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NORME INTERNATIONALE

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Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 2: Spécification et définition des services de la couche physique



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 2: Physical layer specification and service definition

FOREWORD

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

IEC 61158-2 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 seventh edition cancels and replaces the sixth edition published in 2014. This edition constitutes a technical revision.

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

a) Type 12 added power option to 100BASE-TX in Clause 29;
b) enhanced Type 24 specification in Clause 33, Annex S and Annex U;
c) new Type 28 specification;
d) LVDS wire medium up to 100 Mbit/s of Type 12 is removed.

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

Draft	Report on voting
65C/1200/FDIS	65C/1241/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.

NOTE 2 Slight variances from the directives have been allowed by the IEC Central Office to provide continuity of subclause numbering with prior editions.

A 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.

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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

0 INTRODUCTION

0.1 General

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.

0.2 Physical layer overview

The primary aim of this document 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.

0.3 Document overview

This document comprises physical layer specifications corresponding to many of the different DL-Layer protocol Types specified in IEC 61158 series.

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

NOTE 2 Specifications for Types 1, 2, 3, 4, 8, 12, 16, 18, 20, 24 and 28 are included. Type 7 uses Type 1 specifications. The other Types do not use any of the specifications given in this document.

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 document to select interoperating sets of provisions. Refer to the IEC 61784-1 series or the IEC 61784-2 series for standardized communication profiles based on the IEC 61158 series.

A general model of the physical layer is shown in Figure 1.

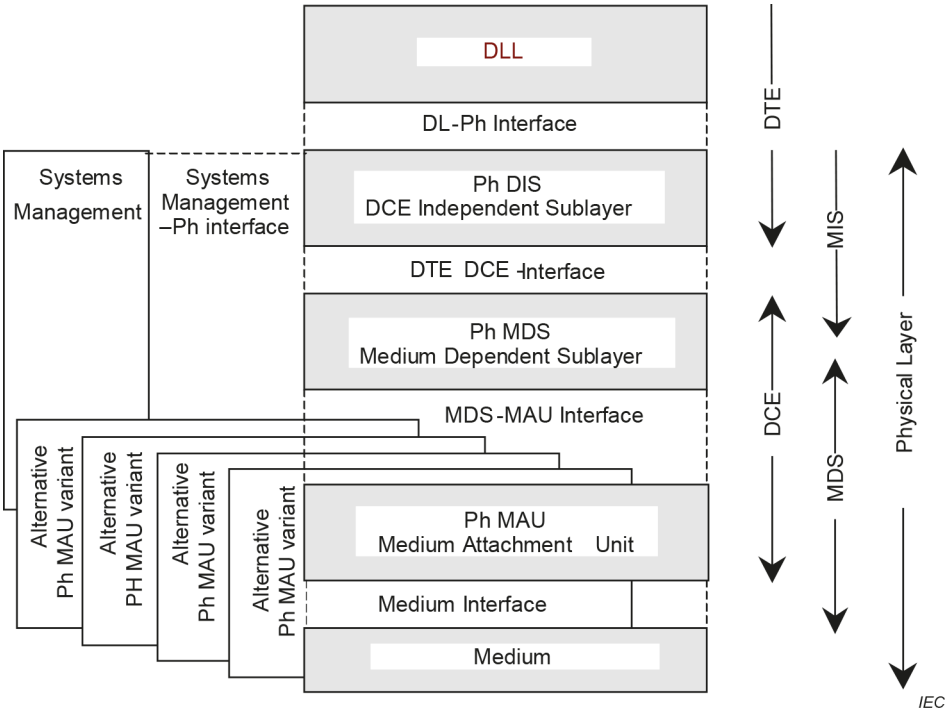


Figure 1 – General model of physical layer

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.

0.4 Major physical layer variations specified in this document

0.4.1 Type 1 media

0.4.1.1 Type 1: Wire media

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

a) voltage mode (parallel coupling), 150 Ω, data rates from 31,25 kbit/s to 25 Mbit/s;
b) voltage mode (parallel coupling), 100 Ω, 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 document 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.

0.4.1.2 Type 1: Optical media

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

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

0.4.2 Type 2: Coaxial wire and optical media

Type 2 specifies the following variants:

– coaxial copper wire medium, 5 Mbit/s;
– optical fiber 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.

0.4.3 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, TIA-485-A;

c) optical fiber medium, up to 12 Mbit/s, with fiber type A4a of IEC 60793-2-40 and fiber type A3c of IEC 60793-2-30.

0.4.4 Type 4: Wire medium

Type 4 specifies wire media with the following characteristics:

– RS-485 wire medium up to 76,8 kbit/s;

0.4.5 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 fiber 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.

0.4.6 Type 12: Wire medium

Type 12 specifies wire media with the following characteristics:

– two pair of wires carrying two separate power supply channels combined with signal transmission.

0.4.7 Type 16: optical media

Type 16 specifies a synchronous transmission using optical fiber medium, at 2 Mbit/s, 4 Mbit/s, 8 Mbit/s and 16 Mbit/s.

0.4.8 Type 18: Media

0.4.8.1 Type 18: Basic media

The Type 18-PhL-B specifies a balanced transmission signal over a shielded 3-core twisted cable. Communication data rates as high as 10 Mbit/s and transmission distances as great as 1,2 km are specified.

0.4.8.2 Type 18: Powered media

The Type 18-PhL-P specifies a balanced transmission signal over a 4-core unshielded cable in both flat and round configurations with conductors specified for communications signal and network-embedded power distribution. Communication data rates as high as 2,5 Mbit/s and transmission distances as great as 500 m are specified.

0.4.9 Type 20: Media

Type 20 uses binary phase continuous Frequency Shift Keying (FSK). A relatively high frequency current is superimposed on a low-frequency analog current, which is usually in 4 mA to 20 mA range. The digital signal and analog signal share the same medium, but differ in frequency contents. The communicating devices signal with either current or voltage, and all signaling appear as voltage when sensed across low impedance. Thus, digital signaling is an extension of conventional analog signaling.

The physical layer commonly uses twisted pair copper cable as its medium and provides solely digital or simultaneous digital and analog communication to distances of at least 1 500 m (ca. 5 000 feet). Maximum communication distances vary depending on network construction and environmental conditions.

0.4.10 Type 24: Media

0.4.10.1 Type 24: Basic media

Type 24 specifies twisted-pair wire medium. The general characteristics of this transmission medium are as follows:

– TIA-485-A bus interface with galvanic isolation using transformer;
– up to 10 Mbit/s;
– half-duplex transmission;
– Manchester coding.

0.4.10.2 Type 24: Powered media

The powered media type provides the following options:

– TIA-485-A bus interface without galvanic isolation using transformer;
– up to 32 Mbit/s;
– half-duplex transmission;
– Manchester coding or NRZI coding;
– power via the bus conductors.

0.4.11 Type 28: Media

Type 28 uses Orthogonal Frequency Division Multiplexing (OFDM) technology. The frequency subcarrier ranges from 1,536 MHz to 32,256 MHz. The transmission distances are up to 500 m on a single bus. The analog signal shall be delivered on the medium that connected to each device in network.

Type 28 specifies the following synchronous transmission:

a) twisted-pair wire medium, up to 100 Mbit/s;
b) coaxial wire medium, up to 100 Mbit/s.

The general characteristics of these transmission media are as follows:

a) full-duplex transmission;
b) OFDM coding.

0.5

Patent declaration

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

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/IEC 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.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE All parts of the IEC 61158 series, as well as the IEC 61784-1 series and the IEC 61784-2 series are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-14:2007[1], *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60079-25, *Explosive atmospheres – Part 25: Intrinsically safe electrical systems*

IEC 60169-17, *Radio-frequency connectors – Part 17: R.F. coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with screw coupling – Characteristic impedance 50 ohms (Type TNC)*

IEC 60189-1:2018, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60255-22-1:1988[2], *Electrical relays – Part 22-1: Electrical disturbance tests for measuring relays and protection equipment – Section 1: 1 MHz burst disturbance tests*

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1 A 2013 edition exists but the listed edition applies.

2 This publication was withdrawn.

IEC 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

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

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

IEC 60603-7-4, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60754-2, *Test on gases evolved during combustion of materials from cables – Part 2: Determination of acidity (by pH measurement) and conductivity*

IEC 60793 (all parts), *Optical fibres*

IEC 60793-2:2019, *Optical fibres – Part 2: Product specifications – General*

IEC 60793-2-30:2015, *Optical fibres – Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres*

IEC 60793-2-40:2021, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

IEC 60794-1-2:2003[3], *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

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 60811-403, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds*

IEC 60811-404:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

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

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

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 44: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61076-2-114:2020, *Connectors for electrical and electronic equipment – Product requirements – Part 2-114: Circular connectors – Detail specification for connectors with M8 screw- locking with power contacts and signal contacts for data transmission up to 100 MHz*

IEC 61131-2:2017, *Industrial-process measurement and control − Programmable controllers – Part 2: Equipment requirements and tests*

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[3] There exists a new edition of IEC 60794-1-2 (2021). Cross-references to 2003 version is described in informative Annex A.

IEC 61156-1:2007, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61158-3-20:2023, *Industrial communication networks – Fieldbus specifications – Part 3-20: Data-link layer service definition – Type 20 elements*

IEC 61158-4-2:2023, *Industrial communication networks – Fieldbus specifications – Part 4-2: Data-link protocol specification – Type 2 elements*

IEC 61158-4-3:2019, *Industrial communication networks – Fieldbus specifications – Part 4-3: Data-link protocol specification – Type 3 elements*

IEC 61169-8:2007, *Radio-frequency connectors – Part 8: Sectional specification – RF coaxial connectors with inner diameter of outer conductor 6,5 mm (0,256 in) with bayonet lock – Characteristic impedance 50 Ω (type BNC)*

IEC 61210:2010, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

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

IEC 61754-13, *Fibre optic connector interfaces – Part 13: Type FC-PC connector*

IEC 61754-22, *Fibre optic connector interfaces – Part 22: Type F-SMA connector family*

IEC 63171, *Connectors for electrical and electronic equipment − Shielded or unshielded free and fixed connectors for balanced single-pair data transmission with current carrying capacity – General requirements and tests*

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

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 8482, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

ISO/IEC/IEEE 8802-3:2021, *Telecommunications and information exchange between systems – Requirements for local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

ISO 9314-1, *Information processing systems – Fibre Distributed Data Interface (FDDI) Part 1: Token Ring Physical Layer Protocol (PHY)*

ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

ISO 4892-1, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

TIA-422-B:1994, *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*

TIA-485-A:1998, *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions of the ISO/IEC 7498 series, and the following definitions 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 Common terms and definitions

NOTE Many definitions are common to more than one protocol type; they are not necessarily used by all protocol types.

3.1.1
activity
presence of a signal or noise at the input terminals of a fieldbus device that is of a level that is above the receiver signal level threshold of that device

3.1.2
barrier
physical entity that limits current and voltage into a hazardous area in order to satisfy intrinsic safety requirements

3.1.3
bit
unit of data consisting of a 1 or a 0

Note 1 to entry: A bit is the smallest data unit that can be transmitted.

3.1.4
bus
trunk and all devices connected to it

3.1.5
cable plant interface connector
CPIC
point at which test and conformance measurements are made and that the interface between the network device and the cable plant

3.1.6
communication element
part of a fieldbus device that communicates with other elements via the bus

3.1.7
connector
coupling device employed to connect the medium of one circuit or communication element with that of another circuit or communication element

3.1.8
coupler
physical interface between trunk and spur or trunk and device

3.1.9
Data Communications Equipment
DCE
embodiment of the media, modulation and coding-dependent portion of a fieldbus-connected device, comprising the lower portions of the physical layer within the device

3.1.10
Data Terminal Equipment
DTE
embodiment of the media, modulation and coding-independent portion of a fieldbus-connected device, comprising the uppermost portion of the physical layer and all higher layers within the device

3.1.11
decibel(milliwatt)
dB(mW)
logarithmic unit of power, referenced to 1 mW

$$P_{dBm} = 10 \log (P_{mW})$$

Note 1 to entry: db(mW) is also written dBm.

Note 2 to entry: If P_{mW} is the measured power in mW, then P_{dBm} is the power expressed logarithmically in dB(mW), or equivalently, dBm.

3.1.12
delimiter
flag that separates and organizes items of data

3.1.13
device
physical entity connected to the fieldbus composed of at least one communication element (the network element) and which may have a control element and/or a final element (transducer, actuator, etc.)

Note 1 to entry: A device may contain more than one node.

3.1.14
effective launch power
effective power coupled into the core of a fiber optic waveguide by the transmitter

Note 1 to entry: Effective launch power is measured with a standard test fiber connected to the CPIC.

3.1.15
effective power
the difference, expressed in dBm, between the absolute optical power measured in milliwatt at the midpoint in time of the Hi level to the absolute optical power measured in milliwatt at the midpoint of the Lo level

Note 1 to entry: Effective power is believed to give a more accurate measurement of the conditions that affect the receivers than traditional measurements, such as peak and average power. methods for measuring effective power are for further study.

3.1.16
error
discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

3.1.17
extinction ratio
ratio of the absolute optical power measured in milliwatt at the midpoint in time of the Hi level to the absolute optical power measured in milliwatt at the midpoint in time of the Lo level.

Note 1 to entry: The following gives an example of the computation of effective power and extinction ratio. If the midpoint of Hi level is measured as 105 µW, and if the midpoint of Lo level is measured as 5 µW, then the difference is 100 µW. Therefore, the effective power is 10 log ((100 µW) / 1 mW)), which equals −10,0 dBm. The extinction ratio is (105/5), which equals 21:1.

3.1.18
fiber optic cable
cable containing one or more fiber optic waveguides with jacketing material provided to facilitate handling and to protect the fiber

3.1.19
fiber optic receiver
combined optics and electronics in the communicating device that accept the optical signal received by the communicating device through the CPIC

3.1.20
fiber optic receiver operating range
range of optical power that has to be present at the CPIC to ensure that the bit error rate specifications are met

3.1.21
fiber optic transmitter
device that emits optical signals for propagation into a fiber optic waveguide through the CPIC

3.1.22
fiber optic waveguide
flexible, optically transparent strand that is used to transport optical signals from one geographic point to another geographic point

3.1.23
frame
set of consecutive digit time slots in which the position of each digit time slot can be identified by reference to a framing signal

3.1.24
intrinsic safety
design methodology for a circuit or an assembly of circuits in which any spark or thermal effect produced under normal operating and specified fault conditions is not capable under prescribed test conditions of causing ignition of a given explosive atmosphere

3.1.25
isolation
physical and electrical arrangement of the parts of a signal transmission system to prevent electrical interference currents within or between the parts

3.1.26
jabber
continuous transmission on the medium due to a faulty device

3.1.27
jitter
offset of the 50 % transition points of pulse edges from their ideal position as the result of all causes

3.1.28
Manchester encoding
means by which separate data and clock signals can be combined into a single, self-synchronizing data stream, suitable for transmission on a serial channel

3.1.29
medium
cable, optical fiber, or other means by which communication signals are transmitted between two or more points

Note 1 to entry: In this part of IEC 61158, "media" is used only as the plural of medium.

3.1.30
network
all of the media, connectors, repeaters, routers, gateways and associated node communication elements by which a given set of communicating devices are interconnected

3.1.31
node
end-point of a branch in a network or a point at which one or more branches meet

3.1.32
optical active star
active device in which a signal from an input fiber is received, amplified and retransmitted to a larger number of output optical fibers

Note 1 to entry: Retiming of the received signal is optional.

3.1.33
optical fall time
time it takes for a pulse to go from 90 % effective power to 10 % effective power, specified as a per cent of the nominal bit time

3.1.34
optical passive star
passive device in which signals from input fibers are combined and then distributed among output optical fibers

3.1.35
optical rise time
time it takes for a pulse to go from 10 % effective power to 90 % effective power, specified as a per cent of the nominal bit time

3.1.36
peak emission wavelength
λp
wavelength at which radiant intensity is maximized

3.1.37
receiver
receive circuitry of a communication element

3.1.38
repeater
two-port active physical layer device that receives and retransmits all signals to increase the distance and number of devices for which signals can be correctly transferred for a given medium

3.1.39
segment
trunk-cable section of a fieldbus that is terminated in its characteristic impedance

Note 1 to entry: Segments are linked by repeaters within a logical link and by bridges to form a fieldbus network.

3.1.40
separately powered device
device that does not receive its operating power via the fieldbus signal conductors

3.1.41
shield
surrounding earthed metallic layer to confine the electric field within the cable and to protect the cable from external electrical influence

Note 1 to entry: Metallic sheaths, armours and earthed concentric conductors may also serve as a shield.

3.1.42
spur
branch-line (i.e. a link connected to a larger one at a point on its route) that is a final circuit

Note 1 to entry: The alternative term 'drop cable' is used in this document.

3.1.43
terminator
resistor connecting conductor pairs at both ends of a wire medium segment to prevent reflections from occurring at the ends of cables

Note 1 to entry: For Type 2 the terminator is mounted in a BNC or TNC plug.

3.1.44
transceiver
combination of receiving and transmitting equipment in a common housing employing common circuit components for both transmitting and receiving

Note 1 to entry: A medium attachment unit can be the transceiver or can contain the transceiver, depending on Type and implementation.

[SOURCE: IEEE Std 100-1996 modified for non-radio use]

3.1.45
transmitter
transmit circuitry of a communication element

3.1.46
trunk
main communication highway acting as a source of main supply to a number of other lines (spurs)

3.1.47
typical half-intensity wavelength
$\Delta\lambda$
range of wavelength of spectral distribution in which the radiant intensity is no less than one-half of the maximum intensity

3.2 Type 1: Terms and definitions

3.2.1
activity
[SEE: 3.1.1]

3.2.2
barrier
[SEE: 3.1.2]

3.2.3
bus
[SEE: 3.1.4]

3.2.4
cable plant interface connector
CPIC
[SEE: 3.1.5]

3.2.5
communication element
[SEE: 3.1.6]

3.2.6
connector
[SEE: 3.1.7]

3.2.7
coupler
[SEE: 3.1.8]

3.2.8
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.2.9
Data Terminal Equipment
DTE
[SEE: 3.1.10]

3.2.10
dBm
[SEE: 3.1.11]

3.2.11
delimiter
[SEE: 3.1.12]

3.2.12
device
[SEE: 3.1.13]

3.2.13
effective launch power
[SEE: 3.1.14]

3.2.14
effective power
[SEE: 3.1.15]

3.2.15
fiber optic cable
[SEE: 3.1.18]

3.2.16
fiber optic receiver
[SEE: 3.1.19]

3.2.17
fiber optic receiver operating range
[SEE: 3.1.20]

3.2.18
fiber optic transmitter
[SEE: 3.1.21]

3.2.19
fiber optic waveguide
[SEE: 3.1.22]

3.2.20
frame
[SEE: 3.1.23]

3.2.21
intrinsic safety
[SEE: 3.1.24]

3.2.22
isolation
[SEE: 3.1.25]

3.2.23
jabber
[SEE: 3.1.26]

3.2.24
Manchester encoding
[SEE: 3.1.28]

3.2.25
medium
[SEE: 3.1.29]

3.2.26
network
[SEE: 3.1.30]

3.2.27
node
[SEE: 3.1.31]

3.2.28
optical fall time
[SEE: 3.1.33]

3.2.29
optical rise time
[SEE: 3.1.35]

3.2.30
peak emission wavelength
λp
[SEE: 3.1.36]

3.2.31
repeater
[SEE: 3.1.38]

3.2.32
segment
[SEE: 3.1.39]

3.2.33
separately powered device
[SEE: 3.1.40]

3.2.34
shield
[SEE: 3.1.41]

3.2.35
spur
[SEE: 3.1.42]

3.2.36
terminator
[SEE: 3.1.43]

3.2.37
transceiver
[SEE: 3.1.44]

3.2.38
transmitter
[SEE: 3.1.45]

3.2.39
trunk
[SEE: 3.1.46]

3.3 Type 2: Terms and definitions

3.3.1
activity
[SEE: 3.1.1]

3.3.2
bit
[SEE: 3.1.3]

3.3.3
blanking or blanking time
length of time required after transmitting before a node is allowed to receive

3.3.4
bus
[SEE: 3.1.4]

3.3.5
communication element
[SEE: 3.1.6]

3.3.6
connector
[SEE: 3.1.7]

3.3.7
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.3.8
dBm
[SEE: 3.1.11]

3.3.9
delimiter
[SEE: 3.1.12]

3.3.10
device
[SEE: 3.1.13]

3.3.11
end delimiter
unique sequence of symbols that identifies the end of a frame

3.3.12
end node
producing or consuming node

3.3.13
error
[SEE: 3.1.16]

3.3.14
frame
[SEE: 3.1.23]

3.3.15
isolation
[SEE: 3.1.25]

3.3.16
jabber
[SEE: 3.1.26]

3.3.17
Manchester encoding
[SEE: 3.1.28]

3.3.18
medium
[SEE: 3.1.29]

3.3.19
M_symbol
representation of the MAC data bits to be encoded and transmitted by the physical layer

3.3.20
MAC frame
collection of M_symbols transmitted on the medium that contains a preamble, start delimiter, data, CRC and end delimiter

3.3.21
network
[SEE: 3.1.30]

3.3.22
network access port
physical layer variant that allows a temporary node to be connected to the link by connection to the NAP of a permanent node

3.3.23
node
[SEE: 3.1.31]

Note 1 to entry: A node is additionally a connection to a link that requires a single M_ID.

3.3.24
non-data symbol
physical layer Manchester coded signal, used for delimiters, carrying no data

3.3.25
optical isolators, optos
components located within the physical layer transceiver of a node that converts current into light, and then back to an electrical signal

3.3.26
permanent node
node whose connection to the network does not utilize the network access port (NAP) physical layer variant

Note 1 to entry: This node may optionally support a NAP physical layer variant to allow temporary nodes to connect to the network.

3.3.27
redundant media
more than one medium to minimize communication failures

3.3.28
repeater
[SEE: 3.1.38]

3.3.29
segment
[SEE: 3.1.39]

3.3.30
shield
[SEE: 3.1.41]

3.3.31
slot time
maximum time required for detecting an expected transmission

Note 1 to entry: Each node waits a slot time for each missing node during the implied token pass.

3.3.32
spur
[SEE: 3.1.42]

Note 1 to entry: This is an integral part of network taps.

3.3.33
start delimiter
unique sequence of symbols that identifies the beginning of a frame

3.3.34
tap
point of attachment from a node or spur to the trunk cable

Note 1 to entry: A tap provides easy removal of a node without disrupting the link.

3.3.35
terminator
[SEE: 3.1.43]

3.3.36
tool
executable software program that interacts with the user to perform some function

3.3.37
transceiver
[SEE: 3.1.44]

3.3.38
transient node
node that is only intended to be connected to the network on a temporary basis using the NAP physical layer medium connected to the NAP of a permanent node

3.3.39
transmitter
[SEE: 3.1.45]

3.3.40
trunk
[SEE: 3.1.46]

3.3.41
trunk cable
bus or central part of a cable system

3.3.42
trunk-cable section
length of trunk cable between any two taps

3.4 Type 3: Terms and definitions

3.4.1
activity
[SEE: 3.1.1]

3.4.2
barrier
[SEE: 3.1.2]

3.4.3
bit time
time to transmit one bit

3.4.4
bus
[SEE: 3.1.4]

3.4.5
communication element
[SEE: 3.1.6]

3.4.6
confirmation (primitive)
[SOURCE: ISO/IEC 10731:1994]

3.4.7
connector
[SEE: 3.1.7]

3.4.8
coupler
[SEE: 3.1.8]

3.4.9
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.4.10
Data Terminal Equipment
DTE
[SEE: 3.1.10]

3.4.11
dBm
[SEE: 3.1.11]

3.4.12
device
[SEE: 3.1.13]

3.4.13
DL-entity
active element within an DL-subsystem embodying a set of capabilities defined for the DL-layer that corresponds to a specific DL-entity-type (without any extra capabilities being used)

[SOURCE: ISO/IEC 7498-1:1994, 5.2.1.11, modified – (N) replaced by DL for the data link layer.]

3.4.14
fiber optic cable
FOC
[SEE: 3.1.18]

3.4.15
frame
[SEE: 3.1.23]

3.4.16
indication (primitive)

[SOURCE: ISO/IEC 10731:1994]

3.4.17
intrinsic safety
[SEE: 3.1.24]

3.4.18
isolation
[SEE: 3.1.25]

3.4.19
jabber
[SEE: 3.1.26]

3.4.20
medium
[SEE: 3.1.29]

3.4.21
(N)-entity
active element within an (N)-subsystem embodying a set of capabilities defined for the(N)-layer that corresponds to a specific (N)-entity-type (without any extra capabilities being used)

[SOURCE: ISO/IEC 7498-1:1994, 5.2.1.11]

3.4.22
(N)-service

[SOURCE: ISO/IEC 7498-1:1994, 5.2.1.5]

3.4.23
network
[SEE: 3.1.30]

3.4.24
node
[SEE: 3.1.31]

3.4.25
Ph-entity
active element within an DL-subsystem embodying a set of capabilities defined for the DL-layer that corresponds to a specific DL-entity-type (without any extra capabilities being used)

[SOURCE: ISO/IEC 7498-1:1994, 5.2.1.11, modified – (N) replaced by Ph for the physical layer.]

3.4.26
Ph-service
capability of the Ph-layer and the layers beneath it, which is provided to DL-entities at the boundary between the Ph-layer and the DL-layer

[SOURCE: ISO/IEC 7498-1:1994, 5.2.1.5, modified – (N) replaced by Ph for the physical layer.]

3.4.27
repeater
[SEE: 3.1.38]

3.4.28
request (primitive)

[SOURCE: ISO/IEC 10731:1994]

3.4.29
reset

[SOURCE: ISO/IEC 7498-1:1994, 5.8.1.17]

3.4.30
segment
[SEE: 3.1.39]

3.4.31
separately powered device
[SEE: 3.1.40]

3.4.32
shield
[SEE: 3.1.41]

3.4.33
spur
[SEE: 3.1.42]

3.4.34
station
node

3.4.35
terminator
[SEE: 3.1.43]

3.4.36
transceiver
[SEE: 3.1.44]

3.4.37
transmitter
[SEE: 3.1.45]

3.4.38
trunk
[SEE: 3.1.46]

3.5 Type 4: Terms and definitions

3.5.1
activity
[SEE: 3.1.1]

3.5.2
bus
[SEE: 3.1.4]

3.5.3
connector
[SEE: 3.1.7]

3.5.4
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.5.5
Data Terminal Equipment
DTE
[SEE: 3.1.10]

3.5.6
device
[SEE: 3.1.13]

3.5.7
idle counter
counter to measure the number of bit periods for which the signal level on the physical link has been high for normal class and simple class devices in half duplex mode

3.5.8
isolation
[SEE: 3.1.25]

3.5.9
medium
[SEE: 3.1.29]

3.5.10
network
[SEE: 3.1.30]

3.5.11
normal class device
device that initiates transmission and replies to requests and that can act as a server (responder) and as a client (requestor) (also called a peer)

3.5.12
shield
[SEE: 3.1.41]

3.5.13
simple class device
device that replies to requests from Normal Class Devices and acts as a server or responder only

3.5.14
transmitter
[SEE: 3.1.45]

3.6 Void

NOTE Subclause 3.6 is a placeholder in this edition to minimize the disruption to existing national and multi-national standards and consortia documents that reference the subclause numbering of the prior edition.

3.7 Type 8: Terms and definitions

3.7.1
activity
[SEE: 3.1.1]

3.7.2
bus coupler
device that divides the ring into segments by opening the ring and integrating another ring at this point

3.7.3
cable plant interface connector
CPIC
[SEE: 3.1.5]

3.7.4
communication element
[SEE: 3.1.6]

3.7.5
connector
[SEE: 3.1.7]

3.7.6
dBm
[SEE: 3.1.11]

3.7.7
effective launch power
[SEE: 3.1.14]

3.7.8
effective power
[SEE: 3.1.15]

3.7.9
fiber optic cable
[SEE: 3.1.18]

3.7.10
fiber optic receiver
[SEE: 3.1.19]

3.7.11
fiber optic receiver operating range
[SEE: 3.1.20]

3.7.12
fiber optic transmitter
[SEE: 3.1.21]

3.7.13
fiber optic waveguide
[SEE: 3.1.22]

3.7.14
frame
[SEE: 3.1.23]

3.7.15
incoming interface
interface to receive data from the previous device and to send data, which are received via an outgoing interface, to the previous device

3.7.16
isolation
[SEE: 3.1.25]

3.7.17
local bus
ring segment of a network with alternate media specifications, which is coupled to a remote bus via the bus coupler

3.7.18
local bus device
device that operates as a slave on a local bus

3.7.19
master
device that controls the data transfer on the network and initiates the media access of the slaves by sending messages and that constitutes the interface to the control system

3.7.20
medium
[SEE: 3.1.29]

3.7.21
minimum optical receiver sensitivity
minimum optical power at the optical receiver input required to achieve a bit error rate of less than 10^{-9} for the optical transmission system

3.7.22
network
[SEE: 3.1.30]

3.7.23
optical fall time
[SEE: 3.1.33]

3.7.24
optical rise time
[SEE: 3.1.35]

3.7.25
outgoing interface
interface to send data to the next slave in a way, that data that is received through this interface is sent via another outgoing interface to the next slave or via an incoming interface to the previous slave and back to the master

3.7.26
peak emission wavelength
λp
[SEE: 3.1.36]

3.7.27
polymer optical fiber
POF
plastic fiber optic waveguide whose nominal characteristics are compatible with IEC 60793-2-40 [fiber type: A4a (980/1000)]

3.7.28
plastic clad silica fiber
PCS
fiber optic waveguide consisting of a glass core and a plastic cladding and whose nominal characteristics are compatible with IEC 60793-2-30 [fiber type: A3c (200/230 µm)]

3.7.29
remote bus
ring segment of a network

3.7.30
remote bus device
device operating as a slave on a remote bus

3.7.31
remote bus link
connection of two remote bus devices

3.7.32
ring segment
one section of a network

Note 1 to entry: The master constitutes the first ring segment, further ring segments may be linked by bus couplers.

3.7.33
shield
[SEE: 3.1.41]

3.7.34
slave
device that accesses the medium only after it has been initiated by the preceding slave or master

3.7.35
spectral full width half maximum
$\Delta\lambda$
range of wavelength of spectral distribution in which the radiant intensity is no less than one-half of the maximum intensity

3.7.36
terminator
[SEE: 3.1.43]

3.8 Type 12: Terms and definitions

3.8.1
2 Pair Powering
2PP
powering concept providing 2 independent channels for power sourcing in combination with a Ethernet 100BASE-TX

Note 1 to entry: One pair is used for powering the device itself including the Ethernet components and for other reliable power consumers and the other pair is used powering external components or elements in the PD that have specific power requests.

3.8.2
Powered Device
PD
portion of a device that is drawing power and possible connect two or more PI

Note 1 to entry: It is an abstraction of the elements that consumes power and do not contain any functional behavior of the components.

3.8.3
Power Interface
PI
mechanical and electrical connection of the PSE or PD and the transmission medium

Note 1 to entry: In an Endpoint PSE and in a PD, the PI is encompassed within the MDI of a 100BASE-TX link of Ethernet.

3.8.4
Power Sourcing Equipment
PSE
portion of the end station equipment that provides the power to a PD

Note 1 to entry: It is an abstraction of the elements that provides power and do not contain any functional behavior of the components. DTE powering is intended to provide 100BASE-TX devices with interfaces for both the reception and transmission of data as well as two power sources to operate. A PSE is electrically specified at the point of the physical connection to the cabling.

3.9 Type 16: Terms and definitions

3.9.1
attenuation
fact that the optical power at the receiver is less than at the transmitter

3.9.2
barrier
[SEE: 3.1.2]

3.9.3
bit
[SEE: 3.1.3]

3.9.4
bit stuffing
procedure, by which after five logical 1's, the transmitter automatically inserts a zero which is then removed again by the receiver

Note 1 to entry: This zero causes a change in signal edges which makes it possible for the receiver to retrieve a receiving clock.

3.9.5
connector
[SEE: 3.1.7]

3.9.6
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.9.7
Data Terminal Equipment
DTE
[SEE: 3.1.10]

3.9.8
dBm
[SEE: 3.1.11]

3.9.9
delimiter
[SEE: 3.1.12]

3.9.10
device
[SEE: 3.1.13]

3.9.11
error
[SEE: 3.1.16]

3.9.12
fiber optic cable
[SEE: 3.1.18]

3.9.13
frame
[SEE: 3.1.23]

3.9.14
F-SMA connector
connector meeting the F-SMA standard in accordance with IEC 61754-22

3.9.15
fill signals
sequence of seven 1's followed by a 0

3.9.16
jitter
[SEE: 3.1.27]

3.9.17
medium
[SEE: 3.1.29]

3.9.18
network
[SEE: 3.1.30]

3.9.19
node
[SEE: 3.1.31]

3.9.20
non-return-to-zero-inverted
NRZI
signal exchanges taking place only at regular, fixed points in time in synchronization with the transmitting clock pulse of the bit rate

Note 1 to entry: A signal edge change is assigned to a logical 0 only.

3.9.21
optical fall time
[SEE: 3.1.33]

3.9.22
optical rise time
[SEE: 3.1.35]

3.9.23
pad
sequence of octets added to assure that the telegram is long enough for proper operation

3.9.24
peak emission wavelength
λp
[SEE: 3.1.36]

3.9.25
receiver
[SEE: 3.1.37]

3.9.26
repeater
[SEE: 3.1.38]

3.9.27
repeater function
feature by which a telegram that has been received by a node is passed on and reclocked to the next node on the network, while being logically unchanged

3.9.28
transmitter
[SEE: 3.1.45]

3.9.29
typical half-intensity wavelength
Δλ
[SEE: 3.1.47]

3.9.30
zero bit stream
sequence of logical zeros which, in NRZI coding, results in a regular signal edge change on the transmission line (only used in test mode)

3.10 Type 18: Terms and definitions

3.10.1
activity
[SEE: 3.1.1]

3.10.2
bit
[SEE: 3.1.3]

3.10.3
bus
[SEE: 3.1.4]

3.10.4
communication element
[SEE: 3.1.6]

3.10.5
connector
[SEE: 3.1.7]

3.10.6
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.10.7
Data Terminal Equipment
DTE
[SEE: 3.1.10]

3.10.8
device
[SEE: 3.1.13]

3.10.9
error
[SEE: 3.1.16]

3.10.10
isolation
[SEE: 3.1.25]

3.10.11
medium
[SEE: 3.1.29]

3.10.12
network
[SEE: 3.1.30]

3.10.13
node
[SEE: 3.1.31]

3.10.14
receiver
[SEE: 3.1.37]

3.10.15
segment
[SEE: 3.1.39]

3.10.16
shield
[SEE: 3.1.41]

3.10.17
spur
[SEE: 3.1.42]

3.10.18
station
network device embodying one node

3.10.19
terminator
[SEE: 3.1.43]

3.10.20
transceiver
[SEE: 3.1.44]

3.10.21
transmitter
[SEE: 3.1.45]

3.10.22
trunk
[SEE: 3.1.46]

3.11 Type 24: Terms and definitions

3.11.1
bit
[SEE: 3.1.3]

3.11.2
bus
[SEE: 3.1.4]

3.11.3
communication element
[SEE: 3.1.6]

3.11.4
connector
[SEE: 3.1.7]

3.11.5
Data Communications Equipment
DCE
[SEE: 3.1.9]

3.11.6
delimiter
[SEE: 3.1.12]

3.11.7
device
[SEE: 3.1.13]

3.11.8
error
[SEE: 3.1.16]

3.11.9
frame
[SEE: 3.1.23]

3.11.10
isolation
[SEE: 3.1.25]

3.11.11
Isolator
parts for signal isolation by inductive or capacitive elements

3.11.12
Manchester encoding
[SEE: 3.1.28]

3.11.13
medium
[SEE: 3.1.29]

3.11.14
network
[SEE: 3.1.30]

3.11.15
node
[SEE: 3.1.31]

3.11.16
Photo coupler
Parts for signal isolation by optical elements

3.11.17
repeater
[SEE: 3.1.38]

3.11.18
shield
[SEE: 3.1.41]

3.11.19
terminator
[SEE: 3.1.43]

3.11.20
transceiver
[SEE: 3.1.44]

3.11.21
transmitter
[SEE: 3.1.45]

3.12 Type 20: Terms and definitions

3.12.1
analog signal
low frequency current, predominantly 4 mA to 20 mA signal sent to or originating from a field device

3.12.2
analog signal spectrum
frequencies from zero to 25 Hz at unit amplitude and decreasing at 40 dB per decade above 25 Hz

3.12.3
analog test filter
two-pole low-pass Butterworth filter with the cutoff frequency of 25 Hz

3.12.4
barrier
physical entity which limits current and voltage into a hazardous area in order to satisfy intrinsic safety requirements

3.12.5
cable capacitance per unit length
capacitance per unit length of cable, measured at 1 kHz from one conductor other than the shield to all other conductors including the shield

Note 1 to entry: For networks comprised of more than one type or gauge of cable, the highest capacitance value of any cable type or gauge is used to determine this value.

3.12.6
character
the 8-bits of data and overhead bits that are transmitted as one continuous unit by the PhE

3.12.7
character time
amount of time required to transmit one character

3.12.8
current sense resistor
resistor that is used to convert analog current signal into a voltage signal

3.12.9
delay distortion
difference in propagation time delays of sine waves of different frequencies when observing the time delay through a network or circuit

3.12.10
device
any entity containing an implementation of this document

3.12.11
digital signal
communication of information using the 1 200 bits per second frequency shift keying signal

3.12.12
digital frequency band
range of frequencies from 950 Hz to 2 500 Hz that is used for digital signal

3.12.13
digital signal spectrum
frequencies from 500 Hz to 10 kHz at unit amplitude, decreasing at 40 dB per decade below 500 Hz and decreasing at 20 dB per decade above 10 kHz

3.12.14
extended frequency band
range of frequencies from 500 Hz to 10 kHz

Note 1 to entry: This frequency band is digital frequency band plus guard band.

3.12.15
field device
physical entity that is connected to the process or to plant equipment and has at least one signalling element that communicates with other signalling element(s) via a cable

Note 1 to entry: It directly connects to the sensor or actuator or performs process control function and it is directly connected to the physical layer specified in this document. It may generate or receive an analog signal in addition to a digital signal.

3.12.16
ground
surface of the earth or the conduits or pipes that are so connected, or the safety bus bar or the zero volt rail to which the barriers are connected

Note 1 to entry: It is possible that ground can be the same as network power supply common, or not.

3.12.17
intrinsic safety
design methodology for a circuit or an assembly of circuits in which any spark or thermal effect produced under normal operating and specified fault conditions is not capable under prescribed test conditions of causing ignition of a given explosive atmosphere

3.12.18
junction
any splice of two cables or any attachment point of another cable or of a field device to an existing cable

3.12.19
multi-drop network
network with more than one slave device connected to one network

3.12.20
network power supply
source that supplies operating power directly to a network

3.12.21
network resistance
resistance or real part of the impedance of a network

Note 1 to entry: It is computed as the equivalent impedance of all devices connected in parallel to the network. Therefore, it is usually dominated by one low impedance device.

3.12.22
non-signaling element
physical entity or an element that does not use or produce analog signal or digital signal

Note 1 to entry: A network power supply is an example of non-signaling element.

3.12.23
point-to-point network
network with only one slave and zero or one master device

Note 1 to entry: The point-to-point Network need not have any master device. This situation would exist, for example, when only an analog controller is used, the single field device having been programmed by a secondary master that was subsequently disconnected.

3.12.24
signaling element
physical entity or an element that uses or produces digital signal

Note 1 to entry: The entity that only uses or produces an analog signal is not part of this definition; the entity that uses/produces only a digital signal, but not an analog signal is part of this definition.

3.12.25
silence
state of the network when there is no digital signal is present

3.12.26
start of message
the preamble of physical layer protocol data unit followed by the delimiter of data link layer protocol data unit without any reception error and inter-character gap

3.13 Type 28: Terms and definitions

3.13.1
carrier mode
data transfer mode over available resources made up of OFDM symbols

3.13.2
clock synchronization
clock calibration of the terminal node device

3.13.3
code block
octet sequence of data interaction between the Type 28 physical layer entity and the Type 28 data-link layer entity

3.13.4
control device
device that controls all field devices for logical operations, timing, calculations and so on

3.13.5
cyclic frame
signal frames which are processed in a regular and repetitive manner

3.13.6
cyclic symbol
OFDM symbols in signal frames which are processed in a regular and repetitive manner

3.13.7
half sideband
upper sideband or lower sideband of an OFDM symbol

3.13.8
lower sideband
subcarriers with a frequency range from 1,536 MHz to 16,896 MHz on an OFDM symbol

3.13.9
management node
device for allocating and managing Type 28 network physical communication resources

3.13.10
orthogonal frequency division multiplexing (OFDM) symbol
minimum data transmission unit in time domain that include all subcarriers in frequency based on OFDM technology

3.13.11
terminal node
device in Type 28 network that communicates based on allocated physical communication resources

3.13.12
two-wire non-bridged
devices are connected by physical media with two wires, without being connected through a bridge device

3.13.13
upper sideband
subcarriers with a frequency range from 16,896 MHz to 32,256 MHz on an OFDM symbol

3.13.14
working mode
OFDM operation in a specific transmission mode, RS code, convolutional code, and modulation mode