NASA Workmanship Standards Program
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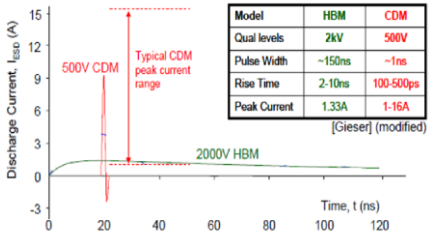
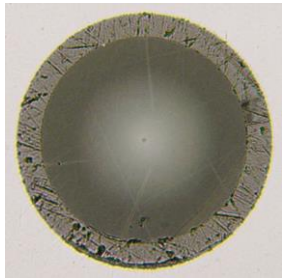
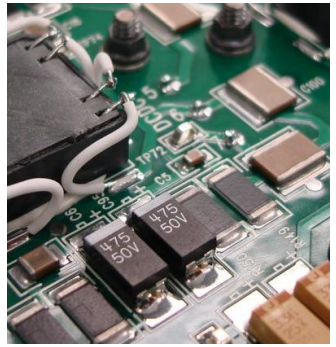
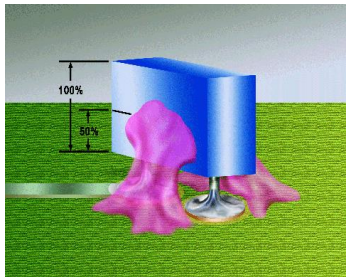


Figure 4: Comparison of current waveforms for CDM and HBM ESD events.

- Bare Printed Circuit Boards (PCBs)
- Soldering: Machine, Hand
- Polymeric Applications (on PCBs): EEE part bonding, EEE part and wire staking, conformal coating
- Electrical Cables and Wiring Harnesses
- Fiber Optic Interconnects and Cables
- Electrostatic Discharge Control







http://nepp.nasa.gov/workmanship

NASA OSMA OFFICE OF SAFETY & MISSION ASSURANCE

Electrostatic Discharge Control	Electrostatic Discharge Sensitivity
Workmanship	EEE Parts
ANSI/ESD S20.20 + Assurance requirements for Space	**JS-001: Joint JEDEC/ESDA Human Body Model** **JS-002: Joint JEDEC/ESDA Charged Device Model**
Machine Model No Longer Used. Considered a subset of HBM.	
Equipment susceptible to damage by electrostatic discharges greater than or equal to 100 volts HBM, 200 volts CDM, and 35 volts on isolated conductors.	Provides test methods for: HBM: <125V to >8kV withstand voltage CDM: <125V to >1kV withstand voltage
To protect product from damage: Users: Lab owners, operators, inspectors Product handling: production processes, storage, shipping	To determine sensitivity level (i.e., qualify, rate) Supplier may or may not identify on datasheet
ESD Controlled areas use sensitivity names (e.g., Class 0, Class C1) to signal to users what hardware can be processed there.	
Every supplier who handles ESD-sensitive item must implement an ESD-control plan.	
Qualification of ESD tools and supplies is the responsibility of the user.	

Challenges

ANSI/ESD S20.20 has to serve **too wide of an industrial base**

- low-cost commercial, high reliability military, semiconductor fab, server farms, large-scale manufacturing, small-volume custom PWA assembly.

Requirements are lowest common denominator. **Emphasis is on performance and not on assurance**.
NASA suppliers' work **areas are reconfigured often** and cannot easily be controlled at the "system" level.

ESD Control Program Managers **lack deep knowledge of ESD science**. Know how to use control techniques but not how to optimize performance and assurance. Training focuses on operator practices.

An accumulation of techniques used within the NASA supply chain **without deep knowledge of safety margin**.

- Ionizers, humidity control, garments, floor grounding, direct grounding, insulators
- Compliance problems, continuous audit findings
- Obstacle to risk management

NASA production environment **is also relatively wide**

- Semiconductor handling, PWA assembly, board-level test, box-level test, instrument and s/c integration, EVA
- ESD Control plans are usually one-size-fits-all. Programmatic risk.

Tendency to equate system sensitivity with most sensitive item within. This can add programmatic risk.

There is a large number of non-compliant ESD tools and materials on the market. Buyer beware. Many users are not equipped or capable of sustaining a ESD product qualification process. ANSI/ESD S20.20 holds users responsible.

Examples of ESD Control Assurance Requirements Sought for Space Community

- Minimum technical certification requirements for ESD Program Managers
- Hands on training for those who perform verification tests of ESD work area and items
- Conditions for certifying, recertifying and decommissioning ESD work areas. Root cause analysis, corrective action/preventative action for non-conforming areas.
- All accept/reject limits will be bounded with both a minimum and maximum value.
- How to maintain grounding during transport (for items that cannot be contained fully within sealed ESD container).
- Groundable garments
- Wrist ground strap check prior to work, each time.
- Managing furniture with and without grounded floors
- No daisy-chained ground connections to single-point-ground point (some exceptions related to personnel grounding)
- Humidity limits (other than >12%) and risk mitigations allowed when humidity cannot be controlled.
- Harness connectors grounded prior to assembly with mission hardware
- Operators shall participate actively in removing insulators from within 12 inches of the ESD sensitive item

Approximately 17 pages in addition to the baseline requirements in ANSI/ESD S20.20.

Plan to push all requirements into “example” ESD Control Plan: NASA-HDBK-8739.21