control design

ESSENTIALS OF **EMERGENCY STOP SWITCHES (E-STOPS)**

A Control Design Essentials Guide, by the editors of *Control Design*

About the Control Design Essentials Series

The mission of the Control Design Essentials series is to provide industrial machinery designers with an up-to-date, top-level understanding of a range of key machine automation topics. Our intent is to present essential engineering concepts in a practical, non-commercial fashion, together with a review of the latest technology and marketplace drivers—all in a form factor well suited for onscreen consumption. Check in at ControlDesign.com/Essentials for other installments in the series.

—The Control Design Editorial Team

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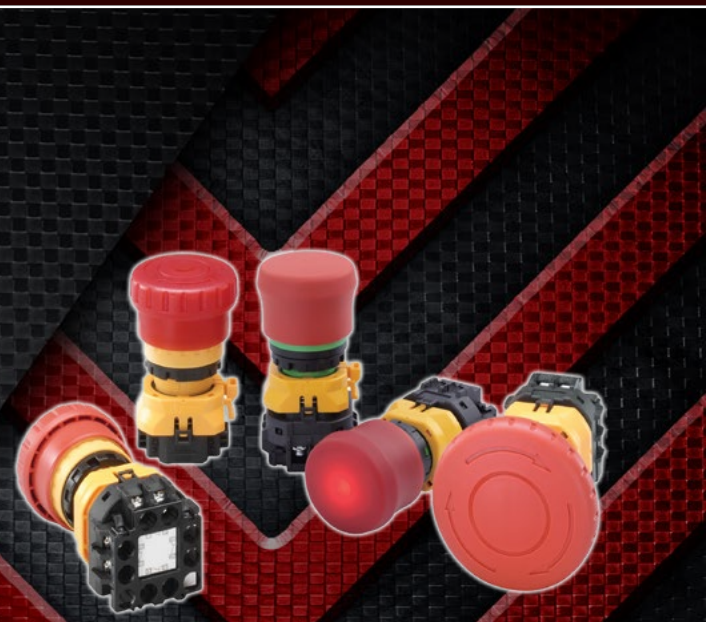
INCREASING THE SAFETY OF MACHINERY

Emergency stops and safety systems are required on just about every automated machine and piece of equipment on the factory floor. The e-stop function is actuated by intended human operation to avert an actual or imminent emergency situation due to the behavior of personnel or from an unexpected hazardous event.

Fortunately, it is getting easier to make sure e-stops comply with the standards dictated by region and industry. In the United States, these include Occupational Safety and Health Administration (OSHA) rules. In Europe and China, CE marks and China Compulsory Certificate (CCC) marks, respectively, certify compliance with relevant health and safety regulations.

These high-level standards say a machine has to be safe. Designers and plant-floor personnel will also appreciate an e-stop's compliance with voluntary standards such as Underwriters Laboratories' UL 508 standard for Safety for Industrial Control Equipment and UL 991 Standard for Tests for Safety-Related Controls Employing Solid-State Devices. Similar international standards include the Canadian Standards Association's CSA C22.2 No. 14, the International Electrotechnical Commission's IEC60947-5-1 and -5-5, and the International Organization for Standardization's ISO 12100-2:2003 and ISO 13850:2015.

In North America, a certified E-stop is listed under Underwriters Laboratories' NISD category. There may also be special rules based on the industry in which the machine is installed. For example, in the semiconductor industry, e-stops certified to the SEMI S2 specification are often required.



ROBUST E-STOP SWITCHES PROTECT THE TOUGHEST APPLICATIONS

The e-stop switch is actuated by an intended operator action in an emergency situation. Because of this, its operability and visibility should be optimized, and it should be actuated without hesitation.

However, it is also necessary to protect a machine from premature or accidental activation of the e-stop by a passing worker bumping it with his or her shoulder. It must be easy to activate, but not accidentally. Quick access is better, but accidental activation can be costly.

Accidentally hitting the e-stop in semiconductor process equipment, for instance, can lead to scrapping or reworking batches of wafers with incorrect or unknown exposures. This could cost hundreds of thousands of dollars. Prevention of unintended actuation of an emergency-stop device starts with locating it away from heavy traffic areas and selecting the appropriate type, size and shape of the device.

Although the use of a protective shroud around an e-stop should be avoided, when necessary to prevent unintended actuation, it can be used when other measures are not practical. This is due to recent regulatory changes in ISO 13850—to prevent unplanned process interruptions.

Other protections include selecting the right ingression protection (IP) rating. An IP65-rated e-stop keeps out dust and resists low-pressure water and rain. And, if the equipment is working where there's a higher risk of explosion, choose an e-stop rated for hazardous locations.

TECHNOLOGY ENSURES FAIL-SAFE OPERATION IN E-STOPS

Sometimes, the accidental activation of an e-stop can be a nuisance, but the alternative is much scarier. What if, in an unfolding emergency, an operator pushes the e-stop button and the machine fails to stop?

E-stop switches are often aggressively activated. Even though an emergency switch was installed, if it breaks prior to or during the panicked activation, not all are designed with built-in fail-safes to ensure the safety circuit opens.

In most e-stops, the force applied directly to push the button is what mechanically operates the normally closed switch to open it. Unfortunately, in many switches, damage that separates the contact block from the mushroom head renders the e-stop ineffective.

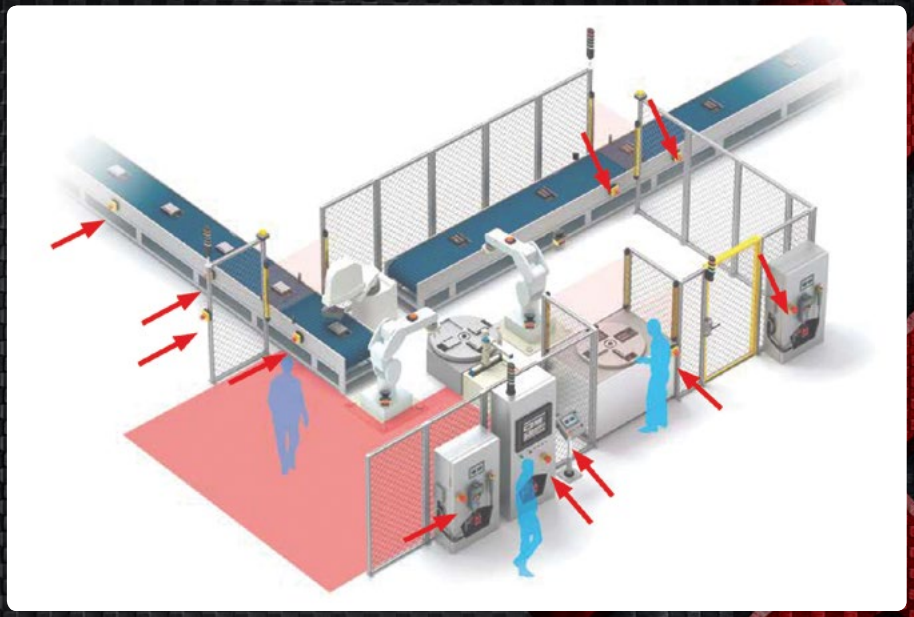
Consider a fail-safe e-stop with a safe break action, similar to a dead-man switch, to eliminate this possibility. By translating the push of a button into spring force that opens the contact, it also ensures that the contact will open automatically if the e-stop is damaged.

FORM, FIT AND FUNCTION OF E-STOPS

E-stops don't work if workers can't find them. The highly visible red mushroom button and yellow background or shroud coloring is dictated by standards, and there is no need for emergency-stop text. However, placement and shape matter, as well. The mushroom head on e-stop buttons range from about 25 to 60 mm in diameter, and the bigger the button, the more rugged the e-stop switch.

The size of the button and the shroud, if used, may require the e-stop to be physically offset a greater distance, in a pushbutton enclosure, than is required for other standard operators such as pushbuttons and pilot lights.

Typical e-stop mounting holes in the control panel range from 16 to 30 mm. Contact blocks providing up to four contacts require space behind the panel, also. Devices are available with a body shorter than 50 mm to help fit into shallow panels.



RESETTING AND REDUNDANCY ARE INTENDED

In addition to considering the best shape, size and location for an e-stop, consider how operators will reset the e-stop when the emergency situation has been resolved. Just releasing the e-stop pushbutton should not reset the device—it must be reset by an intentional human action, such as pushing a reset button, after the machinery is inspected in order to detect the reason for actuation. In some applications, a simple twist or pull to reset is sufficient. However, if the e-stop is part of a lockout feature; consider designs and accessories that let users install padlocks to prevent unauthorized reset.

The risk assessment should be performed on all safety systems to determine the required performance level (PLr) or safety integrity level (SIL). The standards often cited for compliance with safety requirements are ISO 13849-1 and/or IEC 62061. These standards often point out a need for redundancy. E-stops with redundancy can shut down the machine when there's inconsistency between the e-stop's two contacts.

Whether you need redundancy, fail-safe, shallow panel depth, shrouds, hazardous location designs or an industry-specific certification, there are e-stop options available for you. Connect with an e-stop expert by Web, phone or in person for help finding the right equipment for your needs.

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