IEC 61158-3-17

Edition 1.0 2007-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications –
Part 3-17: Data-link layer service definition – Type 17 elements

Réseaux de communication industriels – Spécifications des bus de terrain –
Partie 3-17: Définition du service de la couche de liaison de données –
Éléments de Type 17

IEC 61158-3-17:2007

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,…).
It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,…).
Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC 61158-3-17

Edition 1.0 2007-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications –
Part 3-17: Data-link layer service definition – Type 17 elements

Réseaux de communication industriels – Spécifications des bus de terrain –
Partie 3-17: Définition du service de la couche de liaison de données –
Éléments de Type 17

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX U

ICS 25.040.40; 35.100.20

ISBN 978-2-8322-0985-1

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –**

Part 3-17: Data-link layer service definition – Type 17 elements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

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 IEC 61784 series. Use of the various protocol types in other combinations may require permission of their respective intellectual-property-right holders.

International Standard IEC 61158-3-17 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This first edition and its companion parts of the IEC 61158-3 subseries cancel and replace IEC 61158-3:2003. This edition of this part constitutes a technical addition. This part and its Type 17 companion parts also replace IEC/PAS 62405, published in 2005.

This edition includes the following significant changes with respect to the previous edition:

a) deletion of the former Type 6 fieldbus, and the placeholder for a Type 5 fieldbus data-link layer, for lack of market relevance;
b) addition of new types of fieldbuses;
c) division of this part into multiple parts numbered 3-1, 3-2, …, 3-19.

This edition of this part constitutes an editorial revision.

This bilingual version (2013-07) corresponds to the monolingual English version, published in 2007-12.

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

FDIS	Report on voting
65C/473/FDIS	65C/484/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 of this standard has not been voted upon.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

The 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.

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 3-17: Data-link layer service definition – Type 17 elements

1 Scope

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 17 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 17 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;
- 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.

- Conformance

This standard does not specify individual implementations or products, nor does it 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 17 data-link layer services defined in this standard.

2 Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For all other 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: The Basic Model*

ISO/IEC 7498-3, *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 8802-3, *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*

Internet Engineering Task Force (IETF), *Request for Comments (RFC):*

RFC 826 *Ethernet Address Resolution Protocol*
(available at <http://www.ietf.org/rfc/rfc0826.txt>)

3 Definitions

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

3.1 Terms and definitions

3.1.1 ISO/IEC 10731 terms

a) (N)-connection
b) (N)-entity
c) (N)-layer
d) (N)-service
e) (N)-service-access-point
f) confirm (primitive)
g) deliver (primitive)
h) indication (primitive)
i) request (primitive)
j) response (primitive)

3.1.2 Other terms and definitions

3.1.2.1
bridge
intermediate equipment that connects two or more segments using a data-link layer relay function

3.1.2.2
domain
part of the RTE network consisting of one or two subnetwork(s)

NOTE Two subnetworks are required to compose a dual-redundant RTE network, and each end node in the domain is connected to both of the subnetworks.

3.1.2.3
domain master
station which performs diagnosis of routes to all other domains, distribution of network time to nodes inside the domain, acquisition of absolute time from the network time master and notification of status of the domain

3.1.2.4
domain number
numeric identifier which indicates a domain

3.1.2.5
external bridge
bridge to which neither internal bridges nor RTE stations are connected directly

3.1.2.6
interface port
physical connection point of an end node, which has an independent DL-address

3.1.2.7
internal bridge
bridge to which no routers, external bridges or nodes non-compliant with this specification are connected directly

3.1.2.8
junction bridge

bridge to which at least one router, external bridge or node non-compliant with this specification, and to which at least one internal bridge or RTE station is connected

3.1.2.9

link
physical communication channel between two nodes

3.1.2.10
network time master
station which distributes network time to domain masters

3.1.2.11
non-redundant interface node
node which has a single interface port

3.1.2.12
non-redundant station
station that consists of a single end node

NOTE “non-redundant station” is synonymous with “end node”.

3.1.2.13
path
logical communication channel between two nodes, which consists of one or two link(s)

3.1.2.14
redundant interface node
node with two interface ports one of which is connected to a primary network, while the other is connected to a secondary network

3.1.2.15
redundant station
station that consists of a pair of end nodes

NOTE Each end node of a redundant station has the same station number, but has a different DL-address.

3.1.2.16
route
logical communication channel between two communication end nodes

3.1.2.17
router
intermediate equipment that connects two or more subnetworks using a network layer relay function

3.1.2.18
RTE station
station with real-time capability

3.1.2.19
segment
communication channel that connects two nodes directly without intervening bridges

3.1.2.20
station
end node or a pair of end nodes that perform a specific application function

3.1.2.21
station number
numeric identifier which indicates a RTE station

3.1.2.22
subnetwork
part of a network that does not contain any routers. A subnetwork consists of end nodes, bridges and segments

NOTE Every end node included in a subnetwork has the same IP network address.

3.2 Abbreviations and symbols

3.2.1 ISO/IEC 10731 abbreviations

OSI	Open Systems Interconnection

3.2.2 Other abbreviations and symbols

ASS	Acknowledged sequence of unitdata transfer service
AUS	Acknowledged unitdata transfer service
cnf	Confirmation primitive
DL-	Data-link layer (as a prefix)
DLE	DL-entity (the local active instance of the data-link layer)
DLL	DL-layer
DLM	DL-management
DLMS	DL-management service
DLPDU	DL-protocol-data-unit
DLS	DL-service
DLSAP	DL-service-access-point
DLSDU	DL-service-data-unit
FIFO	First-in first-out (queuing method)
ind	Indication primitive

IP	Internet protocol
ISO	International Organization for Standardization
PDU	Protocol data unit
MSS	Multipoint sequence of unitdata transfer service
MUS	Multipoint unitdata transfer service
QoS	Quality of service
req	Request primitive
rsp	Response primitive
SAP	Service access point
SDU	Service data unit
ToS	Type of service
UUS	Unacknowledged unitdata transfer service

3.3 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.

4 Overview of the data-link layer service

4.1 General

The data-link service (DLS) provides transparent and reliable data transfer between DLS-users. It makes the way that supporting communication resources are utilized invisible to DLS-users.

In particular, the DLS provides the following.

a) Independence from the underlying Physical Layer. The DLS relieves DLS-users from all direct concerns regarding which configuration is available (for example, direct connection, or indirect connection through one or more bridges) and which physical facilities are used (for example, which of a set of diverse physical paths).

b) Transparency of transferred information. The DLS provides the transparent transfer of DLS-user-data. It does not restrict the content, format or coding of the information, nor does it ever need to interpret the structure or meaning of that information. It may, however, restrict the amount of information that can be transferred as an indivisible unit.

c) Reliable data transfer. The DLS relieves the DLS-user from concerns regarding insertion or corruption of data, or, if requested, loss, duplication or misordering of data, which can occur. In some cases of unrecovered errors in the data-link layer, duplication or loss of DLSDUs can occur. In cases where protection against misordering of data is not employed, misordering can occur.

d) Quality of Service (QoS) selection. The DLS provides DLS-users with a means to request and to agree upon a quality of service for the data transfer. QoS is specified by means of QoS parameters representing aspects such as mode of operation, transit delay, accuracy, reliability, security and functional safety.

e) Addressing. The DLS allows the DLS-user to identify itself and to specify the DLSAPs to/from which data are to be transferred.

f) Scheduling. The DLS allows the set of DLS-users to provide some guidance on internal scheduling of the distributed DLS-provider. This guidance supports the time-critical aspects of the DLS, by permitting the DLS-user some degree of management over when opportunities for communication will be granted to various DLEs for various DLSAP-addresses.

g) Common time sense. The DLS can provide the DLS-user with a sense of time that is common to all DLS-users on the network.

h) Queues. The DLS can provide the sending or receiving DLS-user with a FIFO queue, where each queue item can hold a single DLSDU.

4.2 Overview of network structure

Although the DLS conforms formally to the “three-layer” Fieldbus Reference Model, it actually utilizes the transport layer service and the network layer service in addition to the data-link layer service of the OSI Basic Reference Model. The DLS of this specification is actually a transport layer service in terms of the OSI Basic Reference Model. Thus the network may consist of one or more subnetworks interconnected to each other by the network layer relay entities, known as routers.

A network may be a redundant structure. A redundant network consists of two independent networks making dual-redundancy; they are referred to as the primary network and the secondary network. Consequently, dual-redundant independent logical communication channels between two communication end nodes can be implemented. This logical channel is called a route.

A pair of subnetworks comprising a dual-redundant network is called a domain.

A subnetwork consists of one or more segments interconnected by DL-relay entities, known as bridges. The topology of a subnetwork may be a tree, a ring or a mesh consisting of segments interconnected by bridges.

A segment consists of one or more DLEs, all of which are connected directly (i.e., without intervening DL-relay entities) to a single shared logical communication channel, which is called a link.

A path (logical communication channel) consists of one or two physically independent and logically parallel real communication channels, which are called links.

4.3 Overview of addressing

domain number
numeric identifier that indicates a domain. Two subnetworks comprising a dual-redundant domain have an identical domain number.

station number
numeric identifier that indicates a RTE station. Two end nodes comprising a dual-redundant station have an identical station number.

TSAP address
DL-entity actually provides transport layer services, so DLS is provided at TSAPs. TSAP is identified by a set of TSAP-address (IP-address) and TSAP-identifier (UDP port number)

IP address
unique address for each end node. An IP address consists of a network address portion and a host address portion. The network address is assigned according to the domain number, while the host address is assigned based on the station number. Each end node of a dual-redundant station has a different host address

MAC address
MAC address is a unique address for an end node defined in ISO/IEC 8802-3. The destination MAC address is resolved by the mechanism defined in RFC 826 from the destination IP address

4.4 Types of data-link service

There are three types of DLS as follows:

a) a DLSAP management service;

b) a connectionless-mode data transfer service;

c) a DL-management service.