pickering

Application Guide

Utilizing Reed Relays for Medical Equipment

Discover how defibrillators, electrosurgical generators and a variety of medical analysis/monitoring equipment can all benefit from high-reliability reed relays.

In this application guide:

- Medical Applications
- Switching Technologies
- Reed Relay Terminology
- Recommended Products
- Why Pickering Electronics for Reed Relays?

50 years 1968 - 2018

Medical Equipment

Many types of medical equipment can benefit from the use of reed relays. Most standard relays can be used to switch signals and low voltages in non-safety-critical analysis and monitoring equipment, and high-voltage reed relays are suitable for switching high voltages (of up to 12kV, for Pickering devices) in high-energy scanners.

High-voltage reed relays are also used in defibrillators. For example, in a basic monophasic defibrillator (figure 1 shows a simplified diagram), the job of the reed relay is to complete a circuit that charges a capacitor. When the capacitor is fully charged, the reed relay effectively removes it from the charge circuit for inclusion in the discharge circuit - which is made complete by the placement of the paddles on the patient's chest and the depression of paddles' switches. Biphasic defibrillators are a little more complex, but the principle of operation (and the reed relay's role) remains the same.

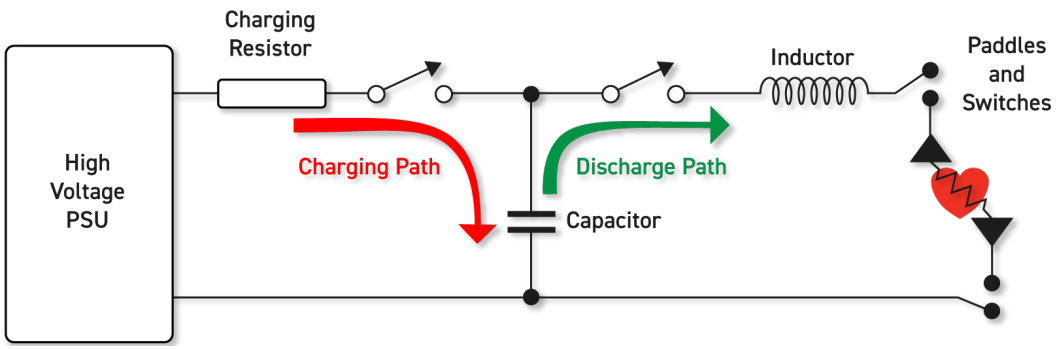


Figure 1 – Above, a basic circuit diagram of a monophasic defibrillator.

High-voltage reed relays can also be used to establish a safe and reliable connection between low- and high-voltage circuits in, for instance, x-ray machines that have a low-voltage circuit for control purposes (and exposure timing) and a high-voltage circuit to accelerate electrons within the tube. Similarly, computerized tomography (CT – which uses x-rays) and magnetic resonance imaging (MRI) scanners incorporate both low- and high-voltage circuits, with the latter sometimes exceeding 100kV.

Furthermore, high-voltage reed relays can be used in electrosurgical generators for electronic scalpels, which require the switching of high voltages at high frequencies, circa 1MHz, to perform cutting and cauterizing simultaneously.

Within many of the above examples, not only is the ability to switch potentially high-voltages important, but so is high-isolation resistance (between the low- and high-voltage circuits).

However, not all reed relays used in medical equipment necessitate high-voltage capabilities. They may though require other properties not found in standard devices. For example, reed relays that have been designed specifically for data acquisition and instrumentation applications are ideal for use in medical monitoring and controlled treatment applications.

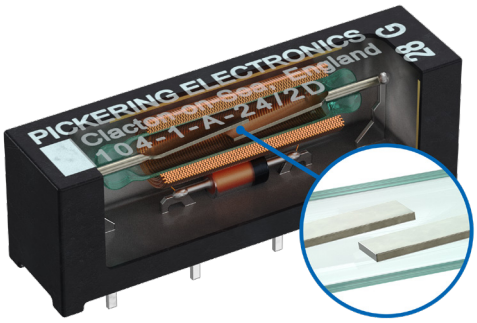
Additionally, reed relays with higher than usual coil resistance are suitable for battery powered / portable medical equipment - as the current draw will be lower than if a standard device were to be used.

In all the above-mentioned applications, ensuring high reliability is essential. The reed relay must operate when required and, if switching a high voltage, it must be fail-safe in case there is a fault in the (lower voltage) control circuitry, for example. In addition, reed relays are used extensively in automatic test equipment (ATE) employed for quality assurance during the manufacture of medical equipment.

Reed Relay Terminology

When choosing a reed relay for a medical application, the following are the most crucial factors to consider:

- **Maximum Switching Voltage.** The highest DC or AC (peak) voltage that can be switched.
- **Minimum Standoff Voltage.** The minimum DC or AC (peak) voltage that can be applied across the open contacts before breakdown occurs. For high-voltage applications, the higher the minimum standoff voltage the better, as it improves safety and reliability.
- **Maximum Switching Current.**The maximum current the contacts can switch within the constraints of the contact power rating. Note: be mindful of switching (on) to highly capacitive loads and when removing power from highly inductive loads.
- **Maximum Carry Current.** The highest continuous current the device can pass through its closed contacts.
- **Coil Voltage.** The nominal DC operating voltage of the relay coil.
- **Coil Resistance.** The nominal resistance of the operating coil, usually specified at 25°C.
- **Insulation Resistance.** This is the resistance between any of the device pins. This needs to be very high (ideally greater than 1TΩ (Tera Ohms, so 1 x 10^{12} Ohms) if you are to keep current leakage to a minimum.
- **External Shield Clearance.** Some devices (typically low-cost) have an external metal shield to protect against EM interference from neighboring relays. If the screen extends to the relay base, or is too close to the base, this can cause problems when placed on a PCB carrying high voltages. However, the clearance might not even be stated on the datasheet, and you may need to refer to technical drawings or measure the clearance on a sample device. Note: the relays we recommend below all have internal shielding in the form of mu-metal screens around their coils.

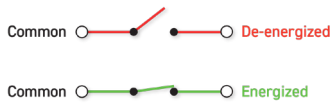
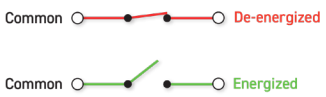
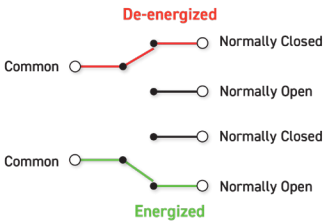


For high-voltage reed relays, the contact is sealed in a vacuum, greatly increasing the minimum standoff and maximum switching voltages. Insulation resistance is high thanks to pin spacing and the relay's base material. As for external shield clearance, this is not an issue when the EM shielding is on the inside of the device.

By considering these key factors, you can make a well-informed decision when selecting the appropriate reed relay for your medical application. Other information you will need to consider when designing your medical equipment includes contact configuration and service life.

Reed Relay Terminology

Contact Configuration (Forms)

Form A	Form B	Form C
		
With the coil de-energized the switch is normally open (NO). If just one switch is present, the form is 1A, meaning single pole single throw normally open (SPST-NO). If two switches are present, the form is 2A, meaning double pole single throw normally open (DPST-NO). With three switches it is 3A (3PST-NO).	With the coil de-energized the switch is normally closed (NC). If just one switch is present, the form is 1B, meaning single pole single throw normally closed (SPST-NC). If two switches are present, the form is 2B, meaning double pole single throw normally closed (DPST-NC). With three switches it is 3B (3PST-NC).	These are changeover devices that break their NC contact (and close the NO one) when the coil is energized. If just one switch is present, the form is 1C, meaning single pole, double throw (SPDT). If two switches are present, the form is 2C DPDT. With three switches it is 3C.

What's the Service Life?

This is the one figure on any datasheet, from any manufacturer, that is open to interpretation. We state 1 x 10^9 operations for most applications, but the fact of the matter is the figure could be higher or lower depending on the exact application. Considerations are: How close to voltage and current limits are you operating? What is the switching duty cycle? Are you likely to see inrush currents?

Also, at what point do you consider the device to be failing? When contact resistance increases by 10%? 20%? More?

Rest Assured, We're Here to Help

Tell us about your application and we'll not only recommend the most suitable device, but we'll also give you an indication of the device's realistic service life.

RECOMMENDATIONS

Pickering Electronics has an extensive range of high-performance reed relays that are ideally suited to medical applications. Furthermore, with device footprints starting at just 46mm2, many relays can be accommodated on a single PCB.

HIGH VOLTAGE REED RELAYS (STANDARD SIZE)

The following are suitable for use in defibrillators and the control circuitry of electrosurgical equipment.

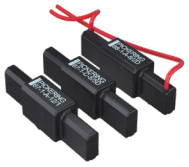
Series 60 & 65

This range has switching voltages up to **12.5kV** and minimum standoff voltages up to **15kV**.
The maximum switch current is **3A** (at **50W**) and the maximum carry current is up to **3.5A**.
Body dimensions (W x H x D): 57.9 x 18.0 x 16.0mm.
Available configurations:
1 Form A, 1 Form B

Series 62 & 63

This range has switching voltages up to **12.5kV** and minimum standoff voltages up to **15kV**.
The maximum switch current is **3A** (at **50W**) and the maximum carry current is up to **3.5A**.
Body dimensions (W x H x D): 63.5 x 29.7 x 19.0mm.
Available configurations:
1 Form A, 1 Form B

Series 67 & 68



This range has switching voltages up to **7.5kV** and minimum standoff voltages up to **10kV**.
The maximum switch current is **3A** (up to **50W**) and the maximum carry current is up to **5A**.
Body dimensions (W x H x D): 58.4 x 19.0 x 12.6mm.
Available configurations:
1 Form A, 1 Form C

HIGH VOLTAGE REED RELAYS (MINIATURE)

The following devices are suitable for applications where high-voltage signals need to be switched or isolated for safety reasons. Applications include medical diagnostic, monitoring and spectroscopy equipment.

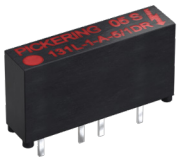
Series 100HV

This range has the same specifications as the Series 104 but with more than twice the coil resistance (up to **6.8kΩ**) and is ideal for low power consumption applications.
Thermal EMF levels are between **3** and **10µV**.
Body dimensions (W x H x D): 24.1 x 12.7 x 10.2mm.
Available configurations:
1 Form A, 2 Form A, 1 Form B

Series 104

This range has switching voltages up to **1kV** and minimum standoff voltages up to **4kV**.
The maximum switch current is **1A** (up to **25W**) and the maximum carry current is **1.5A**.
Body dimensions (W x H x D): 24.1 x 8.1 x 6.2mm.
Available configurations:
1 Form A, 2 Form A, 1 Form B

HIGH VOLTAGE REED RELAYS (MINIATURE) CONTINUED

Series 119	Series 131
	
This range has switching voltages up to **1kV** and minimum standoff voltages up to **3kV**. The maximum switch current is **0.7A** (up to **10W**) and the maximum carry current is **1.25A**. Body dimensions (W x H x D): 15.1 x 6.6 x 3.7mm. Available configurations: 1 Form A, 2 Form A, 1 Form B	This range has switching voltages up to **1kV** and minimum standoff voltages up to **1.5kV**. The maximum switch current is **0.7A** (up to **10W**) and the maximum carry current is **1.25A**. Body dimensions (W x H x D): 12.5 x 6.6 x 3.7mm. Available configurations: 1 Form A

DATA ACQUISITION & INSTRUMENTATION REED RELAYS

The following devices are ideal for general signals and lower voltage switching in medical sensors and monitoring equipment.

Series 107	Series 109	Series 113
		
This range has a maximum switch current of **1A** (up to **20W**), and the maximum carry current is **1.2A**. They feature superb contact resistance stability and ultra-high insulation resistance. Body dimensions (W x H x D): 19.1 x 7.6 x 4.8mm. Available configurations: 1 Form A, 2 Form A, 1 Form B, 1 Form C, and 2 Form C	This range has a maximum switch current of **1A** (up to **20W**), and the maximum carry current is **1.2A**. Coaxial **50** or **75Ω** impedance configurations are suitable for up to **2GHz**. Body dimensions (W x H x D): 15.1 x 6.6 x 3.7mm. Available configurations: 1 Form A Coax, 2 Form A, 1 Form B, and 1 Form C	This range has a maximum switch current of **0.5A** (up to **10W**), and the maximum carry current is **0.5A**. The range includes Form A and Form C configurations, as well as Form A coaxial for up to **3GHz**. Body dimensions (W x H x D): 12.5 x 6.6 x 3.7mm. Available configurations: 1 Form A, 2 Form A, 1 Form A Coax, and 1 Form C

LOW COIL POWER REED RELAYS

These devices have higher than usual coil resistance, greatly reducing the power required to operate them - making them the ideal for use in portable medical equipment. A range of switching options is available including excellent low-level performance and, where important, reducing the influence of thermal EMFs.

Series 100

This range has a maximum switch current of **1A** (up to **20W**), and the maximum carry current is **1.2A**. Devices feature low thermal EMF (around **1µV** or less) and low power consumption, ideal for portable equipment.
Body dimensions (W x H x D): 24.1 x 12.7 x 10.2mm.
Available configurations:
1 Form A, 2 Form A, 1 Form B, and 1 Form C

Series 101

This range has a maximum switch current of **1A** (up to **20W**), and the maximum carry current is **1.2A**. Featuring high coil resistances (up to **6kΩ**), devices can be driven directly from **74HC** or **74HCT** logic (up to **4mA** at **5V**).
Body dimensions (W x H x D): 20.1 x 9.4 x 7.4mm.
Available configurations:
1 Form A, 2 Form A, 1 Form B, and 1 Form C

Series 118

This range has a maximum switch current of **1A** (up to **15W**), and the maximum carry current is **1.2A**. Featuring coil resistance up to **2.2kΩ**, devices are ideal for portable instruments or low-power applications where a small footprint is important.
Body dimensions (W x H x D): 8.13 x 15.24 x 4.8mm
Available configurations:
1 Form A

MINIATURE HIGH DENSITY REED RELAYS

The following devices all offer the traditional advantages of reed switches in very small packages, thus making them ideal for use in medical test equipment and other applications in which space is restricted.

Series 115

This range has a maximum switch current of **1A** (up to **20W**) and the maximum carry current is **1.2A**. The range includes SPST and DPST configurations, both of which have sputtered ruthenium contacts for long life and high reliability.
Body dimensions (W x H x D): 6.6 x 15.5 x 3.7mm.
Available configurations:
1 Form A, and 2 Form A

Series 116

This range has a maximum switch current of **0.5A** (up to **10W**) and the maximum carry current is **0.5A**. Instrumentation grade switches with sputtered ruthenium contacts make them ideal for low-level or 'cold switching' applications.
Body dimensions (W x H x D): 6.6 x 12.4 x 3.7mm.
Available configurations:
1 Form A, and 2 Form A

Series 117

This range has a maximum switch current of **0.5A** (up to **10W**) and the maximum carry current is **0.5A**.
The range includes SPST and DPST configurations. Internal mu-metal screen allows for side-by-side stacking without magnetic interaction.
Body dimensions (W x H x D): 6.6 x 9.5 x 3.7mm.
Available configurations:
1 Form A, and 2 Form A

Recommended Products

ULTRA MINIATURE HIGH DENSITY REED RELAYS		
Series 120	**Series 122**	**Series 124**
		
This range has a maximum switch current of **1A** (up to **20W**), and the maximum carry current is **1.2A**. Devices are of the Form A SPST configuration with **3**, **5** or **12V** coils. They are ideal for very high-density applications such as A.T.E. Body dimensions (W x H x D): 3.9 x 15.5 x 3.9mm. Available forms: 1 Form A contact configuration	This range has a maximum switch current of **0.5A** (up to **10W**), and the maximum carry current is **0.5A**. Fast operate and release times (typically **150µs** or less) make these relays ideal for high-speed test systems. Body dimensions (W x H x D): 3.9 x 12.5 x 3.9mm. Available forms: 1 Form A contact configuration	This range has a maximum switch current of **0.5A** (up to **10W**), and the maximum carry current is **0.5A**. Fast operate and release times (typically **80µs** or less) make these relays suitable for high-speed test systems. Body dimensions (W x H x D): 3.9 x 9.5 x 3.9mm. Available forms: 1 Form A contact configuration

Why Pickering Electronics for Reed Relays?

- ✓ We've been making reed relays since 1968. It's our core business and has laid the foundation for the switching-based solutions of our sister company **Pickering Interfaces**.
- ✓ The relays recommended in this guide are all instrumentation grade and the reed contacts will be plated with either Rhodium (electro-plated), Ruthenium (vacuum spluttered), or Tungsten to **ensure a long life** – typically up to **$5x10^9$ operations**.
- ✓ They are of a **formerless coil construction**, which increases the coil winding volume, maximizes the magnetic efficiency, and allows for the use of less sensitive reed switches, resulting in optimal switching action and **extended lifetime** at operational extremes.
- ✓ Internal mu-metal magnetic screening enables **ultra-high PCB side-by-side packing densities** with minimal magnetic interaction, **saving significant cost and space**. Our magnetic screen reduces EM interaction to approximately 5%. Low quality relays typically exhibit an EM interaction of 30%.
- ✓ ***SoftCenter*™** technology provides maximum cushioned protection of the reed switch, minimizing internal lifetime stresses and **extending the working life and contact stability**.
- ✓ Inspection at every stage of manufacturing **maintains high levels of quality**. Also, **100% testing** for all operating parameters including dynamic contact wave-shape analysis with full data scrutiny to maintain consistency. Stress testing of the manufacturing processes, from -20°C to +85°C to -20°C, repeated 3 times.

While we have recommended a variety of our standard relays, each with performance characteristics and properties that make them ideal for specific medical equipment applications, we have over a thousand catalogue parts; so, there are plenty to choose from. However, if you cannot find a product that meets your exact requirements, we offer a **full customization service**.

The 67, 68, 104, 119 and 131 series already boast high switching voltages, high standoff voltages and high insulation resistances, but these can all be increased in a custom design.

We have a well-proven development lifecycle of: agree requirements, design, manufacture, test, approve, and deliver. And if your custom design is based on one of our existing products (which is likely to be the case) you can expect to receive samples in as few as two weeks.

For further information, contact our technical sales team at **techsales@pickeringrelay.com** or visit pickeringrelay.com/custom-reed-relays

About Pickering Electronics

Pickering Electronics was established over 50 years ago to design and manufacture high quality reed relays, intended principally for use in instrumentation and test equipment. Today, Pickering's Single-in-Line (SIL/SIP) range is by far the most developed in the relay industry, with devices 25% the size of our competitors' electrically equivalent devices. These small SIL/SIP reed relays are sold in high volumes to large ATE and semiconductor companies throughout the world.

The privately-owned Pickering Group comprises three electronics manufacturers: reed relay company Pickering Electronics; Pickering Interfaces, designers and manufacturers of modular signal switching and simulation products, and Pickering Connect, which designs and manufactures cables and connectors. The group employs over 500 people primarily in the UK and Czech Republic with additional employees in sales offices in the US, China, Germany, Sweden, and France.

Technical Help

Please go to: **pickeringrelay.com/help**.
If your questions are not answered here, please e-mail: **techsales@pickeringrelay.com**.
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REACH COMPLIANT

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Product 25+Years Longevity

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