

# **Industrial communication networks – Profiles**

Part 3: Functional safety fieldbuses —  
General rules and profile definitions

**National foreword**

This British Standard is the UK implementation of EN 61784-3:2010. It is identical to IEC 61784-3:2010. It supersedes BS EN 61784-3:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AMT/7, Industrial communications: process measurement and control, including fieldbus.

A list of organizations represented on this committee can be obtained on request to its secretary.

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**Compliance with a British Standard cannot confer immunity from legal obligations.**

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**Amendments/corrigenda issued since publication**

| Date | Text affected |
|------|---------------|
|------|---------------|

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English version

**Industrial communication networks -  
Profiles -  
Part 3: Functional safety fieldbuses -  
General rules and profile definitions  
(IEC 61784-3:2010)**

Réseaux de communication industriels -  
Partie 3: Bus de terrain à sécurité  
fonctionnelle -  
Règles générales et définitions des profils  
(CEI 61784-3:2010)

Industrielle Kommunikationsnetze -  
Profile -  
Teil 3: Funktional sichere Übertragung bei  
Feldbussen -  
Allgemeine Regeln und Profilverfestlegungen  
(IEC 61784-3:2010)

This European Standard was approved by CENELEC on 2010-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**Management Centre: Avenue Marnix 17, B - 1000 Brussels**

## Foreword

The text of document 65C/591A/FDIS, future edition 2 of IEC 61784-3, 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 was approved by CENELEC as EN 61784-3 on 2010-07-01.

This European Standard supersedes EN 61784-3:2008.

The main technical changes with respect to EN 61784-3:2008 are listed below:

- clarifications and additional explanations for requirements, updated references;
- updates of definitions and requirements in relation with the new edition of EN 61508;
- addition of a new informative Annex D providing an assessment guideline;
- updates in parts for CPF 1, CPF 2, CPF 3, CPF 6 (details provided in the parts);
- addition of new parts for CPF 8, CPF 12, CPF 13, CPF 14;
- in CPF parts, addition of an annex to provide information about test laboratories for testing and validating conformance of FSCP products.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- |                                                                                                                                          |       |            |
|------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2011-04-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn                                               | (dow) | 2013-07-01 |

Annex ZA has been added by CENELEC.

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## Endorsement notice

The text of the International Standard IEC 61784-3:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

|                  |      |                                                     |
|------------------|------|-----------------------------------------------------|
| IEC 60204-1      | NOTE | Harmonized as EN 60204-1.                           |
| IEC 61496 series | NOTE | Harmonized in EN 61496 series (partially modified). |
| IEC 61508-4:2010 | NOTE | Harmonized as EN 61508-4:2010 (not modified).       |
| IEC 61508-5:2010 | NOTE | Harmonized as EN 61508-5:2010 (not modified).       |
| IEC 61508-6:2010 | NOTE | Harmonized as EN 61508-6:2010 (not modified).       |
| IEC 61511 series | NOTE | Harmonized in EN 61511 series (not modified).       |
| IEC 61800-5-2    | NOTE | Harmonized as EN 61800-5-2.                         |
| IEC 62061        | NOTE | Harmonized as EN 62061.                             |
| ISO 10218-1      | NOTE | Harmonized as EN ISO 10218-1.                       |
| ISO 12100-1      | NOTE | Harmonized as EN ISO 12100-1.                       |
| ISO 13849-1      | NOTE | Harmonized as EN ISO 13849-1.                       |
| ISO 13849-2      | NOTE | Harmonized as EN ISO 13849-2.                       |
| ISO 14121        | NOTE | Harmonized as EN ISO 14121.                         |

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## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

| <u>Publication</u> | <u>Year</u> | <u>Title</u>                                                                                                                                                                                                                                                                                                                   | <u>EN/HD</u> | <u>Year</u> |
|--------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|
| IEC 61131-2        | -           | Programmable controllers -<br>Part 2: Equipment requirements and tests                                                                                                                                                                                                                                                         | EN 61131-2   | -           |
| IEC 61158          | Series      | Industrial communication networks -<br>Fieldbus specifications                                                                                                                                                                                                                                                                 | EN 61158     | Series      |
| IEC 61326-3-1      | -           | Electrical equipment for measurement,<br>control and laboratory use -<br>EMC requirements -<br>Part 3-1: Immunity requirements for safety-<br>related systems and for equipment intended to<br>perform safety-related functions (functional<br>safety) - General industrial applications                                       | EN 61326-3-1 | -           |
| IEC 61326-3-2      | -           | Electrical equipment for measurement,<br>control and laboratory use -<br>EMC requirements -<br>Part 3-2: Immunity requirements for safety-<br>related systems and for equipment intended to<br>perform safety-related functions (functional<br>safety) - Industrial applications with specified<br>electromagnetic environment | EN 61326-3-2 | -           |
| IEC 61508          | Series      | Functional safety of<br>electrical/electronic/programmable electronic<br>safety-related systems                                                                                                                                                                                                                                | EN 61508     | Series      |
| IEC 61508-1        | 2010        | Functional safety of<br>electrical/electronic/programmable electronic<br>safety-related systems -<br>Part 1: General requirements                                                                                                                                                                                              | EN 61508-1   | 2010        |
| IEC 61508-2        | -           | Functional safety of<br>electrical/electronic/programmable electronic<br>safety-related systems -<br>Part 2: Requirements for<br>electrical/electronic/programmable electronic<br>safety-related systems                                                                                                                       | EN 61508-2   | -           |
| IEC 61784-1        | -           | Industrial communication networks - Profiles -<br>Part 1: Fieldbus profiles                                                                                                                                                                                                                                                    | EN 61784-1   | -           |
| IEC 61784-2        | -           | Industrial communication networks - Profiles -<br>Part 2: Additional fieldbus profiles for real-time<br>networks based on ISO/IEC 8802-3                                                                                                                                                                                       | EN 61784-2   | -           |

| <u>Publication</u> | <u>Year</u> | <u>Title</u>                                                                                                                                  | <u>EN/HD</u>  | <u>Year</u> |
|--------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|
| IEC 61784-3-1      | -           | Industrial communication networks - Profiles - Part 3-1: Functional safety fieldbuses - Additional specifications for CPF 1                   | EN 61784-3-1  | -           |
| IEC 61784-3-2      | -           | Industrial communication networks - Profiles - Part 3-2: Functional safety fieldbuses - Additional specifications for CPF 2                   | EN 61784-3-2  | -           |
| IEC 61784-3-3      | -           | Industrial communication networks - Profiles - Part 3-3: Functional safety fieldbuses - Additional specifications for CPF 3                   | EN 61784-3-3  | -           |
| IEC 61784-3-6      | -           | Industrial communication networks - Profiles - Part 3-6: Functional safety fieldbuses - Additional specifications for CPF 6                   | EN 61784-3-6  | -           |
| IEC 61784-3-8      | -           | Industrial communication networks - Profiles - Part 3-8: Functional safety fieldbuses - Additional specifications for CPF 8                   | EN 61784-3-8  | -           |
| IEC 61784-3-12     | -           | Industrial communication networks - Profiles - Part 3-12: Functional safety fieldbuses - Additional specifications for CPF 12                 | EN 61784-3-12 | -           |
| IEC 61784-3-13     | -           | Industrial communication networks - Profiles - Part 3-13: Functional safety fieldbuses - Additional specifications for CPF 13                 | EN 61784-3-13 | -           |
| IEC 61784-3-14     | -           | Industrial communication networks - Profiles - Part 3-14: Functional safety fieldbuses - Additional specifications for CPF 14                 | EN 61784-3-14 | -           |
| IEC 61784-5        | Series      | Industrial communication networks - Profiles - Part 5: Installation of fieldbuses - Installation profiles for CPF x                           | EN 61784-5    | Series      |
| IEC 61918          | -           | Industrial communication networks - Installation of communication networks in industrial premises                                             | EN 61918      | -           |
| IEC 62280-1        | 2002        | Railway applications - Communication, signalling and processing systems - Part 1: Safety-related communication in closed transmission systems | -             | -           |
| IEC 62443          | Series      | Industrial communication networks - Network and system security                                                                               | -             | -           |

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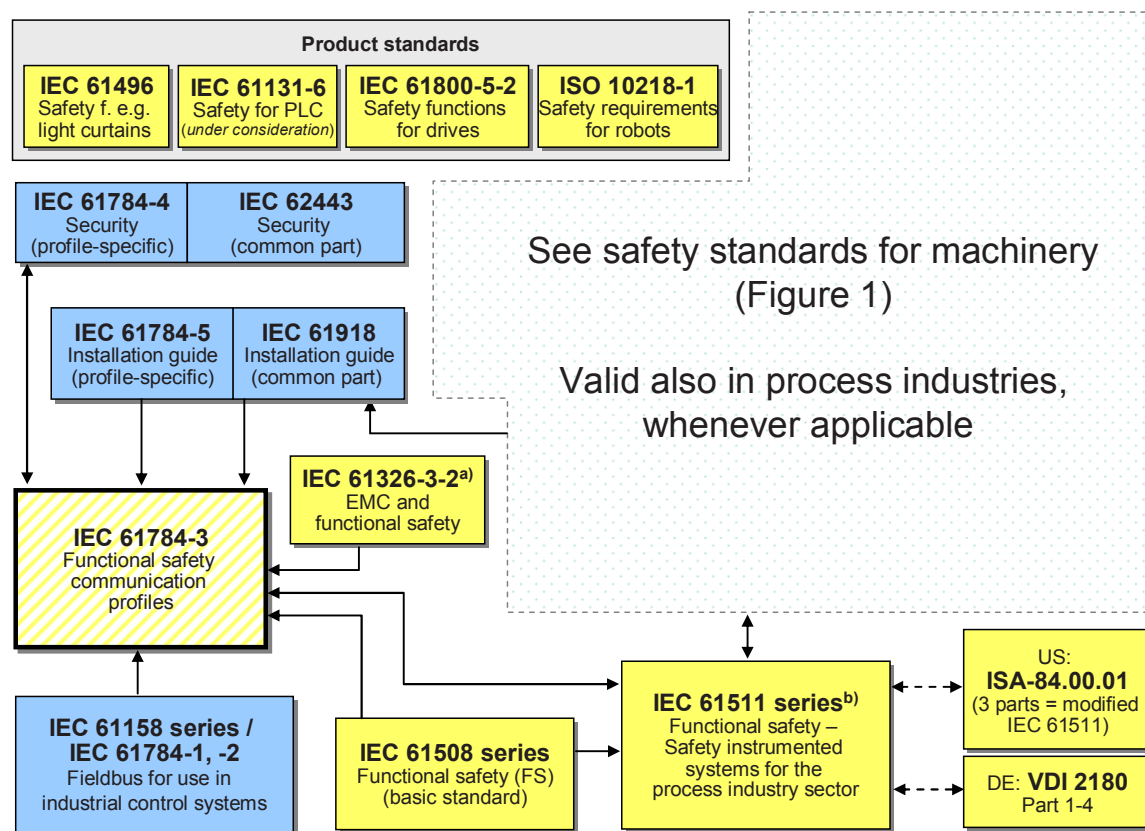
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Figure 2 shows the relationships between this standard and relevant safety and fieldbus standards in a process environment.



#### Key

- (yellow) safety-related standards
- (blue) fieldbus-related standards
- (dashed yellow) this standard

<sup>a</sup> For specified electromagnetic environments; otherwise IEC 61326-3-1.

<sup>b</sup> EN ratified.

**Figure 2 – Relationships of IEC 61784-3 with other standards (process)**

Safety communication layers which are implemented as parts of safety-related systems according to IEC 61508 series provide the necessary confidence in the transportation of messages (information) between two or more participants on a fieldbus in a safety-related system, or sufficient confidence of safe behaviour in the event of fieldbus errors or failures.

Safety communication layers specified in this standard do this in such a way that a fieldbus can be used for applications requiring functional safety up to the Safety Integrity Level (SIL) specified by its corresponding functional safety communication profile.

The resulting SIL claim of a system depends on the implementation of the selected functional safety communication profile within this system – implementation of a functional safety communication profile in a standard device is not sufficient to qualify it as a safety device.

This standard describes:

- basic principles for implementing the requirements of IEC 61508 series for safety-related data communications, including possible transmission faults, remedial measures and considerations affecting data integrity;
- individual description of functional safety profiles for several communication profile families in IEC 61784-1 and IEC 61784-2;
- safety layer extensions to the communication service and protocols sections of the IEC 61158 series.

## 0.2 Patent declaration

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning functional safety communication profiles for families 1, 2, 3, 6, 12, 13 and 14 given in IEC 61784-3-1, IEC 61784-3-2, IEC 61784-3-3, IEC 61784-3-6, IEC 61784-3-12, IEC 61784-3-13 and IEC 61784-3-14.

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these patent rights are registered with IEC.

NOTE Patent details and corresponding contact information are provided in IEC 61784-3-1, IEC 61784-3-2, IEC 61784-3-3, IEC 61784-3-6, IEC 61784-3-12, IEC 61784-3-13 and IEC 61784-3-14.

## INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

### Part 3: Functional safety fieldbuses – General rules and profile definitions

#### 1 Scope

This part of the IEC 61784-3 series explains some common principles than can be used in the transmission of safety-relevant messages among participants within a distributed network using fieldbus technology in accordance with the requirements of IEC 61508 series<sup>1</sup> for functional safety. These principles can be used in various industrial applications such as process control, manufacturing automation and machinery.

This part<sup>2</sup> and the IEC 61784-3-x parts specify several functional safety communication profiles based on the communication profiles and protocol layers of the fieldbus technologies in IEC 61784-1, IEC 61784-2 and the IEC 61158 series.

NOTE 1 Other safety-related communication systems meeting the requirements of IEC 61508 series may exist that are not included in this standard.

NOTE 2 It does not cover electrical safety and intrinsic safety aspects. Electrical safety relates to hazards such as electrical shock. Intrinsic safety relates to hazards associated with potentially explosive atmospheres.

All systems are exposed to unauthorized access at some point of their life cycle. Additional measures need to be considered in any safety-related application to protect fieldbus systems against unauthorized access. The IEC 62443 series will address many of these issues; the relationship with the IEC 62443 series is detailed in a dedicated subclause of this part.

NOTE 3 Additional profile specific requirements for security may also be specified in IEC 61784-4<sup>3</sup> [10].

NOTE 4 Implementation of a functional safety communication profile according to this part in a device is not sufficient to qualify it as a safety device, as defined in IEC 61508 series.

NOTE 5 The resulting SIL claim of a system depends on the implementation of the selected functional safety communication profile within this system.

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

IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

IEC 61326-3-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications*

<sup>1</sup> In the following pages of this standard, “IEC 61508” will be used for “IEC 61508 series”.

<sup>2</sup> In the following pages of this standard, “this part” will be used for “this part of the IEC 61784-3 series”.

<sup>3</sup> Proposed new work item under consideration.

IEC 61326-3-2, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-2: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – Industrial applications with specified electromagnetic environment*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61508-1:2010<sup>4</sup>, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

IEC 61784-2, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

IEC 61784-3-1, *Industrial communication networks – Profiles – Part 3-1: Functional safety fieldbuses – Additional specifications for CPF 1*

IEC 61784-3-2, *Industrial communication networks – Profiles – Part 3-2: Functional safety fieldbuses – Additional specifications for CPF 2*

IEC 61784-3-3, *Industrial communication networks – Profiles – Part 3-3: Functional safety fieldbuses – Additional specifications for CPF 3*

IEC 61784-3-6, *Industrial communication networks – Profiles – Part 3-6: Functional safety fieldbuses – Additional specifications for CPF 6*

IEC 61784-3-8<sup>5</sup>, *Industrial communication networks – Profiles – Part 3-8: Functional safety fieldbuses – Additional specifications for CPF 8*

IEC 61784-3-12<sup>5</sup>, *Industrial communication networks – Profiles – Part 3-12: Functional safety fieldbuses – Additional specifications for CPF 12*

IEC 61784-3-13<sup>5</sup>, *Industrial communication networks – Profiles – Part 3-13: Functional safety fieldbuses – Additional specifications for CPF 13*

IEC 61784-3-14<sup>5</sup>, *Industrial communication networks – Profiles – Part 3-14: Functional safety fieldbuses – Additional specifications for CPF 14*

IEC 61784-5 (all parts), *Industrial communication networks – Profiles – Part 5: Installation of fieldbuses – Installation profiles for CPF x*

IEC 61918, *Industrial communication networks – Installation of communication networks in industrial premises*

IEC 62280-1:2002, *Railway applications – Communication, signalling and processing systems – Part 1: Safety-related communication in closed transmission systems*

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<sup>4</sup> To be published.

<sup>5</sup> To be published.

### 3 Terms, definitions, symbols, abbreviated terms and conventions

#### 3.1 Terms and definitions

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

##### 3.1.1 Common terms and definitions

###### 3.1.1.1

**absolute time stamp**

*time stamp* referenced to a global time which is common for a group of devices using a *fieldbus*

[IEC 62280-2, modified]

###### 3.1.1.2

**availability**

probability for an automated system that for a given period of time there are no unsatisfactory system conditions such as loss of production

###### 3.1.1.3

**black channel**

*communication channel* without available evidence of design or validation according to IEC 61508

###### 3.1.1.4

**bridge**

abstract device that connects multiple network segments along the data link layer

###### 3.1.1.5

**communication channel**

logical connection between two end-points within a *communication system*

###### 3.1.1.6

**communication system**

arrangement of hardware, software and propagation media to allow the transfer of *messages* (ISO/IEC 7498 application layer) from one application to another

###### 3.1.1.7

**connection**

logical binding between two application objects within the same or different devices

###### 3.1.1.8

**Cyclic Redundancy Check (CRC)**

<value> redundant data derived from, and stored or transmitted together with, a block of data in order to detect data corruption

<method> procedure used to calculate the redundant data

NOTE 1 Terms “CRC code” and “CRC signature”, and labels such as CRC1, CRC2, may also be used in this standard to refer to the redundant data.

NOTE 2 See also [29], [30]<sup>6</sup>.

<sup>6</sup> Figures in square brackets refer to the bibliography.

**3.1.1.9****diversity**

different means of performing a required function

NOTE Diversity may be achieved by different physical methods or different design approaches.

[IEC 61508-4:2010<sup>7</sup>]

**3.1.1.10****error**

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

[IEC 61508-4:2010], [IEC 61158]

NOTE 1 Errors may be due to design mistakes within hardware/software and/or corrupted information due to electromagnetic interference and/or other effects.

NOTE 2 Errors do not necessarily result in a *failure* or a *fault*.

**3.1.1.11****failure**

termination of the ability of a functional unit to perform a required function or operation of a functional unit in any way other than as required

NOTE 1 The definition in IEC 61508-4 is the same, with additional notes.

[IEC 61508-4:2010, modified], [ISO/IEC 2382-14.01.11, modified]

NOTE 2 Failure may be due to an *error* (for example, problem with hardware/software design or message disruption).

**3.1.1.12****fault**

abnormal condition that may cause a reduction in, or loss of, the capability of a functional unit to perform a required function

NOTE IEC 191-05-01 defines “fault” as a state characterized by the inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.

[IEC 61508-4:2010, modified], [ISO/IEC 2382-14.01.10, modified]

**3.1.1.13****fieldbus**

*communication system* based on serial data transfer and used in industrial automation or process control applications

**3.1.1.14****fieldbus system**

system using a *fieldbus* with connected devices

**3.1.1.15****frame**

denigrated synonym for DLPDU

**3.1.1.16****Frame Check Sequence (FCS)**

redundant data derived from a block of data within a DLPDU (frame), using a hash function, and stored or transmitted together with the block of data, in order to detect data corruption

<sup>7</sup> To be published.

NOTE 1 An FCS can be derived using for example a CRC or other hash function.

NOTE 2 See also [29], [30].

#### **3.1.1.17 hash function**

(mathematical) function that maps values from a (possibly very) large set of values into a (usually) smaller range of values

NOTE 1 Hash functions can be used to detect data corruption.

NOTE 2 Common hash functions include parity, checksum or CRC.

[IEC/TR 62210, modified]

#### **3.1.1.18 hazard**

state or set of conditions of a system that, together with other related conditions will inevitably lead to harm to persons, property or environment

#### **3.1.1.19 master**

active communication entity able to initiate and schedule communication activities by other stations which may be masters or slaves

#### **3.1.1.20 message**

ordered series of octets intended to convey information  
[ISO/IEC 2382-16.02.01, modified]

#### **3.1.1.21 message sink**

part of a *communication system* in which *messages* are considered to be received  
[ISO/IEC 2382-16.02.03]

#### **3.1.1.22 message source**

part of a *communication system* from which *messages* are considered to originate  
[ISO/IEC 2382-16.02.02]

#### **3.1.1.23 nuisance trip**

spurious trip with no harmful effect

NOTE Internal abnormal errors can be caused in communication systems such as wireless transmission, for example by too many retries in the presence of interferences.

#### **3.1.1.24 performance level (PL)**

discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions  
[ISO 13849-1]

#### **3.1.1.25 protective extra-low-voltage (PELV)**

electrical circuit in which the voltage cannot exceed a.c. 30 V r.m.s., 42,4 V peak or d.c. 60 V in normal and single-fault condition, except earth faults in other circuits

NOTE A PELV circuit is similar to an SELV circuit that is connected to protective earth.

[IEC 61131-2]

### **3.1.1.26** **redundancy**

existence of means, in addition to the means which would be sufficient for a functional unit to perform a required function or for data to represent information

NOTE The definition in IEC 61508-4 is the same, with additional example and notes.

[IEC 61508-4:2010, modified], [ISO/IEC 2382-14.01.12, modified]

### **3.1.1.27** **relative time stamp**

*time stamp* referenced to the local clock of an entity

NOTE In general, there is no relationship to clocks of other entities.

[IEC 62280-2, modified]

### **3.1.1.28** **reliability**

probability that an automated system can perform a required function under given conditions for a given time interval ( $t_1, t_2$ )

NOTE 1 It is generally assumed that the automated system is in a state to perform this required function at the beginning of the time interval.

NOTE 2 The term "reliability" is also used to denote the reliability performance quantified by this probability.

NOTE 3 Within the MTBF or MTTF period of time, the probability that an automated system will perform a required function under given conditions is decreasing.

NOTE 4 Reliability differs from availability.

[IEC 62059-11, modified]

### **3.1.1.29** **risk**

combination of the probability of occurrence of harm and the severity of that harm

NOTE For more discussion on this concept see Annex A of IEC 61508-5:2010<sup>8</sup>.

[IEC 61508-4:2010], [ISO/IEC Guide 51:1999, definition 3.2]

### **3.1.1.30** **safety communication layer (SCL)**

communication layer that includes all the necessary measures to ensure safe transmission of data in accordance with the requirements of IEC 61508

### **3.1.1.31** **safety connection**

connection that utilizes the safety protocol for communications transactions

### **3.1.1.32** **safety data**

data transmitted across a safety network using a safety protocol

NOTE The Safety Communication Layer does not ensure safety of the data itself, only that the data is transmitted safely.

<sup>8</sup> To be published.