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Reed Sensors vs. Hall Effect Sensors

Since their introduction several years ago, the Hall effect sensor has captured the imagination of design engineers. Generally, it was thought that if it's in solid state that it's a more reliable approach, particularly when comparing it to electromechanical devices.

However, several remarkably interesting advantages are observed when comparing the reed sensor technology to the Hall effect technology.

But first, let's take a closer look at the reed sensor technology. The key component in the reed sensor is the reed switch, invented by Western Electric back in the 1940's. The other major component is the magnet or electro-magnet used to open or close the reed switch. Over the last sixty years the reed switch has undergone several improvements, making it more reliable, improving it's quality and reducing it's cost. Because of these dramatic improvements of reed switches, they have become the design-in choice in several critical applications where quality, reliability and safety are paramount.

Perhaps the most dramatic application and testimony of the reed's quality and reliability is its use in Automatic Test Equipment (ATE). Here this technology is used exclusively. The reed switches are used in reed relays, switching in the various test configurations for integrated circuits, ASICs, wafer testing and functional printed circuit board testing. For these applications up to 20,000 reed relays may be used in one system. Here one relay failure constitutes a 50-ppm failure rate. Therefore to meet this requirement, the reed relays need to have quality levels much better than 50-ppm. Heretofore, it was unheard of to have an electromechanical device with this quality level. Similarly the same holds true for several semi conductor devices as well. Once beyond the initial operational quality testing, the reed relays then need to perform well over life. Here they have been proven to out perform all other switching devices. Because, in many cases the automatic test equipment is operated 24 hours a day and 7 days a week to fully utilize it's high capital expense;

and therefore, billions of operations may be required during the reed relay's lifetime.

Another example of its favored use is in air bag sensors, where they have passed the test of time in a crucial safety application. Reed sensors are currently used in many critical automotive safety equipment (brake fluid level sensing, etc.), along with many medical applications including defibrulators, cauterizing equipment, pacemakers and medical electronics where they isolate small leakage currents.

In both technologies, the sizes are shrinking as is evidenced in the enclosed picture.

However, when comparing the reed sensor over a Hall effect sensor we see several advantages:

1. **Cost:** Generally the cost of the Hall effect device is low, but it requires power and circuitry to operate. Also, its signal output is so low it often times requires amplification circuitry as well. The net result, the Hall effect sensor can be considerably more expensive than the reed sensor.
2. The reed switch has superior isolation from input to output and across the switch up to 10¹⁵ Ohms. This reduces leakage currents to femto amps (10⁻¹⁵ amps) levels. On the other hand, Hall effect devices have sub-micro amp leakage levels. In medical electronic devices inserted into the human body as probes (invasive use) or pacemakers it's very important not to have any leakage current near the heart, where micro-amp and sub-micro amp currents can alter the heart's key electrical activity.
3. The reed is hermetically sealed and can therefore operate in almost any environment.
4. The reed has very low on resistance typically as low as 50 milli ohms, whereas the Hall effect can be in the hundreds of ohms.

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5. The reed can directly switch a host of load ranging from nano volts to kilovolts, femto amps to Amps, and DC to 6 GHz. The Hall effect devices have very limited ranges of outputs.

6. The reed sensor has a large range of magnetic sensitivities to offer.

7. Reed sensors are not susceptible to E.D.I., where electrostatic discharge may often times severely damage the Hall effect device.

8. Reed sensors are capable of withstanding much higher voltages (miniature sizes are rated up to 1000 Volts). Hall effect devices need external circuitry for ratings as high as 100 Volts.

9. The reeds are capable of switching a variety of loads, where the Hall effect sensor delivers only smaller voltages and currents.

10. The reed sensor is typically tested to withstand a three-foot drop test, which is comparable to the Hall effect sensor.

11. Because the reed sensor has no wearing parts, low level

loads (<5V @ 10 mA and below), will operate satisfactorily well into the billions of operations. This rivals semiconductor MTBF figures.

12. The reed sensor is unaffected by the thermal environment, and is typically operated from -50°C to $+150^{\circ}\text{C}$ with no special additions, modifications or costs. The Hall effect sensors have a limited operational range.

There are many very good applications of reed products. Selection of the proper reed in the proper application, often time is critical. Some reed/relay companies are excellent at designing in reeds in critical applications where quality, reliability and safety are paramount. Fortunately, MEDER electronic is very much involved in several of the critical requirements mentioned above and represents an excellent choice for those critical safety related applications.

Comparison of Hall Effect Sensor with Reed Sensor

Specifications	Hall Effect Sensor	Reed Sensor
Input requirements	External magnetic Field >15 gauss time	External magnet field >5 Gauss time
Sensing distance	Up to 20 mm effectively	Up to 40 mm effectively
Output requirements	Continuous current > 10 mA, depending on sensitivity	None
Power required all the time	Yes	No
Requirements beyond sensing device	Voltage regular, constant current source, hall voltage generator, small-signal amplifier, chopper stabilization, Schmitt trigger, short-circuit protection, external filter, external switch	None
Hysteresis	Fixed usually around 75%	Ability to adjust to meet design requirement
Detection circuit required	Yes, and generally needs amplification	None
Ability to switch loads directly	No, requires external switching	Yes, up to 2 A and 1000 V, depending on the reed selection
Output switching power	Low milliwatts	Up to 1000 W, depending on switch selection
Voltage switching range	Requires external switch	0 to 200 V (1000 V available)
Current switching range	Requires external switch	0 to 2 A
Output sensitivity to polarity	Yes, critical for proper operation	No
Output offset voltage sensitivity	Yes, exacerbated by sensitivity to overcoming, temperature dependencies, and thermal stress	None
Chopper circuit requirement	Yes, helps reduce output offset voltage; requires additional external output capacitance	None
Frequency range	Requires external switch	DC to 6 GHz
Closed output on resistance	> 200 Ohm	0.050 Ohm
Expected life switching > 5V @ 10 mA	> 1 billion operations	> 1 billion operations
Capacitance across output	100 pF typ	0.2 pF typ
Input / Output isolation	10 ¹² Ohm min.	10 ¹² Ohm min.
Isolation across output	10 ⁶ Ohm min.	10 ¹² Ohm min.
Output dielectric strength	< 10 V typ	205 V typ (2500 V available)
EDI (ESD) susceptibility	Yes, requires external protection	No, requires no external protection
Hermeticity	No	Yes
Shock	> 150 g	150 g (new ones up to 5000 g)
Vibration	> 50 g	10 g
Operating temperature	0 °C to 70 °C Typ above or below range degrades specifications	-55 °C to 150 °C, no specific degradation
Storage temperature	-55 °C to 125 °C	-55 °C to 150 °C