



# NANOCOULOMB METER

## ETS Model 230 Operating Manual

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Products described in this manual are designed and assembled in the U.S.A. by

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## Important Safety Information



### WARNING

This symbol accompanied by the word "WARNING" calls attention to an act or a condition which can lead to serious personal injury or death of operators and bystanders.



### CAUTION

This symbol accompanied by the word "CAUTION" indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

The symbol without any warning text indicates potential damage to device when misused.



This symbol indicates the presence of hazardous AC or DC voltages constituting the risk of electric shock.



This symbol indicates a risk of fire due to improper handling or failure of device. For continued protection against risk of fire, when replacing fuses use only fuses of the specified type and current ratings.



This symbol indicates the danger of an electro-static discharge to which equipment may be sensitive.

Observe all precautions for handling electrostatic sensitive devices.



These symbols indicate extreme temperature which can cause burns or frostbite. Avoid contact with surface. Failure to follow precautions may result in moderate to severe injury.

## SAFETY INSTRUCTIONS

	<b>WARNING</b>	
	<p><b>Read and fully understand operator's manual before using this machine.</b></p> <p><b>Failure to follow operating instructions could result in death or serious injury.</b></p>	

The equipment described in this manual is designed and manufactured to operate within defined design limits. Any misuse may result in electric shock or fire. To prevent the equipment from being damaged, the following rules should be observed for installation, use and maintenance.

**Read the following safety instructions before operating the instrument.**

## POWER



**POWER CORD:** Use only the power cord specified for this equipment and certified for the country of use. If the power (mains) plug is replaced, follow the wiring connections specified for the country of use. When installing or removing the power plug, **hold the plug, not the cord**. The AC supply must be single phase, with RMS Voltage in range 90 – 264 VAC, alternating at a frequency in range 47 – 63 Hz.

## OPERATION

### **CAUTION**



**DO NOT OPERATE WITH COVERS OR PANELS REMOVED.** Voltages inside the equipment consist of line operating up to 240 VAC.



**DO NOT OPERATE WITH SUSPECTED EQUIPMENT FAILURES.** If any odor or smoke becomes apparent turn off the equipment and unplug it immediately. Failure to do so may result in electrical shock, fire, or permanent damage to the equipment. Contact the factory for further instructions.



**DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.** Operating the equipment in the presence of flammable gases or fumes **constitutes a definite safety hazard**. For equipment designed to operate in such environments the proper safety devices must be used such as dry air or inert gas purge, intrinsic safe barriers and/or explosion-proof enclosures.



**DO NOT IMPEDE THE CHAMBER FROM VENTING EXCESS PRESSURE.** Dehumidification system is an open loop system that pumps external air into the chamber. If the chamber is not allowed to vent, pressure can build up and cause serious damage to the chamber. A pressure monitoring system is highly recommended.



**INLET AIR PRESSURE MUST BE LESS THAN 100 PSI (6.89 Bar) & INLET AIR TEMPERATURE MUST BE WITH RANGE OF 33° - 120° F (0.5° - 49° C)** Serious injury could result.



**APPROPRIATE FILTRATION OF COMPRESSED AIR IS RECOMMENDED.** Build-up of contaminants can damage the desiccant towers & reduce their effectiveness in drying inlet air.  
**AIR PRESSURE MUST BE GREATER THAN 50 PSI (3.45 Bar)** For optimal system performance.



**DO NOT USE IN ANY MANNER NOT SPECIFIED OR APPROVED BY THE MANUFACTURER.** Unapproved use may result in damage to the equipment or present an electrical shock or fire hazard.

## Informations Importantes d'inocuite



Ce symbole accompagné du mot « AVERTISSEMENT » (WARNING) attire l'attention sur un acte ou une condition qui peut entraîner des blessures graves ou la mort des opérateurs et des passants.



Ce symbole accompagné du mot « ATTENTION » (CAUTION) indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourra entraîner des blessures mineures ou modérées. Le symbole sans texte d'avertissement indique des dommages potentiels à l'appareil en cas d'utilisation abusive.



Ce symbole indique la présence d'une climatisation dangereuse ou d'un courant continu constituant le risque de choc électrique.



Ce symbole indique un risque d'incendie dû à une mauvaise manipulation ou à une défaillance de l'appareil. Pour une protection continue contre les risques d'incendie, lors du remplacement des fusibles, utilisez uniquement des fusibles du type et des valeurs nominales spécifiés.



Ce symbole indique le danger d'une décharge électrostatique à laquelle l'équipement peut être sensible. Observez toutes les précautions à prendre pour manipuler les appareils sensibles à l'électricité statique.



Ces symboles indiquent une température extrême qui peut causer des brûlures ou des engelures. Éviter le contact avec la surface. Le non-respect des précautions peut entraîner des blessures modérées à graves.

## CONSIGNES DE SÉCURITÉ



L'équipement décrit dans ce manuel est conçu et fabriqué pour fonctionner dans les limites de conception définies. Toute mauvaise utilisation peut entraîner un choc électrique ou un incendie. Pour éviter que l'équipement ne soit endommagé, les règles suivantes doivent être respectées pour l'installation, l'utilisation et l'entretien. Lisez les consignes de sécurité suivantes avant d'utiliser l'instrument.

## ALIMENTATION



**CORDON D'ALIMENTATION** : Utilisez uniquement le cordon d'alimentation spécifié pour cet équipement et certifié pour le pays d'utilisation. Si la fiche d'alimentation (secteur) est remplacée, suivez les connexions de câblage spécifiées pour le pays d'utilisation. Lors de l'installation ou du retrait de la fiche d'alimentation, **tenez la fiche, pas le fil.**



**MISE À LA TERRE** : Le cordon d'alimentation fourni est équipé d'une **fiche à 3 broches avec mise à la terre (une fiche avec une troisième broche de mise à la terre)**. Il s'agit à la fois d'une fonction de sécurité pour éviter les chocs électriques et d'une exigence pour le bon fonctionnement de l'équipement. Si la prise à utiliser n'est pas compatible avec la fiche à 3 broches, changez la prise ou utilisez un adaptateur de mise à la terre.



**FUSIBLES** : Remplacez les fusibles uniquement par des fusibles ayant le courant nominal, la tension et le type spécifié tels que fusion normale, temporisation, etc. **N'UTILISEZ PAS** de fusibles de fortune ou ne court-circuitez pas le porte-fusible. Cela pourrait entraîner un risque d'électrocution ou d'incendie ou endommager gravement l'instrument.

## OPÉRATION

### PRUDENCE



**NE PAS UTILISER AVEC LES COUVERCLES OU LES PANNEAUX RETIRÉS. Les tensions à l'intérieur de l'équipement consistent en une ligne (secteur) pouvant aller de 100 à 240 VAC.**



**NE PAS UTILISER AVEC DES PANNES D'ÉQUIPEMENT SUSPECTES.** Si une odeur ou de la fumée se dégage, éteignez l'équipement et débranchez-le immédiatement. Le non-respect de cette consigne peut entraîner un choc

électrique, un incendie ou des dommages permanents à l'équipement. Contactez l'usine pour plus d'instructions.



**NE PAS UTILISER DANS UNE ATMOSPHÈRE EXPLOSIVE.** L'utilisation de l'équipement en présence de gaz ou de fumées inflammables constitue un **danger certain pour la sécurité**. Pour les équipements conçus pour fonctionner dans de tels environnements, des dispositifs de sécurité appropriés doivent être utilisés, tels que la purge d'air sec ou de gaz inerte, les barrières de sécurité intrinsèque et/ou les enceintes antidéflagrantes..



**NE PAS EMPÊCHER LA CHAMBRE D'ÉVACUER L'EXCÈS DE PRESSION.** Les systèmes de déshumidification disponibles comprennent des systèmes en boucle ouverte qui pompent l'air extérieur dans la chambre. Si la chambre n'est pas autorisée à s'aérer, la pression peut s'accumuler et causer de graves dommages à la chambre.



**UTILISEZ UNE SOURCE D'EAU DISTILLÉE OU DÉSIONISÉE POUR L'HUMIDIFICATION.** L'accumulation de contaminants sur le transducteur causera

des contraintes au transducteur et à l'électronique et entraînera une défaillance prématurée et invalidera la garantie.



**NE PAS UTILISER D'UNE MANIÈRE NON SPÉCIFIÉE OU APPROUVÉE PAR LE FABRICANT.** Une utilisation non approuvée peut endommager l'équipement ou présenter un risque d'électrocution ou d'incendie.



## II. Description of Contents



Item	Qty.	Description
Model 230	1	Model 230 Circuitry in a metal enclosure.
Ground Cable	1	A 5-foot green rubber cable featuring 2 green banana plugs and an alligator clip
Capacitor Cable	1	Coiled cord, extends to 10', with precision 0.1 $\mu$ F Capacitor.
BNC Connector Cable	1	BNC-to-BNC 3-foot cable.
Batteries	2	9 Volt standard alkaline rectangular (installed)
AC Power module	1	Wall plug-in unit, 18VDC output, 100-240VAC input.



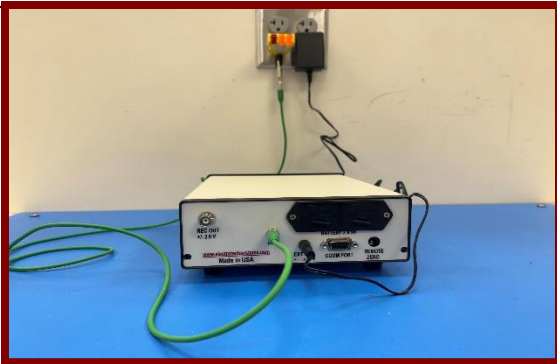
### III. Setup Guide



**Step 1 – Unpack the unit** and verify all parts are present and have survived shipping.

**Note:** *unit comes with batteries installed.*

**Push the POWER button** to turn it on using battery power. At power ON, unit defaults to ZERO STANDBY mode, and RANGE is set to 200nC.



**Step 2 – Verify AC power usage.** Plug **AC Power Module** to an AC source and plug DC cable to “EXT PWR” on rear panel. Then plug one end of the 5-foot green cable to “GND” on rear panel and clamp the alligator clip to an earth ground point. The display’s background lighting should be on.



**Note:** *End user chooses to either use battery or AC power*



**Step 3 - Connect the Faraday cup (or bucket)** to the BNC INPUT connector located on the front panel of the instrument. If the remote READ/ZERO pushbutton and or a recording device are being used, connect them to the respective output connectors located on the rear panel.

**Note:** Cup/bucket not included and can be purchased separately.



**Step 4 – Initial System Test (in battery power only)**

a. **Connect the 0.10  $\mu\text{F}$  test capacitor** supplied with the instrument to the ground jack located on the rear panel and touch the other terminal to the 1.0 Volt red output jack located on the front panel.



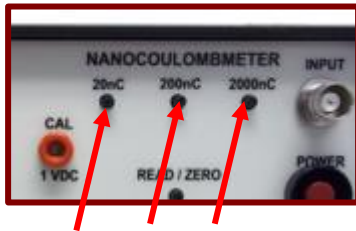
b. **Push READ/ZERO button** to switch to READ mode and touch the tip of charged capacitor to the inner can of the Faraday cup and hold for 2 seconds. The display should indicate  $100 \pm 5 \text{nC}$ .

**Note:** Only touch the inner can with the metal tip of the charged capacitor.



**Step 5 - Push READ/ZERO button** again to return the switch setting to the ZERO STANDBY mode. This completes an initial checkout of the system performance.

## IV. Quick Start Guide.

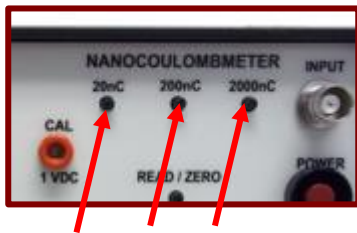


Select the RANGE desired by depressing one of the range selection buttons on the front panel (20, 200 or 2000nC).



Use the READ/ZERO switch to activate the READ mode then immediately drop the charged object to be measured into the cup or bucket without touching the inner cup. Allow approximately 5 seconds before taking a reading.

**Note:** Cup has a conductive rubber disk on the bottom to protect the dropped objects.



If the reading is very low or is over scale, it may be easier to read in an adjacent range. Change the RANGE switch setting and repeat the measurement.

**Note:** Always goes to ZERO STANDBY mode and back to READ mode before making another measurement.

## V. Functionality

The Model 230 measures electrical charge directly, displaying the result in nanocoulombs. The evaluation of triboelectric charge generation is performed by measuring the amount of charge developed on material. When used with a suitable Faraday cup, the charge on a wide range of material types and sizes can accurately be measured by the Model 230 Nanocoulombmeter.

The Model 230 meets the requirements for charge measurement as specified in applicable ESDA, ASTM, EIA, DOD as well as many other industry standards.

The Model 230 is a complete instrument for measuring charge directly in nanocoulombs. The instrument may be used with a Faraday cup or pail, or a detector probe (These items not included – See Appendix A for descriptions.) It can also be used alone to measure the charge on capacitors or from capacitive discharge systems (with adequate protection).

The Nanocoulombmeter has 3 user selectable ranges of 20, 200 and 2000 nanocoulombs to cover a wide range of charge measurement applications. The resolution of the 20 nC scale is 0.01 nC. Drift is <0.05 nC/minute. The instrument incorporates a built-in precision 1.0 Volt output along with a precision 0.10  $\mu$ F, 1% capacitor for checking system calibration.

The Model 230, shown in Figure 4.1, The instrument is housed in a 7.5"L x 10"D x 3"H (190x245x70mm) aluminum case that provides extra shielding from external fields.



Figure 4.1: Model 230 Nanocoulombmeter front panel

The front panel consists of a 2 line / 16-character LCD digital readout with 0.171-inch numerals, 3 push-buttons for RANGE selection, a READ/ZERO push-button, a 1.0 Volt CAL output, POWER ON/OFF switch, and a standard BNC input signal connector. Each depression of a push-button will either select a range (20nC, 200nC, 2000nC) or flip it (between READ/ZERO).

The rear panel, shown in Figure 4.2, consists of the battery compartment, a ground (GND) terminal for referencing the instrument to ground as well as grounding the reference capacitor, a remote READ/ZERO output jack, and a Recorder Output BNC connector.



Figure 4.2: Model 230 Nanocoulombmeter rear panel

The remote REMOTE/ZERO jack enables a remote push-button to be used to place the instrument in the READ mode. When the optional remote push-button is plugged into this jack it parallels the READ/ZERO push-button on the front panel, allowing either button to control this function. This feature makes operating the Model 230 very easy while making measurements in locations such as humidity-controlled glove boxes.

A 0-1.99 Volt signal is available at the Recorder Output corresponding to a 0-full scale reading of the RANGE selected.

The Model 230 is powered by two 9-Volt alkaline batteries that are readily accessible from the rear of the instrument. A “Low Battery” function warns of low battery voltage (<12.2 Volts). An optional AC Power module is included to operate the unit from 100-240VAC, 50/60Hz.



## VI. Detailed Operation

Connect the Faraday cup or bucket to the BNC INPUT connector located on the front panel of the instrument as shown in Figure 6.1. If the remote READ/ZERO pushbutton and or a recording device are being used, connect them to the respective output connectors located on the rear panel.



Figure 6.1: Faraday cup connections

To make a measurement, first select the RANGE desired (20, 200 or 2000nC). Then place the READ/ZERO switch in the READ position or activate the remote READ/ZERO switch immediately prior to placing the charged object to be measured into the cup or bucket. Allow approximately 2 seconds before taking a reading. If the reading is very low or is over scale, but measurable in the adjacent range, change the RANGE switch setting and repeat the measurement.

Each time a new measurement is taken the READ/ZERO button must first be placed in the ZERO STANDBY. When using the ETS Foot Operated Remote READ/ZERO switch the system is functioning as normal. When the foot switch is depressed and released the system flips between the READ/ZERO mode and remains in that mode until the switch is depressed again to switch mode.

When making a measurement **it is extremely important that the operator minimizes the generation of any electrostatic fields.** These fields can be detected, and they will adversely affect the measurement. Cable movement also may cause a triboelectric

charge to be generated on the inner conductor of the shielded input cable and thus any cable movement should be avoided. If the measurement cannot be performed without generating extraneous electrostatic fields, the cover should be placed over the Faraday cup immediately after the charged object has been placed inside, and then the reading taken.

The instrument can also be used to precisely determine the total capacitance of an electronic network by charging the network with a given precise voltage and then discharging the network into the Nanocoulombmeter.

If voltages over 10 Volts are used, then a 1 Megaohm resistor must be placed in series with the input. Otherwise, damage to the instrument may occur. The maximum voltage allowed for this type of measurement **SHOULD NOT EXCEED 1000 Volts**. Using the relationship  $Q=CV$ , the desired capacitance of the network (C) may be calculated by dividing the indicated charge (Q) by the known charging voltage (V).

For example, in several specifications such as Mil-Std-263A and EIA-541 the capacitance of an ESD simulator discharge network is specified at a voltage of 1000 Volts. To determine the capacitance, connect a 1 Megaohm resistor in series with the simulator output and the Model 230 input. Set the charging voltage to precisely 1000 Volts, then discharge the capacitor into the Nanocoulombmeter. A reading of 100nC on the display will correspond to a capacitance of 100pF using the formula:

$$\begin{aligned} C &= Q/V \\ &= 100 \times 10^{-9} / 1 \times 10^3 \\ &= 100 \text{pF} \end{aligned}$$



## VII. Specifications

**READOUT:** 2 lines / 16-character LCD digital meter

**RANGE:** 20, 200, 2000 nC full scale

**RESOLUTION:**

20 nC RANGE: 0.01 nC

200 nC RANGE: 0.1 nC

2000 nC RANGE: 1.0 nC

**DRIFT:** <0.05 nC/minute

**ACCURACY:** 2.0% full scale (max),  $\pm 1$  digit

**ZEROING:** Fully Auto, Front Panel READ/ZERO button & Remote button input

**RECORDER OUTPUT:** 0 -  $\pm 1.99$  Volts, Source Impedance: 1 Ohm (max), BNC connect

**CALIBRATION OUTPUT:** +1.00 Volts,  $\pm 1\%$

**CALIBRATION CAPACITOR:** 0.100  $\mu\text{F}$ ,  $\pm 1\%$

**BATTERY:** 2 each, 9 Volt Alkaline (Duracell MN1804 or equiv.)

**Battery Life:** 20 hours (min) continuous use, 6-12 months (est.) under normal use

**AC Power Module, wall plug-in (+ center):** input 100-240VAC, output 18 VDC

**OPERATING ENVIRONMENT:**  $20 \pm 10^\circ \text{C}$ , 0-60% R.H. (non-condensing)

**DIMENSIONS:** 7.5"L x 10"D x 3"H (190x245x70mm)

**WEIGHT:** 3.3 lbs. (1.5kg)

**FARADAY CONTAINERS:** (Optional – Must be ordered separately)

Model 231 Cup: 3.125" (79mm) Diameter

Model 232 Pail: 12.0" (305mm) Diameter

Model 233 Bucket: 24"x24 x22" (610x610x559mm)

Model 234 Probe: Charge detector Probe

**ACCESSORIES:** (Optional – Must be ordered separately)

PART#230-5844: Foot operated READ/ZERO switch

PART#230-5845: 100-240VAC, 50/60Hz (Replacement)

# VIII. Calibration and Maintenance

## CALIBRATION

The Model 230 is calibrated at the factory using instrumentation traceable to N.I.S.T. Periodic recalibration of any measuring instrument is required if measurement accuracies and proper system performance are to be assured. In most applications, recalibration should be performed on a yearly basis. Contact ETS for recalibration service.

The user can check the calibration of the instrument at any time by using the supplied 0.10 $\mu$ f, 1% polystyrene capacitor, and a calibrated voltmeter having an input impedance greater than 1 Megaohm to verify the accuracy of the built-in voltage source. The capacitor, when charged to 1.00 Volt will produce a reading on the display of 100 $\pm$ 5nC. This procedure provides a system check and **is not a substitute** for periodic laboratory calibration.

To check the calibration of the measurement set-up, connect the clip lead of the calibration check capacitor to the ground terminal on the rear panel or to the outer shell of the Faraday cup or bucket. Select the 200nC RANGE. Touch the lead from the capacitor to the CAL output connector on the front panel. Push the READ/ZERO button to switch to READ mode and then touch the capacitor lead to the inner can or directly to the BNC input connector if a Faraday cup or bucket is not being used. The display should read 100 $\pm$ 5 nC

The other ranges can also be checked with the same capacitor if a precision voltage source is available. 0.10 Volts applied to the capacitor will produce a reading of 10nC in the 20nC RANGE and 10.0 Volts applied to the capacitor will produce a reading of 1000nC in the 2000nC RANGE.

Additional points can also be checked by using different voltages and/or capacitor values (must be known to within 1% and be of the low leakage type). Using the relationship  $Q(\text{nC})=C(\text{nF}) V(\text{Volts})$  any calibration value can be obtained.

## MAINTENANCE

The Model 230 Nanocoulombmeter is designed with low current circuits that provide approximately 20 hours of continuous use from a pair of 9-Volt Alkaline (Duracell Type MN 1604 or equivalent) batteries. When the "Low Battery" indicator appears, this means the 18V battery has dropped to 12.2 Volts, and the batteries should be replaced to retain measurement accuracy.

To change batteries, remove the battery cover mounted on the rear panel. The batteries are connected to the instrument by a pair of standard 9-Volt battery clips. Both batteries should be replaced at the same time. Replace the battery cover.

If the instrument fails to operate properly it should be returned to ETS for repair and recalibration. A Return Material Authorization (RMA) must be obtained from ETS prior to sending in the instrument. The instrument should be packed in adequate packaging to avoid incurring any shipping damage.

## IX. WARRANTY

Electro-Tech Systems, Inc. warrants its equipment, accessories and parts of its manufacture to be and remain free from defects in material and workmanship for a period of one (1) year from the date of invoice. It will, at the discretion of Seller, either replace or repair without charge, F.O.B. Glenside, similar equipment or a similar part to replace any equipment or part of its manufacture which, within the above stated time, is proved to have been defective at the time it was sold. All equipment claimed defective must be returned properly identified to the Seller (or presented to one of its agents for inspection). This warranty only applies to equipment operated in accordance with Seller's operating instructions.

The seller's warranty with respect to those parts of the equipment that is purchased from other manufacturers shall be subject only to that manufacturer's warranty.

The Seller's liability hereunder is expressly limited to repairing or replacing any parts of the equipment manufactured by the manufacturer and found to have been defective. The Seller shall not be liable for damage resulting or claimed to result from any cause whatsoever.

This warranty becomes null, and void should the equipment, or any part thereof, be abused or modified by the customer or if used in any application other than that for which it was intended. This warranty to replace or repair is the only warranty, either expressed or implied or provided by law, and is in lieu of all other warranties. The Seller denies any other promise, guarantee, or warranty with respect to the equipment or accessories. In particular, as to its or their suitability for the purposes of the buyer or its or their performance, either quantitatively or qualitatively or as to the products which it may produce, and the buyer is expected to expressly waive rights to any warranty other than that stated herein.

ETS must be notified before any equipment is returned for repair. ETS will issue an RMA (Return Material Authorization) number for the return of equipment.

Equipment should be shipped prepaid and insured in the original packaging. If the original packaging is not available, the equipment must be packed in a sufficiently large box (or boxes if applicable) of double wall construction with substantial packing around all sides. The RMA number, description of the problem along with the contact's name and telephone number must be included in formal paperwork and enclosed with the instrument. Round trip freight and related charges are the owner's responsibility.

## X. APPENDIX A – Available Accessories

Three different standard size Faraday cups/buckets shown in Figures 9.1 are available. Special Faraday cups or buckets can also be provided on special order. The Model 231, 3.125" (79mm) and the Model 232, 12" (305mm) units consist of two round concentric aluminum containers assembled together with Teflon insulators between them. The outer can is connected to ground and the inner can comprises the sensing input. A cover is supplied to completely shield the inner can when making critical measurements in a high electrostatic field environment.



Model 231



Model 232



Model 233

Figure 9.1: Standard Faraday cups/buckets

The large 24"x24"x22" (610x610x589mm) Faraday Bucket (Model 233) is a welded assembly that is fabricated from 0.093" aluminum. This bucket is designed for evaluating large material samples or complete assemblies. All Faraday cups and buckets are connected to the instrument by a 3-foot Teflon™ insulated cable.

The Model 234 Charge Detector Probe shown in Figure 9.2 is designed to measure charge on the surface of an object while it is being triboelectrically charged due to motion of another media flowing, rubbing against, or separating from the test object.



Figure 9.2: Model 234 Charge Detector Probe