TECHNICAL SPECIFICATION

ISO/TS 19837

First edition
2018-03

Safety of machinery — Trapped key interlocking devices — Principles for design and selection

Sécurité des machines — Dispositifs de verrouillage à clé captive — Principes de conception et sélection

Reference number
ISO/TS 19837:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

Safety of machinery — Trapped key interlocking devices — Principles for design and selection

1 Scope

This document specifies 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.

The requirements of this document apply to the safety related aspects of trapped key interlocking devices and systems. ISO 14119 always applies unless an exception is given in this document.

This document is intended to be used in conjunction with ISO 14119.

This document does not provide testing requirements.

NOTE Documents addressing testing requirements can be found in the Bibliography.

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.

ISO 14119:2013, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

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

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

IEC 60947-1:2008, *Low-voltage switchgear and controlgear — Part 1: General rules*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
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

3.2
key
element used to operate a trapped key interlocking device with matched coding

3.3
trapped key interlocking device
device, part of a trapped key interlocking system, which fulfils a function by trapping or releasing a key in a given system

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

3.4
bolt lock
trapped key interlocking device that extends a bolt to lock an object

EXAMPLE Disconnector switches, valves or sliding doors.

3.5
access lock
trapped key interlocking device used to lock movable guards

Note 1 to entry: Access locks can also be used for locking in position of objects other than guards, e.g. isolators, valves or barriers.

3.6
timed delay device
trapped key interlocking device that releases a key after a pre-determined period of time has elapsed

3.7
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

3.8
key operated switch
trapped key interlocking device comprising a switch which can only be operated by means of a key

3.9
solenoid-controlled switch
trapped key interlocking device comprising a key operated switch which can be mechanically locked by the operation of a solenoid

3.10
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)

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

Note 1 to entry: Access locks can also be used for locking in position of objects other than guards, e.g. an isolator, valve or barrier.

Note 2 to entry: A Key is not covered by this definition, see 3.1.2.

[SOURCE: ISO 14119:2013, 3.12, modified — “interlocking device” has been changed to “access lock”.]

3.12
switch-disconnector
switch which, in the open position, satisfies the isolating requirements specified for a disconnector

[SOURCE: IEC 60947-1:2007, 2.2.10]

3.13
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

3.14
control interlocking
function which allows access to hazardous machine functions if the energy supply is interrupted using indirect means

Note 1 to entry: Examples of indirect means can include a combination of relay modules, standstill monitoring devices, PLCs or other control devices/systems.

3.15
power interlocking
interlocking which directly interrupts the energy supply to the machine actuators or disconnects moving parts from the machine actuators

[SOURCE: ISO 14119:2013, 3.31, modified — The Note 1 to entry has been deleted.]

3.16
locked open
LO
valve locked by a trapped key interlocking device in the open position

3.17
locked closed
LC
valve locked by a trapped key interlocking device in the closed position

3.18
key transfer plan
drawing depicting the trapped key interlock system with its individual devices and the sequence(s) in which they are to be operated

3.19
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.

3.20
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.

3.21
master key
key which can open multiple locks of different coding

3.22
isolation control
sub function of a trapped key interlocking system to achieve and maintain a safe state of power or movement

3.23
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

3.24
access control
sub function of a trapped key interlocking system that controls the access to safeguarded areas or access to machine operating modes and functions

3.25
category 3 behaviour
<for the mechanical parts of trapped key systems> no single fault results in a loss of the safety function

Note 1 to entry: Category 3 behaviour is characterized by (see ISO 13849-1:2015, 6.2.6):

— continued performance of the safety function in the presence of a single fault;

— detection of some, but not all, faults;

— possible loss of the safety function due to accumulation of undetected faults.

3.26
category 4 behaviour
<for the mechanical parts of trapped key systems> no accumulation of faults results in a loss of the safety function

Note 1 to entry: Category 4 behaviour is characterized by (see ISO 13849-1:2015, 6.2.7):

— continued performance of the safety function in the presence of a single fault;

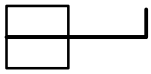
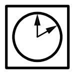
— detection of faults in time to prevent the loss of the safety function;

— the accumulation of undetected faults is taken into account;

— the consideration of an accumulation of two faults is sufficient (unless an accumulation of 3 or more faults is foreseeable).

4 Symbols and abbreviated terms

o.r	Symbol	Function	Definition
1		key	3.2
2		key path	
3		key trapped	3.19
4		key releasable	3.20
5		key inserted and removable	
6		key removed	
7		actuator *locked*	

o.r	Symbol	Function	Definition
8		actuator *unlocked*	
9		actuator removed	
10		timed delay function	3.6

NOTE The figures in this document show general function principles without claiming any PL or SIL for the associated safety functions. Therefore the corresponding links between contacts are shown in dashed lines, independently if the contacts used are mechanically linked, mirror, or normal auxiliary contacts.

5 Operating principles and typical forms of trapped key interlocking system

5.1 General

A trapped key interlocking system relies upon the transfer of key(s), e.g. between a key operated switch and an access lock (see Figure 1).

Typically in trapped key interlocking systems the guard locking and the switching elements are physically separated and functionally linked by the transfer of the key.

Keys shall be coded with the intention that they can fit only into the corresponding devices.

Trapped key interlocking systems shall ensure a sequence of operation for equipment to ensure safety due to the following operating principles.

A designated safe state of the machinery results in the availability of a key. The following sequence shows an example of a simple trapped key system using a key operated switch and an access lock:

— machine in operation (see Figure 1);

— operation of the key results in a stop command (see Figure 2);

— key in transfer between devices from switch to access lock (see Figure 3);

— the key is inserted to the access lock (see Figure 4);

— operation of the key in the access lock changes its state to unlocked (see Figure 5);

— removing the actuator from the access lock traps the key (see Figure 6).

To bring the machine back into operation the sequence shall be reversed.

EXAMPLE In key operated switches, removing the key results in a change of state of the contact(s) which cannot be changed back until the key is reinserted. Typically this change of state initiates a stop command to the machine. Once the key has been removed, it is used to unlock the access lock. Removal of the actuator by opening the moveable guard results in the key becoming trapped.

NOTE

key operated switch
key releasable, contacts closed (machine on)
access lock
key removed, actuator locked

Figure 1 — Machine in operation

NOTE

key operated switch
key inserted and removable, contacts opened
access lock
key removed, actuator locked

Figure 2 — Operation of the key results in a stop command

NOTE

key operated switch
key removed, contacts opened (machine off)
key in transfer
access lock
key removed, actuator locked

Figure 3 — Key in transfer between devices from switch to access lock

NOTE

key operated switch
key removed, contacts opened (machine off)
access lock
key inserted and removable, actuator locked

Figure 4 — Key inserted to the access lock