Safe solutions for your industry

Locking Devices for Machine Safeguards

The principles of Guard Locking and Process Locking

Image 1: a locked machine safeguard door, seen from outside (left) and inside (right).

Machine safeguarding focuses on the protection of personnel from recognized machine hazards. One method of safeguarding is “guard locking” which will prevent access to hazardous areas or conditions until a safe state has been reached. For example, if there is residual motion or other hazardous energy which takes some time to dissipate after a stop command has been triggered. Another area of focus for machine guarding is the protection of a machines’ process. Sudden interruption of a cycle or process may cause damage to machine parts and result in loss of product. To protect against this, “process locking” can be applied.

A locking device will comprise of two separate functions; an interlock function and a locking function.

The interlock function monitors the position of the guard. If the guard is opened (actuator separated from the switch) the interlock function will prevent the safety circuit from completing. This open safety circuit will remove hazardous motions and energy which may cause harm to the operator and at the same time will prevent the machine from an unexpected startup or cycle. For both guard locking and process locking devices this interlock function must satisfy all relevant safety requirements, for example IEC 60947-5-1 and be integrated into the safety circuit.

The role of the locking function is for the safety switch to retain its actuator, thus maintaining a closed and locked guard until a release signal has been received. Only once this signal has been received will the switch unlock allowing the guard to be opened. The monitoring for a safe state which will trigger the unlock signal can be achieved by a variety of different practices. Some of the more common methods include the monitoring of a rotating part. A safe state or “zero speed” is established once the revolutions have been reduced to a predetermined nonhazardous frequency. Another method is monitoring the back electromagnetic force (EMF) directly off of a motor. An EMF reading in the low millivolt range from the line voltage will represent a safe state for opening a guard. If the time it takes for the residual hazards of the machine to abate is constant, a fail-to-safe timer can also be utilized. Once a stop command is initialized the timer will begin a programmed count-down which upon completion will send the unlock signal to the safety device.

For guard locking applications it is imperative that the guard remains closed and locked so that the operator does not expose themselves to operational or residual hazards. For this reason, the locking function of a guard locking device must meet the relevant safety requirements and be integrated into the safety circuit similar to its interlock function. The safety circuit will open once the guard is unlocked even if the guard is still closed. Whereas the locking function of a process locking device is not pertinent to operator safety, thus it is not required to fulfill safety

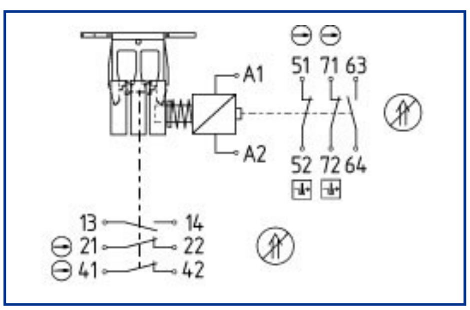


Image 2: An example contact schematic of an electrical mechanical locking switch. At the bottom are shown contacts which monitor the position of the guard (key inserted). These can be used for process locking. To the right are shown contacts which monitor the locking solenoid that can only be locked while the guard is closed. These contacts can be used for guard locking.

requirements or be integrated into the safety circuit. The safety circuit will remain closed even in an unlocked state as long as the guard door remains closed. The main reason for process locking is to avoid damage to goods and/or the machine. Some goods may be temperature sensitive or a process may be time sensitive such that prematurely opening a guard door will damage the goods resulting in loss product and even downtime for resetting a process. Abruptly switching off a motor or drive due to an unauthorized guard opening can also lead to equipment damage.

A locking device will have 1 of 4 different operating principles as defined by ISO 14119:

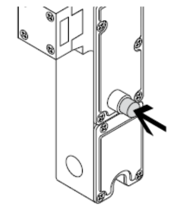
- spring-to-lock, power to release;
- power-to-lock, spring release;
- power-to-lock, power-to-release (bistable); or
- electromagnetic locking.

These locking principles can be seen in both electromechanical and electronic type devices. For guard locking applications certain considerations will need to be observed since these locking functions are directly related the safety function. For example, ISO 14119 acknowledges that a loss in power will result in the loss of the locking function for power-to-lock and electromagnetic devices, which can then lead to the access of residual hazards. As such, this power failure has to be taken into account during the risk assessment. For electromagnetic locking devices, further precautions are defined such as the constant monitoring of the holding force and methods to discourage overriding the safety switch.

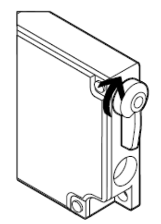
In the event that access to a guarded area is required while the guard is locked, such as an emergency or device fault, a means to override the locking must be available. For example: where full body access is possible, ANSI/RIA 15.06 requires a means to unlock a guard locking device from within a robotic cell, independent of the status of the lock command. This type of release is defined as Escape Release in ISO 14119 and requires that no tool be needed to unlock the device. Similarly, it defines an Emergency Release of the actuator, again without tools but from outside a hazardous area. The third method is Auxiliary Release for outside a hazardous area with the help of special tool or key.

The decision on using an interlock device versus an interlock device with guard locking is based on the time it takes for a machine or system to arrive at a safe state. If the rundown time is greater than the time it take to access the area, an interlock device with guard locking should be selected. A risk assessment can be used to further determine which type of guard locking device shall be used. In addition, current standards such as ISO14119 and ISO13849 will go into detail on how the guard should be installed, all aiming to achieve a safer machine and workplace.

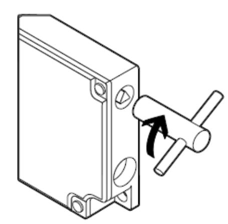
Release types as defined in the standard ISO 14119, section 3.25 to section 3.27



Escape release:
Mounted within the hazardous zone to be able to leave the area independently in the event of danger.
(emergency exit)



Emergency release:
Mounted outside the hazardous area, for emergency use.



Auxiliary release:
For unlocking during setup, no emergency.

Author:
Devin Murray
Functional Safety Engineer
TÜV Rheinland ID-No. 4274/11 Machinery
Schmersal USA

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K.A. Schmersal GmbH & Co. KG

Schmersal USA
15 Skyline Drive
Hawthorne, NY 10532

Tel: 914-347-4775
salesusa@schmersal.com
www.schmersalusa.com