

BS EN 61158-1:2014



BSI Standards Publication

Industrial communication networks — Fieldbus specifications

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

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Part 1: Overview and guidance for the IEC 61158 and IEC 61784
series
(IEC 61158-1:2014)

Réseaux de communication industriels - Spécifications des
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(IEC 61158-1:2014)

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Foreword

The text of document 65C/757/FDIS, future edition 1 of IEC 61158-1, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61158-1:2014.

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This document supersedes CLC/TR 61158-1:2010.

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Endorsement notice

The text of the International Standard IEC 61158-1:2014 was approved by CENELEC as a European Standard without any modification.

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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 document specifies the generic concept of fieldbuses.

This document also presents an overview and guidance for the IEC 61158 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 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 including the application layer service description concepts and the generic fieldbus data types.

2 Normative references

None.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

3.1.3

fieldbus system

system using a fieldbus with connected devices

3.1.4

message

ordered series of octets intended to convey information

[SOURCE: ISO/IEC 2382-16:1996, 16.02.01, modified]

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

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 RFC 791)
kbit/s	thousand bit per second
Mbit/s	million bit per second
LME	layer management entity
(n)-layer	layer <i>n</i> 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.

The 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 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 list of IEC 61158 parts is 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.

4.2 Supported options

Most of the fieldbus types specified in the 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 and IEC 61784-2.

IEC 61784-1 and IEC 61784-2 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.

Annex A of IEC 61784-1 and Annex A of IEC 61784-2 help select 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 part of IEC 61158;
- IEC 61784-1, Annex A: Communication concepts;
- IEC 61784-2, Annex A: Performance indicator calculations;
- IEC 61784-1 and IEC 61784-2, Communication profile family;
- the parts of IEC 61158 as referenced in IEC 61784-1 and IEC 61784-2 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.

The 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 may 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 and IEC 61784-2. Use of the various protocol types in other combinations may require permission from their respective copyright holders.

The protocol types in IEC 61158 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.

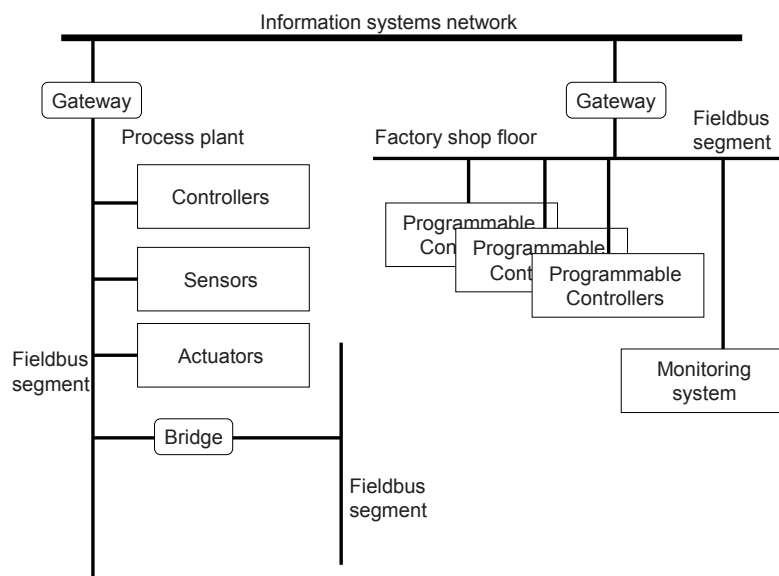


Figure 1 – Example of a fieldbus system

A number of fieldbus types are specified in the 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 specific functions.

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 and IEC 61784-2. 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.

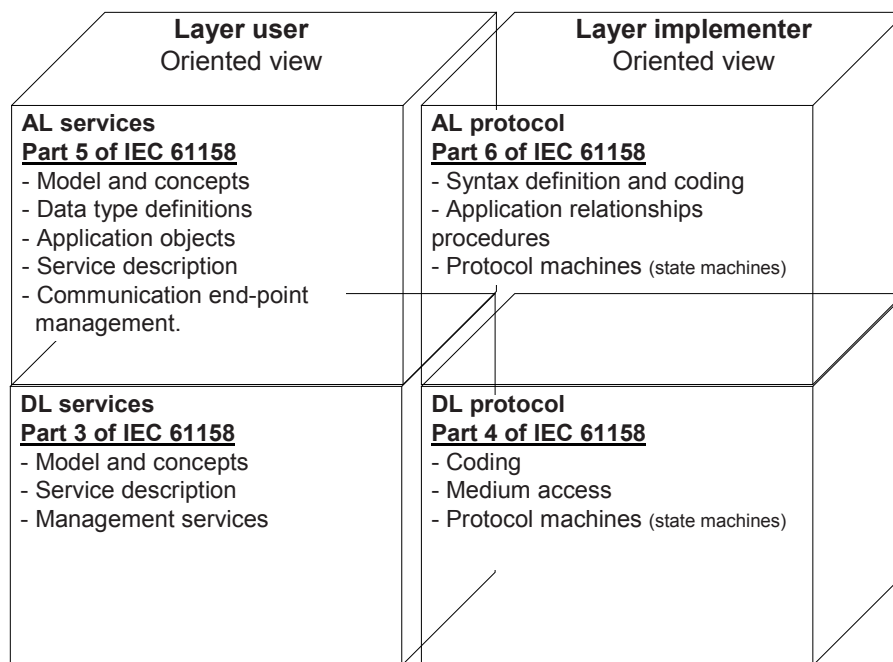


Figure 2 – Concept of DL/AL to separate service and protocol parts

The application layer structure is as follows:

- the "what" is described by application layer service elements (ASE) in the type specific parts of IEC 61158-5; and
- the "how" is described by application layer relationships (AR) in the type specific parts of IEC 61158-6.

The data-link layer structure is as follows:

- the "what" is described by data-link layer services and models in the type specific parts of IEC 61158-3; and
- the "how" is described by data-link layer protocol machines and medium access principles in the type specific parts of IEC 61158-4.

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 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 (see Figure 3).

Table 1 – OSI and IEC 61158 layers

OSI layer	Function	IEC 61158 layer
7 Application	Translates demands placed on the communications stack into a form understood by the lower layers and vice versa	Application (IEC 61158-5- <i>tt</i> , IEC 61158-6- <i>tt</i>)
6 Presentation	Converts data to/from standardized network formats	↑
5 Session	Creates and manages dialogue among lower layers	↑
4 Transport	Provides transparent reliable data transfer (end-to-end transfer across a network which may include multiple links)	↓ or ↑
3 Network	Performs message routing	↓ or ↑
2 Data-link	Controls access to the communication medium. Performs error detection, (point-to-point transfer on a link)	Data-link (IEC 61158-3- <i>tt</i> , IEC 61158-4- <i>tt</i>)
1 Physical	Encodes/decodes signals for transmission/reception in a form appropriate to the communications medium. Specifies communication media characteristics	Physical (IEC 61158-2)

NOTE -*tt* is a placeholder for the part numbers representing types.

NOTE ↓ and ↑ indicate that the functionality of this layer, when present, is included in the fieldbus layer that is nearest in the direction of the arrow. Thus it is possible that the network and transport functionality are included in either the data-link or application layers, and it is possible that the session and presentation functionality are included in the application layer but not in the data-link layer.

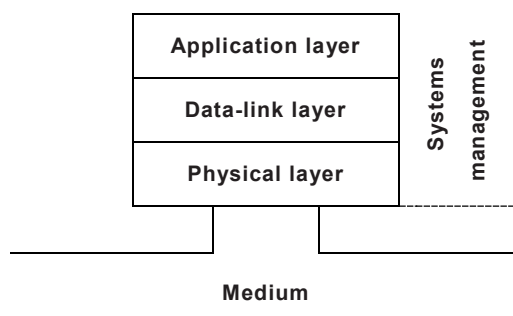


Figure 3 – Basic fieldbus reference model

6.2 Physical layer service and protocol

IEC 61158-2 comprises physical layer specifications corresponding to many of the different DL-Layer protocol types specified in the type specific parts of IEC 61158-4.

NOTE 1 The type numbers used are consistent throughout the IEC 61158 series.

NOTE 2 Not all types have a physical layer specification in IEC 61158-2. In that case the communication profile in IEC 61784-1 or IEC 61784-2 provides appropriate references to other standards.

NOTE 3 For ease of reference, type numbers are given in clause names. This means that the specification given therein applies to this type but does not exclude its use for other types.

NOTE 4 It is up to the user of IEC 61158 to select interoperating sets of provisions. Refer to the IEC 61784-1 and IEC 61784-2 for standardized communication profiles based on IEC 61158.

A general model of the physical layer is shown in Figure 4.

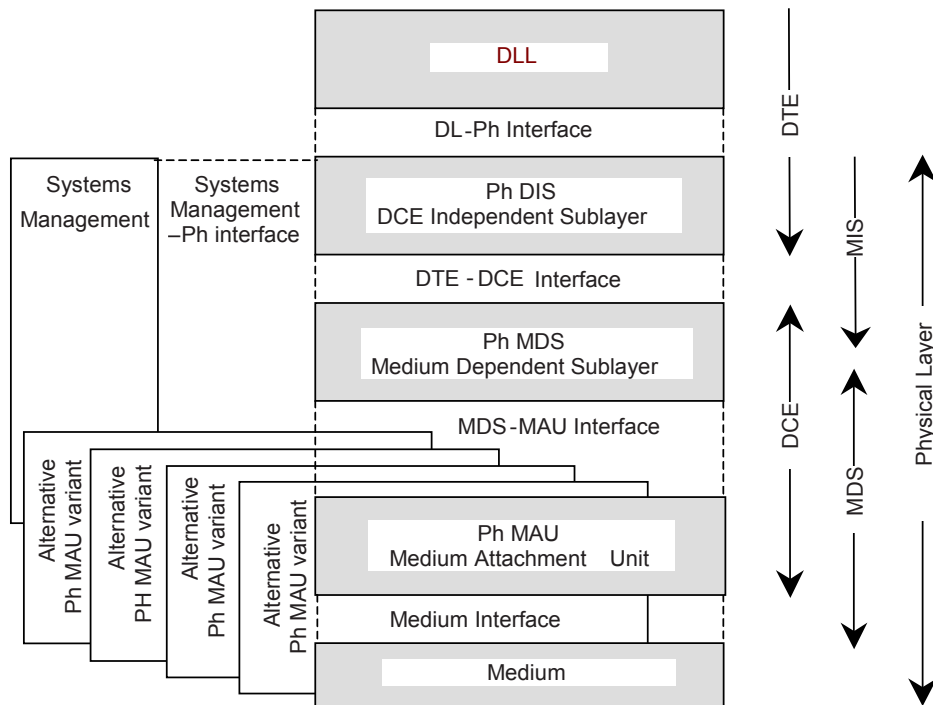


Figure 4 – General model of physical layer

NOTE 5 The protocol types use a subset of the structure elements.

NOTE 6 Since Type 8 uses a more complex DIS than the other types, it uses the term MIS to differentiate.

The common characteristics for all variants and types are as follows:

- digital data transmission; and
- either half-duplex communication (bi-directional but in only one direction at a time) or full-duplex communication.

6.3 Data-link layer service

The data-link service is provided by the data-link protocol making use of the services available from the physical layer. This and related parts of the IEC 61158 series defines the data-link service characteristics that the immediately higher-level protocol may exploit. The relationship between the international standards for fieldbus data-link service, fieldbus data-link protocol, fieldbus application protocol and systems management is illustrated in Figure 5.

NOTE Systems management, as used in the IEC 61158 series, is a local mechanism for managing the layer protocols.

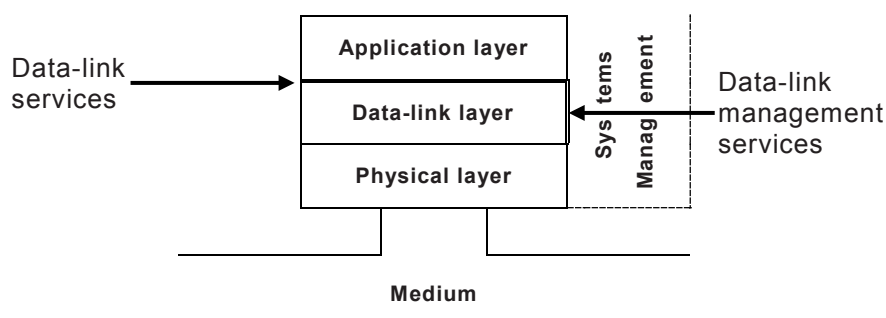


Figure 5 – Relationship of the Data-link layer to other fieldbus layers and to users of the fieldbus data-link service

Throughout the set of fieldbus standards, the term “service” refers to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, a data-link service defined in IEC 61158 is a conceptual architectural service, independent of administrative and implementation divisions.

6.4 Data-link layer protocol

The data-link protocol provides the data-link service by making use of the services available from the physical layer. The relationship between the International Standards for fieldbus data-link service, fieldbus data-link protocol, fieldbus physical service and systems management is illustrated in Figure 5.

NOTE 1 Systems management, as used in the IEC 61158 series, is a local mechanism for managing the layer protocols.

NOTE 2 Not all types have a data-link layer specification. In that case the communication profile in IEC 61784-1 or IEC 61784-2 provides appropriate references to other standards.

The primary aim of the data-link protocol standards 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.

These data-link protocol standards are concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices, using these standards, together with other standards positioned within the OSI or fieldbus reference models; otherwise, incompatible systems may work together in any combination.

6.5 Application layer service

The application service is provided by the application protocol making use of the services available from the data-link or other immediately lower layer. Each part of the IEC 61158-5 series defines the application service characteristics that any immediately higher-level protocols may exploit. The relationship between the international standards for fieldbus application service, fieldbus application protocol and systems management is illustrated in Figure 6.

NOTE Systems management, as used in the IEC 61158 series, is a local mechanism for managing the layer protocols.

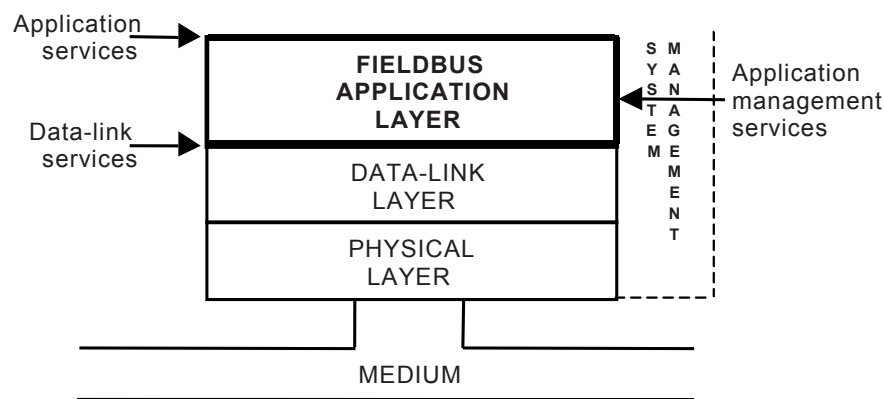


Figure 6 – Relationship of the fieldbus Application layer to other fieldbus layers and to users of the fieldbus application service

6.6 Application layer protocol

The application protocol provides the application service by making use of the services available from the data-link layer or other immediately lower layer. The relationship between the International Standards for fieldbus application service, fieldbus application protocol, fieldbus data-link service and system management is illustrated in Figure 6.

NOTE Systems management, as used in the IEC 61158 series, is a local mechanism for managing the layer protocols.

An application process uses the fieldbus application layer services to exchange information with other application processes. The services define the abstract interface between the application process and the application layer.

The application layer protocol is the set of rules that governs the format and meaning of the information exchange between the application layers in various devices. The application layer uses the protocol to implement the application layer services definitions.

The protocol machine defines the various states of an application layer and the valid transitions between the states. It may be considered as a finite state machine. The protocol machine is described using state tables. The information is exchanged between the application process and the protocol machine through application service data units. The protocol machine exchanges information with other protocol machines through application protocol data units (APDU).

This set of application layer standards does not contain test procedures to ensure compliance with such requirements.

The primary aim of an application layer protocol in IEC 61158 is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer application entities (AE) 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.

IEC 61158 is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices, by using IEC 61158 together with other standards

positioned within the OSI or fieldbus reference models; otherwise, incompatible systems may work together in any combination.

7 Structure of IEC 61158 and IEC 61784 series

7.1 The IEC 61158 physical layer

The IEC 61158 physical layer receives data units from the data-link layer, encapsulates them if necessary by adding communications framing information, encodes the bits and framing information into signals, and transmits the resulting physical signals to the transmission medium connected to the transmitting node.

Signals are then received at one or more other node(s) and decoded, and any communications framing information is checked and removed, before the data units are passed to the data-link layer of the receiving device.

IEC 61158-2 comprises physical layer specifications to support the DL-protocol types specified in the IEC 61158 data-link layer. It defines the services provided

- a) to the various types of fieldbus data-link layer at the boundary between the data-link and physical layers of the fieldbus reference model;
- b) to systems management at the boundary between the physical layer and systems management of the fieldbus reference model.

NOTE This combination of physical service definition and physical protocol specification into a single standard is an historic anomaly; it is not common standards practice.

7.2 The IEC 61158 data-link layer

In the absence of persistent errors, the IEC 61158 data-link layers (see IEC 61158-3-**tt** and IEC 61158-4-**tt**) provide basic time-critical support for data communications among devices in an automation environment. The term “time-critical” is used to describe applications having a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

IEC 61158 data-link layer specifies, in an abstract way, the externally visible service provided by the fieldbus data-link layer in terms of

- a) the primitive actions and events of the service;
- b) the parameters associated with each primitive action and event, and the form which they take;
- c) the interrelationship between these actions and events, and their valid sequences.

IEC 61158 data-link layer defines the services provided

- d) to the various types of fieldbus application layer at the boundary between the application and data-link layers of the fieldbus reference model;
- e) to systems management at the boundary between the data-link layer and systems management of the fieldbus reference model.

IEC 61158-4-**tt** define a number of distinct and non-interoperable fieldbus data-link protocols. Each protocol is most closely related to, and lies within the field of application of, the corresponding services of IEC 61158-3-**tt**.

7.3 The IEC 61158 application layer

The IEC 61158 application layers (see IEC 61158-5-**tt** and IEC 61158-6-**tt**) are designed to support the conveyance of time-critical application requests and responses among devices in an automation environment.

The IEC 61158-5 series specifies interactions between remote applications in terms of

- a) an abstract model for defining application resources (objects) capable of being manipulated by users via the use of fieldbus application layer (FAL) services;
- b) the service primitives (interactions between the FAL and the FAL user) associated with each FAL service;
- c) the parameters associated with each service primitive;
- d) the interrelationship between, and the valid sequences of, the primitives for each service.

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified; only a definition of what requests and responses they can send/receive is specified. This permits greater flexibility to the FAL users in standardizing such object behavior. In addition to these services, some supporting services are also defined to provide access to the FAL to control certain aspects of its operation.

The IEC 61158-5 series defines the services provided

- a) to the various user(s) of the fieldbus application layer at the boundary between the user(s) and the application layer of the fieldbus reference model;
- b) to systems management at the boundary between the application layer and systems management of the fieldbus reference model.

The IEC 61158-6 series defines a number of distinct and non-interoperable fieldbus application protocols. Each protocol is most closely related to, and lies within the field of application of, the services of the corresponding part of the IEC 61158-5 series.

7.4 IEC 61784-1 and IEC 61784-2 fieldbus profiles

IEC 61784-1 and IEC 61784-2 provide sets of communication profiles (CP) in the sense of ISO/IEC TR 10000-1. These answer the need of identifying the protocol families co-existing within the IEC 61158 series, as a result of the international harmonization of fieldbus technologies available on the market. More specifically, these profiles help to correctly state the compliance to the IEC 61158 series, and to avoid the spreading of divergent implementations, which would limit its use, clearness and understanding. Additional profiles to address specific market concerns, such as functional safety or information security, may be addressed by future parts of IEC 61158.

IEC 61784-1 and IEC 61784-2 contain several communication profile families (CPF), which specify one or more communication profiles. Such profiles identify, in a strict sense, protocol subsets of the IEC 61158 series via protocol specific communication profiles. They do not define device-type-specific communication profiles for the purpose of guiding manufacturers in feature set selection – for example, in selecting the minimum set of communication services and protocol to implement a specific class of devices, such as generic slaves or transmitters ("implementation profiles"). Neither do they define device profiles that specify communication profiles together with application functions needed to answer the need of a specific application ("application profiles").

NOTE IEC/TR 62390 provides guidance for the development of device profiles for industrial field devices and control devices. IEC/TR 62390 also defines the relation between device profiles and communication profiles including the levels of functional compatibility and the relations between profiles and products.

It is also important to clarify that interoperability – defined as the ability of two or more network systems to exchange information and to make mutual use of the information that has been exchanged (see 3.2.1 of ISO/IEC TR 10000-1) – can be directly achieved on the same link only for those devices complying with the same communication profile.

Profiles contained in IEC 61784-1 and IEC 61784-2 are made up of references to IEC 61158-2 and 61158-3-*tt* through IEC 61158-6-*tt*, ISO/IEC 8802-3 or IEEE 802.3 and other International Standards, Technical Specifications or worldwide-accepted standards, as appropriate. Each profile is required to reference at least one part of IEC 61158-2 and 61158-3-*tt* through IEC 61158-6-*tt*.

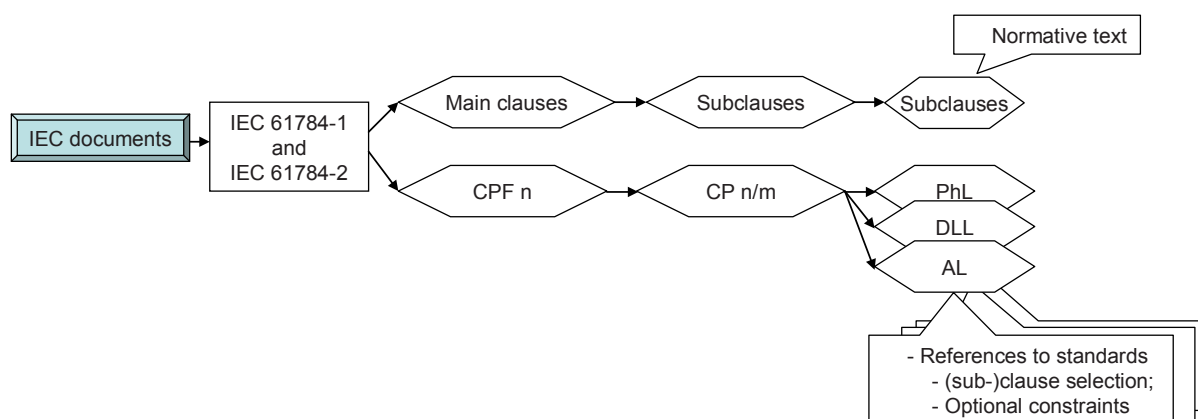
Two or more profiles, which are related to a common family, are specified within a CPF.

IEC 61784-2 specifies additional profiles that meet the industrial automation market objective of identifying real-time Ethernet (RTE) communication networks coexisting with ISO/IEC 8802-3 or IEEE 802.3 (commonly known as Ethernet). These RTE communication networks use provision from ISO/IEC 8802-3 for the lower communication stack layers and, additionally, provide more predictable and reliable real-time data transfer and means for support of precise synchronization of automation equipment.

More specifically, these profiles help to correctly state the compliance of RTE communication networks with ISO/IEC 8802-3 or IEEE 802.3, and to avoid the spreading of divergent implementations.

Each profile selects an appropriate consistent and compatible subset of services and protocols from the total available set of communication types that are defined and modelled in IEC 61158 and other standards. For the selected subset of PhL, services, and protocols, the profile also describes any possible or necessary constraints in parameter values.

The document structure of communication profile families (CPF) is shown in Figure 7.



n is a number of a CPF; m is a number of a CP within a CPF.

Figure 7 – Structure of communication profile families

IEC 61784-1, IEC 61784-2 and future parts and sub-series of the IEC 61784 series specify communication profile families (CPF). A CPF contains at least one communication profile (CP). A CP is always structured to specify PhL, DL, and AL by reference to clauses and subclauses within the IEC 61158 series and other appropriate international standards. These subclauses provide at least one reference to an international standard. Either the international standard is referenced completely or it is referenced by a list of required clauses and subclauses marked YES or NO. YES means the clause or subclause applies, NO means that it does not apply. Optional information may be provided to specify constraints.

Figure 8 is an example of a CPF structure.

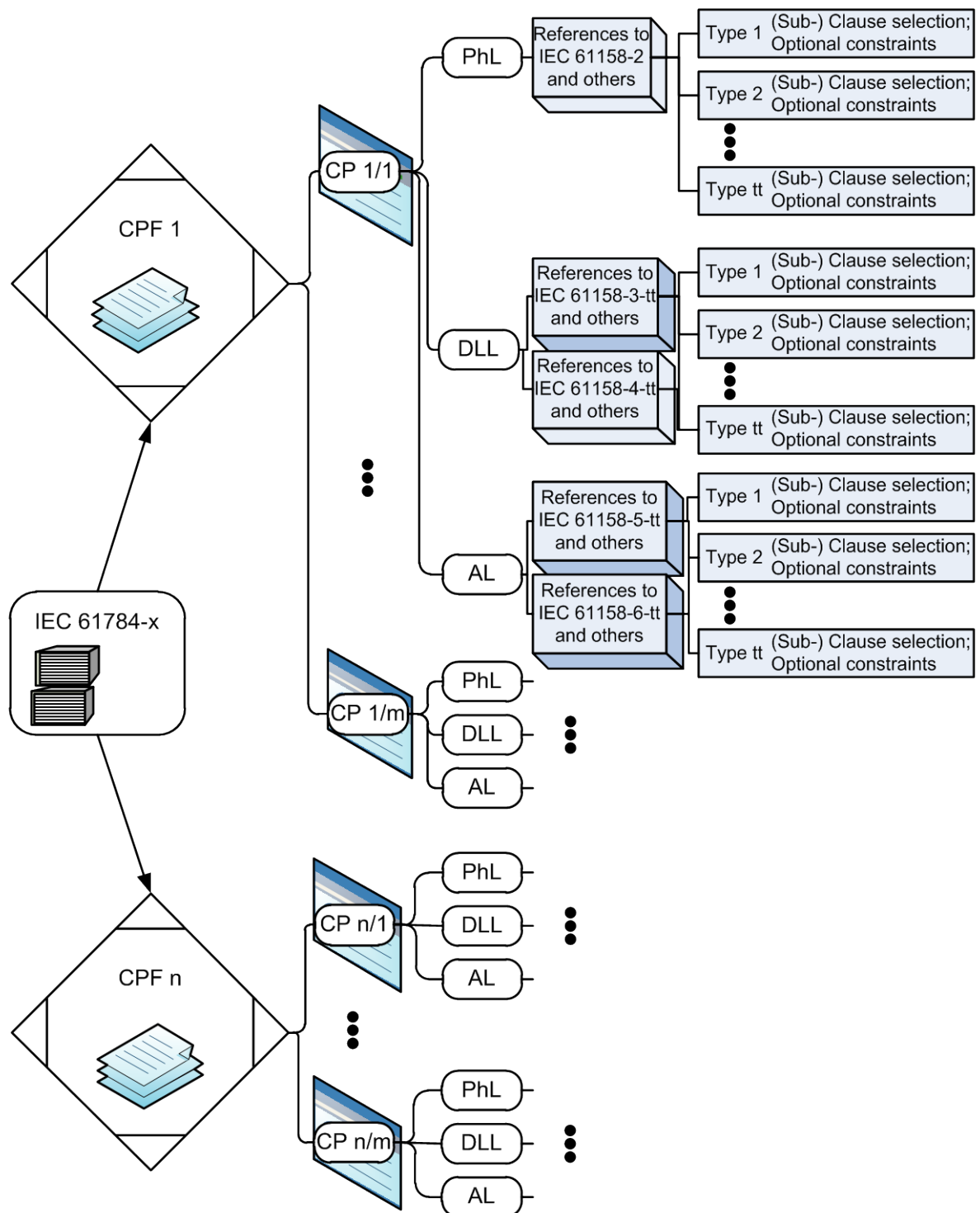


Figure 8 – Example of a CPF structure

Table 2 shows the Communication Profile Families (CPF) that are defined in IEC 61784-1 and IEC 61784-2. It shows the link between technologies and CPFs with their associated CPs and corresponding type numbers in the IEC 61158 series.

Table 2 – CPF, CP, and type relations

Communication Profiles in IEC 61784			Corresponding IEC 61158 types to CPs		
CPF	Technology name	IEC 61784 (Sub-)Parts	CP number	Type number	IEC 61158 (Sub-)Parts
1	FOUNDATION™ fieldbus	1, 3-1, 5-1	CP 1/1 FOUNDATION™ H1	1,9	1, 2, 3-1, 4-1, 5-9, 6-9
		1, 3-1, 5-1	CP 1/2 FOUNDATION™ HSE	5	1, 5-5, 6-5
		1, 3-1	CP 1/3 FOUNDATION™ H2	1,9	1, 2, 3-1, 4-1, 5-9, 6-9
2	CIP™	1, 5-2	CP 2/1 ControlNet™	2	1, 2, 3-2, 4-2, 5-2, 6-2
		1, 2, 3-2, 5-2	CP 2/2 EtherNet/IP™	2	1, 4-2, 5-2, 6-2
		1, 3-2, 5-2	CP 2/3 DeviceNet™	2	1, 4-2, 5-2, 6-2
3	PROFIBUS & PROFINET	1, 3-3, 5-3	CP 3/1 PROFIBUS DP	3	1, 2, 3-3, 4-3, 5-3, 6-3
		1, 3-3, 5-3	CP 3/2 PROFIBUS PA	3	1, 2, 3-3, 4-3, 5-3, 6-3
		—	CP 3/3 Void	—	—
		2, 3-3, 5-3	CP 3/4 PROFINET IO CC-A	10	1, 5-10, 6-10
		2, 3-3, 5-3	CP 3/5 PROFINET IO CC-B	10	1, 5-10, 6-10
		2, 3-3, 5-3	CP 3/6 PROFINET IO CC-C	10	1, 5-10, 6-10
4	P-NET®	1, 5-4	CP 4/1 P-NET RS-485	4	1, 2, 3-4, 4-4, 5-4, 6-4
		—	CP 4/2 removed	—	—
		2, 5-4	CP 4/3 P-NET on IP	4	1, 3-4, 4-4, 5-4, 6-4
5	WorldFIP®	1	CP 5/1 WorldFIP	7	1, 2, 3-7, 4-7, 5-7, 6-7
		1	CP 5/2 WorldFIP with subMMS	7	1, 2, 3-7, 4-7, 5-7, 6-7
		1	CP 5/3 WorldFIP minimal for TCP/IP	7	1, 2, 3-7, 4-7, 5-7, 6-7
6	INTERBUS®	1, 3-6, 5-6	CP 6/1 INTERBUS	8	1, 2, 3-8, 4-8, 5-8, 6-8
		1, 3-6, 5-6	CP 6/2 INTERBUS TCP/IP	8	1, 2, 3-8, 4-8, 5-8, 6-8
		1, 3-6, 5-6	CP 6/3 INTERBUS subset of CP 6/1	8	1, 2, 3-8, 4-8, 5-8, 6-8
		2, 5-6	CP 6/4	8	1, 2, 3-8, 4-8, 5-8, 6-8, 5-10, 6-10
		2, 5-6	CP 6/5	8	
		2, 5-6	CP 6/6	8	
7	This CPF and the associated Type 6 are deleted for lack of market relevance.				
8	CC-Link	1, 3-8, 5-8	CP 8/1 CC-Link/V1	18	1, 2, 3-18, 4-18, 5-18, 6-18
		1, 5-8	CP 8/2 CC-Link/V2	18	1, 2, 3-18, 4-18, 5-18, 6-18
		1, 5-8	CP 8/3 CC-Link/LT	18	1, 2, 3-18, 4-18, 5-18, 6-18
		2, 5-8	CP 8/4 CC-Link IE Controller Network	23	1, 5-23, 6-23
		2, 5-8	CP 8/5 CC-Link IE Field Network	23	1, 5-23, 6-23
9	HART®	1	CP 9/1 HART	20	1, 2, 3-20, 4-20, 5-20, 6-20
		—	CP 9/2 WirelessHART® see IEC 62591, Clause 9	20	See IEC 62591
10	Vnet/IP	2, 5-10	CP 10/1 Vnet/IP	17	1, 2, 3-17, 4-17, 5-17, 6-17
11	TCnet	2, 5-11	CP 11/1 TCnet-star	11	1, 2, 3-11, 4-11, 5-11, 6-11
		2, 5-11	CP 11/2 TCnet-loop 100	11	1, 2, 3-11, 4-11, 5-11, 6-11

Communication Profiles in IEC 61784			Corresponding IEC 61158 types to CPs		
CPF	Technology name	IEC 61784 (Sub-)Parts	CP number	Type number	IEC 61158 (Sub-)Parts
		2, 5-11	CP 11/3 TCnet-loop 1G	11	1, 2, 3-11, 4-11, 5-11, 6-11
12	EtherCAT®	2, 3-12, 5-12	CP 12/1	12	1, 2, 3-12, 4-12, 5-12, 6-12
		2, 3-12, 5-12	CP 12/2	12	1, 2, 3-12, 4-12, 5-12, 6-12
13	Ethernet POWERLINK	2, 3-13, 5-13	CP 13/1 POWERLINK	13	1, 3-13, 4-13, 5-13, 6-13
14	EPA	2, 3-14, 5-14	CP 14/1 NRT	14	1, 3-14, 4-14, 5-14, 6-14
		2, 3-14, 5-14	CP 14/2 RT	14	1, 3-14, 4-14, 5-14, 6-14
		2, 5-14	CP 14/3 FRT	14	1, 3-14, 4-14, 5-14, 6-14
		2, 3-14, 5-14	CP 14/4 MRT	14	1, 3-14, 4-14, 5-14, 6-14
15	MODBUS®-RTPS	2, 5-15	CP 15/1 MODBUS TCP	15	1, 5-15, 6-15
		2, 5-15	CP 15/2 RTPS	15	1, 5-15, 6-15
16	SERCOS	1, 5-16	CP 16/1 SERCOS I	16	1, 2, 3-16, 4-16, 5-16, 6-16
		1, 5-16	CP 16/2 SERCOS II	16	1, 2, 3-16, 4-16, 5-16, 6-16
		2, 3-2, 5-16	CP 16/3 SERCOS III	19	1, 3-19, 4-19, 5-19, 6-19
17	RAPIEnet	2, 5-17	CP 17/1 RAPIEnet	21	1, 3-21, 4-21, 5-21, 6-21
18	SafetyNET p™	2, 3-18, 5-18	CP 18/1 SafetyNET p RTFL	22	1, 3-22, 4-22, 5-22, 6-22
		2, 3-18, 5-18	CP 18/2 SafetyNET p RTFN	22	1, 3-22, 4-22, 5-22, 6-22
19	MECHATROLINK	1, 5-19	CP 19/1 MECHATROLINK-II	24	1, 3-24, 4-24, 5-24, 6-24
		1, 5-19	CP 19/2 MECHATROLINK-III	24	1, 3-24, 4-24, 5-24, 6-24
NOTE The trademark and trade name declarations are given in Annex A.					

7.5 IEC 61784-3 functional safety communication profiles

7.5.1 General

The need to develop safety communications systems is the result of an industrial background where safety requirements have been driven by increasing legislation and market demands; to protect personnel, but also assets. Safety system development has historically followed a similar path to standard control system development, where programmable and networked equipment has fulfilled increasing complexity and flexibility requirements of automation applications. The development of safety networks has brought similar benefits to safety systems, including reduced wiring, ease of configuration and extended diagnostics capabilities.

7.5.2 General concepts and technology-specific profiles

The IEC 61784-3 series is divided into several parts, a generic one, and several technology specific parts:

- IEC 61784-3: Functional safety fieldbuses – General rules and profile definitions;
- IEC 61784-3-*n*: Functional safety fieldbuses – Additional specifications for CPF *n*.

IEC 61784-3 defines common principles for the transmission of safety-relevant messages among participants within a distributed network using fieldbus technology in accordance with the requirements of IEC 61508 series for functional safety. These mechanisms are intended to provide the necessary confidence in the transportation of information on a fieldbus in a safety-related system, or sufficient confidence of safe behavior in the event of fieldbus failures. They may be used in various industrial applications such as process control, manufacturing automation and machinery.