IEC 61158-4-18

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

**Réseaux de communication industriels – Spécifications des bus de terrain –
Partie 4-18: Spécification des protocoles des couches de liaison de données –
Éléments de Type 18**

IEC 61158-4-18:2007-12(en-fr)

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3343036/Japan	[MEC]	"Network System for a Programmable Controller"
5896509/USA	[MEC]	"Network System for a Programmable Controller"
246906/Korea	[MEC]	"Network System for a Programmable Controller"
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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 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 a technical addition.

This bilingual version (2014-12) corresponds to the monolingual English version, published in 2007-12.

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

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

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.

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• withdrawn;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.

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.

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 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 61158-3-18, *Industrial communication networks – Fieldbus specifications – Part 3-18: Data-link layer service definition – Type 18 elements*

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

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

ISO/IEC 13239, *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

Symbol	Definition
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.
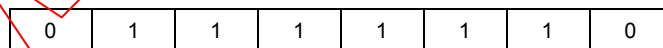
0	1	1	1	1	1	1	0

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.