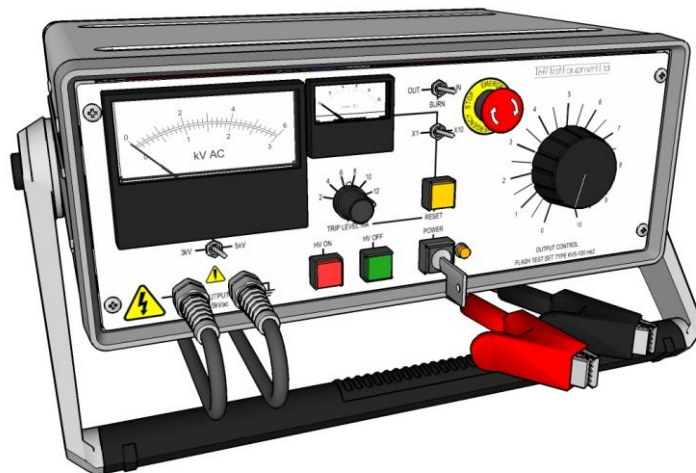

T&R Test Equipment Ltd

OPERATING AND MAINTENANCE MANUAL

Product: **High Voltage AC Test Set**

Type: **KV3-250 mk2**
KV4-300 mk2
KV5-100 mk2
KV5-100T mk2
KV5-200 mk2



DESIGNED AND MANUFACTURED BY:

T & R Test Equipment Limited

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

Telephone: 01483 207428

Fax.: 01483 511229

e-mail: sales@trtest.com

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 for operation in a designated high voltage test area.**

To Avoid Fire Hazards and Personal Injury

- Use the correct power supply lead. Only use a suitably rated and approved power supply lead for the country of use.
- Ensure that systems that the unit is to be connected to are dead.
- Do not connect and disconnect leads whilst outputs are switched on.
- Ensure that the product is grounded. To avoid electric shock it is essential that the grounding conductor is connected to the earth ground. An additional earth terminal is provided on the unit for connection to a local earth if necessary. 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 to the unit.
- 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
- 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 health 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 cause injury or death to the operator or other personnel if not carried out correctly using applicable safety procedures.

CONTENTS

1	DESCRIPTION OF EQUIPMENT	7
1.1	Electrical Specification	7
1.1.1	Supply Requirements	7
1.1.2	Output Specifications	7
1.1.3	Zero Voltage Interlock	7
1.1.4	External Interlock	7
1.2	Output Voltage Control	8
1.3	Overload Protection	8
1.3.1	Variable overload	8
1.4	Metering	9
1.5	Fault Burn Facility (except KV5-200 mk2)	10
1.5.1	Fault Burning	10
1.5.2	Burn Switch	10
1.6	High Voltage Connection	10
1.7	Construction	10
1.8	Timer Operation (KV5-100T mk2 only)	11
2.	OPERATION	12
2.1	Safety	12
2.1.1	Installation	12
2.1.2	Operation	12
2.2	Front Panel Layout	13
2.2.1	Front Panel Control Functions	15
2.2.2	Rear Panel Control Functions	15
2.3	Method of Operation	16
2.3.1	Connections	16
2.3.2	Operation	16
2.3.3	Timer Operation (KV5-100T mk2 only)	16

3.	MAINTENANCE	17
4.	STANDARD ACCESSORIES	18
5.	OVERALL PERFORMANCE SPECIFICATION	19
6.	REVISION	20

1 DESCRIPTION OF EQUIPMENT

1.1 Electrical Specification

1.1.1 Supply Requirements

KV5-100 mk2 115/230V $\pm 10\%$ 600VA max

KV3-250 mk2 115/230V $\pm 10\%$ 900VA max

KV4-300 mk2 230V $\pm 10\%$ 1400VA max

KV5-200 mk2 230V $\pm 10\%$ 1100VA max

1.1.2 Output Specifications

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

Unit	Output voltage	Output current		
		5 min on/ 15 min off	1 min on/ 15 min off	40 seconds on/ 15 min off
KV5-100 mk2	0-5kV	100mA	-	-
KV3-250 mk2	0-3kV	125mA	250mA	300mA
KV4-300 mk2	0-4kV	200mA	300mA	-
KV5-200 mk2	0-5kV	100mA	200mA	-

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 control. This interlock prevents the output being energised unless the output control is in the minimum output position.

1.1.4 External Interlock

The equipment is fitted with a external interlock system. The interlock socket on the back panel must have a short circuit across it terminals to enable the output to be energised.

Note: the open circuit voltage across the interlock terminals is 240Vac and is connected directly to the mains supply.

The unit is supplied with a plug fitted to the external interlock socket on the rear of the unit. The plug contains a shorting link to enable the unit. If external interlocks are used, the interlocks should replace the shorting link. Please note that the output will not switch on without either the link fitted in the plug or a closed external interlock circuit.

1.2 Output Voltage Control

The output from the equipment is controlled from zero by means of the output control. To increase the output voltage turn the control knob in a clockwise direction.

Note: The output cannot be energised unless the regulator knob is set to zero, thus operating the zero voltage interlock switch.

1.3 Overload Protection

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

1.3.1 Variable overload

The variable overload protection system senses current changes in the high voltage circuit. The trip levels are adjustable in two ranges each of 6 steps giving 2-12% and 20-120% rated current.

Unit	Trip current ranges	
	X1	X10
KV5-100 mk2	2, 4, 6, 8, 10, 12mA	20, 40, 60, 80, 100, 120mA
KV3-250 mk2	5, 10, 15, 20, 25, 30mA	50, 100, 150, 200, 250, 300mA
KV4-300 mk2	6, 12, 18, 24, 30, 36mA	60, 120, 180, 240, 300, 360mA
KV5-200 mk2	4, 8, 12, 16, 20, 24mA	40, 80, 120, 160, 200, 240mA

The range change and selector switches are located on the front panel of the instrument. The circuit will activate when the load current exceeds that set by the trip level selector switch.



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

WARNING

1.4 Metering

The equipment is provided with the following metering ranges using analogue moving coil meters:

Unit	Metering Ranges			
	Voltage		Current	
	Low	High	X1	X10
KV5-100 mk2	3kV	6kV	10mA	100mA
KV3-250 mk2	1.6kV	3.2kV	30mA	300mA
KV5-200 mk2	3kV	5kV	20mA	200mA

The ranges on both instruments are selected by means of switches located on the front panel.

1.5 Fault Burn Facility (except KV5-200 mk2)

The KV5-100 mk2, KV3-250 mk2 and KV4-300 mk2 are provided with an internal current limit circuit which limits the output current from the unit under short circuit conditions. This can be used to “burn” faults.

1.5.1 Fault Burning

Fault burn is where the arc is maintained through the failed test object. The product does this by limiting the current and preventing the unit from tripping. Fault burning should be approached very cautiously as it can cause serious damage to the test object, and is totally unsuitable for many test objects.

1.5.2 Burn Switch

When the “burn” switch is in the “out” position, the unit behaves normally and the output current is not limited. Switching the “burn” switch to “in” enables the current limiting

The current is limited to the following values at maximum output voltage when the “burn” is enabled (the burn switch is in the “in” position):

	Output Voltage	Maximum current
KV5-100 mk2	5kV	90-100mA
KV4-300 mk2	4kV	280 –300mA
KV3-250 mk2	3kV	160-180mA

At lower output voltages, the burn current limit reduces in proportion to the output voltage.

1.6 High Voltage Connection



WARNING

The equipment is supplied with crocodile clips on the output. These clips are not insulated for high voltage use, and under no conditions must the high voltage connection be approached or touched whilst the unit is switched on. The test object must be earthed before making or breaking connections after testing. A prohibition zone of at least 30mm must be maintained around the high voltage connection (from EN50191:2000)

This equipment must be used either with an interlocked enclosure for the object under test or in a suitable high voltage test area. Adequate safety clearances must be maintained between the operator and all high voltage parts at all times.

1.7 Construction

The unit is housed in a robust case with a carrying handle. The handle will also act as a tilt support stand which is locked in various positions by pressing the release buttons at each end of the handle.

1.8 Timer Operation (KV5-100T mk2 only)

The KV5-100T mk2 is fitted with a 5 second-5 min test duration timer. The test timer has two controls; 'Select Test Time' and 'Alarm Cancel'. The timer has nine switch-selectable ranges of 5, 10, 15, 20, and 30 seconds and 1, 2, 3 and 5 minutes. There is an 'OFF' position for when the timer operation is not required.

The timer is started when the output 'HV ON' push button is pressed. The timer indicator then flashes per second for the duration of the time selected. When the timer has reached the selected time an intermittent alarm sounds, this is cancelled by pressing the 'Timer cancel' push button.

The audible alarm is cancelled using the 'Timer cancel' push button.



WARNING

The timer does not switch the high voltage output off – it only warns the operator when the required time has elapsed. At the end of the test time, the output control should be run down to zero before switching the output off.

The high voltage output remains until 'HV OFF' button is pressed, 'TIMER CANCEL' does not turn the output off.

The timer is cancelled if there is an over current trip condition, should this occur the 'RESET' button must be pressed to clear the trip and silence the audible alarm.

Timer operation may be aborted by pressing the 'TIMER CANCEL' push button.

Adjusting the 'TIMER' select switch during a timed operation will have one of the following effects:

- Change to a longer setting will extend the period to the new value.
- Change to a shorter setting will limit the period to the new value.
- Change to a setting shorter than has already elapsed terminates the timing.
- Change to the 'OFF' setting triggers the timer alarm

2. OPERATION

2.1 Safety

The outputs from all units in the range are very 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*

The unit is designed to be installed and used in an indoor environment.

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 BS EN50191:2001 and 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.

2.1.1.4 *Earthing*

The unit must be securely earthed. The earth terminal on the rear of the unit may be connected to a low impedance local earth if required.

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 KV5-100 mk2 series are provided with an external interlock circuit that may be used to link to interlock switches on the high voltage test area.

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 Front Panel Layout

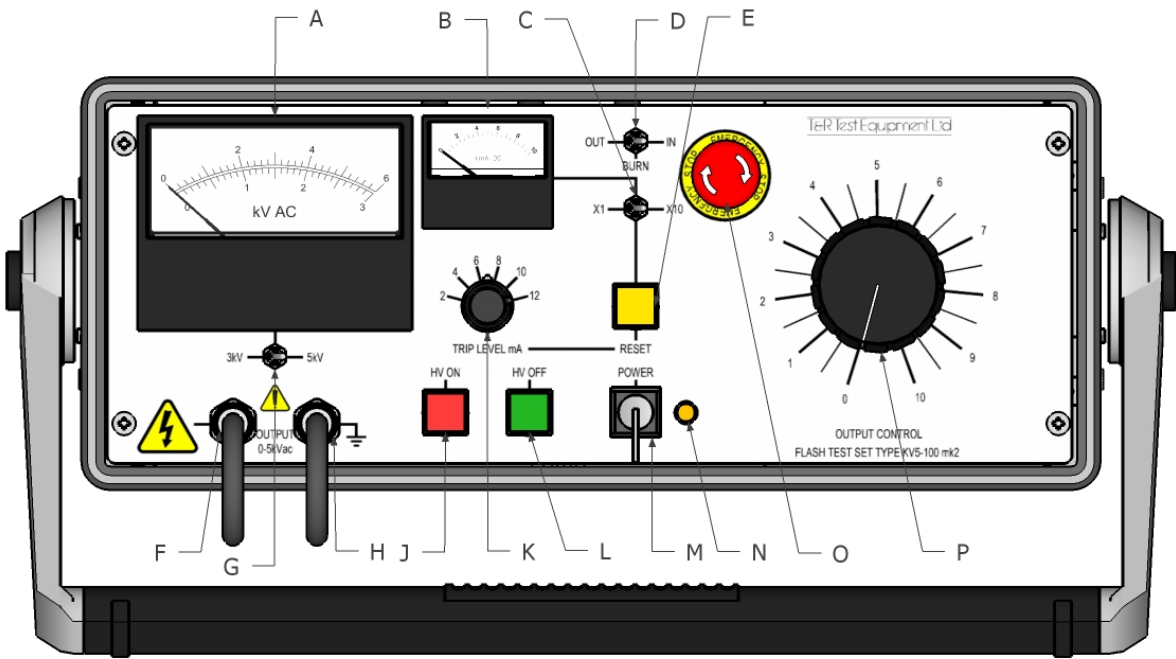


Figure 2.1 KV5-100 mk2 front panel

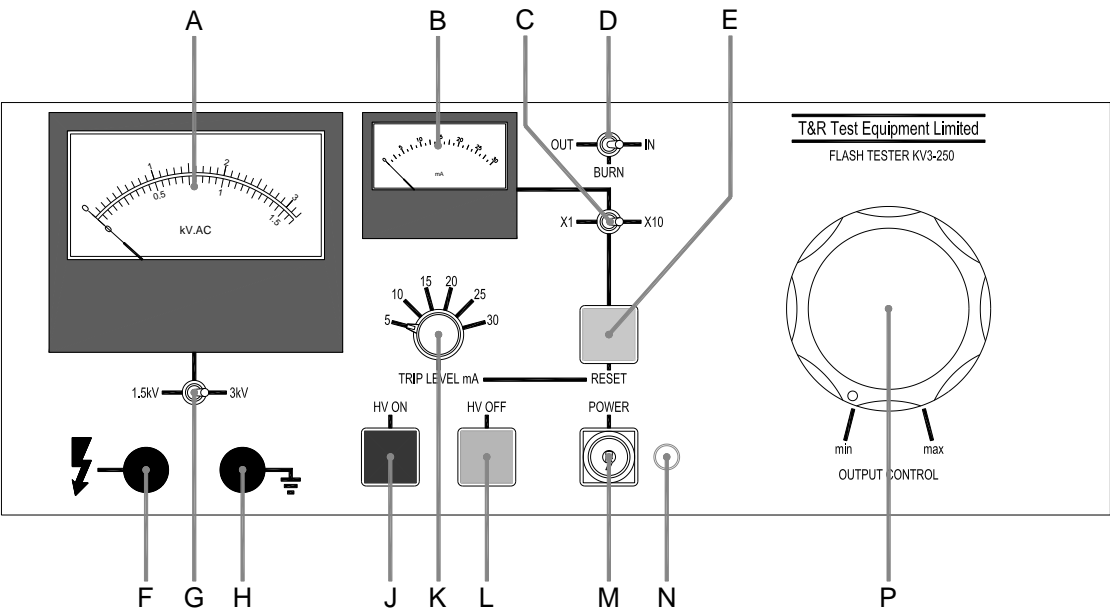


Figure 2.2 KV3-250 front panel

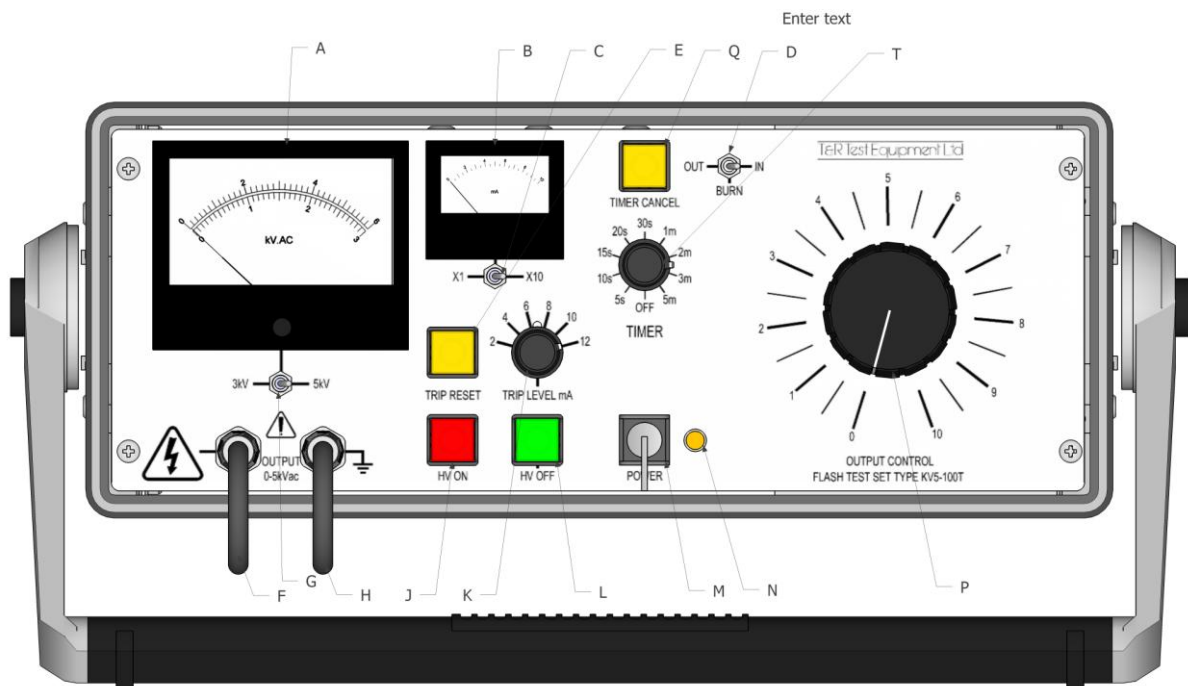


Figure 2.3 KV5-100T front panel

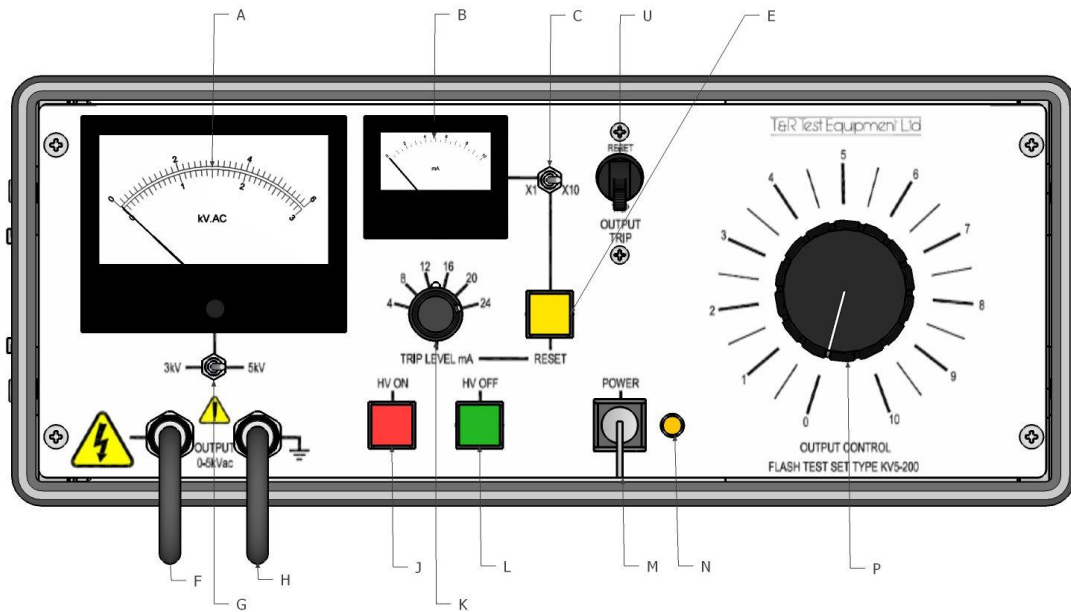


Figure 2.4 KV5-200 front panel

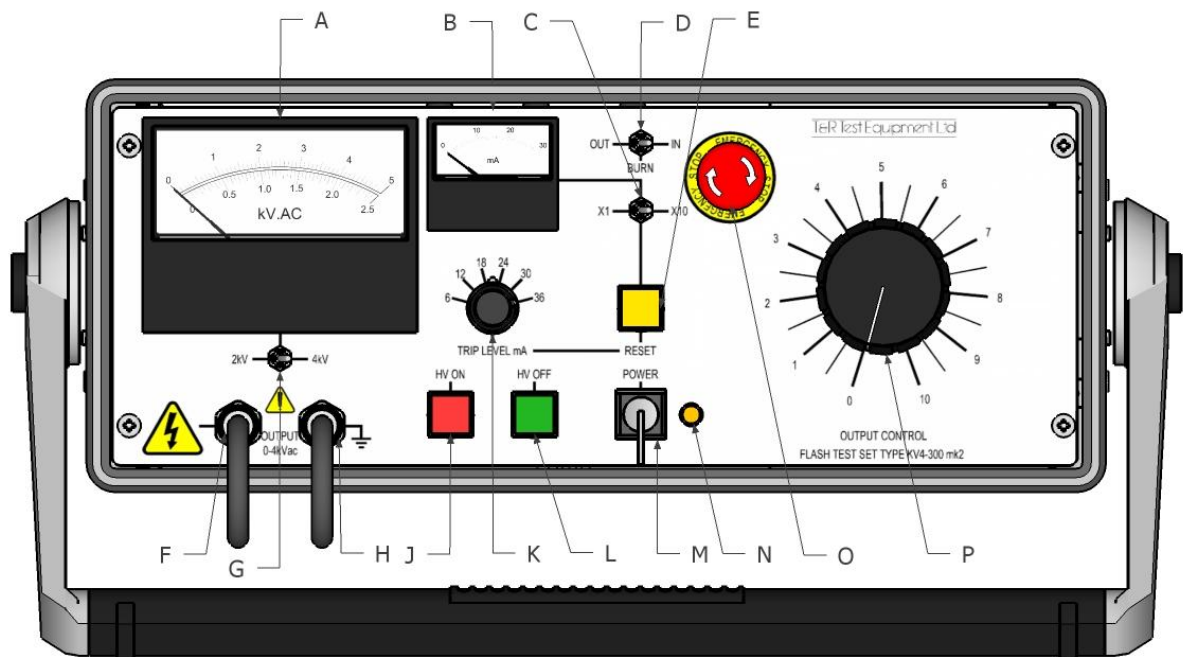


Figure 2.5 KV4-300 mk2 front panel

2.2.1 Front Panel Control Functions

A	kV Meter	Displays output voltage
B	mA Meter	Displays load current
C	mA x1/x10 selector switch	Selects mA meter range
D	Burn switch	Selects burn facility
E	Trip reset switch	Resets the output current trip
F	HV Output lead	HV output to object under test
G	kV meter range switch	Selects kV meter range
H	Earth output lead	Earth output to object under test
J	HV Output ON pushbutton	Switches HV output on. Illuminated red when output is on.
K	Variable trip level select	Selects output current trip level
L	HV Output OFF pushbutton	Switches HV output off. Illuminated green when output is off.
M	Mains supply switch (key operated)	Key operated mains on/off switch
O	Emergency stop button	Switches HV output off.
N	Supply on indicator	Supply on indicator
P	Output level control	Set output voltage
Q	Timer reset pushbutton (T only)	Resets timer and cancels alarm
T	Test time select (T only)	Selects test time
U	Output trip	Flashover trip – KV5-200 mk2 only

2.2.2 Rear Panel Control Functions

Mains voltage selector	Selects mains input voltage
Interlock socket	For connection to an external interlock system
Earth terminal	For connection to a low impedance local earth

2.3 Method of Operation

2.3.1 Connections



WARNING

Before making any connections please ensure that you are aware of all hazards relating to the system and environment in which it is operating. Ensure that the key switch is in the off position and the key is removed before making any connections. The test object must be earthed before making or breaking any connections after testing.

Ensure that the key switch is in the off position and the key is removed before making connections to the object under test or connecting the unit to the mains supply.

Connect the mains input lead to a suitable three pin supply outlet.

2.3.2 Operation

Switch on the key-operated mains switch. 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 variable overload reset push button. This will arm the trip circuit.

Select the desired voltage range on the kV meter and set the desired overload trip level.

Before commencing testing ensure that all external interlocks are closed, the emergency stop button is released and that the regulator is in the fully anti-clockwise position.

Press the HV ON pushbutton. The HV output will now energise, and the red HV on indicator in the pushbutton will light up. 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.

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

In case of emergency, the emergency stop push button is provided, switching off the HV output when engaged.

2.3.3 Timer Operation (KV5-100T mk2 only)

The timer is started when the output is switched on. The indicator in the timer cancel button flashes for the duration of the time selected indicating that the timer is in operation. An alarm sounds to indicate the timer reaches the selected time duration. The audible alarm is cancelled using the 'Timer cancel' push button.



WARNING

The timer does not switch the high voltage output off – it only warns the operator when the required time has elapsed. At the end of the test time, the output control should be run down to zero before switching the output off.

3. MAINTENANCE



WARNING

Maintenance and repair of the KV5-100 mk2 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.

It is advisable to check the carbon brush on the variable transformer for signs of wear on a regular basis. To gain access to the variable transformer 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.

4. STANDARD ACCESSORIES

The following items are provided with the equipment:

- a. Mains input lead.
- b. 2 keys (for mains ON/OFF switch).
- c. Operating & Maintenance Manual.
- d. 1x F5A 1¼ inch fuse and 1x T4A 20mm fuse: KV5-100 mk2, KV3-250 mk2.
1xT5A 1¼ inch fuse and 1xT8A 20mm fuse: KV4-300 mk2.
1 off T6.3A: KV5-200 mk2.

5. OVERALL PERFORMANCE SPECIFICATION

Insulation resistance at 500V DC: >10 megohms between mains input and frame.

Applied voltage test: 2.0kV RMS for 1 minute between mains input and frame.

Accuracy of instruments

kV meter: $\pm 1.5\%$ of FSD

mA meter: $\pm 2.5\%$ of FSD

Instrument calibration is traceable to national standards.

6. REVISION

Product / Type: KV5-100 mk2 series High Voltage AC Test Systems

File: KV5-100mk2 series manual v5.doc

Author: P Cole

Issue / Date: 5 / 24.06.2013

Modified By: TC

Checked By: PRC	Date: 24.06.13
-----------------	----------------

Circuit diagram

A2/001910 KV5-100 mk2

Other unit circuit diagrams available on request

A2/000925 KV3-250

A2/001924 KV4-300 mk2

A2/001948 KV5-100T

A2/001708 KV5-200