

BS EN 61158-3-3:2008



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Industrial communication networks — Fieldbus specifications —

Part 3-3: Data-link layer service definition — Type 3 elements

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National foreword

This British Standard is the UK implementation of EN 61158-3-3:2008. It is identical to IEC 61158-3-3:2007. Together with all of the other sections of BS EN 61158-3, it supersedes BS EN 61158-3:2004 which is withdrawn.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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Compliance with a British Standard cannot confer immunity from legal obligations.

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Amendments issued since publication

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English version

**Industrial communication networks -
Fieldbus specifications -
Part 3-3: Data-link layer service definition -
Type 3 elements
(IEC 61158-3-3:2007)**

Réseaux de communication industriels -
Spécifications des bus de terrain -
Partie 3-3: Définition des services
des couches de liaison de données -
Éléments de type 3
(CEI 61158-3-3:2007)

Industrielle Kommunikationsnetze -
Feldbusse -
Teil 3-3: Dienstfestlegungen
des Data Link Layer (Sicherheitsschicht) -
Typ 3-Elemente
(IEC 61158-3-3:2007)

This European Standard was approved by CENELEC on 2008-02-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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/473/FDIS, future edition 1 of IEC 61158-3-3, 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 61158-3-3 on 2008-02-01.

This and the other parts of the EN 61158-3 series supersede EN 61158-3:2004.

With respect to EN 61158-3:2004 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 3-1, 3-2, ..., 3-19.

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 61158-3-3:2007 was approved by CENELEC as a European Standard without any modification.

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

IEC 61158-2	NOTE Harmonized as EN 61158-2:2008 (not modified).
IEC 61158-4-3	NOTE Harmonized as EN 61158-4-3:2008 (not modified).
IEC 61158-5-3	NOTE Harmonized as EN 61158-5-3:2008 (not modified).
IEC 61158-6-3	NOTE Harmonized as EN 61158-6-3:2008 (not modified).
IEC 61784-1	NOTE Harmonized as EN 61784-1:2008 (not modified).
IEC 61784-2	NOTE Harmonized as EN 61784-2:2008 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO/IEC 7498-1	- ¹⁾	Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model	EN ISO/IEC 7498-1	1995 ²⁾
ISO/IEC 7498-3	- ¹⁾	Information technology - Open Systems Interconnection - Basic Reference Model: Naming and addressing	-	-
ISO/IEC 10731	- ¹⁾	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-

¹⁾ Undated reference.

²⁾ Valid edition at date of issue.

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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.

Throughout the set of fieldbus standards, the term “service” refers to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, the data-link layer service defined in this standard is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 3-3: Data-link layer service definition – Type 3 elements

1 Scope

1.1 Overview

This part of IEC 61158 provides common elements for basic time-critical messaging communications between devices in an automation environment. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This standard defines in an abstract way the externally visible service provided by the Type 3 fieldbus data-link layer in terms of

- a) the primitive actions and events of the service;
- b) the parameters associated with each primitive action and event, and the form which they take; and
- c) the interrelationship between these actions and events, and their valid sequences.

The purpose of this standard is to define the services provided to

- the Type 3 fieldbus application layer at the boundary between the application and data-link layers of the fieldbus reference model, and
- systems management at the boundary between the data-link layer and systems management of the fieldbus reference model.

1.2 Specifications

The principal objective of this standard is to specify the characteristics of conceptual data-link layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of data-link protocols for time-critical communications. A secondary objective is to provide migration paths from previously existing industrial communications protocols.

This specification may be used as the basis for formal DL-Programming-Interfaces. Nevertheless, it is not a formal programming interface, and any such interface will need to address implementation issues not covered by this specification, including

- a) the sizes and octet ordering of various multi-octet service parameters, and
- b) the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

This standard does not specify individual implementations or products, nor do they constrain the implementations of data-link entities within industrial automation systems.

There is no conformance of equipment to this data-link layer service definition standard. Instead, conformance is achieved through implementation of the corresponding data-link protocol that fulfills the Type 1 data-link layer services defined in this standard.

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.

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model — 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, abbreviations and conventions

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 DL-address	[7498-3]
3.1.2 DL-address-mapping	[7498-1]
3.1.3 called-DL-address	[7498-3]
3.1.4 calling-DL-address	[7498-3]
3.1.5 centralized multi-end-point-connection	[7498-1]
3.1.6 DL-connection	[7498-1]
3.1.7 DL-connection-end-point	[7498-1]
3.1.8 DL-connection-end-point-identifier	[7498-1]
3.1.9 DL-connection-mode transmission	[7498-1]
3.1.10 DL-connectionless-mode transmission	[7498-1]
3.1.11 correspondent (N)-entities	[7498-1]
correspondent DL-entities (N=2)	
correspondent Ph-entities (N=1)	
3.1.12 DL-duplex-transmission	[7498-1]
3.1.13 (N)-entity	[7498-1]
DL-entity (N=2)	
Ph-entity (N=1)	
3.1.14 DL-facility	[7498-1]
3.1.15 flow control	[7498-1]

3.1.16	(N)-layer DL-layer (N=2) Ph-layer (N=1)	[7498-1]
3.1.17	layer-management	[7498-1]
3.1.18	DL-local-view	[7498-3]
3.1.19	DL-name	[7498-3]
3.1.20	naming-(addressing)-domain	[7498-3]
3.1.21	peer-entities	[7498-1]
3.1.22	primitive name	[7498-3]
3.1.23	DL-protocol	[7498-1]
3.1.24	DL-protocol-connection-identifier	[7498-1]
3.1.25	DL-protocol-data-unit	[7498-1]
3.1.26	DL-relay	[7498-1]
3.1.27	reset	[7498-1]
3.1.28	responding-DL-address	[7498-3]
3.1.29	routing	[7498-1]
3.1.30	segmenting	[7498-1]
3.1.31	(N)-service DL-service (N=2) Ph-service (N=1)	[7498-1]
3.1.32	(N)-service-access-point DL-service-access-point (N=2) Ph-service-access-point (N=1)	[7498-1]
3.1.33	DL-service-access-point-address	[7498-3]
3.1.34	DL-service-connection-identifier	[7498-1]
3.1.35	DL-service-data-unit	[7498-1]
3.1.36	DL-simplex-transmission	[7498-1]
3.1.37	DL-subsystem	[7498-1]
3.1.38	systems-management	[7498-1]
3.1.39	DLS-user-data	[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 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 data-link service 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

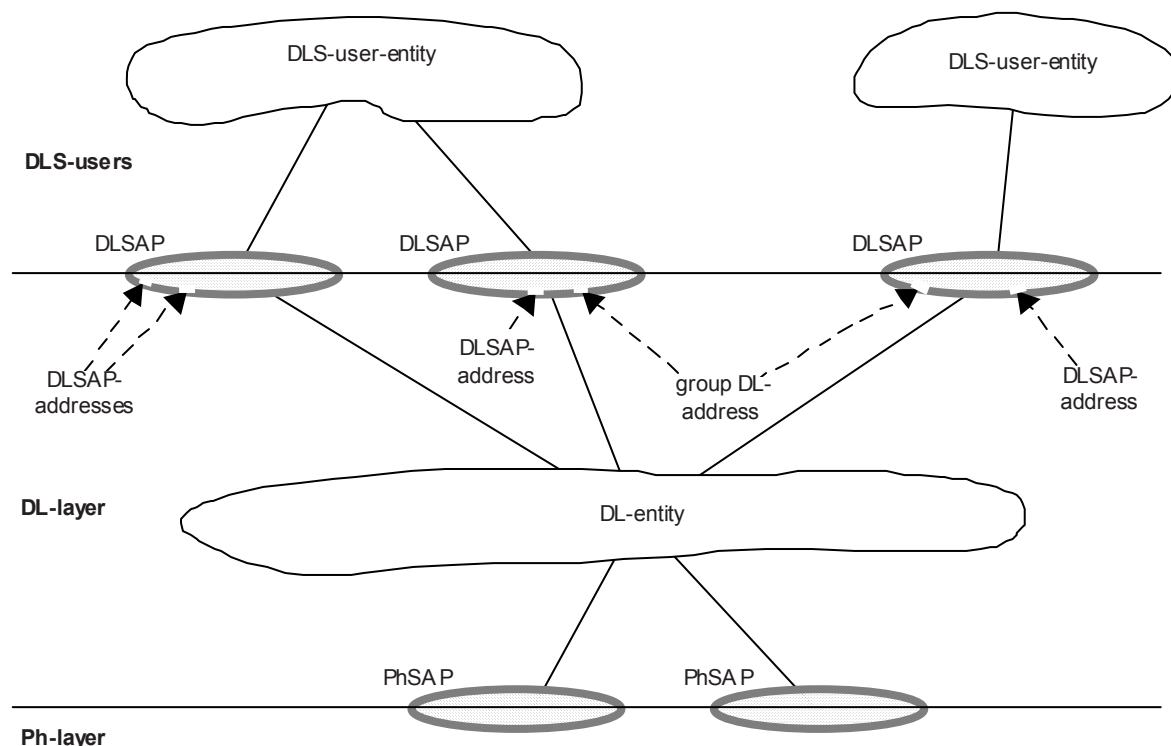
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

3.3.2

DLSAP

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

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



NOTE 1 DLSAPs and 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 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, each of a single DLS-user

NOTE 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 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 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. A single DL-entity can have multiple group DL-addresses associated with a single DLSAP. A single DL-entity also can 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 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 3 data-link specific definitions**3.4.1****acknowledgement DLPDU**

reply DLPDU that contains no DLSDU

3.4.2**bit time**

time to transmit one bit

3.4.3**clock synchronization**

represents a sequence of interactions to synchronize the clocks of all time receivers by a time master

3.4.4**controller_type**

hardware class of the communications entity

3.4.5**data DLPDU**

DLPDU that carries a DLSDU from a local DLS-user to a remote DLS-user

3.4.6**DL_status, DLM_status**

status that specifies the result of the execution of the associated request

3.4.7**GAP**

range of station (DLE) DL-addresses from this station (TS) to its successor (NS) in the logical token ring, excluding stations above HSA

3.4.8**isochronous mode**

special operational mode that implies both a constant (isochronous) cycle with a fixed schedule of high and low priority messages, and the synchronization of the DLS-users with this constant (isochronous) cycle

3.4.9**local DLE**

DLE in a current master station that initiates the current transaction

3.4.10**local DLS-user**

DLS-user that initiates the current service

3.4.11**publisher**

transmitter of messages for consumption by subscribers

3.4.12**region/segment address**

address extension that identifies a particular fieldbus subnetwork

NOTE This supports DL-routing between fieldbuses.

3.4.13**remote DLE**

addressed DLE of a service request (that is, the intended receiving DLE of any resulting request DLPDU)

3.4.14**remote DLS-user**

addressed DLS-user of a service request (that is, the intended receiver of any resulting indication primitive)

3.4.15**reply DLPDU**

DLPDU transmitted from a remote DLE to the initiating (local) DLE, and possibly other DLEs

NOTE When the remote DLE is a Publisher, the reply DLPDU also can be sent to several remote DLEs.

3.4.16**request DLPDU**

DLPDU that carries either a request for data or a DLSDU or both from a local DLS-user to a remote DLS-user

3.4.17**response DLPDU**

reply DLPDU that carries a DLSDU from a remote DLS-user to local DLS-user

3.4.18**station**

master or slave device containing a DLE

3.4.19**subscriber**

receiver of messages produced by a publisher

3.4.20**time event**

message that represents a trigger for a moment of time

3.4.21**time master**

device which is able to send clock synchronization messages

NOTE Link devices have time master functionality.

3.4.22

time receiver

fieldbus device able to be time synchronized by a time master

3.4.23

token passing

medium access method, in which the right to transmit is passed from master station to master station in a logical ring

3.5 Common symbols and abbreviations

NOTE Many symbols and abbreviations are common to more than one protocol Type; they are not necessarily used by all protocol Types.

3.5.1 DL-	data-link layer (as a prefix)
3.5.2 DLC	DL-connection
3.5.3 DLCEP	DL-connection-end-point
3.5.4 DLE	DL-entity (the local active instance of the data-link layer)
3.5.5 DLL	DL-layer
3.5.6 DLPCI	DL-protocol-control-information
3.5.7 DLPDU	DL-protocol-data-unit
3.5.8 DLM	DL-management
3.5.9 DLME	DL-management Entity (the local active instance of DL-management)
3.5.10 DLMS	DL-management Service
3.5.11 DLS	DL-service
3.5.12 DLSAP	DL-service-access-point
3.5.13 DLSDU	DL-service-data-unit
3.5.14 FIFO	first-in first-out (queuing method)
3.5.15 OSI	open systems interconnection
3.5.16 Ph-	physical layer (as a prefix)
3.5.17 PhE	Ph-entity (the local active instance of the physical layer)
3.5.18 PhL	Ph-layer
3.5.19 QoS	quality of service

3.6 Additional Type 3 symbols and abbreviations

3.6.1 ACK	acknowledge(ment) DLPDU
3.6.2 cnf	confirm primitive
3.6.3 CS	clock synchronization
3.6.4 DA	destination address of a DLPDU
3.6.5 DAE	destination address extension(s) of a DLPDU which conveys D_SAP_index or destination region/segment address or both
3.6.6 DS	DL/DLM_status: Disconnected station, local DL-entity not in logical token ring or disconnected from line
3.6.7 D_SAP	destination service access point, the DLSAP which identifies the remote DLS-user.
3.6.8 D_SAP_index	destination service access point index, that component of a DLSAP-address which designates a DLSAP and remote DLS-user within the remote DLE
3.6.9 DXM	data exchange multicast
3.6.10 EXT	address extension bit of a DLPDU
3.6.11 FC	frame control (DLPDU type) field of a DLPDU
3.6.12 G	GAP update factor, the number of token cycles between GAP maintenance (update) cycles
3.6.13 HSA	highest station address installed (configured) on this fieldbus
3.6.14 ind	indication primitive
3.6.15 IsoM	isochronous mode
3.6.16 LMS	list of master stations
3.6.17 LR	DL/DLM_status: Local resource not available or not sufficient
3.6.18 LS	DL/DLM_status: Local service not activated at DLSAP or local DLSAP not activated
3.6.19 MSRD	send and request data with multicast reply (DL-service)
3.6.20 NA	DL/DLM_status: No acknowledgement/response
3.6.21 NIL	locally existing value, but not fixed
3.6.22 NO	DL/DLM_status: Not ok
3.6.23 NR	DL/DLM_status: No response, DL/DLM-data acknowledgement negative and send data ok
3.6.24 NS	Next station, the station to which this Master will pass the token
3.6.25 OK	DL/DLM_status: Service finished according to the rules
3.6.26 RDH	DL/DLM_status: Response DL-data high and no resource for send data

3.6.27 RDL	DL/DLM_status: Response DL/DLM-data low and no resource for send data
3.6.28 req	request primitive
3.6.29 RR	DL/DLM_status: No resource for send data and no response DL-data available (acknowledgement negative)
3.6.30 RS	DL/DLM_status: No service or no remote address activated at remote-service-access-point (acknowledgement negative)
3.6.31 SA	source address of a DLPDU
3.6.32 SAE	source address extension(s) of a DLPDU, which conveys S_SAP_index or source region/segment address or both
3.6.33 SC	single character acknowledge DLPDU
3.6.34 SDA	send data with acknowledge (DL-service)
3.6.35 SDN	send data with no acknowledge (DL-service)
3.6.36 SRD	send and request data with reply (DL-service)
3.6.37 S_SAP	source service access point, the DLSAP associated with the initiates local DLS-user
3.6.38 S_SAP_index	source service access point index, a component of a DLSAP-address which designates that DLSAP within the DLE at which the transaction is being initiated
3.6.39 SYN	synchronizing bits of a DLPDU (period of IDLE), which guarantees the specified DLPDU integrity and facilitates receiver synchronization
3.6.40 SYNCHT	synchronization telegram, indicates the start of a new cycle in IsoM
3.6.41 tBIT	bit time, DL-symbol period, the time to transmit one bit on the fieldbus: $1/(\text{data signaling rate in bit/s})$
3.6.42 TCSI	clock synchronization interval time
3.6.43 TCT	Isochronous cycle time, the requested duration for one cycle in IsoM
3.6.44 TQUI	quiet time, transmitter fall time (line state uncertain time) or repeater switch time or both. The time a transmitting station needs to wait after the end of a DLPDU before enabling its receiver.
3.6.45 TRDY	ready time, the time after which the transmitting master will expect a reply DLPDU
3.6.46 TRR	real rotation time, the time between the last successive receptions of the token by the observing master station
3.6.47 TS	This Station
3.6.48 TSDI	station delay of initiator, the time a master station will wait before sending successive DLPDUs
3.6.49 TSDR	station delay of responder, the actual time a responder needs to generate a reply DLPDU
3.6.50 TSET	setup time, the time between an event (e.g. interrupt SYN timer expired) and the necessary reaction (e.g. enabling a receiver)

3.6.51 TSH	time shift, the time a real isochronous cycle deviates from the requested duration for one cycle in IsoM
3.6.52 TSL	slot time, the maximum time a master station waits for a reply DLPDU
3.6.53 TSYN	synchronization time, the period of IDLE before the beginning of a DLPDU after which a station enables its receiver; the required minimum inter-DLPDU idle period to guarantee DLPDU integrity and a valid DLPDU
3.6.54 TSYNI	synchronization interval time, the maximum time that a receiving station waits for the required inter-DLPDU idle period, of duration TSYN, to occur before it detects a bus fault
3.6.55 TTR	Target rotation time, the anticipated time for one token cycle, including allowances for high and low priority transactions, errors and GAP maintenance
3.6.56 UE	DL/DLM_status: Negative acknowledgement, remote user interface error

3.7 Common conventions

This standard uses the descriptive conventions given in ISO/IEC 10731.

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

Service primitives, used to represent service user/service provider interactions (see ISO/IEC 10731), convey parameters that indicate information available in the user/provider interaction.

This standard uses a tabular format to describe the component parameters of the DLS primitives. The parameters that apply to each group of DLS primitives are set out in tables throughout the remainder of this standard. Each table consists of up to six columns, containing the name of the service parameter, and a column each for those primitives and parameter-transfer directions used by the DLS:

- the request primitive's input parameters;
- the request primitive's output parameters;
- the indication primitive's output parameters;
- the response primitive's input parameters; and
- the confirm primitive's output parameters.

NOTE The request, indication, response and confirm primitives are also known as requestor.submit, acceptor.deliver, acceptor.submit, and requestor.deliver primitives, respectively (see ISO/IEC 10731).

One parameter (or part of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive and parameter direction specified in the column:

- M** — parameter is mandatory for the primitive.
- U** — parameter is a User option, and may or may not be provided depending on the dynamic usage of the DLS-user. When not provided, a default value for the parameter is assumed.
- C** — parameter is conditional upon other parameters or upon the environment of the DLS-user.
- (blank)** — parameter is never present.

Some entries are further qualified by items in brackets. These may be

a) a parameter-specific constraint

(=) indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.

b) an indication that some note applies to the entry

(n) indicates that the following note n contains additional information pertaining to the parameter and its use.

In any particular interface, not all parameters need be explicitly stated. Some may be implicitly associated with the DLSAP at which the primitive is issued.

In the diagrams which illustrate these interfaces, dashed lines indicate cause-and-effect or time-sequence relationships, and wavy lines indicate that events are roughly contemporaneous.

3.8 Additional Type 3 conventions

In the diagrams which illustrate the DLS and DLM interfaces, dashed lines indicate cause-and-effect or time-sequence relationships between actions at different stations, while solid lines with arrows indicate cause-and-effect time-sequence relationships which occur within the DLE-provider at a single station.

The following notation, a shortened form of the primitive classes defined in 3.7, is used in the figures.

4 Connectionless-mode data-link service

4.1 General

This clause describes the interface between a DLE and a data-link service user (DLS-user). The services of this interface are typical of those needed in application fields such as process control, factory automation, power distribution, building automation and other primary process industries:

- general purpose data transfer service;
- time transfer service.

req	request primitive
ind	indication primitive
cnf	confirm primitive (confirmation)

4.2 Model of the connectionless-mode data-link service

4.2.1 Overview

This subclause describes the abstract model for data and time transfer services. The model defines interactions between the DLS-user and the DLL that take place at the DLSAPs. Information is passed between the DLS-user and the local DLE by DLS primitives and their associated parameters.

The DLS-user is provided with the following data and time transfer services:

- Acknowledged connectionless data transfer:
Send Data with Acknowledge (SDA)
- Unacknowledged connectionless data transfer:
Send Data with No Acknowledge (SDN)
- Two-way connectionless data exchange:
Send and Request Data with Reply (SRD)
- M-way connectionless data exchange:
Send and Request Data with Multicast Reply (MSRD)
- Unacknowledged connectionless time event and clock transfer:
Clock Synchronization (CS).

These services permit a DLS-user in a master station, called the local DLS-user, to send DLS-user data or time information (a DLSDU) to a DLS-user, called the remote DLS-user, at either a single remote station (SDN, SDA, SRD, MSRD) or at all remote stations (SDN, CS).

Two of these services (SRD and MSRD) permit a DLSDU to be returned by that single remote station (in an immediate reply) as part of a single transaction. These same two services can be used to retrieve a DLSDU from that remote station without first sending a DLSDU. Additionally, the MSRD service permits a DLSDU to be returned by the remote station as a multicast message.

NOTE All of these services are considered optional.

4.2.2 Acknowledged connectionless data transfer: Send data with acknowledge (SDA)

This service permits the local DLS-user to send a DLSDU to a single remote station. At the remote station the DLSDU, if the respective DLPDU is transferred error-free, is delivered by the remote DLE to its local DLS-user. The originating local DLS-user receives a confirmation concerning the receipt or non-receipt of the DLSDU by the remote DLS-user. If an error occurred during the transfer, the originating DLE repeats the data transfer up to a configured maximum number of times.

4.2.3 Unacknowledged connectionless data transfer: Send data with no acknowledge (SDN)

This service permits a local DLS-user to transfer a DLSDU to a single remote station (unicast), or to all other remote stations (Broadcast) at the same time. The local DLS-user receives a confirmation acknowledging the completion of the transfer, but not whether the DLPDU was duly received. At each addressed remote station this DLSDU, if the respective DLPDU is received error-free, is delivered to a single local DLS-user (Unicast), to the appropriate set of local DLS-users (Multicast), or to all local DLS-users (Broadcast). There is no confirmation to the sending DLS-user that such an intended delivery has taken place.

4.2.4 Two-way connectionless data exchange: Send and request data with reply (SRD)

This service variant permits a local DLS-user to transfer a DLSDU to a DLS-user at a single remote station and as part of the same transaction, to transfer to the requesting DLS-user either a DLSDU that was previously made available by the remote DLS-user, or a status that a DLSDU is not available or that an error has been detected. At the remote station the local DLS-user