



OPERATING AND MAINTENANCE MANUAL

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

Type: ***VC24-24 mk3***



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 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.**

To Avoid Fire Hazards and Personal Injury

- Use the correct power supply lead. Only use a suitably rated and approved power supply lead for the country of use.
- Ensure that systems that the unit is to be connected to are dead.
- Do not connect and disconnect leads whilst outputs are switched on.
- Ensure that the product is grounded. To avoid electric shock it is essential that the grounding conductor is connected to the earth ground. Additional earth terminals are provided on the control unit and HV transformer that must be connected to a local earth. Ensure that the unit is properly grounded before making any connections to inputs or outputs.
- Terminal ratings must be observed to prevent fire hazards and risk of injury to the operator. Consult the product manual for ratings information before making connections to any terminal.
- It is ESSENTIAL to consult the product manual for rating information before making any connection to a terminal or terminal group marked with a warning triangle.
- Only use fuses of a type and rating specified for this product.
- Do not operate the unit out of its case or with any covers or panels removed.
- Do not touch exposed connections and components when power is present.
- Do not operate the product if any damage is suspected. Refer the unit to qualified service personnel to be checked.
- Do not operate the unit in wet or damp conditions
- Do not operate the unit in an explosive atmosphere

If any further queries occur regarding the usage and maintenance of the equipment detailed in this manual, please refer these to the supplier of the equipment in the first case or to:

T & R Test Equipment Limited

HIGH VOLTAGE SAFETY

It is essential to follow safe working procedures when working with high voltage. Information on accepted codes of practice should be obtained from your local health and safety regulatory body.

It is essential that VC24-24 is only used in a suitable test environment. EN50191:2001 (Erection and Operation of Electrical Test Equipment) provides information on the installation and use of test installations and is referenced by health and safety law in the EU. EN50191:2001 is available from T&R Test Equipment.

IEEE standard 510-1983 (IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing) also provides a working framework for establishing safe procedures, but must be read in conjunction with local regulations and accepted codes of practice.

The following excerpts are taken from IEEE 510

- All ungrounded terminals of the test equipment or apparatus under test should be considered as energised.
- Common ground connections should be solidly connected to both the test set and the test specimen. As a minimum, the current capacity of the ground leads should exceed that necessary to carry the maximum possible ground current. The effect of ground potential rise due to the resistance and reactance of the earth connection should be considered.
- Precautions should be taken to prevent accidental contact of live terminals by personnel, either by shielding the live terminals or by providing barriers around the area.
- The circuit should include instrumentation for indicating the test voltages.
- Appropriate switching and, where appropriate, an observer should be provided for the immediate de-energisation of test circuits for safety purposes. In the case of dc tests, provisions for discharging and grounding charged terminals and supporting insulation should also be included.
- In the use of signal-gathering equipment, each device should be used in such a manner that it will not present a personnel hazard should it inadvertently become a part of the high-voltage circuit, or fail to function properly.
- High-voltage and high-power tests should be performed and supervised by qualified personnel.
- Consideration should be given to safety regulations which may apply to specific circumstances; for example, HSE, company, or government regulations.

SAFETY TERMS AND SYMBOLS

The following safety symbols appear on the equipment:



CAUTION/WARNING – Refer to manual



DANGER – High voltage



Mains off



Mains on

The following safety symbols appear in this manual:



CAUTION

This action or procedure may be dangerous if not carried out correctly, and may cause damage to the equipment or connected equipment.



WARNING

This action or procedure may 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	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	Emergency Stop Button	7
1.1.5	External Interlock	7
1.1.6	Output Enabled/Disabled key switch	8
1.2	Output Voltage Control	8
1.3	Overload Protection	8
1.3.1	Variable overload	8
1.4	Metering	9
1.5	Construction	9
2.	OPERATION	10
2.1	Safety	10
2.1.1	Installation	10
2.1.2	Operation	10
2.2	Connections (See Figure 1)	12
2.3	Front Panel Control Functions	14
2.4	Method of Operation	16
3.	MAINTENANCE	17
3.1	Removal of Unit from Case	17
4.	STANDARD ACCESSORIES	18
5.	OVERALL PERFORMANCE SPECIFICATION	19
6.	REVISION	21

1. DESCRIPTION OF EQUIPMENT

1.1 Electrical Specification

1.1.1 Supply Requirements

The VC24-24 mk2 and mk3 (referred hereafter as VC24-24) has a 115/230V auto-selecting mains input.

Supply requirements: 115/230V $\pm 10\%$ 1 phase 50/60Hz 650VA max.

1.1.2 Output Specifications

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

Unit type	Output Voltage	Output current	
		Continuous	5 min on/15 min off
VC24-24	24kV	15mA	24mA

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

1.1.4 Emergency Stop Button

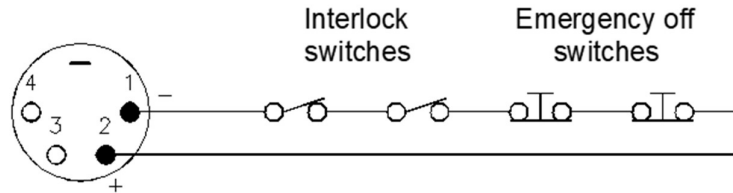
The VC24-24 is fitted with an emergency stop push button on the front panel. When pressed, the output of the unit is switched off and prevented from switching on again until the button is released. To release the button it must be twisted in the direction of the white arrows on the button cap.

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

1.1.5 External Interlock

The VC24-24 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.



1.1.6 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.

1.2 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.

1.3 Overload Protection

The equipment is fitted with fixed 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 level is adjusted by means of a selector switch on the front panel of the unit. The switch allows three trip currents (16, 20 and 24mA) to be selected.

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.

1.4 Metering

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

Unit type	KV meter full scale	mA meter full scale	
	x1	x1	x10
VC24-24	30kV	30mA	3mA

1.5 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 output from the VC24-24 is 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. EN50191:2001 Defines suitable test installations for this equipment.

When testing vacuum bottles it is essential to be aware that the test object may radiate X-ray radiation during the test, and the operator must be located as far away from the vacuum bottle as possible during the test. Consult local health and safety guidelines and the vacuum bottle manufacturer for details of the distances required for safe testing.

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 to ensure that the unit cannot be switched on unless the area is secure. Refer to EN50191:2001 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, and 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.

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

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

Unit	Voltage	Prohibition zone
VC24-24	30kV	170mm

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

2.2 Connections (See Figure 1)

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.

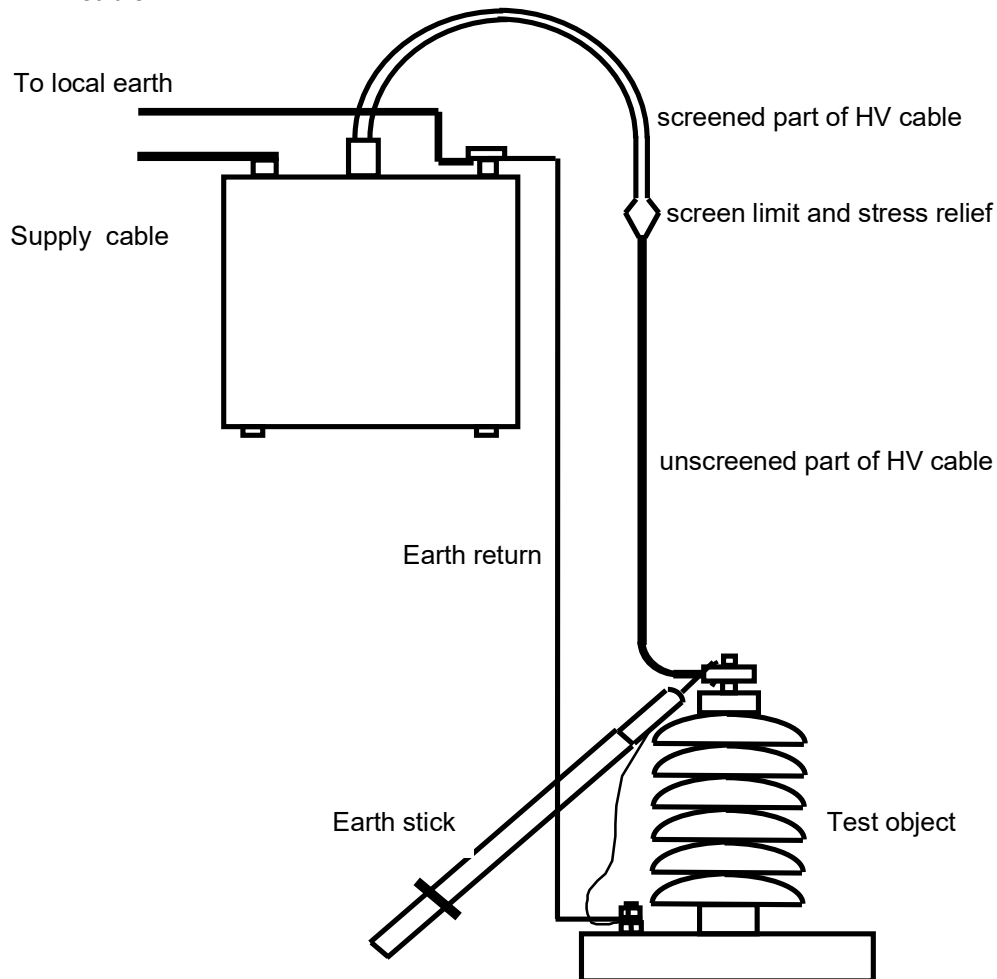


Figure 1 Connection showing earthed test object – before start of test

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.

2.3 Front Panel Control Functions

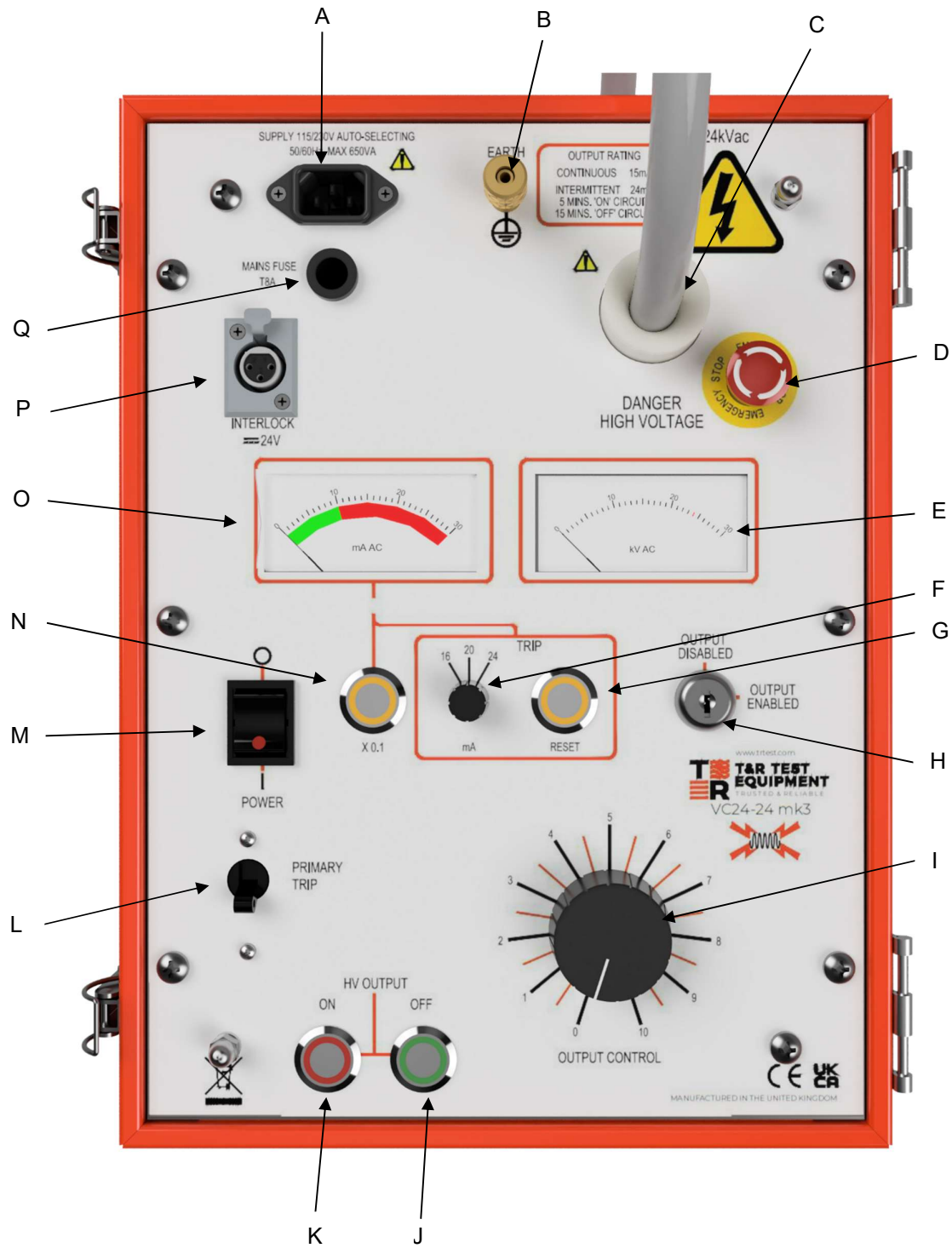


Figure 2 Unit front panel

- A Mains inlet connector
- B Earth terminal for connection to low impedance local earth
- C HV output
- D Emergency stop button
- E kV meter
- F Overcurrent trip level control
- G Overcurrent trip reset switch
- H Output enable switch
- I Output control knob
- J HV output off switch – illuminated green when output is off
- K HV output on switch – illuminated red when output is on
- L Primary trip circuit breaker
- M Mains switch
- N mA meter divide by 10 switch
- O mA meter
- P Interlock socket
- Q Mains supply fuse

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 main supply the key operated switch can be moved to the ON position. The following will now occur:

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

Press the variable overload 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 emergency stop button is released.

Select the desired overload mA trip level.

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

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.

Ground the high voltage connection using the earth stick provided straight after switching off the supply. Leave the earth connection in contact with the HV connection whilst connections are made or broken.

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 five M5 fixing screws from the underside of the set (centre of 4 rubber feet and one in centre of base).
- 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 posidrive 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.

4. STANDARD ACCESSORIES

Spare fuses supplied

- a. 1 off **T8A** 1¼ inch

The following items are provided with the equipment:

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

5. OVERALL PERFORMANCE SPECIFICATION

Insulation resistance at 1000V DC

Not less than 10 megohms between mains input and frame.

Applied voltage test

2kV RMS for 1 minute between mains input and frame

Accuracy of instruments

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

mA meter $\pm 1.5\%$ at 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 100% of normal output voltage

6. REVISION

Product/Type: High Voltage AC Test Set VC24-24
File: OM0031.docx
Author: I Lake

Issue/Date: 6 / 24/01/23
Modified By: G. Bond

Checked By: D. Maxim	Date: 23/02/23
----------------------	----------------

Drawings required

A3/002214 latest Issue VC24-24 mk3