Application Domain specific Standards

10

3

RF metering protocol

Summary

This document specifies the subset of the M-Bus RF metering protocol (EN 13757-3 and EN13757-4) for KNX. It specifies the requirements towards the M-Bus Data Link Layer and Application Layer.

This document is part of the KNX Specifications v2.1.

Version 01.03.07 is a KNX Approved Standard.

Document updates

Version	Date	Modifications
1.0.09	2005.01.18	Start with Document index
1.0.10	2005.01.21	Insert RX-Sequence counter and RX-Reception time
1.0.11	2005.06.02	Insert Memory type for Object structure; Insert VIFE for MWh and GJ; Explanation of "Raw data of Telegram" Insert Memory calculation in Object structure Heat Insert Document "RF metering retransmitter 04.doc"
1.0.12	2005.09.20 2005.10.14	Insert Explanation for Fabrication and Soft address Update of Table 10
1.0.13	2005.11.21	update chapter "fixed fields - Signature", Example Fab. no., Insert "RF Metering Retransmitter 05"
1.0.13	2005.11.21	Update clause "fixed fields - Signature", Example Fab. no., Insert "RF Metering Retransmitter 05".
Part 10/03 "M-Bus interface"		
0.1	2005.12.21	Restyling according KNX Association specifications.
	2006.01.24	Corrections from TF AMR meeting of 2006.01.24.
	2006.02.21	Update according "RF metering retransmitter 07.doc".
	2006.03.02	Editorial Changes, Bug fix in example Heat, Revise Example Parse M-Bus, Recalculation of needed memory by UP
	2006-03-14	Editorial changes
	2006.05.08	[SDB] Corrected and transposed Table 12.
1.0 DP	2006.06.15	Added note about retransmission of frames with long preamble. Preparation of the Draft Proposal.
1.0 DP rev1	2006.10.06	Update according "Compilation_Comments_KTB0572.doc"
1.1 DP	2006.10.25	Add explanation for telegrams without Datapoints in clause 3.2
1.1 DP	2007.01.29	Preparation of the Draft for Voting.
1.2 AS	2007.03.20	DPT_MBus_Address (DPT_ID = 230.1000) moved exclusively to Chapter 3/7/2 "Datapoint Types". Publication of the Approved Standard.
1.2	2009.06.26	Update in view of publication in the KNX Specifications v2.0.
1.3.01	2011.06.26	Add C-Field 47h and 48h in 3.1.3; update use of Address fields in 3.1.5 and 3.2.3, Add Radio converter in 3.1.5.3; Add Annex A (T-Mode); Add new Media Elec.,Gas,Valve,Breaker, and Waste water, Support of Decryption (with example in Annex B later Annex C)
1.3.02	2011.09.27	Add new reference for prEN13757-3/4;
1.3.03	2012.03.13	Add combinable VIFE, update Generic Device, Reduce C-Fields to C=44 and 46h, Update section Connection Interrupt, Add Reference OMSS
1.3.04	2012.05.25	Final revision
1.3.05	2012.06.13	Add Device type Other, Oil meter and Steam meter.
01.03.06	2012.08.06	Preparation of the Draft Proposal.
01.03.07	2013.10.23	Editorial updates for the publication of KNX Specifications 2.1.

References

The KNX RF Metering Protocol bases on European Standard EN13757-3 and EN13757-4.

[01] M-Bus "Specification EN13757-3(2004)"
[02] M-Bus "Specification EN13757-4(2005)"
[03] "Specification EN 62056-21"
[04] "Specification IEC-60870-5-2"
[05] "ERC REC. 70-03"
[06] Chapter 3/2/5 "Communication Medium RF"
[07] Chapter 7/60/1 "Metering Functional Blocks"

[08] M-Bus "Specification prEN13757-3(2013)"
[09] M-Bus "Specification prEN13757-4(2013)"
[10] OMSS_Vol.2 "Open Metering System Specification - Volume 2: Primary Communication"

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Contents

1 Introduction

1.1 Scope

This document introduces a Radio metering Data Link Layer telegram compliant with EN 13757-4.

A reduced M-Bus Application Layer specification according to EN 13757-3 describes how to interpret interesting Datapoints and how to ignore or separate non relevant Datapoints, to integrate Metering data in the KNX system.

1.2 Physical Layer and Data Link Layer

Based on [05], the standards [02] and [06] the parameters of the Physical Layer and Data Link Layer are harmonised between the KNX RF communication medium and the S-Mode of M-Bus RF metering. Optionally a KNX-Receiver may additional support the Mode T of RF-Metering. The Physical Layer and the Data encoding of the Mode T differs from KNX RF-communication and is described in Annex A.

NOTE M-Bus RF metering allows for the use of both a long and a short preamble as specified in [02]. The short preamble is identical to the preamble as specified for the KNX RF communication medium.

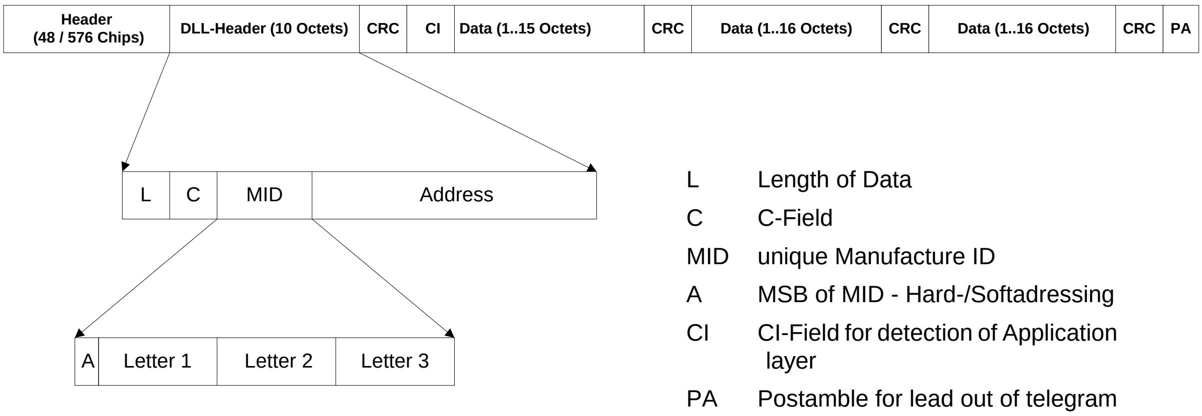
2 Terms and definitions

Meter	Metering device that collects metering consumption data and forwards it by radio.
Metering Data Collector	Unit with radio receiver able to store and forward meter data periodically or by request.
Metering Retransmitter	A unit with radio receiver and transmitter used to receive the meter data and forward it after a short delay. This unit will be useful to expand the radio range of a meter.

3 The M-Bus frame

3.1 The first block

3.1.1 Structure



Example of a Header

L	C=44	0	CEN	Address = 123456780107	CRC

Figure 1 - Structure of the protocol at EN 13757-4 [09]

The block structure complies with [09] and [07]. The content of first block data fields is described in detail in [09] (S1 or S2 Mode). To distinguish between KNX telegrams and metering telegrams the 3rd octet (MID) has to be investigated. If it consists of 7Fh or FFh then it is the Escape sequence of a KNX telegram. Otherwise it is the least significant octet of Manufacture ID of the metering manufacturer. Any block will be separated by the 2 octet CRC checksum. Data fields with multiple octets will always be transmitted with the Least Significant Byte (LSB) firstly, but within the byte the most significant bit is transmitted firstly (MSb).

3.1.2 L field

The L-field describes the length of the telegram. It is described in more detail in [02]. The L-field contains the number of all telegram octets excluding the L-Field itself and the CRC. (Preamble and Postamble are excluded as well.) With that, a telegram that only uses the first block, has a length of L = 9. A telegram should not be longer than 156 octets (without Preamble- and Post amble, but including CRC). Therefore the L-Field can vary from 9 to 137 only.

3.1.3 C field

The second octet is the C-field, which signals the telegram type. According to [04] and [09], the following C-Fields are supported as indicated next.

If the meter is not in installation mode, C = 44h is applied to transport meter data without acknowledgement (data telegram). The content of such a message shall be handled as described in chapter 3.2.

If the meter is in the installation mode, then it uses C = 46h (installation telegram - refer to [09]). This message can be used to teach in the meter address in the Metering Data Collector.

A meter may support additional C-Fields (e.g. for a stay alive message or if it communicate with a Metering readout master). All messages with other C-Fields than stated above ones shall be ignored.

The reception time stamp “RxReceptionTime” of the receiver shall be changed only if a message with C-field 44h were received (refer to [07])!

3.1.4 MID field

The MID field contains the Manufacture ID encoded as a 2 octet unsigned binary value. This Manufacture ID is calculated from the ASCII code of manufacture identification (three uppercase letters) with the following formula [08], [09]:

Manufacture ID = [ASCII(1st letter) – 64] x 32 x 32
+ [ASCII(2nd letter) – 64] x 32
+ [ASCII(3rd letter) – 64]

Note that the flag association, UK (www.dlms.com/flag) administers these three letter manufacturers ID [03].

If the most significant bit of this 2 octet unique user/Manufacturer ID equals zero, the address A is a unique (hard address) manufacturer meter address of up to 6 octets. Each manufacturer is responsible for the worldwide uniqueness of these 6 octets. The coding of the address shall conform to [08].For details refer to chapter 3.1.5.

If the most significant bit of these 2 octet code unique user/Manufacturer ID differs from zero, the 6 octet address is unique at least within the maximum transmission range of the system (soft address) and is usually assigned to the device at installation time. If the soft address is enabled then the meter shall additionally attach the fabrication number in one of following blocks. [02]

EXAMPLE The virtual manufacturer “CEN“ with Ident.no 12345678, version 01 Device type 07 has to create the Manufacture ID of 0CAEh. With LSB first, the transmission (starting with the L-field) has the order:

09 44 AE 0C 78 56 34 12 01 07

3.1.5 Address field

The Address field consist of three parts.

Identification Number	Version	Device type
4 octets	1 octet	1 octet

The combination of Identification Number, Version and Device type shall be unique within the installation.

3.1.5.1 Identification Number

The Identification Number of the first block consists of the non changeable ID of the Radio transmitter unit. This can be the Meter ID itself (if the Radio unit part of the meter) or the ID of a radio unit which is the host of the meter. In this case the Meter ID will be transported in the Application layer using the “fixed data with Address field” (refer to 3.2.2). The Meter ID in the Application layer is changeable and may be modified during the installation for the pairing of a meter with the hosting radio unit.

The Identification Number is always codes as 8 BCD packed digits (4 octets), with valid values between 00000001 and 99999999.

Note in the old Metering standard [01] the Identification Number in the first block was changeable. The original Link address of the radio unit could be replaced by the meter address. To avoid address conflicts the address of the radio unit was added in the application layer as Fabrication number (DIF = 0Ch, VIF = 78h). The newer metering standard [08] supports only changes of the Meter ID within the Application layer.

3.1.5.2 Version

The Version describes the software version of the meter device. It is a mandatory part of the address and has a length of 1 octet. The range shall be between 0 and 254. This field is manufacture specific organised.

3.1.5.3 Device type

The Device type describes the physical dimension that is cumulated with the meter. It has a length of 1 octet. The Device type is defined in [08]. The relevant part for KNX is defined in Table 1.

Media that are not listed here or are marked with "No" are not supported.

Note that the term "device type" has been previously denoted with "medium".

Table 1 - Supported physically media

Device type	Description	Code (hex)	KNX support
Other	used for undefined phys. medium	0	Yes
Oil meter	measures volume of oil	1	Yes
Electricity meter	measures electric energy	2	Yes
Gas meter	measures volume of gaseous energy	3	Yes
Heat meter	heat energy measured in outlet pipe	4	Yes
Steam meter	measures weight of hot steam	5	Yes
Warm Water meter (30 °C to 90 °C)	measured heated water volume	6	Yes
Water meter	measured water volume	7	Yes
Heat cost allocator	measured relative cumulated heat consumption	8	Yes
Compressed Air	measures weight of comp. air	9	No
Cooling Load meter (inlet)	cooling energy measured in inlet pipe	A	Yes
Cooling Load meter (outlet)	cooling energy measured in outlet pipe	B	Yes
Heat (inlet)	heat energy measured in inlet pipe	C	Yes
Heat and Cool	measures both heat and cool	D	Yes
Bus/System	no meter (e.g. communication unit)	E	No
Unknown Device type	used for undefined phys. medium	F	No
Breaker (electricity)	Status of elec. energy supply	20	Yes
Valve (gas or water)	Status of supply of Gas or water	21	Yes
Waste water meter	measured volume of disposed water	28	Yes
Garbage	measured weight of disposed rubbish	29	Yes
Radio converter (meter side)	Enables the radio transmission of a meter without a radio interface	37	No [a)]
Reserved		38..FF	No

[a)] Device type radio converter (code 37h) has to be supported in so far as the relevant Device type of the meter has to be detected from the second block after the CI-Filed 72h.

3.1.5.4 Fabrication number

If the soft address is enabled then the meter shall add the fabrication number in the variable part of the telegram in the following blocks (VIF = 78h). The Fabrication number shall be part of the address and consist of a copy of original Identification number. It is used for a unique identification of meter.

Note that the Fabrication number is needed to support old Metering standard [08]. With the revision of the Metering-standard [08] the Fabrication number is replaced by the usage of the CI-field 72h.

3.2 The following blocks

3.2.1 Number of blocks

The telegram usually consists of more than just the first block. The L-field in first block indicates the presence of subsequent blocks (see 3.1.2).

3.2.2 CI field

The first octet of second block will be interpreted as the CI field. That CI field describes the structure of the Application Layer. For M-Bus Data telegrams the CI fields with value 78h, 7Ah and 72h will be accepted. The Application Layer has always the following structure. The meter can select one of following formats for data transmission. The metering Data Collector has to support all formats.

CI	fixed fields (ID, Status)	variable fields [a] (DIF/VIF)

[a] The variable fields may be empty (no DIF/VIF)!

The following values for the CI field are defined for the Application Layer using radio transmission:

- **CI = 78h (no fixed data)**

CI = 78	Data starting with DIF
1 octet	
	Variable fields

- **CI = 7Ah (fixed data without Address field)**

CI = 7A	Access No	Status	Configuration word	Data starting with DIF
1 octet	1 octet	1 octet	2 octets	
	Fixed fields (4 octets)			Variable fields

Meters apply this CI-Field, if the has an integrated radio unit (radio unit and meter share the same address in the first block).

- **CI = 72h (fixed data with Address field)**

CI = 72	Ident No	Manufacturer	Version	Device type	Access No	Status	Configuration word	Data starting with DIF
1 octet	4 octets	2 octets	1 octet	1 octet	1 octet	1 octet	2 octets	
	Fixed fields (12 octets)							Variable fields

Meters apply this CI-Field, if they need an external radio unit. The radio unit and the meter have different addresses. The radio unit address is located in the first block. The meter address follows in the Address section after the CI-Field 72h.
The content of fixed fields complies with the requirements of [08].

3.2.3 The fixed fields

Address: Identification no, Manufacturer, Version and Device type are parts of the address. Their meaning is as described in the clause 3.1. Be aware that the order of Identification Number and Manufacturer is exchanged! If this address differs from the address field of the first block, the address in the second block contains the meter address.

Access No: is a current telegram number. The value may increase by any telegram for changing calculated CRC at constant consumption. The mechanism is manufacturer specific.

Status: Describes the device status (e.g. error). The Status field is described in detail in [01]. For the Status field the following bits will accepted. All other bits will be ignored!

Table 2 - Supported status bits

Bit number	**Clear Bit**	**Set Bit**
0 (LSb)	Status (see [08]). Shall be ignored.	
1	Status (see [08]). Shall be ignored.	
2	no error	power low – battery will discharged soon
3	no error	permanent error – hard error / service necessary
4	no error	temp. error – device out of condition
5	Manufacturer specific - Shall be ignored.	
6	Manufacturer specific - Shall be ignored.	
7 (MSb)	Manufacturer specific - Shall be ignored.	

Configuration word: Defines the encryption method (MMMM) and length of encrypted data (NNNN).

Table 3 – Structure of Configuration word

MSb 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**LSb 0**
bidirectional communication	accessibility	synchronised	reserved	mode bit3	mode bit2	mode bit1	mode bit0	number of encr. blocks	number of encr. blocks	number of encr. blocks	number of encr. blocks	content of telegram	content of telegram	hop counter	hop counter
B	A	S	R	M	M	M	M	N	N	N	N	C	C	H	H

Beside the control bits for encryption (MMMM and NNNN) the configuration word contains additional configuration bits. The bits B, A ,S ,R and HH shall be ignored. If CC contains a 10b or a 11b then the telegram shall be ignored.
If the bits MMMM contains other values than 0000b (0) or 0101b (5) then the data content can not be encrypted. The message shall be ignored. If MMMM = 0000b the telegram is not encrypted. The first octet of the unencrypted part shall be interpreted as DIF. If MMMM=1010b the telegram is encrypted and shall by decrypted first before the telegram content can be parsed. For the decryption of a meter telegram refer to chapter 4.

3.2.4 The variable fields

3.2.4.1 Data record structure

DIF	DIFE	VIF	VIFE	Data
1 octet	0 to 10 (1 octet each)	1 octet	0 to 10 (1 octet each)	0 to N octet
Data Information Block (DIB)		Value Information Block (VIB)		
Data Record Header DRH				

Figure 2 – Complete Data Information Block

The minimal data record structure shall exist of one Data Information Field (DIF).

3.2.4.2 Data Information Field (DIF)

3.2.4.2.1 Structure

The following information shall be contained in a DIF.

Bit 7	6	5	4	3	2	1	0
Extension Bit	LSb of Storage Number	Function Field		Data Field: Length and coding of data			

Figure 3 – Coding of the Data Information Field (DIF)

3.2.4.2.2 Data field

The Data field shall show how the data from the master shall be interpreted in respect of length and coding. Table 4 contains the possible coding of the data field:

Table 4 - Coding of the data field

Length (Bit)	Code	Meaning	Code	Meaning
0	0000b	No data	1000b	Selection for Readout
8	0001b	8 Bit integer	1001b	2 digit BCD
16	0010b	16 Bit integer	1010b	4 digit BCD
24	0011b	24 Bit integer	1011b	6 digit BCD
32	0100b	32 Bit integer	1100b	8 digit BCD
32 / N	0101b	32 Bit Real	1101b	variable length [a]
48	0110b	48 Bit integer	1110b	12 digit BCD
64	0111b	64 Bit integer	1111b	Special Functions [b]
[a, b] See requirements below.				

NOTE This table has been expanded with optional elements from the original standard.

a **Variable Length**

With data field = 1101b several data types with variable length can be used.

This DIF shall not be supported in KNX. This Datapoint and all Datapoints following to this DIF “Variable Length” shall be discarded! Further parts of the telegram shall not be interpreted.

b **Special Functions (data field = 1111b)**

Table 5 - DIF-coding for special functions

DIF	Function
0Fh	Start of manufacturer specific data structures to end of user data.
1Fh	Same meaning as DIF = 0Fh + More records follow in next telegram.
2Fh	Idle Filler (not to be interpreted), following octet = DIF of next record.
3Fh to 6Fh	Reserved.
7Fh	Global readout request (all storage#, units, tariffs, function fields).

All special functions except the special function with DIF = 2Fh shall not be handled in KNX. All Datapoints following these DIFs shall be discarded. Further parts of the telegram shall not be interpreted.

3.2.4.2.3 Function field

The function field shall give the type of data as specified in Table 6.

Table 6 - Function Field

Code	Description
00b	Instantaneous value
10b	Minimum value
01b	Maximum value
11b	Value during error state

3.2.4.2.4 LSb of Storage Number field

Bit 6 of the DIF shall serve as the LSb of the Storage Number of the concerned data and the slave shall in this way indicate and transmit various stored metering values or historical values of metering data. This bit shall be the least significant bit of the Storage Number and shall therefore allow for the Storage Numbers 0 and 1 to be coded. If Storage Numbers higher than 1 are needed then the following (optional) DIFEs shall contain the higher bits. The Storage Number 0 shall signal a current value. The Storage Number 1 shall be applied for consumption data at last set day.

Note that each Storage Number shall be associated with a given time point. All data records with the same Storage Number shall refer to the timestamp given by the datapoint Date and Time for this Storage Number. It is recommended, that a time/date record with this Storage Number is included somewhere to signal this time point.

3.2.4.2.5 Extension Bit field

The extension bit (MSb) shall signal whether or not more detailed or extended description octets (data field extension = DIFE) shall follow. There are no more than 10 DIFE allowed.

3.2.4.3 Data field extension octet(s) (DIFE)

3.2.4.3.1 Structure

There shall be at maximum 10 DIFE octets. Each DIFE shall again contain an extension bit to show whether a further DIFE shall be sent. Every DIFE shall give the next most significant bit of the Storage Number and shall allow the transmission of information about the tariff and the subunit of the device. In this way, exactly as with the Storage Number, the next most significant bit or bits shall be transmitted. Figure 4 below shows the structure of a DIFE.

Bit 7	6	5	4	3	2	1	0
Extension Bit	(Device) Unit	Tariff		Storage Number			

Figure 4 - Coding of the Data Information Field Extension (DIFE)

With the maximum of ten DIFEs that are provided, there are 41 bit for the Storage Number, 20 bit for the tariff, and 10 bits for the subunit of the meter. There is no application conceivable in which this immense number of bits could all be used.

3.2.4.3.2 Tariff field

This field shall give tariff information. For each (unique) value type designation given by the following Value Information Block (VIB) at each unique time point (given by the Storage Number) of each unique function (given by the function field) there may still exist various data measured or accumulated under different conditions. Such conditions may be time of day, various value ranges of the variable (this is, separate storage of positive accumulated values and negative accumulated values) itself or of other signals or variables or various averaging durations.

Only Tariff 00b and 01b shall be accepted for KNX.

3.2.4.3.3 Unit field

The Unit field shall give information about the subunit. A slave component may consist of several functionally and logically independent subunits of the same or of different functionality. Such a device may either use several different primary and/or secondary addresses. Such it is from a Data Link Layer and an Application Layer view just several independent devices which share a common Physical Layer interface. This is recommended for devices that represent a physical collection of several truly independent (often similar or identical) devices. For devices that share common information and values and have logical connections an approach with a common Data Link Layer (i.e. a single address) the subunit is used in M-Bus.

Only subunit 0 shall be accepted by the Metering Data Collector. Datapoints with higher subunit numbers shall be discarded.

3.2.4.3.4 Extension Bit field

The extension bit (MSb) shall signal that more detailed or extended description octets (data field extension = DIFE) shall follow. There shall be no more than 10 DIFE.

3.2.4.4 Value Information Block (VIB)

3.2.4.4.1 Use

After a DIF (with the exception of xF) or a DIFE without a set extension bit the VIB (Value Information Block) shall follow. This shall consist of at least the VIF (Value Information Field) and may be expanded with a maximum of 10 extensions (VIFE). The VIF and also the VIFEs shall show through a set MSb that a VIFE shall follow. In the Value Information Field (VIF) the remaining seven bits shall give the unit and the multiplier of the transmitted value.

3.2.4.4.2 Value Information Field (VIF)

Bit 7	6	5	4	3	2	1	0
Extension Bit	Unit and multiplier (value)						

Figure 5 - Coding of the Value Information Field (VIF)

The value of the VIF shall indicate whether the coding complies with one of the five standard coding or is manufacturer specific.

1. **Primary VIF: E000 0000b to E111 1011b**

   The unit and multiplier shall be taken from the table for primary VIF as specified in Table 7.

2. **Plain-text VIF: E111 1100b (Not interpreted for KNX!)**

   In case the VIF value equals 7Ch or FCh the true VIF shall be represented by the following ASCII string of which the length shall be given in the first octet.

   Note hat the octet order of the characters after the length octet depends on the used octet sequence. Since only the „LSB first mode" (M = 1) of multi-octet data transmission is recommended, the rightmost character shall be transmitted firstly. This plain text VIF shall allow the user to code units that are not included in the VIF tables.

   The Plain Text VIF shall not be supported within KNX. This Datapoint shall be discarded.

3. Linear VIF-Extension: FBh (partially interpreted for KNX)

In case the VIF value equals FBh then the true VIF shall be given by the next octet (i.e. the first VIFE). The content of this VIFE may vary up to 255 codes, according to table 12 in [01]. From this code range only a subset as specified in Table 8 in clause “Extension of VIF Codes (VIFE)”shall be supported in KNX.

4. Linear VIF-Extension: FDh (Not interpreted in KNX!)

In case the VIF value equals FDh then the true VIF shall be given by the next octet (i.e. the first VIFE) and the coding shall be taken from the tables 11 in [01]. This shall extend the available VIFs by another 256 codes. This VIF and following VIFE’s are not supported in KNX.

5. Any VIF: 7Eh / FEh (Not interpreted in KNX!)

This VIF code can be used in the direction from master to slave for reading out the selection of all VIFs. See [01]. This VIF are not supported in KNX.

6. Manufacturer specific: 7Fh / FFh (Not interpreted in KNX!)

In this case the remainder of this data record including VIFEs has manufacturer specific coding. This VIF are not supported in KNX.

3.2.4.4.3 Primary VIFs (main table)

The first section of the main table contains integral values, the second typically averaged values, the third typically instantaneous values and the fourth block contains parameters. (E: extension bit)

Table 7 - Primary VIF codes

Coding	Description	Range Coding	Range
E000 0nnn	Energy	$10^{(nnn-3)}$ Wh	0,001 Wh to 10 000 Wh
E000 1nnn	Energy	$10^{(nnn)}$ J	0,001 kJ to 10 000 kJ
E001 0nnn	Volume	$10^{(nnn-6)}$ m^3	0,001 l to 10 000 l
E001 1nnn	Mass	$10^{(nnn-3)}$ kg	0,001 kg to 10 000 kg
E010 00nn	On Time	nn = 00b s nn = 01b min nn = 10b h nn = 11b d	Duration of Meter power up
E010 01nn	Operating Time	coded like OnTime	Duration of meter accumulation
E010 1nnn	Power	$10^{(nnn-3)}$ W	0,001 W to 10 000 W
E011 0nnn	Power	$10^{(nnn)}$ J/h	0,001 kJ/h to 10 000 kJ/h
E011 1nnn	Volume Flow	$10^{(nnn-6)}$ m^3/h	0,001 l/h to 10 000 l/h
E100 0nnn	Volume Flow ext.	$10^{(nnn-7)}$ m^3/min	0,0001 l/min to 1 000 l/min
E100 1nnn	Volume Flow ext.	$10^{(nnn-9)}$ m^3/s	0,001 ml/s to 10 000 ml/s
E101 0nnn	Mass flow	$10^{(nnn-3)}$ kg/h	0,001 kg/h to 10 000 kg/h
E101 10nn	Flow Temperature	$10^{(nn-3)}$ °C	0,001°C to 1°C
E101 11nn	Return Temperature	$10^{(nn-3)}$ °C	0,001°C to 1°C
E110 00nn	Temperature Difference	$10^{(nn-3)}$ K	1 mK to 1 000 mK
E110 01nn	External Temperature	$10^{(nn-3)}$ °C	0,001 °C to 1 °C
E110 10nn	Pressure	$10^{(nn-3)}$ bar	1 mbar to 1 000 mbar
E110 1100	Date (current or associated with a Storage Number or function)		data type G [01]
E110 1101	Date and Time (current or associated with a Storage Number or function)		data type F (other Data types will discarded in KNX) [01].
E110 1110	Units for H.C.A.		Dimensionless
E110 1111	Reserved		
E111 00nn	Averaging Duration	coded like OnTime	
E111 01nn	Actuality Duration	coded like OnTime	
E111 1000	Fabrication No		
E111 1001	(Enhanced) Identification	Not mapped to KNX	
E111 1010	Address	Not mapped to KNX	data field 110b (6 octet Header-ID) [02] or 111b (Full 8 octet Header) [01]

3.2.4.4.4 Extension of VIF Codes (VIFE)

The extension bit (MSb) shall signal that one or more detailed or extended description octets (value field extension = VIFE) shall follow. There shall be no more than 10 VIFE.

Only four extensions of VIF codes (VIFE) shall be supported for KNX. For other extensions the complete Datapoint shall be discarded. Nevertheless a consideration of length for any Datapoints using VIFE is necessary to detect precisely the start of next Datapoint. For that reason the interpreter shall to parse any Datapoint.

This subset of VIFE shall allow Datapoints using energy units MWh or GJ respectively power units MW or GJ/h. Be aware that the extension bit is set for mapping to DPT_MeteringValue [07].

Table 8 - Alternate VIFE-Code Extension table (following VIF = 0FBh for primary VIF)

Coding	Description	Range Coding	Range
0000 000n	Energy	$10^{(n-1)}$ MWh	0,1 MWh to 1 MWh
0000 100n	Energy	$10^{(n-1)}$ GJ	0,1 GJ to 1 GJ
0010 100n	Power	$10^{(n-1)}$ MW	0,1 MW to 1 MW
0011 000n	Power	$10^{(n-1)}$ GJ/h	0,1 GJ/h to 1 GJ/h

3.2.4.4.5 Combinable VIFE Codes

There are 3 types of data points where the meaning of a primary VIF or a VIF-Extension using VIF=FBh is expanded by a combinable VIFE:

- Extension of value range
- Modification of the meaning of a data record
- Presenting a row of data points in a compact profile

The presence of a combinable VIFE is marked by setting the extension bit (MSb) of the previous VIF or VIFE. The combinable VIFE follows always after the VIF or the other VIF-Extensions.

Extension of a value range

The value range of the previous VIF/VIFE may be expanded by a fix multiplier of 10^3 if this combinable VIFE = 7Dh is applied.

Modification of the meaning of a data record

Exported Energy of a Electricity Meter

An electricity meter applies a combinable VIFE=3Ch to signal that data record consist values of exported (produced) energy instead of imported (consumed) energy.

Cooling Energy of a combined Heat and Cool meter

A heat and cool meter applies the combinable VIFE=3Ch to separate the cooling energy from the energy for heating (without this combinable VIFE). Alternatively the tariff1 register is applied!

Measuring condition of a Gas meter

The measured volume of a Gas meter has to be converted to an energy value. This conversion needs to consider temperature and pressure of the measured Gas volume. The metering condition may be considered from the Gas meter itself or later one in the billing system. For details of metering conditions for a Gas meter refer to Annex H of [10]. There are 3 metering conditions which may provided by a Gas meter.

For a Gas meter which applies no additional combinable VIFE shall be assumed that the consumption values are temperature converted (V_{tc}).

A Gas meter which provider consumption values without any conversion (value at measurement condition V_m) applies an combinable VIFE=3Ah for each consumption value.

A Gas meter which provider compensated consumption values (value at base condition V_b) applies a combinable VIFE=3Eh for each consumption value.

A Gas meter will provide only one type of these 3 possible metering conditions on the radio interface. The KNX-Receiver has to store the consumption value and the metering condition in separate data points (refer to [07]).

Presenting a row of data points in a compact profile

This combinable VIFE declares an array of data points in one data record. This data record is called compact profile and marked with the combinable VIFE = 1Eh or 1Fh. Details of the compact profile are described in Annex B.

Note that several combinable VIFE may be applied in the same data record. All VIFE except the last one applies additional a set MSb! Example: VIF/VIFE = FBh 10h FDh 3Ch (with multiplier and modification of the data record).

4 Decryption of an encrypted message

The encryption method and the length of encrypted data depends on the configuration word (refer to 3.2.3). When the nibble MMMM consists of a value different from 0000b the following data are encrypted. Within this standard the encryption method 5 (1001b) in MMMM is only supported. This encryption method 5 requires:

- A 16 Byte Block encryption by AES128.
- A chaining of all blocks using Cipher Block Chaining (CBC)
- An Initialisation vector conforming to Table 9
- An Encryption key which shall be provided conform to FIPS 197 with Least Significant Byte first.

Table 9 - Initialisation vector for the CBC-AES-128

LSB	1	2	3	4	5	6	7	8	9	10	11	12	13	14	MSB
Manuf. (LSB)	Manuf. (MSB)	ID (LSB)	ID	ID	ID (MSB)	Version	Dev.-type	Acc. no.	Acc. no.	Acc. no.	Acc. no.	Acc. no.	Acc. no.	Acc. no.	Acc. no.

The length of encrypted data is given by the nibble NNNN in the Configuration word (refer to 3.2.3). NNNN declares the number of encrypted 16 octet blocks. Therefore the NNNN has to be multiplied with 16 to get the number of encrypted octets. When the number of encrypted octets is shorter then the remaining length of the telegram calculated by the L-Field, then the remaining octets are transmitted plain. This is called partial encryption. The unencrypted section shall always start with a DIF and may be interpreted even if the encrypted section is not decrypted yet.

An example of a partial encrypted telegram is presented in Annex C.

To check the encrypted part for a correct decryption the encryption method 5 provides an Encryption verification containing the dummy DIF's “2Fh 2Fh” in the first two octets of the encrypted part. If a decrypted message contains different values than the “2Fh 2Fh” in the first two octets of the decrypted message than the content of the encrypted part shall be ignored. At the end of the last block may additional dummy DIF's 2Fh applied to fill up the last block up to 16 bytes.

5 Parse a M-Bus string

The variable part of the M-Bus string shall always start with a DIF. The DIF describes the format and length of the contained data. If a Datapoint cannot be interpreted then next Datapoint shall be detected. To find next Datapoint the length of these Datapoint shall be calculated.

```
Length = Length of Data + Sum of all DIF/DIFE + Sum of all VIF/VIFE
```

The Length of data shall be calculated by the predefined length as given in Table 4.

Usually only one DIF or VIF per Datapoint is used. If this is not the case then the Extension bit of the DIF/DIFE or VIF/VIFE shall be set.

The Number of DIF/DIFE or VIF/VIFE-fields shall be calculated by cumulating all octets until the Extension Bit is clear.

If special DIFs or DIFs with variable Length are used that shall not be supported for mapping to KNX, then the further parts of the telegram shall not be interpreted.. All following Datapoints up to the end of telegram shall be discarded (see clause3.2.4.2.2).

EXAMPLE

This example shows a volume in gallons at the storage number 33 (e.g. month value). Thus gallons are not part of Main VIF-Table. The interpreter can ignore this Datapoint and parse to next Datapoint.

CCh, 80h, 01h, FBh, 23h, 78h, 56h, 34h, 12h, 2Fh, 2Fh

DIF, .DIFE, VIF, VIFE, example 12345678

Length	= 8 Digits BCD for Data (Type 1100b in Table 4)	= 4 octets
	+ DIF (set extension bit) and DIFE (set ext. bit) and DIFE (cleared ext. bit)	= 3 octets
	+ VIF (set extension bit) and VIFE (cleared extension bit)	= 2 octets

Thus the next DIF (2Fh) follows after 9 octets!

6 Relevant data in dependency of the Device type

Table 10 - combination of possible Datapoints in dependency of Device type

Description	Device type							
	HCA {8}	Water {6,7,28}	Heat or Cool {4,A..D}	Gas {3}	Elec-tricity {2}	Breaker {20}	Valve {21}	Generic { } a)
Energy	-	-	x	-	x	-	-	x
Volume	-	x	-	x	-	-	-	x
Mass	-	-	-	-	-	-	-	x
On time	x	x	x	x	x	x	x	x
Operating Time	x	x	x	x	x	x	x	x
Power	-	-	x	-	x	-	-	-
Volume Flow	-	x	x	x	-	-	-	-
Mass flow	-	-	-	-	-	-	-	-
Flow Temperature	x	x	x	x	-	-	-	-
Return Temperature	-	-	x	-	-	-	-	-
Temperature Difference	-	-	x	-	-	-	-	-
External Temperature	x	-	-	-	-	-	-	-
Pressure	-	-	-	x	-	-	-	-
Date and Time	x	x	x	x	x	x	x	x
Units for H.C.A.	x	-	-	-	-	-	-	-
Reserved	-	-	-	-	-	-	-	-
Averaging Duration	x	x	x	x	x	-	-	x
Actuality Duration	x	x	x	x	x	x	x	x
Fabrication No	x	x	x	x	-	x	x	x
Breaker/ Valve state	-	-	-	x	x	x	x	-

Legend
{n} n is hexadecimal number of relevant Device type concerning reference [08]
x The Datapoint that shall be mapped as KNX-Datapoint.
- The Datapoint shall be discarded by Metering Data Collector.

a) Following device types are supported as generic device 00h, 01h, 02h, 03h, 05h, 29h.

7 Installation procedure

7.1 General

The installation of the metering application shall be executed with the push button method. This means a simple press of a button for both meter and Metering Data Collector will start an assignment of meter to metering Data Collector. The start of the installation can also initiated by other unique events, like the programming of the device.

7.2 Installation of the Meter

If the installation mode of a meter is initiated (e.g. by press a button) it shall change to installation mode. During installation mode at least one installation telegram shall be transmitted. An installation telegram differs from other telegrams by using special C-Field with value 46h (see clause 3.1.3). Inside the Installation telegram at least current date and time and a valid status of meter shall be transmitted. All other Datapoints can be transmitted optionally. It is recommended to transmit at least 6 installation telegrams during Installation mode for safe assignment. In order to avoid unwanted assignment to other Metering Data Collectors it is recommended to finish the transmission of Installation telegrams of meter automatically after a time out of 5 minutes.

7.3 Installation of the Metering Data Collector

If the metering Data Collector is in installation mode and it receives a telegram with a C-Field with value equal to 46h then it shall register the address of received meter for later reception (see example in clause 8). Usually the Installation mode of Metering Data Collector is finished manually. To avoid unwanted assignments of meter it is recommended that the Metering Data Collector leaves installation mode also automatically after an adequate timeout. A timeout of 1 hour is recommended.

Outside installation mode the metering Data Collector will accept meter telegrams only from devices listed in memory. The non volatile memory consist of all parts of address (Identification no, Manufacturer, Version, Device type and Fabrication number (if available)).

8 Connection interrupt

The transmission interval of the meter differs from meter to meter. There is also a dependency between transmission interval and device type of the meter. An electricity meter transmits typically the consumption data more frequently than a water meter. However there are general rules for the meter types. The meter has to transmit the consumption values several times a day. With it if the receiver receives no new data from meter for certain period it shall mark the obsolete data of this meter by setting the data point “ReliabilityOfMeteringData”. This Datapoint should be set 24 hours after the last received data telegram. If it receives a new data telegram (C=44) of the missed meter, the bit “ReliabilityOfMeteringData” shall be cleared. The check can be simple done, by comparing current time with last reception time stamp “RxReceptionTime”.

9 Example of object structure of Metering data for Heat (4, A..D)

The Main object contains all information from meter like ID, Error status or current consumption values. But consumption data are not only used for billing. Several consumption values from the past (Storage Number >0) will be saved in a history array. Through the Storage Number any date can be related with the concerned consumption value or peak value. This array has to be sorted by Storage Number and then by consumption date. If the array is completely filled, the oldest history data will be replaced by newest history value. It is recommended that minimum 10 objects can be stored in a metering Data Collector.

EXAMPLE Reception of an M-Bus telegram from a Heat meter (without line split).

The M-Bus telegram starts with block 2 with CI field value = 72h.

```
        /* Fixed part with CI = 72
72h 78h 56h 34h 12h AEh 0Ch 01h 04h 09h 08h 00h 00h
        /* Fabrication number
0Ch 78h 32h 54h 76h 98h
        /* Current values
04h 6Dh 0Ch 00h 96h 09h 0Bh 06h 87h 01h 00h 0Bh 15h 75h 18h 00h
        /* Max. values / Avg. duration
12h 6Ch 8Fh 06h 1Ah 2Bh 12h 01h 19h 72h 01h
        /* Error date
32h 6Ch 81h 07h
        /* Values for Storage no #1
42h 6Ch 7Fh 0Ch 4Bh 06h 00h 01h 00h
        /* Values for Storage no #3
C2h 01h 6Ch 9Fh 08h CBh 01h 06h 80h 01h 00h DAh 01h 3Dh 18h 00h DAh 01h 2Ch 20h 00h
```

Table 11 - Object structure of Heat/Cool meter (current values)

Field	**Value from example**	**Data Type**	**Memory type**
RX-Sequence counter [1]	02 (by receiver)	Octet	volatile
RX-Reception Time [1]	22.09.04 12:03 (by receiver)	DPT_DateTime	volatile
Manufacturer [2]	CEN	2 octets (See 3.1.4.)	non volatile
identification number [2]	12345678	8 digits BCD	non volatile
Version [2]	01	octet	non volatile
Device type [2]	04	octet	non volatile
Fabrication number [2]	98765432	8 digits BCD (like ident. no)	non volatile
access number	09	octet	volatile
Status	08	octet	volatile
operating time	--	DPT_LongDeltaTimeSec	volatile
on time	--	DPT_LongDeltaTimeSec	volatile
current date	22.09.04 12:00	DPT_DateTime	volatile
current consumption	187 kWh	DPT_MeteringValue	volatile
current consumption (Tarif1)	1875 x 0,1 m^3	DPT_MeteringValue	volatile
current power		DPT_MeteringValue	volatile
max. date	15.06.04	DPT_DateTime	volatile
max. power	112 W	DPT_MeteringValue	volatile
min. date		DPT_DateTime	volatile
min. power		DPT_MeteringValue	volatile
error date	01.07.04	DPT_DateTime	volatile
error consumption		DPT_MeteringValue	volatile
averaging duration	1 h	DPT_LongDeltaTimeSec	volatile
raw data of telegram (starting from CI)[3]	72 78 56 34 12 AE 0C 01 04…	String of octet (min.. 127 octets)	volatile

Table 12 - Object structure of Heat/Cool meter (history values)

Property Array index	Property							
	Storage Number (>0) DPT_Value_1_Ucount	**HistoryDate** DPT_DateTime	**HistoryEnergyConsumption** DPT_MeteringValue	**HistoryEnergyConsumption_T1** DPT_MeteringValue	**HistoryVolumeMaxFlow** DPT_MeteringValue	**HistoryVolumeMinFlow** DPT_MeteringValue	**HistoryMaxPower** DPT_MeteringValue	**HistoryMinPower** DPT_MeteringValue
1	1 (fixed) (billing period)	31.12.2003	100 kWh	void	void	void	void	void
2	3 (monthly value)	30.06.2004	160 kWh	void	16 x 0,1 m^3/h	void	350 W	void
3	3 (monthly value)	31.07.2004	170 kWh	void	17 x 0,1 m^3/h	void	180 W	void
4	3 (monthly value)	31.08.2004	180 kWh	void	18 x 0,1 m^3/h	void	200 W	void
…	…	…	…	…	…	…	…	…
n[4]	void	void	void	void	void	void	void	void

1 The RX-Sequence counter and RX-Reception time shall be not transmitted by the heat meter but shall be generated by receiver itself. If the Meter Data Collector receives and stores a telegram of a meter with a registered ID it shall save the reception time and increase the RX-Sequence counter.
It is recommended for a client before reading the contents of this Interface Object to read RX-Sequence counter firstly. After the data transfer the client should read the RX-Sequence counter again. If the sequence counter has changed, it may be that data set is not consistent anymore. In that rare case the client should to request all data again.

2 The five parts of the addresses have to be saved in non-volatile memory (e.g. flash). All other values may be saved in volatile (e.g. RAM) or non-volatile memory. After power failure, the metering Data Collector shall be able to receive data again from the assigned meters and refuse not assigned meters to refill all lost values after next transmission.

3 Not all Datapoints are converted to KNX. The Datapoint “raw data of telegram” allows an M-Bus Master to translate all information of a Meter. Raw data of telegram shall be a copy of the M-Bus telegram starting from and including the CI field until the end of the M-Bus telegram except the CRC. The radio specific CRC should not be saved in the Raw data of the M-Bus telegram. If the remaining telegram is longer than available memory then the end of the “raw data of telegram” should be cut off. The minimum memory space for “Raw data of telegram” should be 127 octets or more.

4 The History array shall have a minimum length of 8 history entries.

Memory calculation

Calculation of additionally needed memory to store Meter in a Metering Data Collector

	length in octets	no of datapoints (current values)	no of datapoints (for 8 history values)	memory space (octets)
8 digits BCD (in non volatile Memory)	4	2	0	8
Octet (in non volatile Memory)	1	4	0	4
Octet (in volatile Memory)	1	3	8	11
DPT_DateTime	8	5	8	104
DPT_LongDeltaTimeSec	4	3	0	12
DPT_MeteringValue	6	6	48	324
String of octets (min.. 127 octets)	128	1	0	128
Non-volatile memory space				**12**
Volatile memory space				**579**

A Metering Data Collector that supports 16 Meters needs a memory space of 9 264 octets RAM and 192 octets flash to store all data.

10 RF Metering Retransmitter

10.1 Introduction

If the RF communication between a sending metering device and the receiving central unit is blocked due to attenuation of the RF signal, one or more RF retransmitters can be inserted in between these devices. These retransmitters shall receive all frames originating from a sender and resend them.

In order to avoid an avalanche of frames sent by various retransmitters, which would block the communication channel, the following mechanism shall help avoiding multiple resending of a single frame by a retransmitter.

- Opposite to the standard KNX RF protocol the RF metering protocol does not foresee a hop count, repeated flag or other mechanisms in the RF frame to support easy detection of repeated frames and other criteria to suppress endless re-repetition by retransmitters. Therefore other mechanisms (history list and filtering) are introduced.
- Up to 3 retransmitters in sequence are possible.
  - each retransmitter resends a frame only once
  - it is possible that a retransmitter resends frame that has been repeated by another retransmitter
- **History list**

  Detection of repeated frames and suppression of re-repetitions shall be handled by the retrans-mitter itself. This shall be done using a temporary history list (message cache) in the retransmitter.

- **Filtering**

  The history list is necessary to avoid endless repetitions within one metering system but because of its limited buffer size it is not sufficient to avoid never ending loops between multiple independent metering systems. Therefore teach-in of metering devices to the corresponding retransmitter and filtering according to the 8 octet M-Bus address information is mandatory.

EXAMPLE Never ending message loop without filtering

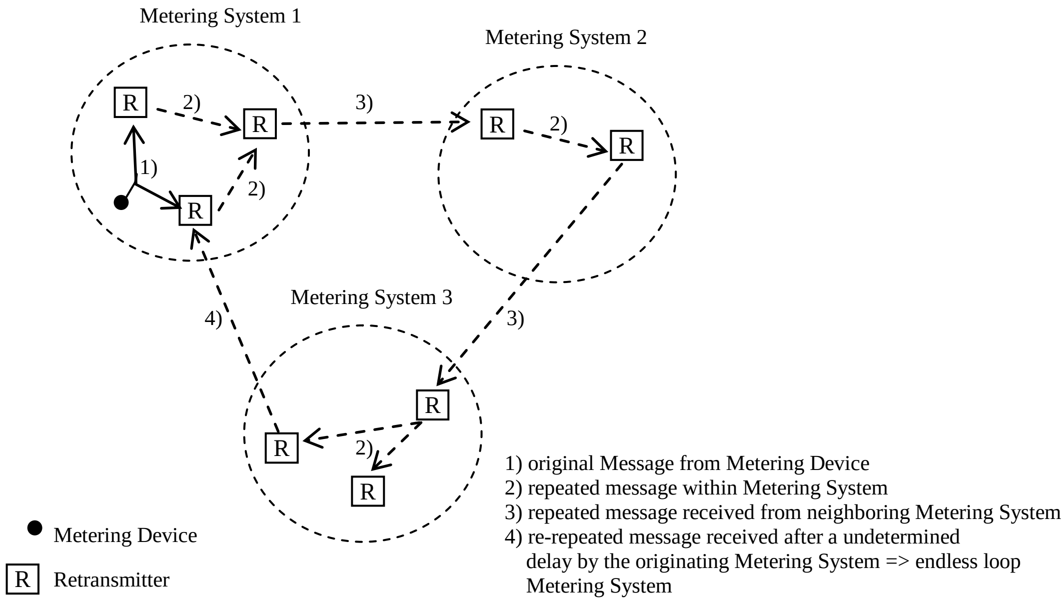


Figure 6 – Message loop across neighbouring systems

10.2 History List

The Data Link Layer of every retransmitter shall have a history list that shall store information about the previously received and retransmitted frames.

The history list shall contain an unambiguous identifier for each received and retransmitted message.

EXAMPLE 1

Store the address information (manufacturer and serial number: 8 octet) of the sender and the CRC of the last RF block (2 octets). This requires storing 10 octets per telegram.

EXAMPLE 2

Save the array index of the metering filter table together with the CRC of the last RF block.

The history list shall be organized as a ring buffer (the oldest entry is overwritten by a new entry if the buffer size is exceeded). It shall have a minimum length of 8 entries.

There shall be a self-clearing mechanism. This means that all entries in the list shall be deleted after a minimum of time-out of 3 seconds during which no valid telegram is received (within 3 seconds all repetitions by up to 3 retransmitters in the same system are normally terminated).

Calculation example for the history buffer size:

- size of the history list: ≥8 entries
  (i.e. ≅ 1 s RF metering peak traffic at 30 % channel capacity, worst case).
- 10 octets per entry

⇒ total size >80 octets

If a retransmitter receives a frame, its Data Link Layer shall check if the received frame is contained in the history list (e.g. address information+CRC in this combination). If this is the case, this frame shall be discarded, otherwise the processing of retransmission shall continue.

10.3 Retransmission mechanism

A retransmitter shall sense whether the medium is free before it transmits. The interframe time shall be the time interval during which a bidirectional device shall wait for the medium to be free (regardless of whether it is addressed by the previous frame or not). If no preamble is detected during this interframe time the device may start sending.

For retransmission of RF metering frames the interframe time in the retransmitter shall be the same as for standard KNX RF frames (this is: fixed delay 5 ms+ random delay 0 ms to 10 ms).

The retransmitter shall be able to buffer at least 3 received RF metering frames in case of RF metering peak traffic. This requires about 300 octets of RAM for the receive buffer.

NOTE M-Bus RF metering allows for the use of both a long and a short preamble as specified in [02]. Messages with long preamble are generally retransmitted with short preamble.

10.4 Filtering

A constellation with multiple retransmitters in nearby Metering Systems – see Figure 6 – may result in long distance retransmission loops, because

- there is no hop count in the RF frame, and
- the size of the history list in the retransmitter is limited and may not be sufficient in case of long distance retransmission loops.

To avoid such loops, Filtering is mandatory in the retransmitter.

Filtering is also useful to reduce the duty cycle of the retransmitter. Duty cycle limitations according to [05] ERC REC. 70-03 shall be considered also for retransmitters.

10.5 Metering Filter Table Property in the Device Object

10.5.1 Specification

The Metering Filter Table shall be an array property of the Device Object.

Table 13 - Metering Filter Table property in the Device Object

Property Name	**PID**	**PDT/DPT**	**M/O**	**Read / Write**	**Description**
Metering Filter Table	84 = PID_METERING_FILTER_TABLE	PDT_GENERIC_08[n] DPT_MBus_Address[n] n≥16	M	R/W	Table containing the address information of associated devices

NOTE DPT_MBus_Address (DPT_ID = 230.1000) is specified in Chapter 3/7/2 “Datapoint Types”.

The property Metering Filter Table shall contain the 8 octet M-Bus address information (2 octet manufactured identification and 6 octet address information) of the associated metering devices. This property shall thus have the following structure:

Manufacturer identification	Identification number	Version	Device type
2 octets	4 octets	1 octet	1 octet

The identification number can be a hard address or a soft address, according to the most significant bit of the manufacturer identification, as specified in 3.1.4.

The array shall contain at least 16 elements.

The filter table can be generated in two ways.

1. It shall be possible to download the Metering Filter Table (n x 8 octets) by Management Client.
   This Management Client may be a service tool.
2. The Filter Table may additionally be generated locally by the Retransmitter itself.
   In this case each metering device shall be linked to the Retransmitter using teach in mechanism via the “push-button procedure”. The Retransmitter shall store the 8 octet address information of the RF metering device.

It shall be possible for a Management Client, like ETS®, to read out, set and overwrite the Metering Filter Table.

The entries of the Metering Filter Table shall contain either the M-Bus address information of the linked M-Bus devices or void table elements as specified below.

- For each additional partner device, the Metering Filter Table shall be extended at the array element with index “last element + 1” with that device’s corresponding 8 octet address information. The table elements need not to be sorted.
- The maximum size of the Metering Filter Table shall be fixed and is product specific. The number of devices that can be associated is therefore limited.
- Ex-factory, the Metering Filter Table shall be empty and void table elements shall contain the address information 00000000000000h.
- There may be “gaps” in the Metering Filter Table with void table elements.
- Read and Write access to the table shall be mandatory (e.g. by ETS)
- Individual table elements can be written. There is no table load state machine.

EXAMPLE

Array Index	Value
1	1st M-Bus address (8 octets)
2	2nd M Bus address (8 octets)
3	0000000000000000h (void)
4	3rd M Bus address (8 octets)
…	…
N	…

Figure 7 – Example of the Metering Filter Table

Special considerations for the Management Client (tool, property client …)

- The available size of the table can be checked via standard property mechanisms (A_PropertyDescription_Read-service).
- Individual elements of the Metering Filter Table can be written by the client. The client shall ensure the integrity of the Metering Filter Table.

Special considerations for the teach in procedure

1. Handling of a full Metering Filter Table

   In case the size of the Metering Filter Table is insufficient the handling can be manufacturer specific; it is recommended to generate an error indication and not to overwrite existing table elements.

2. Deletion of individual table elements

   The deletion of individual links is not foreseen in this standard but it shall be possible to reset the whole table by manufacturer specific means.

Annex

Annex A - Support of Mode T

Normative reference: EN 13757-4:2011

A.1 Physical Layer

Table 14 – Physical Layer of Mode T

Characteristic	**Value or applicable standard**	**Notes**
TX centre frequency	868,95 MHz	
Bandwidth	500 kHz	
Max. Tx frequency tolerance	± 50 kHz	This frequency tolerance includes tolerances due to temperature variations within the operating temperature range and tolerances due to crystal aging.
Tx duty cycle max	0,1%	
Tx modulation type	FSK	
FSK deviation	nom. ± 50 kHz min. ± 40 kHz max. ± 80 kHz,	
Tx chip rate	100 kcps	
Maximum Tx chip rate tolerance	±10 kcps	within header + frame
Maximum Tx jitter per transition	± 3 µs	The bit jitter shall be measured at the output of the microprocessor or encoder circuit.
Tx ERP	Typical : 0 dBm Min : -3 dBm Max: +14 dBm	
Minimal operating temperature range	0°C to 45°C	KNX Physical Layer parameters shall be met on the entire product temperature range declared by the manufacturer. (e.g. : -10°C to +70°C for outdoor usage)
Postamble (trailer) length	2 to 8 chips	The postamble (trailer) shall consists of at least of at least two alternating chips. If the last chip of the CRC was a zero, then the minimum postamble shall be "10", otherwise it’s shall be "01".

A.2 Data encoding

A.2.1 General

"3 out of 6" encoding shall be used for the T1 and T2 mode to achieve an improved efficiency compared to Manchester encoding. Unique codes shall be used for specific control functions such as preamble, message start, etc. The encoding shall be performed as specified in Table 11.
Each 4-bit nibble of data shall be encoded as a 6-bit word. Only those words, out of the 64 combinations, with an equal number of zero's and one's and with a minimum of 2 transitions, have been selected.
The lower frequency shall correspond to a chip value of "0".

Table 15 – Data encoding of Mode T

NRZ-Code (binary)	Decimal	6 chip code (binary]	Decimal	N° of transitions
0000	0	010110	22	4
0001	1	001101	13	3
0010	2	001110	14	2
0011	3	001011	11	3
0100	4	011100	28	2
0101	5	011001	25	3
0110	6	011010	26	4
0111	7	010011	19	3
1000	8	101100	44	3
1001	9	100101	37	4
1010	10	100110	38	3
1011	11	100011	35	2
1100	12	110100	52	3
1101	13	110001	49	2
1110	14	110010	50	3
1111	15	101001	41	4

A.2.2 Order of transmission of the encoded data

The data coded as "3 out of 6" shall be transmitted with most significant bit (MSb = Left bit of the 6-bit code) first and with the most significant nibble (MSN) first.
Each data byte shall be transmitted with the most significant bit first.

A.2.3 Preamble chip sequences

The total preamble (header + synchronisation) chips sequence for this mode shall be "n×(01) 0000111101" with n ≥ 19. After this preamble a frame of the format A shall follow.
The chip sequence "0101010101" has been reserved for the transmission preamble so that a receiver can start sampling at the maximum chip rate and then determine the actual chip rate from these patterns. Also, the high number of transitions ensures the best detection of the actual chip rate. Within the frame, the maximum number of contiguous zeroes or ones is four, but neither the pattern "00001111" nor the pattern "11110000" will ever occur inside a "3 out of 6" encoded chip sequence. The pattern can therefore be used for synchronisation.
The chip sequence 0101010101 will never occur during a normal chip sequence. The decoder may use this to detect that the receiver has captured another transmission. In that case, the receiver shall stop the analysis of the current frame and start detecting a new frame. This "capture detect" feature increases the communication capacity of the system in presence of many users.

Annex B - The M-Bus compact profile

B.1 General

The M-Bus compact profiles are used to transport a series of values with a fix space between each value. In addition to the compact profile a base value and a base time is required to declare a start time and the value of the profile. Additional base parameters like the OBIS-declaration may be added as well. The base time is chained with the compact profile by using the same Storage number in the DIF/DIFE. The base value and the base parameters are chained with the compact profile by using the same Storage-, Tariff- and Subunit numbers in the DIF/DIFE of the data record. If one of this numbers differs from the compact profile, it has to be assumed that the base value or base parameters are missed.

B.2 The base value and base parameter

The data point base value is the eldest value of the data series. It shall always exist unless the increment mode “Absolute value” (00b) is used. In the absence of the base value, the first entry in the profile is used as the first value of the data series instead. The base value and the base parameters may be used with any DIF/DIFE and VIF/VIFE.

Table I.3 — Base value record (connected via Storage-, Tariff-, Subunit number and VIF/ VIFEx)

DIF/DIFE	VIF/VIFEx	Base value

B.3 The base time

The base time shall be encoded with one of the Types F to J (refer to Annex A in [08]). It corresponds to the base value, even if it does not exist. Therefore the first entry in the compact profile is always related to the base time added by one space interval.

Table I.4 — Base time record (connected via the storage number)

DIF/DIFE	VIF (time/date Type F to J)	Time/date value

B.4 Structure of the compact profile

The compact profile record itself starts (like each M-bus data point) with a DIF (DIFE) and a VIF (VIFE) but with an additional (new) orthogonal VIFE signalling a “compact profile”.

The profile record uses a data structure with variable length (DIF= xDh) followed by a length byte with values between 3 and 191 (0BFh). The whole length is accumulated by two control bytes plus N*(element length), where N is the number of elements of the profile. In consequence the length of “2” signals an empty profile.

Table I.5 — Profile record (connected via Storage-, Tariff-, Subunit number and VIF/VIFEx)

DIF/DIFE with variable length DIF=xDh	VIF/VIFEx VIFE = 1Eh/1Fh	LVAR # bytes (03h to BFh)	Spacing control byte	Spacing value byte	Oldest Profile Value	…

NOTE: For the binary integers (low nibble of the DIF=1 to 4, 6 or 7) the incremental modes 01b and 10b use unsigned integers (data type C), whereas the increment modes 00b and 11b use signed integers (data type B). Refer to Annex A in [08].

The first byte (Spacing control byte) of this variable length record structure contains the data size of each individual element in the lower four bits (as in the lower nibble of the DIF definitions, but excluding variable length elements). The next higher two bits signal the time spacing units (00b = sec, 01b = min, 10b = hours and 11b = days). The highest two bits signal the increment mode of the profile (00b = absolute value (signed), 01b = positive (unsigned) increments, 10b = negative (unsigned) increments, 11b = signed difference (deviation of last value – next value)). All values of the profile are initially preset with the coding for “illegal”, e.g. -128 for signed byte, 255 for unsigned byte, -32768 for signed word etc (refer to Annex A in [08], type B and C). Invalid values shall also be used in case of an overflow of an incremental value.

Table I.6 — Spacing control byte

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Table I.7 — Structure of Spacing control byte

bit 6..7: Increment mode	bit 4..5: Spacing unit	bit 0..3: Element size
00b= Absolute value	00b= seconds	Profile DIF, low nibble only, but except 0Dh and except 0Fh
01b= Increments	01b= minutes	
10b= Decrements	10b= hours	
11b= Signed difference	11b= days/month	

After the Space control byte follows the Space value byte (single byte) giving the number of the time spacing units between the profile values. It allows between 1 and 250 time units (s,m,h,d) as time spacing. The values 251, 252 and 255 are reserved. To be able to additionally code monthly and half-monthly profile spacing, the value 253 is used for half-monthly spacing and the value 254 is used for monthly spacing. Both are used together with the spacing unit “days/month”. Spacing unit 0 is used to code a list of values which are not spaced in time. This could be any type of table with up to 4 columns.

Table I.8 — Spacing value byte

Spacing value	**Spacing unit**	**Meaning**
0	00b-11b [a]	Elements of an array, not spacing in time.
1-250	all	Number of days, hours, minutes or seconds between values
251	all	Reserved
252	all	Reserved
253	00b-10b 11b	Reserved; a half month between values
254	00b 01b 10b 11b	Reserved Six full months between values Three full months between values a full month between values
255	all	Reserved

a The spacing unit is used to address up to 4 columns. If one column needed only the spacing unit 00b shall be used. When several columns are needed the spacing unit describes the concerned column number by formular spacing unit +1 (e.g. spacing unit 01b indicates colomn 2).

These first two fixed bytes are followed by the oldest value of the profile, the next oldest value etc. until the end of the variable length structure is reached. Note that if each profile value uses a DIF- data format with a length of more than one byte, each individual profile value is in the “least significant byte first” order.

B.5 Types of Compact profile

The M-Bus supports two types of compact profiles

- “Compact profile with registers” for the transport of a limited number of values with an assigned register number (e.g. recent value)
- “Compact profile without registers” for the transport of an unlimited number of values as a series with no assignment to a register (e.g. load profile)

The definition of both compact profile types is identical with an exception in the use of the Storage number. The transmission of several profiles (e.g. for two tariffs) in parallel is possible, but it requires a different coding in the DIF/DIFE or the VIF/VIFE e.g. by the use of different Tariff numbers. As long as the Storage numbers are identical, all compact profiles are related to the same base time.

B.5.1 Compact profile with registers (orthogonal VIFE=1Eh)

This compact profile has to be selected if the assignment of a historical value to a cumulation register is required.

The first requested register number is coded by the storage number which is used for the base time, the base value and the compact profile. The first value inside the compact profile is related to the second requested register number, the second value to the third register and so on. To support up to 125 registers, a fix coding with a DIF and two DIFE’s shall always be used.

A data series may also contain non periodic entries e.g. in the case of a changed device status. Such a case can be transmitted by chaining several profiles (see in example).

Example: absolute profile of monthly consumption values (Tariff 1) of an electricity meter

Table I.9 — Example of compact profile with registers: Plain data

Event	OBIS-Code	Date/Time	Value
periodic value	1.8.1*32	01.01.2010 00:00	150 kWh
periodic value	1.8.1*33	01.02.2010 00:00	100 kWh
periodic value	1.8.1*34	01.03.2010 00:00	130 kWh
non periodic value	1.8.1*35	25.03.2010 13:12	90 kWh
periodic value	1.8.1*36	01.04.2010 00:00	50 kWh
periodic value	1.8.1*37	01.05.2010 00:00	160 kWh

Table I.10 — Example of compact profile with registers: M-Bus data records

Data point type	Stor.	Tariff	M-Bus data record
Base Time	#32	T0	86h 80h 01h 6Dh 00h 00h A0h 41h 11h 35h
Base value	#32	T1	84h 90h 01h 03h F0h 49h 02h 00h
Profile 1 (2 values: #33;#34)	#32	T1	8Dh 90h 01h 83h 1Eh 0Ah 04h FEh A0h 86h 01h 00h D0h FBh 01h 00h
Base Time	#35	T0	C6h 81h 01h 6Dh 0Bh 0Ch 8Dh 59h 13h 0Ch
Base value	#35	T1	C4h 91h 01h 03h 90h 5Fh 01h 00h
Base Time	#36	T0	86h 82h 01h 6Dh 00h 00h 80h 41h 14h 0Dh
Base value	#36	T1	84h 92h 01h 03h 50h C3h 00h 00h
Profile 2 (1 value: #37)	#36	T1	8Dh 92h 00h 83h 1Eh 06h 04h FEh 00h 71h 02h 00h

B.5.2 Compact profile without registers (orthogonal VIFE=1Fh)

The compact profiles without registers shall start with the Storage number #8. They may use a flexible number of DIF's and DIFE's. Chained compact profiles without registers use (unlike the compact profiles with registers) the next higher Storage number. The use of the Storage number #0 is not permitted for compact profiles without registers.

Example: incremental load profile; 3 hourly volume values after midnight coded with BCD.

Table I.11 — Example of compact profile without registers: Plain data

Base value	01.01.2010 00:00	12300,0 m^3
Oldest profile value	01.01.2010 01:00	12300,3 m^3
Second oldest value	01.01.2010 02:00	12300,5 m^3
Third oldest value	01.01.2010 03:00	12301,6 m^3

Table I.12 — Example of compact profile without registers: M-Bus data records

Data point type	Stor.	Tariff	M-Bus data record
Base Time	#8	T0	84h 04h 6Dh 00h 20h 41h 11h
Base value	#8	T0	8Bh 04h 15h 00h 30h 12h
Profile	#8	T0	8Dh 04h 95h 1Fh 05h 69h 01h 03h 02h 11h

Annex C - Example of a partial encrypted telegram

Example for heat cost allocator with RF-Adapter

Device type	Heat cost allocation
Manufacturer	QDS (4493h)
Serial number of Radio unit (BCD)	11223344
Serial number of Meter (BCD)	55667788
Version	85
Status (Low Power/Battery low)	4
current consumption value	1234 HCA units
set date	30.04.2007
consumption at set date	23456 HCA units
current temperature at sensor	25 °C

AES key according to FIPS 197 (LSB first):
= manu. spec. at least 8 bytes unique for each meter
= 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

AES CBC initial vector according to FIPS 197 (LSB first):
= M Field + A Field + 8 bytes Acces No
= 93 44 88 77 66 55 55 08 00 00 00 00 00 00 00 00

Table 16 – Telegram of a Heat cost allocator (wireless M-Bus)

SND_NR (wM-Bus)					
		wM-Bus frame	**Heat cost allocator example**		
Byte No	**Field name**	**Content**	**Bytes [hex] plain**	**Bytes [hex] AES coded**	
1	L Field	Length of data (46 bytes)	29h	29h	Linklayer (DLL)
2	C Field	44h (means Send - No Reply)	44h	44h	
3	M Field	Manufacturer code	93h	93h	
4	M Field	Manufacturer code	44h	44h	
5	A Field	Serial No LSB (BCD)	44h	44h	
6	A Field	Serial No (BCD)	33h	33h	
7	A Field	Serial No (BCD) (= 11223344)	22h	22h	
8	A Field	Serial No MSB (BCD)	11h	11h	
9	A Field	Version (or Generation number)	55h	55h	
10	A Field	Device type (Medium=HCA)	08h	08h	
11	CRC 1		6Ch	6Ch	
12	CRC 1		B1h	B1h	

Table 16 *(continued)*

SND_NR (wM-Bus)					
		wM-Bus frame	**Heat cost allocator example**		
Byte No	**Field name**	**Content**	**Bytes [hex] plain**	**Bytes [hex] AES coded**	
13	CI Field	72h means 12 bytes header	72h	72h	Application layer (APL)
14	Meter-ID	Serial No LSB (BCD)	88h	88h	
15	Meter-ID	Serial No (BCD)	77h	77h	
16	Meter-ID	Serial No (BCD) (= 55667788)	66h	66h	
17	Meter-ID	Serial No MSB (BCD)	55h	55h	
18	Meter-Man.	Meter Manufacturer code	93h	93h	
19	Meter-Man.	Meter Manufacturer code	44h	44h	
20	Meter-Vers.	Version (or Generation number)	55h	55h	
21	Meter-Dev.	Device type (Medium=HCA)	08h	08h	
22	Access No.	Transmission counter	00h	00h	
23	Status	M-Bus state contents errors and alerts	04h	04h	
24	Conf.word	NNNNCCHHb (1 encr. block)	00h	10h	
25	Conf.word	BAS0MMMMb (unidir., AES)	00h	05h	
26	AES-Verify	Encryption verification	2Fh	00h	
27	AES-Verify	Encryption verification	2Fh	DFh	
28	DR1	DIF (6 digit BCD)	0Bh	E2h	
29	CRC 2		25h	27h	DLL
30	CRC 2		CCh	F9h	
31	DR1	VIF (HCA-units)	6Eh	A7h	AES-Encrypted Block 1 / Application layer (APL)
32	DR1	Value LSB	34h	82h	
33	DR1	Value (= 001234 HCA-Units)	12h	14h	
34	DR1	Value MSB	00h	6Dh	
35	DR2	DIF (Data type G, StorageNo 1)	42h	15h	
36	DR2	VIF (Date)	6Ch	13h	
37	DR2	Value LSB	FEh	58h	
38	DR2	Value MSB (= 30.04.2007)	04h	1Ch	
39	DR3	DIF (6 digit BCD, StorageNo 1)	4Bh	D2h	
40	DR3	VIF (HCA-units)	6Eh	F8h	
41	DR3	Value LSB	56h	3Fh	
42	DR3	Value (= 023456 HCA-Units)	34h	39h	
43	DR3	Value MSB	02h	04h	
44	DR4	DIF (1 Byte integer)	01h	01h	Plain
45	DR4	VIF (Temperature at Heating)	5Bh	5Bh	
46	DR4	Value (= 25 Grad Celsius)	19h	19h	

Table 16 *(continued)*

SND_NR (wM-Bus)					
		wM-Bus frame	**Heat cost allocator example**		
Byte No	**Field name**	**Content**	**Bytes [hex] plain**	**Bytes [hex] AES coded**	
47	CRC 3		11h	61h	DLL
48	CRC 3		9Ah	09h	