

Basic switches are not created equal:

high-quality switch components can have real sex appeal for the informed engineer

“Sexy” is not a word you’d usually use to describe a basic switch. They just don’t seem as interesting as some other components. A basic switch. A micro switch. A commodity, perhaps? Why not spec in the cheapest one and call it a day?

Actually, there are a lot of reasons why not. Choosing the right switch for the right application can dramatically enhance your design and reduce the likelihood of product failure. Ban that commodity thought! Designing in a higher level switch may cost a few cents more, but could markedly improve your products’ performance and life.

Switches come in many styles—rocker, toggle, thumbwheel, key, pushbutton to name a few. Yet with the thousands of choices designers have for switches, many times the selection of a switch, its mounting and connection is frequently left to the end of the design cycle. What many engineers don’t realize is that treating switch selection as an afterthought may have significant negative consequences to the end product’s performance. Therefore, clearly understanding the difference between switch types, their characteristics and expected performance is key to your products’ success in the marketplace.

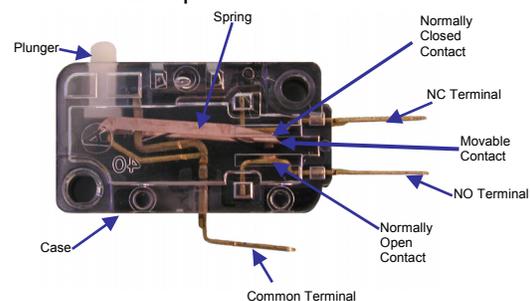
While there are hundreds of styles and designs, focusing on the basic precision industrial switch will illustrate how the mechanical characteristics of switches can differ dramatically. Also, engineering expertise, material selection and the supplier’s infrastructure can play a major role in component quality, and therefore, your product.

So, what are the characteristics of a precision switch a designer needs to note? While most engineers are well versed in the operations of a basic switch, the following primer will illustrate what to focus on when designing-in this component.

The basics of basic switches.*

With the plunger in the completely released or *free position*, the common contact is against the normally closed contact. In this condition, the normally closed circuit of the switch can carry current. This means there is electrical continuity between the common terminal and the normally closed terminal. The common terminal is electrically insulated from the normally open terminal. As the plunger is depressed, it reaches the *operating point*. The distance between the free position to the operating point is called the *pretravel*. At the operating point, without further movement of the plunger, the common contact accelerates away from the normally closed contact. Within a few milliseconds, the common contact strikes, bounces and comes to rest against the normally open contact. Because the mechanism is designed for “snap-action,” the common contact cannot stop part way between the normally closed and normally open contacts.

The normally closed circuit is now open and the normally open circuit is closed. As the plunger is depressed past the operating point, the normally open circuit remains closed and the normally closed circuit remains open.



* This switch is one in the Honeywell V7 series of precision switches. While not all Honeywell switches have these features, you’ll see 65 years of quality switch design and manufacturing built into every Honeywell switch.

Advanced Users Only:

What to look for in a basic switch.

You wouldn’t buy a car without looking under the hood, would you? Not usually. While a switch is not a car, the same principles for specifying, selecting and buying apply. You want to verify superior materials and construction. You want to look for

* *Analysis primarily of Honeywell V7 series basic switch*

potential weaknesses or flaws that might cause failure. You want a component that delivers the best value for your end product. After understanding the principal parts of a switch, it's a good idea to "look under the hood" and see what constitutes superior design, raw materials and construction.

To compare switches, it is important to look at very specific areas. Remember, from the outside, many switches look alike. They may even look identical. Get your hands on some samples and open up the housing. Look at the number of parts and how they are fixed within the case. Examine what materials are used for the parts and what functions they must perform. Do parts seem robust or flimsy?

Looking under the (proverbial) "hood" of any switches you are considering in your designs can empower you to choose the best basic switch for your application.

Check the case.

First, look at the case material. A superior switch case is thicker and contains a high level of glass filler to make it less susceptible to cracking or breaking. Most switch cases are plastic and should not contain more than 50% regrind. Switch cases made from 100% regrind plastic typically do not tolerate harsh operating conditions or high cycle rates, and may have lower melting points and poor heat dissipation. They can form cracks and fissures more easily and be more susceptible to failure. What might be worse than total failure? Intermittent failure might be. If case fissures allow enough moisture into the case to interfere with electrical continuity, the switch might work some of the time, but not all of the time. Normally, a complete failure is easier to troubleshoot and rectify. Double check cases for regrind content and percentage of glass fill. The higher the glass fill, the stronger the case will be, resulting in better electrical insulation. When asked, a reputable switch manufacturer will provide regrind and glass fill content. Finally, case design is critical. Look to see if any components might be over-exposed. Verify specifications and tolerances match published technical data.

Check the metal.

Look at the common terminal, connecting terminals and leaf spring. Are they silver-plated, gold plated or are they un-plated brass or other alloy? Silver plating delivers superior heat dissipation. Gold plating is required to prevent corrosion in low current switching applications. How robust are the

terminals and leaf spring? If they appear flimsy, this can affect the number of cycles before failure. Consider your application. A switch in a hedge trimmer or hot tub may only be actuated 1,000 times during the product's life. A switch in a computer game joystick could see tens of thousands actuations. It's a good practice to specify a switch with a significantly higher cycle life than you anticipate it will see in your final application.

"Under the Hood" Checklist

- √ Check case specifications. Avoid cases that are 100% regrind.
- √ Look for cycle life specifications. If not listed, ask for test results.
- √ Do your own "tear-down" analysis.
- √ Verify case glass content.
- √ Look for locator pins and silver plated metal.
- √ Examine leaf spring design, materials and specifications.
- √ Check leaf spring for notches.
- √ Check leaf spring for deburring and heat-treat hardening.
- √ Verify heat dissipation capability.
- √ Check for smooth actuation.

Check the alignment mechanism.

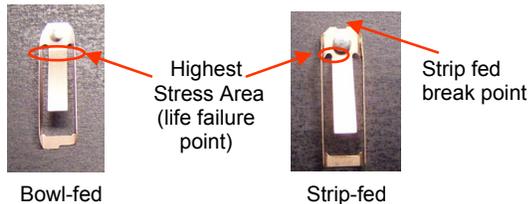
Next, look at the inside of the cover. A superior switch has locator pins to precisely align the body to the cover. These pins help keep all the components aligned to deliver consistent operation from the first to the millionth actuation. An inferior switch does not have alignment pins; rather, two bosses serve as both the main locator guides for the cover and body. Locator pins have one function: to hold all the components in place for consistent out-of-the-box repeatability. The bosses *should* have one function: to create mounting holes. Because there is no other stabilizing component, the case and components can skew if the switch is over-torqued. This could impact the electrical continuity as well as the actuation of the plunger, by changing both the physical and electrical characteristics of the switch.

Make note if the bosses must perform two functions: one to serve as a cover-to-base alignment mechanism; and two, to serve as mounting holes. Bosses that must "multitask" may be more susceptible to change from mounting screw torque. Always pay attention for multi-functioning parts in a precision switch. Doubling up on component functions usually means a part can't do one thing exceptionally well—it does two things only marginally.

While you have the cover off, examine the cover thickness. An inferior switch will have a significantly thinner cover.

Check the leaf spring.

Look at the leaf spring located in the base. This is the workhorse of the precision switch. There are three key features to check.



1. Check if there is a notch at the end of the spring. This may indicate the piece was manufactured using a strip-fed line. If the ends are square, it may indicate the part was manufactured using a bowl-fed line. Strip-fed lines allow high speed automated part production and assembly. Bowl-fed lines are slower, but allow for flexibility in assembly.
2. A superior switch's leaf spring is *heat-treat* hardened after forming for superior characteristics. This process maximizes part strength. It increases life in a critical, high stress area and minimizes possible micro-cracking that can shorten spring life. A switch spring made from *mechanically pre-hardened* metal may give a softer result. This softer material is more likely to flex, bend, crack and break. The only way to verify hardening method is to check with the manufacturer but typically a strip-fed line is mechanically hardened, creating an inferior leaf spring that is more susceptible to early life failures.
3. Check for burrs, rough edges and micro-cracks in the high-stress area. High stress edges should be deburred and polished. Deburring rids the assembly of burrs and rough edges while polishing minimizes micro-cracks and will also stop micro-cracking from perpetuating (similar to how the crack in a car windshield grows over time). Both burrs, rough edges and micro-cracks will impair performance and shorten life. Burr and micro-crack presence and location is unpredictable and not consistent, so, if the leaf spring has not been deburred and polished, characteristics from one switch to another may be different and product life may be greatly reduced.

Examine the spring under a low powered microscope to check for burrs, rough edges and micro-cracks. Typically a strip fed line will not allow time to deburr and polish.

Regardless of what you need the switch to do, it should be designed for repeatability, reliability and a smooth actuation.

Repeatable

The switch should actuate and release within a specified band and repeat this actuation and release every time, even after 500,000 cycles. Of course, expect to pay more for a switch with repeatability over 1,000,000 cycles than one with repeatability over 50,000 cycles.

Reliable

Will moisture, heat, mounting screw torque, or other ambient conditions have the potential to impact performance? Keep a checklist of your sample analysis and document your answers. A superior precision switch should be tested and operate for 10 million cycles before mechanical failure, and it should operate under maximum load for 100,000 cycles before electrical failure occurs.

Smooth actuation

A switch should be easy and smooth to actuate with a short travel. It should have a repeatable snap-action feel and sound. It should not stick, bind, wobble or change travel characteristics, even after 10,000,000 actuations.

High quality switches can improve your product's quality.

The price difference between a high quality switch and one of mediocre quality is usually just a few cents. Don't be fooled into shopping percentages on pennies. Yes, a \$.20 switch is 11% more than a \$.18 switch, but if two cents might eliminate a recall or field failure, it may be worth it. Think of total cost over the life of the switch, and that includes cost of failures not just the cost of the component. Don't expect to buy a commodity-priced switch and expect it to perform like a higher-priced one.

Finding a high quality switch.

Most of the higher-quality switches are from vendors with a long history and large product offering. Make sure they can supply you with testing samples and can deliver on slightly-off-standard specifications if need be. Make sure they

have the engineering expertise you need, before you trust their recommendations.

Consider future potential issues.

Obviously, switch configuration and specifications drive performance and price. But other “soft” factors need to be considered. These include the manufacturer’s technical service, availability, turnaround times, handling, shipping, installation requirements and warranty. Once installed in your product, if this switch doesn’t perform as planned, your company may have to deal with field failures, contractor service calls, product recalls, or even lawsuits. You may discover that the difference between exceptional specs and service may add only a cent or two to the switch’s cost. This is money well spent to avoid headaches down the road. And, this is one good reason to spend some time when specifying switches in any application.

What might happen if an inferior switch is used in some typical applications?

Electromechanical switches can be found in virtually all products we use on a daily basis. To give you a better understanding of how important they are, we’ll illustrate *potential* problems if a lower quality switch is designed-in and fails.

In a microwave oven.

There are 3-4 switches in the door mechanism alone. One of these cuts the power if the door opens. If this switch fails, a consumer could be exposed to microwave radiation.

In a dishwasher.

There is a switch in the float mechanism in the bottom of the dishwasher that controls water level. If this switch fails, the dishwasher can overflow and continue to call for hot water. This would mean a flooded kitchen and expensive service calls. If the thermal switch fails, the result could be electrical fires and calls to 911.

In a riding lawn mower.

An interlock switch in the seat detects the presence or absence of a rider. Another switch in the PTO engages and disengages the clutch on the mower’s blade. A switch failure in either of these two applications could be disastrous.

In a residential furnace or industrial boiler.

A pressure switch monitors the back-pressure of the exhaust from a high efficiency furnace. If a switch fails here, carbon monoxide could vent back into the home. In a commercial boiler system, switches

control the water tank level and functions like a thermostat to control system temperature. If a switch fails here, the water tank could overflow and ruin an expensive boiler.

In an industrial control panel.

There are hundreds of applications where switches are used in industrial panels, equipment, lathes, pumps, blowers and more. Failed switches might only be an inconvenience, but they might cause significant downtime and loss of productivity.

Penny-wise but pound-foolish.

If you believe a switch might contribute to any of these, it’s time to rethink switch selection.

- √ Product recalls
- √ Warranty issues
- √ Brand equity erosion
- √ Negative PR
- √ Service calls
- √ Field failures
- √ Supply chain issues

Where to find high quality industrial switches?

What should you look for when choosing a switch provider? It’s important to choose a vendor with a history of proven performance in the switch business. *Some points to consider include:*

- A good supplier will have a very broad switch portfolio with models that operate over a wide range of specifications and environmental conditions. Does the company have the ability to deliver models with specifications that deviate from standard or off-the-shelf models? Can this company deliver these switches in testing quantities quickly?
- A good supplier can respond quickly. Does the supplier have the infrastructure to address your engineering needs? Could the location of the company’s design, and service centers or manufacturing facilities impact your project.
- A good supplier should have a strong reputation for quality, reliability, on-time delivery, application expertise and creative problem solving. Get recommendations. Check for depth and expertise in electronics, in-house design, instrumentation, research, compliance, engineering, testing, intellectual property and manufacturing.
- A good supplier should be financially strong and secure. They should provide good sales, service

and application support *globally*, but with local access.

- A good supplier should deliver value that adds to your bottom line. Remember, while a low price might at first glance seem to be attractive, do an accurate comparison. Be sure you are tallying up the potential for adding in soft costs or potential failures that may be identified after the final product is in your customers' hands.
- A good supplier should devote the proper engineering, regulatory and research resources to your project up front. Get this company involved early to get the best recommendations.
- A good supplier should make switch samples available. While these samples may not be free of charge, the manufacturer should be willing and able to provide several styles and ranges of specifications, mountings and connecting options for you to test before your final purchase.
- A good supplier should have a sound history of defect-free shipments and they should willingly communicate this data to you. Verify they incorporate processes that are meaningful to your company. These might include Six Sigma, Lean Manufacturing and other statistical models. Verify they are certified in critical processes such as ISO 9000, ISO 9001, ISO 9004 or other quality management standards your company may desire.
- A good supplier should have “next generation” expertise, such as tactile, membrane, wireless and programmable switch technologies. This may be the key ingredient in your next generation design.

Basic switches are not created equal. Really.

We trust that we have pointed out the differences between a superior switch and an inferior one. You need to decide what features and specifications are important in your design, do your own evaluation of switch samples and go with a vendor you can trust. Switches can be sexy... *just look under the hood.*

For more information on Honeywell switches, please visit www.honeywell.com/sensing.