

# Reed Switch Operational Characteristics

## Introduction

The Reed Switch was first invented by Bell Labs in the late 1930s. However, it was not until the 1940s when it began to find application widely as a sensor and a Reed Relay. Here it was used in an assortment of stepping/switching applications, early electronic equipment and test equipment. In the late 1940s Western Electric began using Reed Relays in their central office telephone switching stations, where they are still used in some areas today. The Reed Switch greatly contributed to the development of telecommunications technology.

Over the years several manufacturers have come and gone, some staying longer than they should have, tainting the marketplace with poor quality, and poor reliability. However, most of the manufacturers of Reed Switches today produce very high quality and very reliable switches. This has given rise to unprecedented growth.

Today Reed Switch technology is used in all market segments including: test and measurement equipment, medical electronics, Telecom, automotive, security, appliances, general purpose, etc. Its growth rate is stronger than ever, where the world output can not stay abreast with demand.

As a technology, the Reed Switch is unique. Being hermetically sealed, it can exist or be used in almost any environment. Very simple in its structure, it crosses many technologies in its manufacture. Critical to its quality and reliability is its glass to metal hermetic seal, where the glass and metal used must have exact linear thermal coefficients of expansion. Otherwise, cracking and poor seals will result. Whether sputtered or plated, the process of applying the contact material, usually

Rhodium or Ruthenium, must be carried out precisely in ultra clean environments similar to semiconductor technology. Like semiconductors, any foreign particles present in the manufacture will give rise to losses, quality and reliability problems.

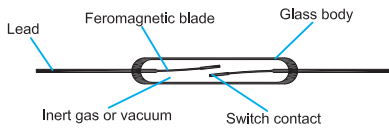
Over the years, the Reed Switch has shrunk in size from approximately 50 mm (2 inches) to 6 mm (0.24 inches). These smaller sizes have opened up many more applications particularly in RF and fast time domain requirements.

## Reed Switch Features

1. Ability to switch up to 10,000 Volts
2. Ability to switch currents up to 5 Amps
3. Ability to switch or carry as low as 10 nanoVolts without signal loss
4. Ability to switch or carry as low as 1 femptoAmp without signal loss
5. Ability to switch or carry up to 7 GigaHertz with minimal signal loss
6. Isolation across the contacts up to 1015 W
7. Contact resistance (on resistance) typical 50 milliOhms (mW)
8. In its off state it requires no power or circuitry
9. Ability to offer a latching feature
10. Operate time in the 100 ms to 300 ms range
11. Ability to operate over extreme temperature ranges from -55 oC to 200 oC
12. Ability to operate in all types of environments including air, water, vacuum, oil, fuels, and dust laden atmospheres
13. Ability to withstand shocks up to 200 Gs
14. Ability to withstand vibration environments of 50 Hz to 2000 Hz at up to 30 Gs
15. Long life. With no wearing parts, load switching under 5 Volts at 10 mA, will operate well into the billions of operations

# The Basic Reed Switch

Shown below Figure #1

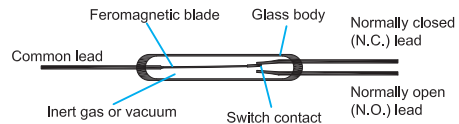


(Figure #1. The basic hermetically sealed Form 1A (normally open) Reed Switch and its component makeup.)

A Reed Switch consists of two ferromagnetic blades (generally composed of iron and nickel) hermetically sealed in a glass capsule. The blades overlap internally in the glass capsule with a gap between them, and make contact with each other when in the presence of a suitable magnetic field. The contact area on both blades is plated or sputtered with a very hard metal, usually Rhodium or Ruthenium. These very hard metals give rise to the potential of very long life times if the contacts are not switched with heavy loads. The gas in the capsule usually consists of Nitrogen or some equivalent inert gas. Some Reed Switches, to increase their ability to switch and standoff high voltages, have an internal vacuum. The reed blades act as magnetic flux conductors when exposed to an external magnetic field from either a permanent magnet or an electromagnetic coil. Poles of opposite polarity are created and the contacts close when the magnetic force exceeds the spring force of the reed blades. As the external magnetic field is reduced so that the force between the reeds is less than the restoring force of the reed blades, the contacts open.

The Reed Switch described above is a 1 Form A (normally open (N.O.) or Single Pole Single Throw (SPST)) Reed Switch. Multiple switch usage in a given configu-

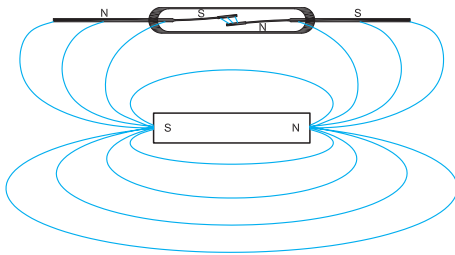
ration is described as 2 Form A (two normally open switches or Double Pole Single Throw (DPST)), 3 Form A (three normally open switches), etc. A normally closed (N.C.) switch is described as a 1 Form B. A switch with a common blade, a normally open blade and a normally closed blade (see Figure # 2) is described as a 1 Form C (single pole double throw (SPDT)).



(Figure #2. The 1 Form C (single pole double throw) three leaded Reed Switch and its component makeup.)

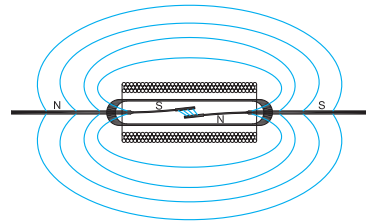
The common blade (or armature blade), the only moving reed blade, is connected to the normally closed blade in the absence of a magnetic field. When a magnetic field of sufficient strength is present, the common blade swings over to the normally open blade. The normally open and normally closed blades always remain stationary. All three reed blades are ferromagnetic; however, the contact area of the normally closed contact is a non-magnetic metal which has been welded to the ferromagnetic blade. When exposed to a magnetic field, both the fixed reeds assume the same polarity, which is opposite that of the armature. The non-magnetic metal interrupts the magnetic flux on the normally closed blade so that the armature sees an un-interrupted flux path to the normally open blade, and it is that which it seeks. Here the attractive force is of sufficient magnitude between the normally open and armature that the contacts close.

To close Reed Switch contacts, two approaches are generally used. 1. The use of a permanent magnet (see Figure #3);



*(Figure #3. The basic operation of a Reed Switch under the influence of the magnetic field of a permanent magnet. The polarization of the reed blades occurs in such a manner to offer an attractive force at the reed contacts.)*

or 2. The use of a coil wound with copper insulated wire (see Figure #4).



*(Figure #4. A Reed Switch sitting in a solenoid where the magnetic field is strongest in its center. Here the reed blades become polarized and an attractive force exists across the contacts.)*

When a permanent magnet, as shown, is brought into the proximity of a Reed Switch the individual reeds become magnetized with the attractive magnetic polarity as shown. When the external magnetic field becomes strong enough the magnetic force of attraction closes the blades. The reed blades are annealed and processed to remove any magnetic retentivity. When the magnetic field is withdrawn the magnetic field on the reed blades also dissipates. If any residual magnetism existed on the reed blades, the Reed Switch characteristics would be altered. Proper processing and proper annealing clearly are important steps in their manufacturing.