

**OPERATING AND MAINTENANCE MANUAL**

Product: **High Voltage AC Test Set**  
Type: **KV30-40D mk4 or KV15-80D mk4**



*DESIGNED AND MANUFACTURED BY:*

**T & R Test Equipment Limited**

15-16 Woodbridge Meadows, Guildford, Surrey, GU1 1BJ, United Kingdom

Telephone: 01483 207428 e-mail: [sales@trtest.com](mailto:sales@trtest.com) Web [www.trtest.com](http://www.trtest.com)



## 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 high voltage (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 KV30-40D mk4 and KV15-80D mk4 series test sets are only used in a suitable test environment. EN50191:2010 (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.

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. Although this standard has since been withdrawn, it does contain very good practices that are still referenced today, 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 be 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 KV30-40D mk4 is a flexible high voltage AC test system, capable of producing 30kV into a variety of loads with a maximum of 40mA of current.

The KV15-80D mk4 is a similar high voltage AC test system, capable of producing 15kV into a variety of loads with a maximum of 80mA of current.

The unit has been designed for general purpose testing insulation systems and measurement of breakdown voltage on electrical plant, switchgear and components.

Improved digital metering for both accuracy and precision gives the user the ability to read a digital value and have a visual indication of a 'needle'.

The equipment has been designed to allow the user/operator to connect the product to an external test setup with interlocks, and now includes a twist to release emergency stop button.

A timer has been included for timed tests on insulation systems, to meet national and international testing standards.

# 1.1 Front Panel Overview

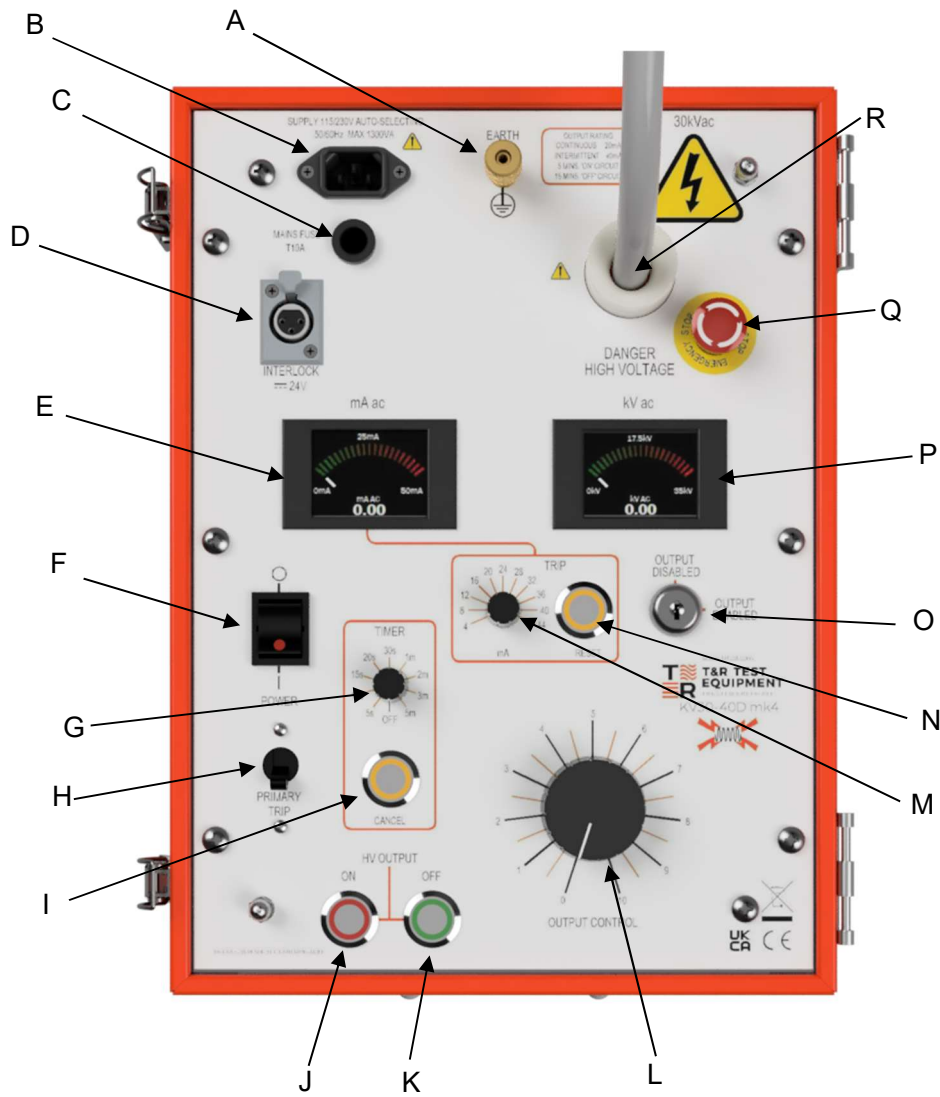


Figure 1.1 KV30-40D mk4 front panel

<b>Ref</b>	<b>Item</b>	<b>Function</b>
A	Earth Terminal	Connect the unit to a local ground for safety
B	Mains Input Connector	Mains supply
C	Mains Input Fuse	Protection
D	Interlock Connector	Connect the unit to an external interlock circuit
E	mA Digital Meter Display	mA metering
F	Mains On/Off Switch	Main power switch
G	Timer Range Switch	Selects timer setting
H	Primary Trip	Transformer Primary circuit breaker
I	Timer Cancel Button	Cancels timer
J	Main Output ON Control	Switches main output ON
K	Main Output OFF Control	Switches main output OFF
L	Main Output Control	Controls the output voltage/current.
M	mA Trip Range Switch	Selects mA trip current
N	mA Trip Reset Switch	Resets mA trip
O	Output Enable/Disable Switch	Safety key switch
P	kV Digital Meter Display	kV metering
Q	Emergency Stop Switch	Emergency Stop
R	Main Output Cable	High Voltage output cable

## 1.2 Electrical Specification

### 1.2.1 Supply Requirements

The KV30-40D mk4 and KV15-80D mk4 series have a 115/230V auto-selecting mains input.

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

### 1.2.2 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
<b>KV30-40D mk4</b>	30kV	20mA	40mA
<b>KV15-80D mk4</b>	15kV	40mA	80mA

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

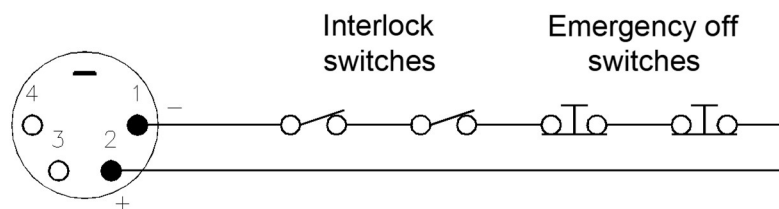
### 1.2.3 Zero Voltage Interlock

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

### 1.2.4 External Interlock

The KV30-40D mk4 and KV15-80D mk4 is fitted with a 24Vdc external interlock socket. This interlock prevents the output being energised unless an external circuit is closed. The interlock circuit may also be used to connect normally closed emergency off switches to the unit wired in series with any interlock switches.

The interlock circuit uses a 4 pin XLR type latching plug and socket with the circuit wired to pins 1 and 2. Pins 3 and 4 are not connected. The connections below are shown from the rear of the interlock circuit plug.



Please note that the unit will not operate without either an external interlock circuit connected or the shorting plug provided with the unit.

### 1.2.5 Output Enabled/Disabled key switch

The equipment is fitted with an output enable/disable key switch. The unit can only generate an output in the output enabled setting. The key can only be removed in the output disabled setting.

## 1.3 Output Voltage Control

The output is controlled from zero by means of a regulating transformer. The transformer is operated by means of a control knob which is located on the front panel. To increase the output voltage the knob is turned in a clockwise direction.

## 1.4 Overload Protection

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

### 1.4.1 *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 10-110% of normal full load current in eleven 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.

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

## 1.5 Metering

The equipment is fitted with a kV meter that measures the output voltage via a resistive divider in the HV circuit. 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.

Unit type	KV meter		mA meter	
	FSD	Resolution	FSD	Resolution
<b>KV30-40D mk4</b>	40kV	0.01kV	50mA	0.01mA
<b>KV15-80D mk4</b>	20kV	0.01kV	90mA	0.01mA

**NOTE – Due to the nature of the digital meters, a non-zero reading may be displayed when the output is off. This should not exceed 0.2 on either meter.**

## 1.6 Construction

The equipment is housed in a robust case with recessed carrying handles. All the controls and metering are located on the front panel together with all external connections.

## 2. OPERATION

### 2.1 Safety

The outputs from the KV30-40D mk4 and KV15-80D mk4 are extremely dangerous, and if used incorrectly could be fatal. The unit must only be installed, operated, and maintained by suitably qualified and trained (skilled) 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. EN50191:2010 Defines suitable test installations for this equipment.

#### 2.1.1 Installation

##### 2.1.1.1 Test Area

The unit must be installed in a suitable high voltage test area completely enclosed by walls or some type of physical barrier. 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 EN50191:2010 for further details of suitable test enclosures. The test area must also be identified with suitable signs.

##### 2.1.1.2 Mains supply

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

##### 2.1.1.3 Earthing

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

The earth connection on the unit must be connected to a suitable low impedance earth in addition to the mains earth to the unit.

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

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

##### 2.1.2.1 Interlocks

The unit is provided with an external interlock circuit that may be used to link to interlock switches and emergency off switches around a high voltage test area. If no external interlock circuit is connected, the shorting plug supplied with the unit must be fitted.

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.

#### 2.1.2.2 Output enable/Disable key switch.

The unit has been fitted with an output enable/disable key switch. The unit can only generate an output with the switch set to the output enable setting. When the unit is not in operation the main power switch should be set to off and the key switch should be set to output disabled, and the key removed.

#### 2.1.2.3 *Grounding of the high voltage output*

A temporary ground should 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.

#### 2.1.2.4 *High voltage connection*

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

#### 2.1.2.5 *High voltage output clearances*

The high voltage output from the unit is from a screened cable with an un-screened termination, and adequate clearances must be maintained between the following parts and any other conducting object (whether earthed or not):

- HV output connection
- Non-screened part of output cable (between the bulge in the cable and the output clip)
- Non-grounded parts of test object

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

Particular attention should be paid to clearances between any parts of the test object at test voltage potential and the test enclosure or barriers.



EN50191:2010 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 distances for the units are shown below.

<b>Unit</b>	<b>Voltage</b>	<b>Prohibition zone</b>
KV30-40D mk4	30kV	170mm
KV15-80D mk4	15kV	85mm

EN50191:2010 also details suitable barrier types and heights such that the prohibition zone cannot be reached by personnel.

#### **2.1.2.6 Emergency Stop**

The output can be immediately terminated by pressing the emergency stop. This has a twist to release mechanism. When activated the unit immediately terminates the High Voltage output.

#### **2.1.2.7 Timer**

The timer has two controls: select test time and alarm cancel. When a test time is selected; the timer starts when the output is switched ON. During the test, the lamp on the CANCEL button will flash. When the pre-set test time has elapsed the lamp in the CANCEL button will illuminate and an intermittent audible alarm will sound. To cancel the alarm, press the CANCEL pushbutton.

## 2.2 Connections (See Figure 2)

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

The input lead on the control unit should be connected to a suitable three pin supply connector.

Connect the earth lead from a reliable, efficient earth to the earth terminal on the equipment. Connect the earth hook lead to the earth terminal on the test set and place the hook on the test object's high voltage terminal.

### IMPORTANT

The output cable is only partially screened. It is therefore essential that the minimum clearance defined in 2.1.2.4 be maintained around the unscreened portion of the output cable.

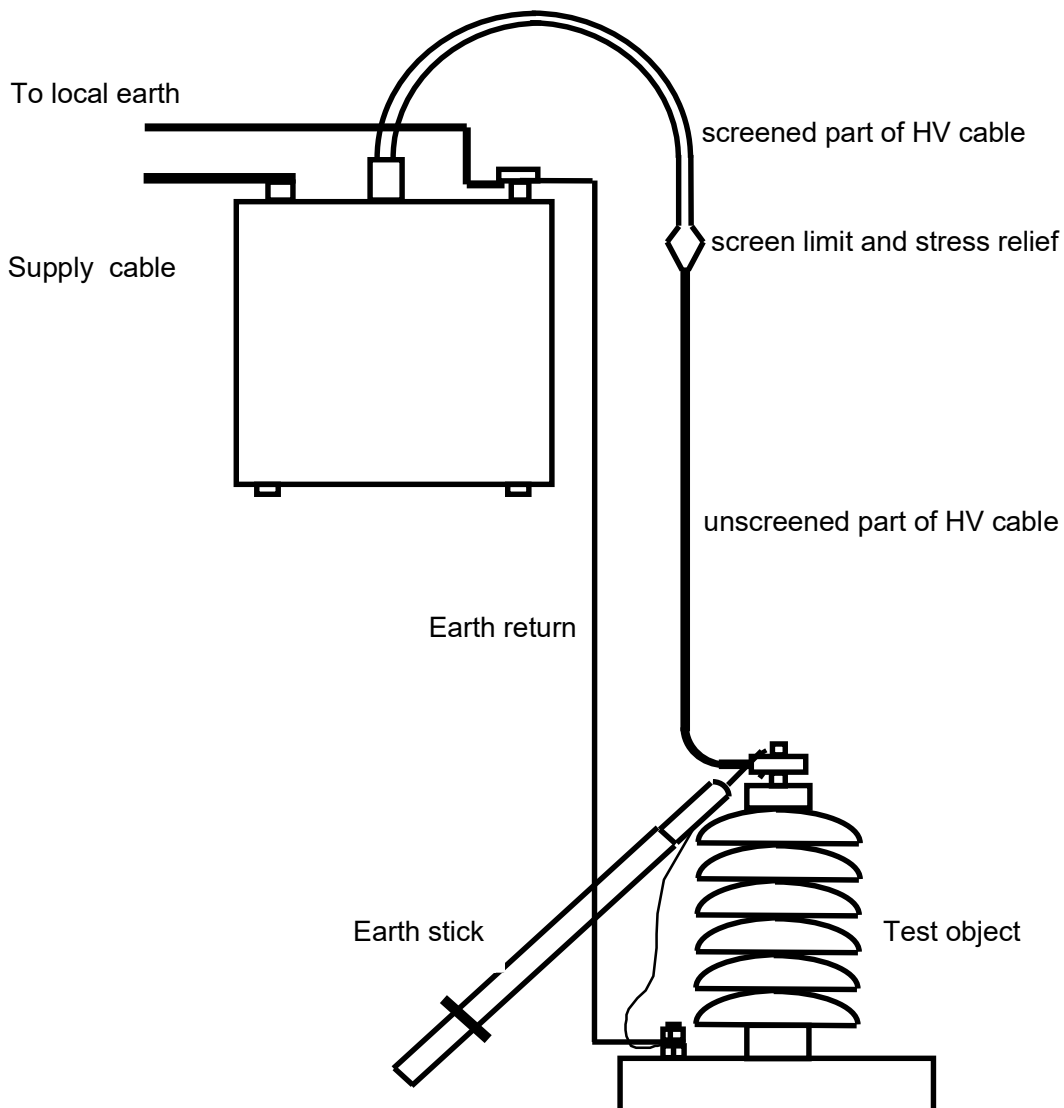


Figure 2 Connection showing earthed test object – before start of test

**Note:** -The test object is shown earthed via the earth stick as it should be between tests and before any adjustment to the test object. The earth stick should be removed from the test object before the test and replaced after the test is complete.



## 2.4 Method of Operation

Connect the equipment as described in **Section 2.2**.

Switch off the unit at the main switch and remove the OUTPUT ENABLE key before connecting the equipment to the main supply. This will ensure the equipment is in the OFF position as the key is only removable in that position.

Once the equipment is connected to the mains supply the mains switch can be turned 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 Digital Meters will boot up.
- d. The variable overload reset lamp will be lit

Press the variable mA Trip reset push-button thus arming the circuit. The indicator lamp in the reset push-button will go out thus indicating that the circuit is armed.

Check that the primary trip circuit breaker is closed, and the external interlock circuit is closed or the shorting plug is fitted.

Set the desired overload mA trip level.

If required, set a desired test time.

Before commencing a test ensure that the regulator is in the fully anticlockwise position at '0'.

Fit the output enable key. Switch the key to the OUTPUT ENABLE position.

Depress the HV ON push-button - this will close the internal circuit breaker. 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.

It is best practice to '0' the regulator control knob after each test.

Before disconnecting the test object ensure the HV connection is grounded using the earthing stick provided.

### **3. MAINTENANCE**

The equipment's output cable should be kept clean and inspected regularly for damage. This applies especially to the unscreened portion of the output cable. All cables and equipment in a high voltage test area should be inspected before use.

#### **3.1 Removal of Unit from Case**

- a. Remove all four M5 fixing screws from the underside of the set (centre of rubber feet).
- b. Place the set in the normal operating position, i.e. with the control panel horizontal and facing upwards.
- c. Remove all six panel fixing screws. (M6 philips head screws, nylon washers)
- d. Remove the two M6 dome nuts from the lifting positions.
- e. Screw on to the exposed threads of the lifting positions the tommy bars provided.
- f. The set can now be lifted from the case taking care not to foul the supporting brackets or catch any components on the metal case.

## 4. STANDARD ACCESSORIES

Spare fuses supplied

- a. 1 off **T10A**

The following items are provided with the equipment:

- a. Mains input lead.
- b. 2 keys (for the output enable switch).
- c. Interlock plug with link fitted.
- d. 5 metre earth lead fitted with clip and tag.
- e. Type ES30-40 earthing stick.
- f. 2 tommy bars.
- g. Operating & Maintenance Manual.

## **5. OVERALL PERFORMANCE SPECIFICATION**

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

Not less than 10 megaohms between mains input and frame.

### **Applied voltage test**

2kV RMS for 1 minute between mains input and frame

### **Accuracy of instruments**

KV meter  $\pm 1.5\%$  of full scale

mA meter  $\pm 1.5\%$  of full scale

### **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 run for 5 minutes at 110% of normal output voltage

Flash over-test

3 flash-overs direct to ground at 33% of normal output voltage

3 flash-overs direct to ground at 100% of normal output voltage





## 6. REVISION

Product/Type: High Voltage AC Test Set KV30-40D mk4 or KV15-80D mk4

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Drawings required

A2/002224 latest issue KV30-40D mk4

Or

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