



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

**01-marec-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

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

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**ICS:**

29.200

Usmerniki. Pretvorniki.  
Stabilizirano električno  
napajanje

Rectifiers. Convertors.  
Stabilized power supply

**oSIST prEN IEC 61800-5-3:2020**

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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: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
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<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING <input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING	
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TITLE:

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

PROPOSED STABILITY DATE: 2022

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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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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

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

263 Prominent amongst these devices and systems are *encoder* which are e.g. applied to measure angle  
 264 and position of machine parts for use in safety-related applications (*Encoder(SR)*). Based on the  
 265 *Encoder(SR)*'s output signals, *PDS(SR)* or other *evaluation units* calculate e.g. speed, acceleration,  
 266 absolute position etc., to perform their *safety sub-functions* SLS, SLA, SLP and others (see IEC  
 267 61800-5-2:2016, clause 4). The *signal processing* necessary to perform some of these *safety sub-*  
 268 *functions* may also be included in the *Encoder(SR)*.

269 Examples of industrial applications are:

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

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

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

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

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

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

## 295 1 Scope

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

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

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

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

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

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

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

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

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

324 This part of IEC 61800 does not specify requirements for:

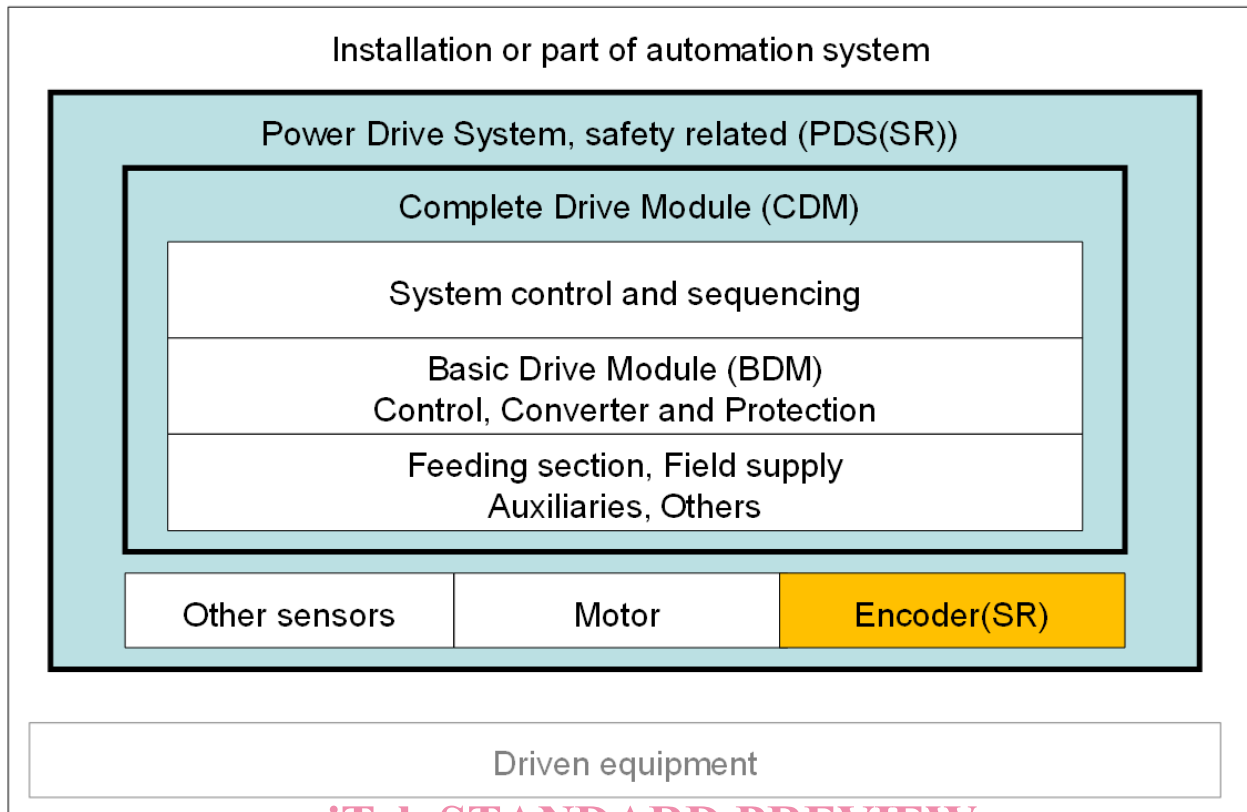
- 325 • the functional properties of an *Encoder(SR)* without any safety relevance;
- 326 • the *hazard* and risk analysis of a particular application;
- 327 • the identification of *safety sub-functions* for that application;
- 328 • the initial allocation of *SILs* to those *safety sub-functions*;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

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

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

340 This part of IEC 61800 provides additional information for *Encoder(SR)* claiming conformity with ISO  
341 13849-1:2015.

342 Figure 1 shows the installation and the functional parts of a *PDS(SR)* including the *Encoder(SR)*  
343 (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*

- 370 IEC 61784-3: 2016, *Functional safety fieldbuses – General rules and profile definitions*
- 371 IEC 61800-1:1997, *Adjustable speed electrical power drive systems – Part 1: General requirements –*  
372 *Rating specifications for low voltage adjustable speed d.c. power drive systems*
- 373 IEC 61800-5-1: 2016 CSV [Consolidated Version, Edition 2.1], *Functional safety of*  
374 *electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*
- 375 IEC 61800-5-2: 2016, *Adjustable speed electrical power drive systems – Part 5-2: Safety*  
376 *requirements – Functional*
- 377 ISO 13849-1: 2015, *Safety of machinery – Safety-related parts of control systems – Part 1: General*  
378 *principles for design*
- 379 ISO 13849-2: 2012, *Safety of machinery – Safety-related parts of control systems – Part 2:*  
380 *Validation*
- 381 ISO/TS 16281:2008 *Rolling bearings -- Methods for calculating the modified reference rating life for*  
382 *universally loaded bearings*

### 383 3 Terms and definitions

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

386 **Table 1 – List of terms and definitions**

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

3.17	<i>protective ELV (PELV) circuit</i>	3.37	<i>signal evaluation</i>
3.18	<i>decisive voltage class DVC</i>	3.38	<i>signal processing</i>

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

### 389 **3.1**

#### 390 **encoder**

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

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

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

### 395 **3.2**

#### 396 **Encoder(SR)**

397 *encoder* providing *safety sub-function(s)*

398 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  
399 any other safety application.

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

### 402 **3.3**

#### 403 **interface unit**

404 separate electronic subassembly of the *Encoder(SR)* for signal conversion

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

### 406 **3.4**

#### 407 **evaluation unit**

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

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

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

### 411 **3.5**

#### 412 **PDS(SR)**

413 adjustable speed electrical power drive system providing *safety sub-functions*

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

### 415 **3.6**

#### 416 **tolerance range**

417 span between upper and lower tolerance limit

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

419 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  
420 +10, ...).

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

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

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

424

425

### 426 **3.7**

#### 427 **interpolation**

428 mathematical method for resolution enhancement

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