Technical Paper – White Paper 6

Interlock Switches

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Overview

Interlock switches are devices used within the safety control system to detect if a guard or access gate is open. Their assured operation is critical to the integrity of the safety control system.

Explanation of terms

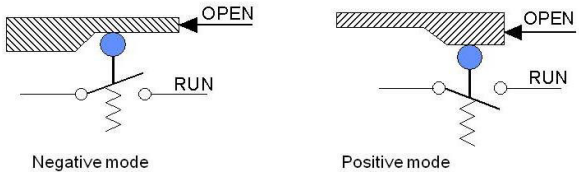
Forced contact switches

Force-guided (or positively-guided) switches or relays have contacts that are mechanically interlocked such that two contacts on the switch will not contradict each other, even in the event that the switch welds.
Such switches and relays have the indication as shown here. All interlock switches used on equipment supplied to your company must have forced contacts.

Positive mode

Switches which operate in the positive mode are those where there is positive contact between the switch contacts and the guard; when the guard is opened, the contacts are forced open.
Switches which operate in the negative mode rely on spring force to open the contacts and may remain closed if contamination or contact welding cannot be overcome by the spring force.

Positive mode must be used for interlocks on all equipment supplied to your company, though negative mode may also be used in conjunction with a positive mode arrangement if this is beneficial.



Safety Category

There are 5 safety categories which are specified fully in EN 13849 (which supercedes EN 954-1) and range from category B (a single fault may lead to total, undetected loss of the safety function) through to category 4 (a single fault does not lead to loss of the safety function, such faults are detected before being required again and faults do not accumulate.) EN 13849 specifies how different categories of switch are necessary to meet overall performance levels (PL) ranging from PL=a (lowest performance) through to PL=e (highest performance). However, it is highly unlikely that Cat. B or Cat. 1 are appropriate.

Types of interlock switch

Tongue type

This comprises a tongue attached normally to the moving part of the guard and the switch unit attached to the frame. The tongue acts on an internal cam in the switch which provides a positive link to the switch contacts. Versions are available with coded keys so that a spare key cannot be used to override the interlock. Up to Cat. 4 is available.

Points to be aware of

- Tongues must be the pressed steel type; zinc die-cast tongues are not robust enough.
- If the guard is flexible enough for the tongue to not engage directly in the switch, then other ways of guiding the mating of the two halves must be arranged.
- Best practice is to use tamper-proof screws to retain the switch and tongue.

Locking switch

The locking switch is a variant on the tongue type switch. Where there is a run-down time of the machine, either for process reasons or because of machinery inertia, then a locking switch linked to either a timer or zero rotation sensor should be used. The switch incorporates a solenoid which locks the switch and prevents the tongue from being released until the machine has stopped.

Points to be aware of

- The logic for unlocking the switch must be suitable.
- A zero rotation sensor is more desirable than a timer.

Rotary switch

The rotary switch has a shaft with an internal cam which acts on the switch contacts. The linkage is positive. It has the advantage that it cannot be easily overridden, but has the disadvantage that its axis of rotation must be aligned with the guard's hinge.

Points to be aware of

- Alignment of axes of hinge and switch.

Hinge switch

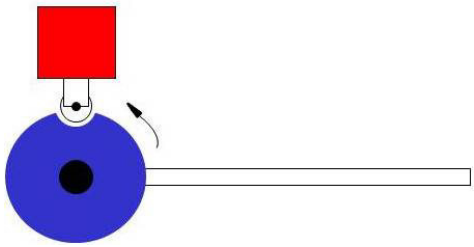
This is a combined switch and hinge, so the alignment issue is overcome. It cannot be easily overridden and always remains in contact with the guard.

Points to be aware of

- Some versions only have a single change-over contact and may be limited to Cat. 1
- Some versions may not be robust

For these reasons, this is a non-preferred arrangement, but is acceptable if the above points can be controlled.

Cam and limit switch



This uses a limit switch, normally with a roller, acting on a cam fixed to the guard. As the cam opens the switch contacts, the arrangement meets the positive mode requirement. Provided that the limit switch has forced contacts and the cam always operates the switch, the higher categories can be met.

Points to be aware of

- If the switch and cam become unaligned[1], the cam does not operate the switch, with no indication of failure.
- If the guard is removed, there is nothing to force open the contacts.

Example 1: cam slips to one side of the switch;

Example 2: screws retaining switch or cam become loose.

For these reasons, this is a non-preferred arrangement, but is acceptable if the above points can be controlled.

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Magnetic switch

This uses a magnet on the guard and a mating sensor on the frame. It has the advantages that close alignment necessary for a tongue-type switch is not required and coded versions are available which respond to only the appropriate mating half. Many switches have LED indications changing from red to green when the switch is closed. There is no potential for dirt ingression which could lead to switch malfunctioning.

Points to be aware of

- There is no positive link between the contacts and the guard and therefore the arrangement does not meet the positive mode requirement. However, the internal arrangement of some magnet switch systems meet Cat. 4/SIL 3/PL e level.

For this reason, this is a non-preferred arrangement, but is acceptable if the switch system meets the Cat. 4/ PL = e level.

Trapped key interlock

This is an arrangement which applicable to areas where whole-body access is required, such as access to machining cells through an gate. A coded key fits both a switch and a mechanical bolt on the gate. The key can only be removed from the switch when it is in the OFF position and the bolt can only be opened by the key.

Variations are available with a bank of switches, suitable where there are multiple access points to the danger area; each access point has its own key.

Trapped key interlocks are typically appropriate where people can be hidden in a machinining cell.

Points to be aware of

- This is a more complex arrangement than using interlock switches described above.
- There is no interlock on the gate itself. In some cases, an extra interlock switch may be necessary.

Switches with internal diagnostics

It is possible for faults to be masked where there are multiple switches.

To overcome this, switches with internal diagnostics can be used. These effectively become a sub-system rather than a switch and are suitable for situations where a high level of integrity is required.

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