

Industrial communication networks — Fieldbus specifications —

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

ICS 25.040.40; 35.100.20

National foreword

This British Standard is the UK implementation of EN 61158-4-4:2008. It is identical with IEC 61158-4-4:2007. Together with all of the other sections of BS EN 61158-4, it supersedes BS EN 61158-4:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AMT/7, 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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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 May 2008

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ISBN 978 0 580 61577 1

Amendments/corrigenda issued since publication

Date	Comments

English version

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

Réseaux de communication industriels -
Spécifications des bus de terrain -
Partie 4-4: Spécification des protocoles
des couches de liaison de données -
Éléments de type 4
(CEI 61158-4-4:2007)

Industrielle Kommunikationsnetze -
Feldbusse -
Teil 4-4: Protokollspezifikation des
Data Link Layer (Sicherheitsschicht) -
Typ 4-Elemente
(IEC 61158-4-4:2007)

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 65C/474/FDIS, future edition 1 of IEC 61158-4-4, 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 was approved by CENELEC as EN 61158-4-4 on 2008-02-01.

This and the other parts of the EN 61158-4 series supersede EN 61158-4:2004.

With respect to EN 61158-4:2004 the following changes were made:

- deletion of Type 6 fieldbus, and the placeholder for a Type 5 fieldbus data-link layer, for lack of market relevance;
- addition of new fieldbus types;
- partition into multiple parts numbered 4-1, 4-2, ..., 4-19.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2008-11-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2011-02-01

NOTE Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders 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 EN 61784 series. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61158-4-4:2007 was approved by CENELEC as a European Standard without any modification.

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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/TR 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 standard 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 standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may 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 standard 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 standard, 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 standard also specifies conformance requirements for systems implementing these procedures. This standard does not contain tests to demonstrate compliance with such requirements.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 61158-2 (Ed.4.0), *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-3-4, *Industrial communication networks – Fieldbus specifications – Part 3-4: Data-link layer service definition – Type 4 elements*

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 abbreviations

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

3.1 Reference model terms and definitions

This standard 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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3.1.2 calling-DL-address	[7498-3]
3.1.3 centralized multi-end-point-connection	[7498-1]
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correspondent Ph-entities (N=1)	
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3.1.7 DL-address-mapping	[7498-1]
3.1.8 DL-connection	[7498-1]
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3.1.37	(N)-interface-data-unit DL-service-data-unit (N=2) Ph-interface-data-unit (N=1)	[7498-1]
3.1.38	(N)-layer DL-layer (N=2) Ph-layer (N=1)	[7498-1]
3.1.39	(N)-service DL-service (N=2) Ph-service (N=1)	[7498-1]
3.1.40	(N)-service-access-point DL-service-access-point (N=2) Ph-service-access-point (N=1)	[7498-1]

3.1.41 (N)-service-access-point-address	[7498-1]
DL-service-access-point-address (N=2)	
Ph-service-access-point-address (N=1)	
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3.1.43 Ph-interface-control-information	[7498-1]
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3.1.54 synonymous name	[7498-3]
3.1.55 systems-management	[7498-1]

3.2 Service convention terms and definitions

This standard 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****3.3.1****broadcast-Node-address**

address used to send broadcasts to all DLEs on a Link

NOTE 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 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**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.

3.3.6**DLSAP**

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

NOTE This definition, derived from ISO/IEC 7498-1, is repeated here to facilitate understanding of the critical distinction between DLSAPs and their DL-addresses.

3.3.7**DL(SAP)-address**

an individual DLSAP-address, designating a single DLSAP of a single DLS-user.

3.3.8

(individual) DLSAP-address

DL-address that designates only one DLSAP within the extended link

NOTE A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP.

3.3.9

frame

denigrated synonym for DLPDU

3.3.10

IPNetID

identification of a unique IP network. The value of IPNetID shall be in the range of 0-127. The values 0, 126 and 127 are reserved for special purposes

NOTE An IPNetID is translated into an IP-address and a UDP port number.

3.3.11

IPNetTable

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

3.3.12

IP Range net

is used 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

3.3.13

Nettype

an IP network is of a certain type, a Nettype that can be “Unused”, “IP Range net” or “UDP Range net”

3.3.14

no-Confirm-Node-address

address used to indicate that a request or response is Unconfirmed

NOTE The value of a No-Confirm-Node-address is 0.

3.3.15

node

single DL-entity as it appears on one local link

3.3.16

node-address

address which uniquely identifies a DLE on a Link

NOTE 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.

3.3.17

normal class device

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

NOTE Such a device can act as a server (responder) and as a client (requestor) - this is also called a peer

3.3.18

Type 4-route

holds a sequence of Type 4-route-elements

NOTE 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.

3.3.19**Type 4-route-element**

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

3.3.20**receiving DLS-user**

DL-service user that acts as a recipient of DL-user-data

NOTE A DL-service user can be concurrently both a sending and receiving DLS-user.

3.3.21**sending DLS-user**

DL-service user that acts as a source of DL-user-data

3.3.22**service-Node-address**

address reserved for service purposes only

NOTE 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 their receipt may or may not be acknowledged. 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.

3.3.23**simple class device**

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

3.3.24**source-DL-route**

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

3.3.25**UDP port number**

a Server can receive requests on two different UDP port numbers: Normal UDP port and Secure UDP port. The UDP port number shall be 34378 for Normal UDP port. The UDP port number shall be 34379 for Secure UDP port

NOTE These UDP port numbers are registered with the IANA (Internet Assigned Numbers Authority)

3.3.26**UDP range net**

is used for remote access, where a node cannot be accessed directly on the same subnet as the client. The IPNetTable holds a NAT Router IP address and access to the node is obtained through this NAT Router

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

3.3.27**Virtual link-access token**

basis for the link-access system

NOTE 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
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4 Data Link Protocol Definition

4.1 Overview of the DL-protocol

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

A DLE is implicitly connected to one PhE and to a single DLSAP. This means, that when a local DLS-user issues a service primitive at a certain DLSAP, the DLE and hence the Link is implicitly selected.

A DLE always delivers received DLSDUs at the same DLSAP, and hence to the same DLS-user.

This concept is illustrated in Figure 1.