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Monitoring the Homogeneity of Temperature Fields in Thermal Chambers

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GOAL OF THE STUDY

Temperature being a non-electrical quality requires additional sensors and circuitry to measure, monitor and control. Thermal chambers allow us to test electronics prior to their release on the market to make sure that they meet the technical specifications we want. In a niche environment, thermal chambers are used to solder the SMD components on the PCBs, being part of reflow ovens. For desktop size reflow ovens, the temperature behavior is particularly important due to the standards we need to follow in order to ensure a repetitive and reproducible reflow profile. For this purpose, the monitor solution designed, build and tested is presented in this article.

METHODOLOGY OF THE INVESTIGATION

The main purpose is to provide a customized way to monitor the temperature distribution in a thermal chamber. Having 5 temperature sensors distributed in a specific configuration in order to evaluate the thermal performance of a reflow oven (chamber shape, PID algorithm, isolation efficiency).

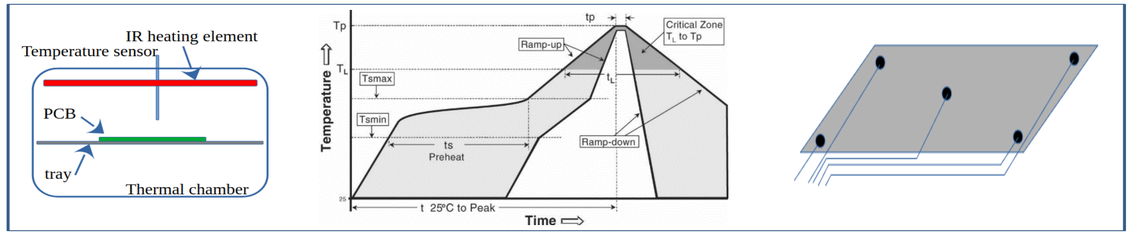

Fig. 1. Depiction of a generic thermal chamber (left), the standard reflow profile (center) and temperature sensors layout (right)

THERMAL PROCESSES IN THERMAL CHAMBERS

The most common form of heat transfer is **conduction** and this occurs through physical contact. Heat conduction is a process depending on the following: the temperature gradient, the cross-section of the material, the length of the heat propagation path and the properties of the material.

Thermal **radiation** propagates through the emission of electromagnetic waves. They take the thermal energy away from the object that emits it.

Thermal radiation can occur through a vacuum or through any substance, be it solid, liquid or gas. Thermal radiation is the direct consequence of the random movements of the atoms and molecules.

When a matter in the form of a gas or liquid is heated and then moved away from the heating source, it transports the thermal energy in the form of **convection**. The movement of fluid near a hot surface is manifested by an increase in volume, becomes less dense and rises.

DEVICE DESIGN

The device was designed to provide more accurate information related to the temperature inside the thermal chamber during the running of the reflow profile. There are two possibilities to characterize the thermal chamber in our desktop reflow oven: using a 2D layout or a 3D layout. The focus of this project was the 2D layout as the 3D one will increase complexity without bringing any additional significant benefit.

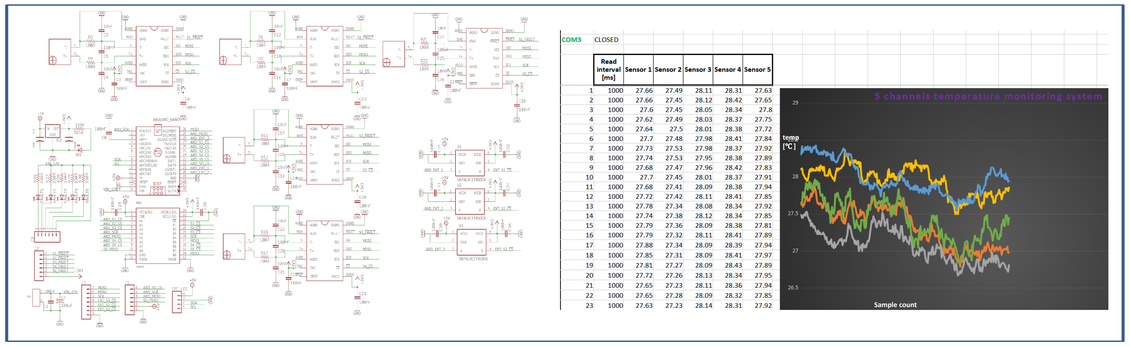

Fig. 2. Device schematic (left), and experimental test data (right)

MAIN RESULTS FROM THE STUDY

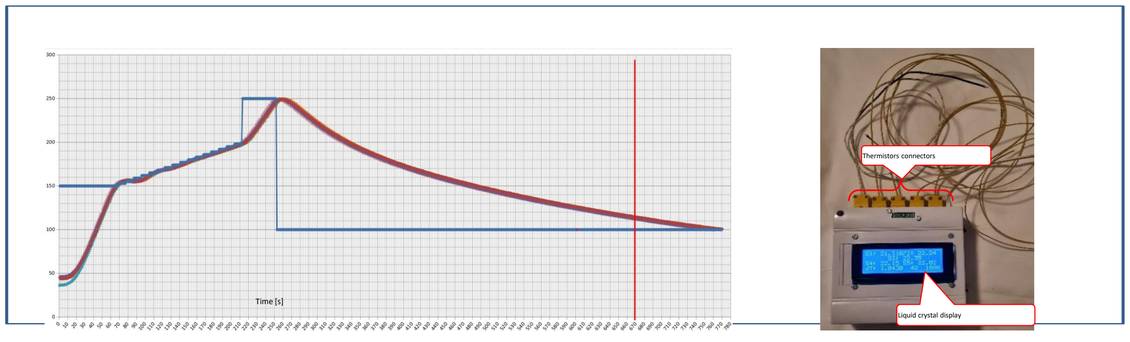

Fig. 3. Experimental data from all 5 sensors (left), and device appearance (right)

CONCLUSIONS

From the experimental data presented, it observed that at the level of the PCB, the temperature is homogenous within very acceptable limits (from the experimental values the maximum difference between the all 5 thermocouples readouts was under 4°C). The temperature set points used in the experiment are not following any kind of lead or lead-free reflow profile, however, it is clearly visible that the thermal regulation works as expected.