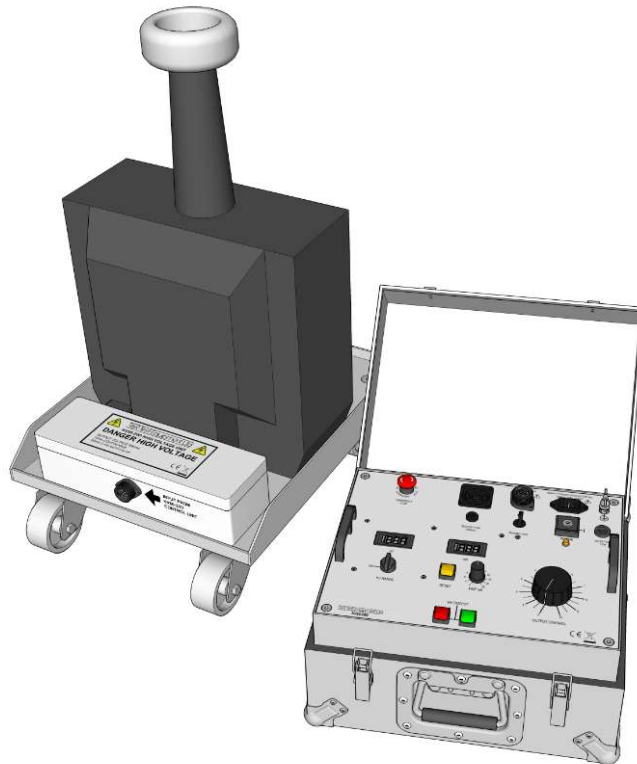




*OPERATING AND MAINTENANCE MANUAL*

Product: ***High Voltage AC Test Set***

Type: ***KV50-20D mk2***



*DESIGNED AND MANUFACTURED BY:*

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## GENERAL SAFETY STATEMENT

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. Additional earth terminals are provided on the control unit and HV transformer 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**

## HIGH VOLTAGE SAFETY

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 health and safety regulatory body.

It is essential that the KV50-20D MK2 is only used in a suitable test environment. EN50191:2001 (Erection and Operation of Electrical Test Equipment) provides information on the installation and use of test installations and is referenced by health and safety law in the EU. EN50191:2001 is available from T&R Test Equipment.

IEEE standard 510-1983 (IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing) also 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.
- 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.
- 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.

# 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 cause injury or death to the operator or other personnel if not carried out correctly using applicable safety procedures.

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# 1. DESCRIPTION OF EQUIPMENT

The KV50-20D MK2 is a 0-50kVac supply designed for testing the insulation and operation of high voltage substation and industrial equipment. Output voltage and current metering facilities are provided.

The output is potentially lethal, and the unit must only be operated with the high voltage transformer in an enclosed, interlocked test area in accordance with EN50191:2001 and other applicable local standards.

## 1.1 Electrical specification

### 1.1.1 Supply requirements

The KV50-20D MK2 has a 115/230V auto-selecting mains input.

Supply requirements: 115/230V  $\pm$ 10% 1 phase 50/60Hz 1400VA max

### 1.1.2 Output specifications

The output voltage, current and duty cycle are as follows:

Unit type	Output Voltage	Output current	
		Continuous	5 min on/15 min off
KV50-20D MK2	0-50kV	12mA	20mA

One side of the high voltage transformer output is connected to the earth system of the equipment.

### 1.1.3 Zero voltage interlock

The equipment is fitted with a zero volt interlock system on the output voltage control. This interlock prevents the output being energised unless the output control is in the minimum output position.

### 1.1.4 External interlock and beacons

The KV50-20D MK2 is fitted with a 24Vdc external interlock circuit. This interlock prevents the output being energised unless an external circuit is closed (such as the door of a test cage). The interlock circuit may also be used to connect normally closed emergency off switches to the unit wired in series with any interlock switches.

See section 2.2.4 for connections.

### 1.1.5 Overload protection

The equipment is fitted with fixed and variable overload protection circuits as standard.

1.1.5.1 *Variable overload*

The variable overload protection system senses current changes in the high voltage circuit. The trip level is adjusted by means of a selector switch on the front panel of the unit. The switch allows the level to be adjusted from 2-22mA in 2mA steps.

The circuit will activate when the load current exceeds that set by the trip level selector switch.

The circuit will respond more slowly to slowly changing levels of load current.



**The variable overload trip circuit does not limit the output current on short circuit.**

**WARNING**

1.1.6 *Metering*

The equipment is fitted with a two-range kV meter that indicates the output voltage. It is also fitted with a mA meter that meters the output current in the earthy end of the HV side of the output transformer.

Range	KV meter		mA meter	
	FSD	Resolution	FSD	Resolution
Range 1	19.99kV	0.01kV	19.99mA	0.01mA
Range 2	50.0kV	0.1kV	-	-

The output voltage is metered from the primary of the HV transformer, and as a result the accuracy of the kV meter is dependent on the output current. The values for accuracy at different load currents are given below.

Load current \ kV accuracy	<2mA	2-8mA	>8mA
20.00kV range	±2% rdg ±5d	±4% rdg ±5d	±5% rdg ±5d
50.0kV range	±2% rdg ±3d	±4% rdg ±3d	±5% rdg ±3d

## 1.2 Front panel control functions

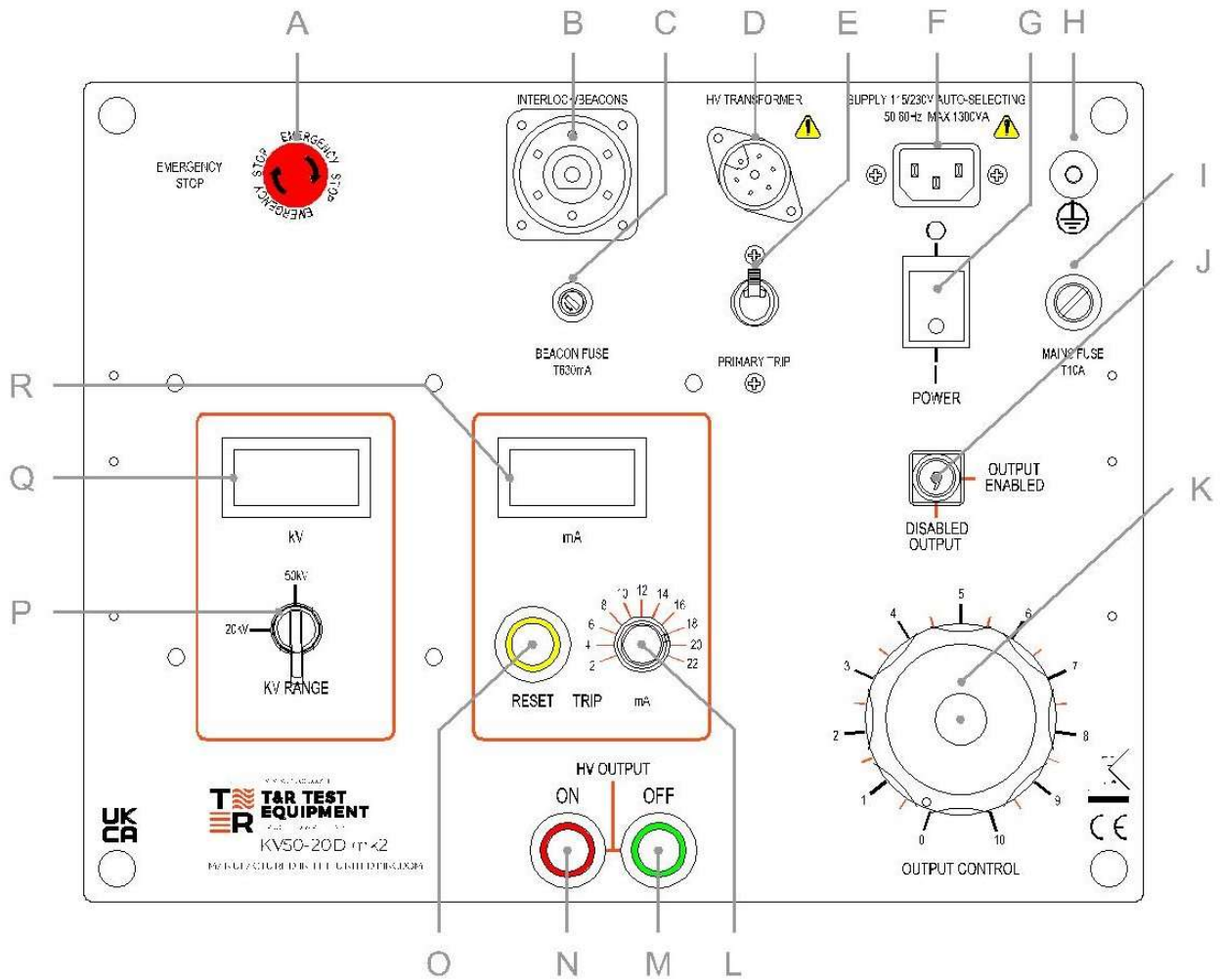
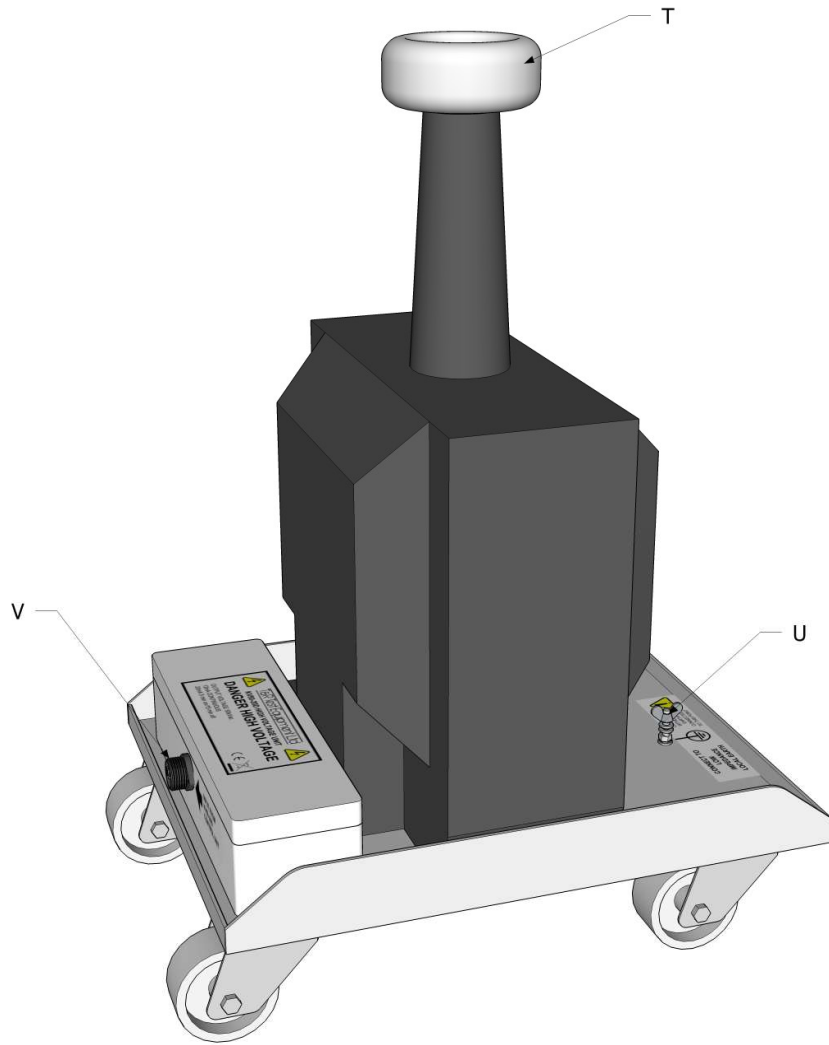


Figure 1.1 Control unit front panel

<b>A</b>	Emergency stop switch.	<b>I</b>	Mains supply fuse.
<b>B</b>	Connector for external interlocks and beacons.	<b>J</b>	Output Enable/Disable key switch
<b>C</b>	Fuse for external beacons.	<b>K</b>	Output voltage control.
<b>D</b>	HV transformer connector.	<b>L</b>	Output trip level control.
<b>E</b>	Primary trip circuit breaker.	<b>M, N</b>	HV output on & off switches – illuminated green when output is off, illuminated red when output is on.
<b>F</b>	Mains inlet connector.	<b>O</b>	Output trip reset switch.
<b>G</b>	Supply ON/OFF switch.	<b>P</b>	kV meter range switch.
<b>H</b>	Earth terminal for connection to low impedance local earth. This terminal MUST be connected as specified.	<b>Q</b>	mA meter.
		<b>R</b>	kV meter.
		<b>P</b>	mA meter.





*Figure 1.2 HV transformer connections*

T	HV output connection.	V	Control unit connector.
U	Earth terminal for connection to low impedance local earth. This terminal MUST be connected as specified.		

## 2. OPERATION

### 2.1 Safety



The output from the KV50-20D MK2 is extremely dangerous, and if used incorrectly could be fatal. The unit must only be installed, operated, and maintained by suitably qualified and skilled personnel.

#### **WARNING**

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. EN50191:2001 Defines suitable test installations for this equipment.

### 2.2 Installation

#### 2.2.1 *Test area*

The unit must be installed in a suitable high voltage test area completely enclosed by walls or other physical barriers. Appropriate controls and safety measures must be applied to this area including interlocks connected to the supply or HV unit interlock to ensure that the unit cannot be switched on unless the area is secure. Refer to EN50191:2001 for further details of suitable test areas. The test area must also be identified with suitable signs.

#### 2.2.2 *Mains supply*

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

#### 2.2.3 *Earthing*

Earthing of high voltage test sets is critical, and the system must not be operated without extra earth connections to the control unit and HV transformer. The extra earth connections must be made to a low impedance earth. If operating in a high voltage test area, this will usually be the test cage earth, and otherwise it will usually be the building frame at a point adjacent to the test area.

Figures 2.2 and 2.3 show the earth connections for the KV50-20D MK2. Note that the test enclosures are not shown to scale and do not indicate safe clearances for 50kV.

The earth clamp is not used in figure 2.3 – it is not required if suitable earth studs are available for the connection of the earth leads.

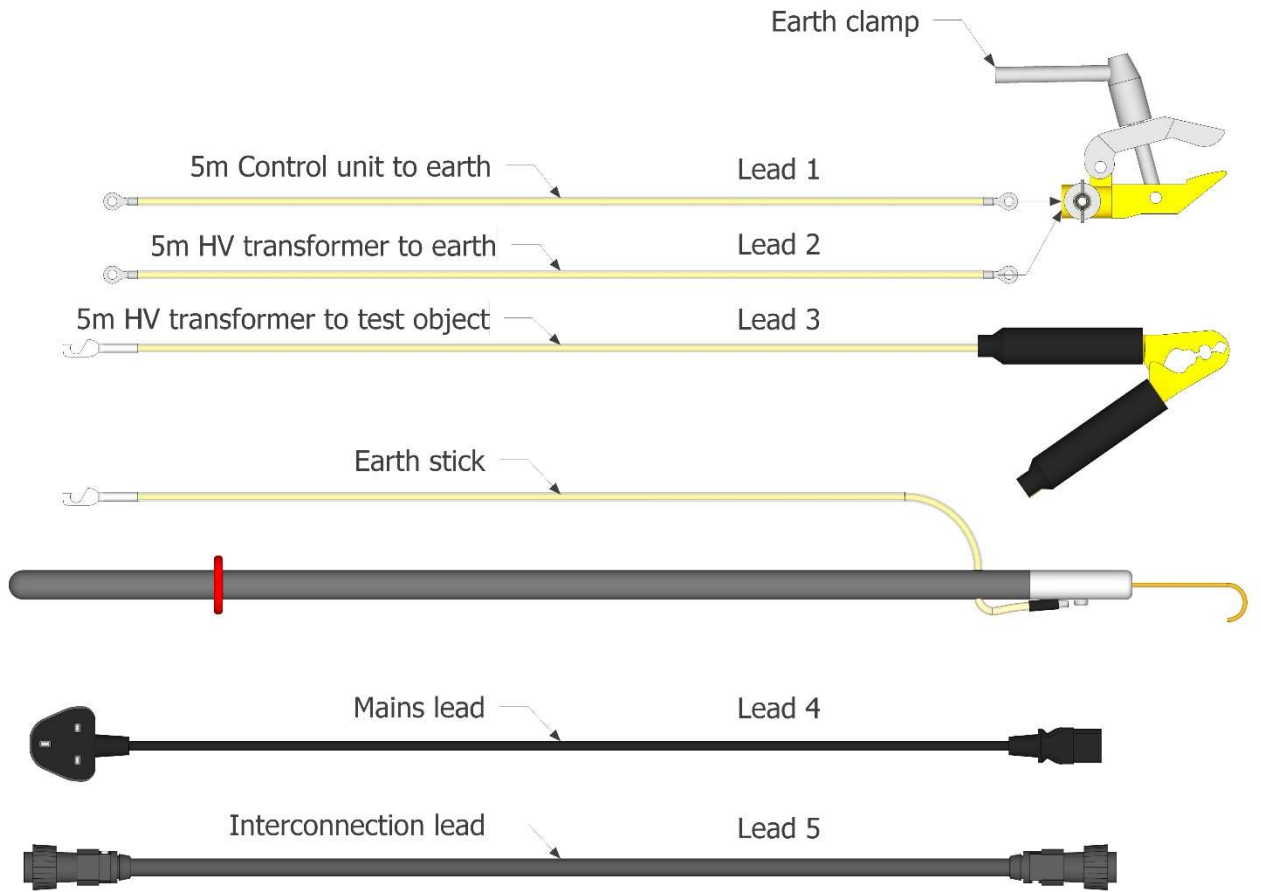


Figure 2.1 KV50-20D MK2 leads

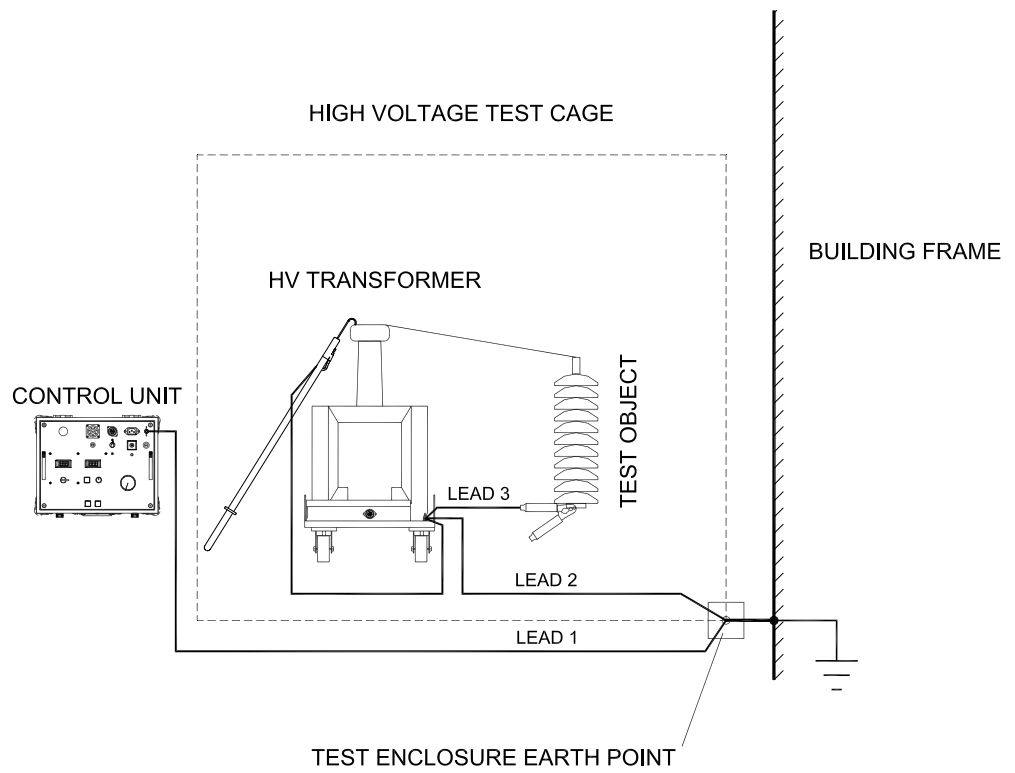


Figure 2.2 Earthing in metal test cage

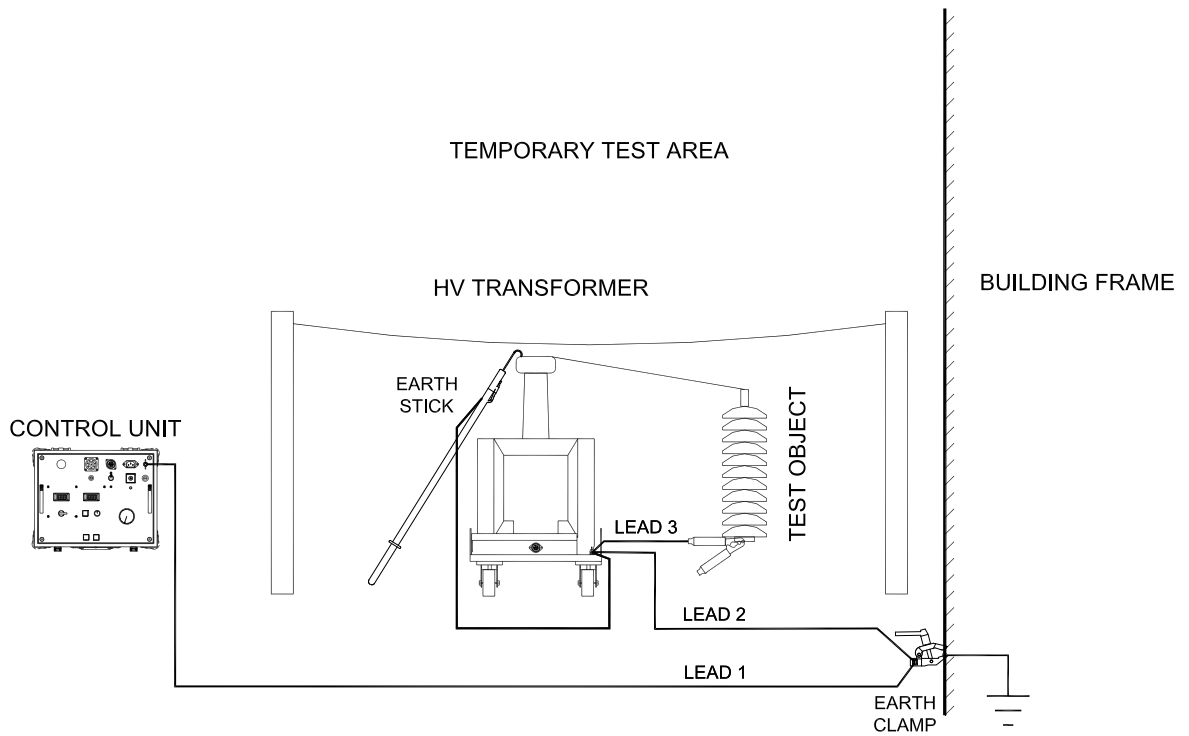


Figure 2.3 Earthing in temporary test area without earthed enclosure

### 2.2.4 Interlock/beacon circuit connections

The external interlock circuit uses an 8 pin Bulgin PX0551 plug with the interlock circuit wired to pins 5 and 6. Extra emergency stop switches may also be connected to this circuit.

The connector is also used to connect external 24V warning beacons to the unit. The beacons mimic the indicators in the on and off pushbuttons – the green indicator lights when the supply to the unit is switched on but the HV output is off and the red indicator lights when the HV output is on.

Please note that the unit will not operate unless either an external interlock circuit is connected, or the shorting plug provided with the unit is fitted.

To connect the unit to an external interlock circuit, remove the shorting link from the plug supplied and wire the external interlock circuit in its place.

The interlock circuit has a self-checking circuit and will sound an audible alarm in the event of a fault with the circuit. If the alarm sounds, stop using the unit and return it to a suitable repair facility.

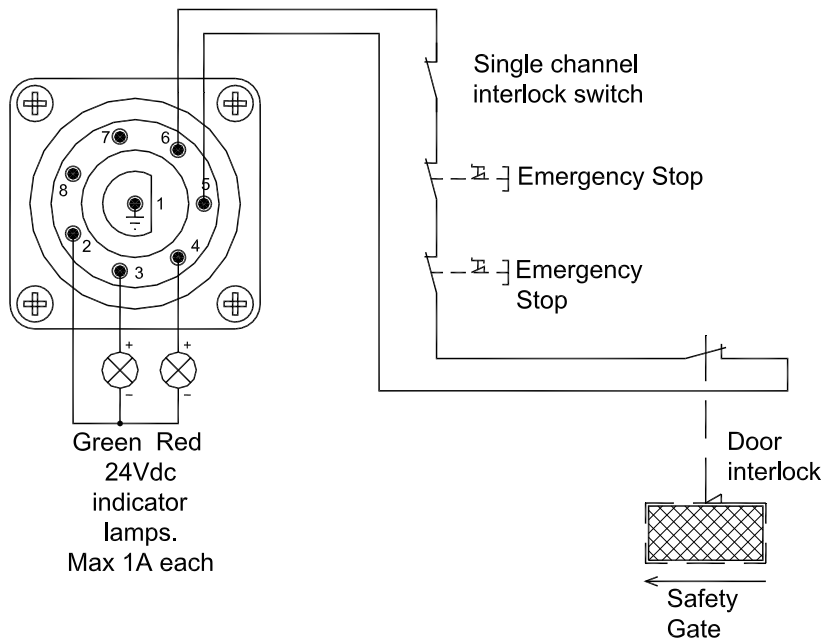


Figure 2.4 Interlock and beacon connections

An interlock should be considered to be a safety back-up feature. An interlock should not be regarded as a substitute for adequate safety rules and proper operator vigilance.

### 2.2.5 Grounding of the high voltage output

A temporary ground must be applied to the high voltage output when the circuit has been de-energised using the earth stick provided. When connections are made or disconnected, the circuit either side of the connection should be grounded first. Extra 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.

## **2.2.6 High voltage connection**

The high voltage output from the KV50-20D MK2 is via the bushing connection on the top of the HV transformer. No HV output lead is supplied with the unit. The HV connection should either be made with a suitable copper tube formed as required (15mm copper plumbing pipe is ideal) or with tinned copper wire.

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.

Avoid sharp points on the connections in the high voltage circuit – these will lead to corona discharge, electrical noise and ozone generation.

### **2.2.6.1 High voltage output clearances**

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

- HV output connection and all parts connected to it
- 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.

EN50191 defines the safety clearance around the high voltage circuit as the prohibition zone and stipulates that it must not be possible for personnel or their tools to touch this zone. The prohibition zone distance for the unit is shown below.

<b>Unit</b>	<b>Voltage</b>	<b>Prohibition zone</b>
KV50-20D MK2	50kV	280mm

EN50191:2000 also details suitable barrier types and heights such that the prohibition zone cannot be reached by personnel.

If used with temporary barriers the barriers should be at least 1m high and 2m away from live parts (1.4m clearance + 280mm prohibition zone + extra factor of safety).

Always refer to the latest version of EN50191 and local health and safety information for clearances.

## 2.3 Connections



**Before making any connections ensure that you are aware of all hazards relating to the system and environment in which it is operating.**

**WARNING**



**Inspect all leads for damage before use. Do not use damaged leads.**

**WARNING**

Ensure that the mains supply has been switch off and the output enable/disable key is removed before making connections.

Connect earth clamp to low impedance local earth (for example building frame).

Connect control unit earth terminal to earth clamp using supplied earth lead.

Connect the following leads to the HV transformer earth terminal: -

- Earth lead to earth clamp.
- Earth stick. Hang earth stick hook on the HV transformer HV connection.
- Earth lead to test object (terminated in big crocodile clip).

Connect interconnection lead between control unit and HV transformer.

Connect interlock/beacon lead to control unit.

Before connecting the supply lead to the control unit make sure that the area is secure and that all necessary safety precautions have been taken.

Finally, connect the supply lead to the control unit.

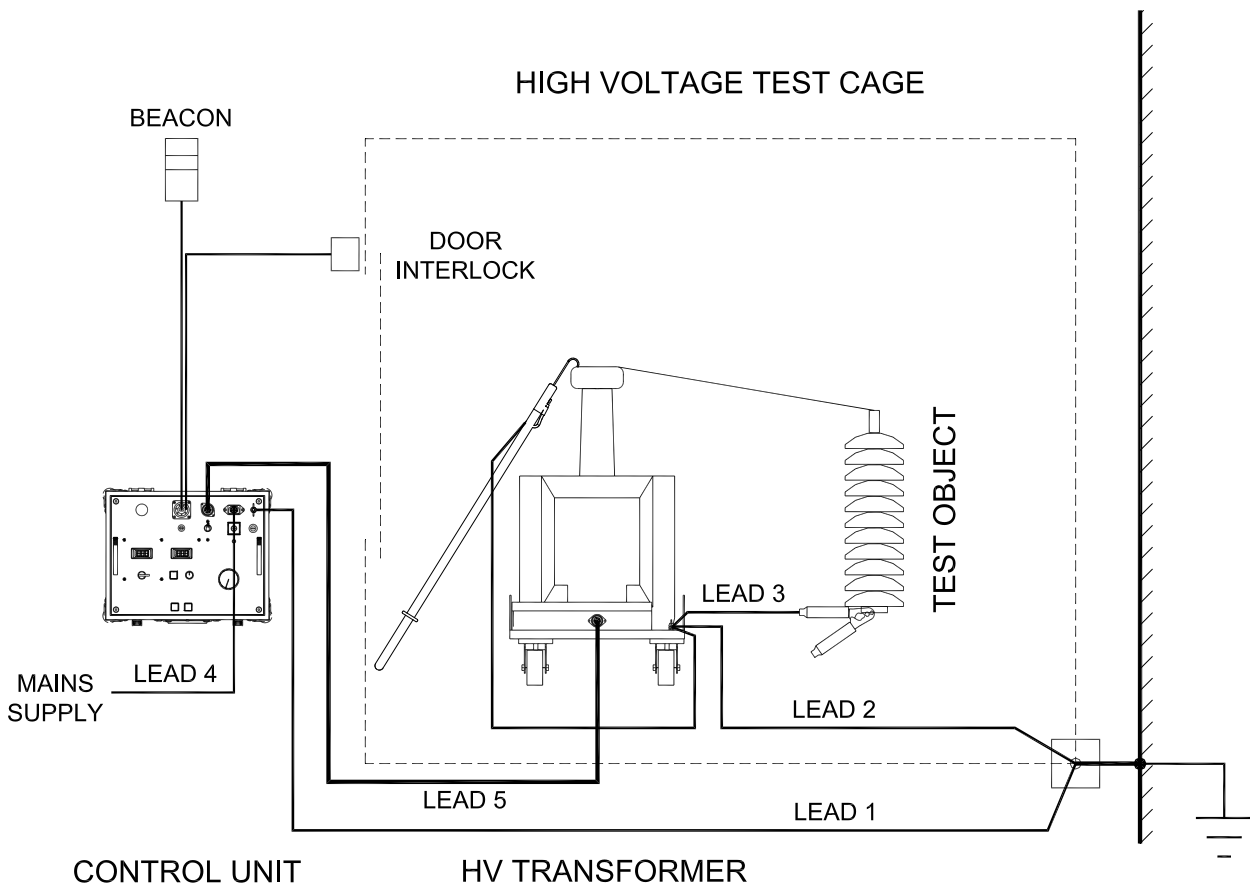


Figure 2.5 Connections

## 2.4 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.

### 2.4.1 Method of operation

Connect the equipment as described in **Section 2.3**.

Remove the output enable key before connecting the equipment to the supply. The key is only removable in the OFF position. The key is trapped in the ON position.

Remove the earth stick from the HV connection of the transformer and leave the test cage. Place the earth stick by the test cage entrance so that it can be picked up and safely re-applied to the HV connection without approaching any high voltage components.

Once the equipment is connected to the main supply switch can be moved to the ON position. The following will now occur:

- a. Power ON lamp will be lit.
- b. HV OFF lamp will be lit.
- c. The variable overload reset lamp will be lit.



Press the overload reset push-button to arm the trip circuit. The indicator lamp in the reset push-button will go out, indicating that the circuit is armed.

Check that the primary trip circuit breaker is closed (in the up position) and the external interlock circuit is closed, or the shorting plug is fitted.

Set the desired overload mA trip level.

Before commencing testing ensure that the regulator is in the fully anticlockwise position.

Turn the key switch to output enabled.

Press the HV ON push-button – the output is now live. The HV OFF lamp will extinguish and the HV ON lamp will be lit. The output voltage can now be increased to the desired level as indicated on the kV meter.

In the event of a test object failure the HV output will be automatically switched off by the protection system. Depending on the level of the fault, either the electronic trip or the primary trip circuit breaker will operate.

When the test is completed, turn the regulator control knob fully anti-clockwise and switch off the HV output and then the main supply key switch.

After the test, remove the key from the control unit and re-apply the earth stick to the HV transformer HV connection. Before approaching the test object always ensure the HV connection is grounded using the earthing stick provided.

### **3. MAINTENANCE**

The equipment should be inspected for damage before use. Inspect all cables and pay particular attention to earth cables.

The only maintainable part in the control unit is the regulator brush. This should be inspected for damage and wear when the unit is re-calibrated.

#### **3.1 Removal of control unit from case**

- a. Remove the lid from the control unit and rest it on the front panel handles.
- b. Remove all four fixing screws from the underside of the unit.
- c. Lift the case off the unit. Be careful of the earth lead connected to the case.

## 4. STANDARD ACCESSORIES

Spare fuses supplied

- a. 1 x T10A 1¼" (32mm) HRC
- b. 1 x T630mA 20mm HRC

The following items are provided with the equipment:

	Replacement part number
a. Mains input lead.	S000-0580
b. Interlock plug.	GX134-0005
c. 2 x 5m earthing leads for control and HV units	AX138-0002
d. Earth clamp	AX138-0003
e. Interconnecting lead	AX138-0001
f. Test object earth lead	103
g. Type ES50 earthing stick.	056
h. Operating & Maintenance Manual.	

## **5. OVERALL PERFORMANCE SPECIFICATION**

### **Insulation resistance at 1000V DC**

Not less than 10MΩ between mains input and frame.

### **Applied voltage test**

2kV RMS for 1 minute between mains input and frame

### **Accuracy of instruments**

kV meter  $\pm 5\%$  of reading  $\pm 5d$

mA meter  $\pm 2\%$  of reading  $\pm 5d$

### **H V Transformer**

2.5kV RMS for 1 minute between primary and earth

2.5kV RMS for 1 minute between earthy end of secondary and earth

### **Complete Equipment**

Over voltage test

Equipment runs for 5 minutes at 110% of normal output voltage

Flash over-test

3 flashovers direct to ground at 100% of normal output voltage





## 6. REVISION

Product/Type: High Voltage AC Test Set KV50-20D mk2

File: OM0041-1.docx

Author: M Clancy

Issue/Date: 1/ 13.09.2022

Checked By: G. Bond	Date: 07.12.22
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Drawings required

A2/002227 latest issue KV50-20D mk2