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BiTS

Burn-in & Test Strategies Workshop

March 4 - 7, 2018

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Archive

Contactor Thermal Control Features

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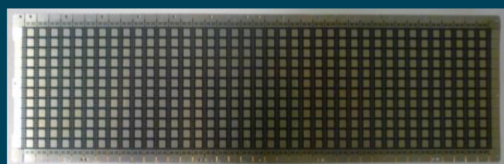
Contents

Introduction

<u>Industry trend</u>

- Today's semiconductor applications do have the need for tighter temperature control
- Temperature ranges expanding to meet more stringent end use condition and there is a need for better control of the temperature range and temperature accuracy
- High test side parallelisms → Test in Strip handling
- Small contact length for high frequency ranges……



Introduction

Thermal and power management

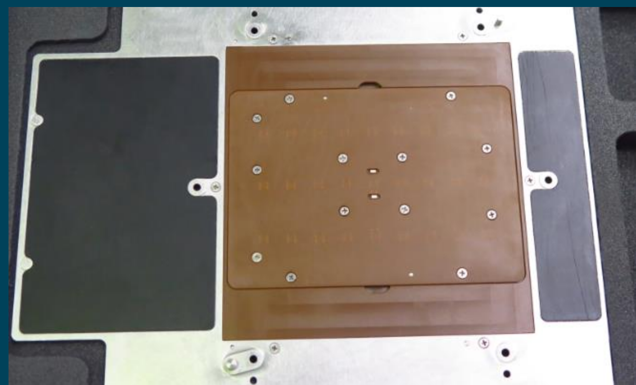
- Increasing total power across a smaller form factors → Power density increase
- Handling the heat, produced by the DUT itself drive the need of active thermal management.
- Temperature range -40° C – 160° C
- Demand for reducing calibration time when setting up a system or change to a different package
- Pre heat or soak time management →utilization of system

Design concept for thermal performance

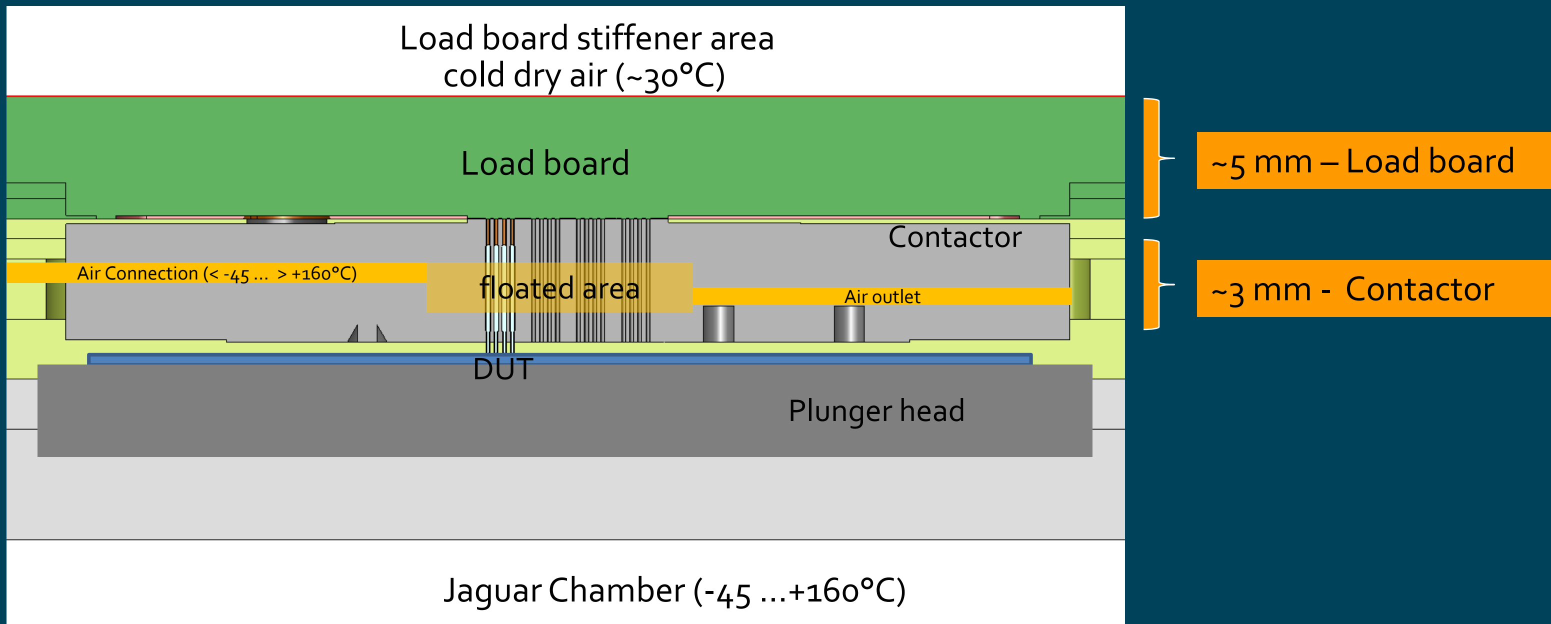
- Dealing with material / Thermal coefficient / High current demands
- DUT to chuck thermal interface
- Preheating and controlling during test.

Project definition

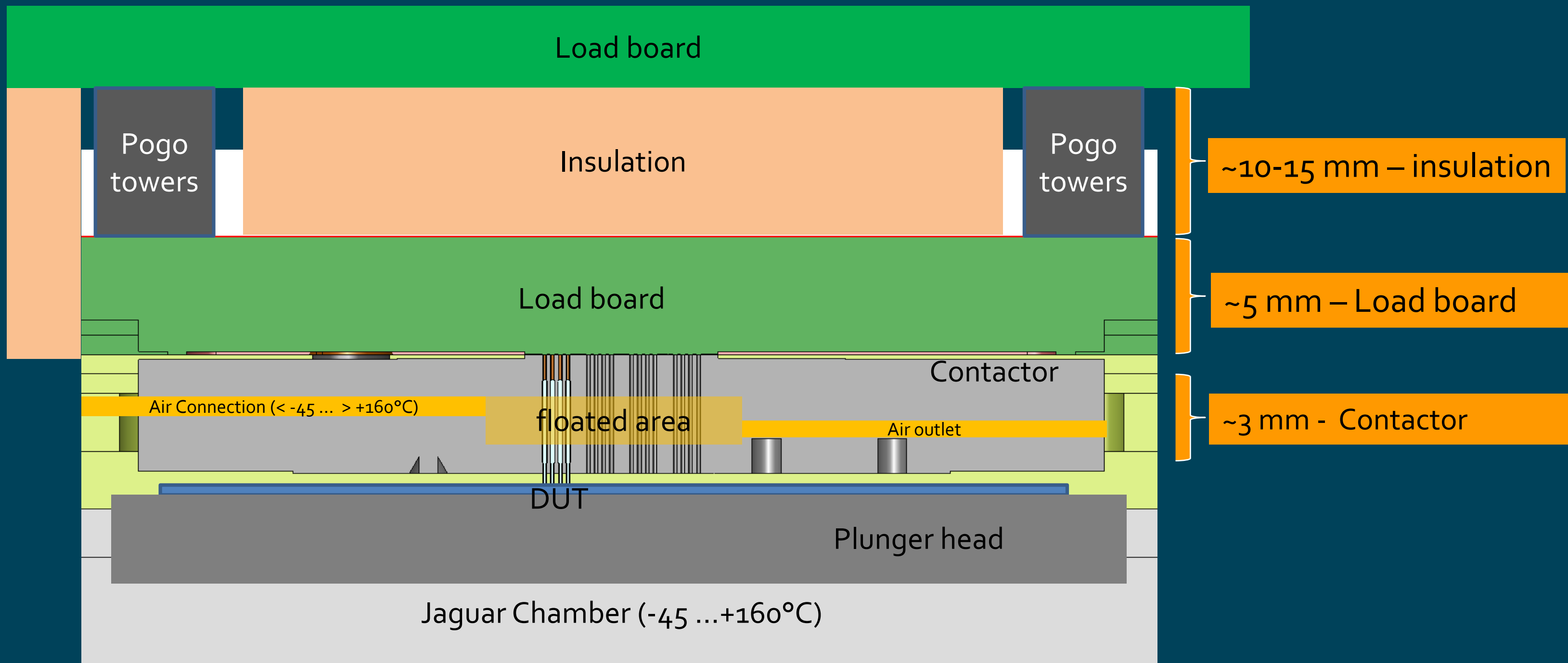
- SOW:
  - Contact site parallelism: x 27
  - Calibration-less contactor: -40° C to 160° C
  - Package size: DFN 2.5 x 2.5, 10 Pin + Ground
  - Handling system: COHU Jaguar Test in Strip Handler
- Challenges:
  - +/- 2° C accuracy
  - High parallelism x 27
  - Small contact element length →
    - HF pins →3.2 mm contact – compressed length
  - Mechanical robustness →
    - contactor array
  - Accurate sensor reading →
    - correlation to DUT



Concept phase Direct Socket to Board V_0.1



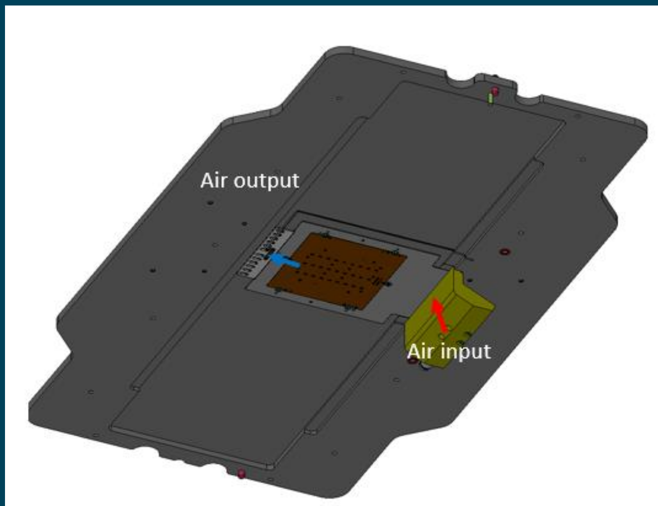
Concept phase – Daughter Board V_0.2

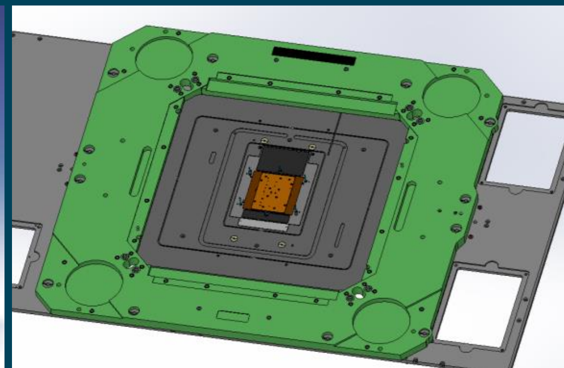


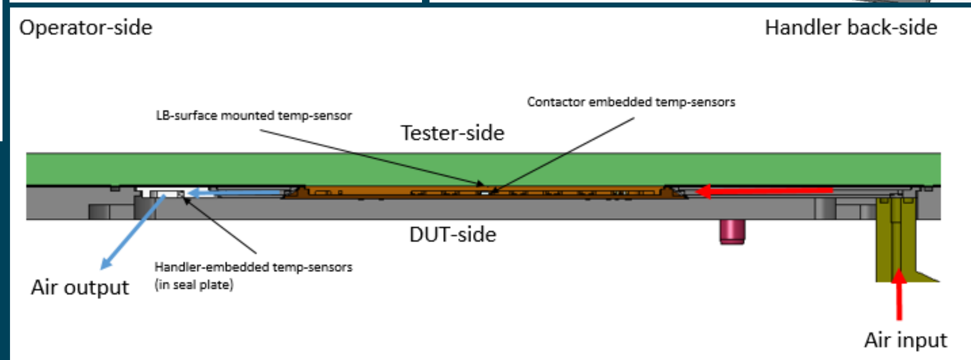
Concept phase

- Advantage Daughter Board:
  - Improved thermal insulation (insulation thickness)
  - Decoupling load board from temperature
  - Improved temperature stability at the device
  - Easier to integrate the thermal connection between seal plate and socket.
  - Possible to use universal load board for different configurations
- Advantage Non Pogo Tower:
  - Shorter signal length to board – signal integrity
  - Direct connection to main board
  - No additional board (reduced interfaces)

Design draft

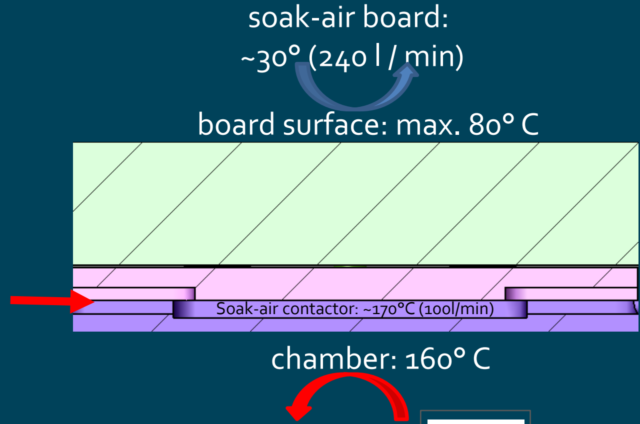






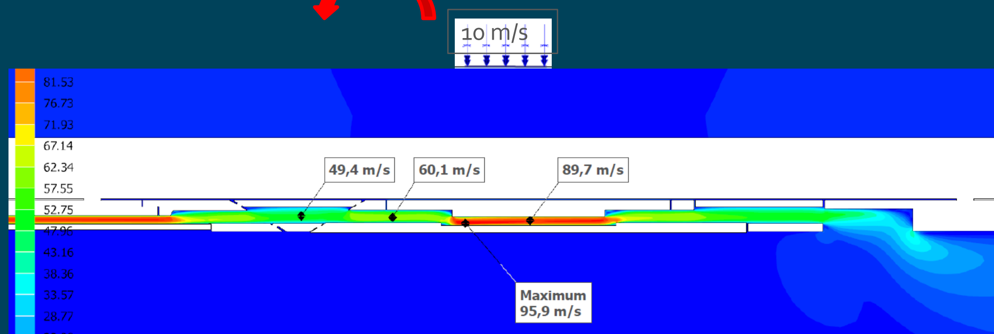
Feasibility study

Basic constraints:



Simulation without pogo pins

Flow rates:



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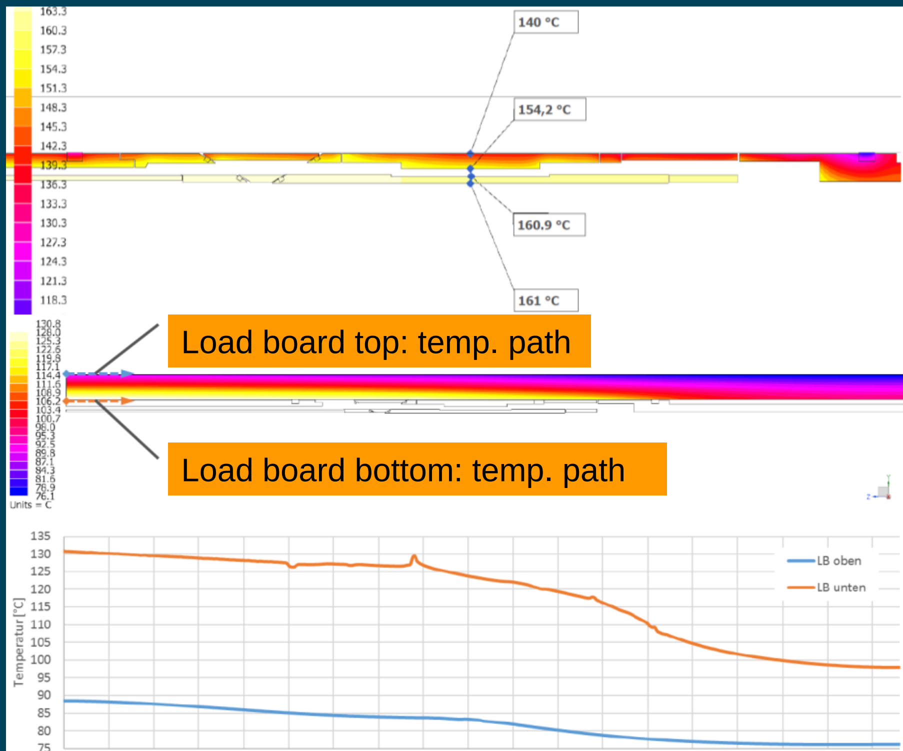
Appraisal

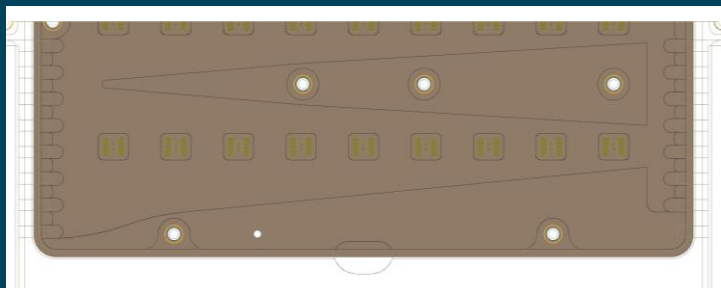
Socket temperatures

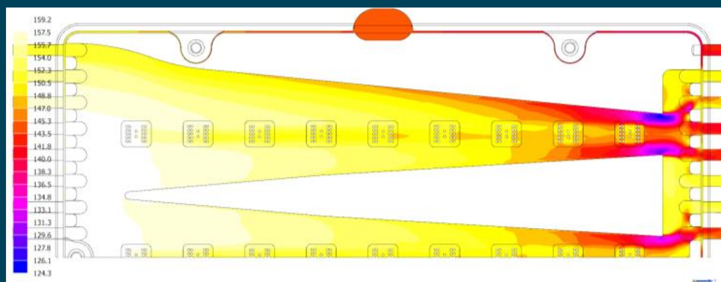
Board temperatures

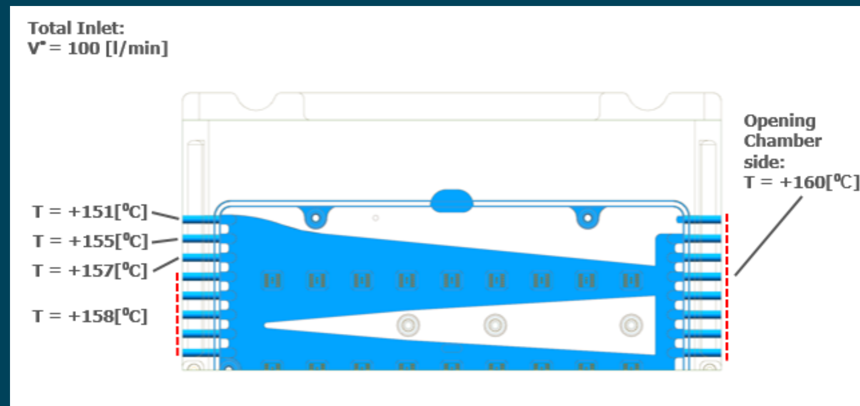


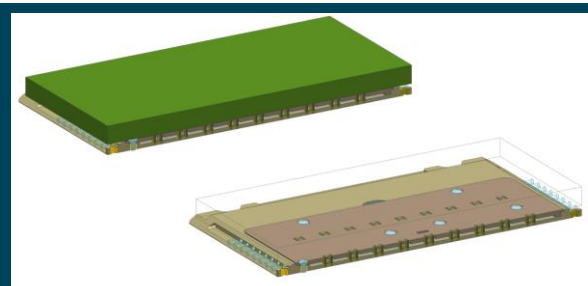
- High flow at load board necessary (240 l / min @ 30° C) to reach ~80° C
- Most critical area above contactor and air supply (~90° C)
- High influence from load board soak-air to contactor: more cooling at load board needs higher contactor air temperature

Concept V1_a Geometry and Simulation

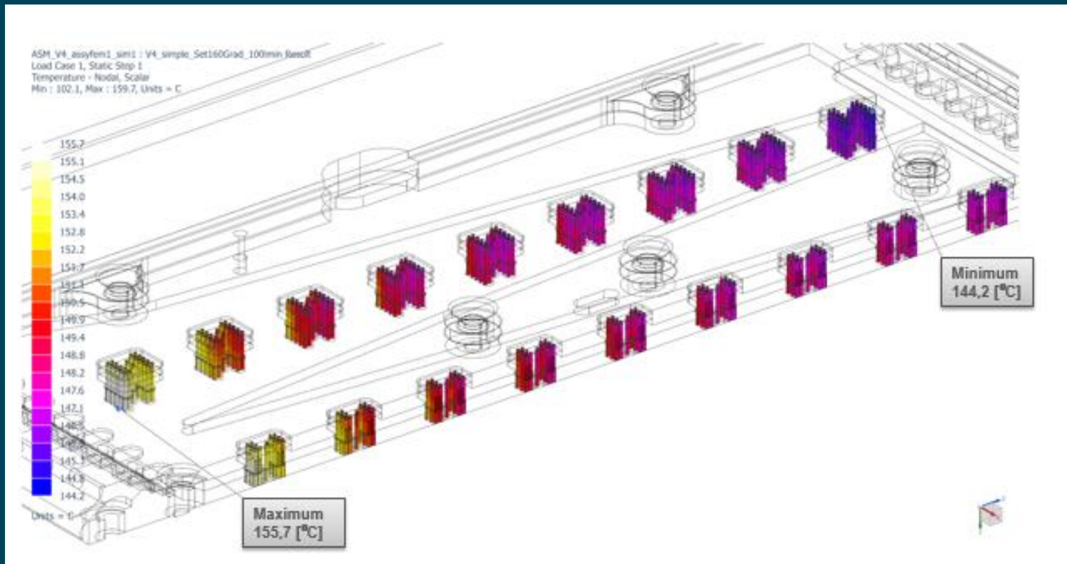






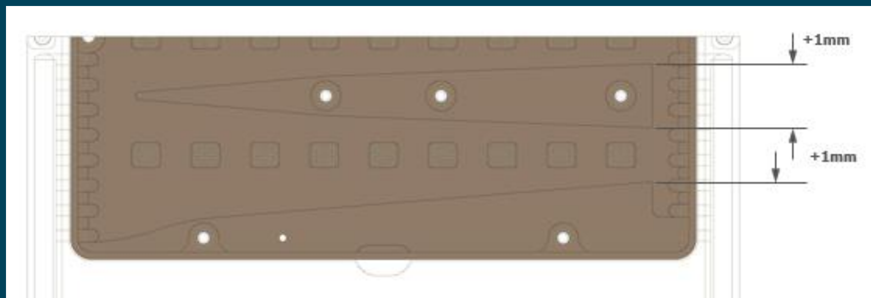


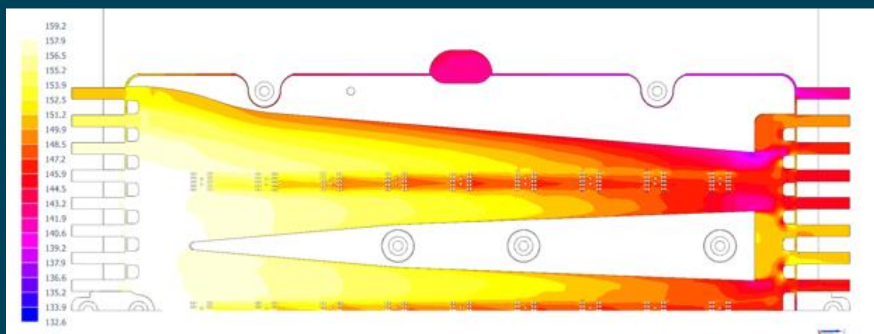
Concept V1_a Simulation



- Spring pin Temperatures:
  - Max: 155.7° C
  - Min: 144.2° C
  - Delta: 11.5° C
- Temperature difference between contact sites on the air entrance and outlet!

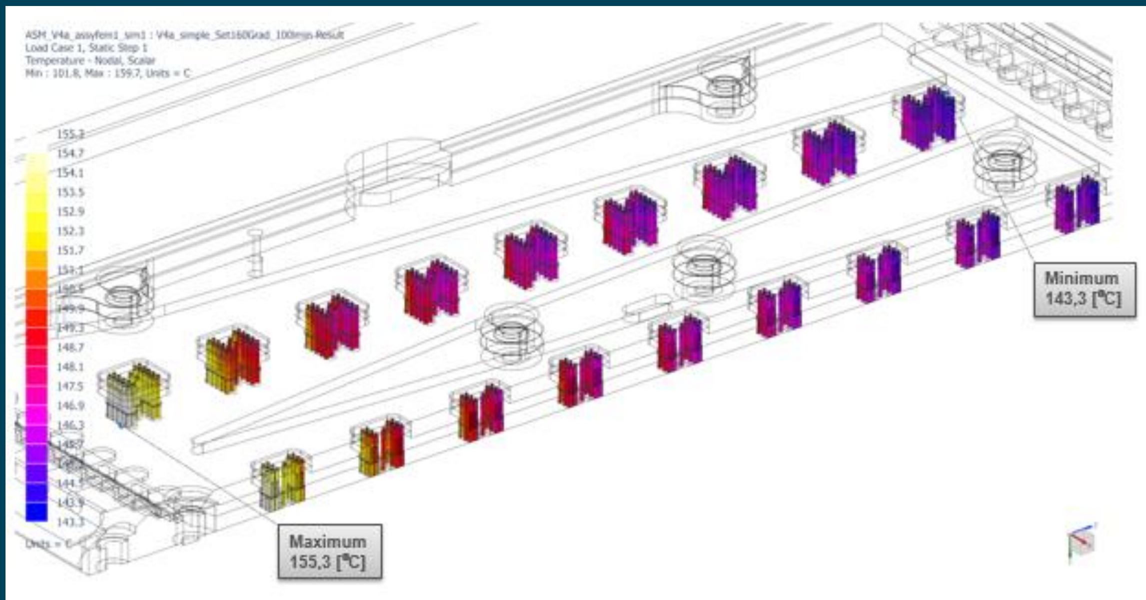
Concept V1_b Geometry and Simulation





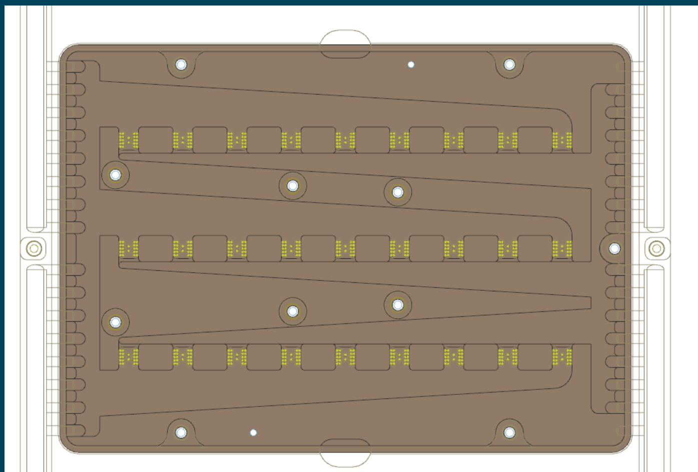
- Change the Air channel geometry:
  – Increase the cross section at the last contact site to avoid the stall effect and reach a more homogeneous temperature

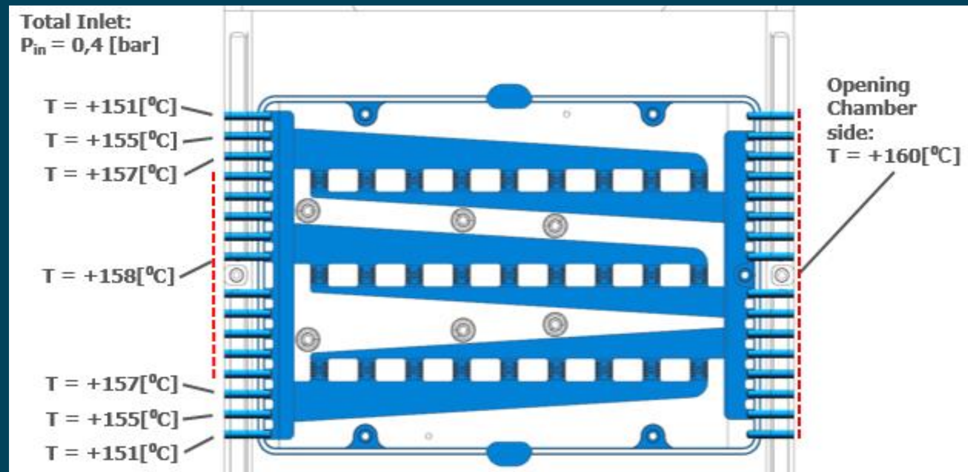
Concept V1_b Simulation



- Spring pin Temperatures:
  - Max: 155.3° C
  - Min: 143.3° C
  - Delta: 12° C
- Temperature difference between contact sites on the air entrance and outlet!
- No improvement!

Concept V2_a Geometry and Boundary

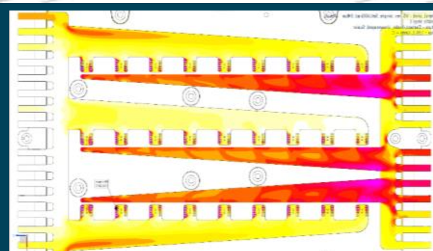




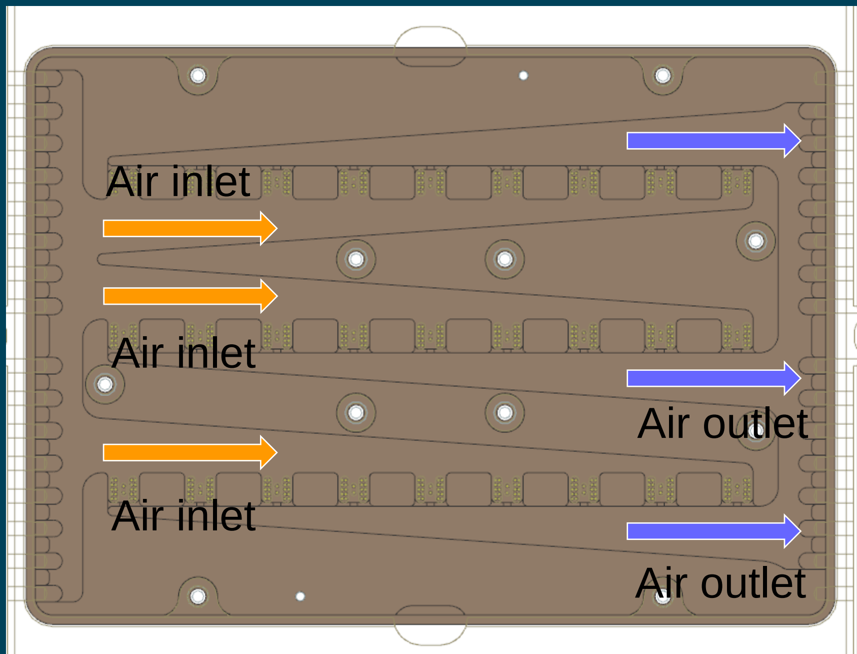
- Change the airflow concept:
  - Purpose: get the same airflow on all contact sites by designing a conical cavity and stream thru each Contact site using a throttle

Concept V2_a Simulation

- Spring pin Temperatures:
  - Max: 148.4° C
  - Min: 128.8° C
  - Delta: 19.6° C
- We made it worse! …?
- Temperature difference between the Pin within one contact site!
- Outer contact sites colder than inner contact sites

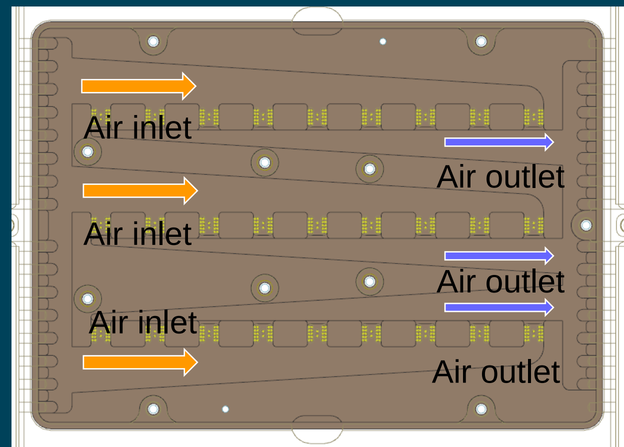


Concept V2_b Geometry



- Change the airflow direction:
  Using the exhaust air to isolate the outer contact sites

Before:

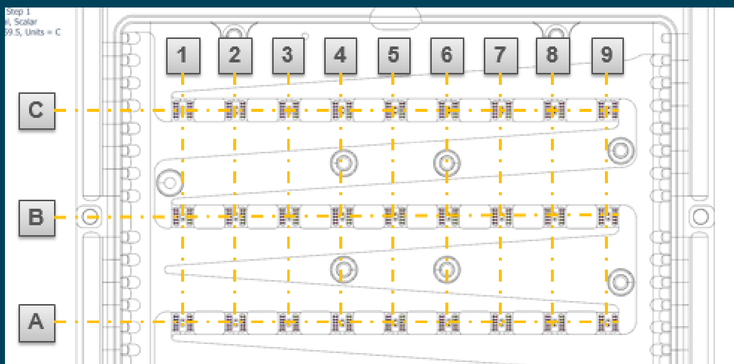


Concept V2_b Simulation

- Spring pin Temperatures:
  - Max: 151.8° C
  - Min: 141.9° C
  - Delta: 9.9° C
- Improved temperature spread over all contact sites

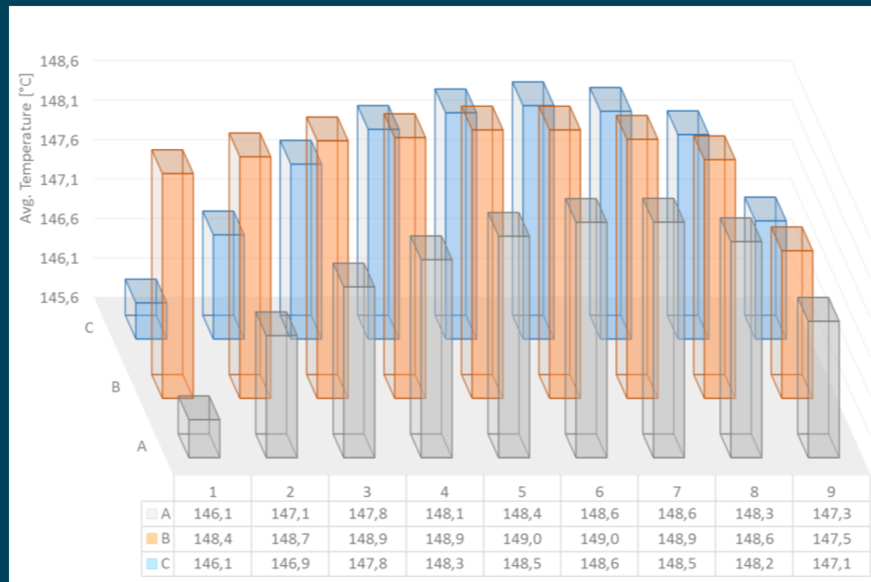
Concept V2_b Results

- Contact site mapping:



- Spring pin temperatures:
  - Max: 149.0° C
  - Min: 146.1° C
  - Delta: 2.9° C

- Average contact site temperature



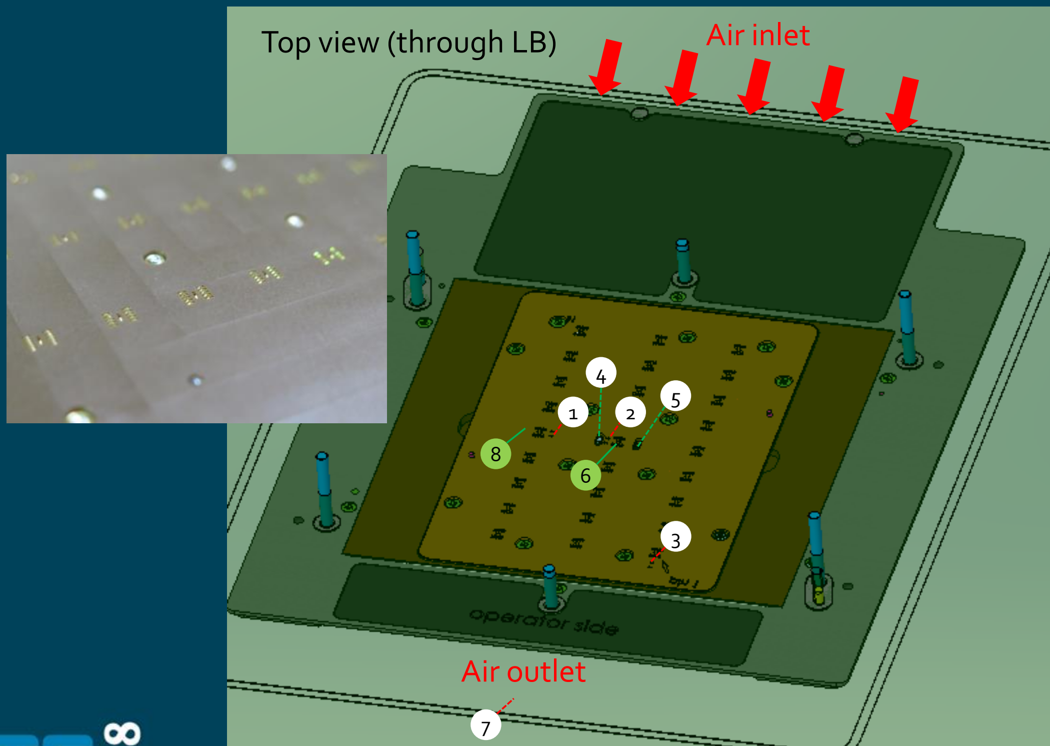
	1	2	3	4	5	6	7	8	9
A	146,1	147,1	147,8	148,1	148,4	148,6	148,6	148,3	147,3
B	148,4	148,7	148,9	148,9	149,0	149,0	148,9	148,6	147,5
C	146,1	146,9	147,8	148,3	148,5	148,6	148,5	148,2	147,1

Conclusion - Simulation

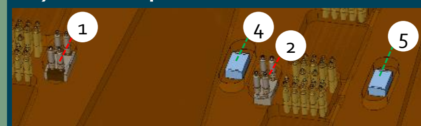
- Simulation results show homogenous temperature over all contact sites:
  - Does it correlate with the reality?
  - Simulation is within +/-2° C average per contact site
  - What is the DUT reading?
  - Is it possible to calibrate the System to the simulated values? (Power – system)
  - One channel to control the contactor air system… is it enough?
  - Where is the right position of the sensor for controlling (→DUT reading?
    - The sensor need to be part of the handler temperature control loop
  - Do we need additional sensors for monitoring?

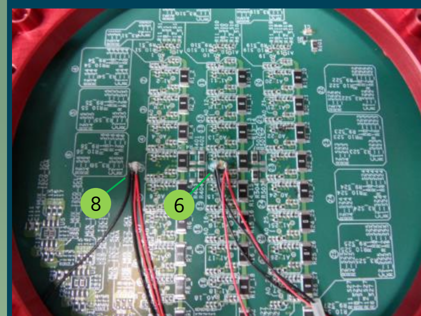
No choice, we have to try it!

Design and manufacturing V2_b



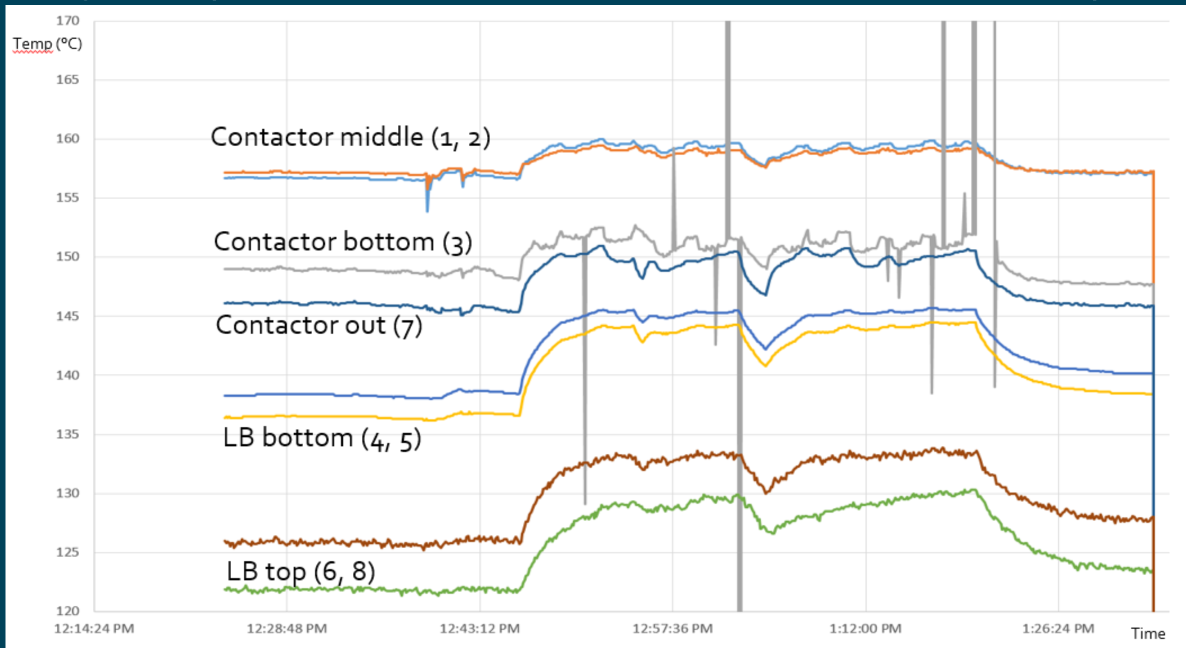
1) Contactor left
2) Contactor middle (left)
3) Contactor bottom right
4) LB bottom left
5) LB bottom right
6) LB top middle
7) Contactor outlet air
8) LB top left



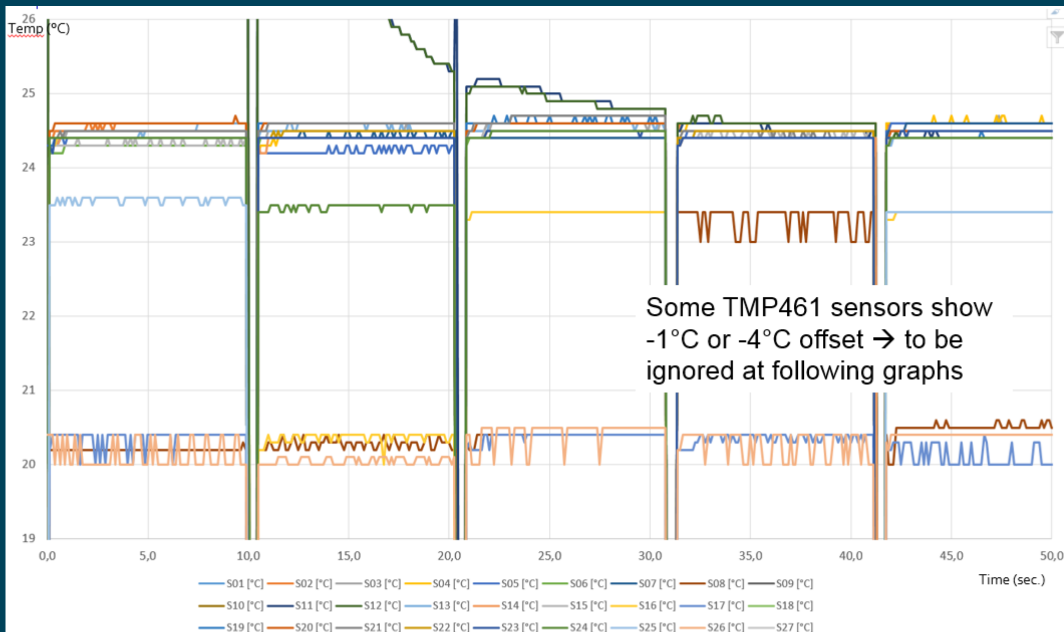


Measurements - Sensor

- Sensor reading @ set point 160° C → which one is the best to control the temperature?



Measurements DUT 24.5° C



For all temperature test the same condition:

- Docking installed
- Purge air cover installed to simulate tester purge air (40l/min)
- 10s test time
- Contactor center sensor (2) for feedback-control

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Measurements DUT 125° C

- Soak-time 60 s (Strip – Chamber)
- 125° C set point – base calibrated, contactor w/o calibration
- Within +/-2° C

Measurements - 40°C

- Soak-time 120 s (Strip – Chamber)
- -40° C set point - base calibrated, contactor w/o calibration
- Within +/-2° C

Measurements +160° C

- Soak-time 120s (Strip – Chamber)
- 160° C set point – base calibrated, contactor w/o calibration
- Within +/-2.5° C (including drift)

Conclusion and next steps

Accomplishment:

- No settling or change during 24h temperature run
- Calibration-less contactor for -40 to 160° C (constant offset for contactor temperature required to achieve best results in drift = depending on internal contactor sensor location)
- High parallelism (x 27) RF-contactor running within +/-2.5° C from -40 to 160° C over complete strip with 2500 devices

Next steps:

- Setup a project to bring calibration-less concept into serial status
  - Integrate the sensor routing into the socket – interface definition
  - Prove of concept for different applications (packages and contact site parallelism)
  - Concept integration in other high parallel handlings concepts → P&P…..