WHY LIMIT SWITCHES? A STRAIGHT-FORWARD SWITCHING SOLUTION

A Honeywell White Paper

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ABSTRACT

For decades, electromechanical technology has made industrial limit switches an easy and practical application in sensing and control solutions.

Honeywell has a long history in supplying limit switches to sense the presence or absence of an object in demanding industrial indoor and outdoor environments.

From factories to agriculture, limit switches work under extreme cold and hot temperatures and are unphased by exposure to water and dust. An industrial limit switch may be the best choice for when handling electrical or environmental application, or physical contact of the object being sensed.

Limit switches provide reliable, consistent, stress-free operation for a range of applications. As they continue to evolve, development has focused on enhanced longevity and dependability.

ENHANCED PERFORMANCE MECHANICAL INTEGRITY

A limit switch is an electromechanical device for digital position sensing (on or off) in industrial applications.

When the actuator of the limit switch has traveled a sufficient distance, the electrical contacts within the limit switch are actuated and change state.

The contacts within the limit switch are typically referred to as either normally closed or normally open. Depending upon the application and the object being sensed, the limit switch actuator can provide either linear or rotary actuation for optimal limit switch performance. They must be able to contact the object being sensed and can be adjusted to operate the switch contacts according to the application requirements.

Updates to limit switches specifically concentrate on the mechanical integrity of the internal contact material and mechanism, mechanical linkage/drivetrain within the switch and the environmental sealing of the package.

THE AUTOMOTIVE INDUSTRY + LIMIT SWITCHES

Over 50 years ago, the automotive industry identified the importance of reliable limit switch integrity, especially in relation to the cost of manufacturing downtime due to poor switch performance. As such, new standards were instated and in conjunction Honeywell MICRO SWITCH designed and developed the HDLS Series of limit switches.

With their rugged and reliable performance in the automotive industry, Honeywell saw the potential for other applications including industrial factory floor, construction, rail, transportation, and even agriculture.

With the capability of up to 50 million operations, many of the HDLS Series limit switch enhancements have been replicated in other products to increase performance.

EMERGING SOLID-STATE TECHNOLOGY

Even as electronic sensing solutions developed, such as proximity, photoelectric, capacitance and ultrasonic sensors, limit switches still stood out because of their inherent advantages. Electronic sensors have their limitations related to their electrical and environmental capabilities, as well as installation and setup.

As applications expanded globally, limit switch designs continued to improve. This includes the development of positive opening contacts ⊖ on select limit switch models. The normally closed positive opening contacts of the limit switch ⊖ are forced open through direct mechanical linkage within the limit switch. When actuated, this ensure the contacts of the limit switch open.

Further modifications include fluorosilicone seals for low temperature applications (down to -40°C/-40°F). Moreover, while most industrial limit switches provide an integral threaded conduit, Honeywell also offers a pre-cabled option for select applications.

Limit switches continue to develop, with frequent modifications to meet demanding industry requirements.

Figure 1. Examples of limit switch progressions

INDUSTRIAL LIMIT SWITCHES, A PROVEN & RELIABLE TECHNOLOGY

Most industrial electromechanical limit switches contain the following three components:

1. **Operating head and actuator** – comes in contact with what is being sensed. The operating head can be rotated in 90º increments for flexible installations. The actuator/lever of the limit switch can be locked in any position, 360º around the shaft.
2. **Switch body** – contains the contact block and the integral threaded conduit. The operating head is fastened to the switch body.
3. **Contact block** – contains the switch mechanism with the terminal screws or other termination for the electrical connection.

These components are illustrated in Figure 2 of a Honeywell LSA3K Heavy Duty Limit Switch (HDLS Series).

Figure 2. Limit switch components

LIMIT SWITCH OPERATION

With a contact-sensing design, the actuator of the limit switch must be in contact with the target being sensed. When the actuator of the limit switch (plunger or lever) has traveled a sufficient distance, the operating point occurs and the electrical contacts inside change state. The normally closed contacts open, and normally open contacts close.

Normally closed contacts "close" when the switch plunger or lever is in the free position (unactuated position). Normally open contacts "open" when the switch plunger or lever is in the free position (unactuated position).

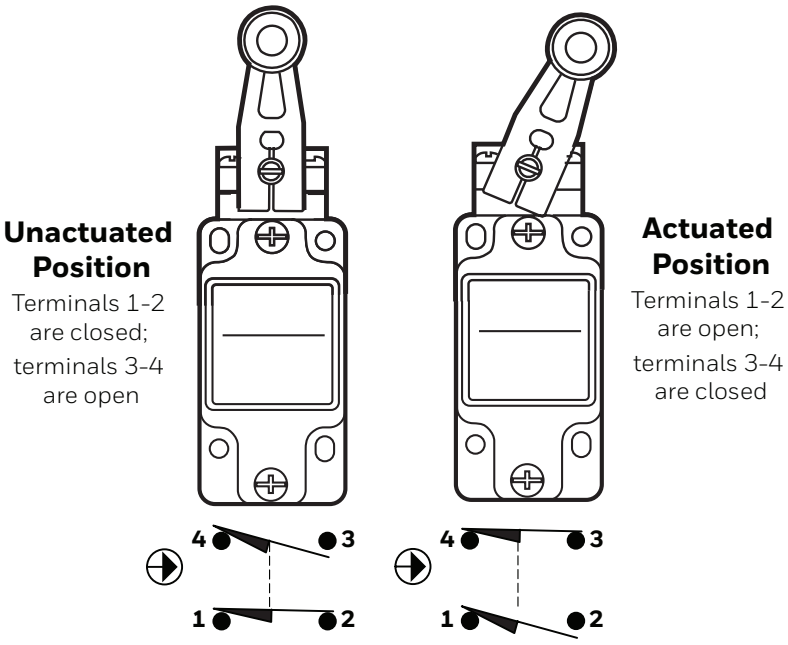

Figure 3. Limit switch normally open/normally closed contacts

ADVANTAGES AND CONSIDERATIONS

ADVANTAGES

- Well-established, straight-forward normally closed and normally open switch technology with a large installed base
- Able to sense most materials with a wide variety of different styles of actuating heads
- Easy to determine when switch contacts operate (with an audible click of snap action contact mechanism or monitor with digital meter)
- Easily troubleshoot switch contacts for proper operation (audible click or monitor with digital meter)
- Most limit switch contacts are a double break design
- Can provide up to four sets of independent contacts
- Select catalog listings have positive opening normally closed contacts
- Rugged sealed housings for IP and NEMA environmental seal requirements
- Suitable for a wide range of indoor and outdoor environments, including temperature variations with or without dust or water present
- Some catalog listing models suitable for ac or dc supply voltage
- Designed for switching a wide range of electrical loads, including switching of power duty loads (up to 10 A) at 24 Vdc and 120 Vac. Select catalog listings rated up to 600 Vac and 300 Vdc
- Minimal voltage drop across switch contacts and no significant leakage current
- Cost-effective sensing solutions

CONSIDERATIONS

- Requires limit switch actuator to be in contact with what is being sensed
- Limit switch mechanical parts may wear out after an extended time period
- Switch contacts may have a shorter life than solid-state outputs
- Not recommended for high-speed counting, greater than 200 operations per minute

Limit switches serve a variety of applications in a range of environments, including the industrial factory floor, agriculture, construction and commercial rail or transportation equipment and machinery.

OTHER SENSING TECHNOLOGIES

While limit switches continue to provide countless switching solutions, there are other sensing technologies available as well.

MAGNETIC ACTUATED (REED) SWITCHES

Magnetic actuated – Reed switches are actuated by a magnetic field. Contacts change state (close or open) when the magnetic field is sensed. Reed switches are generally a two-piece assembly, the reed switch with the electrical contacts and the separate magnet.

Back bias, ferrous target required – A magnet is integral to the reed switch package and is operated by a ferrous target. The ferrous target upsets the internal magnetic field of the switch and the switch contacts change state. This design may be beneficial since the target is a ferrous material and does not require a magnet to operate the switch.

Key Benefits

- No physical contact required between switch and target (no mechanical linkage)
- Switch contacts hermitic sealed (glass-to-metal seal) to keep any contaminants out of switch mechanism

Items to Consider

- Requires a magnet or ferrous target to actuate (depending on sensing style)
- Sensitive to target alignment
- Limited ability to switch power-duty electrical loads

INDUCTIVE PROXIMITY SENSORS

Senses any metal targets in a slide-by or head-on mode

Key Benefits

- No moving parts to wear out
- No physical contact required between sensor and target (no mechanical linkage)
- High speed counting, greater than 500 Hz

Items to Consider

- Require constant power
- Output leakage current
- Sensing distance varies with different metals (for example the sensing distance for steel and aluminum is different)
- Installation and set-up may require more time
- Troubleshooting may require more time
- May require different part numbers for ac or dc supply voltage
- Limited ability to switch power duty electrical loads

CAPACITIVE PROXIMITY SENSORS

Senses the target or material with reference to the dielectric constant of the material

Key Benefits

- Can sense from a lower dielectric constant to a higher dielectric constant (for example, can sense through plastic to sense a liquid level)
- No moving parts to wear out
- No physical contact required between sensor and target (no mechanical linkage)

Items to Consider

- Require constant power
- Output leakage current
- Must sense from a lower dielectric constant to a higher dielectric constant and understand the dielectric constant of different materials
- Installation and set-up may require more time
- Troubleshooting may require more time
- Limited ability to switch power duty electrical loads

ULTRASONIC SENSORS

Transmits high frequency ultrasonic pulses and listens for a returned echo reflected from the target back to the sensor

Key Benefits

- Can sense clear, shiny or opaque surfaces
- No moving parts to wear out
- No physical contact required between sensor and target (no mechanical linkage)

Items to Consider

- Require constant power
- Longer sensing distance may have unacceptable levels of delay
- May have an unacceptable "dead zone" on short sensing distance
- Air currents and temperature variations may affect transmission and return of ultrasonic signals
- Output leakage current
- Installation and set-up may require more time
- Troubleshooting may require more time
- Limited ability to switch power-duty electrical loads

PHOTOELECTRIC SENSORS

A one- or two-piece sensor transmits a modulated signal (typically an infrared signal) with the target breaking the signal or the target reflecting the signal back to the transmitter/receiver.

There are several different photoelectric methods to sense the target;

- **Diffuse –** One-piece transmitter and receiver. When the target is present, the transmitted signal is reflected & returned to the receiver
- **Reflective or Polarized Reflective –** One-piece transmitter and receiver. A reflector or reflective tape required to reflect the transmitted signal to the receiver. A target breaks the transmitted signal
- **Thru-scan –** Two-piece, separate transmitter and receiver. The target breaks the signal to the receiver
- **Convergent beam –** One-piece transmitter and receiver. Fixed distance to target, reflects transmitted signal from target when sensed

Key Benefits

- Able to sense short or long distances
- High speed sensing, greater than 500 Hz

Items to Consider

- Susceptible to inference (attenuated signal) from local environment, dust, humidity etc.
- Optical interference from overhead lighting or sunlight
- Sensing a clear or shiny target may be an issue
- Installation and set-up may require more time
- Troubleshooting may require more time
- Limited ability to switch power-duty electrical loads

LIMIT SWITCHES VS. COMPARABLES

Limit switches have a long history of successful performance in a range of indoor and outdoor applications, especially as compared to other sensing technologies.

LIMIT SWITCHES

- Wide variety of actuators for sensing different materials
- Switch characteristics same regardless of target material
- Switch mechanism requires no power to operate

MAGNETIC (REED) SWITCHES

- Ferrous or magnetic sensing only
- Target alignment is critical for sensing

INDUCTIVE PROXIMITY SENSORS

- Senses metal target only
- Different sensing distance for different metal targets
- Require constant power

CAPACITIVE PROXIMITY SENSORS

- Can sense most materials
- Different sensing distance for different materials
- Require constant power

ULTRASONIC SENSORS

- Target surface must be positioned for sonic reflection
- Sensing may be affected by temperature or air currents
- Require constant power

PHOTOELECTRIC SENSORS

- Susceptible to interference from dust, vapors and extraneous light
- Sensing clear or shiny targets may be an issue
- Require constant power

CONCLUSION

A straight-forward switching and control solution.

Limit switches have dominated the sensing industry for decades because they provide consistent, reliable performance for a breadth of applications and environments. Despite advancements in electronic sensing technology, limit switches consistently outperform and offer a host of advantages to other counterparts.

To keep up with industry certification on a global-scale, limit switch technology continues to develop and modify to preserve mechanical integrity and reduce operation downtime from faulty products. In even the harshest environments – hot or cold, indoor or outdoor – limit switches offer well-established, straight-forward sensing data for a variety of applications.