INTERNATIONAL STANDARD

ISO 14119

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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

Contents

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 14119 was prepared by Technical Committee ISO/TC 199, *Safety of machinery.* ISO 14119 has been published by the European Committee on Standardization (CEN) as EN 1088.

Annexes A to P of this International Standard are for information only.

Introduction

This International Standard has been prepared to give guidance to machinery designers and writers of product safety standards on how to design or to select interlocking devices associated with guards. It may also be used as guidance in controlling the risk where there is no product safety standard for a particular machine.

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

A statement by a manufacturer that an interlocking device complies with this International Standard, without reference to specific clauses, has no meaning.

Annexes A to N contain only examples complying with the principles set out in this International Standard, and the application of which has been validated by experience. Other solutions may be adopted, provided that they comply with the same principles.

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 (as defined in 3.23.1 "interlocking device [interlock]", 3.22.4 "interlocking guard" and 3.22.5 "interlocking guard with guard locking" of ISO/TR 12100-1:1992).

It also provides requirements specifically intended for electrical interlocking devices (see clause 6).

This International Standard covers the parts of guards which actuate interlocking devices.

NOTE Requirements for guards are given in prEN 953. The processing of the signal from the interlocking device to stop and immobilize the machine is dealt with in ISO 13849-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/TR 12100-1:1992, *Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology*

ISO/TR 12100-2:1992, *Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications*

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

ISO 13852:1996, *Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs*

ISO 14118:–[1)], *Safety of machinery - Prevention of unexpected start-up*

ISO 14121:–[1)], *Safety of machinery - Principles for risk assessment*

IEC 60204-1:1992, *Safety of machinery - Electrical equipment of industrial machines - Part 1: General requirements*

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1) To be published.

IEC 60947-5-1:1990, *Low-voltage switchgear and controlgear - Part 5: Control circuit devices and switching elements - Section 1: Electromechanical control circuit devices*

prEN 953, *Safety of machinery - General requirements for the design and construction of guards (fixed, movable)*

prEN 999, *Safety of machinery - The positioning of protective equipment in respect of approach speed of parts of the human body*

3 Definitions

For the purposes of this International Standard the following definitions apply :

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

[ISO/TR 12100-1:1992]

3.2 interlocking guard
Guard associated with an interlocking device, so that :

— the hazardous machine functions "covered" by the guard cannot operate until the guard is closed ;

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

— when the guard is closed, the hazardous machine functions "covered" by the guard can operate, but the closure of the guard does not by itself initiate their operation.

[ISO/TR 12100-1:1992]

NOTE In English "stop signal" and "stop command" are synonyms for "stop instruction". In German "Stop-Signal" and "Stop-Befehl" are synonyms for "Halt-Befehl". In French "ordre d'arrêt" is an all-encompassing term.

3.3 interlocking guard with guard locking
Guard associated with an interlocking device and a guard locking device so that :

a) the hazardous machine functions "covered" by the guard cannot operate until the guard is closed and locked ;

b) the guard remains closed and locked until the risk of injury from the hazardous machine functions has passed ;

c) when the guard is closed and locked, the hazardous machine functions "covered" by the guard can operate, but the closure and locking of the guard do not by themselves initiate their operation.

[ISO/TR 12100-1:1992]

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

a) the machine cannot operate until the guard is closed and locked ;

b) the guard remains locked until the risk has passed.

3.5 automatic monitoring
A back-up safety function which ensures that a safety measure is initiated 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.

NOTE There are two categories of automatic monitoring :

a) "continuous" automatic monitoring, whereby a safety measure is immediately initiated when a failure occurs ;

b) "discontinuous" automatic monitoring, whereby a safety measure is initiated during a following machine cycle, if a failure has occurred.

[ISO/TR 12100-1:1992]

3.6 positive mode actuation
If a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements, the second component is said to be actuated in the positive mode (or positively) by the first one.

[based on ISO/TR 12100-2:1992]

3.7 positive opening operation of a contact element
The achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (e.g. not dependent upon springs).

[IEC 60947-5-1:1991]

NOTE For fluid power, the equivalent concept may be called "positive mode interruption".

3.8 stopping time; time for hazard elimination
The period between the point at which the interlocking device initiates the stop command and the point at which the risk from hazardous machine functions has passed.

3.9 access time; time for access to a danger zone
The time taken to access the hazardous machine parts after initiation of the stop command by the interlocking device, as calculated on the basis of an approach speed whose value may be chosen, for each particular case, taking into account the parameters given in prEN 999.

4 Operating principles and typical forms of interlocking devices associated with guards

NOTE Reference is made to the relevant annexes where it is considered useful for clearer understanding.

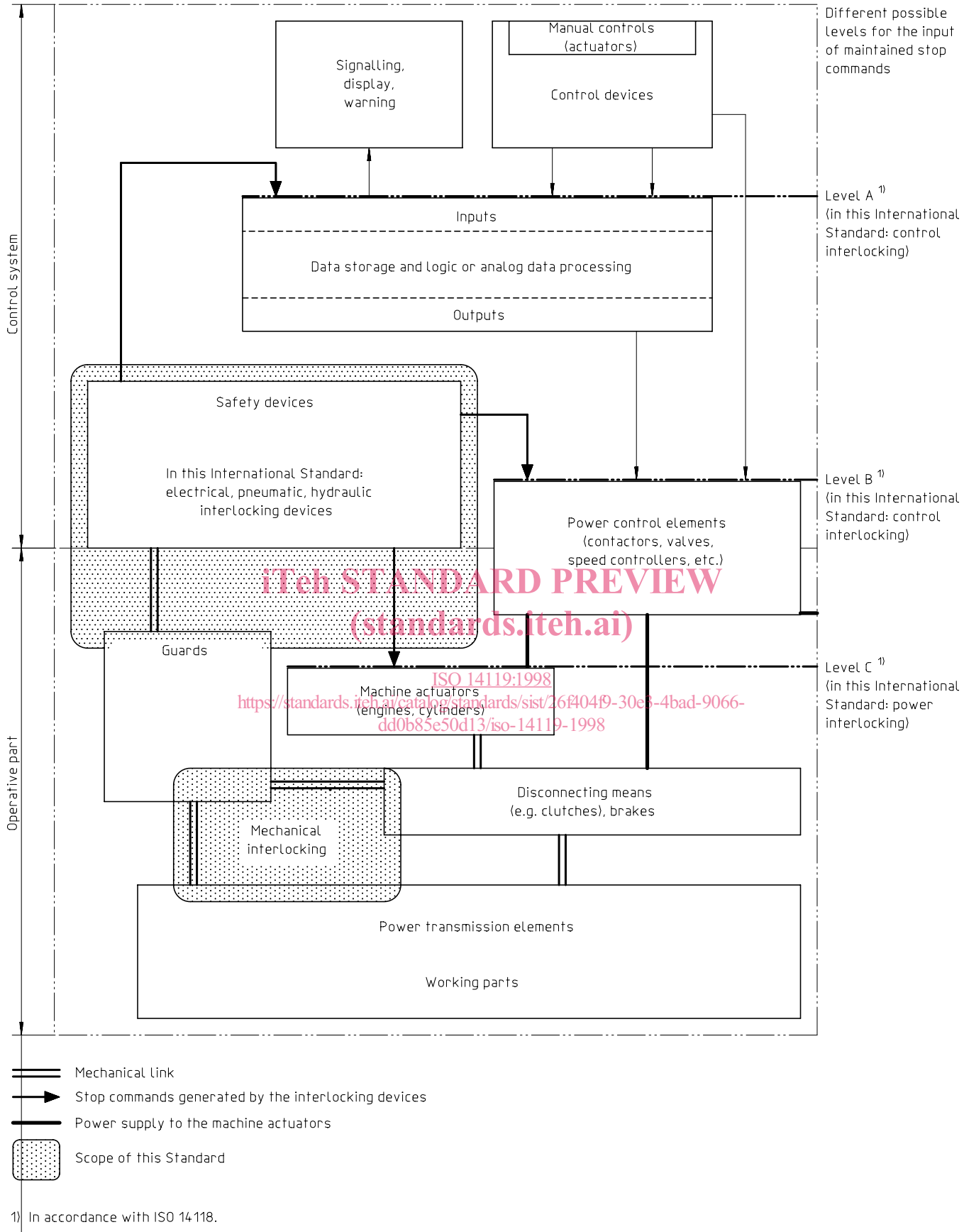
4.1 Interlocking principles

4.1.1 Control interlocking

The stop command from the interlocking device is introduced into the control system so that interruption of the energy supply to the machine actuators – or mechanical disconnection of moving parts from the machine actuators – is triggered by the control system (indirect interruption: levels A and B in figure 1).

4.1.2 Power interlocking

The stop command from the interlocking device directly interrupts the energy supply to the machine actuators or disconnects moving parts from the machine actuators (level C in figure 1). “Directly” means that, unlike control interlocking (see 4.1.1), the control system does not play any intermediate role in the interlocking function.



1) In accordance with ISO 14118.

Figure 1 — Location of interlocking devices in machinery

[based on annex A of ISO/TR 12100-1:1992]

4.2 Typical forms of interlocking devices

4.2.1 Interlocking device (without guard locking) [see table 1 and figure 3 a)]

It is always possible to open the guard. As soon as the guard is no longer closed, the interlocking device generates a stop command. As it is possible to start opening the guard during operation of the machine (or of the hazardous machine elements), the function is that of an interlocking device, as defined in 3.22.4 of ISO/TR 12100-1:1992.

Examples of interlocking devices without guard locking are shown in annexes A, B, F, G, J, K, L.

4.2.2 Interlocking device with guard locking [see table 1 and figure 3 b)]

The guard is held closed by a guard locking device (see 3.4). There are two types of device:

— those where unlocking the guard can be initiated at any time by the operator [unconditional unlocking: see table 1 and figure 3 b1)];

— those where unlocking the guard is possible only if a condition is fulfilled, thus ensuring that the hazard has disappeared [conditional unlocking : see table 1 and figure 3 b2)].

The guard locking device (see 3.4) can be an integral part of an interlocking device, or a separate unit.

In a guard locking device, the part which is intended to lock/unlock the guard can be

— manually applied, manually released (see figure N.1 in annex N);

— spring-applied, power-released [see figure 2 a)];

— power-applied, spring-released [see figure 2 b)];

— power-applied, power-released [see figure 2 c)].

Examples of interlocking devices with guard locking are given in annexes C, D , E, H, M, N.

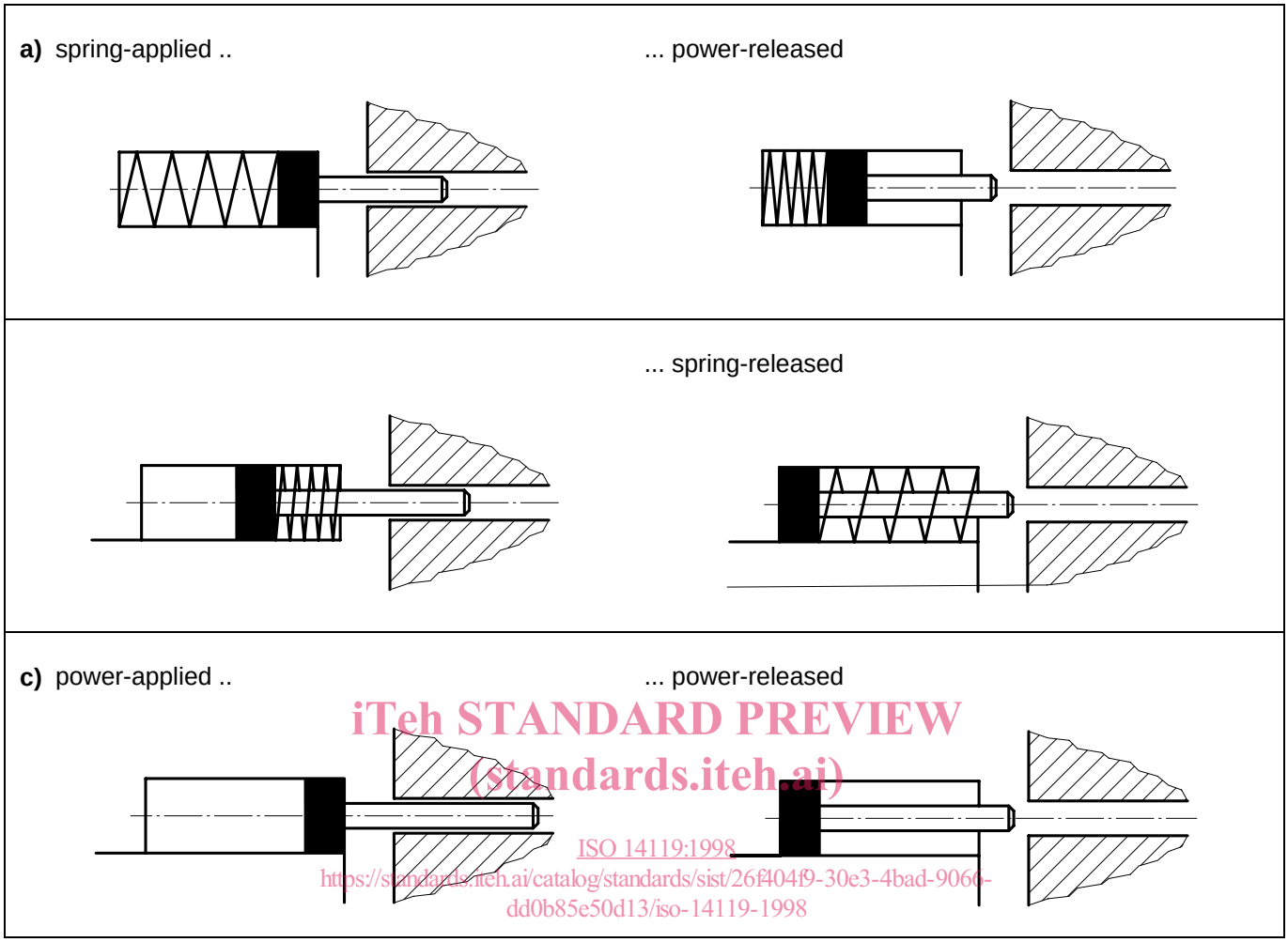
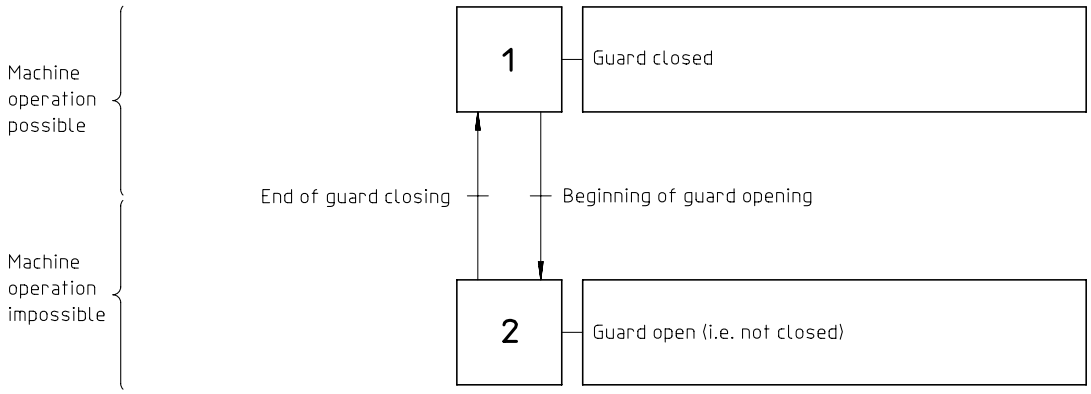
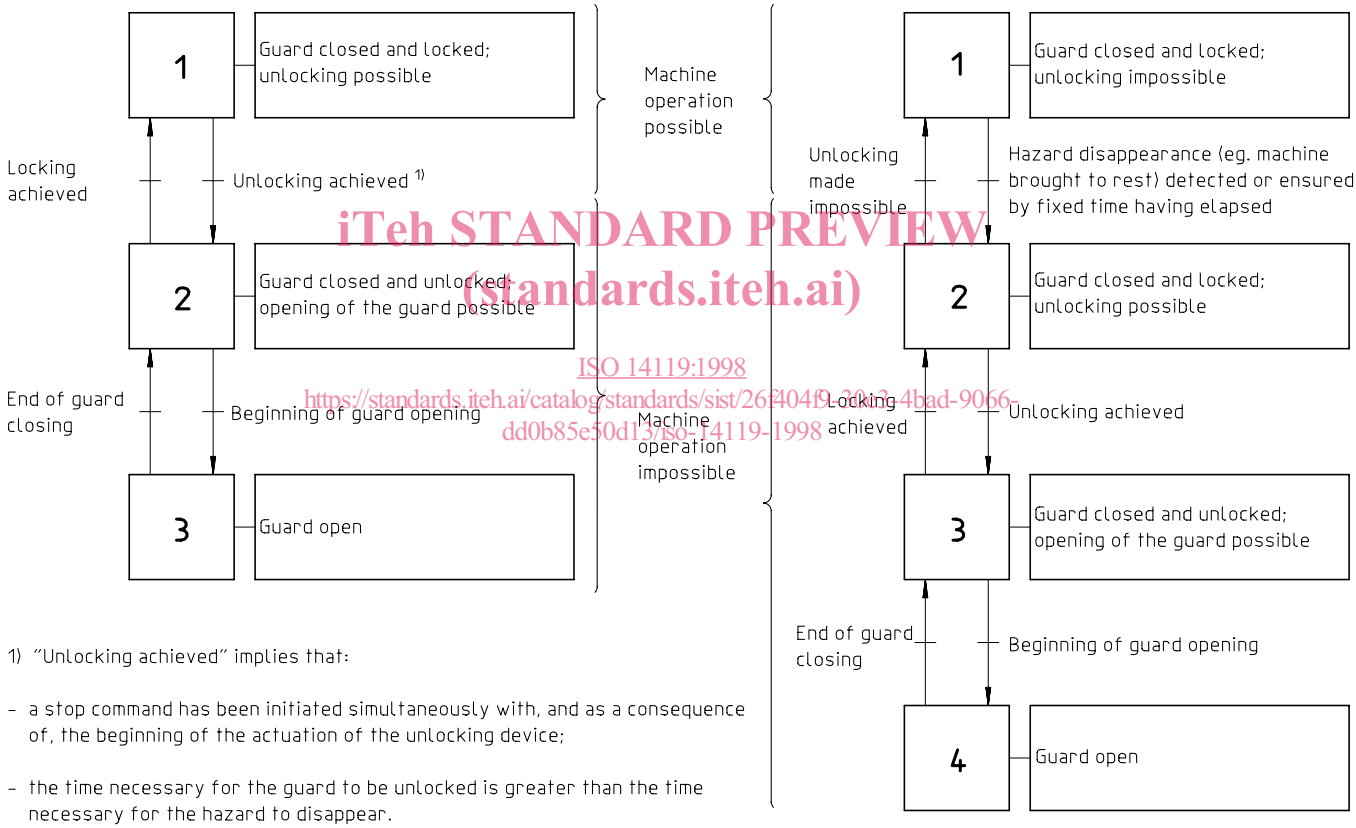


Figure 2 — Operating modes of the guard locking device in power-actuated guard locking devices



a) Interlocking device without guard locking ("two-state interlocking")



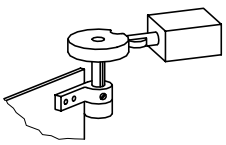
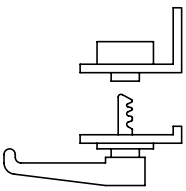
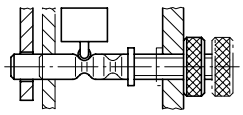
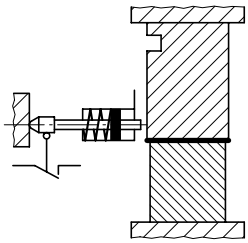
b1) Unconditional unlocking ("three-state interlocking")

b2) Conditional unlocking ("four-state interlocking")

b) Interlocking devices with guard locking

Figure 3 — Functional diagrams of the different types of interlocking devices

Table 1 — Various aspects of the interlocking devices with and without guard locking

Interlocking devices without guard locking [see 4.2.1 and figure 3a)]		Interlocking devices with guard locking [see 4.2.2 and figure 3b)]	
	Unconditional unlocking [see figure 3b1)] Unlocking the guard can be started at any time by the operator, but the time necessary for the guard to be unlocked is longer than the time necessary for the hazard to disappear	Conditional unlocking [see figure 3b2)] Unlocking the guard is made possible only if (or is triggered when) one of the following conditions is fulfilled:	
		– a fixed time[2] has elapsed after the stop command has been given;	– disappearance of the hazard has been detected (e.g. zero-speed detection).
Stop command given:			
– at the beginning of the guard opening stroke (the interlocking device is actuated by the guard itself):	– simultaneously with the beginning of the actuation of the lock[1] and as a consequence of it:	– shortly after the beginning of the actuation of the guard locking device and as a consequence of it:	– by the operator, or automatically by the control system, then memorized by the interlocking device.
 (see annexes A and G)	 (see annex D)	 (see annex N)	 (see annex M)
Typical examples			

1) Strictly speaking, the guard is unlocked after the beginning of the stop command. Where the hazard disappears "as soon as the stop command is given" (in any case before the guard is unlocked), the function ensured is equivalent to that of an interlocking guard with guard locking.

2) Longer than the time necessary for the hazard to disappear.

4.3 Technological forms of interlocking device

Interlocking techniques involve a broad spectrum of technological aspects. As such, interlocking devices can be classified using a great variety of criteria, e.g. the nature of the link between guard and circuit-opening elements, or the technological type (electromechanical, pneumatic, electronic, etc.) of the circuit-opening elements.

Table 2 establishes the link between the main technological forms of interlocking device and the elements of this International Standard which deal with them.

Table 2 — Technological forms of interlocking device

Technological forms	Provisions in subclauses	Examples in annexes
Interlocking devices with mechanically actuated detectors :	5.1 to 5.4, 5.7.2, 6.2	
- with cam-operated detectors	5.7.2.1	A, G, L, M
- with tongue-operated detectors	5.7.2.2	B
Interlocking devices with non-mechanically actuated detectors :		
- with magnetically actuated switches	5.7.3 – 6.3	J
- with electronic proximity switches	5.7.3 – 6.3	K
Systems incorporating keys :		
- captive-key systems;		D
- trapped-key systems.		E
Plug and socket systems	5.7.4	F
Mechanical interlocking between guard and movable parts		H

5 Provisions for the design of interlocking devices (independent of the nature of the energy source)

5.1 Actuation modes of mechanically actuated position detectors

When a single detector is used to generate a stop command, it shall be actuated in the positive mode (see table 3 and 3.6). Non-positive mode actuation is only allowed in conjunction with a detector with positive mode actuation, notably to avoid common-cause failures (see 5.4.1). The design of the actuator should be as simple as possible, since this may reduce the probability of failure.