

## When to use multi-function safety relays

In applications where single-function relays aren't capable enough and a safety-rated PLC is overkill, multi-function safety relays can be the best technology choice. Tables provide examples.

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Many machines and robots require safety circuits to stop all or part of an operation in the event of an emergency event. Safety circuits are also used to keep all or part of a machine or robot from running while there is human activity in close proximity, for either normal operations or maintenance.

These safety circuits are typically configured using safety relays, or a safety-rated programmable logic controller (PLC) or other safety-rated controller. But in many cases, multi-function safety relays are a better option (Figure 1). A multi-function safety relay is a configurable device with multiple inputs and outputs. It's more powerful than a single-function safety relay, and less complex and expensive than a safety-rated PLC.

One or more multi-function safety relays can often be used to replace many basic single-function safety relays, simplifying installations and saving money. In other cases, multi-function safety relays can be used instead of a safety-

rated PLC, resulting in substantial savings while streamlining implementation and maintenance.

### **Relays limit options**

Machine and robot builder original equipment manufacturers (OEMs), and end users with similar applications often have to monitor and control many input and output (I/O) points that include a relatively small number of I/O points performing safety-related functions.

The most common safety circuit for simple machines and up to three safety inputs (such as an emergency stop [E-stop] and two gate switches) is a basic single-function safety relay that has redundant contacts and is self-monitoring. As a machine or robot's safety system requires more safety inputs, an option is to keep adding basic single-function safety relays, or to possibly go to a much more expensive safety-rated PLC.

Adding basic single-function safety relays to monitor and control the safety I/O often results in overly complex installations involving a relatively large number of relays. If zone control is desired, which requires certain parts of the machine or robot to continue operation for particular types of events, then the number of required safety relays can rapidly multiply, and complexity can grow exponentially.

When many relays are used, troubleshooting can be very difficult as each connection point and component needs to be examined to determine the point of failure. Modifications are very difficult to implement as they require rewiring and often the addition of more relays.

## PLCs can present problems

For zone control and other complex safety circuits, another solution is to use a safety-rated PLC to control and monitor just the safety I/O, or even all of the I/O, but this can add expensive and unnecessary complexity.

Adding a separate safety-rated PLC in addition to the main controller requires the OEM to purchase, program, and maintain a second programmable system in addition to the main controller. This safety-rated PLC will need its own programming software, with consequent renewal fees. The learning curve for a safety-rated PLC can be steep, and costs are relatively high.

Alternatively, one safety-rated PLC can be used to perform all required control and safety functions. This eliminates the problem of two separate systems, but it increases costs significantly, and generally only makes sense when a very large percentage of the machine or robot I/O is directly related to safety.

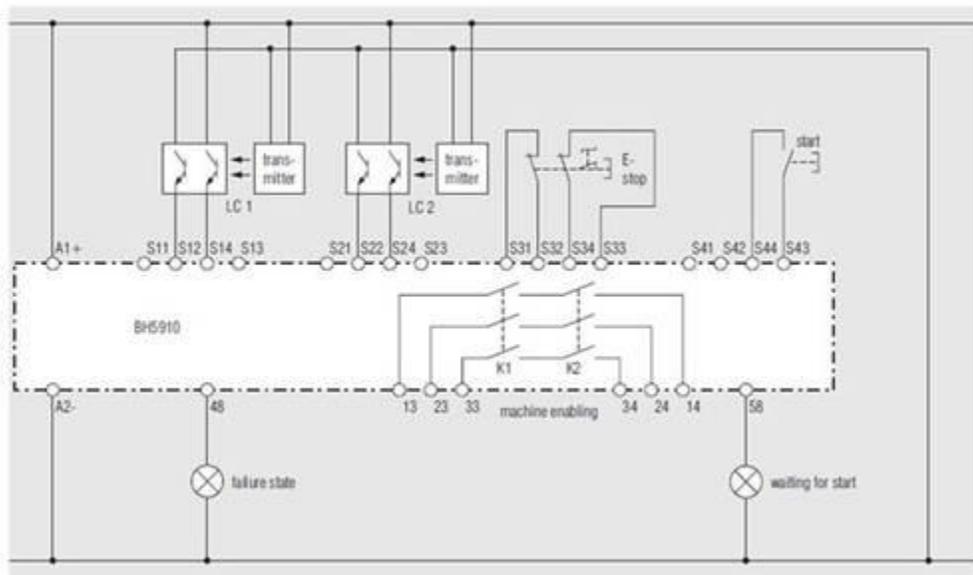
In installations with four or more safety I/O points, one or two multi-function relays can often be used to replace four or more basic single-function safety relays, simplifying installations and saving money.

Table 1 below shows the benefits of this approach.

<b>Table 1: Advantages of multi-function relays vs. single-function safety relays</b>
1. Fewer relays required
2. Less panel space
3. Less wiring
4. Often less costly
5. Simpler installation
6. More flexibility to accommodate changes
7. Easier to add features

Because fewer relays are required, less panel space is needed along with much less wiring. This cuts panel footprint and saves on upfront labor costs.

If changes are required to accommodate modifications to the machine or robot, or to add features, it's much easier to reconfigure a multi-function safety relay, as opposed to adding more basic single-function safety relays.



Multi-function

safety relays are available in a number of styles and configurations, including but not limited to dual channel monitoring with or without time delay, two-hand control, light curtain monitoring, speed monitoring, motor standstill monitoring, and relay extension to increase the number of output contacts.

Such relays offer many I/O configurations. A simple base unit can handle a variety of inputs, and expandable input and output modules can be added as needed. Multi-function relays do not need software for configuration or operation, so setup and maintenance are typically very straightforward and simple.

One specific type of multi-function safety relay allows desired functions to be set via a rotational switch at the front of the relay. It is designed to handle a

variety of inputs such as e-stops, gate switches, light curtains, and/or two-hand buttons—with appropriate outputs to trigger alerts and specific machine or robot operations.

Another type of multi-function relay provides more power through a combination of rotary and DIP [dual in-line package] switches used for initial configuration. This relay type typically can accommodate a much higher number of I/O, up to 24 inputs and 24 outputs, by using separate input and output modules.

A system with an E-stop and two safety light curtains would require three single-function safety relays. The Figure 2 drawing shows the same system with a safety circuit consisting of just one multi-function relay, greatly simplifying the circuit while cutting costs and adding flexibility.

A multi-function safety relay with 24 inputs, 24 outputs, and multiple configuration options can often be used instead of a safety-rated PLC, providing a comparable solution in terms of performance, along with many other advantages.

Multi-function relays can be simpler to use than a safety-rated PLC. One or more multi-function relays can often be used to perform all safety-related functions for a machine or robot, resulting in substantial savings while simplifying implementation and maintenance as compared to a safety-rated PLC. Table 2 below shows benefits.

**Table 2: Advantages: Multi-function safety relays vs. safety-rated PLCs**

1. Less costly
2. Less complex
3. No programming required
4. No software to purchase and maintain
5. Integration with main controller is easier

It's typically much easier to configure a multi-function safety relay than it is to program a safety-rated PLC. There's no need to purchase, update, and maintain programming software, and a programming PC isn't required.

A multi-function safety relay is integrated easily into the main control system by hardwiring a few I/O points between the relay and the controller.

Because a multi-function safety relay is less expensive than a safety-rated PLC, it often can be used to cost-effectively handle all safety-related I/O, obviating the need to upgrade the main controller to one that's safety-rated.

### **Relay exceptions, limits**

Very simple applications are often best served by one or two single-function safety relays and don't require the added expense of multi-function relays. A machine, robot, or other system that may only have an E-stop along with a set of light curtains or door switches is an example of an application where a single-function safety relay would be the best choice.

Multi-function relays have limitations and only can be expanded to a certain practical limit in total number of I/O points and complexity of function. Cost and particularly complexity can increase to a point where it makes sense to use a safety-rated PLC. The programming capability of multi-function relays is limited as compared to safety-rated PLCs, so applications requiring a high degree of complex interaction among inputs and outputs often are best suited to a PLC. Similarly, applications with more than 50 or so I/O are usually better served by a PLC, even if the required programming is simple. Finally, applications where significant changes are anticipated over time are a better fit for PLCs..

Very complex applications with many safety I/O points and multiple zone control, or applications with requirements that change substantially from machine to machine or over time, may be better served by using a safety-rated PLC, either for just the safety I/O or for all of the I/O.

### **Multi-function relay savings**



A manufacturer of limit switches upgraded to a multi-function safety relay system for its production cell to accommodate increased automation of the processes used in the construction of its products (Figure 3). The original safety circuit design was mostly manual, and thus required substantial operator interaction. The circuit had an E-stop, one set of safety light curtains, and door switches.

The newer automated production system required the addition of light curtains, door switches, and safety mats at different locations within the production process. Different interlocking requirements such as speed monitoring of some of the equipment also were needed.

By automating the production process, the manufacturer was able to relocate eight employees to different functions in the company and to increase production by 40%.

By switching to a multi-function safety relay instead of adding more single-function safety relays, the company saved 30% of the initial cost, and gained a much more flexible safety system.

The manufacturer did look at adding a safety-rated PLC, but the cost would have been more than 60% higher than the multi-function relay system, and the complexity of having to support such a system was not justifiable.

Machines and robots with just a couple of basic safety inputs such as an E-stop and one- or two-door switches or other safety-related inputs are typically best served by a safety system with one or two single-function safety relays.

When a machine has many I/O points, with a high proportion safety-related, a safety-rated PLC is often the best fit.

But for a machine or robot in between these two extremes, an easy-to-configure and inexpensive safety system using multi-function relays may be the preferred choice.

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