SIMCO ION
An ITW Company

APPLICATION NOTE

Charge Plate Monitor (CPM)

CPM Measurements

Purpose of CPM Measurements

The production of air ionization by any of the techniques currently in use today (corona, alpha, x-ray, etc.) can be affected by any number of variables, including the environment in which they are used. As a result, most end-users want to verify that the ionization is performing as desired and expected. One of the first standard test methods developed by the ESD Association to address this issue was ANSI/EOS/ESD S3.1. This document was first published in 1991 after several years of discussion regarding the design of the Charged Plate Monitor (CPM). Many meetings and experiments surrounded the design and application of this often used, and sometimes misused, instrument.

Model 280A Charged Plate Monitor

The decision to use a 6” x 6” (15 x 15 cm) square (with rounded corners) CPM was based upon several factors, but the most common reason now expressed is that this matched, relatively closely, the same area as the 6” silicon wafers being manufactured at the time. Over the last 25 years or so, this instrument has become the de-facto standard for measurement of ionizer performance, despite most ionization being used to control static charge on or near devices that look nothing like a 6” wafer.

One of the key technical factors, aside from the surface area that was designed into the CPM, is that the plate must have a 20 picoFarad capacitance. This affects how the plate measures ionization and reports the measurement in volts.

Two key measurements are made with the CPM, although the names of these tests vary between users.

Balance or Offset Measurement

This test is used to measure the deviation from zero (defined by electrical ground) to which the ionization charges the plate (in volts). Typically, one of the specifications of many ionizers is the maximum value of positive and negative voltage the CPM is allowed to see when it is placed into the ionized air stream. The variables affecting this measurement, as well as what this means to the end user's actual devices, will be discussed later.

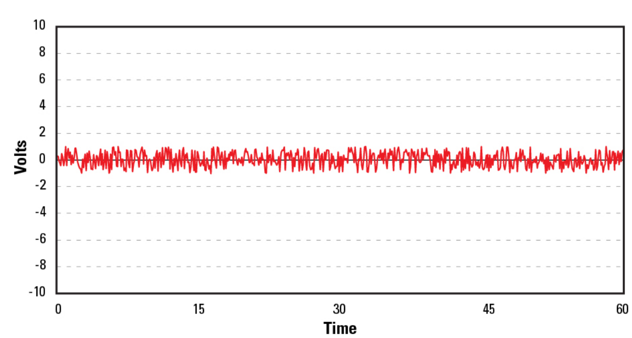

Figure 1. Balance or Offset Test

Discharge Time or Decay Time Measurement

This test is used to measure how quickly the ionization reduces a known voltage on the charged plate to a value closer to zero (typically 10% of the starting value). The first versions of ANSI/EOS/ESD S3.1 had several possible starting values, as high as ±5000V (which drove several design requirements, such as the rounded corners, to reduce the high voltage bleeding off). This was later reduced to a starting value of ±1000V.

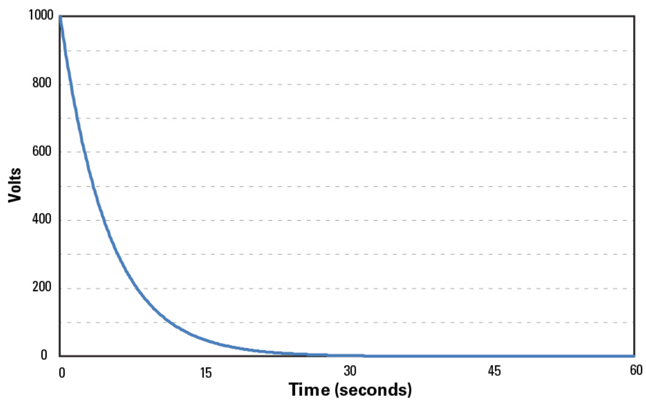

Figure 2. Decay Test

Physics of a Charged Plate Monitor Measurement

Examination of what is actually happening when a charged plate monitor is placed into an ionized airstream (or any other airflow) is important to understand what the CPM is, and is not, telling the user.

A key concept to understand is that the metal plate that is the collection electrode for the ions is an isolated plate that has a 20 pico-farad capacitance relative to the ground. The plate can carry a charge if it is not grounded, and this charge creates a voltage proportional to the charge and inversely proportional to the capacitance that is defined by the formula

$$V = \frac{Q}{C}$$

where V is the voltage on the plate, Q is the charge and C is the capacitance.

Effectively, what we are trying to measure is how much electrical *charge* is present on the plate. In the *offset/balance test* one is evaluating how many ions of each polarity are being measured by the metal plate. When more ions of one polarity than the other are being measured on the plate, the plate becomes charged, and a corresponding voltage defined by the equation above can be measured. In the ***discharge test***, one is measuring how fast the charge on the plate is reduced due to the ion current being collected by the plate. Because the concept and measurement of charge aren't as easy, nor is it as intuitive to most like the concept of voltage, the voltage on the plate is typically measured with either an electrostatic voltmeter or a voltage follower type of circuitry. This can potentially lead to issues with the voltage measurement because of small changes in the capacitance of the plate.

The assumption to all of these measurements is that the metal plate is sitting in free space, but of course, many times that is not possible or practical. When the capacitance of the plate changes due to parasitic capacitance (typically caused by objects too close to the plate or the configuration of the environment); the resulting voltage on the plate is affected.

Variables Affecting Balance

Given the brief discussion above describing some of the physics related to the measurement of ionization balance with a charged plate monitor, one can see there are many variables that can affect the measurement.

In looking at Figure 1, one can do a number of things with the data. Some users will focus on the average voltage, over time, of the measurements. Most charged plate monitors on the market look at the peak positive and negative values. So, anything that dampens the signal will affect the peaks. In some cases, the CPM electronics dampen the speed at which the data is reported. Physics dictates that the capacitance of the plate, as well as the size of the ion collecting surface, will also affect the peaks. The higher the capacitance, the slower the plate will react to ionization impacts. The larger the plate, the more "averaging" of the ion current will be done by the collection plate. The speed of the electrostatic voltmeter can also affect the peak values seen.

Variables Affecting Discharge Times

Discharge times are significantly more prone to measurement effects from instrumentation, environment, and other sources such as objects near the CPM.

As discussed earlier, the size of the electrode used to collect ions is one major factor that can affect the discharge time measurement. The ability of a metal electrode to measure ions from an airstream is proportional to the area of the plate exposed to the airflow. One can compare the areas of typical industry standard charged plate monitors and extrapolate the plate's ability to measure ions. Some manufacturers of CPM's that use a smaller plate will apply a correction factor to make the data match the standard 36 in^2 plate. However, the correction factor is calculated based only on physics, or as in a laboratory-type environment, and may not apply in all environments and under all ionization airstreams.

Plate Description	**Area** (in^2)
Standard 6" x 6"	36
Field Meter 2" x 2"	4
1" x 1"	1
Novx 1-3/4" dia.	2.4

In a decay test, a high voltage is applied to the plate at the beginning of the test. Part of the measurement is affected by the electric field created by the plate. The electric field produced from a metal object is directly proportional to the area and form factor of the metal object. For instance, sharp corners dramatically change the electric field and will affect the measurement by that plate

The environment also impacts all of these factors. Items near the plate, or anywhere near the ionized airstream which will also affect the measurements (see Figure 3).

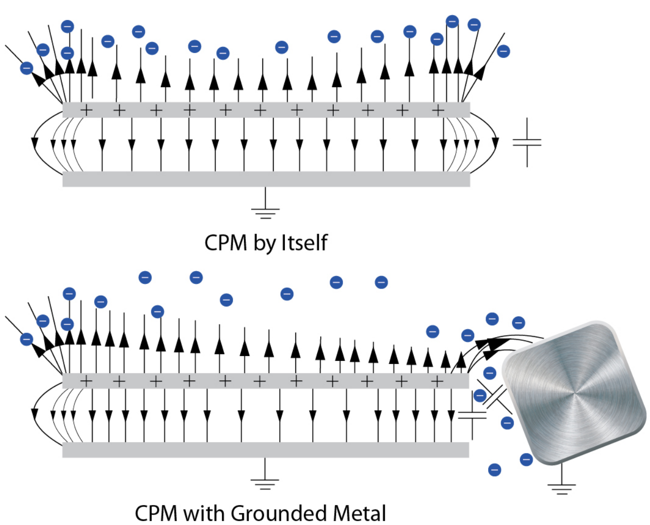

Figure 3. CPM Variables

Airflow has been another variable that has been highlighted as being a major factor, particularly in a non-blower type ionized environment. It should be noted that a larger ion collection plate would do a better job of averaging out these variables, whereas a smaller plate would tend to highlight the differences. For example, in a clean hood with a bar ionizer, a smaller monitoring plate will see differences under each ionizer point or in areas where non-laminar airflow exists, whereas a 6" x 6" plate will tend to average these values out.

The ESD Association wrote ANSI/ESD STM3.1 to lay out an equal playing field in order to qualify air ionization in a controlled environment.

It was quickly realized that although the test method provided an excellent baseline for qualification, it was not as useful in a production environment due to the need to use a large piece of instrumentation. It was also not ideal for ***compliance verification measurements*** (a 100% inspection of all ionizers in a facility to ensure they are still operating as they should after qualification and installation). For this reason, ESDA WG3 developed ANSI/ESD SP3.3, which defines how one should perform compliance verification of ionization systems. They then released ANSI/ESD SP3.4 titled "ESD Association Standard Practice for the Protection of Electrostatic Discharge Susceptible Items--Periodic Verification of Air Ionizer Performance Using a Small Test Fixture," which defines how a small test fixture can be used for compliance verification.

Both SP3.3 and 3.4 state that verification must be made with a non-standard test fixture to the standard 6" x 6" plate. It is also common practice (and is defined in TR53--the "Compliance Verification" document by ESDA) that if compliance verification indicates a problem with an ionization system, the issue should be evaluated using the standard test method--ANSI/ESD STM3.1 including the standard CPM. While not always easy to do, this troubleshooting step is important in order to sort out issues with the ionizer, equipment or environment.

SIMCO ION™
An ITW Company

Technology Group
1141 Harbor Bay Pkwy, Ste 201
Alameda, CA 94502
Tel: (800) 367-2452 (in USA)
Tel: (510) 217-0460
ioninfo@simco-ion.com
www.simco-ion.com

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