# ELECTRO-STATIC DISCHARGE

## Overview

This document discusses topics related to Electro-Static Discharge (ESD) in environments that incorporate the use of precision temperature forcing systems (PTFS). It provides a review of the hazards and sources of ESD. In addition, provides information that can be helpful for ensuring the safety of ESD-sensitive devices. In addition, it describes the methods of measuring ESD and introduces the T-ION system.

Further information is provided by inclusion of a study that clearly demonstrates the low levels of ESD found in Thermonics' PTFS and establishes the effectiveness of the T-ION system.

## What are the Hazards of ESD?

Static charges are found in all phases of semiconductor manufacturing and test environments. Static charges can result in problems such as particle contamination, ESD-generated device degradation, latchup of electronic equipment, or damage to sensitive devices--all adversely affecting production yields.

In environments where precision temperature forcing systems are used, a static charge can build up on improperly grounded or non-conductive surfaces of the DUT (device under test) load board, and non-conductive socket materials, leading to the damage of ESD sensitive devices (ESD event) either directly by conduction or indirectly through induction.

## What Causes ESD?

Triboelectric charging (friction) is the primary cause of the static. It occurs as a result of the high flow of cold air across the various surfaces in and around the test site. Because conductive surfaces can be grounded, ESD is primarily a concern for the non-conductive surfaces.

Air temperature as well as humidity are also important contributing factors. In particular, cold air because of its low humidity, can cause a charge to build up on non-conductive surfaces despite the fact that the PTFS has a grounded air stream. In addition, induction of charge on a non-conductive surface can be caused by a strong electric field.

**How Can I Prevent ESD?**

Some devices are quite resilient to the effects of ESD, while others are ESD-sensitive and require special handling, Often, the safety of these devices is simply a matter of following a few simple guidelines:

1. **Ground the Operator**

   To ensure the safety of the operator and to reduce the chances of providing a ground plane that might discharge the device under test too rapidly, make sure the operator is properly grounded. A ground strap that incorporates a 1M ohm resistor should be worn by anyone handling the DUT.

2. **Use Conductive Silicon Rubber Sheets and Thermal Caps**

   Replacing the silicon rubber sheets and thermal caps that are used in and around the thermal fixture with conductive ones can help shield against ESD. The sheets are constructed of silicon that contains a unique filler that performs four distinct functions: it acts as a conductive surface, shields interference from radio frequencies, eliminates strong electric fields, and protects against ESD. The pads and thermal caps are available from Thermonics. The part numbers are:

   - Conductive Silicon Rubber Sheets: T-SRSC
   - Conductive Thermal Caps: T-CAPC

3. **Use Air Ionization**

   Supplying ion balanced air to the device under test can greatly enhance the safety of the DUT. Two methods of air ionization are currently used for neutralizing static charges. These are electrical and radioactive ionization. Both methods function by dislodging electrons from the neutral air molecules. The particle that lost the electron becomes a positive ion. The loose electron is captured by a neutral air molecule and becomes a negative ion. The flood of particles provides an ion balance to the air stream.

   Thermonics provides an electrical ionization option, the T-ION that can be used in environments where the test device requires additional protection from ESD. No nuclear or radioactive materials are used.

   NOTE: Thermonics' ionization products are based on electrical ionization principals and do not use radioactive isotopes, such as polonium 210, to produce the ions. No NRC regulations must be met to use the system.

## Measuring ESD

Two types of measurement systems are commonly used to measure static. These are hand-held meters and charge plate devices. A hand-held meter measures the static charge on the surface of items and is not applicable to measuring the charge in an air stream. To obtain an accurate measure of the ±ions in an air stream a charge plate must be used.

### Setting up to use a Charge Plate

Prior to making measurements on the test set-up, make sure that the anti-static measures such as conductive rubber thermal caps and conductive silicon rubber sheeting are used to eliminate the causes of ESD.

## The T-ION Air Ionizer System

The optional **T-ION** air ionization system is available to control the build up of static charges within the thermal fixture to help prevent ESD damage to any sensitive devices that interface with the PTFS air stream. The system is an electrical ionization system and does not use radioactive isotopes.

### How the T-ION Functions

The ionization system operates by intensifying positive and negative electric fields around two bipolar pointed surfaces. When the fields overcome the dielectric strength of the air in the thermal fixture-*corona discharge* occurs. As a result of the discharge, large quantities of positive and negative ions spill into the air stream greatly increasing the conductivity of the air. As the ions flow into the air, they are attracted to particles with an opposite charge neutralizing any charged surfaces.

### Installation

The **T-ION** is available with PTFS products including the T-2420 and T-2500X. **The system is not field retrofitable and should be returned to factory for installation.** Contact the factory for availability.

# Electrostatic Field Measurements of Thermonics' T-2420 Temperature Forcing System at DUT Location.

**ABSTRACT:**

**The purpose of the experiments was to demonstrate the effectiveness of the ionizing system installed on T-2427 system. And, to make measurements of electrostatic charge build-up on and around the DUT, with and without the cold air flow. The findings were clear: very little, almost non-existent, static is produced by the PTFS; and the T-ION reduces the static even further.**

**EQUIPMENT USED:**

- THERMONICS T-2420 PTFS
- CHARGE PLATE
- ELECTROSTATIC FIELD METER

**EXERCISE A:**

This exercise was set up to establish a baseline from which the effectiveness of the T-ION could be evaluated. A calibrated charge plate was used in conjunction with a T-2427 system equipped with the ionizer assembly. The plate was charged up to a pre-set voltage and then ground connection removed. The operating parameters set for this experiment are typical for T-2420 system. They are listed as follows:

- Air flow rate: 510 SCFH
- Air temp: -55.0 $^{o}$ C
- Plate charge: +5000 VDC
- Air nozzle: 1.5" above the plate

**Average time to discharge from +5000 Vdc to +500 Vdc = 4.0 Sec.**
**Average time to discharge from -5000 Vdc to -500 Vdc = 3.5 Sec.**
**Average time to discharge from +1000 Vdc to +100 Vdc = 1.3 Sec.**
**Average time to discharge from -1000 Vdc to -100 Vdc = 1.4 Sec.**

**NOTE: In all cases above, the plate discharged to +/- 20 volts in less than 10 seconds.**

With the ionizer power supply off, the discharge takes place at a very slow rate; in some cases about 10 minutes from 5000 Vdc to 500 Vdc.

**EXERCISE (A) CONCLUSION :**

The test results clearly prove that the ionizer assembly drastically improves the system performance against any electrostatic charge build up.

**EXERCISE B:**
The following sets of tests were performed to measure the electrostatic charge build up on and around the Device Under Test (DUT).

Figure. 1 below shows the DUT pad with the test points and the distance from the DUT, where the field meter was positioned.

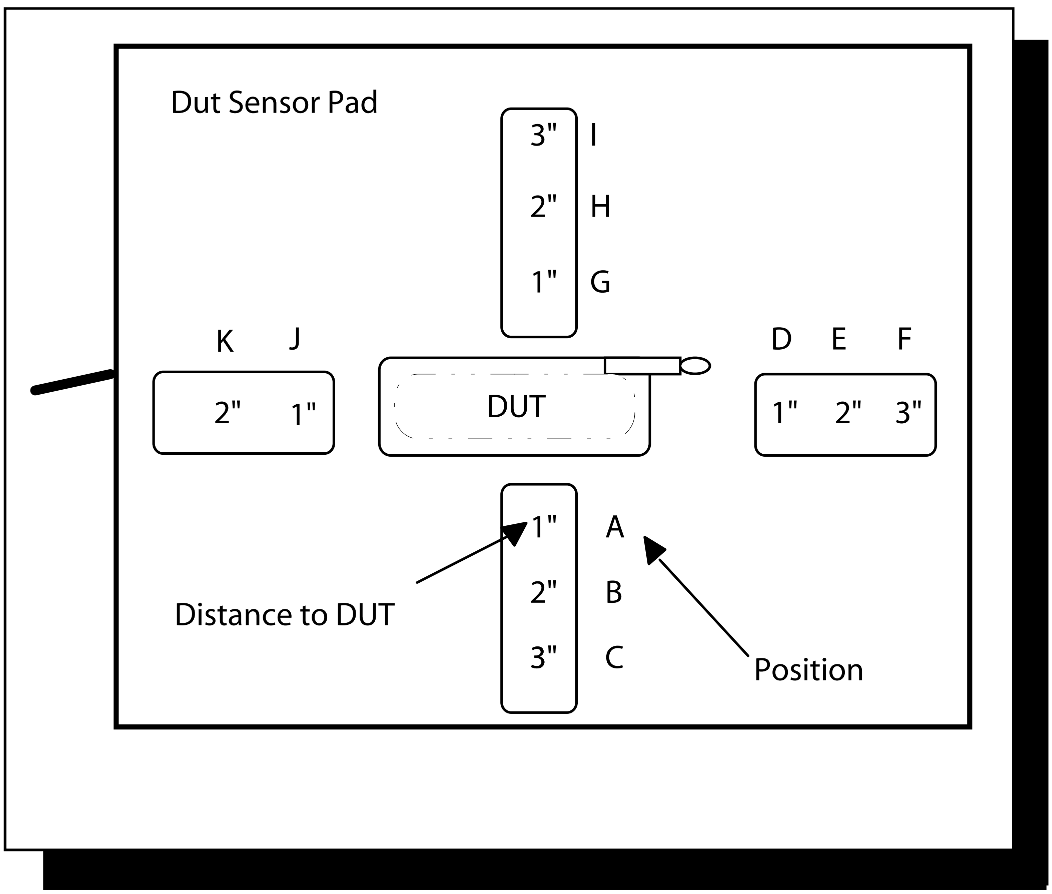
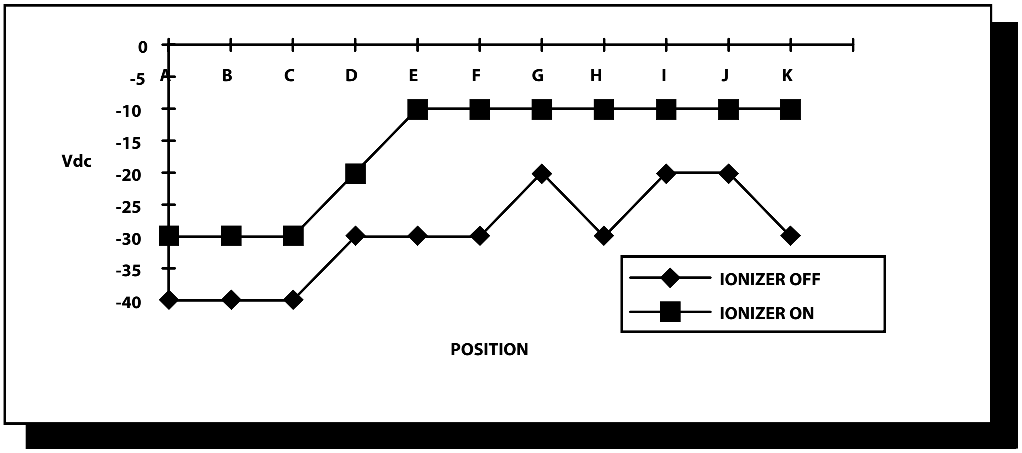



FIG. 1

**NOTE:**
In all cases, conductive rubber pads and rubber boots were used for this experiment.

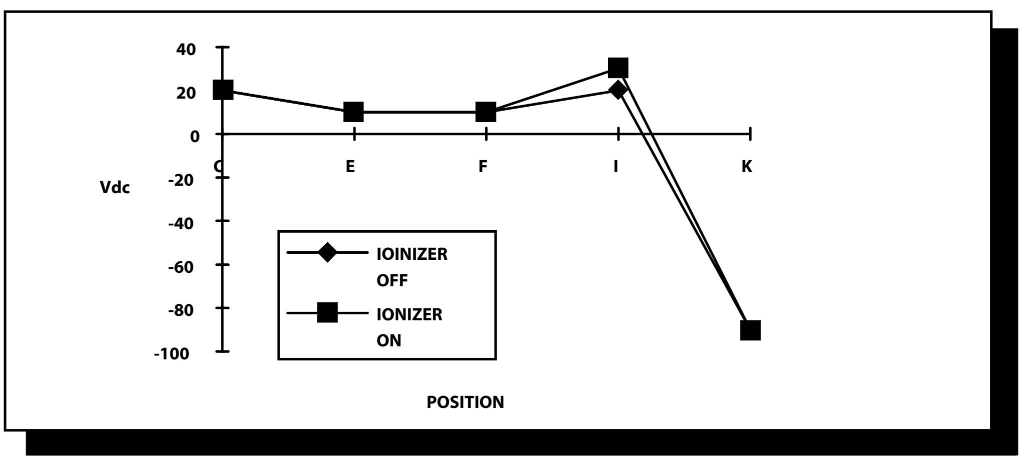
**CASE 1:**

Air Flow @ 0.00 SCFH
Test Head up
Field meter on the pad



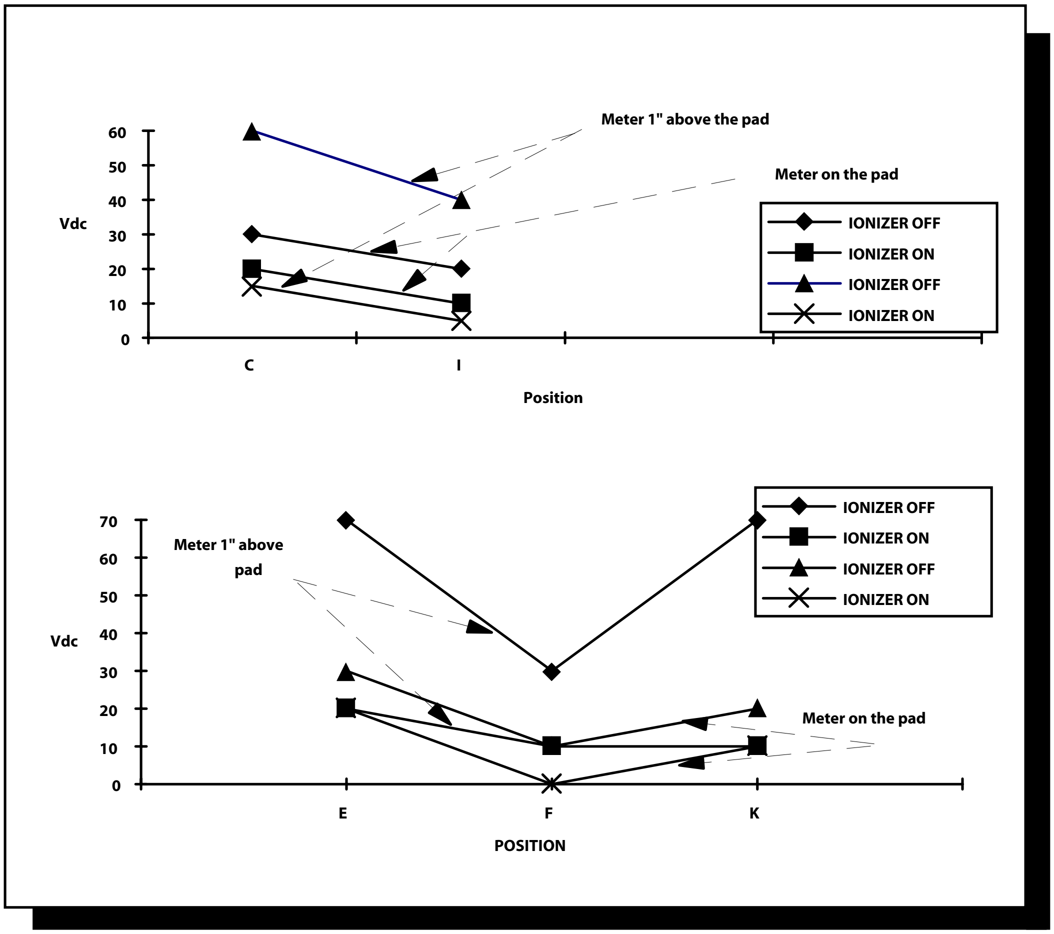

**CASE 2:**

Test Head Down
Air flow @ 0.00 SCFH

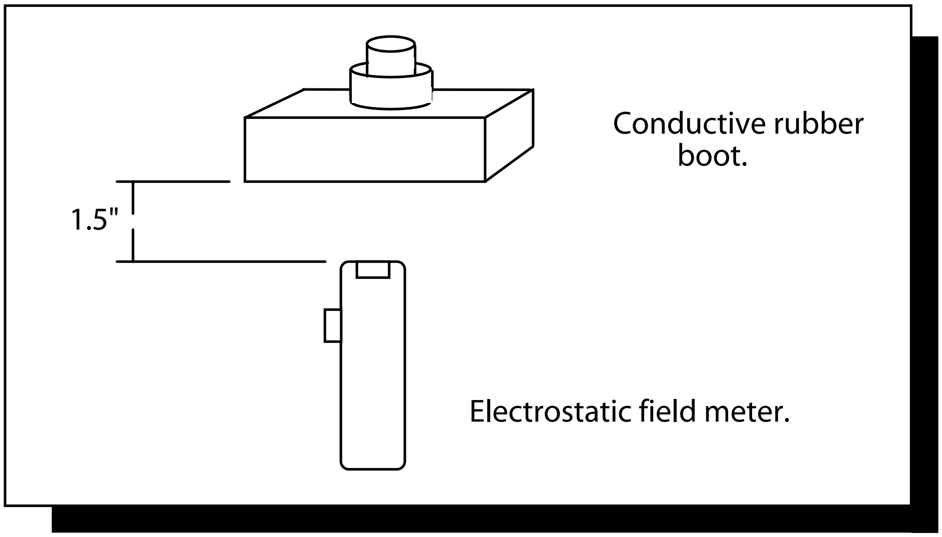


**CASE 3:**

Test Head Down
Cold air flow @ 500 SCFH



**CASE 4:**
As shown below, the field meter was held directly below the conductive rubber boot, covering the air nozzle. The field meter reading remained at zero (0.00 Vdc), detecting no electrostatic charge at no airflow.




**EXERCISE (B) CONCLUSION:**
It is clear from the data presented above that the amount of electrostatic charge build up in the test area is extremely small and almost non-existent. In addition, it demonstrates the effectiveness of the ionizing system in removing the minute amount of charge.