IEC 61158-1

Edition 3.0 2023-03

INTERNATIONAL STANDARD

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Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 1: Vue d'ensemble et recommandations pour les séries IEC 61158 et IEC 61784

IEC 61158-1:2023-03(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 25.040.40; 33.040.40; 35.100.05

ISBN 978-2-8322-6543-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series

FOREWORD

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NOTE Combinations of protocol types are specified in the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61158-1 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This third edition cancels and replaces the second edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) added the new technology AUTBUS specified in Type 28;
b) additional profile within IEC 61784-2-8 referring to Type 23 (CP 8/6, CC-Link IE TSN);
c) additional profile referring to Type 24 (CP 19/3, Σ-LINKII);
d) additional profile within IEC 61784-2-19 referring to a new Type 27 (CP 19/4, MECHATROLINK-4).

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

Draft	Report on voting
65C/1199/FDIS	65C/1240/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series

1 Scope

This part of IEC 61158 specifies the generic concept of fieldbuses.

This document also presents an overview and guidance for the IEC 61158[1] series by:

- explaining the structure and content of the IEC 61158 series;
- relating the structure of the IEC 61158 series to the ISO/IEC 7498-1 OSI Basic Reference Model;
- showing the logical structure of the IEC 61784[2] series;
- showing how to use parts of the IEC 61158 series in combination with the IEC 61784 series;
- providing explanations of some aspects of the IEC 61158 series that are common to the type specific parts of the IEC 61158-5 series including the application layer service description concepts and the generic fieldbus data types.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms, definitions and abbreviated terms apply.

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

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

3.1.1
communication system
arrangement of hardware, software and propagation media to allow the transfer of messages from one application to another

3.1.2
fieldbus
communication system based on serial data transfer as typically used in industrial automation and process control applications

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1 In the following pages of this document, “IEC 61158” will be used as a qualifier for “IEC 61158 (all parts)”.

2 In the following pages of this document, “IEC 61784” will be used as a qualifier for “IEC 61784 (all parts)”.

3.1.3
fieldbus system
system using a fieldbus with connected devices

3.1.4
message
ordered series of octets intended to convey information

3.1.5
network
all of the media, connectors, repeaters, routers, gateways and associated node communication elements by which a given set of communicating devices are interconnected

3.2 Abbreviations and symbols

For the purposes of this document, the following abbreviations, based partially on the concepts developed in ISO/IEC 7498-1, apply:

AE	application entity
AL	application layer (N = 7)
APDU	application layer protocol data unit
APO	application process object
AR	application relationship
AREP	application relationship endpoint
ASE	application service element
CP	communication profile
CPF	communication profile family
DL-	data-link layer (as a prefix)
DLL	data-link layer (N = 2)
FAL	fieldbus application layer
FSCP	functional safety communication profile
IETF	Internet Engineering Task Force
IO	input output
IP	Internet protocol (see IETF RFC 791)
kbit/s	thousand bit per second
Mbit/s	million bit per second
LME	layer management entity
(n)-layer	layer n of the OSI basic reference model
OSI	open systems interconnection
Ph-	physical layer (as a prefix)
PhL	physical layer (N = 1)
SIL	safety integrity level

4 Guidelines for implementers and users

4.1 Background and purpose

Communication in global markets requires a global understanding of a specification (standard or not). ISO/OSI related specifications provide a common basis for understanding and acceptance between international experts (manufacturers and end-users).

Examples are

- ISO/IEC 7498-1 for general layering and structuring;
- ISO/IEC 9545 for general application layer modeling;
- ISO/IEC 8886 for data-link layer modeling.

IEC 61158 series specifies a number of different fieldbus types in each of its parts (IEC 61158-2 and the type specific parts of IEC 61158-3-***tt***, IEC 61158-4-***tt***, IEC 61158-5-***tt*** and IEC 61158-6-***tt***). As a result of the editorial harmonization work done by IEC, each PhL, DLL and AL specification within IEC 61158 series is shown in a homogeneous way. The description of each layer offers, as far as possible, common views, concepts, definitions, and descriptive methods.

NOTE The lists of parts in the IEC 61158 series are abbreviated as IEC 61158-3-***tt***, IEC 61158-4-***tt***, IEC 61158-5-***tt***, or IEC 61158-6-***tt***, where ***tt*** represents one or more type numbers.

This common approach has been adopted to assist users and implementers in understanding the several specifications. It is also intended to assist in comparing available products and their communications-related features.

The added value of having more than one fieldbus standardized in IEC 61158 series, IEC 61784-1 series and IEC 61784-2 series is provided in IEC 61784-1-0, Annex A.

4.2 Supported options

Most of the fieldbus types specified in IEC 61158 series include a range of selectable and configurable options within their detailed specifications. In general, only certain restricted combinations of options will interwork or interoperate correctly.

The recommended combinations of options are collected in IEC 61784-1 series and IEC 61784-2 series.

IEC 61784-1 series and IEC 61784-2 series provide users and implementers with details of supported fieldbus specifications based on selected options that are intended to work together consistently and correctly. In most cases, available product demonstrations and working plant experience support these profiles.

IEC 61784-1-0 and IEC 61784-2-0 provide the common elements of the communication profile families (CPF) specified in the subparts 1 to n of the IEC 61784-1 and IEC 61784-2 series corresponding to the CPF numbers 1 to n.

Annex A of each CPF part of the IEC 61784-1 series and Annex A of each CPF part of the IEC 61784-2 series help selecting the needed fieldbus by showing the key features of each of the profiled fieldbus protocol families.

As a result, the route map recommended to select a fieldbus is:

- Clause 5 to Clause 8 of this document;
- IEC 61784-1 series, Annex A of each CPF part: Communication concepts;
- IEC 61784-2 series, Annex A of each CPF part: Performance indicator calculation;

- the parts of the IEC 61784-1 and IEC 61784-2 series that specify the CPF;
- the parts of the IEC 61158 series as referenced in the relevant CPF parts of the IEC 61784-1 and IEC 61784-2 series for the selected communication profile of interest.

4.3 Benefits from using a common and formal style

The benefits gained from using a common and formal style to specify the communication system are:

- the common look and feel of a specification saves effort during evaluation;
- a common structure helps to identify and to specify common parts and contents;
- the common approach represents a first step to ensure long-term quality and stability;
- the missing parts and items of any specification are more readily identified by comparison with the other specifications, leading to a simplified review and evaluation procedure;
- a common basis facilitates the development of test and certification procedures;
- the modular concepts support future enhancements, extensions and adaptation of new technologies.

5 Concept of the IEC 61158 series

Conceptually, a fieldbus is an industrial digital communication network for integration of industrial control and instrumentation devices into a system. Examples of such devices are transducers, sensors, actuators and controllers.

IEC 61158 series specifies a number of fieldbus protocol types. Each protocol type is designed to permit multiple measurement and control devices to communicate. Devices communicate directly only with other devices of the same protocol type. The basic requirements of industrial communication networks for measurement and control are given in Clause 11.

Devices which use the same lower-layer protocols in a compatible fashion but differ in their higher-layer protocols could be able to share a lower-layer medium.

In all cases, a particular data-link layer protocol type may be used without restriction when coupled with physical layer and application layer protocols of the same type or with other combinations as specified in IEC 61784-1 series and IEC 61784-2 series. Use of the various protocol types in other combinations could require permission from their respective copyright holders.

The protocol types in IEC 61158 series have been engineered to support information processing, monitoring and control systems for any industrial sector and related domains. An example application for high-integrity low-level communication between sensors, actuators and local controllers in a process plant, together with the interconnection of programmable controllers, is shown in Figure 1.

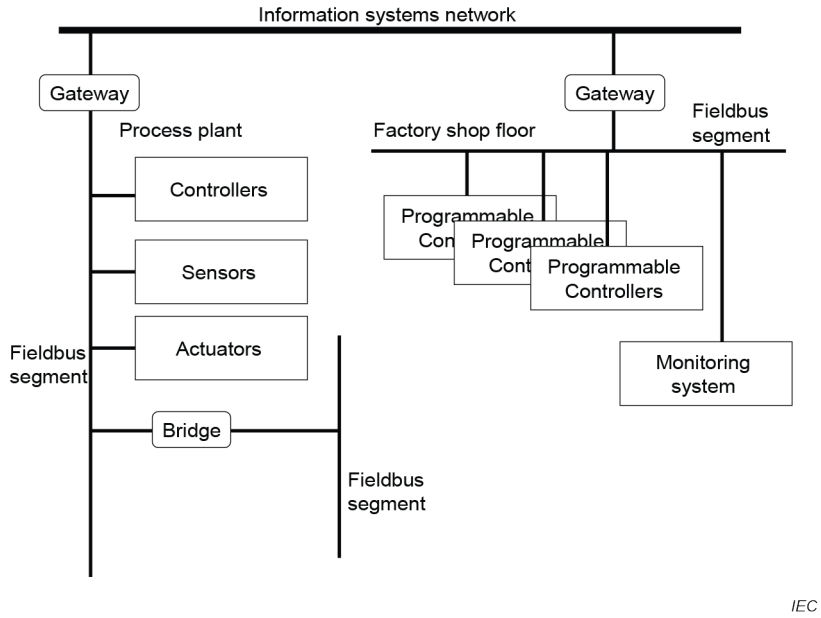

Figure 1 – Example of a fieldbus system

A number of fieldbus types are specified in IEC 61158 series using the following concepts for decomposition.

a) **First concept:** The complex communication task is divided into different layers based on an adaptation of ISO/IEC 7498-1, the ISO/OSI Basic Reference Model, thereby facilitating well-structured functions and interfaces (see Clause 6). This has the following benefits:
   – decomposition of complex tasks;
   – modular structure to adapt different technologies.

b) **Second concept:** Each fieldbus type is composed of one or more layer specifications.

   Most types include a number of services and protocol options that require an appropriate selection to support a working system. Compatible selections of options and services within one of the IEC 61158 fieldbus types are specified as standardized communication profiles in IEC 61784-1 series and IEC 61784-2 series. Most of these profiles are supported by consortia or trade associations which are identified in the profile specification.

c) **Third concept:** The physical, data-link and application layers are described in complementary ways, in terms of the offered services and the protocol which provides those services.

Figure 2 illustrates the differences between service and protocol viewpoints of the data-link and application layers. The protocol parts show the layer implementer's oriented view and the service parts show the layer user's oriented view.

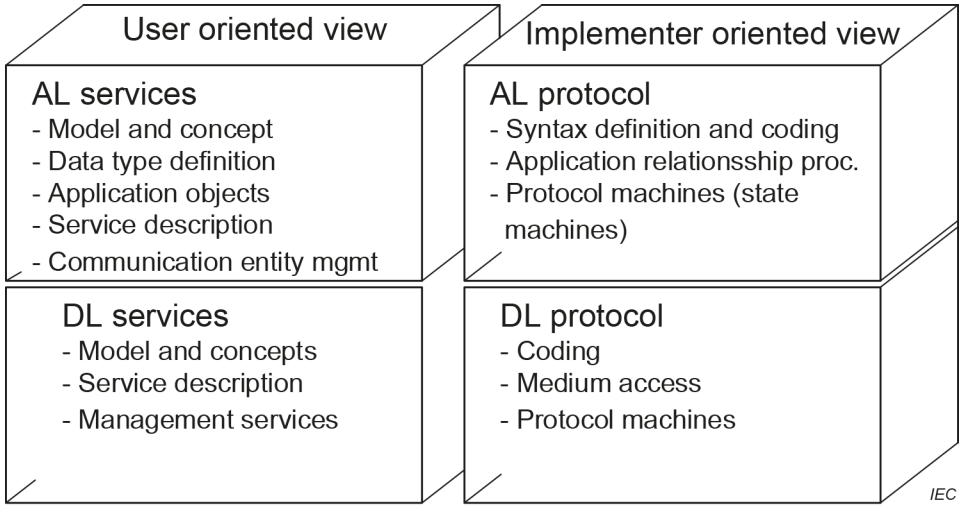

Figure 2 – Concept of DL/AL to separate service and protocol parts

The application layer structure is as follows:

– the user layer view (the what) is described by application layer service elements (ASE) in the type specific parts of the IEC 61158-5 series; and

– the implementer oriented view (the how) is described by application layer relationships (AR) in the type specific parts of the IEC 61158-6 series.

The data-link layer structure is as follows:

– the user layer view (the what) is described by data-link layer services and models in the type specific parts of the IEC 61158-3 series; and

– the implementer oriented view (the how) is described by data-link layer protocol machines and medium access principles in the type specific parts of the IEC 61158-4 series.

The physical layer is structured similarly, but, because its services are readily described, they are described in IEC 61158-2 together with the definitions of the physical protocols:

– the "what" is described by physical layer services and models, and

– the "how" is described by physical layer electrical and mechanical specifications.

6 Mapping onto the OSI Basic Reference Model

6.1 Overview

IEC 61158 protocol types are described using the principles, methodology and model of ISO/IEC 7498-1. The OSI model provides a layered approach to communications standards, whereby the layers can be developed and modified independently. IEC 61158 series specifies functionality from top to bottom of a full OSI stack and, potentially, some functions for the users of the stack. Functions of the intermediate OSI layers, layers 3 through 6, may be consolidated into either the IEC 61158 data-link layer or the IEC 61158 application layer, or may be realized by a separate layer. Likewise, some features common to users of the fieldbus application layer may be provided by the IEC 61158 application layer to simplify user operation.

Table 1 shows the OSI layers, their functions, and the equivalent layers in the IEC 61158 basic fieldbus reference model (Figure 3).