NANOCOULOMBMETER

Model 230

Operating Manual

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electro-tech systems, inc.
www.electrotechsystems.com
3101 Mt. Carmel Avenue, Glenside, PA 19038 • Tel: (215) 887-2196 • Fax: (215) 887-0131

1.0 INTRODUCTION

The evaluation of triboelectric charge generation is performed either by measuring the voltage build up on material after it has been separated from the same or different material or by measuring the amount of charge developed on the 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 is a complete instrument for measuring charge directly in nanocoulombs. The instrument is available with either a 3.125" (79mm) diameter Faraday cup, a 12" (305mm) diameter Faraday pail, a 24"x24"x22" (610x610x559mm) Faraday Bucket; a detector probe or it can 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 µF, 1% capacitor for checking system calibration.

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

2.0 EQUIPMENT DESCRIPTION

The Model 230, shown in Figure 1.0-1, is powered by two 9-Volt alkaline batteries that are readily accessible from the rear of the instrument. An optional AC Power module is available to operate the unit from 95-240VAC, 50/60Hz. A "Low Battery" function warns of low battery voltage (<12.2 Volts). 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.

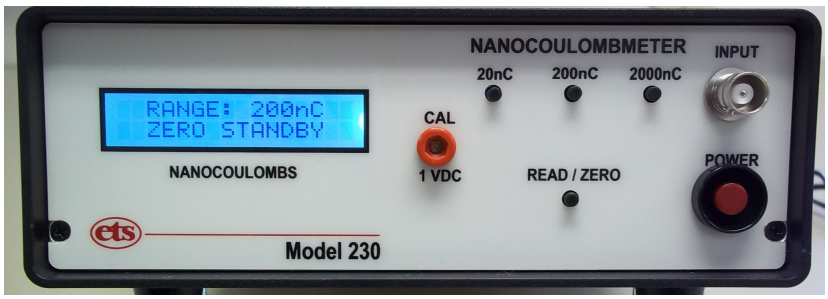

Figure 2.0-1: Model 230 Nanocoulombmeter front panel

The front panel consists of a 2 line / 16 character LCD digital readout with 0.171 inch numerals, a 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 depress of a push-button will either select a range (20nC, 200nC, 2000nC) or flip it (between READ/ZERO).

The rear panel, shown in Figure 2.0-2, 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.

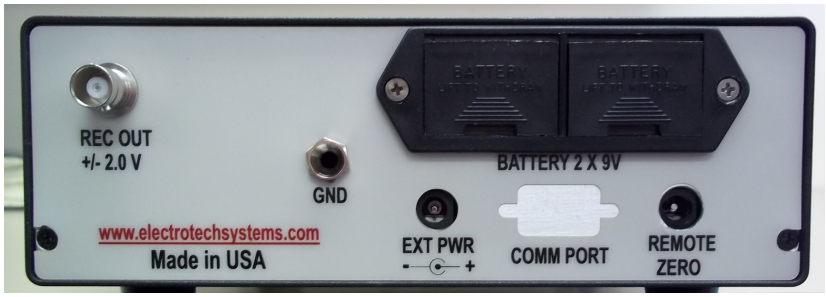

Figure 2.0-2: Model 230 Nanocoulombmeter rear panel

The remote READ/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.

Three different standard size Faraday cups/buckets shown in Figures 2.0-3a, b &c 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.

a
. Model 231 b. Model 232 c. Model 233

Figure 2.0-3: 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 2.0-4 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 or separating from the test object.

Figure 1-1: Model 234 Charge Detector Probe

3.0 OPERATION

Connect the Faraday cup or bucket to the BNC INPUT connector located on the front panel of the instrument as shown in Figure 3.0-1. If the remote READ/ZERO push-button and or a recording device are being used, connect them to the respective output connectors located on the rear panel.

Figure 3.0-1: Faraday cup connections

3.1 Preliminary Checkout

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

Connect the 0.10 μF 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 output jack located on the front panel. Push READ/ZERO button or depress and release the remote foot switch to switch to READ mode and touch the charged capacitor to the inner can of the Faraday cup. The DPM should indicate 100±2nC.

Place the cover on the Faraday cup or bucket. With the RANGE switch set to the 20 nC position, place the READ/ZERO switch in the READ position and observe the DPM for one minute. The reading should not exceed 0.05nC. Return the switch setting to the ZERO STANDBY. This provides an initial checkout of the system performance.

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 (measurable in the next lower range) or is over scale, 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 minimize 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 MegOhm resistor must be placed in series with the input.

Taking measurements using the Model 234 Detector Probe is covered in its respective Instruction Manual.

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 a number of 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 MegOhm 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 DPM will correspond to a capacitance of 100pF using the formula:

$$C = Q/V$$
$$= 100x10^{-9}/1x10^{3}$$
$$= 100pF$$

4.0 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 0.10µf, 1% polystyrene capacitor, and a calibrated voltmeter having an input impedance greater than 1 MegOhm to verify the accuracy of the built-in voltage source. The capacitor, when charged to 1.00 Volt will produce a reading on the DPM of 100±2nC. 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 DPM should read 100±2 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(nC)=C(µF) V(Volts) any calibration value can be obtained.

5.0 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” shows 12.2 Volts, 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.

6.0 SPECIFICATIONS

READOUT: 2 line / 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), ±1 digit
ZEROING: Fully Auto, Front Panel READ/ZERO button & Remote button input
RECORDER OUTPUT: 0 - ±1.99 Volts, Source Impedance: 1 Ohm (max), BNC connect
CALIBRATION OUTPUT: +1.00 Volts, ±1%
CALIBRATION CAPACITOR: 0.100 µF, ±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 (+ center): 90-260VAC, 50/60Hz (Optional)
OPERATING ENVIRONMENT: 20±10º 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:
Model 231 Cup: 3.125" (79mm) Diameter
Model 232 Pail: 12.0" (305mm) Diameter
Model 233 Bucket: 24"x24 x22" (610x610x559mm)
Model 234 Probe:
ACCESSORIES: PART#230-5844: Foot operated READ/ZERO switch
PART#230-5845: 90-260VAC, 50/60Hz (Optional)
PART#230-5847: 0.01 & 1.0 µF Test Capacitors
PART#705-5848: Foot Operated Accessory ON/OFF Switch for ionizer

7.0 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 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.

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 of 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 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 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.