

MOVABLE MACHINE GUARD SAFETY: MEETING OSHA AND ANSI REQUIREMENTS

In many metalworking and other fabricating processes, machine guards are often required to protect workers against injury from hazardous points of operation.

Frequently, such guards must be opened to permit access to change tooling, load/unload material, clear jams, apply lubricant, and/or adjust process parameters. To minimize the impact of movable guards on productivity, they are generally designed to be opened without the use of tools. Such ease of access dictates precautions be taken to protect the workers from exposure to hazards when the guards are open.



This movable guard permits access to load and unload material and clear jams.

Interlock Switches

One commonly used precautionary technique is the use of interlock switches and sensors, which are intended to shut down the machine upon opening of the guard.

Traditionally, design engineers and plant operation personnel have interlocked movable guards with conventional position-presence-sensing devices. These include:

- 1) Conventional non-safety limit switches.
- 2) Inductive proximity sensors.
- 3) Magnet or reed switches.
- 4) Joy plugs.
- 5) Snap-action position switches.
- 6) Hall-effect sensors.

Their widespread use is by default. Until recently, safety components designed expressly for machine guard position sensing/interlocking in safety applications have not been available. Consequently, the availability and familiarity with these conventional position sensors resulted in their use to sense the opening of a machine guard (for example, its position) and provide a signal to shut down the machine.

However, these industrial sensors and switches are not designed for safety applications. Each can be defeated by using tape, wire, scrap metal, or a simple magnet. The sensors and switches might fail because of contacts welding/sticking or because of spring-driven contact-opening mechanisms failing.

New Machine Guarding Safety Concepts

Recognizing these limitations, the Occupational Safety and Health Administration (OSHA), the American National Standards Institute (ANSI), and other performance standards-making organizations support the use of the latest product concepts and designs for movable machine guard safety interlocks and systems (see **Figure 1**). These include:

- 1) Tamper resistance.
- 2) Positive-opening, normally-closed (NC) contacts.
- 3) Positive-guided relays.
- 4) Control reliability.
- 5) Self-checking, safety circuit monitoring and control modules (also called “safety relay modules”).

- OSHA 29 CFR 1910.212: General Machine Guarding Requirements for All Machines
- OSHA 29 CFR 1910.211: Machinery and Machine Guarding
- OSHA 3067-1992 (Revised): Concepts and Techniques of Machine Safeguarding
- ANSI B11.19-1990: Safeguarding Reference for B11 Machine Tool Safety Standards
- ANSI B11.20-1991: Safety Requirements for construction, care, and use of machine tool manufacturing systems/cells
- ANSI-RIA 15.06-1992: Safety Requirements for Industrial Robots and Robot Systems
- European Machinery Safety Directive (EMD) 89/392/EEC
- UL491 (Proposed): Power Operated Machine Controls & Systems

Figure 1

Here is a sampling of selected U.S. and international machine guarding safety standards and guidelines supporting use of the latest product concepts and designs for movable machine guard interlocks.

Each is aimed at heightening the level of safety for the machine operator/maintenance personnel when they open machine guards that expose them to hazardous areas. By their design, they provide manufacturers with a means of creating safer workplaces, meeting legal requirements, and reducing the risk of liability.

Tamper Resistance. Frequently, machine operators find ways to tamper with and/or bypass machine guard safety interlocks. Whether motivated by a desire to increase their production rate, their desire to circumvent what they perceive as an inconvenience, or simply their desire to “beat the system,” the consequences can be serious.

Increasingly, safety standards-making groups have recognized the need for safety interlocks to be “tamper resistant/difficult to defeat.” While the phrase is subjective, its intent is to promote the use of safety interlocks that cannot be defeated via simple means (such as a piece of wire, tape, conventional tool, or other conveniently available material). Instead, defeating the safety interlock should be sufficiently difficult to discourage such actions.

Machine guard safety interlock manufacturers have addressed the tamper-resistant shortcomings of conventional limit switches and other position sensors through the development of a number of difficult-to-defeat components. These include two-piece, positive-opening switches featuring geometrically-unique actuating keys (see **Figure 2**) and sealed, coded-magnet switches.

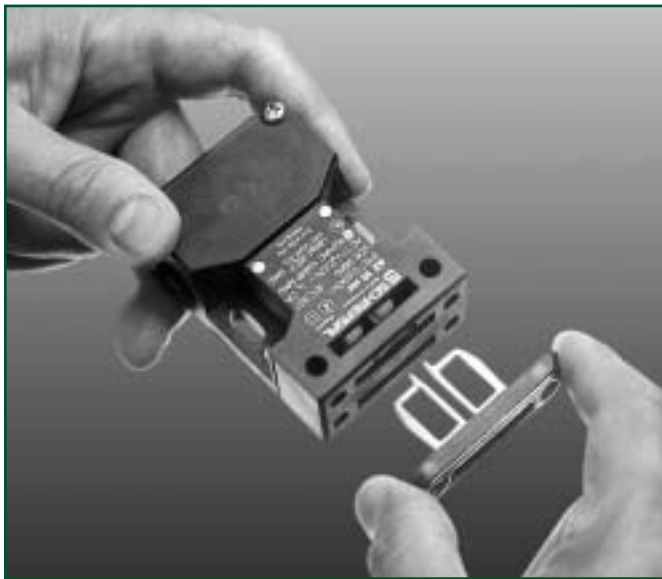


Figure 2

A two-piece, positive-break switch featuring geometrically-unique actuating keys.

Positive-Break Contacts. These are normally-closed contacts which, upon switch actuation, are forced to open by a nonresilient mechanical drive mechanism. By design, positive-break contacts cannot fail to open because of a contact weld or the failure of a resilient (spring) mechanical drive mechanism (see **Figure 3**). These are also known as positive-opening or direct-action contacts.

Positive-Guided Relays. Unlike conventional relays, positive-guided relays are designed with normally-open (NO) and normally-closed (NC) contacts, which function interdependently. In such relays, the NO and NC contacts can never be closed simultaneously. If one of the contacts welds closed the other contacts are prevented from changing state. For example, if one or more of the NO contacts in a positive-guided relay welds or sticks shut when closed, the NC contacts will remain open with a minimum gap of 0.5 millimeter (see **Figure 4**).

Therefore, positive-guided relays are preferred when

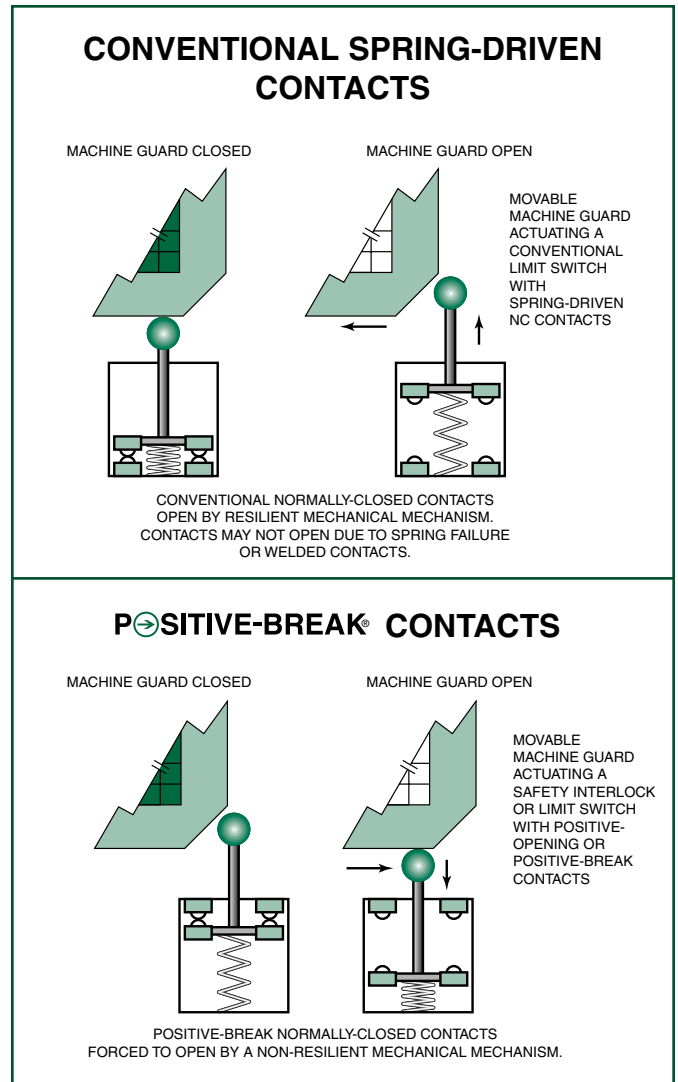


Figure 3

Conventional versus positive-break contacts.

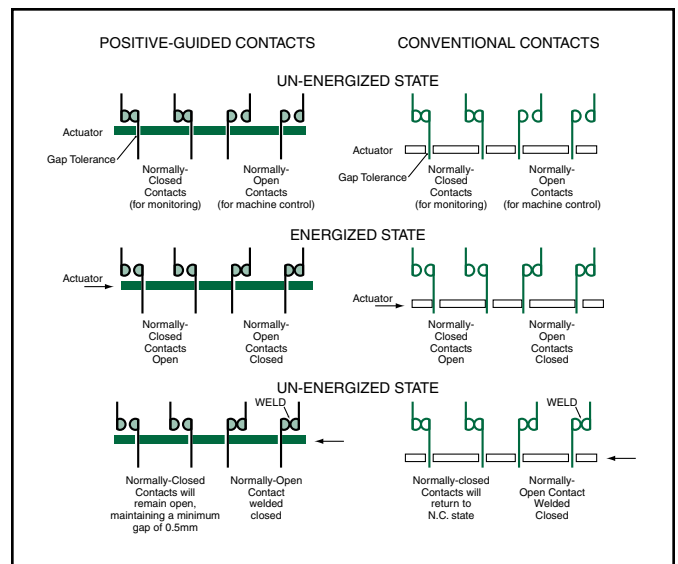


Figure 4

Positive-guided versus conventional contacts.

work or service area via a movable guard must be prohibited until a safe condition exists (such as moving parts come to a stop, dangerous clamping points are completely closed, articulating robot arms reach a safe “home/rest” position, etc.).

Additionally, manufacturers may wish to prevent unauthorized interruption of the production cycle or restrict access for other reasons. In such situations, operator and maintenance personnel can be protected by an electrically latched, positive-opening safety interlock switch (see **Figure 7**).

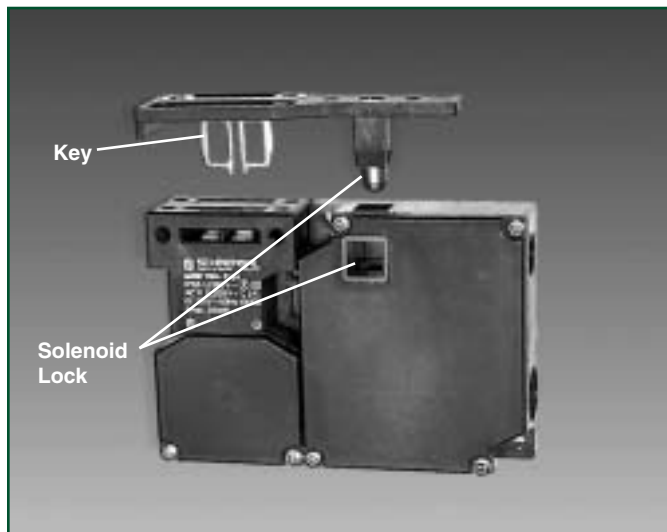


Figure 7

An electrically latched, key-actuated, positive-break safety interlock switch.

Here, the interlock switch actuator key cannot be removed from the switch mechanism (and the movable guard to which it is attached cannot be opened) until a mechanical locking bolt has been released by a solenoid. This solenoid release typically comes from a timer control, motion detector, or other appropriate sensor which is activated when the safe condition is attained.

Safety Circuit Monitoring and Control Modules. To address single component failure control reliability requirements, safety circuit monitoring and control modules have been developed. One such module, together with a noncontact, sealed, tamper-resistant, coded-magnet reed switch position sensor, is shown in **Figure 8**. These control modules have two redundant logic circuits. Each of the logic circuits independently performs self-diagnostics to detect a failure in the safety system’s switches, sensors, and interconnection wiring, and the control module’s monitoring circuits.

In operation, the NO contacts of the positively guided output relays are connected in series to establish an “authorized” output. Before enabling the machine, the control module checks all elements of the safety guard interlock system. Should it detect a component failure in the safety interlock switch/position interlock sensor, out-



Figure 8

A safety controller with a noncontact, sealed, tamper-resistant, coded-magnet reed switch position sensor.

put relays, or control module logic, it will not allow enabling of the machine start circuit, shutting down the system in a safe condition. When used with switches or sensors having NO and NC contacts, the safety circuit control module is also able to detect interconnecting cable failures such as short circuits.

Why Use These New Safety Concepts?

The growing use of these new machine guarding techniques reflects the increasing attention industry is giving to better employee safety. They complement OSHA, ANSI and other industry performance standards.

Such interlock switches and related controls, designed expressly for machine guarding safety applications, provide the means to satisfy these requirements. Machinery manufacturers and users can enhance the safety of the workplace by:

- 1) Eliminating risks associated with workers’ defeating or bypassing safety interlocks.
- 2) Ensuring the positive opening of electrical contacts and thus interruption of power.
- 3) Controlling access to a machine work area until the hazard represented by moving/articulating members or other components has dissipated.
- 4) Reducing the potential for injuries by eliminating these risks.
- 5) Reducing the potential liability of the company.

For machinery manufacturers wishing to market in Europe, these types of safety interlock switches and related controls also provide a means of meeting the requirements mandated in January 1995 by the European Machinery Directive (EMD/89/392) and achieving CE compliance.

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