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Active Load Board Thermal Control

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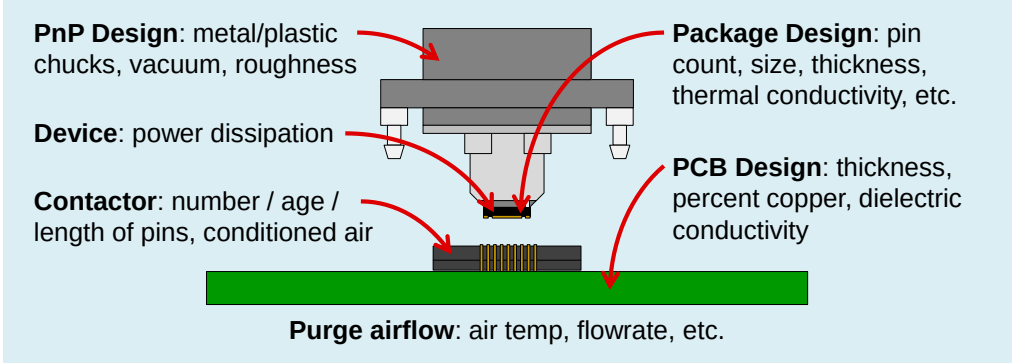
Introduction

- Many chamber-based pick-and-place test setups currently do not have a means to compensate for device thermal loss during the test flow
- Upon DUT insertion, the loadboard, electrical routes, and power/ground planes act as both a thermal connection to ambient and a large thermal mass (heatsink), causing the temperature of the DUT to asymptotically shift towards ambient
- In some cases, shifts as large as 25°C were observed, though additional variables like site count, board layout, test temperature, and device geometry greatly influenced the variability
- By adding actively controlled heater modules, we were able to compensate for both thermal plunge loss and site-to-site variation with no change to the handler and minimal change to the test cell infrastructure

Primary Technical Challenges

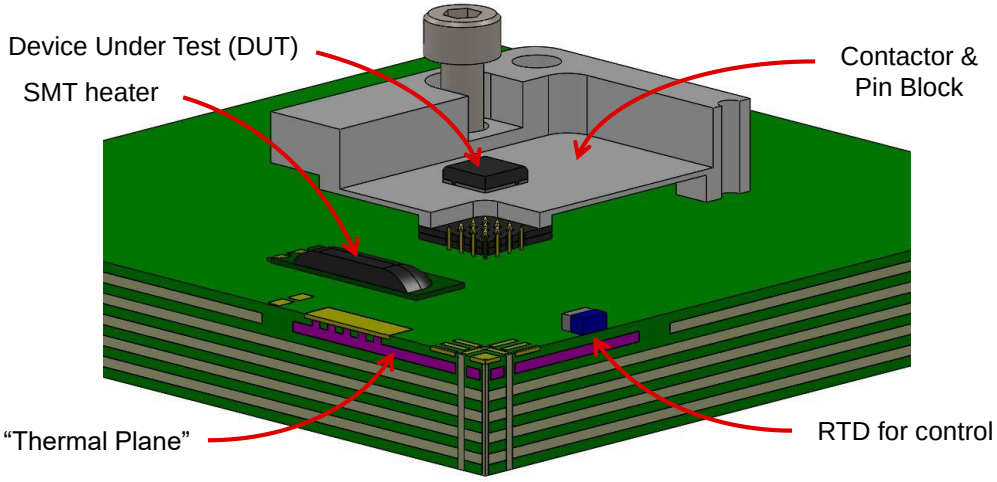
1. Many **different variables** affect the rate of heat transfer within the test cell, and the heater modules must be functional regardless of design differences



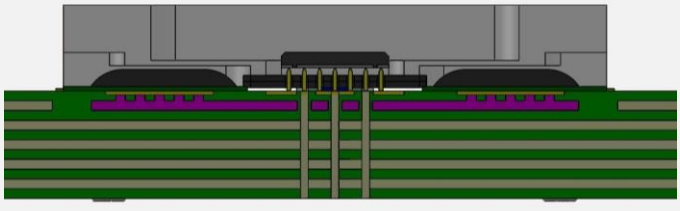
2. **Hardware lifetime** – solution should not cause other components to overheat

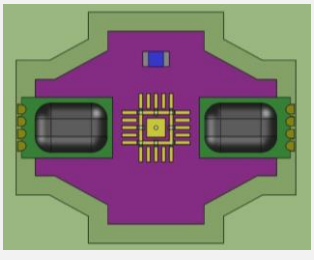
Proposed Solution

Actively-controlled **surface mount heaters** placed within the contactor component pockets to efficiently condition the temperature of the loadboard locally around the DUT and a **controller system** to manage each site's temperature independently



Side view (below) and Top view (right)

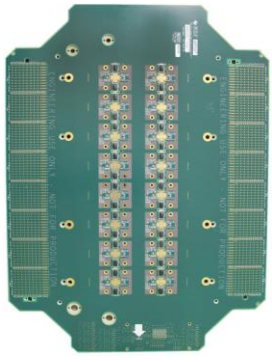




Production Prototype Evaluation Set-up

- Cart developed to store **Sensata Qinex controllers** and other hardware
- Stores 4 controllers (each manages up to 4 sites)
- Other features:
  - Touch-screen monitor for operator I/O
  - Recipe management
  - Temperature off-sets
  - Light tower for alarms

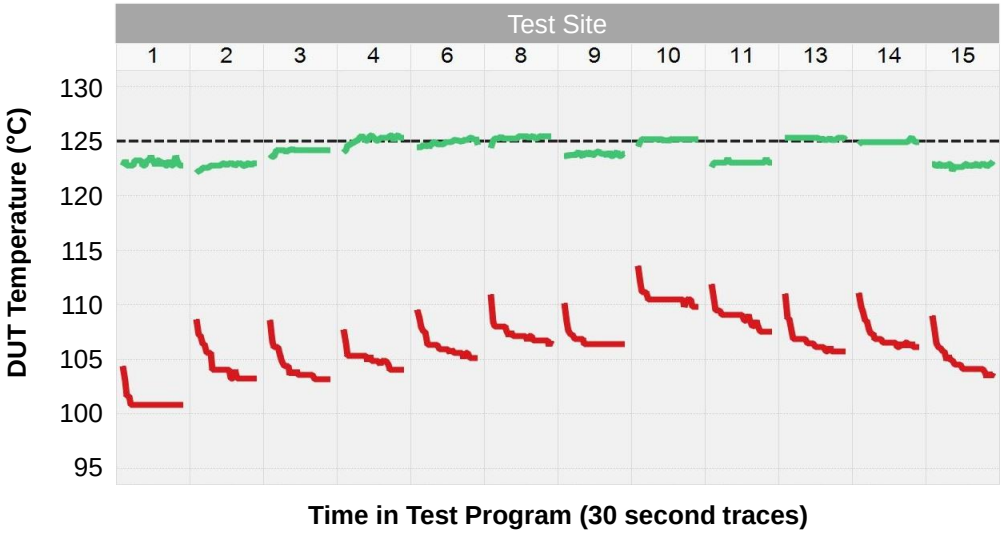
16-site loadboard



Results of Solution

- Solution was evaluated using a 7x7 QFN package, on a 16-site loadboard, and in a handler programmed to a target temperature of 125°C
- DUT temperature was measured every second during a 30 second test flow, and the measurements of approximately 15 units per test site were averaged together, as shown below:

Average DUT Temperature vs. Time in Test Program, Trellised by test site



Surface-mount heaters active, controlling RTD reading to 125°C

Baseline handler performance (surface-mount heaters inactive)

Conclusions & Future Development Work

- TI and Sensata have developed a loadboard heating solution that actively controls the temperature of the PCB area immediately surrounding the DUT
- This solution is capable of being integrated into any pick-and-place test cell, with no change to the handler and minimal change to the test cell infrastructure
- The surface mount heater modules were successfully able to compensate for the thermal loss seen during the baseline evaluations, holding all average temperatures within 2°C
- Additional development work is underway to improve the efficiency and range of the heater modules, with the long-term goal of 175°C
- A similar setup utilizing Sensata's Qinex controller system plans to leverage thermoelectric cooling (TECs) to provide additional benefits at cold temperature test