

The Effects of Short-Time Overload on Resistive Elements in Vishay Bulk Metal[®] Foil and Thin Film Precision Resistors

Introduction

When designing any type of analog circuit, all possible causes of circuit failure need to be taken into consideration, as do the consequences of these failures. Such considerations are particularly important when the long-term reliability, stability, and precision of the circuit are vital to the application.

One source of failure that circuits are exposed to in most applications is temporary overloads of unexpectedly high current, or short-time overloads (STO). A component that is subjected to an STO will be required to dissipate more power than usual, causing extreme heat that can lead to extensive component damage, and even catastrophic failure. However, designs that integrate overload protection can help prevent serious damage or component failure.

Bulk Metal Foil vs. Thin Film Resistors

Vishay's Bulk Metal[®] foil technology inherently has superior overload and pulse handling capabilities compared to other resistor technologies, such as thin film. By nature, foil resistors can withstand prolonged periods of extreme overload conditions, without failure and without sustaining any serious internal or external damage.

The Vishay foil resistive element consists of a thick, flat layer of conductive metal alloy, bonded to an inert alumina substrate, and photo etched into a series of resistance paths. This allows scribe trimming to be performed. The resistor's design achieves almost zero inductance, allowing rapid rise times and excellent high-frequency performance.

Many of the advantages of Vishay's foil resistors over thin film resistors are derived from the thickness of the resistive element, which is 100 times greater than that of thin film. This thickness provides a high heat capacity, which results in the low temperature rise of the resistive element under a short pulse. Thin film resistors, however, lack the pure mass, and therefore the heat capacity, to handle the heat generated in a short pulse, and will typically burn up and fail.

Even under harsh environmental conditions, a Bulk Metal precision resistor rated at a 0.01 % purchased tolerance can retain most of this accuracy throughout its life, with only small predictable changes. Other precision resistors suffer

much less predictable drift, and their specifications may eventually drift by as much as several orders of magnitude.

Vishay foil resistors are made to six-digit accuracy, providing 10 times lower thermal EMF than other resistor technologies, as well as better temperature stability, tighter load life stability, and enhanced reliability.

Though normally housed in moisture-resistant molded packages, the Vishay line of foil resistors also includes surface-mount and hermetic packages for ultra stability.

Short-Time Overload Test

Vishay has performed a test that demonstrates the limited effect of STO on foil resistors when compared to competing technologies.

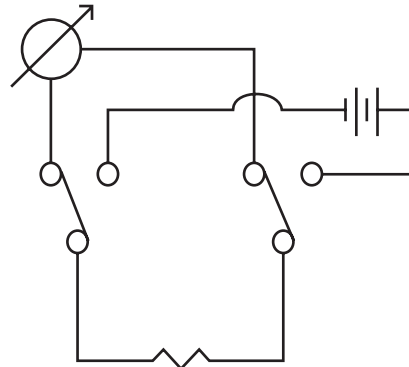
The tested resistor (Rx) is connected to a precision digital multi-meter (DMM), which takes the initial resistance reading (see Figure 1). After the reading is taken, the resistor is switched over to a power supply that applies an overload voltage for five seconds. After a sufficient cool-down time, the subject resistor is then switched back to the DMM, and the resistance is read again. The $\Delta R/R$ is displayed.

The test measures the change in resistance of the subject resistor due to the applied overload. The screen displays the $\Delta R/R$, which is the difference in the resistance readings taken before and after the overload.

Mil-PRF-55342 defines the STO test as 2.5 times the rated continuous working voltage, but not exceeding twice the maximum voltage, applied for five seconds. The resistors are then examined for evidence of arcing, burning, and charring.

This demonstration measures the $\Delta R/R$ (measured in ppm) of a 100R resistor subjected to an overload of 7 W for five seconds. This overload exceeds the power ratings of each device under test, specifically by a factor of nine for the Vishay VSMP2512 resistor, and a factor of seven for the thin film resistor.

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Rx
100R

Figure 1.

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POWER OVERLOAD TEST PARAMETERS .....

NOMINAL TEST VALUE ..... 100R
APPLIED WATTAGE ..... 7 W
ACTUAL APPLIED VOLTAGE ..... 26.5 VDC
TEST DURATION ..... 5 SEC.

PLACE TEST RESISTOR IN FIXTURE AND PRESS <T> TO TEST... <Q> TO QUIT PROGRAM

STAND BY ... TEST IN PROGRESS

** SYSTEM ZEROED **
READY FOR POWER SHOT

POWER SHOT ON !!! ** 26.5 VDC FOR 5 SECONDS **
** COOL DOWN CYCLE *** 5 SECONDS **

DELTA R (RC2-RC1).....11 PPM

ENTER <R> TO RESTART ..... <Q> TO QUIT PROGRAM .....
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STO for Foil Resistor

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POWER OVERLOAD TEST PARAMETERS .....

NOMINAL TEST VALUE ..... 100R
APPLIED WATTAGE ..... 7 W
ACTUAL APPLIED VOLTAGE ..... 26.5 VDC
TEST DURATION ..... 5 SEC.

PLACE TEST RESISTOR IN FIXTURE AND PRESS <T> TO TEST... <Q> TO QUIT PROGRAM

STAND BY ... TEST IN PROGRESS

** SYSTEM ZEROED **
READY FOR POWER SHOT

POWER SHOT ON !!! ** 26.5 VDC FOR 5 SECONDS **
** COOL DOWN CYCLE *** 5 SECONDS **

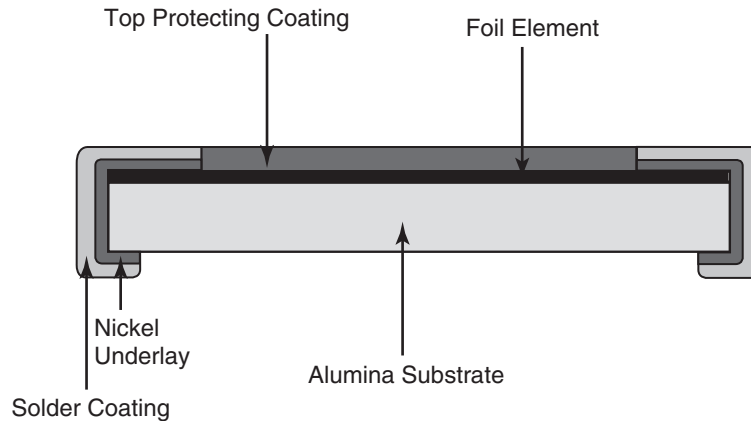
DELTA R (RC2-RC1).....294221 PPM

ENTER <R> TO RESTART ..... <Q> TO QUIT PROGRAM .....
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STO for Thin Film Resistor

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The foil resistors exhibit excellent stability and virtually no drift following the power spikes, demonstrating that the Bulk Metal® foil VSMP2512 chip resistor is capable of handling high power spikes well beyond common test limits.



Drawing not to scale

Figure 2. Surface Mount Wrap-Around Chip Foil Resistor Construction

	VISHAY FOIL RESISTOR	THIN FILM RESISTOR SIZE
Type	VSMP2512	Thin Film Chip
Value	100 Ω	100 Ω
TCR	0.2 ppm/°C (MIL-RANGE)	25 ppm/°C (MIL-RANGE)
Rated Power	750 mW	1000 mW
ΔR under surge	< 100 ppm	open

The following graph illustrates typical foil resistor behavior after undergoing short-time overloads of 6.25 times rated power for five seconds:

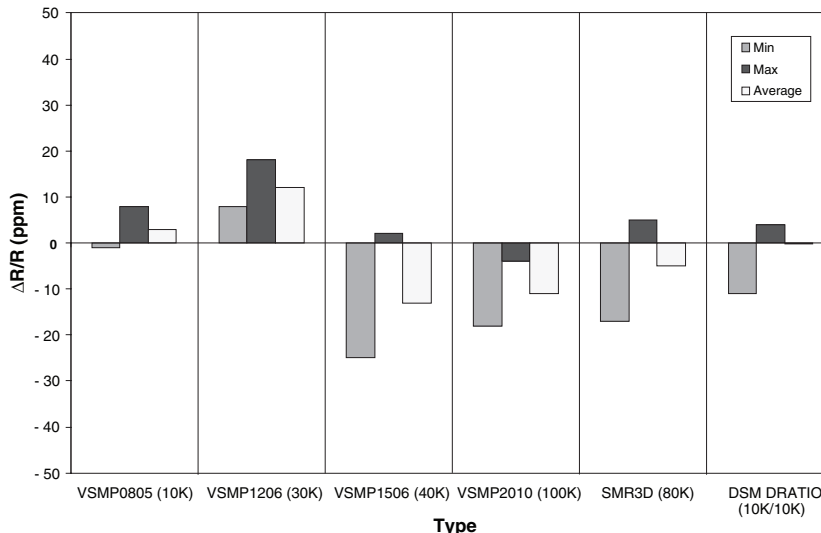


Figure 3. Resistance Deviation after Short Time Overload of x 6.25 Rated power for 5 seconds
VSMP - 10 units tested, SMR3D - 80 units tested, DSM - 20 units tested.