PTS

SERIES

Safety, Operation, and Procedure Instructions for the PTS Series of dc Hipot/Megohmmeters

Please Refer to Documentation Before Operation

Danger- Lethal Voltages:

Equipment to be used by trained personnel only

This Operator Manual contains instructions for the operation of a High Voltage power source. The operator of this equipment must use good judgement and follow all safety precautions noted in this guide to ensure the protection of himself and others in close proximity to the test area. Failure to follow the instructions could result in injury or death. Proper grounding of the test set must be done prior to connecting this unit to a power source.

Operator Manual

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About the Operator Manual

Important

This Operator Manual describes the features and safe operation of a High Voltage Test Set. The instructions are intended to be clear and simple, but the operator must be trained and qualified according to established procedures for the use of this type of equipment.

This Operator Manual is organized to provide information on the PTS Series in steps that familiarize the new operator with the entire scope of operation of this test set.

Section 1: Specifications and Controls.

Section 2: Setup and Operation.

Section 3: Performing Special Operations.

The Functions, Features, and Specifications of the PTS Series of Hipot/Megohmmeters are also discussed in the PTS Brochure available from High Voltage, Inc.

SECTION

1

General Information

This section familiarizes the operator with the features and specifications of the

PTS Series of Portable dc Test Sets manufactured by HIGH VOLTAGE, INC.

Features and Specifications

The PTS Series of dc hipot test sets provide continuously adjustable output voltages for the test and measurement of leakage current in high voltage insulation. The current meter on the PTS Series also has a Megohmmeter scale to allow for easy resistance measurements while the hipot is in operation.

Standard features of the PTS Series of Hipot/Megohmmeter Test Sets

- Continuously adjustable output voltage
- Fixed overload, factory set to 11 milliamperes of output current
- "Zero Start" and External Interlock provision
- Five- range current meter , low range 0 to 1.0 dc microamperes, readability to 20 nanoamperes
- Dual-range voltmeter
- Ferro-resonant input line regulator to minimize line generated output fluctuations to less than 1% for +/- 10% input voltage change (NOT AVAILABLE FOR THE PTS-80,100,130,200, or 300)
- Internal Discharge solenoid with series resistor rated for 7.5 kilojoules(PTS-100, 130), 5.0 kilojoules(PTS-75, 80), and 2.5 kilojoules(PTS-37.5, 15) The PTS-200 has 250 Meg internal bleeder resistor. The PTS-300 has 390 Meg internal bleeder resistor. The PTS-600 has 775 Meg internal bleeder.
- One piece portable design for PTS-15, PTS-37.5, PTS-75, and PTS-80, two piece for PTS-100,PTS-130, PTS-200, PTS-300, and PTS-600
- Transit protected meters prevent meter damage between test sites

- Ground hook provided for increased operator safety. Can be used to safely connect the unit and load to ground before and after test

- Shielded high voltage output cables included on PTS-15, 37.5, 75, 80, 100, 130, 200. No output cables are supplied for the PTS-300 or 600.

Please NOTE:

The Ferro-Resonant transformer in the PTS-15, PTS-37.5, and the PTS-75 requires a frequency stable voltage source. Some generators are not suitable for operating these units

PTS MODEL SPECIFICATIONS

See last page of parts list for Specifications

For particular unit

Operating Environment

Indoor/Outdoor-fair weather

Altitude: 100% of rating;Sea-level, up to 5000ft.(approx.1500M). The maximum output voltage is de-rated 5% above 5000 ft. altitude, 10% above 12,000 ft.(approx. 3600M), and 15% above 15,000 ft.(approx. 4500M)

Storage Temperature: -20°C to 70°C(-4°F to 158°F)

Operating Temperature: -10°C to 50°C(14°F to 122°F)

Maximum Relative Humidity: 80% up to 31°C(88°F), decreasing linearly to 50% at 50°C(122°F)

Mains supply fluctuation: +/-10% of rated voltage

Installation: Category II

Pollution: Degree 2

Safety Symbol Identification

Warning! Please refer to documentation before operation

Protective Earth Terminal

Caution: Hot Surface!

Warning: Hazardous Voltage

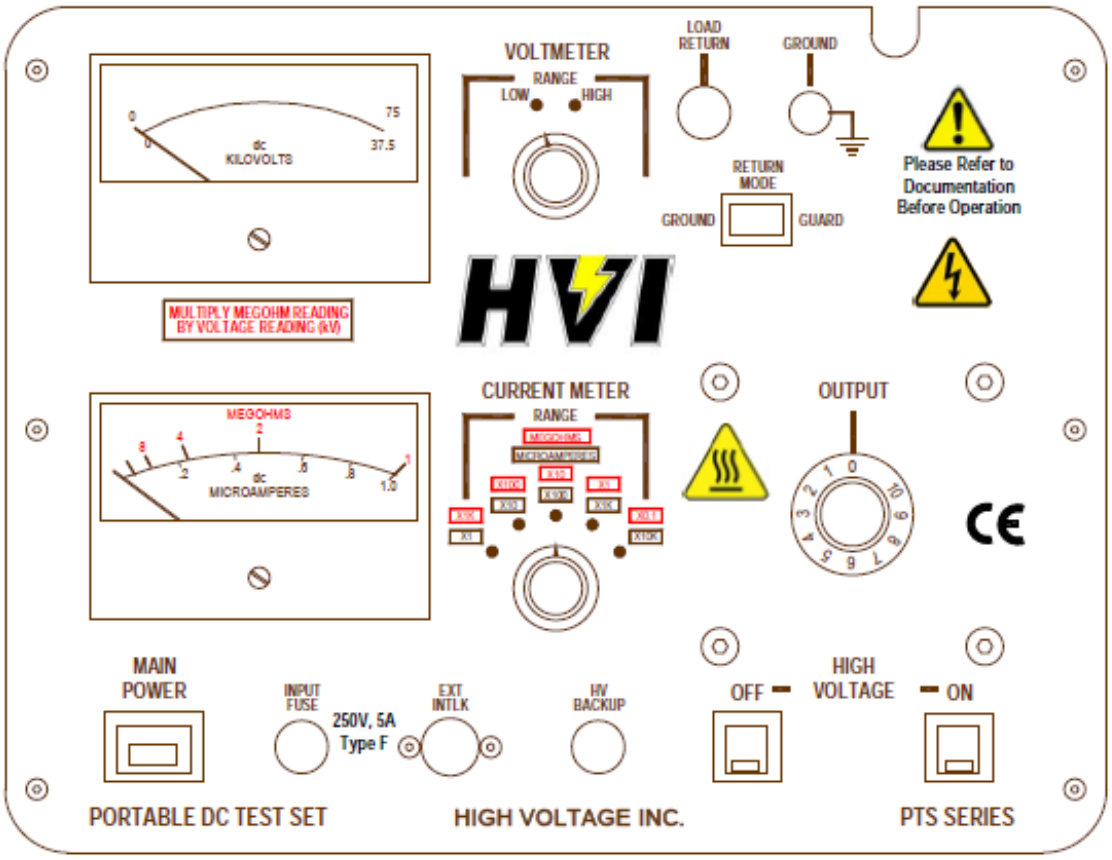


Figure 1 *PTS Series front panel controls.*

MAIN POWER

The MAIN POWER pushbutton switch provides the power to the control and power circuits. The neon lamp in the switch will light when the power is on and voltage is available through input line cord. The INPUT FUSE located electrically before the MAIN POWER switch provides line fault protection for the unit.

EXT.INTLK (EXTERNAL INTERLOCK)

The Ext. Intlk. connector is provided to allow for a normally open safety interlock switch to control the energizing of the high voltage output.

HV BACKUP

The HV BACKUP circuit breaker protects the variable transformer output control brush. Its thermal characteristics allow for the short term overload of the variable transformer while still providing proper protection.

HIGH VOLTAGE ON/OFF

The HIGH VOLTAGE ON (OFF) pushbuttons activate (de-activate) the high voltage power circuits. The LED indicators provide long life positive indication of the circuit status. The RED (ON) LED lights when high voltage is energized, the GREEN (OFF) LED lights when the high voltage is de-energized.

OUTPUT CONTROL

The OUTPUT control variable transformer adjusts the output voltage. The 0-10 markings on the knob indicate the low to high setting. The control must be at ZERO (0) to energize the high voltage circuits. The output control must always be returned to zero at the completion of testing, prior to de-energizing the output

VOLTMETER AND RANGE SWITCH

The KILOVOLT METER and associated range switch allows for more accurate output voltage readings. 1-% precision resistors minimize the need for re-calibration due to aging shift. See Voltmeter Re-calibration in Section 3 for details on calibration.

CURRENT METER AND RANGE SWITCH

The CURRENT METER and associated range switch allows for more accurate output current readings. The five current range resistors are precision 1% tolerance and as such reduce the need for adjustments. See Current Meter Re-calibration in

Reading the Megohm Scale

The MEGOHM SCALE on the Current meter can be read once the output has reached a fixed steady level. To read the resistance, the MEGOHM scale must first be read then multiplied by the scale multiplier, then this product is multiplied by the test voltage, e.g. a reading of 2.5 MEGOHMS on the RED x1k multiplier at 60 kVdc = 2.5 x 1000 x 60 =150,000 Megohms.

Note

The resistance can be easily calculated at any voltage, as the test voltage (kilovolts) is always a direct multiplier in calculating the resistance of the test sample.

RETURN MODE (GUARD/GROUND)

The RETURN MODE rocker switch is used to choose the current measuring mode of the test set. The option of guarded or grounded return measurements has application under various testing conditions. A Grounded return will measure the load currents in the test sample **plus** any stray losses in the air, the unit, and test fixtures used. NOTE: The use of the guarded mode is restricted to the ability to isolate the load or test sample low side from ground. The guarded return mode does enable more accurate load current measurement as the stray currents in the surrounding items are not measured as load current. In the guarded return mode, the currents to ground are diverted around the metering circuit. Further discussion of the application of the GUARD/GROUND circuit is found in SECTION 2: OPERATING THE EQUIPMENT, Using the Guarded Return.

DWELL TIMER (OPTIONAL EXTERNAL BOX)

Operation of the Timer With the PTS Hipot

The Dwell Timer provided in our PTS Series of DC Hipots will function as an end of test alarm only. The timer will start upon initiation of the high voltage. The timing function will count up to the preset value. Upon reaching the dwell time, an alarm will sound indicating the need to return the Output Control to zero, and to turn OFF the high voltage as noted later in the Operating Manual.

To set the timer.

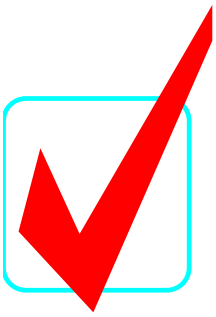
1) Press 'Mode'. When 'Timing Range' appears. Press '1' pushbutton. When desired range appears move to next step.

2) Press 'Mode'. When 'UP/Down Count' appears, press '1' to choose 'UP or 'DOWN'.

3) Press 'Mode''. When 'Output Mode' appears, press '1' until Mode 'A' appears.

This setup should be retained in the timers memory. To change the time in the future see step 1.

List of included components



- ☐ Ground stick with 20 ft. of ground wire
- ☐ 20 ft. Black test lead with black boot for ground connections. (two test leads supplied for two piece units)
- ☐ 20 ft. Red test lead with red boot for return connections
- ☐ Ext. Intlk. jumper plug
- ☐ Attached 20 ft. RG8/U output cable (PTS-75, 80), attached 20 ft. RG58/U (PTS-15, 37.5), removable 20 ft. shielded X-Ray type (PTS-100/130), and attached X-ray cable on PTS-200. The PTS-300 and PTS-600 have no output cable, high voltage connections are made to the ring toroid or the top plate.
- ☐ External Current Limit Resistors are provided for use on the PTS-300 and 600.

SECTION 2

SETTING UP THE EQUIPMENT

The setup of this equipment has been minimized by careful consideration of the operator during design. The PTS Series' one-piece construction (two-piece for PTS-130,200,300,600) reduces the possibility of misplacing components while continuing to allow for reasonable portability.

1. **Select a location** for the unit that will allow easy viewing of the meters at a safe distance from the test object.

2. **Be sure that all the controls are off**, in their de-energized or fully counterclockwise position.

3. **Secure a Safety Ground test lead to the panel**. The **Ground** post on the front panel should be used for that purpose. A black test lead with black boot has been provided for the ground connection. On two piece units a second ground is supplied to ground the high voltage tank separately to a building/station ground. Place the **Return Mode** rocker switch in the **Ground** position.

4. **Connect the ground stick** to a **solid earth ground.**

5. **Insert the EXT INTLK plug into the socket on the panel.** The plug may also be wired to a normally open contact of a safety switch for added protection.

6. **Connect the red return lead to the RETURN binding post**. The information explaining the use of the GUARD/GROUND return circuit is found in the next part of this section, OPERATING THE EQUIPMENT, **Using the Guarded Return.**

7. Connect the interconnect cable between the control and high voltage tank (two piece units only).

The Ferro-Resonant transformer in the PTS-15, PTS-37.5, and the PTS-75 requires a frequency stable voltage source. Some generators are not suitable for operating these units

Operating the Equipment

This section provides step-by-step instruction on various test methods and an explanation on when to use and when not to use the guarded return mode. Many facilities have their own in-house test procedures, and this manual is not to supercede these. The purpose of this section is to explain the capabilities of this test set in real-world applications.

DC Insulation Testing

1. Ensure that all the steps listed in Setting up the Equipment have been accomplished. Take special note to ground the control panel to a solid earth ground using the supplied black test lead. Then connect the GROUND HOOK to the same earth ground.

2. Set the CURRENT RANGE to the x10k (high range).

3. Select the desired VOLTMETER RANGE for the test voltage level expected.

4. Prior to connecting the output cable to the test sample, ground the test sample using the GROUND HOOK supplied with the PTS unit.

5. Connect the red return lead to the low side of the test specimen. Select the GROUNDED RETURN mode if the low side of the test sample is grounded as in the case of a cable shield. For instruction in the use of the GUARDED RETURN mode see the next section Using the Guarded Return.

6. Connect the output to the test sample. ***Be sure that there is enough clearance to grounded objects for the expected test voltage. The minimum clearance in air is 10 kV dc/inch. On the PTS-300 and 600, high voltage connections are made on the top plate or the ring electrode.***

> ***Please Note: On the PTS-200, 300, 600, long cable tests require some external series limiting resistance to protect the rectifiers in the high voltage section. When a long cable arcs, there can be a ringing transient on the line, which can damage the high voltage rectifiers.***

7. Connect the input power cord to a grounded power source (see specifications table). For 230V input, a line connector must be wired to the input cord, brown is HOT, blue is Neutral, green/yellow is ground. The 230V input connector must be rated for 10A minimum. The 15, 37.5, and 75kV units with the ferro-resonant input regulator, will correct for 10% change in input voltage and not affect the output voltage more than 1%. A generator (frequency stable) is an acceptable power source. If the distance to a power source is greater than the cord provided, a standard grounded extension cord can be used.

8. Depress the MAIN POWER switch to energize the control circuits.

CAUTION

POTENTIALLY LETHAL VOLTAGES MAY BE PRESENT

9. With the OUTPUT control at zero (zero start interlock engaged), depress the HV ON pushbutton. The HV ON light will glow.

10. Increase the output by rotating the OUTPUT control slowly clockwise until the desired output voltage is reached. Raising the output too fast may trip the output overload relay, so caution should be used not to exceed the full scale rating of 10 mA output current. On the PTS-200, 300 and 600 the output current should be limited to 5mA (200,300)and 3mA (600).

11. Maintain the output voltage for the test time specified in your standard procedures. To see leakage current, rotate the CURRENT RANGE to a more sensitive scale. Note: During this time the resistance of the test sample may be measured by the following:

Reading the Megohm Scale

The MEGOHM SCALE on the Current meter can be read once the output has reached a fixed steady level. To read the resistance, the MEGOHM scale must first be read then multiplied by the scale multiplier, then this product is multiplied by the test voltage, e.g. a reading of 2.5 MEGOHMS on the RED x1k multiplier at 60 kV dc = 2.5 x 1000 x 60 =150,000 Megohms.

12. After the test is complete, rotate the OUTPUT control to zero, allowing the load to bleed down prior to depressing the HV OFF pushbutton.

13. If the test sample fails during the test, the internal overload relay will de-energize the high voltage, dropping the internal discharge solenoid and bringing the output to zero in less than 1 second.

14. Prior to removing the output connection from the load, observe that the output voltmeter is at zero, and then use the GROUND HOOK to positively ground the test sample and unit.

Using the Guarded Return

The use of the GUARD/GROUND return feature of this test set provides for very accurate leakage current measurements if certain conditions exist allowing for the GUARD circuit to be employed. The following explanation will detail different test samples and methods that lend themselves to the use of this circuit. The same setup precautions such as proper grounding still apply to the test but the grounds will be manipulated to accomplish the test requirements.

1. Grounded Return- With the output return in the grounded mode, the current meter reads all current to ground, internal and external to the power supply. This current might include corona, surface tracking, and any shunt resistance. The typical diagram for grounded return operation is shown in Figure 2 below.

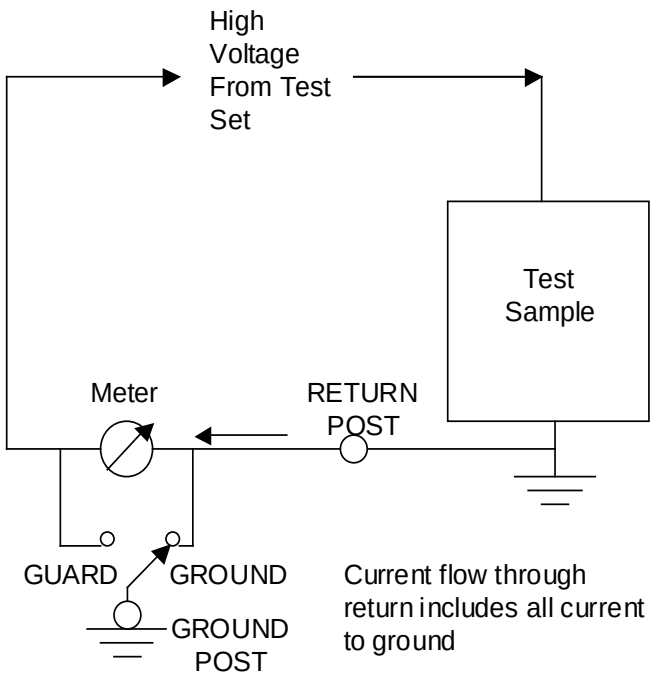


Figure 2, Grounded Return Diagram

2. Guarded Return- With the output return in the guarded mode, the current meter will only read currents through the test sample. The test sample must be isolated from ground on the low side as shown in Figure 3 below.

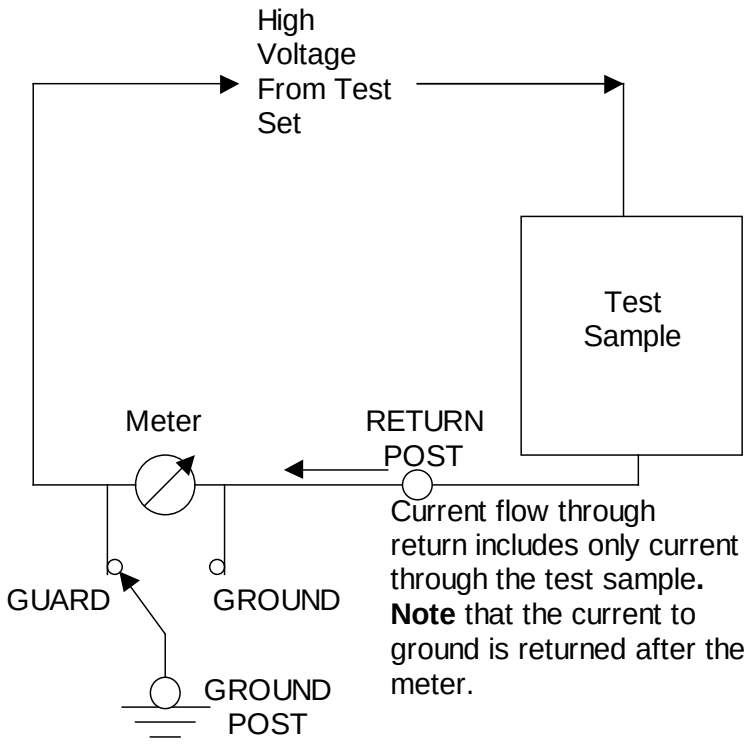


Figure 3, Guarded Return Diagram

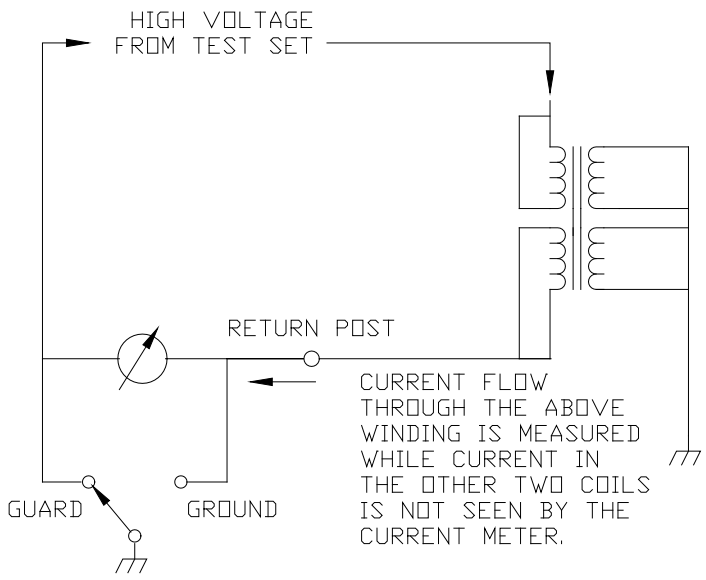


Figure 4, Using the Guarded Return to Test Windings

DC Testing of High Voltage Cables

When testing cables, either single or three phase, there are certain extra steps that must be observed to ensure safe operation.

1. Make sure that all insulators, stress cones, and pot heads are clean and free of moisture. This will prevent flashover and minimize leakage.

Please Note: On the PTS-200, 300. 600, long cable tests require some external series limiting resistance to protect the rectifiers in the high voltage section. When a long cable arcs, there can be a ringing transient on the line, which can damage the high voltage rectifiers.

The shields of all cables must be securely tied to ground at the nearest end of the cable.

2. Isolate the far end of the conductors under test for the test voltage; that may mean separating some of the conductors in a multi-conductor cable from each other and their shields.

3. Any conductors or wires in the cable or the vicinity not being tested must be grounded to avoid a buildup of charge and possible shock hazard.

4. Voltage must be applied according to specifications from the cable manufacturer or any other applicable test standards.

5. The discharge solenoid in the oil filled high voltage tank will support a discharge of up to 7.5 kJ(PTS-100,130), 5.0 kJ(PTS-75,80) or 2.5 kJ(PTS-37.5) of energy. But, the recommended turn off procedure at the completion of the test is return the OUTPUT control to zero and allow the output voltage to bleed to zero before turning off the high voltage.

CAUTION

POTENTIALLY LETHAL VOLTAGES MAY BE PRESENT

STORED ENERGY LEVELS IN THE CABLE GREATLY INCREASE THE RISK OF FATAL INJURY IF CONTACT IS MADE WITH THE LOAD WHILE AT ANY VOLTAGE.

6. Always use the GROUND HOOK to ground the cable(s) prior to disconnecting the RED booted output cable.

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SECTION 3

PERFORMING SPECIAL OPERATIONS

The following section contains information on the care and upkeep of your new PTS SERIES Portable dc Test Set. There are some notes on troubleshooting and service, which will save much time and money over the life of the unit.

Meter Re-calibration

The PTS SERIES of hipots use precision metal film resistors for measurement and calibration of the voltmeter and the current meter. The use of these resistors in both the high voltage tank and the metering circuits has minimized circuit drift due to aging and temperature. But, a potentiometer (R4) on the voltmeter PCB can be used to correct for movement changes from the aging of the meter.

The current meter and associated amplifier circuit is designed for calibration on two range levels. The x1 and x10 ranges are calibrated using one adjustment, and the x100, x1k, x10k ranges are adjusted using another calibration point. If the current meter will not calibrate, the meter should be replaced once it has been determined the amplifier is not the cause.

The certification of meters on a yearly basis is recommended to ensure accurate test results. It is recommended to use a Certified Calibration House or return the unit to the High Voltage Inc. factory when calibration is needed.

Voltmeter Re-calibration

1. Locate the unit in a position that will allow easy reading of the meters.
2. Remove the panel screws and support the panel vertically to gain access to the calibration pot on the back of the voltmeter.
3. Zero the meter movement using the zero adjustment below the scale window.
4. Perform the steps in Setting up the Equipment at the start of SECTION 2. Be sure to ground the front panel to a solid earth ground using the supplied black ground test lead prior to connecting the unit to input power.

5. Set the VOLTMETER RANGE to LOW position.

6. Connect the output cable to a calibrated reference meter with ability to read to the full output voltage of the unit. Be sure to ground the low side of the meter.

7. Place the RETURN MODE in GROUND position.

8. Raise the output to one half scale on the unit meter. Adjust R4 as required.

9. Check calibration at full scale and on the high range at both half and full scale. If the customer facility calibration certification requires more points of reference, follow those procedures instead of these.

Current Meter Re-calibration

1. The low range of 1 μA requires that the current meter be calibrated using an external voltage source and reference meter. Once the two lower ranges are calibrated, it may be desirable to continue with the external source since the setup is done.

2. To properly calibrate the current meter, a reference meter with an accuracy of 0.25% on the 1-microampere range will be required. A dc power supply with 0-30 volts dc, 10 milliamperes output will also be needed.

3. Locate the unit in a position that allows for easy viewing of the meters.

4. Remove the panel screws and support the panel vertically to gain access to the calibration pots on the back of the current meter.

5. Zero the meter movement using the zero adjustment below the scale window.

6. Locate J6 on the Power Protection PCB (PCB-003). Remove the white wire (pin 2) from the cable connector. A small screwdriver will be needed to release the terminal from the connector shell.

7. Connect the external 30 volt power supply to this white wire and the return post. Place the reference meter in series with the power supply. The reference meter must be able to read 1 microampere with accuracy.

8. Perform the steps in Setting up the Equipment at the start of SECTION 2. Be sure to ground the front panel to a solid earth ground using the supplied black ground test lead prior to connecting the unit to input power.

9. Set the CURRENT METER RANGE to x1 position.

10. Raise the output of the external power supply to 1.25 volts. The current meter should deflect to one-half scale. To adjust the meter on this range, locate R14 potentiometer and, using a small blade screwdriver, rotate the adjustment screw as needed. Check linearity at full-scale, make any further adjustments needed.

11. Return the external power supply to zero. Rotate the CURRENT METER RANGE to x10(10-microamperes). Change the reference meter range appropriately.

12. Raise the external power supply to 1.25 volts and check the x10 range the same as the x1 range. The 1% precision divider resistors should maintain the relationship between the x1 and x10 ranges, but if any variation exists the R14 calibration pot can be used to split any deviations to maintain the accuracy needed. Check the full-scale reading prior to moving on to the next range.

13. Next, to check the higher ranges, rotate the CURRENT METER RANGE switch to x100. Change the reference meter range as required.

14. Raise the external power supply output to approximately 12.5 volts while reading the reference meter. To adjust this range, rotate the screw adjustment on R4 to correct any inaccuracy. Then check the full-scale reading before moving on to the next range.

15. Do the rest of the higher ranges as necessary. The R4 adjustment is for these ranges and the 1% precision resistors should maintain the relationship between the ranges. Split any calibration deviation across all these ranges with R14.

Miscellaneous

The only operator serviceable part on this test set is the input fuse. Should an input fuse fail, replace it with a 250Volt, (see parts list for F1 Ampere rating), Type F fuse.

Maintenance Cleaning

Cleaning of the PTS Series of hipots should be accomplished on a semi-annual basis. The control panel should be cleaned with a mild soap or detergent and dried with a clean cloth.

The output cable, return lead, and ground leads should be regularly inspected for fraying and excessive dirt buildup. If the return or ground test leads show signs of insulation damage or fraying, they should be replaced immediately.

Should the output cable arc along the insulation at the 'live' end of the cable, it should be cleaned using WD40 or LPS oils to cut the grease and carbon. The excess oil should then be removed with a clean, lint free cloth.

Cleaning of the output dry well in two piece units should be accomplished periodically. If dirt becomes apparent in the well during a visual inspection, the dry well should be cleaned with a clean lint free cloth and WD40.

Oil Insulated High Voltage Tanks

The oil-filled tanks in all the PTS SERIES of hipots are field serviceable. The only requirement is that the tank must be oil filled under vacuum at re-assembly if left out of the oil for longer than 3 hours. The parts to service the tank are available from HIGH VOLTAGE, INC. at the address noted on the inside front cover of this manual.

The oil level in the tank should be .5 inches from the lid when the oil temperature is 20°C.

Packing the lid for transit

The design of the PTS series requires that the output cable, ground stick, return leads, and input line cord be packed into the lid compartment for transit. There is a sequence that works best. Please take time to read this and practice re-packing cables to avoid frustration each time you use the unit.

Note: The PTS-130 H V tank has a storage compartment on the side for the output cable and ground stick. All other cables and test leads store in the control lid.

1) Coil the output cable into the compartment starting with the end from the panel, keeping the coil to the outside edges. Avoid coiling the cable into the space required for the hinged panel.

2) Next, coil the remaining cables to place them into the center of the output cable coil.

3) Finally, neatly coil the ground stick braid into a 3 inch coil and place the ground stick snugly into the lid corner to corner with the coil of braid behind it. The ground stick will hold all the cables behind it.

4) Close the lid and turn the latch to secure it.

   This procedure can obviously be modified to your own experience if desired, but as a starting point we hope you find this helpful.

RETURNED MATERIAL

If for any reason it becomes necessary to return any equipment or materials to High Voltage, Inc., the Service Department of High Voltage, Inc. must be notified, and authorization received, prior to the shipment of the equipment. When notified, the following information must be provided:

MODEL:
SERIAL NO:
PART NO:
REASON FOR RETURN:
SUSPECTED DEFECT:
CAUSE OF DEFECT:

With the above information provided, High Voltage, Inc. will determine if the return of the equipment is appropriate. If deemed appropriate, a Return Authorization Number will be issued. At that time, the Purchaser will be instructed how to mark and return the equipment.

The above procedure must be adhered to in order to ensure prompt service. No equipment should be returned without the prior knowledge and authorization of High Voltage, Inc.

REPLACEMENT PARTS ORDERING

To order replacement parts, first refer to the Parts List for the product in question. Every part is issued a part number. It will be necessary for this part number and the product model and serial number to be provided. When calling High Voltage, Inc. request the Service Department.

TERMS AND CONDITIONS AND LIMITED WARRANTY Rev. 102113

High Voltage, Inc., 31 County Route 7A, Copake, NY USA 12516
Phone: (518) 329-3275 Fax (518) 329-3271 E-mail: factory@hvinc.com

THESE TERMS AND CONDITIONS OF SALE AND LIMITED WARRANTY OF HIGH VOLTAGE, INC. ("High Voltage") SHALL BE GOVERNED BY AND CONSTRUED ACCORDING TO THE INTERNAL LAWS OF THE STATE OF NEW YORK, USA, WITHOUT GIVING EFFECT TO ITS CONFLICT OF LAWS PROVISIONS. THE RIGHTS AND OBLIGATIONS OF ALL PARTIES AND ALL PERSONS OR ENTITIES CLAIMING HEREUNDER SHALL NOT BE GOVERNED BY THE PROVISIONS OF THE 1980 U.N. CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

1. **ACCEPTANCE.** All orders become effective only when accepted by High Voltage's written order acknowledgment at Copake, New York, USA. Unless modified in writing by an authorized representative of High Voltage, or modified in High Voltage's Quotation or order Acknowledgment, these Terms and Conditions and Limited Warranty shall solely control Purchaser's order. High Voltage expressly rejects any additional or different provisions, terms or conditions proposed by Purchaser at any time.

2. **SCHEDULING.** High Voltage's shipping date specified in High Voltage's quotation or purchase order acknowledgment is approximate and High Voltage shall use reasonable commercial efforts to effect timely shipment. Furthermore, High Voltage shall not be liable for any delay in the performance of orders or contracts or in the delivery or shipment of goods or for any damages suffered by Purchaser by reason of such delay when such delay is, directly or indirectly, caused by, or in any manner arising from Purchaser's fault, fires, floods, accidents, riots, acts of God, war, governmental interference or, embargoes, strikes, labor difficulties, shortage of labor, fuel, power, materials or supplies, transportation delays, or any other cause or causes (whether or not similar in nature to any of these hereinbefore specified) beyond the control of High Voltage.

3. **CANCELLATIONS.** Prior to shipment, Purchaser may request cancellation or delayed delivery of an order or part thereof, but such shall be conditioned upon written consent of High Voltage and upon payment to High Voltage of cancellation or delayed delivery charges to be determined by High Voltage.

4. **SALE AND DELIVERY.** Unless otherwise agreed in writing, sale and delivery of the goods hereunder shall be made EXW or FCA (Incoterms® 2010) at High Voltage's option, High Voltage's dock at Copake, New York, USA, at which time all risk of loss or damage shall pass to Purchaser. All shipments and packaging shall be made in the manner determined by High Voltage, unless otherwise requested by Purchaser, in which case any resultant additional changes and expenses shall be paid by Purchaser.

5. **TAXES.** Any and all sales, use, excise and similar taxes, and duty and all other charges levied or imposed by governmental authority, foreign and domestic, upon any goods sold or contracted to be sold shall be paid by Purchaser and added to the purchase price unless appropriate tax exemption certificates are supplied to High Voltage in form satisfactory to High Voltage.

6. **PAYMENTS.**

a. All payments shall be in US Dollars without discount unless otherwise specified in High Voltage's order acknowledgment. Credit card payments are accepted only if specified in High Voltage's order acknowledgment.

b. Terms of payment are net thirty (30) days from date of invoice, unless otherwise agreed by High Voltage in its order acknowledgment. Delinquent payments are subject to a service charge on the unpaid balance from invoice date equal to the lower of 1-1/2% per month or the maximum rate permitted by law until all amounts are paid in full. If the financial responsibility of Purchaser becomes unsatisfactory to High Voltage for any reason, or if Purchaser has been in default to High Voltage under any order, High Voltage may require full payment in cash before shipment of goods.

c. If Purchaser so requests and makes arrangements prior to shipment which meet High Voltage's full satisfaction, High Voltage in its discretion may accept irrevocable letters of credit in its favor issued by a United States bank which is satisfactory to High Voltage.

7. **INFRINGEMENT, ETC.** On goods manufactured to Purchaser's specifications, Purchaser shall and does indemnify and hold High Voltage harmless against any claims, damages, liabilities, costs and expenses (including attorneys' fees) arising out of or resulting from actual or alleged infringement of patent, copyright, trademark or other proprietary rights, or claim of unfair trade or unfair competition arising from or occasioned by the use, possession, sale or delivery of any such goods sold by High Voltage.

8. **REPRODUCTION RIGHTS.** Drawings, specifications, reports, photographs and other data relating to all orders and all proprietary rights and interests therein and the subject matter thereof shall be and remain the property of High Voltage. Purchaser agrees that it shall not use High Voltage's drawings, specifications or other materials covered by this order, or any similar article from any other source, or reproduce the same or otherwise appropriate them, without the prior written authorization of High Voltage.

9. **LIMITED WARRANTY.**

a. High Voltage warrants to the original Purchaser of any new goods that the goods are free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment by High Voltage. The obligation of High Voltage under this Limited Warranty is limited, in High Voltage's exclusive option, to repair, replace with new or reconditioned parts or issue credit for goods, parts or materials which prove to be defective. Costs incurred by Purchaser for labor or other expenses to repair or replace such goods, parts and/or materials shall be the sole responsibility of Purchaser. High Voltage shall not be responsible for any damage or lack of performance resulting from: (i) defects due to accident, negligence, alteration, modification, faulty installation, abuse or misuse, whether by Purchaser, Purchaser's agents or employees, or by others than High Voltage (ii) attempted or actual dismantling, disassembly, service or repair by any person, firm or corporation not specifically authorized in writing by High Voltage, or (iii) defects caused by or due to handling by carrier, or incurred during shipment, transshipment or other move.

b. High Voltage expressly disclaims any warranty whatsoever of (i) consumables, and of (ii) parts, components, software (including but not limited to object code and source code and software user instructions), accessories, and materials not prepared, compiled or manufactured by High Voltage, and Purchaser must deal directly with such other supplier. High Voltage may elect to assist Purchaser in settling such claim against such other supplier, but any such assistance shall not prejudice High Voltage's position as to its own liability.

c. Compliance with the following Limited Warranty Claim Procedure is a condition precedent to the obligation of High Voltage under this Limited Warranty:

i. Purchaser must notify High Voltage in writing as soon as is reasonably possible, but within the applicable warranty period, of any alleged defect in material, workmanship, or operation of any goods covered under this Limited Warranty. Such notice must describe in detail the defect, any and all defective parts, and the alleged cause of the defect. No goods may be returned to High Voltage without High Voltage's prior written permission, which permission may be withheld by High Voltage in its sole discretion.

ii. At the exclusive option of High Voltage, Purchaser may be directed in writing to dismantle the goods at the Purchaser's cost and expense and ship the goods prepaid to High Voltage (refer to "Returns" Section 10 for provisions regarding the return of any goods to High Voltage). If High Voltage elects to inspect the goods at Purchaser's site, and to repair, replace,

[Section 9.c.ii. continued on page 2]

or ship the defective goods to High Voltage's factory, Purchaser, at its own cost and expense, shall provide the facilities for such work as needed to inspect and evaluate and possibly repair/replace the goods. If inspection discloses that the defect is not one for which High Voltage is liable, then Purchaser shall promptly reimburse High Voltage for all expenses incurred.

iii. Upon receipt of the defective goods, or following access to the same, High Voltage shall inspect and evaluate the goods and determine the validity of Purchaser's claim.

iv. The validity of any warranty claim, Purchaser's compliance with the Limited Warranty and Limited Warranty Claim Procedure, and the obligation to replace, repair, or issue credit for any goods are solely and exclusively to be determined by High Voltage and any determination shall be final and binding.

d. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, STATUTORY OR EXPRESSED OR IMPLIED ON THE PART OF HIGH VOLTAGE, INCLUDING THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT; FURTHERMORE, HIGH VOLTAGE MAKES NO WARRANTY REGARDING NON-INTERRUPTION OF USE OR SOFTWARE FREEDOM FROM BUGS. HIGH VOLTAGE NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON, FIRM, OR CORPORATION TO ASSUME ANY LIABILITY OR OBLIGATION IN CONNECTION WITH THIS SALE OR LIMITED WARRANTY ON HIGH VOLTAGE'S BEHALF AND PURCHASER ACKNOWLEDGES THAT NO REPRESENTATION EXCEPT THOSE MADE HEREIN HAS BEEN MADE TO PURCHASER.

10. **RETURNS.** No goods may be returned to High Voltage without High Voltage's prior written permission, which permission may be withheld by High Voltage in its sole discretion. Any request for return authorization must be in writing and include, as applicable, model number, serial number, part number, reason for return, alleged defect, and apparent cause of alleged defect. Except as specifically provided in Section 9 Limited Warranty, if High Voltage consents to return of goods: (a) all return shipments are to be via prepaid freight and with all other charges prepaid, (b) if goods are returned to High Voltage within sixty (60) days from the date of original shipment for reasons other than an error by High Voltage in filling the Purchaser's order, Purchaser shall only be entitled to receive a credit in an amount equal to the payment received by High Voltage for the goods minus (i) handling charges, and (ii) a restocking fee determined solely by High Voltage which shall not exceed twenty five percent (25%) of the invoiced amount, and (c) if goods are returned to High Voltage after sixty (60) days from the date of original shipment for reasons other than an error by High Voltage in filling the Purchaser's order, Purchaser shall only be entitled to receive a credit in the amount equal to the payment received by High Voltage for the goods minus (x) a handling fee, and (y) a restocking fee in excess of twenty five percent (25%) which shall be determined by High Voltage.

11. **SECURITY INTEREST.** In order to induce High Voltage to ship goods without full payment, Purchaser grants a security interest to High Voltage in any and all of Purchaser's right, title and interest in the goods, and Purchaser agrees to comply with any reasonable request of High Voltage to perfect such security interest. Purchaser hereby further authorizes High Voltage to perfect High Voltage's security interest in said goods and consents to filing one or more financing statements without the signature of Purchaser.

12. **ARBITRATION.** Any controversy arising out of or relating to this document, or any breach thereof, including, without limitation, any claim that this document is voidable or void, shall be submitted to final and binding arbitration before, and in accordance with, the Commercial Rules of the American Arbitration Association then in effect, and judgment upon the award may be entered in any court have jurisdiction thereof; provided, however, that this clause shall not be construed to limit any rights which High Voltage may have to apply to any court of competent jurisdiction for equitable, injunctive or provisional relief. This arbitration provision shall be deemed self-executing, and in the event that either party fails to appear at any properly noticed arbitration proceeding, an award may be entered against such party notwithstanding said failure to appear. Such arbitration shall be conducted before a single arbitrator under the aegis of the American Arbitration Association in Columbia County, State of New York. The arbitrator shall have the authority to award expenses to the successful party.

13. **LIMITATION OF LIABILITY.** TO THE MAXIMUM EXTENT PERMITTED UNDER APPLICABLE LAW, AND NOTWITHSTANDING ANYTHING ELSE IN THIS DOCUMENT OR OTHERWISE, INCLUDING THAT HIGH VOLTAGE WAS WARNED THAT DAMAGES WOULD OCCUR OR WERE LIKELY TO OCCUR, HIGH VOLTAGE SHALL NOT BE LIABLE WITH RESPECT TO ANY SUBJECT MATTER OF THIS DOCUMENT UNDER ANY CONTRACT, NEGLIGENCE, STRICT LIABILITY OR OTHER LEGAL OR EQUITABLE THEORY FOR (i) ANY AMOUNTS IN EXCESS IN THE AMOUNT PAID TO HIGH VOLTAGE FOR THE PARTICULAR GOODS OR PART THEREOF WHICH GAVE RISE TO THE APPLICABLE CAUSE OF ACTION OR CLAIM, OR (ii) ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR LOST OR CORRUPTED DATA, OR (iii) COST OF PROCUREMENT OF SUBSTITUTE GOODS, SOFTWARE, TECHNOLOGY OR SERVICES. HIGH VOLTAGE SHALL HAVE NO LIABILITY FOR ANY FAILURE OR DELAY DUE TO MATTERS BEYOND ITS REASONABLE CONTROL.

14. **SEVERABILITY.** These Terms and Conditions and Limited Warranty are the entire understanding between Purchaser and High Voltage with respect to the subect matter hereof and supersede all prior agreements, dealings and negotiations. No modification, alteration or amendment shall be effective unless made in writing and signed by a duly authorized representative of High Voltage. No waiver of any breach hereof shall be held to be a waiver of any other or subsequent breach. Nothing contained in this document shall be construed as requiring the commission of any act contrary to law. Whenever there is any conflict between any provision of this document and any present or future statute, ordinance or regulation contrary to which the parties have no legal right to contract, the latter shall prevail, but in such event the provision of this document thus affected shall be curtailed and limited only to the extent necessary to bring it within the requirements of the law. In the event that any part, article, section, paragraph, sentence or clause of this document shall be held to be indefinite, invalid or otherwise unenforceable, the entire document shall not fail on account thereof, and the balance of the document shall continue in full force and effect. If any arbitration tribunal or court of competent jurisdiction deems any provision hereof (other than for the payment of money) unreasonable, said arbitration tribunal or court may declare a reasonable modification thereof, and this document shall be valid and enforceable, and the parties hereto agree to be bound by and perform the same as thus modified.

15. **BASIS OF BARGAIN**. Each party recognizes and agrees that the warranty disclaimers and liability and remedy limitations in this document are material, bargained for bases of their agreement and that they have been taken into account and reflected in determining the respective obligations of the parties.

[End]

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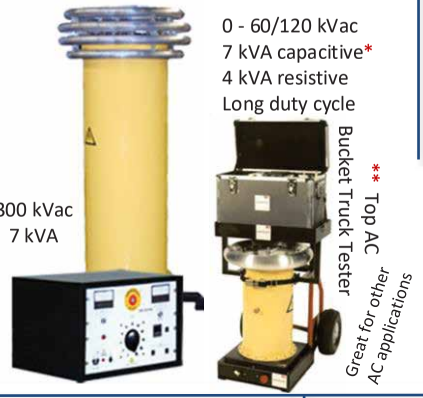

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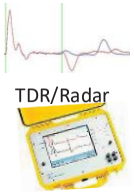

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