DCDTS726V2-UG-EN-V02
MAR 2021

Instruction Manual
for the
DC Dielectric Test Sets

Catalog Nos.

220070-V2:	70 kV	Digital Metering, 120V operation
220070-V2-47:	70 kV	Digital Metering, 230V operation
220123-V2	120 kV	Digital Metering, 120V operation
220123-V2-47	120 kV	Digital Metering, 230V operation
220163-V2	160 kV	Digital Metering, 120V operation
220163-V2-47	160 kV	Digital Metering, 230V operation

High-Voltage Equipment
Read the entire manual before operating.

Megger.

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The information presented in this manual is believed to be adequate for the intended use of the product. If the product or its individual instruments are used for purposes other than those specified herein, confirmation of their validity and suitability must be obtained from Megger.

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INTRODUCTION

Receiving Instructions

Check the equipment received against the packing list to ensure that all materials (see page 14, Cable Carrying Bag /Test Cables and Accessories) are present. Notify your local Megger sales representative of any shortage or call the factory, Telephone +1(610) 676-8500.

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

This instrument has been thoroughly tested and inspected to meet rigid specifications before being shipped. It is ready for use when set up as indicated in this manual.

General Information

Megger dielectric test sets provide the high-voltage dc output needed to check the quality of electrical insulation on motors, power cables, switch gear, bushing, insulators, transformers, and capacitors. The test sets are designed for making proof, acceptance, and maintenance tests of electrical 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. A test set comprises a control unit, a high-voltage (HV) unit, four cables and one input power cord. See Figures 1 through 3.

This instruction manual describes the operation and maintenance of Megger DC Dielectric Test Sets with Catalog Numbers 220070-V2, 220123-V2, and 220163-V2 (for 120VAC operation), and when combined with a "-47 suffix" denote test sets for 220/240 V input power. Unless otherwise specifically stated, information in this manual applies to all models listed in this document.

The tests made by these test sets are based on measurement of the applied dc voltage, the resulting current, and the manner in which current varies with time (leakage current).

These measurements provide an indication of the condition of the insulation system of the object being tested. Information on the interpretation of recorded data and guides for test voltage and time are given in Section 6 of this manual.

Figure 1: Catalog No. 220070V2 / V2-47 70kV Set

Figure 2: Catalog No. 220123V2 / V2-47, 120kV Set

Figure 3: Catalog No. 220163V2 / V2-47, 160 kV Test

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SAFETY

General

The test set and test object, to which it is connected, are a source of high-voltage electrical energy and all persons making or assisting in 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 HV unit 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 unit as indicated in Section 5 of this manual. Position the HV unit on a flat surface at least 3 ft (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 unit.

This HV unit as well as the equipment to be tested should be enclosed in an area where access is restricted. Portable barriers are suggested for field testing

This test set is designed to be connected to either a de-energized cable or another high- voltage power apparatus. Treat all terminals of high-voltage, power equipment as a potential electric shock hazard. There is always the possibility of voltages being induced at these terminals because of proximity to energized high-voltage lines or equipment. Always ground the terminals of power equipment, before attempting to connect or disconnect the test set leads. The ground connection must be the first made and the last removed. An interruption of the grounding connection can create an electric shock hazard.

General Safety Precautions for DC Testing

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

Devices which rely on solid or solid/liquid dielectrics for insulation must be grounded and short-circuited with bonding jumpers when not in use.

Good safety practice requires that capacitive type test objects incl. power cables be short-circuited in the following situations:

- Any capacitive object not in use which might be within the influence of a dc electric field should have its exposed high-voltage terminals grounded. Failure to observe this precaution could result in a voltage being induced in the capacitive object.
- Capacitive objects must be discharged and short-circuited after being tested with dc. Failure to observe this precaution could result in a build-up of voltage on the object due to dielectric absorption in the insulation. The short circuit should remain in place until the dielectric absorption has dissipated or until the object has been reconnected to a circuit.

NOTE

A safe practice for all capacitive type test objects is to always short-circuit them when not in use.

Any open circuit capacitive test object and or device must be short circuited before being contacted by personnel

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 zero reading on the test set kilovoltmeter) before grounding it, 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 ground all live parts. Ground bonds should then be applied and left in place. Do not approach the HV unit until the ground bonds have been applied.

The natural Discharging of a test object by turning the HV energy source off may take a considerable amount of time depending on the type and capacitance of it. To accelerate the discharge process, once the sample has discharged to less

than one-fourth the voltage used during the test, a suitably rated high-voltage resistance discharge stick 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.

For further details on safety practices and precautions in high- voltage testing, refer to IEEE Standard 510-1983, re-affirmed March 19, 1992, "IEEE Recommended Practices for Safety in High-Voltage & High-Power Testing"

If the test set is operated in accordance to the manual and above mentioned IEEE and applicable OSHA regulations, and all ground connection have been correctly made, test personnel is not required to wear rubber gloves. As a routine safety procedure, some company policies require that rubber gloves be worn as a routine safety procedure, not only when making connections to the high-voltage terminals, but also when manipulating controls. Megger supports any measure that reassures the safety of the operator.

THE USER IS RESPONSIBLE TO FOLLOW & MAINTAIN ALL SAFETY RULES AND REGULATIONS

- Never connect the test set to energized equipment or use the test set in wet and high humidity environments and corrosive or explosive atmospheres.
- Maintenance and service must be performed only by Megger Service or an authorized Megger Service Center.
- The word "**DANGER**" on the equipment identifies areas of immediate hazard which could result in personal injury or loss of life.
- The intended use of the test set is limited to as the applications described in this manual. Do not use the test set for non-specified applications, do not use its test leads or cables with any device other than the equipment described in this manual. Personnel wearing pacemakers, shall not operate any high voltage equipment due to potentially strong electric and or magnetic fields that may interfere with the proper operation of the heart pacemaker.

This instrument operates from a single-phase power source. It has a three-wire power cord and requires a two-pole, three- terminal, live, neutral, and ground type connector. The voltage to ground from the live pole of the power source must not exceed the maximum rated input operating voltage.

The neutral pole must be at ground potential. Before making connection to the power source, determine that the instrument rating matches the voltage of the power source and has a suitable two-pole, three-terminal grounding type connector.

The power input plug must be inserted only into a mating receptacle with a ground contact. Do not bypass the grounding connection. Any interruption of the grounding connection can create an electric shock hazard. Determine that the receptacle is properly wired before inserting the plug.

Test sets energized with 220/240 V input power (designated by catalog numbers with a "-47" suffix) are energized via an autotransformer, which is used for voltage reduction. Depending on whether the test set is supplied with a black, white, and green input supply cord or a brown, blue, and green/yellow supply cord, the black or brown cord lead must be connected to the live pole of the line power source and the white or blue cord lead must be connected to the neutral pole of the line power source. The green or green/yellow ground lead of the input supply cord must be connected to the protective ground (earth) contact of the input plug. These test sets ***must not be energized*** from a power source where both poles are live.

If using a power cord other than the one provided, ensure it is rated for at least 250VAC and is 18 AWG (0.75mm^2) or larger. Do not use an inadequately rated power cord.

The following specific warning and caution notices are used throughout this manual where applicable;

WARNING

Warning, as used in this manual, is defined as a condition or practice which could result in personal injury or loss of life

CAUTION

Caution, as used in this manual, is defined as a condition or practice which could result in damage to or destruction of the equipment or apparatus under test

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SPECIFICATIONS

Electrical

Table 1 delineates the electrical specifications for the test sets.

Table 1: Specifications of Input and Output

Cat. No.	Input Voltage Nominal line voltage, single phase	Output Voltage Continuously variable, negative polarity with respect to ground, for loads of less than 1 mA output current.	Output Current Maximum rating (thermal)
220070V2	120 V (105-130 V) 50/60 Hz 5 A	0 to 70 kV	5 mA for 30 min 3.5 mA continuous
220070V2-47	230 V (V207-256 /) 50/60 Hz 2.5 A	0 to 70 kV	5 mA for 30 min 3.5 mA continuous
220123V2	120 V (105-130 V) 50/60 Hz 10 A	0 to 120 kV	5 mA for 20 min 2.5 mA continuous
220123V2-47	230 V (207-256 V) 50/60 Hz 5 A	0 to 120 kV	5 mA for 5 min 2 mA continuous
220163V2	120 V (105-130 V) 50/60 Hz 10 A	0 to 160 kV	5 mA for 20 min 2 mA continuous
220163V2-47	230 V (207-256 V) 50/60Hz 5A	0 to 160 kV	5 mA for 5 min 1.5 mA continuous

Regulation is less than 20 percent 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 μA at full-rated output voltage. Guard terminal on HV output cable allows optional connection to test sample.

VOLTMETER

220070V2 and -47 220123V2 and -47 220163V2 and -47	Digital voltmeter: 0 – 70 kV Resolution: 100 volts Accuracy: ±2% of reading + 100 volts (last significant digit)

AMMETER

220070V2 and -47 220123V2 and -47 220163V2 and -47	Digital ammeter: 0 – 19.9μA, 0 – 199 μA, 0 – 1.99mA, 0 – 5.00mA Accuracy: ±2% of reading +last significant digit (depending on range from 0.1 to 100μA

All high-voltage components are encapsulated or sealed in the dielectric housing for high reliability and 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 any charge stored in the unit.

Safety Features

- Input supply line circuit breaker.
- Output current overload relay.
- Zero-start interlock for high-voltage output.
- Push-button 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 HV unit by 15 ft (4.6 m) of interconnection cable.

Physical Characteristics

CONTROL UNIT

The control unit is housed in a sturdy, suitcase-style portable case.

Cat. No.	Dimensions	Weight
220070V2 220123V2 220163V2	20 x 12 x 12 ½ in. (L x W x H) (50.8 x 30.5 x 31.8 cm)	23 lbs. (10.5 kg)
220070V2-47 220123V2-47 220163V2-47	20 x 12 x 12 ½ in. (L x W x H) (50.8 x 30.5 x 31.8 cm)	25 lbs. (11.4 kg)

HV UNIT

The HV unit is housed in a high-impact strength polyethylene housing with an adjustable shoulder carrying strap.

Cat. No.	Dimensions	Weight
220070V2 and -47	12 x 12 x 20 in. (L x W x H) (30.5 x 30.5 x 51 cm)	44 lbs. (20 kg)
220123V2 and -47	12 x 12 x 29 in. (L x W x H) 30.5 x 30.5 x 74 cm)	65 lbs. (30 kg)
220163V2 and -47	12 x 12 x 29 in. (L x W x H) (30.5 x 30.5 x 100 cm)	73 lbs. (33 kg)

CABLE CARRYING BAG

The cable carrying bag is a sturdy canvas bag that holds all test cables, instruction manual, and test reports. Bag has convenient carrying handle and an adjustable shoulder strap.

Cat. No.	Dimensions	Weight
220070V2 and -47	12 W x 17 H x 4 in. thick (30.5 x 43 x 10 cm)	7 lbs. (3 kg) incl. Cables
220123V2 and -47 220163V2 and -47	15 W x 17 H x 4 in. thick (38 x 43 x 10 cm)	9 lbs. (4 kg) incl. Cables

TEST CABLES AND ACCESSORIES

- One 8-ft, 3-wire input supply cord
- Two 15-ft ground cables
- One 15-ft interconnection cable
- One 15-ft shielded HV output test cable, detachable
- Instruction Manual
- Kilovolt/megohm graph paper, 100-sheet pad (Cat. No. 220000).

Environmental

Operating Temperature Range: -20 to 130°F (-30 to 55°C)

Storage Temperature Range: -40 to 150°F (-40 to 65°C)

Relative Humidity: 0 to 90% non-condensing (operating)
0 to 95% non-condensing (storage)

CAUTION

Storage for extended periods of time at high temperature and relative humidity may cause degradation of the digital displays

Additional Accessories & Options Available (need to be ordered separately)

Cat. No	Item
222070-62	Manual HV Resistance Discharge Stick, 60 to 70 kV
222120-62	Manual HV Resistance Discharge Stick, 120 kV
222160-62	Manual HV Resistance Discharge Stick, 160 kV
Option 56	Longer lengths of shielded HV output test cable. (50 ft maximum)

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CONTROLS AND CONNECTORS

Table 2 describes the controls, indicators, and connectors of the test set. See Figures 1 and 2 for their location.

Table 2: Test Set, Identification of Controls

Test Set Control	Description
MAIN BREAKER	Two-pole magnetic circuit breaker controls all power to the test set and provides short-circuit and overload protection.
AC ON Light	White light indicates circuit breaker ON, test set s connected to AC line voltage
Green HV Ready Light	Green light of the HV ON Switch indicates the instrument is ready to provide High Voltage
HV ON Switch	Push-green HV ON button, controls internal relay, enabling the test set to raise HV, red HV OFF Light will come on.
Red HV Light	Red light, part of the HV OFF Switch, indicates HV is ON and voltage is be applied to the test specimen.
HV OFF Switch	Push red HV-OFF -button, de-energizes relay and cuts power to the HV power supply, turns Red HV light off.
VOLTAGE CONTROL	Variable-ratio autotransformer 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.
OUTPUT VOLTAGE	Kilovoltmeter measures applied dc test voltage.

Test Set Control	Description
OUTPUT CURRENT	Micro/Milli ammeter measures test sample current. Scaling controlled by the Current RANGE Switch
Current RANGE	4-position rotary switch selects output current measuring range.
Key Switch	Operator controlled interlock device. Will disable the High Voltage module when in the open (safe) position. Note that the key is removable only in the Safe position.
EXTERNAL INSTRUMENT	Connector in series with the Current meter, this allows the connection of an auxiliary current indicating meter or recorder.

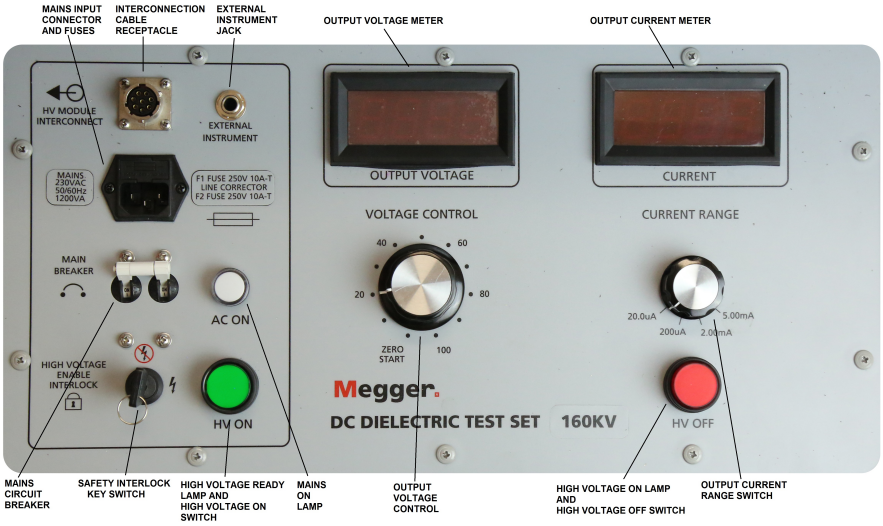

Figure 1: Control Panel and Identification of Controls

WARNING:

Never connect or disconnect an external instrument while the test set is energized.

Figure 2 Test Set and Test Lead Identification

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OPERATION

Safety Precautions

The output of the test is high enough to be lethal when making contact. As with any high-voltage equipment, caution must be used at all times and all safety procedures followed. Refer to Section 2, Safety. Be sure that the test object is de-energized and grounded before making connections. Make certain that no person can come in contact with the HV unit, the HV output terminal, or any material energized by the output. Use protective barriers to cordon off the test area. The control unit and the HV unit must be located in a dry area. Be sure that adequate clearances are maintained between energized conductors or the HV unit and ground to prevent arc-flash (see table next page). Arc-flash occurrence creates an extremely dangerous safety hazard, leading to injury or death of the operator and damage of the equipment and test object. 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 3 indicates minimum personnel clearances that will limit the danger of static induced voltages being developed on nearby insulated objects, including people. The HV unit should be treated as part of the energized circuit.

The clearances shown in Table 3 are absolute minimums. However, as a safety guide, Megger strongly recommends that clearances never be less than 8 ft (240 cm).

Table 3: Minimum Air Clearances

Voltage of Test (kV)	Minimum Personnel Clearances ***with*** Grounded Barrier	Minimum Personnel Clearances ***without*** Grounded Barrier
5	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 (60 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 (240 cm)	14 ft (430 cm)

Setting Up Dielectric High Potential Test Set

First and foremost	**IMPORTANT WARNING**

1. Make sure that a ground bus or building ground with a very low resistance to earth ground is available, less than 5 Ω!

2. Make sure that safety ground lead of HV unit is securely connected to system ground (building ground, substation ground bus etc.)

3. Make sure that control cable is connected between the Control unit and HV unit; it provides also a safety ground connection between the 2 units

To connect the test set to the cable or test object to be tested, perform the following procedure. Figures 6 and 7 show the setup arrangement for testing cable samples.

1. Position the HV module on a flat surface at least 3 ft (90 cm) away from the cable or test object to be tested, as well as any other structure.
2. Connect the wing thumb-nut GROUND terminal of the HV unit to a low-impedance earth ground using one of the 15-ft ground cables supplied with the test set.
3. Connect the wing-thumb nut GROUND terminal of the HV unit to the ground terminal of the test object using the second ground cable supplied with the test set.
4. Position the control unit up to 8 ft (240 cm) away from the HV unit, when using a ***grounded barrier***, depends on the voltage applied, see table on previous page
5. Connect the control unit to the HV unit with the interconnection cable. The plug must be fully screwed down on at the High Voltage module end and the bayonet ring locked at the panel receptacle end.
6. Remove the protective cap from the HV terminal on the HV unit. 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 test object
7. Insert the key into the KEY switch. If the key was already inserted then set the switch to the Safe position before proceeding.
8. With the MAIN BREAKER switched off, connect AC line power cord between control panel receptacle and three-wire AC grounded power outlet.

NOTES

a. The exposed shield connection on the far end of the HV output cable is at guard potential and ***must not be grounded***. If a guarded test is required, connect the shield of the HV test lead to the guard lead of the test object.

b. Keep the core insulation at each end of the cable free from moisture and dirt during set-up and operation, protect the insulation of the HV output cable 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 and allow enough time to evaporate.

c. Drop the webbed carrying strap which wraps around the HV unit to the ground. This strap absorbs moisture and may increase the leakage current reading.

d. If the high-voltage termination of the test object 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.

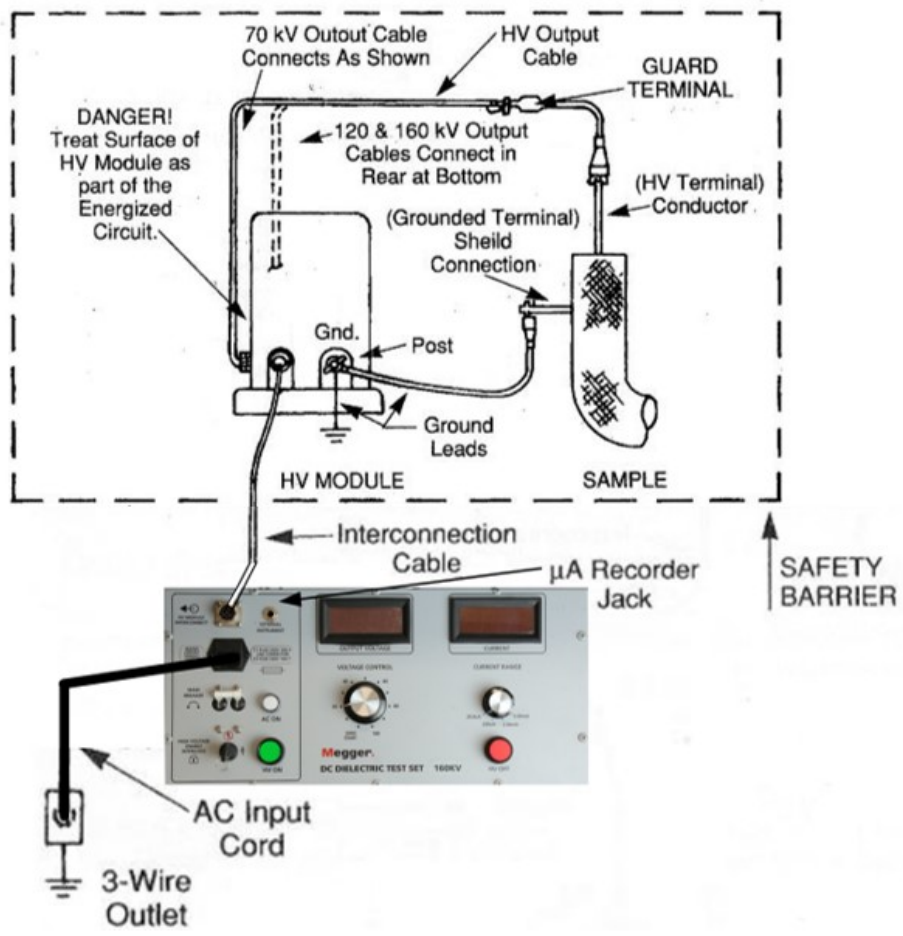

Figure 3: Test Setup for Typical Cable Tests (*Without Guarding*)

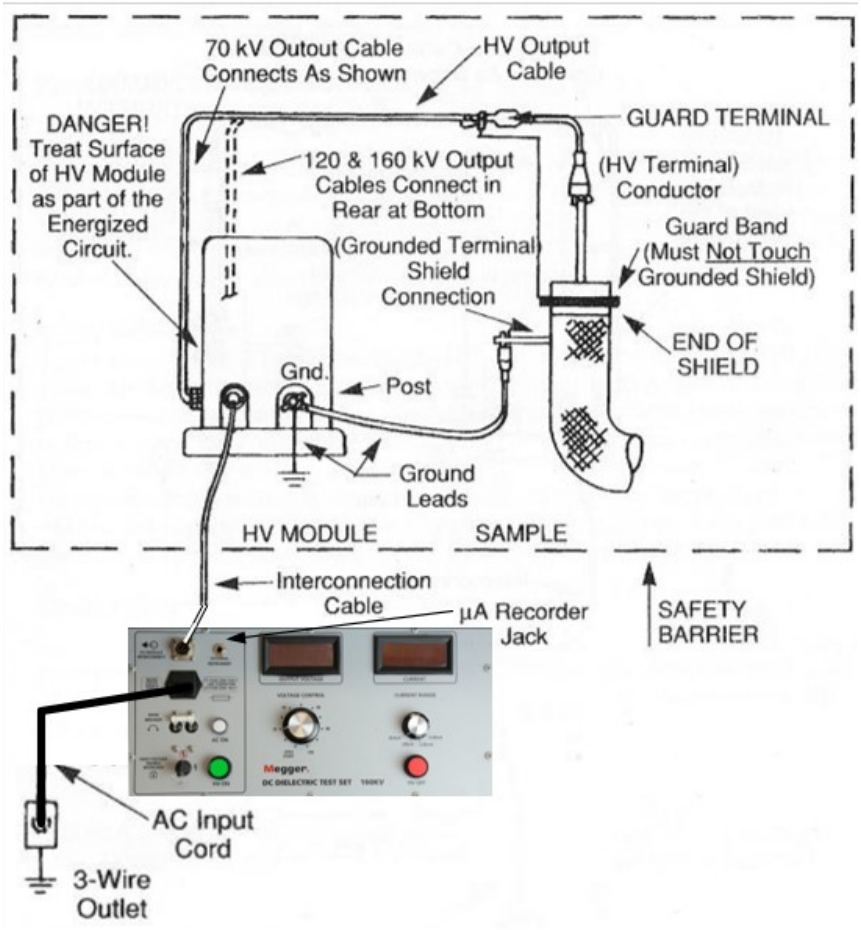

Figure 4: Test Setup for Typical Cable Tests (*With Guarding)*

Operating Procedure

Proceed only after fully understanding Section 2, Safety, and setting up the test set as described. A short form of the operating procedure can be found in the lid of the control unit and can be used to verify together with the manual the correct set-up. The following is a step-by-step procedure for conducting a test on a test object.

1. After setting the dielectric test set up and making all connections as described before, remove all safety grounds from the test object, to be tested.
2. Energize the test set by closing the MAIN BREAKER switch. The White AC ON lamp and the two digital panel meters should light.
3. Initially set the current RANGE switch to the 5mA range. Turn the KEY switch from the Safe position to Operate position.
4. Set the VOLTAGE CONTROL to "0" (RESET) and note that the Green HV READY light in the HV ON switch is lit.
5. Perform a final visual check that all personnel are clear of the HV Terminal of the test object and the HV unit, then depress the green HV ON push-button switch. The Green HV READY lamp will go out and the Red HV ON lamp in the HV OFF switch will light.

   WARNING
   When the red light of the control panel is lit, the test set is in the operational mode to deliver high voltage at its *output!*

6. Advance the VOLTAGE CONTROL slowly until the desired test voltage is reached 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 after the test voltage has been reached and the current has settled
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 red HV OFF push-button and set the KEY switch to the Safe position. Note that if the red HV OFF button is pressed the Red light extinguishes and the Green HV READY light will come on. If the KEY switch is rotated to the safe position, neither light will be lit.

10. Allow sufficient time for the test object to bleed off any charge, which is indicated when the kilovoltmeter reading returns to zero. Note that a suitable rated discharge stick can be used to accelerate the specimen discharge

11. Switch the MAIN BREAKER off. The White AC ON lamp and the two digital panel meters should now be off.

WARNING

The test sample may retain a lethal electrical charge even when the test set is turned off. Follow the steps below:

1. Discharge the test object with a safety discharge stick to ground, then solidly ground the test object with a ground bond
2. Keep the HV terminal of the test object and the test set's HV out -put cable grounded at all times except when applying HV
3. Do not approach the HV unit until the test set's HV output cable has grounded.

CAUTION

In case of an emergency, power can be interrupted immediately by either switching the MAIN BREAKER or the safety interlock key switch off. This procedure should be followed only when key absolutely necessary, since it risks damage to both the test set and the test sample.

12. Disconnect the test set cables in the following sequence:

- Disconnect HV output cable first from the test object
- Disconnect HV from the test set
- Disconnect AC input power cord
- Disconnect interconnection cable
- Disconnect the two ground cables

Operation 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.
2. A high-voltage resistance discharge stick may be used initially to discharge the test object at its high-voltage terminal to accelerate the discharge of the test object after the kilovoltmeter indicates the voltage has diminished to a low, safe level, < 5kV.
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 total current measured by the test set includes the leakage and surface leakage current of the test object unless a guard circuit is used.
4. When measuring the leakage current of test objects, 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 μA (x1) range and will require that the operator judges the indicated current value by visually and mentally averaging the value.
5. Occasionally when measuring the leakage current of a test object, it 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 4 illustrates the guarding. It should be noted that the guard circuit is only a few volts above ground. The exposed shield connection on the output end of the HV output cable is at guard potential and must not be grounded.

Performance Verification

FUNCTIONALITY CHECKS

Proceed only after fully understanding Section 2, Safety, Setting-Up, Operating Procedures and Operating Notes

Set up the test set as described in "Setting Up the Test Set" ***except do not connect*** the far end of the HV cable to a test object. Cover the exposed HV termination with a thin plastic bag and suspend it in free air using dry insulating rope, so that it is clear of all surrounding objects by at least 4ft (120 cm).

1. Set the MAIN BREAKER to the ON position. The white AC ON light should come on. The digital OUTPUT CURRENT meter should read:

   0.00 on 20µA range

   000 on 200µA range

   0.000 on 2mA range

   0.00 on 5mA range

   The OUTPUT VOLTAGE meter should read 00.0.

2. Set the KEY switch to the Safe position and set the VOLTAGE CONTROL to 10. Press the green HV ON push button. The HV ON lamp should not light. Turn the VOLTAGE CONTROL to "0" (RESET).

   2.1 Press the green HV ON push button. The green HV ON light should light only while the push button is depressed. Release the green HV ON button. Set the KEY switch to the Operate position.

   2.2 Press the green HV ON push button. The red red HV light should light and remain lighted when the push button is released.

3. Rotate the VOLTAGE CONTROL knob to 10. The red redHV ON lamp should remain lighted. The OUTPUT VOLTAGE meter should read voltage. The value should be approximately 10 percent of the rated output voltage. The OUTPUT CURRENT meter should read zero on all current ranges

4. Press the red HV OFF push button. The red HV ON lamp should go out. The green HV Ready lamp should not light. 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 the controls function as expected, proceed to Voltage Verification Test.

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Voltage Verification

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

1. Set the OUTPUT CURRENT meter to the 20 μA (x1) range.
2. Energize the test set, and 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 0.1μA.

3. Return the voltage control to "0" (RESET), then depress the red 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 and 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 HV unit.
2. Set the RANGE selector switch to the 2mA 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 200μA and 2mA.

4. Set the RANGE switch to the 200µA range. The OUTPUT CURRENT meter should indicate an overrange or random number, cannot be dark or a random number, cannot be dark.

5. Set the RANGE switch to the 20µA range. The OUTPUT CURRENT meter should indicate an overrange or random number, cannot be dark or a random number, cannot be dark.

6. Set the RANGE switch to the 5mA range. The OUTPUT CURRENT meter should indicate approximately the same value as obtained in step 3.

7. Advance the VOLTAGE CONTROL until either the MAIN BREAKER or line relay trip-outs. This should occur at a current value between 3 and 4 mA due to the time lag of the meter and it being an averaging meter and not a peak reading meter due to the time lag of the meter and it being an averaging meter and not a peak reading meter.

NOTE
Trip-out at the nominal 5.5mA 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
   - Disconnect the AC power cord
   - Disconnect the interconnection cable
   - Disconnect the two ground cables.

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7

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 current, 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.

The following references contain detailed information on the subject of dc testing:

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.

Standard Handbook for Electrical Engineers. Donald G. Fink and John M. Carroll, McGraw-Hill, 1968.

Circuit Description

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 two separate ground cables are provided 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 through the input fuses in the receptacle to the main power switch 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 output Voltage Control autotransformer 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 240 V 50/60 Hz option differ from standard sets only in that a separate step-down transformer is connected in series with the input. It is connected between the input power cord and main power circuit breaker. The 240V ac input is stepped down 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, the two line fuses are sized to provide protection to step-down transformer in case of a malfunction. The step-down transformer is mounted to the bottom of the Control unit chassis and fuses are part of the line (Mains) cord receptacle.

The power controlled by the main power switch is brought to the Control relay. The Voltage Control autotransformer receives power under from of the Control relay. Output voltage is controlled by the variable autotransformer, whose output feeds the primary of the high-voltage transformer 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 knob be set at "0" (RESET) in order for the advance of the voltage control to develop an output voltage. This feature is a function of control relay whose contacts remain open after the power source is connected and after the main power switch is closed. This prevents the application of voltage to the input of high-voltage transformer until the contacts of the Control relay are mechanically closed. The contacts are closed by "0" (RESET) positioning of variable voltage control, which closes zero-start switch and by depressing HV ON switch. The key switch must be in the operate position before the Control relay can be energized. The test sets are shipped with a removable key as an operator safety feature.

The contacts of the Control relay remain closed until power is removed by operation of HV OFF switch, opening of the key switch or opening of the main power switch. To reestablish output, power must again be applied and the voltage control set to zero.

In the 70 kV test set, the High Voltage module contains the High Voltage transformer and a Cockcroft-Walton voltage doubling rectifier circuit that generates

the required High Voltage DC. A surge protection resistor is internally connected to limit the current supplied under fault conditions. A dedicated safety bleeder resistor is included in the High Voltage module to discharge the voltage doubler circuit. A separate resistive voltage divider provides the signal to the Output Voltage meter circuit on the Control Panel. Spark gaps are also included to protect the operator in case of a connection failure or a specimen failure.

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 test set also contains a dc Over Current relay, which is adjusted as part of the calibration procedure, to trip out the high-voltage circuit when the dc current exceeds a nominal value of 5.5mA. The relay includes a set of normally closed contacts in series with the coil of the 120 V ac control relay. When an over current event occurs the Over Current relay contacts open. This opens the coil circuit of the AC Control relay and thereby removes high-voltage power from the test set via the relay contacts. After a trip-out occurs, the voltage control must be returned to zero before test set output voltage can be re-energized.

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 V 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. In the NEMA 5-15 cord 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.

8

ROUTINE MAINTENANCE

Simple Maintenance

WARNING

Maintenance and calibration should only be carried out by qualified personnel familiar with high-voltage test equipment and testing techniques. These personnel should be aware of the hazards involved and must take all necessary safety precautions required to prevent injury.

Routine maintenance is all that is required for these dielectric test sets. The cable 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 HV unit.

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

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. **HV Unit Enclosure**:

   The outside of the enclosure and base can be cleaned with isopropyl alcohol or denatured alcohol. Stubborn dirt may require cleaning with mineral spirits which should then be rinsed with alcohol as above.

FUNCTIONAL CLEANING

1. **HV Cable**:

   A portion of the polyethylene or rubber 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 unit, at the rear, 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 of 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.

Repair

Megger maintains a complete instrument repair .service and recommends that its customers take advantage of this service in the event of any equipment malfunction. Please indicate all pertinent information, including problem symptoms and attempted repairs. 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 Repair Department.

For those users who would find it difficult to return the instrument to the factory for repair there is a network of Authorized Service Centers (ASCs) around the world that are authorized to perform warranty and out of warranty work. Please consult your local sales representative to determine the closest ASC if repairs are required.

When replacement of internal parts is required in the HV unit, 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 flashover within the HV unit at a voltage below rated output voltage. Some of the terminations require specialized equipment that may not be available so Megger strongly recommends that repairs to the High Voltage module be done by the factory or by an ASC technician.

GLOSSARY

Use only in accordance with Instruction Manual.

High-voltage warning

Arc-over A disruptive discharge in the form of an arc or spark between two electrical conductors or between a conductor and earth (also called sparkover or flashover).

Bleeder A resistor connected across the high-voltage capacitors to drain off the charge remaining in capacitors when the power is turned off.

Cockcroft-Walton A high-voltage direct current rectifier-multiplier consisting of cascaded rectifier circuits and capacitors to which a low- voltage alternating current is applied

Guard Terminal A conductor situated between a source of high voltage and ground in such a way that surface leakage currents are conducted to a return terminal (guard) without entering the signal path.

RMS Root mean square

RTV Room temperature vulcanizing (silicone rubber)

Withstand Test Test made to determine the ability of insulating materials and spacings to withstand specified overvoltages for a specified time to assure their strength

WARRANTY

Products supplied by Megger are warranted against 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 must be shipped prepaid and insured. The warranty does not include batteries, lamps or other expendable items, where the original manufacturer's warranty shall apply. We make no other warranty. The warranty is void in the event of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specified maintenance as indicated in this manual.