IEC 61158-4-21

Edition 1.0 2010-08

INTERNATIONAL STANDARD

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Withdrawn

Industrial communication networks – Fieldbus specifications – Part 4-21: Data-link layer protocol specification – Type 21 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 4-21: Spécification du protocole de la couche de liaison de données – Eléments de Type 21

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-21: Data-link layer protocol specification – Type 21 elements

FOREWORD

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International Standard IEC 61158-4-21:2010 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This standard cancels and replaces IEC/PAS 62573 published in 2008. This first edition constitutes a technical revision.

This bilingual version published in 2012-01 corresponds to the English version published in 2010-08.

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The text of this standard is based on the following documents:

FDIS	Report on voting
65C/605/FDIS	65C/619/RVD

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

The French version has not been voted upon.

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

A list of all 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- withdrawn;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.

NOTE The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

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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.

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 profile parts. Use of the various protocol types in other combinations may require permission of 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 21 elements and possibly other types given in subclause 4.1, 4.2 and 7.3 as follows:

KR 0789444	[LS]	A communication packet processing apparatus and method for ring topology ethernet network capable of preventing permanent packet looping
KR 0732510	[LS]	Network system
KR 0870670	[LS]	Method for determining a Ring Manager Node

IEC takes no position concerning the evidence, validity and scope of these patent rights.

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[LS]: LS Industrial Systems Co., Ltd.
LS Tower 1026-6
Hogye-dong, Dongan-gu,
Anyang-si, Gyeonggi-do 431-848
Republic of Korea

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ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-21: Data-link layer protocol specification – Type 21 elements

1 Scope

1.1 General

The DLL provides basic time-critical data communications between devices in an automated environment. Type 21 provides priority-based cyclic and acyclic data communication using an internal collision-free, full-duplex dual-port Ethernet switch technology. For wide application in various automation applications, Type 21 does not restrict the cyclic/acyclic scheduling policy in the DLL.

1.2 Specifications

This standard describes:

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) procedures for giving communication opportunities based on standard ISO/IEC 8802-3 MAC, with provisions for nodes to be added or removed during normal operation;

c) structure of the fieldbus data link protocol data units (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 data link entities (DLEs) through the exchange of fieldbus DLPDUs;

b) the interactions between a data link 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 physical layer 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 that support time-critical communications services in the data link layer of the OSI or fieldbus reference models, and that 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-deterministic communications needs.

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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 61158-3-21:2010 [1], *Industrial Communication Networks – Fieldbus specifications – Part 3-21: Data-link layer service definition – Type 21 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 8802-3:2000, *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*

ISO/IEC 10731:1994, *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, abbreviations, and conventions 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.

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]

[1] To be published.

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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 [ISO/IEC 7498-1]
DL-entity
Ph-entity

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

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

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

3.1.40 (N)-service-access-point [ISO/IEC 7498-1]
DL-service-access-point (N=2)
Ph-service-access-point (N=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 standard also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

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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-protocol-machine

3.2.11 DL-provider-initiated-facility

3.2.12 DL-provider-optional-facility

3.2.13 DL-service-primitive;
primitive

3.2.14 DL-service-provider

3.2.15 DL-service-user

3.2.16 DLS-user-optional-facility

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

3.2.18 multi-peer

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

3.2.20 requestor

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

3.2.22 submit (primitive)

3.2.23 symmetrical service

3.3 Common terms and definitions

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 data link (DL) subnetwork in which any of the connected data link entities (DLEs) may communicate directly, without any intervening data link 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
data-link service access point (DLSAP)
distinctive point at which DL-services are provided by a single DLE 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.(See Figure 1.)

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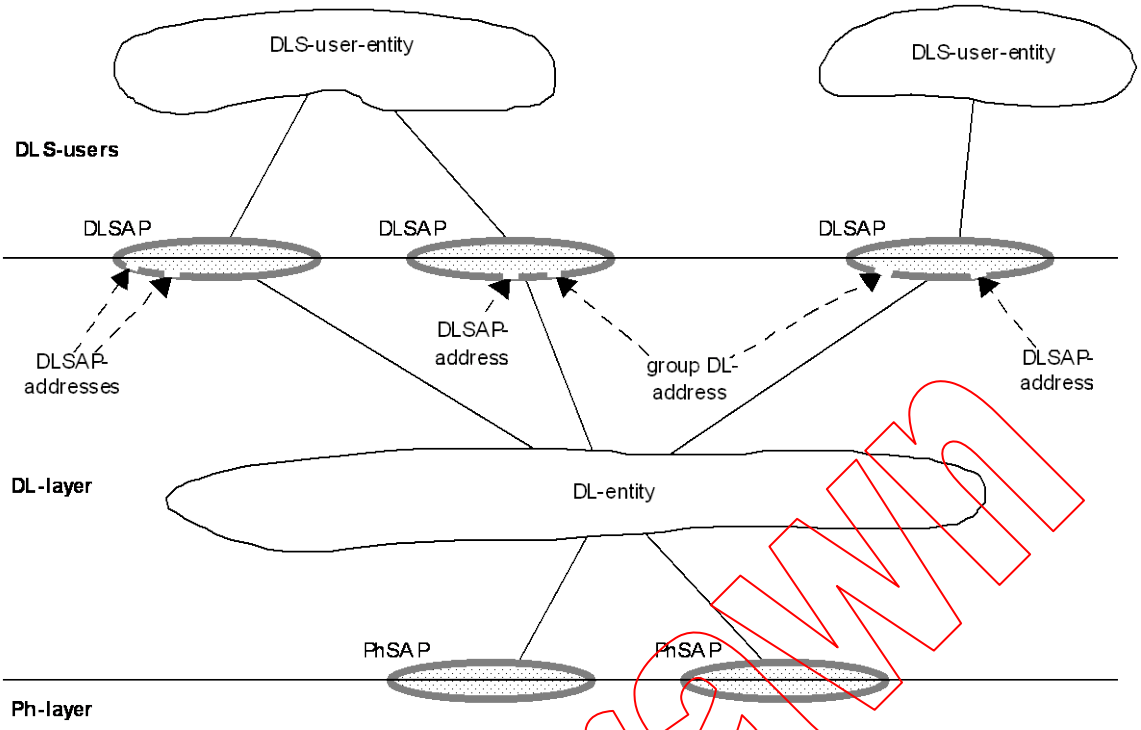

NOTE 1 DLSAPs and physical layer service access points (PhSAPs) are depicted as ovals spanning the boundary between two adjacent layers.

NOTE 2 DL-addresses are depicted as designating small gaps (points of access) in the DLL portion of a DLSAP.

NOTE 3 A single DLE 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 data link service (DLS) user (DLS-user), or a group DL-address potentially designating multiple DLSAPs, each of a single DLS-user

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

3.3.5
Data-link connection endpoint address (DLCEP-address)
DL-address that designates either:

a) one peer DL-connection-end-point;

b) one multi-peer publisher DL-connection-end-point, and implicitly the corresponding set of subscriber DL-connection-end-points, where each DL-connection-end-point exists within a distinct DLSAP and is associated with a corresponding distinct DLSAP-address.

3.3.6
Frame check sequence (FCS) error
error that occurs when the computed frame check sequence value after reception of all the octets in a data link protocol data unit (DLPDU) does not match the expected residual

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3.3.7
frame
synonym for DLPDU

3.3.8
network management
management functions and services that perform network initialization, configuration, and error handling

3.3.9
protocol
convention on the data formats, time sequences, and error correction for data exchange in communication systems

3.3.10
receiving DLS-user
DL-service user that acts as a recipient of DLS-user data

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

3.3.11
sending DLS-user
DL-service user that acts as a source of DLS-user data

3.3.12
device
single DLE as it appears on one local link

3.3.13
DL– entity identifier
address that designates the (single) DLE associated with a single device on a specific local link

3.3.14
device unique identification
unique 8 octet identification to identify a Type 21 device in a network. This ID is a combination of a 6 octet ISO/IEC 8802-3:2000 MAC address and 2 octet DL-address

3.3.15
ring
active network where each node is connected in series to two other devices

NOTE A ring may also be referred to as a loop.

3.3.16
linear topology
topology where the devices are connected in series, with two devices each connected to only one other device, and all others each connected to two other devices, for example, connected in a line

3.3.17
R-port
port in a communication device that is part of a ring structure

3.3.18
real-time
ability of a system to provide a required result in a bounded time

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3.3.19
real-time communication
transfer of data in real-time

3.3.20
Real-time Ethernet (RTE)
ISO/IEC 8802-3:2000 based network that includes real-time communication

NOTE 1 Other communications can be supported, providing that the real-time communication is not compromised.

NOTE 2 This definition is base on, but not limited to, ISO/IEC 8802-3:2000. It could be applicable to other IEEE802 specifications, *e.g.*, IEEE802.11.

3.3.21
RTE end device
device with at least one active RTE port

3.3.22
RTE port
media access control (MAC) sublayer point where an RTE is attached to a local area network (LAN)

NOTE This definition is derived from that of bridge port in ISO/IEC 10038: 1993, as applied to local MAC bridges.

3.3.23
switched network
network also containing switches

NOTE Switched network means that the network is based on IEEE802.1D and IEEE802.1Q with MAC bridges and priority operations.

3.3.24
link
transmission path between two adjacent nodes [derived from ISO/IEC 11801]

3.4 Symbols and abbreviations

3.4.1 Common symbols and abbreviations

DL	data link (used as a prefix or adjective)
DLC	data link connection
DLCEP	data link connection endpoint
DLE	data link entity (the local active instance of the DLL)
DLL	data link layer
DLPDU	data link protocol data unit
DLPM	data link protocol machine
DLM	data link management
DLME	data link management entity (the local active instance of DLM)
DLMS	data link management service
DLS	data link service
DLSAP	data link service-access-point
DLSDU	data link service-data-unit
FIFO	first-in, first-out (queuing method)
NMT	network management
OSI	Open Systems Interconnection

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Ph-	physical layer (as a prefix)
PHY	physical interface transceiver
PhL	physical layer
RTE	Real-time Ethernet
IEC	International Electrotechnical Commission
IP	Internet Protocol (see RFC 791)
ISO	International Organization for Standardization
MAC	media access control
NRT	non-real-time
PDU	protocol data unit
SAP	service access point
RT	real-time
TCP	Transmission Control Protocol (see RFC 793)
UDP	User Datagram Protocol (see RFC 768)

3.4.2 Type 21: Additional symbols and abbreviations

EFR	extremely fast recovery
GD	general device
LNM	line network manager
PO	power on
PnP	plug and play
RNM	ring network manager
RNMP	primary ring network manager
RNMS	secondary ring network manager
RNAC	ring network auto configuration
UID	device unique identification
Type 21 NMIB	Type 21 network management information base

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Withdrawn

4 Overview of the data-link protocol

4.1 General

Type 21 extends Ethernet according to the ISO/IEC 8802-3:2000 standard with mechanisms to transfer data with predictable timing demands typical of high-performance automation. It does not change the basic principles of the Ethernet standard ISO/IEC 8802-3:2000 but extends it toward RTE. Thus, it is possible to continue to use standard Ethernet hardware, infrastructure components, or test and measurement equipment, such as network analyzers.

4.2 Overview of medium access control

A Type 21 device requires an integrated switch with two ports (ring ports) connected to the ring. A Type 21 network system is constructed with full-duplex, collision-free Ethernet switching devices as a ring or a line network. Type 21 guarantees collision-free data transmission between two devices linked by a full-duplex Ethernet connection. Thus, the Type 21 data link layer provides reliable, transparent and collision-free data transmission among DLS-users.