

## TESTING AND INSPECTION OF ELECTRICAL INSTALLATIONS

All new installations must be inspected and tested during erection and upon completion before being put into service. All existing installations should be periodically inspected and tested to ensure that they are safe and meet the regulations of the IEE

### Factors which the installation must be protected against are:

- ✓ Earth leakage and danger of electric shock
- ✓ Excess current
- ✓ Moisture and corrosion

### The reasons for testing the installation are:

- ✓ to ensure that the installation complies with the Regulations,
- ✓ to ensure that the installation meets the specification,
- ✓ to ensure that the installation is safe to use.

## INSPECTION

The installation must be visually inspected before testing begins. The aim of the visual inspection is to confirm that all equipment and accessories are undamaged and comply with the relevant Standards, and also that the installation has been securely and correctly erected

**Regulation 611.3 gives a checklist for the initial visual inspection of an installation; this may include the following however the list is not exhaustive**

- i. **Connection of conductors:** Are terminations electrically and mechanically sound and whether insulation and sheathing is removed only to a minimum to allow satisfactory termination?
- ii. **Identification of conductors:** Are conductors correctly identified in accordance with the IEE Regulations?
- iii. **Routing of cables:** Are cables installed in such a way that account is taken of external influences such as mechanical damage, corrosion, heat, etc.?
- iv. **Conductor selection:** Are conductors selected for current-carrying capacity and voltage drop in accordance with the design?
- v. **Connection of single pole devices:** Are single pole protective and switching devices connected in the line conductor only?
- vi. **Accessories and equipment:** Are all accessories and equipment correctly connected?
- vii. **Thermal effects:** Are fire barriers present where required and protection against thermal effects provided?
- viii. **Protection against shock:** What methods have been used to provide protection against electric shock?
- ix. **Mutual detrimental influence:** Are wiring systems installed such that they can have no harmful effect on nonelectrical systems, and whether the systems of different currents or voltages are segregated where necessary?
- x. **Isolation and switching:** Are there correctly located and installed appropriate devices for isolation and switching?
- xi. **Protective devices:** Are protective and monitoring devices correctly chosen and set to ensure fault protection and/or overcurrent?

- xii. **Labelling:** Are all protective devices, switches (where necessary) and terminals correctly labelled?
- xiii. **External influences:** Have all items of equipment and protective measures been selected in accordance with the appropriate external influences?
- xiv. **Access:** Are all means of access to switchgear and equipment adequate?
- xv. **Notices and signs:** Are danger notices and warning signs present?
- xvi. **Diagrams:** Are diagrams, instructions and similar information relating to the installation available?
- xvii. **Erection methods:** Have all wiring systems, accessories and equipment been selected and installed in accordance with the requirements of the IEE Regulations, and are fixings for equipment adequate for the environment?

**Isolation** means the disconnection and separation of the electrical equipment from every source of electrical energy in such a way that this disconnection and separation is secure.

❖ **Documentation required and to be completed during inspection and testing**

The document that is required as part of the verification process is the Electrical Installation Certificate/wiring certificate signed or authenticated for the design and construction (could be the same person), and then for the inspection and test. A schedule of test results and an inspection schedule must accompany an Electrical Installation Certificate.

**PERIODIC INSPECTION AND TESTING**

The wiring regulations require that installations be inspected and tested at regular intervals as follows:

- ❖ General installations – 5 years (Maximum)
- ❖ Temporary installations – 3 months (maximum)
- ❖ Caravan sites – 1 year
- ❖ Agricultural installations – 3 years

**TEST INSTRUMENTS COMMONLY USED INCLUDE THE FOLLOWING**

1. **Continuity tester**  
Produces an open circuit voltage of between 4 and 24 V ac or dc and delivers a short circuit current of not less than 200mA
2. **Insulation resistance tester**  
Detects insulation leakage between live conductors and between live conductors and earth. It produces a test voltage of 250V, 500V or 1000V and delivers an output current of not less than 1 mA at its normal voltage.
3. **Earth fault loop impedance tester**  
Delivers fault currents as high as 25A for up to 40ms using the supply voltage. During the test, the instrument does an ohm`s law calculation and displays the test result as a resistance reading.
4. **RCD tester**

Used where circuits are protected by a residual current detector (RCD) to ensure that the device will operate very quickly under fault conditions and within time limits set by IEE regulations. It simulates a fault and measures the time taken for the RCD to operate. It is calibrated to give a reading measured in milliseconds to an in-service accuracy of 10%.

## 5. Phase sequence tester

The tests order of sequence given in Regulation 612.1 for reasons of safety and accuracy are as follows:

### Tests Before the supply is connected

1. Test for continuity of protective conductors, including protective equipotential and supplementary bonding.
2. Test the continuity of all ring final circuit conductors.
3. Test for insulation resistance.
4. Test for polarity using the continuity method.
5. Test the earth electrode resistance.

### Tests With the supply connected

6. Test the earth fault loop impedance.
7. Carry out additional protection testing (e.g. operation of residual current devices, RCDs).

### The tests should be carried out on:

- ✓ New installations
- ✓ Additions to existing installations
- ✓ Periodically on existing installations

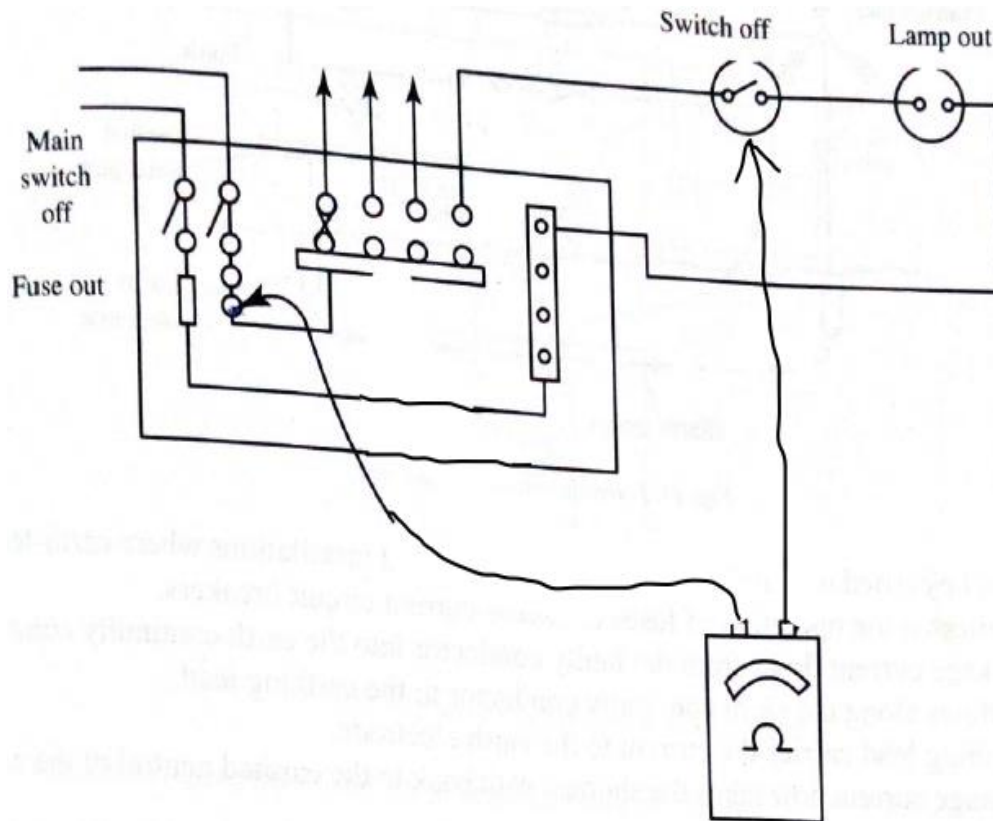
## **POLARITY TEST**

The purpose of this test is to check that the live conductor is taken through the fuse or MCB and switch to the appliances. The polarity of the switches is tested before the installation is connected to the supply. Instrument used is Ohm meter or Bell set.

### *Preparation for the test*

- ✓ *Supply OFF*
- ✓ *Fuses or MCB OUT*
- ✓ *Lamps and appliances OUT/disconnected*
- ✓ *Neutral links IN*
- ✓ *Single pole switches ON*

One lead of the polarity tester is connected to the phase or outer conductor at the outgoing side of the main fuses. The other lead is touched to the terminals of the single pole switches in turn. Provided the polarity is correct the instrument reading will be less than  $1\Omega$  normally. If the single pole switch is in the incorrect conductor the instrument reading will be infinity



pg 117 of TG Francis for more diagrams

### **EFFECTIVENESS OF EARTHING TESTS**

The purpose of this test is:

- ✓ To measure the resistance of the earth continuity conductor
- ✓ To ensure that the earth electrode is effectively connected to the general mass

### **EARTH CONTINUITY**

The purpose of the test is to measure resistance of the earth continuity conductor so as to ensure that should there be an electrical fault, all exposed metal work in a building is bonded together and connected to the earth block in the consumer unit, leaking the current to earth and automatically disconnecting the supply. This test will verify that exposed metalwork in a building is bonded together and connected to the earthing block in the consumer unit.

The ohmmeter leads are connected between the points being tested, between simultaneously accessible conductive parts e.g. pipe works, sinks etc. this test will verify that the conductor is sound.

### **EARTH FAULT LOOP IMPEDANCE TEST**

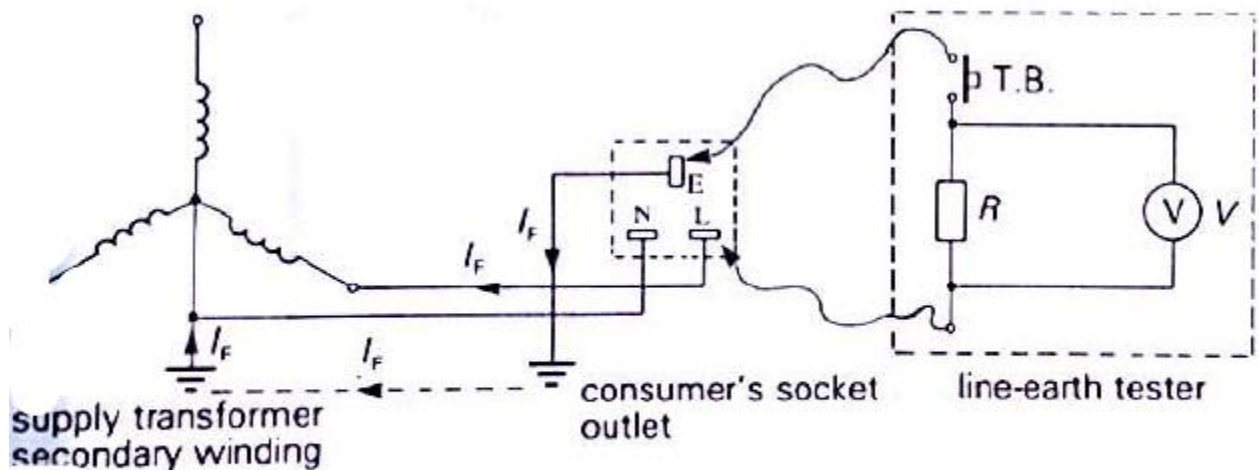
The earth fault loop is the path which the leakage current will take back to the supply transformer when there is an earth leakage in an installation. the test must be carried out on any new or largely

modified installations where earth leakage protection relies on the operation of fuses or excess current circuit breakers

The purpose of this test is to show that the earth fault loop is capable of carrying heavy leakage currents so that the protective gear will operate when leakages occur. The instrument used is the Line earth loop tester (Megger tester)

The test must be carried out on any new or largely modified installations where earth leakage protection relies on the operation of fuses or excess current circuit breakers.

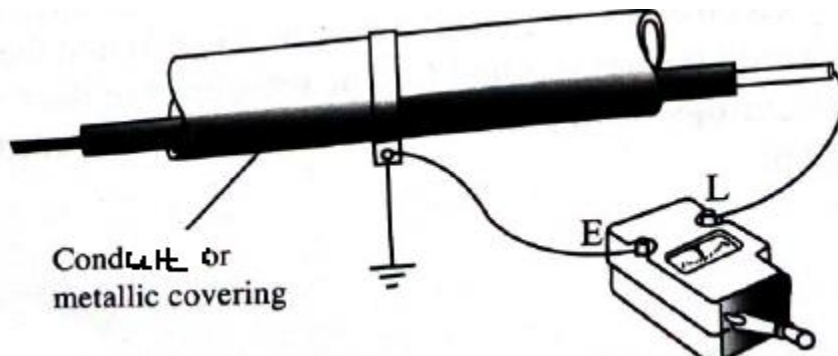
- i. The leakage current flows from the faulty conductor to the earthing lead
- ii. It then flows along the earth continuity conductor to the earthing lead
- iii. The earthing lead carries the current to the earth electrode
- iv. The leakage current now takes the shortest path back to the earthed neutral of the supply transformer



Line earth-loop impedance test.

### INSULATION RESISTANCE TEST

The purpose of this test is to make sure that there is no possibility of leakage currents flowing between insulated conductors and also to make sure that there is no leakage of current between the conductors of the installation and the general mass of earth



## TESTING FOR CONTINUITY OF RING FINAL CIRCUIT CONDUCTORS

### Reasons for the test include:

- ✓ To ensure that all ring circuit cables are continuous around the ring, that is, that there are no breaks and no interconnections in the ring,
- ✓ To ensure that all connections are electrically and mechanically sound.
- ✓ To verify the polarity of each socket outlet.

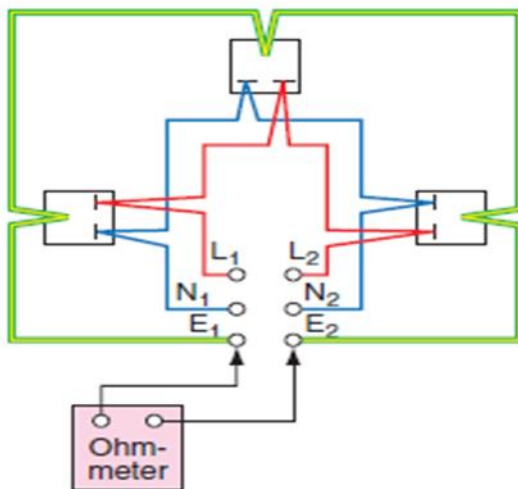
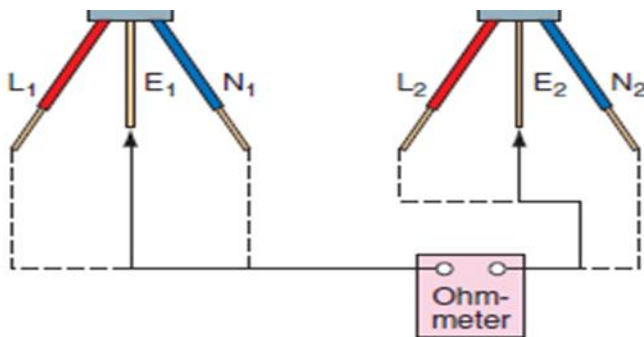
### Procedure

The test is made with the supply disconnected, using an ohmmeter as follows:

Disconnect and separate the conductors of both legs of the ring at the main fuse. There are three steps to this test:

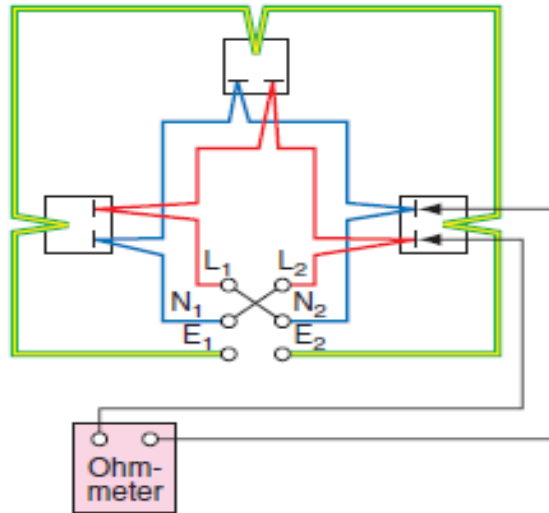
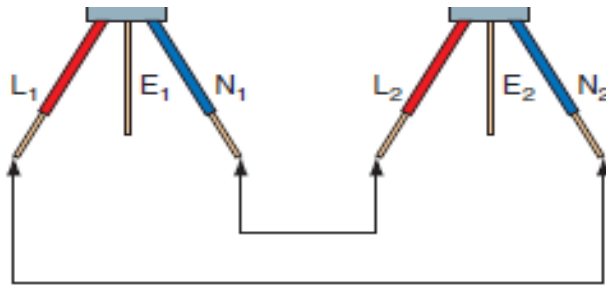
#### Step 1

- ✓ Measure the resistance of the line conductors (L1 and L2), the neutral conductors (N1 and N2) and the protective conductors (E1 and E2) at the mains position as shown below
- ✓ End-to-end live and neutral conductor readings should be approximately the same (i.e. within  $0.05 \Omega$ ) if the ring is continuous.
- ✓ The protective conductor reading will be 1.67 times as great as these readings if 2.5/1.5 mm cable is used.



#### Step 2

- ✓ The live and neutral conductors should now be temporarily joined together as shown below.
- ✓ An ohmmeter reading should then be taken between live and neutral at every socket outlet on the ring circuit. The readings obtained should be substantially the same, provided that there are no breaks or multiple loops in the ring.
- ✓ Each reading should have a value of approximately half the live and neutral ohmmeter readings measured in Step 1 of this test.
- ✓ Sockets connected as a spur will have a slightly higher value of resistance because they are fed by only one cable, while each socket on the ring is fed by two cables



### Step 3

- ✓ Where the CPC is wired as a ring, for example where twin and earth cables or plastic conduit is used to wire the ring, temporarily join the live and CPCs together as shown below
- ✓ An ohmmeter reading should then be taken between live and earth at every socket outlet on the ring.
- ✓ The readings obtained should be substantially the same provided that there are no breaks or multiple loops in the ring. This value is equal to  $R1 + R2$  for the circuit.
- ✓ Record the results on an installation schedule such as that given in Appendix 6 of the IEE Regulations or a table as shown in the table below
- ✓ The Step 3 value of  $R1 + R2$  should be equal to  $(r1 + r2)/4$ , where  $r1$  and  $r2$  are the ohmmeter readings from Step 1 of this test