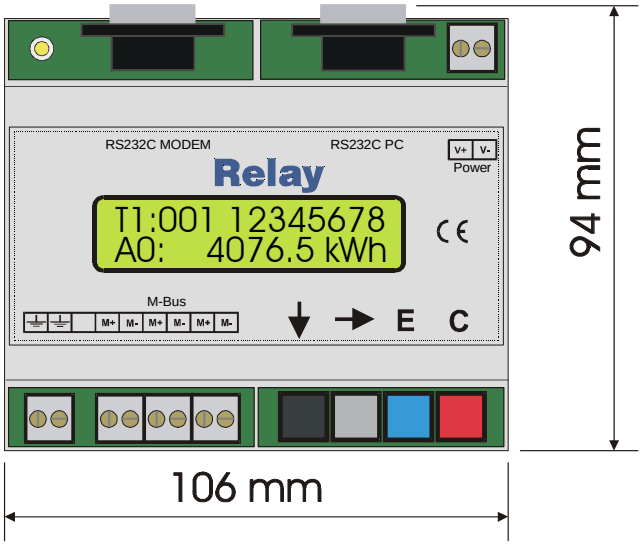
M-Bus Display / M-Bus Datalogger for 3 / 20 meters



- M-Bus data collecting station*
- Intervals: 1 minute .. 1 year*
- Stores due-date values*
- Generates reading profiles*
- 1, 2 or 4MByte FLASH memory *
- Remote display with filtering
- Remote access via 10-bit modem
- Software can be updated
- Level converter for 3 or 20 unit loads
- 300..9600 baud
- Suppression of echo
- Short circuit protection
- Overcurrent protection
- Mountable on DIN rail
- External, flexible power supply

* only with MR00xDL

Ordering information and accessories:

Article no.	
MR005FA	Display and level converter for 3 meters
MR005DL	Display, datalogger and level converter for 3 meters
MR006FA	Display and level converter for 20 meters
MR006DL	Display, datalogger and level converter for 20 meters
Accessories	
MOD001	Analogue 10-Bit modem
SW_DOKOM	DOKOM CS (Readout software)

The standard memory size of the devices is 1 MByte. You can order more data memory by adding the suffix –2M (for 2MByte) or –4M (for 4MByte).

The **M-Bus** is a low cost, 2-wire field bus system for reading and remote powering of consumption meters for heat, gas, water, electricity … The physical layer and basic elements of the protocol are defined in the european standard EN 1434-3.

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Firmware version: V1.9 and higher

This manual describes the **M-Bus Display** (MR005FA and MR006FA) and the **M-Bus Datalogger** (MR005DL and MR006DL). All devices can be operated as a transparent level converter and as a remote display with keyboard or by remote control. The datalogger adds the possibility to read all the meters in the network automatically and store the data into the internal FLASH memory.

Standards:

The M-Bus Display (MR005FA, MR006FA) and the M-Bus Datalogger (MR005DL, MR006DL) follow these standards:

M-Bus:	EN1434-3
Emmission:	DIN EN50081-1, EN 55022 class B, EN 60555
Immission:	DIN EN50082-2, ENV 50140, ENV 50204, EN 61000-4-4

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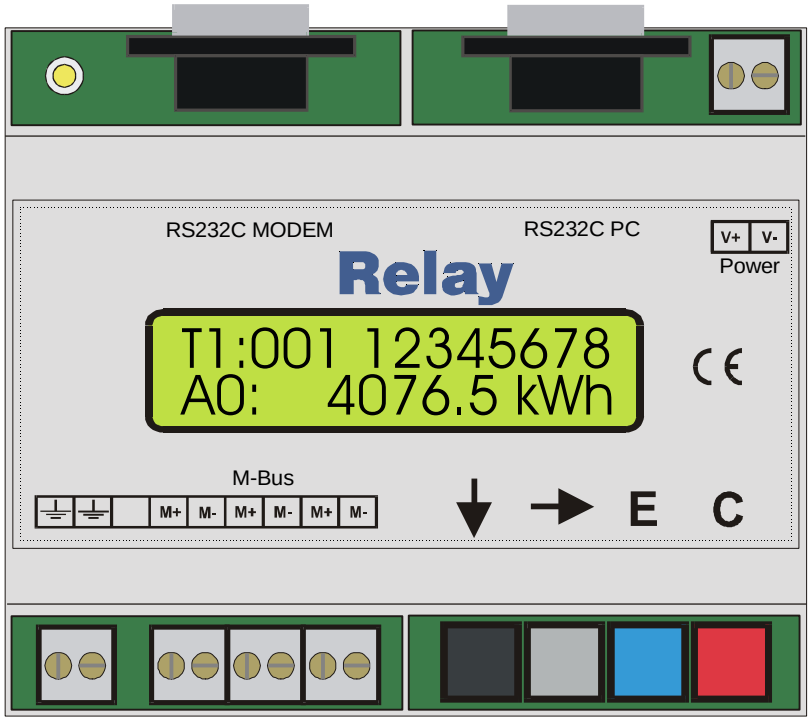
1 Installation and startup

Connectors:



RS232 PC: PC interface for service and level converter operation

RS232 MODEM: Modem interface for service and level converter operation

M-Bus: **M+**, **M-** M-Bus terminals (3 pairs). M-Bus devices are wired polarity independent in parallel to the same line. The signs +, - mark only the different bus lines.

⏚ ⏚ Earth for symmetry of M-Bus

Power: **V+** Power supply: positive terminal for DC (10..28VDC)

V- Power supply: negative terminal for DC

- Polarity independent for AC, 13..27VAC
- Please do not connect mains supply !!

LED lamp: The green LED is on if the power supply is connected and the microcontroller is ready for operation.

RS232 interface:
The M-Bus can be accessed by an RS232C interface. A PC should be connected to the right DB9 socket or a modem to the left DB9 plug. Only one of these connectors can be used simultaneously. You can attach a 1:1 serial cable to PC or the cable which was delivered with you modem to the modem. The modem must be configured before it is connected (see addendum: “Modem configuration”).

Pinning of DB9 connectors:

Pin	Socket	Plug	Usage socket	Usage plug
2	RXD	TXD	Transmit to PC	Receive from modem
3	TXD	RXD	Receive from PC	Transmit to modem
4	-	DTR	Unused	Always active
5	GND	GND	Ground potential	Ground potential
7	RTS	CTS	Handshake unused	Always active
8	CTS	RTS	Always active	Handshake unused

Pin 1, 6 and 9 are not connected

Simultaneous use of interfaces:
In case of a local readout using the keyboard of the remote display or during an automatical readout the RS232 interfaces do not have access to the M-Bus. These functions can produce temporary disturbances in communication. Additionally the datalogger performs no automatic readout of meter data during the operation by keyboard or serial interface.

Hints for installation:

- Write down the individual ID no. of the meters in the flats / real estates
- Configure the meters or puls adaptors
- Configure the M-Bus Display / Datalogger (using keyboard or with the service software FService on a Laptop or by Modem)
- Log in with the PasscodeB (predefined to: 00001767)
- Setup baud rates, search mode .. in the menu „Display config.“
- Start search for installed meters with „List of slaves - AutomaticSearch“
- Check the list of slaves for missing meters, you can add missing slaves manually if it is necessary
- Change the predefined passcodes (at least passcode B)

Trouble shooting:

- No LED is on:
  Check power supply and fuse.
- Display shows “Status: overload”:
  Check the M-Bus wiring for short circuits and ground loops. Defective slaves can also produce an overcurrent. The source for the short circuit can be found easier by removing some bus segments from the M-Bus terminals.
- One or more meters are not detected in automatic search procedure:
  Retry automatic search. Check baud rate and address of this meter. You can manually add the meter to the list of slaves and then perform a single readout of this meter.
- No reply from meter:
  Check baudrate and address of this meter. Check the bus extension: The bus voltage must be >24V at any slave. Temporarily remove other bus segment.
- „Status: Error“:
  MR00xDL/FA in waiting status (inactive): Press ↓ and C keys simultaneously to view the list of errors. Please note the error codes and then delete the error codes by pressing the → key. The most important error codes can be decoded using the table in the addendum.
- Wrong Passcode
  Please do the following steps, if you have forgotten the passcode:
  Do the actions which are described in “Status: Error” and then press the → key again. Please write down the 16 digit string (display config) and send it together with the firmware version no. and serial no. to INFO@RELAY.DE by email. We will send you a working passcode.

2 Description of the Level Converter

Funktion:

The RS232C interface signals are directly connected to the M-Bus all the time except during the operation by keyboard, the remote access using the command menu and the automatic readout. External connected controllers (laptop, building control systems ..) can use the device during the inactivity as a level converter for the physical layer of the M-Bus. The software of the controller must provide the communication protocols of the connected meters. The members of the MR005 family are able to supply up to 3, the members of the MR006 family up to 20 slaves (unit loads) with power.

Technical Data

Supply:	Voltage:	10..28VDC, 5W 13..28VAC, 9W
Environment:	Operating temperature:	0..+45°C
	Storage temperature:	-10..+60°C
	Humidity:	10..70% (non condensing)
Housing:	Dimensions:	W x H x L = 105 x 94 x 58 (mm)
	Protective class:	IP20
	Material / colour:	Noryl / light-grey (similar to RAL 7035)
Weight:	0,23kg	

M-Bus specifications

Parameter	min.	Typ.	max.	Einheit
Max. no of unit loads (slaves): MR005FA/DL	3			
Max. no of unit loads (slaves): MR006FA/DL	20			
Internal resistance			100	Ω
Bus voltage mark (@ 0mA)	29.0	30.5	32.0	V
Voltage drop for space = log. 0	12	12,5	13	V
Level for overcurrent interruption	50	60	70	mA
Level for bit detection from slave		7		mA

1 unit load = 1,5mA

Planning M-Bus networks:

Two effects must be considered before projecting M-Bus networks:

1. The signals must not be distorted to much by the influence of the capacitance of the cable. The capacitance of the network depends on the length of the network, this means the total sum of cable length. Lower baudrates allow a higher bus capacity.

2. Each meter must be supplied by the M-Bus with a minimum voltage of 24V. The voltage drop on the bus line is caused by the transmit current of the communicating slave of up to 20mA, the supply current of the slaves in the respective bus segment, the internal resistance of the M-Bus master, the resistance of the cable and the connection resistances of the joints. The distance between a slave and the master is inverse dependent on the number of slaves in this segment and on the cable diameter.

The maximum allowed resistance of the cable $\mathbf{R_L}$ between the MR005../MR006.. can be estimated with the following formulas (N = no. of unit load, each 1.5mA):

N slaves at end of cable: **to be defined**
N slaves equally distributed: **to be defined**

The calculation for a standard phone cable JYSTY nx2x0.8 (75Ω/km, 150nF/km) presents the following values:

Baudrate	9600 Baud	2400 Baud	300 Baud
Max. total cable length (@150nF/km):	1 km	4 km	12 km

No. of unit loads in the respective segment	Max. distance to the meter (@75Ω/km)	
	Equally distributed	slaves at end of cable
3	4.0 km	4.0 km
20	2.5 km	1.5 km

There are remote repeaters (our art.no. DR007) available for extending the network length and the number of connected slaves. Cascading these remote repeaters allows a nearly unlimited bus extension. The place in which a remote repeater is placed must provide a mains supply.

Shielding

Tests performed by the M-Bus Usergroup showed the result that a shielding of the M-Bus cable is not necessary. Please avoid a connection between any of the bus lines to the shielding or protective ground.

3 Description of the M-Bus Display

Function

The M-Bus Display allows reading the meters using the keyboard and viewing the consumption values on the LCD. The reading personell is then able to get the data of many meters from one central location without the need to enter all the flats and without further technical equipment (laptop..). Additionally the device offers a so-called command mode for remote readout of meters using a standard modem (10-bit). The M-Bus software Dokom CS and FService support this command mode.

Installation

After login with a passcode (predefined as 00001767) the operator gets access to the menu system, which is described later. It is important to generate the list of meters for readout of data. The automatical search for installed meters will be much faster, if the user reduces the search options in search mode or search baudrates (e.g. searching with 300 baud is very slow). These options can be selected in the menu „Display config.“ You should also change passcode B to prevent other persons from changing the setup and passcodes.

Error messages

An exceed of the maximum allowed current and short circuit are signalled with LEDs under the terminal lid compartment and also on the LCD. If there are problems with interpretation of the M-Bus data the display shows „Status: Error“. The “list of errors“ is shown on the LCD after simultaneously pressing the ↓ and C keys in the inactive state. Please note the error codes and then delete the error codes by pressing the → key. The most important error codes can be decoded using the table in the addendum. On restart after power fail the error list is also deleted.

Passcode protection

The M-Bus Display distinguishes between 3 passcode modes and 2 passcode levels:

The operator is requested to enter a passcode after pressing any key in the **standard mode (mode A)**. In this mode the **passcode A** (reader´s passcode) gives only low level access limited to readout functions. The caretaker or tenant can read single meters by selection from the list of slaves or all meters from the network. It is not possible to change the list of slaves or other options of the M-Bus Display here.
The login with the **passcode B** instead of passcode A gives access to the complete menu. On delivery the predefined value for passcode A is 00000000 and for passcode B is 00001767. This allows a simple login to level A by just pressing the E-key. We strongly recommend to change passcode B to avoid manipulation by unauthorized persons. You can setup the passcode from the menus „Display config. – New passcode A” and “Display config. – New passcode B”.

Access by ID: The M-Bus Display supports a different setup of the passcode mode from the menu „Display config. – Passcode mode“. If this mode is activated, the user (tenant) can make a readout limited to his own meter(s). After first key-press the tenant is requested to type in the ID (identification no.) of the required slave. Afterwards this single meter is read and its data displayed. Please note that only meters which support secondary addressing are readable in this mode. The access to the menu is possible in this mode after input of the ID 00000000 and login with the described passcodes.

Access by Adr: This mode allows a direct readout of meters using their primary addresses without any login procedure. This mode is similar to “Access by ID”. The primary address for global readout 254 is used by default. So by just pressing the E key you can read a meter if there is only one meter connected. The cursor keys allow editing the address. You can leave the input mask and step to the passcode request by pressing the → key three times.

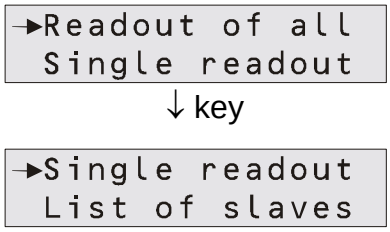
4 Keyboard operation

Basics:

Besides the control using Fservice the device includes 4 keys and a backlighted display for comfortable, local access to all functions. The buttons give a very precise, mechanical feedback and each input is acknowledged by an acoustic signal (beep). Execution of menu entries and input of numbers are described later. The device automatically returns to inactive state after some minutes without input.

Selection of a menu entry:

An arrow marks the active menu entry on the LCD. The arrow is moved down with the ↓ key (black) and up with the → key (grey). Pressing the E button (blue) executes the currently selected menu entry. The C button (red) cancels the input and exits from the menu.



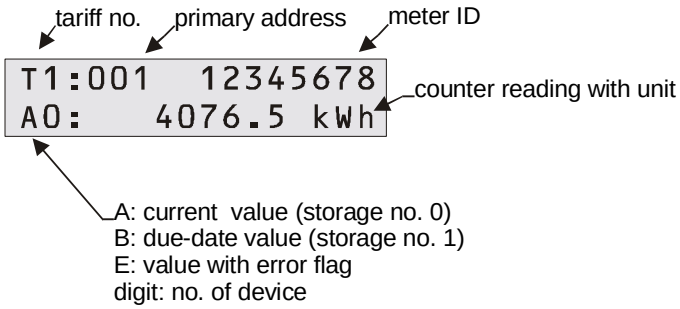
After input of passcode and confirming with the E key the main menu is activated. You can always see two entries of this menu. The first displayed lines are “Readout of all” and “Single readout”. By pushing the ↓ button the LCD scrolls to the next part of the menu. In this example the line “Single readout” will then be marked with the arrow. This submenu would be entered by pressing the E key.

Input of numbers:

The ↓ button increments the number of the active position by one. After the 0 it restarts with the 9 again. The → key moves the cursor to the next position on the right. The active position is blinking. After pressing → at the most right digit the cursor moves to the most left digit. The E button ends and acknowledges the input regardless of the current position. You can cancel the input with the C key.

Displayed data:

The device only displays the most important data for reasons of easy interpretation and not to confuse the reading personell. Some meters offer actual and historical values, different tariffs and additional devices like pulse counters in a heat meter. The first row always shows the primary address and ID for a clear association of the data to the respective meter. The first two characters in this row give information about the tariff.



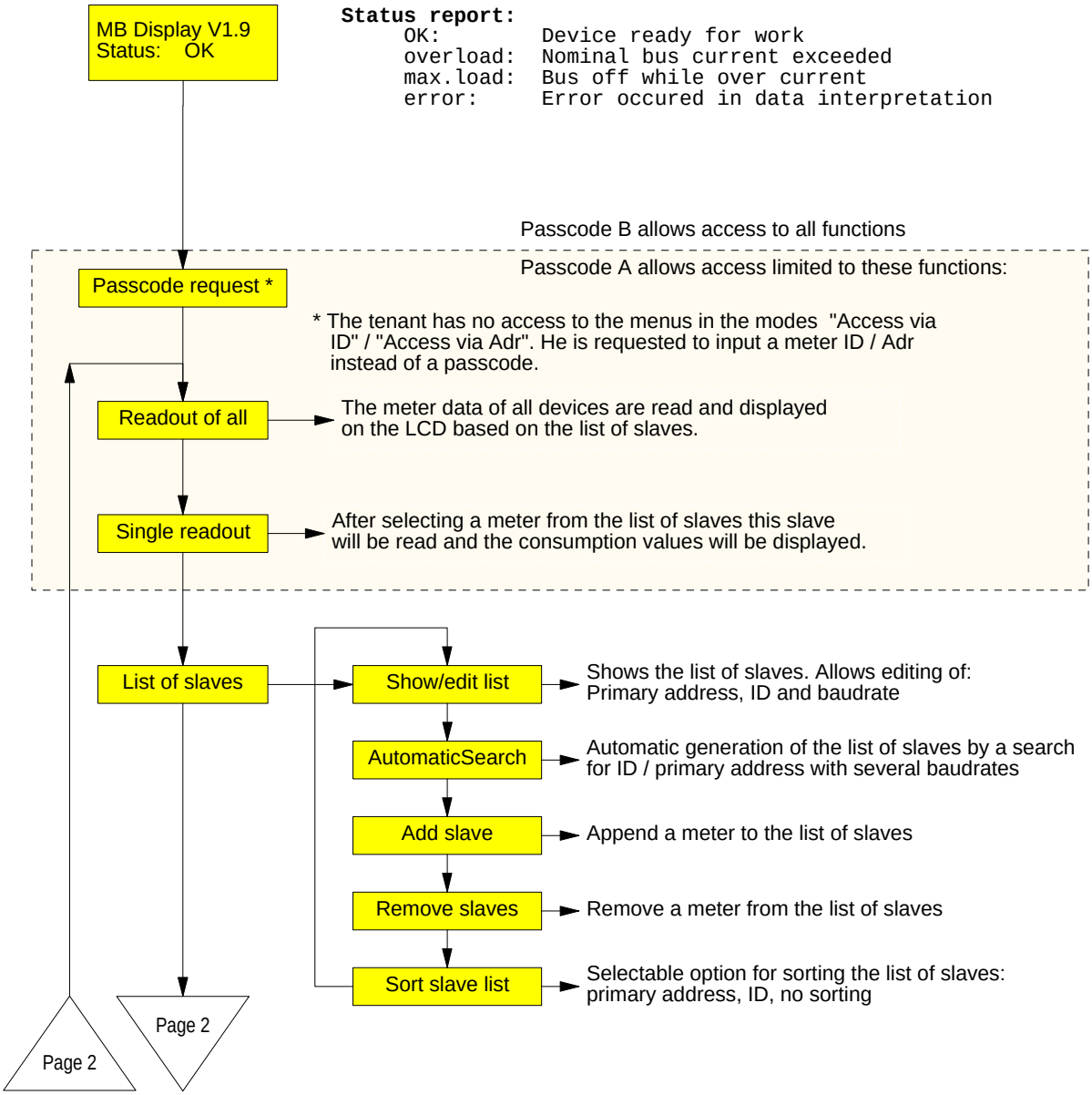
The second row displays the due-date or the data with physical unit. The first two characters show information which distinguishes between the different values:
The character “A” marks current values which are characterized by storage no. 0. The character “B” appears with due-date values (storage no. 1). If the respond frame of the slave contains activated temporary or permanent error bits in the Status byte , an “E” will be shown. The first character follows one digit for the device (0 = main device).

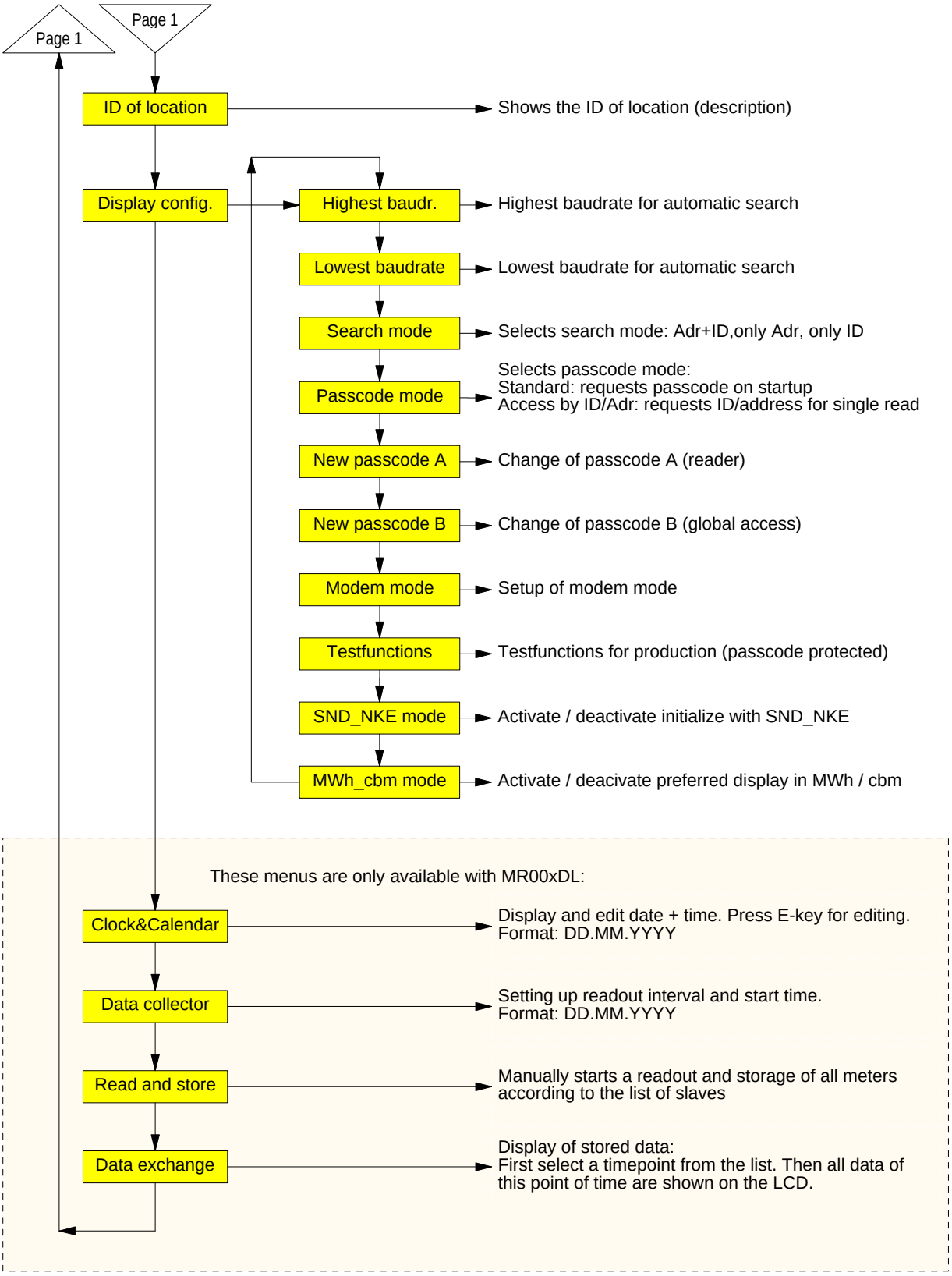
Filtering data:

To make the readout of data easy the device only displays the most important values of the meters. Only the first respond telegram after initialization with SND_NKE is supported. The data is limited to tariff 0 to 3, device 0 to 7, storage no. 0 and 1 and function “instantaneous”. The marking of these values is described above.

The energy, volumes, temperatures (flow, return, differential), volume flow and power are displayed if they are included with the respond frame. The limitation is derived from accepting only the VIF´s $00 ..$1F, $58..$63 and $6E. These are the following basic units and additional power of tens: Wh, J, l, kg, W, l/h °C and HCA. Also available points of time are supported. A maximum number of 30 entries can be viewed from one meter.

Menu structure:




Page 1
Page 1
ID of location
Shows the ID of location (description)
Display config.
Highest baudr.
Highest baudrate for automatic search
Lowest baudrate
Lowest baudrate for automatic search
Search mode
Selects search mode: Adr+ID,only Adr, only ID
Passcode mode
Selects passcode mode:
Standard: requests passcode on startup
Access by ID/Adr: requests ID/address for single read
New passcode A
Change of passcode A (reader)
New passcode B
Change of passcode B (global access)
Modem mode
Setup of modem mode
Testfunctions
Testfunctions for production (passcode protected)
SND_NKE mode
Activate / deactivate initialize with SND_NKE
MWh_cbm mode
Activate / deacivate preferred display in MWh / cbm
These menus are only available with MR00xDL:
Clock&Calendar
Display and edit date + time. Press E-key for editing.
Format: DD.MM.YYYY
Data collector
Setting up readout interval and start time.
Format: DD.MM.YYYY
Read and store
Manually starts a readout and storage of all meters according to the list of slaves
Data exchange
Display of stored data:
First select a timepoint from the list. Then all data of this point of time are shown on the LCD.

Description of the most important menus

Readout of all:
This entry reads all meters according to the list of slaves and displays their data. For each meter its baud rate and primary or secondary address is used for communication.

Single readout:
The readout of single meters also uses information from the list of slaves. The submenu shows the list with the information of position, primary address and ID. The meter will be read after moving the cursor to the desired position and pressing the E button.

Automatical generation of the list of slaves:
The automatical search for installed meters with generation of the list of slaves is started from the menu entry “List of slaves – AutomaticSearch” with the E key. The C button cancels the current part of search and jumps to the next search step. Especially searching with 300 baud takes much time. You should select just the needed baudrates from the menu “Display config. – Highest baudrate / Lowest baudrate” to avoid unnecessary long search times. It is also possible to limit the search to primary or secondary address using the menu “Display config. – Search mode”. At the end of the search the display shows the number of detected meters. You should check the entries of the list of slaves from the menu “List of slaves- Show/edit list”.

Editing the list of slaves:
The entries in the list of slaves can also be edited by the user using the menu “List of slaves – Show/edit list”. Move the cursor to the desired position and start the edit mode with the E key. You can change the chars with the ↓ button and step to the next position with the → button. The E key confirms and the C key cancels editing. The changes affect only the list of slaves, but not the meter options itself. Editing entries is useful if a meter has been exchanged. It is also possible to add new meters from the meu “List of slaves – Add slave” or to delete single meters from the submenu “– Remove slaves”.

Setup of baud rates:
On delivery the M-Bus Display / Datalogger is configured to search with all supported baudrates: 300 and 2400 bd. You can accelerate the search procedure by limiting the search baudrates with “Display config. – Highest baudrate” and “ Lowest baudrate” .

Implemented elements of protocol and data types

The device includes no meter-specific interpretation, but accepts all meters with a M-Bus telegram according to the documentation of the M-Bus Usergroup and the European standard EN1434-3, which fulfill the following demands:

- Variable data structure (mode 1) or fixed data structure (mode 1 or mode 2)
- Number formats: Integer (8bit, 16bit, 24bit, 32bit, 48bit, 64bit)
  Real (32bit)
  BCD (2digit, 4 digit, 6digit, 8digit, 12 digit, 16digit)

5 Remote control with commands

Function

In the inactive state the MR00xFA and MR00xDL work like simple level converter. The signals of the RS232C and RS485 interfaces are converted to M-Bus signals and vice versa. The CPU watches the data transmission and reacts on certain control frames. Following a successful login command the device switches itself from level converter mode to command mode. Then the device can directly be controlled with a PC or via modem using the RS232C interface. This command mode includes reading single meters, downloading alll stored data, configuration and even an update of the software. The document “W60CMxxE.PDF” (xx = version) describes all commands for development of adapted readout software. The following documentation describes our software Fservice for configuration and remote control of MR00xDL and MR00xFA.

Operation with modem

The M-Bus protocol uses an 11-bit format with very critical timing requirements. The modems which are nowadays available on the market don´t support this format. Therefore we offer a special solution called “M-Bus modem” for use with any level converter and also with MR00xDL/FA in level converter mode.
In spite of this the command mode makes use of standard modems with 10-bit format. There are two programs which support communication to MR00xDL/FA using commands: FService and Dokom CS (under preparation).

6 Additional functions of the Datalogger

Functionality

The Datalogger MR00xDL software offers a scheduler for time-triggered readout and storage of M-Bus data. The scheduler distinguishes between two modes:

a) Readout in fixed periods from one minute to one week
b) Readout at fixed points of time (e.g. at end of each month)

On automatic readout the Datalogger reads all meters which are included in the list of slaves. The first respond telegram after a SND_NKE + REQ_UD2 is stored together with the readout time into the FLASH memory.

Selecting readout time

The readout time can be selected using the keyboard and LCD or by remote access with a PC or via a modem. The following selections are possible via keyboard:

- 1, 2, 3 , 5, 10, 15, 20, 30 minutes interval
- 1, 2, 3, 4, 6, 12 hours interval
- once per day, once per week, twice per week, once per month
- 4 times per year, 2 times per year and once per year
- 0 times per year = logging function deactivated

Calculation of storage capacity

The size of the data memory is 1MByte, but optionally 2MByte or 4Mbyte are possible. In the worst case the M-Bus frame can be 261 bytes long, but mostly the telegrams are much shorter. A typical heat meter for example transmits 79 bytes. Water meters and pulse adaptors often use even shorter frames. Additionally a length field and a point of time is stored with the M-Bus frame. This adds 12 Bytes. In our example 20 heat meters with 79 bytes M-Bus frame + 12 bytes occupy 1820 bytes inside the FLASH for every readout. The FLASH is organized as a ring memory with 16 blocks of 64kB (65536 bytes) or in total 1MB. If the current block is full, the next block will be erased completely. So it could happen that only 15 block are full with data. In this example there is enough memory to store minimum 15 x 65536 / 1820 = 540 readouts.The practice shows that usualy there are often installations with less meters and shorter M-Bus telegrams.

Download of stored data

The contents of the data memory can be downloaded in command mode using a direct or a modem connection with FService or Dokom CS.

The most current readouts are also available via keyboard and LCD. The menu “Data exchange” shows a list with the last 25 readout times. You can scroll through the different points of time and select one with the E button. Then the data of all meters for this readout is displayed in the same manner as with “Readout of all”.

7 PC-Software FService

The devices can be operated via keyboard without software or as simple level converters with any M-Bus software. The software FService offers a comfortable access to and control of the Datalogger and M-Bus Display. The software can work locally with a PC or remotely via a modem.

The software is described in a special document delivered with Fservice.

8 Addendum

8.1 Error Codes

The following table shows the error codes. See “Error fixing – Status: Error”:

Code	Error
$00	No error
$01	RAM error (please send the device to us for repair)
$11	EEPROM write problem
$18, $19, $1C	EEPROM read problem
$20	Problem with communication to real time clock
$30, $31, $32, $33	Problem with FLASH memory
$51,$52	Problem with data in real time clock
$61, $62	Problem with YModem transmit , Xmodem reception

8.1 Modem Configuration

You must configure the modem before it is connected to MR00xFA or MR00xDL. Please use a terminal software of your choice, e.g. the Windows HyperTerminal and connect the PC to the modem. Choose 9600 baud, 8 data bits, no parity and one stopbit. Then input the following commands and activate each with the “Enter” key:

Command	Function
AT	for baudrate detection
AT&F	load factory settings
AT&D3	resets modem after DTR signal off
ATS0=1	modem answers a call after one ring
AT\Q0 or AT&K0	deactivate hardware and software handshake
AT\J0	no adaption of the serial baudrate to line speed
AT&W0	stores the settings into profile 0
AT&W1	stores the settings into profile 1

These commands are examples, which will work with several, but not all modems on the market. Please study the manual of your individual modem to find out whether you need to use modified commands.

After configuration please connect the modem to the MR00xFA/DL using the cable delivered with the modem and plug it into the DSUB labelled with “MODEM”.