



MELF Resistors - The World's Most Reliable and Predictable, High-Performing Film Resistors

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ABSTRACT

For more than 25 years, Vishay's MELF resistors have successfully met the demanding requirements of the automotive industry. They offer superior SMD resistor performance in terms of accuracy, stability, reliability, and pulse load capability. The cylindrical construction of MELF devices provides an optimal power rating and pulse load capability related to the mounting space. Continuous development has led to improved long-term stability and moisture resistance, and allows high-temperature operation to + 175 °C.

This paper explores why this resistor series has become so successful, and why there is often no alternative to it today in professional applications.



APPLICATION REQUIREMENTS

The continuously increasing requirements in professional applications call for electronic components that provide superior properties regarding:

- High-reliability electronics
- Predictable behavior of components
- Zero-defect philosophy
- Harsh operating environments
- Environmental awareness

The application areas with the most severe requirements are:

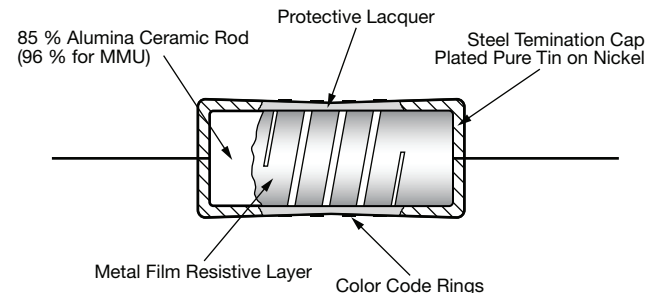
- Automotive industry
- General industrial electronics
- Telecommunication infrastructure

For these applications, MELF resistors have been the customers' first choice for more than 25 years, meeting the requirements for:

- Long-term stability
- Moisture resistance
- Reliability
- Temperature cycling in lead (Pb)-free assembly processes

MELF CONSTRUCTION

MELF resistors consist of a homogeneous film of metal alloy deposited on a high-grade ceramic body. Nickel-plated steel termination caps are pressed on the metalized rods, before a special laser cuts a helical groove in the resistive layer to achieve the target resistance value. The resistor elements are covered by a protective coating, designed for electrical, mechanical, and climatic protection. The terminations receive a pure tin plating for best solderability, either in lead (Pb)-free or lead-containing soldering processes.



ELECTRICAL PERFORMANCE AND THERMAL MANAGEMENT

The resistors' cylindrical 0102, 0204, and 0207 case sizes - equivalent to flat chip sizes 0805, 1206, and 2512 - are suitable for various application requirements. Operating voltages can be applied from 150 V (0102) up to 300 V (0207); rated power dissipation at + 70 °C ambient temperature ranges from 0.3 W (0102) up to 1 W (0207). The maximum film temperature at the specified maximum power rating is + 155 °C.

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The ability to withstand these operating conditions is ensured by the devices' cylindrical construction. Compared to chip resistors of the same mounting space, the area of the effective resistive film is about three times greater, and the larger volume of the ceramic body ensures sufficient heat dissipation.

TEMPERATURE COEFFICIENT, TOLERANCE, AND STABILITY

The resistors' dedicated metal alloy material, applied by a sputtering process followed by thermal treatment, offers excellent properties with respect to temperature coefficient and load-life stability. The smooth helical laser, cutting without damaging the ceramic body, enables very narrow tolerances and creates a current path of constant width for a uniform heat distribution. Consequently, resistor temperature coefficients down to ± 5 ppm/K are available, as well as tolerances down ± 0.02 %. Long-term stability results in a superior maximum resistance change ($\Delta R/R$) of 0.05 % after 8000 h operation for high precision MELF resistors.

PULSE LOAD CAPABILITY

Another aspect of the resistors is their reliability when exposed to various overload conditions. The metal film technology, together with the cylindrical construction of the MELF devices, provides an advantage compared to standard thick and thin film chip resistors in regard to pulse load capability. As shown in the diagram below, thick film flat chip resistors fail at much lower pulse loads than thin film flat chips, and both types are outperformed by thin film MELF resistors.

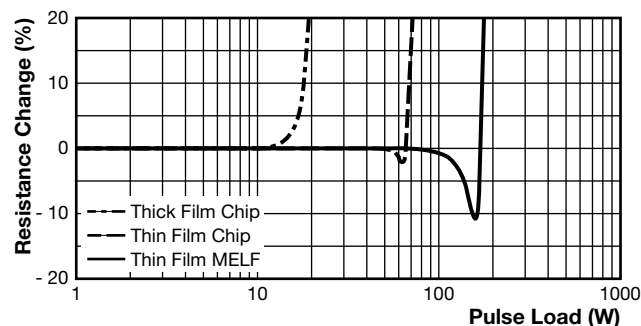


Fig. 1 - Pulse load test - resistance change for different 1 kΩ resistors of comparable body size

RELIABILITY

Tens of billions of MELF resistors have been delivered to customers in the automotive, general industrial industries and telecommunication infrastructure. The devices' approved manufacturing process and certified quality management system are the base for the resistors' excellent observed failure rate of $FIT_{OBSERVED} \leq 0.1 \times 10^{-9}/h$.

APPROVALS

Vishay's MELF resistors are tested in accordance with several international standards, such as EN140401-803 (superseding CECC40401-803). Approval of conformity is indicated by the CECC logo on the package label.

Furthermore, the components meet the requirements of AEC-Q200, which is the most important standard requested by the automotive industry. Environmental aspects are also respected. All products are completely lead (Pb)-free and comply with the Global Automotive Declarable Substances List (GADSL), which includes full compliance with the RoHS directive.

HIGH-TEMPERATURE APPLICATIONS

Further development of the existing MELF series has enabled operation at ambient temperatures to + 175 °C (MELF HT series). This improvement comes along with a higher power rating capability (e.g. from 0.4 W to 0.5 W for the MMA 0204 HT).

For the MELF HT series, three operation modes are specified (e.g. data for size 0204):

- Standard: 0.25 W (derating from + 70 °C)
- Power: 0.40 W (derating from + 70 °C)
- Advanced temperature: 0.50 W (derating from + 70 °C)

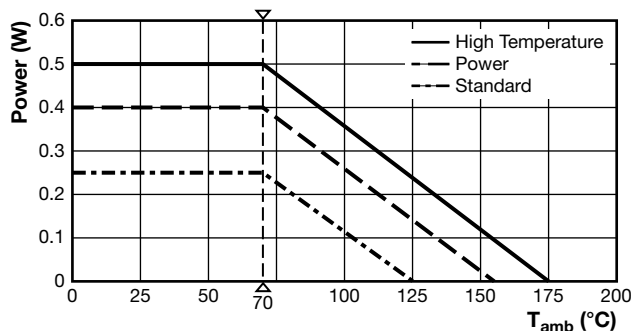


Fig. 2 - Derating diagram for MMA 0204 HT

The maximum resistance change ($\Delta R/R$) after 1000 h of operation is specified for the operation modes:

- Standard: 0.10 %
- Power: 0.15 %
- Advanced temperature: 0.25 %

This performance is unrivalled by thick film or even by most thin film flat chips available on the market. With their improvements in stability and moisture resistance, and by achieving a higher operating temperature, MELF resistors continue to be the first choice for high-reliability professional electronics.