

# INTERNATIONAL STANDARD

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**Digital data communications  
for measurement and control –  
Fieldbus for use in industrial  
control systems –**

**Part 2:  
Physical layer specification  
and service definition**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

# DIGITAL DATA COMMUNICATIONS FOR MEASUREMENT AND CONTROL – FIELDBUS FOR USE IN INDUSTRIAL CONTROL SYSTEMS –

## Part 2: Physical Layer specification and service definition

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Type 2 (subclauses 5.3, 9.4, 10.4, Clauses 18 through 20, Annex F through Annex H):

5,396,197 [AB] Network Node TAP

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International Standard IEC 61158-2 has been prepared by subcommittee 65C: Digital communications, of IEC technical committee 65: Industrial-process measurement and control.

The third edition cancels and replaces the second edition published in 2000 and its amendment. This third edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/289/FDIS	65C/297/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.

This edition includes the following significant changes from the prior edition:

- a) specifications for Types 2, 4, 6 and 8 fieldbuses;
- b) specifications for asynchronous operation of Type 3 fieldbuses;
- c) specifications for increased data rates for Types 1 and 7 fieldbuses;
- d) reorganisation and consolidation of Clauses 11 and following of the prior editions
  - to coalesce those common clauses or subclauses whose primary difference was due to data rate, and
  - to eliminate redundant figures and tables from within the clauses.

The following table attempts to correlate the content of the clauses of Edition 1 and its amendments, and of Edition 2 and its amendment, with the clauses and subclauses of this edition:

Edition 1 and amendments	Edition 2	Edition 3
1	1	1
2	2	2
3	3	3.1, 3.2
4	4	4.1.1, 4.2.1, 4.2.2
5	5	5.1, 5.2
6	6	6.1, 6.2
7	7	7.1, 7.2
8	8	8.1, 8.2
9	9	9.1, 9.2
10	10	10.1, 10.2
11	11	21
12	12	11
13	13	13
14	14	11
Amendment 3: 15	15	16
Amendment 3: 16	16	15
Amendment 3: 17	17	15
Amendment 3: 18	18	15
Amendment 1: 18	19	9.3
Amendment 1: 19	20	10.3
Amendment 1: 20	21	17
Amendment 2: 21	23	14
Amendment 4: 22	22	12
Annex A: Bibliography	Bibliography	Bibliography
Annex B	Annex A	Annex A
Annex C	Annex B	Annex B
-	Annex C	Annex B
Amendment 3: Annex D	Annex D	Annex C
Amendment 3: Annex E	Annex E	Annex D
Amendment 3: Annex F	Annex F	Annex E

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 2007. At this date, the publication will be

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

IEC 61158 consists of the following parts, under the general title *Digital data communications for measurement and control – Fieldbus for use in industrial control systems*:

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

Part 2: *Physical Layer specification and service definition*

Part 3: *Data Link Service definition*

Part 4: *Data Link Protocol specification*

Part 5: *Application Layer Service definition*

Part 6: *Application Layer protocol specification*

The contents of the corrigendum of July 2004 have been included in this copy.

Withdrawn

## 0 Introduction

### 0.1 General

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components by fieldbus networks. It is related to other parts in the set as defined by the fieldbus Reference Model, which is based in principle on the Reference Model for Open Systems Interconnection. Both Reference Models subdivide the area of standardization for interconnection into a series of layers of specification, each of manageable size.

### 0.2 Fieldbus overview

A fieldbus is a digital, serial, multidrop, data bus for communication with industrial control and instrumentation devices such as -- but not limited to - transducers, actuators and local controllers. The Physical Layer specified in this International Standard provides for transparent transmission of data units between Data Link Layer entities across physical connections. The PhL provides services used by Data Link Protocol and Systems Management. The relationship between the fieldbus Data Link Layer standard, fieldbus Physical Service standard and Systems Management application is illustrated in Figure 1.

NOTE Systems Management, as used in this standard, is a local mechanism for managing the layer protocols.

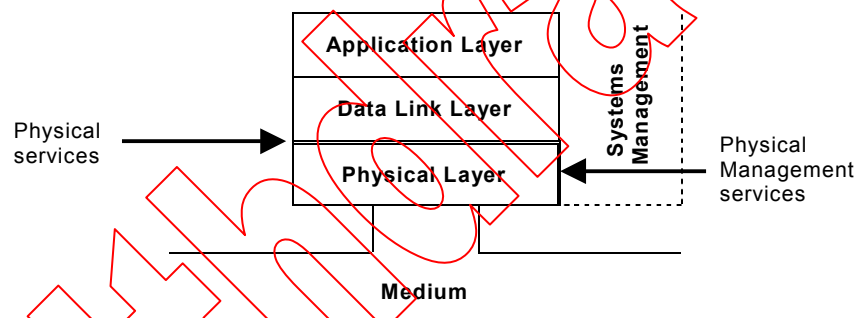


Figure 1 - Relationship of IEC 61158-2 to other fieldbus layers and to users of the fieldbus Physical layer service

### 0.3 Physical Layer overview

The primary aim of this International Standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer Ph-entities at the time of communication.

The Physical Layer receives data units from the Data Link Layer, encodes them, if necessary by adding communications framing information, and transmits the resulting physical signals to the transmission medium at one node. Signals are then received at one or more other node(s), decoded, if necessary by removing the communications framing information, before the data units are passed to the Data Link Layer of the receiving device.

### 0.4 Document overview

This International Standard comprises Physical Layer specifications corresponding to the different DL-Layer protocol types specified in IEC 61158-4.

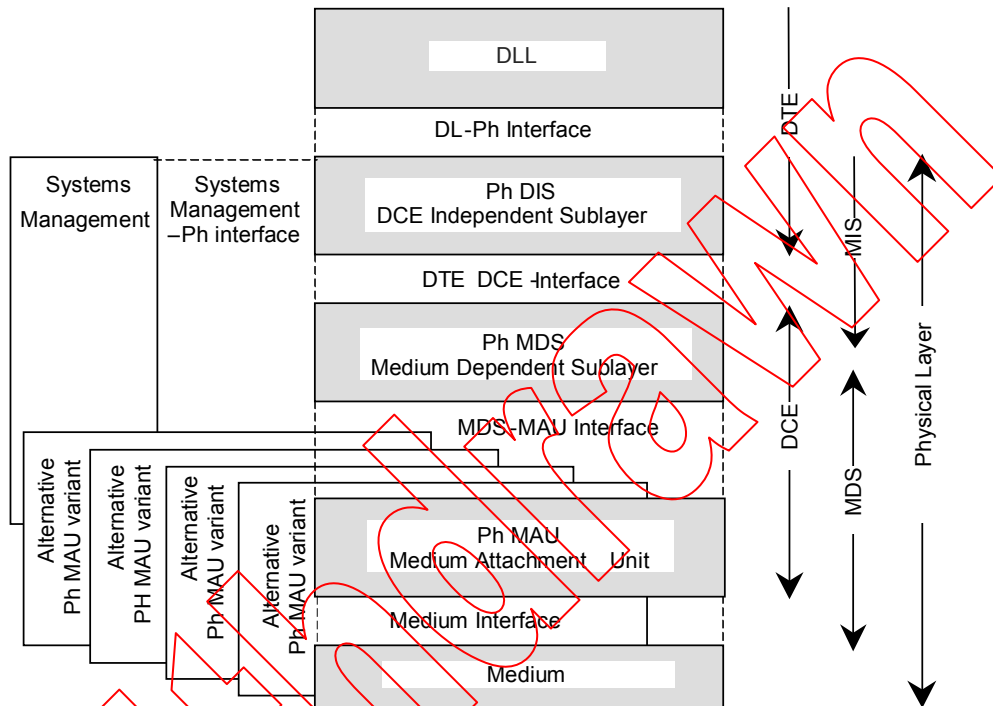
NOTE 1 The protocol type numbers used are consistent throughout the IEC 61158 parts.

NOTE 2 Specifications for Types 1, 2, 3, 4, 6 and 8 are included. Type 5 does not use any of the specifications given in this standard. Type 7 uses Type 1 specifications.

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 this International Standard to select for interworking sets of provisions. Refer to IEC 61784 for standardized communication profiles based on IEC 61158.

A general model of the Physical Layer is shown in Figure 2.



**Figure 2 – 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;
- no separate clock transmission;
- either half-duplex communication (bi-directional but in only one direction at a time) or full-duplex communication



## **0.5 Major Physical Layer variations specified in this part of IEC 61158**

### **0.5.1 Type 1 media**

#### **0.5.1.1 Type 1: twisted-pair wire, optical and radio media**

For twisted-pair wire media, Type 1 specifies two modes of coupling and different signalling speeds as follows:

- a) voltage mode (parallel coupling), 150  $\Omega$ , data rates from 31,25 kbit/s to 25 Mbit/s;
- b) voltage mode (parallel coupling), 100  $\Omega$ , 31,25 kbit/s;
- c) current mode (serial coupling), 1,0 Mbit/s including two current options.

The voltage mode variations may be implemented with inductive coupling using transformers. This is not mandatory if the isolation requirements of this part of IEC 61158 are met by other means.

The Type 1 twisted-pair (or untwisted-pair) wire medium Physical Layer provides the options:

- no power via the bus conductors; not intrinsically safe;
- power via the bus conductors; not intrinsically safe;
- no power via the bus conductors; intrinsically safe;
- power via the bus conductors; intrinsically safe.

#### **0.5.1.2 Type 1: optical media**

The major variations of the Type 1 optic fibre media are as follows:

- dual fibre mode, data rates from 31,25 kbit/s to 25 Mbit/s;
- single fibre mode, 31,25 kbit/s.

#### **0.5.1.3 Type 1: radio media**

The Type 1 radio medium specification provides a 4,8 kbit/s bit rate.

### **0.5.2 Type 2: coaxial wire and optical media**

Type 2 specifies the following variants:

- coaxial copper wire medium, 5 Mbit/s
- optical fibre medium, 5 Mbit/s
- Network Access Port (NAP), a point-to-point temporary attachment mechanism that can be used for programming, configuration, diagnostics or other purposes
- Repeater machine sublayers (RM, RRM) and redundant Physical Layers.

### **0.5.3 Type 3: twisted-pair wire and optical media**

Type 3 specifies the following synchronous transmission:

- a) twisted-pair wire medium, 31,25 kbit/s, voltage mode (parallel coupling) with the options:
  - power via the bus conductors: not intrinsically safe
  - power via the bus conductors: intrinsically safe

and the following asynchronous transmission variants:

- b) twisted-pair wire medium, up to 12 Mbit/s, ANSI TIA/EIA-485-A
- c) optical fibre medium, up to 12 Mbit/s

#### **0.5.4 Type 4: wire medium**

Type 4 specifies wire media with the following characteristics:

- RS-485 wire medium up to 76,8 kbit/s
- RS-232 wire medium up to 230,4 kbit/s

#### **0.5.5 Type 6: wire medium**

Type 6 specifies wire media with the following characteristics:

- RS 485 wire medium up to 5 Mbit/s

The characteristics for wire media are as follows:

- half-duplex communication (bi-directional but in only one direction at a time)
- Manchester coding

#### **0.5.6 Type 8: twisted-pair wire and optical media**

The Physical Layer also allows transmitting data units that have been received through a medium access by the transmission medium directly through another medium access and its transmission protocol to another device.

Type 8 specifies the following variants:

- twisted-pair wire medium, up to 16 Mbit/s;
- optical fibre medium, up to 16 Mbit/s;

The general characteristics of these transmission media are as follows:

- full-duplex transmission
- Non Return to Zero (NRZ) coding

The wire media type provides the following options:

- No power supply via the bus cable, not intrinsically safe
- Power supply via the bus cable and on additional conductors, not intrinsically safe

## DIGITAL DATA COMMUNICATIONS FOR MEASUREMENT AND CONTROL – FIELDBUS FOR USE IN INDUSTRIAL CONTROL SYSTEMS –

### Part 2: Physical Layer specification and service definition

#### 1 Scope

This part of IEC 61158 specifies the requirements for fieldbus component parts. It also specifies the media and network configuration requirements necessary to ensure agreed levels of

- a) data integrity before Data Link Layer error checking;
- b) interoperability between devices at the Physical Layer.

The fieldbus Physical Layer conforms to layer 1 of the OSI 7-layer model as defined by ISO 7498 with the exception that, for some types, frame delimiters are in the Physical Layer while for other types they are in the Data Link Layer .

Withdrawn

## 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.

IEC 60050(131):1978, *International Electrotechnical Vocabulary (IEV) – Chapter 131: Electric and magnetic circuits*

IEC 60050-731:1991, *International Electrotechnical Vocabulary, Chapter 731: optical fibre communication*

IEC 60079, *Electrical apparatus for explosive gas atmospheres*

IEC 60079-11, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety “i”*

IEC 60079-27, *Electrical apparatus for explosive gas atmospheres – Part 27: Fieldbus intrinsically safe concept (FISCO)*

IEC 60096-1, *Radio-frequency cables – Part 1: General requirements and measuring methods*

IEC 60169-8, *Radio-frequency connectors – Part 8: RF coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with bayonet lock – Characteristic impedance 50 ohms (Type BNC)*

IEC 60189-1:1986, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60255-22-1:1988, *Electrical relays – Part 22-1: Electrical disturbance tests for measuring relays and protection equipment – 1 MHz burst disturbance tests*

IEC 60364-4-41, *Electrical installations of buildings – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60603-7, *Connectors for frequencies below 3 MHz for use with printed boards – Part 7: Detail specification for connectors, 8-way, including fixed and free connectors with common mating features, with assessed quality*

IEC 60760, *Flat, quick-connect terminations*

IEC 60793-2:2001, *Optical fibres – Part 2: Product specifications*

IEC 60807-3, *Rectangular connectors for frequencies below 3 MHz – Part 3: Detail specification for a range of connectors with trapezoidal shaped metal shells and round contacts – Removable crimp contact types with closed crimp barrels, rear insertion/rear extraction*

IEC 60874, *Connectors for optical fibres and cables*

IEC 60874-2, *Connectors for optical fibres and cables – Part 2: Sectional specification for fibre optic connector – Type F-SMA*

IEC 60874-7, *Connectors for optical fibres and cables — Part 7: Sectional specification for fibre optic connector - Type FC*

IEC 60874-10-1, *Connectors for optical fibres and cables — Part 10-1: Detail specification for fibre optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 60947-5-2, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*

IEC 61000-4, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques — Part 4-2: Electrostatic discharge immunity test – Basic EMC Publication*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques — Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques — Part 4-4: Electrical fast transient/burst immunity test – Basic EMC Publication*

IEC 61131-2:1992, *Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61156-1:1994, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61158, *Digital data communications for measurement and control – Fieldbus for use in industrial control systems*

IEC 61158-3:2003, *Digital data communications for measurement and control – Fieldbus for use in industrial control systems — Part 3: Data Link Service definition*

IEC 61158-4:2003, *Digital data communications for measurement and control – Fieldbus for use in industrial control systems — Part 4: Data Link protocol specification*

IEC 61300-34:2001, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

IEC 61754-2, *Fibre optic connector interfaces – Part 2: Type BFOC/2,5 connector family*

ISO/IEC 7498 (all parts), *Information technology – Open Systems Interconnection – Basic Reference Model*

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

ANSI TIA/EIA-232-F, *Interface Between Data Terminal Equipment and Data Circuit – Terminating Equipment Employing Serial Binary Data Interchange*

ANSI TIA/EIA-422-B, *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*

ANSI TIA/EIA-485-A, *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

IEEE Std 100:1996, *The IEEE Standard Dictionary of Electrical and Electronics Terms*