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Spring Probe WLCSP Probe Head CCC - ISMI Characterization Is Not Enough

**Valts Treiberigs, Travis Evans, Mitchell Nelson
Cohu**



Presentation Agenda

- ISMI CCC Test Overview
- BiTS/SWTW Background Data
- ISMI Data of a 200 μm Pitch Spring Probe
- ISMI Result Put To The Test – High Current Cycling
- Determination of the ISMI de-rating value
- Validation of the proposal based on a different spring probe

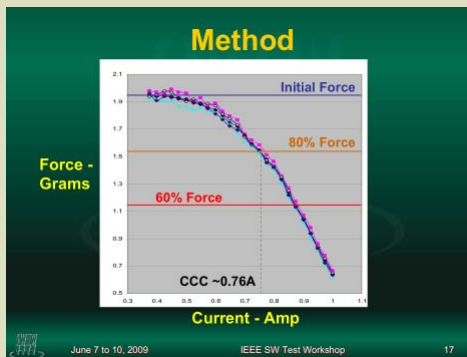


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ISMI* Test Overview



- From the MFGM042M project and presented at SWTW 2009 for wafer probe current carrying capacity (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?

*International SEMATECH (Semiconductor Manufacturing Technology) Manufacturing Initiative



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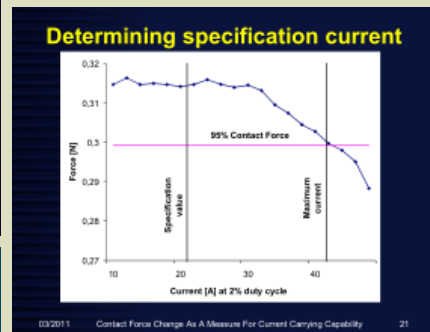


Additional Presentations of Note

Contact Force Change As A Measure For Current Carrying Capability

Marcus Frey
Multitest

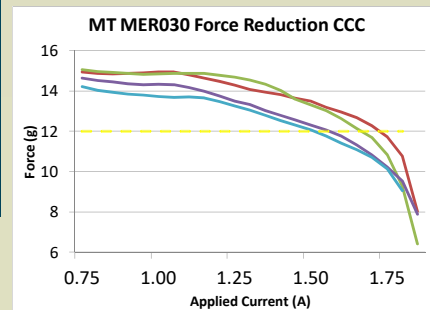
2011 BITS Workshop
March 6 - 9, 2011

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

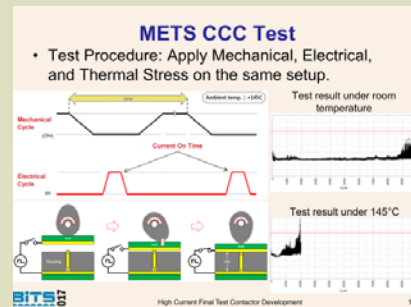
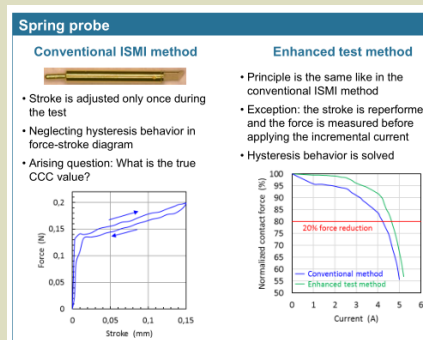
Valts Treibergs, Mitchell Nelson
Xcerra Corporation

2015 BiTS Workshop
Shanghai
October 21, 2015

- 2011 – Marcus Frey from Multitest – showed correlation for T-rise in large cantilever springs with force reduction
- 2015 – Valts Treibergs – Xcerra. ISMI tests on spring probes can be done, however the reported force reduction values and CCC results are highly variable

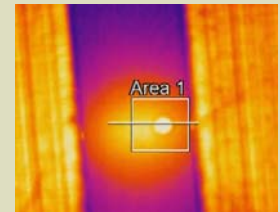
Additional Presentations of Note



- 2018 – Englebrecht – Cohu. Modified ISMI – stroke is reformed and force measured before applying current – eliminating hysteresis
- 2017/20188 – Shwe, Ata (TI) and Sato (Yokowo). During ISMI test – also monitor Cres. Introduction to METS test at elevated temperature

ISMI CCC Test – Good Enough? No

- For spring probe CCC testing, the consensus is that a simple ISMI force reduction test is not good enough
- Other CCC measurement methods (IR camera and thermocouple) can be used but are difficult at fine WLCSP pitches
- The task is to find the proper derating value or find a better method!



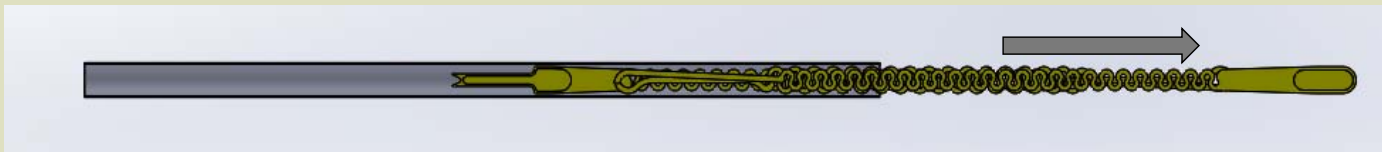
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Let's Start With ISMI

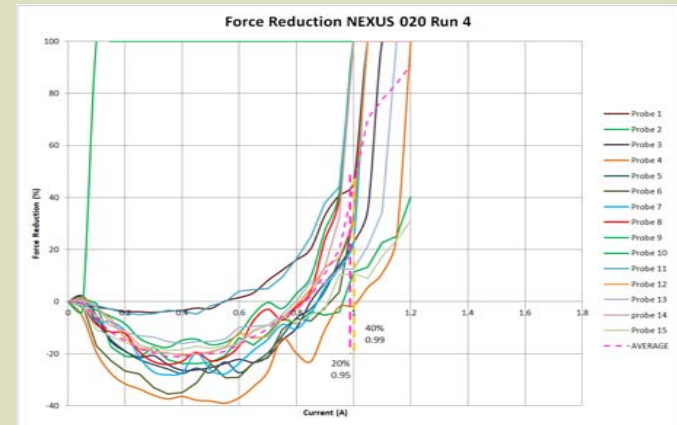
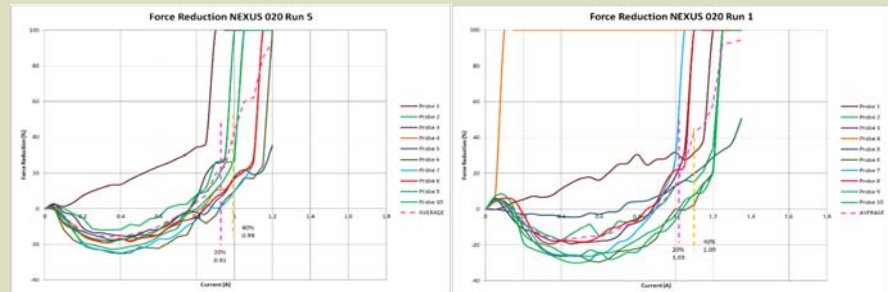
- 200 μm probe was chosen as a test vehicle – NEX020 based on a MEMS spring.
 - This pin was chosen because of extensive recent development work and it has a spring element that is easily removed from its barrel
- Fully automated FReD tester to run ISMI on 35 individual pins



Baseline ISMI CCC Results

- Based on 35 probes tested, 20% force reduction occurs at 960mA DC on average

Run	Probe Type	Fixture Type	Qty Probes	No. "Early" Failures	CCC 20% Force Reduction	CCC 40% Force Reduction
Nex 250	new	new	10	0	1.21	1.39
1	new	new	10	1	1.03	1.09
4	new	old	15	1	0.95	0.99
5	new	new	10	0	0.91	0.99
All 200 Runs			Count	200 Average	0.96	1.02
			35	200 Stdev	0.06	0.06



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Step 2 – High Power Electrical Cycling

- FReD tester was set up to cycle probes under the following test conditions:
 - 2 second dwell time (power on) per cycle
 - Record probe force and resistance to 10K cycles
 - Cycle test individual probes under various current loads: none, 400 mA, 600 mA, 860 mA, 1000 mA – approx. 100 hours continuous testing
 - Repeat 0, 725 mA, 1000 mA

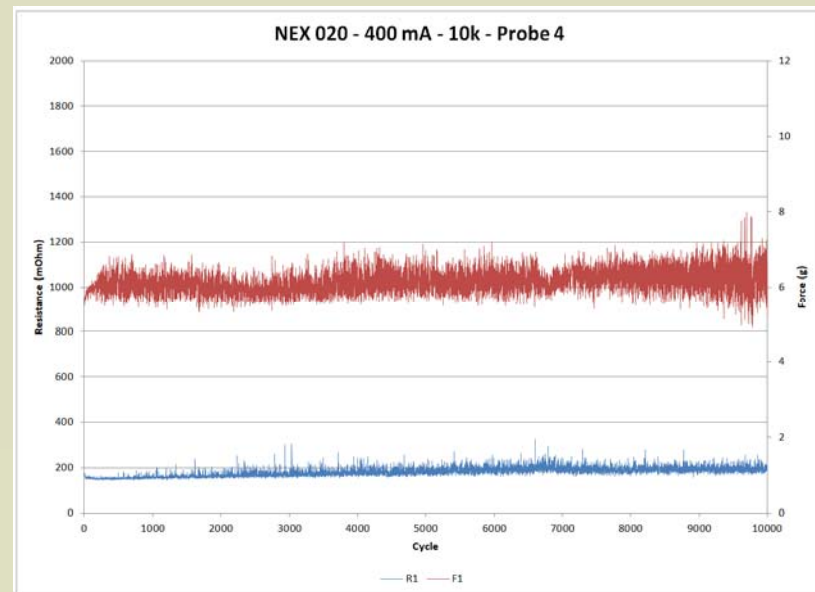
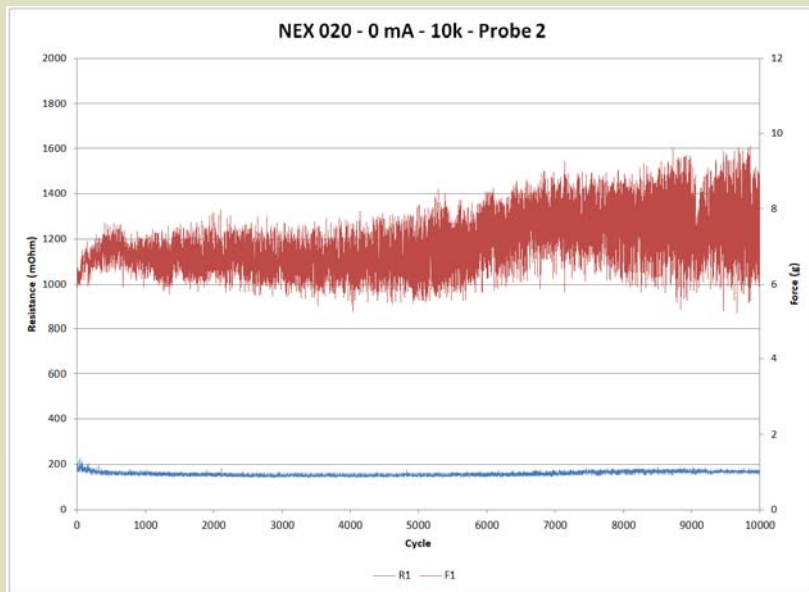


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High Power Electrical Cycling

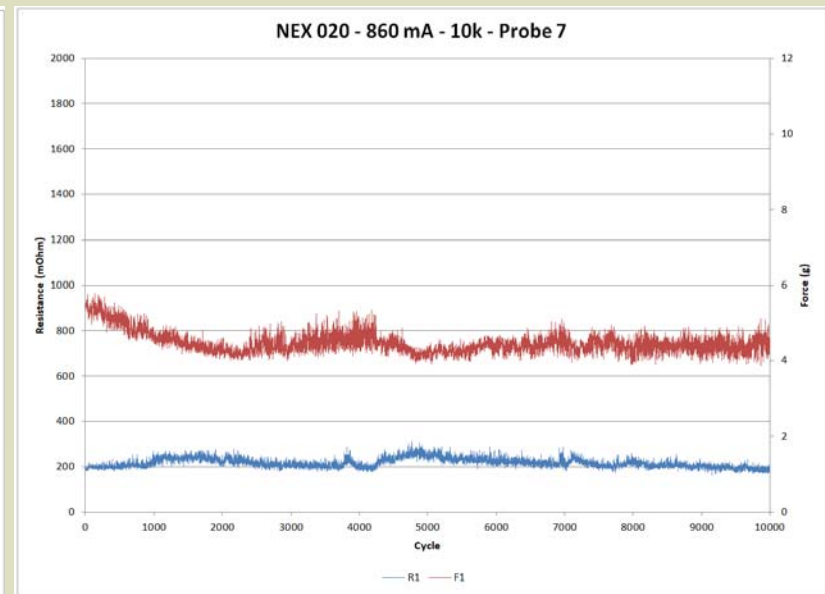
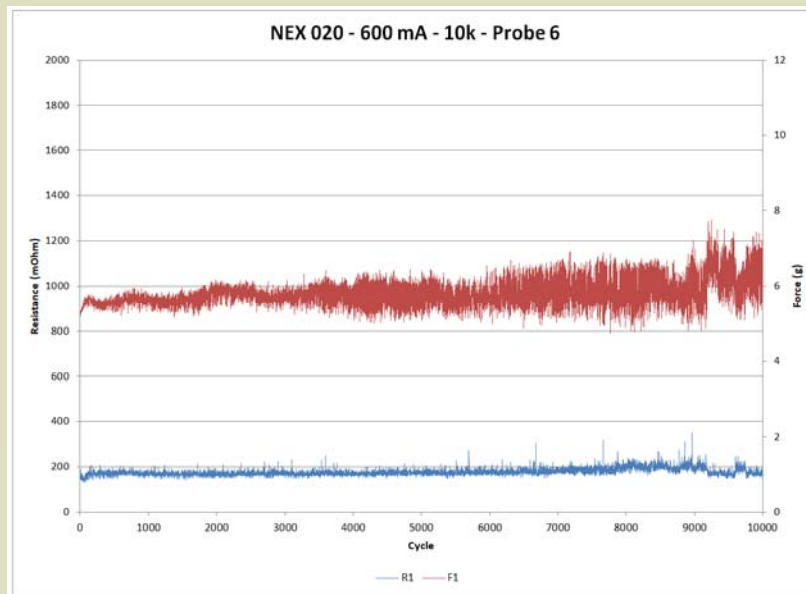


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High Power Electrical Cycling

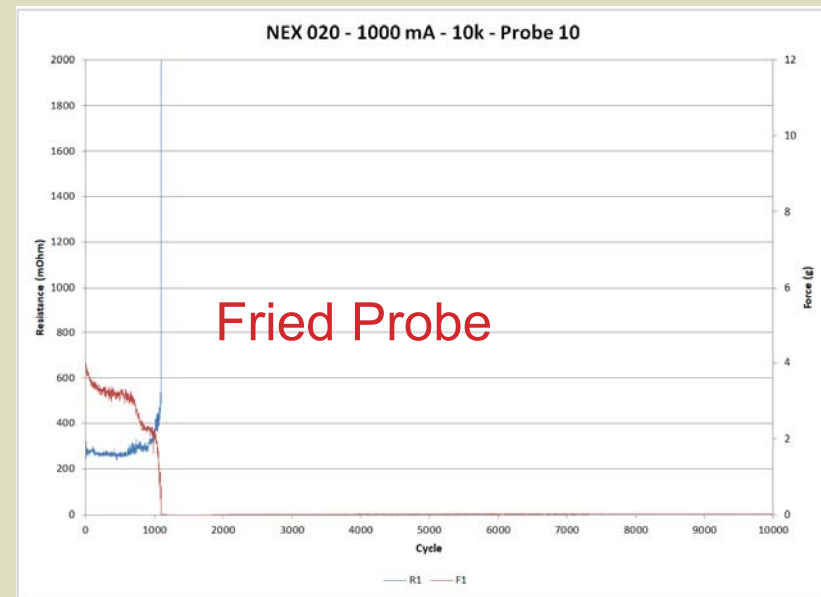
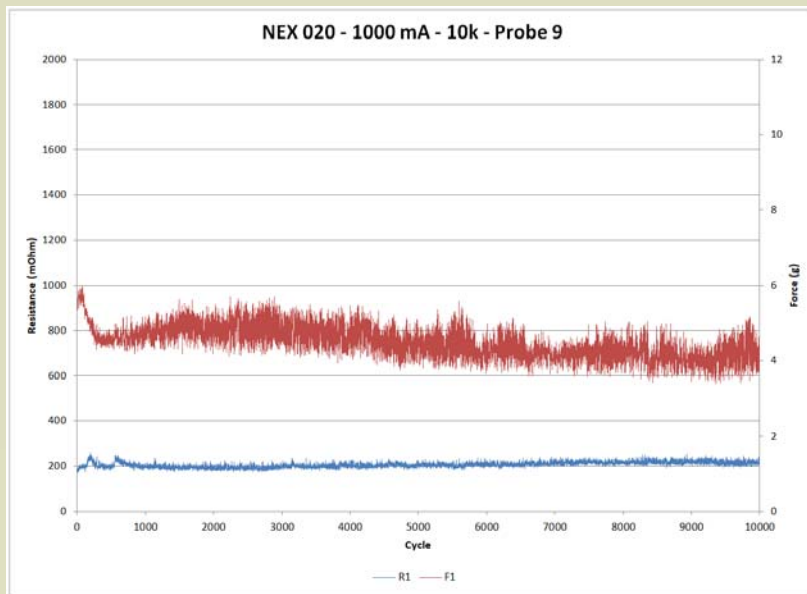


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High Power Electrical Cycling



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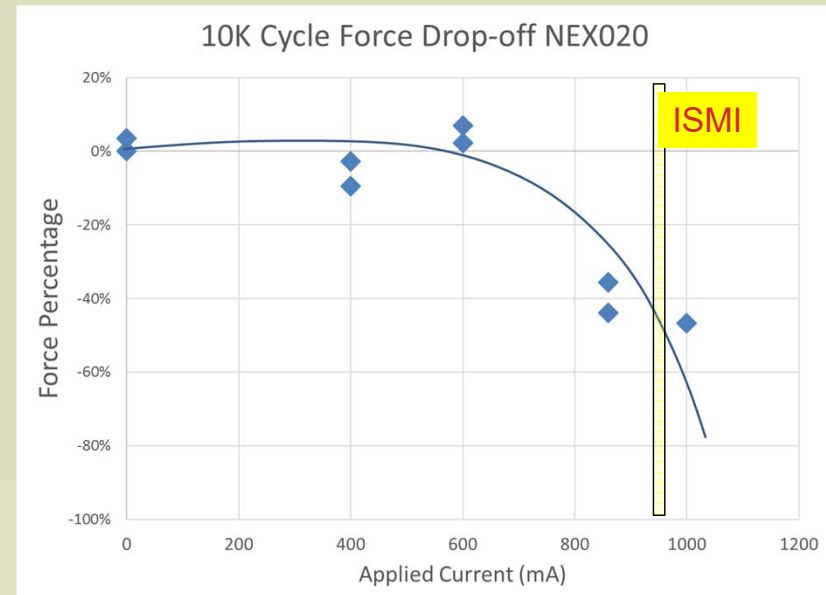
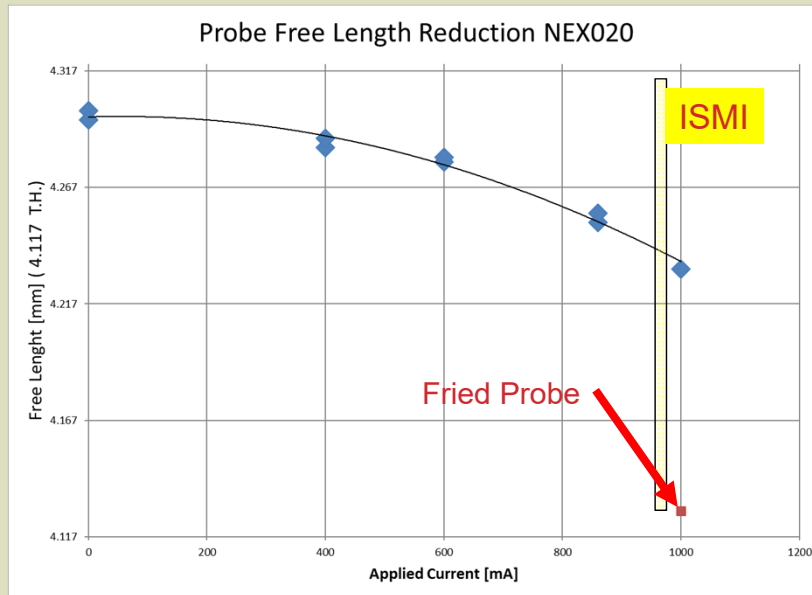


Results Summary

Probe	Current (mA)	F.L. (mm)	Final Force		Force Difference (final-start)
			Avg F (g)	F Std (g)	Percentage
1	10	4.300	7.747	0.701	0%
2	10	4.296	7.532	1.001	4%
3	400	4.284	7.478	0.737	-3%
4	400	4.288	6.230	0.490	-10%
5	600	4.278	7.059	0.947	7%
6	600	4.280	6.440	0.514	2%
7	860	4.252	4.535	0.187	-36%
8	860	4.256	4.155	0.167	-44%
9	1000	4.232	4.044	0.294	-47%
10	1000	4.128	0.027	0.001	-117%

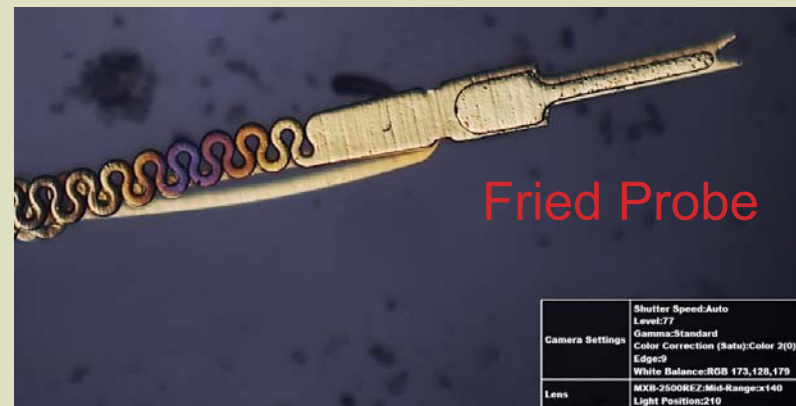
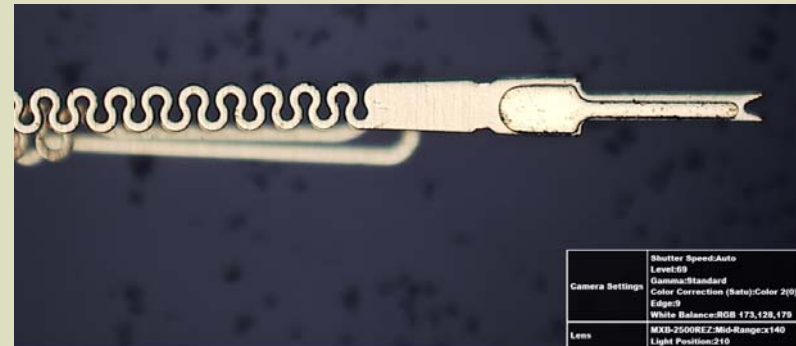
- ISMI predicted 20% force reduction did not correlate to probe CCC during cycling
- Rapid drop-off after 700 mA

Results Summary



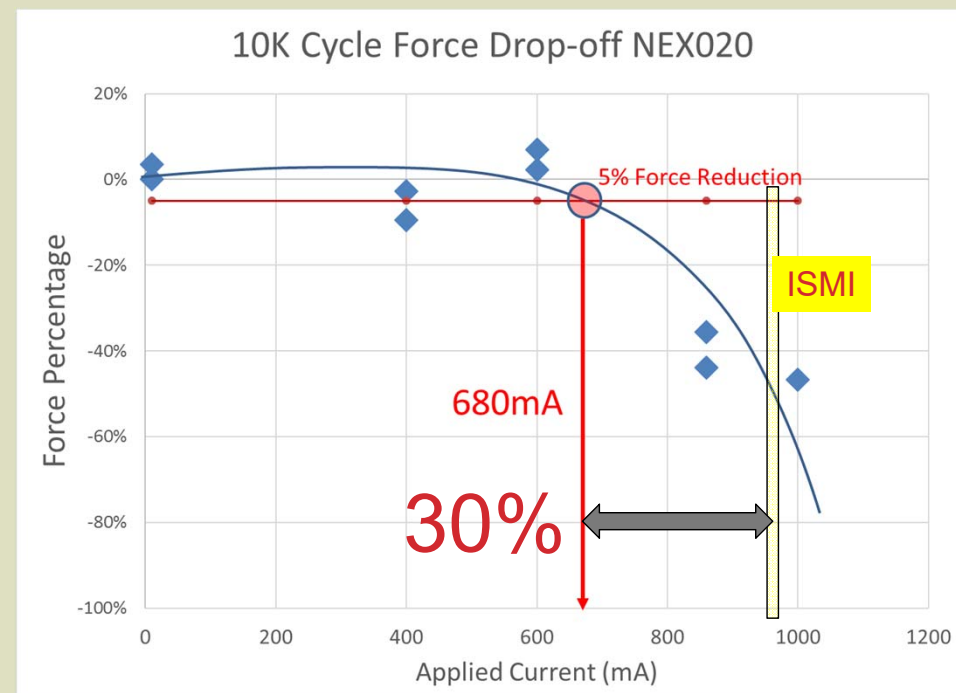
Probe Visual Inspection After Cycling

- Probe spring elements removed from barrels
- Most probes showed no physical marks
- Only one fried probe showed internal spring discoloration



Bounding the Limits

- $\pm 5\%$ force reduction
 - 680mA limit
 - ISMI: 960mA
- 29.2 % reduction
- Therefore propose ISMI derating percentage at 30%



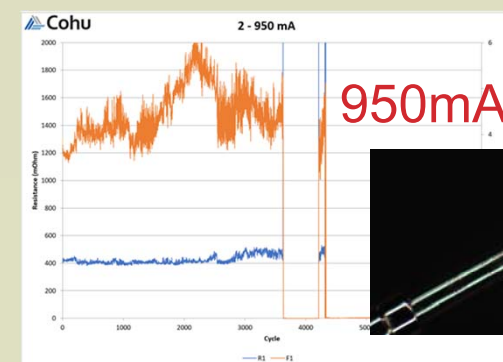
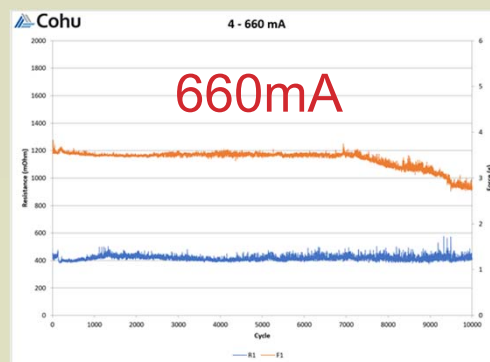
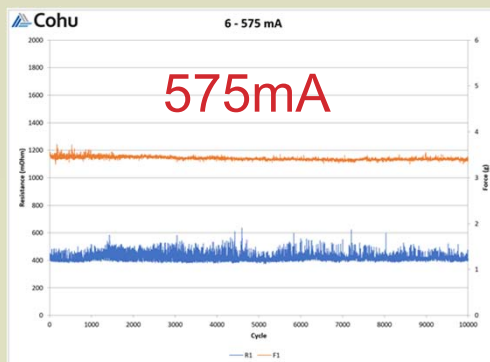
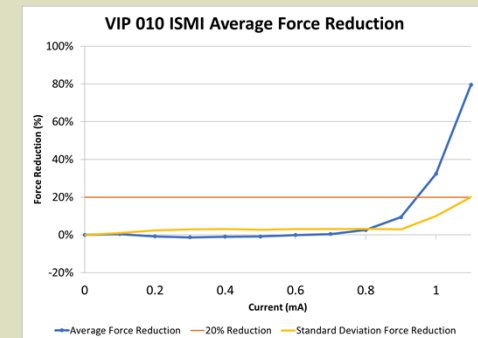
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Validation on Other Spring Pins

- The 30% derating was then applied to another spring pin: cViper 010
- ISMI 20% force reduction @ 950 mA
- 30% derating = 660 mA



Wrap-Up

- It has clearly been shown that a straight ISMI CCC value based on 20% force reduction is not adequate for CCC specification for spring probes
- If a 30% derated current value from tested ISMI is specified, then the results are more believable
 - More validation required to refine this value for all probe types and technologies
- ISMI will then still remain a useful test to compare technologies side-by-side in the lab and on paper only



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Wrap-Up

- Advance qualification testing, such as the METS Test as used and proposed by TI appears to be the best tool to predict the lifetime of spring pin contact interfaces
- Further industry cooperation and standardization on this method is warranted, although every interface has unique requirements, thus needs to be applied properly



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