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Poster Session





An Improved Method to Measure Junction-to-Case thermal characterization parameter ψ_{ic}

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INTRODUCTION

•Thermal characterization parameter ψ_{jc} is used to set test conditions, "bin splits" and thermal set points for integrated heat spreader (IHS) processor products. It is given as $\frac{T_j - T_{case}}{T_{otal Package Power}}$.



Fig 1. Thermal characterization parameter ψ_{ic}

•Digital thermal sensors (DTS) are usually located at the proximity of the cores and are used to measure junction temperature approximately. DTS temperature is derived with a slope equation from two calibration temperature data points. T_{case} is measured with a T-type thermocouple installed in a groove engraved on the IHS lid.

•System dynamic ψ_{jc} data is used to roughly correlate with tester ψ_{jc} . A correlation of within 10% will be sufficient for this purpose but previous measured results shown run-to-run errors up to 40%.

The two main goals are to

1. Improve precision in ψ_{ic} data

- DTS measurements can be improve by using multiple calibration temperature points instead of only two.
- Accuracy of T_{case} measurement can be substantially increased if it is calibrated to a better known standard.
- 2. Explore better measurement setup
 - An active thermal control device is typically used to regulate T_{case} but this is significantly different thermal boundary condition than a fan based heat sink. The differences in the resulting ψ_{jc} need to be investigated.

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Steps of improvement

•Heatsink Vs Active Thermal Tool

• When ψ_{jc} was previously measured in the lab, T_{case} was regulated using an active thermal tool but secondary effects such as bi-directional heat flows on the IHS edges may affect the T_{case} temperature. The result below shows that by keeping DTS at near throttle temperature with the active thermal tool, some reverse heat flow from locations away from hotspot affects the T_{case} temperature.



•Thermocouple calibration

 A thermocouple is usually calibrated with an Omega CL25 calibrator but it's accuracy can be improved by calibrating with an oil bath. Our result shows a difference of 1.5 °C of a thermocouple calibrated between an oil bath and a calibrator. The error is caused by the intrinsic tolerance of the calibrator,



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• Dynamic ψ_{jc} can be approximately evaluated with leakage held constant by maintaining supply voltage and temperature the same while varying speed to change dynamic power. The run-to-run errors in collecting dynamic ψ_{jc} data is caused by the imprecisions when varying the narrow range of the system The solution is to vary the core ratio and uncore ratio in a synchronous manner



Summary

• thermocouple calibration in oil bath provided better accuracy than a handheld calibrator.

• It is better to use a passive heatsink for T_{j-max} prediction when measuring static ψ_{ic} if higher accuracy and repeatability is needed.

•Changing core/uncore ratios instead of varying clock frequency allow wider ranges for power and T_{case} and are less susceptible to minor adjustment errors.

•The new method can be used to reduce guard bands and increase bin splits.

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