

Handling Instructions & Protection against Electrostatic Discharges

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Introduction:

Electrostatic discharge (ESD) is one of the leading causes of failure in power modules and integrated circuits. A strong ESD susceptibility can generate damage in the device that reduce its performance or destroy it. All MOSFET and IGBT power modules are sensitive to ESD because the thickness of the gate isolation only amounts to some ten nanometers. The degree of sensitivity is dependent on the input capacitance value. The Higher the input capacitance is, the lower the ESD risk is. Over time, electronic devices have become faster and smaller, so their sensitivity to ESD has increased. This application note gives the main recommendations in order to reduce component damage due to ESD.

1. What is ESD and how does it occur?

ESD is defined as the transfer of charge, called static electricity, between “bodies” at different electrical potentials. An ESD event can occur when any charged conductor (including the human body) discharges to an Electrostatic Discharge Sensitive (ESDS) device, or when an ESDS device discharges to packaging materials or to a human body. Here an ESDS device is a power module.

People walking along a carpeted room or sitting in a car generate sufficient static electricity to experience a shocking electrostatic discharge when touching a door knob. When the human body feels a shock, the ESD potential is thousands of volts. The electronic components in a power module can be damaged by discharges of much lower voltage such that damage can occur even if an ESD shock is not felt.

Relative humidity variation has an important effect on susceptibility to ESD damage, with high humidity resulting in less susceptibility.

2. How to prevent ESD

ESD is avoided by preventing the buildup of static electricity. An ESDS and bodies within proximity of about one meter of the ESDS should be grounded so that electrostatic charge is bled off. If it is not possible for the ESDS and surrounding bodies to be grounded, then the ESDS should be shielded within conductive package, thus preventing the buildup of electrical charge around the ESDS, and any ESD is absorbed by the packaging.

3. Packaging precautions

To prevent ESD during shipment and storage, the power modules are placed in boxes with a layer of conductive foam in contact with the pins, in order to protect the power modules against ESD when it leaves the facility and when it arrives at the customer. The shipment procedure is:

- Power modules are placed in a box.
- A thin layer of conductive foam is placed on the power modules pins.
- A protection is placed just above the conductive foam to prevent an exterior shock on the pins during shipment. This protection prevents vibration between the package and the power modules, thus avoiding any possible buildup of static electricity and ESD damage.
- A label is placed on the box to inform that inside products are sensitive to ESD.

4. Precautions before opening boxes.

Before open the boxes, place the boxes on an ESD protected workstation. See below for a description of an ESD protective workstation and what employees must wear during handling the power module. Don't forget, unprotected employees may generate thousand of volts and can reduce the performance or destroy the power module.

4.1 ESD workstation

The figure below shows a typical ESD protective workstation. The work surface of the table and the floor area are covered by a static dissipative work surface. Moreover, all the static dissipative surfaces and the workstation must be connected to a common ground point. In addition, an employee's connection must be added and connected to the common ground point. This connection must be used to connect a wrist strap. The use of the static dissipative flooring is especially appropriate when the employee must move around. The static dissipative material for

flooring and table top dissipate static charge to ground thus preventing the accumulation of potentially damaging voltages.

This material has the following properties:

- Surface resistivity: 1×10^5 to 1×10^{12} ohms/sq
- Volume resistivity: 1×10^4 to 1×10^{11} ohm-cm

The electrons can flow across or through the dissipative material, but current is controlled by the surface or volume resistance of the material.

Note: Materials which are conductive (less than 1×10^5 ohms/sq, and 1×10^4 ohm-cm) are not recommended as a static table top because the low resistance increases the speed of discharge. A rapid discharge is more dangerous for the electronic components than a gradual discharge dissipating in the static dissipative material.

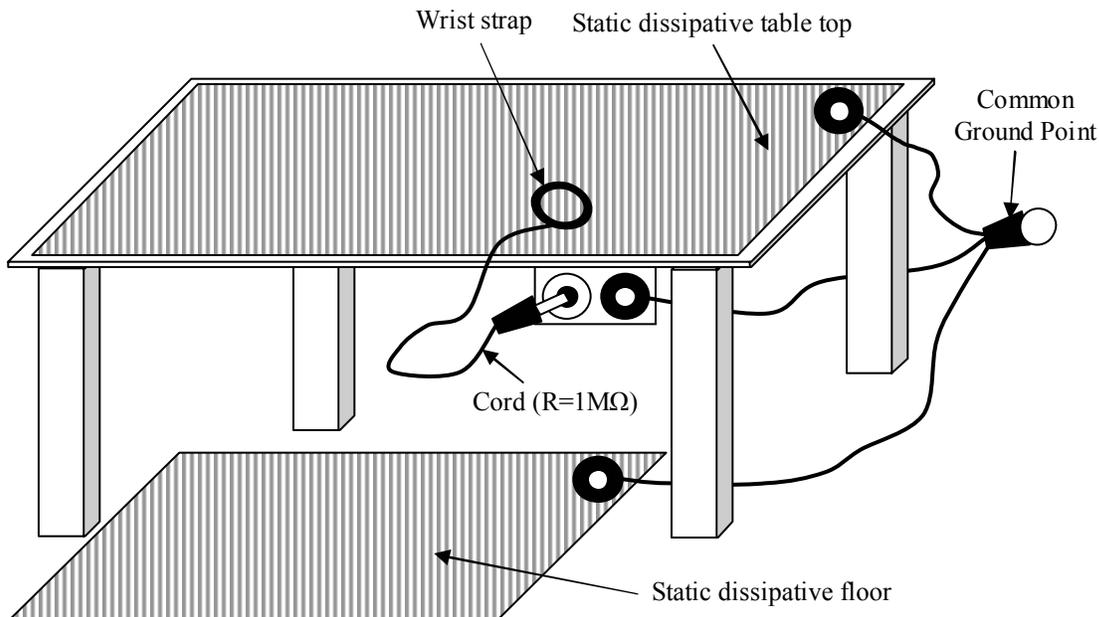


Figure 1: ESD workstation

4.2 Handling instructions

Before handling a power module employees must wear:

- *Wrist strap*

Each employee should have their own wrist strap. The wrist strap is the primary mean of controlling static charge on personnel. When the wrist strap is connected to ground, it keeps the employee near ground potential. Because the employee and other grounded objects in the workstation are at the same potential, there can be no hazardous discharge between them. Static charges are safely dissipated from the person to ground and do not accumulate.

The wrist strap must be worn against the skin. The employee must not be connected directly to the ground, but must be connected through a 1MΩ resistor. This is a safety requirement to prevent electrical shock if the employee comes into contact with high voltage while at the ESD workstation. Generally this resistor is integrated in the cord.

Each employee should test the wrist strap before use. (See a static control test station on figure 2).

Green light in this case indicates that the wrist strap is worn properly and is working as intended

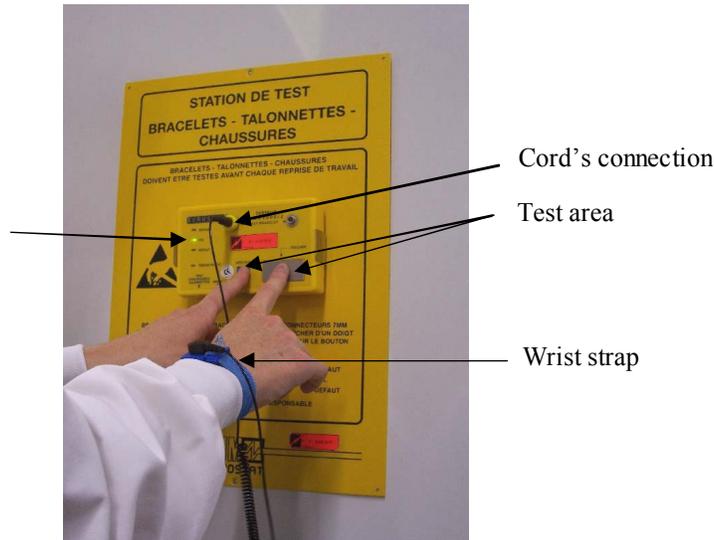


Figure 2: Static control test station

- *Clothing*

The employees must wear appropriate smocks (dissipative material) and the smocks must be closed.

- *Gloves*

Human hands contain oil and this oil can contaminate the contacts and can generate a dysfunction in the future on the assembly product. So it is preferable to handle a power

module with dissipative gloves and always take it by the sides and not by the connectors (see figure 3). See below an example of power module handling. Never pile up the power modules.

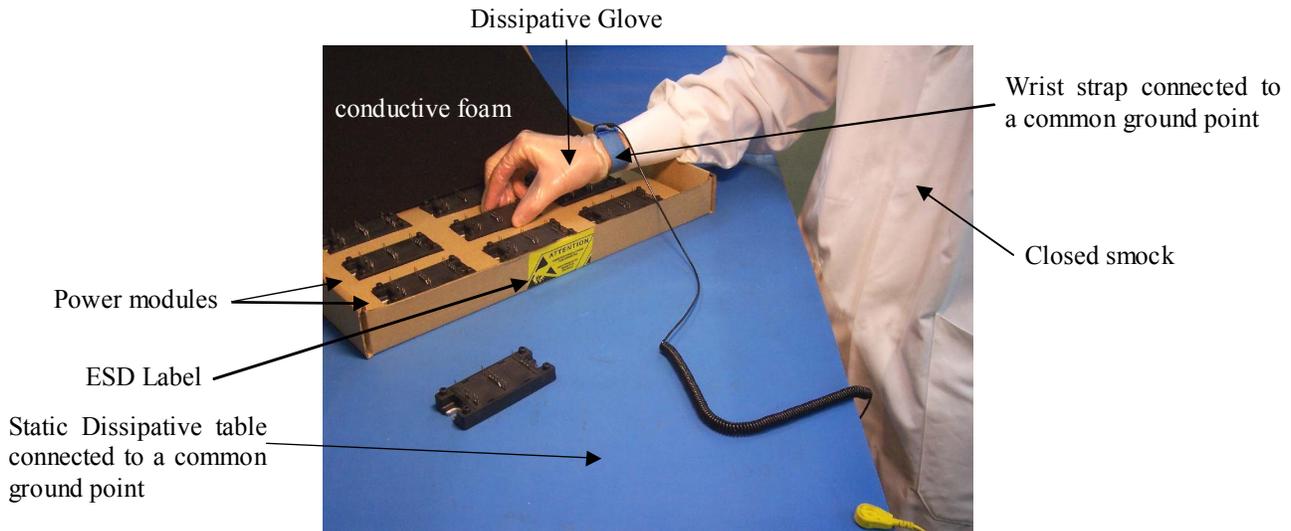


Figure 3: Power module handling

5. Humidity

Humidity is an important factor for the generation of static charges. A humid environment generates lower static charges than a dry environment which generates high static charges. But a too high humid environment is uncomfortable for human. Humidity between 40 and 60% is the best choice for an assembly area and for a storage area.

6. Different symbols in ESD environment

Different symbols are used in an ESD safe environment. See below more information on these symbols.

This symbol showing a slash across a hand in a triangle means electrostatic sensitive device. Handle with appropriate ESD protections.



When power modules are placed in the boxes for the shipment, this symbol with the mention “Electrostatic sensitive devices, observe precautions for handling” is labeled on the boxes.

This symbol shows a hand and a triangle, but protected by an arc means ESD protected. This symbol is applied on ESD safe chairs, mats, wrist strap, garments, automated handlers, etc.



This symbol indicates, as noted on it, an ESD common ground point. It accepts all ESD elements, like wrist strap, workstation dissipative mat, dissipative floor mat, etc.

These points are then connected to earth ground (see figure 1).



Conclusion:

This application note gives the main recommendations regarding the protection against Electrostatic Discharges. Applying these instructions will help avoiding the damages in the device and therefore will ensure long term operation of the system. All these instructions are essential to guarantee the best system reliability and achieve the highest possible MTBF (Mean Time Between Failure). Of course employees must keep the ESD protections as long as the power module is not totally assembled.

Resources:

<http://www.esda.org>