IPC Electronics Midwest 2010

ESD Control for the Automotive Electronics Industry

Gerry Pedone, NCE

Delphi Electronics & Safety

Biography:
Senior ESD Control Specialist for Delphi's global operations.

With 23+ years of ESD control experience, Gerry has used his extensive knowledge base to provide innovative technical solutions to a vast array of ESD control problems. In addition to his work at Delphi, Gerry has consulted with numerous electronics suppliers and automobile companies. His expertise extends from ESD compliant materials, product design issues, factory controls and material handling. He received a BSIE from Purdue before joining Delphi in 1981. He is a member of the ESD Association and an iNARTE certified ESD Control Engineer.

Executive Summary
Like many other electronics industries, the automotive electronics industry has long been concerned about ESD. As dramatically seen in the news today, quality recalls can detrimentally affect the faith and loyalty that a customer has for a company's products. Automotive collision avoidance radar systems, Telematics and some audio products are currently made with parts that are extremely sensitive to ESD. Robust ESD controls at the vehicle electronic system suppliers are needed to protect their customers from ESD. This in most cases can be done by complying with the ESD control industry's standards ANSI/ESD S20.20 and IEC 61340-5-1. The ESD controls built around these standards have been successfully used for over the past 20+ years, but will need improved upon for more sensitive future devices.

In addition, ESD control issues at the assembly plant will also be discussed as current guidelines may need to be improved given the growing trend for more sensitive electronics in vehicles and at the same time, the explosion of even more vehicle parts made from static generative plastics.

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ESD Control for the Automotive Electronics Industry

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Delphi Electronics & Safety
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Association Connecting Electronics Industries

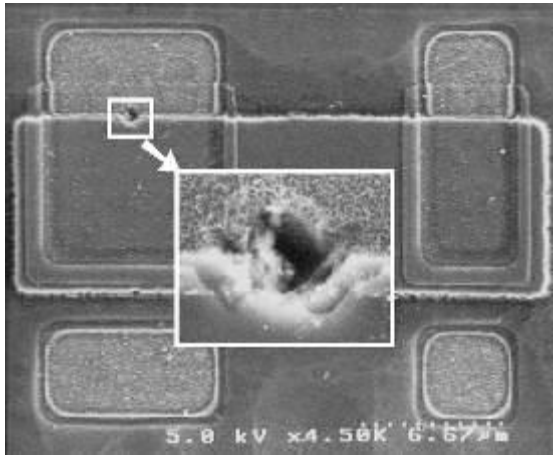
CANON COMMUNICATIONS LLC | IPC

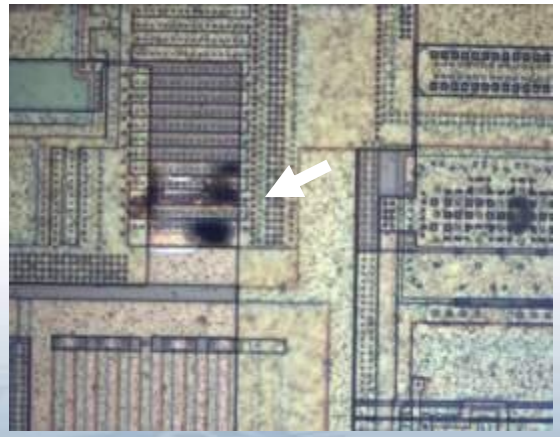
General Outline

- Introduction
- ESD controls
- ESD analysis techniques
- Vehicle assembly ESD control issues
- Vehicle system ESD example
- Summary

ESD versus EOS

- **Characteristics of ESD damage**
  - Triggering events < 1uSec
  - Small failure sites
  - Not always visible in the absence of deprocessing
  - No visible evidence at the package level
- **Characteristics of EOS damage**
  - Triggering event typically > 1uSec and longer
  - Large areas of damage
  - Burned silicon and metallization
  - Visibly evident on package damage in some cases





ESD Standards History

- MIL-STD 1686 (1980/90s)
  - DOD-HDBK-263
- IEC 61340-5-1-1998 1st Edition
  - Developed in Europe
- ANSI/ESDA S20.20-1999 1st Edition
  - North American Standard
- ANSI/ESDA S20.20-2007
- IEC 61340-5-1-2007-08

Compliance to ANSI/ESD and IEC industry standards is expected by our customers.

Electronics IPC Midwest

Global Automotive Electronics Supplier

DAEWOO

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HONDA

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MITSUBISHI

SUZUKI

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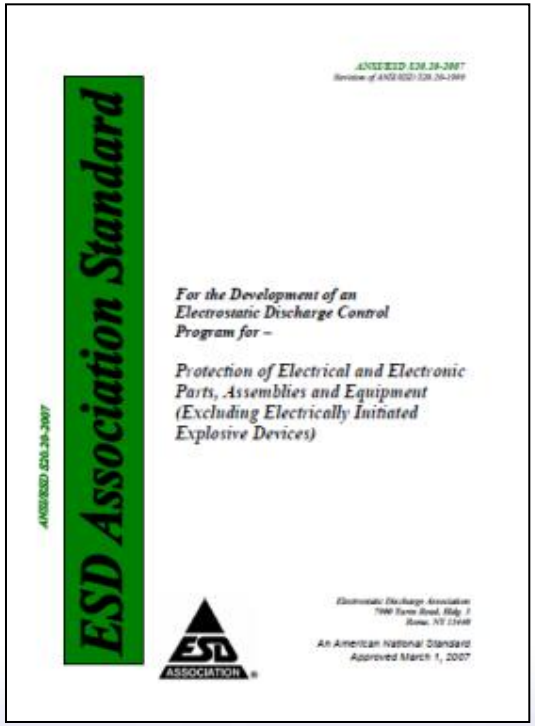
IPC

Delphi Eight Point ESD Control Elements

1. **Documentation** – procedures on handling, specification for processes, service, packaging, suppliers
2. **Standardization** – of ESD control products and materials and labeling
3. **Training** – awareness training for production, engineering, maintenance, purchasing, and service
4. **Central Information Source** – disseminating information
5. **R & D** – on ESD control applications and test methods, and updating knowledge
6. **Audits** – daily audits of wrist straps and footwear, and regular auditing of procedures and other items
7. **Monitoring Failure Rates** – to determine effectiveness of measures
8. **Monitoring of ESD Prevention Costs** – investment, operating costs, as well as personnel costs

Key Elements of ANSI/ESDA S20.20

- Administrative Controls
  - Training
  - Compliance verification
- Technical Controls
  - Grounding/equipotential bonding systems
  - Personnel grounding
  - EPA requirements
  - Packaging systems
  - Marking



Includes reference to ESD SP10.1 Automated Handling Equipment

ESD Control Models & Scenarios

- Human Body Model (HBM) - discharge to a device from a charged person
- Charged Device Model (CDM) – discharge from a charged part to ground
- Machine Model (MM) – discharge from ungrounded metal to a device
- Charged Board Event (CBE) – discharge of a charged PCB to a conductor

ESD Control must cover all models

Issue – Current Standards are HBM Focused

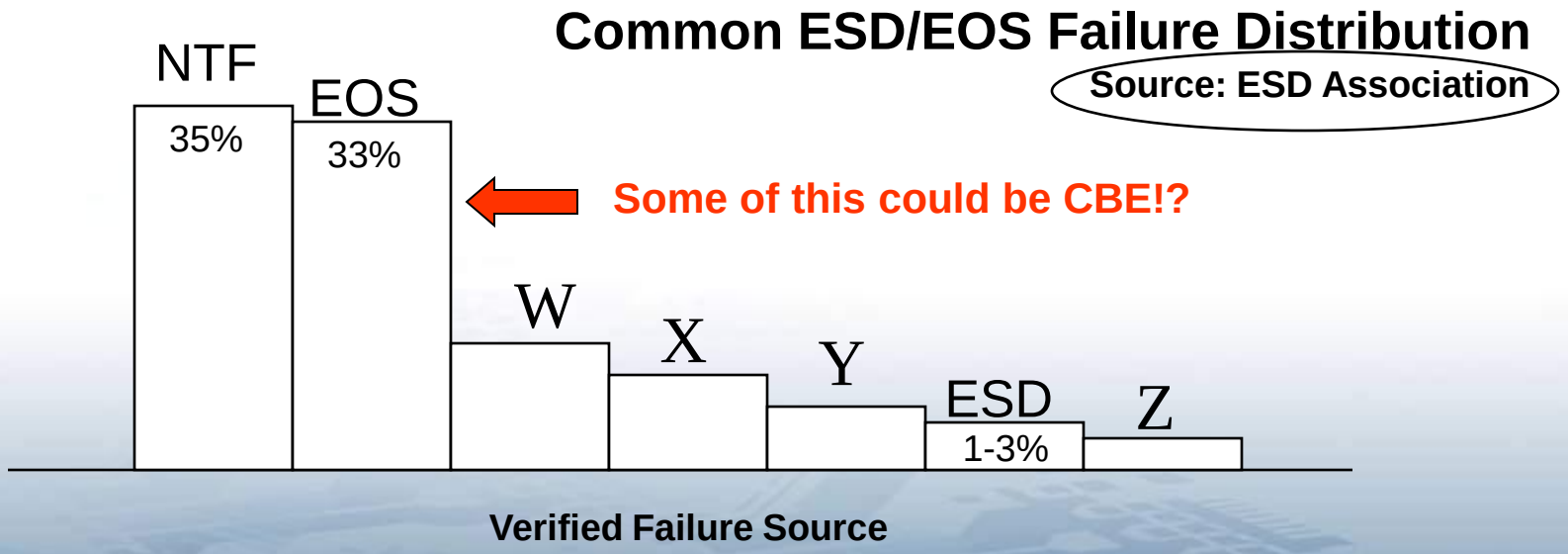
- IEC & ESDA S20.20 are standards that emphasize Human Body Model (HBM) precautions[1]
- Most available information on device sensitivity is HBM
- Current standards designed to protect parts that are sensitive to above 100V HBM
- Additional measures still needed for more sensitive devices (<100V HBM) and Charge Device Model (CDM) scenarios

Today's Emphasis is on Charged Board Event (CBE)

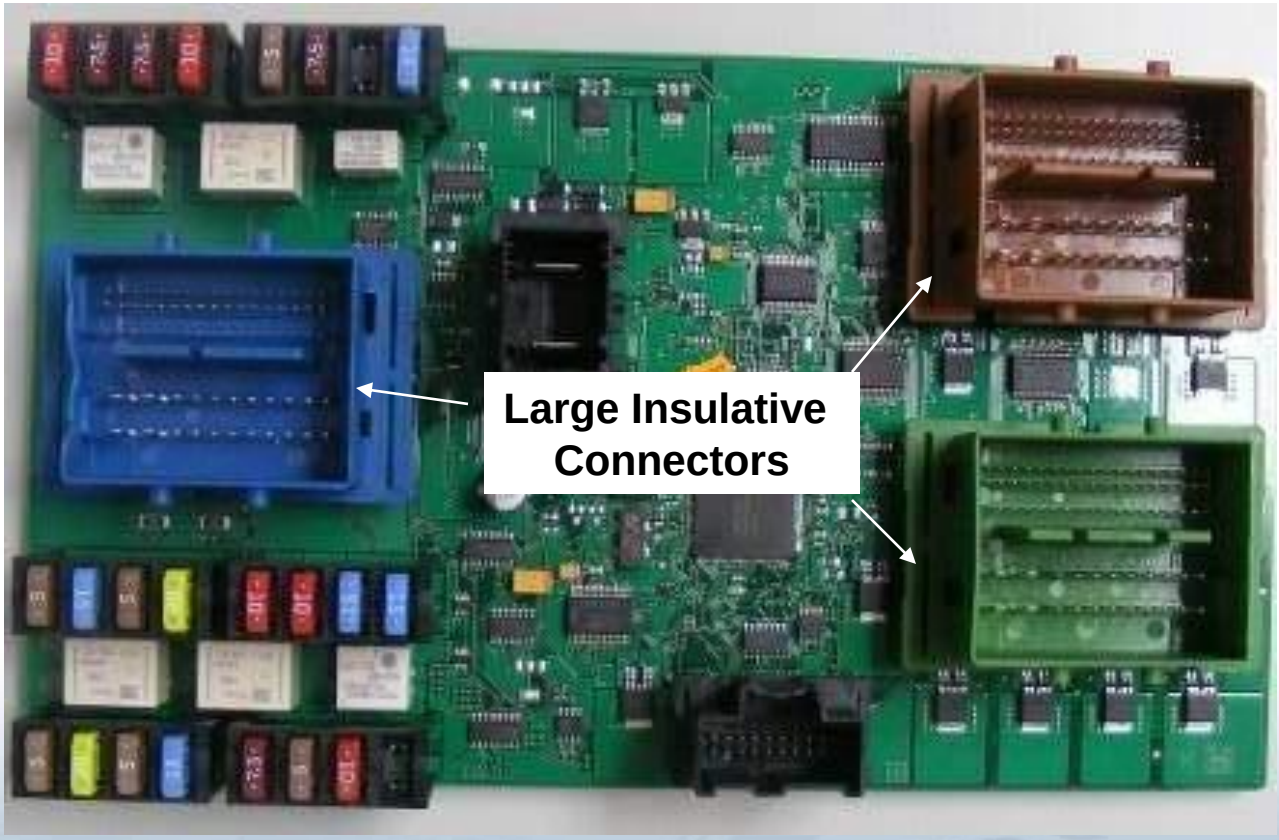
- Analog Devices Inc.™ (ADI) study on Charged Board Event (CBE) for automotive device[2]
  - CBE more damaging than HBM, even CDM
  - A portion of Electrical Overstress (EOS) failures may actually be attributed to CBE
- ESD Association tutorials and seminars now available on CBE scenario

Charged Board Event

- Like Charged Device Model, but board becomes charged
  - Circuit board = larger capacitance
  - Easier to charge a circuit board
- More damaging discharge that can be mistaken for EOS!

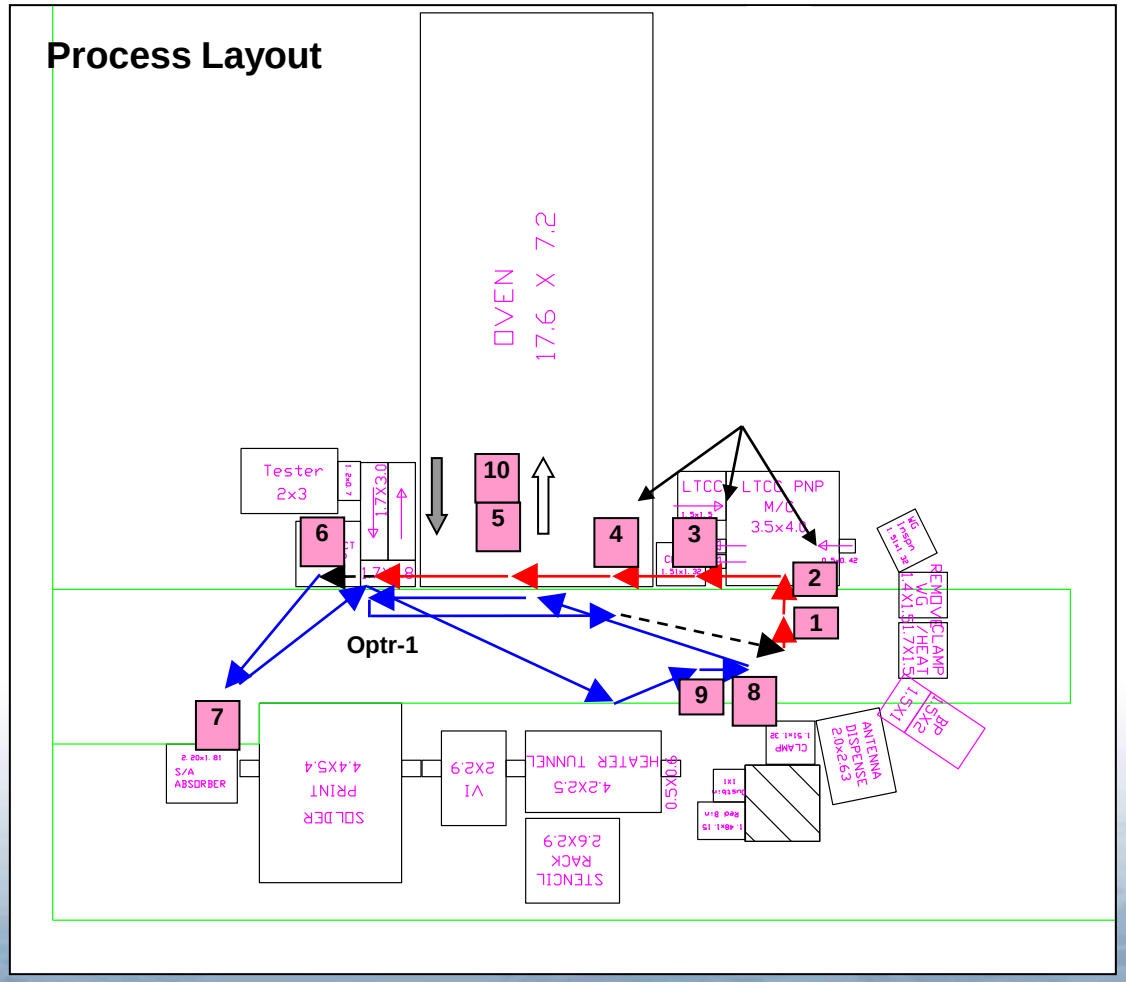


Example – Charged Board Event (CBE)



#1 Source for static charging of a circuit

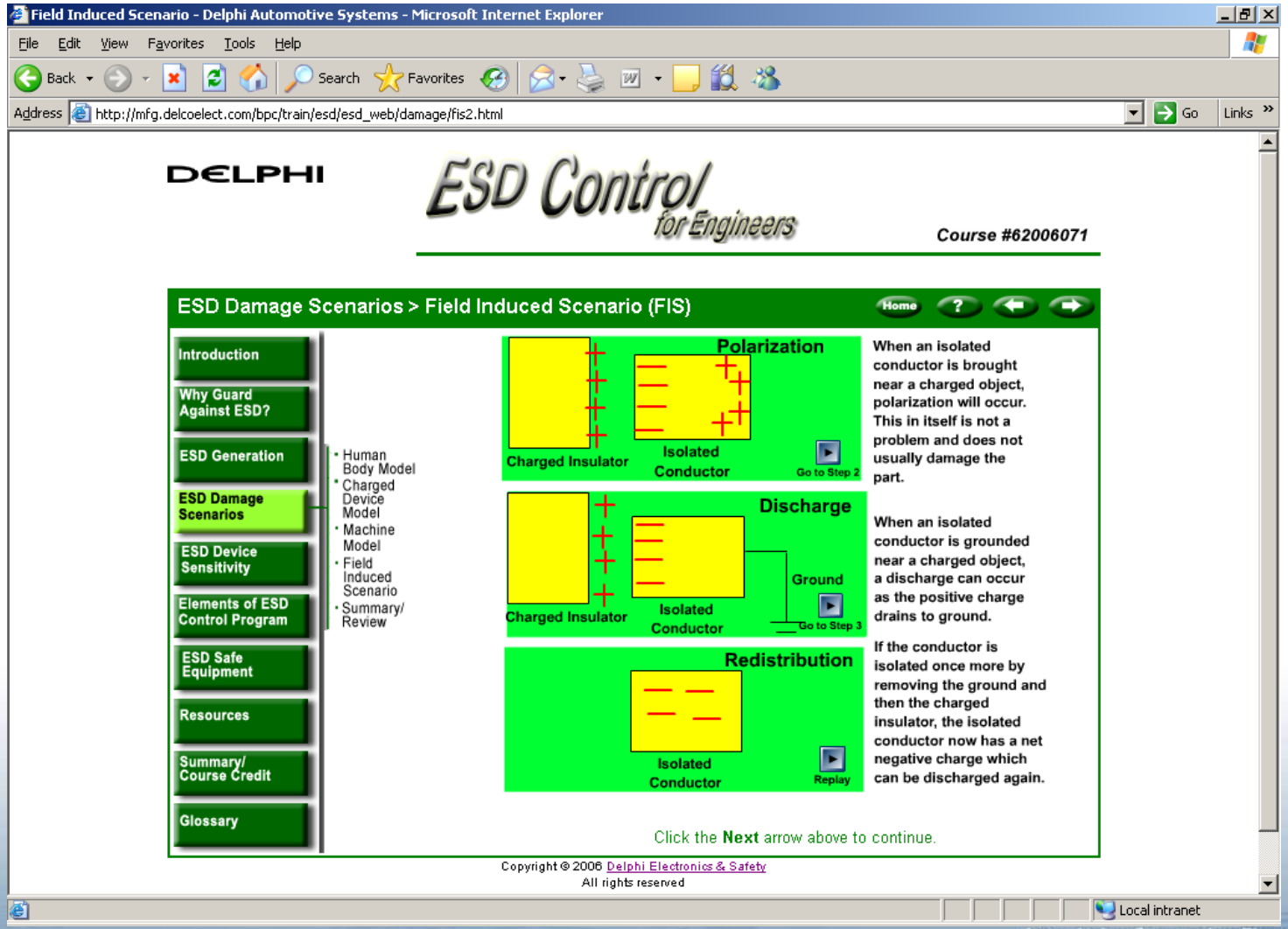
Where is CBE likely to occur?



Identify where a change in grounding status occurs

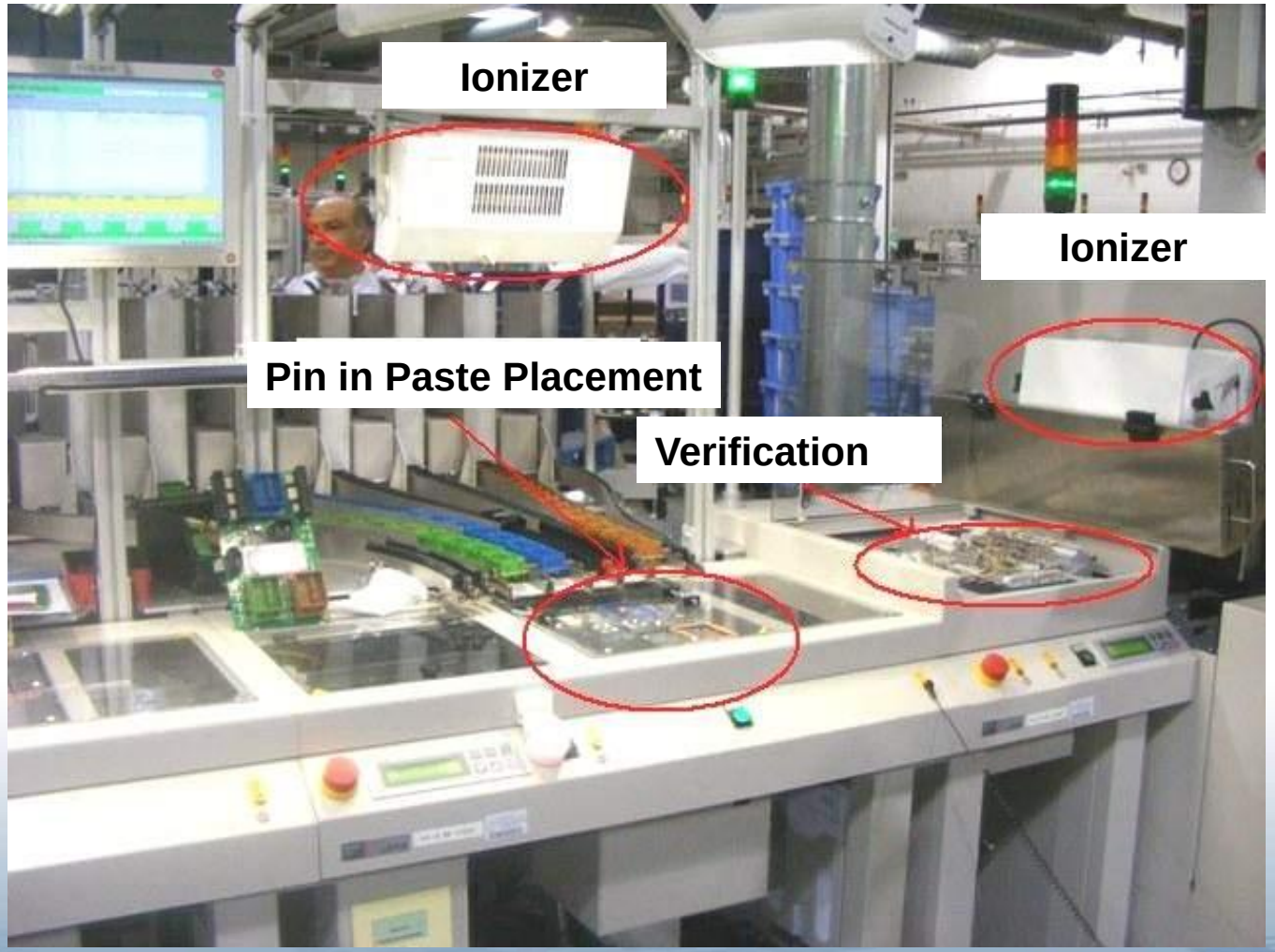
At each location check for...
1. **Product grounding**
2. **Static field**
3. **ESD events**

Static Field Induced Scenario

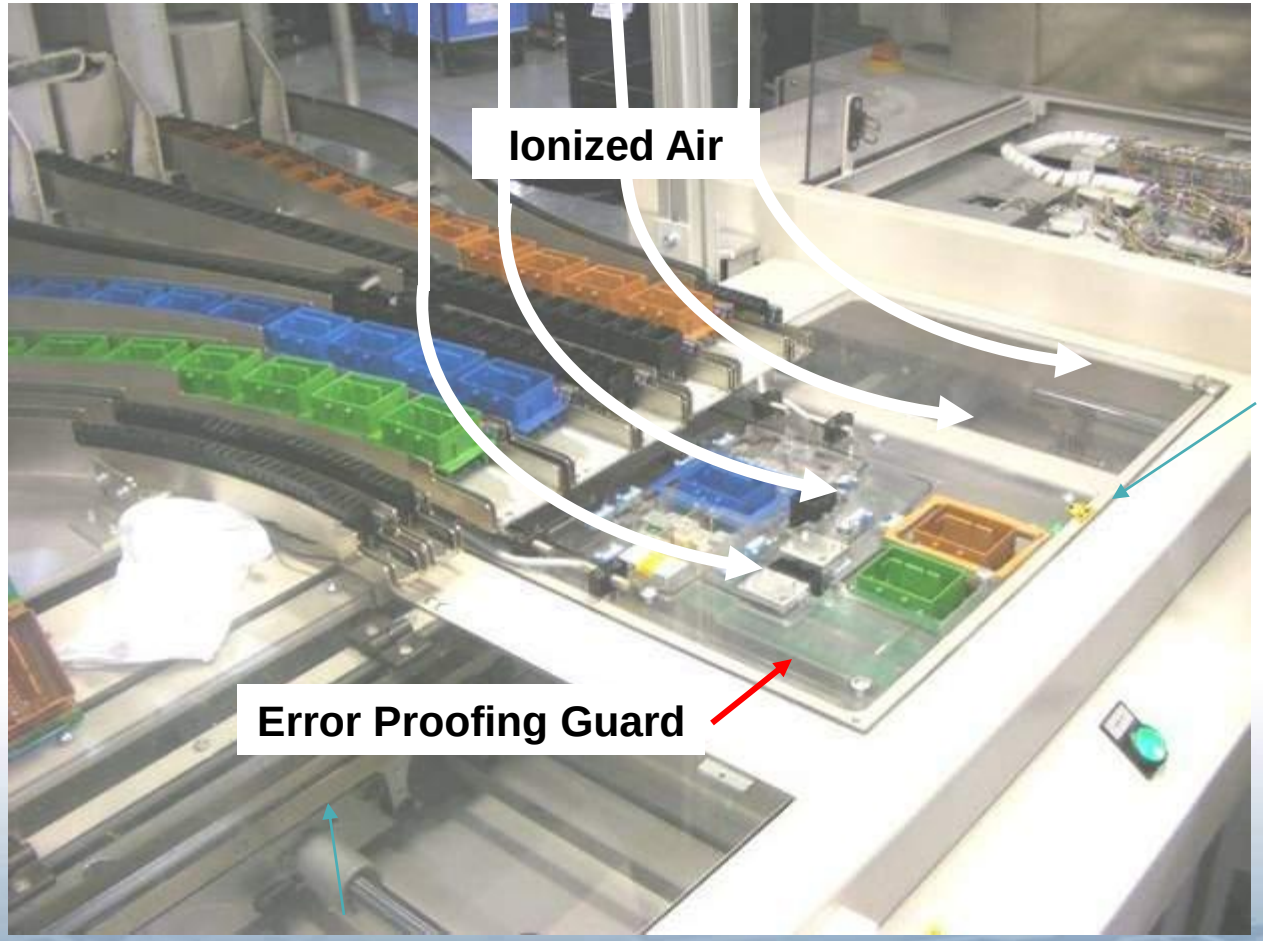


Ionization of PCB Insulators

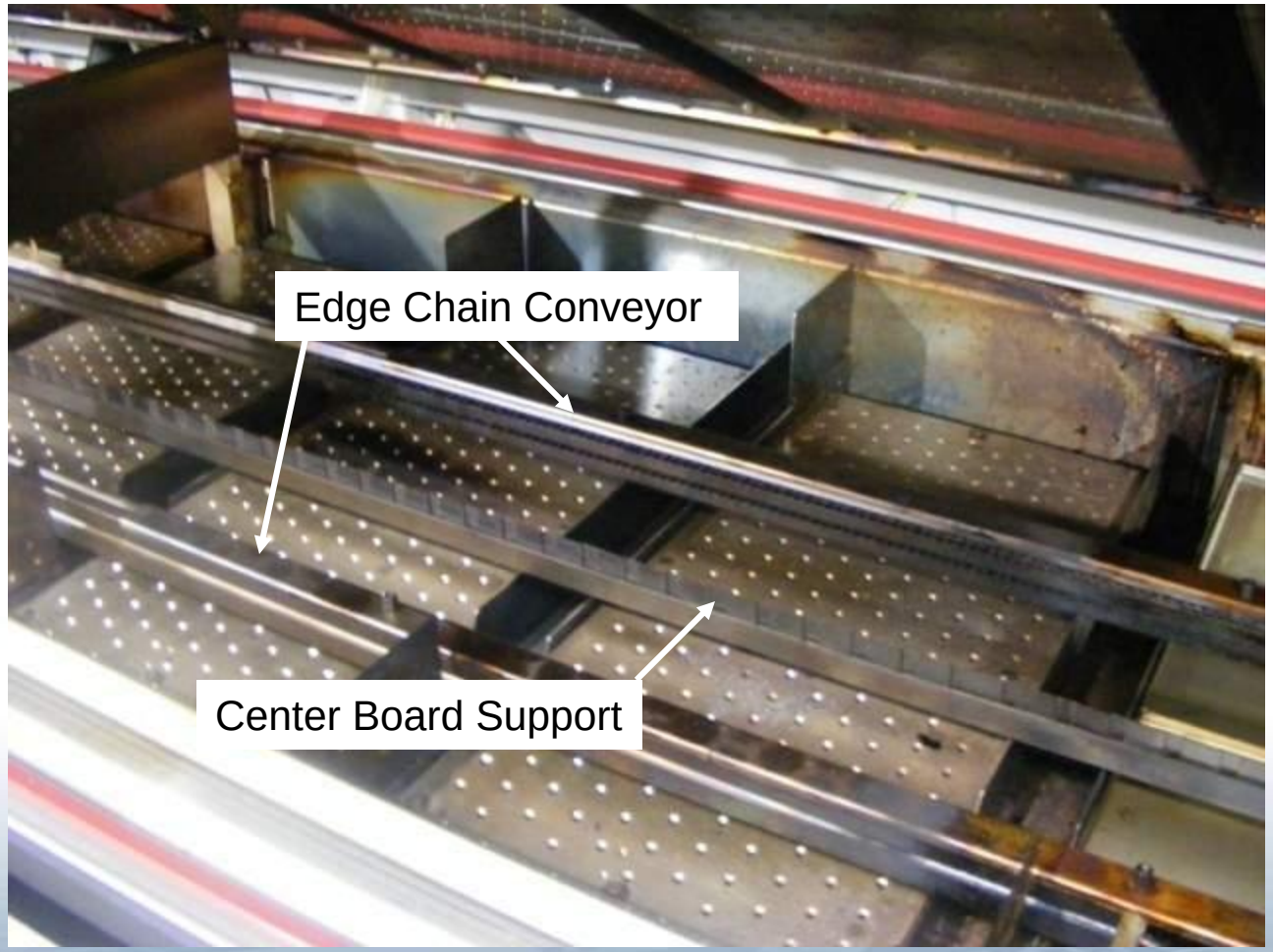
Large Component Placement



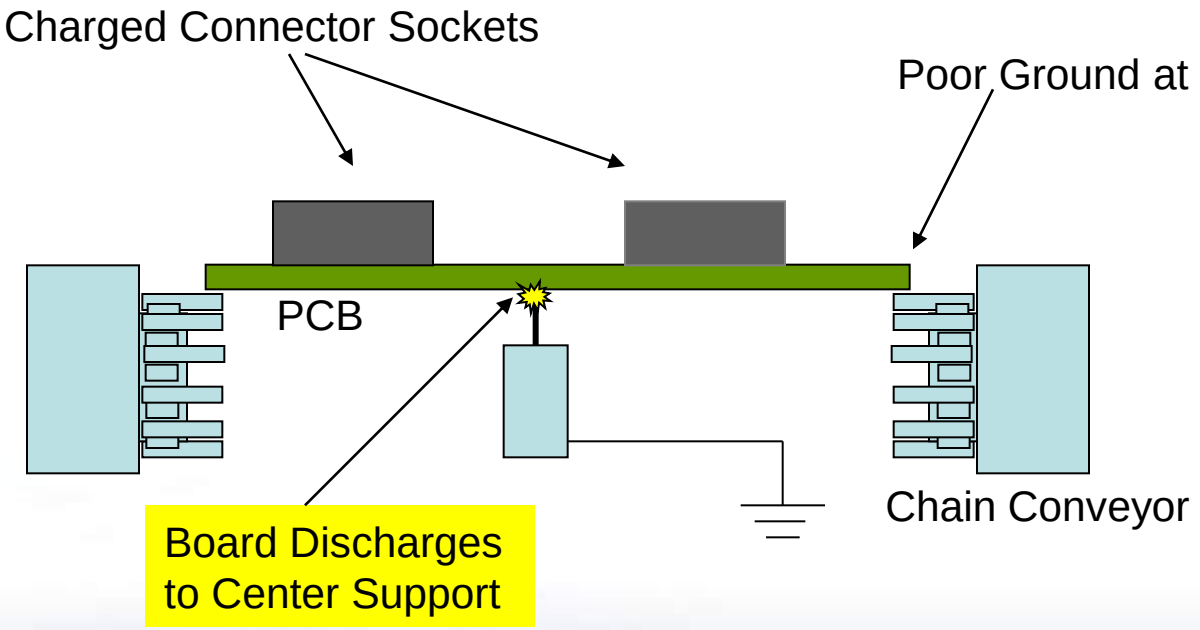
Ionization of Insulators



Reflow Oven Conveyor



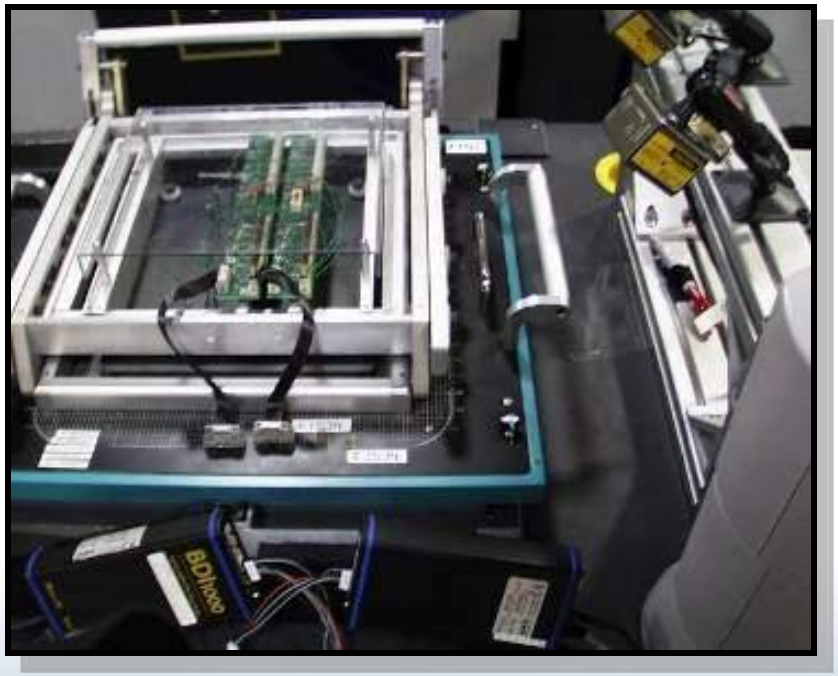
Reflow Oven ESD Event



Example – Charged Board Event (CBE)

Event detector can identify ESD discharges

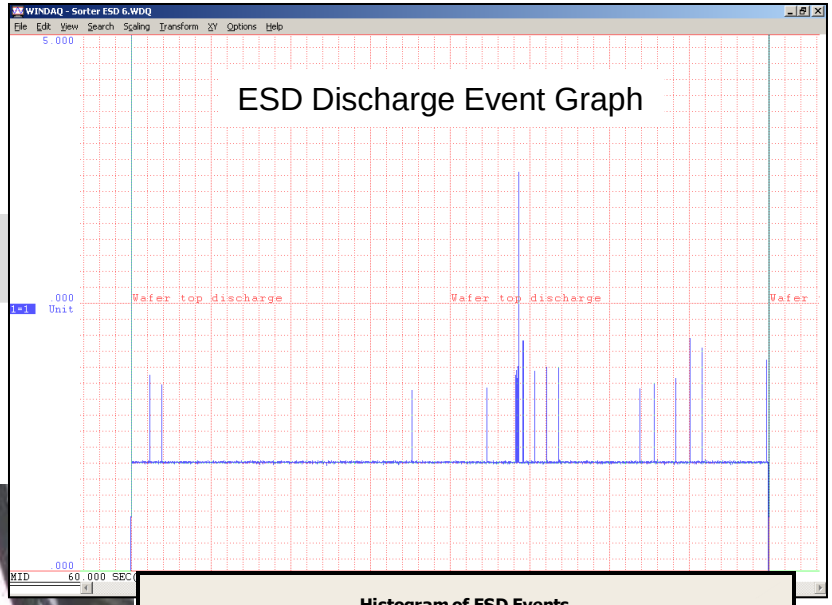
CBE of Incircuit Test

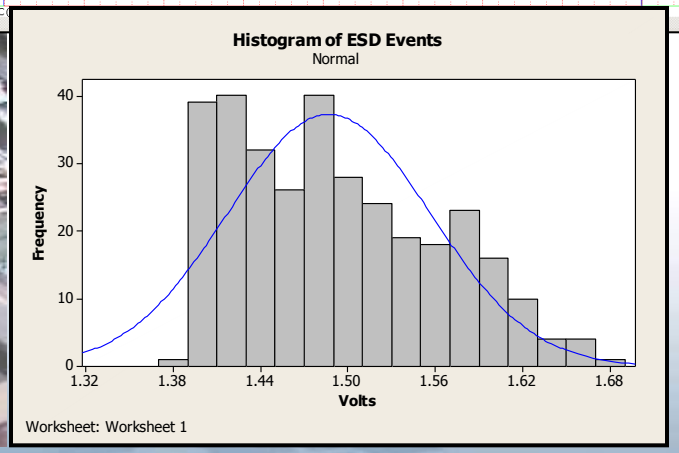


Two-step Static Dissipative Test Pin

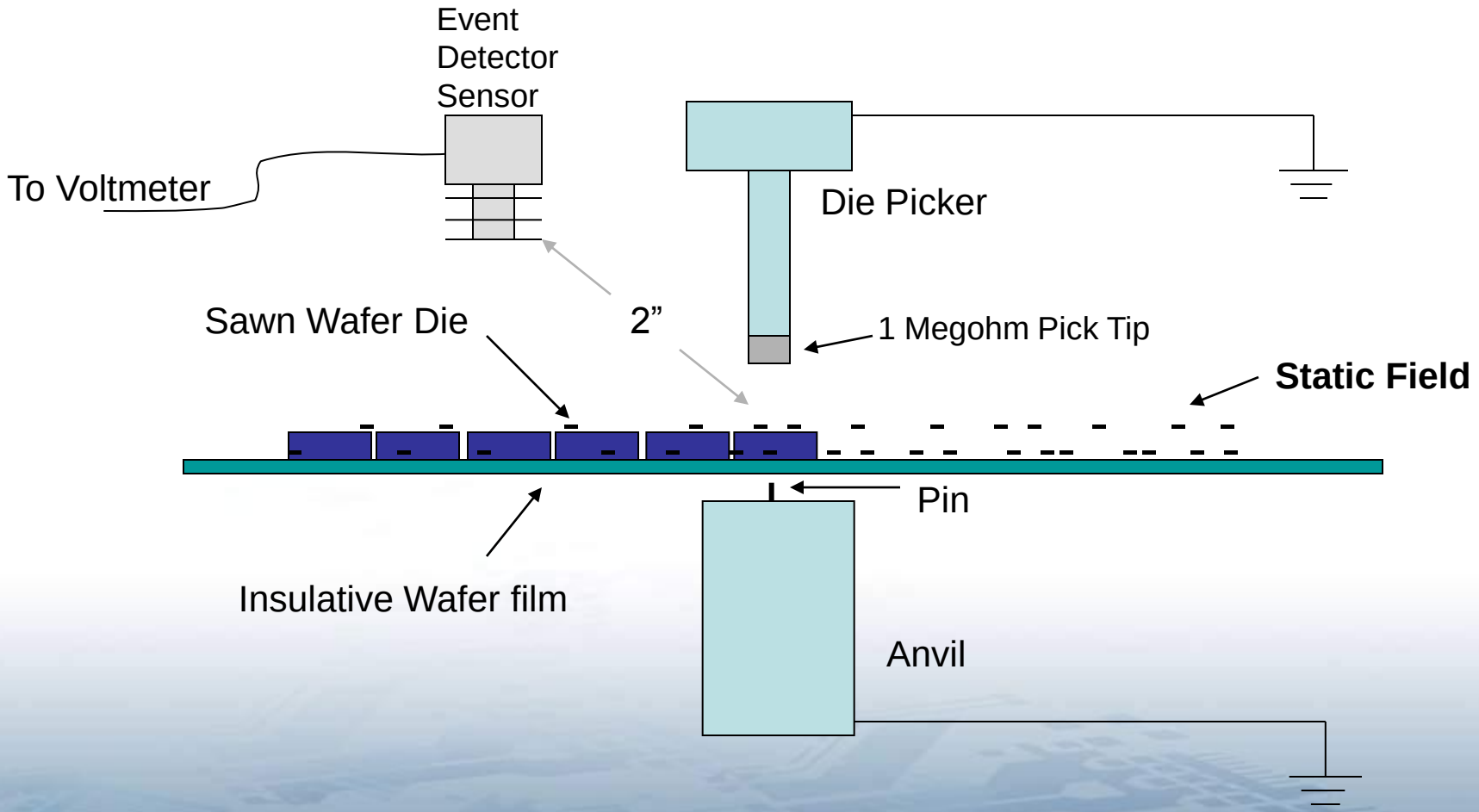
CDM in a Wafer Die Sorter

Remote Event
Detector Antenna

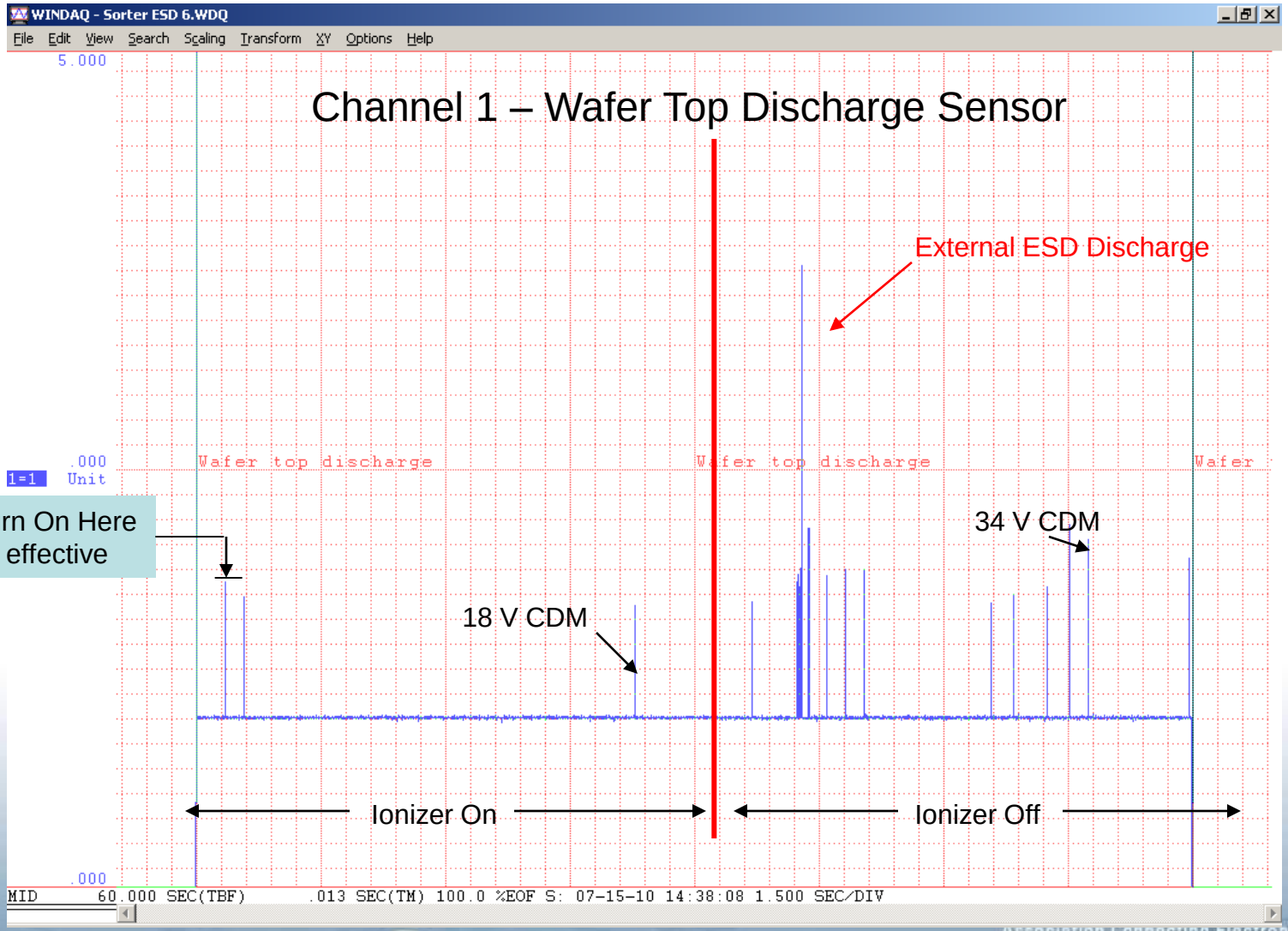




CDM Discharge in a Wafer Die Sorter



ESD Event Detector Graph



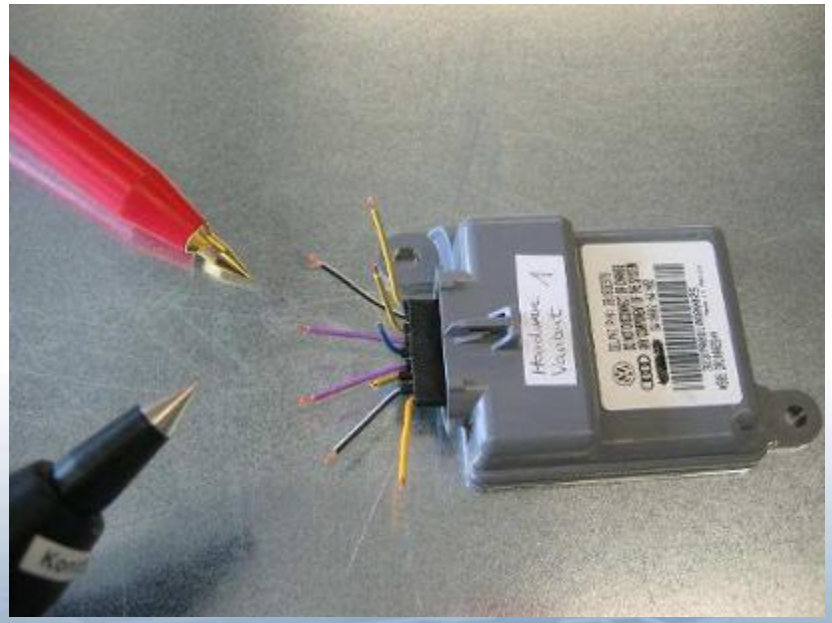
Vehicle Assembly Plant ESD Issues

- Problems with handling
  - Conveyors
  - Manual handling
- Problems with assembling the vehicle
  - Large charged plastic parts
  - Charged cables
- Problems with vehicle design
  - Grounding issues
  - Insulative and conductive parts
- Potential fixes
  - Conductive plastics
  - Antistatic plastics
  - Modified assembly procedures

Automotive Electronics

- Must be able to survive the ESD environment at the VAP (EMC ESD Validation Levels of 8KV modified severe HBM / MM typically)
- Limited ESD Controls at the VAP
- Large use of plastics in automotive electronics

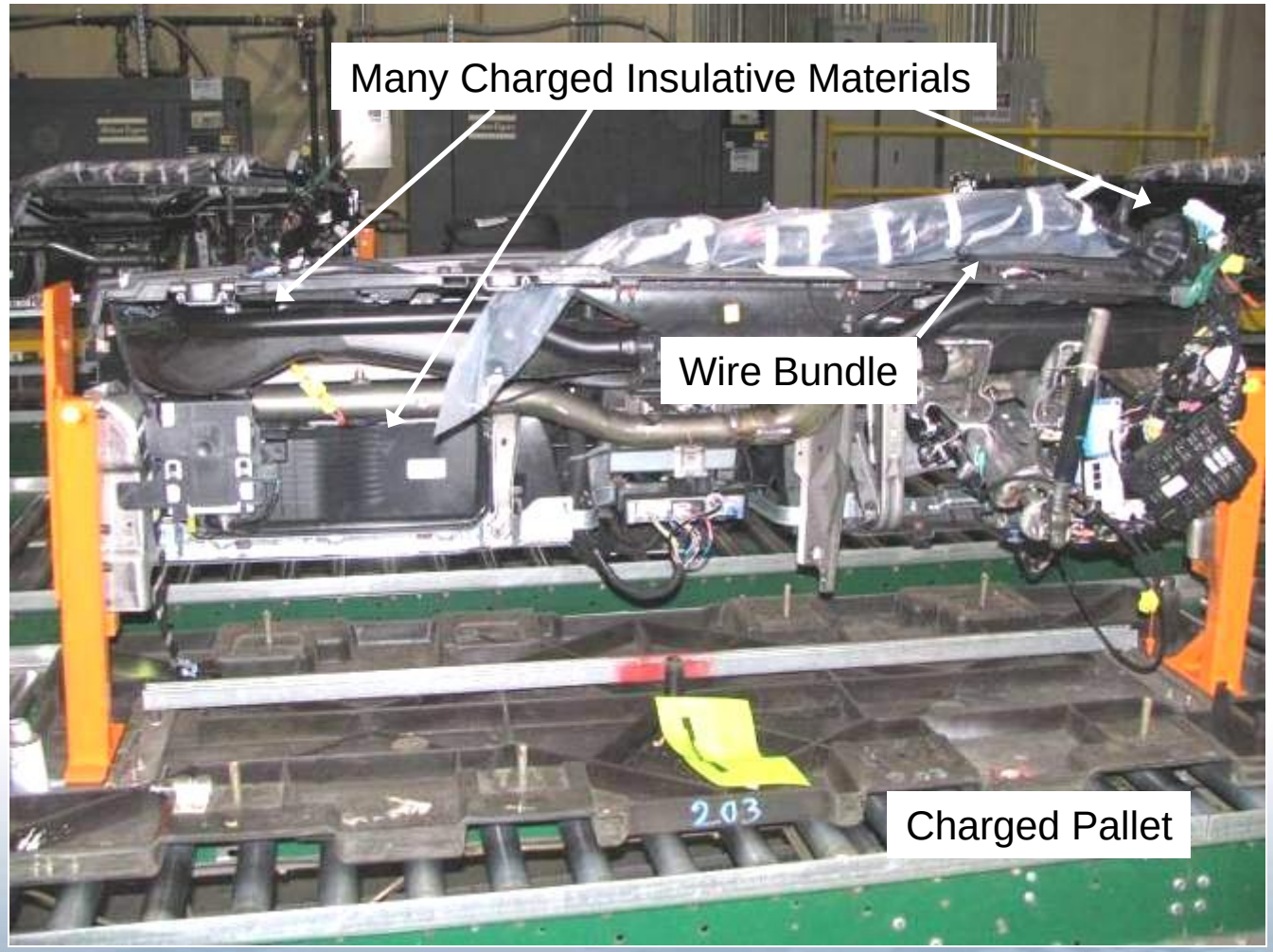
EMC ESD TEST
Discharge Network
(330 ohm, 150 pF)
Up to 15 KV



Common Vehicle Insulators

- HVAC components
- Rocker panels
- Large non-structural parts
- Fuel system components
- Under the hood components
  - Radiator components
  - Engine covers
  - Air intake manifolds

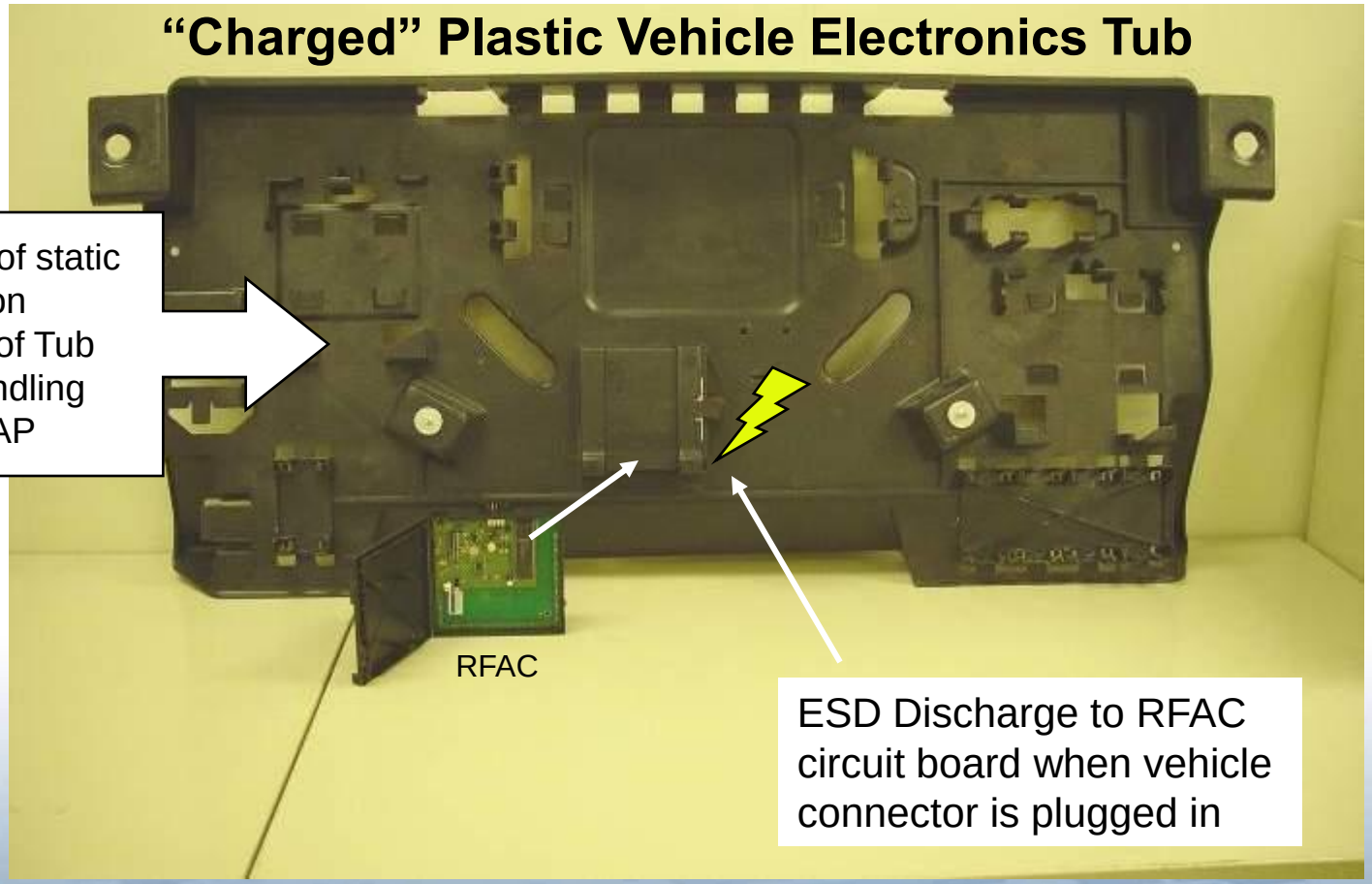
IP Assembly ESD



Charged Vehicle Wiring

EMI (ESD Event) Locator

Large Vehicle Insulators



ESD Upset from Conveyor System

Vehicle Fuel System ESD

. . . recalling vehicles with V8 engines
Possible electrostatic discharge may occur

October 24, 2007

...is recalling about 29,000 vehicles to fix a problem in the electronic control unit that could cause engines to stall.

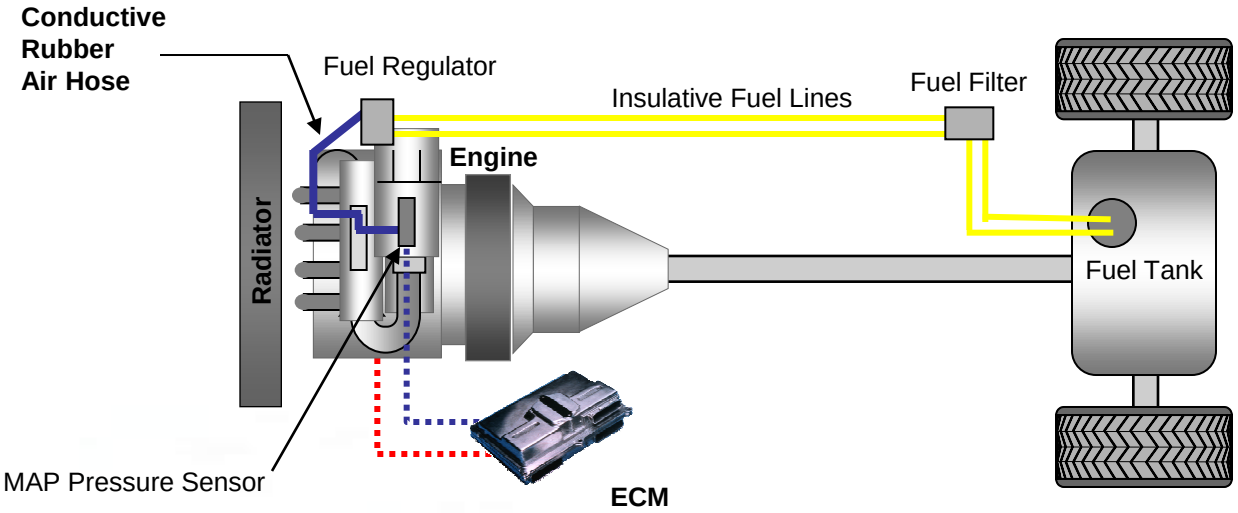
The recall, announced by the National Highway Traffic Safety Administration, involves only vehicles with V8 engines ...

... ***A combination of below freezing temperatures and low humidity makes is possible for an electrostatic discharge to occur at the fuel rails, which could cause the engine to stall.***

Dealers will correct the problem, free of charge, by attaching two additional ground cables in the engine compartment. This is the second recall involving the 2007 ....

Source: ESD Journal

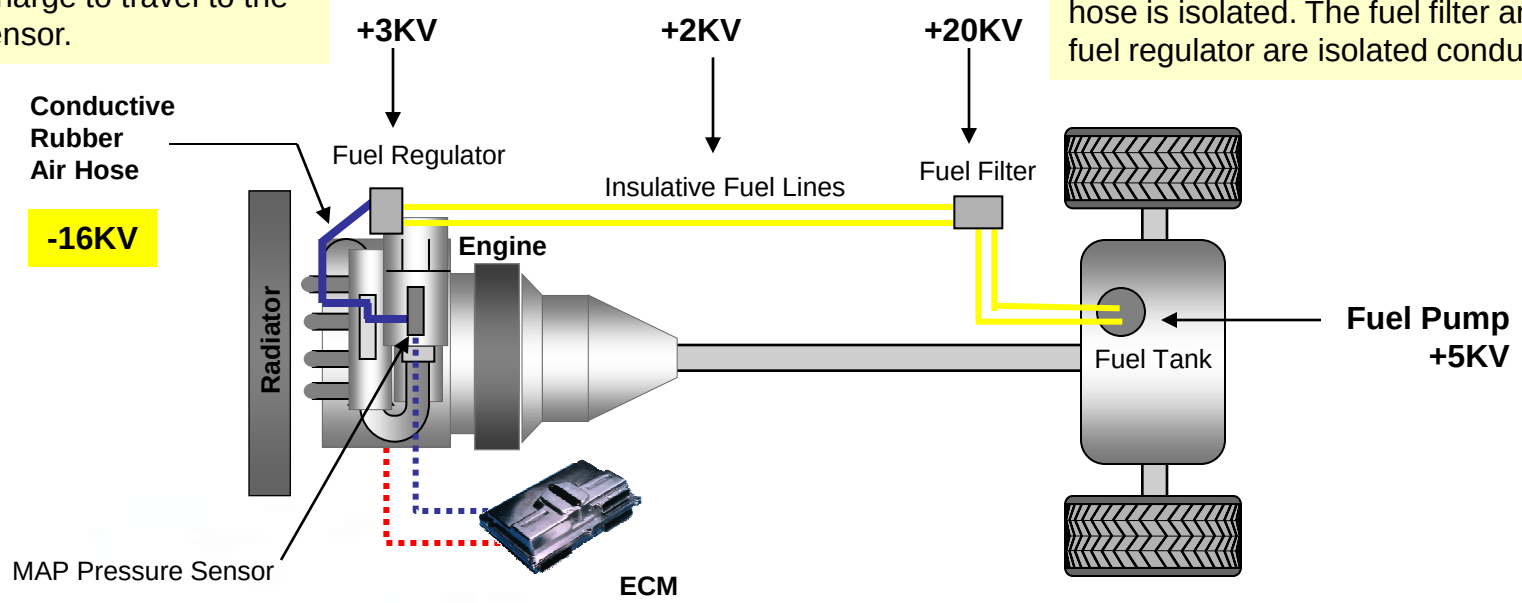
Vehicle Fuel System ESD



Vehicle Fuel System ESD

The fuel regulator and pressure sensor air hoses are conductive and allow charge to travel to the pressure sensor.

The fuel distribution system from the fuel pump to the fuel regulator hose is isolated. The fuel filter and fuel regulator are isolated conductors



ESD occurs when the air gap between the end of the conductive air hose and the pressure sensor cell breaks down.

ZAP!! MAP goes to minimum output – Engine Stalls

Summary

- Understanding and addressing Charged Board Event issues is vital to gain reductions in ESD and EOS failures
- In addition to compliance to industry standards such as ANSI/ESD S20.20, controls for Charged Board Events are necessary to drive continual improvement in product quality (FTQ, Customer & Warranty Returns)
- Additional quantification of ESD hazards during the vehicle assembly process is needed, however potential hazards can be mitigated by proper ESD control methods

Thank you!

- Contact information
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  - Phone: 765-451-8675

References

1. Gaertner, Reinhold, “Do We Expect ESD Failures in an EPA Designed to International Standards”, EOS/ESD Symposium, 2007
2. Olney, Andrew et al., “Real World Charged Board Model ESD Failures”, EOS/ESD Symposium, 2003