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STANDARDS FOR MILITARY MANUFACTURERS AND COMPONENT DISTRIBUTORS

The military services are understandably concerned about ESD protection. To foster maximum manufacturing yields and field reliability in equipment, static controls are mandatory. Two often cited requirements are the recently updated DOD-STD-1686A and JEDEC 108, which set protection requirements for manufacturers and distributors, respectively.

REQUIREMENTS FOR MANUFACTURERS: A REVIEW OF THE PROPOSED DOD STANDARD 1686A

Recently, the Department of Defense issued its latest draft of a revision to DOD Standard 1686. The document sets out the fundamental requirements that component and equipment manufacturers must meet in protecting their manufacturing plants from hazardous effects of electrostatic discharge. The new standards will affect nearly every manufacturer of components or sub-assemblies who sells or services the DOD.

As for its relation to the previous DOD Standard 1686, Section 6.2 says it all: "Asterisks are not used in this revision to identify changes . . . due to the extensiveness of the changes".

As with its predecessor, the standard is broad, covering any activity that designs, tests, inspects, services, manufactures, processes, assembles, installs, packages, labels or otherwise handles electronic parts, assemblies and equipment. Table 1 lays out the specific sections of 1686A and who they apply to. Three classifications for ESD sensitive (ESDS) items are called out. Zero to 1000 volt sensitive devices are Class I, and 1000 to 4000 volt sensitive devices are Class II. A Class III has also been called out, covering 4000 to 15,000 volts. However, the applicability of most of the ESDS requirements only applies to Class III devices if they are part of "mission critical or essential equipment".

STATIC CONTROLS REQUIRED IN MANUFACTURING

Adding detail to the document are MIL-E-17555 for packaging, MIL Standard 1285 for marking and DOD Handbook 263 for the construction of static control programs. The latter is soon to be revised. The marking symbol in EIA RS-471 can also be used.

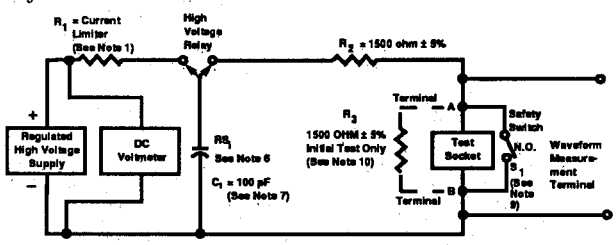
In general, each contractor must "establish, implement and document" his ESD control program. The contractor must also verify and document that subcontractors comply. DOD Standard 1686A lays out in some detail what is required. First, the contractor has to identify the class of each part and assembly used. The classification can be measured using the test apparatus of Appendix B (shown here). Assemblies are classified as I, II or III according to the least sensitive part they employ.

FINISHED PRODUCTS MUST BE LABELLED, I/O CONNECTORS PROTECTED

The final assembled equipment must be able to withstand an ESD event of up to 4000 volts without damage. This includes discharge to exposed pins and I/O connectors. External plastic caps can be used as protection, but installers must be careful to remove the cap just prior to installation of cables and to discharge cables before attaching them. The EIA RS-471 or MIL Standard 1285 symbol must be provided on external surfaces of the equipment along with a warning stating:

"CAUTION: THIS EQUIPMENT CONTAINS PARTS AND ASSEMBLIES SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD)"

This should be marked on the exterior of the equipment adjacent to the connectors.



Notes:

1. Value of R1 shall have a minimum limit of 800 kΩ, and a maximum limit of 3 GΩ; and be of a high voltage type.
2. All components and interconnecting wiring shall have voltage and current rating greater than the maximum specified supply value (Note: This does not apply to resistors).
3. Resistors R_2 and R_3 shall be a matched pair (within 10 percent) and noninductive, and high voltage withstanding.
4. Waveform shall be measured with a 100 MHz minimum oscilloscope (see note 5).
5. A high voltage, high impedance (≥10 MΩ), low capacitance (≤ picofarads (pF)) probe shall be used when measuring pulse waveform.
6. Relay RS contacts shall be of bounceless type (mercury wetted or equivalent), and have a dielectric breakdown voltage and current greater than the maximum specified voltage supply value. Relays shall be break-before-make and normally open type.
7. Effective capacitance shall be determined by charging C1 to 2,000 Vdc plus or minus 5 percent and with no part in test socket and test switch open discharging C_1 into an electrometer or coulometer connected between points A and B of the figure and calculating effective capacitance which shall be 100 pF plus or minus 10 percent. Effective insulation resistance for C_1 shall be 10^{10} ohms minimum.
8. Relay coil power supply shall be of a high current type.
9. Safety switch (S_1) shall be closed only during insertion and removal of any part under test.
10. Resistor R_3 shall be placed in socket across terminals A and B only, when initially discharging circuit for waveform photograph (see 50.3). Test waveform only will be ≈50 percent Vp and ≈$2t_s$.

FIGURE 1: Appendix B of the Proposed DOD-STD-1686A specifies test methods for determining VZAP levels.

MANUFACTURING FACILITIES NEED TO BE MEASURED

In designing manufacturing facilities, protected areas must not exhibit voltage levels higher than the minimum voltage levels that could produce damage. The entire procedure for handling parts must be "developed, documented and implemented". These handling procedures "shall be included in the data ordering document included in the contract or order".

Contractor Requirements	Identification & Classification	Design Protection	Protected Areas	Handling Procedures	Protective Covering	Training	Marking of Hardware	Documentation	Packaging	QA Provisions, Audits & Reviews	Failure Analysis
Design	✓	✓	—	—	—	✓	—	✓	—	✓	—
Production	✓	—	✓	✓	✓	✓	✓	✓	—	✓	✓
Inspection & Test	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓
Storage & Shipment	—	—	✓	✓	✓	✓	✓	✓	✓	✓	—
Installation	—	—	✓	✓	✓	✓	✓	✓	✓	✓	—
Maintenance & Repair	—	—	✓	✓	✓	✓	✓	✓	✓	✓	✓
Logistics	—	—	✓	✓	✓	✓	✓	✓	✓	✓	✓

QUALITY ASSURANCE PROCEDURES STRENGTHENED

Even after the equipment has been designed, handling procedures developed and implemented, 1686A requires more. Quality assurance procedures must be &eveloped and imple-

LIST OF ESDS PARTS BY PART TYPE. CLASS 1: SENSITIVITY RANGE >0 TO ≤1000 VOLTS
PART TYPE
Microwave and High Frequency Devices (Schottky Barrier Diodes, Point Contact Diodes, and Other Detector Diodes)
Discrete MOSFET Devices
Surface Acoustic Wave (SAW) Devices
Junction Field Effect Transistors (JFETs) (Low Leakage, High Breakdown Types)
Charged Coupled Devices (CCDs)
Precision Voltage Regulator Diodes (Line or Load Voltage Regulation < 0.5 Percent)
Operational Amplifiers (OP AMPs)
Thin Film Resistors
Integrated Circuits (SSI, MSI, LSI, VLSI and ULSI) • Bipolar (IIL, Schottky TTL, ECL and Other Technologies) • MOSFETs (CMOS, DMOS, HMOS, NMOS, VMOS, PMOS, CMOS/SOS Technologies)
Hybrids Utilizing Class 1 Parts
Integrated Circuits Utilizing Emerging Technologies (VHSIC)

LIST OF ESDS PARTS BY PART TYPE. CLASS 2: SENSITIVITY RANGE >1000 TO ≤4000 VOLTS
PART TYPE
The Following Devices or Microcircuits When Identified by Test Data As Class 2: • Discrete MOSFET Devices • JFET's • Operational Amplifiers (OP AMPs) • Integrated Circuits (ICs) • ICs Utilizing Emerging Technologies (VHSIC)
Silicon Controlled Rectifiers (SCRs) with I_o <0.175 Amp at 100°C Ambient
Precision Resistor Networks (Type RZ)
Hybrids Utilizing Class 2 Parts
Low Power Bipolar Transistors, P_T ≤100 Milliwatts with I_c <100 Milliamps

LIST OF ESDS PARTS BY PART TYPE. CLASS 3: SENSITIVITY RANGE >4000 TO ≤15000 VOLTS
PART TYPE
All Other Microcircuits Not Included in Class 1 or Class 2
Small Signal Diodes with Power <1 Watt or I_o <1 Amp
General Purpose Silicon Rectifiers
SCRs with I_o >0.175 Amp
Low Power Bipolar Transistors with 350 Milliwatts >P_T >100 Milliwatts and 400 Milliamps >1_c >100 Milliamps
Optoelectronic Devices (LEDs, Phototransistors, Opto Couplers)
Resistor Chips
Hybrids Utilizing Class 3 Parts
Piezoelectric Crystals

mented, both on the contractor and subcontractor level. Records have to be maintained of each audit and be available for government review. Even the design review stage of a product falls within the scope of 1686A. Design reviews must now include classification of items (as I, II or III), discussion of the protected circuitry required to meet the 4K external contact requirement, and, where appropriate, marking of parts, subassemblies and equipment.

A REVIEW OF JEDEC PUBLICATION NUMBER 108

The JEDEC Solid State Products Engineering Council recently released its Publication 108 "Distributor Requirements for Handling of Electrostatic Discharge Sensitive (ESDS) Devices". The document, while controversial, represents a concise standard for the handling of electronic components. JEDEC is a standards organization operating under the authority of the Electronics Industries Association (EIA).

The scope of the standard applies to "methods and materials used to protect the electronic devices processed by the manufacturer to meet military specifications", its guidance is useful for commercial design as well. It classifies devices when sensitivity is under 2000 volts as Category A devices which must be packaged in either a conductive container or an antistatic container with an electrostatic field shielding barrier. These devices must be identified as ESD sensitive by the manufacturer. Category B devices are sensitive to voltages greater than 2000 volts but still must be packaged in an antistatic container.

In describing a static-free workstation, the standard strongly recommends air ionizers in addition to table mats and wrist straps. As a supplement to the program, antistatic solutions can be used but care should be taken that the spray be free of reactive elements (chlorine, phosphorous, etc.) and that it is not applied to electrical parts. The user can expect to reapply such solutions every week for hard, abused surfaces (floor, table tops, etc.) and every six months for other surfaces. All workstations, parts, and containers should be posted with ESD warning signs.

In addition, the standard requires that operators approach a workstation by first touching it. Sleeves and other clothing which might contact components should be rolled up or protected with garters. Any personal items should be removed from the station.

Parts themselves should be received in containers with an electrostatic caution. Any items removed from the package should be removed only at a static-free workstation. Storage of devices is required to be in protective packaging.

As far as auditing workstations, the standard recommends that ground conductivity and static voltage levels be monitored once a week. Conductive floor tile should be checked for resistance at least once a month.

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