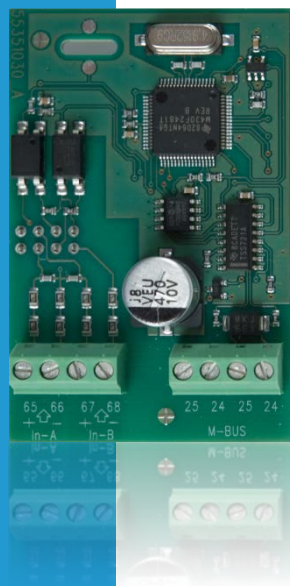


Technical Description

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Wired M-Bus module for  
MULTICAL<sup>®</sup> 402 with  
MULTICAL<sup>®</sup> III  
compatible data package

M-Bus



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# M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

## 1 Introduction

This technical description describes the M-Bus module 5550-1140 for MULTICAL® 402. The module supports primary, secondary and enhanced secondary addressing as well as 300, 2400 and 9600 baud communication speed.

The content of the M-Bus data package is similar to the data package from the M-Bus modules 6604 and 660S for MULTICAL® III and MULTICAL® Compact, allowing installation in older applications, originally designed for e.g. MULTICAL® III.

The module can also be used together with the old 40 slaves M-Bus master with display from Kamstrup as well as older regulators and reading software.

The module is fitted with two pulse inputs (VA and VB) for reading other meters, e.g. water and electricity meters.

### 1.1 Description

M-Bus is a bus system especially suited for communication with heat, cooling and water meters. The system consists of an M-Bus Master and one or more meters with M-Bus module.

This M-Bus module is developed especially for MULTICAL® 402 and cannot be used in other meter types.

The M-Bus system is designed to meet the requirements in the 1434-3 standard, as well as in EN 13757-2 and EN 13757-3.

### 1.2 M-Bus communication

Communication on the M-Bus is an asynchronous serial bit transmission in half duplex mode, which means that it is possible only to transmit one way at a time on the M-Bus.

The framing of the communication is 1 start bit, 8 data bits, 1 parity bit (even) and 1 stop bit.

Transmission speeds for the modules are 300 baud, 2400 baud or 9600 baud. The transmission speed is auto detected by the module. When the M-Bus module receives a message from the M-Bus Master on a certain speed, it will reply with the same speed.

The M-Bus is communicating via voltage modulation from the M-Bus Master to the M-Bus module and current modulation from the M-Bus module to the M-Bus Master. Communication media is via an ordinary two-wire cable. As cable type twisted pair is recommended.

## 2 M-Bus modules for MULTICAL® 402

Kamstrup has developed a number of M-Bus modules for MULTICAL® 402. This description describes the module 5550-1140.

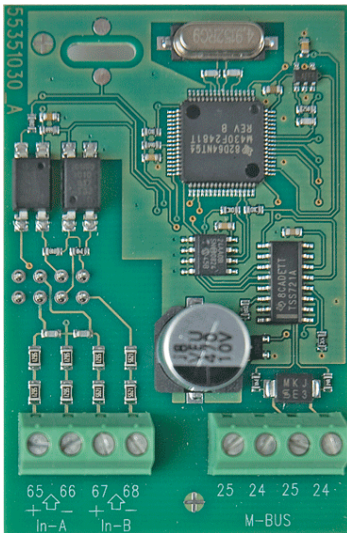
The module cannot be used in other meter types.

### 2.1 M-Bus module

Order number: 402 0 29

Module number: 5550-1140

Software number: 5098-899



#### M-Bus connection

Terminal 24 M-Bus connection

Terminal 25 M-Bus connection

Max. cable size 1 mm<sup>2</sup>

#### Pulse input connections

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 (-)

Max. cable size 1 mm<sup>2</sup>

It is easy to install the M-Bus module in the MULTICAL® 402. Simply place the module in the module space, and press it into the socket.

It is normally not necessary with a special configuration of meter or module, as the system is self-configuring.

# M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

## 3 Design

The module is supplied from the M-Bus Master. The M-Bus module is galvanic isolated from MULTICAL® 402 and communicates with MULTICAL® 402 via opto couplers.

The M-Bus module automatically collects consumption data every 15 minutes and all data every 24 hours. In addition, data are collected in the meter at reset/start up, after communicating with the M-Bus Master and after receiving manual calls from MULTICAL® 402.

The time for collecting consumption data is approx. 4 sec., collecting all data takes approx. 12 sec.

A time limit has been put into the M-Bus module, which means that it always waits min. 28 seconds between several successive readings of data in the meter. This means that irrespective how often data are collected from the M-Bus module, the update period of data from the meter will be approx. 28 seconds, which must be seen in relation to the update period for measurements in MULTICAL® 402, which is min. 24 seconds.

Most frequently recommended reading interval is every 60 seconds. Please note that very frequent read out will result in reduced battery life time.

A reset of the M-Bus module is performed by disconnecting the M-Bus cabling for min. 30 seconds. To have the M-Bus module collect new data in the meter, the M-Bus Master can send either a normalization (SND\_NKE) or an application reset command to the M-Bus module.

In connection with normalization (SND\_NKE) the M-Bus module collects consumption data from the meter (as is the case with ordinary reading, as well as once every 15 minutes).

In connection with an application reset, the M-Bus module collects all M-Bus relevant data in the meter (as is the case after reset, receipt of manual calls as well as every 24 hours).

The M-Bus module uses information from the meter to place units, decimal points and number of decimals on the values in the M-Bus telegram, ensuring that they correspond to the values read on the meter display, as far as it is supported in the M-Bus protocol. E.g. meters with MWh. and 3 decimals will in M-Bus typically be shown as kWh. without decimals.

The M-Bus connection is polarity independent. On the module there are – in addition to the M-Bus connection – 2 pulse inputs. Further details can be found in the technical description for MULTICAL® 402.

## 3.1 Installation

We recommend that the entire M-Bus system is not powered up during installation of new M-Bus modules. Not until then can the M-Bus system be started up. This start-up will cause all M-Bus modules to be initialized.

To install a module into MULTICAL® 402 meters; open the meter and install the M-Bus module in the module space, connect the M-Bus cables and close the meter.

For further details on installing communication modules into the meter, please refer to the Technical Description or Installation and User Guide for MULTICAL® 402.

When the M-Bus cables have been mounted and the meter supply has been connected, the M-Bus modules must have time to collect data (M-Bus Id numbers) from the meter, before read out is possible. It is recommended to wait 1 minute before trying to communicate with the M-Bus modules.

M-Bus ID number is the serial number of the meter, primary/secondary/enhanced secondary address etc.

The M-Bus modules store these data in their own memory and will be ready to communicate on the M-Bus approx. 6 seconds after connecting the supply. In connection with short failures in the M-Bus supply (< 1 sec.) the M-Bus modules will usually be ready to communicate again less than 6 sec. after the supply has been reconnected.

When starting up the M-Bus, the modules try to collect data in the meter every 30 sec., until they have received correct data. This means that if the M-Bus modules have been switched off for approx. 1 min. and are mounted in a MULTICAL® 402 they will automatically be initialized.

M-Bus modules may also be installed without disconnecting the M-Bus system. To ensure that the M-Bus modules are having their M-Bus ID numbers read in from the meter, an "application reset" command can be sent to all M-Bus modules when installed. It is important that the M-Bus modules are mounted in the meters, before the M-Bus cable is connected.

If the M-Bus ID number, primary M-Bus address, or other meter data/setups are changed directly on the meter, e.g. via the optical eye, it will take up to 24 hours before these numbers are updated in the M-Bus module.

In this case it will be advantageous either to disconnect the meter supply or the M-Bus supply to the M-Bus module (for approx. 1 minute), or you can make a manual call on the meter.

A manual call is made by pressing briefly on both front keys on MULTICAL® 402 in 5-6 sec. The text "CALL" will then appear in the display. After "CALL", an "OK" will appear in the display to indicate, that data in the M-Bus module has been updated. This function requires that the M-Bus module is connected to and powered from master.

Manual call may not be performed within the first 30 sec. after the module has been powered up.

# M-Bus module for MULTICAL®402 with MULTICAL® III compatible data package

## 3.2 Addressing forms

To make the M-Bus system function with more M-Bus modules connected, it is necessary to distinguish between the individual M-Bus modules. This is done by means of following M-Bus ID numbers in each M-Bus module:

- Primary addressing 001...250, and the special addresses 000, 253, 254 and 255
- M-Bus ID number 8 digits 00000000 .. 99999999
- Manufacturer ID Always 2D2Ch for "KAM" for Kamstrup M-Bus modules
- Version ID 16h / 22 decimal
- Device type
  - 04h = Heat (volume measured at outlet)
  - 0Ch = Heat (volume measured at inlet)
  - 0Ah = Cooling (volume measured at outlet)
  - 0Bh = Cooling (volume measured at inlet)
  - 06h = Warm water (30 .. 90 deg. C)
  - 16h = Cold water
- Fabrication number Serial number, 8 digits 00000000 .. 99999999

When the M-Bus Master sends a message on the M-Bus, some or all of the above ID numbers on the M-Bus module are encoded in the message. Thus, only the M-Bus module with the addressed ID numbers will reply.

Manufacturer ID and version ID are permanently encoded into the M-Bus module and cannot be changed. The M-Bus module reads the other M-Bus ID numbers in the meter.

# M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

## 3.2.1 Primary addressing

A valid primary M-Bus address has a value between 001 and 250.

The primary M-Bus address is either configured specific in the MULTICAL® 402 or the last digits of the meter number is used.

From the factory the primary address in MULTICAL® 402 equals to the last 3 digits of the meter number. If the last 3 digits in MULTICAL® 402's programmed meter number is larger than 250 (e.g. 345) the first digit is ignored and the M-Bus module's address is only determined by the last 2 digits (e.g. 45).

Setting the primary address can be performed in following ways:

- Using the two push buttons on the MULTICAL® 402
- Programming with METERTOOL
- Programming with MULTITERM Pro handheld unit

Changing the primary address, does not affect the meter number in the meter and vice versa.

In connection with primary addressing of the M-Bus modules, two or more M-Bus modules on the same M-Bus cannot have the same primary address. However, in connection with secondary addressing or enhanced secondary addressing it is possible to distinguish M-Bus modules with the same primary address on the same M-Bus.

Standard address range for an M-Bus module is 001 .. 250.

In addition to this there are 4 special addresses that work as follows:

Adr. 000 Ordinary primary address reserved for non-configured M-Bus modules.

Adr. 253 Used for secondary addressing.  
Only the M-Bus module accepting the address will reply.

Adr. 254 All M-Bus modules will reply to this address. The address can only be used in systems where only 1 M-Bus module is connected.

Adr. 255 No M-Bus modules will reply to this address, but all will receive the message. This address makes it possible e.g. to change the baud rate on an entire system at the same time by sending only one telegram.

# M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

## 3.2.2 Secondary addressing

M-Bus modules for MULTICAL® 402 support secondary addressing.

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

- M-Bus ID – default from Kamstrup: The last 8 digits in the meter number (4 bytes)
- Manufacturer ID = ASCII characters "KAM" for Kamstrup encoded to the value 2C2Dh (2 bytes)
- Version/generation ID number = 14h (1 byte)
- Device type (1 byte).

These 8 bytes make up the secondary address of the M-Bus modules. It is possible to replace the individual bytes with wildcard characters. See chapter 3.2.4 Wildcard characters.

### Selection of M-Bus modules via secondary address (and deselecting other M-Bus modules):

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. M-Bus ID number = 4118737
ID No.	87 or FF BCD	
ID No.	11 or FF BCD	
ID No. MSB	04 or FF BCD	
Man. ID LSB	2Dh or FFh	KAM encoded to 2C2Dh
Man. ID MSB	2Ch or FFh	
Version ID	16h or FFh	
Device type	04h, 07h, 0Ah, 0Bh, 0Ch, or 0Dh (see also ID numbers) or FFh	
Checksum	xxh	
Stop character	16h	

As long as the M-Bus module is selected it will reply to primary address 253, which is dedicated to secondary addressing. The M-Bus module is deselected either by sending a new selection via primary address 253 with a secondary address different from that of the M-Bus module (by means of which another M-Bus module is selected, if necessary) or by sending a normalization SND\_NKE to primary address 253.

### 3.2.3 Enhanced secondary addressing

As the M-Bus ID numbers in the meter can be changed by the user either via the M-Bus or directly on the meter e.g. via the optical eye, more M-Bus modules with the same secondary address may appear on the M-Bus.

The M-Bus module's secondary address can therefore be extended in order to comprise the 8 digit BCD "fabrication number" (4 bytes) that is identical with the serial number of the meter. This number is unique for each MULTICAL® 402 and cannot be changed after production.

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

When an M-Bus module is selected via enhanced secondary address it will reply to primary address 253, as is the case with secondary addressing. The M-Bus module is deselected either by sending a new selection via primary address 253 with an enhanced or ordinary secondary address different from that of the M-Bus module (by means of which another M-Bus module is selected, if necessary) or by sending a normalization SND\_NKE to primary address 253.

#### Selection of M-Bus modules via enhanced secondary address (and deselecting other M-Bus modules):

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 BCD	E.g. M-Bus ID number = 4118737
ID No.	87 or FF BCD	
ID No.	11 or FF BCD	
ID No. MSB	04 or FF BCD	
Man. ID LSB	2Dh or FFh	KAM encoded to 2D2Ch
Man. ID MSB	2Ch or FFh	
Version ID	16h or FFh	
Device type	04h, 07h, 0Ah, 0Bh, 0Ch, or 0Dh (see also ID numbers) or FFh	
Record	0Ch DIF:	4 bytes, 8 digit BCD
Fabrication no.	78h VIF:	Fabrication no. (serial no.), e.g.: 2500176
Fabr. no. LSB	76 or FF BCD	
Fabr. no.	01 or FF BCD	
Fabr. no.	50 or FF BCD	
Fabr. no. MSB	02 or FF BCD	
Checksum	xxh	
Stop character	16h	

# M-Bus module for MULTICAL®402 with MULTICAL® III compatible data package

## 3.2.4 Wildcard characters

Some or all digits in the M-Bus module's secondary or enhanced secondary address can be replaced by wildcard characters. The M-Bus module will not compare the wildcard characters with the equivalent digits in "its own" secondary and enhanced secondary address, and the M-Bus module will be selected if the other characters match.

The 8 digits in the M-Bus ID number and the 8 digits in the "fabrication number" (= serial number) can each be replaced by the wildcard character Fh.

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

The values for 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 search the M-Bus for connected M-Bus modules without knowing the M-Bus modules' primary, secondary or enhanced secondary addresses in advance.

This is called a "wildcard search", and is supported 100% by the M-Bus modules for MULTICAL® 402.

## 3.3 Physical properties

The bus is polarity independent.

The M-Bus modules have a max. power consumption of 1 unit load (1.5 mA).

Rin: 410  $\Omega$

Cin: 0.5 nF

Max. cable resistance: 29  $\Omega$ / 180 nF per pair.

Ambient temperature: 5...55 °C

Storage temperature: -20...60 °C

Bus current and voltages according to EN 13757-2

## 4 Data Communication

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

### 4.1 M-Bus formats

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

Single character	Short frame	Control frame	Long frame
Ack. = E5h	Start = 10h	Start = 68h	Start = 68h
	C-Field	L-Field = 3	L-Field = N + 3
	A-Field	L-Field = 3	L-Field = N + 3
	Checksum	Start = 68h	Start = 68h
	Stop = 16h	C-Field	C-Field
		A-Field	A-Field
		CI-Field	CI-Field
		Checksum	Userdata
		Stop = 16h	(N = 0..252 bytes)
			Checksum
			Stop = 16h

The meaning of the individual characters:

C-FIELD:	40h	SND_NKE		
	08h	RSP_UD		
	0Bh	RSP_SKE		
	49h	REQ_SKE		
	53h	SND_UD (FCB=0)	73h	SND_UD (FCB =1)
	5Ah	REQ_UD1 (FCB=0)	7Ah	REQ_UD1 (FCB =1)
	5Bh	REQ_UD2 (FCB=0)	7Bh	REQ_UD2 (FCB =1)

**OBS:** The FCB bit is not used, but the M-Bus modules accept both FCB=0 and FCB=1.

A-FIELD:	xxh	The primary address of the M-Bus module which is encoded via MULTICAL® 402.
	FDh	(253) The primary address of the M-Bus module in connection with secondary addressing. However, in connection with RSP~_UD the M-Bus module still replies with its own primary address.
	FEh	(254) Address to which all M-Bus modules will reply. By using this address only one M-Bus module can be connected.
	FFh	(255) Joint address where all M-Bus modules can receive data from the M-Bus Master, but replies are not returned.

CI-FIELD:	50h	Application reset, (re-) initialization of application layer.
	51h	Normal transmission of SND_UD, data send (M-Bus Master to M-Bus module).
	52h	Opening for secondary addressing (selection of M-Bus modules) is required.
	72h	Respond in variable structure.
	B8h	Baud rate shift to 300 baud.
	BBh	Baud rate shift to 2400 baud.
	BDh	Baud rate shift to 9600 baud.

#### Note

All Kamstrup's M-Bus modules are equipped with auto detection of the baud rate (300/2400/9600 baud).

# M-Bus module for MULTICAL®402 with MULTICAL® III compatible data package

## 4.2 M-Bus Master to M-Bus module

Communication on the M-Bus is initiated by the M-Bus Master. After this the addressed M-Bus module replies. Basically, there are 2 different communication sequences (from M-Bus Master to M-Bus module):

SEND -> CONFIRM  
REQUEST -> RESPONSE

When using "SEND -> CONFIRM" the M-Bus Master sends a command or data to the M-Bus module, that replies with an acknowledgement (ACK). The acknowledgement (ACK) just means that the M-Bus module has received the telegram successfully, but it has not necessarily accepted the contents.

When using "REQUEST -> RESPONSE" the M-Bus Master sends a request to the M-Bus module, which replies with a telegram containing the last read meter data from the meter or with an ACK.

The M-Bus module only supports "Mode 1" data format where all multi-byte data values to and from the M-Bus module are transmitted with Least Significant Byte (LSB) first.

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

The M-Bus module does not use DFC (Data Flow Control) / ACD (Access Demand) bits, which means that both bits will always have the value 0 in the C-Field from the M-Bus module.

The following describes the individual M-Bus telegrams from M-Bus Master to M-Bus module and from M-Bus module to M-Bus Master that are supported.

REQ_UD1:	Short frame. Request for time-critical data alarm.	
Start character		10h
C-field		5Ah
A-field		xxh or FDh
Checksum		xxh
Stop character		16h

REQ_UD2:	Short frame. Request for data from the M-Bus module (heat meter).	
Start character		10h
C-field		5Bh
A-field		xxh or FDh
Checksum		xxh
Stop character		16h

# M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

<b>REQ_SKE:</b>	Short frame. Status request.		
	Start character		10h
	C-field		49h
	A-field		xxh or FDh
	Checksum		xxh
	Stop character		16h

<b>SND_NKE:</b>	Short frame. Normalizes the M-Bus module.		
	Start character		10h
	C-field		40h
	A-field		xxh or FDh
	Checksum		xxh
	Stop character		16h

<b>SND_UD:</b>	Long frame, Data to the M-Bus module.		
	Start character	68h	
	L-field	xxh	length field = number of data bytes N + 3
	L-field	xxh	length 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 = data send, 52h = create secondary address
	Data byte 1	xx	
	:	:	
	:	:	
	Data byte 1	xx	
	Checksum	xxh	
	Stop character	16h	

## 4.3 M-Bus Slave to M-Bus Master

**RSP\_UD** Long frame.  
Data to M-Bus Master. See telegram later.

**RSP\_SKE** Short frame.  
Data to M-Bus Master. See telegram later.

**ACK** Single control character.  
Data format from M-Bus Master received successfully.

Description of the codes of the individual formats can be viewed later in this document.

## M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

Communication takes place in following sequences:

### 4.3.1 REQ\_UD2 -> RSP\_UD

When meter data are collected from the M-Bus module, an REQ\_UD2 is transmitted from the M-Bus Master. The M-Bus module checks the message, and if it is correct, the M-Bus module returns with an RSP\_UD, which is meter data packed according to the M-Bus format for RSP\_UD. The consumption data collected may be up to 15 minutes old. When RSP\_UD has been sent from the M-Bus module, new data are collected from the meter. This will make it possible to collect actual data by sending REQ\_UD2 twice to the same M-Bus module, or SND\_NKE followed by REQ\_UD2.

As collection of consumption data in MULTICAL® 402 may take 4 sec. (without retry), please wait min. 4 sec. before sending the next request to the M-Bus module to be sure to get fresh data. However, the M-Bus module will still try to reply to the M-Bus while collecting data from the meter, but with a mixture of fresh and previous data, until all fresh data have been read.

A time limit has been put into the M-Bus module, which means that it always waits min. 28 seconds between several successive readings of data in the meter. This means that irrespective how often data are collected from the M-Bus module, the update period of data from the meter will be approx. 28 seconds, which must be seen in relation to the update period for measurements in MULTICAL® 402, which is min. 24 seconds.

An explanation of the format RSP\_UD can be viewed later in the manual.

### 4.3.2 REQ\_UD1 -> ACK

REQ\_UD1 from the M-Bus Master is a request for time-critical (alarm) data from the M-Bus module. The M-Bus module for MULTICAL® does not support time-critical data (alarm protocol), but it replies with an ACK (link layer receipt) when receiving REQ\_UD1, which means that the M-Bus module does not have any time-critical (alarm) data to transmit.

In this way the M-Bus module will function in M-Bus systems with other M-Bus modules supporting time-critical data (alarm protocol).

### 4.3.3 REQ\_SKE -> RSP\_SKE

REQ\_SKE from the M-Bus Master is a request for communication status and for information on whether the M-Bus module has any time-critical (alarm) data to send. When receiving an REQ\_SKE the M-Bus module replies with an RSP\_SKE, but as the M-Bus module does not support time-critical data (alarm protocol) and cannot have overflow in its input buffer, the status bits ACD (Access Demand) and DFC (Data Flow Control) will always be = 0 in the M-Bus module reply, which means that the M-Bus module does not have any time-critical (alarm) data to send and has no buffer overflow.

Therefore, the M-Bus module will function in M-Bus systems with other M-Bus modules supporting time-critical data (alarm protocol) and using communication status bit.

**SND\_NKE**      ->      **ACK**

The M-Bus Master normalizes the M-Bus module with an SND\_NKE and the M-Bus module acknowledges successful receipt of the message by means of an ACK. Normalization results in the fact that the M-Bus module collects consumption data from the meter. Furthermore, an SND\_NKE to primary address 253 will deselect the M-Bus module if it was selected by means of secondary or enhanced secondary addressing.

**SND\_UD**        ->        **ACK**

The M-Bus Master wishes to send data to the M-Bus module or to select/deselect the M-Bus module via secondary or enhanced secondary addressing. The M-Bus module acknowledges successful receipt of the SND\_UD telegram by means of an ACK. The acknowledgement (ACK) just means that the M-Bus module has received the telegram successfully in the Data Link Layer and is as such no guarantee that the M-Bus module has accepted the contents of the Application Layer.

Therefore, when receiving an SND\_UD command with a new baud rate, the M-Bus module will acknowledge receipt by means of an ACK, even though it ignores the contents, as the M-Bus module automatically detects the baud rate on receipt.

## 4.4 Error Messages

MULTICAL® 402 constantly surveys a number of important functions. Where serious errors have occurred in the measuring system or in the installation, a flashing "info" will appear in the display while the error exists. The "Info" panel will flash for as long as the error exists no matter which reading is selected. The "Info" panel will automatically turn off, when the source of error has been corrected.

M-Bus modules for MULTICAL® 402 support info codes from MULTICAL® 402 and are mapped to the two error bits "Permanent Error" (bit 3) and "Temporary Error" (bit 4) in the status field of the data header as described in the following chapter.

### 4.4.1 Permanent Error

Permanent Error (Bit 3) is set when one of the following info codes is active in MULTICAL® 402:

Error Code in MULTICAL®	Status field value	Description
4	0004h	Temperature sensor T2 error
8	0008h	Temperature sensor T1 error
16384	4000h	Flow sensor V1 wrong direction

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## 4.4.2 Temporary Error

Temporary Error (Bit 4) is set when one of the following info codes is active in MULTICAL® 402:

Error Code in MULTICAL®	Status field value	Description
1	0001h	Supply voltage has been cut off
4096	1000h	Flow sensor V1 signal too low (air)

## 4.4.3 Status field

The "Status field" in the M-Bus data header will always have one of the following values:

Status field value	Description
00h	No info code
08h	One or more "Permanent Error" info codes
10h	One or more "Temporary Error" info codes
18h	One or more "Permanent Error" and "Temporary Error" info codes at the same time

## 4.5 Datagram

The M-Bus module for MULTICAL® 402 are transferring following data:

M-Bus data header	Actual data	Target data*	Manufacturer specified data
Meter No.	Energy E1 or E3	Energy E1 or E3	Meter No.
Manufacturer ID	Volume V1	Volume V1	Max. power
Version ID	Hour counter	Target date	Info
Device type	T1 inlet		TA2
Access counter	T2 outlet		TL2
Status	T1-T2		TA3
Configuration	Actual power		TL3
	Actual flow		In-A
			In-B
			Program No.
			Config. No.
			Date

As program number and config number are different, the values have been converted to meet MC III in the best possible way.

As an example is EE in config changed to E in the way that EE=19 is changed to E=9.

DDD cannot be converted and is in this module always 0.

When the MULTICAL® 402 is configured as cooling meter the energy register E1 is replaced with cooling energy register E3.

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\* Target data are yearly data.

## 4.6 Reading and writing data in MULTICAL® 402

The M-Bus modules read MULTICAL® data in blocks of up to 50 bytes at a time. Reading takes place in one of the following two sequences depending on the situation:

- 1 Complete reading of all M-Bus related data in MULTICAL® 402.
- 2 Reading of current consumption values and time (subset of complete reading).

If reading takes place while the M-Bus module is reading data in MULTICAL® 402, data will be a mixture of fresh and previous data. However, data within the same block will be simultaneous and valid but either fresh or previous. As the last data block is always time and date - both complete and consumption data readings – it is possible to determine if data are updated by comparing time in the latest reading with time in the previous reading.

In other words, if time has been updated since last M-Bus reading, all other data have been updated as well. As time is only sent with a resolution of 1 minute, different reading values may appear within the same minute.

### 4.6.1 Complete reading

The M-Bus modules performs a complete reading in following situations:

- After reset
- After manual call – via push buttons on MULTICAL® 402
- After writing data in MULTICAL® 402 via the M-Bus
- After shifting between selecting yearly log data or monthly log data
- After receiving an M-Bus “Application Reset” command
- 24 hours after last complete reading

A complete reading takes approx. 12 seconds.

### 4.6.2 Reading consumption data

In addition, the M-Bus modules read current consumption values and time in following situations:

- After receiving SND\_NKE (M-Bus normalization)
- After receiving REQ\_UD2 (M-Bus data request)
- After receiving REQ\_SKE (M-Bus status request)
- 15 minutes after the last reading of consumption values

A reading of current consumption values and time takes min. approx. 4 seconds.

## 5 Configuration of MULTICAL® via M-Bus

Following data can be sent to the M-Bus module (with CI-field = 51h) and then be changed in MULTICAL®:

- Primary M-Bus address (1 byte binary)
- M-Bus ID number = part of the secondary address (4 bytes - 8 BCD digits)
- Date and time (4 bytes binary encoded as data type F according to EN13757-3 Annex A)
- Preset of pulse input A and B (2 x 4 bytes, binary)
- Readout of monthly target data instead of yearly target data

Selection of the M-Bus module via secondary address or enhanced secondary address, and application reset is obtained via SND\_UD telegram from the M-Bus Master to the M-Bus module with CI-field = 52h (selection of M-Bus modules) and CI-field = 50h (application reset), respectively.

The M-Bus module will also reply with an acknowledgement (ACK) when receiving a set of baud rate telegrams (CI-field = B8h .. BFh), but will ignore the contents, as the M-Bus module is furnished with automatic baud rate detection.

The individual telegrams for writing data in the M-Bus module are shown subsequently.

### 5.1 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 add.	xxh	XX = 01h .. FAh. For primary address = 1 .. 250
Checksum	xxh	
Stop character	16h	

## 5.2 M-Bus ID Number = 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
Meter No.		79h
ID No. LSB	06 BCD	
ID No.	21 BCD	
ID No.	67 BCD	
ID No. MSB	31 BCD	
Checksum	xxh	
Stop character	16h	

## 5.3 Date and time

The date and time format is 4 bytes binary, encoded as data type F according to EN13757-3 Annex A.

In order not to disturb the built-in loggers, setting the time must be done in due time before or after an hour shift. This in order to prevent missing or double loggings.

Most often date and time setting is once a day.

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
Checksum	xxh	
Stop character	16h	

As MULTICAL® 402 uses two digits to indicate year (00 .. 99), the M-Bus module always sends information concerning year as 2000 .. 2099 (bit HY1:HY0 always = 01 in "Date and time record", VIF = 6Dh and DIF = 04h, compound data type F).

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## 5.4 Preset of pulse input A and B

Via the M-Bus module with 2 pulse inputs (VA, VB), the presets of the counter values of the connected meters can be configured and shown in the display of MULTICAL® 402.

### 5.4.1 Preset counter value A

Start character	68h	
L-field	0Ah	VIF: 0,001-1 m <sup>3</sup> or kWh
L-field	0Ah	
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 nr. = 1 (input A)
Volume	14h	VIF: volume in 0,01 m <sup>3</sup> (= 10 l), e.g 001258,73 m <sup>3</sup>
vol. A LSB	B1h	
vol. A	EBh	
vol. A	01h	
vol. A MSB	00h	
Checksum	xxh	
Stop character	16h	

### 5.4.2 Preset counter value B

Start character	68h	
L-field	0Bh	VIF: 0,001-1 m <sup>3</sup> or kWh
L-field	0Bh	
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 B	80h	DIFE: sub unit nr. LSB = 0, DIFE follows
	40h	DIFE: sub unit nr. MSB = 1 => unit nr. = 2 (input B)
Volume	14h	VIF: volume in 0,01 m <sup>3</sup> (= 10 l), e.g. 000732,94 m <sup>3</sup>
vol. B LSB	4Eh	
vol. B	1Eh	
vol. B	01h	
vol. B MSB	00h	
Checksum	xxh	
Stop character	16h	

## 5.5 Application reset

In connection with application reset the M-Bus module re-initializes its M-Bus application protocol layer, which results in the following:

- Resetting of access number, which is included in the RSP\_UD, and counting 1 up every time an RSP\_UD has been sent.
- Default readout of yearly data irrespective of previous configuration
- Reading of all M-Bus related data in MULTICAL® 402.

The M-Bus module does not perform a total reset, as is the case 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	
Sub code	00h	Application Reset sub code, not interpreted by the M-Bus module.
Checksum	xxh	
Stop character	16h	

## 6 Protocol

When using M-Bus Masters and/or software of another make the same commands must be used. The M-Bus modules only support commands stated in this description.

### 6.1 RSP\_UD data

Complete description of replies from the M-Bus modules (RSP\_UD) on requests from M-Bus Master (REQ\_UD2):

DIF - Data Information Field

VIF - Value Information Field

0	<b>Start</b>	<b>68 h</b>		
	L-field	82 h	Length 130 bytes	
	L-field	82 h	Length 130 bytes	
	Start	68 h		
	C-field	08 h	Code for RSP_UD	
	A-field	6A h	Slave address (e.g. address = 106)	
	CI-field	72 h	Code for variable data structure with LSB first (mode 1)	
	ID-no.	06 BCD	Meter No. e.g. 31672106	<b>Data header start</b>
	ID-no.	21 BCD		
	ID-no.	67 BCD		
10	ID-no.	31 BCD		
	Manufacturer	2D h	ID for Kamstrup A/S (KAM)	
	Manufacturer	2C h		
	Version	16 h	Version ID = 22 for this module.	
	Device type	xx h	04h = Heat (volume measured at outlet) 0Ch = Heat (volume measured at inlet) 0Ah = Cooling (volume measured at outlet) 0Bh = Cooling (volume measured at inlet) 06h = Warm water (30 .. 90 deg. C) 16h = Cold water	
	Access	xx h	Increments after each RSP_UD. xx=00 after reset.	
	Status	xx h	Error message. xx=00 no error. Se text.	
	Configuration	00 h	Not used	<b>Data header end</b>
	<b>Record</b>	0C h	DIF: 4 bytes BCD	
20	<b>Energy 1</b>	xx h	VIF: e.g.: xx=0Fh (for 10 MJ) or xx=06h (for kWh)	
		45 BCD	e.g. 137,45 GJ or 13,745 MWh	
		37 BCD		
		01 BCD	If it is a cooling meter, then this is E3 – cooling energy	
		00 BCD		
	Record	0C h	DIF: 4 bytes BCD	
	Volume 1	xx h	VIF: e.g.: xx=14 (for 10 liters resolution)	
		72 BCD	e.g. 258,72 m <sup>3</sup>	
		58 BCD		
		02 BCD		
30		00 BCD		
	Record	0C h	DIF: 4 bytes BCD	

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	Hour counter	22 h	VIF: on time
		86 BCD	e.g. 12486 hours
		24 BCD	
		01 BCD	
		00 BCD	
	Record	0C h	DIF: 4 bytes BCD
	T1 inlet	59 h	VIF: 0,01 °C in resolution
		92 BCD	e.g. 77,92 °C
40		77 BCD	
		00 BCD	
		00 BCD	
	Record	0C h	DIF: 4 bytes BCD
	T2 outlet	5D h	VIF: 0,01 °C in resolution
		65 BCD	e.g. 27,65 °C
		27 BCD	
		00 BCD	
		00 BCD	
	Record	0C h	DIF: 4 bytes BCD
50	T1-T2.	61 h	VIF: 0,01 K in resolution
		27 BCD	e.g. 50,27 K
		50 BCD	
		00 BCD	
		00 BCD	
	Record	0C h	DIF: 4 bytes BCD
	Power	xx h	VIF: e.g.: xx=2Dh (for 0,1 kW )
		74 BCD	e.g. 27,4 kW
		02 BCD	
		00 BCD	
60		00 BCD	
	Record	0C h	DIF: 4 bytes BCD
	Flow	xx h	VIF: e.g.: xx=3Bh (for l/h)
		45 BCD	e.g. 345 l/h
		03 BCD	
		00 BCD	
		00 BCD	
	<b>Record</b>	4C h	DIF: 4 bytes BCD, historic (storage no. = 1)
	<b>Target energy</b>	xx h	VIF: e.g.: xx=0Fh (for GJ), xx=06h (for kWh)
		xx BCD	
70		xx BCD	If it is a cooling meter, then this is E3 – cooling energy
		xx BCD	
		xx BCD	
	Record	4C h	DIF: 4 bytes BCD, historic (storage no. = 1)
	Target volume	xx h	VIF: e.g.: xx=14h (for 0,01 m <sup>3</sup> )
		xx BCD	
		xx BCD	
		xx BCD	
		xx BCD	
	Record	42 h	DIF: 2 bytes, data type G, historic (storage no. = 1)

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80	Target date	6C h	VIF: date
		DE h	e.g. 300706 (2006-07-30)
		07 h	
	<b>MDH</b>	0F h	
	Meter No.	24 BCD	e.g. 6391224
		12 BCD	
		39 BCD	
		06 BCD	
		24 BCD	
		24 BCD	
90	Max. power	23 BCD	LSB
		01 BCD	e.g. 123
		00 BCD	
		00 BCD	
	Info	xx BCD	
		xx BCD	
		xx BCD	see text
		xx BCD	see text
	Tar2	xx BCD	LSB
		xx BCD	
100		xx BCD	
		xx BCD	
	TL2	xx BCD	LSB
		xx BCD	
		xx BCD	
		xx BCD	
	Tar3	xx BCD	LSB
		xx BCD	
		xx BCD	
		xx BCD	
110	TL3	xx BCD	LSB
		xx BCD	
		xx BCD	
		xx BCD	
	Count A	xx BCD	LSB
		xx BCD	
	Vol. or energy	xx BCD	
		xx BCD	
	Count B	xx BCD	LSB
		xx BCD	
120	energy	xx BCD	
		xx BCD	
	Program no.	19 BCD	e.g. ABCCC: 34119 (Note)
		41 BCD	
		03 BCD	
		00 BCD	
	Config. No.	24 BCD	e.g. EFFGG: 12424 (Note)
		24 BCD	

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		01 BCD	
		00 BCD	
130	Date	14 BCD	e.g.: 101214 (year 2010 , month 12, day 14)
		12 BCD	
		10 BCD	
		00 BCD	
	Checksum	xx h	
	Stop	16 h	

# M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package

## 6.2 VIF codes (Value Information Field)

The VIF codes contain both unit and scaling factor / decimal point (multiplier) for the value in a given data record. In the data package from the M-Bus module the VIF codes for energy, volume, flow and power will (as far as possible) reflect the display reading in the meter as regards unit, decimal point and number of decimals.

Thus, the VIF codes for these data values will vary depending on the configuration of the MULTICAL®.

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

VIF: Value Information Field

VIF (HEX)	Coding	Subject	Unit	Size
05h	00000101	Energy	kWh	Wh*10 <sup>2</sup>
06h	00000110	Energy	kWh	Wh*10 <sup>3</sup>
07h	00000111	Energy	MWh	Wh*10 <sup>4</sup>
0Dh	00001101	Energy	MJ	J*10 <sup>5</sup>
0Eh	00001110	Energy	GJ	J*10 <sup>6</sup>
0Fh	00001111	Energy	GJ	J*10 <sup>7</sup>
12h	00010010	Volume	m <sup>3</sup> *10 <sup>-4</sup>	m <sup>3</sup> *10 <sup>-4</sup>
13h	00010011	Volume	m <sup>3</sup> *10 <sup>-3</sup>	m <sup>3</sup> *10 <sup>-3</sup>
14h	00010100	Volume	m <sup>3</sup> *10 <sup>-2</sup>	m <sup>3</sup> *10 <sup>-2</sup>
15h	00010101	Volume	m <sup>3</sup> *10 <sup>-1</sup>	m <sup>3</sup> *10 <sup>-1</sup>
16h	00010110	Volume	m <sup>3</sup>	m <sup>3</sup> *10 <sup>0</sup>
22h	00100010	Hour counter	Hours	Hours
2Bh	00101011	Power	kW*10 <sup>-3</sup>	W*10 <sup>0</sup>
2Ch	00101100	Power	kW*10 <sup>-2</sup>	W*10 <sup>1</sup>
2Dh	00101101	Power	kW*10 <sup>-1</sup>	W*10 <sup>2</sup>
2Eh	00101110	Power	MW*10 <sup>-3</sup>	W*10 <sup>3</sup>
2Fh	00101111	Power	MW*10 <sup>-2</sup>	W*10 <sup>4</sup>
3Ah	00111010	Flow	l/h*10 <sup>-1</sup>	m <sup>3</sup> /h*10 <sup>-4</sup>
3Bh	00111011	Flow	l/h	m <sup>3</sup> /h*10 <sup>-3</sup>
3Ch	00111100	Flow	m <sup>3</sup> /h*10 <sup>-2</sup>	m <sup>3</sup> /h*10 <sup>-2</sup>
3Dh	00111101	Flow	m <sup>3</sup> /h*10 <sup>-1</sup>	m <sup>3</sup> /h*10 <sup>-1</sup>
3Eh	00111110	Flow	m <sup>3</sup> /h	m <sup>3</sup> /h*10 <sup>0</sup>
59h	01011001	Temp. flow pipe	°C	°C*10 <sup>-2</sup>
5Dh	01011101	Temp. return flow pipe	°C	°C*10 <sup>-2</sup>
61h	01100001	ΔT	K	K*10 <sup>-2</sup>
6Ch	01101100	Date	G-Type	Date
6Dh	01101101	Date and time	F-Type	Date and time
78h	01111000	Serial number	A-Type	Serial no.
79h	01111001	ID no.	A-Type	Meter no.
7Ah	01111010	Primary address	C-Type	Primary address

CODING: VIF-field coding in the data package

SUBJECT: Subject in the record

UNIT: Unit required

SIZE: Unit programmed in VIF

### 6.3 DIF (Data Information Field)

Subject	Value	Hex	Description
PRIMARY ADDRESS	00000001	01h	8 bit binary, Current Value, Type C
TARGET_DATE	01000010	42h	16 Integer, Historical Value, Type G
TARGET_ENERGY	01001100	4Ch	8 digit BCD, Historical Value, Type A
TARGET_VOLUME	01001100	4Ch	8 digit BCD, Historical Value, Type A
OTHERS	00000100	0Ch	8 digit BCD, Current Value, Type A

### 6.4 Data header

Data	Value	Type	Description
ID-NO	xxh	A	M-Bus ID number * 10 <sup>1</sup> / M-Bus ID number * 10 <sup>0</sup>
ID-NO	xxh	A	M-Bus ID number * 10 <sup>3</sup> / M-Bus ID number * 10 <sup>2</sup>
ID-NO	xxh	A	M-Bus ID number * 10 <sup>5</sup> / M-Bus ID number * 10 <sup>4</sup>
ID-NO	xxh	A	M-Bus ID number * 10 <sup>7</sup> / M-Bus ID number * 10 <sup>6</sup>
MANUFAC	00101101	C	Manufacturer Id 2D [ascii "K" - 64]*32*32+[ascii "A" - 64]*32+
MANUFAC	00101100	C	Manufacturer Id 2C [ascii "M" - 64] ISO 60870 standard
VERSION ID	16h	C	Module version 22
DEVICE TYPE	xxh	C	04h = Heat (volume measured at outlet) 0Ch = Heat (volume measured at inlet) 0Ah = Cooling (volume measured at outlet) 0Bh = Cooling (volume measured at inlet) 06h = Warm water (30 .. 90 deg. C) 16h = Cold water
ACCESS	xxh	C	Counts 1 up for each data transmission to M-Bus Master
STATUS	xxh	C	00h = No errors 08h = One or more permanent errors 10h = One or more temporary errors 18h = One or more permanent and temporary errors at the same time
CONFIGURATION	00h	C	(not used)
CONFIGURATION	00h	C	(not used)

## 7 Timing summary

Below listed values are typical values for communication between meter and M-Bus module.

### 7.1 Power up

Timing from power on module until data are available for read out.

Data	Min. time	Notes
New data from meter	25 sec.	
Module data	6 sec.	
Module data after short disconnect	3 sec	Disconnect of power < 1 sec.

### 7.2 Automatic data refresh

Timing for automatic refresh of data in module.

Data	Interval	Reading time	Notes
Consumption data	15 min.	4 sec.	
All data	24 hours	12 sec	

### 7.3 Read out

Timing for reading data from the module after initialization, where the module has refreshed data from the meter.

Data	Min time	Notes
Initialize -> Request	6 sec.	SND_NKE -> REQ_UD2

Most often data collection interval from the meter is every 60 seconds. In short periods every 28 seconds.

M-Bus module for MULTICAL® 402 with MULTICAL® III compatible data package