Technical information

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Reduce Unscheduled Downtime from Nuisance Trips on Safety Relays

MONOFLOP function reduces contact bounce effects

WHITE PAPER

Wieland's *MONOFLOP* function reduces the effects of contact bounce in safety circuits

Unscheduled downtime in manufacturing machinery can result in higher costs due to delayed shipping schedules, missed opportunities, and lost sales. One common and often undiagnosed cause of unscheduled downtime is the phenomenon known as "contact bounce", which can occur in industrial safety relay circuits. As one of the industry's leading suppliers of industrial machine safety relays, Wieland has developed the ***MONOFLOP*** function to specifically address and eliminate the negative effects of contact bounce.

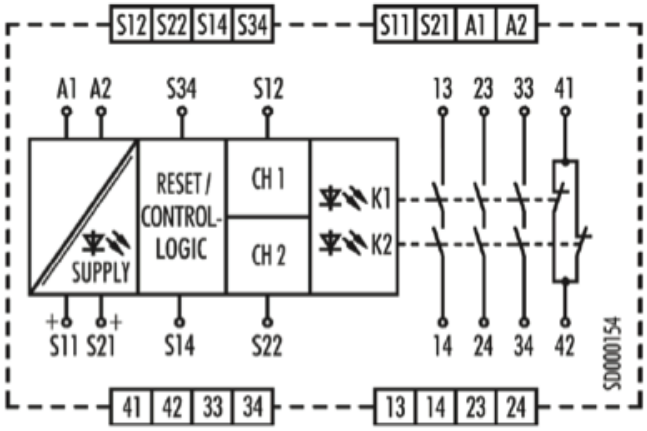


Figure 1: Typical dual channel safety relay schematic representation

The problem:
Contact bounce occurs when a switch is activated and its contacts touch to provide continuity of the circuit. The force of the moving contacts and the inherent elasticity of the contact materials causes several openings and closings of the circuit in the span of a few milliseconds before the contacts come to a rest in a closed position. This is referred to as contact bounce. Vibrations on a machine can also cause a closed contact to open momentarily, providing another form of contact bounce.

In many machine applications, the effects of contact bounce are inconsequential. However, when it occurs in an electromechanical safety relay circuit that is designed to respond in milliseconds, contact bounce can result in a critical fault of the safety circuit. In most cases, resetting this critical fault can only be accomplished by cycling the machine power, which leads to unscheduled downtime and the potential loss of product.

To understand how contact bounce leads to relay faults, we need to review the design of safety relays. The basic operating principle of a safety relay is redundancy – an internal logic circuit controls two normally-open relays (shown as K1 and K2 in Figure 1). Given a sufficient duration of the input signals, both K1 and K2 will switch and the safety relay will operate properly.

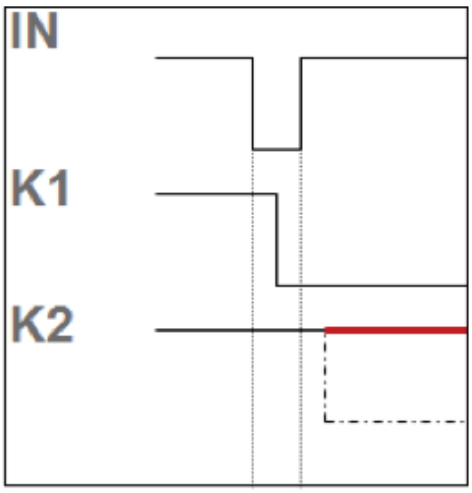


Figure 2:
The difference in states of K1 and K2 at the time when the input is applied is deemed a critical fault by the safety relay's internal control circuit.

Theoretically, the switching time of K1 and K2 should be identical. However, manufacturing tolerances inevitably lead to mismatches in the actuation time of the two relays. When contact bounce causes short pulses on the input signal, it is possible that one relay will open but the other will not. When the input signal changes again, the safety relay's monitoring logic will see a discrepancy in the status of K1 and K2. This discrepancy is interpreted as a fault condition (as shown in figure 2).

This kind of critical fault condition in the safety system cannot be reset by the machine operator. To clear the fault, a service technician needs to be summoned to cycle power to the safety relay, which may also mean cycling power to the entire machine.

The solution:
As a result of years of experience designing and manufacturing safety relays, Wieland incorporated an anti-contact bounce function into its line of advanced safety relays. The ***MONOFLOP*** function is specifically designed to reduce the effects of contact bounce in safety circuits.

The ***MONOFLOP*** function built into Wieland's safety relays prolongs the input signal (shown in Figure 3). This effectively eliminates the negative effect of contact bounce by ensuring that both the K1 and K2 relays are given sufficient time to switch in response to rapid changes in the input signal.

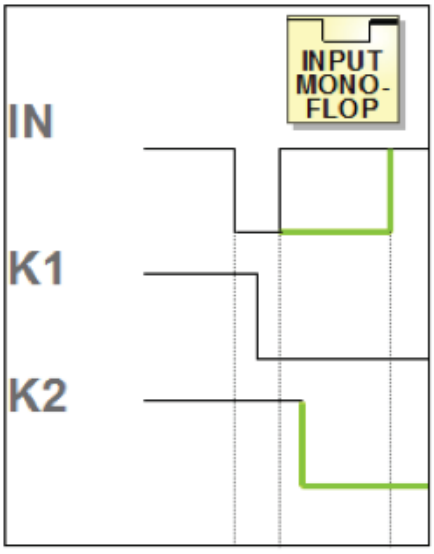
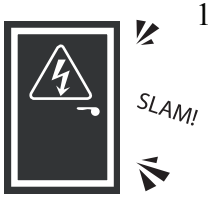


Figure 3:
MONOFLOP technology extends the input signal to allow both internal relays to switch properly.

Contact bounce machine scenerios:

It is important to understand when ***MONOFLOP*** technology is most useful. The table below details cases where downtime could be reduced and productivity increased with ***MONOFLOP*** technology.

	Case	Circuit Reset Type	Cause of problem	Detailed Explanation
	1	Auto	Door slamming	The operator slams the door and the interlock "bounces." A fault occurs after the second contact closure (after the first bounce).
	2	Any	Weld spatter	The weld spatter causes interruptions of the light curtain long enough to cause the OSSD (Output Safety Switching Device) to turn off, but not long enough to allow proper switching of both K1 and K2.
	3	Any	Vibration	High vibrations cause the safeguard to "open" slightly and causes short interruptions in the safety circuit input.
	4	Any	Malicious operator teases switch	An intelligent but unmotivated machine operator has discovered that a fault condition can be created by "teasing" the electrical safeguard into a contact bounce situation. The operator rather enjoys this situation as it is an unexpected break for him while the maintenance technician is being summoned, and yet it does not draw attention to his malicious intent. Frustration by the machine owner builds due to the perception of a "temperamental machine."

In each of these scenarios, a Wieland safety relay equipped with ***MONOFLOP*** technology would have prevented the fault and the downtime. By specifying Wieland safety relays with ***MONOFLOP*** technology, unscheduled downtime caused by the effects of contact bounce can be eliminated.

Perspective:

Contact bounce is not a new problem. Electrical engineers have been grappling with its ramifications since the early days of electronic circuits. A traditional solution has been to simply add a delay to the circuit before responding to a signal change. While this does work, the strategy has not often been implemented in safety circuits. Further, ***MONOFLOP*** technology proves to be superior to internal delays for three reasons:

- Since there is no artificial delay, the relay can react faster, thereby increasing machine safety.
- A faster safety circuit response time allows engineers to place safeguards closer to the hazards, thereby reducing the machine's size.
- A short disruption could be the sign of a larger problem. ***MONOFLOP*** will catch these short disruptions that may otherwise be missed by a safety relay with an input signal filter.

Product datasheets, specifications and other technical information for Wieland's safety relays with ***MONOFLOP*** technology can be downloaded from the Wieland website at: www.wieland-safety.com

About Wieland

Wieland Electric Inc., founded in 1910, is a leading global manufacturer of electrical interconnect technology products. Headquartered in Germany with a North American Operations Center and subsidiaries throughout the world, Wieland Electric has 2200 employees in more than 70 countries to service worldwide customers. Wieland provides solutions to the industrial & building automation, wind, solar, HVAC, and power generation markets. Local inventory, value-added services and technical resources at the North American Operations Center support a national sales and distribution channel. Wieland is ISO 9001 certified.

For more information about Wieland Electric's comprehensive offering of machine safety products: call 1-800-WIELAND (1-800-943-5263), or visit: www.wieland-safety.com