

## 1. SCOPE

This document details the procedures to be followed when jointing **LV** mains and service cables and specifies the following testing activities on **LV** cables:

- Insulation resistance tests
- Continuity tests
- Polarity tests at the cut-out position
- Phase rotation tests at the cut-out position
- Earth loop impedance tests at the cut-out position


This is a controlled maintained document.

All copies printed via the Intranet or photocopied will be deemed uncontrolled.

## 2. ISSUE RECORD

Issue Date	Issue No	Author	Amendment Details
24/06/2004	1	J Neilson	Initial Issue: 18pages

## 3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Name Jack Neilson Title Operational Compliance Manager	Name Jack Neilson Title Operational Compliance Manager	Name William Cuthbert Title Business Risk & Safety Manager  

## 4. REVIEW

This document will be subject to review at an interval of no more than 3 years.



**5. CONTENTS**

**1. SCOPE ..... 1**

**2. ISSUE RECORD..... 1**

**3. ISSUE AUTHORITY ..... 1**

**4. REVIEW ..... 1**

**5. CONTENTS..... 2**

**6. INTRODUCTION..... 3**

**7. TESTING PROCEDURES ..... 4**

7.1 POLARITY TEST ..... 4

7.1.1 *New Services*..... 4

7.1.2 *Existing Services*..... 4

7.1.3 *SNE Service* ..... 4

7.1.4 *CNE Service*..... 4

7.2 PHASE ROTATION TEST ..... 4

7.2.1 *New services* ..... 4

7.2.2 *Work associated with existing services*..... 5

7.3 EARTH LOOP IMPEDANCE TEST ..... 6

**8. CONNECTION OF UNDERGROUND EXTENSIONS TO THE SYSTEM..... 7**

8.1 CONNECTION OF UNDERGROUND SERVICES ONLY ..... 7

8.2 CONNECTION OF UNDERGROUND MAINS WITH OR WITHOUT SERVICES ..... 8

**9. APPENDICES ..... 10**

9.1 APPENDIX 1..... 10

9.1.1 *Polarity Test - Single Phase SNE*..... 10

9.1.2 *Polarity Test - Single Phase CNE*..... 11

9.2 APPENDIX 2..... 12

9.2.1 *Polarity Test Three Phase - SNE* ..... 12

9.2.2 *Polarity Test Three Phase - CNE*..... 13

9.3 APPENDIX 3..... 14

9.3.1 *Phase Rotation*..... 14

9.4 APPENDIX 4..... 15

9.4.1 *Insulation resistance test/Continuity Test SNE* ..... 15

9.4.2 *Insulation resistance test/Continuity Test - CNE* ..... 15

9.5 APPENDIX 5..... 16

9.5.1 *Continuity Tests from Cut-out to Service Mains Termination Position*..... 16

9.6 APPENDIX 6..... 17

9.6.1 *Polarity Check Carried out at Socket Outlet Position within Customers Property*..... 17

APPENDIX 7 ..... 17

9.7.1 *Earth Loop Impedance - SNE* ..... 17

9.7.2 *Earth Loop Impedance – CNE*..... 18



## 6. INTRODUCTION

When extensions to the **System** are being connected, whether service(s) or mains, the following tests shall where practicable be carried out prior to connection of the extension(s):

- Insulation resistance test.
- Continuity test.

When work has been carried out to install a new service cable, repair a cable fault on an existing service or reposition a service position, etc the cut-out fuse(s) shall not be installed before the following tests have been successfully carried out:

- Single phase service:
  - Voltage test.
  - Polarity test.
  - Earth loop impedance test.
- Three phase service:
  - Voltage test.
  - Polarity test.
  - Phase rotation test.
  - Earth loop impedance test.

During the course of the testing detailed within this document, it may be necessary to isolate existing customers' installations. Before the customer's installation is **Isolated**, the customer shall be advised that any sensitive electrical equipment (e.g. personal computers or satellite systems), should be switched off to avoid damage.

Where the testing identifies any defect on the customer's installation (e.g. reverse polarity at a socket outlet, defective earthing, etc), the defect shall be brought to the attention of the customer. If appropriate, the customer's installation shall be left switched off at the main switch(es). In these circumstances, the customer shall be advised to contact a Competent electrician to carry out appropriate repairs before switching the installation on.

## **7. TESTING PROCEDURES**

### **7.1 Polarity test**

#### 7.1.1 New Services

Where the polarity test is being carried out following the installation of a new service, the test shall be carried out in accordance with the diagrams in Appendix 1 (single phase services) and Appendix 2 (three phase services).

#### 7.1.2 Existing Services

Where the polarity test is being carried out following work on an existing service, in addition to the test detailed in Appendices 1 and 2, polarity shall be checked on the customer's installation in the following manner:

At the socket outlet closest to the cut-out position, check polarity using either the **Approved** 'Ring Main Tester' on a 13A socket outlet or the **Approved** Test Lamp on a 15A socket outlet. Where reasonably practicable, this test shall be carried out on the customer's ring main circuit.

During the course of the test appropriate PPE, as required by the Live Working Manual, shall be worn.

#### 7.1.3 SNE Service

Where the service is SNE the test shall be carried out using the **Approved** Test Lamp.

#### 7.1.4 CNE Service

Where the service is CNE the test shall be carried out using the **Approved** 'Neo Mains Tester'.

Note: When the Neo Mains tester is being used, one Insulated Glove must be removed otherwise the tester will not provide correct indication. Contact with exposed metalwork shall be avoided whilst using the Neo Mains tester.

### **7.2 Phase rotation test**

#### 7.2.1 New services

Where the phase rotation test is being carried out following the installation of a new service, the test shall be carried out in accordance with the diagrams in Appendix 3. The supply shall be installed with the 'National Standard' phase rotation, i.e. R-Y-B, at the meter terminals.



Upon successful completion of the phase rotation test, all phases shall be identified at the service position in accordance with **Company** procedures.

The test shall be carried out using an **Approved** phase rotation meter. During the course of the test appropriate PPE, as required by the Live Working Manual, shall be worn.

#### 7.2.2 Work associated with existing services

When work is being carried out on an existing service (e.g. service reposition), where practicable the phase rotation tests detailed in Appendix 3 shall be carried out prior to the commencement of work to establish the original phase rotation.

Upon completion of the work phase rotation shall be tested in accordance with Appendix 3. The supply shall be reconnected with the original phase rotation.

When work is being carried out on an existing service and it is not practicable to complete the tests detailed in Appendix 3 prior to the commencement of work to establish the original phase rotation (e.g. under fault conditions), the work shall be carried out as follows:

- Where practicable, enquiries shall be conducted to establish whether the customer's installation has any 3-phase machinery.
- Where it is established that there is no 3-phase machinery, work shall be completed and the supply connected with 'standard' phase rotation.
- Where it is established that there is 3-phase machinery, then:
  - Work shall be carried out up to the stage where the cut-out can be made **Live** safely, although the full extent of the work may not be complete, e.g. on an underground service the cable joint does not have the shell applied. Under no circumstances shall a joint be left unattended without the shell having been applied. The work to this point shall be carried out with the intention of establishing 'standard' phase rotation.
  - Tests in accordance with Appendix 3 shall be carried out to establish phase rotation.
  - A suitable item of machinery shall be run safely to establish whether it is rotating in the correct direction.
  - If the rotation of the machinery is correct, the work shall be completed with that supply phase rotation.
  - If the rotation of the machinery is incorrect, such alterations as required shall be carried out to reverse the supply phase rotation.
  - The rotation of the machinery shall be re-checked to ensure it is correct.
  - Work shall then be completed.
- Where it cannot be established whether there is any 3-phase machinery present, work shall be completed to provide a supply with standard rotation, the fuse carriers shall be inserted and sealed with the cut-out fuses left out. Where appropriate, one phase of the installation may be energised to provide lighting, heating, etc. The customer shall be advised that the cut-out fuses will be installed when the enquiries and tests outlined above have been completed.



Upon successful completion of the phase rotation test, all phases shall be identified at the service position in accordance with **Company** procedures.

Throughout all of the above procedures, tests shall be carried out using an **Approved** phase rotation meter. During the course of the tests appropriate PPE, as required by the Live Working Manual, shall be worn.

### **7.3 Earth Loop impedance test**

An earth loop impedance test shall be carried out on every occasion when work has been undertaken at the service position, irrespective of whether work has been carried out on the supply earth. This test shall be carried out to ensure that the supply earth provided meets minimum statutory requirements.

The test shall be carried out between phase, neutral and the PowerSystems earth terminal at either the PowerSystems isolator, or if there is no isolator present at the cut-out position. Where there is no isolator fitted, consideration shall be given to fitting an isolator at this time.

The test shall be carried out with the customer's installation **Isolated** and the customer's earth disconnected. The customer's earth shall be disconnected to ensure that the measured value of the earth loop impedance is not rendered artificially low due to connection to metallic water pipes, gas pipes, etc.

An **Approved** earth loop impedance tester shall be used in conjunction with the appropriate PPE, in accordance with the Live Working Manual. The earth loop impedance tester shall be operated and the test completed in accordance with the manufacturer's operating instructions.

The maximum acceptable earth loop impedance values are:-

- SNE services - 0.8 ohms
- PME services - 0.35 ohms

Should a value greater than that stated above be measured, then checks shall be carried out to determine whether the fault lies with the newly connected service (e.g. as a result of a poor earth connection between the service cable and the existing mains cable) or on the existing main. In the event that it is suspected that the fault lies on the main, then the fault shall be reported for immediate investigation as other customers could be similarly affected.

Note: New services shall not be connected, or in the case of an existing service it shall not be re-connected, until such time as corrective actions have been completed to bring the earth loop impedance in line with the maximum values stated above.

Immediately following completion of the test it shall be ensured that the customer's earth has been reconnected and the customer's installation shall be switched on.

An earth loop impedance test shall then be carried out on the customer's installation at the socket outlet closest to the cut-out position. Should any problem be identified on the



customer's earthing system, the defect shall be brought to the attention of the customer. Where appropriate, the customer's installation shall be left switched off at the main switch(es). In these circumstances, the customer shall be advised to contact a Competent electrician to carry out appropriate repairs before switching the installation on.

## **8. CONNECTION OF UNDERGROUND EXTENSIONS TO THE SYSTEM**

### **8.1 Connection of Underground Services Only**

Before work or testing is commenced to allow connection of the services, the jointer shall, where reasonably practicable, confirm the information within the work request by completing the following checks/tests:-

- Check that the details on the work request match the conditions on site in terms of the number of services to be connected and the addresses of the services to be connected. Where any discrepancies are identified, no services shall be connected until all discrepancies have been resolved.
- Carry out a visual check that for every service that has been requested, there is a service cable in place, correctly terminated into an **Approved** cut-out (where the installation of the cut-out does not form part of his work request). Where any discrepancies are identified, no service shall be connected until all discrepancies have been resolved.

Upon completion of the above checks, but before the services are connected to the **System**, the following checks/tests shall be carried out:

- As-laid records shall be examined to ensure that they show the service is fully installed, e.g. all intermediate joints have been completed.
- An insulation resistance test shall be carried out between each phase conductor and the neutral individually, in accordance with Appendix 4. If the service is SNE, the same test shall also be carried out between each phase conductor and the earth individually and then between the neutral and earth. The test shall be carried out using an **Approved** insulation resistance tester. The insulation resistance shall equal or exceed 5 M $\Omega$  to allow the service to be connected.
- A continuity test shall be carried out on each conductor (phase, neutral and earth as appropriate) individually, in accordance with Appendix 4.

Once the above checks and tests have been successfully completed the service may be connected to the **System**. Where it has not previously been installed, the cut-out shall be completed first with the fuse carrier in place but the cut-out fuse left out.

### **Main Live**



Where the main to which the service is being connected is **Live**, once the service has been connected, a polarity test, a phase rotation test (on 3-phase services) and an earth loop impedance test shall be carried out as detailed within this procedure.

Subject to the satisfactory completion of the above tests, the cut-out shall be sealed in accordance with **Company** procedures.

### Main Not Live

Where the main to which the service is being connected is not **Live**, it is not practicable to carry out the normal tests detailed within this procedure, e.g. voltage, polarity, earth loop impedance, etc. At this point, the cut-out fuse carrier shall be inserted without a fuse being fitted and the cut-out shall be sealed in accordance with **Company** procedures.

In these circumstances, the responsibility to ensure correct voltage, polarity, earth loop impedance, etc shall rest with the **Authorised Person** who receives the work instruction to connect the customer's installation. No such connection shall be carried out until all appropriate tests have been successfully carried out in accordance with Section 7 of this document.

## **8.2 Connection of Underground Mains With or Without Services**

Where the extension to the **System** runs to a terminal pot-end, when reasonably practicable, the work instruction to connect the extension to the **System** shall include the instruction to carry out the terminal pot-end joint. This will facilitate the continuity test required below.

Before these extensions are connected to the **System**, the following checks/tests shall be carried out:

- As-laid records shall be examined to ensure that they show the extension to the **System** is fully installed.
- Prior to connection, the **Authorised Person** shall ensure that he is in receipt of all appropriate third party developer paperwork (e.g. record of completed jointing works, record of completed insulation resistance tests, including measured values, etc) in accordance with **Company** procedures.
- If the extension to the **System** includes services, a visual on-site check shall be carried out to ensure that for every service that has been requested, there is a service cable in place correctly terminated into an **Approved** cut-out, with the cut-out fuse removed. If any discrepancies are identified, the extension shall not be connected until all discrepancies have been resolved.
- At the point of connection to the **System**, an insulation resistance test shall be carried out, as detailed within this procedure, between each phase conductor and the neutral, individually. If the cable is SNE, the same test shall also be carried out between each phase conductor and the earth individually and then between neutral and earth. The test shall be carried out using an **Approved** insulation resistance tester. To allow connection the insulation resistance shall equal or exceed 5 MΩ.





- Where reasonably practicable, a continuity test, as detailed within this procedure, shall be carried out between the point of connection and the terminal pot-end position (or the other point(s) of connection where the extension to the **System** is to be an interconnector). If the terminal pot-end joint has been completed prior to this point, where reasonably practicable a continuity test shall be carried out between the point of connection to the **System** and the furthest service connection on the extension.

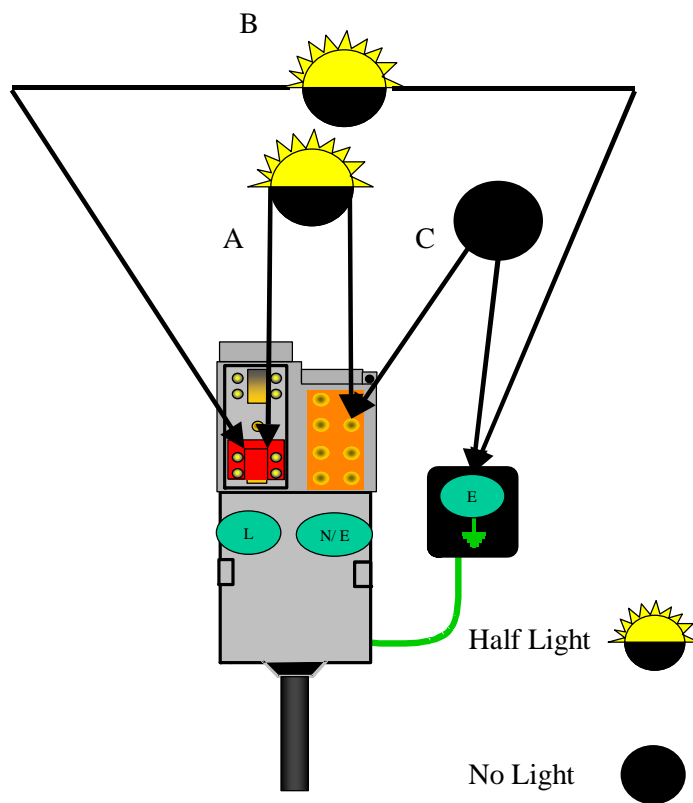
Upon completion of the above checks/tests, the extension may be connected to the **System**.

Where the extension includes services, a polarity test, a phase rotation test (on 3-phase services) and an earth loop impedance test, as detailed in this procedure, shall be carried out at every cut-out position. Following these tests the cut-outs shall be sealed in accordance with **Company** procedures.

**9. APPENDICES**

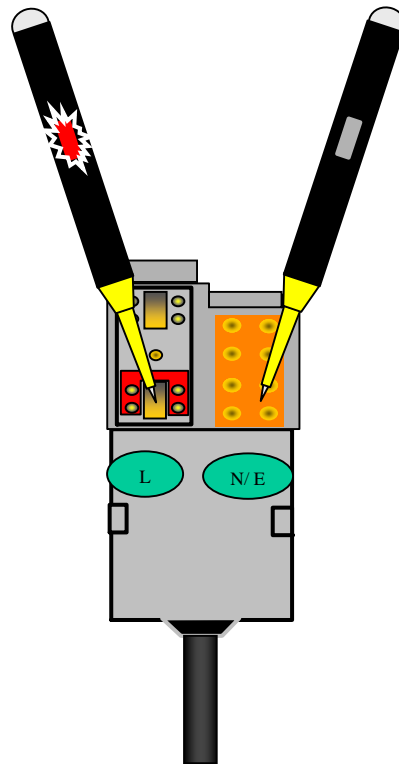
**9.1 Appendix 1**

9.1.1 Polarity Test - Single Phase SNE



A = Test lamp between Phase and Neutral ( Half Light 230 volts)  
 B = Test lamp between Phase and Earth (Half Light 230 volts)  
 C = Test lamp between Neutral and Earth (No Light 0 volts)

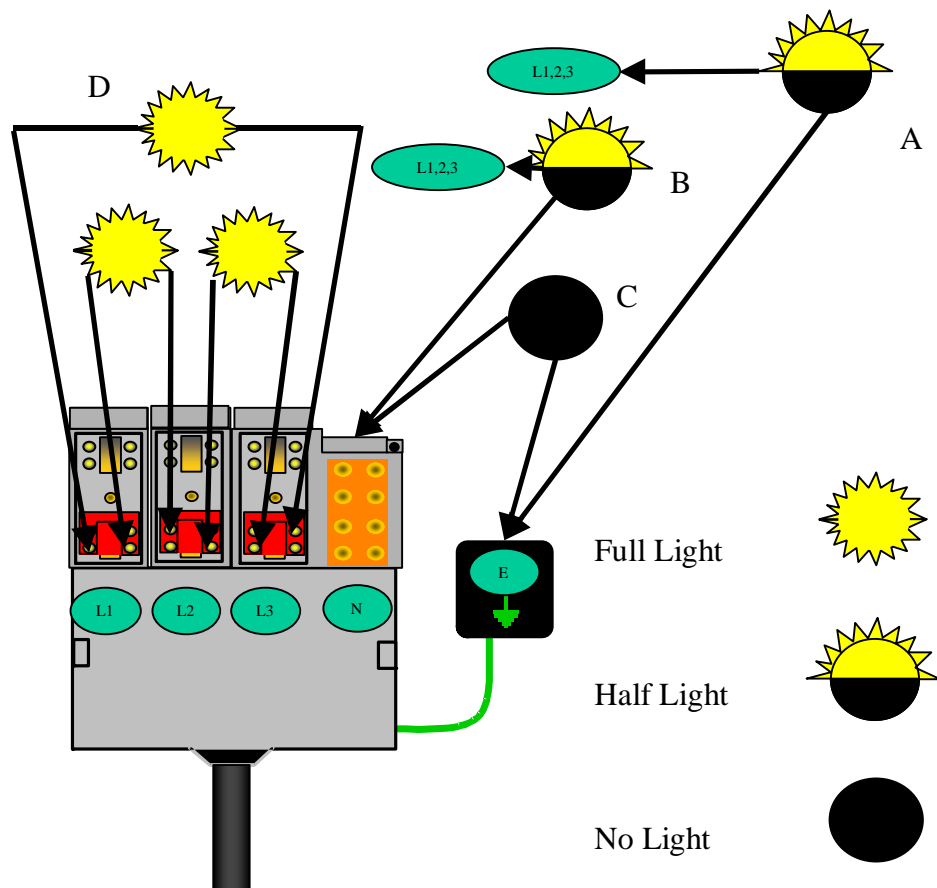
9.1.2 Polarity Test - Single Phase CNE



A = Neo-mains tester - Apply to phase. (Light)  
B = Neo-mains tester - Apply to neutral/earth (No Light)

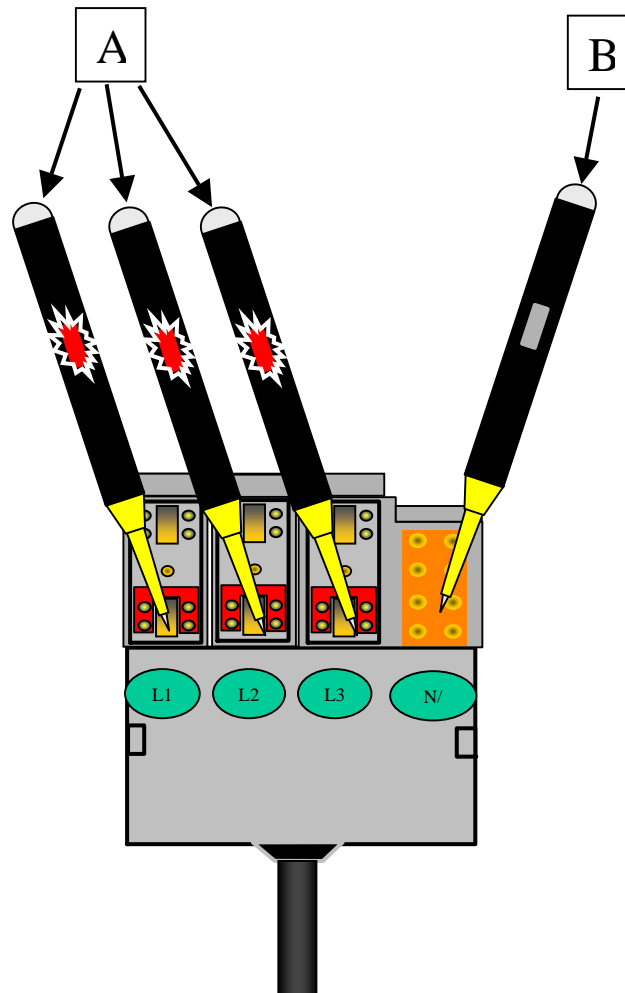
## 9.2 Appendix 2

### 9.2.1 Polarity Test Three Phase - SNE



- |   |
|---|
| A = Test lamp between all Phases (L1,2,3) and Earth ( Half Light 230 volts)   |
| B = Test lamp between all Phases (L1,2,3) and Neutral ( Half Light 230 volts) |
| C = Test lamp between Neutral and Earth (No Light 0 volts)                    |
| D = Test lamp between all Phase (L1,2 and 3) ( Full Light 400 volts)          |

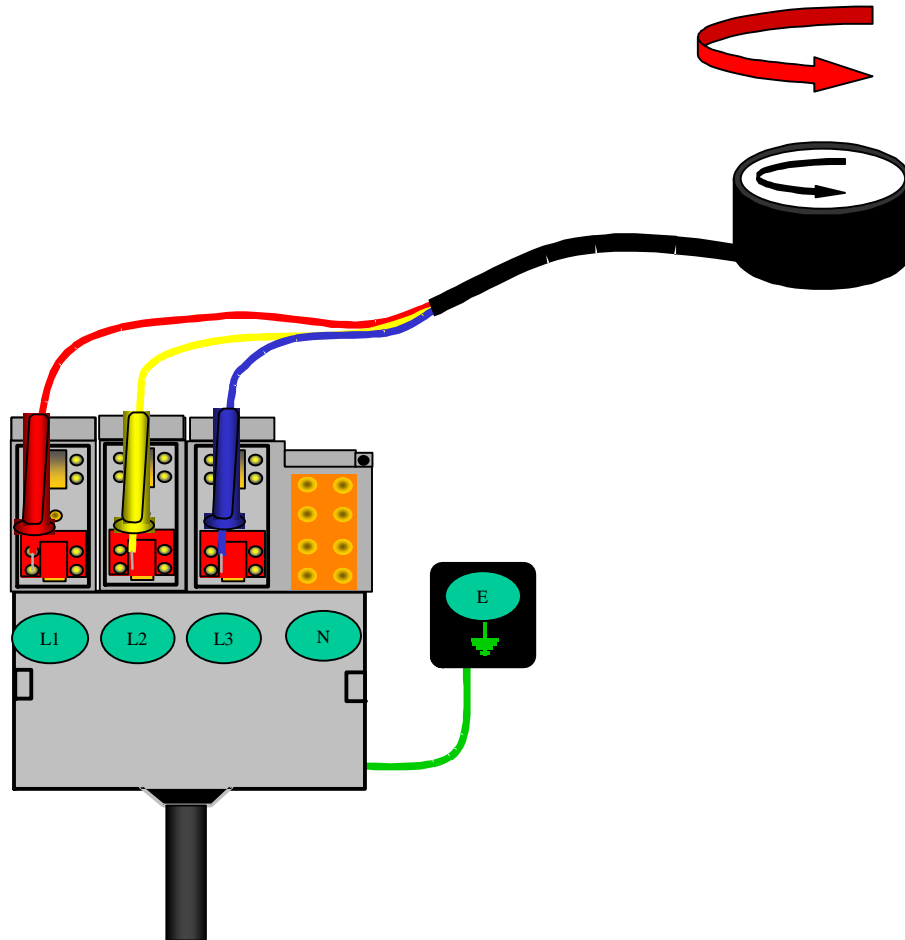
9.2.2 Polarity Test Three Phase - CNE



A = Neo-mains tester - Apply to all phases separately. (Light)  
B = Neo-mains tester - Apply to neutral/earth (No Light)

**9.3 Appendix 3**

9.3.1 Phase Rotation



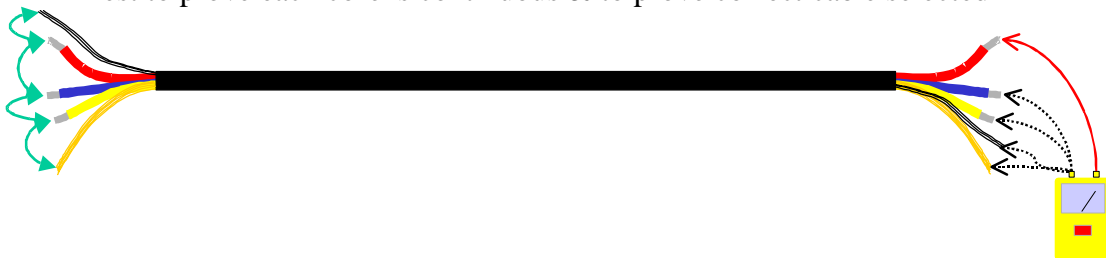
## 9.4 Appendix 4

### 9.4.1 Insulation resistance test/Continuity Test SNE

Test to prove each core is clear between Phase to Phase, Phase to Neutral & Neutral to Earth



Test to prove each core is continuous & to prove correct cable selected



### 9.4.2 Insulation resistance test/Continuity Test - CNE

Test to prove each core is clear between Phase to Phase and Phase to Neutral /Earth



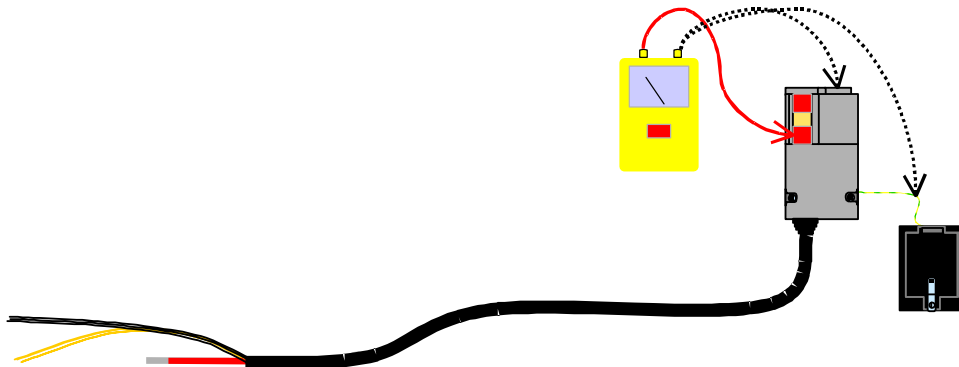
Test to prove each core is continuous & to prove correct cable selected



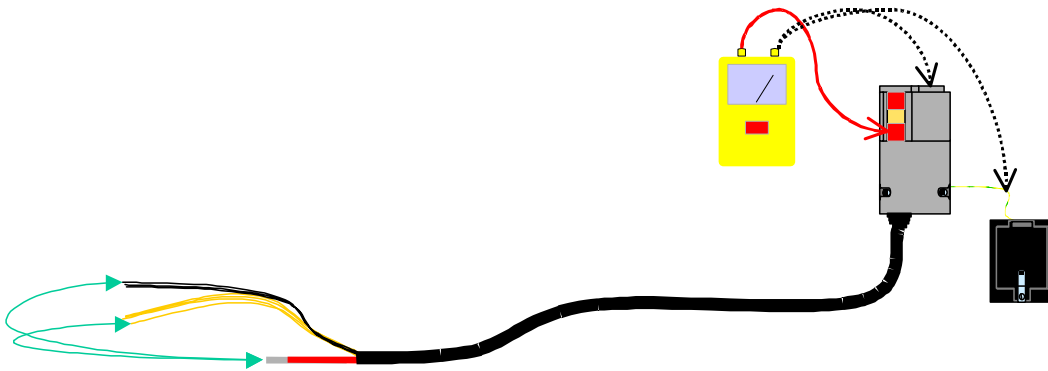
**9.5 Appendix 5**

9.5.1 Continuity Tests from Cut-out to Service Mains Termination Position

Test cable from cut out to prove cable clear



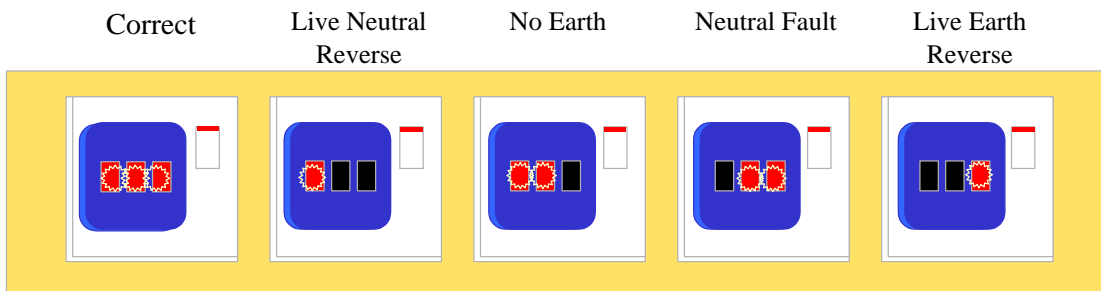
Test cable from cut out to “short” to prove continuous





**9.6 Appendix 6**

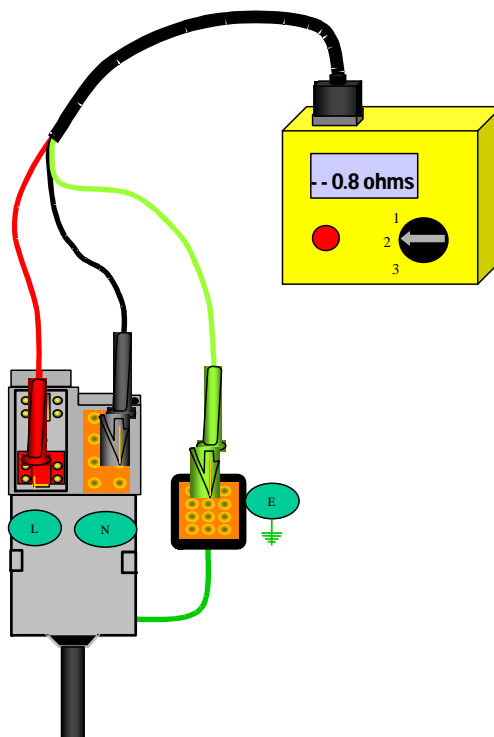
9.6.1 Polarity Check Carried out at Socket Outlet Position within Customers Property.



The above indications are of one specific type of 13amp socket tester.  
 Authorised persons shall refer to the operating instruction of the unit being used.

**9.7 Appendix 7**

9.7.1 Earth Loop Impedance - SNE



9.7.2 Earth Loop Impedance – CNE

