

Contact normal state and make/break sequence

Any kind of switch contact can be designed so that the contacts "close" (establish continuity) when actuated, or "open" (interrupt continuity) when actuated. For switches that have a spring-return mechanism in them, the direction that the spring returns it to with no applied force is called the *normal* position. Therefore, contacts that are open in this position are called *normally open* and contacts that are closed in this position are called *normally closed*.

For process switches, the normal position, or state, is that which the switch is in when there is no process influence on it. An easy way to figure out the normal condition of a process switch is to consider the state of the switch as it sits on a storage shelf, uninstalled. Here are some examples of "normal" process switch conditions:

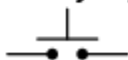
- **Speed switch:** Shaft not turning
- **Pressure switch:** Zero applied pressure
- **Temperature switch:** Ambient (room) temperature
- **Level switch:** Empty tank or bin
- **Flow switch:** Zero liquid flow

It is important to differentiate between a switch's "normal" condition and its "normal" use in an operating process. Consider the example of a liquid flow switch that serves as a low-flow alarm in a cooling water system. The normal, or properly-operating, condition of the cooling water system is to have fairly constant coolant flow going through this pipe. If we want the flow switch's contact to *close* in the event of a loss of coolant flow (to complete an electric circuit which activates an alarm siren, for example), we would want to use a flow switch with *normally-closed* rather than normally-open contacts. When there's adequate flow through the pipe, the switch's contacts are forced open; when the flow rate drops to an abnormally low level, the contacts return to their normal (closed) state. This is confusing if you think of "normal" as being the regular state of the process, so be sure to always think of a switch's "normal" state as that which its in as it sits on a shelf.

The schematic symbology for switches vary according to the switch's purpose and actuation. A normally-open switch contact is drawn in such a way as to signify an open connection, ready to close when actuated. Conversely, a normally-closed switch is drawn as a closed connection which will be opened when actuated. Note the following symbols:

Pushbutton switch

Normally-open



Normally-closed



There is also a generic symbology for any switch contact, using a pair of vertical lines to represent the contact points in a switch. Normally-open contacts are designated by the lines not touching, while normally-closed contacts are designated with a diagonal line bridging between the two lines. Compare the two:

Generic switch contact designation

Normally-open

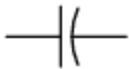


Normally-closed



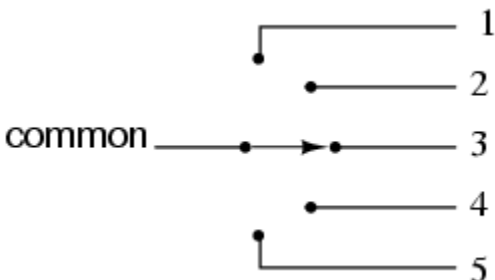
The switch on the left will close when actuated, and will be open while in the "normal" (unactuated) position. The switch on the right will open when actuated, and is closed in the "normal" (unactuated) position. If switches are designated with these generic symbols, the type of switch usually will be noted in text immediately beside the symbol. Please note that the symbol on the left is *not* to be confused with that of a capacitor. If a capacitor needs to be represented in a control logic schematic, it will be shown like this:

Capacitor



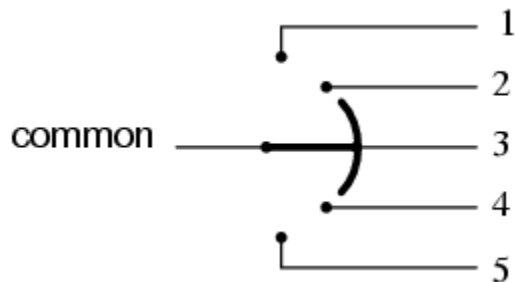
In standard electronic symbology, the figure shown above is reserved for polarity-sensitive capacitors. In control logic symbology, this capacitor symbol is used for *any* type of capacitor, even when the capacitor is not polarity sensitive, so as to clearly distinguish it from a normally-open switch contact.

With multiple-position selector switches, another design factor must be considered: that is, the sequence of breaking old connections and making new connections as the switch is moved from position to position, the moving contact touching several stationary contacts in sequence.



The selector switch shown above switches a common contact lever to one of five different positions, to contact wires numbered 1 through 5. The most common configuration of a multi-position switch like this is one where the contact with one position is broken *before* the contact with the next position is made. This configuration is called *break-before-make*. To give an example, if the switch were set at position number 3 and slowly turned clockwise, the contact lever would move off of the number 3 position, opening that circuit, move to a position between number 3 and number 4 (both circuit paths open), and then touch position number 4, closing that circuit.

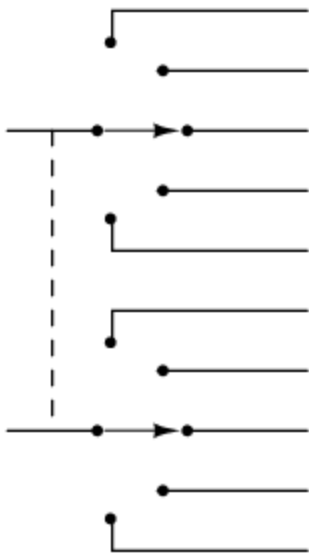
There are applications where it is unacceptable to completely open the circuit attached to the "common" wire at any point in time. For such an application, *make-before-break* switch design can be built, in which the movable contact lever actually bridges between two positions of contact (between number 3 and number 4, in the above scenario) as it travels between positions. The compromise here is that the circuit must be able to tolerate switch closures between adjacent position contacts (1 and 2, 2 and 3, 3 and 4, 4 and 5) as the selector knob is turned from position to position. Such a switch is shown here:



When movable contact(s) can be brought into one of several positions with stationary contacts, those positions are sometimes called *throws*. The number of movable contacts is sometimes called *poles*. Both selector switches shown above with one moving contact and five stationary contacts would be designated as "single-pole, five-throw" switches.

If two identical single-pole, five-throw switches were mechanically ganged together so that they were actuated by the same mechanism, the whole assembly would be called a "double-pole, five-throw" switch:

Double-pole, 5-throw switch assembly



Here are a few common switch configurations and their abbreviated designations:

Single-pole, single-throw (SPST)



Double-pole, single-throw (DPST)



Single-pole, double-throw
(SPDT)



Double-pole, double-throw
(DPDT)



Four-pole, double-throw
(4PDT)



REVIEW:

- The *normal* state of a switch is that where it is unactuated. For process switches, this is the condition its in when sitting on a shelf, uninstalled.
- A switch that is open when unactuated is called *normally-open*. A switch that is closed when unactuated is called *normally-closed*. Sometimes the terms "normally-open" and "normally-closed" are abbreviated N.O. and N.C., respectively.
- The generic symbology for N.O. and N.C. switch contacts is as follows:

Generic switch contact designation

Normally-open



Normally-closed



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- Multiposition switches can be either break-before-make (most common) or make-before-break.
- The "poles" of a switch refers to the number of moving contacts, while the "throws" of a switch refers to the number of stationary contacts per moving contact.

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