Open Metering System Specification

Requirements for Wired M-Bus

Annex P to
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P.1 General

P.1.1 Scope

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], [EN 13757-3] and [EN 13757-7]
5 standard. During application of the [EN 13757] 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.

Therefore, a number of different M-Bus datagrams from different manufacturers exist, with partially identical content. Because of this, problems often arise during the interpretation of
10 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.

This annex contains a normative (P.2) and an informative (P.3) part.

P.1.2 Reference

15 References to other documents are marked with square brackets. They are defined in [OMS-S1].

P.2 Normative

P.2.1 Physical Layer

P.2.1.1 Wiring rules

Shielding shall be only connected to the protective earth on the master side and not at any slave.

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

A ring structure topology is not allowed for wired M-Bus systems. The OMS end-device shall not contain a termination resistor as well as the complete topology shall not contain any termination resistors.

NOTE: The topologies are explained in P.3.1.1.2.

P.2.1.2 SC Charge / Discharge

As the master in the wired 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.

The capacitor shall be sized to meet the following conditions:

- 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

NOTE: On best practice solutions for the usual slave transceiver devices has resulted in a 100 nF – 330 nF storage capacitor.

P.2.1.3 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 shall be <100 mA.

P.2.1.4 Rise and Fall Times

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

- < 75 V/µs (test condition: no load)
- < half of a bit time (test condition: see [EN 13757-2:2018], 4.3.3.4)

P.2.1.5 Identification of the Unit Loads

The number of unit loads (UL) shall be listed in the data sheet. Additionally, it shall be printed on the device.

The identification is done in a total of 4 groups, where the maximum of 4 UL, is not exceeded (see Table P.1).

Table P.1 - 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

P.2.1.6 Switch-on Process

5   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

NOTE: According to the electrical requirements for M-Bus slaves (P3.1.1.3, [EN 13757-
10   2:2018], 4.2.2.11 – start-up delay) a slave shall reach its full communication capabilities less than 3 seconds after an M-Bus voltage start-up or drop-out. This 3 seconds start-up delay is measured from the time the M-Bus voltage at slave terminals reaches the minimum mark voltage level of 21 V.

P.2.1.7 Upper Limit for Voltage Variation

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

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

where

- $U_{delta,\ mark\text{-}space}$: 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.

20   **NOTE 1:** The dimensioning of the M-Bus cabling should ensure that in space state ≥ 12 V are always guaranteed at all slave terminals.

The maximum allowable voltage variation between mark and space state is derived from the requirement of [EN 13757-2:2018], 4.2.2.3.

The maximum usable voltage variation between mark and space state for a specific M-Bus mark voltage level is depicted in Figure P.1.
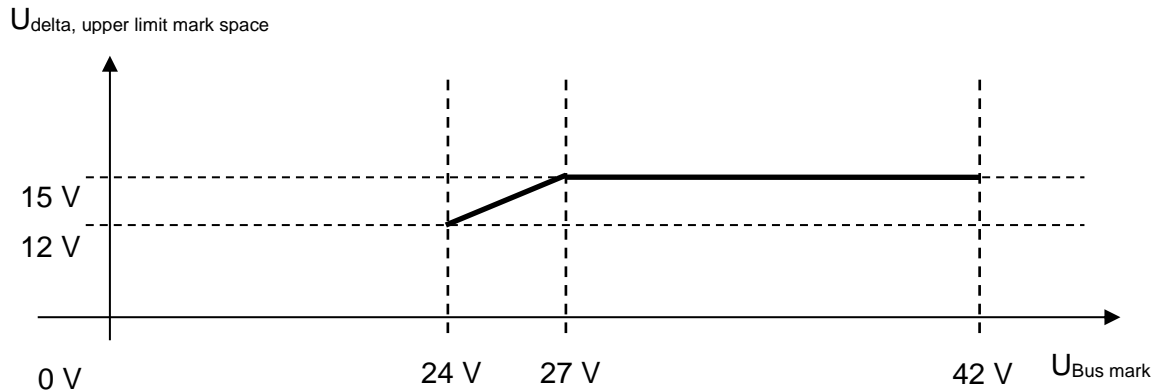
Figure P.1 – Voltage variation

5   **NOTE 2:** $U_{Bus\ mark}$ is the voltage level at M-Bus slave terminals. $U_{Bus\ mark}$ should consider the max allowable voltage drop U_r (for explanation see [EN 13757-2:2018], 4.3.1.2).

P.2.1.8 Break Detection

All OMS end-devices shall implement the break detection functionality (see [EN 13757-2:2018], 4.3.3.8 and 5.6).

10   ## P.2.1.9 Logical Slave Disconnect

[EN 13757-2] specifies that slaves shall permanently maintain a (logical) connection to the wired M-Bus. This also applies for OMS unless otherwise declared by the manufacturer.

The manufacturer shall declare the communication capabilities of the device for maintaining a permanent connection (e.g. battery budget for wired M-Bus communication and metrological
15   functionality) and – if a protection mechanism e.g. according to P.3.2.3 is implemented – shall define the communication depot and regeneration time in the [MANDEC].

P.2.2 Link layer

P.2.2.1 Baud rates

Master and slave devices shall support 300 Baud and 2400 Baud.

Master or slave devices may support 9600 Baud, 19200 Baud and 38400 Baud.

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

If a device supports baud rates of 9600 Baud, 19200 Baud or 38400 Baud, it shall also support the lower baud rates (see Table P.2).

Table P.2 - Required baud rate support

Maximum supported baud rate of the device	Required baud rate support				
	300 Baud	**2400 Baud**	**9600 Baud**	**19200 Baud**	**38400 Baud**
2400 Baud	X	X			
9600 Baud	X	X	X		
19200 Baud	X	X	X	X	
38400 Baud	X	X	X	X	X

Other baud rates may be supported additionally.

10   ### P.2.2.2 Change of Primary and Secondary Address

The change of the primary address shall be possible. The change of the primary address of a device shall be done by using the MB-Command-Tag XID3! (according to [OMS-S2], Annex B). Other data points shall not be used. The change of the primary address shall be possible using primary as well as secondary addressing.

15   A change of the secondary address is not permitted. Excluded from this rule are adapters. Adapters that are capable of setting the secondary address via wired M-Bus shall support this function using the MB-Command-Tags setID2! or XID2! (complete identification number) or setID11! or XID11! (ID of identification number). The manufacturer and version shall not be changeable in the adapter. The device type may be changeable in adapters.

20   The secondary address shall be worldwide unique (according to [OMS-S2], 3.1.2.2). For wired M-Bus devices, customer and vendor may agree to an exception to this rule. This exception shall be declared in the [MANDEC].

P.2.2.3 Special Primary Addresses FEh and FFh

A message sent with an A-field FEh or FFh for broadcast shall be handled as if it is addressed
25   to an M-Bus slave's real primary address.

NOTE 1: Slaves with more than one logical address (see P.2.2.4) do not apply to this rule.

NOTE 2: A message sent with an A-field FFh is not answered by the OMS end-device (according to [EN 13757-2:2018], 5.7.5).

P.2.2.4 Two or More Logical Wired M-Buses in One Hardware Environment

Some slaves are addressable with more than one primary and/or secondary address (e.g. distinguish different functional units within one physical device).

<u>Slave search and selection</u>

5　When searching for slaves or selecting a slave address, conflicts may appear for addresses of a multi-address device. The device shall react with simulating a collision; either responding with A5h or several concatenated E5h representing the number of devices that produced the collision.

<u>Baud rate change</u>

10　A baud rate change command to a multi-address device shall always change the baud rate for the physical device and not only for the logical address the baud rate change is sent to.

NOTE 1: This is supported by the mandatory automatic baud rate detection for devices (see P.2.2.1)

<u>Special primary addresses FEh and FFh</u>

15　When a datagram with A = FEh is received by a multi-address device, it shall respond correctly with one of its logical addresses.

NOTE 2: The master can identify which of the logical units has replied according to the A-field of the respond.

A datagram sent with A = FFh shall be processed by every logical M-Bus unit (see [EN 13757-20　2:2018], 5.7.7).

<u>FCB handling</u>

In case the logical device supports multiple applications and/or blocks, each logical device shall trace the last selected application and/or block independently.

In case the logical device supports multi datagram messages, there shall be a separate FCB 25　handling implemented for each logical device.

P.2.2.5 Datagram Detection

For a stable communication on a wired M-Bus network, devices need to be compliant with specific wait times between a received datagram and the next datagram that is sent.

There are two different scenarios:

1. Reception of a correct datagram

2. Reception of a disturbed datagram

After reception of a correct datagram the slave needs to wait at least 11 bit times and not more than 330 bit times + 50 ms until the response is transmitted (see Figure P.2).
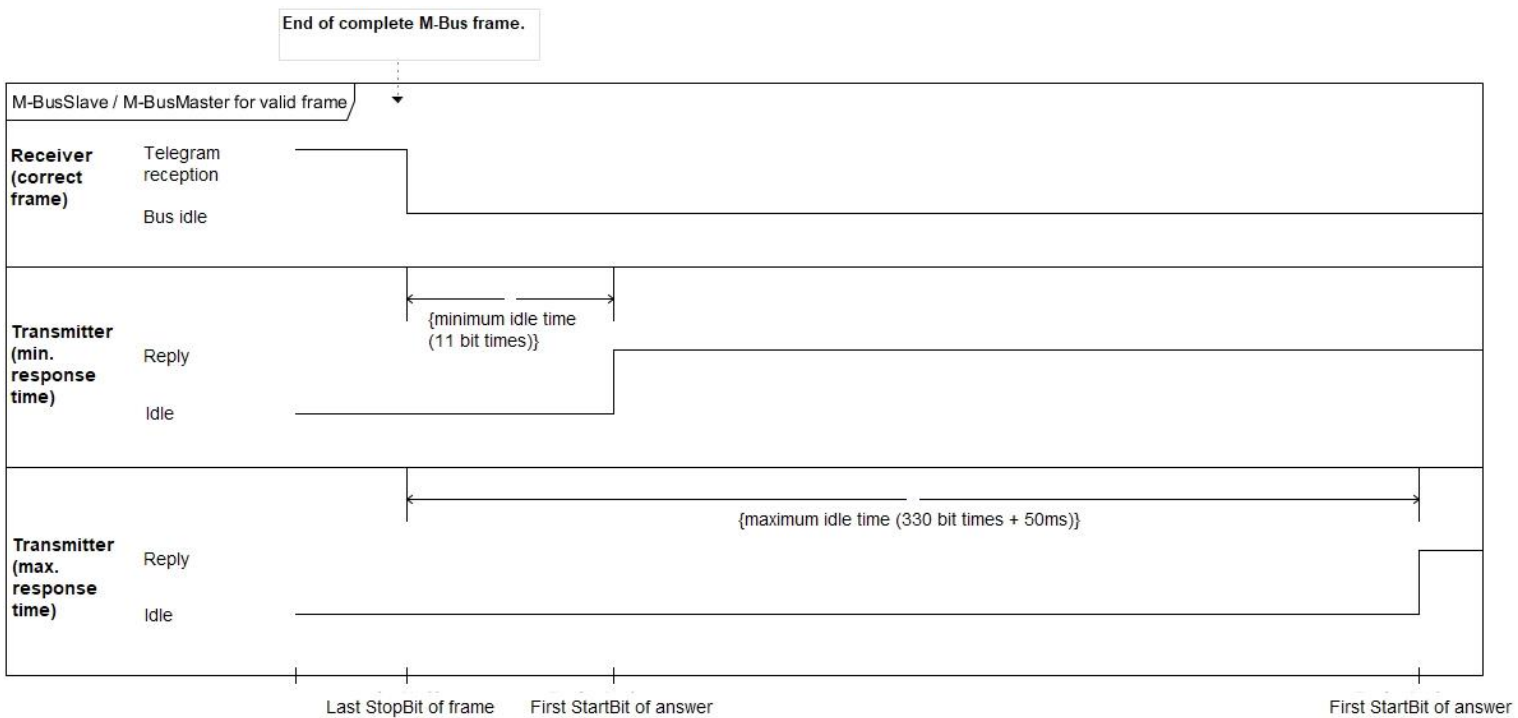
Figure P.2 - Quiescent time requirements for correct decodable datagram

If a datagram is disturbed during transmission the receiving device may detect this after +P% (see [EN 13757-2:2018], Table 1) and shall detect 22 bit idle time as the end of a frame. After detection of the disturbance or the end of the frame, the next datagram may be sent (see Figure P.3).
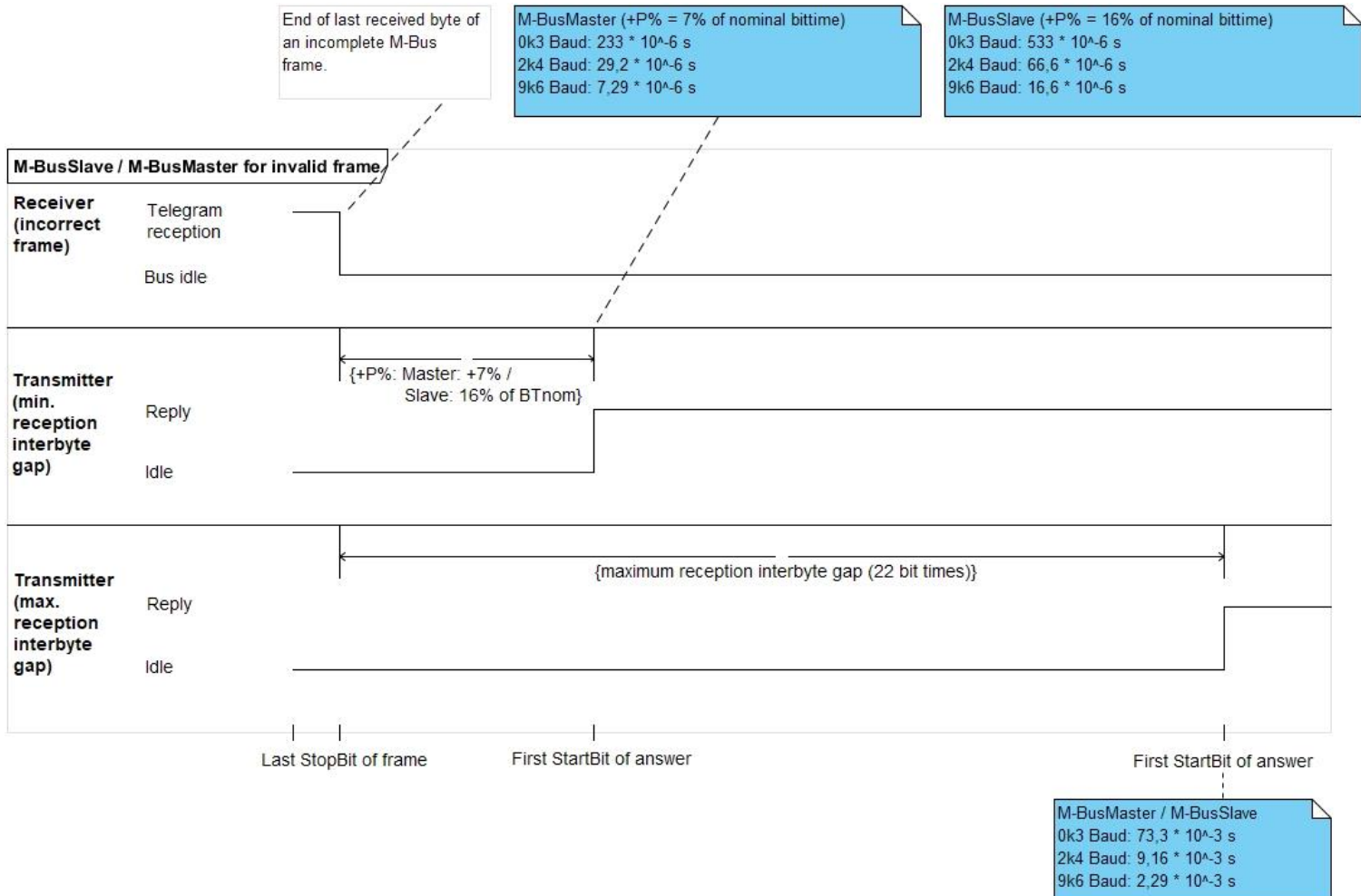
5 **Figure P.3 - Quiescent time requirements for disturbed messages**

P.2.2.6 Repetitions

P.2.2.6.1 Slave Behaviour

The slave shall be designed to respond at the first attempt. The slave shall not force repetitions systematically in order to gain time for internal purposes.

P.2.2.6.2 Master Behaviour

For mitigating communication errors (no or erroneous response in link layer, response in conflict with timing requirements) the master shall apply at least 2 repetitions (3 communication attempts in total).

P.2.2.7 Secondary addressing

Secondary addressing is mandatory.

P.2.3 Networking Layer / Secondary Addressing

P.2.3.1 Enhanced Selection

For slaves the enhanced selection is optional. If a slave implements enhanced selection, it shall be implemented according to [EN 13757-7:2018], 8.5.

A master shall be able to process slaves with secondary address selection as well as with enhanced selection. If a master cannot distinguish slaves using the secondary address selection, it shall use the enhanced selection.

P.2.3.2 Determination of Addresses in Adapters

OMS end-devices should be labelled with the DIN address (14-position identification) according to [OMS-S2], 3.2. It is recommended to label mechanical and electronic OMS end-devices without wired/wireless M-Bus that can be attached to an adaptor with the DIN address.

If the labelling does not comply with [OMS-S2], 3.2, the rules to define the ALA including the identification number of the adapter in [OMS-S2], 3.3 and figure 15 apply:

1. For numeric serial numbers, the following procedure shall be used:

   - If the number of characters in the serial number equals eight, the serial number shall be the identification number.

   - If the number of characters in the serial number is more than eight, the number of digits shall be reduced to the length of eight by removing the characters starting from the left (from leading numbers).

   - If the number of characters in the serial number is less than eight, the identification number shall be filled to eight places from the left with "0" (leading zeros).

2. For alphanumeric serial numbers, the following procedure shall be used:

   - The letters and special characters shall be removed from the serial number. The following steps are described under point 1 "*Numeric serial numbers*" depending on the resulting length.

P.2.4 Application Layer

P.2.4.1 Selection of Application Data

The selection of the application data shall only be done using the application select protocol (see [OMS-S2], 8.10). The OMS-UC-14 provides a specific way of data selection (see [OMS-S2], Annex M, M.2.11).

P.2.4.2 Minimum Communication Capabilities for Slaves

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 the MB-Command-Tag setID2! / XID2! or setID11! / XID11! according to [OMS-S2], Annex B (for adapters with changeable address only, see P.2.2.2).

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

P.2.4.3 Commands for Communication If Applicable

A slave shall support setting of the due date, if a calendar and due date function is present in the device. The required procedure is defined in [OMS-S2], Annex M, M.2.10.2 UC-12a Due Date Management.

A slave shall support setting the date and time if a clock is present in the device. The required procedure is defined in [OMS-S2], Annex M, M.2.5 UC-04 Clock Management.

P.2.4.4 Table with CI-Fields

Several CI-fields shall not be used for wired M-Bus, especially 7Ah (see footnote e in [OMS-S2], 2.2, table 1).

P.2.4.5 New Device Type for Wired Adapters

Device type 38h is introduced for wired adapters (see [OMS-S2], Table 3).

P.3 Informative

P.3.1 Physical Layer

P.3.1.1 Cabling

P.3.1.1.1 Cable Types

5   The OMS recommends using a separate, shielded cable with twisted pairs for protection against EMC interferences in harsh environments.

The OMS reference cable for the wired 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)

10   This cable type has the following properties:

- 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
15 - 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 used. All following explanations and calculations in this document refer to the OMS reference cable type.

P.3.1.1.2 Topology

20   There are some basic physical configurations used for the cable connections between the wired M-Bus master and the slaves. These topologies are star, line and tree wiring as shown below in Figure P.4. In real installations, a combination of these topologies will be used.
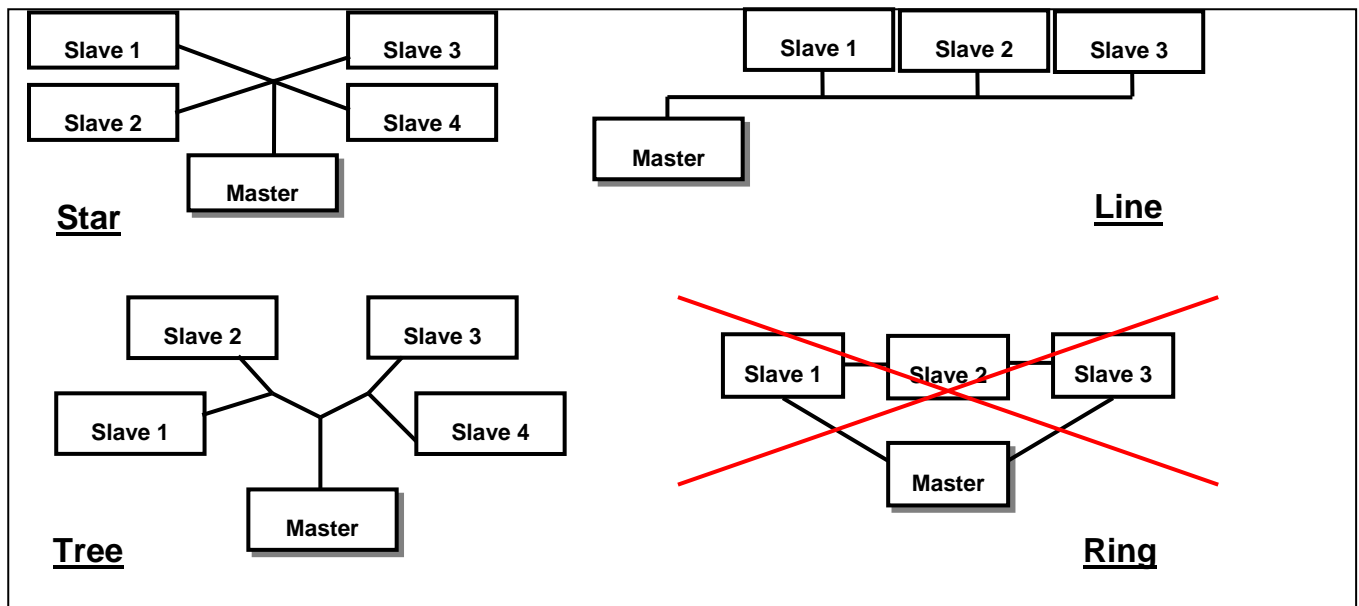
Figure P.4 - Topology variants

P.3.1.1.3 Minimum Slave M-Bus Voltage

5 According to [EN 13757-2:2018] the M-Bus voltage at M-Bus slave terminals shall be at least 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 (see [EN 13757-2:2018], 4.2.1).

The M-Bus voltage may fall below the typical mark state voltage of 24 V (at M-Bus slave
10 terminals) in following cases:

- another wired M-Bus slave responds

- there is a data collision of two or more wired M-Bus slaves

- at least one wired M-Bus slave has a fault (for current limitation requirements in case of wired M-Bus slave faults see [EN 13757-2:2018], 4.2.2.6)

15 The following diagram (Figure P.5) summarises the requirements from [EN 13757-2:2018] concerning the M-Bus voltage for master and slave.
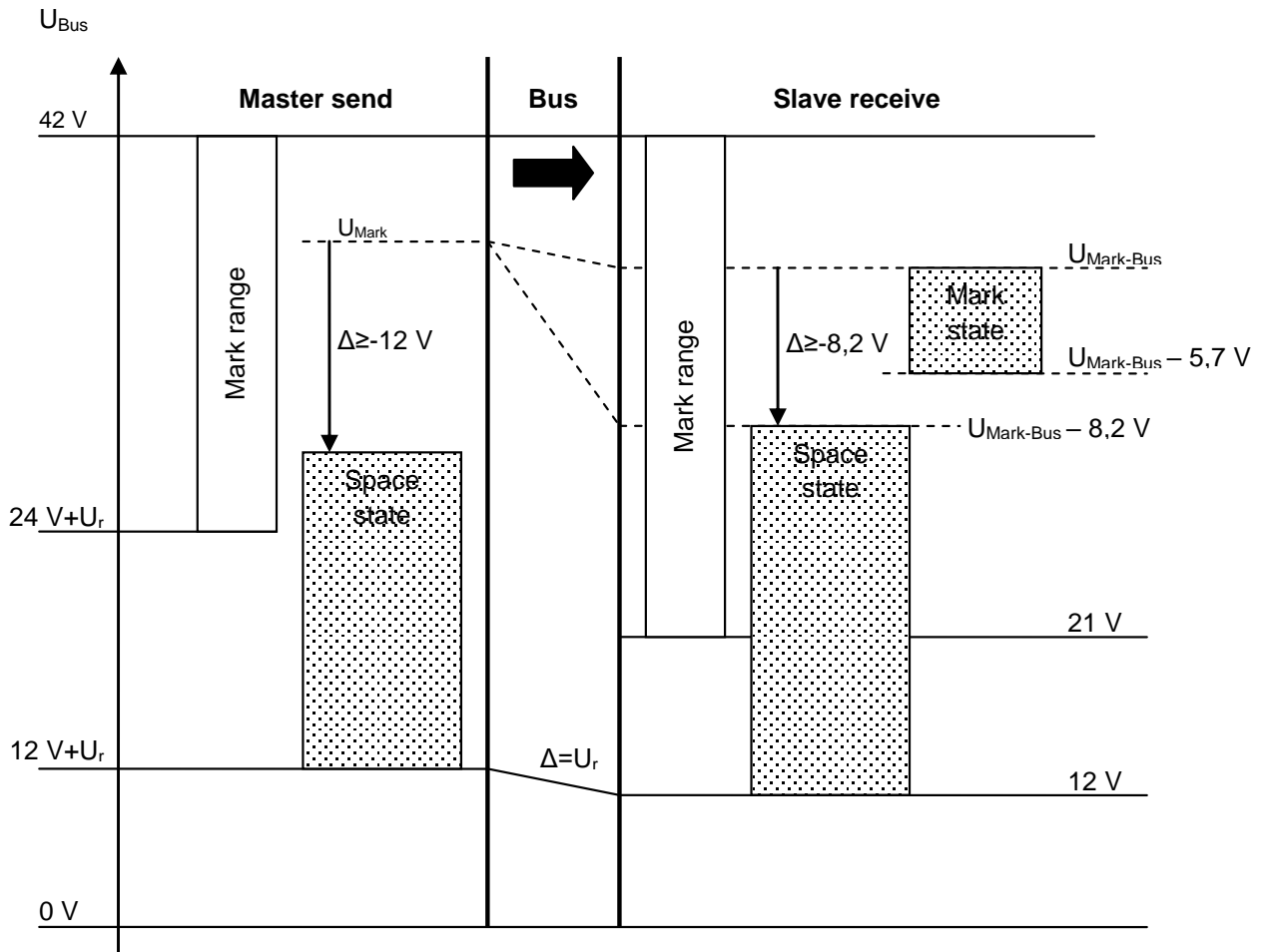
Figure P.5 - M-Bus voltage

$U_{r, max}$ = (max. usable bus current)*(max. bus resistance) +

(max. usable bus current)*(max. master source impedance)

5 > 0; with $U_{Space-Bus@MBusSlave} \geq 12$ V

The following chapters define the voltage requirements according to [EN 13757-2:2018].

Electrical requirements, master

- [EN 13757-2:2018], 4.3.3.1

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

- [EN 13757-2:2018], 4.3.3.2

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

- [EN 13757-2:2018], 4.3.1.2 Max. allowed voltage drop (U_r)

  The maximum 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 (OMS end-device) gives the maximum useable bus current for a
  10   given combination of segment resistance and master.

Electrical requirements, slave:

- [EN 13757-2:2018], 4.2.1 master to slave bus voltage

  "…

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

  15   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.

  20   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}."

- [EN 13757-2:2018], 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
  25   shall be less than 3 s.

The following diagram (Figure P.6) represents the requirements from [EN 13757-2:2018] for state recognition and collision detection for the wired M-Bus slave to wired M-Bus master communication.
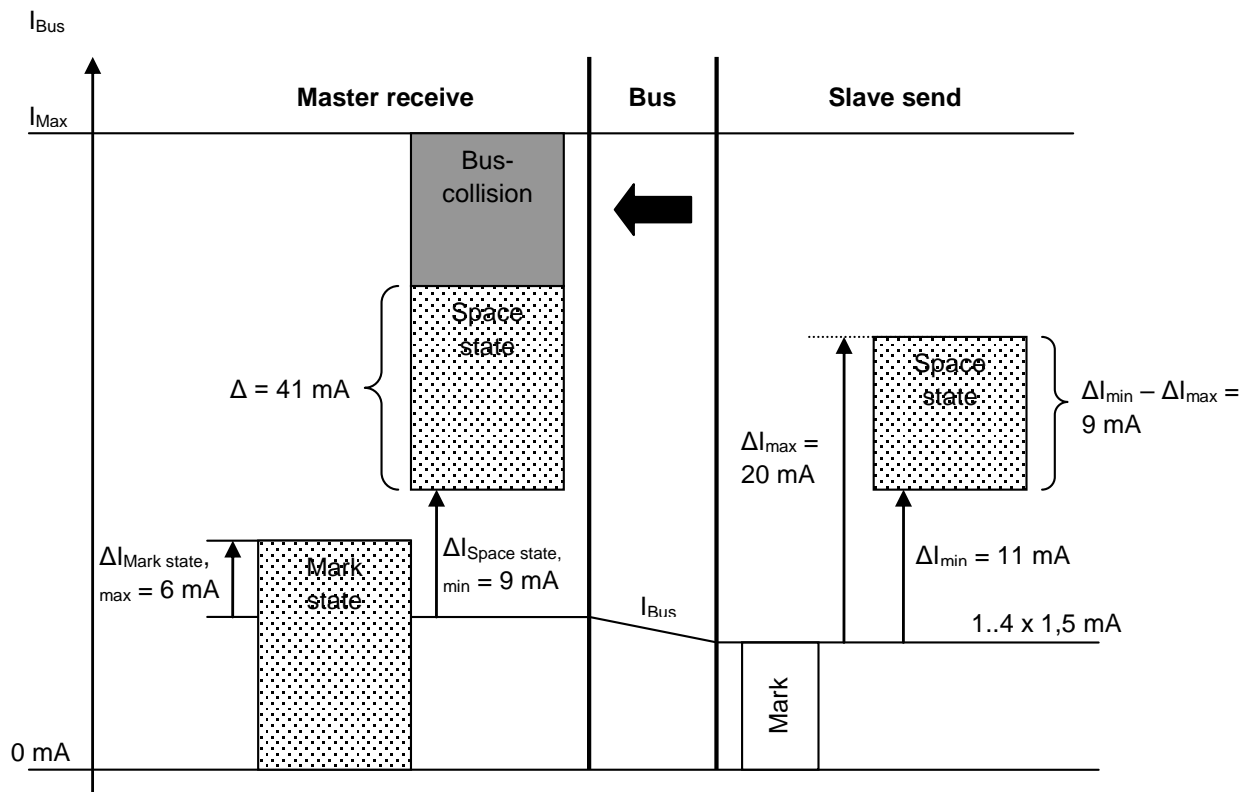
Figure P.6 - M-Bus states

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

5    $\Delta I_{Space\ state,\ min}$: Threshold where the master detects space state of a wired M-Bus slave response.

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

The following chapters define the voltage requirements according to [EN 13757-2:2018].

-    [EN 13757-2:2018], 4.2.2.9 – space send current

10   "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:

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

-    [EN 13757-2:2018], 4.3.3.7 - Data detection current (reception of slave current pulses)

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

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

-    [EN 13757-2:2018], 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."

P.3.1.1.4 Transmission of Remaining Energy in Battery for Communication

For transmitting the remaining battery lifetime, the OMS end-device shall use the MB-Data-Tag MM8! according to [OMS-S2], Annex B, B.2.2.

The number of remaining days/months should be continuously calculated depending on (or a combination of):

- reading frequency

- number of total readouts

- bus traffic

- measurement cycle frequency

- etc.

Applicable implementation:

- Devices with non-replaceable battery:

- Battery-driven devices should transmit the remaining lifetime with every datagram.

- In case the number of days / remaining readouts decreased until the value zero is reached, the value should remain zero. Only positive values including zero are allowed.

- In case the remaining lifetime is less than 15 months, the device should set 'power low' in the status byte (see [OMS-S2], 7.2.3).

- Devices with replaceable battery:

- See 'Devices with non-replaceable battery'.

- External powered devices without limitations in lifetime and/or readout:

- Such devices are not required to transmit the remaining lifetime or requests. The 'power low' in the status byte is never set.

- Devices with mains power loss set 'power low' in the status byte upon detecting mains power loss. Upon recovery of mains power the 'power low' in the status byte is reset.

- Devices with an empty backup battery and/or regained external power signal this discharge state by 'power low' in the status byte.

P.3.2 Link Layer

P.3.2.1 Baud Rates

The following recommendations apply (see also P.3.1.1.2):

- use 300 Baud for "poor" line conditions and "long" distances.

- use 2400 Baud for standard applications and medium distances.

- use 9600 Baud or higher for "very good" line conditions and "short" distances.

NOTE: In order to have a good performance during the Slave search it is recommended to use as few baud rates as possible in the wired M-Bus network.

P.3.2.2 Functionality of SND-NKE

The link layer command SND-NKE has an effect on the FCB (see [EN 13757-3:2018], 5.7.7) and deselects a secondary selected slave if the SND-NKE datagram is applied with A-field FDh.

SND-NKE does not trigger any other data or state changes in the slave like change of selected application or block.

P.3.2.3 Preserving Communication Budget

The following is an example how to implement a protection mechanism for the communication:

5 The basic principle consists of a communication depot. Its capacity defines the number of bytes to read without any limitations. This communication depot is constantly refilled with the communication budget.

In case the requested bytes exceed the communication budget permanently the communication depot is emptied. When the communication depot is exhausted the device is
10 henceforth only listening.

The communication depot is constantly refilled with the number of bytes defined by the communication budget. When the threshold to support a readout of at least three datagrams is reached, the communication is released again. The duration from pausing communication until its release is the regeneration time.
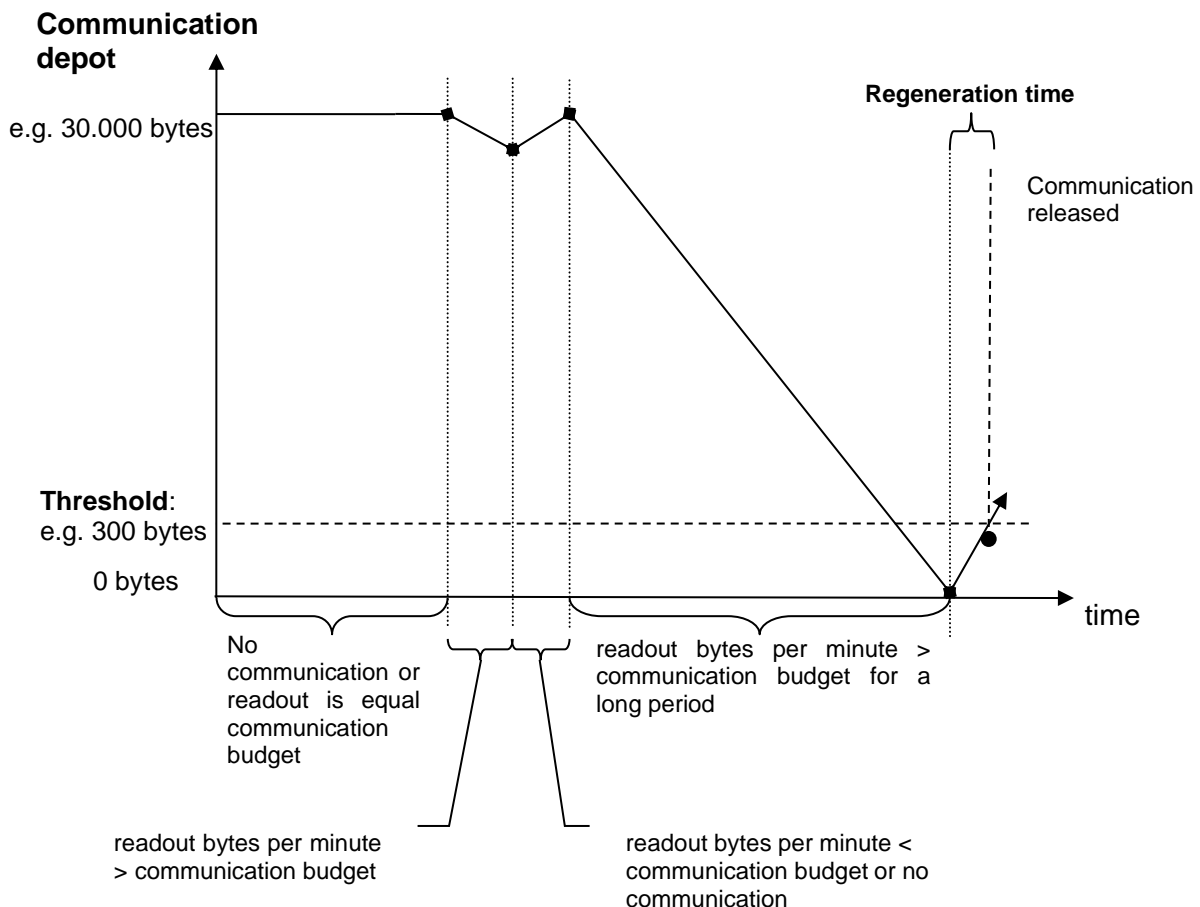
15 **Figure P.7 - Communication depot**

NOTE 1: The device should send at least an application error 09h according to [EN 13757-3:2018], 10.3 before the communication is stopped due to an empty communication depot.

NOTE 2: For a selection of the above given parameters, the following minimum values should
20 be applied:

Table P.3 - Example for minimum requirements

Minimum requirements for communication budget	Value
Communication budget	50 bytes/minute
Regeneration time	Maximum permitted value: 1080 seconds
Communication depot	30.000 bytes

P.3.3 Networking Layer / Secondary Addressing

P.3.3.1 Repetitions

P.3.3.1.1 Secondary Address Search (Slave Select)

The repetition of a secondary selection is not mandatory.

The slave select should be repeated twice in the following conditions:

- if there is no valid response at a search with secondary address with the defined timing conditions

- if there are still collisions at a maximum restricted search area

P.3.3.1.2 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.

5
- 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:

  - o Deselection of the selected slave with SND-NKE.

10
  - o The slave confirms the deselection with ACK.

  - o 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
15 the slave selection command of a new slave which leads to at least two selected slaves on the bus.