ThermOptics®

COMPARISON OF HEATER MOUNTING METHODS

ThermOptics® proportionally controlled heaters are used to control the temperature of sensitive electronic components and other small devices that need to be temperature stabalized for proper operation. These heaters are attached to the device being heated with a thin layer of thermally conductive material between the surface of the heater and the device being heated. Ideally, the heated device would stabalize to the temprature of the heater surface it is attached to. Unfortunately, there is a temperature drop across the thermally conductive interface material between the heater and the device being heated. This temperature drop is due to the thermal resistance of the interface materials. This report makes a comparison between three different types of thermal interface materials and illustrates the effect each has on heat transfer between a heater and the device being heated.

The thermal interface materials that are compared are Dow Corning 340, Loctite 384, and Ablefilm 561. Dow Corning 340 is a Metal Oxide filled thermally conductive cream that is applied between the surface of the heater and the device being heated. Mechanical clamping is necessary to provide good thermal transfer from the heater to the device being heated when this material is used. Loctite 384 is a room temperature cure thermally conductive adheasive. Ablifilm 561K is a glass supported thermally conductive flexible adhesive film that must be clamped and cured between 125°C and 150°C. Loctite 384 and Ablifilm 561K require no additional mechanical clamping after the curing cycle is completed.

A DN505 heater was mounted to an aluminum block as shown in Figure 1c and Figure 1d. The temperature of this heater was set to 80°C with a 7.15KΩ temperature set resistor. The temperature of the block and the electrical power required to heat the block were measured at ambient temperature (TA). Next, the heater and aluminum block assembly was placed in an oven. The temperature of the oven was increased to a temperature slightly below the heater set temperature so that heater draws only several milli amperes of current. The temperature that was measured was 79.1°C. The graph shown in Figure 2 illustrates how the temperature of the block varies as a function of power required to heat the block. The graph was created by drawing a straight line between 79.1°C on the "Y" axis (zero heater power) and the point on the graph representing the measured block temperature and heater power when the measurements were made at ambient temperature.

A second graph (Figure 3) was made to illustrate how the temperature of the block varies as a function of ambient temperature. This graph was made by drawing a straight line between the point when the block temperature and the ambient temperature are 79.1°C (Zero heater power) and the point defined by the intersection of the block temperature and the ambient temperature.

The same DN505 and temperature set resistor was used with all of the thermal compounds tested. A test using Dow Corning 340 was also conducted using a DN515 heater that has approximately three times the surface area as the DN505.

As it can be seen from Figure 2, The Dow Corning 340 thermal interface compound gave the best results. Thermal resistance of 0.28°C/Watt was achieved with the DN505 and 0.134°C/Watt for the DN515. The results using the DN515 was better because the heater surface area is 2.8 times greater than the heater surface of the DN505. The only problem with the Dow Corning 340 is that the heater and the object being heated must be mechanically clamped. The Loctite 384 yielded a thermal resistance of 0.48°C/Watt. This means that if temperature drop across the thermal interface would be 4.28°C if the heater was operating at full heating capacity of 10 Watts. The Ablefilm produced the poorest results with a thrermal resistance of 1.33°C/ Watt. This is because the glass supporting film is 0.005" thick. This is quite thick compared to a thicknes of one to two thousands of an inch for the Dow Corning 340 and Loctite 384 which causes higher thermal resistance.

It is important to clean the heating surface of the heater and the device being heated regardless of the thermally conductive compound used to mount the ThermOptics® Proportionally Controlled Heaters. Any particle or foreign matter between the surfaces can result in poor heat transfer.

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TEST SET-UP USED TO MAKE A COMPARISON OF THE THERMAL RESISTANCE OF THREE TYPES OF THERMAL INTERFACE MATERIALS

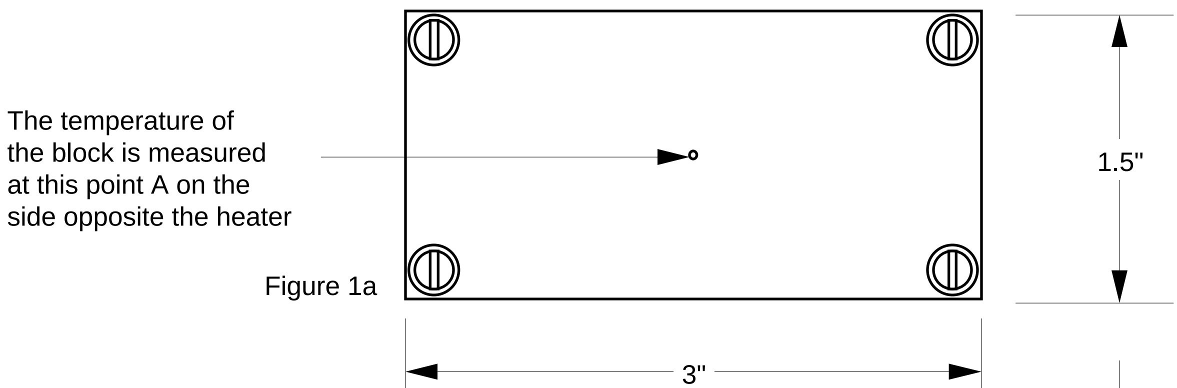

Figure 1a

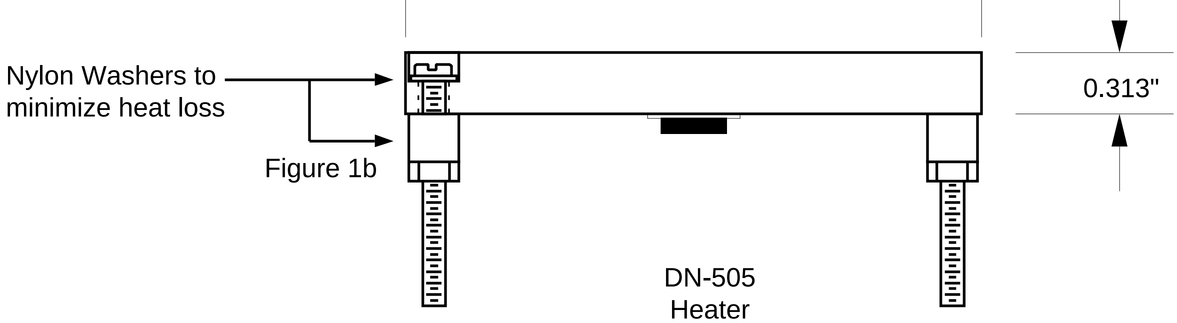

Figure 1b

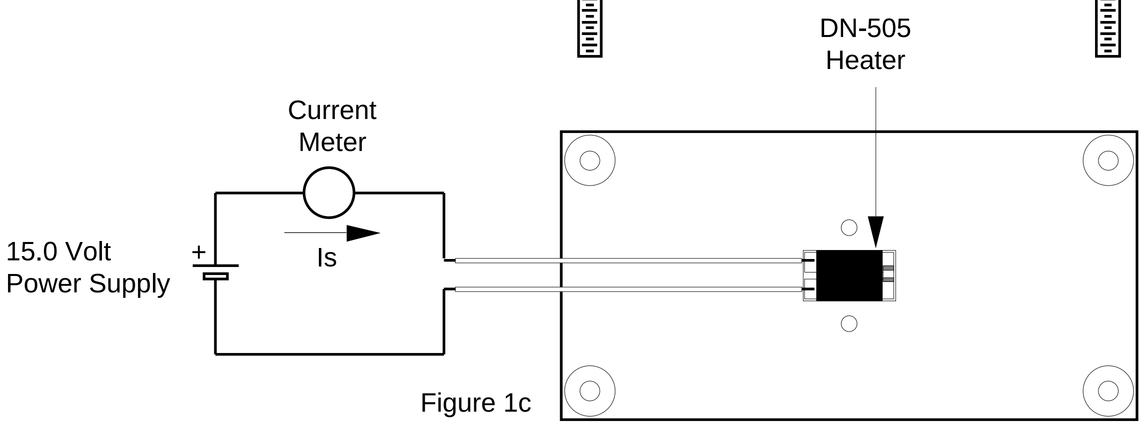

Figure 1c

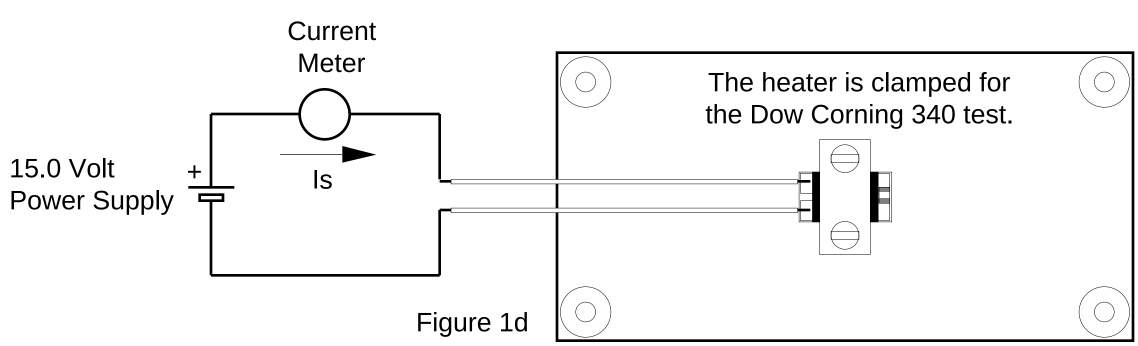

Figure 1d

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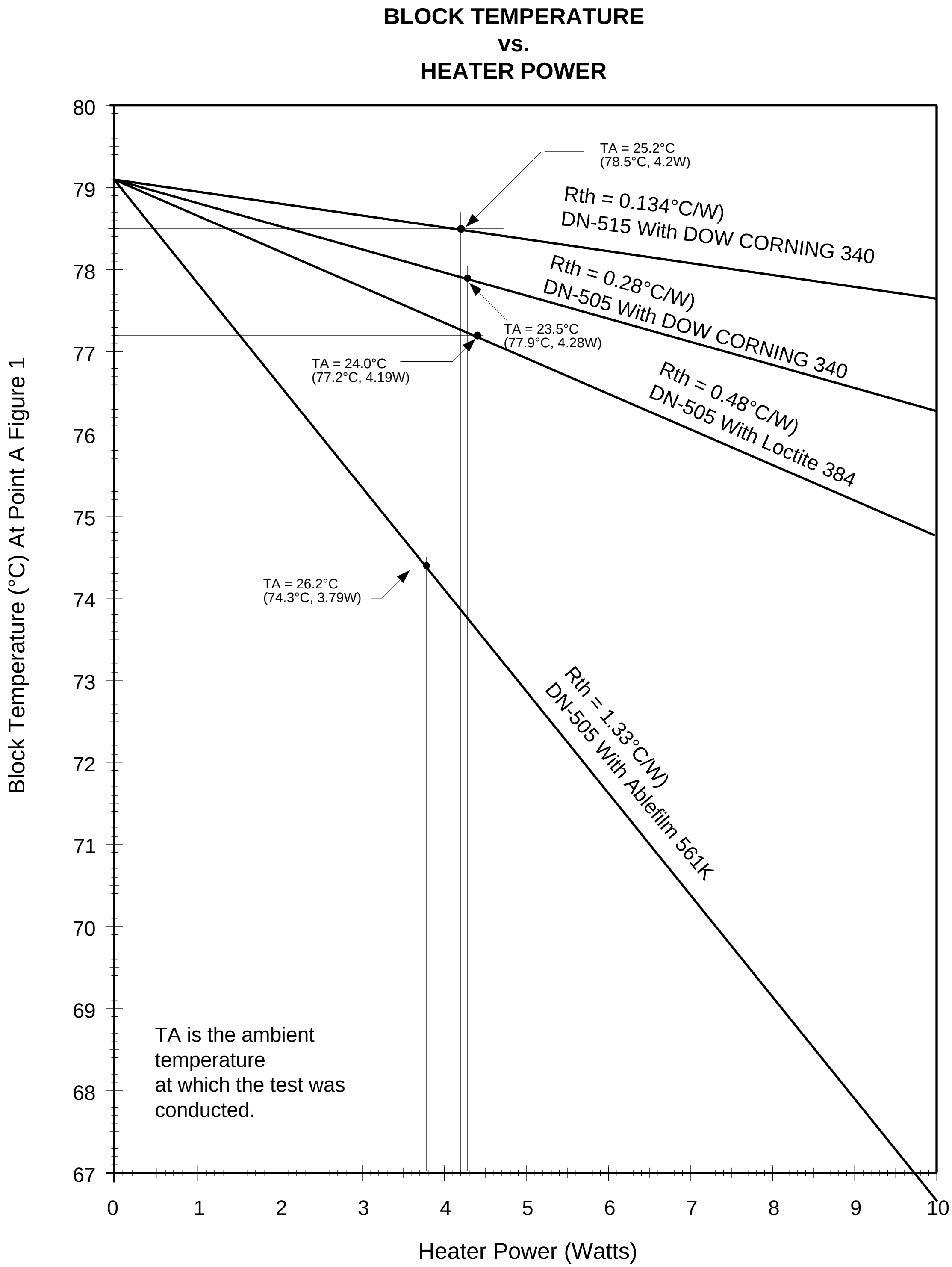

Figure 2

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Block Temperature @ Point A
vs.
Ambient Temperature

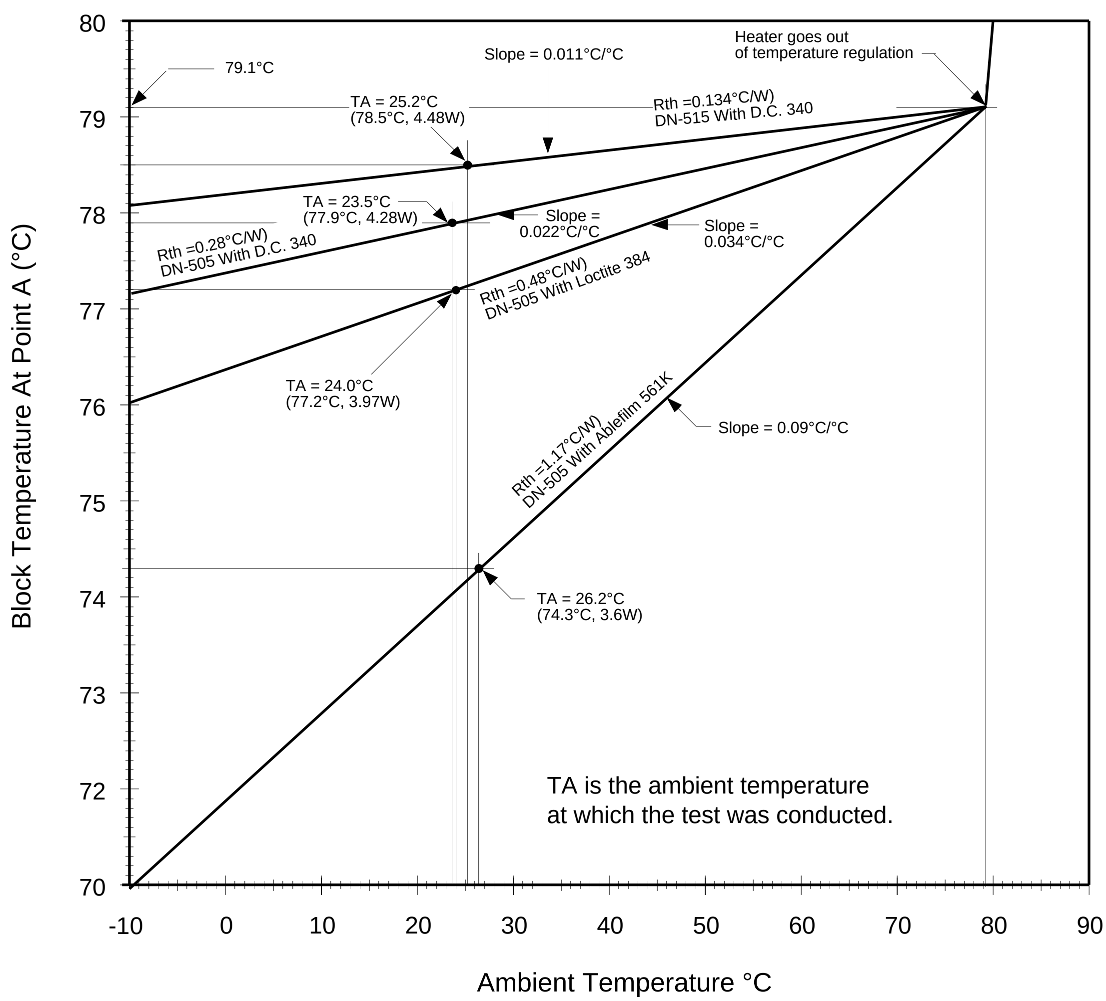

Figure 3

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