Important Information on the Use of VDRS, VDRH, and VDRUS Through-Hole Varistors With Leads

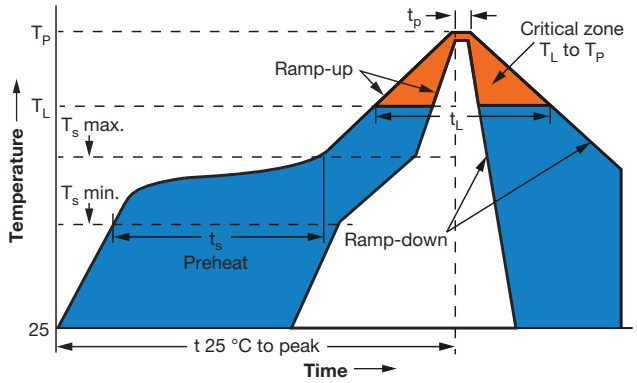
MOUNTING AND HANDLING INSTRUCTIONS

1. SOLDERING

VDR or MOV varistors with leads comply with the solderability requirements outlined in IEC 60068-2-20. The recommended soldering process is wave soldering and for the VDRUS series a reflow soldering (PiP or PiH) is feasible under specified conditions. The combined maximum process temperatures and the maximum time of exposure listed below should be followed:

REFLOW SOLDERING

TEMPERATURE PROFILE (as specified in IPC / JEDEC® J-STD-020D)



PiP / PiH REFLOW PROFILE FOR VDRUS ONLY (as specified in IPC / JEDEC J-STD-020D)

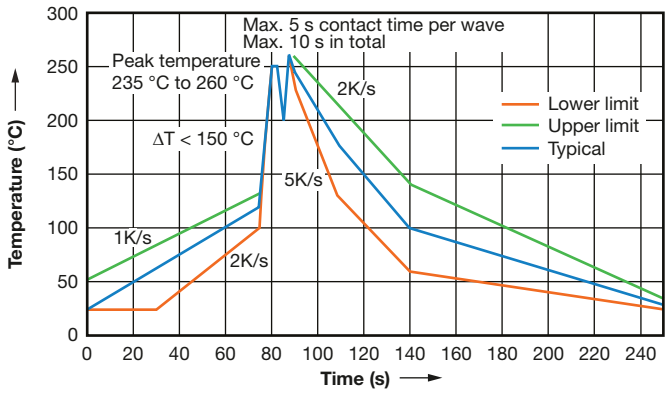
PROFILE FEATURE	TIN (Sn) / LEAD (Pb) REFLOW PROFILE	LEAD (Pb)-FREE REFLOW PROFILE
Average ramp-up rate (T_s max. to T_P)	3 °C/s max.	3 °C/s max.
Preheat - Temperature minimum (T_s min.) - Temperature maximum (T_s max.) - Time (T_s min. to T_s max.) (t_s)	 100 °C 150 °C 60 s to 120 s	 150 °C 200 °C 60 s to 180 s
Time maintained above: - Temperature (T_L) - Time (t_L)	 183 °C 60 s to 150 s	 217 °C 60 s to 150 s
Minimum peak temperature (T_p min.)	215 °C	235 °C
Recommended peak temperature (T_p)	235 °C	245 °C
Maximum peak temperature (T_p max.)	250 °C	250 °C
Time within 5 °C to recommended peak temperature (t_p)	10 s to 20 s	10 s to 20 s
Ramp-down rate	6 °C/s max.	6 °C/s max.
Time 25 °C to peak temperature	6 min max.	8 min max.

As a general rule for all methods of soldering:

1. Preheat the components and the board to within +100 °C of the soldering temperature for a minimum of 60 s. This ramping should not exceed 1.5 °C to 3 °C per second
2. (a) The reflow soldering temperature should not exceed +250 °C, with a maximum time of 20 s
   (b) The wave soldering temperature should not exceed +260 °C, with a maximum time of 5 s
   (c) Vapor phase reflow soldering should not exceed +220 °C, with a maximum time of 30 s
3. In all cases, gradual cooling to room temperature is recommended

WAVE SOLDERING

WAVE SOLDERING PROFILE



The maximum wave temperature should always be limited to 260 °C, and the total wave immersion time should be limited to 10 s max. In the case of double wave soldering, the total soldering time, including the time between waves, should also be limited to 10 s max.

Proper pre-heating and limitation of the temperature difference between the pre-heating stage and the maximum first wave temperature should be limited to 150 °C.

The use of resin-type flux or non-activated flux is recommended. Failure to follow the above soldering conditions may result in thermal-electrical damage to material and permanent resistance changes.

2. WIRE BENDING

The robustness of the termination leads meets the requirements of IEC 60068-2-21. During bending or separating of the leads there should be no mechanical stress at the outlet of the coated body, and the leads may not be bent closer than 4 mm from the outlet of the coated body or from the seating plane. The bending radius should be at least 2 x the wire diameter. VDR or MOV parts should be soldered at their seating plane levels. Specified clamping voltage levels or reaction time can increase if the soldering and mounting height or lead length of the VDR are modified. The part should not be exposed to mechanical stresses, including tensile, torsion, or vibration forces, during normal operation in the application. Larger or heavy VDR parts may benefit from fixing adhesives to damp or neutralize vibration forces.

3. STORAGE - SHELF LIFE

VDR or MOV varistors need to be stored in their original packing containers. The storage location and package containers need to be maintained within the following limits:

Storage temperature: 10 °C up to 40 °C

Relative humidity (without condensation): 10 % to 70 %

Varistors must not be stored in corrosive or deoxidizing atmospheres (Cl_2, H_2S, NH_3, NO_x, SO_x, etc.). Avoid storage in heat or direct (UV) sunlight. The presence of ozone or ionizing radiation must be avoided at all times. Humidity, temperature, and container materials are critical factors that can influence the solderability of the parts. Touching the exposed metal lead wires may change their soldering properties.

Shelf life: properly packaged and stored VDR (MOV) varistors have a minimum shelf life of 24 months after their manufacturing date (DC). Electrical functionality will not be influenced after longer storage time under the conditions described above. The solderability of exposed leads should be checked before using parts that have been stored for more than 24 months after their manufacturing date.

4. HANDLING

VDR or MOV varistors must not be dropped. When handling the devices, chip-offs or any other damage must be avoided. Do not touch components with bare hands; gloves are recommended to prevent contamination of the varistor surface and the ceramic structure during handling. Perspiration or other liquids touching the ceramic body can modify the electrical characteristics in an irreversible way. Rough handling of VDR varistors may result in coating adhesion failures, coating cracks, or reduction of insulation withstanding voltage.

5. SEALING, POTTING, AND GLUING

It is not recommended to pot or seal VDR varistors. MOVs are sensitive to materials that are in close contact with them. The specified characteristics of VDR varistors are only valid when used in standard mounting and ambient conditions. Sealing, potting, or gluing can only be made with suitable resins that are electrically non-conductive, and chemically and mechanically stable over the whole operating temperature range of the VDR varistor. It should be mentioned that the maximum surface or body temperature of some VDRs can reach 175 °C when they are operating in a constant or high power mode under high frequency voltage or current surges. For this reason, Vishay recommends silicone-based adhesives or sealing compounds that have long term stability up to 200 °C, or maximum possible body temperature in the application's conditions of use. There must be no mechanical stress exerted on the component due to thermal expansion or compression during the production process (curing / overmolding / gluing) or in the final application. Glue attached or potted parts can have a reduced thermal cycling capability with induced cracking of the coating and reduction of the maximum surge current capability. There must be no residual forces or stress on the device during normal operation. Extensive testing is encouraged to determine whether sealing, potting, or gluing influences the functionality and / or reliability of the component.

6. CLEANING

Cleaning processes can affect the reliability of the component. If cleaning is necessary, mild cleaning agents are recommended. Cleaning agents based on water are not allowed. Washing processes may damage the product due to the possible static or cyclic mechanical loads (e.g., ultrasonic cleaning). They may cause cracks, which might lead to reduced reliability and / or lifetime. Intensive spraying may lead to coating damage.

7. INSPECTION MEASURING

VOLTAGE VS. (PULSED) CURRENT

VDR varistors exhibit a voltage-dependent resistance that can be expressed by $V = C \times I^{\beta}$, in which C is the voltage at 1 A_{DC} (or pulsed) and β is the tangent or slope coefficient for zinc oxide ceramic material (≈ 0.035). The standard method for measuring the varistor voltage is by applying a 1 mA controlled reference current during limited time (to prevent self-heating) and measuring the voltage across the VDR with a high impedance (> 100 MΩ) voltmeter or source meter at the reference temperature of 25 °C. As the operating current range of a VDR is very wide, ranging from µA to several kA, only specialized measuring equipment can be used to check a wide operating voltage dependent on controlled current. VDR varistors should be measured with very low self-heating (< 1 °C or < D-factor mW application). For higher current levels, only pulses (square or 8/20 µs wave) can be applied to limit the energy load and prevent self-heating (< 1 °C).

DIMENSIONAL

All VDR (MOV) varistor production batches are controlled dimensionally on a statistical basis to guarantee compliance with specifications. When designing a VDR in your application, please verify that the application conditions will not induce any compression stress on the coated varistor body. For example, if the component must be placed in a low height enclosure, the available height must be larger than the specified maximum mounting height of the VDR. Bulk packed VDR varistors have a pitch specified at the seating plane or at the outlet of the coated body. The lead wires can be in a deviating position, though.

VISUAL

Some slight deformations or indentations on the lead wires at the seating plane or at the outlet of the coated body will not affect the reliability of the component. Small coating cracks around the lead-wire outlets do not impact the reliability of the component.

8. OPERATION

Use varistors only within the specified operating temperature range. Varistors should not be used above their maximum specified voltage and current levels unless specified by derating curves as a function of operating ambient temperature. VDRS, VDRH, and VDRUS varistors have not been designed or qualified for use in automotive applications. Varistors that have been sealed, potted, or glued can have reduced maximum operating voltage and current levels. Standard varistors cannot sustain overvoltages for a prolonged time. Prolonged overvoltages can instantly induce heating power beyond specified energy and power levels, with potential thermal runaway and fire ignition, short circuits, or open circuit failures. Environmental conditions must not harm the varistors. Avoid operation of varistors in corrosive, deoxidizing, or reducing atmospheres (Cl_2, H_2S, NH_3, NO_x, SO_x, etc.) unless specified. Only use the varistors under normal atmospheric conditions or within the specified conditions. Avoid any contact with water or electrically conductive liquids. For measurement purposes, see the "Inspection Measuring" section (7). Avoid dew formation and condensation unless the varistor is specified for these conditions. Varistors should normally have low surface temperatures near their ambient temperature. Varistors with a high surface temperature above their ambient should be considered as high risk with potential failing behaviour.

VDR varistors are insulated with a minimum insulation dielectric withstanding voltage as specified in the datasheet. Insulated varistors should not be used above their specified dielectric withstanding voltages.

9. FAILURE MODES

For safety-critical applications, be sure to provide an appropriate fail-safe or redundancy function in the circuit to prevent secondary (product) damage caused by a malfunctioning or failed VDR or MOV varistor. For every use of Vishay varistors, it is the customer's responsibility to consult and respect the Vishay disclaimer notice, which is part of every Vishay product datasheet. If you have any doubt as to the possible failure modes in your application, consult Vishay.

This list of guidelines and information does not claim to be complete but represents the experiences of Vishay and may be supplemented, adapted, or enhanced at any time.