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INTERNATIONAL STANDARD

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



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

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

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

This fourth edition cancels and replaces the third edition published in 2018. This edition constitutes a technical revision.

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

a) Use of extended data size for DLS-user data. This extension is restricted to nodes operating on a P-NET IP network.

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

Draft	Report on voting
65C/1202/FDIS	65C/1243/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.

A list of all the parts of the IEC 61158 series, 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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 could work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-4: Data-link layer protocol specification – Type 4 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 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 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.

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.

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 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

3 Terms, definitions, symbols and abbreviated terms

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 [7498-3]

3.1.2 calling-DL-address [7498-3]

3.1.3 centralized multi-end-point-connection [7498-1]

3.1.4 correspondent (N)-entities [7498-1]
correspondent DL-entities (N=2)
correspondent Ph-entities (N=1)

3.1.5 demultiplexing [7498-1]

3.1.6 DL-address [7498-3]

3.1.7 DL-address-mapping [7498-1]

3.1.8 DL-connection [7498-1]

3.1.9 DL-connection-end-point [7498-1]

3.1.10 DL-connection-end-point-identifier [7498-1]

3.1.11 DL-connection-mode transmission [7498-1]

3.1.12 DL-connectionless-mode transmission [7498-1]

3.1.13 DL-data-sink [7498-1]

3.1.14 DL-data-source [7498-1]

3.1.15 DL-duplex-transmission [7498-1]

3.1.16 DL-facility [7498-1]

3.1.17 DL-local-view [7498-3]

3.1.18 DL-name [7498-3]

3.1.19 DL-protocol [7498-1]

3.1.20 DL-protocol-connection-identifier [7498-1]

3.1.21 DL-protocol-control-information [7498-1]

3.1.22 DL-protocol-data-unit [7498-1]

3.1.23 DL-protocol-version-identifier [7498-1]

3.1.24 DL-relay [7498-1]

3.1.25 DL-service-connection-identifier [7498-1]

3.1.26 DL-service-data-unit [7498-1]

3.1.27 DL-simplex-transmission [7498-1]

3.1.28 DL-subsystem [7498-1]

3.1.29 DL-user-data [7498-1]

3.1.30 flow control [7498-1]

3.1.31 layer-management [7498-1]

3.1.32 multiplexing [7498-3]

3.1.33 naming-(addressing)-authority [7498-3]

3.1.34 naming-(addressing)-domain [7498-3]

3.1.35 naming-(addressing)-subdomain [7498-3]

3.1.36 (N)-entity [7498-1]
DL-entity
Ph-entity

3.1.37 (N)-interface-data-unit [7498-1]
DL-service-data-unit (N=2)
Ph-interface-data-unit (N=1)

3.1.38 (N)-layer [7498-1]
DL-layer (N=2)
Ph-layer (N=1)

3.1.39 (N)-service [7498-1]
DL-service (N=2)
Ph-service (N=1)

3.1.40 (N)-service-access-point [7498-1]
DL-service-access-point (N=2)
Ph-service-access-point (N=1)

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

3.1.42 peer-entities [7498-1]

3.1.43 Ph-interface-control-information [7498-1]

3.1.44 Ph-interface-data [7498-1]

3.1.45 primitive name [7498-3]

3.1.46 reassembling [7498-1]

3.1.47 recombining [7498-1]

3.1.48 reset [7498-1]

3.1.49 responding-DL-address [7498-3]

3.1.50 routing [7498-1]

3.1.51 segmenting [7498-1]

3.1.52 sequencing [7498-1]

3.1.53 splitting [7498-1]

3.1.54 synonymous name [7498-3]

3.1.55 systems-management [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 DL-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 Terms and definitions

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

3.3.1
broadcast-Node-address
address used to send broadcasts to all DLEs on a Link

Note 1 to entry: All DLEs on a Link receive all DLPDUs where the first Node-address is equal to the Broadcast-Node-Address. Such DLPDUs are always Unconfirmed, and their receipt is never acknowledged. The value of a Broadcast-Node-address is 126.

3.3.2
destination-DL-route
holds a sequence of DL-route-elements, describing the complete route to the destination

Note 1 to entry: This includes both the destination DLSAP and a local component meaningful to the destination DLS-user.

3.3.3
DL-route
combination of a Destination-DL-route and a Source-DL-route

3.3.4
DL-route-element
octet holding a Node-address or an address used by the DLS-user

3.3.5
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.

3.3.6
DL(SAP)-address
an individual DLSAP-address, designating a single DLSAP of a single DLS-user

3.3.7
(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.

3.3.8
frame
denigrated synonym for DLPDU

3.3.9
IPNetID
identification of a unique IP network

Note 1 to entry: An IPNetID is translated into an IP-address and a UPD port number.

3.3.10
IPNetTable
definition of the relation between IPNetID, IP address, UPD port number and Router NodeAddress, where IPNetID is used as index in the table

3.3.11
IP Range net
definition of the use of the IP network for local access, where nodes can be accessed directly on the same subnet as the client, or through a local Router where the subnets are configured in the local Router

3.3.12
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

3.3.13
no-Confirm-Node-address
address used to indicate that a request or response is Unconfirmed

Note 1 to entry: The value of a No-Confirm-Node-address is 0.

3.3.14
node
single DL-entity as it appears on one local link

3.3.15
node-address
address which uniquely identifies a DLE on a Link

Note 1 to entry: The value of a Node-address can be in the range of 0 to 127, with the values 0, 126 and 127 reserved for special purposes.

3.3.16
normal class device
device which replies to requests from other normal class devices, and initiates transmissions

Note 1 to entry: Such a device can act as a server (responder) and as a client (requestor) – this is also called a peer.

3.3.17
Type 4-route
a route that holds a sequence of Type 4-route-elements

Note 1 to entry: A Type 4-route is defined as an encoded DL-route, with one of the formats used when transmitting the DLPDU on the Link. The Type 4-route format can be Simple, Extended, Complex, Immediate or IP.

3.3.18
Type 4-route-element
octet, holding a 7-bit DL-route-element or Remaining-route-length, and a 1-bit source/ destination designator

3.3.19
receiving DLS-user
DL-service user that acts as a recipient of DL-user-data

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

3.3.20
sending DLS-user
DL-service user that acts as a source of DL-user-data

3.3.21
service-Node-address
address reserved for service purposes only

Note 1 to entry: All DLEs on a Link receive all DLPDUs where the first Node-address is equal to the Service-Node-Address. Such DLPDUs can be Confirmed or Unconfirmed, and it is possible that their receipt can be acknowledged or not. The Service-Node-Address can be used on Links with only two DLEs – the requesting Normal class DLE and the responding Simple or Normal class DLE. The value of the Service-Node-Address is 127.

3.3.22
simple class device
device which replies to requests from normal class devices, and can act as a server or responder only

3.3.23
source-DL-route
route that holds a sequence of DL-route-elements, describing the complete route back to the source

3.3.24
UDP port number
port number from where a Server can receive requests

Note 1 to entry: The UDP port number is 34378 for Normal UDP port. The UDP port number is 34379 for Secure UDP port.

Note 2 to entry: These UDP port numbers are registered with the IANA (Internet Assigned Numbers Authority).

Note 3 to entry: There are two different UPD port numbers: Normal UDP port and Secure UDP port.

3.3.25
UDP range net
definition of the use of the IP network for remote access, where a node cannot be accessed directly on the same subnet as the client

Note 1 to entry: The IPNetTable holds a NAT Router IP address and access to the node is obtained through this NAT Router.

Note 2 to entry: The NAT Router shall hold a table that translates the UDP port number to the actual server node IP address and UDP port number.

3.3.26
virtual link-access token
basis for the link-access system

Note 1 to entry: It is called virtual because the token is not explicitly sent from one normal-class DLE to another, but implicitly passed as the link is idle.

3.4 Symbols and abbreviations

3.4.1 Constants, variables, counters and queues

3.4.1.1	**BNA**	broadcast node address
3.4.1.2	**C(LAC)**	link access counter
3.4.1.3	**C(LIC)**	link idle counter
3.4.1.4	**SNA**	service node address
3.4.1.5	**NCNA**	no confirm node address
3.4.1.6	**Q(UR)**	user request queue
3.4.1.7	**V(ACPDU)**	acknowledge confirmed PDU
3.4.1.8	**V(AUPDU)**	acknowledge unconfirmed PDU
3.4.1.9	**V(BR)**	bit rate
3.4.1.10	**V(DC)**	device class (simple or normal)
3.4.1.11	**V(DMRT)**	default max retry time
3.4.1.12	**V(MID)**	max indication delay
3.4.1.13	**V(NA)**	node address
3.4.1.14	**V(NDLE)**	number of DLEs
3.4.1.15	**V(PNR)**	permitted number of retries
3.4.1.16	**IPNetTable**	Table to convert IPNetID to IP-addresses

3.4.2 Miscellaneous

3.4.2.1	**RCL/ACK**	response comes later / acknowledge

4 Data Link Protocol Definition

4.1 Overview of the DL-protocol

4.1.1 General

The DLL provides connectionless data transfer services for limited-size DLSDUs from one DLS-user to one or more (broadcast) DLS-users.