



Instruction Manual AVTM670600a

for

Resonating Inductor

Catalog No. 670600

High-Voltage Equipment

Read the entire manual before operating.

Aparato de Alto Voltaje

Antes de operar este producto lea este manual enteramente.

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Resonating Inductor Instruction Manual

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Section 1

Introduction

Receiving Instructions

Check the equipment received against the packing list to ensure that all materials are present. Notify AVO International of any shortage. Telephone (215) 646-9200 and ask for the Customer Service Department.

Examine the equipment for damage received in transit. If damage is discovered, file a claim with the carrier at once and notify AVO International, giving a detailed description of the damage.

The Resonating Inductor 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

The Resonating Inductor (Fig. 1) is an accessory for use with the Extended-Range Capacitance and Dissipation Factor Test Set (Cat. No. 670070) and the DELTA-2000 10-kV Automated Insulation Test Set (Cat. No. 672001). The Resonating Inductor is connected in parallel with the internal power supply of the test set and will extend its capability to test larger test samples, particularly for the motor, generator, and cable test market. The use of the Resonating Inductor extends the short time rating of the power supply of the test set from 200 mA to 3.77 A. This capacity is suitable for testing capacitance loads up to 1 μ F at 10 kV. A manual tuning wheel varies the inductance to tune the parallel circuit for minimum load current.

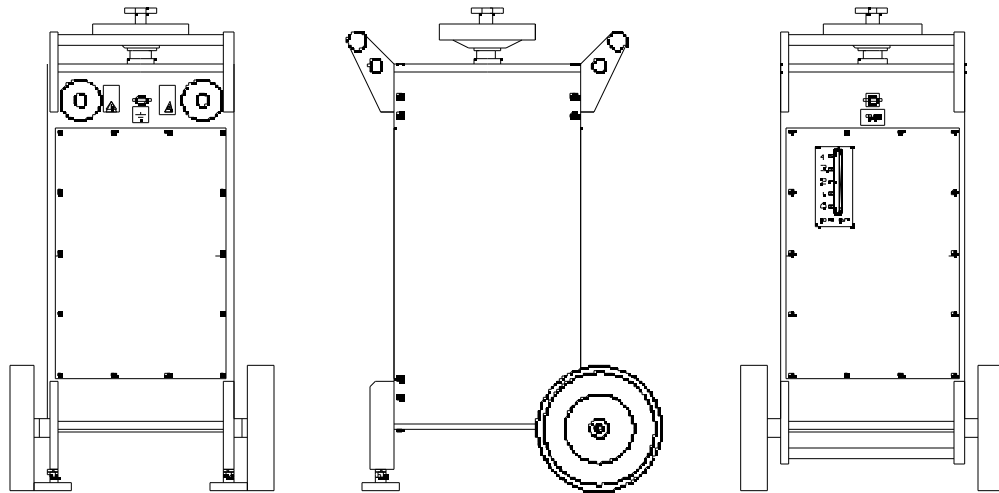


Figure 1: Resonating Inductor

Section 2 Safety

The Resonating Inductor, the test set, and the specimen 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, including all connections, unless the test set is de-energized and all parts of the test circuit are grounded. Persons not directly involved with the work must be kept away from test activities by suitable barriers, barricades, or warnings. An interlock circuit is provided on the control unit of the test set to enable the operator to enclose all parts of the complete high-voltage circuit within a secure area. The interlock circuit should be used to shut off input power automatically upon unauthorized entry into the high-voltage area.

Treat all terminals of high-voltage power equipment as a potential electric shock hazard. There is always the potential of voltage being induced at these terminals because of proximity to energized high-voltage lines or equipment. Always use a safety ground stick to ground the high-voltage conductor. A safety ground jumper must then be installed between the terminals of the specimen under test and ground. Always disconnect test leads from power equipment before attempting to disconnect them at the test set. The ground connection must be the first made and the last removed. Any interruption of the grounding connection can create an electric shock hazard.

AVO International has made formal safety reviews of the initial design and any subsequent changes. This procedure is followed for all new products and covers areas in addition to those included in applicable ANSI standards. Regardless of these efforts, it is not possible to eliminate all hazards from electrical test equipment. For this reason, every effort has been made to point out in this instruction manual the proper procedures and precautions to be followed by the user in operating the tester and to mark the tester itself with precautionary warnings where appropriate. However, it is not possible to foresee every hazard which may occur in various applications of this tester. It is therefore essential that the USER, in addition to following the safety rules in this manual, also carefully consider all safety aspects of the test before proceeding.

If the test equipment is operated properly and all grounds correctly made, test personnel need not wear rubber gloves. 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 the controls. AVO International considers this an excellent safety practice.

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 of possible risks before using this equipment or being close to equipment while it is in operation.

- Safety is the responsibility of the user.
- Misuse of this high-voltage equipment can be extremely dangerous.
- The purpose of this equipment is limited to use as described in this manual. Do not use the equipment or its accessories with any device other than specifically described.

- Never connect the Resonating Inductor to energized equipment.
- Operation is prohibited in rain or snow.
- Do not perform tests in an explosive atmosphere.
- Hearing protection may be required; refer to Section 3, Specifications, for sound levels.
- Refer to Section 4, Operation, for detailed instructions for test setup and grounding requirements.
- Connect the GROUND terminal of the Resonating Inductor and test instrument to a low-impedance earth ground.
- A qualified operator should be in attendance at all times while the test equipment is in operation.
- Observe all safety warnings marked on the Resonating Inductor and test equipment.
- Stay clear of all exposed connections and conductors while tests are in progress.
- To avoid electric shock hazard, operating personnel must not remove the protective instrument covers. Corrective maintenance must only be performed by qualified personnel who are familiar with the construction and operation of the equipment and the hazards involved.
- Refer to IEEE 510 - 1983, "IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing," for information.

The following warning and caution notices are used throughout this manual where applicable and should be strictly observed. These notices are used in the format shown and are defined as follows:

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.

Section 3 Specifications

Electrical

Voltage rating: 10 kV ac

Current rating: 3.77 A at 50/60 Hz
15 minutes on, 2 hours off

Maximum capacitive load: 1 μ F @ 60 Hz, 1.2 μ F @ 50 Hz

Note: At maximum capacitive load, test set may reach its maximum output current rating at less than full output voltage depending on dissipation factor of specimen.

Minimum capacitive load: 0.05 μ F, 50 or 60 Hz

Tuning: By manual tuning wheel

Test modes: UST (ungrounded specimen test) and GST (grounded specimen test); in both these test configurations, the Resonating Inductor does not affect the accuracy specification of the test set.

Physical Characteristics

Enclosure: Self-contained, air-insulated. The housing is a sturdy metal cabinet using welded construction throughout to withstand the rigors of transportation and field operation. Large wheels and handles are provided for convenience in transportation.

Dimensions: 38.7 x 21.4 x 25.3 in. (98 x 54 x 64 cm) (H x W x D) overall

Weight: 310 lb (141 kg)

Environmental Conditions

Operating temperature range: -4 to 140°F (-20 to 60°C)

Storage temperature range: -58 to 158°F (-50 to 70°C)

Relative humidity: 0 to 90% noncondensing (operating)

0 to 95% noncondensing (storage)

Altitude: Up to 6562 ft (2000 m)

The voltage rating must be derated at higher altitudes.

Noise

60 Hz 75 to 94 dB, A weight (maximum to minimum load)

50 Hz 88 to 96 dB, A weight (maximum to minimum load)

Accessories Supplied

- High-voltage lead, 8 ft (2.4 m) double shielded, with connector termination each end.
- Inductor return lead, 8 ft (2.4 m) with spade lug terminations for use with the Cat. No. 670070 test set and inductor return lead for use with the Cat. No. 672001 test set.
- Ground lead, 15 ft (4.6 m).

Section 4

Use of the Resonating Inductor with the Extended-Range Capacitance and Dissipation Factor Test Set (Cat. No. 670070)

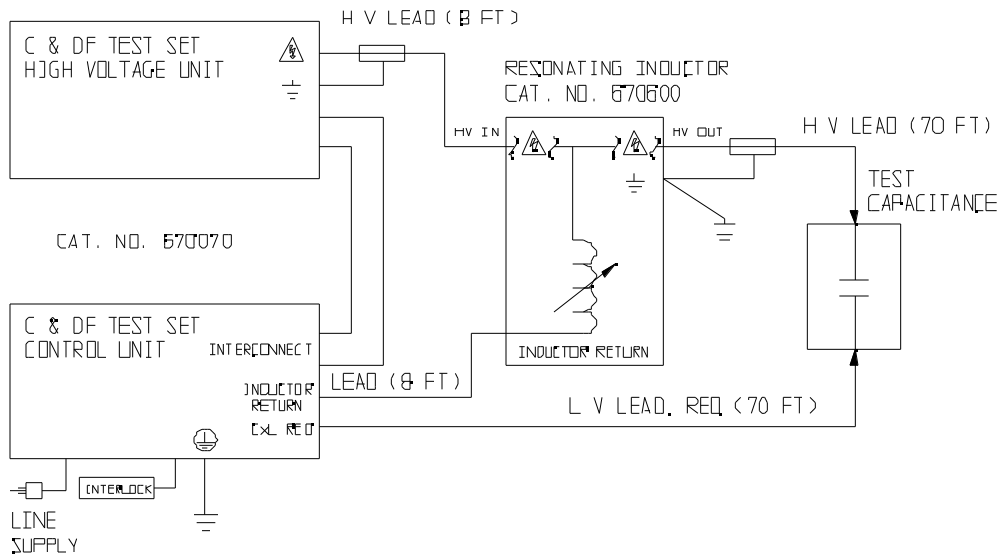
Setup

WARNING

Testing high-voltage power equipment can be dangerous if improperly performed. Read and understand all safety information in this instruction manual as well as the instruction manual for the test set. Ensure test specimen is de-energized, grounded, and safety ground jumpers have been applied before making connections. Read and understand all details of setup and operation in both instruction manuals.

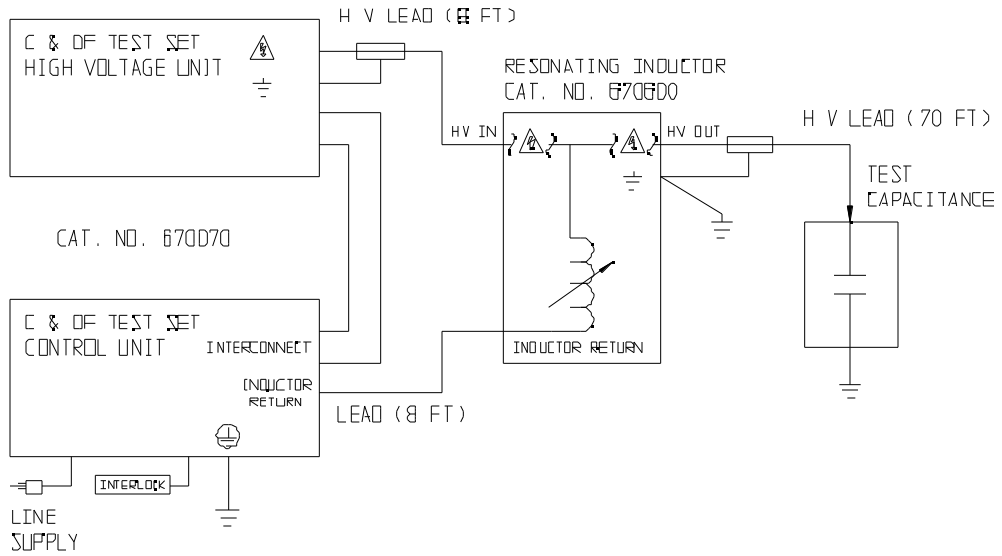
The following steps are a general guide for setting up the Resonating Inductor for use with the Extended Range Capacitance and Dissipation Factor Test Set (Cat. No. 670070). Figure 2 shows the setup for testing ungrounded capacitance specimens; Figure 3 shows the setup for grounded capacitance specimens.

1. Locate the test set and Resonating Inductor on a sturdy level surface at least 6 ft (1.8 m) from the specimen to be tested.
2. Connect the wing thumb-nut ground terminal of the test set to a low-impedance earth ground using the 15 ft (4.6 m) ground lead supplied.
3. Connect the wing thumb-nut ground terminal of the Resonating Inductor to a low-impedance earth ground using the 15 ft (4.6 m) ground lead supplied.
4. Connect the test set control unit interconnection receptacles to the corresponding high-voltage unit receptacles using the two 5 ft (1.52 m) interconnecting cables (supplied with the test set). Make sure the bayonet type plugs are fully locked on the receptacles.
5. If making a UST test, connect the low-voltage lead with red colored boot to the C_xL RED receptacle of the test set. Make sure the connector locks to the receptacle.
6. Connect the external interlock cable to the INTERLOCK receptacle of the test set. Make sure the bayonet type plug is fully locked on the receptacle.



3 UST

Figure 2: Setup for Making Ungrounded Specimen Test



4 GST L-GROUND

Figure 3: Setup for Making Grounded Specimen Test

7. Connect the 8 ft (2.4 m) low-voltage lead with spade lug at each end to the INDUCTOR RETURN wing thumb-nut terminals of the test set and Resonating Inductor.
8. Using the 8 ft (2.4 m) high-voltage lead, connect the end with pigtail lead to the HV receptacle on the high-voltage unit of the test set. Connect the pigtail lead to the black binding post adjacent to the HV receptacle. Connect the other end of the high-voltage lead to the high-voltage receptacle on the Resonating Inductor labeled HIGH VOLTAGE IN. Insert the plug shells fully into the receptacles.
9. Connect the 70 ft (21.4 m) high-voltage cable (supplied with the test set) to the high-voltage terminal of Resonating Inductor labeled HIGH VOLTAGE OUT. Insert the plug shell fully into the receptacle. Connect the pigtail lead of this cable to the wing thumb-nut ground terminal.

Note: The crocodile clip for the high-voltage lead should be used instead of the hook assembly since test current levels will be considerably higher than use of the test set without Resonating Inductor.

10. If making a UST test, connect the crocodile clip of the low-voltage lead to the low-voltage terminal of the test specimen.
11. Connect the crocodile clip of the high-voltage lead to the desired high-voltage terminal of the test specimen.
12. With the test set main breaker OFF, plug the input power cord into the test set power receptacle and into a three-wire grounded power receptacle having the appropriate voltage and current ratings.
13. The setup is now complete and ready for testing.

Operation

Proceed only after fully understanding Section 2, Safety, and setting up the test set and Resonating Inductor as described. The following instructions are the normal procedures for conducting a test.

1. Set the test set controls to the following initial settings.

Main Breaker	OFF
HV ON/OFF switch	OFF
HV Polarity switch	NORM
UST/GST switch	GST 4, Grounded Specimen Test or UST 3, Ungrounded Specimen Test
Voltage Control	0
Sensitivity switch	d (normally)
Milliamperes LO/HI switch	HI (normally)
5 kV/10 kV range switch	10 kV (normally)
Test kV switch	10 kV (normally)
Range switch	20% (normally)
Interference Suppressor switches	OFF
CAP. Multiplier switch	SHORT

2. Remove all safety ground jumpers from the specimen terminals (not housing).

CAUTION

Observe the following precautions (different from normal test set operating procedures) to prevent damage to the test set:

- Do not change the setting of the UST/GST test mode switch while testing.
- Use only normal voltage polarity when making measurements.
- Do not change the setting of the capacitance and dissipation factor interference suppressor controls from OFF.
- When initially energizing the test specimen, always set the capacitance multiplier dial to SHORT and the measuring dials to "0." This will prevent possible damage to the test set in the event of a specimen breakdown.

3. Close the test set main breaker.
4. Check for proper selection of the mode of operation on the UST/GST selector switch.
5. Close the external interlock switch.
6. Set the HV ON/OFF switch to ON. The red lamp should light when the VOLTAGE CONTROL is set to "0."
7. Advance the VOLTAGE CONTROL gradually while observing both the test voltage and the test current. The initial voltage level should not exceed 20 percent of the desired test voltage and the initial current level should not exceed 50 mA.

Note: Circuit breaker trip-out will occur if the current level exceeds 200 mA.

8. Using the manual tuning wheel on the Resonating Inductor, tune for a minimum current reading. The graph of Figure 4 shows the approximate gap opening versus a tuned load.
9. Continue to advance the VOLTAGE CONTROL to the desired test voltage, while tuning the Resonating Inductor for minimum current in approximately 1 to 2 kV intervals. The test voltage must be the same as the setting of the TEST kV switch.

EMERGENCY SHUTDOWN

Switch the HV ON/OFF switch to OFF, open the external interlock, or switch the main breaker to OFF.

10. Adjust the "C" multiplier dial and the "C" measuring dials in the normal way to bring the null indicator to zero. The first "C" measuring dial should have at least one step in circuit for full accuracy.

CAUTION

Use only the 1K, 2K and 10K capacitance multiplier ranges to prevent overcurrent damage to the bridge circuit windings. Always initially balance the bridge on the highest capacitance multiplier range. Once balanced, a lower multiplier of 1K or 2K may be selected if appropriate. The following is the final capacitance multiplier range for capacitance measurements.

<u>Capacitance Multiplier</u>	<u>Capacitance Value</u>
10K	0.2 to 1.1 μ F
2K	0.1 to 0.2 μ F
1K	0.04 to 0.1 μ F

11. Read the capacitance value from the sum of “C” dial settings multiplied by the setting of the “C” multiplier dial.
12. Read the % DF value from the digital panel meter. Note the sign of reading (+ or -).

Note: Watt readings are direct readings of equivalent 10 kV watt values. However, when using the 10 K capacitance multiplier, the reading must be multiplied by a factor of 10 to obtain the correct watt value. The % DF value is a direct reading on all capacitance multiplier ranges.

13. When the tests have been completed, gradually reduce the test voltage to zero, switch the HV ON/OFF switch to OFF, then switch the main breaker to OFF.
14. Set the Capacitance Multiplier dial to SHORT and the Capacitance Measuring dials to their respective “0” positions.

15. Discharge the specimen with a safety ground stick, then apply safety ground jumpers to the specimen terminals while the safety ground stick is still in place.
16. Disconnect the test leads from the specimen terminals.
17. Disconnect the leads from the test set and the Resonating Inductor. The ground leads should be disconnected last.

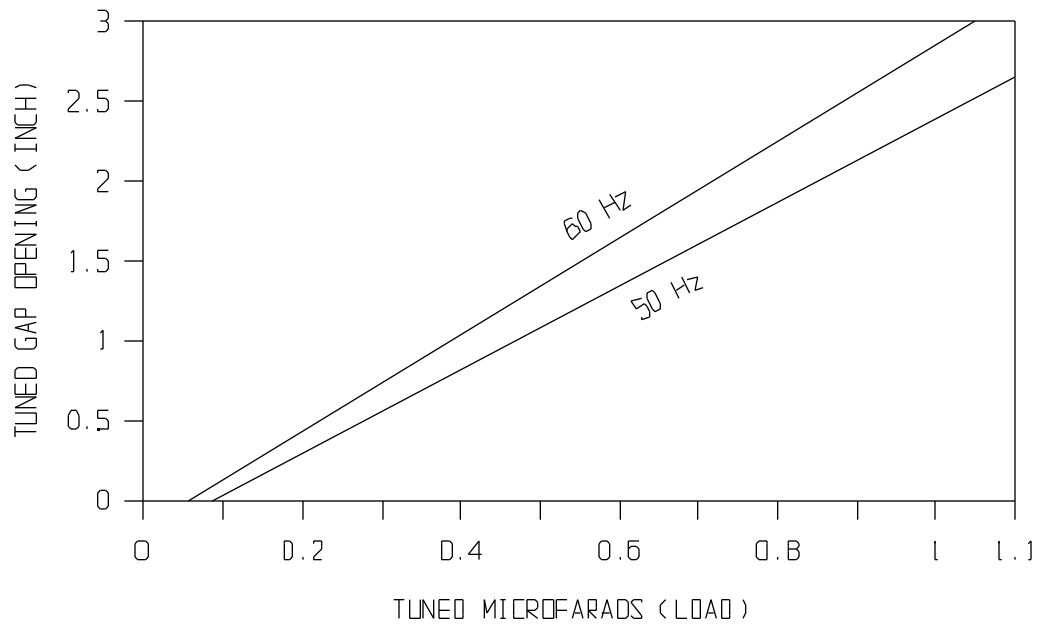


Figure 4: Resonating Inductor Gap Opening vs Tuned Load

Section 5

Use of the Resonating Inductor with the DELTA-2000 10-kV Automated Insulation Test Set (Cat. No. 672001)

Setup

WARNING

Testing high-voltage power equipment can be dangerous if improperly performed. Read and understand all safety information in this instruction manual as well as the instruction manual for the test set. Ensure test specimen is de-energized, grounded, and safety ground jumpers have been applied before making connections. Read and understand all details of setup and operation in both instruction manuals.

The following steps are a general guide for setting up the Resonating Inductor for use with the DELTA-2000 Test Set (Cat. No. 672001). Figure 5 shows the setup for testing ungrounded capacitance specimens; Figure 6 shows the setup for grounded capacitance specimens.

1. Locate the test set and the Resonating Inductor on a sturdy level surface at least 6 ft (1.8 m) from the specimen to be tested.
2. Connect the wing thumb-nut ground terminal of the test set to a low-impedance earth ground using the 15 ft (4.6 m) ground lead supplied.
3. Connect the wing thumb-nut ground terminal of the Resonating Inductor to a low-impedance earth ground using the 15 ft (4.6 m) ground lead supplied.
4. Connect the test set control unit interconnection receptacles to the corresponding high-voltage unit receptacles using the two 5 ft (1.52 m) interconnecting cables (supplied with the test set). Make sure the bayonet type plugs are fully locked on the receptacles.
5. If making a UST (MEASURES RED, GROUNDS BLUE) test, connect the low-voltage lead to the LOW VOLTAGE RED receptacle of the test set. Make sure that the connector locks to the receptacle.
6. Connect the external interlock cables to the INTERLOCK receptacles of the test set. Make sure the bayonet type plugs are fully locked on the receptacle.

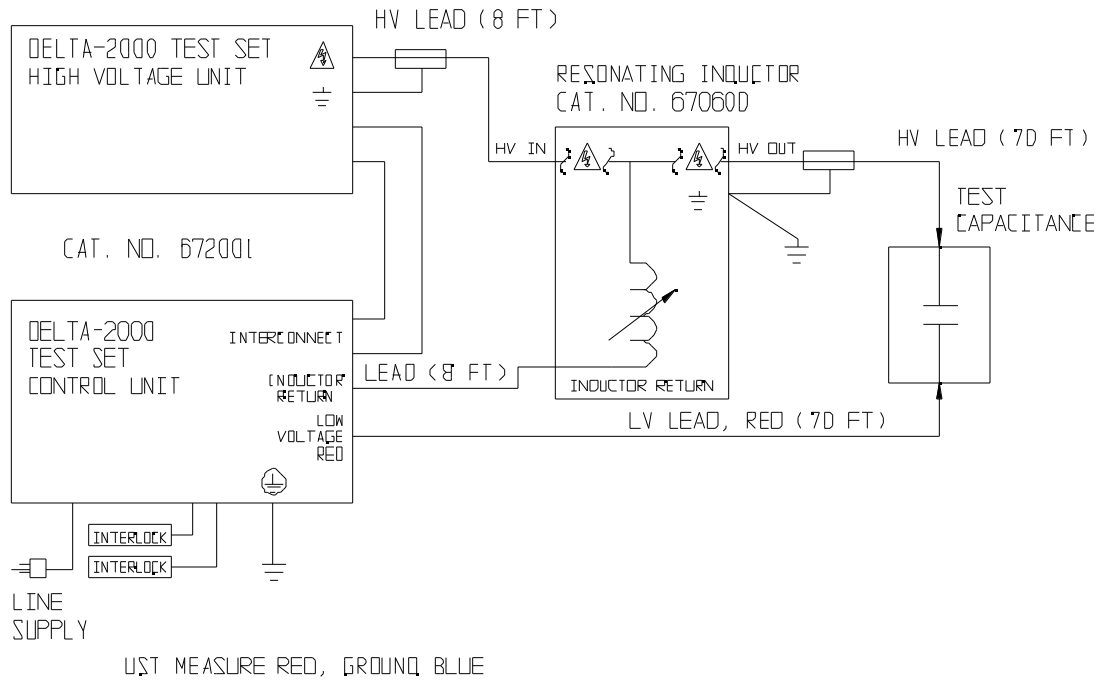


Figure 5: Setup for Making Ungrounded Specimen Test

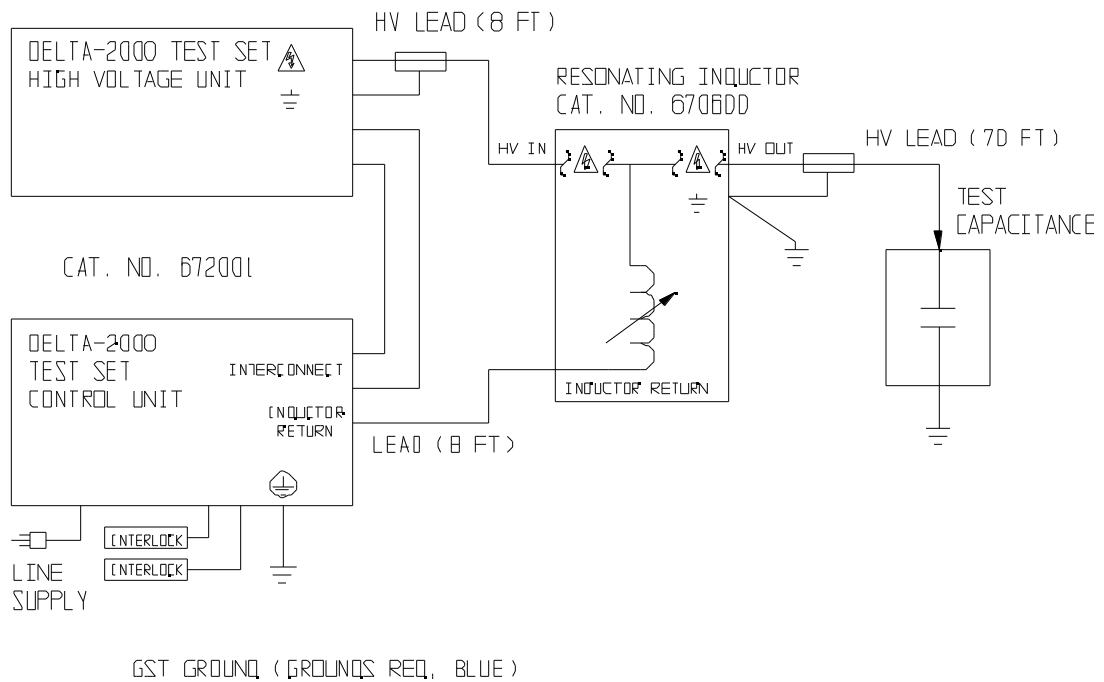


Figure 6: Setup for Making Grounded Specimen Test

7. Connect the inductor return cable with spade lug at one end to the INDUCTOR RETURN wing thumb-nut terminal of the Resonating Inductor. Connect the other end of the cable (end with connector) to the INDUCTOR RETURN receptacle of the test set.
8. Using the 8 ft (2.4 m) high-voltage lead, connect the end with pigtail lead to the HV receptacle on the high-voltage unit of the test set. Connect the pigtail lead to the thumb nut ground terminal adjacent to the HV receptacle. Connect the other high-voltage connector of the cable to the high-voltage receptacle on the Resonating Inductor labeled HIGH VOLTAGE IN. Insert the plug connectors fully into the receptacles.
9. Connect the 70 ft (21.4 m) high-voltage cable (supplied with the test set) to the high-voltage terminal of the Resonating Inductor labeled HIGH VOLTAGE OUT. Insert the plug connector fully into the receptacle. Connect the pigtail lead of this cable to the wing thumb-nut ground terminal.

Note: The crocodile clip for the high-voltage lead should be used instead of the hook assembly since test current levels will be considerably higher than use of the test set without Resonating Inductor.

10. If making a UST (MEASURES RED, GROUNDS BLUE) test, connect the crocodile clip of the low-voltage lead to the low-voltage terminal of the test specimen.
11. Connect the crocodile clip of the high-voltage lead to the desired high-voltage terminal of the test specimen.
12. With the test set main breaker OFF, plug the input power cord into the test set power receptacle and into a three-wire grounded power receptacle having the appropriate voltage and current ratings.
13. The setup is now complete and ready for testing.

Operation

Proceed only after fully understanding Section 2, Safety, and setting up the test set and Resonating Inductor as described. The following instructions are the normal procedures for conducting a test.

1. Remove all safety ground jumpers from the specimen terminals (not housing).
2. Close the test set main breaker.
3. See Figures 19 and 20 in the DELTA-2000 Instruction Manual AVTM 672001 for sample test screens.
4. Check for proper selection of the low-voltage lead configuration.
5. Close the external interlock switches.
6. Press the HIGH VOLTAGE ON button. The red lamp should light when the HIGH VOLTAGE CONTROL is set to "0."

7. Advance the HIGH VOLTAGE CONTROL gradually while observing both the test voltage and test current. The initial voltage level should not exceed 20 percent of the desired test voltage and the initial current level should not exceed 50 mA.

Note: Circuit breaker trip-out will occur if the current level exceeds 200 mA.

8. Using the manual tuning wheel on the Resonating Inductor, tune for a minimum current reading. The graph of Figure 4 shows the approximate gap opening versus a tuned load.
9. Continue to advance the HIGH VOLTAGE CONTROL to desired the test voltage, while tuning the Resonating inductor for minimum current in approximately 1 to 2 kV intervals.

EMERGENCY SHUTDOWN

Press the HIGH VOLTAGE OFF button, open any of the external interlocks, or switch main breaker OFF.

10. Press the MEASURE button to start the test.
11. When the measurement is completed, observe the test results on the LCD screen. Readings may be printed out or stored as desired.
12. When the tests have been completed, gradually reduce the test voltage to zero and press the HIGH VOLTAGE OFF button.
13. Discharge the specimen with a safety ground stick, then apply safety ground jumpers to the specimen terminals while the safety ground stick is still in place.
14. Disconnect the test leads from the specimen terminals.
15. Disconnect the leads from the test set and the Resonating Inductor. The ground leads should be disconnected last.

Section 6 Service

Periodic Maintenance

Maintenance should be performed only by qualified persons familiar with the hazards involved with high-voltage test equipment. Read and understand Section 2, Safety, before performing any service. To maintain the Resonating Inductor in maximum operating condition, perform the following periodic maintenance:

After every 50 hours of operation, grease the fitting situated under the tuning wheel using a petroleum oil base grease with lithium thickening agent. The grease should be of medium soft consistency (NLGI No. 2) with a temperature rating of -10 to 250°F.

Annually, remove panel above wheels, being careful not to damage guard wire connection to panel shield. Disconnect guard wire connection by unscrewing retaining nut. Set the panel aside. Using an air compressor, blow out the inside to remove accumulated dirt, dust, and debris. Reconnect guard wire to panel shield and reinstall panel.

Periodically, check all nuts and bolts to ensure that they are properly secured. Tighten as necessary.

Repair

AVO International offers a complete 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 equipment should be specified. Equipment returned to the factory for repair must be shipped prepaid and insured and marked for the attention of the Repair Department.

Section 6 Replaceable Parts List

Description	Part No.
Terminal, ground wing nut	5026
Manual tuning wheel	30438
High-voltage lead, 8 ft (2.4 m)	30012-4
Ground lead, 15 ft (4.6 m)	4702-5
Inductor return lead for use with Cat. No. 670070	30991-1
Inductor return lead for use with Cat. No. 672001	34654

Glossary



Use only in accordance with Instruction Manual.



Grounding procedures must be followed.



High-voltage warning.

NLGI

National Lubricating Grease Institute. Numbers define ranges of worked penetration, an indirect measure of viscosity. The most commonly used consistency number is No. 2.

Warranty

Products supplied by AVO International 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. This warranty does not include batteries, lamps or similar 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 specific maintenance as indicated in this manual.