

## Large Case Size Chip Resistors

### Cracking Concerns, Broken Solder Joints and Potential Alternatives

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High power electronics often require resistors with higher power ratings. For surface mount resistors, that usually means using large case size chips such as 2010, 2512 and larger. These larger case size resistors are commonly used without any issues. But if the device experiences large temperature variations or board flex, large case size chips may not be a viable option due to connection integrity issues. In this article, we discuss the options for engineers facing this problem.

#### Cracked and Broken Solder Joints and Part Cracking

A previous Stackpole article titled “Coefficient of Thermal Expansion for Chip Resistors” discussed why large case size chip resistors are susceptible to part and connection integrity problems. In short, typical FR4 materials used for PCB substrates have twice the ability to expand, contract, and flex than the 96% alumina ceramic substrates used for film chip resistors. This discrepancy causes too much stress for the solder joints or part itself to withstand.

Normally restricting chip sizes to 1206 and smaller will eliminate these concerns. High power applications, however, may require resistor power ratings too high for a 1206 chip resistor. For situations such as this, there are several options. These options have their own advantages and disadvantages that must be evaluated to determine which option is the best choice.

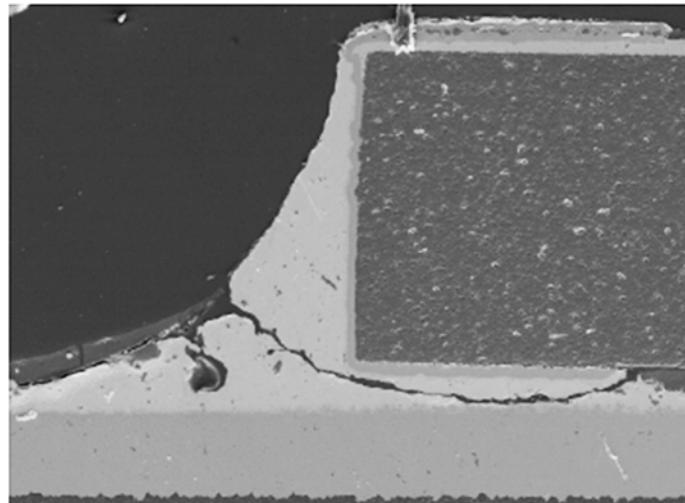


Fig. 1 2512 Size Chip Resistor Showing Cracking at Solder Joint

#### Potential Alternatives

Often, the simplest solution to avoid part or solder joint cracking is to simply replace the large case size chips with multiple smaller size chips. 2010 chip resistors for example may be replaced with two 1206 size chip resistors to dissipate the same power. For 2512 size chip resistors, four 1206 chips would be required. If multiple 2512 size chip resistors are being replaced, the chip resistor count can skyrocket. In addition, 1206 size chip resistors are not as widely available as 0805 size and smaller. Replacing one 2512 size part would require eight 0805's. If multiple 2512 need to be replaced or if board space is limited, this solution is clearly not practical.

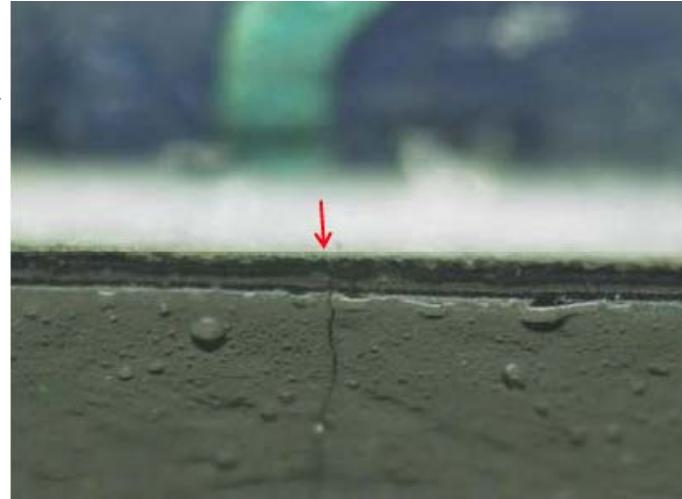


Fig. 2 Cracked Chip Resistor





Fig. 3 Surface Mount Resistors with Compliant Terminations

Surface mount resistors with compliant terminations provide a robust solution to eliminate solder joint and part cracking issues. These terminations flex with the board and provide a solid reliable circuit connection regardless of board flex or temperature changes. This part configuration may have a wirewound, cylindrical metal film, or thick film chip element for a wide range of power, pulse, and frequency requirements. In addition to the termination flexibility, this type of part will inherently experience lower self-heating at full rated power (see Fig. 4), further contributing to the termination robustness under normal full power conditions. However, regardless of power rating, these resistor types are typically larger than resistors with comparable power ratings and are often more expensive as well.

One additional option for applications requiring 1W of power handling or less may be MELF resistors. MELF resistors offer the benefit of a cylindrical substrate which is far more robust to board flex compared to flat chip substrates. In addition, the larger terminations are less susceptible to solder joint failure. Finally, the hot spot temperature of a 1W MELF is roughly 80°C less than a comparable 1W flat chip resistor (see Fig. 4). This means significantly less CTE stress from thermal heat rise of the resistors themselves. MELF resistors are not as readily available as flat chip resistors, are more expensive, and the cylindrical package requires placement equipment to be more sophisticated than what is required for a flat chip resistor.

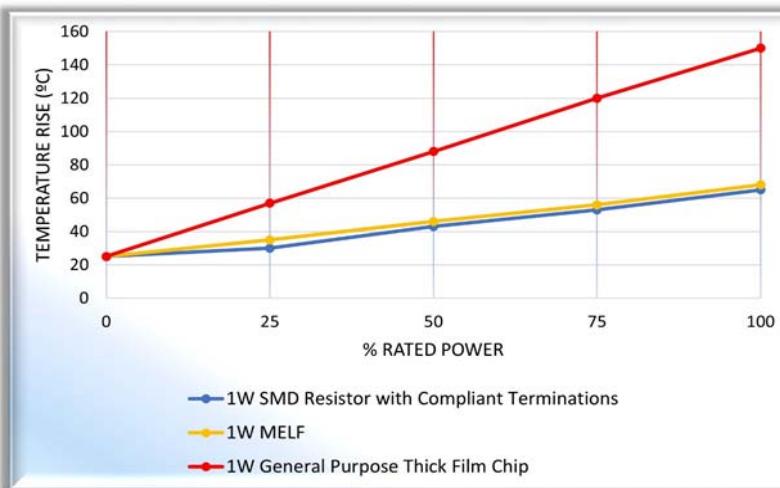


Fig. 4 Hot Spot Temperature comparison for 1W SMD Resistors

## Summary

Applications that require high power as well as being subjected to large variations in temperature or board flex may have difficulty using large case size chip resistors. This combination of factors can lead to part cracking and/or solder joint failure. In some cases, simply downsizing to smaller chip resistors may be the best option. However, when board space is limited, a better solution may be to use resistors with compliant terminations or MELF resistors. Each option has its advantages and disadvantages which should be evaluated to ensure an optimal design for long term reliability and cost effectiveness.

