

The top half of the cover features a circular graphic with a blue and white abstract pattern of overlapping lines and curves, resembling a stylized globe or a complex network. The word "TREK" is written in a bold, white, sans-serif font across the center of this graphic.

**TREK**

Products and Systems Catalog



WWW.TREKINC.COM

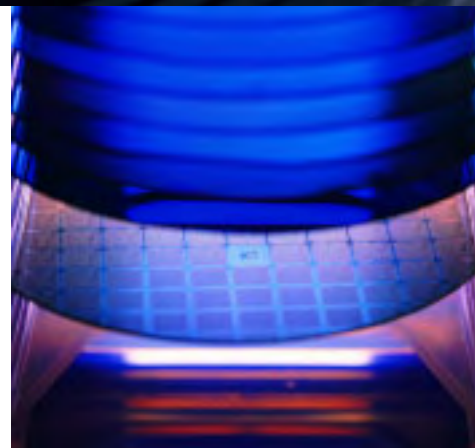
For nearly forty years, TREK, INC. has been providing innovative electrostatic measurement and high-voltage solutions to customers worldwide. Trek's superior engineering design capability allows us to provide high quality, cost-effective products and services to meet market needs and customer-specific applications.

Our proprietary technology and technical expertise, coupled with our long-term relationships, sets us apart from our competitors and has made us the leader in the markets we serve. Trek's commitment to develop new technologies will enable us to continue to provide current and future customers with innovative solutions.



Louise Cadwalader

President



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## ELECTROPHOTOGRAPHY

Electrophotography is utilized in laser printers, copiers, fax machines and many other printing devices. Our close association with, and commitment to, the electrophotography industry continues with innovative designs for voltmeters, charger-roller power supplies, and low cost, high performance OEM sensors. These products are used in many elements of the electrostatic image-forming process. Trek electrostatic voltmeters (stand-alone or on-board) are used in electrophotographic R&D, manufacturing, and quality control, and frequently provide feedback for on-line process adjustment. Trek also supplies products for precise toner charge-to-mass ratio measurements.

## ELECTROSTATIC DISCHARGE (ESD)

Static electricity presents a problem that can impact product quality, throughput and worker safety in many industries. In electronics and media, Electrostatic Discharge (ESD) affects semiconductor manufacturing, electronics assembly, flat panel display & hard disk drive production, and film processing. In industrial, food, telecom, textile, packaging, chemical, medical and pharmaceutical manufacturing, static electricity creates problems with cling and particulates such as in the processing of paper, fabrics, plastics, powders and other materials. Trek can assist you by providing effective and efficient solutions in many areas including ionizer evaluation, auditing and monitoring; electrostatic charge detection and measurement; resistance and resistivity measurement; and charge decay monitoring. Trek also offers ESD seminars and surveys.

## SEMICONDUCTOR EQUIPMENT

Trek's high-voltage amplifiers are used for ion and electron beam deflection/steering during semiconductor wafer processing; Trek's technology enables precise control of the charged beam particle strike position on semiconductor devices. Trek amplifiers are also used in coulombic and Johnsen-Rahbeck wafer clamping; these electrostatic chucks are used to clamp semiconductor wafers or flat panel displays during device processing and handling operations. Other semiconductor applications for Trek's products include corona charging supplies, work function measurements, wafer/thin film potential measurements and ion source power supplies.

## RESEARCH & DEVELOPMENT

Trek's products are utilized in research for smart materials, piezoelectrics, plasma chemistry, materials poling, displays, electrostatics, mass spectrometry and more. Check the Trek website for a more complete listing. We work with a variety of corporate and academic research groups; let us help you with your R&D application.

## OTHER APPLICATIONS

Power Amplification and Metrology are a few examples. Trek can also provide custom solutions for applications needing more than an off-the-shelf product. Our decades of experience and technical expertise can assist you in the design and development stages as well as in production. Consider Trek a member of your team; we work with organizations around the world, providing technical advice and solutions.



**AMPLIFIER SELECTION TABLE**

Amplifier Model*	Output Voltage (DC or peak AC unless otherwise noted)	Output Current (DC or peak AC unless otherwise noted)	Slew Rate (greater than)
PZD50	0 to $\pm 50$ V or 0 to +100 V or 0 to -100 V	$\pm 6$ A rms, $\pm 8.5$ A peak AC, $\pm 1.5$ A DC	20 V/ $\mu$ s
603	0 to $\pm 125$ V or 0 to +250 V or 0 to -250 V	$\pm 40$ mA DC, $\pm 80$ mA peak AC	100 V/ $\mu$ s
PZD350	0 to $\pm 350$ V (bipolar), 0 to +700 V or 0 to -700 V (unipolar)	0 to $\pm 200$ mA (bipolar) 0 to $\pm 100$ mA (unipolar)	500 V/ $\mu$ s (bipolar) 350 V/ $\mu$ s (unipolar)
PZD350 M/S		0 to $\pm 400$ mA (bipolar) 0 to $\pm 200$ mA (unipolar)	
601C	0 to $\pm 500$ V, 0 to +1 kV, 0 to -1 kV	$\pm 10$ mA DC, $\pm 20$ mA peak AC	50 V/ $\mu$ s
PZD700	0 to $\pm 700$ V (bipolar) or 0 to +1.4 kV or 0 to -1.4 kV (unipolar)	0 to $\pm 100$ mA (bipolar) 0 to $\pm 50$ mA (unipolar)	150 V/ $\mu$ s (bipolar) 100 V/ $\mu$ s (unipolar)
PZD700 M/S		0 to $\pm 200$ mA (bipolar) 0 to $\pm 100$ mA (unipolar)	
PZD2000A	0 to $\pm 2$ kV	$\pm 200$ mA DC, $\pm 400$ mA peak AC	750 V/ $\mu$ s
677B	0 to $\pm 2$ kV	0 to $\pm 5$ mA	15 V/ $\mu$ s
623B	0 to $\pm 2$ kV	0 to $\pm 40$ mA	300 V/ $\mu$ s
609E-6	0 to $\pm 4$ kV	0 to $\pm 20$ mA	150 V/ $\mu$ s
609E-6-FG	0 to $\pm 4$ kV	0 to $\pm 20$ mA	150 V/ $\mu$ s
615A-1 & 615-3	0 to 10 kV peak-to-peak AC 0 to $\pm 5$ kV DC Bias	0 to 10 mA p-p or 5 mA (Resistive or Average AC current control)	80 V/ $\mu$ s
PM04015A	0 to 20 kV peak-to-peak	$\pm 10$ mA DC, $\pm 35$ mA peak AC	500 V/ $\mu$ s
5/80	0 to $\pm 5$ kV	0 to $\pm 80$ mA	1000 V/ $\mu$ s
PD05034	0 to $\pm 7.5$ kV	0 to $\pm 50$ mA DC, 160 mA peak AC	1000 V/ $\mu$ s
609B-3	0 to $\pm 10$ kV	0 to $\pm 2$ mA	30 V/ $\mu$ s
10/10B	0 to $\pm 10$ kV	0 to $\pm 10$ mA	250 V/ $\mu$ s
10/10B-FG	0 to $\pm 10$ kV	0 to $\pm 10$ mA	250 V/ $\mu$ s
610E	0 to $\pm 10$ kV or 0 to $\pm 1$ kV	0 to $\pm 200$ $\mu$ A or 0 to $\pm 2000$ $\mu$ A	20 V/ $\mu$ s
10/40A	0 to $\pm 10$ kV	0 to $\pm 40$ mA	700 V/ $\mu$ s
20/20D	0 to $\pm 20$ kV	0 to $\pm 20$ mA	350 V/ $\mu$ s
30/20A	0 to $\pm 30$ kV	0 to $\pm 20$ mA	500 V/ $\mu$ s
621P	0 to +30 kV	0 to $\pm 20$ mA	350 V/ $\mu$ s
621N	0 to -30 kV	0 to $\pm 20$ mA	350 V/ $\mu$ s
605A	0 to $\pm 1$ kV	0 to $\pm 1$ mA	
668B	0 to $\pm 3$ kV	0 to $\pm 5$ mA	

**Most models have all of the following controls and adjustments:  
Remote High-Voltage ON/OFF Control, Dynamic Adjustments  
for Waveforms, Current Limit/Trip Options, Output Voltage and  
Current Monitors**

Large Signal Bandwidth 1% Distortion (DC to greater than)	Small Signal Bandwidth -3dB (DC to greater than)	Special Features	Applications (see product pages for more)	Page
30 kHz	30 kHz	Inverting, noninverting and differential input configurations	Drive large capacitance loads, piezoelectric driver	8
150 kHz (5% distortion)	150 kHz (5% distortion)	Dual channel units available	Piezoelectric driver, MEMs	8
40 kHz (bipolar) 14 kHz (unipolar)	100 kHz	Dual channel units available	Semiconductor research, piezoelectric driver	9
		High current	Ion beam control, piezoelectric driver	9
8 kHz	30 kHz	Dual channel units available, low noise	Modulating electrooptics, piezoelectric driver	9
15 kHz (bipolar) 12 kHz (unipolar)	50 kHz	Dual channel units available	Piezoelectric driver	10
20 kHz (bipolar) 12 kHz (unipolar)	100 kHz	High current	Semiconductor research, piezoelectric driver	10
60 kHz (3% distortion)	100 kHz	High current	Dielectric material characterization	10
1.2 kHz	5 kHz	Amplifier & power supply, digital display	Precise voltage control	11
10 kHz	40 kHz	Inverting, noninverting and differential input configurations	Electrophoresis research	11
6 kHz	35 kHz	Inverting, noninverting and differential input configurations	AC and DC biasing, electrorheological fluids	12
6 kHz	35 kHz	Amplifier & waveform generator	AC and DC biasing	12
3 kHz	10 kHz	Amplifier, DC supply & waveform generator	R&D, electrophotography, charger roller supply	13
7.5 kHz (2% distortion)	20 kHz	Amplifier, DC supply & waveform generator	R&D, electrophotography	13
50 kHz (3% distortion)	75 kHz	Precise high-voltage control with high current	Polymer & ceramic charging, plasma chemistry	14
15 kHz (3% distortion)	75 kHz	Precise high-voltage control with high current	Polymer & ceramic charging, plasma chemistry	14
400 Hz	10 kHz	Inverting, noninverting and differential input configurations, low noise	Ferroelectric characterization	16
4 kHz	20 kHz	Precise high-voltage control	Electrostatic deflection, electroactive polymers	15
4 kHz	20 kHz	Amplifier & waveform generator	R&D, electrophotography	15
600 Hz	10 kHz	Amplifier, DC supply & transconductance controller	R&D, electrophotography	16
7.5 kHz	25 kHz	Precise high-voltage control with high current	Electrostatic deflection	17
3.75 kHz	20 kHz	Precise high-voltage control	Dielectric studies, electrostatic deflection	17
2.5 kHz (2% distortion)	20 kHz	Precise high-voltage control	Electrostatic deflection	18
3.5 kHz	25 kHz	Positive unipolar voltage control	Electrostatic deflection	18
3.5 kHz	25 kHz	Negative unipolar voltage control	Poling of materials	18
Adjustable in 1 volt increments by a precision dial or fixed at either +1 kV or -1 kV. Output accuracy better than 0.1% of full scale.		DC reference supply	DC reference supply	19
Adjustable and programmable in 1 kV, 100 V, 10 V, 0.1 V steps. Output accuracy better than 0.015% of full scale.		Precision DC reference supply	DC reference/power supply	19

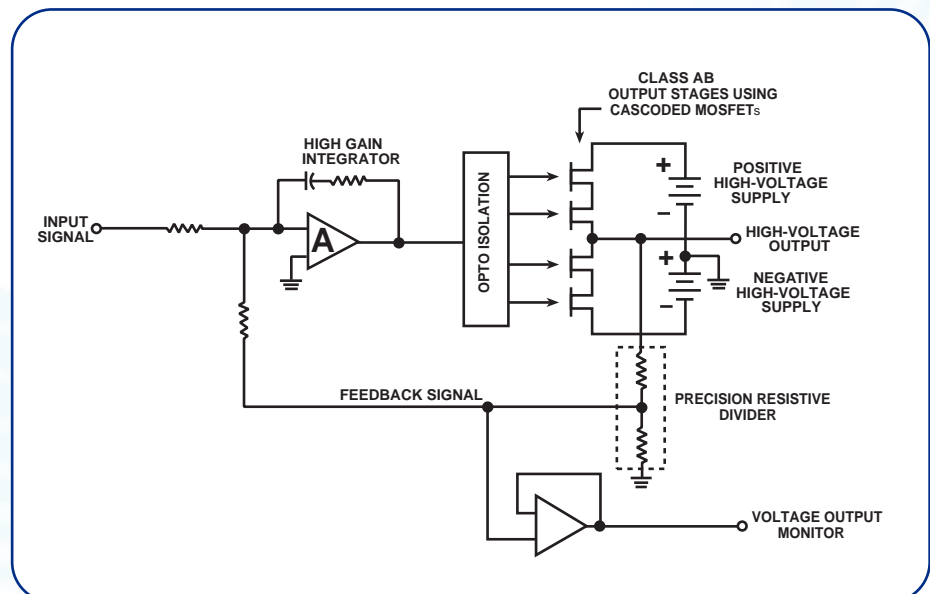
Trek high-voltage power amplifiers employ unique and proprietary circuitry to produce a closed-loop amplifier system which features exceptional DC stability and excellent wideband performance characteristics.

Featuring all-solid-state construction, Trek amplifiers are fully protected against arc-over and operation into short circuits. Please refer to the simplified block diagram. Trek power amplifiers employ a unique four-quadrant class AB high-voltage output stage which is constructed using MOS power transistor devices in a proprietary multidevice cascode connection. This cascode connection provides tight voltage and power sharing across all devices in the cascode array to yield exceptional MTBF reliability performance.

As the stability of the closed-loop amplifier system is dependent upon the feedback voltage divider stability over time, temperature, and humidity, Trek employs an advanced thin film resistance technology in its feedback dividers. The signal from the feedback divider, being a precision divided representation of the amplifier output signal, is used to provide a low-level voltage monitor signal and to complete the feedback loop by comparing the divider output against the amplifier input signal in a high-gain integrating stage (A). The output of the integrating stage is used to drive optical couplers connected to the output stage cascode connected MOS device arrays, thus closing the feedback loop. To generate the high voltage required by the output stages, high-voltage, high-frequency switching type power supplies are typically used.

## Typical capabilities of Trek's DC high-voltage power amplifiers include:

- Voltage ranges to 80 kV peak-to-peak
- Current ranges to 8 A peak
- Small signal bandwidth to 150 kHz
- Slew rates to 1000 V/ $\mu$ s
- Gain stability to  $\pm 10$  ppm/ $^{\circ}$ C
- Full 4-quadrant, class AB, all-solid-state output stages
- Short circuit protection
- Noise less than 0.005% of full scale
- All-solid-state for high reliability, low maintenance
- Transconductance mode to precisely control output current



# DRIVING CAPACITIVE LOADS WITH TREK AMPLIFIERS

In applications which involve driving capacitive loads, the useful bandwidth of the amplifier is often limited by the peak output current capability of the amplifier rather than the amplifier's AC gain bandwidth characteristics.

Engineers at Trek have designed many amplifiers with various voltage and current levels which can be used to drive capacitive loads. The table on page 4-5 lists many of the Trek amplifiers with their voltage and current ranges. To determine which Trek model amplifier is most suitable for your application:

- Substitute the peak-to-peak voltage ( $V_{\text{peak-to-peak}}$ ) in Volts that will be applied to your load into the appropriate equation for driving capacitive loads with sine, triangle or square waves (see below).
- Use the table on page 4-5 to make an initial selection of a Trek amplifier with the appropriate voltage characteristics. Substitute the internal capacitance value in Farads of the selected Trek amplifier\* into the appropriate variable ( $C_{\text{int}}$ ) of the equation.
- Substitute the capacitive value in Farads of your load ( $C_{\text{load}}$ ) into the equation.
- Substitute the desired frequency (f) in Hertz or square wave slope (dV/dt) of the output waveform into the equation.
- Solve for the peak current ( $I_{\text{peak}}$ ) in Amps needed from the amplifier.

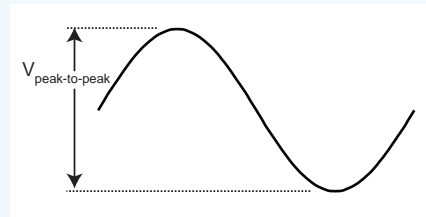
*Note: If the calculated peak current is equal to or less than the peak current range of the amplifier, the Trek amplifier will not be bandwidth limited due to output current limitations. For example, if the calculated peak current is equal to or less than 20 mA, the Model 20/20D will not be bandwidth limited due to output current limitations.*

Please refer to the following diagrams and formulas for assistance, or contact Trek for technical guidance.

## Driving Capacitive Loads with Sine Waves

$$I_{\text{peak}} = (C_{\text{load}} + C_{\text{int}}) \cdot \pi \cdot f \cdot V_{\text{peak-to-peak}}$$

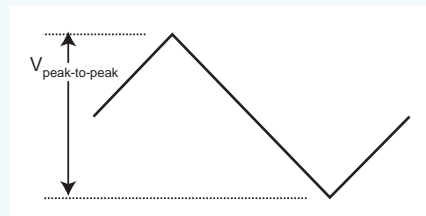
where:  $I_{\text{peak}}$  = the peak current needed from the amplifier  
 $C_{\text{load}}$  = the load capacitance (including cable capacitance)  
 $C_{\text{int}}$  = the internal output capacitance of the amplifier\*  
 $f$  = the output frequency  
 $V_{\text{peak-to-peak}}$  = the peak-to-peak voltage applied to the capacitive load



## Driving Capacitive Loads with Triangle Waves

$$I_{\text{peak}} = (C_{\text{load}} + C_{\text{int}}) \cdot 2 \cdot f \cdot V_{\text{peak-to-peak}}$$

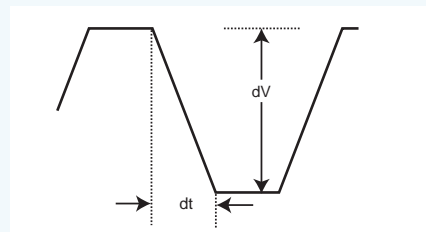
where:  $I_{\text{peak}}$  = the peak current needed from the amplifier  
 $C_{\text{load}}$  = the load capacitance (including cable capacitance)  
 $C_{\text{int}}$  = the internal output capacitance of the amplifier\*  
 $f$  = the output frequency  
 $V_{\text{peak-to-peak}}$  = the peak-to-peak voltage applied to the capacitive load



## Driving Capacitive Loads with Square Waves

$$I_{\text{peak}} = (C_{\text{load}} + C_{\text{int}}) \cdot dV/dt$$

where:  $I_{\text{peak}}$  = the peak current needed from the amplifier  
 $C_{\text{load}}$  = the load capacitance (including cable capacitance)  
 $C_{\text{int}}$  = the internal output capacitance of the amplifier\*  
 $dV$  = the peak value of the square wave  
 $dt$  = the rise time required  
 $dV/dt$  = the slope of the rise/fall time



\*Trek amplifiers represent a broad range of internal capacitance values as demonstrated by a sampling of Trek's models at right. Please contact Trek for the internal capacitance value of an amplifier that interests you, if it is not listed here.

Trek Model	$C_{\text{int}}$
10/10B	$40 \times 10^{-12}$
30/20A	$50 \times 10^{-12}$
20/20D	$60 \times 10^{-12}$
5/80	$70 \times 10^{-12}$
601C	$400 \times 10^{-12}$



## Model PZD50 High Power Amplifier System

Model PZD50 Amplifier (shown) and Power Supply Assemblies (not shown) comprise a high current, high power amplifier system to drive large capacitive loads such as piezoelectric actuators

- Able to Drive High Capacitance Loads
- High Current Range
- Differential Input Capability

Output Voltage Range(s) Factory Configured  
 0 to  $\pm 50$  V DC or peak AC  
 0 to +100 V DC or peak AC  
 0 to -100 V DC or peak AC  
 (other configurations available)

Output Current Range  $\pm 6$  A rms,  $\pm 8.5$  A peak,  $\pm 1.5$  A DC  
 Bandwidth DC to greater than 30 kHz (-3dB)



## Model 603 High-Voltage Power Amplifier

Applications include Driving piezoelectric actuators, Modulating electrooptics, Electrostatic control of ion beams and Electrostatic deflection

- Single or dual channel units
- Customer specified voltage output ranges
- Customer specified gain ratios (50 V/V or 25 V/V)
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Voltage and Current Monitors

Available Output Voltage Ranges  
 Output Voltage Range 0 to  $\pm 125$  V DC or peak AC  
 Output Voltage Range 0 to +250 kV DC or peak AC  
 Output Voltage Range 0 to -250 kV DC or peak AC  
 Output DC Current Range 0 to  $\pm 40$  mA DC  
 Output AC Current Range 0 to  $\pm 80$  mA peak AC  
 Large Signal Bandwidth DC to greater than 150 kHz  
 (5% distortion)



### Model PZD350 Piezo Driver /Amplifier Series

Applications include Piezoelectric driving/control, Laser modulation, Semiconductor research and Ion beam control

- Adjustable DC gain control
- Single or dual channel units
- Customer specified voltage output ranges
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Voltage and Current Monitors

#### Factory Set for One of Three Output Voltage Ranges

0 to  $\pm 350$  V DC or peak AC voltage range

Current 0 to  $\pm 200$  mA  
 Slew Rate (10% to 90%) Greater than 500 V/ $\mu$ s  
 Large Signal Bandwidth DC to greater than 40 kHz (1% distortion)

0 to +700 V DC or peak AC voltage range

Current 0 to  $\pm 100$  mA  
 Slew Rate (10% to 90%) Greater than 350 V/ $\mu$ s  
 Large Signal Bandwidth DC to greater than 14 kHz (1% distortion)

0 to -700 V DC or peak AC voltage range

Current 0 to  $\pm 100$  mA  
 Slew Rate (10% to 90%) Greater than 350 V/ $\mu$ s  
 Large Signal Bandwidth DC to greater than 14 kHz (1% distortion)

ALSO AVAILABLE: Model PZD350 M/S with TWICE the current capability of the PZD350



### Model 601C High-Voltage Power Amplifier

Applications include Driving piezoelectric actuators, Modulating electrooptics, Electrostatic control of ion beams, Electrostatic deflection

- Single or dual channel units
- Customer specified voltage output ranges
- Customer specified gain ratios (100 V/V or 50 V/V)
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Voltage and Current Monitors

#### Available Output Voltage Ranges

Output Voltage Range 0 to  $\pm 500$  V DC or peak AC  
 Output Voltage Range 0 to +1 kV DC or peak AC  
 Output Voltage Range 0 to -1 kV DC or peak AC  
 Output DC Current Range 0 to  $\pm 10$  mA DC  
 Output AC Current Range 0 to  $\pm 20$  mA peak AC  
 Slew Rate (10% to 90%) Greater than 50 V/ $\mu$ s  
 Large Signal Bandwidth DC to greater than 8 kHz (1% distortion)  
 Small Signal Bandwidth DC to greater than 30 kHz (-3dB)



**Model PZD700 Piezo Driver / Amplifier Series**

Applications include Piezoelectric driving/control, Laser modulation, Semiconductor research, Ion beam control

- Adjustable DC gain control
- Single or dual channel units
- Customer specified voltage output ranges
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Voltage and Current Monitors

Factory Set for One of Three Output Voltage Ranges

0 to $\pm 700$ V DC or peak AC voltage range	
Current	0 to $\pm 100$ mA
Slew Rate (10% to 90%)	Greater than 150 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 15 kHz (1% distortion)
0 to +1.4 kV DC or peak AC voltage range	
Current	0 to $\pm 50$ mA
Slew Rate (10% to 90%)	Greater than 100 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 12 kHz (1% distortion)
0 to -1.4 kV DC or peak AC voltage range	
Current	0 to $\pm 50$ mA
Slew Rate (10% to 90%)	Greater than 100 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 12 kHz (1% distortion)

*ALSO AVAILABLE: Model PZD700 M/S with TWICE the current capability of the PZD700*



**Model PZD2000A High-Voltage, High Bandwidth Power Amplifier**

Applications include Dielectric material characterization, Polymer and ceramic charging, Piezoelectric driving and control

- Adjustable Current Limit or Current Trip
- Precision Voltage and Current Monitors
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response

Output Voltage Range	0 to $\pm 2$ kV DC or peak AC
Output Current Range	0 to $\pm 200$ mA DC or $\pm 400$ mA peak AC (2 ms at 50% duty cycle using a square wave)
Slew Rate (10% to 90%)	Greater than 750 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 60 kHz (3% distortion)
Small Signal Bandwidth	DC to greater than 100 kHz (-3dB)



### Model 677B High-Voltage Power Amplifier/Supply

Applications include Precise voltage control, Electrostatic deflection, Electrophoresis research, Polymer and ceramic charging, AC and DC biasing in the electrophotography process

- Adjustable Current Limit
- Remote High-Voltage ON/OFF capability
- Voltage and Current Monitors

Output Voltage Range	0 to $\pm 2$ kV DC or peak AC
Amplifier Mode	Adjustable from 0 to +2 kV or 0 to -2 kV with 1 volt resolution
Supply Mode	Adjustable from 0 to +2 kV or 0 to -2 kV with 1 volt resolution
Output Current Range	0 to $\pm 5$ mA DC or peak AC with adjustable current limit
Input Voltage Range	0 to $\pm 10$ V DC or peak AC
DC Voltage Gain	200 V/V
DC Voltage Gain Accuracy	Better than 0.1% of full scale
Slew Rate (10% to 90%)	Greater than 15 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 1.2 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 5 kHz (-3dB)

### Model 623B High-Voltage Power Amplifier

Applications include Electrostatic beam deflection, Electrooptic modulation, Electrophoresis research, Piezoelectric poling and driving

- Precision Voltage and Current Monitors
- Adjustable Current Limit or Current Trip
- Response Adjust optimizes output voltage waveform
- Remote High-Voltage ON/OFF capability
- Low Noise
- Dynamic Adjustment for output AC response



Output Voltage Range	0 to $\pm 2$ kV DC or peak AC
Output Current Range	0 to $\pm 40$ mA DC or peak AC
Slew Rate (10% to 90%)	Greater than 300 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 10 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 40 kHz (-3dB)



## Model 609E-6 High-Voltage Power Amplifier

Applications include Electrorheological fluid research, Dielectric material characterization, Piezoelectric driving, AC and DC biasing in the electrophotography process

### Features

- Noninverting, inverting, or differential amplifier input configuration programming
- Remote High-Voltage ON/OFF capability
- Response Adjust for output AC response
- Adjustable Current Limit or Current Trip
- Out of Regulation Indicator
- Voltage and Current Monitors

Output Voltage Range	0 to ±4 kV DC or peak AC
Output Current Range	0 to ±20 mA DC or peak AC
Input Voltage Range	0 to ±4 V DC or peak AC
DC Voltage Gain	
Noninverting	+1000 V/V
Inverting	-1000 V/V
Differential	Function of the difference between two input signals represented by the equation:

$$V_{out} = 1000 (V_A - V_B)$$

Slew Rate (10% to 90%)	Greater than 150 V/μs
Large Signal Bandwidth	DC to greater than 6 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 35 kHz (-3dB)

### Specifications

## Model 609E-6-FG High-Voltage Function Generator

Applications include Electrorheological fluid research, Dielectric material characterization, AC and DC biasing in the electrophotography process

### Features

- Internal generator for sine, square, or triangle wave output
- Noninverting, inverting, or differential amplifier input configuration programming
- Remote High-Voltage ON/OFF capability
- Response Adjust for output AC response
- Adjustable Current Limit or Current Trip
- Out of Regulation Indicator
- Voltage and Current Monitors



Output Voltage Range	0 to ±4 kV DC or peak AC
Output Current Range	0 to ±20 mA DC or peak AC
Input Voltage Range	0 to ±4 V DC or peak AC
Internal Generator Frequency	100 Hz to 10 kHz
DC Voltage Gain	
Noninverting	+1000 V/V
Inverting	-1000 V/V
Differential	Function of the difference between two input signals represented by the equation:

$$V_{out} = 1000 (V_A - V_B)$$

Slew Rate (10% to 90%)	Greater than 150 V/μs
Large Signal Bandwidth	DC to greater than 6 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 35 kHz (-3dB)

### Specifications



### Model 615 AC/DC Generator Series

Applications include Electrostatic charger roller applications, R&D

- Constant Voltage Mode or Constant Current Mode
- Internal generator for sine, square, or triangle wave output
- Precise DC bias adjustments
- External Amplifier Input
- Remote High-Voltage ON/OFF capability
- Compliance feature for precise limit adjustments
- High rejection of load current noise components
- Voltage and Current Displays & Monitors

#### Output Voltage Limits

AC Voltage (DC bias is zero)	0 to 10 kV peak-to-peak
AC Voltage + DC Bias	0 to ±5 kV peak
DC Bias (AC voltage is zero)	0 to ±5 kV DC
AC Current (DC current is zero)	
Model 615A-1	0 to 10 mA, peak-to-peak
Model 615-3	0 to ±5 mA, rectified average
AC Current + DC Current	0 to ±8 mA peak
DC Current (AC current is zero)	0 to ±8 mA DC
Internal Generator Frequency	100 Hz to 10 kHz
Slew Rate (10% to 90%)	Greater than 80 V/μs
Large Signal Bandwidth	DC to greater than 3 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 10 kHz (-3dB)



### Model PM04015A High-Voltage AC/DC Generator

Applications include Electrostatic charger roller applications, R&D

- Constant Voltage Mode or Constant Current Mode
- Internal generator for sine, square, or triangle wave output
- Precise DC bias adjustments
- External Amplifier Input
- Remote High-Voltage ON/OFF capability
- Compliance feature for precise limit adjustments
- High rejection of load current noise components
- Voltage and Current Displays & Monitors

Output Voltage Range	0 to 20 kV peak-to-peak
Output Current Ranges	0 to ±35 mA peak AC
	0 to ±10 mA DC
DC Bias Range	0 to ±10 kV DC
Output Limits (any mode)	
AC Voltage (DC bias is zero)	0 to 20 kV peak-to-peak
DC Bias (AC voltage is zero)	0 to ±10 kV DC
AC Voltage + DC Bias	0 to ±20 kV (combined AC and DC instantaneous voltage value)
AC Current (DC current is zero)	0 to ±10 mA average where: $AC\ current\ average = \frac{(2) I_{peak}}{\pi}$
DC Current (AC current is zero)	0 to ±10 mA DC
AC Current + DC Current	0 to ±35 mA peak
Internal Generator Frequency	100 Hz to 10 kHz



## Model 5/80 High-Voltage Power Amplifier

Applications include Dielectric material characterization, Polymer and ceramic charging, Piezoelectric driving and control, Plasma chemistry

- Remote High-Voltage ON/OFF capability
- Voltage and Current Monitors
- Adjustable Current Limit or Current Trip
- Dynamic Adjustment for output AC response

Output Voltage Range	0 to $\pm 5$ kV DC or peak AC
Output Current Range	0 to $\pm 80$ mA DC or peak AC
Slew Rate (10% to 90%)	Greater than 1000 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 50 kHz (3% distortion)
Small Signal Bandwidth	DC to greater than 75 kHz (-3dB)

## Model PD05034 High-Voltage Power Amplifier

Applications include Dielectric material characterization, Polymer and ceramic charging, Piezoelectric driving and control, Plasma chemistry

- Remote High-Voltage ON/OFF capability
- Voltage and Current Monitors
- Adjustable Current Limit or Current Trip
- Dynamic Adjustment for output AC response



Output Voltage Range	0 to $\pm 7.5$ kV DC or peak AC
Output Current Range	0 to $\pm 50$ mA DC with a 0 to $\pm 160$ mA peak AC current capability for 60 $\mu$ s
Slew Rate (10% to 90%)	Greater than 1000 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 15 kHz (3% distortion)
Small Signal Bandwidth	DC to greater than 75 kHz (-3dB)



### Model 10/10B High-Voltage Power Amplifier

Applications include Electrostatic deflection, Electrophoresis research, Electrophotography research, Electrooptic modulation, AC and DC biasing, Electroactive polymers, Plasma chemistry

- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Adjustable Current Limit or Current Trip
- Voltage and Current Monitors

Output Voltage Range	0 to $\pm 10$ kV DC or peak AC
Output Current Range	0 to $\pm 10$ mA DC or peak AC
Slew Rate (10% to 90%)	Greater than 250 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 4 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 20 kHz (-3dB)



### Model 10/10B-FG High-Voltage Function Generator

Applications include Electrostatic deflection, Electrophoresis research, Electrophotographic research, Electrooptic modulation, AC and DC biasing, R&D

- Internal generator for sine, square, or triangle wave output
- Amplifier mode
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Adjustable Current Limit or Current Trip
- Voltage and Current Monitors

Output Voltage Range	0 to $\pm 10$ kV DC or peak AC
Output Current Range	0 to $\pm 10$ mA DC or peak AC
Internal Generator Frequency	100 Hz to 10 kHz
Slew Rate (10% to 90%)	Greater than 250 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 4 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 20 kHz (-3dB)



**Model 609B-3 High-Voltage Power Amplifier**

Applications include Ferroelectric characterization, Electrostatic deflection, Electrophoresis research, Polymer and ceramic charging, AC and DC biasing in the electrophotography process

- Noninverting, inverting, or differential amplifier input configuration programming
- Remote High-Voltage ON/OFF capability
- Voltage Monitor

Output Voltage Range	0 to $\pm 10$ kV DC or peak AC
Output Current Range	0 to $\pm 2$ mA DC or peak AC
Slew Rate (10% to 90%)	Greater than 30 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 400 Hz (1% distortion)
Small Signal Bandwidth	DC to greater than 10 kHz (-3dB)

Specifications



**Model 610E High-Voltage Supply/Amplifier/Controller**

Applications include Materials research, Polymer and ceramic charging, Electrophotographic research, Photoreceptor corona charging, AC and DC biasing

- Six modes of high-voltage operation including: VOLTAGE supply/amplifier/controller and CURRENT supply/amplifier/controller
- Noninverting, inverting, or differential amplifier input configuration programming
- Remote High-Voltage ON/OFF capability
- Compliance features for precise limit adjustments
- DC Supply
- Voltage and Current Monitors

Output Voltage Ranges	0 to $\pm 1$ kV or 0 to $\pm 10$ kV DC or peak AC, switch selectable
Output Current Range	0 to $\pm 200$ $\mu$ A or 0 to $\pm 2000$ $\mu$ A DC or peak AC, switch selectable (Transconductance Amplifier and Controller)
Slew Rate (10% to 90%)	Greater than 20 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 600 Hz (1% distortion)
Small Signal Bandwidth	DC to greater than 10 kHz (-3dB)

Specifications



### Model 10/40A High-Voltage Power Amplifier

Applications include Pulsed field electrophoresis, Electrostatic deflection, AC and DC biasing of electrophotographic rollers, Electrorheological fluid research

## Features

- Remote High-Voltage ON/OFF capability
- Voltage and Current Monitors
- Adjustable Current Limit or Current Trip
- Dynamic Adjustment for output AC response

Output Voltage Range	0 to $\pm 10$ kV DC or peak AC
Output Current Range	0 to $\pm 40$ mA DC or peak AC
Slew Rate (10% to 90%)	Greater than 700 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 7.5 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 25 kHz (-3dB)

## Specifications



### Model 20/20D High-Voltage Power Amplifier

Applications include Dielectric studies, Electrostatic deflection, Electrophoresis research, Electrophotographic research, Electrooptic modulation, AC and DC biasing, Electroactive polymers

- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Adjustable Current Limit or Current Trip
- Voltage and Current Monitors
- DC Offset Adjustment (to  $\pm 20$  kV)

Output Voltage Range	0 to $\pm 20$ kV DC or peak AC
Output Current Range	0 to $\pm 20$ mA DC or peak AC
Slew Rate (10% to 90%)	Greater than 350 V/ $\mu$ s
Large Signal Bandwidth	DC to greater than 3.75 kHz (1% distortion)
Small Signal Bandwidth	DC to greater than 20 kHz (-3dB)

*ALSO AVAILABLE: Double current capability and transconductance options*

## Specifications



**Model 621N & Model 621P High-Voltage Power DC Amplifiers**

Applications include Electrostatic deflection, Pulsed field electrophoresis, Poling of materials

**Features**

- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Adjustable Current Limit or Current Trip
- Voltage and Current Monitors

Model 621P Output Voltage Range  
 Model 621N Output Voltage Range  
 Output Current Ranges  
 Slew Rate (10% to 90%)  
 Large Signal Bandwidth  
 Small Signal Bandwidth

0 to +30 kV DC or peak AC  
 0 to -30 kV DC or peak AC  
 0 to  $\pm 20$  mA DC or peak AC  
 Greater than 350 V/ $\mu$ s  
 DC to greater than 3.5 kHz (1% distortion)  
 DC to greater than 25 kHz (-3dB)

**Specifications**



**Model 30/20A High-Voltage Power Amplifier**

Applications include Electrostatic deflection, Electrophoresis research, Dielectric studies, Electrooptic modulation, AC and DC biasing, Abrasive coatings research

- DC Offset Adjustment (to  $\pm 30$  kV)
- Remote High-Voltage ON/OFF capability
- Dynamic Adjustment for output AC response
- Adjustable Current Limit or Current Trip
- Voltage and Current Monitors

**Features**

Output Voltage Range  
 Output Current Range  
 Slew Rate (10% to 90%)  
 Large Signal Bandwidth  
 Small Signal Bandwidth

0 to  $\pm 30$  kV DC or peak AC  
 0 to  $\pm 20$  mA DC or peak AC  
 Greater than 500 V/ $\mu$ s  
 DC to greater than 2.5 kHz (2% distortion)  
 DC to greater than 20 kHz (-3dB)

*ALSO AVAILABLE: Double current capability and transconductance options*

**Specifications**

### Model 668B Precision, High-Voltage Reference Supply

Applications include use as DC Reference/Power Supply

- Nine memory presets, each location containing polarity, voltage value, and current limit value
- Remote High-Voltage ON/OFF capability
- Highly accurate Current Limit/Trip feature
- 16 character front panel LED display



Output Voltage Range	0 to $\pm 3$ kV in 0.1 V steps
Accuracy	Better than 0.015% of full scale, 100 ppm/ $^{\circ}$ C
Output Current Range	0 to $\pm 5$ mA DC

## Specifications

### Model 605A High-Voltage Reference Supply

Applications include use as DC Reference Supply

- Automatic Current Limit
- Remote High-Voltage ON/OFF capability
- Variable Voltage Selection



Output Voltage Range	
Fixed Mode	+1 kV DC or -1 kV DC, switch selectable
Variable Mode	0 to $\pm 1$ kV DC, adjustable
Accuracy	Better than 0.1% of full scale
Output Current Range	0 to $\pm 1$ mA DC

## Specifications

## ELECTROSTATIC VOLTMETER (ESVM) SELECTION TABLE

ESVM Model	Measurement Range (V DC or Peak AC)	Speed of Response (10-90%) (less than)	Voltage Monitor Output Accuracy (better than)
PR1182	0 to $\pm 40$ V	4 ms for a 40 V step	$\pm 0.1\%$ of full scale
325	0 to $\pm 40$ V	3 ms for a 10 V step	$\pm 0.05\%$ of full scale
320C	0 to $\pm 100$ V	300 ms for a 100 V step	$\pm 0.05\%$ of full scale
323	0 to $\pm 100$ V	300 ms for a 100 V step	$\pm 0.05\%$ of full scale
400, 400-1	0 to $\pm 2$ kV	3 ms for a 1 kV step, 200 $\mu$ s for a 1 kV step (high-speed)	$\pm 0.05\%$ of full scale
368A	0 to $\pm 2$ kV	200 $\mu$ s for a 1 kV step	$\pm 0.1\%$ of full scale
344	0 to $\pm 2$ kV	3 ms for a 1 kV step	$\pm 0.05\%$ of full scale
347	0 to $\pm 3$ kV	3 ms for a 1 kV step	$\pm 0.05\%$ of full scale
370	0 to $\pm 3$ kV	50 $\mu$ s for a 1 kV step	$\pm 0.05\%$ of full scale
370TR	0 to $\pm 3$ kV	200 $\mu$ s for a 1 kV step	$\pm 0.05\%$ of full scale
341B	0 to $\pm 20$ kV	200 $\mu$ s for a 1 kV step	$\pm 0.1\%$ of full scale
<i>The voltmeters above all utilize Trek's novel noncontacting technology (see p.23)</i>			
800	0 to $\pm 100$ V	3.5 ms for a 100 V step	$\pm 0.1\%$ of full scale

<b>Probes</b>	<b>Special Features</b>	<b>Applications</b> (see product pages for more)	<b>Page</b>
P1182P	Low Voltage, High Spatial Resolution, Noise/Speed Adjustments	Materials Evaluation Electrophotographic Research Contact Potential Measurement	24
PD1216P	Low Voltage, High Sensitivity, Noise/Speed Adjustments	Materials Evaluation Electret Studies Contact Potential Measurement	24
3250	High Sensitivity, Noise/Speed Adjustments	Materials Evaluation Electret Studies Contact Potential Measurement	25
6000B Series 555P Miniature 6300 High-Temperature	Noise/Speed Adjustments	Semiconductor Wafer Surface Voltage Measurement Contact Potential Measurement Disk Drive Charge Accumulation Measurements	25
400P Standard 402P High-Speed 403PH High-Temperature	High Spatial Resolution, Variety of Probe Options	Electrostatic Potential Measurement Research & Development Electrophotography	26
3800 Series 3870 High-Temperature	Multichannel Enclosure	Research & Development Applications Electrostatic Potential Measurement on Film, Polymers and Paper Electrophotographic Research & Development	26
6000B Series 555P Miniature 6300 High-Temperature	Wide Variety of Probe Options	Electrophotographic Research & Development Charge Accumulation Monitoring in Semiconductor Production Radiation Effect Studies	27
6000B Series 555P Miniature 6300 High-Temperature	Wide Variety of Probe Options	Photoconductor/Dielectric Surface Voltage Measurement Charge Accumulation Monitoring in Semiconductor Production Electrostatic Potential Measurement on Film, Polymers and Paper	27
3800 Series 3870 High-Temperature	Optional Data Acquisition Module	Electrophotographic Research & Development Research & Development of Photoreceptors Charge Accumulation Monitoring in Semiconductor Production Measuring Electrostatic Potential on Moving Objects or Surfaces Radiation Effect Studies	28
3629A Transparent 3627 Standard	Transparent Probe Option	Photosensitive Surface Studies Research & Development	28
3450 3453/3455 High-Temperature, High-Vacuum	High Voltage, High Speed	Electrostatic Research & Development Charge Accumulation Monitoring of LCD Production Processes Monitoring Surface Potentials in Electrostatic Painting Processes Electrostatic Potential Measurement on Polymers, Rubber, Fabrics and Paper	28
800P Contacting or Noncontacting Probe	Infinitron™ Ultra-High Impedance Voltmeter [ $10^{16} \Omega$ and $10^{-15} F$ ]	Measurement of ESD-sensitive components and circuitry	33

*Trek's new technology permits electrostatic measurements with an ultra-high impedance contacting probe (Model 800 below)*

Many voltage measurement applications cannot be made using conventional contacting voltmeters because they require charge transfer to the voltmeter, thus causing loading and modification of the source voltage. For example, when measuring voltage distribution on a dielectric surface, any measurement technique that requires charge transfer, no matter how small, will modify or destroy the measured data. In these types of applications a new approach to voltage measurement is needed.

An instrument that measures voltage without charge transfer is called an electrostatic voltmeter. A primary characteristic of an electrostatic voltmeter is that it accurately measures surface potential (voltage) on any kind of material without physical contact and therefore, no charge transfer and loading of the measured source can occur.

In practice, an electrostatic probe is placed in close proximity (1 mm to 5 mm) to the surface to be measured. The electrostatic voltmeter functions to drive the potential of the probe body to the same potential as the measured unknown. This achieves a high accuracy measurement that is virtually insensitive to variations in probe-to-surface distances, as well as preventing arc-over between the probe and measured surface.

Trek is known in the marketplace for its novel non-contacting voltmeter designs, first introduced in 1968 to address charge transfer issues associated with contacting voltmeter designs at the time. Trek's non-contacting instruments continue to find extensive use in environments where surface contact must be avoided. Trek's new InfiniTron™ (Model 800) contacting voltmeter advances the state of the art, enabling precision and accuracy when an application requires surface contact measurements. This need for site-specific measurement is taking on greater importance as electronics are miniaturized, and other critical surface phenomena are being scrutinized.

### **Scientific, industrial, or research applications for Trek electrostatic voltmeter systems include:**

- Research and development of electrophotographic processes
- Light decay measurements of photoreceptors
- High-speed measurements of photoreceptor characteristics
- Contact potential measurements
- Materials evaluation
- Charge accumulation monitoring of LCD production processes
- Monitoring surface potentials in electrostatic painting processes
- Measuring electrostatic potential on polymers, rubber, fabrics, and paper
- Charge accumulation monitoring in clean rooms
- Radiation effect studies
- Measuring electrostatic potential on moving objects or surfaces

# NONCONTACTING ELECTROSTATIC VOLTMETER

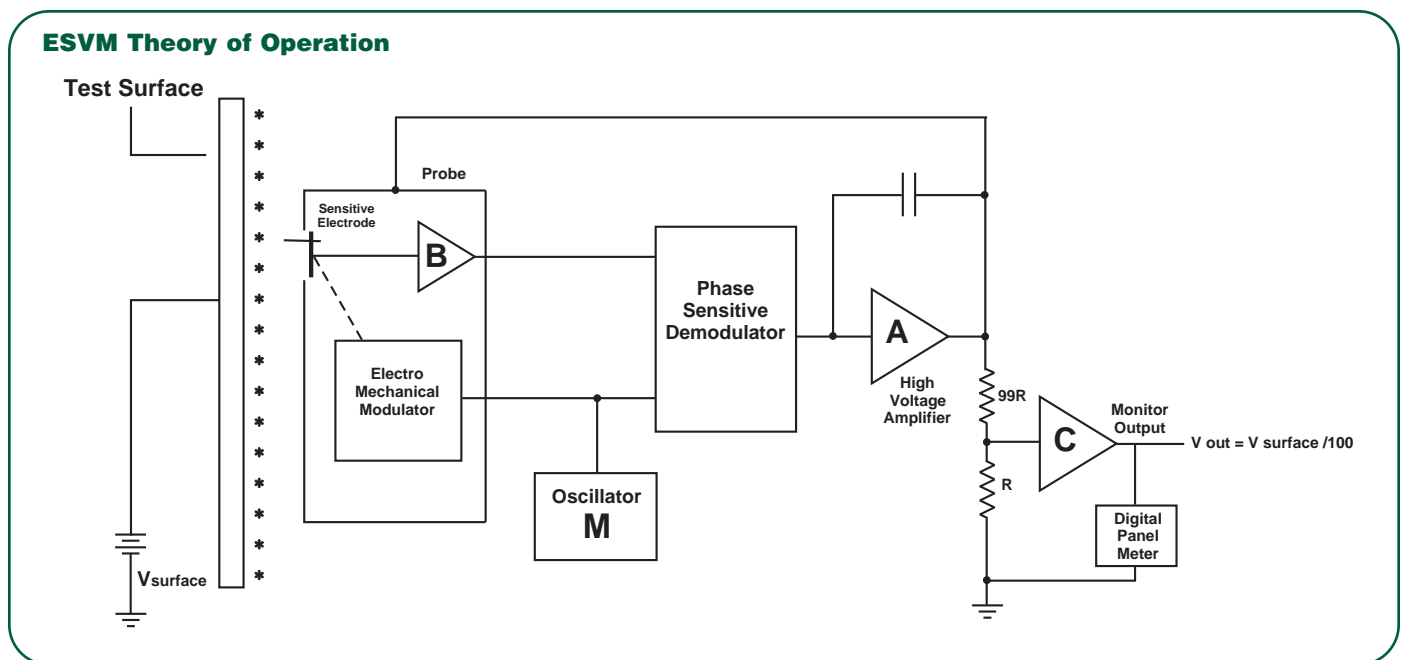
To measure an unknown voltage on a test surface, the electrostatic probe is positioned in close proximity to the test surface at a spacing of approximately 1 mm to 5 mm. The sensitive electrode, having a small surface area, “views” the test surface through an aperture in the body of the probe. The use of a small area electrode and aperture serves to increase the spatial resolution of the probe to a relatively small area on the test surface. For the present explanation, we consider the surface under test to be a large conductive surface with a uniform potential. (Refer to block diagram below.)

The probe housing is constructed of a conductive material which serves as a reference surface and is connected to the output of the high-voltage amplifier (A), which adjusts the voltage applied to the probe reference surface.

The sensitive electrode is electromechanically vibrated to produce capacitive modulation between the electrode and the test surface. If the voltage of the test surface is different than the voltage of the reference surface (probe housing), the difference in voltage induces an AC signal on the electrode due to the modulating of the capacitance there between. The amplitude and phase (either 0° or 180°) of the AC signal are related to the magnitude and polarity of the voltage difference.

The signal induced on the electrode is then fed to a preamplifier (B) in the probe.

The amplified electrode signal and the output voltage of the oscillator (M) which drives the electromechanical modulator are connected to a phase sensitive demodulator whose output is a DC voltage whose magnitude and polarity are related to the voltage difference.



The signal from the phase sensitive demodulator is connected to the input of an integrating DC high-voltage amplifier (A), the output of which is the probe housing reference potential, which is thus driven toward the potential of the test surface.

This process quickly drives the probe housing potential to the same potential as the potential on the test surface. At this point, the electrostatic field between test surface and probe will be nulled to zero.

With the electric field nulled, the signal induced upon the electrode is reduced to zero, thereby reducing the demodulated signal to the integrating DC amplifier to zero. Thus the high-voltage amplifier (A) output and the probe housing are maintained at the potential of the test surface.

The output of the high-voltage amplifier (A) is precisely divided down to a low voltage level to drive buffer amplifier (C) for accurate monitoring and display of the measured electrostatic potential on the test surface.



## Model PR1182 High-Spatial Resolution, DC Stable Electrostatic Voltmeter

Applications include Contact potential measurement, Materials evaluation, Electrophotographic research

### Features

- $\pm 10$  Volt Null Voltage Supply
- Adjustable Response Speed Control
- Drift Spacing/Null Adjustment
- Monitor Output

Measurement Range	0 to $\pm 40$ V DC or peak AC
Spot Resolution	200 $\mu\text{m}$ with probe-to surface spacing of 50 $\mu\text{m}$
Voltage Sensitivity	10 mV
Speed of Response	Less than 4 ms for a 40 V step
Measurement Accuracy	Better than 0.1% of full scale

### Specifications



## Model 325 High-Sensitivity, DC Stable Electrostatic Voltmeter

Applications include Contact potential measurement, Materials evaluation, Electret studies

### Features

- $\pm 10$  Volt Null Voltage Supply
- Drift Spacing/Null Adjustment
- Voltage Monitor Outputs: 1:1 and 10:1 of the measured voltage

Measurement Range	0 to $\pm 40$ V DC or peak AC
Sensitivity	1 mV
Measurement Accuracy	Better than 0.05% of full scale
Noise	Less than 1 mV rms referenced to measured voltage
Speed of Response	Less than 3 ms for a 10 V step

### Specifications



### Model 320C High-Sensitivity, DC Stable Electrostatic Voltmeter

Applications include Contact potential measurement, Materials evaluation, Electret studies

- $\pm 10$  Volt Null Voltage Supply
- Response Control
- Voltage Monitor

Measurement Range                    0 to  $\pm 100$  V DC or peak AC  
 Sensitivity                                1 mV  
 Speed of Response (10% to 90%)    Less than 300 ms for a 100 V change



### Model 323 High-Sensitivity, DC Stable Electrostatic Voltmeter

Applications include Semiconductor wafer surface voltage measurement, Contact potential measurement, Disk drive charge accumulation measurements

- $\pm 10$  Volt Null Voltage Supply
- Adjustable Response Speed Control
- Drift Spacing/Null Adjustment
- Monitor Output

Measurement Range                    0 to  $\pm 100$  V DC or peak AC  
 Sensitivity                                5 mV  
 Speed of Response                    Less than 300 ms for a 100 V step (10% to 90%) adjustable



## Model 400 Electrostatic Voltmeter

Applications include use in Electrophotography, Research & Development, and for Electrostatic potential measurements

- Excellent Speed of Response and Spatial Resolution
- Remote Measurement ON/OFF Control
- Push-button Auto ZERO
- Available with Standard and High-Speed Probes

Measurement Range  
Measurement Accuracy  
Speed of Response

0 to  $\pm 2$  kV DC or peak AC  
Better than  $\pm 0.05\%$  at the Voltage Monitor Output  
Less than 3 ms  $\pm 10\%$  for a 1 kV step (with standard probes)  
Less than 200  $\mu$ s  $\pm 10\%$  for a 1 kV step (with high-speed probes)



## Model 368A Electrostatic Voltmeter

Applications include Electrophotographic research and development, Electrostatic potential measurement on polymers, film and paper

- Zero Control
- Selectable Voltage Monitor Output Ratios
- Response Control
- Full Rack holds up to 4 channels

Measurement Range  
Speed of Response

0 to  $\pm 2$  kV  
Less than 200  $\mu$ s for a 1 kV step



### Model 344 Electrostatic Voltmeter

Applications include Radiation effect studies, R&D for electrophotographic processes, Charge accumulation monitoring in semiconductor production

- Superb noise and drift performance
- Variety of probes available
- Precision Voltage Monitor Output
- Digital Enable
- Easy-to-read LED display

Measurement Range  
Speed of Response

0 to  $\pm 2$  kV DC or peak AC  
Less than 3 ms for a 1 kV step (10% to 90%)



### Model 347 Electrostatic Voltmeter

Applications include Surface voltage measurements of photoconductors or dielectric surfaces, Charge accumulation monitoring in semiconductor production, Measuring electrostatic potentials on film, polymers, and paper

- Superb noise and drift performance
- Variety of probes available
- Precision Voltage Monitor Output
- Digital Enable
- Easy-to-read LED display

Measurement Range  
Speed of Response

0 to  $\pm 3$  kV DC or peak AC  
Less than 3 ms for a 1 kV step (10% to 90%)



## Model 370 Electrostatic Voltmeter

Applications include Electrophotographic (and photoreceptor) research and development, Charge accumulation monitoring of semiconductor production processes, Measuring electrostatic potential on moving objects or surfaces, Radiation effect studies

- Push button zeroing
- Voltage Monitor Output
- Automatic Gain Control
- Optional IEEE-488 Data Acquisition Module
- Digital Enable to enable or disable the measurement remotely
- 4 character, 7 segment LED display

Measurement Range      0 to  $\pm 3$  kV  
 Speed of Response      Less than 50  $\mu$ s for a 1 kV step



## Model 370TR DC Stable Electrostatic Voltmeter

Applications include Photosensitive surface studies, R&D

- Push button zeroing
- Voltage Monitor Output
- Automatic Gain Control
- Optional IEEE-488 Data Acquisition Module
- Digital Enable to enable or disable the measurement remotely
- 4 character, 7 segment LED display

Measurement Range      0 to  $\pm 3$  kV  
 Speed of Response      Less than 200  $\mu$ s for a 1 kV step



## Model 341B High-Speed, High-Voltage Electrostatic Voltmeter

Applications include Electrophotographic research and development, Charge accumulation monitoring of LCD production processes, Monitoring surface potentials in electrostatic painting processes, Measuring electrostatic potential on polymers, rubber, fabrics and paper

- 10-turn Zero Control to null offsets or other zero errors which occur in system
- Voltage Monitor Output provides a low voltage replica of the measured voltage
- Easy-to-read LED display

Measurement Range      0 to  $\pm 20$  kV DC or peak AC  
 Speed of Response      Less than 200  $\mu$ s for a 1 kV step

**NONCONTACTING ELECTROSTATIC PROBE SELECTION TABLE**

Voltmeter Model	Probe Model	Dimensions	Body Shape/ Aperature Location/ Aperature Size	Special Feature	Speed of Response (less than)	Noise (rms) (less than)
Model 320C 0 to ±100 V DC or peak AC	3250	30.5 mm H 28.7 mm W 57.2 mm L	square / side / 6.35 mm dia.	high-sensitivity	300 ms	3 mV
Model 325 0 to ±40 V DC or peak AC	PD1216P	10 mm dia. 56 mm L	round / side / 4.6 mm dia.	high-sensitivity	3 ms	1 mV
Model 323 0 to ±100 V DC or peak AC	555P-1	5.6 mm sq. 49.8 mm L	square / side / 2.56 mm dia.	miniature	3 ms	3 mV
	555P-4	5.6 mm sq. 49.8 mm L	square / end / 1.17 mm dia.	miniature	4.5 ms	4 mV
and	6000B-5C	11.2 mm dia. 65.7 mm L	round / end / 0.79 mm dia.	high-resolution	4.5 ms	4 mV
	6000B-6	10.3 mm dia. 69.7 mm L	round / side / 0.79 mm dia.	high-resolution	3 ms	3 mV
Model 344 0 to ±2 kV DC or peak AC	6000B-7C *	11.2 mm dia. 65.7 mm L	round / end / 1.32 mm dia.		4.5 ms	4 mV
	6000B-8 *	9.5 mm dia. 68.6 mm L	round / side / 1.32 mm dia.		3 ms	3 mV
and	6000B-13C	10.2 mm sq. 63.7 mm L	square / end / 0.79 mm dia.	high-resolution	4.5 ms	4 mV
	6000B-14	10.2 mm sq. 68.6 mm L	square / side / 0.79 mm dia.	high-resolution	3 ms	3 mV
Model 347 0 to ±3 kV DC or peak AC	6000B-15C*	10.2 mm sq. 63.7 mm L	square / end / 1.32 mm dia.		4.5 ms	4 mV
	6000B-16 *	10.2 mm sq. 68.6 mm L	square / side / 1.32 mm dia.		3 ms	3 mV
*The speed of response and noise specs may vary from those listed here when these probes are used with Model 323	6300-7*	11.8 mm H 11.1 mm W 76.2 mm L	square / end / 1.32 mm dia.	high-temperature (to 100°C)	4.5 ms	10 mV
	6300-8*	11.8 mm H 11.1 mm W 76.2 mm L	square / side / 1.32 mm dia.	high-temperature (to 100°C)	3 ms	10 mV
Model 341B 0 to ±20 kV DC or peak AC	3450	11.8 mm H 11.1 mm W 76.0 mm L	square / side / 3.05 mm x 1.52 mm		200 µs	20 mV
	3453ST	11.8 mm H 11.1 mm W 76.2 mm L	square / side / 3.05 mm x 1.52 mm	high-temperature (to 100°C) high-vacuum	200 µs	20 mV
	3455ET	11.8 mm H 11.1 mm W 76.2 mm L	square / end / 1.52 mm dia.	high-temperature (to 100°C) high-vacuum	200 µs	20 mV
Model 368A 0 to ±2 kV DC or peak AC	3800E-2	5.6 mm sq. 50 mm L	square / end / 1.85 mm dia.	miniature	Model 368A is less than 200 µs	Model 368A is less than 25 mV
	3800S-2	5.6 mm sq. 50 mm L	square / side / 2.35 mm dia.	miniature		
and Model 370 0 to ±3 kV DC or peak AC	3870ET-2	5.6 mm H 5.6 mm W 50.0 mm L	square / end / 1.85 mm dia.	high-speed	Model 370 is less than 50 µs	Model 370 is less than 20 mV
	3870ST-2	5.6 mm H 5.6 mm W 50.0 mm L	square / side / 2.35 mm dia.	high-speed		
Model 370 0 to ±3 kV DC or peak AC	7000ER	8.7 mm sq. 69.8 mm L	round / end / 1.60 mm dia.		50 µs	20 mV
Model 370TR 0 to ±3 kV DC or peak AC	3627	11.8 mm sq. 72.2 mm L	square / side / 1.5 mm x 3.0 mm		200 µs	20 mV
	3629A	11.8 mm sq. 72.2 mm L	square / side / 5.3 mm dia.	nonfringing transparent	200 µs	20 mV
Model 400 0 to ±2 kV DC or peak AC	400P-E	5.5 mm sq. 50 mm L	square / end / 1.2 mm dia.	miniature	3 ms	3 mV
	400P-S	5.5 mm sq. 50 mm L	square / side / 1.9 mm dia.	miniature	3 ms	3 mV
	402P-E	6.4 mm sq. 50 mm L	square / end / 2.2 mm dia.	miniature / high-speed	200 µs	5 mV
	402P-S	6.4 mm sq. 50 mm L	square / side / 2.2 mm dia.	miniature / high-speed	200 µs	5 mV

See p. 38 for more information

# ELECTROSTATIC VOLTMETER SENSORS AND MONITORS



## Model 542 Electrostatic Voltmeter

Applications include Static charge evaluation in semiconductor, LCD, and electronic assembly environments

- LCD screen displays the present voltage, and holds the most positive and the most negative measured values
- Visual and audible alarms
- Voltage Output Monitor for remote monitoring or control

### Measurement Ranges

Model 542-1                    0 to  $\pm 10$  kV DC or peak AC  
 Model 542-2                    0 to  $\pm 20$  kV DC or peak AC

### Speed of Response

Model 542-1                    Less than 50 ms for a 1 kV step  
 Model 542-2                    Less than 50 ms for a 1 kV step

### Accuracy (both models)

5% of full scale

## SENSORS AND MONITORS SELECTION TABLE

Model	Measurement Range	Measurement Accuracy	Probe to Surface Separation
540	0 to $\pm 100$ V	$\pm 0.2\%$ of full scale	Charged-Plate Sensor
541-2	0 to $\pm 100$ V	$\pm 1\%$ of full scale	2.5 mm $\pm 1$ mm
541-1	0 to $\pm 1$ kV	$\pm 1\%$ of full scale	2.5 mm $\pm 1$ mm
706A/1	0 to +1 kV or 0 to -1 kV	$\pm 0.5\%$ of full scale	3.2 mm $\pm 1$ mm
520A-1 520A-2	0 to $\pm 2$ kV	$\pm 5\%$ of full scale	15 mm $\pm 10$ mm
P0876A	0 to $\pm 2$ kV	$\pm 5\%$ of full scale	15 mm $\pm 10$ mm
542-1	0 to $\pm 10$ kV	$\pm 5\%$ of full scale	15 mm to 30 mm
542-2	0 to $\pm 20$ kV	$\pm 5\%$ of full scale	30 mm to 60 mm
523-1	0 to $\pm 20$ kV	$\pm 5\%$ of full scale	45 mm $\pm 15$ mm
P0884A	0 to $\pm 20$ kV	$\pm 5\%$ of full scale	45 mm $\pm 15$ mm



### Model 520A and Model 523-1 Hand-Held Electrostatic Voltmeters

Applications include Measuring charge accumulation in the LCD manufacturing process, Measuring static charge in semiconductor production

## Features

- Accurately measures surface voltage over a wide range of probe-to-surface spacings
- Monitors the voltage level of small areas to determine charge accumulation
- DC stable for drift-free operation in ionized environments
- Measure charge accumulation in difficult-to-reach locations

Model 520A  
Measurement Range 0 to  $\pm 2$  kV DC  
Accuracy Better than  $\pm 5\%$  of full scale over the recommended probe-to-surface separation of 15 mm  $\pm 10$  mm

Model 523-1  
Measurement Range 0 to  $\pm 20$  kV DC  
Accuracy Better than  $\pm 5\%$  of full scale over the recommended probe-to-surface separation of 45 mm  $\pm 15$  mm

Cable Length	Special Features	Applications	Page
3 meter (10 ft)	Programmable Alarms, LED Bar Graph Display, Output Monitor	Evaluation of Ionizers, Semiconductor, LCD, Electronic Assembly	35
3 meter (10 ft)	Programmable Alarms, LCD Display, Output Monitor, Probe Options	Static Charge Evaluation Semiconductor, LCD, Electronic Assembly	33
3 meter (10 ft)	Programmable Alarms, LCD Display, Output Monitor, Probe Options	Static Charge Evaluation Semiconductor, LCD, Electronic Assembly	33
1.8 meter (6 ft)	Portable, LCD Display	Measures Photoreceptor Surfaces in Copiers and Laser Printers	32
Probe Tip on Hand-Held Unit	Hand-Held, Portable, LCD Display, Voltage Monitor (Model 520A-2)	Charge Accumulation in LCD Manufacturing, Static Charge in Semiconductor Manufacturing	31
1.8 meter (6 ft)	Hand-Held, Portable, LCD Display	Charge Accumulation in LCD Manufacturing, Static Charge in Semiconductor Manufacturing	32
5 meter (16 ft)	Programmable Alarms, LCD Display, Output Monitor, Probe Options	Static Charge Evaluation Semiconductor, LCD, Electronic Assembly	30
5 meter (16 ft)	Programmable Alarms, LCD Display, Output Monitor, Probe Options	Static Charge Evaluation Semiconductor, LCD, Electronic Assembly	30
Probe Tip on Hand-Held Unit	Hand-Held, Portable, LCD Display	Charge Accumulation in LCD Manufacturing, Static Charge in Semiconductor Manufacturing	31
1.8 meter (6 ft)	Hand-Held, Portable, LCD Display	Charge Accumulation in LCD Manufacturing, Static Charge in Semiconductor Manufacturing	32



## Model P0876A and Model P0884A Hand-Held Electrostatic Voltmeters

Applications include Measuring charge accumulation in LCD manufacturing processes, Measuring static charge in semiconductor production

### Features

- Accurately measures surface voltage over a wide range of probe-to-surface spacings
- Monitors the voltage level of small areas to determine charge accumulation
- DC stable for drift-free operation in ionized environments
- Measure charge accumulation in difficult-to-reach locations

Model P0876A

Measurement Range  
Accuracy

0 to  $\pm 2$  kV DC  
Better than  $\pm 5\%$  of full scale over the recommended probe-to-surface separation of 15 mm  $\pm 10$  mm

Model P0884A

Measurement Range  
Accuracy

0 to  $\pm 20$  kV DC  
Better than  $\pm 5\%$  of full scale over the recommended probe-to-surface separation of 45 mm  $\pm 15$  mm

### Specifications



## Model 706A/1 Portable Electrostatic Voltmeter

Applications include Field service measurement of photoreceptor surfaces in copiers and laser printers

### Features

- LCD Display
- Battery Test Switch
- DC-Stable Probe with Side Viewing Aperture Orientation
- Low Noise

Measurement Range  
Accuracy

0 to +1 kV or 0 to -1 kV DC (switch selectable)  
Better than 0.5% of full scale

### Specifications



### Model 541 Electrostatic Voltmeter

Applications include Monitoring critical operations associated with semiconductor, LCD, electronic assembly, and other processes where static charge accumulation poses a threat to production yields or product quality

- LCD screen displays the present voltage, and holds the most positive and the most negative measured values
- Visual and audible alarms
- Voltage Output Monitor for remote monitoring or control

Measurement Ranges	
Model 541-1	0 to $\pm 1$ kV DC or peak AC
Model 541-2	0 to $\pm 100$ V DC or peak AC
Speed of Response	
Model 541-1	Less than 50 ms for a 1 kV step
Model 541-2	Less than 50 ms for a 100 V step
Accuracy (both models)	1% of full scale



### Model 800 Infinetron™ Ultra-High Impedance Voltmeter

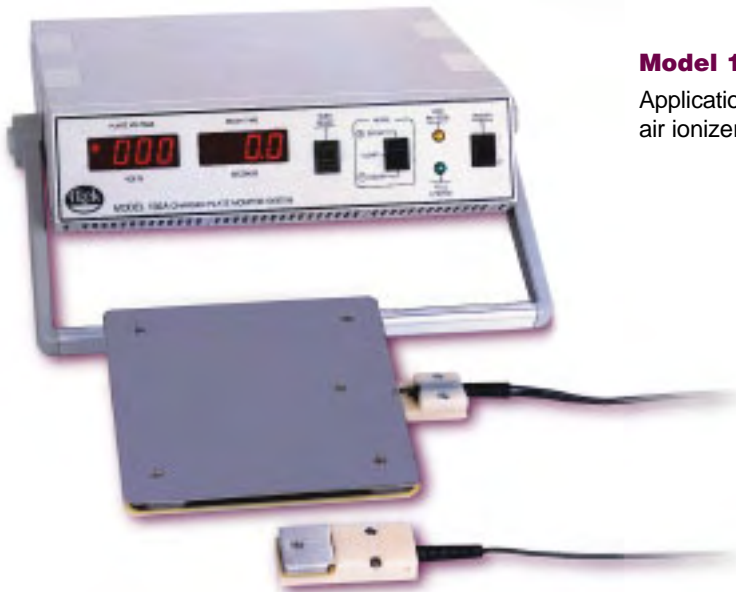
Applications include Accurate reading of electrostatic voltage levels associated with ESD-sensitive components, circuits, and surfaces

- Contacting or noncontacting measurement of electrostatic voltages on surfaces
- HOLD and ZERO Modes: Commanded from the unit, from the probe, or from remote locations
- Voltage Monitor Outputs: 1:1 and 20:1 of measured voltage
- Probe Electrode: May be replaced or interchanged with other style sensor tips

Measurement Range	0 to $\pm 100$ V DC or peak AC
Accuracy	Better than $\pm 0.1\%$ of full scale

*This product is included in the table on p. 20-21*

## CHARGED-PLATE MONITORS



### Model 156A Charged-Plate Monitor

Applications include Evaluating the type, placement and performance of air ionizers used to neutralize static charges

- +Decay, -Decay, or Float mode of operation
- Voltage Monitor Output
- Digital Panel Meter
- Precision Timer for Decay Tests

Monitored Voltage Range  
Stop/Start Voltage Settings  
Start Accuracy

0 to  $\pm 1100$  V DC or peak AC  
1 to  $\pm 1000$  V in 1 V increments  
 $\pm 1$  V of programmed start voltage



### Model 157 Charged-Plate Monitor

Applications include Evaluating the type, placement and performance of air ionizers used to neutralize static charges

- Store & retrieve data as data points or graphs
- Record operator comments for reference
- "Fast" data acquisition mode available
- Ideal for monitoring static charge in a manufacturing facility
- +Decay, -Decay, or Float mode of operation
- Voltage Monitor Output
- Digital Panel Meter
- Precision Timer for Decay Tests

Monitored Voltage Range  
Stop/Start Voltage Settings  
Start Accuracy

0 to  $\pm 1100$  V DC or peak AC  
1 to  $\pm 1000$  V in 1 V increments  
 $\pm 1$  V of programmed start voltage



### Model 158 Charged-Plate Monitor

Applications include Evaluating the type, placement and performance of air ionizers used to neutralize static charges

- Graphical depiction of data
- Store & retrieve data as data points or graphs
- Record operator comments for reference
- "Fast" data acquisition mode available
- Ideal for monitoring static charge in a manufacturing facility
- +Decay, -Decay, or Float mode of operation
- Voltage Monitor Output
- Digital Panel Meter
- Precision Timer for Decay Tests

Monitored Voltage Range 0 to  $\pm 1100$  V DC or peak AC  
 Stop/Start Voltage Settings 1 to  $\pm 1000$  V in 1 V increments  
 Start Accuracy  $\pm 1$  V of programmed start voltage



### Model 540 Electrostatic Monitor

Applications include On-line monitoring of the performance of air ionizers used in critical operations associated with semiconductor, LCD, electronic assembly, and other processes where static charge accumulations pose a threat to production yields and/or product quality

- 3-Digit DPM displays present voltage readings with 0.1 V resolution
- LED bar graph displays present voltage and holds most positive (+) and most negative (-) voltage values
- Programmable audio/visual alarms
- DC stable in ion fields

Monitored Voltage Range 0 to  $\pm 100$  V DC or peak AC  
 Voltage Measurement Accuracy 0.2% of full scale

## CHARGED-PLATE MONITOR SELECTION TABLE

Charged-Plate Monitor Model	Voltage Range (DC or peak AC)	Plates Available	Special Features
156A	0 to $\pm 1100$ V	EOS/ESD Standard 15 cm x 15 cm, 25 mm x 25 mm also	LED Display, Ion Balance, (+) and (-) Decay Measurements
157	0 to $\pm 1100$ V		LCD Display, Ion Balance, (+) and (-) Decay Measurements, Data Storage and Transfer, Computer Software
158	0 to $\pm 1100$ V	Custom Sizes & Custom Capacitances	LCD Display with Waveform Display, Ion Balance, (+) and (-) Decay Measurements, Data Storage and Transfer, Computer Software
540	0 to $\pm 100$ V	25 mm x 25 mm	Ion Balance Monitoring, Programmable Visual and Audible Alarms



**Model 152 Resistance Meter**

Applications include Measurements which comply with ANSI/ESD Association standards for measuring surface resistance and surface resistivity including STM2.1 for garments, STM4.1 for work surfaces, STM7.1 for flooring, STM11.11 for planar materials, and STM11.13 for two-point resistance measurements

**Features**

- Elastomer electrodes for excellent surface contact
- Battery or AC line operated with automatic shutoff
- Light-weight and portable

Offers a wide measurement range of  $10^3$  to  $10^{13}$  ohms, or  $10^4$  to  $10^{14}$  ohms/square using the concentric ring probe

Performs surface resistance measurements with the point-to-point probe or two-point resistance probe and/or surface resistivity measurements with the concentric ring probe

**Specifications**

**PROBE SELECTION TABLE FOR MODEL 152**

Probe Model	Measurement Range	Special Feature
152AP-5P Point-to-Point Probe <i>(upper left in photo above)</i>	$10^3$ to $10^{13}$ ohms	ANSI/ESD-STM4.1 standards  Point-to-point or resistance to ground measurements
152P-CR Concentric Ring Probe <i>(upper right in photo above)</i>	$10^4$ to $10^{14}$ ohms/square	ANSI/ESD-STM11.11 standards  Pre-amplifier internal to the probe eliminates the usual noise, stray pick-up, and long settling time associated with other probe designs
152P-2P Two-Point Resistance Probe <i>(center front in photo above)</i>	$10^3$ to $10^{13}$ ohms	Performs measurements on surface areas too small to be measured with conventional probes



### Model 210HS-2B Charge-to-Mass Ratio (Q/m) Test System\*

Applications include Quick and accurate determination of the charge-to-mass ratio characteristics of both single and dual component electrophotographic toners and other charged particulates

- Pump Switch
- Sample Cell Case
- Display 1 to indicate the charge of the Faraday cage in the Absorption Nozzle Unit
- Display 2 to indicate the charge of the Faraday cage in the Sample Cell Case

# Features

Measurement Range	0 to $\pm 2$ microcoulombs (1.999 $\mu\text{C}$ ) full scale (other ranges optionally available)
Measurement Resolution	0.001 $\mu\text{C}$ (1 nC)
Accuracy	Better than 0.25% of full scale ( $\pm 5$ nC)

# Specifications

\* Measuring toner mass requires the use of a weigh scale which is not included in the Charge-to-Mass Ratio Test System

## PROBES FOR ELECTROSTATIC VOLTMETERS

Please use the table on p.29 as a guide. Selected models which depict the breadth of Trek's offerings are shown here. Standard probe cable length is 3m but other lengths are available.

### Standard Resolution Probes

Available with side/end view options and round/square body options.



### High Resolution Probes

Available with side/end view options and round/square body options.



### Miniature Probes

Available with side/end view options.



### Transparent Probes

These special probes are designed for applications such as photosensitive voltage measurement.



### High Temperature Probes (100°C)

Available with side/end view options.

## ION COLLECTING PLATES FOR CHARGED-PLATE MONITORS

Please use the table on p.35 as a guide. Standard models are shown below. Custom plate sizes and custom capacitances are available by special order.

### Standard Models

Model 156AP-C150x150-R3M  
15 cm x 15 cm (6" x 6" square) plate

Model 156P-C25x25-S3M  
25 mm x 25 mm (1" x 1" square) plate



### High Temperature Charged-Plates

Trek now offers high temperature ion collecting plates (charged-plates) for applications requiring up to 160°C operation. Please contact Trek for more information about this "HT" series.



## PROBES FOR SURFACE RESISTANCE METER

Please use the table on p.36 as a guide. Trek offers three probe styles for its Model 152 Surface Resistance Meter. Please contact Trek for additional assistance with your application.

## ACCESSORIES

### AC Adapters

Trek offers AC adapters for its models that require an AC adapter. The adapters can also be used to charge the internal rechargeable battery of Trek units containing such batteries.

### Bar Code Wand

For Trek's Model 157 Charged-Plate Monitor, a bar code wand is available for applications that need to measure and record data for bar-code-identified equipment.

### Carrying Cases

Please contact Trek if you are interested in obtaining a carrying case for your portable Trek unit. Our standard case is provided with the appropriate internal cushioning to address most situations (to accommodate probes, collecting plates and other accessories as needed).

### High-Voltage Cables

For its high-voltage amplifiers, Trek offers double-insulated high-voltage output cables in standard length (3m) as well as other lengths (5m, 10m, 20m) for additional versatility.

### Ion Collecting Plate Tripod

This portable tripod can be quickly configured to angle the ion collecting plate between 0° and 90° (horizontal vs. vertical position).



### Rack Mount Adapters

Trek offers a variety of rack adapters for its amplifiers and voltmeters. Contact Trek for details.

### Thermohygrometer

A thermohygrometer is available for use with Trek Model 157 Charged-Plate Monitor, for applications where humidity/temperature measurement is important for data collection purposes.

Please go to the Trek website ([www.trekinc.com](http://www.trekinc.com)) for additional helpful information. There you will find more extensive technical information about our products and applications, as well as the latest news regarding Trek's product developments, business endeavors and awards. Rental, sales and service information is also provided, as well as contact details for our global sales & service organizations. There is also a helpful glossary of terms at the website. Trek attends various trade shows and conferences around the world, and frequently authors technical papers and presentations. Information about these and other upcoming events is continually updated at the website.



Trek manufactures standard products as shown in this catalog. We can also design and manufacture custom products for specific applications. We look forward to hearing from you whether you are interested in standard or custom products. Please contact us for assistance.

***TREK, INC. supports the initiatives of both the "Restriction on the use of certain Hazardous Substances" (RoHS) in electrical and electronic equipment and the European Union on "Waste Electrical and Electronic Equipment" (WEEE).***

***Trek product photos in this brochure are not necessarily shown at the same scale.***

***Due to our continuous product quality improvement and customer satisfaction programs, TREK, INC. reserves the right to change specifications in this brochure without notice.***

CE compliant for most products



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FM 56910

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