

Modifications To The ECAL Heater Controls

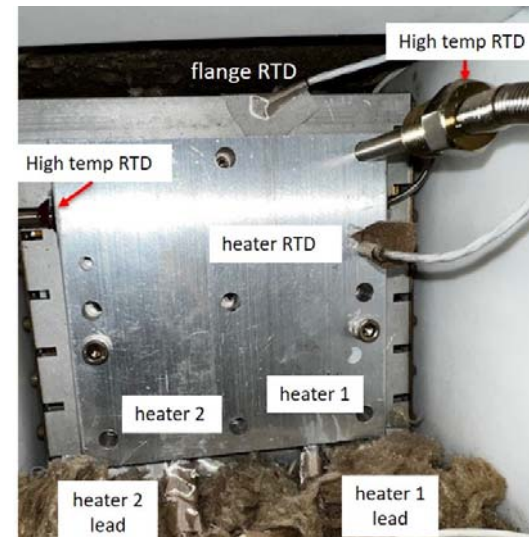
Marc McMullen
2023-03

This month I modified the ECAL heater controls software to control the power output of a new prototype dual heater block. The new heater block is a 4" x 4" x 0.5" aluminum block, with a hole pattern designed to mount the block directly to the ECAL supermodule front flange. The block has two holes drilled in the top edge of the block which is designed to fit a 6mm x 25mm cartridge heater in each hole. Additional holes were drilled in the sides for cartridge-style RTDs.

The first iteration of the software I developed for the ECAL heater controls teststand was designed to power a single 125 W heater. The new heater block has two 24 V, 70 W heaters. Initially, I tried to power each heater with a single channel (50 V, 5 A) of the Agilent N6700B supply. The LabVIEW-based power supply controls sub-VI would supply the voltage set point and output enable to the power supply channel and I should get the appropriate output power. However, the supply has an internal power limiter of ~50 W per channel. At 24 V, each heater would draw almost 3 A of current, which exceeds the internal power limit of the power supply, causing the supply output voltage to stop around 21 V. The heater output was stuck at ~53 W. To improve the output, I put two channels in series and reconfigured the power supply control sub-Vi to split the demand among the two channels. Each channel would supply half the voltage, allowing all the power required for each heater.

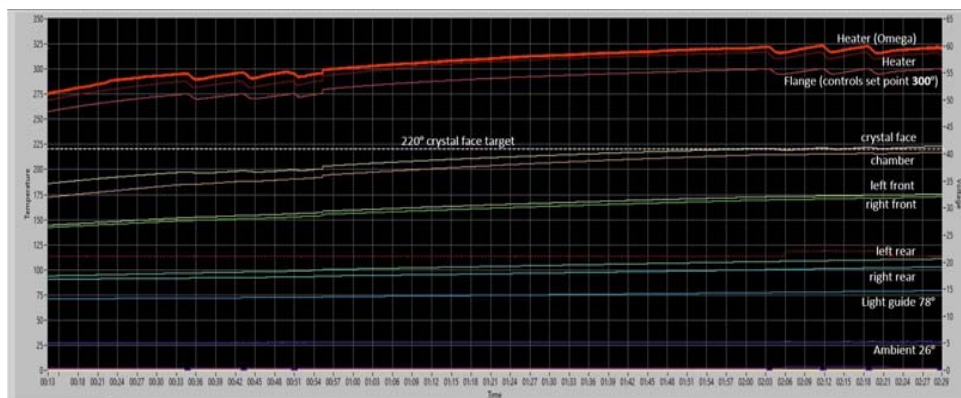
I also needed to display live monitoring of all signals during the heating process. During the initial run, I would just monitor the temperature values, but it was difficult to track the trend over time. So, I developed a monitor plot of all the signals which runs independently of the controls software.

- Modify the controls for the prototype heater
- Develop a realtime monitoring plot
- Develop independent safety controls



Prototype heating block with cartridge heaters and RTDs

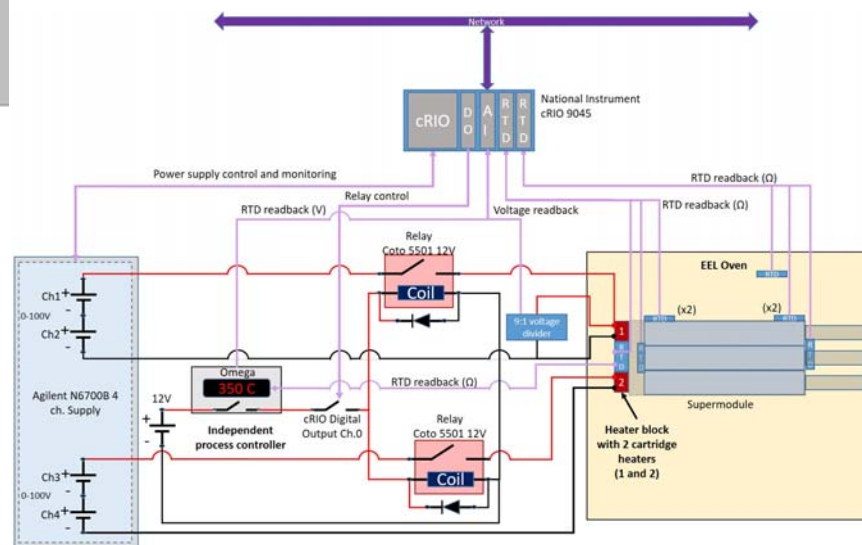
ECAL Heater Controls Test Stand



Live monitoring plot of temperatures as the target temperature was reached

Finally, I decided to include an independent safety monitor for the system using an Omega process controller in-line of the voltage to the heater relay coils. I installed an RTD so the Omega can independently monitor the heater temperature. Next, I downloaded software drivers for the Omega and uploaded settings to the Omega so that it would open its relay contacts if the heater temperature exceeded the setpoint I had uploaded. I set the Omega setpoint to 350°C, which was 50° above the heater controls setpoint for the front flange. I feel this is necessary, as an additional safety check to prevent the temperature from exceeding a “Hi-Hi” setpoint if any of the control elements fail. For instance, an RTD could stop reading properly, which would cause the controls to continue to provide power beyond the desired setpoint.

In conclusion, the teststand was able to hit the target temperature of 220°C on the front surface of the crystals using the prototype heater. I will move the equipment to the six-supermodule teststand. The current controls are setup to operate two channels in tandem. I will modify it so that channels are independently controlled. However, the Omega will still monitor the temperature of the chamber and turn off power to all channels to prevent an over-temperature of the whole system.



Two channel ECAL heater controls teststand diagram