

BS EN 13757-5:2015



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Communication systems for meters

Part 5: Wireless M-Bus relaying

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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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European foreword

This document (EN 13757-5:2015) has been prepared by Technical Committee CEN/TC 294 “Communication systems for 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of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by May 2016.

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 13757-5:2008.

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

EN 13757 comprises the following parts:

- *Part 1: Data exchange*
- *Part 2: Physical and link layer*
- *Part 3: Dedicated application layer*
- *Part 4: Wireless meter readout (Radio meter reading for operation in SRD bands)*
- *Part 5: Wireless M-Bus relaying*
- *Part 6: Local Bus*

According to the CEN-CENELEC Internal Regulations, the national standards organizations 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.

1 Scope

This European Standard specifies the protocols to use when performing relaying in wireless meter readout networks. This European Standard is an extension to wireless meter readout specified in EN 13757-4. It supports the routing of modes P and Q, and simple single-hop repeating of modes S, T, C, F and N.

The main use of this European Standard is to support simple retransmission as well as routed wireless networks for the readout of meters.

NOTE Electricity meters are not covered by this standard, as the standardization of remote readout of electricity meters is a task for IEC/CENELEC.

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 13757-1:2014, *Communication systems for meters — Part 1: Data exchange*

EN 13757-3:2013, *Communication systems for meters and remote reading of meters — Part 3: Dedicated application layer*

EN 13757-4:2013, *Communication systems for meters and remote reading of meters — Part 4: Wireless meter readout (Radio meter reading for operation in SRD bands)*

EN 60870-5-1:1993, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 1: Transmission frame formats (IEC 60870-5-1:1990)*

EN 60870-5-2:1993, *Telecontrol equipment and systems — Part 5: Transmission protocols — Section 2: Link transmission procedures (IEC 60870-5-2:1992)*

EN 62054-21:2004, *Electricity metering (a.c.) — Tariff and load control — Part 21: Particular requirements for time switches (EN 62054-21:2002)*

RFC 1662 July 1994, *HDLC-like Framing, Appendix C. Fast Frame Check Sequence (FCS) Implementation*

ETSI EN 300 220-1:2012, *Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods*

CEPT/ERC/REC 70-03, *Relating to the use of short range devices (SRD)*

3 Terms and definitions

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

3.1

Bidirectional Single Hop Repeater

BSHR

repeater retransmitting original frames in upstream as well as downstream direction

Note 1 to entry: The 'H' bit in the Extended Link Layer shows whether or not frames are original or repeated.

3.2

block

sub-element of a frame

Note 1 to entry: For an EN 60870-5-1 based protocol; this will be up to 16 bytes of user data completed by a CRC check.

3.3

downlink

transmission in downstream direction

3.4

downstream

transmission of data in the direction from the Data Collecting Unit to the Meter

3.5

end node

Meter or Data Collecting Unit

Note 1 to entry: The Data Collecting Unit is named Other Device in EN 13757-4.

3.6

frame

set of data encapsulated by a header and optionally a trailer

Note 1 to entry: For an EN 60870-5-1 based protocol this will be a start character followed by up to 16 blocks of data.

3.7

gateway

intermediate node in a data communications network, connected to two or more logical networks, where the protocols or modes used on the logical networks are different

3.8

hop

transfer of a set of data from one node to an adjacent node, as one of the steps in the transfer of data between end nodes

3.9

intermediate node

node in a network sitting in-between a Data Collecting Unit and a Meter

3.10

meter assignment

exclusively pairing a Meter to a repeater

Note 1 to entry: This is performed by Network Control. This allows access and downstream communication to the meter.

3.11

meter registration

registration of a meter in one or several repeaters

Note 1 to entry: This allows the repeater to repeat the transmissions from the Meter upstream.

3.12

Network control

NC

logical unit to control and supervise repeaters in the network

Note 1 to entry: Network Control may be located in a Data Collecting Unit, in a repeater or in a dedicated device outside the network.

3.13

node

unit in a network that is able to send and receive data

3.14

Other Device

Data Collecting Unit

Note 1 to entry: This is the term used in EN 13757-4.

3.15

primary station

network node that controls all of the data exchange in a simple network with one central node, unbalanced data transfer and multiple remote nodes

Note 1 to entry: All data transfer will (normally) be controlled by the primary station. A Data Collecting Unit will be a primary station.

3.16

radio scan list

list of all Meters having sent a valid frame

Note 1 to entry: Entries in this list will be removed after a certain time (time out).

3.17

relaying

forwarding of information from one logical network to another

3.18

repeat meter list

RML

list of end nodes registered for repetition

Note 1 to entry: The list is allocated to (and downloaded into) a repeater by Network Control. The list is generated from meter assignment and meter registration.

3.19

repeater

intermediate node in a data communications network, retransmitting data without modifying address information

3.20

router

intermediate node in a data communications network, connected to two or more logical networks with identical protocols and modes

3.21

secondary station

node in a hierarchical network, that is able to receive commands and requests from a central node, the primary station, and to send a response back to the central node

Note 1 to entry: A Meter will be a secondary station.

3.22

Uni-directional single hop repeater

USHR

repeater retransmitting original frames in upstream direction only

Note 1 to entry: The 'H' bit in the Extended Link Layer shows whether or not frames are original or repeated.

3.23

uplink

transmission in upstream direction

3.24

upstream

transmission of data in the direction from the Meter to the Data Collecting Unit

4 Symbols

The following symbols are used for timing parameters on drawings in Annex A.

t_{DRFS}	Time delay repeater, fixed, start of message reference
t_{DRFE}	Time delay repeater, fixed, end of message reference
$t_{DRSlotN}$	Time delay repeater, where N may be 1 to 7
t_{DRR}	Time delay repeater, randomized
t_{IA}	Time delay Installation Announcement
t_{RO}	Time for response from Other Device (default, fast)
t_{RO_slow}	Time for response from Other Device(slow)
t_{RR}	Time for response from repeater (default, fast)
t_{RR_slow}	Time for response from repeater (slow)
t_{TxD}	Time delay for transmission in Frequent Access Cycle (FAC)

5 Introduction

5.1 General

This clause is an explanatory clause, and the specific requirements are to be found in the latter clauses of this European Standard.

5.2 Use of retransmission

The availability of low cost radio modules has made it feasible to use radio communication for the readout of meter data. Many meters are battery operated and have a very strict power budget and regulatory requirements are imposed as well. This limits the transmitting power levels and thereby the useful distance between transmitters and receivers. The use of reinforced concrete, conductive surface coatings and placement of meters below ground level like in pits and in the basement of the buildings

aggravates the problem of directly communicating between a data collecting unit and a meter. This limits the useful size of radio networks unless forwarding is used. By letting some of the nodes forward, the effective size of the network can be increased. This makes radio based networks a more cost effective solution.

A forwarding concept will still have a number of constraints. The cost of adding this capability to the meters has to be low, since meters are cost sensitive high volume products. The limited energy and computing power available in the individual nodes mandates a limited complexity of the software handling the communications protocol and the forwarding.

Operating and installation costs are important factors when planning for meter networks. The reconfiguration of the network when adding, replacing or removing meters may be automated to limit the operating cost.

The overhead due to forwarding of data transmitted is required to be low to keep the transmission duty cycle within the limitations imposed by the authorities.

The fact that meters are cost sensitive devices makes it advantageous to allow for simple single-hop retransmission (repeating) as well. This transmission works mainly at the Physical Layer level. Such repeaters have a limited functionality but cover the needs for low cost meters. The architecture of such repeaters is described in the subclause below and is specified in detail in Clause 9.

5.3 Repeating

If a direct transmission between a Meter and an Other Device is not possible a repeater may be used in between. Such a repeater shall be able to work without complex installation procedures and without routing capability. The single hop repeater shall support one-way or two-way communication.

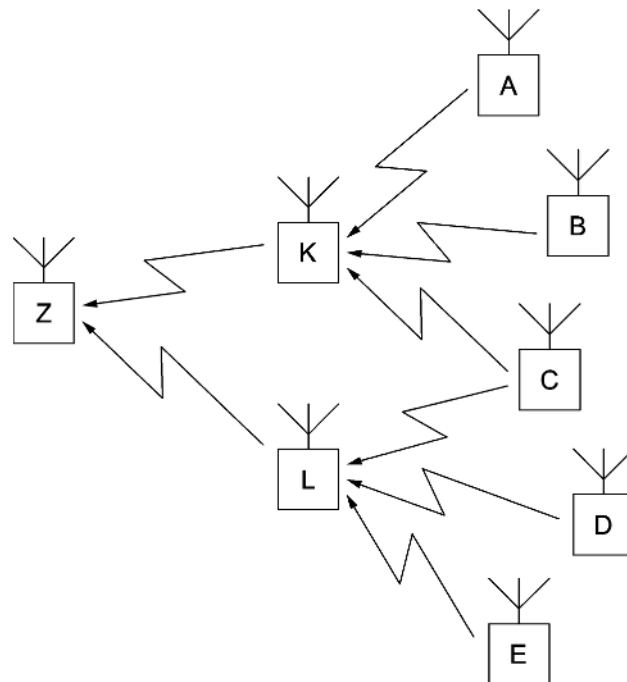
NOTE A repeater according to this European Standard is only able to forward the message for a single hop.

- Unidirectional Single Hop Repeater (USHR) only repeating messages from the Meter upstream to the Other Device.
- Bidirectional Single Hop Repeater (BSHR) repeating messages in both directions, i.e. from the Meter upstream to the Other Device and from the Other Device downstream to the addressed Meter.

A repeater may, at the same time, operate as an USHR for some meters and as a BSHR for other meters.

The network architecture is shown on Figure 1. The Meters A, B, C, D, and E, are not always able to reach the Other Device Z directly. Two repeaters, K and L, are inserted to handle this. Meters A, B, C are able to reach repeater K that will forward the frames to the Other Device Z. Meters C, D and E are able to reach repeater L that will forward their frames to the Other Device Z. Repeater K may as well be able to receive the data from repeater L but it will not repeat the frames once more, as a 'repeated flag' is already set in the frame.

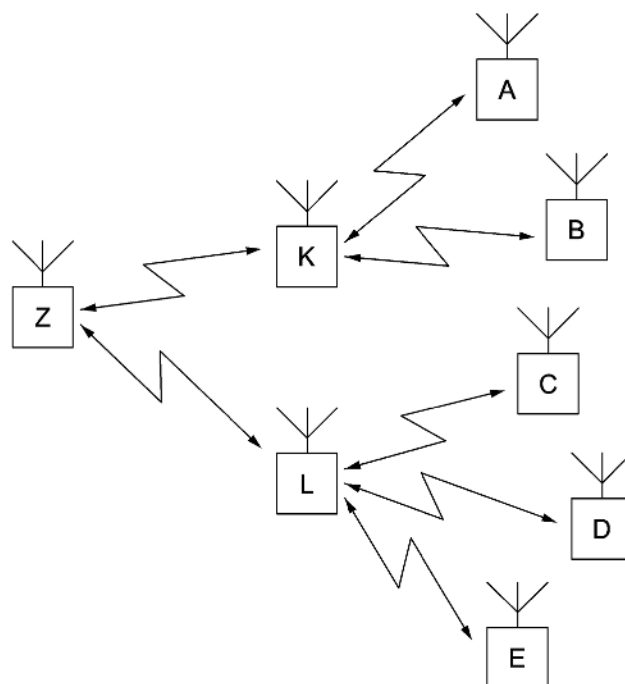
Meter C is able to reach both repeaters. This can generate duplication and collisions. A randomized timing in the individual repeaters ensures that the frame from a meter will not collide frequently if it is repeated by multiple unidirectional single hop repeaters.



Key

A – E meters
K – L repeater
Z Other Device

Figure 1 — Unidirectional Single Hop Repeater, USHR



Key

A – E meters
K – L repeater
Z Other Device

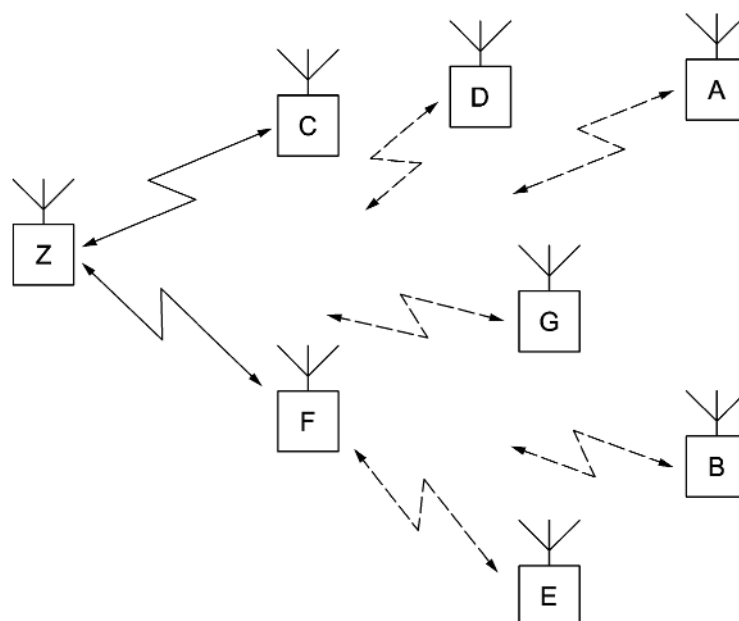
Figure 2 — Bidirectional Single Hop Repeater, BSHR

Bi-direction repetition, as shown on Figure 2, may get a little more complex once bidirectional meters and repeaters are used. The bidirectional meters may, for energy saving purpose, only enable its receiver in a narrow listening window. The setup in the repeater ensures that any response from the Other Device is transmitted in this listening window. The details of this are specified in Clause 9.

5.4 Relaying

5.4.1 Overview

A radio network may have a structure like the one shown in Figure 3 below. The Nodes A, B, C, D, E, F and G are simple meters. They all need to communicate with Node Z, the data collecting unit / the primary station. In the current setup only the Nodes C and F, are able to reach the Node Z. The other nodes cannot reach the Node Z. The useful size of this network is thereby limited to only 2 nodes, Nodes C and F.



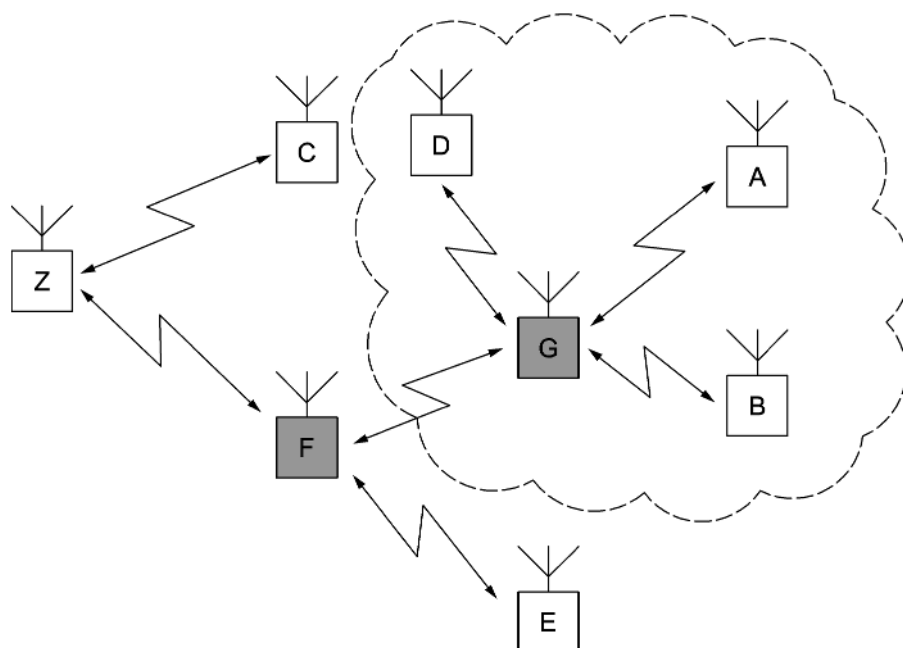
Key

A – G simple meters

Z data collecting unit/primary station

Figure 3 — Network with simple nodes, without relaying

Extending the network by adding some nodes with relaying capability will give a structure as shown on Figure 4. Nodes F and G have now been extended to include relaying capability. Communication between Nodes A, B and D and the primary station is achieved by relaying the data through Nodes G and F. Node A sends data to node G, node G relays data to node F and node F relays data to the Node Z, the data collecting unit. The size of the network can now be extended to include all of the nodes shown. The Nodes F and G may be dedicated relaying nodes or meters with extended capabilities. Transmission from one node to another is called a hop. The transmission from node A to the data collecting unit/primary station consists of three hops.

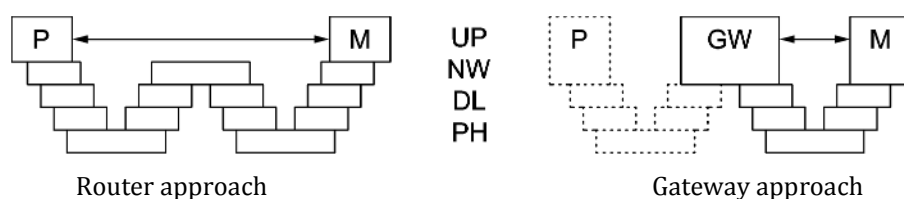


Key

- A – E simple meters
- F, G nodes with relaying capability
- Z data collecting unit/primary station

Figure 4 — Network with relaying nodes

Remark that the network still has a hierarchical structure at the application level, despite the relaying nodes. All end-to-end data transfer is performed between the data collecting unit and the meters. The meters do not communicate with one another at the application level nor do the relays.



Key

- UP upper layers (Transport – Application)
- NW Network Layer
- DL Data Link layer
- PH Physical layer
- M meter
- GW node with relaying capability (gateway)
- P data collecting unit/primary station

Figure 5 — Router vs. gateway solution

The relaying can be performed in two different ways as shown in Figure 5 using either a gateway or a router approach.

In the router approach all nodes in the network are aware of the other nodes in the network and they all use the same protocol in both directions. The nodes are aware of the routing capability of certain nodes as well. Node B, as shown on Figure 4 will know that it for instance has to send data through the relaying Nodes G and F to reach the data collecting unit.

In the gateway approach only the locally reachable nodes are known. Nodes beyond the gateway are hidden. To Nodes A, B and D in Figure 4, the network is limited to the area inside the dashed line, and node E is to all subordinate units the "data collecting unit". The gateways are organised in a hierarchy of networks as well, as shown in Figure 4, where node E is at the bottom of the hierarchy, node F is one level above it and node Z the real data collecting unit is at the top level.

The generic details of the gateway and the router approach are specified in the following sub clauses.

5.4.2 Use of routers

In a routed network the nodes all behave like peer entities at the network level. Transfer between nodes is based on pairs of addresses, the sender node address and the receiver node address. This allows for a non-hierarchical structure of the nodes in a network with parallel paths.

The fact that a pair of addresses is needed makes the routed approach incompatible with the data link layer used in EN 13757-4. There is thus a need of being able of distinguishing between native EN 13757-4 data and routed data at the data link layer. This to ensure that simple nodes do not try to decode and handle routed data by mistake.

The way of selecting the path to use when sending a package through a network can be determined in two ways. The first is the hop-by-hop method. Here the full path is set up prior to the first transmission, and it includes all the nodes to connect through. The second method use network generated paths. Here the first node sends the data to suitable neighbour router, and this router then determines the next hop for the data, based on its routing information. This latter method is the one used by the IP protocol on the Internet. The approach selected for this application is the hop-by-hop addressing method, as this is less complex to implement and requires less network traffic overhead and less intelligence in the nodes in the network.

5.4.3 Use of gateways

A simple node has only a single address field. It is only able to work in a network with a single primary station controlling the network and one or more secondary stations / meters. A simple node will when receiving data look for its own address in the address field. It will assume that all data sent to it originates from the primary station. A simple node will when responding include its own address in the header. It will assume that all data will be received by the primary station.

The gateway hides the network and network complexity from the simple nodes. To the nodes the gateway appears as the primary station. If the network shown in Figure 4 is using the gateways approach, then node G will appear as the primary station to Node A, B and D. Node E will assume that node F is the primary station, and only node C will actually connect directly to node Z, the data collecting unit. A gateway node may be a dedicated node, or a meter with extended functionality.

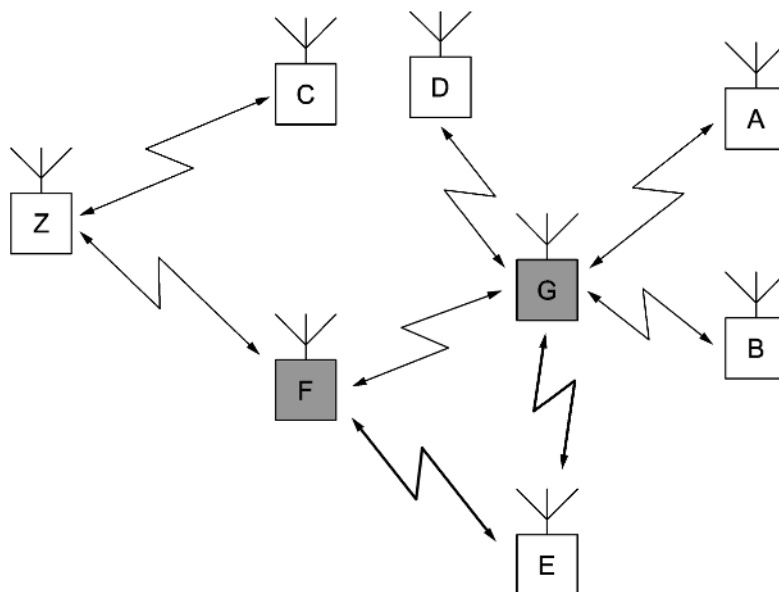
The gateway will when sending data downstream to the simple node(s) appear like the primary station. It will when receiving data sent upstream from a simple node appear like a primary station.

The gateway does not have any prior knowledge of the overall network configuration. Relaying of data will either be based on fixed rules, or on information provided in the header of the data. Both of these approaches are used in this gateway protocol.

The gateway may when data are sent upstream use the generic rule that the network is hierarchical. The gateway will when it has received data from a simple node to be sent upstream forward them further upstream. Data will then be received by another gateway or the primary station. There is no need for destination addressing of data sent upstream.

5.4.4 Data duplication

Not all data sent upstream should be forwarded, as this may cause data duplication. This can be seen on Figure 6 below.



Key

- A – E simple meters
- F, G nodes with relaying capability
- Z data collecting unit/primary station

Figure 6 — Data duplication

Data sent by Node E can be received by gateway G as well as by gateway F. When Node E sends a set of data, it will be received by both gateways. One set of data will be sent along the path E – G – F to node Z, the data collecting unit and another set of data will be sent along the path E – F to node Z. The use of unconditional relaying will cause duplication of the data received by the data collecting unit and cause unnecessary traffic on the network as well. Methods and rules need to be implemented to ensure that data duplication is limited.

Two issues should be handled when looking into avoidance of data duplication;

- a) Whether to use enabling or disabling lists,
- b) Whether to use a list of local or global nodes.

The nature of radio communication is that the actual transmitting distance may vary a lot over time. It is thus not feasible to generate a list of nodes, not allowed to relay for. Special transmitting conditions, due to for instance special metrological conditions, may make it possible to hear nodes located far away. It is as well possible, that a new operator, also following this European Standard, could set up new nodes that were not known, when the initial network was set up. Data from the new nodes is not to be performed by default, but there is no possibility of knowing the coming of these nodes in advance. These are examples of situations that cannot be handled orderly by a disabling list. An enabling list shall therefore be used.

The use of a global list of nodes, would require, that nodes at the higher levels of the hierarchy contains very large lists holding the address of all subordinate units it is to receive data from. All possible intermediate nodes has as well to contain information about all their subordinate nodes. This would

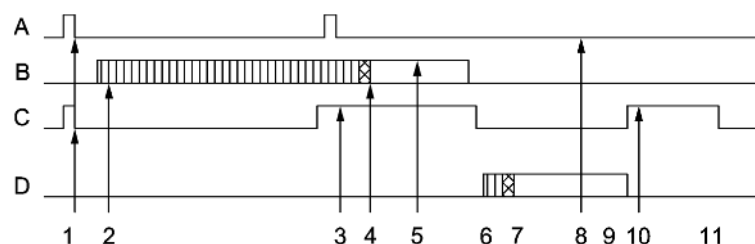
require a lot of data memory in the gateways, and cause a lot of network traffic when the lists are to be updated. The use of a local list has therefore been evaluated as superior, and selected. The use of a local list has the minor drawback that data sent upstream needs to contain the (local) address of the sending node, as well as the address of the originator, the meter.

The gateway will need further address information when it receives data to be sent downstream. It has to know what node(s) to forward the data to. This information, network control information, is to be available as a part of the header of the data.

Modes using gateway are no more a part of this standard.

5.4.5 Use of power strobed units

Many meters and intermediate nodes are battery operated, and have to operate from a single battery for several years. This makes it necessary to conserve power by switching off part of the circuits in the node when not in use. One such part is the radio. This is further described in Figure 7. The control program in a node may, when the node is not communicating, only switch on the receiver briefly with fixed intervals (1, 3). This listening will be disabled when the node is transmitting (8). Another node wanting to communicate with the power strobed node then sends a wake up signal (2). The power-strobed receiver will during its listening interval look for data transfer of the expected type (a wake up signal), and will switch off again if no data transfer is detected (1). The receiver shall, once wake up is detected (3), look for a synchronization pattern (4) and start to collect data (5). The receiver may, if the destination address of the information does not match that of the node switch off to conserve power. A node should, after the transmitter in the node has been active (6, 7, 9), switch on the receiver for a period (10, 11) in anticipation of a response to the transmitted message. Such behaviour will improve the processing of the data, and limit the duty cycle, as no wake up sequence is needed.



Key

- A receiver 'listening' window
- B 'wake up' and data signal
- C receiver active
- D data transmitted

Figure 7 — Power strobed receiver

The duration of the wake up sequence shall be long enough that it is detected by the node during the first listening interval to ensure an effective data transfer, i.e. be longer than the listening interval of the receiver.

To prevent unnecessary wake up of meters the wake up signal uses a different data rate than normal data transfers. On-going data transfers between nodes will not awake sleeping nodes, thus saving power.

The parameters specifying power wake up behaviour should be standardized to ensure energy efficient data transfer in the radio network.

5.4.6 Error handling

The data error rate will be higher in a radio based network than in a wired network. Some of the reasons for this are:

- The units are operating in a license free band, where a lot of other units may be operating at the same time. Such units may garble or block the transmission between a pair of nodes in the metering network.
- Noise from other sources may impair the signals.
- The radio transmission conditions may change due to changes in the environment (new building erected, container placed in front of the meters) or changes in weather conditions.
- The transmission of information from a meter to the data collecting unit may traverse multiple links. The overall transmission is only successful if all of the individual hops, forth and back, are successful.

All this makes it necessary with an efficient error handling algorithms in a radio based multi-hop networks. That is networks with routers or gateways. To alleviate the error handling, the following concepts are implemented in the protocols mode P and mode Q:

- data transmission is acknowledged for each hop;
- there is a fast acknowledge at the link layer;
- a negative acknowledge is returned if the message that should have been acknowledged, is garbled and the sender can be identified;
- a standardized retry algorithm is used.

If the retry algorithm fails, then the originating node is informed about the failure and about the hop where the failure occurred. This information is provided to higher layer protocols that may attempt to reroute the traffic through other nodes in the network. The protocols for such rerouting are outside the scope of this European Standard.

5.4.7 Time synchronization

New regulations in the energy market [COM (2003) 739 Final] demand improved energy efficiency. This requires reporting of actual time of use and thereby precise time information from the meters. Standards for energy meters, like EN 62054-21 already quantify these requirements. This imposes capabilities of precision timing in the meters, and thereby for a communications system that allows for a precision time synchronization through the network.

This need is to some extent in conflict with the use of power strobed meters and routers as shown in Figure 8.

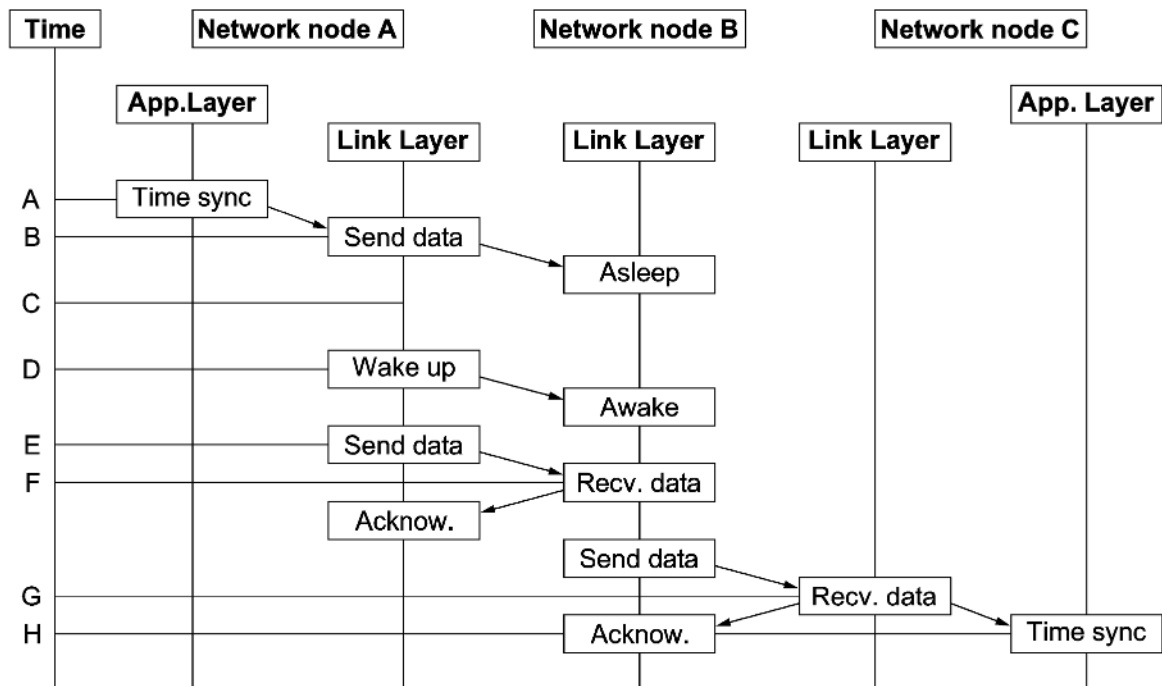


Figure 8 — Time synchrony propagation

The scenario is that a network Node A distributes a time synchronization signal to some other nodes in the network, Nodes B, C. One of the receiving Nodes B is asleep and will need a wake up signal before data can be transferred to it.

The management application in node A retrieves the time information at t_A . The information is processed by the lower protocol layers in the node, and sent to the network at t_B . The information is not detected by the receiving node that is asleep. This will at t_C cause a timeout condition in the sending Node A, as no acknowledge signal is received. The time-out condition will cause the link layer in node A to send a 'wake up' signal at t_D , followed by a retransmission of the packet at t_E . The receiving Node, B, is now awake and will receive the data at t_F , acknowledge the packet, and send the packet on to Node C. Node C receives the data at t_G , and passes the information on to the application layer at t_H .

The synchronization time in the application data is t_{BA} , whereas the actual time is t_H . This time difference $t_H - t_A$ will be in the (multiple) seconds range if one or more of the intermediate nodes were asleep prior to the transfer. This is not acceptable according the requirements for modern meters in EN 62054-21.

It is necessary to have a transmission protocol that ensures that precise timing information can be transferred. Such a protocol takes into account the delay introduced during the end to end transmission. This information is updated for each hop in the transmission. This processing of the data takes place at the link layer of the nodes. Experience from other precision timing protocols like IEEE 1588-2002 shows that this requires a special handling at the lower protocol layers. A special set of lower layer protocols will be specified for this purpose. The protocol shall contain a synchronization time t_A as well as delay information $t_H - t_{BA}$. The synchronization time is a part of the application data. The delay information is a part of the link layer information. The delay information is updated for each hop / retransmission of the data. This protocol may be used, if requirement for precision timing exists.

NOTE The use of this protocol will require that an Application Layer gateway is used if interfacing to meters using an EN 13757-4 interface.

5.5 Protocol possibilities

Based on the general needs expressed in this clause, three different protocols for relaying in a radio network are defined. They have the following general characteristics;

- A router based protocol. This protocol, named Mode P, extends the addressing to a dual address /balanced protocol, as used by all modern Data Link Layer protocols. This is done using the EN 60870-5-1 physical layer and EN 60870-5-2 link layer. Nodes using the mode P protocol cannot communicate directly with R2 nodes but the nodes can coexist in the same frequency band. The P and the R2 protocols are by structure very similar and dual-mode nodes supporting mode R2 as well as mode P may be foreseen. This is the protocol to use when one wants to use a true routed network with full addressing, but at the same time wants to keep the general structure of the R2 protocol.
- A contemporary protocol supporting precision timing. This protocol, named mode Q, is intended where one has not the need of following the EN 60870-5 series of standards. These EN 60870-5 series of standards were developed around 15 years ago and do not fulfil all the needs of a modern protocol. Mode Q takes into account; the possibility of energy saving using power strobing of the nodes, the needs for transfer of precision timing information and the possibility of using NRZ coding based on digital signal processors. The protocol is applicable as the transport service for a modern object oriented high level Application Layer service like the DLMS protocol specified in EN 13757-1.
- Single hop repeating protocol. A physical and link layer protocol. It is applicable to nodes using the Modes R, S, T, C, N and F as specified in EN 13757-4.

6 Mode P, protocol using routers

6.1 General

This protocol is applicable to communication between nodes with routing capability. The protocol shall use Mode P at the Physical Layer and the Data Link Layer to ensure that nodes without routing capability do not try to handle such messages.

The protocol is optimized for battery operated units with power strobed radio unit.

6.2 Physical Layer protocol

6.2.1 General

All the parameters shall, at the minimum, conform to ETSI EN 300 220, even if some applications may require extended temperature or voltage range. The channel and frequency band shall be as specified in Table 1.

Table 1 — Mode P, General

Characteristic	Min	Typ	Max	Unit
Frequency band ^a	868,0		868,6	MHz
Channel spacing		60		kHz
Transmitter duty cycle ^b			1	%
NOTE The characteristics are, for the SRD band, identical to the characteristics for the S and R2 modes in EN 13757-4.				
^a The standard is optimized for the 868-870MHz band, but with local radio approval, it may allow for operation in other frequency bands.				
^b Duty cycle shall be as defined by ETSI EN 300 220-1 in the SRD bands. It may with local radio approval allow for other duty cycles in other frequency bands.				

6.2.2 Transmitter

The parameters for the transmitters shall be as specified in Table 2.

Table 2 — Mode P, Transmitter

Characteristic	Sym	Min	Typ	Max	Unit	Remark
Centre frequency, ^a (Other Device)			868,330		MHz	
Centre frequency ^a (meter)			868,030 + $n \times 0,06$ ^h		MHz	
Frequency tolerance (meter / Other Device)			0	±17	kHz	~20ppm
FSK Deviation		±4,8	±6	±7,2	kHz	
Chip rate Wake up ^b			3,12		kcps	
Chip rate tolerance, Wake up			0	±2,5	%	
Wake up signal duration	t_{WD}	5200		6000	µs	
Chip rate Communications ^b			4,8		kcps	
Chip rate tolerance, Communications			0	±1,5	%	
Digital bit jitter ^c				±5	µs	
Data rate (Manchester encoding) ^d			$f_{chip} \times 1/2$		bps	
Preamble (leader) length including bit / byte-sync	L_{PR}	96			chips	
Postamble (trailer) length ^d	L_{PO}	2		16	chips	
Acknowledge window ^f	t_{AW}	3		50	ms	
Response delay ^g	t_{RD}	5		10 000	ms	
NOTE The Wake up chip rate has been selected in such a way, that it may be possible to derive it from the same master clock as the Communications chip rate.						
^a The standard is optimized for the 868-870MHz band, but with local radio approval, it may allow for operation in other frequency bands.						
^b The chip rate during communication deviates from the chip rate during wake up. This ensures that an ongoing transmission to another node is not detected as a wake up signal by a power-strobed unit.						
^c The bit jitter shall be measured at the output of the micro-controller or encoder circuit.						

Characteristic	Sym	Min	Typ	Max	Unit	Remark
d Each bit shall be coded as 2 chips (Manchester coding)						
e The postamble (trailer) shall consists of n=1 to 8 "ones" i.e. the chip sequence shall be n × (01).						
f Acknowledge window: After transmitting a message the node shall be ready for the reception of an acknowledge message in less than the minimum acknowledge window. After transmitting a message the node shall at least continue receiving for the duration of the maximum acknowledge window.						
g Response delay: After receiving a request message, the node shall not start sending the response back in less than the minimum response delay and shall start sending the response back in less than the maximum response delay.						
h n shall be in the range 0..9						

6.2.3 Receiver

The parameters for the receivers shall be as specified in Table 3.

Table 3 — Mode P, Receiver

Characteristic	Class	Sym	Min	Typ	Max	Unit	Remark
Sensitivity ^b	H _R	P _o	-105	-110		dBm	
Blocking performance	L _R		3			Class ^a	
Blocking performance ^c	M _R		2			Class ^a	
Blocking performance ^{c,d}	H _R		2			Class ^a	
Acceptable chip rate range		f _{chip}	4,7	4,8	4,9	kcps	~ 2%
Acceptable chip rate variation during header and frame		Df _{chip}		0	±0,2	%	
Wake up period		t _{WUP}			5000	ms	
Acknowledge delay ^e		t _{AD}	5		48	ms	
Response wait ^f		t _{RW}			21 000	ms	

NOTE The characteristics, with respect to frequencies and performance, are the same as for mode R2 in EN 13757-4.

- ^a Receiver class according to ETSI EN 300 220-1:2000, 9.3.
- ^b The sensitivity shall either be measured at (BER < 10⁻²) in conducted mode as specified in ETSI EN 300 220-2:2000, 4.1, or if this is not possible then it shall be measured at (Block acceptance rate > 80 %) as specified in ETSI EN 300 220-2:2000, 4.2.
- ^c Additional requirement for MR and HR receiver class: The receiver shall meet the performance criteria as specified in ETSI EN 301 489-1:2002, 9.2 and ETSI EN 301 489-3, Clause 6.
- ^d Additional requirement for the HR receiver class: Adjacent band selectivity shall be > 40 dB and Adjacent channel selectivity shall be > 40 dB minimum, as specified in ETSI EN 300 220-1:2000 V1-3-1, 9.1 and 9.2 respectively.
- ^e Acknowledge delay: After receiving a message, the node shall not start sending the acknowledge in less than the minimum acknowledge delay. After receiving a message, the node shall start sending the acknowledge in less than the maximum acknowledge delay.
- ^f Response wait: After sending a message and expecting a response, a node shall, at the Application Layer, not time out the connection in less than the maximum response wait time. The maximum value takes into account that some units needs a wake up signal. The maximum value may be extended, after agreement with the operator.

6.3 Data encoding

6.3.1 Manchester encoding

Manchester encoding shall be used for this mode. It allows for a simple coding/decoding. Each bit shall either be encoded as "10" chip sequence representing a data value of "0" or as "01" chip sequence representing a "1". The lower frequency shall correspond to a chip value of "0".

6.3.2 Order of transmission of the encoded data

Each data byte shall always be transmitted with the most significant bit (MSB = most significant bit) first. The byte sequence of the CRC shall be transmitted with the high byte first. The byte sequence of all other multi-byte field shall be transmitted with the low byte first.

6.3.3 Wake up and preamble chip sequences

This protocol is designed for use with long lifetime battery powered meters. It is important not to activate such meters at the wrong moment. The communications part of the meter is normally asleep / unpowered. The meter shall with regular intervals listen for a dedicated wake up signal for a short time. It may, if no wake up signal is detected go asleep again.

The chip-rate for the wake up signals shall deviate from the chip-rate for normal communication. This ensures that normal data traffic is not detected as a wake up signal.

A wake up signal shall be sent before the preamble, when the sender expects the receiver to be asleep. The wake up signal shall be immediately followed by the preamble. The total preamble (header + synchronization) chip sequence for this mode is $n \times (01) 000111 0101 1010 0101$ with $n \geq 39$.

NOTE 1 In Manchester coding, the chip sequence 000111 is invalid. But it is used near the end of the header to allow a receiver to detect the start of a new or a stronger transmission. This applies even during reception of a weaker transmission. The capture effect allows efficient communication even in a channel where many weak transmitters from a large area might otherwise effectively block the reception of a nearer (stronger) transmitter. In addition it allows receivers with power strobing to distinguish safely between the start of a valid frame and an accidental "sync" sequences within an ongoing transmission.

NOTE 2 The synchronization pattern differs from that of Mode S and mode R2 of EN 13757-4.

All chips of each frame, including pre- and postamble shall form an uninterrupted chip sequence.

6.4 Data Link Layer protocol

6.4.1 General

The protocol used shall be symmetrical, i.e. the same formatting of the data is used independent of whether it is an upstream or a downstream data transfer.

The Link Layer of EN 60870-5-2, 3.4 with the format class FT3 with the below mentioned exceptions shall be used;

- The two start characters as specified in EN 60870-5-1 6.2.4.4.2 are not used, as there is a preamble instead.
- Some of the header information, the address of the source node, extends into the second block, to allow for sufficient size address fields.

6.4.2 Frame format

A frame shall consist of at least two and optionally more blocks.

The format of the first block shall be as specified in Table 4.

NOTE 1 The size of the first block is less than 16 bytes to avoid breaking an address into two parts.

Table 4 — First block format

L-field	C-field	M1-field	A1-field	CRC-field
1 byte	1 byte	2 bytes	6 bytes	2 bytes

Where

L-field The total number of data in block 2 and onward as specified in EN 60870-5-1.

C-field The control field as specified in EN 60870-5-2, 6.1.2 (balanced transmission).

M1-field The Manufacturer ID field, for the destination node, as specified in EN 13757-4:2013, 11.5.5.

A1-field: The address of the destination node.

CRC-field: The check field as specified in EN 60870-5-1 Table 1, Format Class FT3.

NOTE 2 The size of the two A-fields has been set to 6 bytes to make it compatible with the meter address format used in EN 13757-4, to be able to uniquely identify the meter by the link layer address. This makes it necessary to split the total address information across two blocks, inserting a part of the address information in the second block.

The format of the second block shall be as specified in Table 5.

Table 5— Second block format

M2-field	A2-field	CI-field	Data	CRC-field
2 bytes	6 bytes	1 byte	(7 or if it is the last block (L-9)) bytes	2 bytes

Where

M2-field The Manufacturer ID field, for the source node, as specified in EN 13757-4:2013, 11.5.5.

A2-field: The address of the source node

CI-field The Control Information field.

Data Network control and application data.

CRC-field: The check field as specified in EN 60870-5-1 Table 1, format class FT3.

The format of the other optional blocks shall be as specified in Table 6.

Table 6 — Optional blocks format

Data	CRC-field
(16 or if it is the last block ((L-1) modulo 16)+1) bytes	2 bytes

Where

Data Network control and application data.

CRC-field: The check field as specified in EN 60870-5-1, Table 1

NOTE 3 The total number of blocks in a frame is limited to 16 by the size of the L-field.

6.4.3 C-field

6.4.3.1 General

For relays using the router approach, the requirements for the coding of the C-field, as specified in EN 60870-5-2, 6.1.2 shall apply. This is balanced transmission.

NOTE The definitions from EN 60870-5-2 are used in the subclauses that follow.

The format of the C-field, bit by bit shall be as specified in Figure 9.

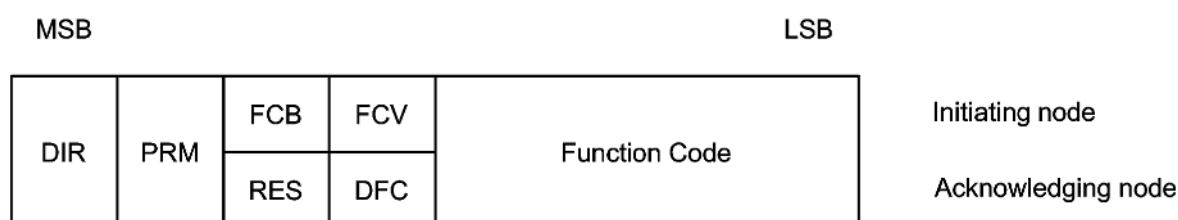


Figure 9 — C-field data format

6.4.3.2 When initiating a data exchange

When initiating a data exchange the following shall apply:

DIR – bit shall be '1' as the direction is from the initiating node.

PRM – bit shall be '1' if the direction is downstream and '0' if the direction is 'upstream'

FCB and FCV bit coding shall be as specified in EN 60870-5-2.

The Function code shall have one of the values listed in Table 7.

Table 7 — Initiating function codes

Function code ^a	Symbolic name	Function	Acknowledge
0 _h	LRESET	Link reset, shall be used when the FCB bit for this link shall be reset	No
3 _h	SEND	Send data, shall be used when the node sends normal data.	Yes
4 _h	BCAST ^b	Broadcast data, shall be used when the node sends broadcast data.	No
6 _h	INSTALL	Install information, shall be used when the node sends data and is itself in installation mode	Yes
NOTE There is no need for a REQUEST Function code at Link Layer level as requests and responses are handled at the Application Layer level.			
^a The value of the 4 bit Function code is specified in hexadecimal format as denoted by the trailing subscript 'h'.			
^b Broadcast data shall not be relayed through routers.			

6.4.3.3 During acknowledge of a data exchange

When responding to a data exchange the following shall apply:

DIR – bit shall be '0' if the direction is from the responding node.

PRM – bit shall be '1' if the direction is downstream and '0' if the direction is upstream;

RES – bit shall be '0';

DFC - bit shall be '1';

Function code shall have one of the values listed in Table 8.

Table 8 — Acknowledging function codes

Function code	Symbolic name	Function
0 _h	ACK	Acknowledge, shall be used when the node confirms a message with a Function code of SEND or INSTALL.
1 _h	NACK	Not acknowledge, shall be used when the node rejects a message with a Function code of SEND or INSTALL.

6.4.4 M- and A-fields

The size of the first block is by EN 60870-5-1 limited to 16 bytes. This block shall according to EN 60870-5-2 include all of the address fields. This does not allow for a full 8 bytes address field. The address has been extended into the second block to allow for the use of full 8 bytes address fields. This is not fully compliant to EN 60870-5-2:1993, 3.4.

The M1 and M2 field shall contain a unique User/Manufacturer identification of a node. The 15 least significant bits of these two bytes shall be formed from a three letter code, as specified in EN 13757-3. If the most significant bit of the M-field is '0' then the corresponding A-field shall be a unique (hard coded) manufacturer specified node address of 6 bytes. If the most significant bit of the M-field is '1', then the corresponding A-field may be a soft coded address. This address shall be unique within maximum range of the network. Such an address is normally assigned to the node at installation time.

A node may be multi-homed, i.e. it may respond to respond to multiple destination addresses.

NOTE The order of the M- and A-fields ensures that the receiving node is able to distinguish the destination address of the frame, as early as possible. This improves the possibility of limiting the on time and thereby the power consumption.

EN 60870-5-2 specifies that the broadcast address is an address field with all bits set to '1'. This shall, in the current context, be interpreted in the following way.

The concatenated destination M- and A-field shall have all bits set to '1' in a broadcast message. The source M-field and A-field shall be that of the sending node of the broadcast message.

6.4.5 The CI-field

The CI-field is the header of the upper layers. The use of this byte is explained in the subsequent subclauses on the Network Layer and on the Application Layer.

6.4.6 Message handling

6.4.6.1 General

The message handling requirements specified here are all at the Data Link Layer level.

6.4.6.2 Sending from an initiating node

The transmitter should, before initiating a transmission, receive on the selected channel, and ensure that a transmission is not blocking another ongoing transmission.

The initiating node shall initially send the message without a leading wake up signal.

The initiating node shall 1'st time and 2'nd time a message is retransmitted due to a NACK prepend the message with a Link Reset message. It shall not send a leading wake up signal.

The initiating node shall, 1'st time a message is retransmitted due to timeout, resend it with a leading wake up signal.

The initiating node shall, 2'nd time a message is retransmitted due to timeout, resend it without a leading wake up signal.

The initiating node shall, if the transmission has not succeeded after 3 attempts, pass a 'not success' flag to the Network Layer.

6.4.6.3 Sending from a acknowledging node

The acknowledging node shall send the acknowledge message without a leading wake up signal.

NOTE This is a reply to a node, that recently sent a message, and it should still be powered and active.

6.4.6.4 Receiving from an initiating node

When receiving from an initiating node the following shall apply;

The receiving node shall drop the frame, if the destination address, i.e. the M1- or the A1-field, is incorrect.

The node shall drop the frame if the CRC check of the first block fails.

The node shall not acknowledge a message if the Function Code does not request acknowledge, see Table 4.

The node shall reply with a NACK if the DIR bit is '0'.

The node shall reply with a NACK if the FCV / FCB control of the frame fails

The node shall reply with a NACK if the Function Code is not in the set specified in Table 4.

The node shall reply with a NACK if any of the subsequent CRC checks of the blocks fail.

The node shall, if all of the above tests are passed, reply with an ACK and forward the data to the Network Layer.

6.4.6.5 Receiving from an acknowledging node

When receiving from an acknowledging node the following shall apply;

The node shall drop the frame, if the destination address, i.e. the M1 – or the A1-field, is incorrect.

The node shall initiate retransmission if the CRC check of the first block fails.

The node shall initiate retransmission if the DIR bit is '1'.

The node shall reset the link and start a retransmission if a NACK is received.

The node shall, if all of the above tests are passed, pass an 'accepted' flag to the Network Layer.

6.4.7 Timing requirements

The timing requirements specified here are all at the Data Link Layer level.

The timing parameters referenced in this subclause are specified in Table 2 and Table 3.

A node shall when an ACK or a NACK shall be sent by the Data Link Layer, not start the reply before the minimum value of t_{AW} .

NOTE 1 This ensures that the receiver in the former transmitting node is able to settle before the message is received.

A node shall, when an ACK or a NACK shall be sent by the Data Link Layer, start the reply within t_{AD} of the end of the received message.

A node expecting an ACK or a NACK shall timeout the transfer if no data is received before the maximum value of t_{AW} .

NOTE 2 Requests and responses are handled at the Application Layer.

6.5 Network Layer protocol

6.5.1 General

This protocol shall only be used with the mode P Data Link Layer.

The presence of a CI-field specifies that higher layer data follows. The structure of higher layer protocols shall be as shown in Table 9.

A CI-field $\neq 81_h$ shall be used when the Network Layer is empty. An empty Network Layer may only be used when there is a direct connection between two end nodes. In this case no 'Network Layer information' is transferred and the first byte of the higher layers shall be the Application Layer CI-field.

A CI-field $= 81_h$ shall be used when there is a Network Layer. The Network Layer information shall then be followed by a secondary CI-field, the Application Layer CI-field.

Table 9 — Higher layer format

CI	Hop info	Address 1		Address n	App-CI	Application data
81_h	2 bytes	8 bytes		8 bytes	1 byte	x bytes
Network layer information					Application layer information	

6.5.2 Network Layer format

The format of the network layer information is mainly a list of intermediate routers to hop via. The format shall be as shown in Table 10.

Table 10 — Network Layer format

CI	Hop count	Current hop	Source Addr.	Interm. Addr. 1	...	Interm. Addr. n	Destin. Addr.
81_h	1 byte	1 byte	8 bytes	8 bytes		8 bytes	8 bytes

Where

CI, 1 byte Shall be 81_h , specifying that network layer information follows.

Hop count, 1 byte, The total number of hops to perform, range 1 .. 10.

NOTE 1 This field will be '1' if it is an end-to-end transfer without any intermediate nodes. The total number of address elements in the network layer information is hop count + 1 as the source address is transmitted as well.

Current hop 1 byte, The number of the next intermediate node to use as destination, range 1 .. 10.

NOTE 2 This field will have the value '1' during the first hop, i.e. when sent from the end node. It will have the value 'Hop count' during the last hop, i.e. when received by the end node.

Source Addr	8 bytes	The Data Link Layer address of the initiating end node. It shall as well be in the Network Layer data, to ensure that a response can be sent back. The field is the concatenation of the M-field and the A-field from the Data Link Layer.
Interm. Addr.1	8 bytes	Optional, the Data Link Layer address of the first intermediate node (router) to use in this transfer. It shall be empty if it is an end-to-end connection.
Interm. Addr.n	8 bytes	Optional, the Data Link Layer address of the last intermediate node (router) to use in this transfer. It is the 'Interm. Addr.1' field if there is only 1 router. It shall be empty if it is an end-to-end connection. There may be up to 9 intermediate addresses.
Destin. Addr.	8 bytes	The Data Link Layer address of the receiving end node for the data transfer.

Data in the Network Layer protocol shall not be moved as data are transferred through the network. The only parameter shall change for each hop is the 'Current hop' field. It shall be incremented. The order of the Network Layer address elements shall be reversed at the end node before a response may be sent back to the initiating node.

6.5.3 Relaying rules

These are the rules that shall be used for handling of information at the network layer, and the rules that shall be used for passing of control information from the Network Layer to the Data Link Layer:

- a) The 'Current hop' shall be '1' at the initiating end node.
- b) The 'Hop count' value shall be in the range 1 to 10. If the 'Hop count' value is outside this range then the frame shall be rejected.
- c) If the 'Current hop' value is outside the range 1 to 'Hop Count' then the frame shall be rejected.
- d) There shall be 'Hop count + 1' address element in the Network Layer data, including the Source Address and the Destination Address.
- e) The Source Address may be interpreted as 'Intermediate Address 0' and the Destination Address may be interpreted as 'Intermediate Address (Hop count)'.
- f) In an intermediate node (router), the Data Link Layer addresses for the next hop shall be generated in the following way:
 - 1) Move the information from 'Intermediate Address (Current hop -1)' to the Source Address field in the Data Link Layer;
 - 2) Move the information from the 'Intermediate Address (Current hop)' into Destination Address field in the Data Link Layer.
- g) The intermediate (or initiating) node shall then pass the information on to the Data Link Layer, i.e. send the data.
- h) The receiving node shall, if 'Current hop' = 'Hop count' pass the data on to the Application layer.
- i) The receiving node shall, if 'Current hop' < 'Hop count' increment 'Current hop' and repeat from step f).
- j) The sending node shall, if the Data Link Layer returns a flag of 'not success' when trying to send data perform error handling as follows:

- 1) If the direction of transfer is downstream, then it shall return an error message back to the Data Collecting end node;
- 2) If the direction of transfer is upstream, then it may optionally store the information about missing upstream connection in an error log, and shall flag that the upstream connection is faulty.

The protocol is balanced at the Data Link Layer level and at the Network Layer level, but is master driven at the Application Layer level. The meter will only send data when so requested by the Data Collecting unit. An error in the upstream path will in the downstream path either cause a timeout on the acknowledge at Data Link Layer level, or a timeout of the response at the Application Layer level. It is then up to the Data Collecting Unit to determine what to do. The intermediate node shall not queue the data at transmission errors in the upstream direction.

6.6 Application Layer protocol

6.6.1 CI-field

The CI- or Control Information-field indicates the type of application data that follows. Specific values that are described in the following sub-clauses are listed in Table 11. General data elements and manufacturer specific CI-Fields may be used in addition to the listed CI-Field values. See EN 13757-3:2013, Table 1 for such values.

Table 11 — Application Layer, Control Information field

CI value	Designation	Remarks
6E _h	Error reporting	Application error from device (short header)
6F _h	Error reporting	Application error from device (long header)
70 _h	Error Reporting	Application error from device (no header)
81 _h	Network Layer data	Not allowed as Application Layer data
82 _h	Reserved	Reserved for Network management data
83 _h	Network management Application	For management of the Network Layer

6.6.2 Error reporting service

6.6.2.1 General

A routing node shall contain an error reporting service. The node shall use the service to return error status information. Error information returned shall use a CI-field of 6E_h, 6F_h or 70_h. The first byte following the CI-field is a Type field. The format of the data shall be as shown in Table 12.

Table 12 — Error status data format

CI	Type	Application data
6E _h /6F _h /70 _h	XX _h	Further error information
1 byte	1 byte	n bytes

The Type field may have the values as defined in Table 13.

Table 13 — Error type

Type value	Designation	Remarks
00 _h	Unspecified error	Unspecified error or data field missing
01 _h	No application	Unimplemented CI – field
02 _h – 09 _h	Application error	Compatible with EN 13757-3
0A _h – 10 _h		Reserved
11 _h	No function	Function in Network Management not implemented
12 _h	Data error	Data to be supplied not available
13 _h	Relaying error	Cannot relay data further
14 _h	Access violation	Data access right violation
15 _h	Parameter error	Parameter wrong or missing
16 _h	Size error	The amount of data requested cannot be handled
17 _h – 1F _h		Reserved
20 _h	Wrong Encryption key	Decryption fails ^a
21 _h	Wrong encryption method	Encryption method not supported
22 _h - EF _h		Reserved
F0 _h		Dynamic application error ^b
F1 _h – FF _h	Manufacturer specific	Manufacturer specific error information
^a This error code was previously defined as "Meter installation mode". It has been changed to be compatible with EN 13757-3. ^b The data point is coded as a M-bus specific data point with a leading DIF/VIF. The declaration is vendor specific. The dynamic application error is limited to 7 bytes.		

Detailed specification of the different types of error status is defined in the subclauses that follow.

6.6.2.2 No application

This error status shall be returned by the Application Layer, if the requested application CI-field is not implemented in the node. The type field shall be followed by a copy of the incorrect CI-field.

6.6.2.3 Application error

These error codes may be used if an EN 13757-3 Application Layer is implemented.

6.6.2.4 No function

This error status shall be returned by the Application Layer, if the requested function, that is a defined function, is not implemented in the actual Application Layer. The type field shall be followed by a copy of the not implemented function field.

6.6.2.5 Data error

This error status shall be returned by the Application Layer, if the data provided to Application Layer are incorrect.

6.6.2.6 Relaying error

This error status shall be returned by the Application Layer, if the node cannot forward data to the next node. The format of the data returned shall be as shown in Table 14.

Table 14 — Relay error format

Type value	Status	Destin Addr.	Num. fields	Interm, Addr. n	...	Interm. Addr. 1	Initiating Addr.
13 _h	1 byte	8 bytes	1 byte	8 bytes		8 bytes	8 bytes

The data returned shows the path the data had traversed before relaying failed where:

Type	13 _h indication relaying error
Status	Enumerated, showing status of attempt: 0 no response from node, timeout three times; 1 Node responds, but with NAK; 2 Node reacts, but with error in answer.
Destin. addr	8 bytes, the Destination Address that cannot be reached.
Num fields	1 byte, the number of address fields that follows, including the Initiating Address. The list holds the addresses of the nodes that the frame passed on its way out, The range is 1 to 10.
Interm Addr n	8 bytes, Intermediate Address n. The address of the current node, i.e. the node to handle the data when they 'got stuck', Shall be Intermediate Address 1 if only one relay node has been active.
Interm.Addr 1	8 bytes, Intermediate Address 1. The address of the first node that relayed the message.
Init. Addr	8 bytes, Initiating Address. The address of the node that initiated the transfer, either the Data Collecting Unit or a Meter.

The minimal situation will be when an end node can only reach the first relay. Then the 'Num field' shall be '1', all but Intermediate Address field 1 shall be absent and the 'Initiating Address' will be that of the end node.

6.6.3 Network management service

6.6.3.1 General

A routing node shall contain a network management application. Data shall be passed on to the network management application, whenever the CI-field is 83_h. The format of the data shall be as shown in Table 15. The 1 byte field following the CI-field is the Function field or F-field and it defines the way data shall be interpreted.

Table 15 — Network management data format

CI	Function	Application data
83 _h	XX _h	Function specific information
1 byte	1 byte	x bytes

The functions listed in Table 16 below covers the following network management requirements:

- There will be a demand for precision time tagging of information the nodes as there is a drift of the real time clock in the nodes. It shall thus be possible to set the time in the nodes, this time setting may include corrections for the delay in intermediate nodes.