



# Reed Switch Application Notes

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# APPLICATION NOTES: Reed Switch Basics

## What is a Reed Switch?

A reed switch consists of two or three metal reed contacts (blades) that are hermetically sealed inside a glass tube containing an inert atmosphere. Reed switches come in various sizes, magnetic sensitivities, high power capabilities, high voltage capability, contact configurations, and lead configurations.

## Basic Function

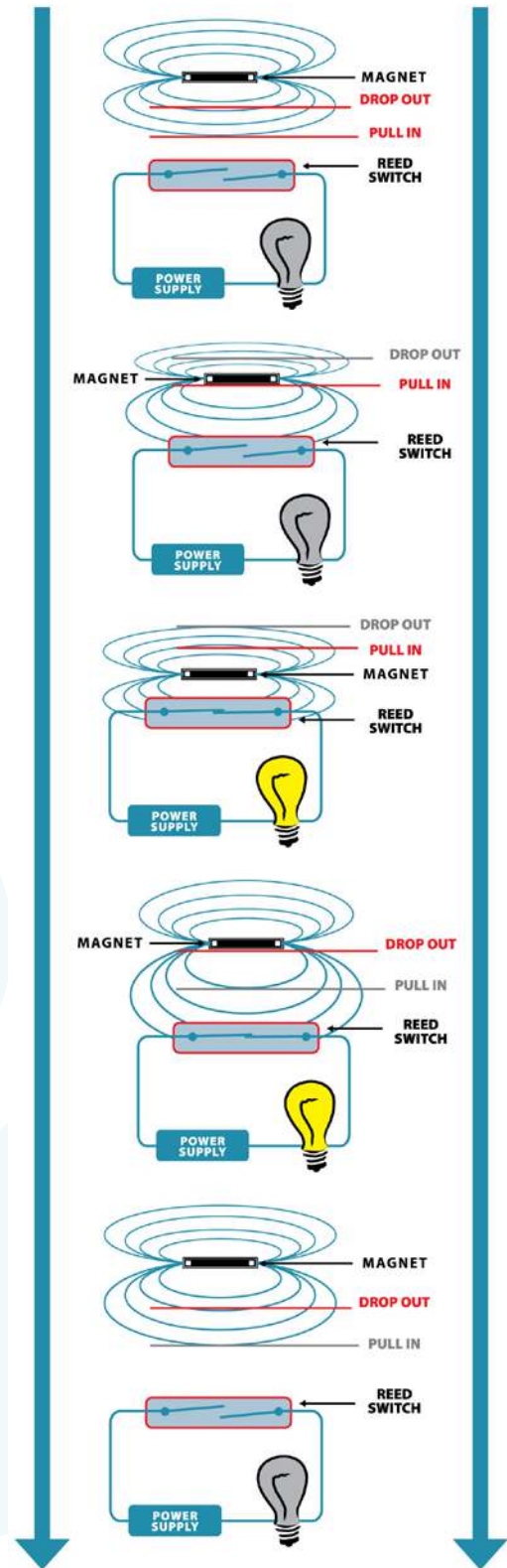
Reed switches have three basic configurations: Normally Open (NO), Normally Closed (NC) and Form C which has both NO and NC. Depending on this original contact configuration, the contacts will either complete or interrupt a circuit when actuated by a magnetic field.

The reed blades act as magnetic flux conductors or a "magnetic antennae." When exposed to an external magnetic field from a magnet or an electromagnetic coil, poles of opposite polarity are created across the open contact. When the magnetic force exceeds the spring force of the reed blades the contacts will close (Pull-In). When the magnetic force of the magnetic field is less than the spring force of the reed blades the contacts will open (Drop-Out).

From top to bottom in the illustration, step 1 to 3 shows a magnet coming close to a Normally Open switch, actuating it, and completing the circuit (turning on the light). When the magnet moves away, illustrated in steps 4 and 5, the switch's contacts open, and the circuit is interrupted (turning off the light).

The normally closed contact functions in the opposite mode. The light is on, magnetic moves near the switch and the circuit opens turning off the light. Magnet is withdrawn and the light comes back on.

The Form C switch can work two lights.

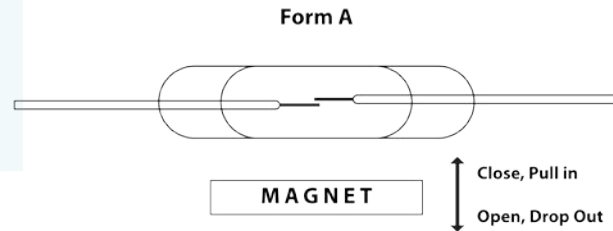


## Basic Types

### Form A

SPST (Single pole, single throw).

Normally open reed switch contacts close in the presence of a magnetic field.



### Form B

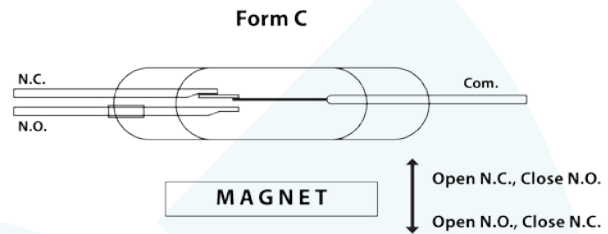
SPST (Single pole, single throw).

Normally closed reed switch contacts open in the presence of a magnetic field (no picture reference).

### Form C

SPDT (Single pole, double throw).

Break-before-make reed, the normally closed contact opens and then the normally open contact closes in the presence of a magnetic field.



### Latch

Reed Switch contacts lock into either position until reset by the reversal of the magnetic field. Available in SPST and SPDT.

# APPLICATION NOTES: Reed Switch Operation

## With a Magnet

A reed switch is activated by a magnetic field. It's important to realize that there are numerous possibilities for a switch's orientation within a given magnetic field. In the diagrams on page 7 you can see several basic examples of reed switch operation with the use of a moving and stationary magnet.

The length of the magnet and the length of the reed switch both affect the magnetic field coupling. Removal of the switch lead material reduces the "magnetic antennae." The magnetic coupling is reduced, the sensitivity is decreased, and the magnet must get closer to the reed switch to activate it. This is a general rule for a parallel mode of operation

## Magnetic Sensitivity

Reed switches are tested in standard test coils. Being long and slender with contact leads at each end, a coil of magnetic wire spread over the glass length provides excellent magnetic coupling. The switch leads protrude from each end of the coil for connection during the test. The magnetic sensitivity is stated in Ampere-Turns, which is related to that specific test coil. The sensitivity rating reflects the amount of current (Ampere) that is flowing through the coil having a specific number of TURNS, when the switch contacts operate.

## Definitions

### **Pull-In (Operate)**

Magnetic field strength at which the reed switch is activated.

### **Drop-Out (Release)**

Magnetic field strength at which the reed switch is de-activated.

### **Differential**

The difference between the Pull-In and Drop-Out of a reed switch expressed in Ampere-Turn, usually identified by the symbol  $\Delta$ . Differential is commonly specified when the contacts must Drop-Out when the magnetic field strength is reduced a specific amount.

### **Dwell**

In a Form C switch, the difference in field strength (expressed in ampere-turns) between the value when the common reed breaks the Normally Closed contact and the value when the common reed makes the Normally Open contact. Dwell can be an undesirable phenomenon. If mentioned at all, it is stated to limit the size of any Dwell in the acceptable product.

### **Custom Sensitivity**

By design HSI Sensing's equipment is capable of manufacturing reed switches to precise and custom pull-in, drop-out and differential specifications. HSI Sensing has years of experience in customizing the sensitivity of reed switches to specific application requirements.

### **Static Contact Resistance**

The resistance of the reed switch when the contacts are closed (measured in Ohms). Initial Contact Resistance refers to the maximum resistance of new contacts. All switches are measured for contact resistance at a specified magnetic overdrive after contacts are stabilized. HSI Sensing employs the four-point connection testing method (Kelvin Method).

## **Magnetic Overdrive**

Magnetic overdrive is the additional voltage or current applied to the coil beyond the Pull-In value. Overdrive is typically defined in additional Ampere-Turns or Voltage.

When testing contact resistance, it is 2 to 5 Ampere-Turns, or, 10% - 25% Ampere-Turns more than Pull-In. In the application it is recommended that 25% - 50% more magnetic overdrive be applied to ensure long life.

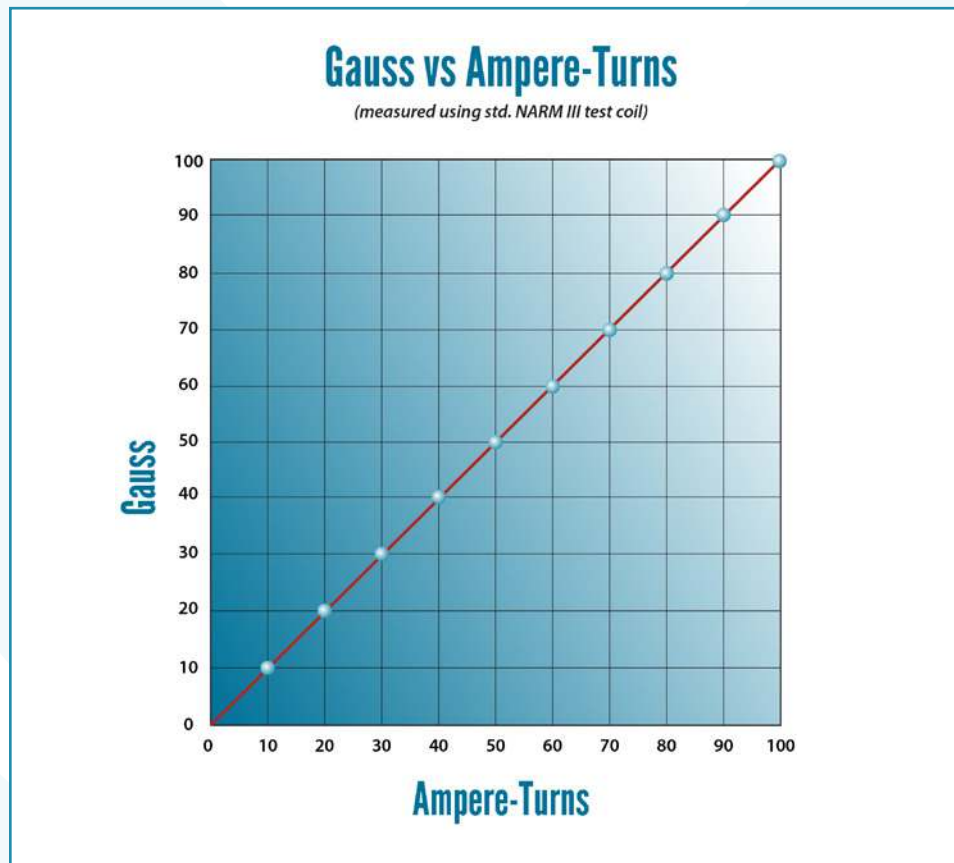
Magnetic overdrive in a magnet application is achieved by additional magnet travel beyond the point the switch achieves pull-in, moving the magnet closer to the reed switch.

Magnetic Overdrive is a critical parameter because it provides low and stable contact resistance as well as outstanding performance in applications over the life of the reed switch.

## Ampere Turns versus milli-Tesla and/or Gauss

The measure of the magnetic field strength required to operate a reed switch is expressed in ampere turns. The relationship between magnet strength (measured in gauss or Tesla) and reed switch sensitivity (measured in ampere-turns) to the corresponding activation distance depends on the magnet size, shape, and material, as well as the size and modification (if any) of the reed switch. The orientation of the magnet relative to the reed switch is also very important. Is the switch being operated by one pole of the magnet or both north and south poles?

Magnets are manufactured to feature-specific gauss strength. Magnet shape and size dictates how strong the magnetic field is at a specific distance from the magnet. In many motion and/or proximity sensor (reed switch in a housing) applications it is known how much gauss is available to activate the switch. Hence the need to understand the correlation of gauss to ampere turns. The Gauss vs Ampere Turns graph illustrates the measurement of gauss versus ampere turns in one standard test coil. In this example the magnetic field is uniform in shape and alignment. Since magnets do not deliver the type of uniformity in field shape as compared to the inside of a test coil, this graph should be used only as a guide.



As a guide, approximately 0.1 milli-Tesla (mT) is equivalent to 1 Gauss is equivalent to 1 ampere turn. Many applications specify a specific magnetic field strength in Tesla, or more specifically mT.



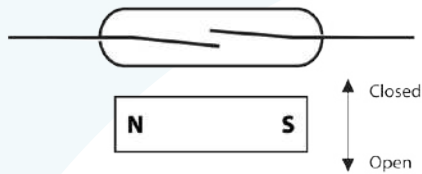
## Switch, Sensor and Magnet Engineering

Several factors affect the magnetic coupling between the reed switch and the magnet. These factors include but are not limited to switch modification, neighboring ferrous components, magnet-to-switch orientation, and magnet motion. To solve a specific problem with a magnet motion and reed switch activation, experimentation using switches with a range of sensitivity and a set of magnets of different sizes, strengths, shapes, and possibly materials is required. Magnet materials to consider are neodymium, alnico and others.

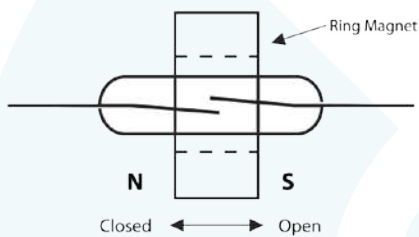
For end-on operation with an offset-gap reed switch, placing the gap end toward the magnet approach and removing the lead will allow magnetism to reach the gap more efficiently and can increase the sensitivity. However, this alignment, which employs only one pole of the magnet, typically requires a magnet double the strength of a magnet with a parallel mode operation, or the activate distance may be about half. Experimentation and research is key in determining the switch and magnet specifications.

HSI Sensing offers engineering assistance to match the proper reed switch with magnet motion. We offer many stock magnets to aid in application development. In many cases our production equipment utilizes the customer end-use product in our test fixtures. Sampling and/or 100% testing ensures every switch or sensor meets the functional operational requirements. For more information on reed switch and magnet designs to work with your specific application contact HSI Sensing.

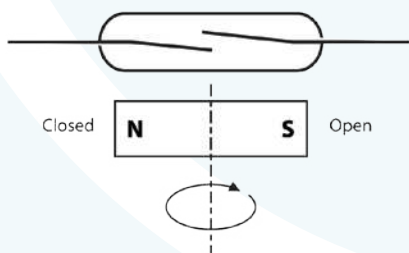
As explained on the previous pages, reed switches are activated by magnetic fields. It's important to realize that there are numerous possibilities for a switch's orientation within a given magnetic field. On this page, you can see several basic examples.



A magnet moved in a front to back motion (perpendicular towards and away) will operate the reed switch

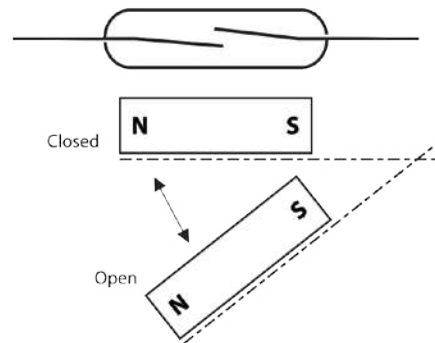


A reed switch moving through a circular/ring magnet will operate up to 3 times.

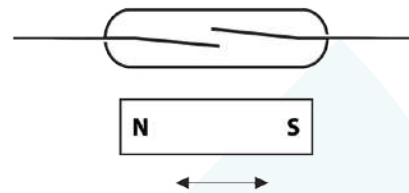


#### Rotation:

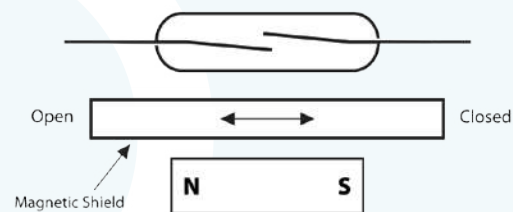
Magnets can be rotated several different ways to operate the reed switch. For more information on the effects of rotary magnetic motions, contact HSI Sensing.



A pivoting/swinging magnet will operate the reed switch.

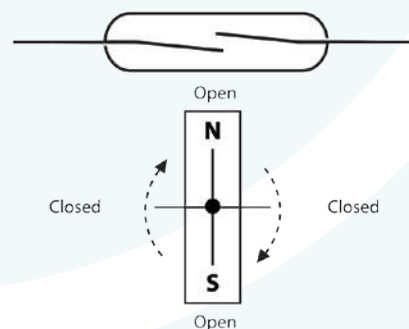


A reed switch can operate with a magnet moving parallel to the reed switch.



#### Shielding (Indirect Actuation):

If the reed switch and magnet are stationary, the movement of a shield (made of ferro-magnetic material) between the switch and the magnet will open and close the switch's contacts. The shield is used to divert the magnetic field away from the switch.

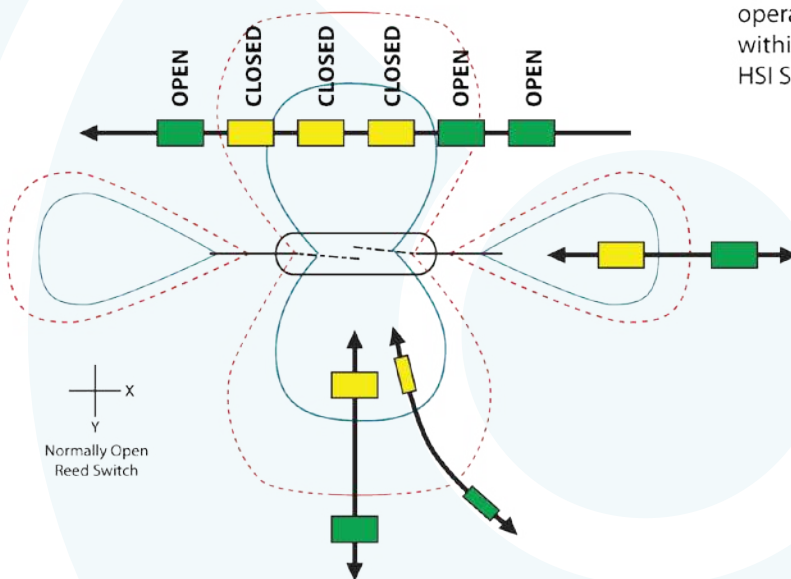


## Common Paths of Reed Switch Activation...

- ↔ A magnet's path
- The magnet is activating the switch
- The magnet is not activating the switch
- The point of activation, also known as Operate or Pull-In
- The Point of de-activation, also known as Release or Drop-Out

A magnet can actuate a reed switch several different ways. The drawing below demonstrates several common paths a magnet travels to operate the switch's contacts. The blue line represents the point at which the switch is activated by the magnet (also called the Release or Drop-Out). As shown in the drawing, a magnet must pass the Operate point (blue line) for the switch to be activated. To de-activate the switch the magnet must travel outside the Release point (red dotted line).

If you have specific questions about the operation of a reed switch, especially within a certain application, please contact HSI Sensing.



# APPLICATION NOTES: Reed Switch Signal / Electrical Requirements

Reed switches, though mechanical in nature, ultimately transfer current and voltage when it completes a circuit. HSI Sensing uses several basic definitions and formulas when determining the electrical and signal requirements for each application.

## Maximum Switching Current

The maximum electrical current that will pass or is passing through the contact(s) at the time of closure or at the time of opening. More arcing will occur at the opening and closing of contacts when the current is at the maximum specified limit. Arcing between the contact(s) will shorten the life expectancy of the reed switch. Maximum Switching Current is measured in amperes DC or amperes peak AC.

## Maximum Switching Voltage

The maximum circuit voltage allowed across the open contact(s). Reed switches are designed for tens of millions of cycles. One of the factors that may shorten the life of a reed switch is contact arcing. The higher the voltage, the greater the possibility of arcing. Arcing can cause metal transfer or damage the contact(s). To minimize contact arcing, it is imperative to select a reed switch with the appropriate features including vacuum, inert gas or pressurized inert gas. In general, applications switching above 250 volts require a reed switch with an internal vacuum or pressurized gas. Maximum switching voltage is less than the breakdown voltage.

## Maximum Switching Power

The maximum recommended switching power (in Watts or VA) that the contacts can withstand. Switching power is calculated by multiplying the open-circuit voltage across the switch by the closed-circuit current that will flow through the contacts.

**Example:** 24 volts x .100 amps = 2.4 watts

Although maximum recommended current and maximum recommended voltage are both given, the maximum power restriction usually requires limiting the actual values. HSI Sensing specification sheet power ratings are for resistive type loads.

## AC and DC loads

Reed switches can operate on AC or DC loads. In general, the AC maximum voltage is approximately 70% of the DC maximum voltage rating. Power and current ratings are equal.

## Minimum Switching Power

The minimum recommended power level the contacts need for signal transfer.

## Contact Material versus Performance

HSI Sensing manufactures a variety of contact materials intended to provide optimum performance over a wide variety of applications. A universal contact to cover the broad range of current, voltage, and power levels does not exist. Durel, Rhodium and Tungsten are contact materials that offer benefits to enhance specific applications. See our Application Notes: Plating versus Performance for additional information.

## Radio Frequency Loads (RF)

Radio frequency signals travel along the surface of the conductor. HSI Sensing specializes in the manufacturing of reed switches featuring custom plating that enhances RF performance.

## Load versus Life

The life expectancy of a reed switch is about a hundred thousand to millions of switching cycles at maximum power. With a low electrical load, the life expectancy can reach half a billion operations. Operation of the reed switch above the maximum electrical ratings of the switch can damage the contacts and reduce the life of the part. Life expectancy can be prolonged with contact protection measures. Selection of proper contact material is imperative for optimal contact performance.

The contact material, wire diameter, internal atmosphere, applied magnetic field, electrical load, and circuit protection (if any) all affect the life of a reed switch. For more information on choosing the right reed switch for your application, contact HSI Sensing.

## Types of Electrical Loads

The electrical ratings on HSI Sensing specification sheets are for resistive type loads. Lamps, capacitive and inductive loads tend to be more destructive and may require some form of transient or arc suppression. HSI Sensing has several recommendations to prolong life of the contacts and keep the load within the voltage or current ratings specified. This information is for reference only. Actual contact performance improvement and/or compatibility in the application should be verified.

### Resistive Loads

An electrical load not having any significant inrush current; an electrical load in which voltage and current are consistent. When a resistive load is energized, the current rises instantly to its steady-state value, without first rising to a higher value.

### Inductive Loads

An electrical load which pulls a large amount of current (an inrush current) when first energized. After a short time the current “settles down” to the full-load running current.

When using reed switches for inductive loads, such as motors, relay coils, solenoids, long signal wires and cables, the contacts will be subjected to high induced voltages during the opening of the contacts. Such high induced voltages may cause damage to the typical reed switch (electro-plated or sputtered contacts) or significantly reduce its life. To withstand these inductive loads HSI Sensing recommends Tungsten contacts. These are available in Form A and Form C switch types.

Depending on the value of the inductance, HSI Sensing recommends contact protection circuits such as RC, resistors or clamping diodes.

### Capacitive Loads

An electrical load which closes on a large amount of voltage when first energized.

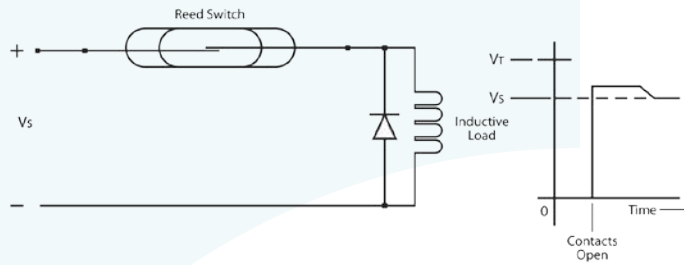
When using reed switches for capacitive loads such as capacitors or long cable runs, the contacts can be subjected to high surge (inrush) current. Therefore, protective circuits such as surge suppressors or current-limiting resistors are recommended.

### Basic electrical science formulas

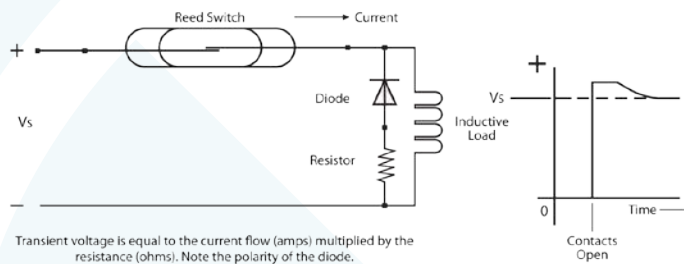
$$\text{Power} = \text{Volts} \times \text{Amps} \quad (P = VA)$$

$$\text{Volts} = \text{Amps} \times \text{Resistance} \quad (V = IR)$$

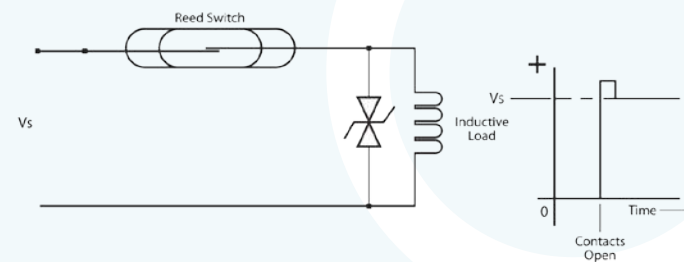
### DC Load, Inductive Load, Diode Protection



### Inductive Load, Diode-Resistor Protection

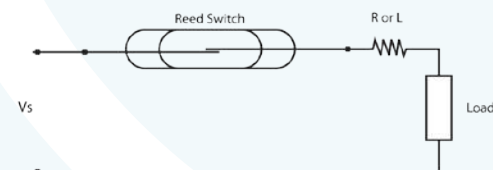


### Inductive Load, Zener Diode Protection, Featuring Back to Back Zener Diode

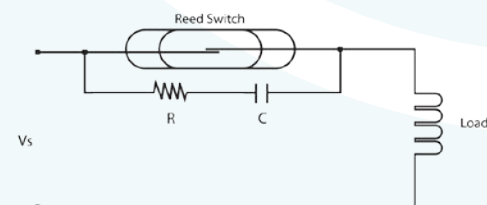


### AC or DC Loads

- 1) Series Resistor or Inductor for capacitive lamp or long cable (or wire) loads



- 2) Resistor Capacitor Protection for inductive or resistive loads



Capacitor and/or Resistor Value Calculation:

#### Capacitance

$$C = \frac{I^2}{10}$$

Value in Micro-farads just prior to contacts opening [I = Amperes of current flowing.]

Voltage = Voltage of source immediately prior to closing to closing contacts.

# APPLICATION NOTES: Reed Switch Mechanical Requirements

Several mechanical requirement factors should be taken into consideration when choosing or working with a reed switch.

## Physical Strength Glass-to-Lead Diameter

HSI Sensing has found that a reed switch is strongest when the glass diameter and switch lead diameter have a ratio of at least 5-to-1. Glass-to-lead diameter ratio should be taken into consideration when choosing a switch or when modifying reed switches. Contact HSI Sensing for assistance in selecting the best reed switch for your application.

## Reed Switch Gap Location

Reed switches have two types of gap locations:

### Center Gap

- More resistant to shock and vibration than an offset gap
- Typically wider in differential between Pull-in and Drop-out

### Offset Gap

- More susceptible to shock and vibration than a center gap
- Typically used in end on sensor application (e.g. tubular proximity sensors)
- Typically has a shorter glass length
- Typically closer in differential between Pull-in and Drop-out

## Blade Orientation

The orientation of a reed switch's internal components is designed to minimize the effects of shock and/or vibration in a particular direction. Contact HSI Sensing for more information on recommended blade orientation.



# APPLICATION NOTES: Reed Switch Environmental Considerations

Several environmental factors should be taken into consideration when choosing or working with a reed switch. These various environments can have an impact on how the reed switch performs.

## Shock and Vibration

Reed switches are most susceptible to shock and vibration in the direction the armature moves. The armature is the flexing member inside the reed switch. Center-gap switches are slightly more resistant to shock and vibration than offset-gap switches. Severe shock or vibration can change the magnetic sensitivity of the reed switch or render it non-functional. In severe cases a crack in the glass capsule may occur. Dropping a reed switch may cause shock damage.

Care should be taken when considering how to mount a reed switch. Please review the Application Notes: How to Handle a Reed Switch on the proper methods for mounting.

Contact HSI Sensing for mounting guidance to minimize the effects of shock and vibration.

## Thermal

By design, the glass and metal of the reed switch have the same coefficient of expansion. Caution should be taken in each application to avoid thermal shock when changing from extreme heat to extreme cold. If operating near or above the recommended maximum temperature, power and current ratings should be evaluated as they may diminish. Review reed switch specification sheets for recommended storage and operating temperatures.

The coefficient of expansion of other components surrounding the reed switch should also be considered. Incompatible components could cause stress, affecting magnetic function or damaging the reed switch.

## Temperature Cycling and Temperature Shock

Temperature changes creating movement of materials due to their coefficients of thermal expansion will stress and possibly damage a reed switch. Careful consideration should be given to the location of the reed switch to avoid interference from temperature cycling and temperature shock. Mismatch of coefficient of expansion between the switch and encapsulating materials can cause damage or affect operation.

## Magnetic Interference

Reed switches are designed to react to a specific magnetic signal. If another magnetic field enters the activation zone, the response of the reed switch will change, causing false activation, de-activation, or no activation. Careful consideration should be given to the location of the reed switch to avoid interference by other magnetic sources. Examples of these sources include but are not limited to other magnets, coils, motors, weld joints, capacitors, resistors, batteries, and relays.

## Ferrous Components

Components containing ferrous materials in the immediate proximity of the reed switch can increase or decrease the magnetic flux required to activate the reed switch. These components can interfere with the reed switch function. Careful consideration should be given to the location of the reed switch to avoid interference by other ferrous sources. Examples of these sources include but are not limited to resistors, capacitors, inductors, screws, bolts, nuts, brackets and housings.

# APPLICATION NOTES: How to Handle a Reed Switch

Reed switches consist of two or three metal reed contacts (blades) that are hermetically sealed inside a glass tube. This seal, while strong, may be damaged if proper handling is not used. HSI Sensing has years of experience handling reed switches and have identified several best practices.

## Handling

By design, reed switch raw materials (glass and metal) have a similar coefficient of expansion. They are designed to handle thermal and environmental changes well. The integrity of the glass-to-metal seal must be protected while handling, cutting, bending, mounting, encapsulating, welding, soldering, etc. During modification, care must be taken not to apply excessive mechanical force that could result in hermetic seal damage. Damage can be immediately visible in the form of a cracked seal, but it can also be latent and may only show up over time.

## Drop, Shock, Vibration Warnings

After a reed switch has been dropped or has been subject to excessive physical shock or vibration, always test the reed switch and inspect for physical damage before use in the actual application. Make sure all characteristics are within the acceptable limits. Excessive physical shock or vibration can alter the contact gap size of the switch and/or cause glass damage, both of which could lead to changes in magnetic sensitivity and hermeticity.

## Modification

### Using Ultrasonics

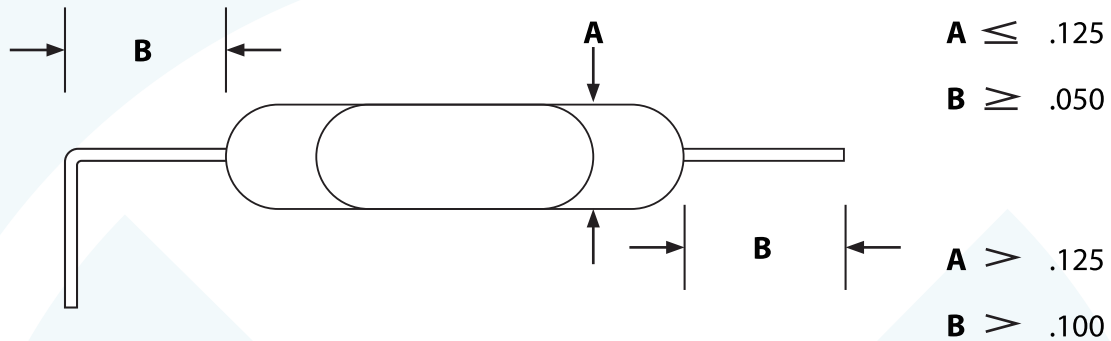
Ultrasonic cleaning or welding can damage the reed switch. Severe damage can occur to the contacts as well as the glass capsule. Be very cautious when using ultrasonics, and perform visual inspections and electrical tests to validate that the switch has not been affected negatively.

### Bending/Forming and Cutting/Cropping

When cutting or bending leads, extreme caution should be exercised not to exert any undue stress that can result in damage or deterioration of the glass-to-metal seal. Proper clamping is necessary.

Recommended distance from end of glass capsule for lead bending and cutting:

- for glass diameter less than 0.125 inches (3.175 mm), no less than 0.050 inches (1.270 mm)
- for glass diameter greater than 0.125 inches (3.175 mm), no less than 0.100 inches (2.540 mm)



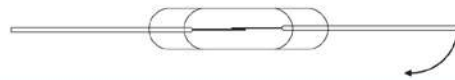
As a result of cutting external leads, pull-in and drop-out AT (Ampere Turns) will increase, and magnetic sensitivity will decrease. This should be taken into consideration during design. Bending of external leads will have a similar effect.

When cutting the reed switch leads, ensure the cutting blades are sharp and in good condition. Care should be taken not to allow any shock from cutting the reed switch along the lead and subsequently into the seal. When performing an overall length cut, use of a hard stop is not recommended as it may cause shock to one or both seals. For best quality only cut one reed switch at a time.

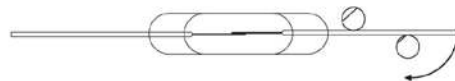
Use of a clamp between the seal and the cut/bend is the preferred method. If a clamping device is not used, the reed switch seal can experience additional stress.

The top and bottom seals of the switch should be inspected for cracks and damage after any modification is performed. HSI Sensing has years of experience cutting, forming and modifying reed switches. To eliminate the risk of quality problems, HSI Sensing can perform these modifications for you using appropriate tooling and fixtures. HSI Sensing can also prepare reed switches to mount on circuit boards.

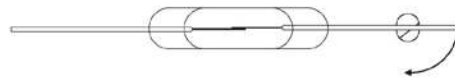
**No clamping – Do not consider**



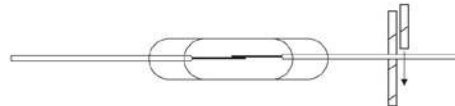
**Light clamping – Will reduce seal stress**



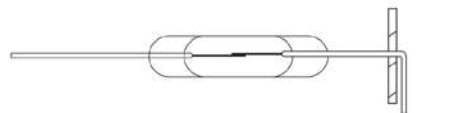
**Good Clamping Method**



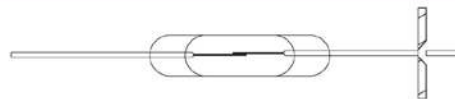
**Good Clamping Method**



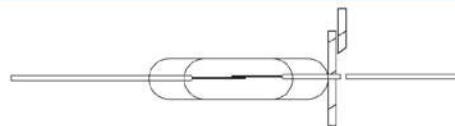
**Good Clamping Method**



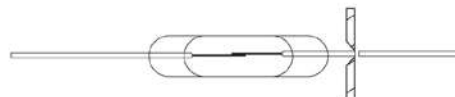
**Good Cutter, but no clamping – Consider shock back on the seal**



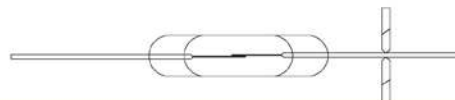
**If glass is touching clamp it could be damaged as it is pulled toward the cutter**



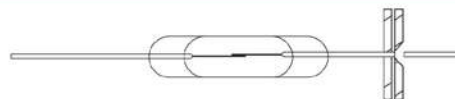
**Shock will damage switch**



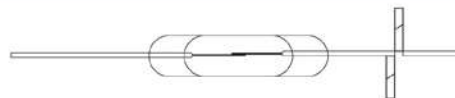
**Bad Design – Type of cutter. Chisel cutter sends shock in both directions**



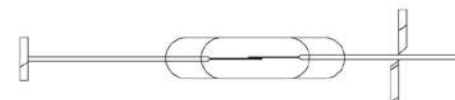
**Good Cutter with Good Clamping**



**Not recommended because of side of rotational stress**



**Do not put switch in bind. Flexible hard fixed stop to control overall length.**



**STOP CAUTION GO**

## Soldering and Welding

When soldering or welding to a reed switch, certain considerations must be made to avoid glass-to-metal seal damage such as breaking, chipping, cracking, contact damage and hermeticity leakage. HSI Sensing has years of experience soldering and welding to reed switches. To eliminate the risk of quality problems, HSI Sensing can perform these modifications using the appropriate tooling, fixtures, temperature, solder, flux and cleaning procedures.

HSI Sensing offers two external coating options when soldering to a reed switch: electroplated lead-free pure Tin (Sn), or electroplated Gold (Au). When welding to a reed switch, HSI Sensing offers clean reed switch leads (52 Alloy base metal) or electroplated Gold (Au).

A heat sink is recommended between the solder connection and the seal. We recommend soldering at a minimum 0.120 inches (3 mm) from the reed switch seal. Extreme temperature and exposure time may cause damage to the glass capsule and seal. Exposure time and temperature should be kept to a minimum to achieve the proper solder joint. When removing flux after soldering, do not use ultrasonic cleaning baths on reed switches with a normally-closed contact.

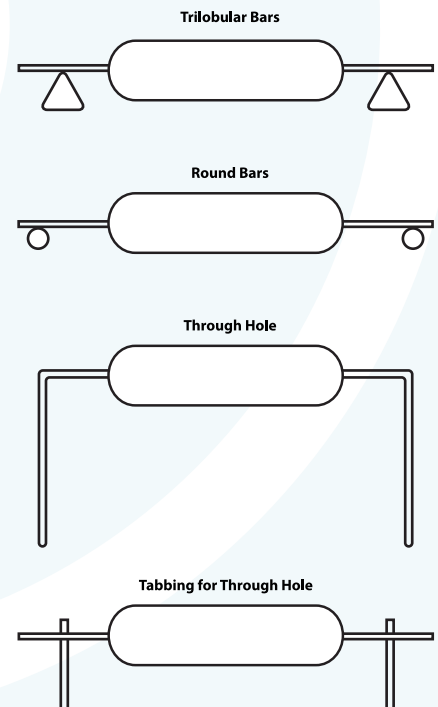
The welding process generates an electro-magnetic field that is capable of operating the switch. This may create an alternate current path that could result in contact damage. Never weld both reed switch leads at the same time, and take precautions when setting current, timing and voltage. Use caution when welding near the glass, as it may cause damage to the glass capsule and seal.

## Printed Circuit Board Mounting

HSI Sensing led the way in developing the methodology for mounting reed switches to printed circuit boards (patent number 5,796,254).

When mounting on a printed circuit board, attention should be given to flexing and thermal expansion characteristics. Using epoxy to secure a reed switch to a printed circuit board or using varnish to coat an already mounted reed switch may cause stress on the reed switch. Stress caused by these factors can lead to glass-to-metal seal damage, such as breaking, chipping, cracking, magnetic function and hermeticity leakage. In typical applications it is better for the mounted reed switch to rely on its own strength. However, if the application requires additional stress protection, HSI Sensing recommends using one of our various proximity sensor configurations.

HSI Sensing has multiple options for mounting reed switches to a printed circuit board: trilobular bars, multiple diameter round bars, bending and tabbing for through hole. HSI Sensing can prepare Form A, Form B, and Form C reed switch types for printed circuit board mounting.



## Potting and Overmold

Applications requiring sealing, potting, encapsulating and overmold processes can cause damage to a reed switch such as breaking, chipping, cracking, magnetic function and hermeticity leakage. Caution should be taken when selecting potting and encapsulating materials due to the linear coefficient of thermal expansion. HSI Sensing recommends using a buffer between the reed switch and the potting, encapsulating, and overmold material. The benefit is enhanced performance in shock and vibration environments. Examples of buffers may include: heat shrink tubing, soft epoxy, and silicone based potting materials.

HSI Sensing has years of experience sealing, potting, encapsulating, and overmolding reed switches. To eliminate the risk of quality problems HSI Sensing can perform these modifications using the appropriate materials.

## Storage

When storing reed switches avoid areas that have a fast thermal change. Also avoid storing near magnetic fields. An oscillating field such as a transformer could activate the reed switch and wear it out prematurely. A large fixed magnetic field holding the normally-open durel contacts of a reed switch closed for extended periods of time may cause the reed switch blades to stick and not release properly. See HSI Sensing specification sheets for proper storage temperature recommendations.

# APPLICATION NOTES: Reed Switch Plating versus Performance

When manufacturing reed switches HSI Sensing takes great care when selecting internal and external plating material to ensure it functions properly in the final application. Each material has its own unique set of benefits that change the way a reed switch performs.

## Internal Contact Material

**HSI Sensing offers four internal contact options:**

### **R – Rhodium**

- Rhodium, a noble metal contact material, is intended for low to midrange power level circuits (.01 watts to 25 watts)
- High durability and wear resistance
- Rhodium contacts are mechanically capable of up to billions of cycles under normal operating conditions
- Rhodium has a higher power rating than Ruthenium
- HSI recommends Rhodium contacts for applications that remain closed for long periods of time

### **D – Durel**

- This is a dissimilar contact design. Diffused copper plating paired with treated 52 alloy that HSI Sensing designates as Durel
- Durel is intended for very low power level circuits (less than 1 watt)
- Contacts using Durel can go into the millions of cycles
- HSI recommends Durel contacts for applications that are in the normally open state.

### **W – Tungsten**

- Solid Tungsten contacts
  - Highest power level contact material available (3 watts to 200 watts)
  - High voltage rating
  - Rated for switching inductive and capacitive loads
- Coated Tungsten contacts
  - High power level coating (1 watts to 50 watts)
  - Highest voltage rating
- Tungsten contacts have high durability and wear resistance
- Intended for midrange to high power level circuits
- Tungsten contacts within a vacuum atmosphere can switch up to 200 Watts, 10,000 Volts DC, or 3 Amps
- Tungsten contacts can go into the millions of cycles



- Tungsten contacts within a pressurized gas atmosphere can switch up to 100 Watts, 500 Volts or 3 Amps
- HSI recommends Tungsten contacts for applications that remain closed for long periods of time

#### **F – Rhodium over Copper**

- Proprietary process for Radio Frequency applications

To ensure that you are getting the best plating or coating for your application, please consult individual product specification sheets and then HSI Sensing staff. Actual contact performance may vary depending on the switching power load.

### **External Lead Preparation**

The coatings we provide to the external leads are RoHS compliant. To ensure that you are getting the best external preparation for your application please contact HSI Sensing staff. HSI Sensing offers four external lead preparation options:

#### **T – Tin**

- Applied for excellent solderability

Resists oxidation

#### **G – Gold**

- Applied for excellent solderability
- Resists oxidation
- Recommended for welding applications

#### **FT – Tin over Copper**

- Recommended for Radio Frequency applications
- Tin plating applied to prevent copper oxidation
- Applied for excellent solderability

#### **O – Clean (52 Alloy base metal)**

- Recommended for welding applications

## APPLICATION NOTES: Reed Switch Testing

Reed switches, invented in the 1930s, required a means to accurately and efficiently measure their magnetic sensitivity. Standard test coils were developed for this purpose. These coils, available in various sizes and matched physically to the variety of reed switch sizes, can be operated rapidly by computer-controlled test systems. For efficient operation the coils have either 5,000 or 10,000 turns, and the coil lengths are designed to deliver an efficient magnetic field shape (typically over the glass length of the reed switch). With computer-controlled precise incremental steps of current flowing in the coil, the switch is tested into specific sensitivity windows of ampere turns (number of turns in coil multiplied by the current flow required to activate the switch).

For some of our world's smallest switches and/or our tiny surface-mount sensors, HSI employs equipment utilizing a Helmholtz coil to generate a uniform magnetic field to surround the component. The computerized test system takes the sensor through a number of functional activation and deactivation cycles depending on the requirements of the application.

### Magnetic Sensitivity Testing

In magnetic sensitivity testing HSI Sensing employs all four standard test coils defined in EIA/NARM RS-421A and MIL-S-55433. Standard and specific test coils are used to test the operating characteristics of reed switches.

**NOTE:** Different coils provide different measured values. The proper coil for each reed switch is listed on HSI Sensing specification sheets.

Important factors to consider in order to obtain accurate, stable and consistent pull-in and drop-out readings are:

- The magnetic sensitivity is stated in Ampere Turns, which is related to that specific test coil. The sensitivity rating reflects the amount of current (Ampere) that is flowing through the coil having a specific number of TURNS, when the switch contacts operate.
- The current in the test coil must be carefully controlled and measured with a calibrated instrument.
- Position of the reed switch inside the coil should be controlled. Changing the position of the switch inside the coil will change the AT measurement of the reed switch.
- External magnetic fields need to be considered. The earth's magnetic field can cause reading errors up to about 1 AT. Magnetic fields can be produced by nearby fans, motors, or moving magnets.
- Ferrous material near a test coil can cause errors by altering the magnetic field. Possible ferrous items include screws, brackets, connectors and tabletops.
- Stresses applied on the reed switch glass or leads by test equipment can affect the sensitivity readings of the switch by slightly changing the reed switch contact gap.

- HSI Sensing tests all of our reed switches at 25°C.
- Reed switches are normally designed to operate in a temperature range of - 40°C to 125 °C. Temperatures above 125 °C can cause an increase in pull-in.
- The reed switch blades form a part of the magnetic circuit. Cutting and or bending the leads can result in changed pull-in and drop-out values.

## Voltage Breakdown Testing

HSI Sensing employs various commercially available test equipment for voltage breakdown testing (dielectric strength). For voltage breakdown product capabilities see HSI Sensing specification sheets.

Important factors to consider in order to obtain accurate, stable and consistent voltage hold-off and leakage current measurements are:

- Regulated and precise voltage test equipment capable of measuring current in micro amps. Contact HSI Sensing for recommended test equipment options.
- Placing the reed switch in a suitable holding fixture that will not contribute to any leakage current and not apply any stress
- Limiting the current so that reed switches are not damaged
- Testing consistently and not beyond the listed voltage breakdown specifications

Care must be taken to prevent damage to contact surfaces during testing. Uncontrolled voltage breakdown or improper equipment can cause damage to the contact. Examples of this damage include:

- Contact resistance
- Degraded voltage hold-off
- Increased leakage current
- Decreased life performance





3100 NORGE ROAD, CHICKASHA, OKLAHOMA 73018 | PHONE 405.224.4046 | FAX 405.224.9423 | [HSISENSING.COM](http://HSISENSING.COM)