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:: Reed Relays Set a Standard for Insulation Measurement ::

Reed Relay technology offers outstanding qualities for isolation measurement thanks to its high dielectric strength and negligible leakage currents in the open state - By David Stastny, Standex-Meder Electronics

High, consistent and reliable isolation properties are crucial for the precise functionality and safety of a diverse array of modern and complex electric applications, such as Electric Vehicles, Solar Panels, Medical, and Test & Measurement. Furthermore, these are vital when two different electric networks need to be interconnected and isolated. For safety reasons, the isolation voltage needs to be in some cases even three or four times higher than the actual nominal voltage of the monitored circuit. One example is Battery Management Systems (BMS) in E-Cars.

Reed Relay technology offers outstanding capabilities for this kind of isolation measurement thanks to its high dielectric strength and negligible leakage currents in the open state.

E-Vehicle

Reed relays are ideal in battery isolation systems, power inverters, and battery conditioning applications

As the utilization of rechargeable batteries in E-cars and Photovoltaic systems is increasingly present, there is also a higher demand on the electric storage capacity, power, long life, and safety of the accumulators. The present day trends of E-mobility are in connecting single accumulators of 6–24 VDC and stacking them into battery arrays that can ensure up to 200–800 VDC system voltage and provide enough capacity and power while lowering the needed electrical currents. Such high voltage and current levels need to be accurately monitored by the BMS units, not only to maximize the battery efficiency, but also to ensure the user's safety and system reliability. For this purpose, among other parameters like voltage, current or temperature, the isolation and leakage currents of the battery array, in relation to electronic systems circuits and vehicle chassis, must be regularly monitored in order to prevent any malfunction and safety risk.

Solar Panel System

Transformer-less invertors

There are also other applications operating with higher voltages that require a higher isolation as well. For example, solar power plants. Currently, there are transformer-less inverters commonly used in a photovoltaic grid, to transform a direct current into alternating current, in order to transfer power into the national electrical grid. These DC and AC circuits are interconnected through the inverters and must function reliably with applied voltages of up to 1500 VDC. Due to the missing internal transformer, there is not a safe galvanic isolation between the DC and AC circuits, necessitating a regular insulation measurement similar to the case of E-Car battery systems. Improper insulation would lead not only to current leakage and an energy loss, but would also pose a serious threat in terms of safety.

In comparison to other relay technologies with a similar size, used in **isolation measurement**, the reed relays are capable of switching voltage levels from zero up to 400–1000 VDC, while providing not only a high **dielectric strength** between the coil and contact, but also high breakdown voltage across the open switch. This exceptional voltage isolation comes together with a very **high insulation resistance** ensuring very low leakage currents in the range of picoamperes.

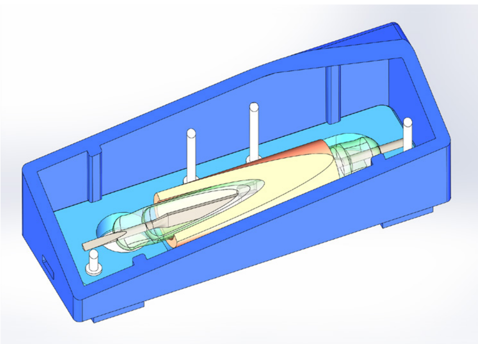
Reed relay description

The features mentioned, can be accomplished thanks to the nature of the reed switch as well as by the design and material composition of the reed relay itself.

Reed Switch

The standard reed switch is composed of two soft magnetic metal alloy contacts that are called reed blades. The reed blades are placed in a glass body that is hermetically sealed and either filled with an inert gas or evacuated to create a vacuum. This arrangement perfectly protects the contacts from corrosion or any subjected external environmental factors like water, humidity, oil, grease, etc. In addition, especially in the case of a vacuum, the inner environment functions as a high quality insulator between the reed blades in the open state, while having an ideal, low contact resistance in milliohms when closed. Not only does this provide the open reed switch with a great voltage isolation from 500 VDC up to 15 kVDC, but the off-state contact resistance is also very high, as it scales up to 1–100 TOhm. This is a significant advantage in comparison to, for example, semiconductor based switching components such as solid state relays or Photo-MOS.

To build a relay, the reed switch is inserted into a copper coil, which when conducting current, creates a magnetic field that activates the magnetically conductive blades of the switch. The coil is ideally wound into the shape of a solenoid in order to concentrate the magnetic flux into its middle point where the contact areas of reed blades overlap each other. This kind of positioning provides the most effective use of the magnetic flux generated by the current flowing through the coil, allowing a low power consumption, usually in the range of tens or hundreds of milliwats depending on the coil dimensions. There is no coil power needed for the off-state of the normally open (N.O.) reed relay.



3-D Model of an Open Reed Relay

The assembly of the reed switch and coil is then encapsulated into a housing to ensure mechanical stability and resistance against shock, temperature, stress, and other external influences. Based on what parameters are required to be reinforced, the encapsulation is usually made by using a potting resin such as polyurethane or it is overmolded with epoxy. For instance, the potted style is suitable for more complicated internal assemblies with multiplied switches or for larger, high voltage relays where a lot of surrounding protective material is needed. On the other hand, rugged overmolded relays offer a robust and compact housing suitable for harsh environments or for production processes such as reflow soldering.

Last but not least, what determines the final relay features and parameters is the overall shape, exterior dimension and pin layout that can enhance the insulating properties by increasing the creepage and clearance distances. The ongoing trend of miniaturization usually contradicts the large size and considerable clearance needed for an insulation of high voltage in the levels of a thousand volts. The expertise in building a good switching component then lies in finding a balance between the mentioned contradictory requirements such as the small size, low weight, shock resistance, high isolation and switching voltage, low consumption, and other parameters needed for example in the BMS or Medical applications.

KT relay

One of the better examples of such a balanced design is the KT series Reed Relay, which is capable of switching 1 kVDC while having a **breakdown voltage** up to 4.5 kVDC and **dielectric strength** between coil and contact of 7 kVDC. After winding, the assembly of the coil and reed switch is then over-molded in a compact and yet robust housing with external dimensions of approx. 30 x 11 x 9 mm. The unique pin layout ensures satisfactory **creepage distance** of over 17 mm and an **air clearance** of 12 mm. This layout is particularly helpful in Automotive, Solar or Medical applications where the international safety standards are regulated, for example IEC 60664-1, IEC 60255-27, IEC 62109-1/2 or IEC 60601-1.

KT Series Reed Relay

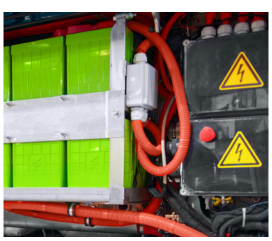
Reed Relays in general are well known for their fast switching time in the range of hundreds of microseconds and long life-time capability that surpasses electromechanical relays. However, this feature, as for every mechanical switch, will always be affected by the switching load. When designing an electric circuit with a reed relay, the switching voltage and current has to be taken into consideration, in order to prevent an overload arcing that can harm the contact area of the switch.

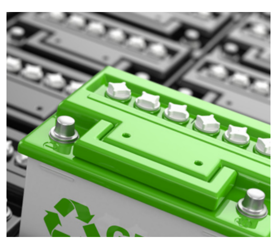
As an example, with a “cold switching” without load or with a low load of 5V at 1mA the Reed Relay will reach up to billions (10^9) of switching cycles.

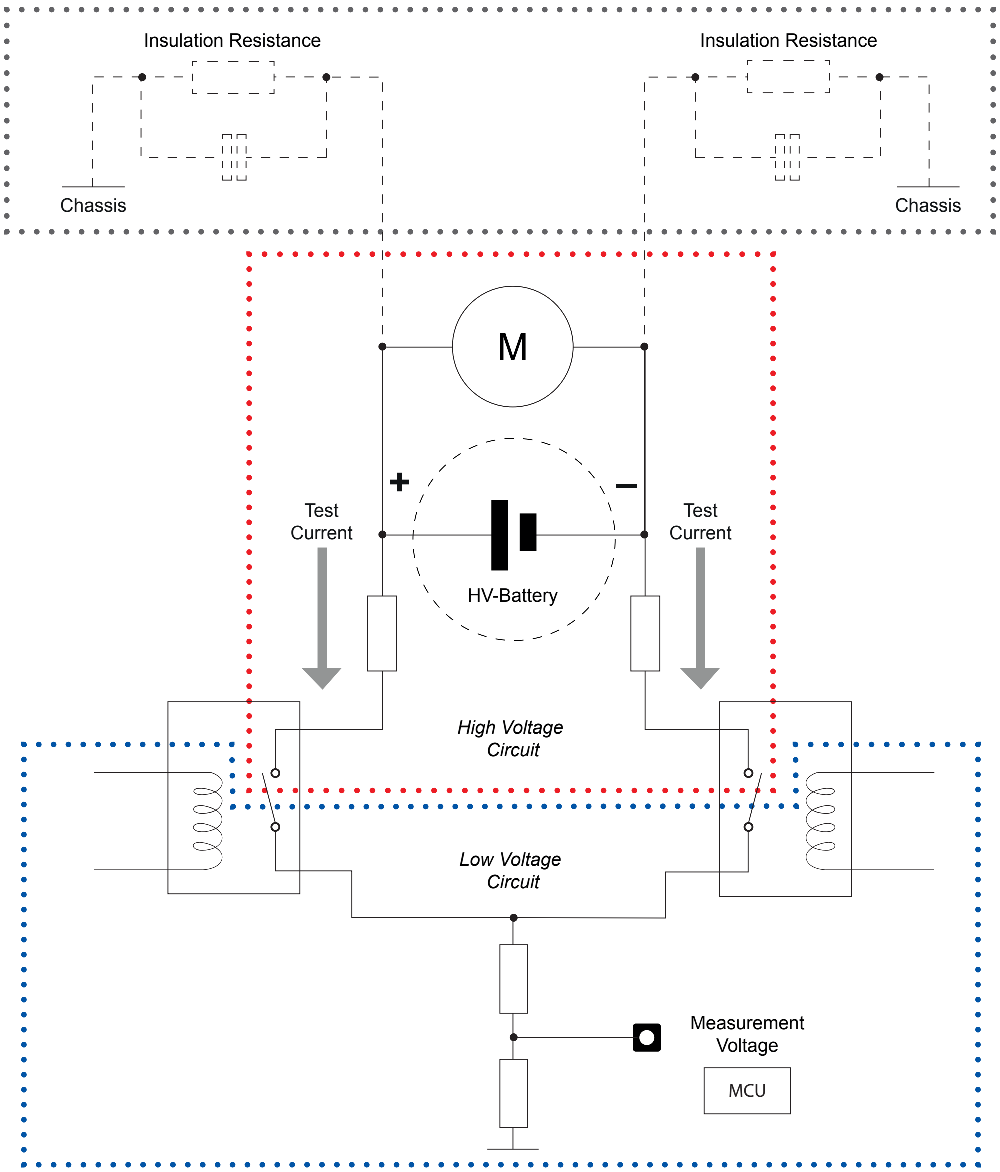
When working with a higher voltage level (e.g. 800–1000 VDC), the life time in the range of several millions of switching cycles can be expected. The total number of switching cycles is, in general, determined by the combination of switching voltage and current, together with other factors, such as temperature or even a presence of a coil suppressing diode.

The KT relay can operate in ambient temperatures from -40°C ~ +105°C and its internal temperature can safely reach up to 125°C.

In order to fulfill these high standards, the part was listed under the internationally recognized Flammability Test UL94 (Underwriters Laboratories Inc.®). Furthermore, to prove the reliability and durability of the relay against vibration, shock, humidity and temperature, it was successfully tested in accordance with the AEC-Q200 standard. This set of norms was created by the Automotive Electronics Council, which consists of key automotive manufacturers, and is being internationally adopted by the automotive industry as a quality standard that verifies and simplifies the process of product acceptance and implementation.





KT in BMS Schematic

Example of Relay applications in BMS

The application of the relay in Battery Management Systems (BMS) can take various forms, which reflect the developer's needs. In general, however, the relay is connected in the path between the battery and ground and used as a separation to isolate the high voltage circuit of the battery from low voltage circuit of the measurement microcontroller unit. When contacts are open, the high breakdown voltage provides a perfect isolation between these two circuits so that they don't interfere with one another.

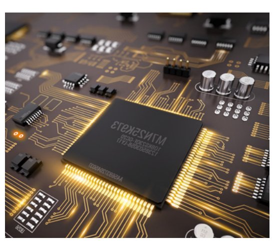
When the relay becomes activated, the closed contacts are used by the system to measure a sample current from one or both battery poles. This sample is then compared by the MCU with a referential voltage level. Based on the result, the system can evaluate the state of the battery. As the relay contact resistance is very low, in the range of tens of milliohms, it doesn't influence the measurement results.

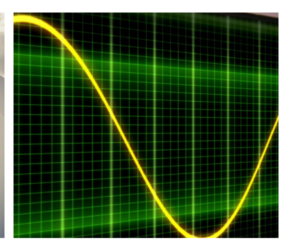
This comparison measurement can take place from tens of thousand to several millions of times, depending on the design and system requirements.

Summary

Whether E-Car, Photovoltaic, Medical or Test environment, all applications put high demands on the relay in terms of reliability, safety and fulfilling of the norms. Reed Relays are precise switching components that combine reliability, fast switching times, and longevity with great electrical and mechanical isolation characteristics. When properly designed-in, these features ensure that the reed relay will stand up to the high requirements of modern electric devices very well.





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