IEC 61158-4-19

Edition 2.0 2010-08

INTERNATIONAL STANDARD

colour inside

Industrial communication networks – Fieldbus specifications – Part 4-19: Data-link layer protocol specification – Type 19 elements

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XF

ICS 25.04.40; 35.100.20; 35.110

ISBN 978-2-88912-090-1

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 7
INTRODUCTION 9
1 Scope 11
1.1 General 11
1.2 Specifications 11
1.3 Procedures 11
1.4 Applicability 11
1.5 Conformance 12
2 Normative references 12
3 Terms, definitions, symbols, abbreviations and conventions 12
3.1 Reference model terms and definitions 12
3.2 Additional Type 19 terms and definitions 12
3.3 Symbols 15
3.4 Abbreviations 16
3.5 Additional conventions 17
4 DL-protocol overview 18
5 DLPDU structure 19
5.1 Overview 19
5.2 General DLPDU identification 19
5.3 General DLPDU structure 20
5.4 DLPDU header 21
5.5 MDT DLPDU 21
5.6 AT DLPDU 32
6 DL management 42
6.1 Overview 42
6.2 Enable and disable cyclic communication 42
6.3 Hot-plug procedure 50
6.4 Status procedures 51
7 Data transmission methods 51
7.1 Overview 51
7.2 SVC 52
7.3 RTC 52
7.4 Multiplexing of real-time data with data containers 52
7.5 Multiplexing of real-time data using SMP 59
8 Telegram timing and DLPDU handling 62
8.1 Usage of real-time channel with different network topologies 62
8.2 Communication mechanisms 63
8.3 Device synchronization 69
9 Error handling and monitoring 70
9.1 Failure of telegrams 70
9.2 Response to MDT and AT telegram failure 70
9.3 Service channel error messages 71
Annex A (normative) IDN – Identification numbers 72
Annex B (normative) SCP– Classification 106
Annex C (normative) GDP (Generic Device Profile) 118

Bibliography 140

Figure 1 – Valid MDT and AT telegram combinations 19
Figure 2 – Offsets within MDT payload 26
Figure 4 – Communication phase transitions 43
Figure 6 – Block diagram of master and slave 63
Figure 7 – Telegram sequence 65
Figure 8 – Beginning of telegram 66
Figure 9 – Access to the medium 66
Figure 10 – Timing diagram of CP0 68
Figure 11 – Timing diagram of CP1 and CP2 with 2 MDT/AT 69
Figure 12 – Timing diagram of CP1 and CP2 with 2 MDT/AT 69
Figure 13 – Synchronization timing 70
Figure 14 – Synchronization signal generation 70
Figure A.1 – Lengths of MDTs (example) 80
Figure A.2 – Lengths of ATs (example) 82
Figure A.3 – Structure of MAC address 87
Figure A.4 – Structure of IP address 88
Figure A.5 – Structure of subnet mask 88
Figure A.6 – Structure of gateway address 89
Figure B.1 – Technical Profiling in Type 19 106
Figure C.1 – Type 19 state machine 121

Table 1 – Ethernet DLPDU identification 20
Table 2 – Data structure in a DLPDU 20
Table 3 – DLPDU payload header 21
Table 4 – DLPDU type 21
Table 5 – MDT MST header 22
Table 6 – MDT MST fields to be considered by the slave 22
Table 7 – MDT phase 22
Table 8 – MDT0 structure in CP0 23
Table 9 – Communication version 23
Table 10 – MDT0 in CP1 and CP2 24
Table 11 – MDT1 in CP1 and CP2 24
Table 12 – MDT2 in CP1 and CP2 25
Table 13 – MDT3 in CP1 and CP2 25
Table 14 – MDT data field 26
Table 15 – MDT hot-plug field in HP0 and HP1 27
Table 16 – Device address field 27
Table 17 – HP control field (in HP0 and HP1) 28
Table 18 – MDT service channel field 29
Table 19 – MDT SVC (for each slave) 29
Table 20 – SVC control word (DLL) 29

Table 21 – MDT real-time data field 30
Table 22 – MDT real-time data (device control) 30
Table 23 – MDT real-time data (connection data) 30
Table 24 – Device control field 31
Table 25 – Connection control 31
Table 26 – Structure of a configured connection 32
Table 27 – AT MST header 32
Table 28 – AT MST fields to be considered by the slave 33
Table 29 – AT0 structure in CP0 33
Table 30 – AT0 in CP1 and CP2 34
Table 31 – AT1 in CP1 and CP2 35
Table 32 – AT2 in CP1 and CP2 35
Table 33 – AT3 in CP1 and CP2 36
Table 34 – AT data field 36
Table 35 – AT hot-plug field in HP0 and HP1 37
Table 36 – HP status field (in HP0 and HP1) 38
Table 37 – AT service channel field 38
Table 38 – AT SVC (for each slave) 38
Table 39 – AT SVC status description (DLL) 39
Table 40 – AT real-time data field 39
Table 41 – AT real-time data (device status) 40
Table 42 – AT real-time data (connection data) 40
Table 43 – Device status field 41
Table 44 – MDT hot-plug field in CP3 and after ring recovery 47
Table 45 – Structure of the Session Control Header 60
Table A.1 – List of relevant communication-related IDNs 72
Table A.2 – Attributes of IDN S-0-1000 75
Table A.3 – Attributes of IDN S-0-1002 76
Table A.4 – Attributes of IDN S-0-1003 76
Table A.5 – Attributes of IDN S-0-1005 77
Table A.6 – Attributes of IDN S-0-1006 77
Table A.7 – Attributes for IDN S-0-1007 78
Table A.8 – Attributes for IDN S-0-1008 79
Table A.9 – Attributes of IDN S-0-1009 79
Table A.10 – C-Dev Offset in MDT 80
Table A.11 – Attributes of IDN S-0-1010 80
Table A.12 – Attributes of IDN S-0-1011 81
Table A.13 – S-Dev Offset in AT 81
Table A.14 – Attributes of IDN S-0-1012 82
Table A.15 – Attributes of IDN S-0-1013 83
Table A.16 – SVC Offset in MDT 83
Table A.17 – Attributes of IDN S-0-1014 84
Table A.18 – SVC Offset in AT 84

Table A.19 – Attributes of IDN S-0-1015 85
Table A.20 – Attributes of IDN S-0-1016 85
Table A.21 – Attributes of IDN S-0-1017 86
Table A.22 – Attributes of IDN S-0-1019 86
Table A.23 – Attributes of IDN S-0-1020 87
Table A.24 – Attributes of IDN S-0-1021 88
Table A.25 – Attributes of IDN S-0-1022 89
Table A.26 – Attributes of IDN S-0-1023 90
Table A.27 – Attributes of IDN S-0-1024 90
Table A.28 – Attributes of IDN S-0-1026 91
Table A.29 – Attributes of IDN S-0-1027.0.1 91
Table A.30 – Attributes of IDN S-0-1027.0.2 92
Table A.31 – Attributes of IDN S-0-1028 92
Table A.32 – Attributes of IDN S-0-1035 93
Table A.33 – Attributes of IDN S-0-1040 93
Table A.34 – Attributes of IDN S-0-1041 94
Table A.35 – Attributes of IDN S-0-1044 94
Table A.36 – Attributes of IDN S-0-1045 95
Table A.37 – Attributes of IDN S-0-1046 95
Table A.38 – Attributes of IDN S-0-1050.x.1 96
Table A.39 – Attributes of IDN S-0-1050.x.2 96
Table A.40 – Attributes of IDN S-0-1050.x.3 97
Table A.41 – Attributes of IDN S-0-1050.x.4 97
Table A.42 – Attributes of IDN S-0-1050.x.5 98
Table A.43 – Attributes of IDN S-0-1050.x.6 98
Table A.44 – Attributes of IDN S-0-1050.x.8 99
Table A.45 – Attributes of IDN S-0-1050.x.10 99
Table A.46 – Attributes of IDN S-0-1050.x.11 100
Table A.47 – Attributes of IDN S-0-1050.x.12 100
Table A.48 – Attributes of IDN S-0-1050.x.20 101
Table A.49 – Attributes of IDN S-0-1050.x.21 101
Table A.50 – Attributes of IDN S-0-1051 102
Table A.51 – Attributes of IDN S-0-1100.0.1 102
Table A.52 – Attributes of IDN S-0-1100.0.2 103
Table A.53 – Attributes of IDN S-0-1100.0.3 103
Table A.54 – Attributes of IDN S-0-1101.x.1 104
Table A.55 – Attributes of IDN S-0-1101.x.2 104
Table A.56 – Attributes of IDN S-0-1101.x.3 105
Table C.1 – List of relevant communication-related IDNs 123
Table C.2 – Attributes of IDN S-0-1300.x.1 124
Table C.3 – Attributes of IDN S-0-1300.x.2 125
Table C.4 – Attributes of IDN S-0-1300.x.3 125
Table C.5 – Attributes of IDN S-0-1300.x.4 126

Table C.6 – Attributes of IDN S-0-1300.x.5 126
Table C.7 – Attributes of IDN S-0-1300.x.6 127
Table C.8 – Attributes of IDN S-0-1300.x.7 127
Table C.9 – Attributes of IDN S-0-1300.x.8 128
Table C.10 – Attributes of IDN S-0-1300.x.9 128
Table C.11 – Attributes of IDN S-0-1300.x.10 129
Table C.12 – Attributes of IDN S-0-1300.x.11 129
Table C.13 – Attributes of IDN S-0-1300.x.12 130
Table C.14 – Attributes of IDN S-0-1300.x.13 130
Table C.15 – Attributes of IDN S-0-1300.x.14 131
Table C.16 – Attributes of IDN S-0-1300.x.20 131
Table C.17 – Attributes of IDN S-0-1300.x.21 132
Table C.18 – Attributes of IDN S-0-1300.x.22 132
Table C.19 – Attributes of IDN S-0-1300.x.23 133
Table C.20 – Attributes of IDN S-0-1301 133
Table C.21 – Coding of S-1301 134
Table C.22 – Attributes of IDN S-0-1302.x.1 134
Table C.23 – Coding of S-1302.x.1 135
Table C.24 – Attributes of IDN S-0-1302.x.2 135
Table C.25 – Attributes of IDN S-0-1302.x.3 136
Table C.26 – Attributes of IDN S-0-1303.0.1 136
Table C.27 – Attributes of IDN S-0-1303.0.2 137
Table C.28 – Coding of S-1303.0.2 137
Table C.29 – Attributes of IDN S-0-1303.0.3 137
Table C.30 – Coding of S-1303.0.2 138
Table C.31 – Attributes of IDN S-0-1303.0.10 138
Table C.32 – Attributes of IDN S-0-1303.0.11 139
Table C.33 – Attributes of IDN S-0-1305.0.1 139

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-19: Data-link layer protocol specification – Type 19 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 61158-4-19 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- increasing the number of supported devices (511 instead of 254);
- introducing a communication version identification;
- adding a mechanism for remote address allocation;
- introducing enhanced parameter addressing (32 bit instead of 16 bit);
- restructuring control and status word;
- improving the redundancy and hotplug features;

- improving the error handling;
- adding a multiplexing protocol (SMP: Type 19 Messaging Protocol).

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.

A list of all the 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 from 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 19 elements and possibly other types given in this document as follows:

DE 102 37 097	[RI]	Korrektur von Signallaufzeiten in verteilten Kommunikationssystemen
DE 102 00 405 0416.4-42	[RI]	Verfahren zur Synchronisation in einem redundanten Kommunikationssystem
DE 102 00 502 4759.8-32	[RI]	Verfahren zur Laufzeitkorrektur in einer Kommunikationsstruktur
DE 102 00 4056364.0-31	[RI]	Verfahren zum Betreiben eines Netzwerks mit Ringtopologie
DE 103 12 907.3-31	[RI]	Kommunikationssystem mit redundanter Kommunikation

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 licenses 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:

[RI] Rexroth Indramat GmbH
Bgm.-Dr.-Nebel-Str. 2
D - 97816 Lohr
Germany

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.

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 4-19: Data-link layer protocol specification – Type 19 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 communication opportunities to all participating data-link entities

a) in a synchronously-starting cyclic manner, according to a pre-established schedule, and
b) in a cyclic or acyclic asynchronous manner, as requested each cycle by each of those data-link entities.

Thus this protocol can be characterized as one which provides cyclic and acyclic access asynchronously but with a synchronous restart of each cycle.

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.

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 part of 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 61158-4-16:2007, *Industrial communication networks – Fieldbus specifications – Part 4-16: Data-link layer protocol specification – Type 16 elements*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Part 1: Basic Reference Model: The Basic Model*

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Part 3: Basic Reference Model: Naming and addressing*

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*

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*