



ISMI Probe Council Current Carrying Capability Measurement Guideline

**International SEMATECH Manufacturing Initiative
Technology Transfer #09075021A-TR**

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Abstract: This document from the MFGM042M project presents guidelines for measuring the current carrying capability (CCC) of wafer probes. The goal is to minimize variability in this measurement.

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Authors: Tom Wear

Approvals: Tom Wear, Author/Project Manager
Ron Remke, Program Manager
Joe Draina, Director, ISMI
Laurie Modrey, Technology Transfer Team Leader

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1 INTRODUCTION

The measurement of current carrying capability (CCC) of wafer probes is a critical parameter for probe cards. The ability to maintain reliable contact as current and power levels increase is a determining factor for pairing probe to product and will likely become even more critical in the future.

Failure of a probe subjected to high current is a thermal event. This requires highly sensitive measurement techniques and setup details. Heat transfer in the mounting and contacting of the probe sample drives significant variation in the CCC rating due to small differences in mounting techniques.

The goal of this guideline is to minimize variability in the measurement of this critical parameter.

2 SCOPE

With a focus on reproducible measurements, this guideline provides CCC ratings that are inherently different from what a user will see in a production environment. The CCC measured for single wires with excellent electrical connections is typically higher than values seen in a large array of wires with varying contact resistance to power supplies and to product.

The factors that translate measurements made using this guideline into ratings for any particular production application are unique.

By focusing on a reproducible technique, this guideline provides a comparison metric for CCC that can be used to easily rate any probe. Accuracy relative to each unique test application is sacrificed for the sake of repeatable and standard measurements. The underlying value of this measurement standard is a relative comparison between different probing technologies.

3 MEASUREMENT CONDITIONS

The fail signature chosen for the CCC value is a permanent reduction of the spring force of the probe. In most cases, there is a direct relationship between the force applied by the probe to the pad and the quality of electrical contact. By measuring the point at which this force is reduced by 20% for nominal overdrive settings, good electrical contact is still temporarily maintained.

However, the robustness of the contact has changed dramatically, and further use in production may lead to higher maintenance and eventual loss of contact.

3.1 Fail Definition

The 20% force reduction method is applied to the force measured for a new probe before exposure to current. In practice, the force of the probe at nominal overdrive actually increases as current is first applied. Additionally, some amount of work hardening increases the spring constant of the wire during the initial touchdowns. The 20% force reduction does not apply to the higher force seen early on during testing.

3.2 Measurement Timing

While measurements can certainly be made in situ while current is being applied, this standard calls for the measurement to be made at least 10 seconds after current has stopped. This gives the probe a chance to cool and recover, which is felt to be more representative of a production environment.

3.3 Temperature

Given that the failure mode is directly caused by heat, the temperature of the testing environment will have a significant impact on the CCC. For comparison, the simplest environment, ambient (23–25°C), was chosen.

3.4 Overdrive

Many recipes are used by different companies for production. For this guideline, the overdrive chosen is the distance recommended by the probe supplier for the production setup for the probe being tested.

3.5 Extensions

While the guideline addresses a simple DC application of current on a single wire at ambient temperature, the production environment is likely quite different. Multiple wires, tests at high or low temperature, pulsing current supplies, and different interface materials and metallurgy are just a few conditions that will cause the wire to have a different CCC during production. Any of these conditions, and many others, may lead to a derating of the standard CCC for most production applications.

4 SETUP

The setups for CCC measurement are shown in Figure 1 through Figure 3. The basic system consists of a force transducer mounted on a vertical micrometer stage and fixturing that captures the probe between two conductive contacts. A constant current power supply and current and voltage meters complete the setup.

4.1 Probe Mounting

4.1.1 MEMS, Membrane, and Advanced Technology

Micromechanical system (MEMS) probes must be mounted to a conductive carrier in a way that closely approximates the mounting method on the actual probe card (MLS, MLC, PCB, etc.). On the wafer side of the probe, a rhodium-plated stainless steel plate is used for contact (as shown in Figure 1).

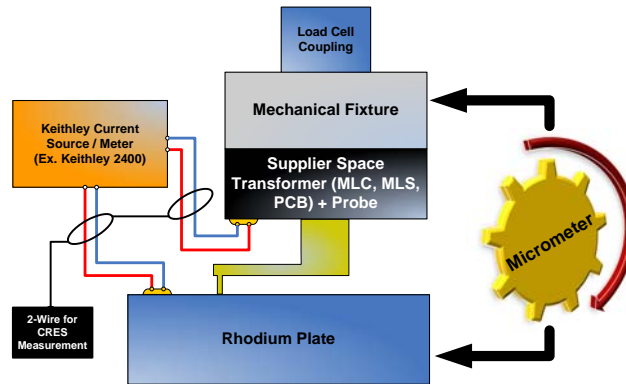


Figure 1 Measurement Setup for MEMS and Membrane Probes

4.1.2 Vertical (Buckling Beam, Cobra)

For vertical probes, probe samples are captured between two conductive surfaces. The tester side of the probe is interfaced to a space transformer or PCB coupon that closely approximates the probe card supplier's standard process to provide a conductive path to the current meter. On the wafer side of the probe, a rhodium-plated stainless steel plate is used for contact as shown in Figure 2.

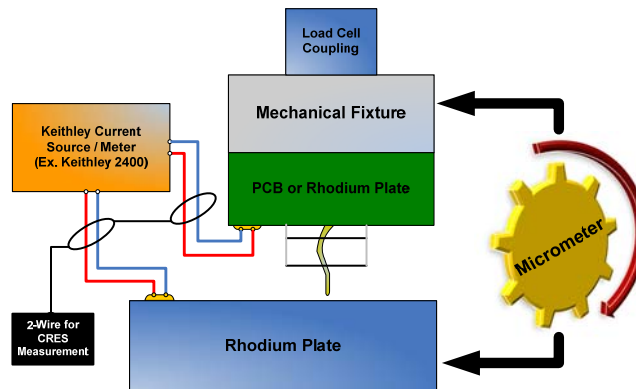


Figure 2 Measurement Setup for Vertical Probes

4.1.3 Cantilever Needle

Probe samples are soldered to a printed circuit board to closely approximate the probe card supplier's standard process to provide a conductive path to the current meter. On the wafer side of the probe, a rhodium-plated stainless steel plate is used for contact as shown in Figure 3.

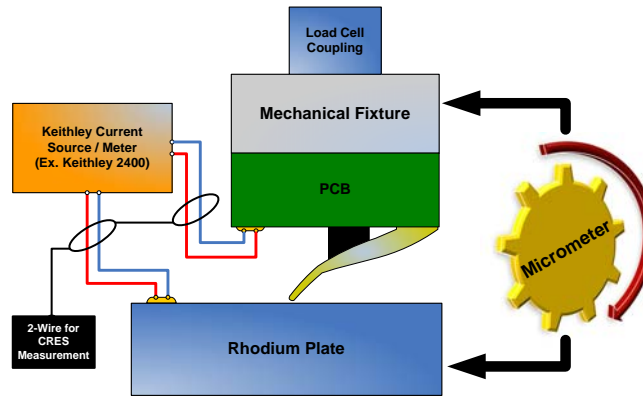


Figure 3 Measurement Setup for Cantilever Probes

4.2 Measurement of Nominal Overtravel

The force transducer is mounted on a micrometer table. Since the compliance of the transducer is significantly less than the single probe being measured, z-travel is measured directly using the micrometer readings rather than a dial indicator measuring actual probe deflection. The user must record and correct overtravel for transducer displacement.

4.3 Ranges and Resolution Recommended for Measurement Equipment

- The force transducer should have a resolution of <0.1 gm with a range of 0–50 gm.
- The current meter needs a resolution of 10 mA with a range of 0–5 amps.
- Voltage must be monitored to ensure CRES and current path resistance are maintained below 1 ohm.
- The DC power supply needs 10 mA resolutions from 0–5 amps.
- The micrometer resolution must be ≤ 1 μm .

5 METHOD

At nominal overtravel, DC current is applied to the probe for 2 minutes, then a force measurement is taken. The current is then incremented, and the cycle repeated until the probe spring force is reduced by 40%. The CCC rating becomes the average of all readings at which a permanent 20% force reduction is measured.

5.1 Number of Samples

The probes should be new and not subjected to any touchdown cycling before the test. The sample size consists of three sets of 10 probes picked randomly from at least three different production batches for a total of 30 probes.

5.2 Ambient Temperature

The measurements are made in a room temperature environment. The environmental temperature should remain between 23–25°C for the duration of the measurements.

5.3 Initial Measurements

Before any significant current is applied to the probe, the spring force of the probe should be measured at nominal overdrive. This is done by electrically establishing the vertical dial setting when contact is first made between the probe and the two conductive surfaces. The current should be limited to < 1 mA to establish an initial electrical contact. Then, the nominal overdrive as specified by the probe supplier is applied. The probe force is then measured at this setting. This “as new” number is then used to establish the 20% reduction limit used as the fail point for the CCC rating.

5.4 DC Current Measurements

The steps for ramping and measuring the current limit are as follows:

1. Determine a probable CCC fail value by referencing the probe card supplier’s specification. Set the current source to 75% of the specified value.
2. Apply current for 2 minutes, and then reduce it to zero.
3. Measure probe forces after a 10-second cooldown period.
4. Increment the current by 25 mA.
5. Repeat steps 2–4 until the force has dropped to 40% of the initial value.

6 RESULTS

The current at the fail point is then averaged over the 30-probe sample to define the CCC value for this probe.

**International SEMATECH Manufacturing Initiative
Technology Transfer
2706 Montopolis Drive
Austin, TX 78741**

**<http://ismi.sematech.org>
e-mail: info@sematech.org**