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Stackpole's TMJ Thermal Jumpers for Temperature Issues for Power Supplies Amplifiers and Servers.

Electronic equipment such as power supplies, amplifiers, and servers continue to shrink in size and push the power envelope. In response, resistor manufacturers are designing resistors with higher power ratings, but which come in commonly used surface mount sizes and packages. Of course, when more power gets dissipated in a smaller package, it is important to consider the thermal impact on the PCB and surrounding components. Thermal stresses are critical in current sensing applications using resistors where the sense resistor is typically one of the larger components due to the heat generated by the high supply current. Surface mount components dissipate a larger percentage of their heat into the PCB, as opposed to thru hole components that dissipate more thermal energy into the ambient air. Keeping surface mount components within their safe operating temperature range is critical to the long term reliability of any electronic device.

For general purpose chip resistors, the technology is primarily a film type element on an alumna ceramic substrate. Current sensing resistors such as those used in power supplies may be a wide range of technologies using different materials. For example, metal alloy resistors, whether wire-wound or made with low resistance alloys for current sensing, will exhibit better thermal conduction and have more mass than similar resistors with film elements. Consequently, metal alloy resistors typically have higher power ratings. The amount of heat that a particular resistor can dissipate depends on the thermal conductivity of its materials and is proportional to the mass of the material used. But regardless of technology there are practical limitations to the amount of heat that can be safely dissipated by any given resistor technology.

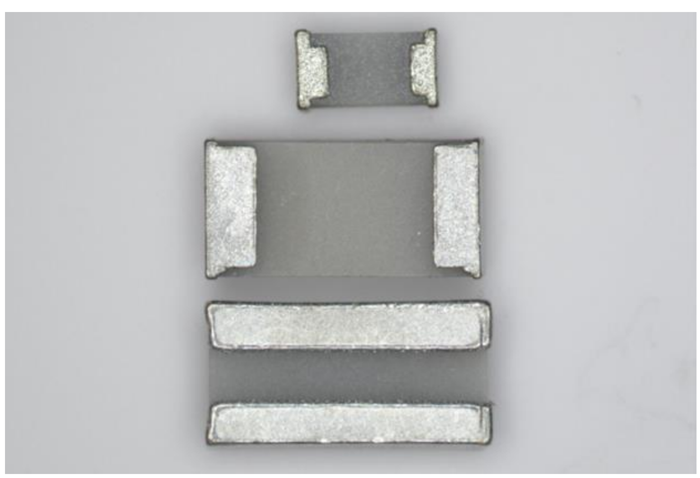


Fig. 1 Surface Mount Thermal Jumpers

A potential solution to these thermal challenges for surface mount resistors that may be running at or beyond their recommended operating temperature is the use of surface mount thermal jumpers. Stackpole's TMJ thermal jumpers such as those shown in fig. 1, provide an electrically isolated, but highly thermally conductive surface mountable device that can be used in conjunction with a variety of existing heat generating components. The TMJ utilizes an aluminum nitride substrate which has excellent thermal conductance, although other substrate materials may be used in the future. Electrical Isolation is important for this kind of thermal device to prevent any type of electrical leakage to the ground plane or heat sink which would be detrimental to the performance of the circuit. For thermal jumpers, isolation is normally defined by dielectric withstand voltage. The table shown in Fig. 2 shows the specifications for thermal jumpers from Stackpole and a competitor. The competitor specifications appear superior except that they are typical values and not rating limits as they are with the Stackpole TMJ, therefore a direct comparison would require assumptions.

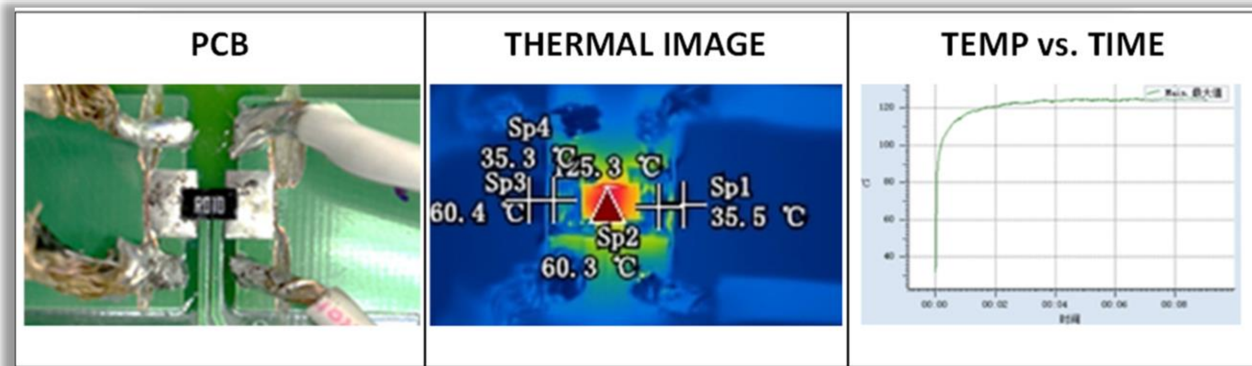
Thermal Jumper Spec Comparison

	Thermal Resistance	Thermal Conductance	Dielectric Withstand Voltage
Stackpole TMJ 0612	**5 (degC/W)**	**216 (mW/degC)**	**>1500VAC rms**
Competitor 0612	4 (degC/W typical)	259 (mW/degC typical)	>1500VAC rms
Stackpole TMJ1206	**18 (degC/W)**	**55 (mW/degC)**	**>1500VAC rms**
Competitor 1206	15 (degC/W typical	65 (mW/degC typical)	>1500VAC rms
Stackpole TMJ1225	**5 (degC/W)**	**216 (mW/degC)**	**>1500VAC rms**
Competitor 1225	4 (degC/W typical)	259 (mW/degC typical)	>1500VAC rms

Fig. 2 Surface Mount Thermal Jumpers Specifications

Stackpole's TMJ SMD thermal jumpers enhance high power designs by lowering the temperature of critical components while maintaining circuit integrity with high standoff voltage and low capacitance. The benefits can be improving the long term reliability of the design due to lower the temperatures, or to allow an existing design to run at higher power, which is often the case with data servers today due to the proliferation of AI.

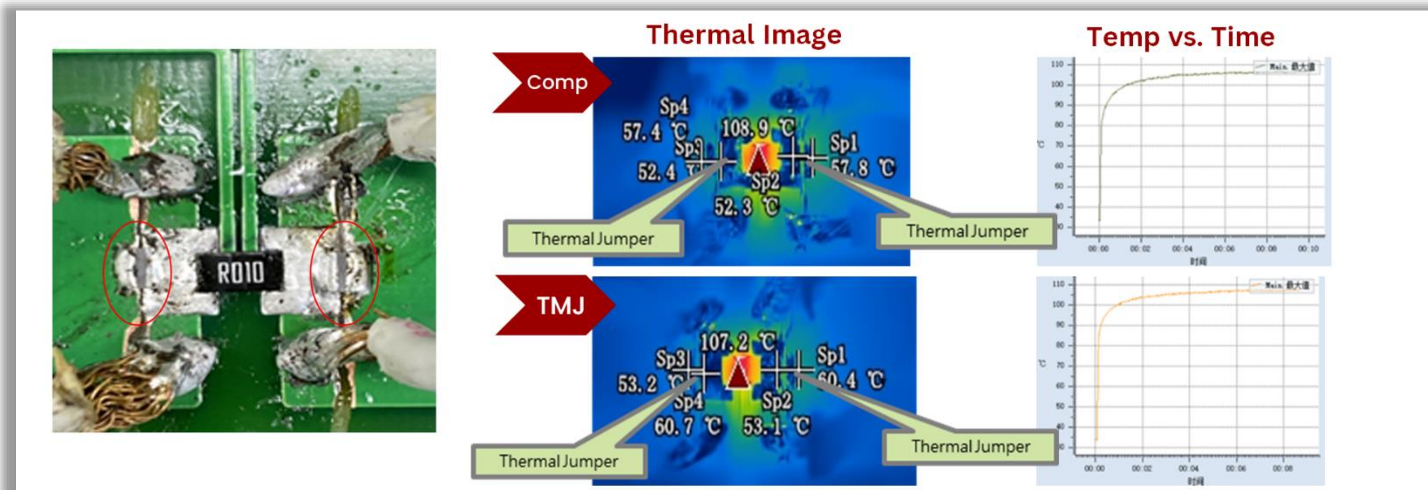
The example shown in figure 3 below shows Stackpole's high power CSSJ2512 size 3W metal element current sense resistor which will generate significant heat due to the current it can carry. The PCB on which the resistor is mounted is designed to handle high current. Yet at rated power, the hot spot temperature of this part is 125°C with this PCB layout, materials, and construction. While this temperature is no problem for a metal element sense resistor, there may be surrounding passive and active components that derate to zero power at 85°C to 125°C. Other components such as power inductors and power semiconductors will also generate heat to further complicate things.



HOT POINT	TERMINAL (SP1)	TERMINAL (SP2)	TERMINAL (SP3)	TERMINAL (SP4)
125.3°C	35.1°C	60.3°C	60.4°C	35.3°C

Fig.3 High Power Resistor Temperature with No Thermal Jumper

Fig. 4, shown below, shows the improvement in hot spot temperature using an 0612 size thermal jumper from Stackpole and the competitor. By adding thermal jumpers to the solder pads to both sides the hot spot temperature of the resistor was lowered by more than 18 degrees using the Stackpole TMJ0612 compared to the competitor improvement by only 16.4 degrees.



BRAND	HOT POINT	TERMINAL (SP1)	TERMINAL (SP2)	TERMINAL (SP3)	TERMINAL (SP4)
Comp	108.9°C	57.8°C	52.3°C	52.4°C	57.4°C
SEI TMJ	107.2°C	60.4°C	53.1°C	53.2°C	60.7°C

	TEST POINT DEFINITION	AREA		COPPER THICKNESS
SP1	Right side heat sink copper temp	30 mm x 20 mm	600 mm	1 oz.
SP2	Right side soldered joint temp	3 mm x 20 mm	60 mm	
SP3	Left side soldered joint temp	30 mm x 20 mm	600 mm	
SP4	Left side heat sink copper temp	3 mm x 20 mm	60 mm	

Fig. 4 High Power Resistor Temperature Comparison Using Thermal Jumpers

An important factor in the effectiveness of thermal jumpers is the speed in which they dissipate heat. The image shown below in Fig. 5 shows the comparison temperatures for the Stackpole TMJ and competitor jumper with temperature measurements on the thermal jumper itself and on the copper pad close to the jumper. The relatively flat graphs show after 2 minutes the temperature of the Stackpole TMJ jumper is stable. The competitor jumper appears to not be at thermal equilibrium after 2 minutes. The higher the thermal efficiency, the faster the jumper helps lower the heat on the protected components.

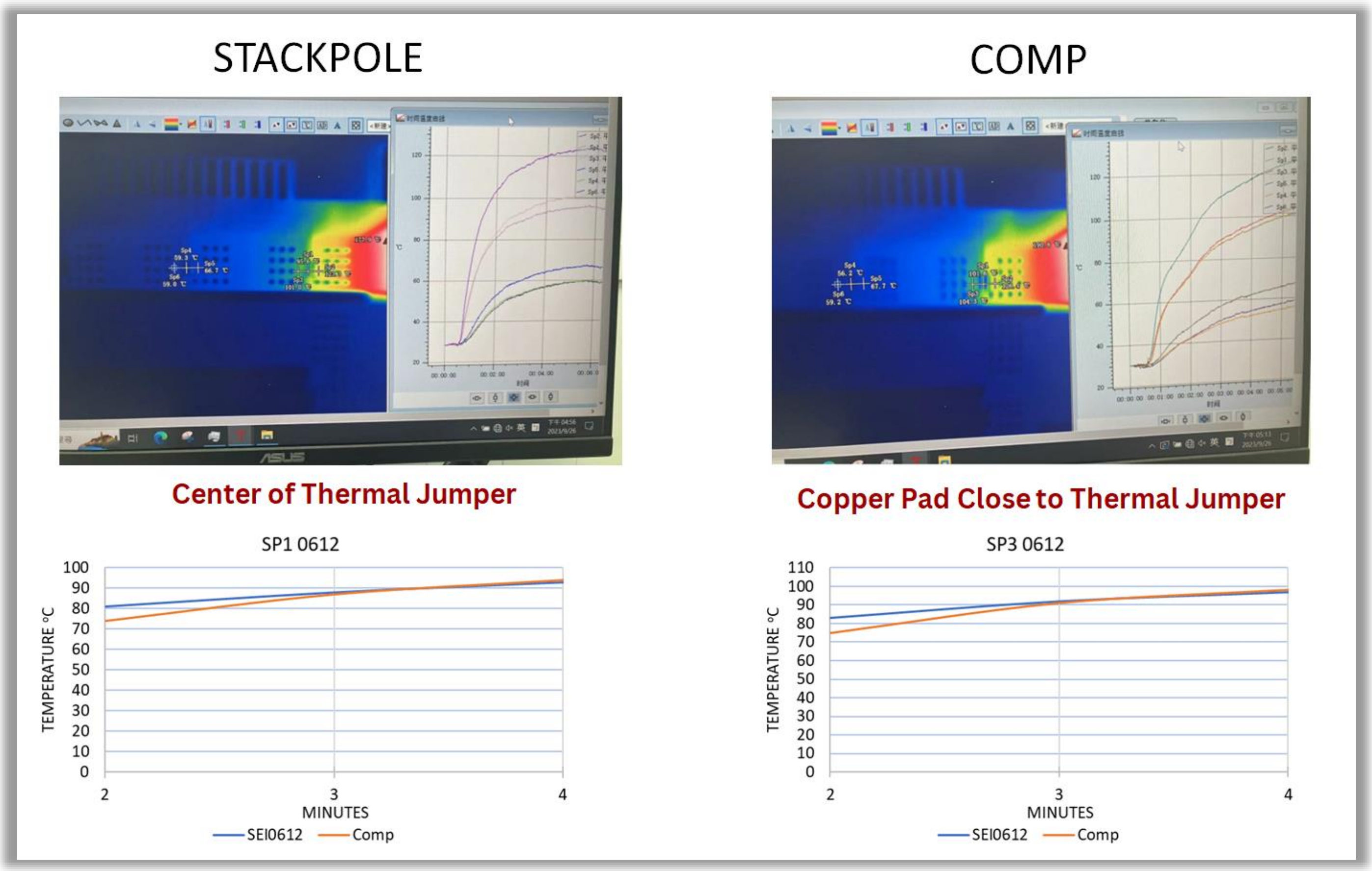


Fig. 5 Heat Dissipation Speed Comparison of Thermal Jumpers

As electronic devices such as power supplies, amplifiers, and data servers continue to provide higher performance, the thermal impact of this higher performance must be considered. High temperatures may affect component performance in the short term and have been proven to reduce long term reliability. Surface mount thermal jumpers such as Stackpole's TMJ series can provide an effective means to improve the performance of a design by lowering the thermal load on adjacent components. Use of the TMJ also allows for increased performance for existing designs by allowing higher power levels while maintaining safe operating temperatures. TMJ thermal jumpers maintain EMC and EMI compliance and offer excellent electrical isolation for components that can't be electrically grounded to heatsinks or chassis.

	No Thermal Jumper Resistor Temp.	One Thermal Jumper Resistor Temp	One Thermal Jumper Temp Diff (ΔT)	Two Thermal Jumpers Resistor Temp	Two Thermal Jumpers Temp Diff (ΔT)
Comp	125.3	118.4	6.9	108.9	16.4
SEI TMJ	125.3	115.8	9.5	107.2	18.1

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