



# IN SERVICE INSPECTION AND TESTING OF ELECTRICAL EQUIPMENT

## THE EARTH CONTINUITY TEST

By John Ware

Electrical equipment must be maintained so as to prevent danger. The IEE's Code of Practice for In-Service Inspection and Testing recommends that maintenance of electrical equipment is carried out in four stages: Visual inspection, Test to verify earth continuity, Test to verify insulation, and Functional test. In this article we will discuss Class I equipment and the earth continuity test.

### Class I equipment

Class I equipment is defined as 'Equipment in which protection against electric shock does not rely on basic insulation only, but which includes means for the connection of exposed-conductive-parts to a protective conductor in the fixed wiring of the installation'.

Class I equipment includes appliances and tools and for such equipment protection against electric shock is provided by:

- (i) using basic insulation, and
- (ii) connecting metal parts to the protective earthing conductor in the connecting cable and plug and hence via the socket-outlet to the fixed installation wiring and the means of earthing.

The metal parts could assume a hazardous voltage if the basic insulation should fail.

Class I equipment may have parts with double insulation or reinforced insulation or parts operating in extra-low voltage circuits.

Where Class I equipment is intended to be used with a flexible cable, there must be a protective earthing conductor incorporated in the cable.

Class I equipment relies for its safety upon a satisfactory means of earthing for the fixed installation and an adequate connection to it, normally via the flexible cable connecting the equipment, the plug and socket-outlet and the circuit protective conductors of the fixed installation. See Figures 1 and 2.

The earth continuity test can only be applied to Class I equipment, extension cables or cords. Class I equipment is equipment that relies on a connection with earth for its safety (protective earthing) and/or needs a connection with earth for it to work (functional earthing).

Where protective earthing is provided, as is likely

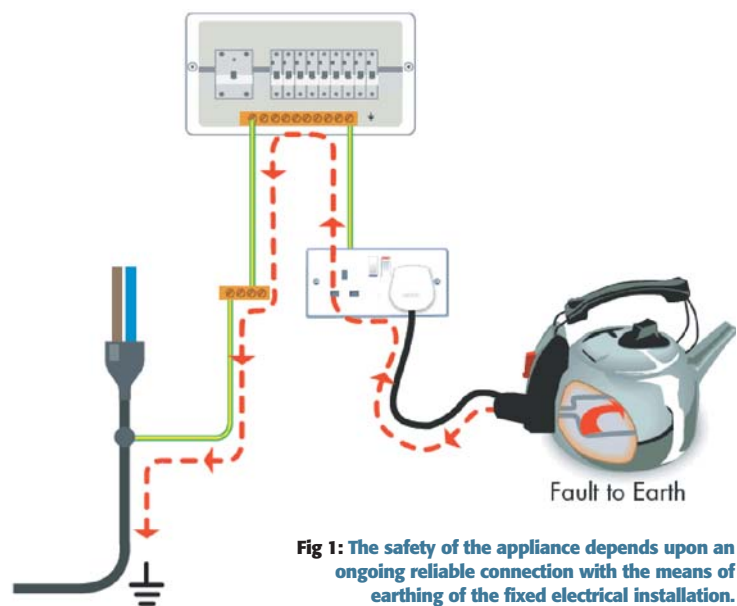


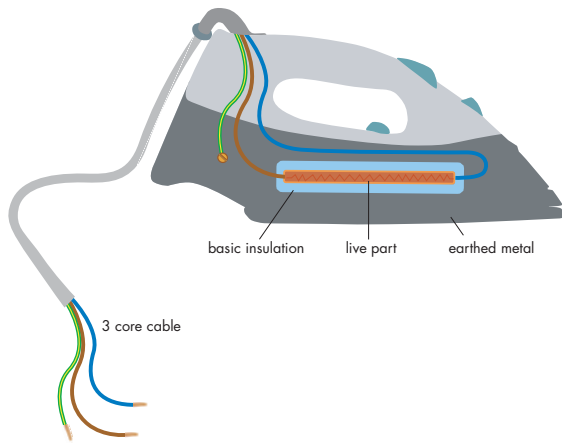
Fig 1: The safety of the appliance depends upon an ongoing reliable connection with the means of earthing of the fixed electrical installation.

for many household appliances, tools and luminaires, the earth continuity test is vital as the safety of the appliance depends upon an ongoing reliable connection with the means of earthing of the fixed electrical installation.

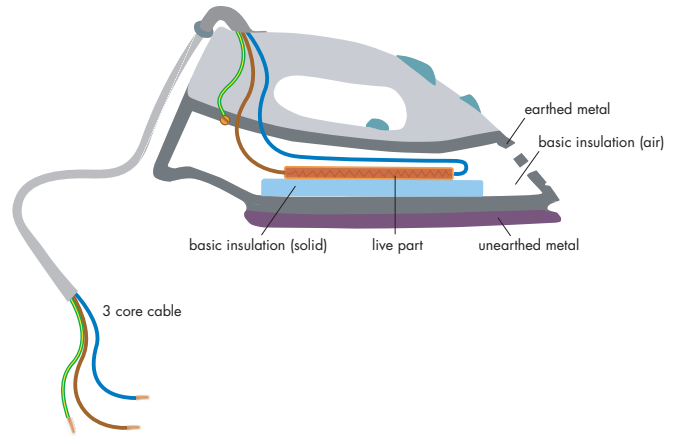
### The earth continuity test

One of the following two tests should be carried out.

- (i) A continuity measurement with a test current up to a maximum of the order of 25 A (The hard test). A continuity measurement should be made with a test current not less than 1.5 times the rating of the fuse and no greater than 25 A for a period of between 5 and 20 seconds.
- (ii) A continuity measurement with a short-circuit test current in the range 20 to 200 mA. (The soft test)



**Fig 2: Class I equipment showing basic insulation and earthed metal**



**Fig 3: Class I construction incorporating unearthed metal separated from live parts by basic insulation and earthed metal**

### Which test to perform?

Test (i) is the preferred test. It must be remembered that some electrical test equipment can apply tests which are inappropriate and may even damage equipment containing electronic circuits, possibly causing degradation to safety. If there is a possibility that damage may result due to the test current which can be up to a maximum of 25 A when Test (i) is used then Test (ii) should be performed. Metal-cased business equipment, such as a computer mainframe, is normally tested by using Test (ii) whereas an appliance such as an electric fire, washing machine or fridge normally should be tested using Test (i).

### Performing the test

The continuity test should be made between:

- All accessible earthed metal parts of the equipment (exposed-conductive-parts) and the earth pin of the plug for a plug-in appliance or

- The earthing terminal of the fixed wiring supply for equipment which is permanently-connected such as a hand drier.

Multiple continuity tests on a single appliance may be required.

Care must be taken that alternative earth paths are not provided by inadvertent contact or connection to other equipment which may provide an earth path e.g. via a signal cable. This would result in grossly false measurements.

The value of resistance measured should be observed while flexing the flexible cable at the points of entry to the equipment and to the plug. Any variation in the measured value should be investigated. The terminations should be inspected for any evidence of deterioration, poor contact, looseness, corrosion etc.

Some equipment may have accessible metal parts



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Tel: +44 (0)1438 313311 Fax: +44 (0)1438 313465

**Sales and Project Coordinator** L Hall +44 (0)1438 767351 lhall@theiet.org **Editor** G D Cronshaw +44 (0)1438 767384  
gcronshaw@theiet.org **Contributing Editors** J Ware, M Coles, J Elliott **Design** Sable Media Solutions

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which are earthed only for functional or screening purposes with protection against electric shock being provided by double or reinforced insulation. It is very important that these non-safety earthed metal parts are not subjected to the above test (i) otherwise damage may result. Connections may be checked using a low current continuity tester as in Test (ii).

Care should be taken to ensure that the contact resistance between the tip of the test probe and the metal part under test does not influence the test result.

The test should only be carried out for the duration necessary for a stable measurement to be made, and to allow time for flexing of the cable.

If the resistance of the protective conductor of the supply cord cannot easily be measured, Table VI (Appendix VI) (shown right) of the IEE's *Code of Practice for In Service Inspection and Testing* provides nominal cable resistances per metre length for various types of cable. The supply cord cross-sectional area must first be identified and the length measured. The resistance of the protective conductor can then be calculated.

Some portable appliance testers with go/no-go indication may fail cord-connected appliances with earth continuity resistance exceeding 0.1 ohm. If it is not possible to re-programme the appliance tester it will be necessary for a measurement of the actual resistance to be made with another instrument.

Figure 3 illustrates a Class I appliance with unearthed metal that may be in fortuitous contact with the earthed metal. A continuity test made to this 'unearthed' metal may give misleading test results. When considering safety, the 'unearthed' metal is not required to be earthed.

**The measured values**

The measured resistance should not exceed the values given in Table 1. In the event that a higher resistance is measured, the person testing the equipment will have to ascertain the reason for the elevated reading, decide if it can or should be corrected and, if not, decide if the appliance is safe for continued use. ■

For appliances with a supply cord	(0.1 + R) ohm where R is the resistance of the protective conductor of the supply cord
For appliances without a supply cord	0.1 ohm

**Table 1: Continuity readings**

**APPENDIX VI from the IEE's Code of Practice for In-Service Inspection and Testing: RESISTANCES OF FLEXIBLE CABLES**

Nominal resistances of appliance supply cable protective conductors (Figures are for cables to BS 6500 or BS 6360)

Nominal conductor csa	Nominal conductor resistance at 20 °C	Length		Resistance at 20 °C		Maximum current-carrying capacity	Max. diameter of individual wires in conductor	Approx. no. of wires in conductor
		m	m	mΩ	mΩ			
mm <sup>2</sup>	mΩ/m	m	m	mΩ	mΩ	A	mm	
0.5	39	1 2 3 4 5	1.5 2.5	39 78 117 156 195	58.5 97.5	3	0.21	16
0.75	26	1 2 3 4 5	1.5 2.5	26 52 78 104 130	39 65	6	0.21	24
1.0	19.5	1 2 3 4 5	1.5 2.5	19.5 39 58.5 78 97.5	29.3 48.8	10	0.21	32
1.25	15.6	1 2 3 4 5	1.5 2.5	15.6 31.2 46.8 62.4 78	23.4 39	13	0.21	40
1.5	13.3	1 2 3 4 5	1.5 2.5	13.3 26.6 39.9 53.2 66.5	20 33.3	15	0.26	30
2.5	8	1 2 3 4 5	1.5 2.5	8 16 24 32 40	12 20	20	0.26	50
4	5	1 2 3 4 5	1.5 2.5	5 10 15 20 25	7.5 12.5	25	0.31	53

The Table gives figures for the nominal resistance of the protective conductor per meter length and for various lengths of cable that may be fitted as supply leads to appliances. Once an Earth Continuity Test has been performed the approximate resistance of the protective conductor can be found and deducted from the test result to give an accurate figure for the earth continuity reading of the appliance. Note: 1000 milliohms (mΩ) = 1 ohm (Ω)