SLOVENSKI STANDARD
oSIST prEN IEC 61800-5-3:2020

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Električni pogonski sistemi z nastavljivo hitrostjo - 5-3. del: Varnostne zahteve za kodirnike - Funkcionalne, električne in okoljske

Adjustable speed electrical power drive systems - Part 5-3: Safety requirements for encoders - Functional, Electrical and Environmental

Ta slovenski standard je istoveten z: prEN IEC 61800-5-3:2019

ICS:

29.200	Usmerniki. Pretvorniki. Stabilizirano električno napajanje	Rectifiers. Convertors. Stabilized power supply

oSIST prEN IEC 61800-5-3:2020 **en,fr,de**

22G/406/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 61800-5-3 ED1**	
DATE OF CIRCULATION: **2019-12-20**	CLOSING DATE FOR VOTING: **2020-03-13**
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IEC SC 22G : ADJUSTABLE SPEED ELECTRIC DRIVE SYSTEMS INCORPORATING SEMICONDUCTOR POWER CONVERTERS

SECRETARIAT: United States of America	SECRETARY: Mr Christopher Johnson
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY

☒ SUBMITTED FOR CENELEC PARALLEL VOTING ☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

Attention IEC-CENELEC parallel voting

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Adjustable speed electrical power drive systems - Part 5-3: Safety requirements for encoders - Functional, Electrical and Environmental

PROPOSED STABILITY DATE: 2022

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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IEC 61800 ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 5-3: Safety requirements for encoders – functional, electrical and environmental

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

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,

250 • withdrawn,
251 • replaced by a revised edition, or
252 • amended.
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INTRODUCTION

As a result of automation, demand for increased production and reduced operator physical effort, control systems of machinery and plant items play an increasing role in the achievement of overall safety. These control systems increasingly employ complex electrical/electronic/programmable electronic devices and systems.

Prominent amongst these devices and systems are *encoder* which are e.g. applied to measure angle and position of machine parts for use in safety-related applications (*Encoder(SR)*). Based on the *Encoder(SR)'s* output signals, *PDS(SR)* or other *evaluation units* calculate e.g. speed, acceleration, absolute position etc., to perform their *safety sub-functions* SLS, SLA, SLP and others (see IEC 61800-5-2:2016, clause 4). The *signal processing* necessary to perform some of these *safety sub-functions* may also be included in the *Encoder(SR)*.

Examples of industrial applications are:

- machine tools, robots, production test equipment, test benches;
- papermaking machines, textile production machines, calendars in the rubber industry;
- plastics processing lines, chemicals or metal production lines, rolling-mills;
- cement crushing machines, cement kilns, mixers, centrifuges, extrusion machines;
- drilling machines;
- conveyors, materials handling machines, hoisting equipment (cranes, gantries, etc.);
- pumps, fans, etc.

This standard can also be used as a reference for developers using *Encoder(SR)* for other applications, e.g. in wind power plants.

Users of this standard should be aware that some type C standards for machinery currently refer to ISO 13849-1 for safety-related control systems. In this case, *Encoder(SR)* manufacturers may be requested to provide further information (e.g. category and *performance level PL*) to facilitate the integration of an *Encoder(SR)* into the safety-related control systems of such machinery. This has been considered during development of this standard and corresponding indications are included where appropriate.

NOTE "Type C standards" are defined in ISO 12100 as machine safety standards dealing with detailed safety requirements for a particular machine or group of machines.

There are many situations where control systems that incorporate *Encoder(SR)* are employed, for example as part of safety measures that have been provided to achieve risk reduction. A typical case is reducing the speed during start-up in order to protect personnel from hazards arising by unexpected fast movements of machine parts. This part of IEC 61800 gives a methodology to identify the contribution made by an *Encoder(SR)* to identified safety *sub-functions* and to enable the appropriate design of the *Encoder(SR)* and verification that it meets the required performance.

Measures are given to co-ordinate the safety performance of the *Encoder(SR)* with the intended risk reduction taking into account the probabilities and consequences of its random and systematic *faults*.

1 Scope

This part of IEC 61800, which is a product standard, specifies requirements and makes recommendations for the design and development, integration and validation of safety related *encoder* (*Encoder(SR)*) in terms of their *functional safety* considerations, electrical safety and environmental conditions. It applies to *Encoder(SR)*, being sensors as part of a *PDS(SR)*.

This standard can also be referred to and used for *Encoder(SR)* in any other safety-related application, e. g. safety-related position monitoring.

NOTE 1 The term "integration" refers to the *Encoder(SR)* itself, not to its incorporation into the safety-related application.

NOTE 2 This standard specifies only complementary *functional safety*, electrical safety and environmental condition requirements that are not clearly provided by other parts of the IEC 61800 series.

This International Standard is applicable where *functional safety* of an *encoder* is claimed and the *Encoder(SR)* is operating mainly in the high demand or continuous mode.

NOTE 3 While low demand mode operation is possible for an *Encoder(SR)*, this standard concentrates on high demand and continuous mode. *Safety sub-functions* implemented for high demand or continuous mode can also be used in low demand mode. Requirements for low demand mode are given in IEC 61508 series. Some guidance for the estimation of average probability of *dangerous failure* on demand (PFD_{avg}) value is provided in IEC 61800-5-2:2016, Annex F.

The requirements of IEC 61800-5-2:2016 for *PDS(SR)* apply to *Encoder(SR)* as applicable. This part of IEC 61800 includes additional or different requirements for *Encoder(SR)*. It sets out safety-related considerations of *Encoder(SR)* in terms of the framework of IEC 61508, and introduces requirements for *Encoder(SR)* as subsystems of a safety-related system. It is intended to facilitate the realisation of the electrical/ electronic/ programmable electronic (E/E/PE) and mechanical parts of an *Encoder(SR)* in relation to the safety performance of *safety sub-function*(s) of a *PDS(SR)*.

Manufacturers and suppliers of *Encoder(SR)* will by using the normative requirements of this part of IEC 61800 indicate to users (system integrator, original equipment manufacturer) the safety performance of the *Encoder(SR)*. This will facilitate the incorporation of *Encoder(SR)* into safety-related control systems using the principles of IEC 61508, and possibly its specific sector implementations (for example IEC 61511, IEC 61513, IEC 62061 or ISO 13849).

By applying the requirements from this part of the IEC 61800 series, the corresponding requirements of IEC 61508 that are necessary for an *Encoder(SR)* are fulfilled.

This part of IEC 61800 does not specify requirements for:

- the functional properties of an *Encoder(SR)* without any safety relevance;
- the *hazard* and risk analysis of a particular application;
- the identification of *safety sub-functions* for that application;
- the initial allocation of *SIL*s to those *safety sub-functions*;
- the driven equipment except for interface arrangements;
- secondary *hazard*s (for example from failure in a production or manufacturing process);
- the *Encoder(SR)* manufacturing process;
- the validity of signals and commands to the *Encoder(SR), and*
- security aspects (e.g. cyber security or *Encoder(SR)* security of access)

NOTE 4 The *functional safety* requirements of an *Encoder(SR)* are dependent on the application, and can be considered as a part of the overall risk assessment of the installation. Where the supplier of the *Encoder(SR)* is not responsible for the driven equipment, the installation designer is responsible for the risk assessment, and for specifying the functional and safety integrity requirements of the *Encoder(SR)*.

This part of IEC 61800 applies to *Encoder(SR)* implementing *safety sub-functions* with a *SIL* not greater than *SIL* 3.

This part of IEC 61800 provides additional information for *Encoder(SR)* claiming conformity with ISO 13849-1:2015.

Figure 1 shows the installation and the functional parts of a *PDS(SR)* including the *Encoder(SR)* (sensor) which is considered in this part of IEC 61800.

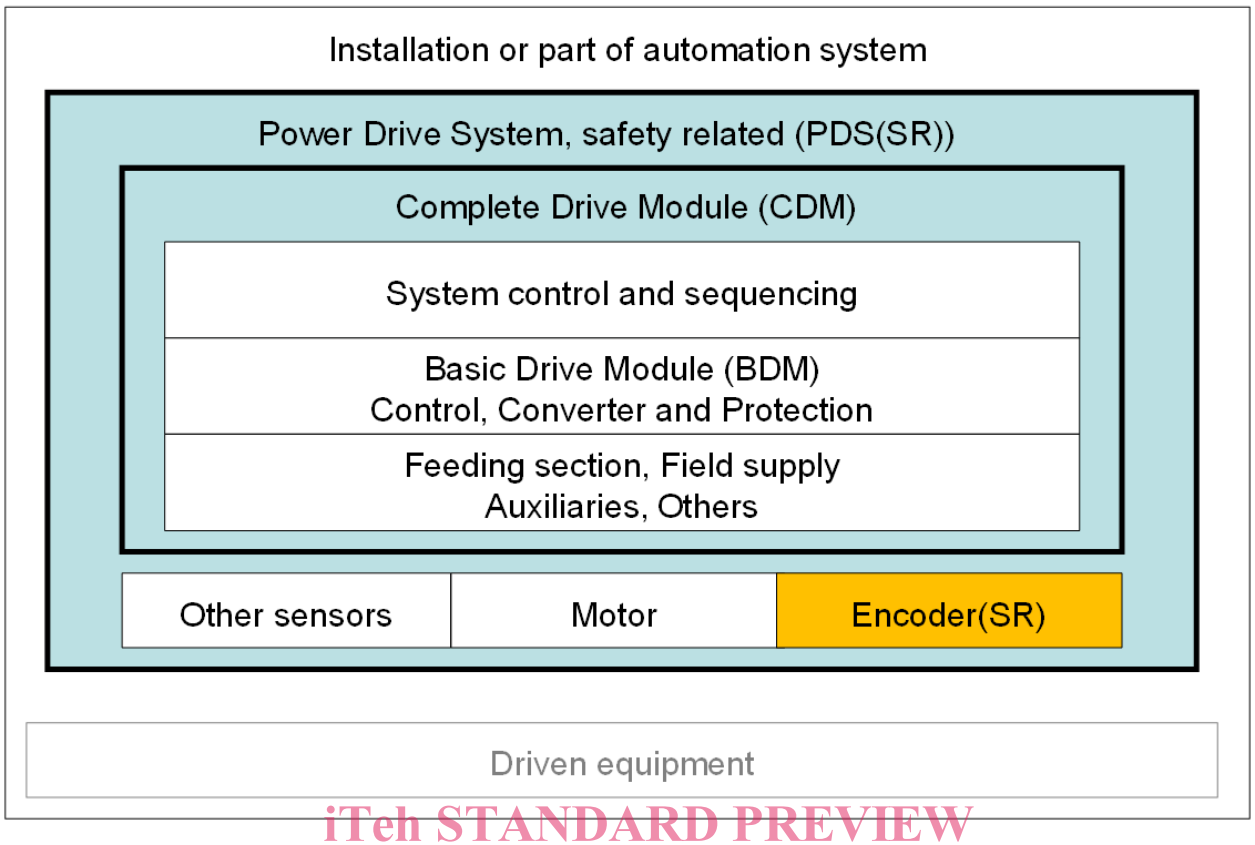

Figure 1 – Context of *Encoder(SR)*

Figure 1 shows a logical representation of a *PDS(SR)* rather than its physical description.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 This does not mean that compliance is required with all clauses of the referenced documents, but rather that this document makes a reference that cannot be understood in the absence of the referenced documents.

IEC 60068-2-47, *Environmental testing – Part 2-47: Tests – Mounting of specimens for vibration, impact and similar dynamic tests*

IEC 61000-6-7, *Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

IEC 61508-2: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

IEC 61508-6: 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3*

IEC 61709: 2017 *Electric components - Reliability - Reference conditions for failure rates and stress models for conversion*

IEC 61784-3: 2016, *Functional safety fieldbuses – General rules and profile definitions*

IEC 61800-1:1997, *Adjustable speed electrical power drive systems – Part 1: General requirements – Rating specifications for low voltage adjustable speed d.c. power drive systems*

IEC 61800-5-1: 2016 CSV [Consolidated Version, Edition 2.1], *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61800-5-2: 2016, *Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional*

ISO 13849-1: 2015, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 13849-2: 2012, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation*

ISO/TS 16281:2008 *Rolling bearings -- Methods for calculating the modified reference rating life for universally loaded bearings*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. Table 1 shows a list of terms and definitions.

Table 1 – List of terms and definitions

3.1	*encoder*	3.19	*functional safety*
3.2	*Encoder(SR)*	3.20	*safety function*
3.3	*interface unit*	3.21	*safety sub-function*
3.4	*evaluation unit*	3.22	*fault*
3.5	*PDS(SR)*	3.23	*dangerous failure*
3.6	*tolerance range*	3.24	*hardware fault tolerance* *HFT*
3.7	*Interpolation*	3.25	*single-fault tolerance*
3.8	*solid measure*	3.26	*safety integrity level* *SIL*
3.9	*mechanical fastening*	3.27	*SIL capability*
3.10	*mechanical connecting element*	3.28	*performance level* *PL*
3.11	*shaft-rotor coupling*	3.29	*diagnostic coverage* *DC*
3.12	*stator coupling*	3.30	*safe failure fraction* *SFF*
3.13	*bearing blockage*	3.31	*average frequency of a dangerous failure* *PFH*
3.13.1	*spontaneous bearing blockage*	3.32	*mean time to dangerous failure* $MTTF_D$
3.13.2	*gradual bearing blockage*	3.33	*process safety time*
3.14	*measurement point for working temperature*	3.34	*Ideal fault detection*
3.15	*working temperature range*	3.35	*quantitative FMEDA*
3.16	*extra low voltage* *ELV*	3.36	*qualitative FMEDA*

3.17	*protective ELV (PELV) circuit*	3.37	*signal evaluation*
3.18	*decisive voltage class* *DVC*	3.38	*signal processing*

NOTE Throughout this International Standard, references to the following definitions are identified by writing them in *italic* script.

3.1
encoder
electromechanical device that generates an analogue or digital output signal in response to the position of a moveable part

Note 1 to entry: Within this standard the definition of '*encoder*' includes resolvers and all types of motor feedback sensors.

Note 2 to entry: Annex A includes examples of type of *encoder*.

3.2
Encoder(SR)
encoder providing *safety sub-function(s)*

Note 1 to entry: The *safety sub-function(s)* of the *Encoder(SR)* allow(s) execution of *safety sub-functions* of a *PDS(SR)* or any other safety application.

[SOURCE: IEC 61800-5-2:2016, 3.16, modified – "adjustable speed electrical power drive system" replaced by "*encoder*"]

3.3
interface unit
separate electronic subassembly of the *Encoder(SR)* for signal conversion

Note 1 to entry: The functionality of the *interface unit* may be integrated in the *Encoder(SR)*.

3.4
evaluation unit
external item of equipment in which the output signal of the *Encoder(SR)* is evaluated

Note 1 to entry: Examples for *evaluation units* are *PDS(SR)*, safety elements for monitoring speed or stoppages.

Note 2 to entry: The *evaluation unit* may also perform diagnostic measures for the *Encoder(SR)*.

3.5
PDS(SR)
adjustable speed electrical power drive system providing *safety sub-functions*

[SOURCE: IEC 61800-5-2:2016, 3.16]

3.6
tolerance range
span between upper and lower tolerance limit

Note 1 to entry: The *tolerance range* is expressed in measuring units.

Note 2 to entry: Tolerance range T(R) is usually given in the form T(R): -X to +Y, with T(R) = X+Y; (e.g. -5 to +5, 0 to +10, ...).

Note 3 to entry: The tolerance range should take into account accuracy and resolution.

EXAMPLE 1:Tolerance range for an Encoder(SR) with digital output signals.

EXAMPLE 2:Tolerance range for an Encoder(SR) with analogue output signals.

3.7
interpolation
mathematical method for resolution enhancement

EXAMPLE Forming the arc tangent of the ratio of analogue sine and cosine signal (A-/B-Signals).