

This is a preview of "IEC 61158-4-21 Ed. 1...". Click here to purchase the full version from the ANSI store.



Edition 1.0 2010-08

INTERNATIONAL STANDARD

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XD**

ICS 25.04.40; 35.100.20; 35.110

ISBN 978-2-88912-091-8

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	10
1.1 General.....	10
1.2 Specifications.....	10
1.3 Procedures.....	10
1.4 Applicability.....	10
1.5 Conformance.....	11
2 Normative references.....	11
3 Terms, definitions, symbols and abbreviations.....	11
3.1 Reference model terms and definitions.....	11
3.2 Service convention terms and definitions.....	13
3.3 Common terms and definitions.....	14
3.4 Symbols and abbreviations.....	17
4 Overview of the data-link protocol.....	18
4.1 General.....	18
4.2 Overview of medium access control.....	18
4.3 Service assumed from the physical layer.....	19
4.4 DLL architecture.....	19
4.5 Data type.....	21
4.6 Local parameters and variables.....	23
5 General structure and encoding.....	38
5.1 Overview.....	38
5.2 MAPDU structure and encoding.....	38
5.3 Common MAC frame structure, encoding and elements of procedure.....	39
5.4 Order of bit transmission.....	47
5.5 Invalid DLPDU.....	47
6 DLPDU structure and procedure.....	48
6.1 General.....	48
6.2 Common DLPDU Field.....	48
6.3 DL-DATA Transfer.....	48
6.4 DL-SPDATA Transfer.....	51
6.5 Network control messages.....	53
7 DLE elements of procedure.....	59
7.1 Overall structure.....	59
7.2 DL-protocol machine (DLPM).....	59
7.3 DLL management Protocol.....	69
8 Constants and error codes.....	102
8.1 General.....	102
8.2 Constants.....	102
8.3 Data-link layer error codes.....	104
Bibliography.....	105
Figure 1 – Relationships of DLSAPs, DLSAP-addresses, and group DL-addresses.....	15
Figure 2 – Interaction of PhS primitives with DLE.....	19

Figure 3 – Data-link layer architecture	20
Figure 4 – Common MAC frame format for Type 21 DLPDU	39
Figure 5 – MAC frame format for other protocols	39
Figure 6 – Version and Length field	40
Figure 7 – DST_addr field	41
Figure 8 – SRC_addr field	42
Figure 9 – Frame Control Field	43
Figure 10 – Extension field	45
Figure 11 – DSAP field	46
Figure 12 – Source service access point field	46
Figure 13 – Length of group mask and extension information	47
Figure 14 – Group mask option field	47
Figure 15 – Common DLPDU field	48
Figure 16 – Building a DT DLPDU	49
Figure 17 – DT DLPDU structure	49
Figure 18 – SPDT DLPDU structure	52
Figure 19 – NCM_LA DLPDU structure	54
Figure 20 – DLL structure and elements	59
Figure 21 – State transition diagram of the DLPM	63
Figure 22 – State transition diagram of DLM	73
Table 1 – DLL components	20
Table 2 – UNSIGNEDn data type	22
Table 3 – INTEGERn data type	23
Table 4 – DLE configuration parameters	24
Table 5 – Queues to support data transfer	25
Table 6 – Variables to support SAP management	26
Table 7 – Variables to support device information management	26
Table 8 – DL-entity identifier	27
Table 9 – Device Flags	27
Table 10 – DLM state	27
Table 11 – Device Unique Identification	28
Table 12 – Unique identification of device connected to R-port1	28
Table 13 – Unique identification of device connected to R-port2	28
Table 14 – MAC address	28
Table 15 – Port information	29
Table 16 – Protocol version	29
Table 17 – Device type	30
Table 18 – Device description	30
Table 19 – Hop count	30
Table 20 – Variables to support managing network information	31
Table 21 – Topology	31
Table 22 – Collision count	31

This is a preview of "IEC 61158-4-21 Ed. 1...". [Click here to purchase the full version from the ANSI store.](#)

Table 23 – Device count	32
Table 24 – Topology change count	32
Table 25 – Last topology change time.....	32
Table 26 – RNMP device UID	32
Table 27 – RNMS device UID	33
Table 28 – LNM device UID for R-port1	33
Table 29 – LNM device UID for R-port2	33
Table 30 – Network flags	34
Table 31 – Variables and counter to support managing path information.....	35
Table 32 – Hop count for R-port1 direction.....	36
Table 33 – Hop count for R-port2 direction.....	36
Table 34 – Preferred R-port	36
Table 35 – Destination R-port	36
Table 36 – In net count	37
Table 37 – In net time	37
Table 38 – Out net count	38
Table 39 – Out net time	38
Table 40 – Version and Length	41
Table 41 – Destination DL–entity identifier	41
Table 42 – Source DL–entity identifier	42
Table 43 – Frame control	43
Table 44 – Extension	45
Table 45 – Destination service access point	46
Table 46 – source service access point.....	46
Table 47 – DT DLPDU parameters	49
Table 48 – Primitives exchanged between DLS-user and DLE to send a DT DLPDU	51
Table 49 – Primitives exchanged between DLS-user and DLEs to receive a DT DLPDU	51
Table 50 – SPDT DLPDU Parameters	52
Table 51 – Primitive exchanged between DLS-User and DLEs to send an SPDT DLPDU	53
Table 52 – Primitives exchanged between DLS-user and DLEs to receive an SPDT DLPDU	53
Table 53 – NCM_LA DLPDU parameters.....	54
Table 54 – NCM_AT DLPDU parameters	55
Table 55 – NCM_LS DLPDU parameters.....	56
Table 56 – NCM_RS DLPDU parameters	57
Table 57 – NCM_AR DLPDU parameters	58
Table 58 – Primitives exchanged between DLPM and DLS-user.....	60
Table 59 – Parameters exchanged between DLPM and DLS-user	61
Table 60 – Primitives exchanged between DLPM and DLM	62
Table 61 – Parameters used with primitives exchanged between DLPM and DLM.....	63
Table 62 – DLPM state table.....	64
Table 63 – DLPM functions table	68
Table 64 – Primitives exchanged between DLM and DLS-user.....	70

This is a preview of "IEC 61158-4-21 Ed. 1...". [Click here to purchase the full version from the ANSI store.](#)

Table 65 – Parameters used with primitives exchanged between DLM and DLS-user.....	71
Table 66 – Primitive exchanged between DLM and DMAC	71
Table 67 – Parameters used with primitives exchanged between DLM and DMAC	72
Table 68 – Primitive exchanged between DLM and DPHY.....	72
Table 69 – Parameters used with primitives exchanged between DLM and DPHY.....	72
Table 70 – DLM state table	75
Table 71 – DLM function table	100
Table 72 – DLL constants	103
Table 73 – Type 21 DLL error codes	104

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –**

**Part 4-21: Data-link layer protocol specification –
Type 21 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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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.

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.

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.

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

This is a preview of "IEC 61158-4-21 Ed. 1...". [Click here to purchase the full version from the ANSI store.](#)

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.

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.

The holder of these patent rights has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of these patent rights is registered with IEC. Information may be obtained from:

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

This is a preview of "IEC 61158-4-21 Ed. 1...". [Click here to purchase the full version from the ANSI store.](#)

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.

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.

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 61158-3-21:2010¹, *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.