IEC 61158-4-28

Edition 1.0 2023-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Industrial communication networks – Fieldbus specifications – Part 4-28: Data-link layer protocol specification – Type 28 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 4-28: Spécification du protocole de la couche liaison de données – Éléments de type 28



IEC 61158-4-28:2023-03(en-fr)



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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-28: Data-link layer protocol specification – Type 28 elements

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

Draft	Report on voting
65C/1206/FDIS	65C/1235/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- amended.

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INTRODUCTION

This part of IEC 61158 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 implementers 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 standard positioned within the OSI or fieldbus reference models, otherwise incompatible systems could work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-28: Data-link layer protocol specification – Type 28 elements

1 Scope

1.1 General

The data-link layer provides several types of messaging communications between devices in an automation environment.

This part of IEC 61158 provides a means of connecting devices through a partial mesh network, such that most failures of an interconnection between two devices can be circumvented. In common practice, the devices are interconnected in a non-redundant hierarchical manner reflecting application needs.

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 the 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 the fieldbus reference models, and which require the ability to interconnect in an open systems interconnection environment.

1.5 Conformance

This document also specifies conformance requirements for systems implementing these procedures. 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 the IEC 61784-1 series and the IEC 61784-2 series 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 61158-2:2023, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-3-28:2023, *Industrial communication networks – Fieldbus specifications – Part 3-28: Data-link layer service definition – Type 28 elements*

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Basic Reference Model: The Basic Model*

ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

ISO/IEC 8886:1996, *Information technology – Open Systems Interconnection – Data link service definition*

ISO/IEC/IEEE 8802-3:2021, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

3 Terms, definitions, symbols, abbreviated terms and conventions

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

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://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:

3.1.1 called-DL-address **[ISO/IEC 7498-3]**

3.1.2 calling-DL-address **[ISO/IEC 7498-3]**

3.1.3 centralized multi-end-point-connection **[ISO/IEC 7498-1]**

3.1.4 correspondent (N)-entities **[ISO/IEC 7498-1]**
correspondent DL-entities (N=2)
correspondent Ph-entities (N=1)

3.1.5 Demultiplexing **[ISO/IEC 7498-1]**

3.1.6	**DL-address**	**[ISO/IEC 7498-3]**
3.1.7	**DL-address-mapping**	**ISO/IEC 7498-1]**
3.1.8	**DL-connection**	**[ISO/IEC 7498-1]**
3.1.9	**DL-connection-end-point**	**[ISO/IEC 7498-1]**
3.1.10	**DL-connection-end-point-identifier**	**[ISO/IEC 7498-1]**
3.1.11	**DL-connection-mode transmission**	**[ISO/IEC 7498-1]**
3.1.12	**DL-connectionless-mode transmission**	**[ISO/IEC 7498-1]**
3.1.13	**DL-data-sink**	**[ISO/IEC 7498-1]**
3.1.14	**DL-data-source**	**[ISO/IEC 7498-1]**
3.1.15	**DL-duplex-transmission**	**[ISO/IEC 7498-1]**
3.1.16	**DL-facility**	**[ISO/IEC 7498-1]**
3.1.17	**DL-local-view**	**[ISO/IEC 7498-3]**
3.1.18	**DL-name**	**[ISO/IEC 7498-3]**
3.1.19	**DL-protocol**	**[ISO/IEC 7498-1]**
3.1.20	**DL-protocol-connection-identifier**	**[ISO/IEC 7498-1]**
3.1.21	**DL-protocol-control-information**	**[ISO/IEC 7498-1]**
3.1.22	**DL-protocol-data-unit**	**[ISO/IEC 7498-1]**
3.1.23	**DL-protocol-version-identifier**	**[ISO/IEC 7498-1]**
3.1.24	**DL-relay**	**[ISO/IEC 7498-1]**
3.1.25	**DL-service-connection-identifier**	**[ISO/IEC 7498-1]**
3.1.26	**DL-service-data-unit**	**[ISO/IEC 7498-1]**
3.1.27	**DL-simplex-transmission**	**[ISO/IEC 7498-1]**
3.1.28	**DL-subsystem**	**[ISO/IEC 7498-1]**
3.1.29	**DL-user-data**	**[ISO/IEC 7498-1]**
3.1.30	**flow control**	**[ISO/IEC 7498-1]**
3.1.31	**layer-management**	**[ISO/IEC 7498-1]**
3.1.32	**Multiplexing**	**[ISO/IEC 7498-3]**
3.1.33	**naming-(addressing)-authority**	**[ISO/IEC 7498-3]**
3.1.34	**naming-(addressing)-domain**	**[ISO/IEC 7498-3]**
3.1.35	**naming-(addressing)-subdomain**	**[ISO/IEC 7498-3]**
3.1.36	**(N)-entity** **DL-entity** **Ph-entity**	**[ISO/IEC 7498-1]**
3.1.37	**(N)-interface-data-unit** **DL-service-data-unit (N=2)** **Ph-interface-data-unit (N=1)**	**[ISO/IEC 7498-1]**
3.1.38	**(N)-layer** **DL-layer (N=2)** **Ph-layer (N=1)**	**[ISO/IEC 7498-1]**
3.1.39	**(N)-service** **DL-service (N=2)** **Ph-service (N=1)**	**[ISO/IEC 7498-1]**
3.1.40	**(N)-service-access-point** **DL-service-access-point (N=2)** **Ph-service-access-point (N=1)**	**[ISO/IEC 7498-1]**

3.1.41 (N)-service-access-point-address [ISO/IEC 7498-1]
DL-service-access-point-address (N=2)
Ph-service-access-point-address (N=1)

3.1.42 peer-entities [ISO/IEC 7498-1]

3.1.43 Ph-interface-control-information [ISO/IEC 7498-1]

3.1.44 Ph-interface-data [ISO/IEC 7498-1]

3.1.45 primitive name [ISO/IEC 7498-3]

3.1.46 Reassembling [ISO/IEC 7498-1]

3.1.47 Recombining [ISO/IEC 7498-1]

3.1.48 Reset [ISO/IEC 7498-1]

3.1.49 responding-DL-address [ISO/IEC 7498-3]

3.1.50 Routing [ISO/IEC 7498-1]

3.1.51 Segmenting [ISO/IEC 7498-1]

3.1.52 Sequencing [ISO/IEC 7498-1]

3.1.53 Splitting [ISO/IEC 7498-1]

3.1.54 Synonymous name [ISO/IEC 7498-3]

3.1.55 Systems-management [ISO/IEC 7498-1]

3.2 Service convention terms and definitions

This document also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

3.2.1 acceptor

3.2.2 asymmetrical service

3.2.3 confirm (primitive);
requestor.deliver (primitive)

3.2.4 deliver (primitive)

3.2.5 DL-confirmed-facility

3.2.6 DL-facility

3.2.7 DL-local-view

3.2.8 DL-mandatory-facility

3.2.9 DL-non-confirmed-facility

3.2.10 DL-provider-initiated-facility

3.2.11 DL-provider-optional-facility

3.2.12 DL-service-primitive;
primitive

3.2.13 DL-service-provider

3.2.14 DL-service-user

3.2.15 DLS-user-optional-facility

3.2.16 indication (primitive);
acceptor.deliver (primitive)

3.2.17 multi-peer

3.2.18 request (primitive);
requestor.submit (primitive)

3.2.19 requestor

3.2.20 response (primitive); acceptor.submit (primitive)

3.2.21 submit (primitive)

3.2.22 symmetrical service

3.3 Common terms and definitions

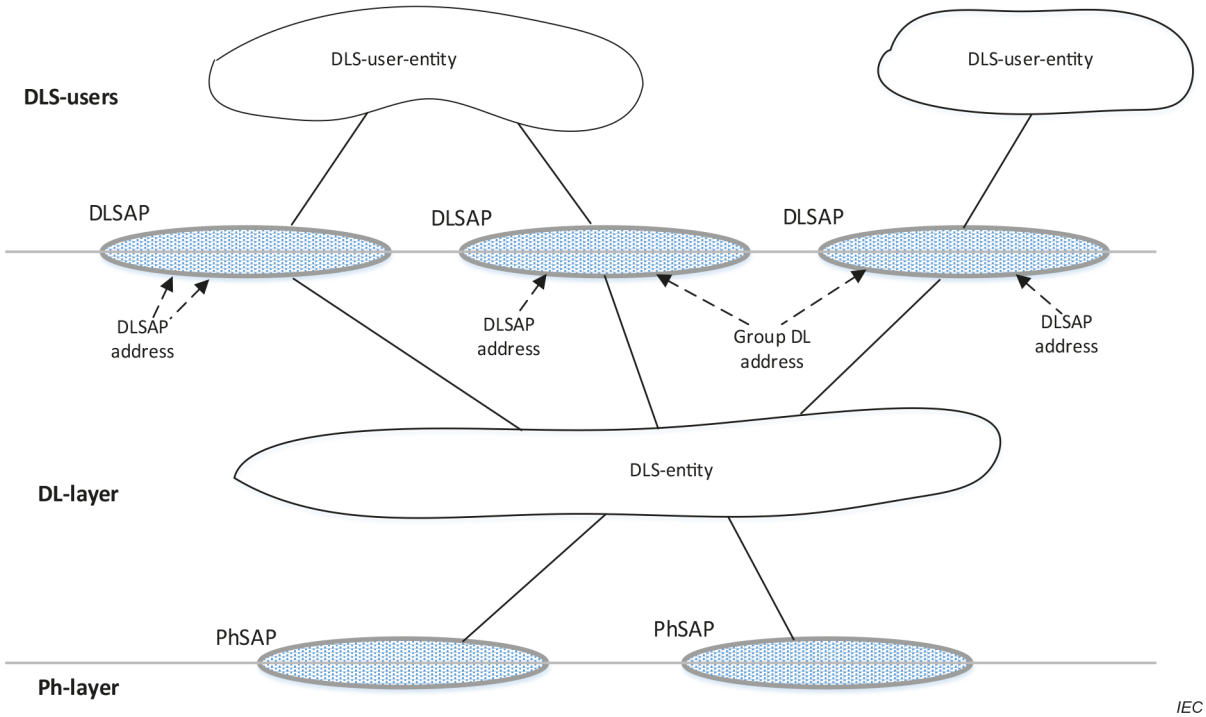
For the purposes of this document, the following terms and definitions apply.

NOTE Many definitions are common to more than one protocol Type; they are not necessarily used by all protocol types.

3.3.1
DL-segment, link, local link
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

3.3.2
DLSAP
distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

Note 1 to entry: This definition, derived from ISO/IEC 7498-1, is repeated here to facilitate understanding of the critical distinction between DLSAPs and their DL-addresses (see Figure 1).



Note 2 to entry: DLSAPs and PhSAPs are depicted as ovals spanning the boundary between two adjacent layers.

Note 3 to entry: DL-addresses are depicted as designating small gaps (points of access) in the DLL portion of a DLSAP.

Note 4 to entry: A single DL-entity may have multiple DLSAP-addresses and group DL-addresses associated with a single DLSAP.

Figure 1 – Relationships of DLSAPs, DLSAP-addresses and group DL-addresses

3.3.3
DL(SAP)-address
either an individual DLSAP-address, designating a single DLSAP of a single DLS user, or a group DL-address potentially designating multiple DLSAPs where each DLSAP is from a single DLS-user

Note 1 to entry: This terminology is chosen because ISO/IEC 7498-3 does not permit the use of the term DLSAP address to designate more than a single DLSAP at a single DLS-user.

3.3.4
(individual) DLSAP-address
DL-address that designates only one DLSAP within the extended link

Note 1 to entry: A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP.

3.3.5
extended link
DL-subnetwork, consisting of the maximal set of links interconnected by DL-relays, sharing a single DL-name (DL-address) space, in which any of the connected DL-entities may communicate, one with another, either directly or with the assistance of one or more of those intervening DL-relay entities

Note 1 to entry: An extended link may be composed of just a single link.

3.3.6
frame
denigrated synonym for DLPDU

3.3.7
group DL-address
DL-address that potentially designates more than one DLSAP within the extended link

Note 1 to entry: A single DL-entity may have multiple group DL-addresses associated with a single DLSAP. A single DL-entity may also have a single group DL-address associated with more than one DLSAP.

3.3.8
node
single DL-entity as it appears on one local link

3.3.9
receiving DLS-user
DL-service user that acts as a recipient of DLS-user-data

Note 1 to entry: A DL-service user can be concurrently both a sending and receiving DLS-user.

3.3.10
sending DLS-user
DL-service user that acts as a source of DLS-user-data

3.4 Additional Type 28 terms and definitions

3.4.1
control device
device that controls all field devices for logical operations, timing, calculations, etc.

3.4.2
management node
device for allocating and managing Type 28 network physical communication resources

3.4.3
terminal node
device in Type 28 network that communicates based on allocated physical communication resources

3.4.4
clock synchronization
clock calibration of the terminal node device

3.4.5
cyclic time
time of cyclic processing of a device or module

3.4.6
RT data
data sensitive to time deterministic requirements

3.4.7
non-RT data
data insensitive to time deterministic requirements

3.4.8
orthogonal frequency division multiplexing (OFDM) symbol
minimum data transmission unit in time domain that include all subcarriers in frequency based on OFDM technology

3.4.9
upper sideband
subcarriers with a frequency range from 16,896 MHz to 32,256 MHz on an OFDM symbol

3.4.10
lower sideband
subcarriers with a frequency range from 1,536 MHz to 16,896 MHz on an OFDM symbol

3.4.11
carrier mode
data transfer mode over available resources made up of OFDM symbols

3.4.12
working mode
OFDM operation in a specific transmission mode, RS coding, convolutional coding, and modulation mode

3.4.13
cyclic frame
signal frames which are processed in a regular and repetitive manner

3.4.14
cyclic symbol
OFDM symbols in signal frames which are processed in a regular and repetitive manner

3.4.15
code block
octet sequence of data interaction between the Type 28 physical layer entity and the Type 28 data-link layer entity

3.4.16
data transmission channel
logical channel of the Type 28 data-link layer mapped by the determined physical communication resource for transmitting data-link layer data frames

3.4.17
BITMAP
bitmap format type including Width and Mask_Info information and the length range from 2 octets to 256 octets

Note 1 to entry: See Figure 2.

Note 2 to entry: Width has 1octet, its value indicates the number of the octets of Mask_Info.

Note 3 to entry: Mask_Info represented by bit. The octet length is Width value and the bit length is Width × 8.

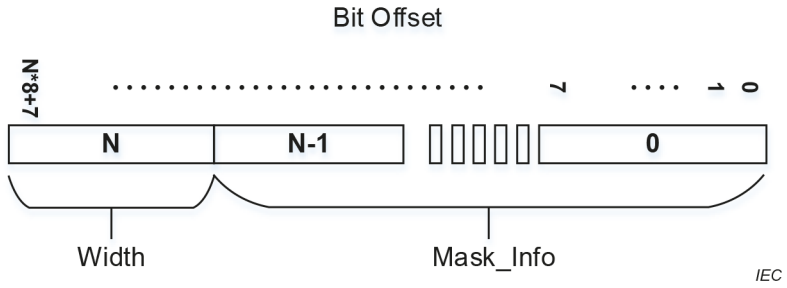


Figure 2 – Bitmap data type diagram

3.5 Additional Type 28 symbols and abbreviations

AL	Application layer
C/S	Client/Server
CLMDTA	Connection-less Mode Data Transmission with Acknowledge
CLMDTNA	Connection-less Mode Data Transmission with No Acknowledge
CLMDTRA	Connection-less Mode Data Transmission with Request and Acknowledge
CLMDTRRNA	Connection-less Mode Data Transmission with Request and Response but No Acknowledge
CMDTA	Connection Mode Data Transmission with Acknowledge
CMDTNA	Connection Mode Data Transmission with No Acknowledge
DL-	Data-link layer (as a prefix)
DLCSS	Data-link clock synchronization service
DLDE	Data-link data entity
DLE	Data-link entity
DLL	Data-link layer
DLM	Data-link management
DLME	Data-link management entity
DLMS	Data-link management service
DLMS-user	Data-link management service user
DLS	Data-link service
DLP	Data-link protocol
DLS-user	Data-link service user
DTC	Data transmission channel
DTS	Data transmission service

DLSDU	Data-link service data unit
DLPDU	Data-link protocol data unit
MAC	Medium access control
MN	Management node
NodeID	Node identifier
nRT	non-Real-Time
OFDM	Orthogonal Frequency Division Multiplexing
PhL	Physical layer
PhL-	Physical layer (as a prefix)
RT	Real-Time
RTA	Real-Time acyclic
RTC	Real-Time cyclic
SAP	Service access point
TM	Transmit mode
TN	Terminal node

4 Overview of the DL-protocol

4.1 DLL protocol architecture

Figure 3 illustrates the position of DLL on the protocol stack architecture of the Type 28.

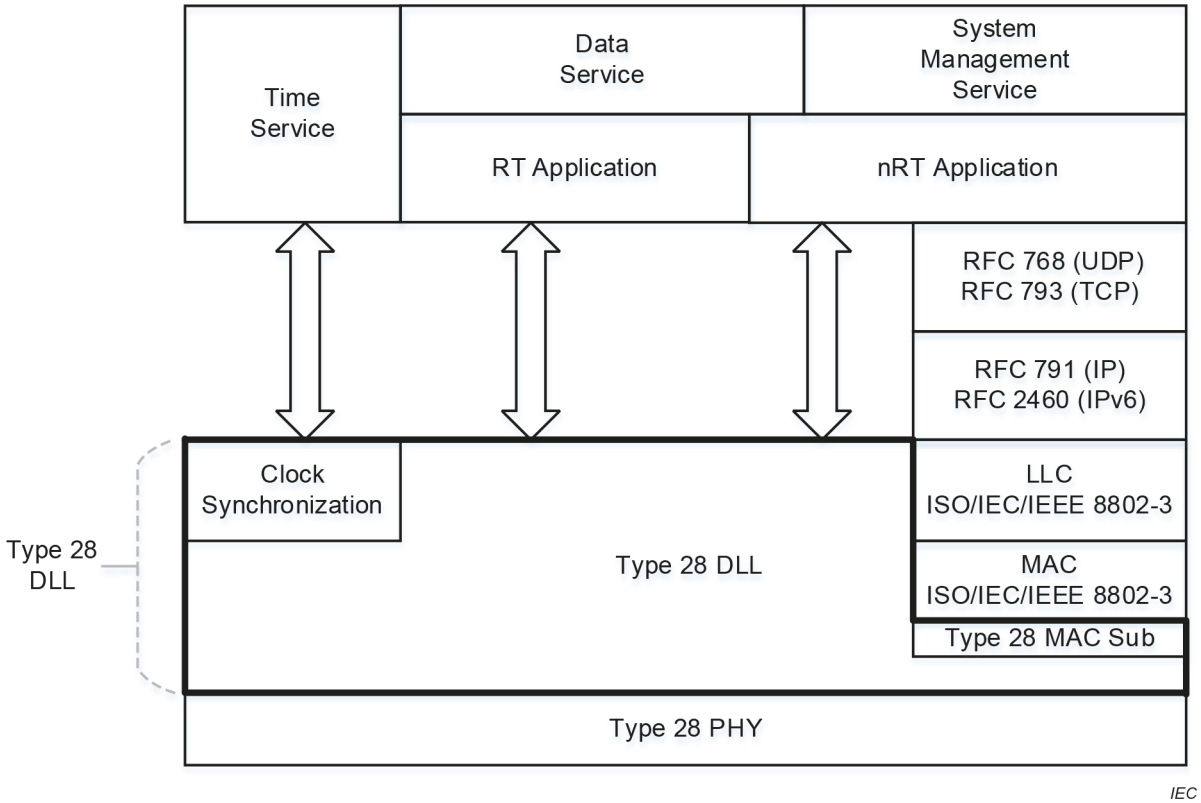


Figure 3 – DLL in Type 28 protocol stack architecture

Type 28 data-link service (DLS) is provided by the Type 28 data-link protocol (DLP) making use of the services available from the Type 28 physical layer (PhL). The DLS characteristics and function defined in this document should be exploited by the higher-level protocol. Type 28 DLL