Honeywell

THE POWER OF CONNECTED

KSMW-PA2502 - Companion Standard

M-Bus Implementation Guide

Revision 1.~~0~~1

20.09.2018~~18.09.2018~~

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1. Introduction

1.1. Scope

This companion standard is a functional description of the 1 and 3-phase meters for the smart metering program of Kooperation Smart Meter West.
The companion standard will define the external interfaces including the communication profiles of the smart meters as well as the used object model and necessary program specific functionalities.
It must be noted, that the companion standard is not a substitution of the metering specification published by Kooperation Smart Meter West. It has to be seen as further definition to ensure interoperability between different metering devices within the here used smart metering infrastructure.

1.2. Normative references

This companion standard is based on the following document:

- OMS Volume2 Primary Communication V4.~~0~~1.2 ~~2014-01-27~~2016-12-16 [A]
  - *Available at http://oms-group.org/download4all/oms-spezifikation/*
- DLMS Blue Book version 1000-1 Ed. 12.2 [B]
- DLMS Green Book version 1000-2 Ed. 8.3 [C]
- IDIS Standard Package 2, Edition 2.0, 03-06-2014 [D]
- Published Specification “05_PA2502_Beschreibung_Anforderungen_IMS_V2” from 17.11.2016 [E]

The above mentioned documents are valid unless explicitly mentioned.
Mentioning DLMS/COSEM in this document refers to the above mentioned versions of the Green and Blue Book.

1.3. Document list

This companion standard references to the following documents, which are delivered together with the companion standard:

- KSMW-PA2502 Companion Standard Object Model rev 1.~~0~~1.xls [1]
- KSMW-PA2502 Companion Standard Display Implementation Guide rev 1.~~0~~1.pdf [2]
- KSMW-PA2502 Companion Standard G3-PLC Implementation Guide rev 1.~~0~~1.pdf [3]
- KSMW-PA2502 Companion Standard Main Document rev 1.~~0~~1.pdf [4]
- KSMW-PA2502 Companion Standard P2P WAN Implementation Guide rev 2.~~4~~5.pdf [5]

1.4. Abbreviations

Abbreviation	Explanation
AA	Application Association

AARE	Application Association Response
AARQ	Application Association ReQuest
ACSE	Association Control Service Element
APDU	Application Protocol Data Unit
ASE	Application Service Element
A-XDR	Adapted Extended Data Representation
CII	Consumer Information Interface
CIP	Consumer Information Push
class_id	Interface class identification code
COSEM	Companion Specification for Energy Metering
COSEM object	An instance of a COSEM interface class
DC	Data Concentrator used for PLC communication
DLMS	Device Language Message Specification
ERP	Enterprise Resource Planning
FC	Frame Counter
G3	G3 PLC supporting IPv6
GCM	Galois/Counter Mode, an algorithm for authenticated encryption with associated data
UTC	Coordinated Universal Time
CSD	Circuit Switched Data
HDLC	High-level Data Link Control
HES	Head End System similar to MDC
HLS	COSEM High Level Security
IC	COSEM Interface Class
IEC	International Electrotechnical Commission
LLC	Logical Link Control (Sublayer)
LLS	COSEM Low Level Security
LN	COSEM Logical Name
MDC	Meter Data Collect similar to HES
MDM	Meter Data Management
OBIS	Object Identification System
PDU	Protocol Data Unit

PUSH	the data is pushed by the meter to the HES using the Data Notification service
SAP	Service Access Point
SMS	Short Message Service
L_SAP	Link layer Service Access Point

Table 1: List of used abbreviations

1.5. Conventions

Some sections of the present document are referring to other reference documents in order to specify more precisely the requirements to be fulfilled by the implementations. The status of each clause of the reference document is given using the following convention:

- I = "Informative": the statements of the reference document are provided for information only.
- M = "Mandatory": the statements of the reference document shall apply without modifications or remarks.
- S = "Selection": the statements of the reference document shall apply with the selections and/or the modifications specified.
- E = "Extension": the statements of the reference document shall apply with the extensions specified.
- N/R = "Not Relevant": the statements of the reference document do not apply.

1.6. Revisions History

Version	Revisions	Date	Author
0.0	Initial Draft Version	10.01.2018	R. Thor
0.1	2nd Draft Version	11.01.2018	R. Thor
0.2	1st Draft Release	29.01.2018	R. Thor
0.3	Update according: KSMW PA2502 Companion Standard Review List Rev 0.3.xlsx	22.02.2018	R. Thor
0.4	Update according: KSMW PA2502 Companion Standard Review List Rev 0.4.xlsx	06.03.2018	R. Thor
0.5	Update according: KSMW PA2502 Companion Standard Review List Rev 0.5.xlsx	19.03.2018	R. Thor
0.6	Update according: KSMW PA2502 Companion Standard Review List Rev 0.6.xlsx	06.04.2018	R. Thor
1.0	Update according: KSMW PA2502 Companion Standard Review List Rev 1.0.xlsx	03.07.2018	R. Thor
1.1	Update according:	18.09.2018	R. Thor

	KSMW PA2502 Companion Standard Review List Rev 1.1.xlsx		

Table 2: Revisions History

2. M-Bus interface

The M-Bus interface is used to connect additional submeters like Gas, Water or Heat-meters to the E-meter.

Both wired and wireless communication is supported.
- Wired M-Bus protocol stack as defined in EN 13757-2 (wired M-Bus physical and link layer) in combination with EN13757-3 (M-bus application layer).
- Wireless M-Bus protocol stack as defined in EN 13757-4 (wireless M-Bus physical and link layer) in combination with EN13757-3 (M-bus application layer).

The Multi Utility interface can support the wired, wireless or even both communications in parallel.

The wired or wireless M-Bus communication shall be compliant to the detailed OMS specification [A]

Open Metering System Specification
Volume 2: Primary Communication
Issue 4.0.2 / 2014-01-27

2.1.1. Wired M-Bus Master

The wired M-Bus interface shall conform to OMS specifications [A] concerning physical and link layer.

The connection interface is defined as RJ12 Modular Jack 6P6C connector with the following pinout!!

1 - NC
2 - NC
3 - MBUS1 (+)
4 - MBUS2 (-)
5 - NC
6 - NC

Figure 1: RJ12 connector (Tab Down) front view

The wired M-Bus master supports 16 Mbus loads as a minimum

⇨ 4 devices with up to 4 Mbus loads each

2.1.2. Wireless M-Bus Interface

The wireless M-Bus interface shall conform to OMS specifications [A] concerning physical and link layer.

As for the various modes described in the OMS specification, only the modes T1, T2, C1 and C2 are supported.
These modes operate in duty-cycle limited 35 sub bands of the 868 – 870 MHz license free frequency range.

3. OMS standard compliancy

3.1. M-Bus Frame Structure

<table>
<tr><th>Clause</th><th>Title and remarks/modifications</th><th>Statement</th></tr>
<tr><td>2</td><td>M-Bus Frame Structure</td><td>M</td></tr>
<tr><td>2.1</td><td>M-Bus-Layer model</td><td>M</td></tr>
<tr><td>2.2</td><td>Supported CI-Fields
Mandatory support for the following CI is required
<table>
<tr><th>CI-Field</th><th>Function/Layer</th><th>Up- or Down-Link</th><th>Header-Type</th><th>Protocol or Service</th></tr>
<tr><td>51h</td><td>Command</td><td>down</td><td>none</td><td>M-Bus</td></tr>
<tr><td>5Ah</td><td>Command</td><td>down</td><td>short</td><td>M-Bus</td></tr>
<tr><td>5Bh</td><td>Command</td><td>down</td><td>long</td><td>M-Bus</td></tr>
<tr><td>6Ch</td><td>Time Sync</td><td>down</td><td>long</td><td>Generic</td></tr>
<tr><td>6Eh</td><td>Application Error</td><td>up</td><td>short</td><td>Generic</td></tr>
<tr><td>6Fh</td><td>Application Error</td><td>up</td><td>long</td><td>Generic</td></tr>
<tr><td>70h</td><td>Application Error</td><td>up</td><td>none</td><td>Generic</td></tr>
<tr><td>72h</td><td>Response</td><td>up</td><td>long</td><td>M-Bus</td></tr>
<tr><td>7Ah</td><td>Response</td><td>up</td><td>short</td><td>M-Bus</td></tr>
<tr><td>80h</td><td>Pure Transport Layer</td><td>down</td><td>long</td><td>None</td></tr>
<tr><td>8Ah</td><td>Pure Transport Layer</td><td>up</td><td>short</td><td>None</td></tr>
<tr><td>8Bh</td><td>Pure Transport Layer</td><td>up</td><td>long</td><td>None</td></tr>
</table></td><td>S</td></tr>
</table>

	8Ch	Extended Link Layer	Up{down	short	Lower Layer Service (2 Byte)
	8Eh	Extended Link Layer	Up{down	long	Lower Layer Service (10 Byte)
	All other CI field values should not be required and may be either ignored or correctly implemented in case they are supported.				
2.3	Supported Device Types Mandatory support for the device types defined in Table 2. All other device types are optional				S

3.2. Address handling

Clause	Title and remarks/modifications	Statement
3	Address handling	M
3.1	M-Bus Address	M
3.1.1	Overview M-Bus Address	I
3.1.2	Wired M-Bus	M
3.1.2.1	Primary Address	M
3.1.2.2	Secondary Address The selection of a meter by Secondary Address and the wild card search is not required. The enhanced selection with Fabrication Number is also not required	S
3.1.3	Wireless M-Bus	M
3.1.3.1	Link Layer Address (LLA)	M
3.1.3.2	Extended Link Layer Address (ELLA)	M
3.1.3.3	Application Layer Address (ALA)	M
3.1.4	M-Bus Address elements	M
3.2	DIN Address according to the DIN 43863-5	M
3.3	Address handling by adapters	N/R

3.3. Physical Layer

Clause	Title and remarks/modifications	Statement
4	Physical Layer	M
4.1	General	M

4.~~1~~2	~~Twisted Pair Connection~~Wired Communication (M-Bus)	M
4.2.1~~.1~~	Electrical Specification	M
4.~~1~~2.2	Hardware Connections and Cable	M
4.~~2~~3	Wireless Communication (wM-Bus)	M
4.~~2~~3.1	Modes and Requirements Only the modes T1, T2, C1 and C2 are supported.	S
4.3.2~~.2~~	Wireless Data Transmission Intervals	M
4.~~2~~3.2.1	Synchronous versus asynchronous transmission	M
4.~~2~~3.2.2	Interval of consumption data	M
4.~~2~~3.2.3	Interval of installation data	M
4.~~2~~3.2.4	Interval of management data	M
4.3.2.5	Minimum time delay	M
4.~~2~~3.3	Access Timing of a bidirectional Meter or Actuator	M
4.~~2~~3.3.1	Detection of the accessibility	M
4.~~2~~3.3.2	Preamble length	M
4.~~2.~~3.3.3	Frequent Access Cycle	M
4.~~2~~3.4	Transmissions Limits and Transmission Credits	M
4.~~3~~4	Power Line Communication	N/R

3.4. Data Link Layer

Clause	Title and remarks/modifications	Statement
5	Data Link Layer	M
5.1	Wired Communication (M-Bus)	M
5.2	Wireless Communication (wM-Bus)	M
5.2.1	General	M
5.2.2	L-Field (Datagram-length)	M
5.2.~~1~~3	Supported C-Fields	M
5.2.~~2~~4	~~Optional~~ Repeater for the Wireless Communication	N/R
5.2.4.1	General	N/R
5.2.4.2~~.1~~	Unidirectional Repeater	N/R
5.2.~~2.2~~4.3	Bidirectional Repeater	N/R

5.2.~~3~~5	Rules for the gateway	M
5.3	Extended Link Layer	M
5.3.1	General	M
5.3.2	Structure of the Extended Link Layer (ELL)	M
5.3.3	The Communication Control Field (CC)	M
5.3.4	Condition to apply the Extended Link Layer	M

3.5. Authentication and Fragmentation Layer

Clause	Title and remarks/modifications	Statement
6	Authentication and Fragmentation Layer	M
6.1	Introduction	M
6.2	Structure of the AFL	M
6.2.1	Overview	M
6.2.2	AFL-Length Field (AFL.AFLL)	M
6.2.3	AFL Fragmentation Control Field (AFL.FCL)	M
6.2.4	AFL Message Control Field (AFL.MCL)	M
6.2.5	AFL ~~Message Length~~ Key Information-Field (AFL.~~ML~~KI)	M
6.2.6	AFL Message Counter Field (AFL.MCR)	M
6.2.7	AFL MAC-Field (AFL.MAC)	M
6.2.8	AFL Message Length Field (AFL.ML)	M
6.3	Conditions to apply an AFL	M

3.6. ~~Combined~~ Transport~~/Application~~ Layer

Clause	Title and remarks/modifications	Statement
7	~~Combined~~ Transport/~~Application~~ Layer	M
7.1	Overview~~ of Application Layers~~ ~~Possible Application Protocols:~~ ~~Only the support of the M-Bus application layer is mandatory.~~ ~~DLMS and SML communication must be ignored if not supported.~~	~~S~~M

<table>
<tr><td></td><td>~~Application Protocols for special services~~
~~Support for the following protocols is required~~
~~- Clock Synchronisation Protocol (refer to 8.5)~~
~~Security Management Protocol (refer to Annex F)~~</td><td></td></tr>
<tr><td>7.2</td><td>Common Part for all ~~combined~~ Transport~~/Application~~ Layers</td><td>M</td></tr>
<tr><td>7.2.1</td><td>General structure of the Transport Layer</td><td>M</td></tr>
<tr><td>7.2.2</td><td>Access Number</td><td>M</td></tr>
<tr><td>7.2.2.1</td><td>Access Number for wM-Bus</td><td>M</td></tr>
<tr><td>7.2.2.2</td><td>Access Number for M-Bus</td><td>M</td></tr>
<tr><td>7.2.3</td><td>Status Byte

The status byte has the following meaning:
<table>
<tr><th>Bit</th><th>Meaning with Bit set</th><th>Significance with Bit not set</th></tr>
<tr><td>0,1</td><td>Application errors, see EN 13757-3</td><td>Application errors, see EN 13757-3</td></tr>
<tr><td>2</td><td>Power low (Battery replacement expected)</td><td>Not power low</td></tr>
<tr><td>3</td><td>Permanent error</td><td>No permanent error</td></tr>
<tr><td>4</td><td>Temporary error</td><td>No temporary error</td></tr>
<tr><td>5</td><td>Clock Synchronisation error: more than 60 seconds deviation</td><td>No significant clock deviation.</td></tr>
<tr><td>6</td><td>Fraud attempt registered</td><td>No fraud attempt registered</td></tr>
<tr><td>7</td><td>Valve alarm</td><td>No valve alarm</td></tr>
</table></td><td>M</td></tr>
<tr><td>7.2.4</td><td>Configuration Field</td><td>M</td></tr>
<tr><td>7.2.4.1</td><td>General
Only Encryption Mode 7 will be used</td><td>S</td></tr>
<tr><td>7.2.4.2</td><td>Configuration Field for Encryption Mode 0</td><td>M</td></tr>
<tr><td>7.2.4.3</td><td>Configuration Field for Encryption Mode 5</td><td>N/R</td></tr>
<tr><td>7.2.4.4</td><td>Configuration Field for Encryption Mode 7</td><td>M</td></tr>
<tr><td>7.2.4.5</td><td>Configuration Field for Encryption Mode 13</td><td>N/R</td></tr>
<tr><td>7.2.4.6</td><td>Special bits of the Configuration Field</td><td>M</td></tr>
<tr><td>7.3</td><td>Conditions to apply the Transport Layer</td><td>M</td></tr>
</table>

3.7. Application Protocols

Clause	Title and remarks/modifications	Statement
8	Application Protocols	M
8.1	~~General requirements~~Overview Possible Application Protocols: Only the support of the M-Bus application layer is mandatory. DLMS and SML communication must be ignored if not supported. Application Protocols for special services Support for the following protocols is required - Clock Synchronisation Protocol (refer to 8.6) Security Management Protocol (refer to Annex F)	~~M~~S
8.~~1.1~~2	Required Values and their Resolution and Accuracy	M
8.~~2~~3	M-Bus Application Protocol	M
8.3.1	General	M
8.3.2~~.1~~	OMS-Data Point List	I
8.~~2.2~~3.3	OMS-Gateway - Support of the listed M-Bus data points is required - Support of the standard load profile and the M-Bus compact profile is not required.	S
8.~~2.~~3.4	OMS meter	I
8.~~2.4~~3.5	Usage of specific data points	M
8.~~2.4~~3.5.1	Date, time and intervals	M
8.3.5.2~~.4.2~~	Management data	M
8.~~2.5~~3.6	OBIS code	N/R
8.3.7	Descriptors	N/R
8.~~3~~4	DLMS Application Protocol	N/R
8.~~4~~5	SML Application Protocol	N/R
8.~~5~~6	Clock Synchronisation Protocol	M
8.~~6~~7	Application Error Protocol	N/R
8.8	Security Management Protocol	N/R

3.8. Communication security

Clause	Title and remarks/modifications	Statement
9	Communication security	M
9.1	Overview Encryption for wired communication is mandatory Only Security Profile B will be used in this application - Using 'No security profile' or 'Security Profile A' is not allowed - Support of Security Profiles C is optional	S, E
9.2	~~Encryption~~Security Modes	M
9.2.1	General	M
9.2.~~1~~2	No encryption with Mode 0	N/R
9.2.~~2~~3	Symmetric encryption with Mode 5	N/R
9.2.~~3~~4	Advanced symmetric encryption with Mode 7	M
9.2.~~4~~5	Asymmetric encryption with Mode 13	N/R
9.3	MAC-Generation	M
9.3.1	CMAC (AES 128 – 8 Byte truncated)	M
9.3.2	HMAC (TLS1.2)	N/R
9.4	Key-ID	M
9.~~4~~5	Key Derivation Function	M
9.~~4~~5.1	General	M
9.~~4~~5.2	Individual Master Key (MK)	M
9.~~4~~5.3	Derivation Constant (D)	M
9.5.4.~~4~~	Message Counter (C and C')	M
9.5.4.1	Overview	M
9.5.4.2	Message counter handling in a meter	M
9.5.4.3	Message counter handling in a gateway	M
9.~~4~~5.5	Meter-ID	M
9.~~4~~5.6	Padding	M
9.~~4~~5.7	Key calculation	M

3.1. Annex

Clause	Title and remarks/modifications	Statement
Annex A	List of OBIS codes for Basic Meters	N/R
Annex B	OMS-Data Point List	M
Annex C	Requirements on the gateway as a Physical M-Bus-Master - Support of a minimum of 16 unit loads required - Baud rate is fixed to 2400bd - Collision detection is not required	E
Annex D	The Structure of the Transport and Application Layer	I
Annex E	Communication profiles for compliance with national regulations	N/R
Annex F	Transport Layer Security (TLS) with wM-Bus	N/R
Annex G	Examples for the conversion of Load Profiles to single data points	N/R
Annex H	Gas Meter Consumption Data and their Coding	I
Annex I	Collision Avoiding Mechanism of the gateway	M
Annex J	Handling of Message Counter ~~C/C'~~	~~N/R~~I
Annex K	~~Obsolete~~Descriptors	N/R
Annex L	Timing Diagram	M
Annex M	Obsolete	N/R
Annex N	Datagram Examples for M-Bus and wM-Bus	I
Annex O	Alternative Physical Layers for OMS	N/R

4. M-Bus device installation

The connection of M-Bus devices to the E-meter requires the support of the HES via LAN/WAN interface or appropriate installation tools using the WZ interface.
A local installation procedure without tool support is not foreseen.

4.1. Installation procedure

The installation procedure requires the pre-configuration of the identification parameters using the DLMS Cosem objects for setting up the M-Bus client channels.

Step1: Registration of the new M-Bus device to the E-meter:
An M-Bus device is called registered in the E-meter when the M-Bus Address values are written in respective DLMS/COSEM M-Bus objects.

An M-Bus device is registered in the E-meter by setting the M-Bus Address through the WZ or LAN/WAN interface.
Please find further details in the chapter 4.2 M-Bus Address

Step2: Binding of the new M-Bus device to the E-meter:
The binding procedure is different between wired and wireless connected M-Bus devices.

- Wired M-Bus device binding is initiated by the E-meter using the slave_install() method.
- Wireless M-Bus device binding is initiated by the M-Bus device using a specific installation mode.

In both cases, the binding is only accepted if the registered M-Bus Address in the E-meter is matching the Address of the detected M-Bus device.
The successful binding of the new M-Bus device is reported to the HES by sending an alarm message (New M-Bus Device Installed Chx)
Please find further details in the chapter 4.2 M-Bus Address

Step3: Exchange of the Encryption keys:
After the successful binding of the new M-Bus device to the e-meter, the HES transfers the corresponding encryption keys to the E-meter using the transfer_key() and set_ encryption_ key() methods.

Step4: Time synchronisation
After the successful key exchange between E-meter and M-Bus device, the E-meter automatically starts is time synchronisation procedure.

To complete the functional integration of the M-Bus device to the E-meter, the HES needs to set the expected capture definition and capture period in the M-Bus client setup objects for the regular data retrieval.

4.2. M-Bus Address

The M-Bus Address allows the identification of a M-Bus device during the installation procedure. The M-Bus address is part of the M-Bus data header
It consists of the following parts

- Identification Number (Device ID)
- Manufacturer ID
- Version
- Device Type

The following table shows mapping between the attributes of the COSEM objects of M-Bus client channel X and M-Bus Address elements:

M-Bus Address	Object (IC 72): M-Bus client channel X
Identification Number 8 BCD digits (part of the Data Header)	Attribute: identification_number Type: double-long-unsigned. Contains the integer value represented by the 8 BCD digits (not BCD !)
Manufacturer	Attribute: manufacturer_id

	Type: long-unsigned
Version	Attribute: version Type: unsigned
Medium	Attribute: device type Type: unsigned

4.3. Wired M-Bus device binding

Wired M-Bus device binding is initiated by the E-meter using the slave_install() method.

Triggered by this method, the E-meter starts scanning for new M-Bus devices (scan on both primary address 0 as well as 1-250, when not already in use). Scanning for new devices shall be done in one scan-cycle only.

In case the slave_install() method was invoked with a value of 0, the primary address of the new M-Bus device is selected automatically and changed accordingly.
In case the slave_install() method was invoked with a value between 1 and 250, the primary address of the new M-Bus device is using selecting the provided value and changed accordingly.

- ⇨ The slave_install() invocation reports a fail in case the provided value is outside the valid range or is already used by an already connected M-Bus device
- ⇨ The slave_install() invocation reports success in all other cases, even if no applicable device is found. The reporting of the successful binding is using the alarm reporting feature.

4.4. Wireless M-Bus device binding

Wireless M-Bus device binding is initiated by the M-Bus device using a specific installation mode.
When the M-Bus device is installation mode, it will start periodic transmissions of installation messages (SND_IR) with the M-Bus Address as sender address. The selected E-meter shall respond with a confirmation message (CNF_IR) to the specific M-Bus device.