HEALTHY
SENSING.

Do You Know When Your Proximity Sensor is Sick?

A Honeywell White Paper

Honeywell

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ABSTRACT

A proximity sensor is a sensor capable of detecting the presence of nearby metal objects without any physical contact. The proximity sensor generally functions by detecting changes in a local electromagnetic field. This field could be emitted by the proximity sensor itself, or by the metal target (magnet) being detected. When a metal object is detected by the sensor, the output of the sensor changes state.

The general application of a proximity sensor is very similar to that of an electromechanical position switch, though there are a few differences: No physical contact is required for the proximity sensor to detect the position of metal objects, it has the potential for variable near/far sensing, and it may include FAVCO (Fixed Amplitude Variable Current Oscillator) technology.

Some common areas of use within aerospace applications are doors and slides, thrust reversers, engine accessories, landing gear, Ram Air Turbine (RAT), flap skew, and flight control surfaces.

INTRODUCTION

In today's competitive technology landscape, pressure to have the longest-life components at the lowest cost with increased accuracy is at an all-time high.

This pressure has created demand for next-generation contactless sensing technologies that can outperform their less reliable predecessors. There are a host of options for contactless sensing, but most current choices do not offer options for harsh environments, a wide range of electrical input capability ranges, and built-in technologies to report sensor health status back to the control module.

HEALTHY SENSING:
DO YOU KNOW WHEN YOUR PROXIMITY SENSOR IS SICK?

> Honeywell has engineered a next-generation class of enhanced ECKO sensing technologies, called FAVCO, that address these current hurdles.

What is ECKO technology?

ECKO: Eddy Current Killed Oscillators

- Honeywell ECKO proximity switches are non-contact, non-interactive sensors that are sensitive to all metals. They consist of an oscillator, demodulator, level, and switching amplifier.

- ECKO technology is a delineation from inductive technology.
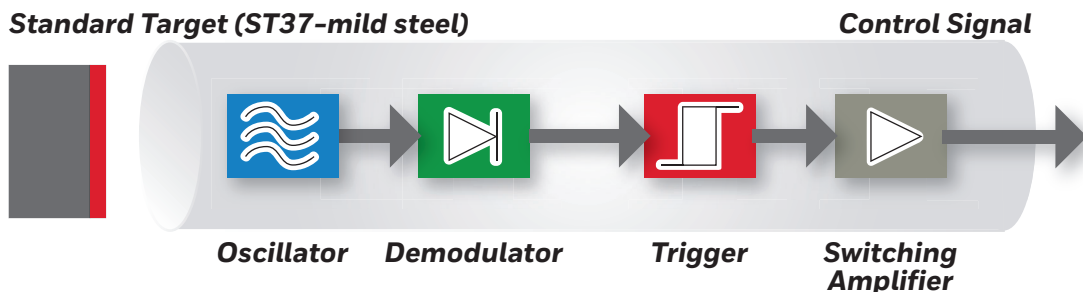
What are Eddy currents?

- Electric currents induced within a conductor by a changing magnetic field in the conductor.

- These currents circulate within the material and cause energy losses within magnetic circuits.

How do Honeywell ECKO Proximity Sensors work?

- When a conductive object (or target) approaches the sensor's oscillating electromagnetic field, Eddy currents are induced in the target and increase as the target gets closer to the sensor. In an ECKO-type proximity switch, the loss of energy to the target increases enough to kill the natural magnetic field oscillation of the sensor.

- This loss of oscillation is detected internally to the sensor and used to trigger the sensor's output.

Figure 1. Standard target to control signal.

Standard Target (ST37–mild steel)   **Control Signal**

Oscillator   **Demodulator**   **Trigger**   **Switching Amplifier**

Honeywell has enhanced the existing technology to offer a next-generation Series of proximity sensors.

What is FAVCO?

- Honeywell FAVCO (Fixed Amplitude Variable Current Oscillator) proximity sensing technology is based on an enhanced ECKO technology platform.

- It is a proprietary technology developed by Honeywell.

How is it "enhanced" from standard ECKO sensing technology?

- The FAVCO technology adds a variable gain amplifier that keeps oscillation at a constant level and increases the current to maintain the oscillation amplitude.

- Like ECKO, FAVCO measures the Eddy current losses caused by the target but measures the current in the oscillation circuit instead of the oscillation amplitude.

- FAVCO technology utilizes additional circuitry to monitor critical circuitry for faults and normal operation.

What can cause a proximity sensor to fail?

- Broken/faulty oscillator coils

- Sealing failure => corrosion to the oscillator coil

- Electrical component failures in the ECKO sensing circuitry

What is the "value" above ECKO?

- Because the IHM circuit always is oscillating, it is able to detect failure modes that traditional ECKO sensors cannot. For example, in the traditional ECKO sensor, if the coil breaks or an electrical component faults (stops the oscillator), the sensor cannot determine if the target is near or if there is a fault that stopped the oscillation, and may indicate an incorrect target position. With sensors built with the FAVCO technology, if the coil breaks, the oscillation would stop and the circuit would change the output to a fault mode rather than the incorrect state.

- FAVCO increases system Mean Time Between Failures (MTBF) and reliability by continuously monitoring the sensor's health and detecting sensor faults that can mask system failures.

- FAVCO allows for continuous sensor health verification during operation, simplifying system verification while in operation.

What is the benefit and use case?

- True "three-state" output indicates target near, far, and fault detected. Failure detection is extremely valuable in commercial aircraft maintenance and fault diagnosis as it allows for easier troubleshooting.

- Unlike Built-In Test (BIT) technology that requires extra wiring, Honeywell GAPS and HAPS proximity sensors (engineered with FAVCO technology) provide continuous sensor health monitoring with only three wires. This eliminates additional cabling and processing required to achieve sensor health verification.

- Various package configurations make this sensor family more flexible to fit many applications.

- The Honeywell GAPS and HAPS Series are durable and capable of maintaining accuracy over a full range of aircraft thermal, vibration, EMI, and lightning environments, including engine nacelle, landing gear, wing, and door environments.

The Honeywell GAPS and HAPS Series of proximity sensors offers health monitoring with continuous real-time diagnostics and customizable three-state outputs that allow discernment between system target faults and sensor malfunctions. We started with a standard ECKO sensor and then added our proprietary FAVCO technology. This means, for example, that a pilot who sees a fault light in his or her aircraft landing gear system can discern, even in mid-flight, if the landing gear truly is not fully stowed or if the proximity sensor itself has failed. With this additional and vital information, the pilot can decide to continue with the flight as normal rather than diverting to the nearest airport or delaying the flight, potentially saving airline companies lost revenue. Additionally, repair mechanics on the ground will know if the proximity sensor has failed without a long and expensive troubleshooting session.
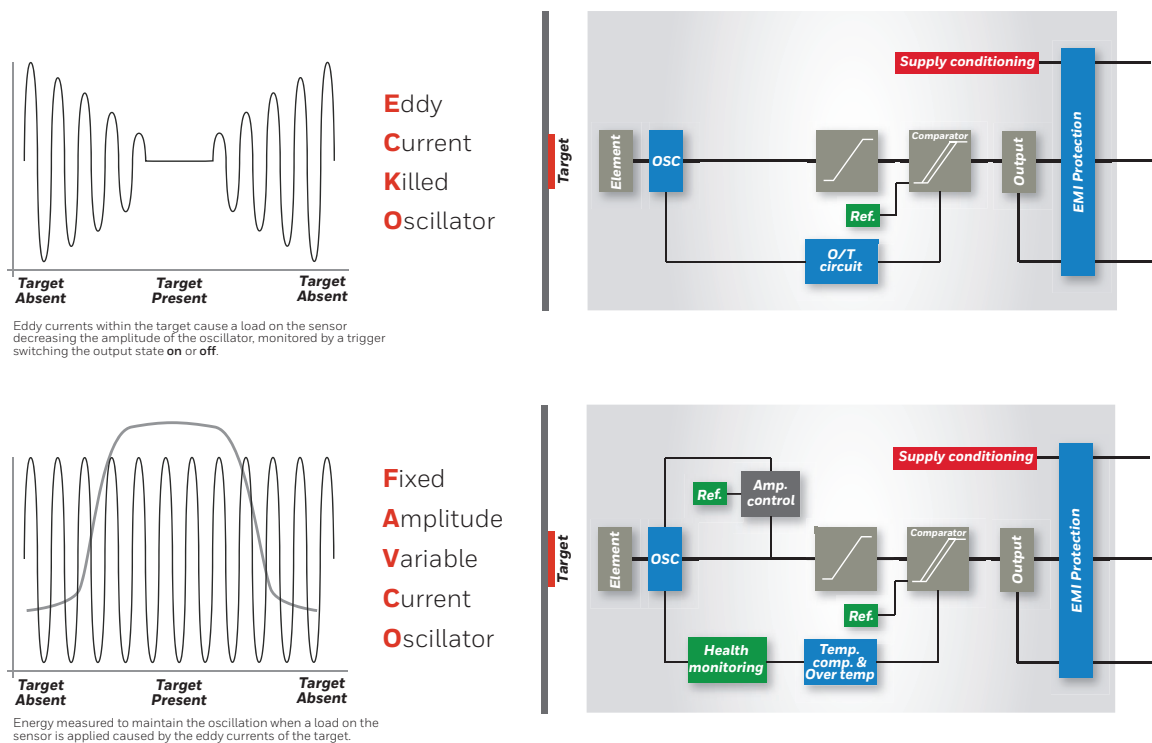
Options are also available for fire detection (high temperature signal) with an integral thermal sensor that sets sensor output to alarm state if temperature exceeds preset value. Various package configurations are offered (flange, threaded, integral connector, or pigtail) to provide flexibility within the application, and the design is capable of rapid customization. GAPS and HAPS Series sensors are certified to customer-specified DO-160G requirements. HAPS sensors have a typical reliability (MTBF) in excess of 1,000,000 hours. Honeywell has sensing packages as light as 60 g. Honeywell is lighter in a good deal of parts.

These new sensors are already in use in various aircraft in the following applications:

- Doors and slides
- Thrust reverser and engine accessory
- Landing gear
- Ram Air Turbine (RAT)
- Flap skew
- Flight surface travel limits

How has Honeywell achieved these advancements over standard ECKO proximity sensors available on the market? In essence, we have added FAVCO circuitry to our sensors in series with our over-temp circuitry. The block diagram below explains this visually.

Figure 2. Shows ECKO technology vs. FAVCO technology

Eddy currents within the target cause a load on the sensor decreasing the amplitude of the oscillator, monitored by a trigger switching the output state **on** or **off**.

Energy measured to maintain the oscillation when a load on the sensor is applied caused by the eddy currents of the target.

CONCLUSION

Honeywell has expanded on current ECKO technology in the industry to offer a line of next-generation proximity sensors with integral sensor fault indication. This detection can potentially save companies both money and labor in operating their airlines.

There are three significant advantages to proximity sensors:

1) There are no moving parts to wear out or require re-adjustment;
2) They do not require physical contact with the target; and
3) They are capable of monitoring the health of internal electronics.

Honeywell has more than 50 years experience in the aircraft sensing industry. Contact us today for a demonstration of how our new technology, available in both the GAPS and HAPS Series proximity sensors, is a true game changer for aerospace subsystems.

FOR MORE INFORMATION

Honeywell Sensing and Internet of Things services its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing, or the nearest Authorized Distributor, visit sensing.honeywell.com or call:

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