Operators' Manual
Monroe Electronics, Inc.
Model 284
NanoCoulomb Meter

P/N 0340117
284-1/100
Rev A

MONROE ELECTRONICS
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Section 1

SPECIFICATIONS:

Display: ½" x 3½ digit LCD

Standard Ranges:

Range:	Resolution:
200nC	0.1nC
20nC	0.01nC

Optional Ranges Available:

Range:	Resolution:
2000nC	1.0nC
2.0nC	0.001nC

Accuracy: 2%

Output: 0 to ±2 volt analog, 1kΩ

Drift: 0.1pC/sec. Typical

Battery: 9 volt Eveready #216 or equivalent NEDA #1604.
Battery life over 400 hours.

Dimensions: 6" x 3½" x $2^{1}/_{8}$" (150mm x 90mm x 54mm)

Weight: 8½ oz. (0.24 kg) with battery

Compatible accessory probes:

Faraday Cup, Model 284/22A:
Outer dimensions (nominal)—
3½" dia. x 5¾" tall
Inner dimensions (nominal)—
$2^{5}/_{8}$" dia. x 2¾" deep

Faraday Cup, Model 284/22B:
Outer dimensions (nominal)—
8" dia. x 10" tall
Inner dimensions (nominal)—
6" dia. x 6¾" deep

Faraday Cups are equipped with BNC connectors and furnished with 3-foot mating cable to connect to Model 284 instrument. Can be used to measure powders and liquids as well as solid objects.

Point contact probe:
Various—contact factory

Section 2

GENERAL INFORMATION

The Monroe Electronics Model 284 Nanocoulomb Meter is a convenient battery powered portable instrument for direct measurement of charge in the range between 1 picocoulomb (limit of resolution) and 2 microcoulombs (maximum displayable value). The standard instrument configuration provides two ranges—±19.99nC and ±199.9nC—with one-decade extension in either direction available as a factory option at time of order or as an aftermarket upgrade.

The NanoCoulomb Meter charge amplifier consists of an I.C. electrometer amplifier with a high quality capacitor connected in the negative feedback position. The input terminal (center pin of a BNC connector) feeds the inverting input of the amplifier through a current limiting resistor. This inverting input is at zero volts or virtual ground so all charge that is induced or directly deposited at the input terminal is transferred to the integrating capacitor. Since Q=CV, the output voltage of the charge amplifier is directly proportional to the charge injected in the input, that is, for a 0.1μF integrating capacitor, a +100 nanocoulomb input equals –1.0 volt at the output. The input being at virtual ground reduces leakages and polarization of insulators, thus minimizing these effects on the readings.

The NanoCoulomb meter is zeroed by a low leakage momentary contact switch, which discharges the integrator. A built-in reference quality voltage splitter corrects for all offsets.

The electrometer is followed by a scaled-gain inverter, which is used to correct the gain error caused by variations in capacitors and the inversion of the input amplifier and to drive the 3½ digit Liquid Crystal Display (LCD) and the analog output circuit.

The readout is thus always expressed directly in nanocoulombs with the decimal point properly placed and the output is always 2 volts for full scale, regardless of range.

In order to be fully functional, the Model 284 requires some sort of input source device. Two types of input devices are readily available from Monroe Electronics as accessories to the Model 284—Faraday cups and contact probes.

The Faraday cup consists of two concentric cans with expanded polyethylene as an insulator between them. The outer can is at ground potential and the inner can is the sensing electrode for the electrometer. These are available in two standard sizes or may be custom designed to order.

The point contact probe is held in a manner similar to which one would hold a pen or pencil and is used to make charge measurements by direct contact with small objects or small areas of objects such as individual pins on IC's.

Any input device used must have low leakage ($>10^{11}\Omega$) and provide an electrical reference (usually earth ground).

Section 3

OPERATION

The Monroe Electronics Model 284 Nanocoulomb Meter has been designed for extreme ease of operation.

1. Connect Faraday cup to Model 284.
2. Switch power on.
3. Set to least sensitive range (decimal point furthest to the right for your instrument).
4. Zero the instrument.
5. Place charged object in cup and take reading.

The Faraday cup comes with a cover, which can be used when zeroing or when taking readings in areas where one suspects that outside electric fields may be affecting readings.

One can measure both “mobile” and “immobile” charge in objects to be tested. To do this, follow the above procedure. After step 5, note the reading (this reading is the “total” charge reading). Then remove the object being tested by dumping it out of the cup or by lifting it out with a set of wooden tongs. The reading that is now being displayed in the meter is the “mobile” charge on the object being tested.

Since “total” charge = “mobile” charge + “immobile” charge, we can calculate the “immobile” charge by subtracting the “mobile” charge from the “total” charge.

Section 4

CALIBRATION CHECK

The purpose of this section is to provide the operator of the Monroe Electronics Model 284 Nanocoulomb Meter with a means of verifying that overall calibration of the instrument is within the specified limits (±2%).

Method 1:

Procure a calibration capacitor. It should be a polystyrene or polypropylene capacitor with a precisely known value of approximately 10nF (0.01μF) (Mallory SX-110 or equivalent).

With the capacitor charged to exactly 1.00 volt and then discharged directly into the input terminal (BNC connector) or between the inner and outer parts of the Faraday cup, a meter reading equal to the capacitor value (±2%) should appear on the Digital Panel Meter (DPM) set to the 20-nCoulomb range.

Charging the calibration capacitor to 10.00 volts and then discharging it into the input should produce a DPM reading of ten times the capacitor value (±2%) on the 200-nCoulomb range.

It is important to handle the calibration capacitor very carefully. Do <u>not</u> hold the capacitor by its body or discharge it by touching both leads with the fingers. Hold the capacitor by <u>one lead only</u>. Use a clip-lead connected between the GND jack and this lead of the capacitor to maneuver the other lead of the capacitor between the “hot” side of the charging source and the input terminal.

Method 2:

Use a secondary standard charge source such as a Keithley Model 263 Calibrator/Source, following manufacturer’s instructions.

Incorrect DPM readings indicate a need for calibration.

WARRANTY

Monroe Electronics, Inc., warrants to the Owners, this instrument to be free from defects in material and workmanship for a period of two years after shipment from the factory. This warranty is applicable to the original purchaser only.

Liability under this warranty is limited to service, adjustment or replacement of defective parts (other than tubes, fuses or batteries) on any instrument or sub-assembly returned to the factory for this purpose, transportation prepaid.

This warranty does not apply to instruments or sub-assemblies subjected to abuse, abnormal operating conditions, or unauthorized repair or modification.

Since Monroe Electronics, Inc. has no control over conditions of use, no warranty is made or implied as to the suitability of our product for the customer's intended use.

THIS WARRANTY SET FORTH IN THIS ARTICLE IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS, IMPLIED OR STATUTORY INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS. Except for obligations expressly undertaken by Monroe Electronics, in this Warranty, Owner hereby waives and releases all rights, claims and remedies with respect to any and all guarantees, express, implied, or statutory (including without limitation, the implied warranties of merchantability and fitness), and including but without being limited to any obligation of Monroe Electronics with respect to incidental or consequential damages, or damages for loss of use. No agreement or understanding varying or extending the warranty will be binding upon Monroe Electronics unless in writing signed by a duly authorized representative of Monroe Electronics.

In the event of a breach of the foregoing warranty, the liability of Monroe Electronics shall be limited to repairing or replacing the non-conforming goods and/or defective work, and in accordance with the foregoing, Monroe Electronics shall not be liable for any other damages, either direct or consequential.

RETURN POLICIES AND PROCEDURES

FACTORY REPAIR:

Return authorization is required for factory repair work. Material being returned to the factory for repair must have a *Return Material Authorization* number. To obtain an RMA number, call 716-765-2254 and ask for Customer Service.

Material returned to the factory for warranty repair must be accompanied by a copy of a dated invoice or bill of sale, which serves as a proof of purchase for the material.

Repairs will be returned promptly. Repairs are normally returned to the customer by UPS within ten working days after receipt by Monroe Electronics, Inc. Return (to the customer) UPS charges will be paid by Monroe Electronics on warranty work. Return (to the customer) UPS charges will be prepaid and added to invoice for out-of-warranty repair work.

EXPEDITED FACTORY REPAIR:

All material returned to the factory by air or by an overnight service will be expedited. Expedited factory repairs will be returned to the customer by the same mode of transportation by which the material was returned to the factory for repair (i.e., material returned to the factory by an overnight service will be returned to the customer by an overnight service).

NOTE: Return (to the customer) transportation expenses for expedited factory repairs will always be at the expense of the customer despite the warranty status of the equipment.

FACTORY REPAIRS TO MODIFIED EQUIPMENT:

Material returned to the factory for repair that has been modified will be not tested unless the nature and purpose of the modification is understood by us and does not render the equipment untestable at our repair facility. We will reserve the right to deny service to any modified equipment returned to the factory for repair regardless of the warranty status of the equipment.