SIXTEENTH ANNUAL

BiTS™

Burn-in & Test Strategies Workshop

March 15 - 18, 2015

Hilton Phoenix / Mesa Hotel
Mesa, Arizona

Archive – Session 2

Session 2

Mike Noel

Session Chair

BiTS Workshop 2015 Schedule

Frontiers Day

Monday March 16 1:30 pm

Spanning the Socket Rainbow

"Contacting Solutions for High Power Bare Die Testing (IGBT MOS-FET and Diodes)"

Markus Wagner - Cohu SEG

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

Valts Treibergs - Xcerra Corporation

"Are New Temperature Test Strategies Needed? Meeting Performance and Cost Requirements of Today's Applications"

Andreas Nagy - Xcerra Corporation

"Extreme Temperature and High Current Testing Challenges of Automotive Devices"

Praveen kumar Ramamoorthy & Murad Hudda - Infineon Technologies
Dan Maccoux & Muhamad Izzat bin Roslee - JF Microtechnology

BiTS Burn-in & Test Strategies Workshop 2015

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

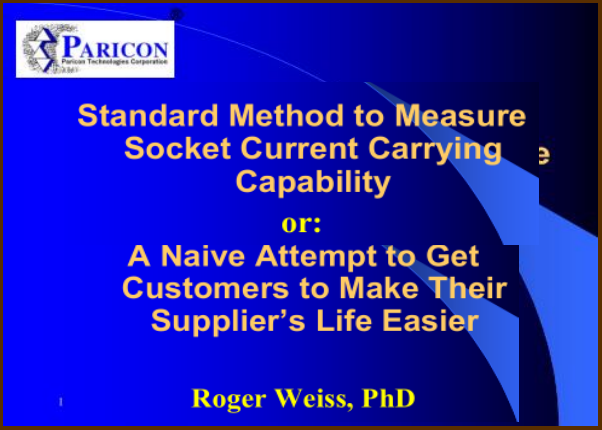
Valts Treibergs, Mitchell Nelson
Xcerra Corporation

2015 BiTS Workshop
March 15 - 18, 2015

Presentation Agenda

- Current Carrying Capacity (CCC) as discussed at BiTS, SWTW, and standards
  - – 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

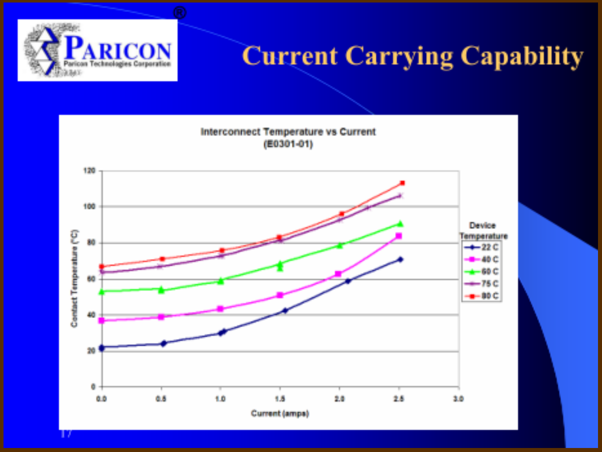


Standard Method to Measure Socket Current Carrying Capability

or:

A Naive Attempt to Get Customers to Make Their Supplier's Life Easier

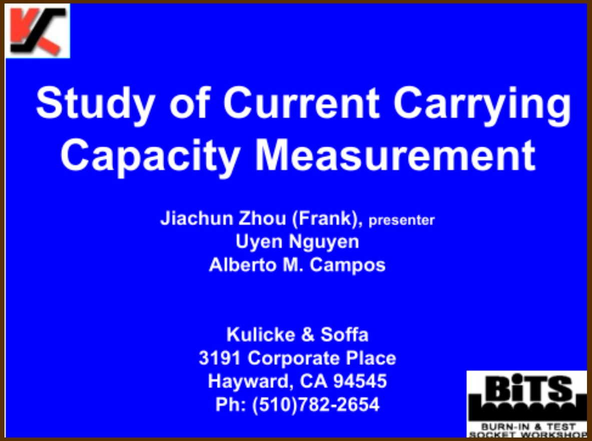
Roger Weiss, PhD



Current Carrying Capability

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

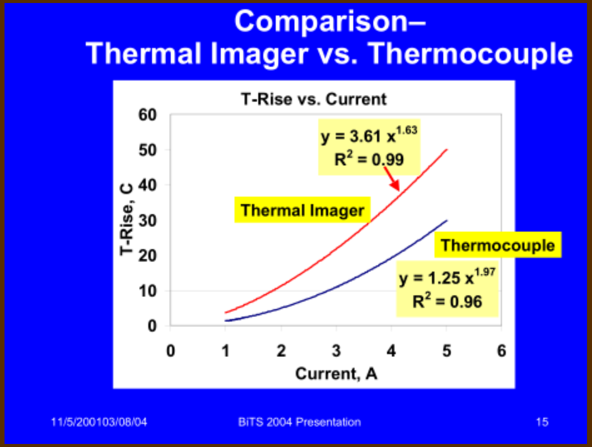
BiTS 2004 – K&S



Study of Current Carrying Capacity Measurement

Jiachun Zhou (Frank), presenter
Uyen Nguyen
Alberto M. Campos

Kulicke & Soffa
3191 Corporate Place
Hayward, CA 94545
Ph: (510)782-2654



Comparison–
Thermal Imager vs. Thermocouple

11/5/200103/08/04 BiTS 2004 Presentation 15

- 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

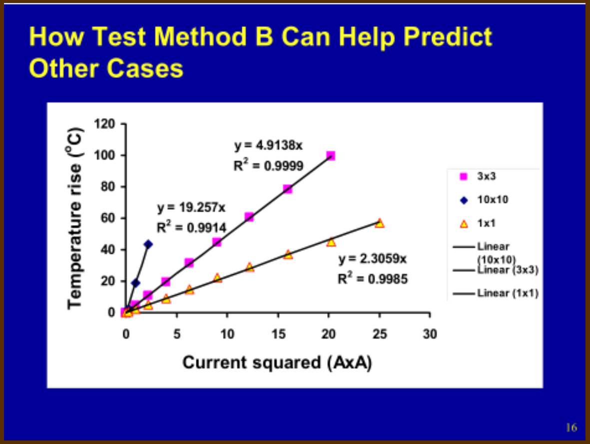
BiTS 2004 - IBM

Current Rating for Contacts
Time to Standardize the Test Method

Qifang "Michelle" Qiao
IBM Microelectronics

Karl G. Schoenfeld
Gonzer Associates

IBM.



How Test Method B Can Help Predict Other Cases

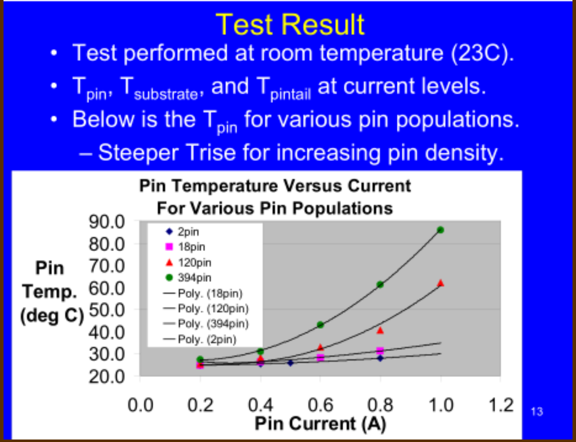
- 2-Step approach – characterize T-rise of single pin at ambient in air then of cluster of pins
- Develop model to predict socket performance
- Test based on EIA-364-70 standard

BiTS 2004 - Intel

Socket Current Carrying Capacity (CCC) Characterization

Victor Henckel
Glenn Cunningham
Hongfei Yan

Intel Corporation



Test Result

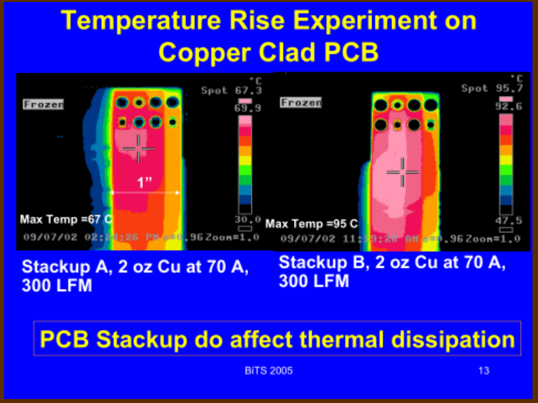
- Test performed at room temperature (23C).
- T_{pin}, $T_{substrate}$, and $T_{pintail}$ at current levels.
- Below is the T_{pin} for various pin populations.
  - Steeper Trise for increasing pin density.

- 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

Challenges In High Current PCB Power Delivery

Hon Lee Kon
Anthony Wong Yeh Chiing
Intel Test Tooling Operations



Temperature Rise Experiment on Copper Clad PCB

Stackup A, 2 oz Cu at 70 A, 300 LFM

Stackup B, 2 oz Cu at 70 A, 300 LFM

PCB Stackup do affect thermal dissipation

BiTS 2005 13

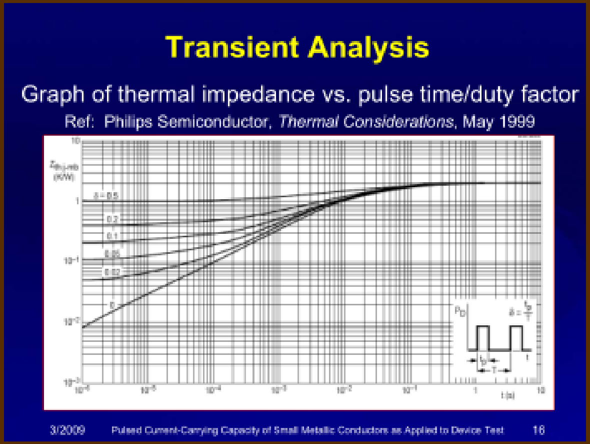
- Intel then further pushed the challenge into the PCB for power delivery
- Demonstrated the same methodology used in characterizing socket interconnects
- Introduced thermal simulation

BiTS 2009 - Johnstech

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

Harlan Faller, P.E.
Johnstech International

2009 BiTS Workshop
March 8 - 11, 2009



Transient Analysis

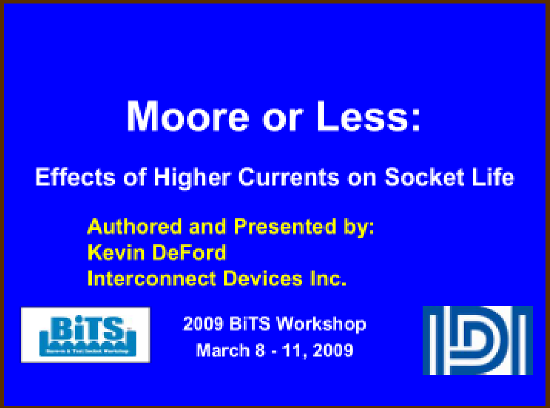
Graph of thermal impedance vs. pulse time/duty factor

Ref: Philips Semiconductor, *Thermal Considerations*, May 1999

3/2009 Pulsed Current-Carrying Capacity of Small Metallic Conductors as Applied to Device Test 16

- 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

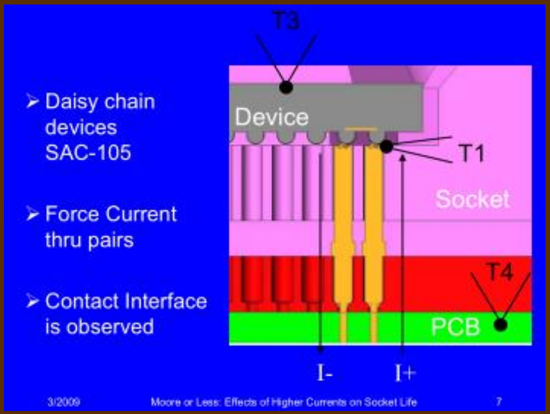


Moore or Less:

Effects of Higher Currents on Socket Life

Authored and Presented by:
Kevin DeFord
Interconnect Devices Inc.

2009 BiTS Workshop
March 8 - 11, 2009



- Daisy chain devices SAC-105
- Force Current thru pairs
- Contact Interface is observed

3/2009 Moore or Less: Effects of Higher Currents on Socket Life 7

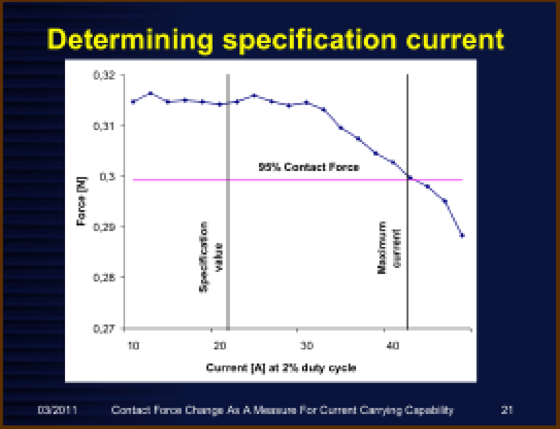
- Single-pin in air (thermocouple) method not adequate, but a good baseline
- Propose to introduce DUT metallic interface into the mix – simulate real world
- Intermetallics and electromigration degrade even CCC even more

BiTS 2011 - Multitest

Contact Force Change As A Measure For Current Carrying Capability

Marcus Frey
Multitest

2011 BiTS Workshop
March 6 - 9, 2011

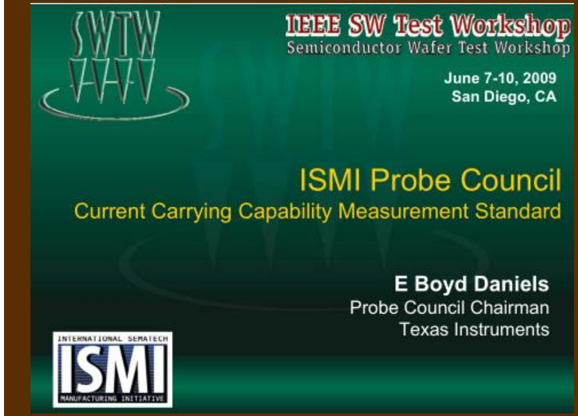


Determining specification current

03/2011 Contact Force Change As A Measure For Current Carrying Capability 21

- 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

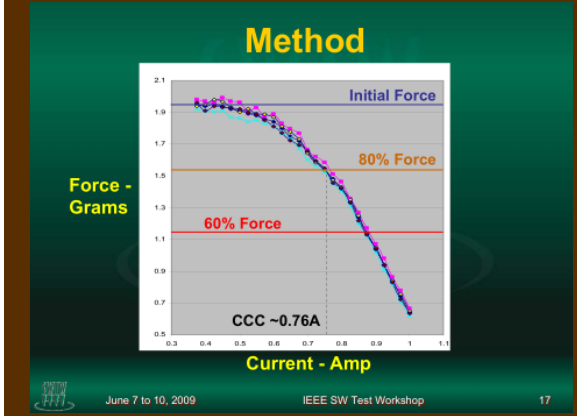
ISMI Probe Council CCC Measurement Guideline



IEEE SW Test Workshop
Semiconductor Wafer Test Workshop
June 7-10, 2009
San Diego, CA

ISMI Probe Council
Current Carrying Capability Measurement Standard

E Boyd Daniels
Probe Council Chairman
Texas Instruments

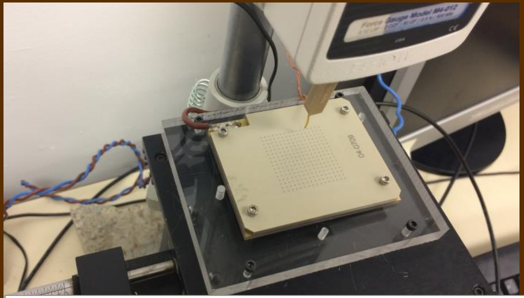


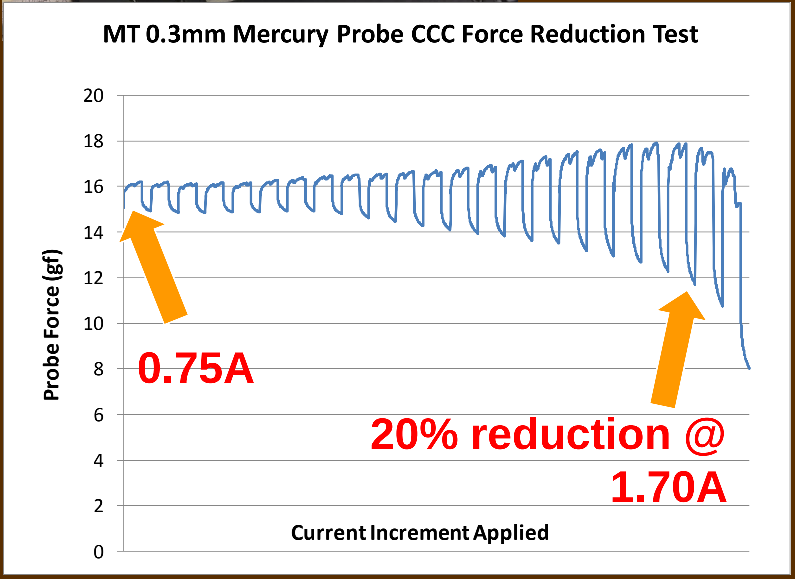
Method

June 7 to 10, 2009 IEEE SW Test Workshop 17

- 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





MT 0.3mm Mercury Probe CCC Force Reduction Test

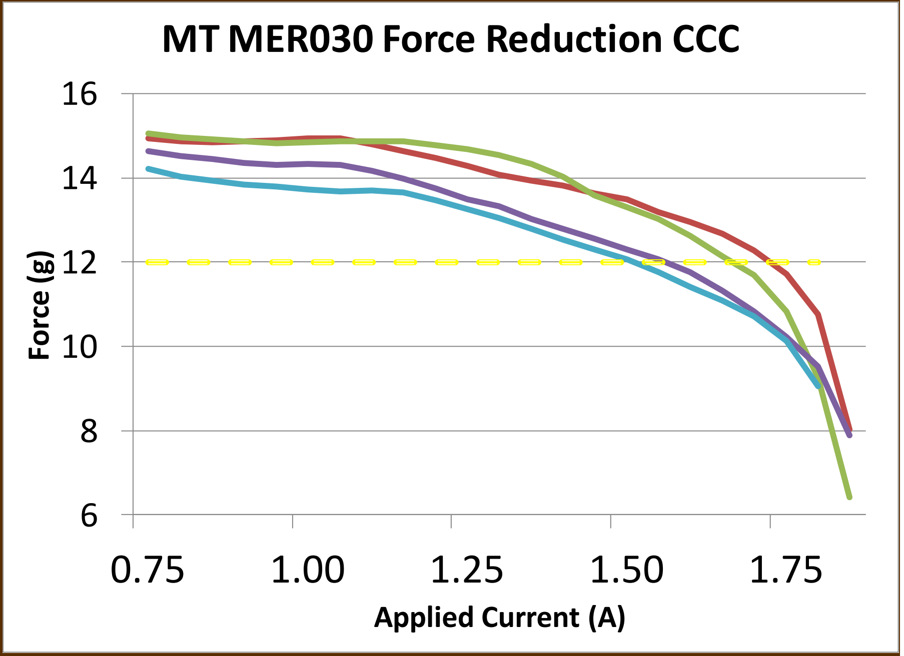
0.75A

20% reduction @ 1.70A

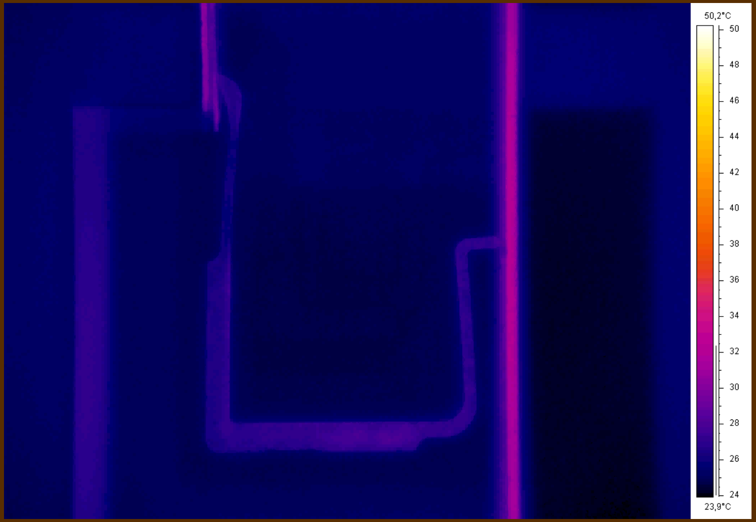
- Single probe placed in fixture
- Stage adjusted until nominal probe force achieved
- Each DC current increment applied for 2 min, 1min cool-down *
- Looped until 40% reduction seen

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

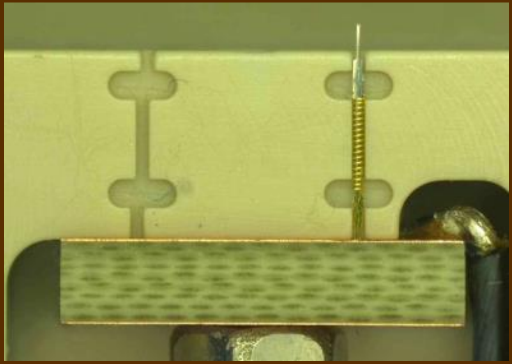


Example: pulsed current in MT high-power ecoAmp one-piece cantilever contact

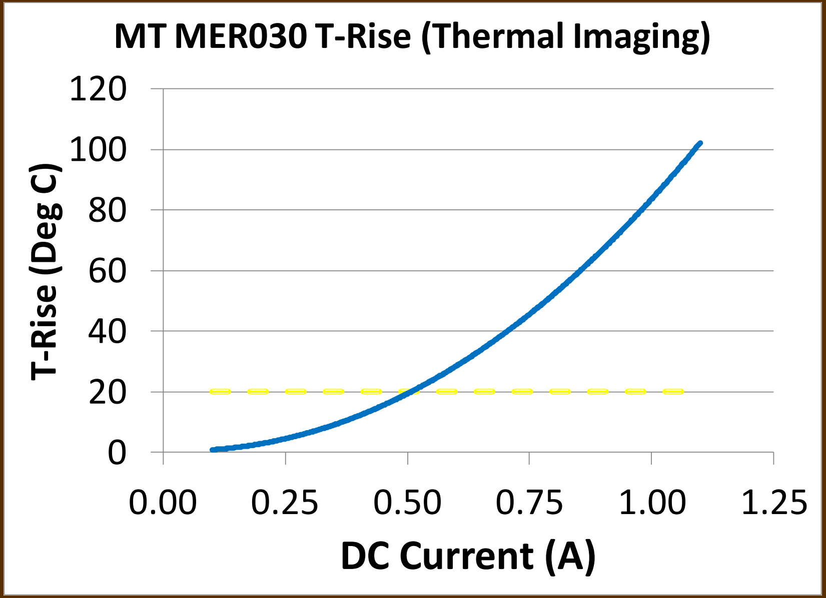
- Sees thermal conduction in real-time – finds hot-spot
- Observe accumulating heat in socket housing

Thermal Imaging Example: 0.3mm Spring Probe

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



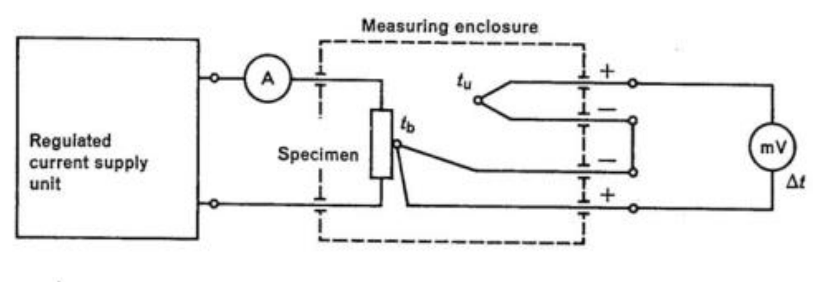
Thermal Imaging Example: 0.3mm Spring Probe

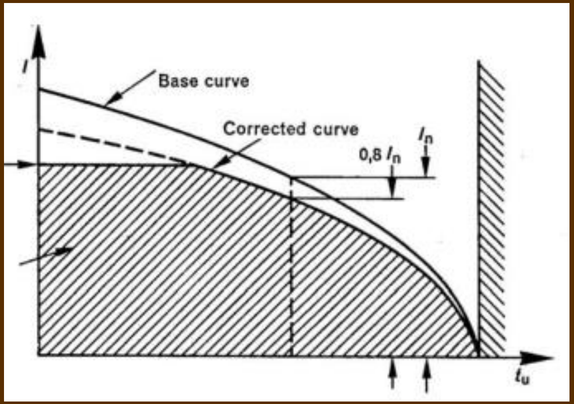


- IR camera reported highest temperature
- Smooth data, but limited in resolution

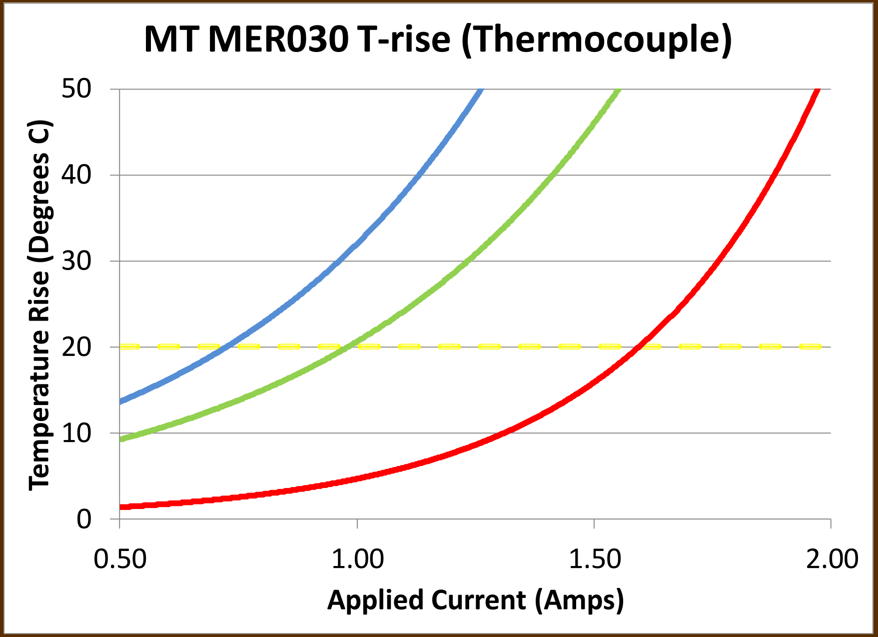
Thermocouple T-Rise Method

- 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



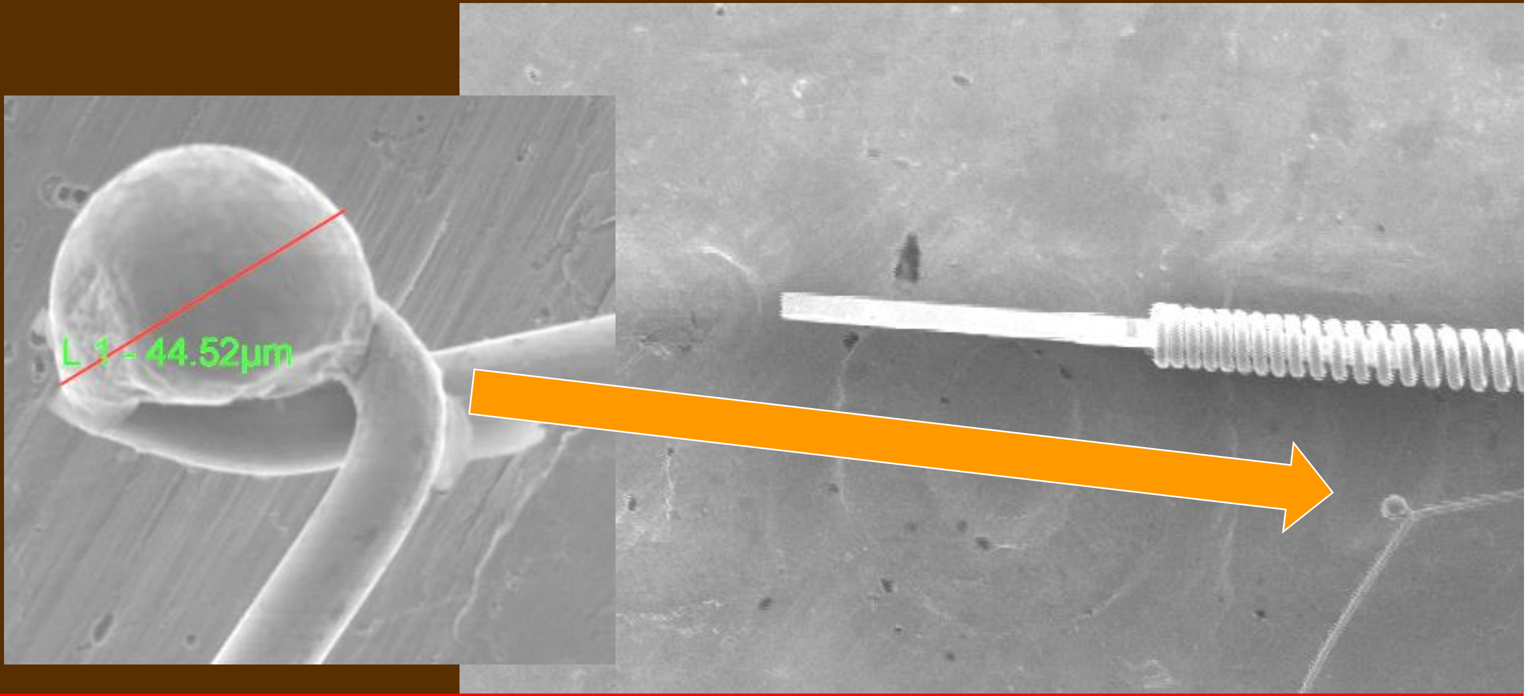


Thermocouple Example: 0.3mm Spring Probe



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

Thermocouple Insanity



2.1.3.1 Thermocouples

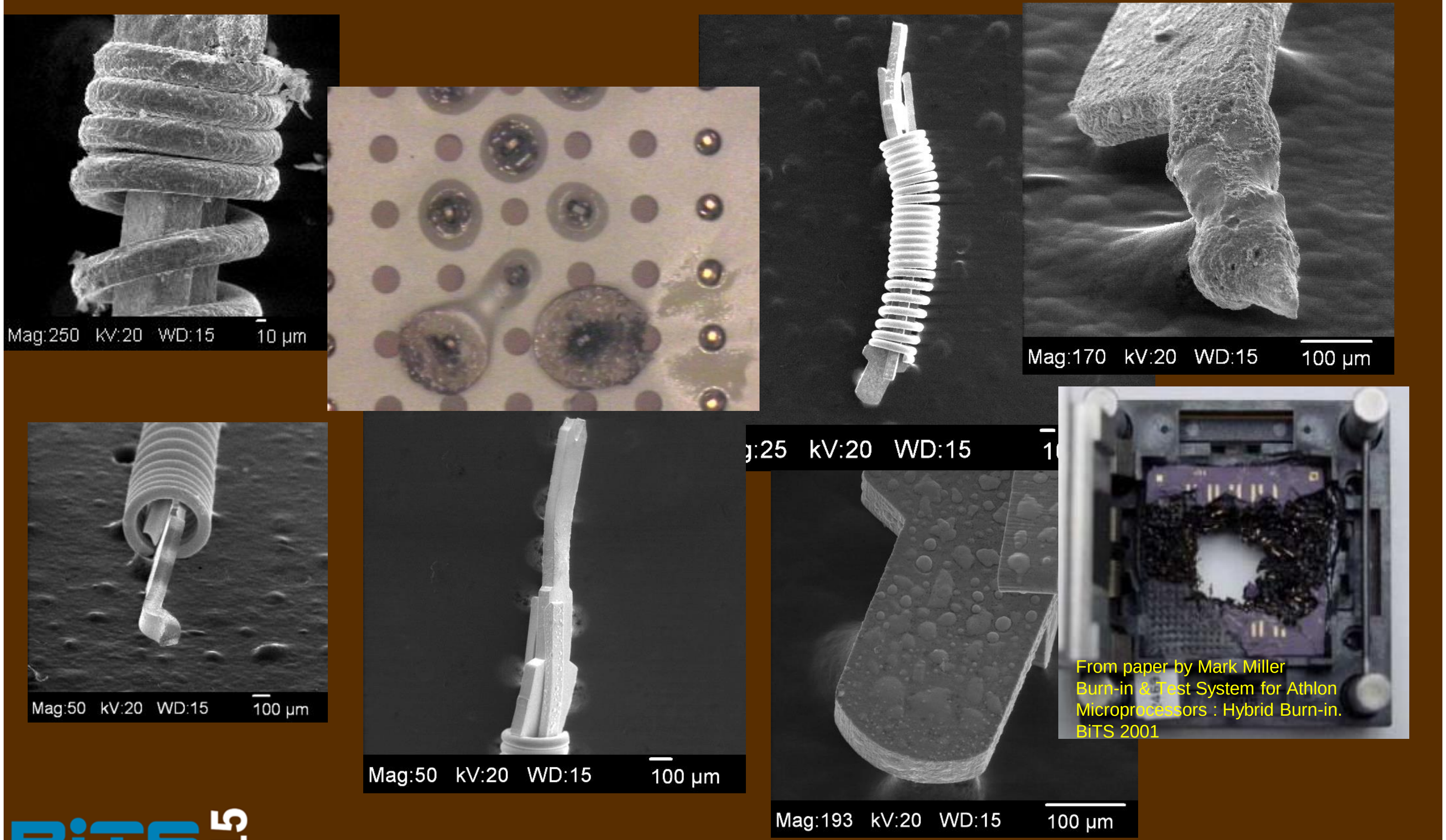
From EIA 364-70

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.

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 😐



From paper by Mark Miller
Burn-in & Test System for Athlon
Microprocessors : Hybrid Burn-in.
BiTS 2001