Application Guide

Mining

Reed Relays: The Logical Choice for Power & Signal Switching in Mining Applications

pickering

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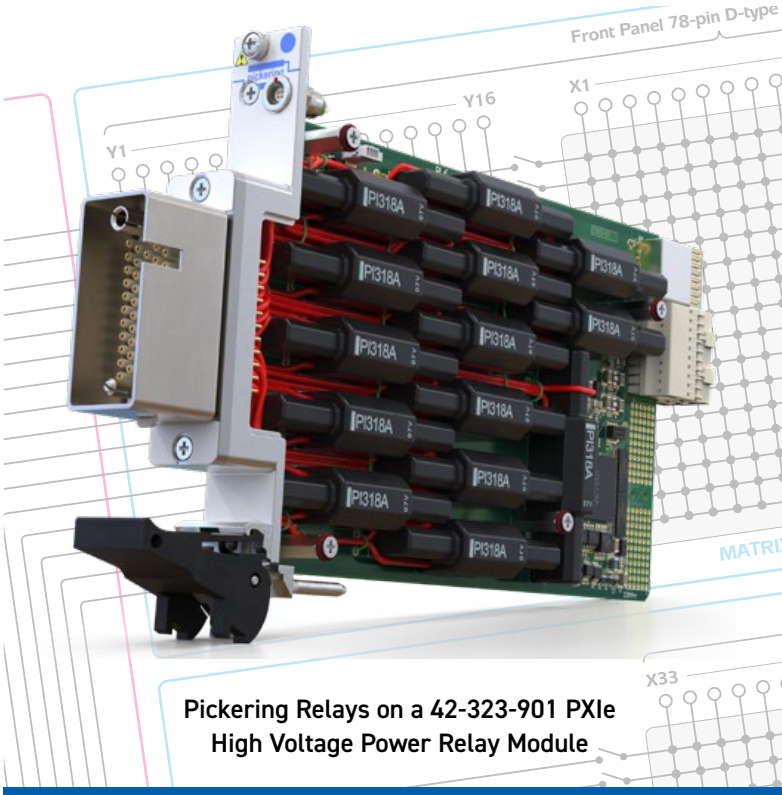
Mining Applications

Electricity is used extensively in mining operations and must be safely distributed, monitored and managed properly to ensure mining equipment and safety systems have a reliable power source. Also, as in other industries, increasingly higher voltages are being used to reduce power losses. In this application guide we explain why reed relays are the ideal switching solution for use in mining equipment.

Greater Electrification

Within subterranean mines, electricity is used to power conveyor belts, comminution machinery, ventilation systems, water pumps, and lighting. However, the industry is seeing greater electrification, and many types of equipment (such as drills and shovels) are switching from pneumatic to electrical power.

Moreover, in order to reduce power losses and by extension operating costs, increasingly higher voltages are being employed within mining equipment/machinery and throughout the mine's power distribution system. For example, in the US, equipment and cable manufacturers are moving from 480 to 995 VAC: deliberately falling short of 1 kVAC to avoid expensive design and compliance changes. Popular high voltages used elsewhere include 1 kVAC in Europe and 1.1 kVAC in Australia.



Pickering Relays on a 42-323-901 PXIe High Voltage Power Relay Module

Reed relays are ideal for use in high or low voltage switching and sensing mining applications, providing fast, low power performance with minimal EMI.

Applications: Power

High-voltage (HV) reed relays can be used in the monitoring, control and safety/protection circuitry of variety of mining equipment, including:

- Power distribution units (PDUs), as used to switch or isolate high-voltage power lines within underground or surface distribution networks. These can span a wide range of operating voltage from sub 1 kVAC to a few tens of KVAC.
- Underground load centers and switchgear. Primary (input) voltages can range from 4 kVAC to more than 20 kVAC, and secondary (output) voltages can range from a few hundreds of Volts to 3.3 kVAC.
- Electric drills and rock cutters. For example, most high-power drills typically operate from between 3.3 and 10 kVAC, and even 'lower-voltage' mining drills will require circa 1 kVAC.
- Conveyor, pumping and ventilation systems, where the reed relays are used in circuits to monitor for and protect against overcurrent and overvoltage conditions.

There are also uses for HV reed relays in underground charging stations for battery-powered mining vehicles and equipment: in which the voltage is DC rather than AC. Specifically, the HV reed relays can be used in voltage and current monitoring circuitry and to provide isolation.

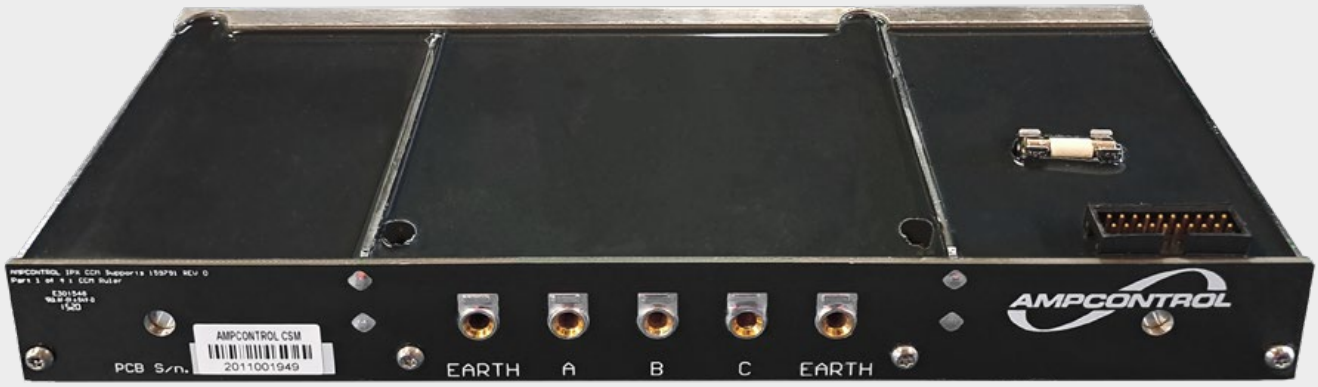
Applications: Sensing

In modern mining operations, sensor-based systems are widely used to improve safety, efficiency, and ore recovery. For example, sensor-based ore sorting (SBOS) uses various sensors to determine the properties of extracted rocks as they travel along conveyors.

The predictive maintenance of machinery through condition monitoring is also heavily reliant on sensors - for temperature, pressure, load, torque and vibration levels, for example – and environmental monitoring is performed using air and water quality sensors.

Underground safety is assured through the use of gas and smoke detectors, air flow / ventilation sensors, RFID personnel tracking systems and strain and roof bolt sensors. Geotechnical and ground stability monitoring systems also aid safety, through reducing the risk of roof collapses and other seismic hazards: sensor types include inclinometers, piezometers, and micro seismic sensors.

Reed relays can be used in the circuitry of many of the above sensor-based systems to switch signals.



Case Study: Ampcontrol Uses Pickering Electronics Custom Built Reed Relays to Provide its Electrical Power Protection Units with Enhanced Reliability

With the core functionality of its electrical power protection units intended for use in mines largely reliant on the functionality of two high voltage relays, Ampcontrol decided to switch to devices designed, built and tested by Pickering Electronics specifically for the task. Read the case study here.

Hermetically Sealed

In terms of what gives a reed relay a competitive advantage over (say) an electromechanical relay (EMR), much is down to the fact that the reed switch contacts are in a hermetically sealed tube that is either filled with an inert gas or at near-vacuum.

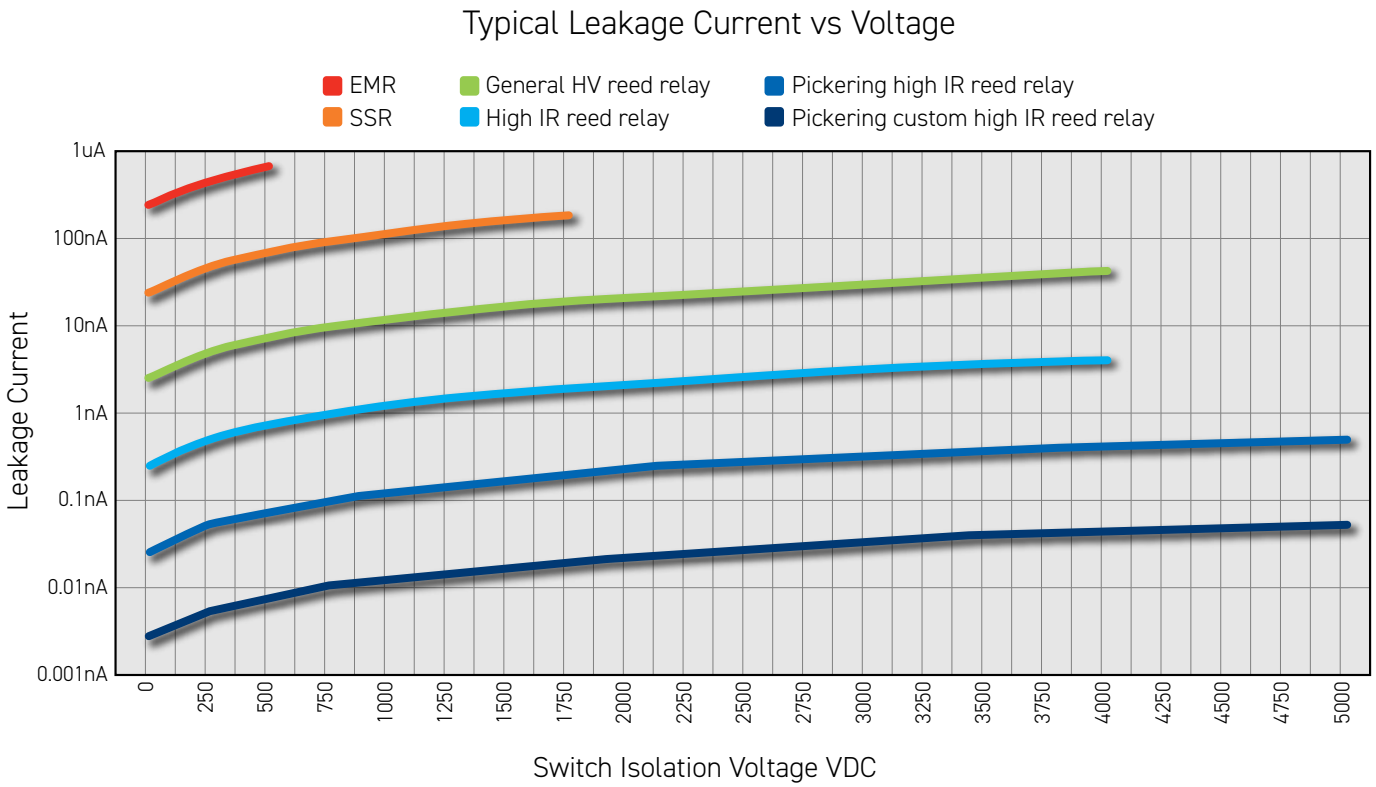
Importantly, any arc produced by the opening or closing of the switch cannot ignite any explosive gases or dust in the atmosphere. It also means the reed switches can achieve very high switching and high stand-off voltages (see Reed Relay Terminology below), particularly if the switch is in a near vacuum. For example, some modern reed relays can switch up to 12.5 kV and have a stand-off voltage up to 20 kV.

Similarly, any dust and moisture in the atmosphere cannot reach the switch contacts and affect their electrical characteristics and compromise the accuracy of precision sensor-based systems.

Fast & Low Power

Reed relays boast fast operating speeds, typically sub 1 ms, making them ideal for use in monitoring and control applications that require fast, precise switching. Also, most reed relays typically require only a low coil current to operate. This can be very important in mining systems that are low powered and/or which are battery-operated, either permanently or during the loss of the primary power source.

In addition, reed relays have virtually no leakage current. This is largely attributable to the use of compounds with very high electrical resistance. Several standard devices on the market have an insulation resistance greater than $10^{12}\,\Omega$, and custom devices can achieve more than $10^{14}\,\Omega$.



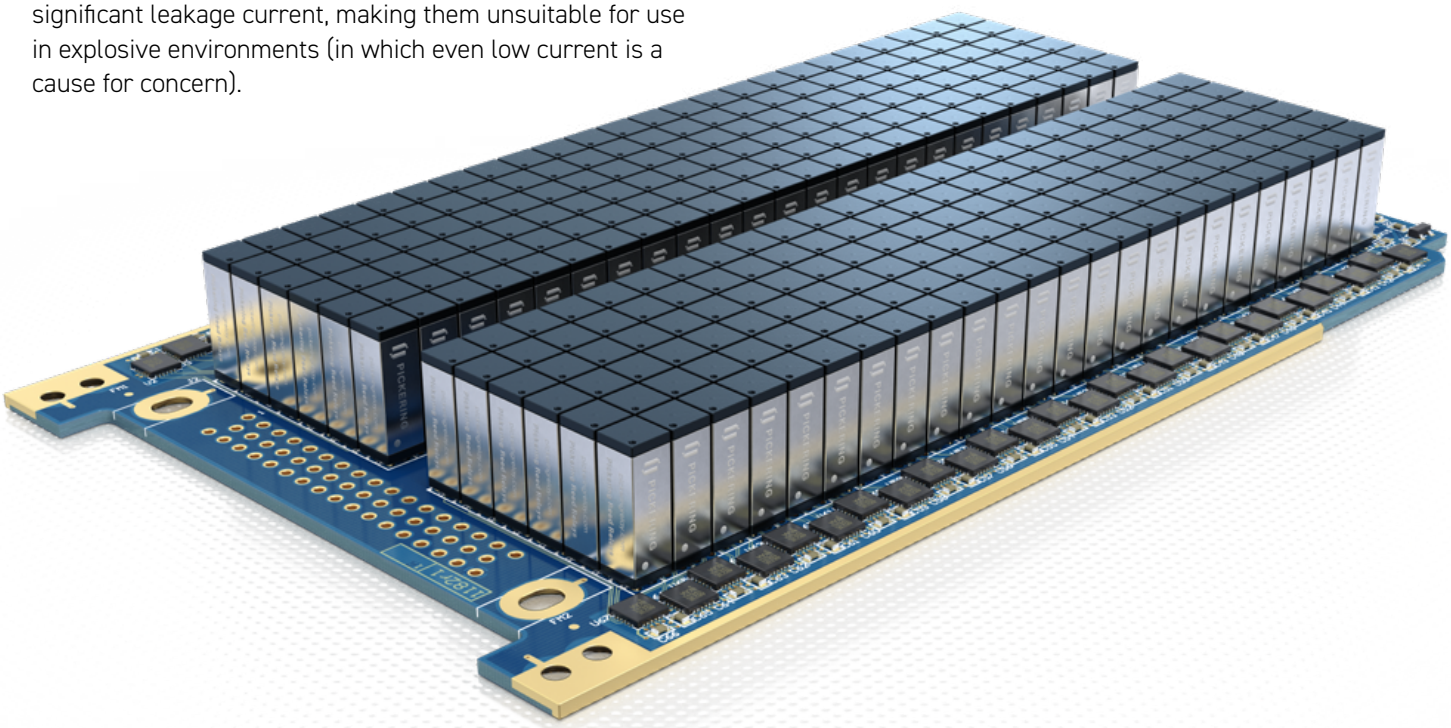
This graph compares leakage current performance across a range of switch types as isolation voltage increases.

Galvanic Isolation & Minimal EMI

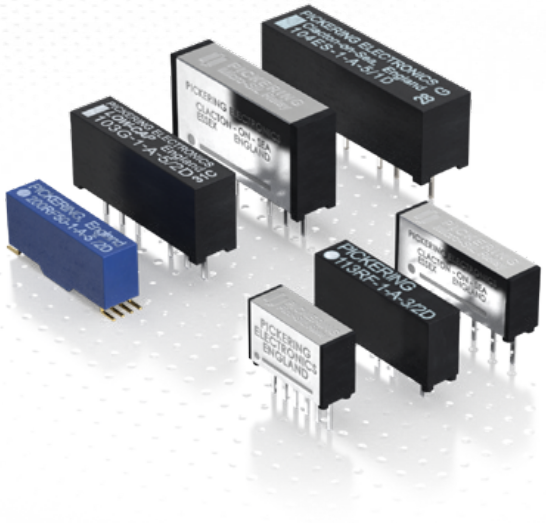
If you are wondering about solid-state relays (SSRs), which can operate faster than reed relays and can switch high voltages, they have many disadvantages that make them an unattractive proposition for mining.

For instance, reed relays are truly galvanically isolated, whereas an SSR can fail in such a way that the high voltage signal path and the low voltage control path may short circuit, resulting in the high voltage signal making its way into the control circuitry, potentially causing damage to equipment and endangering life. SSRs also have a significant leakage current, making them unsuitable for use in explosive environments (in which even low current is a cause for concern).

For low voltage signaling it is worth noting that reed relays offer better signal isolation and produce minimal electromagnetic interference (EMI) compared to SSRs. This makes them better suited to monitoring systems that require EMI-free switching.



In summary, reed relays are the logical choice for not only switching or monitoring voltages up to **12.5 kV**, but also for switching low voltage signals where the emphasis is accuracy and repeatability. They are galvanically isolated, have minimal leakage current, cause minimal EMI and when used within their specified operating parameters they can perform millions and even billions of operations with little change in performance.

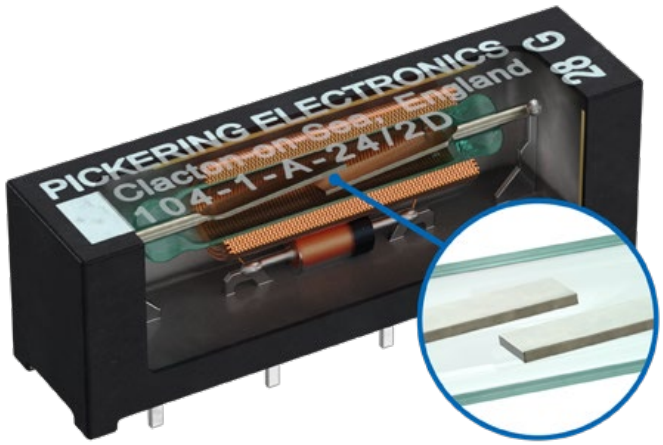


Reed Relay Terminology

Term	Definition	Why it Matters in Mining
Maximum Switching Voltage	Highest DC or AC (peak) voltage that can be switched safely.	Ensures the relay can handle the voltage without arcing or damage during operation.
Minimum Standoff Voltage	Max voltage that can be applied across open contacts without breakdown.	Critical for safe isolation at high voltages; prevents false failures and safety risks.
Maximum Switching Current	Highest current the relay can switch within power limits.	Important when charging/discharging capacitive DUTs.
Maximum Carry Current	Highest continuous current through closed contacts.	Ensures the relay won't overheat or fail when current is sustained.
Coil Voltage	Nominal DC voltage required to energise the relay coil.	Needs to be compatible with control circuitry in the mining application.
Coil Resistance	Resistance of the coil, usually measured at 25 °C.	Impacts power consumption and thermal performance.
Insulation Resistance	Resistance between device pins (ideally $>10^{12}$ Ω, higher for custom parts).	Key to measuring extremely low leakage currents accurately.
Switch-to-Coil Isolation	Voltage that can be applied between switch contacts and coil before breakdown.	Prevents high voltage from feeding back into control electronics — protects test equipment.
Shock Rating	Peak acceleration relay can withstand without malfunction.	Pickering reed relays are specified at 50 G shock. (A 150 G peak acceleration half sinewave over 11 ms will not cause a de-energized open switch to close, nor an energized 80 AT coil closed switch to open.)
Vibration Rating	Frequency/acceleration relay can tolerate without malfunction.	Pickering reed relays are specified at 20 G vibration. (20 G Acceleration, below cross-over-frequency 57 to 62 Hz, amplitude 0.75 mm, in the frequency range 10 to 2000 Hz for 90 minutes will not cause a de-energized open switch to close, nor an energized 80 AT coil closed switch to open.)
External Shield Clearance	Distance between external shield and base of relay.	Poor clearance can cause arcing at high voltages; Pickering uses internal shielding to avoid this.

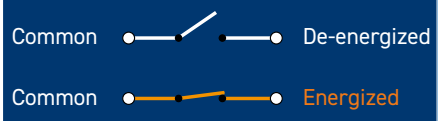
For high-voltage reed relays, the contact is sealed in a vacuum, greatly increasing the minimum standoff and maximum switching voltages. Insulation resistance is high thanks to pin spacing and the relay's base material. As for external shield clearance, this is not an issue when the EM shielding is on 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 mining application. Other information you will need to consider when designing your mining application includes contact configuration and service life.



Contact Configuration (Forms)

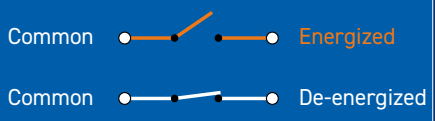
Form A



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) etc.

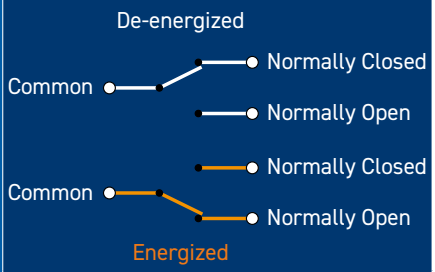
Form B



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) etc.

Form C



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 DPDT, 2C (pictured). With three switches it is 3PDT (or 3C) etc.

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

Speak with our engineers today to find the ideal relay solution for your mining application requirements.

Email: **techsales@pickeringrelay.com**

Recommended Products

Pickering Electronics has an extensive range of high-performance, high voltage isolation reed relays that are ideally suited to high voltage mining applications. Furthermore, with device footprints starting at just 16 mm^2, many relays can be accommodated on a single PCB. We particularly recommend the following series.

Series 60 & 65	Series 62 & 63
	
Switching up to 12.5 kV. Standoff up to 15 kV. Max switch current 3 A (to 50 W). Max carry current 3.5 A.	Switching up to 12.5 kV. Min standoff up to 20 kV. Max switch current 3 A (to 50 W). Max carry current 3.5 A.
Series 67 & 68	**Series 600**
	
Switching up to 7.5 kV. Min standoff up to 10 kV. Max switch current is 3 A (up to 200 W), max carry current up to 5 A. High power 200 W switch available. 5, 12 or 24 V coils. Optional electrostatic shield available.	Fully customizable, modular design. Up to 20 kV standoff, 12.5 kV switching & 200 W power handling. 5 V, 12 V, or 24 V coils and optional EMF suppression. Forms A, B & C. Vacuum-sealed reed switches, >10^{13} Ω insulation. Magnetic/electrostatic shielding.
Series 104	**Series 144**
	
Switching up to 1.5 kV. Min standoff up to 5 kV. Max switch current is 1 A (up to 25 W). Max carry current 1.5 A. High Temperature option available up to 125 °C (up to 150 °C as a standard build option). Optional electrostatic shield.	Switching up to 1 kV. Min standoff up to 3 kV. Max switch current 2.0 A (up to 60 W), or 1.0 A (up to 80 W). Max carry current 3.0 A. Optional electrostatic shield.
Series 100HV	**Series 119**
	
5, 12 or 24 V coils. HV + high coil resistance in Form A & B. 3 kV stand-off, 1 kV switching. Up to 6800 Ω coil resistance.	Switching up to 1 kV. Min standoff up to 3 kV. Max switch current 0.7 A (up to 10 W). Max carry current 1.25 A.
Series 131	**Series 219**
	
Switching up to 1 kV. Min standoff up to 1.5 kV. Max switch current 0.7 A (up to 10 W). Max carry current 1.25 A.	Switching up to 1 kV. Min standoff up to 3 kV. Max switch current is 0.7 A (up to 10W). Max carry current is 1.5 A.

Why Pickering Electronics for Reed Relays?

Pickering Electronics has specialised in reed relays since 1968 — it's our core business, and the foundation behind the wider Pickering Group's switching expertise.

Our relays use former-less coils, allowing more winding volume in the same package for improved magnetic efficiency. The result is consistent actuation and long service life, even in demanding operating conditions.

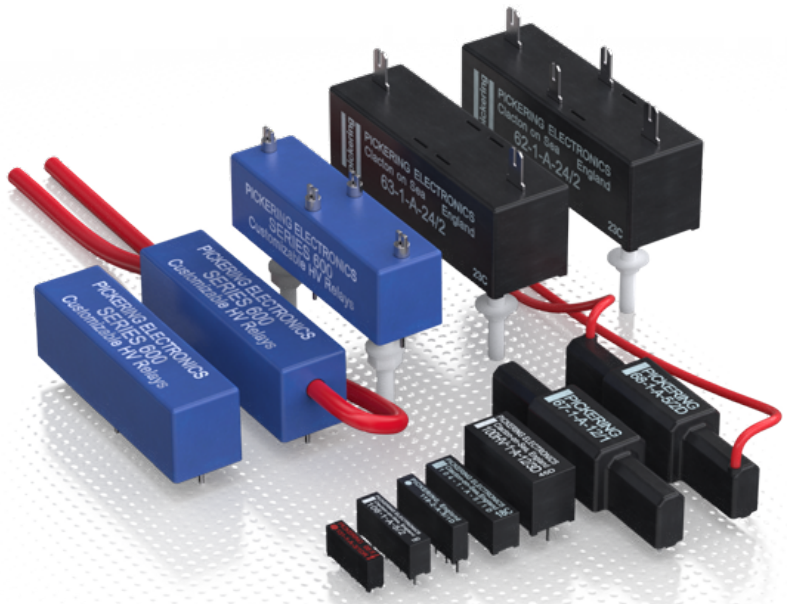
For high-voltage and high-reliability designs, SoftCenter™ encapsulation cushions the hermetically sealed glass switch with carefully selected materials. This reduces internal mechanical stress, improving contact stability over time.

To support dense layouts, internal mu-metal magnetic screening helps minimise magnetic interaction when relays are stacked closely on a PCB — enabling higher packing density and helping protect channel-to-channel performance.

Our internal mu-metal screen is designed to reduce magnetic interaction to around 1-5% in typical conditions; unscreened designs can be significantly higher (often ~30%), depending on relay type and spacing.

Quality is built in at every stage. Inspection is performed throughout manufacturing, and 100% of relays are tested against operating parameters, including dynamic contact waveform analysis, with full data review to ensure consistency. Manufacturing processes are also stress-tested through repeated thermal cycling (–20 °C to +85 °C to –20 °C, three cycles) to validate robustness.

Every relay recommended in this guide is instrumentation-grade, using contact materials chosen for performance and longevity: rhodium (electroplated), ruthenium (vacuum sputtered), or tungsten for higher-voltage switching — delivering lifetimes typically up to 5×10^9 operations.



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.

Contact Pickering

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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