Mounting and Soldering Nickel-Lead Thermistors

INTRODUCTION

The ubiquitous Negative Temperature Coefficient (NTC) thermistor is found in temperature control applications ranging from telecom lasers to biomedical diagnostic testing. Thermistors are inexpensive, small, and offer the best value in temperature sensing accuracy when they are properly used.

This Application Note focuses on the practical topic of installing thermistors to maximize temperature control effectiveness in your application. For information on choosing the best thermistor for your application, refer to our Application Note *TN-TC01: Optimizing Thermoelectric Temperature Control Systems*.

THERMISTOR PACKAGES

The majority of thermistors sold by Wavelength Electronics have conformally-coated bead-heads, with a diameter of 0.095" (2.4 mm). The head is approximately 0.12" long (3.0 mm). These are nominal dimensions and it's important to remember that size can vary slightly from device to device. Other thermistor packages are available: discs, surface mount chips, and compact axial lead devices.

THERMISTOR MOUNTING METHOD

The most secure method for mounting a thermistor is to place it in a slightly oversized hole in the mounting plate near the device-under-test (DUT). The hole should be about 0.002" to 0.003" oversized: too tight a fit may break the thermistor, and too loose a fit will result in poor thermal contact. Pack the hole with thermally conductive epoxy or thermal paste before inserting the thermistor, and try to avoid leaving air gaps in the hole.

If the thermistor can't be placed in a hole, it can be surface mounted near the DUT. The thermistor must firmly contact the load, either by gently clamping it or using thermally conductive epoxy.

THERMISTOR MOUNTING LOCATION

The location of the thermistor relative to the DUT determines the controller reaction time and load temperature accuracy. Generally the best results are obtained by placing the thermistor as close as possible to the DUT.

Figure 1 illustrates a 6 W power resistor used as the device under test, on a plate mounted to a TEC and heatsink. Two thermistors were used for the test: one thermistor mounted directly on the DUT; a second thermistor located remotely, approximately 6 mm from the DUT. The temperature controller setpoint was 20ºC, and the load resistor was switched on at time = 0.

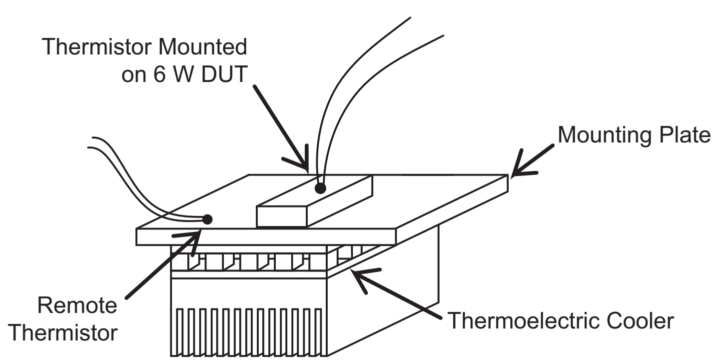

Figure 1. Thermistor Location Test

THERMISTOR MOUNTING LOCATION

Figure 2 shows the results of the tests.

The first test used the DUT-mounted thermistor in the control feedback loop. The controller reacted quickly to the change in thermal load, and settled to the setpoint in under three minutes.

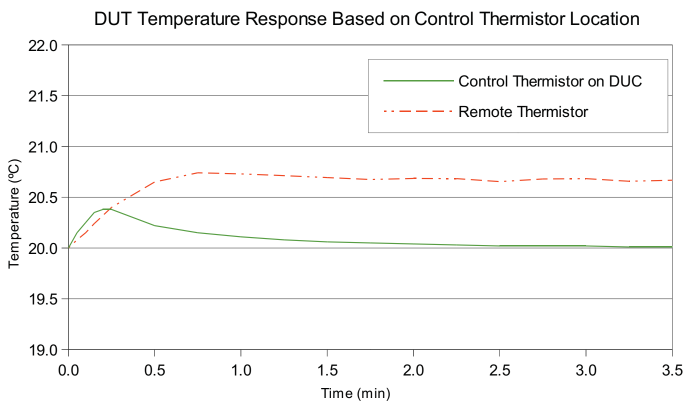

Figure 2. Temperature Response

The second test used the remote thermistor in the control feedback loop, and the resistance of the DUT-mounted thermistor was recorded and plotted. Although the control thermistor indicated good temperature control to the setpoint, the actual DUT temperature was offset by 0.6ºC and exhibited some instability.

The controller failed to bring the DUT to 20ºC because of the thermal resistance of the mounting plate. The instability is caused by small ambient fluctuations, but the control thermistor is too far from the DUT to register the changes, so the controller does not compensate.

This test demonstrates the importance of placing the thermistor as close as possible to the DUT in order to minimize settling time and maximize stability. If the thermistor can not be collocated with the DUT then the P-I-D control loop parameters can be tuned to compensate to some degree.

SOLDERING SOLID NICKEL OR NI-PLATED LEADS

The difficulty with soldering nickel (Ni) wires arises from its propensity to oxidize at elevated temperatures, and once it is oxidized it is virtually impossible to solder cleanly.

Often times, the person soldering leaves the tip of the iron in place too long. The insulation on the wires starts to melt, the nickel wire oxidizes, the soldering iron tip oxidizes, and finally the joint is flooded with solder to form an ugly blackish glob. This technique results in a useable joint, but is ugly, inefficient, and prone to failure.

Here are our tips for soldering Ni-plated or solid Ni thermistor leads to connecting wires and can be used for both leaded and unleaded solder processes. In either case, small diameter (0.015”) flux-core solder is suitable.

- First, strip the insulation from about 1/4” (6 mm) of the thermistor leads. Use high quality mechanical wire strippers that are sharp and well maintained. Avoid nicking the wire by using strippers that are matched to the wire gauge. For high volume production, thermal strippers are worth the expense since they are very quick and do not nick the wire.

- Use light-gauge connecting wire; 24 gauge is sufficient, and stranded is preferable.

- Strip about 1/4” of insulation from the connecting wire:
  - » When using solid wire, lightly tin the exposed end. Use flux and flux-core solder, and use only enough solder to just cover the wire. Using an excessive amount of solder will complicate the soldering process later on.
  - » When using stranded wire, untwist the strands but do not tin the end.

- Lay the thermistor wire side-by-side with the connecting wire, with the ends even.
  - » When using stranded wire, lay the bare end of the thermistor wire in the middle of the bundle and twist them together.
  - » When using solid connector wire, firmly twist the thermistor wire around the pre-tinned wire.

- Use an active flux, such as Kester 2235; non-activated fluxes are much less effective when soldering nickel wires. Flood the joint with flux.

- Touch the solder to the side of the joint, then place the tip of the iron on the other side of the wires. As soon as the solder begins to melt, push about 1/4” more solder onto the joint. Use only as much solder as necessary, and avoid the temptation to flood the joint.

ADDITIONAL SOLDERING TIPS

A few tips will help you master soldering nickel wires.

- If the solder is not flowing into the joint, the solution is not to continue holding the soldering iron in place. The problem is that the nickel has oxidized, and it's time to start over.
- Don't solder at an excessively high temperature; 700ºF is sufficient. The Metcal 138 tip is a good all-purpose soldering tip at that temperature.
- Don't flood the joint with solder.
- The soldering iron tip must be clean and bright. A dull tip is oxidized and does not transfer heat efficiently to the wires.
- While soldering, watch for the tip to turn dull. Once this happens the solder no longer flows onto the tip; instead it balls on the end of the solder wire. This is an indication that the tip has oxidized and needs to be cleaned and tinned.
- If the solder does not flow over the wires smoothly, or if the insulation starts to burn, then the joint has been over-heated and the nickel is oxidized. Clip at least 1/2" from the Ni leads and restart the process.
- If the solder is black or dull once it is cooled then the solder has been overheated and the wires should be clipped and the process repeated.

FINISHING AND STRAIN RELIEF

Finish the solder joint by covering the bare ends with heat-shrink tubing or another insulator.

Ensure the thermistor leads are not stressed in the final mounting configuration. Do not pull the leads tight, and also make sure they can not flex or vibrate. Vibrating leads eventually work-harden, become brittle, and then break.

It is particularly important than the leads not be pulled or vibrated where they connect to the thermistor because it is not possible to resolder the leads to the bead-head.

Install the first strain relief clamp between the thermistor and the solder joint, and install a second clamp on the other side of the solder joint. The remaining length of the connecting wire should be clamped at intervals that are appropriate for the design and application.

REVISION HISTORY

REV	DATE	NOTES
A	4-30-12	Initial Release

KEYWORDS

Thermistor, ntc thermistor, Ni-plated leads, nickel-plated wires, soldering nickel, solder joint, wire oxidation, soldering thermistor leads