

2020 EOS/ESD Symposium

Novel Design Steady-State DC Bar Ionizer Technology Introduction for ESD Sensitive Device Handling Manufacturing Environment

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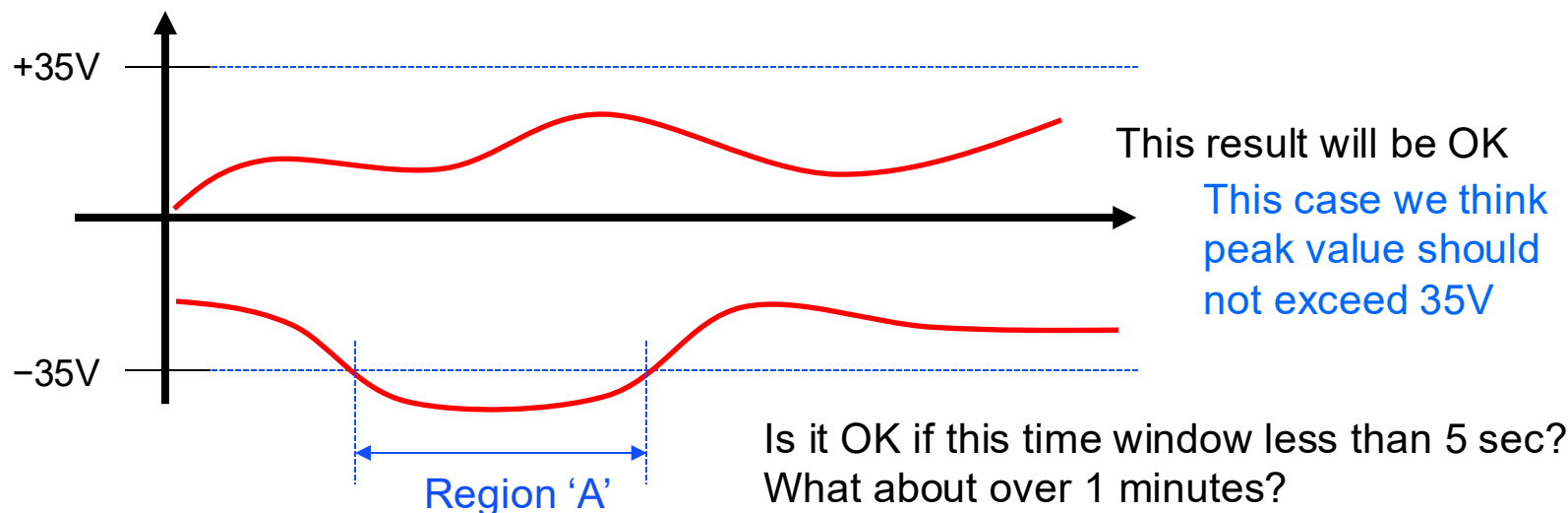


Outline

- Standard Review of Ionization Test Methods and Terminology
- Motivation of this new development
- CPM Measurements and Limitation
- ESD Risk Analysis of AC Type Ionizers
- Novel Design Steady-State DC Bar Ionizer Technology
- Conclusion

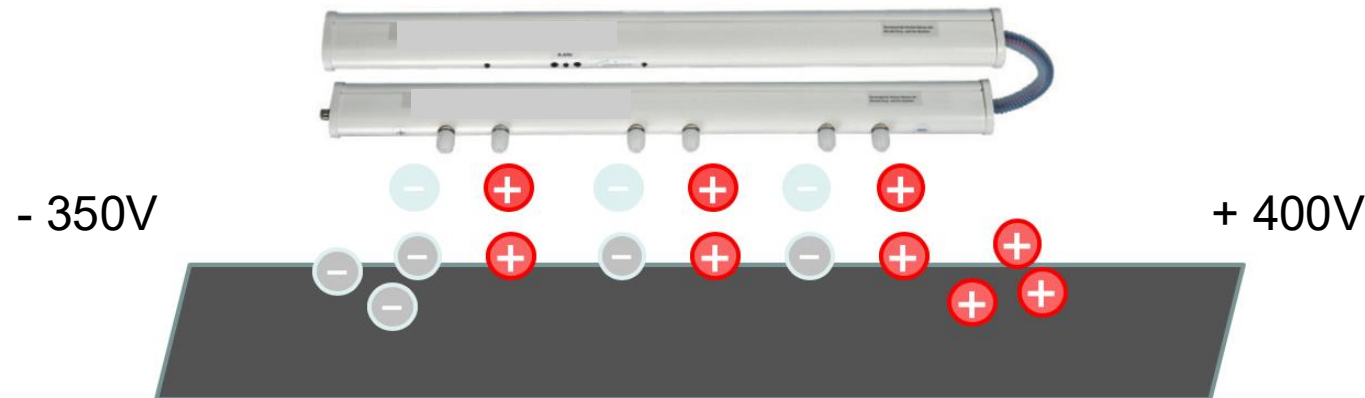
Standard Review of Ionization Test Methods

- ANSI/ESD **STM3.1** provides various type of ionizer testing set up and test locations. **SP3.5** provides test methods for soft X-ray, air assist bar, alternative room and alpha ionizers.
- ANSI/ESD **S20.20** requires two type of testing categories
 - Decay Time: **User Define** from $\pm 1000\text{ V}$ to $\pm 100\text{ V}$
 - Balance: Less then **$\pm 35\text{ V Offset}$**



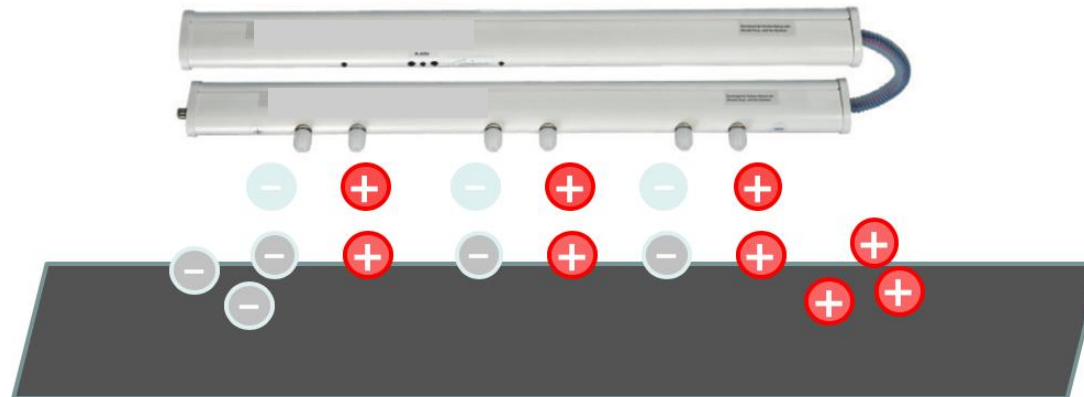
Bar Ionizer Construction - DC Technology

- Over a decade ago, designated output polarity type of DC bar ionizers used in many places in semiconductor manufacturing environment and other applications.
- Dual emitters are set and pairs to make ions in balance at center of them. Each side of measurements will read higher offset voltage than the center.



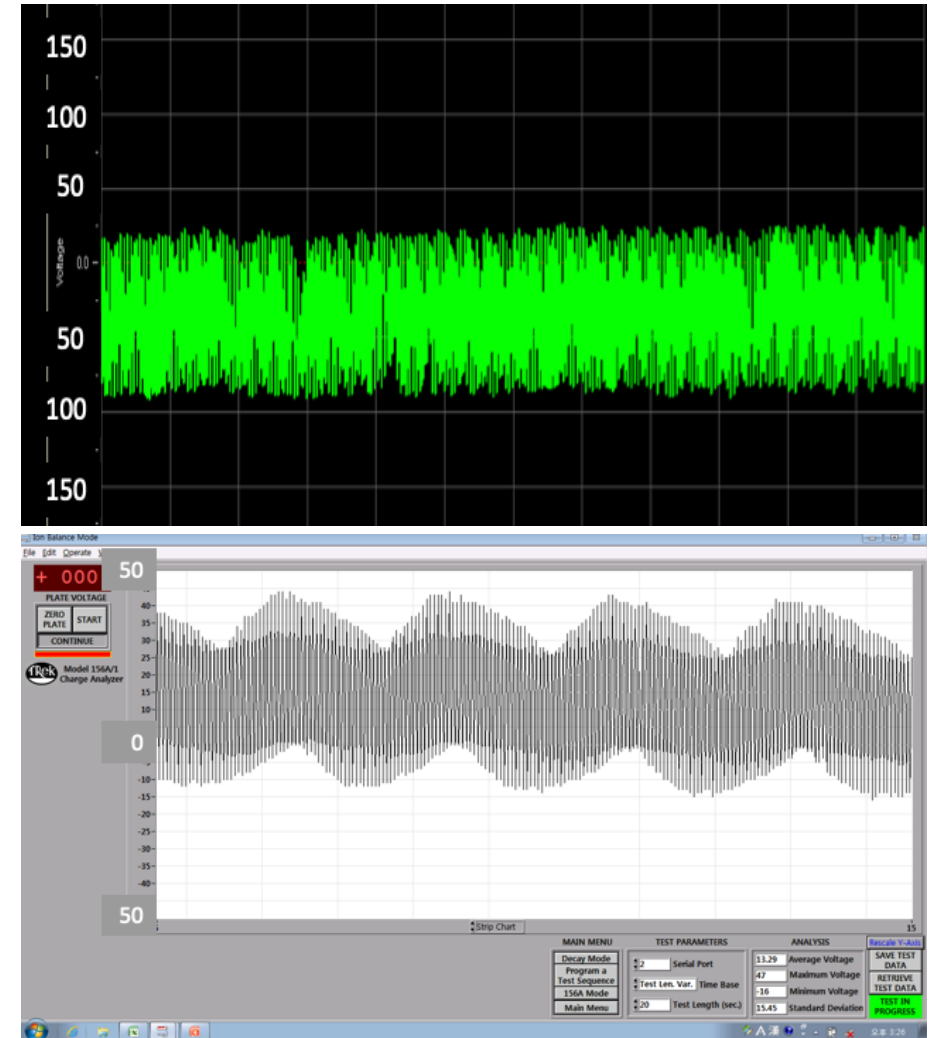
Bar Ionizer Construction - DC Technology

- As similar with wafer process, contamination is major issue in FPD industry and less ESD issues until panel technology changes for example COG, LPTS, oxide TFT or thin gate insulator
- A DC type of ionizer has been adopted in FPD processes and found **ESD damage occurs** by this ionizers due to polarization. Thus, AC switching high voltage type of ionizer developed and used in FPD environment for uniform ionization on display panel as alternative.



Motivation: Ionizer Balance Measurement

- Ionizer balance measurement has been conducted for **AC technology bar ionizers** and observed noise like signals and difficult to define balance value
- ANSI/ESD S20.20 is only the document specified value by STM3.1 and should take offset voltage
- Offset voltages for DC and AC are different peak value and S20.20 has intended for DC biased offset voltage level that equivalent energy for isolated conductor at $\pm 35V$.



CPM Measurements and Limitation

- Most of CPM operating speed is quite slow around 10Hz for full scale of 2000Vp-p value.
- Fast operation speed of CPM is 1kHz for small signal which is **20Vp-p only**.
- There are some type of switching high voltage ionizers within industry and their operating frequencies are **10Hz to 70kHz**

Model #	Speed of Response	Accuracy	Manufacturer
Model 300	6Hz	2%	Monroe
Model 288	1kHz 20Vp-p 10Hz 2000Vp-p	0.1% (-3dB)	Monroe
Model 156A/1	1kHz 20Vp-p 10Hz 2000Vp-p	0.1% (-3dB)	Trek
Model 157	80Hz	1% (-3dB)	Trek

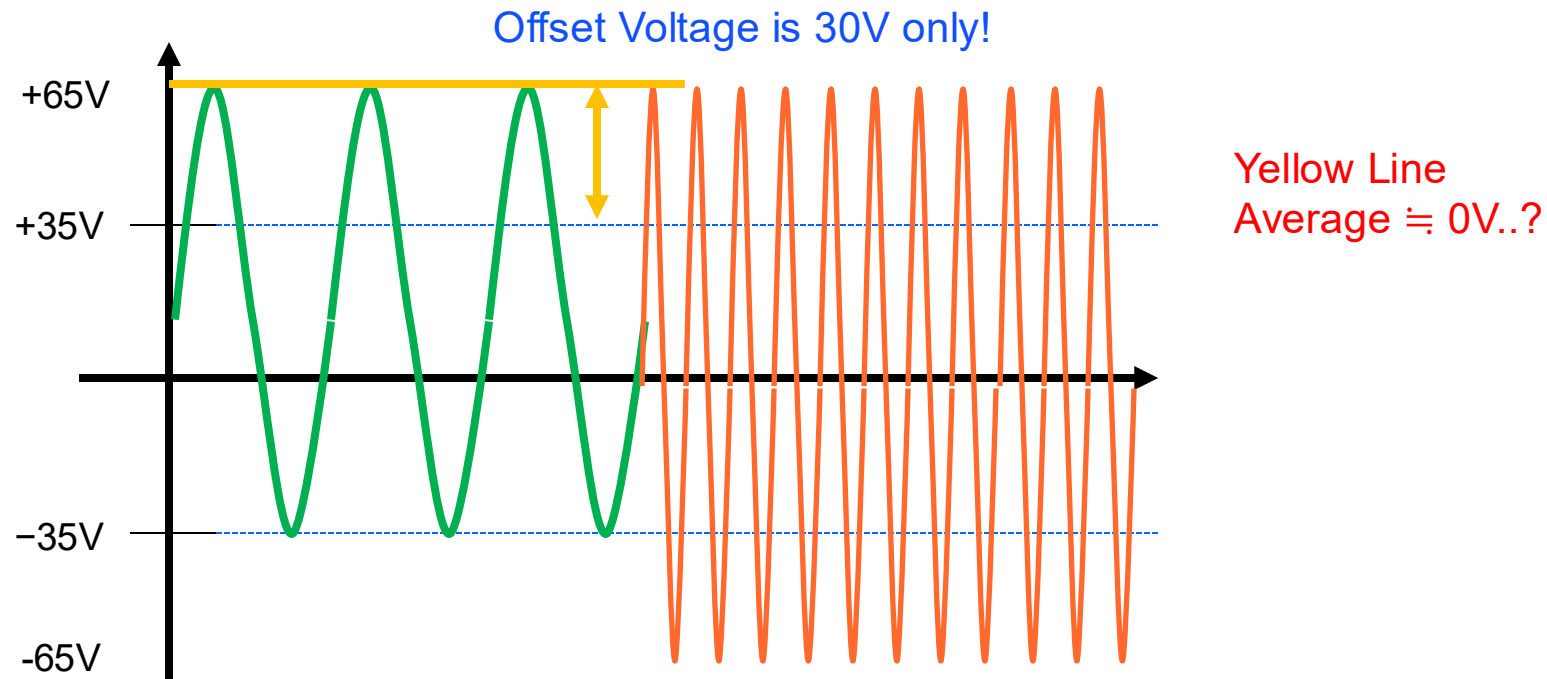
CPM Measurements and Limitation

- Analog (or even FPD) display windows of CPM or equivalent test equipment has limited to show accurate value for AC ionizers due to their number of data display capability (or reading by human eyes) and operation speed at 500ms.
- They may read offset value of AC signals and automatically minimize the risk of peak value of AC ionizers unintendedly.



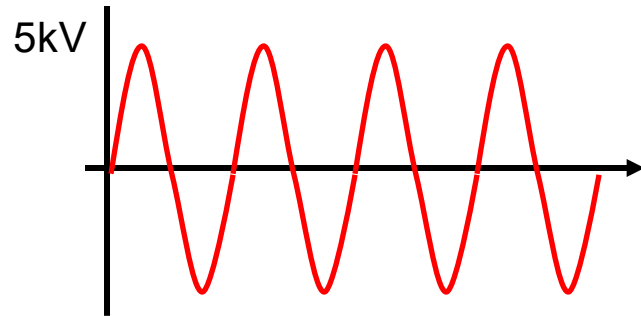
Standard Review of Ionization Test Methods

- Less than ± 35 V means that voltage should not exceed over this limit in Table 3 of ANSI/ESD S20.20
- What if this measured valued from AC signal such as switching high voltage AC ionizers?

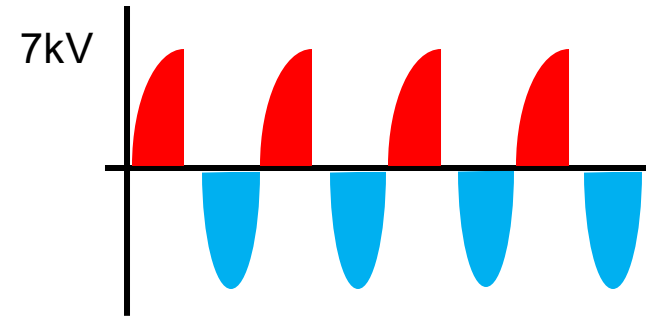


AC Switching High Voltage Type of Ionization

- Traditional AC Ionization vs. Pulsed AC Ionization



- Fixed Output Voltage
- 50/60Hz Frequency
- No Output Control for Ionizer Balance

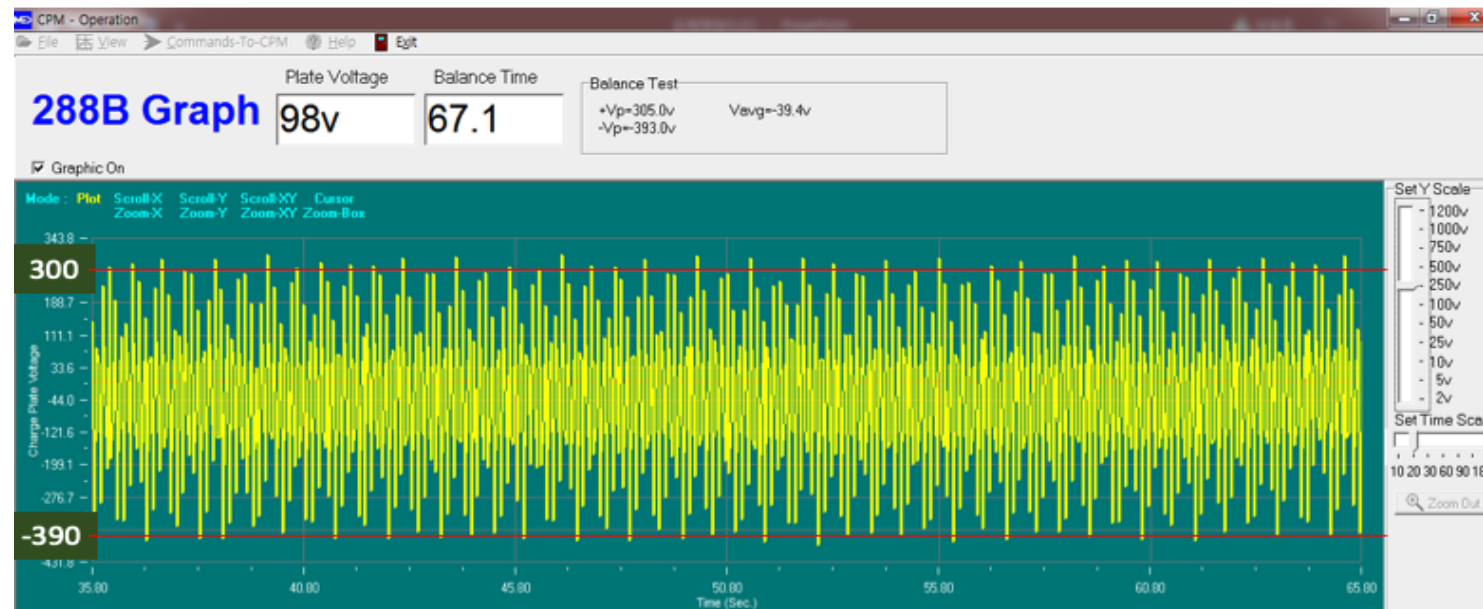


- Output Voltage Adjustable
- Frequency Control: 10 - 70 Hz
- Duty Ratio Adjustable for fine tuning
- Application Adjustable Output

Risk Analysis of AC Type Ionizers

Experiment 1: Ionizer Balance Measurement

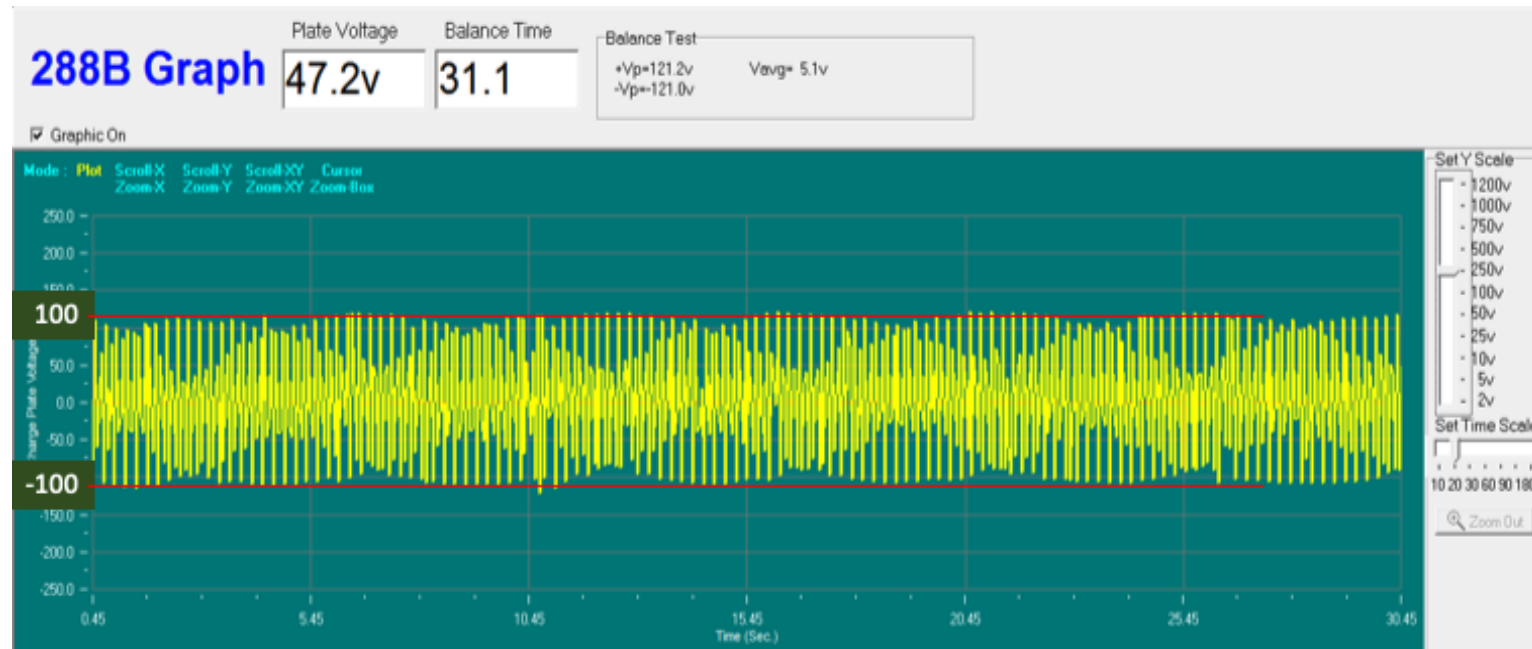
- Monroe's Model 288 CPM has taken that response speed up to 10 Hz for ± 1000 Vp-p and 1 kHz ± 20 Vp-p
- Ionizer Output: **12 Hz**, + 5.5 kV and - 4.8 kV as first test
- Test result shows the peak-to-peak value much greater than 6Hz CPM measurement result
- Max = **+305 V**, Min = **-393 V**, Ave = -39.4 V, **698Vp-p**



Risk Analysis of AC Type Ionizers

Experiment 1: Ionizer Balance Measurement

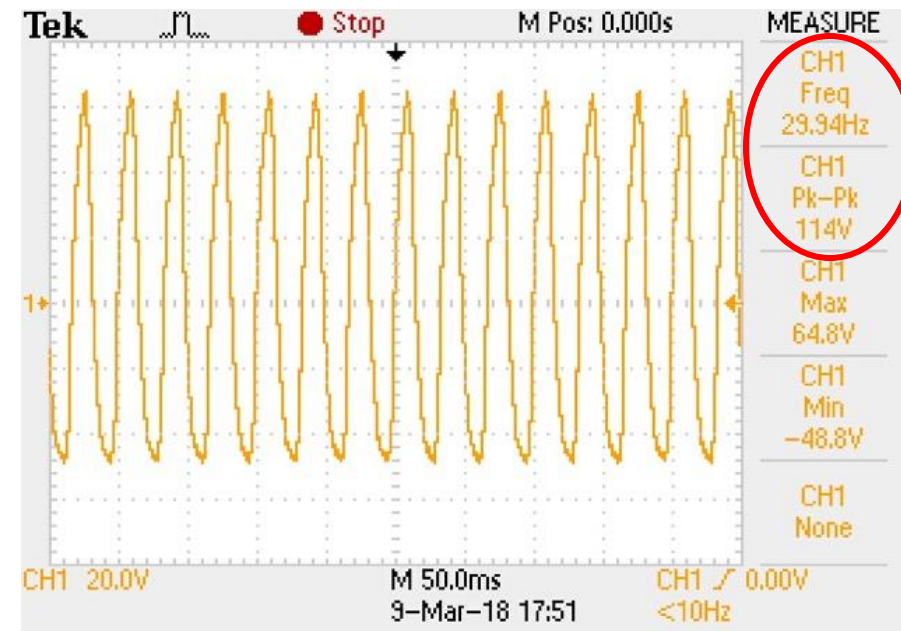
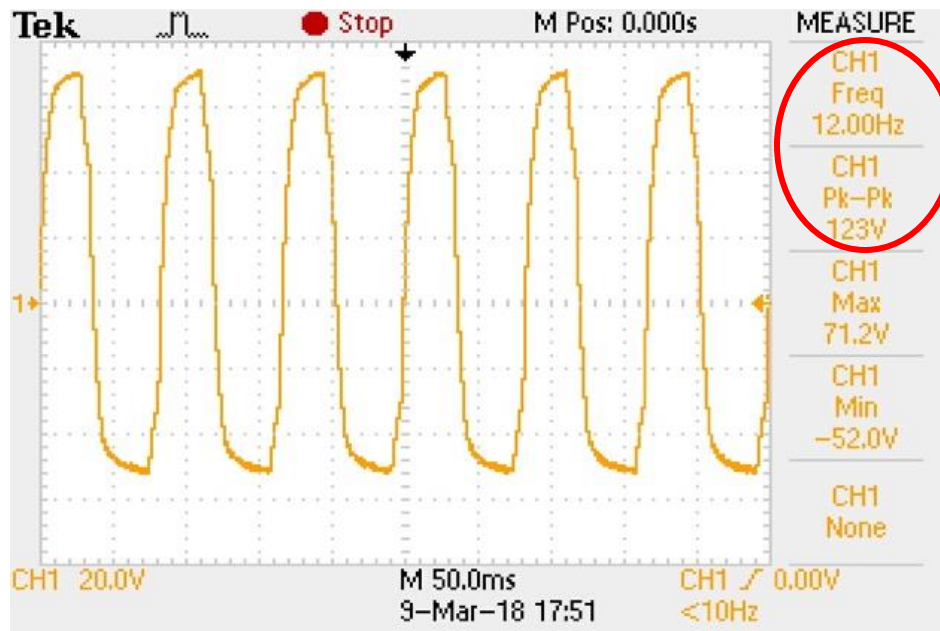
- Changed ionizer output frequency at 30Hz as second testing with same CPM instrument.
- CPM response speed: 10 Hz for ± 1000 Vp-p and 1 kHz ± 20 Vp-p
- Ionizer Output: **30 Hz**, + 5.5 kV and - 4.8 kV
- Test result shows the peak-to-peak value significantly reduced than 12 Hz
- Max = **+121 V**, Min = **-121 V**, Ave = 5.1 V, **242Vp-p**



Risk Analysis of AC Type Ionizers

Experiment 2: Actual Voltage Measurement

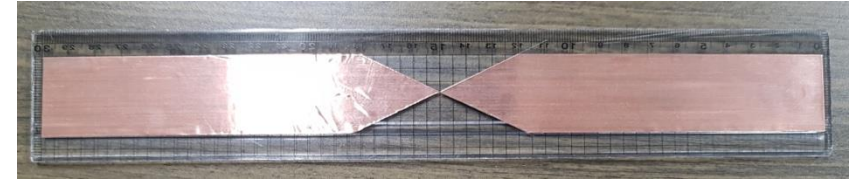
- So, it is important to make sure the real high voltage on emitter points and their voltage drop ratio based on frequency changes of ionizers
- Using Tektronix TDS2022C oscilloscope and P6015A high voltage divider, measurement results shows the output high voltage from ionizer slightly drops from **12.3 kVp-p** to **11.4 kVp-p** (7%) when switching frequencies from 12Hz to 30Hz.



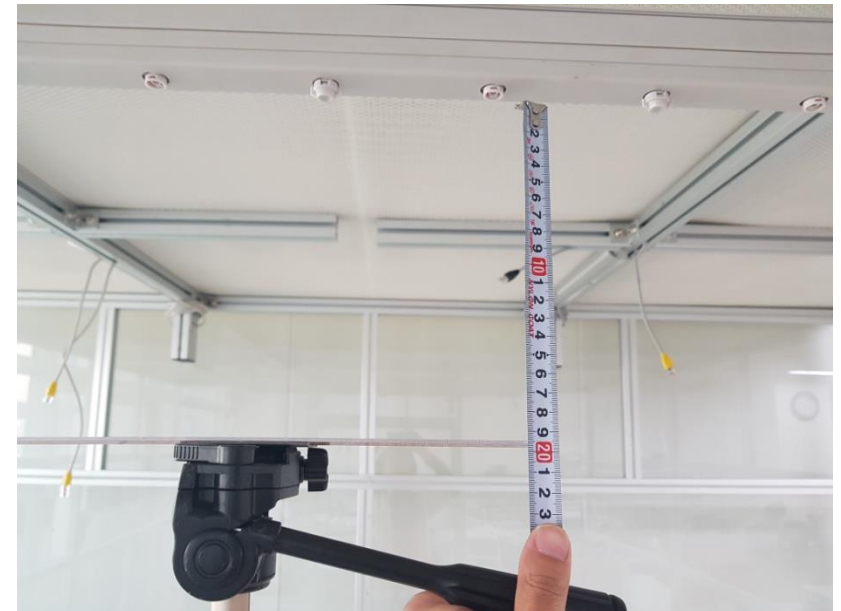
Risk Analysis of AC Type Ionizers

Experiment 3: ESD Event Measurement

- For risk analysis of AC ionizers for ESD sensitive devices, ESD event measurement experiment conducted with micro gap apparatus and 4" display panel at 200mm distance from ionizers.
- CT-1 probe and 2GHz RF antenna with TDS-3052B (500MHz) scope used for this experiments



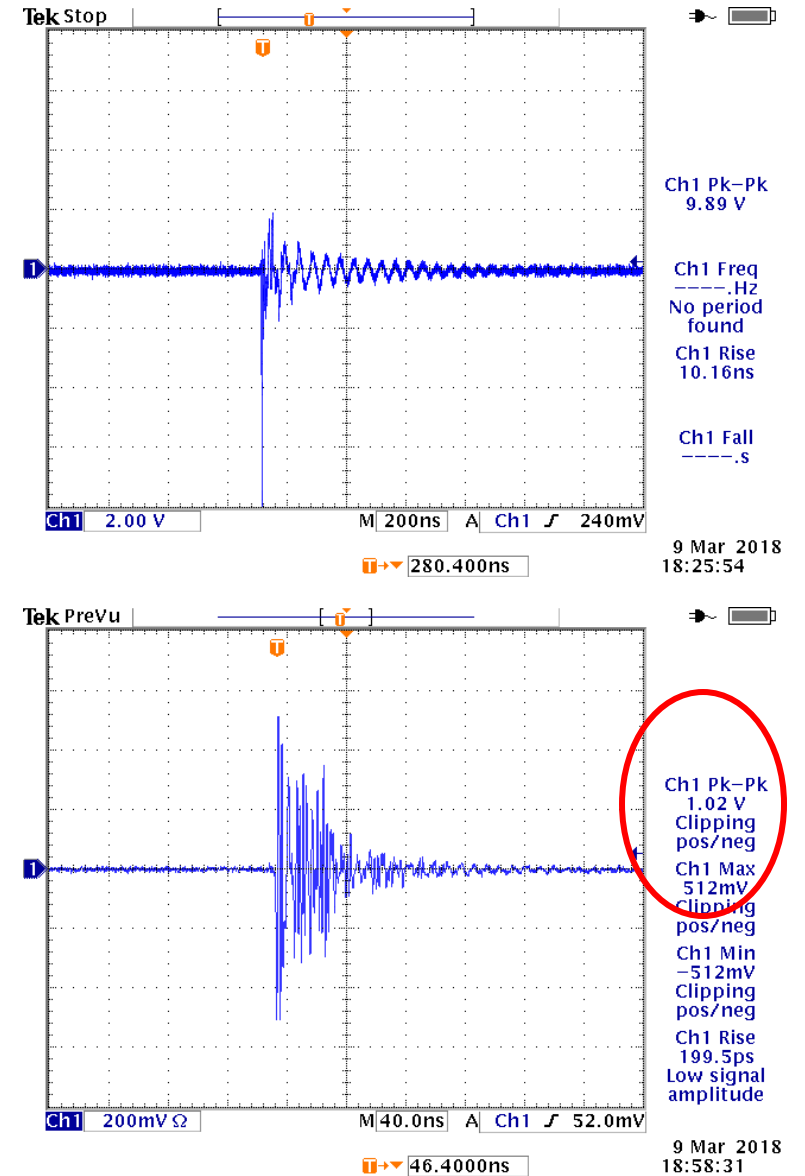
D.C. Smith, System Level ESD/EMI



Risk Analysis of AC Type Ionizers

Experiment 3: ESD Event Measurement

- Discharge current measured over 8A by CT-1 probe when one side grounded test apparatus and 4" display panel.
- RF signature captured both with grounded and floating test apparatus at 1-meter distance.
- This type of ESD event happen when test apparatus has ground through CT-1 probe and is repeatable



ESD Safe Ionization

- To minimize ESD risk for sensitive device handling, Steady-State DC ionizers are strongly recommended for most of ESD control program.
- If user must be use AC ionizers, it should be safe distance 300mm or further with fast enough performance at higher frequency such as 30Hz or beyond.



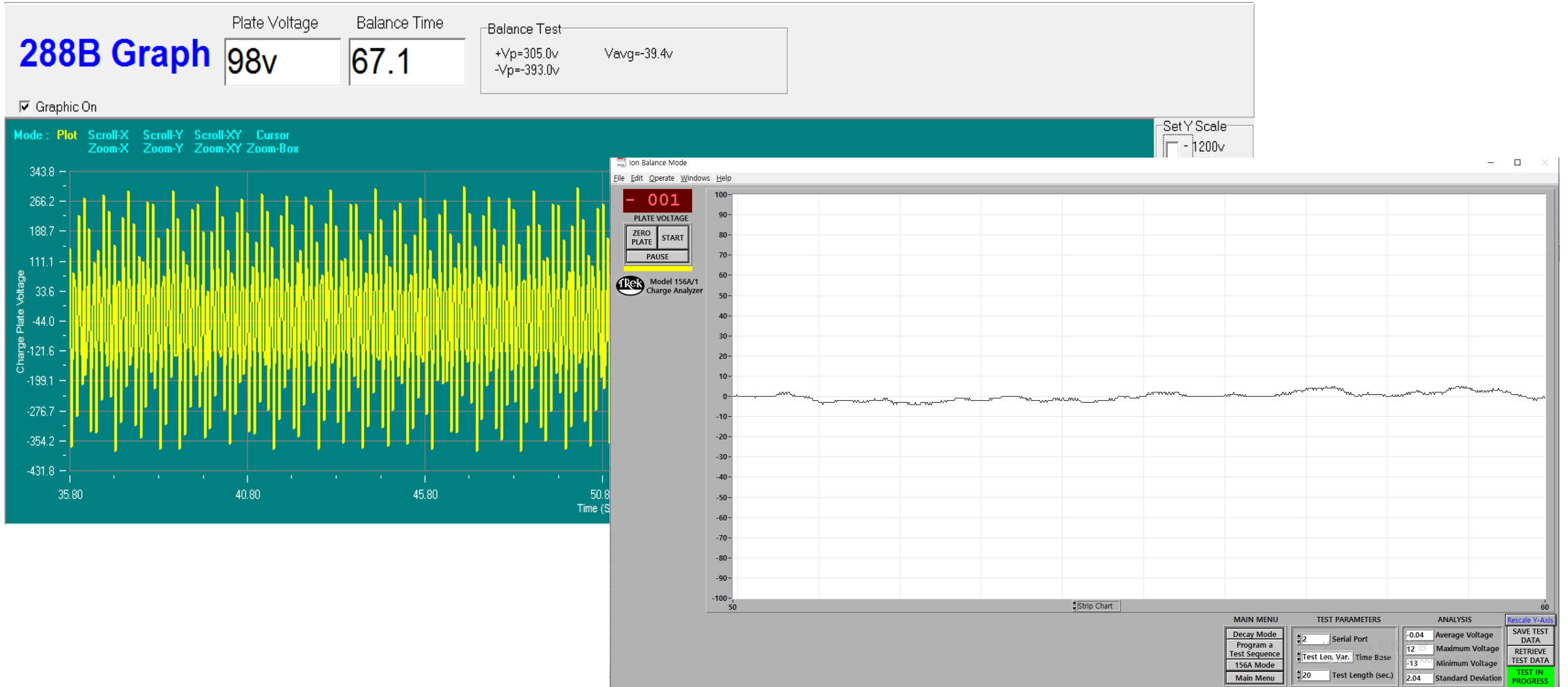
Novel Design Steady-State DC Bar Ionizer

- Bipolar Emitters on single nozzle
- Low Offset Voltage - each ends and middle
- Ion Balance Alarm
- Output Adjustable for Application
- LED Display
- Audio Alarm
- IR Remote Controller



- Same offset level at any direction
- **Patent Issued!**

Novel Design DC Bar Ionizer Test Results



Conclusion

- Current ionizer test methods and measurement technology are limited to accurate measurement for AC type of ionizer and minimize ESD risk in EPA
- Novel design Steady-State DC bar ionizer is the only one that maintain True Ion Balance less than $\pm 35V$ in any direction of approach and suitable for ANSI/ESD S20.20 based ESD control program in place.

Thank you very much!