

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 4-25: Data-link layer protocol specification – Type 25 elements**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables 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 It also gives information on projects, replaced and withdrawn publications.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 online and once a month by email.

IEC 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: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

Preview generated by EVS



IEC 61158-4-25

Edition 1.0 2019-04

INTERNATIONAL STANDARD

**Industrial communication networks – Fieldbus specifications –
Part 4-25: Data-link layer protocol specification – Type 25 elements**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.40; 35.100.20; 35.110

ISBN 978-2-8322-6780-6

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
1.1 General.....	8
1.2 Specifications	8
1.3 Procedures	8
1.4 Applicability	9
1.5 Conformance	9
2 Normative references	9
3 Terms, definitions, symbols, abbreviations and conventions	9
3.1 Reference model terms and definitions	10
3.2 Service convention terms and definitions	11
3.3 Terms and definitions.....	11
3.4 Symbols and abbreviations	13
3.5 Common conventions.....	14
3.6 Additional Type 25 conventions	16
3.6.1 Primitive conventions.....	16
3.6.2 State machine conventions.....	16
4 Overview of the DL-protocol	17
4.1 General.....	17
4.2 Overview of the medium access control	17
4.2.1 General	17
4.2.2 Network topology.....	18
4.2.3 Priority control with VLAN.....	19
4.2.4 The maximum delivery delay in Type 25 network	20
4.2.5 Traffic control for real-time communication	21
4.3 Service assumed from PhL	21
4.4 DL Layer architecture.....	22
4.5 Local parameters and variables	23
4.5.1 Overview	23
4.5.2 Variables, parameter, counter and timer	23
5 General structure and encoding of PhPDUs and DLPDU and related elements of procedure.....	24
5.1 Overview	24
5.2 Common MAC frame structure, encoding and elements of procedure.....	24
5.2.1 MAC frame structure.....	24
5.2.2 Elements of the MAC frame	25
6 DLPDU-specific structure, encoding and elements of procedure	27
6.1 General.....	27
6.2 Structure of the RCL DLPDU.....	27
6.2.1 RCL header	27
7 DLE elements of procedure	29
7.1 Overview	29
7.2 RCL communication control (RCLC).....	29
7.2.1 General	29
7.2.2 Primitive definitions	29

7.2.3	RCLC state machine	32
7.2.4	Function of RCLC	48
7.3	Real-time communication control (RTC)	48
7.3.1	General	48
7.3.2	Primitive definitions	48
7.3.3	RTC state machine	50
7.3.4	Function of RTC	51
7.4	Transmit/Receive control (TRC)	52
7.4.1	General	52
7.4.2	Primitive definitions	52
7.4.3	TRC state machine	52
7.4.4	Function of TRC	57
7.5	DLL management protocol (DLM)	58
7.5.1	Overview	58
7.5.2	Primitive definitions	58
7.5.3	DLM state machine (DLM_SM)	59
	Bibliography	61
	Figure 1 – Relationships of DLSAPs, DLSAP-addresses and group DL-addresses	16
	Figure 2 – Ring control in Type 25 network	18
	Figure 3 – Communication ranges of Type 25 frames	19
	Figure 4 – Priority control with VLAN of Type 25 network	20
	Figure 5 – The mechanism of transmission delay in a node	20
	Figure 6 – The maximum delay in Type 25 network	21
	Figure 7 – Data-Link layer internal architecture	22
	Figure 8 – Type 25 fieldbus DLPDU frame format	25
	Figure 9 – RCL frame format	26
	Figure 10 – State transition diagram of RHE_SM-A	33
	Figure 11 – State transition diagram of RHE_SM-B	36
	Figure 12 – The state diagram of RCLNode_SM	39
	Figure 13 – The state diagram of RCLTR_SM	46
	Figure 14 – The state diagram of RTTR_SM	51
	Figure 15 – The state diagram of TRC_SM	52
	Figure 16 – The state diagram of DLM_SM	59
	Table 1 – State transition descriptions	16
	Table 2 – Descriptions of state machine elements	17
	Table 3 – Conventions used in state machine	17
	Table 4 – Characteristics of the node states	18
	Table 5 – Characteristic of the frame classes	19
	Table 6 – VLAN priority mapping of Type 25 network	19
	Table 7 – Data-link layer components	22
	Table 8 – Destination address format	25
	Table 9 – VLAN tag format	26
	Table 10 – Types and classes of RCL frames	27

Table 11 – Structure of RCL header.....	28
Table 12 – Class field format	28
Table 13 – Destination address field format	28
Table 14 – Source address field format.....	29
Table 15 – CMD field format	29
Table 16 – The primitives and parameters for DLS-user interface	30
Table 17 – Parameters used with primitives exchanged between RCLC and DLS-user	30
Table 18 – The primitives and parameters for TRC interface.....	31
Table 19 – Parameters used with primitives exchanged between RCLC and TRC	31
Table 20 – The primitives and parameters for DLM interface.....	32
Table 21 – Parameters used with primitives exchanged between RCLC and DLM	32
Table 22 – Transitions of RHE_SM-A at RCL communication.....	33
Table 23 – Transitions of RHE_SM-B at RCL communication.....	36
Table 24 – Transitions of RCLNode_SM at RCL communication	39
Table 25 – Transitions of RCLTR_SM at RCL communication	47
Table 26 – RCLC function table	48
Table 27 – The primitives and parameters for DLS-user interface	49
Table 28 – Parameters used with primitives exchanged between RTC and DLS-user.....	49
Table 29 – The primitives and parameters for TRC interface.....	49
Table 30 – Parameters used with primitives exchanged between RTC and TRC	50
Table 31 – The primitives and parameters for DLM interface.....	50
Table 32 – Parameters used with primitives exchanged between RTC and DLM	50
Table 33 – Transitions of RTTR_SM at RT communication	51
Table 34 – RTC function table.....	51
Table 35 – The primitives and parameters for DLM interface.....	52
Table 36 – Parameters used with primitives exchanged between TRC and DLM	52
Table 37 – Transitions of TRC_SM	53
Table 38 – TRC function table.....	57
Table 39 – Primitives exchanged between DLM and DLS-user.....	58
Table 40 – Parameters used with primitives exchanged between DLM and DLS-user.....	59
Table 41 – Transitions of DLM_SM	60

Generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
 FIELDBUS SPECIFICATIONS –**
**Part 4-25: Data-link layer protocol specification –
 Type 25 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.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61158-4-25 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
65C/946/FDIS	65C/955/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC website.

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.

A bilingual version of this publication may be issued at a later date.

This document is a preview generated by EVS

INTRODUCTION

This document 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 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 document 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 implementers 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 document is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this document 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 a patent concerning Type 25 elements and possibly other types given in this document as follows:

JP4074631 [HI]	Transmission line system, frame transmitter therein, and transmission line switching method
JP4653800 [HI]	Transmission line system, frame transmission apparatus, method and program for switching transmission line in transmission line system
JP4944986 [HI]	Transmission line system and transmission line construction method
CN1964307 [HI]	Transfer path system and frame transfer device in same system, transfer path handover method and system
CN101515887 [HI]	Transmission line system, frame transmitter therein, transmission line switching method and program

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right 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 this patent right is registered with IEC. Information may be obtained from:

[HI] Hitachi, Ltd.
Intellectual Property Division
20-2, Saiwai-cho 1-chome, Hitachi-shi,
Ibaraki-ken, 317-0073 Japan

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://patents.iec.ch>) 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 4-25: Data-link layer protocol specification – Type 25 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 document 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 datalink service provider;
- b) procedures for giving communications opportunities to all participating DL-entities, sequentially and in a cyclic manner for deterministic and synchronized transfer at cyclic intervals up to one millisecond;
- c) procedures for giving communication opportunities available for time-critical data transmission together with non-time-critical data transmission without prejudice to the time-critical data transmission;
- d) procedures for giving cyclic and acyclic communication opportunities for time-critical data transmission with prioritized access;
- e) procedures for giving communication opportunities based on ISO/IEC/IEEE 8802-3 medium access control, with provisions for nodes to be added or removed during normal operation;
- f) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this document, 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 capability, and thus its applicability to various time-critical communications needs.

1.5 Conformance

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE All parts of the IEC 61158 series, as well as IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

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/IEEE 8802-3:2017, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

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

IEEE Std 802.1D, *IEEE Standard for Local and metropolitan area networks – Media access Control (MAC) Bridges*, available at <http://www.ieee.org> [viewed 2018-09-17]

IEEE Std 802.1Q, *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks*, available at <http://www.ieee.org> [viewed 2018-09-17]

3 Terms, definitions, symbols, abbreviations and conventions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>