

## ***Translation***

Principles of testing and certification for  
electromechanical enabling switches and enabling  
devices

Status as of 2010-11

Expert committee for electrical engineering  
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**GS-ET-22**

These Principles of testing serve as verification that the requirements of the German Equipment and Product Safety Act (GPSG) and, as such, the 1st and 9th provisions of the GPSG in particular, have been complied with in connection with DIN EN 60947-5-8.

These principles will be revised and supplemented periodically in consideration of knowledge gained in the area of occupational health and safety, as well as technical progress. The most recent edition shall always be binding for tests conducted by the testing and certification body of the committee for electrical engineering.

The Principles of testing, GS-ET-22, Issue 11.05, may be used until 29.12.2009.

These Principles of testing supplement the requirements and tests set forth in DIN EN 60947-5-8 for enabling switches and devices with additional requirements.

**Note:** DIN EN 60947-5-8 is not covered in all points from the following principles of testing.

**This is the English translation of the German test principle. The German original version is obligatory.**

***Changes with respect to Issue 11.05:***

- ***New structural classification related to DIN EN 60947-5-8***
- ***Reconciliation of content related to Directives 2006/42/EC, 2006/95/EC and 2004/108/EC***
- ***Inclusion of content related to DIN EN 60947-5-8:2007***
- ***Inclusion of requirements in accordance with DIN EN ISO 13849-1 + 2***
- ***Generally:***
  - ***Editorial changes,***
  - ***Updating of standards***

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## **1 General**

### **1.1 Scope**

These Principles of testing are set forth as a basis for the testing of electromechanical enabling switches (two- and three-position design) or of stationary or non-stationary enabling equipment (DIN EN 60947-5-8: enabling device), henceforth referred to as enabling switch(es)/enabling device(s).

Electromechanical enabling devices are used in industry robots and automated manufacturing systems, for example, to effect control functions under hazardous conditions via different command devices.

*Note: Unless otherwise mentioned, all requirements of the test principles refer to enabling switches/devices in two- and three-position configuration.*

#### **1.1.1 Classification of directives**

Electromechanical enabling switches or enabling devices are included within the scope of Directive 98/37/EC and, as of 29.12.2009, within the scope of Directive 2006/42/EC as well as Directive 2006/95/EC, depending on the level of voltage. With the use of active electronic components, it is possible that the equipment will fall within the scope of Directive 2004/108/EC.

## **2 Terms/Characteristic features**

### **2.1 Definition of terms**

DIN EN 60947-5-8:2007, Section 2, applies with the following additions:

#### **2.1.1 Enabling switch**

The enabling switch designates the circuit element that takes over the Off or Enable position via an actuator when under the influence of a corresponding force.

#### **2.1.2 Two-position enabling switch**

- ▶ Position 1: Off-function (control actuator not depressed)
- ▶ Position 2: Enable function (control actuator depressed)

### 2.1.3 Enabling device

The definition of terms from DIN EN 60947-5-8, Section 2.1 applies.

The enabling device designated in DIN EN ISO 12100-1 is the identical to the enabling device designated in DIN EN 60947-5-8.

Enabling devices are connected with a start-up controller, yet they do not necessarily form a physical unit. The start-up controller can be a part of the machine's control unit as well as a separate start-up control unit.

*Note:*                    *Enabling devices are not only restricted to equipment intended to be actuated by hand (see DIN EN 60947-5-8, Section 4.2.1).*

### 2.1.4 Start-up controller

Within the context of these Principles of testing, the start-up controller is a signal processor that warrants the enabling switch/device safety function in connection with monitoring measures, such as contact and performance monitoring.

Additionally, other functions, such as start functions, can be integrated in this signal processor.

*Note:* *If the start-up controller is required for the safety function, it should be considered as an integral part of the enabling equipment. If it is not required for the safety function of the enabling equipment, it should not be considered as an integral part within the context of GS-ET-22.*

### 2.1.5 Safety function

A machine function, through which a loss of the function will lead to an immediate increase in the level of risk (the risks).

### 2.1.6 Bypass

Bypass is the exertion of an influencing in order to alter the intended use of an object.

## 2.2 Characteristic features

DIN EN 60947-5-8:2007, Section 4 applies.

### **3 Test documentation to be submitted**

#### **3.1 Technical documents**

The information for connection and commissioning of the electromechanical enabling switches/devices must be provided in the form of drawings, circuit diagrams, tables and user information. The following test documents must be submitted for the technical test:

- Instruction manual
- Sales literature (if available)
- Block circuit diagram (if applicable)
- Electric circuit diagram
- Description of the functional process
- Parts list(s)
- Maintenance procedures and setting instructions (if applicable)
- Installation instructions
- Insofar as they are available, data sheets, test certificates, certificates for the enabling switch/enabling device and/or the parts it comprises;
- Printed circuit board layouts (if applicable)
- Layout diagrams (if applicable)
- Software documentation (if applicable)
- Insofar as a  $B_{10d}$ -value is specified for the enabling switch, which is larger than the typical values listed in DIN EN ISO 13849-1, Table C.1, all test reports, test certificates and calculations, which were used in its determination, must be provided.
- FMEA and fault-combination analysis for enabling equipment

The testing facility can request further documents if necessary.

#### **3.2 Prototype**

As a rule, three type prototype samples are to be provided for the test.

The testing facility can request additional prototypes if necessary.

### **4 General test conditions**

Electromechanical enabling switches/devices must satisfy all the requirements below. Fulfilment of farther reaching manufacturer specifications must be verified separately. Tests shall be conducted on enabling switches/devices according to the rating data specified by the manufacturer.

Refer to DIN EN 60947-1, Table 8, for test value variance limits.

Unless otherwise specified in the individual test instruction, the proper functioning of the enabling switches/devices must be ascertained prior to the initial test, and subsequent to each individual test.

## **5 Product information**

DIN EN 60947-5-8:2007, Section 5 is replaced by Sections 5.1 to 5.3 of the Principles of testing.

*Note:* Sections 5.1 to 5.3 of the Principles of testing also comply with the requirements of DIN EN 60947-5-8:2007, Section 5.

### **5.1 Labels and markings**

#### **5.1.1 Type plate**

The following information must be provided on the outer casing:

- Manufacturer's/authorised representative's name and complete address
- Nomenclature of the safety component
- CE-marking
- Design series or type designation
- Serial number, as appropriate
- Year of manufacture
- IP-Protection class
- Symbol for Protection class II or III, if applicable
- „IEC 60947-5-8“, in the event the manufacturer claims conformity with this standard
- Type of design: two-stage or three-stage  
On three-stage models, the alternative symbol in accordance with Section 5.1 (d) of DIN EN 60947-5-8: 2007
- Actuation forces/actuation strokes\*
- Rated operational voltage\*
- Rated operational current\*
- Utilization category\*
- Rated insulation voltage and rated surge voltage resistance\*
- Degree of contamination (see IEC 60947-5-1, Section 6.1.3.2)\*

- Type of and highest rated value of the short-circuit devices (see IEC 60947-5-1, Section 8.3.4.3)\*
- Conditional short-circuit current if lower than 1000A\*
- Mechanical and/or electrical service life\*

\* The specifications can be provided on the type plate or in the Instruction manual.

**Test:** Visual inspection of the available prototype or the Instruction manual, as necessary.

### 5.1.2 Terminal connection designation and identification

Terminal connections and clamps must be identified in accordance with DIN EN 60947-1, Section 7.1.8.4.

**Test:** Visual inspection of the available prototype.

### 5.1.3 Functional identification

Black, white or grey should be chosen as colour for the actuator. Other colours are permissible if there is not potential for mix-up with the emergency-stop device. The colour red is not permissible.

**Test:** Visual inspection.

### 5.1.4 Size of graphic symbols, lettering and digits

The size of graphic symbols, lettering and digits must be at least 2 mm.

**Test:** Visual inspection/measurement of inscriptions or those on the type plate (if available).

### 5.1.5 Durability

Inscriptions must be durable and clearly legible.

**Test:** Gently rub using two cotton cloths, one soaked in water and the other in a test fluid\*, for 15 s each.

The markings must remain clearly legible. It must not be possible to easily remove the marking labels, nor should they be wrinkled or creased.

\*The chemical product with the trade name "n-Hexan for analysis" fulfils the requirements for the test fluid defined in DIN EN 60335-1 and DIN EN 60950-1.

### 5.1.6 Position

The inscriptions should not be affixed to assembly parts (screws, washers, seals).

**Test:** Visual inspection.

## 5.2 Instruction manual

The enabling switches/devices should be accompanied by the information required for proper connection and commissioning.

Safety-related information must be provided in a language acceptable in the country, in which the enabling switch/enabling device is to be installed.

If the Instruction manual is not in German, a German translation must be provided.

The test will be conducted with reference to the German translation.

The Instruction manual supplied with the product must contain the following characteristic features of the enabling switch/enabling device:

- Manufacturer's/authorised representative's name and complete address
- Designation of the safety component (enabling switch or enabling device)
- Rendering of the content found in the Declaration of Conformity (except for serial number and signature)
- General description of the safety component
- Terminal connection diagram/Circuit diagram
- Example of an application (integration in the machine controller) for realization of the planned category or performance levels in accordance with DIN EN ISO 13849-1 or, as necessary, special required components or parameters must be more closely specified.
- Description of intended usage
- Warning notices, as necessary, related to foreseeable faulty application thereof
- Specification of the safety function
- Instructions for assembly, installation and connection of the safety component, including drawings, circuit diagrams and attachments
- Annotated reference that the enabling switch/enabling device user should evaluate and document the remaining residual risk.

- Description of required maintenance measures, if applicable
- Technical specifications for electrical system components:
  - The missing specifications from Section 5.1.1 of the Principles of testing, if applicable
  - Overvoltage category
  - Degree of contamination
  - Rated insulation voltage
  - Information about short-circuit equipment
  - Specification of the conductor type, as well as largest and smallest conductor cross-sections, for which the conductor clamps are suitable.
- Maximum enabling switch actuation count
- Specifications according to DIN EN ISO 13849-1:

Enabling device with start-up controller:

- Category
- PL
- $MTTF_d$  or PFH

Enabling switch and enabling device without start-up controller:

- $B_{10d}$  value

- Ambient temperature range
- IP protection class for enabling switch or enabling device
- Information regarding fault characteristics
- Notice to the user that the overall control concept, into which the enabling switch/enabling device has been integrated, must be validated in accordance with DIN EN ISO 13849-2.
- Note: Electromechanical enabling switches/devices need to be connected with the control unit in such a manner that the safety-related demands on electric circuit are fulfilled in accordance with DIN EN ISO 10218-1, DIN EN 60204-1, DIN EN ISO 13849-1 and DIN EN ISO 11161, as well as VDI 2854.
- Annotated reference that control signals introducing potentially hazardous conditions must not be initiated by enabling switches, alone (see EN 60204-1, Section 9.2.6.3).
- Information regarding the use of two or more enabling switches in one unit; see Section 9

- The supplemental information provided in DIN EN 60947-5-1, Section 5.4, is valid only for enabling switches, whose completion to an enabling device is foreseen together with an additional mechanical enabling system.

**Test:** Review of the technical documents submitted; check for completeness, correctness and consistency.

### **5.3 Sales literature**

Sales literature, in which the enabling switch/enabling device is described, must not contradict the Instruction manual with respect to usage. If performance characteristics are described in the sales literature, these must agree with the specifications in the Instruction manual.

**Test:** Review of the technical documents submitted; check for correctness and consistency.

## **6 Normal operating, installation and transport conditions**

DIN EN 60947-5-8:2007, Section 6 applies with the following supplements:

### **6.1 Supplement to DIN EN 60947-1, Section 6.1.1**

**Test:** The enabling switch/device should be stored at highest and lowest temperature limits until a steady state condition is realized and must pass the functional test according to DIN EN 60947-5-8, Section 8.2.5.

## **7 Requirements for construction and characteristics**

### **7.1 Construction requirements**

DIN EN 60947-5-8:2007, Section 7.1 applies with the following supplements:

### 7.1.1 Supplement to DIN EN 60947-5-8, Section 7.1.1

Insulating materials must be sufficiently resistant to heat and fire.

**Test A:** Ball pressure test of the switching element at 125 °C and of the casing at 75 °C.  
The test is undertaken in a heating cabinet at a temperature of (125 ± 2) °C or (75 ± 2) °C respectively. The test object is heated to the appropriate temperature.

The surface of the test object is then placed in a horizontal position and a steel ball with a diameter of 5 mm is pressed against this surface with a force of 20 N.

After one hour, the ball is removed from the test object, which is then cooled to the approximate room temperature within 10 s through immersion in cold water. The diameter of the impression left by the ball is then measured, which must not be larger than 2 mm.

**Test B:** DIN EN 60947-1, Section 7.1.1.1 applies.

Insulating materials, which are used to affix current-carrying components in place, must be tested at a heat-filament temperature of 850 °C, with all other insulating materials being tested at 650 °C.

The test is carried out according to DIN EN 60947-1, Section 8.2.1.1.1 in conformity with DIN EN 60695-2-10 and DIN EN 60695-2-11.

### 7.1.2 Supplement to DIN EN 60947-5-8, Section 7.1.4.3

The enabling switches/devices must be designed from an ergonomic perspective in order to facilitate actuation and fatigue-free manual handling over a longer period of time.

**Test:** Actual trial

### 7.1.3 Supplement to DIN EN 60947-5-8, Section 7.1.7

Protection class I, II or III conforming to DIN EN 61140 may be applied.

**Test:** Visual inspection of the prototype on hand, review of the technical documentation related to the rated operating voltage.

### 7.1.4 Supplement to DIN EN 60947-5-8, Section 7.1.8

#### 7.1.4.1 Cable insertion point

Enabling equipment must be designed with tension-/pressure-relief in order to relieve the cables from strain and pressure, as well as twisting.

The connection cable must be outfitted with a bend/kink protection sleeve or trumpet-shaped inlet opening at the location where the connection cable enters the enabling device enclosure.

Suitable tension relief and bend/kink protection must be provided for all existing plug connections in the circuit.

**Test:** Visual inspection of the prototype on hand as to whether the construction requirements above have been fulfilled.  
Tests according to DIN EN 60947-5-1, Annex G.

#### 7.1.4.2 Cable assembly

Enabling switches/devices must be designed in such a manner that the connection cables described in the Instruction manual can be connected. At the same time, the switches/devices referenced above must be equipped with the possibility for monitoring short- and cross-circuits connections. This depends on the usage and the desired performance level according to DIN EN ISO 13849-1.

Note: *Avoidance of short-circuits can be achieved through the use of isolated sheathed cables within the connection circuitry. A closure between different enabling circuits can be recognized by switching the individual circuits to various potentials.*

**Test:** Review of the user information and appropriate visual inspection of the prototype.

### 7.1.4.3 Environmental influences

Connection lines must be resistant to environmental influences. It must be considered that connection lines on portable enabling equipment, in particular, will be pulled over the floor on a regular basis.

**Test:** Visual inspection of the connection lines and review of the data sheets.

### 7.1.4.4 Conductor cross-sections

Individual conductor cross-sections in the connection circuit must be at least 1 mm<sup>2</sup>. Smaller cross-sections are permissible if the mechanical stability of the connection line can be otherwise guaranteed (e.g. protective tube covering).

**Test:** Measurement and calculation of the individual conductor cross-sections; evaluation of the connection circuitry.

### 7.1.5 Supplement to DIN EN 60947-5-8, Section 7.1.9

The spring for resetting stage 2 or stage 3 back to 1 must be designed as a reliable spring according to DIN EN ISO 13849-2, Table A5 or A2. Alternatively, and depending on the individual situation, a dual-channel reset-system assembly (without reliable spring) and contact monitoring can be realized.

**Test:** Trial of the prototype on hand, visual inspection as to whether the specified requirements are fulfilled, measurement of the winding distance and comparison with the wire diameter, as necessary.

Three-staged enabling switches/devices must have at least one positively opening break-contact circuit element for the third stage in accordance with DIN EN 60947-5-1, annex K. Alternatively, comparably safe techniques can be used (e.g. dual-channel signalling with corresponding control-related monitoring).

Additionally, the third stage may contain a make-contact circuit element that must be galvanically isolated from the break-contact circuit element. Further galvanically isolated circuit elements, such as signalling contacts, are permissible.

Overlapping contact signals for the third stage by make- and break-contact circuit elements are not permissible.

The control actuator can latch into the actuated position with actuation of the third stage.

**Test:** Functional check of the prototype on hand, manual test or, dismantle a prototype to determine if the criteria above has been fulfilled, as necessary.

### 7.1.6 Supplement to DIN EN 60947-5-8, Section 7.1

Protection against bypassing

Enabling switches/devices must be constructed in such a manner that

In the context of VDI 2854, control actuators must not be able to be bypassed (e.g. shielded push-button, push-button with circumferential collar, push-button positioned in a depression, etc.).

The protection against bypassing can also be achieved via the controller. For example,

- the electromechanical enabling switch can be re-actuated with each new aligning or test cycle,
- the actuation can be time-limited.

**Note:** *The measures taken against simple bypassing must always consider ergonomic actuation options. Consequently, design measures, in part, are possible only on a limited basis. This does not relieve the manufacturer from initiating appropriate design measures, however.*

**Test:** Visual inspection of the prototype, check the switch operating function (if present) according to the criteria above.

### 7.1.7 Supplement to DIN EN 60947-5-8, Section 7.1

External materials and properties:

No materials containing substances harmful to health may be used on any part of the enabling switch/device that comes in regular contact with the operator's skin.

**Test:** Review of the safety data sheets for the materials used, especially with regard to the proportion of polycyclic aromatic hydrocarbons (PAH).  
Test according to the ZEK decision ZEK 01.2-08.

Unit components accessible by hand must have no sharp corners or edges, or abrasive surfaces that can cause injuries.

**Test:** Handling and visual inspection.

## 7.2 Characteristic requirements

DIN EN 60947-5-8:2007, Section 7.2 applies with the following supplements:

### 7.2.1 Fall times for safety-related contacts

The fall time for safety-related output contacts in the start-up controller must be maximum 200 ms.

**Test:** Measurement of the contact fall time at the tolerance specification limits zone for the operating voltage.

## 8 Tests

### 8.1 Type of tests

DIN EN 60947-5-8:2007, Section 8.1 applies with the following variance:

#### 8.1.1 DIN EN 60947-5-8, Section 8.1.3 is replaced as follows:

Functional test

The intended function of each enabling switch or enabling device must be checked with consideration given to the following designs:

- a) two-stage design:
  - ▶ Position 1: Off-function (control actuator not depressed)
  - ▶ Position 2: Enable function (control actuator depressed)
  
- b) three-stage design:
  - ▶ Position 1: Off-function (control actuator not depressed)
  - ▶ Position 2: Enable function (control actuator pressed to the middle position)
  - ▶ Position 3: Off-function forced opening (control actuator pressed to the middle position)

The enabling function must not be activated when returning from position 3 to position 2.
  
- c) With multiple enabling switches in one unit, the proper sequential interaction of the switches must be checked.

Depending on the enabling switch/device assembly design and the installation conditions, additional component tests may need to be carried out at the responsibility of the manufacturer.

### 8.2 Conformance to construction requirements

DIN EN 60947-5-8:2007, Section 8.2 applies.

### **8.3 Operating characteristics**

DIN EN 60947-5-8:2007, Section 8.3 applies with the following supplements:

Note: For enabling switches/devices with Protection class II, the test voltage for doubled or reinforced insulation used during the „verification of insulation“ test must be selected in accordance with DIN EN 60947-5-1, Section F.7.3.

#### **8.3.1 Supplement to DIN EN 60947-5-8, Section 8.3.1, Test sequence I, Test 3**

Mechanical properties of connectors

The tests according to DIN EN 60947-1, Sections 8.2.4.3 (bending test) and 8.2.4.4 (extraction test) should be carried out only on enabling equipment with external terminal connections. If the terminal connections are located within an enclosed casing foreseen for the connection of light plastic-sheathed wiring, these tests can be dispensed with.

#### **8.3.2 Supplement to DIN EN 60947-5-8, Section 8.3.1, Test sequence II, Test 1**

Required utilization category

The connections must conform to utilization categories AC 15 and/or DC 13 if they interact, or are able to interact with contact-based controllers in contactor/relay technology. Contacts must conform to utilization categories AC-12 and/or DC -12 if they switch only ohmic loads or semiconductor loads with isolation by means of optical couplers.

Note: Positively opening contacts must always conform to utilization categories AC15 and/or DC13.

#### **8.3.3 Supplement to DIN EN 60947-5-8, Section 8.3.1, Test sequence III, Test 1**

Section 8.3.2 of of these Principles of testing also applies.

#### **8.3.4 Supplement to DIN EN 60947-5-8, Section 8.3.1, Test sequence IV, Test 1**

Testing in accordance with DIN EN 60947-5-1, Section K.8.3.4 must also be carried out for positively opening contacts.

#### **8.3.5 Supplement to DIN EN 60947-5-8, Section 8.3.1, Test sequence V, Test 1**

Protection class

Note: Test sequence IX, Test 1 should be carried out for this test.

Enabling switches in installed condition or ready-for-use enabling equipment must at least conform to protection class IP 54 (with negative pressure).

**Test:** Protection class according to DIN EN 60529.

### 8.3.6 Supplement to DIN EN 60947-5-8, Section 8.3.1, Test sequence VI, Test 1

Air gaps and creepage distances

Air gaps and creepage distances must be dimensioned according to overvoltage category III, contamination level 3.

Reliable isolation of all circuit elements

All circuit elements from the various stages must feature reliable isolation from each other. The requirements referenced above apply with regard to air gaps and creepage distances.

**Test:** Verification through visual inspection and measurement of air gaps and creepage distances, or through a voltage check, as necessary.

Supplement to Test sequence VI, Test 2:

In variance to DIN EN 60947-5-8, Test sequence IV, Test 2 for enabling equipment, the forces F2 and F3 measured at the enabling equipment actuator must be oriented to the forces required according to DIN EN 894-3, Table 4. Travel distances S2 and S3 must be measured with consideration given to the type of actuation.

Note: Actuating forces and travel distances must always be seen from an ergonomic perspective with relation to the type of actuation.

**Test:** Measurement of the actuating forces and travel distances on the test object actuator. Evaluation of the actuation forces according to DIN EN 60947-5-8, Section 8.2.5 with consideration given to DIN EN 894-3, Table 4.

Handling of enabling equipment with respect to forces and travel distances.

Note: Maximum forces for F3 in preparation.

### **8.3.7 Variance from DIN EN 60947-5-8, Section 8.3.1, Test sequence VII, Test 1**

The test for mechanical service life can be dispensed of, as Test sequence VIII, Test 1 already comprises this test.

*Note: The fault-criteria from section. 8.3.3.6.1, mechanical service life must be considered during the test for electrical service life.*

### **8.3.8 Replacement of DIN EN 60947-5-8, Section 8.3.1, Test sequence IX, Test 1 with the following tests:**

Mechanical strength

Note: Testing of the Protection class (Test sequence V, Test 1) should be carried out subsequent to this test using the same test object.

Enabling switches/devices must possess sufficient mechanical strength with respect to expected operational demands when used as intended, such as jolting, shock or impact.

Note: The requirements according to GS-ET-20, Section 4.4 shall apply for start-up controllers as separate structural units, which are part of the enabling equipment.

**Test:** In accordance with Sections 8.3.8.1 - 8.3.8.4.

Prior to testing in accordance with Sections 8.3.8.1 - 8.3.8.4, the test object must be stored in an indoor climate for at least 24 h.

*Note: Contact monitoring during testing according to Sections 8.3.8.1 and 8.3.8.2 is not necessary because contact signalling for position 2 and contact opening in position 3, by themselves, must not trigger any hazardous movement when the enabling equipment is used in compliance with the standards.*

#### **8.3.8.1 Vibration test**

Enabling switches/devices must be subjected to mechanical vibrations in their potential mounting or usage positions in accordance with Table 1, I. Enabling switches/devices are set in position 1 during the test.

#### **8.3.8.2 Shock test**

Enabling switches/devices will be subjected in-turn to mechanical shocks in their potential mounting or usage positions in accordance with Table 1, II, III. Enabling switches/devices are set in position 1 during the test.

### 8.3.8.3 Impact test

Weak points on enabling switch/device enclosures as well as the accessible actuation system components must be subjected to a one-time impact load of 1 Nm using an impact testing device according to DIN EN 60068-2-75, Section 5.

**Test:** Ehb test: undertaken using a spring hammer at room temperature ( $T = 20\text{ °C} + 5\text{ °C}$ ). Enabling switches/devices are set in position 1 during the test.

### 8.3.8.4 Drop test

The test shall be carried out on ready-for-use mobile enabling equipment in accordance to the provisions of DIN EN 60068-2-31, Procedure 1 – Free-falling, from a drop height of 1000 mm.

Two drop tests are to be carried out from each transport/usable position.

Execution of the test in accordance with DIN EN 60068-2-31 is expedient only on mobile switches.

The test can also be carried on equipment without connection circuitry.

Enabling switches/devices are set in position 1 during the test.

Following the test according to Sections 8.3.8.1 - 8.3.8.4, test object functionality must still be warranted in accordance with DIN EN 60947-5-8, Section 8.2.5 and it must not be damaged. This means:

1. It must not be possible to physically touch active components.
2. The effectivity of the insulation material lining and isolating partitions must not be impaired.
3. The test object offer protection against the infiltration of dust, solid foreign objects and water that conforms with the Protection class and corresponds to the Instruction manual.

**Test:** Visual inspection.

## Mechanical test

Component test		Notes
I. Continuous vibration: Test standard  Frequency range Amplitude  Frequency cycle count Tuning speed	DIN EN 60068-2-6  10 - 150 Hz $\pm$ 1 Hz 0.35 mm/5g $\pm$ 15 % at the control point 20 1 octave/min	The prescribed frequency range applies only to enabling equipment components, which are directly exposed to machine vibration.  A separate start-up controller, which, as a rule, is installed in a separate control cabinet, is exempted from this provision. (see note, Section 8.3.8)
II. Shock: Test standard  Type of shock Shock amplitude Shock duration Number of shocks	DIN EN 60068-2-27  Half-sine wave 30 g 11 ms 3 per axis	
III. Continuous shock: Test standard Type of shock Shock amplitude Shock duration Shock sequence Number of shocks	DIN EN 60068-2-29  Half-sine wave 10 g 16 ms (1 - 3)/s 1000 $\pm$ 10	

**Table 1:** Minimum requirements for vibration and shock loading

## 9 **Additional requirements for equipment with two separate enabling switches**

For equipment with two separate enabling switches, which can be arranged either on the left or right casing side, the switch interaction should be realized as „Exclusive-OR“.

If, due to ergonomic reasons for machine operation, an OR-operation is used instead of an Exclusive-OR-operation, reference should be made in the equipment Instruction manual as to the absence of the Exclusive-OR-operation so the user can take this into account for the risk assessment.

Short- or cross-circuits in the enabling circuitry must be sufficiently excluded or readily identifiable with consideration given to DIN EN ISO 13849-1 + 2.

**Test:** Functional test, review of the circuit diagram.

## 10 **Fault characteristics**

The following requirements are to be tested only within the scope permitted by the enabling equipment based on its technical design, or in connection with the manufacturer's requirements with regard to subsequent signal processing. Control-related measures, which do not directly take over the enabling equipment, must be realized via the machine controller. The measures must be described in the enabling equipment Instruction manual.

### 10.1 **Safety function**

**The enabling equipment safety function must be opened to the enabling circuit by actuating enabling switch position 1 (or 3) and holding it open until the next actuation of the enabling function (position 2). Additionally, the enabling function must not be activated when returning from position 3 to position 2 or position 1.**

**This also applies to hand-held control devices with two or more separate enabling switches.**

### 10.2 **Determination of the $B_{10d}$ value**

For mere enabling switches or enabling devices without start-up controllers, a  $B_{10d}$  value should be determined and specified by the manufacturer.

If the characteristics have been fulfilled according to DIN EN ISO 13849-1, Section C.2 („Procedures for good engineering practices“), the  $B_{10d}$  value can be specified in accordance with DIN EN ISO 13849-1, Table C.1.

If the  $B_{10d}$  value are specified, which varies from the typical values according to DIN EN ISO 13849-1, Table C.1, then it must be determined under the following conditions:

1. Test the mechanical service life (based on DIN EN 60947-5-8, Section 8.3.3.6.1) with 10 test objects. Determine the  $B_{10}$  value by means of "Weibull approximation".
2. If a 50 % hazard-producing failure rate is assumed, the  $B_{10d}$  value is determined by doubling the  $B_{10}$  value:  $B_{10d} = 2 \times B_{10}$ .
3. Alternatively to Point 2, the  $B_{10d}$  value can also be determined through analysis of the failed test objects and by determining the percentage of potentially hazardous failures.

**Test:** Plausibility check of the specifications and documents submitted by the manufacturer.

### 10.3 Determination of performance levels (PL)

For enabling switches/devices with start-up controllers, the manufacturer must determine and specify:

- Category
- Performance Level (PL)
- $MTTF_d$  or PFH

in accordance with DIN EN ISO 13849-1.

**Test:** Validation of the specifications and documents (FMEA, fault-combination analysis, component failure rate, calculations, etc.) submitted by the manufacturer in accordance with DIN EN ISO 13849-1 + 2.

## 11 Electromagnetic compatibility

Immunity to interference

In addition to the requirements of DIN EN 60947-5-1 regarding immunity to interference, enabling devices must also satisfy the requirements of DIN EN 61326-3-1 as of 1 June 2011 **at the latest**.

**Test:** See DIN EN 61326-3-1.

## Annex 1:

### **Directives, regulations, standards**

These Principles of testing are based upon

2006/42/EC Machinery Directive

2006/95/EC Low-Voltage Directive

2004/108/EC EMC Directive

DIN EN ISO 12100-1  
2004-04 Safety of machinery;  
Basic concepts, general principles for design, Part 1: Basic terminology, methodology

DIN EN ISO 12100-2  
2004-04 Safety of machinery; Basic concepts, general principles for design,  
Part 2: Technical principles

DIN EN ISO 13849-1  
2008-12 Safety of machinery; Safety-related parts of control systems;  
Part 1: - General principles for design -

DIN EN ISO 13849-2  
2008-09 Safety of machinery; Safety-related parts of control systems;  
Part 2: - Validation -  
Revision 1  
2009-01

DIN EN ISO 10218-1  
2009-07 Robots for industrial environments -Safety requirements;  
Part 1: Robots

DIN EN 894-3  
2009-02 Safety of machinery - Ergonomics requirements for the design  
of displays and control actuators;  
Part 3: - Control actuator -


DIN EN 60204-1  
(VDE 0113 Part 1)  
2007-06 Safety of machinery  
Electrical equipment of machines;  
Part 1: - General requirements -

DIN EN 60947-1  
(VDE 0660 Part 100)  
2008-04 Low-voltage switchgear and controlgear;  
Part 1: - General rules -

DIN EN 60947-5-1  
(VDE 0660 Part 200)  
2005-02 Low-voltage switchgear and controlgear;  
Part 5-1: - Control circuit devices and switching elements;  
Electromechanical control circuit devices -


DIN EN 60947-5-8 (VDE 0660-215) 2007-08	Low-voltage switchgear and controlgear; Part 5-8: - Control units and switching elements; Three-position enabling switch
DIN VDE 0282-4 02.05 Revision 1: 05.05	Cables of rated voltages up to and including 450/750 V and having cross-linked insulation, Part 4: - Cords and flexible cables -
DIN EN ISO 11161 2008-01	Safety of machinery; Integrated manufacturing systems; - Basic requirements -
VDI 2854 1991-06	Safety-related requirements for automated manufacturing systems

**Annex 2**

 <b>DGUV Test</b> Prüf- und Zertifizierungsstelle Fachausschuss Elektrotechnik	Specifications for contract preparation - Enabling equipment -	Company:
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Product identification information	
Product nomenclature	
Type	
Product variants available?	yes <input type="checkbox"/> / no <input type="checkbox"/>
Variant matrix attached?	yes <input type="checkbox"/> / no <input type="checkbox"/>

Test specification(s) and parameters to be used according to test specification(s)	
<b>Testing in accordance with DIN EN ISO 13849-1</b> yes <input type="checkbox"/> / no <input type="checkbox"/>	
Category	
PL	
MTTF <sub>d</sub> in [a]	
DC / DC <sub>avg</sub> in [%]	
CCF in [points]	
Service life in [years]	
Mean operating duration d <sub>op</sub> in [days/years]	
Mean operating duration d <sub>op</sub> in [hours/days]	
Cycle time t <sub>cycle</sub> in [s <sup>-1</sup> ]	
<b>EMC-Tests</b>	
Testing in accordance with DIN EN 61326-3-1	<input type="checkbox"/> / no <input type="checkbox"/> <div style="text-align: right;">yes</div>

 <b>DGUV Test</b> Prüf- und Zertifizierungsstelle Fachausschuss Elektrotechnik	Specifications for contract preparation	
	- Enabling equipment -	
<b>Documentation to be submitted</b>	<i>attached</i>	<i>will be submitted</i>
User information	<input type="checkbox"/>	bis
Sales literature	<input type="checkbox"/>	bis
Circuit diagram(s)	<input type="checkbox"/>	bis
Printed circuit board-layout(s)	<input type="checkbox"/>	bis

<b>Documentation to be submitted</b>	<i>attached</i>	<i>will be submitted</i>
Parts list(s)	<input type="checkbox"/>	bis
Component failure rate (if available)	<input type="checkbox"/>	bis
Single fault analysis (e.g. FMEA)	<input type="checkbox"/>	bis
Fault combination analysis (e.g. FTA)	<input type="checkbox"/>	bis
Documentation of software according to Principles of Testing	<input type="checkbox"/>	bis
	<input type="checkbox"/> not applicable	

<b>Test reports provided by external accredited test bodies for...</b>	<i>attached</i>	<i>will be submitted</i>
Electromagnetic compatibility	<input type="checkbox"/>	bis
Switch-ON/switch-OFF capacity of the safety-related shutdown devices	<input type="checkbox"/>	bis
Contingent short-circuit current from safety-related shutdown devices	<input type="checkbox"/>	bis
Electrical service life	<input type="checkbox"/>	by

<b>Test reports provided for tests performed under special agreement for...</b>	<i>attached</i>	<i>will be submitted</i>
	<input type="checkbox"/>	bis
	<input type="checkbox"/>	bis

**Note:** In the interest of prompt order processing, it is essential that the information above be provided in its entirety!

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Date                      Name                      Signature