INDUSTRIAL ELECTRICAL MACHIN DRIVE TECHNOLOGY LEVEL II

LEARNIG GUIDE . 18

Unit of Competence:	**Install and terminate wiring system**
Module Title:	**Installing and terminating wiring system**
LG Code:	**EEL EMD2 05 0811**
TTLM Code:	**EEL EMD2 M05 1019**

LO3 Inspect and notify completion of work

Instruction Sheet	Learning Guide #18

This learning guide is developed to provide you the necessary information regarding the following learning outcome and content coverage

MODULE CONTENTS:

LO3: Inspect and notify completion of work

- Inspection of installed apparatus
- Functional test of installed apparatus
- Notification of completion work

-This guide will also assist you to attain the learning outcome and contents stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Inspect installed apparatus
- Test the installed apparatus
- Notification of completion work

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instruction described blew 3 to 5
3. Read the information written in the "Information Sheet 1 up to information sheet 3".
4. Accomplish the "Self-check 1, self-check 2, and Self-check 3, " in page (7, 30 and 32) respectively.
5. If you earned a satisfactory evaluation from the "Self-check" proceed to other information sheet.

1. Inspection of installed apparatus

Step 1 - before you start inspecting switch off the power and unplug the equipment**.** Never open the casing of the equipment. If you suspect there is a fault inside the casing you should seek help from someone appropriately qualified.

Step 2 - the electrical cable Run the cable slowly through your hands and feel for any lumps, cuts or rough areas. At the same time inspect all round the cable whilst working down it a little section at a time. Watch out for any areas that are discoloured, this might indicate an area of damage. Be particularly vigilant with any part of the cable that may be prone to having equipment sat on it or that may be habitually curved or twisted. These are sections that are likely to become damaged.

If any part of the outer insulation of the cable is breached, or if you have reason to believe that thewires within it may be damaged, refer immediately to Step 5.

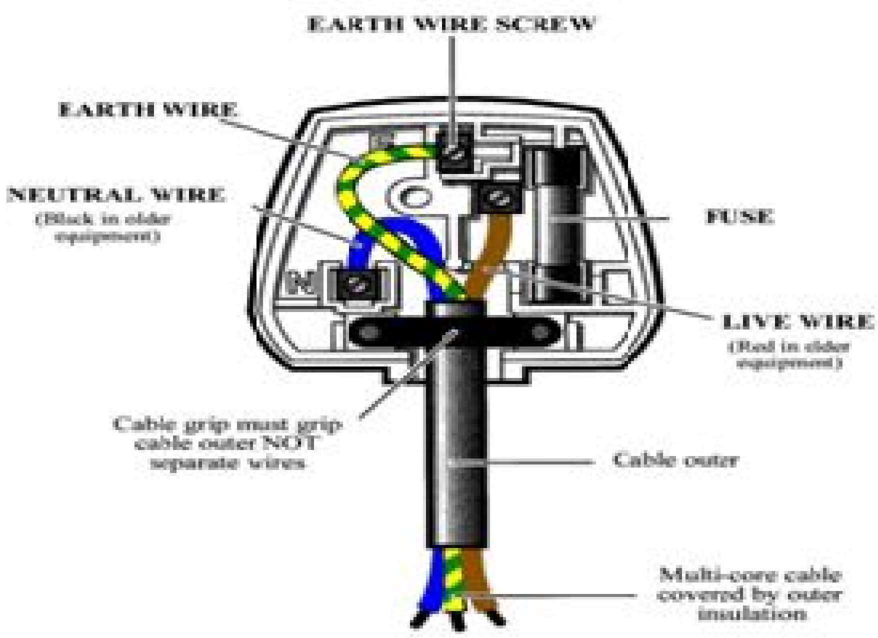
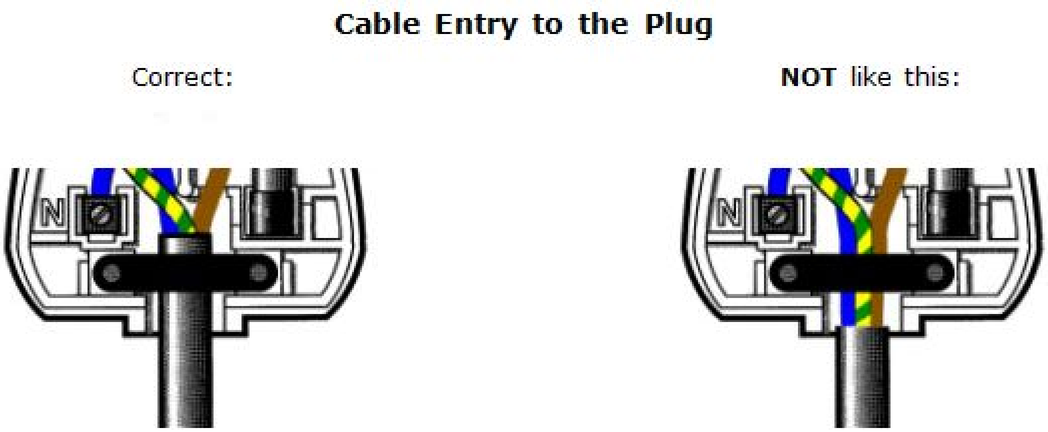


Fig 1

Begin your inspection of the plug by looking at the point where the cable enters it. The outer insulation of the cable should be tightly gripped by the plug cable grip and none of the thinner internal wires should be visible from the outside of the plug.



The plug casing Next look at the plug itself. The casing should not be cracked, chipped or damaged. There should be no bent pins. If the plug is not permanently bonded to the cable you should be able to open the casing using a small screwdriver. Again look closely at the point where the cable enters the plug through the cable grip, this time examining it from the inside of the plug. As before, the outer cable should be securely gripped and the thinner inner cables should emerge from the outer only beyond this point.

The wires within the plug Next examine each of the individual thinner cables. It is not necessary to unwire the plug to do this. Make sure that the BROWN wire (RED in older equipment) is connected to the LIVE terminal (usually labelled L), that the BLUE wire (BLACK in older equipment) is connected to the NEUTRAL terminal (usually labelled N) and that the GREEN and YELLOW wire is connected to the EARTH terminal (often labelled E, this is at the top of the plug). Ensure that there are no damaged parts on any of the cables and make sure that there is no excess cable that may snag or be trapped when the plug is re-assembled. If any of the smaller cables are too long you may see rub or pinch marks on the outer insulating surface. You should check the point where the inner wires are connected to the plug terminals and ensure that there is not an excessive amount of bare wire exposed. Ideally the insulating outer should cover the inner conducting wire entirely and no conducting wire should be visible. In practice this is often difficult to achieve and it may be necessary to have a gap of about one millimetre of conductor showing between the insulating material and the terminal.

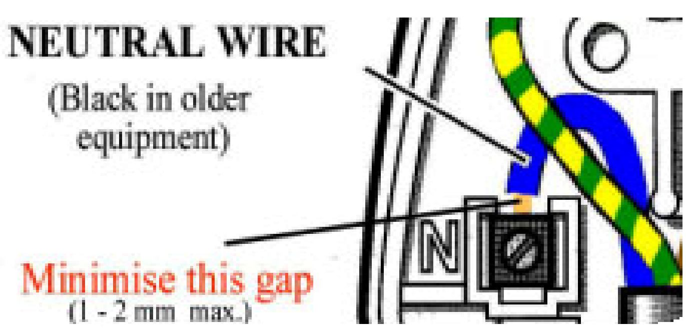


Fig 2

Finally check the connections at each terminal. Ensure that the conducting wire is securely housed and that no stray wires are sticking out. Make sure that the terminal screws are securely tightened.

What if there are only two wires inside the plug?

Remember that some appliances have a cable that contains only two wires (e.g. some desk lamps). If you see only two wires when you open the plug take a close look at the end of the cable where these wires emerge. Make sure that there isn't a third wire that has been cut off. You should also check that the two wires are connected correctly. This means that the BROWN (RED in older equipment) wire should be connected to the LIVE terminal and the BLUE (BLACK in older equipment) wire to the NEUTRAL just as they are when three wires are present. In this case the only wire that should be missing is the GREEN and YELLOW connection to the EARTH terminal.

A two wire plug:

Fig 3

Step 4 - the fuse Any plug that is designed to make a connection between a piece of equipment and a mains socket should be fitted with a cartridge fuse. In the case of sealed plugs this fuse is located in a compartment that can be opened from outside the plug. This compartment is located on the face of the plug from which the pins protrude. In unsealed plugs the fuse is located inside the body of the plug and is connected to the LIVE terminal next to the BROWN wire. When you open an unsealed plug to inspect the cables and connections the fuse should be readily visib

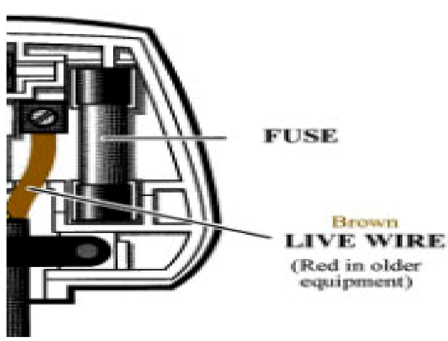


Fig 4

If you know the energy usage then the correct fuse rating can be calculated using the table below

'Wattage' of Equipment = Fuse Rating

'Wattage' of Equipment	Fuse Rating
Up to 600 Watts	3 Amps
Between 600 Watts and 1000 Watts (1KW)	5 Amps
Between 1KW and 3KW (3000 Watts)	13 Amps

Step 5 - Putting the equipment back into service

No faults observed

If you have found no faults it is now a simple matter to reassemble the plug. Before putting the equipment back into use you should label the plug to show that an inspection has been carried out.This label should give details of the date of inspection and who carried out the inspection. Proprietary labels may be purchased, but it is perfectly acceptable to use self-adhesive labels so long as they remain attached to the plug until the next inspection.

If you found one or more faults:

If you found any of the following simple faults you are likely to be competent to correct the by yourself:

- Incorrect fuse
- Missing fuse
- Connections inside the plug are loose
- Outer cable is not gripped tightly by the cable grip.

After a little practice most people are able to rewire a plug if they have the correct equipment. If you do not have the correct equipment to do this job, or if you feel it is beyond your ability you should seek assistance. If the cable is damaged you should not attempt to repair this and should seek assistance.If you have identified faults during the inspection that cannot be immediately fixed then the equipment should be taken out of service until the necessary repairs can be undertaken. This can be achieved by removing it to a secure storage area. If this is not possible the plug should be removed to prevent use. In all cases the equipment should be labelled to indicate that it should not be used.

Step 6 - Keeping records The department should keep a record of all of the equipment inspected. This record should include a description of the equipment, dates of each inspection and information about who carried out the inspection. You may also find it useful to record the size of fuse the equipment should have in its plug and to keep a record of any major faults and the steps taken to repair these.

Self-check 1	Written test

Name .... Date....................................

<u>Direction</u> Say true or false for the following question

1. If you start inspecting switch ON the power of the equipment
2. Recording should include a description of the equipment, dates of each inspection and information about who carried out the inspection.
3. Connections inside the plug loose and Missing are can corrected by yourself:
4. If you have reason to believe that the wires within it may be damaged, refer to Putting the equipment back into service

***Note:* Satisfactory rating - 5 points** **Unsatisfactory – 5 below**

Information Sheet-2	Functional test of installed apparatus

2.1 Functional test of installed apparatus

2.1.1 Initial Testing of an Installation

Before a utility will connect an installation to its supply network, strict pre-commissioning electrical tests and visual inspections by the authority, or by its appointed agent, must be satisfied. These tests are made according to local (governmental and/or institutional) regulations, which may differ slightly from one country to another. The principles of all such regulations however, are common, and are based on the observance of rigorous safety rules in the design and realization of the installation. IEC 60364-6-61 and related standards included in this guide are based on an international consensus for such tests, intended to cover all the safety measures and approved installation practices normally required for residential, commercial and (the majority of) industrial buildings. Many industries however have additional regulations related to a particular product (petroleum, coal, natural gas, etc.). Such additional requirements are beyond the scope of this guide. The pre-commissioning electrical tests and visual-inspection checks for installations in buildings include, typically, all of the following:

- Insulation tests of all cable and wiring conductors of the fixed installation, between phases and between phases and earth
- Continuity and conductivity tests of protective, equipotential and earth-bonding conductors
- Resistance tests of earthing electrodes with respect to remote earth
- Verification of the proper operation of the interlocks, if any
- Check of allowable number of socket-outlets per circuit
- Cross-sectional-area check of all conductors for adequacy at the short-circuit levels prevailing, taking account of the associated protective devices, materials and installation conditions (in air, conduit, etc.)
- Verification that all exposed- and extraneous metallic parts are properly earthed (where appropriate)
- Check of clearance distances in bathrooms, etc.

2.1.2 Periodic Check Testing of an Installation

In many countries, all industrial and commercial-building installations, together with installations in buildings used for public gatherings, must be re-tested periodically by authorized agents.

2.1.3 Testing of the Wiring Installation The test to be performed before a new installation or an addition to an existing installation is connected to the supply mains are as follows.

1) Testing insulation resistance between the wiring and the earth with all fuses and lamps in and all switches 'ON'.
2) The insulation resistance between the conductors with all lamps out and all switches 'ON'.
3) Testing of polarity of non-linked pole switches.
4) Testing of earth continuity path.
5) Testing of earth resistance

1. **Testing of Insulation Resistance Between the Wiring and Earth**:- The resistance offered to leakage from conductors to earth is known as **insulation resistance** between the wiring and the earth. The values of insulation resistance are so high that they are measured in Mega-ohms.

   The aim of this test is to know weather the wires or cables used in the wiring system are sufficiently insulated to avoid leakage of current. The instrument used to test the insulation resistance is known as Megger.

   Before making an insulation resistance ensures that: -

   i. Main switch is in off position
   ii. Main fuse is taken out
   iii. All other fuses are in position
   iv. All the switches are in 'on' position
   v. All the lamps are in their position or the holders are short-circuited and
   vi. Line and neutral terminals are shorted on the insulation resistance.

The measured resistance should not be less than 50 mega-ohms divided by the number of outlets.

2. **Testing the Insulation Resistance between Conductors** :- The objective of this test is to ensure that the insulation is sound between the conductors so that there may not be an appreciable leakage between them.

In this case::-

i. The loop at the main switch is removed.
ii. All the lamps and metallic connections between the two wires of the insulation are removed from the holders.

Reset of all things remaining the same i.e. the main switch off, main fuse with drawn, all other fuses in their positions and all single pole switches in 'on' position, the terminals of the Megger are connected to the two poles or lines of the installation and insulation resistance is measured between two conductors (line and neutral conductors).

3. **Testing Polarity of Single Pole Switches**:- It is necessary that single pole switches should always be placed in positive side or live side so that by making switch off the lamp can be made quite dead. The reason of it is that if the switch is provided on neutral wire, then lamp holder or the fan as well as part of wiring will remain a live, even when the single pole switch is in open position, which may lead to accidents.

To ensure that all switches are placed in phase or live conductors and not in neutral conductor, this test is performed. The instrument used to test polarity of single pole switches is neon tube tester (Pocket neon testing tube) or test lamp.

4. Testing of Earth Continuity Path:- For safely all the metallic pieces or covering such as conduits, metal covers of switches, etc. must be solidly connected to earth otherwise on the damage of insulation, the leakage current will start giving serve shock to the person touching it.
For earth continuity test, main switches should be opened, main fuse withdrawn, all other switches in on position and lamps in their respective holders. One end of the earth continuity tester is connected to an independent earth and the other end is connected to the wiring say to a switch or conduit. The pointer will indicate the earth resistance, which should not exceed the value of one ohm. Higher than this value shows that the conduit or switch has not been properly earthed.

5. Testing of Earth Resistance:- The determination of résistance between the earthing plate and the surrounding ground in distribution system is of utmost important. This measurement is done by potential fall method.

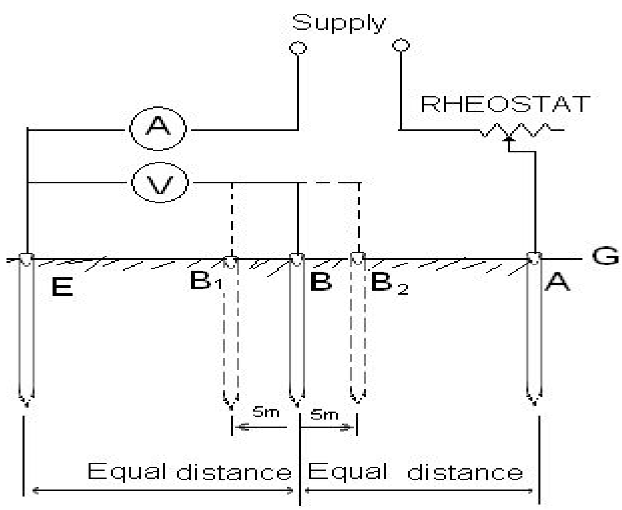


Fig.5 Testing of Earth Electrode resistance

The resistance area of an earth electrode is the area of soil around the electrode within which a voltage gradient measurable with commercial instrument exists. In fig. 1, E is the earth electrode under test, A is an auxiliary earth electrode positioned so that two resistance areas do not overlap. B is a second auxiliary electrode placed half way between E and A.

An alternating current is passed through the earth path from E to A and the voltage drop between E and B is measured.

$$The\ earth\ resis\tan ce\ R = \frac{Voltage\ drop\ between\ E\ and\ B}{Current\ throuhg\ earth\ path} = \frac{V}{I}$$

To ensure that the resistance area do not overlap, the auxiliary electrode B is moved to positions B_1 and B_2 respectively. If resistance values determined are of approximately the same magnitude in all the three cases, the mean of the readings can be taken as the earth resistance of the earth electrode. Otherwise the auxiliary electrode A must be driven in at a point further away from E and the above test repeated until a group of these readings is obtained which are in good agreement.

Inspection of Internal Wiring Installation

Internal wiring should be inspected once a year and the following points should be checked while carrying out inspection of the wiring installation.

1. **Service Connections**:- In case of overhead line, check and ensure that
   i. The lines are terminated a sufficient distance away from the building
   ii. The fuse wire of correct rating is provided on the phase line
   iii. The lead-in-wires are of size sufficient to carry the full load current

2. **Main Switch Board**:- In case of ,main switch board please check up and ensure that
   i. The voltage available is correct
   ii. The main switch is provided close to the point of commencement of supply
   iii. The fuse of correct size is provided on the live pole
   iv. The phase and neutral wires are clearly marked for identification
   v. Caution notice in English or other local language is placed.
3. **Miscellaneous**:- The points to be checked are
   i. No branch circuit feeds more than the breaker can feed
   ii. The single pole switches are provided on the live conductor
   iii. The metallic frames of all power equipment are earthed by the independent earth conductors

Fault-Tracing in Circuits and Equipment

The types of fault which may occur in an electrical circuit fall into four general groups:

1. Open – circuit fault (loss of continuity)
2. Earth fault (low resistance between live conductor and earthed metalwork)
3. Short- circuit fault (low resistance between phase and neutral conductors)
4. High- value series – resistance fault (bad joint or loose connection in conduction path)

These fault types occur in lighting and power circuits, appliances, apparatus and electric motors; variations do, occur with the type of electrical equipment. Before any fault can be found and rectified it is necessary for the electrician to adopt a method or system based on a sound knowledge of circuitry and electrical theory, and on experience. The electrician detailed to repair a fault circuit is in many ways like a doctor who makes his diagnosis on the basis of the symptoms revealed through a visual inspection or a test using the correct instruments . Haphazard tests carried out at random seldom lead to success in the quick location of faults. The investigation must always be based on an intelligent assessment of the fault and its probable causes, judged from its effects. In many instances, faults arise from installations or circuits which do not in some way or other comply with the requirements of the IEE regulations, or else are used in such a manner that the abuse results in a fault. Most faults are easily located by following up reports such as There was a flash at the lamp; The wires got red hot; The lamp goes dim when it is switched on; or 'The bedroom light will come on only when the bathroom switch is ON ; By careful questioning, these reports will enable the electrician to locate the fault quickly and restore the circuit to normal operation again. The following are some common installation defects and omissions which eventually lead to faults';

Fault-tracing in circuits and equipment

1. The provision of double –pole fusing on two wire systems with one pole permanently earthed. This frequently occurs with final circuit distribution boards when the main and /or sub main control equipment is single pole and solid neutral.
2. Fuse protection not related to the current rating of cables to be protected . This is very often due to the equipment manufactures fitting the fuse- carriers with a fuse – element of maximum rating for the fuse- units in the equipment.
3. Connecting boxes for sheathed- wiring systems placed in inaccessible positions in roof voids and beneath floors, indiscriminate bunching of too may cables using screw- on or inadequate connections .
4. Insufficient protection provided for sheathed wiring, e.g. to switch positions and on joints in roof voids.
5. Incorrect use of materials, not resistant against corrosion, in damp situations (e.g. enameled conduit and accessories and plain – steel fixing screws).
6. Inadequate or complete omission of segregation between cables and /or connections, hosed within a common enclosure, supplying systems for extra- low voltage; or telecommunication and power and /or lighting operating at a voltage excess if extra- low voltage.
7. Insufficient attention given to cleaning ends of conduit and/or providing bushings omission of bushings to prevent abrasion of cables at tapped entries, particularly at switch positions.
8. Insufficient precautions taken against the entry of water to duct and /or trunking systems particularly where installed within the floor.
9. Incorrect use of PVC insulated and /or sheathed cables and flexible cords instead of heat-resistant type, for connections to immersion heaters, heaters, thermal- storage block heaters , etc.
10. Incorrect use of braided and twisted flexible cords for bathroom pendant fittings and similar situations subject to damp or condensation .
11. The incorrect use of accessories, apparatus or appliances inappropriate for operating conditions of the situation in which they are required to functions

12. Installation of cables of insufficient capacity to carry the starting current of motors. Causing excessive volt drop.

13. Incorrect rating of fuse-element to give protection to the cables supplying the motor.

Open-circuit faults

The instrument used to locate this type of faults is the continuity . The usual effect of this fault is that the apparatus or lamp in the circuit will not operate. The fault can be (a) a break in a wire; (b) a very loose or disconnected terminal or joint connection; (c) a blown fuse; (d) a faulty switchblade contact. The fuse should always be easily inspected. The cartridge type can be tested for continuity of the fuse-element. If the fuse has operated, the reason why it has done so must be found out . It is not enough to repair or replace the fuse and leave it at that . A broken wire or a disconnection will show on the continuity tester as an extremely high resistance in the khoum or me gohm ranges. Before each wire in the faulty circuit is tested in turn (live feed, switch- wire and neutral) all mechanical connections should be inspected (lamp holders , junction box, plug or the metal sheeting of convenient return when testing the continuity of very long conductors . In an all insulated wiring system, other healthy conductor can be used as returns for testing purposes making sure that the aright al connections are restored once the fault has been found .

Earth faults An earth fault between alive conductor and earthed metalwork will have the same effect as a direct short – circuit : the circuit fuse will blow . To trace the fault . it is necessary to isolate the live conductor from the neutral by removing all lamps etc, and placing all switches in the ON position . An isolation- resistant (IR) tester is used to trace this fault circuits should be subdivided as far as is possible to finally locate the position of the fault . The reading obtained on the instrument used will be in the low- ohms range. An earth fault on the neutral conductor seldom shows up except by an IR –to earth test on the neutral conductor in most instances this type of fault does not affect the operation of the circuit or the devices or equipment connected to it . However, it is important to rectify any such fault found, otherwise if it is ignored it may cause a shock and fire hazard .

Short – circuit fault On testing the insulation resistance between the live and neutral conductors with an IR tester, the reading will show itself in the low ohms range .again, subdivision of the installation at the distribution board , and subdivision of the faulty circuit is the only way to locate and confirm the position of the faults . Short circuits can occur as the result of damaged insulation bare wire in junction boxes and fittings , or by a conductor becoming loose from terminals and moving so as to come into contact with a conductor of opposite polarity. The result of short circuit is a blown fuse , though if there is a sufficiently current can flow to blow the circuit fuse) the result will be over heating of the conductors and sparking or arcing at the point of contact . The test involves the removal of all lamps and appliances from the faulty circuit, open all switches, and carry out an IR test between the live and neutral conductors . If the reading obtained is satisfactory , close each circuit switch in turn until the faulty conductor, a switch wire, is located. If a low or near-zero reading is obtained on the first test, the circuit will have to be disconnected at convenient points until the faulty wire is isolated .

High- value series –resistance faults This type of fault is most difficult to trace as it usually means that a connection, joint or termination has become loose . the effect of this is invariably dim lights; or motor going very slowly and heating up : in new installations the demises of the lamps may well be caused by a wrong connection in junction box resulting in two or more lamps being connected in series .

Main faults in new wiring Faults in new wiring are generally the of careless or inadvertent wrong connections which will either blow a fuse , cause lamps to operate dimly as above, not work at all or work only when another circuit switch is placed on the ON position . If a lamp lights only when another switch in the same final circuit is ON this indicates that the live feed to the faulty lamp has been looped from the switch – wire side of the previous circuit switch instead of from the live-feed side . The fact that overloading a circuit will blow a fuse should not be overlooked .

Faults in fluorescent –lamp circuits The following tables summaries the faults , effects and the remedies associated with fluorescent –lamp circuits.

Faults in motors and circuits Table 28-4 sum arises briefly the faults . effects and remedies associated with motors and their associated circuitry and control gear. Because the voltage of low – and extra- low voltage circuits is relatively small, small, a poor or dirty contact will immediately prevent bells and similar devices from operating . These faults are thus most difficult to trace, and it is often a matter of systematic checking for continuity (zero or near –zero) readings . The prevention of faults in ELV circuits is more often than not a matter of regular periodic maintenance attention (cleaning contacts, tightening connections, etc) than anything else .

Fault –finding in fluorescent lamp fittings

NO	item	Test to be applied
1	Supply and fuse	Check supply voltage at input to fitting. Check polarity of incoming supply and ensure frame is earthed. If fuse has blown, suspect circuit or component and find the fault before replacing fuse.
2	Lamp	Check lamp in a good fitting and if proved faulty replace with a new lamp. Remember, Never try a new Lamp in a fitting which has faulty components circuit.
3	Circuit	Examine wiring inside the fitting and if possible check against the wiring diagram check insulation resistance between the circuit and the metal frame of the fitting. The resistance should be above 2 megohms . If an earth fault is found . trance the cause and replace the component.
4	ballast chokes	Examine for signs of overheating . if possible check continuity of windings and insulation resistance compare the impedance or inductance against a good replica.
5	Capacitors	Examine for leakage or damage. If possible check the capacitance and check that discharge resistor has value between ¼ -1 megaohm . the insulation resistance between case and terminals should be above 2 megaohms .
6	Sartre switches	Check operation of starter in another good circuit and , if found faulty, fit a new replacement.
7	Ambient conditions	Remember that normal fluorescent fittings may overheat if the surrounding temperature is above 30-15^{o}C . Lamp starting may be difficult with some types of circuit if the temperature is below 5 ^{o}C .

Visual Inspection

The quality of visual inspection is dependent on the experience and knowledge of the person carrying out the inspection. Visual inspection should lead testing with instruments and must of course be prior to the installation being made live. It may be necessary to inspect some parts of an installation during the construction phase as these parts may be concealed later. A checklist for a Domestic Installation might read as follows:

Fixed Wiring

1. Correct type.
2. Correct voltage rating.
3. Correct current rating.

4. Correct color coding.
5. Permitted volt-drop not exceeded.
6. Protected against mechanical damage and abrasion (scrap).
7. Non-sheathed cables protected by enclosure in conduit, duct or trunking.
8. Not exposed to direct sunlight or, if so exposed, of a suitable type.
9. Correctly selected and installed for use on exterior walls etc.
10. Internal radii of bends.
11. Correctly supported.

Flexible Cables and Cords

1. Correct type.
2. Correct voltage rating.
3. Correct current rating.
4. Correct color coding.
5. Selected for resistance to damage by heat.
6. Cable coupler used for joints.
7. Final connections to fixed apparatus as short as possible.

Terminations

1. All terminations enclosed.
2. Conductors doubled back where possible.
3. All strands securely clamped in terminals.
4. No damage to conductor.
5. Proper terminal used.
6. Braid / sheath cut back to identify core color and provide flexibility at the termination.
7. Braid / sheath not removed outside of enclosure.
8. Bare protective conductors sleeved green/yellow.
9. Insulation not clamped in terminal.
10. No mechanical damage on terminations, loose available
11. Terminations accessible for inspection, except as otherwise permitted.
12. Tightened sufficiently, mechanically and electrically sound.
13. Enclosure cover fitted properly.

Lighting Switches

1. Adequate current rating.
2. Readily accessible.
3. Installed at correct height, e.g. centered at 1100 mm.
4. Labeled to indicate purpose, where this is not obvious.
5. Single-pole switches connected only in phase conductors.
6. Earthing of exposed metalwork, e.g. metal switch plate.
7. Protective conductor terminated in an earthing terminal.
8. Not installed in the incorrect zone in a shower or bathroom.

Ceiling Roses

1. Fixed in position.
2. Protective conductor connected to earthing terminal.
3. Phase terminal shrouded to prevent accidental contact.
4. Switch wires identified as live (phase) conductors.
5. Suitable for the weight suspended.

Trunking

1. Constructed of non-combustible insulating material.
2. Securely fixed and adequately protected against mechanical damage.
3. Covers securely fixed.
4. Holes surrounding trunking made good to prevent spread of fire.

Protection

1. Distribution board correct and mounted in suitable location.
2. Earth Electrode connection accessible and correct.
3. Main switch fuse or MCB fitted.
4. Socket circuits protected by an RCD (Residual Current Device). (some exceptions)
5. Immersion heater circuit protected by an RCD.
6. Shower circuit protected by an RCD.
7. Box or other enclosure securely fixed.
8. Flush box, level with wall surface to ensure non-combustible enclosure.
9. No damage to cables by sharp edges, screw heads etc.

Socket Outlets

1. Correct type.
2. 30cm to 40cm above the floor or working surface except in shower or bathroom.
3. Correct polarity.
4. Earthing tail from metal box, to earthing terminal of socket outlet.

Joint Boxes

1. Fixed in position.
2. Accessible for inspection.
3. Protected against mechanical damage.
4. Protective conductors correctly connected.

Testing

On completion of the visual inspection the following tests must be completed where applicable: They must be carried out in the following order.

Tests before connection of the installation to the supply:

1. Continuity of all protective conductors.
2. Continuity of ring final circuit conductors.
3. Insulation Resistance of the electrical installation.

4. Protection by separation of circuits.
5. Polarity test.
6. Electrical strength test.

Tests after connection of the installation to the supply

1. Automatic disconnection of supply including earthing and bonding.
2. Functional tests.

If the installation should fail any test, the fault must be rectified before any further testing is done. That test and any preceding tests that may have been affected by the fault should now be repeated. If all is satisfactory continue with testing as above.

Continuity of Protective Conductors

This test is to ensure that:

- All protective conductors and bonding conductors are electrically sound and correctly connected and continuous throughout their length. (Remember that this includes the Main Protective Conductor and the Earthing Conductor).
- All equipment and accessories are properly connected to the protective conductor where required.
- All bonding connections and clamps are making good electrical contact.

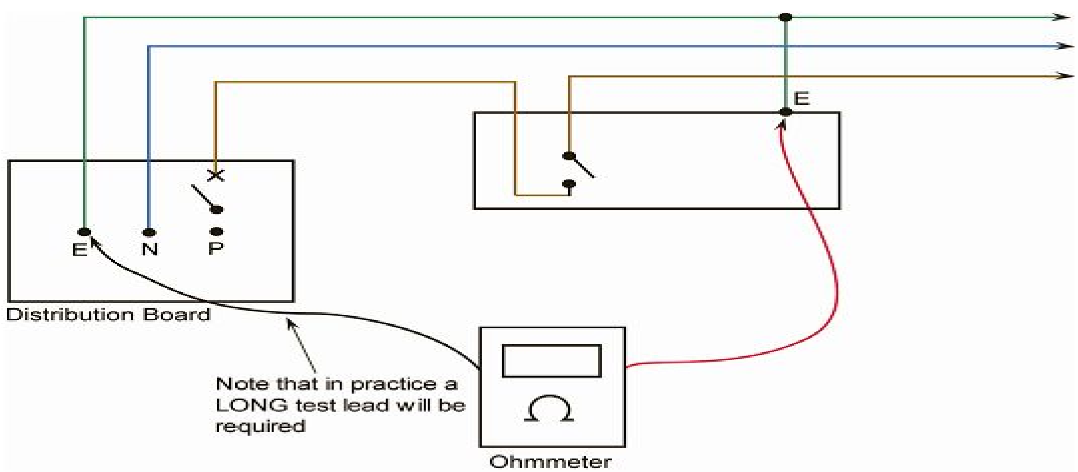


Fig 6

Protective conductor resistance equals Meter reading minus Test lead resistance

Note: When carrying out this test it is essential to be aware that parallel paths can exist through extraneous conductive parts. If this is the case the conductor under test should be disconnected from its terminal and any other conductor.

Test of Main Equipotential Bonding on a Domestic System
with <u>Metallic Incoming Services</u>

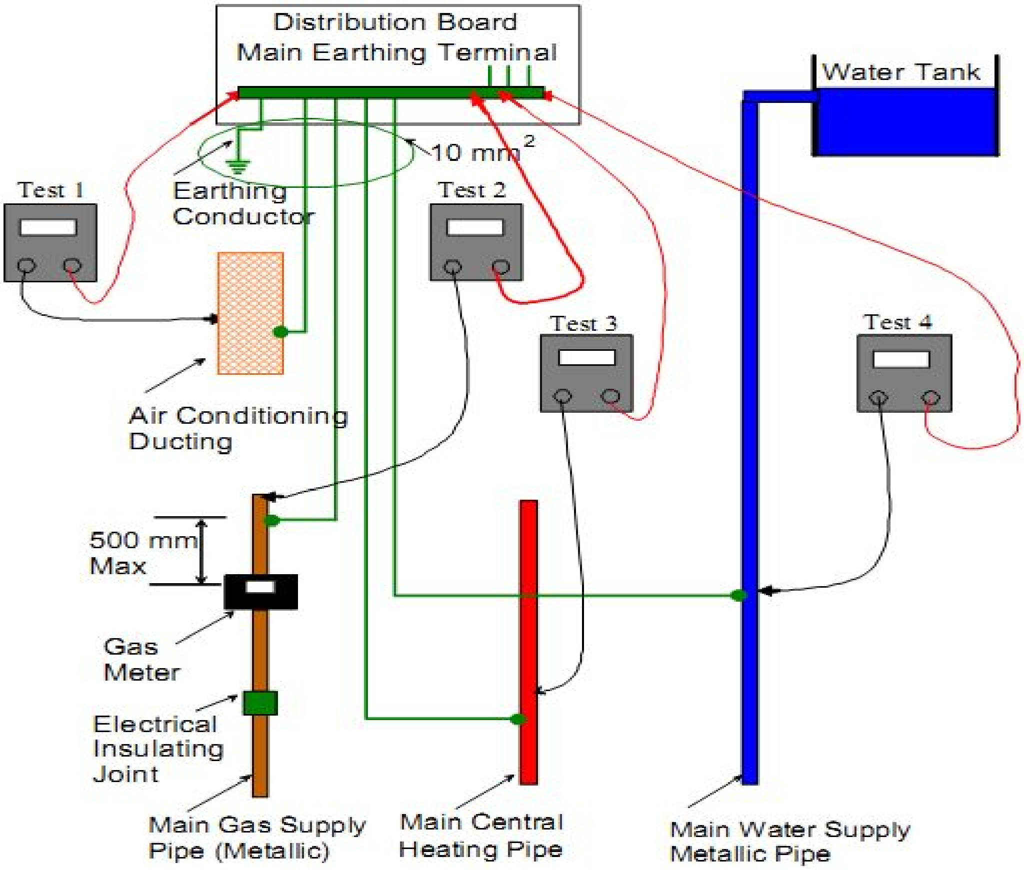


Fig 7

Test of Main Equipotential Bonding on a Domestic System

with <u>Non-Metallic Incoming Services</u>

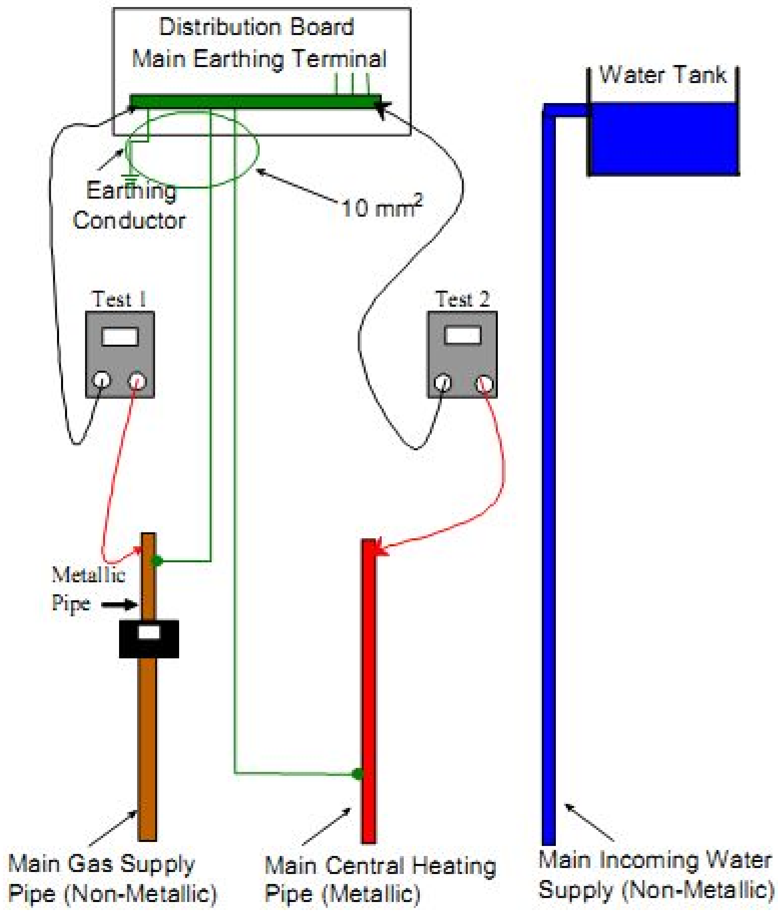


Fig 8

Test of Bathroom Equipotential Bonding System

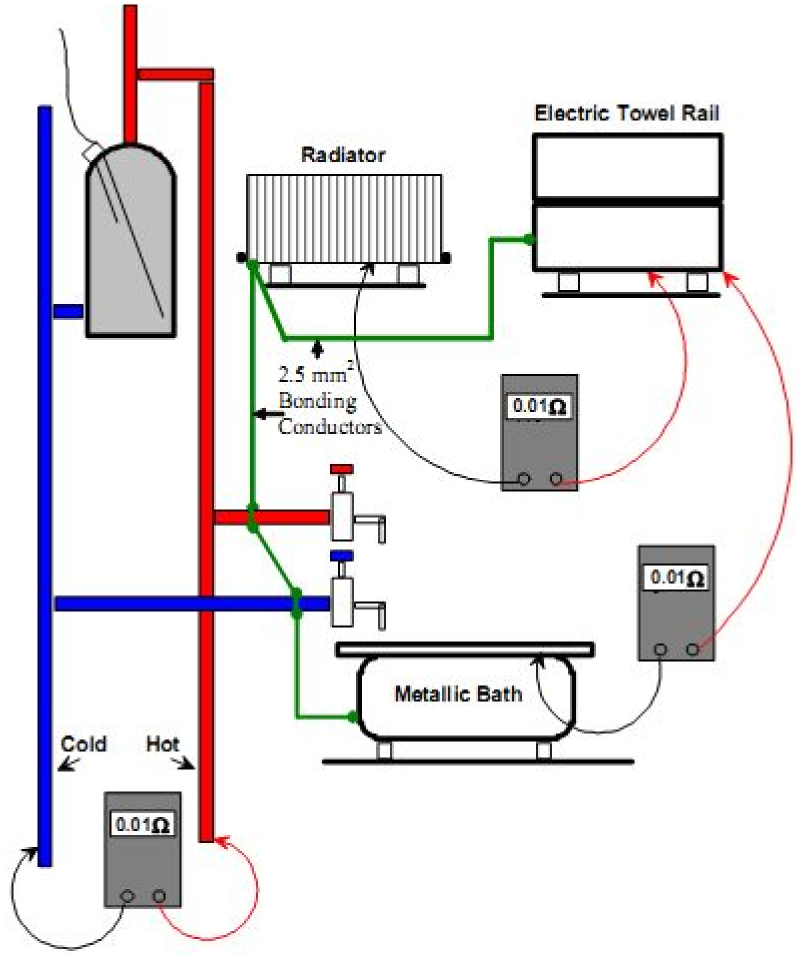

Electric Towel Rail
Radiator
2.5 mm^2
Bonding
Conductors
0.01Ω
0.01Ω
Metallic Bath
Cold
Hot
0.01Ω

Fig 9

Test of Kitchen Equipotential Bonding System

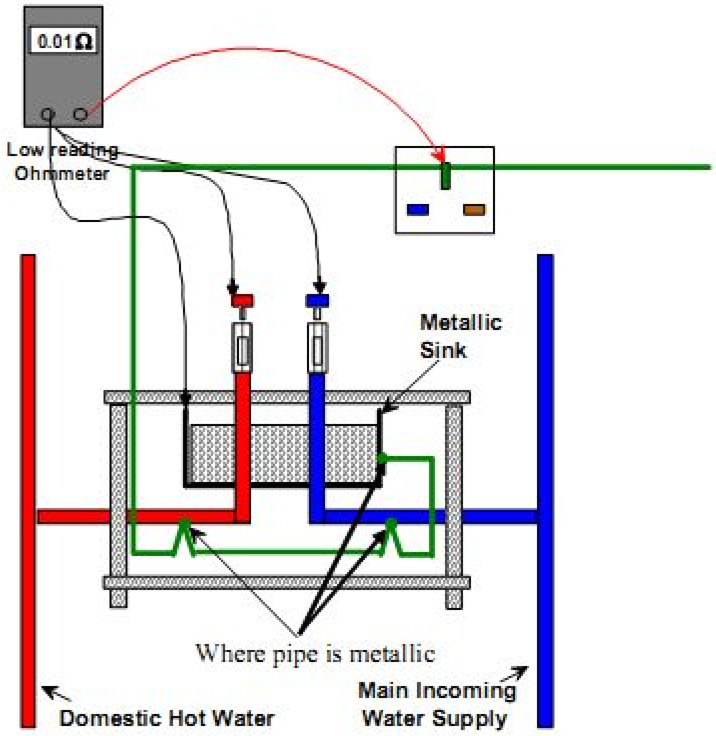


Fig 10

Continuity of Ring Final Circuit Conductors

This test is to verify that ring final circuits are:

1. Correctly wired and connected.
2. Continuous throughout. (Step 1)
3. Their conductors are not interconnected or bridged. (Step 2)

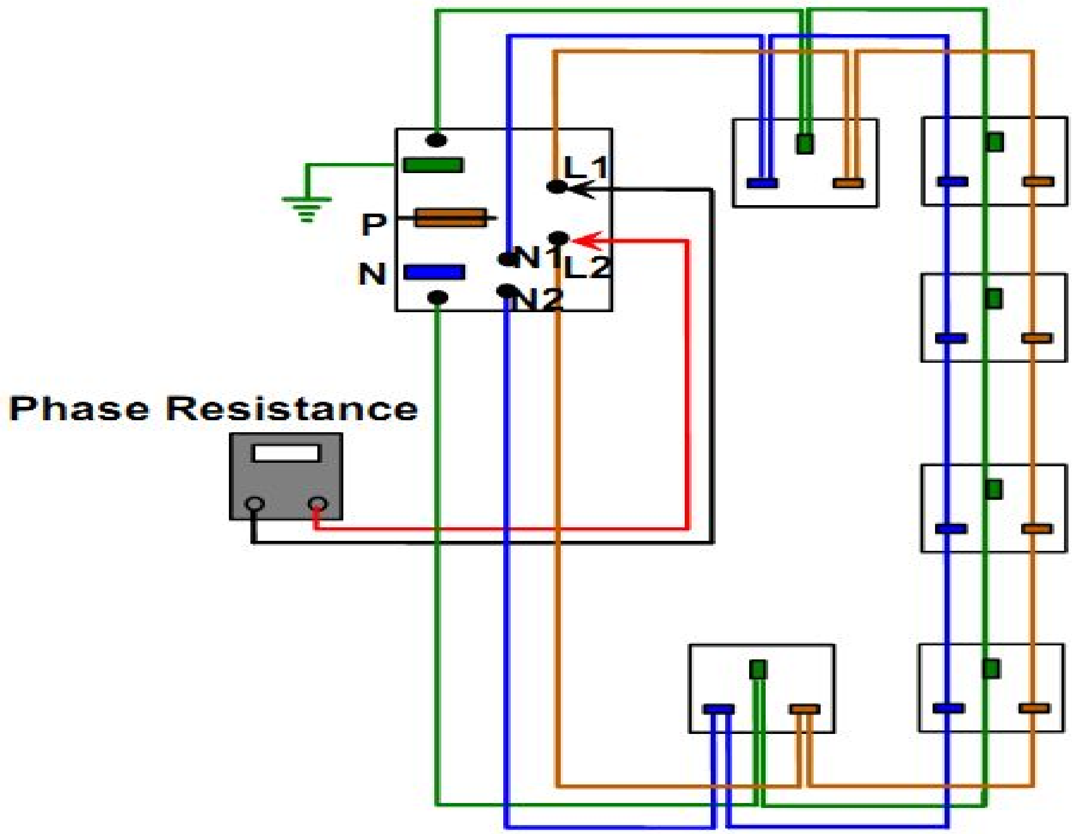
Test Instrument Required

A low reading DC Ohmmeter capable of passing a minimum test current of 200 mA. There are two steps involved in completing this test.

Method

Disconnect the phase, neutral and earth conductors from their terminals in the distribution board. Separate them from each other. Measure the resistance of each of the three loops individually and record the readings taken. The phase and neutral readings should be equal. The protective conductor may have a different cross-sectional area to that of the phase and neutral.

Test of Continuity of Ring Final Circuit Conductors



Insulation Resistance

Fig 11

This test is to ensure that there are no short circuits between live conductors or between live conductors and earth, and that there is no deterioration in insulation resistance caused by damage or dampness.

A direct voltage is applied, to test insulation resistance as the capacitive current quickly falls to zero so that it has no effect on the measurement. A high voltage is used because this will often break down poor insulation or surface leakage paths. In other words the high voltage may show up insulation weaknesses which would not be noticed at lower voltage levels. An insulation resistance tester measures the applied voltage and the resulting leakage current flow. The resistance displayed, is obtained by an internal calculation based on Ohm’s Law.

$$\text{Insulation Resistance (M}\Omega\text{)} = \frac{\text{Test voltage (V)}}{\text{Leakage Current (}\mu\text{A)}}$$

As the effective capacitance of the system charges up, the leakage current reduces. A steady insulation resistance reading indicates that the cables are fully charged, and that the capacitive component of the test current has fallen to zero. If a wiring system is wet and / or dirty, the surface leakage component of test current will be high, giving a low insulation resistance reading. Insulation resistances are all effectively connected in parallel. The total insulation resistance will therefore be lower than that of each individual circuit. In a large electrical installation, the total insulation resistance may be lower than that of a smaller installation.

Warning:

Ensure that circuits are not live before commencing testing. Never turn the function dial whilst the test button is depressed. This may damage the instrument. Never touch the circuit under test during insulation resistance testing. Before testing always check the following:-

- The "battery low" indicator is not showing.
- There is no visual damage to the tester or test leads.
- Check the continuity of the test leads.

To check the continuity of the test leads:

Select the continuity function- and the lowest resistance range. Short the test leads together.

- The reading should be almost Zero Ohms.
- An over-range OR indication will mean that the leads are faulty or the instrument fuse is blown.

Select the required test voltage (250 V, 500 V or 1000 V) by rotating the function dial.

Note: - The test voltage used for low voltage installations is **500** Volts.

Pre Test Procedures and Observations

1. The installation must be disconnected from the supply.
2. The Main Protective Conductor must be disconnected from the supply neutral.
3. All fuses are intact and all MCBs and switches are closed.
4. All current using equipment including lamps, pilot lights, bell transformers, smoke alarm units, timers etc. are disconnected or otherwise excluded from the test between live conductors.
5. Note:- Where disconnection or removal of these items is impractical the control switches should be in the off position. Items left in circuit will cause

false low readings.

6. Any equipment containing electronic circuitry must be disconnected or switched off in order to prevent damage by the high test voltage

Insulation Resistance between All Live Conductors and the Protective Conductor

Method

Connect all live and neutral conductors together at the distribution board and test between them and the protective conductor. The reading obtained should be 1 MΩ or greater.

An infinitely high resistance reading would be ideal.

Test of Insulation Resistance between all Live Conductors and the Protective Conductor

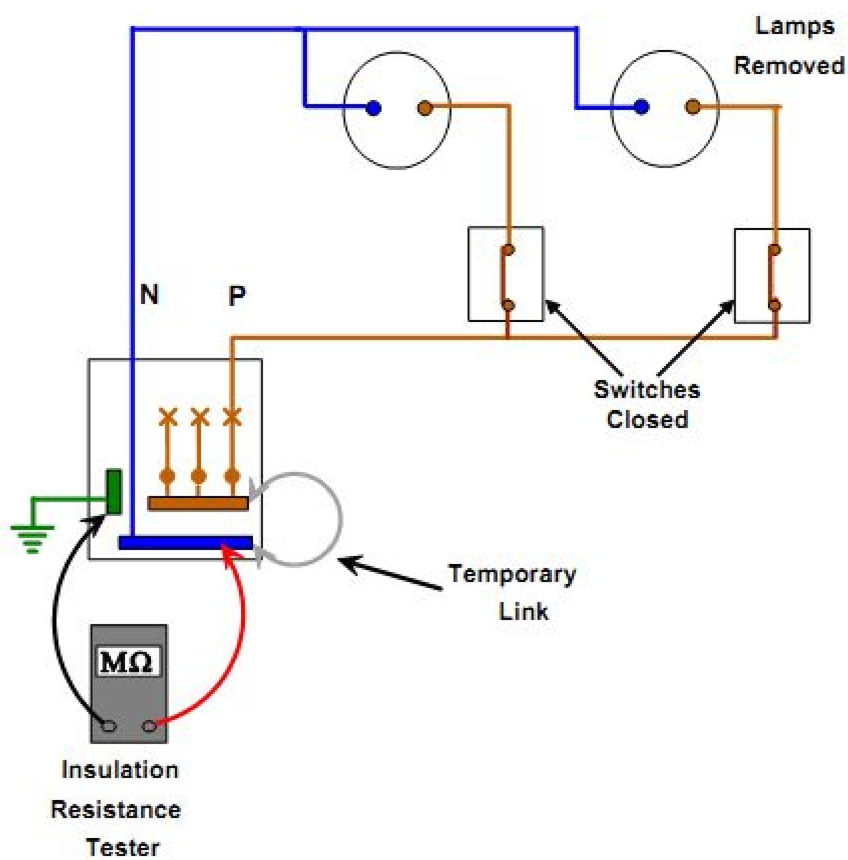


Fig 12

N.B. Do not forget to remove the temporary link.

When testing ***two way or two way and intermediate lighting*** circuits, it is essential that both of the two way switches are switched over and the test repeated at each stage. This is to ensure that all strappers and switch wire are included in the test.

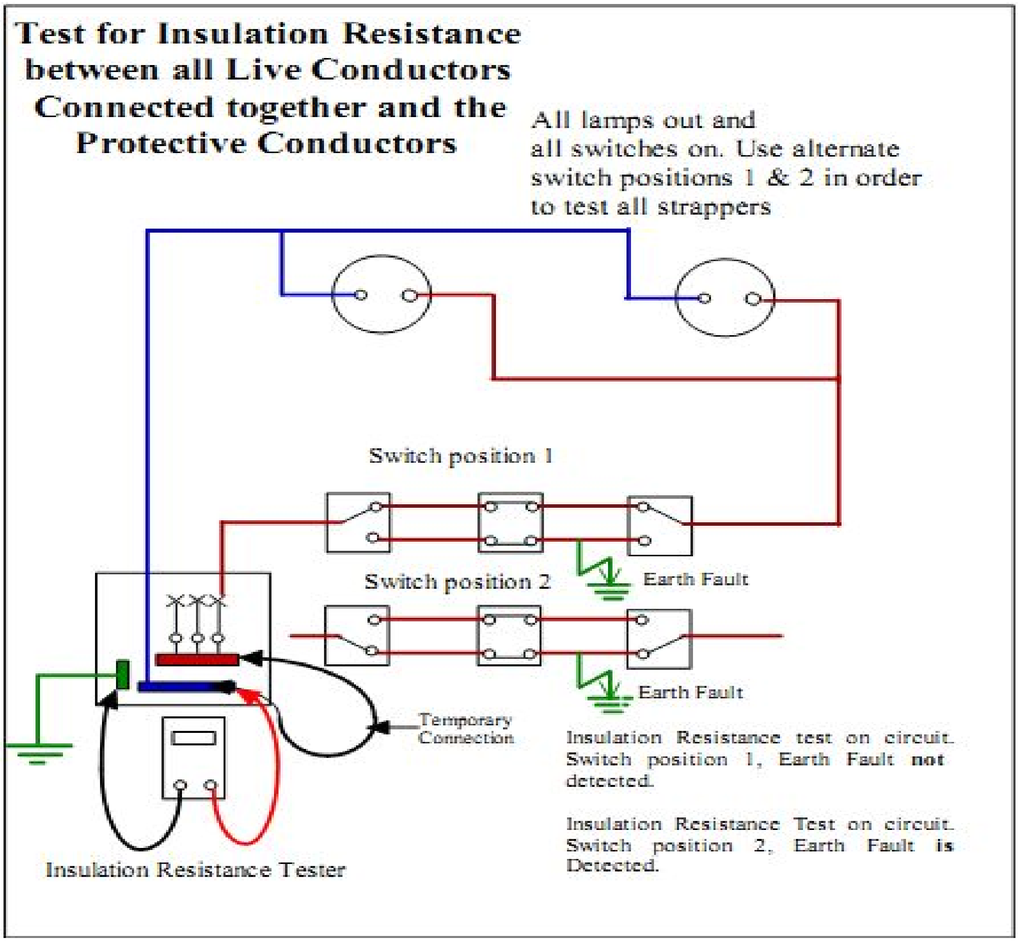


Fig 13

Insulation Resistance between Live Conductors

Method

Test between phase and neutral conductors. The reading obtained should be 1 MΩ or greater. An infinitely high resistance reading would be ideal.

Test for Insulation Resistance between Live Conductors

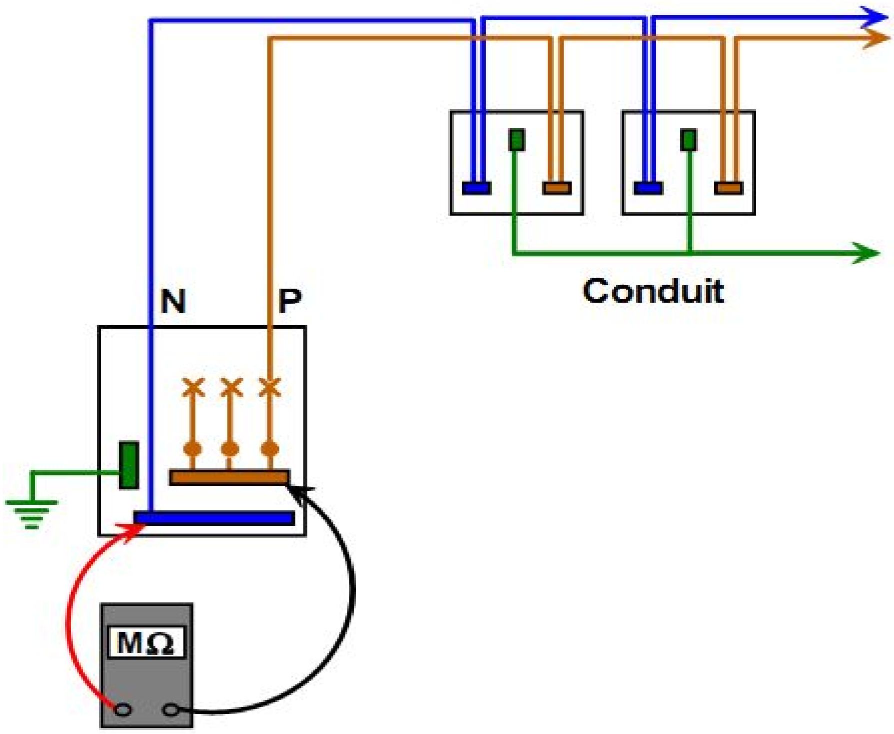


Fig 14

Polarity

This test is carried out to ensure that:

- Polarity at the main supply point is correct.
- The phase conductor is connected to fuses, single pole circuit breakers and switches.
- Incoming supply is connected to back contact of screw in type fuses.
- The phase conductor is connected to the center contact of ES type lamp holders.
- All wiring is correctly connected at socket outlets and other similar accessories.

The continuity of the protective conductor has already been verified. This test can be completed in basically the same manner. Ensure that all appliances, lamps etc are unplugged or otherwise removed. With the circuit MCB in the “off” position, connect one end of the long trailing lead to the outgoing terminal of the circuit MCB. Using the other end in conjunction with the test meter leads, take readings from the phase terminal of all the points around the circuit e.g. switches, luminaries, sockets etc. Continuity (approx. resistance of conductor involved) at each outlet ensures that polarity is correct.

If the supply is disconnected from the installation the long trailing lead may be connected to the phase busbar and the MCB should then be left in the “on” position.

Test of Polarity of Socket Circuits

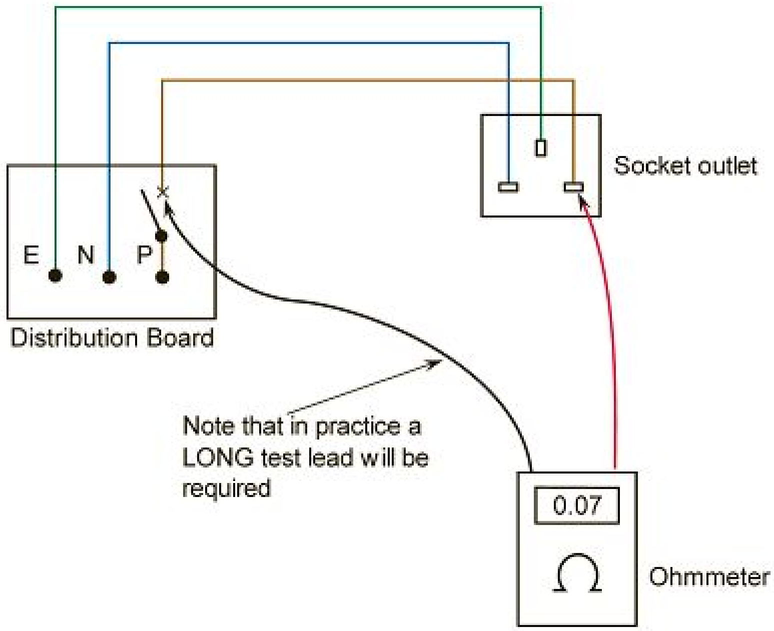


Fig 15

Test of Polarity of Lighting Circuits

This test must be done with the supply disconnected and may be carried out as follows: Remove circuit FUSE or open MCB. Remove all lamps from relevant circuit. Connect one end of the long trailing lead to the outgoing terminal of the circuit MCB. Using the other end in conjunction with the test meter leads, take readings from the phase terminal at all the points around the circuit e.g. switches and ES lampholders. Continuity (approx. resistance of conductor involved) at each point ensures that polarity is correct.

If the supply is disconnected from the installation the long trailing lead may be connected to the phase busbar and the MCB should then be left in the “on” position.

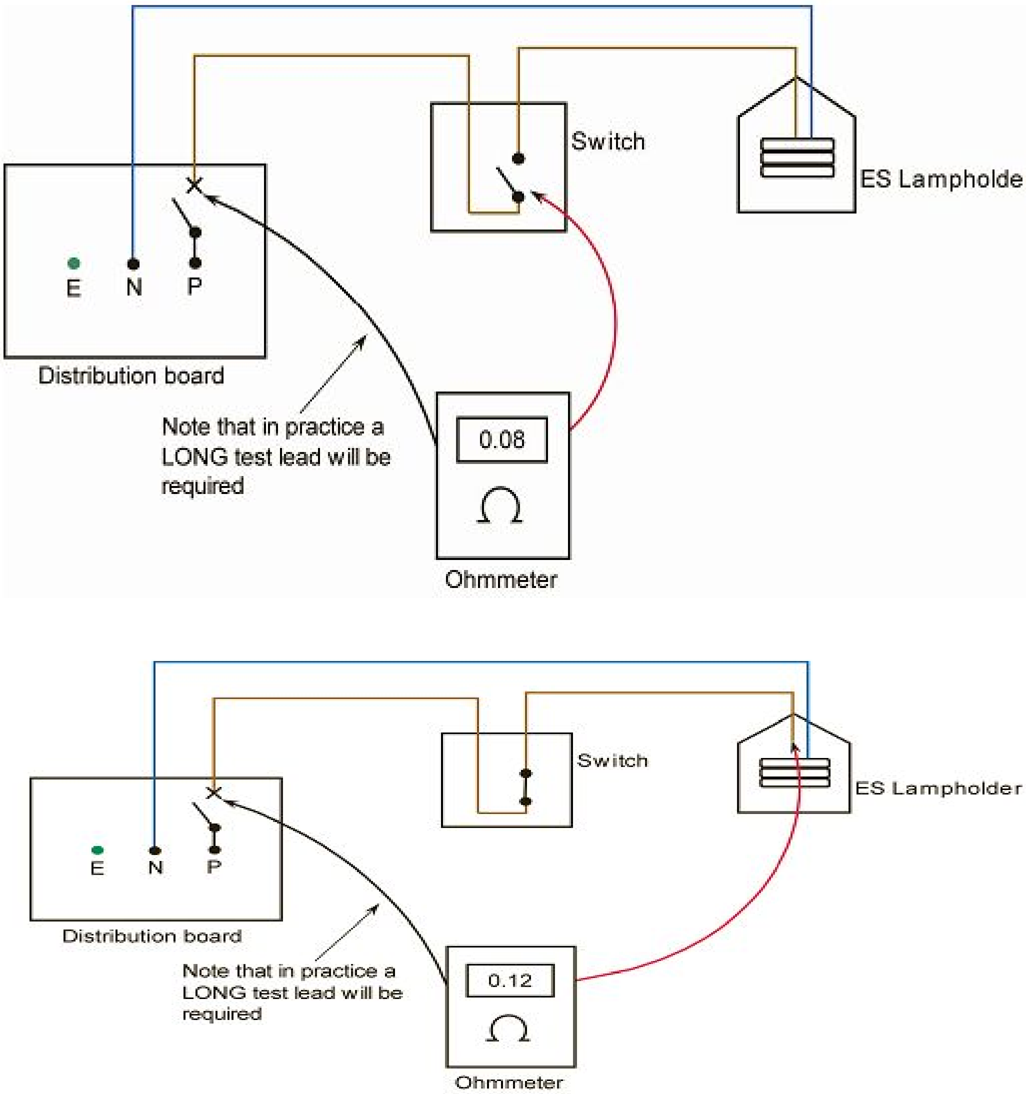


Fig 16

Note:

The circuit switch must be operated when checking polarity of ES lamp holder.

Hazards Associated with Live Testing

1. The circuit under test should be isolated prior to connecting any test equipment and then made live in order to conduct the test.
2. It is essential that all leads and crocodile clips are in good condition.
3. Care must be taken to ensure that leads do not short to each other or to earth.

Self-check 2	Written test

Name ……………………………………………. Date……………………………………..

Say true or false

1. Continuity test of all protective conductors must before connection of the installation to the supply
2. In Pre Test Procedures and Observations the installation must be disconnected from the supply.
3. Care must be taken to ensure that leads do short to each other to test battery cell
4. The instrument used to test the insulation resistance is known as Megger.

Matching

A	B
1. Open – circuit fault	A. low resistance between phase and neutral conductors
2. Earth fault	B. loss of continuity
3. Short- circuit fault	C. low resistance b/n live conductor and earthed metalwork

***Note:* Satisfactory rating - 7 points** **Unsatisfactory – 7 below**

Information Sheet-3	Notification of completion work

Verification and Certification

New electrical installations and extensions to existing installations must be inspected and tested. This is done to ensure that all electrical equipment has been correctly selected, installed and interconnected. Two categories of tests must be carried out on an installation. One test is carried out prior to the installation being made live for the first time, and the other when the installation is live. Both tests must be carried out by competent persons using prescribed test equipment. They also must be carried out in a particular sequence. The results of the tests are recorded and a copy given to the installation owner.

How to notify work all notifiable work must be notified using one of the three routes

Route 1: Direct notification through Local Authority Building Control The homeowner must contact Building Control directly to ensure that a Building Control Officer visits the installation and issues a compliance certificate. The cost for this can vary depending on area.

Route 2: Self-certification through a recognized scheme

Route 3: Certification by a registered Third Party In the latest Approved Document, a provision has been made for an alternative route for installers who are not registered competent persons (Route 2) and wish to appoint a registered third-party certifier to inspect and test the work as necessary. Note that there is no process as yet to facilitate this route for building regulations notification.

The notification process: The core principle of EBCS is to keep the additional paperwork and hassle that you have to endure to an absolute minimum. To this end, we have implemented a system whereby all the responsibility of notifying the homeowner and the relevant Local Authority of the installation is handled by us – all you need to do is inform us once you have completed the installation. We do not require you to submit the BS7671 test results and certificates to us.

Who needs to be notified? It is a legal requirement that each notifiable installation carried out by a registered contractor needs to be notified to three separate bodies:

- The relevant self-certifying scheme

- The relevant Local Authority
- The householder

Self-check 3	Written test

Name ………………………………………..………….. Date………………..

<u>Direction 1</u> **Say true or false**

1. New electrical installations and extensions to existing installations must be inspected and tested.
2. Tests must be carried out by competent persons using prescribed test equipment.

<u>Direction 2</u> Blank space

1. How to notify work
    a. …………………………………
    b. …………………………………
    c. …………………………………

***Note:* Satisfactory rating - 5 points** **Unsatisfactory – 5 below**

Reference

- https://www.archsd.gov.hk/media/11269/e102.pdf
- https://www.ee.co.za/article/basic-electrical-installation-testing.html
- https://flh.fhwa.dot.gov/resources/construction/forms/wfl/documents/wflhd-470.pdf