T&R Test Equipment Ltd

OPERATING AND MAINTENANCE MANUAL

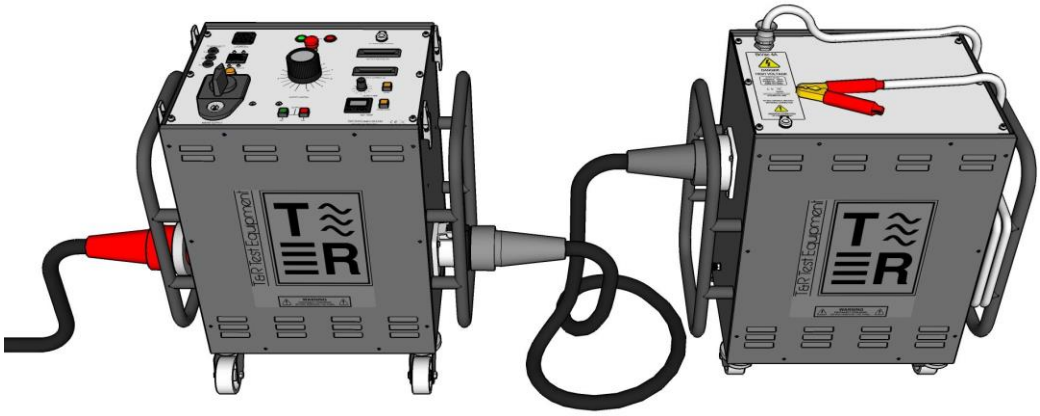
Product: ***High Voltage AC Test Systems***

Two Unit Trolley2

Type: ***KV5-4000***

KV10-2000

KV15-1200



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

Fax.: 01483 511229 Web: 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.**
- **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.

It is essential that the HV trolley series test sets are 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 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 HV trolley2 system is a high voltage test system comprising a control unit and high voltage unit generating a high voltage, high power output (for voltage levels see 1.1.2). The output voltage is connected to the load by an HV cable.

Features:

- One side of the high voltage output transformer is connected to earth.
- Zero voltage interlock – the output will only switch on with the output control in the zero position.
- Emergency off push buttons.
- Dual output protection circuit – 10-110% electronic trip and fast-acting circuit breaker.
- External interlock circuit
- Contactor fail alarm

1.1 Electrical Specification

1.1.1 Supply Requirements

Unit	Supply voltage	Supply maximum VA	Frequency	Phases
KV5-4000	400V ±10%	22kVA	50/60Hz	2
KV10-2000	400V ±10%	22kVA	50/60Hz	2
KV15-1200	400V ±10%	22kVA	50/60Hz	2

1.1.2 High Voltage Output

Unit	Output voltage	Output current	
		Continuous	5 min on/ 15 min off
KV5-4000	0-5kV	2A	4A
KV10-2000	0-10kV	1A	2A
KV15-1200	0-15kV	600mA	1.2A

The output is controlled from zero by a variable transformer. Turn the control in a clockwise direction to increase the output voltage.

1.1.3 Overload Protection

The equipment is fitted with a variable electronic overload protection circuit and a fast-acting circuit breaker to provide protection under flash-over conditions.

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.

Trip setting	Unit type		
	KV5-4000	KV10-2000	KV15-1200
10%	400mA	200mA	120mA
20%	800mA	400mA	240mA
30%	1.2A	600mA	360mA
40%	1.6A	800mA	480mA
50%	2.0A	1.0A	600mA
60%	2.4A	1.2A	720mA
70%	2.8A	1.4A	840mA
80%	3.2A	1.6A	960mA
90%	3.6A	1.8A	1.08A
100%	4.0A	2.0A	1.2A
110%	4.4A	2.2A	1.32A

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 overload trip circuits do not limit the output current on short circuit.

1.1.4 Thermal Protection

The unit is fitted with a thermal switch on the HV transformer that operates at 70°C. The output will switch off when the thermal switch operates, and will not switch on again until the transformer has cooled.

1.2 Metering

The equipment is fitted with true rms digital kV and mA meters. The kV meter measures the output voltage via a resistive divider in the HV circuit and the mA meter measures the output current in the earthy end of the HV side of the output transformer.

Unit	Meter	Full scale	Resolution	Accuracy
KV5-4000	kV	5.000kV	0.001kV	0.8%rdg ± 6digits
	mA	4.000A	0.001A	0.8%rdg ± 6digits
KV10-2000	kV	10.00kV	0.01kV	0.8%rdg ± 6digits
	mA	2.000A	0.001A	0.8%rdg ± 6digits
KV15-1200	kV	15.00kV	0.01kV	0.8%rdg ± 6digits
	mA	1.200A	0.001A	0.8%rdg ± 6digits

The values are held on the meter when the output trips or the output is switched off.

1.3 Construction

The unit is housed in robust ventilated steel cases mounted on castors. All the controls and metering are located on the front panel of the control unit.

The unit is provided with the following cables:

- 2.5m mains cable
- 2.5m power interconnecting cable
- 5m metering interconnection cable
- 15m high voltage cable terminated with a copper clip connector
- 15m clear silicon rubber earth cable terminated with a copper clip connector
- 5m 10mm^2 earth cable to connect to local earth
- 5m earth interconnection cable

1.4 Unit layout

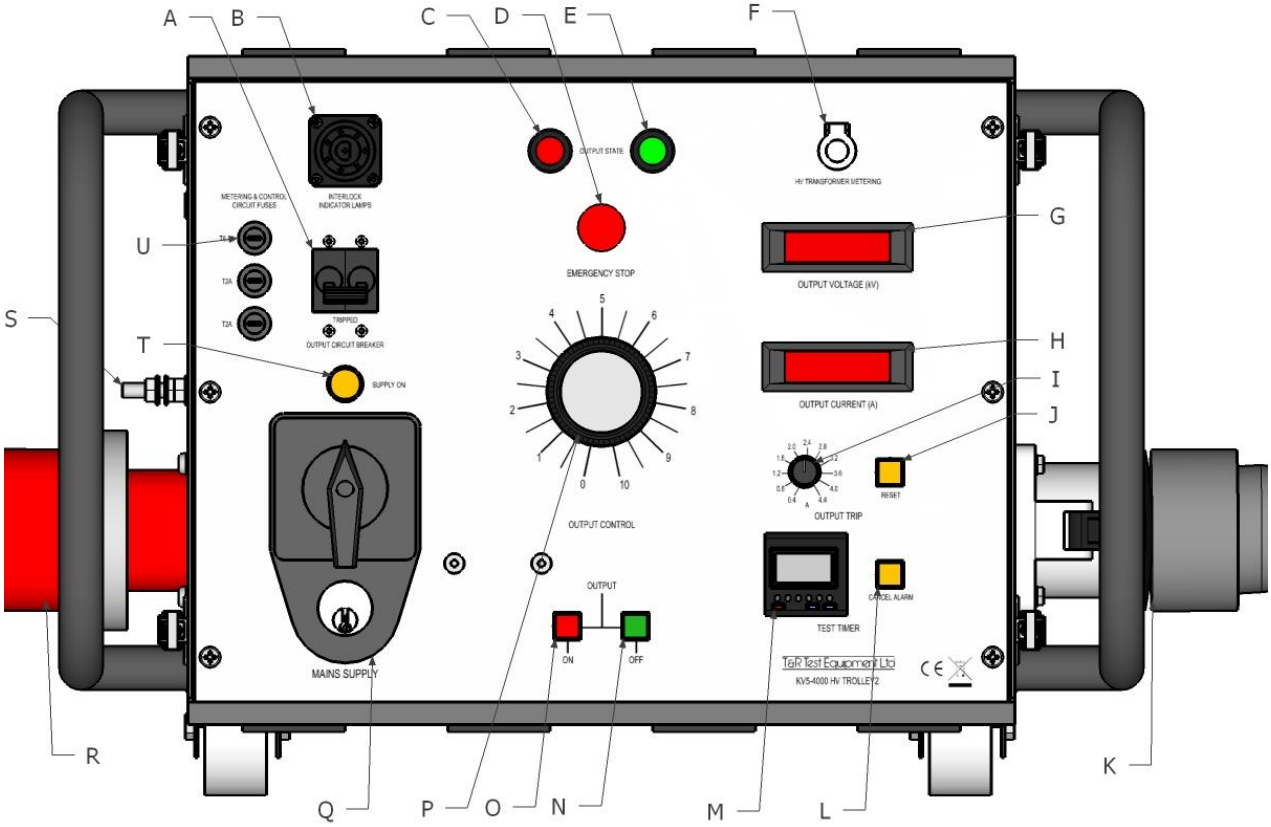


Figure 1.1 control unit front panel

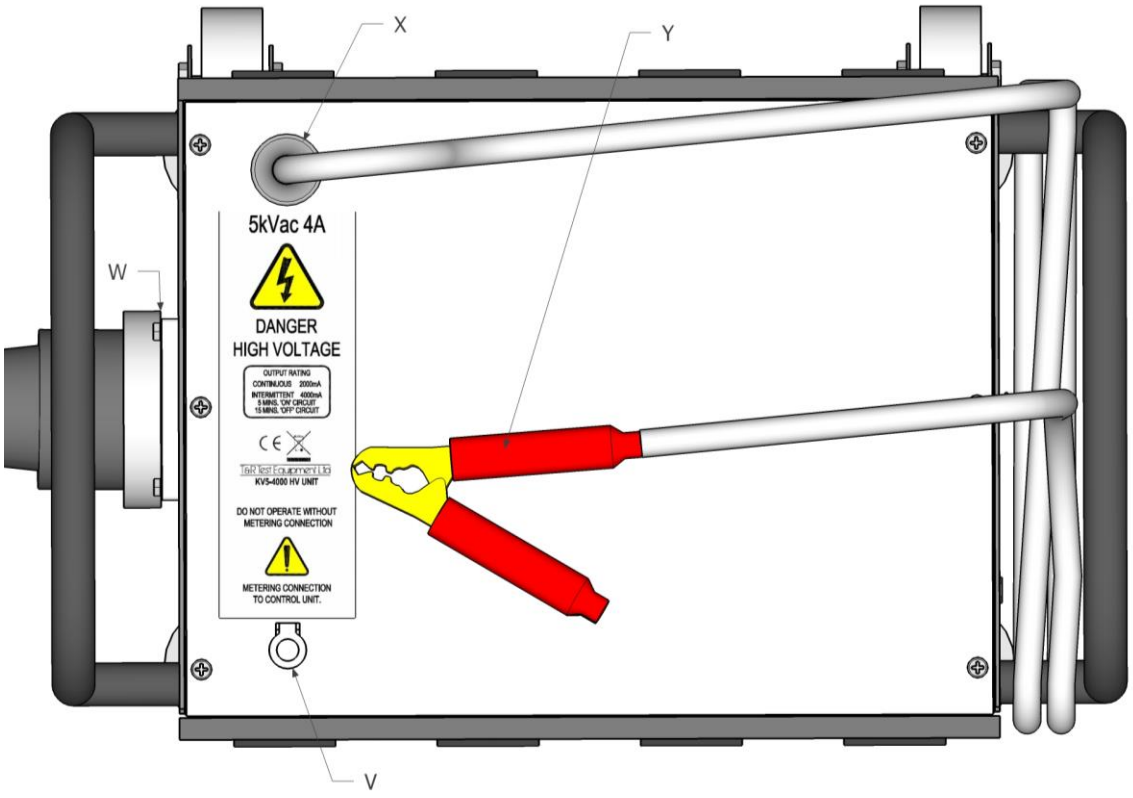


Figure 1.2 HV unit front panel

Item	Description
Control unit	
A	Output circuit breaker. Trips if object under test flashes over.
B	Interlock and lamp output socket
C	Red output on indicator
D	Emergency stop switch
E	Green output off indicator
F	Metering connector – connect to HV unit. Do not operate without this connection.
G	kV meter
H	mA meter
I	Output trip adjust – set output trip level
J	Output trip reset – lamp lights in case of output trip/test object failure
K	Power output to HV unit
L	Alarm cancel pushbutton and indicator
M	Test timer module
N	Output off pushbutton
O	Output on pushbutton
P	Output control
Q	Mains supply switch
R	Mains inlet
S	Earth stud for connection to local earth
T	Supply on indicator
U	Control and metering circuit fuses
HV unit	
V	Metering connector – connect to control unit. Do not operate without this connection.
W	Power inlet from control unit
X	HV lead outlet
Y	High voltage connection clip

1.5 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 output control is at zero, i.e. fully anticlockwise.

1.6 Overload Protection

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

1.6.1 Fixed Overload

The fixed overload protection system senses any rapid increase in the load current which exceeds approximately 100% of the full load current in the high voltage circuit. The circuit will respond more quickly to low impedance faults.

1.6.2 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.

1.7 Interlock Circuits

1.7.1 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.

1.7.2 External Interlock/Emergency Stop Circuit

The control unit is fitted with a two channel external interlock system monitored by an internal safety relay. Pin 5 must be linked to pin 6 and pin 7 must be connected to pin 8 of the interlock connector to enable switching of the HV output. The output cannot be energised if the two channels are shorted.

The external circuit is implemented as a chain of switches, e.g. door or cage switches and emergency stop buttons, each having two pair of normally closed contacts (i.e. contacts open when an emergency stop button is pressed or an interlocked enclosure gate is opened). Fig. 1.3 shows the general arrangement.

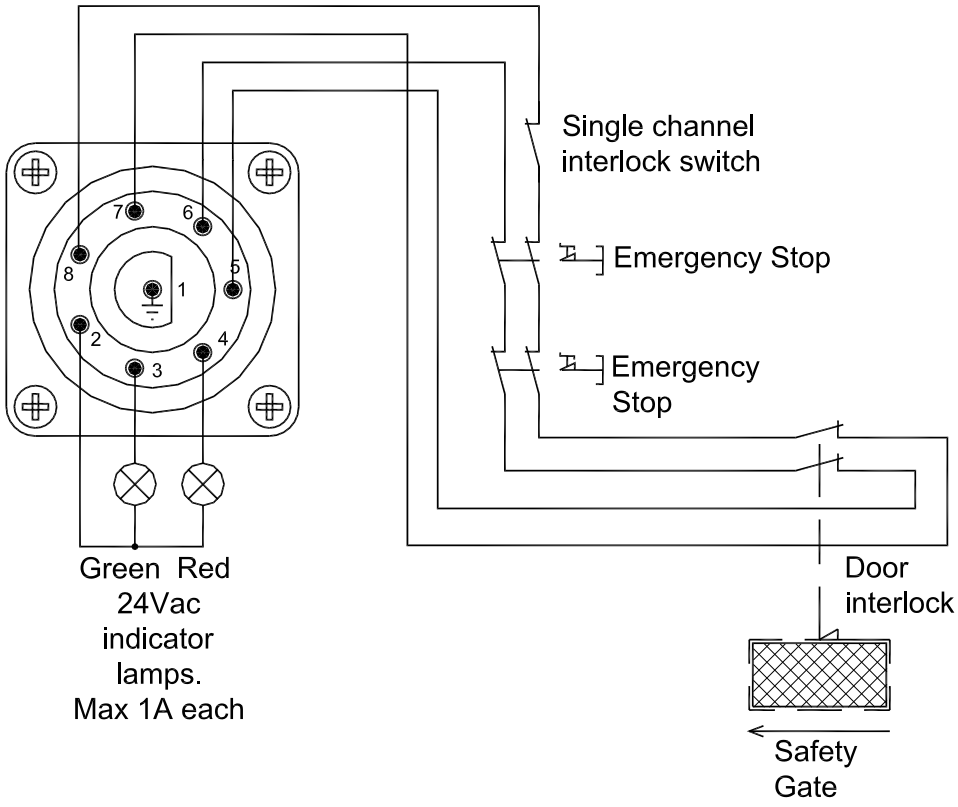


Fig. 1.3 External interlock/emergency stop circuit arrangement

1.7.3 Safety Relay Contactor Monitoring

The external interlock and emergency stop circuit is monitored by a safety relay that also monitors the contactor contacts. Every time the unit is switched off a short bleep will sound. This indicates that the contactor monitoring circuit is working correctly. If the contactor main contacts should become welded, the unit will sound an intermittent alarm when power is switched on. If the intermittent tone sounds please refer the unit to qualified service personnel.

1.8 External Beacons

The unit has outputs for an external beacon/indication lamps that mirror the state of the internal HV on/off indicators. For connection details see fig. 1.3.

Voltage:	24Vac
Maximum current per output:	1A

2. INSTALLATION

WARNING

The KV series high voltage units are hazardous and may cause injury or death if not installed and operated correctly.

2.1 Test Area

The unit must be installed in a suitable high voltage test area that complies with all applicable health and safety standards and accepted codes of practice. Appropriate controls and safety measures must be applied to the test 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 BS EN50191 for further details of suitable test areas. The test area must also be identified with suitable signs.

2.2 Mains supply

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

The trolley is connected to two phases of a three phase supply and does not have a neutral connection. The connections in the mains cable are:

Brown:	L1 (phase A)
Black: (blue with black sleeving):	L2 (phase B)
Green/yellow:	Earth (see section 2.3)

Please refer to section 1.1 for the supply requirements for each unit.

2.3 Earthing

It is essential that the unit is connected to a secure earth via the mains cable. The unit must also be connected to a suitable local low impedance earth (such as a building frame) via the earth studs on the control unit and HV unit. All high voltage earth connections must be made with a minimum of 6mm² conductors with secure joints.

An earthing stick is provided with the system to earth the test object between tests.

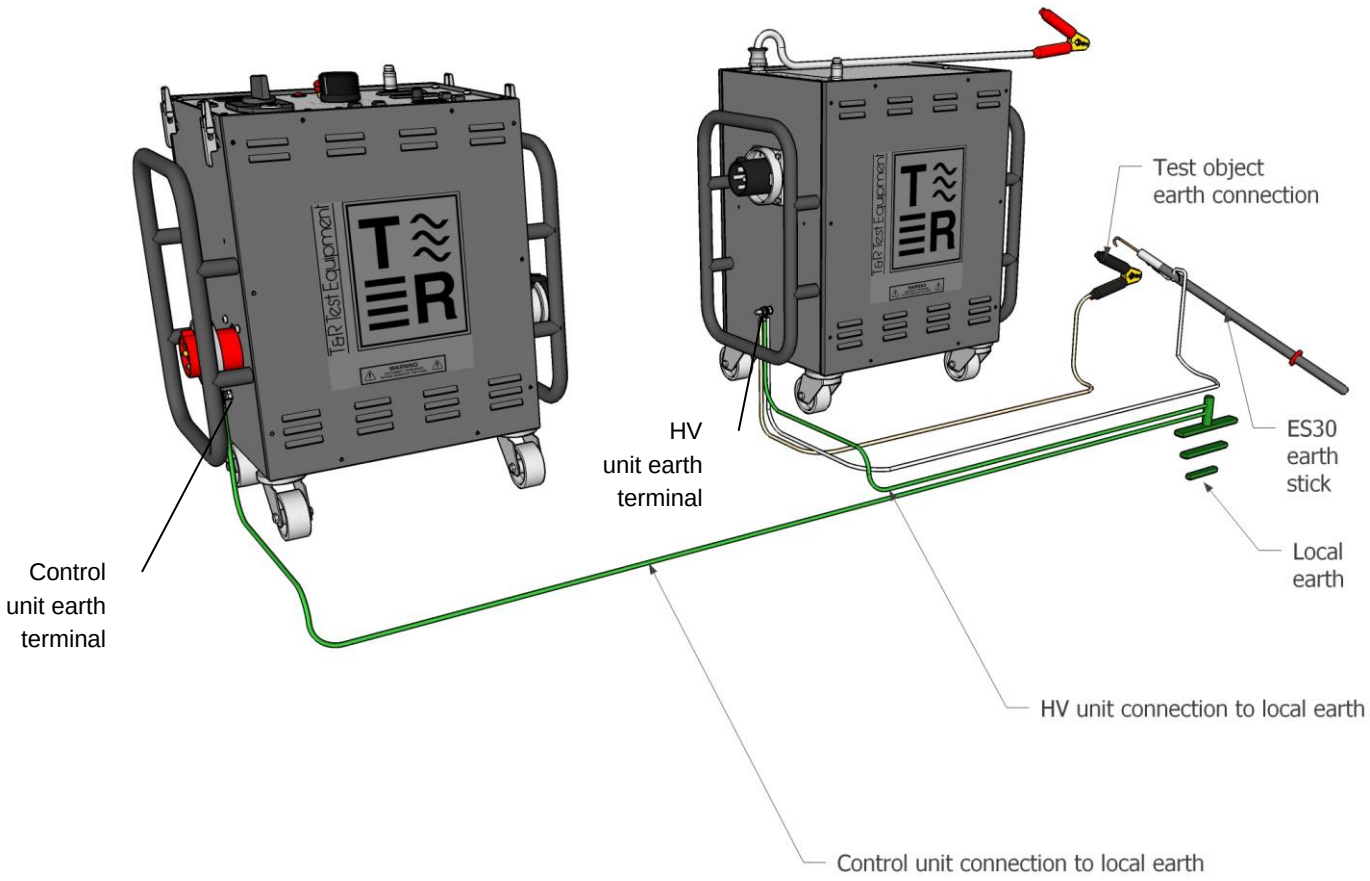


Figure 2.1 Earth connections

3. OPERATION

3.1 Safety

WARNING

The outputs from the KV series are hazardous, 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.

3.1.2 Operation

It is essential that safe working practices are maintained when conducting high voltage testing. Safe working procedures must be implemented to accepted standards (e.g. EN50191:2001 in the EU).

3.1.2.1 Interlocks

The units are fitted with a connector for external interlocks and emergency stop switches, and should be used with an interlocked enclosure. However, 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.

3.1.2.2 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.

3.1.2.3 High Voltage Connection

The HV connection to the test object must be made securely. The high voltage output from the unit is via a screened output lead. Note that the output crocodile clip is NOT insulated for high voltage purposes and connections must NOT be made unless the output is safe.

3.1.2.4 High Voltage Output Clearances

The high voltage output from the unit is via a high voltage lead terminated in a crocodile clip. Adequate clearances (distances between objects through the air) must be maintained between the following parts and any other conducting object (whether earthed or not):

- HV 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.

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 and can be obtained from BS EN50191.

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 BSEN61010-1:2001).

Unit type	Maximum voltage	Functional clearance
KV5-4000	5kVac	17mm
KV10-2000	10kVac	42mm
KV15-1200	15kVac	55mm

3.2 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.

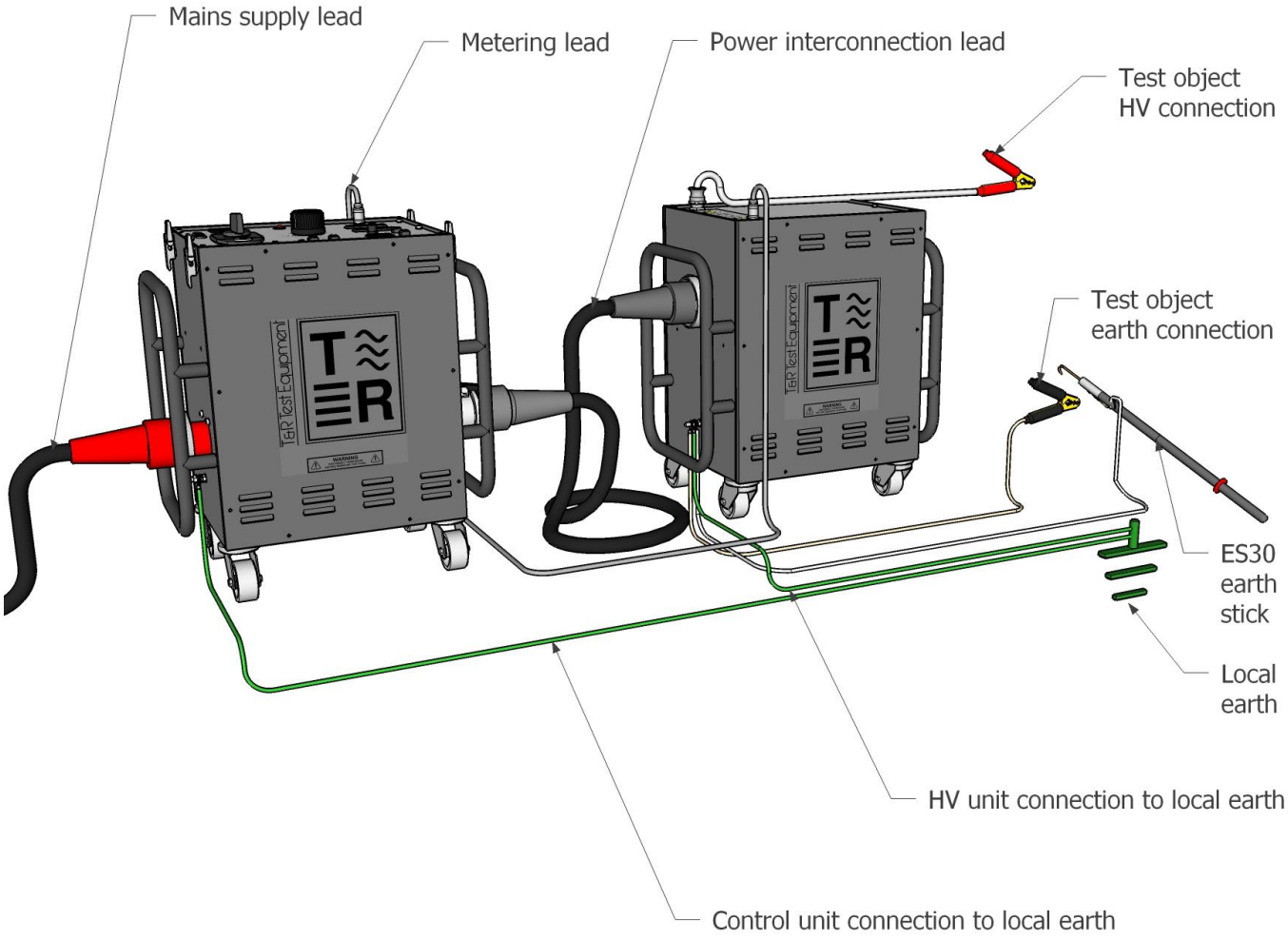


Figure 3.4 HV trolley connections

3.3 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.

WARNING

NEVER approach the test object or HV connection when power is applied to the system. The output is extremely hazardous and violating safety clearances will result in serious injury or death.

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 3.2, keeping the HV output/test object earthed 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. Ensure that Emergency stops are released.

Before commencing testing set the regulator to 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 mains 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.

Always remove the key when the unit is not in use.

3.4 Test timer

The test timer fitted to units may be pre-set with a test time in hours, minutes and seconds. The timer counts down when the output is switched on and an alarm sounds when the timer reaches zero.

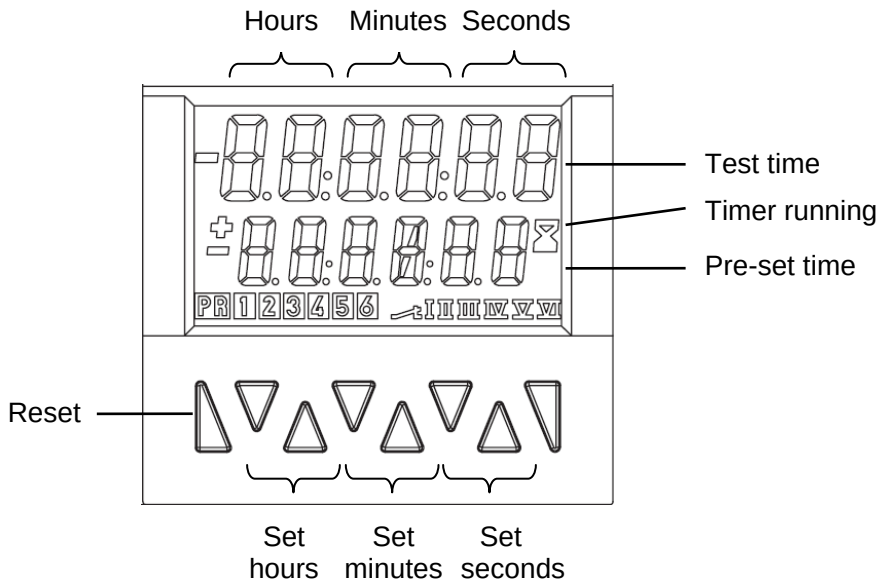


Fig. 1.5 Test timer

3.4.1 Setting the Test Time

Set the test time using the six central triangular buttons on the front of the timer. Each button sets one digit of the timer. The timer displays the time in the format hh:mm:ss in hours, minutes and seconds. When the test time has been set, press the Reset button on the timer twice to set the current test time to the pre-set time.

3.4.2 Starting the Timer

The timer automatically starts when the HV output is switched on. The timer counts down from the pre-set value to zero.

3.4.3 Resetting the Timer

The timer is automatically reset to zero when the HV output is switched off.

3.4.4 Cancelling the Alarm

The alarm is cancelled by pressing the CANCEL ALARM button or switching off the output. If the alarm is cancelled while the output is still switched on the time is reset to the pre-set value and the timer will start counting down again.

3.4.5 Disabling the Timer

It is not possible to disable the timer, but if you do not wish to use the test timer, set the test time to a large value (e.g. 10 hours). The timer will still run, but will not affect the test.

4. 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.

4.1 Output Control Variable transformers

It is advisable to check the carbon brushes on the variable transformers for signs of wear on a regular basis. To gain access to the variable transformers remove the side cover of the unit.

Replacement brushes are available from T&R Test Equipment, part number SPA-0110.

4.2 HV Output Lead

The HV output lead should be visually checked every time that the unit is used for signs of damage. Do not use the unit if the lead is damaged.

4.3 Earth Leads

All earth leads must be checked visually every time the unit is used. If any damage is observed, the leads must be replaced or repaired before the unit is used.

4.4 Mains Lead

The mains lead should be checked visually for signs of damage before use. Do not use the unit if the lead is damaged.

The correct settings may then be programmed in to the timer:

Action	Display after action
Press PGM and hold for 3s to enter programming mode	Prog Type
Press SEL	Type Counter
Press RH (right hand) grey button	Type Timer
Press SEL	Timer T base
Press RH grey button	Timer Pause
Press SEL	Pause Enable
Press RH grey button	Pause Disable
Press SEL	Timer Pause
Press RH grey	Timer T base
Press SEL	T base 1 sec
Press RH grey button until nn-SC displayed	T base nn-SC
Press SEL	Timer T base
Press PGM twice	Prog Type
Press RH grey button	Prog Reset
Press SEL	Reset Rst 0
Press RH grey button	Reset Rst P1
Press SEL	Prog Reset
Press RH grey button twice	Prog Auto
Press SEL	Auto On
Press RH grey	Auto Off
Press SEL	Prog Auto
Press RH grey	Prog R1type
Press SEL	R1type Pulse
Press SEL	Pulse 0.01
Use grey buttons to set to	60.00
Press SEL	Prog R1type
Press PGM to exit programming mode	

5. ACCESSORIES

5.1 Standard Accessories

Spare fuses supplied

- 2 x A3 63A
- 3 x 32mm HRC T6.3A
- 2 x 32mm HRC T2A

The following items are provided with the equipment:

- 2 keys for mains ON/OFF switch.
- Power supply lead
- Power interconnect lead
- Metering interconnect lead
- 15m 6mm^2 output earth lead with clip.
- 2 x 5m 10mm^2 local earth lead.
- ES30 Earthing stick with 15m lead.
- Interlock plug
- Operating & Maintenance Manual.

6. OVERALL PERFORMANCE SPECIFICATION

6.1 Insulation resistance at 1000V DC

Not less than 10 megohms between mains input and frame.

6.2 Applied voltage test

2.2kV RMS for 1 minute between mains input and frame.

6.3 Accuracy of instruments

Unit	Meter	Full scale	Resolution	Accuracy
KV5-4000	kV	5.000kV	0.001kV	0.8%rdg ± 6digits
	mA	4.000A	0.001A	0.8%rdg ± 6digits
KV10-2000	kV	10.00kV	0.01kV	0.8%rdg ± 6digits
	mA	2.000A	0.001A	0.8%rdg ± 6digits
KV15-1200	kV	15.00kV	0.01kV	0.8%rdg ± 6digits
	mA	1.200A	0.001A	0.8%rdg ± 6digits

6.4 Flash-over tests

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

7. REVISION

Product:	HV trolley2
File:	HV trolley2 manual v4.doc
Author:	I Lake
Issue / Date:	4 17/07/14
Modified By:	S O'Hara

Checked By: P Cole	Date: 17/07/14

Drawings to include (latest issue):

001724 – KV5-4000