T&R Test Equipment Ltd

OPERATING AND MAINTENANCE MANUAL

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

Type: ***KV30-100***

KV50-100

KV50-200 (LD)

KV100-100 (LD)

DESIGNED AND MANUFACTURED BY:

T & R Test Equipment Limited

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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.**
- **This unit is designed only for operation in a designated high voltage test area with suitable interlocks and safety procedures..**

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.
- Output ratings must be observed to prevent fire hazards and risk of injury to the operator. Consult the product manual for ratings information before making any connections.
- 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
- Some test objects may generate X-rays when tested (particularly those containing a vacuum). Ensure adequate safe distances to the test object are maintained or suitable screening is used.
- This unit is not designed for unattended operation

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 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.

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.

CONTENTS

1. DESCRIPTION OF EQUIPMENT

The KV series of high voltage test systems consist of a separate control unit and high voltage transformer. In addition, low partial discharge systems (-LD suffix on unit name) have a brush noise filter which is fitted in the power lead between the control unit and HV transformer.

All references to the “KV series” in this manual refer to the KV30-100, KV50-100, KV50-200 and KV100-100 and low discharge derivatives unless a specific reference is made to a particular unit.

1.1 Electrical Specification

1.1.1 Input and Output

Supply requirements 230V±10% 50/60 Hz

Unit	Supply voltage	Supply maximum VA	Output voltage	Output current	
				Continuous	5 min on/ 15 min off
KV30-100	230V ±10%	3.5kVA	0-30kV	50mA	100mA
KV50-100	230V ±10%	6kVA	0-50kV	50mA	100mA
KV50-200	230V ±10%	6kVA	0-50kV	100mA	200mA
KV100-100	230V ±10%	11kVA	0-100kV	50mA	100mA

1.1.2 Partial Discharge Level

The partial discharge of the standard units in the KV series range is not specified. Two models in the range (the KV50-200LD and KV100-100LD) have specified partial discharge levels and are supplied with a brush noise filter to prevent noise from the supply and control unit variable transformer being transmitted through to the HV output. The partial discharge levels specified for the KV series are shown in the table below.

Unit	Maximum Partial Discharge	Brush Noise Filter Supplied
KV30-100	Not specified	No
KV50-100	Not specified	No
KV50-200	Not specified	No
KV100-100	Not specified	No
KV50-200LD	1pC	Yes
KV100-100LD	3pC	Yes

1.2 Front Panel Controls

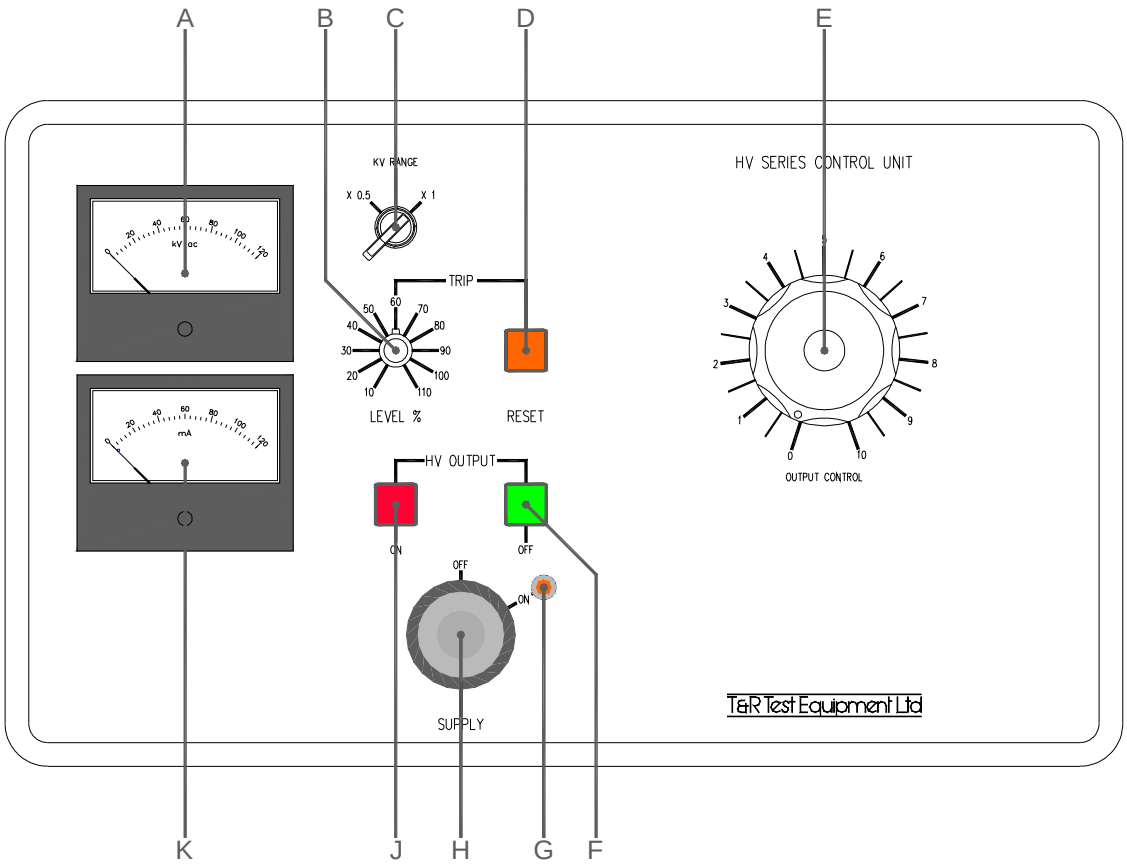

Figure 1.1 Control panel front panel layout

A	kV meter*	F	HV output off switch
B	Trip level select	G	Supply indicator
C	kV meter range switch	H	Supply on/off switch
D	Trip reset switch	J	HV output on switch and indicator
E	Output control knob	K	mA meter

* The meters shown are for a KV100-100

1.3 Output Voltage Control

The output is controlled from the output control located on the front panel of the control unit. To increase the output voltage the knob is turned in a clockwise direction. Note:-The output cannot be energised unless the regulating transformer is at zero, ie fully anticlockwise.

1.4 Overload Protection

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

1.4.1 Fixed overload

The fixed overload protection system senses any rapid increase in the load current which exceeds approximately 120% of the full load current in the high voltage circuit. The circuit will respond more quickly to low impedance faults.

1.4.2 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 control unit. The switch allows the level to be adjusted from 10-110% of normal full 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 to more 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

Different units in the KV series range use different methods of HV metering. The KV30-100 and KV50-100 use a primary HV meter and the KV50-200 and KV100-100 use secondary tap metering.

The type of metering used on any unit may be determined by inspecting the metering socket on the rear of the control unit. Units with secondary tap metering have a socket marked "secondary metering" with a four pole connector. Primary metering units have a two pole connector.

If accurate kV metering is required, it is necessary to use an external HV divider.

All of the units use moving coil analogue meters.

1.5.1 KV Series Control Unit with Primary HV Metering

Primary metering measures the voltage on the primary of the HV transformer, and shows the voltage that would appear on the secondary with a light load. Heavier resistive loads will cause the meter to read high, and capacitive loads will cause the meter to read low.

1.5.2 KV100-100 with Secondary Tap HV Metering

Secondary tap metering measures the voltage at a tap on the high voltage secondary winding of the transformer. This can be more accurate than primary metering, although capacitive loads will still cause the meter to read low.

1.5.3 Metering Ranges

Unit	Voltmeter FSD		mA meter FSD
	X1	X0.5	
KV30-100	40kV	20kV	120mA
KV50-100	60kV	30kV	120mA
KV50-200	60kV	30kV	240mA
KV100-100	120kV	60kV	120mA

1.5.4 IMPORTANT NOTE - Metering Connections

It is essential that the metering lead from the high voltage transformer to the control unit is connected in circuit. If this lead is not connected, the metering on the control unit will not function and the variable overload trip will not function.

1.6 Interlock Circuits

1.6.1 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 zero position.

1.6.2 External Interlock

The equipment is fitted with an external interlock system. This circuit is controlled by an external switch, e.g. door or cage switch. The external switch must be closed before the output can be energised.

Unit	Interlock circuit			
	Open circuit voltage	Short circuit current	Isolated from mains	Floating
KV30-100	230Vac	50mA	NO	NO
KV50-100	230Vac	50mA	NO	NO
KV50-200	24-30Vac	20-30mA	YES	YES*
KV100-100	24-30Vac	20-30mA	YES	YES*

* The 24Vac interlock circuits are not grounded, and should be connected to earth either at the control unit or externally.

** The 230Vac interlock circuit may pass up to 250mA (60VA) as the contactor closes.

1.7 Output configuration

Note: The circuits shown below show a simplified arrangement. A full circuit diagram of the unit may be found at the rear of the manual.

1.7.1 KV100-100 HT transformer terminals

Screen 1 Screen between primary winding and core

Screen 2 Screen between primary and secondary windings

HV Start Earthy end of secondary (HV winding)

HV Earth Transformer earth terminal

100V Tap 100V tap on secondary winding

In normal use, the HV earth, screen 1 and screen 2 terminals must be linked together.

1.7.2 KV30-100 and KV50-100 - Primary HV Metering

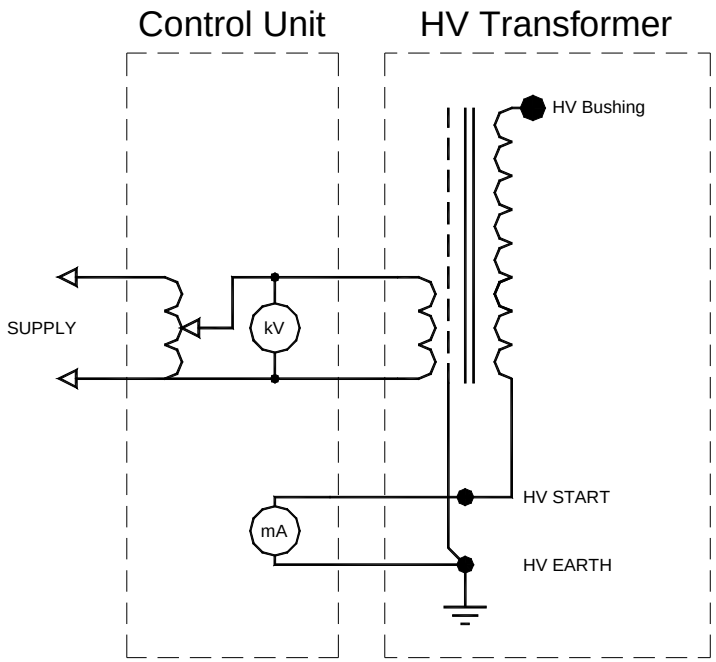

Figure 1.2 Primary metering output configuration

1.7.3 KV50-200 and KV100-100 - Secondary Tap HV Metering

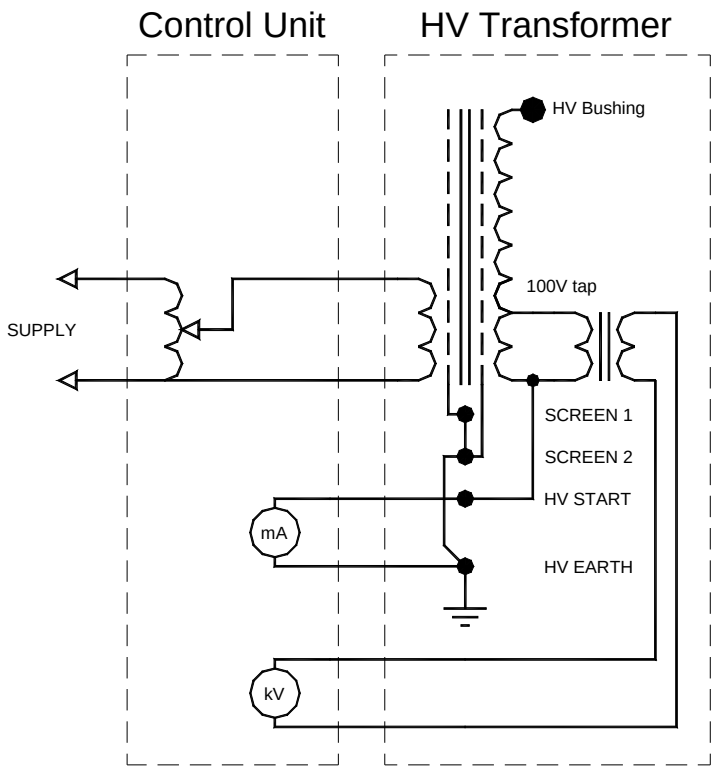

Figure 1.3 Secondary tap metering output configuration

1.7 Brush Noise Filter (Low Partial Discharge Units Only)

The KV50-200LD and KV100-100LD units are supplied with a brush noise filter to prevent interference and noise from the control unit variable transformer and supply affecting the output from the HV transformer. The brush noise filter is connected in the power lead between the control unit and the HV transformer.

1.8 Construction

1.8.1 Control Unit

The control unit is housed in aluminium case, All controls and metering functions are located on the front panel. All power and interconnecting outputs are located on the rear panel.

1.8.2 HV Transformer

The high voltage transformer is housed in an indoor type sheet steel tank of all welded construction. The tank is fitted with an oil drain plug, free air breather, lifting eyes, rating plate, earthing terminal and an initial filling of insulating oil to BS 148.1972.

The high voltage end the winding is terminated in an indoor type bushing mounted on the transformer cover.

2. OPERATION

2.1 Safety

The outputs from the KV series are 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.

2.1.1 Installation

2.1.1.2 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 IEEE Std 510-1983 for further details of suitable test enclosures. 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. Please refer to section 1.1 for the supply requirements for each unit.

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.

The earth connection on the HV transformer must be connected to a suitable low impedance earth. It is also advisable to connect the control unit earth terminal to the local earth.

The earth return from the test object must also be made with a suitable conductor back to the earth point on the HV transformer (see figure 2.1).

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 on the high voltage test area. The test area must be interlocked in some way.

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 an proper operator vigilance.

2.1.2.2 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.

2.1.2.3 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. The KV series are designed to be used with an air-insulated output conductor. No HV connection lead is supplied with the KV series units.

2.1.2.4 High voltage output clearances

The high voltage output from the unit is from a bushing, and adequate clearances (distances between objects through the air) must maintained between the following parts and any other conducting object (whether earthed or not):

- HV bushing
- Wiring connected to HV bushing
- Non-grounded parts of test object

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

The clearances required when high voltage testing may be split into two groups – functional clearances and safety clearances.

- Functional clearances relate to the clearances entirely within the test enclosure to ensure that there is no risk of breakdown. These distances will need to be increased when partial discharge testing.
- Safety clearances are the clearances required to ensure the safety of personnel at all times, and relate to clearances that may affect the test enclosure or personnel outside the test enclosure. Safety clearances will always be higher than functional clearances.

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 safety clearances required.

The functional clearances to prevent breakdown within the enclosure are shown in the table below (derived from BSEN61010:1993).

Unit type	Maximum voltage	Functional clearance
KV30-100	30kVac	120mm
KV50-100, KV50-200	50kVac	200mm
KV100-100	100kVac	400mm

2.2 Connections

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 test object must be isolated, proved to be dead and earthed before any connections are made.

Ensure that the system is properly earthed - connect a substantial earth lead of low resistance and impedance from a reliable efficient earth to the earth terminal on the high voltage transformer and the earth terminal on the control unit.

Connect the control unit to the HV transformer with the supplied power and metering leads. If the unit is a low partial discharge type, connect the brush noise filter in the power lead between the control unit and the HV transformer as shown in figure 2.2.

Connect a suitable conductor from the high voltage transformer bushing to the test object. Please note that an HV connection lead is not supplied with the unit. The unit is designed to be used with an air-insulated HV connection (such as tinned copper wire or copper tubing of an appropriate diameter). It is important to ensure that adequate clearances to earthed objects are maintained from the output terminal, HV connection and test object. The HV conductor must be supported securely.

Connect a suitable conductor from the test object earth to the earth terminal on the high voltage transformer (see figure 2.1 & 2.2).

The interlock connections are not shown in figure 2.1 or 2.2.

Note: HV connection lead and earth lead not supplied with unit.

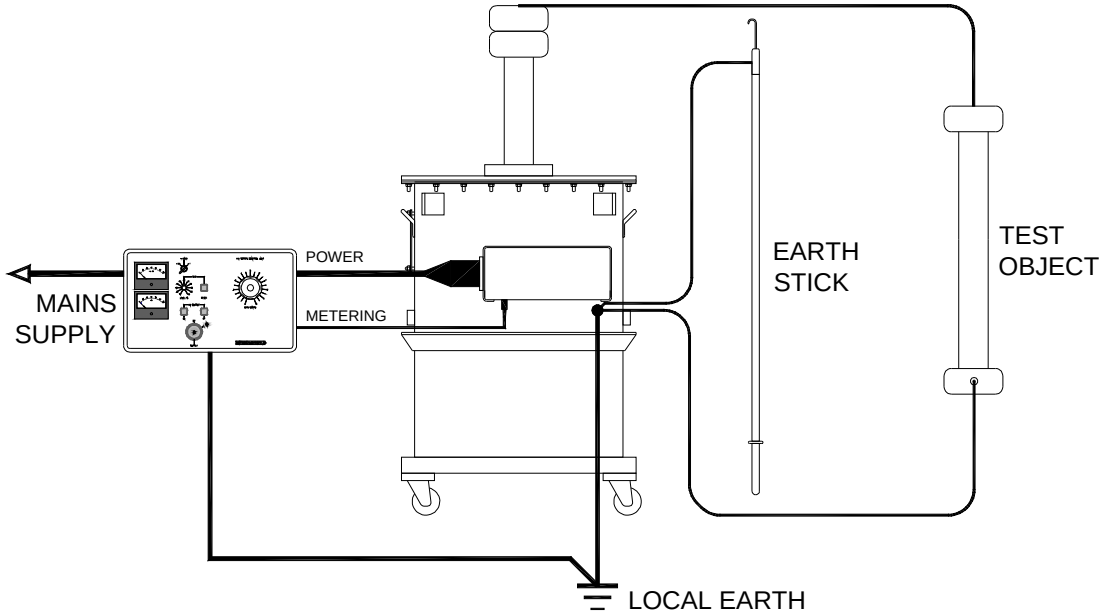

Figure 2.1 KV Series connections (KV100-100 shown)

Note: HV connection lead and earth lead not supplied with unit.

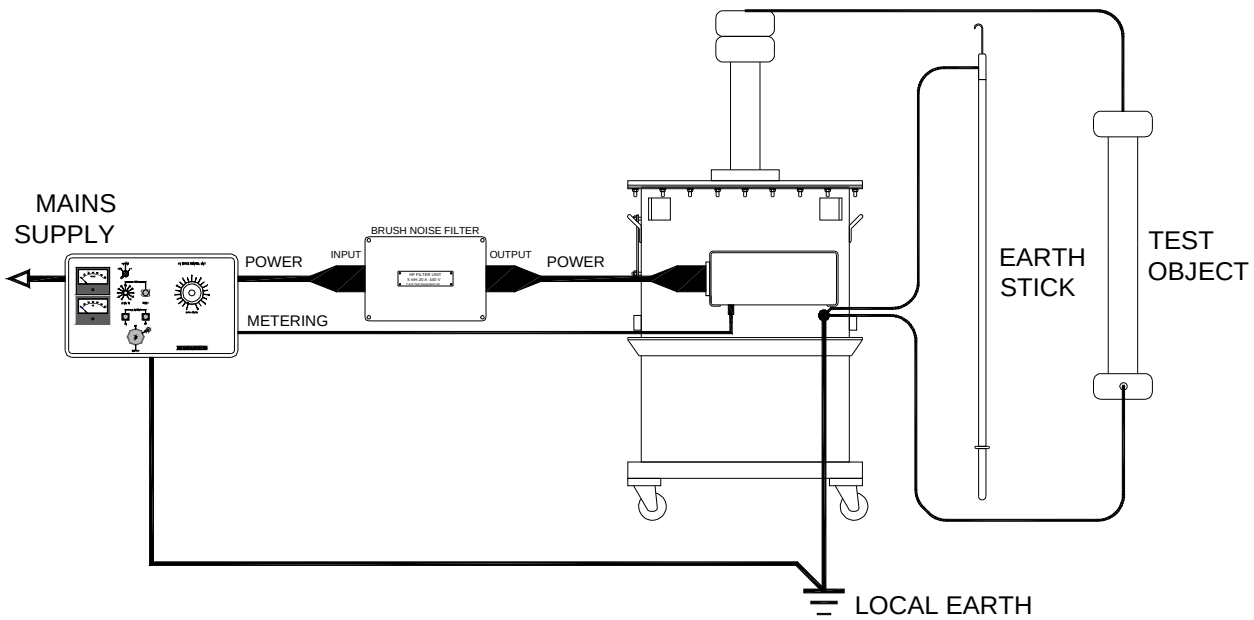

Figure 2.2 KV Series Connections for low partial discharge (-LD) units with brush noise filter

2.3 Method of Operation

Before operating the unit please ensure that you are aware of all hazards relating to the system and environment in which it is operating, and that you have complied with all necessary safety regulations and precautions.

Remove the key from the mains on/off switch before making any connections. This will ensure that the unit is off because the key may only be removed in the off position. The key is trapped in the on position.

Connect the equipment as described in section 2.2, keeping the test object earthed at all times using the earth stick provided.

Remove the earth connection from the test object before applying the test voltage to the test object.

Connect the mains supply to the unit.

Switch the main power key switch on. This will cause the following indicators to illuminate:

- Mains on indicator
- HV off green indicator in HV off pushbutton
- Variable overload indicator in variable overload reset switch

Press the variable overload reset switch to reset the trip and arm the circuit.

Set the desired kV meter range, and set the variable overload to the desired trip level.

Before commencing testing ensure that all external interlocks are closed and that the regulator is in the fully anti-clockwise (minimum) position.

Press the HV output on pushbutton. The HV output off (green) indicator will extinguish and the HV on indicator (red) will illuminate.

The HV output level can now be increased to the desired level.

In the event of a test object failure the HV output will be automatically switched off by the protection system.

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

Re-apply the earthing stick to the test object.

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

3 MAINTENANCE

WARNING

Maintenance and repair of the KV series must only be carried out by suitably qualified and trained personnel. Potentially lethal voltages are present inside the unit and on the output leads.

Ensure that the unit is disconnected from the mains before removing any covers.

3.1 Output Control Variable transformers

It is advisable to check to carbon brush on the variable transformers for signs of wear on a regular basis. To gain axis to the variable transformers remove the top cover of the unit (secured by four screws - two in each side of the case).

Replacement brushes are available from T&R Test Equipment.

3.2 HV Output Transformer

The HV transformer oil level should checked every time the transformer is used. A sample of oil should be taken every 2 years for chemical and electrical analysis. The top cover and bushing must be kept free of dirt and dust and must be wiped regularly with a damp cloth. Do not use solvent cleaners, and ensure that the top cover and bushing are totally dry before operating the unit.

4 STANDARD ACCESSORIES

Spare fuses supplied

- 1 off 4amp, Bussmann Ref. NSD4
- KV30-100: 1 off 16A Bussmann Ref. AA016
- KV50-100: 1 off 25A, Bussmann Ref. AA025
- KV50-200: 1 off 50A, Bussmann Ref. BA050
- KV100-100: 1 off 50A, Bussmann Ref. BA050

. The following items are provided with the equipment:

- 2 keys (for mains ON/OFF switch).
- 5 metre power interconnecting lead.
- 5 metre screened interconnecting lead.
- Earthing stick.
- Operating & Maintenance Manual.

5 OVERALL PERFORMANCE SPECIFICATION

5.1 Insulation resistance at 1000V DC

Not less than 10 megohms between mains input and frame.

5.2 Applied voltage test

2.5kV RMS for 1 minute between mains input and frame

5.3. Accuracy of instruments

Kilovoltmeter:- DC moving coil (rectified AC) ±2.0% F.S.D

Milliammeter:- DC moving coil (rectified AC) ±2.0% F.S.D

Note:- Equipment with primary voltage metering, kV accuracy quoted for no-load.

5.4. 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

5.5. Complete Equipment

Flash-over tests

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

6. TEST CERTIFICATE

PRODUCT TYPE	KV30-100	
	KV50-100	
	KV50-200	
	KV100-100	

Tick as appropriate

PRODUCT SERIAL NUMBER	
TEST PROCEDURE - as routine test sheet:	
TESTED BY	
PASSED BY	
DATE	

7. Revision

Product:	KV Series High Voltage AC Test System
File:	KV100-100 series manual v10.doc
Author:	I Lake
Issue / Date:	10 / 08.01.2004
Modified By:	-

Checked By: D Buckle	Date: 08/01/04

Drawings to include (latest issue):

000748 – KV30-10

000749 – KV50-100

001401 – KV100-100I