Optimizing Semiconductor Test Through Advanced Simulation in Automation and Thermal

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TestConX中国 China

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Background

Title: Optimizing Semiconductor Test Through Advanced Simulation in Automation and Thermal

The complexity of semiconductor test is driving many challenges in production planning. AEM has been using simulation to help AEM's customers to better prepare for production and advising the best system configuration for their needs ahead of time.

This presentation shares AEM's experience in leveraging the power of simulation to

a. Choose the right platform and platform configuration with best optimized throughput
b. Optimize the thermal kit design / thermal system setting for its best possible performance and cost.

Why Do We Perform Simulations?

- AEM uses simulation to predict the system throughput and optimize it for production.
  - Determine the platform configuration that is best suitable,
  - Determine the number of equipment & test collaterals to be prepared for production,
  - Determine the design of thermal change kit to handle the DUT power,
  - Determine the system setting / recipe ahead of the production run.

Equipment Simulation Parameters

- We simulate for
  - Best UPH
  - Best thermal design
  - Best total cost
- The factors we consider for simulation
  - Test time
  - DUT form factor
  - Tray matrix
  - Test board parallelism
  - Estimate bin distribution
  - Vision requirement (DUT top / bottom imaging, 2D / 3D scanning)
  - Thermal requirement

Simulation for Automation

- AEM's simulation runs with the actual handler software and shows DUTs movement and trays movement within the handler. It helps us to understanding the bottleneck of UPH in various scenario.
- Simulation can determine the throughput of the handler of various configurations (bins grouping, sites enabling, DUT rotations, etc).
- The outcome of the simulation helps production planning in preparation of material needed (test boards, sockets, change kit, etc), equipment scheduling, etc.

Automation Simulation for System Reconfiguration

AEM Z-series FT Handler

Example 1:

Test time of a device and bin distribution changes through its product life cycle.

As the test time and bin distribution changes, the system needs to be re-configured for the tray stacks and pick and place sequence to have the system running for the longest duration without operator to load/unload trays.

Simulation helps to understand the improvement of throughput with different configurations.

Example of Automation Simulator #1

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Automation Simulation for System Reconfiguration

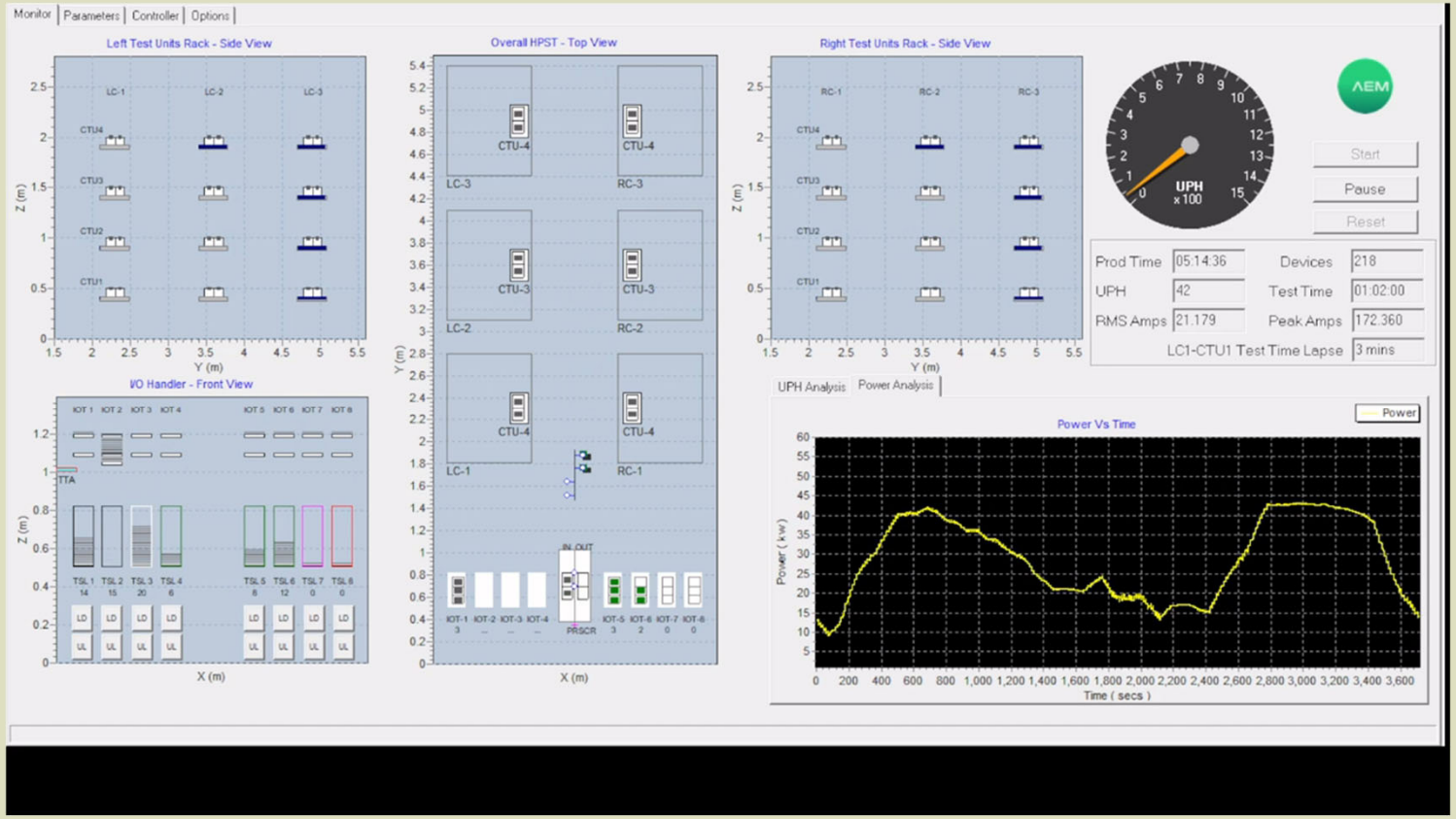
Example 2 :

As the production volume changes at different phases, a high parallelism multi-cell test system changes in population of cell for the optimized UPH and cost of collaterals.

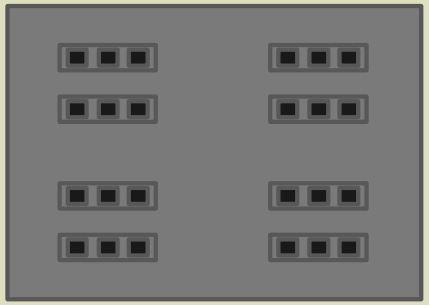
Cases of mix lot, mix product in a multi-cell system is complex. Simulation helps to determine the number of cells to be populated or reconfigured for its optimized throughput.

Simulation for such dynamic multi-cell system, can also determine the facility consumption. For example, electric power and cooling capacity.

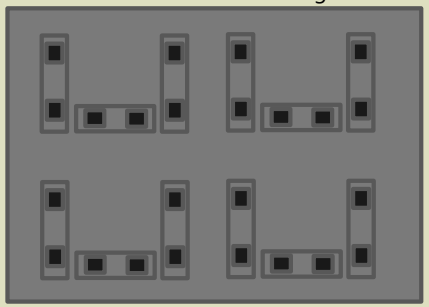
Example of Automation Simulator #2



Automation Simulation for System Reconfiguration



Load board configuration 1



Load board configuration 2

Example 3 :

In the case of System Level Test, the test board sometimes come with DUTs arrangement and orientation that is not automation friendly.

When developing new load board and change kit, the simulation helps to understand the best optimum pick and place sequence and expected throughput as a result.

Simulation for Thermal

Thermal control can be one of the most complex requirement for test. AEM helps customer in selecting and designing the thermal system for the optimized thermal performance for the device. Also consider the system fungibility of the system to be able to support their future product in roadmap.

AEM utilize simulation to predict the performance of the thermal system in terms of

a. Capability to handle the DUT power & temperature range
b. Capability to handle the hotspot of a complex package
c. Time of thermal handling impacting the test time

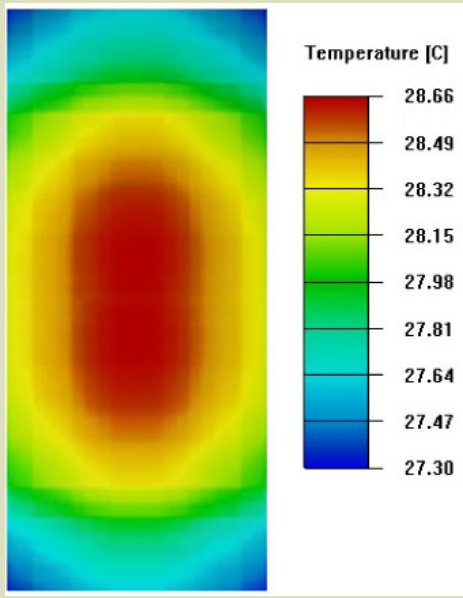
Simulation for Thermal

A thermal simulation should consider the thermal behaviour specific to the DUT design.

With the input of expected die power, thermal resistance, & material properties, the simulation can help to achieve / understand

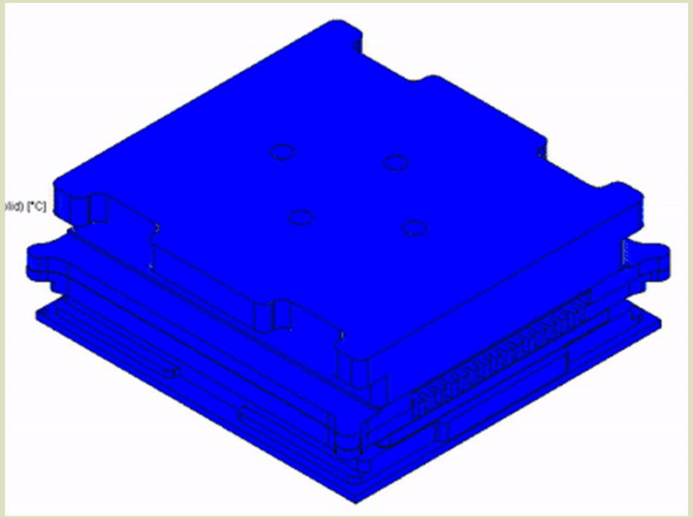
- Optimized change kit design (reuse or new),
- Best suitable selection of thermal interface material,
- Coolant temperature setting / coolant selection (in some case),
- Temperature spike that may happen during DUT power event,
- Time it takes for the DUT to return to set temperature when DUT power spike happen.

The system can be optimized for the best throughput and thermal handling capability for each specific package.



Hotspot on DUT

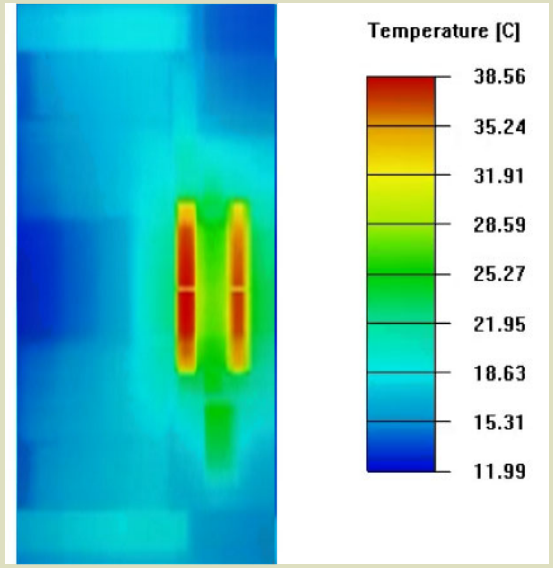
Simulation for Thermal



- The temperature ramp up and ramp down time can be significant to the test time. Short temperature ramp time is always desired.
- With thermal simulation, we understand the ramp time and optimize the kit design to best fit the DUT requirement and best ramp time.

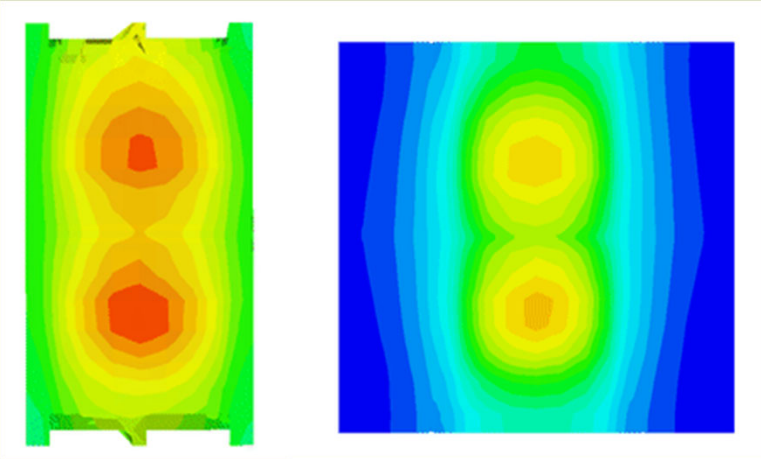
Simulation for Thermal – Limitation of TTV

- Often, a Thermal Test Vehicle is used for validating the thermal performance of a thermal system.
- A TTV is usually in generic form factor and does not mimic the die geometry, power mapping, and thermal properties.
- The thermal behaviour of a device is different from package to package and cannot be simulated using a generic TTV.



Simulated Device Temperature Base on Power Map

Simulation for Thermal – Transient Modelling



Transient Thermal Behaviour of DUT and Thermal System

When analysing the DUT thermal behaviour, the specification of a thermal system act merely as a reference and does not guarantee the performance on a device.

A transient thermal modelling can determine the

- Capability of thermal system in handling hot spot
- The ramp time of each die achieving the set temperature
- The time for each die / hotspot return to set temperature after spike
- The thermal crosstalk of multiple dies

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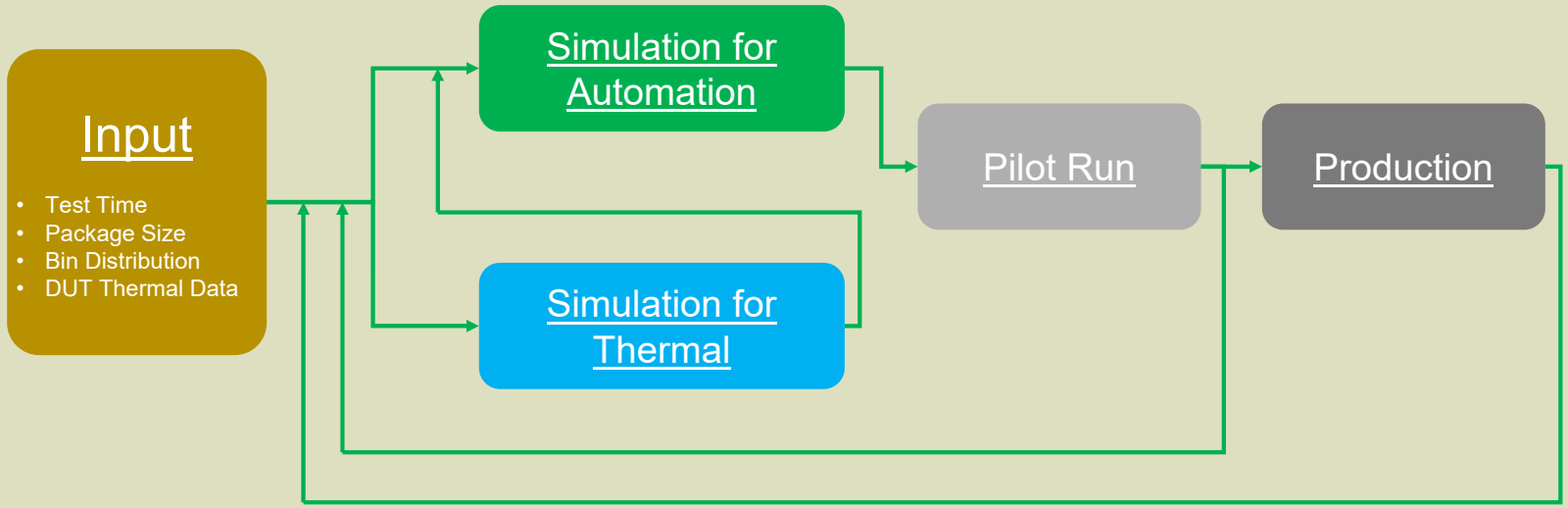
High Level Flow of Simulation



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Closing

- AEM perform simulation for AEM's solutions and help our customers to
  - Optimize equipment setup to achieve best throughput and cost,
  - Optimize the design of a thermal change kit to achieve the test objectives

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