max. value
Read pk. flow	xx hex	VIF : flow, e.g. xx=3B (for l/h resolution)
	xx hex	
	xx hex	
	xx hex	
	xx hex	
Record	C4h	DIF : 4 bytes binary, hist. (storage no. = 1), DIFE follows
Pulse counter A	40h	DIFE : sub unit no. = 1 (input A)
Read volume	xx h	VIF : volume, e.g. xx=14 (for 10^{-2} m³ resolution)
	B1h	Example 001258.73 m³
	EBh	
	01h	
	00h	
Record	C4h	DIF : 4 bytes binary, hist. (storage no. = 1), DIFE follows
Pulse counter B	80h	DIFE : sub unit no. LSB = 0, DIFE follows
	40h	DIFE : sub unit no. MSB = 1 => unit no. = 2 (input B)
Read volume	xx h	VIF : volume, e.g. xx=14 (for 10^{-2} m³ resolution)
	4Eh	Example 000732.94 m3
	1Eh	
	01h	
	00h	
Record	42 hex	DIF : 2 bytes, data type G, historic (storage no. = 1)
Read date	6C hex	VIF : date
	88 hex	Example: 080904 (displayed as 0040908 in MC401)
	09 hex	
MDH	0F hex	Manufacturer Data Header. Manufacturer specific data
Info	xx hex	4 bytes binary, starting with LSB for all subseq. MULTICAL data
	xx hex	
	xx hex	
	0x hex	
Tar2	xx hex	
	xx hex	
	xx hex	
	xx hex	
TL2	xx hex	

	xx hex	
	xx hex	
	00 hex	
Tar3	xx hex	
	xx hex	
	xx hex	
	xx hex	
TL3	xx hex	
	xx hex	
	xx hex	
	00 hex	
Read Tar1	xx hex	
	xx hex	
	xx hex	
	xx hex	
Read Tar2	xx hex	
	xx hex	
	xx hex	
	xx hex	
Prog. no.	6F hex	Example: 000ABCCC : 00043119
	A8 hex	
	00 hex	
	00 hex	
Config. No.	A2 hex	Example: 0DDEFFGG : 02302626
	22 hex	
	23 hex	
	00 hex	
Meter type	01 hex	Example: meter type 0141 h
+	41 hex	(NOTE: MSB first !!)
Revision no.	0C hex	Example: revision 0C01 h
	01 hex	(NOTE: MSB first !!)
Module type	xx hex	
+	xx hex	
Revision no.	xx hex	
	xx hex	
Check sum	xx hex	
Stop	16 hex	

5.2 VIF codes (Value Information Field)

The VIF codes include both unit and scaling factor/decimal point position (multiplier) of the value of a specific data record. The VIF codes for energy, volume, flow and power of the data package from M-Bus Slave to MULTICAL®401 reflect the display indication of the meter with a view to unit, decimal point position and number of decimals (if possible).

Therefore, the VIF codes of these data values will vary according to the configuration of MULTICAL®401.

The unit, decimal point position and number of decimals of the manufacturer specific tariff values of the data package from M-Bus Slave to MULTICAL®401 are the same as those of the standard M-Bus coded energy values (stated with corresponding VIF code). This does not apply, however, if the tariff type is 4 (m^3 x Tf and m^3 x Tr) meaning that the tariff value units are m^3 x degrees C.

The tariff limits of the manufacturer specific part of the data reply are always stated in the meter's basic units for the actual tariff selected in MULTICAL®401 (defined by the E-code of the config. No. DD-E-FF-GG).

VIF: Value Information Field

VIF (HEX)	CODING	ITEM	UNIT	SIZE
05h	00000101	Energy	kWh	$Wh*10^{2}$
06h	00000110	Energy	kWh	$Wh*10^{3}$
07h	00000111	Energy	MWh	$Wh*10^{4}$
0Dh	00001101	Energy	MJ	$J*10^{5}$
0Eh	00001110	Energy	GJ	$J*10^{6}$
0Fh	00001111	Energy	GJ	$J*10^{7}$
12h	00010010	Volume	m^3*10^{-4}	m^3*10^{-4}
13h	00010011	Volume	m^3*10^{-3}	m^3*10^{-3}
14h	00010100	Volume	m^3*10^{-2}	m^3*10^{-2}
15h	00010101	Volume	m^3*10^{-1}	m^3*10^{-1}
16h	00010110	Volume	m^3	m^3*10^{0}
22h	00100010	Hour counter	Timer	Timer
2Bh	00101011	Power	$kW*10^{-3}$	$W*10^{0}$
2Ch	00101100	Power	$kW*10^{-2}$	$W*10^{1}$
2Dh	00101101	Power	$kW*10^{-1}$	$W*10^{2}$
2Eh	00101110	Power	$MW*10^{-3}$	$W*10^{3}$
2Fh	00101111	Power	$MW*10^{-2}$	$W*10^{4}$
3Ah	00111010	Flow	$l/h*10^{-1}$	$m^3/h*10^{-4}$
3Bh	00111011	Flow	l/h	$m^3/h*10^{-3}$
3Ch	00111100	Flow	$m^3/h*10^{-2}$	$m^3/h*10^{-2}$
3Dh	00111101	Flow	$m^3/h*10^{-1}$	$m^3/h*10^{-1}$
3Eh	00111110	Flow	m^3/h	$m^3/h*10^{0}$
59h	01011001	Temp. forward	°C	$°C*10^{-2}$
5Dh	01011101	Temp. return	°C	$°C*10^{-2}$
61h	01100001	ΔT	K	$K*10^{-2}$
6Ch	01101100	Date	G-type	Date
6Dh	01101101	Date and time	F-type	Date and time
78h	01111000	Constructor's number	A-type	Serial no.
79h	01111001	ID no.	A-type	Customer no.
7Ah	01111010	Primary address	C-type	Primary address

CODING : The VIF-field's coding in the data package ITEM : Subject of the record

UNIT : The required unit SIZE : Unit encoded in VIF

5.3 DIF (Data Information Field)

SUBJECT	VALUE	HEX	DESCRIPTION
PRIMARY ADDRESS	00000001	01h	8 Bit binary, Current Value, Type C
ID (CUSTOMER) NO	00001100	0Ch	8 Digit BCD, Current Value, Type A
SERIAL NO	00001100	0Ch	8 Digit BCD, Current Value, Type A
DATE_READ	01000010	42h	16 Integer, Historic Value, Type G
ENERGY_READ	01000100	44h	32 Bit binary, Historic Value, Type B
WATER_READ	01000100	44h	32 Bit binary, Historic Value, Type B
PEAK POWER_READ	01010100	54h	32 Bit binary, Maximum, Historic Value, Type B
PEAK FLOW_READ	01010100	54h	32 Bit binary, Maximum, Historic Value, Type B
INPUT A+B	10000100	84h	32 Bit binary, Current Value, Type B, DIFE extension follows
INPUT A+B_READ	11000100	C4h	32 Bit binary, Historic Value, Type B, DIFE extension follows
OTHERS	00000100	04h	32 bit binary, Current Value, Type B

5.4 DATA HEAD

DATA	VALUE	TYPE	DESCRIPTION
ID-NO	--H	A	Customer number $* 10^1$ / customer number $* 10^0$
ID-NO	--H	A	Customer number $* 10^3$ / customer number $* 10^2$
ID-NO	--H	A	Customer number $* 10^5$ / customer number $* 10^4$
ID-NO	--H	A	Customer number $* 10^7$ / customer number $* 10^6$
MANUFACT	00101101	C	[ascii “K” - 64]*32*32+[ascii “A” – 64]*32+
MANUFACT	00101100	C	[ascii “M” - 64] ISO 60870 standard
VERSION ID	02H	C	Heat meter generation
DEVICE TYPE ID	04H or 0CH	C	**Heat Code
ACCESS	--H	C	Increments by one each time data is sent to the M-Bus Master
STATUS	--H	C	Error code (always = 00)
SIGNATURE	00H	C	(not in use)
SIGNATURE	00H	C	(not in use)

**04H is used when data is collected from a return pipe meter

**0CH is used when data is collected from a forward pipe meter

5.5 Error messages

No error messages are sent from M-Bus Slave to MULTICAL 401.

The "Status" field of the data head will therefore always include the value 00 hex.