Magic Resistor

Top-Side Cooling

Thin Film Technology Corp.'s (TFT) magic resistor is a result of a collaboration with Picotest in which a resistor/heat sink configuration was required for a high-stress, high load application. The testing results from both parties concluded the resistor could withstand far beyond its presumed specifications. Thus, dubbed as the "magic" resistor, this component dissipated heat from the PCB (Printed Circuit Board) like magic.

The Magic Resistor

As a project collaboration with Steve Sandler, president of Picotest and Design Con's 2023 Engineer of Year, the magic top-side cooling resistor is a result of a joint thermal dissipation study. The purpose of this study was to better understand the properties of a resistor/heat sink configuration in a high stress environment and to further push the power/temperature ratings of each part. TFT developed and tested several solutions before configuring one of its 0508 resistors mounted downward in the simulation environment and finding that it performed well beyond its stated specifications. Initially it had been rated up to 1 watt, but after testing conducted by both parties the "magic" resistor withstood up to 50 watts with the Picotest heatsink.

The key factor in this performance change is the dependence of the heat dissipation relative to the resistive element position; downwards or upwards. When the resistor is mounted downward, with the resistive element closer to the PCB, there is a significant amount of heat traveling through the PCB board as opposed to the top of the resistor. Most conventional resistor designs are constructed to be mounted this way. Figures 1 & 3 shows the simulation model and graph plot of the heat traveling at the top of the resistor and bottom of the PCB board with just the mounted part on the PCB. Both peak temperatures are high, and the peak temperature of the bottom PCB board is also much higher than the top. This means that the heat is staying down in the PCB traces, rather than being dispersed in the air.

Figure 1: Downward Facing Element

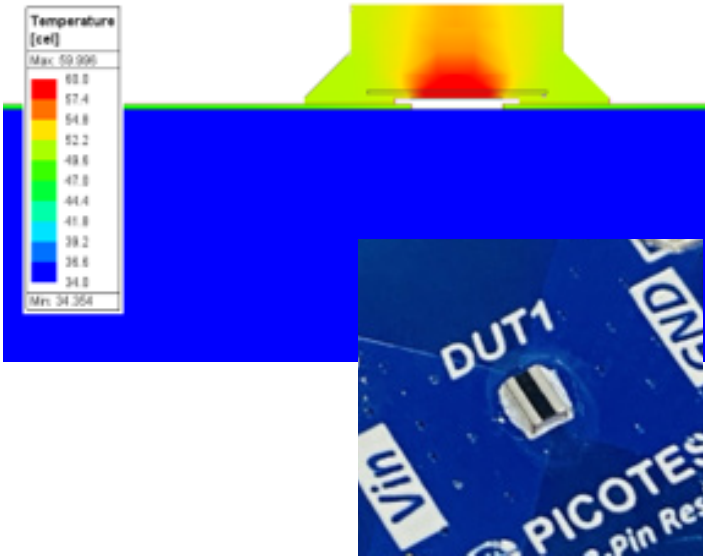


Figure 2: Upwards Facing Element

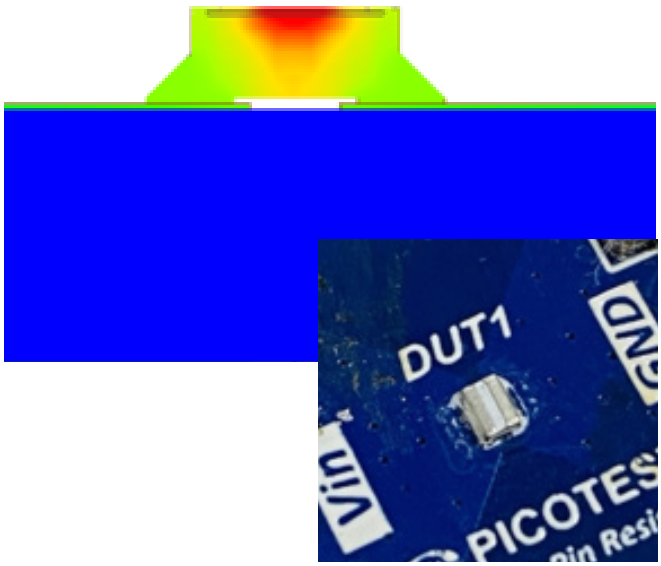


Figure 3: Downward Facing Temperatures of Top PCB vs Bottom PCB

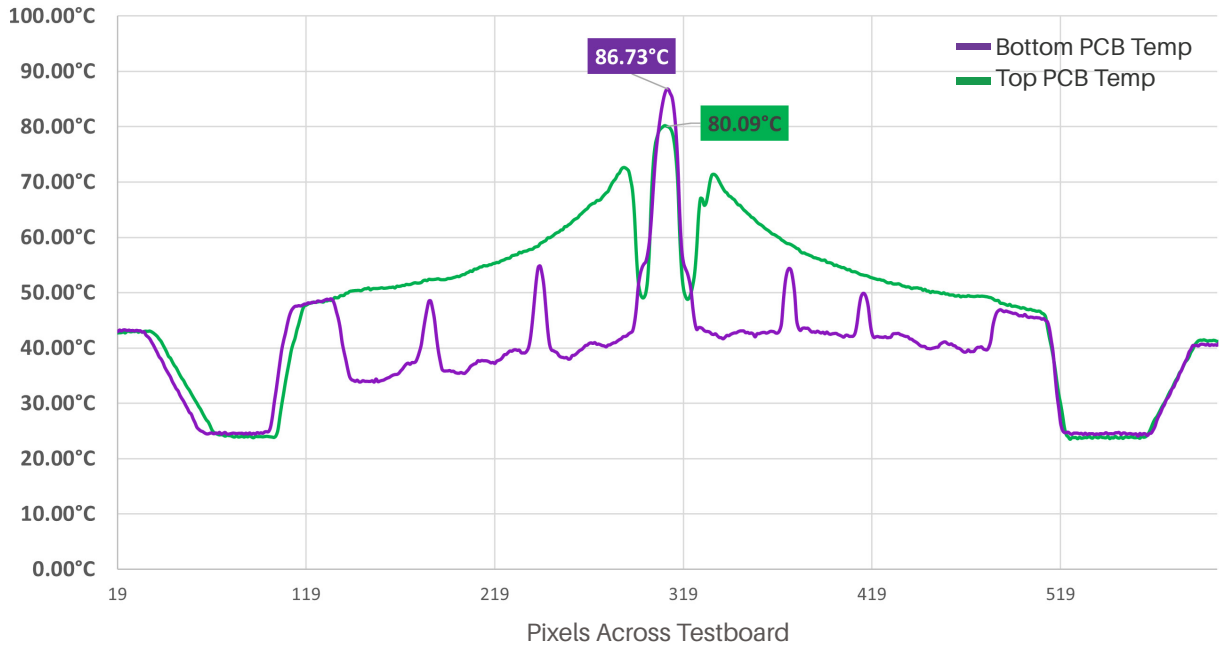
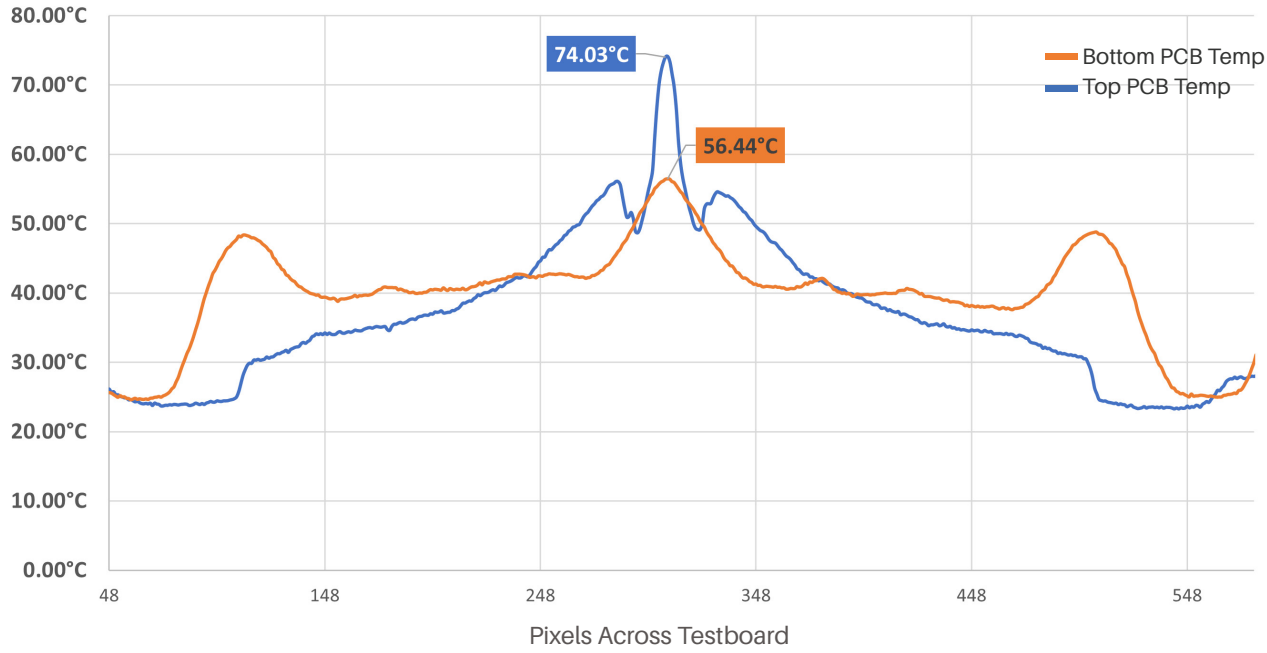


Figure 4: Upward Facing Temperatures of Top PCB vs Bottom PCB

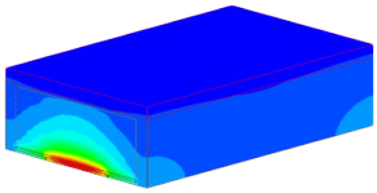


Both Graphs Note Temperatures of PCB with a Mounted 50ohms Resistor without the Heatsink at 1 Watt

Figures 2 & 4 show lower overall PCB temperatures with the bottom peak temperature much lower than the top of the PCB while the resistor is mounted facing upwards on the PCB. When the resistor is mounted upward, with the resistive element facing away from the PCB board, the amount of heat going through the air is much higher as opposed to the path through the board. The dissipation of heat away from the PCB is better while the resistor element is facing upwards than downwards.

The true "magic" of this resistor was due to the shockingly simple solution, flipping it over. With flipping it over, TFT and Picotest found it performed better than expected under high power. They both concluded that due to the location of the resistive element, the thermal integrity of the overall board improved.

Resistance Range:	10mΩ~2Ω
Tolerance:	±0.5%, ±1.0%, ±2.0%, ±5.0%
TCR:	±150ppm/˚C, ±100ppm/˚C



Sometimes the toughest questions are best solved with help from a fresh perspective. TFT is dedicated to tailoring creative, bespoke solutions for even the most challenging of projects. With a long history of developing products such as high-frequency passives and current sensing resistors, it has assisted global industry innovation since the 1970s.