EN

The way through the standard

Questions and answers on EN ISO 14119:2013

EUCHNER

More than safety.

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Questions and answers on the standard EN ISO 14119:2013

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

These guidelines provide an aid to the application of EN ISO 14119 in the form of a procedure for the selection of a suitable interlocking or guard locking device. However, the guidelines are no substitute for reading the standard, as the entire contents cannot be given.

What is the purpose of EN ISO 14119 and what does the standard actually contain?

The standard describes the selection and the usage of interlocking devices / interlocks with and without guard locking on safety doors, safety covers and other movable safety guards. The term interlocking devices refers to safety switches that are fitted to safety doors and ensure the machine or system is safely shut down on opening the door.

Interlocking devices with guard locking (guard locking devices) only enable access once the risk of injury has been eliminated. For example the hazard due to overtraveling machine movements, or machine rundown time due to inertia of moving parts.

The application of the standard gives the machine design engineer, like all safety-related standards of this type, an assurance that the requirements of the Machinery directive are met.

Must EN ISO 14119 be used to obtain the CE marking?

To be able to assign the CE marking to a machine or system, the law in the form of the Machinery directive permits various possibilities. One of those is the usage of harmonized standards. If all relevant standards are applied, it can be assumed that the law is met. One such harmonized standard (published in the Official Journal of the EU) is EN ISO 14119. It represents a type B standard, i.e. it is applicable independent of the machine type for the usage of safety switches on safety doors.

It is easier for the machine design engineer if a dedicated standard in the form of a type C standard exists for a specific machine type. In this standard all essential aspects for the related machine type are explained. Often the usage of a type B standard is then no longer necessary.

Many type C standards, e.g. for turning machines, reference EN 1088. As this standard ceased to be valid on 30.04.15, EN ISO 14119 is now available as the successor standard. There are only a few changes in the content, however the explanation in the new standard on the usage of interlocking and guard locking devices is significantly better and more detailed.

If a type C standard refers to the previously valid EN 1088 (in the form: EN 1088:2008), this reference retains its full validity. In this case it is not necessary to use the successor standard. However, the new standard is often easier to use. In particular, in EN ISO 14119 the requirements for protection against " tampering of safety devices in a reasonably foreseeable manner" may be the same as in EN 1088, however the procedure is described in significantly more detail and more straightforwardly. Furthermore, over the coming years the majority of type C standards will be updated and as such EN ISO 14119 will be applicable in the majority of cases.

How do I best use the standard?

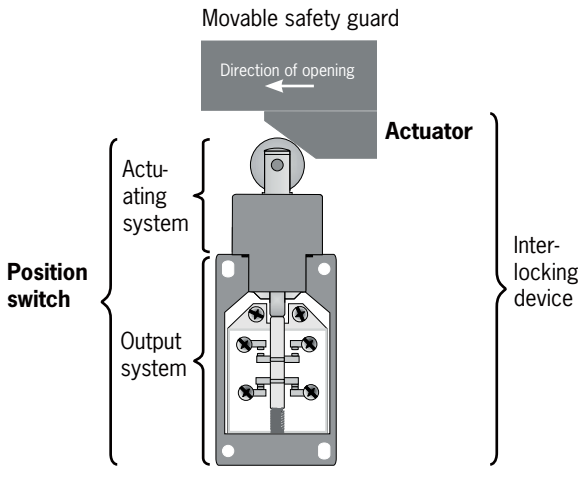
The standard provides a large amount of information especially on the selection of a suitable interlocking device. The procedure can be summarized very clearly in a flowchart, as can be seen on page 4.

Like the predecessor standard EN 1088, EN ISO 14119 is applicable internationally. As an ISO standard, EN 1088 already always had the number 14119.

What are the component parts of an interlocking device?

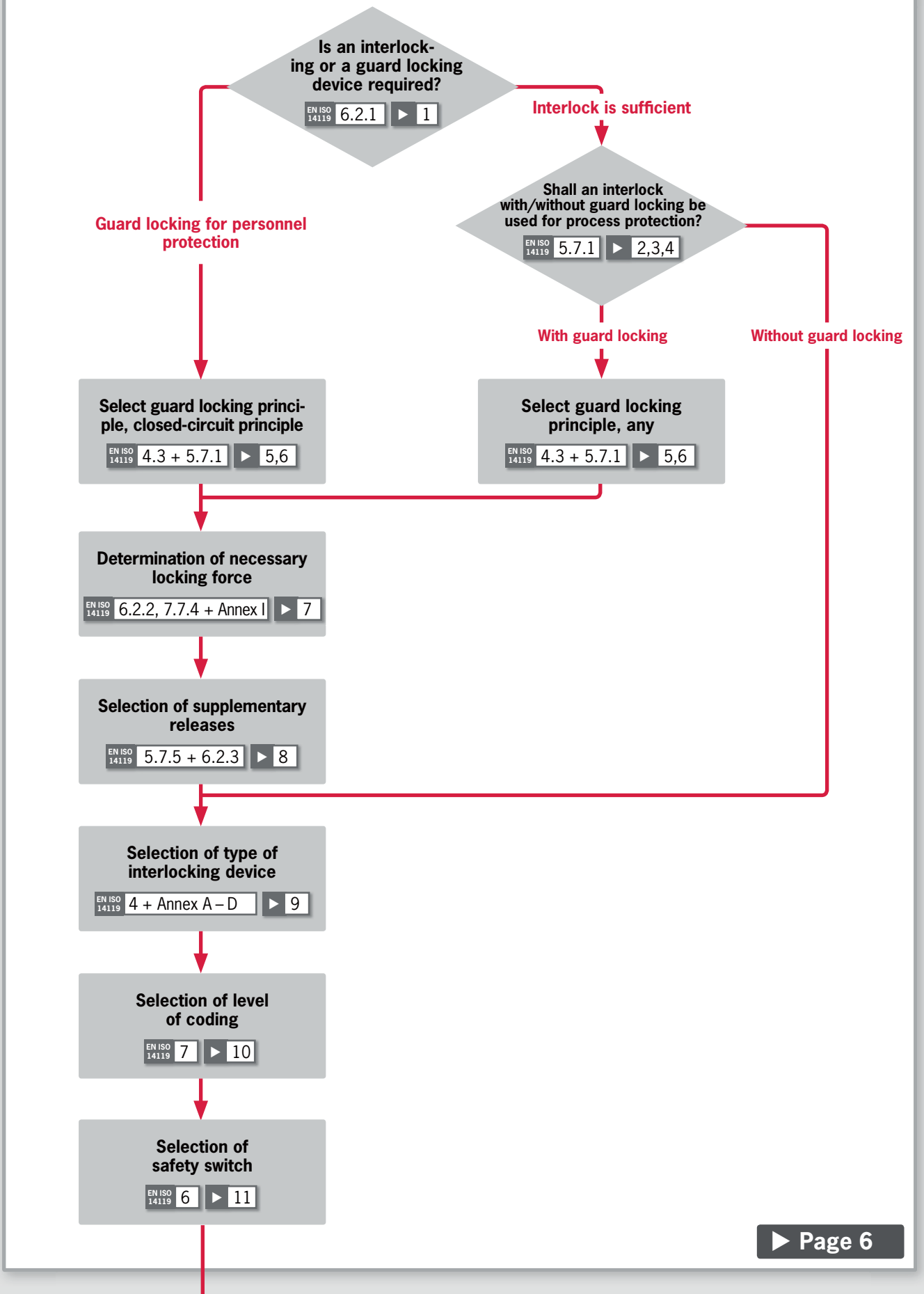
The standard defines the term "interlocking guard". This includes the movable safety guard and the interlocking device itself. In turn this device generally has two parts, the actuator and the position switch. The terms are used independent of the type.

Schematic depiction of an interlocking guard



»The way through the standard«

Selection of an interlocking device with or without guard locking



EN ISO 14119 X — Section in the standard

▶ X — Question in these guidelines

Design measures

Arrangement and fastening of position switch

EN ISO 14119 5.2 ▶ 12

Arrangement and fastening of actuator

EN ISO 14119 5.3 ▶ 13

▶ Page 16

Safety evaluation

Determine Performance Level (PL)

EN ISO 14119 8 ▶ 14–18

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Measures against tampering

Basic measures against tampering

EN ISO 14119 7 ▶ 19

Is there a motivation to tamper?

EN ISO 14119 7.1 + Annex H ▶ 20

Yes

No

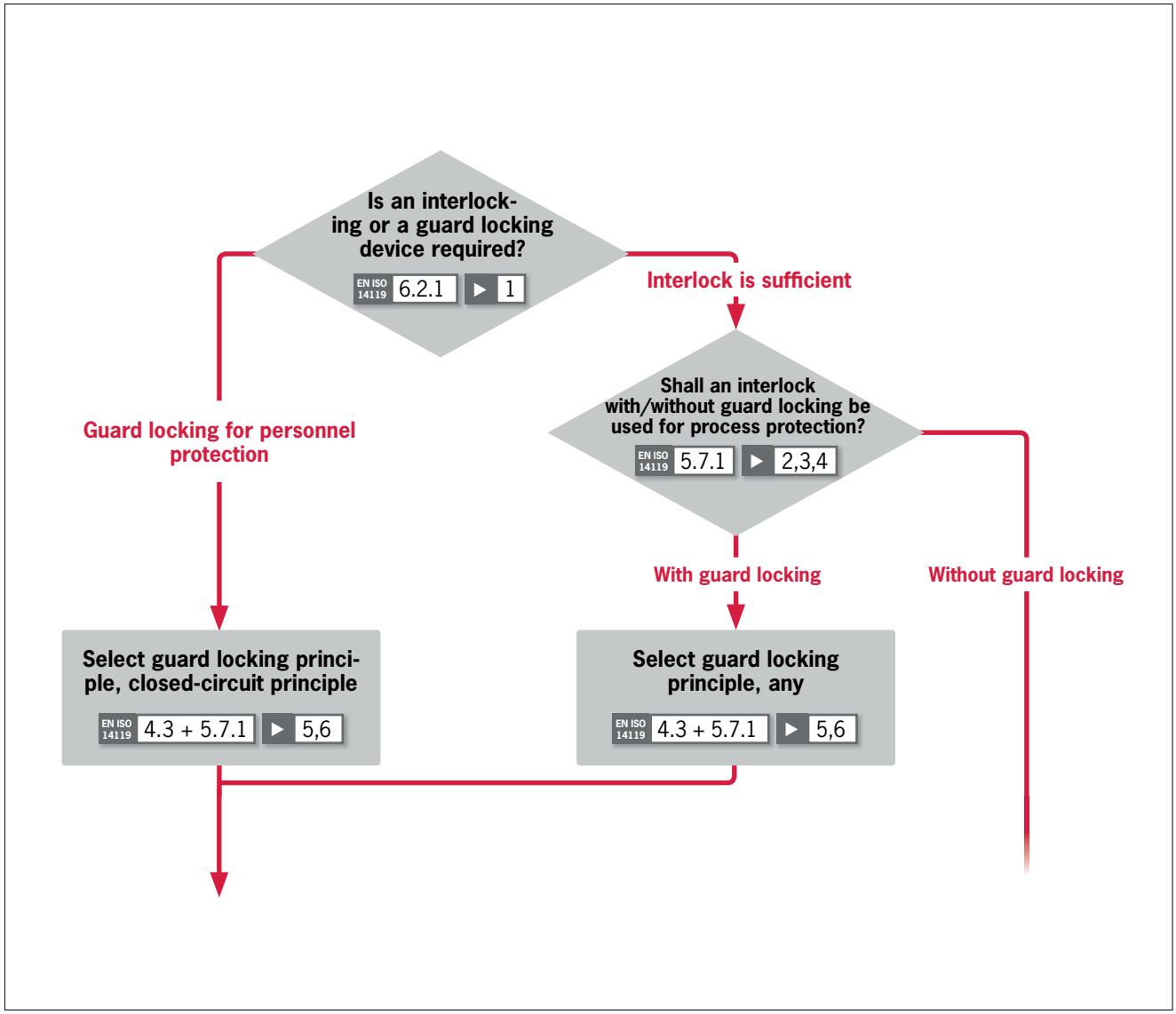
Additional measures against tampering

EN ISO 14119 7.2 + Table 3 ▶ 21

▶ Page 20

FINISHED

Selection of an interlocking device with or without guard locking (1)



▶ 1 Must a guard locking device be used for personnel protection or is an interlock enough?

An interlocking device with guard locking is always used if, on opening the safety door, a hazard cannot be eliminated in time before the operator reaches the hazardous point. To determine if this is the case, the standard provides a simple, clear instruction: the time to eliminate the hazard must be determined (e.g. due to overtraveling machine movements).

This time must be less than the time the user requires to reach the hazardous point. To determine this time EN ISO 14119 refers to EN ISO 13855:2010, section 9. The time can be determined using a formula that includes the defined approach speed of a person. In all other cases an interlocking device is sufficient. A guard locking device can of course always be used instead of an interlock, whether for process protection or personnel protection.

▶ 2 What is personnel protection and what is process protection?

Both terms are used in relation to guard locking devices. Guard locking devices for personnel protection ensure an operator is protected by locking a safety door as long as there is a hazard on entering a machine. For this purpose requirements from the standard in relation to the guard locking function must be met.

For guard locking devices for process protection there are no requirements to be met by the guard locking. The guard locking is not used to protect the operator, but instead to prevent the interruption of a work process.

For process protection an interlocking device must meet all requirements according to the standard and the design of the guard locking device must not degrade the safety of the interlocking device.

▶ 3 Which conditions must a guard locking device meet for process protection according to EN ISO 14119?

In relation to the guard locking device and the control of the guard locking, it must be ensured that the interlocking function (the monitoring of the position of the safety door) is not degraded. In addition all requirements on the interlock must be met.

- The first safety function of an interlock, whether with or without process protection guard locking, is the immediate shutdown of the dangerous movement on opening the safety guard.
- The second safety function is protection against the unexpected starting of a machine.

▶ 4 How can it be ensured that the interlock is not degraded with a process protection guard locking device?

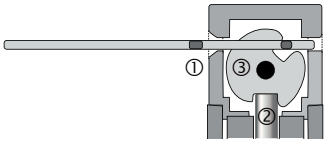
On a guard locking device it is necessary that the guard locking bolt (the standard refers here to a locking mechanism) only moves to the "locked" position if the safety door is also actually in the closed position. The guard locking is therefore not allowed "to lock in thin air". This feature is ensured by a failsafe locking mechanism that is mostly of mechanical design.

Only if the door is actually closed and the guard locking is locked a machine is allowed to start. EUCHNER safety guard locking devices in general include a prevention of inadvertent locking position. The safety function "protection against unintentional starting of a machine" can only be met if there is a prevention of inadvertent locking position.

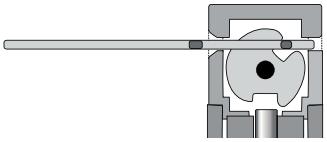
Prevention of inadvertent locking position

Position of the safety guard

Closed and locked

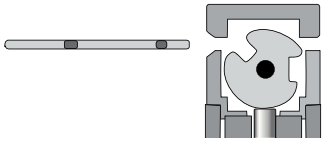


Closed and not locked



Not closed and not locked

Guard locking pin cannot be inserted



① Actuator (tongue)
② Locking mechanism (bolt)
③ Actuating system (internal cam)

On guard locking devices for process protection this failsafe locking mechanism helps to ensure the function of the interlocking device is not degraded. As required in the standard.

In the "locked" position a prevention of inadvertent locking position ensures that the safety door is in the "closed" position.

▶ 5 Which principles are there for guard locking?

EN ISO 14119 contains four different principles of operation for guard locking devices:

▶ Spring applied – Power-ON released
The principle "Spring applied – Power-ON released", at EUCHNER also called "mechanical guard locking", is a closed-circuit current principle in relation to the function of guard locking. It means that the guard locking device is moved to the "locked" position by a spring on the removal of the power. On switching on the power the guard locking device opens.

▶ Power-ON applied – Spring released
The principle "Power-ON applied – Spring released" therefore operates in the opposite manner and is called "electrical guard locking" at EUCHNER. It is an open-circuit current principle.

▶ Power-ON applied – Power-ON released
The principle "Power-ON applied – Power-ON released" is a principle that does not change position on the removal of power. It is also called the bistable principle. Power must be applied to change it to the other state. As the removal of the power does not change the position of the guard locking device, this principle is considered a closed-circuit current principle.

▶ Power-ON applied – Power-OFF released
The principle "Power-ON applied – Power-OFF released" corresponds to an open-circuit current principle, as the guard locking device opens on the removal of the power. The principle is used for electromagnets, for example on the CEM.

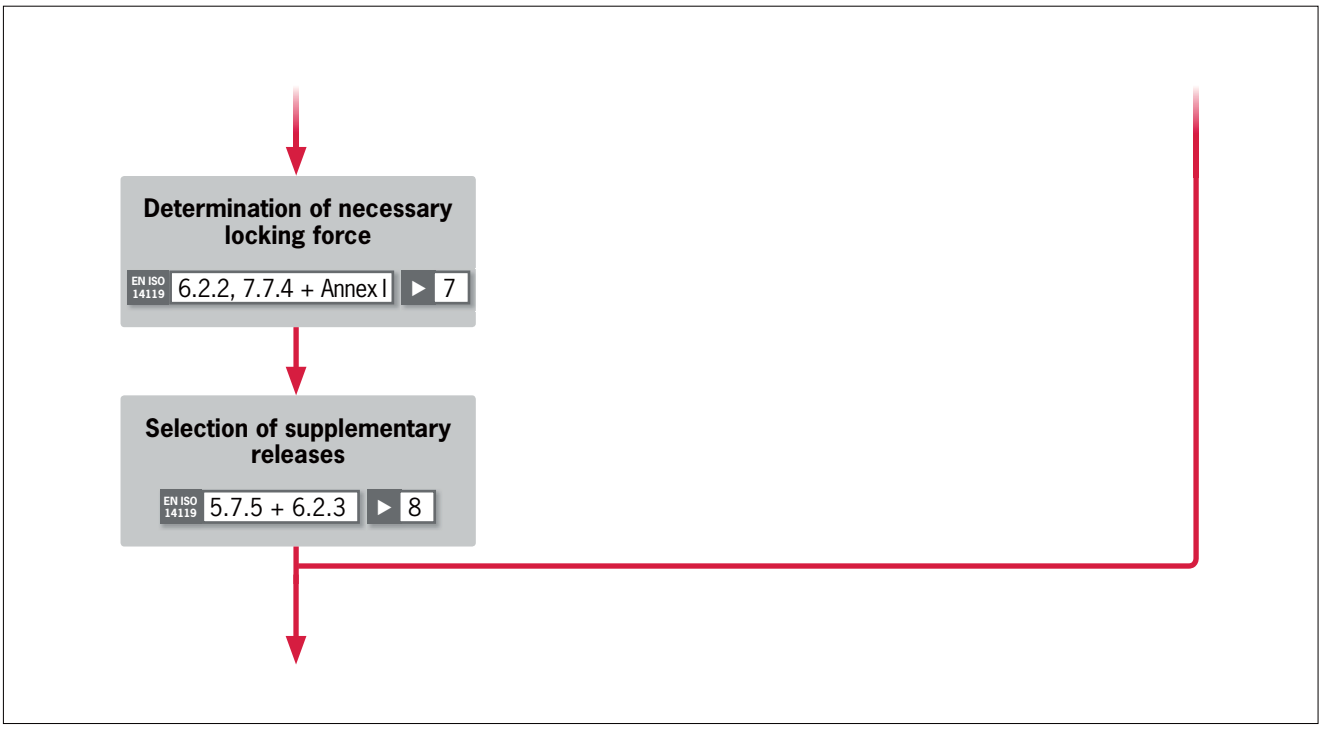
▶ 6 Which guard locking principle must be selected?

It is possible to select from the options described above for the operation of the guard locking. Two of these are so-called closed-circuit current principles. With these two principles the guard locking device is closed (locked) in the event of a power failure. A guard locking device for personnel protection must use one of these two principles.

The standard permits a very minor exception from this selection only if it can be shown that a closed-circuit current principle is an unsuitable method. The evidence for this statement will probably be very difficult to find. Often an open-circuit current principle is chosen for the access to the machine in the event of a power failure. However, this aspect can also be ensured using a closed-circuit current principle guardlock with an emergency release mechanism.

For process protection the design engineer is completely free to decide which type of guard locking is selected, as it does not represent a safety function. The only requirement in the standard is that on guard locking devices for process protection the safety of the interlocking device must not be degraded.

Selection of an interlocking device with or without guard locking (2)



▶ 7 How much force must a guard locking device have?

According to the standard the locking force F_{Zh} must be stated for every guard locking device. For the very wide range of different types of doors there are safety switches with a locking force from 500 to more than 5000 N. The force that occurs at the related safety door can only be determined by the machine design engineer. In annex I of the standard there is a table with the static forces that a person can apply in various situations. It is to be noted that this force can often be significantly increased by the action of a lever. In addition, there are many small safety doors on which lower forces occur. A guard locking device must be able to withstand the actual static forces that occur.

Dynamic forces are also given in a dedicated section in EN ISO 14119. They arise when the locking bolt engages automatically on closing the safety door. As the door bounces the entire force is absorbed by the guard locking device. This situation must be avoided. A simple solution is to operate the guard locking device only once the safety door is closed and stationary.

▶ 8 What is the purpose of optional releases for a guard locking device and when should they be used?

EUCHNER products already meet the majority of the requirements that the standard places on supplementary releases. A few requirements, e.g. correct attachment, must be met by the machine tool manufacturer.

The standard foresees the following release options:

Auxiliary release

▶ Auxiliary release
An auxiliary release is not a safety function. It is used to make it possible to access the machine in the event of a power failure. The auxiliary release must be secured against misuse, e.g. by means of sealing or lacquering. The majority of guard locking devices from EUCHNER are already prepared in this manner.

Escape release

▶ Escape release

An escape release is not a safety function. It ensures that a person locked-in can escape independently from the machine. This requirement does not stem from EN ISO 14119 but from the Machinery directive. An escape release must be attached such that it cannot be reached from the exterior.

Emergency release

▶ Emergency release

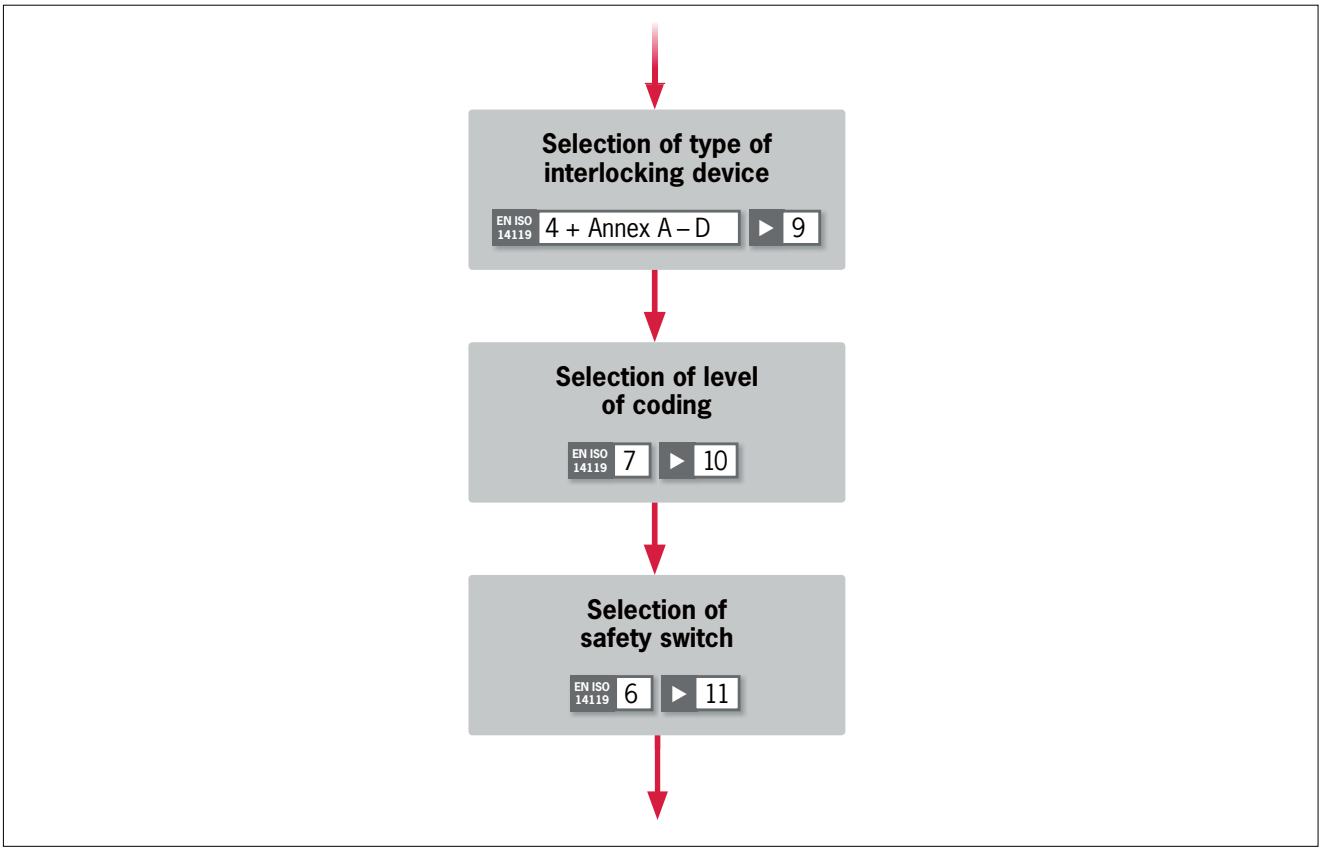
The emergency release, also not a safety function, is used to make it possible to reach the danger area in a machine quickly in an emergency. An example here is the outbreak of a fire in the system that must be extinguished quickly. In this case access without tools is possible. To reset the emergency release a tool or similar must be used. The closed-circuit current principle for guard locking solenoids can be used in almost all cases with an emergency release if rapid access to the machine from the exterior must be ensured.

The usage of a release feature is not stipulated. The necessity to use an optional release is only defined by the related application. An emergency release can be necessary, e.g., if there is a risk of fire in the work process and rapid access to the system must be ensured.

Technically both an escape release and emergency release can be designed more or less as required. EN ISO 14119 only requires for these two features that they can be operated without tools and straightforwardly. If the guard locking device is mounted such that it is hidden, a wire front release is very suitable for these applications. Depending on the planned usage, this feature is available with or without detent mechanism. The requirement for reset with a level of effort similar to a repair (e.g. usage of a tool or by resetting the control system) for the emergency release can be implemented in the version with detent mechanism. The requirement for reset with a level of effort similar to a repair is not required to application of an escape release.

Wire front release

Selection of an interlocking device with or without guard locking (3)



▶ 9 What is the purpose of division into types?

The division is used in the standard to formulate different requirements on the various possible interlocking devices. The standard differentiates between four types:

- **Type 1**
  Uncoded mechanically actuated position switch
- **Type 2**
  Coded mechanically actuated position switch
- **Type 3**
  Uncoded non-contact position switch
- **Type 4**
  Coded non-contact position switch

These types apply both to interlocking devices and guard locking devices. For a non-contact guard locking device, e.g. as on the CET and CTP, it is not the principle for the guard locking that is meant, but the principle for the interlock that is integrated into every guard locking device. Uncoded types do not require special actuators, instead they react, e.g., to the approach of metal. Coded position switches always require a special actuator. The type does not provide any information on the level of the coding, which can be from low to high.

In annexes A to D of the standard there are lists of examples for the application areas as well as the advantages and disadvantages of the various types.

Examples for different types

Type 1
Electromechanical
safety switch
without guard locking

Type 2
Electromechanical
safety switch
with guard locking

Type 4
Transponder-coded
safety switch

▶ 10 Which levels of coding are there and for what are they required?

There are three levels of coding for actuators:

- **Low**
  Up to 9 different actuators are available
- **Medium**
  10 to 1000 different actuators are available
- **High**
  More than 1000 different actuators are available

In the standard this information refers to the number of different actuators. Mechanical safety switches with separate actuator correspond to the low level of coding. Transponder-coded safety switches from EUCHNER are available with low and high coding. Multicode devices have low coding, conversely all unicode devices have high coding. The coding has nothing to do with the safety categorization of the devices. The achievable Performance Level (PL) is not affected by this issue.

The coding level is important as a measure against the tampering of safety devices. In general on a safety switch with high coding less effort is required to protect the system against tampering than on a safety switch with low coding. However, there is also the question as to whether there is a motivation to bypass the interlocking device and therefore it is necessary to take measures against tampering. This evaluation is explained in one of the following steps in the flowchart (page 4). In principle all systems must be secured against tampering.

▶ 11 Which interlock with or without guard locking must be selected from a normative point of view?

The safety switch should meet the normative requirements. All interlocking and guard locking devices from the EUCHNER range meet this requirement. Beyond the normative references a large number of practical considerations apply to the selection; these are partially defined by the standard. E.g. the significance of dust and dirt for type 2 safety switches is described in the standard. This is the case both in the normative part in section 6 and in the informative annexes.

The EUCHNER program offers a suitable interlocking or guard locking device for practically every application. In addition, the products include other useful functions (e.g. pushbuttons, bolts, emergency stop, etc.) that are independent of compliance with the standard.

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	Interlocking devices	
		
Series	NZ-WO, NZ-RS, NZ-HB, NZ-HS, NZ-PB, NZ-RK, NM, ESH	NZ-VZ, NM-VZ, GP, SGP, SGA, NX, NP, NQ
Type	1	2
Coding	Uncoded	Low
Guard locking principle	–	–
Interlocking safety function	Yes	Yes
Guard locking process protection function	–	–
Guard locking personnel protection safety function	–	–
Guard locking control safety function	–	–
Maximum locking force (F_{Zh})	–	–

	Interlocking devices with process protection guard locking			
				
CMS, CES, ESL, MGB-LO	TQ1, NZ..VZ..VSM	TQ2, NZ..VZ..VSE	CTP-I1	CTP-I2, CEM
4	2	2	4	4
CMS, Multicode: Low Unicode: High	Low	Low	Multicode: Low Unicode: High	Multicode: Low Unicode: High
–	Mechanical	Electrical	Mechanical	Electrical
Yes	Yes	Yes	Yes	Yes
–	Yes	Yes	Yes	Yes
–	–	–	–	–
–	–	–	–	–
–	Up to 2600 N	Up to 2600 N	Up to 2600 N	Up to 2600 N

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	Guard locking device without interlocking device		
			
Series	TK1	TK2	TZ1, TP1, TP3, STP3, TX1, TX3, STA3, STM1
Type	1	1	2
Coding	Uncoded	Uncoded	Low
Guard locking principle	Mechanical	Electrical	Mechanical
Interlocking safety function	No	No	Yes
Guard locking process protection function	Yes	Yes	Yes
Guard locking personnel protection safety function	Yes	Limited	Yes
Guard locking control safety function	Up to PL e	Up to PL e	Up to PL e
Maximum locking force (F_{Zh})	Up to 5000 N	Up to 5000 N	Up to 2000 N

Guard locking device with interlocking device

TZ2, TP2, TP4, STP4, TX2, TX4, STA4, STM2	TP-BI, STP-BI, STA-BI	CET1, CET3, CTP-L1 MGB-L1	CET2, CET4, CTP-L2 MGB-L2	CTP-LBI
2	2	4	4	4
Low	Low	Multicode: Low Unicode: High	Multicode: Low Unicode: High	Multicode: Low Unicode: High
Electrical	Bistable	Mechanical	Electrical	Bistable
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes
Limited	Yes	Yes	Limited	Yes
Up to PL e	Up to PL b	Up to PL e	Up to PL e	Up to PL e
Up to 2000 N	Up to 2000 N	Up to 5000 N	Up to 5000 N	Up to 2600 N

Design measures

Arrangement and fastening of position switch

EN ISO 14119 5.2 ▶ 12

↓

Arrangement and fastening of actuator

EN ISO 14119 5.3 ▶ 13

↓

▶ 12 How must a position switch be installed?

The most important requirement in the standard is that the position cannot be changed during operation. This statement applies to the entire service life of the machine. A change in the position would mean that forces could act on the position switch for which it is not designed and as a result increased wear could occur.

A further important aspect is that a position switch is not allowed to be used as an end stop. An exception can only be made if the manufacturer expressly designs the switch as an end stop and the stop can withstand the forces. An example of such a product is the MGB. On this product a funnel for the handle module is already integrated.

The correct attachment of the position switch is already a basic measure against tampering of a safety device. As there will always be a motivation to completely disable a safety device that is not functioning reliably.

Examples for safety switches that can also be used as an end stop

MGB

CEM

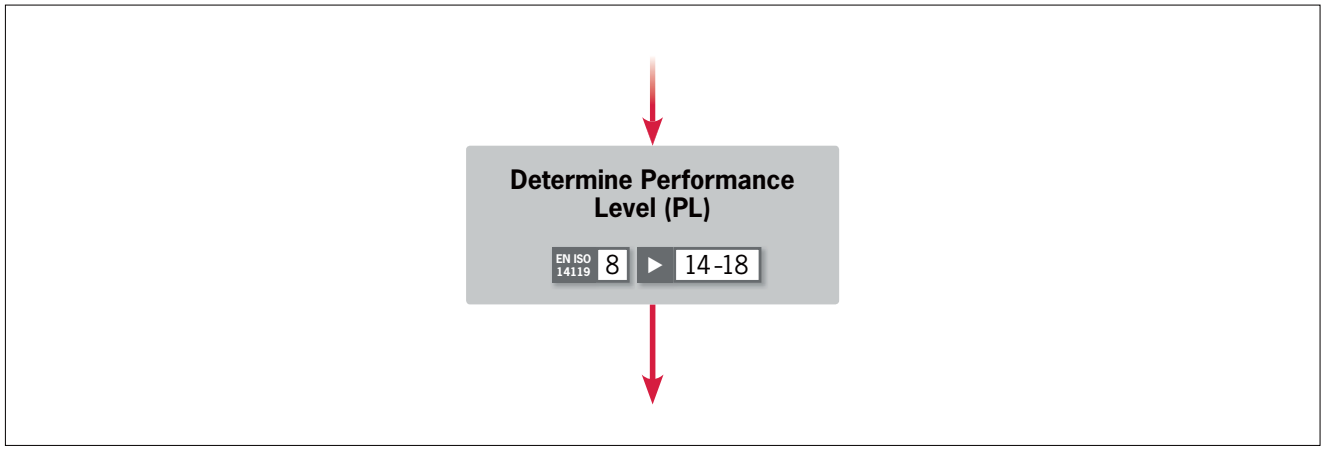
▶ 13 How must an actuator be fastened?

It is required that an actuator cannot become detached on its own. The same requirements applies as for the position switch. (see ▶ 12)

An incorrectly adjusted actuator may damage the interlocking device such that the safety function is not longer provided. An actuator is also not designed to absorb the forces that could result from an unintentional impact.

The correct attachment of the actuator, like the attachment of the position switch, is already a basic measure against tampering of a safety device. As there will always be a motivation to completely disable a safety device that is not functioning reliably.

Safety evaluation



▶ 14 Which safety functions must an interlocking device according to EN ISO 14119 provide?

An interlocking device provides in most cases two different safety functions:

- The first, very obvious safety function is the immediate shutdown of the dangerous movement on opening the safety guard.
- The second safety function is, as for guard locking, protection against the unexpected starting of a machine.

Conversely it also applies that a machine can only be started if the safety door is closed.

▶ 15 Which safety functions must a guard locking device for personnel protection according to EN ISO 14119 provide?

A guard locking device must inhibit access to the hazardous point until the risk of injury has been adequately reduced. This action is performed on guard locking devices by not opening the so-called locking mechanism until the hazard has been eliminated. Typical is the hazard due to overtravel on shutting down a machine, or machine rundown time due to inertia of moving parts.

- The most important safety function is therefore the monitoring of the position of the locking mechanism for the guard locking device. On mechanical guard locking this is the position of the guard locking solenoid.
- A second safety function that is very frequently considered in conjunction with this component is the prevention of unintentional starting of a machine. This safety function can always be provided by a guard locking device if a so-called inadvertent locking prevention (see ▶ 4) is integrated.
- The third safety function is newly defined in EN ISO 14119. The risk for the control of the guard locking must also be determined since this standard was published. In the majority of cases this risk if significantly lower than for the monitoring of the actual guard locking. On this topic also see EN ISO 14119:2013, section 8.4, note 2.

A very important criterion from EN ISO 14119 is the selection of the correct guard locking principle. Conversely it also applies that to start a machine the safety guard must be closed and locked.

▶ 16 What does EN ISO 14119 state in relation to the determination of the PL for a safety function?

Unlike in the predecessor standard EN 1088, EN ISO 14119 provides a large amount of information on the safety functions on interlocking devices and on interlocking devices with guard locking.

EN ISO 14119 adopts the requirement from EN ISO 13849-2 that, on the usage of electromechanical safety switches for PL e, fault exclusion cannot be applied to the mechanical failure of an actuator. For PL d a justification is required as to why the “mechanical failure of an actuator” fault exclusion has been applied. A possible justification is if the actuator and switch do not need to absorb external forces due to corresponding protection.

Also the diagnostic coverage on interlocking devices is addressed. Electromechanical safety switches can only be checked for function on movement of the safety guard, as only then do the integrated contacts change their state. As a consequence a fault may remain undiscovered for an extended period on infrequently opened safety doors, the standard therefore contains requirements on the frequency of opening a safety guard. For PL e the period must not be more than one month, for PL d not more than one year.

Especially on guard locking devices it is not easy to develop dual-channel circuits that meet all requirements in relation to the diagnostic coverage of an interlocking device and guard lock monitoring.

A safety switch can be checked for correct function very easily if a further switch acts as a second channel and provides the same information on the position of the safety guard. It is only necessary to check both signals for plausibility. This redundancy is necessary if category 3 or category 4 according to EN ISO 13849-1 must be achieved.

For applications that require a guard locking device, a further guard locking device is not imperative for redundancy. A second switch without guard locking is adequate for the second channel. This statement applies up to Performance Level e (PL e). EN ISO 14119, section 8.4 note 2 provides clarification on this issue. Unlike for an interlocking device, fault exclusion for the mechanical failure of a locking mechanism is possible up to PL e. This fault exclusion on mechanical components does not apply for safety switches without guard locking (on this topic see EN ISO 13849-2:2012 Table D.8).

Practical notes on these circuits are given in the flyer “Proven Systems – Proven Safe” from EUCHNER.

An entirely new requirement from EN ISO 14119 is the assessment of the unlocking of a guard locking device in section 8.4. Here it is required for the first time that the control of the guard locking must also meet a PL_r according to a risk assessment. This statement only applies for guard locking devices for personnel protection. In general it can be stated this is mostly lower than the PL for the guard lock monitoring. The following examples clarify this point:

The operator is outside the machine’s safety guard. The control of the guard locking fails. This failure has the consequence that the guard locking is unlocked. Due to the monitoring of the guard locking, a stop command is initiated and the machine transferred to a safe state. There is a residual risk for the operator in the period until the machine has reached a safe state. However, this risk only arises if the operator opens the safety guard during exactly this period and is therefore exposed to the hazard.

On a machine tool, PL c or even PL a (prEN ISO 16090) is often adequate, as the hazard due to the overtraveling machine movement is visible and the hazard occurs very infrequently.

On the other hand, applications such as centrifuges or extruder covers on plastic injection molding machines require a higher PL for the control of the guard locking. As here the duration of the hazard is significantly longer and less obvious.

A little unusual in the assessment of the control of the guard locking for personnel protection is that the guard locking solenoid in the safety switch is itself an actuator that is de-energized (shutdown of the voltage at the guard locking solenoid). The solenoid therefore does not contribute to the probability of failure of the safety function and has neither a PFH_d value nor a B_{10d} value for the control of the guard locking. As a consequence the PL for the control of the guard locking is only defined by the PL of the controlling device, e.g. a standstill monitor.

However, some guard locking devices from EUCHNER have internal electronics to control the guard locking. Devices with internal electronic control of guardlocking must be considered when calculating probability of failure for the overall behavior of the safety function.

You will find practical information on fault exclusion up to PL e in the flyer “Proven Systems – Proven Safe”

▶ 17 How must a guard locking device be controlled and how is the PL of the circuit determined?

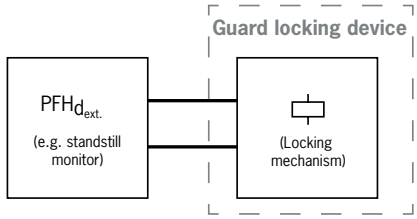
The greatest change in EN ISO 14119 compared to the predecessor standard EN 1088 is the requirement to consider the control of the guard locking as a safety function. This does not mean that a guard locking device must always be controlled with dual-channels with immediate effect, only that a risk analysis must be undertaken to determine the necessary PL. This aspect is explained in question 16. Often a low level will result as a hazard due to the incorrect control of a guard locking device and does not result directly in a risk for the operator.

A detailed risk assessment has been undertaken, e.g., for prEN ISO 16090, Safety of milling machines. Here the requirement is for PL a.

The determination of the PL actually achieved by the circuit depends on whether the guard locking solenoid, which represents the actuator in this case, can be de-energized directly or whether internal electronics need to be taken into account.

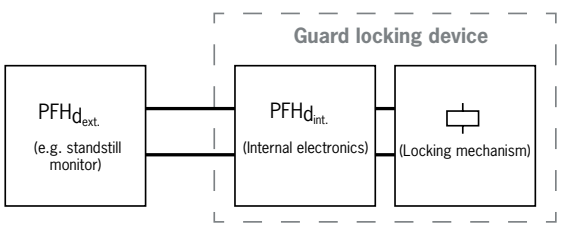
If the guard locking solenoid is fully de-energized from the exterior, the device does not have a safety characteristic for the control of the guard locking. It therefore does not contribute to the probability of failure. The safety chain is shown in Figure 1.

Figure 1: Schematic diagram of the safety chain with de-energized guard locking solenoid



Guard locking devices like the MGB function differently. These devices have a permanent power supply and the control of the guard locking is undertaken via inputs. As such the guard locking is not fully de-energized even on shutting down the two inputs. On these guard locking devices the electronics contribute to the probability of failure of the control chain and a block must be added to the block diagram for the safety device, as shown in Figure 2.

Figure 2: Schematic diagram of the safety chain on which the guard locking solenoid is not completely de-energized.



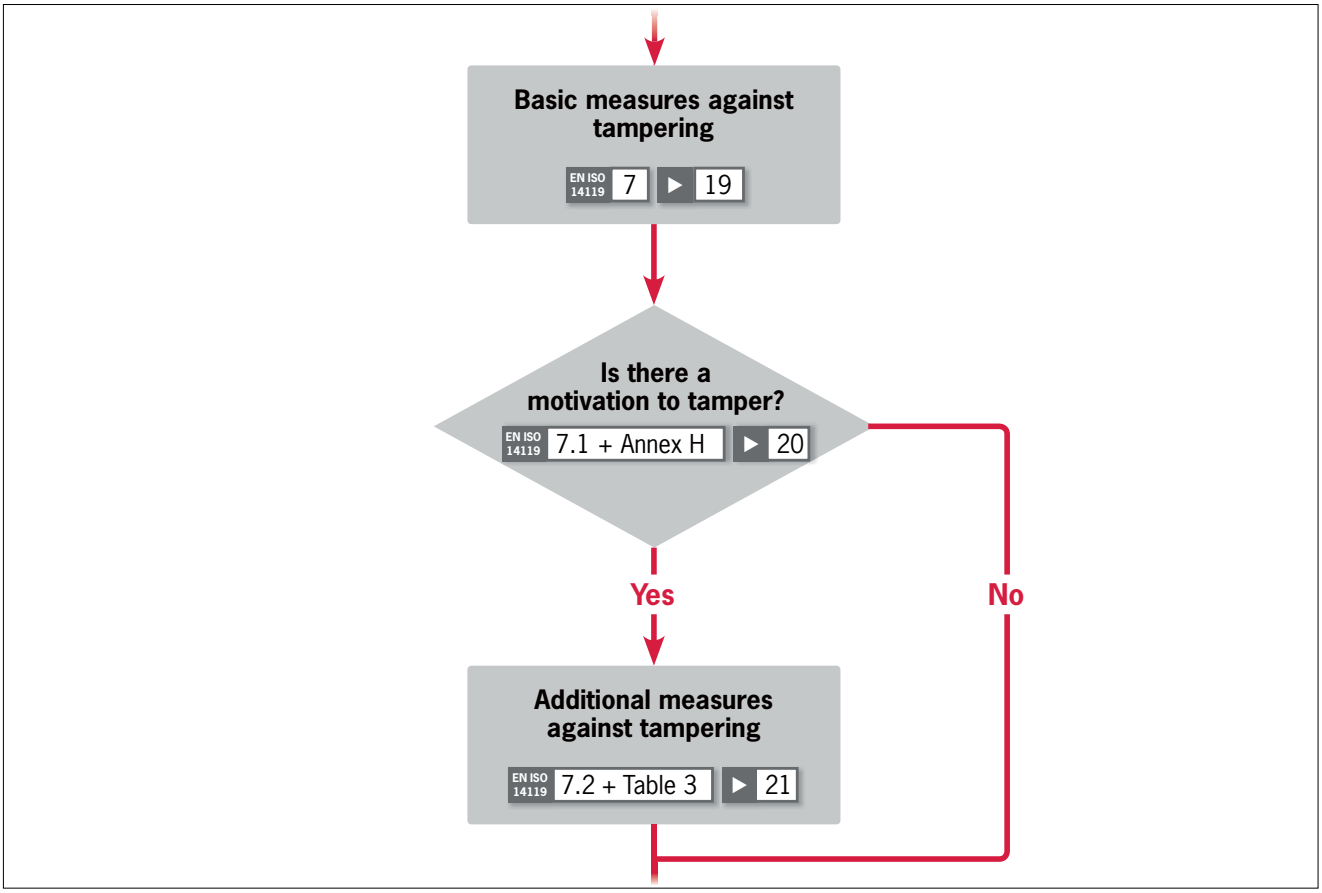
▶ 18 Is the series connection of electromechanical guard locking devices safe?

Series circuits can be used without problems up to category 1. The situation becomes difficult if diagnostics on the individual safety switch is necessary. The problem here is that with a series connection faults are masked by other safety switches. It is difficult to include this fault masking in a value for the diagnostic coverage acc. to EN ISO 13849-1. A possible method for determining the diagnostic coverage is given in a new paper, TR 24119, to which EN ISO 14119 already refers.

The result of the method from TR 24119 yields for a maximum of 30 safety switches in series a possible diagnostic coverage of “low or medium”, with which PL d can be achieved.

Various electromechanical safety switches with guard locking

Measures against tampering



▶ 19 Is it in general necessary to take measures against bypassing a safety device?

Basic measures must be taken against tampering on safety switches. These relate above all to the correct fastening of all parts of the interlocking device. It is in principle only necessary to take additional measures for type 3 interlocking devices, e.g. covered mounting.

▶ 20 When is it necessary to take measures against tampering on safety guards?

The basic measures are adequate if it can be shown that there is no motivation to bypass a safety door. To determine whether there is a motivation to tamper the safety device, the standard provides a possible method in the form of a simple table. This is described in annex H. Here it is checked for each individual operating mode of a machine whether an operator obtains an advantage from bypassing the safety device. If there are advantages, it must be checked whether these advantages can be eliminated. For this purpose the standard states two possibilities (refer to EN ISO 14119 section 7.1): first design measures must be taken to ease operation. As these measures have in the majority of cases already been implemented, the remaining possibility is the introduction of suitable operating modes. As examples the standard states operating modes that permit adjustment, tool changing, troubleshooting, service or process monitoring. The best way to prevent the tampering of safety guards is that an operator can undertake all the necessary work without excessive effort. If it is also not possible to remove the motivation even with this procedure, further measures must be taken. It is consciously not considered that every safety guard can be bypassed in some form.

▶ 21 How can the bypassing of safety switches be prevented?

Tampering cannot be prevented with technical means. It is always possible to bypass a safety guard. Whether by unscrewing an element from the fence next to the safety door or removing a cover on the machine.

Tampering cannot be prevented, but made more difficult. There is clear information on this issue in EN ISO 14119. This includes such simple measures as the covered attachment of the interlocking device, but also purely control system-related measures such as a plausibility check. However, the selection of the measures is not entirely open. Depending on the type of safety switch and the level of coding, there are different possibilities. The simplest is to use a type 4 safety switch with high coding. Here it is only necessary to fasten the actuator so it cannot be detached. Safety screws are included with all EUCHNER actuators for this purpose.

In relation to the coding, EN ISO 14119 differentiates between three levels. “Uncoded” means that the safety switch does not require a specific mating piece as the actuator. “Low level coding” means that between one and nine different actuators are available. A “medium coding level” is not known for interlocking devices. For this coding between 10 and 1000 different actuators must be available from the manufacturer.

More than 1000 different actuators is considered a “high coding level”. EUCHNER unicode safety switches are taught-in for exactly one single actuator. As such they are completely unique and exceed the requirement in the standard for “high coding level”. EUCHNER multicode devices uses the same coded actuators. However, these devices only evaluate a small part of the code, which is identical in all actuators. The coding level for this type of device is therefore 1 and is therefore a low level coding. Both forms of type 4 safety switches meet the same PL according to EN ISO 13849-1.

EN ISO 14119 only defines coding levels for actuators. As shown in the example above, however, the coding must be considered over the entire system.

Further literature

1) **DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL** of 17 May 2006 on machinery, an amending Directive 95/16/EC (recast)

2) **Guide to implementation of the Machinery Directive 2006/42/EC**

3) **DIN EN ISO 14119:2014-03**
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4) **DIN EN ISO 13849-1:2008-12**
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5) **DIN EN ISO 13849-2:2013-02**
Safety of machinery. Safety related parts of control systems. Part 2: Validation, Beuth Verlag

6) **DIN ISO 13855:2010-10**
Safety of machinery. The positioning of safeguards with respect to the approach speeds of parts of the human body, Beuth Verlag

7) **prEN ISO 16090-1:2014**
Machine tools safety – Machining centres, Milling machines, Transfer machines – Part 1: Safety requirement (ISO/DIS 16090-1:2014);

8) **DGUV Information 203-079**
Auswahl und Anbringung von Verriegelungseinrichtungen (Selection and attachment of interlocking devices)
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9) **BGIA Report 2/2008**
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10) **Proven Systems – Proven Safe. Categories and Performance Level acc. to EN ISO 13849-1**
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The flyer can be downloaded at www.euchner.com in Service / Standards and safety.

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