



BSI Standards Publication

Communication systems for and remote reading of meters

Part 3: Dedicated application layer

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/894, Remote Meter Reading.

A list of organizations represented on this committee can be obtained on request to its secretary.

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**Communication systems for and remote reading of meters - Part
3: Dedicated application layer**

Systèmes de communication et de télérelevé de compteurs
- Partie 3: Couche d'application spéciale

Kommunikationssysteme für Zähler und deren
Fernablesung - Teil 3: Spezielle Anwendungsschicht

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Contents

Page

Foreword	8
Introduction.....	9
1 Scope.....	10
2 Normative references.....	10
3 Terms and definitions, abbreviated terms and numbers	10
4 General principles: CI-field.....	12
5 Variable Data Send and Variable Data Respond	17
6 Variable data blocks (records)	29
7 Value Information Block (VIB).....	33
8 Application layer status and error reporting	42
9 Generalised object layer	45
10 Manufacturer specific unstructured data block	45
11 Management of lower layers	46
Annex A (normative) Coding of data records	50
Annex B (normative) Interpretation of hex-codes Ah – Fh in BCD-data fields.....	57
Annex C (normative) VIF coding for special units	58
Annex D (informative) Alarm protocol	60
Annex E (informative) Examples	61
Annex F (informative) Secondary search	69
Annex G (informative) International reference works	72
Annex H (informative) Special sequences for wireless M-Bus devices	73
Annex I (normative) Transmission of profiles	77
Annex J (informative) The structure of higher protocol layers	82
Annex K (normative) Compact M-Bus frame	84
Annex L (informative) Use of standards for smart metering applications.....	89
Annex M (informative) Installation and registration	94
Annex N (informative) M-Bus data container	97
Annex O (normative) Translating M-Bus type record descriptors to OBIS-type record descriptors	99
Annex P (informative) Datagram examples for the M-Bus and the wM-Bus.....	116
Bibliography.....	151

Figures

Figure A.1 — Change of time by daylight savings	54
Figure F.1 — Number of selections with wildcard searching procedure	69
Figure F.2 — Flow diagram for slave search with wildcards	70

Tables

Table 1 — CI-field codes used by the master or the slave	12
Table 2 — Coding of the upper 4 bits of the first parameter after CI = 50h or 53h	15
Table 3 — Variable data structure in answer send and respond direction	17
Table 4 — Short data header	18
Table 5 — Long data header	18
Table 6 — Device type identification	19
Table 7 — Coding of the status field	22
Table 8 — Application errors coded with the status-field	22
Table 9 — Meaning of status byte for partner messages	23
Table 10 — General definition of the configuration field	23
Table 11 — Definition of the mode bits (encryption method)	24
Table 12 — Definition of the configuration field for encryption modes 2 and 3	25
Table 13 — Definition of the configuration field for encryption mode 5	26
Table 14 — Initialisation vector mode 5 for the CBC-AES-128	26
Table 15 — Contents of meter message	27
Table 16 — Contents of partner message	28
Table 17 — Accessibility of a meter	28
Table 18 — Address structure of the wireless link layer	29
Table 19 — Structure of a data record (transmitted from left to right)	29
Table 20 — Coding of the Data Information Field (DIF)	30
Table 21 — Coding of the data field	30
Table 22 — DIF-coding for special functions	31
Table 23 — Function field	31
Table 24 — Coding of the Data Information Field Extension (DIFE)	32
Table 25 — Coding of the Value Information Field (VIF)	33

Table 26 — Primary VIF-codes	34
Table 27 — Special VIF-codes.....	35
Table 28 — Main VIFE-code extension table.....	35
Table 29 — Alternate extended VIF-code table	38
Table 30 — Combinable (orthogonal) VIFE-table	39
Table 31 — Extension of combinable VIFE-table (following VIFE = FCh of combinable (orthogonal) VIFE-table)	41
Table 32 — Application error (no header).....	42
Table 33 — Application error (short data header)	42
Table 34 — Application error (long data header)	42
Table 35 — First error code byte for general application errors.....	43
Table 36 — Codes for record errors (E = Extension bit)	44
Table 37 — Action codes for the generalised object layer (master to slave)	45
Table 38 — Management layer of the M-Bus link layer according EN 13757-2	46
Table 39 — CI-field codes for baud rate switching	46
Table 40 — Structure of a datagram for selecting a slave	47
Table 41 — Application layer structure of a datagram for enhanced selection (mode 1)	48
Table A.1 — Type A: Unsigned BCD	50
Table A.2 — Type B: Signed integer	50
Table A.3 — Type C: Unsigned integer.....	50
Table A.4 — Type D: Boolean.....	51
Table A.5 — Type F: Date and time (CP32)	51
Table A.6 — Type G: Date (CP16).....	51
Table A.7 — Type H: Floating point	52
Table A.8 — Type I: Date and time (CP48).....	53
Table A.9 — Type J = Time (CP24)	54
Table A.10 — Type K: Daylight savings.....	55
Table A.11 — Type L: Listening window management.....	56
Table B.1 — Decoding table.....	57
Table C.1 — Metric/non-metric units	58
Table C.2 — Data record structure for plain text VIF usage	58

Table C.3 — Values for the remote control of the valve	59
Table E.1 — Data structure for writing data	62
Table E.2 — Coding of primary address	62
Table E.3 — Coding of single identification number	62
Table E.4 — Coding of complete secondary address	63
Table E.5 — Structure of secondary address	63
Table F.1 — Secondary addresses found with a wildcard search of four slaves.....	71
Table H.1 — Least significant error byte (EF1)	73
Table H.2 — Meaning of error bits in the least significant error byte (EF1)	73
Table H.3 — Second least significant error byte (EF2)	73
Table H.4 — Least significant byte of the remote control (RC1)	74
Table H.5 — Remote control (RC1): adjust power	74
Table H.6 — Remote control (RC1): enable test mode	74
Table H.7 — Remote control (RC1): power save mode.....	74
Table H.8 — Remote control (RC1): reserved	74
Table H.9 — Structure of TC-field	75
Table H.10 — Application frame “time setting” with CI=6Ch (Set date and time)	75
Table H.11 — Application frame “time adjustment” with CI=6Dh (Add/Subtract Time Offset).....	75
Table I.1 — Example for load profile: plain data	77
Table I.2 — Example for load profile: M-Bus-sequence.....	77
Table I.3 — Base value record (connected via storage-, tariff-, subunit number and VIF/ VIFEx)	78
Table I.4 — Base time record (connected via the storage number)	78
Table I.5 — Profile record (connected via storage-, tariff-, subunit number and VIF/VIFEx).....	78
Table I.6 — Spacing control byte	79
Table I.7 — Structure of spacing control byte	79
Table I.8 — Spacing value byte	79
Table I.9 — Example of compact profile with registers: Plain data	80
Table I.10 — Example of compact profile with registers: M-Bus data records	81
Table I.11 — Example of compact profile without registers: Plain data	81
Table I.12 — Example of compact profile without registers: M-Bus data records	81

Table J.1 — Application layer without a fixed header (none)	82
Table J.2 — Application layer with a short header	82
Table J.3 — Application layer with a long header	82
Table J.4 — Transport layer with a short header	83
Table J.5 — Transport layer with a long header	83
Table K.1 — CI-fields for the Request of Full and Compact and Format M-Bus frame format.....	85
Table K.2 — CI-fields for the Full and Compact and Format M-Bus frame format	85
Table K.3 — Structure of Full M-Bus frame	85
Table K.4 — Structure of M-Bus-Compact frame	85
Table K.5 — Structure of M-Bus-Format frame.....	86
Table L.1 — Required value resolution for meter with power/flow data.....	91
Table L.2 — Required value resolution without power/flow data	92
Table N.1 — Structure of data record	97
Table O.1 — M-Bus-OBIS-Translation: legend	100
Table O.2 — M-Bus-OBIS-Translation: general (for all devices)	101
Table O.3 — M-Bus-OBIS-Translation: electricity meter	102
Table O.4 — M-Bus-OBIS-Translation: heat cost allocator	104
Table O.5 — M-Bus-OBIS-Translation: cooling meter	105
Table O.6 — M-Bus-OBIS-Translation: combined heat and cooling meter	107
Table O.7 — M-Bus-OBIS-Translation: heat meter	109
Table O.8 — M-Bus-OBIS-Translation: gas meter.....	111
Table O.9 — M-Bus-OBIS-Translation: water meter (cold).....	113
Table O.10 — M-Bus-OBIS-Translation: water meter (hot, warm)	114
Table P.1 — SND-NR - Gas meter (wM-Bus)	116
Table P.2 — RSP-UD - Gas meter (M-Bus).....	119
Table P.3 — SND-NR - Water meter (wM-Bus)	121
Table P.4 — RSP-UD - Water meter (M-Bus).....	124
Table P.5 — SND-NR - Heat meter (wM-Bus)	126
Table P.6 — RSP-UD - Heat meter (M-Bus).....	129
Table P.7 — SND-NR - H.C.A. (wM-Bus)	131

Table P.8 — RSP-UD - H.C.A. (M-Bus)	134
Table P.9 — SND-IR (wM-Bus)	136
Table P.10 — CNF-IR (wM-Bus)	140
Table P.11 — SND-UD (wM-Bus)	141
Table P.12 — ACK long (wM-Bus)	143
Table P.13 — REQ-UD2 (wM-Bus)	145
Table P.14 — RSP-UD (wM-Bus data)	146
Table P.15 — RSP-UD (wM-Bus Appl.error)	147
Table P.16 — SND-NKE (wM-Bus)	149

Foreword

This document (EN 13757-3:2013) has been prepared by Technical Committee CEN/TC 294 "Communication systems for meters and remote reading of meters", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2013, and conflicting national standards shall be withdrawn at the latest by November 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13757-3:2004.

It shall be noted that the following significant technical changes compared to the previous edition have been incorporated in this European Standard:

- Extension of existing frames formats for different data protocols to support various wireless transmission schemes (harmonisation with EN13757-4).
- Adding an annex with a Smart Metering profile based on the requirements of the "Smart Meter Coordination Group" of the ESO's.
- Adding an annex to have a unique translation of M-Bus-data points to OBIS-Codes.
- Update of the encryption methods to the state of the art.
- Enhancement of data points for electricity meter.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

EN 13757, *Communication systems for meters and remote reading of meters* consists of the following parts:

- *Part 1: Data exchange*
- *Part 2: Physical and link layer*
- *Part 3: Dedicated application layer*
- *Part 4: Wireless meter readout*
- *Part 5: Wireless relaying*
- *Part 6: Local bus*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This document belongs to a series of parts of EN 13757, which covers communication systems for meters and remote reading of meters. EN 13757-1 contains generic descriptions and a communication protocol. EN 13757-2 contains a physical and a link layer for twisted pair based Meter-Bus (M-Bus). EN 13757-4 describes wireless communication (often called wireless M-Bus or wM-Bus). EN 13757-5 describes the wireless network used for repeating, relaying and routing for the different modes of EN 13757-4. EN 13757-6 describes a twisted pair local bus for short distance (Lo-Bus).

This dedicated application layer (M-Bus-Protocol) can be used with various physical layers and with link layers and network layers, which support the transmission of variable length binary transparent messages. Frequently, the physical and link layers of EN 13757-2 (twisted pair) and EN 13757-4 (wireless) as well as EN 13757-5 (wireless with routing function) or the alternatives described in EN 13757-1 are used. This dedicated application layer has been optimised for minimum battery consumption of meters, especially for the case of wireless communication to ensure long battery lifetimes of the meters. Secondly, it is optimised for minimum message length to minimise the wireless channel occupancy and hence the collision rate. Thirdly, it is optimised for minimum requirements towards the meter processor regarding requirements of RAM size, code length and computational power.

An overview of communication systems for meters is given in EN 13757-1, which also contains further definitions.

This standard concentrates on the meter communication. The meter communicates with one (or occasionally several) fixed or mobile communication partners which again might be part of a private or public network. These further communication systems might use the same or other application layer protocols, security, privacy, authentication, and management methods.

To facilitate common communication systems for CEN-meters (e.g. gas, heat, water meters and heat cost allocators) and for electricity meters, in this standard occasionally electricity meters are mentioned. All these references are for information only and are not standard requirements. The definition of communication standards for electricity meters (possibly by a reference to CEN standards) remains solely in the responsibility of CENELEC.

NOTE 1 Annex L describes how parts of this standard and of EN 13757-2 and EN 13757-4 can be used to implement smart meter functionalities. Similar functionalities could also be implemented using other physical and link layers.

NOTE 2 For information on installation procedures and their integration in meter management systems, see Annex M.

1 Scope

This European Standard applies to communication systems for meters and remote reading of meters.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13757-1, *Communication system for meters and remote reading of meters — Part 1: Data exchange*

EN 13757-2, *Communication systems for meters and remote reading of meters — Part 2: Physical and link layer*

EN 13757-4, *Communication systems for meters and remote reading of meters — Part 4: Wireless meter readout (Radio meter reading for operation in the 868 MHz to 870 MHz SRD band)*

EN 13757-5, *Communication systems for meters and remote reading of meters — Part 5: Wireless relaying*

EN 62056-21, *Electricity metering — Data exchange for meter reading, tariff and load control — Part 21: Direct local data exchange (IEC 62056-21)*

EN 62056-5-3, *Electricity metering data exchange — The DLMS/COSEM Suite — Part 5-3: DLMS/COSEM application layer (IEC 62056-5-3:2013)*

NOTE Further information and examples are available in the download area of <http://www.m-bus.com>.

3 Terms and definitions, abbreviated terms and numbers

For the purposes of this document, the following terms and definitions apply.

3.1 Terms and definitions

3.1.1

byte

an octet of bits

3.1.2

datagram

unit of data transferred from source to destination

Note 1 to entry: In previous versions of EN 13757-3 datagram was called telegram.

3.1.3

message

functional set of data transferred from source to destination

Note 1 to entry: A message may consist of one or more datagrams.

3.2 List of abbreviated terms

ACC-DMD Access Demand

ACC-NR	Access – No Reply
ACK	Acknowledge
AES	Advanced Encryption Standard
BCD	Binary Coded Decimal numbers
CI	Control Information field
CBC	Cipher Block Chaining
CMD	Command
CNF-IR	Confirm Installation Request
DES	Data Encryption Standard
DIB	Data Information Block
DIF	Data Information Field
DIFE	Data Information Field Extensions
DLMS	Device Language Message Specification
DRH	Data Record Header
E	Extension bit
LSB	Least Significant Byte
LSBit	Least Significant Bit
MDH	Manufacturer Data Header
MSB	Most Significant Byte
MSBit	Most Significant Bit
OBIS	Object Identification System (EN 62056-61)
REQ-UD	Request User Data (class 1 or 2)
RSP_UD	Respond User Data
RSSI	Received Signal Strength Indicator
SM-CG	Smart Meter Co-ordination Group
SND-IR	Send Installation Request
SND-NKE	Send Link Reset
SND-NR	Send – No Reply
SND-UD	Send User Data
VIB	Value Information Block

VIF Value Information Field

VIFE Value Information Field Extensions

3.3 Hexadecimal and binary numbers

Hexadecimal numbers are designated by a following "h"

Binary numbers are designated by a following "b"

Decimal numbers have no suffix!

4 General principles: CI-field

4.1 Overview

All higher protocol layer messages have a variable length. The length information is part of the link layer. It shall be known to the application layer in order to properly terminate its decoding of each datagram. Each message starts with a 1-byte CI (control information) field, which distinguishes between various message types and application functions and header length. It is also used to distinguish between true application layer communication and management commands for lower layers. The meaning of the remaining bytes of the message depends also on the value of the CI-field.

The fixed header structures after CI-fields are:

- No data header (None) (0 bytes), as for CI=78h: If the message contains such a "none" header the meter identification is taken from the link layer; additional control fields for application layer (like configuration field) are non-existent.
- Short data header (4 bytes or more), as for CI=7Ah: If the message contains such a "short" header, the meter identification is taken from the link layer; data header length is at least 4 bytes. Additional bytes may follow in dependency of the selected encryption mode. If no encryption is applied (encryption mode 0), the header has the minimum length of 4 bytes.
- Long data header (12 bytes or more), as for CI=72h: If the message contains such a "long" header, this header contains (independent of transmission direction) the meter identification; data header length is at least 12 bytes. Additional bytes may follow in dependency of the selected encryption mode. If no encryption is applied (encryption mode 0), the header has the minimum length of 12 byte.

When using a long data header, the meter application address is contained in this header, whereas the manufacturer assigned unique link layer address may be different (but still within the common universally unique address structure). This allows, for example, a wired to wireless converter to supply the supported meter application address in the long data header and its own address in the radio link layer. For a simple meter, which doesn't need an additional converter, the short header is sufficient.

Refer to Annex J for the details of the CI-field specific frame structure.

Table 1 — CI-field codes used by the master or the slave

CI-field	Direction	Header	Higher layer protocol
00h-1Fh	Reserved for DLMS-based applications		DLMS (See EN 13757-1)
20h-4Fh	Reserved		
50h	Application reset or select to device	None	M-Bus

Table 1 (continued)

CI-field	Direction	Header	Higher layer protocol
51h	Data send to device	None	M-Bus (not for wireless)
52h	Selection of device	None	Generic
53h	Application reset or select to device	Long	M-Bus
54h-59h	Reserved		
5Ah	Command to device	Short	M-Bus
5Bh	Command to device	Long	M-Bus
5Ch	Synchronise action		
5Dh-5Fh	Reserved		
60h	Command to device	Long	Application layer DLMS/ COSEM with OBIS-Identifier (EN 62056-5-3) ^a
61h	Command to device	Short	Application layer DLMS/ COSEM with OBIS-Identifier (EN 62056-5-3) ^a
62h-63h	Reserved		
64h	Command to device	Long	Reserved for OBIS-type value descriptors ^a
65h	Command to device	Short	Reserved for OBIS-type value descriptors ^a
66h-68h	Reserved		
69h	Response from device (M-Bus-Format frame)	None	See Annex K
6Ah	Response from device (M-Bus-Format frame)	Short	See Annex K
6Bh	Response from device (M-Bus-Format frame)	Long	See Annex K
6Ch	Time sync to device	Long	Generic
6Dh	Time sync to device	Long	Generic
6Eh	Application error from device	Short	Generic
6Fh	Application error from device	Long	Generic
70h	Application error from device	None	Generic
71h	Alarm from device	None	Generic
72h	Response from device	Long	M-Bus
73h	Response from device (M-Bus-Compact frame)	Long	See Annex K
74h	Alarm from device	Short	Generic
75h	Alarm from device	Long	Generic
76h-77h	Reserved		
78h	Response from device	None	M-Bus
79h	Response from device (M-Bus-Compact frame)	None	See Annex K

Table 1 (continued)

CI-field	Direction	Header	Higher layer protocol
7Ah	Response from device	Short	M-Bus
7Bh	Response from device (M-Bus-Compact frame)	Short	See Annex K
7Ch	Response from device	Long	Application layer DLMS/ COSEM with OBIS-Identifier (EN 62056-5-3) ^a
7Dh	Response from device	Short	Application layer DLMS/ COSEM with OBIS-Identifier (EN 62056-5-3) ^a
7Eh	Response from device	Long	Reserved for OBIS-type value descriptors ^a
7Fh	Response from device	Short	Reserved for OBIS-type value descriptors ^a
80h	Transport layer to device	Long	See EN 13757-4
81h	Network layer data		See EN 13757-5
82h	Reserved for network management data		See EN 13757-5
83h	Network management data		See EN 13757-5
84h	Transport layer to device (M-Bus-Compact frame expected)	Long	See Annex K
85h	Transport layer to device (M-Bus-Format frame expected)	Long	See Annex K
86h-88h	Reserved		See EN 13757-4, EN 13757-5
89h	Reserved for network management data from device		See EN 13757-5
8Ah	Transport layer from device	Short	See EN 13757-4
8Bh	Transport layer from device	Long	See EN 13757-4
8Ch-8Fh	Link layer extension		See EN 13757-4
90h-9Fh	Reserved		
A0h-B7h	Manufacturer specific		
B8h	Set baud rate to 300 Bd		
B9h	Set baud rate to 600 Bd		
BAh	Set baud rate to 1 200 Bd		
BBh	Set baud rate to 2 400 Bd		
BCh	Set baud rate to 4 800 Bd		
BDh	Set baud rate to 9 600 Bd		

Table 1 (continued)

CI-field	Direction	Header	Higher layer protocol
BEh	Set baud rate to 19 200 Bd		
BFh	Set baud rate to 38 400 Bd		
C0h-FFh	Reserved		
NOTE All SND_UD datagrams are acknowledged in the link layer, even if the function of these CI-fields is not implemented.			
^a These application protocols also contain OBIS identifiers. In the M-Bus application protocol, these OBIS identifiers are not included, but they can be added afterwards. For generating the OBIS identifiers from M-Bus data records, Annex O shall be used.			

Every data header for wireless M-Bus (EN 13757-4) shall contain at least:

- access number;
- status byte;
- configuration field.

Alternatively, the link extension (CI=8Ch – 8Fh) may be applied.

NOTE Multi byte values in short or long header are transmitted with LSB first.

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

4.2.1 Application reset

With the CI-field 50h or 53h (without additional parameter), the master can release a reset of the application layer in the slaves. Each slave itself decides which parameters to change, e.g. which data output is default – after it has received such an application reset.

4.2.2 Application select with subcode (optional)

It is allowed to use optional parameters after CI = 50h or 53h. In this case, the CI-field acts as application select. If more bytes follow, the first byte is the application select subcode. Further bytes are ignored. The application select subcode defines which message function and which sub message is requested by the master. The data type of this parameter is 8 bit binary. The upper 4 bits define the message type or message application and the lower 4 bits define the number of the sub message or datagram number (the meaning of this number is device specific). The lower 4 bits may be ignored for slaves which provide only a single datagram for each application. The use of the value zero for the number of the sub message means that all datagrams are requested.

Slaves with only one type of message may ignore application select and the added parameters. The following codes can be used for the upper 4 bits of the first parameter:

Table 2 — Coding of the upper 4 bits of the first parameter after CI = 50h or 53h

Coding	Description	Examples
0000b	All	
0001b	User data	Consumption
0010b	Simple billing	Current and fixed date values + dates
0011b	Enhanced billing	Historic values
0100b	Multi tariff billing	

Table 2 (continued)

Coding	Description	Examples
0101b	Instantaneous values	For regulation
0110b	Load profile values for management	
0111b	Reserved	
1000b	Installation and startup	Bus address, fixed dates
1001b	Testing	High resolution values
1010b	Calibration	
1011b	Manufacturing	
1100b	Development	
1101b	Self test	
1110b	Reserved	
1111b	Reserved	

4.3 Slave select (52h) (optional)

The CI-field code 52h is used for the management of the optional secondary addressing (see 11.3).

4.4 Synchronise action (CI = 5Ch) (optional)

This CI-field can be used for synchronising functions in slaves and masters (e.g. clock synchronisation). Special actions or parameter loads may be prepared but their final execution is delayed until the reception of such a special CI-field command. No data follows this CI-code.

NOTE Wireless M-Bus does not provide broadcast communication. Therefore, this function cannot be used for wireless M-Bus.

4.5 Clock synchronisation (CI = 6Ch, 6Dh) (optional)

For wireless communication (but not limited to this one), the clock synchronisation is executed by a special protocol for clock synchronisation. For this protocol CI-fields 6Ch and 6Dh are used. Annex H.3 specifies the transmission of clock synchronisation to meter.

Alternatively, the clock may set by an M-Bus-command. The communication partner may send date and time in all command messages to ensure that the meter can detect a replay of an old command. The meter shall not use this time stamp for synchronisation of its clock except when a dedicated action code (see Table 37) was added.

4.6 Report of application errors (slave to master) (CI = 6Eh, 6Fh and 70h) (optional)

For details of the report of general application errors, see 8.3. For error reporting of individual data elements, see 8.4.

4.7 Report of alarm status (slave to master) (CI = 71h, 74h and 75h) (optional)

For details of the report of alarm status errors, see Annex D.

4.8 Variable Data Send (master to slave) (CI = 51h, 5Ah, 5Bh, 60h, 61h, 64h, 65h)

These CI-field codes are used to indicate a message of application data sent from master to slave.

The CI-fields CI = 51h, 5Ah and 5B are used to transport the M-Bus protocol as described in this standard starting from Clause 6. For details, refer to Clause 5.

The CI-fields CI = 60h and 61h are used to transport the COSEM-Protocol as described in EN13757-1 and EN 62056-5-3.

The CI-fields CI = 64h and 65h are reserved so far for an alternative OBIS based protocol.

4.9 Variable Data Respond (slave to master) (CI = 69h to 6Bh, 72h, 73h, 78h to 7Fh)

These CI-field codes are used to indicate a message of application data responded from slave to master.

The CI-fields 72h, 78h and 7Ah are used to transport the M-Bus protocol as described in this standard starting from Clause 6. For details, refer to Clause 5.

The CI-fields 69h, 6Ah and 6Bh, as well as 73h, 79h and 7B, are used to transport the M-Bus protocol in the compact format. For details, refer to Annex K.

The CI-fields CI = 7Ch and 7Dh are used to transport the COSEM-Protocol as described in EN13757-1 and EN 62056-5-3.

The CI-fields CI = 7Eh and 7Fh are reserved so far for an alternative OBIS based protocol.

4.10 Baud rate switch commands B8h – BFh (optional)

These optional commands can be used by a master to switch the baud rate of a slave. For details, see 11.2.

5 Variable Data Send and Variable Data Respond

5.1 Introduction

The data headers of the Variable Data Send with the CI-field codes as listed in 4.8 are used to indicate the variable data structure in long frames (SND_UD) with optional fixed header.

The data headers of the Variable Data Respond with the CI-field codes as listed in 4.9 are used to indicate the variable data structure in long frames (RSP_UD) with optional fixed header.

Table 3 shows the way this data is represented.

Table 3 — Variable data structure in answer send and respond direction

Data header (resp.)	Variable data blocks (records)	MDH(opt.)	Optional manufacturer specific data)
None header			
Short header	Variable number	1 byte	Variable number
Long header			

5.2 Structure of none data header

This structure has no data header. The first byte following the CI-field is the start of the first data record. This data structure does not support transmission properties like encryption, access number or an additional meter address.

This structure can be used together with the extended link layer of EN 13757-4.

5.3 Structure of short data header

The first 4 bytes after the CI-field consist of a block with a fixed length and structure (see Table 4).

The short data header is used for systems supporting the physical and link layer of wireless M-bus communication (refer to EN 13757-4). In this standard, the link layer address contains the information fields of the manufacturer, the device type, the version and the identification number. If the meter address is identical with link layer address or the meter address was clearly selected before, then the 8 bytes of the meter address do not have to be added in the application layer again.

Table 4 — Short data header

Access No.	Status	Configuration
1 byte	1 byte	2 byte

The structure of the short header can be enlarged by additional bytes in dependency of the encryption mode (refer to 5.12.6.5).

5.4 Structure of long data header

The first 12 bytes after the CI-field consist of a block with a fixed length and structure (see Table 5).

Table 5 — Long data header

Ident. no.	Manufr.	Version	Device type	Access no.	Status	Configuration
4 byte	2 byte	1 byte	1 byte	1 byte	1 byte	2 byte

The address fields always contain the address of the meter independent of the transmission direction. In case of wireless communication based on EN 13757-4, this CI-field shall be used when the link layer address differs from meter address.

The structure of the long header can be enlarged by additional bytes in dependency of the encryption mode (refer to 5.12.6.4).

5.5 Identification number

The **identification number** is either a fixed fabrication number or a number changeable by the customer, coded with 8 BCD packed digits (4 byte), and which thus runs from 00000000 to 99999999. It can be preset at fabrication time with a unique number, but can be changeable afterwards, especially if, in addition, a unique and not changeable fabrication number (DIF = 0Ch, VIF = 78h, see 7.2) is provided.

5.6 Manufacturer identification

The field **manufacturer** is coded unsigned binary with 2 bytes. This manufacturer ID is calculated from the ASCII code of EN 62056-21 manufacturer ID (three uppercase letters) with the following formula:

$$\begin{aligned}
 \text{Man. ID} = & \quad [\text{ASCII}(1\text{st letter}) - 64] \times 32 \times 32 \\
 & + [\text{ASCII}(2\text{nd letter}) - 64] \times 32 \\
 & + [\text{ASCII}(3\text{rd letter}) - 64]
 \end{aligned}
 \tag{1}$$

NOTE The flag association, UK (<http://www.dlms.com/>) administers these three letter manufacturers ID of EN 62056-21.

5.7 Version identification

The field version specifies the generation or version of the device and depends on the manufacturer. It can be used to make sure that within each version number the identification number is unique.

The value FFh is reserved as a wildcard and shall not be used by any device.

5.8 Device type identification

The device type is coded as follows:

Table 6 — Device type identification

Device type (previously called medium)	Code bin. Bit 7 ... 0	Code hex.
Other	0000 0000	00
Oil meter	0000 0001	01
Electricity meter	0000 0010	02
Gas meter	0000 0011	03
Heat meter	0000 0100	04
Steam meter	0000 0101	05
Warm water meter (30 °C ... 90 °C)	0000 0110	06
Water meter	0000 0111	07
Heat cost allocator	0000 1000	08
Compressed air	0000 1001	09
Cooling meter (volume measured at return temperature: outlet)	0000 1010	0A
Cooling meter (volume measured at flow temperature: inlet)	0000 1011	0B
Heat meter (volume measured at flow temperature: inlet)	0000 1100	0C
Combined heat / cooling meter	0000 1101	0D
Bus / system component	0000 1110	0E
Unknown device type	0000 1111	0F
Reserved for consumption meter	...	10 to 13
Calorific value	0001 0100	14
Hot water meter (≥ 90 °C)	0001 0101	15
Cold water meter	0001 0110	16
Dual register (hot/cold) water meter ^a	0001 0111	17
Pressure meter	0001 1000	18

Table 6 (continued)

Device type (previously called medium)	Code bin. Bit 7 ... 0	Code hex.
A/D converter	0001 1001	19
Smoke detector	0001 1010	1A
Room sensor (e.g. temperature or humidity)	0001 1011	1B
Gas detector	0001 1100	1C
Reserved for sensors		1D to 1F
Breaker (electricity)	0010 0000	20
Valve (gas or water)	0010 0001	21
Reserved for switching devices		22 to 24
Customer unit (display device)	0010 0101	25
Reserved for customer units		26 to 27
Waste water meter	0010 1000	28
Garbage	0010 1001	29
Reserved for carbon dioxide	0010 1010	2A
Reserved for environmental meter		2B to 2F
Reserved for system devices		30
Communication controller (Gateway)	0011 0001	31
Unidirectional repeater	0011 0010	32
Bidirectional repeater	0011 0011	33
Reserved for system devices		34 to 35
Radio converter (system side) ^b	0011 0110	36
Radio converter (meter side) ^c	0011 0111	37
Reserved for system devices		38 to 3F
Reserved		40 to FF
^a Such a meter registers water flow above a limit temperature in a separate register with an appropriate tariff ID. ^b A radio converter at system side operates as radio master like a wireless communication partner. ^c A radio converter at meter side operates as radio slave like an RF-meter.		

5.9 Access number

5.9.1 Overview

The access number is a part of the fixed header. It is used by the extended link layer, the transport layer or the application layer protocol. It is coded as a 1-byte unsigned binary number. It has originally been added to support the wired M-Bus of EN 13757-2 and signals to the user that its meter has been read out by the pull-type readout of EN 13757-2. This function supports the detection of unwanted frequent readouts. For the typical push type frequent transmit modes of radio devices based on the EN 13757-4, this usage is no longer sensible. Acceptable maximum readout or transmit frequency is either an issue of legal requirements or of a contract between the meter reading organisation and the consumer. For devices based on the EN 13757-4, the access number shall be applied for clear

indication of a new datagram for both pushed data as well as for requested data by strict rules of increments. For the partner-generated datagrams, relaxed generation rules simplify the implementation. The detection rules are identical between meter and partner; i.e. a datagram with an identical access number is considered a repetition of an identical previously already received datagram and shall be ignored. All datagrams with a different access number than the last received datagram are considered as a new data datagram. The term "new data" means that the meter application provides newer measurement values than in the last (old) data datagram.

NOTE 1 This link layer oriented function is not sufficient to uniquely identify messages from an application. If an application requires such a unique identification of a message, a data record with a VIF of =FDh,08h (unique message identification) and a data length of at least 4 bytes is added to each message.

NOTE 2 If both extended link layer and transportation layer exist, then the access number of the extended link layer will be applied for the timing of synchronous transmission, whereas the access number in the transport layer will be used to indicate new data.

5.9.2 Generation of access number for meter initiated datagrams

If a meter generates a datagram (SND-NR, SND-IR, ACC-DMD or ACC-NR), the access number is incremented (modulo 256) by one before or after each new transmission of the meter.

If the meter supports the feature of synchronised transmission for battery operated receiver (refer to EN 13757-4) then the access number shall be incremented by one and only one with every synchronous transmission. For every asynchronous transmission between two synchronous datagrams, the meter shall use the access number from the last synchronous transmission. To avoid the detection of zero consumption, it is recommended to add a time stamp or an incremental counter (VIFE "unique message identification") to the message content if one or several asynchronous transmissions are sent in the interval between two synchronous transmissions. If such asynchronous transmission contains new data, the extended link layer may be applied to separate the indication of synchronous transmission from the indication of new data.

After the power up of the meter, its value of the access number shall be set by a randomised initial value from 0 to 255. The access number of the meter shall not be resettable.

When the datagram is a response to a datagram of the communication partner (i.e. ACK, RSP-UD or other) then the access number repeats the received access number of the communication partner. Otherwise, the access number of the meter is used.

NOTE Meter initiated datagrams are not allowed by the wired M-Bus standard (refer to EN13757-2).

5.9.3 Generation of access number for partner generated datagrams

If the communication partner generates a wireless datagram (SND-UD, SND-NKE, REQ-UD1, REQ-UD2), each such datagram shall use a different value of the access number within 300 s or within a frequent access cycle as defined in EN 13757-4. A simple increment is recommended to fulfil this requirement. If the partner transmits an answer to the meter (i.e. ACK or CNF-IR with CI-field), the transmitted access number of the partner repeats the received access number of the meter. After the power up of the communication partner, its value is undefined, but an initial value of zero is recommended. For the usage of the FCB, see E.7.

For the wired communication according to EN13757-2, the meter shall increment its own access number before or after each response (RSP_UD) to the communication partner. If the communication partner (M-Bus-master) transmits an access number (e.g. SND-UD), it may be ignored.

NOTE The communication partner has to provide an access number in case of encrypted commands.

5.10 Status byte in meter messages

Table 7 — Coding of the status field

Bit	Meaning with bit set	Significance with bit not set
0,1	See Table 8	See Table 8
2	Power low	Power ok
3	Permanent error	No permanent error
4	Temporary error	No temporary error
5	Specific to manufacturer	Specific to manufacturer
6	Specific to manufacturer	Specific to manufacturer
7	Specific to manufacturer	Specific to manufacturer

Table 8 — Application errors coded with the status field

Status bit 1 bit 0	Application status
0 0	No error
0 1	Application busy
1 0	Any application error
1 1	Abnormal condition / alarm

The status bits shall be used in this meaning:

Power low	Warning - The bit “power low” is set only to signal interruption of external power supply or the end of battery life.
Permanent error	Failure - The bit “permanent error” is set only if the meter signals a fatal device error (which requires a service action). Error can be reset only by a service action.
Temporary error	Warning – The bit “temporary error” is set only if the meter signals a slight error condition (which not immediately requires a service action). This error condition may later disappear.
Any application error	Shall be used to communicate a failure during the interpretation or the execution of a received command, e.g. if a not decrypt able message was received.
Abnormal conditions	Shall be used if a correct working application detects an abnormal behaviour like a permanent flow of water by a water meter.

NOTE More detailed error signalling can be provided by the VIF/VIFE FDh/17h (refer to Annex H) in the message body. If a failure happens because of a wrong command it responds with a message of application error with CI= 6Eh, 6Fh, 70h.

5.11 Status byte in partner messages

Table 9 — Meaning of status byte for partner messages

Bit no.	Value
0 ... 5	Last received RSSI value from this meter for a reception level in range of: -128 ... -6dbm Reception level is calculated by $-130\text{dbm} + 2 * \text{RSSI value (1 ... 62)}$ If RSSI value = 0 no RSSI value or wired communication If RSSI value = 1 RSSI value is -128dbm or below If RSSI value = 63 the reception level is $> -6\text{dbm}$
6	Reserved (0 by default)
7	Reserved (0 by default)

The value of « 0 » in bits 0...5 means either that the partner does not provide RSSI values or that the partner has so far not received any message from the meter. Information about link quality is helpful for the rating of several radio links between a meter and different partners. It will also be used for signalling the link quality to an installation service tool. Therefore, the partner should support a valid RSSI value.

5.12 Configuration field (previously: signature field)

5.12.1 General

The **configuration field** contains information about the encryption mode and the number of encrypted bytes. Depending on the mode, it may contain additional information about:

- meter accessibility;
- contents of the message;
- repeated wireless datagrams;
- synchronous wireless transmissions.

If no functionality of the configuration field is used, its value shall be 0000h. Table 10 shows where to find the mode bits. The number of encrypted bytes is contained in the low byte of the configuration field (bit 0 – bit 7). The exact coding of those bits depends on the mode.

Table 10 — General definition of the configuration field

MS Bit 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	LS Bit 0
mode specific	mode specific	mode specific	reserved	mode bit 3	mode bit 2	mode bit 1	mode bit 0	mode specific	mode specific	mode specific	mode specific	mode specific	mode specific	mode specific	mode specific
X	X	X	0	M	M	M	M	X	X	X	X	X	X	X	X

5.12.2 Functions

The use of encryption provides the following functions:

- data privacy for consumption meter values;
- detecting simulated meter transmission;
- preventing later replay of old meter values;
- preventing the detection of zero consumption by comparing messages.

5.12.3 Structure of encrypted messages

- a) The long or short data header (see 5.3 or 5.4) is always unencrypted. The last word of this block is the configuration field. If the number of encrypted bytes in the configuration field is zero (even if the encryption mode differs from zero) the following data are unencrypted.
- b) If the transmission uses configuration field functionality (like encryption), the method has to be defined with the mode bits in the high byte of configuration field. Table 11 shows the already defined modes.
- c) The encrypted data follow directly after the configuration field, thus forming the beginning of the application data e.g. DIF/VIF-structured part of the message for M-Bus. The calculation of the length of encrypted data is mode specific.

Table 11 — Definition of the mode bits (encryption method)

Mode	Meaning
0	No encryption used
1	Reserved
2	DES encryption with CBC; initialisation vector is zero (deprecated)
3	DES encryption with CBC; initialisation vector is not zero (deprecated)
4	Reserved
5	AES encryption with CBC; initialisation vector is not zero
6	Reserved
7	Reserved
8 – 15	Reserved

5.12.4 Partial encryption

- a) If the number of encrypted bytes is less than the total length of the data in this datagram then unencrypted data may follow after the encrypted data. They shall start at a record boundary, i.e. the first byte after the encrypted data will be interpreted as a DIF.
- b) If a partially encrypted message shall contain encrypted manufacturer specific data, a record with a suitable length DIF (possibly a variable length string DIF) and a VIF = 7Fh (manufacturer specific data record) shall be used instead of the usual MDH-DIF = 0Fh. This is required to enable after decryption standard DIF/VIF-decoding of a previously partially encrypted message containing encrypted manufacturer specific data.

5.12.5 Encryption methods DES (modes 2 and 3)

Table 12 — Definition of the configuration field for encryption modes 2 and 3

MS Bit 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	LS Bit 0
reserved	reserved	reserved	reserved	mode bit 3	mode bit 2	mode bit 1	mode bit 0	number of encr. bytes	number of encr. bytes	number of encr. bytes	number of encr. bytes	number of encr. bytes	number of encr. bytes	number of encr. bytes	number of encr. bytes
0	0	0	0	M	M	M	M	N	N	N	N	N	N	N	N

- a) Due to the withdrawal of standards ANSI X3.92:1981 and ANSI X3.106:1983, new implementations based on DES are not recommended.
- b) Cipher Block Chaining (CBC) method as described in INCITS/ISO 8372:1987 with an initial initialisation vector of zero: (encryption method code = 02xxh). In this case, the message should contain the current date before the meter reading data. Thus, the data after the date record changes once per day even if the meter index itself is constant. This prevents an undetectable later replay of stored encrypted meter readings by a hacker.
- c) The initialisation vector with length 64 bits of this standard may alternatively be defined by the first 6 bytes of the identification header in mode 1 sequence, i.e. identification number in the lowest 4 bytes followed by the manufacturer ID in the two next higher bytes and finally by the current date coded as in record structure "G" for the two highest bytes. Thus, all encrypted data change once per day even if the data content itself is constant. This prevents an undetectable later replay of any stored encrypted data by a hacker.

In this case the encryption method is coded as "03xxh".

- d) To simplify the verification of correct decoding and to prevent an undetected change in the identification of the not encrypted header, the encrypted part of the message shall contain at least together with the appropriate application layer coding (DIF and VIF) again the same identification number as in the unencrypted header.
- e) Due to the mathematical nature of the DES-algorithm, the encrypted length contained in the low byte of the configuration field (see Table 12) shall be an integer multiple of 8 byte if the high byte signals DES-Encryption. Unused bytes in the last 8-byte block shall be filled with appropriately structured dummy data records to achieve the required record boundary at the end of the encrypted data. One or several bytes containing the filler DIF = 2Fh shall be used to fill such gaps.
- f) The application of certain encryption methods might be prohibited by local laws.

5.12.6 Encryption methods AES-128 (mode 5)

5.12.6.1 General

Encryption according to the AES-128 (Data Encryption Standard) as described in NIST FIPS 197.

5.12.6.2 Encryption mode 5

- a) Cipher Block Chaining (CBC) method as described in NIST SP800-38A.
- b) Definition of the configuration field according to Table 13:

Table 13 — Definition of the configuration field for encryption mode 5

MS Bit 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	LS Bit 0
bidirectional communication	accessibility	synchronised	reserved	mode bit 3	mode bit 2	mode bit 1	mode bit 0	number of encr. blocks	number of encr. blocks	number of encr. blocks	number of encr. blocks	content of message	content of message	repeater access	hop counter
B	A	S	0	M	M	M	M	N	N	N	N	C	C	R	H

- c) The coding of the configuration field for the AES encryption mode with a dynamic initialisation vector is 5 (MMMM=0101b). The high nibble "NNNN" of the lower byte declares the number of encrypted 16-byte blocks (see Table 13).
- d) The initialisation vector for encryption mode 5 is (written in low to high order according to the AES standard FIPS 197):

Table 14 — Initialisation vector mode 5 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 (MSB)	Ver- sion	Device type	Acc. no.	..	..	..	..	..	..	Acc. no.

The initialisation vector always contains the address of the meter.

- e) Since the meter access number changes with each new transmission, the initialisation vector is different in each new transmission of meter data. Due to the mathematical properties of the encryption algorithm, this changes the complete message even if the unencrypted data (e.g. the meter index) is constant (e.g. because of zero consumption) which might indicate an uninhabited apartment and might hence be some indication for possible burglars. This protection may be increased by using an additional time stamp or an incremental counter (VIFE "unique message identification") in the first block.

- f) To simplify the verification of correct decoding and to prevent an undetected change in the identification of the not encrypted header, the encrypted part of the message shall start with two bytes "2Fh" (see 5.12.6.4).
- g) Due to the mathematical nature of the AES-algorithm, the encrypted length contained in the low byte of the configuration field shall be an integer multiple of 16 bytes if the high byte signals AES-encryption. Unused bytes in the last 16-byte block shall be filled with appropriately structured dummy data records to achieve the required record boundary at the end of the encrypted data. One or several bytes containing the filler DIF = 2Fh shall be used to fill such gaps.
- h) Partial encryption may be used to allow unencrypted access to operational parameters. The encrypted bytes follow as zero, one or several encrypted 16-byte blocks directly after the header. Optional unencrypted bytes may follow the encrypted blocks if the link layer datagram length signals more bytes than the encryption length of 16*NNNNb bytes in the low byte of the configuration field.
- i) The full 16-byte key shall be assigned by the manufacturer together with the meter identification and safely transferred to its customers. The format is according to FIPS 197.
- j) The application of certain encryption methods might be prohibited by local laws.

5.12.6.3 Additional functionality of configuration field

The configuration field in general declares the length and method of data encryption. For encryption mode 5, additional communication status bits are defined. For the communication on wired M-Bus, all bits in the configuration field except "MMMM" and "NNNN" shall be set to "0".

Bit 0 (H) and bit 1 (R) of the configuration field are reserved for use in repeated messages (see EN 13757-5). A meter shall always set H=0b and R=0b in a transmitted message. The meter may ignore these bits in a received message.

Bit 2 and bit 3 (CC) are used to describe the contents of the message (refer to Table 15). The definition distinguishes between a meter and a partner message. The declaration of the authentication methods helps the meter to detect the authentication method used by the message originator (refer to Table 16).

Table 15 — Contents of meter message

Bit 3 C	Bit 2 C	Contents of the message
0	0	Standard data message with unsigned variable meter data
0	1	Reserved for signed data message
1	0	Static message (consists of parameter, OBIS-definitions and other data points which are not frequently changed). Static messages shall be transmitted at least twice a day.
1	1	Reserved for future extensions

Table 16 — Contents of partner message

Bit 3 C	Bit 2 C	Contents of data point authentication
0	0	Standard command message
0	1	Reserved for authenticated command message type 1
1	0	Reserved
1	1	Reserved for future extensions

Bit 13 (S) is used to declare a synchronised transmission. If the transmission timing (predictable transmission time) fulfils the requirements of a synchronous transmission as defined in EN 13757-4, it shall mark this transmission with a set bit 13. Otherwise, the bit 13 shall always be 0.

The configuration field bits 14 (A) and 15 (B) (**A**ccessibility and **B**idirectional communication) are used as defined in Table 17 for access control to the meter.

Table 17 — Accessibility of a meter

Bit 15 B	Bit 14 A	Accessibility of a meter
0	0	Meter/actuator provides no access window (unidirectional meter)
0	1	Meter supports bidirectional access in general, but there is no access window after this transmission
1	0	Meter provides a short access window only immediately after this transmission
1	1	Meter provides unlimited access (at least until the next transmission)

5.12.6.4 Decryption verification

In order to verify that the message is decrypted correctly, the encrypted part starts with a known sequence. The header will be expanded by decryption verification in dependency of the selected encryption mode. A device supporting encryption mode 5 shall start with 2 bytes of 2Fh (AES-check) before the first data record.

Since the message must have an encrypted length of an integer multiple of 16 bytes, idle filler bytes often will also be added at the end of the last encrypted block.

NOTE The decryption verification is independent of the wired or wireless transmission.

5.12.7 Examples

Annex P shows examples with both unencrypted and encrypted data.

5.13 Address structure if used together with the wireless link layer according to EN 13757-4

The link layer of EN 13757-4 contains an 8-byte address, which starts with a 2-byte manufacturer identification according to EN 62056-21 (see 5.6), followed by 6 bytes consisting of the identification number, version and device type, as shown in Table 18.

Table 18 — Address structure of the wireless link layer

Manufacturer identification	Identification number	Version	Device type
2 byte	4 byte(BCD)	1 byte	1 byte

The content of the fields shall be according to 5.5, 5.6, 5.7 and 5.8.

The 8-byte address in the long header of this standard uses the same elements but they are structured in a different order (see Table 5 in 5.4).

6 Variable data blocks (records)

6.1 General

The single datagram has a maximum length of 255 bytes. The data, together with information regarding coding, length and the type of data, is transmitted in data records in arbitrary sequence. According to EN 13757-2, the maximum space for data is 252 bytes. The effective usable space depends on the layers with variable length below the application layer and the applied header type and the encryption method. This restriction is required to enable gateways to other link- and application layers. The Manufacturer Data Header (MDH) is made up by the character 0Fh or 1Fh and indicates the beginning of the manufacturer specific part of the user data and shall be omitted if there is no manufacturer specific data (refer also to 6.4).

Table 19 — Structure of a data record (transmitted from left to right)

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

Each data record consists of a Data Record Header (DRH) and the value (data). The DRH in turn consists of the Data Information Block (DIB) to describe the length, type and coding of the data and the Value Information Block (VIB) to give the value of the unit and the multiplier.

NOTE An application message can contain either just a single data record but also an arbitrary number of such data records in arbitrary order, each describing and containing a data element. For examples of such multi record messages see Annex E, or for further information on M-Bus see Annex G.

6.2 Data Information Block (DIB)

The DIB contains at least one byte of Data Information Field (DIF), and can be extended by a maximum of ten Data Information Field Extensions (DIFE).

6.3 Data Information Field (DIF)

The following information is contained in a DIF:

Table 20 — Coding of the Data Information Field (DIF)

Bit 7	6	5	4	3	2	1	0
Extension bit (E)	LSB of storage number	Function field		Data field : Length and coding of data			

6.4 Data field

The data field shows how the data from the master shall be interpreted in respect of length and coding. The following table contains the possible coding of the data field:

Table 21 — Coding of the data field

Length in bit	Code	Meaning	Code	Meaning
0	0000	No data	1000	Selection for readout
8	0001	8 bit integer/binary	1001	2 digit BCD
16	0010	16 bit integer/binary	1010	4 digit BCD
24	0011	24 bit integer/binary	1011	6 digit BCD
32	0100	32 bit integer/binary	1100	8 digit BCD
32 / N	0101	32 bit real	1101	Variable length
48	0110	48 bit integer/binary	1110	12 digit BCD
64	0111	64 bit integer/binary	1111	Special functions

For a detailed description of data types, refer to Annex A "Coding of data records" (e. g. BCD = type A, Real = type H). The coding as "integer/binary" implies always type B (signed integer) unless the VIF/-VIFE of the record implies another data type (e.g. date/time).

Variable length:

With data field = '1101b' several data types with variable length can be used. The length of the data is given after the DRH with the first byte of real data, which is here called LVAR (e.g. LVAR = 02h: ASCII string with two characters follows).

If LVAR is used as the variable length of a wireless M-Bus data container (see Annex N) it counts the number of bytes inside the container.

LVAR = 00h – BFh 8-bit text string according to ISO 8859–1 with LVAR (0 to 191) characters

NOTE 1 A text string (like all other multibyte data) is transmitted "least significant byte first".

LVAR = C0h – C9h :	Positive BCD number with (LVAR – C0h, i.e. 0 to 9)*2 digits (0 to 18 digits)
LVAR = D0h – D9h :	Negative BCD number with (LVAR – D0h)*2 digits (0 to 18 digits)
LVAR = E0h – EFh :	Binary number with (LVAR – E0h) bytes (0 to 15 bytes)
LVAR = F0h-F4h:	Binary number with 4*(LVAR-ECh) bytes (16, 20, 24, 28, 32 bytes)
LVAR = F5h	Binary number with 48 bytes

LVAR = F6h

Binary number with 64 bytes

Others LVAR values : Reserved

Like all multibyte fields the last character is transmitted first.

NOTE 2 In previous versions of EN 13757-3, LVAR=F8h was used for floating point number according to IEEE 754, but it is no longer applicable.

Special functions (data field = 1111b):

Table 22 — 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 datagram
2Fh	Idle filler (not to be interpreted), following byte = DIF of next record
3Fh ... 6Fh	Reserved
7Fh	Global readout request (all storage numbers, units, tariffs, function fields)

If data follows after DIF = 0Fh or 1Fh these are manufacturer specific unstructured data. The number of bytes in these manufacturer specific data can be calculated from the link layer information on the total length of the datagram. The DIF 1Fh signals additionally a request from the slave to the master to readout the slave once again. The master shall readout the slave until there is no DIF = 1Fh inside the responded datagram (multi-datagram message readout) or use an application reset. The variable data block of the next datagram starts with a normal DIF. If a multi-datagram message contains M-Bus records only, but no manufacture specific data, the DIF 1Fh has to be the last byte in the application frame of all except the last datagram.

6.5 Function field

The function field gives the type of data as follows:

Table 23 — Function field

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

6.6 Storage number

The bit 6 of the DIF serves as the LSB of the storage number of the data concerned, and the slave can in this way indicate and transmit various stored metering values or historical values of metering data. This bit is the least significant bit of the storage number and allows therefore the storage numbers 0 and 1 to be coded. If storage numbers higher than "1" are needed, following (optional) DIFE's contain the higher bits. The storage number 0 signals a current value.

NOTE Each storage number is associated with a dedicated time point. Each data record with the same storage number refers the value to this (common) time point given by this storage number. A time/date record for each storage number can be included somewhere in the message to signal this time point associated with this

storage number. This date or date/time is coded with a data record with a VIF=E110110n. Normally (but not necessarily) higher storage numbers indicate an older time point. A sequential block of storage numbers can be associated with a sequence of equidistantly spaced time points (profile). Such a block can be described by its starting time, by the time spacing, by the first storage number of such a block and by the length of such a block. For an example see Annex I.

6.7 Extension bit (E)

The extension bit (MSBit) signals that more detailed or extended descriptions (data field extension = DIFE)-bytes follow. E = 1 if other VIFE or DIFE follow.

6.8 Data Information Field Extension (DIFE)

Each DIFE (maximum ten) contains again an extension bit to show whether a further DIFE is being sent. Besides giving the next most significant bits of the storage number, DIFEs 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 will be transmitted. Table 24 shows the structure of a DIFE:

Table 24 — Coding of the Data Information Field Extension (DIFE)

Bit	7	6	5	4	3	2	1	0
Value	Extension Bit (E)	(Device) Subunit	Tariff		Storage number			

With the maximum of ten DIFEs, which are provided, there are 41 bits for the storage number, 20 bits 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.

6.9 Tariff information

For each (unique) value type designation given by the following VIB at each unique time point (given by the storage number) of each unique function (given by the function field), there might exist still various different data, measured or accumulated under different conditions. Such conditions could be time of day, various value ranges of the variable (i.e. separate storage of positive accumulated values and negative accumulated values) itself or of other signals or variables or various averaging durations. Such variables, which could not be distinguished otherwise, are made different by assigning them different values of the tariff variable in their data information block.

NOTE This includes but is not necessarily restricted to various tariffs in a monetary sense. It is at the distinction of the manufacturer to describe for each tariff (except 0) what is different for each tariff number. Again, as with the storage numbers, all variables with the same tariff information share the same tariff associating condition.

6.10 Subunit information

A slave component may consist of several functionally and logically independent subunits of the same or of different functionality. Either such a device uses several different primary and/or secondary addresses or it uses the subunit information field for addressing a logically independent subunit within a device that uses only one primary and/or secondary address. This is recommended for devices which represent a physical collection of several truly independent (often similar or identical) devices. For devices which share common information and values and have logical connections, an approach with a common link layer (i.e. a single address) is recommended. The various subunits can include their specific information into a common message and have them differentiated by the individual subunit number in the subunit-data field of their records.

7 Value Information Block (VIB)

7.1 General

After a DIF (with the exception of Table 22) or a DIFE without a set extension bit there follows the VIB. This consists at least of the value information field (VIF) and can be expanded with a maximum of 10 VIF-extensions (VIFE). The VIF and also the VIFEs with a set MSBit show that another VIFE will follow. In the value information field VIF, the other seven bits give the unit and the multiplier of the transmitted value.

Table 25 — Coding of the Value Information Field (VIF)

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

There are five types of coding depending on the VIF:

a) **Primary VIF: E000 0000b ... E111 1011b**

The unit and multiplier are taken from Table 26 Primary VIF-codes (7.2).

b) **Plain-text VIF: E111 1100b**

In case of VIF = 7Ch / FCh, the true VIF is represented by the following ASCII string with the length given in the first byte.

Annex C.2 shows an example for a plain text VIF.

c) **Linear VIF-extension: FDh and FBh**

In case of VIF = FDh and VIF = FBh the true VIF is given by the next byte (i.e. the first VIFE) and the coding is taken from Table 28 in 7.4 and Table 29 (for secondary VIF) in 7.5, respectively. This extends the available VIFs by another 256 codes.

d) **Any VIF: 7Eh / FEh**

This VIF-Code can be used in direction master to slave for readout selection of all VIFs. See special function in 6.4.

e) **Manufacturer specific: 7Fh / FFh**

In this case, the remainder of this data record including VIFEs has manufacturer specific coding.

7.2 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 26 — 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 ^a	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 seconds nn = 01b minutes nn = 10b hours nn = 11b days	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	0,000 l/min to 1 000 l/min
E100 1nnn	Volume flow ext.	10 ⁽ⁿⁿⁿ⁻⁹⁾ m ³ /s	0,001 ml/s to 10 000ml/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 (actual or associated with a storage number/function)		Data field = 0010b, type G
E110 1101 ^b	Date and time (actual or associated with a storage number/function)		Data field= 0100b, type F
E110 1101 ^b	Extended time point (actual or associated with a storage number/function)	Time to s	Data field= 0011b, type J
E110 1101 ^b	Extended date and time point (actual or associated with a storage number/function)	Time and date to sec.	Data field= 0110b, type I
E110 1110	Units for H.C.A.		Dimensionless
E110 1111	Reserved for a future third table of VIF-extensions		
E111 00nn	Averaging duration	nn coded like on time	
E111 01nn	Actuality duration	nn coded like on time	
E111 1000	Fabrication no		See Annex E.8.2
E111 1001	(Enhanced) identification		
E111 1010	Address		For EN 13757-2: one byte link layer address, data type C (x = 8) For EN 13757-4: data field 0110b (6 byte header-ID) or 0111b (full 8 byte header)
^a For gas it is the temperature converted volume, unless a VIFE signals volume at metering- conditions or volume at base-conditions. ^b Meaning depends on data field.			

7.3 VIF-codes for special purposes

Table 27 — Special VIF-codes

Coding	Description	Purpose
1111 1011 (FBh)	First extension of VIF-codes	True VIF is given in the first VIFE and is coded using (Table 29 in 7.5) (128 new VIF-Codes)
E111 1100	VIF in following string (length in first byte)	Allows user definable VIF's (in plain ASCII-String) ^a
1111 1101 (FDh)	Second extension of VIF-codes	True VIF is given in the first VIFE and is coded using (Table 28 in 7.4) (128 new VIF-Codes)
1110 1111 (EFh)	Reserved for third extension table of VIF-codes	reserved for a future table especially for electricity meters
E111 1110	Any VIF	Used for readout selection of all VIF's (see 6.4, 7.1)
E111 1111	Manufacturer specific	VIFE's and data of this block are manufacturer specific
^a Coding the VIF in an ASCII-String in combination with the data in an ASCII-String (data field in DIF = 1101 b) allows the representation of data in a free user defined form (see Annex C.2).		

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

Table 28 — Main VIFE-code extension table

Coding	Description	Group
E000 00nn	Credit of 10^{nn-3} of the nominal local legal currency units	Currency units
E000 01nn	Debit of 10^{nn-3} of the nominal local legal currency units	
E000 1000	Unique message identification (previously named "Access number (transmission count)") ⁹	Enhanced identification
E000 1001	Device type	
E000 1010	Manufacturer	
E000 1011	Parameter set identification	
E000 1100	Model / Version	Improved selection and other user requirements
E000 1101	Hardware version number	
E000 1110	Metrology (firmware) version number	
E000 1111	Other software version number	
E001 0000	Customer location	Improved selection and other user requirements
E001 0001	Customer	
E001 0010	Access code user	
E001 0011	Access code operator	
E001 0100	Access code system operator	

Table 28 (continued)

Coding	Description	Group
E001 0101	Access code developer	
E001 0110	Password	
E001 0111	Error flags (binary) (device type specific)	
E001 1000	Error mask	
E001 1001	Security key ⁱ	
E001 1010	Digital output (binary)	
E001 1011	Digital input (binary)	
E001 1100	Baud rate [baud]	
E001 1101	Response delay time [bit-times]	
E001 1110	Retry	
E001 1111	Remote control (device specific e.g. gas valve)	
E010 0000	First storage number for cyclic storage	
E010 0001	Last storage number for cyclic storage	
E010 0010	Size of storage block	
E010 0011	Reserved	Enhanced storage
E010 01nn	Storage interval [sec(s) ... day(s)] ^a	management
E010 1000	Storage interval month(s)	
E010 1001	Storage interval year(s)	
E010 1010	Operator specific data ^h	
E010 1011	Time point second (0 to 59)	
E010 11nn	Duration since last readout [sec(s) ... day(s)] ^a	
E011 0000	Start (date/time) of tariff ^b	
E011 00nn	Duration of tariff (nn=01 ... 11: min to days)	
E011 01nn	Period of tariff [sec(s) to day(s)] ^a	
E011 1000	Period of tariff months(s)	Enhanced tariff
E011 1001	Period of tariff year(s)	management
E011 1010	Dimensionless / no VIF	
E011 1011	Data container for wireless M-Bus protocol ^f	
E011 11nn	Period of nominal data transmissions [sec(s) to day(s)] ^a (e.g. for RF-transmissions)	Installation and start up
E100 nnnn	10 ⁿⁿⁿⁿ⁻⁹ volts	Electrical units
E101 nnnn	10 ⁿⁿⁿⁿ⁻¹² A	
E110 0000	Reset counter	
E110 0001	Cumulation counter	
E110 0010	Control signal	
E110 0011	Day of week ^e	
E110 0100	Week number	

Table 28 (continued)

Coding	Description	Group
E110 0101	Time point of day change	
E110 0110	State of parameter activation	
E110 0111	Special supplier information	
E110 10pp	Duration since last cumulation [hour(s) ... years(s)] ^c	
E110 11pp	Operating time battery [hour(s)..years(s)] ^c	
E111 0000	Date and time of battery change ^b	
E111 0001	RF level units: dBm ^d	
E111 0010	Daylight savings (beginning, ending, deviation) data type K	
E111 0011	Listening window management data type L	
E111 0100	Remaining battery life time (days)	
E111 0101	Number times the meter was stopped	
E111 0110	Data container for manufacture specific protocol ^f	
E111 0111 – E111 1111	Reserved	

a nn = 00 second(s)
01 minute(s)
10 hour(s)
11 day(s)

b The information about usage of data type F (date and time) or data type G (date), I (time to seconds) or J (extended date/time) can be derived from the data field (0010b: type G / 0011b: type J, 0100: type F).

c pp = 00 hour(s)
01 day(s)
10 month(s)
11 year(s)

d Typically this VIFE is used in context with a function field of 00b of the leading DIF. If this VIFE used together with the function field 10 b it declares a preset quality limit of the reception level which was exceeded (e.g. RF-Level > -80dBm). If this VIFE is used together with the function field 11 b it declares the typical noise level detected by this radio device.

e Data type A (1 = Monday; 7 = Sunday, 0 = all the days).

f Using this VIFE as a data container for wireless M-Bus or manufacturer specific protocol in combination with the variable length DIF = 0Dh (LVAR from 00h to BFh only, see Annex N).

g The unique message identification is not resettable.

h This data point is reserved for the transport of any special information for the operator. It shall not be used by the vendor!

i Typically the security key needs to be set with data field LVAR , due to its large size.

7.5 Alternate VIFE-code extension table (following VIF = FBh for primary VIF)

Table 29 — Alternate extended VIF-code table

Coding	Description	Range Coding	Range
E000 000n	Energy	$10^{(n-1)}$ MWh	0.1 MWh to 1 MWh
E000 001n	Reactive energy	$10^{(n)}$ kVARh	1 to 10 kVARh
E000 010n	Apparent energy	$10^{(n)}$ kVAh	1 to 10 kVAh
E000 011n	Reserved		
E000 100n	Energy	$10^{(n-1)}$ GJ	0.1 GJ to 1 GJ
E000 101n	Reserved		
E000 11nn	Energy	$10^{(n-1)}$ MCal	0.1 MCal to 100 MCal
E001 000n	Volume	$10^{(n+2)}$ m ³	
E001 001n	Reserved		
E001 01nn	Reactive power	$10^{(nn-3)}$ kVAR	0.001 kVAR to 1 kVAR
E001 100n	Mass	$10^{(n+2)}$ t	100 t to 1 000 t
E001 101n	Relative humidity	$10^{(n-1)}$ %	0.1 % to 100 %
E001 1100 – E001 1111	Reserved		
E010 0000	Volume	feet ³	
E010 0001	Volume	0,1 feet ³	
E010 0010	Reserved		a
E010 0011	Reserved		a
E010 0100	Reserved		a
E010 0101	Reserved		a
E010 0110	Reserved		a
E010 0111	Reserved		
E010 100n	Power	$10^{(n-1)}$ MW	0,1 MW to 1 MW
E010 1010	Phase U-U (volt. to volt.)		0.1°
E010 1011	Phase U-I (volt. to current)		0.1°
E010 11nn	Frequency	$10^{(nn-3)}$ Hz	0.001 Hz to 1 Hz
E011 000n	Power	$10^{(n-1)}$ GJ/h	0,1 GJ/h to 1 GJ/h
E011 001n	Reserved		
E011 01nn	Apparent power	$10^{(nn-3)}$ kVA	0.001 kVA to 1 kVA
E011 1000 – E101 0111	Reserved		
E101 1000 – E110 0111	Reserved		a
E110 1nnn	Reserved		
E111 00nn	Reserved		a
E111 01nn	Cold/warm temperature limit	$10^{(nn-3)}$ °C	0,001 °C to 1 °C
E111 1nnn	Cum. max. of active power	$10^{(nnn-3)}$ W	0,001 W to 10 000 W
a These codes were used until 2004, now they are reserved for future use.			
NOTE Refer also to Annex C for non-metric units.			

7.6 Combinable (orthogonal) VIFE-Code extension table

This code follows immediately the VIF or the VIFE (in case of code extension) and modifies its meaning.

Table 30 — Combinable (orthogonal) VIFE-table

VIFE-Code	Description
E000 xxxx	Reserved for object actions (master to slave): see Clause 9 or for error codes (slave to master): see 8.4
E001 0100	Relative deviation ^a
E001 0000 – E001 0100	Reserved
E001 0101 –E001 1100	Record error codes (slave to master); (see 8.4)
E001 1101	Standard conform data content ^b
E001 1110	Compact profile with registers ^c
E001 1111	Compact profile without registers ^c
E010 0000	Per second
E010 0001	Per minute
E010 0010	Per hour
E010 0011	Per day
E010 0100	Per week
E010 0101	Per month
E010 0110	Per year
E010 0111	Per revolution / measurement
E010 100p	Increment per input pulse on input channel number p
E010 101p	Increment per output pulse on output channel number p
E010 1100	Per litre
E010 1101	Per m ³
E010 1110	Per kg
E010 1111	Per K (Kelvin)
E011 0000	Per kWh
E011 0001	Per GJ
E011 0010	Per kW
E011 0011	Per (K*l) (Kelvin*litre)
E011 0100	Per V (volt)
E011 0101	Per A (ampere)
E011 0110	Multiplied by s
E011 0111	Multiplied by s / V
E011 1000	Multiplied by s / A
E011 1001	Start date(/time) of ^{d, e}

Table 30 (continued)

VIFE-Code	Description
E011 1010	VIF contains uncorrected unit or value at metering conditions instead of converted unit
E011 1011	Accumulation only if positive contributions (forward flow contribution)
E011 1100	Accumulation of abs value only if negative contributions (backward flow)
E011 1101	Reserved for alternate non-metric unit system (according to Annex C)
E011 1110	Value at base conditions ^f
E011 1111	OBIS-declaration (data type C follows in case of binary coding)
E100 u000	U = 1: upper, u = 0: lower limit value
E100 u001	Number of exceeds of lower u = 0) / upper (U = 1) limit
E100 uf1b	Date (/time) of: b = 0: begin, b = 1: end of, f = 0: first, f = 1: last ^b u = 0: lower, u = 1: upper limit exceed
E101 ufnn	Duration of limit exceed (u, f: as above, nn = duration)
E110 0fnn	Duration of ^{a, b} (f: as above, nn = duration)
E110 1u00	Value during lower (u = 0), upper (u = 1) limit exceed
E110 1001	Leakage values
E110 1101	Overflow values
E110 1f1b	Date (/time) of ^a (f,b: as above)
E111 0nnn	Multiplicative correction factor for value (not unit): 10^{nn-6}
E111 10nn	Additive correction constant: $10^{nn-3} \cdot \text{unit of VIF (offset)}^g$
E111 1100	Extension of combinable (orthogonal) VIFE-Code (refer to Table 31)
E111 1101	Multiplicative correction factor for value (not unit): 10^3
E111 1110	Future value
E111 1111	Next VIFEs and data of this block are manufacturer specific
a Use the multiplier VIFE E111 0nnn to generate % or ppm values, e.g. multiplier of 10-2. b This VIFE shall be attached to a special VIFE if the content of the related data point has not a manufacture specific use but conforms exclusively to the definitions of the Annex H. c This VIFE declares a series of data points as compact profile. According to Annex I. d "Date(/time) of" or "Duration of" relates to the information which the whole Data Record Header contains. e The information about usage of data type F (date and time) or data type G (date) can be derived from the data field (0010b: type G / 0100: type F). f Used either to indicate that the consumption value is referenced, respectively converted to base conditions (e.g. gas volume at base temperature and base pressure) or for the base condition itself (e.g. reference/ base temperature or reference/ base pressure). g The additive correction constant is given as a separate data record.	

The codes of Table 31 follow immediately after the VIFE=FCh of Table 30.

Table 31 — Extension of combinable VIFE-table (following VIFE = FCh of combinable (orthogonal) VIFE-table)

VIFE-Code	Description
E000 0000	Reserved
E000 0001	At phase L1
E000 0010	At phase L2
E000 0011	At phase L3
E000 0100	At neutral (N)
E000 0101	Between phase L1 and L2
E000 0110	Between phase L2 and L3
E000 0111	Between phase L3 and L1
E000 1000 – E000 1111	Reserved
E001 0000	Accumulation of abs. value for both positive and negative contribution ^a (absolute count)
E001 0001 – E111 1111	Reserved
^a This extension is used in special case if the meter index counts up independent of the polarity of the meter (for both directions).	

8 Application layer status and error reporting

8.1 General

The acknowledgement by the data link layer reports only a successful communication. Errors happened by the handling of the transmitted application data are not reported. There are three different techniques for the reporting of application errors.

8.2 Status field

The presence and type of an application error shall be indicated by the status field in the variable data structure (refer to Table 8 in 5.10).

8.3 General application layer errors

For reporting general application errors, a slave can use a RSP_UD datagram with CI = 6Eh, 6Fh or 70h and zero, one or several data bytes, which describe the type of error:

Table 32 — Application error (no header)

CI=70h	Optional first error code byte (1 byte - see Table 35)
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Table 33 — Application error (short data header)

CI=6Eh	Short data header (see Annex J)	Optional first error code byte (1 byte - see Table 35)
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Table 34 — Application error (long data header)

CI=6Fh	Long data header (see Annex J)	Optional first error code byte (1 byte - see Table 35)
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The following values for DATA are defined:

Table 35 — First error code byte for general application errors

Byte	Designation	Type of error
00h	Unspecified error	Unspecified error: also if data field is missing
01h	CI-field error	Unimplemented CI-field
02h	Buffer overflow	Buffer too long, truncated
03h	Record overflow	Too many records
04h	Record error	Premature end of record
05h	DIFE overflow	More than 10 DIFE's
06h	VIFE overflow	More than 10 VIFE's
07h	-	Reserved
08h	Application busy	Application too busy for handling readout request
09h	Credit overflow	Too many readouts (for slaves with limited readouts per time)
0Ah...0Fh	-	Reserved
11h	No function	Function not implemented (command unknown or not supported) ^a
12h	Data error	Data to be supplied not available ^a
13h	Routing/Relaying error	Cannot route/relay data further ^a
14h	Access violation	Data access right violation ^a
15h	Parameter error	Parameter is missing or wrong ^a
16h	Size error	The amount of data requested cannot be handled ^a
17h to 1Fh	-	Reserved
20h	Wrong encryption key	Decryption fails
21h	Wrong encryption method	Encryption method not supported
22h to EFh	-	Reserved
F0h	-	Dynamic application error ^b
F1h...FFh	-	Manufacture specific application error

^a These error codes are applied in EN 13757-5.

^b The data point is coded as M-Bus-specific data point with a leading DIF/ VIF. The declaration is vendor specific. The dynamic application error is limited to 7 bytes.

8.4 Record errors

To report errors belonging just to a special record and not to the full application, the slave can add to the defective record a VIFE containing one of the values of Table 36 to code the type of application error, which has occurred for this record.

Table 36 — Codes for record errors (E = Extension bit)

VIFE-Code	Type of record error	Error group
E000 0000	None	DIF errors
E000 0001	Too many DIFEs	
E000 0010	Storage number not implemented	
E000 0011	Unit number not implemented	
E000 0100	Tariff number not implemented	
E000 0101	Function not implemented	
E000 0110	Data class not implemented	
E000 0111	Data size not implemented	
E000 1000 to E000 1001	Reserved	
E000 1010	Reserved	VIF errors
E000 1011	Too many VIFEs	
E000 1100	Illegal VIF-Group	
E000 1101	Illegal VIF-Exponent	
E000 1110	VIF/ DIF mismatch	
E000 1111	Unimplemented action	
E001 0000 to E001 0100	Not used for record errors	
E001 0101	No data available (undefined value)	Data errors
E001 0110	Data overflow	
E001 0111	Data underflow	
E001 1000	Data error	
E001 1001 to E001 1011	Reserved	
E001 1100	Premature end of record	Other errors

In case of record errors the data maybe invalid. The slave has some options to transmit the data:

- data field = 0000b: no data;
- data field = 0000b: no data and idle filler (DIF = 02Fh): fill record up to the normal length;
- other data field: dummy data of correct length;
- other data field: unsafe or estimated data.

9 Generalised object layer

The fundamental idea of an object is the encapsulation of data and methods or actions for the data. In case of writing data to a slave the master software can pack data and information about the action, which the slave shall do with this data, in one data record. This variable data record with actions is now called an object. Following any VIF including a VIF = FDh or VIF = FBh with the true value information in the first VIFE, another (usually the last) VIFE can be added which contains a code signalling object actions according to the following table.

Table 37 — Action codes for the generalised object layer (master to slave)

VIFE-Code binary	Action	Explanation
E000 0000	Write (replace)	Replace old with new data
E000 0001	Add value	Add data to old data
E000 0010	Subtract value	Subtract data from old data
E000 0011	OR (set bits)	Data OR old data
E000 0100	AND	Data AND old data
E000 0101	XOR (toggle bits)	Data XOR old data
E000 0110	AND NOT (clear bits)	NOT data AND old data
E000 0111	Clear	Set data to zero
E000 1000	Add entry	Create a new data record
E000 1001	Delete entry	Delete an existing data record
E000 1010	Delayed action	A CI = 5Ch will follow and execute the desired action
E000 1011	Freeze data	Freeze data to storage no.
E000 1100	Add to readout-list	Add data record to RSP_UD
E000 1101	Delete from readout-list	Delete data record from RSP_UD
E000 111x	Reserved	
NOTE The object action "write/ replace" (VIFE = E000 0000) is the default and is assumed if there is no VIFE with an object action for this record.		

10 Manufacturer specific unstructured data block

The MDH consists of the character 0Fh or 1Fh (DIF = 0Fh or 1Fh) and indicates that all following data are manufacturer specific. When the total number of bytes given from the link/network layers and the number of record-structured bytes and the length of the fixed header is known, the number of remaining unstructured manufacturer specific bytes can be calculated.

NOTE Structured manufacturer specific data (i.e. those with a known data structure including variable length binary or ASCII but with a manufacturer specific meaning or unit) can be described using normal data records with a value information field of VIF = E1111111b.

The MDH = 1Fh is used for multi datagram messages (refer to 6.4).