Busbar Contact Resistance Testing Procedures

Astronics AES – Summer 2024 Internship
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1. Purpose

This document outlines the test procedures developed to evaluate contact resistance in busbar connections under varying mechanical configurations. The tests were designed to analyze the effects of torque, bolt orientation, and stack-up on electrical resistance using controlled conditions and repeatable methods.

Part A: Coin Compression Testing

Objective:

Simulate small-scale electrical contact under controlled contact pressure using coin-shaped metal samples to measure resistance behavior across material types and force levels.

Materials:

- Small and large circular plates (Aluminum 6061-T6, Aluminum 1100-H14, Copper 110 H02)
- Kapton tape
- Copper foil tape
- Hydraulic press
- Load cell + DAQ system
- Micro-ohmmeter with Kelvin (4-wire) probes
- Isopropyl alcohol
- Power supply (10V DC)

Procedure:

1. **Prepare Test Platform:**
    - Wrap the test beam with **Kapton tape** to insulate it.
    - Apply **copper foil tape** on top of the Kapton; this will act as the lead.

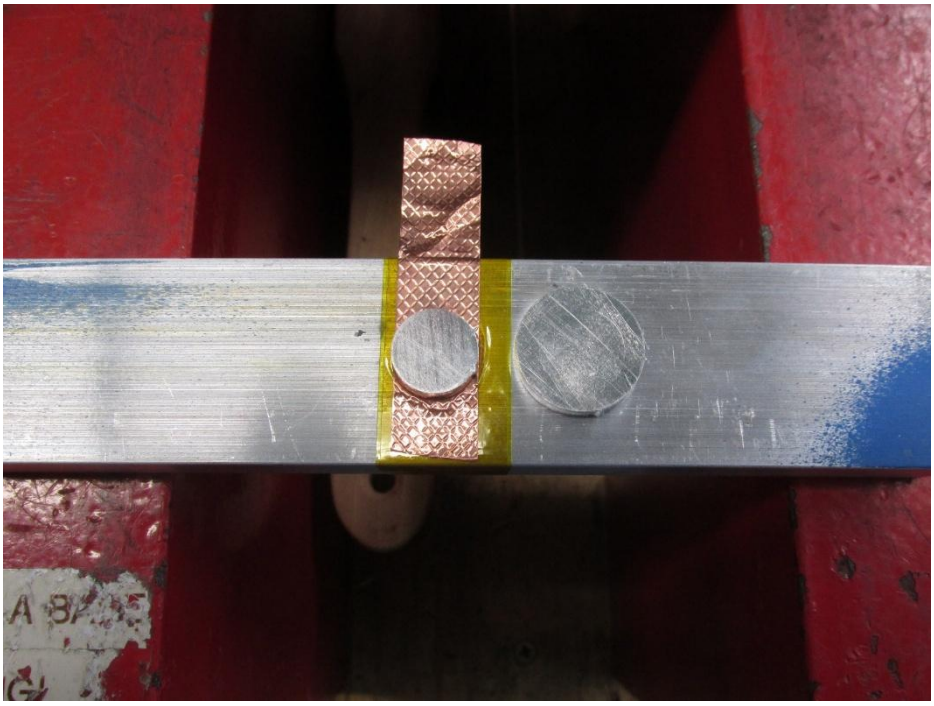

Figure 1. Kapton and Copper Foil tape on test beam.

2. **Clean Surfaces:**
    - Clean both coins and all copper contact areas with **isopropyl alcohol**.
3. **Stack Coins:**
    - Place the **smaller coin on the bottom**, centered on the copper foil.
    - Place the **larger coin on top**, aligned vertically.
    - The contact area is defined by the smaller coin.
4. **Install Coins into Press:**
    - Align coin stack centered between the **ram** and **load cell**.
    - Use Kapton/copper foil leads on both the ram and base for connections.

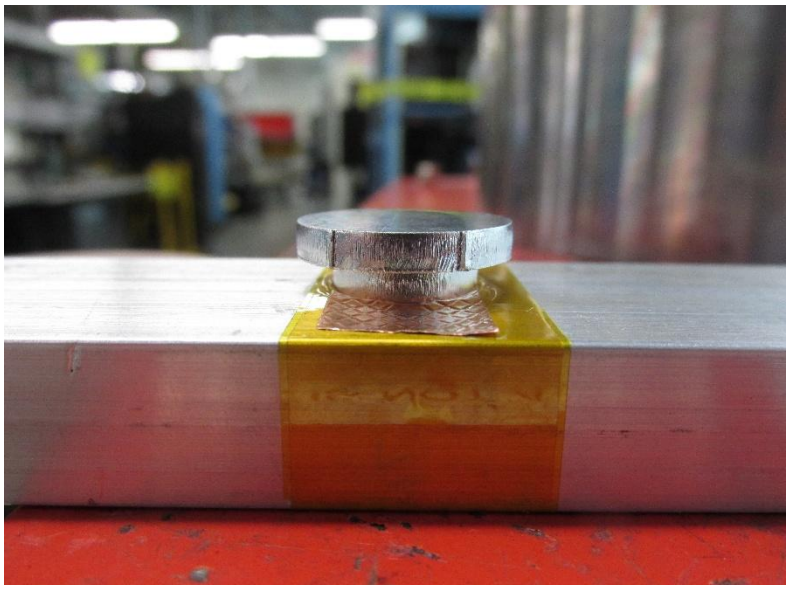

Figure 2. Large coin atop smaller coin: smaller coin defines surface area (thus, the large coin does not need to be deburred).

5. **Connect Equipment:**
    - Connect a **10V power supply** to the load cell.
    - Connect the **load cell signal output to a DAQ** to record real-time force.
    - Attach the **4-wire Kelvin probes** from the micro-ohmmeter to the top and bottom copper leads (source high/low and sense high/low).

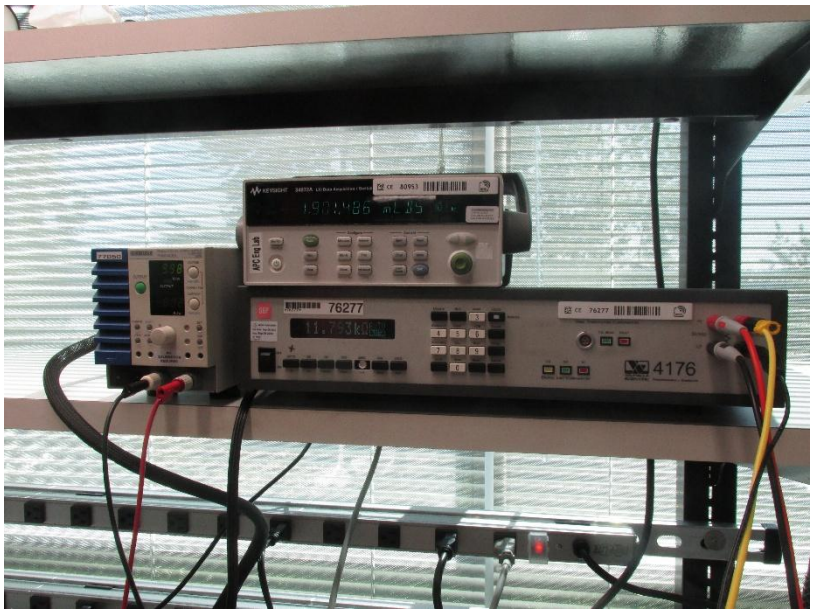

Figure 3. Power Supply and DAQ.

6. **Apply Load and Measure:**
    - Gently compress coins to hold them in place.
    - Gradually increase load using the hydraulic press.
    - Record resistance at discrete force intervals.

Part B: Bolt Stack-Up Resistance Testing

Objective:

Evaluate how bolt orientation, torque, and washer configurations affect electrical contact resistance in full-scale busbar plate assemblies.

Materials:

- Copper and aluminum busbar plate samples
- Screws, nuts, flat washers, Belleville washers
- Torque wrench
- Micro-ohmmeter with Kelvin probes
- Isopropyl alcohol

Procedure:

1. **Clean Parts:**
    - Wipe busbar plates and all contact hardware with **isopropyl alcohol**.

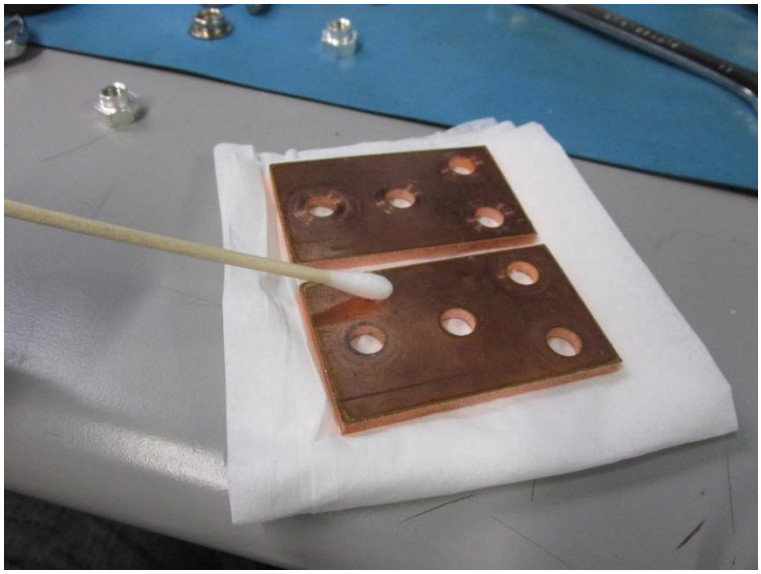

Figure 4. Clean samples with isopropyl alcohol.

2. **Assemble Test Stack:**
    - Stack busbar plates in the desired configuration (copper/copper or aluminum/aluminum).
    - Use:
        - **1 screw (centered)**
        - **2 screws, vertically oriented**
        - **2 screws, horizontally oriented**

Figure 5. Three bolt orientations to test.

3. **Apply Torque:**
    - Tighten screws to designated torque values using a calibrated **torque wrench**.
    - Record torque level for each trial.
4. **Measure Resistance:**
    - Connect the **4-wire micro-ohmmeter** across the busbar plates.
    - Record resistance for each bolt orientation and torque setting.
    - Repeat for different washer and hardware combinations.

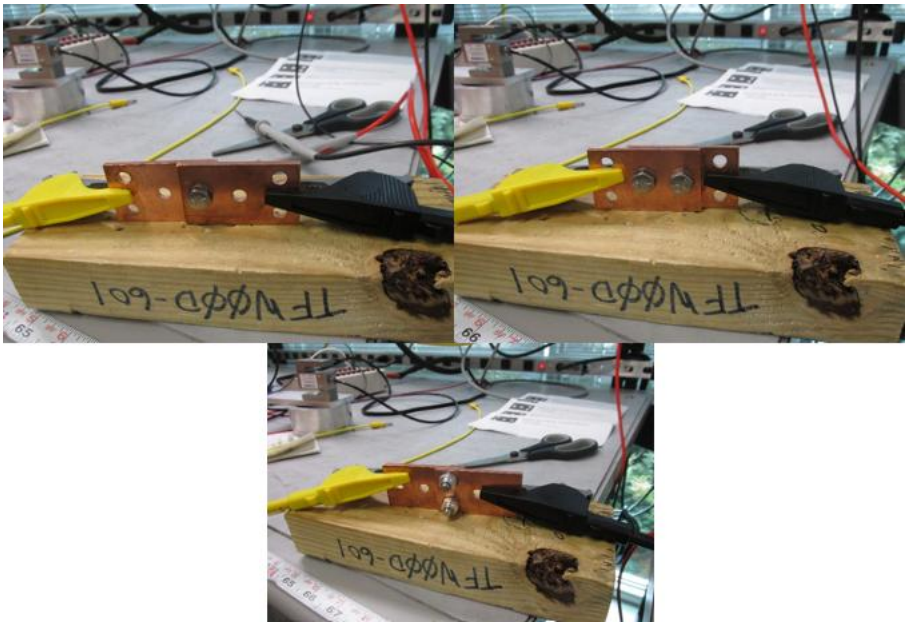

Figure 6. Measure the resistance across the samples in an identical manner.

Notes:

- Ensure consistent alignment and contact across all trials.
- Use identical surface preparations for all materials.
- Resistance readings should stabilize before recording.
