New Methodology for Probe Current Carrying Capacity (CCC) Characterization

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Agenda

- Problem Statement
- Key Parameters that impact a probes ability to carry current
- A Need for a Common Methodology
- Example of one Methodology used currently
- What’s wrong with the methodology (s)?
- A Proposed Industry Methodology
- Test Description and Results
- Conclusion

Problem Statement

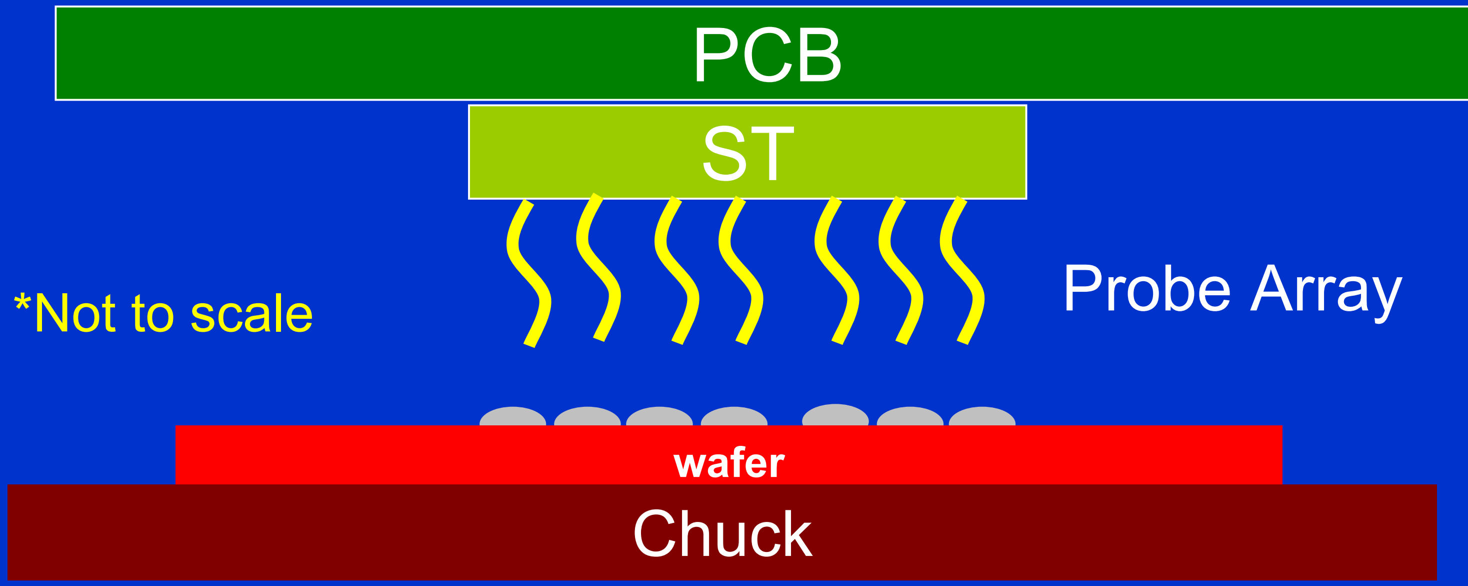
There are Two!

1. There is <u>no</u> industry standard on how probe current carrying capacity is established. Company A may use a different method than Company B.

2. Present method<u>s</u> Industry uses in characterizing probe current carrying capacity (CCC) are outdated and do not account for today's test conditions, which include increased power and test temperatures.

This material will address <u>both</u> of these Problems

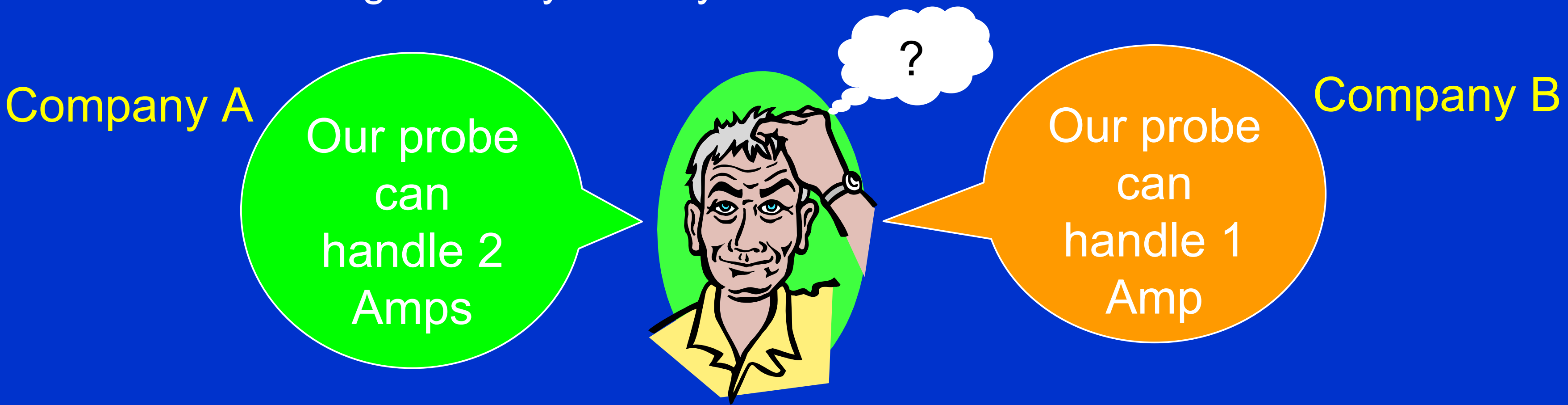
Key Parameters that Determine Probe Current Carrying Capacity



- Contact force
- Chuck Temperature
- Bump material
- Probe tip geometry
- Temperature of environment
- Probe condition (age, wear)
- Probe tip condition

Why is a Common Methodology Required?

- **Typically when companies are being evaluated for next generation processes, probe current carrying capacity is an important parameter in determining which technology will be used**
  - The companies typically provide some baseline data on the probe technologies ability to carry current

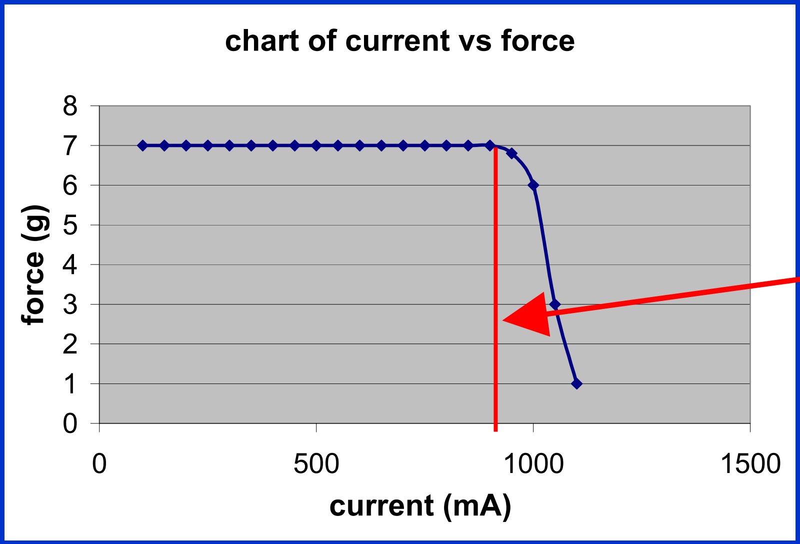


  - How can we compare data from different companies when they may or may not be using the same methodology to establish a probes CCC?
  - To validate the data, We need to put ALL companies on a level playing field

A COMMON METHODLOGY IS REQUIRED!

Example of a Methodology a Company might currently use

- One method for determining current carrying capacity of a probe is to measure force as current is increased
- Where the force drops off significantly, the probe has reached its current carrying capability (CCC)
- This CCC characterization test is done at room temperature.



“current carrying capacity of probes”

A Positive thing about this methodology and other industry methodologies

Use of force as a primary indicator is justified since force has a direct correlation to Cres and ultimately sort process health

However…..

…What's wrong with this methodology?

1. Does not account for the impact of increased test temperature on the probes ability to carry current
2. Does not account for impact of probe fatigue or probe age on probe current carrying capacity
3. Marginalities in the probing environment are not accounted for
   - e.g. variations in over travel, poor contact, dirty probe tips

Proposed Industry Methodology

Proposal to close gaps of Common Methodologies

GAP: Accounting for thermal environment of the probe during test

Solution: Use a thermally controlled chuck/hot plate to simulate varying sort temperatures

However, one problem needed to be addressed to incorporate a hot chuck into the test environment:

Problem: Companies attach the probes into the probe card using different manufacturing techniques (e.g. fixed or floating contact with Space Transformer)

FEA analysis concluded that the temperature range across a probe remains consistent regardless which side heat is applied to the probes

- The importance of this analysis is that it justifies the use of the hot plate for use with all probe technologies regardless how the probe will come in contact with the test fixture

Proposal to close gaps of Common Methodologies

GAP: Impact of probe fatigue

Solution: To account for probe fatigue, probe carrying capacity should be characterized on probes at different age levels (e.g. new vs EOL)

- Typically, an aged probe will not be able to handle as much current as a new probe
- As the probe ages, it may have undergone some plastic deformation and may also have dirty, worn probe tips
  - Both of these items <u>lower the probes ability to carry current!</u>

Proposal to close gaps of Common Methodologies

GAP: Accounting for marginalities in the probing environment

examples

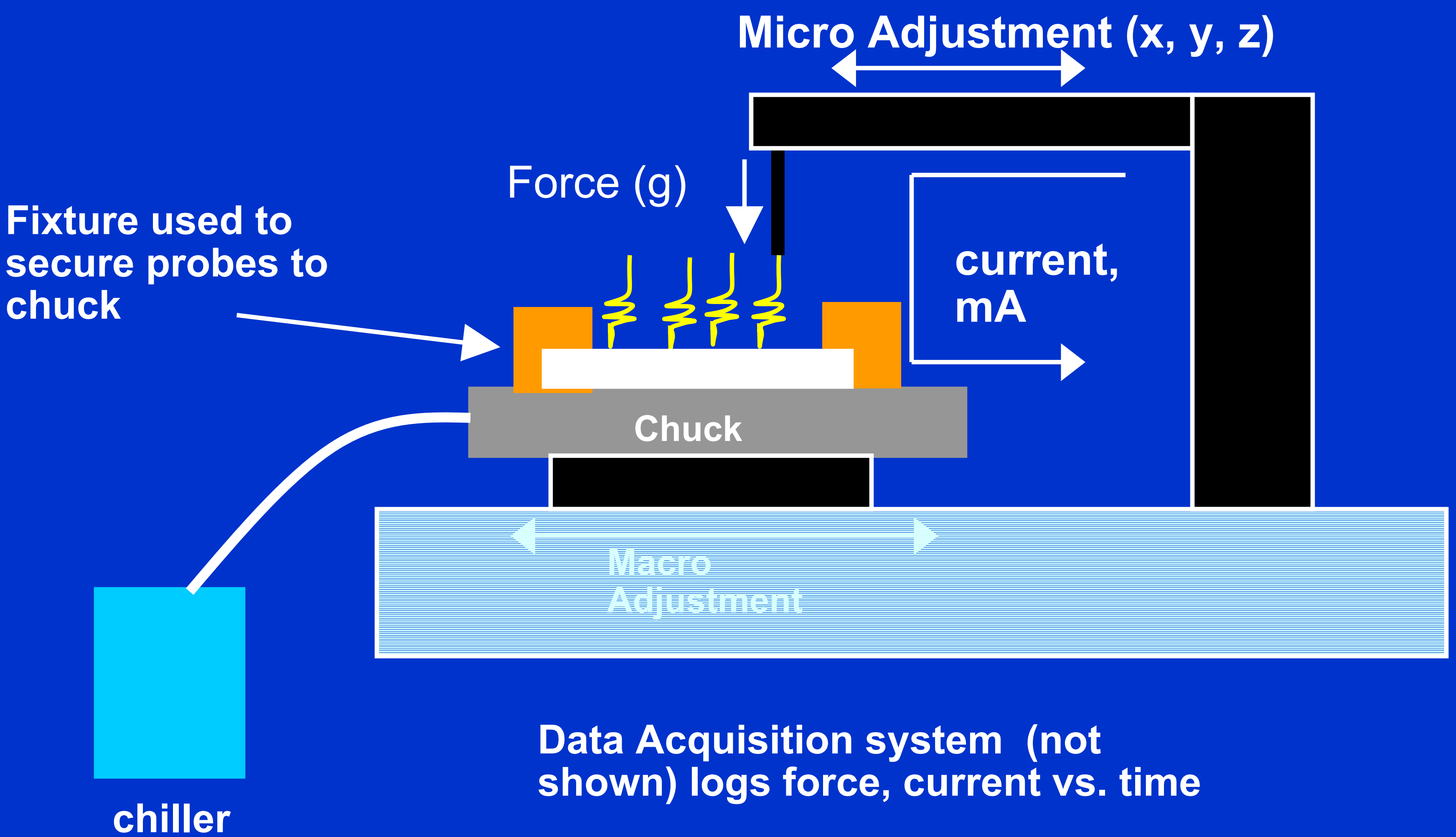
- dirty probe tips
- Differences in probe compression across the probe array
  - As you probably know, not all probes receive the same OT…. and in many cases a number of the probes are not compressed as much as others
  - A lower OT would simulate….
    1. the case where a probe was dirty leading to poor contact
    2. cases where probe is not compressed as much as other probes

Solution: To account for marginalities in the probing environment, the current carrying capacity of probes should be <u>characterized at different over travel levels</u>

Equipment Required to Run Test

- Gram Force machine to measure force during test
- Hot plate/chuck, with chiller for temperature control
- Fixturing to secure an array of probes onto hot plate/chuck
- Power supply to supply current
- Multi meter to set current level
- Data acquisition system that can measure force, current vs. time
- IR scanner to measure temperature of the probe as the current increases (optional but advised)

Representation of Fixture/Equipment

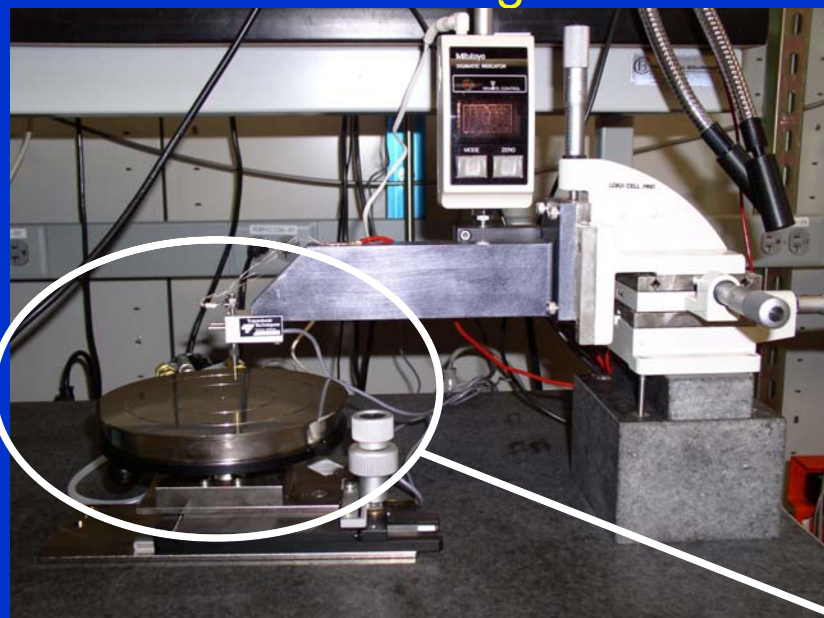


Data Acquisition system (not shown) logs force, current vs. time

Pictures Of Test Equipment

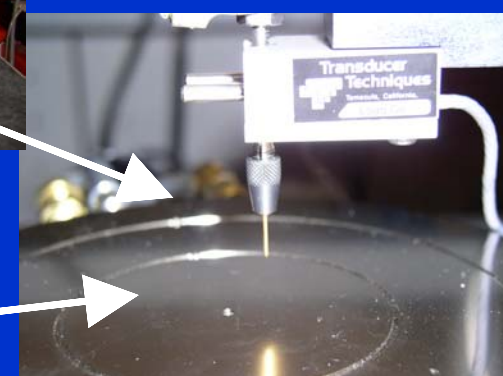
Power Supply/DMM

Chuck/Stage



chiller

Gram force Pin



Chuck

Experimental Procedure

Basic Procedure

1) Secure probe array to the chuck
2) Set chuck to desired temperature
3) Apply a set OT to probe, and begin logging force and current data (current is set to 0 mA initially)
4) Turn Power supply ON
5) Apply a constant current to the individual probe for 30 seconds
6) Turn Power supply OFF
7) After force has stabilized, turn off data logging
8) Repeat for a minimum of 30 probes in the array

It is important to note the force and current should be recorded <u>before, during and after current is applied</u>

Success Criteria

GOAL: Consistent Gram Force during and after current is applied

- A drop in gram force is possible and very likely especially at higher current
- Industry support is needed to determine how much of a drop is acceptable (5%, 10%, 50%)
- Intel would like to collaborate with companies to better define success criteria

Experimental Procedure (cont)

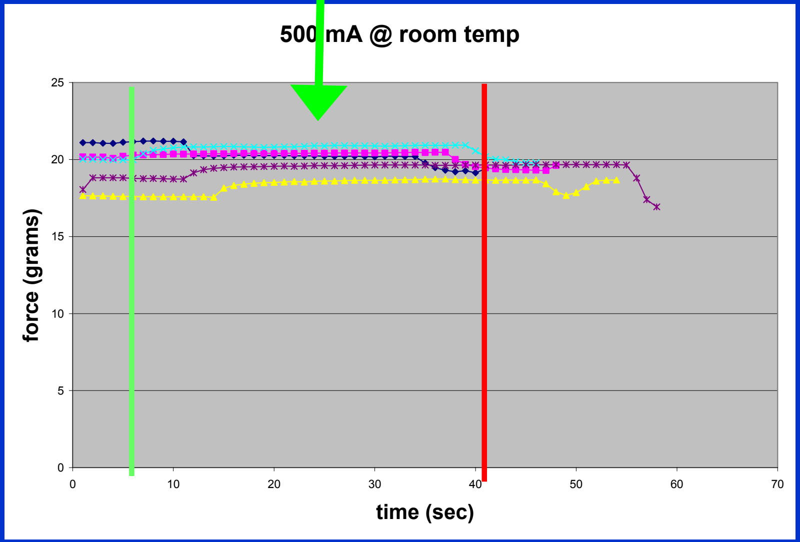
This experiment should be set up as a full factorial study to vary

1) Over travel
2) Current
3) Temperature
4) Probe age (e.g. new vs. EOL)

Each of these items above can impact the probes ability to carry current!

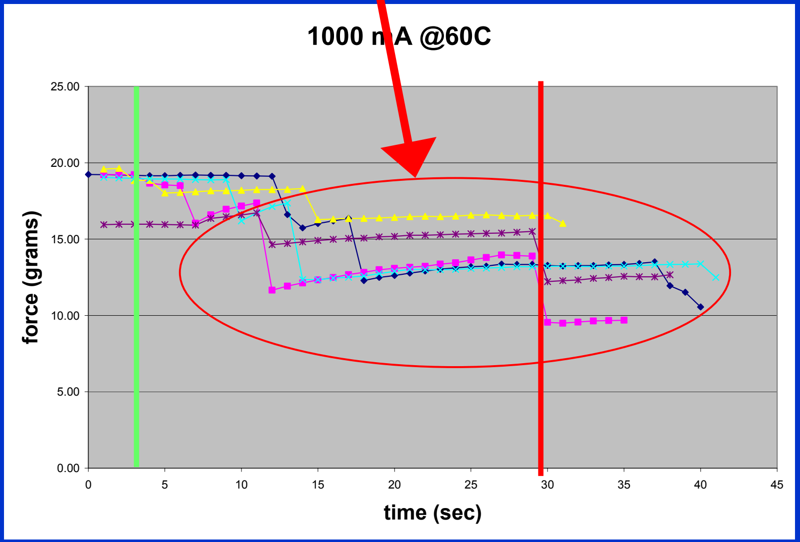
Test Results

GOOD



500 mA room temp

BAD



1000 mA 75C

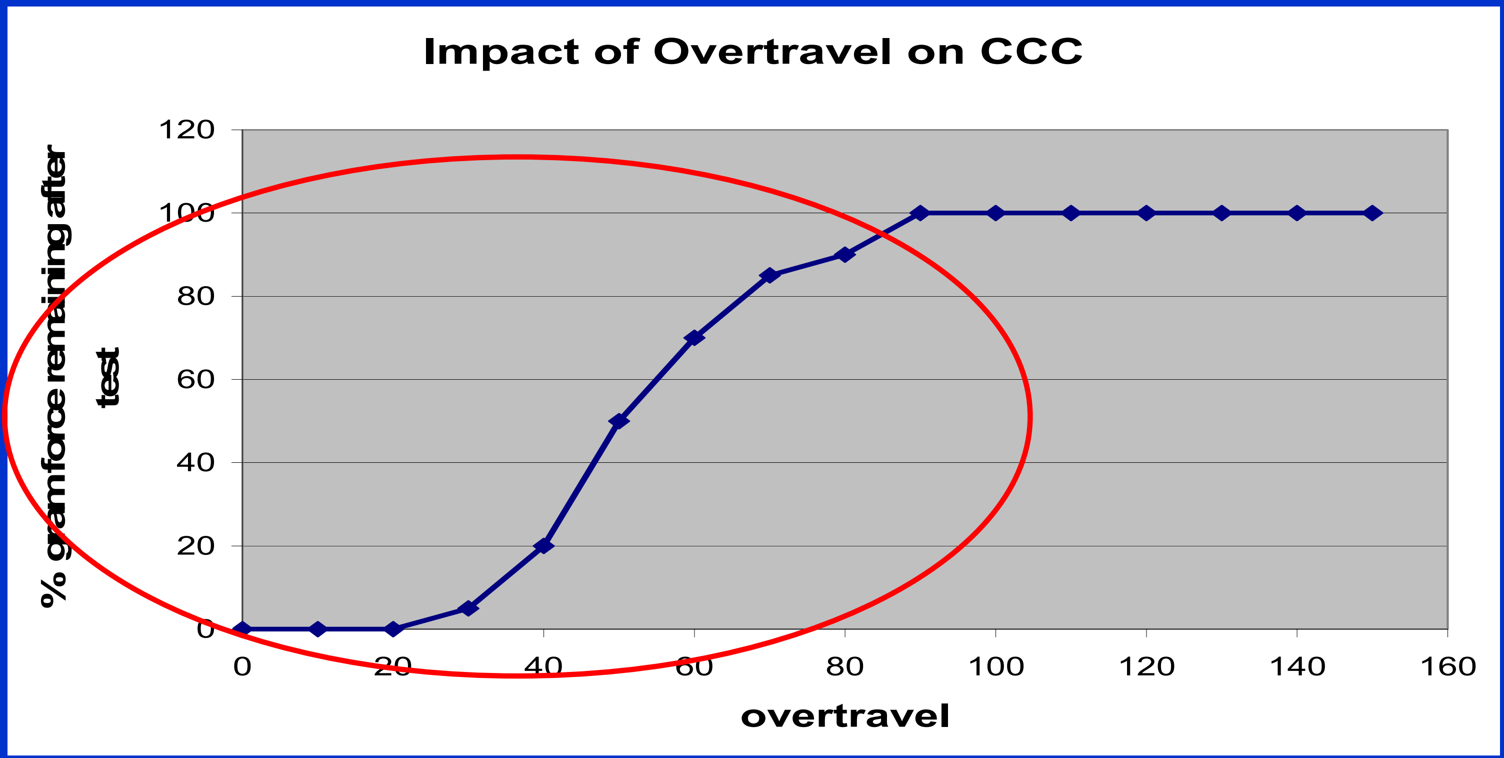
Current “ON”

Current “OFF”

From the graphs above, it is clear that at higher temps and current, gram force drops of significantly, but industry support is needed to define <u>where the current carrying “cliff” of a probe exists</u>

Impact of Over travel on Current Carrying Capacity

% gram force remaining after current is applied



Lower over travel levels <u>greatly</u> impact a probes ability to carry current

Conclusion

1. Present methodologies used by Industry do not predict performance of a probe in the HVM sort test condition.
2. The Methodology needs to account for impact of temperature and other variables on probe current carrying capacity
3. Intel would like to collaborate with other companies to define current carrying capacity success criteria
4. Industry needs to adopt a uniform methodology to predict the current carrying capacity of each probe design