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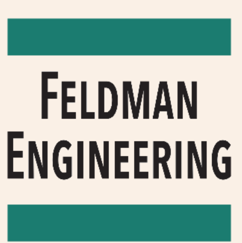

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Session 1

Yuanjun Shi
Session Chair

BiTS Shanghai

The Best of BiTS 2015

"PCB Test Fixture and DUT Socket Challenges for 32 Gbps/GBaud ATE Applications "

Jose Moreira - Advantest

-15 minute break-

"Designing Sockets for Ludicrous Speed (80 GHz)"

Don Thompson - R&D Altanova

"Comparison of Different Methods in Determining Current Carrying Capacity of Semiconductor Test Contacts"

Valts Treibergs - Xcerra Corporation

"The Economics of Semiconductor Test – Challenges and Opportunities for 2016"

John West - VLSI Research Europe

Comparison of Different Methods in Determining Current Carrying Capacity of Semiconductor Test Contacts

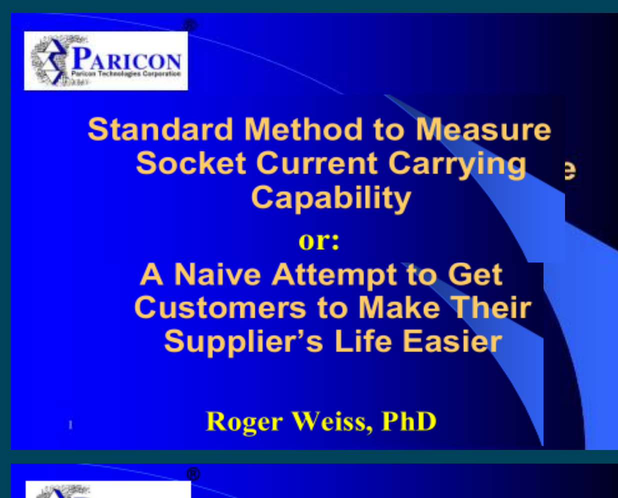
Valts Treibergs, Mitchell Nelson
Xcerra Corporation

2015 BiTS Workshop
Shanghai
October 21, 2015

Presentation Agenda

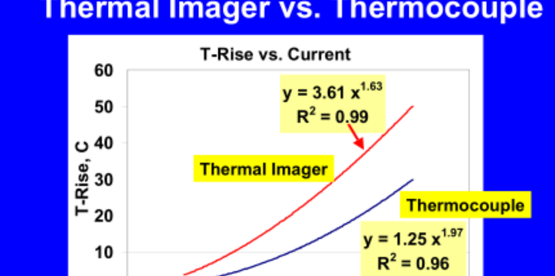
- Current Carrying Capacity (CCC) as discussed at BiTS and elsewhere
  - Force relaxation method
  - IR Thermal imaging method
  - Thermocouple T-Rise method
- Example case study: CCC testing of a 0.3mm pitch spring probe
- Discussion and comparison of results – is there a best method for BiTS interconnects?

BiTS 2003 - Paricon



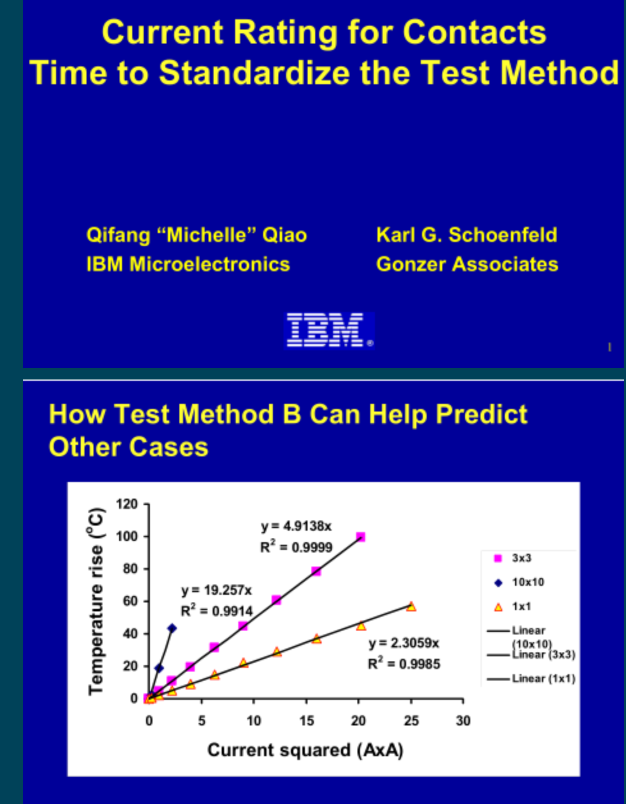
- No industry standards apply to power charachterization of sockets
- Single thermocouple approach from PCB side of interconnect
- Emulates socket thermal environment

BiTS 2004 – K&S



- Thermocouple T-Rise vs. IR Camera
  - Thermal Imager and thermocouple measurements generally agree – IR camera more repeatable and accurate
  - Thermocouple only 1-point measurement and act as heat-sink

BiTS 2004 - IBM



- 2-Step approach – characterize T-rise of single pin at ambient in air then of cluster of pins
- Develop model to predict socket performance
- Test based on EIA-364-70 standard

BiTS 2004 - Intel

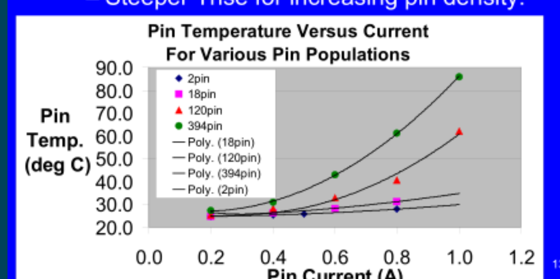
Socket Current Carrying Capacity (CCC) Characterization

Victor Henckel
Glenn Cunningham
Hongfei Yan

Intel Corporation

Test Result

- Test performed at room temperature (23C).
- T_{pin}, $T_{substrate}$, and $T_{pintail}$ at current levels.
- Below is the T_{pin} for various pin populations.
  - Steeper Trise for increasing pin density.



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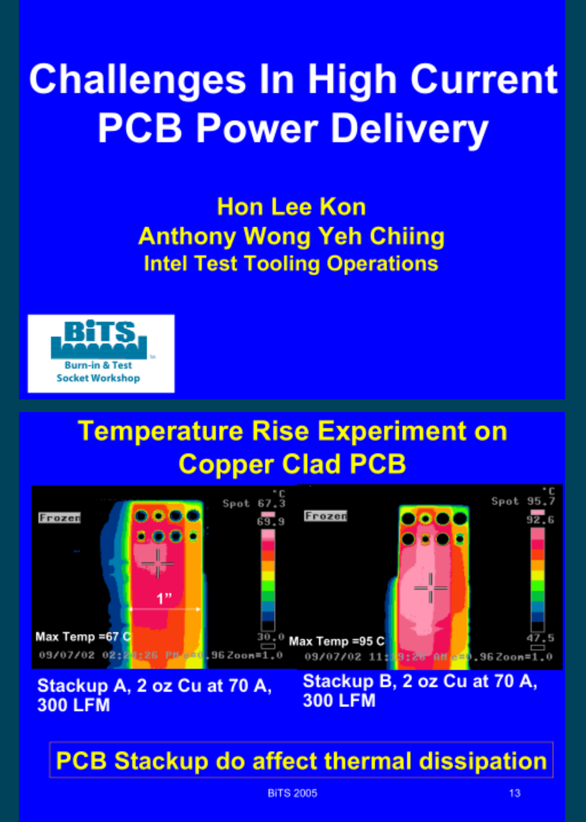
- One-pin thermocouple method not adequate
- Socket thermal environment must be taken into account
- Capability from socket suppliers needed to characterize entire socket CCC

BiTS 2004 - Intel



- Intel then further pushed the challenge into the PCB for power delivery
- Demonstrated the same methodology used in characterizing socket interconnects
- Intruduced thermal simulation

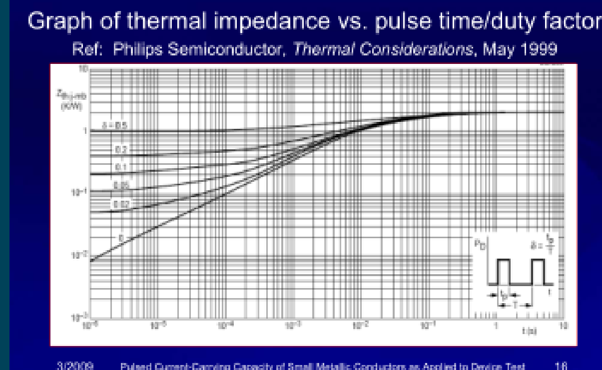
BiTS 2009 - Johnstech

Pulsed Current-Carrying Capacity of Small Metallic Conductors as Applied to Device Test

Harlan Faller, P.E.
Johnstech International

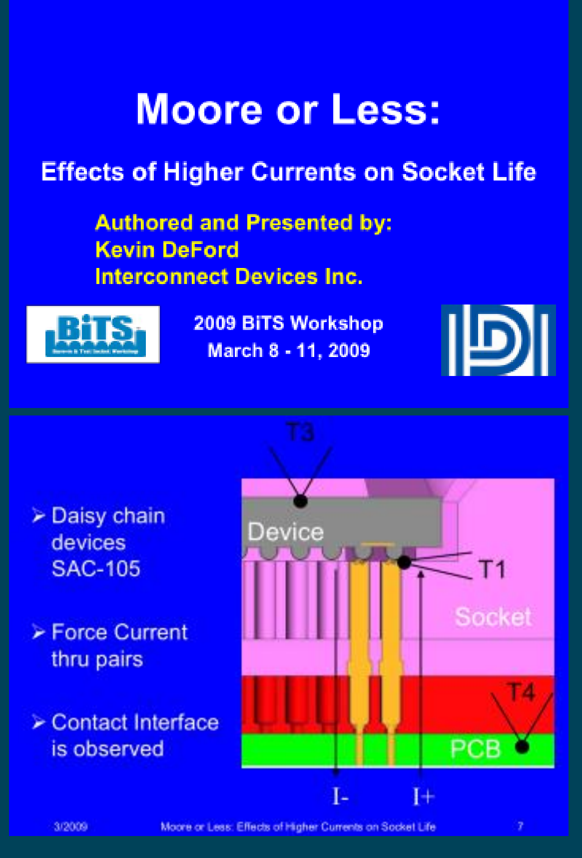
BiTS
2009 BiTS Workshop
March 8 - 11, 2009
Johnstech

Transient Analysis



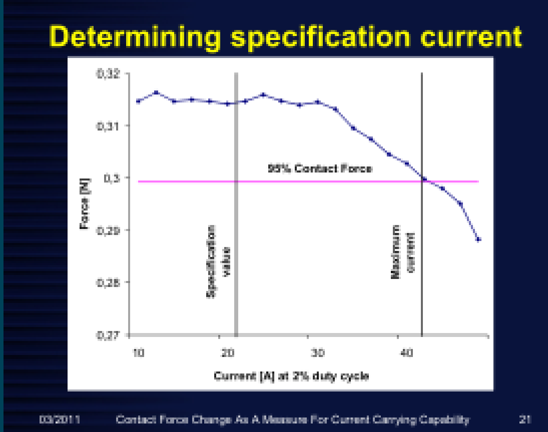
- Very useful tutorial in correlating pulsed current applications to steady-state
- Guidelines presented for pulsed current contact reliability, but no specific test method

BiTS 2009 - IDI



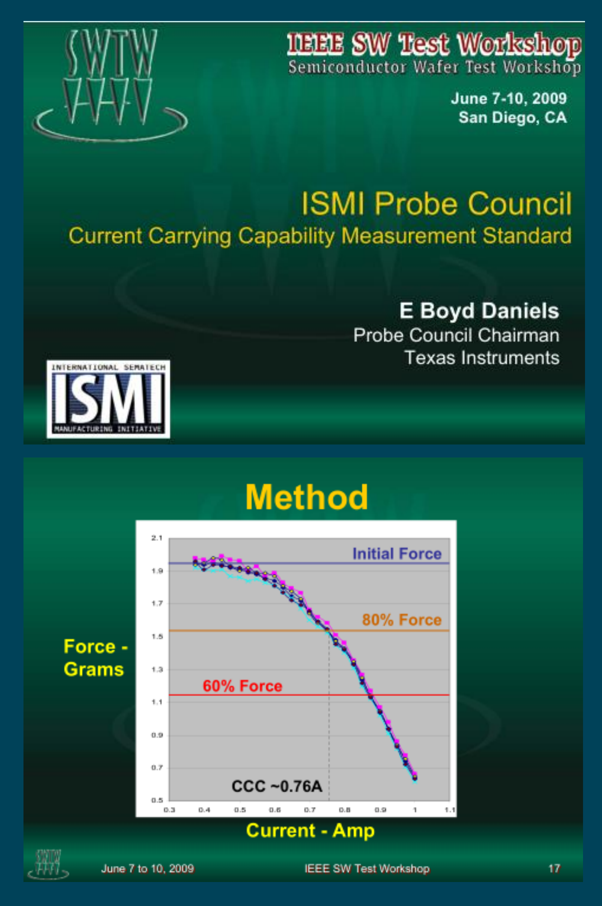
- Single-pin in air (thermocouple) method not adequate, but a good baseline
- Propose to introduce DUT metallic interface into the mix – simulate real world
- Intermetallics and electromigration degrade even CCC even more

BiTS 2011 - Multitest



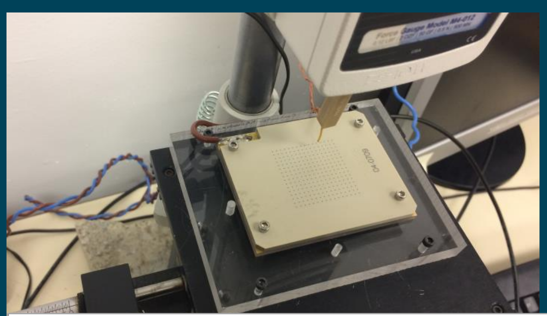
- Proposed and compared a loss of contact force in a cantelever-based contact due to joule heating
- Proved that method can be correllated with single-pin T-rise thermocouple method

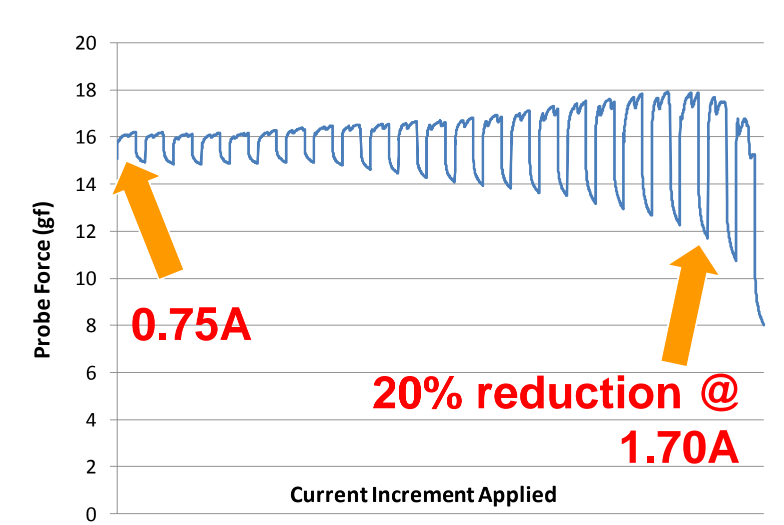
ISMI Probe Council CCC Measurement Guideline



- Pub. 2009 from the MFGM042M project –and presented at SWTW 2009 for wafer probe CCC
  - Failure defined as 20% force reduction
  - DC current applied at nominal overdrive, then force is measured at room temp. after prescribed cool-down period
  - Test is stopped when probe force reduction reaches 40%
  - 30 probes are tested – selected randomly
  - Is it useful for socket contacts – one piece or assembled probes?

ISMI CCC Example: 0.3mm Spring Probe

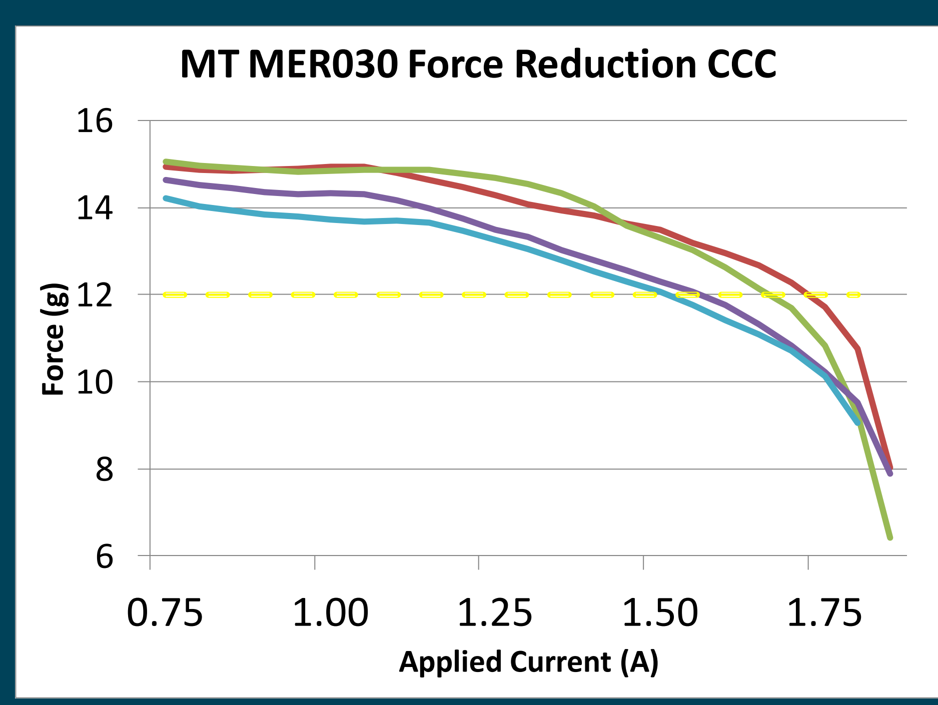




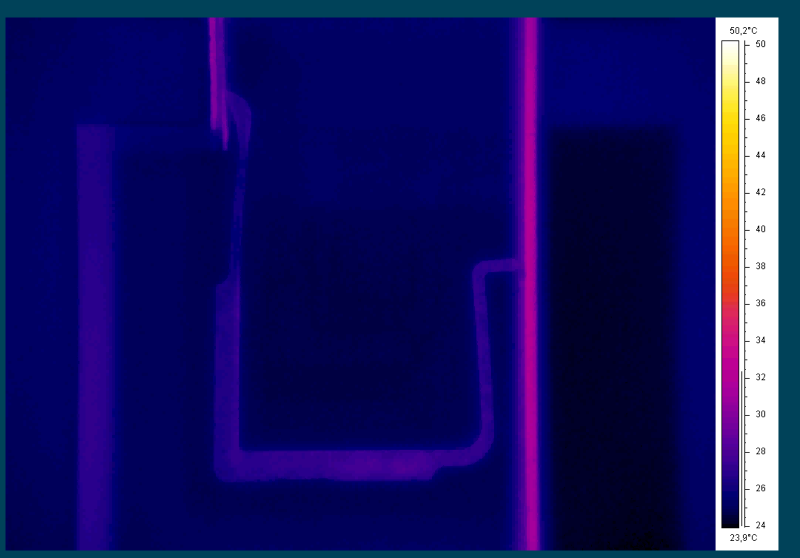
- Single probe placed in fixture
- Stage adjusted until nominal probe force achieved
- Each DC current increment applied for 2 min, 1min cool-down *
- Looped until 40% reduction seen

ISMI CCC Example: 0.3mm Spring Probe

- Spring element in probe heats and expands – increasing probe force during power cycle
- Cool-down period is very long: 5-10 minutes required at higher currents.
  - Socket housing materials and cross-sections dissipate heat very slowly



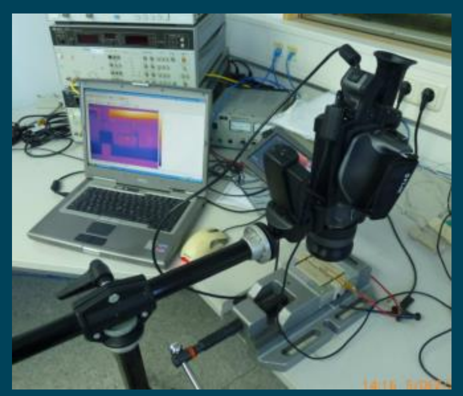
Thermal Imaging CCC Method



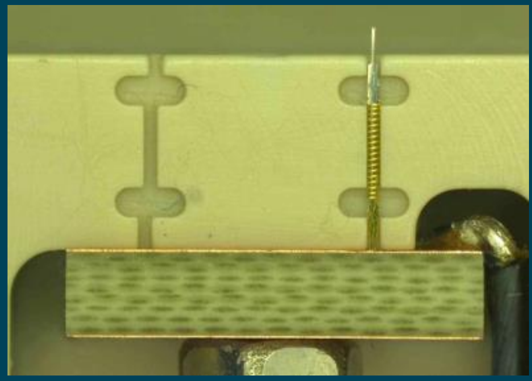
- Sees thermal conduction in real-time – finds hot-spot
- Observe accumulating heat in socket housing

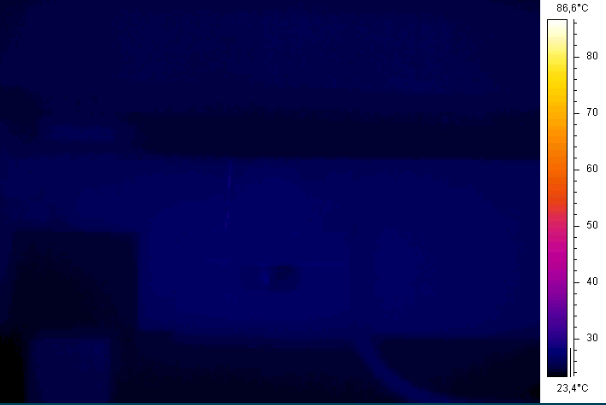
Example: pulsed current in MT high-power ecoAmp one-piece cantilever contact

Thermal Imaging Example: 0.3mm Spring Probe



- FLIR P640 camera
- Custom PEEK fixture with exposed side
- Clamped to probe test height





Comparison of Different Methods in Determining Current Carrying Capacity of Semiconductor Test Contacts

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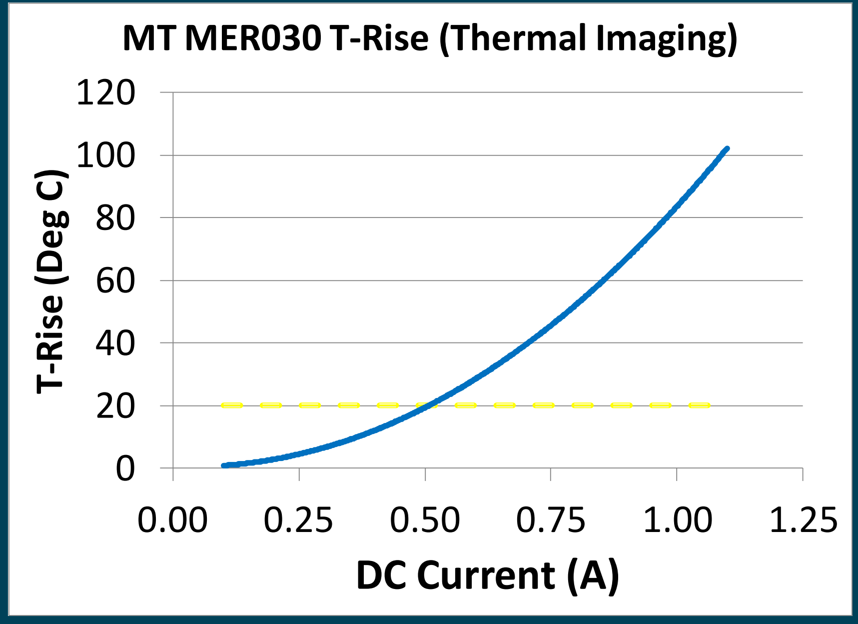
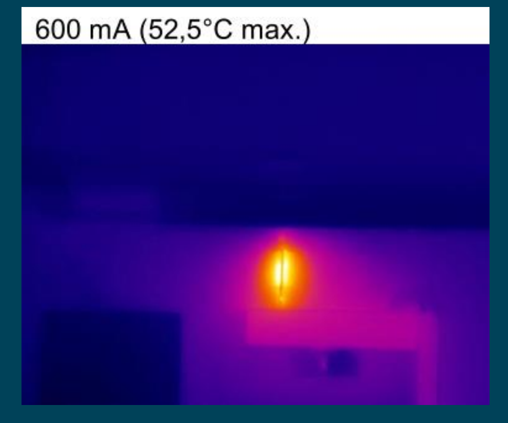
Thermal Imaging Example: 0.3mm Spring Probe

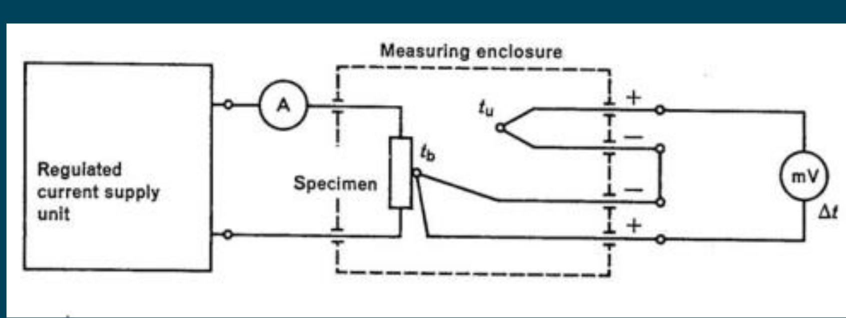


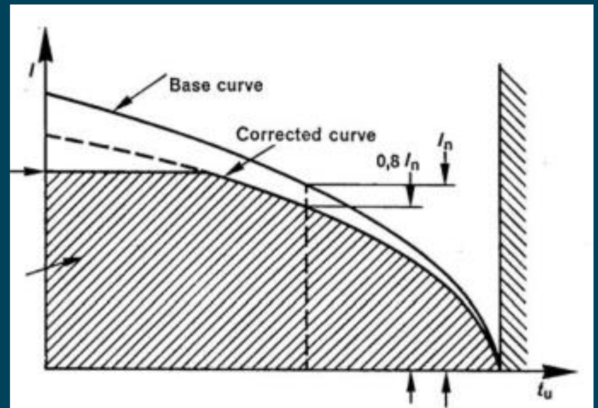
- IR camera reported highest temperature
- Smooth data, but limited in resolution



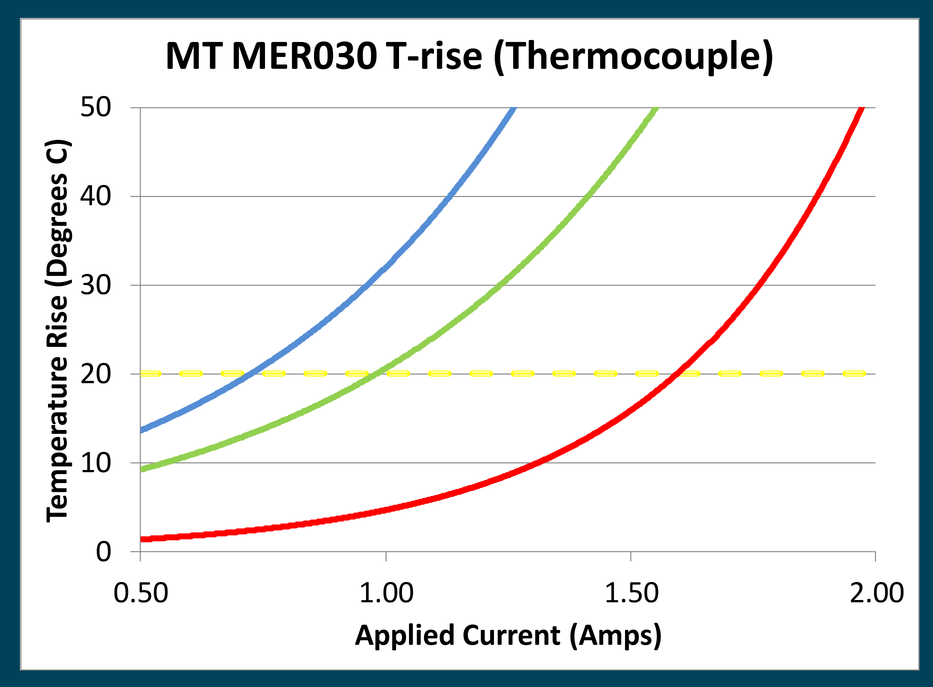
Thermocouple T-Rise Method

- IEC 60512-5-2 Test 5b
  - Standard test method to assess the CCC of electromechanical components (connectors) at elevated ambient temperature.
- EIA/ECA 364-70
  - Temperature rise versus current test procedure for electrical connectors and sockets

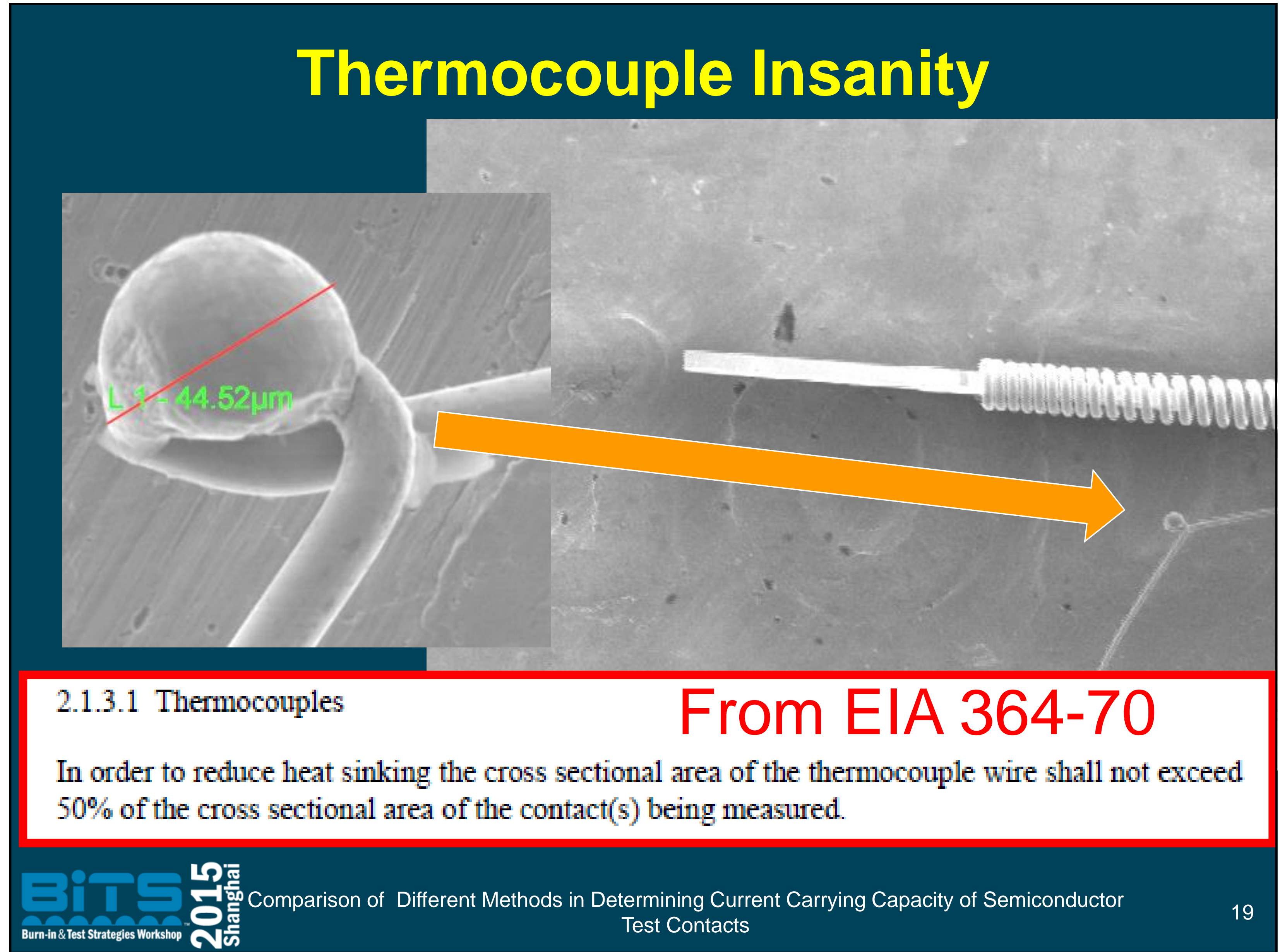




Thermocouple Example: 0.3mm Spring Probe



- 3 test runns – avg. 10 pins each
- Very high variability of results
- Thermocouple proximity to hotspots questionable


Thermocouple Insanity
L 1 - 44.52µm
2.1.3.1 Thermocouples
From EIA 364-70
In order to reduce heat sinking the cross sectional area of the thermocouple wire shall not exceed 50% of the cross sectional area of the contact(s) being measured.
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Comparison & Discussion

Method	Pros	Cons
Thermocouple	•'Standard' methods	•<.3mm challenging •Derating curve •Miss hot-spots
ISMI Force-Reduction	•Can be done in socket housings •Can be robotically automated – lights-out	•Long test time •Derating curve
Thermal Imaging	•See real-time hot-spots	•Thermal environment not real •Resolution
Modeling & Simulation	•Learn about design in advance of hardware	•Model assumptions •Needs accurate correlation

All We Want To Do Is Avoid This