# Open Metering System
# Technical Report 02
# Wired M-Bus

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RELEASE

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# 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 and -7 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 standardizations 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 transport and security services are defined in part 7. 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 reduced. 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 standard but 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 7). Finally, the scope for interpretation is restricted by specifications and definitions (chapter 5). 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 |
| DR | Data Record | Data Record |
| 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** |
| SC | Source Capacitor | Source Capacitor |
| 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 = Ohm/meter, L/m = Henry/meter, C/m = Farad/meter) | Parameter für Eigenschaften von Kabeln und Verbindungselementen (R/m = Ohm/meter, L/m = Henry/meter, C/m = Farad/meter |
| | | |
| **X** | **X** | **X** |
| | | |
| **Y** | **Y** | **Y** |
| | | |
| **Z** | **Z** | **Z** |
| | | |

# 4 References

OMS:

- OMS Specification Volume 1, General Part, Issue 2.3.1
- OMS Specification Volume 1, General Part, Annex A , Release E
- OMS Specification Volume 2, Primary Communication, Issue 3.0.1 / 2011-01-29
- OMS Specification Volume 2, Primary Communication, Issue 4.5.1
- OMS-Conformance-Test-Specification Generation 4 Release 6, Volume 1 General Part, Issue 4.0.9, Volume 2 PHY (Radio Parameters), Issue 4.0.11, Volume 3 Data Link Layer, Issue 4.0.8, Volume 4 Application layer, Issue 4.0.12

EN:

- EN 13757-2: Communication systems for meters – Part 2: Wired M-Bus communication: February 2018 is currently valid. All references are linked to the standard edition of February 2018 unless a date is specified.
- EN 13757-3: Communication systems for meters – Part 3: Application protocols; August 2018 is currently valid. All references are linked to the standard edition of August 2018 unless a date is specified.;
- EN 13757-7: Communication systems for meters – Part 7: Transport and security services; first edition August 2018;
- CEN/TR 17167 Communication system for meters – Accompanying TR to EN 13757-2, -3 and 7, Examples and supplementary information
- EN 60870-5-2: Telecontrol equipment and systems – Part 5: Transmission Protocols – Part 2: Link transmission procedures, EN 60870-5-2:1992

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 1.1

# 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 interferences.

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 recommended for M-Bus systems. A termination resistor is not allowed.

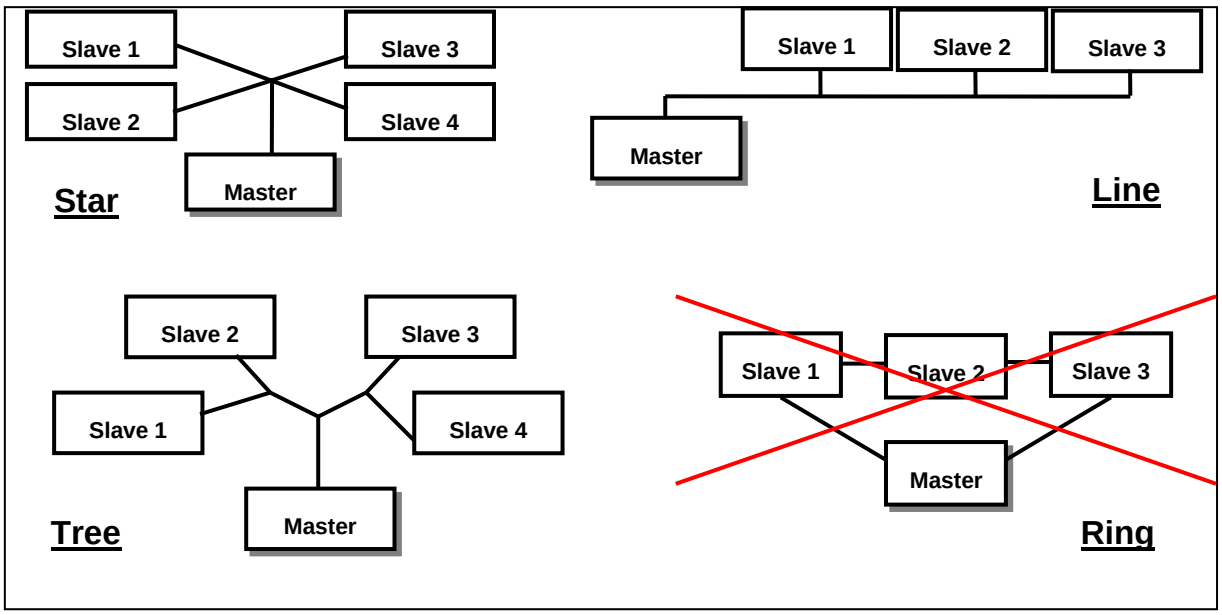



**Figure 1: Topology variants**

#### *5.1.1.3 Wiring rules*

- Keep total cable length as short as possible
- Be mindful of interference (EMC) from other cables and installations: The Wired M-Bus cable shall be used for Wired M-Bus exclusively.
- 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.
- The M-Bus lines shall not be coupled with ground / earth or any other voltage potential

#### *5.1.1.4 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 ** | Cross section | 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<br>** 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 available as technical report OMS-TR09. It provides all relevant aspects for an appropriate installation.

### 5.1.2 SC Charge / Discharge

As the master in the M-Bus system modulates 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 / discharging this capacitor. Following specifications are based on best practice solutions and follow available slave transceiver devices (e.g. ON Semiconductor, Texas Instruments) with a 100 nF – 330 nF storage capacitor:

- Charge: Voltage shall increase at 25 to 500 V/s
- Discharge: Voltage shall decrease at 0,5 to 15 V/s
- Ratio between charge and discharge speeds shall 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 resistors 2x Rs/2

Annex B reference schematic with over-voltage protection V3 and series resistors 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 drawing up to 300 mA inrush current. 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 53.3.4)

### 5.1.5 Identification of the Unit Loads

The number of unit loads (UL) must be listed in the data sheet. Additionally it shall 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 device, 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. This is also the limit according to EN 13757-2:2018.

### 5.1.6 Switch-on Process

M-Bus master:

Initial startup of the M-Bus master

$t_{\text{Reaching Allowed M-Bus mark voltage level}} = t_{\text{Powerup M-Bus master}} + t_{\text{M-Bus voltage rise time}}$

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

$t_{\text{Reaching Allowed M-Bus mark voltage level}} = t_{\text{M-Bus voltage rise time}}$

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

- Strictly increasing
- Minimum slew rate : 168 V/s

Test conditions:

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

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

with $R_{load}$ || $C_{load}$, 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 minimum mark voltage level of 21 V.

### 5.1.7 Upper Limit for Voltage Variation

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

$15\ V \geq U_{delta,\ mark\text{-}space} \geq 12\ V$, 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 EN13757-2:2018 / 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:

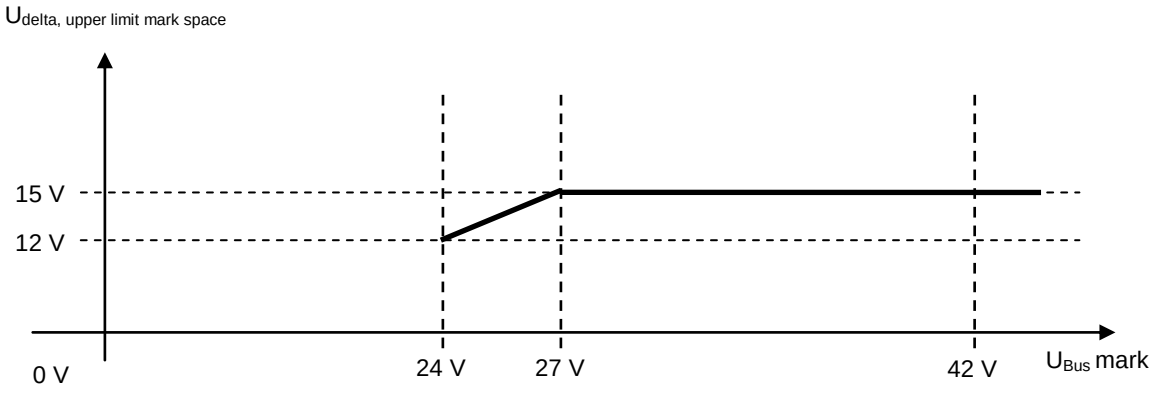



**Figure 2: Voltage variation**

**NOTE:** With $U_{Bus\ mark}$ for the voltage level at M-Bus slave terminals; for $U_{Bus\ mark}$ voltages for the M-Bus master, $U_r$ (for explanation see EN 13757-2:2018, 4.3.1.2) must be taken into account.

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

- EN13757-2:2018 / Chapter 4.3.3.2

  $U_{Space} < U_{Mark} - 12\ V$, but $\geq 12\ V + U_r$.

- EN13757-2:2018 / 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 ($C_{Load}$ selected from the E12 value series):

  - baud rate 300 Bd: $C_{Load}$ = 1,5 µF;
  - baud rate 2400 Bd: $C_{Load}$ = 1,2 µF;
  - baud rate 9600 Bd: $C_{Load}$ = 0,82 µF;
  - baud rate 38400 Bd: $C_{Load}$ = 0,39 µF.

- EN13757-2:2018 / 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 EN13757-2:2018 / 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 EN13757-2:2018 / Chapter 4.2.2.6).

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

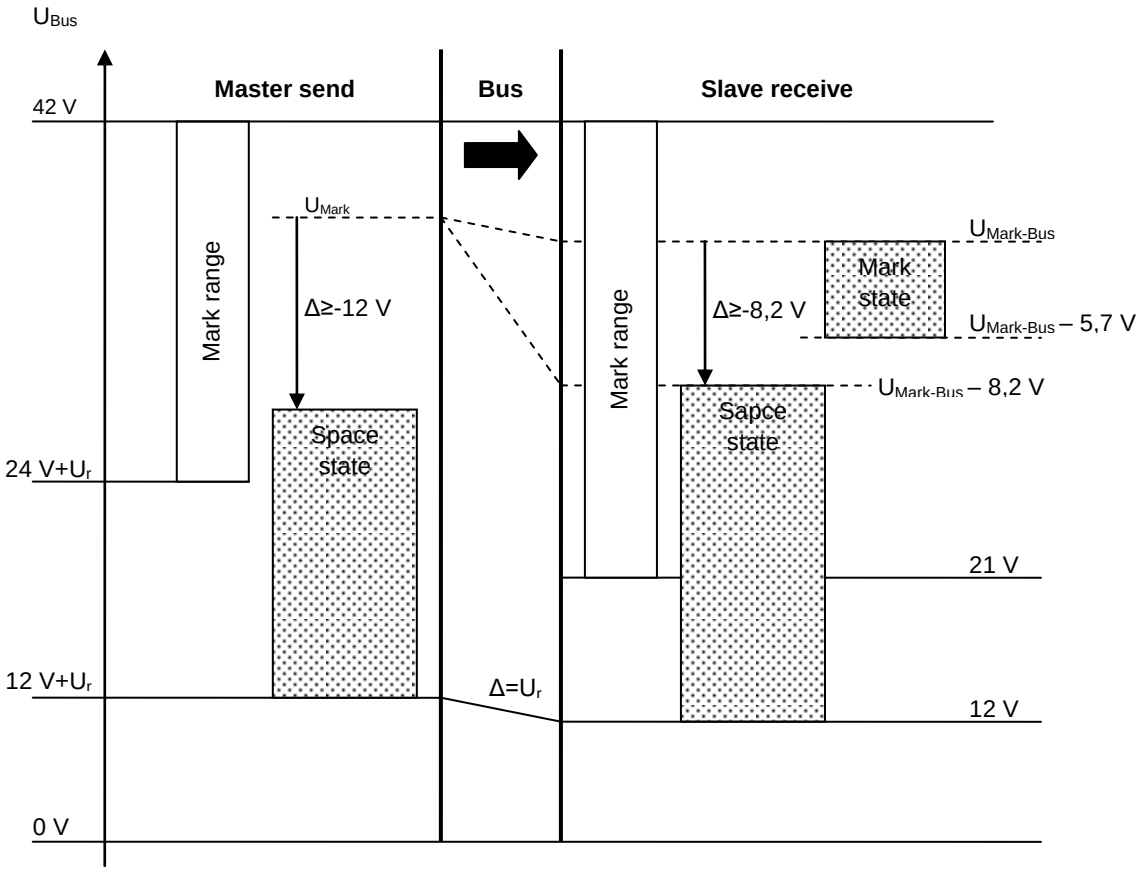



**Figure 3: M-Bus voltage**

5 $U_{r,\,max}$ = (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 EN13757-2:2018.

#### 5.1.8.1 Electrical requirements, master

10 - EN13757-2:2018 / Chapter 4.3.3.1

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

- EN13757-2:2018 / Chapter 4.3.3.2

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

- EN13757-2:2018 / Chapter 4.3.1.2 Max. allowable voltage drop ($U_r$)

15 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:**

- EN13757-2:2018 / 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 (= $U_{Mark}$) 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 $U_{Mark}$ may drop in 50 ms by not more than 0.2 V for all voltages between 12 V and $U_{Mark}$."

- EN13757-2:2018 / 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 EN13757-2:2018 for state recognition and collision detection for the M-Bus slave to M-Bus master communication.

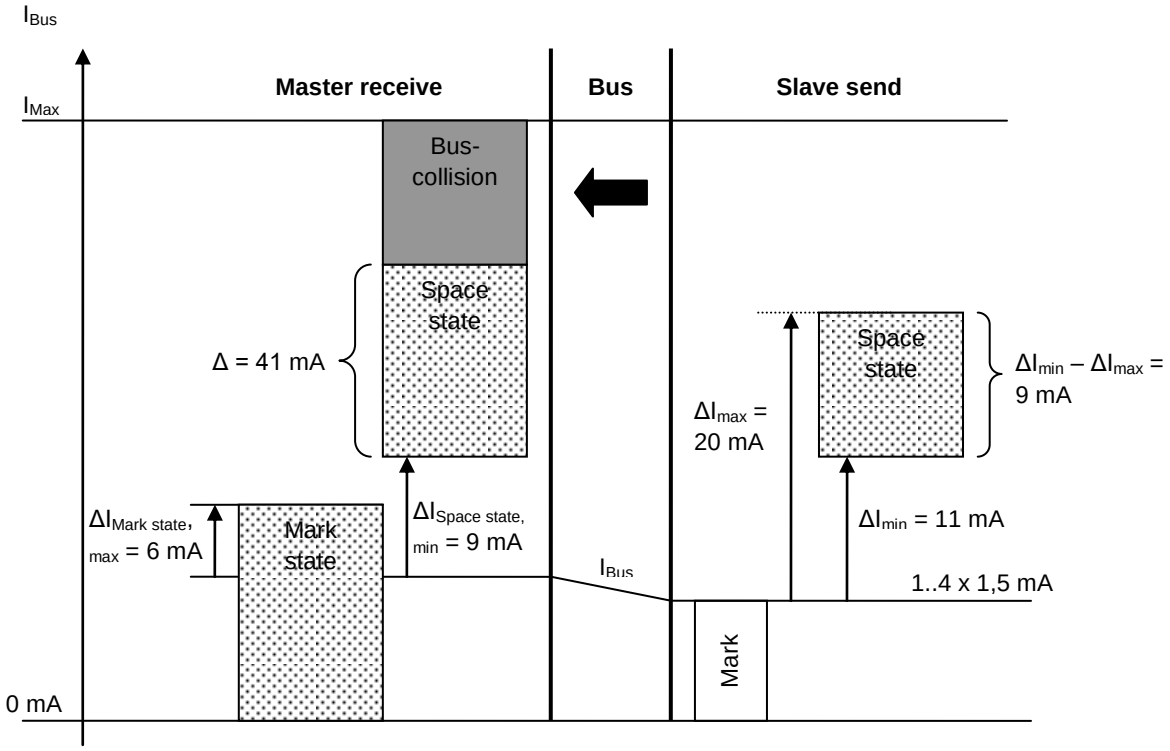



**Figure 4: M-Bus states**

$\Delta I_{Mark\ state,\ max}$: 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.

$I_{Bus}$: Master receive: Total of all slave currents; Slave send: Current of one slave

The following chapters define the voltage requirements according to EN13757-2:2018.

- EN13757-2:2018 / 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."

- EN13757-2:2018 / 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."

- EN13757-2:2018 / 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 13757-2:2018, 4.3.3.1):**

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

PASS: $24\ V + U_r \leq U_{Mark} \leq 42\ V$

**Test 2, Space state (EN 13757-2:2018, 4.3.3.2):**

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

PASS: $U_{Mark} - 15\ V \leq U_{SPACE} \leq U_{Mark} - 12\ V$
AND $U_{Space} > 12\ V + U_r$

**Test 3, rise / fall time (EN 13757-2:2018, 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 ($C_{Load}$ selected from the E12 value series):
> - baud rate 300 Bd: $C_{Load}$ = 1,5 µF;
> - baud rate 2400 Bd: $C_{Load}$ = 1,5 µF;
> - baud rate 9600 Bd: $C_{Load}$ = 1,0 µF;

**Test 4, effective source impedance (EN 13757-2:2018, 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 13757-2:2018, 4.3.3.8):**

- 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 13757-2:2018, 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 13757-2:2018, 4.3.3.6)**

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

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

**Test 8, Bus recovery (EN 13757-2:2018, 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 13757-2:2018, 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, Unit loads N (EN 13757-2:2018, 4.2.2.1):**

- device specification for *N* by manufacturer

PASS: $N \leq 4$

**Test 2, Maximum permanent voltage (EN 13757-2:2018, 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 13757-2:2018, 4.2.2.2) and fast change (EN 13757-2:2018, 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: $(N\text{-}1) \times U_L < I_{Mark} \leq N \times U_L$ ($N_{max}$=4)

Repeat for inverted polarity

**Test 4, $I_{MARK}$ variation over bus voltage variation (EN 13757-2:2018, 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 13757-2:2018, 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 13757-2:2018, 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 13757-2:2018, 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 13757-2:2018, 4.2.2.10):**

- measure capacity without bias at 10 kHz

PASS: capacity ≤ 0,5 nF

**Test 9, Mark / Space state (EN 13757-2:2018, 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 13757-2:2018, 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 13757-2:2018, 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.

5 **Table 3: Master tests**

| Test No. | Comment | Equipment |
|---|---|---|
| 1 | Mark range<br>(EN 13757-2:2018, 4.3.3.1) | • Current sink<br>• Multimeter |
| 2 | Space state<br>(EN 13757-2:2018, 4.3.3.2) | • Current sink from one slave transceiver<br>• Command interface to master<br>• Oscilloscope<br>• Evaluation software for oscilloscope data |
| 3 | rise / fall time<br>(EN 13757-2:2018, 4.3.3.4) | • Command interface to master<br>• Oscilloscope with time resolution <=0,1 µs<br>• Evaluation software for oscilloscope data<br>• Current sink from one slave transceiver<br>• Capacity switchable by software with specified capacitors |
| 4 | effective source impedance<br>(EN 13757-2:2018, 4.3.3.5) | • Command interface to master<br>• Current sink from one slave transceiver<br>• Load of 20 mA switchable by software<br>• Multimeter |
| 5 | bus-collision<br>(EN 13757-2:2018, 4.3.3.8) | • Current sink from one slave transceiver<br>• Load of 50 mA switchable by software<br>• Oscilloscope<br>• Evaluation software for oscilloscope data |
| 6 | Mark / Space state<br>(EN 13757-2:2018, 4.3.3.7) | • Current sink from one slave transceiver<br>• Command interface to master<br>• Slave with variable current (from NCN5150) |
| 7 | Hum, ripple and short term stability<br>(EN 13757-2:2018, 4.3.3.6) | • Current sink from one slave transceiver<br>• Oscilloscope<br>• Evaluation software for oscilloscope data |
| 8 | Bus recovery<br>(EN 13757-2:2018, 4.3.3.8) | • Current sink from one slave transceiver<br>• Short circuit switchable by software (current sink with 0 Ohms)<br>• Oscilloscope<br>• Evaluation software for oscilloscope data |
| 9 | Galvanic isolation<br>(EN 13757-2:2018, 4.3.3.9) | • Ohm meter |

5.1.9.3.2 Test slave

**Table 4: Slave tests**

| Test No. | Comment | Equipment |
|---|---|---|
| 1 | N<br>(EN 13757-2:2018, 4.2.2.1) | • Visual check |
| 2 | Maximum permanent voltage<br>(EN 13757-2:2018, 4.2.1) | • Voltage source with +/-50 V (switchable by software)<br>• Master for REQ-UD2 (incl. command interface) |
| 3 | $I_{MARK}$<br>(EN 13757-2:2018, 4.2.2.2) and Fast change<br>(EN 13757-2:2018, 4.2.2.8 | • Voltage source (switchable by software)<br>• Ammeter (readable by software, resolution 0,1 ms) |
| 4 | $I_{MARK}$ variation over bus voltage variation<br>(EN 13757-2:2018, 4.2.2.3) | • Voltage source (switchable by software)<br>• Ammeter (readable by software) |
| 5 | Short term variation of the mark state current<br>(EN 13757-2:2018, 4.2.2.4) | • Voltage source (switchable by software)<br>• Ammeter (readable by software, resolution 1 ms) |
| 6 | Total variation over allowed temperature and voltage range of slave device<br>(EN 13757-2:2018, 4.2.2.5) | • Climate chamber (controllable by software)<br>• Voltage source (switchable by software)<br>• Ammeter (readable by software, resolution 1 ms) |
| 7 | Slow start<br>(EN 13757-2:2018, 4.2.2.7) | • Voltage source (switchable by software)<br>• Ammeter (readable by software, resolution 1 ms) |
| 8 | Capacity<br>(EN 13757-2:2018, 4.2.2.10) | • Capacitance meter (readable by software) |
| 9 | MARK / SPACE state<br>(EN 13757-2:2018, 4.2.1) | • Master with adjustable voltages $U_{SPACE}$ and $U_{MARK}$ |
| 10 | $I_{SPACE}$<br>(EN 13757-2:2018, 4.2.2.9) | • Master with adjustable voltages $U_{SPACE}$ and $U_{MARK}$<br>• Current measurement clamps with 10 µs resolution (evaluable by software, possibly on oscilloscope) |
| 11 | Start-up delay<br>(EN 13757-2:2018, 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)

The VIF/VIFE for battery lifetime is defined in Table 12 and Table 13 of EN 13757-3.2018. The following VIFs are applicable: FDh 74h, FDh FDh 02h/03h

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.
  In case the number of days / remaining readouts decreased until the value zero is reached, the value shall remain zero. Negative values are not 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-replaceable 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) | | | | Max. cable length at 2400 bd (all slaves at end of cable) | | | | Max. cable length at 300 bd (all slaves at end of cable) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 20 UL | 60 UL | 120 UL | 250 UL | 20 UL | 60 UL | 120 UL | 250 UL | 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 and slaves shall support 300 and 2400 Bd and may support 9600 Bd, 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.

Slave devices shall support automatic baud rate detection for all supported baud rates.

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 may reject responds from a slave which arrive earlier than the wait time of 11 bit times according to EN 13757-2:2018.

### 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 using Wired M VIF=79h (see OMSS Vol. 2).

The secondary address shall be unique worldwide (according to OMSS Vol. 2, 3.1.2.2). Customer and vendor may agree an exception to this rule, if necessary. This exception need to defined in the [MANDEC].

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: EN13757-2:2018, 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: EN13757-2:2018 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 (see Figure 5)

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

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

Basis for determining the tolerances: nominal stop bit time

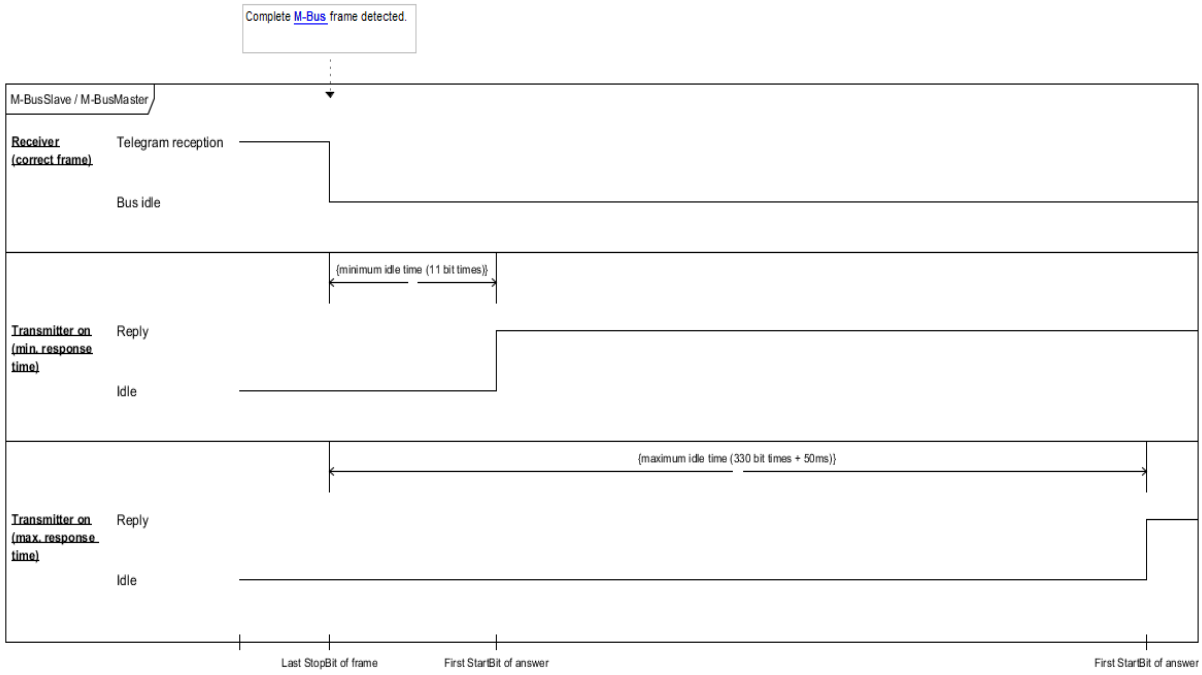



**Figure 5: End of datagram detection for a valid M-Bus frame**

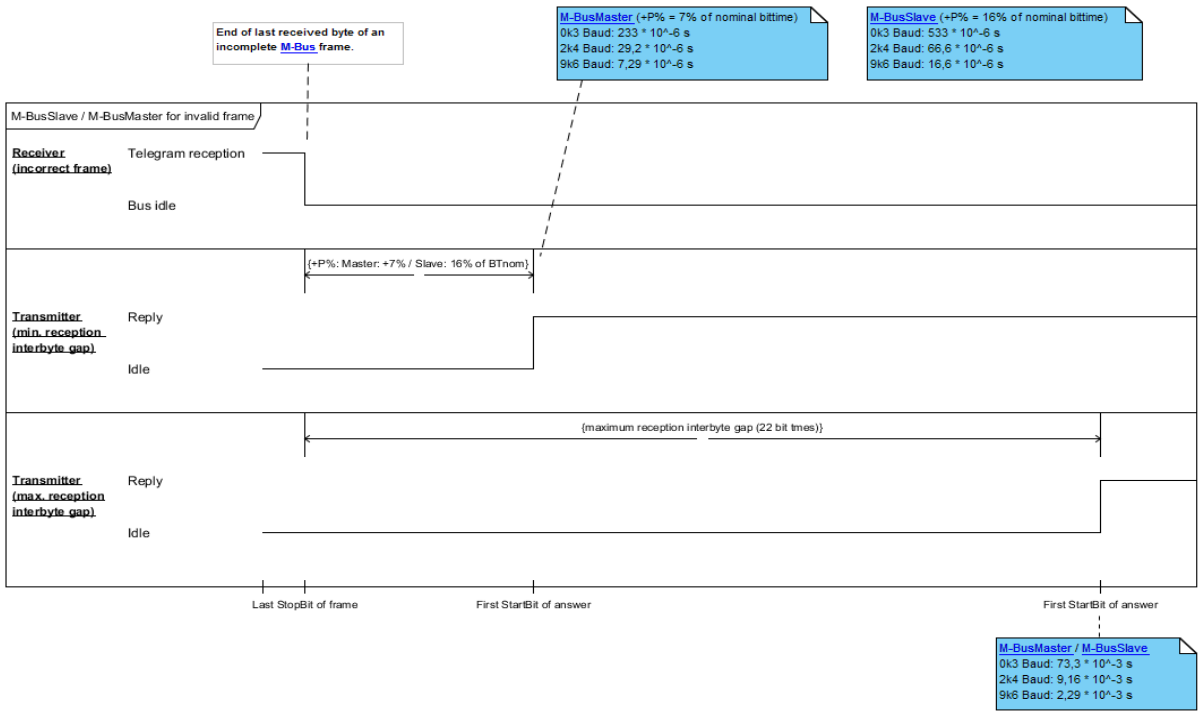



**Figure 6: End of datagram detection for an invalid / incomplete M-Bus frame**

### 5.2.6 Special Primary Addresses 254, 255 (Mandatory)

5 A message to address 254 and 255 must be handled as if it is addressed to its own primary address.SND-NKE (mandatory)

**NOTE:** Slaves with more than one logical address (see 5.2.4) do not apply to this rule.
**NOTE:** A message sent with an A-field 255 is not answered by the OMS end-device (acc. to [EN 13757 2:2018], 5.7.5).

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 OMSS Vol. 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 according to [OMS-S2], 3.2 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 [OMS-S2], 3.2:

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

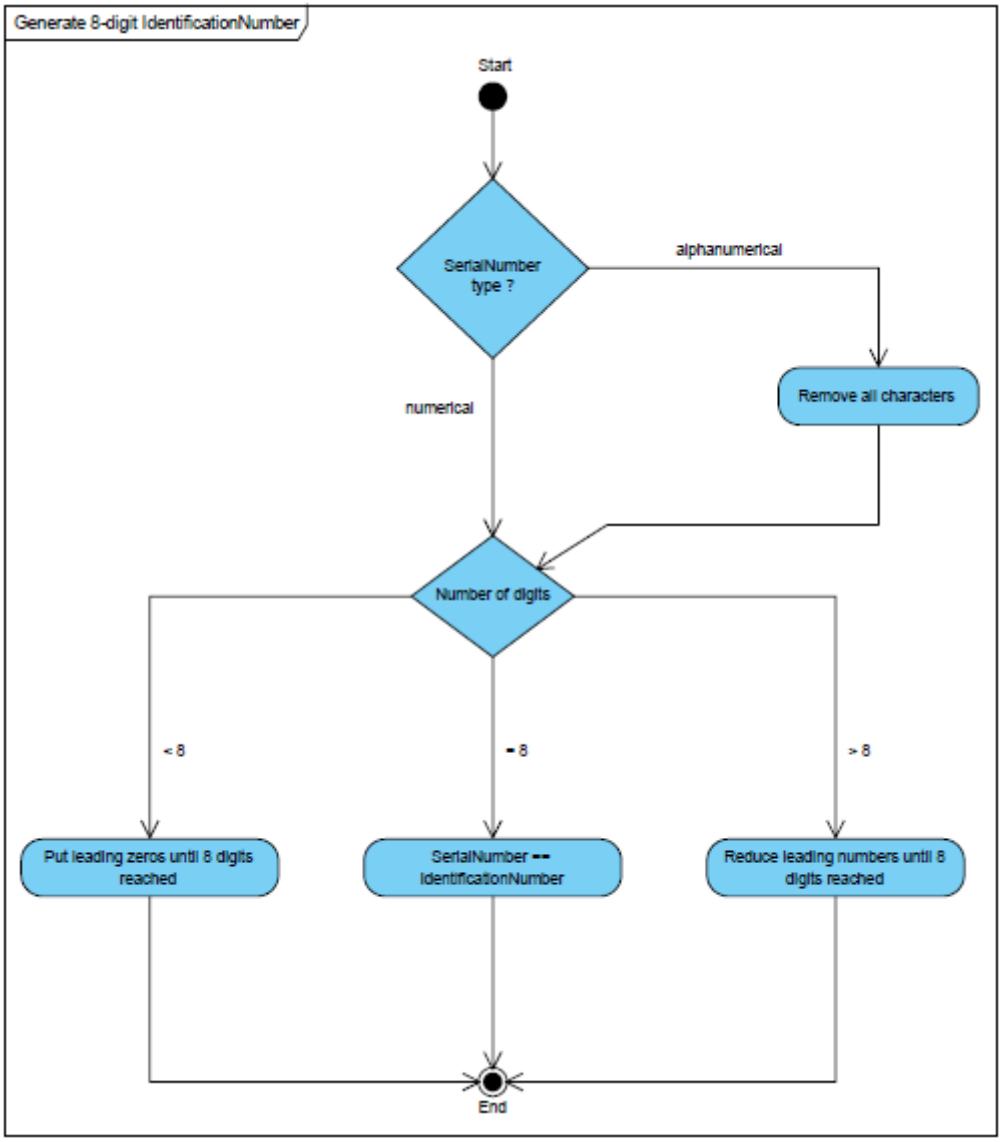



**Figure 7: Generation of 8-digit identification number**

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 OMSS 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 Device Type for Wired Adapters (Mandatory)

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

### 5.4.3 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.
- The application of the AFL excludes the usages of the DIF 1Fh (see EN 13757-3:2018, 6.5).

### 5.4.4 Minimum Communication Capabilities for Slaves (Mandatory)

A slave shall support the following minimum communication capabilities in addition to [EN 13757-2:2018]:

- Set the primary address using XID3! (according to [OMS-S2], Annex B).
- Support application reset and application select with CI = 50h or 53h.
- Change of secondary address with DIF = 07h or DIF = 0Ch, VIF = 79h (for adapters with changeable address only, see 5.2.3).

**NOTE:** The [EN 13757-3:2018], 7.3 describes additional CI fields (54h, 55h, 66h and 68h) for special cases.

### 5.4.5 Commands for Communication if Applicable (Mandatory)

- Set the due date (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
- This chapter will be replaced by the future issue of [OMS-S2], Annex M.

## 5.5 Reserved

## 5.6 Installation

An OMS installation guide is currently in preparation.

## 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 OMSS (Vol. 2, Annex E, Annex F). Annex N of OMSS 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 OMSS Vol. 2 provides an unencrypted example for a RSP-UD for the Wired M-Bus.

The following layer structure is used for this example:

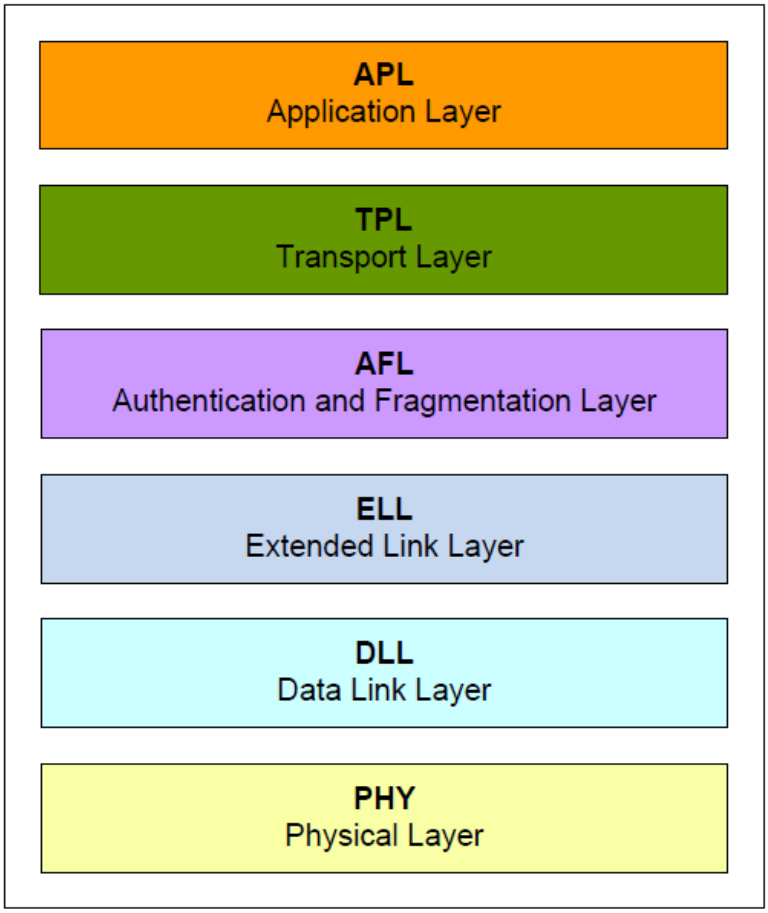
| |
|---|
| Data Link Layer (DLL): Header |
| Transport Layer (TPL):<br>• CI=72h<br>• Transport Layer address field<br>(contains the address of the M-Bus Slave from which the RSP-UD is sent)<br>• Config Field:<br>○ Mode 0<br>○ 2 Bytes length<br>○ Value: 00h 00h |
| Application Layer (APL): Set of Data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

One DR consists of VIB, DIB and data.

### 5.8.3 Layer Structure

OMSS 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 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). The application of the AFL excludes the usages of the DIF 1Fh (see EN 13757-3:2018, 6.5).

First fragment of Multi-RSP-UD:

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

Following fragments:

| Data Link Layer (DLL): Header |
|---|
| Authentication and Fragmentation Layer (AFL):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML)<br>• No Message Authentication Code (MAC)<br>• No Message Counter (MCR) |
| Application Layer (APL): Set of DRs (Encrypted) |
| Data Link Layer (DLL): Termination |

Last fragment:

| Data Link Layer (DLL): Header |
|---|
| Authentication and Fragmentation Layer (AFL):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML)<br>• No Message Authentication Code (MAC)<br>• No Message Counter (MCR) |
| Application Layer (APL): Set of DRs (Encrypted) and Set of DRs (Unencrypted) |
| Data Link Layer (DLL): Termination |

The number of encrypted blocks (in the TPL) provides the possibility to add unencrypted DRs after the encrypted DRs. One example for unencrypted DRs 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):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• Message Length Field (ML) required<br>• No Message Authentication Code (MAC)<br>• No Message Counter (MCR) |
| Transport Layer (TPL):<br>• CI=72h<br>• Transport Layer address field<br>(contains the address of the M-Bus Slave from which the RSP-UD is sent)<br>• Config Field:<br>○ Mode 5<br>○ 2 Bytes length<br>○ Number of encrypted blocks<br>○<br>• Decryption Verification (2Fh, 2Fh, encrypted) |
| Application Layer (APL): Set of DRs (Encrypted) and Set of DRs (Unencrypted) |
| Data Link Layer (DLL): Termination |

Alternative solution 2 according to EN 13757-3:2018: Single-RSP-UD without AFL:

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

### 5.8.5 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.

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

Following fragments:

| Data Link Layer (DLL): Header |
|---|
| Authentication and Fragmentation Layer (AFL):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML)<br>• No Message Authentication Code (MAC)<br>• No Message Counter Field (MCR) |
| Application Layer (APL): Set DRs (Encrypted) |
| Data Link Layer (DLL): Termination |

Last fragment:

| Data Link Layer (DLL): Header |
|---|
| Authentication and Fragmentation Layer (AFL):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML)<br>• Message Authentication Code (MAC) required<br>• No Message Counter Field (MCR) |
| Application Layer (APL): Set DRs (Encrypted) and Set of DRs (Unencrypted) |
| Data Link Layer (DLL): Termination |

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

### 5.8.6 Security Profile C

5 Annex F of OMSS Vol. 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):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML)<br>• Message Authentication Code (MAC) required<br>• Message Counter Field (MCR) required |
| Transport Layer (TPL):<br>• CI=5Bh<br>• Transport Layer address field<br>(contains the address of the M-Bus Slave from which the RSP-UD is sent)<br>• Config Field:<br>o Mode 13<br>o 3 Bytes length<br>o Protocol type<br>o Number of bytes<br>• TLS Header |
| Application Layer (APL): Set DRs (Encrypted) |
| Data Link Layer (DLL): Termination |

First fragment of Multi-RSP-UD:

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

Following fragments:

| Data Link Layer (DLL): Header |
| --- |
| Authentication and Fragmentation Layer (AFL):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML) required<br>• No Message Authentication Code (MAC)<br>• No Message Counter Field (MCR) required |
| Application Layer (APL): Set DRs (Encrypted) |
| Data Link Layer (DLL): Termination |

Last fragment:

| Data Link Layer (DLL): Header |
| --- |
| Authentication and Fragmentation Layer (AFL):<br>• CI=90h<br>• AFL.AFLL<br>• AFL.FCL<br>• No Message Length Field (ML) required<br>• Message Authentication Code (MAC) required<br>• No Message Counter Field (MCR) required |
| Application Layer (APL): Set DRs (Encrypted) |
| Data Link Layer (DLL): Termination |

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

## 5.9 New Topics in Version 2 of the Technical Report

### 5.9.1 Slave Readout

Questions: Does REQ-UD2 require a repetition? Is there a maximum numbers of repetitions?

The number of repetitions (2) is for the whole mbus communication can currently only be found in “M-Bus: A documentation V 4.8, 5.4” at “m-bus.com”. This definition can currently not be found in OMSS Vol. 2 V 4.1.2 and EN 13757-2:2018. The informative annex EN 1434.3;2015, D.2.1 defines 2 repetitions.

Therefore it is necessary to add this definition in future versions of OMSS Vol. 2 and EN 13757-2. A least 2 repetitions are necessary for the correction of communication errors (no or erroneous answer in link layer, answer in conflict with timing requirements).

The exception to this rule is a secondary search: The repetition of a secondary selection is not mandatory.

The slave shall not force repetitions systematically in order to gain time for internal purposes.

### 5.9.2 Secondary Address Search

Questions: Does a slave select by the master require a repetition? Does a slave have to answer on the first slave select command with ACK?

If no slave answers at a search with secondary address with the defined timing conditions or if there are still collisions at a maximum restricted search area the slave select shall be repeated – in all other cases not.

### 5.9.3 Deselection

SND-NKE to primary address 253 or 254:

- A SND-NKE to address 254 does not change the status of the slave selection.
- Having received an ACK (E5h) as response to a SND-NKE to address 253 no repetition is required.
- Having received no valid response to a SND-NKE to address 253 or 254 (no or erroneous response in link layer, response in conflict with timing requirements) at least 2 repetitions should be sent.

SND-NKE to primary address 255:

- A SND-NKE to address 255 does not change the status of the slave selection.
- The slave should apply the first received SND-NKE and resets the FCB.
- The master may apply SND-NKE several times.

By selection of a new slave:

- Having received an ACK (E5h) as response there should be no repetition.
- Having received no valid response to a slave select (no or erroneous response in link layer, response in conflict with timing requirements) at least 2 repetitions should be sent.
- A selected slave should deselect at the first selection command for another secondary address.

  **NOTE:** If an explicit deselection confirmation is required the following procedure can be applied:
  - Deselection of the selected slave with SND-NKE.
  - The slave confirms the deselection with ACK.
  - Selection of the required slave with the selection command.

  This procedure requires a communication overhead compared to the immediate selection command, but ensures that the previously selected slaves are really deselected. Under “poor” M-Bus line conditions it is possible that a selected slave does not receive the slave selection command of a new slave which leads to at least two selected slaves on the bus.

# 6 Cross-Reference Table for Chapters 7 and 5

**Table 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 13757-2:2004. |
| 7.1.14 | Decision no. 7-5: New work item proposal to change EN 13757-2:2004. |
| 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 13757-2:2018.<br><br>OMS Vol. 2 V4.0.2 was aligned to this decision: Primary address 0 shall not be used for meter addressing.<br><br>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 13757-2:2018.<br>OMS Vol. 2 V4.0.2 was aligned to this decision: Primary address 0 shall not be used for meter addressing.<br>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 13757-2:2004 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 13757-2:2018 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 |
| **7.10** | **New topics in version 2 of technical report** |
| 7.10.1 | 5.9.1 |
| 7.10.2 | 5.9.2 |
| 7.10.3 | 5.9.3 |

# 7 Known Wired M-Bus Issues

This chapter shows the original comments and questions which have been provided as input to OMS.

## 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 13757-2:2004 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 13757-2:2004 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 13757-2:2004 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 13757-2:2004 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 mA 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 13757-2:2004 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 13757-2:2004 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 13757-2:2004 chapter 4.2.1

### 7.1.13 Inconsistent Description of the M-Bus Break Length (Slave Collision Detect)

Reference EN13757-2:2004 Annex D: Send break signal for 50 ms

Reference EN13757-2:2004 chapter 5.6 / 4.3.3.8: Greater than 22 BT but less than 50 ms

Reference EN13757-2:2004 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 EN13757-2:2004 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 EN13757-2:2004 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 EN13757-2:2004 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 EN13757-2:2004 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 13757-2:2004 chapter 5.5.3

### 7.2.3 Faster Scanning of M-Bus Devices

“Faster scanning of M-Bus devices” was requested.

### 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 EN13757-2:2004, 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 13757-2:2004 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 supported?

EN 13757-2:2004 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 13757-2:2004 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 13757-2:2004 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 13757-2:2004 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 13757-2:2004 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 13757-2:2004 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 13757-3:2018, 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 EN13757-3:2013 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:

**Table 7: 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 |

**Table 8: 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 EN13757-2:2004 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)

## 7.10 New topics in Version 2 of the Technical Report

### 7.10.1 Slave Readout

Does REQ-UD2 require a repetition?

Is there a maximum numbers of repetitions?

### 7.10.2 Secondary Address Search

Does a slave select by the master require a repetitions?

Does a slave have to answer on the first slave select command with ACK?

### 7.10.3 Deselection

SND-NKE to primary addresses 253 or 254:

- Shall this be repeated (number of repetitions)?
- Does a slave have to answer the first SND-NKE of the master with an ACK?

SND-NKE to primary address 255:

- Shall this be repeated (number of repetitions)?
- Shall a slave have to deselect to the first SND-NKE of the master?

By selection of a new slave:

- Shall this be repeated (number of repetitions)?
- Shall the selected slave deselect at the first selection command to another slave?

# 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

V 1.0.5

- Annex C deleted

V 1.0.6

- Chapters 5.1.6, 5.1.10, 5.2.5, 5.4 changed
- Chapter 5.9 and 7.10 added
- Annexes A and B deleted

V 1.0.7

- Corrections in chapters 1, 2, 4 and 5

V 1.0.8

- Editorial changes

V 2.0.0

- Final draft version 2 for request for comments

V 2.0.2

- Release version

V 2.0.3

- Alignment with OMS-S2, Annex P
- Release version