

**Instruction Manual  
22-726Jb**

**For the use of  
Portable  
High Voltage  
DC Dielectric  
Test Sets  
Catalog Nos. 220070,  
220120, 220160-1 Series**



**Biddle Instruments**

BLUE BELL, PA 19422

**Instruction Manual 22-726Jb  
for  
BIDDLE Portable High Voltage DC  
Dielectric Test Sets**

**70 kV, 5 mA Test Set  
Cat. No. 220070 Series**

**120 kV, 5 mA Test Set  
Cat. No. 220120 Series**

**160 kV, 5 mA Test Set  
Cat. No. 220160-1 Series**

**HIGH VOLTAGE EQUIPMENT  
PLEASE READ CAREFULLY BEFORE OPERATING**

**Safety is the responsibility of the user  
APARATO DE VOLTAJE ALTO  
SIRVANSE LEER ESTE LIBRO CON CUIDADO  
ANTES DE OPERARLO**

**La Seguridad es el cargo del operador**

**BIDDLE INSTRUMENTS  
Blue Bell, PA 19422  
April 1982**

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Figure 1: The Catalog No. 220070 70 kV DC Test Set.



Figure 2: The Catalog No. 220120 120 kV DC Test Set.

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Figure 3: The Catalog No. 220160-1 160 kV DC Test Set.

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## SECTION A INTRODUCTION

The Biddle 70, 120 and 160 kV DC Dielectric test sets provide the high-voltage dc output needed to check the quality of electrical insulation on motors, power cables, switchgear, bushings, insulators, transformers and capacitors. The test sets are designed for making proof, acceptance, and maintenance tests on electrical insulation of equipment used by electrical utilities and industry for generation and distribution as well as for the testing of aerial boom trucks and other high-voltage equipment.

This instruction manual is intended as a guide for the operation and maintenance of these test sets. Unless otherwise specifically stated, all information in this manual applies to all three models.

The tests made by these test sets, which are based on measurement of the applied dc voltage, the resulting current and the manner in which current varies with time, provide data that indicate the condition of the insulation system of the sample being tested. When the data are recorded on graph paper such as Biddle Kilovolt/Megohm paper Cat. No. 220000, the shape of the curve made by connecting the plotted points will aid in evaluating the conditions of the insulation system. Information on the interpretation of observed data and guides for test voltage and time are given in Section G of this manual and in Biddle Technical Publication 22T1 entitled "Insulation Testing by DC Methods". Detailed information on dc testing is available in a course entitled "DC Testing of Power Apparatus Insulation" offered by the Biddle Technical School.



## SECTION B SAFETY PRECAUTIONS

### SAFETY IS THE RESPONSIBILITY OF THE USER LA SEGURIDAD ES EL CARGO DEL OPERADOR

The test set and sample to which it is connected are a source of high-voltage electrical energy and all persons making or assisting in the tests must use all practical safety precautions to prevent contact with energized parts of the test equipment and related circuits. Persons actually engaged in the test must stand clear of all parts of the complete high-voltage circuit unless the set is de-energized and all parts of the test circuit are grounded. Any persons not directly associated with the work must be kept away from test activities by suitable barriers, barricades or warnings.

The surface of the high voltage module *must* be treated as part of the energized circuit during tests. It *must* also be isolated from personnel by suitable barriers barricades or warnings. Locate the control unit with an absolute minimum air clearance from the HV module as indicated in Section F, Table III. Position the HV module on a flat surface at least 3 feet (90 cm) away from the test sample and any other structures to prevent the possibility of an accidental flashover through the insulated cover of the HV module.

While energized at high voltage, a test setup may induce a static voltage charge on nearby insulated objects, including people. To avoid such a condition, all insulated objects must be grounded or kept at least at the minimum air clearances from the energized structure, as indicated in Section F, Table III.

Upon completion of a test, after the high-voltage power source has been shut down, allow sufficient time for the sample to discharge (indicated by a "O" reading on the test set kilovoltmeter), then switch the test set main breaker off. The terminals of the test sample must be short-circuited with a safety ground (hot stick) to solidly ground all live parts. Ground bonds should then be applied and left in place. Do not approach the HV module until the ground bonds have been applied.

Discharging a test sample may take a considerable amount of time depending on the type and size of the sample. To hasten the discharge, once the sample has discharged to less than one-fourth the voltage used during the test, a high-voltage resistance discharge stick, if available, may be applied to the high-voltage terminal. This should be followed by the direct ground with a safety ground (hot stick) and the ground bond.

NEVER

If the test set is used in accordance with Section B, a routine test should not only be performed but also be supervised by a qualified person.

Correct construction and use of the test set is essential for safe operation.

The equipment should be used in accordance with the instructions.

Access to the test set should be restricted to qualified personnel.

**Caution**

Users should be aware of the high voltage sources and the possibility of a heart attack or other injury if possible in operation.

**Test**

The test set should be used in accordance with the instructions. The test set should be used in accordance with the instructions. The test set should be used in accordance with the instructions.

The test set should be used in accordance with the instructions.

## SAFETY PRECAUTIONS (cont'd)

### CAUTION!

#### **NEVER CONNECT THE TEST SET TO ENERGIZED EQUIPMENT OR USE THE TEST SET IN AN EXPLOSIVE ATMOSPHERE**

If the test set is operated in accordance with the safety precautions noted above and in Section F, and if all grounds are correctly made, rubber gloves are not necessary. As a routine safety procedure, however, some users require that rubber gloves be worn, not only when making connections to the high-voltage terminals, but also when manipulating controls. Biddle Instruments considers this an excellent safety practice.

Corrective maintenance must be performed only by a person who is familiar with the construction and operation of the test set and the hazards involved.

The equipment provided should not be used for any purpose except as described in the instruction manual.

Accessories and optional equipment, including cables and leads, are only to be used with the specified equipment and **not** for any other application.

#### **Caution Concerning Heart Pacemakers**

Users of high-voltage equipment should note that high-voltage discharges and other sources of strong electric or magnetic fields may interfere with the proper operation of heart pacemakers. Personnel having heart pacemakers should obtain expert advice on possible risks before using this equipment or being close to the equipment while it is in operation.

### CAUTION!

#### **Test Sets energized with 220/240 volts input voltage.**

These sets are intended to be exported. The sets are energized via an internal autotransformer which is used for voltage reduction. The common terminal of the autotransformer (white cord lead) *must* be connected to the neutral pole of the line power source. The green ground lead of the input supply cord *must* be connected to the protective ground (earth) contact of the input plug.

These sets *must not* be energized from a power source where both poles are live.

**SECTION C**  
**RECEIVING INSTRUCTIONS**

When your instrument arrives, check the equipment received against the packing list to ensure that all materials are present. Notify Biddle Instruments, Blue Bell, PA 19422, of any shortage of materials.

Examine the instrument for damage received in transit. If any damage is discovered, file a claim with the carrier at once and notify Biddle Instruments, or its nearest authorized sales representative, giving a detailed description of the damage observed.

This instrument has been thoroughly tested and inspected to meet rigid inspection specifications before being shipped. It is ready for use when set up as described in Section F. A Performance Check is also given in Section F.

The test set consists of three items: (1) Control Unit, (2) High-Voltage Unit and (3) Cables.

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## SECTION D SPECIFICATIONS

Electrical specifications are given in Table I below. Other specifications and physical characteristics are given in the following paragraphs:

**TABLE I SPECIFICATIONS OF INPUT & OUTPUT**

Cat. No.	Input Voltage	Output Voltage	Output Current
	For nominal line voltage, single phase	For nominal dc line voltage, continuously variable, negative polarity with respect to ground, less than 1 mA output current	maximum rating (thermal)
220070	120V (105-130V) 50/60 Hz 5A	0-70 kV	5 mA for 30 min. 3.5 mA continuous
220070-47	240V (210-260V) 50/60 Hz 2.5A	0-70 kV	5 mA for 30 min. 3.5 mA continuous
220120	120V (105-130V) 50/60 Hz 10A	0-120 kV	5 mA for 20 min. 2.5 mA continuous
220120-47	240V (210-260V) 50/60 Hz 5A	0-120 kV	5 mA for 5 min. 2 mA continuous
220160-1	120V (105-130V) 50/60 Hz 10A	0-160 kV	5 mA for 20 min. 2 mA continuous
220160-1-47	240V (210-260V) 50/60 Hz 5A	0-160 kV	5 mA for 5 min. 1.5 mA continuous

### CHARACTERISTICS

**Ripple** is less than 2% on capacitive test samples at continuous-rated output values.

**Regulation** is less than 20% from no-load to continuous-rated output current.

Special **internal guard circuit** eliminates the extra meter connection lead required on most dc test sets. The simplified guard circuit reduces internal leakage current to less than 0.1  $\mu$ A at full-rated output voltage. Guard terminal on HV output cable allows optional connection to test sample.

## SPECIFICATIONS (cont'd)

Digital **voltmeter** covers full output voltage range with 100V resolution and accuracy of  $\pm$  (2% of reading + 100 V). It is protected against damage caused by test sample breakdown.

Digital **ammeter** with 4 switch-selected measuring ranges: 0-19.9  $\mu$ A, 0-199  $\mu$ A, 0-1.99 mA and 0-5 mA and accuracy of  $\pm$  (2% of reading + 1 count). It is protected against damage caused by test sample breakdown.

**All high-voltage components** are encapsulated or sealed in dielectric housing for high reliability and a minimum size and weight. There is a surge-limiting resistor in series with the high-voltage output and a bleed-off resistor for the discharging of charge stored in the unit.

### SAFETY FEATURES

- Input supply line circuit breaker.
- Output current overload relay.
- Zero-start interlock for high-voltage output.
- Pushbutton controls for high-voltage ON and OFF.
- Indicating lights for high-voltage ON and OFF.
- Connection for external permissive and safety switches.
- Protection against damage by overloads and surges.
- Control unit separated from high-voltage unit by 15 ft. (4.6m) of interconnection cable.

### PHYSICAL CHARACTERISTICS

**Control Unit** in a sturdy durable suitcase-style portable case, contains all controls and has a metal top panel.

<u>Cat. No.</u>	<u>Dimensions</u>	<u>Weight</u> (approx.)
220070, 220120, and 220160-1	20" $\times$ 12" $\times$ 12½" high (50.8 $\times$ 30.5 $\times$ 31.8 cm)	23 lb. (10.5 kg)
220070-47, 220120-47, and 220160-1-47	20" $\times$ 12" $\times$ 12½" high (50.8 $\times$ 30.5 $\times$ 31.8 cm)	25 lb. (11.4 kg)

**High-Voltage Unit** in high-impact strength polyethylene housing with an adjustable shoulder carrying strap.

<u>Cat. No.</u>	<u>Dimensions</u>	<u>Weight</u> (approx.)
220070 & -47	12" $\times$ 12" $\times$ 20" high (30.5 $\times$ 30.5 $\times$ 51 cm)	44 lb. (20 kg)
220120 & -47	12" $\times$ 12" $\times$ 29" high (30.5 $\times$ 30.5 $\times$ 74 cm)	65 lb. (30 kg)
220160-1 & -1-47	12" $\times$ 12" $\times$ 39" high (30.5 $\times$ 30.5 $\times$ 100 cm)	73 lb. (33 kg)

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## SPECIFICATIONS (cont'd)

**Cable Carrying Case** is a sturdy navy blue canvas bag which holds all test cables. Contains pocket for instruction manual and test reports. Bag has convenient carrying handle and an adjustable shoulder strap.

<u>Cat. No.</u>	<u>Dimensions</u>	<u>Weight</u> (approx.)
220070 & -47	12" W × 17" H × 4" thick (30.5 × 43 × 10 cm)	7 lb. (3 kg) including cables
220120 & -47	15" W × 17" H × 4" thick	9 lb. (4 kg)
220160-1 & -1-47	(38 × 43 × 10 cm)	including cables

### **Test Cables and Accessories**

8-ft. 3-wire input supply cord.

Two 15-ft. ground cables.

15-ft. interconnection cable.

15-ft. shielded HV output test cable, detachable.

Instruction Manual.

Kilovolt/Megohm graph paper, 100-sheet pad (Cat. No. 220000).

### **ADDITIONAL ACCESSORIES & OPTIONS AVAILABLE**

<u>Cat. No.</u>	<u>Item</u>
222070-62	Manual HV Resistance Discharge Stick, 60-70 kV
222120-62	Manual HV Resistance Discharge Stick, 120 kV
222160-62	Manual HV Resistance Discharge Stick, 160 kV
220004	External Line Voltage Regulator.
220003	Miniature DC Current Recorder with 2 measuring ranges of: 0-50 $\mu$ A and 0-500 $\mu$ A.
650110	Auxiliary Impulse Generator Accessory (Thumper).
Option 56	Longer lengths of shielded HV output test cable.

## SECTION E CONTROL & CONNECTOR IDENTIFICATION

TABLE II TEST SET CONTROL IDENTIFICATION

Refer to Figures 4 & 5.

Test Set Control	<u>Description</u>	<u>Function</u>
Main Breaker	2-pole magnetic circuit breaker with instantaneous overload trip.	<ul style="list-style-type: none"> <li>— test set ON/OFF switch.</li> <li>— short-circuit and overload protection.</li> <li>— controls all power to test set.</li> </ul>
Green AC ON Lamp	green light	<ul style="list-style-type: none"> <li>— indicates circuit breaker ON, test set energized.</li> </ul>
HV ON Switch	pushbutton switch	<ul style="list-style-type: none"> <li>— controls an internal relay, energizing the set, and the HV ON lamp.</li> </ul>
Red HV ON Lamp	red light	<ul style="list-style-type: none"> <li>— indicates HV is ON and voltage can be applied.</li> </ul>
HV OFF Switch	pushbutton switch	<ul style="list-style-type: none"> <li>— de-energizes line relay, which turns off the output voltage.</li> <li>— turns off red HV ON lamp.</li> </ul>
Voltage Control	variable-ratio autotransformer	<ul style="list-style-type: none"> <li>— adjusts output voltage by controlling primary voltage of HV power transformer, in conjunction with zero-start switch, which requires the control shaft in "0" (RESET) position for operation.</li> </ul>
Output Voltage Meter	kilovoltmeter	<ul style="list-style-type: none"> <li>— measures applied dc test voltage.</li> </ul>
Output Current Meter	ammeter	<ul style="list-style-type: none"> <li>— measures test sample current.</li> </ul>
Current Range Switch	4-position rotary switch	<ul style="list-style-type: none"> <li>— selects output current measuring range.</li> </ul>
External Interlock Receptacle	plug receptacle	<ul style="list-style-type: none"> <li>— allows connection of a normally open external interlock switch (test sets are shipped with short-circuited plug, with removable jumper, inserted in receptacle).</li> </ul>
External Instrument Jack	output jack (in series with current meter)	<ul style="list-style-type: none"> <li>— allows connection of an auxiliary current-indicating meter or recorder. Standard 1/4" phone plug (not supplied) will fit this jack.</li> </ul>



## CONTROL & CONNECTOR IDENTIFICATION (cont'd)

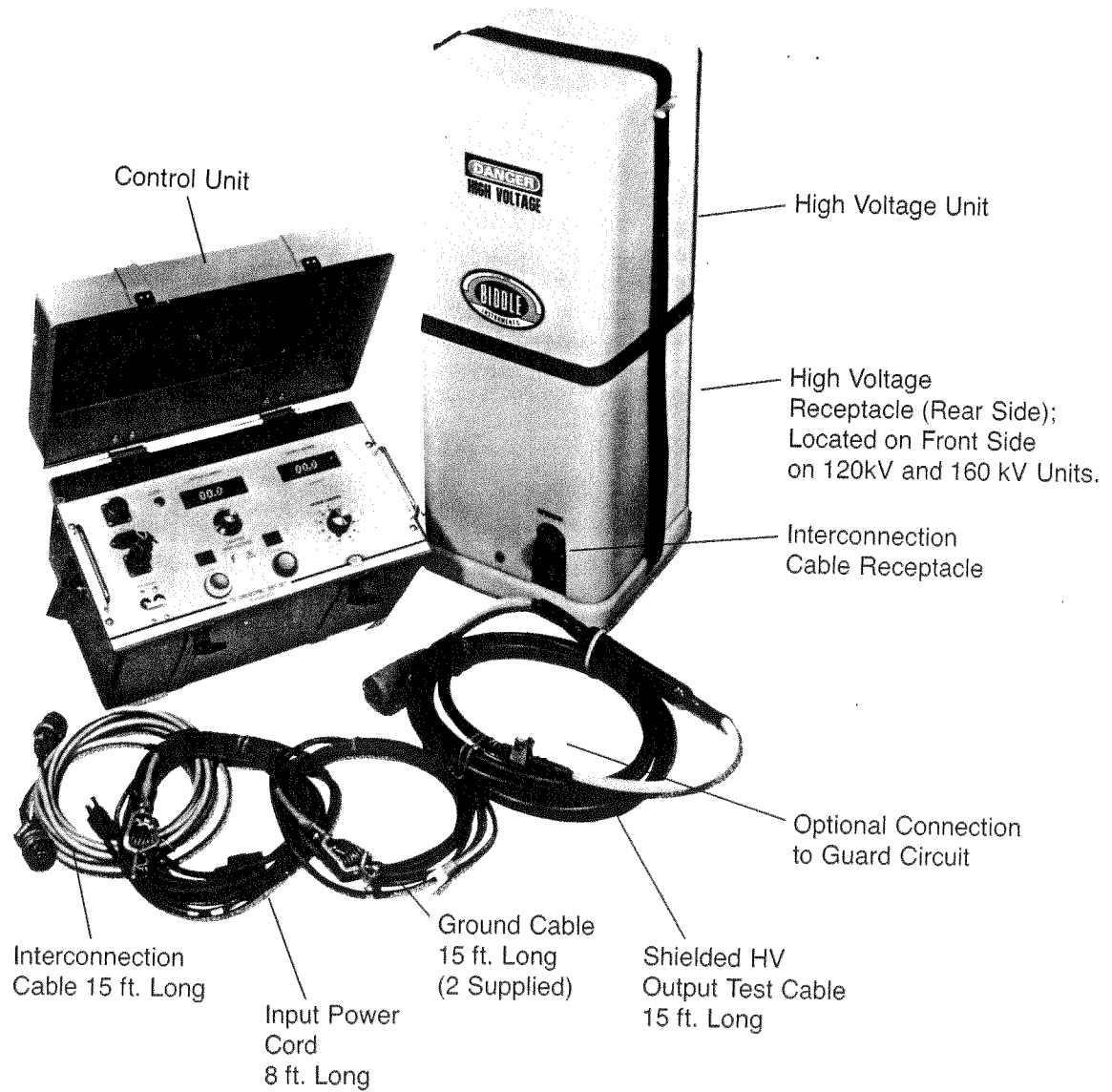


Figure 4: Test Set and Cable Identification.



## CONTROL & CONNECTOR IDENTIFICATION (cont'd)

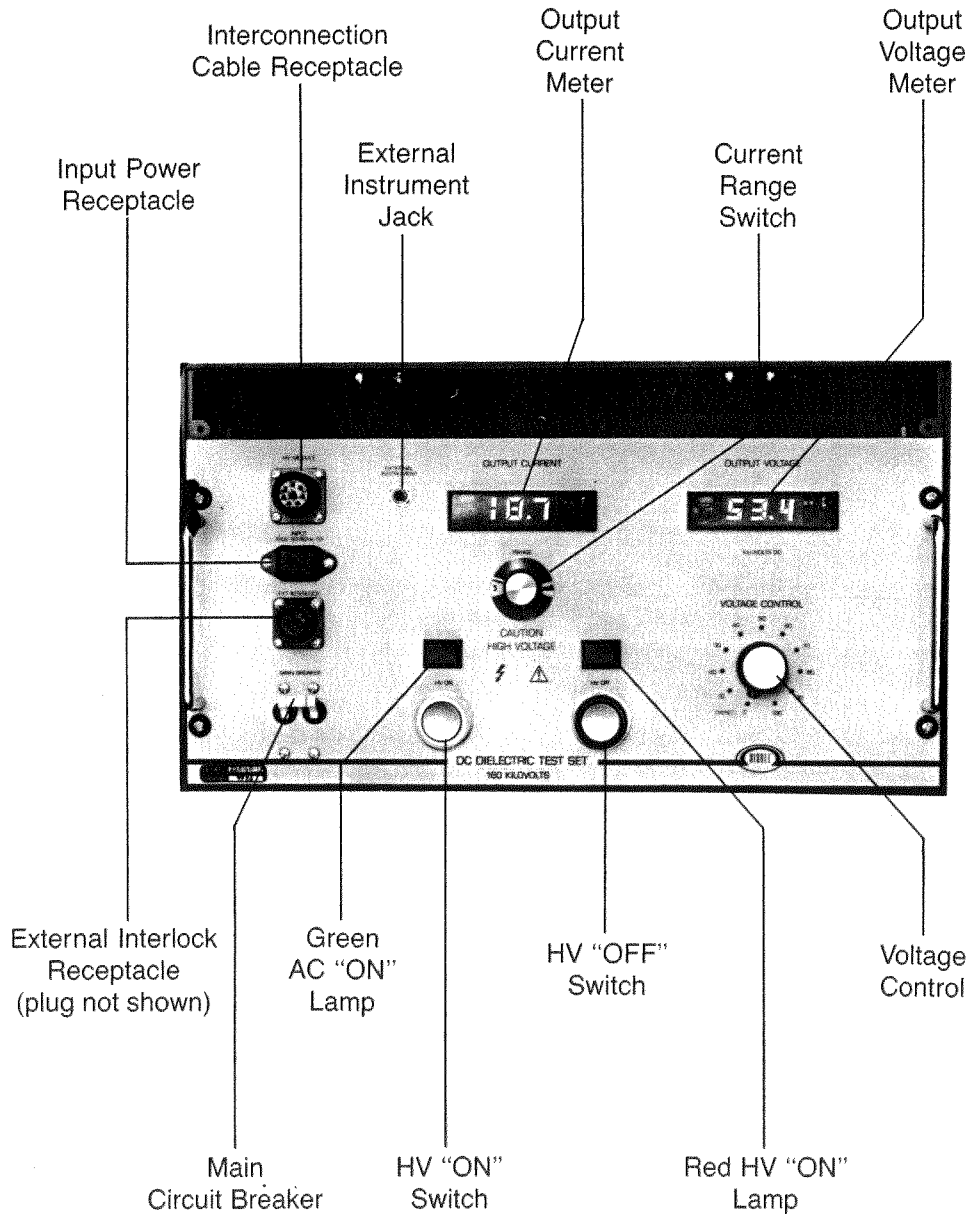


Figure 5: Control Panel and Connector Identification.

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## SECTION F OPERATION

### SETTING UP

The following steps are listed as a general guide for setting up the dielectric test set. Figures 6, 7 and 8 show the setup arrangement for testing cable samples. The test set controls, leads and terminals are identified in Figures 4 and 5.

### SAFETY PRECAUTIONS

The output of this test set can be lethal. As with any high-voltage equipment, caution must be used at all times and all safety procedures followed. (Refer to Section B, Safety Precautions.) Be sure that the test sample is de-energized and grounded before making connections. Make certain that no person can come in contact with the HV module, the HV output terminal or any material energized by the output. Use protective barriers if necessary. Locate the control unit in an area which is as dry as possible.

Be sure that adequate clearances are maintained between energized conductors or the HV module and ground to prevent arc-over. Such accidental arc-over may create a safety hazard or damage the equipment being tested. The position of the exposed conductors with respect to ground can often be maintained by tying the conductors in place with clean, dry nylon rope. Table III indicates minimum personnel clearances that will limit the danger of static induced voltages being developed on nearby insulated objects, including people. The HV module should be treated as part of the energized circuit.

**TABLE III: MINIMUM AIR CLEARANCES**

The clearances given below are absolute minimums. However, as a safety guide, Biddle Instruments strongly recommends that clearances never be less than 6 feet (180 cm).

Voltage of Test (kV)	Minimum Personnel Clearances (Feet With Grounded Barrier)	Minimum Personnel Clearances (Feet Without Grounded Barrier)
5 kV	2 ft. (60 cm)	2 ft. (60 cm)
10	2 ft. (60 cm)	2 ft. (60 cm)
20	2 ft. (60 cm)	2 ft. (60 cm)
30	2 ft. (60 cm)	3 ft. (90 cm)
40	2 ft. (60 cm)	3 ft. (90 cm)
50	2.5 ft. (75 cm)	4 ft. (120 cm)
60	3 ft. (90 cm)	5 ft. (150 cm)
70	3.5 ft. (110 cm)	6 ft. (180 cm)
80	4 ft. (120 cm)	7 ft. (210 cm)
100	5 ft. (150 cm)	9 ft. (280 cm)
120	6 ft. (180 cm)	10 ft. (310 cm)
140	7 ft. (210 cm)	12 ft. (370 cm)
160	8 ft. (250 cm)	14 ft. (430 cm)

## OPERATION (cont'd)

### SETTING UP THE TEST SET

To connect the test set to the cable or apparatus to be tested, follow the procedure listed below. Also refer to Figure 7 or 8.

1. Position the HV module on a flat surface at least 3 feet (90 cm) away from the cable or apparatus to be tested, as well as any other structure.
2. Connect the wing thumb-nut GROUND terminal of the HV module to a low-impedance earth ground using one of the 15-ft. ground cables supplied with the test set.

#### NOTE

The safety ground ("hot stick") should also be connected to earth ground.

3. Connect the wing thumb-nut GROUND terminal of the HV module to the test sample ground terminal using the second ground cable supplied with the test set.

#### WARNING!

Improper grounding may present a shock hazard to the operator or cause damage to the tester.

4. Position the control unit at least 6 feet (180 cm) away from the HV module.
5. Connect the control unit to the HV module with the interconnection cable. The plug shells should be fully screwed down on the receptacles.
6. Remove the protective cap from the HV terminal on the HV module, then connect the HV output cable to this terminal. Screw down the plug shell fully on the receptacle. Connect the alligator clip of the HV cable to the HV terminal of the sample to be tested.

#### NOTE

- a. **The exposed shield connection on the outboard end of the HV output cable is at guard potential and must not be grounded.** If a guarded test is to be run, connect the cable shield to the guard lead of the sample to be tested.
- b. Keep the core insulation at each end of this cable free from moisture and dirt during installation and operation and also protect this insulation from cuts and abrasions as corona will cause deterioration of the insulation. Clean as required with a clean, dry rag or one moistened sparingly with alcohol.

## OPERATION (cont'd)

- c. If the high-voltage termination of the test setup contains sharp points or corners or is in close proximity to grounded objects, the adjacent air may be ionized by electrical stress when energizing the test sample. This can cause excessive leakage current and since such current can be significant, it may tend to mask the true sample current. To minimize this effect, the exposed high-voltage termination should be spaced as far as possible from grounded objects or it should be covered with Kearney Air Seal or similar compounds. Another very effective method of preventing excessive leakage current is to wrap the exposed high-voltage termination with a thin plastic film or bag.
7. Insert the external interlock plug into the receptacle marked EXT INTERLOCK. This plug must be wired to an external interlock switch or short-circuited with a jumper (Pins 1 and 3 of interlock plug). When connection is made to an external interlock switch, it is recommended that two conductor-shielded wires be used and the shield connected to Pin 2 of the interlock plug.
8. With the MAIN BREAKER switched off, plug input power cord into control panel receptacle and into 3-wire grounded power outlet.

### OPERATING PROCEDURE

Proceed only after fully understanding Section B, Safety Precautions and setting up the test set as described above. An operator familiar with the contents of this manual, the test setup and the operation of the test set may follow the condensed operating procedure in the lid of the test set. The following is a step-by-step procedure for conducting a test on a sample.

1. Remove all safety grounds from the sample to be tested.
2. Energize the test set by closing the MAIN BREAKER switch. The green AC ON lamp and the two digital panel meters should light.
3. Initially set the current RANGE switch to the 5 mA range.
4. Close the external interlock switch, if used.
5. Set the VOLTAGE CONTROL to "0" (RESET), then depress the HV ON pushbutton switch. The red HV ON lamp should light.

#### **CAUTION!**

The test set is now capable of producing high voltage at the output.

## OPERATION (cont'd)

6. Advance the VOLTAGE CONTROL slowly until the desired test voltage is read on the OUTPUT VOLTAGE kilovoltmeter.
7. Maintain the test voltage for the desired period of time. The OUTPUT CURRENT meter indicates the leakage current of the sample under test. Set the current RANGE switch to the desired current range.
8. After maintaining the test voltage for the desired time, turn the VOLTAGE CONTROL slowly in the counterclockwise direction to "0" (RESET).
9. Depress the HV OFF pushbutton switch, or open the external interlock switch.
10. Allow sufficient time for the test sample charge to bleed off, which is indicated when the kilovoltmeter reading returns to zero.
11. Switch the MAIN BREAKER off. The green AC ON lamp and the two digital panel meters should now be out.
12. **In case of an emergency**, power can be interrupted immediately by either switching the MAIN BREAKER off, or opening the external interlock switch. This procedure should be followed only when absolutely necessary, since it risks damage to both the test set and the test sample.

### **WARNING**

The test sample may retain a lethal electrical charge even when the test set is turned off. Discharge the test sample with a safety ground ("hot stick") to ground all live parts, then solidly ground these parts with a ground bond. Keep the HV terminal of the sample and the test set's HV output cable grounded at all times except when actually performing tests. Do not approach the HV module until the test set's HV output cable has been grounded.

13. Disconnect the test set cables in the following sequence: Disconnect the HV output cable first from the sample, then from the test set; then disconnect the input power cord; then disconnect the interconnection cable; and finally disconnect the two ground cables.

### OPERATING NOTES

1. In the event of a test sample breakdown or an excessive load current, either the MAIN BREAKER or line relay will trip out. The VOLTAGE CONTROL must be returned to the "0" (RESET) position before high voltage can be applied again.

## OPERATION (cont'd)

2. A high-voltage resistance discharge stick may be used to initially ground the test sample high-voltage terminal to hasten the sample discharge after the kilovoltmeter indicates the voltage has diminished to a low, safe level.
3. If excessive leakage current is observed, it may be due to a high corona high-voltage termination. Refer to the setup instructions. It should also be noted that the test set measures the total test sample current including surface leakage, unless guarded.
4. When measuring the leakage current of test samples which have a significant capacitance, small line voltage transients may cause large transient swings of the current meter. This effect will be most noticeable when using the 20  $\mu$ A range and will require that the operator judge the indicated current value by visually and mentally averaging the value. The transient swing can be substantially reduced with an external Line Voltage Regulator, Biddle Cat. No. 220004.
5. Occasionally when measuring a test sample the leakage current of interest is masked by a parallel path. This is often encountered when measuring the leakage current of a cable. The value of current along the leakage path from the conductor over the insulation surface to ground may be greater than that within the major length of cable. Under such conditions, the guard feature of the test set is useful in excluding the undesired surface leakage current. This is accomplished by forming an intercepting electrode around the outer insulation surface between the conductor and the ground shield. The electrode may be made by tightly wrapping bare wire or a conductive band around the insulation surface close to ground. The electrode should then be connected to the guard terminal of the high-voltage output cable. Figure 8 illustrates this guarding. It should be noted that the guard circuit is only a few volts above ground. The exposed shield connection on the outboard end of the HV output cable is at guard potential and must not be grounded.

### PERFORMANCE CHECK

#### Preliminary Checks

Proceed only after fully understanding Section B, Safety Precautions, the Setting-Up subsection above, and the Operating Procedure.

Set up the test set as described in "Setting-Up" except do not connect the outboard end of the HV cable to a test sample. Cover the exposed HV termination with a thin plastic bag and suspend it in free air, using dry nylon rope, so that it is clear of all surrounding objects by at least 4 feet.

## OPERATION (cont'd)

Check the following:

1. Set the MAIN BREAKER to the ON position. The AC ON lamp should light.  
The OUTPUT CURRENT meter should read:

0.0 on 20  $\mu$ A range                      .00 on 2 mA range  
00 on 200  $\mu$ A range                      0.00 on 5 mA range

The OUTPUT VOLTAGE meter should read 00.0.

2. Remove the EXT INTERLOCK plug from the control panel and set the VOLTAGE CONTROL to 10.

Press the HV ON pushbutton. The HV ON lamp should **not** light.

Turn the VOLTAGE CONTROL to "0" (RESET).

Press the HV ON pushbutton. The HV ON lamp should light only while the pushbutton is depressed.

Replace the EXT INTERLOCK plug.

Press the HV ON pushbutton. The HV ON lamp should light and remain lighted when the pushbutton is released.

3. Rotate the VOLTAGE CONTROL knob to 10.

The HV ON lamp should remain lighted.

The OUTPUT VOLTAGE meter should read voltage. The value should be approximately 10% of the rated output voltage.

The OUTPUT CURRENT meter should read **zero** on all current ranges.

4. Press the HV OFF pushbutton.

The HV ON lamp should go out.

The digital displays should remain lighted.

The AC ON lamp should remain lighted.

5. Switch the MAIN BREAKER to the OFF position.

All lamps and digital displays should go out.

6. If there are no malfunctions, proceed to Voltage Withstand Test.

### Voltage Withstand Test

The test setup is the same as for the preliminary check. Proceed with the test as follows:

1. Set the OUTPUT CURRENT meter to the 20  $\mu$ A range.

## OPERATION (cont'd)

2. Energize the test set, then slowly raise the output voltage to the specified voltage control settings. Hold at each setting for the specified time interval.

VOLTAGE CONTROL SCALE SETTING	TIME INTERVAL
70	1 min.
80	1 min.
90 (rated output)	5 min.

There should be no breakdowns and the output current, for a new unit, should not exceed  $0.1 \mu\text{A}$ .

3. Return the voltage control to "0" (RESET), then depress the HV OFF push-button.
4. Allow sufficient time for the internal charge to bleed-off, which is indicated when the output voltage reading returns to zero.
5. Switch the MAIN BREAKER to the OFF position.
6. Puncture the plastic bag on the outboard end of the HV output cable with a safety ground ("hot stick"), then ground the alligator clip of the HV cable with the hot stick, then solidly ground the clip with a ground bond.

### Current Meter Operation and Current Overload Trip

1. Connect the alligator clip of the HV cable to the GROUND terminal on the high voltage module.
2. Set the DTS RANGE selector switch to the 2 mA range.
3. Energize the test set then slowly advance the VOLTAGE CONTROL from "0" (RESET) until the current meter indicates a minimum reading. A normal reading is anywhere between  $200 \mu\text{A}$  and 2 mA.
4. Set the DTS RANGE switch to the  $200 \mu\text{A}$  range. The current meter should indicate an overrange, i.e., the first digit should be 1 and the remainder of the digits blanked-out.
5. Set the DTS RANGE switch to the  $20 \mu\text{A}$  range. The current meter should also indicate an overrange.
6. Set the DTS RANGE switch to the 5 mA range. The current meter should read approximately the same value as obtained in step 3.



## OPERATION (cont'd)

7. Advance the VOLTAGE CONTROL until either the MAIN BREAKER or line relay trips-out. This should occur at a current value between 3 and 4 mA.

**NOTE:** Trip-out at the nominal 5.5 mA overload value will only occur when the test set is connected to a normal resistance load.

8. This completes the performance check. Disconnect the test set cables in the following sequence: disconnect the HV output cable first; then disconnect the input power cord; then disconnect the interconnection cable; and finally disconnect the two ground cables.

OPERATION (cont'd)

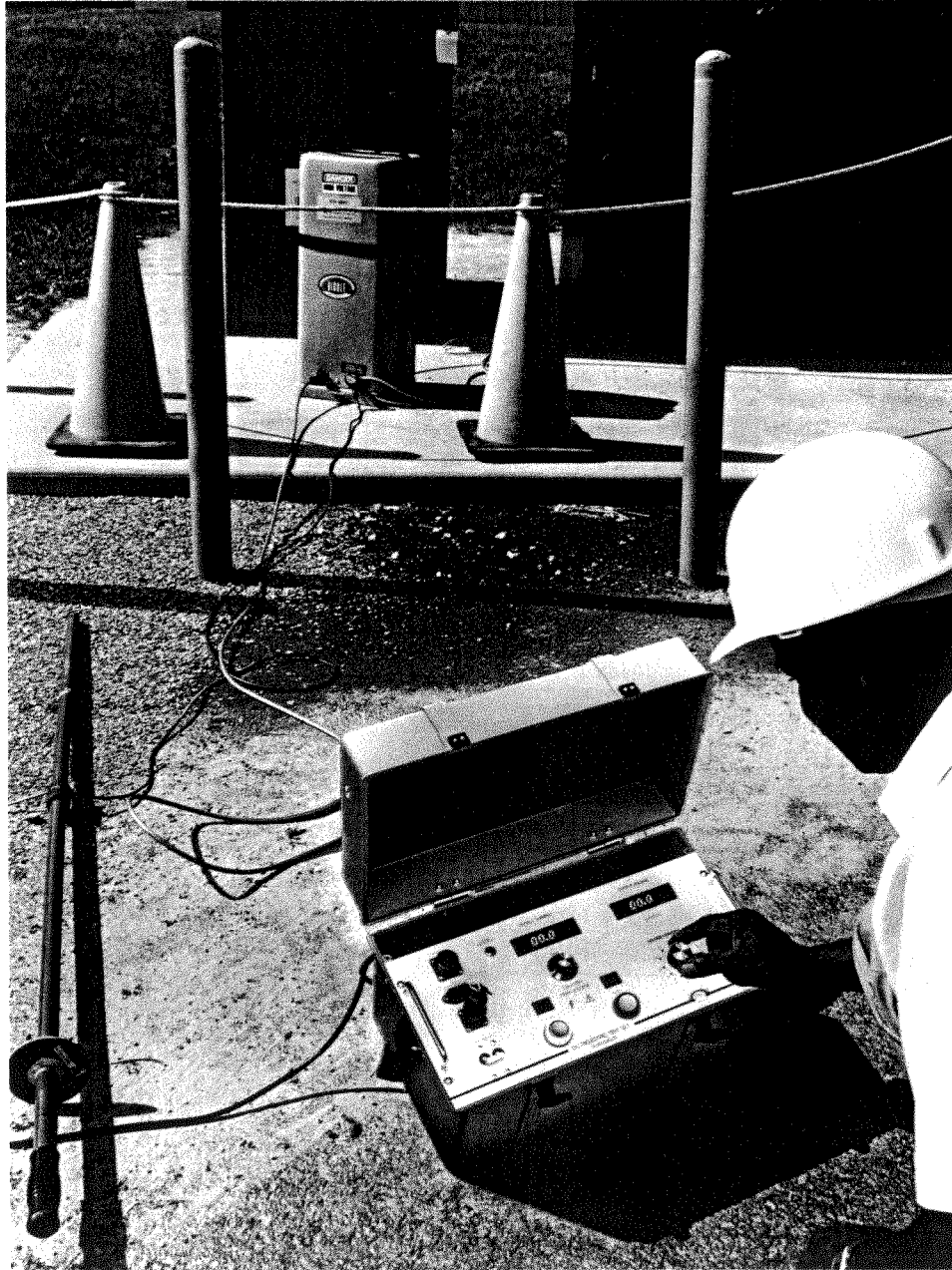
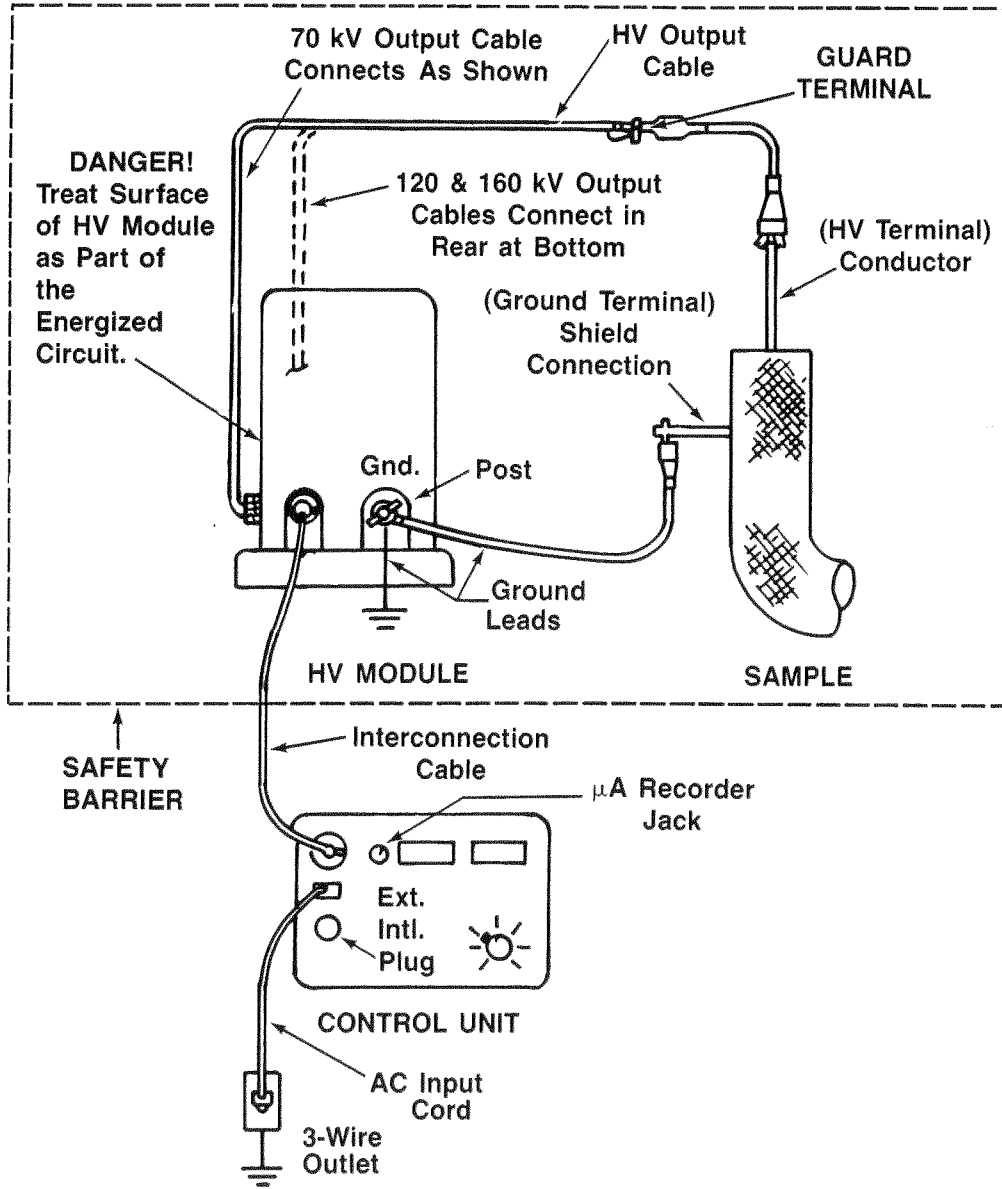


Figure 6: Typical Test Setup Arrangement.

OPERATION (cont'd)



DANGER! Treat Surface of HV Module as Part of the Energized Circuit.

Figure 7: Test Setup for Typical Cable Tests (Without Guarding).

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### OPERATION (cont'd)

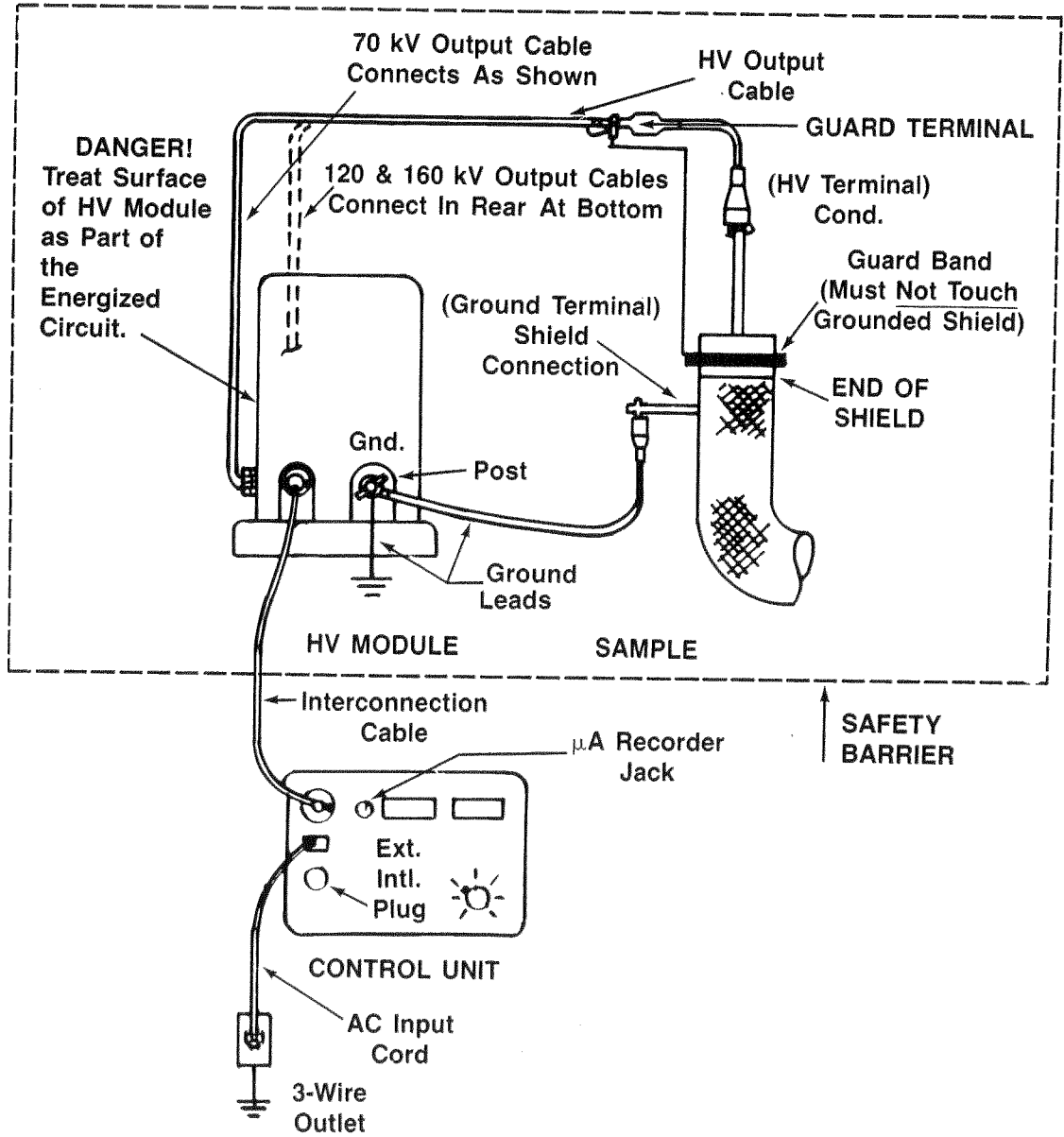


Figure 8: Test Setup for Typical Cable Tests (With Guarding).

## SECTION G APPLICATION NOTES

### THEORY

Any device that uses electrical energy can ordinarily be considered as consisting of elements that may be classified in two separate categories: those parts of the apparatus that conduct the electrical energy, and those parts that are not intended to conduct. It follows that any such apparatus includes an insulation system that is not intended to conduct electrical energy but which is under electrical stress. If such insulating parts do become conductive, the apparatus will fail. Electrical insulation can be tested by a variety of methods, and measures may be taken to anticipate such failures. Each method has its own merits but one technique is to apply a dc voltage to the insulation system and measure such quantities as the applied voltage, the leakage current, and the manner in which such quantities vary with time. These dc test techniques have been well developed over many years, and considerable literature exists on this subject. Detailed information on dc testing is also available in a course entitled "DC Testing of Power Apparatus Insulation" offered by the Biddle Technical School.

The few references given below are not presented in any special order, and no particular preference is implied; they are included merely for the convenience of the user so that he may make full use of this dielectric test set.

Insulation Testing by DC Methods. Biddle Technical Publication 22T1, 1975.

Fink, Donald G. and Carroll, John M. Standard Handbook for Electrical Engineers (New York: McGraw-Hill, 1968).

Guide for Testing Insulation Resistance of Rotating Machinery, IEEE Standard 43.

Guide for Insulation Maintenance for Large Alternating Current Rotating Machinery. IEEE Standard 46.

Guide for Making Dielectric Measurements in the Field. IEEE Standard 62.

Guide for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage, IEEE Standard 95.

Guide for Making High Direct Voltage Tests on Power Cables in the Field. IEEE Standard P400.

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## SECTION H ROUTINE MAINTENANCE

### CIRCUIT DESCRIPTION

The electrical operation of the test set is described below and is illustrated in the following schematic diagrams.

Figure 20 for 70 kV DC test set,  
Figure 21 for 120 & 160 kV DC test sets.

The basic electrical operation and the following description is applicable to all units.

Power is supplied to the test set through the three-conductor input cable. The green wire of this cable conforms to electrical code requirements and provides a separate panel ground connection. For safety purposes the two (2) separate ground cables that are provided **must** also be used to prevent a shock hazard to the operator or damage to the test set. The ground lead connected to the test sample provides a current return path to the test set while the other ground lead permits connection to a known earth ground.

Input power is brought directly to the main power switch (K1), a magnetic circuit breaker of the trip-free type. This switch also serves as the test set ON/OFF switch. A second pole on this circuit breaker provides protection for autotransformer T1 so that under all overload circumstances at least one pole will have a current overload. If either circuit breaker pole is tripped by overload, both poles will open.

Test sets equipped with the 240V 50/60 Hz option differ from standard sets only in that a separate step-down transformer (T2) is connected in series with the input. It is connected between the input power cord and main power circuit breaker K1. The 240 V ac input is stepdown to 120 V ac before reaching the circuit breaker. This transformer is wired as an autotransformer to minimize the required kVA rating and thus reduce size and weight. With this option, line fuses F1 and F2 are connected in the two input lines to provide protection to stepdown transformer T2 in case of a malfunction. The stepdown transformer and fuses are mounted in the bottom of the instrument case.

The power controlled by K1 is brought to relay K2. Autotransformer T2 receives power under control of K2. Output voltage is controlled by the variable autotransformer T1, whose output feeds the primary of the high voltage transformer T101 via the test set interconnection cable. The shield of the interconnection cable provides a second ground for the test set control panel.

The zero-start safety feature of this test set requires that the voltage control T1 be set at "0" (RESET) in order for the advance of the voltage control to develop an output

## ROUTINE MAINTENANCE (cont'd)

voltage. This feature is a function of control relay K2, whose contacts remain open after the power source is connected and after circuit breaker K1 is closed. This prevents the application of voltage to the input of high voltage transformer T101 until the contacts of relay K2 are mechanically closed. The contacts are closed by "0" (RESET) positioning of variable voltage control T1, which closes zero-start switch E1, and by depressing HV ON switch S1. The external-interlock circuit must also be closed before relay K2 can be energized. The test sets are shipped with external-interlock plug P2 short circuited with a removable jumper, therefore, when connection is made to a normally open external-interlock switch, this switch must also be closed.

The contacts of relay K2 remain closed until power is removed by operation of HV OFF switch S3, opening of an external-interlock switch or opening of the main circuit breaker switch K1. In order to re-establish output, power must again be applied and the voltage control set to zero.

In the 70 kV test set, transformer T101, rectifiers CR101 and CR102, and capacitors C101 and C102 form a Cockcroft-Walton voltage doubling rectifier circuit that provides the required dc output voltage. Resistors R101 and R102 provide current overload protection to the rectifiers. Resistor R107 provides current limiting protection of the output to help prevent damage to a test sample during a breakdown. Resistor R103 is a safety bleeder resistor to discharge high voltage capacitors C101 and C102 when the test set is disconnected.

Resistor R105 is the high voltage portion of a voltage divider circuit used for measuring the actual dc output voltage. Spark gaps E101 and E102 are included to prevent a shock hazard to the operator or damage to the test set in the event of a test sample breakdown.

The high voltage section of the 120 kV and 160 kV test sets is similar in operation to that of the 70 kV test set. The circuit used in these units is a Cockcroft-Walton voltage quadrupler circuit.

The voltmeter metering circuit is composed of digital panel meter M2, resistors R9 and R10, and capacitor C6. Resistor R9 is adjustable to calibrate the voltmeter. Capacitor C6 provides meter damping for line voltage transients. An additional capacitor C9 provides meter protection from high frequency surges, while transient voltage suppressor CR2 provides overvoltage protection.

The resultant ground current in the test sample is measured by the four-range digital panel meter M1. Current meter ranges are selected by the front panel RANGE switch. The range selector resistors consist of resistors R1 through R8. Resistors R1, R2, R3 and R4 are adjustable resistors to calibrate the respective 5 mA, 2mA, 200  $\mu$ A and 20  $\mu$ A ranges. Capacitors C2 through C5 provide meter damping for line voltage tran-

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## ROUTINE MAINTENANCE (cont'd)

sients. An additional capacitor C8 provides meter protection from high frequency surges, while transient voltage suppressor CR1 provides overvoltage protection. As a convenience, a jack (J4) is provided so that the current in the test sample can be monitored by an external device such as a recorder.

The test set also contains a dc current overload relay (K3), which is adjusted by resistor R11, to trip out the high voltage circuit when the dc current exceeds a nominal value of 5.5 mA. The relay includes a set of normally closed contacts in series with the coil of 120 V ac control relay K2. When an overload current exists the K3 relay contacts open. This opens the coil circuit of K2 and thereby removes high voltage power from the test set via the K2 relay contacts. After a trip-out occurs, the voltage control must be returned to zero before test set output voltage can be obtained. Capacitor C9 provides relay protection from high frequency surges, while spark gap DS3 provides overvoltage protection. The "C" switch deck of S4 is used for decimal point selection on digital panel meter M1, while the "B" deck is used for blanking of the least significant digit of M1 when using the 5 mA current range.

Power supply PS1 provides the +5V dc power necessary to energize digital panel meters M1 and M2. Both panel meters are identical and **may** be interchanged, without disturbing calibration of the voltage or current ranges, when troubleshooting a test set malfunction.

The guard connection on the outboard end of the HV output cable is used to bypass leakage current around the current meter. This connection must **not** be grounded since this would short-circuit the current meter.

Because of the many different input plugs in general use, the input cable has been provided with a plug for which adaptors are readily available for 220/240 volt operation. If use of an adaptor is not desirable, the plug supplied can be cut off and replaced with the plug best suited to the service conditions. The green lead of the input cable is to be connected to ground, the white to line neutral, and the black to the "hot" side of the line.

## SIMPLE MAINTENANCE

Routine maintenance is all that is required for these dielectric test sets. The cables should be inspected frequently to be sure all connections are tight and all ground connections intact. The appearance of the test set can be maintained by occasional cleaning of the case and panel of the control unit and the enclosure of the high voltage module.

Contamination of some parts of the high-voltage structure will show up as residual current meter readings. Cleaning of these sensitive parts will remove the leakage paths which are the cause of the unwanted leakage current.



## ROUTINE MAINTENANCE (cont'd)

### Cosmetic Cleaning

1. Control Unit Carrying Case:  
The outside of the carrying case can be cleaned with detergent and water. Dry with a clean, dry cloth.
2. Control Unit Panel:  
The panel can be cleaned with a cloth dampened with detergent and water. Water must not be allowed to penetrate panel holes, as it may adversely affect components on the underside. Household furniture spray wax can also be used to clean the panel. Polish with a soft, dry cloth.
3. High-Voltage Module Enclosures:  
The outside of the enclosure and base can be cleaned with isopropyl alcohol or denatured alcohol. Stubborn dirt may require cleaning with Xylol which should then be rinsed with alcohol as above.

### Functional Cleaning

1. HV Cable:  
A portion of the polyethylene insulation is exposed at each end of the HV cable. Dirt, fingerprints, etc. on the surface of these exposed portions will cause leakage under voltage stress, which will appear as a spurious reading on the instrument current meter. The exposed insulation can be cleaned with isopropyl alcohol or denatured alcohol applied with a clean cloth.
2. HV Outlet Tube:  
The HV outlet tube is located inside the HV module, at the rear. It is where the HV cable plugs in. The outlet tube may become a high-voltage leakage path if dirt or dust accumulate on the inside surface. The tube can be cleaned with isopropyl alcohol or denatured alcohol on a small piece of clean cloth. The cloth is inserted using a piece of flexible wire with a small loop formed on the end to hold the cloth. The wire must be approximately 18 in (46 cm) long to reach the full depth of the tube and still allow a suitable hand hold. Care must be taken that no sharp points on the wire are allowed to score the inside surface of the output tube.

### CALIBRATION

A complete Performance Check, as described in Section F, should be performed on the test set prior to making any calibration checks. This will insure that the test set is functioning properly.

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## ROUTINE MAINTENANCE (cont'd)

### Kilovoltmeter Calibration

Connect the test set to a standard kilovoltmeter such as  
Biddle Cat. No. 513100 (100 kV range),  
Biddle Cat. No. 513160 (160 kV range).

The test setup is illustrated in Figure 9. Observe the setting up procedure described in Section F.

Proceed as follows:

1. Set the OUTPUT CURRENT meter to the 200  $\mu$ A range.
2. Energize the test set, then slowly raise the output voltage to the units' rated operating voltage as indicated on the standard kilovoltmeter. If necessary, adjust trimmer R10 located on the printed circuit board within the control unit, until the Dielectric Test Set output voltage meter matches the standard kilovoltmeter.
3. Return the voltage control to "0" (RESET), then de-energize the test set and ground the alligator clip of the HV output cable, following the operating procedures described in Operation Section F.

### Current Meter Calibration

1. Connect a digital multimeter to the test set's EXTERNAL INSTRUMENT jack. A standard  $\frac{1}{4}$ " phone plug will fit this jack. Use shielded cable for this connection and connect the shield to the negative voltage terminal of the multimeter and the plug shell; center conductor to positive terminal and insulated center pin of plug.
2. Connect the test set to the appropriate value resistive load bank as illustrated in Figure 10. Observe the setting up procedure described in Section F.

### 20A and 200A Ranges

1. Connect the test set to a nominal 300 M $\Omega$  resistance load which has a voltage rating of at least 70 kV, and a wattage rating of at least 20 watts.
2. Set the DTS RANGE selector switch to the 20  $\mu$ A range, and set the digital multimeter to its correct DC current range.
3. Energize the test set, then slowly raise the output voltage until the digital multimeter reads 18  $\mu$ A. If necessary, adjust trimmer R4 located on the printed circuit board within the control unit, until the DTS current meter matches the digital multimeter reading.
4. Set the DTS RANGE selector switch to the 200  $\mu$ A range, and set the digital multimeter to its correct DC current range.
5. Adjust the DTS voltage control until the digital multimeter reads 150  $\mu$ A. If

## ROUTINE MAINTENANCE (cont'd)

necessary, adjust trimmer R3 until the DTS current meter matches the digital multimeter reading.

6. Return the voltage control to "0" (RESET), then de-energize the test set and ground the alligator clip of the HV output cable, following the operating procedure described in Operation Section F.

### 2 mA and 5 mA Ranges and Current Overload Trip

1. Connect the test set to a nominal 10 M $\Omega$  resistance load which has a voltage rating of at least 70 kV, and a wattage rating of at least 250 watts.
2. Set the DTS RANGE selector switch to the 2 mA range, and set the digital multimeter to its correct DC current range.
3. Energize the test set, then slowly raise the output voltage until the digital multimeter reads 1.9 mA. If necessary, adjust trimmer R2 until the DTS current meter matches the digital multimeter reading.
4. Set the DTS RANGE selector switch to the 5 mA range, and set the digital multimeter to its correct DC current range.
5. Adjust the DTS voltage control until the digital multimeter reads 4.5 mA. If necessary, adjust trimmer R1 until the DTS current meter matches the digital multimeter reading.
6. Advance the DTS voltage control slowly and note the reading of the DTS current meter when trip-out occurs. If necessary, adjust trimmer R11 for trip-out at  $5.5 \pm 0.2$  mA.
7. Return the voltage control to "0" (RESET), then de-energize the test set and ground the alligator clip of the HV output cable, following the operating procedure described in Operation Section F.
8. This completes the Calibration procedure. Disconnect the test set cables in the following sequence: disconnect the HV output cable first from the resistance load bank, then from the test set; then disconnect the input power cord; then disconnect the digital multimeter; then disconnect the interconnection cable; and finally disconnect the two ground cables.

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### ROUTINE MAINTENANCE (cont'd)

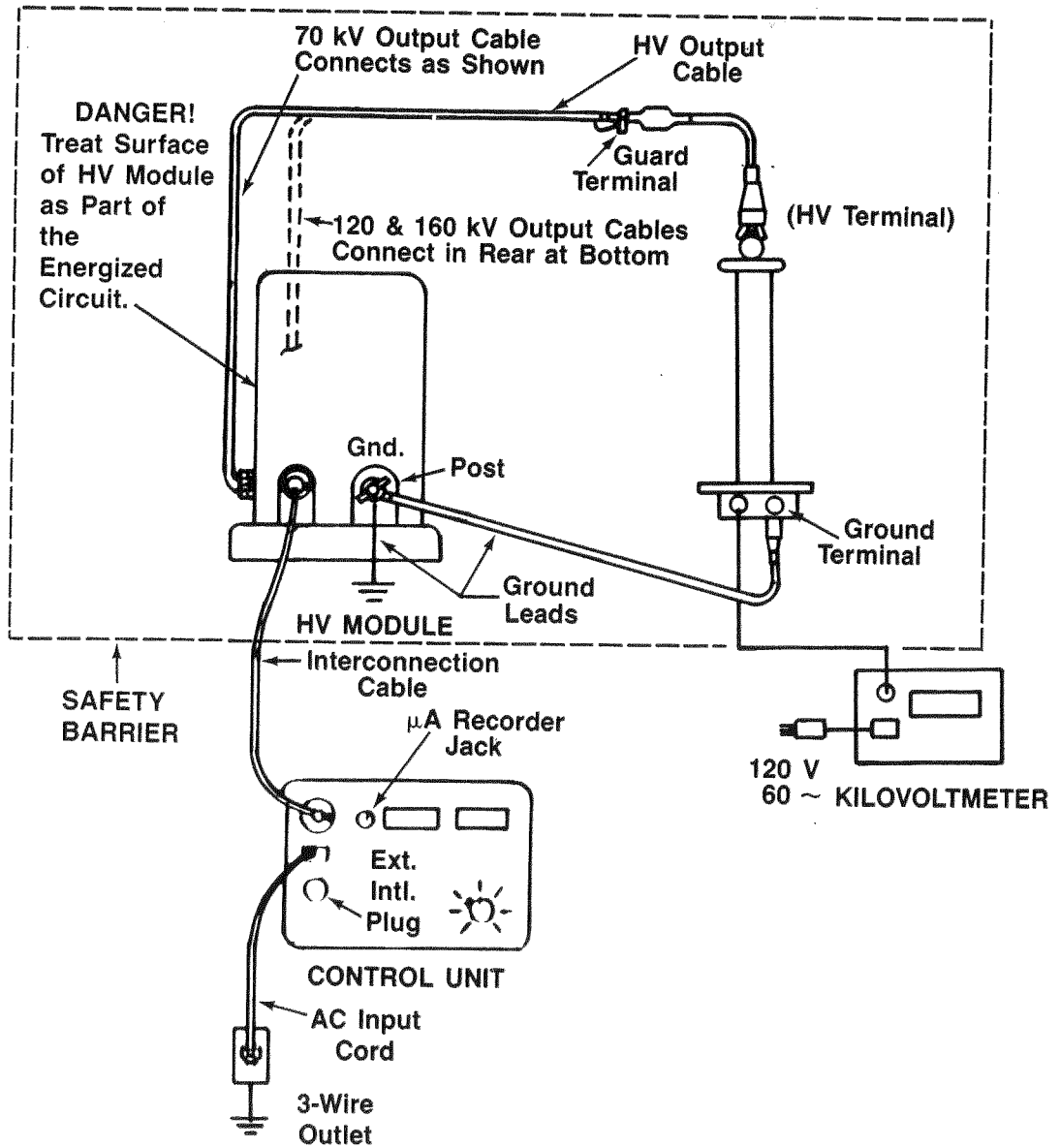


Figure 9: Dielectric Test Set Kilovoltmeter Calibration.

**ROUTINE MAINTENANCE (cont'd)**

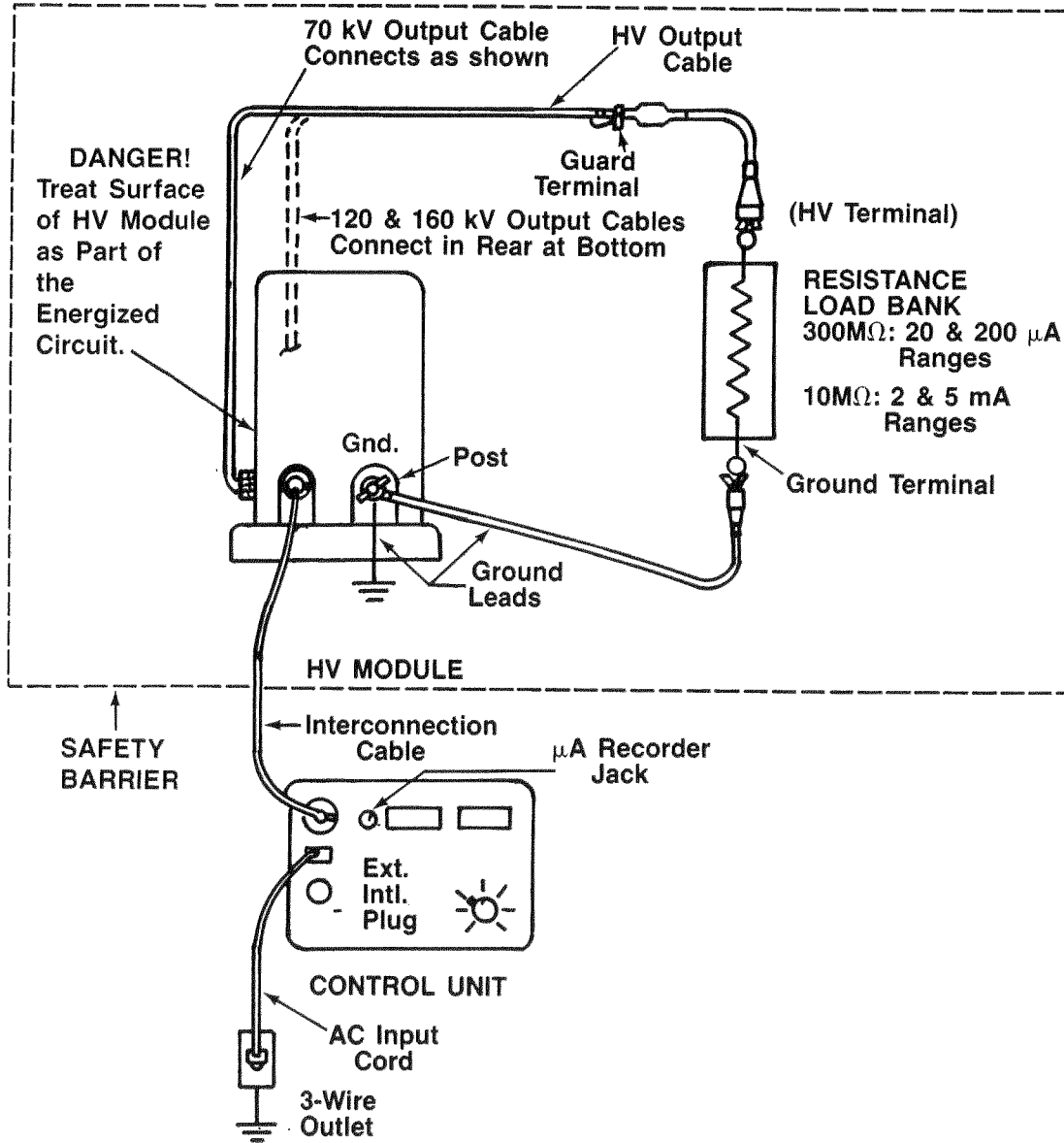


Figure 10: Dielectric Test Set Current Meter Calibration.

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## SECTION I TROUBLESHOOTING and REPAIR

### REPAIRS

Biddle Instruments maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When contacting our service department, complete information concerning the trouble and any steps taken in attempting repair should be given. The catalog number and serial number of the test set should also be specified. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.

For those users who prefer to make their own repairs, replacement parts are available from the factory. Refer to Section J when ordering replacement parts.

When replacement of internal parts is required in the high-voltage module it is important that all parts be installed in their originally located positions. It is also important that the high-voltage terminations be made in the same manner as originally made. Failure to observe these precautions may result in an internal flash-over within the high-voltage module at a voltage below rated output voltage. Figures 14 to 16 show the component locations, and Figures 17 to 19 illustrate the methods of making the high-voltage terminations.

### TROUBLESHOOTING

The Troubleshooting Guide, Table IV, is arranged to follow the sequence of the performance check covered in Section F. The Table gives possible equipment malfunctions observed during operation or check-out and suggests the possible cause and the means of determining the defective component. The schematic diagrams of Figures 20, 21 and the internal component illustrations of Figures 11 to 16 will be helpful in locating the components.

#### **CAUTION!**

This is high voltage equipment and contains dangerous voltages; repairs must only be made by those well qualified to deal with such hazards and familiar with routine precautions required to prevent injury.

Since high voltage can be stored in components of the test set interior even after the set has been de-energized, it is recommended that the test set be de-energized for at least 15 minutes prior to any attempt to gain access to the interior.

When troubleshooting the control unit, the high-voltage module should be completely disconnected from the control unit to prevent accidental high-voltage feedback from the high-voltage module.

## TROUBLESHOOTING and REPAIR (cont'd)

**TABLE IV TROUBLESHOOTING GUIDE**

Malfunction	Possible Cause
AC ON Lamp does not light.	No service power. Defective line cord. Main Breaker K1 not closed. Defective AC ON lamp (DS1): Fuse F1 or F2 blown (240V units only). Defective Stepdown Transformer T2. (240V units only).
Digital panel meters do not light.	Defective panel meters (M1 or M2). Defective connection terminal for M1 and M2. Connection terminal not mated properly to panel meters M1 or M2. Defective PS1 Power Supply.
Main Breaker trips on closure.	Defect in wiring. Defective PS1 Power Supply. Transient suppressor CR3 shorted.
HV ON lamp does not light.	Voltage Control not at "0" (RESET). External Interlock open. Defective zero start switch (E1). Defective K2 or K3 relays. Defective HV ON switch (S1). Defective HV OFF switch (S2). Defective HV ON lamp (DS2).
Main Breaker closes initially but trips when HV ON pushbutton depressed.	Defective Voltage Control transformer (T1). Defective Relay (K2). Defect in wiring.
Main Breaker or line relay trip-out when output voltage is increased.	Test set output shorted. Defective interconnection cable. Defective HV output cable. Defective rectifier assemblies: CR101 & CR102, 70 kV HV module, CR101 to CR104, 120 & 160 kV HV module. Defective filter capacitors: C101 & C102, 70 kV HV module, C101 to C104, 120 & 160 kV HV module. Defective current limiting resistors for rectifiers: R101 & R102, 70 kV HV module, R101 to R104, 120 & 160 kV HV module. Defective HV transformer T101. Defective Voltage Control transformer (T1). Defective high-voltage insulation. Defect in wiring.

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## TROUBLESHOOTING and REPAIR (cont'd)

### TROUBLESHOOTING GUIDE (cont'd)

Malfunction	Possible Cause
No output voltage, or inability to reach rated output voltage.	Defective interconnection cable/connection. Defective HV output cable. Defective rectifier assemblies (see above description). Defective filter capacitors (see above description).
No output voltage, or inability to reach rated output voltage.	Defective current limiting resistors for rectifiers (see above description). Defective HV transformer T101. Defective Voltage Control transformer (T1). Defective HV voltage divider resistor: R105, 70 kV HV module. R108, 120 kV HV module. R109, 160 kV HV module. Defective safety bleeder resistors: R103, 70 kV HV module. R105, 120 kV HV module. R105, 160 kV HV module. Defective output current limiting resistor: R107, 70 kV HV module. R111, 120 kV HV module. R113, 160 kV HV module. Defective output voltage meter (M2). Defective voltmeter resistor/capacitor/protective circuit. Defective high-voltage insulation. Defect in wiring.
No output current.	Defective or poor grounding. Defective interconnection cable/connection. Guard circuit grounded. Current RANGE switch set too high. Transient voltage protectors E101 or E102 shorted. Capacitor C105 shorted. Defective output current meter (M1). Defective RANGE selector switch. Defective current meter resistors/capacitors/protective circuit. Defective external instrument jack (J4). Defect in wiring.



## TROUBLESHOOTING and REPAIR (cont'd)

### TROUBLESHOOTING GUIDE (cont'd)

Malfunction	Possible Cause
Output voltage erratic.	Test sample failing. Defective output cable (open circuit or poor connection). Defective interconnection cable/connection. Defective rectifier assemblies (see above description). Defective filter capacitors (see above description). Defective current limiting resistors for rectifiers (see above description). Defective HV transformer T101. Defective Voltage Control transformer (T1). Defective HV voltage divider resistors (see above description).
Output voltage erratic.	Defective output current limiting resistors (see above description). Defective output voltage meter (M2). Defective voltmeter resistor/capacitor/protective circuit. Defective high-voltage insulation.
Output current erratic or excessive leakage current observed.	Line voltage transients (most noticeable on 20 $\mu$ A range). HV terminal of output cable spaced too close to nearby objects. HV terminal of cable or test sample burred, has sharp edges or is dirty. High surface leakage at test sample termination, unless guarded. Dirty HV output cable. Dirty HV module enclosure. Defective output current meter (M1). Defective current meter resistors/capacitors/protective circuit. Defective or dirty high-voltage insulation within HV module.

Figure

## TROUBLESHOOTING and REPAIR (cont'd)

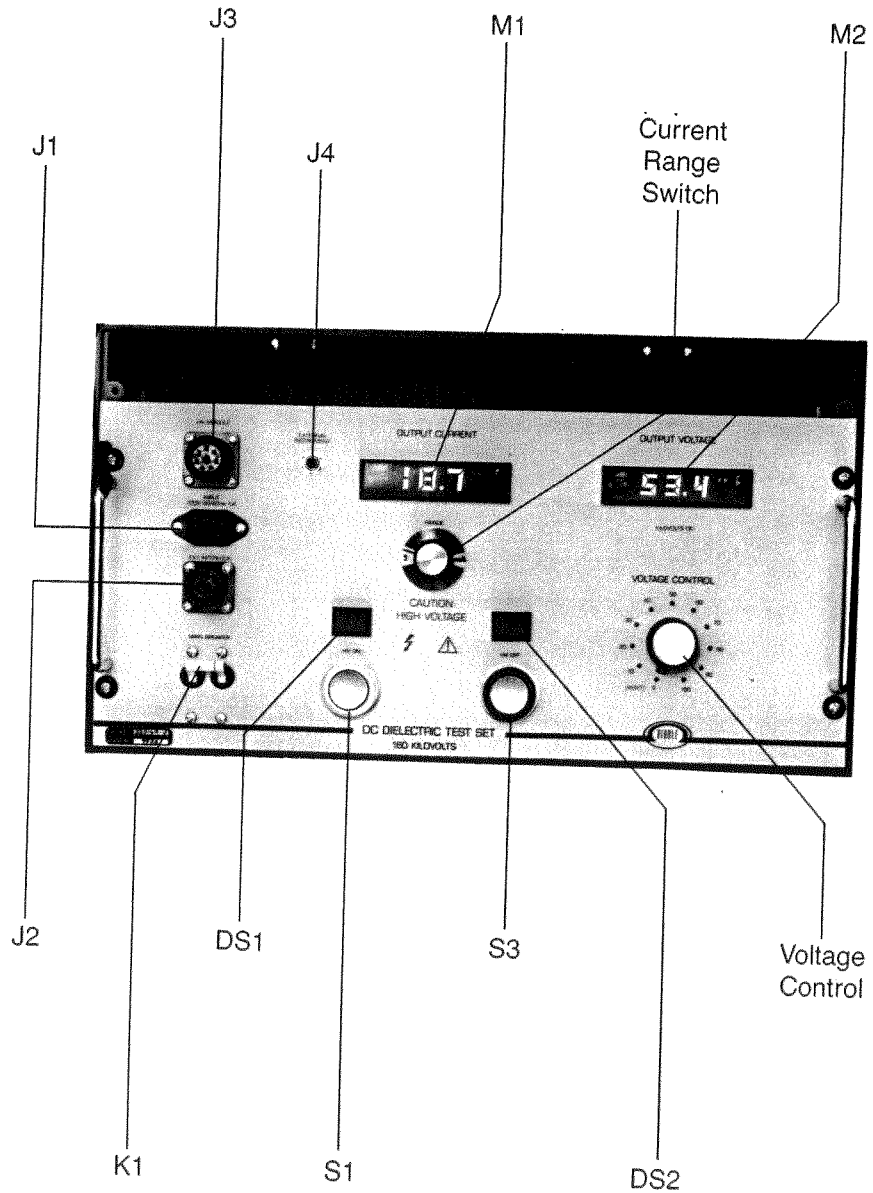


Figure 11: 70, 120, 160 kV Control Unit Component Identification, Top Panel View.

## TROUBLESHOOTING and REPAIR (cont'd)

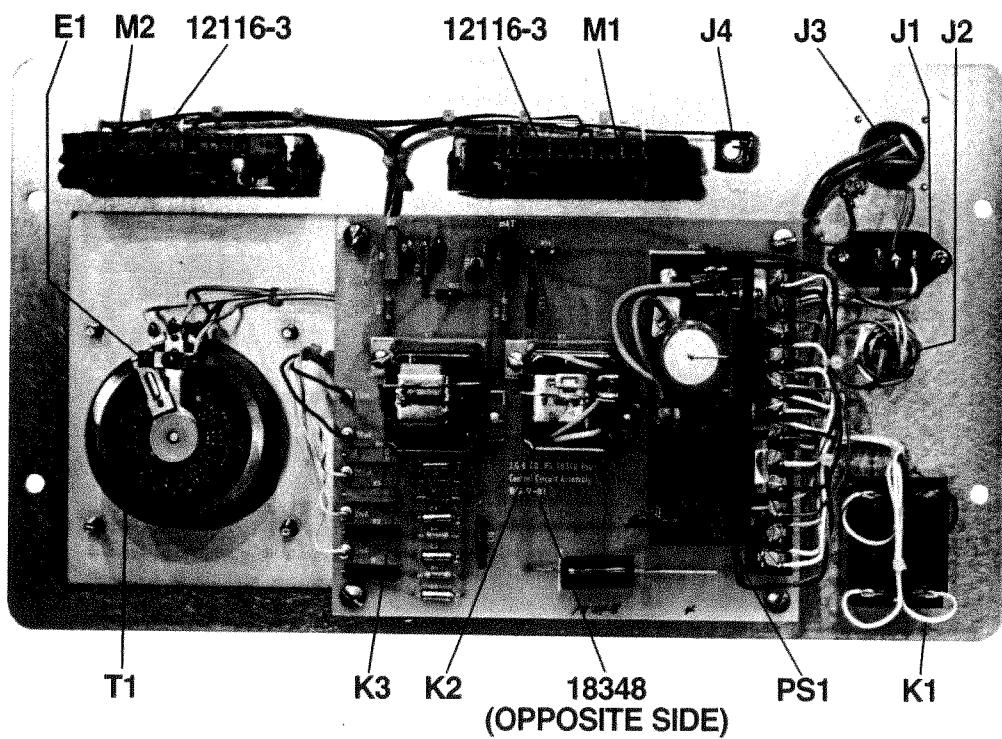
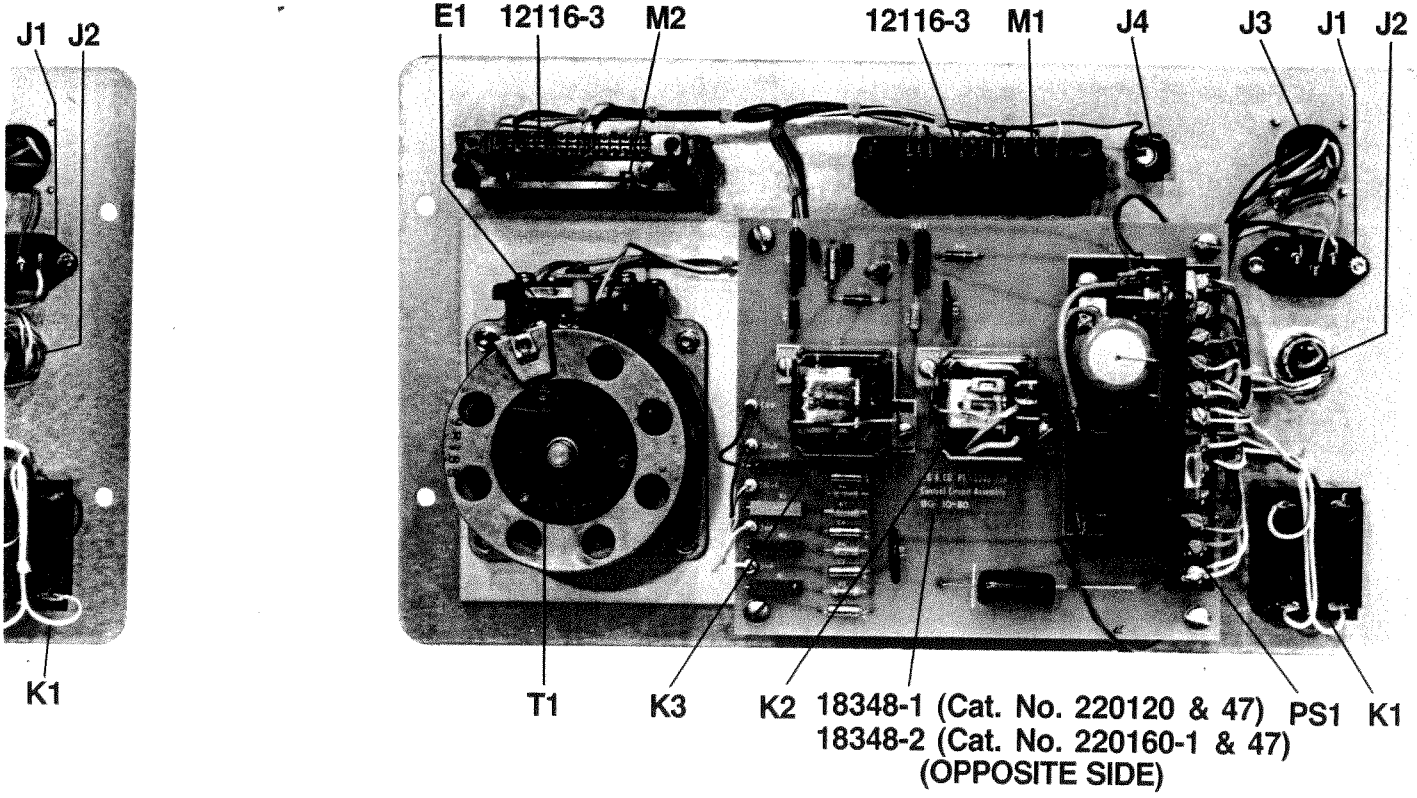


Figure 12: 70 kV Control Unit Component Identification, Internal View.

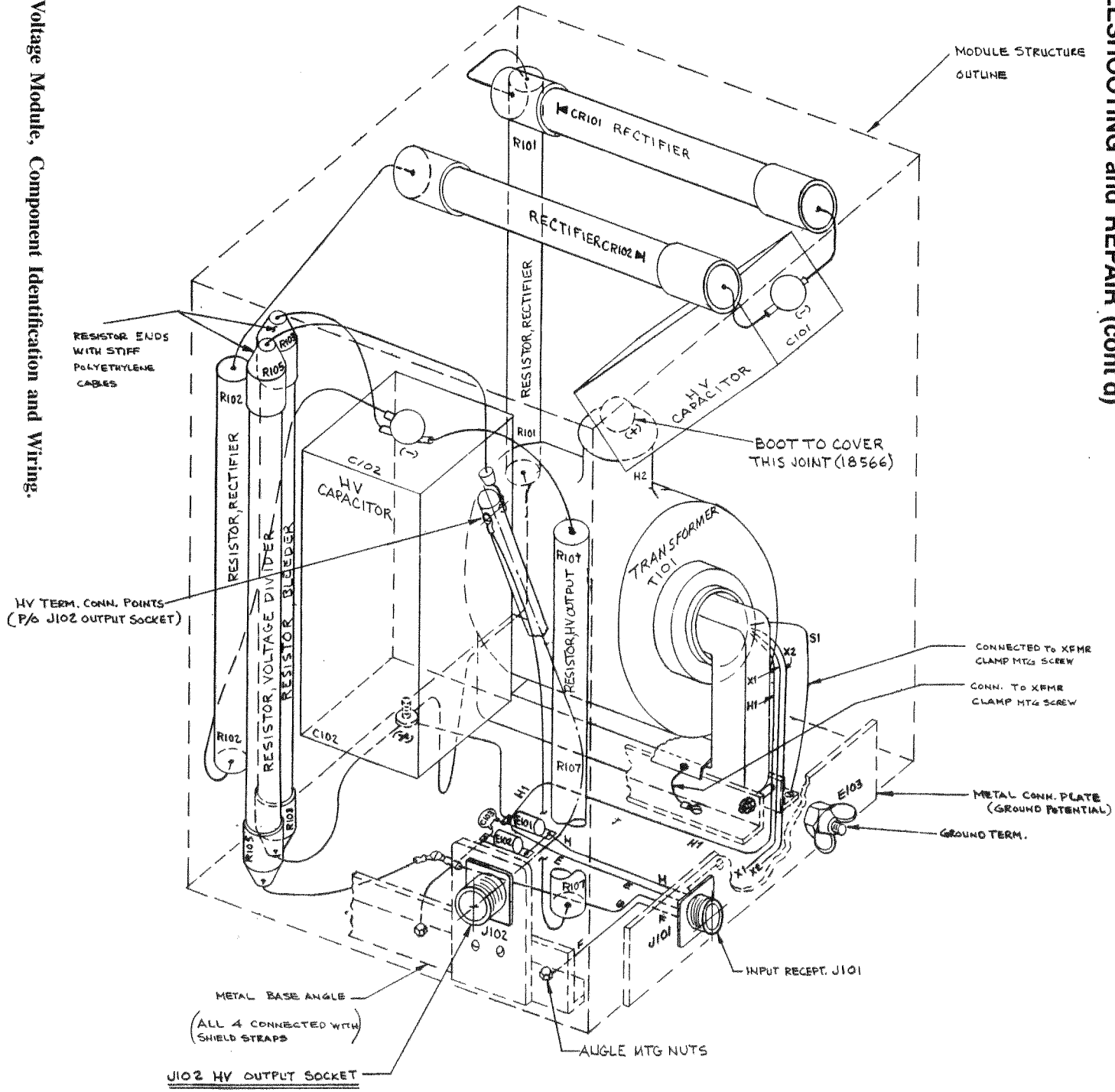
Figure

**TROUBLESHOOTING and REPAIR (cont'd)**



**Figure 13: 120 and 160 kV Control Unit Component Identification, Internal View.**

Figure 14: 70 KV High Voltage Module, Component Identification and Wiring.



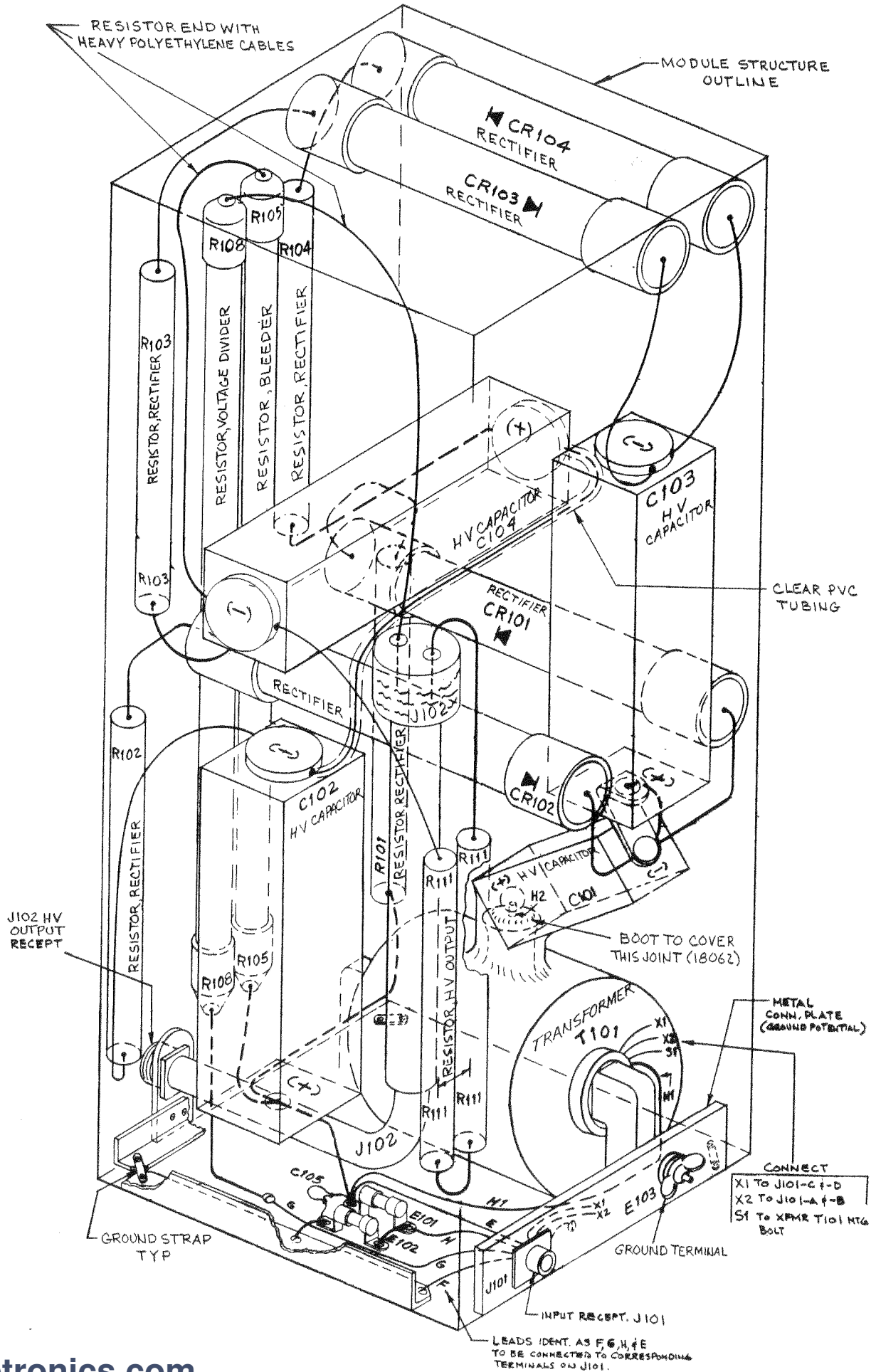
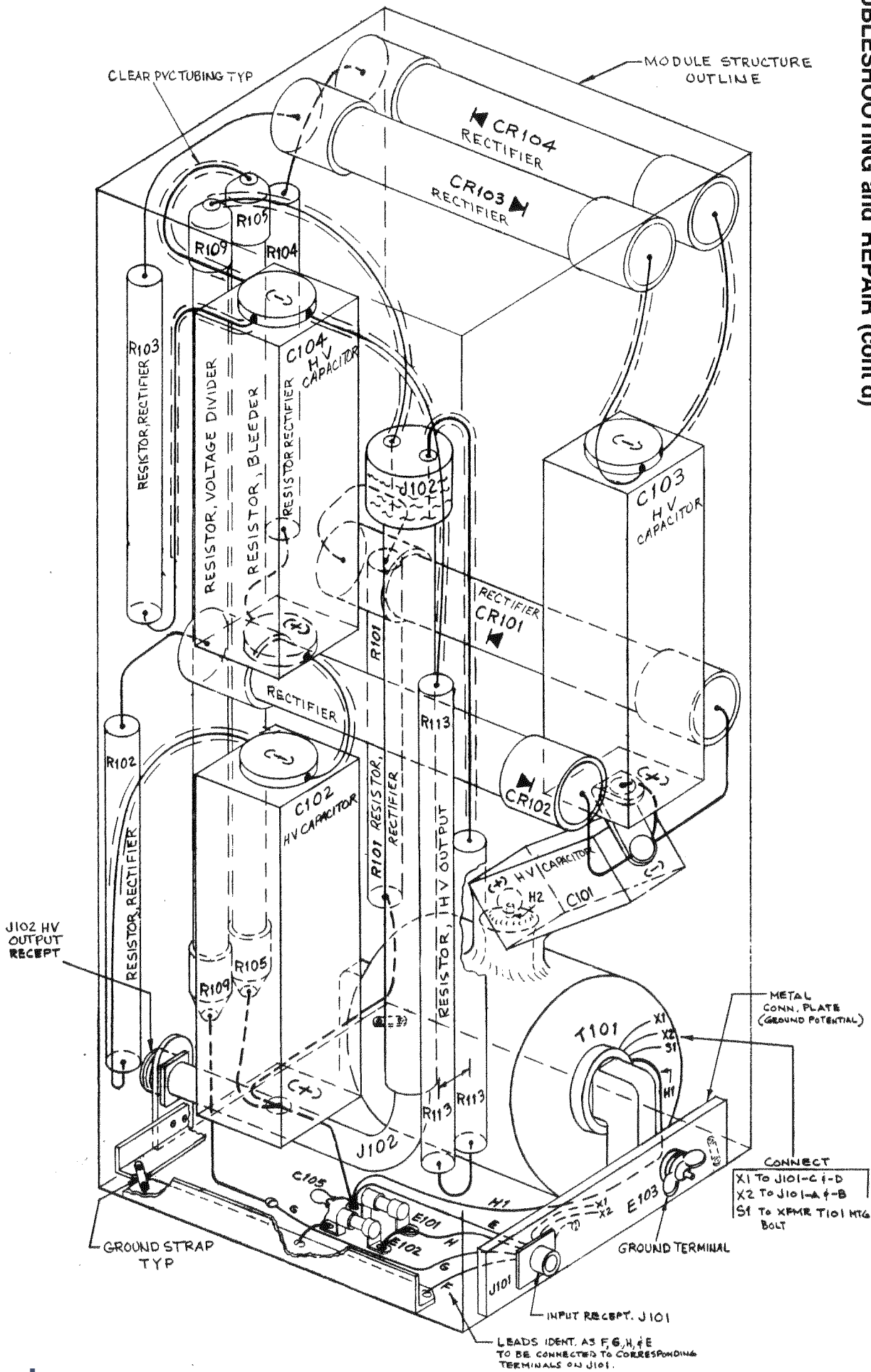
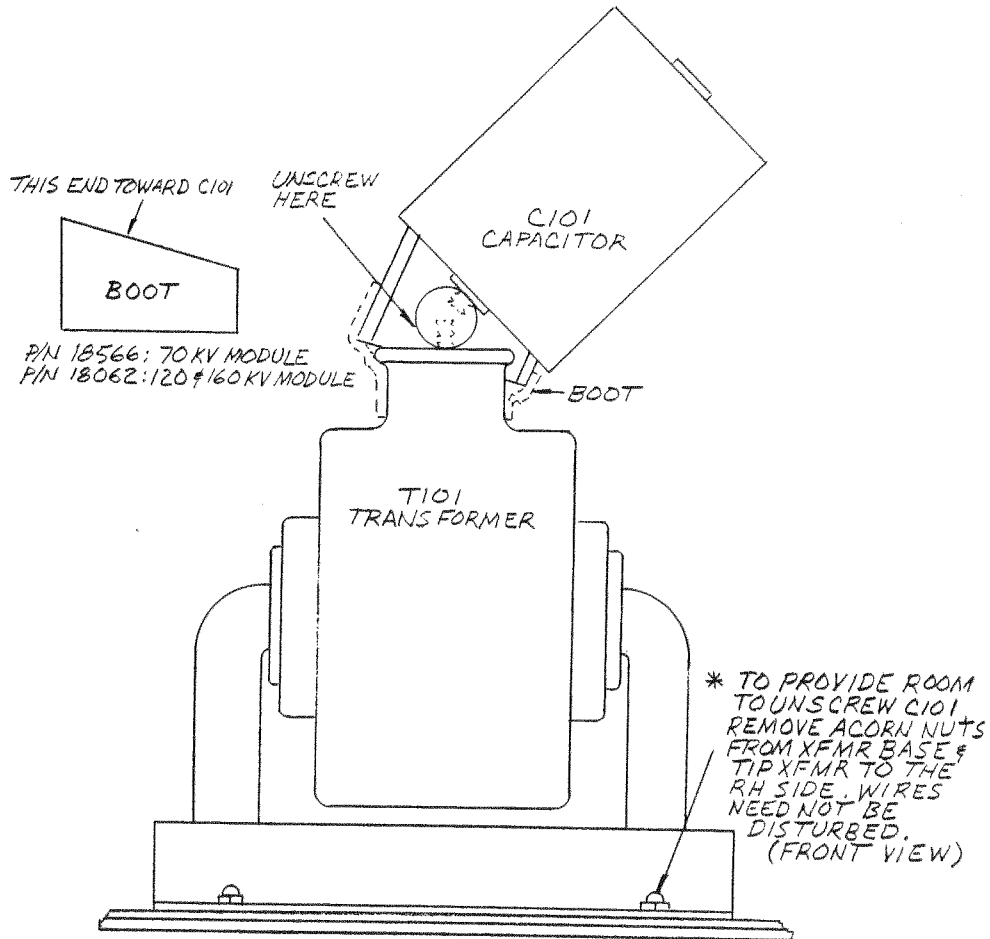


Figure 15: 120 kV High Voltage Module, Component Identification and Wiring



## TROUBLESHOOTING and REPAIR (cont'd)

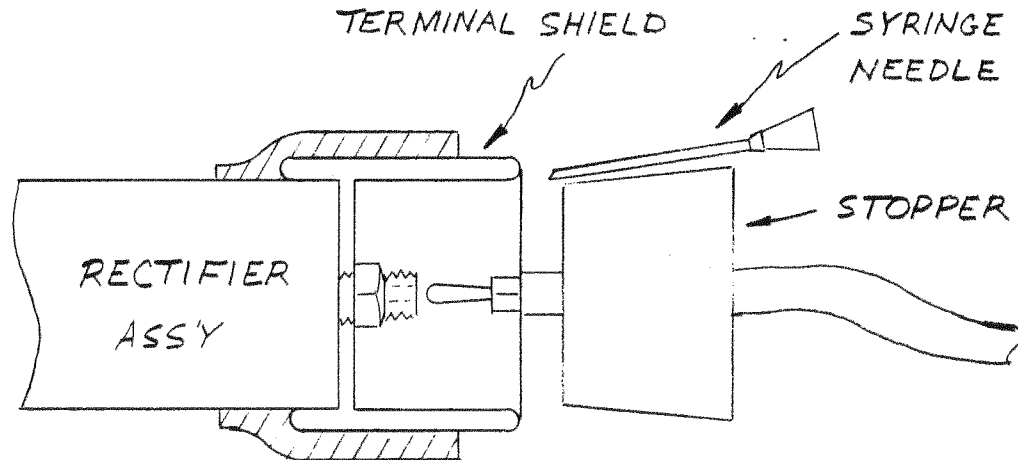


- TO REPLACE C101
1. REMOVE BOOT
  2. DETACH C101 AT UPPER TERM.
  - \* 3. UNSCREW (CCW) FROM XFMR.
  4. REMOVE BALL FROM OLD C101 & INSTALL ON NEW C101.
  5. INSTALL NEW BOOT.
  6. SCREW NEW C101 ONTO XFMR STUD & LINE UP WITH UPPER TERM.
  7. REATTACH UPPER C101 TERMINAL
  8. HEAT SHRINK BOOT

Figure 17: High Voltage Module Capacitor/Transformer Replacement.



## TROUBLESHOOTING and REPAIR (cont'd)



DE ROOM  
NEW C101  
ORN NUTS  
BASE #  
TO THE  
WIRES  
BE  
ED.  
VIEW)

### TO REPLACE RECTIFIER ASS'Y

1. REMOVE OLD ASSEMBLY BY PULLING END STOPPERS AND CUTTING TY-WRAPPS.
2. INSTALL STOPPERS INTO NEW ASSEMBLY USING A SYRINGE NEEDLE BETWEEN STOPPER AND TERMINAL SHIELD TO ALLOW DISPLACED AIR TO ESCAPE. REMOVE NEEDLE.
3. FASTEN RECTIFIER ASS'Y WITH NEW TY WRAPS (P/N 18537-2)

Figure 18: High Voltage Module Rectifier Replacement.

## TROUBLESHOOTING and REPAIR (cont'd)

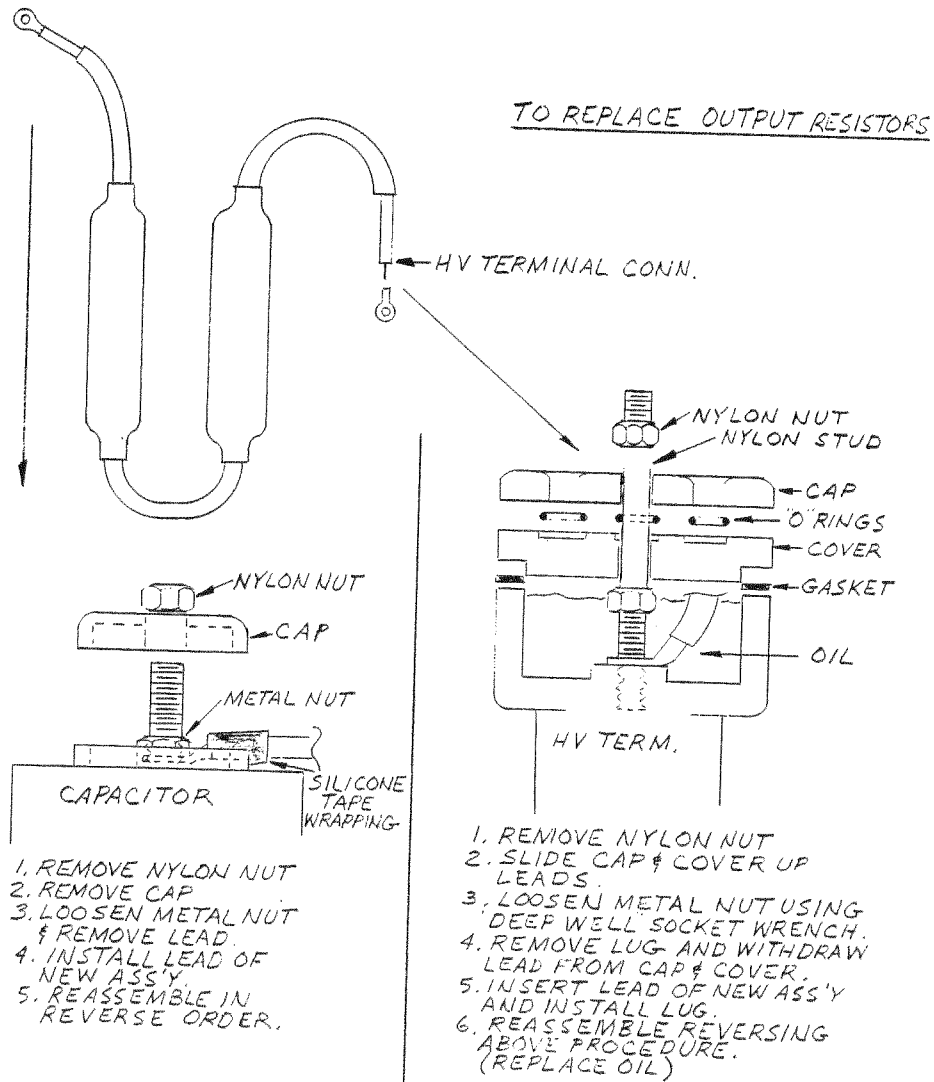


Figure 19: High Voltage Module Output Resistor Replacement.

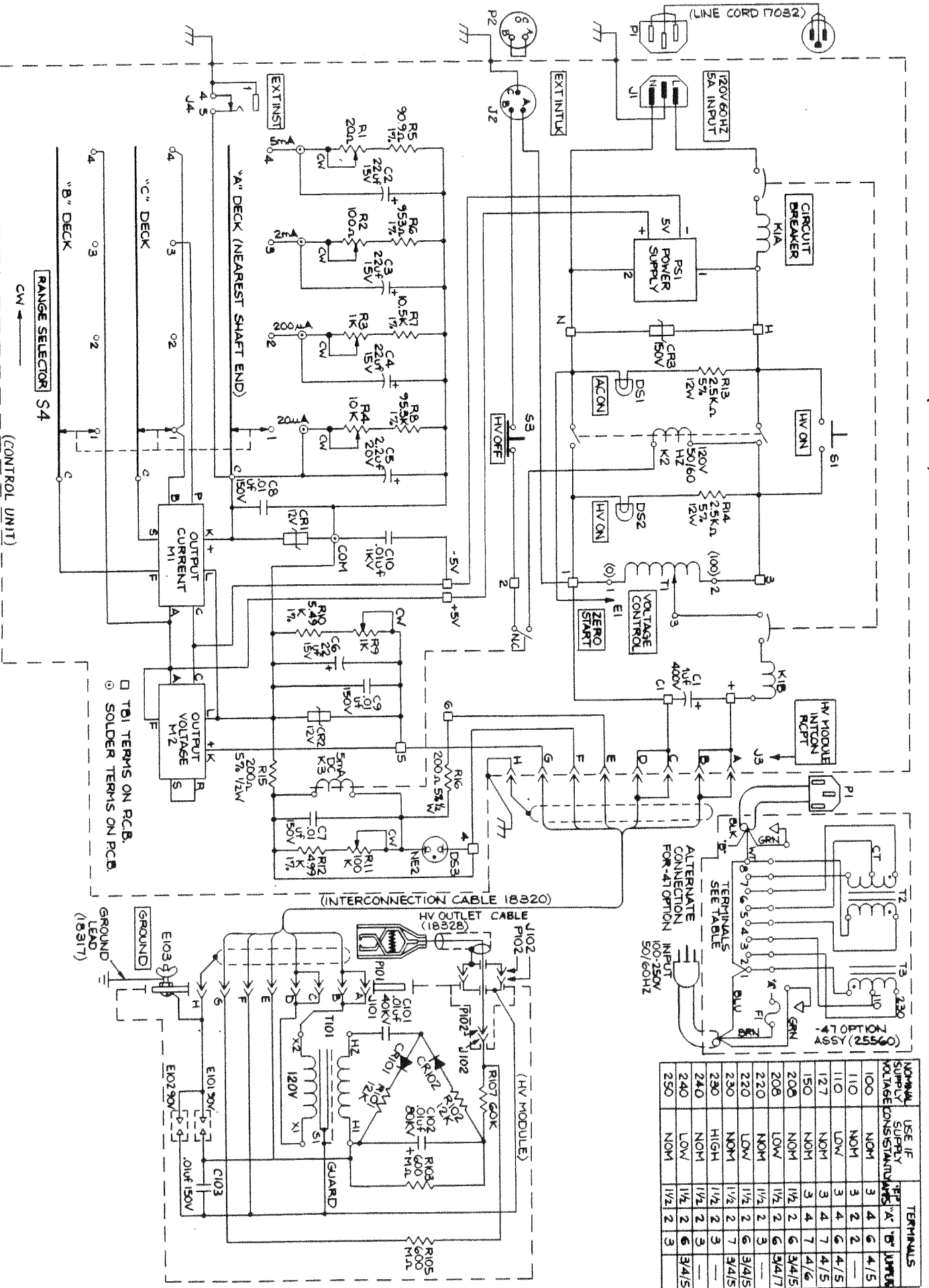


Figure 20: Schematic Diagram, 70 kV DC Test Set.

# TROUBLESHOOTING and REPAIR (cont'd)

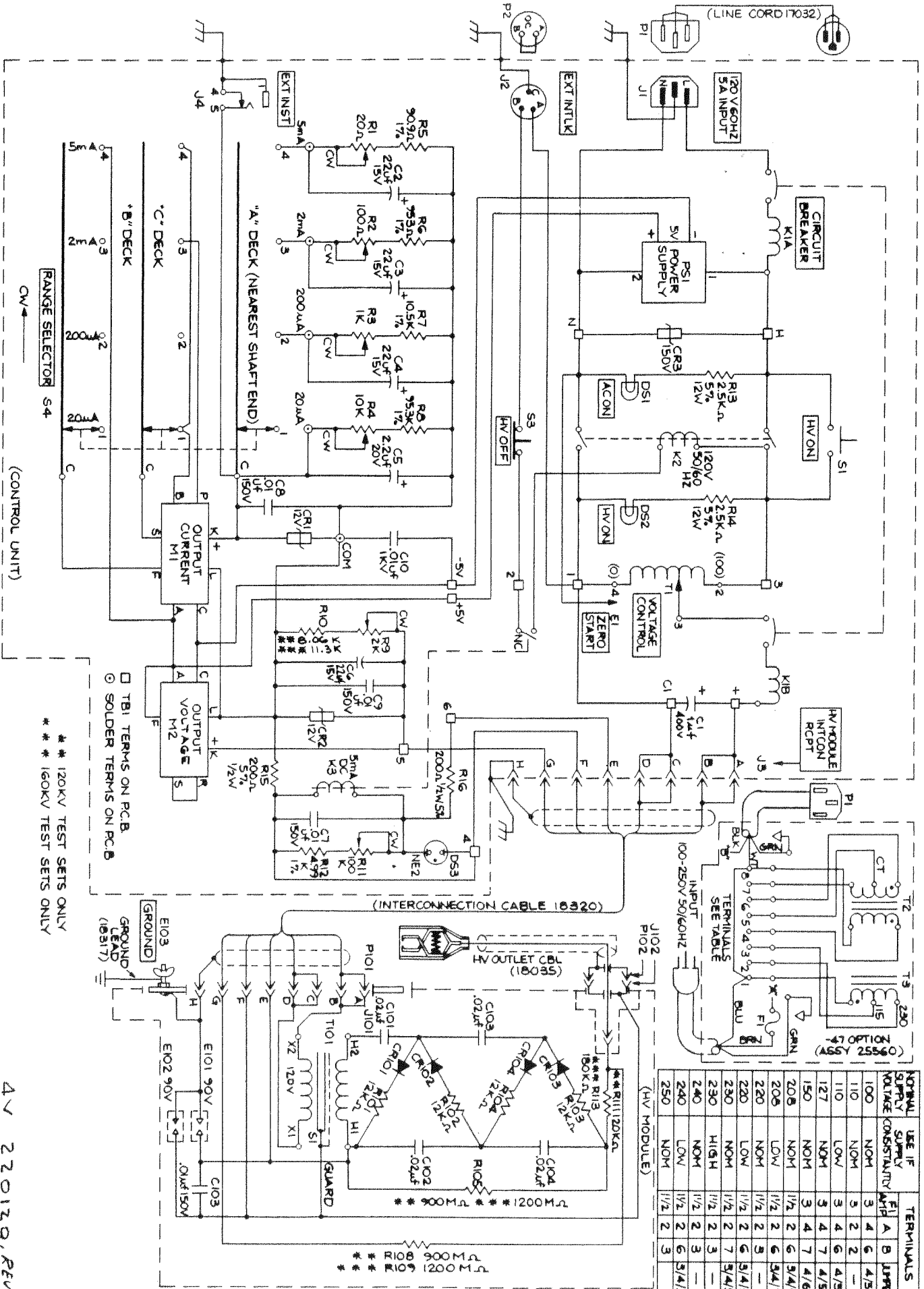


Figure 21: Schematic Diagram, 120 and 160 kV DC Test Sets

**SECTION J  
PARTS LIST**

Symbol	Description & Vendor	Vendor Part No.	Biddle Part No.
<b>CONTROL UNIT ASSEMBLY (ALL UNITS)</b>			
None	Case and Lid	—	25743-1
M1, M2	Meter, Voltage & Current	—	18310
*K1	Circuit Breaker, 250 V, 50/60 Hz, 2-pole, 5A (Potter & Brumfield)	W68X2Q1-0-5	18315
** ***K1	Circuit Breaker, 250 V, 50/60 Hz, 2 Pole, 10A (Potter & Brumfield)	W68X2Q1-0-10	18315-1
*T1	Voltage Control Transformer (Superior Electric)	10-C	6408-2
** ***T1	Voltage Control Transformer (Superior Electric)	21	16820
E1	Zero Start Contact	—	14869
S1	Switch, HV ON (G.E.)	CR2940U310A	16698-1
S1	Housing, Switch, White (G.E.)	CR2940UA200F	5824-2
S3	Switch, HV OFF (G.E.)	CR2940U301A	16698-2
S3	Housing, Switch, Red (G.E.)	CR2940UA200C	5824-1
S4	Switch, Range (Centralab)	SA-2006	1524-3
DS1, DS2	Indication Lamp (Arrow-Hart, Inc.)	83501	6847-10
DS1, DS2	Lens for Lamp, HV ON	—	6867-19
DS1, DS2	Lens for Lamp, AC ON	—	6867-38
DS1, DS2	Bulb, Lamp, Type T-1 3/4 (G.E.)	334	5297
R13, R14	Resistor, W.W., 2.5 k $\Omega$ , 5%, 12 W	—	4500-76
J1	Receptacle, 120/240 V Input (Belden)	17252	18305
J2	Receptacle, Ext. Interlock (Switchcraft)	B3M	12831
J3	Receptacle, HV Module (Amphenol)	MS3102A-18-8-S	9018-31
J4	Receptacle, Ext. Instrument (Switchcraft)	112A	4733-2
P2	Plug, Ext. Interlock (Switchcraft)	A3F	12824
None	Knob, Range Switch (Buckeye)	PS-95PL-2	4690-8
None	Knob, Voltage Control (Buckeye)	PS-125PL-2	4690-25
None	Connector, M1 & M2 Meters (Amphenol)	225-21521-10100	12116-3
None	Bumper Feet, Case (3M Co.)	SJ-5123	5599-1

## PARTS LIST (cont'd)

Symbol	Description & Vendor	Vendor Part No.	Biddle Part No.	Symbol
None	Instruction Card, Case Lid	—	19253	*R9
T2	Transformer (Acme)	—	22758-1	** *** I
T3	Autotransformer	—	22754-1	*R10
*	Printed Circuit Board Assembly:	—	18348	**R10
**	Printed Circuit Board Assembly:	—	18348-1	***R10
***	Printed Circuit Board Assembly:	—	18348-2	R11
C1	Capacitor, film, 1 $\mu$ F, 240 V ac, $\pm$ 10%	—	18309-1	R12
C2, C3, C4, C6	Capacitor, tantalum, 22 $\mu$ F, 15 V, $\pm$ 20%	—	12019-3	R15, R
C5	Capacitor, tantalum, 2.2 $\mu$ F, 50 V, $\pm$ 20%	—	12019-12	HIGH ' C101
C7, C8, C9	Capacitor, ceramic, 0.01 $\mu$ F, 150 V, +60–40%	—	9865-1	C102
C10	Capacitor, ceramic, 0.01 $\mu$ F, 1 kV, $\pm$ 20%	—	9865-10	C103
CR1, CR2	Voltage Suppressor (General Semiconductor)	P6KE12C	17040-3	CR101
CR3	Varistor, 150 V rms, 0.85 W (General Electric)	V150LA20A	3384-1	E101, R101
DS3	Neon Lamp (G.E.)	NE2E	4636	R102
K2	Relay, 120 V ac (Cutler-Hammer)	D5PR3A	17831	R103
K3	Relay, DC, 5 mA (Struthers-Dunn)	292XAXC	18302	R105
—	Spring, Relay Holdown (Struthers- Dunn)	37067	18303-4	T101
PS1	DC Power Supply (Xentek)	X17-5	18304	—
R1	Potentiometer, 20 $\Omega$ (Bourns)	3006P-1-200	13183-2	J101
R2	Potentiometer, 100 $\Omega$ (Bourns)	3006P-1-101	13183-4	J102
R3	Potentiometer, 1 k $\Omega$ (Bourns)	3006P-1-102	13183-7	E103
R4	Potentiometer, 10 k $\Omega$ (Bourns)	3006P-1-103	13183-10	—
R5	Resistor, RN60D, 90.9 $\Omega$ , 1%, 1/4W	—	12026-131	—
R6	Resistor, RN60D, 953 $\Omega$ , 1%, 1/4W	—	12026-132	—
R7	Resistor, RN60D, 10.5 k $\Omega$ , 1%, 1/4W	—	12026-133	—
R8	Resistor, RN60D, 95.3 k $\Omega$ , 1%, 1/4W	—	12026-134	—

## PARTS LIST (cont'd)

Idle Part No.	Symbol	Description & Vendor	Vendor PART No.	Biddle Part No.
9253	*R9	Potentiometer, 1 k $\Omega$ (Bourns)	3006P-1-102	13183-7
2758-1	** *** R9	Potentiometer, 2 k $\Omega$ (Bourns)	3006P-1-202	13183-8
2754-1	*R10	Resistor, RN60D, 3.48 k $\Omega$ , 1%, 1/4W	—	12026-70
8348	**R10	Resistor, RN60D, 8.06 k $\Omega$ , 1%, 1/4W	—	12026-30
8348-1	***R10	Resistor, RN65D, 11.3 k $\Omega$ , 1%, 1/2W	—	11445-28
8348-2	R11	Potentiometer, 100 k $\Omega$ (Bourns)	3006P-1-104	13183-13
8309-1	R12	Resistor, RN60D, 4.99 k $\Omega$ , 1%, 1/4W	—	12026-29
2019-3	R15, R16	Resistor, C.C., 200 $\Omega$ , 5%, 1/2W	—	4501-134
<u>HIGH VOLTAGE MODULE (70 kV Test Set)</u>				
2019-12	C101	Capacitor, High Voltage	—	18307-1
865-1	C102	Capacitor, High Voltage	—	18307-2
865-10	C103	Capacitor, Ceramic, 0.01 $\mu$ F, 150 V, +60–40%	—	9865-1
7040-3	CR101, CR102	Rectifier Assembly	—	18572
384-1	E101, E102	Voltage Protector, 90 V (Siemens)	S8-C90	16026-2
636	R101	Resistor Assembly, Rectifier	—	18541-1
7831	R102	Resistor Assembly, Rectifier	—	18541-2
8302	R103	Resistor Assembly, Bleeder	—	18540-2
8303-4	R105	Resistor Assembly, Voltage Divider	—	18540-1
8304	R107	Resistor Assembly, HV Output	—	18542
3183-2	T101	Transformer Assembly	—	18352
3183-4	—	Boot, C101 to T101 joint	—	18566
3183-7	J101	Receptacle, Interconnection (Amphenol)	MS3102A-18-8-S	9018-31
3183-10	J102	Receptacle, HV Output (ITT Cannon)	MS3105-20	18574
2026-131	E103	Wing Nut, Ground	—	5026
2026-132	—	Module Cover	—	18345
2026-133	—	Carrying Strap	—	19021
2026-134	—	Cap Plug, HV Output (Protective Closures)	CD-150	13353
	—	Cap Plug, Interconnection (Protective Closures)	CD-130	13353-1

## PARTS LIST (cont'd)

Symbol	Description & Vendor	Vendor Part No.	Biddle Part No.	Symbol
<b>HIGH VOLTAGE MODULE (120 kV Test Set)</b>				
C101	Capacitor, High Voltage	—	18063	HIGH VO
C102	Capacitor, High Voltage	—	18064-1	C101
C103	Capacitor, High Voltage	—	18064-2	C102
C104	Capacitor, High Voltage	—	18064-3	C103
C105	Capacitor, Ceramic, 0.01 $\mu$ F, 150 V, +60-40%	—	9865-1	C104
CR101-CR104	Rectifier Assembly	—	18572	C105
E101, E102	Voltage Protector, 90 V (Siemens)	S8-C90	16026-2	CR101-C1
R101, 103, 104	Resistor Assembly, Rectifier	—	18541-1	E101, E1
R102	Resistor Assembly, Rectifier	—	18541-3	R101
R105	Resistor Assembly, Bleeder	—	18043-2	R102, R1
R108	Resistor Assembly, Voltage Divider	—	18043-1	R104
R111	Resistor Assembly, HV Output	—	18038	R105
T101	Transformer Assembly	—	18352-1	R109
—	Boot, C101 to T101 joint	—	18062	R113
J101	Receptacle, Interconnection (Amphenol)	MS3102A-18-8-S	9018-31	T101
J102	Receptacle, HV Output (ITT Cannon)	MS3105-20	18574	—
E103	Wing Nut, Ground	—	5026	J101
—	Module Cover	—	18345-1	J102
—	Carrying Strap	—	19021	E103
—	Cap Plug, HV Output (Protective Closures)	CD-150	13353	—
—	Cap Plug, Interconnection (Protective Closures)	CD-130	13353-1	—
<b>CABLES</b>				
	Ground Lead (2 per test set)		18317	
	Interconnection Cable		18320	
*	Output Cable Assembly		18328	
** ***	Output Cable Assembly		18035	
	Line Cord, 120 V Input		17032	
$\Delta$	Line Cord, 240 V Input		17032-2	
	Cable Carrying Bag		18313	



## PARTS LIST (cont'd)

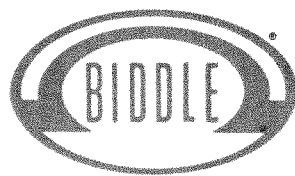
Biddle Part No.	Symbol	Description & Vendor	Vendor Part No.	Biddle Part No.
<b>HIGH VOLTAGE MODULE (160 kV Test Set)</b>				
18063	C101	Capacitor, High Voltage	—	18063
18064-1	C102	Capacitor, High Voltage	—	18064-4
18064-2	C103	Capacitor, High Voltage	—	18064-5
18064-3	C104	Capacitor, High Voltage	—	18064-6
9865-1	C105	Capacitor, Ceramic, 0.01 $\mu$ F, 150 V, +60-40%	—	9865-1
18572	CR101-CR104	Rectifier Assembly	—	18572
16026-2	E101, E102	Voltage Protector, 90 V (Siemens)	S8-C90	16026-2
18541-1	R101	Resistor Assembly, Rectifier	—	18541-1
18541-3	R102, R103	Resistor Assembly, Rectifier	—	18541-3
18043-2	R104	Resistor Assembly, Rectifier	—	18541-2
18043-1	R105	Resistor Assembly, Bleeder	—	19252-2
18038	R109	Resistor Assembly, Voltage Divider	—	19252-1
18352-1	R113	Resistor Assembly, HV Output	—	19254
18062	T101	Transformer Assembly	—	18352-2
9018-31	—	Boot, C101 to T101 joint	—	18062
	J101	Receptacle, Interconnection (Amphenol)	MS3102A-18-8-S	9018-31
18574	J102	Receptacle, HV Output (ITT Cannon)	MS3105-20	18574
5026	E103	Wing Nut, Ground	—	5026
18345-1	—	Module Cover	—	18345-2
19021	—	Carrying Strap	—	19021
13353	—	Cap Plug, HV Output (Protective Closures)	CD-150	13353
13353-1	—	Cap Plug, Interconnection (Protective Closures)	CD-130	13353-1
18317				
18320	$\Delta$	240 V, 50/60 Hz Test Sets only.		
18328	*	70 kV, Test Sets only.		
18035	**	120 kV Test Sets only.		
17032	***	160 kV Test Sets only.		
17032-2				
18313				

## **SECTION K WARRANTY**

### **WARRANTY**

All products supplied by Biddle Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. **WE MAKE NO OTHER WARRANTY.**

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance indicated in this manual.



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