BS EN IEC 61158-4-19:2019

BSI Standards Publication

Industrial communication networks - Fieldbus specifications

Part 4-19: Data-link layer protocol specification - Type 19 elements

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National foreword

This British Standard is the UK implementation of EN IEC 61158-4-19:2019. It is identical to IEC 61158-4-19:2019. It supersedes BS EN 61158-4-19:2014, which will be withdrawn on 23 May 2022.

The UK participation in its preparation was entrusted to Technical Committee GEL/65/3, Industrial communications: process measurement and control, including fieldbus.

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

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The text of document 65C/946/FDIS, future edition 4 of IEC 61158-4-19, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61158-4-19:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-02-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-05-23

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61131 series	NOTE Harmonized as EN 61131 series
IEC 61158-1	NOTE Harmonized as EN 61158-1
IEC 61158-3-19	NOTE Harmonized as EN 61158-3-19
IEC 61158-5-16	NOTE Harmonized as EN 61158-5-16
IEC 61158-5-19	NOTE Harmonized as EN 61158-5-19
IEC 61158-6-16	NOTE Harmonized as EN 61158-6-16
IEC 61158-6-19	NOTE Harmonized as EN 61158-6-19
IEC 61784-1	NOTE Harmonized as EN 61784-1
IEC 61784-2	NOTE Harmonized as EN 61784-2
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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61158-4-16	2007	Industrial communication networks - Fieldbus specifications - Part 4-16: Data-link layer protocol specification - Type 16 elements	-EN 61158-4-16	2008
ISO 8601	-	Data elements and interchange formats — Information interchange – Representation of dates and times		-
ISO/IEC 7498-1	-	Information technology - Open Systems-Interconnection - Basic reference model: The basic model		-
ISO/IEC 7498-3	-	Information technology - Open Systems-Interconnection - Basic reference model: Naming and addressing		-
ISO/IEC/IEEE 8802-3	-	Information technology — Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet		-
IEEE Std 802.3	-	IEEE Standard for Information technology– Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications		-
RFC 879	-	The TCP - Maximum Segment Size and Related Topics		

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-19: Data-link layer protocol specification – Type 19 elements

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NOTE Combinations of protocol types are specified in IEC 61784-1 and IEC 61784-2.

International Standard IEC 61158-4-19 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

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This edition includes the following significant technical changes with respect to the previous edition:

- improving the hotplug and redundancy features;
- improving the phase switching and the error handling;
- editorial improvements.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
65C/946/FDIS	65C/955/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts of the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

This document is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC 61158-1.

The data-link protocol provides the data-link service by making use of the services available from the physical layer. The primary aim of this document is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer data-link entities (DLEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

a) as a guide for implementors and designers;

b) for use in the testing and procurement of equipment;

c) as part of an agreement for the admittance of systems into the open systems environment;

d) as a refinement to the understanding of time-critical communications within OSI.

This document is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this document together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

NOTE Attention is drawn to the fact that use of the associated protocol type(s) is restricted by its (their) intellectual-property-right holder(s). In all cases, the commitment to limited release of intellectual-property-rights made by the holder(s) of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in Type combinations as specified explicitly in the profile parts. Use of the various protocol type(s) in other combinations may require permission from their respective intellectual-property-right holders.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning Type 19 elements and possibly other types given in this document as follows:

DE 102 00 502 4759.8-32	[BR]	Verfahren zur Laufzeitkorrektur in einer Kommunikationsstruktur
DE 102 37 097	[RI]	Korrektur von Signallaufzeiten in verteilten Kommunikationssystemen

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-19: Data-link layer protocol specification – Type 19 elements

1 Scope

1.1 General

The data-link layer provides basic time-critical messaging communications between devices in an automation environment.

This protocol provides communication opportunities to all participating data-link entities

a) in a synchronously-starting cyclic manner, according to a pre-established schedule, and
b) in a cyclic or acyclic asynchronous manner, as requested each cycle by each of those data-link entities.

Thus this protocol can be characterized as one which provides cyclic and acyclic access asynchronously but with a synchronous restart of each cycle.

1.2 Specifications

This document specifies

a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed data-link service provider;
b) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this document, and their representation as physical interface data units.

1.3 Procedures

The procedures are defined in terms of

a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus DLPDUs;
b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;
c) the interactions between a DLS-provider and a Ph-service provider in the same system through the exchange of Ph-service primitives.

1.4 Applicability

These procedures are applicable to instances of communication between systems which support time-critical communications services within the data-link layer of the OSI or fieldbus reference models, and which require the ability to interconnect in an open systems interconnection environment.

Profiles provide a simple multi-attribute means of summarizing an implementation's capabilities, and thus its applicability to various time-critical communications needs.

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1.5 Conformance

This document also specifies conformance requirements for systems implementing these procedures. This part of this document does not contain tests to demonstrate compliance with such requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE All parts of the IEC 61158 series, as well as IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61158-4-16:2007, *Industrial communication networks – Fieldbus specifications – Part 4-16: Data-link layer protocol specification – Type 16 elements*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Part 1: Basic Reference Model: The Basic Model*

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Part 3: Basic Reference Model: Naming and addressing*

ISO/IEC/IEEE 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

IEEE Std 802.3, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*

Internet Engineering Task Force (IETF), *Request for Comments (RFC): RFC 879, The TCP Maximum Segment Size and Related Topics* (available at <http://www.ietf.org/rfc/rfc0879.txt>) [viewed 2018-09-13]

3 Terms, definitions, symbols, acronyms, abbreviations and conventions

For the purposes of this document, the following terms, definitions, symbols, acronyms, abbreviations and conventions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Reference model terms and definitions

This document is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein.

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3.2 Additional Type 19 terms and definitions

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

3.2.1
broadcast
transmission to all devices in a network without any acknowledgment by the receivers

3.2.2
communication cycle
fixed time period between two master synchronization telegrams in which real-time telegrams are transmitted in the RT channel and non-real-time telegrams are transmitted in the IP channel

3.2.3
control unit
control device (for example, a PLC as specified in the IEC 61131)

3.2.4
control word
two adjacent octets inside the master data telegram containing commands for the addressed device

3.2.5
cross communication
direct multicast data transfer between devices

3.2.6
cycle time
duration of a communication cycle

3.2.7
cyclic communication
periodic exchange of telegrams

3.2.8
cyclic data
part of a telegram, which does not change its meaning during cyclic operation of the network

3.2.9
cyclic operation
operation in which devices in the communication network are addressed and queried one after the other at fixed, constant time intervals

3.2.10
device
a slave in the communication network, (for example, a power drive system as defined in IEC 61800-7 (all parts), I/O stations as defined in IEC 61131 (all parts))

3.2.11
device address field
address field (eight bits) containing the address of the device

3.2.12
device control
four adjacent octets inside the master data telegram containing commands for each device

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3.2.13
device status
four adjacent octets inside the acknowledge telegram containing status information for each device

3.2.14
DLE station identifier
network address assigned to a DLE

3.2.15
DLE station slot
unit (granularity of one) of position dependent mapping (for cyclic data field) of which a DLE may occupy one or more, delineated by the range beginning at the DLE station identifier with a length equal to the configured number of occupied slots

3.2.16
element
part of IDNs – each IDN has 7 elements, whereas each one has a specific meaning (for example: number, name, data)

3.2.17
EtherType
part of the Type 19 specific telegram header

3.2.18
forwarding
mode by which a device passes on a received telegram to the other port, either changed or unchanged

3.2.19
identification number
IDN
designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data

3.2.20
line
line structure
network topology, in which the transmission medium is routed from station to station in the form of a line; the information is transmitted in one direction from the master down to the last slave in the line, and then flows back to the master via all the slaves in the reverse order (CP16/3)

3.2.21
loopback
mode by which a device passes on a received telegram to the same port and to the other port, either changed or unchanged

3.2.22
master
node, which assigns the other nodes (i.e., slaves) the right to transmit

3.2.23
master data telegram
MDT
telegram, in which the master inserts its data

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3.2.24
master DLE
DLE that performs the functions of network master

3.2.25
master synchronization telegram
MST
telegram, or part of a telegram, in which the master inserts a time synchronization signal

3.2.26
MDT0 telegram
telegram, in which the master transmits its synchronization data, as well as parts or all of its real-time data, to the slaves

3.2.27
participant
node which is connected to the network

3.2.28
physical layer
first layer of the ISO-OSI reference model

3.2.29
protocol
convention about the data formats, time sequences, and error correction in the data exchange of communication systems

3.2.30
real-time data
part of the telegram that does not change its meaning during cyclic operation of the interface

3.2.31
RT channel
defined time slot within the communication cycle, which passes the CPF16 real-time telegrams

3.2.32
service channel
SVC
non real-time transmission of information upon master request during RT channel

3.2.33
slave
node, which is assigned the right to transmit by the master

3.2.34
slave DLE
DLE that performs the functions of network slave

3.2.35
station
node which is connected to the network

3.2.36
status word
two adjacent octets inside the acknowledge telegram containing status information of a device

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3.2.37
S-0-nnnn
designation of IDNs

3.2.38
telegram
DLPDU

3.2.39
topology
physical network architecture with respect to the connection between the stations of the communication system

3.2.40
topology index
position of a slave in a Type 19 network using a daisy chain numeration starting with value 1 at the first slave after the master

3.3 Symbols

ADR	device address (1 ≤ ADR ≤ 511) adjusted directly on the device, for example using a selector switch
AT MST	header in AT
AT0...3	acknowledge telegrams
INFO	service channel information
JtScyc	jitter in tScyc
MDT0	master data telegram with synchronization data that the slaves evaluates
MDT1...3	master data telegrams without synchronization data
P1	port 1
P2	port 2
RxD	received data
SLKN	slave identification parameter, slave arrangement
SVC	service channel
t1	AT transmission starting time
t1min	shortest AT transmission starting time
t3	command value valid time
t4	feedback acquisition capture point
t5	minimum feedback processing time
tcable	time, by which the transmitted signal is delayed by the cable, for each unit of length (approx., 5 ns/m)
trep	time, by which the received signal is delayed by a forwarding slave (input-output)
tRing	time, which a master telegram needs, until it has passed through the network and reached the master again

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tScyc	communication cycle time
TxD	transmitted data

3.4 Acronyms and abbreviations

AHS	service transport handshake of the device (acknowledge HS)
AT	acknowledge telegram
C-CON	connection control
C-DEV	device control
C1D	class 1 diagnostic
CP	communication phase
CPS	communication phase switching
CRC	cyclic redundancy check
CSoS	CIP Safety on SERCOS
FCS	DLPDU check sequence
FG	Function Group
FSP	Function-specific Profile
GDP	Generic Device Profile
HP	Hot-Plug
HP0	Hot-Plug phase 0
HP1	Hot-Plug phase 1
HP2	Hot-Plug phase 2
HS	service channel handshake (see AHS and MHS)
IDN	identification number
IP	Internet protocol
MAC	media access control
MDT	master data telegram
MDT MST	header in MDT
MHS	service transport handshake of the master
MS	communication from slave to master
MST	master synchronization telegram
NRT	non real-time
P-channel	primary channel
P-telegram	primary telegram

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PL	parametrization level
RT	real-time
RTC	real-time channel
RTD	real-time data in MDT or AT
S-DEV	device status
S-channel	secondary channel
S-telegram	secondary telegrama
SCH	session control header
SCP	Type 19 Communication Profile
SE	structure element
SERCOS	serial real-time communication system interface
SFD	start DLPDU delimiter
SI	structure instance
SMP	Type 19 Messaging Protocol
SVC	service channel
UCC	unified communication channel

3.5 Additional conventions

All data types are assigned identification numbers (IDNs). They include real-time data (commands and feedback values), parameters, and procedures. Most IDNs are similar to those for Type 16 (see IEC 61158-4-16, 3.6). Several IDNs relate to the application and are defined in their relevant standards (for example, IEC 61800-7-20x for Power Drive Systems).

Refer to Annex A for additional information, as well as to IEC 61158-4-16, Clause A.1 for detailed IDN specification.

4 DL-protocol overview

4.1 Overview

This protocol type provides a highly optimized means of interchanging fixed-length real-time data and variable-length segmented messages between a single master device and a set of slave devices, interconnected in a ring or a line topology. The ring topology provides for redundant communication paths, and in case of a fault it automatically switches to a set of two lines without disturbing the communication.

This protocol type also provides for direct real-time data transmission between slaves, inside the real-time channel (RTC), within each communication cycle.

The exchange of real-time data is totally synchronous by configuration and is unaffected by the messaging traffic.

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The device addresses are set by the user, using a selector for example. Additional devices may be added whenever required, even during operation, without affecting the address selections, which already exist. The determination of the number, identity and characteristics of each device may be configured or may be detected automatically at start-up.

Slave interfaces shall be used to connect the slave devices to the network. At the physical layer, a slave represents the connection of one or more devices to the network. Logically, one slave with several devices shall act the same as several slaves with one device each.

This protocol type also provides a unified communication channel (UC channel), in which any Standard Ethernet DLPDUs can be exchanged between Type 19 devices and any other connected Ethernet network nodes.

There are two classes of Type 19 DLE:

a) master DLE;

b) slave DLE.

Only the master DLE is able to initiate cyclic transmission.

Type 19 telegrams are Ethernet DLPDUs according to ISO/IEC/IEEE 8802-3. Type 19 real-time telegrams shall be transmitted in the real-time part of the communication cycle time. They mainly transport input and output data, for example command and feedback values. The Type 19 header specifies two types type 19 telegrams:

a) Master data telegram (MDT), in which the master transmits real-time data to the slaves;

b) Acknowledge telegram (AT), in which the slaves transmit real-time data to the master and other slaves.

Other Ethernet DLPDUs can be transmitted in the UC channel.

Type 19 specifies 4 MDTs (MDT0 to MDT3). The MDTs shall be transmitted by the master and received by each slave. The MDTs shall contain all information (for example: synchronization, command values, digital outputs) which is sent from the master to the slaves through the real-time channel.

MDT0 shall always be transmitted. MDT1 through MDT3 shall be transmitted only if required depending on the configuration of the application data to be transmitted. The master shall always send the same number of MDTs during each communication cycle.

Type 19 specifies 4 ATs (AT0 to AT3). The ATs shall be transmitted by the master with the configured AT length. The AT data fields are set to 0, except the application data of cross communication. Each slave shall insert its data into its allocated data field within the AT. The ATs shall contain all information (for example: feedback values, digital inputs) which is sent from the slaves to the master as well as to other slave devices through the real-time channel.

AT0 shall always be transmitted. AT1 through AT3 shall be transmitted only if required depending on the configuration of the application data to be transmitted. The master shall always send the same number of ATs during each communication cycle.

The order of the service channels (SVC), the device control (C-DEV), the device status (S-DEV) and the connections in the Type 19 telegrams shall be configured with parameters. The lengths of connections in the MDTs and the ATs shall depend on the amount of application data and may be different for each slave depending upon configuration. The number of MDTs and ATs may also be different because of the configuration. This order generated by the configuration of the payload shall meet the following requirements.

a) A SVC of a slave shall be transmitted within one MDT or one AT and shall not be spread into different MDTs or ATs.

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b) A connection of a slave shall be transmitted within one MDT or one AT and shall not be spread into two different MDTs or ATs.

c) Each connection and SVC shall start at an even address in the MDT and AT.

d) Each device control and device status shall start at an even address in the MDT and AT.

e) All other combination of configurations of SVCs, connections, device control and device status are possible.

Devices in a Type19 network use the order of little endian for the serial transmission of data. Little endian describes the least significant bit of the least significant octet of the least significant word is sent first, followed by the rest of the bits of this octet, then by the rest of the octets of this word, and so on in the same order.

4.2 General DLPDU identification

4.2.1 Introduction

DLPDUs shall be identified as specified in Table 1.

Table 1 – Ethernet DLPDU identification

DLPDU field	Data type	Value/description
Dest MAC	octet[6]	Destination MAC address
Src MAC	octet[6]	Source MAC address
EtherType	WORD	0x88CD (Type 19)

4.2.2 Destination address (Dest MAC)

The master shall transmit DLPDUs to all slaves using the broadcast address 0xFFFF FFFF FFFF as the destination address.

4.2.3 Source address (Src MAC)

The source address shall always be the MAC address of the master.

4.2.4 EtherType

The EtherType for real-time DLPDUs shall contain the value 0x88CD, which is the unique type field number that has been allocated by the IEEE EtherType Field Registration Authority for Type 19 telegrams.

NOTE This field number refers to Type 19 communication.

4.3 General DLPDU structure

4.3.1 Introduction

The data structure in a DLPDU shall consist of the following data entries as specified in Table 2.

Table 2 – Data structure in a DLPDU

Data field	Data type	Value/description
Header	octet[6]	Defines the DLPDU type
Payload	octet[40-1494]	Data fields are padded (filled with 0x0), if less than 40 octets

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4.3.2 DLPDU header

The DLPDU header shall specify two types of telegrams, as specified in 4.4:

- **Master data telegram (MDT):** MDTs shall transmit data from the master to the slaves;
- **Acknowledge telegram (AT):** ATs shall transmit data from the slaves to the master, as well as to other slaves within the Type 19 network.

4.3.3 DLPDU payload

All transmitted data are permitted to have arbitrary bit sequences.

Padding octets shall be added if the Type 19 data is less than 40 octets, in order to reach a total data field length of at least 46 octets.

The DLPDU payload shall be as described in 4.5 and 4.6.

4.4 DLPDU header

4.4.1 Introduction

The DLPDU header shall distinguish the various DLPDUs.

It shall be coded in the telegram whether the DLPDU is transmitted in the primary or secondary channel, whether it is an MDT or an AT, and which one (MDT0 to MDT3, respectively AT0 to AT3).

In a line topology, the master shall decide whether the telegrams are marked as primary or secondary telegrams, depending upon configuration.

The DLPDU header structure is shown in Table 3:

Table 3 – DLPDU payload header

Data field	Data type	Value/description
DLPDU type	octet[1]	See 4.4.2
Reserved	octet[1]	—
Reserved	octet[4]	—

4.4.2 DLPDU type

The DLPDU type contains the telegram type and shall be generated by the master and transmitted in every MDT and AT. Its content shall be as shown in Table 4.

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Table 4 – DLPDU type

Bit number	Bit value	Description
7	—	Primary or secondary telegram
	0	Telegram on the primary channel (P-telegram)
	1	Telegram on the secondary channel (S-telegram)
6	—	MDT or AT
	0	MDT
	1	AT
5	—	Cycle CNT (used to set Type 19 time)
	0	Cycle CNT is disabled
	1	Cycle CNT is enabled (Cycle CNT is defined in MDT phase (bit 6-4)
4	—	(reserved)
3-2		(reserved for telegram number 4 to 15)
1-0	—	Telegram number
	00	Telegram number 0
	01	Telegram number 1
	10	Telegram number 2
	11	Telegram number 3

4.5 MDT DLPDU

4.5.1 MDT MST field summary

The MDT shall be as specified in Table 5. The MDT header of MDT0 is called MST.

Table 5 – MDT header

DLPDU part	Data field	Data type	Value/Description
MDT header	MDT type	octet[1]	See 4.5.3
	MDT phase	octet[1]	See 4.5.4
	MDT CRC	octet[4]	See 4.5.5

4.5.2 Evaluation of MDT header in the slaves

The MDT header shall be generated by the master and evaluated by the slaves. Each slave shall evaluate the MDT header according to Table 6. If the MDT CRC is valid, then the slave shall evaluate the MDT type and in case of MDT0 (MST) additionally the MDT phase. If the MDT CRC is invalid, then the slave shall not evaluate the MDT header and the MDT payload.

Table 6 – MDT header to be considered by the slave

	MDT type	MDT phase	MDT CRC
MDT0 = MST	Yes	Yes	Yes
MDT1	Yes	No	Yes
MDT2	Yes	No	Yes
MDT3	Yes	No	Yes

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4.5.3 MDT type

Refer to 4.4.2, whereas bit #6 shall be 0.

4.5.4 MDT phase

The MDT phase shall contain the status of the Type 19 communication in CP0 to CP4. The structure is shown in Table 7.

Table 7 – MDT phase

Bit number	Bit value	Description
7	—	Communication phase switching (CPS)
	0	Current CP Communication phase (bit 3-0) contains current CP.
	1	New CP Communication phase (bit 3-0) contains the target CP for phase switching.
6-4	—	Cycle CNT (shall be enabled in MDT DLPDU type, bit 5 is set to 1)
	0-7	Value of Cycle CNT (is incremented by 1 in each communication cycle by the master)
3-0	—	Communication phase (CP)
	0000	CP0
	0001	CP1
	0010	CP2
	0011	CP3
	0100	CP4
	0101 to 1111	(reserved)

4.5.5 MDT CRC

The cyclic redundancy check (CRC) shall be used by the transmit and receive algorithms to generate a CRC value for the MDT CRC field. The MDT CRC field shall contain a 4-octet (32-bit) cyclic redundancy check (CRC) value. This value shall be computed as a function of the contents of the destination address (see 4.2.2), source address (see 4.2.3), EtherType (see 4.2.4), Type 19 type (see 4.4.2) and phase (see 4.5.4). The encoding shall be as defined by the Standard Ethernet CRC generating polynomial (see ISO/IEC/IEEE 8802-3).

The MDT CRC shall be generated by the master and transmitted in every MDT (MDT0 to MDT3). This CRC shall be evaluated in every MDT by the slave (see Table 6).

4.5.6 MDT payload during initialization

4.5.6.1 General

The content of the MDT data field depends on the communication phase (CP) and is described in the following subclauses.

4.5.6.2 MDT payload in CP0

The master shall always transmit MDT0 telegrams only, and no MDT1, MDT2, nor MDT3 telegrams. MDT0 shall be structured as stated in Table 8.

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Table 8 – MDT0 structure in CP0

DLPDU part	Data field	Data type	Value/Description
MDT	MDT type	octet[1]	MDT0, see 4.5.3
	MDT phase	octet[1]	CP0, see 4.5.4
	MDT CRC	octet[4]	See 4.5.5
MDT payload	Communication version	octet[4]	See Table 9
	MDT Data Field	octet[36]	Shall be padded and not used

Table 9 – Communication version

Bit number	Bit value	Description
31-23	—	(reserved: 0x00 as valid combination shall be checked by slaves)
22	—	Switch off Type 19 telegrams: Requested function to connect Industrial Ethernet Devices to the last Type 19 device in line topology
	0	Non-Type 19 (Industrial Ethernet) devices not used by application: last slave in line shall forward Type 19 telegrams to the inactive port (loopback with forward shall be activated). All slaves shall set S-0-1032 Communication control.Bit 3 = 0.
	1	Non-Type 19 (Industrial Ethernet) devices used by application: last slave in line shall not forward Type 19 telegrams to the inactive port (loopback without forward shall be activated), only last slave shall set S-0-1032 Communication control.bit 3 = 1. Shall be acknowledged by the slave in the topology index field of AT0-CP0
21	—	Fast CP switch
	0	Transmission of MST (MDT0) interrupted during CP switch for CPS delay time (120ms)
	1	CPS delay time reduced to the reconfiguration time of the master (shall be acknowledged by the slave in the topology index field of AT0-CP0)
20	—	Transmission of communication parameters in MDT0 of CP0
	0	No transmission of parameters
	1	Transmission of the following parameters: - AT0 transmission starting time (t1-CP1&CP2) - Beginning of UC channel (t6-CP1&CP2) - End of UC channel (t7-CP1&CP2) Shall be acknowledged by the slave in the topology index field of AT0-CP0.
19-18	—	(reserved: 0x00 as valid combination shall be checked by slaves)
17-16	—	Structure and number of MDTs and ATs in CP1 and CP2
	00	2 MDTs and 2 ATs in CP1 and CP2 (include SVCs, C-DEV, S-DEV) – up to 255 slaves
	01	4 MDTs and 4 ATs in CP1 and CP2 (include SVCs, C-DEV, S-DEV) – up to 511 slaves
	10	invalid combination (shall be checked by slave also)
	11	invalid combination (shall be checked by slave also)
15-8	—	(reserved)
7-1	—	(reserved: 0x00 as valid combination shall be checked by slaves)
0	—	Address allocation
	0	Without address allocation (used for Type 19 Version 1.0 only)
	1	Address allocation (shall be used for Type 19 Version 1.1.1 and greater)

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4.5.6.3 MDT payload in CP1 and CP2

The master shall choose between two communication sequences used in CP1 and CP2:

a) If the master supports 255 slaves or less, it may transmit either MDT0 to MDT3 or MDT0 and MDT1 only, for example to save initialization time.

b) If the master supports 256 slaves or more (up to 511 slaves) it shall transmit MDT0 to MDT3.

The slaves shall support both sequence options. It shall select the required one by evaluating bit 17 and bit 16 of the communication version (see Table 9).

The MDT data fields shall contain the service channel (see 6.2) and the device control (see 4.5.7.4.2) of the topology indices as shown in Table 10, Table 11, Table 12 and Table 13 respectively.

In CP1 a slave shall behave as requested if the handshake bit (MHS) is set to 1 in the corresponding SVC control. The MDT SVC INFO is “don’t care”. The content of device control shall be valid.

Telegrams in CP2 shall have the same structure as in CP1, but the contents of SVC INFO shall be valid.

Table 10 – MDT0 in CP1 and CP2 (topology indices 0 to 127)

DLPDU part	Data field	Data type	Value/Description
MDT MST	MDT type	octet[1]	MDT0, see 4.5.3
	MDT phase	octet[1]	CP1 or CP2, see 4.5.4
	MDT CRC	octet[4]	See 4.5.5
MDT data field	MDT SVC for topology index #0	octet[6]	—
	…	…	(And so on for topology indices #1 to #126)
	MDT SVC for topology index #127	octet[6]	—
	Device control for topology address #0	octet[2]	—
	Reserved for topology index #0	octet[2]	—
	…	…	(And so on for topology indices #1 to #126)
	Device control for topology index #127	octet[2]	—
	Reserved for topology index #127	octet[2]	—

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Table 11 – MDT1 in CP1 and CP2 (topology indices 128 to 255)

DLPDU part	Data field	Data type	Value/Description
MDT MST	MDT type	octet[1]	MDT1, see 4.5.3
	MDT phase	octet[1]	CP1 or CP2, see 4.5.4
	MDT CRC	octet[4]	see 4.5.5
MDT data field	SVC of topology index #128	octet[6]	—
	…	…	(And so on for topology index #129 to #254)
	SVC of topology index #255	octet[6]	—
	Device control of topology index #128	octet[2]	—
	Reserved for topology index #128	octet[2]	—
	…	…	(And so on for topology index #129 to #254)
	Device control of topology index #255	octet[2]	—
	Reserved for topology index #255	octet[2]	—

Table 12 – MDT2 in CP1 and CP2 (topology indices 256 to 383)

DLPDU part	Data field	Data type	Value/Description
MDT MST	MDT type	octet[1]	MDT2, see 4.5.3
	MDT phase	octet[1]	CP1 or CP2, see 4.5.4
	MDT CRC	octet[4]	See 4.5.5
MDT data field	SVC of topology index #256	octet[6]	—
	…	…	(And so on for topology index #257 to #382)
	SVC of topology index #383	octet[6]	—
	Device control of topology index #256	octet[2]	—
	Reserved for topology index #256	octet[2]	—
	…	…	(And so on for topology index #257 to #382)
	Device control of topology index #383	octet[2]	—
	Reserved for topology index #383	octet[2]	—

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Table 13 – MDT3 in CP1 and CP2 (topology indices 384 to 511)

DLPDU part	Data field	Data type	Value/Description
MDT MST	MDT type	octet[1]	MDT3, see 4.5.3
	MDT phase	octet[1]	CP1 or CP2, see 4.5.4
	MDT CRC	octet[4]	See 4.5.5
MDT data field	SVC of topology index #384	octet[6]	—
	…	…	(And so on for topology index #385 to #510)
	SVC of topology index #511	octet[6]	—
	Device control of topology index #384	octet[2]	—
	Reserved for topology index #384	octet[2]	—
	…	…	(And so on for topology index #385 to #510)
	Device control of topology index #511	octet[2]	—
	Reserved for topology index #511	octet[2]	—

4.5.6.4 MDT payload in CP3

In CP3, the master shall transmit MDTs with the same structure as in CP4 (see 4.5.7).

In CP3, only the service channel and the device control shall be valid. The configured application data in the connections of the MDTs shall not be evaluated, but they shall have the number of octets required for CP4. The positions of the service channels and the connections in the MDT relevant to the individual slaves shall be as transmitted by the master to the slaves during CP2 with the corresponding communication parameters.

4.5.7 MDT payload in normal operation (CP4)

4.5.7.1 Introduction

In CP4, the master shall transmit MDTs with the same structure as in CP3.

In CP4, the configured application data shall be valid and filled with command values as determined by the parameters that the master transmitted to the slaves during CP2. The connection control and the resource control which depend on the application profile shall be valid.

The MDT payload of MDT0 (see Table 14) shall always contain

a) one hot-plug field (see 4.5.7.2)

and may contain depending on the configuration

a) one extended function field;
b) several service channels, one per slave only (see 5.5.7.2.4);
c) several device controls, one per slave only;
d) several connections (see 4.5.7.4).

The MDT payload of MDT1 to MDT3 (see Table 14) may contain depending on the configuration

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a) several service channels, one per slave only (see 5.5.7.2.4);

b) several device controls, one per slave only;

c) several connections (see 4.5.7.4).

Table 14 – MDT data field

DLPDU part	Data field	Data type	Value/Description
MDT data field	MDT0 hot-plug field	octet[8]	In MDT0 only, see 4.5.7.2
	MDT0 extended field	octet[4]	In MDT0 only, see 4.5.7.2
	MDT0 to MDT3 service channels	octet[see 4.5.7.3]	Optional. see 4.5.7.3
	MDT0 to MDT3 real-time data	octet[see 4.5.7.4]	Optional. see 4.5.7.4

For each slave,

- IDN S-0-1013 (SVC offset in MDT) shall set the offset for its service channel;
- IDN S-0-1009 (Device Control offset in MDT) shall set the offset for the device control;
- IDN S-0-1010 (Lengths of MDTs) shall contain the lengths of all MDTs (in Figure 1 shown for MDT0 only).

A slave with connection shall support the following parameters:

- IDN S-0-1050.x.3 (Telegram assignment) shall set the offset for the connection data;
- IDN S-0-1050.x.5 (Current length of connection) shall contain the length of the connection data (determined by slave);

The non write protected parameters shall be transmitted by the master to the slaves in CP2.

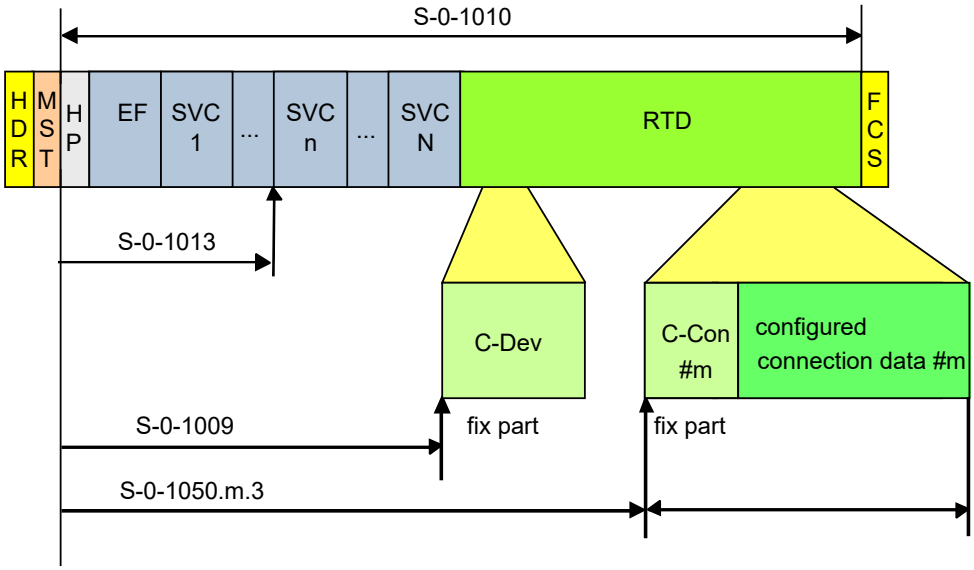

Figure 1 – Example of offsets within MDT payload

4.5.7.2 MDT hot-plug field

4.5.7.2.1 MDT hot-plug field summary

The structure of the MDT hot-plug field shall be as specified in Table 15, depending upon hot-plug phases (see 5.5).

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