INSTRUCTION MANUAL

MODEL 245

PORTABLE ELECTROSTATIC FIELDMETER

Model 245 S/N ______

Model 1019B-___ S/N ______

MONROE ELECTRONICS

●Manual Revisions●

State-of-the-art improvements are incorporated in instruments manufactured by Monroe Electronics, Inc. as they are proven by our Engineering Department. This ensures that our customers receive the very latest in electronic technology in our products.

As these revisions are instituted sometimes just prior to shipment, the main body of the applicable instruction manual may not reflect the information pertinent to specific change.

Alterations to your manual should be made as follows to assure technical correctness:

Product: 245K .... Eng. Ref.: Special

Man. P/N: 245/100 .... Man. Rev.: ....

Eff. S/N: .... Date: ....

DESCRIPTION OF CHANGE

The Monroe Electronics Model 245K is virtually identical to Model 245 with the following exceptions:

1. Model 245K is supplied with a Model 1019B-5 probe instead of Model 1019B-4. The sensitivity of the 1019B-5 is exactly one half that of the 1019B-4 (when properly standardized). Thus, Model 245K has a range of ±20,000 volts per centimeter.

2. Front panel range switch markings refect this variation so that the user need only read the meter directly to obtain a correct answer.

   Values of R-45 and R-48 inthe meter range switch circuit have been changed to effect this change.

3. Voltage at the recorder output jack is such that +2kv/cm at the input produces +1 volt at the output and -2kv/cm at the input produces -1 volt at the output for linear monitoring and one volt per decade for logarithmic scaling.

4. In steps 4-D-4 and 4-D-6 and NOTE following 4-D-11 (Section 4) use ±5 volts, ±1% instead of ±10 volts for calibration of Logarithmic Amplifier. Table 2-1 is correct.

5. A precision -2000 volt high voltage source is required for calibration. (See Section 4)

■Manual Revisions■

State-of-the art improvements are incorporated in instruments manufactured by Monroe Electronics, Inc. as they are proven by our Engineering Department to ensure that our customers receive the very latest in electronic technology as relates to our products.

As these revisions are instituted sometimes just prior to shipment, the main body of the applicable instruction manual may not reflect the information pertinent to specific change.

Alterations to your manual should be made according to the following to ensure technical correctness.

Product: 1019 Eng. Ref.: New product

Man. P/N: n/a Man. Rev.: n/a

Eff. S/N: ______ Date: March 5, 1991

DESCRIPTION OF CHANGE

Monroe Electronics, Inc. fieldmeter probes Types 1019A and 1019B are no longer being produced and have been replaced by Types 1019E and 1019F, respectively.

The new probes are directly electrically interchangeable with the old and offer superior performance in most respects. They are approved for use in Class I, Division 1, Groups C and D hazardous locations when used with appropriate barriers.

A manual specific to the new Types 1019E and 1019F probes has been included with your order. The information presented is to supplement or supercede references to the older probes given in your instrument manual.

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Section 1

SPECIFICATIONS

A. General:

The Model 245 Portable Electrostatic Fieldmeter measures electrostatic field (potential gradient) in kilovolts per centimeter. It may also be used to measure surface voltage by using the probe-to-surface separation as a calibration factor.

The instrument utilizes all solid state components including modern integrated and hybrid circuits and Light Emitting Diode indicators.

It may be operated from world-wide AC power lines or afield using a built-in lead dioxide battery pack.

All essential operating controls are located on the instrument's panel. The meter features both linear scales and a logarithmic scale. Seven linear ranges and one logarithmic range are switch selectable. A panel mounted BNC connector provides a choice of linear or logarithmic output.

Also on the panel are a 5-way grounding post, a probe holder/ zeroing plate, battery condition LED indicators and connector for interchangeable probes (1019B-4 is standard).

The rugged case is fitted with a cover which has breakaway hinges and provides storage space for the probe and line cord. It is equipped with a carrying handle and shoulder strap.

B. Applications:

A major application of the Model 245 is the monitoring of electrostatic charge accumulation. As charge increases on the surface of a material, the electrostatic field in the vicinity also increases proportionately. Thus the Model 245 reliably provides an output signal proportional to the surface charge accumulation while making NO PHYSICAL CONTACT to the material being monitored.

Other applications include:

--- Safety monitoring in explosive atmospheres
--- Atmospheric electricity measurements
--- High voltage DC transmission terminal measurements
--- Monitoring of coating, capping or filling processes

C. Intrinsic Safety Features:

The Model 1019 Probe is designed to meet intrinsic safety standards for operating in hazardous areas. The Model 245 contains internal barriers so that non-intrinsically safe equipment may monitor its output.

The following specific safety features illustrate the general design philosophy:

1. The power to the probe (which may be used in hazardous location) is limited by use of zener diodes and MF or WW resistors for "safe" limiting with two failures.

2. Spark energy at the probe is limited to less than 50μ J.

3. Output is protected by an internal resistor/zener diode barrier and fuse so that a line voltage "fault" applied to the output cannot get into the low voltage circuitry even under "two fault" conditions. Therefore, equipment connected to the Model 245 fieldmeter need not be intrinsically safe.

D. Specifications:

Range:	0 to ±10,000 v/cm. Zero center meter ranges of 100, 200, 500, 1000, 2000, 5000, 10,000 v/cm. A zero center logarithmic scale is also provided covering the entire range of the instrument on a single meter scale. ±20,000 v/cm, ±1000 v/cm and ±100 v/cm full scale probes are also available.
Sensitivity:*	10 v/cm.
Static Accuracy:*	Better than 3%.
Drift:*	Less than 5 v/cm/hr, non-cumulative after 30-minute stabilization.
Noise:*	Less than 3 v/cm rms.
Speed of Response:	Less than 500 msec, 10% to 90%.
Safety:	A maximum of 14 v and 50μ J is available AT THE PROBE to minimize spark hazards and provide for personnel safety.
Temperature Range:	1. Probe: -30 to +100°C. 2. Main Electronics: 0 to +50°C.

Power Requirements:	180-260 v or 90-130 v AC, ±10%, 50/60 Hz, <10 w.
Battery Life:	12 hours of continuous operation without recharging. Rechargeable a minimum of 500 times (with normal care, as required by lead dioxide type batteries).
Output:	An output connector is provided for external recording or control. Two output signals are available; linear at +1 v/kv/cm, and logarithmic at +1 v/decade.
Probe Dimensions:	Standard probe Model 1019B-4 1 3/4" (4.5 cm) diameter x 1 5/16" (3.3 cm) high. 10 oz (0.28 kgm) with standard 10 foot (3 M) cable.
Size and Weight:	6" x 9" x 8 1/2" high case (with carrying handle and shoulder strap). 10 lbs (4.5 kgm).

*These parameters are specified with a 1019B-4 probe in an uncontaminated atmosphere at constant temperature and humidity using a probe purged constantly with clean dry air.

Specifications are subject to change without notice.

Section 2

INSTALLATION

A. Portable Operation:

The Model 245 Portable Electrostatic Fieldmeter is designed to provide portable operation and is equipped with a rechargeable lead dioxide battery power supply, carrying handle, shoulder strap and breakaway cover hinge.

Since electrostatic field measurements are made with respect to ground, a large copper grounding clamp is provided for the purpose of establishing a ground reference. A binding post on the upper left corner of the instrument panel is instrument ground.

B. Power Line Operation:

A removable three-wire grounding line cord is provided for battery recharging and for line operation of the Model 245. The instrument chassis is normally grounded when connected to the power line.

The power line connector is located on the rear of the instrument.

When the instrument is shipped from the factory, it is set to operate and has been tested at the predominant line voltage and frequency of the country in which its use is anticipated. An adhesive label is affixed near the power connector indicating this voltage and frequency. It is recommended that prior to use, this tag be checked to ascertain that the operating voltage and frequency does indeed match the voltage and frequency of the power line to which the instrument will be connected.

NOTE: Model 245 will operate only on AC power.
DO NOT CONNECT TO A DC LINE!

In the event the operating voltage must be changed to match the available power source, set voltage selector switch (inside case, near power connector) to the appropriate position. It is then recommended that a user supplied tape or label indicating the correct line voltage and frequency be applied over the above-mentioned tag.

It may, in some cases, be desirable to change the line cord plug to another style. A grounding type adapter may be used or the plug may be cut off and another substituted.

The wire color code for the line cord provided is:

HIGH SIDE OF LINE	-	BLACK
LOW SIDE OF LINE	-	WHITE
SAFETY GROUND	-	GREEN

C. Installation of Probe:

NOTE: Model 1019-4 supplied as standard.

Probe mounting requirements for electrostatic field determinations will vary somewhat with the nature of the desired measurement. In general, it will be best to mount the probe as near as possible to the surface to be monitored --- so long as the input signal remains less than 10 kv/cm.

The mounting block is electrically isolated from the rest of the probe and should be connected to an electrically grounded holder.

The gradient cap, however, is not at ground potential and must be insulated from grounded parts of the probe and supporting structure.

It is recommended that, if possible, the probe be mounted "looking" downward in order to minimize the possibility of contamination entering the aperture.

Two diametrically opposite #6-32 threaded holes 7/8" (22.2 mm) O.C. in the top plate are intended for mounting purposes. These are blind holes 1/4" (6.4 mm) deep, therefore, the correct length screw must be chosen for a given situation to avoid bottoming in the holes.

The probe may be hand held by its cover for field survey measurements.

D. Purge Tube:

See OPERATION Section and APPENDIX II.

The purge tube supplied with each probe is designed to screw into one of two tapped holes in the top plate of the probe. These exit at 90° to each other. The choice of which to use is primarily a matter of convenience of routing of the hose carrying the purging gas.

To attach the purge tube to the probe, one of the two #6-32 Allen set screws near the cable should be removed and the purge tube inserted in its place.

A Monroe Electronics, Inc. Purge Kit, Model 1019/22G, or clean, dry shop air or dry inert gas such as nitrogen may be used for purging. Gas pressure should be in the order of 14" of water (1/2 lb/sq in or 35 gm/sq cm).

E. Output:

In addition to a zero-center panel meter, a BNC connector is provided for a choice of analog or logarithmic (switch selectable) output. The analog output has a range of ±10 v DC for an input of 100% of the probe sensitivity or +1 v per +1 kv per cm when the standard probe is used.

The logarithmic output is 1 v per decade as shown in Table 2-1.

Table 2-1

INPUT	OUTPUT	INPUT	OUTPUT
+0.01 kv/cm	+1 v	-0.01 kv/cm	-1 v
+0.1 kv/cm	+2 v	-0.1 kv/cm	-2 v
+1.0 kv/cm	+3 v	-1.0 kv/cm	-3 v
+10.0 kv/cm	+4 v	-10.0 kv/cm	-4 v

The output impedance is 1 kΩ (required for intrinsic safety). Recommended loading of 1 meg will introduce a fixed 0.1% error. Lower resistance loading, obviously will produce a greater error.

The output is referred to the shell of BNC connector (ground).

Section 3

OPERATION

The probe should be mounted in proximity to the surface under measurement in accordance with the preceding installation instructions.

A. Power Supply:

Charging current is supplied to the internal battery power supply whenever the Model 245 is connected to the correct AC power source (90-130 v, 50-60 Hz or 180-260 v, 50-60 Hz - See SPECIFICATIONS), whether or not the instrument is in operation.

The instrument may be turned off and stored with its line cord connected to the power line as electronic regulation prevents overcharging of the internal battery.

Electronic regulation also prevents operation of the instrument whenever the battery voltage has decayed below the normal, useful output. The battery must be recharged when this occurs.

NOTE: A complete recharging cycle requires approximately 8-16 hours regardless of whether or not the instrument is in operation.

B. Battery Condition Indicators:

Two panel mounted Light Emitting Diodes indicate the condition of the internal rechargeable battery. The GREEN L.E.D. (marked O.K.) flashes approximately every 1 1/2 seconds when the battery is charged to its normal operating voltage range also indicating that the instrument is turned on.

The RED L.E.D. (marked LOW), normally off will be illuminated only when the battery voltage is approaching a critically low state thus warning the user that the instrument will soon cease to operate normally.

The GREEN L.E.D. continues to flash so long as the instrument is in operation.

In the event that neither L.E.D. is lighted, the instrument is no longer functioning and the internal battery must be recharged.

Further information may be found in the THEORY section.

C. Meter Range/Power Switch:

The OFF position turns the instrument off, although the battery charging circuit remains active whenever the line cord is connected to the power line.

The LOG position allows the operator to use the logarithmic meter scale for set-up purposes and gross evaluation of operating conditions.

The remaining switch positions select the maximum full scale meter ranges.

D. Zero Control:

The proper use of the instrument's ZERO control necessitates a thorough comprehension of instrument limitations which, in turn, influence the instrument's ZERO. Please consider the following.

1. Importance of Stable Medium:

   It can be demonstrated that any "contamination" present in the probe or in the vicinity of the measurement will have an adverse affect on performance which will be exhibited as a DC offset that usually will drift with time. "Contamination", in this sense, refers to any time varying change in contents of the local environment around the probe and surface under measurement. Included are changes in the constituent gases of the atmosphere as well as aerosols and airborne particles.

   The nature of this contamination effect is easily understood in the case of non-conducting solids or liquids which can trap electrostatic charges on a sensitive surface. Less obvious is the influence of gaseous atmospheric constituents which "contaminate" by altering the contact potentials between critical surfaces.

2. Probe Cleanliness:

   Where accurate and/or low level measurements are called for, drift must be avoided. Extreme cleanliness and attention to airborne contaminants is vital.

   All surfaces involved in measurement should be scrupulously cleaned by the use of a suitable volatile solvent. (See Appendix I.)

   CAUTION: DO NOT USE ANY ABRASIVE CLEANERS ON THE PLATED ELECTRODES OR THE SURFACE WILL BE DESTROYED.

3. Gas Purging:

A distinct aid in maintaining a clean environment in which to use the probe is a gas purge kit (1019/22G) available for the Model 1019B series probes. This kit consists of a low volume, long life air pump which is connected to a filter capable of both mechanical and chemical air filtration. The necessary tubing and additional fittings are included with the kit which is available from the factory in the event it was not ordered with the instrument.

This kit is particularly recommended in the event that the probe is to be used in a highly contaminated environment.

The pump is fully capable of operation on a 24-hour per day basis, thus keeping the probe ready for immediate use.

4. Reference Electrode:

A reference electrode is mounted on the panel of the Model 245. It consists of a grounded, gold plated surface and an upper insulating structure to act as an insulated spacer between the gold reference surface and the probe.

> NOTE: TO AVOID UNNECESSARY CONTAMINATION OF BOTH PROBE AND REFERENCE ELECTRODE STORE THE PROBE IN THIS HOLDER WHEN NOT IN USE.

5. Zero Adjustment-Gold Reference:

The instrument ZERO is established by mounting the probe in the form fitting holder on the reference electrode.

If the probe and electrodes are clean and stable, a zero field and contact potential condition exists between the surface and the probe.

The instrument ZERO control can now be adjusted for zero output as indicated on the front panel meter or external indicator.

6. Zero Adjustment-Arbitrary Reference:

The above procedure is recommended to establish a zero field environment for zeroing the instrument.

It is quite possible that the user may wish to observe gradient changes with reference to some other ground electrode.

In this event it is necessary only to bring the probe into close proximity to the chosen reference surface as described in the INSTALLATION section and adjust the Zero control as desired.

CAUTION: THE BOTTOM PLATE OF THE PROBE MUST NEVER MAKE PHYSICAL CONTACT WITH THE SURFACE UNDER TEST.

E. Output:

A BNC type output connector provides either linear or logarithmic output signals representative of the input. The choice is selectable by a two position toggle switch directly below the connector.

Please refer to the INSTALLATION section and Table 2-1 for further information.

F. Test Button:

The panel mounted miniature red pushbutton switch marked TEST, when pressed, verifies that the instrument is operational. While operating closed loop, pushing this button should deflect the meter to its right hand stop when the range switch is set to the 10 kv/cm position. Upon releaseing the button the meter reading should return to its previous reading within a second. If the response appears sluggish or uncertain, you may have instrument problems.

G. Power Cord Connector:

Located on the rear of the instrument cabinet, this connector mates with the power cord supplied.

CAUTION: CONNECT ONLY TO THE CORRECT AC POWER SOURCE AS INDICATED BY THE LABEL NEAR THE POWER CONNECTOR.

H. Break-Away Cover Hinge:

It may be desirable to remove the case cover under some operating conditions.

This is done as follows:

1. Open the cover to the vertical position.
2. Slide to the right.
3. Cover will come off at the hinges.

Section 4

INTERNAL ADJUSTMENTS

A. General:

1. Normal operating procedure requires the use of only the front panel controls as described in the OPERATING section.

2. All internal adjustment control settings are stable with respect to time and temperature, therefore, frequent adjustment is neither necessary nor recommended.

3. To reduce the interaction effects, all adjustments should be made in the order given.

4. All adjustments are to be made with the instrument operating from the AC line and with the probe positioned in its holder on the front panel, unless otherwise noted.

5. All indicated voltages are with respect to the grounded binding post on the instrument panel unless otherwise noted.

6. Internal controls are accessible by removing the four #10-32 screws near the corners of the panel and lifting the instrument from its case.

B. Battery Charge Rate:

1. With battery fully charged and the instrument OFF adjust R-4 (RATE ADJ.) for +7.40 to +7.50 v at the base of Q-1.

   NOTE: Please refer to Fig. 4-1. The above points are located on Model 3262 Battery Charger PC Board, which is mounted on a base plate in the bottom of the instrument case. The most convenient point at which to connect to the base of Q-1 is the lead of R-2 as shown in Fig. 4-1.

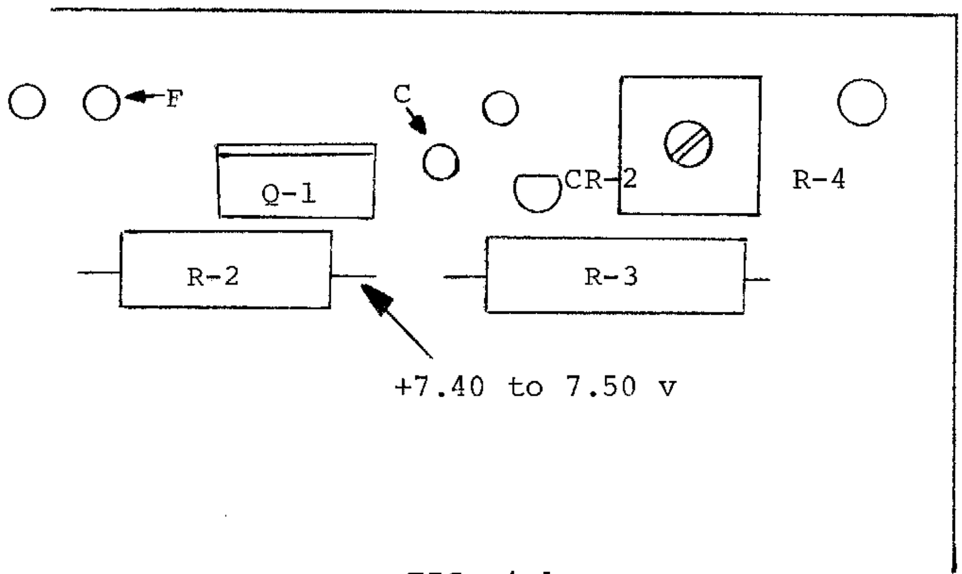


FIG. 4-1

C. Trip Point Calibration:

1. Disconnect instrument from power line.

2. Disconnect RED and BLACK wires from terminals C and F, respectively, on Model 3262 Battery Charger PC Board. See Fig. 4-1.

3. Apply DC power to these wires from an adjustable external power supply with at least 1.5 ampere capacity, low ripple and a voltage range including 5.60 to 6.50 v. Red wire is +. Black wire is ground.

   Set power supply output to 6.50 v.

4. Set Meter Range/Power Switch to LOG position.

5. Turn R-56 (TRIP CAL) to its fully clockwise position then slowly advance counter-clockwise until the red BATTERY LOW indicator just turns on.

   NOTE: For pertinent component locations refer to Fig. 4-2.

6. Slowly reduce power supply voltage while observing BATTERY LOW indicator which should turn off at 5.4 v ±2%. Simultaneously, the probe should stop humming, indicating that the shutdown circuit is functioning.

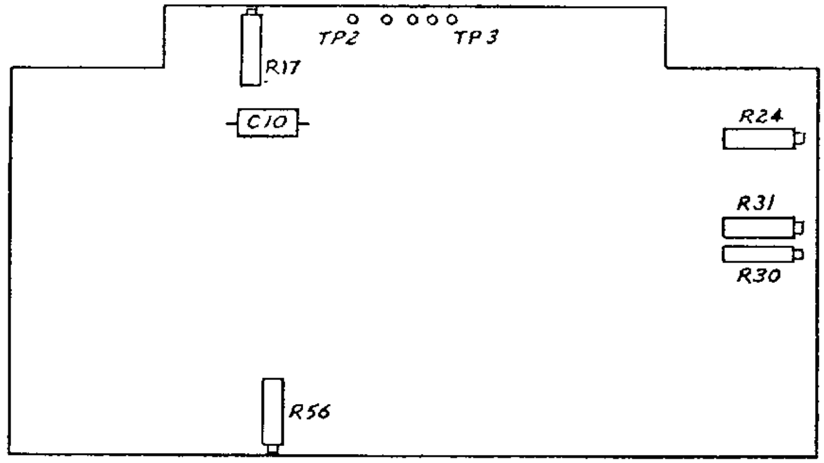
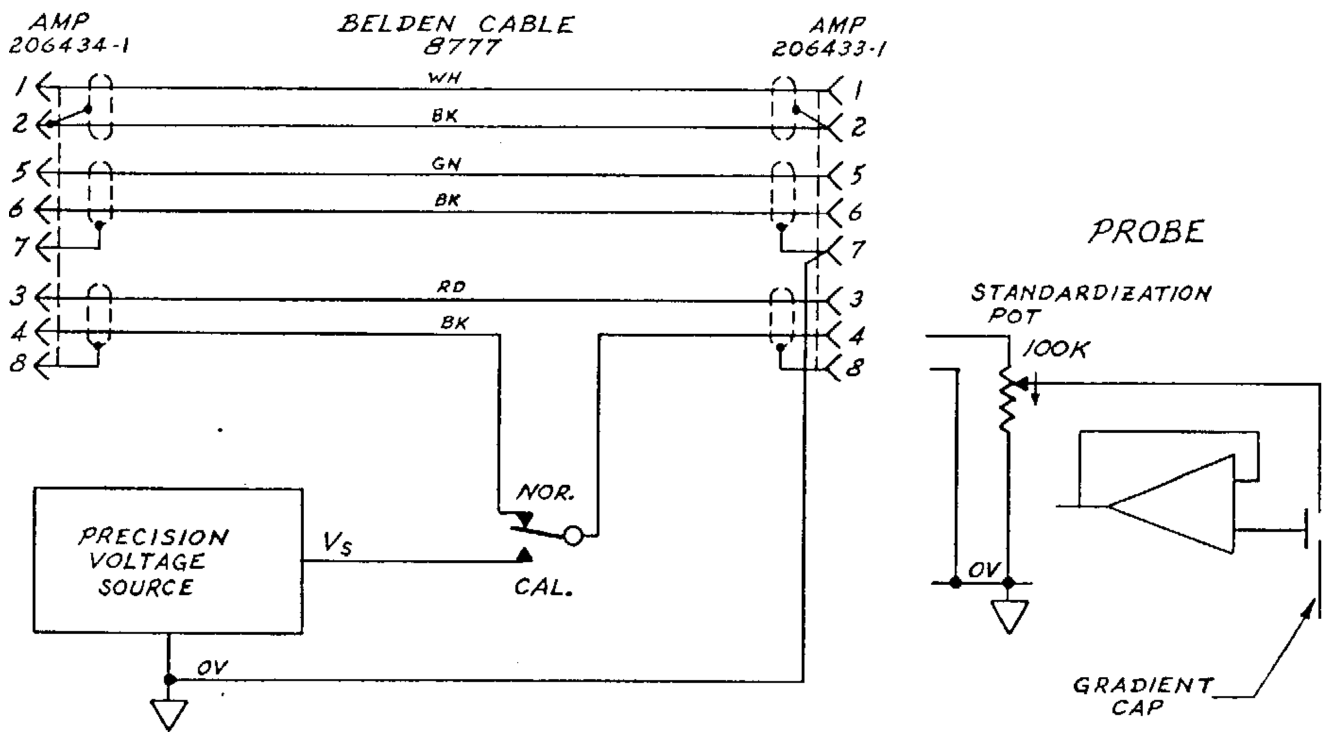


FIG. 4-2



PROBE STANDARDIZATION ADAPTER CABLE

FIG. 4-3

7. Slowly increase the power supply voltage. The instrument should restart at 6.10 v, ±2% as indicated by sound from the probe. (The red BATTERY LOW indicator does not operate as power supply voltage is increased.)

8. Re-connect RED and BLACK wires removed in step C-2.

D. Logarithmic Amplifier:

NOTE: Before attempting any of the following adjustments, correct the mechanical zero of the panel meter if necessary. Mechanical adjustment is made through a hole in the panel just above the reference plate. It should be executed with the instrument OFF and in its normal operating position (generally with the meter in the horizontal position).

1. Allow the entire instrument to stabilize to room temperature.

2. Turn Meter Range/Power Switch to LOG position. Allow an additional 10-minute stabilization period.

3. Remove jumper at TP-3 (see Fig. 4-2).

4. Apply +10 v, ±1% to TP-3.

5. Adjust PLUS BIAS (R-31) for an indication of +10 kv/cm.

6. Apply -10 v, ±1% at TP-3.

7. Adjust MINUS BIAS (R-30) for an indication of -10 kv/cm.

8. Ground TP-3.

9. Adjust ZERO (R-24) for an indication of 0 kv/cm.

10. Repeat steps 4 through 9 until no further change is noted.

11. Replace jumper at TP-3.

NOTE: The logarithmic output may be calibrated in preference to calibration to the panel meter if desired. In that case, +4 v would appear at OUTPUT for an input of +10 v and -4 v for an input of -10 v. (See Table 2-1.)

E. Calibration (General Information):

All type 1019 probes and Model 245 Electrostatic Fieldmeter instruments are shipped from the factory calibrated for a "perfect parallel field" using a fixture similar to that described in Fig. 4-4.

Calibration accuracy is directly proportional to the accuracy to which the fixture is constructed, the care taken to ensure that the face of the gradient cap of the probe is perfectly flush with the underside of the ground plate and the accuracy of the calibrating voltage supplies.

The probes are "standardized" at the factory to assure interchangeability of probes. They should only be re-standardized if they are rebuilt by changing parts such as gradient caps or transducer/amplifier assemblies.

The "standardization" potentiometer is intentionally not readily accessible in field installations. Standardization should be done under controlled conditions such as a suitably equipped electronics laboratory.

F. Probe Standardization:

NOTE: Two special devices are required for probe standardization:

1. Calibration fixture, Fig. 4-4.
2. Standardization Adapter Cable, Model 1019B/22C, Fig. 4-3, available from the factory.

Additionally, two precision voltage sources are required:

1. A precision low voltage DC source of +0.650 v.
2. A precision high voltage DC source of -1000 v - Monroe Electronics, Inc. Model 241 or equivalent.

1. Place probe in calibration fixture as shown in Fig. 4-4, being certain that the face of the gradient cap is perfectly flush with the underside of the ground plate and that the distance from the surface of the gradient cap (and ground plate) to the calibration surface is precisely 1 cm.
2. Connect the probe to the Model 245 through the probe standardization adapter cable (Model 1019B/22C).

CALIBRATION AND STANDARDIZATION
FIXTURE

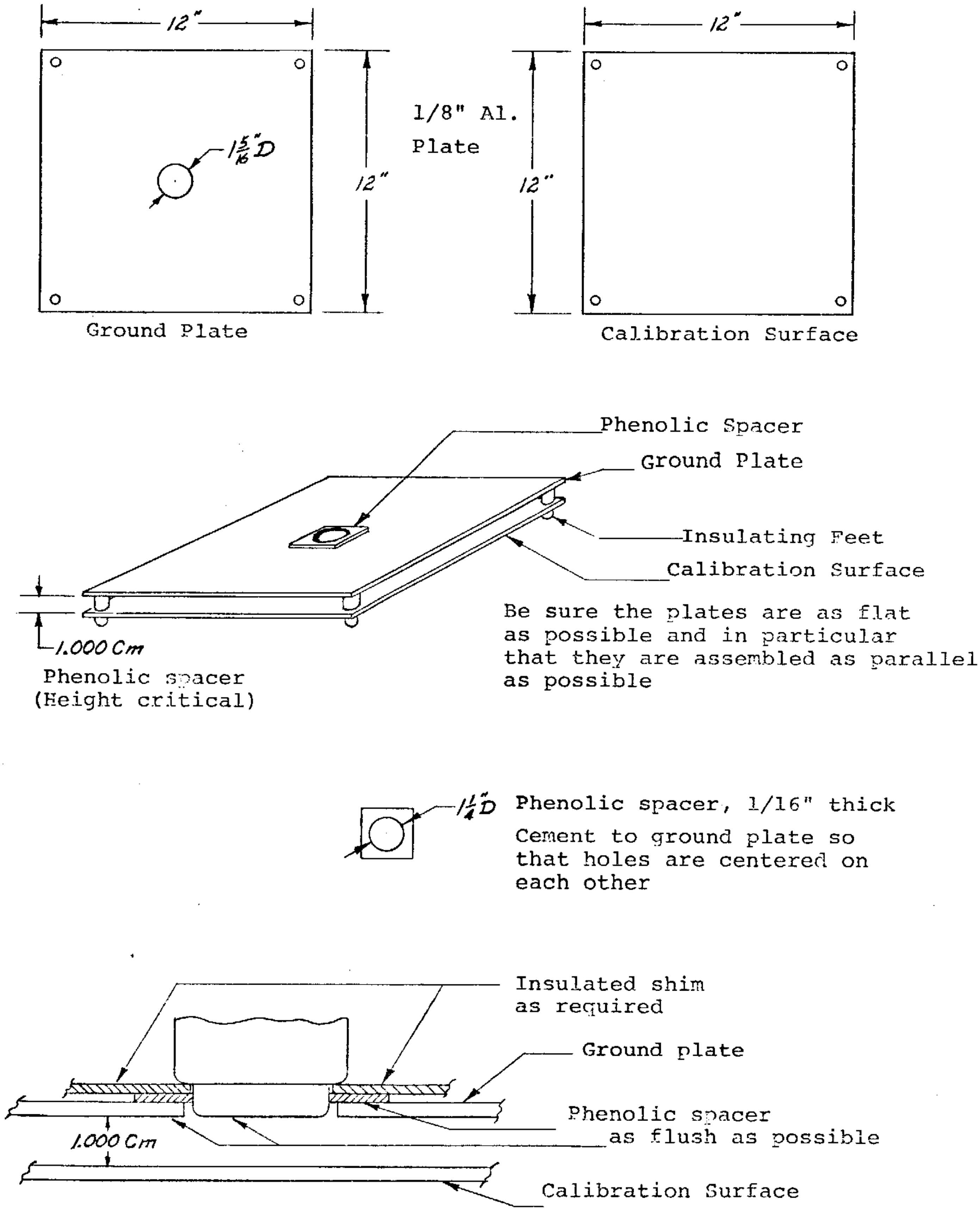


FIG. 4-4

3. Connect a 10 meg, ¼ w, 5% resistor across capacitor C-10 (See Fig. 4-2 for location). This converts the instrument to a null detector.

   NOTE: If the instrument has been functioning normally then the CAL potentiometer, R-17, (see Fig. 4-2) need NOT be adjusted. However, if in doubt, turn R-17 to its counter clockwise stop. This will then require recalibration of R-17. (Refer to "Fieldmeter Calibration".)

4. Connect precision low voltage source to GR connector on standardization cable and set to 0.000 v.

   Set switch on standardization adapter cable to CAL.

5. Connect the precision high voltage source to the calibration fixture. Ground should be connected to the (upper) "ground" plate and also to instrument ground (located on panel).

6. Connect the high voltage lead to the calibration (lower) surface.

7. Set this source to 0.000 v.

8. Turn Meter Range/Power Switch (on Model 245 panel) to 0.1 kv/cm range. (0.2 KV/cm on 245K)

9. Zero Model 245.

10. Set precision low voltage source to +0.650 v and precision high voltage source to -1.000kv. (-2.000 KV for 245K)

11. Adjust standardization potentiometer in probe for an indication of zero on the panel meter.

    NOTE: Standardization potentiometer is accessible through an opening in the probe directly under the cable. The small rubber plug may be removed by pulling on its skirt. Replace plug after adjustment.

12. Re-Check zero and repeat sequence as required.

13. Remove 10 meg resistor installed in step 3.

G. Fieldmeter Calibration:

1. Place a "standardized" probe in calibration fixture as shown in Fig. 4-4, being certain that the face of the gradient cap is perfectly flush with the underside of the ground plate and that the distance from the surface of the gradient cap (and ground plate) to the calibration surface is precisely 1 cm.

2. Connect the probe directly to the Model 245.

3. Connect a precision high voltage DC source (Monroe Electronics, Inc. Model 241 or equivalent) to the calibration fixture. Ground should be connected to the (upper) "ground" plate and also to instrument ground (located on panel).

4. Connect the high voltage lead to the calibration (lower) surface.

5. Set the high voltage source to 0.000 V.

6. Turn Meter Range/Power Switch (on Model 245 panel) to 1 kv/cm range.

7. Zero Model 245.

8. Set precision high voltage source to +1.000 kv.

9. Adjust CAL potentiometer, R-17, (see Fig. 4-2 for location) for an indication of +1 kv/cm.

10. Set precision high voltage source to -1.000 kv.

11. Meter should indicate -1 kv/cm, ±3%.

    NOTE: In many cases, it may be desirable to have the instrument calibrated so that negative fields are more accurately measured than are positive fields.

    The same general procedure as above would be followed except that R-17 would be adjusted with -1.000 kv applied to the calibration surface.

    Differences between the observed meter readings, if any, are primarily due to inherent meter error.

    The linear output may be calibrated in preference to calibration to the panel meter. +1.00 v should appear at OUTPUT connector for an input of +1.000 kv and -1.00 v should appear for a -1.000 kv input.

H. <u>Exceptional Geometric Configurations</u>:

To reiterate, the above procedures calibrate the fieldmeter for a "perfect parallel field" configuration, i.e., the probe is "looking" through and is mounted flush with a presumed "infinite" plane which is also presumed parallel to an "infinite plane" source, therefore, creating a parallel field. Any departure from this ideal geometry will cause field distortions and result in measurement "errors".

In the event that it is desirable to calibrate the instrument to meet specific requirements, please consult the factory.

Section 5

THEORY

The following is a block by block description of the components of the system including a description of how the blocks utilize feedback to achieve the desired performance.

Please refer to schematic diagaram 245/1 at the rear of this manual.

A. Power Supply:

Power for the Model 245 and its probe, Model 1019B is derived indirectly from a single, sealed, lead dioxide, 6 volt battery (B-101) designed for float/discharge service.

Whenever the instrument is connected to the appropriate power line (see Specifications), a built-in battery charger, Model 3262 maintains the battery in a state of charge regardless of whether or not the instrument is operating.

Transistor Q-1 and its associated circuitry maintains a constant voltage across the battery and its load.

In normal operation, inverter A-10 converts the 6 volt current from the battery to ±15 v, which is zener diode regulated (CR-12 and CR-13) and ±6.9 v of reference quality (CR-14 and CR-15), those voltages to be used in circuitry in the remainder of the instrument.

Flasher circuit A-9 causes green light emitting diode CR-102 (BATTERY OK) to produce a short duration flash approximately every 1.5 seconds as long as the battery voltage is in the normal range, thus indicating proper operation.

During portable operation, the battery can be expected to discharge to a voltage too low to allow for proper operation after several hours (depending on initial state of charge).

When battery voltage decreases to approximately 5.6 v, comparator A-8 senses the condition and switches red light emitting diode CR-101 (BATTERY LOW) on (CR-102 continues to flash) to alert the user to take appropriate action.

If charging current is not supplied by the battery charger, the battery voltage will continue to decrease until, at about 5.4 v, comparator A-7 switches the entire instrument (including the battery condition indicators) off via transistor Q-3.

Beginning with a fully charged battery, this sequence can reasonably be expected to take place over a period of time in excess of 12 hours.

Power transformer T-101 has two nominal 117 v 50-60 Hz windings which are connected in series or parallel by switch S-101 to match standard world-wide AC power sources.

B. Type 1019 Probe:

The probe, shown at the upper left of schematic diagram 245/1 consists of three essential elements: A transducer, a sensitive electrode, and a special hybrid preamplifier in addition to appropriate shields.

The transducer is a mechanical driver which vibrates the 0.5 inch diameter circular sensitive electrode along an axis perpendicular to its surface.

The sensitive electrode has a voltage induced upon it which is directly proportional to both the ambient DC electric field intensity and the displacement imparted by the mechanical driver.

In order to achieve maximum available signal voltage from the sensitive electrode, the undesired distributed capacitance to surfaces other than the unknown or intended feedback surface is minimized by use of a special voltage follower preamplifier, which also serves to minimize capacitance loading of all the follow-on circuitry.

This preamplifier exhibits an input capacitance which is small in comparison to the "source" capacitance of the sensitive electrode. It also exhibits an extremely high input resistance. Its gain is very close to unity at the operating frequency ($A > +0.999$).

Additionally, because of its low output impedance and large phase margin, it is capable of driving a large capacitive load with stability. This characteristic insures a capability for driving a long interconnecting cable thus permitting large separation between the probe and its indicator.

C. Oscillator:

The oscillator, A-2c and its associated circuitry provides the driving signal for the electromechanical transducer in the probe assembly as well as providing a reference signal for the demodulator and zeroing circuit.

It is an amplitude stabilized oscillator utilizing the transducer as the resonant element. AGC action is achieved via photocoupler PC-1.

D. Bandpass Filter:

Filter A-1 with its associated circuitry produces a sinusoidal replica of the probe output and eliminates undesired frequencies.

It also serves to shift the phase of the signal such that it is in the proper relationship with the reference signal generated by the oscillator.

E. A.C. Gain/Zero:

This stage (A-2a) serves to amplify the AC signal. Adjustable portions of a reference signal from the oscillator at the differential inputs of this amplifier vary its output amplitude and phase when the probe is "looking" at a ground reference. A single panel mounted control thus provides zeroing for the entire system loop.

F. Demodulator:

The demodulator (A-2b) detects the relative magnitude of the signal and the phase angle between the reference and signal voltages, thereby determining the polarity of the unknown signal.

G. Integrator:

Output current from the demodulator is integrated by operational amplifier A-3a and its associated integrating capacitor C-10. The linear output of the functional system is taken from the output of the integrator with respect to ground (circuit common).

H. Closing the Loop:

The aperture size in the gradient cap is carefully chosen such that a fraction of the output voltage (whose polarity is opposite to the unknown field under measurement), when fed back to the gradient cap creates a null in the net field, incident upon the probe's sensitive vibrating electrode.

The CAL potentiometer (R17) controls the fractional voltage feedback with the result that the system can be calibrated in a straightforward manner. (An additional calibration potentiometer in the probe allows for standardization of probes. See "Probe Standardization", INTERNAL ADJUSTMENTS section.)

I. Test Pushbutton:

The panel mounted TEST pushbutton (S-102) allows for a test of gross operation of the instrument. When this switch is closed, +15v DC is applied directly to the gradient cap. This is seen by the instrument as a large positive DC signal which will cause saturation of the integrator in the negative direction causing full scale deflection of the meter and saturation of the output in the positive direction. (See "INVERTER" page 5-4.)

J. Inverter:

A-3b is a unity gain inverter which produces a signal at the OUTPUT connector with a polarity to match the unknown as the output of the INTEGRATOR has already been shown to be of opposite polarity but of a magnitude representative of the unknown field gradient. This signal is also applied to the appropriate meter multipliers in the linear meter modes and to the input of the LOG AMPLIFIER.

K. Logarithmic Amplifier:

The operation of LOGARITHMIC AMPLIFIER (A-4) and its associated circuitry is based upon the logarithmic change in the collector current of transistor Q-2a or Q-2b (depending on input polarity) with a linear change in base-emitter voltage.

The amplifier used here is a bipolar circuit, i.e., it will accept either a positive or a negative input and will produce an inverted logarithmic function of the input at its output. It functions over many decades of input voltage.

Transistors Q-2c and Q-2d provide biasing and temperature compensation and are thermally bridged to Q-2a and Q-2b.

L. Scale Factor Amplifier:

Scaling amplifier A-5 is a precision, fixed gain, inverting, direct coupled amplifier used for calibration purposes. The one-volt-per-decade-logarithmic output is taken directly at its output.

M. Meter Circuit:

The 50 microampere, 100 millivolt, center zero meter is connected between power supply common and appropriate multiplier resistors by rotary switch S-103b in eight of its nine positions and is shorted in the OFF position to provide damping.

The LOG scale covers the entire range of the instrument.

Diodes CR-7 and CR-8 serve to protect the meter movement against overload.

N. Output:

Either linear or logarithmic output is available at the OUTPUT BNC jack and the choice is selected by S-104. Load impedance should be limited to one megohm or greater.

Network CR-9, CR-10, R-50 and F-1 provides protection to instrument circuitry from inadvertent application of external current

Section 6

MAINTENANCE

Modern solid state circuitry has virtually eliminated the need for routie maintenance of this instrument except for periodic cleaning of the probe (see APPENDIX I).

Several precautionary measures have been taken in the design of this instrument to prevent overcharging and complete discharging of the lead dioxide battery. Therefore, a useful life of many hundreds of charge/discharge cycles can be expected. In the event that replacement becomes necessary, please contact the factory.

Repairs will be made to damaged or defective instruments in accordance with a standard repair price schedule. Factory repair of defective instruments is recommended. In the event of difficulty, please contact the factory.

Some "First Aid" measures are:

1. A thorough review of the INSTALLATION and OPERATION sections of this manual may be helpful.

   NOTE: THIS IS A NON-CONTACTING INSTRUMENT. IT IS NOT INTENDED THAT THE PROBE BE DIRECTLY CONNECTED TO A SOURCE. THE INSTRUMENT MAY NOT SURVIVE DIRECT ARC OVERS TO THE PROBE.

   MAINTAIN ADEQUATE PROBE TO SOURCE SPACING.

2. The cause of failure, if known, will be an aid to troubleshooting.

3. Look for obvious physical damage (charred parts, loose connections, broken solder joints, broken circuit boards, etc.).

4. Check power line voltage. Be sure that VOLTAGE SELECTOR is in the correct position.

5. Check fuses.

   a. Power line fuse, F-101, is located on the base plate (inside case) near the power connector.

   b. Output fuse, F-1, is located on the main circuit board. Its purpose is to protect the instrument from external power introduced through the OUTPUT connector.

6. Changing probes, if a spare is available, may help to identify which part of the system is at fault.

7. Always correct the <u>cause</u> of the problem.

APPENDIX I

CARE OF MODEL 1019B TYPE PROBES

A. General:

The Monroe Electronics, Inc. Model 1019B type probes are highly sophisticated, complex devices representing advanced state of the art techniques and should, therefore, be maintained as such.

They are rugged to the degree that they will survive a wide range of environmental conditions so long as the inherent limitations are recognized and dealt with accordingly.

It must be emphasized that especially the critical elements of the probes (gradient cap and vibrating electrode) must be kept free from contaminants, e.g., dust, adsorbates, etc.

The materials of which these elements are made were very carefully chosen to minimize contact potential and any foreign matter which will cause relative electrical activity, when combined with relative motion will tend to cause drift and measurment errors.

Therefore, it is recommended that:

1. The probe be constantly purged, even when not in use, if this is practical. (See APPENDIX II.)

2. Alternatively, the probe be stored in the form-fitting protective holder (reference electrode) provided on the panel of the instrument and that the instrument cover be kept closed when not in use.

3. The probe be cleaned only to the degree and frequency necessary to achieve the required stability.

4. Major cleaning and reconditioning be performed by the factory.

B. Cleaning:

1. The simplest and safest method of cleaning the probe is by immersion in either denatured ethyl alcohol or isopropyl alcohol.*

*Denatured ethyl alcohol (5% methanol) and 99% isopropyl alcohol are available from Riverside Chemical Company, 871-947 River Road, North Tonawanda, New York 14120 (716-692-1350).

Outside surfaces of the probe should first be wiped clean using a lint-free wiping tissue** saturated in alcohol. The entire probe may then be immersed and agitated in clean alcohol. Use of an ultrasonic cleaner is <u>not</u> recommended.

The probe should then be allowed to drain and to dry thoroughly. A three hour bake-out at +60°C is recommended to assure stability.

2. In the event that the need for more thorough cleaning is indicated, the probe must be disassembled.

   a. Loosen the two #6-32 binder head machine screws securing the shell to the body about one-half turn.

   b. Place the probe on a flat surface with the sensitive aperture "looking" upward.

      NOTE: The purge tube may have to be removed if it prevents this.

   c. While holding the two screw heads (a) firmly downward with thumb and forefinger of one hand, grasp the outer shell of the probe with the thumb and forefinger of the other and pull gently upward to remove the shell.

   d. Remove the small white rubber plug from the hole in the shell and the red rubber O-ring from inside. Set these parts aside.

   e. Loosen the two #4-40 binder head machine screws securing the gradient cap about one-half turn.

   f. Position the probe as in (b) above and pull gently upward on the gradient cap in a manner similar to (c).

   g. The gradient cap, shell and rubber parts may now be cleaned with alcohol and lint free wiping tissue (previously specified) or they <u>may</u> be placed in an ultrasonic cleaner charged with alcohol.

      Once the gradient cap has been so cleaned, avoid touching the inside and the area adjacent to the sensitive aperture with the fingers.

**KIMWIPES® manufactured by Kimberly-Clark Corporation, Neenak, Wisconsin 54956.

CLEANCARE™ manufactured by The Kendall Company, Convenience Products, Boston, Massachusetts 02101.

h. Very carefully wipe the sensitive electrode with alcohol and a lint-free tissue.

The electrode and the inside parts of the probe may also be cleaned with FREON® T-P 35 Solvent available as stock number MS-160 from Miller-Stephenson Chemical Company, Inc., Box 628, Danbury, Connecticut 06810 (203-743-4447).

i. Re-assemble in reverse order being certain that the gradient cap and then the shell are correctly located before pressing firmly in place.

j. Bake-out at +60°C for three hours, allow probe to stabilize at room temperature and re-standardize probe as outlined in INTERNAL ADJUSTMENTS section.

APPENDIX II

PURGING OF TYPE 1019B PROBES

Constant purging of the Type 1019B Probe with clean, dry air or an inert gas is recommended whenever practicable in order to prevent airborne contaminants from entering the aperture in the gradient cap and being deposited on the electrode thus creating undesired voltage offsets.

The air supply should meet Industrial Standards Association standard ISA/S7.3 (1975) or be filtered with a filter such as a Koby "Junior" Filter available from Monroe Electronics, Inc. or Koby, Inc., 297 Lincoln Street, Marlboro, Massachusets 01752.

This filter or equivalent will provide sufficient filtration for 1-4 probes under most conditions.

> NOTE: Clean, dry purging air as specified will be adequate under normal operating conditions. If the probe is to be subjected to unusual environmental conditions, please contact the factory.

Please refer to the INSTALLATION section of this manual for additional information.

APPENDIX III

GRADIENT CAPS

A. Probes:

1. Ranges

There are four ranges of probes available for different applications. The 245 Fieldmeter is not altered for these different probes they are:

± 20KV/cm	±10VDC output full scale
± 10KV/cm	±10VDC output full scale
± 1KV/cm	±10VDC output full scale
±100 V/cm	±10VDC output full scale

2. Sizing

The output for a full scale reading in each of these ranges is ±10VDC. It is therefore necessary to be aware of which range each probe is intended for. The aperture in the gradient cap varies for the different ranges with 100V/cm being the largest and 20KV/cm the smallest. This simply means a probe whose range is ±10KV/cm will indicate full scale when looking at ±10KV on a surface spaced 1cm from the gradient cap. Also a probe of ±100V/cm range will read full scale for ±100V on a surface of the same spacing, etc.

3. Front Panel

The designations for the range switch on the front panel are for ±10KV/cm probes. For other probe ranges 10KV/cm indicates full scale, 1KV/cm indicates 0.1 x probe range full scale meter reading, etc.

TABLE AIII-1

Probe Model	Aperture Size in.	Aperture Size mm	Meter Range 10KV/cm Full Scale Reading	Switch Position 1KV/cm Full Scale Reading	
1019_-5	0.096	2.35	20KV/cm	2KV/cm	
1019_-4	0.116	2.95	10KV/cm	1KV/cm	ETC.
1019_-3	0.245	6.22	1KV/cm	100 V/cm	
1019_-2	0.470	11.94	100 V/cm	10 V/cm	