OPERATING AND MAINTENANCE MANUAL

Product: ***High Voltage DC Cable Test Set***

Type: ***PT30-10 mk2 and PT30-10 mk3***

PT30-10C mk2 with Current Limit

DESIGNED AND MANUFACTURED BY:

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GENERAL SAFETY STATEMENT


WARNING

The following safety precautions should be reviewed to avoid injury to the user and damage to the product (and other products connected to it). To avoid potential hazards only use this product as specified.

- **Only suitably qualified personnel should use this equipment. Servicing of this product should only be carried out by suitably qualified service personnel.**
- **The high voltage generated by this unit is extremely dangerous and may be fatal.**

To Avoid Fire Hazards and Personal Injury

- Use the correct power supply lead. Only use a suitably rated and approved power supply lead for the country of use.
- Ensure that systems that the unit is to be connected to are dead.
- Do not connect and disconnect leads whilst outputs are switched on.
- Ensure that the product is grounded. To avoid electric shock it is essential that the grounding conductor is connected to the earth ground. An additional earth terminal is unit that must be connected to a local earth. Ensure that the unit is properly grounded before making any connections to inputs or outputs.
- Terminal ratings must be observed to prevent fire hazards and risk of injury to the operator. Consult the product manual for ratings information before making connections to any terminal.
- It is ESSENTIAL to consult the product manual for rating information before making any connection to a terminal or terminal group marked with a warning triangle.
- Only use fuses of a type and rating specified for this product.
- Do not operate the unit out of its case or with any covers or panels removed.
- Do not touch exposed connections and components when power is present.
- Do not operate the product if any damage is suspected. Refer the unit to qualified service personnel to be checked.
- Do not operate the unit in wet or damp conditions
- Do not operate the unit in an explosive atmosphere

If any further queries occur regarding the usage and maintenance of the equipment detailed in this manual, please refer these to the supplier of the equipment in the first case or to:

T & R Test Equipment Limited

SAFETY TERMS AND SYMBOLS

The following safety symbols appear on the equipment:

CAUTION/WARNING – Refer to manual

DANGER – High voltage

Mains off

Mains on

The following safety symbols appear in this manual:

CAUTION — This action or procedure may be dangerous if not carried out correctly, and may cause damage to the equipment or connected equipment.

WARNING — This action or procedure may be cause injury or death to the operator or other personnel if not carried out correctly using applicable safety procedures.

HIGH VOLTAGE SAFETY

 WARNING

It is essential to follow safe working procedures when working with high voltage. Information on accepted codes of practice should be obtained from your local heath and safety regulatory body.

IEEE standard 510-1983 (IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing) provides a working framework for establishing safe procedures, but must be read in conjunction with local regulations and accepted codes of practice.

The following excerpts are taken from IEEE 510

- All ungrounded terminals of the test equipment or apparatus under test should be considered as energised.
- Common ground connections should be solidly connected to both the test set and the test specimen. As a minimum, the current capacity of the ground leads should exceed that necessary to carry the maximum possible ground current. The effect of ground potential rise due to the resistance and reactance of the earth connection should be considered.
- Precautions should be taken to prevent accidental contact of live terminals by personnel, either by shielding the live terminals or by providing barriers around the area.
- The circuit should include instrumentation for indicating the test voltages.
- Appropriate switching and, where appropriate, an observer should be provided for the immediate de-energisation of test circuits for safety purposes. In the case of dc tests, provisions for discharging and grounding charged terminals and supporting insulation should also be included.
- High-voltage and high-power tests should be performed and supervised by qualified personnel.
- Consideration should be given to safety regulations which may apply to specific circumstances; for example, HSE, company, or government regulations.
- In the use of signal-gathering equipment, each device should be used in such a manner that it will not present a personnel hazard should it inadvertently become a part of the high-voltage circuit, or fail to function properly.

CONTENTS

1. DESCRIPTION OF EQUIPMENT

1.1 Electrical Specification

Supply requirements	115V/230V±10% auto-selecting 50/60Hz 750VA maximum
Output voltage	0-±30kVdc with respect to earth (0-60kV between outputs, centre earthed)
Output current	5mA continuous from each output 10mA from each output with a duty cycle of 5 minutes on/15 minutes off
Current limiting (PT30-10C only)	The PT30-10C has an extra pushbutton control to limit the output current to a maximum of 7.5mA (dependent on the output voltage).
Output earth connection	The earthy end of the high voltage outputs is connected to the earth system of the equipment.

1.2 Front Panel Layout

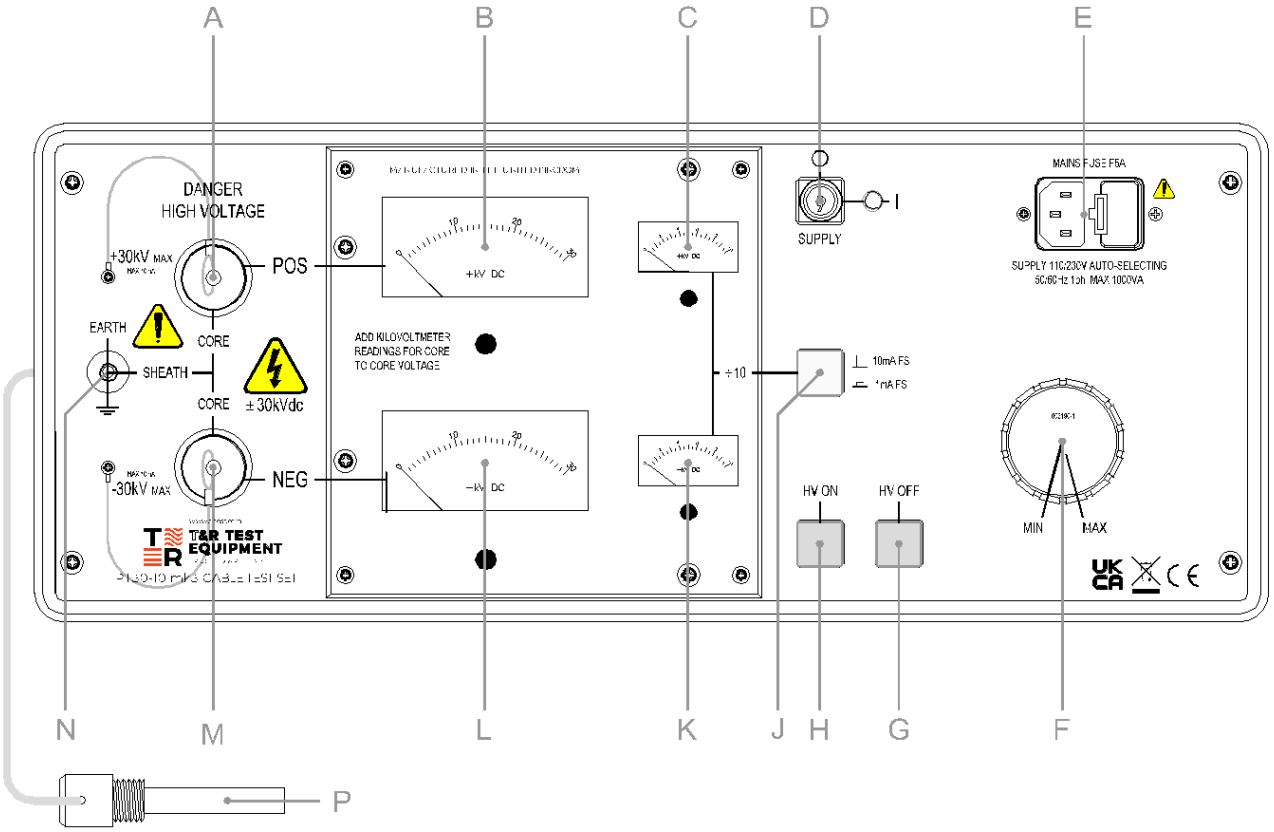

Figure 1 PT30-10 Front panel

A	Positive HV output with dust cap	H	Output HV on pushbutton
B	Positive kV meter with dust cap	J	mA range select pushbutton
C	Positive mA meter	K	Negative mA meter
D	Supply on/off key switch	L	Negative kV meter
E	Mains inlet and fuse	M	Negative HV output
F	Output control	N	Earth terminal
G	Output HV off pushbutton	P	HV Output blanking plug

1.3 Output Voltage Control

The voltage from the equipment is controlled by the output control on the front panel. To increase the output voltage turn the control knob in a clockwise direction, and to decrease the output voltage turn the knob anti-clockwise.

Note: The output can not be energised unless the regulator knob is set to zero.

1.4 Overload Protection

The unit is fitted with an F5A fast acting fuse which protects the incoming mains supply to the unit.

The outputs from the instrument are protected by means of an electronic trip circuit. The overload is set for 12-15mA at the output.

1.5 High Voltage Output Cables and Connectors

. Screened 5 metre long high voltage output cables are provided with the equipment terminated with large clips. If these clips are not suitable for creating a secure connection to your test object they should be replaced with a suitable termination. The cable type used is UR67M with a multi-stranded inner core. The outer screen is connected via the high voltage plug to the ground connection on the PT30-10.

Longer output cables are available as an optional accessory.

The high voltage plug is protected in transit by a plastic cover attached to the output cable by a nylon cord.

The high voltage plugs used on the PT30-10 are fully de-mountable.

WARNING

NEVER connect or disconnect the output leads with the unit connected to the mains.

1.6 Metering

The PT30-10 has separate, independent current and voltage metering for each output.

1.6.1 kV Meters

The equipment is fitted with two output kilovolt meters, which monitor both the positive and negative outputs simultaneously. Both instruments have a single range of 0-30 kilovolts. Each division on the instruments represent 1 kilovolt. The individual meters are labelled as follows:

a. Positive kV meter: +kV DC

b. Negative kV meter: -kV DC

1.6.2 mA Meters

The equipment is fitted with two output milliammeters, which sense both the positive and negative output currents simultaneously. The individual meters are labelled as follows:

a. Positive mA meter: +mA DC

b. Negative mA meter: -mA DC

The output mA meters are dual range as follows:

Range 1:	0-10mA	Each division being 0.5mA
Range 2:	0-1.0mA	Each division being 0.05mA

1.7 Discharge and Earthing

WARNING

The load must be discharged and earthed before any connections are made, broken or touched, and an earth must be maintained on the test object at all times during testing except when high voltage is

actually applied. The unit has an internal automatic discharge system and is also supplied with a DP40 external discharge probe suitable for discharging higher capacitance loads.

1.7.1 Automatic Discharge/Earthing

The unit has an internal fail-safe automatic discharge system with the following ratings:

- Max. discharge voltage (kVdc) 30kVdc
- Max. discharge energy 2.5kJ
- Max. discharge capacitance 4μF
- Max. discharges per hour 4

The outputs are earthed by the automatic discharge/earthing system when the HV output is off or the unit is switched off.

The automatic discharge/earthing switch is controlled by a solenoid that may produce a noticeable hum when the HT output is energised, particularly when operating from reduced mains voltages.

CAUTION

Ensure that the energy stored in the cable under test does not exceed the capabilities of the discharge system.

1.7.2 Manual Earthing Using DP40 Discharge/Earthing Probe

WARNING

Under no Circumstances Must the Discharge/ Earthing Probe be Used on Energised A.C. Distribution Systems. Failure to Observe the Above Will Result in Severe Damage to the Discharge Probe and, more importantly, possible fatal Injury to the operator.

The DP40 supplied with the PT30-10 has a higher rating than the internal discharge system. It has the following ratings:

- Max. discharge voltage (kVdc) **40kVdc**
- Max. discharge energy 7.2kJ
- Max. discharge capacitance 6μF
- Max. discharges per hour 4

When used with a PT30-10 at a maximum voltage of 30kV, it may be used to discharge a higher capacitance:

- Max. discharge voltage (kVdc) **30kVdc**
- Max. discharge energy 7.2kJ
- Max. discharge capacitance 11μF
- Max. discharges per hour 4

CAUTION

Ensure that the energy stored in the cable under test does not exceed the capabilities of the discharge system.

1.8 Construction

The PT30-10 is housed in a robust case consisting of a rigid frame construction with removable side covers to provide good access and serviceability.

All the controls are located on the equipment's front panel, together with all input and output connections. The instrumentation is mounted on a sub-chassis which, in turn is mounted to the front panel via a shock absorbing system. The instrumentation is further protected by means of a polycarbonate cover to prevent damage to the instruments' front faces.

The PT30-10 is housed in a padded bag for maximum protection during transit.

1.9 Storage

The PT30-10 when not in use must be stored in a dry environment, corrosion damage may occur to the HV components if stored in damp environment.

Note:
If the unit is moved from a cold area to a warmer area condensation could form on the HV components, this would greatly reduce the internal breakdown voltage.

If it is suspected that condensation may have formed the PT30-10 should not be used until its temperature has stabilised and any condensation evaporated.

2. OPERATION

2.1 Safety

WARNING

The output from the PT30-10 is extremely dangerous, and if used incorrectly could be fatal. The unit must only be installed, operated, and maintained by suitably qualified and trained personnel.

It is essential to follow accepted safety procedures and local health and safety regulations and guidelines when installing and operating high voltage equipment. A risk assessment should be undertaken on both the installation and the working procedures to ensure the safety of test personnel and all other personnel.

If no local guidelines exist, IEEE Std 510-1983 (IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing) provides a framework for safe installation and testing. This standard is available from the IEEE web site at www.ieee.org.

Test procedures and safety precautions are provided for guidance only.

2.1.1 Installation

WARNING

Incorrect installation and use of this equipment may result in injury or death.

2.1.1.2 Test Area

The unit must only be installed in a suitable high voltage test area, whether this be a permanent test area or a temporary test area. Appropriate controls and safety measures must be applied to this area including interlocks connected to the supply to ensure that the unit cannot be switched on unless the area is secure. Refer to IEEE Std 510-1983 for further details of suitable test areas. The test area must also be identified with suitable signs.

2.1.1.3 Mains supply

The unit must be connected to a suitable supply via an approved and suitably rated mains connector with earth connection.

2.1.1.4 Earthing

Particular attention must be made in earthing the equipment, and all earth connections must be made with substantial conductors with secure joints.

It is important for the safety of the operator and to protect the equipment that an adequate earth connection is made.

The earth connection on the unit must be connected to a suitable low impedance earth, which may be provided via the cable sheath (but check that the cable sheath has been properly earthed before using it as an earth point).

The earth return from the test object must also be made with a suitable conductor back to the earth point on the unit.

All earth connections must be able to withstand the largest fault current that may be encountered in the system.

2.1.2 Operation

WARNING

It is essential that safe working practices are maintained when conducting high voltage testing. Safe working procedures must be implemented to accepted standards.

Always ensure by means of a live line tester that the cable about to be tested is not live. This applies both to old and newly installed cables and also to all phases.

Large amounts of energy will be stored in the cable under test, and this must be discharged safely. It is vital that the maximum energy that will have to be discharged from the cable is calculated before commencing testing, and that appropriate arrangements are made for discharging.

2.1.2.1 Discharge and Grounding of the Load and High Voltage Output

The output circuit and load must be discharged and grounded before any connections are made or disconnected. The PT30-10 does include an automatic dump and grounding mechanism, but it is important not to overload this (see section 1.7.1 and 1.7.2) A temporary ground should be maintained at all times on the high voltage circuit when the HV is not energised. When connections are made or disconnected, the circuit either side of the connection should be grounded first. Extra discharge probes and earth sticks are available from T&R Test Equipment as an optional accessory.

If the test circuit includes capacitors, each capacitor should be grounded separately before connections are made or broken. In the case of capacitors connected in series, the intermediate terminals should also be grounded.

It is good practice for all capacitive devices to remain short-circuited when not in use.

2.1.2.3 High voltage connection

The HV connection to the test object must be made securely, and suitable stress relief components should be used where required to keep electrical stresses within acceptable limits.

WARNING

NEVER connect or disconnect the output cables with the mains supply connected or with the HV output switched on. Always ensure that the unused output has the plastic blanking plug (not the metal dust cap) fitted when carrying out unipolar testing.

2.1.2.4 High voltage output clearances

WARNING

Safe clearances must maintained between the following parts and any other conducting object (whether earthed or not):

- HV cable termination
- Non-screened part of HV cables
- Wiring connected to HV cable termination
- Non-grounded parts of test object

Any part of the test object not connected to earth should be considered live at the test voltage.

Particular attention should be paid to clearances between any parts of the test object at test voltage potential and the test enclosure or barriers. Refer to local safety standards for details of the clearances required.

2.1.3 Inspection

Ensure that the unit and all leads are inspected for integrity and for signs of damage each time before any testing is started.

Ensure the high voltage leads are carefully stored and that the exposed ends are kept clean, and that the protective plastic cover is fitted over the connector.

The earth cable and the earth cable on the discharge/earthing probe are both made from a very flexible copper conductor with transparent silicon insulation to allow visual inspection.

2.2 Connection and Testing

2.2.1 Connection Sequence

WARNING - Ensure that all necessary safety procedures are followed at all times!

a. Connect earth lead between test object earth and PT30-10 earth terminal.

b. Connect discharge/earthing probe to the PT30-10 earth terminal. The earth hook on the probe must now be placed on the test object HV connection point.

c. Connect the phases not being tested to earth. This means 1 phase for bipolar test and 2 phases for a unipolar test.

d. For a unipolar test connect the black/negative HV lead to the negative output socket on the PT30-10 and the test object. The positive output must be blanked off using the plastic blanking plug provided (not the metal dust cap). It is also possible to carry out a positive unipolar test, as shown in figure 3, although it is more common to use a negative test as this is more onerous.

e. For a bipolar test connect both the red/positive and black/negative HV leads to the output sockets on the PT30-10 and the test object as shown in figure 4.

f. Connect the PT30-10 to mains supply.

h. **Check that all connections are secure and that all safety procedures have been followed. Re-check that all personnel are out of the test area.**

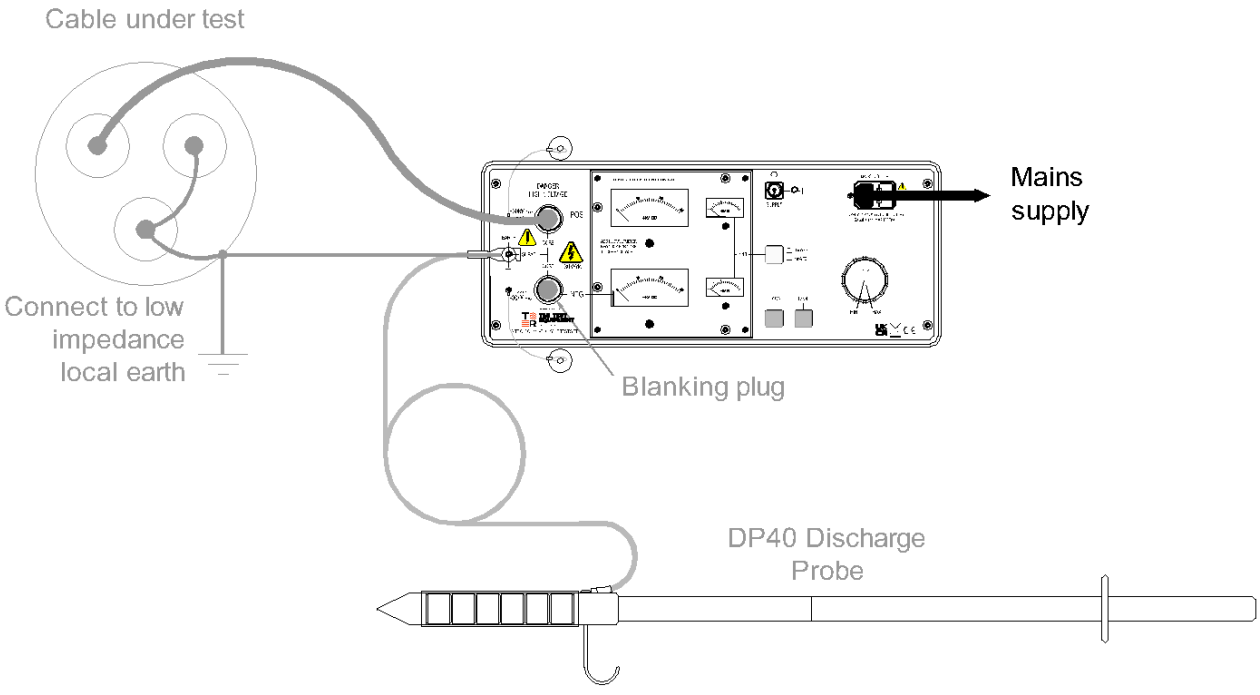

Figure 2 Connections for positive unipolar test

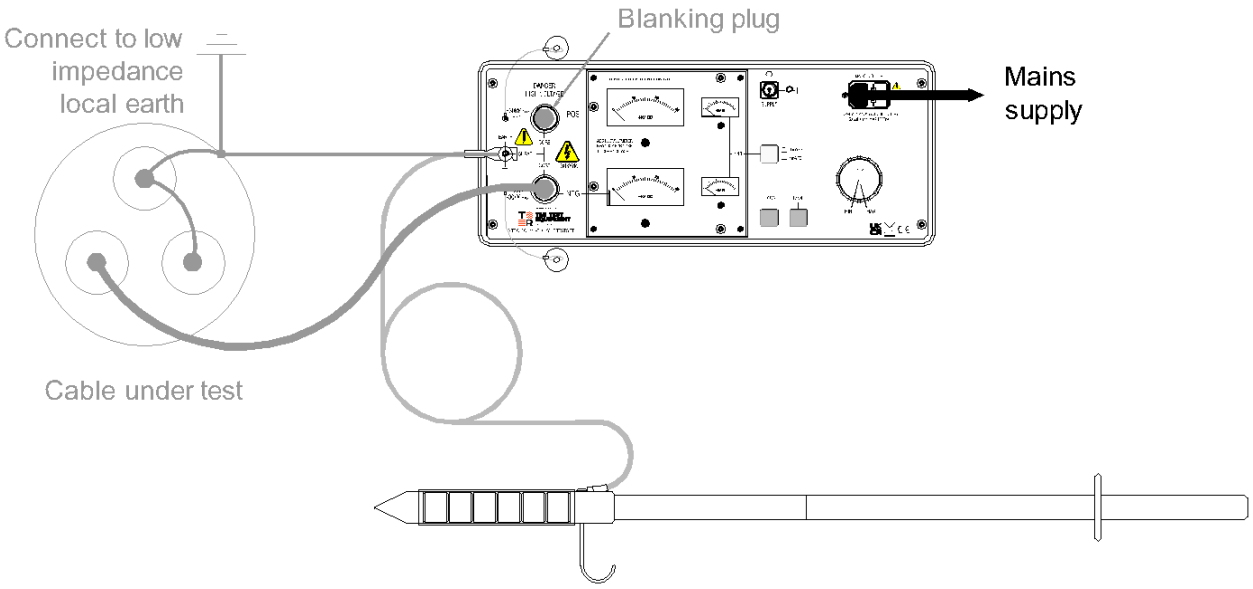

Figure 3 Connections for negative unipolar test

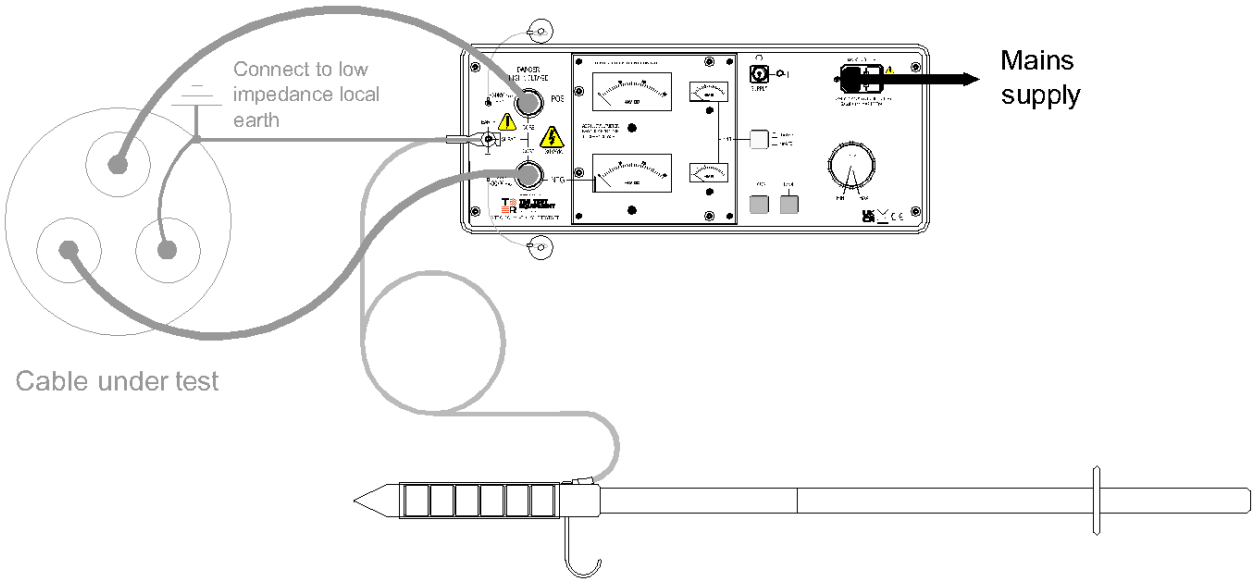

Figure 4 Connections for bipolar test

2.2.2 Testing Sequence:

 WARNING

a. **Check that all connections are secure and that all safety procedures have been followed. Re-check that all personnel are out of the test area.**

b. Remove the discharge/earthing probe from the test object.

c. Switch ON the supply to the PT30-10 using the key provided.

d. Ensure that the output control is at zero and press the RED HV ON push-button to switch on the HV output. SLOWLY increase the output voltage until the desired test level is reached.

e. Hold the test voltage for the prescribed testing time.

f. At the end of the test time DO NOT SWITCH OFF THE HV OUTPUT, but return the voltage regulator to the zero voltage position.

g. Observe the slow decay in the output voltage indicating a healthy cable.

h. After 30 seconds, discharge the cable. This may be achieved either using the DP40 discharge probe or the internal dump circuit, depending on the level of energy stored in the cable. If the DP40 is used when carrying out bipolar tests, ensure that both cable cores are discharged.

The internal discharge circuit is automatically engaged when the output is switched off.

g. Using the DP40 discharge probe tip discharge any remaining charge on the cable, then connect the earthing hook on to the test terminal.

2.2.3 Disconnection Sequence:

 WARNING

To disconnect repeat the connection sequence in the reverse order, ensuring that both sides of a connection are earthed before breaking a connection. Maintain an earth on the test object after testing to avoid problems with voltage recovery due to dielectric absorption.

REMEMBER!

ALWAYS CHECK EACH POINT ABOVE AND ENSURE THAT YOU ARE FOLLOWING ALL APPLICABLE SAFETY PROCEDURES

2.3 Current Limit Mode (PT30-10C only)

2.3.1 Current Limit Description

The PT30-10C is fitted with a selectable current limit on the outputs for use in capacitor charging. This limits the output current to a maximum of 7.5mA from each output, reducing proportionally with output voltage. The output over-current trip is inactive when current limit mode is selected.

2.3.2 Current Limit Operation

Current limit mode is selected by pressing the “current limit” push-button on front panel. The indicator in the switch will light to show that the unit is in current limit mode. The mode is deselected by pressing the HV OFF switch.

NOTE: CURRENT LIMIT MODE MUST ONLY BE SELECTED WHEN CAPACITOR CHARGING. IT SHOULD ***NOT*** BE SELECTED WHEN CABLE TESTING.

3. MAINTENANCE

WARNING

Extremely hazardous voltages are present internally and on the output of the PT30-10. The unit must only be serviced by suitable qualified and authorised maintenance personnel.

Before carrying out any maintenance activity, ensure that the unit is disconnected from the mains. Under no circumstances connect the unit to the mains whilst it is removed from its case.

The PT30-10 requires very little maintenance. However, as with all high voltage equipment, it is essential that the unit and its accessories be kept clean.

It is advisable to check the voltage regulator carbon brush condition on a regular basis. Access is gained by removing the unit from the padded bag and then removing both of the side panels.

Rotate the regulator until the carbon brush can be seen. Ensure no excessive wear has taken place and that there is adequate brush pressure. If badly worn replace immediately with a new brush.

Ensure the high voltage leads are carefully stored and that the exposed ends are kept clean. Always ensure that the protective plastic cover is fitted over the connector.

Always ensure that the output sockets' dust caps are fitted when the equipment is not in use.

The earth cable and the earth cable on the discharge/earthing probe are both made from a very flexible copper conductor with transparent silicon insulation to allow visual inspection.

4. STANDARD ACCESSORIES

The following items are provided with the equipment:

a. Mains input lead.

b. 2 keys (for mains ON/OFF switch).

c. 5 metre earth lead fitted with clip and tag.

d. 5 metre high voltage output cable fitted with HT plug & clip, colour coded red. Supplied with protective cap for plug.

e. 5 metre high voltage output cable fitted with HT plug & clip, colour coded black. Supplied with protective cap for plug.

f. HV blanking plug for unipolar testing.

g. DP40 discharge/earthing probe.

h. Operating & Maintenance Manual.

j. Carry bag with pocket for above items.

k. The unit is supplied with a spare F5A 32mm (1¼") mains fuse.

5. PERFORMANCE SPECIFICATION

Insulation resistance at 1000V DC:

Not less than 10 megohms between mains input to frame

Applied voltage test:

2.0kV rms for 1 minute between mains input and frame

Induced voltage test:

± 35kV DC for 5 minutes

Flashover test:

6 flashovers at 30kV DC on each output direct to earth

Normal voltage test:

± 30kV DC on no load for 30 minutes

Accuracy of instruments:

Output kV meters ± 1.5% at full scale

Output mA meters ± 2.5% at full scale on each range

6. REVISION

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