

Automation Analysis for Class 0 & CDM



Professional Services Only
No Product Sales!

● **Client Locations**

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Hard at Work “Down Under”!



Agenda

- **Introduction**
- **Examples of Automation Issues**
- **Diagnostic Methods**
- **Materials Testing**
- **Corrective Action Trials**
- **50 V Qualification Case Studies**

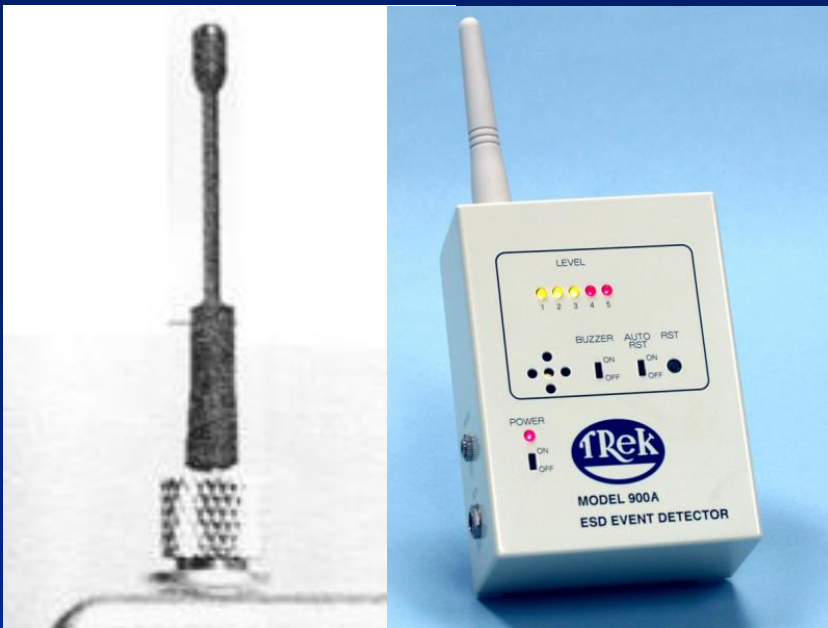
Strategic Options to Begin Analysis

Pros and Cons

- **Detailed Resistance & Voltage Measurements**
 - **Process Surrogate Module**
 - **ESDA Working Group**
- **ESD Event Detection**
 - **Then Detailed Resistance & Voltage Measurements**

Hand-held ESD Event Detectors

Low cost alternative to high speed scopes



Event Detectors Useful for Workstation Analysis



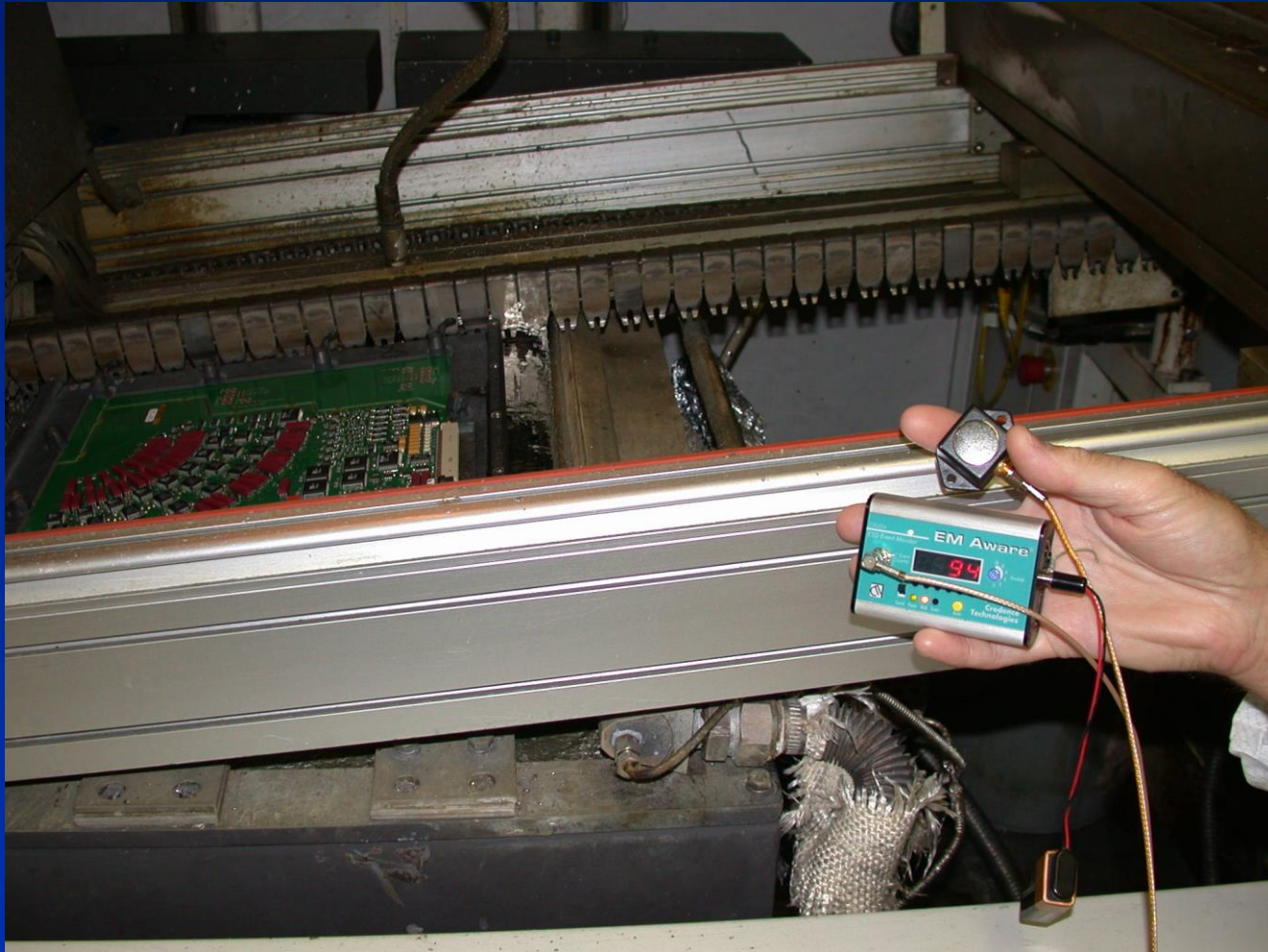
Photo Courtesy Dangelmayer Associates

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Wafer Saw Class 0 Failures

- **90% failure rate**
 - **30 volt CDM Withstand Voltage**
- **Complex Resolution**
 - **CO2 Bubbler**
 - **Cutting Blade Material Change**
 - **Depth of Cut**
 - **Travers Speed**

ESD Events at Contact with Solder Wave



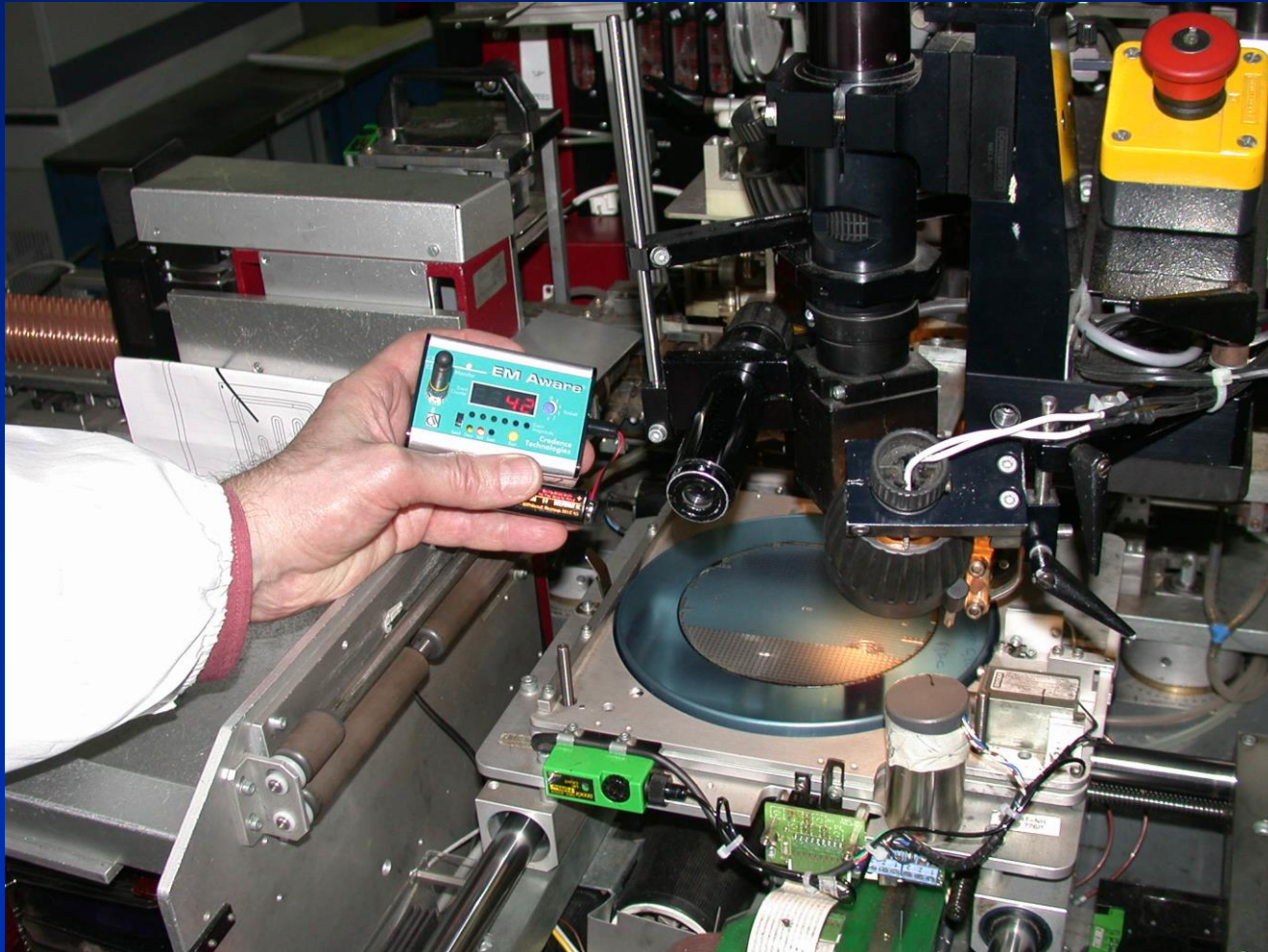
Charged Carrier Tape



Events at Solder Past Tool



Die Attach



SMT ESD Events



Metal Automation Fixture



Events in Glove Box



Diagnostic Methods

Initial Diagnostics

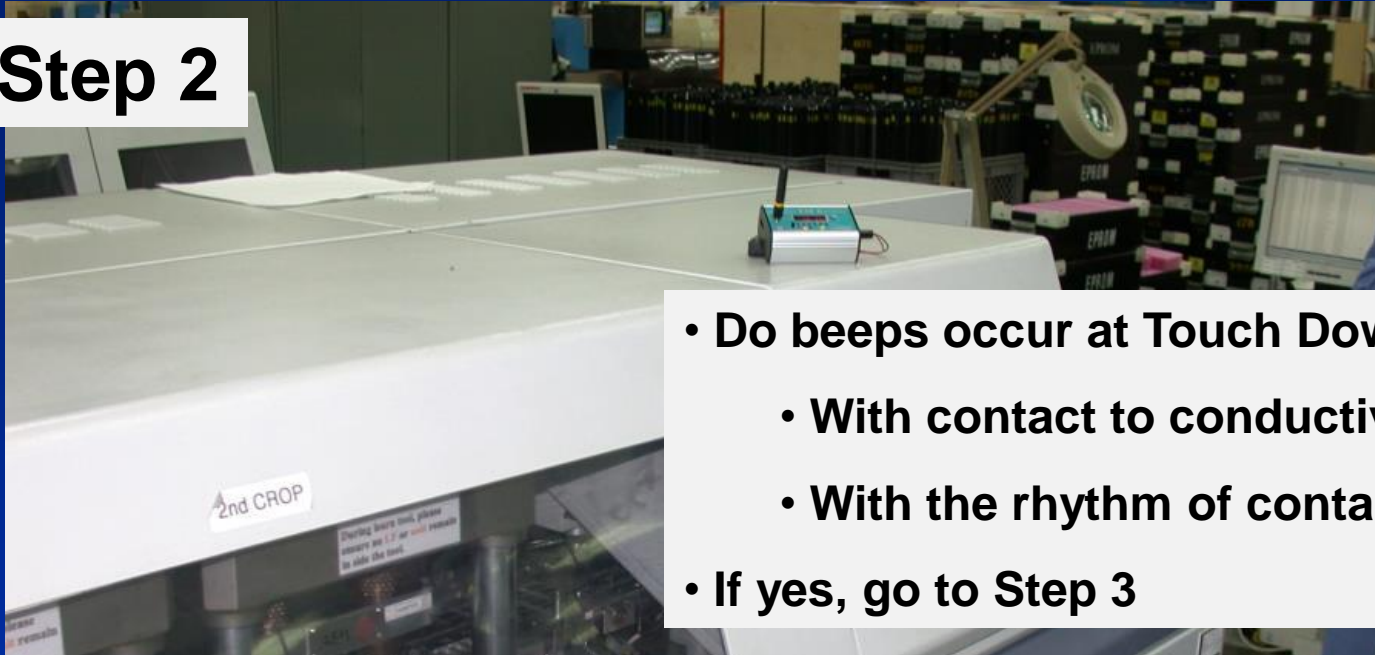
Step 1 – “Wet Run”

Event Detector
Approximately
30 cm from
movement of
pieces

- Watch movement
- Listen for Beeps
- If No Events, No Corrective Action
- Events Detected, go to Step 2

Initial Diagnostics

Step 2



- Do beeps occur at Touch Down?:
 - With contact to conductive surface?
 - With the rhythm of contact?
- If yes, go to Step 3

- Are the beeps EMI Interference?:
 - Come in bursts?
 - In rapid succession?
 - In rhythm with relays?
- If yes, go to Step 3



Step 3: "Dry Run"

- "Normal Operation!"
- But No Pieces

Same Tool Movements

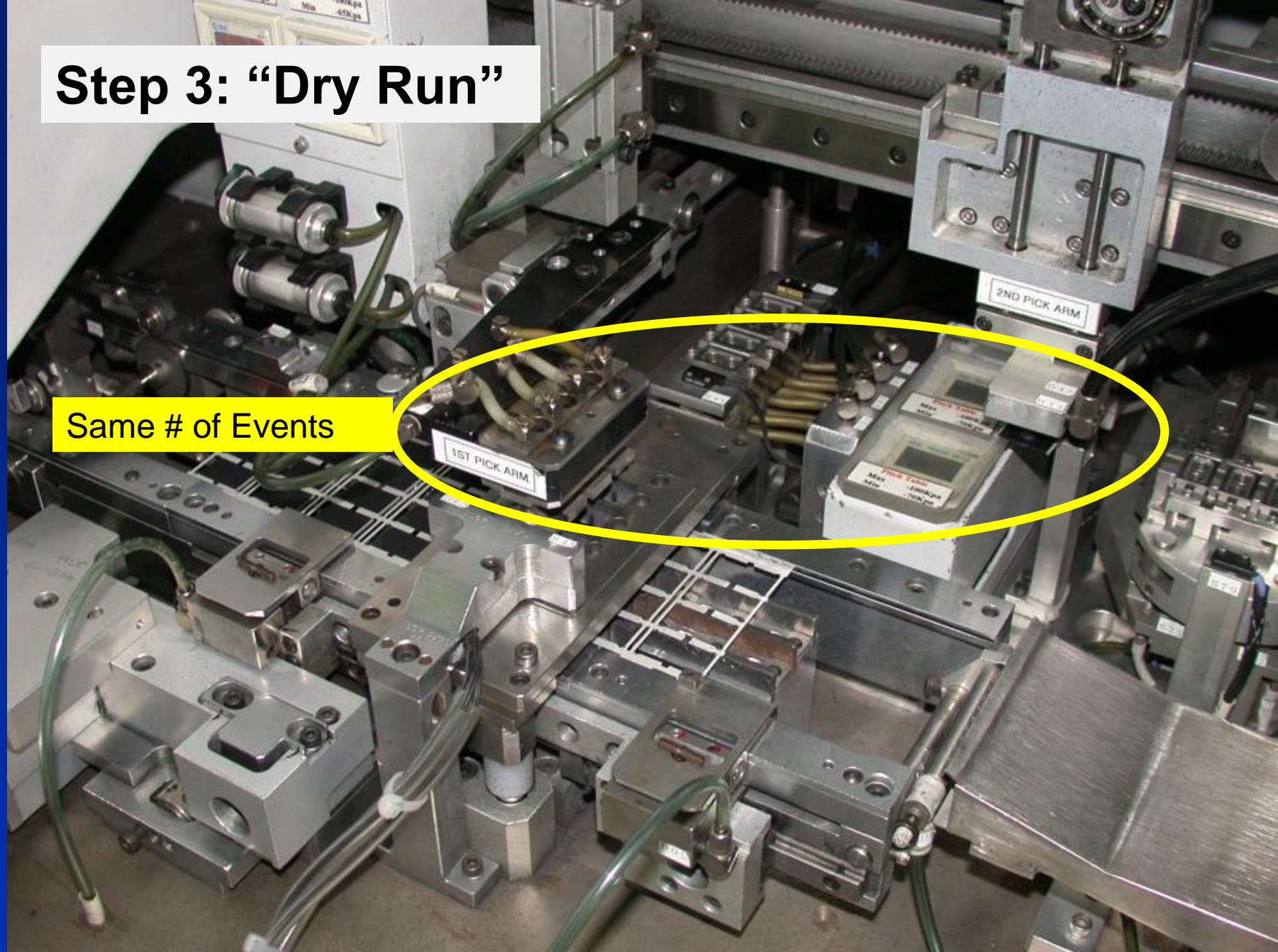
Same Relay Activity

Same Trays

- Hard to Isolate ESD Source!
- Therefore, shut down part of tool

Step 3: "Dry Run"

Same # of Events



Step 3: "Dry Run"



Not Operating



Still Operating Normally

No Events!



Step 4: Continuity to Ground Test



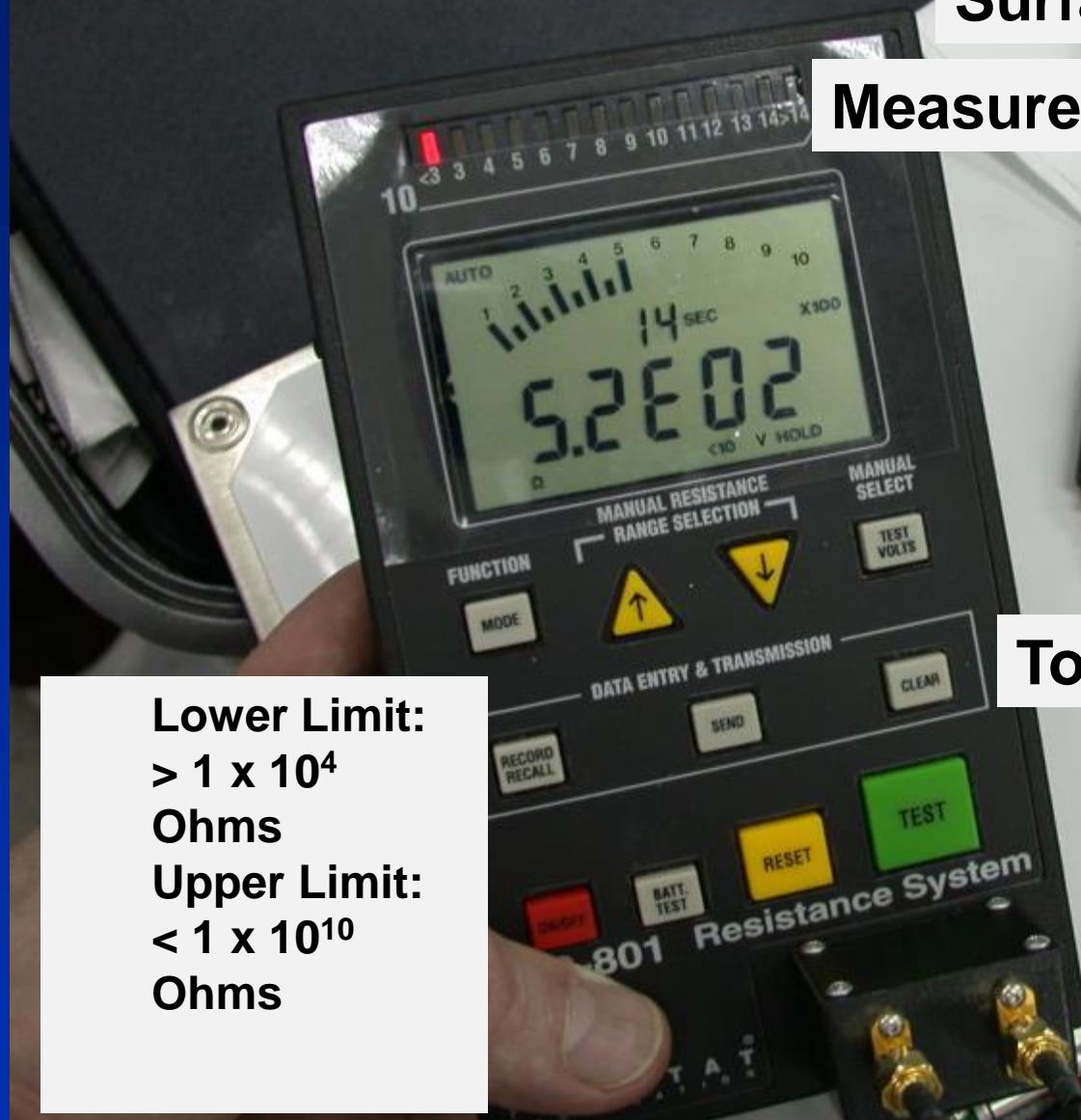
High Resistance



Step 5: Materials Testing

Surface Resistance Test

Measure Points of Contact



Lower Limit:
 $> 1 \times 10^4$
Ohms
Upper Limit:
 $< 1 \times 10^{10}$
Ohms

Too Conductive!

**Step 6: Corrective Action Trials: -
Material Substitution**



**Pomalux Substitution
– Static Dissipative**

Note: Conduct Proof of Concept First – If possible

A person wearing a green protective suit is working on a piece of equipment. The equipment has a large fan with a metal grille. The person's hand is visible, reaching into the equipment. The background is a white wall with some text, including "surface MAUVAS".

**Step 6: Corrective Action Trials: -
Temporary Ionization**

Do ESD Events Stop?

If yes, Repeat prior Steps to try to Correct Root Cause.

Add Ionization Only if other steps do not work!

Go to Next Step

Two Automation Case Studies

Customer Requires 50 Volt Qualification

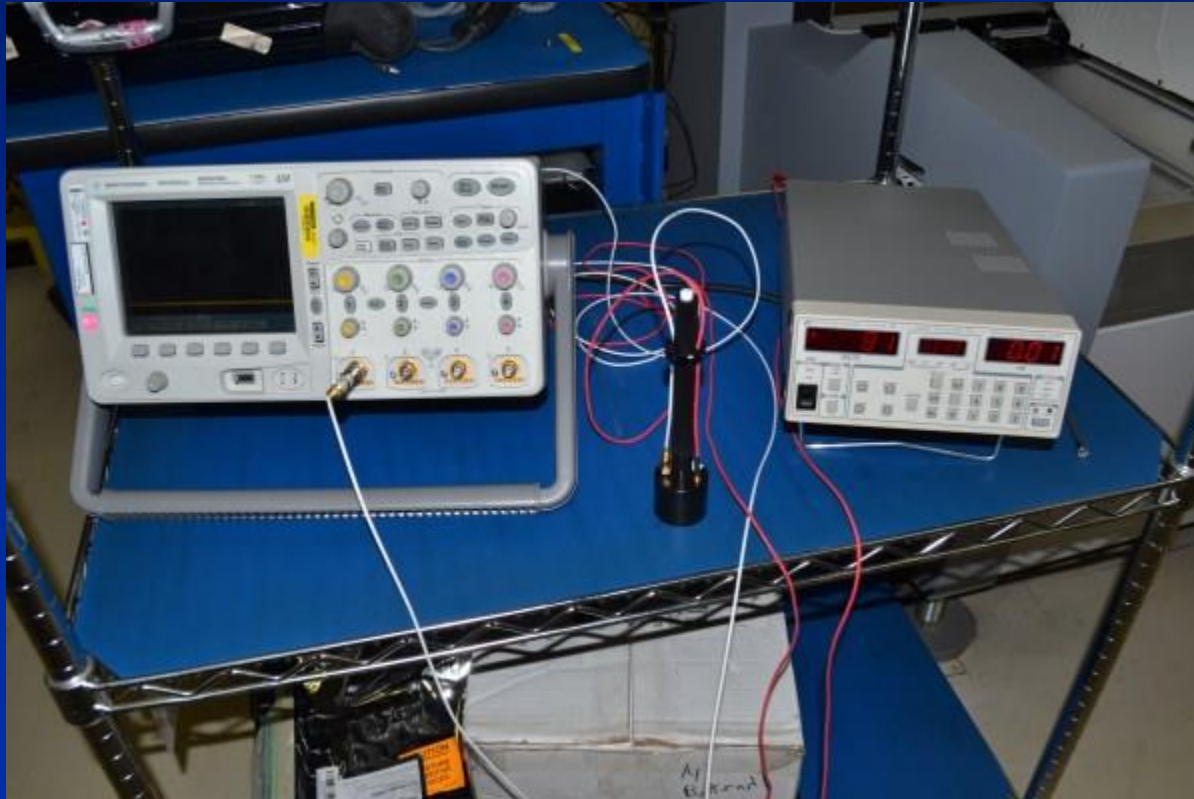
Class 000 (< 50 V) Automation Qualification

- **Are Voltage Measurements the Correct Criteria?**
 - **No! Current (not Voltages) Causes IC Damage**
 - **Customers Require Class 000 Certification for 50 volt Devices**
 - **Often Current Thresholds Not Available**
- **Discharge Currents & Voltage**
 - **Difficult to Measure**
 - **Due to Process Speeds**
 - **Limited Access Points**
 - **Pausing for Measurements Alters Charge/Voltage Levels**

Class 000 (< 50 V) Automation Qualification

- **ESD Event Detection – Good Option**
 - **Can be Correlated to Voltage on Devices in Automation Tool**
 - **Requires Calibration of Event Detectors**
 - **CDMES Provides Reproducible CDM Source In-situ**
 - **Creation of Calibration/Characterization Curves**
 - **Event Free Automation Ultimate Objective**
 - **Justification for 50 Volt Certification/Qualification**

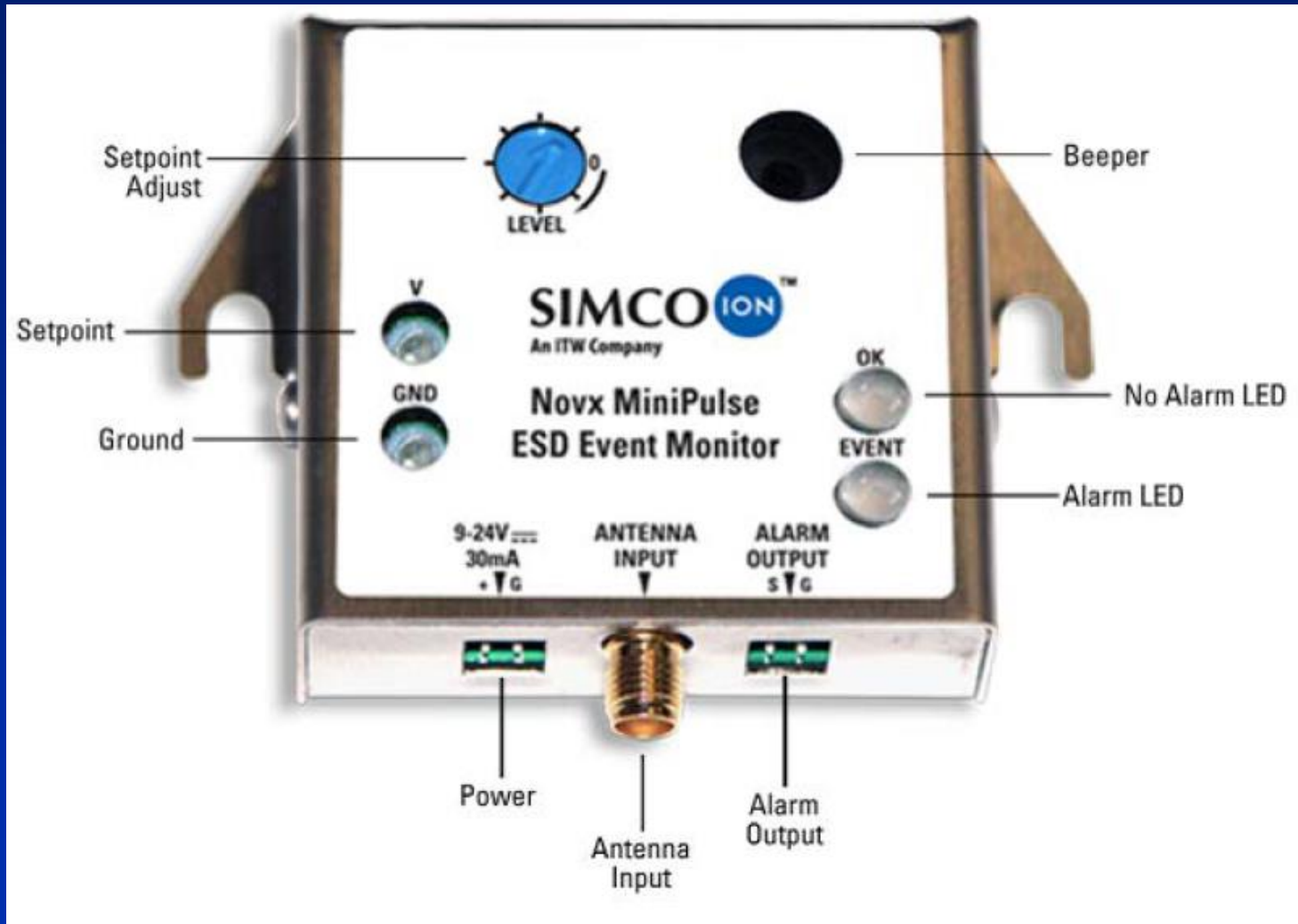
ESD Simulator & Test Equipment



Simco-Ion Mini Pulse Set/Reject Table

Target Voltage	Distance (inches)	MP Setting
50	1	1.228
75	1	1.265
100	1	1.329
150	1	1.387
200	1	1.421
250	1	1.454
300	1	1.474
350	1	1.633
400	1	1.662
500	1	1.694
600	1	1.729
700	1	1.798
900	1	1.817
1000	1	1.84

Simco-Ion MiniPulse

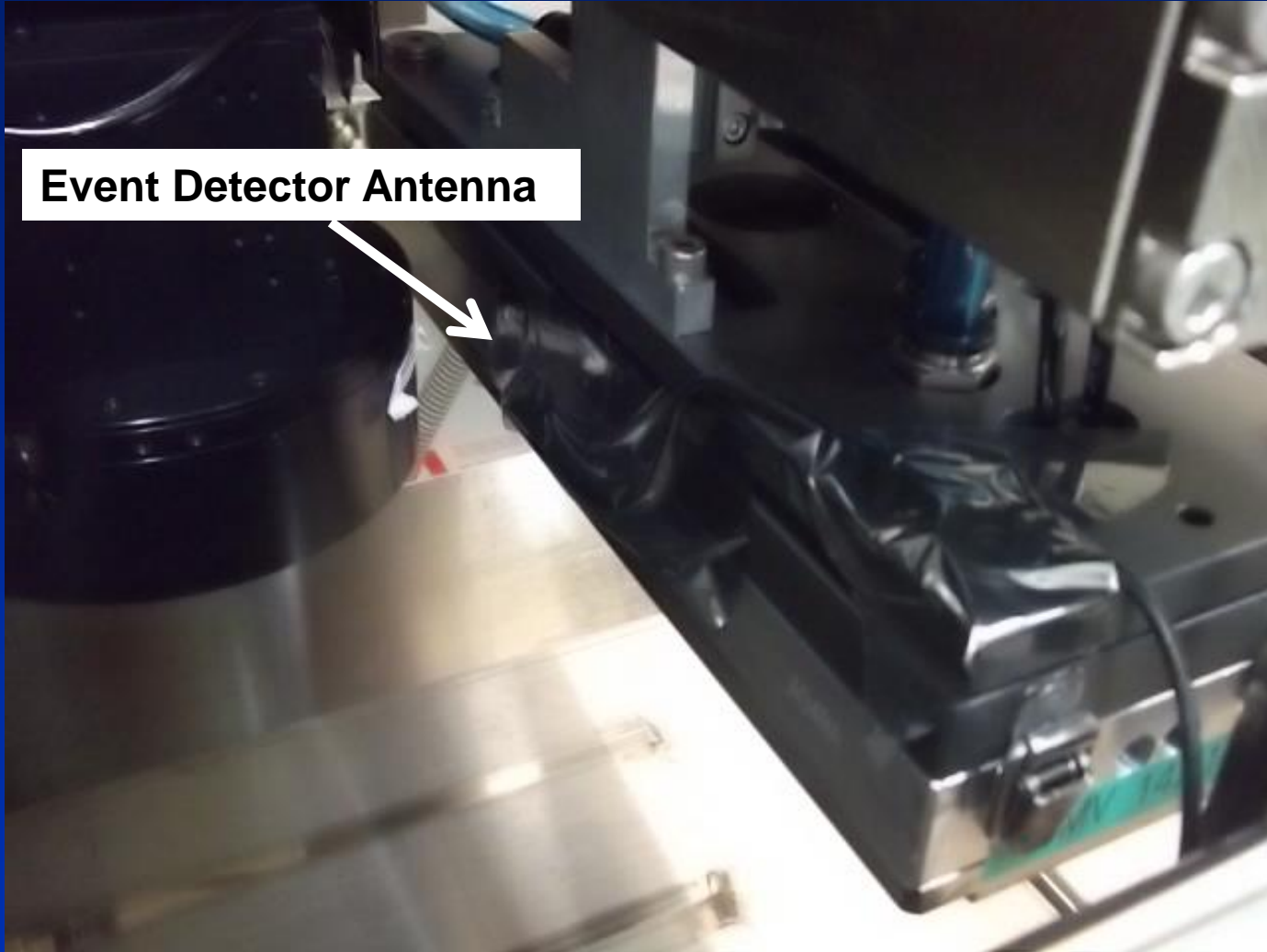


200 Volts on Device

Evaluate Risk With Event Detection



200 Volts: No ESD Events Above 10 Volts

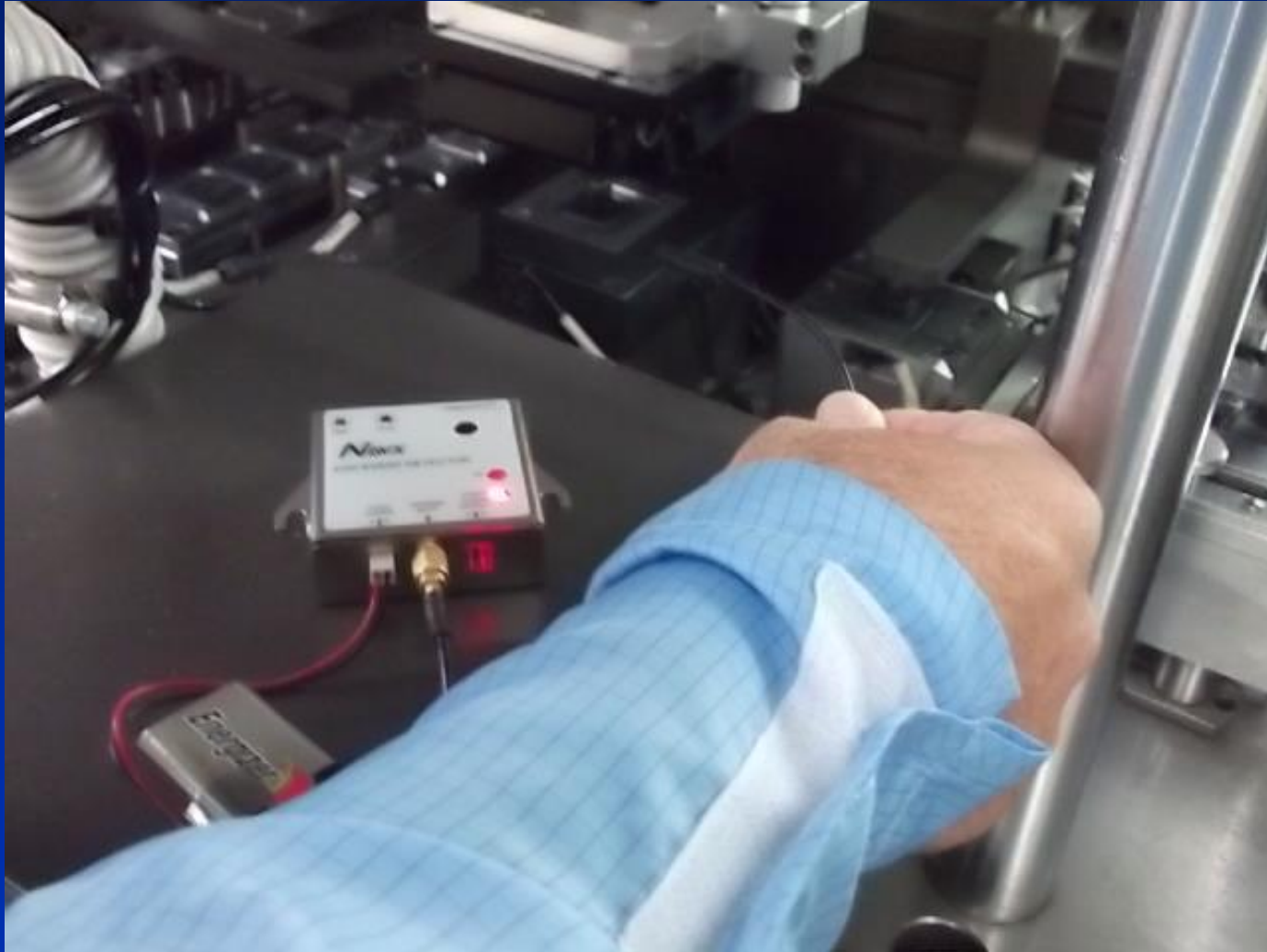


30 Volts on Device

Evaluate Risk With Event Detection



30 Volts on Device ESD Events Detected – Must Determine Source!



Case Study #2: 50 Volt Qualification

MyData Automation Pick & Place Tool Case Study: 50 Volt Qualification



Tests Conducted

- Fields
 - **Electrostatic Voltmeter**
- Ionizer Performance
- Resistance Measurements
 - **RTG; SRM**
- Material Qualification
- ESD Event Detection
 - **50 Volt Sensitivity Settings**

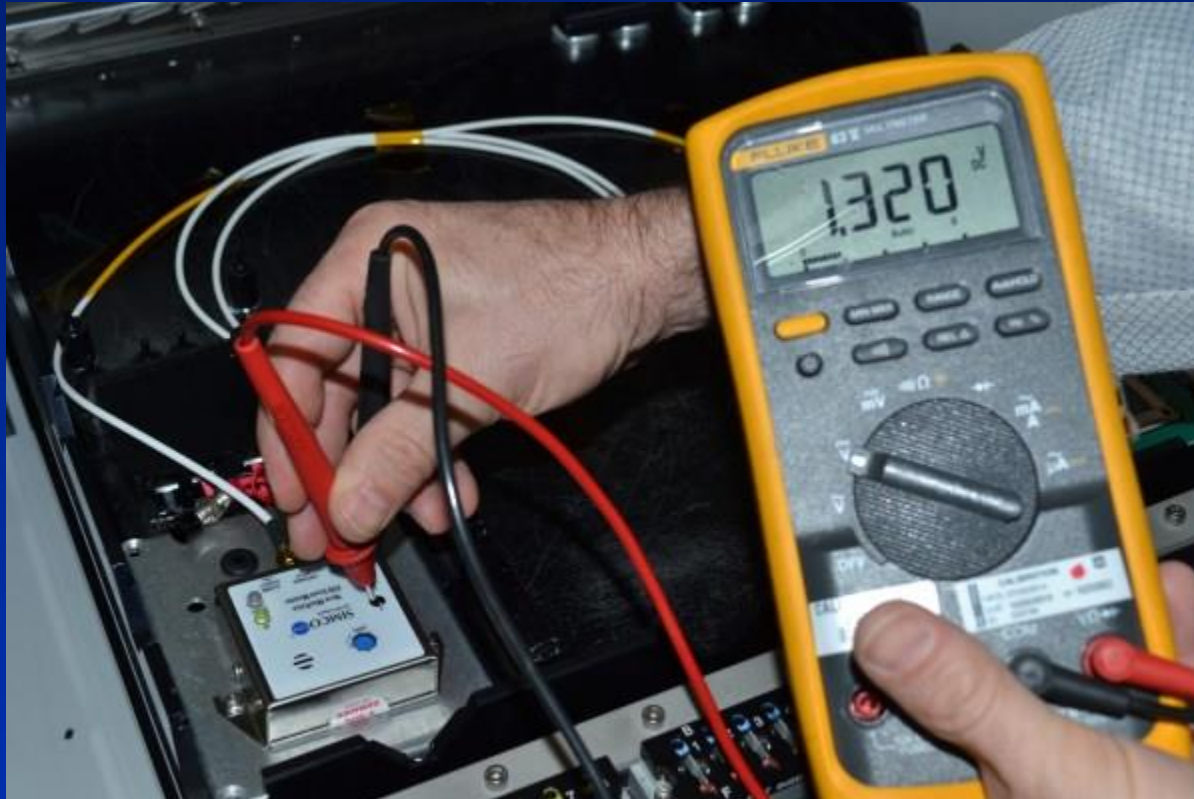
Circuit Board Input Tray



ESD Event Detector Location Circuit Board Input Tray



ESD Event Detector: Location and 50 V Sensitivity Setting



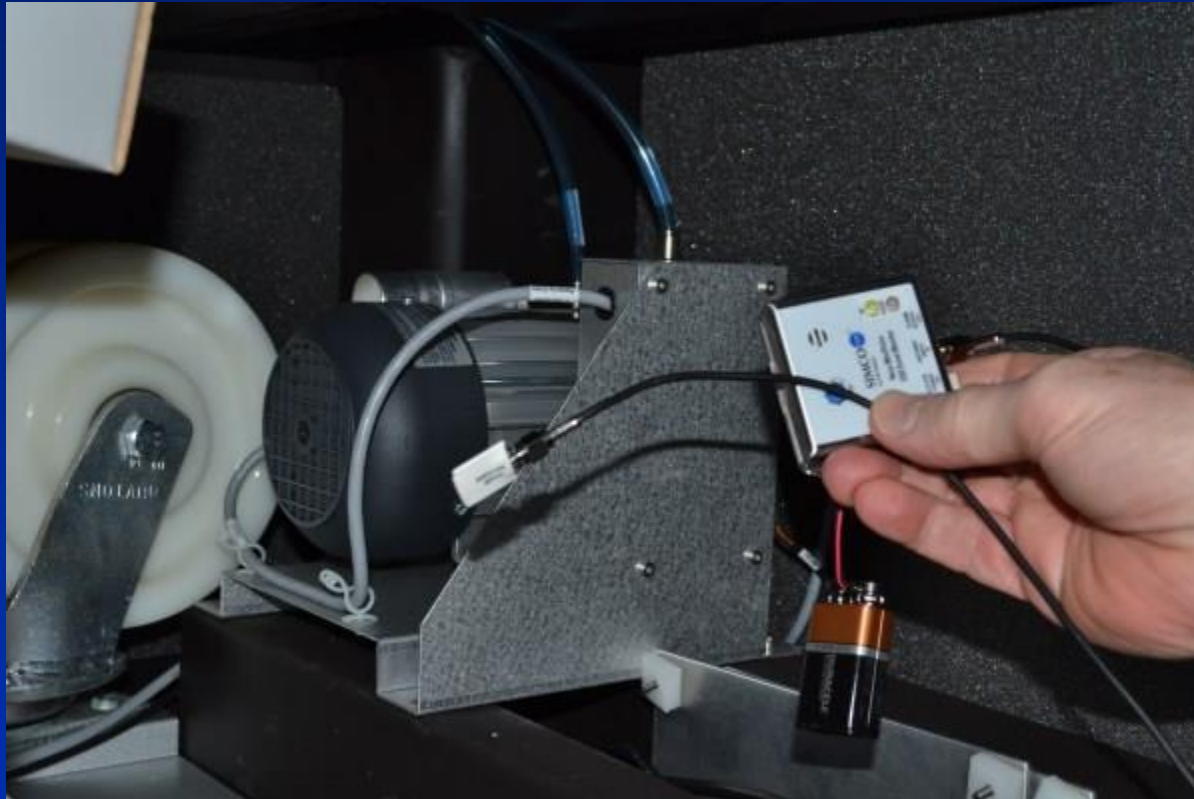
ESD Event Detector: Location and 50 V Sensitivity Setting



RF Interference: Vacuum Line Relay



RF Interference: Vacuum Pump Starter Capacitor



Input Tray Materials



Input Tray Materials



Input Tray Materials



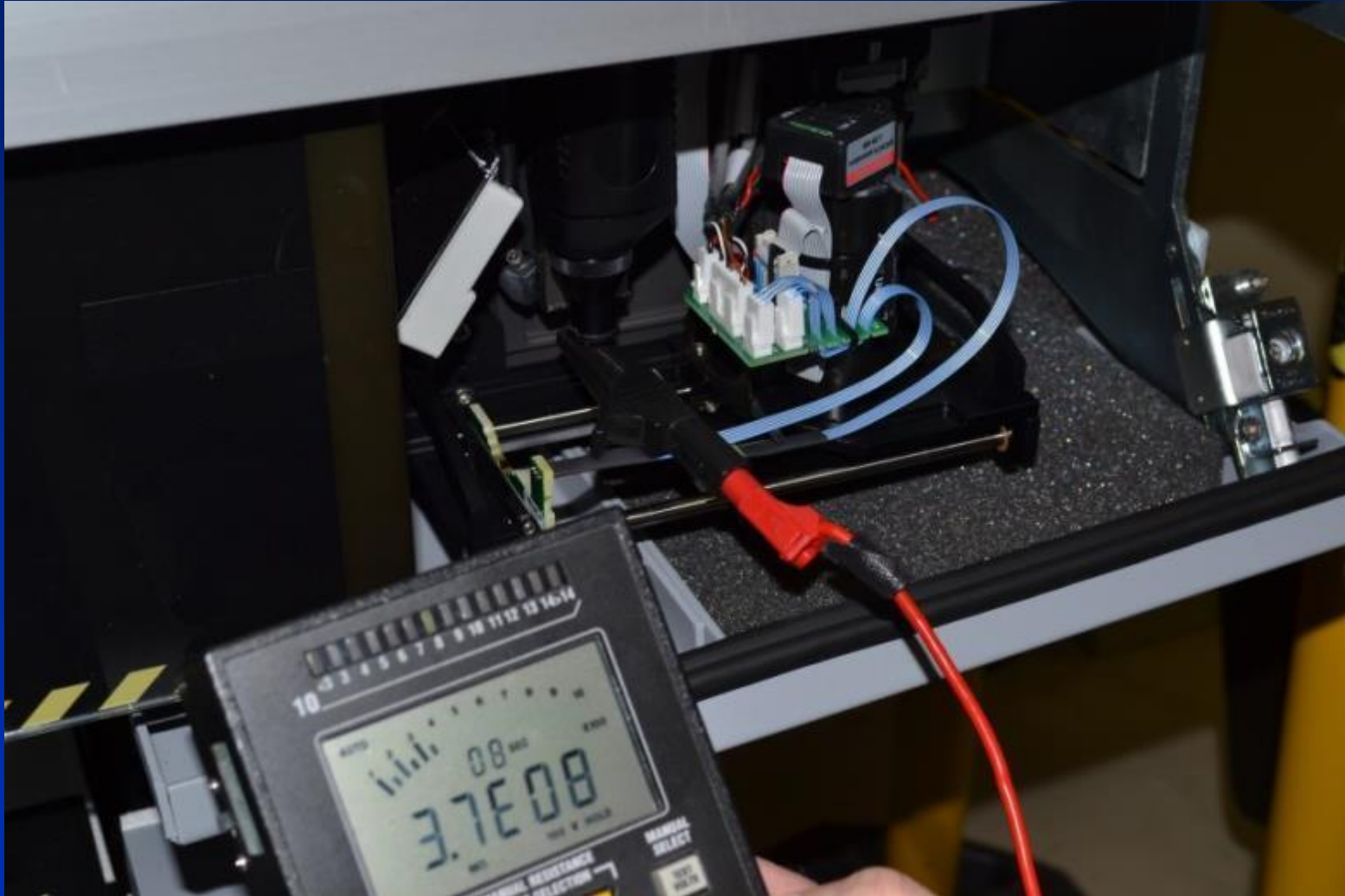
Individual Device Input Tray: SRM - Dissipative Powder Coat Paint



SRM Double Sided Tape



Pick Up Nozzle RTG



Pick Up Nozzle Resistance



Questions?

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