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NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications – Part 4-18: Data-link layer protocol specification – Type 18 elements

Réseaux de communications industriels – Spécifications de bus de terrain – Partie 4-18: Spécification de protocole de couche de liaison de données – Eléments de Type 18

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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

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-18: Data-link layer protocol specification – Type 18 elements

FOREWORD

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International Standard IEC 61158-4-18 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This bilingual version (2012-08) corresponds to the monolingual English version, published in 2010-08.

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:

- Editorial improvements
- Addition of cyclic data segmenting

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.

The French version of this standard has not been voted upon.

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- withdrawn;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.

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 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.

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3343036/Japan	[MEC]	Network System for a Programmable Controller
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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-18: Data-link layer protocol specification – Type 18 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 part of IEC 61158 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) 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 standard ISO/ IEC 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 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 part of IEC 61158 does not specify individual implementations or products, nor do they 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 18 data-link layer services defined in this standard.

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.

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 13239:2002, *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures*

3 Terms, definitions, symbols, abbreviations and conventions

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 additional terms:

3.1.1
DLE station identifier
network address assigned to a DLE

3.1.2
DLE station slot
unit (granularity of one) of position dependent mapping (for cyclic data field) of which a DLE may occupy one or more, delineated by the range beginning at the DLE station identifier with a length equal to the configured number of occupied slots

3.1.3
Master DLE
DLE that performs the functions of network master

3.1.4
Master-packed DLE
master DLE that uses the packed response access protocol

3.1.5
Master-polled DLE
master DLE that uses the polled response access protocol

3.1.6
Packed response
transmission of data managed by the process of a master broadcasting a trigger message whereupon each slave waits a time period unique to its DLE station identifier then transmits its response resulting in a time-sliced packing of all slave responses triggered by a single master request

3.1.7
Polled response
transmission of data managed by the process of a master individually interrogating each slave in a request/response paradigm

3.1.8
Slave DLE
DLE that performs the functions of network slave

3.1.9
Slave-packed DLE
slave DLE that uses the packed response access protocol

3.1.10
Slave-polled DLE
slave DLE that uses the polled response access protocol

3.2 Type 18: Symbols

RX	DLS-user visible register containing bit-oriented cyclic data of type input data that is transmitted from a slave DLE to a master DLE
RY	DLS-user visible register containing bit-oriented cyclic data of type output data that is transmitted from a master DLE to a slave DLE
RWr	DLS-user visible register containing word-oriented cyclic data of type input data that is transmitted from a slave DLE to a master DLE
RWw	DLS-user visible register containing word-oriented cyclic data of type input data that is transmitted from a master DLE to a slave DLE

3.3 Type 18: Additional conventions

3.3.1 DLE support level

There are three levels of data transmission support for a DLE.

- Level A – supports only bit-oriented cyclic data transmission
- Level B – includes level A as well as word-oriented cyclic data transmission
- Level C – includes level B as well as acyclic data transmission

4 DL-protocol overview

4.1 Introduction

There are four classes of Type 18 DLE:

a) Master-polled DLE

b) Slave-polled DLE

c) Master-packed DLE

d) Slave-packed DLE.

Only the master DLE classes are able to initiate traffic. Slave DLEs only transmit in response to master DLE requests.

4.2 Polled DLE classes

A slave-polled DLE transmits a response immediately upon receipt of an explicitly coded poll request addressed to the slave-polled DLE from a master-polled DLE. The polled classes support both cyclic and acyclic data transport.

4.3 Packed DLE classes

A slave-packed DLE transmits a response after a unique time has elapsed following a receipt of an explicitly coded poll request broadcast from a master-packed DLE. This results in a time-sliced packing of all slave-packed DLE responses to a single master-packed DLE request. The packed classes support cyclic data transport only.

5 DLPDU encoding and transmission

5.1 DL – PhL interface

5.1.1 Overview

The polled DLE classes employ the Type 18 Ph-MDS standard type. The packed DLE classes employ the Type 18 Ph-MDS high-density type.

In order to effect transmission, reception and management via the PhE, the DLE assumes a requisite set of support services as described in the following subclauses.

5.1.2 Transmission

A Type 18 DLE uses the following procedure to transmit data:

1) Segment DLPDUs into PhSDUs (single bits) using the HDLC protocol specified in 5.1
2) PH-DATA request (START-OF-ACTIVITY)
3) PH-DATA request (PhSDU)
4) PH-DATA confirm (SUCCESS)
5) repeat steps (3) and (4)
6) PH-DATA request (END-OF-ACTIVITY).

The DLE must sustain a rate of PhS requests that supports the configured baud rate as regulated by the PH-DATA success confirmation.

5.1.3 Reception

A Type 18 DLE uses the following procedure to receive data:

1) Ph-Data indication (START-OF-ACTIVITY)
2) Ph-Data indication (PhSDU)
3) If not Ph-Data indication (END-OF-ACTIVITY), repeat step (2), otherwise proceed to step (4)
4) Reassemble PhSDUs (single bits) into a DLPDU using the HDLC protocol specified in 5.1.

The DLE must sustain a rate of PhS indications that supports the configured baud rate.

5.1.4 Management

A Type 18 DLE assumes that the PhE supports the following services:

- PH-RESET
- PH-SET-VALUE (baud-rate)

5.2 DLPDU transmission encoding

5.2.1 General

The Type 18 DL implements a subset of the High-level Data Link Control (HDLC) protocol corresponding to ISO/IEC 13239:2002, named HDLC throughout the remainder of this clause, with some exceptions as noted.

5.2.2 Polled DLE

5.2.2.1 Preamble

A preamble of three consecutive HDLC flags is transmitted as defined by ISO/IEC 13239:2002 and shown in Figure 1.

Figure 1 – HDLC flag

5.2.2.2 End of activity

An end-of-frame (EOF) of three consecutive HDLC flags is transmitted as defined by ISO/IEC 13239:2002 and shown in Figure 1.

5.2.3 Packed DLE

5.2.3.1 Start of activity

A preamble of one HDLC flag is transmitted as defined by ISO/IEC 13239:2002 and shown in Figure 1.

5.2.3.2 End of activity

An end-of-frame (EOF) of one HDLC flag is transmitted as defined by ISO/IEC 13239:2002 and shown in Figure 1.

5.2.4 HDLC conventions

5.2.4.1 Data encoding

Data is encoded using NRZI encoding as defined by ISO/IEC 9314-1.

5.2.4.2 Frame format

The non-basic frame format is specified with a non-standard address field, as specified in 5.2.5.1, and a non-standard control field, as specified in 5.2.5.2.

5.2.4.3 Frame checking sequence field

The 16-bit frame checking sequence (Cyclic Redundancy Check, CRC) option shall be implemented for all DLEs of the polled class. The 8-bit frame checking sequence (CRC) option shall be implemented for all DLEs of the packed class.

5.2.4.4 Header check sequence field

The header check sequence field shall not be implemented.

5.2.4.5 Operational mode

The Normal Response Mode (NRM) shall be implemented.

5.2.4.6 Start/stop transmission – basic transparency

The protocol for basic transparency shall not be implemented.

5.2.4.7 Summary

The HDLC conventions implemented by the DL are summarized in Table 1.

Table 1 – HDLC convention summary

Component	Implementation
Data encoding	NRZI
Frame format	non-basic frame
Frame checking sequence field	16-bit / 8-bit
Header check sequence field	not implemented
Operational mode	normal response mode
Start/stop transmission – basic transparency	not implemented

5.2.5 HDLC exceptions

5.2.5.1 Address field

The DLE implements a two-octet address field the encoding of which does not conform to HDLC. A special subset of the response type messages are defined that exclude the address field entirely (field length = 0).

5.2.5.2 Control field

The DLE implements a two-octet control field the encoding of which does not conform to HDLC. Throughout the remainder of this clause, the control field is named the status field.

A special subset of the request type transmissions are defined that exclude the status field entirely. Another special subset of the response type transmissions are defined with an abbreviated 4-bit status field.

5.2.5.3 Inter-frame time fill

The polled DLE class implements an inter-frame time fill the encoding of which does not conform to HDLC. The polled DLE class inter-frame time fill shall be accomplished by transmitting a continuous stream of alternating zeros and ones.

5.2.5.4 Summary

The HDLC exceptions implemented by the DLE are summarized in Table 2.