
EIGHTEENTH ANNUAL
BiTS
TM
Burn-in & Test Strategies Workshop
March 5 - 8, 2017
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Poster
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Enabling Temperature Margining Solutions for Validating Automotive Electronics in Lab Automation Environment

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Introduction

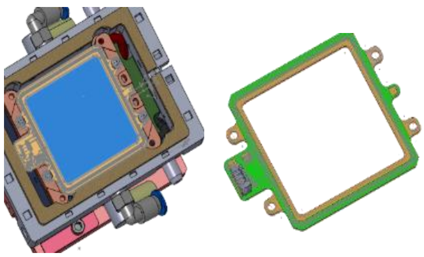
The growth of automotive electronics due to its wide use in automotive for powering the in-vehicle infotainment system (IVI), navigation system, autonomous driving platform, and advanced driver assistance systems (ADAS) has inherently increased the need for automotive electronics to be designed and tested to meet more stringent industrial specs. Consequently, the need for new and reliable testing strategies are critical to accommodate the ***lab automation environment*** for meeting ***industrial temperature spec*** from ***-40°C to 130°C***.

Challenges & Proposed Solution

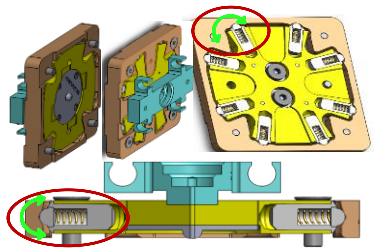
- Thermal margining solution that can enable localized temperature control on the device under test (DUT) from -40°C to 130°C
  - ❖ ***Solution:*** A ***multi-stage thermoelectric module*** (TEC) as part of the liquid-cooled thermal solution with resistance temperature detector (RTD) sensor embedded on the pedestal served as the temperature feedback to the thermal controller
- Condensation management solution inside the automation cell
  - ❖ ***Solution:*** A ***purge chamber*** where dry air is pumped into the automation cell to control the humidity level around the DUT and thermal solution
- Leak detection solutions
  - ❖ ***Solution:*** Customized ***flex circuit film*** and ***leak detection wire*** for detecting condensation and leak around DUT in the automation cell

Challenges & Proposed Solution

- Innovative pedestal and gimbaling mechanism design to ensure good alignment of thermal solution on DUT, thermal conduction and electrical contact.
  - ❖ ***Solution:*** a gimbaling design to compensate on parallelism mismatch with DUT to ensure good electrical and thermal contact and a plate with mounting holes to fit onto the existing mounting hardware inside the automation cell
  - ❖ ***Solution:*** A pedestal with floating X-Y plane compensation mechanism to compensate the parallelism mismatch with DUT

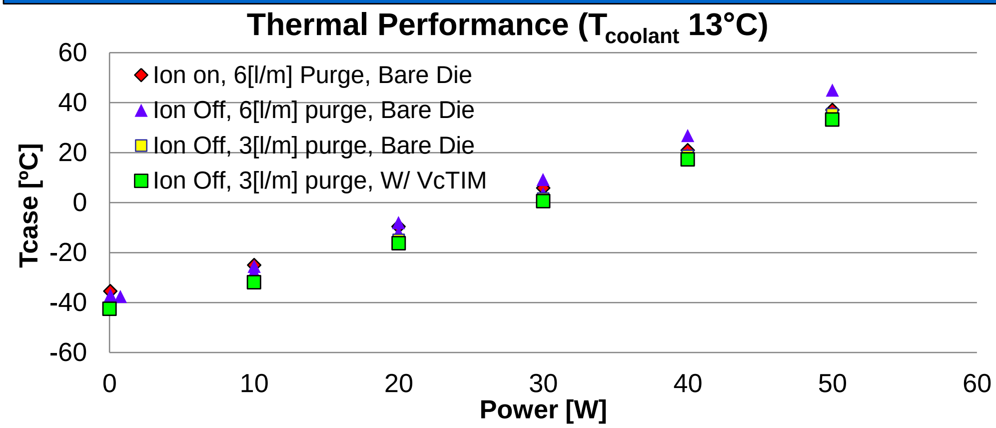


Flex circuit leak detector thru I2C sensor communication with thermal controller



Gimbaling design with parallelism compensation with DUT

Impact of Ionizer & Dry Air Purge on Thermal Performance

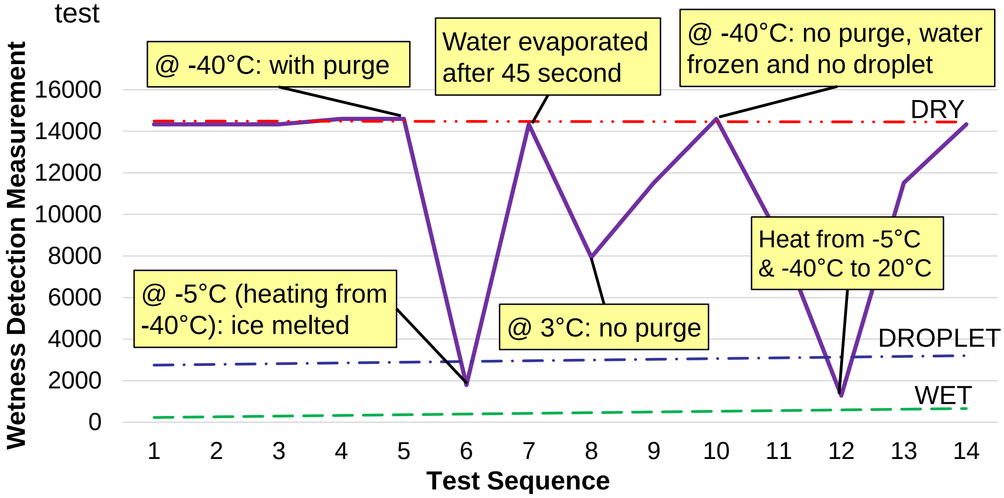


- ❑ Ionizer is used to prevent electro-static discharge (ESD) in the automation cell
- ❑ -40ºC at boot can be achieved with the proposed thermal solution
- ❑ Minimum of 3 [l/m] dry air purge is required to prevent condensation during test
- ❑ Higher dry air purge flow rate would reduce the thermal performance, but can be improved with having the ionizer on
- ❑ Ionizer reduces thermal performance at cold temperatures, but can improve thermal performance at higher temperatures

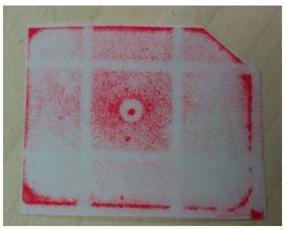
Verification of Leak Detection

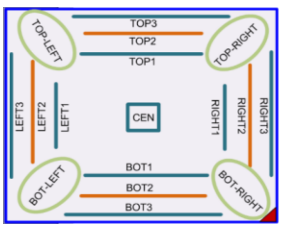
Liquid detector resistance on different wetness condition was tested

- ❑ Resistance value is measured high when the condition is dry (no droplet/water detected)
- ❑ Resistance value is measured the lowest when water is detected
- ❑ System can be turned off and notified users when leak is detected during test



Thermal Interface Contact and Socket CRES





Location	Ω Per Pin
TOP-RIGHT	0.45
TOP-LEFT	0.55
TOP1	0.25
LEFT2	0.05
CEN	0.05
BOT-LEFT	0.55

Pressure Paper Test
- Uniformity of pressure on DUT

Socket Contact Resistance Measurement (CRES)
- Shows good resistance of ~0.5Ω per pin on daisy chain boards

Summary

- ❖ A combination of innovative mechanical and thermal designs is required for achieving a solution that can meet industrial spec temperature testing in a lab automation environment
- ❖ Thermal performance, leak detection verification, thermal interface contact, and socket contact were evaluated and verified for the lab automation environment