



Continuity of Protective Conductors

Introduction

This test is of great importance and arguably the most important of them all for many reasons, despite of this fact at times shortcuts are taken and things are over looked.

Many electrical contractors who carry out testing very rarely understand the reasons for doing such a test, and the acceptable results obtained.

In this section we will not only be showing you how to conduct the test but the reasons for doing it, and which method to choose for a particular installation/wiring system.

This is the first test to be conducted in the sequence of tests, the reason for doing it as the first test in the sequence is because of the possible rise in potential across different metallic items that could arise if the CPC's and bonding were not in place or disconnected when carrying out other tests. An example of this is when doing an insulation resistance test, this typically puts 500V dc through the system, if metallic items were not bonded, then it could rise to a dangerous voltage.

The Tests

Before we talk about the individual tests, there has been a lot of confusion around the little things that need doing prior to even picking up an instrument.

Hint

This test is only conducted on radial circuits

Q ***“Do we or don't we disconnect the main bonding conductors from the MET?”***

A ***“Well this is dependent upon whether the installation is already connected to the supply. If it is an initial verification (new installation) then it is permissible to disconnect the protective and equipotential conductors from the main earthing terminal to carry out testing.”***

If the installation is an existing one (Periodic) then testing, the protective and equipotential conductors Must Not be disconnected. If this is the case then a loop test may be conducted to verify the integrity of the system.

There are 3 different methods that can be used to carry out this test, and is dependent upon a number of factors.

- Ω Is the protective conductor under test part of a final circuit or a sub circuit?
- Ω Is the protective conductor under test a bonding conductor?
- Ω Does the circuit under test form part of a metallic wiring system?

Test Method 1

Test method 1 uses the Phase as a return lead, otherwise known as the R1 + R2 method.

This is the most common method used for final circuits. As in most final circuits, the phase conductor runs alongside a cpc conductor and this factor is utilised in the test.

Instrument to be used:

Low-resistance ohmmeter

Scale to be used:

The Ohm Ω

Method

Before the test can begin, if the circuit to be tested is not isolated, then follow the correct safe isolation procedures.

Step 1: A temporary link is made at the distribution board between the PHASE and PROTECTIVE conductor systems

Important

Null the leads. This is very important as the wander lead will add a considerable resistance to the instrument reading. If your instrument does not have a null function, then simply subtract the resistance from the actual reading.

The low resistance Ohmmeter is then connected at the most furthest point of the circuit, and a reading is obtained. This reading is made up of the resistance of the PHASE conductor and the PROTECTIVE conductor and is given the name R1 + R2.

Hint

Guidance Note 3 published by the IEE gives a column for recording R1+R2 on the Schedule of Test results.

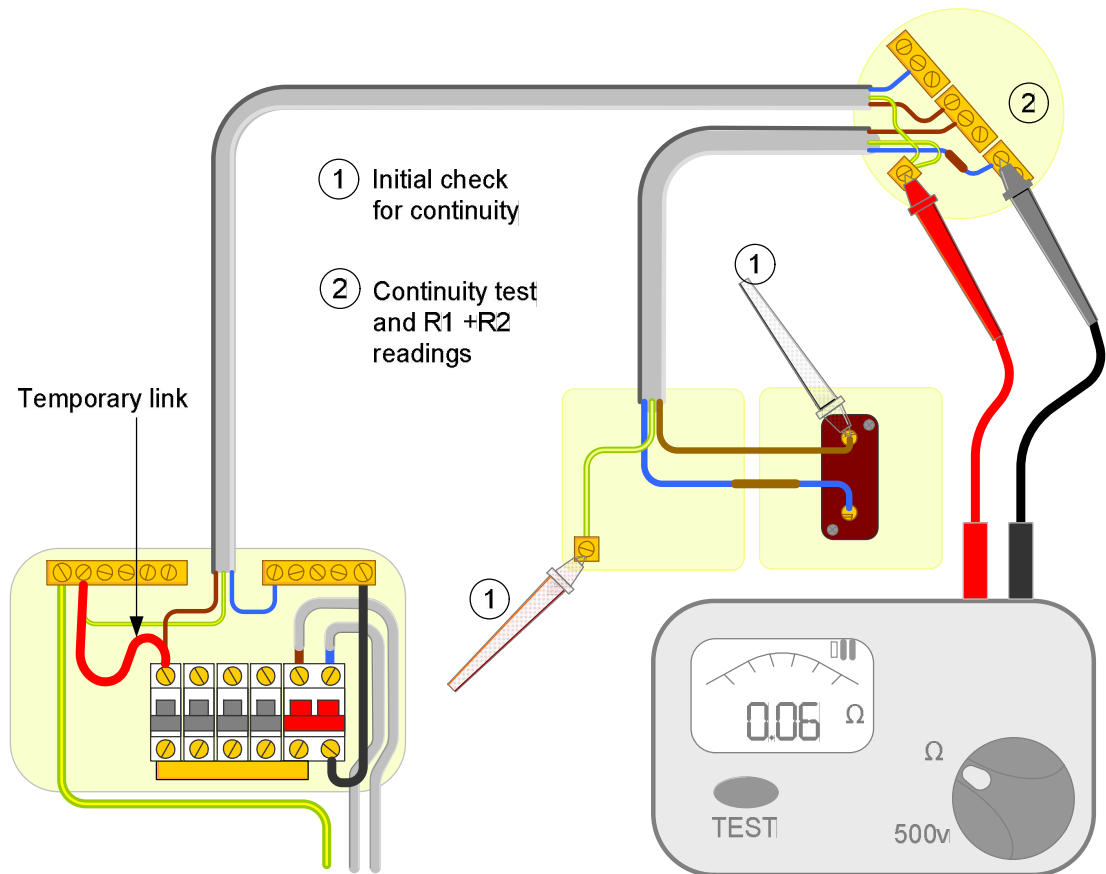
Q *“But I only want the resistance of the cpc, why am I bothering with the resistance of the phase?”*

A *“This method has many advantages, not only to this test, but to other future tests. The main one being we can use phase conductor as part of the circuit as it eliminates any awkward and possibly dangerous wander leads draping everywhere. Also this (R1 + R2) reading can be used for working out our earth Fault Loop Impedance value if we decided not to measure it. Polarity of the circuit is also obtained at the same time. “*

Important

Don't forget to remove the link once the test is finished!

Test Method 1



Test Method 2

Test method 2 uses the wander lead or R2 Method

This test can be performed on Final circuits, but this test is mainly used on Equipotential bonding conductors.

Hint

The only time where you would have to use method 2 on final circuits is where you have used 'the alternative method' in determining the size of CPC (table 41C of the Regulations) for a 5 second disconnection time.

As the title suggests, we must also confirm the continuity of Equipotential bonding conductors. This makes

sense, but how do we go about doing this? Can we adopt method 2 as above? The answer is no as we do not have a phase conductor as a return path.

We do this by using a wander lead.

Q "What is a wander lead?"

A "A wander lead is simply a long length of conductor that can be moved to different points in an installation. Often a drum of cable is used however commercial ones can be purchased."

Method

As in test method 2, health and safety is a priority so ensure safe isolation procedures have been followed before you begin.

Step 1: Disconnect any parallel paths (this can be done by disconnecting bonding conductor from the MET, ensure that you have the permission beforehand as this may have safety implications)

Important

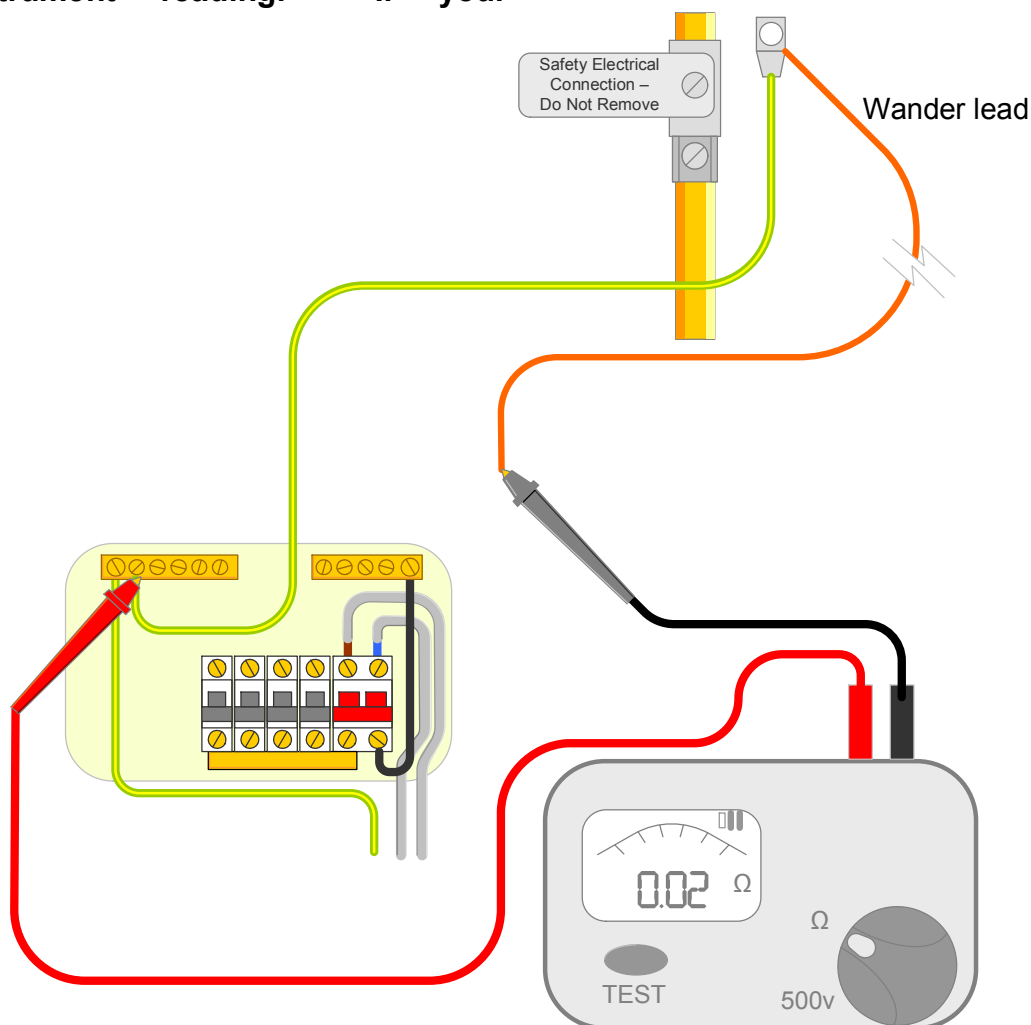
Null the leads. This is very important as the wander lead will add a considerable resistance to the instrument reading. If your

instrument does not have a null function, then simply subtract the resistance from the actual reading.

Step 2: Connect one end of the wander lead to the instrument and the other onto the bonding connection. The remaining end of the instrument can be then connected to the MET end of the bonding conductor.

Step 3: Remember to reconnect parallel paths.

This resultant reading can be recorded as the resistance of the cpc (R2) on the schedule of test results where the alternative method is used for final circuits.



Test Method 3

Test method 3 is used where a metallic enclosure forms all or part of the protective conductor.

It is highly possible that the protective conductor under test forms part of a steel conduit steel trunking or similar. If this is the case then a few problems arise.

Due to possible corrosion or loose joints, the protective conductor resistance could rise to unsafe levels.

Parallel paths will form if there is a separate cpc, this must also be taken into consideration.

Because of this there are 3 tests that can be carried out. Only one need be adopted, but they differ due to the difficulty of gaining an accurate reading and increasing severity with regard to current carrying capacity.

The 3 tests

1. A standard ohmmeter test as indicated in method 1 or 2 above. This will not exploit any high resistance joints in the enclosure, and if used after must be visually expected along the length of run.
2. Phase-earth loop impedance test can be carried out if it is thought by the inspector that the soundness of the system is questionable.
3. If the protective conductor is suspect then a high current test can be used of around

1.5 times the design current, with a maximum of 25A to be used. The resistance of the protective conductor can be calculated from

$$R_2 = \frac{V}{A}$$

The resistance between any extraneous conductive part and the main earthing terminal should be 0.05 Ohms or less; all supplementary bonds if required should also have the same resistance.

The maths involved in the test

When doing an inspection and testing course it is highly likely that you will encounter some form of maths involved while learning about the tests. At the end of the day, electricity is a form of Physics which deals with resistances voltages and currents. The duty holder whom carries out the inspection and testing must have a knowledge of why he/she is doing it, what to expect of the readings from the instrument and how to interpret these readings.

Below we will look at the maths involved with this particular test.

Prior learning

Before we start we need to familiarise ourselves with a table form GN3, page 107. This table is table 1A (can also be found in the onsite guide page 158 as table 9A)

The table given in the Regulations is extremely useful and will be used both in the exam and in other tests. It is a table of values for resistances of R1 and R2 and is measured per metre in milliohms (one thousandth of an ohm).

Some rows will have the resistance for R1 and some for just R2 and also for both, depending of the size of conductor. We are going to use this table for our calculations.

Q *“When conducting a Continuity of protective conductor test, what kind of calculations could we be asked?”*

Well let's take a look

1. The value of R2 can be found using a test result from method 1 above
2. The max Length & Actual Length of the circuit under test can be found when applying method 1 & 2 above.
3. Subtraction of the wander lead resistance form the reading in method 2