Open Metering System
Technical Report 02
Wired M-Bus

Version 1.0.4 – 2015-10-26
Release

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-NKE-NKE

1 Preface

This document describes the Open Metering System requirements for the Wired M-Bus. The Wired M-Bus is normatively represented in the EN 13757-2 / -3 standard. During application of the said standard, a certain amount of scope for interpretation or design freedom is offered. Among other things, this factor applies to the coding of the data within the application layer.

A number of different M-Bus datagrams from different manufacturers therefore exist, with partially identical content. Because of this, problems often arise during the interpretation of datagram data in processing by readout systems or readout programs.

The specifications and standardisations in this document should contribute to increase the interoperability of Wired M-Bus products and minimise or solve existing problems.

2 Introduction

The Wired M-Bus is a field bus for the capture of consumption data from different media. It was developed in the 1990s by Prof. Dr. Horst Ziegler (University of Paderborn) in cooperation with the Techem and Texas Instruments companies.

The Wired M-Bus was initially defined in the standard for heat meters, EN 1434. Later followed an independent standard for the Wired M-Bus and the Wireless M-Bus, EN 13757. The physical layer and the data link layer are defined in part 2 of EN 13757. The application layer is represented in part 3.

The Wired M-Bus is designed as a two-wire bus which is inexpensive to implement. The wiring topology requirements are very tolerant. In addition to communication, the power supply to the connected devices can be provided via the Wired M-Bus.

In normative terms, many configuration options are allowed at the datagram level to the manufacturer of Wired M-Bus products. As a consequence, a variety of different datagrams exist, with partially identical contents. This variety leads to incompatibilities, together with increased implementation and maintenance costs for downstream readout systems.

With the aid of the OMS system definition, the existing shortcomings, incompatibilities and normative grey areas are eliminated. The objective is to ensure the highest degree of interoperability between all Wired M-Bus products. The intention is not to replace the M-Bus standardbut to supplement or limit those places where too much freedom of interpretation is present.

First of all therefore, the terms used are explained (chapter 3) and the references are listed (chapter 4). The known problems in using the Wired M-Bus are then stated and briefly explained (chapter 6). Finally, the scope for interpretation is restricted by specifications and definitions (chapter 7). In addition, further standards and documents are referred to in some chapters.

3 Glossary of terms

Additional terms and clarifications for glossary annex of OMS Vol. 1 (see chapter 4 for reference).

Term	Description, English	Description German
A	**A**	**A**
B	**B**	**B**
C	**C**	**C**
C-Field	Control Field containing the FCB and FCV bits and other control information	Das Kontrollfeld enthält die FCB und FCV Bits, sowie weitere Kontrollinformationen
CI-Field	Control Information Field, contains the type of command sent (set baud rate, application reset, select slave, etc.)	Kontrollinformationsfeld. Enthält die Art des Befehls (set baud rate, application reset, select slave…)
Collision	More than one slave sending at the same time, leading to corrupted data	Mehr als ein Slave senden zur gleichen Zeit Daten, wodurch eine Kollision entsteht
D	**D**	**D**
Deselection	Clearing the “selected” status by sending a SND-NKE command or a selection command with a non-matching secondary address	Entfernen des „Selected“ Status durch senden eines SND-NKE Befehls oder eines Selection Befehls mit einer nicht übereinstimmenden Sekundäradresse.
DIB	The Data Information Block contains one DIF and zero to ten DIFEs for the length, type and coding of the data – also see *VIB*	Der Data Information Block enthält ein DIF und null bis zehn DIFE für die Datenlänge, -type und –codierung – siehe auch *VIB*
DIF	Data Information Field – control field – element of the M-Bus datapoint, for the resolution and additional control elements	Data information field – Kontrollfeld – Element des M-Bus-Datenpunktes für die Auflösung und zusätzliche Steuerelemente
DIFE	Data Information Field Extension, contains additional information such as tariff or subunit of the device; see: *DIF*	Erweiterung des Data Information Field. Enthält zum Beispiel den Tarif oder eine Untereinheit; siehe: *DIF*
DIN	German Institute for Standardization	Deutsches Institut für Normung
DRH	Data Record Header, contains the DIB and VIB information bytes and is followed by the data to be transmitted	Der Data Record Header enthält die DIB und VIB Informations-Bytes gefolgt von den zu übertragenden Daten.
E	**E**	**E**
F	**F**	**F**
FCB	Frame Count Bit is a toggling bit, signalling if data blocks are repeated due to an error condition (bit not changed) or in correct order.	Das Frame Count-Bit ist ein Umschalt-Bit welches signalisiert ob Datenblöcke Aufgrund eines Fehlers (Bit wechselt nicht) wiederholt werden
FCV	Frame Count Valid bit signals whether the frame count mechanism is active	Das Frame Count Valid-Bit legt fest ob das FCB aktiv ist.
G	**G**	**G**
H	**H**	**H**
I	**I**	**I**
J	**J**	**J**
K	**K**	**K**
L	**L**	**L**

M	**M**	**M**
Master	Provides the power on the M-Bus. Collects data from the slave devices on the M-Bus.	Stellt die Spannungsversorgung auf dem M-Bus bereit. Datensammler für die Informationen der Slave-Geräte am M-Bus
MDH	Manufacturer-specific Data Header, followed by manufacturer-specific data	
N	**N**	**N**
O	**O**	**O**
P	**P**	**P**
Q	**Q**	**Q**
R	**R**	**R**
REQ-UD1	The master Requests User Data (class 1)	Request the User Data. Anfrage des Masters für Benutzerdaten (class1)
REQ-UD2	The master Requests User Data (class 2)	Request the User Data. Anfrage des Masters für Benutzerdaten (class2)
RSP-UD	Response with user data	Respond User Data. Antwort mit Benutzerdaten
S	**S**	**S**
Slave	The slaves (usually meters) are seen from the master as constant current sinks connected to the bus, which signal the master by using two different currents if a mark or space has to be transmitted. Data packets from the master are detected by the slaves because of changed voltage levels	Die Slaves (üblicherweise Messgerät) werden vom Master als Konstant-Stromsenken am Bus angesehen. Die Signale werden vom Master über zwei verschiedene Stromschwelle (Mark / Space) erkannt. Datenpakete des Masters werden vom Slave über unterschiedliche Spannungen erkannt.
Selection	The master sends a SND-UD command to the address 253, using the specific meter secondary address to select a slave. From that time, the device can be addressed by address 253 until it is deselected.	Der Master sendet ein SND-UD Befehl zur Adresse 253 unter der Verwendung der spezifischen sekundären Adresse des Zählers. Ab jetzt kann der Zähler über die Adresse 253 erreicht werden, bis eine Deselektion erfolgt.
SND-UD	Send User Data to slave	Send User Data. Senden von Benutzerdaten zum Slave
SND-NKE	The value of the FCB is adjusted in master and slave and the slave is deselected when secondary addressing is used	Die Wertigkeit des FCB wird im Master und Slave angeglichen. Unter Benutzung der Sekundäradressierung wird der Slave deselektiert.
T	**T**	**T**
Topology	Structure of the M-Bus network with cable lengths, cable types and number and distribution of slaves	Netzwerktopologie: Struktur des M-Bus-Netzwerks mit Kabellängen, -typen und Anzahl und Verteilung der Slaves
U	**U**	**U**
Unit load	Constant load (UL) of 1,5 mA which is drawn from the bus if the slave is in idle mode or transmits a “mark” to the master. One to four ULs are allowed.	Last (UL) von 1,5 mA, welche der Slave im Idle-Mode dem Bus entnimmt wenn der Bus im Ruhezustand ist oder der Slave ein „Mark“ an den Master sendet. Es sind ein bis vier ULs erlaubt.
User	A person who designs, installs or starts up M-Bus installations in the field.	Der Benutzer projektiert, installiert oder betreibt M-Bus-Installationen im Feld.

V	**V**	**V**
VIB	The Value Information Block contains one VIF and zero to ten VIFEs	Der Value Information Block enthält eine VIF und null bis zehn VIFE um den Messwerten eine Einheit und Multiplikator zuzuweisen.
VIF	Value Information Field. Element of the MBus protocol used to define units and scaling factor of a datapoint and additional information.	Das Value Information Field definiert Einheiten und Skalierungsfaktoren sowie Zusatzinformationen.
VIFE	Value Information Field Extensions. Adds information to the VIF (e.g. m3), such as "per hour" or an error status or actions to be performed (e.g. clear data).	Die Value Information Field Extension fügt zur VIF (z. B. m3) Zusatzinformationen wie „pro Stunde" oder einen Fehlerstatus oder Operationen (wie z. B. Daten löschen) hinzu.
W	**W**	**W**
Wired M-Bus	Wired version of M-Bus	Drahtgebundene Variante des M-Bus
Wiring parameters	Specific parameters of the cable and connectors (R/m, L/m, C/m)	Parameter für Eigenschaften von Kabeln und Verbindungselementen (R/m, L/m, C/m)
X	**X**	**X**
Y	**Y**	**Y**
Z	**Z**	**Z**

4 References

OMS:

- OMS Specification Volume 1, General Part, Issue 1.4.0 / 2011-01-31 *(insert updated version)*
- OMS Specification Volume 2, Primary Communication, Issue 3.0.1 / 2011-01-29
- OMS Specification Volume 2, Primary Communication, Issue 4.0.2
- OMS Conformance Test, Volume 1 General Part, Issue 1.0.1 *(change to 3.0.0)*, Volume 2 PHY (Radio Parameters), Issue 1.0.0 *(change to 3.0.0)*, Volume 3 Data Link Layer, Issue 1.0.1, Volume 4 Application layer, Issue 1.0.1 *(change to 3.0.0)*
- Appendix to the OMS Specification, Glossary of Terms, Issue 1.0.1 / 2011-11-04

EN:

- EN 13757-2: Communication systems for and remote reading of meters – Part 2: Physical and link layer; if not more precisely declared: February 2005
- EN 13757-3: Communication systems for and remote reading of meters – Part 3: Dedicated application layer; August 2013 is currently valid; if not more precisely declared: August 2005;
- EN 60870-5-2: Telecontrol equipment and systems – Part 5: Transmission Protocols – Part 2: Link transmission procedures, EN 60870-5-2:1992

DIN:

- DIN 43863-5: Identification number for measuring devices applying for all manufacturers

Further set of rules:

- M-Bus documentation: “The M-Bus: A Documentation” Rev. 4.8 from www.M-Bus.com
- Technical Directive BSI TR-03109-1, Requirements for the interoperability of the communication unit of an intelligent measuring system, version 1.0

5 Decisions and new definitions by OMS AG4

5.1 Physical Layer

The definition / description shall support the user with an application guideline to design and setup M-Bus networks for the required number of M-Bus slaves with respect to topology / wiring parameters and communication speed (alternative: the required readout interval) without applying measurement equipment during setup.

5.1.1 Cabling

The informative annex E in the standard EN13757-2 gives the user some examples of typical M-Bus installations using two different cable types. This chapter shall support the user with a refined application guideline to design and setup M-Bus networks for the required number of M-Bus slaves with respect to topology / wiring parameters and communication speed.

5.1.1.1 Cable Types

The standard refers to a telephone cable and a standard mains cable (cross section 1,5 mm^2). The mains cable is rarely used in real installations because this cable has no shielding and the wires are not twisted. The OMS does not suggest using this cable type in heavy-interference environments due to the missing protection against EMC influences.

The OMS reference cable for the M-Bus is defined as:

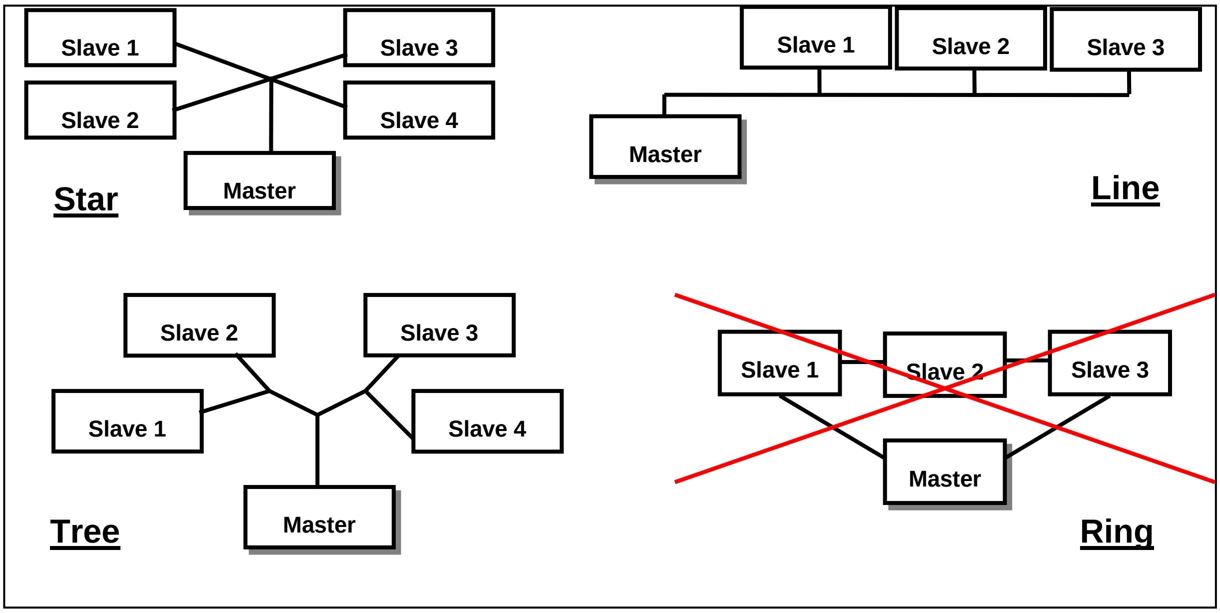
- J-Y(St)Y 2 x 2 x 0,8 mm (EN 50441:2012 Cables for indoor residential telecommunication installations, . DIN VDE 0815 Installationskabel und -leitungen für Fernmelde-und Informationsverarbeitungsanlagen)
- N x 2 x 0,8 mm diameter copper (0,5 mm^2 cross-section), resistance max. 75 Ohm/km per wire loop, with N = number of pairs of wires, N=1 is enough)
- twisted copper pairs
- shielding
- operating capacity at 800 Hz max. 100 nF/km
- attenuation at 800 Hz max. 1,1 dB/km

Other cables with comparable characteristics can be also used. The following explanations and calculations refer to the OMS reference cable type.

5.1.1.2 Topology

There are some basic physical configurations used for the cable connections between the M-Bus master and the slaves. These topologies are star, line and tree wiring as shown below. In real installations, a combination of these topologies will be used. A ring structure is not possible for M-Bus systems. A termination resistor is not allowed.

Figure 1: Topology variants



5.1.1.3 Wiring rules

- Keep total cable length as short as possible
- Be mindful of disturbance (EMC) from other electricity cables and installations
- Normally connect just one pair of wires; connecting a second pair would decrease the resistance, but increase the capacity of the cable
- Shielding shall be only connected to the protective earth on the master side and not at any slave.

5.1.1.4 The M-Bus lines shall not be coupled with ground / earth or any other voltage potential.Maximum length

The maximum possible cable length in an M-Bus system depends on the specific configuration, in particular on the type of master (maximum voltage drop), the cable, the topology, and the number of connected meters (unit loads). There are two limits to be considered:

The capacitive length is the maximum total cable length which can be wired to an M-Bus master. The capacity of the cable and the meters deforms the square wave signals. The capacity restricts the highest possible baud rate (communication speed) as shown here:

9600 Bd: 100 nF -> max. 1 km cable

2400 Bd: 400 nF -> max. 4 km cable

300 Bd: 1000 nF -> max. 10 km cable

The total cable length shall never be exceeded.

The resistive length is the maximum length of one cable connected to the master. The resistors in the master, the cable, and the protection resistors in the slaves cause a voltage drop. Each slave must have a minimum of 24 V DC mark voltage at its M-Bus terminals to work properly. The following examples show some typical situations in worst case topologies (all slaves at the end of the cable) and typical topologies (slaves connected to the cable at equal distances):

Example 1: Master for max. 20 meters with 30 V mark voltage and 50 Ohm internal resistance

- 20 slaves, worst case at the end: max. 3,0 km cable length
- 20 slaves, equally distributed: max. 4,0 km cable length

Example 2: Master for max. 60 meters with 40 V mark voltage and 15 Ohm internal resistance

- 60 slaves, worst case at the end: max. 1,0 km cable length
- 60 slaves, equally distributed: max. 2,5 km cable length

Example 3: Master for max. 250 meters with 42 V mark voltage and 10 Ohm internal resistance

- 60 slaves, worst case at the end: max. 2,0 km cable length
- 60 slaves, equally distributed: max. 4,0 km cable length
- 120 slaves, worst case at the end: max. 0,9 km cable length
- 120 slaves, equally distributed: max. 2,0 km cable length
- 250 slaves, worst case at the end: max. 0,4 km cable length
- 250 slaves, equally distributed: max. 0,9 km cable length

M-Bus repeaters can be used if the resistive or capacitive limits are exceeded.

The following table summarizes the suggestions of the EN13757-2:

Table 1: M-Bus applications

Application	Max. distance *	Total length **	Cable type	Max. no. of meters	Max. baud rate
Small in-house installation	350 m	1 km	0,5 mm²	250	9600 Bd
Large in-house installation	350 m	4 km	0,5 mm²	250	2400 Bd
Small field installation	1 km	4 km	0,5 mm²	64	2400 Bd
Large field installation	3 km	5 km	1,5 mm^2	64	2400 Bd
District	5 km	7 km	1,5 mm^2	16	300 Bd

* calculated for the worst case situation with all meters at the end of the cable

** Accumulated length of all cable segments in the network topology.

Chapter 5.1.14 shows measured / calculated characteristics of existing products (level converters, master).

An OMS installation guide is currently in preparation. It provides all relevant aspects for an appropriate installation.

5.1.2 SC charge / discharge

As the master in M-Bus systems are modulating the voltage, the slaves have to detect one threshold voltage for determining between logic high and low state of the bus voltage. Because of possible long term changes of the bus voltages and a wide span of allowed bus voltages, the threshold has to be determined dynamically. This can be done by storing the threshold voltage in a capacitor as reference.

It is recommended to use a fixed charge / discharge current solution for charging this capacitor. Following specifications are based on best practise solutions and follow available slave transceiver devices (e.g. ON Semiconductor, Texas Instruments) with a 100 nF – 330 nF storage capacitor:

- Charge: Stored voltage must increase at [25 – 500] V/s
- Discharge: Stored voltage must decrease at [0,5 – 15] V/s
- Ratio between charge and discharge speeds must be > 30

5.1.3 Inrush current

5.1.3.1 Definition and measurement of inrush current

The inrush current is the current flowing into a slave device within 1 µs after powering the bus to any allowed voltage level and must be <100 mA.

The inrush current is measured during the first 1 µs after powering the bus to voltage level U_{space}. It is measured with a shunt resistor (i.e. 1 Ohm) in one M-Bus line or with a fast acting current probe. The power source (M-Bus master or power supply) should have a very low impedance (i.e. <1 Ohm) for appropriate measuring. Voltage rise of the supply should be >100 V/µs. For measuring the inrush current the upper limit of the bus voltage is limited to 42 V.

5.1.3.2 Referenced sources from EN13757-2 for defining the inrush current

According to 4.2.2.6 bus load should be less than 100 mA within 1 min in any case

According to 4.2.2.8 bus load should be at its unit load within 1 ms after any bus voltage change

According to 4.2.2.10 input capacity at the slave terminals must be <= 0,5 nF

Annex A schematic implementation with series termination 2x Rs/2

Annex B reference schematic with over-voltage protection V3 and series termination R1-R4

5.1.3.3 Hints and remarks

As there is a long-term limit of 100 mA, it is logical to limit the inrush current to 100 mA.

Inrush current is mainly drawn by the input capacity.

Some measurements show that this 100 mA will be sufficient for current designs. But there are also some slaves which need up to 300 mA. One possible reason is that the over-voltage protection has a significant capacity and series termination (as shown in reference designs) follows that over-voltage protection. If termination is in front of over-voltage protection, it will limit the current load to less than 100 mA.

The measurements also show that the time concerned is about 1 µs. After about 200 ns, most of the current traces return to unit load.

5.1.4 Rise and fall times

The following limits on rise and fall times of the voltage modulation apply:

- < 75 V/µs (test condition: no load)
- < ½ x bit time (test condition: see 4.3.3.4)

5.1.5 Identification of the unit loads

The number of unit loads must be listed in the data sheet. Additionally it can be printed on the device. For devices that are to be installed in switching cabinets, care must be taken that the identification is applied close to the counter, so that as far as possible it cannot be hidden by a screen.

The identification is done in a total of 4 groups, where the maximum of 4 UL, i.e. a current draw of up to 6 mA, is not exceeded.

Table 2: UL ranges

Current draw of device (I)	Identification
I <= 1.5 mA	1 UL
1.5 mA < I <= 3.0 mA	2 UL
3.0 mA < I <= 4.5 mA	3 UL
4.5 mA < I <= 6.0 mA	4 UL

The current draw of 4 UL must not be exceeded.

5.1.6 Switch-on process

M-Bus Master:

Initial startup of the M-Bus Master

$t_{ReachingAllowedM\text{-}BusMarkVoltageLevel} = t_{Powerup\ M\text{-}Bus\ Master} + t_{M\text{-}Bus\ Voltage\ rise\ time}$

Resetting the M-Bus voltage after detection of an overload / short circuit of the M-Bus master

$t_{ReachingAllowedM\text{-}BusMarkVoltageLevel} = t_{M\text{-}Bus\ Voltage\ rise\ time}$

Conditions for the activation of the M-Bus voltage from 0 V ≤ U_{Bus} < 12 V until reaching the allowed mark state voltage:

- Strictly increasing
- Minimum slew rate ($t'_{M\text{-}Bus\ Voltage\ rise\ time}$): 168 V/s

Test conditions:

$$R_{load} = \frac{U_{MBusMaster,\ nominal}}{N \cdot UL}$$

$$C_{load} = 1{,}5\ \mu F$$

with $R_{load} \parallel C_{load}$, N=Number of Unit Loads, UL = Unit Load = 1,5 mA

M-Bus slave:

Initial startup of the M-Bus network

$t_{Slave\ communication\ ready} = t_{Powerup\ M\text{-}Bus\ Master} + t_{Linedelay} + t_{Sum\ Slave\ Capacities} + t_{M\text{-}Bus\ Voltage\ rise\ time} + t_{Slave\ Startup\ delay}$

Resetting the M-Bus voltage after detection of an overload / short circuit of the M-Bus master

$t_{Slave\ communication\ ready} = t_{M\text{-}Bus\ Voltage\ rise\ time} + t_{Linedelay} + t_{Sum\ Slave\ Capacities} + t_{Slave\ Startup\ delay}$

Note:

The startup delay of 3 seconds is measured from the time when the M-Bus voltage at slave terminals reaches the voltage level of 24 V.

5.1.7 Upper limit for voltage variation

The voltage variation between mark and space state must not exceed the following range:

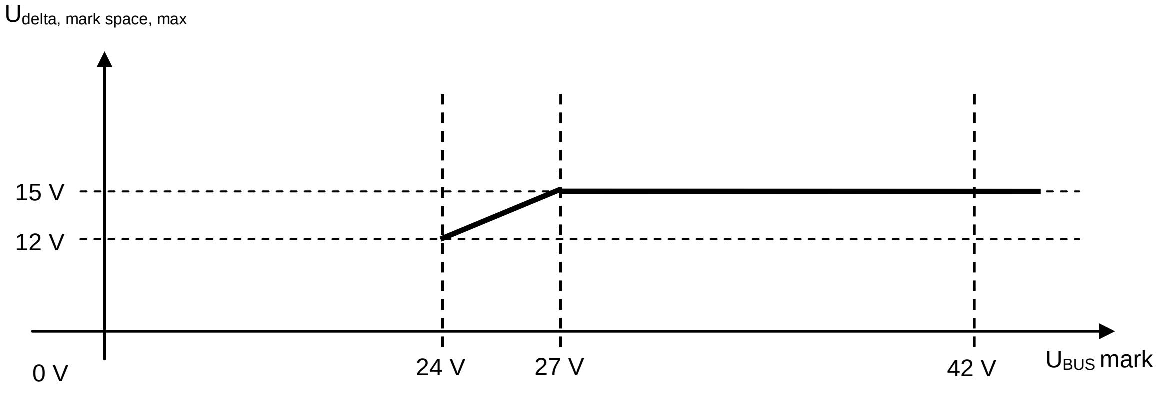
15 V ≥ $U_{delta,\ mark\text{-}space}$ ≥ 12 V, where upon $U_{M\text{-}Bus,\ Slave}$ shall always be ≥ 12 V"

$U_{delta,\ mark\text{-}space}$: Voltage variation between mark and space state of the M-Bus voltage
$U_{M\text{-}Bus,\ Slave}$: M-Bus voltage at the slave terminals for mark and space state.

The maximum allowable voltage variation between mark and space state is derived from the requirement of EN13757-2 / Chapter 4.2.2.3. The limitation of the change of the M-Bus current consumption of an M-Bus slave is defined for a voltage variation between 1 V and 15 V.

The maximum usable voltage variation between mark and space state for a specific M-Bus mark voltage level is depicted as follows:

Figure 2: Voltage variation



Note: With $U_{BUS\ mark}$ for the voltage level at M-Bus slave terminals; for $U_{BUS\ mark}$ voltages for the M-Bus master, U_r must be taken into account.

Referenced sources to define the voltage requirements from EN13757-2:

- EN13757-2 / Chapter 4.3.3.2

  USpace < UMark – 12 V, but ≥ 12 V + U_r.

- EN13757-2 / Chapter – 4.3.3.4 Minimum voltage slope

  The transition time between space state and mark state voltages from 10% to 90% of the steady state voltages shall be ≤ 1/2 of a nominal bit time. The asymmetry of these transition times shall be ≤ 1/8 of a nominal bit time.

  Test conditions (CLoad selected from the E12 value series):

  - baud rate 300 Bd: CLoad = 1,5 μF;
  - baud rate 2400 Bd: CLoad = 1,2 μF;
  - baud rate 9600 Bd: CLoad = 0,82 μF;
  - baud rate 38400 Bd: CLoad = 0,39 μF.

- EN13757-2 / Chapter 4.2.2.3 - Variation of the mark state current with bus voltage

  For bus voltages in the range (12 V ... 42 V), a voltage variation of 1 V … 15 V shall not change the bus current by more than N × 3 μA/V.

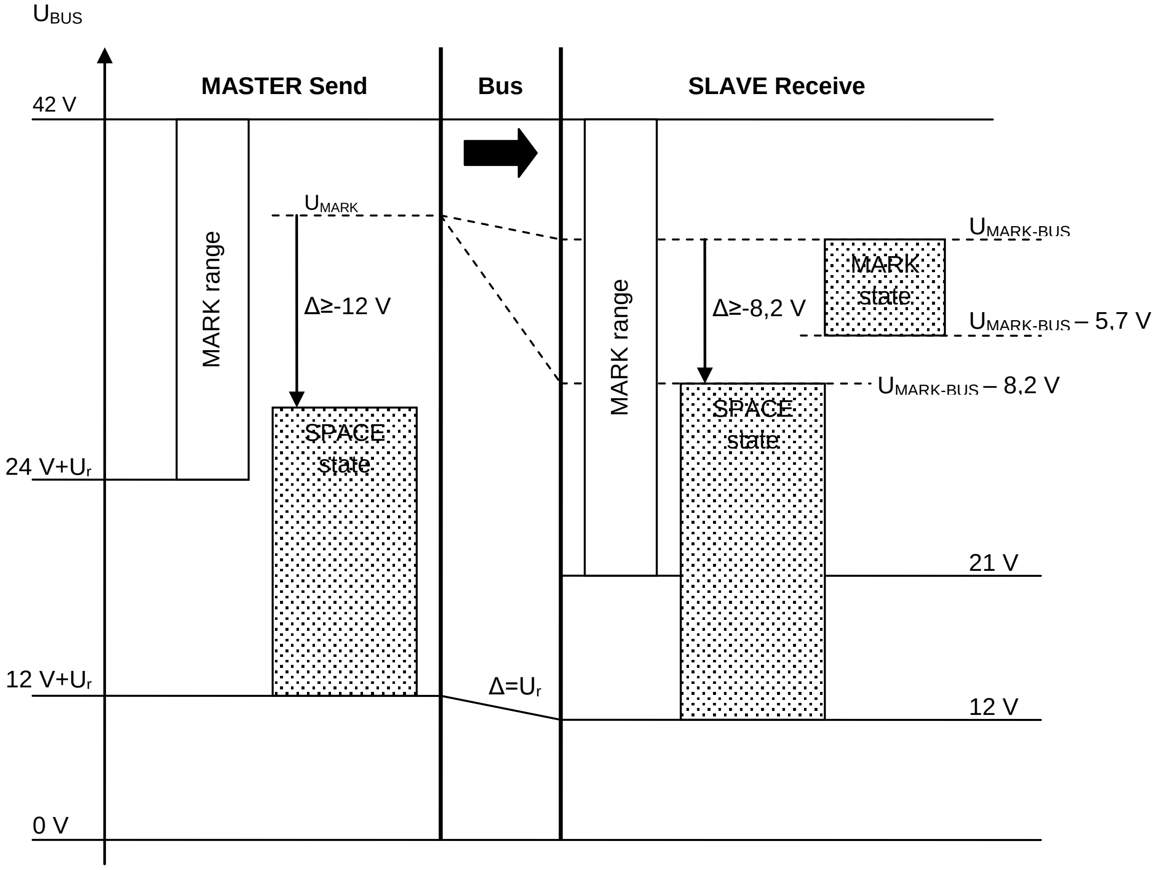
5.1.8 Minimum slave M-Bus voltage

The M-Bus voltage at M-Bus slave terminals shall be at least ±24 V (±21 V) for mark and ±12 V for the space state of the M-Bus voltage.

The slave requirement for a minimum allowable mark state voltage at M-Bus slave terminals is ±21 V (for details, refer to EN13757-2 / Chapter 4.2.1). The M-Bus voltage may fall below the typical mark state voltage of ±24 V (at M-Bus slave terminals) in case another M-Bus slave responds, there is a data collision of two or more M-Bus slaves or at least one M-Bus slave has a fault (for current limitation requirements in case of M-Bus slave faults, refer to EN13757-2 / Chapter 4.2.2.6).

The following diagram summarises the requirements from the EN13757-2 concerning the M-Bus voltage for master and slave.

Figure 3: M-Bus voltage



$U_{r,\ max}$ = (max. usable bus current)*(max. bus resistance) +
(max. usable bus current)*(max. master source impedance)
> 0; with $U_{SPACE\text{-}BUS@MBusSlave} \geq 12$ V

The following chapters define the voltage requirements according to EN13757-2:2004.

5.1.8.1 Electrical requirements, master

- EN13757-2:2004 / Chapter 4.3.3.1

  For currents between 0 … I_{Max}: U_{Mark} = (24 V + U_r) … 42 V.

- EN13757-2:2004 / Chapter 4.3.3.2

  U_{Space} < U_{Mark} - 12 V, but ≥ 12 V + U_r.

- EN13757-2:2004 / Chapter 4.3.1.2 Max. allowable voltage drop (U_r)

  The max. voltage drop U_r (> 0 V) is defined as the minimum space state voltage minus 12 V. U_r divided by the maximum segment resistance between the master and any terminal device (meter) gives the maximum useable bus current for a given combination of segment resistance and master.

Electrical requirements, slave:

- EN13757-2 / Chapter 4.2.1 master to slave bus voltages

  "…

  Voltage range for meeting all specifications: ± (12 V … 42 V).

  The bus voltage at the slave terminals in mark (quiescent) state of master - slave communication (= UMark) shall be ± (21 V … 42 V).

  The mark voltage shall be stored by a voltage maximum detector with an asymmetric time constant. The discharge time constant shall be greater than 30 × (charge constant) but less than 1 s.

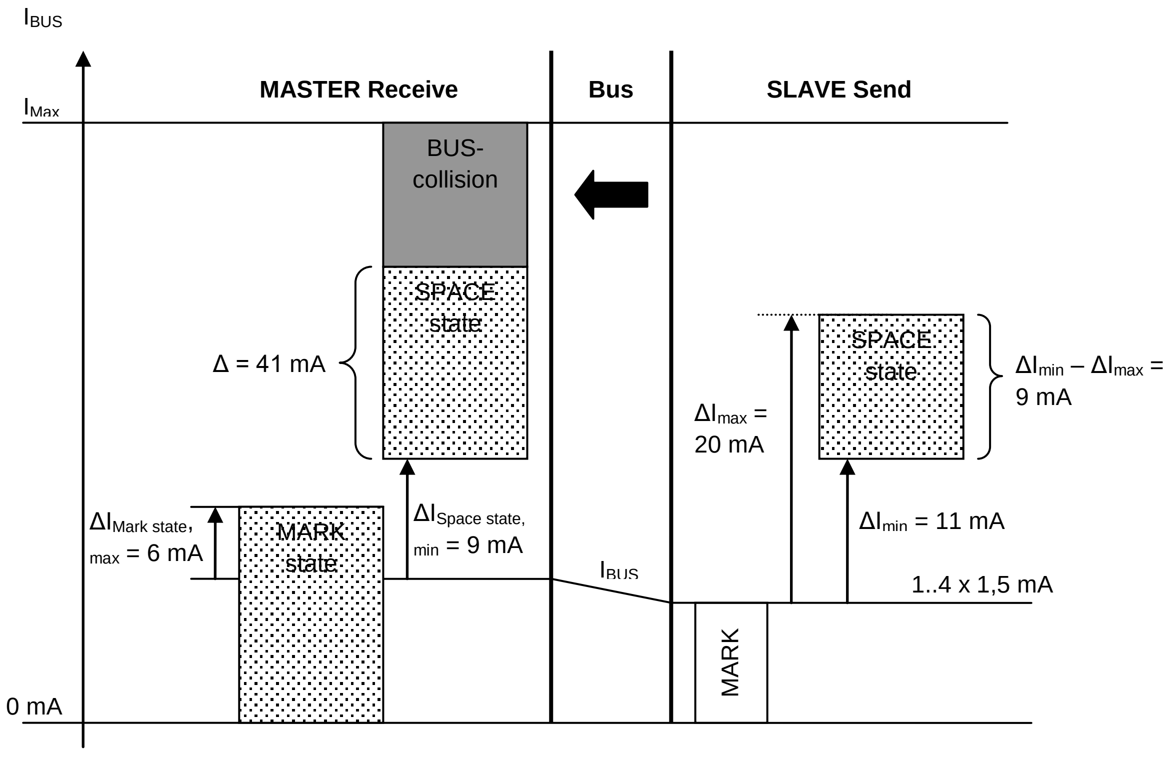
  The stored voltage maximum UMark may drop in 50 ms by not more than 0.2 V for all voltages between 12 V and UMark."

- EN13757-2 / Chapter 4.2.2.11 - Startup delay

  In case of a bus voltage drop below 12 V for longer than 0,1 s the recovery time after applying an allowed mark state voltage until reaching full communication capabilities shall be less than 3 s.

The following diagram represents the requirements from EN13757-2:2004 for state recognition and collision detection for the M-Bus slave to M-Bus master communication.

Figure 4: M-Bus states



$\Delta I_{Mark\ state,\ max}$: maximum allowable variation of the mark state current at the M-Bus master terminals to remain detecting mark state current.

$\Delta I_{Space\ state,\ min}$: Threshold where the master detects space state of an M-Bus slave reply.

The following chapters define the voltage requirements according to EN13757-2:2004.

- EN13757-2:2004 / Chapter 4.2.2.9 – space send current

  "The bus current for a slave space state send shall be higher by (11 ... 20) mA than in the mark state for all allowed bus voltages:

  $I_{Space} = I_{Mark} + (11 ... 20)$ mA."

- EN13757-2:2004 / Chapter 4.3.3.7 - Data detection current (reception of slave current pulses)

  "Bus current ≤ Bus idle current + 6 mA: mark state receive.
  Bus current ≥ Bus idle current + 9 mA: space state receive.

  Measurement with current pulses of < 50 ms, duty cycle < 0,92."

- EN13757-2:2004 / Chapter 4.3.3.8 - Reaction at large data currents (collision)

  "Current increases of > 25 mA may be considered, current increases of > 50 mA shall be considered as a collision state. If for …"

5.1.9 Hysteresis voltage deviation

5.1.9.1 Test master

U_r: defined by manufacturer
I_{max}: maximum load current before short detection defined by manufacturer
UL: unit load
UL_{max}: maximum *UL* for a master defined by manufacturer
N: number of unit loads, defined by manufacturer (must be ≤4)
All values measured to ±1%.
All tests are performed with baud rates of 300, 2400, and 9600.
All tests are performed at room temperature (20°…25°C) if no other temperature is specified.
To simplify the test equipment, U_L can be implemented using the NCN5150 from ON Semiconductor or the TSS721A from Texas Instruments.

Test 1, MARK range (EN 13757-2:2004, 4.3.3.1):

- device idle
- apply load 0, $I_{max}/2$, I_{max}

PASS: $24\ V + U_r \le U_{MARK} \le 42\ V$

Test 2, SPACE state (EN 13757-2:2004, 4.3.3.2):

- apply load 0, $UL_{max}/2$, UL_{max}
- send REQ-UD2

PASS: $U_{MARK} - 15\ V \le U_{SPACE} \le U_{MARK} - 12\ V$
AND $U_{SPACE} > 12\ V + U_r$

Test 3, rise / fall time (EN 13757-2:2004, 4.3.3.4):

- no load
- send REQ-UD2

PASS: > 0,2 µs for a voltage change of 15 V

- apply load 0, $UL_{max}/2$, UL_{max}
- send REQ-UD2

PASS: < ½ · bit time (test condition: see 4.3.3.4)

> 4.3.3.4:
> The transition time between space state and mark state voltages from 10% to 90% of the steady state voltages shall be ≤1/2 of a nominal bit time. The asymmetry of these transition times shall be ≤1/8 of a nominal bit time.
> Test conditions (CLoad selected from the E12 value series):
> - baud rate 300 Bd: CLoad = 1,5 µF;
> - baud rate 2400 Bd: CLoad = 1,5 µF;
> - baud rate 9600 Bd: CLoad = 1,0 µF;
>
> Proposed capacitor types: Panasonic EEAGA1H1R0, EEAGA1H1R5, EEAGA1H2R2

Test 4, effective source impedance (EN 13757-2:2004, 4.3.3.5):

- stable U_{MARK}
- apply load 0, $UL_{max}/2$, UL_{max}
- apply +20 mA
- after 50 ms

PASS: $U_{MARK}' \geq U_{MARK} - 1{,}2$ V

Test 5, bus collision (EN 13757-2, 4.3.3.8) (updated according to amendment for EN 13757-2):

- stable U_{MARK}
- apply load 0, $UL_{max}/2$, UL_{max}
- apply load +50 mA
  - for 2 bit times
    PASS: if no reaction
  - for > 2 bit times and <50 ms
    PASS:
    - if master emits break signal (U_{SPACE}) for 40 ms to 50 ms
    - and then applies U_{MARK}

Test 6, MARK / SPACE state (EN 13757-2:2004, 4.3.3.7):

- apply stable 0, $UL_{max}/2$, UL_{max}
- Master send: REQ-UD2
- Slave respond: SND-UD
- $I_{SPACE} < I_{MARK} + 6$ mA

PASS: no signal

- $I_{SPACE} \geq I_{MARK} + 9$ mA

PASS: signal

Test 7, Hum, ripple and short term stability (EN 13757-2:2004, 4.3.3.6)

- stable U_{MARK}
- apply load 0, $UL_{max}/2$, and UL_{max}

PASS: $U_{MARK,peak\text{-}peak} < 200$ mV over 10 s (measure with 1 µs resolution)

Test 8, Bus recovery (EN 13757-2:2004, 4.3.3.8):

- apply load UL_{max}
- short bus
- release after 10 s

PASS: recovery time of $U_{MARK} \leq 3$ s

Test 9, Galvanic isolation (EN 13757-2:2004, 4.3.3.9):

- measure resistance from any bus terminal to at least three metal parts (not the terminals) of the master *(Measurement shall be done with a conventional Ohm meter and not with 500 V test voltage.)*
- repeat with inverted polarity
- if the master is mains-powered or has a connection to ground based systems repeat measurement from these terminals

PASS: if resistance > 1 MOhm

5.1.9.2 Test slave

Voltages measured at the terminals of the device under test.
All values measured with ±1%.
All tests done with specified baud rates.

Test 1, N (EN 13757-2:2004, 4.2.2.1):

- device specification for N by manufacturer

PASS: $N \leq 4$

Test 2, Maximum permanent voltage (EN 13757-2:2004, 4.2.1):

- device idle
- apply +50 V and -50 V (static)
- for 5 minutes

PASS: no damage:

  - REQ-UD2 successful
  - AND test 3 pass

Test 3, I_{MARK} (EN 13757-2:2004, 4.2.2.2) and fast change (EN 13757-2:2004, 4.2.2.8:

- apply U = 42 V
- change U to 27 V with 15 V/ms
- wait 1 ms
- measure I
- change U to 12 V with 15 V/ms
- wait 1 ms
- measure I
- change U to 27 V with 15 V/ms
- wait 1 ms
- measure I
- change U to 42 V with 15 V/ms
- wait 1 ms
- measure I

PASS: $(N-1) \times U_L < I_{MARK} \leq N \times U_L$ (N_{max}=4)

Repeat for inverted polarity

Test 4, I_{MARK} variation over bus voltage variation (EN 13757-2:2004, 4.2.2.3):

Proposal:

- measure $I_{MARK,U}$ for U_{MARK} in the range from 12 V to 27 V in steps of 1 V
- calculate $\Delta I = abs(I_{MARK,U1} - I_{MARK,U2})$ for all abs(U1-U2) ≤15 V

PASS: ΔI ≤ N x 75 µA for all abs(U1-U2) ≤15 V

Repeat for inverted polarity

Test 5, Short term variation of the mark state current (EN 13757-2:2004, 4.2.2.4):

- apply U = 12 V, 24 V, and 42 V

PASS: variation of I_{MARK} < 1% over 10 s

Test 6, Total variation over allowed temperature and voltage range of slave device (EN 13757-2:2004, 4.2.2.5):

- test for T_{min}, 20°C, and T_{max}
- test for static U_{MARK} = 12 V, 24 V, and 42 V

PASS: variation of I_{MARK} < 10%

T_{min}, to T_{max} is the operation temperature range defined by manufacturer

Test 7, Slow start (EN 13757-2:2004, 4.2.2.7):

- apply *U* from 0 V to +/-42 V with rise time of 0,25 V/s
- measure *I* every second

PASS: $I \leq N \times U_L$

Test 8, capacity (EN 13757-2:2004, 4.2.2.10):

- measure capacity without bias at 10 kHz

PASS: capacity ≤ 0,5 nF

Test 9, MARK / SPACE state (EN 13757-2:2004, 4.2.1):

- apply stable U_{MARK} = 21 V AND 42 V
- $U_{SPACE} = U_{MARK}$-5,7 V

PASS: no signal

- $U_{SPACE} = U_{MARK}$-8,2 V

PASS: signal

The signal can either be determined by measurement of the reaction within the electronics of the device under test or by sending a REQ-UD2 and detection of the response.

Repeat for inverted polarity

Test 10, I_{SPACE} (EN 13757-2:2004, 4.2.2.9):

- apply stable U_{MARK} = 21 V AND 42 V
- Master send: REQ-UD2
- Slave send: SND-UD

PASS: $I_{MARK} + 11\ mA \leq I_{SPACE} \leq I_{MARK} + 20\ mA$

Repeat for inverted polarity

Test 11, Start-up delay (EN 13757-2:2004, 4.2.2.11):

- apply U_{MARK} (42 V) from 0 V
- after U_{MARK} > 24 V
  - wait 3 s
  - then send REQ-UD2

PASS: Slave sends SND-UD

5.1.9.3 Test equipment

5.1.9.3.1 Test master

As mentioned above, there are some integrated circuits available for slave designs. Such slave transceivers can be used for testing the masters.

Table 3: Master tests

Test No.	Comment	Equipment
1	MARK range (EN 13757-2:2004, 4.3.3.1)	• Current sink • Multimeter
2	SPACE state (EN 13757-2:2004, 4.3.3.2)	• Current sink from one slave transceiver • Command interface to master • Oscilloscope • Evaluation software for oscilloscope data
3	rise / fall time (EN 13757-2:2004, 4.3.3.4)	• Command interface to master • Oscilloscope with time resolution <=0,1 µs • Evaluation software for oscilloscope data • Current sink from one slave transceiver • Capacity switchable by software with specified capacitors
4	effective source impedance (EN 13757-2:2004, 4.3.3.5)	• Command interface to master • Current sink from one slave transceiver • Load of 20 mA switchable by software • Multimeter
5	bus-collision (EN 13757-2:2004, 4.3.3.8)	• Current sink from one slave transceiver • Load of 50 mA switchable by software • Oscilloscope • Evaluation software for oscilloscope data
6	MARK / SPACE state (EN 13757-2:2004, 4.3.3.7)	• Current sink from one slave transceiver • Command interface to master • Slave with variable current (from NCN5150)
7	Hum, ripple and short term stability (EN 13757-2:2004, 4.3.3.6)	• Current sink from one slave transceiver • Oscilloscope • Evaluation software for oscilloscope data
8	Bus recovery (EN 13757-2:2004, 4.3.3.8)	• Current sink from one slave transceiver • Short circuit switchable by software (current sink with 0 Ohms) • Oscilloscope • Evaluation software for oscilloscope data
9	Galvanic isolation (EN 13757-2:2004, 4.3.3.9)	• Ohm meter

5.1.9.3.2 Test slave

Table 4: Slave tests

Test No.	Comment	Equipment
1	N (EN 13757-2:2004, 4.2.2.1)	• Visual check
2	Maximum permanent voltage (EN 13757-2:2004, 4.2.1)	• Voltage source with +/-50 V (switchable by software) • Master for REQ-UD2 (incl. command interface)
3	I_{MARK} (EN 13757-2:2004, 4.2.2.2) and Fast change (EN 13757-2:2004, 4.2.2.8	• Voltage source (switchable by software) • Ammeter (readable by software, resolution 0,1 ms)
4	I_{MARK} variation over bus voltage variation (EN 13757-2:2004, 4.2.2.3)	• Voltage source (switchable by software) • Ammeter (readable by software)
5	Short term variation of the mark state current (EN 13757-2:2004, 4.2.2.4)	• Voltage source (switchable by software) • Ammeter (readable by software, resolution 1 ms)
6	Total variation over allowed temperature and voltage range of slave device (EN 13757-2:2004, 4.2.2.5)	• Climate chamber (controllable by software) • Voltage source (switchable by software) • Ammeter (readable by software, resolution 1 ms)
7	Slow start (EN 13757-2:2004, 4.2.2.7)	• Voltage source (switchable by software) • Ammeter (readable by software, resolution 1 ms)
8	Capacity (EN 13757-2:2004, 4.2.2.10)	• Capacitance meter (readable by software)
9	MARK / SPACE state (EN 13757-2:2004, 4.2.1)	• Master with adjustable voltages U_{SPACE} and U_{MARK}
10	I_{SPACE} (EN 13757-2:2004, 4.2.2.9)	• Master with adjustable voltages U_{SPACE} and U_{MARK} • Current measurement clamps with 10 µs resolution (evaluable by software, possibly on oscilloscope)
11	Start-up delay (EN 13757-2:2004, 4.2.2.11)	• Master with adjustable voltages U_{MARK}

5.1.9.3.3 Test equipment:

- Voltage source:
  - Controllable by software
  - +/- voltages
  - U_{max} = +/-50 V
  - rise: 0.25 V/s, 15 V/ms
  - Current: 1000 mA
- Current sink 1 for U_L:
  - Controllable by software
  - Built up from one slave transceiver
- Current sink 2:
  - Controllable by software
  - Static current to 500 mA
- Current sink 3 (possibly together with current sink 2):
  - Controllable by software
  - Short circuit
  - Switching time 1 ms
- Slave with variable current (possibly together with current sink 1):
  - Command interface for evaluation of M-Bus datagrams
  - Current adjustable by software (one slave transceiver)
- Climate chamber:
  - Controllable by software
  - -20°C to +150°C
  - Feed-throughs for measurement cables
- Master with adjustable voltage:
  - Command interface
  - U_{MARK} and U_{SPACE} adjustable separately
- Current clamps or ammeter:
  - Current to 100 mA
  - Resolution 1 µA
  - Time resolution 10 µs
  - Can be read out by software (possibly via oscilloscope)
- Oscilloscope:
  - Controllable and can be read out by software
  - Resolution 1 µs @ 10 MSamples
  - Resolution <0,1 µs @ 1 MSamples
- Capacitance meter:
  - Measuring frequency 1 kHz, 10 kHz
  - Voltage deviation: tbd (1 V_{PP})
  - Can be read out by software
- Voltage meter (multimeter):
  - Can be read out by software
  - Resolution: 0,1% of measurement range
- PC
  - Measurement software
  - GPIB interface (depending on measurement equipment used)

5.1.10 Transmission of the remaining communication energy of the battery (optional)

In the protocol there is a VIF / VIFE for the estimated battery lifetime or a bit in the status byte. See table 7 on p. 20 / table UL_{max}28 from p. 35 in DIN EN 13757-3:2013
The remaining estimated lifetime is transmitted using VIF=FDh VIFE=FDh E000 000p (remaining lifetime of the battery, p=0 for month(s), p=1 for year(s)) or VIF=FDh VIFE=E111 0100 (remaining lifetime of the battery in days). The number of remaining days / months / years is dynamically calculated depending on the read frequency / number of total readouts / bus traffic / measurement cycle frequency etc.

Relevant meters are:

- mains powered devices (e.g. partially M-Bus powered)
  For mains powered devices which do not have limitations in lifetime and / or readouts due to restrictions in energy budget, the transmission of the remaining lifetime or remaining requests can be omitted. The 'power low' in the status byte is never set. Purely mains powered devices may be not allowed in metrological regulations.
  For mains powered devices with backup battery to retain functionality in case of mains power loss the 'power low' in the status byte is set in case mains power loss is detected. In case mains power is recovered the 'power low' in the status byte is reset (independent from the remaining lifetime of the backup battery).
- devices with non-replaceable battery;
  For battery-driven devices the remaining lifetime shall be retrievable. The remaining lifetime can be either transmitted with every datagram or at least in static frames (Wireless M-Bus).
  In case the number of days / remaining readouts decreased until the value zero is reached, the value shall remain zero. No negative values are allowed.
  The 'power low' in the status byte shall be set in case the condition of less than 15 month (referenced in Vol. 2, 7.2.3) is met. In case the cyclic re-calculation of the energy budget results in a remaining lifetime of now more than 15 month (according to Vol. 2, 7.2.3), the power low bit shall be reset.
- Devices with replaceable battery
  Same as for devices with non-replacable battery.

5.1.11 Break detection (mandatory)

Adherence to the specification of the break identification is compulsory for all meters.

5.1.12 EMC requirements

The EMC requirements are sufficiently specified in EN 61000.

5.1.13 Logical slave disconnect (mandatory)

A (logical) disconnect of slaves from the M-Bus for saving battery power is not permitted.

The meter manufacturer shall declare the communication abilities for every M-Bus device (also those without restrictions).

5.1.14 Overview master characteristics

Table 5: Master characteristics

Manufacturer	Master / Level Converter	Max. no. of unit loads	Master no load voltage MARK in V	Master no load voltage SPACE in V	Master internal resistance in Ohm	Max. baudrate in Bd	Max. cable length at 9600 bd (all slaves at end of cable) 20 UL	60 UL	120 UL	250 UL	Max. cable length at 2400 bd (all slaves at end of cable) 20 UL	60 UL	120 UL	250 UL	Max. cable length at 300 bd (all slaves at end of cable) 20 UL	60 UL	120 UL	250 UL
[redacted]		250	41,5	28,5	10	38400	1000	1000	1000	453	3676	1918	1079	453	3676	1918	1079	453
		120	41,5	28,5	10	38400	1000	1000	1000	x	3676	1918	1079	x	3676	1918	1079	x
		60	38	25,5	12	9600	1000	1000	x	x	2983	1532	x	x	2983	1532	x	x
		20	30,5	18,5	68	9600	808	x	x	x	808	x	x	x	808	x	x	x
		3	30,5	18,5	68	9600	x	x	x	x	x	x	x	x	x	x	x	x
		32	42	26	2	2400	x	x	x	x	3878	x	x	x	3878	x	x	x
		64	42	26	2	2400	x	x	x	x	3878	2047	x	x	3878	2047	x	x
		128	42	26	2	9600	1000	1000	1000	x	3878	2047	1010	x	3878	2047	1010	x
		256	42	26	2	9600	1000	1000	1000	471	3878	2047	1010	471	3878	2047	1010	471
		32	30	17	24	9600	1000	x	x	x	1299	x	x	x	1299	x	x	x
		64	30	17	24	9600	1000	421	x	x	1299	421	x	x	1299	421	x	x
		8	28	17	51	9600	x	x	x	x	x	x	x	x	x	x	x	x
		75	37	25	5,5	2400	x	x	x	x	2879	1516	x	x	2879	1516	x	x
		150	37	25	5,5	2400	x	x	x	x	2879	1516	866	x	2879	1516	866	x
		250	37	25	5,5	2400	x	x	x	x	2879	1516	866	389	2879	1516	866	389
		25	34	22	15	2400	x	x	x	x	2181	x	x	x	2181	x	x	x
		50	34	22	15	2400	x	x	x	x	2181	x	x	x	2181	x	x	x
		75	34	22	15	2400	x	x	x	x	2181	1082	x	x	2181	1082	x	x
		25	32	20	15	2400	x	x	x	x	1800	x	x	x	1800	x	x	x
		250	36	24,1	1	9600	1000	1000	865	417	2749	1474	865	417	2749	1474	865	417
		25	37,4	23,4	11	9600	1000	x	x	x	2882	x	x	x	2882	x	x	x
		60	37,4	23,4	11	9600	1000	1000	x	x	2882	1484	x	x	2882	1484	x	x
		120	37,4	23,4	11	9600	1000	1000	698	x	2882	1484	698	x	2882	1484	698	x
		250	37,4	23,4	11	9600	1000	1000	698	259	2882	1484	698	259	2882	1484	698	259
		20	36,6	24	5	38400	1000	x	x	x	2810	x	x	x	2810	x	x	x
		80	36,6	24	5	38400	1000	1000	x	x	2810	1482	x	x	2810	1482	x	x
		10	32	20	8	9600	x	x	x	x	x	x	x	x	x	x	x	x
		80	36,6	24	5	38400	1000	1000	x	x	2810	1482	x	x	2810	1482	x	x
		80	36,6	24	5	38400	1000	1000	x	x	2810	1482	x	x	2810	1482	x	x
		25	35,8	23,8	10	9600	1000	x	x	x	2590	x	x	x	2590	x	x	x
		250	41	28	2	9600	1000	1000	1000	542	3688	1973	1155	542	3688	1973	1155	542
		80	37,5	24,5	18	9600	1000	1000	x	x	2808	1401	x	x	2808	1401	x	x
		25	36	18	20	19200	1000	x	x	x	2400	x	x	x	2400	x	x	x
		60	36	18	20	19200	1000	622	x	x	1000	622	x	x	1000	622	x	x
		100	36	18	20	19200	1000	622	x	x	1000	622	x	x	1000	622	x	x
		50	36	24	20	19200	1000	x	x	x	2495	x	x	x	2495	x	x	x
		90	36	24	20	19200	1000	1000	x	x	2495	1221	x	x	2495	1221	x	x
		250	34,7	35,7	2	9600	1000	1000	773	397	2488	1327	773	397	2488	1327	773	397

5.2 Link layer

5.2.1 Baud rates (mandatory)

Masters shall support 300 Bd, 2400, Bd and 9600 Bd.

Slaves shall support 300 and 2400 Bd.

Masters or slaves may support 19200 Bd and 38400 Bd.

The respective lower baud rates shall also be supported:

- • The master / slave supports 2400 Bd: support for 300 Bd is mandatory.
- • The master / slave supports 9600 Bd: support for 300 Bd and 2400 Bd is mandatory.
- • The master / slave supports 19200 Bd: support for 300 Bd, 2400 Bd and 9600 Bd is mandatory.
- • The master / slave supports 38400 Bd: support for 300 Bd, 2400 Bd, 9600 Bd and 19200 Bd is mandatory.

Automatic baud rate detection is specified as mandatory.

In principle, there is only one reason for using baud rates different to those given above: this is the matching to different M-Bus network topologies (bus expansion). Otherwise, a restriction could be made to one baud rate, for instance to 2400 baud.

It is a disadvantage that the "Search on the M-Bus" lasts that much longer as more baud rates are used. This is because the search must be restarted for each baud rate. The baud rates quoted are a good compromise:

- a lower baud rate 300 Bd for "poor" line conditions and "long" distances.
- an intermediate baud rate of 2400 Bd for standard applications and medium distances.
- an upper baud rate of 9600 Bd for "very good" line conditions and "short" distances.

The M-Bus is applicable for taking readings automatically from many meters within a specified readout period. This also still allows the quarter-hour readout period for electricity meters with the quoted baud rates and a large number of meters to be very well achieved.

5.2.2 Idle time between datagrams

The master is permitted to reject responds from a slave which arrive earlier than the wait time of 11 bit times according to EN 13757-2.

5.2.3 Change of primary and secondary addresses, unique secondary address

Changing the primary address of meters via the Wired M-Bus may only be done using VIF=7Ah.

A change of the secondary address is not permitted. Exceptions to this are adapters. Changing it via the Wired M-Bus may only be done usingWired M VIF=79h (see Vol. 2 V 4.0.2).

The secondary address shall be unique worldwide (according to Vol. 2, 3.1.2.2). Customer and vendor may agree an exception to this rule, if necessary.

The change of primary address must be possible using primary and secondary addressing.

5.2.4 Two or more logical M-Buses in one hardware environment

Reference: EN13757-2:2004, chapter. 5.7.7

Defined behaviour for the implementation of two or more logical M-Bus devices in one hardware environment (two primary, secondary addresses):

- Behaviour during secondary search: in event of collision, respond with A5h or E5h E5h …
- Changing baud rate: OK (always for entire physical device; supported by mandatory automatic baud rate detection)
- Application reset: OK (for the responding logical device)
- Primary address change: OK (for the responding logical device)
- Secondary address change: OK (for the responding logical device; change of secondary address according to the rules of chapter 7.2.3)
- SND-NKE: OK (for the responding logical device)
- REQ-UD1: OK (for the responding logical device)
- REQ-UD2: OK (for the responding logical device)

The manufacturer is free to decide which of the logical M-Bus devices responds. It is important that the user must have the option to determine the logical device that responds to M-Bus commands with the A-field FEh. For this he can send a REQ-UD2 (A = FEh) to the M-Bus slave before every M-Bus command. In the RSP-UD, it can then be recognised, according to the A-field and the ALA, which of the logical devices is active for the reaction to A = FEh.

This mechanism only works for point-to-point connections between M-Bus master and M-Bus slave. For more than one slave

- Behaviour for special addresses FEh: one of the logical M-Bus devices responds.
- Behaviour for special addresses FFh: all logical M-Bus devices process command datagrams.

5.2.5 Datagram detection

Reference: EN13757-2:2004 Figure 7, Key 5

The following rules apply for datagram detection:

Receiver:

Minimum response time:

- On detection of a correct frame: 11 bit times wait time (seeFigure 5)

Incomplete, defective frame: min. +P%; max. 22 bit times wait time (seeFigure 6)

Maximum response time: 330 bit times + 50 ms (seeFigure 5)

Basis for determining the tolerances: nominal stop bit time

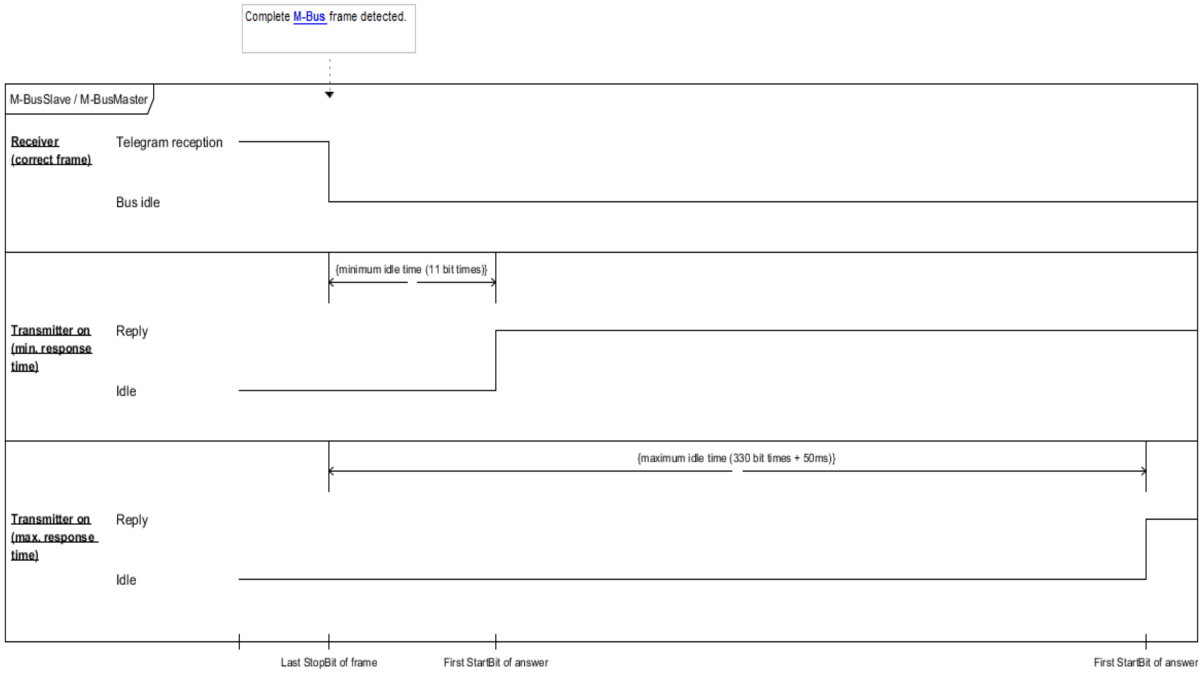


Figure 5: End of datagram detection for a valid M-Bus frame

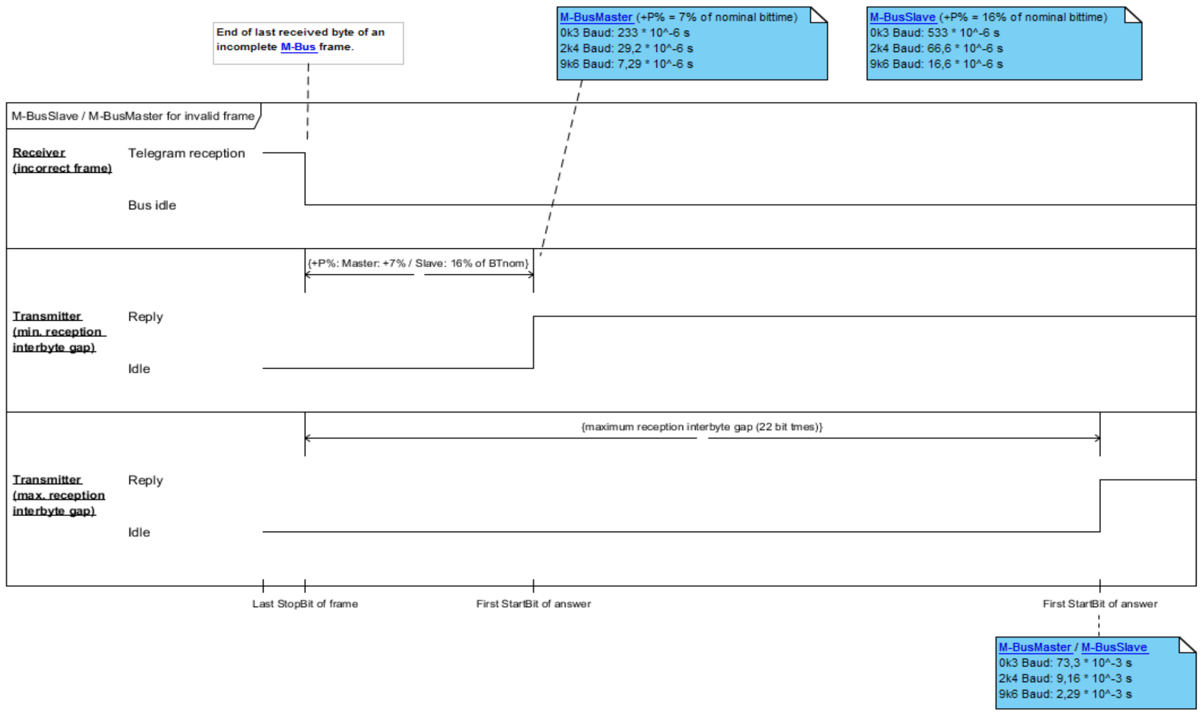


Figure6: End of datagram detection for an invalid / incomplete M-Bus frame

5.2.6 Special primary addresses 254, 255 (mandatory)

Each slave must support the addresses 253, 254 and 255. Commands to address 254 and 255 must always be executed.

5.2.7 SND-NKE (mandatory)

SND-NKE has effects on

- FCB: see EN 13757-3:2013
- Secondary addressing: deselection (only primary address 253, not for other addresses)

Further data changes / state changes in the slave are not permitted.

5.3 Networking layer / secondary addressing

5.3.1 Enhanced Selection (mandatory)

Clarification of the definitions for the enhanced selection:

- The valid specifications for secondary addressing are according to OMS Vol. 2, Version 4.0.2, chapter 3.1.2.2 "Secondary Address".
- The enhanced selection continues to be considered as optional for slaves.
- For the enhanced selection, the same mechanism applies as for secondary address selection (for resolution of the above-mentioned conflict with the OSI model).
- A master must process slaves with secondary address selection as well as with enhanced selection. A master is not able to distinguish slaves having equal secondary address fields and not supporting enhanced selection.
- Mechanical and electronic meters without Wired / Wireless M-Buses should state the universal meter ID DIN 43863-5 on the meter as unique identification.

5.3.2 Determination of addresses in adapters: Rule for incorrectly labelled meter (mandatory)

Fundamentally there are two serial number types possible in the field

- Numeric
- Alphanumeric

These can each have differing lengths and – for the alphanumeric serial numbers - contain any combination of letters, numbers and if necessary special characters.

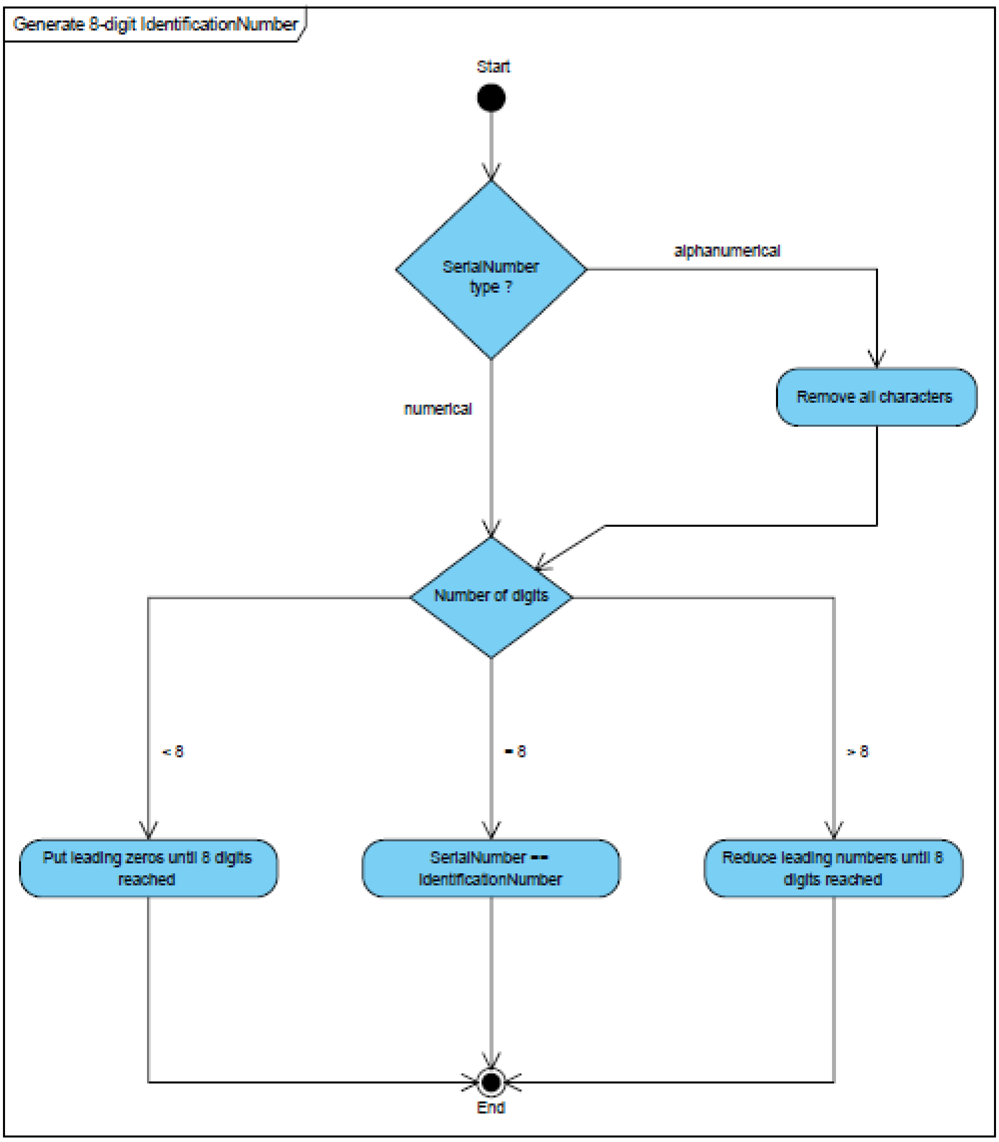
1. For meters with a 14-position identification number according to DIN 43863-5:

   No need for action

2. For numeric serial numbers, the following procedure is intended:
   - If the number of characters in the serial number = 8
     - Serial number → Identification number
       example: Serial number = "87468134" → Identification number = "87468134"
   - If the number of characters in the serial number > 8
     - Reduce the length to 8 places by removing the characters starting from the left
       Example: Serial number = "3887468134" → Identification number = "87468134"
   - If the number of characters in the serial number < 8
     - Fill the length to 8 places from the left with "0" (leading zero)
       Example: Serial number = "68134" → Identification number = "00068134"

3. For alphanumeric serial numbers, the following procedure is provided:
   a) Remove the letters and special characters from the serial number
   b) Proceed as described in "Numeric serial numbers" depending on the resulting length

Figure 7: Generation of 8-digit identification number



Examples:

Serial number	15DEP114	FF699299.000	5578/AAA	##0815muLi5AA5
Resulting identification number	00015114	99299000	00005578	00081555

4. Manufacturer and version cannot be changed in the adapter.

5. The device type can be adjusted in the adapter.

5.4 Application Layer

5.4.1 OMS Vol. 2 chapter 2.2: table with CI-fields (mandatory)

The CI-field 7Ah is restricted to the Wireless M-Bus.

5.4.2 New VIF / VIFE for the frame identification for multi datagram RSP-UD (mandatory)

The proposal in annex A is subject to modification during the standardization process in CEN / TC294.

5.4.3 New device type for wired adapters (mandatory)

Device type 38h is introduced for wired adapters (will be added to OMS Vol. 2 table 3).

5.4.4 Rules for multi datagram RSP-UD (mandatory, derived from EN 13757 definitions)

The following rules must be observed:

- Selection of the RSP-UD datagram may only be done via application select.
- SND-NKE shall not have any effect on the selected datagram.
- Datagram sequence control is realised using FCB.

5.4.5 Rules for discarding application errors (mandatory)

Using Application Select / Application Reset, the content of the output buffer is brought into a defined state, i.e. application errors are hereby also cleared from the output buffer.

5.4.6 Identification of a meter type in the master (mandatory)

If a device type with the existing header fields manufacturer, medium and version cannot be uniquely assigned (e. .g. different meter types / versions lead to the same manufacturer, medium and version), at least one of the fields VIF=FDh and VIFE=09h to 0Fh must be present and unique within the meter data RSP-UD.

5.4.7 Minimum communication capabilities for slaves (mandatory)

In addition to the specifications for minimum communication contained in EN 13757-2, the following commands are defined as obligatory for slaves:

- Set the primary address (DIF= 01h VIF =7Ah)
- Set the secondary address (only allowed for adapters, DIF=0Ch VIF=79h)
- Application reset and application select (CI = 50h or 53h)

5.4.8 Commands for communication if applicable (mandatory)

- Set the set day (data type G [DIF=42h VIF=6Ch]), if a calendar is present in the device
- Set the date and time (at least one of the data types F [DIF=04h VIF=6Dh], G [DIF=02h VIF=6Ch], I[DIF=03h VIF=6Dh], J[DIF=06h VIF=6Dh]), if a clock is present in the device

5.4.9 Extension of FDh table

The proposal in annex B is subject to modification during the standardization process in CEN / TC294.

5.5 Application Profile

t. b. d.

5.6 Installation

t. b. d.

5.7 Certification

5.7.1 Bit timing

OMS certified masters must comply with the rules for “Bit Timing”. The rules are checked during certification.

5.7.2 Startup

OMS certified slaves must comply with the rules for “Startup”. The rules are checked during certification.

5.7.3 Scope

All test conditions of TR-02 apply for discrete setups just as for integrated M-Bus ICs.

5.7.4 Test setup

Here we would suggest a “protocol tester” which monitors the (indeed rather slow) processes on a time basis.

This could be used in three scenarios:

(2a) setup 1: The case of a good and standard-conformant communication can be monitored with the protocol tester, which here assumes the role of a normal protocol monitor.

(2b) setup 2: To test the fault tolerance of the slave, the protocol tester can assume the role of the master and input fault cases while the behaviour of the slave is observed.

(2c) setup 3: To test the fault tolerance of the master and other devices, the protocol tester assumes the role of the slave and inputs fault cases while the behaviour of the master is observed.

5.8 Security

5.8.1 Introduction

Up to now the Wired M-Bus was used exclusively with unencrypted data. Due to the requirements for privacy and security the introduction of encrypted modes for Wired M-Bus communications is essential. Several countries (e. g. Germany) make these requirements a prerequisite for smart metering.

The foundation for the necessary definitions has already been set in OMS (Vol. 2 V 4.0.2, Annex E, Annex F). Annex N of Vol. 2 provides examples for Wired and Wireless M-Bus.

The purpose of this document is to clarify the basics, to explain the structure and to provide examples for possible variants.

5.8.2 Unencrypted messages for Wired M-Bus

N.1.2 in Annex N of Vol. 2 V 4.0.2 provides an unencrypted example for a RSP-UD for the Wired M-Bus.

The following layer structure is used for this example:

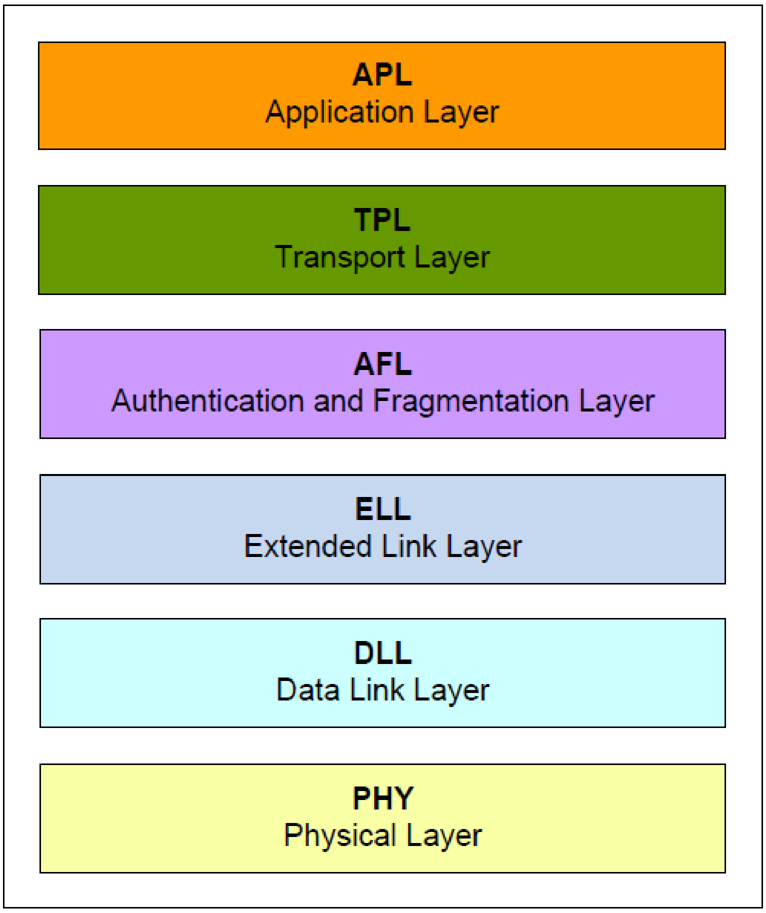
Data Link Layer (DLL): Header
Transport Layer (TPL): • CI=72h • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent) • Config Field: ○ Mode 0 ○ 2 Bytes length ○ Value: 00h 00h
Application Layer (APL): Set of Data Points (DPs), unencrypted
Data Link Layer (DLL): Termination

One DP consists of VIB, DIB and data.

5.8.3 Layer structure

OMS Vol. 2 V 4.0.2 introduced the AFL in order to enable fragmentation and authentication:

Figure 1 – M-Bus Layer model



ELL shall not be used for Wired M-Bus.

5.8.4 AFL mode 5 (Security Profile A)

Security profile A uses Mode 5 for encryption but does not use authentication (CMAC). AFL is required for fragmentation,

This message consists of several blocks (Multi-RSP-UD).

First fragment of Multi-RSP-UD:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • Message Length Field (ML) required • No Message Authentication Code (MAC) • No Message Counter (MCR)
Transport Layer (TPL): • CI=72h • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent) • Config Field: ○ Mode 5 ○ 2 Bytes length ○ Number of encrypted blocks • Decryption Verification (2Fh, 2Fh, encrypted)
Application Layer (APL): Set of DPs (Encrypted)
Data Link Layer (DLL): Termination

Following fragments:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) • No Message Authentication Code (MAC) • No Message Counter (MCR)
Application Layer (APL): Set of DPs (Encrypted)
Data Link Layer (DLL): Termination

Last fragment:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) • No Message Authentication Code (MAC) • No Message Counter (MCR)
Application Layer (APL): Set of DPs (Encrypted) and Set of DPs (Unencrypted)
Data Link Layer (DLL): Termination

The number of encrypted blocks (in the TPL) provides the possibility to add unencrypted DPs after the encrypted DPs. One example for unencrypted DPs is address information.

The message length ML in the AFL is calculated from the size of the whole message (see also Vol. 2 chapter 6.2.5).

Alternative solution 1: Single-RSP-UD with AFL:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • Message Length Field (ML) required • No Message Authentication Code (MAC) • No Message Counter (MCR)
Transport Layer (TPL): • CI=72h • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent) • Config Field: ○ Mode 5 ○ 2 Bytes length ○ Number of encrypted blocks ○ • Decryption Verification (2Fh, 2Fh, encrypted)
Application Layer (APL): Set of DPs (Encrypted) and Set of DPs (Unencrypted)
Data Link Layer (DLL): Termination

Alternative solution 2 according to EN 13757-3:2013: Single-RSP-UD without AFL:

Data Link Layer (DLL): Header
Transport Layer (TPL): • CI=72h • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent. • Config Field: ○ Mode 5 ○ 2 Bytes length ○ Number of encrypted blocks ○ • Decryption Verification (2Fh, 2Fh, encrypted)
Application Layer (APL): Set of DPs (Encrypted) and Set of DPs (Unencrypted)
Data Link Layer (DLL): Termination

5.8.5 AFL mode 7 (Security Profile B)

The following example shows an enhanced mode 7 structure.

All listed bullet points for the configuration of the AFL are exclusively valid for the current fragment.

Mode 7 uses MAC for Authentication which is located in the last fragment.

This message consists of several blocks (Multi-RSP-UD).

First fragment of Multi-RSP-UD:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • Message Length Field (ML) required • No Message Authentication Code (MAC) • Message Counter Field (MCR) required
Transport Layer (TPL): • CI=72h • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent) • Config Field: ○ Mode 7 ○ 3 Bytes length ○ Key ID K=0: Master Key ○ Key Derivation Function D=01h ○ Number of encrypted blocks ○ • Decryption Verification (2Fh, 2Fh, encrypted)
Application Layer (APL): Set DPs (Encrypted)
Data Link Layer (DLL): Termination

Following fragments:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) • No Message Authentication Code (MAC) • No Message Counter Field (MCR)
Application Layer (APL): Set DPs (Encrypted)
Data Link Layer (DLL): Termination

Last fragment:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) • Message Authentication Code (MAC) required • No Message Counter Field (MCR)
Application Layer (APL): Set DPs (Encrypted) and Set of DPs (Unencrypted)
Data Link Layer (DLL): Termination

ELL shall not be used. for Wired M-Bus.

5.8.6 AFL mode 13 (Security Profile C, TLS)

Annex F of Vol. 2 V 4.0.2 provides the definitions for the integration of TLS including the conditions when to use the Authentication service provided by the AFL. Due to the length of TLS communications, messages (AFL, Multi-RSP-UD) shall be fragmented.

SND-UD to Slave:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) • Message Authentication Code (MAC) required • Message Counter Field (MCR) required
Transport Layer (TPL): • CI=5Bh • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent) • Config Field: ○ Mode 13 ○ 3 Bytes length ○ Protocol type ○ Number of bytes • TLS Header
Application Layer (APL): Set DPs (Encrypted)
Data Link Layer (DLL): Termination

First fragment of Multi-RSP-UD:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • Message Length Field (ML) required • No Message Authentication Code (MAC) • Message Counter Field (MCR) required
Transport Layer (TPL): • CI=72h • Transport Layer address field (contains the address of the M-Bus Slave from which the RSP-UD is sent) • Config Field: ○ Mode 13 ○ 3 Bytes length ○ Protocol type ○ Number of bytes • TLS Header
Application Layer (APL): Set DPs (Encrypted)
Data Link Layer (DLL): Termination

Following fragments:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) required • No Message Authentication Code (MAC) • No Message Counter Field (MCR) required
Application Layer (APL): Set DPs (Encrypted)
Data Link Layer (DLL): Termination

Last fragment:

Data Link Layer (DLL): Header
Authentication and Fragmentation Layer (AFL): • CI=90h • No Message Length Field (ML) required • Message Authentication Code (MAC) required • No Message Counter Field (MCR) required
Application Layer (APL): Set DPs (Encrypted)
Data Link Layer (DLL): Termination

The requirements for the TLS configuration are defined in Vol. 2. V 4.0.2 Annex F. For Wired M-Bus ELL is not applied.

6 Cross-reference table for chapters 7 and 5

Chapter 7: Known Wired M-Bus issues	Chapter 5: Decisions and new definitions by OMS AG4; Decision in meeting minutes of OMS AG4
7.1	**5.1**
7.1.1	5.1.1
7.1.2	Action no. 2-3: No demand for connector. Action Item closed. No further actions.
7.1.3	5.1.2
7.1.4	5.1.3
7.1.5	5.1.4
7.1.6	Decision no. 2-3: Matter of certification. No further actions.
7.1.7	5.1.5
7.1.8	5.1.5
7.1.9	5.1.6
7.1.10	5.1.7
7.1.11	5.1.8
7.1.12	5.1.9
7.1.13	Decision no. 7-5: New work item proposal to change EN 13757-2.
7.1.14	Decision no. 7-5: New work item proposal to change EN 13757-2.
7.1.15	Decision no. 3-9: Register freeze as alternative solution is recommended.
7.1.16	Decision no. 3-10: The duty cycle rule does not apply to break states. No further actions.
7.1.17	5.1.11
7.1.18	Decision no. 3-12: Currently no further actions. Topic is copied to chapter 5.9.10 and therefore postponed.
7.1.19	Decision no. 3-13: Disconnecting slaves from M-Bus logically to save battery power is not permitted (see 5.1.13). For transmission of remaining energy see chapter 5.1.10.
7.1.20	Decision no. 3-14: Outside the scope of OMS. Individual device marking recommended. No further actions.
7.1.21	5.1.10
7.1.22	5.1.10
7.1.23	5.1.10
7.1.24	5.1.10
7.1.25	Decision no. 4-4: Same rules apply for discrete as well as for integrated circuits.
7.1.26	Decision no. 4-5: Implementation according to EN 13757-2 required.
7.1.27	5.1.12
7.1.28	5.1.12
7.1.29	Decision no. 4-6: Request for certification of M-Bus IC.
7.1.30	5.1.1
7.1	5.1.14
7.2	**5.2**
7.2.1	Decision no. 5-1: Matter of certification. No further actions.
7.2.2	5.2.2
7.2.3	Decision no. 5-2: No need for improvement. No further actions.
7.2.4	Decision no. 5-1: Matter of certification. No further actions.
7.2.5	Decision no. 5-3: No contradiction with specification: Valid primary address space 0…250 according to EN 13757-2. OMS Vol. 2 V4.0.2 was aligned to this decision: Primary address 0 shall not be used for meter addressing. No further actions.
7.2.6	5.2.3
7.2.7	Decision no. 5-4: Primary address change is only allowed using CI=7Ah. Secondary address change is only permitted for adapters (see chapter 5.2.3). No further actions.
7.2.8	Decision no. 5-3: No contradiction with specification: Valid primary address space 0…250 according to EN 13757-2. OMS Vol. 2 V4.0.2 was aligned to this decision: Primary address 0 shall not be used for meter addressing.

	No further actions.
7.2.9	5.2.4
7.2.10	5.2.5; Matter of certification.
7.2.11	5.2.6
7.2.12	5.2.1.
7.2.13	5.2.1.
7.2.14	Decision no. 6-2: A2h is not used for multiple M-Bus devices. No further actions.
7.2.15	Action Item no. 7-6: Revision of EN 13757-2 for a more detailed specification.
7.2.16	5.2.7
7.2.17	5.4.2
7.2.18	Action no. 6-2: FCB has been clarified by OMS AG1. No further actions.
7.2.19	Decision no. 6-2: See 5.2.1.
7.2.20	Decision no. 8-7: Secondary addressing is obligatory.
7.2.21	Decision no. 7-1: First sentence is obligatory (see 5.2.3). Second sentence is not necessary.
7.2.22	Decision no. 8-1: No exceptions to automatic baud detection permitted. Baud rate fixing is not permitted.
7.2.23	Decision no. 7-2: Matter of certification. No further actions.
7.2.24	Decision no. 7-3: EN 13757-3:2013 table 26 defines necessary exception for this case.
7.3	**5.3**
No immediate reference to chapter 6.3	5.3.1
7.3.1	Decision no. 8-2: Timing of EN 13757-2 is obligatory.
7.3.2	Decision no. 8-3: Rules for secondary addressing are obligatory.
7.3.3	Decision no. 8-4: Secondary addressing is obligatory.
7.3.4	Decision no. 8-5: Effects of application reset are restricted to application layer. No influence on other layers, e. g. no influence on secondary address selection. No further actions.
7.3.5	Decision no. 8-6: Matter of certification. No further actions.
7.3.6	Decision no. 8-7: Secondary addressing is obligatory.
7.3.7	Decision no. 8-7: Secondary addressing is obligatory.
7.3.8	Decision no. 8-7: DIN address is part of the type plate of a meter (see 5.3.2).
7.4	**5.4**
No immediate reference to chapter 7.4	5.4.1
No immediate reference to chapter 7.4; yet reference to 7.2.17	5.4.2
No immediate reference to chapter 7.4	5.4.3
7.4.1	Decision no. 8-8: For all meters, data tagging according to OMS Vol. 2 V 4.0.2 Annex B is obligatory. Manufacturer-specific coding is not allowed for this data.
7.4.2	Decision no. 8-9: FCB, FCV and application reset set rules for multi-message RSP-UD. Slaves have to be implemented according to FCV rules and support the application reset command. Other commands have no effect on frame selection (see 5.4.4)
7.4.3	Decision no. 8-9: FCB, FCV and application reset set rules for multi-message RSP-UD. Slaves have to be implemented according to FCV rules and support the application reset command. Other commands have no effect on frame selection (see 5.4.4)
7.4.4	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.5	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.6	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.7	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.8	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.9	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2

7.4.10	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.11	Decision no. 9-1: M-Bus master ensures full decoding of DIB / VIB. No further actions.
7.4.12	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.13	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.14	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.15	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.4.16	Decision no. 9-2: No further actions required: the correct application of the M-Bus definitions (error bits of link layer and application layer) guarantees that main registers retain data unmodified.
7.4.17	Decision no. 9-3: No further actions required: M-Bus architecture includes listening by slaves. Needs to be included in battery life time calculations.
7.4.18	Decision no. 9-4: No further actions required: Application select is considers for this use case.
7.4.19	Decision no. 9-5: No further actions required: M-Bus data types define the sign bit. For BCD encoded data types the BCD extension F provides the facility to encode negative values.
7.4.20	5.4.6
No immediate reference to chapter 7.4	5.4.4
No immediate reference to chapter 7.4	5.4.5
7.5	**5.5**
7.5.1	5.4.9, 5.4.10, Action Item no. 8-1: Meter profile; Action Item no. 10-1: Verification of Annexes A and B of OMS Vol. 2 V 4.0.2
7.5.2	5.4.7
7.5.3	5.4.7
7.5.4	5.4.7
7.5.5	5.4.7
7.6	**5.6**
7.6.1	Action Item no. 11-2: Installation guide
7.6.2	Action Item no. 11-2: Installation guide
7.6.3	Action Item no. 11-2: Installation guide
7.6.4	Action Item no. 11-2: Installation guide
7.6.5	Action Item no. 11-2: Installation guide
7.6.6	Action Item no. 11-2: Installation guide
7.7	**Tasks of OMS AG3**
	No further actions in AG4
7.8	**Security**
7.8.1	Decision no. 14-1: TF Security shall prepare example for Wired M-Bus
7.8.1	Decision no. 14-2: Revision of Vol. 2 Annex N necessary.
7.8.1	Decision no. 14-3: Extension of existing reference implementation for Wired M-Bus
7.8.1	5.8
7.9	**Postponed for future work of OMS AG4**
	Not covered by TR-02

7 Known Wired M-Bus issues

7.1 Physical Layer

7.1.1 Cabling

There is no clearly defined “reference cable” in the standard. Only “telephone cable” is mentioned, and this can vary depending on the country. It would be better if the test specification defined the cable parameters (R/m, L/m, C/m) for a reference cable type, so that testing can be performed with a known cable type and the test results can be easily compared.

Furthermore, two “worst-case” test topologies should be defined and described (based on “usage types” in the standard) with a fixed topology, so that easy comparisons can be made between different masters and slaves.

Reference EN 13757-2 Annex E.1 to E.6

7.1.2 Connectors

There is no standard connector defined for M-Bus installations. So far we have seen circular DIN connectors and several types of screw connectors used.

Could RJ45 be a possible solution?

7.1.3 SC Charge / Discharge

The M-Bus standard defines the bus level storage by means of RC-constant. However, most implementations use a Texas Instruments or ON Semiconductor transceiver, both of which implement bus level storage by linear charge and discharge of the SC capacitor. A clear test specification should be defined interpreting the RC constant requirement for linear charge / discharge systems.

Reference EN 13757-2 chapter 4.2.1

7.1.4 Inrush Current

There is currently no limitation on the inrush current of the slave device. This parameter is related to the maximum capacitance on the device terminals (since the inrush current is mostly used to charge the capacitance of the terminals), but is easier to measure.

7.1.5 Rise and fall times

The standard defines a maximum slope on the master voltage modulation, but there is no lower limit for this parameter. In the masters currently on the market, there is a wide variation of modulation slope ranging from as steep as possible to carefully controlled. For the slave device, there is no specification on current rise and fall times. This may vary, for example in discrete applications.

Reference EN 13757-2 chapter 4.3.3.4

7.1.6 Bit timing

Some masters enforce the strict bit time requirements set in the standard, which may cause interoperability issues with certain slaves.

Reference EN 13757-2 table 1

7.1.7 Number of unit loads > 1

If the number of unit loads is >1, on many meters it is not stated on the device itself and on some it is also not given in the data sheet / manual. This makes it more difficult to select a suitable level converter, on-site this may lead to the equipment not functioning.

7.1.8 Statement of unit loads for master and slave

For M-Bus slaves: A clear indication of the number of standard loads (= 1.5 current draw) on the devices is required.

For M-Bus masters: Indication of the maximum number of standard loads which can be connected is required, instead of the number of M-Bus devices.

7.1.9 M-Bus voltage switch-on process

Definitions for the M-Bus master for the ramp-up voltage under load (n x Unit load) need to be defined?

If necessary, increase voltage via several stages; rise and fall times, etc.

Reference EN 13757-2 chapter 4.2.2.7

7.1.10 Specify upper limit for voltage deviation (due to M-Bus slaves current regulation)

U delta max for the M-Bus voltage deviation (minimum: 12 V): is an upper limit defined anywhere? How does it look with current regulation for large deviations?

Reference EN 13757-2 chapter 4.3.3.2

7.1.11 Minimum M-Bus voltage (mark and space)

Clearly state the minimum M-Bus voltage at which the slaves must still work (mark and space).

Where applicable, state more clearly for which point the voltage level data is valid (terminal voltage at the M-Bus master and / or M-Bus slave terminals).

Reference EN13757-2:2004 chapter 4.2.1, chapter 4.3.3.1, chapter 4.3.3.2

7.1.12 Hysteresis voltage deviation

Absolute voltage thresholds (hysteresis) must be defined, from which an M-Bus slave detects either the space or mark state, to make it possible to test them (for marginal voltage deviation of the master and the same for marginal low M-Bus base voltage of the master).

Reference EN 13757-2 chapter 4.2.1

7.1.13 Inconsistent description of the M-Bus break length (slave collision detect)

Reference EN13757-2 Annex D: Send break signal for 50 ms

Reference EN13757-2 chapter 5.6 / 4.3.3.8: Greater than 22 BT but less than 50 ms

Reference EN13757-2 chapter 4.2.3

7.1.14 M-Bus break: Scope for interpretation concerning the definition of the M-Bus break

When an M-Bus master detects the condition for sending out an M-Bus break and sends it out: How long should the break be? With safety, less than 50 ms, so say 49 ms. But should the break terminate as soon as the trigger condition for it ceases, or should it be sent for a period of 49 s? EN13757-2:2004(E) 4.3.3.8: "... with a duration of >= 22 bit times ...." and Annex D (informative) "... new master hardware with double current detect can detect light collisions of (20...200) mA and then transmit a break (50 ms space) on the bus, ..." 22 bit times at 2400 Bd is 9.16 ms.

Reference EN13757-2 chapter 4.3.3.8

See 6.1.12

7.1.15 M-Bus break (I)

Is it permitted to use the M-Bus break to drop higher priority communication of the M-Bus master on the M-Bus?

7.1.16 M-Bus break (II)

Does the duty cycle of 0.92 for the space state also apply for this?

Reference EN13757-2 chapter 4.2.1:

7.1.17 Break detection

In many meters, break detection is not implemented and this can cause problems during secondary searching.

7.1.18 Intrinsically safe M-Bus

Creation of Appendix for intrinsically safe M-Bus protocol (explosion-proof environment)

7.1.19 Battery-powered devices

Battery-powered devices are not allowed to stop communication when polled often

7.1.20 Problems with special meters: M-Bus converters to 20 mA

These converters only cause a physical conversion of the M-Bus signals on the (digital) 0 / 20 mA interface. I.e. a level change of 20 mA on the M-Bus. They are not capable of converting protocols and are also not suitable for binding sensors such as for example temperature sensors etc. with 0...20 mA in an M-Bus.

7.1.21 Limitations in the readout frequency (energy meters and water meters generally)

The interface electronics of energy meters and water meters are mostly supplied by a lithium battery. If an M-Bus is connected, some meters are able to be supplied with voltage over the M-Bus while others are not. Some meters permit the installation of a power supply module; others continue to run from battery. In particular, for those which run from battery, the number of request cycles per day is limited so that the meter achieves the guaranteed service life.

In their data sheets, the manufacturers specify how many requests per day the meter allows. There are also meters for which this number is not fixed but is calculated instead by the meter using various parameters.

A problem such as this, with meters in which the number of request cycles per day is limited, is shown by the meters starting to supply data regularly after midnight. At a certain time, they thereby cease to be readable for the rest of the day. After midnight they then deliver values again.

7.1.22 Readout frequency

The maximum number of readouts is a major problem with battery-powered meters. There are for instance meters which can only be read once per day. Some meters automatically block further readouts, but others continue to communicate and thus permit anticipation of the battery capacity before the end of the calibration period. Communication with the other meters in the network as a rule also places a load on the battery of the meter which in this case is only listening. For many meters, only very vague or even no information is obtained about this behaviour.

7.1.23 Behaviour of battery-powered meters

Battery-powered M-Bus devices often limit the number of datagrams which can be read per day. The number of datagrams is calculated in different ways.

Sometimes only datagrams on its own M-Bus device are taken into account, sometimes the total bus traffic.

For M-Bus masters that regularly request data from a large number of M-Bus devices as a data logger, such devices cannot be used.

This type of behaviour is not provided for in the M-Bus protocol.

It would be useful here to provide a solution which takes into account both the limited battery resources and also the specified behaviour on the bus.

7.1.24 Problems with special meters: Meter xxx in battery operation

During battery operation, the meters are limited with regard to the maximum request cycles per day. According to the manufacturer, not only the requests of the affected meters enter into this calculation, but possibly all the activities on the bus. For this reason, the meter is practically unusable in M-Bus systems.

Problems with special meters: Meter yyy:

The M-Bus connection requires a polarity, i.e. it is important which cable is connected to which M-Bus connection.

7.1.25 Contravention of specification: Discrete designs

Some meter manufacturers do not use the M-Bus chip from Texas Instruments (or recently from ON Semiconductor), instead they construct the interface discretely and then do not comply with the required specifications, especially concerning the constancy of the current draw.

7.1.26 Contravention of specification: Capacitance too high

With some meters, protective elements are inserted at the M-Bus terminals, and these have a capacitance which is too high. For example, in one case approx. 12 nF instead of the maximum permitted 0.5 nF. On large networks, this can also lead to communication problems.

Reference EN13757-2 chapter 4.2.2.10:

7.1.27 EMC basic requirements for sockets / casing

Definition of EMC basic requirement, burst / surge / on sockets? Casing?
Parts defined in EN1434
Definition of two device classes (class 1: In-house; class 2: M-Bus leaves building)
In general: Who tests what and according to which standards / criteria?

7.1.28 Define EMC compliant input wiring for the M-Bus slave

Definition of input circuitry which is EMC compliant

7.1.29 Certification of built-in M-Bus ICs

Should this become an inherent part of the specification and / or the OMS conformance testing?

7.1.30 Topology key questions

- Is it possible to define a set of *typical* network topologies which cover most of the applications in the field?
- Which parameters are necessary to design an M-Bus network:
    - f(topology, wiring parameter) resulting in the number of usable M-Bus slaves at baud rate x
    - f(number of M-Bus slaves, topology) resulting in the requirements for the wiring parameters and applicable communication speed
- Necessity to define a standard OM cable and / or connectors with specific characteristics?
- Necessity to specify a function or functions to calculate M-Bus networks in design phase?

7.2 Link Layer

7.2.1 M-Bus timing requirements

General treatment of the timing requirements for the M-Bus datagram

Reference EN13757-2 chapter 5.7.6 and chapter 6

7.2.2 Idle time between datagrams

Suppression of slave responses <= 11 bit times
Should a master suppress “active” responses from slaves which arrive earlier than 11 bit times?

Reference EN 13757-2 chapter 5.5.3

7.2.3 Faster scanning of M-Bus devices

7.2.4 Contravention of specification: Incorrect timing

Some meters use a 2-processor system, with an extra processor for the M-Bus, that exchanges data with the main processor. There are implementations here in which a communication between the processors occurs after each communication and during this time (up to 30 secs.) the M-Bus interface cannot be operated. For instance the sequence SND-NKE plus REQ-UD2 therefore leads to a timeout.

7.2.5 Contravention of specification: Delivery state primary address

In the delivery state, the primary address should be 0. There are meters which are delivered with the address = 1.

7.2.6 Contravention of specification: Change to the meter address

On some meters, the address cannot be reprogrammed with the standard datagram.

7.2.7 Contravention of specification: Change to the primary address

The M-Bus master finds a meter with its M-Bus ID (secondary address) and now wants to assign it a primary address. This could not always be done. However, once informed, the meter manufacturers then adapted to this over time.

7.2.8 Primary addressing difficulties

According to the standard, the primary address at delivery should be 0.

In the configuration phase this should be assigned to the M-Bus slave by the M-Bus master; the slave should then retain it until a new assignment or a reboot.

Reality:

Delivery of the M-Bus devices (slaves) very often takes place with a preset primary address (e.g. 1). This is also naturally retained after a reboot, until it is actively reset by the M-Bus master.

This can lead to conflicts if new M-Bus devices are inserted into an existing system, in which there is already an M-Bus device with the same primary address (e.g. 1).

There are also M-Bus devices which do not allow their primary address to be reset to 0.

7.2.9 Two or more logical M-Buses in one hardware environment

Implementation of two or more logical M-Bus devices in one hardware environment (two primary, secondary addresses); behaviour for instance during search (send E5h twice or simulate collision, behaviour with special addresses FEh, FFh)

NOTE: Device with several primary addresses defined in EN13757-2, chapter 5.7.7

7.2.10 Detection of datagram end through timeout or interpreter (valid datagram)

Wait for datagram end detection maximum 22 bit times. However, response may also already occur after 11 bit times (if the correct frame was detected previously). This could be expanded in Figure 7 key 5. The wording with “may” must be more clearly qualified here.

Reference EN 13757-2 Figure 7 Key 5:

7.2.11 A-field: Are special addresses FEh, FFh always to be supported?

Exact specification of the application case

Address 255 - always supportted?

EN 13757-2 chapter 5.7.5

7.2.12 Automatic baud detection: Mandatory / mandatory only for recommended baud rates?

Should M-Bus slave automatic baud detection always be supported? (Perhaps only for the mandatory and recommended baud rates?)

Reference EN 13757-2 chapter 5.2.6

7.2.13 Auto baud rate fallback: Mandatory; clarify time window

Auto fallback of the baud rate time window (time): Between 2 and 10 minutes

Reference EN 13757-2 chapter 5.2.5

7.2.14 Special single control character A2h: Meaning, specify use?

If necessary stipulate that this should function as the collision character for multiple virtual M-Bus devices

Reference EN 60870-5-2:1993 chapter 3.2 frame format FT1.2:

7.2.15 Status request (REQ_SKE) is required; use needs to be more exactly specified

Reference EN 13757-2 chapter 5.7.3.4

7.2.16 SND-NKE

Should last received FCB reset --> it follows from this that with multi block responds they must also be reset to the first?

Background: A deliberate setting of responses should be done by application reset.

Reference EN 13757-2 chapter 5.7.7

7.2.17 Multiple messages: Identification in link layer

Notification outside the application layer (1Fh)

Suggested solution: By identification in C-field or AFL?

Reference EN 13757-3:2013 chapter 6.1, chapter 6.4, table 22

7.2.18 Definition of FCB

Reference EN 13757-3:2013 Annex E.7

7.2.19 Limitation of the permitted baud rates to 300, 2400 and 9600

Elimination of the optional baud rates according to EN 13757-2 increases the operational security.

Reference EN 13757-2 chapter 5.2

7.2.20 Addressing

All meters should work with both the primary address and the secondary address.

7.2.21 Primary address

All meters should be able to change the primary address as default. If the customer needs to lock the primary address it could be fixed with a write command.

7.2.22 Baud rate

All meters should be able to change the baud rate. If a customer needs to lock the baud rate this could be done with a write command.

7.2.23 Specification issue

Contravention of specification: The timing of the serial interface displays too much deviation from the set points.

7.2.24 Definition deficiency: Set primary address

According to EN 13757-3, chapter E.5, setting the primary address is as follows:

DIF=01h, VIF=7Ah, data=address

Here however, DIF=01h means an 8-bit integer, i.e. -128...127. Theoretically therefore, addresses >127 cannot be assigned.

For purely 8-bit implementations, this is not critical. With more complex architectures in the slave (32-bit) this can however lead to errors, if a 80h is then handled internally as FF80h or similar and addresses >250 are rejected ("If then else" comparison).

Should address allocation therefore also be possible with 02h? What do existing meters do? Or should DIF=01h together with VIF=7Ah have a different meaning (unsigned integer)?

7.3 Networking layer / secondary addressing

7.3.1 REQ-UD2

There are meters for which an unspecified pause is required between the selection of the secondary address and the REQ-UD2.

7.3.2 Secondary address (I)

There are meters with a secondary address that is hexadecimal (normally it is decimal).

7.3.3 Secondary address (II)

There are meters which have a secondary address but do not support scan.

7.3.4 Select is lost (electricity meters generally)

There are some meters where, after selection using select via the secondary address and sending an application reset, the selection becomes lost, i.e. a second select command is necessary.

7.3.5 Contravention of specification: Secondary addressing

There are also some meters on which the secondary addressing is incorrectly implemented.

7.3.6 Secondary addressing mandatory

Secondary addressing is mandatory for OMS.

Reference EN13757-3 chapter 11.3

7.3.7 Secondary addressing as minimum requirement for M-Bus slaves

There are sometimes simple devices which only support primary addressing.

7.3.8 Serial number

It should always be possible to read the serial number on the front of the meter – a recommendation.

7.4 Application Layer

7.4.1 DIF / VIF use (electricity meters generally)

There are some meters in which the measured variables that are actually defined in the M-Bus by means of DIF and VIF are represented by manufacturer-specific DIFs and VIFs.

7.4.2 Problems with special meters: Meter zzz

With multiple responses for which all data was requested, at the next request the meter does not supply the 1st part response as expected but repeats the last part of the multiple response. The 1st part is only delivered after sending 2 application resets.

7.4.3 Contravention of specification: Multi datagran readout

The behaviour for multi datagram message is different depending on the meter. Many meters switch over to the first datagram after an SND-NKE (actually wrong according to the standard), others with an application reset. There is one meter which only switches back with SND-NKE but does not do this for a selection (secondary addressing) (should it likewise switch back?). An application reset on this meter is not implemented.

7.4.4 Consistent implementation

The application layer is naturally the most serious problem because practically every meter has a different structure for the datagram. In this respect we hear time and again from customers, that “M-Bus is not always the same as M-Bus”. The problem here however is actually in the only partial implementation of the application layer in the M-Bus programs for PCs, DDC, GLTs etc. Many programs need a datagram definition for each meter type and assume that the structure of the datagram is always the same. As soon as a new version of the meter with a changed datagram appears on the market, the definition may not match. Some meters also add to individual blocks as soon as data such as set day values are generated for the first time.

7.4.5 Datagram content

The standardisation of the M-Bus in the area of electrical energy is unsatisfactory.

The result is an uncontrolled growth in manufacturer-specific data records.

Standardisation is urgently needed here.

7.4.6 Function of VIFE

VIFEs can also present a serious problem because these elements can turn the meaning and content of a block completely upside down and theoretically a maximum of 10 VIFEs including VIF is possible.

7.4.7 Missing VIFs

Some values and units are missing from the standard (have been greatly expanded in the latest standard). Therefore some manufacturers transmit a considerable amount of manufacturer-specific data but nevertheless expect that this data can be interpreted and assigned by the software. This is only possible however with a meter-specific software component.

7.4.8 Readout of extended data

Readout of the standard page by RSP-UD2 is not a problem. Many meters allow further protocol pages to be read out. The way to read this data out has been solved in different ways in part. For some meters, the datagram is changed by application reset + subcode, with other manufacturers the same is realised via manufacturer-specific data.

7.4.9 Manufacturer-specific VIFs, as an example: Electricity meters with 3 phases

In addition to energy, some alternating current meters allow the values for voltage, current or instantaneous power for each phase to be read out over the M-Bus. There are different possible solutions when assigning this data in the datagram.

In the following two examples:

Example 1: Implementation via manufacturer-specific VIF / VIFE – manufacturer A

Data field	Meaning
02	2 byte integer
FD C9 FF 8**1** 00	Table FD, storage 0, tariff 0, channel 0, voltage [V], next VIFE manufacturer-specific, 81_H → phase 1
00 00	value → 0
02	2 byte integer
FD C9 FF 8**2** 00	Table FD, storage 0, tariff 0, channel 0, voltage [V], next VIFE manufacturer-specific, 82_H → phase 2
00 00	value → 0
02	2 byte integer
FD C9 FF 8**3** 00	Table FD, storage 0, tariff 0, channel 0, voltage [V], next VIFE manufacturer-specific, 83_H → phase 3
00 00	value → 0

Example 2: Implementation via manufacturer-specific VIF / VIFE – manufacturer B

Data field	Meaning
02	2 byte integer
FD C8 FF 0**1**	Table FD, storage 0, tariff 0, channel 0, voltage [100 mV], next VIFE manufacturer-specific, 01_H → phase 1
00 00	value → 0
02	2 byte integer
FD C8 FF 0**2**	Table FD, storage 0, tariff 0, channel 0, voltage [100 mV], next VIFE manufacturer-specific, 02_H → phase 2
00 00	value → 0
02	2 byte integer
FD C8 FF 0**3**	Table FD, storage 0, tariff 0, channel 0, voltage [100 mV], next VIFE manufacturer-specific, 03_H → phase 3
00 00	value → 0

Without a specification of the protocol, it is not apparent what meaning the VIFE bytes 81h / 82h / 83h and 01h / 02h / 03h have. Examples of “uncertainties” such as these in the datagram too often lead to implementation cost.

7.4.10 Month end value / set day values

During the setup of the M-Bus datagram, there is a variety of different implementations with regard to the transmission of set days or month end values.

Correctly, each stored value (e.g. set days or month end values) should be provided with a storage number. The associated date carries the same storage number. The date and stored value can be assigned using the storage number.

Unfortunately there are many different implementations which are not always unambiguous, e.g.

- Storage numbers are used as “month”.
- Sometimes, manufacturer-coded (binary) storage values are transmitted in the manufacturer-specific part.
- Month values are transmitted without any time information.
- Example from an electronic heat cost allocator (EHKV): The values for month end and mid-month (value on the 15th of the month) are therefore transmitted without time information. According to this, only every second value is to be interpreted as the month end value.
- Month reset values are transmitted without storage number. Ultimately, these can then be confused with instantaneous values.

Two suggestions are made for this purpose in the documents *OMS Vol. 2 Pri. Communication Issue 2.0.0 Annex G and OMS Vol. 2 Pri. Communication Issue 3.0.0 Annex G1/G2*.

7.4.11 Datagrams with dynamic length

There are meters which have a dynamic datagram length. These datagrams often have “data records” with customer-specific character strings. Here the option is offered for the customers to deposit important information (e.g. street, apartment, etc.) in the datagram.

Because of limited storage space or resources, some readout programs have rigid M-Bus interpreters where building control systems (GLT) are concerned. To some extent, fixed datagram lengths are expected. If the datagram length changes, then the meter is often no longer recognised or the data is incorrectly interpreted – a software or firmware update from the manufacturer is then sometimes necessary.

7.4.12 Meters with ambiguous data in the datagram

- There are combined cold and heat meters which transmit identical DIF / VIF for the cold or heat register. Without specification of the protocol, a clear assignment of the register is not available.
- There are meters which transmit the tariffs under the channel number.
- There are meters which differentiate instantaneous values using storage numbers.

7.4.13 Time information in datagram

A timestamp in the datagram is transmitted without the time of day. It is not clear when the associated value was generated. Was the value generated at the start of the day, at the end or at some time during the day?

7.4.14 Consumption meters with pulse inputs

There are meters available with pulse inputs for further meters (often heat meters with pulse inputs for water meters).

The meter reading is transmitted in a standard datagram (RSP-UD2). It is often not clear which medium the pulse meter is metering (cold water, hot water, etc.). The medium is important for the assignment of an OBIS code (8: or 9:) for storage of the value in a database.

7.4.15 Date format 03.05.----: Only for parameter readout; identification of set days not permitted.

An application rule is necessary, so that a date format without the year number is not used for identification of set days. This should only be used together with set days to output the parameter of the next yearly set day.

7.4.16 Problems with special meters: Meter aaa

An energy meter displays meter reading 999999999 in the event of an error. In a particular case, with the heating switched off, the temperature of the return flow was slightly higher than the flow temperature and the meter reading was thereby no longer readable over the M-Bus.

7.4.17 Battery driven meters

If a customer has a mixture of battery meters and external power supply meters, the battery meters should not be affected if there are other requests on the M-Bus loop.

7.4.18 Multi-RSP-UD

Ability to read out a specific M-Bus datagram number with a write command.

7.4.19 DIB

Add information into DIB part if the values are signed or unsigned.

7.4.20 Unique manufacturer device type of every meter should be mandatory in OMS

M-Bus networks are steadily becoming more varied:

- Different manufacturer's meters in a network as a rule
- All media
- Different meter types from one manufacturer
- Different configurations / settings for one meter type where appropriate.

Changes to an existing M-Bus network are not exceptional. It should be possible to install new meters **EASILY** into an M-Bus network and to read out from them - without specialist personnel.

The M-Bus standard information:

- Manufacturer
- Medium
- Version

Is not adequate.

7.5 Application Profile

7.5.1 Specifications on meter design

Which values are required, e.g. consumption last month as a datapoint)?

Definition of meter profiles:

- Profile: Description of the representation, organisation and coding of the data which is made available by a meter.
- for unambiguous determination of the datapoints of a meter (meter reading according to OMS Vol. 2 and EN 13757-3:2013)
- e. g. for prestored values (= month values or similar), maximums, tariffs
- in extension of the OMS OBIS tables from OMS Vol. 2 and EN 13757-3:2013

7.5.2 Configuration of meter devices

Setting addresses, setting tariff, etc.

7.5.3 Meter configuration: Define standard commands

Specify M-Bus commands for OMS for standard functionality; these should then also be mandatory for every meter.

Example:

- Set secondary address
- Set time of day
- …

7.5.4 Define communication procedures

Startup: SND-NKE, meter configuration, etc.

Definition of procedures / communication sequences for different application cases (defined to some extent in Annex F). Example for start up (power up): SND-NKE, which also resets the last FCB for multi datagram messages.

Reference EN13757-2 Annex F

7.5.5 Standard response

The first datagram should be specified for different meters, electricity, heat meter, gas meter, water meter etc.

7.6 Installation

7.6.1 S0 meters

S0 meters are looped directly into the M-Bus.

7.6.2 Pt100

Pt100 or other sensor technology is directly looped into the M-Bus.

7.6.3 Topology

Topology: Ring formation

7.6.4 230 V mains

Short-circuit to 230 V mains

7.6.5 Documentation

Cabling without documentation

7.6.6 Installation and cabling

There is no clear specification for cabling. Experiences from practice show that any cable (from NYY to Cat7 network cables) that is present will be used for the M-Bus cabling. For existing systems this may be practical for financial reasons, clear specifications would be helpful for new installations.

Furthermore, a specification or recommendation for distributor terminals would be useful (also with respect to any troubleshooting which it may be necessary to perform).

The KNX bus seems to have been well defined here. Keyword: Green cable and plug-in terminals.

7.7 Certification

- **Specifications for interoperability testing and certification**
- **Certification of tested products**
- **Set up testing procedures and ask laboratories to perform the testing**

7.8 Security

Security issues, cases of use, when, what type and how to apply security

7.9 Postponed topics

7.9.1 Machine readable data sheet (EDS)

Machine readable data sheet (EDS) for every meter (for reading into SCADA systems)

7.9.1.1 Data sheet availability

The depiction of the data as given above for each meter type must be defined and explained in the **manufacturer's data sheet** for the meter type. The data sheet should be available on the manufacturer's website and **uniquely and easily traceable** using the type identifier.

7.9.1.2 Electronic Data Sheet (EDS)

The EDS is explicitly linked to the meter type via the meter identifier. Gateways and readout software can very easily be configured **explicitly** to the desired data.

7.9.2 Internet Website with tested devices, data sheets

Internet Website with tested devices, data sheets (electronically?)

7.9.2.1 HDS – Human readable data sheet

Normal data sheets – free formatting: Each manufacturer does as it wishes with the formatting and company logo etc.

7.9.2.2 TDS – Technical data sheets

Exact description of the data which the meter delivers and its mapping in the M-Bus.

User: Technician who selects and configures the meter

7.9.2.3 EDS – Electronic data sheets

For gateways and metering software

Suggestion: XML file with all the relevant data

Tested meters should / can only follow later, i.e. certification or similar testing should not delay the web site.

7.9.3 Marketing

- M-Bus brand and update (e.g. the logo)
- Publications, magazine, newsletter, technical online forum, etc. concerning the M-Bus
- Continuing the M-Bus conference
- International interest concerning the M-Bus

7.9.4 Low power modes

The NCN5151 also implements a low power mode similar to M-Bus, but with a lower current consumption. The application can then decide which communication mode to use. These low power modes could be integrated into the M-Bus standard as well. Several implementations of the stand-by mode of the master exist, where sometimes a lower voltage is left on the bus. The requirements of such a mode could be better defined, for example concerning the minimum slave startup voltage.

7.9.5 Communication over Ethernet

If communication over Ethernet is used, add a transaction ID header like Modbus TCP.

7.9.6 Intrinsically safe M-Bus protocol

Appendix for intrinsically safe M-Bus protocol (explosion-proof environment)

8 Version history

V 0.0.1

- First issue

V 0.0.2

- Introduction of change history
- Meter types and meter manufacturers made anonymous
- Addition of input from BTR NETCOM:
    - Contravention of specification: Change to the primary address
    - Behaviour of battery-powered meters
    - Statement of unit loads for master and slave
    - Secondary addressing as minimum requirement for M-Bus slaves
    - Primary addressing difficulties
    - Datagram content

V 0.0.3

- Addition of input from ON Semiconductor:
    - Cabling
    - Connector
    - SC Charge / Discharge
    - Low Defect Current
    - Inrush Current
    - Rise and Fall times
    - Master Voltage Modulation Stability
    - Bit Timing
    - Larger Number of Unit Loads
    - Startup
    - EMC / ESD Tests
    - Low Power Modes
- New chapter “Decisions and new definitions by OMS AG4”

V 0.0.4

- Additions in chapters 6.1 and 6.2
- Individual topics rearranged in chapters 6.1 and 6.2

V 0.0.5

Changes according to the decisions from meeting no. 2 of OMS AG4 (see minutes of meeting)

V 0.0.6

- Addition of input from Fredrik Winroth:
  - All meters should work with both primary address and secondary address.
  - All meters should be able to change primary address as default. If the customer needs to lock the primary address it could be fixed with a write command.
  - All meters should be able to change baud rate, if customer need to lock the baud rate it could be fixed with a write command.
  - Recommendation that it should always be possible to read the serial number located at the front of the meter.
  - If the customer has a mixture of battery-powered meters and meters with an external power supply, the battery-powered meters should not be affected if there are other requests on the M-Bus loop.
  - The first datagram should be specified for different meters, electricity, heat meter, gas meter, water meter etc.
  - If communication over the Ethernet is used, add a transaction ID header like Modbus TCP.
  - Ability to read out a specific M-Bus datagram number with a write command.
  - Add information into the DIB part indicating whether the values are signed or unsigned.
- Addition of input from Hermann Lertes:
  - An energy meter […] displays meter reading 999999999 in the event of an error. In a particular case, with the heating switched off, the temperature of the return flow was slightly higher than the flow temperature and the meter reading was thereby no longer readable over the M-Bus.
- Addition of input from Werner Frenzel:
  - The timing of the serial interface displays too much deviation from the set points.
- Addition of input from Remo Reichel:
  - Ambiguity when setting the primary address.

V 0.0.6 (continued)

Inclusion of the action items from the 2nd meeting of AG4

- Action no. 2-1: Development of future obligatory definitions (in variants) for M-Bus cabling (cable type, master specification, topology, distances, slave specification)
- Action no. 2-2: Definition of the aim for the chapter “Cabling”
- Action no. 2-3: Consideration of the need for a choice of connectors
- Action no. 2-4: SC Charge / Discharge: ON Semiconductor is preparing a suggestion for an alternative, modern definition
- Action no. 2-5: Development of a definition for the inrush current
- Action no. 2-6: Definition of the minimum and maximum values for the rise and fall times
- Action no. 2-7: Definition of the limitation of the permitted baud rates to 300, 2400 and 9600
- Action no. 2-8: Definition of the identification of the number of unit loads on the device and in the data sheet
- Action no. 2-9: Suggestions for the detailed definition of the conditions for the switch-on process
- Action no. 2-10: Development of a suggestion for “Defining the upper limit for voltage deviation”
- Action no. 2-11: Investigation into the existing status of the master and slave definitions for “Minimum M-Bus voltage”
- Action no. 2-12: Development of a suggestion for the “Minimum M-Bus voltage” for the slave
- Action no. 2-13: Introduction
- Action no. 2-15: References
- Action no. 2-16: Introduction

V 0.0.7

Inclusion of action items from the 2nd meeting of AG4:

- Action no. 2-14: Glossary of terms
- Action no. 2-16: Introduction (expansion)

V 0.0.8

- Changes / expansions to action items from the 3rd meeting of AG4:
  - Action no. 2-2: Cabling
  - Action no. 2-4: SC Charge / Discharge
  - Action no. 2-5: Inrush current
  - Action no. 2-6: Flank slope
  - Action no. 2-7: Definition of the limitation of the permitted baud rates to 300, 2400 and 9600
  - Action no. 2-10: Upper limit for voltage deviation
  - Action no. 2-12: Minimum M-Bus voltage
  - Action no. 2-13: Preface
  - Action no. 2-14: Glossary of terms
  - Action no. 2-15: References
  - Action no. 2-16: Introduction
  - Enhanced Selection
  - Action no. 3-3: Break signal
- Addition of input from Martin Braband:
  - Unique manufacturer device type of every meter should be mandatory in OMS
  - Machine-readable data sheet (EDS) for every meter (reading it into SCADA systems)
  - Internet Website with data sheets

V 0.0.9

- Changes / expansions to action items from the 4th meeting of AG4:
  - Action no. 2-2: Cabling

V 0.0.10

- Changes / expansions to action items from the 4th meeting of AG4:
  - Action no. 2-11 / 12: Change to “Minimum slave M-Bus voltage”
  - Action no. 4-4: Hysteresis voltage deviation
  - Action no. 4-1: Introduction of the first master identification data
- Inclusion of the results of the 5th meeting of AG4:
  - Removal of the chapter “Test case for slave input capacity <= 0,5 nF”
  - Decision no. 5-4: Introduction of chapter: “Change of primary and secondary addresses”

V 0.0.11

- Inclusion of the results of the 6th meeting of AG4:
  - New chapter: Test set up, detection of end of datagram, two or more logical M-Buses in one hardware environment, SND-NKE. A-field: Are special addresses FEh, FFh always to be supported?
  - Changes to chapter: Hysteresis voltage deviation, transmission of remaining communication energy of the battery

V 0.0.12

- Inclusion of the results of the 7th meeting of AG4:
  - Decision no. 7-1: Term "Worldwide unique" removed from chapter on secondary addressing
  - Determination of addresses in adapters: Rule for incorrectly labelled meter
  - OMS Vol. 2 chapter 2.2: Table with CI-fields: The CI-field 7Ah is restricted to Wireless M-Bus.
  - New VIF / VIFE for the frame identification for multi datagram RSP-UD
  - New device type for wired adapters

V 0.0.13

- Inclusion of the results of the 8th meeting of AG4:
  - Correction of a definition field in the chapter "Transmission of remaining communication energy of the battery"
  - Start preparation for release of TR-02 in the English language
  - Fixing of chapter numbers
  - Introduction of chapter 8 as cross-reference between chapters 6 and 7

V 0.0.14

- Inclusion of the results of the 9th meeting of AG4:
  - Addition of chapters 5.4.1 to 5.4.5

V 0.0.15

- Revision of chapter 5.1.9 (M-BUS test V8.0)

V 0.0.16

- Addition of chapter 5.4.6
- Revision of chapters 3 and 6

V 0.0.17

- Results of the 10th, 11th and 12th meetings of AG4:
  - Revision of chapter 5.4.2
  - Addition of chapter 5.4.7

V 0.0.18

- Results of the 13th meeting of AG4

V 0.0.19

- Results of the 15th meeting of AG4
- Addition of the results of the “meter profiles” subgroup concerning application select

V 0.0.20

- Update of chapter 6 (cross-reference table)
- Addition of chapter 5.1.13

V 0.0.21

- Change of “primary address” to “secondary address” in one bullet point of chapter 5.2.4

V 0.0.22

- Change of description for “secondary address” in chapter 5.2.4
- Change of command for time and date setting to “optional” in chapter 5.4.7

V 0.0.23

- Complete translation to English language
- Reordering of chapters
- Decision about optional / mandatory
- Inclusion of standardisation proposals for application select, descriptor system and extension of FDh table

V 0.0.24

- Proof reading of whole document
- Standardization proposal are moved to the annex.

V 1.0.0

- Final draft for request for comments

V 1.0.1, 1.0.2, 1.0.3

- Final editing versions

V 1.0.4

- Release version

9 Annex A

Standardisation proposal for CEN / TC294:

Proposal for an extension of application select
Achim Reissinger, 2015-04-17 of CEN / TC294 WG4 (Version 2)

Application select is currently defined in EN 13757-3 chapter

4.2 Application reset and application select (CI = 50h, 53h) (optional)

This proposal is focused on the following topics:

- Using application select / application reset the contents of the transmission buffer shall be set to a defined state, i.e. all application errors are cleared.
- The master shall be able to read to current application selection ahead of an application reset.
- Application select is controlled outside of the application protocol, i.e. DIB / VIB is not being used for reading/writing of application reset / select.
- The function of application select shall be available for Wired M-Bus as well for Wireless M-Bus.

New CI fields for new functions of application select

The following CI fields shall be supported for application select:

CI field	TPL length	wM-Bus	M-Bus	Name	Description
50h	none	-	x	Application reset or select to device (master to slave)	Selects the requested application or block in the application (with parameter) or resets to application to default state (without parameter)
53h	long	x	x	Application reset or select to device (master to slave)	Selects the requested application or block in the application (with parameter) or resets to application to default state (without parameter)
54h	none	-	x	Request of selected application to device (master to slave)	Readout of selected application and next block
55h	long	x	x	Request of selected application to device (master to slave)	Readout of selected application and next block
66h	none	-	x	Response of selected application from device (slave to master)	Transmission of selected application and next block
67h	short	x	-	Response of selected application from device (slave to master)	Transmission of selected application and next block
68h	long	x	x	Response of selected application from device (slave to master)	Transmission of selected application and next block

All meters supporting several applications or one application with several blocks shall support these CI fields.
An application reset forces the fallback to standard reply. The standard response is a (predefined) application. Typically the standard reply is application 0. The standard reply always starts with 0.
A SND-UD with “Request of selected application” is confirmed with ACK. The successive REQ-UD2 shall be replied with “Response of selected application”. SND-UD2 can alternatively be used: The slave responds

immediately with “Response of selected application”. The return to the M-Bus application protocol is accomplished by using “Application reset” or “Application select”.

Extension of parameters for „Application select“

Currently only the first byte after application select is defined.
The following extension of considers additional bytes:
From master to slave: CI = 50h / 53h ax by cz
or
from slave to master: CI = 66h / 67h / 68h ax by cz
using
the bytes ax, by, cz as unsigned integer value

a	Application block = a (if a<Fh)
b	Application block = a + b (if a=Fh and b<Fh)
c	Application block = a + b + c (if a=Fh, b=Fh and c<Fh)
x	Bit 0..3 of block number
y	Bit 4..7 of block number
z	Bit 8..11 of block number

After the CI field up to 10 additional bytes are permitted. The above state definitions are using only 3 additional bytes.
NOTE The usage of Fh for the application block ensures backward compatibility to previous revisions of this standard.

Rules for application selection

1. Reset of current slave response

   The current application selection is retained until:
   - An application reset or application select is received.
   - Until a timeout condition is reached
   - A device reset has been accomplished.

   NOTE: A bus voltage dropout does not automatically imply an application reset. In this case the master shall select the requested application.
   NOTE: A secondary address selection or deselection, SND-NKE or break do not lead to a change of the application selection.

2. Erroneous application select

   An erroneous application select (selection of not supported application) shall be processed as application reset.

Rules for block selection

1. Current block

   The selected application block is delivered as next block by the slave.
2. Wrap around

   If no successive block is available the next transmitted block will be the first block (block 0).
3. Wrong block selection

   If a master selects a block that is not available the next transmitted block will be the first block (block 0).
4. Application reset

   After application reset the next transmitted block will be the first block (block 0).

The first block shall contain the most important information.

Selected application block in M-Bus Application protocol

Definition of a new data point:
VIB: FDh 77h   Currently selected Application block (same data as in CI = 66h)
Coding of data fields with BCD is not permitted.

The master requests a certain block from the slave. It is possible that the slave transmits a different block. Therefore it is necessary that the slave transmits the current block number in each block. If meters are providing more than one block in a selected application the defined data point shall be transmitted in each block.
If the M-Bus application protocol is encrypted the encryption of this data point is optional.

Examples:
Example for application 20:
The application block 20d is coded with Fh+5h = 14h, a = Fh und b = 5h .
The command is CI = 50h F0h 50h.
Old slaves are not capable of recognizing the application block Fh. Therefore this command is ignored.

Example for block ID 30:
The reply for a block ID 30 of the application 10 is:
CI=66h AEh 01h

VIB example 1: 01 FD 77 31
Application select 03d and block number 01d

VIB example 2: 03 FD 77 F1 F2 30
Application select 33d and block number 33d

10 Annex B

Standardisation proposal for CEN / TC294 (All references are based on EN 13757-3:2013):

Proposal for additions to table 28 (FDh table)
Achim Reissinger, 2015-04-17 of CEN / TC294 WG4 (Version 2)

Additions to table 28 in chapter 7.4

7.4 Main VIFE-code extension table (following VIF = FDh for primary VIF)

Table 28 — Main VIFE-code extension table

Coding	Description	Group
E010 0011	Descriptor for tariff and subunit; data type C	
E111 0111	Currently selected application block	
E111 1100	First secondary VIFE code extension table	
E111 1101	Second secondary VIFE code extension table	

Footnote for fist line: Descriptor for Tariff or Subunit usage according Annex …
All above listed entries are previously defined as reserved. All other entries remain unchanged.

The usage of E010 0011 is described in “Proposal for the introduction of a descriptor system for storage number, tariffs and subunits”.
The usage of E111 0111 is included in “Proposal for an extension of application select V1”.

New Table

Table xx — First secondary VIFE code extension table

Coding	Description	Group
E111 00pp	Remaining lifetime of the battery (pp according to note c of table 28)	
E111 0100	Remaining responses to REQ-UD2	
E111 1000 to E111 1110	Firmware versions	

Note for E111 0100: The meter shall calculate the remaining energy for communication and convert the result to energy equivalents of RSP-UD blocks.
The usage of E111 1000 to E111 1110 is defined in “Proposal for software download

11 Annex C

Data point analysis: Data points that may be included in OMS Vol. 2 Annex A+B

Zähler-Typ	Bezeichnung	M/O/A	Data field	[T]	[F]	[X]	[S]	[DIF]	[FD]	VIB	VIB-Type	OBIS-Code	Beschreibung
HKV	c2-Wert	O	REAL	0	0	0	0	05h	no	-		4-x:0.4.3*255	Thermal coupling rating factor room side, Kcr
Elektrizität	Energie	M	12BCD	0	0	0	0	0Eh	no	04h	EW01	-	Wirkenergie-Import, gesamt
Elektrizität	Energie Tarifregister 1	M	12BCD	1	0	0	0	8Eh	10h	04h	EW01	-	Wirkenergie-Import, Tarif 1
Elektrizität	Energie Tarifregister 2	M	12BCD	2	0	0	0	8Eh	20h	04h	EW01	-	Wirkenergie-Import, Tarif 2
Elektrizität	Energie Tarifregister 3	M	12BCD	3	0	0	0	8Eh	30h	04h	EW01	-	Wirkenergie-Import, Tarif 3
Elektrizität	Energie Tarifregister 4	M	12BCD	4	0	0	0	8Eh	80h 10h	04h	EW01	-	Wirkenergie-Import, Tarif 4
Elektrizität	Energie, Subunit 1	M	12BCD	0	0	0	1	8Eh	40h	04h	EW01	-	Wirkenergie-Export, gesamt
Elektrizität	Energie Subunit 1 Tarifregister 1	M	12BCD	1	0	0	1	8Eh	50h	04h	EW01	-	Wirkenergie-Export, Tarif 1
Elektrizität	Energie Subunit 1 Tarifregister 2	M	12BCD	2	0	0	1	8Eh	60h	04h	EW01	-	Wirkenergie-Export, Tarif 2
Elektrizität	Energie Subunit 1 Tarifregister 3	M	12BCD	3	0	0	1	8Eh	70h	04h	EW01	-	Wirkenergie-Export, Tarif 3
Elektrizität	Energie Subunit 1 Tarifregister 4	M	12BCD	4	0	0	1	8Eh	C0h 10h	04h	EW01	-	Wirkenergie-Export, Tarif 4
Elektrizität	Aktuelle Uhrzeit / Datum	M	12BCD	0	0	0	0	0Eh	no	6Dh	DT01	-	Aktuelle Uhrzeit / Datum
Elektrizität	Leistung	M	32INT	0	0	0	0	04h	no	29h	PW01	-	Wirkleistung, gesamt
	Die folgenden Netzkenngrößen sind bei ABB herstellerspezifisch kodiert, würden sich aber wie folgt korrekt darstellen lassen:												
	Wirkleistung gesamt												
Elektrizität	Wirkleistung L1	O	32INT	0	0	0	0	04h	no	A9 FC 01	-		Leistung bei Phase L1
Elektrizität	Wirkleistung L2	O	32INT	0	0	0	0	04h	no	A9 FC 02	-		Leistung bei Phase L2
Elektrizität	Wirkleistung L3	O	32INT	0	0	0	0	04h	no	A9 FC 03	-		Leistung bei Phase L3
Elektrizität	Blindleistung gesamt	O	32INT	0	0	0	0	04h	no	FB 14	RP01		Blindleistung
Elektrizität	Blindleistung L1	O	32INT	0	0	0	0	04h	no	FB 94 FC 01	-		Blindleistung bei Phase L1
Elektrizität	Blindleistung L2	O	32INT	0	0	0	0	04h	no	FB 94 FC 02	-		Blindleistung bei Phase L2
Elektrizität	Blindleistung L3	O	32INT	0	0	0	0	04h	no	FB 94 FC 03	-		Blindleistung bei Phase L3
Elektrizität	Scheinleistung gesamt	O	32INT	0	0	0	0	04h	no	FB 34 ???	-		Scheinleistung
Elektrizität	Scheinleistung L1	O	32INT	0	0	0	0	04h	no	FB B4 FC 01 ???	-		Scheinleistung bei Phase L1
Elektrizität	Scheinleistung L2	O	32INT	0	0	0	0	04h	no	FB B4 FC 02 ???	-		Scheinleistung bei Phase L2
Elektrizität	Scheinleistung L3	O	32INT	0	0	0	0	04h	no	FB B4 FC 03 ???	-		Scheinleistung bei Phase L3
	Spannung L1	O	32INT	0	0	0	0	04h	no	FD C8 FC 01	VV01		Spannung bei Phase L1 (zu N)
	Spannung L2	O	32INT	0	0	0	0	04h	no	FD C8 FC 02	VV02		Spannung bei Phase L2 (zu N)
	Spannung L3	O	32INT	0	0	0	0	04h	no	FD C8 FC 03	VV03		Spannung bei Phase L3 (zu N)
	Strom L1	O	32INT	0	0	0	0	04h	no	FD DA FC 01	CA01		Strom bei Phase L1
	Strom L2	O	32INT	0	0	0	0	04h	no	FD DA FC 02	CA02		Strom bei Phase L2
	Strom L3	O	32INT	0	0	0	0	04h	no	FD DA FC 03	CA03		Strom bei Phase L3
	Strom N	O	32INT	0	0	0	0	04h	no	FD DA FC 04	CA04		Strom bei Nulleiter N
Wasser	Volumen	M	8BCD	0	0	0	0	0Ch	no	13h - 17h	VM01	-	Aktuelles Volumen
Gas	Volumen	M	8BCD	0	0	0	0	0Ch	no	13h - 17h	VM01	-	Aktuelles Volumen korrigiert
Gas	Volumen	M	8BCD	0	0	0	0	0Ch	no	93h - 97h 3Ah	VM03	-	Aktuelles Volumen nicht korrigiert
Gas / Wasser	Fabrikationsnummer	M	8BCD	0	0	0	0	0Ch	no	78h	ID01	-	Fabrikationsnummer

Thermische Energie	Temperaturdifferenz	M	4BCD	0	0	0	0	0Ah	no	62h	-	-	aktuelle Temperaturdifferenz
Thermische Energie	Fabrikationsnummer	M	8BCD	0	0	0	0	0Ch	no	78h	ID01	-	
Thermische Energie	Mittelungszeit	M	2BCD	1	0	0	0	89h	10h	71h/72h	DP02	-	Mittelungszeit in Minuten/Stunden
Thermische Energie	Leistung Maximum	M	6BCD	1	0	0	0	9Bh	10h	2Dh/2Eh	PW01	-	
Thermische Energie	Leistung Maximum Vorjahr	M	6BCD	1	0	1	0	DBh	10h	2Dh/2Eh	PW01	-	
Thermische Energie	Durchfluss Maximum	M	6BCD	1	0	0	0	9Bh	10h	3Bh/3Ch/3Dh/3Eh	VF01	-	
Thermische Energie	Vorlauftemperatur Maximum	M	4BCD	1	0	0	0	9Ah	10h	5Bh	TC01	-	
Thermische Energie	Rücklauftemperatur Maximum	M	4BCD	1	0	0	0	9Ah	10h	5Fh	TC02	-	
Thermische Energie	Betriebszeit	M	8BCD	0	0	0	0	0Ch	no	22h/23h	-	-	Betriebszeit in Stunden/Tagen
Thermische Energie	Fehlzeit	M	8BCD	0	1	0	0	3Ch	no	22h/23h	-	-	Zeit während Fehler in Stunden/Tagen
Thermische Energie	Fehlzeit Vorjahr	M	8BCD	0	1	1	0	7Ch	no	22h/23h	-	-	
Thermische Energie	Stichtag Vorjahr	M	16INT	0	0	1	0	42h	no	6Ch	DT02	-	Typ G, Jahr = 0 stets
Thermische Energie	Energie Tarifregister 1	M	8BCD	2	0	0	0	8Ch	20h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 2; d. h. Tarifregister 1
Thermische Energie	Energie Tarifregister 2	M	8BCD	3	0	0	0	8Ch	30h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 3; d. h. Tarifregister 2
Thermische Energie	Energie Tarifregister 3	M	8BCD	4	0	0	0	8Ch	80h 10h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 4; d. h. Tarifregister 3
Thermische Energie	Energie Tarifregister 1 Vorjahr	M	8BCD	2	0	1	0	CCh	20h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 2; d. h. Tarifregister 1
Thermische Energie	Energie Tarifregister 2 Vorjahr	M	8BCD	3	0	1	0	CCh	30h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 3; d. h. Tarifregister 2
Thermische Energie	Energie Tarifregister 3 Vorjahr	M	8BCD	4	0	1	0	CCh	80h 10h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 4; d. h. Tarifregister 3
Thermische Energie	Vorlauftemperatur Maximum, jüngster Vormonatswert	M	4BCD	1	0	2	0	9Ah	11h	5Ah/5Bh	TC01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Rücklauftemperatur Maximum, jüngster Vormonatswert	M	4BCD	1	0	2	0	9Ah	11h	5Eh/5Fh	TC02	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Durchfluss Maximum, jüngster Vormonatswert	M	6BCD	1	0	2	0	9Bh	11h	3Bh/3Ch/3Dh/3Eh	VF01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Leistung Maximum, jüngster Vormonatswert	M	6BCD	1	0	2	0	9Bh	11h	2Dh/2Eh	PW01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Fehlzeit, jüngster Vormonatswert	M	8BCD	0	1	2	0	BCh	01h	22h/23h	-	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Energie, jüngster Vormonatswert	M	8BCD	0	0	2	0	8Ch	01h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Energie Tarifregister 1, jüngster Vormonatswert	M	8BCD	2	0	2	0	8Ch	21h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 2; d. h. Tarifregister 1; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Energie Tarifregister 2, jüngster Vormonatswert	M	8BCD	3	0	2	0	8Ch	31h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 3; d. h. Tarifregister 2; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Energie Tarifregister 3, jüngster Vormonatswert	M	8BCD	4	0	2	0	8Ch	81h 10h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 4; d. h. Tarifregister 3; Speichernummer 2 = jüngster Vormonatswert

Thermische Energie	Volumen, jüngster Vormonatswert	M	8BCD	0	0	2	0	8Ch	01h	14h/15h	VM01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeitstempel Vorlauftemperatur, jüngster Vormonatswert	M	32INT	1	0	2	0	94h	11h	DAh 6Fh	-	-	Typ F; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeitstempel Rücklauftemperatur, jüngster Vormonatswert	M	32INT	1	0	2	0	94h	11h	DEh 6Fh	-	-	Typ F; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeitstempel Durchfluss Maximum, jüngster Vormonatswert	M	32INT	1	0	2	0	94h	11h	BBh 6Fh	-	-	Typ F; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeitstempel Leistung Maximum, jüngster Vormonatswert	M	32INT	1	0	2	0	94h	11h	ADh 6Fh	-	-	Typ F; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeit mit Durchfluss, jüngster Vormonatswert	M	8BCD	0	0	2	0	8Ch	01h	27h	-	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Volumen Impulseingang 1, jüngster Vormonatswert	M	8BCD	0	0	2	1	8Ch	41h	16h	VM01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Volumen Impulseingang 2, jüngster Vormonatswert	M	8BCD	0	0	2	2	8Ch	81h 40h	16h	VM01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeitstempel, jüngster Vormonatswert	M	32INT	0	0	2	0	84h	01h	6Dh	DT01	-	Typ F; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Temperaturdifferenz Maximum, jüngster Vormonatswert	M	4BCD	0	0	2	0	9Ah	11h	62h	-	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Zeitstempel Temperaturdifferenz Maximum, jüngster Vormonatswert	M	32INT	0	0	2	0	9Ah	11h	E2h 6Fh	-	-	Typ F; Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Volumen Impulseingang 1	M	8BCD	0	0	0	1	8Ch	40h	16h	VM01	-	Speichernummer 2 = jüngster Vormonatswert
Thermische Energie	Volumen Impulseingang 2	M	8BCD	0	0	0	2	8Ch	80h 40h	16h	VM01	-	Speichernummer 2 = jüngster Vormonatswert
Beispiel für 40. Vormonatswert													
Thermische Energie	Vorlauftemperatur Maximum, 40. Vormonatswert	M	4BCD	1	0	2	0	DAh	94h 01h	5Ah/5Bh	TC01	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Rücklauftemperatur Maximum, 40. Vormonatswert	M	4BCD	1	0	2	0	DAh	94h 01h	5Eh/5Fh	TV02	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Durchfluss Maximum, 40. Vormonatswert	M	6BCD	1	0	2	0	DBh	94h 01h	3Bh/3Ch/3Dh/3Eh	VF01	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Leistung Maximum, 40. Vormonatswert	M	6BCD	1	0	2	0	DBh	94h 01h	2Dh/2Eh	PW01	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Fehlzeit, 40. Vormonatswert	M	8BCD	0	1	2	0	FCh	84h 01h	22h/23h	-	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Energie, 40. Vormonatswert	M	8BCD	0	0	2	0	CCh	84h 01h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Energie Tarifregister 1, 40. Vormonatswert	M	8BCD	2	0	2	0	CCh	A4h 01h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 2; d. h. Tarifregister 1; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Energie Tarifregister 2, 430. Vormonatswert	M	8BCD	3	0	2	0	CCh	B4h 01h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 3; d. h. Tarifregister 2; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Energie Tarifregister 3, 40. Vormonatswert	M	8BCD	4	0	2	0	8Ch	84h 11h	06h/07h 0Eh/0Fh FBh 01h FBh 09h	EW01 EJ01 EW02 EJ02	-	Tarif = 4; d. h. Tarifregister 3; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Volumen, 40. Vormonatswert	M	8BCD	0	0	2	0	CCh	84h 01h	14h/15h	VM01	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeitstempel Vorlauftemperatur, 40. Vormonatswert	M	32INT	1	0	2	0	D4h	94h 01h	DAh 6Fh	-	-	Typ F; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeitstempel Rücklauftemperatur, 40. Vormonatswert	M	32INT	1	0	2	0	D4h	94h 01h	DEh 6Fh	-	-	Typ F; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeitstempel Durchfluss Maximum, 40. Vormonatswert	M	32INT	1	0	2	0	D4h	94h 01h	BBh 6Fh	-	-	Typ F; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeitstempel Leistung Maximum, 40. Vormonatswert	M	32INT	1	0	2	0	D4h	94h 01h	ADh 6Fh	-	-	Typ F; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeit mit Durchfluss, 40. Vormonatswert	M	8BCD	0	0	2	0	CCh	84h 01h	27h	-	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Volumen Impulseingang 1, 40. Vormonatswert	M	8BCD	0	0	2	1	CCh	C4h 01h	16h	VM01	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Volumen Impulseingang 2, 40. Vormonatswert	M	8BCD	0	0	2	2	8Ch	81h 40h	16h	VM01	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeitstempel, 40. Vormonatswert	M	32INT	0	0	2	0	C4h	84h 01h	6Dh	DT01	-	Typ F; Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Temperaturdifferenz Maximum, 40. Vormonatswert	M	4BCD	0	0	2	0	DAh	94h 01h	62h	-	-	Speichernummer 41 = 40. Vormonatswert
Thermische Energie	Zeitstempel Temperaturdifferenz Maximum, 40. Vormonatswert	M	32INT	0	0	2	0	D4h	94h 01h	E2h 6Fh	-	-	Typ F; Speichernummer 41 = 40. Vormonatswert

Water	Volume, current value, total, high resolution		8BCD	1	0	0	0	8Ch	10h	10h,11h,12h,13h,14h,15h,16h	VM01		
Water	Volume, current value, return		8BCD	1	0	0	0	8Ch	10h	10h,11h,12h,13h,14h,15h,16h	VM01		
Water	Volume, current value, forward		8BCD	2	0	0	0	8Ch	20h	10h,11h,12h,13h,14h,15h,16h	VM01		
Water	Future / Next due date date		2INT	0	0	1	0	42h		ECh 7Eh	-		Date type G, next value
Water	Pulse weight 1		4BCD	0	0	0	0	0Ah		91h 2Ah	-		Volume (here 10ml), pulse output channel #0
Water	Pulse weight 2		4BCD	0	0	0	0	0Ah		91h 2Bh	-		Volume (here 10ml), pulse output channel #1
Water	Flow rate, minimum value, total		6BCD	0	2	0	0	2Bh		38h,39h,3Ah,3Bh,3Ch,3Dh,3Eh,3Fh ,40h, 41h,42h,43h,44h,45h,46h,47h,48h, 49h,4Ah,4Bh,4Ch,4Dh,4Eh,4Fh	-		
Water	Flow rate, maximum value, total		6BCD	0	1	0	0	1Bh		38h,39h,3Ah,3Bh,3Ch,3Dh,3Eh,3Fh ,40h, 41h,42h,43h,44h,45h,46h,47h,48h, 49h,4Ah,4Bh,4Ch,4Dh,4Eh,4Fh	-		
Water	Operating hours		6BCD	0	0	0	0	0Bh		26h	-		
Water	Error hours counter		4BCD	0	0	0	0	0Ah		A6h 18h	-		
Water	Medium temperature °C/°F		2INT	0	0	0	0	02h		5Ah DAh 3Dh	TC01 -		
Water	Ambient temperature °C/°F		2INT	0	0	0	0	02h		64h,65h,66h,67h	-		
Water	Temperature						0						
Water	Other FW version		3INT	0	0	0	0	03h		FDh 0Fh	-		
Water	Metrological FW version		3INT	0	0	0	0	03h		FDh 0Eh	-		
Water	Remaining battery lifetime		2INT	0	0	0	0	02h		FDh 74h	-		
Water	Battery renewal date		2INT	0	0	0	0	02h		FDh 70h	-		
Water	Due Date 1, return volume						0						
Water	Due Date 1, forward volume						0						
Water	Due Date 2, total volume						0						
Water	Due Date 2, return volume						0						
Water	Due Date 2, forward volume						0						
Water	Due Date 2						0						
Water	Radio interval		2INT	0	0	0	0	02h		FDh 3Ch	-		
Wärme	Temperaturdifferenz	O	INT / BCD	0	0	0	0			60h / 61h / 62h / 63h			dT = T VL - T RL
Wärme	Energie	O	INT / BCD			1	0			06h / 07h 0Eh / 0Fh	EW01 EJ01	6-0:1.0.0*1 ???	Energieregister am Stichtag
Wärme	Stichtagsdatum	O	INT	0	0	1	0	42h		6Ch	DT02		Stichtagsdatum
Wärme	zukünfiges Stichtagsdatum	O	INT	0	0	0	0	02h		ECh, 7Eh	-		Stichtagsdatum, nächster Stichtag (typ. Jahr++)