



Using a High-Voltage Reed Relay for a Pulsed-Field Ablation (PFA) System

Atrial fibrillation is one of the most common cardiac arrhythmias, causing irregular and rapid heartbeats. One common treatment for this condition is “catheter ablation” – a surgical procedure where doctors insert a catheter



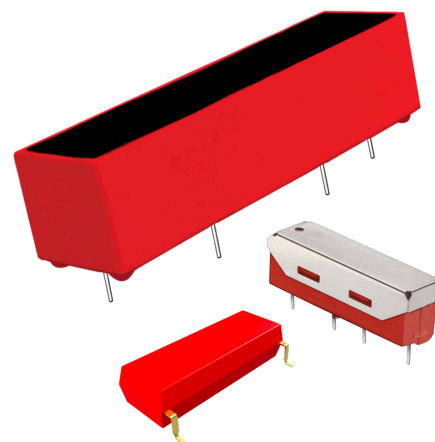
through a blood vessel and into the heart to deliver minimal energy. The released energy damages small selective areas of cardiac tissue, causing them to lose their ability to generate

currents, thus blocking abnormal electrical impulses. Three different energy techniques used are radiofrequency ablation (heat), cryoablation (cold), and pulsed-field ablation (electroporation). The first two methods (radiofrequency ablation and cryoablation) have limitations which can sometimes result in discontinuous lesions and nontargeted tissue injury.

A more precise method – Pulsed-Field Ablation (PFA) – employs a pulse generator to deliver high-voltage electrical pulses in microseconds or nanoseconds through an electrode array on the catheter to stimulate the cell membrane and cause irreversible electroporation. Depending on the depth of the lesions, the applied voltage could be up to 3 kV. In some cases, there may be more than one hundred electrodes on each catheter to enhance ablation efficiency. A high-speed, relay-based matrix system is used to switch the electrode array on/off and deliver voltage to specific electrodes. Once the energy is delivered, the relay matrix can quickly reconnect electrodes for a diagnostic measurement.

There are many different types of relays available today - including reed relays, solid-state relays, and electromechanical relays. However, due to its sealed contact system, high speed, and ability to sustain high-voltage pulses, reed relays are the best type of relay for pulsed-field ablation.

The 5500 series reed relay from Coto Technology is a high-voltage reed relay able to switch signals up to 7500V. The relay’s blade contacts are coated with Tungsten, which is ideal for high voltage switching. These switch blades are in a vacuum-sealed glass tube, encapsulated with epoxy to prevent arcing and mechanical damage. Unlike the standard electromechanical relay, a reed relay switches faster in milliseconds and has a longer lifetime – typically greater than hundreds of millions of times. All of these features make the 5500 series reed relay an ideal candidate for pulsed-field ablation applications. Coto Technology has its own custom engineered test system which is used to conduct parametric tests on 100% of its manufactured product. Coto believes that testing its parts is the only way to guarantee quality, which is most important for successful medical applications.



Coto Technology’s 5500, 9104 and 9105 reed relays are ideal for use with pulsed-field ablation systems. (Note: photos not to scale.)

While using reed relays in a matrix, magnetic interaction is an important factor to keep in mind. Reed relays are

subject to external magnetic effects which may change performance characteristics. One common source of an external magnetic field acting on a relay is another relay operating in close proximity. Therefore, it is helpful to orient adjacent reed relays in the proper direction in order to cancel out any external magnetic influence and ensure all reed relays operate appropriately. For minimizing magnetic interaction in a reed relay matrix, Coto recommends alternating the coil polarity in adjacent relay pairs as shown in Figure 1 below. This is especially helpful for minimizing magnetic interactions in the center of the matrix.

Coto Technology's 940X series reed relay has a dielectric strength up to 300V between contacts. With appropriate layout orientation, the 940X series is an ideal solution for high density switching matrix of electrophysiology measurement unit due to its small footprint. On the other hand, 910X series comes with a magnetic shield to prevent interaction between adjacent relays; furthermore, it provides a dielectric strength ranging from 2kV to 4kV – which could be also used as isolation protection.

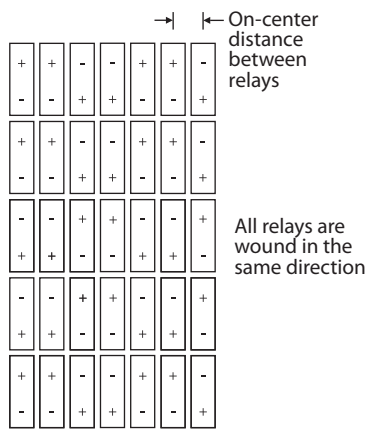


Figure 1: It is helpful to orient adjacent reed relays in the proper direction in order to cancel out any external magnetic influence and ensure all reed relays will operate appropriately.

Figure 2 shows an example of a reed relay-based matrix used to control an electrode array in a PFA application. The number of relays used for each of these functions can vary and will be dependent on any specific system design requirements. In the drawing, relays K_{P1} - K_{Pn} (e.g., Coto 5500 series High Voltage relays) are used to connect the High Voltage Pulse Generator to the electrode array. Relays K_{M1} - K_{Mn} (e.g., Coto 910X and/or 940X series with small footprint) are used to connect the Electrophysiology Measurement System to the electrode array to take readings of the patient's cardiac signals.

Coto Technology also provides custom lead terminations and packages to fulfill requirements of different designs. For more information, including how Coto Technology's applications support can help with your design efforts, please contact Coto engineering at www.cotorelay.com.

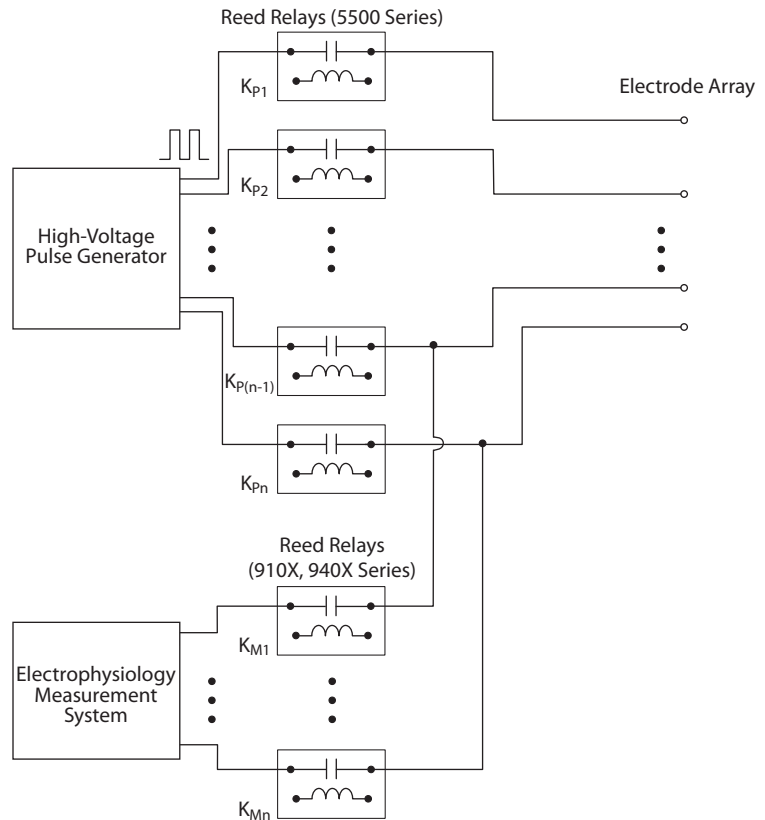


Figure 2: Example of a relay-based matrix system used to control the electrode array in a PFA application.