Understanding REED RELAY POWER RATINGS and How to EXTEND SWITCHING CAPABILITIES

Due to their unparalleled insulation resistance and reliability features, reed relays continue to soar in popularity across numerous and varied applications. However, many electronics engineers unfamiliar with reed relays, are often puzzled by datasheet terminology and power ratings specifications when considering a reed relay solution.

This application note will provide both an explanation of reed relay power ratings and clarification of some key specifications found in Coto's reed relay datasheets. Additionally, we will reveal possible methods with which to extend switching capabilities beyond published specifications.

Cold Switching and Hot Switching

There are two types of switching methods: cold switching and hot switching. Cold switching is a circuit design that ensures that the relay contacts are fully closed before the load is applied, considering both relay operation and release time. Alternatively, hot switching is a circuit design where the relay opens and closes while the load remains active. While cold switching is generally recommended, in some applications it is not possible and hot switching is required.

The first important clarification is that the power rating in Coto's datasheets refers to the worst case scenario, which is a hot switching condition. This holds true for both the "Switching Voltage" and "Switching Current" specifications listed in the datasheets.

CALCULATING THE POWER DISSIPATION OF A PULSED LOAD

1. Calculate the Duty Cycle

Duty Cycle = (Pulse Duration / Period Time)

Example: 5ms / 50ms = 0.10

If the pulse duration is 5ms and the total time of the period is 50ms, then the Duty cycle is 0.10 (or 10%).

2. Calculate the effective RMS Current

Effective RMS Current = (√Duty Cycle) × Max Peak Current

Example: $(\sqrt{0.10}) \times 10A_{PK} = 3.2A_{RMS}$

Multiplying the square root of the decimal duty cycle by the max peak current of the pulse: in this example, the max peak current is 10APK, resulting in 3.2 ARMS.

3. Calculate the voltage drop through the relay contacts

Voltage Drop = Effective RMS Current × Max Contact Resistance

Example. $3.2A_{RMS} \times 0.5\Omega = 1.6V$.

Multiplying the effective RMS current by the maximum contact resistance in this example of 0.5Ω: a brand new relay typically has a contact resistance below 0.150Ω, but you will need to consider the increase in contact resistance over the operational life of the relay.

4. Calculate the power dissipation due to the pulsed load

Power = Voltage Drop × Effective RMS current

Example. $1.6V \times 3.2A_{RMS} =$ **5W**

Calculating the power dissipation of a pulsed load, helps the relay user to confirm that the chosen relay model will withstand the applied load of the application.

Figure 1: Power Rating Calculation

Cold Switching / Pulsed Switching – Higher Switching Capabilities

Using cold switching can allow for the switching of higher voltages and currents than those specified, as long as other specifications (such as breakdown voltage and power rating) are not exceeded. One common example is when switching high-current pulses – as long as the effective power remains below the specified limit and the duty cycle permits proper heat dissipation. Nevertheless, it's essential to avoid excessive duty cycles, as they can lead to overheating, causing contact opening due to heat, followed by contact damage due to unexpected hot switching.

By applying cold switching and pulsed switching, one can extend switching capabilities beyond specifications provided in the datasheet.

While the step-by-step Power Rating calculation (Figure 1) represents a good initial approach to relay selection, it does not take into account other factors, such as additional heat generated by the environment or heat generated inside the relay due to the timing of the coil energization.

Additionally, one should note that there is a common misunderstanding with the specification listed as **"Carry Current"**. This specification refers to the ability to maintain a constant current level in the closed state for a minimum of 10 minutes without opening. It is not only and necessarily related to contact damage, but rather to the effect of temperature on the magnetic properties of the reed contacts.

Extending Switching Voltages – Achieving 1500V with Coto's 9104 Series Reed Relay

As presented, cold switching and pulsing permit the relay to withstand higher ratings than are stated in a datasheet. This may be of interest, for example, for some of our most popular miniature high-voltage series, such as the 9104. The datasheet shows a **"Switching Voltage"** of 1000V and a **"Breakdown Voltage"** (aka **"Dielectric Strength")** of up to 4000V. As expressed in the datasheet, the switching voltage corresponds to a hot switching scenario, where the 9104 opens and closes its contacts with the 1000V active on its terminals.

A common application method that combines cold switching and pulsing involves using the 9104 reed relay as an isolation mechanism alongside other switching options connected in series. Here's how it works: the reed relay (K1) closes [Cold Switching], allowing a high-voltage transistor (Q1) to deliver the HV pulse; then the reed relay (K1) opens to create an open connection, providing insulation of up to 4000V to the channel. (See Fig. 2.)

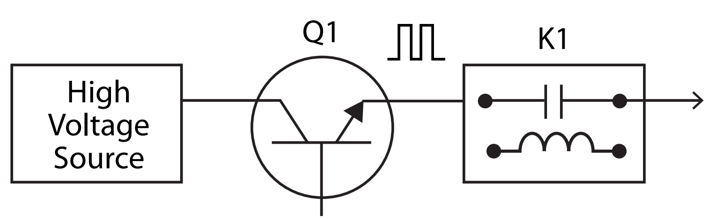

Figure 2: Block Diagram of a HV transistor + HV Reed Relay

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By implementing this methodology, it becomes possible to switch pulses of 1500V without drastically compromising the relay's lifes pan. In fact, the relay's expected lifespan under these conditions can be comparable to the expectation at 1000V in hot switching scenarios. Furthermore, having a higher Contact Rating will enhance the relay's life expectancy, making it even more suitable for demanding applications where extending switching capabilities may be required. Coto offers custom versions with higher capabilities than those shown in the 9104 datasheet, such as a version with a breaking voltage of up to 4250V and a higher contact rating of up to 70W.

With the demystification of reed relay specifications, engineers can fully appreciate the popular features of reed relays and design them in with confidence. And – understanding power ratings is key to extending switching capabilities beyond published specifications. For more technical and application information about reed relays, be sure to download our **Technical & Application documentation** from our website.

About Coto's Products and Testing Criteria

Coto Technology proudly offers the most comprehensive range of reed relay solutions on the market. Our products feature industry-leading electrical power ratings, boasting switching capacities of up to 100W and the ability to isolate voltages of up to 14KV.

Coto's testing criteria for life tests are the most stringent in the industry, based on ATE requirements. We monitor not only contact resistance but also ensure the correct functionality of parameters such as actuate and release time throughout the switching life. This comprehensive approach distinguishes our testing methodology from competitors, who often conduct a predetermined number of cycles, test the relay externally, and repeat until failure, lacking the capability to detect "soft stick" or "soft miss" issues.

Related Technical Resources

Quick Selector Guide to Reed Relays by Coto Technology

Reed Relay Technical & Applications Information Guide

Contact Coto Technology for additional technical support tailored to your specific application case. For other Application Notes in our growing Technical Resource Library, please visit our website at **www.cototechnology.com**

COTO CLASSIC™ 9104 SERIES HIGH VOLTAGE SIP REED RELAYS

5 Parameters - Model Number 9104

Parameters	Test Conditions	Units	4 Pin SIP		
Relay Configuration			**9104-XX-1X**	**9104-XX-3X**	**9104-XX-4X**
Coil Specs.					
Nom. Coil Voltage		VDC	5.0 12.0	5.0 12.0	5.0 12.0
Max. Coil Voltage		VDC	6.5 15.0	6.5 15.0	6.5 15.0
Coil Resistance	+/- 10%, 25°C	Ω	175 500	175 500	140 500
Operate Voltage	Must Operate By	VDC - Max.	3.75 9.0	3.75 9.0	3.75 9.0
Release Voltage	Must Release By	VDC - Min.	0.5 1.0	0.5 1.0	0.5 1.0
Contact Ratings					
Switching Voltage[3]	Max DC/Peak AC Resist.	Volts	1000		
Switching Current	Max DC/Peak AC Resist.	Amps	0.5		
Carry Current	Max DC/Peak AC Resist.	Amps	1.3		
Contact Rating	Max DC/Peak AC Resist.	Watts	10		
Life Expectancy - Typical[1]	Signal Level 1.0V, 10mA	x 10^6 Ops.	300		
Static Contact Resistance (Max. Init.)	50mV, 10mA	Ω	0.150		
Dynamic Contact Resistance (Max. Init.)	0.5V, 50mA at 100Hz, 1.5msec.	Ω	0.200		
Relay Specifications					
Insulation Resistance (Min.)	Between all Isolated Pins at 100V, 25°C, 40%RH	Ω	10^{11}		
Capacitance - Typical Across Open Contacts	No Shield	pF	1.0		
Open Contact to Coil	No Shield	pF	-		
Dielectric Strength (Min.)	Between Contacts Contacts/Shield to Coil	VDC/peak AC VDC/peak AC	2000 3000	3000 3000	4000 4000
Operate Time - Including Bounce - Typical	At Nominal Coil Voltage, 30Hz, Square Wave	msec.	0.75		
Release Time - Typical		msec.	0.5		

Figure 3: Above is an example of a reed relay datasheet table with key specifications highlighted.

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