

DIN EN 61784-3-6

ICS 35.160; 35.240.50

Ersatz für
DIN EN 61784-3-6:2008-11
Siehe Anwendungsbeginn

**Industrielle Kommunikationsnetze - Profile –
Teil 3-6: Funktional sichere Übertragung bei Feldbussen –
Zusätzliche Festlegungen für die Kommunikationsprofilfamilie 6
(IEC 61784-3-6:2010);
Englische Fassung EN 61784-3-6:2010**

Industrial communication networks - Profiles –
Part 3-6: Functional safety fieldbuses –
Additional specifications for CPF 6 (IEC 61784-3-6:2010);
English version EN 61784-3-6:2010

Réseaux de communication industriels –
Partie 3-6: Bus de terrain à sécurité fonctionnelle –
Spécifications complémentaires pour le CPF 6 (CEI 61784-3-6:2010);
Version anglaise EN 61784-3-6:2010

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DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2010-07-01 angenommene Europäische Norm als DIN-Norm ist 2011-08-01.

Daneben darf DIN EN 61784-3-6:2008-11 noch bis 2013-07-01 angewendet werden.

Nationales Vorwort

Zu diesem Dokument wurde ein Kurzverfahren in den DIN-Mitteilungen veröffentlicht.

Für diese Norm ist das nationale Arbeitsgremium UK 914.1 „Profile für funktional sichere Kommunikationssysteme“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 65C „Industrial networks“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (stability date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

- bestätigt,
- zurückgezogen,
- durch eine Folgeausgabe ersetzt oder
- geändert.

DIN EN 61784-3 (VDE 0803-500-3) erläutert die Grundsätze für funktional sichere Kommunikation, bezogen auf die Normen der Reihe DIN EN 61508 (VDE 0803). Für sie ist eine deutsche Sprachfassung verfügbar.

Die Normen der Reihe DIN EN 61784-3 legen mehrere Sicherheitskommunikationsschichten (Profile und entsprechende Protokolle) basierend auf den Kommunikationsprofilen und Protokollschichten der DIN EN 61784-1, der DIN EN 61784-2 und der Reihe DIN EN 61158 fest. Für diese Kommunikationsnormen ist keine deutsche Sprachfassung verfügbar. Sie allein sind nicht ausreichend zur Auslegung eines sicherheitsbezogenen Systems nach DIN EN 61508 (VDE 0803), stets ist die Beachtung der letztgenannten Normenreihe und der DIN EN 61784-3 erforderlich.

Die Kommunikationsnormen der Reihe DIN EN 61784-3 weisen alle die gleiche Gliederung auf, sie ist in DIN EN 61784-3 (VDE 0803-500), Anhang C, in deutscher und englischer Sprache wiedergegeben, so dass ein Bezug zwischen der deutschsprachigen DIN EN 61784-3 (VDE 0803-500) und der englischsprachigen Reihe DIN EN 61784-3-x jederzeit möglich ist. Darüber hinaus sind in ersterer alle Begriffe und Abkürzungen jeweils in Deutsch und Englisch wiedergegeben.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der IEC 61784-3-6 veröffentlicht. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Änderungen

Gegenüber DIN EN 61784-3-6:2008-11 wurden folgende Änderungen vorgenommen:

- a) Änderungen, die sich aus DIN EN 61784-3 (VDE 0803-500):2011-02 ergeben, eingearbeitet.

Frühere Ausgaben

DIN EN 61784-3-6: 2008-11

– Leerseite –

English version

**Industrial communication networks -
Profiles -
Part 3-6: Functional safety fieldbuses -
Additional specifications for CPF 6
(IEC 61784-3-6:2010)**

Réseaux de communication industriels -
Partie 3-6: Bus de terrain à sécurité
fonctionnelle -
Spécifications complémentaires
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Industrielle Kommunikationsnetze -
Profile -
Teil 3-6: Funktional sichere Übertragung
bei Feldbussen -
Zusätzliche Festlegungen
für die Kommunikationsprofilfamilie 6
(IEC 61784-3-6:2010)

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.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

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Foreword

The text of document 65C/591A/FDIS, future edition 2 of IEC 61784-3-6, 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 61784-3-6 on 2010-07-01.

This European Standard supersedes EN 61784-3-6:2008.

The main changes with respect to EN 61784-3-6:2008 are listed below:

- updates in relation with changes in EN 61784-3.

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.

Endorsement notice

The text of the International Standard IEC 61784-3-6:2010 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:

EN 50170

IEC 61131-2	NOTE	Harmonized as EN 61131-2.
IEC 61326-3-1	NOTE	Harmonized as EN 61326-3-1.
IEC 61326-3-2	NOTE	Harmonized as EN 61326-3-2
IEC 61496 series	NOTE	Harmonized in EN 61496 series (partially modified).
IEC 61508-1:2010	NOTE	Harmonized as EN 61508-1:2010 (not 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 61784-5 series	NOTE	Harmonized in EN 61784-5 series (not modified).
IEC 61800-5-2	NOTE	Harmonized as EN 61800-5-2.
ISO 10218-1	NOTE	Harmonized as EN ISO 10218-1.
ISO 13849-2	NOTE	Harmonized as EN ISO 13849-2.

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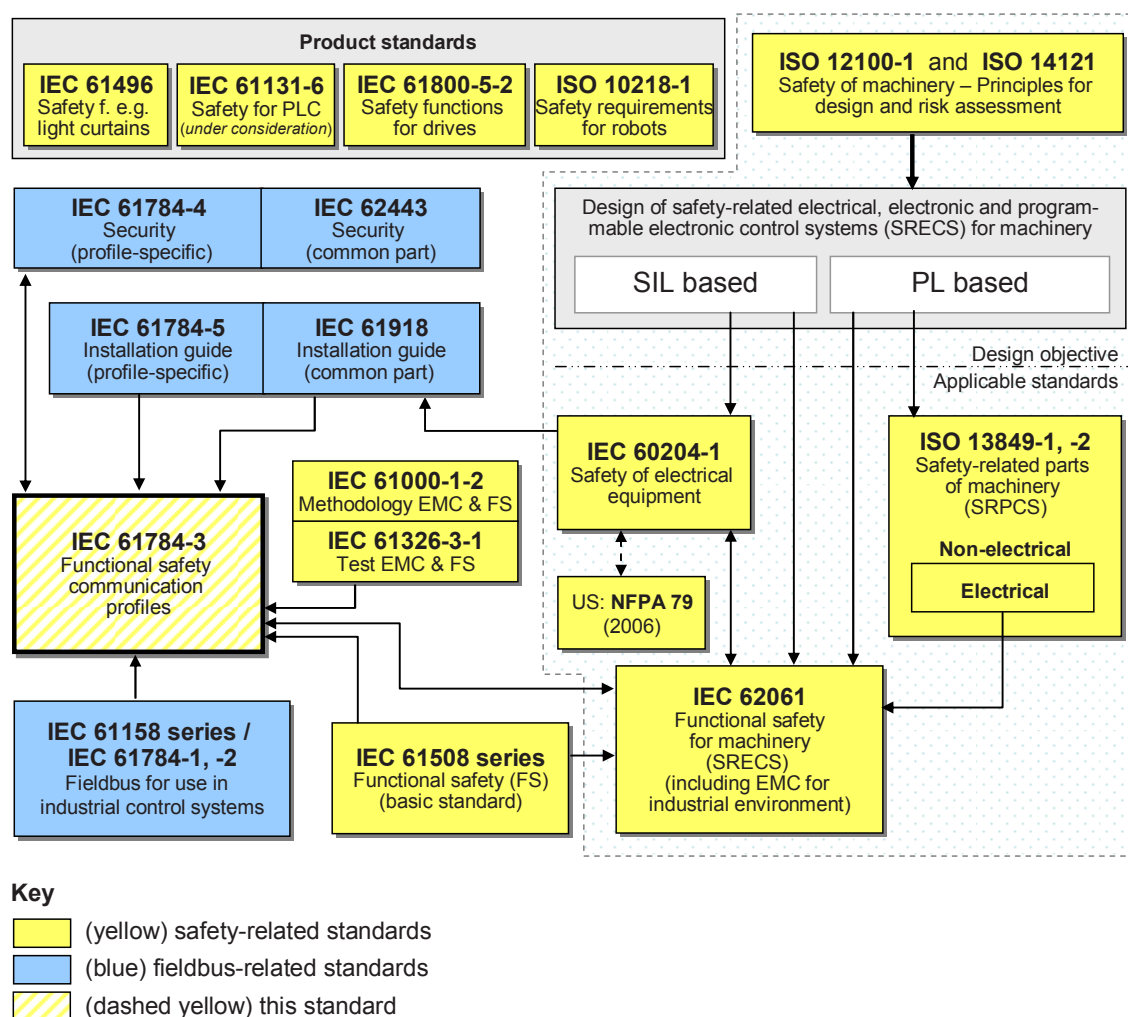
0 Introduction

0.1 General

The IEC 61158 fieldbus standard together with its companion standards IEC 61784-1 and IEC 61784-2 defines a set of communication protocols that enable distributed control of automation applications. Fieldbus technology is now considered well accepted and well proven. Thus many fieldbus enhancements are emerging, addressing not yet standardized areas such as real time, safety-related and security-related applications.

This standard explains the relevant principles for functional safety communications with reference to IEC 61508 series and specifies several safety communication layers (profiles and corresponding protocols) based on the communication profiles and protocol layers of IEC 61784-1, IEC 61784-2 and the IEC 61158 series. It does not cover electrical safety and intrinsic safety aspects.

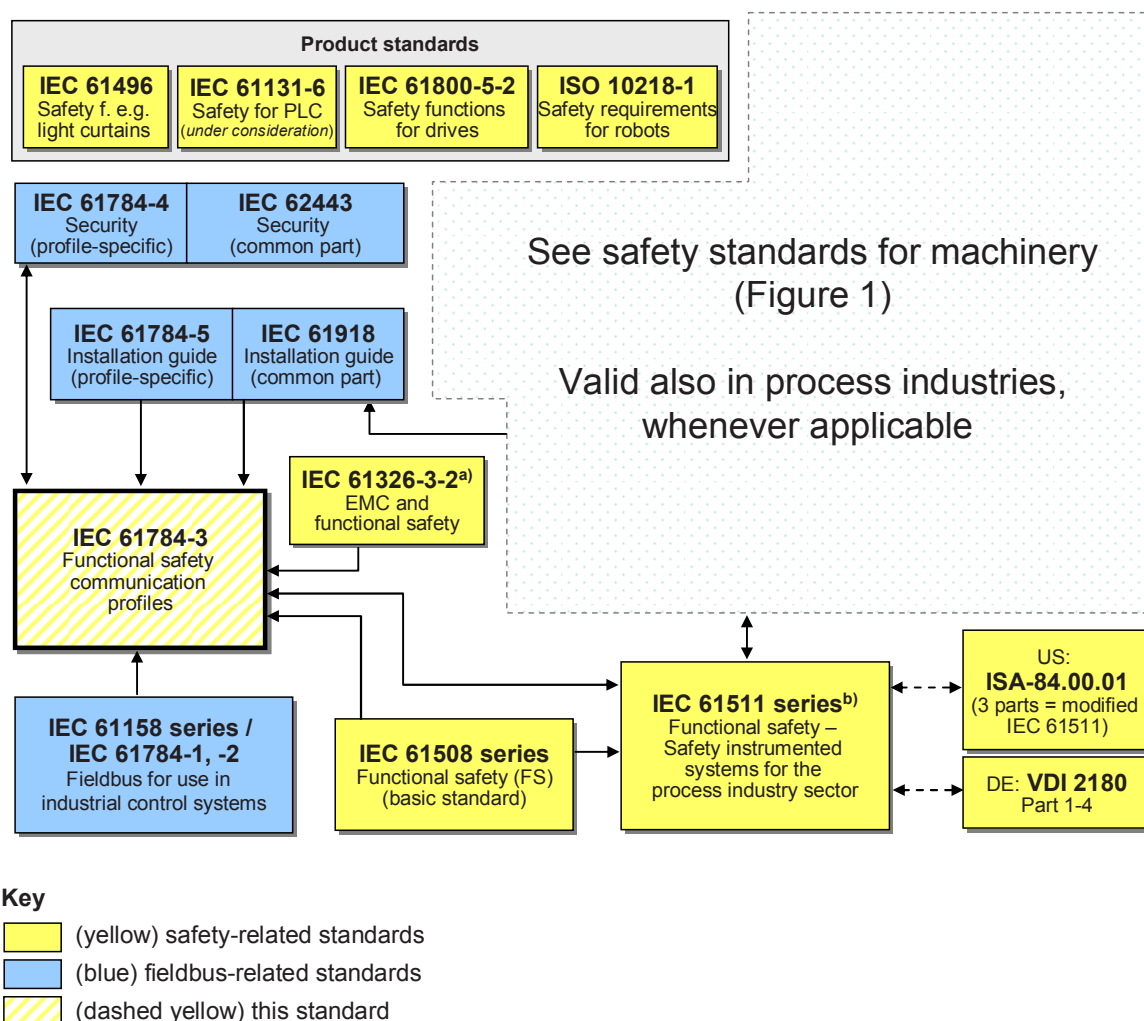
Figure 1 shows the relationships between this standard and relevant safety and fieldbus standards in a machinery environment.



NOTE Subclauses 6.7.6.4 (high complexity) and 6.7.8.1.6 (low complexity) of IEC 62061 specify the relationship between PL (Category) and SIL.

Figure 1 – Relationships of IEC 61784-3 with other standards (machinery)

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



^a For specified electromagnetic environments; otherwise IEC 61326-3-1.

^b 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 the functional safety communication profiles for family 6 as follows, where the [xx] notation indicates the holder of the patent right:

DE 103 25 263 A1	[PxC]	Sicherstellung von maximalen Reaktionszeiten in komplexen oder verteilten sicheren und/oder nicht sicheren Systemen
DE 103 18 068 A1	[PxC]	Verfahren und Vorrichtung zum Paket-orientierten Übertragen sicherheitsrelevanter Daten

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

The holders of these patents rights have assured the 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 statement of the holders of these patent rights are registered with IEC.

Information may be obtained from:

[PxC]	Phoenix Contact GmbH & Co. KG Intellectual Property Licenses & Standards Flachsmarktstr. 8 D-32825 Blomberg, GERMANY
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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

INDUSTRIAL COMMUNICATION NETWORKS – PROFILES –

Part 3-6: Functional safety fieldbuses – Additional specifications for CPF 6

1 Scope

This part of the IEC 61784-3 series specifies a safety communication layer (services and protocol) based on CPF 6 of IEC 61784-1, IEC 61784-2 and IEC 61158 Type 8. It identifies the principles for functional safety communications defined in IEC 61784-3 that are relevant for this safety communication layer.

NOTE 1 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.

This part¹ defines mechanisms for the transmission of safety-relevant messages among participants within a distributed network using fieldbus technology in accordance with the requirements of IEC 61508 series² for functional safety. These mechanisms may be used in various industrial applications such as process control, manufacturing automation and machinery.

This part provides guidelines for both developers and assessors of compliant devices and systems.

NOTE 2 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 according to this part in a standard device is not sufficient to qualify it as a safety device.

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 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 61131-3, *Programmable controllers – Part 3: Programming languages*

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

IEC 61158-2, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-3-8, *Industrial communication networks – Fieldbus specifications – Part 3-8: Data-link layer service definition – Type 8 elements*

IEC 61158-4-8, *Industrial communication networks – Fieldbus specifications – Part 4-8: Data-link layer protocol specification – Type 8 elements*

¹ In the following pages of this standard, “this part” will be used for “this part of the IEC 61784-3 series”.

² In the following pages of this standard, “IEC 61508” will be used for “IEC 61508 series”.

IEC 61158-5-8:2007, *Industrial communication networks – Fieldbus specifications – Part 5-8: Application layer service definition – Type 8 elements*

IEC 61158-6-8, *Industrial communication networks – Fieldbus specifications – Part 6-8: Application layer protocol specification – Type 8 elements*

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

IEC 61511 (all parts), *Functional safety – Safety instrumented systems for the process industry sector*

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 61784-3:2010³, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 61784-5-6, *Industrial communication networks – Profiles – Part 5: Installation of fieldbuses – Installation profiles for CPF 6*

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

IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*

ISO 12100-1, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

ISO 13849-1, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

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

availability

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

3.1.1.2

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 In preparation.

3.1.1.3

connection

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

3.1.1.4

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 [32], [33]⁴.

3.1.1.5

error

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

[IEC 61508-4:2010⁵], [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*.

3.1.1.6

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)

3.1.1.7

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]

3.1.1.8

fieldbus

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

3.1.1.9

fieldbus system

system using a *fieldbus* with connected devices

⁴ Figures in square brackets refer to the bibliography.

⁵ To be published.

3.1.1.10

frame

denigrated synonym for DLPDU

3.1.1.11

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

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

NOTE 2 See also [32], [33].

3.1.1.12

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]

3.1.1.13

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

3.1.1.14

master

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

3.1.1.15

message

ordered series of octets intended to convey information

[ISO/IEC 2382-16.02.01, modified]

3.1.1.16

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]

3.1.1.17

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]

3.1.1.18

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]

3.1.1.19

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]

3.1.1.20

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]

3.1.1.21

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 61508-5:2010⁶.

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

3.1.1.22

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

3.1.1.23

safety connection

connection that utilizes the safety protocol for communications transactions

3.1.1.24

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.

3.1.1.25

safety device

device designed in accordance with IEC 61508 and which implements the functional safety communication profile

⁶ To be published.

3.1.1.26

safety extra-low-voltage (SELV)

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, including earth faults in other circuits

NOTE An SELV circuit is not connected to protective earth.

[IEC 61131-2]

3.1.1.27

safety function

function to be implemented by an E/E/PE safety-related system or other risk reduction measures, that is intended to achieve or maintain a safe state for the EUC, in respect of a specific hazardous event

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

[IEC 61508-4:2010, modified]

3.1.1.28

safety function response time

worst case elapsed time following an actuation of a safety sensor connected to a fieldbus, before the corresponding safe state of its safety actuator(s) is achieved in the presence of errors or failures in the safety function channel

NOTE This concept is introduced in IEC 61784-3:2010⁷, 5.2.4 and addressed by the functional safety communication profiles defined in this part.

3.1.1.29

safety integrity level (SIL)

discrete level (one out of a possible four), corresponding to a range of safety integrity values, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

NOTE 1 The target failure measures (see IEC 61508-4:2010, 3.5.17) for the four safety integrity levels are specified in Tables 2 and 3 of IEC 61508-1:2010⁸.

NOTE 2 Safety integrity levels are used for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems.

NOTE 3 A safety integrity level (SIL) is not a property of a system, subsystem, element or component. The correct interpretation of the phrase "SILn safety-related system" (where n is 1, 2, 3 or 4) is that the system is potentially capable of supporting safety functions with a safety integrity level up to n.

[IEC 61508-4:2010]

3.1.1.30

safety measure

<this standard> measure to control possible communication *errors* that is designed and implemented in compliance with the requirements of IEC 61508

NOTE 1 In practice, several safety measures are combined to achieve the required safety integrity level.

NOTE 2 Communication *errors* and related safety measures are detailed in IEC 61784-3:2010, 5.3 and 5.4.

3.1.1.31

safety-related application

programs designed in accordance with IEC 61508 to meet the SIL requirements of the application

⁷ In preparation.

⁸ To be published.

3.1.1.32

safety-related system

system performing *safety functions* according to IEC 61508

3.1.1.33

SIL claim limit (SIL CL)

maximum SIL that can be claimed for a *safety-related system* in relation to architectural constraints and systematic safety integrity

[IEC 62061, modified]

3.1.1.34

slave

passive communication entity able to receive messages and send them in response to another communication entity which may be a master or a slave

3.1.1.35

time stamp

time information included in a *message*

3.1.2 CPF 6: Additional terms and definitions

3.1.2.1

cycle

interval at which an activity is repetitively and continuously executed

3.1.2.2

parameterized shutdown time

safety function response time (worst-case response time for each safety function) without t_1 and t_2

NOTE See IEC 61784-3:2010, 5.2.4, Figure 4.

3.1.2.3

safety PDU

synonym for safety-related DLPDU

3.1.2.4

safety (input/output) data

data that is input or output safely at the external interfaces (terminal blocks) of the function blocks

3.2 Symbols and abbreviated terms

3.2.1 Common symbols and abbreviated terms

CP	Communication Profile	[IEC 61784-1]
CPF	Communication Profile Family	[IEC 61784-1]
CRC	Cyclic Redundancy Check	
DLL	Data Link Layer	[ISO/IEC 7498-1]
DLPDU	Data Link Protocol Data Unit	
EMC	Electromagnetic Compatibility	
EMI	Electromagnetic Interference	
EUC	Equipment Under Control	[IEC 61508-4:2010]
E/E/PE	Electrical/Electronic/Programmable Electronic	[IEC 61508-4:2010]
FAL	Fieldbus Application Layer	[IEC 61158-5]
FCS	Frame Check Sequence	
FS	Functional Safety	

FSCP	Functional Safety Communication Profile	
MTBF	Mean Time Between Failures	
MTTF	Mean Time To Failure	
PDU	Protocol Data Unit	[ISO/IEC 7498-1]
PELV	Protective Extra Low Voltage	
PES	Programmable Electronic System	[IEC 61508-4:2010]
PFH	Average frequency of dangerous failure [h^{-1}] per hour	[IEC 61508-6:2010 ⁹]
PhL	Physical Layer	[ISO/IEC 7498-1]
PL	Performance Level	[ISO 13849-1]
PLC	Programmable Logic Controller	
SCL	Safety Communication Layer	
SELV	Safety Extra Low Voltage	
SIL	Safety Integrity Level	[IEC 61508-4:2010]
SIL CL	SIL Claim Limit	[IEC 62061]

3.2.2 CPF 6: Additional symbols and abbreviated terms

3.2.2.1 Additional abbreviated terms

SCLM	Safety Communication Layer Master
SCLS	Safety Communication Layer Slave
SRC	Safety Relevant Controller
SRP	Safety Relevant Peripheral
S_CON_ID	Safety Connection ID

3.2.2.2 Additional symbols

Symbol	Definition	Unit
a	Number of all slaves	—
AF	Availability factor	—
I_s	Number of safety slaves	
M	Type 8 master implementation factor	—
n	Number of data octets	octet
n_{as}	Number of safety slaves	—
n_{FBS}	Number of used function blocks (in the safety-related application software)	—
P_e	Bit error probability	—
$R_{SL}(P_e)$	Residual error probability of a safety message	—
t_A	Response time of the actuator	ms
t_{CTSCS}	Cycle time of the functional safety communication system	ms
t_G	Guaranteed shutdown time	ms
T_{bit}	Nominal bit duration	ms
t_{IB}	Cycle time of the IEC 61158 Type 8 communication system	ms
t_{IN}	Processing time of the safety input	ms

⁹ To be published.

Symbol	Definition	Unit
t_{FBS}	Average function block processing time (in the safety-related application software)	ms
t_{OD}	Processing time of the safety output device	ms
t_{PST}	Parameterized shutdown time of a safety output	ms
t_S	Sensor response time	ms
t_{SF}	Safety function response time	ms
t_{SRC}	Processing time of the SRC	ms
t_{Stop}	Machine stopping time	ms
t_{SW}	Software processing time of the master (application specific)	ms
$\Lambda_{SL}(P_e)$	Residual error rate per hour of the safety communication layer with respect to the bit error probability	—
v	Maximum number of safety messages per hour	—

3.3 Conventions

The conventions for service definitions of IEC 61158-5-8:2007, 3.8.4, are used.

4 Overview of FSCP 6/7 (INTERBUS™ Safety)

4.1 General

Communication Profile Family 6 (commonly known as INTERBUS®¹⁰) defines communication profiles based on IEC 61158-2 Type 8, IEC 61158-3-8, IEC 61158-4-8, IEC 61158-5-8, and IEC 61158-6-8.

The basic profiles CP 6/1, CP 6/2, CP 6/3 are defined in IEC 61784-1. The CPF 6 functional safety communication profile FSCP 6/7 (INTERBUS Safety™¹⁰) is based on the CPF 6 basic profiles in IEC 61784-1 and the safety communication layer specifications defined in this part.

4.2 Technical overview

FSCP 6/7 uses the existing conveyance path for cyclic transmission of data (for process data). This is in principle a master slave concept with a physical ring topology and logical one-to-one relationships between one master and each of its slaves (Figure 3). The data is transmitted via a PDU – commonly known as summation frame – from which each slave extracts its output data and insert its input data.

¹⁰ INTERBUS® and INTERBUS Safety™ are trade names of Phoenix Contact GmbH & Co. KG, control of trade name use is given to the non profit organization INTERBUS Club. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this part does not require use of the trade names INTERBUS® or INTERBUS Safety™. Use of the trade names INTERBUS® or INTERBUS Safety™ requires permission of the INTERBUS Club.

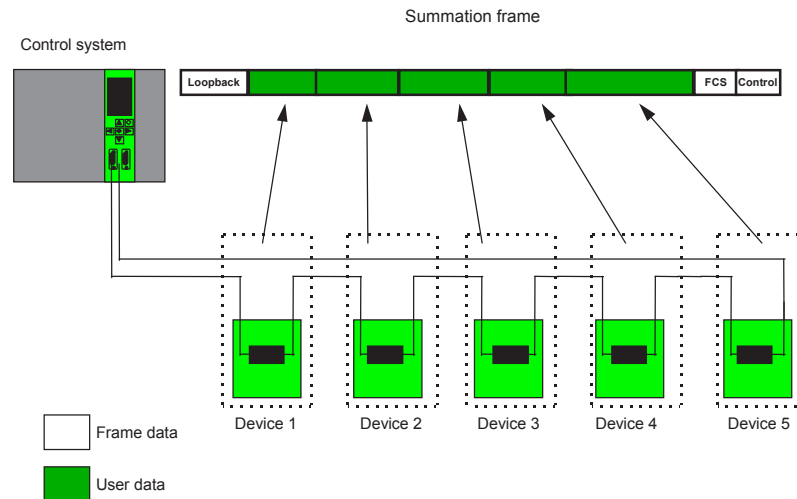


Figure 3 – FSCP 6/7 communication preconditions

The safety communication layer of FSCP 6/7 provides the following safety measures to realize its safety communication layer:

- sequence number;
- time stamp;
- connection authentication;
- cyclic redundancy checking for safety data integrity.

Sequence numbering uses the range from 001 to 111 without 000. The connection authentication (sender/receiver information) consists of 7 bits so that up to 126 slaves can be integrated in the safety fieldbus. Safety data can be conveyed from the safety master to each safety slave and from each safety slave to the safety master within a single data cycle. A separate watchdog timer in each safety output slave ensures a safety function response time for each safety function and can be widely parameterized. The watchdog timer can be adjusted for each safety output channel of a safety output slave.

The safety communication layer of FSCP 6/7 can be used for safety functions up to SIL 3. Therefore the safety fieldbus consumes at a maximum 1 % of the overall PFH. Within the safety fieldbus $\Lambda < 10^{-7}$ is achieved. An integrated watchdog timer providing the time expectation of each output channel on each safety output slave ensures a functional safety response time. The functional safety response time comprises the fieldbus transmission time from a safety input slave to the master and from the master to the safety output slave including also possible repetitions of the safety PDU due to transmission errors, the processing time on each safety slave (input and output) and the processing time within the PES (usually realized as a safety PLC with an integrated master) and the stopping time of a machine. If the configured time of the integrated watchdog timer of a specific output channel of a safety output slave is exceeded the corresponding output channel is set to its safe state which is usually the powerless state.

The structure of the safety PDU comprises the safety measures (sequence number, time stamp, connection authentication, CRC) and the safety data. The safety data and the safety measures for each safety slave will be integrated in the summation frame.

4.3 Functional Safety Communication Profile 6/7

The CPF 6 functional safety communication profile FSCP 6/7 is based on the CPF 6 profiles CP 6/1, CP 6/2 and CP 6/3 specified in IEC 61784-1. The profiles CP 6/1, CP 6/2 and CP 6/3 contain optional services, which are specified by profile identifiers. The suitable profile identifiers for CP 6/7 are shown in Table 1.

Table 1 – Overview of profile identifier usable for FSCP 6/7

Profile	Master		Slave		
	Cyclic	Cyclic and non cyclic	Cyclic	Non cyclic	Cyclic and non cyclic
Profile 6/1	618	619	611	—	613
Profile 6/2	—	629	—	—	623
Profile 6/3	—	639	—	—	633

The safety communication layer specification given in this part fully applies.

5 General

5.1 External documents providing specifications for the profile

Manufacturers of a safety device are recommended to check the documents [31], and [44] to [50] that provide additional specifications which may be relevant for implementation of the SCL defined in this part.

5.2 Safety functional requirements

Requirements for the design of safety devices such as safety master and safety slaves are outside the scope of this part. The designer of such devices shall have take into account the requirements of IEC 61508.

Some of the requirements for the function blocks which shall be implemented on the safety devices are specified in 6.3. The requirements for the function blocks used in this part for specification of services and protocols are specified in 5.4.

Specifications of subsystems or elements according to IEC 61508 are implementation specific and therefore outside the scope of this part. This part only specifies the services and protocols for a functional safety communication system based on IEC 61158 series Type 8.

The description of safe states is given in 5.4.6.

5.3 Safety measures

5.3.1 General

The safety communication layer described in this part provides the following deterministic remedial measures to implement its safety communication layer:

- sequence number;
- time stamp;
- connection authentication;
- cyclic redundancy check for safety data integrity (CRC 24);
- different data integrity assurance systems.

The selection of the various measures for possible errors is shown in Table 2.

Table 2 – Selection of the various measures for possible errors

Communication errors	Deterministic Remedial Measures							
	Sequence number	Time stamp	Time expectation	Connection authentication	Feedback message	Data Integrity assurance	Redundancy with cross checking	Different data integrity assurance systems
Corruption						X		
Unintended repetition	X							
Incorrect sequence	X							
Loss	X							
Unacceptable delay		X ^c	X ^b					
Insertion	X			X ^a				
Masquerade				X				X
Addressing				X				
NOTE Table adapted from IEC 62280-2 [18] and EN 954-1 [27].								
^a Only for sender identification. Detects only insertion of an invalid source. ^b Required in all cases. ^c Time stamp is created locally on SCLS side. Detection of unintended repetition and incorrect sequence can not be done with this. IEC 61158 series Type 8 specific.								

5.3.2 Sequence number

Safety messages contain a sequence number with a width of 3 bits and a specified sequence (see 7.1 and 7.2). If the sequence is not followed, all safety related output signals shall be set to their safe states (Figure 47, Figure 48). All safety slaves shall have the same sequence number at all times (see 7.1 and 7.2).

5.3.3 Time stamp

The sequence number and a local clock can be used to generate a local relative time stamp for each SCLS. This relative time stamp refers to all safety input and output data in the system.

5.3.4 Time expectation

The SCLS can use the time stamp to determine whether or not the safety input data that is used to link the safety output data is too old.

5.3.5 Acknowledgement

An acknowledgement is provided when the sequence number is updated correctly.

5.3.6 Connection authentication

The connection authentication is implemented by a safety connection ID (S_CON_ID), which consists of 7 bits so that up to 126 slaves can be integrated in the functional safety communication system. The assignment of safety connection IDs shall be unique within a functional safety communication system.