



IEC 61158-4-1

Edition 1.0 2007-12

# INTERNATIONAL STANDARD

---

**Industrial communication networks – Fieldbus specifications –  
Part 4-1: Data-link layer protocol specification – Type 1 elements**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE

**XP**

---

ICS 35.100.20; 25.040.40

ISBN 2-8318-9425-5

## CONTENTS

FOREWORD.....	9
0 Introduction .....	11
0.1 General.....	11
0.2 Nomenclature for references within this standard .....	11
1 Scope.....	12
1.1 General.....	12
1.2 Specifications.....	12
1.3 Procedures.....	12
1.4 Applicability.....	13
1.5 Conformance.....	13
2 Normative references .....	13
3 Terms, definitions, symbols and abbreviations.....	13
3.1 Reference model terms and definitions.....	13
3.2 Service convention terms and definitions.....	15
3.3 Terms and definitions.....	16
3.4 Symbols and abbreviations.....	25
4 Overview of the DL-protocol .....	29
4.1 Three-level model of the DLL .....	29
4.2 Service provided by the DLL.....	31
4.3 Structure and definition of DL-addresses .....	38
4.4 Service assumed from the PhL .....	51
4.5 Functions of the DLL .....	54
4.6 Functional classes.....	56
4.7 Local parameters, variables, counters, timers and queues.....	58
5 General structure and encoding of PhIDUs and DLPDUs, and related elements of procedure.....	72
5.1 PhIDU structure and encoding.....	72
5.2 Common DLPDU structure, encoding and elements of procedure .....	72
6 DLPDU-specific structure, encoding and elements of procedure.....	83
6.1 Establish connection (EC) DLPDU.....	85
6.2 Disconnect connection (DC) DLPDU.....	87
6.3 Reset connection (RC) DLPDU.....	89
6.4 Compel acknowledgement (CA) DLPDU .....	91
6.5 Compel data (CD) DLPDU .....	98
6.6 Exchange data (ED) DLPDU.....	105
6.7 Data (DT) DLPDU.....	114
6.8 Status response (SR) DLPDU.....	121
6.9 Compel time (CT) DLPDU .....	124
6.10 Time distribution (TD) DLPDU .....	126
6.11 Round-trip-delay query (RQ) DLPDU .....	128
6.12 Round-trip-delay reply (RR) DLPDU .....	130
6.13 Probe node DL-address (PN) DLPDU .....	132
6.14 Probe response (PR) DLPDU .....	134
6.15 Pass token (PT) DLPDU .....	136
6.16 Execute sequence (ES) DLPDU .....	145
6.17 Return token (RT) DLPDU .....	151

6.18	Request interval (RI) DLPDU .....	153
6.19	Claim LAS (CL) DLPDU .....	154
6.20	Transfer LAS (TL) DLPDU .....	156
6.21	Wakeup (WK) DLPDU .....	159
6.22	Idle (IDLE) DLPDU .....	161
6.23	Spare DLPDUs .....	162
6.24	Reserved (not to be used) DLPDUs .....	163
7	DLPDU-parameter structure and encoding .....	164
7.1	Structure and encoding of EC-PARAMETERS .....	164
7.2	Structure and encoding of DC-PARAMETERS .....	169
7.3	Structure and encoding of RC-PARAMETERS .....	170
7.4	Structure and encoding of SD-Parameters .....	172
7.5	Structure and encoding of SR-parameters .....	179
7.6	Structure and encoding of TD-parameters .....	180
7.7	Structure and encoding of RQ-parameters .....	183
7.8	Structure and encoding of RR-parameters .....	183
7.9	Structure and encoding of PN-parameters .....	184
7.10	Structure and encoding of DD-parameters .....	186
8	DL-service elements of procedure .....	186
8.1	Operation of the DL(SAP)-address, buffer and queue management services .....	187
8.2	Operation of the connection-mode services .....	191
8.3	Operation of the connectionless-mode services .....	232
8.4	Operation of the scheduling guidance services .....	243
9	DL-support subprotocol .....	253
9.1	Scope .....	253
9.2	Overview of LAS operation .....	253
9.3	DL-support subprotocol definition .....	254
9.4	Elements of Procedures for receiving SPDUs .....	287
10	Other DLE elements of procedure .....	288
10.1	DLE initialization .....	289
10.2	LAS behavior and operation .....	293
10.3	DL-support operation .....	299
10.4	DL-bridge elements of procedure and bridge sub-protocol .....	305
10.5	DL-management-information .....	335
10.6	Implementation profiles .....	339
11	PICS proforma .....	345
11.1	Introduction .....	345
11.2	Scope .....	345
11.3	Normative references .....	345
11.4	Definitions .....	345
11.5	Abbreviations .....	345
11.6	Conformance .....	346
11.7	Instructions .....	346
11.8	Identification .....	346
11.9	Implementation profile .....	347
11.10	Major low-level capabilities .....	351
11.11	Major high-level capabilities .....	365
Annex A	(informative) – Exemplary FCS implementation .....	376

Annex B (informative) – Type 1: Formal protocol finite state machines.....	378
B.1 Basic reception and transmission FSMs .....	378
B.2 FSMs for DLCs.....	389
B.3 FSMs for scheduling.....	395
B.4 FSMs for bridges.....	395
Annex C (informative) – Type 1: DLPDU and DL-addressing short-form summaries .....	397
C.1 Fields used in short-form summaries .....	397
C.2 DLPDU short-form summary grouped by function .....	399
C.3 DLPDU short-form summary in alphabetic order of DLPDU names .....	401
C.4 DLPDU short-form summary in alphabetic order of DLPDU acronyms.....	402
C.5 DLPDU FC code-point assignment matrix – overview and detail .....	403
C.6 SD-parameters (status and data-description parameters) of CA, CD, ED and DT DLPDUs.....	406
C.7 EC parameters of EC DLPDUs .....	409
C.8 Parameters of DC and RC DLPDUs.....	411
C.9 Parameters of TD, RQ and RR DLPDUs .....	413
C.10 Parameters of PN, PT, ES and RI DLPDUs .....	415
C.11 Addressing summary extracted from figures and tables of 4.3 .....	417
Bibliography.....	421
INDEX .....	422
Figure 1 – Relationships of DLSAPs, DLSAP-addresses, DLCEPs, DLCEP-addresses, DLSEP-addresses and group DL-addresses .....	19
Figure 2 – Basic structure of a DL-address .....	38
Figure 3 – Basic structure of a sublink selector.....	39
Figure 4 – DL-address alternative structures.....	39
Figure 5 – Basic structure of MAC-addresses .....	51
Figure 6 – Representation of a DL-address as a MAC-address .....	51
Figure 7 – Linear relationships of sending and receiving DLCEP sequence-number variables.....	63
Figure 8 – DL-address alternative structures.....	75
Figure 9 – SHORT DL-address field – alternative implicit structures.....	75
Figure 10 – NODE DL-address field – implicit structure .....	76
Figure 11 – State transition diagram for a DLCEP.....	191
Figure 12 – Projection of the sending and receiving DLCEP sequence-number variables of Figure 7 onto the cyclic sequence-number parameters of CA, CD, DT, ED and RC DLPDUs, with consequent determination of required actions.....	208
Figure 13 – State transitions of a DLE .....	289
Figure 14 – Bridged network topology.....	306
Figure 15 – Spanning tree representation .....	306
Figure 16 – DLSDU transit delay, DLPDU lifetime and bridge forwarding delay.....	311
Figure 17 – Forwarding and delivering a received DLPDU .....	315
Figure 18 – Forwarding a locally-originated DLPDU .....	315
Figure 19 – Republishing a DLSDU received from another link .....	316
Figure 20 – Bridge architecture.....	318
Figure 21 – Replacement for [IL] Fig 3-2 Bridge ports .....	327
Figure 22 – Replacement for [IL] Fig 3-3 Bridge architecture .....	327

Figure A.1 – Example of FCS generation .....	376
Figure A.2 – Example of FCS syndrome checking on reception.....	376
Figure B.1 – Gross structure of FC code points.....	403
Figure B.2 [Figure 2] – Basic structure of a DL-address .....	417
Figure B.3 [Figure 3] – Basic structure of a sublink selector.....	417
Figure B.4 [Figure 4] – DL-address alternative structures .....	417
Figure B.5 [Figure 5] – Basic structure of MAC-addresses .....	417
Figure B.6 [Figure 6] – Representation of a DL-address as a MAC-address .....	417
Table 1 – Link    node    selector addressing .....	42
Table 2 – Link-local node    selector addressing.....	44
Table 3 – Link-local node designators.....	46
Table 4 – Node-local selector addressing .....	48
Table 5 – Predefined flat non-local DL-addresses .....	49
Table 6 – Predefined flat link-local DL-addresses .....	50
Table 7 – Predefined node-local DL-addresses .....	50
Table 8 – Correlation of DLPDUs with functional classes .....	56
Table 9 – FCS length, polynomial and expected residual .....	77
Table 10 – Summary structure of DLPDUs .....	84
Table 11 – DLPDU restrictions based on dominant token.....	85
Table 12 – Structure of EC DLPDUs .....	85
Table 13 – Structure of DC DLPDUs .....	88
Table 14 – Structure of RC DLPDUs .....	90
Table 15 – Structure of CA DLPDUs .....	92
Table 16 – Structure of CD DLPDUs .....	98
Table 17 – Structure of ED DLPDUs .....	106
Table 18 – Structure of DT DLPDUs .....	114
Table 19 – Structure of SR DLPDUs .....	122
Table 20 – Structure of CT DLPDUs .....	124
Table 21 – Structure of TD DLPDUs .....	126
Table 22 – Structure of RQ DLPDUs .....	128
Table 23 – Structure of RR DLPDUs .....	130
Table 24 – Structure of PN DLPDUs .....	132
Table 25 – Structure of PR DLPDUs .....	135
Table 26 – Structure of PT DLPDUs.....	136
Table 27 – Structure of ES DLPDUs .....	145
Table 28 – Structure of RT DLPDUs .....	151
Table 29 – Structure of RI DLPDUs.....	153
Table 30 – Structure of CL DLPDUs.....	154
Table 31 – Structure of TL DLPDUs .....	156
Table 32 – Structure of WK DLPDUs.....	159
Table 33 – Structure of IDLE DLPDUs.....	161
Table 34 – Assumed structure of undefined (spare) DLPDUs .....	162

Table 35 – Assumed structure of RESERVED (NOT TO BE USED) DLPDUs .....	164
Table 36 – Structure of an EC DLPDU's parameters .....	165
Table 37 – EC-parameters: 1st octet.....	165
Table 38 – EC-parameters: 2nd octet.....	165
Table 39 – EC-parameters: 3rd and 4th octets .....	166
Table 40 – EC-parameters: 5th and 6th octets .....	166
Table 41 – EC-parameters: 7th octet .....	167
Table 42 – EC-parameters: 8th octet .....	167
Table 43 – EC-parameters: 9th and 10th octets .....	168
Table 44 – EC-parameters: 11th octet.....	168
Table 45 – EC-parameters: 12th octet.....	169
Table 46 – EC-parameters: 13th and 14th octets .....	169
Table 47 – DC-parameters and RC-parameters: 1st octet .....	169
Table 48 – DC-parameters and RC-parameters: 2nd octet .....	170
Table 49 – Disconnect reasons .....	171
Table 50 – Reset reasons .....	172
Table 51 – RC-parameters: 3rd octet .....	172
Table 52 – RC-parameters: 4th octet .....	172
Table 53 – Structure of connectionless-mode CA, CD, DT and ED DLPDUs.....	173
Table 54 – Short format SD-parameters for connectionless transaction initiators .....	174
Table 55 – Short format SD-parameters for connectionless responders .....	174
Table 56 – Reply status for unitdata-acknowledgment and exchange-unitdata-reply DT DLPDUs.....	175
Table 57 – Structure of connection-oriented CA, CD, DT and ED DLPDUs.....	177
Table 58 – Short format SD-parameters for DLCEP state.....	178
Table 59 – Long format SD-parameters for DLCEP state: 1st octet .....	178
Table 60 – Long format SD-parameters for DLCEP state: 2nd octet.....	178
Table 61 – Long format SD-parameters for DLCEP state: 3rd octet.....	179
Table 62 – Reply status for SR DLPDUs .....	180
Table 63 – Short format SR-parameters.....	180
Table 64 – Structure of TD-parameters .....	181
Table 65 – Structure and encoding of the DL-time-quality measures .....	181
Table 66 – Approximate numeric significance of the bits of seven-octet DL-time .....	182
Table 67 – Approximate numeric significance of the bits of three-octet short time .....	183
Table 68 – Structure of RQ-parameters .....	183
Table 69 – Structure of RR-parameters.....	184
Table 70 – Structure and encoding of the RR-time-quality measures .....	184
Table 71 – Structure of PN-parameters .....	185
Table 72 – PN-parameters: 1st octet.....	185
Table 73 – PN-parameters: 2nd octet.....	185
Table 74 – PN-parameters: 3rd and 4th octets .....	186
Table 75 – PN-parameters: 5th octet .....	186
Table 76 – PN-parameters: 6th octet .....	186

Table 77 – Structure of DD-parameters.....	186
Table 78 – Components of returned DL-time.....	244
Table 79 – Time synchronization computation.....	246
Table 80 – SPDU 1st octet: SPDU class, and protocol version or subclass .....	254
Table 81 – Probe-response SPDU .....	255
Table 82 – DL-protocol versions supported.....	255
Table 83 – PR-SPDU: 3rd and 4th octets .....	256
Table 84 – Node-activation SPDU.....	257
Table 85 – Node-activation SPDU: 4th octet .....	257
Table 86 – LAS-data-base-status SPDU .....	258
Table 87 – LAS-data-base-status SPDU: 2nd octet.....	258
Table 88 – Live-list- change SPDU .....	259
Table 89 – DLE-status structure.....	259
Table 90 – Live-list-detail SPDU .....	260
Table 91 – DL-conformance-reply SPDU.....	261
Table 92 – DL-protocol versions supported.....	261
Table 93 – DL-conformance encoding (portion 1).....	262
Table 94 – DL-conformance encoding (portion 2).....	262
Table 95 – DL-conformance encoding (portion 3).....	262
Table 96 – DL-conformance encoding (portion 4).....	263
Table 97 – Link-basic-parameters-reply SPDU.....	263
Table 98 – Link-master-parameters-reply SPDU .....	264
Table 99 – Token-hold-time-request SPDU .....	265
Table 100 – Token-hold-time-array SPDU.....	266
Table 101 – Sequence element header encoding.....	268
Table 102 – SHORT DL-address and duration sequence element .....	268
Table 103 – LONG DL-address and duration sequence element .....	269
Table 104 – Wakeup request sequence element .....	269
Table 105 – Schedule-request SPDU .....	270
Table 106 – Sequence type, schedule type and priority encoding .....	270
Table 107 – Scheduling-completed SPDU.....	272
Table 108 – Status and reason codes .....	272
Table 109 – Cancel-schedule SPDU .....	273
Table 110 – Schedule-cancelled SPDU.....	273
Table 111 – Link-schedule .....	274
Table 112 – Schedule-summary SPDU .....	275
Table 113 – Subschedule-SPDU reference .....	276
Table 114 – Subschedule SPDU .....	276
Table 115 – Sequence Sub-SPDU .....	277
Table 116 – Element-description.....	278
Table 117 – Schedule-summary-request SPDU.....	279
Table 118 – Subschedule-request SPDU .....	279
Table 119 – Parameter-list element-header encoding .....	280

Table 120 – Begin/end-of-list element.....	280
Table 121 – Continuation-of-list element.....	280
Table 122 – SHORT DL-address list element .....	281
Table 123 – LONG DL-address element .....	281
Table 124 – DLSAP-address-characteristics element.....	282
Table 125 – DLCEP-characteristics element .....	282
Table 126 – Address-query SPDU .....	283
Table 127 – Address-report SPDU .....	284
Table 128 – Address-list-query SPDU .....	285
Table 129 – DL-address selection criteria .....	285
Table 130 – Address-list-reply SPDU .....	287
Table 131 – Topology change notification BPDU format.....	334
Table 132 – Configuration BPDU format .....	334
Table 133 – Maximum permitted phase-tracking error in a DLE's sense of DL-time at the minimum requireable Time Distribution period.....	343
Table B.1 – Generic assignment of FC code points.....	404
Table B.2 – Individual assignment of FC code points .....	405
Table B.3 – Reply status for SR DLPDUs.....	408
Table B.4 – Reply status for unitdata-acknowledgment and exchange-unitdata-reply DT DLPDUs.....	409
Table B.5 – Approximate numeric significance of the bits of seven-octet DL-time.....	414
Table B.6 – Approximate numeric significance of the bits of N(NT), A...A, and three-octet C(NT).....	414
Table B.7 [Table 1] – Link    node    selector addressing .....	418
Table B.8 [Table 2] – Link-local node    selector addressing.....	418
Table B.9 [Table 5] – Predefined flat non-local DL-addresses .....	419
Table B.10 [Table 6] – Predefined flat link-local DL-addresses.....	419
Table B.11 [Table 3] – Link-local node designators .....	420
Table B.12 [Table 4] – Node-local selector addressing.....	420
Table B.13 [Table 7]– Predefined node-local DL-addresses .....	420



## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –  
FIELD BUS SPECIFICATIONS –****Part 4-1: Data-link layer protocol specification – Type 1 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 from their respective intellectual-property-right holders.

IEC draws attention to the fact that it is claimed that compliance with this standard may involve the use of patents as follows, where the [xx] notation indicates the holder of the patent right:

Type 1 time synchronization and possibly other Types:

JP Hei4-35096 [YC] Communication control method

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

The holders of these patent rights have assured IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights are registered with IEC. Information may be obtained from

[YC]: Jun-ichi Tsuboi, Mr.  
Yamatake Corporation  
Shibuyaku Shibuya, 2-12-19  
Tohtate International Building  
150-8316 Tokyo  
Japan

Attention is drawn to the possibility that some of the elements of this standard 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.

International Standard IEC 61158-4-1 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 61158-4 subseries cancel and replace IEC 61158-4:2003. This edition of this part constitutes an editorial revision.

This edition of IEC 61158-4 includes the following significant changes from 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 -4-1, -4-2, ..., -4-19.

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

FDIS	Report on voting
65C/474/FDIS	65C/485/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.

NOTE Slight variances from the directives have been allowed by the IEC Central Office to provide continuity of subclause numbering with prior editions.

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.

## 0 Introduction

### 0.1 General

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.

### 0.2 Nomenclature for references within this standard

Clauses, including annexes, can be referenced in their entirety, including any subordinate subclauses, as “Clause N” or “Annex N”, where N is the number of the clause or letter of the annex.

Subclauses can be referenced in their entirety, including any subordinate subclauses, as “N.M” or “N.M.P” and so forth, depending on the level of the subclause, where N is the number of the subclause or letter of the annex, and M, P and so forth represent the successive levels of subclause up to and including the subclause of interest.

When a clause or subclause contains one or more subordinate subclauses, the text between the clause or subclause heading and its first subordinate subclause can be referenced in its entirety as “N.0” or “N.M.0” or “N.M.P.0” and so forth, where N, M and P are as above. Stated differently, a reference ending with “.0” designates the text and figures between a clause or subclause header and its first subordinate subclause.

**NOTE** This nomenclature provides a means of referencing text in hanging clauses. Such clauses existed in earlier editions of IEC 61784-3, Type 1 clauses. Those hanging clauses are maintained in this edition to minimize the disruption to existing national and multi-national standards and consortia documents which reference that prior subclause numbering.

## **INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –**

### **Part 4-1: Data-link layer protocol specification – Type 1 elements**

## **1 Scope**

### **1.1 General**

The data-link layer provides basic time-critical messaging communications between devices in an automation environment.

This protocol provides the data-link service by making use of the services available from the physical layer. The relationship between the International Standards for fieldbus data-link service, fieldbus data-link protocol, fieldbus physical service and systems management is described in IEC/TR 61158-1.

This protocol provides communication opportunities to all participating data-link entities

- a) in a cyclic asynchronous manner, sequentially to each of those data-link entities, and
- b) in a synchronous manner, either cyclically or acyclically, according to a pre-established schedule.

The specified protocol also provides means of changing the set of participating data-link entities and of modifying the set of scheduled communications opportunities. When the set of scheduled communications opportunities is null, the distribution of communication opportunities to the participating data-link entities is completely asynchronous.

Thus this protocol can be characterized as one which provides access asynchronously but with a synchronous overlay.

### **1.2 Specifications**

This standard specifies

- a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed data-link service provider;
- b) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this standard, and their representation as physical interface data units.

NOTE In IEC 61158-4-1, gray boxes have been used in the tables to indicate that the specified field is not a conceptual part of the specific DLPDU.

### **1.3 Procedures**

The procedures are defined in terms of

- a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus DLPDUs;
- b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;
- c) the interactions between a DLS-provider and a Ph-service provider in the same system through the exchange of Ph-service primitives.

## 1.4 Applicability

These procedures are applicable to instances of communication between systems which support time-critical communications services within the data-link layer of the OSI or fieldbus reference models and which require the ability to interconnect in an open systems interconnection environment.

Profiles provide a simple multi-attribute means of summarizing an implementation's capabilities, and thus its applicability to various time-critical communications needs.

## 1.5 Conformance

This standard also specifies conformance requirements for systems implementing these procedures. This standard does not contain tests to demonstrate compliance with such requirements.

## 2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 61158-3-1(Ed.2.0), *Industrial communication networks – Fieldbus specifications – Part 3-1: Data link service definition – Type 1 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 10038:1993, *Information technology – Telecommunications and information exchange between systems – Local area networks – Media access control (MAC) bridges*

NOTE This edition has been withdrawn and replaced by ISO/IEC 15802-3:1998. However, the detailed references in this standard are to the 1993 edition.

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*