# Important Information on the Use of PTCCL, PTCTL, and PTCEL Leaded PTC Thermistors

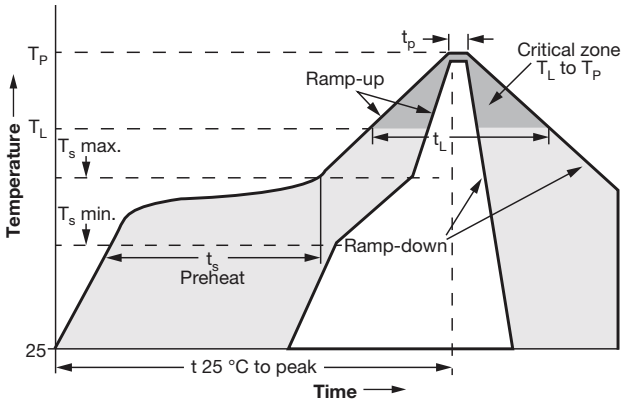
## MOUNTING INSTRUCTIONS

### 1. SOLDERING

Leaded PTC thermistors comply with the solderability requirements outlined in IEC 60068-2-20. Recommended soldering processes are wave soldering and reflow soldering (PiP or PiH). The combined maximum process temperatures and the maximum time of exposure listed below should be followed:

### 1.1 REFLOW SOLDERING

**TEMPERATURE PROFILE**




As specified in IPC / JEDEC® J-STD-020E

**PiP / PiH REFLOW PROFILE**

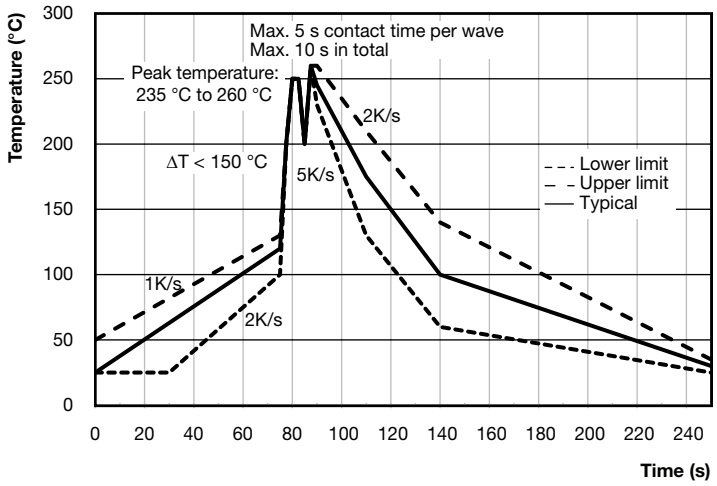
| PROFILE FEATURE | TIN (Sn) / LEAD (Pb) REFLOW PROFILE | LEAD (Pb)-FREE REFLOW PROFILE |
|---|---|---|
| Average ramp-up rate ($T_s$ max. to $T_p$) | 3 °C/s max. | 3 °C/s max. |
| **Preheat** | | |
| Temperature min. ($T_s$ min.) | 100 °C | 150 °C |
| Temperature max. ($T_s$ max.) | 150 °C | 200 °C |
| Time ($T_s$ min. to $T_s$ max.) ($t_s$) | 60 s to 120 s | 60 s to 180 s |
| **Time maintained above** | | |
| Temperature ($T_L$) | 183 °C | 217 °C |
| Time ($t_L$) | 60 s to 150 s | 60 s to 150 s |
| Minimum peak temperature ($T_p$ min.) | 215 °C | 235 °C |
| Recommended peak temperature ($T_p$) | 235 °C | 250 °C |
| Maximum peak temperature ($T_p$ max.) | 260 °C | 260 °C |
| Time within 5 °C of recommended peak temperature ($t_p$) | 10 s to 30 s | 10 s to 30 s |
| Ramp-down rate | 6 °C/s max. | 6 °C/s max. |
| Time 25 °C to peak temperature | 6 minutes max. | 8 minutes max. |
| As specified in IPC / JEDEC® J-STD-020E | | |

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 +260 °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 40 s
3. In all cases, gradual cooling to room temperature is recommended

## 1.2 WAVE SOLDERING

**WAVE SOLDERING PROFILE**




The maximum wave temperature should be limited to 260 °C at all times 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.

## 1.3 HAND SOLDERING

**LEADED PTC THERMISTORS**

| | WITH Cu WIRES Ø < 0.65 mm | WITH Cu CLAD STEEL WIRES Ø < 0.85 mm |
|---|---|---|
| **Solder iron (manual or robot)** | | |
| Maximum solder tip temperature | 340 °C | 360 °C |
| Maximum soldering iron wattage | 50 W | 50 W |
| Maximum soldering time | 3 s | 5 s |
| Minimum distance from thermistor body | 4 mm | 3 mm |

The use of resin-type flux or non-activated flux is recommended. Solder tip may not be applied to ceramic (lacquered) surface or to an exposed ceramic electrode. No flux can reach the ceramic. 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. Before or during mounting, any bending, twisting, or separating of the leads should be avoided. There should be no mechanical stress at the outlet of the coated body. 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. PTC*L parts should be soldered at their seating plane levels. Changing the mounting height by lowering the seating plane can induce higher PCB and solder joint temperatures. Specified current levels can change if the soldering height or position of the PTC is 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 PTC*L parts may benefit from fixing adhesives on the upper seating plane to the PCB level, to damp or neutralize vibration forces.

## 3. STORAGE - SHELF LIFE

PTC*L thermistors 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 to 40 °C
Relative humidity (without condensation): 10 % to 70 %

Thermistors 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 leadwires may change their soldering properties.

Shelf life: Properly packaged and stored PTC*L thermistors have a minimum shelf life of 24 months after their manufacturing date (DC). Thermo-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

PTC*L thermistors 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 thermistor surface and the ceramic structure during handling. Perspiration or other liquids touching the ceramic body can modify the thermo-electrical characteristics in an irreversible way. Rough handling of PTC*L thermistors may result in coating adhesion failures, coating cracks, or chip-offs. Exposed electrodes must not be scratched during handling.

## 5. SEALING, POTTING, AND GLUING

It is not recommended to pot or seal PTC*L thermistors. Ceramic PTC thermistors are sensitive to all materials that are in close contact with them. The specified characteristics of PTC*L thermistors 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 PTC thermistor. It should be mentioned that the maximum surface or body temperature of many PTC*L types can reach 200 °C or more when they are operating in the tripped high resistance mode under high voltage. 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. There must be no residual forces or stress on the device during normal operation. As PTC thermistors are temperature-sensitive components, molding sealing or gluing will affect the thermal surrounding and will influence the response time, power dissipation, and thermal gradient inside the bulk ceramic material. Extensive testing is encouraged in order to determine whether molding, 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. Ceramic PTC material has a porous nature and can absorb liquids easily. Any absorbed cleaning liquid should be removed completely before operation.

## 7. INSPECTION MEASURING

### Resistance Versus (Reference) Temperature

PTC thermistors exhibit a large resistance change depending on the changing surrounding temperature. The change of resistance can range from -1 % to +25 % per degree Celsius. When measuring or inspecting resistance values of PTC thermistors, it is advisable to immerse the thermistor body and its connecting leads in a good thermal conductive homogeneous medium. Such a medium is preferably silicone oil or PFPE non-reactive, per-fluorinated liquid polymers. Water is not recommended because of its electrical conductivity. In any case, when PTC thermistors have been measured in liquids, the measured parts should be discarded, as the fluids can easily enter in the porous ceramic matrix. The liquid medium should be measured with a calibrated thermometer and referenced close to the PTC thermistor body. Measuring PTC thermistors in stirred air is acceptable in most cases where higher tolerance parts are specified. Temperature accuracy levels of ±0.5 °C are acceptable. PTC thermistors should be measured with very low self-heating (< 0.1 °C or < 10 % of specified D-factor in mW/°C) and with voltage levels below 5.0 $V_{DC}$ (preferred ≤ 1.5 $V_{DC}$). When PTC resistance values are measured at higher voltage levels, only pulsed voltages can be used to limit the energy load and prevent self-heating (< 0.1 °C).

**Dimensional**

All PTC thermistor production batches are controlled dimensionally on a statistical basis in order to guarantee compliance with specifications. When designing a PTC in your application, please verify that the application conditions will not induce any compression stress on the coated thermistor 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 PTC thermistor. Bulk packed PTC*L thermistors have a pitch specified at the seating plane level. The lead wires can be in a deviating position, though.

**Visual**

Some PTC*L can have uncoated body parts or exposed electrodes and lead-wires that do not impact the reliability of the parts. Some slight deformations or indentations on the lead wires at the seating plane level won't affect the reliability of the component. The protective coating layer used on PTC*L products has no insulating properties unless specified. Small coating cracks around the lead-wire outlets do not impact the reliability of the component.

## 8. OPERATION

Use thermistors only within the specified operating temperature range. PTC*L thermistors should not be used above their maximum specified voltage and current levels unless specified by derating curves as a function of operating ambient temperature. PTC*L thermistors that have been sealed, potted, or glued can have reduced maximum operating voltage and current levels. Specified holding and tripping currents, dissipation factor, thermal time constant, and response time will change when the parts are not used in a still-air ambient or when sealing, potting, or gluing materials have been applied. Overpowering a PTC*L thermistor can cause thermal runaway and fire ignition, short circuits, or open circuit failures. Environmental conditions must not harm the thermistors. Avoid operation of PTC*L thermistors in corrosive, deoxidizing or reducing atmospheres ($Cl_2$, $H_2S$, $NH_3$, $NO_x$, $SO_x$, etc.) unless specified. Only use the PTC thermistors under normal atmospheric conditions or within the specified conditions. PTC*L thermistors may not be used in vacuums, or at very low or high air pressure. 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 thermistor is specified for these conditions. PTC*L thermistors can have high surface temperatures up to or above 200 °C in some operation modes (tripped state at high voltage). Make sure that surrounding components can withstand higher local temperatures induced by radiation or convection of heat and remain stable at these higher temperatures.

PTC*L thermistors are non-insulated unless a minimum insulation dielectric withstanding voltage is clearly specified in the datasheet. For non-insulated thermistors, any contact with a metallic or conductive surface could result in a leakage current, disruption, short circuit, or a malfunctioning of the component. Insulated thermistors 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 PTC thermistor. For every use of Vishay thermistors, 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.