

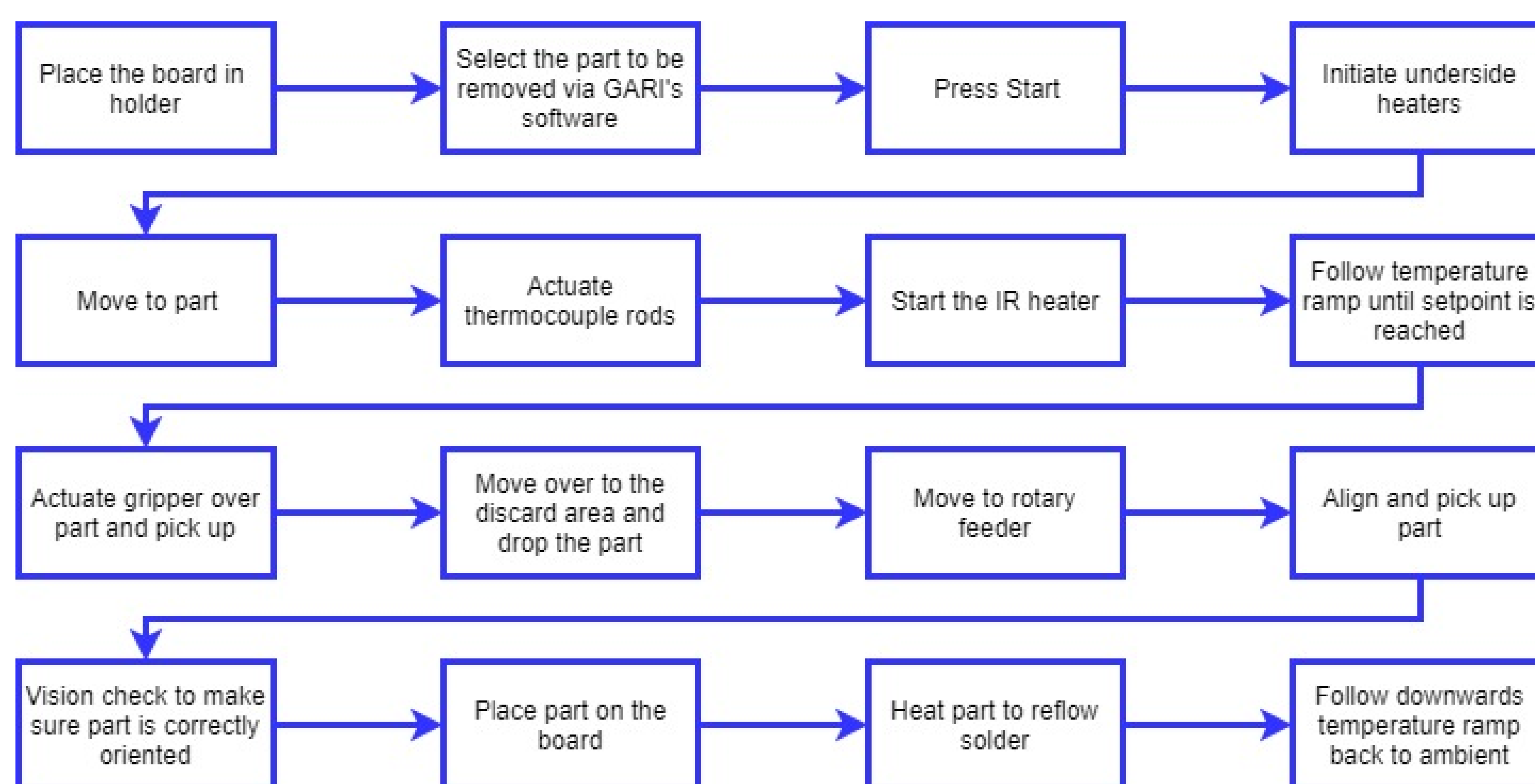
Background

. Northrop Grumman utilizes many low volume electronic components. Due to the low volume nature, it is labor and cost effective to rework components. The Gantry Automated Rework interface is a fully automated platform that revolutionizes industrial rework. G.A.R.I. provides an easy to use interface that allows inexperienced technicians to remove and replace the smallest ball grid array packages in industry.

Overview / Design Specs

- Remove and replace components of edge length 1mm to 5mm
- 0.005" of precision
- Achieve solder reflow at 220°C
- Thermal Ramp < 2.2°C/sec
- Full automation
- Closed loop heater control
- Closed loop vision position control

Process



G.A.R.I.

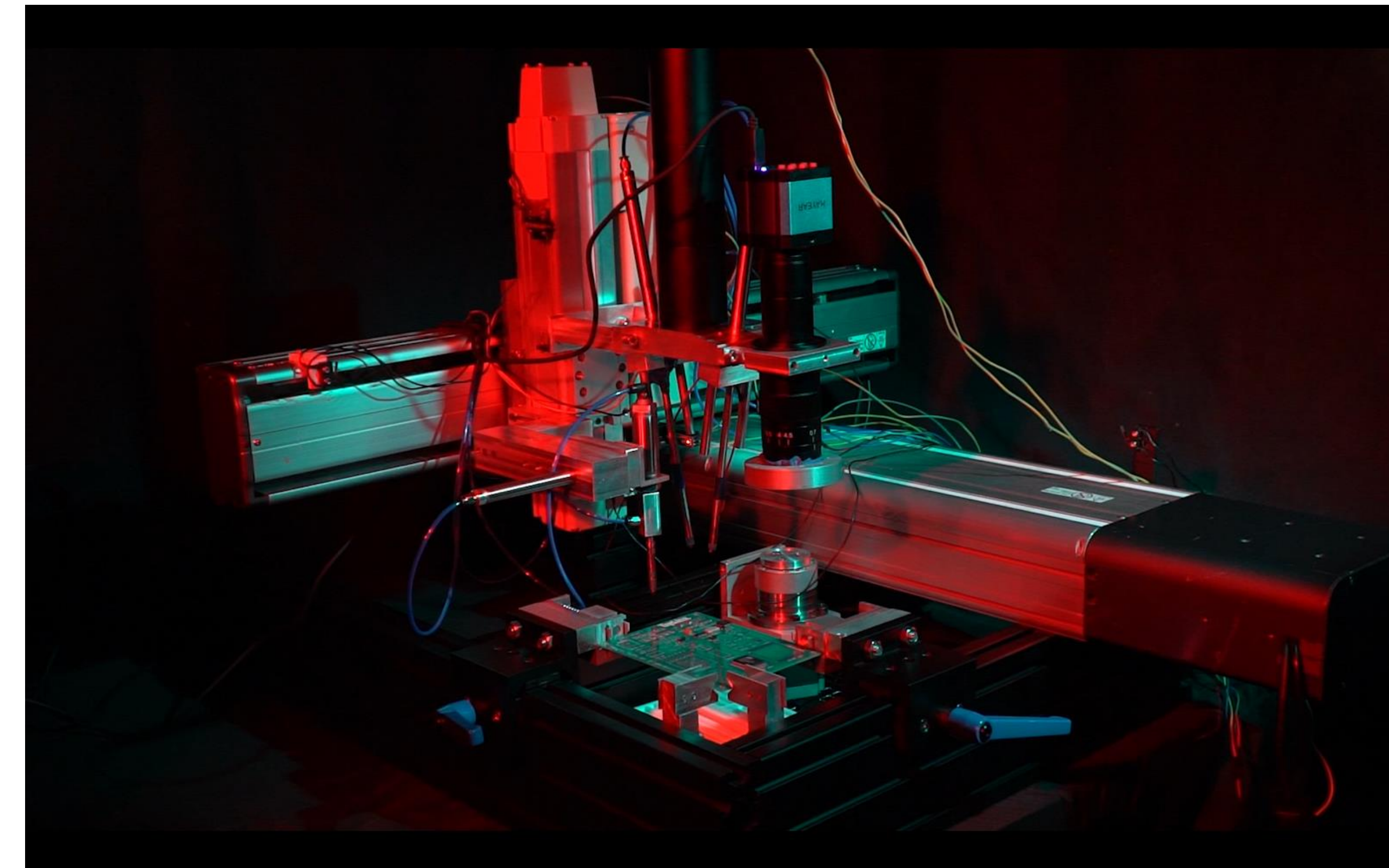
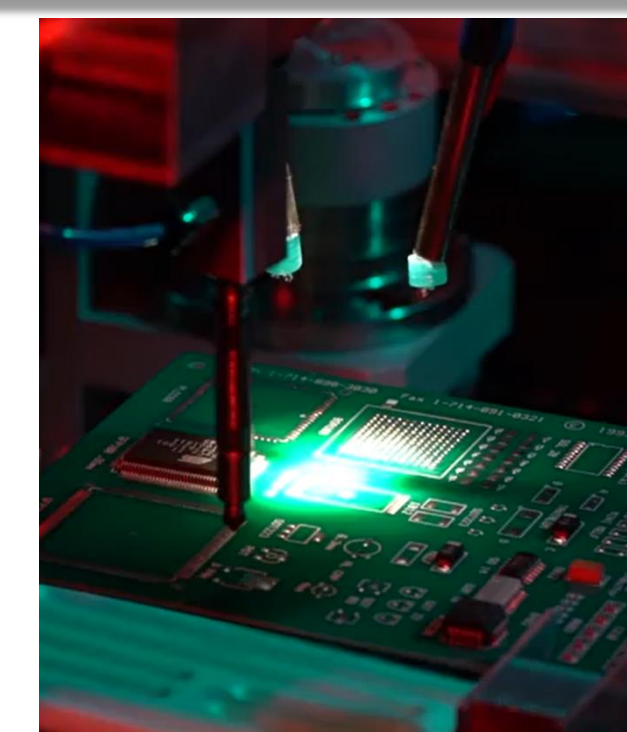


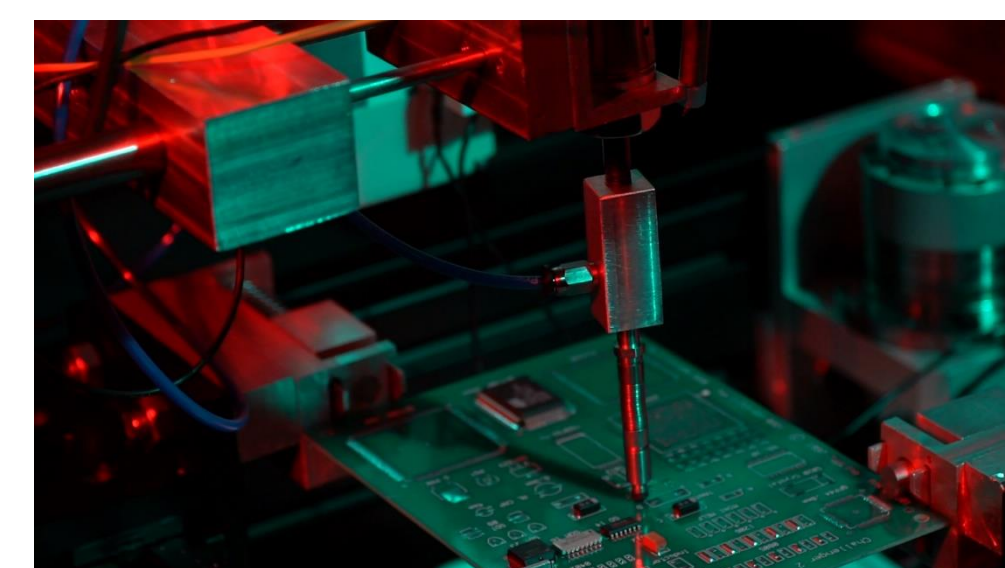
Figure 1: Assembly of Gantry Automated Rework Interface

Hardware / Key Components



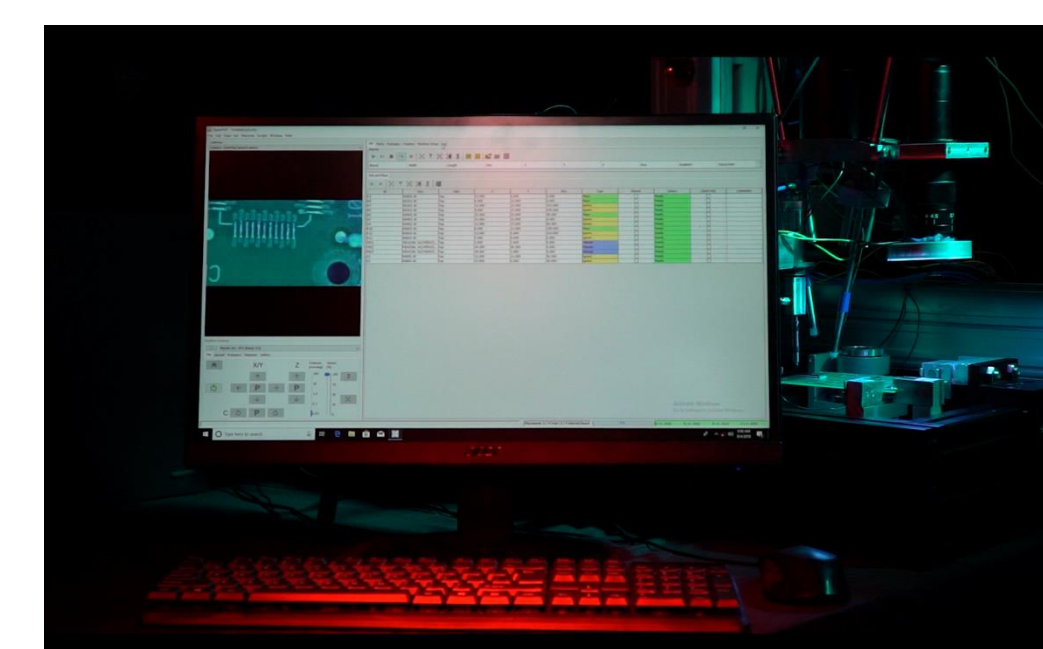
Heater

Focused infrared heater that achieves solder reflow temperature of 220°C without damaging nearby components.



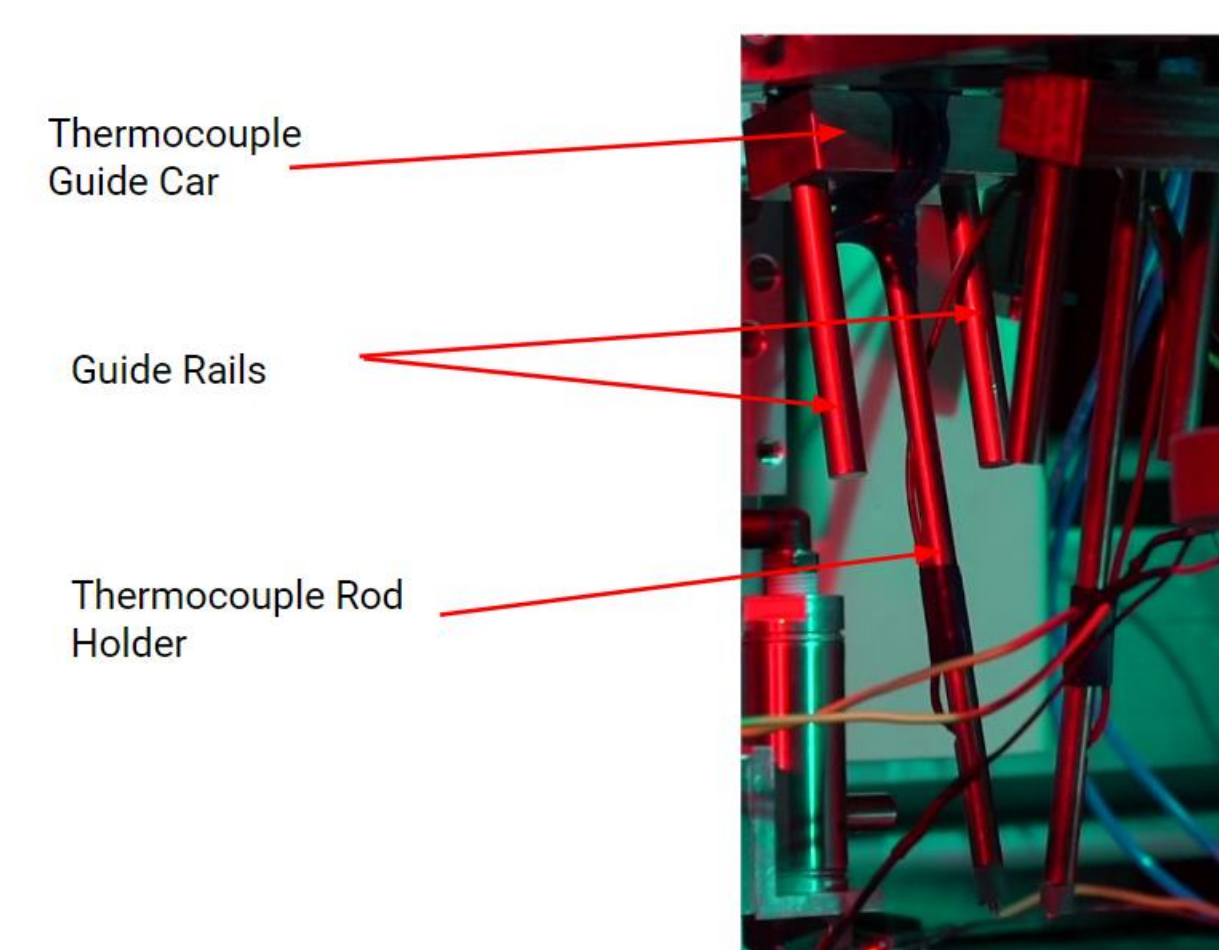
Gripper

Pneumatically actuated, heat resistant, vacuum gripping system to handle delicate parts precisely.



Vision

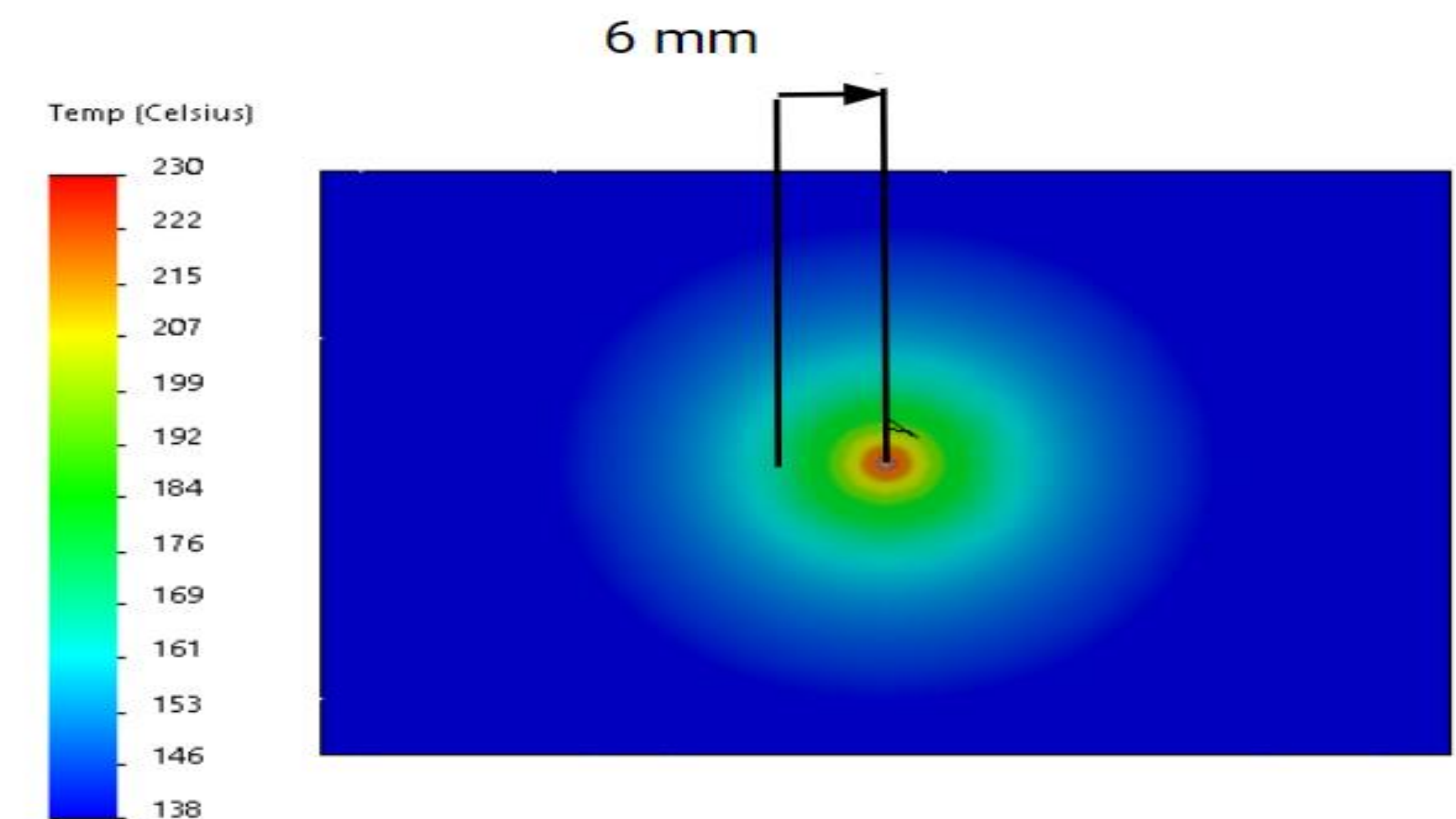
Computer vision processing to ensure accurate removals and placements.



Heat Sensing

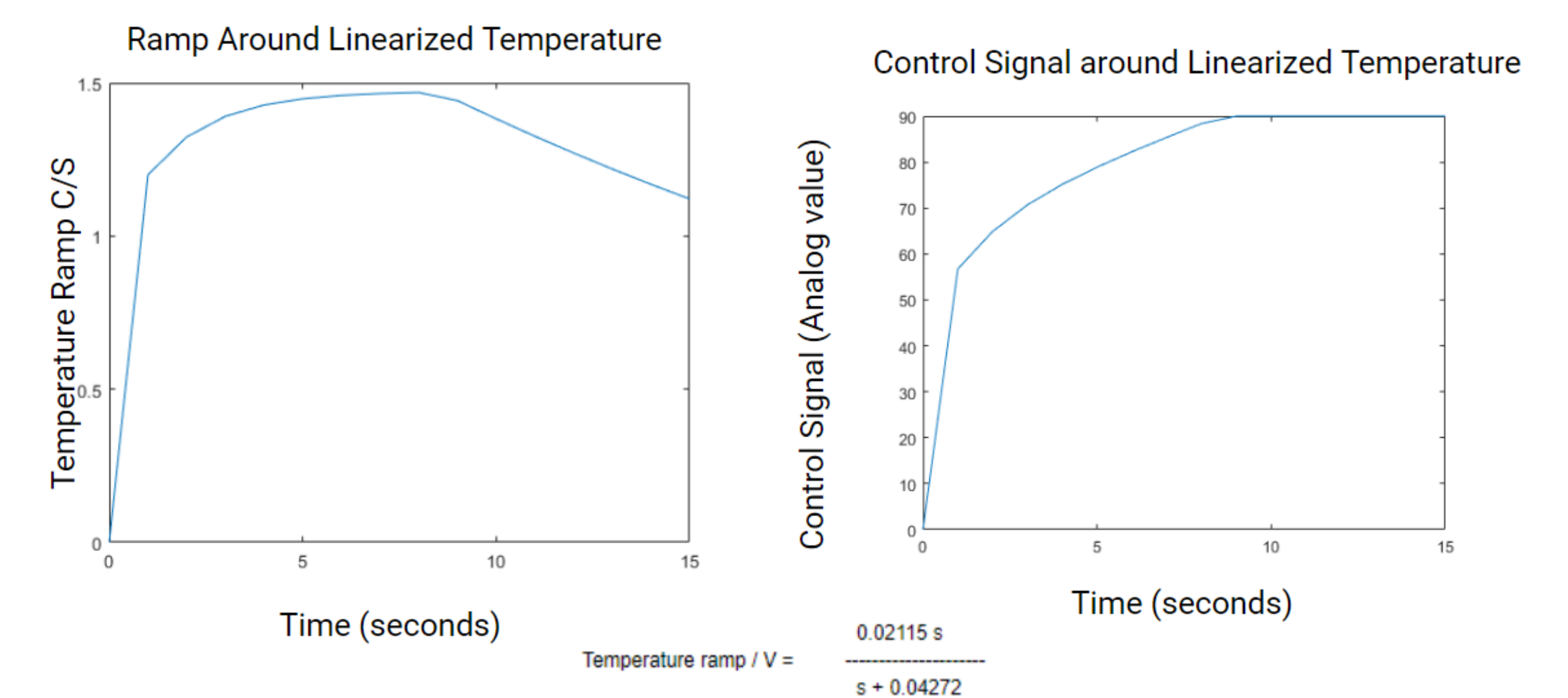
Angled thermocouple deployment that allows for precise closed loop control for various chip sizes.

Steady State Temperature of Circuit Board at Reflow



Within the 6 mm radius spot, the temperature decreases from 230 at the center to 192 around the edges. Outside the spot, the temperature drops down to the average board temperature within 4 mm.

Characterization of Thermal Ramp



The system model of the Infrared Heater that takes an input voltage and outputs a ramp was estimated using input and output data from square waves at different frequencies. The model effectively follows the ramp of 1.5 C/s in the first 10 seconds about the linearized temperature. Every 10 seconds the system must be linearized around the new temperature to remain valid.