



WSKW0612 Welded Terminal Advantage

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The welded copper terminal of the WSKW Power Metal Strip® resistor reduces the terminal resistance and the associated measurement error that can result from clad construction parts. Additionally, the Kelvin termination improves TCR performance to assure measurement stability across the full temperature range and under varied power conditions. This application note will explore the WSKW's features, the differences between welded copper and copper-clad terminal construction, and the recommended pad layout.

COMPONENT FEATURES

Kelvin Termination

This construction feature is beneficial to current-sensing applications with resistance values < 25 mΩ because it removes a portion of the high-TCR copper terminal (3900 ppm/°C) from the measurement circuit and connects closer to the temperature-stable resistance element. This improves the component's TCR performance. The Kelvin termination also improves measurement accuracy by reducing contact resistance.

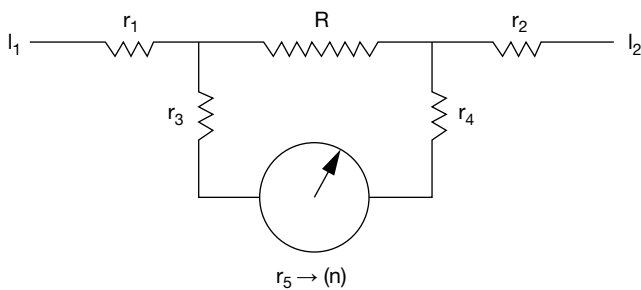


Fig. 1

Long-Side or Reverse Termination

This termination enables a higher power density when compared to a standard-terminated part in two ways. First, by reducing the distance or thermal path from where the heat is being generated in the resistor element to the heat sinking of the circuit board. Second, by increasing the surface area that is soldered to the circuit board. Both aspects improve thermal performance, enabling a higher power capability for the same footprint. The increased power density reduces component count and board space requirements, which reduces costs.

All-Metal Construction

This provides the three key benefits of superior pulse capability, low TCR, and a very low coefficient of thermal expansion (CTE) mismatch between the resistor and PCB. First, the element of the WSKW Power Metal Strip resistor has a substantial cross-section that is self-supporting and does not require a substrate, as compared to a thick film or thin film current sense resistor. This translates into a resistor element with a large comparable mass that provides for superior pulse performance by being able to absorb more electrical energy before the resistor element reaches a similar temperature.

The second benefit of an all-metal construction is that it provides superior TCR performance for very low resistance values, as compared to a thick film resistor.

Lastly, the Power Metal Strip has a CTE that is closer to the circuit board CTE, which results in reduced mismatch and lower solder joint stress. The ceramic substrate of a thick film or thin film resistor is very rigid and does not expand and contract with changes in board temperature, which can result in solder joint failure and reduced reliability.

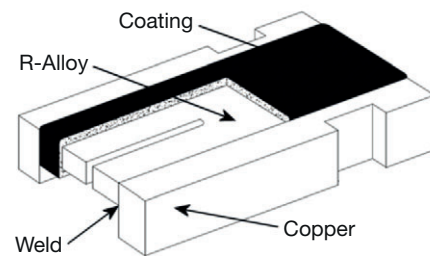


Fig. 2

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WELDED COPPER VS. COPPER-CLAD TERMINAL CONSTRUCTION

The majority of Vishay Power Metal Strip products utilize an all-copper metal terminal that is electron-beam welded to the resistance alloy, as shown in Fig. 3a. Other types of thin copper terminal construction used in the industry are bonded, plated, or clad to a resistance alloy. The thin cross-section electrode imparts different performance characteristics to the part that affect contact resistance and TCR (Fig. 3b).

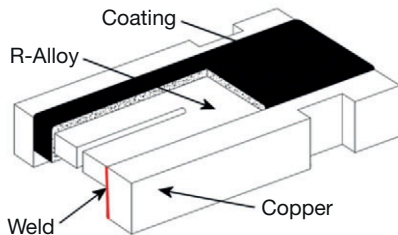


Fig. 3a - Welded Construction (WSKW0612)

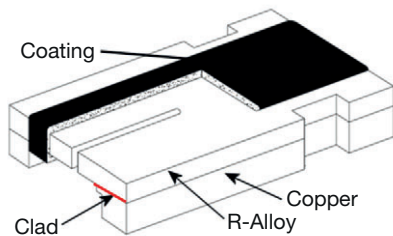


Fig. 3b - Clad Construction

Effects of Clad Construction

The clad or thin cross-section terminal construction increases the resistivity of the termination and changes the interface angle of the current into the resistance alloy. This has two major effects on performance. First, mounting accuracy is reduced, causing less consistency in resistance values when parts are mounted to a circuit board. This means that it is essential for designers using a thin copper terminal construction to take into account the direction and positioning for the current traces to be presented to the part. The second effect is higher TCR, which may seem counterintuitive because the thin cross-section terminal has less copper in the circuit; however, the higher TCR is caused by how the current distributes into the resistor element.

Benefits of Welded Construction

A welded copper terminal reduces the resistance of the termination, which reduces the proportion of the overall resistance that is due to the terminal. In other words, the ratio of the total resistance that is due to the termination versus the resistance alloy is reduced. This significantly reduces the sensitivity to variations in the board mounting process and insures the most consistent in-circuit measurement performance for all resistance values. Additionally, the welded construction improves the TCR performance by directing current flow more consistently to the resistance element. In short, this construction provides a part that is less sensitive to circuit board design and is more stable across a wide range of operating temperatures, which ultimately results in a more accurate resistor.

RECOMMENDED PAD LAYOUT

An evaluation board (Fig. 4a) was designed to assess the impact of component construction and PCB layout on the measured value. Tests were conducted by applying current to the part along different traces labeled “Current Input” A through D and taking voltage measurements at the locations indicated by “Voltage Sense.” We evaluated numerous combinations of different current input locations and multiple voltage measurement locations. For example, we applied a current through the A terminal and took voltage measurements, and then changed the current input to the B terminal and repeated the voltage measurements. We also considered multiple sensing locations, as indicated below in Fig. 4a.

As expected, the different voltage sensing locations resulted in no significant change to the measured value. When current was supplied into trace A and out trace D for the current path, however, it did significantly change the value. A 1 mΩ component with a clad type construction had a 300 μΩ (30 %) change in value when powered through A vs D traces. The WSKW0612 with a welded construction only had 130 μΩ (13 %) of change. This shows the sensitivity of the measured value to part construction and circuit board layout.

To provide a uniform current flow to the part and to establish a standard that can be used in designs, Vishay has provided the layout shown in Fig. 4b.

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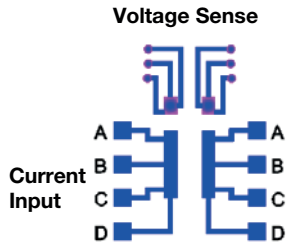


Fig. 4a - Evaluation Board

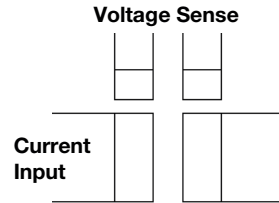


Fig. 4b - Recommended PCB Layout

ADDITIONAL RESOURCES

- Components and Methods:
www.vishay.com/doc?30304
- Product Overview:
www.vishay.com/doc?49581
- WSKW datasheet:
www.vishay.com/doc?30332