Sizing and applying limit switches

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Mechanical position and electrical circuitry meet in the no-nonsense limit switch. These cost-effective input devices excel in tough environments and are as simple to install as they are to maintain.

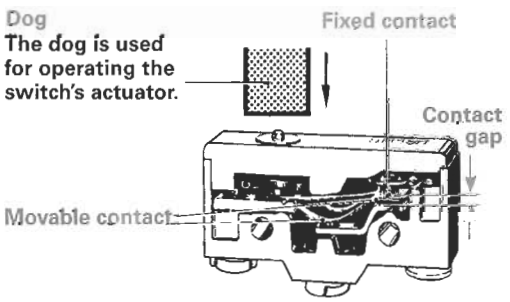
How it works

Limit switches convert mechanical motion into an electrical signal by using a lever to force open or closed a set of electrical contacts. They come in die-cast metal as well as rugged plastic housings, with a

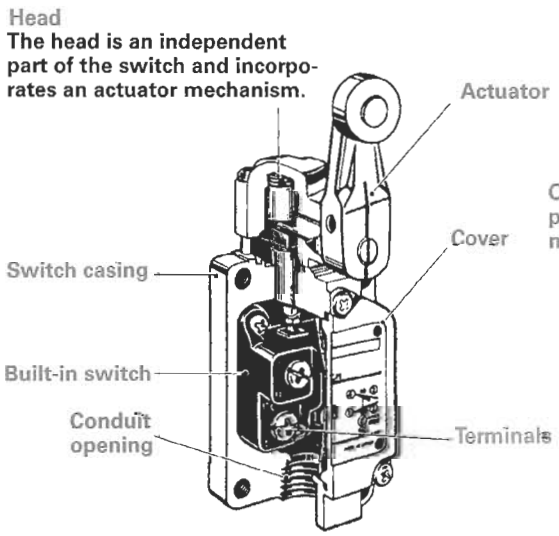
Elements of a limit switch

Common limit switch styles include enclosed pin plunger switches, side rotary lever switches, and direct opening safety limit switches. Choice of style depends on the specific application.

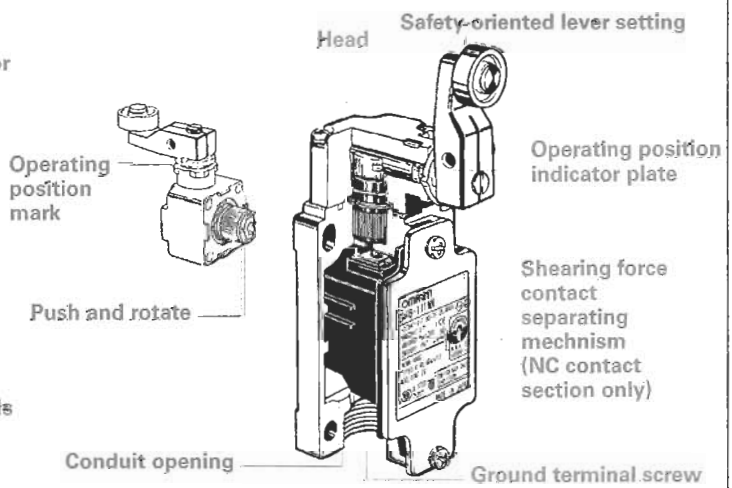
Direct opening contact type limit switches, designated by a symbol of a circle with an arrow inside, avoids one of the problems (stuck contacts) sometimes encountered by other switch types. If metal deposition between mating contacts occurs on the normally closed contact side, the contacts are usually pulled apart by the shearing and tensile forces generated when the safety cam or plunger engages the movable contact blade.



Enclosed pin plunger style



Side rotary lever style



Direct opening safety limit switch

variety of conduit openings based on the intended machine destination. Common styles include pre-wired and connector versions (usually found on enclosed switches), some of which even incorporate indicator LEDs to simplify monitoring and diagnostics.

Because the switch's actuator is in direct physical contact with moving objects, limit switches are designed for easy servicing, especially the replacement of the actuator and internal switch. In some cases, the levers and actuator heads are adjustable, simplifying installation as well.

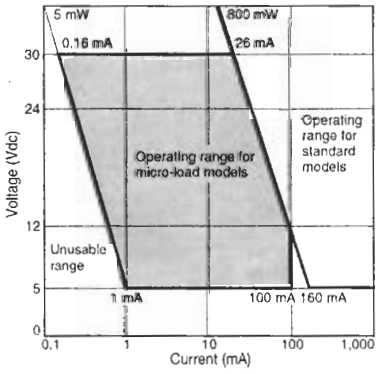
Versatile switches

Limit switches are used in a variety of applications, including conveyors, elevator control, counting, positioning, detecting, sequencing, and monitoring. Machine operations they initiate when tripped can include start, stop, change direction, recycle, slow down, or speed up. About 80% of all applications use a roller lever type actuator. Plunger types are the next most common, and a few use "wobble stick" rod or spring actuators.

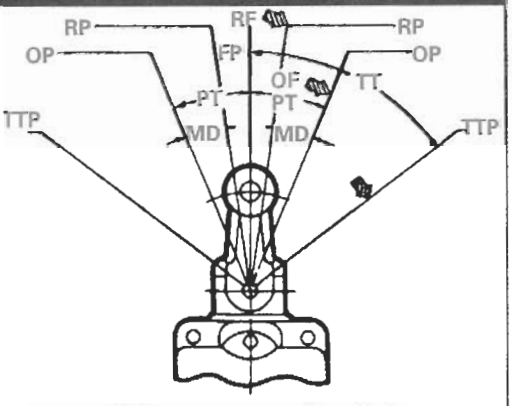
Direct opening limit switches are typically used in failsafe applications such as slow/stop positioning for gantry cranes, elevator doors, and telescoping passenger bridges to aircraft. Enclosed switches are used on conveyors, cutting and machining tools, and a wide range of assembly equipment. Other styles include slim compact switches that facilitate close mounting and multi-element switches used for stacking.

Sizing savvy

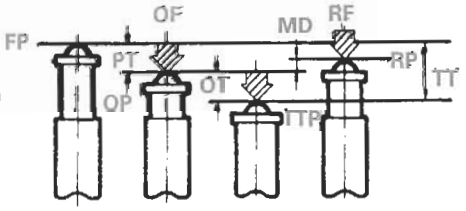
Standard limit switches are designed to actuate frequently (up to 30 electrical operations per minute) without long periods of inactivity and with a steady current to prevent corrosion on the contacts. Microload limit switches handle low current applications below 0.1 A. For critical failsafe applications, choose a safety limit switch with direct opening contacts. Limit switches usually come with one normally open (NO) contact and one normally closed (NC) contact. Typical contact configurations include single-pole double throw (SPDT), SPDT double break, DPDT and DPDT double break.



OF = Operating force
RF = Releasing force
PT = Trip travel (pretravel)
OT = Overtravel
MD = Reset travel (movement differential)
TTP = Total travel position
OP = Trip position (operating position)
RP = Reset position (releasing position)
FP = Start position (free position)
TT = Bypass (total travel)



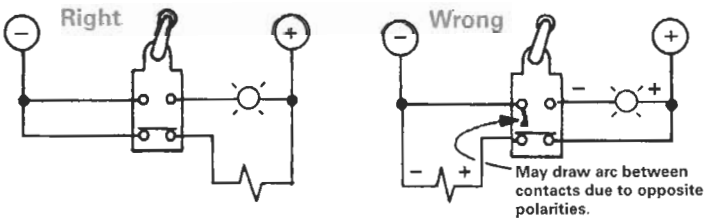
Rotary movement switch



Linear movement switch

Wiring wisdom

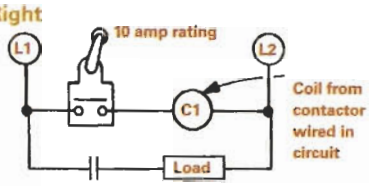
Polarity must be observed when wiring limit switches. Failure to observe polarity may result in arcing between contacts.



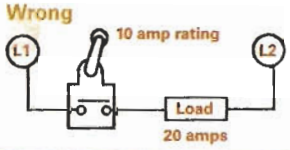
Connections to contactors

Using a contactor in the control circuit can help in cases where the limit switch contacts are not rated to directly handle the load.

Right



Wrong



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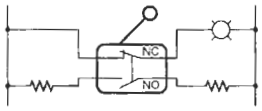
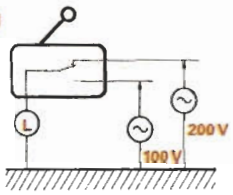


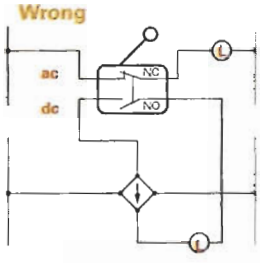
Connect the load to the same polarities.

Wrong



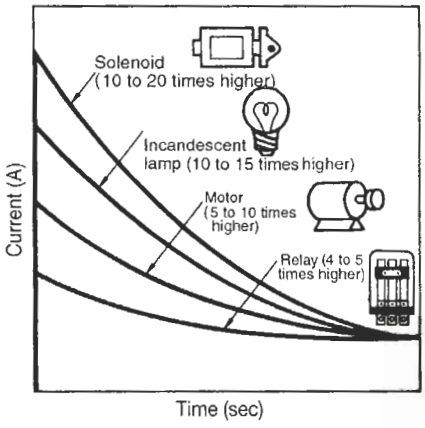
Be sure to choose the electrical rating of the contacts carefully, staying within the proper voltage and current size according to the load and manufacturer's specifications. If the load current exceeds the contact rating, a relay, contactor, or motor starter must be used to interface the switch with the load. Also be careful not to mix ac and dc in the same circuit.

Wrong



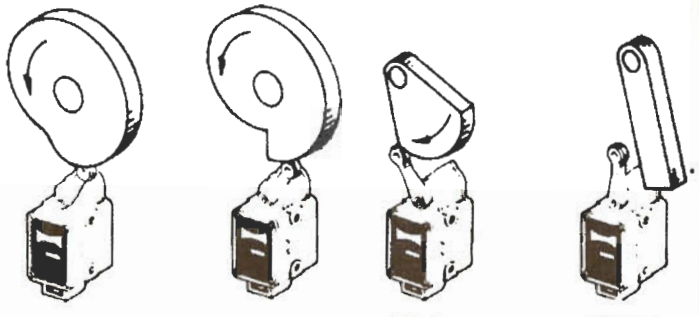
Inductive load considerations

When testing the switch, it's important to apply the actual load condition together with the true operating environment. Most limit switches are rated with an inductive load – a minimum power factor of 0.4 for ac or a maximum time constant of 7 msec for dc. Because an inductive load causes a problem in dc circuitry, it's essential to know the time constant of the load's inrush current. For example, an A600 rating refers to a "pilot-duty" load under the parameters discussed in the standards and regulations section.



Installation information

With rotary actuator limit switches, the cam or piece (dog) encountering the actuator should be shaped to prevent the roller lever from snapping back freely. Use a cam that's tapered to allow a slow release of the lever. This reduces contact bounce and switch wear, and improves repeat accuracy. In installations where the limit switch actuator encounters a fast-moving cam or piece, make sure the limit switch's lever does not receive a severe impact. Instead, taper the cam to extend the interval over which electrical contacts are engaged. These precautions assure the circuit is completed and prevent excessive switch wear.



Cam configuration

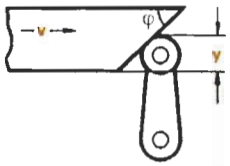
Cams must be configured according to the type of actuator as well as the type of cam being used. Following are guidelines for roller lever actuators (both non-overtravel and overtravel type cams) and plunger type actuators.

Roller Lever Actuators

Non-overtravel type cams

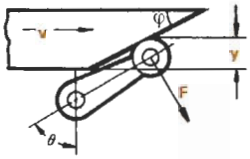
Velocity: less than or equal to 0.25 m/sec

If velocity (v) does not exceed 0.25 m/sec, the lever can be set vertically. As operating speed increases, the cam angle decreases.

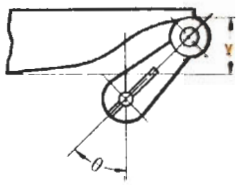


Velocity: greater than or equal to 0.25 m/sec but less than or equal to 2 m/sec

In higher-speed operations, the lever angle (θ) may be required to change according to the cam angle (φ). Set the lever angle within a range of 45° to 75°.



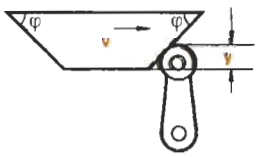
Velocity: greater than or equal to 2 m/sec but less than or equal to 3 m/sec



Overtravel type cams

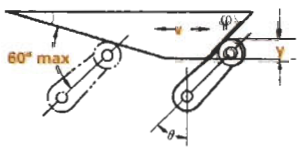
Velocity: less than or equal to 0.25 m/sec

If velocity (v) does not exceed 0.25 m/sec, the lever can be set vertically. As operating speed increases, the cam angle decreases. Cam stroke (y) may be up to 80% of total travel.



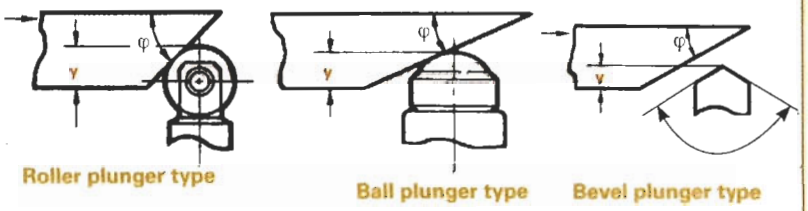
Velocity: greater than or equal to 0.5 m/sec

In higher-speed operations, the cam angle (φ) of the rear edge should be in a range of 15° to 30°. Otherwise, make sure the cam's acting surface is straight in order to reduce lever shaking.



Plunger Type Actuators

Cams that override the actuator may have the same shape for both forward and backward directions. Avoid cam shapes that leave the actuator abruptly. Possible reference locations are shown here.



Protecting the limit switch

When an overtravel situation may occur, such as an emergency stop application, choose a rotary actuator lever limit switch instead of a pin or roller-plunger type. Plunger type switches are not designed for use beyond the normal travel length, and will be damaged if the switch is used as a stop without protection. To use a plunger type switch, a stop plate should be added to protect the limit switch and its mounting from damage due to overtravel. A marginal overtravel (OT) value should be set. The ideal value is the rated OT value x 0.7.