
TWENTIETH ANNUAL
TestConX™
March 3 - 6, 2019
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive

COPYRIGHT NOTICE

www.testconx.org

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

Valts Treibergs, Travis Evans, Mitchell Nelson
Cohu

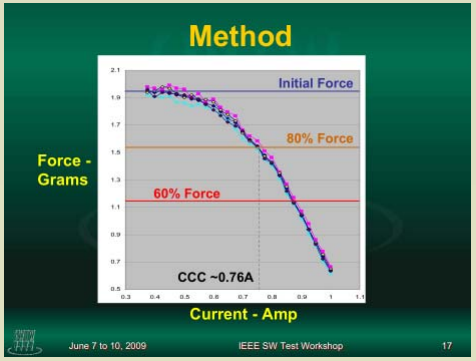
TestConX™
Mesa, Arizona • March 3 - 6, 2019

2000 - 2019 20 YEARS ANNIVERSARY

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

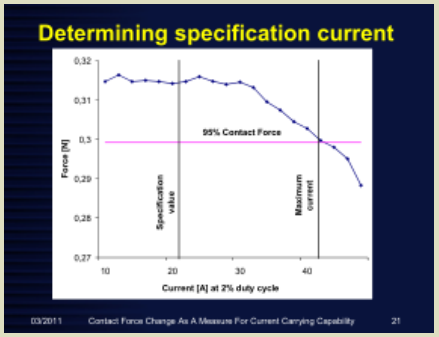


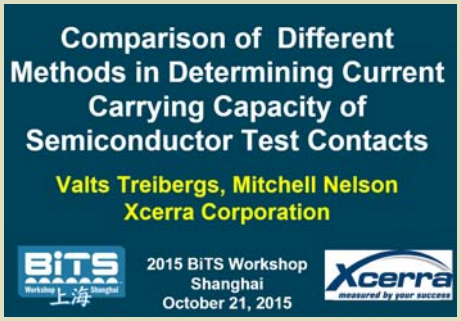
ISMI* Test Overview

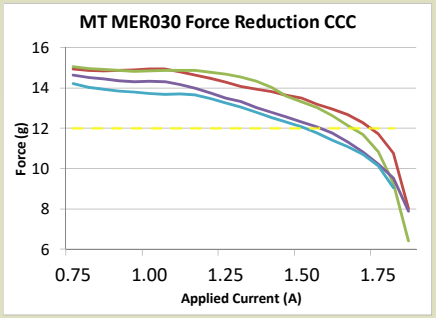
- From the MFGM042M project and presented at SWTW 2009 for wafer probe current carrying capacity (CCC)
- Failure defined as 20% force reduction
- DC current applied at nominal overdrive, then force is measured at room temp. after prescribed cool-down period
- Test is stopped when probe force reduction 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

Additional Presentations of Note

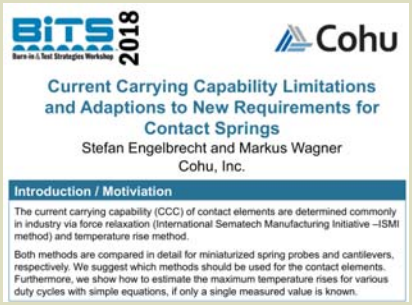


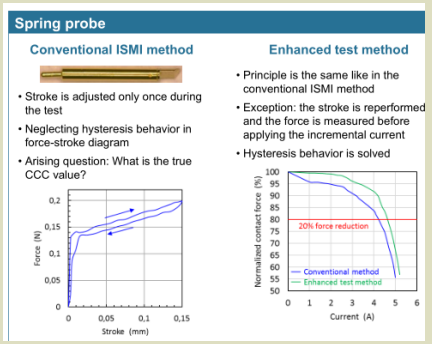


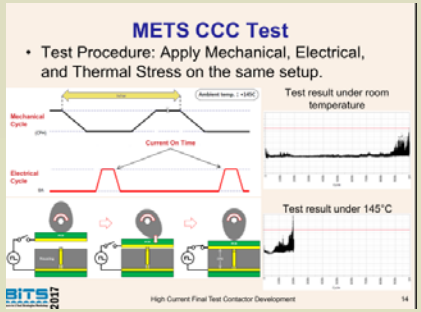


- 2011 – Marcus Frey from Multitest – showed correlation for T-rise in large cantilever springs with force reduction
- 2015 – Valts Treibergs – Xcerra. ISMI tests on spring probes can be done, however the reported force reduction values and CCC results are highly variable

Additional Presentations of Note



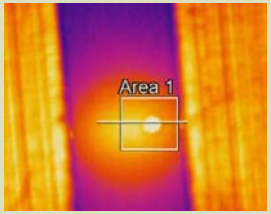




- 2018 – Englebrecht – Cohu. Modified ISMI – stroke is reperformed and force measured before applying current – eliminating hysteresis
- 2017/20188 – Shwe, Ata (TI) and Sato (Yokowo). During ISMI test – also monitor Cres. Introduction to METS test at elevated temperature

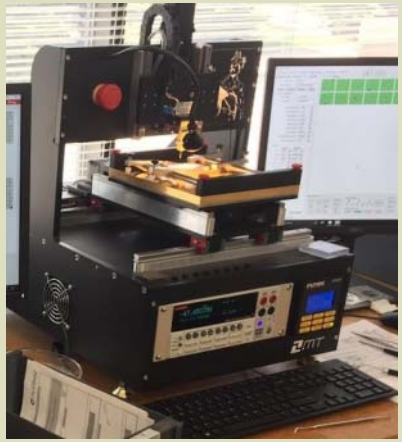
ISMI CCC Test – Good Enough? No

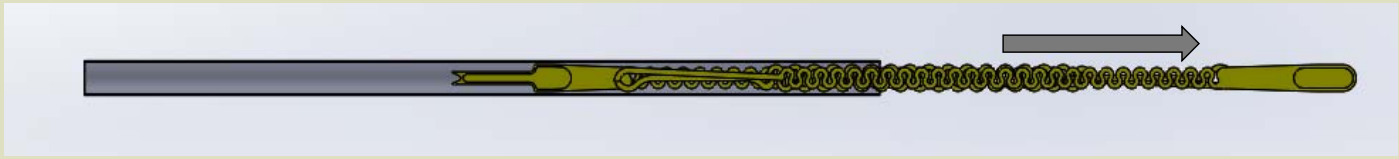
- For spring probe CCC testing, the consensus is that a simple ISMI force reduction test is not good enough
- Other CCC measurement methods (IR camera and thermocouple) can be used but are difficult at fine WLCSP pitches
- The task is to find the proper derating value or find a better method!



Let's Start With ISMI

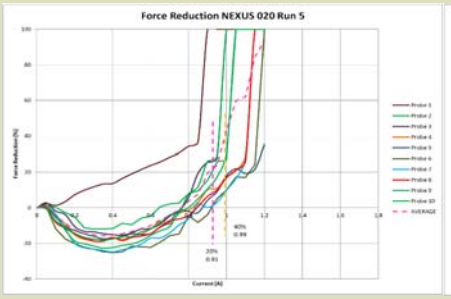
- 200 µm probe was chosen as a test vehicle – NEX020 based on a MEMS spring.
  - This pin was chosen because of extensive recent development work and it has a spring element that is easily removed from its barrel
- Fully automated FReD tester to run ISMI on 35 individual pins

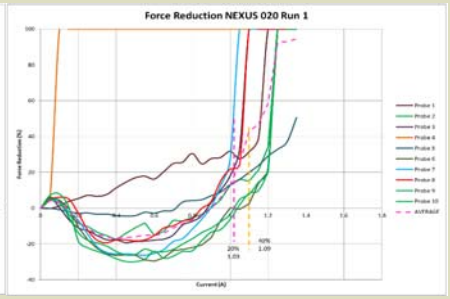


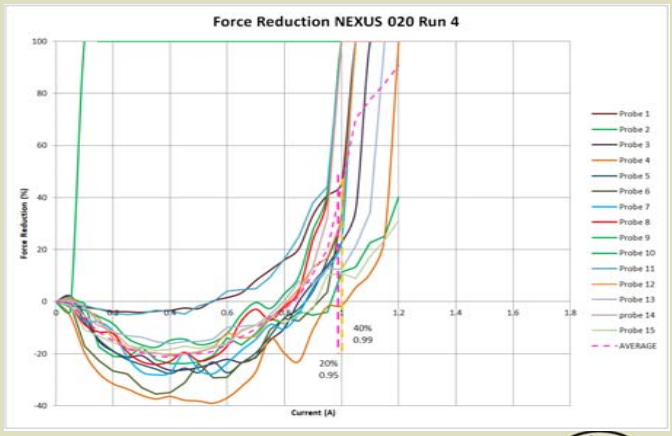


Baseline ISMI CCC Results

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





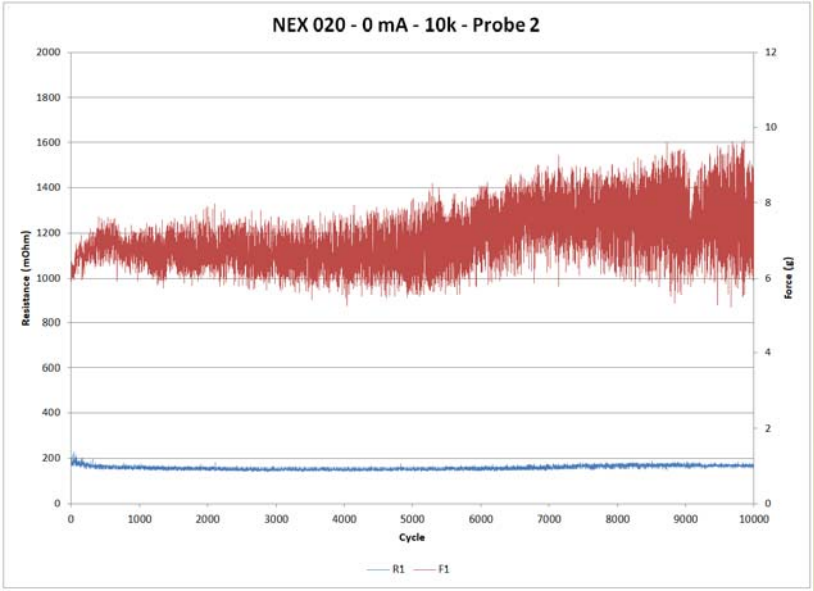


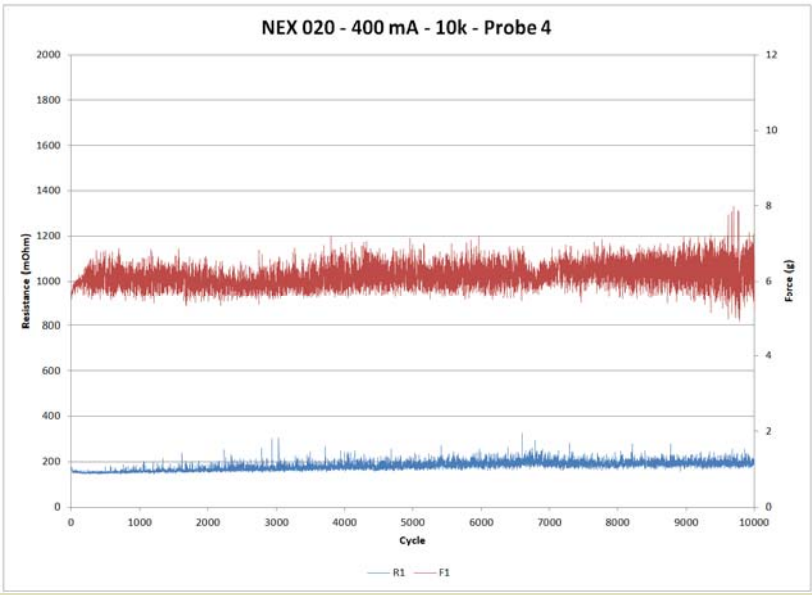
Run	Probe Type	Fixture Type	Qty Probes	No. "Early" Failures	CCC 20% Force Reduction	CCC 40% Force Reduction
Nex 250	new	new	**10**	0	**1.21**	1.39
1	new	new	10	1	1.03	1.09
4	new	old	15	1	0.95	0.99
5	new	new	10	0	0.91	0.99
All 200 Runs			Count	200 Average	**0.96**	1.02
			35	200 Stdev	0.06	0.06

Step 2 – High Power Electrical Cycling

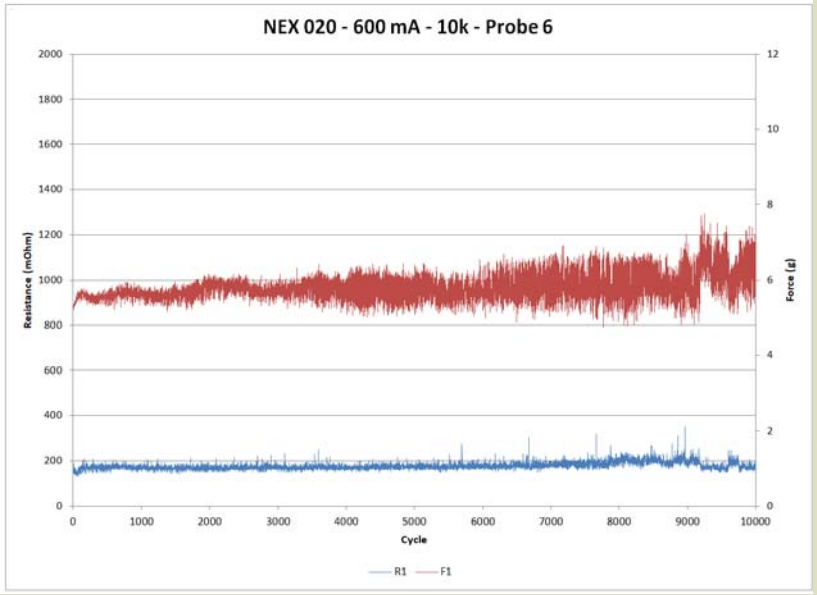
- FReD tester was set up to cycle probes under the following test conditions:
  - 2 second dwell time (power on) per cycle
  - Record probe force and resistance to 10K cycles
  - Cycle test individual probes under various current loads: none, 400 mA, 600 mA, 860 mA, 1000 mA – approx. 100 hours continuous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

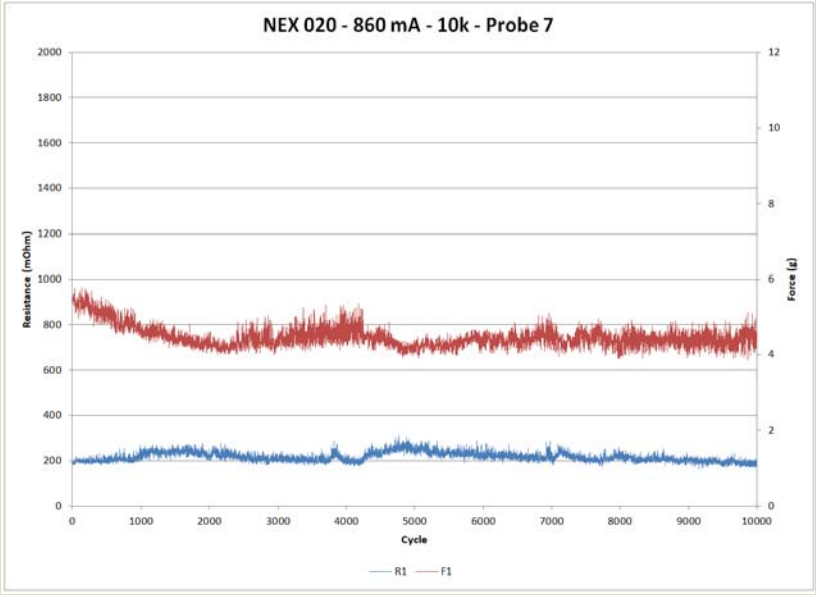
High Power Electrical Cycling



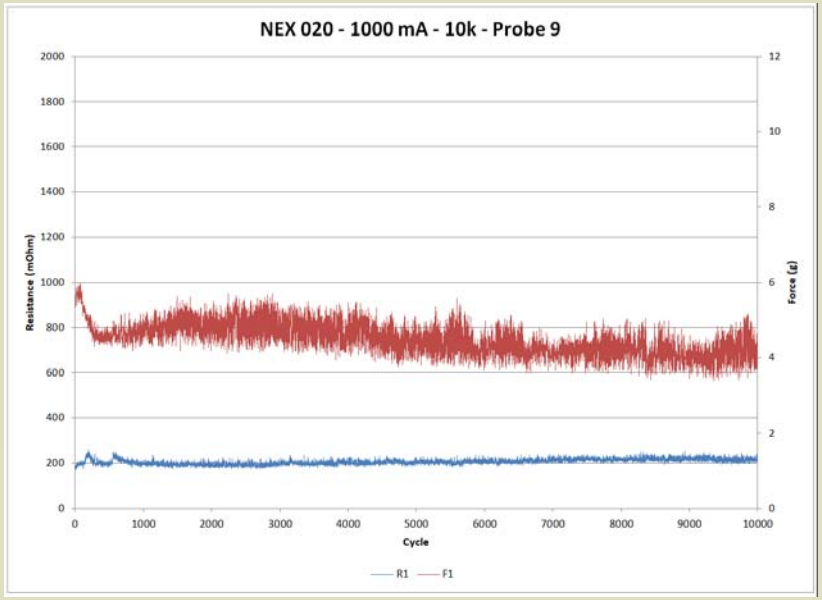


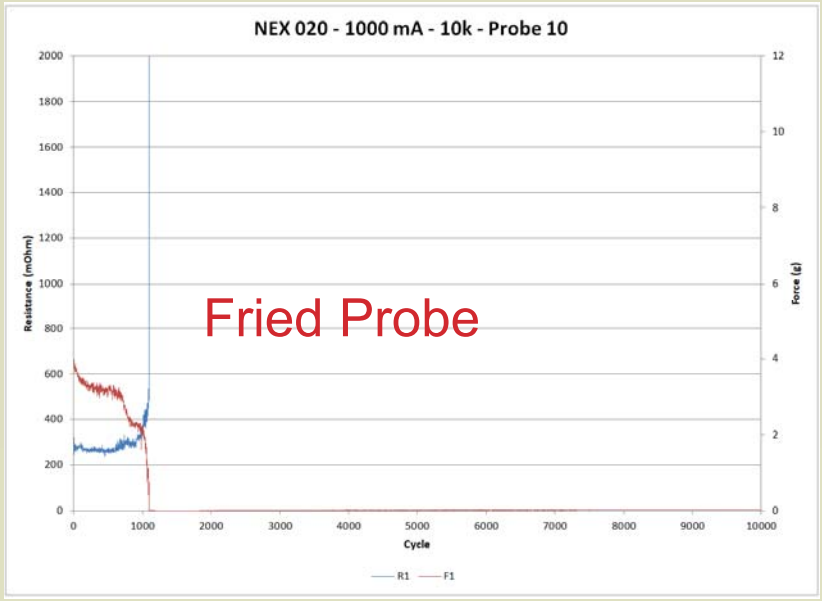
High Power Electrical Cycling





High Power Electrical Cycling



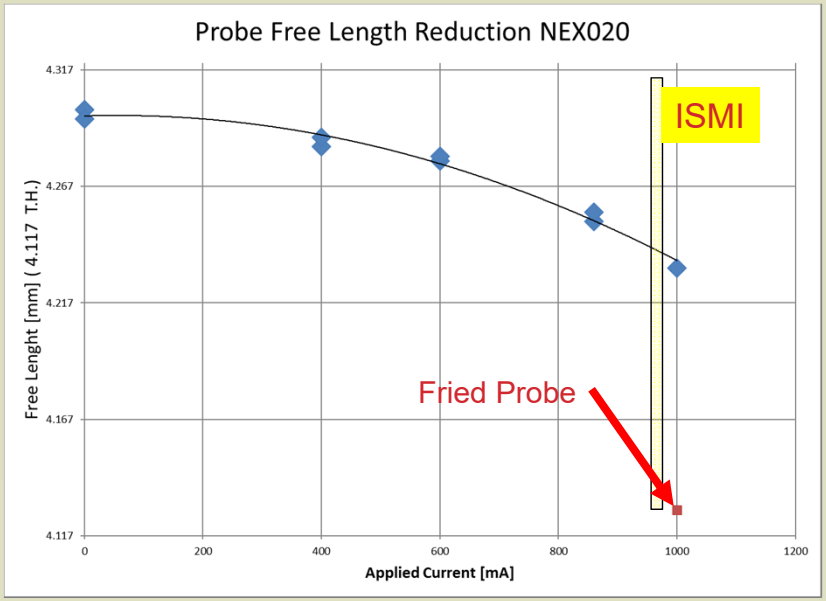


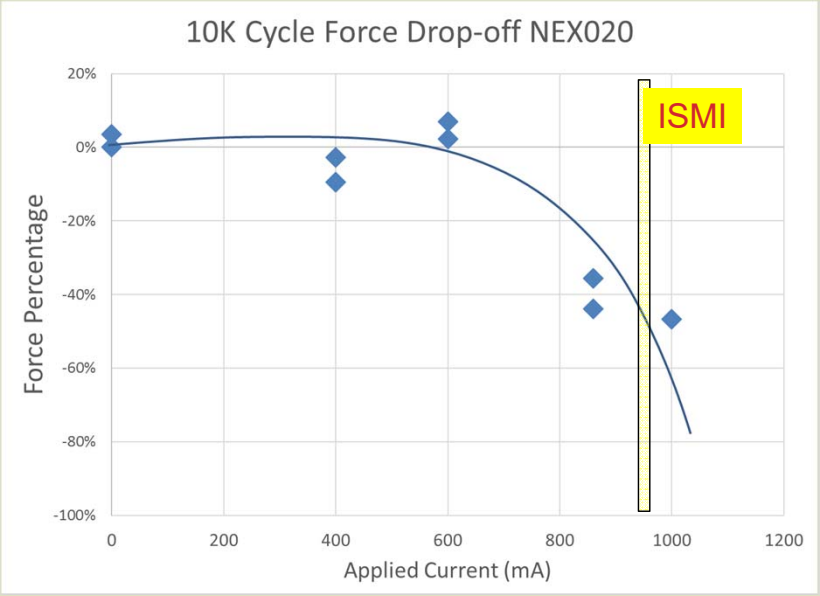
Results Summary

			Final Force		Force Difference (final-start)
Probe	Current (mA)	F.L. (mm)	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

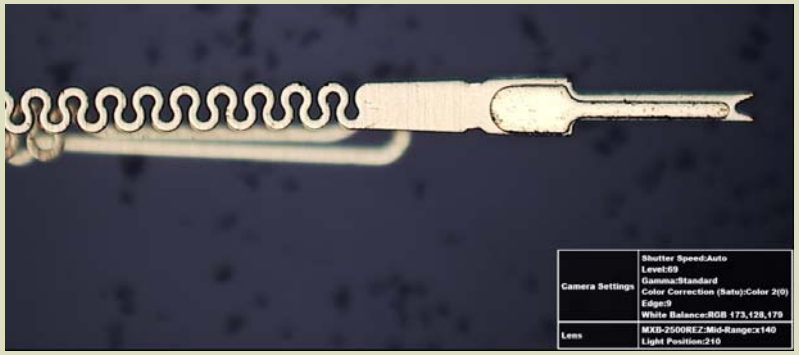
Results Summary





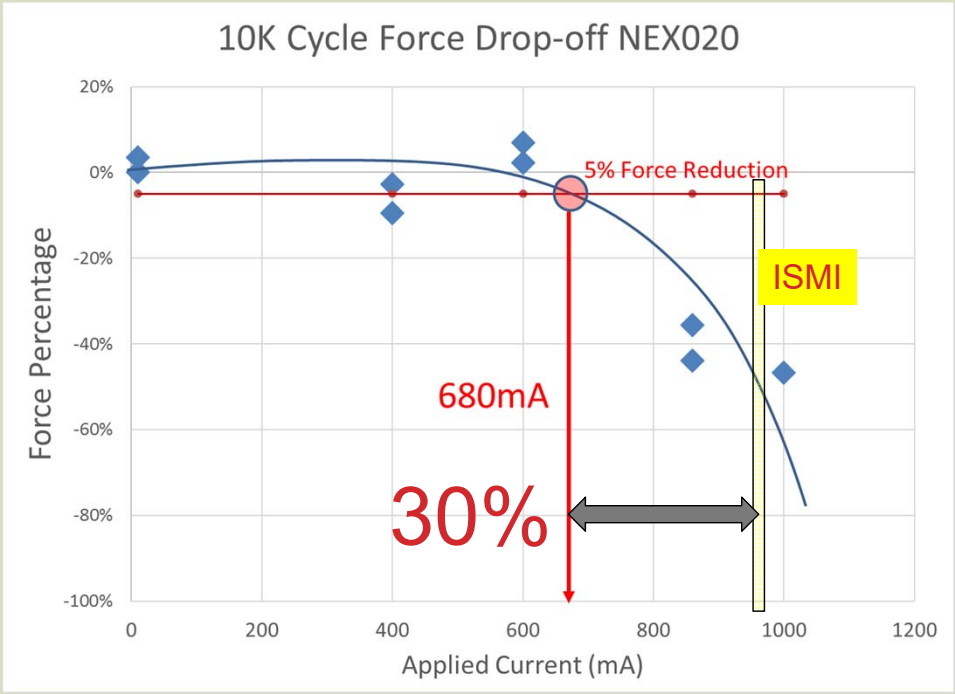
Probe Visual Inspection After Cycling

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



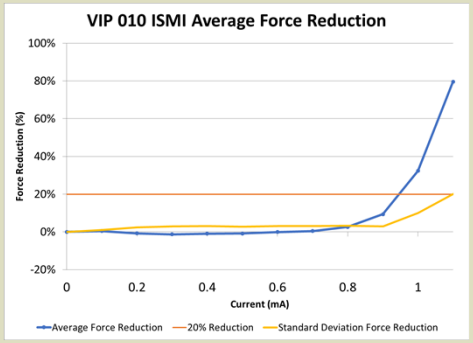
Bounding the Limits

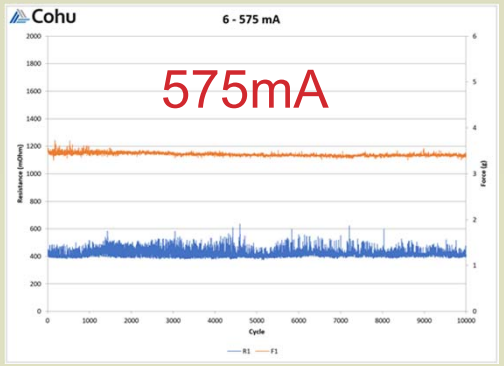
- ± 5% force reduction
  - **680mA limit**
  - **ISMI: 960mA**
- **29.2 % reduction**
- **Therefore propose ISMI derating percentage at 30%**

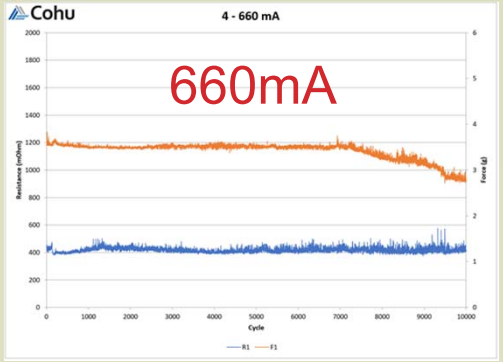


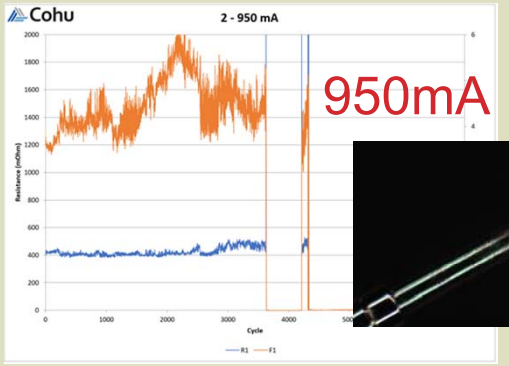
Validation on Other Spring Pins

- 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

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