SLOVENSKI STANDARD
oSIST prEN ISO 14119:2021

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Varnost strojev - Zaporne naprave, povezane z varovali - Načela za načrtovanje in izbiro (ISO/DIS 14119:2021)

Safety of machinery - Interlocking devices associated with guards - Principles for design and selection (ISO/DIS 14119:2021)

Sicherheit von Maschinen - Verriegelungseinrichtungen in Verbindung mit trennenden Schutzeinrichtungen - Leitsätze für Gestaltung und Auswahl (ISO/DIS 14119:2021)

Sécurité des machines - Dispositifs de verrouillage associés à des protecteurs - Principes de conception et de choix (ISO/DIS 14119:2021)

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ICS:

13.110	Varnost strojev	Safety of machinery

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Safety of machinery — Interlocking devices associated with guards — Principles for design and selection

Sécurité des machines — Dispositifs de verrouillage associés à des protecteurs — Principes de conception et de choix

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

This second edition cancels and replaces the first edition (ISO 14119:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— ISO/TS 19837 “Safety of machinery — Trapped key interlocking devices — Principles for design and selection” is integrated as new normative Annex L with specific requirements for type 5 interlocking devices - key interlocking devices;

— “Trapped key interlocking systems” are defined as “Type 5 interlocking systems”;

— Table 4 is improved and renamed into “Additional measures in case foreseeable motivation for defeat continues to exist depending on type of interlocking devices”;

— test procedures are described in a new normative Annex J;

— ISO/TR 24119 “Safety of machinery — Evaluation of fault masking serial connection of interlocking devices associated with guards with potential free contacts” integrated in a new normative Annex K.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The structure of safety standards in the field of machinery is as follows:

a) Type-A standards (basic safety standards) giving basic concepts, principles for design, and general aspects that can be applied to all machinery;

b) Type-B standards (generic safety standards) dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:

   — Type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

   — Type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure-sensitive devices, guards);

c) Type-C standards (machine safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This document is a Type-B2 standard as stated in ISO 12100.

The requirements of this document can be supplemented or modified by a Type-C standard.

For machines which are covered by the scope of a Type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that Type-C standard take precedence.

This International Standard has been prepared to give guidance to machinery designers and writers of product safety standards on how to design and select interlocking devices associated with guards.

Relevant clauses of this International Standard, used alone or in conjunction with provisions from other standards, may be used as a basis for verification procedures for the suitability of a device for interlocking duties.

The informative Annexes A to F describe the technology and the typical characteristics of the defined interlocking devices types 1 to 4. Other solutions may be adopted, provided that they comply with the principles of this standard. The informative Annexes G to I give information on particular aspects like interlocking devices used within safety functions, risk assessment considering the motivation to defeat and static action forces. The informative Annex J describes a holding force test and an impact resistance test for guard locking devices. Normative Annex K provides information on the masking of faults in series connection of interlocking devices. Normative Annex L provides requirements for type 5 interlocking systems (trapped key interlocking systems) and describes their technology.

Safety of machinery — Interlocking devices associated with guards — Principles for design and selection

1 Scope

This International Standard specifies principles for the design and selection — independent of the nature of the energy source — of interlocking devices associated with guards and provides guidance of measures to minimize the possibility of defeat of interlocking devices in a reasonably foreseeable manner.

This International Standard covers the parts of guards which actuate interlocking devices and principles for the design, selection and application of trapped key interlocking devices and systems for machinery applications, independent of the type of energy used to control them or that they control

NOTE ISO 14120 specifies general requirements for the design and construction of guards provided primarily to protect persons from mechanical hazards. The processing of the signal from the interlocking device to stop the machine and prevent unexpected start up is dealt with in ISO 13849-1 or IEC 62061:2015.

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.

EN 13906-1, *Cylindrical helical springs made from round wire and bar — Calculation and design — Part 1: Compression springs*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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*

IEC 60204-1:2016, *modified, Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60947-5-1:2016, *+ COR:2016, Low voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

IEC 60947-5-3:2013, *Low-voltage switchgear and controlgear — Part 5-3: Control circuit devices and switching elements — Requirements for proximity devices with defined behaviour under fault conditions (PDDB)*

IEC 62061:2015, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 13849-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

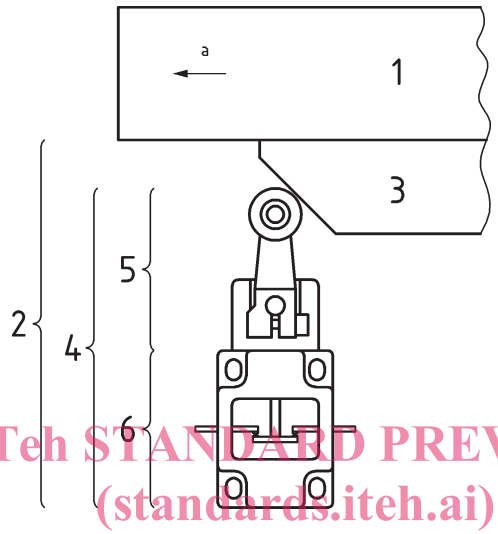
— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
interlocking device
interlock
mechanical, electrical or other type of device, the purpose of which is to prevent the operation of hazardous machine functions under specified conditions (generally as long as a guard is not closed)

Note 1 to entry: See Figure 1 and Table 1.

[SOURCE: ISO 12100:2010, 3.28.1]



Key

1	guard	4	position switch
2	interlocking device	5	actuating system
3	actuator	6	output system
a	Direction of opening		

Figure 1 — Example of an interlocking device

3.2
interlocking guard
guard associated with an interlocking device so that, together with the control system of the machine, the following functions are performed:

— the hazardous machine functions associated with the guard cannot operate until the guard is closed;

— if the guard is opened while hazardous machine functions are operating, a stop command is given;

— when the guard is closed, the hazardous machine functions associated with by the guard can operate. The closure of the guard does not by itself start the hazardous machine functions.

Note 1 to entry: An interlocking guard can contain/be equipped with one or more interlocking devices. These interlocking devices can also be of different types.

[SOURCE: ISO 12100:2010, 3.27.4]

3.3
interlocking guard with a start function
control guard
special form of an interlocking guard which, once it has reached its closed position, gives a command to initiate the hazardous machine function(s) without the use of a separate start control

Note 1 to entry: ISO 12100:2010, 6.3.3.2.5 gives detailed provisions regarding the condition of use.

[SOURCE: ISO 12100:2010, 3.27.6]

3.4
guard locking device
device intended to lock a guard in the closed position and linked to the control system

3.5
interlocking guard with locking function
guard associated with an interlocking device and a guard locking device so that, together with the control system of the machine, the following functions are performed:

— the hazardous machine functions associated with the guard cannot operate until the guard is closed and locked;

— the guard remains closed and locked until the risk due to the hazardous machine functions associated with the guard has ceased, and

— when the guard is closed and locked, the hazardous machine functions associated with the guard can operate (the closure and locking of the guard do not by themselves start the hazardous machine functions)

[SOURCE: ISO 12100:2010, 3.27.5]

3.6
safety–related part of a control system
SRP/CS
part of a control system that performs a safety function, starting from safety-related input(s) to generate safety-related output(s)

Note 1 to entry: The combined safety-related parts of a control system start at the point where the safety-related input signals are initiated (including e.g. the actuating cam and the roller of the position switch) and end at the output of the power control elements (including, for example, the main contacts of a contactor).

Note 2 to entry: If monitoring systems are used for diagnostics, they are also considered as SRP/CS.

[SOURCE: ISO 13849-1:2015, 3.1.1]

3.7
Defeat
defeat in a reasonably foreseeable manner
reasonably foreseeable action, either manually or by using readily available objects, that makes interlocking devices inoperative or bypasses them with the result that a machine is used in a manner not intended by the designer or without the necessary protective measures

Note 1 to entry: This definition includes the removal of position switches or actuators using tools that are needed for the intended use of the machine or that are readily available (screw drivers, wrenches, hexagon keys, pliers).

Note 2 to entry: Readily available objects for substitute actuation include:

— screws, needles and sheet-metal pieces,

— objects in daily use such as keys, coins, adhesive tape, string and wire,

Note 3 to entry: Uncontrolled spare and master keys for type 5 interlocking devices (see also L 4.2) and spare actuators (for all types) are also considered as readily available objects.

3.8
automatic monitoring
diagnostic function which initiates a fault reaction function if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed in such a way that hazards are generated

3.9
direct mechanical action
positive mechanical action
movement of a mechanical component which arises inevitably from the movement of another mechanical component either by direct contact or via rigid elements

3.10
direct opening action
positive opening operation
<contact element>achievement of contact separation as a direct result of a specified movement of the switch actuator through non-resilient members (for example not dependent upon springs)

[SOURCE: IEC 60947-5-1:2016 + COR1:2016, K 2.2.]

3.11
actuator
separate part of an interlocking device which transmits the state of the guard (closed or not closed) to the actuating system

EXAMPLE Guard-mounted cam, shaped tongue, reflector, magnet, RFID tag.

Note 1 to entry: See also Annexes A to E and L.

Note 2 to entry: For Type 1 interlocking devices the actuator can be a part of the guard itself.

Note 3 to entry: Examples of actuators are shown in Figure 2.

Note 4 to entry: A key as used in a trapped key system is not covered by this definition.

3.12
coded actuator
actuator which is specially designed (e.g. by shape) to actuate a certain position switch

3.12.1
low level coded actuator
coded actuator for which 1 to 9 variations in code are available and the different codes are evaluated by the interloking device

3.12.2
medium level coded actuator
coded actuator for which 10 to 1 000 variations in code are available and the different codes are evaluated by the interloking device

3.12.3
high level coded actuator
coded actuator for which more than 1 000 variations are available and the different codes are evaluated by the interloking device

3.13
actuating system
part of the interlocking device which transmits the position of the actuator or the key and changes the state of the output system

EXAMPLE Examples are roller plunger, cam mechanism, and optical, inductive or capacitive sensor.

Note 1 to entry: Examples of actuating systems are shown in Figure 2.

3.14
output system
part of the interlocking device that signals the state of the actuator or the key to the control system

EXAMPLE Contact element (electromechanical), semiconductor output, valve.

3.15
type 1 interlocking device
interlocking device with mechanically actuated position switch with uncoded actuator

EXAMPLE Hinged interlocking devices.

Note 1 to entry: See Annex A for detailed examples.

3.16
ype 2 interlocking device
interlocking device with mechanically actuated position switch with coded actuator

EXAMPLE Tongue-actuated position switches.

Note 1 to entry: See Annex B for detailed examples.

3.17
type 3 interlocking device
interlocking device with non-contact actuated position switch with uncoded actuator

EXAMPLE Proximity switches.

Note 1 to entry: See Annex C for a detailed example.

3.18
type 4 interlocking device
interlocking device with non-contact actuated position switch with coded actuator

EXAMPLE RFID tag actuated position switches.

Note 1 to entry: See Annex D for detailed examples.

3.19
type 5 interlocking system
Trapped key interlocking system
system fulfilling safety function(s) or part of safety function(s) and comprising of at least two trapped key interlocking devices which work together through the transfer of a key.

Note 1 to entry: See Annex L for detailed examples.

3.19.1
type 5 interlocking device
Trapped key interlocking device
device, part of a trapped key interlocking device, which fulfils a function by trapping or releasing one or more keys in a given system

EXAMPLE Door locks, key operated switches, key exchange units.

3.19.2
personnel key
key which is released from a trapped key interlocking device (typically a access lock used in conjunction with whole body access) and retained by a person to prevent a hazardous situation, e.g. unexpected start-up

3.19.3
key trapped
key which is locked until an external input releases it

EXAMPLE A solenoid or the insertion of an actuator releases the trapped key.

3.19.4
key releasable
key which is not locked and so can be (turned and) removed at any time causing a change of state of the device

EXAMPLE Change of state of the device releases or traps another key or changes contact state.

3.19.5
master key
key which can open multiple locks of different coding

3.19.6
key transfer plan
drawing, scheme or diagram depicting the trapped key interlock system with its individual devices and the sequence(s) in which they are to be operated

3.19.7
bolt lock
trapped key interlocking device that extends a bolt to lock an object

EXAMPLE Disconnector switches, valves or sliding doors.

Note 1 to entry: Examples of objects locked by bolt lock are disconnector switches, valves or sliding doors.

3.19.8
access lock
trapped key interlocking device used to lock movable guards

EXAMPLE Access locks can also be used for locking in position of objects other than guards, e.g. isolators, valves or barriers.

3.19.9
timed delay key release
trapped key interlocking device that releases a key after a pre-determined period of time has elapsed

3.19.10
key exchange device
trapped key interlocking device in which the insertion of one or more keys releases one or more keys with a different coding, trapping the inserted keys

3.19.11
trapped key switch
trapped key interlocking device comprising a switch which can only be operated by means of a key

3.19.12
trapped key solenoid-controlled switch
trapped key interlocking device comprising a key operated switch which can be mechanically locked by the operation of a solenoid

3.19.13
trapped key valve lock
trapped key interlocking device used to lock a valve in the open position (locked open), in the closed position (locked closed) or in both positions by different keys (LO/LC)

3.19.14
isolation control
sub function of a trapped key interlocking system to achieve and maintain a safe state of power or movement

3.19.15
intermediate transfer
sub function of a trapped key interlocking system that allows the transfer of keys between isolation control and access control, subject to the designated conditions

3.19.16
access control
sub function of a trapped key interlocking system that controls the access to safeguarded spaces or access to machine operating modes and functions

3.19.17
whole body access
situation where a person can be completely inside a safeguarded space

Note 1 to entry: The term whole body access is used in other standards to specify the opening size for safe access.

[SOURCE: ISO/WD 11161:2019, 3.x]

3.19.18
safeguarded space
area or volume enclosing a hazard zone(s) where guards and/or protective devices are intended to protect persons

[SOURCE: ISO WD 11161:2019, 3.x]

3.19.19
switch-disconnector
switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[SOURCE: (IEC 60947-1:2007 + A1:2010 + A2:2014, 2.2.10]

3.20
stop command
signal generated by the interlocking device that causes the hazardous machine function to cease

3.21
overall system stopping performance
time interval between the stop command given by opening the guard and the termination of the hazardous machine function

[SOURCE: ISO 13855:2010, 3.1.2, modified.]

3.22
access time
time taken by a person to reach the hazard zone after initiation of the stop command by the interlocking device, as calculated on the basis of an approach speed of the body or part of the body

Note 1 to entry: For the selection of the approach speed and the calculation, see ISO 13855.

3.23
holding force
force that a guard locking device can withstand without being damaged so that its further use will not be impaired and the guard will not leave the closed position