TECHNOLOGY SOLUTIONS

Achieving Full Static Discharge Performance with Synchronization

Greater Challenges in FPD Static Control

Because flat panel display (FPD) manufacturing is performed in a cleanroom environment, it faces the same problems resulting from static electricity buildup that other high technology manufacturing processes in cleanrooms do. Static charge developed throughout the manufacturing process causes dramatic increases in product contamination. Even worse, discharge on panel surfaces can result in damage to the delicate thin film transistor (TFT) and color filter structures, rendering the panels useless.

To combat static charge, FPD fabs employ air ionization to dissipate the surface charge on panels and the surrounding environment. This technique increases the electrical conductivity of the air and provides a path to ground for the surface charge. The most commonly used ion delivery modes in FPD ionization are bi-polar and pulsed DC. Both technologies are employed to minimize recombination of the two ion polarities. Due to the dynamics of ion travel in these delivery modes, discussed below, it is necessary to employ synchronization technology to achieve full electrostatic discharge control.

Ion Movement Considerations

Bi-polar mode functions by successively emitting positive ions and then negative ions from each emitter point. Pulsed DC is similar but employs separate emitter points for each polarity. By alternating and generating each ion polarity for the duration of the ion travel from the emitter to the product, recombination is drastically reduced and delivery efficiency is maximized. (The swing is roughly sinusoidal, so sine waves are used for simplicity in the figures below.) See Figure 1.

Ions move in laminar air flow but can be driven more strongly by electric fields. The resulting fields from the voltage required to operate corona ionizers are an important consideration when operating two or more ionizers in close proximity (<1m) to each other. If two ionizers near each other are out of phase (one with positive output and the other with negative output, both on simultaneously), the ions from each ionizer will travel toward the other ionizer rather than downward in the laminar air flow as they should.

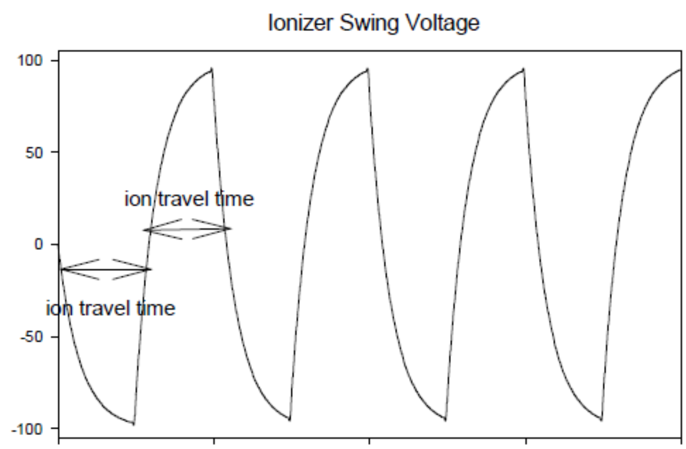

Figure 1. Ionizers Using Pulsed Technology

When this happens, the ions from each ionizer recombine, resulting in no static protection at the target. Unless there is some way to make the two ionizers work together in phase, there is no guarantee that the ionizers will protect the product.

In addition, the frequencies of two ionizers can be slightly different due to circuit variations, even if they start with ions in phase.

As figures 2 and 3 show, the waveforms from two ionizers continuously progress from in phase to out of phase and back again. Consequently, the sum of the waveforms first exhibit constructive addition of the two ionizers, but are then cancelled out due to recombination, providing no discharge protection. Figure 4 shows the sum of the two waveforms.

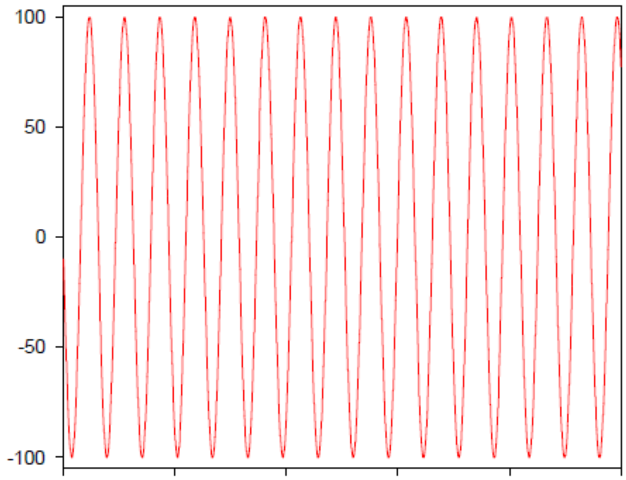

Figure 2. Swing From A Single Ionizer

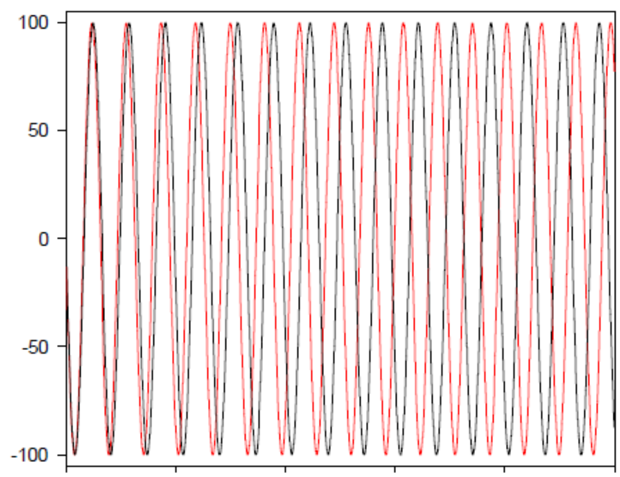

Figure 3. Swing From Each Of Two Ionizers

Synchronization for Efficiency

The net effect of two asynchronous ionizers is that excellent protection is provided part of the time, with no protection provided the rest of the time. As a result, the ionizers do not provide continuous protection of the products. A charge plate monitor (CPM) was placed under a pair of ionizers operating asynchronously. The resulting trace shown in Figure 5 clearly shows the same pattern as was predicted in Figure 4.

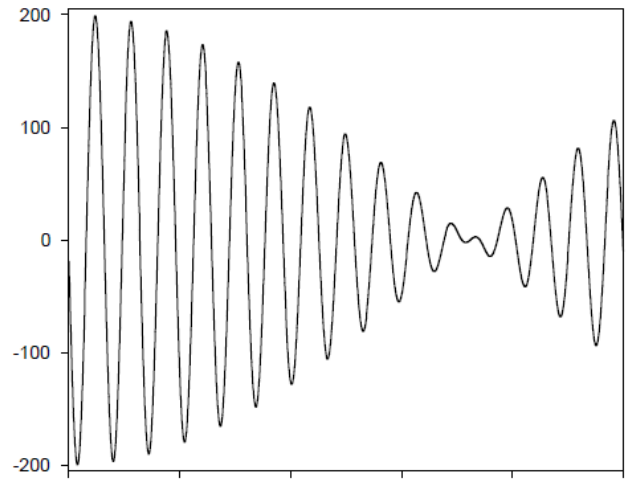

Figure 4. The Overall Performance Of Two Ionizers

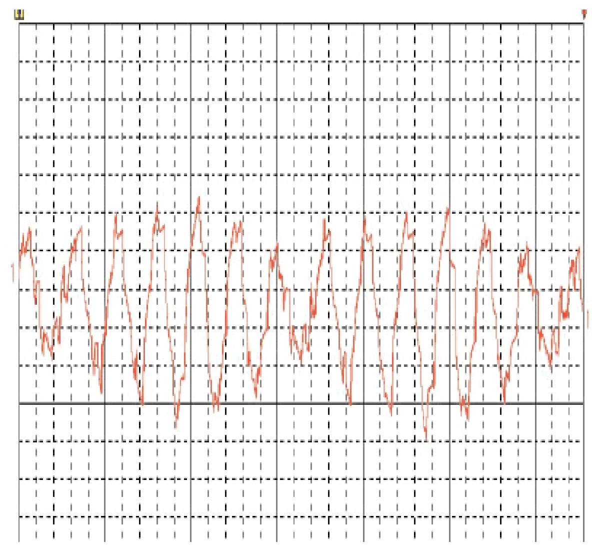

Figure 5. Swing Measurement Of Two Unsynchronized Ionizers With A Charge Plate Monitor

The solution to this dilemma is to ensure that the ionizers are synchronized with each other. This is accomplished by issuing a synchronization pulse to all ionizers within a single control system so that they are brought into phase with each other. If the ionizers have a synchronization feature, the performance of two ionizers together is assured of the time rather than part of the time. If this is the case, the amount of yield loss due to electrostatic discharge will be lower than if the ionizers are not synchronized.

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