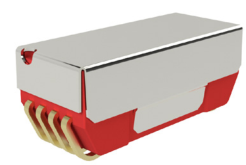
Significant Advancement in Relay Technology by Coto:

THE NEW 9853 SERIES - A NEW FORM C REED RELAY WITH SUPERIOR, TESTED RELIABILITY

The new 9853 reed relay series, the latest release from Coto Technology, represents a significant advancement in relay technology. Designed to meet ATE grade specifications, it features a true Form C configuration with a real break-before-make relay mechanism. Despite its compact footprint, this relay series offers superior performance and reliability when compared to other form C switches in the market. The 9853 is an SMD reed relay with 3W hot switching and up to 50V hot switching capacity. It includes a coaxial shield for 50 Ω impedance and gold-plated terminals for enhanced durability.



COTO CLASSIC™

The New Compact ATE-grade, Form C 9853 Reed Relay Series

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Form C relays are crucial components in Automated Test Equipment (ATE) setups specifically designed for semiconductor device testing. Their compact design addresses space constraints commonly found on load boards within the ATE landscape. These relays efficiently switch signals for high-pin-count semiconductor devices, seamlessly integrating into modern ATE systems for comprehensive testing, including parametric measurements and high-speed signal sources.

A standout feature of Form C relays in ATE is their unique ability to preserve signal integrity, especially with RF frequency signals. The Coto 9853 Form C relay excels in this regard, with robust RF bandwidth capabilities in the GHz level, that ensure minimal signal distortion and optimal transmission line performance, even in demanding ATE environments.

Simultaneously, the 9853 aims to redefine the paradigm of Form C switch reliability. Its enhanced robust design, packaged in a compact form, offers superior reliability compared to other Form C options available on the market.

Extensive testing has demonstrated proven exceptional performance, longevity, and reliability throughout its switching life. The following report presents the test results from two specialized tests under the strictest ATE standards, which surpass the worst possible conditions in an ATE environment.

1. Coto's Reliability Test

Since even one soft failure[2] can be problematic in ATE, Coto records failures for "expected life" estimation as the first soft failure due to sticking, missing, or excessive contact resistance. This is a deliberately conservative criterion. Comparison with the reliability data published by other relay manufacturers is difficult because they may be less rigorous in their choice of failure criteria or less scrupulous in presenting statistical reliability data. The reliability of a relay is best defined in terms of the number of cycles it can operate while meeting its specifications before it fails. The MCBF (mean cycles before failure) is a useful measure of reliability for relays, and it is one of the measures that Coto uses to estimate relay reliability / life testing. Coto Technology evaluates reliability using its own custom ATE system (the System 300) designed and built internally.

1. Hot switching is defined as a circuit design that applies the switched load to the switch contacts during the period while they are opened and closed.
2. Soft Failure is defined as an intermittent, self-recovering failure.

Failure definition - Reed relays eventually fail in one of three ways:

- They do not open when they should (termed as "sticking")
- They fail to close when they should (termed as "missing")
- Their static contact resistance gradually drifts up to an unacceptable level.

The first two listed mechanisms can be further subdivided into "soft" and "hard" failures. A soft failure is recorded when a relay is found to have missed or stuck for a few milliseconds after coil activation or deactivation, but then it is found to have recovered from the problem when checked a short time later. If recovery from the initial soft failure has not occurred by the time the second check is made, the failure is classified as permanent or "hard".

Coto's Failure criteria:

- Soft Stick > 1ms
- Soft Miss > 1ms.
- Hard Stick > 0.5 sec.
- Hard Miss > 0.5 sec.
- Contact resistance > 1 Ohm.

32 relays were evaluated in Coto's System 300, with 16 parts tested on the normally open contact and the remaining 16 tested on the normally closed contact. The load condition was a signal of 1V 10mA, hot-switched (meaning the relay opened and closed with the load always active) at an opening and closing frequency of 50Hz. The table below summarizes that both results exceeded the expectations specified in **Coto's 9853 Series datasheet.**

Contact	MCBF Result	Specification
Normally Open Contact	244 million Ops	200 million Ops
Normally Closed Contacts	154 million Ops	100 million Ops

For additional life test information, contact Coto Technology directly. We may be able to predict reliability under different load conditions or set up a specialized life test to meet your specific requirements.

2. Coto's Sticking Tendency Test

In the realm of reed technology, the concept of "sticking" holds significant importance. This phenomenon refers to the propensity of reed contacts to remain closed regardless of coil activations/deactivations. Consequently, these contacts may fail to open as intended, presenting a common failure mode, particularly with other Form C type relays.

Coto's Sticking Tendency Test procedure was developed to simulate worst-case conditions. This test is a variant of Coto's reliability test described previously, and is conducted in conjunction with an automatic temperature chamber. In this controlled environment, relay components are subjected to temperature fluctuations, pushing them to their operational limits. An essential aspect of this test is the evaluation of the impact of temperature changes on coil resistance.

Constructed of copper, relay coils exhibit a resistance variation of

0.4% for every 1°C change in temperature, resulting in fluctuations in the magnetic power generated by the coil. This phenomenon is significant as the coil's primary function is to properly control the opening and closing of the reed contacts.

32 relays were evaluated, with 16 of them tested on the normally open contact and the other 16 tested on the normally closed contact. The temperature chamber setup ranged from -20°C to +85°C, utilizing 30-minute ramps and 30-minute soaks at the minimum and maximum operating temperatures. The load used was 1V 10mA, hot-switched at a lower frequency of 20Hz. This setup provided a longer contact soak period compared to higher drive frequencies, increasing the opportunity for contact sticking to occur.

The 9853 Series testing graphs (Figure 1 and Figure 2) show that contact resistance data recorded throughout the duration of the test cycle, indicate zero instances of soft stick failure.

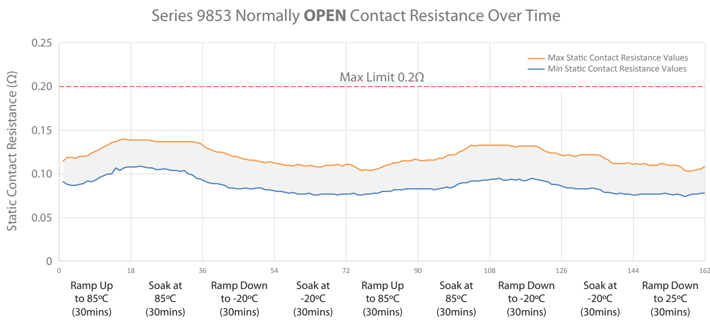

Figure 1: Graph of Static Contact Resistance for the Normally Open Contact on the 9853 series Reed Relay as the temperature is cycled (total test duration: 4h30mins). 16 units were tested and their Static Contact Resistance values all fell within the area shown in the graph.

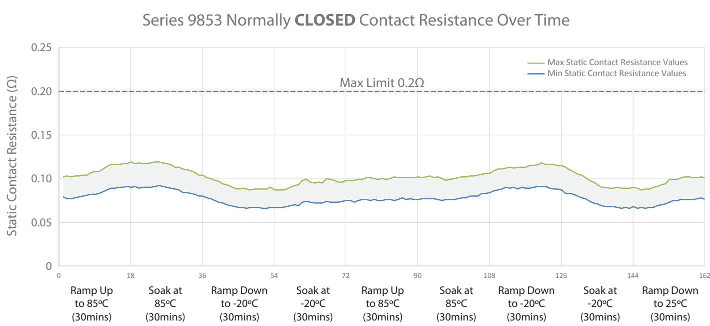

Figure 2: Graph of Static Contact Resistance for the Normally Closed Contact on the 9853 series Reed Relay as the temperature is cycled (total test duration: 4h30mins). 16 units were tested and their Static Contact Resistance values all fell within the area shown in the graph.

Contact Coto Technology for additional information and further support with different signal loads.

3. How does the 9853 Function?

All reed relays contain a coil that generates a magnetic field when an electrical current passes through it. This field causes two flexible ferromagnetic switch blades to be attracted together, closing an electrical circuit between them. The simplest type, known as a "form A", "Normally Open" or "single pole single throw" (SPST) relay, operates in this manner. However, the 9853 reed relay achieves a real form C or single pole double throw (SPDT) capability by incorporating a changeover reed switch with a common input terminal, a normally closed (N/C) output lead, and a normally open (N/O) output. When activated by the coil's magnetic field, an internal beam flexes, opening the N/C contact and closing the N/O contact. In the absence of a magnetic field, the internal beam returns to its original position, maintaining electrical continuity with the N/C contact without consuming electrical power. This energy-saving feature is particularly significant in systems containing numerous relays.

Proven Tips for Improving Reed Relay Performance and Reliability

The test data presented is for the standard load of 1V 10mA, under hot switching conditions. If your signal load is lower or if you are using cold switching conditions, such as switching pulses, the life expectancy could be higher. Below, we provide some recommendations to help you make the most of this new design:

- **Cold switch if possible:** It is not always practical and depends on the application, but if you can design your system so that the relay only switches when the current is off, the relay life will be greatly extended.
- **Avoid reactive loads:** Reed Relays are most reliable when switching resistive loads. Heavy inrush current from capacitive circuits can cause premature contact failure or even contact welding, and inductive loads can cause excessive arcing.
- **Maintain Overdrive:** Try to ensure that the voltage applied to the coil is min. 25% higher than the operating voltage spec. This 25% overdrive will ensure that the relay contacts are firmly closed, enhancing the relay's life. Coto's recommendation is to aim for 33% overdrive.
- **Keep the operating temperature low:** An increase in temperature results in a corresponding reduction in the power supplied to the coil. This reduces overdrive and could reduce relay life.
- **Maintain coil voltage after relay closure:** Avoid using relay driver IC's that allow the coil voltage to be lowered after the relay closes to "save power" (or simply turn off the programmed reduction).
- **Program an occasional exercise cycle:** Form C reed relays that are only activated occasionally spend a lot of time with the normally closed contact shut. This can lead to contact sluggishness when the relay is first activated. Programming an occasional burst of relay operations before making critical electrical measurements can greatly improve performance.

4. Key Terms

Cold Switching: A circuit design that ensures the relay contacts are fully closed before the switched load is applied (taking into account bounce, operate and release time). If technically feasible, cold switching is the best method for maximizing contact life at higher loads.

Hot switching: A circuit design that applies the switched load to the switch contacts during the period while they are opened and closed.

Sticking (contacts): A reed switch failure mechanism, whereby a closed contact fails to open by a specified time after relay de-energization. "Sticking contacts" can be subclassified as hard or soft failures.

Soft Failure: Intermittent, self-recovering failure.

Hard failure: Highly-repeatable, permanent failure of the contact or relay.

Overdrive: The fraction or percentage by which the voltage applied to the relay coil exceeds its pull-in voltage. An overdrive of at least 25% ensures adequate closed contact force, and well controlled bounce times, which result in optimum contact life. Coto Technology's relays are typically designed for a minimum of 33% overdrive.

Inrush current: Generally, inrush current refers to the current waveform immediately after a load is connected to a source. Inrush current can form a surge flowing through a relay switching a low impedance source load - typically a highly reactive circuit, or one with a non-linear load characteristic such as a tungsten lamp load. Such abusive load surges are sometimes encountered when reed relays are inadvertently connected to test loads containing capacitors, or to long transmission lines with appreciable amounts of stored capacitive energy. Excessive inrush currents can cause switch contact welding or premature contact failure.

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